DOBRICH
Bulgaria

HYPOGEA
3rd International Congress of Speleology in Artificial Cavities 2019

PROCEEDINGS OF INTERNATIONAL CONGRESS OF SPELEOLOGY IN ARTIFICIAL CAVITIES

DOBRICH - BULGARIA - MAY 20-25 2019

Bulgarian Caving Society
Българско пещерно дружество

PROCEEDINGS OF INTERNATIONAL CONGRESS OF SPELEOLOGY IN ARTIFICIAL CAVITIES

HYPOGEA2019

Dobrich, Bulgaria, 20-25 May 2019

Proceedings of International Congress of Speleology in Artificial Caves

HYPOGEA2019

Dobrich , Bulgaria , 20/25 May 2019

Editors

Alexey Zhalov, Vanyo Gyorev, Peter Delchev

Scientific Committee

Mario Parise, Boaz Zissu,Carla Galeazzi, Alexey Gunko, Bogdan Ridush ,Carlo Germani ,

Kamen Bonev, Laurent Triolet ,Magdalena Stamenova , Nodar Bakhtaze , Valeri Kinov

Organization Committee

Alexey Zhalov,Yordan Yordanov, Carla Galeazzi, Mario Parise,

Dobri Dobrev , Kamen Bonev, Valentin Pletnyov , Valeri Kinov , Vanyo Gyorev

Graphic Design

Alexey Zhalov, Vanyo Gyorev, Peter Delchev

Photos

Front Cover: Konstantinos Bakolitsas , Qanat of Bulgarain Monastery, Athos, Greece

Back Cover: Alexey Zhalov, Millstone Quarry , Varna, Bulgaria

Patronages and Sponsors

UIS, International Union of Speleology

FSE, European Speleological Federation

Hypogea Federation - Italy

Municipality of Dobrich

Bulgarian Caving Society

Regional Museum of History - Dobrich

Varna Archaeological Museum

Rousse Regional Museum of History

ISBN 978-619-7526-01-1

HYPOGEA

ROUSSE REGIONAL MUSEUM OF HISTORY

Varna Museum of Archaeology

Table of Contents

The international congresses Hypogea/UIS 2015-2021
PARISE Mario , VOLPINI Elena Alma, GALEAZZI Carla I

TYPOLOGIES, SYMBOLS_ TERMS AND CADASTRE OF ARTIFICIAL CAVITIES

Cave settlements in southern Apulia. DDACO – the dynamic database of the artificial caves of Otranto
CALO Stefano, MARTELLOTA Mariangela 1

HYPOGEAN CIVILIAN DWELLINGS

Tunnels of awe, justice and freedom: underground structures in modern literature
CANAVAS Constantin ..... *7.*

The patterns of development of cave shelters in Cappadocia
BOBROVSKYY Tymur, GREK Igor .... *12.*

Orte (vt) – a complex hypogean heritage. New acquisition data
PASTURA Giancarlo , TESSICINI Letizia ....*21.*

Artificial cave shelters of the Phrygian highland (Turkey): defensive devices and principles of organisation
BOBROVSKYY Tymur, GREK Igor, SHIROKOV Mykhailo .... *28.*

Inventory and analysis of underground oil mills in the territory of Lecce (Apulia, Southern Italy)
MARGIOTTA Stefano, MARTELLOTTA Mariangela , PARISE Mario ....*33.*

Rock settlements on vertical cliffs in Matera
DELL'AQUILA Franco, FOSCHINO Francesco, PAOLICELLI Raffaele ....*39.*

Ancient man-made rock structures along the Black sea coast of Dobrudzha
SALKIN Asen ....*45.*

Excavations and surveys of underground cavities at Hurbat husham, Judean foothills
KLEIN Eitan, ZISSU Boaz..... .....*51.*

GEOLOGY, GEOMORPHOLOGY, ENVIRONMENTAL HAZARDS

Natural radioactivity in some caves of the Vayots Dzor province, Armenia
ALBOV Dmitry , GASPARYAN Boris .... 57.

Knowing the underground, as the first step for hazard management: an experience in southern Italy, in the aftermath of a catastrophic collapse
PARISE Mario , DERAZZA Aniello , GARZIANO Giuditta , GENTILE Mimmo, LANGA Francesca, SANNICOLA Gianclaudio, Samantha, SANTARCANGELO , VIVA Marco ..... . 59.

The new policy of the government of the Armenia on protection of underground cultural and natural monuments
SHAHINYAN Samvel .....65.

RELIGIOUS STRUCTURES

Underground complex of Pskovo-pechersky dormition monastery (Pskov region, Russia)
AGAPOV Ilya ..... 69.

Central complex of Gochants cave monastery
GUNKO Alexey, KONDRATEVA Sofia, SHAHINYAN Samvel ....75.

Rock-cut caves of medieval Orhei (Republic of Moldova)
RIDUSH Bogdan, BOBROVSKI Timur, GHEORGHE Postica ……...…… 83.

Hypogea of San Pietro in Vincoli at Sant'Angelo in grotte
CARNEVALI Laura, CARPICECI Marco , ANGELINI Andrea …… ……88.

Crypta Neapolitana (Naples, Italy) A multidisciplinary underground heritage site
FERRARI Graziano , LAMAGNA Raffaella, ROGNONI Elena …….. ……94.

Cave complex in Valuiki
GUNKO Alexey, KONDRATEVA Sofia , GUNKO Alexander ……... ……100.

Creation of new map documentation of the rock cloisters on the periphery of Shumen's plateau 2012 - 2019
STOICHKOV Konstantin …… ……106.

Via Crucis in the caves of Divnogorsky monastery in Voronezh region, Russia
STEPKIN Vitaly …….. ……110.

Architectural peculiarities of religious cavities complex in the Ihlara valley (Cappadocia)
IANOVSKAIA Ekaterina …… ……116.

Cave necropolis in the vicinity of Kizilin village, Adiyaman province, Turkey
ZHALOV Alexey , STOICHKOV Konstantin …… …… .121.

Underground explorations at Horvat Qasra, southern Judean foothills, Israel
ZISSU Boaz, KLONER Amos ……..…… 125.

New considerations on the architectural structure of the Vardzia rock-cut ensemble and peculiarities of t he ongoing monastic life
BAKHTADZE Nodar …….. ……131.

HYDRAULIC UNDERGROUND WORKS

The resurgence near Yarimburgaz cave
Şengül G. AYDINGÜN, Haldun AYDINGÜN, Metin ALBUKREK, Gülşen ÜSTÜN, Berk ÜSTÜN…..……139.

The artificial drainage system of Gabii (or Castiglione) lake in Latium, Italy. A comparison among the I nvestigations of the '90s and a recent study aiming at a possible restoration of the Old lake basin
CALOI Vittoria , GERMAN Carlo, GALEAZZI Carla …… ……...143.

Water itakes and sewrage facilities of Bulgarian St.George the Zograf monastery in Mount Athos, Greece
ZHALOV Alexey, STOICHKOV Konstantin ……..……149.

MINING WORKS

Iron hearth: the re-exploration of the old mine "Manina" (Italy)
BELVEDERI Giovanni, GARBERI Maria Luisa …… ……154.

Sasso rancio: an iron mine on Lake Como (Italy)
FERRARI Graziano, ROGNONI Elena, BELVEDERI Giovanni, GARBERI Maria Luisa……. 160.

Underground limestone quarries in Tula region, Venyov district (Russia)
GARSHIN Dmitry, GARSHINA Yulia, STRUKOV Stanislav, DOLOTOV Yury……. 166.

Limestone mines nearby village Maleevo Ryazan region
LEONTEV Michael …….. ……178.

The geosite of Tabuna and Streppenosa asphalt mines (Ragusa, South-east Sicily)
RUGGIERI Rosario , TRICOMI Salvatore ……. 181.

The problem of abandoned mines – only hazards? A case study from the Nízký jeseník upland (Czech)
SCHUCHOVÁ Kristina , LENART J., FALTEISEK L., BÍLÁ J., KUPKA J. …….. ……..186.

MILITARY AND WAR WORKS (DEFENSIVE)

Second world war air-raid shelters in genoa (Italy): knowledge, protection and use of an underground historical and cultural heritage in urban environment
BIXIO Roberto, FACCINI F., PERASSO L, PIANA P., SAJ Stefano., TRAVERSO M… ……. ……..191.

Underground Military Objects in Serbia
MILOSAVLJEVIC Nemanja ……..…….. ……197.

***

The Rock-hewn Churches of Ivanovo are a group of monolithic churches, chapels and monasteries hewn out of solid rock and completely different from other monastery complexes in Bulgaria, located near the village of Ivanovo, 20 km south of Rousse
The monastery complex owes much of its fame to 13th- and 14th century frescoes, preserved in 5 of the churches, which are thought of as wonderful examples of Bulgarian mediaeval art . UNESCO World Heritage Site .

***

AS A FOREWORD

THE INTERNATIONAL CONGRESSES
HYPOGEA/UIS 2015-2021

Mario PARISE, Elena Alma VOLPINI**, Carla GALEAZZI****
** President of UIS Commission of Speleology on Artificial Cavities*
*** President of HYPOGEA*
**** Secretary of UIS Commission of Speleology on Artificial Cavities*

UIS International Union of Speleology is the world reference organization for the scientific speleological activities, formed in 1965, counting members from all continents, represented by a delegate from each country (this delegate acts as the representative of all the country's cavers and speleologists). An elected Bureau runs the affairs of the UIS between the once-every-four-years General Assembly meetings held at the International Congresses. The actual speleological work of the UIS is done by the members of its Commissions and Working Groups, which are open to everyone who is interested.

The Commission on Artificial Cavities is a part of the Department of Scientific research at UIS. The updated members of the Commission belong from the following countries: Australia, Belgium, France, Great Britain, Ireland, Israel, Italy, Netherlands, Portugal, Russia, Turkey and United States of America.

HYPOGEA Research and valorization artificial cavities is a Federation of Associations: ASSO, Egeria Centro Ricerche Sotterranee e Roma Sotterranea. The three organizations joined together to combine and integrate their respective areas of expertise in the knowledge, preservation, management and protection of the Italian underground cultural heritage.

Cooperation between UIS Commission on Artificial Cavities and Hypogea Federation was very useful for sharing studies in artificial cavities at the international level. Hypogea2015, the first International Congress of Speleology in Artificial cavities took place in Rome (Italy); Hypogea2017, born of the same collaboration, was held in Cappadocia (Turkey) and today, in Bulgaria, we are celebrating the third international appointment: Hypogea2019.

The main goal of the Hypogea/UIS Congresses is to continue the exchange of experiences acquired at the international level in the field of artificial cavities, also in conjunction with the other activities of the UIS Commissions.
So, the story does not stop here… which destination will host the next Hypogea2021 congress?

CADASTRE OF ARTIFICIAL CAVITIES

CAVE SETTLEMENTS IN SOUTHERN APULIA. DDACO – the DYNAMIC DATABASE of the ARTIFICIAL CAVES of OTRANTO

Stefano Calò [1], Mariangela Martellotta [2]

[1] Gruppo Speleologico Leccese 'Ndronico, Via Regina Isabella, 1, 73100 Lecce (LE)/Federazione Speleologica Pugliese, c/o Museo F. Anelli 70013- Castellana Grotte (BA), calostefano@hotmail.it, [2] Gruppo Speleologico Leccese 'Ndronico, Via Regina Isabella, 1, 73100 Lecce (LE)/Federazione Speleologica Pugliese, c/o Museo F. Anelli 70013- Castellana Grotte (BA), mariangelamartellotta@yahoo.it

Absrtact

The cave settlements phenomenon in Southern Italy show cultural similarities with those present in several other Mediterranean countries. In Salento (Apulia, Southern Italy), there are several types of cave settlements: from small villages (composed by few units), to underground churches, to complex rupestrian villages, many of them showing common features with the *sub-divo* settlements. The inhabited areas in cliff of the sub-region of Salento develop him with some meaningful cultural expressions that are noticed both in the zone of "SerreSalentine" that in the oriental areas. The spectacular Italian rocky landscape which best testifies the ancient relationship between man and nature of southern Italy, Otranto, cultural heart of the East Salento, has been object of an analytical and systematic investigation that has brought to the census of the numerous rupestrian hypogea and it has contributed besides to define the civil character of an ample settlement revealed him partly similar, in the organization and in the structure, to the urban inhabited areas. The gotten data are also inserted in an useful database for the realization of projects related to the guardianship and to the exploitation of the territory through the creation of forms of sustainable eco-tourism.
Aim of this paper is to study the rupestrian landscape of Otranto, Eastern Salento, where a systematic analysis has contributed to construct a register of all cave units. To this day has been registered in the regional cadastre of caves over 140 hypogea of which a part has become object of study for close examinations, seen their peculiar characteristics. Besides the single caves, during the exploratory and documentation step, edited by speleo-archaeologists, are picked up data in field relative also to characterizing elements of the rupestrian landscape, traces of anthropization to unearth through the involvement of experts of geology, archaeology etc., actual natural phenomena and signs of the environmental conditions and the landscape changes (today above all agrarian). We have realized there that just with a work documentation could be aspire to something that was not a job "static" but a project "dynamic": first of all something that could involve the same city of Otranto and to widen its tourist perspectives on one side and to guarantee its preservation of the historical identity from the other.

Keywords

Cave settlements, Apulia, Otranto, eco – tourism, database

1. Introduction

DDACO project – "DYNAMIC DATABASE of the ARTIFICIALS CAVES of OTRANTO", coordinated by two speleologists that in the life they respectively deal him withArchaeology and of Architecture, he has taken the movements from a job undertaken in 2012 on the study of some rocky installations of Southern Apulia.

Before it spoke of villages and rocky settlements in Apulia, the scientific interest for this phenomenon it was focused on the analysis of the church-crypts.

Those that was evaluated mostly worthy from the artistic and architecturalpoint of view, they were object of a study and an academic orientation extremely shallowand end an ends to in themselves that, beginning from the end of the Nineteenth Century, it saw the diffusion of the vision "*panmonastica*" according to which all the demonstrations of Byzantine art in rocky environmentother they were not that the consequence of the cultural importation operated by the italo-Greek monks, come in italic territory during the persecutions iconoclasts.
According to this orientation all the caves and the hypogea were considered unquelyas"hemitagecrypts"and monastic installationsand it were begun to define them indiscriminately and wrongly "basiliani" (*Gabrieli, 1936; Medea, 1939*).

Among the years Sixty and Seventy of the 20th Centuryit were begun to speak of rocky settlementswith civil characteristics, moving in this way the attention from the religious sphere to that laic and showing as these settlementswere the expression of a housing tendency not necessarily tied up to the monastic phenomenon.(Fonseca, 1970-1975).

Despite the meaningful goalsreached , the searches on these rocky settlements don't use yetcomplete and systematicinvestigationsneither topographical neither archaeological. In accordance of this was initiated an analytical study that has allowed to analyze the already known system in cliff of Otranto (Lecce). (Fonseca et al., 1979).

A systematic investigation in the valleys of Otranto, that lasted 6 years, hehas allowed to survey a rocky habitat made up of 154 caves, for the 90% of artificial origin and

only in least part of natural origin, but with important anthropic tampering.(Calò 2018).

In the wake of the debates on the sense of the territorial history and about his formalities of study and sharing risen then within the constituting multidisciplinaregroup of job(that during the years has given the contribution for some publications and stackings of the hypogea of these places)a project has been formulated, first of all, to individualize and to surveythe available historical sources on and in the territory of Otranto; then to elaborate a system of cataloguing and search that it connected these sources among them.

hypogeain the Momories Valley 46 artificial caves are been identified; shed on more levels and with various morphology among which it has been possible to recognize residences, factories, service's areas and religious places. The various hypogea are homogeneously distributed along the slopes of the valley.

The Hydro Valley has developed in South-Ouest direction than that the city and its morphology is marked by the homonym river; its extension overcomes of few the 3 km^2 and the greatest elevation, of around 50 metres above sea level, it's reached on the zone of Saint Angelo Mount, in the area of Uggiano la Chiesa.

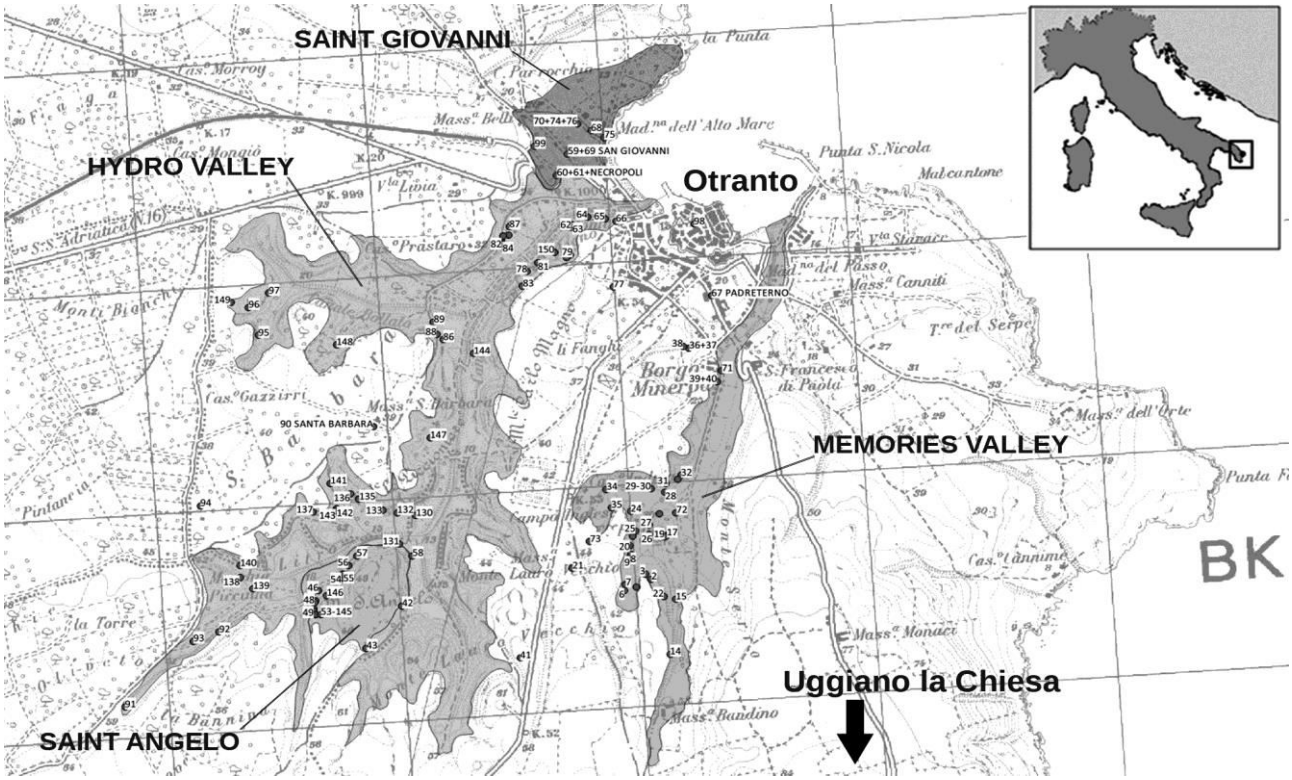


Figure 1. The territorial area of study.To the left, the Hydro Valley; to the right, Memories Valley.

Gives the necessity to work, at least for a first phase, on a circumscribedcase study, treating itself of a project-pilot, DDACO is geographically limited to the zones of the rocky settlement between Otranto and Uggiano la Chiesa, also being adoptablein any other territorial context.

The product of this idea, in progress of development and improvement, it is a multi-informative webGIS that he will go to illustrate in its essential lines.

2. General lines of the structure of the rocky landscape in the Hydro Valleyand in the Memories Valley

The Memories Valley, circumscribed from three small hilly areas, does not show obvious complexities and has an extension of 1,5 Km^2, with an elevatrion of 50-60 metres above sea level. The rupestrian units appear already to the limits of the city area, and earlier studies had also show the existence of other hyopogea and caves destroyed frome the urbanizations phases. (Gianfreda 1989, pp. 138-139).

Despite the morphological affinities of these little

In this whole area 108 rupestrian unities have been currently identified, organized on more levels again. Also in the Hydro Valley, as for that of the Memories, the morphology of the caves is various and we finds again underground spaces used both as residences and as factories or with other destinations to which systems are added for the water catchment and transformation and production of the resources. The only place of worshipidentified in this zone is set on the western side of S. Angel Mountain and it is the homonym rupestrian church (currently listed with n. 45 – Fig. 1).

Despite the morphological affinities of these little hypgeawith those of the Memories Valley, in that of the Hydro Valley we don't find again the same homogeneity in the displacement. Along the two slopes borderingthe river the various caves they find themselves in small cluster, and it is difficult to say, at the moment, if everybody these groups of caves are inhabited clustersor if indeed belongs to an only settlement.The whole system of the artificial caves can be defined a settlement articulated and inhabited in different moments. The most recurrent type is the hypogea with one single cell having quadrangular, rectangular, elliptic or semicircular layout.

In more than a case it was foudthe presence of a pillar or a wall that separates two environments, perhaps destined to a different uses andthat it can be found again in recurrent way in other rupestrian sites of the Southern Apulia. Only in few cases the presence of a more articulated layout has been identified: these are formed sometimes from compartments – habitable or not – and referable to examples already classified(Caprara-Dell' Aquila 2004; Sammarco et. al., 2008). (Fig.2)The inside of the artificial caves has a simple structure;usuallyit's found the presence on the ceilings of holes used as air vents or hearths, and of niches of different sizes and formon the walls.Where are the presence of zones destined to the rest has been foreseen,there are some beds dug or graven, or organized in the parts defined from the dig of the cave (Cfr. Caprara-Dell'Aquila 2004; Calò 2015a-b).The functions of all these artificial caves (and even of the natural caves) is various and not yet identifiable with certainty. In addition to the residences, that are characterized sometimes by the presence of sheepfolds, there are stalls, caves with cellars and underground chambers that could also have had a sepulchral destination, at least in origin.(cfr. De Mitri 2010, p. 93).Among the artificial caves that have been identified and registered for sure, the dovecots very interesting , used for the breeding of the pigeon, and between these two categories have been identified: the dovecot to hypogea-room and that to wally.(cfr. Antonaci 1974, p. 124; Fonseca et al. 1979, p.136; Calò-Santucci 2017; Rossi 2012).

The valleys, in relationship to the evidences, they appear as a housing system organized in at least two villages.The various levels on whose the caves (artificial and natural)are distributed they are terraced and connectedwith the a visible system formed by paths, ramps and dug staircases.

Besides it seems, that the installations in matter are also interested from an ampler and more ancient road system (De Ferraris 1558; Uggeri 1983, pp. 287 e 308; Calò 2018).

Apart from the dovecots, other artificial caves have been recognized as shops and oil mills, in which productive activities was practised tied up to the rural economy of the territory. (Uggeri 1979; Fonseca et al., 1979, p. 146).In the two valleys three rupestrian worship buildings have been identified. They are three churches that during the Middle Ages – and also in the following epochs – have constituted the religious center and of aggregation of the communities that have lived these settlements..All these rupestrian churches, found in very distant points the one from the others, they are very probably been commissioned by private clients; in fact the church of the Padreterno (cave n.67) it is set out some ancient urban center of Otranto; the *Saint Nicola Churh*(cave n.12)is found in the heart of the Memories Valley and the *Saint Angelo Church*(cave n.45) dominate the homonym mount on the Hydro Valley(Calò 2018 and relative biography).

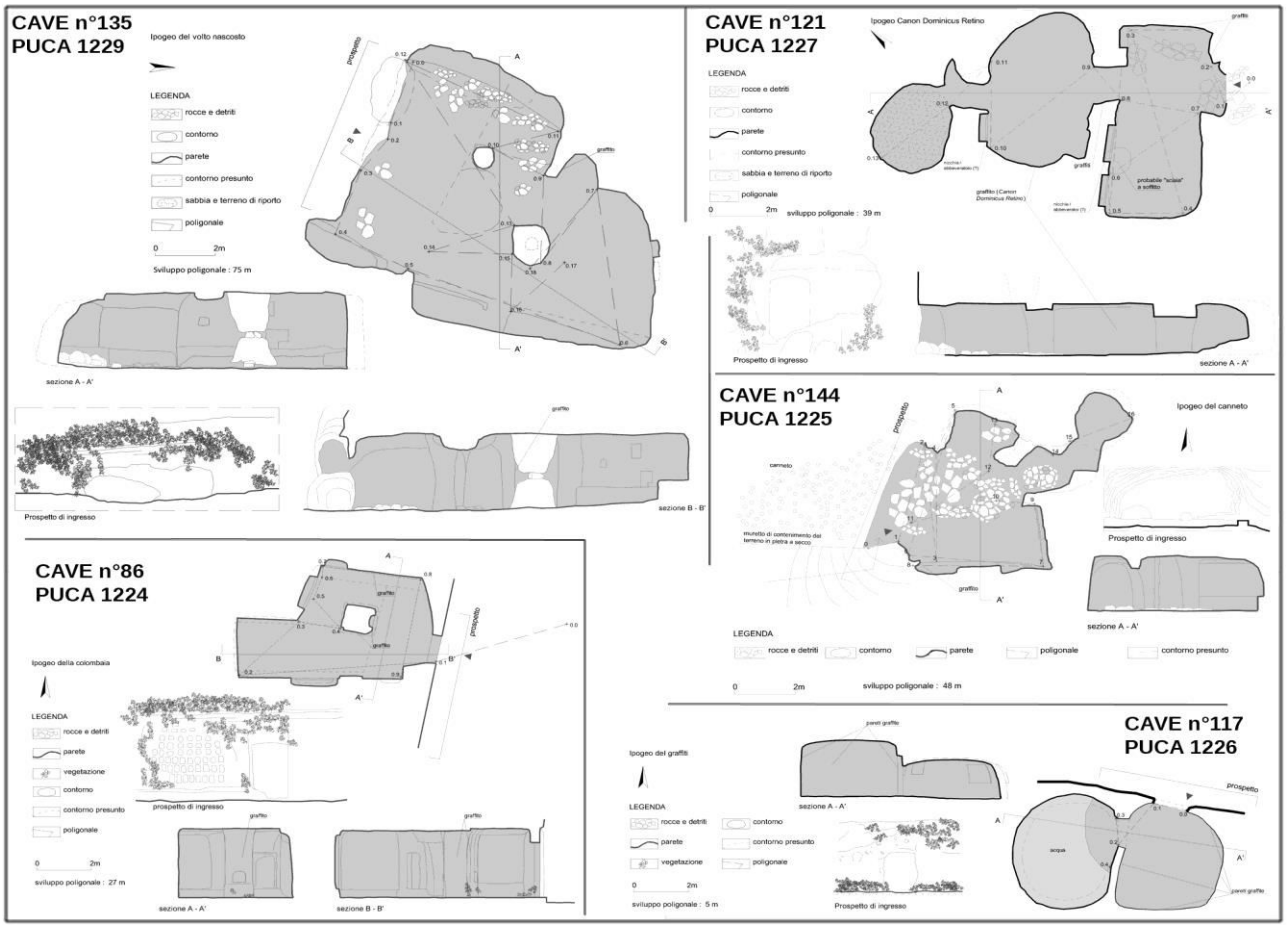


Figure 2. The topographical relief, of some artificial caves, in one of the exploredrupestrian site. The first number is the code of DDACO database; the second is the code of speleological cadastre of Apulia (http://www.catasto.fspuglia.it/)

understand the density of the investigated rupestrian settlements, unfortunately it has not furnished enough chronological data:above all because of the lack of superficial anthropic material (ex. ceramic relics) on around the 80% of the investigated areas.

The sampling of the picked material allows only to have some circumstantial evidencearound the possible acquaintances of the various caves that cover an arc of very ample time that goes from the late Roman age (IV-V sec.) to the full Middle Ages(IX-XIII sec.), up to the centuries XV-XVIII (Arthur 1992 a-b: D' Andria 1996; De Mitri 2005-2010; Leo Imperiale 2001; Tinelli 2006).

3. General nature of DDACO system

The typologies of sources merged in the database are seven: bibliographical, archival, historical-cultural, photographic, speleo-archaeological, topographical, environmental (comprehensive the geology). In order to wield its massive structure potentially endless, it has been chosen an approach which provide a progressive individualization from the general to the particular, and what therefore it considers the understood sources both singly and as a part of data sets and subsets.The general architecture of the database reflects this criterion of individualization through three levels of close examination, to each of which it corresponds a specific cataloguing. The form of first level picks up the relative information to all sources typical of the cadastre of the caves (cartography data, geological informations, speleological data,etc...). (Fig. 3).

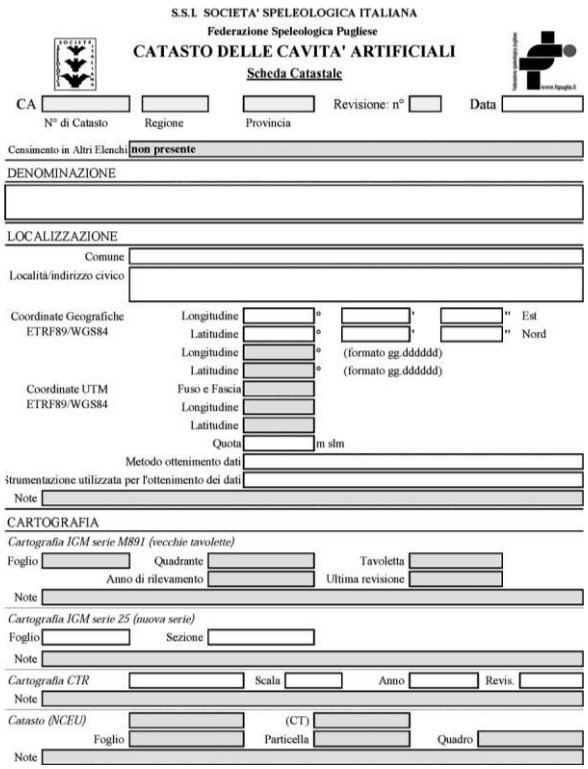

S.S.I. SOCIETA' SPELEOLOGICA ITALIANA
Federazione Speleologica Pugliese
CATASTO DELLE CAVITA' ARTIFICIALI
Scheda Catastale
CA N° di Catasto Regione Provincia Revisione: n° Data
Censimento in Altri Elenchi non presente
DENOMINAZIONE
LOCALIZZAZIONE
Comune
Località/indirizzo civico
Coordinate Geografiche ETRF89/WGS84 Longitudine Latitudine Est Nord
Longitudine Latitudine (formato gg.dddddd)
Coordinate UTM ETRF89/WGS84 Fuso e Fascia Longitudine Latitudine
Quota m slm
Metodo ottenimento dati
Strumentazione utilizzata per l'ottenimento dei dati
Note
CARTOGRAFIA
Cartografia IGM serie M891 (vecchie tavolette)
Foglio Quadrante Tavoletta
Anno di rilevamento Ultima revisione
Note
Cartografia IGM serie 25 (nuova serie)
Foglio Sezione
Note
Cartografia CTR Scala Anno Revis.
Note
Catasto (NCEU) (CT)
Foglio Particella Quadro
Note

Figure 3. A part of the filing type of 1th level, using the model for the cadastre of artificial caves of Italy, edited by Commissione Nazionale Cavità Artificiali.(source *http://catastoartificiali.speleo.it/applications/1.0/docs/SSI/Scheda_ca_nazionale.xlsx.)*

The charts of 2th level classifies the unities contained in such data sets : functional typologies, constructive typologies, actual uses, etc…. Some typologies of sources have asked besides for the elaboration of a third level of detail examination to understand theevolution of the whole settlement and not only of the single cave-element (archival fund, a scientific essay, an archaeological study, old road connection, system of provisioning of the water etc...).

4. Technical aspect

4.1 Data links

In accordance with the multidisciplinaryvocation of the project, the two administrators have tried to underline the existing connections among the various cards and to immediately make them "navigable" so much in vertical direction(what allows to cross the various levels of close examination), how much in transversal direction(putting therefore in communication among them cards related to sources of different type). In every cataloguing chart they have been in fact predisposed some special fields to contain the links that directly open both the belonging cards to the same one "typology" (those of superior and/or inferior level), and the cards of sources of other nature, but thematically similar.

4.2 Geographic dimension

In order to exploit to the best the potentialities of the webGIS, the cards contain two different types of geographical data: the location (thopographic punctually data) and the area of interest (data as areale).The location is a datum-point: it points indicate the actual physical location of the source or its place of maintenance (to es., the center of a crypt, of a cave, etc...). Different it is for the area of interest, with which he intends the geographical area subtended to the information of which the source or the whole sources are carriers (a graffito that describes the path of a native inhabitant of the settlement toward a sacred place, will have for instance, this last as area of interest and the cave with the graffito engraved as location). (Fig. 4).

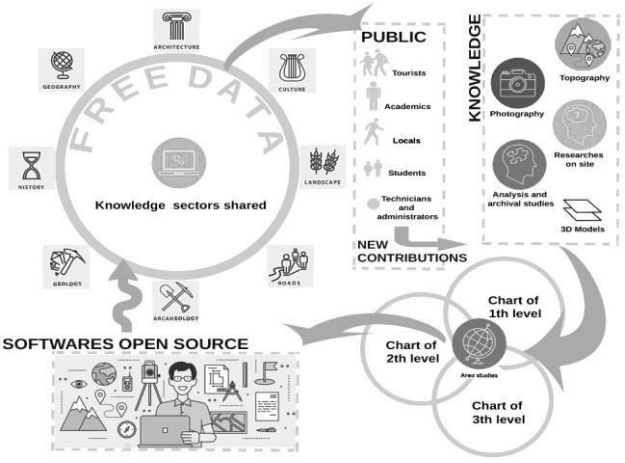


Figure 4. The relational structure of DDACO database, according to the principle of the "circular knowledge".

Besides every source can be connected to more areas of interest: taking back the last example, the descriptions of the graffiti that concern trips will contain information on various places and as many therefore will be the areas

connected to the filing chart.The different nature of the sources has involved the use of different geometric forms to point out the areas of interest: this way the area of interest of a road will be a polilinea; that of a photo, instead, a triangle that represent the visual range of the image; that of an archival site, will be expressed instead by a rectangle, correspondent to a portion of territory (more or less wide); that of an speleological emergency will often coincide with the point of entry to a cave and so on.

4.2 Historical dimension

Further fundamental characteristic of the webGIS is its historical dimension: every area of interest not only expresses the geographical context of which it speaks one determined source, but also the temporal position of this last.The case of the bibliographical sources and archivistiche, but above all the reasoning to in retrospect made on the base of the explorations in field, it was inspiring above all in such sense, because thanks to their intersection in phase of analysis it has been possible to consider the chronological circle of the treated matters For instance, the chronology of an archival source published to the first years of the '900 regarding the census of underground quarries, or that of a document recorded in the 16th century on the same matter, must include the period of use of a zone for the extraction of stone material. In other words “the object” of the informations, and not simply the date of publication of the source of file or recording of the document.Only in this way, in fact, the examples brought here can be connected, in the optics of a chronological search, with the archival sources, photographic, historical-cultural, archaeological, and going up again quant'altro to the same historical period.

4.3 Software

The whole system will be entertained on server devoted with an ability esteemed since 4 to the 8 Gb of memory. The spatial data management are submitted to QGis Desktop and Global Mapper. The heart of the system is represented by the database (in phase of implementation) published on base QGIS Cloud to powerful Web-GIS platform for publishing maps, dates and services on the internet, creating and editing professional maps with all the capabilities from QGIS (Fig. 5).

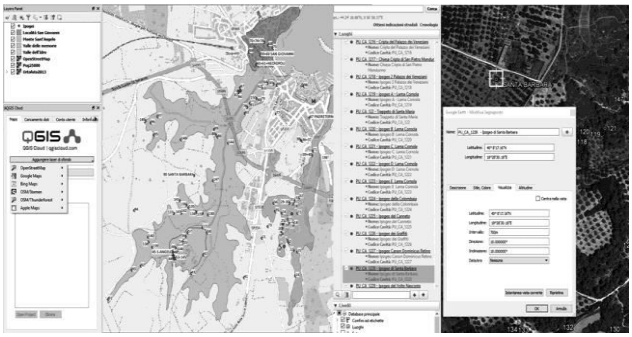


Figure 5. The WebGIS interface that constitutes the multipurpose map of DDACO project.

The web interface is in phase of creation with the aid of the base of "personal publishing" Wordpress and the aid of HTML and CSS3 as it regards the graphic part. For the management of the maps it was chosen to use a bookstore OpenLayers, integrated with functions written to hoc, also to facilitate both the job of the compilers, is the interaction of the external users.

5. Focus of the work

The aim of the project is to make public, understandable and useful for various purposes -from the tourist to the didactic one- information on the new discoveries made on rock settlements unknown even to the locals. The purpose of the dissemination of information is to create a network of circular knowledge that serves to protect the rupestrian heritage, to promote the territory of Otranto and to raise awareness of the historical-cultural data thanks to the help of Speleo-Archaeology.

Figure 6. An image inside one of the hypogea (cave n. 135) piled up at the Cadastre of Puglia’s Caves (PUCA 1229). (Ph. credit: M. Martellotta)

6. Some thoughts on the historical-territorial sources and on the free data

These years of job have been rich of trials. While has been established the logical-linguistic system of the database through hypothesis gradually improved, correct or tested with the practice, a common platform was built to share common information among different (history, history of the art, archaeology, archivistica, oral history, history of the material culture) disciplinary methodologies. Parallelly, the project focused on the formulation of a code that could have resolved the well known problems of "translation" of concepts belonging to the humanistic disciplines in computer language, like the chronological data or geographical coordinates of the historical sources, without losing sight of the necessity to create a research tool, inside an enormous mass of information and correlations, the easiest and intuitive possible.During such run the stimulus offered by the job have been numerous. Here we would want at least to detain us on the territorial dimension of the project, in an optics of sharing of data.The common denominator of the seven typologies of sources met in the database is the fact that they have been taken in consideration as historical-territorial sources.If for all the material sources (speleo-archaeological, environmental, etc...) the characteristic of "territoriality" it is clear - in the sense that the same nature of the source, revealing itself through a concrete and tangible testimony, it makes immediate the relationship with the territory- the other types of sources (archival, bibliographical, photographic, topographical, historical-cultural immaterial,) impose a further reflection. During the approach to the territory through the speleo-archaeological recognition, we have used what is considerabile as

"residual materiality of that that we are observing": an useful piece to represent a disappeared element and therefore material. In other words it has been reconstructed "an image" of a reality on a territory. The meaning is really in this trace: for how much our data could be material, the relationship that they establish with the territory is related to a representation of the same. From this perspective, the sources of any other nature they can be bearers of historical-territorial information: also a story, a missive, a notarial action – just like the archaeological find – they compete to draw an image of a territory as it has been once.Unlike the majority of the present free data online (often drawn by the simple reading of a tool: one thinks for instance, to the meteorological data), the historical data must be interpret firstly. It must be kept therefore in mind that a project of census as "DDACO" it implies some operations: the selection, the reading, the description of the filed sources. They all are also it departs of a process of mediation and interpretation.

7. Conclusions

The most important results emerged by the systematic investigation have shown and confirmed the civil and secular character of the whole area rocky settlement, often considered wrongly center of a monastic community. Besides, on the base of the structure and the diffusion of all the caves, these installations appear very similar in the establishment to the installations *sub-divo*.The publication of these data, is directed to satisfy a triplex requirement: on one side, the respect of the methodology and the criterions of filing system elaborated by every of the involved disciplines; from the other side, the necessity to make sure that a free datum is always able, in general, to have dialogue - to be related in other words - with other free data; and last but certainly not least, the possibility of updating and implementation of the information contained in the database

Acknowledgments

A special thanks to all the members of "GSLN - GruppoSpeleologicoLeccese 'Ndronico" that they have taken part to the explorations and the speleological activities in this years. Sincere thanks also to all the owners of the funds, met during these years, that have allowed us the investigation in their estate.

References

Antonaci A. 1974. Otranto, cuore del Salento, Galatina.

Arthur P. 1992. La produzione di anfore Bizantine, in Arthur P. et al., Fornaci altomedievali ad Otranto. Nota preliminare, in Arch. Med., XIX, pp. 103-110.

Arthur P. 1992b. Amphorae for Bulk transport, in D'andria F., Whitehouse D. (a cura di), Excavations at Otranto. Volume II: The Finds, , Lecce, p. 199-217.

Calò S. 2018. Gli insediamenti rupestri nelle valli di Otranto, in Sogliani F., Gargiulo B., Annunziata E., Vitale V. (a cura di), VIII Congresso Nazionae di Archeologia Medievale, chiesa del Cristo Flagellato 8ex Ospedale di san Rocco), Matera, 12-15 settembre 2018, vol. 3, sez. V, pp. 247-252.

Calò S. 2015a. Cave settlements in southern Apulia. Rupestrian evidence in the valleys of Otranto, in Proceedings of Hypogea 2015, Int. Congress of Speleology in Artificial Cavities -Rome (Italy), March 11-17, pp. 30-40.

Calò S. 2015b. Paesaggio di pietra. Gli insediamenti rupestri delle serre salentine, Roma.

Calò S., Santucci E. 2017. Hypogea with niches of southern Apulia. Examples of rural economy in medieval cave settlements of Salento, in Proceedings of Hypogea 2017, Int. Congress of Speleology in Artificial Cavities - Cappadocia (Turkey), March 6/8 2017, pp. 20-29.

Caprara R., Dell' Aquila F. 2004. Per una tipologia delle abitazioni rupestri medievali, in Arch. Med. XXXI, pp. 457-472.

D' Andria F. 1996. La casa in Messapia, in D' Andria F., Mannino K. (acura di), Ricerche sulla casa in Magna Grecia. Atti del colloquio (Lecce 23-24 giugno 1992), Galatina, pp. 403-438.

De Ferraris A. 1558. De situ Japigiae, Biffi N. (trad. di), Galatina 2004.

De Mitri C. 2005. Otranto, anfore da trasporto di età tardo romana (IV-VI sec. d. C.), in LRCW I, pp. 413- 424.

De Mitri C. 2010. Inanissima Pars Italiae. Dinamiche insediative nella penisola salentina in età romana, Oxford.

Fonseca C. D., 1970, Civiltà rupestre in Terra Jonica, Milano - Roma.

Fonseca C. D., 1975, La civiltà rupestre medievale nel Mezzogiorno d'Italia. Ricerche e problemi. Atti I Convegno Internazionale di Studi sulla Civiltà Rupestre Medioevale nel Mezzogiorno d'Italia (Mottola-Casalrotto 1971), Genova.

Fonseca et al. 1979= Fonseca C.D, Bruno A.R., Ingrosso V. Marotta A.. Gli Insediamenti Rupestri Medievali Nel Basso Salento, Galatina.

Gabrieli G., 1936, Inventario topografico e bibliografico delle cripte eremitiche casigliane di Puglia, Roma.

Gianfreda G. 1989. Otranto nascosta, Lecce.

Leo Imperiale M. 2001. Otranto, cantiere Mitello: un centro produttivo nel Mediterraneo bizantino. Note attorno ad alcune forme ceramiche di fabbricazione locale in S. Patitucci Uggieri (a cura di), La ceramica altomedievale in Italia, Quaderni di Archeologia Medievale VI, atti del V Congresso di Archeologia medievale (Roma, CNR, 26-27 novembre 2001), pp. 327-342.

Medea A., 1939, Gli affreschi delle cripte eremitiche pugliesi, Roma.

Sammarco et al. 2008= Sammarco M., Parise M., Donno G.P., Inguscio S., Rossi E.. Il sistema rupestre di località Macurano presso Montesardo (Lecce, Puglia), in Atti VI Convegno Nazionale di Speleologia in Cavità Artificiali - Napoli, 30 maggio - 2 giugno 2008 OPERA IPOGEA 1/2.

Rossi G. 2012. Le colombaie del Salento meridionale. Rilevi e documenti, Roma.

Rossi D. 1979. Note illustrative della carta geologica d' Italia. foglio 2015 Otranto, Napoli.

Tinelli M. 2006. Evoluzioni e trasformazioni dell' anfora dipinta dal Medioevo al Rinascimento. Osservazioni dal Salento, in Francovich R., Valenti M. (a cura di), IV Congresso nazionale di Archeologia Medievale, Abazia di San Gallo (Chiusdino-Siena), 26-30 settembre 2006, pp. 485-489.

Uggeri G. 1979. Otranto paleocristiana: Itinerari (Contributi alla Storia dell' Arte in memoria di Maria Luisa Ferrari) vol. I, Firenze, pp. 37-46.

Uggeri G. 1983. La viabilità romana nel Salento, Fasano

HYPOGEAN CIVILIAN DWELLINGS

TUNNELS OF AWE, JUSTICE AND FREEDOM: UNDERGROUND STRUCTURES IN MODERN LITERATURE

Constantin Canavas
Faculty of Life Sciences, Hamburg University of Applied Sciences,
Ulmenliet 20, 21033 Hamburg, Germany, constantin.canavas@haw-hamburg.de

Abstract

Going underground has been a literary *topos* with several symbolic connotations since ancient times. The present study focuses on man-made or man-extended underground structures as they are reflected in modern literature. A major goal of the study is to trace possible correspondence between specific narrative patterns and the specific *topos* of underground tunnel in its regional and historical context.

The first category includes the English novels *The Castle of Otranto* (1764/65) by Horace Walpole and *A Sicilian Romance* (1790) by Ann Radcliffe. Both are prominent examples of Gothic-style early romantic literature, in which the subterranean passages materialize awe and curiosity as effects of experiencing the natural sublime in conjunction with human interventions in nature and actions of horror. The patterns engendered in the narrative inscribe the human actions and feelings in an underground environment inspired by the "underground ruins and gardens" of Syracuse, presumably a re-use of an ancient quarry, as described by Henry Swinburne in his *Travels in the Two Sicilies in the Years 1777, 1778, 1779 and 1780*, published in London from 1783 to 1790.

The second case also refers to Sicily. In Luigi Natoli's popular (historical) novel "*I Beati Paoli*" the underground caves of Palermo (*ngruttatu*) – a system of overlapping Etruscan-Roman *cunicoli*, Christian catacombs of the 4th-5th centuries, and Arab-Norman *qanāt* of the 12th century – is used as a network of secret passages for the action stage of the historical performance, in which the main role is attributed to the famous secret group (sect) of the Beati (Blessed) Paoli at the beginning of the 18th century, just before the occupation of Sicily by the Spanish crone. The Italian novel – published by Natoli in serial form since 1909, as a book in 1921, and, then, again in 1949 – can be regarded as a literary written form of the oral Palermitan societal reception of a tumultuous historical period with its obscure and ambivalent actors. The Arab-Norman *qanāt* systems are interwoven with earlier historical layers linked with the Etruscan-Roman ancestors and the early history of Christendom, and serve as stage and refuge for an underground activist movement in its actions related to popular perceptions of social justice and revenge. It is significant to remark that some Palermitan *cunicoli* are considered as a major issue of Palermo's tangible heritage and are nowadays accessible through guided visits which are promoted with reference to the legend of the Beati Paoli as presented in Natoli's novel.

The third case is *Puslu kitalar atlası* (*The Atlas of Misty Continents*) (1995) by the Turkish author İhsan Oktay Anar. In this post-modern explosive narrative Bünyamin, son of the Long İhsan and nephew of the Black İhsan, the two central figures of the novel, is engaged in a tunnel-digging troop during an operation of liberating Zülfiyar, a spy of the Ottoman Sultan, imprisoned in a castle in today Bulgaria. The *mise-en-scène* of the whole operation is embodied in an oneiric narrative – a dominant pattern of the novel – in which the liberating action can only be accomplished on the condition of destroying the tunnel – the most effective way of letting the fugitive spy escape from his capturers by letting them perish in the collapsing tunnel.

Keywords

Underground tunnel, modern literature, narrative patterns.

1. Introduction

The division between a visible and a not directly accessible underground world has been a literary *topos* with several symbolic connotations since ancient times. The present study focuses on man-made or man-extended underground structures as these are reflected and described in modern literature. Such descriptions are mostly provided from the perspective of persons going underground – even if it is the auctorial narrator who undertakes the task of describing the experience of the figures. A major goal of the study is to showcase descriptions of underground structures in literary texts and to analyse their function(s). Such structure can be tunnels, passages, caves and other geological forms, found in nature and re-arranged by man, or constructed entirely by man. The texts are chosen out from the English Gothic novel, the Italian popular historical romance, and the post-modern Turkish novel. A further questioning regards possible correspondence between specific narrative patterns and the specific *topos* of underground tunnel or similar structure in its regional and historical context.

2. Methods

The method of approaching the *topos* of underground structures will be a structural analysis of its function in the specific narrative. The understanding of this function, however, will be embedded into the historical frame of the reception of the texts in the tradition of the specific

literary *genre*. The historical-hermeneutic approach from the perspective of reception aesthetics should help to reconstruct the impact of the narrative patterns involved in the description of underground structures upon the development of the specific literary *genre*.

3. Tunnels of awe: The Gothic novels *The Castle of Otranto* and *A Sicilian Romance*

The first group of texts comprises the English novels "*The Castle of Otranto*" (1764/65) by Horace Walpole and "*A Sicilian Romance*" (1790) by Ann Radcliffe. Both are prominent examples of Gothic-style early romantic literature, in which the subterranean passages materialise "awe and curiosity" (Radcliffe 1790/1992, p. 1) as effects of experiencing the natural sublime in conjunction with human interventions in nature and actions of horror.

"*The Castle of Otranto*" was first published in 1764, allegedly as a translation of an Italian original story by a certain William Marshall. Four months later, in April 1765, a second edition was published under the title "*The Castle of Otranto – A Gothic Story*" with a preface in which Walpole acknowledges the authorship of his novel and explains the deviations in the publishing practice. As Michael Gamer underlines in his introduction, the novel itself and the intriguing publishing assemble a spectrum of generic elements that hence constituted the repertoire of the English Gothic novel from the middle of the 18th to the end of the 19th century (Walpole 1764/2001, p. xiii). The plot of the fiction is centred upon Isabella, the promised bride of Conrad, son of Manfred, lord of the Castle of Otranto. After the mysterious death of his son, Manfred attempts to marry himself Isabella, but she escapes from the castle through a trapdoor in a subterraneous vaulted chamber. Matilda, the daughter of the tyrant Manfred, instructs Theodore, how to find Isabella in the subterranean church of Saint Nicholas (Walpole 1764/2001, p. 65). This itinerary initiates a remarkable narrative of romanticised underground caves – allegedly from the perspective of Theodore:

"Arriving there, he sought the gloomiest shades, as best suited to the pleasing melancholy that reigned in his mind. In this mood he roved insensibly to the caves which had formerly served as a retreat to hermits, and were now reported round the country to be haunted by evil spirits. He recollected to have heard this tradition; and being of a brave and adventurous disposition, he willingly indulged his curiosity in exploring the secret recesses of this labyrinth. He had not penetrated far before he thought he heard the steps of some person […] He thought the place more likely to be infested by robbers, than by those infernal agents who are reported to molest and bewilder travellers." (Walpole 1764/2001, p. 67)

There are numerous phenomena in the romance which cannot be explained reasonably – they have to be considered as supernatural. In his introduction to a later edition (1811) Walter Scott characterises such descriptions as "held impossible in more enlightened ages", but "consonant with the faith of earlier times" (Walpole 1764/2001, p. 137). "*The Castle of Otranto*" holds a balance between natural and supernatural claims regarding phaenomena in the narrative of the underground world. In this conjuncture he underlines the "improvement upon the Gothic romance" introduced through Ann Radcliffe, in the sense that she provides with natural explanations for her prodigies. Her novel "*A Sicilian Romance*" was published in 1790 and is considered as a highlight of Gothic fiction and romantic narrative. The plot regards the fallen nobility of the house of Mazzini, on the northern shore of Sicily, as related by a traveller. Alike in "*The Castle of Otranto*", Julia, the beautiful daughter of an oppressing father, Marquis Mazzini, escapes from an arranged wedding with the Duke de Luovo that fills her with dismay. This decision leads her and the Duke who runs after her in the cavernous landscapes and underground passages of Sicily. The reader enters with the Duke into the cave of the banditti sitting "round a rude kind of table formed in the rock" (Radcliffe 1790/1992, p. 85). Later, Julia and Ferdinand, the son of Marquis Mazzini, flee following a path indicated by a friar, a *topos* already found in "*The Castle of Otranto*". They hide themselves in a "winding cave, from whence branched several subterraneous avenues" (Radcliffe 1790/1992, p. 149). The next place of concealment is underneath the floor of a ruined castle (Radcliffe 1790/1992, p. 168-169). Eventually Julia discovers her mother imprisoned in a cavern underneath the palace of Mazzini – a characteristic Gothic *topos* connoting the underground caverns as a prison belonging to another world, even if "avenues" are leading to it (Radcliffe 1790/1992, p. 181-183). In fact, both natural sublime and human-arranged prison melt together in the (narrative) element of the underground cave.

The underground – natural or natural-artificial – cavities referred to in Radcliffe's novel constitute a major component of the "sublime style" of northern Sicily. Among the numerous descriptions by 18th century travellers the most influential was certainly found in "*Travels in the Two Sicilies*" published by Henry Swinburne in several volumes between 1783 and 1790 (four volumes in the 2nd edition in 1790), also published in French and German translations in 1785:

"From hence I ascended the hill to a convent of Capuchin friars, a light neat church. When a stranger walks up to this monastery, he sees near him neither verdure nor tree; all appears one bare dreary rock, and little does he suspect he is within reach of extensive orchards, which by their produce yield a handsome income to the friars. No fight can be more singular than the gardens of this convent, which are in some measure subterraneous, being contained in the areas of immense excavations, made by cutting stone for the ancient city. I descended by a slope into these extraordinary bowers, where my view was confined on all sides by shaggy walls of great height, either purposely hewn into shape, or rudely figured by the corrosive sea air. Huge masses have been broken off, and rolled on the platform, where they contribute to the composition of a most wild, yet solemn picture. The area is covered with a thick grove of trees, loaded with rich-scented blossoms and beautiful fruit; I was delighted with their variety of kinds, vigour of growth, and brilliancy of foliage; […] There are several sepulchres in these quarries, and some projection of the stone are scooped into rings, by which I conjecture, that, after the place

ceased to be used as a quarry, it was converted into a prison.

The vaults of this convent have the property of drying the bodies of the dead in a very short space of time; after which they are dressed in religious habits, and placed as statues in niches on each side of subterraneous alleys.

I passed on the sea side, where no traces of antiquity subsist, except some steps and a few courses of stones; not a vestige of house, temple, or monument, is to be seen on this extensive plain, once the most crowded best-built quarter of Syracuse." (Swinburne H, 1790).

A comparison between the passage quoted above from "*Travels in the Two Sicilies*" and the two Gothic novels considered here shows that many of the underground structures described by Swinburne (vaults, quarry transformed into prison, shaggy walls) appear in the novels – however in a much shorter form, serving as accelerators of coming and fleeing underground, or as narrative patterns inducing "awe and horror" – not only in the eyes of the acting figures, but also upon the reader.

4. Tunnels of justice: Natoli's *Beati Paoli*

The other literary example of the present study is Luigi Natoli's popular (historical) novel "*I Beati Paoli*". Natoli (1857-1941) published the story about the secret order (from the perspective of their adversaries: the sect) of the Beati (i.e. the Blessed) Paoli in serial form from May 1909 to January 1910 under the pseudonym William Galt in the newspaper "*Giornale di Sicilia*". Natoli's novel was published in book form in Italy in 1921, and then again, after the fascist period, posthumously in 1949 and 1955 (Castiglione 1987/2010, p. 18). A later edition with a foreword by Umberto Eco appeared in 1971 – the novel is currently accessible in a commented edition by Sellerio in two volumes (Natoli 2016).

The Beati Paoli issue constitutes at the present the most important and most popular subject of modern Sicilian folklore (Renda 1998). Presumably the narrative traditions go back to references to the activities of the sect of the Vendicosi in Norman Sicily around 1185. In several additions later historical figures, such as the 15th century bandit Antonio di Blasco, were incorporated in the narrative, and romanticising transformations should have shaped the narrative during the 19th century (Castiglione 1987, p. 15). Eventually the legend was worked out in 1841 by Vincenzo Linares in his "*Racconti Popolari*" (Castiglione 1987/2010, p. 9-11). Linares' Beati Paoli are rather urban bandits and confidential contract killers – whereas Natoli's figures appear in a glamorous light of informal justice servants and public heroes. What is important for the present study is the link between the Beati Paoli and the Palermitan underground tunnel network; precisely this link seems to exist in the public perception already in the middle of the 19th century with a square named after the group on the basis of their underground tribunal supposed to be just underneath that place (Castiglione 1987/2010, p. 28-29). Natoli has organized the material in form of a trilogy. In the first part, "*I Beati Paoli*", the plot is placed mostly in Palermo between 1698 and 1719, just before the occupation of Sicily by the Spanish crone. The events are cast in stories about power abuse by the nobles and operations conducted by the secret group of the Beati Paoli who try to avenge unpunished crimes and injustice exercised by the mighty nobles. The second part, "*Coriolano della Floresta*", stretches over the period 1720-1773, whereas the last one, "*Calvello il bastardo*", refers to the last decade of the 18th century in Sicily (Montemagno 2017, p. 79-98). The focus of the present study is placed upon the first part.

Interestingly, some of the major judgment and punishment scenes set by the Beati Paoli take place in underground caves of Palermo called in local speech *ngruttatu* (literally "in the grotto/cave") – a system of overlapping Etruscan-Roman *cunicoli* (water transport channels), Christian catacombs of the 4th-5th centuries, and Arab-Norman *qanāt* (water transport channels) of the 12th-13th centuries, as these components can be identified on the basis of ceramic finds (Todaro 2002, 40). The technological issue of the *qanāt* is attributed to an Arab-Norman cultural syncretism: the oldest existing tunnel (at least in its present form) should not date earlier than to the 12th-13th century. The underground network of caves of Palermo is described in detail by Todaro (Todaro 1988; Todaro 2000). The term *ngruttatu* was used, presumably for the first time, at the beginning of the 19th century in a treatise on hydraulics (Todaro 2002, p. 41). The terms used in Natoli's novel for the underground locations are *grotta* (cave) and *cavo/passaggio sotterraneo* (underground cave/passage) or qualifiers such as *sotterraneo misterioso*, however the connections between the several underground spaces correspond to the *cunicoli-ngruttatu-qanāt* formations described above.

Natoli's novel follows the tradition of the 19th century Italian popular romance with distinct separation limits between morally "good" and "bad" figures. The plot is based on oral traditions concerning the obscure activities of the secret order, as well as on written sources, such as Antonio Mognitore's "*Diario Palermitiano*" and Marquis de Villabianca's "*Opuscula Palermitiani*", vol. XIV (1790). Some of the figures can be traced historically, others are fictional. The locations correspond to real places in Palermo, such as the quarter Capo and the Palazzo Chiaramonte-Steri, as well as the legendary underground caves and channels with entrances, some of which still exist. The general motif of the novel is the struggle for justice carried out by brave figures such as Blasco Da Castiglione against intriguing and power-abusing villains such as Don Raimondo della Motta, in which struggle leading figures of the Beati Paoli such as Coriolano della Floresta and Girolamo Ammirata intervene imposing their own agenda.

The underground passages are described in a short way, mostly from the perspective of a central figure of the scene – e.g. the kidnapped Andrea Lo Bianco with the eyes bound can only smell and feel the moisture of the stone walls when he is brought to the tribunal cave (Natoli 2016, p. 211-220). When Blasco da Castiglione is brought – again with bound eyes – to the underground tribunal cave of the Beati Paoli, only the visible details of the room (rotunda) after the unbinding of his eyes are given:

"Riaperti gli occhi vide che era in una specie di rotunda, evidentemente una antica cripta scavata nella roccia dalla quale si dipartivano due corridoi, perdentisi nell'infinito delle tenebre. […] In mezzo era una specie di piccolo altare di pietra." (Natoli 2016, p. 677-678)

An act of great significance in the novel is the court held twice by the Beati Paoli against Don Raimondo della Motta accused for injustice, abuses, usurpation of power etc. In the first occasion Don Raimondo is kidnapped by the Beati Paoli and brought to an underground catacomb-cave where he is forced to write a letter recommending the release of Girolamo Ammirata (Natoli 2016, p. 321-326). On the second occasion a court against Don Raimondo is held by the Beati Paoli in an old catacomb in order to judge and eventually punish him – apparently to death – at the presence of Blasco (Natoli 2016, p. 871-880). The location is described in details – including the secret rescue exits used by the Beati Paoli when they are assaulted by the guardians of the state. The place resembles to an underground well or cistern – which still today is called "the cave (*grotta*) of the Beati Paoli". The association with an underground cistern or aqueduct is supported by the presence of water and the narrow width of the side caves and tunnels – used as secret passages and rescue ways. A more detailed description is provided in the scene where Blasco tries to return to the place where Don Raimondo was punished– an underground formation shaped by the infiltrating water (Natoli 1998, p. 886). Perhaps the only description given as an overview and orientation by the narrtaor (Natoli) regards the location of the underground cave of the Beati Paoli near the catacombs of Porta d'Ossuna (Natoli 2016, p. 940) – a detail known only to the leading figures of the sect, Girolamo and Coriolano, that explains *ex post* the successful escape of the Beati Paoli on the occasion of the assault of the guardians just after the punishment of Don Raimondo.

5. Tunnels of dreems and freedom: *Puslu kitalar atlası* (*The Atlas of Misty Continents)*

The third case is *Puslu kitalar atlası* (*The Atlas of Misty Continents*), a post-modern historical novel published in 1995 by the Turkish author İhsan Oktay Anar. The plot begins in Kostantinye (present Istanbul) in 1681. In one of the numerous episodes of an explosive narrative between dream and reality Bünyamin, son of the "Long" İhsan and nephew of the "Black" İhsan (Arab İhsan Efendi), the two central figures of the novel, is engaged in a tunnel-digging troop (*lağımcı*) during an operation of liberating Zülfiyar, a spy of the Ottoman Sultan, imprisoned in a castle in today Bulgaria (Anar 1995, p. 64). The adventures of the tunnel-digging troop are described in the chapter named "Underground (*yeraltı*)" from the perspective of the auctorial narrator (Anar 1995, p. 67-91). The work itself is described along the experience of older members as extremely dangerous. Even if the goal of the digging action is achieved and the explosion at the end of the excavated tunnel is successful, no gesture of recognition is waiting for the *lağımcı*, who are always working beyond perception horizon of the public and the ruler'. In this sense the setting of the underground activities in Anar's novel corresponds to the backside of a stele which in its front side bears an inscription exalting glorious deeds. In *Puslu kitalar atlası* the narrative of the underground world is the medial denial of the sublime positive connotations of the Gothic underground landscape. Moreover, it is a temporary space that will be destroyed upon fulfilment of its "goal".

The *mise-en-scène* of the whole operation is embodied in a fulminant narrative in which the liberating action can only be accomplished on the condition of destroying the tunnel – the most effective way of letting the fugitive spy escape from his capturers by letting them perish in the collapsing tunnel. In mirroring the fiction on an oneiric narrative – a dominant pattern of the novel – Bünyamin dreams of the (possible) end of his life during the underground digging operation (Anar 1995, p. 84-86).

6. The role of the underground tunnels in the narrative strategy

6.1. A comparative approach

In the Gothic novels the description of the natural sublime possesses a central value and occupies a large part of the narrative. In Natoli's novel the underground landscape turns up only as (an underlining of the astonishing actions of the Beati Paoli and their movements in the underground network of Palermo – their appearing and disappearing according to the needs of the justice-delivering sect. Common element in both cases is the functional relationship between ground buildings and underground landscape – like both sides of a coin. Both in the Gothic novels as well as in the popular Italian romance virtuous figures flee under the pressure of an usurping tyrant in a network of subterranean passages and caves.

Natoli's novel can be regarded, to a certain extent, as a literary form of the Palermitan societal reception of a tumultuous historical period – the beginning of the 18th century – with its obscure and ambivalent actors. The underground of Palermo, a multilayer-sediment of Arab-Norman *qanāt* systems and later aqueducts, interwoven with earlier historical layers linked with the Etruscan/Roman ancestors and the early history of Christendom, serves as stage and refuge for an underground activist movement in its actions related to popular perceptions of social justice and revenge. In Natoli's narrative, the underground cave network – once in the service of water transfer – functions as a symbol of invisible movements, unpredictable actions, and occult ceremonies. In this sense the Palermitan underground tunnel network is itself an actor of the narrative, however in a different way than in the English Gothic novel. Instead of being a natural (or nature-like technological) Gothic sublime, the Palermitan underground tunnel and cave network is an actor who intervenes unexpectedly in the plot and interacts with both the Beati Paoli and their adversaries.

The atmosphere of the underground narrative in *Puslu kitalar atlası* is of quite different quality. The close description of adventurous actions underground is as risky as the actions themselves: small details suffice reto kip the

suspense of the description of adventures into a parody of suspense. When the fulminous event description of the underground digging operation is interrupted by the *lağımcı* master Verdapest because he contemplates on the obverse of a coin, the explosion in the tunnel interrupts mortally this interruption. Even if Bünyamin survives from the explosion, he is so badly wounded that he does not recognise not even his own face in the mirror. Heroic descriptions would omit such details – the novel *Puslu kitalar atlas* is full of them.

The specific issue of tunnel-digging in Anar's novel is itself a realistic parody of any idealisation of artificial underground constructions. Instead of the glorious and spectacular hit-and-go actions of the Beati Paoli, the *lağımcı* often inflict themselves severe wounds. One of the suspense (albeit comic) scenes of the Anar's narrative regards the mutual tunnel-digging (contra-digging) of adversary *lağımcı* groups (Anar 1995, p. 77). The parody accompanies Bünyamin's dreams showcasing the search for underground hidden treasures. Indeed, parody is a typical narrative pattern of post-modern fiction.

6.2. Repercussion of narratives of historical heritage and social struggles

The *topos* of underground structures became eventually generic for the *genre* of Gothic novel. In fact, the narrative pattern of underground structures was linked with that of ruined buildings to form common *topoi* in the romantic fiction – even without the link of awe and horror.

In the case of Natoli's narrative the Palermitan underground network of *cunicoli/qanāt* and early Christian catacombs became the material linkage between historical heritage and the imaginary of social solidarity. Natoli describes scenes of initiation as well as scenes of revenge taking place in the underground tunnels and caves. The actions of the secret order of the Beati Paoli follow the moral goal of re-establishing respect to honourable families. As in the Gothic novels, the Beati Paoli in Natoli's novel are covered mostly with legends. Natoli provides the reader with links between the scret eorder and historical persons, historical events, as well as real locations and still existing buildings. Natoli's novel, however, is not a scholar product – it belongs to a long tradition of living legends and popular novels, of public puppet performances based on the Beati Paoli legends, and on popular artistic representations of the legendary figures. Its publication since 1909 owes much to the already circulating material, but it has itself largely contributed to the increase of popularity and actuality of the links between the Beati Paoli and modern Palermo. It is under the influence of the novel and its touristic impact that some streets and places in Old Palermo bear references to the activities of the Beati Paoli, such as the quartier of Capo, Piazza Marina and the church Santa Maruzza, under which the cave Camera dello Scirocco has been found, which – according to Natoli's descriptions – should have been the place in which the Beati Paoli held their legendary court (e.g. against Don Raimondo della Motta). Thus the underground and the urban network of Natoli's novel were projected on existing underground formations as well as on several places in the modern town of Palermo. In consequence, many of these places, including underground ones, became since 2010 sites of special guided tours and touristic visiting programmes. In this sense it can be claimed that Natoli's novel, by inheriting popular legends and linking them to locations of Palermo, including the underground caves, has largely contributed to the revitalisation of public awareness and the enhancement of touristic promotion in respect with the Palermitan *ngruttatu*.

7. Conclusions

The tracing of the *topos* of man-made or man-extended underground structures in fiction yields several effect patterns. From the awe-and-horror pattern of the Gothic novels to the glorifying narrative of justice in Natoli's version of the legend of the Beati Paoli the issue of underground structures retains the adventure feature while accompanying different cultural and political settings – up to the parody of this feature in post-modern fiction.

References

Anar İO, 1995. Puslu kıtalar atlası. İtelişim, İstanbul (in Turkish).

Castiglione FP, 1987/2010. Indagine sui Beati Paoli. Sellerio, Palermo (in Italian).

Montemagno G, 2017. L'uomo que inventò i Beati Paoli. Sellerio, Palermo (in Italian).

Natoli L, 1949/1971-1993 (Flaccovio)/2016. I Beati Paoli (2 vol). Sellerio, Palermo (in Italian).

Radcliffe A, 1790/1992. A Sicilian Romance. Oxford University Press, Oxford.

Renda F, 1988/1991(2nd rev. ed.)/1998. I Beati Paoli. Storia , letteratura e leggenda. Sellerio, Palermo (in Italian).

Swinburne H, 1790 (2nd ed.). Travels in the Two Sicilies in the Years 1777, 1778, 1779 and 1780. P. Elmsly, London, vol. IV, p. 93-96.

Todaro P, 1988. Il sottosuolo di Palermo. Flaccovio, Palermo (in Italian).

Todaro P, 2000. The ingruttati of the plain of Palermo. Proceedings of the 1st International Symposium on Qanat. Yazd, Iran , vol. 4, p. 44-70.

Todaro P, 2002. Guida di Palermo sotterranea. L'Epos, Palermo (in Italian).

Walpole H, 1764/2001. The Castle of Otranto. Penguin, London.

THE PATTERNS OF DEVELOPMENT OF CAVE SHELTERS IN CAPPADOCIA

Tymur Bobrovskyy[1], Igor Grek[2]
[1]Saint Sophia National Preserve, Volodymyrskaya str. 24, 01001 Kyiv, Ukraine,bobrovskij@ukr.net
[2]Speleoclub "Poisk", Rabina str.47 ap.112, 65072 Odessa, Ukraine, grekigor@mail.ru

Abstract

Rock and underground shelters make up a considerable part of the cave monuments of Cappadocia. A large number of complexes have been inspected by us in recent years, and certain patterns in their development have been determined.
Simple layouts of the shelters designed for defense of certain families characterized the initial stages of the development of the cave complexes. The creation of labyrinth systems indicates a transition to collective forms of defense, perhaps, long term ones. For this purpose, they created necessary infrastructure that included wells, churches, toilets, and passages to move manpower inside the complex as well as emergency ways. In a number of cave complexes the period of utility use, proceeding the time of creation of shelters, is fixed. Also in most cave complexes the stage of destruction of shelters is well documented. During this period defensive devices, mainly moving millstone doors and loopholes, were destroyed. Finally, for most cave shelters in Cappadocia, a period of subsequent utility use is observed. At this time cave premises were used mainly as dovecotes or stalls for domestic animals. These patterns are typical for both "underground cities" and "rock settlements".

Keywords

Cappadocia, underground cities, rock settlements, shelters, defensive devices.

Introduction

Historical region Cappadocia locates in central Turkey and is known for its remarkable landscapes, medieval Christian frescoes and monuments of rock cut architecture. The appearance of grandiose complexes of artificial caves in the territory of Cappadocia is obviously connected with a unique combination of climatic, geological and historical factors in the life of this region.
The rock architecture of Cappadocia is represented by artificial caves of various types: dwelling and monastic complexes, waterways tunnels and storages, tombs and churches, stalls for domestic animals, shelters and quarries.
The significance of the cave shelters in the rocky architecture of Cappadocia is very great. They are the most extensive and most remote from the surface undergrounds cavities. Cave shelters exist both separately from other caves, and as part of more extensive complexes.
Therefore, the study of shelters is of paramount importance for understanding the nature of large (combined in purpose) complexes of artificial caves, better known as "underground cities" and "rock settlements".
Initially, analyzing the sequence of creating large underground complexes of artificial caves, we noticed that these structures were not connected by a single design, and were not created simultaneously[1]. We selected a variety of objects for the subsequent analysis its structure, located in the provinces of Nevsehir and Aksaray in Cappadocia, both underground and rock-cut[2]. For these cave complexes we made the relative chronology of their formation. (Grek et al 2010; Grek and Kolchin 2013; Bobrovskyy et al 2015; Bobrovskyy and Grek 2015, 2016,2017).

We used several approaches. First, to understand the structure of artificial cave complexes, we have done mapping and description of objects, mainly with the help of a liquid compass and a measuring tape[3].

[1] Similar conclusions regarding non-simultaneity of the creation of some cave complexes in Cappadocia can be seen, for example, in the works of R. Osterhout [Osterhout 2005]
[2]Cave shelters can be conditionally divided into two types - rock and underground complexes [Gülyaz and Yenipınar2007]. By the first we mean caves cut in rock cliffs, mainly in the natural light zone, and protected, first of all, by their location at some height above the surface. Underground shelters, often called "underground cities", on the contrary, are located outside the natural light zone and protected, first of all, by their location at some height above the surface. Underground shelters, often called "underground cities", on the contrary, are located outside the natural light zone at some depth below the surface.
[3] This method in speleology is most often used for horizontal caves. For objects located on several levels, we created floor plans. In some cases, we combined our method with the conventional method of mapping using the compass "Suunto Tandem".

Figure 1. Traces from instruments on the ceiling of the rooms allow restoring their original configuration. Photo M. Shyrokov

Traces of instruments on the walls of narrow tunnels[4] show well the direction of the development (cutting) of underground cavities, and, as a rule, allow establishing the initial points of cutting, the junction of different parts, and the direction of further development of underground systems. Sometimes, various traces from instruments on the ceiling or on the floor of the rooms allow restoring their original configuration [Bobrovskyy and Grek 2018] (Fig. 1)

.Patina on the walls of the premises in a number of cases makes it possible to distinguish parts of different time (for example, in room 1 in the complex, which we described in the valley of Meskendir [Bobrovskyy and Grek 2015] or in room 4 in the Zemi-2 Complex [Bobrovskyy et al 2015]).

To protect cave shelters, defensive devices of various types were used [Bixio 2015]. In some cases, defensive devices were not preserved, instead of them we cannoticefragments of such devices or traces of their use. For example, in the cave complexes of Tekkaya [Bobrovskyy and Grek 2017] there is loophole, groove and traces from the movement of millstone door well preserved. (Fig. 2)

Figure 2. Loophole, groove and traces from the movement of millstone door in the cave complexes of Tekkaya. PhotoT. Bobrovskyy.

The location of defensive devices in the structure of cave shelters shows that some of them lost their function during the subsequent reconstructions of the underground space. The analysis of such transformations allows restoring the initial or earlier configuration of a shelter[5].

The duplication of structural elements also suggests several stages in the development of cave shelters. For example, in the shelters in the valley of Meskendir [Bobrovskyy and Grek 2015] and "Gelveri-1" [Bobrovskyy and Grek 2018], there are deep water wells located both at the entrance and in more remote from the entrance and better protected sites.

It can be noted that sometimes during creation of some elements of the underground infrastructure elements created earlier were destroyed. This is observed in almost all the complexes of cave shelters in Cappadocia. For example, in the rock complex in the Meskendir valley special ventilation tunnels were cut to supply air to the shelter chambers, which were later destroyed during the later reconstruction [Bobrovskyy and Grek 2015]. The use of standard modules[6] can also be effective for understanding the initial configuration of objects.

Unfortunately, the dating of the creation of shelters in Cappadocia is difficult due to the fact that archaeological research was not conducted directly in underground complexes. Some considerations on the chronology of the individual stages of cave shelters can be made on the basis of an analysis of the liturgical layout of the churches included in the shelter complexes (for example, for the Zemi-1, Mazi-1, and Tekkaya complexes) [Bobrovskyy and Grek 2013, 2016].

Results

In constructing the relative chronology of the creation of large "underground cities" (Mazi-1, Mazi-2, Gelveri-1, Sivasa), we managed to identify the period when the underground structures consisted of a group of separate "primitive" shelters. [Bobrovskyy and Grek 2016, 2017](Fig. 3; e,g). The stage of creation of "primitive" shelters can also be noted in the structure of medium-sized underground complexes, such as "Refuge-2" and "Northern Settlement-1, 2" in Chanly-kilise or a shelter in the Yally-Hut complex.

Moreover, we know such "primitive" shelters which exist separately. (For example, a refuge in the complex of the Belha monastery and in the complex with the Karabash church in the Soganly valley). (Fig. 3; b, c) Obviously, such “primitive” complexes were intended for short-term use only by one family or a small monastic community.

Perhaps, they were typical of a certain historical period, when military invasions were not long, and underground shelters were not attacked.

---

[4]For wide passages or chambers, such an analysis is only applicable with caution, since in different areas various directions of excavation could be used, with subsequent correction of the walls and ceilings.

[5] Such conclusions can be drawn about room No. 29 in the complex "Mazi-1"(Fig. 4; d). [Bobrovsky and Grek 2016] or rooms No. 2a, 3, 4, 5 in the "Gelveri-1" complex [Bobrovskyy and Grek 2018] (Fig. 5).

[6]Such modules have been described in Bixio's works [Bixio 2012, 2015] and have been used successfully to analyze the structure of shelters.

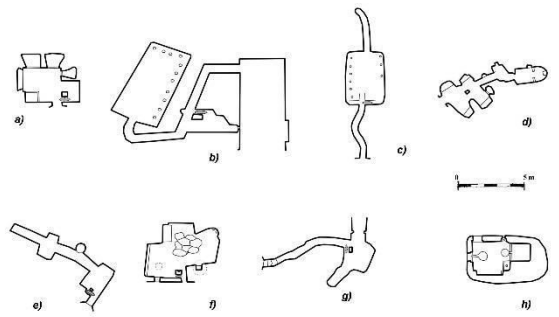


Figure 3. Primitive caves - shelters. (a,b,c,d – separate underground shelters, Gulshehir, Belha, Carabash kilise in Soganli, Mazi-3, e and g – part of big underground system Mazi-1 and Gelveri -1, f –part of middle size cave system Ak-koy, h-separate cliff shelter near Gereme 34.) Drawing T. Bobrovskyy.

From the military point of view, such structures were not intended for active defense and are probably more characteristic for the period of civil strife, when all fought against all. It is important to note that "primitive" shelters were used not only for sheltering people. We see holes for installing earthenware (Belha, Karabash church in the Soganly valley (Fig.3;b,c), chambers and pits for food storage

("Northern Settlement-1, " in Chanly-kilise , S-1 complex in Sivasa, mangers for domestic animals ("Mazi-1", "S-1" in Sivasa, "Zemi-2", and others).

At present, we cannot date this stage exactly. However, the presence of aedicules in the entrance chambers of the "Northern Settlement- 2" in Chanly-kilise, as well as churches or chapels in the simplest Ak-koy and "Mazi-3" complexes,(Fig3;d,f) undoubtedly points to the Christian time.[7]

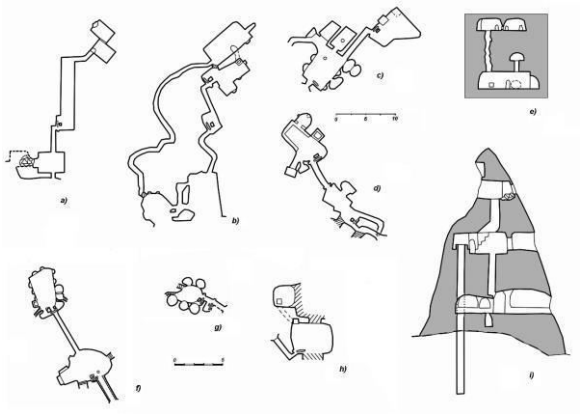


Figure 4. Creation of several defensive lines. (a,b –Akdam and Yalli-hut [Bixio 2012]- separate underground shelters; c,d – Mazi-1; f,g –Sivasa S-1; h-Gelveri-1- parts of large underground systems; e and i – cliff shelters Ak-koy and Zemi-2.) Drawing T.Bobrovskyy.

It is important to note that the creation of "primitive" cave shelters is not always the first stage of the existence of cave structures. Using the example of the underground S-1 systems in Sivas and Mazi-1 [Bobrovsky and Grek 2016, 2017], it can be seen that the economic use of caves precedes the establishment of shelters.

The next stage in the development of shelters is characterized by the creation of several lines of defense, which was achieved in two methods. (Fig.4)

First, the successive arrangement of several, as a rule, different types of defensive devices. For example, shelter in Yally Hut, Northern settlement-1 in Chanly-kilise, section "S1" in Sivas and others. [Grek and Kolchin 2010; Bixio 2012; Bobrovskyy and Grek 2017].

Second, by combining two "primitive" shelters nearby with passage protected by defensive devices from both sides (for example, in the shelter "S1" in Sivasa). It is important to note that the creation of several defense lines, as well as these two methods used in this case, are typical for both underground and rock complexes[8].

This stage of creation of shelters is characterized by the fact that primitive shelters of the first period formed the structure of more extended complexes, in which the most protected premises were located at maximal distance from the surface upwards or into the interior of the rock. These most remote cells were additionally equipped with water wells or cisterns, pits for storage of supplies and even toilets (Sivas, "Gelveri-1"). This stage is also characterized by the creation of emergency ways. ("Northern Settlement-2" in Chanly-kilise, Sivasa, Yally-hut). In addition, some rooms were equipped with Christian aedicule (Zemi-2, Northern settlement-2 in Chanly-kili) or church. ("Zemi-1", "Mazy-1" and Tekkaya) Liturgical arrangement of Church Zemi-1 gives us the dating between the 9th and 12th century, and in the Mazi-1 and Tekkaya[9]- not earlier than the beginning of the 13th century [Bobrovskyy and Grek 2013, 2016].

The subsequent development of shelters in some cases leads to the formation of labyrinth structures, for different directions. [Bixio and De Pascale 2015; Bobrovskyy and Grek 2016, 2017, 2018] At this stage, shelter defenders were able to move in the underground labyrinth, go into the rear of the enemy, create a numerical advantage and fight using the limited conditions of narrow communication tunnels.

Discussion of the results and conclusions

Thus, the example of underground and rock monuments of Cappadocia shows gradual development of cave shelters from primitive forms to more complex and extended ones. In this case, for the initial stages of development of shelters, it seems that only individual forms of defense (more often - passive) are characteristic. The change in the structure of shelters, the creation of labyrinth systems and

[7]We see such aedicules in several complexes examined by us (Zemi-2 [Bobrovskyy et al 2015]), ("Northern Settlement-2" in Chanly-kilise [Grek and Kolchin 2012].The liturgical planning of churches in Ak-Koy and Mazikoy-3 allows one to assume their creation within the limits of the 9th-12th centuries.

[8]For example, we see this stage in the rock cut complexes, Zemi-1, Zemi-2, Tekkaya, Ihlara-3 described in our works. [Bobrovskyy and Grek 2012, 2016,2017, Grek et al 2010, Bobrovskyy et al 2015]

[9]In this case, we use the local name.

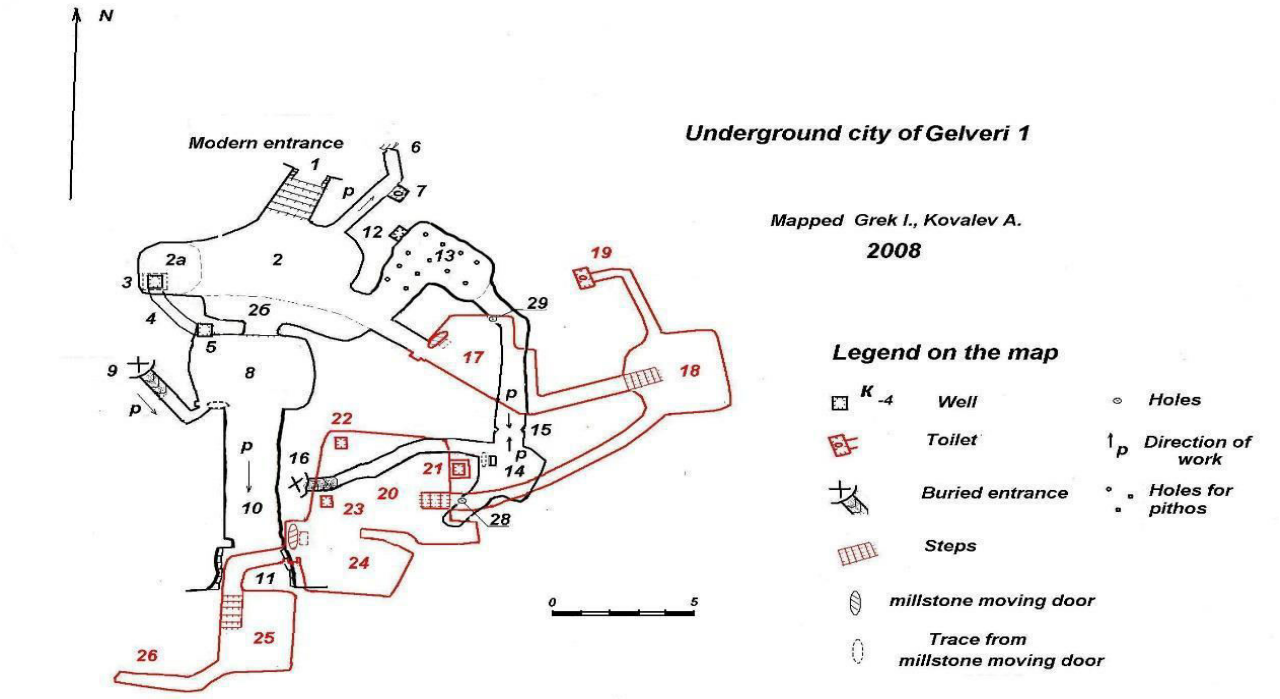


Figure 5. Labyrinthine shelter. «Underground city» Gelveri-1. Drawing I. Grek.

infrastructure, including water wells, large storage facilities, churches, toilets, hidden ways to move manpower within the complex, emergency ways, all indicate a transition to collective and active forms of defense designed to stand against long-term sieges.

It is obvious that such essential changes are most likely associated with changes in the historical situation. Probably, simpler forms of shelters, at some point in time, were no longer able to deter attackers. Returning to the dating issues of these complexes, we note that, in our opinion, the development of cave shelters in Cappadocia was going on for long time. The earliest dated premises described in the structure of underground complexes (late antique tombs in Sivas and "Mazi-3", which unconditionally refer to pre-shelter stage), arose in the first half of 1 thousand AD. The latest dating are connected with churches in underground complexes

Tekkaya and "Mazi-1". Their liturgical arrangement indicates a period note earlier than the beginning of the XIII century. Ceramics from the underground complex S1 in Sivas refers to the XV-XVI centuries. [Triolet 1993]. Such a considerable time range for the creation and use of cave shelters, covering almost a millennium, seems to us quite justified, given the complex military and political situation in central Anatolia in the VII-VIII, XI-XII, XIII, XV-XVI centuries.

It is important to note that when the need to create and use shelters disappeared, many underground spaces continued to be used (and are used up to today), but exclusively for economic purposes - as storage facilities, stalls and workshops.

References

Bixio R., De Pascale A. Defensive devices in ancient underground shelters: Comparision among the sites of Aydintepe, Ani, Ahlat and Cappadocia in Turkey // Proceedings International Symposium on East Anatolia - South Caucasus Cultures, Erzurum (Turkey), October 2012.-Cambridge, 2015. - Vol. 2. - P. 461-480.

Bixio. R. Cappadocia: Records of the underground sites. - Oxford, 2012.

T.Bobrovskyy, I.Grek. The Gelveri-1 “Underground City”. Opera Ipogea. 1-2018, pp. 51-58.

Gülyaz M.E., Yenipınar H. Rock settlements and underground cities of Cappadocia. - Nevşehir, 2007. 96p.

Ousterhaut R. A Byzantine settlement in Cappadocia.

Dumbaton oaks studies. - V.XXII. Washington, 2005.

Triolet J., Triolet L. Les villes souterraines de Cappadoce. - Torcy, 1993.(in French)Грек И.О., Долотов Ю. А. Подруцкая Н. Б. Подземный город в долине реки Мелендиз. Материалы международной конференции по спелеологии и спелеостологии. Россия. Набережные Челны. 2010. С. 150-153.(in Russian)

Бобровский Т.А., Грек И.О. Пещерные комплексы Каппадокии: итоги и перспективы исследований // Праці Науково-дослідного інституту пам’яткоохоронних досліджень. – Випуск 6. – Вінниця, 2011. – С. 116-137.(in Russian)

Бобровский Т.А. Грек И.О. Скальное убежище в долине Земи близ поселка Гереми в Каппадокии. Материалы международной конференции по спелеологии и спелеостологии. Россия. Набережные Челны. 2013.стр 172-176. (in Russian)

Бобровский Т.А., Грек И.О., Климишина О.И. Комплекс в отдельном конусе в долине Земи в Каппадокии Материалы международной конференции по спелеологии и спелеостологии. Россия. Набережные Челны. 2015. С 154-159.(in Russian)

Бобровский Т.А. Грек И.О. Комплекс искусственных пещер в туфовых останцах в окрестностях Гереме. Материалы международной конференции по спелеологии и спелеостологии. Россия. Набережные Челны. 2016. С 192-210.(in Russian)

Бобровский Т.А., Грек И.О. К изучению «подземного города» в селении Мазыкой (Мазы) в Центральной Каппадокии. Материалы международной конференции по спелеологии и спелеостологии. Россия. Набережные Челны. 2016 С.98-114.(in Russian)

Бобровский Т.А. Грек И.О. Комплекс искусственных пещер в долине Мескендир близ Гьореме (Каппадокия) Материалы международной конференции по спелеологии и спелеостологии. Россия. НабережныеЧелны. 2015. с129-135.(in Russian)

Бобровский Т.А. Грек И.О. Заметки о формировании пещерного комплекса S1 в поселке Гьокчетопрак (Сиваса) Материалы международной конференции по спелеологии и спелеостологии. Россия. Набережные Челны. 2017 С.130-141.(in Russian)

Грек И.О., Колчин К.Б. Пещерные убежищаСеверного поселения Чанлы-Килисе в западном пограничье Каппадокии // Праці Науково-дослідного інституту пам'яткоохоронних досліджень. - Випуск 8. - К.: Фенікс, 2013. - С. 213-221. (in Russian)

ORTE (VT) – A COMPLEX HYPOGEAN HERITAGE. NEW ACQUISITION DATA

Giancarlo Pastura[1], Letizia Tessicini[2]

[1]*Tuscia University, L.go dell'Università snc, 01100 Viterbo,* g.pastura@unitus.it
[2]*Orte Sotterranea, Via Matteotti, 57 01028 Orte (Viterbo),* letiziatessicini@gmail.com

Situated in connection between the territories of Umbria and Lazio, the city of Orte has been continuously inhabited since the 6th century b.C.. Inside the tufo plateau the underground aqueducts (tunnels, cisterns and wells), storage rooms, dovecotes and nymphaeums have been excavated during 2500 years of life. The complex of all these structures determines a wide and articulated hypogean landscape, generated by continuous transformations along the centuries. The mapping of the underground aqueducts, of the hypogean dovecotes and of all the accessible cavities, high lightened the privileged relationship developed between the solid morphology and humans, that since the origins have been able to deploy its properties to guarantee water and food supply, amusement places and services, fundamental for the development of a city that had a central role in the Middle Tiber Valley.

Through a mapping of the modifications and transformations of the cavities, the present contribution wants to underline how the Etruscan and Roman cavities have been reused during the centuries to adapt to the socio-economic and political growth of Orte. Moreover the research brought to light the continued exploitation of the underground in the Middle Age, time of the maximum expansion of the city.

Keywords

hypogean structures, cisterns, nymphaeum, water system, snow well, Middle Age, decovetes

1. Introduction

The historical village of Orte develops on a tufaceous rock that rests on clay deposits, formed on the seabed up to about a million years ago, when intense volcanic activity begins. The cliff is oriented east-west, with a characteristic globular shape and an increasingly pronounced thinning going west, while a rounded top floor favors the occupation[1].

Located in a strategic position, in control of the middle Tiber valley and of the main communication routes, Orte is certainly founded by the Etruscans of Volsinii (Orvieto) and has been inhabited since at least the VI century BC, as documented by the excavation of the necropolis of Le Piane and San Bernardino. It is in this territory that Rome wins over the Etruscans with the two battles of Lake Vadimone (309 and 283 BC), and Orte is given the status of municipium at the beginning of the 1st century BC. In this period the territory is dotted with villas, which benefit from the transit of the via Amerina and from the important river port of Seripola The importance of the town will be augmented in the Augustan age, concurrently with a monumental redefinition of the town.

Since the emergence of Christianity in the Early Middle Ages, the growing importance of Orte in the Tiber Valley can be followed through different facts, as the foundation of the monastery of San Giovenale by the Byzantine General Belisario and the recognition of the bishop's seat already in the middle of the seventh century. After being disputed by the Lombards for the control of the main roads connecting Rome and Ravenna, Orte experienced further development in the mid-ninth century, with the foundation of a second cathedral (Pastura 2017). Occupied by the Arabs and reconquered in 914, it intensified its control over the river in the 10th and 11th centuries, contending its primacy with Amelia, Narni and with the great Roman monasteries, such the Abbey of Farfa. It this phase begins the most prosperous period of the city, which increases its inhabitants with the development of suburban villages and with the definitive control over the bridge on the Tiber.

Within the cliff that houses the town, benefiting from a favorable geological conformation, the excavation of services such as the water supply network (tunnels, cisterns, wells) and waste water evacuation system, warehouses, depots, cellars, stalls, dovecotes, dwellings and places of delights took place during Orte's whole history. The set of these activities is today partially visible to visitors thanks to the complex of "Orte Sotterranea", a journey through the centuries, which winds for hundreds of meters in the heart of the cliff.

2. Methods

Given the variety of underground works, research in urban areas undoubtedly has a strong interest, as cities must be considered as organisms in constant movement and their understanding cannot be limited to emerging volumes.

The subsoil of Orte has been used since the early stages of occupation of the plateau, a layered use over the centuries that has led to the reuse and adaptation of artificial cavities to different purposes. The strong need for

[1] Fatucci 2013.

development and raw materials that the city has known over the centuries has meant that many of the cavities were destroyed or that we lost track of them, being incorporated into large building complexes or covered under layers of asphalt (De Minicis, Pastura 2015).
In consideration of this, several cavities and about two kilometers of underground network were surveyed, allowing a reorganization of knowledge and a specific protection plan for the buried heritage.

It was decided to organize the research by homogeneous fields. On the basis of the acquired knowledge, the study initially focused the attention on the underground hydraulic network, which presents a greater number of archival information and archaeological data and could give more information on the production activities carried out in the subsoil.

The bibliography was checked to verify its reliability and obtain further insights, for example particular attention was paid to an important contribution by Angela Napoletano and Marina Marcelli[2]that surveyed in detail the subsoil for the realization of a general planimetry in conjunction with the methane works of the historic center started in 1991.

At this point, undisputed was the need for new research, a "carpet" survey of the subsoil, with the aim to increase the amount of data; in fact activities like the building development and restoration can bring to light new ancient elements, previously unknown.

In recent years. the studies on artificial cavities have intensified and methodologically specialized, allowing, in addition to the global understanding of the formation and development of the hypogeal complexes, also the diachronic analysis of the individual units[3].

In the case treated, attention was given to the relations between the hypogean cavities and the inhabited area in order to clarify the diachronic temporal development of the complexes.

A fundamental tool for the knowledge of hypogeum structures is the realization of planimetric surveys performed with extreme scientific rigor, to capture the organization of the space and record useful information for the realization of a reference polygonal for the correct functional interpretation, although the morphological roughness in some cases complicates the operations, and to realize a complete tracking of the accessible hypogea and the reporting of those difficult to access.

We then moved on to the direct survey of the hypogean cavities which, after the scanning and tracing operation performed using a vector graphics software, were placed inside an integral relief and then superimposed on the cadastral map by means of known georeferenced points.

For the definition of the relative chronologies we used the survey methods established by recent research, paying particular attention to the analysis of architectural planimetric anomalies and to the analysis of traces of excavation[4], while it was not possible to carry out, especially in the cunicular network, morphological typologies.

With regard to the tunnels, it was therefore not possible to extrapolate a typological classification based on the intrinsic characteristics of the artifacts and they were classified only according to their function and the chronological terms, unlike other cavities such as the dovecote of Via Solferino or the Pozzo di Neve, are always relative. The indirect methods have been used exclusively for the understanding of the development of the single unit as the archive sources offer an absolute dating.

For planimetric-architectural anomalies we mean the elements that betray the continuity of the excavation: folds of the walls, steps on pavements, vaults, changes of direction and shape variations; all elements able to provide fundamental data for the understanding of the development of the hypogeal complexes. The same potential is offered by the analysis of the traces of excavation, that in the undergrounds of Orte benefit from the "lucky" condition of a very soft geological substratum that allowed the formation of very evident traces, highlightened also by the granulometry of the tuff that facilitates their measurement.

The reading and identification of the development phases is certainly the central moment of the research, for the interpretation of a primary function and of possible transformations. The traces of the pointed excavation tools left on the walls are essential information in the reading of the directions in which the excavation proceeded, above all in the points of intersection between originally independent tunnels or rooms.

As for the instruments used, Riera summarizes for the hydraulic works in this way "according to the testimonies we don't go further than the use of the gravina, the hammer, the wedge, the chisel, the perch, the shovel, the harpoon and the bucket in their most varied forms[5]. Some of the tools used are direct percussion (pickaxe, adze, etc.) and others with indirect percussion (chisels, wedges, irons, etc.). The latter are mainly used for finishing. Among the best documented instruments there is the two-pointed pickaxe, whose traces have been identified in all the cavities inspected, even if there are variations in the dimensions of the tips, probably attributable to the different functions that were to perform during the excavation operations as already emerged from the analysis of the Sienese “Bottini”[6].

The detailed analysis of the tracks, based on the elaboration of digital images, highlighted a particular accuracy in the original plant of the hydraulic works with the tufaceous walls worked with extreme care by means of a pick and verticalized in correspondence of the accessional wells by means of a flat-blade tool similar to an adze. The most coarse interventions in the water network, realized with tools with a much wider blade,

2 Napoletano, Marcelli 2006.

3 De Minicis, Pastura 2015.

4 Pastura 2013.

5 De Minicis, Pastura 2015.

6 Bargagli Petrucci 1992.

without paying particular attention to the verticalization of the walls, seem to be related to later phases when the underground aqueduct spaces were reused for production, storage and in some cases abandoned.

With regard to the dovecotes and other relevant areas of additional production activities, the excavation does not have the accuracy of the ancient sectors of the hydraulic network, but it is still well crafted, unlike the quarrying activities identified at Palazzo Alberti where the walls narrate a fairly intense extraction activity carried out with "heavy" instruments.

A different interpretation must be made for the rock nymphaeum, where the care of the excavation is strongly connected to the final destination of the cavity and based on an aesthetic criteria that requires an extreme accuracy of the workers.

In conclusion, the methods of excavation appear related to the final destination of use of the cavities, that determine the degree of accuracy and the manner of execution.

4. Results and discussion

4.1. The path of the water

The hydraulic network looks like a tangle of tunnels, surveyed for 1800 m, that crosses the entire cliff, in a longitudinal and latitudinal direction, and whose backbone is represented by a duct that crosses the whole plateau from West to East.

The plant was conceived in the Etruscan period to recover the infiltration rainwater and channel it into wells thanks to the porosity of the tuff, as testified by the recent archaeological investigations in the lateral branch of Via Gramsci.

It is only later that the articulated water system is created and designed to transfer spring water from the Colle delle Grazie to the urban fountains. It is difficult to provide the chronologies of these transformations, even if we can hypothesize the establishment of the aqueduct in contemporary with the monumental redefinition that the town has undergone during the Augustan age[7].

In fact, according to archaeological data on the consistency of the town in the Augustan age, it is evident that the hydraulic network based on percolation water was insufficient to cope with the number of inhabitants, for which it was probably replaced by the aqueduct supplied by external sources. We can hypothesize that, as documented for the Renaissance period, in the Roman aqueduct the channeled water from the springs located on the Colle delle Grazie, descended through the small valley between the hill and the rocky spur of the Bastia, and then it was rised by pressure on its summit continuing through arches to the cliff of Orte, where it connected to the hypogean ducts up to the square fountain[8].

The Roman aqueducts remained in use, undergoing only maintenance interventions, until the early Middle Ages, with the first renovation work dated to the ninth century, a period in which some piping made of hollow parallelepiped peperino elements are put in place.

During the Middle Ages restoration and consolidation work were made in the aqueduct, but those are difficult to identify archeologically. Shortly after the mid-fifteenth century, following the collapse of the tuff between the Bastia and the Rocca cliff, a new arched acqueduct was built.

Once arrived in the Rocca area the water penetrated in the underground ducts to be distributed in the urban area through the tunnel network up to the Fontana Grande. Between the end of the sixteenth and the beginning of the seventeenth century the Leoncini describes the aqueduct of Orte in these terms *".. la sua fonte sotterranea, scendendosi per alcuni gradili (sic) in essa, e l'acqua della quale viene per l'acquedotto di legno, che sale alla Bastia et viensi per mezzo la città, danno (sic) a molti cittadini comodità di poterla pigliare passando sotto le lor case, è l'acqua in somma perfectione (?) nascendo nel sasso sotto la Madonna delle Grazie, ch'è leggiera e dolce".*

A bird's eye plan dated to 1781 related to the construction of the parish of San Michele Arcangelo, from the archives of the Episcopal curia of Orte, depicts an aqueduct in wooden pipelines that reaches the arches that supplied the village with water. The latter were almost completely demolished when the Bastia was mined in the fifties of the nineteenth century and when the cast iron pipes aqueducts was already in use, as can still be observed todays in the tunnels of the ancient aqueduct. The wooden pipes route has a sinuous trend, characterized by various changes of direction probably dictated by the need to slow down the speed of water, as well as by the changes in consistency encountered in the bedrock.

The entrance is currently located in the area of the Rocca fortress and, thinking of following the original route of the water, today you can begin the inspection of the tunnels from a segment obstructed by a modern wall up until the Hypogenean Fountain, which is now the access for tourist tours. The Fountain, despite the numerous changes, still partially maintains its original appearance: two marble columns supporting a cross vault framing the front, consisting of a small arch on pilasters framing from which water flows.

Fiureg.1: Cocciopesto well

7 Pastura 2013.

8 Napoletano, Marcelli 2006.

Conceived as a cistern, probably in correspondence with the monumentalization of the town mentioned above, it represented the terminal of the primitive aqueduct and for a long time it was the only source of public water supply and storage for the city. On the travertino slabs on the sides of the basin there are still evident signs of the vessels that the women for centuries lined up to draw water. The city statutes provided for severe penalties for anyone who had soiled. A custodian, commissioned by the Priors, was obliged to clean it and keep the keys to the fence, and no one was allowed to open it outside of him[9].

Along the path of the main tunnel numerous side openings are visible, used for the vent of the water in case of exceeding the levels of guard, or for other uses. Among these, the well of via Gramsci, the cistern of piazza Fratini, the Cocciopesto well and the Vascellaro hypogeum are of particular importance.

In particular, the first represents the central part of the water distribution network in the Via Gramsci area, a few meters north of the apse of Santa Maria Assunta cathedral, and is connected to the main tunnel by a 10 meters long "overflow" side branch. The well has an inlet and a ring made entirely of dry-wall limestone blocks, the cistern is dug entirely in the tufaceous bedrock and is covered with a particular engobe of clay which isolates the tufaceous wall and waterproofs the inside of the well. The results of a recent archaeological survey, still in print, seems to date the well back to the 5th - 4th century BC, in consideration of its closure in the late republican age.

G.P.

4.2. Dovecotes

The examples of cavities related to productive activities are best represented by the rock dovecotes, that are distributed on several levels on all the slopes of the cliff.

With the term of rock dovecotes are identified hypogeal chambers on the upper edge of the tufaceous plateau, often near or below still existing inhabited nuclei; they are characterized by walls almost completely covered with niches arranged neatly on several rows, and by windows, even if these are not always preserved[10].

The analysis of these structures gives not only a greater knowledge of the subsoil but also important indications on the socio-economic context of the city in the Middle Ages and on its urban development.

In recent years the Lazio rock dovecotes have been the subject of numerous studies, mainly linked to rural areas, which have allowed a first typological classification and the identification of some recurrent elements that characterize them. Among these, certain aspects of a topographical nature are of particular importance, such as the distance from the human dwellings, the orientation towards the south and the view on watercourses; other characteristics are strictly functional, as for example the arrangement of the nests at a height such as to allow the birds to deposit the guano, which could then be easily collected by the farmer.

At the current state of research we can count about fifty dovecotes on the slopes of Orte, while many others have to be added even if incorporated into private properties or made unreachable by the numerous collapses that have affected the northern slope of the cliff.

The possibility to analyse such a large number of examples has made it possible to identify some recurring elements and to correlate them with those highlighted by recent research on this category of artificial cavities.

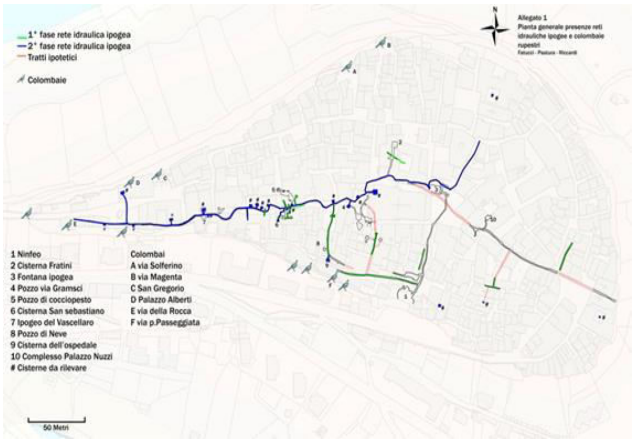


Figure 2. Orte sottoranea complex

Firstly, on the one hand the archaeological research documents with certainty that these cavities have been excavated in non-anthropized places near the cliffs and without reusing pre-existent environments, on the other hand it is evident that the orientation rules are ignored. Basically, while it is easy to have openings near watercourses, which touch the plateau in all its sides, it is clear that the need to have new production spaces is in itself a strong discriminating factor for the exposure of the structures, which are most likely excavated in the only surfaces left free.

The intensive use of these structures, in fact, must have created the continuous need to excavate new cavities and it is easy to imagine that they have reached the point of occupying all the available surfaces.

This moment of intense exploitation of the subsoil is characterized by the maintenance of pivotal concepts, which had to be at the base of the correct functioning of the structures.

The recurring elements appear to be the verticalization of the external walls to prevent the unpleasant animals from attempting to climb the window, to which only in some cases a very clean white plaster was applied, to make the access visible to the birds and prevent the climbing of predatory species . Also for indoor spaces there are rather recurrent characteristics; in the first place, the niches for the pigeons, dug in the tufaceous bench and arranged in several rows, generally did not have to be at the level of the floor (even if the Via Solferino dovecotes show that this is a gradually matured trick) to prevent animals such as mice from accessing the broods and to ensure that the guano is deposited on the ground and does not stain the nests placed in the lower rows. In this way the breeder

9 Pastura 2013.

10 Pastura 2013b.

was facilitated in the removal of the guano, which was then used for agricultural activities. The niches are generally inclined inward to prevent the egg from slipping out of the nest and falling to the ground. The rooms are almost always equipped with drainage channels, able to facilitate the breeder in the cleaning of the dovecote.

Furthermore, the study of the planimetries, accompanied by the observation of the architectural elements and the reading of the excavation traces, allowed a typological classification of the structures based on the shapes of the niches, which initially have an irregular shape with staggered rows and later pass to regular shaped niches arranged on horizontal rows, which represent the most commonly used type, and last, in the fourteenth-fifteenth century, they end with the so-called "cottage" niches.

Starting from the mid-fourteenth century these structures lose their function, probably due to changes in food and socio-economic needs. These changes are reflected from the material point of view by the reuse of cavities as cellars or for other productive activities. Moreover these phases coincide with a radical topographical transformation of the inhabited area which, thanks to a notable demographic increase, also occupies the areas closest to the cliff slopes, now no longer occupied by vegetable gardens and by areas destined to feed pigeons.

4.3. Snow well

One of the many production activities present in the subsoil of Orte is linked to the exploitation of snow for the conservation of the products necessary for the functioning of the city hospital. The snow pit represents the lower level of an articulated hypogeum complex that, restored in 1891 as evidenced by an inscription in situ, is one of the very few surviving examples of this type of structure. The snow, transported in compact blocks wrapped in straw and taken from the nearby Monti Cimini, was deposited inside the structure and used to guarantee the refrigeration of the entire hypogeum[11].

The set of rooms and passages that make up the hypogeum complex is attributable to interventions that took place at different times. The most ancient nucleus, visible in the room on the right after the first two flights of stairs, consists of a network of tunnels, branches of the "overflow" system of the main conduct of the Roman acqueduct. The “overflow” tunnels are articulated in a main passage, subsequently tampered with the breaking of the western wall, and by two lateral branches that allowed to temporarily divert the water and to intervene, if necessary, in the maintenance of the tunnels. When the Raccomandati hospital is established on the surface and the cellars are escavated under it, the water conveyance is changed and diverted into the right branch towards the large cistern and into the one on the left towards the hospital service lavatories.

The excavation of the third flight of stairs, with slides on both sides and a ring to secure the barrels, is probably dated to the nineteenth century; these new steps lead to a compartment transformed in 1891 into a real cold storage, with the construction of a well for the preservation of snow blocks.

This is a large rectangular chamber dug into the tuff where the snow was stored at a constant temperature in a semicircular masonry structure containing a well and flanked by a small cistern to collect the water generated by melting snow.

The snow well is almost a rarity, since it is one of the few examples that has been perfectly preserved up to the present day and also because it bears a graffiti inscription to its side in which the architect declares his identity, the date of the end of the work, the destination of use of the structure and the name of the client: “*Cecchini Albino nel 1891 20 ge(nna)io fu fabbricato questo Pozzo di Neve deposito ordinato dal Sig(no)r Luigi Tan(---) chi Amministrato(re) de(ll’) Ospedale*”.

At the end of the cycle or in case of maintenance, the residual water was deposited in the well below the inscription, which was subsequently emptied.

Figure.3: Dovecotes. A complex of Via Magenta

4.3. Hypogean Nymphaeum

An example of an underground Nymphaeum, opened on the southern slope of the tuffaceous cliff, is located under the garden of via Belvedere. The artifact consists of a system of rooms, connected to each other and distributed on two overlapping levels, almost totally dug into the tuff. Some of the rooms have openings on the south slope overlooking the via della Passeggiata. The different levels are connected by two flights of stairs dug into the rock. All rooms are characterized by a system of columns, arches, basins and channels that supplied water to the various pools and fountains. These elements are also obtained by digging directly into the tuff bedrock. The Nymphaeum is the final part of the water supply duct coming in South-West direction from the Piazza della Libertà[12].

There are two accesses: the easiest one is the flight of stairs that from the garden leads to the underground

[11] Lopardo, Fatucci 2013.

[12] Schiano 2013.

rooms, while the second, currently obstructed, is the side tunnel which from the underground fountain of Piazza della Libertà, supplied the basins and fountains system of the Nymphaeum.

The first level consists of three rooms: the first two have windows on the southern slopes of the cliff and are characterized by rectangular openings framed by bricks, while the two other opening leading to the inside rooms are made by brick arches, probably remade in a later phase; the two rooms have a roughly rectangular shape and the walls are made of irregularly squared tuff blocks. The first of the two rooms is covered by a succession of pseudo-vaults, consolidated with two large metal chains placed on two pillars emerging from the perimeter walls. The third room has a less regular shape and the walls are entirely dug into the tuff, as this is the deepest room of the complex (moreover on the ceiling we find a portion of a possible tunnel, similar to the section of all the others found in the rest of the inhabited area); the walls are decorated at various levels by a series of niches with an arched profile no deeper than 40 cm, while on the northern wall a small brick vault, rather degraded and deformed, and a series of small arch shaped recesses (dimensions 3x3 cm) make one think of small fixed beams arranged to form a sort of additional barrel vault. All the three rooms of the first level do not present any type of floor or cladding on the walls: both the small recesses on the walls and the brick vault would suggest something much more recent, probably an intervention after the first use LIZZO.

From the first level a rather steep ramp located on the north wall of the third room reconnect with the tunnel (North-East South-West axis) coming from the fountain of Piazza della Libertà and flowing into the second level of the Nymphaeum at an altitude of -9m from the garden level. Along the path of the ramp on the south wall, exactly under the brick barrel vault, we find an arched brick opening, with a sort of compartment behind and obstructed by debris, in correspondence of the third room of the first level.

Figure .4: Hypogean Nyphaeum. First level

The second level is also accessible from the first of the three rooms of the first level, through a staircase entirely carved into the rock with slightly arched profile. Going down this staircase you have access to a small almost totally plastered room, at an altitude of - 8.5 m, with an opening on the north wall about 1.5 m from the floor which gives onto a rectangular water storage cistern at an altitude -9m, entirely plastered and covered with a vault. The cistern was supplied directly from the canal carved in the tunnel coming from Piazza della Libertà and is vertically connected to a well in the garden, from where the water was probably extracted with buckets. Under the opening level of the first cistern a small tank captured the water through a hole in the wall.

From this first small room you access the second cavity, the largest of the Nymphaeum, the ending point of the tunnel coming from the main square. Entirely dug into the tuff rock, with an irregular shape, this compartment has a series of pools on its perimeter at different altitudes, probably forming a series of water games, exploiting the differences in height. On the north side there is a rather low and squat column with hexagonal section and Tuscanic capital carved directly from the bedrock.

In this room we also find the reproduction of an Etruscan chamber tomb open on three sides and a funeral bed carved into the tuff. All the tanks were supplied by a perimeter channel dug on the walls and directly connected to the tunnel. In one of the tanks a sculpted mask is used as an element of dripping, in fact a small hole in communication with the inside of the tank made the water percolate from the mask's mouth into another tank at a lower level.

From this room, through a small ramp along the south wall, we descend into the third compartment, at an altitude of -10m. Here too we find a series of pools creating water games and on the north wall a system of arches and columns carved directly into the tufa bench. The latter is characterized by a central block with a closed arc from which the water supplied by the perimeter channel, as in the previous room, flows into a small basin fixed in the wall and then into the rectangular fountain below. On either side of the arch two large columns with capitals and without base occupy the whole height of the room, while on both sides a system of two arches supported by slender columns with capitals and no base. This system of arches is repeated partly behind the north wall of the room and forms a sort of small barrel vaults through which one can access the fourth compartment, a cistern situated at a lower level.

L.T.

References

Bargagli Petrucci F, 1992. Le fonti di Siena e i loro acquedotti. Note storiche dalle origini fino al 1555. Siena .

Napoletano A, Marcelli M., 2006, L'abitato di Orte: il sistema idraulico ipogeo. In Aureli P, De Lucia Brolli M.A, Del Lungo S (Ed), Orte (Viterbo) e il suo territorio. Scavi e ricerche in Etruria Meridionale. Notebook on Medieval Topography. 7, BAR 1545, Oxford, pp. 75-114.

De Minicis E, Pastura G, 2015 . Insediamenti rupestri e popolamento: l'area della Tuscia tra monti Cimini e il Tevere. In Arthur P , Imperiale M.L, (Eds.), VII Congresso Nazionale di Archeologia Medievale, I, Firenze, pp. 411-417.

Fatucci M, 2013. Inquadramento storico. In Pastura G (Ed.) La città sotto la città:Analisi e ricerche nella parte sepolta dell'abitato di Orte. In Quaderni del Museo Civico Archeologico di Orte, I, Acquapendente, pp. 17-25.

Leoncini : *Fabbrica d'Orta*, handwritten,vol. IV, f. 51.

Lopardo S, Fatucci M, 2013, Conserve e pozzi di neve. In Pastura G (Ed.) La città sotto la città:Analisi e ricerche nella parte sepolta dell'abitato di Orte. In Quaderni del Museo Civico Archeologico di Orte, I, Acquapendente, pp.95-113.

Pastura G, 2013. La città sotto la città: Analisi e ricerche nella parte sepolta dell'abitato di Orte.- In Quaderni del Museo Civico Archeologico di Orte, I, Acquapendente.

Pastura G, 2013b. Le colombaie rupestri. In Pastura G (Ed.), La città sotto la città: Analisi e ricerche nella parte sepolta dell'abitato di Orte.- In Quaderni del Museo Civico Archeologico di Orte, I, Acquapendente, pp. 77-95

Pastura G, 2017. Tra Monti Cimini e Tevere. Forme dell'insediamento tra VI e XII secolo. Dadidalos. Studi e ricerche di Archeologia e Antichità, Università degli Studi della Tuscia, Viterbo.

Schiano P,2013. Il ninfeo. In Pastura G (Ed.), La città sotto la città: Analisi e ricerche nella parte sepolta dell'abitato di Orte. In Quaderni del Museo Civico Archeologico di Orte, I, Acquapendente, pp.61-76.

ARTIFICIAL CAVE SHELTERS OF THE PHRYGIAN HIGHLAND (TURKEY): DEFENSIVE DEVICES AND PRINCIPLES OF ORGANISATION

Tymur Bobrovskyy[1], Igor Grek[2], Mykhailo Shyrokov[3]
[1]*Saint Sophia National Preserve, Volodymyrskaya str. 24, 01001 Kyiv, Ukraine,bobrovskij@ukr.net*
[2]*Speleoclub "Poisk",Rabina str.47 ap.112, 65072 Odessa,Ukrain,grekigor@mail.ru*
[3]*Speleoclub "Poisk",Rabina str.47 ap.112. 65072 Odessa, Ukrain, mikeshyrokov@gmail.com*

Abstract
The Phrygian Highland is located in central Anatolia to the southwest of Ankara. Here in the rocky outcrops there are a lot of monuments carved in stone: pagan and Christian tombs, sanctuaries and churches, as well as cisterns, storages and shelters. Cave shelters fixed in the territory of the Phrygian Highland by analogy with Cappadocian cave monuments can be for convenience divided into two types - rock and underground complexes. In this article, we considered the design features of some artificial cave complexes that were inspected by us during visit to this region in 2015-2016.
The rocky shelters of the Phrygian Highland are fairly simple structures consisting of one or several chambers protected by a single and uncomplicated defensive device: an inclined cave gallery with steps (Ayazin V-VI, Ayazin XV-XVI), a rock with footholds and handholds (Ayazin V-VI, Ayazin IX), vertical or steeply inclined shafts (Doyer, Ayazin V-VI, Ayazin IX). In two cases, the development of the shelters occured simultaneously with or after the appearance of the cave churches (Doger and Ayazin XV-XVI). The liturgical arrangement of these churches indicates that the time of creation was not earlier than XII-XIII centuries. The underground shelters of the Phrygian Highland, similarly to the Cappadocian shelters, developed successively and in stages - from the simplest forms to the echeloned and labyrinthical structures created with use of similar principles of defense organization. However, unlike in the underground shelters of Cappadocia, where moving millstone doors were the most common defensive element, only shafts and traps were used in the shelters of the Phrygian Highlands.

Keywords
Artifical caves, cave shelters, rock and underground complexes.

1. Introduction

The Phrygian Highland is located in central Anatolia southwest of Ankara. Here in the rock outcrops there are a lot of monuments, carved in stone: the pagan and Christian tombs, sanctuaries and churches, as well as the cisterns, storages and shelters. The most famous monuments of this territory dated to the Phrygian time, but there are no less common the cave structures of late antiquity and the Middle Age (Freely 1999, p. 42-57).

The cave shelters, that are fixed here (*Fig. 1*), by analogy with the Cappadocian cave monuments, can be conditionally divided into two types – rock and underground complexes (Gülyaz et al. 2007, p. 29).

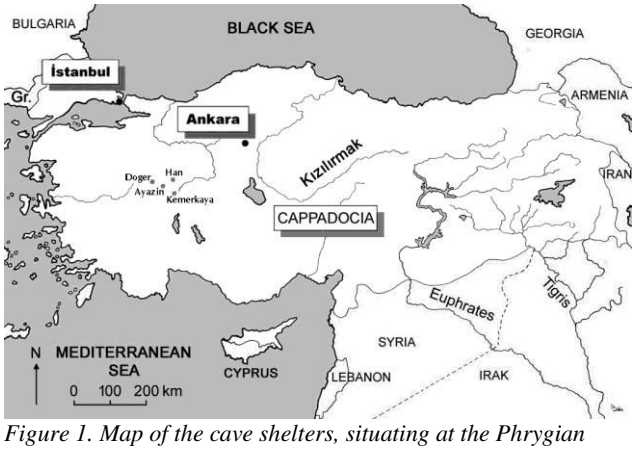


Figure 1. Map of the cave shelters, situating at the Phrygian Highland (drawing R. Bixio / add. T. Bobrovskyy).

As a rule, the rock shelters consist of the caves, carved in tuff outcrops and situated mainly in the zone of natural illumination, at some (sometimes considerable) height above the surface. In contrast, the underground shelters, often also called "underground cities", are located outside the natural light zone and extended beneath the earth's surface.
As established by previous studies in the Cappadocia, the cave shelters, regardless of their variety, consist of the rooms, that are additionally protected by a various defensive elements: the narrow tunnels, vertical or inclined shafts, steep rocky areas with a ditches for rock climbing, the millstone swinging doors and other (Bixio and De Pascale 2015).
Besides, the rock and underground shelters, encountered in Cappadocia, have a similar arrangement. Here we can see the fairly simple structures, consisting of the one or few rooms that were protected by the minimal defensive devices. From another side, there are more complex monuments with a number of the escheloned protective devices and premises, protected by them. However, even complexical plannings of the cave shelters fix only a certain stage of their development, when the "primitive" and initially isolated constructions became more complex and, eventually, merge into the treepod or labyrinthine structures (Bobrovskyy and Grek 2011).

Immediately note, that the "Phrygian" cave shelters, although not as numerous as the "Cappadocian" monuments, have many features in common with the

latter, indicating certain uniform patterns in the development of these rock-cut constructions in both regions.

2. Constructions of the cave shelters

2.1. “Primrtive” cave shelters

As in the Cappadocia, the extremely simple formations are the basis for the formation of the cave shelters at the Phrygian Highland. These formations represented by the rooms that are protected in a natural way: by an arrangement at a considerable height on the rock massive or by a camouflage in the walls of the deep shafts in the underground space. Often the cave chambers of the Roman's tombs of the rock complexes (“Ayazin-V-VI”, “Ayazin-IX”, “Ayazin-XI”) and too the walls of hydraulic structures (water intake wells and drenage galleries) of the underground sites (“Kemerkaya-A”, “Kemerkaya-B”, “Han-1”) were used to equip "primitive" shelters (*Fig. 2: Kemerkaya-B/A-A,K1; Han-1/3; Fig. 3: Ayazin-IX/1,3a*).

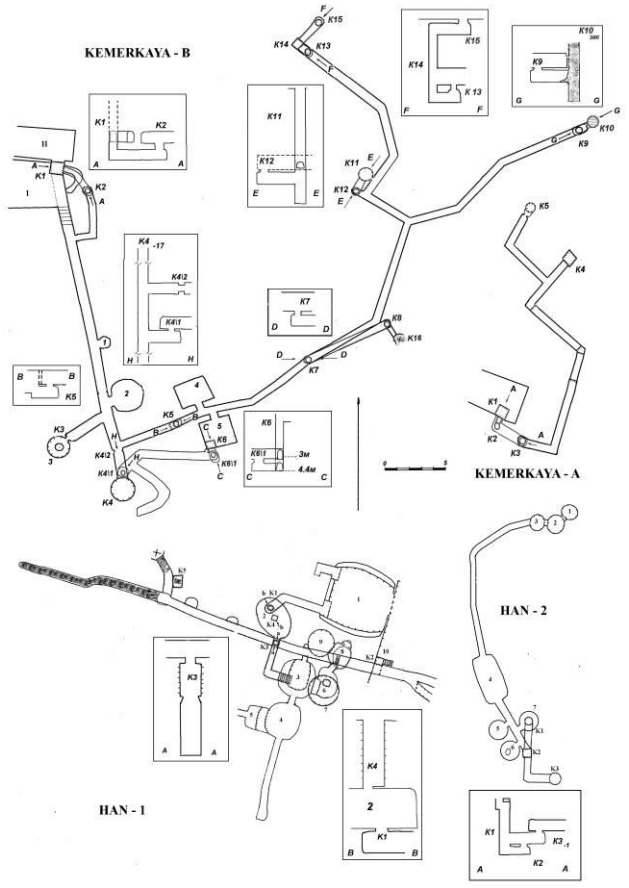


Figure 2. Plans and cross-sections of the underground shelters (drawing I. Grek).

The difficulty of entering into the tombs, that were cut high in the facades of steep cliffs with the "hooks" for climbing leading to them, was complicated by the installation of massive wooden doors, that were locked from the inside. In the rock sites of Cappadocia a similar solution is observed for the numerous cave rooms of the "Tekkaya", "Zemi-2" etc. (Bobrovskyy et al. 2015; Bobrovskyy and Grek 2016a). And also the reach of the chambers, cut down at considerable depths in the side walls of the water intake wells, was further hampered by the disguise of the enters of these shelters by the overhanging stone massifs, as, for example, in the famouses Cappadocian "underground city" Derynkuyu.

The masking of the underground shelters in Phrygian Highland was also manifested in arranging the entrances to the simplest or even sufficiently developed shelters in the floor and walls of large storage pits, as in the complexes "Han-1" and "Han-2" (Fig. *2: Han-1/6-7, Han-2/1-3*). The similar constructions are fixing in a number of Cappadocian complexes, for example, in the "Mazy-1", where the many storage pits were interconnected by hidden internal breakdowns (Bobrovskyy and Grek 2016b).

Also in the rock complexes of the Phrygian Highland another simplest shelters were organisated. They had the entrances with a protective devices in the form of shafts (or steeply sloping narrow passages), that were connecting easily accessible cave structures at the foot of rock outcrops with the actual shelter chambers, located above ("Ayazin-IX","Ayazin-XV-XVI" etc.) (*Fig. 3: Ayazin-IX/2*).

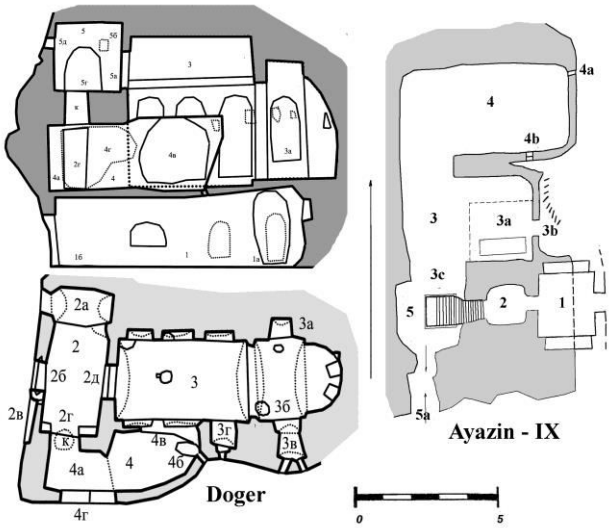


Figure 3. Plans and cross-sections of the rock shelters (drawing T. Bobrovskyy).

As a universal means of protection input communication shafts (not water intake wells) are characteristic also for a number of underground complexes (“Kemerkaya-A”, “Kemerkaya-B”, “Han-2”) (*Fig. 2: Kemerkaya-A/K1; Kemerkaya-B/K1; Han-2/K2*). Besides, these defensive devices are the important elements of the subsequent complication of Anatolian cave shelters, both in the territory of the Phrygian Plateau and within Cappadocia.

2.2. “Escheloned” cave shelters

As in the Cappadocia, the most part of the "primitive" cave shelters of the Phrygian Highland have been complicated over time: they were equipped with additional aisles and rooms, as well as defensive devices - communication shafts and manholes. As a result the several-tiered rock complexes with sequential protection of each level were formed, as, for example, in the complex "Ayazin-XV-XVI" (*Fig. 4*).

Among other things, this stage is characterized by the appearance in the shelters of elements, that indicating their

adaptation to a long stay - ovens, shelves and pits for the installation of vessels, latrines etc. ("Doger", "Ayazin-V-VI", "Ayazin-IX", "Ayazin-XV-XVI") (*Fig. 3: Doger/4b; Ayazin-IX/4b*).

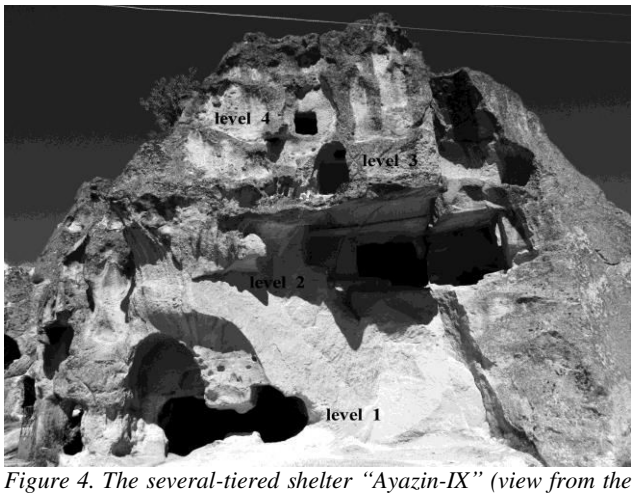


Figure 4. The several-tiered shelter "Ayazin-IX" (view from the souht)(photo T. Bobrovskyy).

In the underground complexes the traces of a similar process are observed: the originals "primitives" shelters were supplemented by one or several defensive lines also protected by shafts and manholes. They deeped into the rock massif by the long aisles (sometimes with a side chambers) and often were supplied with additional evacuation outcrops (for example, site "K2-K3" in the complex "Han-2", "K4-K5" in the "Kemerkaya-A", "K11-K15" in the "Kemerkaya-B") (*Fig. 2*). Although the latrines, common in the underground cities of Cappadocia, are not found in the underground complexes of the Phrygian Highland, there are a number of other signs of the fitness of the local shelters for a long stay: an equipment of chambers with ventilation (site "K3-K5" in the complex "Kemerkaya-B"), a memorial chapel with a child burial in the floor (room 8 in the complex "Han-1") etc.

It should be noted, that far from all the mentioned above evacuation passages in the underground complexes of the shelters of the Phrygian Highland have been opened to the surface. Some of them (branches from chambers 4 and 5 in the complex "Han-1" or from the "K1-K3" shafts system in the "Kemerkaya-A", "K1-K2" in the "Kemerkaya-B") were left in the form of dead-end galleries, similar to the numerous structures in the Cappadocian caves (Sivasa-Gokcetoprak, Mazikoy and others).

2.3. "Labyrinthical" cave shelters

Further, the scattered developed structures of the shelters of the Phrygian Highland, which had several lines of defense, as far as in most analogous Cappadocian monuments, were combined into integral labyrinthical systems. This is best seen in the example of underground complexes. In particular, the cave system "Kemerkaya-A" was formed by the merge of the counter underground passages from the two local shelters (developed around the shafts K1 and K4-K5), and the system "Kemerkaya-B" - from the four shelters (from the shafts K1, K4-K10, K11-K15, K16), and the system "Han-1" - from the two shelters (with a connecting at the rooms 2 and 3), and the system "Han-2" - from the three shelters (with a connecting through the shafts K1 and K2, and between the rooms 3 and 4) (*Fig. 2*). In the rock monuments this is recorded only once: on the late stage the three different shelters of the complex "Ayazin-V-VI" were interconnected by the communication shaft.

It remains to add, that almost all rock and underground Cappadocian labyrinthical complexes were formed in this way - by the combining an initially isolated shelters (Bobrovskyy and Grek 2011; Bixio and De Pascale. 2015). Consequently, the formation of the cave shelters of the Phrygian Highland and Cappadocia occurred according to the similar principles and, quite probably, under the same historical conditions.

3. The notes about chronology and principles of organisation of the cave shelters

Questions of the chronology of the cave shelters are extremely difficult, as the systematic archaeological studies on these monuments usually have not been carried out. At the same time, there are few late-antique tombs were converted into the shelters ("Ayazin-V-VI", "Ayazin-IX", "Ayazin-XV-XVI"), and the shelter "Ayazin-XV-XVI" was constructed from the medieval cave church. On the earliest stage of the development the shelter near the Doger village had premises of the cave church too (*Fig. 3: Doger/3*). The liturgical planning of this church (the probable arrangement of the prothesis in the altar part) indicates that it was built not earlier than the XII-XIII centuries (Vinogradov et al. 2005). The cave church, fixed at the foot of the comlex "Ayazin-V-VI", has the same liturgical arrangement and dating. And although this church do not directly connected with the shelter itself, it was originated in the same manor, i.e. at the same period. Finally, the mentioned Christian chapel was constructed at the one of the late stages of the shelters formation in the underground complex "Han-1". (*Fig. 2: Han-1/8*).

Perhaps the grafical image of the board for "mill" play (the so-called "babylon") in the upper tier of the complex "Ayazin-XV-XVI" is another evidence in favor of the medieval origin of the cave shelters of the Phrygian Highland (*Fig. 5*).

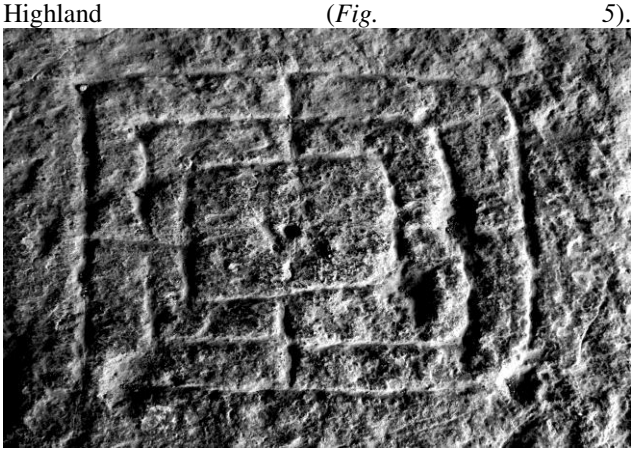


Figure 5. The grafical board for "mill" play in the rock shelter "Ayazin-XV-XVI" (photo T. Bobrovskyy).

The same image was found in the upper (shelters) chamber of the Cappadocian rock hermitage of the St.

Symeon (X century) near Zelve (Rodley 1985, p. 189-193).

Despite the similarity of the arrangements and the general trend in the development of the cave shelters of the Phrygian Highland and Cappadocia, there are several significant differences between them. First of all, it concerns the protective devices, among which in the Cappadocia caves one of the main roles is played by the so-called "millstone" doors (Bixio and Pascale 2015). In none of the complexes of the Phrygian Highland this element has been encountered so far, which seems to be a very characteristic, although not understood feature of the local monuments.

On the other hand, in the complexes Kemerkaya we see a consistent use of a series of the chambers and passages, connected by the narrow hatches ("K2-K3" in the "Kemerkaya-A" and "K2, K5, K6, K7-K8, K9, K12, K13" in the "Kemerkaya-B") (*Fig. 2: cross-sections*). And although in Cappadocia the similar protection of the premises is known too (Bixio and Pascale 2015), however, the defense-observation points, as a separate formed devices type, were implemented precisely in western Anatolia (*Fig. 6*).

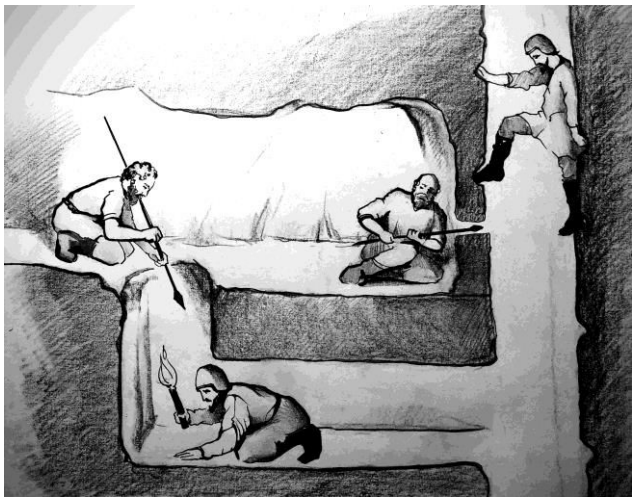


Figure 6. The reconstruction of the defensive organisation in the cave shelter "Kemerkaya-B" (drawing O. Sukhetska).

4. Conclusion

Thus, after examining some cave shelters of the Phrygian Highland in the vicinity of the numbers settlements in the province of Afyon, we can draw a few important conclusions.

All the objects, inspected by us, arose in the structures of the certain settlements, most likely, at the residential estates.

In the case of the complexes of Ayazin these manors were formed on the territory of a large ancient rock cemetery. It was at a time, when the cave tombs became out of use. Since the shelters did not appeared in all homesteads, determined by the number of churches, it should be assumed that the need for protective structures increased as the settlement itself shrank.

Under similar conditions the underground shelters were formed also. Here already the existing water intake wells, the water-supply galleries and the settlements storage pits were used as a started points for cuting.

Virtually all the cave shelters of the Phrygian Highland were not created at a time, but developed gradually, in stages. Their structures, regardless of the rock or underground nature of the complex, were formed from simple to complex, probably reflecting the also inherent Cappadocian monuments' transition from individual "passive" shelters to shelters with escheloned elements of active defense (surveillance of the enemy, covert movements, sudden counterattacks). It should be noted that in the later stages development the shelters of both regions had such elements of the infrastructure as water wells, food stores and seclusion sites. They provided defenders with the ability to withstand prolonged sieges.

Finally, we have no archaeological data on the possibility of creating shelters in the Phrygian Plateau, as well as Cappadocian complexes, earlier than the medieval period. At the same time, in our opinion, the relatively small number of cave shelters, recorded in western Anatolia, testifies to the insufficient speleo-archaeological study of this region.

References

Bixio R., De Pascale A. 2015. Defensive devicesin ancient underground shelters: comparison among the sites of Aydintepe, Ani, Ahlat and Cappadocia in Turkey. International Symposium on East Anatolia – South Caucasus Cultures, October 10-14, 2012 (Erzurum, Turkey). Cambridge, vol. 2, pp. 461-480.

Freely J. 1999. The Western interior of Turkey. Istanbul.

Gülyaz M.E., Yenipınar H. 2007. Rock settlements and underground cities of Cappadocia. Nevşehir.

Rodley L. 1985. Cave monasteries of Cappadocia. Cambrige.

Бобровский Т.А., Грек И.О. 2011. Пещерные комплексы Каппадокии: итоги и перспективы исследований. Праці Науково-дослідного інституту пам'яткоохоронних досліджень. Vinnitsa, v. 6, pp. 116-137 (on russian).

Бобровский Т.А., Грек И.О., Климишина О.И. 2015. Комплекс в отдельном конусовидном останце в долине Земи, Каппадокия. Спелеология и спелестология (Сборник материалов VI Международной научной конференции). Naberezhye Chelny, pp. 154-159 (on russian).

Бобровский Т.А., Грек И.О. 2016a. Комплекс искусственных пещер в туфовых останцах в окрестностях Гёреме. Спелеология и спелестология (Сборник материалов VII Международной научной конференции). Naberezhye Chelny, pp.. 192-209 (on russian).

Бобровский Т.А., Грек И.О. 2016b. К изучению «подземного города» в селении Мазыкой (Мазы) в Центральной Каппадокии. Спелеология и спелестология (Сборник материалов VII Международной научной конференции). Naberezhye Chelny, pp. 98-113 (on russian).

Виноградов А.Ю., Гайдуков Н.Е., Желтов М.С. 2005. Пещерные храмы Таврики: к проблеме типологии и хронологии. Российская археология, № 1, pp. 72-80 (on russian).

INVENTORY AND ANALYSIS OF UNDERGROUND OIL MILLS IN THE TERRITORY OF LECCE (APULIA, SOUTHERN ITALY)

Stefano Margiotta[1], Mariangela Martellotta[2], Mario Parise[3,4]
[1] *Geologist, Lecce, Italy*
[2] *Gruppo Speleologico Leccese 'Ndronico, Lecce, Italy; mariangelamartellotta@yahoo.it*
[3] *Università Aldo Moro, Bari, Italy; mario.parise@uniba.it*
[4] *Centro Altamurano Ricerche Speleologiche, Altamura, Italy*

Abstract

The production of olive oil is known as one of the main agricultural activities in many Italian regions. This fame comes from a long history, and a complex chain of working phases as well, which at some locations occurred mostly underground. In Apulia, southern Italy, and particularly in its southeasternmost sector, Salento, oil mills were typically realized as subterranean spaces, due to a number of reasons, the main ones being lower expenses (when compared to the cost of building up an over-surface structure), and the easy workability of the outcropping rocks. These latters consist of soft rocks, represented by Miocene to Plio-Pleistocene calcarenites.
In the territory of Lecce, the most important town in Salento, the historical documentation reports about 40 oil mills (locally called *trappeti*) during the second half of the 18th century. These were underground structures related to rural houses (locally called *masserie*), north of the town. From the structural standpoint, they belong to the typology of "cavities dug in the subsoil", being underground structures in the strict sense: that is, rooms obtained by removing and digging rocks under the surface level. In the classification of artificial cavities by the Commission of the International Union of Speleology, underground oil mills belong to Type B: Hypogean civilian dwellings, and specifically they are classified as B.3 – Underground plants or factories. They were actually real working places, where workers often used also to sleep, especially during the hot season. The underground spaces could be very large, with a high number of rooms dedicated to collection and work of the olives, but also as storing places, stables for the animals, and sleeping rooms for the workers. In a few cases, water wells or sites to collect and preserve the ice were excavated in the same underground structure, too. Working underground had, on the other hand, negative outcomes for the overall quality of the oil, due to lack of air and light, heating due to presence of workers and animals, and the process of fermentation of the olives stored in the rooms. All of this resulted in low quality of the oil, so that it was typically used for industrial purposes (i.e., lighting) rather than for food.
Starting from the beginning of the 19th century, a transformation was registered in the rural setting, since olive farming was not convenient anymore, and the passage to intensive vineyards occurred. This had as a consequence the progressive abandonment of underground oil mills, for many and many of which a loss of memory had to be recorded.
In this contribution we present the results of recent geological and topographic surveys that allowed us to find 17 underground oil mills, not included in the Cadastre of Artificial Cavities of Apulia Region. Six out of them have been restored by the owners, and are presently used for different types of tourist activities; the remaining 11 are generally in bad conditions, abandoned, and often have been used as illegal waste disposal. In addition to illustrating their main characters, some considerations about the stability of the underground structures will also be presented, by describing the main situations where instability features have been observed and mapped.

Keywords

artificial cavity, oil mills, inventory, Apulia.

1. Introduction

The production of olive oil is known as one of the main agricultural activities in many Italian regions. This fame comes from a long history, and a complex chain of working phases as well, which at some locations were mostly occurring underground. In Apulia, southern Italy, and particularly in its southeasternmost sector, Salento, oil mills were typically realized as subterranean spaces, due to a number of reasons, the main ones being lower expenses (when compared to the cost of building up an over-surface structure), and the easy workability of the outcropping rocks. These latters consist of soft rocks, essentially represented by Miocene (Pietra Leccese) to Plio-Pleistocene calcarenites (Gravina Calcarenites).
In the territory of Lecce, the most important town in Salento, the historical documentation reports about 40 oil mills (locally called *trappeti*) during the second half of the 18th century. These were underground structures related to country houses (locally called *masserie*), north of the town. From the structural standpoint, they belong to the typology of "cavities dug in the subsoil", being underground structures in the strict sense: that is, rooms obtained by removing and digging rocks under the surface level (Galeazzi, 2013; Parise et al., 2013). In the classification of artificial cavities by the Commission of the International Union of Speleology, underground oil mills belong to Type B: Hypogean civilian dwellings, and specifically they are classified as B.3 – Underground plants or factories (Parise et al., 2013, 2015). They were actually real working places, where workers often used also to sleep, especially during the hot season. The

underground spaces could be very large, with a high number of rooms dedicated to collection and work of the olives, but also as storing places, stables for the animals, and sleeping rooms for the workers. In a few cases, water wells or sites to collect and preserve the ice were excavated in the same underground structure, too. Working underground had, on the other hand, negative outcomes for the overall quality of the oil, due to lack of air and light, heating due to presence of workers and animals, and the process of fermentation of the olives stored in the rooms. All of this resulted in low quality of the oil, so that it was typically used for industrial purposes (i.e., lighting) rather than for food.
Starting from the beginning of the 19th century, a transformation was registered in the rural setting, since olive farming was not convenient anymore, and the passage to intensive vineyards had to be registered in wide sectors of Salento. As a consequence, there was a progressive abandonment of underground oil mills, for many and many of which a loss of memory had to be recorded.

In this contribution we present the results of recent geological and topographic surveys that allowed us to find 17 underground oil mills, not included so far in the Cadastre of Artificial Cavities of Apulia Region. Six out of them have been restored by the owners, and are presently used for different types of tourist activities; the remaining 11 are generally in bad conditions, abandoned, and often have been used as illegal waste disposal. In addition to illustrating their main characters and the local geology, some considerations about the stability of the underground structures will also be presented, by describing the main situations where instability features have been observed and mapped.

2. Oil production in Salento

Apulia region, the heel of the Italian boot, has an economy strongly based on agriculture, with some products such as vines and olive oil representing the main field of activity of farmers. In particular, cultivation of olive trees, and production of olive oil, has always played a significant role in many sectors of the region. Oil industries were, in Salento (the southernmost peninsula) as elsewhere, the last evidences of a significant rural culture (Monte, 2003).

Figure 1. Inner view of an underground oil mill in the rural area around Lecce.

Together with pasture and cereals, oil production was in fact part of the main system of work for the Apulian agriculture, especially during the time of greatest development, in the 16th century (Costantini, 2017). In this setting the underground oil mills (known as *trappeti* in the local dialect) transformed not only working spaces, but rather real factories where the human and animal activities were continuous, typically covering the period from November to May (Monte, 1992, 1995; De Marco & Sannicola, 2007; Fornaro et al., 2008).
Safeguarding and exploiting sites such as the underground oil mills in the Lecce area represents an effort toward discovering those values that were in the past economic and working activities, and that nowadays are a significant testimony of the past working places, and of the relationships between man and the natural setting as well.
Access to the underground oil mills (Figure 1) typically occurs through a steep stairway excavated in the rock mass, which had to be wide enough to allow the passage of a donkey. This animal served as the labor force to let spin the stone mechanism needed for the press. Once transported underground, the donkey was destined not to see the light anymore since, at the end of its life cycle, it was consumed as food by the same workers.

From the stairway it was possible to have access to the underground space, reaching the main room, where the millstones and the presses were present, together with the wells for the collection and the decantation of the oil (Figure 1). Size of the room changed in function of the importance of the oil mill, and of the surrounding lands as well. The main element of the room was the mill tank (also called “the spring”), shaped as a bowl, about 3 m wide, and where the millstone was placed (Figure 2). This latter, with a diameter of at least 2 m and some 0.6 m thick, was obtained from a single block of rock, typically in the Mesozoic limestones cropping out in the area. Locally, millstones in calcareous breccia have also been found. In connection with the main room, there were the so-called *sciave, sciaie* or *sciaghe*, depending upon the local dialects, that is smaller rooms with the function of storage rooms, often with an opening toward the ground to allow the direct discharge of the olives, directly from the carriages. In many oil mills there were also further spaces, dedicated to stable for the animals, sleeping sites for the workers, and a site where the meals were consumed.

Figure 2. Stone mill.

As also happened for the development of underground quarries for the extraction of building materials, the reasons at the origin of the choice to build underground oil mills were twofold: the lower cost of excavation, when compared to the costs necessary for building an above-ground structure; and the possibility to use the ground for other purposes, i.e. agriculture (Parise, 2010). Further, the opportunity to work underground at temperatures between 18 and 20 degrees in a period where, above the ground, the temperatures were well above the thirties, if not up to 40°, was an additional reason to develop these subterranean working sites. Actually, underground there was a constant temperature, thanks to the isolation capacity of the calcarenite rock mass (Sammarco & Parise, 2008; Sammarco et al., 2008; Del Prete & Parise, 2013). On the other hand, there were some contrasting negative features: lack of air exchange with the outer environment, and of light, and the heat produced by presence of men and animals, and because of the fermentation of the olives, made the oil quality quite low, such that it was destined to industrial uses (in particular, for lighting), rather than for food (Barletta, 2010; Costantini, 2017).

At the end of the 18th century, and the beginning of the 19th century, there was a deep transformation in the country habitat, and many olive trees were eliminated, due to the poor quality of production, and because of the presence of cheaper oil (typically produced in Spain) in the general market. As a consequence, the oil mills were progressively abandoned, and for many of them a complete loss of memory had to be registered. More recently, expansion of the urban areas toward the countryside brought in many situations to build above, or in proximity of, these underground voids, and in several localities instability problems, with localized collapses and sinkholes (*sensu* Gutierrez et al., 2014), had to be recorded (Parise, 2010, 2012, 2015).

3. Distribution of the underground oil mills in relation to the local geology

From a geological standpoint (Bossio et al., 1999, 2006), the Lecce area is characterized by outcrops covering the time span from Cretaceous up to the present (Figure 3). The geological formations, corresponding to seven sedimentary cycles, are, starting from the oldest: Altamura Limestones, Galatone Formation, Lecce Formation, Pietra Leccese, Andrano Calcarenites, Trubi, Uggiano la Chiesa Formation, and Gravina Calcarenites.

The Cretaceous Unit, extensively cropping out in the northern sector, consists of white, pale grey or brown limestones, and of dolomitic and micritic limestones, stratified in layers from a few centimeters to some meters in thickness.

The Galatone (Oligocene) and the Lecce (Oligocene – Miocene) Formations crop out only in the southern sector of the Lecce area. Since none of the oil mills is located within these formations, they will not be described in the following.

The fourth sedimentary cycle is documented by Pietra Leccese and the overlying Andrano Calcarenites. Pietra Leccese is a biomicrite, yellowish in colour. Locally, al the base of the unit a breccia deposit is present, whilst in other cases the contact with the older units is marked by a thin phosphoriferous layer. The basin of deposition of Pietra Leccese became the external sector of a carbonate platform (depth about 150-200 m), with sedimentation of fine, white-yellowish, deposits, overlain by marl layers. Upward, Pietra Leccese shows a greenish colour, depending upon the abundance of glauconite. The Andrano Calcarenites represent the sedimentary product of the regressive trend started in the Upper Miocene. Limestones and calcarenites of this unit, which fossil contents are indicative of environmental conditions of low waters, close the Miocene cycle, in the study area as well as in the whole Salento.

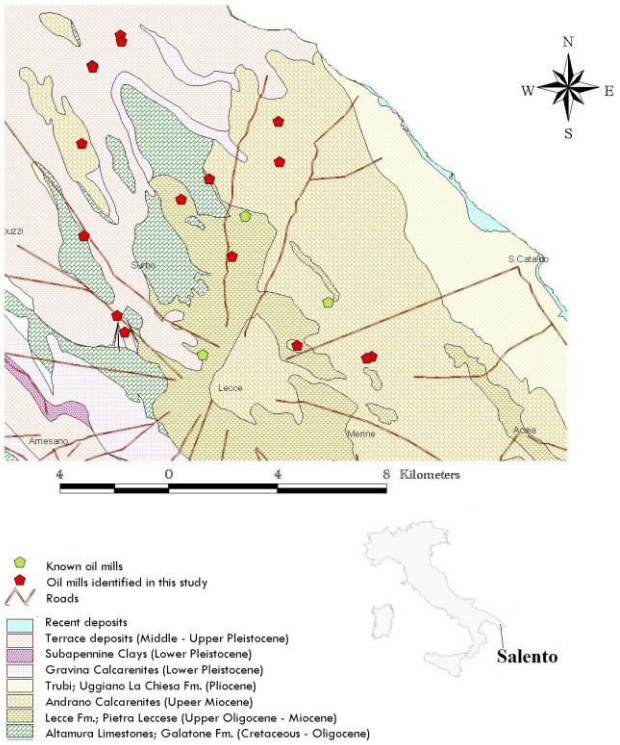


Figure 3. Geological sketch of the Lecce area, and location of the underground oil mills (red polygons) described in the text.

The fifth sedimentary cycle is represented by the Trubi, rarely cropping out in the study area.

The sixth sedimentary cycle is the Uggiano la Chiesa Formation (Pliocene), consisting of several tens of meters of fine to coarse, pale yellow, detritic limestones, with many fossils.

The seventh, last, sedimentary cycle is represented by the Gravina Calcarenites (Lower Pleistocene). This unit, prevailingly calcarenitic, a few tens of meters thick, shows fossils typical of depositional environments of low depth. The resulting sediments, depending upon the colour, grain size, fossil abundance, and area of provenance, are designated with different dialectal terms, and have been extensively quarried in the last

centuries for building purposes (Parise, 2010).

The underground oil mills were excavated in the soft Apulian calcarenites, namely in the Miocene Pietra Leccese and in the Pleistocene Gravina Calcarenites (Figure 3, Table 1). The voids excavated in the fine calcarenites of Miocene age are generally in good stability conditions, except where some marl intervals are present. In these cases, such intervals are strongly affected by selective erosion; when they are part of the pillars sustaining the underground void, the erosion may be so intense to cause them to loose the sustaining function. As concerns stability issues, others problems are related to presence of discontinuities such as joints and fractures, later widened by karst processes attacting the soluble rocks. Such widening in several cases has been then filled with residual deposits (terre rosse).

Two underground oil mills were excavated in the Miocene sediments, and are located within properties of the Lecce Municipality. The first, partly recovered, is within a public park, at the Belloluogo Tower, in the northern outskirts of town. The tower is a remarkable example of French architecture (Angevin domination), and was built during the 14th century by the Brienne family. Nearby the tower, a beautiful underground oil mill was excavated in the Pietra Leccese, which at the site shows a typical pale yellow colour.

Figure 4. General view of the main room in the oil mill at the eastern outskirts of Lecce.

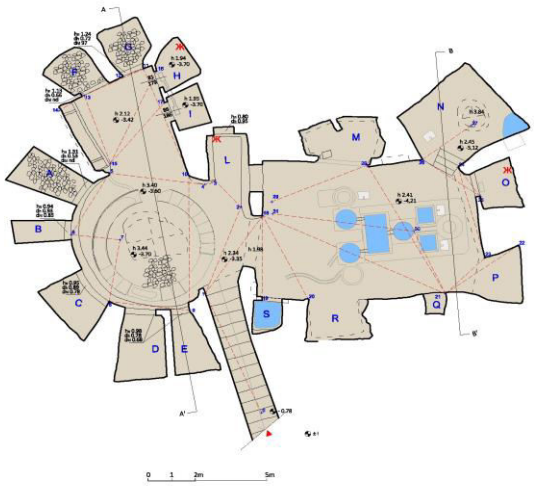


Figure 5. Map of the underground oil mill at the eastern outskirts of Lecce.

The second oil mill, still within municipal land, is in the eastern part of town, not far from several civil buildings, and in proximity of two schools. Entirely covered by debris in the last decades, this underground oil mill was brought again to light in consequence of some local collapses that interested the soil cover (Figures 4 and 5).

The oil mill is prevailingly excavated in the Pietra Leccese, with presence of glauconitic levels, but in its upper portion it shows calcarenitic marls, rich in anellids and small fossils, belonging to the unit of the Andrano Calcarenites. This top interval has a lower resistance to weathering than the rest of the structure, and shows localized erosional features that, nevertheless, do not compromise the overall stability of the underground space. The discontinuities are quite rare, with the exception of a joint oriented N 20, open some decimeters, enlarging toward the base of the void, and filled with reddish clay residual deposits. The filling material was excavated from the discontinuity, which lower part thus began a site for discharging liquid wastes by the workers. Such a practice was very common in the past, and many cavities of karst origin were used at this aim (named, in the local dialect, *"capuientu"*; see Parise et al., 2003). The underground oil mill at the eastern outskirts of Lecce has been recently included in the register of artificial cavities of Apulia region, managed by the Apulian Speleological Federation.

Lack of attention toward hygiene of the workers is also testified by another underground oil mill, located toward the Adriatic coast, at Torre Chianca. This oil mill, again excavated in the Miocene sediments, has a similar site for discharge of liquid waste, but also, in the same room, a well from where the workers were used to take water, from a depth of some 10 meters from the base of the artificial cavity.

As concerns stability issues, the oil mills realized in the Pleistocene coarse-grained calcarenite rock mass are typically in better conditions than those excavated in the Miocene rocks, due to greater homogeneity of the rock mass. These are the oil mills located in the northernmost portion of the municipality, nearby the coastal areas between Torre Rinalda and Torre Chianca. In this sector, some problems of instability are only related to presence of intervals particularly rich in fossils, thus representing areas of higher weakness in the rock masses.

The two oil mills in the Cerrate Abbey belong to this type of category. According to the legend, the abbey was founded by the Norman king Tancredi di Altavilla, after a vision where he saw the Virgin Mary following a fawn in a cave; more realistically, the abbey was built between the end of the 11th and the beginning of the 12th century by Boemondo d'Altavilla, who established at the site a Greek monastery, following the rule by San Basilio Magno, looking for sites where to refuge in Salento in order to escape the iconoclastic persecutions from Bisanzio. The Cerrate Abbey, in proximity of the road linking Brindisi to Lecce and Otranto, became one of the most remarkable monastic sites in southern Italy, and in 1531 it passed under the control of the Ospedale degli Incurabili of Naples. Importance of the activities at the place is pointed

out by presence, in addition to the two underground oil mills, of the church, the stables, settlements for the farmers, a well, and a water mill. In 1711 the abbey complex was plundered by the Saracens, and following this event the site was abandoned for more than two centuries and a half. Nowadays, after it became property of the Lecce Province, the Abbey and its heritage have been recovered and are managed by the Italian Emvironmental Fund (*Fondo Ambiente Italiano* - FAI).

Table 1. List of the underground oil mills identified in this study within the territory of the Lecce Municipality.

no.	name	lithology
1	Zona 167, Lecce	Pietra Leccese
2	Via Fondone – Via Lecce San Cataldo	Pietra Leccese – Andrano Calcarenites
3	Casino San Giuseppe	Miocene calcarenites
4	Masseria Giampaolo	Pleistocene calcarenites
5	Masseria Ghietta	Pleistocene calcarenites
6	Masseria Mosco	Pleistocene calcarenites
7	Masseria Cerrate 1	Pleistocene calcarenites
8	Masseria Cerrate 2	Pleistocene calcarenites
9	Masseria Tracasci	Pleistocene calcarenites
10	near road Lecce-Trepuzzi	
11	Masseria Mosca	
12	Masseria Santoni	Pietra Leccese
13	Masseria Barba ai Monti	
14	Masseria Monacelli	Pleistocene calcarenites
15	Masseria Vadacca	Pietra Leccese
16	Masseria La Grotta	Pleistocene calcarenites
17	Masseria between Via Fondone – Via Lecce San Cataldo	

4. Conclusions

Before the present study, only three underground oil mills were included in the register of artificial cavities of Apulia Region. This was a quite contrasting data with regard to the diffuse presence of olive trees in the territory, especially as concerns the northern sector of the area under study. Looking at historical documents dating back to the second half of the 18th century, the land around Lecce counted at least 40 underground oil mills, mostly related to the main country houses (*masserie*) located north of the town.

Starting from the information contained in these documents, and through detailed bibliographic research and field work, seventeen, previously unknown, oil mills have been found (Table 1). Six of them have been reworked by land owners and used for a variety of purposes, mainly related to tourist activities, whilst eleven oil mills are at present abandoned. In many cases the underground oil mills have become sites where to discharge illegally solid wastes, following a practice which, unfortunately, characterizes many sites of karst landforms in rural Apulia (Parise and Pascali, 2003).

If properly valorized, and once their stability conditions have been ascertained, the underground spaces could represent remarkable examples of the interactions between the anthropogenic activities of industrial archaeology and the local geology. In this sense, recovering the oil mill of municipal property, located within the boundaries of the town, should be the priority, and contribute to point out the importance of this cultural and historical heritage, as a testimony of the past activities of rural Salento.

References

Barletta R., 2010. Architettura contadina del Salento. Capone Editore, Lecce

Bossio A., Foresi L., Margiotta S., Mazzei R., Monteforti B., Salvatorini G., 1998. Carta geologica del settore nord orientale della Provincia di Lecce; scala 1:25000; settore 7,8,10 scala 1:10000. Università di Siena

Bossio A., Foresi L., Margiotta S., Mazzei R., Salvatorini G., Donia F., 2006. Stratigrafia neogenico-quaternaria del settore nord - orientale della provincia di Lecce (con rilevamento geologico alla scala 1:25000). Geologica Romana.

Costantini A., 2017. Guida all'architettura contadina del Salento. Congedo Editore, Lecce.

Del Prete S., Parise M., 2013. An overview of the geological and morphological constraints in the excavation of artificial cavities. In: Filippi M., Bosak P. (Eds.), Proceedings 16th International Congress of Speleology, Brno, 21-28 July 2013, 2, 236-241.

De Marco M., Sannicola G.C., 2007. Aspetti e caratteri dei trappeti ipogei in Puglia. Speleo Club Cryptae Aliae, Grottaglie.

Fornaro A., Greco A.V., Marangella A., Maranò P., Nuzzo A., Parise M., Sannicola G.C., 2008. Studi e ricerche speleologiche sul sistema degli ipogei di Masseria Lonoce in agro di Grottaglie (Taranto, Puglia). Proc. 6th National Congress of Speleology in Artificial Cavities, Napoli, 30 May – 2 June 2008, Opera Ipogea, 1-2, pp. 283-294.

Galeazzi C., 2013. The typological tree of artiicial cavities: a contribution by the Commission of the Italian Speleological Society. Opera Ipogea, 1, 9–18.

Gutiérrez F., Parise M., De Waele J., Jourde H.,.2014. A review on natural and human-induced geohazards and impacts in karst. Earth Science Reviews, 138, 61–88.

Monte A., 1992. I frantoi ipogei di Terra d'Otranto. Lu Lampiune, 8, 3, 65-75.

Monte A., 1995. Frantoi ipogei del Salento. Edizioni del Grifo, Lecce.

Monte A., 2003. L'antica industria dell'olio. Itinerari di archeologia industriale nel Salento, Edizioni del Grifo, Lecce.

Parise M., 2010. The impacts of quarrying in the Apulian Karst. In: Carrasco F., La Moreaux J.W., Duran Valsero J.J., Andreo B. (Eds.), Advances in Research in Karst Media. Berlin, Heidelberg, Springer, pp. 441–447.

Parise, M., 2012. A present risk from past activities: sinkhole occurrence above underground quarries. Carbonates and Evaporites, 27 (2), 109–118.

Parise M., 2015. A procedure for evaluating the susceptibility to natural and anthropogenic sinkholes. Georisk, 9, 272-285.

Parise M., Pascali V., 2003. Surface and subsurface environmental degradation in the karst of Apulia (southern Italy). Environmental Geology, 44 (3), 247-256.

Parise M., Federico A., Delle Rose M., Sammarco M., 2003. Karst terminology in Apulia (southern Italy). Acta Carsologica, 32 (2), 65-82.

Parise M., Galeazzi C., Bixio R., Dixon M., 2013. Classification of artiicial cavities: a first contribution by the UIS Commission. In: Filippi M., Bosak P. (Eds.), Proceedings 16th International Congress of Speleology, Brno, 21-28 July 2013, 2, pp. 230-235.

Parise M., Galeazzi C., Bixio R., Germani C., (Eds.) 2015. Proceedings of the International Congress in Artiicial Cavities "Hypogea 2015". Rome, March 11-17, 2015, ISBN 978-8889731-79-6, 543 pp.

Sammarco M., Parise M., 2008. Cavità artificiali per uno studio di storia salentina: il caso dell'ipogeo di Leuca Piccola a Barbarano. Proc. XX National Congress of Speleology, Iglesias, 27-30 April 2007, Memorie dell'Istituto Italiano di Speleologia, s. II, 21, pp. 389-393.

Sammarco M., Parise M., Donno G., Inguscio S., Rossi E., 2008. Il sistema rupestre di località Macurano presso Montesardo (Lecce, Puglia). Proc. 6th National Congress of Speleology in Artificial Cavities, Napoli, 30 May – 2 June 2008, Opera Ipogea, 1-2. pp. 273-282.

ROCK SETTLEMENTS ON VERTICAL CLIFFS IN MATERA

Franco Dell'Aquila[1], Francesco Foschino[2], Raffaele Paolicelli[2]
[1]*Independent, Italy, franco.dellaquila@inwind.it*
[2]*Mathera historical magazine, Via Bradano 45, 75100 Matera, Italy, redazione@rivistamathera.it*

Abstract

The entire old city of Matera, Italy, is a rupestrian city and in the surrounding area there are over one hundred rupestrian settlements. Only few of them are on vertical cliffs: the goal of the research was to study their functionality, their logistics, their structures, to determine the purpose of this kind of settlements, when they were established and what are the main differences with other rupestrian settlements established on gentle slopes, terraces or plateau. Old researches wrongly interpreted these settlements as monasteries, and their main focus was pointed only towards the rock churches. As a matter of fact, widening the study area, it was possible to determine how each rupestrian settlement was part of a bigger and complex agro-pastoral organization. In Matera only the strict agricultural and pastoral production happened in the fields, in a rural environment: all the raw materials were then quickly transported to the city to be stocked (wheat or beans) or processed (grapes to wine, olives to oil, milk to cheese, wheat to flour, animals to leather or meat) and it was again in the city that the final goods were stored and sold. All these activities took place in a urban environment, where it was safer to store them and easier to sell them, and the workplaces and storages were either dug or built. So the rupestrian settlements located in a rural setting took only part in the first phase (producing raw material) but not in the following ones (processing, storing, selling). Indeed all the settlements are contiguous to agricultural fields composed of clay and to streams to water the animals. The rupestrian settlements were part of a bigger organization which included the contiguous fields and very often a built farm with stables, storages, houses. All the cavities of the settlements provided structures for some of the agro-pastoral activities: goats and sheep pens, pigeon houses, beehives, warehouses for tools, manure heaps, stables for the ploughing animals, straw storages, cisterns and canals, and a few ones useful for the working community: little dwellings, kitchens, ovens, pallets, place of worship, little warehouses for food. The common structure of a settlement on vertical cliffs is composed of many horizontal levels. The cavities of each level are connected among them with a path along the cliff, and each level is connected to another one through dug-out stairs, and sometimes with internal tunnels: all movements are forced to follow the existing paths and the stairs.

Most of the settlements have some kind of connection to the bottom of the canyon, mainly for animals, but the proper entrance is from the top, so from the fields. The main advantage of a settlement on vertical cliffs is the higher degree of safety: it is not necessary to guard all the cavities, but it is enough to control the two or three entrances to the settlement to have a full control over the entire property: predators or thieves can reach any of the cavity only passing through one of the few entrances.This research clearly shows how the rupestrian settlements of Matera were functional to the rural phase of the agro-pastoral production: they were not permanent villages and had nothing to do with monasteries.

Keywords

Matera, vertical cliffs, rock churches, rupestrian settlements, agro-pastoral production.

1. Introduction

The area around the city of Matera (South Italy) is mainly composed of two types of soils: the clay of the "Fossa Bradanica" and the limestone of the rocky Murge. The first one shows rolling hills and the latter one wide plateau, terraces and deep canyons called gravine (fig. 1). These are winding canyons with variable depth and stratigraphy whose cliffs vary from gentle slopes to vertical cliffs. The stratigraphy of the limestone shows a bottom layer of Calcare di Altamura, a hard rock where hand-tools digging is not possible. On top of this, a layer of a softer limestone called Calcarenite is superimposed: this is a easy-to-dig rock, and strong enough to get self-sustaining cavities and good building material. This soft limestone is very widespread in the area and together with the contiguous presence of fertile clay hills (offering water springs and agricultural fields) allowed and facilitated the establishment of dozens of rupestrian settlements.

Figure 1. The rocky cliffs and the overhead clay plateau

The focus of the scholars in the past was mainly pointed to the cavities displaying elaborated architecture, such as the rock churches. They are in most rupestrian settlements, so these were erroneously interpreted as the monasteries related to the rock church. As a matter of fact, each settlement is composed of many cavities, each one of them with a specific purpose, and the place of worship shows only one of the many features composing the life of the community and its agro-pastoral activities.

Most rupestrian settlements in Matera are located along the gentle slopes of the ravines or in little valleys, few ones are established on the plateau, very rarely on the vertical cliffs of the canyon: the latter ones are the target of this paper.

2. Rupestrian settlements on vertical cliffs in Matera, Italy

We have selected eleven settlements (the majority of them and -we think- the most representative ones), located in three different ravines (fig. 9).

In the Gravina di Matera the settlements: Lamaquacchiola, Ofra, Cozzica, S. Nicola al Vallone della Femmina, S. Eustachio alla Selva/Pandona. In the Gravina di Picciano the settlements: Masseria del Monte, Casale del Cristo, Mandolalena, Pietrapenta (also known as Casale di Cinto Mancuso). In the Gravina del Bradano: S. Giuliano (conventional name: La Scaletta 1995) and S. Gennaro (also known as Defesella di Alto di Rota).

Even though most settlements include a core of cavities dating back to the Bronze Age (Lionetti and Pelosi 2011), as proven by archeological findings, the rupestrian settlements have been achieving the current appearance starting from the Early Middle Age. The most common -if not exclusive- purpose of these settlements, is related to agro-pastoral activities. All the studied settlements have got fertile clay fields on the overhead plateau. In the few cases where the agricultural field is not contiguous to the settlement, it is no more than 600 meters far; in this case the overhead plateau is rocky and becomes part of the rupestrian settlement, housing winemaking facilities, cisterns, canals and perishable structures, whose traces are still visible on the rocky surface (as it happens on Cozzica, fig. 2).

Figure 2. Cozzica settlement seen from San Nicola settlement.

Even though today all the settlements appear to be secluded, actually from a logistic point of view all of them used to be located along the most important trading routes: carriageable roads, shepherds tracks, fords, bridges and path junctions allowed daily exchanges and facilitated the movement of people, animals and goods.

The agricultural productive cycle is divided in many phases: the production of the raw material, its processing, its storage and the final sale. The rupestrian settlements of Matera only took part in the first phase. Indeed the processing of the raw material (production of wine, olive oil, flour, cheese, honey, wax, wool, leather, meat) did not occur in a rural setting, but in centralized facilities, usually in the urban perimeter of the city. The products' storages were also located in the city (apart from the little quantities needed for the basic necessities of the working community of the settlement), and indeed it is very common to see in the city of Matera old warehouses and storages (built or dug) where processed and unprocessed agricultural produce were stocked: wheat silos, wine cellars, olive oil mills, tanneries, wax and honey making facilities, cheese storages, mills, slaughterhouses.

Many cavities of the settlements have collapsed along the centuries. It may be very difficult to determine the original purpose of some of them, and many others have been constantly repurposed, overlaying new traces to the old ones. Nevertheless, we can easily recognize many cavities designated to support the agro-pastoral activities such as: warehouses for tools, stables for the ploughing animals, goat and sheep pens, beehives, pigeon houses, straw storages, manure heaps (manure was extremely important to fertilize the fields); many cavities were related to the daily life of the working community: little dwellings, kitchens, ovens, pallets, place of worship, little warehouses for food; only very rarely these rupestrian settlements have got wine cellars, wheat silos, wheat or olive mills, presses. As we stated earlier, most phases of the agricultural cycle did not take place on fields, but in the city; and the productive activities taking place in the fields were not only supported by cavities, but also by buildings, according to which setting gave the best benefit. Very often, in the proximity of the rupestrian settlement, we can see buildings (farmhouses or sheep pens) which were complementary to the settlement as two parts of the same organization. Sometimes the buildings have collapsed and are no longer visible; on the opposite the rupestrian part is still visible even when partly collapsed.

The settlements on vertical cliffs are endowed with unique features compared to the usual ones, but they also suffer some inconveniences, as we describe in the next chapters.

3. The structure of the settlements

The cavities on vertical cliffs settlements are arranged on one or more horizontal levels. The number of levels is limited by the thickness of the soft limestone layer.

The harder limestone, located just under the soft one, until the bottom of the canyon, did not allow artificial cavities, but included a few natural ones that often became part of the settlement. The artificial cavities of the settlement had no outdoor area and the internal mobility of the settlement was forced to follow the existing path.

The connection through cavities of the same level was possible either along a path obtained directly on the cliff, out of the cavities, or through a passage occupying the most external part of each cavity: in this case it was necessary to pass through every and each cavity to reach the last one. The connection between levels were arranged through stairs dug out of the rock and facing the canyon, often provided with a parapet of rock, and sometimes entirely indoor, similar to steep tunnels with stairs.

Two fronts were possibly available to access the settlements: from the bottom of the canyon or from the overhead plateau. The one from the bottom of the canyon was usually uneven, as often it had to be created on the hard limestone, so usually there were only passageways for the animals to reach the stream of water and the pasture at the bottom. The easiest access was from the plateau, through ramps or wide stairs (fig. 3)

.

Figure 3. Access through stairs from the plateau in S.Giuliano

The first level of the settlement was always connected to the overhead plateau through ramps or stairs, meanwhile the lower levels were rarely directly connected to the plateau: they were usually only connected the to the contiguous upper and lower levels. All the settlements have an entrance ramp to the first cavity of the first level. In case there are more accesses from the plateau, all the others will hit the settlements halfway. We never found two entrances at both extremities of the settlement: so some cavities may always be regarded as the terminal ones.

4. Advantages and inconveniences of the vertical cliffs

Probably in some cases the use of a vertical cliff for a settlement was not a choice, but the only available area for creating cavities in the same property. On the other hand, it is undeniable that the vertical cliffs provided advantages compared to the other rupestrian settlements. The most important benefit is that it makes the settlement much less vulnerable to external attacks and undesired visits. It wasn't necessary to control or lock all the cavities, but it was enough to guard the access points to the entire settlement. The settlement was safer, there was a lower risk of theft of tools, animals and temporary stocks, and the herds were much more protected against the predators. It's also important to consider that the settlement was not visible from the overhead plateau, and often also hidden by the vegetation; thus increasing its safety. The steep ramps and stairs of the settlements were not suitable for all animals, but goats were particularly inclined to climb vertical cliffs. One of the most representative examples is in Lamaquacchiola (fig. 4) where at the far end of the

Figure 4. The first level of Lamaquacchiola

settlement there is a goat pen with a high megalithic wall to protect the goats from bad weather (according to a local tradition goats are very sensitive to the cold temperatures) and to prevent the escape of the animals, renowned for their skill in jumping over walls (fig. 5).

Figure 5. The high wall of the goat pen in Lamaquacchiola

5. Places of worship

Eight out of the eleven studied settlements include a medieval place of worship perfectly integrated in the settlement for liturgical functions and a weekly holy Mass. In two settlements (Lamaquacchiola and Masseria

Del Monte) the church is less than one hundred meters out of the settlement (respectively S. Maria of Lamaquacchiola and S. Pietro in Lama). Only in Mandolalena there is no place of worship, but we have a rock church exactly in the opposite side of the canyon (S. Stasio alla Gravina) and a 19th century church inside the farm on the overhead plateau (S. Isidoro). The dating of the place of worship is more simple than dating other cavities due to artistic and architectural styles, so we can often deduct useful information for the dating of the entire settlement studying its church.

6. Main features of each settlement

Five settlements in the Gravina of Matera:

Ofra: It is one of the most impressive and scenographic ones, with many horizontal levels, originally connected with external stairs and later adapted to a partial collapse: the front line of the cavities was moved back and the external stairs were replaced by tunnels (fig. 6).

Figure 6. Ofra settlement and its built farm

Ofra area has been inhabited for three millennia. The bottom level has got natural caves, and one of them has been used in the Bronze Age (also on the overhead plateau there are tombs of the same age). In the proximity there are Greater Greece Age quarries (pottery of the same age has also been found), the place of worship, dedicated to S. Pellegrino, displays fresco dating back to the 13th century, 16th century archive records prove the use of the settlement for breeding animals and there are clear modification dating back to the last century. (Lionetti et al. 2015).

Lamaquacchiola: Two level settlement, with the first level composed of two different cavities units, later connected with a wide carriageable path dug out on the cliff, and a second ramp hits halfway this level (fig. 4). The terminal cavity is the goat pen with high wall we already described (fig. 5) and just before we can see a cheese-making facility with a chimney, whose hood was made of intertwined canes, and shelves to smoke the cheese. It is possible to reach the bottom of the canyon from the settlement, walking along a narrow path. It first reaches the natural caves and then the water stream at the bottom. From here, it is easy to ford the stream, and get to the opposite side of the canyon.

Cozzica: Mostly known to include the impressive rock church of Cristo Crocifisso alla Selva (fig. 2), this settlement has got seven levels, including the natural caves level at the bottom. A ramp connects the first level to the plateau and two more stairs connect some of the lower levels directly to the plateau. The first level was mainly used as sheep and goat pens, the rocky plateau had wine making presses (so just the wine was transported to the urban wine cellar, and not all the grapes), and in the lower levels we can easily recognize a church, a little wine cellar, a few cisterns, a beehive, and two dwellings with kitchen. The main activities were pastoralism, wine making and beekeeping. The area has been inhabited during the Bronze Age, as proven by tombs and archeological findings, and Paleolitich findings have been found on the plateau.

San Nicola al Vallone della Femmina: this is actually the marginal part of a bigger settlement, the Villaggio Saraceno, mainly located in a little valley and only partly on a vertical cliff on the side of the canyon. There are three places of worship, only one of them on the vertical cliff, whose architecture and frescoes can be dated back between the 9th and the 13th centuries.

S. Eustachio alla Selva/Pandona: Alike the previous one, also this is part of a bigger settlement mainly located in a little valley, the Loe. The vertical cliff area is made of many levels, down to the bottom of the canyon, allowing the watering of the animals and the passage to the opposite side of the canyon. Its southern orientation allowed many beehives. The area was extensively inhabited during the Bronze Age.The places of worship suggests two periods of intense use of the settlement: a medieval one (from the 9th to the 12th century) (Lapadula 2005) and another one during the 17th century.

Four settlements in the Gravina di Picciano:

Casale del Cristo: It is a four level settlement with three access points, one of them leading to the bottom of the canyon, where there are still agricultural fields. A big farm is located in the overhead plateau, which is also fertile. In the area there have been findings from the Iron Age (Lionetti G., Pelosi M. 2011). The rock church has got two apses and has no paintings. It can be dated back to the 10th century.

Masseria del Monte: Below the farm called Masseria del monte there is an old settlement very hard to study as there have been huge collapses. In this case the entire cliff is made of the soft limestone, so it has been entirely exploited. It is a few hundred meters long, as many groups of cavities that today look apart from each other, were surely joined together in a single settlement. A wide medieval bridge crosses the water stream at the bottom of the canyon, connecting the two sides of the canyon, and also this settlement with the tock church of S Pietro in Lama.

Pietrapenta: Even though the settlement has been subject to big collapses, we can still determine the main structure. It is still connected to the overhead fertile

plateau with a flight of stairs. The old access to the bottom of the canyon allowed to reach another settlement on the opposite side, but it is not in place anymore. It has only got one horizontal level: the soft limestone is a few meters thick and did not allow more levels. The place of worship stands out and is very famous: the so-called Crypt of the Original Sin, dated back to the 830 AD, where we have the oldest frescoes of the entire Matera area.

Mandolalena: The site has been devastated by many collapses, so many cavities are not reachable anymore, and others are completely gone, so today we see cavities far from each other, where in the past there was only one continuous settlement. Both the bottom of the canyon and the overhead plateau are fertile. This is the only settlement lacking a rock church. The settlement has been enlarged in the 17th century, as proven by some decorative inscriptions engraved in the rock.

Two settlements in the Gravina del Bradano:

San Giuliano: It is a two level settlement (fig. 7), with the lower one laid over the hard limestone. The shapes of the cavities are irregular. The settlement is spread over both sides of the canyon, and has got a wide fertile field on the plateau. Its place of worship has got a simple architecture, and has got a consecration inscription dating back to the 14th century (Caprara 2017).

San Gennaro: It has been heavily altered (the ground floor of the church was lowered down by a quarry) and has been used until the 20th century. We can clearly see ovens, pallets, pastoral-related cavities, and it is connected to the plateau with a flight of stairs. The frescoes of the church are dated to the 13th and 14th century.

7. Comparison with settlements on vertical cliffs in other contexts

The same technique of an external path along the cliff is observed in the sicilian ddieri (Messina 2008) as in Cava Cava Baulì (in Noto), Cavagrande del Cassibile (in Noto-Avola-Siracusa) and Timpa Ddieri. The main access to them is from the bottom of the quarries, climbing over to the top, the opposite of the Matera area where the main accesses are from the top. The connection through levels is possible in Sicily through vertical stairs. Similarly in Spain, in the Cuevas de los Moros a Bocairente (Navarro 2003) there is only one access, placed halfway on the height of the cliff, for safety reasons. The connections through levels is possible in this case through temporary wooden ladders. In Cappadocia all the settlements have the entrances on the ground floor, and internal stairs connect all the levels. The protection is enhanced by a cylindric rock that closes the passageway. The same technique is used for the settlements created in the great cones above the ground and for the so-called underground cities.

8. Conclusions

The settlements on vertical cliffs in Matera were strictly related to agro-pastoral activities, and facilitated the safe-guarding of the site. It is important to note that the main access connects the site to the overhead plateau, where the fields were located and often also a built farmhouse. The settlements were composed of horizontal levels connected among them with outdoor and indoor passages (fig. 8). It represented a safer option to keep the livestock, the tools and the belongings. The rupestrian settlement took part in the productive process of the agricultural cycle and not in the following ones (processing, storing, selling). The transformation in the agricultural sector after the crisis of the 14th century determined drastic change in their usage and some of them were abandoned. The massive changes in the agricultural production in the 19th and 20th century determined the complete abandonment of all of them. The first researches were only focused on the rock churches included in the settlements which were than mistakenly interpreted as monasteries and not as the rupestrian part of a bigger agricultural organization, as we concluded.

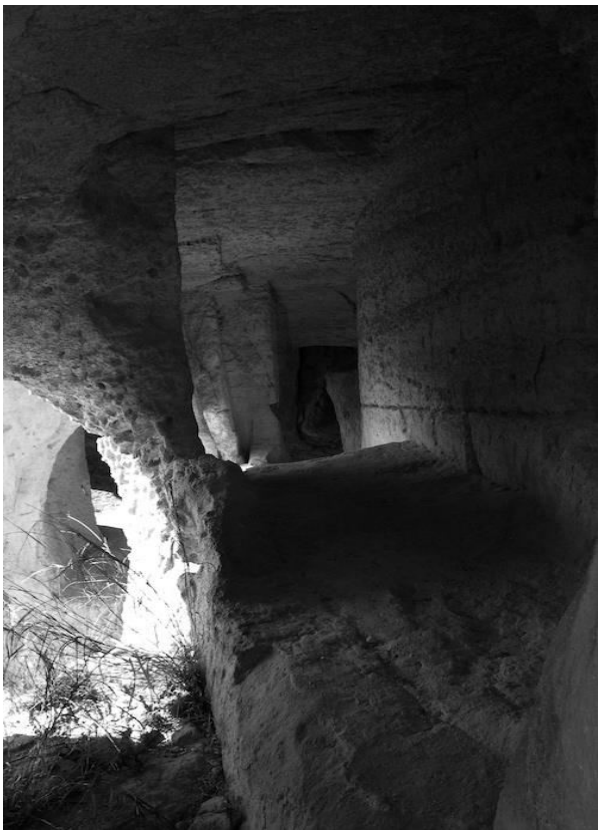


Figure 8. Example of indoor passageways in the settlements

Acknowledgments

We are deeply thankful for their support to Gianfranco Lionetti, Giuseppe Gambetta and Santino Cugno.

References

Caprara R., 2017. L'inedita iscrizione di San Giuliano al Bradano, (in italian) in Mathera, Anno I n. 1, Matera, 2017.

Giordano D, 1992. Il comprensorio rupestre appulo-lucano (in italian), Bari.

Lapadula E, 2008. Il villaggio della Loe nella Murgia materana in Insediamenti rupestri di Età medievale (in italian), Cisam, Spoleto.

La Scaletta, 1995. Chiese e asceteri rupestri di Matera (in italian), Roma.

Lionetti G. et alii, 2015. The San Pellegrino rock-hewn complex at Matera (in italian), in Hypogea 2015 – Rome.

Lionetti G, Pelosi M, 2011. Considerazioni sui complessi rupestri artefatti preellenici della murgia materana, in Le aree rupestri dell' Italia centro-meridionale nell'ambito delle civiltà italiche (in italian), Cisam, Spoleto.

Messina A, 2008. Sicilia rupestre (in italian), Salvatore Sciascia Editore, Caltanisetta/Roma.

Navarro F, 2003. Materia prima. Arquitectura subterrànea excavada en Levante, (in spanish), Valencia.

Figure 7. S.Giuliano settlement

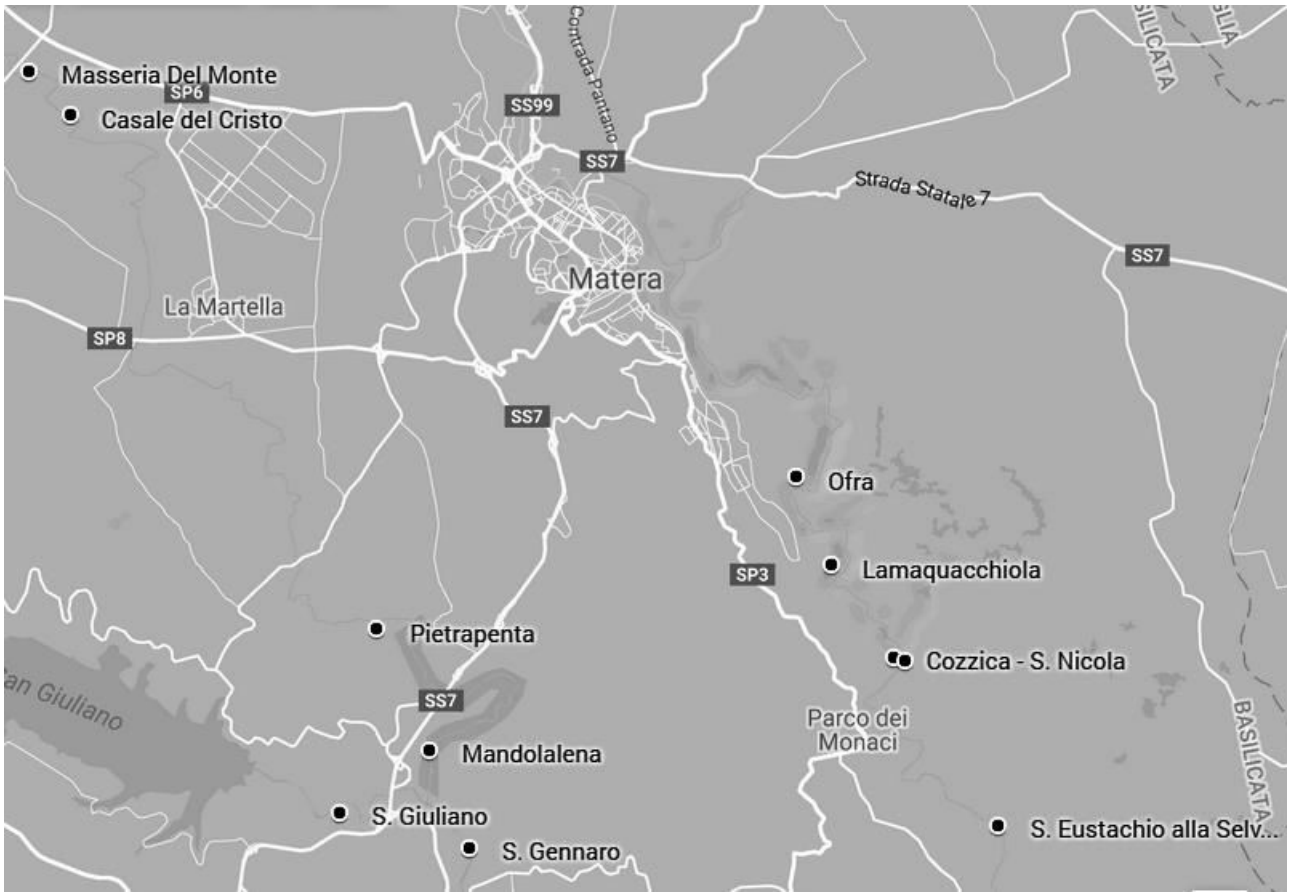


Figure 9. Map of the rupestrian settlements on vertical cliffs in the Matera studied in this research

ANCIENT MAN-MADE ROCK STRUCTURES ALONG THE BLACK SEA COAST OF DOBRUDZHA

Asen Salkin
Historical Museum Velingrad, Vlado Chernosemski 2, 4600 Velingrad , Bulgaria, SalkinAsen@abv.bg

Abstract

On the rocky Dobruzha Black Sea coast as a result of the human activity there were excavated in the various in form and purpose artificial cavities , functioning in chronological limits of the V millennium BC until the Late Middle Ages - XVII century. There were studied four complexes of cave dwellings known in the literature as Dobruzha cave colonies determined in chronological range of residing V mill. BC to - XVII Century AD, four necropolis of rock tombs functioned II to V century AD, sacrificial stones and stone wineries from the Ancient age. In the port of Kavarna - the ancient Bisone, in the rock massif partially were studied and documented over 30 caves, warehouses for grain / antique silos, damp and many other rock cut structures some of them unexplored. All of this outlines Dobruzha as a contact zone of cultural interaction, cultural elements and preserved traditions of the local population during the various historical eras.

Keywords

Rock stuctures, sancturies, tombs, Dobrudza, Bulgaria

1. Introduction

The Black sea coast in the region of Dobrudzha has a unique geomorphology (Мишев, Попов 1974), which has also pre-determined the main stages of its paleo-geographic development through the Holocene (Орачев 1990). Its strategic location favored the formation of Northeast Bulgaria as a contact zone for different cultures and various influences (Шкорпил 1894: 48-78). The port system of the rocky Dobrudzha coastline creates conditions for sea contacts and trade with the Black Sea and the Mediterranean world (Салкин 1986; Орачев, Русинов 1988; Salkin 2007). I offer in the present work, a study of some rocky facilities that I have discovered along the 20 km coastal strip between Shabla and the port of Kavarna, where the shore rises up to 110 m in height (Fig. 1). I conditionally accept the time from V millennium BC until XVII century AD as chronological boundaries of their using.

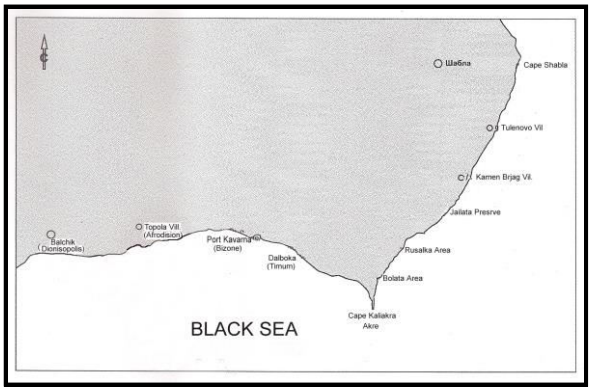


Figure 1. Map of the seashore from Cape Shabla to Balchik

2. Cave colony-towns in Dobrudzha

In the contact area between Shabla and Kaliakra three complexes are located, which are known in the science as Dobroudza cave colony-towns. They are grouped as follows: near Tyulenovo village (on the coastal cliff); in the archaeological reserve Yailata near the village of Kamen Bryag; in the valley of Bolata where 30 caves were found on the steep bank, as well as some smaller groups in the Taukliman and Cape Kaliakra.

2.1. Complex of caves near Tyulenovo village

Near the village of Tyulenovo, the Dobrudzha plateau has an altitude of about 10 m. Right next to the sea there, several groups of interconnected caves have been carved in the steep rock massif. They have small rooms of irregular shapes and have been constructed so that their occupants could communicate with each other (Fig. 2). The access to them is either through openings from the side of the plateau or by ladders from the seashore. The height of the chambers reaches up to 2.50 m, and Karel Shkorpil, when describing them at the end of the XIX century, was so impressed by what he saw that called them Cave Colony-Towns (Шкорпил 1894: 53). Apparently, those caves had been used for housing, but the lack of serious research still does not allow us to accept that this was their only function, and also to specify the date of their further upgrading so that they got their present form.

One of these caves – the so-called Kotelna Cave (Kazan Maara), meaning the Cauldron Cave – which directs us to another function of the caves, deserves particular attention. Karel Shkorpil described it so (Шкорпил 1894: 53): *The cave consists of four high compartments, open to the sea. In front of the entrance there are cavities in 15 places in the cave, having the form of large cauldrons, which seemingly accommodated up to 10 people. Those dents were called cauldrons or barns. People say they found bones when they did excavations at those places*.
Those funerals indicate that when people stopped using the barns for grain storage, the grain pits (the siruses) were reused for graves. Similar cases with found human bones in cave pits are also known from the *Yailata* cave

complex.

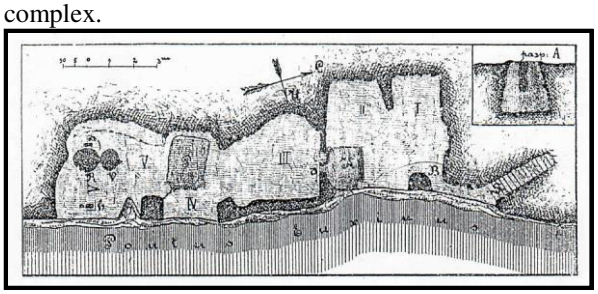


Figure 2. Plan of staircase cave near the village of Tyulenovo (according to Шкорпил 1894: 53, Figure 5).

2.2 Cave-dwellings in Yailata Archeological Reserve

One kilometer south-west of the village of Kamen Bryag, the archaeological reserve Yailata is located. It is a three-level seashore terrace, 250 m wide and 1200 m long, with traces of intensive landslide-collapsing processes (Попов, Мишев 1974). Several hundred cave dwellings (Салкин, Топтанов 1988; see Делев 1985) were documented along the rocky coast and on the two older and higher-level positioned sea terraces. They are similar to those of Tyulenovo, but their number is greater and they had been better worked, having a right rectangular shape. Among them, scattered in three groups in the upper two terraces, at the base of the vertical rocky slope, the entrances of robbed rock cave-tombs were discovered. The pottery found there dates back to the Roman era and the Late Antiquity, indicating a safe human habitation during I – VI century AD. In some of the cave-dwellings funerals from the Roman era were found, performed in shallow pits, and the crosses cut on the walls suggest that they had also been used during the early Christian period.

The so-called Cave-church is located on the highest terrace (under the plateau of Dobrudzha). It consists of three compartments, one of which is equipped with an opening (vent) on the ceiling (Fig. 3).

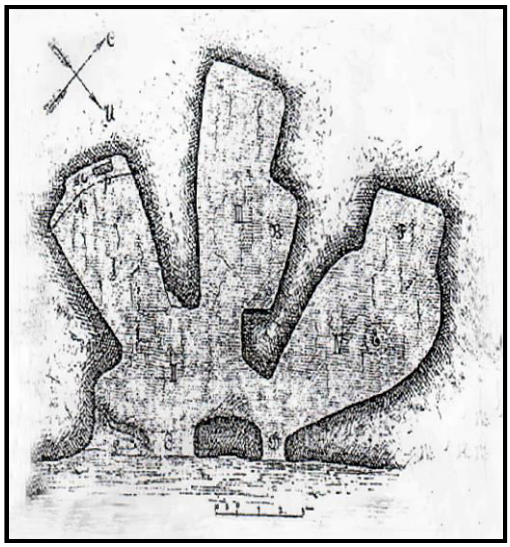


Figure 3. The Church-cave at the Yailata Archeological Reserve (after Шкорпил 1894)

There are crosses, cut out on the walls of the western compartment and an Ypsilon with two hastas (IYI) (Fig. 4) was carved on the entrance wall. When pictures were taken by using powerful halogen lighting, numerous lines of Cyrillic and other inscriptions were also documented (Orachev, Handjiyski 2008). They probably date back to the Early Christian era, and here it should be noted that an Early Byzantine fortress from V – VI century AD was explored on the lower terrace. Its ruins contained traces of a Bulgarian settlement that had existed until the XI century AD (Салкин, Топтанов 1987). Here the entrance of the gallery was converted into a chapel, which had probably been also used in parallel with the Cave-Church during the early middle Ages.

Figure 4. Ypsilon with two hastas

Three wells were documented in the lower southern part of the Yailata Plateau, and stone tools of labor were found near them, which proved that the beginning of life dates as early as from the V millennium BC.

2.3 Complex of Cave-dwellings in the locality of Bolata

The locality of Bolata is 1 km north of Cape Kaliakra and is a small valley with a river flowing through it. Thirty cave-dwellings were found on its two bank slopes. They are similar to the others from the rock complexes along the Dobrudzha coast, but are more roughly made (Fig. 5). Specifying of their definite date is hindered by the reuse of the caves as livestock stalls, which has continued until nowadays, but the earliest materials from the valley date back both to the early and to the late Iron Age.

3. Rock tombs along the Dobroudzha Black Sea coast

Along the Dobroudzha sea coast, on the six-kilometer stretch from Cape Kaliakra to the village of Kamen Bryag, 130 rock tombs have been studied in the last years, from the following necropolis: near the seashore of Kamen Bryag; in the Yailata Archeological Reserve; and at Cape Kaliakra. The rock massif in these areas protrudes right to the surface and the burial facilities were cut into a variety of forms that can be defined in the following groups:

3.1. Rock tombs with shaft-like antechambers

The burial chamber of that kind of tombs had been entered through a rectangular opening which was surrounded by a groove for closing and sealing the tomb. The tomb chamber itself has a square or rectangular shape about 2.00 x 1.50 m in size. Some of the chambers have an

opening to the surface and are covered with slabs, while others have no such apertures.

Figure 5. Picture of Bolata with the bay and the valley

3.2. Rock tombs with staircases

They have a well-designed antechamber and a staircase leading to a rectangular opening (Fig. 6). The opening in turn, lead to the grave chamber that had a trapezoidal cross section and was closed with a slab on the top. Those are the most precisely constructed tombs and not only single-chamber but also multi-chamber tombs were found (as is the case with the tombs near Kamen Bryag village – Fig. 7).

Figure 6. Picture of a tomb with a shaft-like anteroom

3.3. Rock pit tombs

They are shallow, dug into the rock massif and have a tube-like shape. The bone materials found in them allow me to define them as children's graves.

4. Caves-tombs

They were scattered across the Yailata Terrace in three groups. They have small entrances (dromoi) carved in the base of the vertical slope which leads to a rectangular burial chamber (Fig. 7). An important element appears to be a rock niche, cut at 3 m above the tomb's vault. With few exceptions, almost all the tombs have been robbed even since antiquity or in the recent times. The materials found in that type of tombs date back to the II - V century AD.

Figure 7. Multi-chamber tomb with a staircase from the necropolis near the village of Kamen Bryag

In several burial chambers, the gathered bones of 14-15 skeletons were found in a non-anatomic order (in disarray), indicating their prolonged and multiple use for family funerals. A ritual funeral of a 6-7 year old horse was a definite support of the above-mentioned dating. Osteology studies have clarified that the horse had been killed on the spot and still warm was buried with the horse ammunition. The ammunition consisted of a silver bronze mouthpiece, an iron buckle with a saddle belt and an openwork decoration. In turn, the anthropological analysis has found – despite the poor condition of the bones – that the men had belonged to the northern racial species and had coarser proto-Europeid characteristics. The buried in No. 2 necropolis (Fig.8) of Yailata had been very tall people for their time and had well developed muscles, which was not common for the Bulgarian lands. The insignificant percentage of Mediterranean features and the total absence of graceful Mediterranean characteristics typical for the Thracians, suggests that those were people who had come from elsewhere.

The comparative, formally typological analysis of the local cave-tombs revealed quite a number of coincidences with the similar graves in the Northern Black Sea coast. This implies of certain traditions brought about by the Barbarian invasions to North-eastern Bulgaria in the first centuries of the first millennium AD. The fact that this type of tombs only occurs in the area between Kaliakra and Kamen Bryag, makes us believe that during the

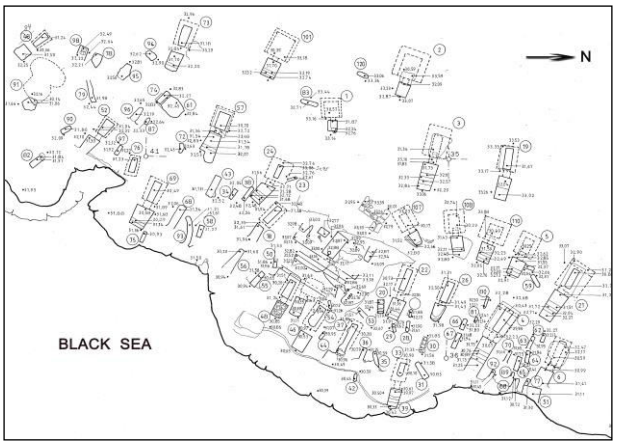


Figure 8. Necropol №1 with rock-cut tombs

Gothon (Gothic) invasions from the middle of the III century AD on (see Орачев 2013 et cit.lit.), a small group of Sarmatians and/or Alans had joined them. It is possible however, that such influx of inhabitants from the North Black Sea coast had already existed before – as early as in the II century AD.

4. Antique Cave-warehouses in Kavarna Bay

The Bay of Kavarna is located at the mouth of two deep valleys and is limited to the east and west by a 100-meter-long rock massif that surrounds a port, relatively well-protected from the winds. In the valley opposite the bay and the plateau of Cape Chirakman (where the Antique Βιζώνε/Βιζών was located), traces of civilized life from the V millennium BC were discovered (Салкин 1984). During the Hellenistic and Roman epochs, Bisone - whose Thracian name had been Βιζών (Орачев 2008) - became a significant trading partner and mediator between the local Thracian population and the merchants from the Black Sea area, the Marble Sea and the Mediterranean (Salkin 2007). One of the main commodities for exchange was exactly the grain.

In 1971, while constructing a road, the entrances of 31 cave-warehouses for commodities and mainly for grain, were revealed alongside the coast (Fig.9). Their altitude varied from 5 to 15 meters, where 25 cave-warehouses were discovered on the east and 5 on the western slope under Cape Chirakman (the ancient Bison).

Only two cave-warehouses have been explored, and those were rooms with semi-cylindrical openings, up to 20 m long, carved in the friable limestone layers. The first storehouse was 3 m wide, 2.50 m high and 18 m long. In the middle of the floor traces of holes of 45 and 50 cm in diameter with a groove and tightly glued plates were found. They are dug-in syruses (granaries) of pear-shaped form. The second warehouse had the same size, but its length was 15 meters. Two funnel-like apertures in the ceiling distinguished that warehouse from the previous one. They most likely had served as outlets for air ventilation.

The function of those warehouses as syruses became further clearer during the construction of a road in the western part of the Bay under Cape Chirakman, when a cave was cut and two syruses were dug into its floor. One had a height of 1.70 m, a diameter at the base of 2.75 m and a hole with a diameter of 40 cm and plant seeds were found there. Their analyses identified the following varieties (Salkin 1984): common millet (panicum miliaceum), wheat, soft, compact (triticum aestivo compactum), rye (secale cereal) and bare-grain barley (hordeum vulgare var, nudum).

The extremely precise workmanship of the syruses shows the importance people were giving over the antiquity and the middle Ages to the proper grain storage for a longer period of time, without spoiling it. For this purpose, the earth-borne syrus had to remain dry and to be inaccessible to rodents. Before they loaded it with grain, they burned it, and then closed it tightly.

As far as the date is concerned, the pottery found during the explorations was from V – VI century AD, which date should be also acknowledged as the date of the found drawings of birds and animals, as well as an inscription, yet to be decoded. Ceramics from the Hellenistic and Roman epochs were found in one of the cave-warehouses, suggesting that they had been functioning from V century BC until VI century AD, but only further research could fine-tune the date. It should be added here that in the slope of Cape Chirakman – collapsed after some earthquakes – where the Antique Bison was located, until recently a series of syruses could be clearly seen.

The archaeological excavations in Balchik (Ancient Dionysopole) revealed an ancient Greek inscription – Horotesia (Mihailov 1995: 5011; Slavova 1998), which had set the boundaries of the people of Bison against the territories of King Kotys, Dionysopole and Kalatis. The following text is important for our study: ... after we learned from the old documents, we judged this to belong to the Dionysopolians and to the purchasers in Ponta, and as to the Aphrodision, the Dionysopolians agreed with King Kotys that he shall use it for sending grain.

The inscription was dated from the XV century AD and the Aphrodision was located on the sea shore near the village of Topola (Торбатов 2002) – halfway between Bison and Dionysopole, 7 km from each of the two ancient cities. Cave-warehouses and structures from the Roman era, similar to those in Kavarna, were revealed there. All these are a good indication of the local Thracian population's ability to produce enough grain for both the Black Sea and the Mediterranean market. The grain purchasers mentioned, had definitely assumed the commitments to buy also grain from Dobrudzha.

An eloquent example of how close the contacts of the local population with the Hellenic Black Sea and Mediterranean apoykias had been, is my statistics of the Thracian settlements around Bison. It is in a ratio of 6: 1 in favor of the import. In turn, the inscribed amphora stamps also show the centers (Rhodes, Thasos, Kos, Knidos, Sinope, Heraclea, etc.) from where olive oil, wine and other Mediterranean products were imported (Салкин 2007).

An extremely important problem is how the loading and unloading at the Kavarna Bay had been carried out. It is known that merchant ships had, as a general rule, been anchored in the bays (not far from the shore), and the unloading and loading of goods was done by boats. In 2005 however, a sunken port facility was found in front of the cave-warehouses (Орачев, Салкин 2016). There was a great internal drainage during that time, revealing a

large stone pile, with well-shaped profiled stones, probably from the decoration of a large building or from

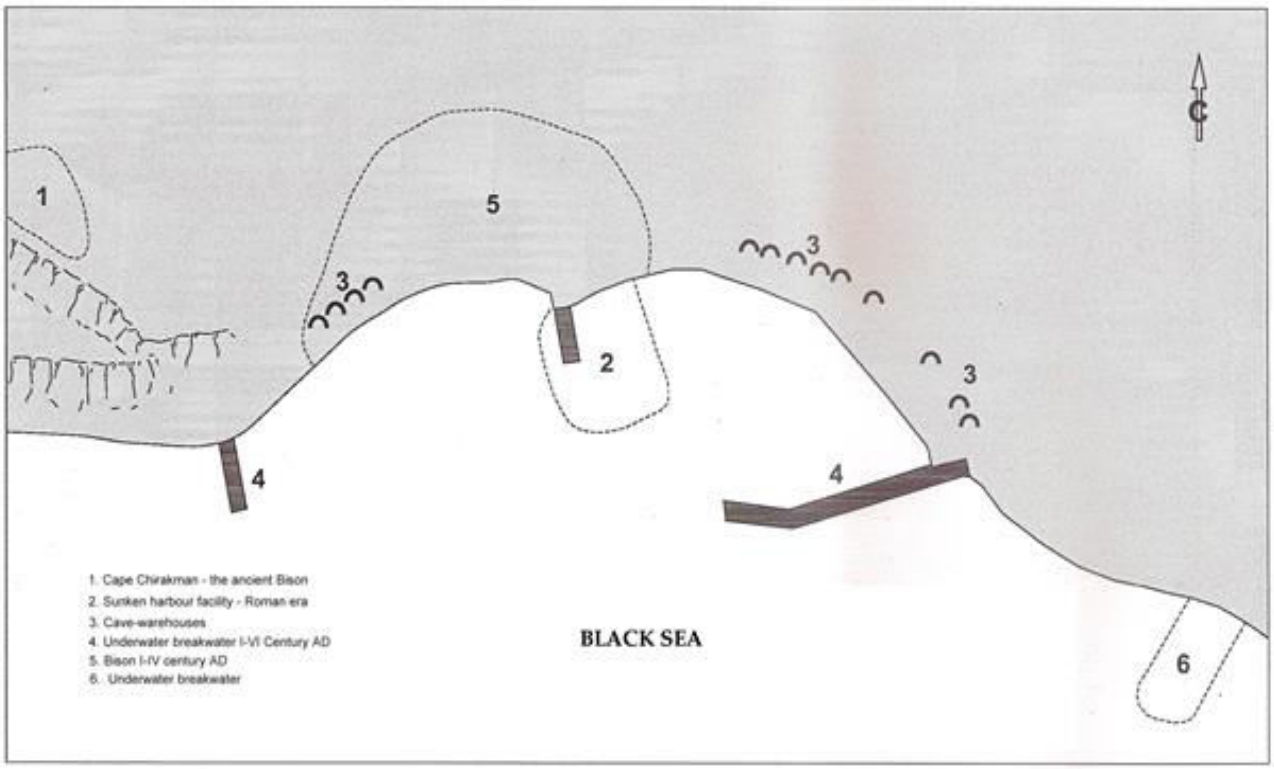


Figure 9. Map of the Bay of Kavarna

storage facilities, parallel to those on land. The quern, the axial door stone, the fragments from two bronze trays, the animal bone material, and the local ceramics found there suggest that the explored site had been used for commercial and domestic activities. In the southern part of the stone piles, some sort of arrangement emerged, passing into the quay wall. This definition is reinforced by the on-site (in situ) stone bollard for ship mooring, a bronze coin of Emperor Hadrian (117-130 AD), which dates precisely that port facility back into the first half of the II century AD. All of the above said allows me to claim that during the Roman era there had been a well-constructed man-made harbor that was equipped with a stone quay wall to facilitate loading and unloading activities.

5. Sacrificial stones

From Cape Shabla to Kavarna harbour, I have counted 50 sacrificial stones that can be found only along the coastal strip and in the valley of Bolata. They are carved shallow (up to 5 cm) rectangular or round pots, measuring 1.30 x 80 cm (Fig. 10).

Through the grooves they are connected to a second, smaller pot. So far most of the researchers believe that those were the ritual sacrificial stones of the local Thracian population, with chronological boundaries from the early Iron Age to the Roman era. In close proximity to the early Byzantine fortress in the Yailata Archaeological Reserve, the cleaning of a sacrificial stone revealed that the bottom had been levelled with mortar, similar to that of the fortress. In my opinion, this means that, due to its convenient form (after possible further deepening of the receptacles), some sacrificial stones were also used for chopping grapes (the so-called sharaptashes or sharpanes).

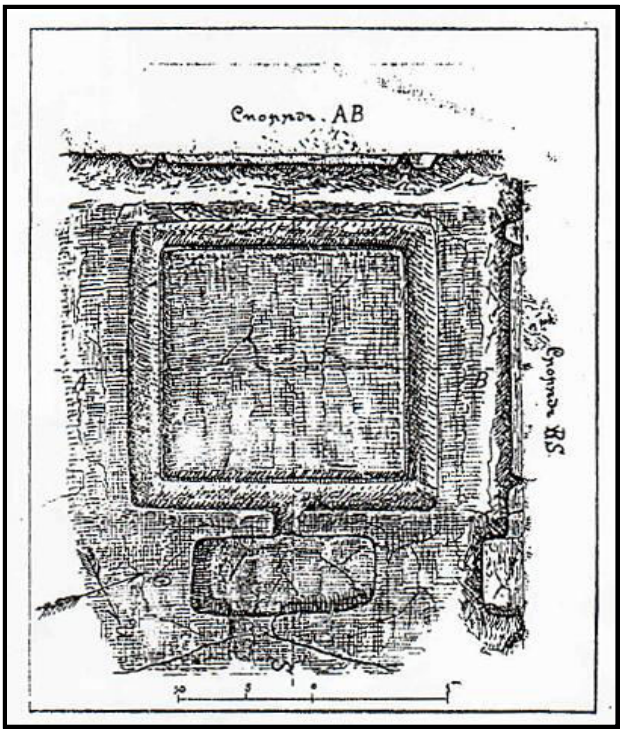


Figure 10. Sacrificial stone (according to Шкорпил 1894: 67, Fig. 15)

References

Делев 1985: П. Делев. Проблеми на скалните паметници в североизточна България. – В: Сб. Североизточна България – древност и съвремие 1, 1985, 49-55.

Кузманов, Салкин 1992: Г. Кузманов, Ас. Салкин. Антични амфори от акваторията на Черноморското крайбрежие на Южна Добруджа. – Известия на Народния музей Варна, 28, 1992, 27-61.

Орачев 2011: Ат. Орачев. Проучвания върху морската история и археология на Левия Понт: 3: Земетресения и последици по добруджанското крайбрежие през III - IV век (предварителни наблюдения). – Acta Musei Varnensis 8.1, 2011, 119-140.

Орачев 2008: Ат. Орачев. Проучвания върху историята и географията на Левия Понт. 2: „Пустата мера" (χῶρον ἔρημον) на Бизоне и данните за земетръсни последици по Българското Черноморие от 279/278 и 63 г. пр. Хр. – ИНМ-Варна 44, 2008, 64-95.

Орачев 2007: Ат. Орачев. Проучвания върху морската история и археология на Левия Понт: 1: Каменните блокове с отвори от Българското Черноморие. – ИНМ-Варна 43, 2007, 9-39.

Орачев 1990: Ат. Орачев. Приноси към палеогеографията на Добруджанското крайбрежие. – Добруджа 7, 1990, 32-52.

Орачев 1990a: At. Oracev. Писмените сведения за кари по Добруджанското крайбрежие. - Studia in honorem Borisi Gerov. Sofia, 1990, 158-173.

Орачев, Русинов 1988: Ат. Орачев, В. Русинов. Средновековен гръцки портулан за Българското Черноморие. – Paleobulgarica 12.4, 1988, 76-91.

Орачев, Салкин 2016: Ат. Орачев, Ас. Салкин. Потъналият Бизоне. - Форум 1, 2016, 10-20.

Попов, Мишев 1974: Вл. Попов, К. Мишев. Геоморфология на Българското черноморско крайбрежие и шелф. София, 1974.

Салкин 2007: Ас. Салкин. Търговските контакти на Бизоне VI - I в. пр. Хр. – В: Каварна – средище на Българския североизток. Каварна, 44-51.

Салкин 1987: Ас. Салкин. Антични пристанищни съоръжения в залива на Каварна. – Фар, 1987, 245-248.

Салкин 1984: Ас. Салкин. Каварна и районът през древността (II хил. пр. н. е.–IV в. от н. е.). – В: Каварна, 1984, 44-61 .

Салкин, Топтанов 1988: Ас. Салкин, Д. Топтанов. Некрополи от скални гробници по Добруджанското черноморско крайбрежие от нос Калиакра до село Камен бряг. – Terra antiqua Balcanica 3, 1988, 195-198.

Славчев 2008: В. Славчев. Бележки към проучването на културните контакти в района на днешното Българско Черноморие през късния енеолит. – In: Acta Musei Varnensis 6, 2008, 43-56.

Топтанов, Вълев, Дерменджиев 1991: Д. Топтанов, П. Вълев, В. Дерменджиев. Ориентация на скалните гробници от некропол № 1 в археологическия комплекс „Яйла" при с. Камен бряг, Толбухинско. – Интердисциплинарни изследвания 18, 1991, 231-242.

Тодорова 1988: Х. Тодорова. Каменно-медната епоха в България. София.

Торбатов 2002: С. Торбатов. Укрепителната система на провинция Скития (края на III-VII век.). Велико Търново, 2002.

Цонев 2009: Л. Цонев. Мегалити в България – скални долмени. Група долменоподобни скално-изсечени камери в Яйлата (КОД RD-002/BG). – http://www.balkanmegaliths.bgjourney.com/Bulgaria/SpecMegObj/RD/RD-002BG/RD-002BG.html

Шкорпил 1894: Х. и К. Шкорпил. Североизточна България в географско и археологическо отношение. – Сб. НУНК 6, 1894, 48-78.

Orachev, Handjiyski 2008: At. Orachev, A. Handjiyski. Bulgarian Script – a european Phenomen. Sofia, 2008.

Mihailov, 1970: G. Mihailov. Inscriptiones graecae in Bulgaria repertae. 2.1. Serdicae, 1970.

Mihailov, 1997: G. Mihailov. Inscriptiones graecae in Bulgaria repertae. 5. Serdicae, 1997.

Salkin 2007: As. Salkin. Byzone. - In: D. Gramenos, E. Petrepoulos (eds)Ancient Greek Colonies in the Black Sea 1 = BAR International Series 1675(1), 209-278.

Salkin 1986: As. Salkin. Evidence for the Earlier Fondation of Bizone Colony. – Thracia Pontica 3, 1986, 251-255.

Salkin, Toptanov 1987: As. Salkin, D. Toptanov. 1987. Forteresse de la haute époque Byzantine au lieu dit "Jajla" pres du village Kamen brjag, department de Tolbuhin. – In: Dobrudža. Etudes ethno-culturelles, Sofia, 22–35.

Salkin 1994: A.Salkin Antique harbor facilities in Kavarna bay (Preliminary report) In: Proc.of the Int,Symposium Tracia Pontica VI-18-24 September 1994, p.245

Petrov P, Pruner P, Zupan Hajna N, 1998. Paleomagnetic research of cave sediments in SW Slovenia. Acta Carsologica, 27(2), 151-179.

Left A, White G, 1994. Cave exploration in Portugal. Elsevier, Amsterdam.

Smith MW, 1988. The significance of climatic change for the cave environment. Final Proc. Int. Conf. Permafrost. Tapir, Trondheim, Norway, pp. 14-19.

Smith JA, Black RJ, 1990. Biology of the Big Cave. Cave Portal, http://www.xxxxx/yyyyy/zzzzz

Smith J, 1992. Diversification of bats in caves. In: PD Pink and DB White (Eds.). Bats of the world. Charles Univ. Press, Prague, pp. 245-271.

Ivanov J, 1990. Morphological properties of cave entrances. Ph.D. Thesis, Technical Univ. Berlin, Germany.

EXCAVATIONS AND SURVEYS OF UNDERGROUND CAVITIES AT HURBAT HUSHAM, JUDEAN FOOTHILLS

Eitan Klein[1], Boaz Zissu[2]
[1] *Israel Antiquities Authority, P.O. Box 586, Jerusalem, Israel, eitankn@hotmail.com*
[2] *Martin (Szusz) Land of Israel Studies and Archaeology Department, Bar-Ilan University, Ramat-Gan, Israel, bzissu@gmail.com*

Abstract

Hurbat Husham is situated in the Judean Foothills at the summit of a hill that overtops its surroundings (elev. 380 m above sea level). It is located in the northern section of a ridge that is part of the High Shephelah, between the Nahal Soreq and Nahal Elah basins. The ruin covers some 50 dunams at the top and along the slopes of the knoll. It affords a view in all directions, including towards the coastal plain, the Shephelah, the Soreq valley, and extensive stretches of the Judean Hills as far as the Beit El Hills. The name of the site, Hurbat Husham, or, in Arabic, Kh. el Kheishum (i.e., "nose") reflects the fact that it towers prominently over its surroundings.

Beginning in the late 1990s, the authors documented and mapped underground cavities and other archaeological features there, in the wake of intensive illegal excavations carried out by antiquities looters. We documented a variety of elements, including mikvaʾot (ritual immersion baths), underground storage cavities, a hiding complex, agricultural facilities, a small fortress at the top of the hill, and burial caves. A large underground cistern similar in its layout and design to others that have been found on the slopes of Hasmonean/Herodian fortresses throughout Judea were also documented at the site. These findings bear witness to a large Jewish settlement from the Second Temple period until the Bar Kokhba Revolt. The site's unique topography, the name, the existence of a long rectangular cistern from the Second Temple era, and pottery from the second century BCE all suggest the existence of a Hasmonean/Herodian fortress intended to guard the western approach and one of the major access routes (the Soreq valley) to Judea in the late Second Temple period.

Keywords

Judea, Second Temple Period, Bar-Kokhba Revolt, Judean Foothills, Mikvaʾot, Hasmonean-Herodian Fortress.

1. Introduction

Hurbat Husham is located in the Judean Foothills at the summit of a hill that overtops its surroundings (elev. 380 m above sea level). It is situated in the northern section of a ridge that is part of the High Shephelah, between the Nahal Sorek and Nahal Elah basins. The ruin covers some 50 dunams at the top and along the slopes of the knoll, approximately 3.5 km north of Tel Azeka and approximately 2 km west of the Beit Jamal Monastery. It affords a view in all directions, including of the Judean coastal plain – from Jaffa in the north, through Yavneh, Gedera, and Ashdod, all the way to Ashqelon and Gaza in the south – as well as of large areas of the Judean Hills and the Beit-El Hills. The name of the site, Hurbat Husham, or, in Arabic, Kh. el Kheishum (i.e., "nose, spur") reflects the fact that it towers prominently over its surroundings (Vilnay 1976, 2531).

During the nineteenth century, the site was visited by Victor Guérin (1969) and the members of the British survey (Conder and Kitchener 1883, 118). Though Felix M. Abel once proposed identifying this site with the Biblical Makedah, this identification is not accepted today (Abel 1967, 378; Broshi 1968). Yehuda Dagan reported the existence of a square fortress-like structure at the top of the site, as well as caves, cisterns, a winepress, and agricultural installations. He also reported the presence of potshards from various periods, including Iron II and the Roman and Byzantine periods. Dagan proposed identifying the site with Enam, one of the Biblical cities of the Judean Shephela, mentioned in the book of Joshua (Joshua 15:34; Dagan 1992, 86; Dagan 1996, 138). Boaz Zissu documented the existence of a plastered ritual bath on the summit, adjacent to the fortress (see below), and reported finding some pottery and a base of a chalk vessel as well as the existence of a network of underground tunnels, detected by IAA inspectors (Zissu 1999; Zissu 2001, 148-149).

This article presents the results of the authors' documentation, survey, and excavation work at the site and its immediate environs, beginning in the late 1990s. The finds attest to the presence of a large Jewish settlement at the site from the Second Temple period until the Bar Kokhba revolt and suggest the existence of a Hasmonean/Herodian fortress. Some of these finds will be described below, based on their geographic location within the ruin.

2. The Finds from the Survey

2.1. A Small Fortress, Storehouse, and Ritual Bath atop the Site

The remains of a square building were detected at the summit of the site. It is preserved to a height of approximately four courses and is built of large hewn stones. The building measures approximately 9 × 9 m; the

walls are approximately 1 m thick. On the inside, the corners have a buttress (a base of a pendentive?) measuring 1 × 1 m; this suggests the existence of a groin vault and perhaps even a second floor. The architecture of the structure, along with its location at the summit and views to the south, west, and north, as well as of the road at the foot of the site, allows us to identify it as a fortress.

A small opening below the abutment in the building's northeastern corner leads to an underground system cut into the rock, which extends below the eastern part of the structure. The architectural plan for this system, which include a rock cut entry shaft leading to an oval chamber hewn on a lower level, narrow opening leading to a second oval chamber and triangular niche cut in the wall to hold a lamp, along with several ceramic finds, allow us to identify it as a family's underground storage system, of the type common during the late Second Temple Period (Zissu and Ganor 2002, 20-21; Kloner and Zissu 2003, 183).

Approximately 5.5 m east of the fortress there are two rock-cut and plastered chambers adjacent to and connected to each other (fig. 1).

Figure 1: Ritual Bath, adjacent cistern, and fortress; view to the W (photo: Boaz Zissu)

The southern chamber is unroofed and trapezoidal in shape. Four steps running the width of the chamber and a starting step are cut into the floor and descend into the immersion basin. The chamber is plastered with two layers of plaster. An opening (approximately 0.9 m wide) joining the two chambers was cut in the center of the northern wall. Its maximum possible height was 1.4 m (although it was probably less later on, the opening was blocked by a wall of rough stones, plastered on both sides. Based on these characteristics, Chamber 1 was probably a ritual immersion bath, roofed over by a vault that has not survived. Subterranean Chamber 2, which is trapezoidal, was carved out north of it. Its walls were covered with gray plaster and carefully smoothed, though its ceiling was not plastered. An opening was cut into the ceiling of this room.

In the past, it was proposed that Chamber 2 initially served as a ritual bath while Chamber 1 served as a stepped antechamber leading to the ritual bath (Zissu 1999; Zissu 2001, 148-149). According to this suggestion, after Chamber 2 ceased to function as a ritual bath, perhaps as a result of cracks in its walls, the opening between the two structures was plugged and plastered, and Chamber 1 was repurposed as a ritual bath. However, in light of the discovery of a ritual bath with characteristics similar to this one and based on a finding of an identical opening between two adjacent plastered structures at Hurbat Tayassim West, we propose that Chamber 1 was the ritual bath and Chamber 2 served as its reservoir (Klein and Zissu 2012, 229-232). We believe that the opening between them was intended to facilitate the installation of Chamber 2. After it had been fully installed, the opening was sealed, and the reservoir was filled through the shaft in its ceiling. It appears that that the two chambers were connected through a small hole left in the plugged opening between the two structures. This left Chamber 2 as a 'reservoir (*Otzar*)' that permitted the frequent replacement of drawn water in the adjacent ritual bath.

2.2. Ritual Baths on the Northern Slope

The dense pine forest and many fallen tree trunks made it difficult to conduct an extensive survey of the underground spaces on the site's northern slope. However, remnants of walls from early structures that were built of large fieldstones and covered most of this slope were identified on the surface. Of the subterranean structures discovered on the slope, we should dedicate a special discussion to two ritual immersion baths from the Second Temple period, which were later repurposed for use as cisterns, apparently during the Late Roman/Byzantine period.

2.2.1. The Birds Ritual Bath – This ritual bath was discovered on the site's northern slope in 2013. The installation is located at 367 m above sea level, outside the settled area of the ancient site. Remnants of pinkish plaster were found on the walls of the immersion chamber; its floor was made of shards of ribbed clay jars of the type characteristic of the Late Roman/Byzantine period (Porat 2002). No earlier layer of plaster was discovered.

An Israel Antiquities Authorities excavation was conducted at the installation in September 2013 (IAA permit A-6962/2013). The structure, which was completely plastered, includes three rock cut elements running in a line from north to south: a shallow basin, a stepped entryway, and an immersion chamber (Fig 2). During the course of our excavation, the stepped antechamber was cleaned out in its entirety, and a section was made the length of the immersion chamber from the western doorpost to the wall opposite the door. Thus, more than one-third of the central immersion chamber was cleared of debris; this provided an understanding of the structure's architecture and stages of use (Fig. 3).

The entrance to the immersion chamber is 0.8 m wide and approximately 1.8 m high. An intricate graffito above the eastern doorpost (Fig 4) includes two large birds, apparently doves or partridges, shown in exquisite detail and, just to their right, a braided element, apparently a woven cage. Behind the two birds are smaller birds, the upper one with its tail spread out like a fan; it seems that

the artist wanted to portray peacocks. The motif of birds next to or inside a cage was common during the Byzantine period; in early Christian art it represents the Holy Ghost or the believer's soul trapped inside the body. A graffito with Christian motifs was found on top of the eastern doorpost. We believe that this was a Second Temple–period ritual bath that was repurposed as a water cistern during the Byzantine period. Above the birds is a monogram of a cross combined with the Greek letters X (chi) and P (rho), the initial letters of Χριστός ('Christos'); this makes it clear that the artist was Christian. Below and to the right of the monogram is a graffito made up of multiple lines but the picture is not clear (perhaps a fish).

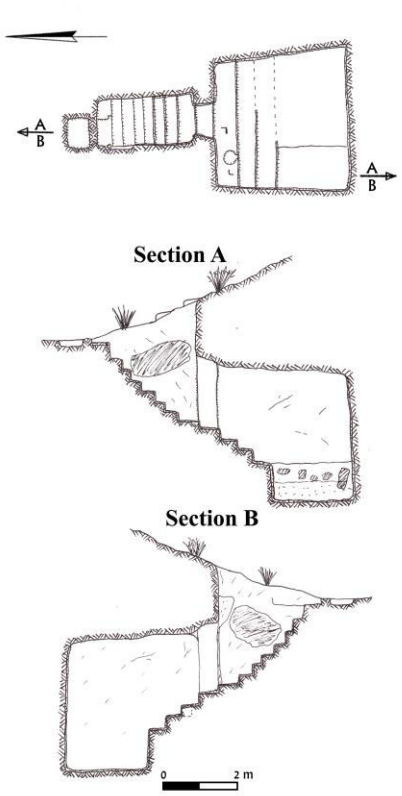


Figure 2: The Birds Ritual Bath (drawing: Eitan Klein)

Figure 3: The rock-hewn out and plastered dromos, with the hewn basin of the Birds Ritual Bath in front of it (photo: Boaz Zissu)

It is possible that the birds were incised around the Christogram in order to augment the symbol's apotropaic and life-giving power, as in many other cases where it appears in early Christian art (Ziffer 1998, 111). The graffito was damaged by stone-cutting tools that made shallow dimples in the doorposts so as to create a rough surface in preparation for a layer of plaster, of which remnants remain around the graffito. It is clear that the inscription predates (at least technically speaking) the plastering of the doorpost. The western doorpost features another monogrammed graffito of a cross plus the chi-rho. The excavation did not turn up any artifacts that could help us date the structure. Hence our dating of when it was in use is based on its architecture, the texture of the pottery shards used as the base for the plaster, and the images in the graffito. The architectural layout, which includes a flight of stairs leading to a plastered subterranean chamber, is typical of Second Temple–period mikvaot, common in the Judean Hills and Foothills, that served the area's Jewish population (Reich 2013). However, the texture of the plaster in this structure consists of a fairly uniform layer of ribbed jar shards that are typical of the Late Roman and Byzantine periods (Porat 2002). In addition, the Christograms etched into the doorposts of the entrance, which are generally dated as beginning with the Constantinian dynasty – and certainly no earlier than the late third century CE (Jensen 2000, 138)– suggests a date after the Second Temple period and the Bar Kokhba revolt.

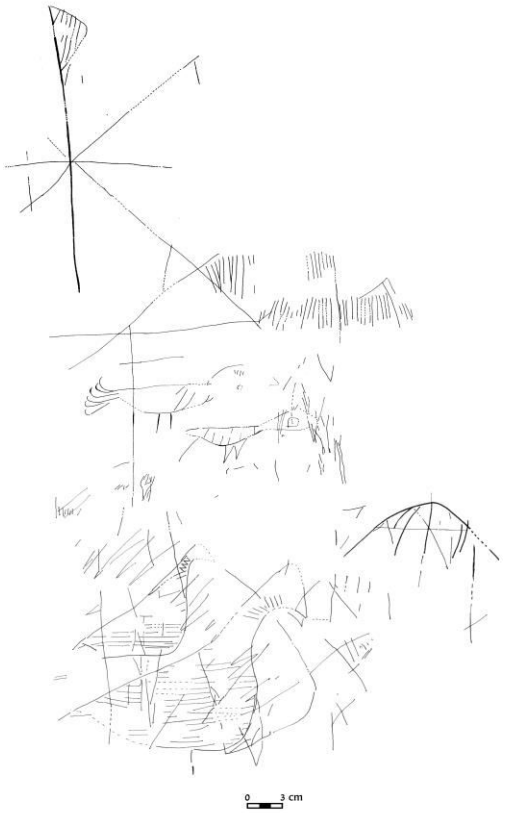


Figure 4: Graffito on the E doorpost of the ritual bath with birds next to a cage and a Christogram (drawing: Eitan Klein)

We emphasize that the graffiti has been plastered over, which means that they predated the plastering of the structure (i.e., the plaster itself must also postdate the late

third century CE and it should apparently be assigned to the Byzantine Period). It is clear that the graffiti were not visible at the time the structure was last used. This suggests that the focus of the structure when it was used was not related to the graffiti, because these were covered by plaster and would not have been visible to users. Therefore, it is probably that during the Byzantine period and certainly not earlier than the late third century CE the ritual bath was converted into a cistern and maybe by one of the workers who plastered the installation sketched the graffiti on it's walls.

2.2.2. A ritual bath repurposed for use as a cistern

Another hewn-out and plastered underground structure (Fig 5) is located approximately 25 m north of the Birds Ritual Bath, on the slope of the ridge and outside the boundaries of the ancient settlement. Entrance to the structure is currently possible through a rectangular shaft whose southern, eastern, and western walls are hewn out of the rock, whereas its northern wall is built of fieldstones (the shaft is 1.4 m long and approx. 1 m wide). All of the walls were covered with a uniform layer of gray plaster, without gravel (this may be of a later date). In some areas, it is possible to see an additional layer of pinkish plaster underneath the gray plaster, on a base of shards of ribbed pottery.

Figure 5: Immersion chamber in ritual bath. Note the plastered steps running widthwise and the blocked dromos leading to the structure; view to the N (photo: Boaz Zissu)

The features of this structure, which contains a stepped dromos leading towards a hewn underground chamber with widthwise stairs at its bottom, indicate that it was used as a ritual bath by the Jewish residents of the settlement during the late Second Temple period. At some stage, the easy access to the installation was blocked by the construction of a fieldstone wall atop the stepped entrance hallway (dromos); a vertical shaft was installed to serve as the entrance to the structure. At the same time, the stairs to the ritual bath were cut out, the floor was deepened, and the structure was covered in an additional layer of plaster, which, on the basis of the pottery shards mixed in with it, can be dated roughly to the Late Roman/Byzantine period (Porat 2002). The changes were so that the ritual bath could be repurposed as a cistern, with an increased capacity, and with the possibility of fill it all the way up to the mouth of the shaft; when completely full, the structure could then hold at least 80 cubic meters of water.

2.3. The underground Hiding Complex (Fig 6)

At the summit, some 30 meters northeast of the fortress and within the ancient settlement, a winepress was found, which includes a crushing floor and a collection vat lined with orange-colored plaster on a foundation of ribbed pottery shards. This type of plaster is typical of the Late Roman/Byzantine period (Porat 2002). A shaft located in the middle of the crushing floor (Fig 16–shaft i1; length: approximately 1.2 m, width: 7 m) is sealed with a rectangular stone cut with extreme precision to fit its dimensions. The cracks in the shaft were sealed with cement, so that the crushing floor could be used without leakage. Next to one wall of the crushing floor, but outside the winepress, we found another shaft (Shaft i2; height approximately 2 m). It is not sealed and serves as the mouth of a cistern that is lined with gray hydraulic plaster (Cistern I). The shaft that lies in the center of this cistern's roof (Shaft i1) is, as noted, sealed with a rectangular stone. It is clear that the closure of the shaft and installation of the crushing floor are later than the installation of the cistern located directly under the crushing floor. It thus seems that the people who built the winepress also cut out Shaft i2 so that they would be able to use the pre-existing chambers located underneath the crushing floor while the winepress was in operation.

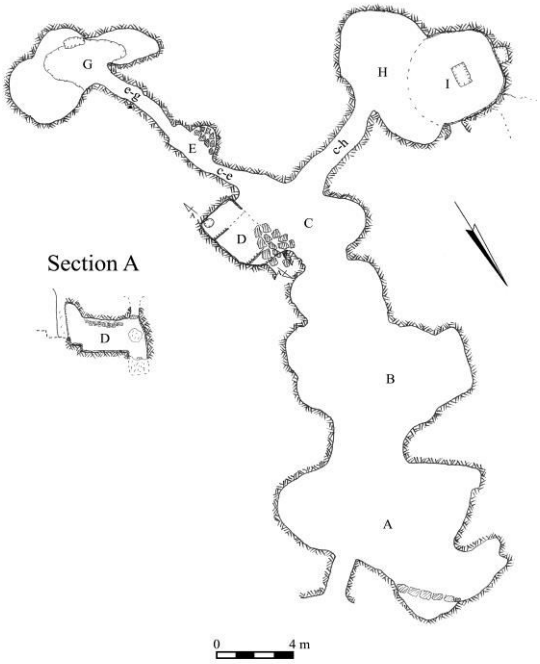


Figure 6: Plan and cross-section of underground hiding system into which a ritual bath was incorporated (drawing: Eitan Klein)

At some stage, the eastern wall of Cistern I was breached and it was linked to Chamber H, which is elliptical in shape (approx. 8 m long and 5 m wide). A narrow tunnel (c-h) was dug in the eastern wall of Chamber H, about 5 m long (approx. 0.7–1.1 m wide with an average height of approx. 0.8 m). It leads to Chamber C, which is irregular in shape (approx. 6.5 m long, 3 m wide, and 1.2 m high).

During the eastward extension of Chamber C, the western wall of the adjacent rectangular chamber (Chamber D;

approx. 4 m long, 2.2 m wide, and 1.8–2 m high) was removed. All the walls of this space were covered with gray hydraulic plaster; in some areas, beneath the plaster one can discern repairs to cracks in the walls, by means of medium-sized fieldstones and cement. This chamber has an entrance approximately 1 m wide, which affords easy access to the structure. Today, the entrance has been blocked by rock fall from the surface. Two plastered steps have been discovered running the width of the structure. The structure's plan indicates that it served as a ritual bath for the Jewish residents, from the late Second Temple period until the Bar Kokhba revolt.

A narrow tunnel approximately 2.5 m long was dug in the southern wall of Chamber C, leading towards room E. The tunnel continues southward from Room E; after about six meters it reaches the irregularly shaped Chamber G, which has an access shaft in its ceiling that is currently sealed. This tunnel has a layout and cross-section typical of a burrow of a hiding complex (Fig 7); several recesses were cut out along its length to hold lamps. We surmise that Chamber G served as an underground storehouse and was built under a residential building, and that the tunnel leading from it towards Chamber C and Room E was built when the system was repurposed for hiding.

Figure 7: Tunnel e-g in the refuge system; view to the N (photo: Eitan Klein)

A wide opening (approximately 2.2 m) in the northern wall of Chamber C breached the ceiling of a large underground chamber (Chamber B). This chamber is about 4–5 m high. It is not clear what use this chamber served in the past. It is linked via an opening 3.8 m wide to another large chamber (Chamber A). An opening in its northeastern wall, approximately 2 m long, 1 m wide, and 1.6 m high, leads to the surface of the eastern slope, outside the settlement, via a rock-hewn dromos.

The pottery shards collected from this system indicate the periods of settlement on the site. The underground hiding system consists of a series of earlier underground chambers that were used for various purposes and were connected by burows, creating a complex underground system. Because it is cut within soft and brittle chalk of Adullam formation (Sneh 2009), most of the tunnels do not have the cross-section typical of a hiding system (Tepper 1987; Kloner and Zissu 2003, 182-183). The system began at the top of the site, inside the boundaries of the ancient settlement and ended on the northern slope, apparently outside the bounds of the settlement as it existed in the period between the two revolts against the Romans. This allowed the people who took refuge in this system to flee the settlement in times of danger. Underground hiding systems from that period, with exits outside the settlement, are known from several nearby locations, such as Hurbat Lavnin and (Zissu 2001, 164) Tel Socho (Zissu 2000), and they have been classified as escape systems, enabling residents fast escape from the settled areas (Kloner and Zissu 2003, 185).

2.4. A Large and Elongated Cistern on the Northeastern Slope

On the northeastern slope of the site, in a dense pine forest approximately 200 m from the summit, we discovered the opening of a hewn-out and plastered underground cistern (Fig 8) that had been broken into by antiquities looters. The cistern, which is located outside the boundaries of the ancient settlement, is reached by steps cut out of the rock. Today, one can enter the structure through a 3 m shaft that reaches the bottom of a hewn entrance 1.7 m wide, which is mostly blocked by large boulders. The façade is partially roofed over by a large slab.

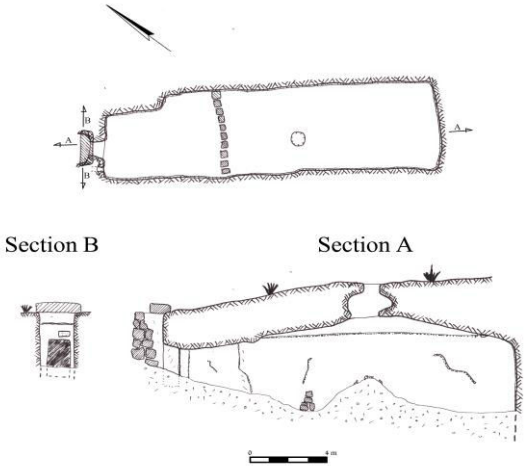


Figure 8: Plan and cross-section of the rectangular cistern (drawing: Eitan Klein)

The structure (Fig 9) is approximately 17.5 m long from the opening in the north to its southern end. The structure has a trapezoidal cross-section. From the rock ceiling down to the floor, which is covered by silt and fallen boulders, is approximately 5 m; however, it is clear that the original floor of the cistern was located even deeper. The walls were covered with a thick layer of gray plaster mixed with gravel and small stones, of the type typical to the Second Temple period (Porat 2002). Where the plaster was damaged or peeled, it was repaired with pinkish plaster on a ground of broken ribbed pottery; this is typical of the Late Roman/Byzantine periods (Porat 2002) and indicates continued use of the cistern then. A shaft for drawing water was cut in the center of the roof. We believe that this shaft was not original but was created when the structure was plastered and repaired and repurposed as a cistern. We propose dating it to the late Second Temple period based on the type of plaster, which is typical of that period. In addition, its design – an elongated cavity with plastered walls and the original entrance at the narrow end – is typologically identical to

the cisterns previously discovered on the slopes of the royal fortresses in Judea that date from the Hasmonean-Herodian period. The royal fortresses built by the Hasmoneans and Herod have specific features, including large cisterns; they were built on elevated sites that dominate their surroundings and are surrounded by steep slopes. These sites were first identified and studied in the Judean Desert (Tsafrir 1975, Shatzman 1991, 36-52, 227-233). In recent years, fortified sites dating to the Second Temple period have been identified in settled areas (mostly in Judea), with the same features as those in the Judean Desert: they dominate their surroundings and have cisterns on their slopes (see for instance the cisterns of the fortress at Horvat Tura: Zissu 2008).

Figure 9: Rectangular enlongated cistern; view to south (photo: Boaz Zissu)

The cistern's location on the slope outside the boundaries of the settlement, the site's physical characteristics (i.e., its elevation, which allows it to control over a wide area) and the appropriate pottery finds allow us to propose, with a high degree of certainty, that the ruin served as a royal fortress built during the Hasmonean or Herodian period. If Hurbat Husham was indeed a Hasmonean-Herodian fortress (it would be the first in the Judean Foothills to be so identified), its role was to defend the western approaches and one of the main routes (through Nahal Soreq and Nahal Elah) to Judea during the late Second Temple Period.

3. Conclusions

The findings from our surveys and excavation presented above point to activity at Hurbat Husham beginning in the Hellenistic period, in the third and second centuries BCE. The large number of mikvaot and the pottery shards appropriate to this period allow us to identify a Jewish settlement, active from the late Second Temple period until the Bar Kokhba revolt. Like other Jewish settlements in the region, it seems to have been abandoned after the Bar Kokhba revolt. Thereafter, apparently in the Late Roman or early Byzantine period, the site was resettled by a Christian community, as indicated by the graffito with crosses etched into the walls of the ritual bath at the site. At this stage, the cisterns at the site were renovated; this included repurposing the mikvaot for water storage. The summary of the data we have provided, and especially the name of this site, its topography, the elongated cistern from the Second Temple period, and the pottery finds from the second century BCE through the Bar Kokhba revolt are the basis of our suggestion that Hurbat Husham was the site of a Hasmonean-Herodian fortress meant to protect the western approaches and one of the major

routes (via Nahal Soreq and Nahal Elah) to Judea during the late Second Temple period.

References

Abel F.M, 1967. Géographie de la Palestine II. Gabalda, Paris.

Broshi M, 1968. Maqeda. In: H Beinart and M Haran (Eds.). Encyclopaedia Biblica V. Institute Bialik Jerusalem, pp. 303–304 (Heb).

Conder C.R, Kitchener H.H, 1883. The Survey of Western Palestine: Memoirs of the Topography, Orography, Hydrography, and Archaeology, Vol. III. Palestine Exploration Committee, London.

Dagan Y, 1992. The Shephela During the Period of the Monarchy in Light of Archaeological Excavations and Survey. M.A Thesis, Tel-Aviv, Tel-Aviv University (Heb).

Dagan Y, 1996. Cities of the Judean Shephelah and their Division into Districts Based on Joshua 15'. Eretz-Israel, 25, 136–146 (Heb).

Guérin M.V, 1969. Description Géographique, Historique et Archéologique de la Palestine: Judée Tome II. Oriental Press, Amsterdam.

Jensen R.M, 2000. Understanding Early Christian Art. Routledge, London.

Klein E, Zissu B, 2012. Ritual Immersion Baths (Miqwa'ot) with Double Entrances in the Jerusalem Hills. In: E Baruch, Y Levin and A Levy-Reifer (Eds.). New Studies on Jerusalem: Volume 18. Ingeborg Rennert Center, Ramat-Gan, pp. 225–245 (Heb).

Kloner A, Zissu B, 2003. Hiding Complexes in Judaea: An Archaeological and Geographical Update on the Area of the Bar-Kokhba Revolt. In: P Schäfer (Ed.). The Bar-Kokhba War Reconsidered. Mohr Siebeck, Tübingen, pp. 181–216.

Porat Y, 2002. Hydraulic Plaster in Aqueducts as a Chronological Indicator. In: D Amit, J Patrich and Y Hirschfeld (Eds.), The Aqueducts of Israel (JRA Supplementary Series 46). RI, Portsmouth, pp. 25–36.

Reich R, 2013. Ritual Baths during the Second Temple Period and in the Mishnah and Talmud Periods. Yad Izhak Ben-Zvi and Israel Exploration Society, Jerusalem (Heb).

Shatzman I, 1991. The Armies of the Hasmonaeans and Herod. Mohr Siebeck, Tübingen.

Sneh A, 2009. Geological Map of Israel 1:50,000: Beit Shemesh, Sheet 11:I. Israel Geological Survey, Jerusalem.

Tepper Y, 1987. Present Research of the Hiding Complexes. In: A Kloner and Y Tepper (Eds.). The Hiding Complexes in the Judean Shephelah. Ha-Kibbutz Hameuchad Publishing House and the Israel Exploration Society, Tel-Aviv, pp. 37–75 (Heb).

Tsafrir Y, 1975. The Desert Forts of Judea in Second Temple Times. Qadmoniot, 30–31, 41–53 (Heb).

Vilnay Z, 1976. Khushem. Ariel Encyclopedia, 3, 2531 (Heb).

Ziffer I, 1998. O my Dove, that Art in the Clefts of the Rock: The Dove-Allegory in Antiquity. Eretz Israel Museum, Tel-Aviv.

Zissu B, 1999. Ḥorbat Ḥushsham. Ḥadashot Arkheologiyot, 109, 81.

Zissu B, 2000. The Ossuary of "Imma, Daughter of Hanania", and the Second Temple Period Jewish Settlement at Sokho, Judaean Foothills. In: A Faust and E Baruch (Eds.). New Studies on Jerusalem: Proceedings of the Sixth Conference. Ingeborg Rennert Center for Jerusalem Studies, Ramat-Gan, pp. 64–74 (Heb).

Zissu B, 2001. Rural Settlement in the Judaean Hills and Foothills from the Late Second Temple Period to the Bar-Kokhba Revolt. Ph.D. diss, Jerusalem, Hebrew University (Heb).

Zissu B, 2008. The Hellenistic Fortress at Horvat Tura and the Identification of Tur Shimon. IEJ, 58, 171–194.

Zissu B, Ganor A, 2002. Ḥorvat ʿEtri – The Ruins of a Second Temple Period Jewish Village on the Coastal Plain. Qadmoniot, 123, 18–27 (Heb).

GEOLOGY, GEOMORPHOLOGY, ENVIRONMENTAL HAZARDS

NATURAL RADIOACTIVITY IN SOME CAVES OF THE VAYOTS DZOR PROVINCE, ARMENIA

Dmitry Albov[1,2], Boris Gasparyan[3]
[1]*Lomonosov Moscow State University, Chemistry Department, Leninskiye Gory 1-3, Moscow, 119991 Russia*
[2]*Czech Speleological Society ZO 3-05,Vítězná 414/72, Karlovy Vary, 36009 Czech Republic, dmitryalbov@gmail.com*
[3]*Institute of Archaeology and Ethnography, Charents st. 15, Yerevan, 0025 Armenia, borisg@virtualarmenia.am*

Abstract

During the international expedition in Armenia in 2017 levels of gamma radiation were measured in four caves in Vayots Dzor province. Background radiation levels in the Archeri, Mozrov and Magel caves show no difference with the medium level in the district, but in one hall of the Areni-1 cave gamma radiation level is up to 3 times higher. This hall contains archaeological layers with the cultural material of Chalcolithic period. The results of gamma spectral measurements of samples from this cave are presented in this article.

Keywords

Radioactivity, gamma radiation, archaeology, cave

To find a suitable location for radon monitoring, levels of gamma radiation were measured in four caves in the area of Noravank monastery, Vayots Dzor province, Armenia. Radon is known as an important earthquake predictor (Riggio & Santulin, 2015), its isotopes are formed by the radioactive decay of the uranium and thorium traces in the most rocks. Radon is released during rock fracture and can be easily detected due to its radioactivity. Its very short half-life makes radon levels sensitive to short-term geological processes. Radon concentrates in underground structures such as natural and artificial caves, mines and cellars. Radon is a pure alpha emitter, but its daughter isotopes yield strong gamma radiation, so there is a reasonable correlation between radon concentration and gamma radiation level suitable for a preliminary search of radon.

Measurements were carried out in the caves Archeri, Mozrov, Magel and Areni-1 using a SRP-68 scintillating exploration radiometer. Background radiation levels in three of them show no difference with the medium level in the district, they are in the range of 7-11 μR/h. An interesting anomaly was found on the floor in one of the galleries of the Areni-1 cave, where gamma radiation level reached 21 μR/h, up to 3 times exceeding levels on the surface and in other caves. However, this cave is perfectly ventilated through several entrances, so radon hardly concentrates there and we could suppose that it should not be the main reason of radiation.

The Areni-1 cave is a noticeable archaeological site, it is situated at 1 km from the Areni village on a bank of the Arpa river. Archaeological excavations were carried out from 2007 to 2014. Several strata were found dating since the Late Chalcolithic to Medieval time. Excavations showed that different parts of the cave were used by inhabitants for different purposes such as storage, living and ritual purposes. Soil in the cave consists of sand-rich silts of unknown genesis, probably by weathering of the cave enclosing rock and cultural activities took place inside of the cave.

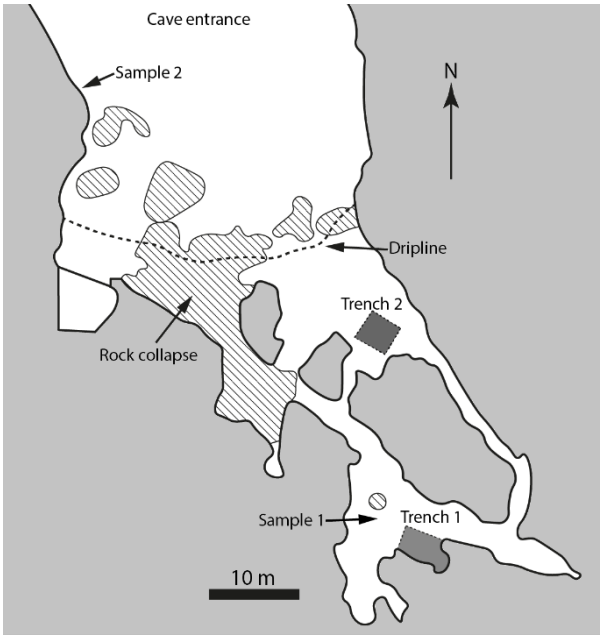


Figure 1. Plan of Areni-1.

In the remote hall (Fig. 1) the Trench 1 was excavated, revealing four archaeological layers of late Chalcolithic period with thickness of 4.5 m (units 1002-1005, Wilkinson et al., 2012). Unit 1005 contained scattered ceramics and animal bones (mainly of sheeps and goats). Units 1003 and 1004 contained whole ceramic vessels, pottery fragments, animal bones and obsidian artefacts. Two of the pots contained sub-adult human crania and an adult femoral shaft. Six large ceramit storage vessels contained plant remains and were set within clay basins, which in turn formed part of a more extensive baked clay surface. A ^{14}C date on charcoal from Unit 1004 suggests that deposition occurred around 4230–3970 Cal B.C.

In the entrance of the cave the Trench 2 was excavated. Several units of the Chalcolithic period also contained crania in ceramic vessels, storage vessels, bones of animals and remains of plants. Units in the Trench 2 containing storage and ritual vessels dated by 3970-3800 B.C. are contemporary with the units 1002 and 1003 in the Trench 1.

Unusual gamma radiation level was found only in the Trench 1 and at the soil surface around it (Fig. 1). The Trench 2 snows no radiation anomaly as well as the rest of the cave.

Table 1. Activities of major nuclides.

Nuclide	Decay chain	Sample 1 Bq/kg	Sample 2 Bq/kg
^{235}U	^{235}U	0.82	0.66
^{211}Bi	^{235}U	36.11	32.43
^{238}U (calculated)	^{238}U	17.51	14.19
^{234}Th	^{238}U	11.12	10.40
^{214}Pb	^{238}U	13.47	12.83
^{214}Bi	^{238}U	12.30	11.54
^{232}Th (calculated)	^{232}Th	33.66	2.30
^{228}Th	^{232}Th	77.41	5.30
^{228}Ac	^{232}Th	12.87	0.91
^{212}Pb	^{232}Th	14.91	1.05

Activities of nuclides belonging to the ^{235}U and ^{238}U decay chains are a little bit more in the sample 1. However, activities of nuclides belonging to the ^{232}Th decay chain is about 14 times higher in the sample 1.

We assume that higher content of thorium and its dauther isotopes is a result of human activity in the Areni-1 cave. For example, thorium may present in a peculiar type of pottery made from thorium-rich clay. Also the source of thorium could be bones of animals and humans who lived in the area with high thorium content. Also we can not exclude the role of geological processes in thorium accumulation. In order to locate thorium containing material it might be possible to use alpha radiation meter in the cave and namely in the Trench 1, followed by gamma spectrometry of some artefacts.

References

Riggio A, Santulin M, 2015. Earthquake forecasting: a review of radon as seismic precursor. Bollettino di Geofisica Teorica ed Applicata, 56(2), 95-114.

Wilkinson K, Gasparian B, Pinhasi R, Avetisyan P, Hovsepyan R, Zardaryan D, Areshian G, Bar-Oz G, Smith A, 2012. Areni-1 Cave, Armenia: A Chalcolithic–Early Bronze Age settlement and ritual site in the southern Caucasus. Journal of Field Archaeology, 37(1), 20-33.

KNOWING THE UNDERGROUND, AS THE FIRST STEP FOR HAZARD MANAGEMENT: AN EXPERIENCE IN SOUTHERN ITALY, IN THE AFTERMATH OF A CATASTROPHIC COLLAPSE

Mario Parise[1,2], Aniello Derazza[3], Giuditta Garziano[3], Mimmo Gentile[3], Francesca Lagna[3], Gianclaudio Sannicola[3], Samantha Santarcangelo[3], Marco Viva[3]

[1] *Università Aldo Moro, Bari, Italy; mario.parise@uniba.it*
[2] *CNR IRPI, Bari, Italy*
[3] *Federazione Speleologica Pugliese, Castellana-Grotte, Italy*

Abstract

Several types of geological hazards are related to the underground, the most typical being represented by sinkholes, a subtle and dangerous hazard which generally occurs with very little precursory signs, thus putting at high risk the vulnerable elements present nearby. Italy is worldwide known for its long history, and the beauty of many historical town centres. Where the local geological conditions allowed, more than one civilization used the underground, to dig and excavate in the soft rocks (volcanic rocks, calcarenites, etc.) artificial cavities to be used for a variety of purposes. As a matter of fact, artificial cavities, once abandoned, become sites of likely degradation of the rock mass, suffering a slow but continuous decaying process, potentially bringing to decreasing the physical properties of the rock mass, due to water infiltration, weathering processes, etc. At present, many of these cavities lie below the urbanized areas, quite often without the present population is aware of them, which might be at the origin of situations at risk. In January 2014, a collapse due to instabilities in artificial cavities developed at the historical centre of Ginosa (a small town in southern Italy), forcing the local authorities to close a large sector of the historical part of the town. In the aftermath of this event, we worked to evaluate the susceptibility to other possible collapses, as a consequence of bad instability conditions in the existing network of artificial cavities. At this aim, about 100 cavities were surveyed, documented and controlled in two months and a half. The susceptibility to collapse was evaluated in accordance to a specific procedure (which is also applicable to natural caves) aimed at contributing to mitigate the risk from this geohazard. The procedure develops from the identification and geographical location of the cavities, and then proceeds with the speleological survey, before characterising the caves in terms of geological-structural data (highlighting all the existing discontinuities in the rock mass, of both stratigraphic and tectonic origin), and of all the features related to occurrence and development of instability processes. Laboratory tests and monitoring are also mentioned as further possible steps of the analysis. Eventually, the procedure results in a zonation depicting the sectors most prone to development of sinkholes.
In this contribution we present the outcomes of our work at Ginosa, within the framework of the emergency phase management, highlighting the possible use of the method, at the same time also describing the difficulties encountered in developing such a study.

Keywords

Artificial cavity, collapse, hazard, management, mapping.

1. Introduction

Several types of geological hazards are related to the underground environment, directly or indirectly. Among these, the most typical is represented by sinkholes (Waltham et al., 2005; Parise and Gunn, 2007; Parise, 2008, 2010a; Gutierrez et al., 2014, and references therein), a subtle and dangerous hazard which generally occurs with very little precursory signs, thus putting at high risk the vulnerable elements present nearby.
Italy is worldwide known for its long history, and the beauty of many historical town centres. Where the local geological conditions allowed, more than one civilization used the underground, to dig and excavate in the soft rocks (volcanic rocks, calcarenites, tufa, etc.) artificial cavities to be used for a variety of purposes, as shown in the different categories of the Classification of artificial cavities, developed at international level by the specific Commission of the International Union of Speleology (UIS; Galeazzi, 2013; Parise et al., 2013). Whatever the purpose of realization, artificial cavities, once abandoned, may soon became sites of likely degradation of the rock mass, suffering a slow but continuous decaying process, potentially bringing to decreasing the physical properties of the rocks, due to water infiltration and weathering processes (Canakci, 2007; Calcaterra and Parise, 2010). Such changes may originate with time failure mechanisms, and contribute to the progressive development of instability toward the surface, until producing a real sinkhole (Fraldi and Guarracino, 2009; Ferrero et al., 2010; Lollino et al., 2013; Fiore et al., 2018; Parise et al., 2018).
At present, many artificial cavities lie below the urbanized areas, quite often without the present population is aware of them, which might be at the origin of situations at risk. In January 2014, a collapse (Figure 1)

due to instabilities in artificial cavities developed at the historical centre of Ginosa (a small town in Apulia, southern Italy), forcing the local authorities to close a large sector of the historical part of the town. In the aftermath of this event, we worked to evaluate the susceptibility to other possible collapses, as a consequence of negative instability conditions in the existing network of artificial cavities. At this aim, about 100 cavities were surveyed, documented and controlled in two months and a half. The susceptibility to collapse was evaluated in accordance to a specific procedure (which is also applicable to natural caves) aimed at contributing to mitigate the risk from this geohazard (Parise, 2015). The procedure develops from the identification and geographical location of the cavities, and then proceeds with the speleological survey, before characterising the caves in terms of geological-structural data (highlighting all the existing discontinuities in the rock mass, of both stratigraphic and tectonic origin), and of all the features related to occurrence and development of instability processes.

Figure 1. Frontal (above) and downhill (below) view of the 21 January, 2014, collapse at Ginosa.

Laboratory tests and monitoring could represent further possible steps of the analysis. Eventually, the procedure results in a zonation depicting the sectors most prone to development of sinkholes.

In this contribution we present the outcomes of our work at Ginosa, within the framework of the emergency phase management, highlighting the possible use of the method, at the same time also describing the difficulties encountered in developing such a study.

2. Natural and anthropogenic sinkholes in Apulia

Sinkholes are a very subtle hazard, caused by processes developing underground, that reach the surface only during the collapse stage, typically occurring in a catastrophic and very rapid way. Nevertheless, in most of the cases instability phenomena are preceded by deformations, which direct observations could allow to understand the processes occurring underground, and plan interventions to mitigate the risk to people and society.

In all of this, the importance of cave surveying, mapping and documentation has to be pointed out, with particular regard to all those elements related to instability processes that can be directly observed underground (Klimchouk and Andrejchuk, 2002; Palmer, 2007; Parise and Lollino, 2011). In subterranean environments, the main problem lies in the possibility to detect and recognise such phenomena. Due to difficulties in working underground, scarce attention has been generally given in the scientific literature to the issue of these precursory signs, as pointed out by Swedzicki (2001).

Apulia region, in south-eastern Italy, is among the Italian sectors with the highest number of documented sinkhole events, both related to the presence of natural caves or man-made cavities (Parise and Vennari, 2013, 2017). This derives from a number of reasons, the main ones being the local geology, almost entirely consisting of rocks susceptible to karst (carbonates, and subordinate evaporites), and therefore to development of caves. This combines with a huge number of artificial cavities, excavated by man during different epochs and with a variety of functions (settlements, quarry/mine, worship sites, etc.). As regards artificial cavities, underground quarries are definitely the type which has been demonstrated as the most responsible for sinkhole occurrence (Parise, 2010b, 2012; Pepe et al., 2013), so that they have become the main field of application of numerical codes to model the evolution of the instabilities observed underground, and to forecast the size of sinkholes at the ground surface (Delle Rose et al., 2004; Parise and Lollino, 2011; Lollino et al., 2013; Fazio et al, 2017; Perrotti et al., 2018).

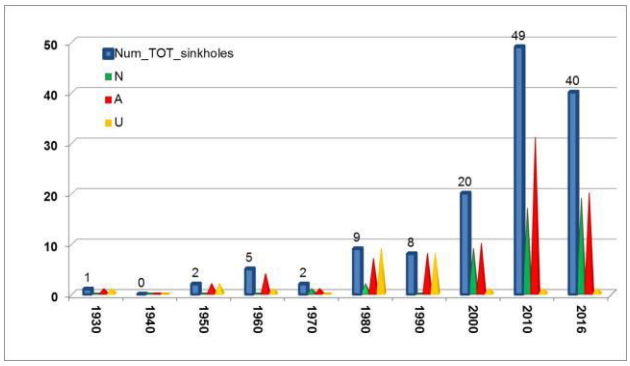


Figure 2. Chronological distribution of documented sinkholes in Apulia: green marks the natural sinkholes, and red the artificial sinkholes, whilst yellow indicates the uncertain events.

According to the most recent studies (Parise and Vennari, 2017), the documented sinkholes in Apulia are more than 150, the oldest ones dating back to 1925. They affect the whole regional territory, and shows a prevalence of

sinkholes related to man-made cavities (about 66%), with about one third originated by natural karst caves (32%). For 3 events only (2%) the origin of the documented sinkholes is unknown. When looking at the temporal distribution of the documented events (Figure 2), an increase in the number of events comes up when reaching the year 2000, and afterwards, with a frequency at least doubling with respect to the pre-2000 years. This is at least in part due to greater awareness of the problem, after the series of events that were registered in locations as Altamura and Gallipoli (Parise, 2012; Pepe et al., 2013). In the aftermath of these (and others) events, a more careful record of the occurrence of sinkholes was produced, also as a consequence of specific regulations issued by the Basin Authority of Apulia (that is, the Regional Body in charge of dealing with hydrogeological hazards and defining the related regulations for land management).

3. The 2014 collapse at Ginosa

On October and December 2013 two rainstorms interested wide areas of southern Italy, with particular regards to sectors of the Apulia and Basilicata region, causing, among many other slope movements, the landslide that cut the main road to the town of Montescaglioso (Manconi et al., 2014). One of the most affected area was the town of Ginosa, where the event of October 7, 2013, caused 4 casualties in consequence of the floods which hit the main karst valleys (*gravine* in the local dialect; see Parise et al., 2003). Both the events of the last months of 2013 acted in producing severe degradation in the calcarenite rock mass of the Ginosa area, in particular along the flanks of the main valley, where hundreds of artificial cavities are present at different levels.

On December 2013 the valley was entirely flooded by the running waters (Figure 3), and the cavities at lower levels were inundated by water and debris. Serious damage had to be recorded, also because the water reached some of the inhabited areas, in consequence of the partial damming produced by trees and branches at the bridge (Figure 4).

Figure 3. The valley at Ginosa inundated by waterflood during the night of the December 2013 event (photo courtesy M. Pastore).

Following the flood events, the stability conditions along the valley flanks decreased, especially at those sites already characterized by weaknesses in the rock mass. Few weeks later, on January 21, 2014, a system of several adjoining artificial cavities collapsed (Figure 1), destroying one house and the main road to the historic part of town, and damaging many others. Luckily, nobody was injured in the collapse.

After this event, a phase of surveying and checking of the many artificial cavities in the historic centre of Ginosa was started, with the goal to understand if there were other underground voids in critical conditions. This proceeded through several phases of work, described in detail in the next section, and resulted in a preliminary zonation of the susceptibility to collapses related to artificial cavities, after having surveyed about 100 cavities.

Figure 4. Effects of the December 2013 flood (photos courtesy M. Pastore). Note the trees and branches obstruction at the main bridge crossing the valley.

4. Surveying the cavities in the historical center

The procedure applied, dedicated to evaluation of the susceptibility to sinkholes, developed through the following steps:

(1) Locating the underground cavities;
(2) Typology of the cave;
(3) Speleological survey;
(4) Structural survey;
(5) Identification of instability features;
(6) Weathering;
(7) Preliminary zonation.

To precisely **locate the entrance** (or the entrances, in case more than one access is present) of the cave was the first step in the procedure. The entrance is, as a matter of fact, the reference point from where to start the

topographic survey, and therefore must be positioned with the highest possible precision, by means of Global Positioning Systems (GPS) tools. Identification of the site where the cave opens might not be a simple matter, due to loss of memory of old artificial cavities, or clogging with waste materials, or presence of vegetation masking the access. A further problem might be related to attempts by the landowners in keeping hidden the cave, fearing that its exploration might result in legal constraints or in the necessity to perform some kind of works at their own expenses.

Location of an artificial cavity is generally not casual, but depends upon the local geology and geomorphology, since the characters and properties of the rock mass are crucial in choicing the sites where man used to start excavating in the past (Del Prete and Parise, 2013).

Typology of the artificial cavity at the origin of possible failures must be established, following the internationally established standards by the International Union of Speleology (UIS; Galeazzi 2013; Parise et al. 2013). The classification is organised like a tree, based on seven main types, identified by capital letters (A to G); these are in turn divided into sub-types, by adding a number to the capital letter.

Once the cave entrance was positioned by means of GPS measurements, it will represent the starting point for the main survey line of the **topographic survey**, to be carried out with caving techniques by expert cavers. Fixed reference points (benchmarks) must be established, or marked in the cave, to help the surveyors during the work, and to allow repeated measures, if necessary. The first necessary activity is to ascertain the spatial development of the underground cavities, and to verify the possibility of failures and/or the likely involvement of nearby infrastructures.

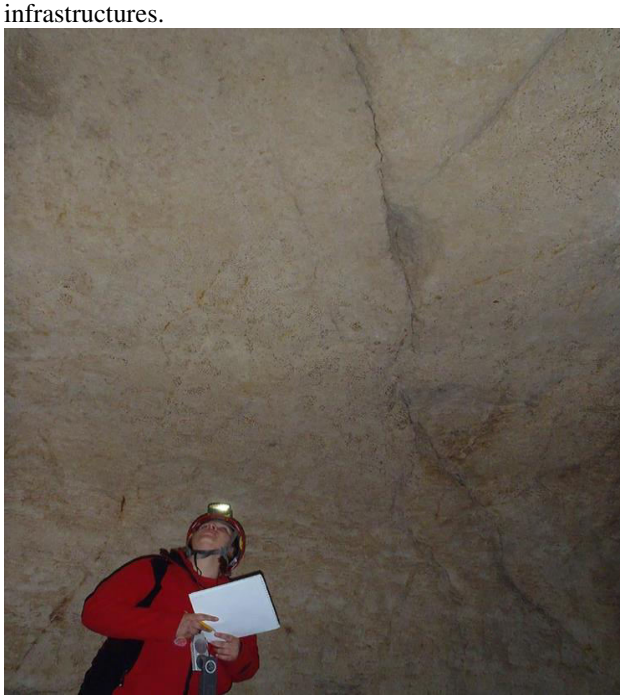


Figure 5. Open discontinuities, related to tensional release, on the vault and wall of one of the surveyed cavities.

All the activities of the speleological survey have to be carried out with high degree of precision of the survey lines, following the standards established at the international level (Day 2002; Häuselmann 2006, 2010). Each phase of the survey was accompanied by detailed photographic (and video) documentation. During the field work, we also used directly in the cave a blue tooth connection between the measuring instruments and a palmtop, aimed to draw directly during the survey the sketch of the cave.

A structural survey was carried out in each cavity, aimed at the careful identification of the discontinuities in the rock mass (Figure 5), that were measured and mapped, with particular attention to their location (wall, vault, pavement, pillar), aperture, infilling material and presence of water. Pervasiveness of the discontinuity, that is its extension within the rock mass, was also evaluated whenever possible, being one of the most important feature in terms of instability. Whenever possible, the observed discontinuities were discriminated as produced by local failures, or originated as tectonic or stratigraphic discontinuities in the rock mass. This is important in order to identify the sectors most prone to future failures, that is to reach a preliminary zonation of the underground spaces.

Among the most important elements to take into account, there is the presence of **instability features** in the cavity. Different types of failures can be observed underground, originated by different processes of rupture in the rock mass. All these features must be carefully identified and mapped, in order to provide the necessary information for the following steps. For further details the reader is referred to the work by Parise and Lollino (2011).

- Falls from the vault often develop the formation of a single or double arch, as an effect of the reduction in the rock strength of the cave roof. They are typically preceded by formation of joints through the roof, which propagation leads to a complete or local failure mechanism.
- Falls from the vault (Figure 6), due to lack of support from previously existing pillars (induced failure). The roof span becomes too long to be sustained by the rock strength (Hutchinson et al., 2002; Fraldi and Guarracino, 2009; Ferrero et al., 2010).
- Failures from the pillar corners, generated by local accumulation of compressive stress too high with respect to the rock strength.
- Lateral failures along sliding surfaces parallel to the walls. This process may work in progressively enlarging the cave until it reaches a critical configuration, then leading to general failure and eventually to sinkhole formation.

Evolution of instability processes in underground settings is generally dependent upon internal factors, such as the low mechanical strength of soft rocks (Andriani and Walsh, 2002), or upon external natural and/or anthropogenic factors that can modify the boundary conditions, the loading, or the physical and mechanical properties of involved materials. Changes in loading can be represented by construction of buildings or infrastructures above the ground surface, that can modify the stress state around the cave, the destruction of pillars within underground rooms with consequent increase in the cave span, as well as seismic loading conditions or man-made vibrations due to traffic or construction works.

Weathering processes may contribute to decrease the physical properties of the rock mass, and to facilitate the

development of failures. Decay in the strength of the rock, typically deriving from water infiltration, may result in the formation of layers of loose clasts along the main discontinuity where water flows or infiltrates. Especially when the weathered bands are located close to occurred failures, their presence must be carefully evaluated.
Once the previous elements were observed and measured, they were analyzed in order to perform a **preliminary zonation** of the cavities as concerns stability, and to identify those where the possibility of occurrence of failures is highest. First and foremost, the presence of occurred failures, including the related deposits, was considered, and the mechanism of rupture ascertained. At the same time, the presence of features that could lead to other impending failure (i.e., blocks in precarious equilibrium, open cracks, dripping water) was carefully checked.
Dripping water at a certain site might be an indicator of a constant flow through a specific discontinuity (or a set of discontinuities), producing a weakness in that sector. The source of infiltration of water must be looked for, aimed at diverting it from the underground cave.
Presence of works aimed at sustaining the vault or the walls of the cave, as well as any other human action realised in order to improve the stability of the cave, must be pointed out, since they represent evidence of past failures.
It must also be considered whether the cavity is isolated or in close connection, or in the vicinity with others (a cavity where no failure and discontinuity was observed may be involved in a collapse originated in a nearby cave).
All the above factors can be put in a simple matrix, or a weight can be assigned to them, depending upon the relative importance at the specific site. The resulting sum will provide a qualitative assessment of the stability for each sector, after having established a ranking in low, medium, high susceptibility to failure.

Figure 6. Local failures on the vault of a cavity.

4. Conclusions

Due to progressive, upward evolution of the failure process, instability occurring underground may eventually result in producing subsidence or sinkholes at the ground surface over large areas. In inhabited areas with a high number of cavities, dislocated at different heights along the cliffs, this poses serious problems in terms of Civil Protection issues. Knowledge of the cave development, and of the stability conditions therein as well, is mandatory to carry out any possible action addressed to mitigate the hazard. In addition to possible damage to built-up areas and infrastructures, the sinkhole hazard should also be considered as concerns protection and safeguarding of cultural heritage sites: as a matter of fact, several man-made cavities at Ginosa host remarkable examples of frescoes and are of importance for historical and religious issues, attracting a large number of tourists and pilgrims.
The procedure adapted after the 2014 collapse at Ginosa was aimed at providing a rapid assessment of the stability conditions of underground caves, and to obtain in short time a preliminary zonation of the related susceptibility to sinkholes. Further, it represents a good starting point for deepening the analyses, where necessary, aimed at a more complete understanding of the phenomena, and at the planning and implementation of stabilization engineering works.

References

Andriani G.F., Walsh N., 2002. Physical properties and textural parameters of calcarenitic rocks: qualitative and quantitative evaluations. Engineering Geology, 67 (1–2), 5–15.

Calcaterra D., Parise M. (Eds.), 2010. Weathering as a predisposing factor to slope movements. Geological Society of London, Engineering Geology Special Publication no. 23.

Canakci H., 2007. Collapse of caves at shallow depth in Gaziantep City center, Turkey: a case study. Environmental Geology, 53, 915–922.

Day A., 2002. Cave Surveying. British Cave Research Association, Cave Studies Series, 11.

Delle Rose M., Federico A., Parise M., 2004. Sinkhole genesis and evolution in Apulia, and their interrelations with the anthropogenic environment. Natural Hazards and Earth System Science, 4, 747–755.

Del Prete S., Parise M., 2013. An overview of the geological and morphological constraints in the excavation of artificial cavities. In: Filippi M., Bosak P. (Eds.), Proceedings 16th International Congress of Speleology, Brno, 21-28 July 2013, 2, 236-241.

Fazio N.L., Perrotti M., Lollino P., Parise M., Vattano M., Madonia G., Di Maggio C., 2017. A three-dimensional back analysis of the collapse of an underground cavity in soft rocks. Engineering Geology, 238, 301-311.

Ferrero A.M., Segalini A., Giani G.P., 2010. Stability analysis of historic underground quarries. Computers and Geotechnics, 37 (4), 476–486.

Fiore A., Fazio N.L., Lollino P., Luisi M., Miccoli N.M., Pagliarulo R., Perrotti M., Pisano L., Spalluto L., Vennari C., Vessia G., Parise M., 2018. Evaluating the susceptibility to anthropogenic sinkholes in Apulian calcarenites, southern Italy. In: Parise M., Gabrovsek F., Kaufmann G., Ravbar N. (Eds.), Advances in Karst Research: Theory, Fieldwork and Applications. Geological Society, London, Special Publications, 466, pp. 381-396.

Fraldi M., Guarracino F., 2009. Limit analysis of collapse mechanisms in cavities and tunnels according to the Hoek–Brown failure criterion. International Journal of Rock Mechanics and Mining Sciences, 46 (4), 665–673.

Galeazzi C., 2013. The typological tree of artificial cavities: a

contribution by the Commission of the Italian Speleological Society. Opera Ipogea, 1, 9–18.

Gutiérrez F., Parise M., De Waele J., Jourde H.,.2014. A review on natural and human-induced geohazards and impacts in karst. Earth Science Reviews, 138, 61–88.

Häuselmann P., 2006. Symbols for karst surfaces: the UIS list. Zeitschrift fur Geomorphologie 147, International Atlas of Karst Phenomena, Sheets 18–21, 3–7.

Häuselmann P. (Ed.), 2010. UIS Mapping Grades. Version 2. http://www.uisic.uis-speleo.org/UISmappingGrades.pdf.

Hutchinson D.J., Phillips C., Cascante G., 2002. Risk Considerations for Crown Pillar Stability Assessment for Mine Closure Planning. Geotechnical and Geological Engineering, 20 (1), 41–64.

Klimchouk A., Andrejchuk V., 2002. Karst breakdown mechanisms from observation in the gypsum caves of the Western Ukraine: implications for subsidence hazard Assessment. International Journal of Speleology, 31 (1/4), 55–88.

Lollino P., Martimucci V., Parise M., 2013. Geological survey and numerical modeling of the potential failure mechanisms of underground caves. Geosystem Engineering, 16 (1), 100–112.

Manconi A., Casu F., Ardizzone F., Bonano M., Cardinali M., De Luca C., Gueguen E., Marchesini I., Parise M., Vennari C., Lanari R., Guzzetti F., 2014, Rapid mapping of event landslides: the 3 December 2013 Montescaglioso landslide (Italy). Natural Hazards and Earth System Sciences, 14, 1835-1841.

Palmer A.N., 2007. Cave Geology. Dayton, OH: Cave Books.

Parise M., 2008. Rock failures in karst. In: Cheng Z., Zhang J., Li Z., Wu F., Ho K. (Eds.), Landslides and Engineered Slopes. Proc. 10th International Symposium on Landslides, Xi'an: Taylor and Francis, June 30–July 4, pp. 275–280.

Parise M., 2010a. Hazards in karst. In: Bonacci O. (Ed.), Proceedings International Interdisciplinary Scientific Conference "Sustainability of the karst environment. Dinaric karst and other karst regions", Plitvice Lakes (Croatia), 23-26 September 2009, IHP-UNESCO, Series on Groundwater no. 2, pp. 155-162.

Parise M., 2010b. The impacts of quarrying in the Apulian Karst. In: Carrasco F., La Moreaux J.W., Duran Valsero J.J., Andreo B. (Eds.), Advances in Research in Karst Media. Berlin, Heidelberg, Springer, pp. 441–447.

Parise, M., 2012. A present risk from past activities: sinkhole occurrence above underground quarries. Carbonates and Evaporites, 27 (2), 109–118.

Parise M., 2015. A procedure for evaluating the susceptibility to natural and anthropogenic sinkholes. Georisk, 9, 272-285.

Parise M., Gunn J. (Eds.), 2007. Natural and Anthropogenic Hazards in Karst Areas: Recognition, Analysis and Mitigation. London Geol. Society, Special Publication 279.

Parise M., Lollino P., 2011. A preliminary analysis of failure mechanisms in karst and man-made underground caves in Southern Italy. Geomorphology, 134 (1–2), 132–143.

Parise M., Vennari C., 2013. A chronological catalogue of sinkholes in Italy: the first step toward a real evaluation of the sinkhole hazard. In: Land L., Doctor L.H., Stephenson B. (Eds.), Proceedings of the 13th Multidisciplinary. Conference on Sinkholes and the. Engineering and Environmental Impacts of Karst, Carlsbad, National Cave and Karst Research Institute, pp. 383–392.

Parise M., Vennari C., 2017. Distribution and features of natural and anthropogenic sinkholes in Apulia. In: Renard P., Bertrand C. (Eds.), EuroKarst 2016, Neuchatel. Advances in the hydrogeology of karst and carbonate reservoirs. Springer, ISBN 978-3-319-45464-1, pp. 27-34.

Parise M., Federico A., Delle Rose M., Sammarco M., 2003. Karst terminology in Apulia (southern Italy). Acta Carsologica, 32 (2), 65-82.

Parise M., Galeazzi C., Bixio R., Dixon M., 2013. Classification of artificial cavities: a first contribution by the UIS Commission. In: Filippi M., Bosak P. (Eds.), Proceedings 16th International Congress of Speleology, Brno, 21-28 July 2013, 2, pp. 230-235.

Parise M., Gabrovsek F., Kaufmann G., Ravbar N., 2018, Recent advances in karst research: from theory to fieldwork and applications. In: Parise M., Gabrovsek F., Kaufmann G., Ravbar N. (Eds.), Advances in Karst Research: Theory, Fieldwork and Applications. Geological Society, London, Special Publications, 466, pp. 1-24.

Pepe P., Pentimone N., Garziano G., Martimucci V., Parise M., 2013. Lessons learned from occurrence of sinkholes related to man-made cavities in a town of Southern Italy. In: Land L., Doctor L.H., Stephenson B. (Eds.), Proceedings of the 13th Multidisciplinary. Conference on Sinkholes and the. Engineering and Environmental Impacts of Karst, Carlsbad, National Cave and Karst Research Institute, pp. 393–401.

Perrotti M., Lollino P., Fazio N.L., Pisano L., Vessia G., Parise M., Fiore A., Luisi M., 2018, Finite Element–based stability charts for underground cavities in soft calcarenites. ASCE International Journal of Geomechanics, 18 (7), 04018071.

Swedzicki T., 2001. Geotechnical precursors to large-scale ground collapse in mines. International Journal of Rock Mechanics and Mining Sciences, 38 (7), 957–965.

Waltham T., Bell F., Culshaw M., 2005. Sinkholes and Subsidence. Chichester, Springer.

THE NEW POLICY OF THE GOVERNMENT OF ARMENIA ON THE PROTECTION OF UNDERGROUND CULTURAL AND NATURAL MONUMENTS

Samvel M. Shahinyan[1]

[1]*National University of Architecture and Construction of Armenia, Chair of Geoecology and Biosafety E-mail Samvel.shahinyan1954@gmail.com*

Abstract

Following the nine years of struggle by the Speleological Center of Armenia (SCA), the Armenian Ministry of Culture adopted, after some editing, as a working document and put into circulation the principles developed by SCA relating the caves as natural and cultural monuments. Thus, according to the new approaches, the Government of Armenia views caves as natural and cultural monuments. Caves can be used, for example, by including them in tourist routes but not necessarily operating them. To use the caves, the applicants are required to meet the 32 conditions, and only then caves will be operated on a contractual basis for a 25 year period.

Keywords

caves, monuments of nature and civilization, protection, state requirements, use

1. Introduction

All caves that are accessible and are not used are on the verge of extinction. Over the recent 25 years, 60 percent of stone-door caves in Aragatsotn marz (province) were completely destroyed, while the rest were half-destroyed; the upper archaeological layer of cave Magil, 90 percent of the natural occurrences, the natural occurrences of the second hall of cave Arjer, many of the rock-cut mausoleums and other monuments were destroyed. Unlike these caves, Geghard and a few other caves have not only been wonderfully preserved, but also restoration works are underway to protect these monuments from natural risks.

There are four natural and a few dozens of anthropogenic caves that are world renowned, including: the rock-cut churches of Geghart and Martiros; settlements of Khndzoresk, Karashen and Tegh; among karst caves – Arjer, named by Dublyanski the only thermokarst in the territory of the former Soviet Union; Magil as one of the largest caves in the world among conglomerates; and Mozrov with its unique mineral occurrences; the Stone Age monuments; and finally the oldest monument of the civilization in the world, Areni-1 cave. Preserving all these caves in their original appearance requires daily care.

2. The only specialized agency in Armenia:

During the soviet era, the Speleological Expedition of the Geological Society of the Academy of Sciences of the Armenian Soviet Socialist Republic was the only agency involved in development of speleology in Armenia; later on the Speleological Center of Armenia, established in 1984, became involved. Over 1,000 caves were documented and more than 100 research reports and articles were presented to the international community. The RA Ministry of Culture and partially the Ministry of Nature Protection are the authorized bodies responsible

for the management and protection of caves. The activities of these ministries have been ineffective in protection and research of the monuments. Moreover, the problem becomes even more unsolvable due to the professional ignorance, insufficient budgetary allocations and the absolute lack of desire from the Government.

3. How to solve the problem:

It is necessary to lease out all valuable caves for a long term and operate them on the contractual bases, provided that the RA Ministry of Nature Protection and the Ministry of Culture will carry out control to ensure the purity of the original appearance of the caves under protection, clearly mentioned in the contract.

The main requirements for restoration and use of caves:

The permit for operation of caves should be diversified for:

1. the caves having natural and historic value, with strict requirements to be applied;
2. the caves with no natural and historic value, with simplified operations.

The geological component of natural caves:

1. The geological component. The description of the general geological and geotectonic structure is needed;
2. Availability of the cave's geochemistry, hydrogeology and geophysics in the Project;
3. The seismic stability;
4. The microclimate.

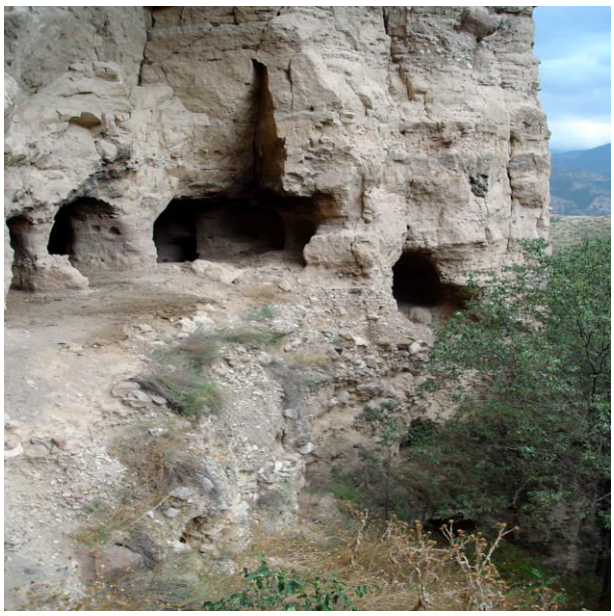


Figure 1.Hochants Anapat. During nearly the entire 18th century and early 19th century, Hochants has been a spiritual and cultural center; it was blown and destroyed during the Soviet rule.

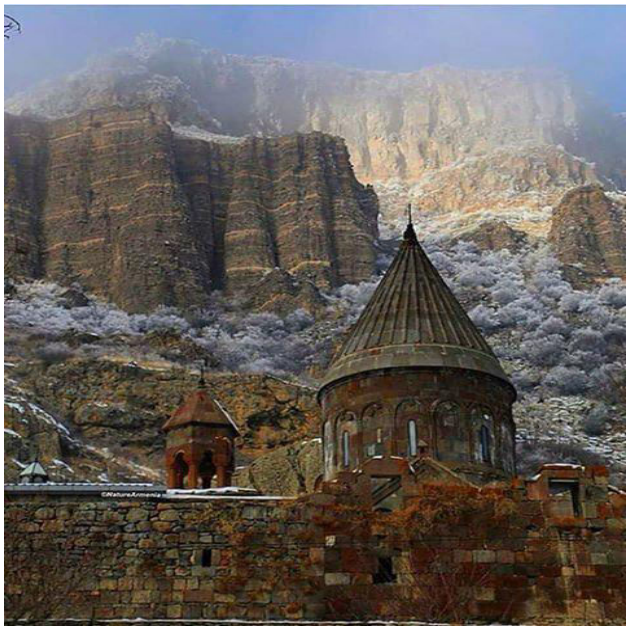


Figure 2. Gegard Monastery. The cave itself and the outer sections are well preserved due to the fact that it has been permanently used.

The ecological component of the natural caves:

1. The fauna. Animals that use the cave as a temporary housing or shelter – birds, bats, wolves, bears, leopards, bezoar goats, mouflons, mice, etc. Organisms that use the cave as housing – spiders, worms, bacteria, etc.
2. The flora: mushrooms, moss, etc.
3. The impact on the environment due to the restoration works and stream of people

Archaeological and Paleontological components of natural caves:

1. Initial information about the availability of a cultural layer. The Project will contain the results of archaeological and paleontological excavations.

The tourism component of natural caves:

1. The Ministry shall make a decision on and confirm the areas, passes and paths designed for tourism, marking them on the particular cave's plan. Further changes will be made according to the logic of the grounding behind the decision.
2. The number of people entering the caves and the periodicity of entrance is determined depending on the volumes of the caves and the safety issues of the natural and cultural monuments.
3. During the cave improvement works, exclude the use of wood and building materials that contribute to occurrence and propagation of fungi, mold and moss.

4. The benefits: The monuments will be under continuous control. 90 new jobs will be created in 12 communities of Aragatsotn and Vayots Dzor marzes only. Tourism will become a new source of income for those communities. The population will become aware of the history of its own biotope.

Community involvement or an investment project in adjacent communities using the income received:

1) Ensuring possible involvement of international investors in the initial or further phases of the project;
2) A plan/schedule of financial investment and documents grounding the possible involvement of assets;
3) Information on the number of jobs to be created within the scope of the project and the average salaries of the employees;
4) Activity plan for the first 5 years and for the next 20 years of lease.

Program of tourist safety measures;

The program on creation of additional facilities/infrastructures intended for the convenience of

the visitors (public toilets, garbage disposal, parking, information, etc.). The program of treatment and operation of the toilet.

4. Summary: In the Republic of Armenia, as well as in many countries in Europe, there is no law on caves. There are also no common standards for operation of caves. This hinders the process of finding more efficient ways for the protection of caves, including making them touristic sites and transforming them into museums, which has become a necessity today.

References:

IUCN Guidelines for Cave and Karst protection;

ISCA management guidelines

Agreement on the Conservation of Populations of European Bats, EUROBATS, 1991

A. J. Mitchell-Jones, Z. Bihari, M. Masing, L. Rodrigues "Protecting and managing underground sites for bats" Eurobats Publication Series No. 2 (English version). UNEP/EUROBATS Secretariat, Bonn, Germany. 2007/

ISCA management guidelines

www.showcaves.com; www.i-s-c-a.com, etc

Figure 3. Examples of stone-door caves depicted 30 years ago

Figure 4. Examples of stone-door caves now; it is clearly seen that even the most strict control cannot save the caves from destruction.

RELIGIOUS STRUCTURES

UNDERGROUND COMPLEX OF PSKOVO-PECHERSKY DORMITION MONASTERY (PSKOV REGION, RUSSIA)

Ilya Agapov

Russian Geographical Society. Karstology and Speleology Commission, Saint-Petersburg, Russia,
agapov_ilya@mail.ru

Abstract

The monastery is located in Pskov Region, Russia. The underground complex of Pskov-Pechersky Dormition Monastery, dated by the XV century, is described in the paper. It includes various artificial cult and utility caves (underground churches, underground burials, cave cells, cellars, an underground sewer, wells). Several small natural pseudokarst caves, used by monks, are also known. Generalized materials on the history of the monastery, as well as the results of the author's studies are presented in the paper.

Keywords

Cristianity, cave convent, cult cave, sandstone, necropolis, Pskov, speleostology, pseudo-karst.

1. Introduction

PSKOVO-PECHERSKY DORMITION convent is one of the largest Orthodox cave convents in Russia (Agapov 2010, Agapov et al. 2013). It is situated in Pskov region Pechyory town. The convent complex is located in the Kamenets Creek valley (Fig.1). There are Devonian red and yellow sandstones exposures in the creek valley slopes.

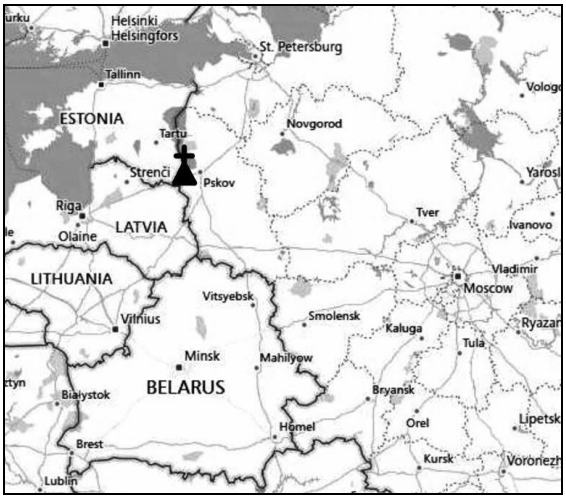


Fig.1. Pskovo-Pechersky Dormition Monastery on the map of Russian Federation. Based on Bing Maps

First this convent was mentioned in the 15th century connected to "God created caves" invention and Uspensky cave cathedral blessing in 15(28).04.1473. The first local monks appeared in the 14th century, according to local convent legends, however we can't historically prove this fact. The convent constantly existed and developed from the 15th to the 21st centuries. A fortress wall with towers was constructed around the convent. The convent was several times under siege and was a forward stronghold on the Russian border. The convent is unique in the Russian history for it has never been closed since it had appeared (The Soviet state tried to close it but did not succeed). It has been constantly existed and developed for more than 600 years. Pskovo-Pechersky convent accumulated main North-West Russian traditions, connected with natural and artificial objects worshiping. The convent foundation is connected with the Russian Orthodox Church missionary work among the local Finno-Ugrian population.

Two main sacral complex functioning stages can be distinguished (Agapov 2011): the pre-Christian (the 14th century and earlier) and the Christian (since the late 15th century till nowadays) periods. These periods can not be strictly divided as different religious traditions known as so-called folk Orthodoxy (a combination of Christianity and Pagan beliefs) existed in the convent complex territories (Panchenko 1998).

A Pagan sacral complex based on natural objects (the local landscape facie) worshiping is thought to have existed in the territory of the convent in the pre-Christian period. The probable ancient sacral complex base can be distinguished based on the author's works (Agapov 2011, 2013), ethnographers' researches (Gadlo 1998 and Plotkin 2002) and analogues among North-West Russian (Agapov 2011) and the Baltic states (Estonia, Latvia, Lithuania) worshiped objects (Sandis 2009; Yuris 1997; Vykintas 2004; Heinsalu 1987):

1. The Kamenets Creek walley with high sandstone exposures (water flows) (Plotkin 2002).
2. A sacred hill with a worshiped oak wood (Plotkin 2002) and two cult stones on the top.
3. A group of erosion-suffosion natural caves in the bottom of the sacred hill (with springs flowing out from them) (Agapov 2011). Probably these caves were later enlarged by the monks. Their traces have not remained.
4. The cult "Tit's stone" ("*Titov kamen'* " so-called "the warm stone") downstream the creek valley, in 300 meters to the West of the convent. Was honored by the local Setoo People (Gadlo, 2008).
5. A group of erosion-suffusion natural caves in 400 meters downstream the Kamenets Creek from the convent. It is supposed that a spring flowed from the caves in the past. Its water could be thought to be healthy.

According to this all the complex worshiping was based on traditional for North-Western Russia natural objects such as water flows, springs, caves (also grottoes and niches), trees and stones. These objects were included to the convent influence sphere when Christian missionaries came and the convent was founded, so they started their existence in the folk Orthodoxy while the convent developed in the traditional Orthodox way.

As a result of such evolution a special sacral complex, including all the surface and underground objects, was formed. Its structure is rather complicated. Here are its main features (Fig.2):

1. "God created caves" ("*Bogom sdannye peschery*") - an underground necropolis and a cave temple. They are about 177 meters long. These caves were developed in the traditional way of Kievan cave convents.
2. The Dormition cave cathedral.
3. The Sacred hill (with the cave entrances in its bottom) with the oak wood and two cult stones, connected with the first convent hermits veneration.
4. The St. Cornelius' spring (a well)
5. "The Bloody Way" ("*Krovavy put'"*). Russian Tsar Ivan IV the Terrible carried the convent prior's corps, murdered by him, using this way, according to local legends.
6. Hermits' cave cells (Simeon the Elder's cave cell and etc.)
7. The convent surface cells.
8. "The Tit's stone" – a cult worshiped stone.

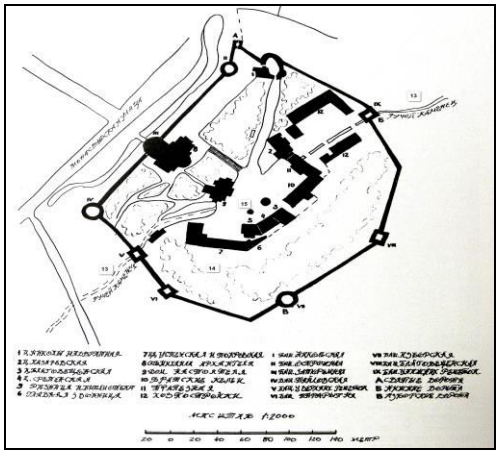
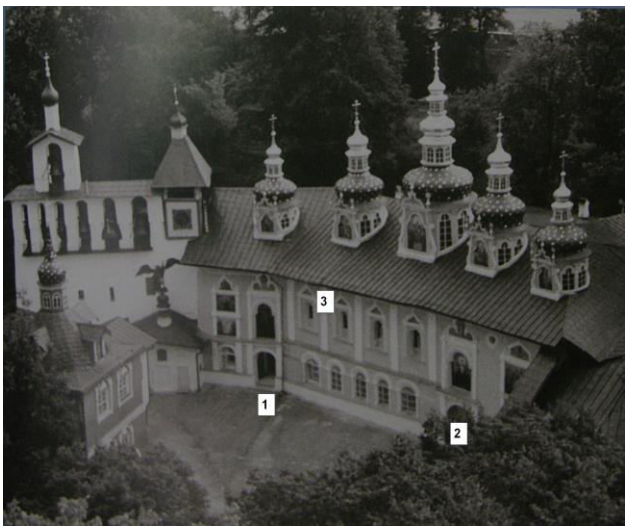


Fig.2. Pskovo-Pechersky Dormition Monastery plan (Morozkina 2007) Plans designation: 1 - Barbican , Church; 2 – Lazarius Church; 3 – the Annunciation Cathedral ; 4 – the Candlemas Church; 5 – the vestiaries and the library; 6 – the main campanile; 7 - the Dormition Cathedral and the Pokrovsky Church, caverns entrances; 9 – the Archangel Michael Cathedral; 10 – the brethren's cells; 11 - refectory; 12 - outbuildings; 13 – Kamenets Stream; 14 – The Holly Hill; 15 – Saint Cornelius Spring (the will); I - IX – fortifications towers; А, Б, В - gates.

The convent underground objects.

The "God created caves" underground necropolis and the Dormition Cathedral.

The entrance is located in the Sacred hill slope, reinforced with a stone wall where the cave entrances are organized and the cave temple lighting windows are also made (Fig.3)



.

Fig.3. The Dormition Cathedral view, the main campanile and vestiaries. M. Semyonov's photo 1960-s (Morozkina 2007). Designations: 1 – caverns entrance (the underground necropolis); 2- The Cathedral of the Assumption cavern entrance; 3 – The Pokrovskaya church (2nd floor over the Cathedral of the Assumption)

These caves are connected to the convent foundation. Originally they were probably of natural origin (erosion-suffusion pseudo-karst caves). This thought is proved with other natural pseudo-karst caves, surveyed by the author, in the creek valley (see below). Literary sources on the convent foundation (Archimandrite 1860) also mention natural caves discovered by the monks. Later these natural caves were enlarge in an artificial way and their entrance parts were enlarged with stone filling. That is why it is impossible to observe the original cave complex structure. Probably there are natural cavities fragments and first hermits' cells hided behind the stone filling reinforcement.

The "**God created caves"** (Passport of the… 1977a) feature themselves the system consisting of seven galleries-streets with the total length of around 177 meters (Fig.5): the 1st street with a length of 23 meters; the 2nd street (the Elders street) is 32 meters; the 3rd Women's street is 23.5 meters; the 4th Temple street is 27 meters; the 5th Brothers street is 31 meters, the 6th Brothers – 9 meters, the 7th Byuntingov is 25 meters. There is a building with an old brotherhood cemetery in the end of the 6th street up to 1700, and a building with a new brotherhood cemetery in the end of the 5th street and the beginning of the 6th street. The artificial origin galleries are cut down in the sandstones. For the purposes intended the caverns present the necropolis (the catacomb), where around 10 000 people are buried (there is not exact number of buried people considered). There are the lay people as well as the monks amid the buried people.

Some grave parts are covered with the special 'ceramids' (Fig.4) tombstones (Pleshanova 1966, 1978) as of XVI-XVIII centuries with the number of around 350 items. The tombstones are made of limestone and ceramics and distinct of the highest artistry.

Figure 4. The ceramic tombstone ('ceramid') number 2 – Chebatayeva D.G. 1559 (Pleshanova 1966)

The Dormition Cathedral (Fig.6) of XV-XVIII centuries (Passport of the... 1977b) is located near the underground necropolis and presents itself a separate underground system consisting of two floors. The cathedral's length is 18 meters; the width (depth) is 20 meters. The cathedral's vaults are based upon 10 massive sandstones pillars, set by bricks. The fresco paintings of XVI century have been discovered by the instaurations in 1971. The cathedral had been redeveloped and expanded several times. There was a passage from the western gallery of the Dormition cathedral in a new brotherhood cemetery upward of 1710. It's been embedded after the plague epidemics. Presumably, it's been used for the round pass nearby the Dormition Cathedral at the Cross Procession. The northern cathedral foreside is situated on the ground surface and carries on the lines of the Ukrainian Baroque.

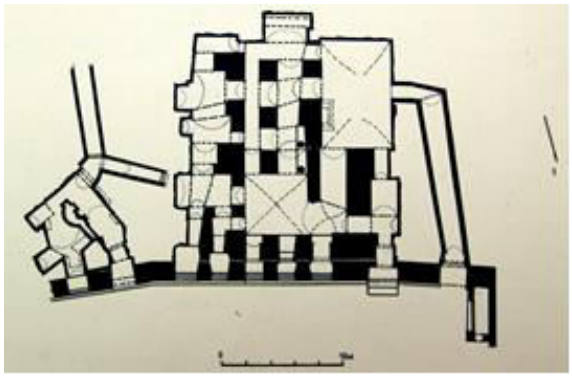


Figure 6. The Dormition Cathedral. 1472. The measurement - Mikhailov S.P., Semyonov M.I., 1975. Drafted out by Mikhailov S.P (Passport of the... 1977b)

Pokrovskaya Church (Fig.7) built in 1758 (styled as the baroque) is situated on the second floor under the Uspensky church (Passport of the... 1977c). Built in a triangle form. Apparently, it's been digged partially into the ground. 25 meters by length and 9 meters by breadth. The convent roof is situated on the surface and decorated by the 5th domes. The church has an entrance from the cave necropolis (left in the plan on fig.7) onto the special gallery stairs (right in the plan on fig.7). Alternatively, there is an exit to the highest point of the Holly Hill, 15 meters by length outside the church and the gallery.

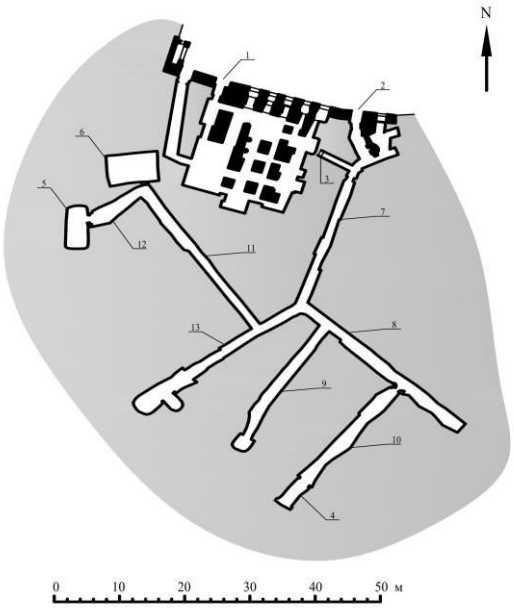


Figure. 5. Underground complex plan of the Pskovo-Pechersky Dormition Monastery . Computer processing – I. Agapov. 2013. The scheme is based on the plans from the archives of the Institute "Spetsproektrestavratsiya" (Special Project of Restoration): Mikhail Semyonov 1966. Drawing by Mikhailov S.P. 1977, Semenov M.I., Mikhailov S.P. 1975. Drawing by – Mikhailov SP (Passport of the… 1977a; Passport of the... 1977b). Legend: 1 – entrance to the Assumption Cathedral of the XV–XVIII centuries; 2 – entrance to the underground necropolis of the XV– XXI centuries. ('The God created caves'); 3 – the rise to the second (upper) layer in the Church of the Protection, of the XVIII century; 4 – the Church of the Resurrection; 5 – the old common cemetery before 1700; 6 – new common cemetery after 1700; 7 - 1st Bratskaya Street; 8 – 2nd Startsev Street; 9 – 3rd Zhesnkaya Street; 10 – 4th Khramovaya Street; 11 – 5th Bratskaya Street; 12 – 6th Bratskaya Street; 13 – 7th Byuntingov Street.

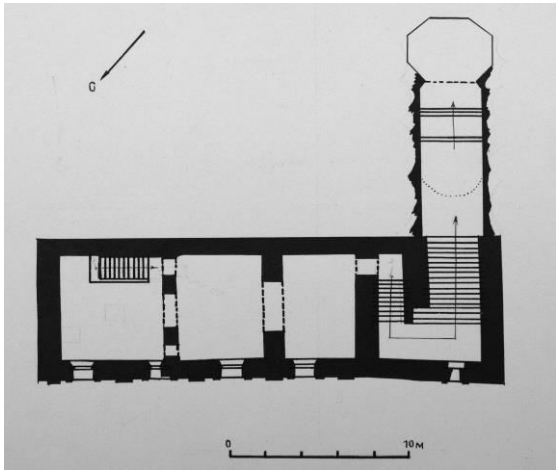


Figure .7. The Pokrovskaya Church - XVIII century. The measurement - Mikhailov S.P., Semyonov M.I., 1973. Drafted out by Mikhailov S.P., 1977 (Passport of the... 1977c).

The analogies of the underground necropolis are traced in the cavern convents in Kiev (Bobrovsky 2007) where you may also find the gallery-streets with the cemeteries. The distinction, worth to say, is the plan solution. There are the closed-loop systems in Kiev cavern monasteries whereas we keep a fan system in our case. Besides, the underground gallery cross-cut sections in the Pskov

Monastery of the Caves are massively more than in Kiev cavern convents, that is connected with the high density of sandstones in comparison with the loess-like loam where the galleries of cavern Kiev convents are paved.

Cave cells

Simeon the Elder's cave cell, known from 1927, is known in the convent territory. There is no data on this cell (Agapov 2011).The author surveyed natural pseudo-karst caves (Agapov 2011), located in Devonian sandstones, downstream the Kamenets Creek in 2009 (Fig.8, 9). A part of the caves has been used by people.

Pecherskaya-2 cave is located in 300 meters to the North-West of the convent in the Kamenets Creek valley. The cave is 4.5 meters long. It has two layers. The second layer houses a hermit cave with its dimensions of about 1.4x1.4 meters and about 1.5 meters high, with two icon niches. Originally it is a natural cave. It was artificially enlarged by men.

Pecherskaya-3 cave is situated in 50 m to the North-East of Pecherskaya-2. Its total length is 13 meters. The cave consists of two natural galleries enlarged by men. An oval hermit cell with its dimensions of 1.9x1.5 m and a 1.115 m high arching ceiling is situated in the farthest part.

larger Pecherskaya-4 cave is situated next to Pecherskaya-3. Its total length is about 7 m. The ceilings are arched.

The cave is a typical erosion-suffusion cavity with a large entrance hall. There are no water flows inside. A small niche for a lighter can be found in the cave, there are also ancient graffiti including different Orthodox crosses inscriptions. One can suppose that there was an honored spring with healthy water in the cave, along with other natural caves in the North-West Russia (Agapov 2010, Agapov 2011, Agapov 2012) and Baltic states (Sandis 2009; Yuris 1997; Vykintas 2004; Heinsalu 1987).

The usage of the cave finished when the spring disappeared.

There are two small caves situated higher on the same slope. They are Pecherskaya-5 (1 meter long) and Pecherskaya-6 (3 meters long) being probably small sand mine workings of the 20th century.

The slope was partially collapsed where Pecherskaya 3-6 caves are situated. Probably there were other caves used by hermits till the mid-20th century there in the past.

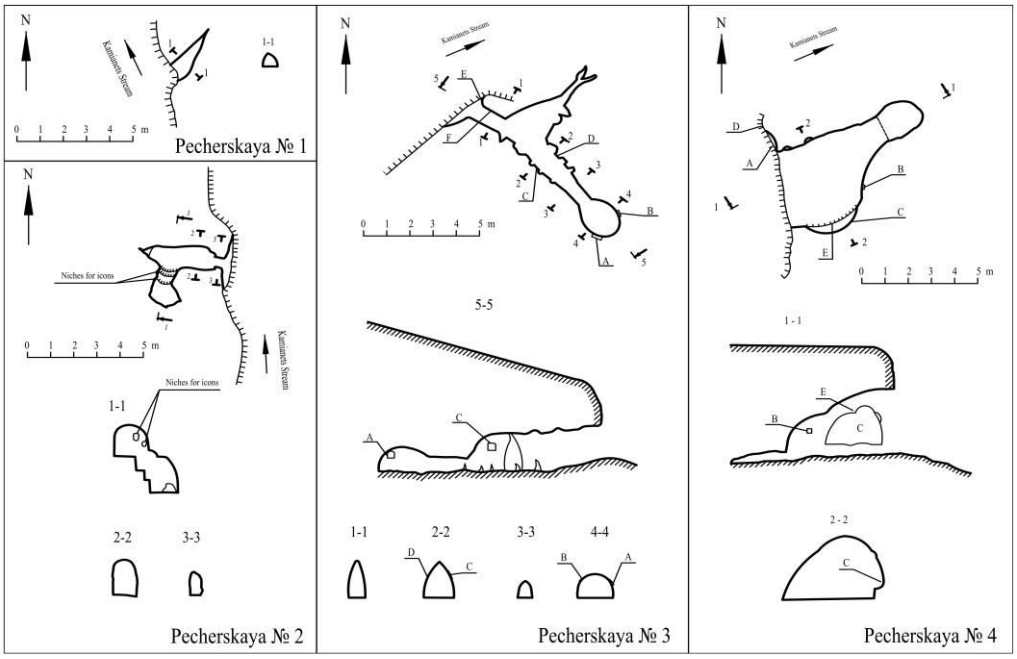


*Fig.8. Pecherskaya caves - 1, 2, 3, 4. Topographical survey: Agapov I.A., Kaminsky S.V., Yanchuk T.S., 04.2009. The computational processing - Agapov I.A. Designations: Pecherskaya-3: A – icons niche 40x30x10 centimeters (the dimensions); B – light and icons niche 20x20x5 centimeters; C – icons niche 30x40x5 centimeters; D – icon niche 20x20x2 centimeters; E - christcrosses graffitis; F – horseshoe graffitis – Pecherskya-4: A – various graffiti baring (of the sandstones); B – icons or lamp niche ~20x20x10 centimeters; C – an artificial niche of rough improper shape (potentially appeared as a consequence of sandstone getter or simply isn't finished till the end yet); D – a small niche with an extract of christcrosses images; E - christcrosses **images (over** the niche)*

Several icon niches were cut out in the cave.
The hermit cells were probably created in the 20th century. This conclusion is based on the cave walls finishing (Agapov 2011). More ancient cells have not remained due to the banks collapses

Other caves in the Kamenets Creek valley.
Pecherskaya-1 cave is situated not far from Pecherskaya-2. Its length is 1.5 m. It is a natural cave and it proves the pseudo-karst caves existence in the creek valley. The other

Utility and military objects.

Several utility objects are known in the territory of the convent. They are: underground storages and a drainage

collector where the Kamenets Creek flows across the convent territory. Probably there were also military underground passages as the convent was a stronghold in the past. They has not remained.

.

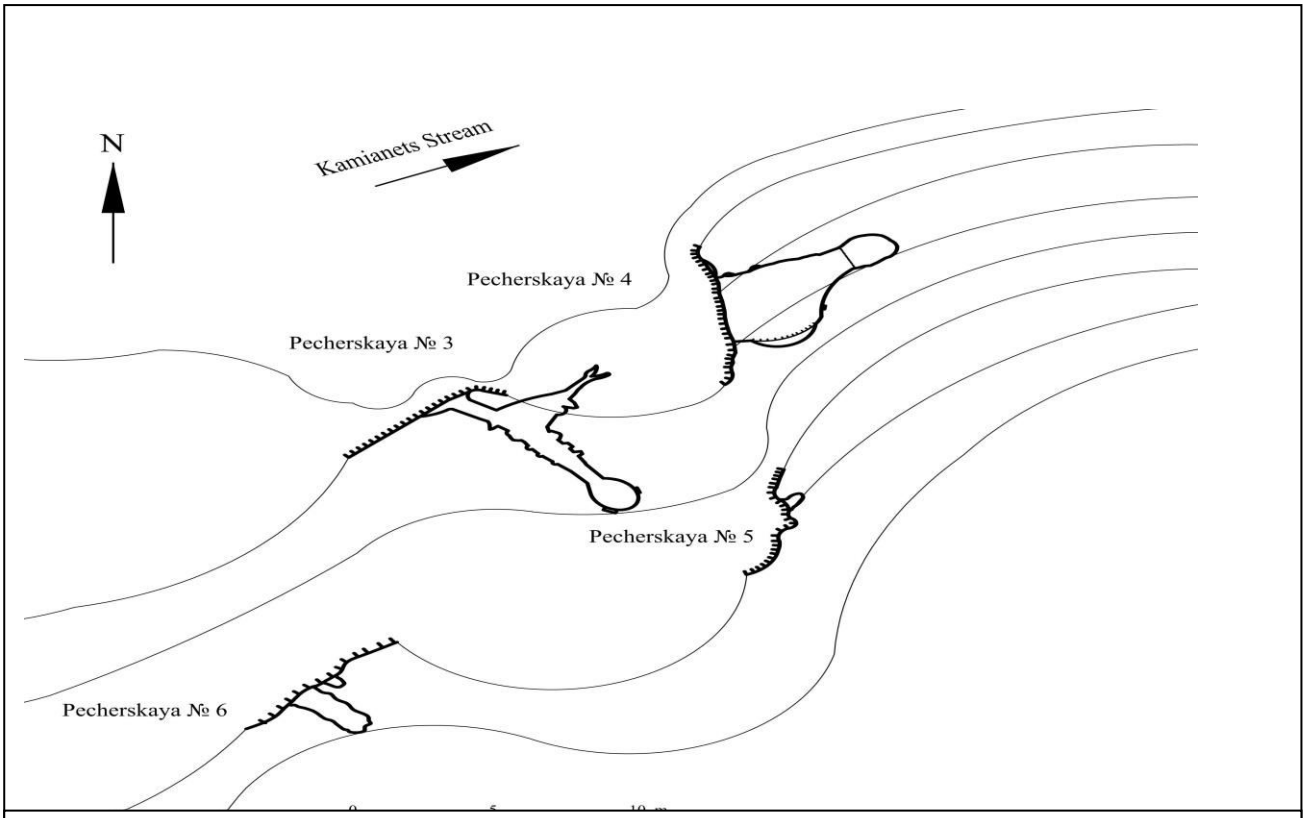


Fig.9. General disposition plan of Pecherksya-3, -4, -5, -6. Topographical survey: Agapov I.A., Kaminsky S.V., Yanchuk T.S., 04.2009. The computational processing - Agapov I.A.

Conclusion

We shortly described the main parts of the Pskovo-Pechersky Dormition convent underground complex. It consists of different natural and artificial underground structures. The main conclusion is that the artificial caves are based on original natural pseudo-karst cavities changed by men. Nowadays the convent caves are surveyed poorly so the future researches must be conducted.

Acknowledgements

The author pays special thanks to Dmitry Garshin, Elena Murzina and Ekatherina Yanovskaya for their help in translating the paper into English.

References

Archimandrite Theodore (censor), 1860. Pskovo-Pechersky monastery, St.-Petersburg (in Russian).

Agapov I.A., 2011. On the possible origin of the caves of the Pskovo-Pechersky monastery. Christianity in the regions of the world (Christian's archaic). Ad .by M.F. Albedil, U. U. Shevchenko RAS. Peter the Great Museum of Anthropology and Ethnograph. : St-Petersburg's orientalis, Vol. 3, 237-260. (in Russian).

Agapov I. A., 2010. The largest cave-monasteries of Russia. Brief review. Gunko A.A. Dolotov Y.A. Lavrov I.A. Markov A.V. Ad. By Gunko O. G. Speleology and Spelestology: development and interaction of sciences., Nabereznye Chelty, 215-222. (in Russian).

Agapov I. A., 2013. Underground complex of Pskovo-Pechersky monastery. Mohyla scientific conference 2012. Proceedings: Traditions of cave's monastic complexes in Ukraine and eastern Europe. Problems of studying, preservation and museumification. National Kyiv-Pechersk Historical and Cultural Preserve. Ad by Kolpakova V.M.. Kiev, 197-201 (in Russian).

Agapov I. A, 2010. The largest suffosional caves (Piping) in sandstones of Northwest Russia. Utilization of caves in human culture. COMMISSION FOR PSEUDOKARST at the International Union of Speleology. Newsletter., 3-9

Agapov I. A., 2012. Natural caves of the North-West of Russia. The use of caves in human culture. Proceedings of the 13th National Congress of Speleology. 29. Sept. – 1. Okt. 2012 Muotathal, Schweiz Speleodiversity.- 63-67

Agapov I. A. Lyakhnitsky Y.S., Hlebalin I.U., 2013. The man-made underground cavities of North-West Russia. Proceedings of 16th International Congress of Speleology, Vol.2, Brno, 179 – 184

Bobrovsky T., 2007. Underground structures of Kiev from ancient times to the middle XIX century. Kiev., 2007. (in Ukrainian).

Gadlo A. V., 1998. Ethnohistorical review of Pskov region. Ad by Gadlo A.V. Pskov, PRIATEW, 280 (in Russian).

Heinsalu Ü., 1987. Caves of Estonia. Tallinn: Valgus, 160 (in Estonian)

Morozkina E.N., 2007. Ecclesiastical architecture of ancient Pskov, Vol. 2 Northern pilgrim., 107 (in Russian).

Panchenko A.A., 1998. Research in folk orthodoxy. Rustic relics of North-west of Russia. St. Petersburg, “Science”, 319 (in Russian).

Passport of the... 1977c. Passport of the archaeological site «Pokrovskaya church of Pskovo-Pechersky monastery». Archive of Pskov department of institute "Spechproektrestavrachia", 1977 (in Russian).

Passport of the... 1977b. Passport of the archaeological site «Uspensky Cathedral of Pskovo-Pechersky monastery». Archive of Pskov department of institute "Spechproektrestavrachia", 1977 (in Russian).

Passport of the... 1977a. Passport of the archaeological site «Caves of Pskovo-Pechersky monastery». Archive of Pskov department of institute "Spechproektrestavrachia", 1977 (in Russian).

Pleshanova I.I., 1966. Ceramic gravestones of the Pskovo-Pechersky monastery. Numismatology and epigraphies. Vol. 6, Moscow, “Science”, 149-206 (in Russian).

Pleshanova I.I. 1978. Ceramic gravestones of the Pskovo-Pechersky monastery. Numismatology and epigraphies. Vol. 12, Moscow, “Science”, 63-185 (in Russian).

Plotkin K.M., 2002. Setu area: sacrifice and border. Finno-Ugrians and their neighbours. Ethnocultural relationship in Baltic and Barents regions. Proceedings. St. Petersburg, 197-209 (in Russian).

Sandis Laime., 2009. The sacred underworld. Cave folklore in Latvia. Riga. (in Latvian)

Yuris Urtans., 1997. Cult cave of Latvia. The human use of caves. BAR international series 667., 90-100

Vykintas Vaitkeviius., 2004. Studies into the Balts' Sacred Places. BAR international series 1228. 47

CENTRAL COMPLEX OF GOCHANTS CAVE MONASTERY

Alexey Gunko[1], Sofia Kondrateva[2], Samvel Shahinyan[3]
[1] *Naberezhnye Chelny State Pedagogical University, Naberezhnye Chelny, Russia, gunko.a@mail.ru*
[2] *Natural, architectural and archaeological museum-reserve «Divnogorye», Voronezh, Russia, kosofia@yandex.ru*
[3] *National University of Architecture and Construction, Yerevan, Armenia samvel.shahinyan1954@gmail.com*

Abstract

Gochants cave monastery is in the Kashatagh region of Artsakh (Nagorno-Karabakh) in Gochants gorge. Reliabl information about the existence of Gochants monastery relates only to the first half of the XVII century. The exact date of appearance of cave complex is unknown. Complex consists of several rooms including cave temple. Unfortunately, the front part of the complex is ruined. Entrance to complex could be in gallery, leading to the room №8. From the base of the outcrop to the entrance could lead wooden ladder retractable in case of siege. Cells could be the place of residence for senior priest of the oldest members of the brotherhood. Church is carved as single-nave basilica, but it is asymmetrical and not typical. There are a lot of extraordinary elements. Perhaps it has not been completed. Modernization of the church for daily purpose could go not only horizontally, but also vertically and necessary elements were added.

Keywords

Cave monastery, cave church, Christianity, Gochants gorge, Transcaucasia.

Gochants cave monastery (Ochants, Hochintse) is located in the territory of the Kashatagsky district of Artsakh (Nagorno-Karabakh) within the Gochansky gorge. Gonchank village was already mentioned in the 13th century as a large settlement. (Орбелян, 1986: 399]. A few centuries later, a historian of the 17th century Arakel Davrizhetsi, who was Archimandrite of the Etchmiadzin Monastery, writes about the hermitage in Gochants in his chronicles.

The appearance (revival?) of the monastery relates to the Christian ascetics who came here. It became one of the most significant event that took place in the spiritual life of Armenia in the first half of the XVII century. It began in Jerusalem, where bishop Sargis and father Kirakos met. Sargis Amberdtsi was originally from the village of Abeni, Ararat region. He settled in the famous monastery of Sagmosovank, where he became the abbot of the monastery. He sought solitude and spiritual life, that's why he went to worship in Jerusalem. Kirakos Trapezonzi was originally from Trabizond (now Trabzon, Turkey). A few days after the marriage, he lost his wife, then retired from the world. Having given part of the property to the poor, and the house and the land to the Trabizond church, he went in search of Sargis, of whom he had heard (Даврижеци, 1973). When they met there were no hermitages and people who know rules of life of the clergy in Armenia (Даврижеци, 1973: 208).

Together they began to wander along the banks of the river Jordan and the Greek monasteries searching for a place for their hermitage until they met vardapet (educated monk) Movses Tatevatsi (well-known preacher who turned into a monk from the age of 15, the future Catholicos (1629-1632) of the Armenian church). He was born in Syunik province and told them that there were a lot of places such as they were looking for in the eastern countries, and especially in the Syunik region – an indigenous Armenia with Christian population. He also promised that he himself will join them later, because fully shared their views. Inspired by his words, Sargis and Kirakos immediately went to Syunik with the hope of finding the ancient "hermitages, the tracks of which are still visible there." First, they arrived in Tatev Monastery, one of the important spiritual centers of Armenia. Then they went to Dzoroyvan, and from there to the monastery of Tanahat. Finally, they founded a Big hermitage in "*safe, quiet and secure place*". They "*built a church and cells…- very small, gloomy and dark*" (Даврижеци, 1973: 209). Since that moment, Sargis and Kirakos, together with bishop from Tatev Tuma and the arrived vardapets Nerses, Pogos and Movses, have begun the process of reviving traditional monastic life. It should be mentioned that reading books has become an integral part of their lives. It was the rare case when such educated men gathered in one place, sincerely worrying about saving Armenia and praying for its spiritual revival. People from the Big hermitage went to all corners of Armenia. By spreading forgotten knowledge and preaching godliness, they founded many monasteries that survived to the present day. After many years of joint residence, it was time for the founding fathers to go further. Sargis was headed Big hermitage. "*Father Kirakos and bishop Tuma went to the country of Kshtakh* (lands of the Kashatag melikstvo (Armenian principality)) *built near the village of Ochanz and settled there*" (Даврижеци, 1973: 215). Unfortunately, the details of the life of the new monastery have not been preserved. Arakel Davrizhetsi notes only the date of the death of father Kirakos, who lived for a year longer then Sargis. Kirakos, who lived the rest of his life in the same monastic stricture, was buried in his hermitage near the village of Ochants in 1621. Tuma became vardapet and went to the Shamakhi region.

Thus, in written sources, only one period of existence of the monastery Gochants, belonging to the first half of the 17th century, was authentically recorded. Modern studies of the cave complex took place during three expeditions, including an international one, organized by the Armenian Speleological Center under the guidance of S.M. Shaginyan (2001, 2002, 2010). In the gorge, a large

number of man-made rooms were studied, including, among other things, a large cave church (Шагинян, 2016: 196). In 2016 another expedition took place with speleologists from Armenia and Russia. The aim of the work was the study and documentation of the church complex of the cave monastery. The results of the work are presented in this article.

Church complex of the cave monastery.

As a church complex of the cave monastery, we consider a group of caves that are in the same level and close to each other. The core of the complex is the church itself. Other rooms, a large number of which are located in the gorge, are not considered in this article. Church complex is located in the left (NW) open-pit side of the gorge in the middle part of the rock outcrop (length over 700 m), opening layers of limestones, breccias and conglomerates (Fig. 1). In the past, the complex was damaged. According to one version, it occurred in the Soviet period as a result of a directed explosion. As a result, a significant part of the rock collapsed, and advanced fragments of some underground rooms were destroyed (Fig. 2). Main rooms of the complex are well preserved.

Room №1. The westernmost area of the complex (Fig. 3/1). The entrance is on a small platform, hanging over the precipice. Its depth is 1.9 m. A short pass leads to a round chamber, 1.5 m wide. The modern floor of the chamber is made of conglomerate and. Height of the spherical vault is approx. 1.4 m. Three small niches are cut in the walls of the chamber: two in the north-east and one in the south-west wall. Despite the small size of the chamber it could be a residential cell.

Figure 1. View of the rock outcrop in the gorge of Gochants monastery

Figure 2. The site of the collapse of the rock in the area of room № 8.

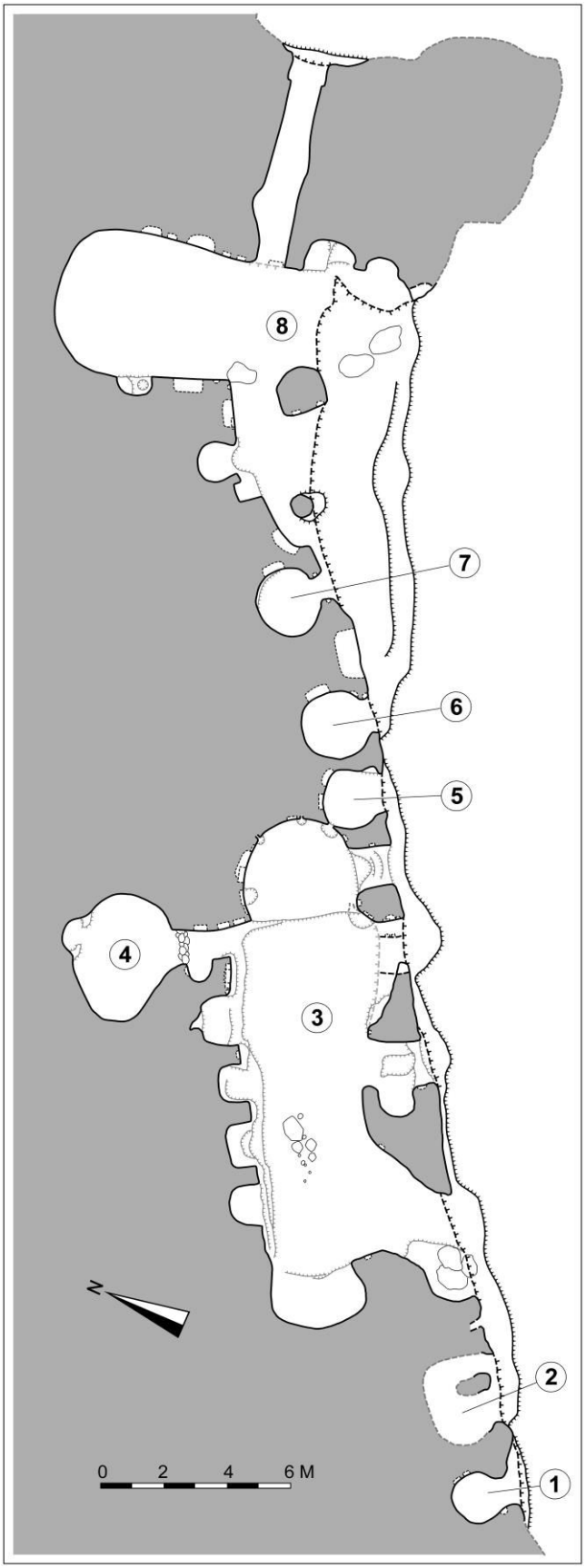


Figure 3. The plan of the church complex (survey by A.A. Gunko, S.K. Kondrateva, 2016).

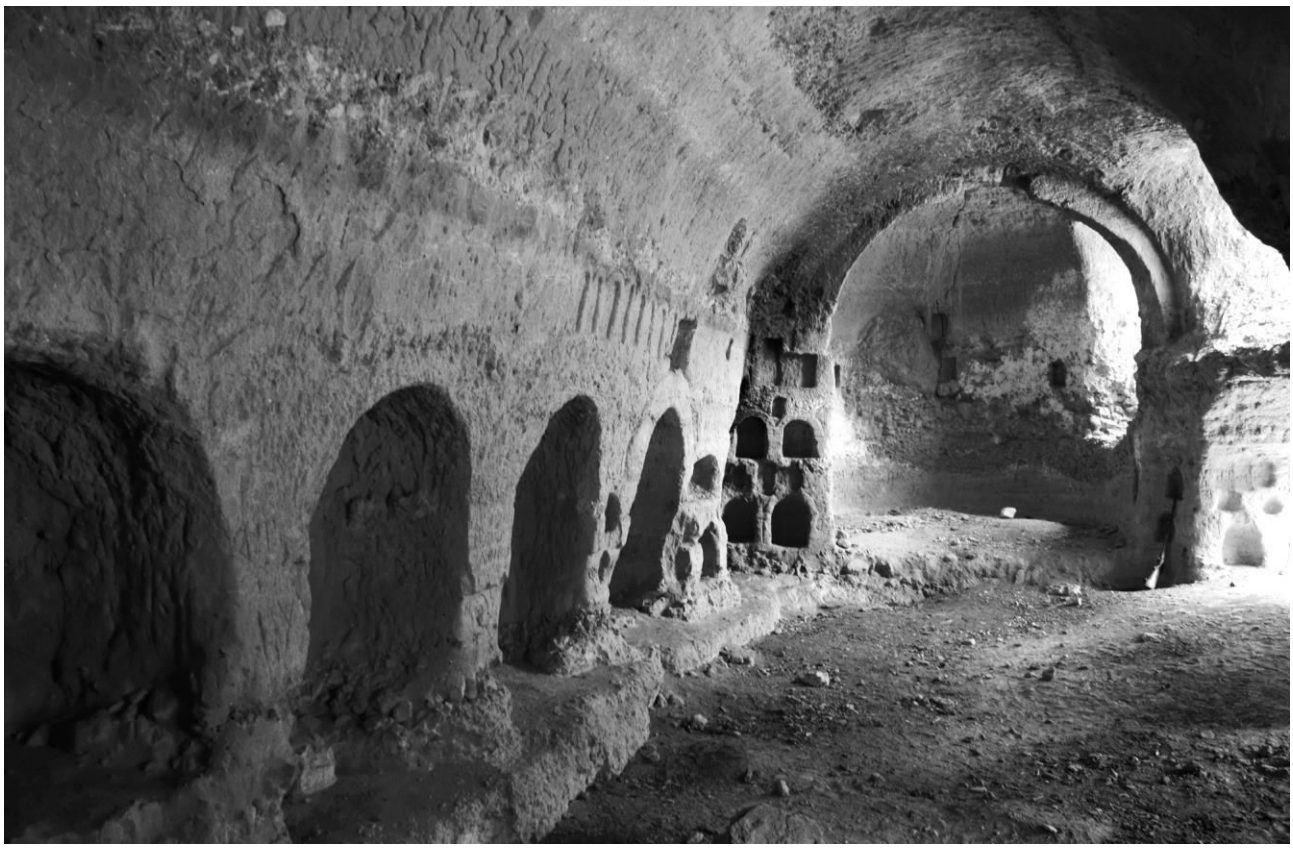


Figure 4. Church, view towards the altar apse

Room №2. Mostly filled with mantle rock and fragments of rock, a room with a width of approx. 3 m. There are two low half-buried entrances (Fig. 3/2). It could have a household purpose.

Room №3 (Church). The main room of the cave monastery is a cave church (Fig. 3/3). From the surface inside the church lead three passes, as well as two windows. The first pass (western) has first a width of more than 3 m, then it narrows, and after 3 m it again expands to 3.5 m, smoothly closing with the nave. The second pass (central) begins at 3.8 m east from the first. Its length is 2.4 m and its width is within 1.3-1.4 m. The passage looks wider due to a large niche cut in its left wall. In the floor of the passage there is a rocky ledge and an elongated pit. The third (eastern) passage is the shortest in length and it has a width of 1.5 m. Almost immediately it opens into the area of the nave near the altar. In the right wall of the passage there are three levels of small niches with vaulted arches. The largest of which is at the level of the modern floor and has a width of more than 0.4 m, a depth of more than 0.25 m.

The church is made as a single-nave basilica (Fig. 4). It extends subparallel to the rock outcrop and is oriented with the altar part to the northeast. The nave is 11.5 m long, the average width is approx. 4 m, the height of predominantly semicircular arches up to 5 m. In the western part of the nave, the arch has traces of gravitational growth. From the south-west to the nave is an elliptical niche with a rough semi-dome vault. From the main space in the lower part of the temple it is separated by a ledge. The depth of the niche is 1.6 m, width 2.5-2.8 m. The niche is like the apse and has a barely noticeable frame-slot. The north-west wall of the temple has a complex structure and décor (Fig. 5).

It is separated by a small ledge with a width of 0.5 m and a height of 0.2-0.3 m. Four niches-exedras are cut in the wall. Exedra № 1 (conditional numbering from west to east) is located opposite the western entrance, has a width of 1.3 m, a depth of 1 m. In its upper part, it is laid on one level with others, but in the lower part it is unfinished. Its height is only 1.2 m. The small (0.5 m) bridge is separated from the exedra № 2. Its width is 1.4 m, depth is 0.7 m, height is approx. 1,9 m. It cut down more accurately, but in the bottom part there are also traces of an incomplete work. In 0,6 m to the east is laid exedra № 3. Its width is 1.2 m, the depth is 0.9 m, the height of the semi-dome arch is more than 1.9 m. All three exedras are horseshoe-type. Exedra № 4 is separated by a 0.6 m wide bridge, in which two small niches with semi-circular and triangular arches are cut down. Exedra № 4 is the largest has a width of 1.6 m, a depth of 1.3 m. Despite a somewhat oblique section, it looks most completed. Archivolt with a width of 0.35 m, exquisite emphasizing the contour of the conch. Archivolt is crowned with a large niche of square cross-section with the width of sides of approx. 0.5 m. To the left of this niche for 2.5 m in the wall of the church an arcade of 8 symbolic "openings" with archivolts and pilasters is cut out, at the junction of which the "orders" are guessed. The north-west wall ends with an arched passageway into the room adjoining nave from the north. From the exedra № 4 the passage is separated by a bridge with a width of 1.1 m. In the bridge there are 4 niches with semicircular arches. The largest of them, located at a height of approx. 1 m, has a width of 0.85 m and a height of more than 0.4 m. Above the passage a corner-type niche is cut. It consists of two parts of different heights. Nearby, in the area of adjoining the arch to the eastern wall of the church, there is a niche similar in structure, but larger in size (Fig. 6). similar in structure, but larger in

Figure 5. Church, view of the northwest wall

size (Fig. 6). Both niches have a small depth, so in them it was possible to install only flat rectangular objects. Such objects could be, for example, khachkars (a type of Armenian architectural monuments - a stone stele with a carved image of a cross). Numerous vertical scratches are in the base and in the arch of the niche located above the passage. They can point to the attempts to break a khachkar from a tightly fitted niche with the help of an acute metal tool.

From the north-east the altar part, cut in the form of a traditional apse adjoins to the nave (Fig. 4). It is horseshoe shaped in plan, in narrow part (at the entrance to the altar) width is 3,4 m, in the wide part - 3,9 m. The altar floor rises above the main church space by an average of 0.45 m. The semi-dome arch (conch) is 4.2 m high. It is framed by the archivolt on the side of the nave.

Figure 6. Niches over the passage to room № 4

At the junction of the floor and the walls of the apse, depressions and cracks, perhaps of predatory nature, are noticeable. In one of these depressions there is a breach hole in the adjacent room (№. 5). In the walls of the apse there are 11 various niches. Their main group is concentrated on the left side (Fig. 7). These are 7 niches cut at different heights. The lowest of them is located only 0.2 m from the floor, the uppermost (and largest in size) - at height of more than 2 m. Two niches have a triangular (close to lancet) arch, and one has a carved frame. The altar part is illuminated through a window cut in the southern wall of the apse in the form of a "corridor" with a ledge (from the side of the apse), completed by an oval hole. In the eastern wall of this corridor there is a small niche. The second window, laid at the same level as the first, is above the eastern passage to the church. It also has two niches in the eastern wall. The window well illuminates the front of the part of the nave near altar and the passage to room № 4.

On both sides of the altar there are two sections of the eastern wall of the church. The right site is very short, with a width of approx. 1 m. It has two small niches, located one above the other. The left section is one of the most remarkable places of the complex. Several niches and depressions have been cut down here (Fig. 8). 4 niches are the most interesting. Their disposition, similar shapes and sizes, as well as external design, correlated to the details of the arcade of the north-west wall, indicate the intent of the creators of the complex. In these niches could be located some relics, the same value for the monastery. According to S.M. Shaginyan there could be books – four Gospels (Шагинян, 2016: 198). The size of the niches – height 0.43-0.50 m, width 0.28-0.37 m – quite

allowed to install in them large books in covers.

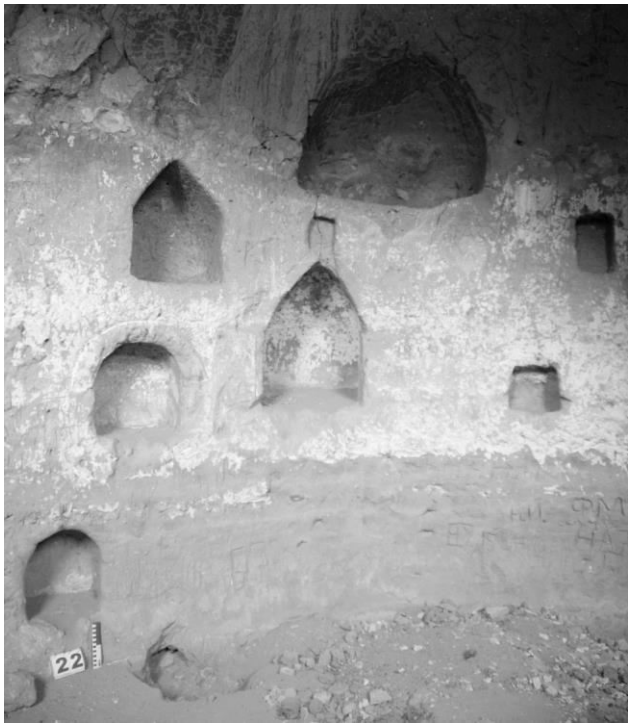


Figure 7. Niches in the left part of the altar apse

Between the "main" niches cut into two levels (two on the level) there are several small niches and depressions. This ensemble is crowned by the angular niche mentioned earlier. The left section of the eastern wall of the church passes into the wall of the passage leading to room number 4. The width of this passage is 1.0-1.3 m. In this (right) wall, at a height of approx. 0.3 m from the floor there is a niche, which visually participates in the ensemble described by us. Opposite it, in the left wall of the passage, a depression is cut with a width of 0.8 m and a depth of 0.8 m.

Room №4. It is located to the north of the church and connects to it with a short passage (Fig. 3/4). The room is irregular in shape, with a depth of 3.4 and a width of 4 m. The walls do not have corners, but they are roughly worked, pass into the vaulted ceiling. In the northern part of the room, less than 0.1 m above the floor is a depression with an ellipsoidal base, narrowing to the top. Its height is approx. 1.5 m, width 1.2 m. The purpose of the room is not clear, but its connection with the church is obvious, because it has a single entrance from its part near altar.

Room №5. It is located to the west of the church and has an entrance from the surface (Fig. 3/5). The room is rounded, 1.9 m deep, 1.8 m wide. The entrance width is 1.2 m. The spherical vault is up to 1.95 m high. Two niches are cut in the northern part of the room. Through the breach in the wall the room is connected with the altar apse of the church. Possible destination is residential cell.

Room №6. A separate room, which, like the previous one, could have a residential function (Fig. 3/6). The width of the entrance aperture is 1.2 m, the height is 1.5 m. The room in the plan is rounded, with a diameter of 2.3 m, and a height of 1.6 m. In the north-eastern part, at a height of 0.5 m from the floor there is a niche with a width of 0.85 m and a height of 0.45 m.

A large niche 1.6 m wide and 0.76 m deep is 0.5 m to the east of the entrance to the room, on the outside wall of the outcrop. From this site a small ledge, along the rock, widens sharply, forming a wide terrace. This terrace is the floor of the once large monastic room, the vaults of which were supported by two pillars (Fig. 2). In the western part there was a passage to a small cell – room № 7.

Room №7. It is rounded in plan, with a width of 1.9-2.4 m (Fig. 3/7). It opens with the 0.8 m wide aperture with traces of jamb. The floor of the room is partially filled with mantle rock. The height of the spherical vault is 1.6 m. In the northeastern part is a niche with a width of 0.4 m.

Room №8. It has a complex configuration and, as already mentioned above, is partially lost (Fig. 3/8). The western wing of the room looks structurally like a corridor, separated from the main space by two columns. The western column is badly damaged but continues to carry its function. About its primary size can be judged from the surviving base. The eastern column, located 2.5 m from the western, is more massive and is a pillar 1.5 × 1 m long with small niches. The western wing begins with a rectangular niche of 0.8 m wide, located on the bend 0.9 m from the western column. Further along the wall of the corridor after 1,2 m there is a complex of three large deep niches (Fig. 9/1). Two of them have a common ledge-base 0.55 m high. One - a width of 0.6 m and a depth from the ledge of 0.6 m, the other is horseshoe-shaped in plan and has a height of more than 1 m, the depth from the ledge is 1.2 m, the width at the entrance is 0,9 m, inside - 1,2 m. The third niche is laid independently at a height of 0.75 m. Its height is 0.6 m, width is 0.85 m. Below the niche, almost at the level of the modern floor, is a round depressions width of more than 0,3 m.

The west wing (corridor) goes into the main preserved part of room № 8. It stretches from the north-west to the south-east. It is possible to distinguish its northern and southeastern part. The northern part has a depth of 6 m, the width at the entrance 4 m, inside – 4.8 m. The ceiling is flat with a round connection with the walls. The ceiling height is 1.9 m. Several niches and depressions of various shapes and sizes have been cut down in the walls. On the west side is a small vaulted niche on the transition to the ceiling; a large rectangular niche, with a width of more than 1 m, a height of 0.7 m; a stepped niche with a width of more than 1 m with a rounded depression and a small ledge located higher. On the eastern wall is a small undercut niche; a vertical niche with an average width of 0.4 m and a height of more than 1 m (Fig. 9/2); a small vaulted niche, with a width of 0.25 m; a large niche with a width and height of 0.9 m with a rounded back wall and a semi-dome arch (Fig. 9/3); two identical in height niches with indistinct contours, width 0,18-0,3 m.

The northern part is separated from the southeast by passage into the gallery. A niche with a width of 0.7 m and a height of 0.6 m is cut above it. The passage is low, filled in the lower part with mantle rock (Fig. 9/4). The gallery's arch is firstly basket-shaped, then semi-circular. Gallery is 1,0-1,6 m width and 1,5 m height. It goes to the

northeast, where after 6 m it goes to the cliff in the middle part of the rock outcrop.

Figure 8. Niches and depressions to the left of the altar apse

The south-eastern part of the room faces the terrace, formed by rockfall. It consists of two depressions cut down by the type of exedra. The first with a width of 1.6 m and a depth of 1.3 m is divided into two parts - the left one is ф rising ground with the remains of a small partition wall, the right one is a horseshoe-shaped base lowered to the floor level (Fig. 9/5). A small partition of 0.2 m the first "exedra" is separated from the second one. Its width is 0.9 m, and the depth is 0.5 m. Further, the room wall bends to the south-west and breaks off. On this precipice, the "shelf" is clearly visible. It could be part of the window through which the light spread to the room № 8 (Fig. 9/6).

Under the level of the complex described above, which can be taken as the upper one, several large rooms with a width of up to 4 m are located. In addition, entrances to other similar rooms can be filled up with collapsed rock fragments.

Discussion

The main question is the dating of the monastery. Z.I. Yampolsky with reference to the field materials of 1931-1961 mentions Gochants caves in the context of their potential pagan origin. He notes that Christian cave church built there is not orientated to the east by the altar, as was customary, but is orientated to the north (Ямпольский, 1962: 200). There was an error in the interpretation of the rooms (the church) during the collection of materials, Yampolsky's preliminary conclusions should be considered erroneous. Moreover, the Gochants caves, due to a completely anthropogenic nature, could not refer to the caves-sanctuaries, which are discussed in his book.

From written sources, we know about the foundation of the hermitage by the father Kirakos at the beginning of the 17th century. However, it seems very strange that Kirakos, who sought seclusion, chose a for the creation of a new hermitage the gorge, located very close to the large for that time Ochants village. This apparent contradiction, in our opinion, is explained by the fact that the Gochants hermitage existed before, and father Kirakos, who moved here in the declining years, settled with his monks in the already existing complex of caves. How this complex was looking like we do not know, nor is the amount of work carried out by new settlers to improve the hermitage left by someone.

The architecture of the complex and the church could contribute to solving the issue of dating. According to its structure, the church belongs to the one-nave basilicas, which dominated in Byzantium until the end of the 5th century. In Armenia, this type of basilicas became widespread immediately after the adoption of Christianity. The spread of Christianity in Armenia was mainly through Syria. That fact determined congeniality of the Armenian religious architecture with the Syrian (Токарский, 1946). Nevertheless, at the base of their early Christian churches was the same Byzantine basilica. Later, Armenia began to form its own architectural style and approach to the construction of churches, of course, while maintaining the relationship with the Byzantine (Якубсон, 1973). From the V century basilicas are replaced by domed churches, but one-nave basilicas continued to be constructed throughout the Christian Transcaucasia until the XVII-XVIII century. A large number of them are preserved, for example, in the form of small rural churches (Беридзе, 1948: 48). In Gochants village there is also a small rural one-nave church of untreated stone, dated according to various data to the16th-17th centuries. Their construction as a whole did not change, except, perhaps, the creation in the XII-XIV centuries the original two-sided basilica (Всеобщая.., 1966: 260–261). Considering the possible evolution of the church in Gochants (during the period of the monastery's existence), we can be sure only that it never went beyond the traditional basilica. So, it is impossible to date objectively it according to the type of composition. At the same time, we do not have the right to talk about the church of the Gochants monastery as a "typical" architecture, because there are many extraordinary elements. The church, unlike many well-known one-nave basilicas of early Christian Armenia, is asymmetric. Of course, its southern is mostly in ruins, but even preserved fragments indicate that the sides of the nave were very different from each other. In the composition of the north-west wall 4 niches-exedra participate, while the composition of the southern wall looks unformed. The modern appearance of the wall is formed under the influence of destruction. In addition, in the past, before the destruction of the monument, the number of entrance openings could be smaller (most likely there were 2).

Figure 9. Niches and depressions in room № 8

The asymmetry of the church can indicate its incompleteness. It is clearly visible in detail. For example, we see that the appearance of the exedra №4 and №3 differs from the two western exedra - №1 and №2. The last are rougher in processing, and №1 has smaller size and obvious traces of "ongoing" works. An arcature decorating the north-west wall is interrupted by the exedra №3 (Fig. 5). Exedra № 3 and 4 and the arcature forms a balanced ensemble, while the № 1 and 2 exedras look like unnecessary elements. The large apse-like niche, which adjoins the nave from the south-west, clearly contrasts with the general composition of the church. The contrast is completed by roughly surface of walls, vividly emphasize the later nature of the work. It is possible that it is an example of a "frozen" process of reorganizing a small basilica into a large church by increasing its length. It was the only way to expand the internal space without destroying the structure. Another important detail, reflecting the evolution of the Gochants church, can be a group of niches in the northwestern part of the altar apse. Traditionally, in Armenian churches in this part of the apse there is a large niche for the Holy Gifts, which is sometimes accompanied by 1-2 small niches. In the case of Gochants, 7 niches are concentrated in one place and the largest one is at a height of 2 m from the floor (Fig. 7). It is difficult to imagine what role this niche could perform in the liturgy, because a ladder is necessary if you want to take anything from it or put anything on it. There was no need for this niche. However, its large size and location relative to the high altar may indicate that at a certain time it was itself a prosthesis. Thus, the transformation of the temple for everyday needs of the monks could go not only in a horizontal plane, but also vertically, even without interrupting its functioning. During the deepening and expansion were added the necessary elements - a new prosthesis, exedras, etc. Of course, the stages of development of the church in Gochants has debatable character. The analysis of individual architectural details does not allow us to be sure in dating the complex because all of them could equally appear in different periods.

The second question that arises during studying the monastery Gochants is the original appearance and the reasons for the destruction of the monument. The construction of the complex experienced significant changes - during the collapse of the rock some parts of the church complex were lost. Large fragments of the rock, which fell to the base of the outcrop, formed the way from the bottom part. In the past, the location of the complex in the middle part of the slope was dictated not only by the lithologic features of the rock (favorable conditions for cave-digging), but also by strategic defensive purposes. The church and the adjoining to it from the east rooms, laid in one horizon, were interconnected. Entrance to the complex was through the gallery leading to room № 8. From the base of the outcrop to the entrance could lead a wooden ladder, that could be taken away in case of a siege. Room № 8, in view of its size, undoubtedly played an important public role. The surviving descriptions of the life of the Big hermitage, made by Arakel Davrizhetsi, are obviously valid for the monastery in Gochants, where father Kirakos and bishop Tuma had to transfer strict traditions and church constitution. For example, the monastic cells were half empty and inside eating was forbidden. Throughout the year, except for Saturdays, Sundays and holidays, monks spent in a continuous fast. They completely refused meat and wine, confessing twice a day (Даврижеци, 1973). Room № 8 - the only space that could simultaneously accommodate a large number of people. That's why it could be the refectory of the monastery. Next to the refectory there should be a kitchen. It could be placed outside near the lost wall. Here were chimney and windows through which the light went to the refectory. On the section between rooms № 6 and № 7 (near a large niche), probably was an exit from the

refectory. Using a narrow cornice, equipped with a wooden platform and a parapet, near two cells you could go to the cave church and two rooms to the west of it. The cells within the church complex described by us are similar in morphology and size. Most likely, they served as the residence for the archpriest and the oldest members of the fratry. In case of danger, the rest of the monastery's monks left their cells in the gorge and climbed to this well-protected level.

No matter how good this defense was, it did not save the monument from physical destruction. Information about the last days of the monastery Gochants has not been preserved. We can find them only in indirect historical sources. In the XVII century in order to weaken the connection of Nagorno-Karabakh with Armenia, the Persians populate this region with Kurds (Шнирельман, 2003). At the end of the XVII century the village was already under their control. Probably by this time the brothers left the hermitage. In the following three centuries, the monastery was first plundered, then partially destroyed. The plundering continued during the Soviet period. Parochial church in Gochants villadge was used first as a warehouse for feed, and then as a bakery. On the territory of the cave complex there are numerous traces of already punctured robber pits, the Christian symbols on the walls have been completely destroyed. The rocky facade of the complex, apparently, was exploded using explosive substance. This is indicated by the numerous traces of cleavage face, as well as the damage of part of the interior.

Conclusions

When was the Christian complex in Gochants founded? It is known that in this part of the highlands Christianity came at the earliest stage. For example, 6 km from Gochants located the famous monastery of the IV-VI centuries Tsitserovank. Since then, the Armenian culture, which experienced considerable external pressure in these lands, has adapted in every possible way, experiencing periods of prosperity and decline. By the periods of recovery, which manifested itself in the cult architecture, it is possible to attribute the IX-XI, XII-XIII centuries (Всеобщая.., 1966). Gochants monastery could be founded in any of these centuries. An exact answer to this question can be given after additional studies, including archaeological excavations, which have never been organized here.

Regardless of when the monastery was founded, it belongs to the most important Christian monuments of Transcaucasia. Hermitage Gochants was a link in a whole series of events related to the spiritual revival of Armenia at the turn of the 16th-17th centuries. One of the most famous preachers - father Kirakos was buried here, but his grave still must be found.

References

Беридзе В.В., 1948. Архитектура Грузии (IV-XIX вв.). Изд-во Академии архитектуры СССР, Москва. (in Russian).

Всеобщая история архитектуры, 1966ю Т.3 «Архитектура Восточной Европы, Средние века», Л-М. (in Russian).

Даврижеци А., 1973. Книга историй (пер. с армян. Л.А. Ханларян), сер. «Памятники письменности Востока» т. XXXVII, Москва: Наука (in Russian).

Орбелян С., 1986. История Сюника, «Советакан Грох», Ереван (in Russian).

Токарский Н.М., 1946. Архитектура древней Армении. Изд-во АН Армянской ССР, Ереван (in Russian).

Шагинян С.М., 2016. Монастырь Очанц // Пещеры как объекты истории и культуры. Сборник материалов Международного научного форума (19–22 апреля 2016 г., Воронеж-Дивногорье, Россия). – Воронеж: ИПЦ «Научная книга» (in Russian).

Шнирельман В.А., 2003. Войны памяти: мифы, идентичность и политика в Закавказье М.: Академкнига (in Russian).

Якобсон, А. Л., 1973. Взаимоотношения раннесредневековой архитектуры Армении и Византии // Историко филоглогический журнал № 4. С. 33-42. (in Russian).

Ямпольский З.И., 1962. Древняя Албания III–I вв. до н.э. Изд-во АН Азербайджанской ССР, Баку. (in Russian).

ROCK-CUT CAVES OF MEDIEVAL ORHEI (REPUBLIC OF MOLDOVA)

Bogdan Ridush[1], TimurBobrovski[2], Postica Gheorghe[3]
[1]*Yuriy Fedkovych Chernivtsi National University, Kotsyubynsky 2, 58012, Chernivtsi, Ukraine, b.ridush@chnu.edu.ua*
[2]*National Sanctuary Complex "Sophia of Kiev" 24, Volodymyrska str., 01001, Kyiv, Ukraine,*
[3]*Moldova State University, str. Alexe Mateevici, 60 Chisinau, MD-2009, Republic of Moldova*

Abstract

Six rocky complexes were investigated in vicinities of Medieval Orhei. They were cut in limestone cliffs of a meander of the Reut River, between modern villages Butucheny and Trebuzheny. Complexes are concentrated at the southern border of the medieval city, 300-400 m far from each other, and represent multi-levels congestions of cave constructions. Architectural features of complexes allow their interpretation as the cave monasteries of late-medieval time. Besides, in intervals between complexes, the small single cave chapels and traces of ancient communications are fixed. Totally more than 250 various caves were fixed. Most of them are artificial or naturally-artificial.

On walls of cave rooms, numerous graffiti are fixed. The earliest of them concern to the end of 15th century. This date corresponds with the archaeological artefacts of 14-15 centuries, which have been found out at investigations of complexes «Kilyor», «Peshtere» and «Subbakota». Besides this, on a terrace of «Bosiya» monastery 11 monastic tombs of late-medieval time and also traces of an initial layout of the complex, which consist from several separate cave chapels, connected with monastic cells, were investigated. The data of initial inspection of the cave monasteries of Medieval Orhei allow considering them as a uniform monastic ensemble, which was organized on type Byzantian «cliff-laura», in which a monastic hostel was combining with asceticism.

Keywords

Medieval Orhei, rock cut cave, hypogenic karst, cave monastery, cave dwelling.

1. Introduction

Mentions about caves and the place called Peshtera, close to Butuceni Village, near Old Orhei, can be found in Medieval Moldovan documents. In the historical-geographical description of Bessarabia of 1903 (Krushevan, 1903), a cave and the church in a rock, near the ruins of the Old Orheev River, on the river Reut (near Orhei town) are mentioned. P. Batiushkov in his historical description of Bessarabia lists cave monasteries and churches on both banks of the Dniester River and its tributaries. On the Bessarabia bank he mentions also the caves near Peresichyn Village of Orhei district (Batiushkov, p. 39). V. Grigorovich visited these caves in the middle of the nineteenth century. (Grigorovich, 1871). The most detailed description of these caves was given by V. Kurdinovsky (Kurdinovsky, 1918). After a long break, since the 1980's the interest to these caves somewhat resumed (Grosu, Vasylaki, 1984; Taras, 1986).
In 1999-2001, the study of these monuments was carried out by the authors of this article together with the staff of the expedition "Old Orhei". Some preliminary results were published by authors (Bobrovskiy, Ridush, 2002), as well as our raw materials were used by other authors studying local history (Ciocanu, 2008, 2009, 2011; Tentiuc, Popa, 2009).
Below, there are brief results of our research.

2. Geography and geology

The investigated area is located in the canyon-like valley of the Reut (Răut) River, the largest right tributary of the Dniester River, not far from its inflow into the Dniester R. (fig. 1). On the segment between Trebujeni and Butuceni villages, the valley is developed in carboniferous sediments of the Middle Sarmatian beds (Neogen), built mainly of oolithic and detrital limestones with thin (0,1-0.5 m) interbeds of marlstone. The valley is incised into the bedrocks up to 120-140 m deep, forming steep limestone cliffs 20-50 m high. Due to the different speed of weathering of solid limestones and mild males, numerous natural niches and cornices were developed. As a result many cornices collapsed forming collapse deposits at the slope foot. This is the main reason of short-life of both natural and artificial caves in the valley.
In the area, there are two types of natural cavities, which usually were used as a base for rock cut rooms. The most numerous are the weathering forms, like grottoes, niches and shelters (Vznuzdaev, 1956). Usually they are not too deep, up to first meters, but can be quite elongated along the slope/cliff, up to tens meters. The other type is represented with hypogenic karst caves and cavities. Usually, they are developed in the layers of dense and clean detrital limestone due to the difference in a porosity of these limestones and marlstones' interbeds (the mechanism of hypogenic karstification is described in (Klimchouk, Ford, 2000)). These caves have a diameter from 0.5 m to more than 3 m, and they can penetrate deep into the massive, up to tens meters. They were developed inside the rock massive in the time of the river incision, and now they open on the daylight due to the slope regression. The recent occurrence of the entrances to such cavities is confirmed by the presence of only recent sediments on the floor.

3. Methods

The most of the caves are placed on the steep slopes or

vertical cliffs and are accessible only by climbing or using the alpine equipment. Partly the caves were mapped by the half-instrumental method, with a geological compass and a tape measure, and partly by drawing scaled sketches. Inside artificial rooms, the sediments very often were thrown away by some local amateurs, to who seemed that the historical caves should be clean. Only in few, the most hardly accessible rooms the cultural layer was preserved and was investigated. Besides excavation of the cultural layer, the rare petroglyphs were fixed, as well as architectural elemets.

Figure 1. The location of the investigated area (is shown by the arrow).

4. Results and discussion

In the vicinity of the medieval Orhei, there are 6 rock cut complexes located in the rocky cliffs of the meander of the Reut River, in the interval between the villages Butucheni and Trebujeni of the Orhei District. The complexes are located along the southern border of the medieval city, at a distance of 300-400 m from each other and represent multilevel complexes of rock cut structures.

The first complex is located to the south of Butucheni village, on the right bank of the Reut R. (fig2, IV). In literature, it is known under the name "Kilior'" or "Skeet Raphael". There were 20 cave rooms recorded, located in 4-5 levels, with traces of monastic habitation in them. The caves are made by expanding natural cavities (grottoes, cracks etc.), and have some traces of graffiti and graffiti on the walls. Monks lived in these caves yet at the beginning of the XIX century. In the 1920s, part of the complex, including the former cave church, was destroyed as a result of the explosion. When examining one of the caves of the lower tier (a karst cavity with traces of processing at the entrance), some surface finds were collected: several fragments of Moldovan ceramics from the 17-18th centuries. The present condition of this monument indicates that a significant part of its premises has not survived to our time, or is buried under numerous taluses and collapses.

The second complex, called "Subbakota", is located on the right bank of the Reut R., 400 m to the north-west from the previous one, at the site "Stynka Korbule" (Raven Cliff – in Romanian) (fig. 2, III). At the five levels of this complex, there are 25 rock cut rooms, which are the remains of natural grottoes and karst galleries along the fracture line, partly modified and used by people. The presence of only five modified chamber rooms,

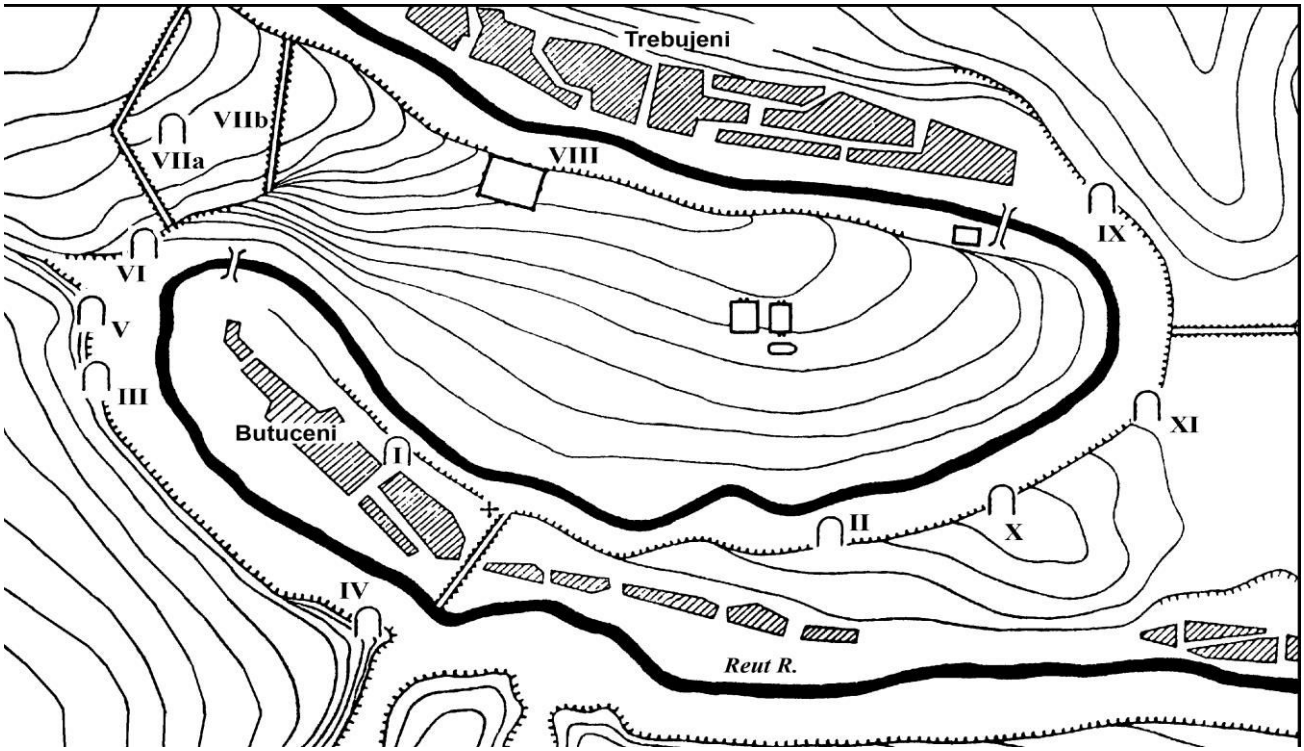


Figure 2. Location of rock cut monuments in the vicinities of Butuceni.

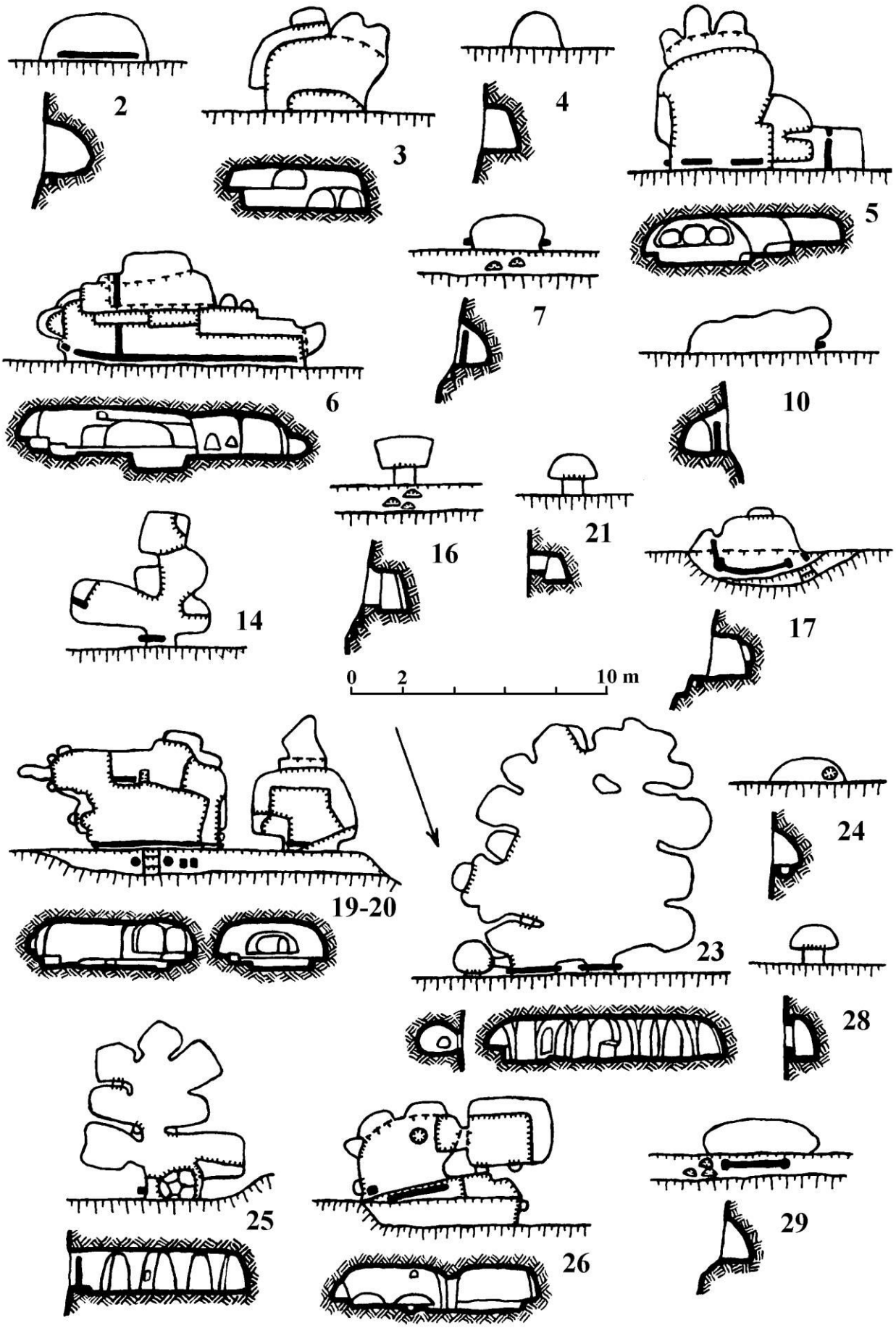


Figure 2. Cave plans and sections of the "Peshtere" complexe (1-29).

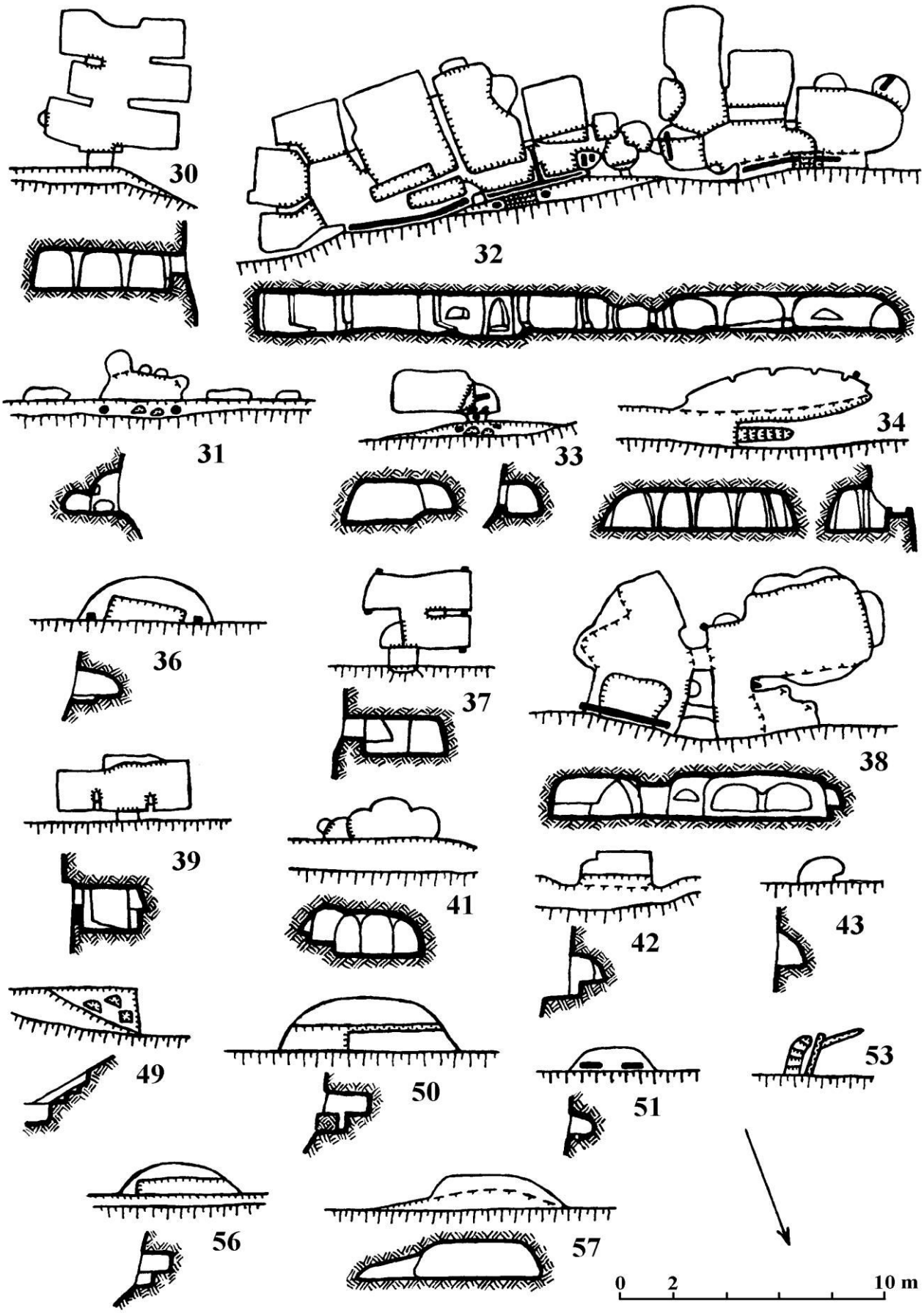


Figure 3. Cave plans and sections of the "Peshtere" complexe (30-53, 56-57).

concentrated on the lower levels, the presence in them of the pendants looking like benches, and the niches orientated to the east, as well as several Cyrillic graffiti on the upper level, suggest the existence of a tiny monastic settlement - the hermit monastery. Archaeological materials also allow suggesting that the upper levels of the "Subbakota" complex in the XVII century (at the late stage of their existence) were used as civil shelters or storage facilities.

The third complex is also located on the right bank of the Reut R., 200 m to the west of the previous one, in the site "Holm" or "Climbers' Cliff" (fig.2, V). It consists of several inaccessible niche-shaped chamber-grottoes, accompanied by numerous grooves from wooden structures. At the upper level of the complex there is a half-ruined rock terrace, on which several large natural cavities of a complex configuration, with traces of processing on the walls, are discovered,. Probably, a small hermit monastery was in this place in the Middle Ages. At the foot of the cliff, on the river bank, a huge limestone block was found, with the "tarapan" (wine press) cut out in it, probably indicative of the monastic wine industry.

The fourth complex is the largest and most well-known. It is the so-called "Peshtere" monastery. It is located to north of the Butucheni Village, in a 40-meter rocky cliff, on the left bank of the Reut., 400 m to the north-east of the previous one (fig. 2, I). At 10 levels of the complex, at an altitude of 10-35 m from the river level, at a distance of 350-400 m, there are about 150 cave cavities of various characters (fig. 2, 3). The levels are marked with the remains of the collapsed rocky terraces formed at the joints of the bedrocks of the solid limestone. The beds are not laid horizontally, but with a slight dip to the east. Most of the rooms in the complex are represented with natural formations and only 50-60 of them bear traces of artificial processing. The lower levels of the caves are partially covered with taluses, landslides and collapsed limestone blocks, forming a steep grassy slope. Probably, a certain number of unknown cavities are buried under this slope.

The rooms in this complex are represented by the following types of cavities:

1) natural cavities, are represented mainly by grottoes and weathering niches with dimensions of 1-10x1-5x1-2 m. Presumably, similar grottoes were also used when cutting down most of the rocky rooms. Untreated grottoes are currently known for about 100, the vast majority of them are located in the lower part of the cliff or under its upper edge (levels 1-5 and 8-10);

2) natural cavities with minor cut traces, are represented mainly by medium-sized grottoes, in which traces of tools on the walls, grooves from wooden partitions, pits and remnants of cutting down staircases are preserved. In several cases, the use of grottos as mines was recorded. Totally about 20 cavities of this type are recorded. They are located mainly at medium (3-6) levels;

3) natural cavities that underwent significant reconstruction, are represented by rock cut rooms of small and medium sizes, of various configurations, with mostly rounded outlines. It is often fixed the use in one construction of two or more original grottoes, as a rule, entirely swallowed up by the new cavity. In total, about 20 such rooms are located at the middle and upper levels;

4) rock cut rooms constructed without using natural cavities are represented by cavities (niches, chambers and cameras' complexes) of small and medium size, rectangular or trapezoidal configuration. They are located, as a rule, in hard-to-reach places, at levels of 6-7th tiers. In total, more than 15 rooms are known. It is important to note that among the cavities of this type, several architectural and planning options are clearly distinguished: small-sized niche chambers, room-complexes with chamber-compartments in the walls, and finally, the rooms of the rock church.

Observations of all varieties of the cavities of the complex allow us to judge with certain accuracy the relative chronology of the monument as a whole. Undoubtedly, the appearance of rocky buildings in this area was facilitated by the prevalence of natural cavities here. Probably the oldest of the rock structures should be considered rooms of the 2nd and 3rd types (natural grottoes with varying degrees of subsequent cutting). We believe that these rooms (of economic, residential and religious purpose – totally about 40) were the core of a rocky medieval monastery with a center in the eastern part of the present complex. It is possible that to the same time belong the difficult to access small niche cameras, which have broad analogies in the medieval cave complexes of South-Eastern Europe. Their purpose is not entirely clear; dimensions and inaccessibility of such niches in the context of monastic asceticism allow us to assume in them the so-called "Hesychasteria", a place of seclusion and solitary prayer. At a later time, some of these niches, as well as some cavities of the 2nd and 3rd types (the most inaccessible ones) were converted into rooms with chamber-compartments in the walls. The designation of these structures also remains unclear; however, their connection with the actual monastic life is very problematic, taking into account the abundance of graffiti drawings with non-Christian symbols on their walls. As a version we can offer the following: difficult access roomss with the same type of cameras-compartment, marked with certain (sometimes related but not repetitive) symbols, served as a kind of refuge or storage for local civil inhabitants. Finally, the latest stage in the history of the complex is characterized by the creation of a large cave church (now in operation) and the partial destruction of rock walls between the aforementioned chamber compartments. Probably, this happened in the late XVII-XVIII centuries, when the monastery was renewed.

Currently, it is difficult to determine the time of occurrence of a monastery. The dating of the first stages of its existence requires further investigation cave structures, however, given the materials obtained in the exploration of nearby similar complexes suggest that the development of the area by the monks did not happen later then the XV century.

The fifth complex is also a well-known one, the monastery "Bosia". It is located 300 m to the north-east of the previous one, in the bend of the Reut R., on its left bank, between Butucheni and Trebujeni villages, in the lower part of the slope (fig. 2, II). The rooms of the complex are located, mainly, in one level, at a height of 15-20 m from the river level. Below, there is a fairly gentle slope formed by landslide and collapsed rocks, under which the cavities of the lower tier may possibly be preserved (as indicated by low-lying natural grottoes in the western part of the complex). At present, about a

dozen cave rooms are observed here, connected by a terrace and inner passes. All the rooms are made by expanding the original natural cavities that appeared along the line of a fault in the limestone rock. Among the rooms is a large cave church, as well as several cells with rock shelves and benches. On the terrace at the entrance to the church there are numerous graffiti of the XVII century, indicating the renewal of the monastery during this period. One of the inscriptions of the complex is dated to 1492, which suggests the existence of the monastery already in the second half of the 15th century. This date is in full agreement with the earliest archaeological finds (XIV-XV centuries) in the complexes "Kilior", "Peshtere" and "Subbakota".

In 1999-2000 excavations of a small section of this terrace in the area of the cave church were found remnants of the monastery necropolis with tombs carved into the rock. Totally, 11 graves were found, in three of which burials were recorded in situ. It was also found that the original layout of the monastery included several rock cut chapels connected to residential cells, which testifies to the hermit's character of the monastic settlement.

The sixth complex, not named, is located 300 m to the north-east of the previous one, on the left bank of the river, at the foot of the coastal slope (fig. 2, IX). It consists of a dozen cave structures located in two tiers, while the upper tier rooms are represented by small natural grottoes with traces of artificial processing. In the lower tier there are several artificial caves planned for cutting down, which have not been completed. By the character of cutting, they can be correlated with the rooms of the 17th century in the complex "Bosia". Probably, this complex is the latest in the Orhei monuments and its construction has not been completed. At the end of the 17^{th} – 18^{th} centuries monastic life was concentrated in the complexes "Peshtere" and "Kiliori". The remaining complexes were abandoned.

In addition to the above mentioned complexes, in this area there are a few isolated cave rooms more. One of them, grotto-shaped with images of crosses on the walls, is located to the north of the complex on the site "Holm". Another, in the form of a tiny cave chapel with numerous graffiti crosses on the walls, is in the lower part of the slope midway between the Subbakota and Kiliori complexes. The third, a cell-like room, with a narrow entrance in the lower part of the slope, is situated halfway between the unnamed Complex 6 and the monastery "Bosia".

5. Conclusions

Totally more than 250 various caves were fixed. Most of them are artificial or naturally-artificial.The architectural features of the complexes make it possible to interpret them as the remains of rock monasteries and hermitages as well as cave dwellings of Late Medieval and Early Modern times.

References

Batiushkov P, 1891. Podolia. Istoricheskoje opisanie [Podolia. Historical description.], Sankt-Pitersberg (in Russian).

Bâzgu E, 1996. Mănăstirile rupestre din bazinul fl uviului Nistru - artere de răspândire a creştinismului, Arta ‘96, 98-104 (republicat in: Sud-Est (Artă, cultură, civilizaţie) 4(30), 1997, 10-19.

Bilinkis GM, Drumia AV, Dubinovskiy VL, Pokatilov VP, 1978. Geomorfologia Moldavii [Geomorphology of Moldovia]. Shtiintsa, Kishinev.

Bobrovskiy T, Ridush B, 2002. Doslidzhennia pechernykh pamiatok v okolytsiakh seredniovichnogo Orheya [Investigation of cave monuments in the vicinity of medieval Orhei], Pytannia Starodavnioi ta Seredniovichnoi Istorii, Arheologii i Etnologii, 2, 153-160 (in Ukrainian).

Ciocanu S, 1998. Biserica rupestră de la mănăstirea lui Bosie din Orheiul Vechi în Basarabia. Arhitect Design, 9-10, 44-47 (in Romanian).

Ciocanu S, 2008. Schitul Peştera şi moşia Peştera (Orheiul Vechi) din ţinutul Orhei (de la primele atestări documentare până în secolul al XIX-lea) [Orhei district Peştera hermitage and Peştera estate. From the first mentions to the 19th century], Tyragetia (Serie Nouă) 1, 141-162 (in Romanian).

Ciocanu S, 2009. Schitul Trebujeni (al lui Bosie Pârcălab) şi moşia Trebujeni/Butuceni din ţinutul Orhei [Orhei district Trebujeni hermitage („al lui Bosie pârcălab”) and Trebujeni/Butuceni estate]. Tyragetia (Serie Nouă) 2, 89-109 (in Romanian).

Ciocanu S, 2011, Schitul Maşcăuţi/Macicăţi (al lui Albu Pârcălab) şi moşia Maşcăuţi din ţinutul Orhei [Orhei district Maşcăuţi hermitage („al lui Albu pârcălab”) and Maşcăuţi estate]. Tyragetia (Serie Nouă) 2, 119-138 (in Romanian).

Grigorovich V, 1871. Zapiska ob arheologicheskom izledovanii Dnestrovskago poberezhia [Note about archaeological study of the Dniester shore], Odessa (in Russian).

Grosu VG, Vasilaki KG, 1984. Lapidarnyje znaki Butuchenskikh peshcher [Lapidary symbols of the Butucheni caves], Izvestia Akademii nauk Moldavskoi SSR, 3, 61-69 (in Russian).

Krushevan PA, (Ed.) 1903. Bessarabia. Geograficheskii, istoricheskii … sbornik. [Bessarabia. Geographical, historical collection], Moscow (in Russian).

Kurdinovskii V, 1918. Obshchii ocherk o peschernykh hramakh Bessarabii [General essay on the cave temples of Bessarabia]. In: Drevneishyia tipichnyie pravoslavnyia tserkvi Bessarabii (Ch.1) [The oldest Orthodox churches of Bessarabia, P.1], Trudy Bessarabskogo Tserkovnago Istoriko-Arheologicheskogo Obshchestva, 10, 1-11 (in Russian).

Musteaţă S, 2005b, Studiu asupra mănăstirilor rupestre din Republica Moldova. Consideraţii istoriografi ce. In: Analele Asociaţiei Naţionale a Tinerilor Istorici din Moldova. Anuar istoric, Chişinău, 197-202.

Postică Gh, 1997, Arhitectura sacră rupestră în contextul civilizaţiilor sud-est europene, Sud-Est (Artă, cultură, civilizaţie) 4(30), 5-9 (in Romanian).

Postică Gh, 2007, Mănăstiri şi schituri rupestre creştine. In: Postică Gh, Civilizaţia medievală timpurie din spaţiul pruto-nistrean (secolele V-XIII), Bucureşti, 193-196 (in Romanian).

Tentiuc I, Popa A, 2009. Some considerations regarding rock-cut monasteries and spreading of the Christianity in eastern Moldova during the late roman period and early middle age. In: Zanoci A. et al. (eds) Studia Archeologiae et Historiae Antiquae, Chişinău, 349-363.

Vznuzdayev ST, 1956. Groty vyvetrivania v dolinie Dnestra. Priroda, 2, 113-114 (in Russian).

HYPOGEA OF SAN PIETRO IN VINCOLI AT SANT'ANGELO IN GROTTE

Laura Carnevali[1], Marco Carpiceci[1], Andrea Angelini[2]
[1]*SAPIENZA University of Rome, Department of History, Representation and Restoration of Architecture;*
laura carnevali@uniroma1.it, marco.carpiceci@uniroma1.it
[2] *National Research Council of Italy - Institute for Technology Applied to Cultural Heritage;*
andrea.angelini@itabc.cnr.it

Abstract

Since many years the research unit of the Sapienza University of Rome has dealt with the cataloging and surveying of several examples of rupestrian architectures in Italy and Cappadocia. In 2017 hypogea of the nineteenth-century church of San Pietro in Vincoli in the village of Sant'Angelo in Grotte (Italy) have been surveyed. For the first time in 1954, during pavement removal work were discovered hidden and forgotten cavities. A small chapel with a rectangular plan covered by a barrel vault was found. The surfaces of the chapel were completely painted with representation of the spiritual works of mercy, the Celeste Jerusalem and the Sun. The paintings were stylistically attributed to the Sienese school and placed temporally at the end of the XIVth century. In another room a pictorial trace remained near the area of the vault. Unfortunately the vault and the entire pictorial cycle have been completely lost, probably due to the intense earthquakes in 1456 and 1805 that have tragically marked the life of this village. Between the two seismic events, probably took place the "covering" of the ruins and the construction of a new place of worship for the community. After 1883 the archpriest Federico Taddei rebuilt the main church as it is now. A phase-based laser scanner was used for surveying the entire hypogea systems. The scans were performed completely in the dark for registering the morphological data and favouring an homogeneous acquisition of the painted surfaces through the reflectance information. With a high definition reflex camera, a fixed optic lens and a color checker several images of the main chapel were taken in order to control the chromatic appearance of the paintings and the homogeneity of the lighting sources. The entire numerical model was processed with different procedures. The surface reconstruction was performed with algorithms able to reduce the points, maintaining however a good quality of the morphology. In particular the mesh model of the chapel was mapped with the high resolution images. Some specific tools were applied for the texture mapping of the vault. The result has been a navigable 3D virtual model with realistic images.

Further elaborations were performed for the canonic representation of plans and sections through the method of the "contour lines". Experimented in different projects in Italy and Cappadocia the method allows to exploit the classic representation method and the use of multiple sections for the shape analysis of the rupestrian architecture.

A detailed study concerned the surfaces of the chapel that belong mainly to planar and striped surfaces. The surfaces have been unrolled for observing the paintings in the real shapes out of the morphological context.

Keywords
hypogea architecture; laser scanner; digital photography, chromatic survey.

1. Preamble

In 1954 the parish church of San Pietro in Vincoli, in the ancient village of Sant'Angelo in grotte (currently in the municipality of Santa Maria del Molise in the province of Isernia) decided to renovate the old paving of the nineteenth-century. During the demolition work on the old paving and the foundation, the cavities below were discovered.

Between the various environments a small rectangular chapel, entirely painted, was brought to light. The pictorial cycle represents a rare representation of the Corporal Works of Mercy, currently attributed to a period between the 14th and 15th centuries. This little jewel of medieval Molise painting was inexplicably erased from the local culture between the late seventies and early eighties of the twentieth century.

Considering the good condition of the chapel and the singularity of the theme represented, the research group decided to include the entire structure (church and hypogea) in the project on the Italian rupestrian architecture; the aim of the project is to improve those episodes that, despite not having had a great (or sometimes minimal) critical fortune, show noteworthy reasons of cultural interest (Valente 2003).

2. Historical events

The village of Sant'Angelo in Grotte develops along the road axis (North-Sud) that leads from the Castle to the church; the town is characterized by a classic form, tipycal of the of early medieval settlements. It is still possible to individuate the axial delimitation marked by the entrance tower, in front of the parish church, and the probable one of the castle, today almost totally destroyed. In the church, the chapel of the works of mercy remains the oldest witness.The dating of the paintings can be placed between the end of the 14th and the beginning of the 15th century (Marino 2013, Marino 2013a). In that period the presence of two feudal lords, Filippo and Angelo (of Santangelo) related to the ruling family of the d'Angiò, is testified.

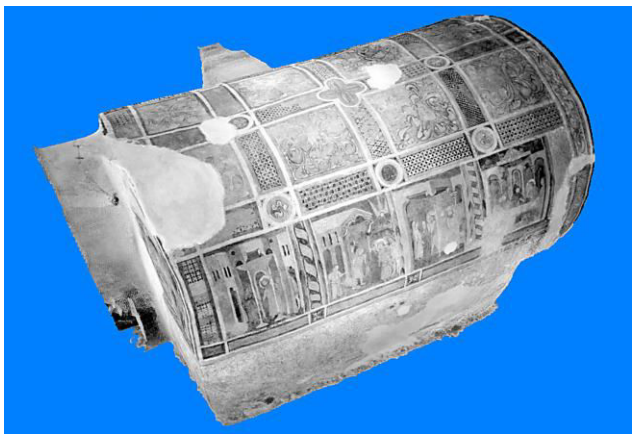


Figure 1. Numerical model of the chapel of the works of mercy performed with a phase-based laser scanner.

The catastrophic earthquake of December 1456 led to a general renewal of the small city.

It is therefore reasonable to suppose that the mother church was also subjected to transformations between the 16th and 18th centuries. However, this is a period not yet defined and on which it is necessary to investigate both at documentary and archaeological level.

In 1805 another disastrous earthquake defined the need for further reconstruction. Some souvenir-signatures testify how the chapel of the works of mercy was still accessible in 1829. After this date there are no more news regarding the chapel, which probably suffered a lasting abandonment that in 1878 led the Town Hall to rebuild the collapsed building, works that lasted for five years.

On the church's facade the inscription recalls the reconstruction on the ruins of the previous church: TEMPLUM HOC / PENITUS COLLAPSUM / MUNICIPII SUMPTIBUS / ARCHIPRESBJTER / FEDERICUS TADDEI / AB IMO / ERIGENDUM CURAVIT / MDCCCLXXXIII / Nazarius Frantiello fecit. Fortunately, in 1954 it was decided to redo the floor in an evident state of decay. During the demolition of the background the hypogeal environments were discovered again, conserved and restored in their current appearance.

The pictorial cycle was restorated twice, in 1974 and 1996, and the current state of conservation seems to be good and stable.

3. The survey

The church of San Pietro in Vincoli consists of a single-aisle structure and a straight line termination. The hypogeal part is characterized by a series of environments connected to each other in an annular form at different levels.

Figure 2. Small fragments of fresco in the second chapel with rectangular barrel-vault shape.

The scanning operations began precisely from the chapel of the Works of Mercy, a small rectangular room covered with a barrel vault oriented East-West. The scans were carried out in the dark, in order to have a good reflectance value with a final B&W image, not influenced by uneven natural or artificial lighting. This was applied for those environments in which total obscuration could be achieved, not being able to do all the scans at night (Sgrenzaroli and Vassena 2007).

For the small painted chapel, a series of high-definition photographs were taken (50 MB in Full Frame with sensor without Low Pass Filter) and with a fixed focal length lents of 28 mm, sufficiently wide as a field angle and with little radial distortion. The shots were taken in manual exposure, aperture f/8 with fixed focus, in order to have a sufficient depth of field and constancy of optical deformation for all the photos.

Obviously all the focusing and stabilization automatisms have been turned off, which introduce constant changes to the geometry of the optics. With the camera on a tripod and flexible snap, any vibrations were avoided. For the lighting, considering the general good level of homogeneity of the artificial light, it has been decided to increase the colour consistency with an indirect flash. Five scans allowed to obtain the right density of points and the almost total coverage of the surfaces, avoiding areas of shade (Fig.1).

The scans continued anticlockwise until reaching another room apparently similar to the first chapel. This also has a rectangular barrel-vault shape, larger in size than the first but orthogonally oriented. The shape of the cover is still visible in a small portion that has small pieces of paint; the rest of the vault is now cut from the pavement of the upper church (Fig.2). For the scan registrations, the use of targets was excluded due to the open polygonal sequence, and it was decided to use special spheres, able to provide the geometric centre, independently of the direction of their observation (Fig.3; Besl and McKay 1992, Angelini and Portarena 2017).

In total 28 scans were carried out, covering as much as possible the entire church and its urban context, employing only an entire day (Fig.4; Boehler et al. 2003). Further scans could have covered the undercuts, the external North (in a very narrow alley) and West (towards the valley) walls.

The roofing would require a photogrammetric coverage by means of a drone, but the wind is almost always present and the instability of the UAV under these conditions would compromise the result.

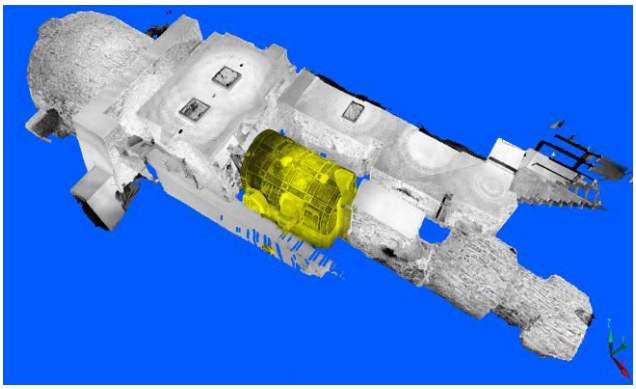


Figure 3. The hypogean rooms were registered through the use of spherical target in order to improve the general accuracy of

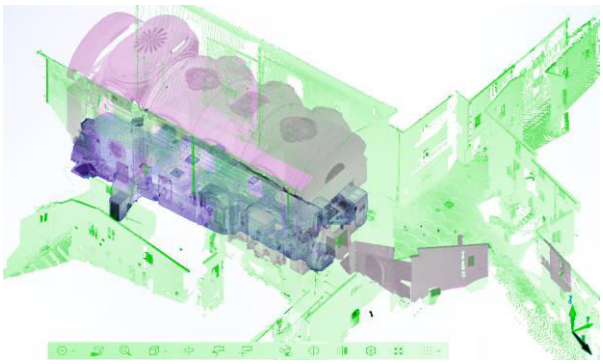


Figure 4. The whole point cloud of the church and the related hypogea

4. The representation

On the basis of the experience in the study of the representation, the authors exploited the formal characteristics of the rupestrian architecture for defining an innovative protocol of representation able to use the same characteristics for analyzing the shapes of the architecture (Carpiceci and Inglese 2015).

4.1. The morphology

The Equidistant Multiple Sections system (EMSS), developed by the authors over the last ten years, makes it very clear to understand the geometric shape of the vaulted architectural structures. In aerial projection, above all, the contour lines show the trend of the roofs and allow to easily identify the type and the "accuracy" of the geometric vaults.

The different colour applied on the environments and/or levels, also makes it possible to simultaneously read the morphology of several levels, showing their mutual dimensional relationships (Fig.5). In the specific case the overlap of the levels shows multiple characteristics.In the hypogeum level the small chapel has a fairly regular rectangular conformation with a dimension of 4.30x2.60 m and the longitudinal axis oriented WSW-ENE (West South West - East North East). The vault generators show a parallel and regular pattern of the cylindrical surface, with a slight anomaly at the entrance where the curvature arrives in advance at the horizontal ridge position, generating the feeling of greater width of the roof in that wall.

The environments towards ENE show a very jagged and irregular coverage, but with a similarly cylindrical trend, denounced by the same orientation of the contour lines.

The large room immediately west of the chapel shows its longitudinal profile not perfectly rectangular, but rather parallelogram.

The contourn lines of the roof, regular but present only near the shutter, show how this vault has been deprived of its upper part to make space for the realization of the floor slab of the upper church. The greater environment, towards the apse area of the complex, has a square shape with a vaulted barrel vault in the same orientation as the small chapel. The lines shows how the isoipse rotate as it grows in level giving rise to a slightly conoidal surface, such that the ridge is a sloping line with a greater height towards WSW.

With the MES system is also possible to identify different alignments between the rooms. In particular it has been possible to individuate the South wall of the primitive Renaissance church, analyzing the alignment of the chapels (Fig.6).

Clearly the textured mesh model can be navigated, thus analyzing the architecture in a traditional way, but also according to an unusual point of view, the external one (Carpiceci et al 2018).

The different feeling allows an innovative vision, and then adds similar sensations and observations but different than traditional ones. The scans with reflectance (but also RGB) is actually a sequence of spherical panoramic

Figure 5. The numerical model of San Pietro in Vincoli represented with coloured contourn lines in order to understand the different levels of the archaeological structure.

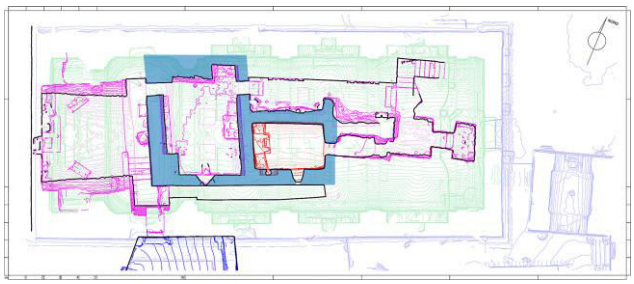


Figure 6. The hypogean rooms with the medieval structures evidenced.

photographs, which makes them available for the creation of a Virtual Tour through mutual calls and thus allowing a visit to the monument from the same points of view of the laser survey.

4.2. The painted surfaces

Photographic shooting of the painted surfaces always requires extreme care in order to make a chromatically correct recording and an image geometrically free of radial distortion.

Good chances of success are there for the rough surfaces, as for frescos and wall paintings in general. The more the surface is shiny and reflective the more its homogeneous illumination will be difficult. In the case study, the presence of a discrete artificial lighting required only the contribution of an indirect flash source to improve the general light spectrum.

The use of a color checker (standard and calibrated) in an initial frame allowed the chromatic correction of all the frames taken with that same lighting condition (Devebec and Malik 1997). The optics used for this kind of chromatic survey are a 28mm and a 50 mm (on Full Frame) whose slight radial distortion can be almost eliminated already in the recording by the camera or later in the digital development process from RAW files.

The images can be rectified by projective deformation operations based on the knowledge of the spatial location of four points sufficiently distant from each other and present in the frame in peripheral areas. From a metric point of view, the best result is the image projection on the point cloud, using an orthogonal projection of the entire wall. This system was applied for the two vertical entrance and bottom walls of the chapel and for the lower part of the longitudinal walls.

The cylindrical surface of the vault is within the developing surfaces and can therefore be treated by two operations. The first is achieved by shooting with the camera positioned (approximately) with the Anterior Nodal point along the geometric axis and the optical axis perpendicular to the painted surface (Fig.7); however, the tripod must have a panoramic head for the nodal acquisition. In this way, each series of photos can be processed with a software for panoramas that can perform a cylindrical view and then automatically provide the developed cylindrical surface (Marks and Fuller 1960; Van Wijk 2008).

A second operation can be made by projecting the images

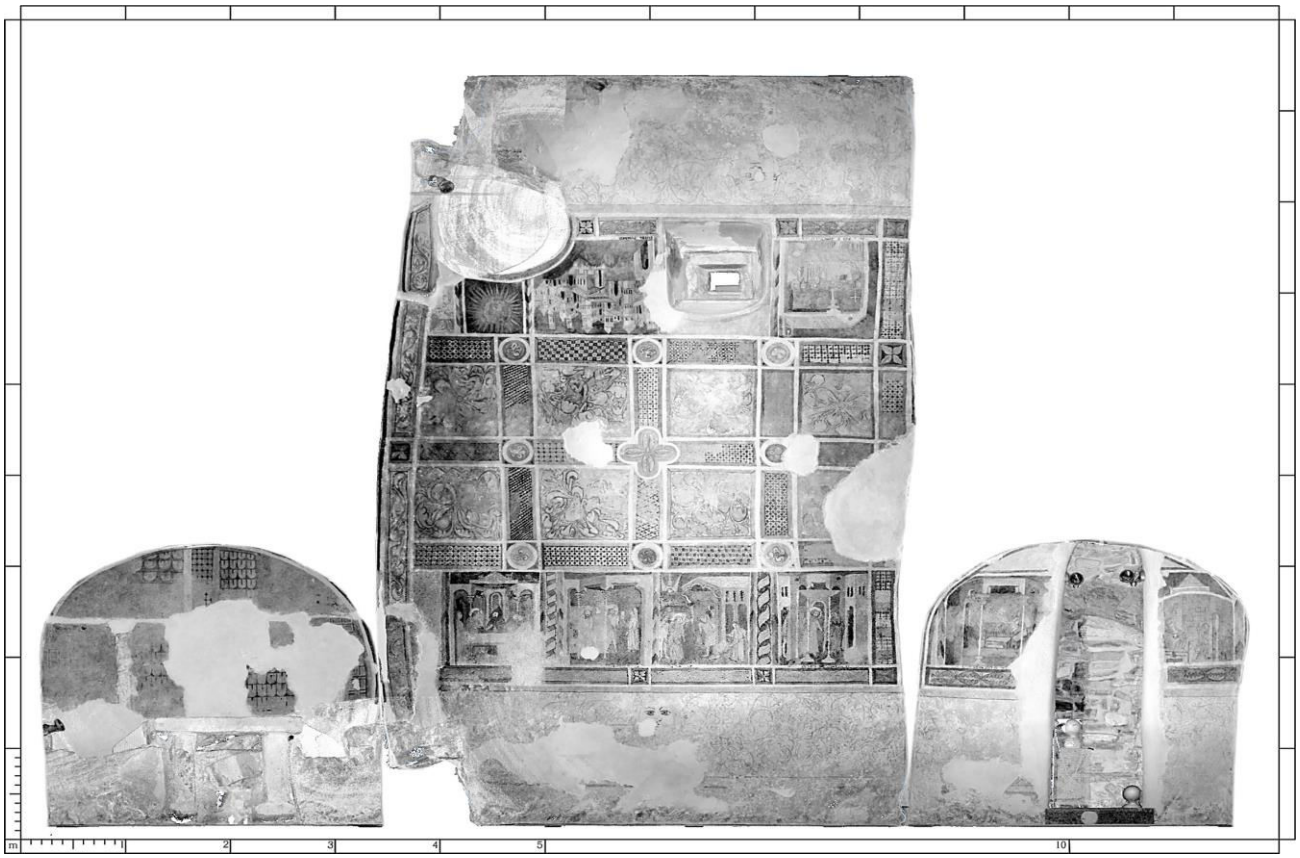


Figure 7. The barrel vault of the chapel was completely unfolded for observing the real shapes of the pictorial decorations.

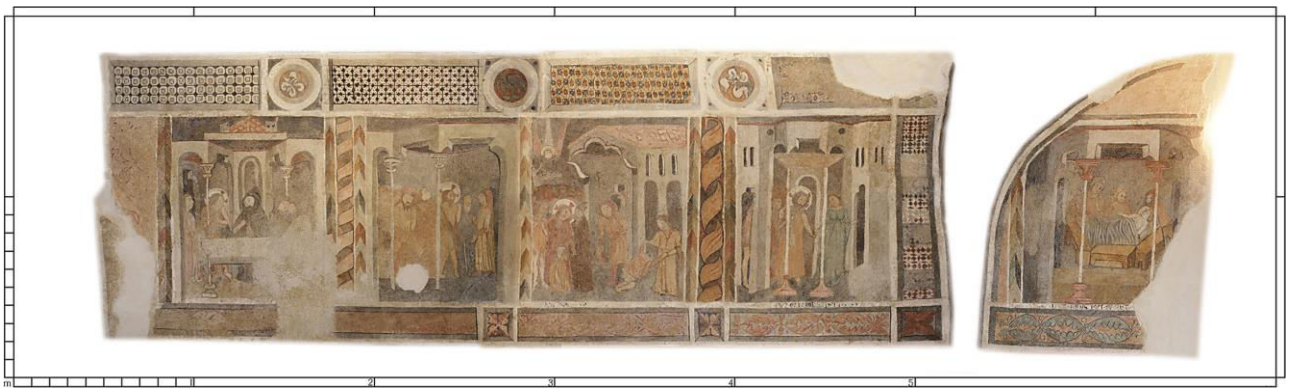


Figure 8. The numerical model was textured and unfolded for analyzing the pictorial cycle. Works of Mercy, 1,2,3,4,and 5.

on the point cloud and performing a cylindrical scan with the coinciding axis (as much as possible) with the longitudinal axis of the vault (Carpiceci er al 2018b).

4.3. The pictorial cycle

Despite their origin in the Gospels, the representation of the Corporal Works of Mercy is realized only from the late Middle Ages and in a few times, at least on the basis of the known pictorial cycles. Worthy of note is the cycle of the apse of the church of Santa Maria Assunta in Santa Maria La Fossa (from the end of the 12th century) and that in the church of S. Nicola in San Vittore del Lazio (from the beginning of the 14th century).

Usually the representation of the Works of Mercy is divided into two forms:

- the corporal ones, for the hungry, the thirsty, the naked, the pilgrims, the sick, the prisoners and the dead;

- the spiritual ones, to the doubtful, the ignorant, the sinners, the afflicted, those who offend, the harassing people and in prayer for the living and the dead.

In our case the chapel is entirely painted with a significant variability of decorative motifs that make up a homogeneous environment and realized according to a careful iconographic project. The Works of Mercy are only the seven Corporal and extend in clockwise directions along the perimeter on a band between 140 and 220 cm from the floor. The frames begin on the longitudinal wall NNW immediately to the right of the small altar. In this wall are present the first four works (from left to right; Fig.8):

1- *feed the hungry*, Christ assists a woman on the left of a table in the courtyard of a house, while feeding some people;

2- *give drink to the thirsty*, Christ at the head of a group of people on the left while a female figure offers a jug to quench their thirst;

3- *clothe the naked*, Christ on the left in the middle of a group of needy and on the right the female figure in the act of changing the tunic to a kneeling person;

4- *shelter the homeless*, Christ with some people is led into the house by the merciful lady.

Two other panels are on the entrance wall:

5- *visit the sick*, the charitable woman with two other people assist a young patient;

6- *visit the imprisoned* (Fig.9), a prisoner looks out of the window of the cell and down a woman with the book of scriptures entering the prison, preceded by a person holding a kind of comfort wrapped in a cloth.

On the wall towards SSE the last work:

7- *bury the dead*, a large group of priests in a church, who celebrate a funeral ceremony with the bier.

Unfortunately, the lower frame, where we could see signs of writing that should have explained each related box, is almost illegible.

The series of panels of the Works of Mercy is then followed by two panels. In the first one the city of Betlem

Figure 9. Works of Mercy, 6, 7, Betlem and the Sun.

is represented; in the lower frame we read: CITTAS BETOELEM. The panel with the anthropomorphic sun concludes the series.

5. Conclusions

The laser and chromatic survey of the chapel of the Works of Mercy of Sant'Angelo in Grotte gives the collective knowledge the full visibility of this jewel of Molise. This is thanks to modern technologies that allow us to cover fields of research that until today were unthinkable. The continuous experimentation of original applications pushes us more and more towards a better unified approach in the historical, metric and communication analysis of Cultural Heritage (fig.10).

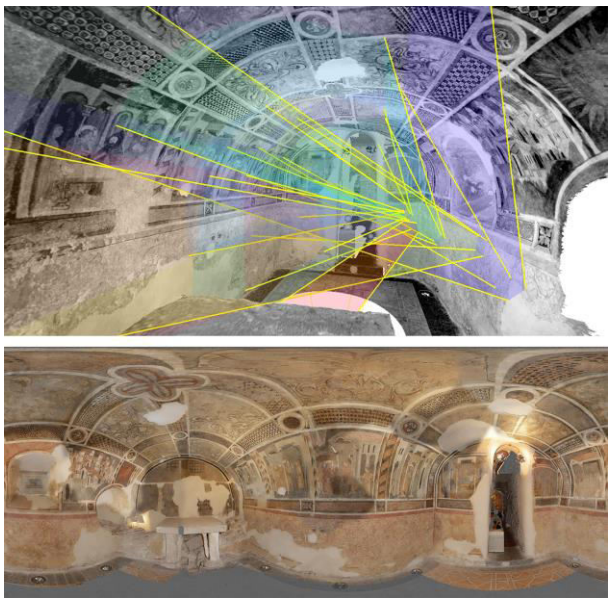


Figure 10. The main chapel was completely textured with high resolution images in order to have a complete image-based virtual model

Acknowledgments

The paper is the result of the collaboration between the authors. In particular Laura Carnevali developed the paragraphs 2, Marco Carpiceci the paragraphs 4 and 5, Andrea Angelini the paragraphs 1 and 3. All the authors have contributed equally to the survey campaign.

References

Angelini, A., and Portarena, D., 2017. A procedure for point clouds matching from range-data and image-based systems. The e-Journal of the International Measurement Confederation, Acta IMEKO, 6(3), pp. 57-66.

Besl, P.J., and McKay, N.D. 1992. A Method for Registration of 3-D Shapes. IEEE Transaction on Pattern Analysis and Machine Intelligence, 14(2), pp. 239-256.

Boehler, W., Bordas, M.V., and Marbs, A. 2003. Investigating laser scanner accuracy. In: CIPA 2003 XIXth International Symposium: new perspectives to save cultural heritage, Antalya, Turkey, pp. 696-701.

Carpiceci, M., and Inglese, C., 2015. Laser Scanning and Automated Photogrammetry for the knowledge and the representation of the architecture cave in Cappadocia: Sahinefendi and the Open Air Museum in Goreme. In: CAA 2014: 21st Century Archaeology Concepts, methods and tool. Proceedings of the 42nd annual conference on Computer Applications and quantitative methods in Archaeology, Paris, France, pp. 87-94.

Carpiceci, M., Russo, M., and Angelini, A., 2018. The digital model of the S. Zenone chapel inside Santa Prassede in Rome. A case study for the morphological analysis. In: VSMM2017, 23rd International Conference on Virtual Systems and

Multimedia : Through the Looking Glass - Back to the Future of Virtual Reality, Dublin, Ireland, in press.

Carpiceci M., Carnevali L., Angelini A., A new protocol for texture mapping process and 2d representation of rupestrian architecture. In: ISPRS TCII Symposium "Towards Photogrammetry 2020". International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, vol. XLII, p. 209-215, 2018

Devebec, P.E., and Malik, J., 1997. Recovering high dynamic range radiance maps from photographs. In SIGGRAPH '97 The 24th International Conference on Computer Graphics and Interactive Techniques, ACM, NewYork, pp. 369-378.

Marks, R., Fuller, R.B, 1960. The Dymaxion World of Buckminster Fuller. Reinhold Publishing, New York.

Marino, V., 2013. Sant'Angelo in Grotte e la Carità cristiana: gli affreschi della chiesa di San Pietro in Vincoli. Altri Itinerari, 10(23), pp.50-63.

Marino, V., 2013a. Gli affreschi delle opere di Misericordia corporali e del Cristo Pantocratore a Sant'Angelo in Grotte e i rapporti con Roccaravindola e Pizzone. Studi Medievali e Moderni, 17(1), pp. 269-297.

Sgrenzaroli, M., and Vassena, G.P.M., 2007. Tecniche di rilevamento tridimensionale tramite laser scanner, Volume 1 – Introduzione generale. Starrylink Editrice, Brescia.

Van Wijk, J.J., 2008. Unfolding the Earth: Myriahedral Projections. The Cartographic Journal, 45(1), pp. 32-42.

Valente, F., 2003. Luoghi antichi della provincia di Isernia. Edizioni Enne, Bari.

CRYPTA NEAPOLITANA (NAPLES, ITALY) A MULTIDISCIPLINARY UNDERGROUND HERITAGE SITE

Graziano Ferrari[1], Raffaella Lamagna[1], Elena Rognoni[1]
[1]*Associazione Cocceius, via della Grotta Vecchia 3, I-80125, Naples, Italy, associazionecocceius@gmail.com*

Abstract

The *Crypta neapolitana* is a 699 m long tunnel, which connects Naples to Pozzuoli. It was already in use in the 1st century A.D., when it was referenced by Strabo, Seneca and Petronius. It was part of an ancient connection *per cryptam* (through a tunnel) between *Neapolis* and *Puteoli*, as opposed to an awkward route *per colles* (over the hills). As such, it is the only cavity depicted on the *Tabula peutingeriana*. Its function discontinued in 1917, due to internal collapses. A partial restoration action was performed at the beginning of the 21st century, but the middle 500 m are still severely damaged. The road tunnel is flanked by an aqueduct, part of the main course of the Augustan Aqueduct, which tapped large springs in the Apennines and ran 105 km to feed several ancient cities, the harbours in *Puteoli* and *Misenum* and the thermal establishments in *Baia*.

As part of a speleological research project about ancient aqueducts in the Phlegraean Fields, we were allowed access to the *Crypta*. We identified and documented 15 evenly spaced entrances to the aqueduct, together with several aqueduct sections. We also collected information about scientific and cultural issues related to the *Crypta* and the aqueduct, so as to perceive the cavity not as a mere road tunnel, but as a complex system, strictly related to the surrounding surface environment and to local history and culture.

Keywords

Roman tunnels, Augustan Campanian Aqueduct, underground water ducts.

1. Introduction

The Phlegraean Fields (fig. 1) are an active volcanic caldera, composed by several craters in an area of about 65 km² in the surroundings of Naples (Campania, Southern Italy). Presently, the volcanic activity is limited to fumaroles and thermal springs but in 1538 a new volcano erupted and destroyed a large area. Main eruptions are dated at 39/35 ky b.p. and 15 ky b.p., while several minor volcanoes erupted in pre-historical times. The area is affected by bradyseism: a long-period raising and lowering of the land, related to variations in the underlying magmatic chamber. In ancient times the presence of safe harbours, thermal springs, a temperate climate and fertile land raised attention by Greeks and Romans. In the first century b.C. the area was exploited with leisure establishments, fisheries, storehouses and with the Roman Navy harbour plants. Many caves were dug in Roman times, as tunnels, aqueducts, water tanks, hot water catchments, and steam tubes to warm spas.

A major drawback in the Phlegraean Fields was their lack of fresh water. The volcanic land provided just thermal salt springs. In the last decades of the first century b.C., in order to support a growing population and the demanding military and commercial fleets, Romans designed and built the Augustean aqueduct (*Aqua Augusta Campaniae*), tapping important springs in the calcareous Apennines. The aqueduct course was mostly underground. Side branches reached the ancient cities of *Pompeii*, *Nola*, *Atella,* and *Acerra*. The main branch skirted *Neapolis* and reached *Puteoli*, the *Portus Julius* harbour, the wealthy settlement of *Baia* and the *Misenus* harbour, after leaving side branches to Posillipo, Nisida and *Cuma*. The main

Figure 1. The area between Puteoli *and* Neapolis*. In white: the road '*per cryptam'.

branch was about 105 km long (Keenan-Jones 2010), that is, the longest Roman aqueduct at that time and the only one designed to provide several cities.

Strabo (*Geographica*, V, 4, 5, 7) reports about a renowned architect, Lucius Cocceius Auctus, who designed the excavation of two main tunnels in the Phlegraean Fields. Cocceius name is connected also to the Augustus' Temple on *Puteoli* acropolis and to the original design of the Pantheon in Rome.

Strabo's words about the tunnel between *Puteoli* and *Neapolis* were the following: "wide enough to allow two carriages to run in opposite directions". It is the so called *Crypta neapolitana,* the only ancient tunnel which name was preserved (Busana and Basso 1997, p. 114), by Seneca (*Epistle* 57) and by Petronius (*Fragmenta* XIV).

Furthermore, the *Crypta neapolitana* was the only tunnel depicted in the *Tabula Peutingeriana*, a map of Roman roads from Britannia to India.

From 2010 we are performing research about the Phlegraean Fields ancient hydraulic systems. The *Crypta neapolitana* has effectively long been the 'entrance' to the Phlegraean Fields. Our search for surviving aqueduct sections started in the *Crypta*, since the presence of an aqueduct section was reported by several authors (Celano 1692, v. 9, p. 59; Amato et al. 2002).

Caving research in the *Crypta* collected information about the main tunnel and the Roman aqueduct, but also about several minor features which layered during time over and within the main structure. Research on the little-known Phlegraean section of the *Aqua Augusta* is ongoing (Ferrari and Lamagna 2013, 2015b, 2016a, b).

2. The main tunnel

The *Crypta Neapolitana* is a 699 m long tunnel which in Roman times connected *Puteoli* with *Neapolis*. It is an imposing underground road bored through the Posillipo ridge. It was intended as a direct road connection (*per cryptam*, i.e. through a tunnel) between *Puteoli* and *Naples*, avoinding the awkward road *per colles* (i.e. over the hills, Johannowsky 1953). The tunnel is presently disarrayed and closed to transit for more than a century.

The cavity has two main entrances; one is on the Naples side, in a district called Mergellina. The neighbourhood is called Piedigrotta (i.e. at the foot of the Cave). The entrance is in a small park consecrated to the memory of the poet Vergil. Scholars of the past believed that a Roman columbarium located just aside the *Crypta* entrance was Vergil's tomb (Cocchia 1888). The park houses also the tomb of the poet Giacomo Leopardi.

The entrance on the Pozzuoli side opens in a district called Fuorigrotta (i.e. out of the Cave), amidst private houses, on a road called *via della Grotta vecchia* (i.e. Ancient Cave street). The Fuorigrotta entrance is about 23 m high. The Mergellina entrance floor was lowered several times in the past, until the entrance reached a height of about 25 m. In 1930 a restoration action aimed at preserving the collapsing Vergil's Tomb, raised the floor on the Mergellina side, so the entrance is now about 16.5 m high. Presently, the elevation of the Mergellina entrance is 33.8 m a.s.l., while the Fuorigrotta entrance elevation is 44.6 m a.s.l. So, the *Crypta* floor rises from Naples to Fuorigrotta.

On both sides of the main tunnel, an inclined shaft reaches the surface, providing some light inside the main tunnel.

Figure 2. Crypta neapolitana*: the middle section, with wall collapses (photo by B. Bocchino).*

Some scholars (e.g. D'Ancora 1792, p. 27) maintained that the shafts were commanded by King Alfonso I of Aragon (1442-1458), but masonry at the shaft exit on the Fuorigrotta side looks Roman. An archaeological research is needed in order to ascertain the point.

The main tunnel is straight, in a NNE-SSW direction. The width varies between 4.7 m and 12 m. The vault lowers slowly till a minimum of 2.4 m height at a 180 m distance from the Fuorigrotta entrance. The middle section height varies between 4 and 10 m.

The *Crypta neapolitana* has been operational for more than 1800 years, until the end of the 19th century, when fissurations caused boulder collapses (fig. 2). On 1893, further collapses forced the Naples Municipality to command a recovery project. About one third of the tunnel, on the Mergellina side, was reinforced with tuff masonry pointed arches, so as to look like a gothic nave (De La Ville sur-Yllon 1900). Unfortunately, such action was short-lived: on 1917 the tunnel was finally closed to public and the traffic was diverted to a nearby new tunnel, designed for a tramway line. The 19th century arches collapsed too; few of them are still in place, but they are severely damaged. However, the vault looks intact and it could reasonably belong to the original Roman design.

Several hypotheses about the collapses were discussed. Possibly, the reasons are manifold: the floor lowering on the Mergellina side, which caused an increased side wall weakness, a weaker tuff rock in the core of the Posillipo hill (Amato et al. 2002), the boring of other tunnels on the side, between 1882 and 1925, that caused vibrations and shocks and, last but not least, the discontinuity in the north wall represented by the aqueduct passage.

The underground route, dark, gloomy, dusty and filled with screams by horse and carriage drivers, struck a chord in scholars, from Seneca to Petrarch and Boccaccio, and in scores of foreigners in the course of their *Grand Tour* in Italy. Most of them left memories of their approach to Naples through the *Crypta*. Among them, in the 12th century, we can account for the Ebrew Bejamin of Tudela and Conrad of Querfurth, Chancellor of Emperors Henry VI and Frederick II. In the 14th century, a legend stated that the *Crypta* was bored in a single night by the poet Vergil, reportedly a powerful magician of the past. The King of Naples Robert of Anjou asked the poet Francesco Petrarca about his opinion on the subject. Petrarca answered that he saw no sign of magic but many chisel marks instead. On February, 27th, 1787, Goethe witnessed the sun setting at Fuorigrotta and sending a shaft of light through the whole tunnel till the Mergellina entrance: "I can pardon all who lose their senses in Naples" (Goethe 1849, p. 412). The event occurs at the end of February and at the middle of October. Unfortunately, Dumas stated that the event occurs on equinoxes (Dumas 1846, p. 232). Such a wrong statement is reported acritically by a number of esoteric books and web sites. Presently, collapses in the middle of the tunnel stop the light shaft, but the sighting of half a tunnel lighted by the setting sun is a touching event anyway.

A strong link exists between underground sites and transcendent speculation. In the *Crypta*, such link was strong even in ancient times and it survived to present. Petronius stages a cult of Priapus in the tunnel (*Satyricon*, XVI). The National Archaeological Museum in Naples holds a Mithraic bas-relief, dated to the 3rd – 4th century AD, which was found in 1455 in the *Crypta* (Amalfitano et al. 1990, p. 41). In 1548, viceroy Peter of Toledo established a shrine halfway in the *Crypta*. The shrine was consecrated to Saint Mary of the Cave. High on the wall over the shrine, faint traces of a crucifixion bas-relief can be spotted. The bas-relief was older than the shrine, since it was mentioned in 1494 (Burckardt 1884, v. 2, p. 174): "*circa medium habens crucifixum ipso monti incisum*". A hermit attended the shrine, at least from 1587 till 1880 (D'Ambrosio 2001, pp. 179-180). He lodged in a neaby *dormitorium*, dug in the *Crypta* southern wall, 50 m west of the shrine. We rediscovered the room, which was walled up in the course of the last *Crypta* restoration. The room is heavily disarrayed and contains a 37 m deep well (Giustiniani 1793, p. 77), which reached the groundwater layer, intended to provide water to the hermit.

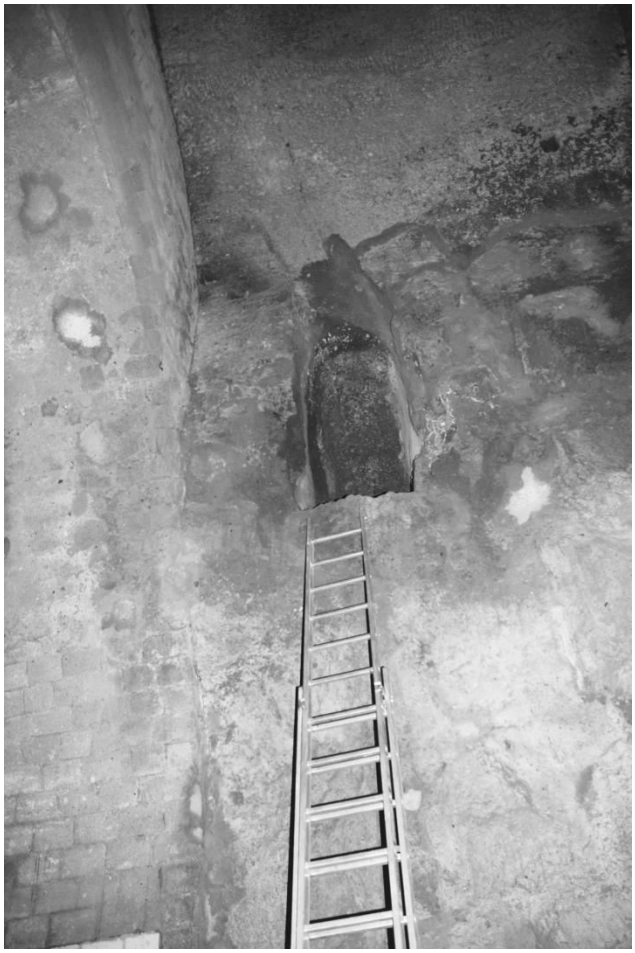


Figure 3. Crypta neapolitana*: aqueduct manhole n. 16.*

3. The aqueduct

A further important cultural feature in the *Crypta neapolitana* is the Augustean aqueduct which runs parallel to the main tunnel, few meters deep within its north wall (Amato et al. 2002, Ferrari and Lamagna 2015a, b). On the Mergellina side, four manholes open high on the *Crypta* wall (fig. 4: manholes n. 15-18). In 2012 we were able to enter through manhole n. 16 (fig. 3). We explored and surveyed a 130 m-long section of the aqueduct. The

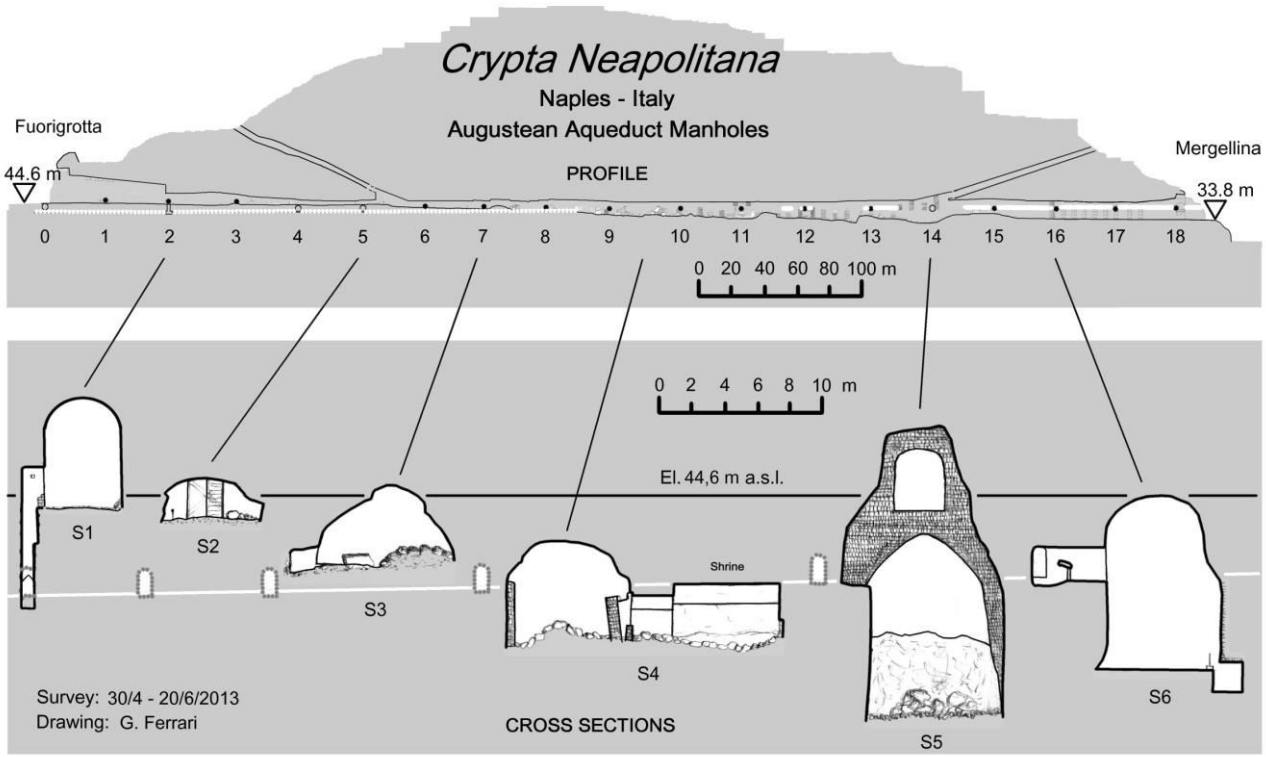


Figure 4. Crypta neapolitana*: profile and cross-sections. Explored aqueduct sections are in solid white, the inferred ones are dotted.*

channel is often partly filled with a variable thickness of fine tuff sand (mean height about 1 m), so explorers are required to crawl. The hydraulic plaster (*opus signinum*) is intact; its height reaches the vault impost. The usual limestone deposit lines the hydraulic plaster. The exploration ended where a *Crypta* wall collapse exposed the aqueduct, revealing interesting details about the building techniques. A further section of the aqueduct is visible after the wall collapse.

Later, we identified eleven more manholes, all on the north wall of the tunnel. The three most western ones (fig. 4, manholes n. 1-3) open on the Fuorigrotta side. Each of them is a recess dug in the tuff, at the floor side, 1.5 m wide and about 2 m high, without any plaster. At the bottom of the recess, a pit opens, completely filled with debris and tuff sand. The three manholes are spaced by about 40 m, that is, about 130 Roman feet. Manhole n. 2 was only partly filled, revealing a descending shaft. We dug out some rubbish and nearly three meters of rubble to reach the bottom, 6.5 m below the *Crypta* floor. A passage similar to an aqueduct specus was revealed, 0.8 m wide and 2.2 m high, but no hydraulic plaster is present. The passage roof is gabled. However, just the roof mark in the tuff is visible.

Next, a *Crypta* section follows, where the original pavement is buried under a thick alluvial layer and fallen rocks. We can figure two more manholes (fig. 4, n. 4 e 5), spaced by 130 Roman feet and presently unreachable.

In the next 300 m of the main tunnel we identified eight more manholes (fig. 4, n. 6-13), as little horizontal tunnels, usually soon filled with dirt and rocks. These tunnels too are evenly spaced by about 130 Roman feet. Manhole n. 13 and n. 15 are spaced by 261 feet, so we can infer the presence of a further manhole (n. 14). In the expected position, a thick late-19th century arch stands, that possibly covered the manhole. The last manhole (n. 18) actually opens into a large recess, 4.6 m high on the *Crypta* north wall, aside the Mergellina entrance. The recess is decorated with a much worn medieval fresco, representing some saints. At the foot of the fresco, we identified remnants of a water basin, layered with sinter. Before being converted to a shrine, the recess was a *diversorium* for an aqueduct side branch, which crossed the *Crypta* under the Roman floor, aimed at the Posillipo area.

As a summary, fifteen manholes are visible, and three more can be inferred (fig. 4). Table 1 shows the distances between the center points of the visible manholes. The mean distance is 133 Roman feet, with a minimum value of 124 feet and a maximum of nearly 150 feet.

The Grotta di Cocceio is a 920 m long Roman tunnel, unequivocally ascribed by Strabo to the architect Cocceius. This second tunnel is about 12 km apart from tha *Crypta neapolitana*, as the crow flies, and it is flanked by an aqueduct channel too. Caputo (2004) mentions seven vertical manholes in the westernmost section of the Grotta di Cocceio. They are 120 Roman feet apart, or double that distance in places where explosions of WW II ammunition caused severe damage to the tunnel floor, walls and roof. The surviving manholes are recesses in the Grotta di Cocceio north wall, opening at the floor side, 1.10 m wide, 1.78 m high and 1.24 m deep, with a rubble-filled pit at the bottom. Some manholes still show the original masonry railing, in *opus reticulatum*. There are intriguing similarities between the Grotta di Cocceio and the *Crypta neapolitana* manholes, so as to figure a single architectural design behind the tunnels and the Augustean aqueduct system. Furthermore, both tunnels rise from east

to west, while the aqueduct channels on their sides are expected to drop slightly from east to west. In the *Crypta neapolitana*, the channel floor at manhole n. 18 is at 40.5 m a.s.l. elevation, that is, 6.0 m above the *Crypta* present pavement, while the floor at the bottom of manhole n. 2 pit is at 37.5 m a.s.l. elevation, that is, 6.5 m below the main tunnel floor. However, we expect that the main course of the Augustean aqueduct left the *Crypta* side at an indeterminate point between manholes n. 6 and n. 10, to run north (Ferrari and Lamagna 2016b), at about 40 m a.s.l. elevation. The channel section at the bottom of manhole n. 2 could belong to a second side branch, aimed at Nisida.

Table 1. Crypta neapolitana: distance between manholes.

Manhole # From	Manhole # To	Distance (m)	Distance (Roman feet)
1	2	38,06	128,36
2	3	42,04	141,78
3	6	116,52 (38,84 each)	393,00 (131,00 each)
6	7	36,84	124,25
7	8	38,51	129,87
8	9	38,60	129,37
9	10	44,28	149,33
10	11	40,24	135,71
11	12	37,60	126,82
12	13	42,30	142,67
13	15	77,54 (38,77 each)	261,54 (130,77 each)
15	16	38,45	129,66
16	17	40,09	135,21
17	18	39,79	134,20
Mean		39,46	133,05

A typical aqueduct channel section is visible inside manhole n. 16 (fig. 5), 80 m apart from the Mergellina entrance of the *Crypta*. The channel width is 0.77 m and the height is 1.87 m. The section is rectangular with a vaulted roof. The channel opens in the tuff rock, without any masonry lining. The channel bed is based over a mixed rock filling, 14 cm high. The bed itself is a 4.5 cm high hydraulic plaster layer. At the corners between the bed and the sides, a quarter-round mould (radius 4 cm) is present. The hydraulic plaster covers the side walls, up to the vault impost (1.47 m). The side plaster width varies from 3 cm at the bottom to 5.5 cm at the top. The channel roof is lined with a thin layer of plain plaster. A 1 cm high sinter layer covers the channel bed. Sinter thickness at the bottom of the side wall plaster is up to 8.5 cm. Thickness decreases to zero at 1.16 m channel height.

Data about the sinter height provide information about the water flow. Taking into account the sinter deposit on the side walls, the channel cross-section can be approximated by a trapezoid with bases equal to 0.60 m at the bottom and to 0,77 at the top. A 1.16 m height means an area of about 0.7946 m^2. A relatively slow water speed of about 0.5 m/s means a maximum flow of more than 34,000 m^3/d. Such rough estimation, together with similar values in other Augustean aqueduct channels, provides information about the whole aqueduct management and water provision in the Phlegraean Fields area (Ferrari and Lamagna 2015b).

In the Mergellina side section, slight misalignments of the specus direction are evident nearly halfway between two consecutive manholes. They were the connection points between the excavation teams working in opposite directions from consecutive entrances.

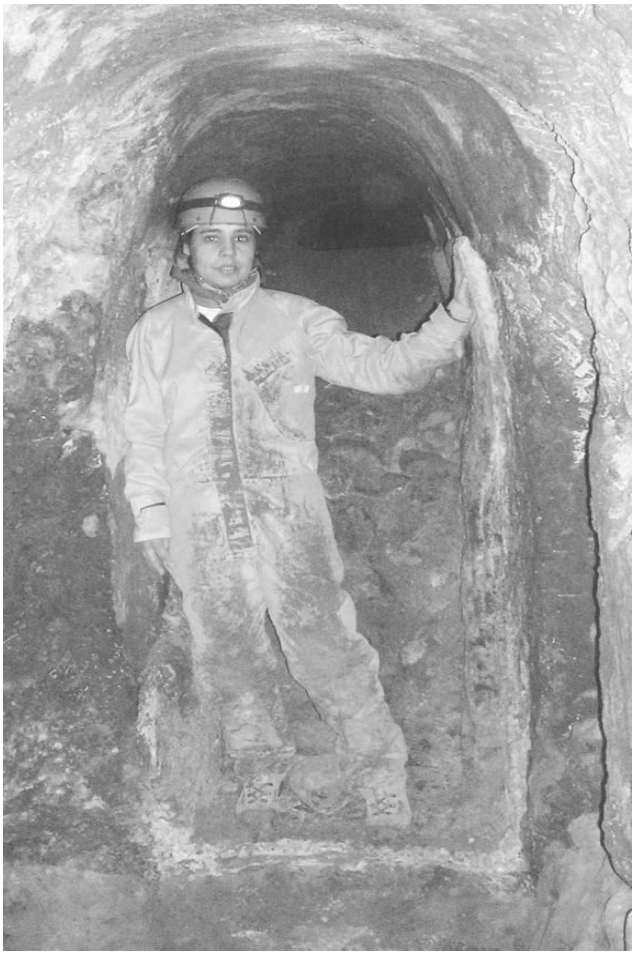


Figure 5. Crypta neapolitana: aqueduct cross-section at manhole n. 16.

4. Discussion

After one century from final dismissal, the *Crypta neapolitana* is still heavily disarrayed, as a wonderful unexploited cultural heritage. In the first decade of the 21st century, recovery actions were performed near the two entrances. Presently, just 90 m on the Fuorigrotta side and 110 m on the Mergellina side can be easily visited, but they are still not open to public. On the other hand, the middle 500 m can be negotiated only by properly trained and equipped cavers. The recovery actions did not include the Augustan Aqueduct. On the contrary, the channel was damaged by reinforcement iron bars and concrete injections. However, the surviving channel could be recovered and exploited as a cultural and touristic attractor.

Our investigations collected useful information about the *Crypta* present conditions and the several cultural and environmental values contained within. So, we can see the

cavity not only as a gloomy ancient tunnel but as a multi-disciplinary cultural heritage, full of historical layers and of scientific and cultural issues, in close relation with the surface and the surrounding city.

So we wish that the exploration, research and recovery actions could be completed and that they would care for the monument integrity and protection as a whole. A critical preliminary step is represented by an engineering and environmental monitoring plan, as dictated by International Show Caves Association *et al.* (2014). This is needed in order to avoid dangerous or short-lived actions, as it happened in the near past.

About future actions, the most promising idea is the recovery of the *Crypta* as a pedestrian and cycling route. Such project would restore the *Crypta* traditional purpose, as a protected road, far from motor exhaust emissions. The City management would restore an extremely important cultural and touristic route, similarly to the traditional Neapolitan and Phlegraean *Grand Tour* of the past.

Acknowledgments

We are grateful to the Superintendency for Cultural Heritage of Naples, especially to the Heads of the local office in Naples (Mr. Vecchio, Mr. Stanco) and their staff. Furthermore, Mr. Sirano and Ms. Casule allowed access to the Grotta di Cocceio. The Municipality of Naples, Direction for Cultural Heritage (Ms. Dello Russo, Mr. Pascapé) and the Campanian Museums Headquarter (Ms. Capobianco) allowed access to the areas they manage. The Diocesan Library and Archives in Pozzuoli (Ms. Lenci, Mr. Cutolo) provided information about the shrine and the hermits. Last but not least, we are indebted with the caving friends who shared dust, sweat and emotions with us, especially with Berardino and Rossana, who performed the levelling among the manholes and with Mauro Palumbo, who reached the Mergellina shaft.

References

Amalfitano P, Camodeca G, Medri M, 1990. I Campi Flegrei. Un itinerario archeologico. Marsilio, Venezia (in Italian).

Amato L, Evangelista A, Nicotera MV, Viggiani C, 2002. The Crypta Neapolitana; a Roman tunnel of the early imperial age. Proceedings of Archi2000: Paris, 10-12/09/2001.

Burckard J, 1884. Johannis Burchardi Argentinensis Capelle pontificie sacrorum rituum magistri diarium, sive Rerum urbanarum commentarii (1483-1506). Leroux, Paris (in Latin).

Busana MS, Basso P, 1997. Le strade in galleria nell'Italia romana. In: MS Busana (Ed.), *Via per montes excisa*: strade in galleria e passaggi sotterranei nell'Italia romana. L'Erma di Bretschneider, Roma, pp. 81-250 (in Italian).

Caputo P, 2004. La Grotta di Cocceio a Cuma: nuovi dati da ricerche e saggi di scavo. In: L Quilici, S Quilici Gigli (Eds.). Viabilità e insediamenti nell'Italia antica. L'Erma di Breitschneider, Roma, pp. 309-330 (in Italian).

Celano C, 1692. Notizie del bello e dell'antico della città di Napoli, per le signore e i forestieri. Raillard, Napoli (in Italian).

Cocchia E, 1888. La tomba di Virgilio: contributo alla topografia dell'antica città di Napoli. Archivio storico per le province napoletane, 13, 511-568, 631-744 (in Italian).

D'Ambrosio A, 2001. Eremiti nella Diocesi di Pozzuoli nei secoli XVI-XX. Campania sacra, Napoli, 32 (1-2), 173-196 (in Italian).

D'Ancora G, 1792. Gvida ragionata per le antichità e le curiosità naturali di Pozzuoli e dei luoghi circonvicini. Zambraia, Napoli (in Italian).

De La Ville sur Yllon L, 1900. La grotta di Pozzuoli. Napoli Nobilissima, 9 (2), 19-22 (in Italian).

Dumas A (père), 1846. Le corricolo. Boulé, Paris (in French).

Ferrari G, Lamagna R, 2013. The Augustean aqueduct in the Phlegraean Fields (Naples, Southern Italy). Proceedings of the 16th International Congress of Speleology, Brno, vol. 2, 200-205.

Ferrari G, Lamagna R, 2015a. Crypta neapolitana: non solo un tunnel. Trasporti e Cultura, 40, 88-93 (in Italian).

Ferrari G, Lamagna R, 2015b, Aqua Augusta Campaniae: considerazioni sulle morfologie degli spechi in area flegrea. Atti del 22° Congresso nazionale di speleologia "Condividere i dati", Pertosa-Auletta (SA), 435-440 (in Italian).

Ferrari G, Lamagna R, 2016a. L'Acquedotto Augusteo della Campania nei Campi Flegrei (Napoli). Archeologia Sotterranea, 13, 24-33 (in Italian).

Ferrari G, Lamagna R, 2016b. Aqua Augusta Campaniae: lo speco di Macrinus. Puteoli, studi di storia e archeologia dei Campi Flegrei, 1, 273-296 (in Italian).

Giustiniani L, 1793. La Biblioteca storica, e topografica del Regno di Napoli. Orsini, Napoli (in Italian).

Goethe JW, 1849. The auto-biography of Goethe. Bohn, London.

International Show Caves Association (I.S.C.A.), International Union for the Conservation of Nature (I.U.C.N.), International Union of Speleology (U.I.S.), 2014. Recommended International Guidelines For The Development And Management Of Show Caves. At: http://www.uis-speleo.org/documents/Recommended_International_Guidelines_published_version.pdf

Johannowsky W, 1953. Contributi alla topografia della Campania antica. I. La «Via Puteolis – Neapolim». Rendiconti della Accademia di Archeologia, Lettere e Belle Arti, Napoli, 27, 83-146 (in Italian).

Keenan-Jones D, 2010. The Aqua Augusta. Regional water supply in Roman and late antique Campania. Unpublished PhD dissertation, Macquarie University, Australia.

Petronius Arbiter, Fragmenta (in Latin).

Petronius Arbiter, Satyricon (in Latin).

Seneca, LA, Epistulae morales ad Lucilium (in Latin).

Strabo, Geographica (in Latin).

CAVE COMPLEX IN VALUIKI

Alexey Gunko [1], Sofia Kondrateva[2], Alexander Gunko[1]
[1] *Naberezhnye Chelny State Pedagogical University, Naberezhnye Chelny, Russia, gunko.a@mail.ru*
[2] *Natural, architectural and archaeological museum-reserve «Divnogorye», Voronezh, Russia, kosofia@yandex.ru*

Abstract

Ignatius the God-bearer's cave complex is situated to the south-west of the city Valuiki, Belgorod region, Russia. Its appearance is connected with the Valuiki Saint Nicholas Monastery of the Dormition. There is no information about first caves. Cave church was opened in 1914. In 2006 the cave complex was reconstructed. It consists of several galleries and the church, which isn't used at the present time. The length of the cave complex is 406 m. The article describes the versions of the appearance of the complex.

Keywords

Cave church, chalk, Russia.

Ignatius the God-bearer's cave complex is situated to SW of the city Valuiki, Belgorod region, Russia Its appearance is connected with the Valuiki Saint Nicholas Monastery of the Dormition, which was founded in 1613 by decree of Tsar Mikhail Fedorovich (Oleynikov, 1915–16: 188). Cave complex was created as a part of monastic hermitage situated 800 meters from the monastery on the opposite bank of the river. Oskol. The history of this hermitage is unknown. Only in documents of beginning of the XX century is information about hermitage and caves, when the cave church was opened here.

In 1914 a note "In hermitage of Valuiki monastery" written by priest I. Nabivach was published. It tells the story of the opening of the cave church on the 4 of May 1914 (Nabivach, 1914: 911–916).

In 1916 T. Oleynikov gathered materials about the general information about the size of the complex and the underground church, and also featured the date of the beginning of "new" works in the cave that verst from the monastery in chalk mountains there are caves with Ignatius the God-bearer's cave church (Verst is a Russian unit of distance equal to 1.067 km. Sagene is old Russian measure of distance equal to 2.13 m).

Who started the creation of these caves is unknown, but in 1897 some monks begun to put them in order and even expand caves.

In 1910 caves were inspected by the architect who declared that caves were safe. According to T. Oleynikov the length of caves is more than 300 sagene at a height of about 50 sagene above the water level in the river (Oleynikov, 1915–16: 201–202).

After the 1917 revolution, there was pressure on the monastery from the new local authorities. In 1924 it was closed. Probably at the same time cave hermitage was abandoned.

In 2005, at the level of the regional administration the question of the revival of the complex was raised. Since 2006 landscaping, clearing and strengthening of the cave galleries was started. Formal opening was in 2007. Wooden church was build above the cave complex (Fig.1A). The lower entrance to the cave was equipped (Fig. 1B). Caves were partly electrified.

In 2014 the complex was studied by the authors. A detailed plan of the complex on a scale of 1: 100 was done (Fig.2).

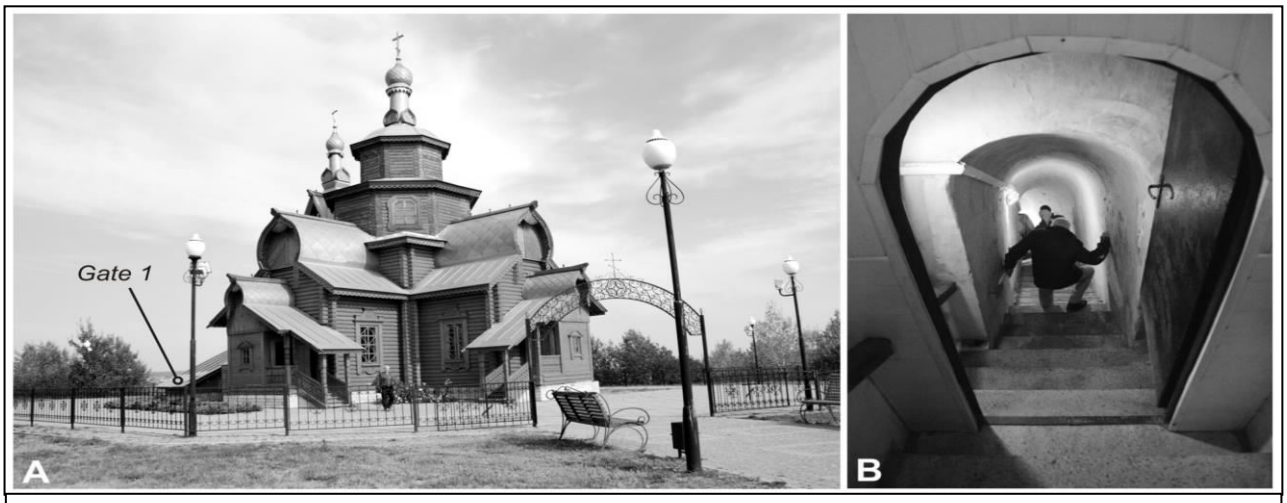


Figure 1. Land church (A) where the entrance (B) to the cave complex is.

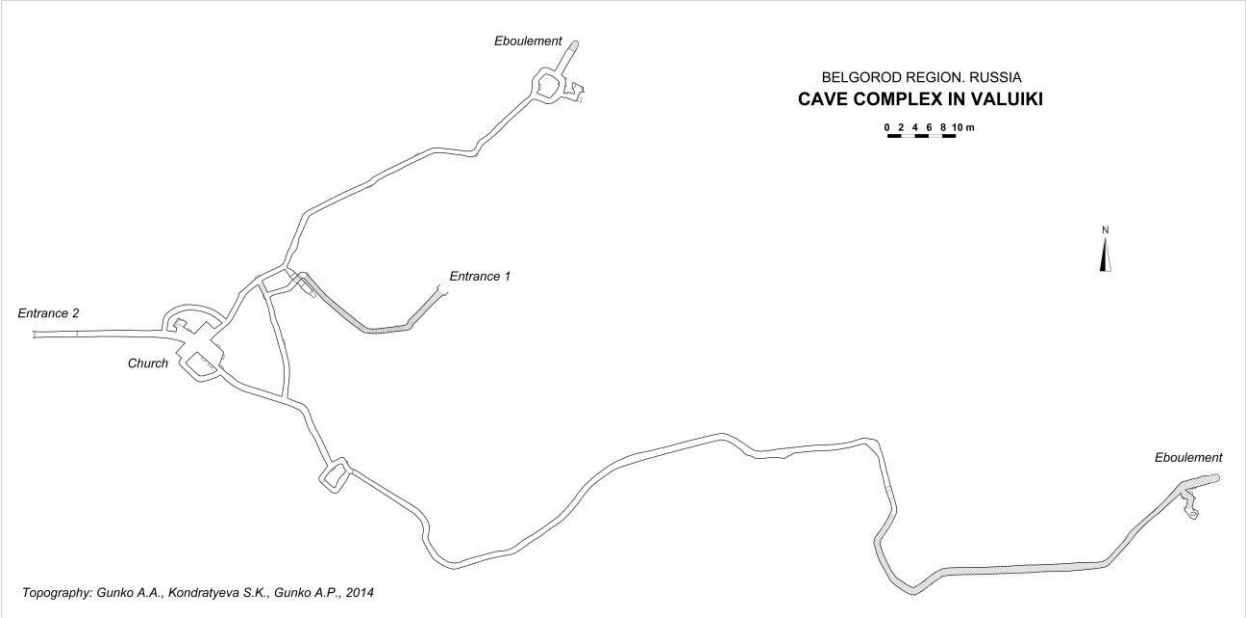


Figure 2. Plan of the cave complex in Valuiki

Current description of the complex

Cave complex is situated in chalk massif of the right bank of the river Oskol. The height difference in this area is more than 100 m. Massif is covered with deciduous forest.

The main (upper) entrance to the complex is located in the basement of a modern church Ignatius the God-bearer's. It is located 200 m SW of the river Oskol and 1 km to NW of its confluence with the river Valuy, at an altitude of approx. 130 m A.S.L. Just beyond the entrance to SW begins semi-steep gallery equipped with100 steps (Fig. 3). The average slope of the gallery is 30-40º, width 0.7-1.0 m, height 1.8-2.6 m. Gallery gradually bends, changing direction to W, and then NW. At a depth of –23 m is a small pace with icon case. Then the gallery turns SW. After 6 meters is the first T-shaped divarication. It goes to the gallery, which is the link between the large galleries that have received the conditional name of North and South. The length of linking gallery is 17.5 m. It stretches from NW to S, with a width of 0.6-0.7 m. There are 5 steps at the junction with the North gallery. Two icon cases are located in the walls of the gallery; one of them is in the west wall of T-shaped divarication, characterized by impressive size: height 1.57 m, 0.7 m wide (laid at a height of 0.35 m from the floor).

Cave church

Despite the fact that the temple is no longer used for its original purpose it is still the central room of the complex (Fig. 4). It is the place of intersection of North, South and West galleries. West gallery leads to the modern lower entrance of the complex, which is in the right side of ravine, bounding the complex from west. Its length is 20 m, width – 0.8 m, height is from 1.8 to 2.4 m (near the entrance). When you walk along the West gallery in E direction from the entrance and passing through two doors, you can go directly into the nave of the church. Temple is cross-shaped, asymmetrical and it is oriented SE (Fig.5). Near the entrance a width of naos is 2 m. From NW side is a small room with cut out chalk bench. Apparently, the room was used as a choir. The height of the naos reaches 2.7 m. It crosses the high transept, 2.0-2.2 m wide, 6 m long. The height of the transept is from 3 to 3.3 m. A spherical dome is located at the intersection. The height of the transept with the dome is 4.7 m. From NE wing of the transept begins large North Gallery and from SW is a small gallery-pass 8 m length, which connects with the South gallery. The former altar part of the church begins to SE of the transept with 2.5 m wide passage. During the functioning of the church iconostasis was installed here (Fig. 6).

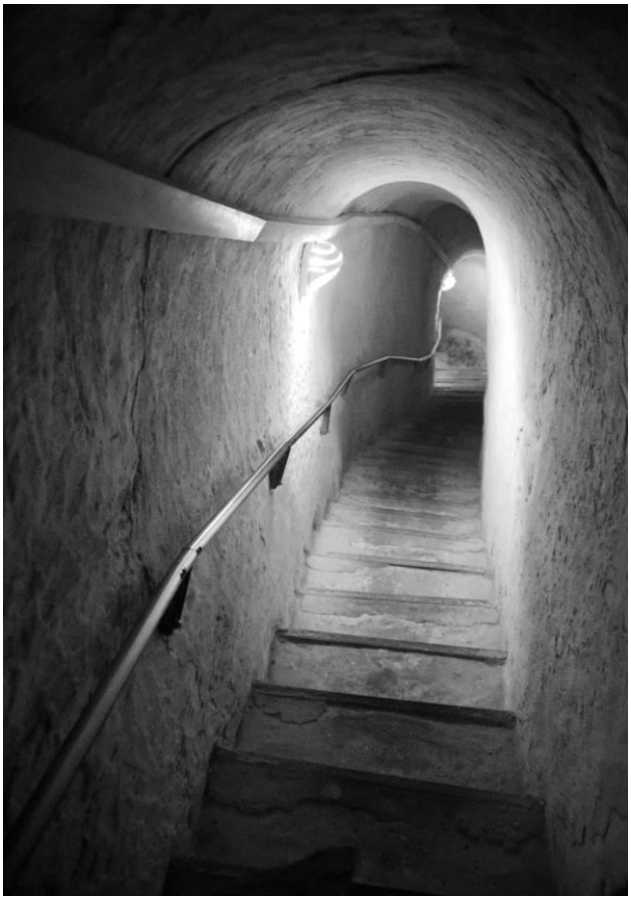


Figure 3. Semi-steep gallery

Figure 4. Modern view of the former church: A – view on the naos of the church; B – alter part; C – SW part

Before the modern reconstruction small passage extended from the altar part to NE wing of the transept. It is obvious that the entrance to it played the role of the Northern Gate and small bending pillar – the role of the supporting column. Currently, the passage is walled up. The height of the altar part is 2.5-2.8 m, length - 3.5 m. Two icon cases depth of 0.4 m are on the right side in the wall at a height of 0.8 m. They were here before reconstruction, but now they are modernized. Alter apse has wrong "angular shape". Here begins South gallery. Icon case in the east wall of apse apparently is in place of Prothesis

North gallery

From NE wing of the transept across the pass width of 0.8 m is the North Gallery. In 1.5 m in NW direction a small gallery branches off. It bends the church from the north and connects with the West gallery. From this branch Northern gallery slightly bent and in 8 m leads to the next branch – connecting gallery which is described above. Opposite its steps in the left wall cut out icon case width of 0.6 m and 1 m in height. After another 4 m in the right wall a narrow passage 0.45 m wide is. It is followed by pass length of about 6 m, ending by eboulement. Its arch is near sloping gallery from the surface. Brickwork which bonds them is visible. Pass is tooled roughly and has an unfinished appearance. Further gallery, making small bends, stretches in NE direction. Width of the gallery is 0.7-0.8 m; height is from 1.9 to 3.0 m.

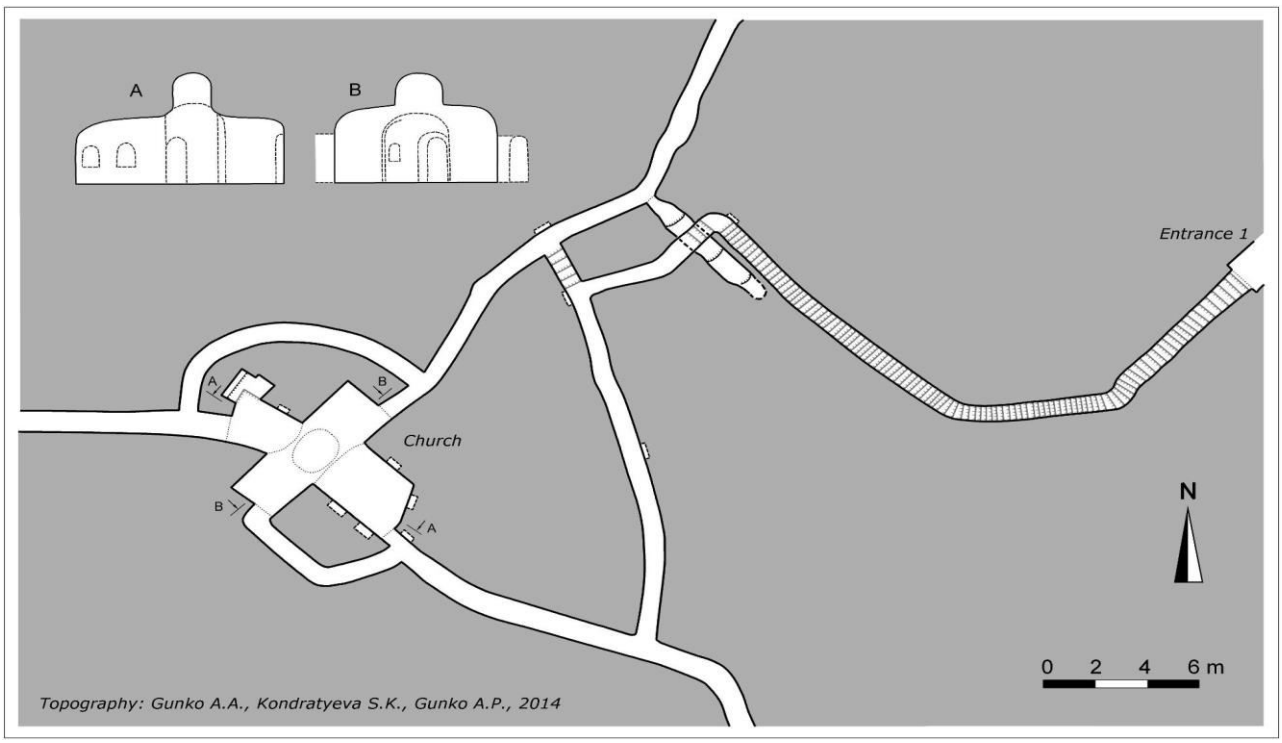


Figure 5. The central part of the complex with the section drawings of the cave church

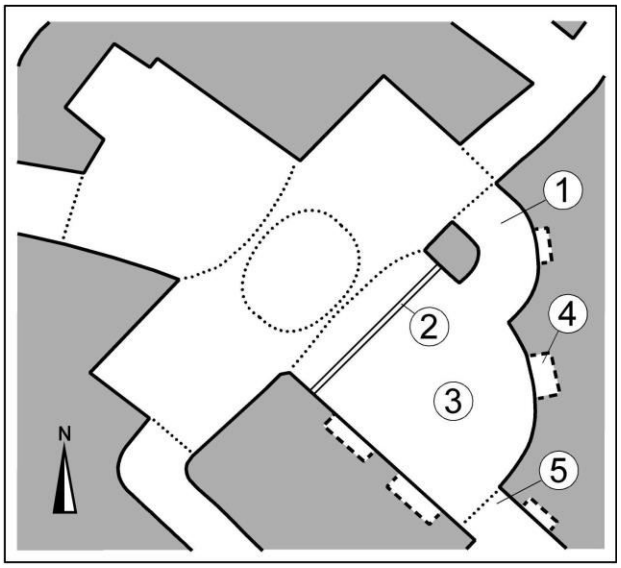


Figure 6. Configuration of cave church before modern restoration. Indicated: 1 – North entrance to the alter part; 2 – location of the iconostasis; 3 – suppositional place of the throne of in the altar part; 4 – niche- prothesis; 5 – passage from the alter part to the South gallery

In 62 m from the church is a fork where the gallery forms a "ring". There is an icon case and several small alcoves in the walls. Two branches go from this "ring". To NE stretches a short 5m gallery, ending by eboulement. To the east of the "ring" is a passage 0.4 m wide, which leads to a small curved chamber. According to its size, configuration, icon cases and the protrusions, this chamber could be used for solitary prayer.

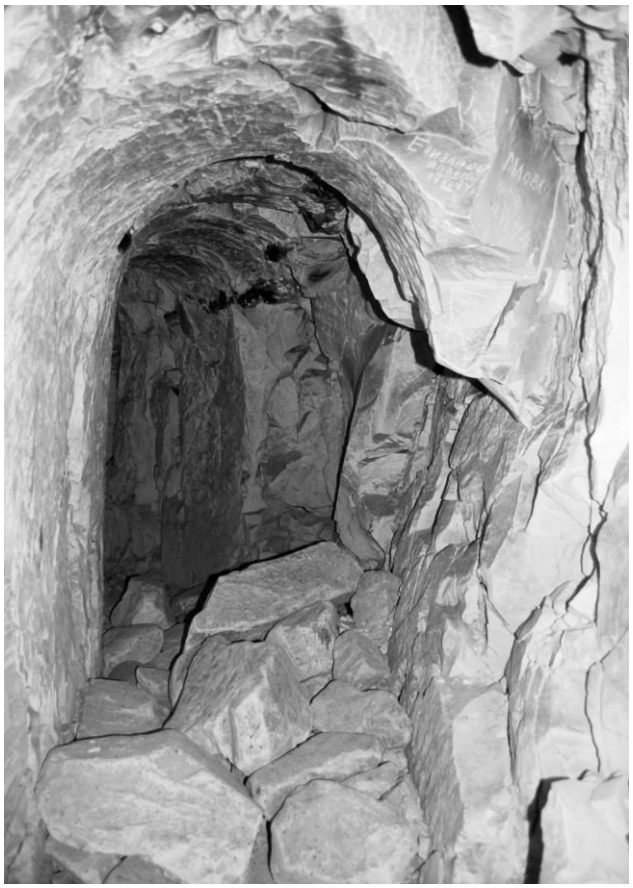


Figure 7. South gallery

South gallery extends from the alter apse in SE direction. After 11 m to N there is a branch to connecting gallery, which is already described. South gallery is stretching to S and after 13 m forms trapezoidal-shaped "ring". In the place of connection with the main gallery on the inside wall of "ring" icon case height of 1.4 m and a width of 0.68 m is made. In the eastern corner of the "ring" is a passage in the far part of the South gallery, which is not reconstructed. This part is separated with armature door. After it there is a gallery width 0.8-0.9 m extending to SE. Floor gradually decreases; the height of the ceiling is 1.8-1.9 m. After 15 m it bends sharply to S, then E, and for more than 45 m stretches in NE direction. Gallery width ranges from 0.6 to 1.4 m, height – from 1.6 to 1.85 m, the slope of the gallery is -5-7º (Fig. 7). By making a slight bend, gallery directs to E, where it reaches the expansion of 1.5 m and a fast turn to S. Floor here has heavy gradient and is equipped with 4 dilapidated steps. Arch height is 2.4 m. Then the gallery is reduced, presenting a short manhole with height of only about 0.6 m. On this part it turns first to SW, then S and SE. There are a lot of piecemeal stopings. After 30 m gallery turns to NE, and after another 15 m reaches a fork - the deepest part of the cave on the depth -42 m from the upper entrance of the complex. It extends for 5 m to NE and ends with impassable eboulement. Bent branch length 6 m extends to SE. Its width is 0.6-1.1 m, height up to 1.8 m. Two icon cases and shelf width 0.25 m are cut on the left wall. On the right wall is an icon case and small niche. Deepening in the floor can be treasure-hunter's pit. South gallery could have been constructed from the side of church. "Ring" in the beginning, as well as the "ring" in the North Gallery, likely was has a technological nature and has been used to accelerate the process of taking out the chalk using handcart during simultaneous work of several people. Since the width of the gallery does not allow passing together, there should be a "pocket" or such "ring" so that person from the surface could let pass another one from the cave.

Discussion and Conclusions

The total length of the cave complex is 406 m. In 2015 the authors inspected of the slopes around the complex. In the middle part of the northern slope at a distance of approx. 50 m to NE from the modern church (direction of the North gallery) several heaps and face of rock is clearly visible. It is obvious that in this part of the slope the entrance in the northern part is located. Now it is unknown if the face of rock is connected with the entrance or the entrance was downslope. About 20-30 m of gallery is unavailable. 130 m to the SE of the church in the left of part of the deep ravine landslide area is found. It is surrounded by heaps of chalk chips and crumbs. Heaps were formed during the process of removal the chalk to the surface at the period of construction of cave complex. They show the place of the former entrance to the South gallery of the complex. Investigated part is not farther than 15-20 m from this place.

Time of appearance of caves is unknown. On the basis of brief materials of the beginning of XX century some later stages of development of the complex could be identified.

Priest Nabivach left the description of the cave monastery. He pointed out that work was started a few years before 1910 (Nabivach, 1914). First monastery workers started the pass near the hermitage cell. It is divided into two: one of which was “along above the river”, and another was dug upward, “rising to one hundred and twenty steps” (Nabivach, 1914). So the author outlined two galleries - steeply inclined with steps, and the second, in our opinion, is more likely North gallery.

Construction of the gallery with steps was probably the final stage and the attempt to connect the future Transfiguration Church with an underground church. In near the upper entrance was only the chapel. This gallery should be build from the top point with the removal of the chalk to the surface. Work from the bottom with this kind of slope would be virtually impossible. Rising pass toward it was dug from North gallery. Apparently, its purpose was to intercept the downward gallery and direct it in the right way. Perhaps he was done at random, when the workers could distinguish the sounds of construction work. On the depth of – 23-24 m, pass and gallery intercrossed. Place of intersection was very inconvenient. There was a hole in the floor. Traces of its strengthening and backfill we see today in the top of the rising pass.

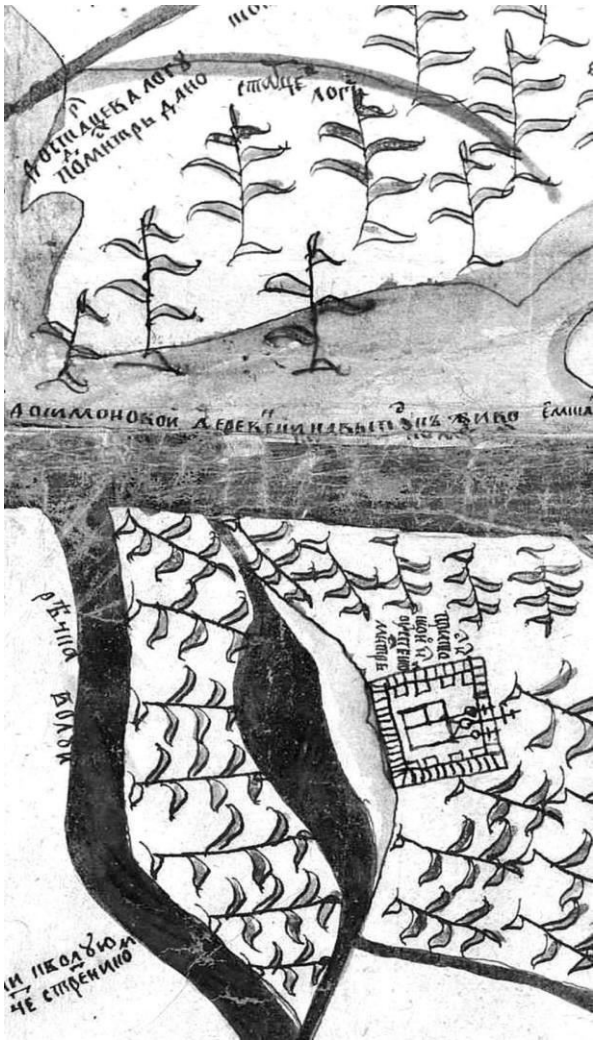


Figure 8. Fragment of drawing of land around the city Valuiki in 1687

Workers had the opportunity to orient future work and construct the gallery to SW. The latter stages of the work are likely bypassing gallery around the underground church. In conjunction with the gallery, connecting the North and South galleries, bypassing galleries are a kind of "circular" route which allows making a procession without surfacing.

What was the purpose of constructing the North gallery shortly before 1914? Its end was at the north slope of massif in relative proximity to the main (at previous time) entrance to the complex. Perhaps it could be used for the monastic brotherhood who came to the religious service on holidays, when the church was also visited by ordinary people. Purpose of the South gallery is not clear. It cut the entire massif through, and came out in a remote ravine about 200 m E from the main entrance. It is difficult to imagine that such a long gallery, which in addition to high labor costs, in terms of morphology makes great bends, could be established only for regular communication between two points. It is hard to escape a conclusion that the gallery has been made to ensure that at the difficult moment it was possible to leave the cave (or an object on the surface) and escape through the other way out-of-sight.

According to the early cartographic sources in 1687 area of this hermitage belonged to monastery (Fig.8) (Drawing.., 1687). The figure shows Starets (elders) ravine here. Starets in Eastern Orthodoxy is a monastic spiritual leader, one who had already achieved a real experience of the future kingdom of God. It is possible that in the first decades of the existence of the monastery here was a hermitage where some “starlets” lived intermittently or continually and this fact gave the name to this place. It is known that in 1634 the monastery was ravaged and burned by Lithuanians and Cherkas, and all the property was completely robbed (Portfolio.., 1890). Perhaps these tragic events became the reason for creation of cave as a hiding place. It was relevant for the monastery since Valuiki city has been a Russian outpost outside the fortified Belgorod defence line (Zagorovsky, 1969: 63). The cave, located in the forest apart from the monastery, in the case of danger could become a place for safekeeping of church property. But where could they be stored? There are few rooms in this complex. If it was used for household purpose of monastery, then, in addition to the galleries, there had to be useful space. It is likely that during reconstruction of the caves in the early twentieth century some rooms we rebuilt and became part of church. This fact could explain the presence of the passage in alter apse, in which there was no need in normal circumstances. In case of real danger they could ruin or block the entrance to the cave from the inside and then quietly come to the surface on the opposite side of the hill. In this context the small room at the eastern end of the South gallery is interesting. Morphometric it is more like a short dead-end gallery. Shelf and niches carved out on a limited area show that this room was playing a major role. Another feature of it is seeming incompleteness, rough cutting of the walls with visible notches of tool. Perhaps this space could be used as a box room. Later, during the reconstruction, the need in the South gallery has disappeared, and it was not used. The

lack of information about the caves until the end of the XIX century can be explained the fact that their existence has been hidden deliberately.

Also the version that the South gallery was excavated during the renovation of the 1897-1914 should be analyzed. Pass “along above the river” in the story of the priest Nabivach could be South gallery, because it also extends subparallel to the river Oskol despite considerable bending. Then the North gallery could be cut down later, after the official opening of the complex. Available volumes of caves before reconstruction did not go far beyond the cave church. Perhaps, monastery hermitage, which was near the entrance to the caves, was supposed to move into the next ravine, connecting it with the temple by an underground passage.

With great regret should be stated that the reconstruction of 2006-2007 was so significant that led to some changes in plan of the cave church. Strengthening works, the need for which was quite objective (to ensure security for the pilgrimage tourism), changed the texture of the walls and floor, the location and shape of a number of icon cases. Destruction of small architectural details made impossible to continue the study and analysis of the space of the Former cave church. Nevertheless, the cave complex Ignatius of Antioch is a unique underground construction with large scientific potential.

References

Portfolio of humble petitions of starets Gelasius with monastic brotherhood about renewal Valuiki Saint Nicholas Monastery of the Dormition. and starets Cyril about renewal Voluiki Pristanskaya Nikolsky monastery, devastated by the Lithuanian and Cherkas, 1890. Acts of the Moscow government issued by the Imperial Academy of Sciences. Volume I. Order-in-charge prikaz. Moscow area. 1571-1634. Saint-Petersburg (in Russian).

Zagorovsky V.P., 1969. Belgorod defence line. Voronezh: Publishing Voronezh State University (in Russian).

Nabivach I., 1914. In hermitage of Valuiki monastery. Voronezh diocesan journal, № 34 (in Russian).

Oleynikov T.M., 1915–1916. Documents about the history of Valuiki Saint Nicholas Monastery of the Dormition. Voronezh antiquity. Vol. 14. Voronezh: Church Historical and Archaeological Committee, pp.186–262 (in Russian).

Drawing of land around the city Valuiki behind the river Oskol in Valuiki district, 1687 Russian State Archive of Ancient Documents (RGADA) F.1209, inventory 77, portfolio 34699, p.161 (in Russian).

CREATION OF NEW MAP DOCUMENTATION OF THE ROCK CLOISTERS ON THE PERIPHERY OF SHUMEN PLATEAU 2012 - 2019

Konstantin Stoichkov
Caving Club" Helictite", Kiril I Metodii,42 , 1000 Sofia , Bulgaria, danailspeleo@abv.bg

In memory of Danail Nakev: 1950 – 2017

Abstract

Shumen Plateau is a plateau in northeastern Bulgaria, the eastern Danube plain, Shumen region. On the periphery of the Shumen Plateau there are many rock monasteries, churches, cellars, burial chambers, underground quarries as well as natural caves, in the "soft" vertical rock wreaths. A large number of them are carved in natural caves and niches, but also fully artificial carvings are discovered. Early evidence of the hermitage of skittles dates back to 1640 when Archbishop Peter Bogdan Bakshev visits the area and tells of a hermitage monument carved into the rock north of the town (Shumen) in the mountain. The first explorer of the rock monasteries in question was Karel Shkorpil (1859-1944), who described and made detailed sketches of most of them. After him, StoyanMaslev - 1963, as well as other historians, studied the rock monasteries on the Shumen Plateau, TsvetankaDremsizova and Vera Antonova. The first more detailed maps were made by BozhanMarinov, At. Spasov, Radush Radushev, St. Dimitrov, Zdravko Iliev, Margarita Mircheva and others. The idea to pay more attention to the rocks at the periphery of the plateau and especially in the southern periphery of the village of Khan Krum raised in 2012. Surveys have been carried out in the area of Kaluger Boaz - village of Khan Krum, Troyski Boaz, Troitsa, Osmarski Boaz, Osmar, valley of the river Strazka, Lozevo, Shumen Boaz, Shumen and the Star Fort "- Shumen. During these expeditions 25 rock cut churches, monasteries, natural caves , underground quarry and water stand were mapped and remapped using some modern cave surveying methods.

Keywords

Cave church, cave monastery, cells, Shumen, Bulgaria

1. Location and Relief

The Shumen plateau is located in north-east Bulgaria, East Danube Plain, Shumen region. Its name originates from the town of Shumen, located in the eastern foothills. It is a remnant of a structural-denudation surface and is made of inferior mergel sedimentary rocks, sandstone and limestone. The northern slopes are ramp, but the others are steep with rock wreaths. The area is abundant with above and underground karst forms. On the periphery of the plateau, in the "soft", sheer rocks, lay a multitude of rock monasteries, churches, cellars, burial chambers, underground quarries. Many of them are carved inside natural caves and niches. Most of them originate during the spread of the hesychasm religious teaching on these lands in the 12 – 15th centuries and the formation of significant monastic colonies. Almost everywhere around the explored sites, there are traces of rock art. For the most part the rock monuments have no preserved frescoes, but in most of them there are many runic signs, petroglyphs, Christian symbols and inscriptions, symbols and carvings of unknown significance. A number of carvings of a domestic, religious and economic character have also been found in the vicinity of the sites. Such traces in some of the caves indicate that they were used for rearing livestock. There are also completely artificial carved caves - quarries. Some of these carvings were designed for cells that were probably covered with wooden structures. There also can be found baptismal chambers, burial chambers and beds, and grooved chasms and rainwater collection tanks. The famous artificial rocks in the area of the plateau are revealed in the following locations: Shumenski Boaz, Zwezdno Ukreplenie(Star Fort), Divdyadovski Boaz, Kaluger Boaz, Troyshki Boaz, Osmarski Boaz and in the valley of the river Strajka. The above mentioned places are situated to the north - northeast of the city of Shumen and the village of Lozevo, and to the south - southeast of the village of Divdyadovo, Khan Krum village, Troitza village and the village of Osmar. It is possible, unexplored sites to be found around the lands of Kochevo, Cherencha, Novosel, Sredna and Gradishte villages.

2. Surveys History

Early evidence of hermitage cells dates back to 1640 when Archbishop Peter Bogdan Bakshev visits the area and tells of a hermitage monument carved into the rock north of the town (Shumen) in the mountain. The first explorer of the rock monasteries in question was Karel Shkorpil (1859 - 1944) who described and made detailed sketches of a large portion of them. (Fig.1). After him, Stoyan Maslev - 1963, as well as other historians, studied the rock monasteries on the Shumen Plateau, Tsvetanka Dremsizova and Vera Antonova.

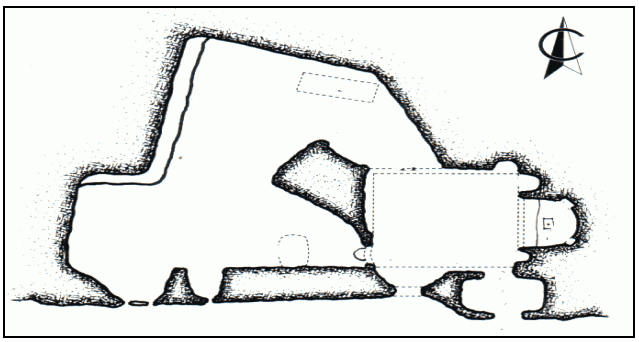


Figure1. Map of Kostadinov monastery ater K.Shkorpil (1905)

3. Contemporary Research

The first, more detailed maps were made by Bozhan Marinov, At. Spasov, Radush Radushev, St. Dimitrov, Zdravko Iliev, Margarita Mircheva and a number of other cavers in the period ... Later in the period 2012 - 2015. have been organised several expeditions. In the beginning, the cavers of Speleo Club(SC) "Hades"- Shumen, organized and carry several National expeditions, which include people from the clubs: SC "Hades" Shumen, SC "Helictit" Sofia, SC "Strinava" Dryanovo, SC "Iskar" Sofia and SC "Zmeeva dupka" Tryavna. During those expeditions, was emphasized more on the natural caves and chafts and less on the rock cloisters. After couple of years of silence, there was an idea to pay more attention to these artificial cavities, located mainly in the periphery of the plateau and especially in the southern part near the village of Khan Krum. An idea about the format of the expeditions was proposed by Ivo Tachev - SC "Iskar" (he is included in the second stage of the study). In the preparatory stage of the survey, the available information, old and current maps and descriptions of the sites were collected. Zdravko Iliev, SC "Helictit" and Head of the Main Cave File of Bulgarian federation of speleology (BFS), provides copies of the sketches made by Karel Shkorpil and comprehensive books with descriptions and access information of the sites. The main organizer of the following events is Margarita Mircheva from SC "Hades" - Shumen, supported by Danail Nakev, who provides logistical support on the spot and finds local guides with information on uncharted caves and rock cells. Surveys have been carried out in the area of Kaluger Boaz - village of Khan Krum, Troyski Boaz, Troitsa, Osmarski Boaz, Osmar, valley of the river Strajka, Lozevo, Shumen Boaz – Shumen and "Zwezdnoto Ukreplenie" - Shumen.

4. New guidelines

The exploration and study of caves and shafts in Bulgaria is carried out mainly by cavers and less often by scientists, especially during the period between late 1980s and first decade of the twenty first century. From this period, in the Main Cave File of Bulgaria are registered less and less maps of artificial underground sites. One big reason is the fact that some of these sites are of negligible size and that they can not be define as caves. However, when compared, it was found that there were artificial workings recorded as natural caves.

A new impetus in the purposeful mapping and compilation of full mapping documentation of the rock cloisters, spring the interest to several cavers in the country to explore and map the artificial underground sites and in particular the rock monasteries. The speleology as a direction for exploration of artificial and abandoned underground sites gives the cave researchers the freedom to explore and map small scale underground sites of cultural, historical, religious, economical and scientific significance.

The introduction and application of modern and electronic mapping methods greatly facilitates the documenting process of the underground architecture carved in a rock. The basis for new research is the elaboration of more detailed plans of the studied and already known rock churches, cells, underground quarries and natural caves. All the carvings are placed on the maps. They are clarified with inscriptions, conditional signs and photos. Conditional signs are borrowed from the mapping of natural caves. The more complex nature of mapping, because of the many details, leaves constant questions for development, and one of the next stages will be to make 3D visualizations of the sites.

The contemporary expeditions are of a research nature - and are mainly aimed at capturing and mapping the rock cloisters. They do not or rarely involve archaeologists, historians and geologists.

Modern map documentation was made as follows:

8 rock churches and monasteries: Khan Krumovski – Khan Krum, Kiliyata(The Cell) – Khan Krum, Kostadinov – Osmar, Troishki – Troitza, Momina Skala 4 - Troitza, Direcliyta – Osmar, Aleksandrovski - Shumen, Rock Church at Zwezdnoto Ukreplenie - Shumen.

9 rock cells: Podkovata(Horseshoe) - Osmar, Momina Skala 1 - Troitza, Momina Skala 2 - Troitza, Momina Skala 3 -Troitza, Cell-observatory - Osmar, Cell-Tomb - Lozevo, Kiliya 1 – Hisarlaka - Shumen, Kiliya 2 - Hisarlaka - Shumen, Prohodna Kiliya - Zvezdnoto Ukreplenie - Shumen.

4 natural caves with carved inscriptions and images (symbols): Tokmak Hasan Maara - Khan Krum, Osmarskata Maara - Osmar, Suhata peshtera(The Dry cave) with drawings - Osmar, Peshterata v Hisarlaka - Shumen.

2 natural caves: Cepkata(The crack) - Khan Krum and Malkata Osmarska - Osmar.

1 underground quarry - Artificial Cave:Quarry of Tsar Simeon - Lozevo.

1 water stand: Stenata(The Wall) v Hisarlaka - Shumen.

After the field surveys and measurements, a new, complete mapping documentation with the described and deprecated GPS coordinates of the investigated sites was made. Map processing was carried out by Konstantin Stoichkov, SC "Helictit" Sofia. Desislava Yordanova - SC "Hades" Shumen and Ventsislav Panev - SC "Strinava" Dryanovo took participation in two of the expeditions. They also carry independent research in the area. Their documented sites are not subject of this report.

There is no information on the names of most of the studied rock quarters. Some of these are known by the name of the Monastery or the Cell they belong to. All of them also have Turkish names. Often the names directly correspond to the locations they are in, others are given by their researchers.

5. Resuls - maps and descriptions of some of the most important rock quarters of the Shumen Plateau:.

5.1. **Kostadinov Rock Monastery – Osmar; Osmarski Boaz. (Monastery Valley)** (Figs. 1, 2)

Length (30.4 m), displacement (+ 1 m).
The rock monastery is located in the Osmar Boaz, 2.5 km

north of the village of Osmar in the rocks of Kostadinov's gorge. The monastery entrance is located around 10 - 12 meters above the base of the rock. An iron ladder leads to it. The entrance is rectangular and is facing south. It is a vast rocky abbey with many spacious rooms, cells, apses, rock benches, grave beds, carved walls and windows. There are remnants of frescoes. It is believed that the monastery bears the name of Constantine the "King and master of all Bulgarians", who ruled during the Second Bulgarian Kingdom, when the city of Great Preslav was an important spiritual center. Information about the Kostadinov Rock Monastery is given by Czech explorer Karel Shkorpil (Shkorpil, 1905).

Fugure 1. Actual map of Kostadinov monastery

Figure 2. Inside the Kostadinov monastery

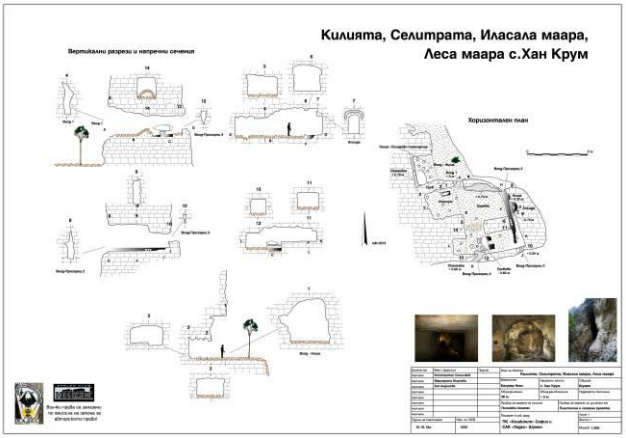
5.2 Kiliyata/The Cell (Selitrata, Ilasala Maara, Lesa Maara) - Khan Krum; Kaluger Boaz (Adgemoglu rock). (Fig.3)

Length (38.0 m), displacement (+ 5 m).

Kiliyata Rock Monastery is located north of Khan Krum village in the Kaluger Boaz area. The entrance is 4 meters high. There is an original and interesting interior architecture. In the middle there is a dense rock mass with smooth walls, resembling a column, that conditionally divides the interior space into several compartments. There is specific three-section church in the northern part. The altar of the church includes a semi-circular apse with a relief-shaped arched upper part. Information on "Kiliyata" is given by Czech explorer Karel Shkorpil. He is the first explorer of the rock monasteries and churches in Bulgaria, including those on the Shumen Plateau.

5.3 Suhata Peshtera s risunkite/The Dry Cave with the drawings - Osmar village; Osmarski Boaz.

Length (17.5 m), displacement (+ 6 m).
The cave is located in the Osmar Boaz, 2.5 km north of the village of Osmar in the rocks of Kostadinov's gorge. The entrance of the cave is of irregular shape and size; 4.50 meters wide and 3.40 meters high. It has a southeast exposure. To reach it, it has to be overcome a rock threshold of 1.40 meters high. There are dozens of stylized images of animals and people on the walls and arch of the antechamber. There are also modern inscriptions. The cave has long been known to the locals. Surveyed and mapped by K. Stoichkov, SC "Helictit" Sofia.



Fugure 3. The map of Kiliyata cell

5.4 Rock Church Momina Skala 4 - village of Troitza; Momina Skala. (Fig.4)

Length (20.0 m), displacement (- 3.80 m).

The rock cells are located in the northern part of the Troitza Boaz. The locals call this part - Mamil Bair(hill). On the steep slope of the hill stands a lonely rock with carved cells. This rock tower is called Momina Skala or (Dikilitash, Mamil tash). It is 15 meters high and clearly shows four cells. They are located almost on the top of the rock tower. The cells point south and west respectively. The inner space of the church is quite spacious, with a complex shapes. The elements are well-shaped according to the basic ecclesiastical architecture. Earliest information about the rock complex Momina Skala has been given by Karel Shkorpil. The modern map was made by Ts. Ostromski and K. Mastikov from SC "Iskar" Sofia, with the technical support of G. Lekov and B. Dinov from the same club.

Figure 4. Rock Church Momina Skala 4

References

Angelova D, Stefanov, P., Benderev. A, 1999 Rock Monasteries on the Shumen Plateau. National Park Directorate "Shumen Plateau". Shumen, Bulgaria

Neotectonics and Geodynamic Development of the Shumen Plateau - Collection of summaries from the Jubilee Scientific Conference "50 Years of Systemic and Condensed Geological Charging" Bulgaria -25-26.1999, Sofia, 5-7.

Yolchechev, H. 1989. Stratigraphy of the epicontinental type of upper chalk, Bulgaria. Ed. SofUni. "St. Kl. Ohridski", Sofia

Mircheva , Iliev, Z. Iliev - 40 years cave club in Shumen. 1961-2001, Shumen, Bulgaria

Mircheva , Iliev, Z. Iliev , Stoichkov, K, 2013, Rock Hermits of Shumen, Book 1, Shumen, Bulgaria

Mircheva , M, Stoichkov, K. ,2014, Rock Hermits of Shumen, book 2, Shumen, Bulgaria

VIA CRUCIS IN THE CAVES OF DIVNOGORSKY MONASTERY IN VORONEZH REGION, RUSSIA

Vitaly Stepkin
Pavlovsk Secondary School with Enhanced Coverage of Certain Subjects , 15, Prospekt Revolyutsii, Pavlovsk, Voronezh region, Russia, speluncae@gmail.com

Abstract

The objective of the provided research is to reveal the meaning of the cave tunnel architectural elements in the Dormition Divnogorsky Monastery at the Middle Don. We hypothesize upon the objective fulfillment on a symbolic reflection here of Via Crucis (Via Dolorosa), a street in Jerusalem being a symbolic reflection of Jesus Christ's way to his crucifixion. Herewith we address the following issues: 1) clarification of the monument historical background; 2) written sources analysis: pilgrimage to Holy Land description and application of the findings to the architectural elements of caves in Divnogorye. The second task solvation allows opening a new methodological aspect to understand the intended purpose for the numerous underground passages and spaces of ancient cult caves in Russian Plain. The Dormition Divnogorsky Monastery is located in the area of Tikhaya Sosna inflow into Don. It traces its roots to the middle of XVII century. It was a result of secular and monastery settlement in the south border of Moscow State by Orthodox Christians native of Western Ukraine. The monks arrived to the new community brought a European tradition of Via Crucis construction. The tradition dates back to XIV century and in XVII century it became widespread in European countries. Initially the Via Crucis had seven symbolic architectural stations, which reflected significant events of the latter day of Jesus Christ's earthly life. The same principle can be seen in the caves of The Divnogorsky Monastery. The first station is outlined by a chapel, it is Pilate's Trial. This very station starts the Via Crucis in Jerusalem. The stations from two to five are outlined by turns of the underground tunnel, which make a form of a cross on the plan emphasizing the plentitude of suffering on the cross. The second station is the place where Christ met His Blessed Mother. The third station is the place where Christ met Simon of Cyrene. The fourth station is the place where Christ spoke to the women of Jerusalem. The fifth station is the place where the soldiers cast lots for Jesus Christ's garment. The stations identification was made in accordance with the early European tradition based on the Gospels. The sixths station is Golgotha. Its symbolism can be easily recognized due to the steps leading up and down in the cave tunnel. Besides, the number of the steps is equal to the Church of Resurrection in Jerusalem described by Russian pilgrims Vasiliy Poznyakov and Trifon Korobeynikov in XVI century. The seventh station is the Edicule of the Holy Sepulture. It is clearly symbolized by its hexagonal shape and sepulture carved out in the chalk. The sepulture is positioned in accordance with the present tradition. The Via Crucis explained hereby is unique and non-typical for Russia, which is strengthened by its underground position. A very important task now is its preservation and further study due to its earlier dating.

Keywords

Divnogorye; pilgrimage to Holy Land; New Jerusalem; Via Crucis; caves.

1. Introduction

Among more than fifty caves of the river Don region is a rocky cave complex in the area of Malye Divy in Liskinsky district of Voronezh region, which is a real perl (Stepkin 2008; Stepkin 2015). By now, the history of its study covers about two and a half centuries. However, there has been no detailed study of the roundabout gallery, carved in chalk rock around the cave temple, for its semantic load. This work aims to neutralize this gap, revealing the issue of symbolic repetition of the sacred topography of Jerusalem in this place.

According to the well-known today documentary evidence the Dormition Divnogorsky Monastery is the most ancient monastery in the Don region founded before the middle of XVII century. At present, the total length of its underground mazes is 351 m (Gun'ko 2013) (Fig. 1).

Their structure contains cells, communication moves, the temple and a roundabout gallery around it. Examining the symbolism of the latter, we consider the hypothesis of a symbolic reflection here of Via Crucis – the Way of the Cross of Jesus Christ.

When solving the problem of semantics of Via Crucis in Malye Divy, it is necessary to take a journey into historical and cultural canvas of the Jerusalem prototype, following the tradition of its transfer onto European soil. The Sacred center of Christianity is the complex of the Church of the Holy Sepulchre in Jerusalem. Pilgrims who visit these places eager to pass along the Via Crucis procession, reflecting Christ's way to his crucifixion. Tourist guidebooks refer to Via Dolorosa. Via Dolorosa is only an image of Savior's way with symbolic stops, called stations.

2. Tradition of the Via Crucis

Tradition of the Via Crucis in Jerusalem goes back not farther than to the 14th century. Its origin is connected with activities of the Franciscan Order. In 1342 Franciscans were granted the right to care of the Holy places of Jerusalem. Here on the Via Crucis they specially

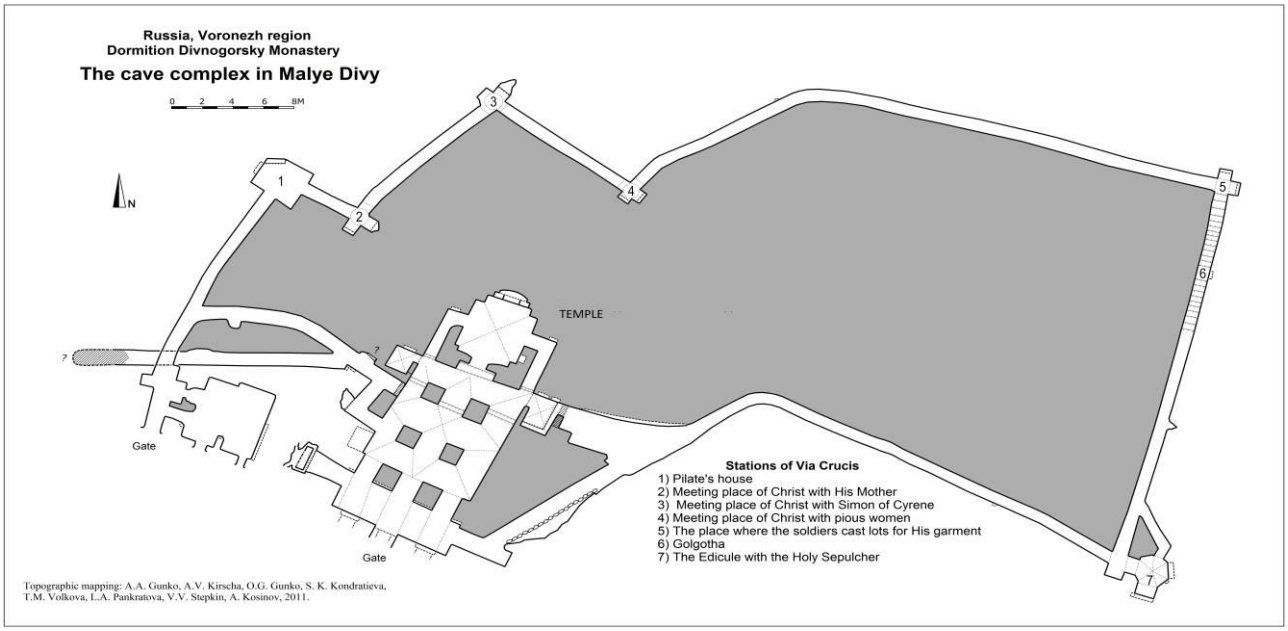


Figure 1. Plan of cave complex in Malye Divy drawn by A.A. Gunko in 2011, depicting stations of Via Crucis by V.V. Stepkin in 2017

emphasize "the place where Christ met His Blessed Mother, where He spoke to the women of Jerusalem, where He met Simon of Cyrene, where the soldiers cast lots for His garment, where He was nailed to the cross, Pilate's house, and the Holy Sepulchre" (Alston 1912). It should be noted that originally the Franciscans had no uniformity about the number, names and even sequence of stations in shaping the sacred space of Jerusalem and transfer of its image onto European soil. The number of stations in European "New Jerusalem's", created by them in XV-XVI centuries, was different. Most often included seven of them. Number seven in number of later-medieval stations can be interpreted through the fullness of Christ's suffering for all the sins of mankind, impersonated in the concept of "seven deadly sins" (Rickert 2014). It is noteworthy that in the development of the cult of Via Dolorosa not only the sacred space of Jerusalem transfer onto European soil takes place, but also the reverse kind of structuring of cultural landscape. Well-confirmed by now 14 stations in Jerusalem first appear in the Netherlands. Number fourteen in this sense can be thought of as doubling of number seven, which belongs to an earlier tradition of creating a number of stations.

If we talk about forms of expression through the art of European Catholic cult of Passion of Christ, then the numerous stations created here were usually expressed in the temple space through change of sculptures or paintings, and in monastic landscape by change of thematic chapels, i.e. calvarias. In Eastern Europe, bordering on Russia, there are such calvaries like Zebzhidovskaya and Veykherovskaya in Poland, Vilnius and Zhyamaitiyskaya in Lithuania, Minsk and Myadelskaya in Belarus, created in the XVII-XVIII centuries.

Russia itself starts copying Holy Places from the mid 16th century. For example, from that time forward in Moscow and its suburbs temples are built like the topos of Jerusalem. That was also when a widespread transfer of Palestinian names of sacred loci onto Russian soil began (Ponomarev 1877). The project of the Holy land cultural landscape reproduction on the Russian plain had the fullest and integrated form in the second half of the 17th century: patriarch Nikon organizes construction of a new Jerusalem near Moscow. Here we can see such oronyms like Zion, Olivet, Tabor, Rama, hydronym Jordan; the Churches of the Nativity, of Transfiguration, of the Lord's entrance into Jerusalem, of the Resurrection and Ascension and so on were built. Creation of this project became possible for Nikon to philosophical reflection of Jerusalem like a material prototype which can be Figure 2. Stairs leading to Golgotha, Malye Divyreproduced "everywhere", since the city itself is only an icon of the Heavenly Kingdom (Zelenskaya 2009).

Figure 2. Stairs leading to Golgotha, Malye Divy

Figure 3. Vault of Edicule, Malye Divy

We cannot fail to note the political background for such projects in Russia. For example, one of the initiators of the drawing together of the Russian Christian cultural tradition and the Eastern Greek one was Patriarch Paisius of Jerusalem, who greatly influenced Nikon's views shaping. Amid this approach it was important for Paisius to push Moscow State to fight with Turkey, to liberate the Holy Land from the foreign influence (Kapterev 1895). "With the development in the 16th century of view of Moscow as the last Orthodox realm, the veneration of Palestine relics became nation-wide and went on to a traditional for Western Europe direction. Making their realm similar to the Holy Land and its capital to the new Jerusalem, Moscow czars sought to transfer to Russia the topography of the Holy places" (Batalov, Belyaev 2006).

The tradition of sacred space of the Holy Land transfer onto Russian soil continued in the St. Petersburg period, when Russia became an empire. For example, in the 18th century there were monasteries of the Holy Trinity - St. Sergius Lavra - Bethany and Gethsemane created. In the late 19th and early 20th centuries on Balaam in the Host Resurrection Monastery upon the project of Finnish architect V.I. Barankeev Temple of Christ's Resurrection was built, in the ground floor of which there was the Edicule made similar to the Hierosolymitan one. When hegumen Maurice, who personally visited the Holy Land, was the head of the monastery in 1907, Biblical place names of ancient Palestine were transferred to the map of Balaam. Here Resurrection and Gethsemane monasteries, Mount Zion, Qidron River, mount of Olives, Valley of Jehoshaphat (Nikonovskoe field), river Jordan (Kirpichnaya ditch), Dead Sea (Leshchevoe lake) became a part of the new Jerusalem.

Figure 4. Western entrance to Edicule, Malye Divy

The sample of Balaam's topography reconstruction on the model of the Holy Land suggests another, together with the political one, component of this process. It is referred to the impact on a person of a personal pilgrimage to the Holy places of Jerusalem or reading about such a journey in numerous "walkings" and proskynetarions. We are not intended to refer to all this kind of sources in this work, our purpose is to make a primarily focus on chronologically close monuments of pilgrim literature to the arrangement of Divnogorskiy monastery in the 17th century. In the 16th century they were primarily descriptions of visits to Holy Land of Vasiliy Poznyakov (1559-1561) and Tryphon Korobeynikov (1593-1594). From the 17th century the known pilgrims were Vasiliy Gagara (1634-1637), Iona Malenkiy (1649-1652) and Arseniy Sukhanov (1651-1653). Taking into account the migrations to the southern outskirts of Moscow State of Ukrainian natives, we cannot also leave aside the journey to the Holy land of Polish Duke Nicholay Radziwill, who visited Jerusalem in 1583. L.A. Belyaev paid attention to the important feature of transferring to Russia of Jerusalem topos. All projects of such kind "have the imprint of European influences, they are localized in areas

of constant (geographical) contact with the West (Novgorod) or in the framework of westernization (Belyaev 2009).

3. Via Crucis in the caves of Divnogorsky Monastery

Analyzing the architectural space of the roundabout gallery in Malye Divy, we are faced with the inevitable difficulty of a specific identifying of stations. In fact, as

we have already noticed, the number of stations and their sequence did not have any firm rule for a long time. However, a number of architectural details help shed light on this issue. First of all, anyone visiting the caves in Malye Divy could not fail to pay attention to one of the apparent oddities. The horizontal corridor suddenly starts to sharply rise, and then all at once it drops down (Fig. 2). Figure. It cannot be explained with any reasonable practicality. This is nothing more than Golgotha. If we count the total number of steps leading to the Calvary from the North, we can see that there are 13 steps. The 14th step is a platform of 0.7 m x 0.8 m. After walking upstairs, we can observe in the Eastern wall of the corridor on the height of 0.8 m from the floor a niche, stretching up to the ceiling (1.2 m). Its width is 0.56 m, depth 0.35 m. We can assume that earlier in this niche was an icon depicting Christ's crucifixion or there was a kiot cross. Down from the platform there are 9 steps leading to the South. It is important to note that the 13 steps to Golgotha we spoke about are well correlated with the description of that topos in the Church of the Holy Sepulchre in Jerusalem in walkings of Vasiliy Poznyakov and Tryphon Korobeinikov. Vasiliy Poznyakov writes: “And a rise to the Holy Mount Golgotha up the stairs of thirteen steps” (Walking to the East of guest Vasiliy Poznyakov with companions. 2001). Tryphon Korobeinikov writes: “On the right hand of the Resurrection, after entering a big church, go high up on the mountain, the stairway is stone of 13 stairs, there is a high mountain, the Holy Golgotha” (Walking of Tryphon Korobeinikov 1593-1594. 1889). There is also no contradiction with the described number of steps to Golgotha in Radziwill’s description: “From there going up on the Calvary mountain in ten and a little over steps you pass the place, where the cross of Christ stood” (Journey to Holy Places and to Egypt of Duke Nicholay Christophor Radzivil. 1787). However, it should be noted that in the considered walkings of XVI-XVII centuries we can also meet other description of steps number. For example Iona Malenkiy tells us about 22 steps: “from those doors on the same wall in a midday winter corner to the East up to the top of the Holy Golgotha there are 22 steps, there our Lord Jesus Christ was crucified for our salvation” (Story and legend of walking to Jerusalem and to Tsargrad of Iona, a regular deacon of the Trinity Sergiev monastery, called Malenkiy 1649-1652. 1895). We can withdraw this contradiction, summing up the total number of steps to Golgotha from different sides. In the gallery of Malye Divy at the way up to Golgotha on one side we have 13 steps, and on the other side there are 9 steps, 22 steps in total. It is noteworthy that this ratio of steps cannot be inferred solely from the considered written sources, where number 9 does not appear at all. If as a basis for creation of Golgotha in Divnogorie only the wakings materials were taken, then the designers would cut either 13 or 22 chalk steps. This factor, in our view, may indicate a personal visit of one of the creators of the Divnigorie caves to the Temple of Resurrection in Jerusalem.

The next station in the Way of the Cross in Malye Divy is located south of Golgotha and we interpret it as the Edicule or the chapel of the Holy Sepulchre. Its key features resemble the Jerusalem prototype - the premise is hexagonal on the map and it contains a funeral bed. Width of the premise sides, starting with the West one clockwise, is 1.58 m, 1.09 m, 1.1 m, 1.15 m, 1.1 m, 1.1 m. The chapel is of 3.15 m high. The ceiling has the form of a sexfoil (Fig. 3). In contrast to Golgotha and other stations of the Way of the Cross this room is isolated. There are two entrances into it from the gallery: the Western one of 1.18 m wide, 2.08 m high (Fig. 4), and the Northern one of 0.62 m wide and of 1.83 m high. The corridor in front of the western entrance to the room is getting wider from 0.9 m, which is common for a chalk galley, to 1.4 m, creating extra volume.

Figure 5. Southern wall of Edicule with the Holy Sepulcher, Malye Divy

There is a rectangular kiot, cut in the eastern wall of the chapel, of 1.67 m high and of 1.2 m wide. At the base of the kiot at the height of 0.82 m from the floor there is a chalk step-shelf with dimensions of horizontal surface of 1.2 m x 0.27 m. it has gains at its ends for wooden constructions. It can be assumed that earlier there was an icon depicting Resurrection of Christ. Duke Radziwill described the similar image in Jerusalem Edicule in 1853 in the following way: “There is a timeworn board on the

wall depicting the risen Christ between two kneeled Angels" (Journey to Holy Places and to Egypt of Duke Nicholay Christophor Radzivil. 1787).

The Southern wall of the Chapel is deepened into the body of the hexagon framework. Distance from it to the Western entrance is 1.2 m. There is a step-bed at the base of the wall of 0.45 m high from the floor, of 1.48 m from the ceiling with dimensions of upper surface of 1.36 m x 0.35 m (Fig. 5). This step has an inset in the Western side wall of 0.45 m high and 0.34 m deep and we interpret it as a funerary bed.

Similarity of this premise to the Edicule can be clearly seen while perceiving the whole concept of the Holy Sepulchre reproduction in architecture, painting, metal-plastic sculptures, literature, where the author emphasizes visual dominant elements of ironically recognizable parts of Jerusalem composition. As it has already been noted, first of all, it is a polyhedron of external shape of the Edicule and a funeral bed of interior (Batalov, Belyaev 2006). In this case for creators of the funeral bed in Divnogorskaya Edicule the symbolic context was more important than natural copying of the prototype, the size of which changed in Jerusalem during the XII-XVII centuries that can be explained by reconstruction works.

Figure 6. Pilate's house, view from the South-East, Malye Divy

If we speak about location of the funeral bed, all the walkings are of one mind, they locate it on the right side of the entrance. The same location can be noted in Divnogorskaya Edicule. It has its prototype in the description of Evangelical events: "And entering the sepulchre, they saw a young man sitting on the right side, wearing white clothes; and they were horrified. He told them: do not be horrified. Look for Jesus man of Nazareth, who was crucified; He has risen, He is not here. Here is the place where He was laid"(Gospel of St. Mark 16.5).

Having performed the Golgotha and the Edicule as stations, we have to solve the task of identifying the remaining five stations of Via Crucis in Divnogorye. The first stop is particularly outstanding among them, it is carved in the rock in the form of a chapel. Four other stations have a similar layout in crossings of the turning gallery: the ceiling has a form of a dome, kiots are in the end walls with shelves in front of them. This architectural solution optimally fits the liturgical content. The four-pointed cross, visible in planigraphy of four crossings, underlines the completeness of crucifixion suffering. Turns on the crossroads interrupt the monotony of

moving, making us perceive the stations as separate loci of sacred space. In addition, the crossings with kiots cut in two ends afforded without changing the sacred importance of the total number of stations - seven, to emphasize with the help of icons four more possible stops.

Out of these five stations the first one is more accessible for semantic analysis. This is due to the fact that we are dealing with the beginning of the Way of the Cross, which in Jerusalem tradition begins with Pilate's house - the place where Christ was condemned to death. Radziwill writes: "From the house of Pilat <…> begins the path of sorrow". In this context, the first chapel of the Way of the Cross in Divnogorye is Pretoria, the official residence of the Roman Governor. The size of the premise is 2.62 m x 2.89 m (Fig. 6). Its height is 3.53 m, the ceiling is designed as a vault. The north-western wall is of particular interest in the premise, the cult architectural elements are formed around it. There is a big arched kiot cut in the center of the wall in 0.7 m from the floor, of 0.91 m wide in base. It can be assumed that earlier there was an icon depicting trial of Jesus. At the base of the kiot there is a shelf of 0.91 m x 0.33 m. At the time of inspection in front of the shelf there were large rectangular chalk bricks that could be parts of steps in the "stairs of Pilate", connected with chalk side steps.

We cannot identify the remaining four junction stations of Via Crucis in Divnogorye with the same degree of confidence as the previous three ones, taking into account the absence in the late Middle Ages of a standard canon of European tradition for transition of Jerusalem sacred topos. However, if we talk about projection of early Franciscan tradition of the XIV century in establishing of seven stations, you can assume those were meeting place of Christ with his Mother, with Simon of Cyrene, pious women and the place where the soldiers cast lots for His garment (Alston 1912). This sequence correlates with Evangelical text on the last day of the earthly life of Jesus Christ and later cartographic material (Sandys 1621).

4. Conclusions.

Thus, as a result of our study we managed to identify semantics of the architectural elements of the underground passage around cave temple of John the Baptist in Malye Divy in the Middle Don area. As a result, we have

confirmed our hypothesis about symbolic reflection here of Via Dolorosa - the image of the Way of the Cross of Jesus Christ in the Christian cultural tradition. The sequence of stations in Divnogorye in our interpretation is as follows: 1) Pilate's house, 2) Meeting place of Christ with His Mother, 3) Meeting place of Christ with Simon of Cyrene, 4) Meeting place of Christ with pious women, 5) The place where the soldiers cast lots for His garment, 6) Golgotha, 7) The Edicule with the Holy Sepulcher.

Construction of the Via Crucis on the Don land vividly depicts the influence of the Western Christian tradition. If Via Dolorosa was constructed in Malye Divy in the second half of the 17th century, this could happen after the monks learnt the tradition of calvary building at their former home and in cross-border regions. It should be noted that the interpenetration of Catholicism and Orthodoxy at the level of creation and use of objects of

worship was not an exceptional case in the ascetic tradition of cave living in the Don region. For example, in 2007 in the cave of Belogorye a kiot cross and a pendant were found which had been made according to Western Christian tradition, dating back to the end of the 18th century. (Stepkin 2014). However, the influence of Western Christianity did not concern issues of dogmatic theology, as defending it pushed the colonizational flows of monks from Western Ukraine to the southern outskirts of Moscow State in the 17th century. At the same time, a number of architectural elements of Via Dolorosa (hexahedron Edicule with two entrances into it) and the total number of stations - seven, suggest an earlier creation of the monument, which is the subject of a separate study.

References

Alston, George Cyprian, 1912. Way of the Cross. The Catholic Encyclopedia. Vol. 15. New York: Robert Appleton Company, http://www.newadvent.org/cathen/15569a.htm

A. P. Batalov, L. A. Belyaev 2006. Veneration of the Holy Sepulchre in Russia. Orthodox encyclopedia. Volume XIII. Moscow, pp. 145–148, (in Russian).

L. A. Belyaev 2009. Visible and invisible Jerusalem: on typology of visual reflections of the Holy Land in ancient Russian culture. New Jerusalems. Hierotopy and iconography of sacred spaces. Moscow, pp. 202–220, (in Russian).

Gunko A.A. 2013. Morphometric studies of caves in Divnogorye, Kostomarovo and Kolybelka (Voronezh region). Speleology and spelestology. Naberezhnye Chelny, pp. 163–168, (in Russian).

G.M. Zelenskaya 2009. New Jerusalem near Moscow. Aspects of design and new discoveries. New Jerusalems. Hierotopy and iconography of sacred spaces. Moscow, pp. 745–773, (in Russian).

N. F. Kapterev, 1895. Relations of Jerusalem Patriarchs with Russian Government from the middle of the 16th to the end of the 18th century. St. Petersburg, (in Russian).

Story and legend of walking to Jerusalem and to Tsargrad of Iona, a regular deacon of the Trinity Sergiev Monastery, called Malenkiy 1649-1652. 1895 Orthodox Palestinian collection. Volume XIII. Third Edition. St. Petersburg, (in Russian).

C. Ponomarev, 1877. Jerusalem and Palestine in Russian literature, science, art and translations (materials for bibliography). St. Petersburg, (in Russian).

Journey to Holy Places and to Egypt of Duke Nicholay Christophor Radzivil. 1787. St. Petersburg, (in Russian).

Rickert, John. 2014. Stations of the Cross: An imitative devotional exercise conducted at Lamb of God Lutheran Church Spartanburg, South Carolina, http://digitalcommons.gardner-webb.edu/cgi/viewcontent.cgi?article=1006&context=divinity_etd

Sandys G. 1621. Relation of a journey begun an Dom: 1610. London.

V. V. Stepkin, 2008. Cave digging as a kind of Christian asceticism in the forest-steppe Don region. Herald of church history. No 3(11). Moscow, pp. 141–150, (in Russian).

Stepkin V. V. 2015. Caves in Divnogorye and Belogorye: monastic and folk tradition in the river Don caves construction//Proceedings of International Congress of Speleology in Artificial Cavities Hypogea 2015, Italy, Rome, March 11/17, 2015. Rome, pp. 351–354.

V. V. Stepkin, 2014. Material and spiritual culture of a cave digger in Don steppe in late 18th century (based on materials of Belogorsky Monastery complex). Bulletin of Voronezh State University. Series: History. Politology. Sociology. No 3. pp. 118-122, (in Russian).

Walking to the East of guest Vasiliy Poznyakov with companions. 2001. Novels and tales of Ancient Russia. Literature monuments of XI-XVII centuries in featured translations. Izbornik. St. Petersburg, pp. 464–487, 999–1012, (in Russian).

Walking of Tryphon Korobeinikov 1593-1594. 1889. Orthodox Palestinian collection. Volume IX. Third Edition. St. Petersburg, (in Russian).

ARCHITECTURAL PECULIARITIES OF RELIGIOUS CAVITIES COMPLEX IN THE IHLARA VALLEY (CAPPADOCIA)

Ekaterina Ianovskaia

MSU, Faculty of History, *katherinyanovskaya@gmail.com*

Abstract

During the exploration of the western slope of the Ihlara Valley (Cappadocia) in early 2017 two rock-cut artificial cavities were found. Presumably, they form one complex of buildings destroyed by an earthquake. The upper building presents rectangular hall with two small rooms behind the back wall. The lower building presents two rooms - narthex and cross-in-square main temple. Both cavities have graffiti brushed on a red paint on the stone surface. This graffiti represents not only the Christian symbols - crosses, ceiling rose - but also the architectural details comparable with architectural elements of the surface constructions. It is stone masonry, piers, archivolts. All these elements are made as anaglyphs and painted. Taking into account underground conditions of building it is absolutely clear that these elements doesn't have any constructional purposes but only decorative. We can suggest that a builder (or a workshop of builders) previously took part in the building of the similar construction on the surface.

Key words

Aarchitecture, cut rock church, Cappadocia, basilica, baptistery.

Peristrema valley it is a place with cut-rock buildings domination. Narrow canyon with sheer cliffs and stormy shallow river on the bottom, it was one of the safest and comfortable places in the Cappadocia, which several times became border province of Byzantine Empire.

Cappadocia wasn't the region of cities. Most settlements were agricultural villages. Volcanic soil allowed locals to grow unique sorts of grapes and other farm products. All they needed was water.

Peristrema was safe and fertile place thus it lured numerous settlers. Length of the settlement here was more than 10 kilometers. All dwellings, cut in the rock cliffs, had several floors and, of course, were either the shelters. Usually, it was equipped with the system of wells and round doors which let to hide in the stone labyrinths and wait out the siege.

Christianity appeared in Cappadocia very early. In the 4th century, Julian The Apostate, who tried to return paganism in the Empire, wrote to philosopher Aristoksen (unknown person) "..- I beg you to come. For Zeus, keeper of the friendship, meet us in Theana and show us in Cappadocia the true Hellenent (mean pagan). Until now I see that nobody wants to bring sacrifices to the gods. And few of them who wants do not remember how to do it." (Furman, 1970). First monasteries were established here also in the 4th century (Niewöhner, 2017).

Numerous sanctuaries in Peristrema valley demonstrate the great importance of religion for the local population. In total there are several dozens of churches. And a lot of them still aren't discovered.

From the beginning of Christian architecture appeared two main types of churches - crossed-dome (or cross-in-square) and basilica. Basilica temple was the first type, but exactly crossed-dome type become the dominating in the Byzantine architecture. Basilica is more typical for western Christian churches.

Baptistery (gr. βαπτιστήριον) - room or part of the room with tank or pool for the sacrament of baptism. As a separate space or building, it appeared when numerous people desired to become Christians and to baptize. Separate building with huge basin was necessary for baptizing adult people. Lateran Baptistery (4-5 century C. E.) became the first stands apart from the main temple (Basilica di San Giovanni in Laterano, Rome). Greek Orthodox Cathedral of Hagia Sophia also had separate baptistery (so-called Small Baptistery, built in the 6 century, not preserved). (Great Russian Encyclopedia, 2005)

During the later centuries when custom of baptizing newborn extended, necessity to use large pools disappeared, as well as the tradition to construct of the standalone structures.

The rock-cut ecclesiastical architecture of Cappadocia in general and Peristrema valley in specifically followed the canons of the surface churches. Despite the features of the building process (or better to say digging) of rock churches master-builder often tried to repeat main constructional details of surface temples. Thus we see columns, ceilings, spandrels - parts of an architectural construction made not for functional purposes but according to canons. Ceilings of numerous temples were decorated by imitation of masonry.

Constantinople was the main center of architectural traditions development which influenced for all hinterlands. Main architectural details of the temples were unchangeable. We can't see great varieties of forms but in some details master-builder could show us his own style features. Robert Ousterhout supposed that the different technical details appeared and developed exactly in the workshops (groups of workers where they could not only worked but also learned) and analysis of such details could help us to identify them and the time of constructional works (Ousterhout, 1999, p. 255-256).

Undoubtedly Cappadocian cut rock architecture stands apart from the other byzantine architecture but in the main temple shapes imitates the forms of surface buildings (Ousterhout, 1999, p. 37). Thus we have the same situation when small details could give us the answers about time and circumstances of construction.

Description of the complex.

In the early 2017 in the middle of Peristrema valley was discovered the complex of two rock-cut constructions - single-nave basilica (top level) and stands apart baptistery (low level).

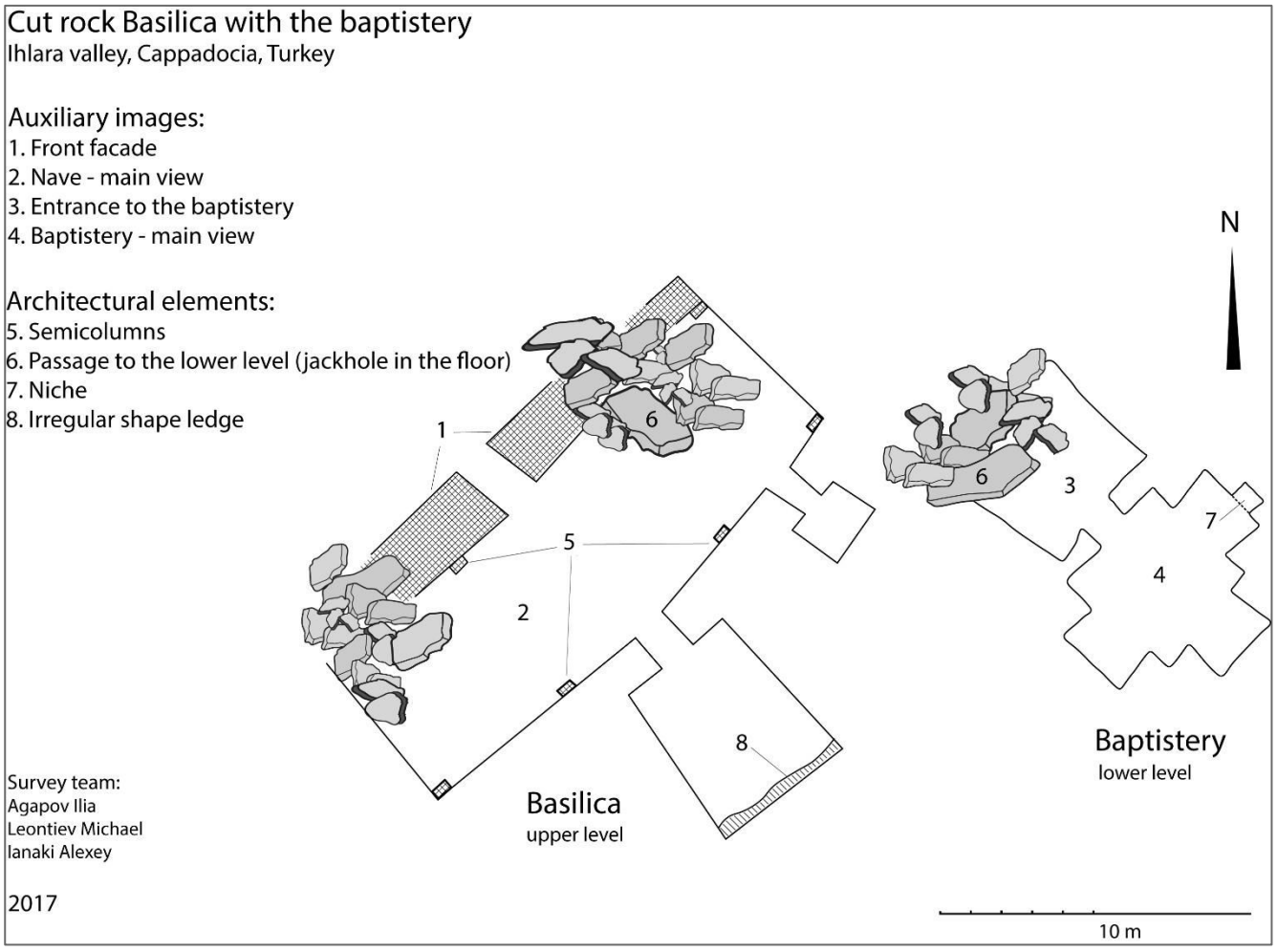


Fig.1 Plan of the basilica and baptistery.

The Basilica is situated on the top of the steep slope and is frequented by occasional tourists who brave enough to climb here.

The Baptistery wasn't available for a long time because of the destruction. Huge collapse closed the entrance, and now only narrow passage through the debris lead to the main volume of the temple. This circumstance let to preserve unique ornamental paintings in the main scope of the Baptistery.

The Basilica consists of three rooms. The main space is rectangle hall with four arches based on the engaged columns. Two rooms cut in the south-east wall also has the rectangle shape and seemed made later than the main temple. The larger one is not finished - on the floor, we can see the uncut rock "step". There are no any architectural details in both rooms.

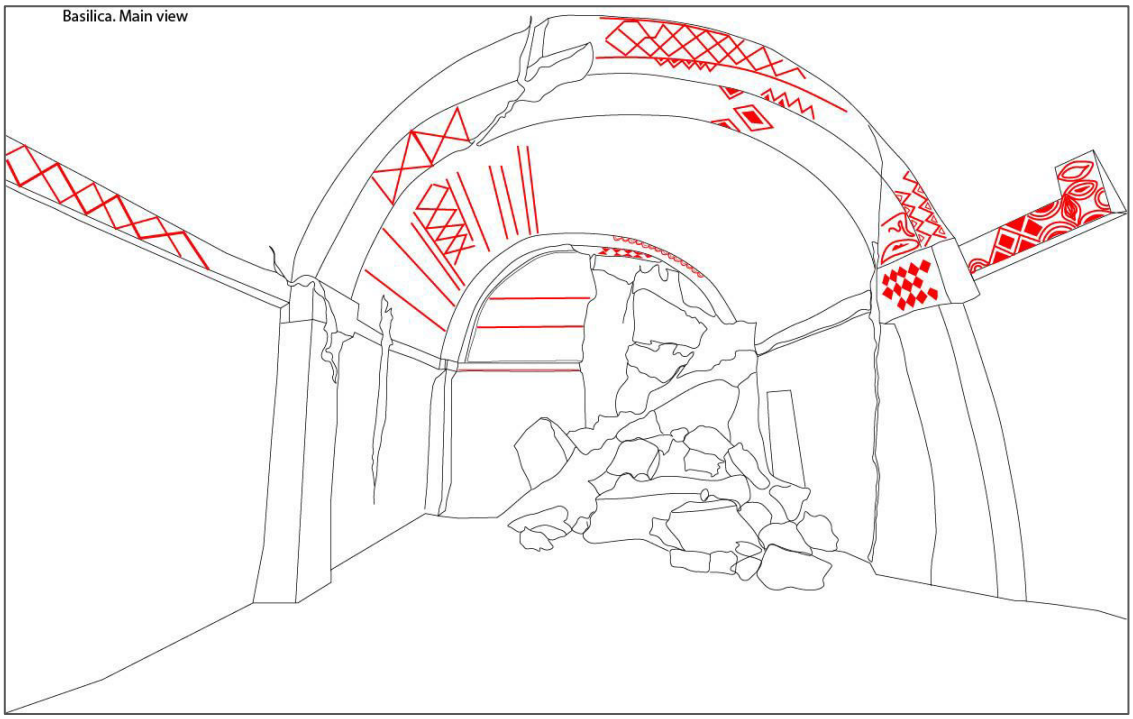


Fig.2 Main view of basilica

Front facade is decorated by cut pilaster strips and arches between. Carved crosses, eight-pointed shape, decorate two of them (Fig. 3). Over the entrance on the semi-circular pediment preserved markings of lime. It is possible to suggest that all space between pilaster strips was painted and decorated.

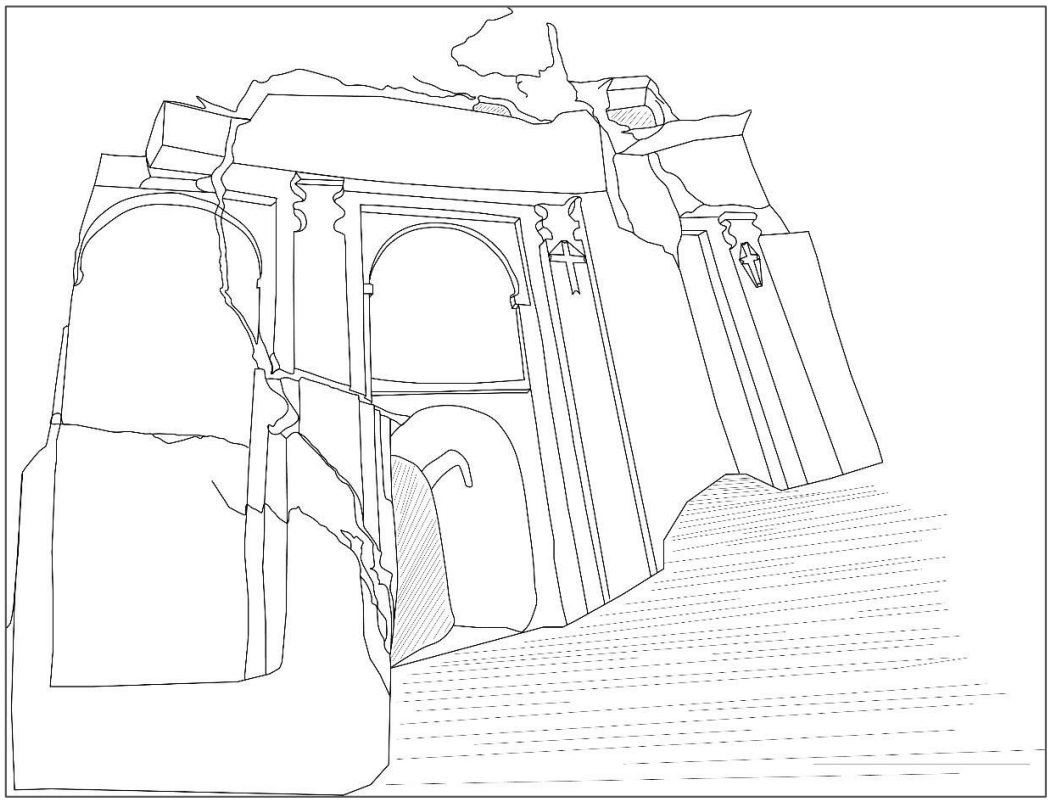


Fig.3 Front facade of the basilica.

Interior space also was decorated. On the engaged columns, on the ceiling and on the impost we can see red-paint graffiti were painted atop of white-lime.

Baptistery consists of two rooms. One of them, almost destroyed by collapse, was the vestibule or narthex. Only one south-east wall (with entrance to the main room of Baptistery) decorated. It is red-painted geometrical ornament around small window over the entrance and remains of the cross in the bottom right corner.

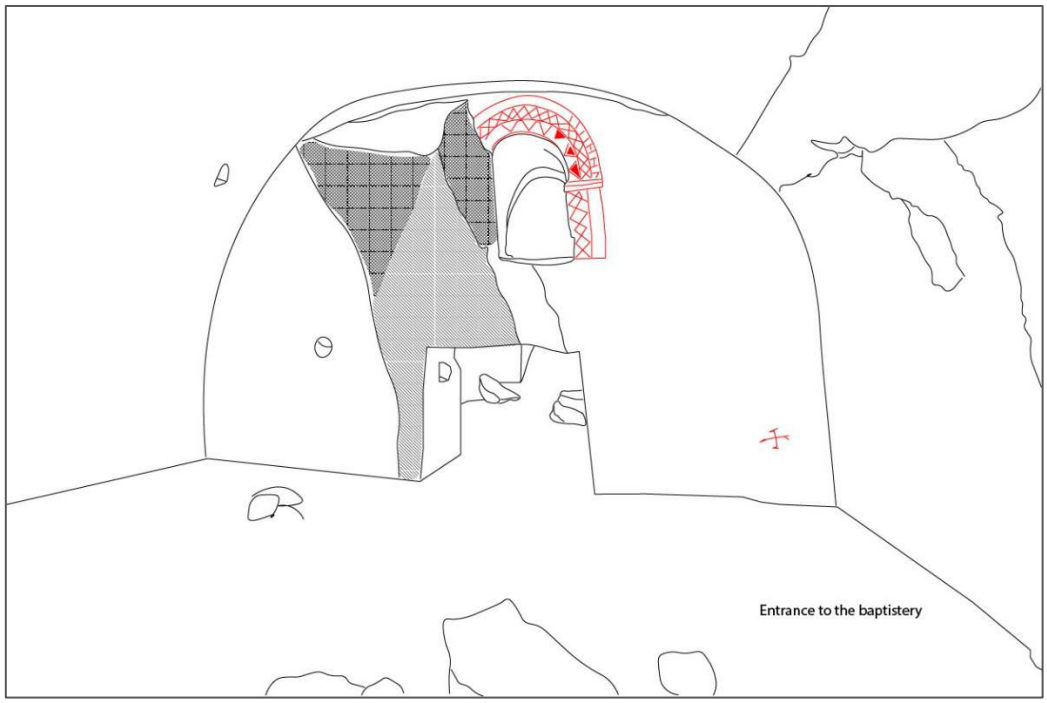


Fig.4 Narthex of baptistery

The main room of the Baptistery has the eight-pointed cross shape and rich ornamentation. On the north-east part the niche of rectangular shape was curved.

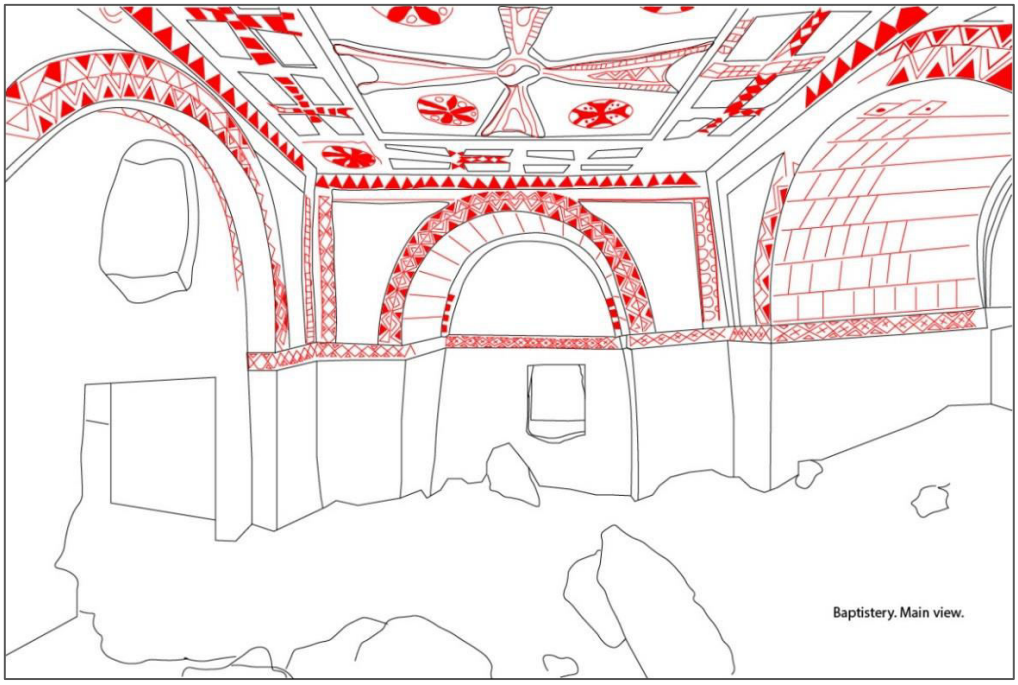


Fig.5 Main view of baptistery

On the cofferings we can see the imitation of stone masonry. It is worth noting that top rows seem unusual. It was "made" not from equal stones or bricks (masonry from bricks was usual for Constantinople architecture and stone dry masonry for Oriental architecture), but from smaller stones stacked in irregular rows, that could give durability to the construction. It is possible to suggest that master-painter had deal with this kind of masonry on the surface and just replaced his knowledge of this underground structure.

In the corners of the Baptistery there are curved and painted pilaster strips, two for each corner. Impost and the edges of niches are covered by lines and triangles.

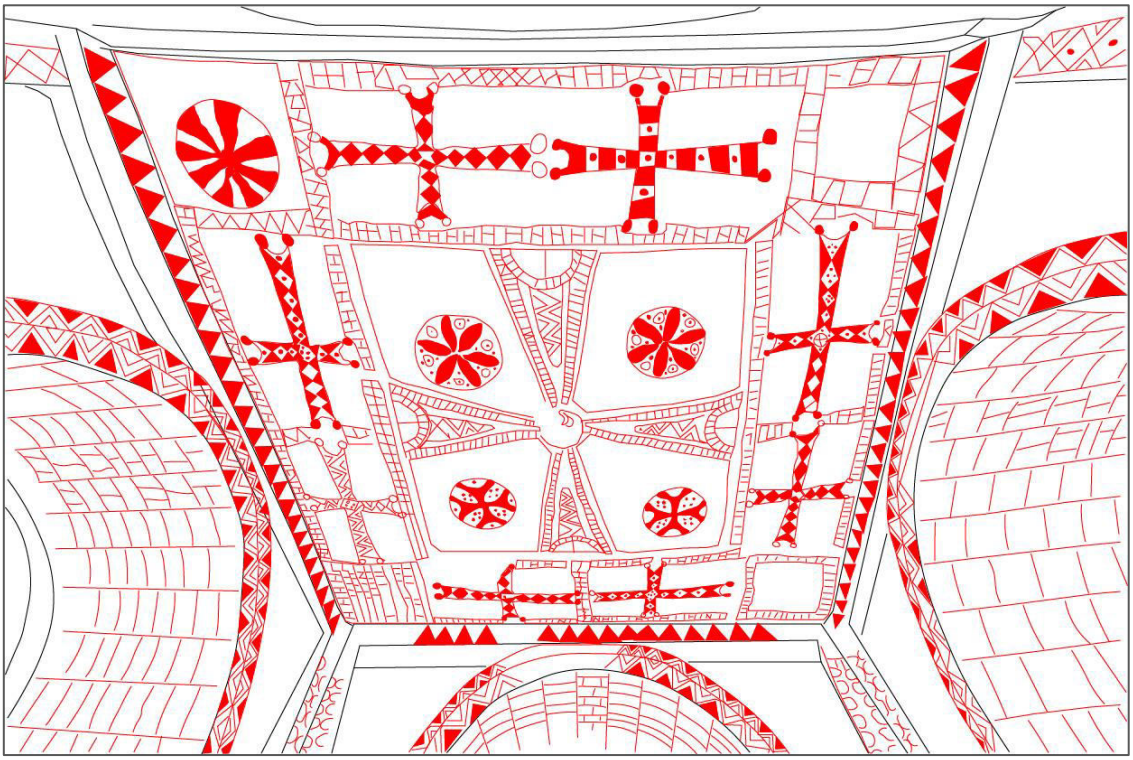


Fig 6. Selling of the baptistery.

It's necessary to pay special attention to the ceiling, covered by both stone carving and ornamental paintings. It's divided into several parts and each one contained crosses and rosettes of the different shape. It seems like exactly this part of the room must to be dominating in general space.

Unsurprisingly that only top half of the walls is covered by paintings. On the bottom of it, we see the markings of water level, different for different periods. In total four lines marked the water levels. It is unclear where did locals take water to fill this huge pool. River is situated pretty far on the bottom of the valley.

It is also necessary to say that in both parts of the complex domes absent. Indeed domes were used in Byzantine architecture but the cross-dome temples evolve in a new type (recognizable type) only in the late 9 century. This feature could be considered like one more confirmation of early period of construction. One more interesting constructional detail it's an absence of apse. Both these features jointly with large separate baptistery predicates that this complex appeared in the period from 4th to 9th century.

There is no doubt that this Baptistery was used for baptizing adult people. Thus it is possible to suggest that time of construction must correspond with the time when such tradition was relevant. It is supposed that it was from the 4th to the 7th century. But also it could be later time when in Cappadocia were resettled a lot of Slavonic and Bulgarian folks in the 9-10 centuries.

Either way, it is suggestions and only archaeological excavation could give the true answer to the question - who was the flock of this church and when it was built. In the northeast corner of the baptistery was dig some kind of trench. It is unclear what was the purpose of this digging and when it was done. Anyway, such kind of objects needs a special protection from vandals who could destroy this unique object.

References

Emperor Julian. Letters. Translate D. E. Furman, ed. by A. C. Kozarzewski. Journal of Ancient History. 1970. No. 1-3, №33

Great Russian Encyclopedia, Vol 3. Moscow, 2005, p. 22

Philipp Niewöhner, The archaeology of Byzantine Anatolia, 2017, Oxford, p.121 – 123.

Robert Ousterhout "Master builders of byzantium" Princeton University Press, 1999.

CAVE NECROPOLIS IN THE VICINITY OF KIZILIN VILLAGE, ADIYAMAN PROVINCE, TURKEY

Alexey Zhalov[1], Konstantin Stoichkov[2]
[1] *Bulgarian Caving Society, Christo Belchev 45, 1000 Sofia, azhalov@gmail.com*
[2] *Caving Club "Helictite", Kiril I Metodii, 43, 1202, Sofia, Bulgaria, danailspeleo@abv.bg*

Abstract

The rock cut cave tombs are situated on the boundary of Adiyaman province 3.6 km NE from Kizilin vill. on the right side of Göksu (Blue water) the river (influent river of Euphrates) close to the famous Göksu Roman Bridge. On both sides of the river there are natural and artificial caves. The most interesting discovery of the place was the unknown necropolis, consisting 4 rock cut cave tombs. All they are elaborate funeral chambers, carved directly into the rock face. (The basic plan of the tomb consists of dromos (corridor), leading down to the chamber. The burial chambers have square or rectangular shape. They are buried more than one human body and have three or more stone couches inside. The tombs have no decoration, however the interiors are very well preserved and one can see the funerary beds (benches). The explored tombs were without relief carving or paintings so probably they belong to poor persons. No artifacts were discovered in the tombs neither bone remains. Such burial structures have been found in other places in Turkey and specially in Shunliufra and Aidyaman provinces as in Zeugma, Perrin (Perre), Söğütlü etc. all recognized as monuments belonged to the kingdom of Commagene.

Keywords

Cave tombs, necropols, Turkey, Kizilin

1. Introduction

The river Euphrates emerges close to the town of Keban, Southeast Turkey. The river flows for about 1.230 km in Turkish territory, before entering Syria. Five dams have been built on the river since 1975. The Birecik Dam is situated 8 km upstream of Birecik town and ends 60 km upstream to Atatürk Dam. In this part, the river flows through two Turkish provinces - Şanlıurfa and Adıyaman, both in the Southeast Anatolian Region of Turkey. The area extending northwest from Sanliurfa city is built of limestone, whose thickness is more than 400 m. The river Euphrates were inscribed on the limestone rock and modeled canyon in which vertical walls there are many natural caves and artificial cavities with different functions, carved the soft limestone. The study of the cavities on the territory of Şanlıurfa province started in 2013 and was carried out from the OBRUK Cave Research Group – Turkey. During the first stage of the exploration were discovered and studied 73 rock settlements on both banks of the river. There were localized tens other rock cut structures, but due to the lack of time, they were not studied and mapped [Yamaç, 2015. P.83-85]

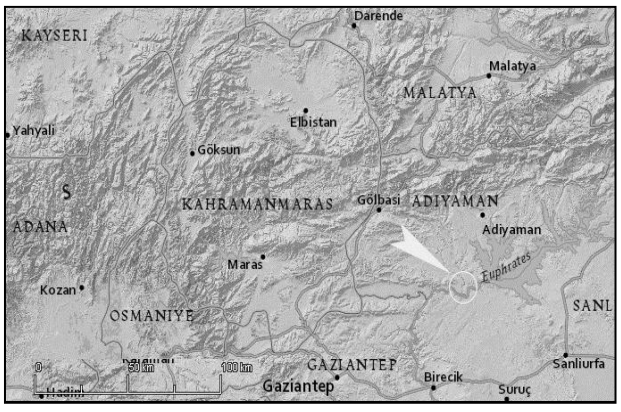


Figure 1. Area of exploration

The exploration continued in 2015 during International expedition, organised by Ali Yamac from OBRUK Society. The expedition was held from 5 until 13 June 2015. The team was composed by 8 Turkish cavers from different clubs, the Bulgarians A. Zhalov and K. Stoichkov – members of Bulgarian Caving Society and the Caving Club "Helictit" Sofia and L. Makrostergios from the Speleological group of Karditsa – Greece. During the expedition were explored in total 28 artificial caves and complexes – upon 15 of them were located in the territory of Adıyaman province.

2. Geology

The Euphrates basin is situated in a region having a very complex geology and also a very active seismicity. The younger units are mainly composed of sedimentary rocks including marl, mudstone and limestone, and shale alternation. At his work [Yamaç, 2015. P.83-85] reported that the area is buid by horisonally bedded, netric, Eocene limestones which thickness is more than 400 m. Miocene - Lower Miocene netrick limestones, overlying this formation and observed on the northern and southern part of the region, are placed as discordant within this main structure. The North Anatolian Fault and East Anatolian Fault Zone are the common structural features in the basin. (Bokzut,2001)

2. Caves explored in Adiyaman province

The caves on the boundary of Adiyaman province are situated 3.6 km NE from Kizilin vill. on the right side of Göksu (Blue water) the river (influent river of Euphrates) close to the famous Göksu Roman Bridge (probably built by soldiers of the Legio XVI Flavia Firma during the reign of Emperor Septimius Severus about 212 AD.) (fig.1)

The riversides are steep, but in some places they became vertical, so the passage looks like a canyon. On both sides

of the river there are situated natural and artificial caves. During our stage, we started the exploration with the cave complex on the right side of the river, named by the first explorers of the place – Group EK-3. Nine more caves were explored. Based on their architecture, we can conclude that all they are used as dwelling places or for economic purposes (storehouses, etc.). (fig.2&3). The most interesting discovery of the place was the unknown necropolis, consisting 4 (or probably more) rock cut cave tombs [Osborne, 2011. P. 35-53].

Figure 2. Locdtion of cave complex & necropolis

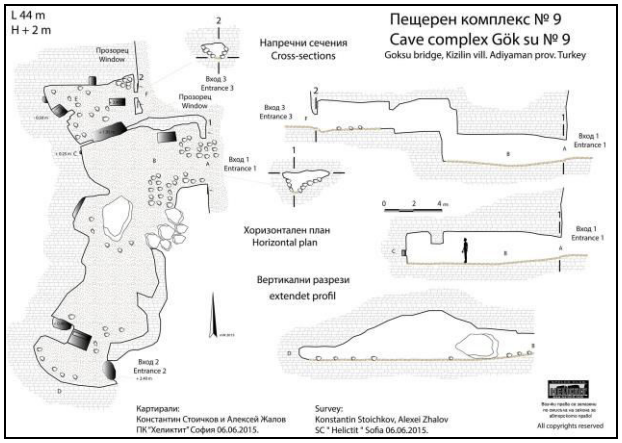


Figure 3. Cave Complex № 9

3. Methods

Tombs were mapped using laser roulette Disto. The resulting data was processed in AutoCAD 2009 , and subsequently using the Adobe Illustratov CS 3 program.

4. Results and discussion

4.1 General characteristics

The necropolis is situated at N37°26.643', E38°09.740', at 1311 m.a.s.l. All tombs are elaborate funeral chambers, carved directly into the rock face. (The basic plan of the tomb consists of dromos (corridor), leading down to the chamber. The burial chambers have square or rectangular shape. They are buried more than one human body and have three or more stone couches inside. The tombs have no decoration, however the interiors are very well preserved and one can see the funerary beds (benches). It is well known that the presence of decoration of the tombs is symbol of the status of the buried person. In our case all of the explored tombs were without relief carving or paintings so probably they belong to poor persons. No artifacts were discovered in the tombs neither bone remains. Rock-cut tombs are not exclusive here. Such burial structures have been found in other places in Turkey and specially in Shunliufra and Aidyaman provinces as in Zeugma, Perrin (Perre), Söğütlü etc. [Zeyrek, 2007. P. 194-221] all recognized as monuments belonged to the kingdom of Commagene.

4.2 Descriptions of the tombs

Cave Tomb №1

The burial cave was hewn in limestone bedrock on the NW slope of the riverbed. (fig.4). There is ante chamber (Forecourt) – it is a natural cave with some little artificial shapes (width 4.63, heigh -2.50 m). In the upper part of the entrance arch there are 5 hollowing's. The slope ditch (width 0,75, depth 1.25 m) leads to the dromos with length 1.78 m. The burial chamber is cruciform. The short half-line is oriented SW-NE, with length 5.70 m. The direction of the long ray is NW-SE, length 8.32 m). Three troughshaped burial benches (loculi) (fig.4) were hewn along the south-western side and 3 more – on the opposite side. Rock-cut partitions separate the benches from the chamber. The average dimensions of the graves are about 2 m in length, 0.5 m width and depth – 0.23 m. Acrosoliums are formed above all benches (depth about 0.6 m) (fig.5).

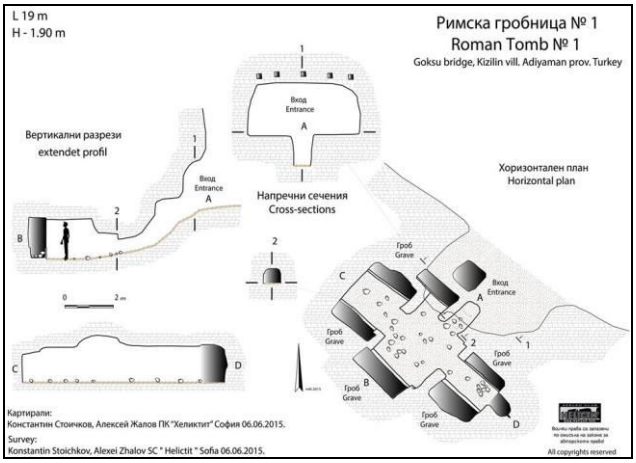


Figure 4. Roman Tomb №1

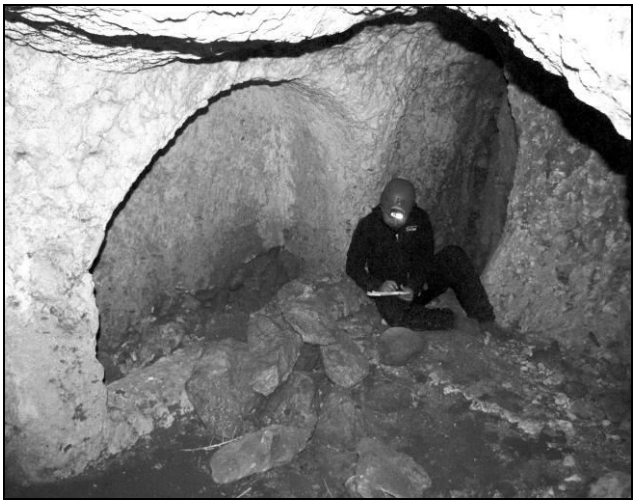


Figure 5. Roman Tomb №1 the birual camber with acrosolium

Cave Tomb №2

The tomb is placed few meters north-eastern from the first one. (fig.6).

The entrance is pentagonal (0.7 wide, height -1.15 m) (fig.7) and leads to a dromos (0.86 m). Three niches (loculi) were carved into the bedrock inside the tomb: one on each side and one at the back. The bench along northern side rises above at 0.62 m from the floor. Its length is 1.95, width 0.7 and depth 0.2 m. The south grave

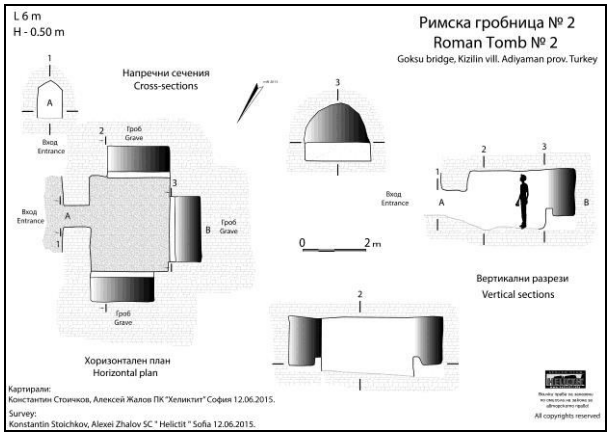


Figure 6. Plan of the Roman Tomb №2

is 1.9 m long, 0.72 m wide and 0.22 m deep. Its disposition is 0.65 m up from the floor. On the western side is placed the largest of the three burial benches 2.1×0.5,depth 0.2 m. Acrosoliums were carved above all benches high about 1.2 and depth 0.92 m. Surface of the tomb is about 12 m^2

Cave Tomb №3

The next tomb is semi-artificial and semi-natural. It consists of 5 burial niches (fig.7).

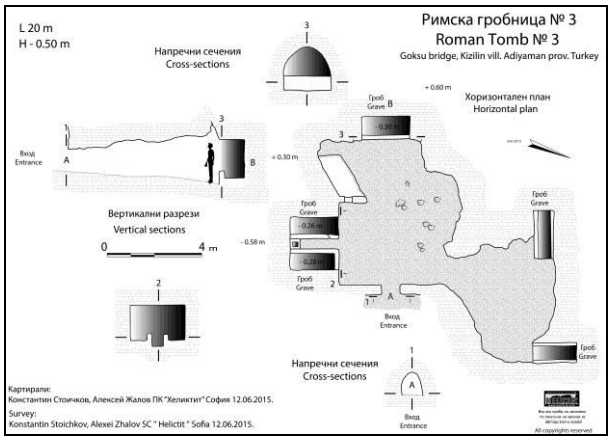


Figure 7. Plan of the Roman Tomb №3

The dromos of 0.4 m leads to a asymmetric chamber with long axis of 11 m and short one - 7.5 m. The total surface is about 56 m^2. In the eastern side of the cave was hewn arc-form niche with two graves - each 0.5 m above the floor, 2 m long, 0.7 m wide and 0.26–0.28 m deep. The grave at the western side of the chamber is located 0.6 m above the ground and under acrosolium. The length of the burial place is 2.1 m, width 0.8 m, depth 0.3 m. Two more graves are located on the right natural branch of the tomb. It is visible that it the past, this part was longer and consisted more graves, but the passage leading to this sector is not penetrable and needs enlarging.

Cave Tomb №4

Probably this is the most interesting underground structure, we have explored (fig.8). It comes from its absolutely cruciform architecture. The entrance has elliptic shape. A short dromos (0.4 m) leads to the burial chamber with two perpendicular each to other rock cut galleries. The heading of the galleries are approximately North-South and East-West! In each part of the chamber there are 3 burial niches so the total number of the graves in the tomb are 9! The benches are about 0.3 m above the floor and have an acrosoliums above. The height of the acrosolium's arc from the basis of the niches is 1.5 m. The depth of the graves varies from 0.1 to 0.15 m. Surface - 35.5 m^2. It is important to note that the architecture of Tomb N4 is absolutely the same as the KB-Mezar 1 (fig.9) reported by Turgut H. Zeyrek [Zeyrek, 2007. P. 207]. Having in mind this fact we could presume that architecture of the tombs in the region and time of Commagene was standardised.

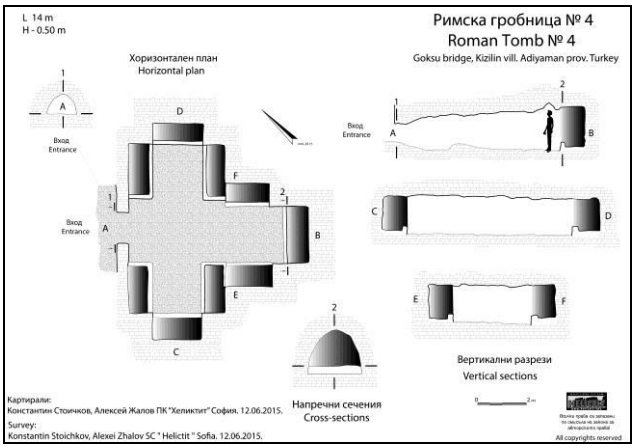


Figure 8. Plan of the Roman Tomb №4

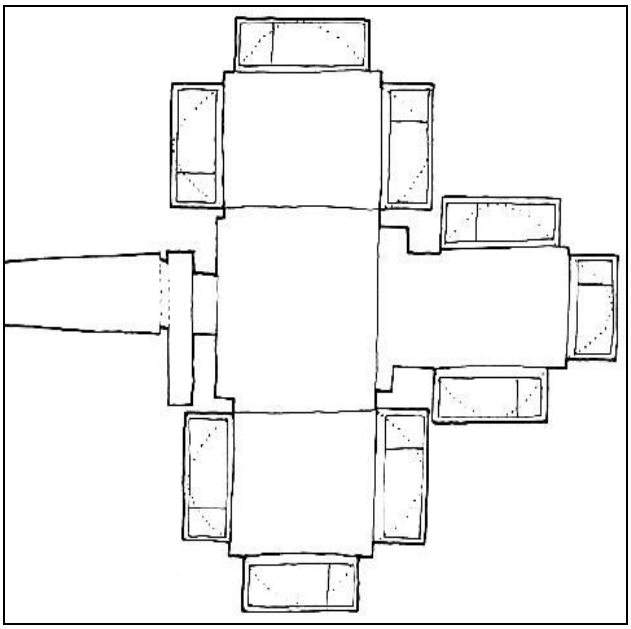


Figure 9. Tomb BK-Mezar (after Turgut H. Zeyrek, 2007)

5. Discussion and Conclusions

The general questions are when all this underground structures was made. If we could conclude that they are done from Commagene then the time of their hewing should have wide boundaries – from late Hellenistic to Roman period. The most precise answer about the time of we could obtain after specialized archaeological studies and probably excavations in the area.

References

Osborne James F. Secondary Mortuary Practice and the Bench Tomb: Structure and Practice in Iron Age Judah// Journal of Near Eastern Studies, Vol. 70, No. 1 (April 2011). – P. 35-53.

Yamac A. Cave dwellings of Halfety – Ufra (Southeastern Turkey) // Hypogea 2015 Proceedings of International Congress of Speleology in Artificial Cavities Italy, Rome, March 11/17, 2015.

Zeyrek, Turgut H. Yukarı Söğütlü Nekropollerinden Kaya Mezarları Gaziantep // Üniversitesi Sosyal Bilimler Dergisi, 6(2), 2007. – P. 194-221 [Web resource]. – URL: http://unchartedruins.blogspot.bg/2012_07_01_archive.html.

UNDERGROUND EXPLORATIONS AT HORVAT QASRA, SOUTHERN JUDEAN FOOTHILLS, ISRAEL

Boaz Zissu[1], Amos Kloner[2]
[1]*Bar- Ilan University, Ramat Gan, Israel, bzissu@gmail.com*
[2]*Bar-Ilan University, Ramat Gan, Israel*

Abstract

Horvat Qasra is located on a hilltop in the southern Judean Foothills, Israel. The site consists of a central building, with rooms built arround an inner courtyard; A well-built tower stands at the corner of the architectural complex. Its foundations are protected by a sloping wall (protechisma) on the outside, an architectural type known from elsewhere in Judea. Under the main building, a typical rock-cut hiding complex was explored. It included three underground installations, linked by narrow, low and winding burrows. Additional rock-cut cavities were carved into the soft chalk of the slopes surrounding the architectural complex: underground quarries, two cross-shaped columbaria installations and some cisterns. According to architectural parallels from other Judean sites, and due to the absence of dating archaeological material, we suggest that the underground installations were rock-cut initially during the Hellenistic and Early Roman periods. They were used for chalk quarrying, storage of water and agricultural products, underneath the buildings of a fortified estate. During the preparations of the Bar-Kokhba Revolt, the installations' original openings were blocked and they were interconnected by typical burrows. The system was used by the local residents for hiding purposes, apparently during this revolt. In the southern part of the site, a Jewish rock-cut burial complex from the 1st-2nd centuries CE was excavated. During the Byzantine period (5th c. CE), the burial complex was transformed into a Christian chapel; Numerous inscriptions and graffiti, mostly Greek, incised on its walls attest that Holy Salome was worshipped here until the Early Islamic period.

Keywords

Judean Foothills, Christian archaeology, inventio loca sancta, holy tomb, burial complex, hiding complex, Bar-Kokhba revolt, columbaria, chalk quarry, underground quarries.

1. The Archaeological Site

Horvat Qasra extends over 7.5 acres on a hilltop in the southern Judean Foothills. The site consists of a central building (c. 20 X 20 m) with rooms arranged around an inner courtyard; A well-built and fortified tower stands at the corner of the architectural complex. Its foundations are protected on the outside by a sloping wall built of large stones (Fig. 1). This feature – known as a protechisma - was a Hellenistic fortification element, designed to block tunnels dug by the enemy against the foundation of a building or a wall, and provided protection against siege machinery (Lawrence 1979, 277).

Figure 1. Tower with sloping wall – looking south (B. Zissu).

Ancient settlements having similar features were recorded elsewhere in Judea - at Rujum Hamiri, Rujum e-Deir, Khirbet al-Qasr, Nahal Eshtamoa, Rujum al-Qasr, Rujum Abu Hilal, Khirbet Qumran, Ofarim, Khirbet Canaan, Horvat Tsalit and ‘Aroer (Zissu 2001, 262-260). These sites control their immediate surroundings and access roads. Scholars differed as to the purpose of these sites: whether they served as forts, fortresses, fortified settlements, or fortified manor houses (Hirschfeld 1998, 2000). The paucity of excavations and the scarcity of publications about these sites do not make it possible to determine with certainty their purpose and their chronology (Zissu 2001, 265-261).

2. The Hiding Complex

Under the central building, a typical rock-cut hiding complex was explored. It consists of three underground halls (A, B, C), each functioning independently during the Hellenistic and Early Roman periods: A – a storage hall, A1 – a water installation and A2 – apparently a ritual immersion bath; B and C functioned as underground chalk quarries. A, B and C were connected by narrow, low and winding tunnels and burrows, converting it into a typical hiding complex. Some square chambers (as D, F, H, K) were hewn in the walls of these tunnels and burrows, apparently serving hiding and storage purposes.

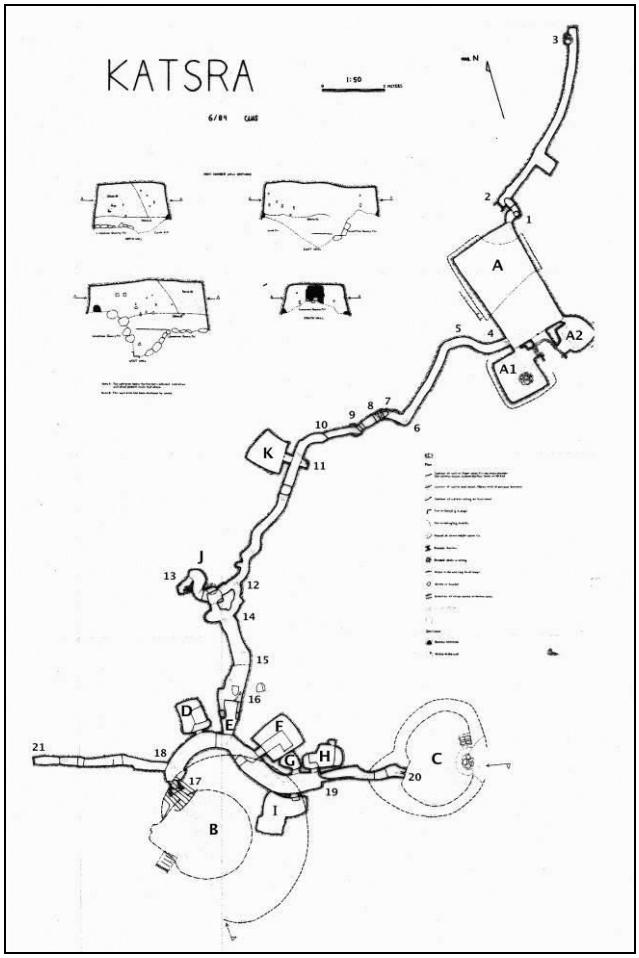


Figure 2. Hiding complex - plan and sections (A. Kloner).

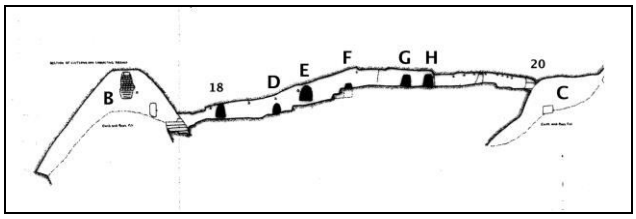


Figure 4. Hiding complex – long section (A. Kloner).

We assume that the hiding complex hewn underneath the ancient settlement, served the residents of the ancient settlement during the Bar Kokhba Revolt (132 - 136 CE), when the Jews rebelled against the Roman rule and established in Judea independent government institutions (Eck 1999; Eck 2007; Eshel and Zissu 2015).

We have no comprehensive, first-hand historical work describing the Bar Kokhba Revolt. The writings of Roman authors, the Church Fathers and Rabbinic literature contain a few brief accounts of the revolt, some of which are biased and contradict one another. Therefore, a careful study of archaeological evidence is much needed for the understanding of the events (Eshel and Zissu 2015).

According to most scholars, the account given some eighty years after the war by Cassius Dio in his Roman History (69, 12–14; trans. E. Cary) - is a fairly comprehensive and reliable overview of the revolt from a Roman perspective (Eck 1999).

Dio reports on the reinforcement of militarily advantageous sites with fortifications, passages and underground networks, and the rebels' tactic of avoiding head-on clashes with the Roman army:

"To be sure, they [the Jews] did not dare try conclusions with the Romans in the open field, but they occupied the advantageous positions in the country and strengthened them with mines and walls, in order that they might have places of refuge whenever they should be hard pressed, and might meet together unobserved underground; and they pierced these subterranean passages from above at intervals to let in air and light" (Cassius Dio, Historia Romana, 69, 12)."

This account is consistent with the finds of the Judean hiding complexes, which were prepared as secret underground bases for the rebels.

Figure 5. Opening of burrow into Hall B – looking north (B. Zissu).

One of the characteristics of this revolt, is the extensive use of underground cavities for hiding, escape and refuge purposes. Scholars are distinguishing between two main groups of cavities in use: hiding complexes and refuge caves. (The refuge caves are found mainly in the Judean Desert, in the steep cliffs overlooking the Dead Sea and the Jordan Valley. These natural caves served as places of refuge for people from the Judean Mountains and the Jordan Valley when they fled for their lives at the end of the Bar Kokhba Revolt. Few refuge caves are situated in the western part of the Judean and Benjamin Mountains. The refuge caves are beyond the scope of the present paper).

Figure 6. Hall A looking north. Notice opening of burrow (marked 1) into corner of hall (B. Zissu).

The complex at Horvat Qasra, has similar characteristics in common with other hiding complexes found in the Judean Foothills. These complexes were hewn artificially under or near residential buildings in ancient settlements. They include several rock-cut chambers connected to each other by a maze of low, narrow and winding burrows. Passage through the burrows requires one to kneel down, crawl and sometimes even to creep. The burrows are the typical feature that identifies a rock-cut system of underground cavities as a hiding complex. The openings into chambers are always small and low, and require one to kneel down in order to enter. Underground chambers, storerooms, halls and burrows could be sealed from the inside. Thus, the complexes were designed so that the occupants could defend themselves from within, against an enemy attempting to enter. Rock-cut cavities and installations, which clearly antedate the revolt were connected by burrows and created an underground system. Burrows covertly connected various parts of the upper settlement. They descended to the tunnels by means of shafts carved into the floors and courtyards of the houses. The shafts were most probably blocked with stone slabs that could be camouflaged. The edges of the system sometimes led to escape openings located outside the settled area (Kloner and Zissu 2003; 2009; Zissu and Kloner 2014).

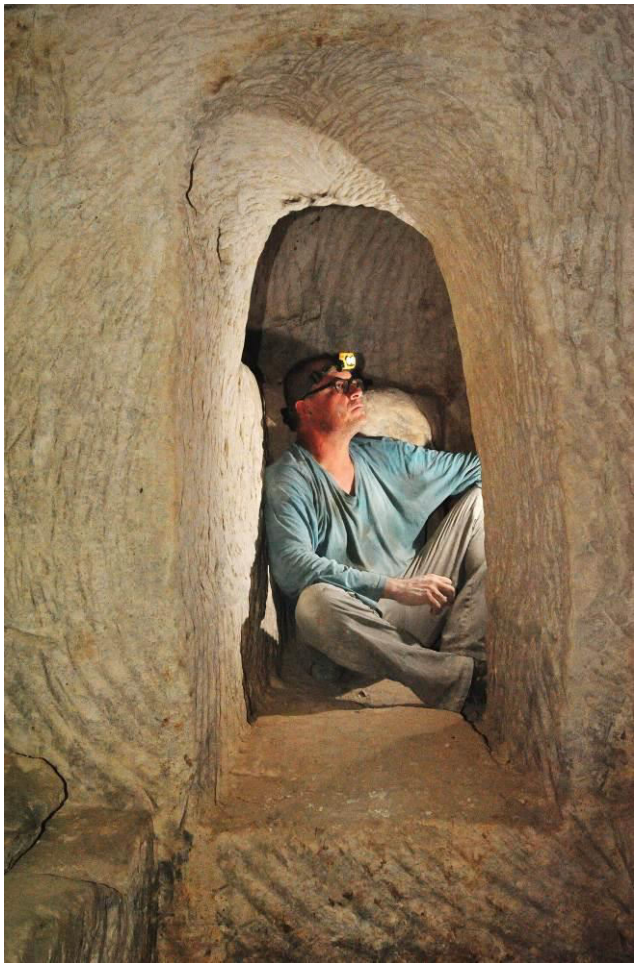


Figure 7. Opening of chamber F, looking west (Y. Zissu).

According to architectural and typological parallels from other Judean sites, and due to the absence of dating archaeological material, we suggest that the underground installations at Horvat Qasra were hewn initially during the Hellenistic and Early Roman periods. They were used for stone quarrying, storage of water and agricultural products, underneath the buildings of a fortified estate.

During the preparations of the Bar-Kokhba Revolt, the installations' original entrances were blocked and they were interconnected by typical burrows. The complex was used by the local residents for hiding purposes, apparently during this revolt.

2. Columbaria and Additional Rock-Cut Cavities

Additional rock-cut cavities were carved into the soft chalk of the slopes surrounding the architectural complex: underground quarries and water cisterns, and two cross-shaped columbaria installations (or dovecotes).

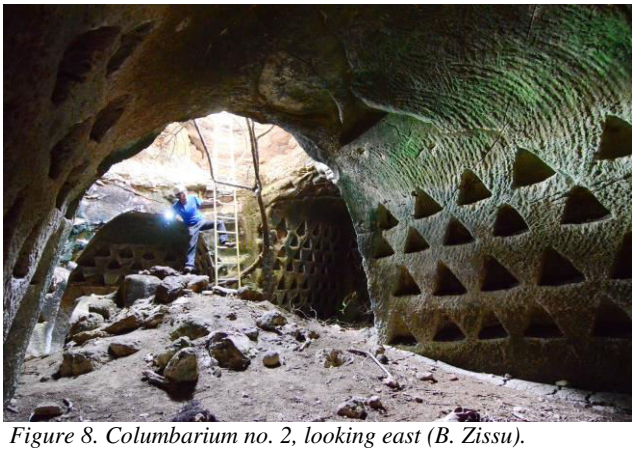


Figure 8. Columbarium no. 2, looking east (B. Zissu).

Pigeon-raising in ancient Israel, particularly in the area of the Judean Foothills, dates back as far as the third century BCE; it flourished during the Hellenistic, Roman, Byzantine and Early Islamic periods.

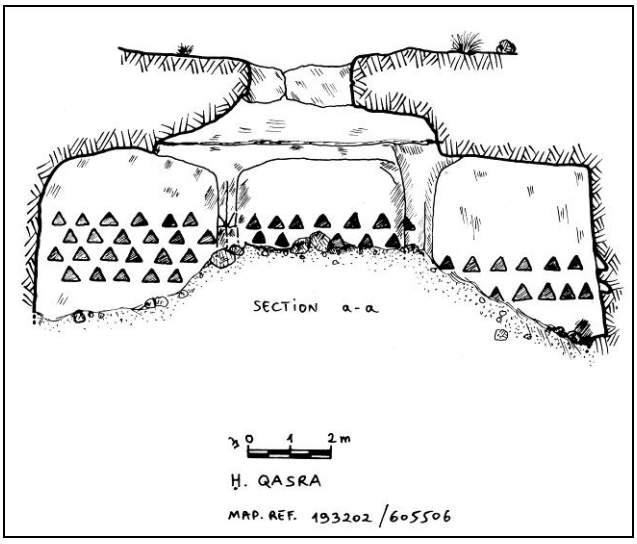


Figure 9. Columbarium no. 2; Section (B. Zissu).

Hundreds of rock-cut, underground columbaria have been found in Israel; Most of them are located in the Judean foothills. The number and technological sophistication of

underground columbaria reached their peak this region. This large number may be due to the ease of hewing the soft limestone and the structures' durability even when subjected to secondary use in later periods. The built columbaria, on the other hand, generally did not survive, and archaeological excavations conducted in Israel have uncovered only few built dovecotes (Zissu 1995).

A great deal of research has been devoted to ascertaining the purpose of the columbaria, and numerous explanations have been offered. Today, most researchers tend to agree that the structures in question were used to raise pigeons for the production of fertilizer and meat (Zissu and Rokach 1999; Kloner 2001; 2003).

Archaeological and artistic evidence, ancient classical and rabbinic sources, and the practice of pigeon-raising today, all attest to the crucial role played by pigeon-raising in ancient farming and societies.

3. A Rock-Cut Jewish Burial Complex and Christian Underground Chapel

A monumental burial complex situated on the southern outskirts of the ancient site was explored. It was initially breeched into and looted and subsequently excavated by the second author.

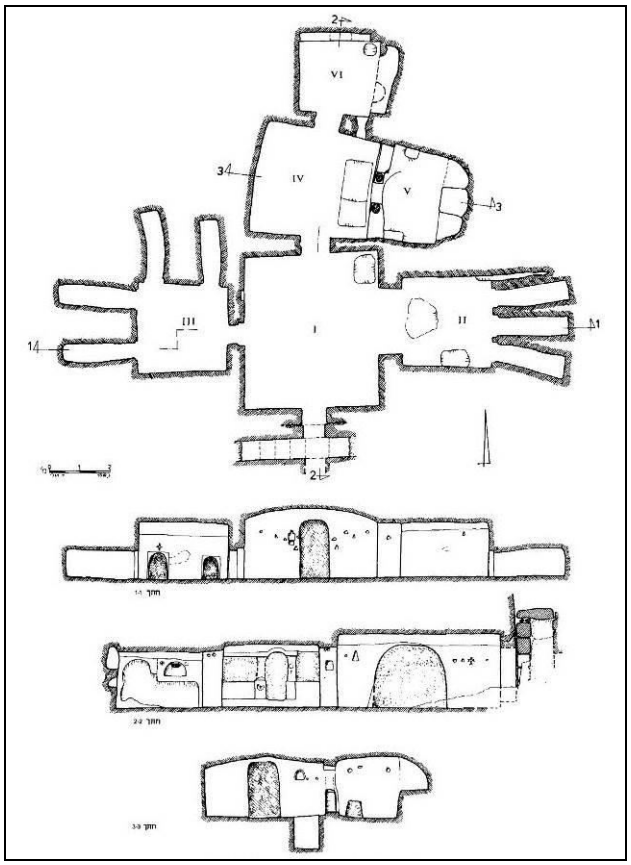


Figure 10. Plan and sections of the tomb (A. Kloner and IAA).

Two major periods of use were observed. In the first phase - the first and second centuries CE - the cave was used for burial – and apparently served the Jewish residents of the site. It consisted of a rectangular antechamber (I) probably blocked with a round blocking-stone, which led to three inner chambers (II-IV). Rooms II and III contained seven arched *kokhim* (elongated burial niches) while Room IV, which underwent extensive alterations in the later phase, appears to have served for storage of ossuaries. Finds of the first period of use include fragments of four ossuaries, red painted and decorated in geometric patterns, first and second century CE oil-lamps, and a limestone 'measuring cup' of a similar date.

Figure 11. Unaltered chamber III – looking west (B. Zissu).

Figure 12. Chamber IV was converted into a chapel – looking east (B. Zissu).

In the second phase - the Byzantine (from c. the 5th century CE), and Early Islamic periods - the cave became a subterranean Christian chapel complex. Within this complex, Rooms I-III retained their original function of antechamber and burial place. Modifications included the widening of the passage into Room II and the carving of an inscription on its right doorpost, the installation of iron lamp hooks in the ceiling of Room I, and the carving of a cross over kokh No. 6. Rooms IV and V constituted the center of the chapel. The entrance from Room I was remodeled as an archway, adorned with Greek inscriptions on the soffit (Di Segni and Patrich, 1990), as well as

Arabic and Syriac grafitti on the doorpost.

Figure 13. Greek inscription – dedicated to Holy Salome, on the soffit (B. Zissu).

Room IV was also adorned with various grafitti and inscriptions, and was further modified by the excavation of a cist tomb in the floor, and the addition of an apsed chancel (V) to the east. The entrance to the chancel was flanked by columns and a chancel screen; these too bore inscriptions in Greek and Arabic, as well as crosses and other grafitti.

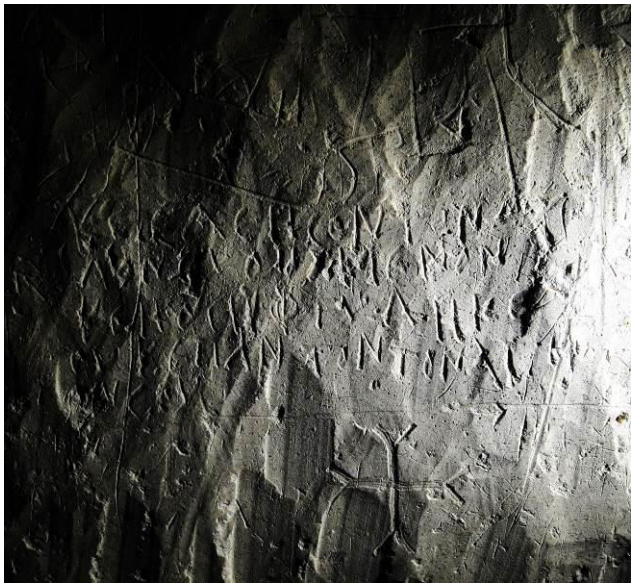


Figure 14. Greek and Arabic inscription – dedicated to Holy Salome (B. Zissu).

A semi-detached stone slab at the center of the apse served as an altar, and two similar slabs along the south and north walls were apparently used as benches. Inscriptions in Greek and Arabic were carved in the apse, and the remaining walls of the chancel also bore inscriptions in Greek, Arabic and Syriac. Room VI was originally furnished with a small apse in the east and an elongated niche in the northern wall, above which lay a smaller niche. In the center of the apse an encircled cross was carved in relief in its center, and was flanked by two smaller Maltese crosses. The three crosses were all painted red. A ledge at the base of the apse may originally have extended to the end of the wall. The elongated niche in the north wall was probably used to accommodate oil-lamps, as testified by the thick layer of soot on the wall. At a later phase, a deep recess was cut into the northern part of the east wall. The walls of this chamber carried Greek inscriptions and grafitti.

Figure 14. Crosses and Arabic inscription (B. Zissu).

Finds from the second period of use include many ceramic fragments of Byzantine and Early Islamic date, including a great number of lamp fragments.

4. Discussion and Conclusions.

Numerous inscriptions and graffiti, mostly Greek, but also Arabic and Syriac incised on the walls indicate that the previous Jewish tomb was venerated during the Byzantine and Early Islamic periods - as the Tomb of a certain Holy Salome. This Salome was perhaps the follower of Jesus who is mentioned in the canonical gospels and in some apocryphal writings. She is sometimes identified as the wife of Zabedee and the mother of the Apostles James and John.

Early Byzantine sources afford a number of reports of *inventiones*—miraculous discoveries of tombs of biblical figures or Christian saints. This phenomenon was not restricted to the Holy Land; it is also recorded throughout the Christianized Roman Empire. In other parts of the Empire, inventiones pertained almost exclusively to Christian martyrs, whereas in the Holy Land the focus was on biblical figures. Only obviously ancient tombs, it would seem, could be identified with a personage from Scripture; these were usually tombs or other rock-cut features of the Second Temple period and sometimes even of the Iron Age (Di Segni 2007).

L. Di Segni summed up this phenomenon as follows:

“It is clear that the “archaeological” process of discovery of ancient tombs had a particular effect in Byzantine Palestine, namely the foundation of memorial churches, some of them in a very early phase of the Christianization of the country. These churches were not erected to serve a community but as pilgrim sites, to focus the Christian cult on potentially non-Christian holy places throughout the country.”

Interestingly, the cult of Holy Salome continued during

the Early Islamic period (on this phenomenon see Patrich 2011).

To sum up, the H. Qasra tomb complex of the first-second centuries CE was converted into a chapel complex during the Byzantine period, (Kloner 1990; Di Segni and Patrich 1990). The evidence for the early Islamic utilization of the complex suggests that the Arabic inscriptions, which employ Christian phraseology, were carved by Arabic-speaking Christians of the Early Islamic period, rather than Christian Arabs of the Byzantine times. It appears that these inscriptions are evidence of the Arabization in Palestine in the early phase of Arab rule, which preceded by a few generations the processes of Islamization.

Acknowledgments

The exploration was directed by the authors, with the participation of archaeology students from the Martin (Szusz) Department of Land of Israel and Archaeology at Bar-Ilan University, and the support of Nili Graicer, Yotam and Gilad Zissu and Yehuda Mizrachi. Research has been made possible by the assistance of the Krauthammer Cathedra and the Jeselsohn Epigraphic

Center of Jewish History at the Bar-Ilan University.

References

Cassius Dio, Historia Romana, ed. E. Cary [Loeb Classical Library, 8], London, 1968.

Di Segni L, 2007. On the Development of Christian Cult Sites on Tombs of the Second Temple Period, ARAM 18-19, 381-401.

Di Segni L, Patrich J, 1990. The Greek Inscriptions in the Cave Chapel of Horvat Qasra, 'Atiqot 10, 141-154 (Hebrew).

Eck W, 1999.The Bar Kokhba Revolt: The Roman Point of View, Journal of Roman Studies 89, 76-89.

Eck W, 2007. Rom herausfordern: Bar Kochba im Kampf gegen das Imperium Romanum, Das Bild des Bar Kochba-Aufstandes im Spiegel der neuen epigraphischen Überlieferung, Roma, Unione internazionale degli istituti di archeologia, storia e storia dell'arte.

Eshel H, Zissu B, 2015. The Bar Kokhba Revolt, The Archaeological Evidence, Jerusalem, Israel Exploration Society and Yad Izhak Ben-Zvi 2015 (Hebrew)

Hirschfeld Y, 1998. Early Roman Manor Houses in Judea and the Site of Khirbet Qumran, Journal of Near Eastern Studies 57/3, 161-189.

Hirschfeld Y, 2000. General Discussion: Ramat Hanadiv in Context, in: Y. Hirschfeld (ed), Ramat Hanadiv Excavations, Final Report of the 1984-1998 Excavations, Jerusalem, Israel Exploration Society, 679-735

Kloner A, 1990, The Cave Chapel of Horvat Qasra, 'Atiqot 10. 129-137 (Hebrew).

Kloner A, 2001. The Economy of Hellenistic Maresha, in ZH Archibald, J Davis, V Gabrielsen and GJ Oliver (eds.) Hellenistic Economies. London-New York, 103-131.

Kloner A, 2003. Maresha Excavations Final Report I: Subterranean Complexes 21, 44, 70 (IAA Reports 17), Jerusalem.

Kloner A, Zissu B, 2003. Hiding Complexes in Judaea: An Archaeological and Geographical Update on the Area of the Bar Kokhba Revolt, in: P Schäfer (ed.), The Bar Kokhba War Reconsidered, New Perspectives on the Second Jewish Revolt against Rome, Tübingen, 181–216.

Kloner A, Zissu B., 2009, Underground Hiding Complexes in Israel and the Bar Kokhba Revolt, Opera Ipogea 1/2009, 9-28.

Kloner A, Zissu B, 2013. The Subterranean Complexes of Maresha: An Urban Center from the Hellenistic Period in the Judean Foothills, Israel, Opera Ipogea, Journal of Speleology in Artificial Caves 2/2013, 45-62.

Kloner A, Zissu B, and Graicer N, 2015. The Hiding Complexes at Horvat Qasra, Southern Judean Foothills. in: A. Tavger, Z. Amar and M. Billig (eds.), In the Highland's Depth, Ephraim Range and Binyamin Research Studies 5. Ariel-Talmon. 151-163 (Hebrew).

Lawrence, AW, 1979, Greek Aims in Fortifications, Oxford.

Patrich J. 2011. The Impact of the Muslim Conquest on Monasticism in the Desert of Jerusalem, Continuités de l'occupation entre les periodes byzantine et abbasside au Proche-Orient, viie-ixe siècles [Colloque Intrenationale Proche-Orient, Paris, 18-20 Octobre 2007], Turnhout 205-218.

Zissu B, 1995. Kh. Aleq and Kh. Abu Haf - Two Herodian Columbaria Towers. in: J. Humphrey (ed.). Roman and Byzantine Near East, Journal of Roman Archaeology, Supplementary Series 14. Ann Arbor. Michigan, 56-69.

Zissu B, 2002. Rural Settlement in the Judaean Hills and Foothills from the Late Second Temple Period to the Bar Kokhba Revolt, Ph.D. Dissertation, Jerusalem, The Hebrew University, (Heb)

Zissu B, Kloner A, 2014, Rock-Cut Hiding Complexes from the Roman Period in Israel, Der Erdstall, Beitraege zur Erforschung kuenstlicher Hoehlen 40, 96-119.

Zissu B, Rokach S, 1999. A Hellenistic Columbarium at Ziqim. 'Atiqot 38, 65-73.

NEW CONSIDERATIONS ON THE ARCHITECTURAL STRUCTURE OF THE VARDZIA ROCK-CUT ENSEMBLE AND PECULIARITIES OF THE ONGOING MONASTIC LIFE

Nodar Bakhtadze
Ilia State University, 3/5 K. Cholokashvili Ave, Tbilisi 0162, Georgia
Georgian National Museum,3 Rustaveli Ave, Tbilisi 0105, Georgia

Abstract

Many, often mutually exclusive – views have been expressed in Georgian historiography regarding the peculiarities of the architectural structure and purpose of the grand rock-cut ensemble of Vardzia, situated in historical Javakheti, Georgia. In the author's view, Vardzia is the only cave monastery in Georgia, cut in rock according to a plan worked out in advance. By this it sharply differs from all the other fairly large cave monastic complexes in Georgia were gradually expanded over several centuries. Hence they constitute conglomerates of churches and cells or other cave facilities, created in different styles, only finally brought into a single conceptual system.

The fact that – unlike other Georgian cave monasteries – it is only in the Vardzia complex that we find numerous dwellings of monks, hewn side by side in succession, represented by single planning and conceptualized by artistic style, unified, as it were, typologically, may serve as proof of practically concurrent creation of the facilities of the Vardzia complex.

Such sectional planning of the cave dwelling of Vardzia seems to have influenced some Georgian scholars in the past, leading them to the opinion that this complex was originally hewn as a strong hold. I believe, such conceptualization of even the primary function of Vardzia is unreal: fixed barracks of similar planning are unknown in medieval Georgian or foreign military practice. The extremely close arrangement of the rock dwellings and the unnaturally small sizes of everyday life facilities rules out even the version of the development of the monastery on the basis of secular settlement.

Thus, the dwelling sections – the most numerous part of the cave rooms of the Vardzia complex – appear to have been created to accommodate the monks with maximum comfort and convenience. The fact that some dwelling sections of this type have an individual chapel, cut in rock, is one more proof of such private churches near the dwellings of small groups of monks, as well as provision of each cave-cell with a solid supply of foodstuffs in larders, may be indicative of Vardzia initially organized on the pattern of a laura, one of the two recognized types of monastery of the orthodox church. Unlike general dwelling monasteries (coenobia), the monks gathered for liturgy and prayers and refectory not every day but only on Saturdays and Sundays, This being in full accordance with the rules recorded in Vardzia.

I am left with the impression that the creation of the Vardzia cave monastery in the cited architectural style in the high Middle Ages was due to the desire to harmonize the ascetism characteristic of the cave monasteries of the early Middle Ages, on the one hand, with the spirit of the Eastern renaissance, i.e. bringing man's individualism to the fore, on the other.

Keywords

Georgia, Rock-cut, Cave Monastery, Coenobia, Laura

Fig. 1: The Vardzia Cave Monastery (photo N. Bakhtadze).

1. Introduction

The Vardzia rock-cut monastic ensemble is located in the South of Georgia, in the province of Meskheti, on the left slope of the river Mtkvari.

A lot of opinions, often even contradictory, are expressed in the Georgian historiography about the structural peculiarirites of the Vardzia ensemble as well as the destination of its constituent cave storing spaces. That is why we considered that some of our new viewpoints might possibly represent a step forward towards understanding the function of the Vardzia ensemble and resolving the problem of its creation date.

In different regions of Georgia in the great majority of the known Christian cave monasteries‘ architectural structure the following regularity can be clearly observed: their constituent, more or less exquisitely planned cave chapels and other abode, since early middle ages, during centuries gradually, frequently due to rock relief, have ut matching organically their own ideas with the different styles of their predecessors (Bakhtadze 2003, 2007; Bakhtadze et al., 2017).

The Gareji Mravalmta – the groups of the Georgian most powelful cave monasteries provide the grounds of such assumption. The research conducted in the last decades convinced us that all the Gareji Mravalmta monasteries without exception, have been built as a result of thorough reconstruction of the relatively primitive deserts, existing prior to the High Middle Ages. In their structure, here and there, the early medieval cave monastic cells and chapels are still preserved up to now. Consequently, speaking about a unified architectural and compositional style of the renewed cloister is doubtful.

2. How Convincingly the Initial Planning of the Vardzia Ensemble indicates its Monastic destination

As it seems, in High medieval Georgia, the Vardzia rock – cut ensemble represents the only vast cave monastery, definitely created according to the previously elaborated detailed architectural design.

We don’t mean at all that in the given spacious rock massif, where nowadays the Vardzia grandiose ensemble is located,

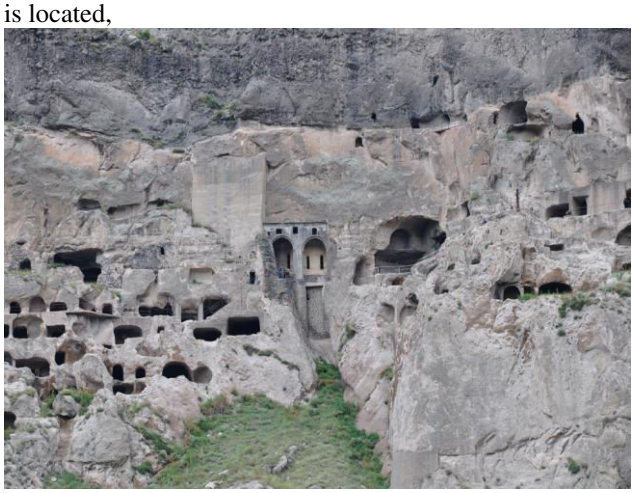


Fig. 2: Central part of the Vardzia Monastery (photo N. Bakhtadze).

it is impossible to find more or less extensive cave-dwellings or even small abodes for hermit monks of earlier epoch. On the contrary, the factual materials confirm that rocky slopes of Vardzia represented rather attractive places to cut cave shelters from the ancient times (Gaprindashvili 1960; Melitauri 1961). K. Melitauri – a well-known researcher of the Georgian rock monuments at the time of reviewing the planning of the Vardzia monastic ensemble, noticed the fact that in the western part of the complex there are remains of several caves of much more primitive planning.

What is more, another resercher of rock-cut monuments – G. Kipiani consideres that planning elements of pre-Christian phase are still considerably present in the Vardzia general architectural structure (Kipiani 2004).

When we call the Vardzia cave monastery as simultaneously constructed architectural ensemble, we mean that unlike Gareji Mravalmta rather adapted monasteries, its creators practically did not take into account the previously existed cave abodes, which were almost entirely sacrificed to the mentioned above totally new construction (excluding a separately constructed *Ananauri* group).

It’s obvious that we do not use the expressions _ "created at the same time", "unified plan", according to theur current understanding. Written historical sources tell us that cutting of the Vardzia cave monastery was started at the will of the Georgian King Giorgi III and was finished only in the reign of his daughter – Tamar in the 80-s of the XII century (History and... 1959, 91). Perhaps, within the period of a few decades, in accordance to the various Ktitors‘ viewpoints, the ensemble’s scale or planning development of separate parts were partially changed, but it’s hard to say now how serious such revision was.

There is an opinion that the central monastery was remarkably altered in Queen Tamar’s period and instead of originally conceived, relatively modest church it was replaced by the one that we can see nowadays (Gaprindashvili 1960; Melitauri 1975).

A researcher G. Gaprindashvili thinks that at the time of Giorgi III, there was a small rock-cut church, which could not satisfy the need for monastery during Queen Tamar’s reign and, as a result of the reconstruction, a new larger existing currently hall Church of the Assumprion of the Blessed Virgin Mary was created in its place (table II-4). He considers part of the apsis arch, preserved up to now in the east of the temple gate as the remains of the old church (Gaprindashvili 1960, 50). However, the scientist could not find the explanation of the fact, why in the middle of the XII century, the central cathedral of the Vardzia grandiose cave monastery was hewn so small-sized that only 2 decades later, it became necessary to thoroughly

reconstruct it and create practically new, much larger temple.

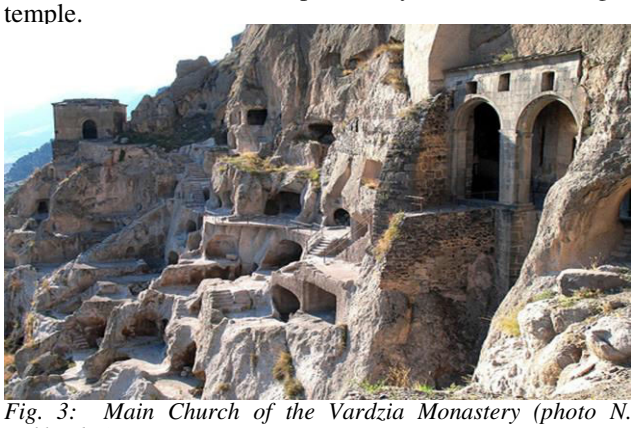


Fig. 3: Main Church of the Vardzia Monastery (photo N. Bakhtadze)

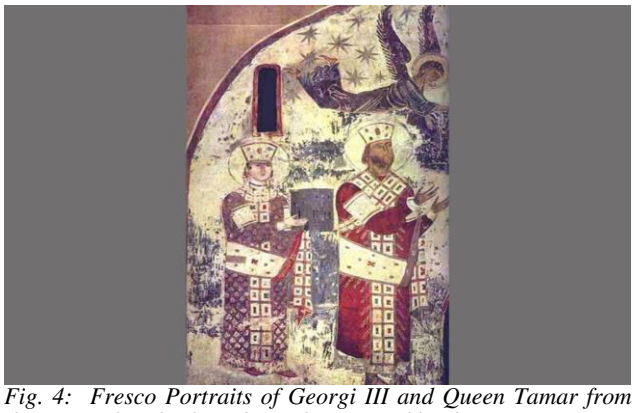


Fig. 4: Fresco Portraits of Georgi III and Queen Tamar from the Main Church of Vardzia (photo N. Bakhtadze).

K. Melitauri imagined the replacement of Vardzia old church with the new main temple in the exactly same way; however, we think his position in relation with the mentioned above issue can be explained in a simpler manner due to the following circumstances: he believed that Vardzia was intended by Giorgi III not as monastery, but as strategically conveniently located rock-cut fortress (Melitauri 1975, 11), where permanent Royal military post (garrison) should have been situated. This hypothesis was taken into consideration by several well-known Georgian scientists (Zaqaraia 1986; Privalova 1986). According to the researcher, planning and architectural peculiarities of most cave dwellings and spaces in Vardzia indicate the given functional load: from the porticos, passing through each other that at the same time create longitudinal "girders", the entrances into soldiers‘ cave dwellings were arranged; these entrances with their spaces and planning complexity (single or several-cave spaces), beautifications and some artistic elements, corresponded to their dwellers‘ military rank differentiation (Melitauri 1975, 16).

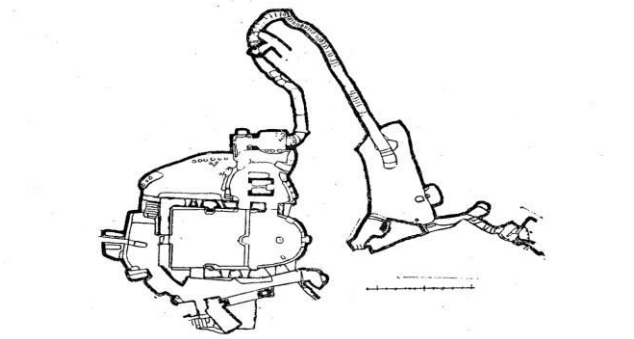


Fig. 5: Plan of Main Church of the Vardzia Monastery (drawing K. Melitauri).

Perhaps, this situation helped to develop the version, according to which a small church at the given site during Queen Tamar’s reign, was replaced by today’s central temple after the transformation of the Vadzia fortification complex into monastery.

Such interpretation of the first phase of Vardzia construction seems to us rather unconvincing. Indeed, among the medieval fortresses, preserved in Georgia and adjacent regions, there is no proven precedent that the army dwelling barraks represent individual, isolatied from each other clusters of accommodation, equiped with autonomous subsidiary utility spaces, storages and devices (storerooms, larders and closets, wine cellars, wine presses and etc.) and beautified with artistic elements.

Fig. 6: Interior of typical cell from the Vardzia Monastery (photo M. Vakhromeyeva).

Moreover, it is unlikely the small, individual chapels to be hewn in the rock for small groups of warriors (regardless of their military rank) together with separated dwelling spaces.

The general scheme of Vardzia caves and dwellings, at a glance finds some common signs with ethnographically and archeologically confirmed traditional Georgian medieval communal (common) dwellings: here a „corridor“, main room and subsidiary spaces (wine cellar, storerooms) were located along a longitudinal axis (in this case, in the direction to the rock depth). Nevertheless, the planning and spatial proportion of each rock dweling element in Vardzia differs significantly from stone architecture samples: here we can clearly see the tendency – their narrowing and elongation toward the rock depth. The main difference between these two dwelling types is as follows: unlike the dwelling houses of households, the Vardzia rock dwellings are situated unnaturally close to each other, side by side (they are often separated from each other only by the narrow wall of rock); at the same time, their small-size subsidiary storage spaces (larders) can only be used to store semi-prepared food products and not for producing and processing agricultural crops (it is especially true about arable farming and livestock products).

Therefore, it’s obvious that in the form of rock dwelling clusters, we have to do with some kind of shared dwelling system, the community members of which did not practice

any independent economic activity. If we also take into consideration frequent existence of the small churches and chapels into these dwelling cells, we will be even more convinced that the mentioned above cave „sections“ of Vardzia could have been nothing, except maximally cosy dwelling cells with storage spaces for monks, initially created for them to be estranged from the secular problems and practice spiritual life.

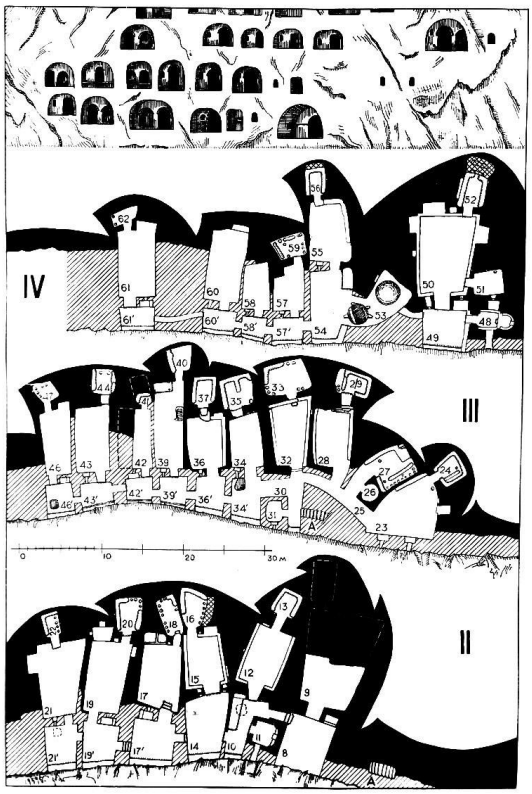


Fig. 7: Plans of the cells of the Vardzia Monastery (drawing K. Melitauri).

Here the following question naturally arises: we have excluded the initial secular function of the dwellings in the Vardzia complex the due to absence of fortresses, citadels and mundane settlements of the aforesaid analogous structure; however, can we find so sensibly-planned, built all-in-one-piece dwelling caves and cells, constructed in single artistic style among the monasteries of Georgia and neighboring Christendom countries?

Really, regularly planned cells as monks‘ dwelling shelters were not hewn in the desert monasteris of the early mediaeval Georgia and Eastern – Christian countries (Chubinashvili 1948; Hirschfeld 1992). And even afterwards, in the High Middle Ages, in this respect, the situation in Georgia has only partially changed: for example., in the Gareji Mravalmta rock–cut monasteries, in the newly founded and reconstructed cave complexes, apparently instead of narrow and shapeless shelters of ascetic monks, much more convenient, well-formed and elaboratly planned cave dwellings were hewn, however, even among these shelters we cannot notice not only analogous to Vardzia cave-cell rows, but also even the smallest groups of monastic cave dwellings sitiated close to one another, planning of which was carried out in accordance with and based on the same general principle.

As it was found out, the main difference between the Vardzia monastery and Georgian other cave dwellings of the approximately same time, is in typological unification of the mentioned above cave shelters and transforming this theme into the leading planning principle for the entire complex.

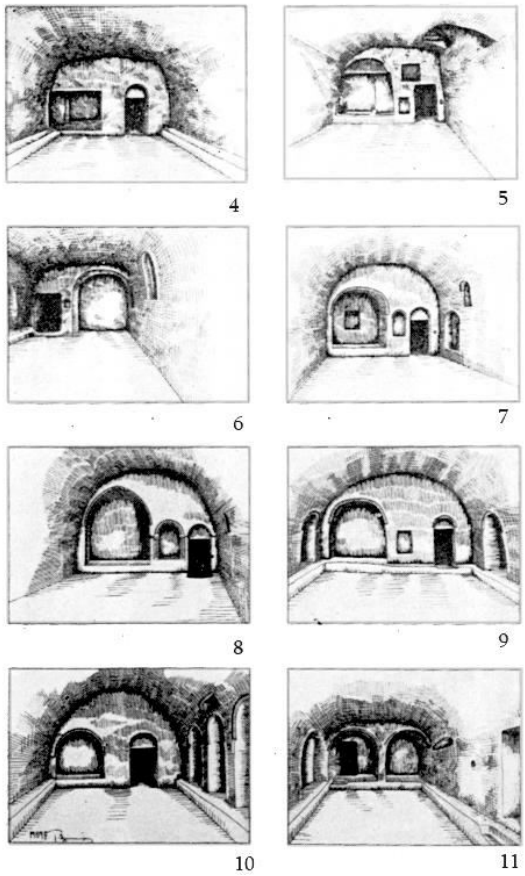


Fig. 8: Typhical cave cells of the Vardzia Monastery (drawing K. Melitauri)

We tried to understand whether such systematization of dwelling cells represents reflection of peculiarities characteristic for cave stone monastic architecture of the given period, but transformed into rock-hewn dwelling spaces of the same destination.

During the High Middle Ages, in particular in XII-XIII centuries, rather lively monastic construction was underway in Georgia: new, brilliant monastic ensamples were being built, old complexes were being expanded and beautified (Gelati, Opiza, Oshki, Khakhuli, Betania, Kvatakhevi, Ikalto,Ubisa and many others) (Beridze 1974).

Due to cataclysms and peripeties in the subsequent centuries, out of the constituent buildings of the mentioned above monastery complexes, only churches and a few samples of monumental architecture reached us in the initial or more or less altered forms (belfries, refectories and others). The fact is that in the late Middle Ages, during every subsequent restoration and reconstruction that was carried out, exactly these buidings used to be restored close to original form first of all, whereas subsidiary, economic and fortification structures were constructed anew, and often carelessly.

Regardless scarcity of the factual material, the

compositional integrity and careful elaboration of the structures, preserved on the premises of these outstanding monasteries, still make us think that in thier general plans, even dwelling cells would have definite places there, and we do not believe that they could bring discord into this brilliant ensemble with their occasional forms and inappropriate facelessness.

Architectural structure of monastic complexes, built in the mentioned above period of time throughout the Byzantine world countries, represents the basis for such proof. Apparently, in the subsequent centuries the monasteries in these countries also underwent destruction and reconstruction, however, due to special political status or simply thanks to their numerousness, some of the monastic complexes are still preserved in the given regions; unlike the Georgian abodes, the mentioned above monasteries have retained the High Medieval structure almost intact.

Familiarization with a number of Byzantine monasteries of the aforesaid epoch (for example., St. Luke's Church and St. Daphni Monastery on the Mount of Athos and others) has convinced us (Kondakov 1902) that dwelling sections for monks are built within the complexes, arranged as a rule side by side and following one another successively, located in section-style, with approximately equal–size rooms, constructed along the monastery wall. These dwellings with dead wall, or illuminated by small windows, are situated with their back to the fence, they can be entered directly from the monastery yard or elongated, the open gallery arranged on the same side. In places, such „common dwellings" for monks are found around the several walls, stretched towards the fortress yard, sometimes in 2 floors. Not rarely these „typical" residential accommodations have additional utility spaces at one side of the cells or another.

Similarly planned cell systems have been also preserved in some of the High Medieval Armenian monastery complexes (Geghardi, Tatevi and etc.). According to the Armenian scientists' argumentation, these dwellings are also contemporary with the main buildings of the monasteries (Khalpakhchian 1971, 36, 42).

We do not have any information about wide prevalence of the cave cell systems with analogical structure (i.e. Vadzia type) among the X-XIV c.c. cave monasteries of the Byzantine world. As it seems, in the cave monasteries of Cappadocia and some other regions, similarly to the Gareji deserts, shifting the tradition of hewing out the cave dwellings into the background was practiced during the given period and all the attention was again focused on „sculpturing" churches and other public facilities (Rodley 1985; Kostof 1989).

While discussing the origins and genesis of the Christian cave monateries' sectional structure we cannot avoid one more circumstance. The fact is that if rock hewn Christian monasteries of such planning are rare, compositionally similar to them complexes (obviously, with other kinds of temples), are very characteristic of the Buddhist monasticism of central and South Asia.

Rock-cut Buddhist monateries were spread in IV-X c.c. AD, successively first of all in Western India, then in Balkh (Afganistan), Eastern Turkistan and North China (Litvinski; Pichikjan 1986). Separate chapels and abodes of such monasteries, were characterized by straight geometric shapes and monumentality from the early stages, however, initially they were hewn in the rocky massifs in more or less scattered groups and only later gained the shape of a compactly planned cluster. The monastic cells – constituent components of the latest phase (approximately VIII-X c.c.) of the Buddhist monasteries, are distinguished with regularly repeated structure. For example, the formed and typically planned dwellings of the Buddhist monastery „Tuiuk-Mazari", located in Eastern Turkestan, were hewn side by side (Litvinski; Pichikjan 1986, pic. 15). Each of these cave dwelling sections consists of 3 elongated towards the rock depth and passing through each other storing spaces, out of which the latest small-sized one represents a larder.

In the Buddhist monasteries of this category and rank, the cave-cells of the described structure are hewn in the vertical rock masifs in several tiers and it calls up an association with the Vardzia monastery from the viewpoint of planning as well as visually. It is noteworthy that some of the monastery cave cells with arched ceilings and decorated interiors (for example, Shikshini Abbey) are similar to the Vardzia rock houses (Litvinski; Pichikjan 1986, pic. 3, 4).

Obviously, we are far from the idea to look for direct prototypes of the Christian monasteries (including Vardzia), created according to regular planning in the High Middle Ages among Buddhist monasteries of Central Asia, but the mentioned above similarity, is probably not completely accidental.

In our opinion, identity of the dwelling cells for the monks representing different religions, first of all, indicates their inhabitants' same social status and is the consequence for the development of organized monasticism. We should also take into consideration that separate elements of the Christian as well as Buddhist cave abodes were probably taken from the common residental spaces, built with ordinary materials; and resemblance to these cave dwelligns may represent the reflection of the stony residential houses, typologically identical for the mentioned above region.

On the other hand, in Georgia – the country located at the confluence of Eastern and Western cultures, in the XII-XIII centuries, out of the other fields of art, enriched from aforesaid cultural flows, it would be improper to consider only rock architecture (even cult architecture) as a phenomenon formed owing to only local art, or thrived under the influence of the western civilization. We should suppose that the architects – creators of Vardzia would be very much aware of secular or cult construction art, characteristic for western as well as eastern civilizations and existence of rock-cut Buddhist monasteries widespread in central regions of Asia would not be unknown for them either.

Naturally, while planning and compositional solution of the Vardzia monastic ensemble, the Georgian craftsmen would combined local, centuries-old traditions of rock architecture with Oriental and Western world architectural achievements as it was happening in any field of Georgian culture of the mentioned above epoch (for

example, phylosophy, secular or ecclesiastic literature).
We believe that the presented analysis of the leading atchitectural theme of Vadzia and the provided parallels about it will further consolidate the idea that this complex was originally intended by the customers and architects as the state Christian cultural leading hub of Georgia on its path towards political and economic prosperity, a grandiose monastery, which with its marvellous artistic appearance represented and reflected the Georgian faithful believers' aspiration for spiritual and aestethic perfection.
When we talk about the primary prerequisite of the

Vardzia construction, we have sufficient ground to assume that it was a very ambitious project of the powerful monarches, ruling over the politically and economically strong Georgia in the heyday of its glory, and undoubtly considering their country as potential successor of the Byzantine Empire, being at the time in grave crisis, and at least preparing themselves to perform the role of the bearing political and ideological power of Christian ideology throughout Western Asia and Black Sea countries.

3. Theoretical reconstruction of the monastic life style in Vardzia

Highly meaningful architectural style of the Vadzia cave ensemble, enables us to think about the creation of the monastery and liturgical service, performed in it at the time of its prosperity. In particular, we will try to address a very important issue: from the two types of monasteries in fact officially recognized by Eastern Christian churches (of Byzantine orientation), which functional monastic style cloister the customers and architects of Vardzia would like to create – common residential accommodation or Lavra.
In our opinion, it's quite possible that the mentioned above planning structure of the Vardzia rock-cut dwellings should indicate the arrangement of the monastery as Lavra. Otherwise, it is difficult to explain the circumstance that togeter with little refectory,

Fig. 9: Refectory of the Vardzia Monastery (photo M. Vakhromeyeva).

each cave cell was equipped with autonomous larders for storing large quantity of food and drink and an individual bakehouse oven and a hearth characteristic for High Medieval Georgian dwellings (Gaprindashvili 1960; Melitauri 1975). The fact of the matter is that in the monasteries functioning under the principle of living together (coenobia), monks' daily meal was common for everyone and, accordingly, larders for stroring foodstuffs and area for preparing meals were specially selected or localized in dwellings. However, in the planning structure of the Vardzia cave-cells, long-lasting care for individual meals by the monks is reflected, and that was only characteristic for Lavra (Hirschfeld 1992, 82-91).

The fact that there is a sufficient quantity of cave churches and chapels in the structure of the ensemble supports the assumption, proving functioning of the Laura-type monastery in Vardzia: daily obligatory prayers and liturgy in coenobia for monks living in the monastery were offered collectively in central churches, whereas in order to utter prayers related to certain event or activity for individual monks or their small groups, creation of separate chapels was only rare exception (for the purpose of uttering such kinds of prayers, cells were arranges with small praying niches inside).

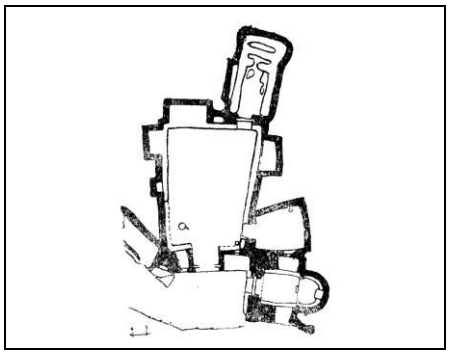


Fig. 10: Plan of the Cave cell with prayer room of the Vardzia Monastery (drawing G. Gaprindashvili).

We consider groundless the opinion of some researchers that in the large cave monasteries of the High Medieval Georgia, and in particular, within the Vardzia structure, the churches, existent at some of the monks'dwellings groups together with special architectural beautifications of the cave cells, represent on the one hand, the certain separatist trends and aspirations of the monks from the promoted social circles, living and functioning in these monasteries, and on the another hand, reflect the process of decentralization taking place in them (Gaprindashvili 1960, 68).
It is widely known that in medieval Georgia, as well as in the entire Christian world, monasteries together with spiritual practice often played the role of large landowning organizations. At the same time, within their hierarchy, high rank and well-off persons from promoted social strata frequently held especially high positions. It is logical to suppose that at the mentioned period of time, the monastery leaders would give certain privileges to the representatives of the highest aristocracy who used to come the monastery for spiritual activity, and would provide them with better living conditions compared to other monks of the same community (Javakhishvili 1984, 56-85). However, as it is known nowadays, these kind of exceptions in the Georgian monasteries of the given epoch did not become normality and, moreover, such approach

could not become the planning basis for a newly created monastery (Charter of the... 1939). As was mentioned earlier, the Vardzia dwelling groups of monks repeat nearly the same planning schemes and only slightly differ from each other in living conditions: we cannot consider some of the excessive niches or closets, hewn in the dwellings, or several richly decorated ornaments (tab. III) as signs, reflecting inequality due to social origin among brothers living and practicing in the monastery.

Such a slight difference of the cave dwellings, for example, decorative intensity of the cells' interior design, speaks more about monks' hierarchical differentiation in the monastery. Therefore, existence of "autonomy" in the depth of the Vardzia Royal monastery together with its own church and the internal regulations almost analogous to common secular rules cannot be regarded as regularity.

In the period of political unification of the Georgian Kingdom, expansion of Christian culture, the supreme secular authorities of Georgia and the highest church official leaders might have adopted one out of two officially recognized directions of monasticism throughout the Orthodox world, or implemented mixed principle in this extremely important cloister, but not something artificially created non-centralized system (even community of hermits - Lavra is strictly centralized monastic organization) (Hirschfeld 1992).

At first glance, a cave refectory, existent in Vardzia looks as an argument against the idea of Lavra-type monastic organization priority here, but from a position of our hypothesis, this fact can be explained: first of all, estimated number of inhabitant monks in the given monastery several times exceeds the probable number of the repast participants, having meal simultaneously in the mentioned above refectory section; secondly, experience of studying Christian monasteries abroad suggests that existence of a refectory in the monastery does not at all necessarily represent the factor, indicating functioning of the coenobium there, as apart from weekend communal prayer and liturgy in Lavras, also common meals were frequently arranged: fairly extensive refectories are confirmed in many well-known Eastern – Christian Lavras.

We should not rule out the possibility that within the Vardzia monastery complex, as well as in a number of other Eastern – Christian cloisters (for example, in Palestine, at monasteries of Mount Athos and others) (Hirschfeld 1992; Kondakov 1902), the principles of Lavra and coenobitic (communal) monasticism might have been merged, i.e., one part of monks may have lived in the coenobitic (communal) style, but separate hermits and anchorites could have been allowed to practice in cave dwelling groups. On the basis of the Vardzia planning principle, we still consider the latter assumption less probable: combining the mentioned above style of practices is more characteristic for monastic organizations scattered around on the relatively large territories (for example, Lavra of St. Savas); however, in such a compact monastery complex as Vardzia, it is difficult to imagine coenobitic monks living in the cells of nearly identical structures, and monks - recluses - in the rest of the dwellings; in Vardzia ensemble "hermits' groups" having their own chapels are not even slightly separated from the totality of dwelling cells. In addition, almost all cave dwellings and not only certain part of them, have their own larders or closets.

4. Theological ground for creation of the Vardzia Monastery

The facts stated above indicate that the Vardzia monastery was conceived and constructed as grandiose Lavra where, in contrast to early Christian deserts, the distance between monks' accommodation was no longer meaningful, and strict initial asceticism of the monks living and practicing in Lavra on weekdays (apart from Saturday and Sunday) was reduced to separated daily routine, and symbolic rules of life in cave cells. Perhaps the desire to revive the Lavra life style became one of the reasons to create large rock-cut monastic ensemble that was already anachronistic for the High Medieval Georgia and characterized only the Gareji desert at the time. Maybe the authors of the idea of building this magnificent monastery wanted to prove that life in the spacious, comfortable, aesthetically and artistically well-arranged, perfectly planned cave dwellings, situated in close vicinity to each other and created with the efforts of the Royal power would not prevent true ascetic practitioner from spiritual purification and devotedly serving Christian faith.

Of course, other unforeseen until today and stimulating factors may have been influenced the idea of the Vardzia monastery construction. In general, not many opinions are expressed by the Georgian scientists about the ideological or political and economic background that contributed to origin of the grandiose cave monastery in Vardzia. Among these theories, we consider one supposition very noteworthy, according to which gigantic scale and highly artistic architectural planning of the Vadzia monastery should be regarded as reflection of Eastern Renaissance in Georgian culture of the mentioned above epoch (Gaprindashvili 1975). Taking into account the factual material we have, we think that this idea might not be far from the truth.

As it is known, in the beginning of the XI century, in the philosophical thinking of the Byzantine world, the theological trend under the name of "Hesychasm" appeared. Later, especially in the XIII-XIV c.c., it gained much popularity in the cultural circles of Northern-Eastern regions. Some oversea scientists link Hesychasm movement to the revival of the strict ascetic rule of life in the Eastern - Christian monasticism (Ekonomtsev 1989, 130-132; Ханджийски 1985). For example, in the aforesaid period of time, increasing number of cave monasteries around the Balkan Peninsula, Bulgaria, Transdniestria and Kieven Rus, is perceived as a consequence of reinforcing the given direction (Ekonomtsev 1989, 5). According to recent foreign theological studies, Hesychasm followers not only consider isolation from only secular temptation as the goal, but also tried to enrich their own creativity and get closer to the divine nature through solitary prayer, delving deeply into their own way of thinking (although, they believed that it was impossible to delve deeply and

entirely into the divine nature) (Ekonomtsev 1989, 65-68). Therefore, in comparison with early Christian asceticism based on only regret, Hesychasm brought human individualism to the forefront by means of which this trend came nearer to the humanistic spirit of Western European Renaissance.

In our opinion, it is not excluded that in Georgia, where spiritual culture in the reported period was developing more or less in parallel with the processes taking place in Byzantine world, the aforesaid trends nourished by theological doctrines took roots; as a result, this event may have been reflected in different organizations of monastic movement or architectural structure of the dwelling shelters.

In the mentioned above planning peculiarities of Vardzia, we seem as if to really notice some similar signs characteristic to spirit of monasticism: practice and activity in cave dwellings emphasizes the hermits' aspirations towards asceticism, whereas equipping the "rock houses" with convenient and comfortable common household elements and their artistic decoration represent the reflection of the Renaissance approach to people's living environment.

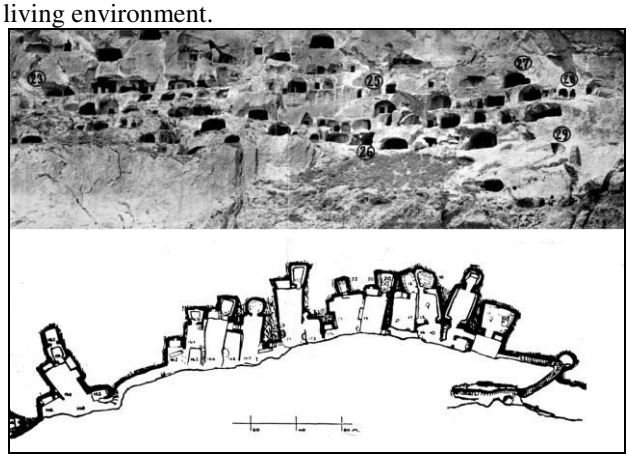


Fig. 11: Group of Cave cells of the Vardzia Monastery (drawing and photo G. Gaprindashvili).

References

Amiranashvili S, 1963. Исстория Грузинского Искусство (History of the Georgian Art). Moscow, 1963. [in Russian].

Bagrationi V, 1959. Description of the Kingdom of Georgia. Kartlis Tskhovreba, Vol. IV. Tbilisi. [In Georgian].

Bakhtadze N, 2003. Several Problems of the Genesis and Structure of Georgien Medieval Monasteries in Modern Georgien Historiografhy, Scientific Journal "Logos", 1, Tbilisi. pp. 13-21. [In Georgian].

Bakhtadze N, 2007. The Genesis and Paths of Development of Rock-Cut Architecture in Georgia. Tbilisi. [in Georgian].

Bakhtadze N, Gabekhadze B., Mamiashvili V , 2017. Typological and Chronological Problems of David-Gareji (Georgia) Cave Churches Against the Background of Cappadocian Rock-cut Monuments. Proceedings of International Congress of Speleology in Artificial Cavities – Cappadocia, March 6/8 2017. pp. 395-403.

Basili, Annalist of Queen Tamar, 1959. Kartlis Tskhovreba (History of Georgia), Vol. II. Tbilisi. pp. 115-150. [in Georgian].

Beridze V, 1974. Old Georgian Architecture. Tbilisi [in Georgian].

Charter of the Vakhani Monastery (13th century), 1939. Monuments of Georgian Law, 1. Ed. L. Muskhelishvili. Tbilisi. [in Georgian].

Chubinashvili G, 1948. Пещерные монастыри Давид-Гареджи (Cave Monasteries of David-Gareji). Тбилиси.[in Russian].

Gaprindashvili G, 1975. Ancient Monuments of Georgia: Vardzia. Leningrad. [in Russian].

Gaprindashvili G, 1987. Gareji . Тбилиси. [in Georgian].

Gaprindashvili G, 1960. Cave Complex of Vardzia (1156-1213). Tbilisi. [in Russian].

Gaprindashvili G, 1959. Cave Dwellings in the Village of Pia. Tbilisi. [in Georgian].

Gaprindashvili G, 1977. Скальные купольные храмы и их значение в развитии монументальной архитектуры Грузии. Пещеры Грузии, №12. pp. 34-50. Tbilisi [in Georgian].

Gaprindashvili G, 1957. Caves of Vardzia and Its Environs. Tbilisi, [in Georgian].

Khalpakhchian O, 1971. Civil Architecture of Armenia. Moscow. [in Russian].

Kipiani G, 2007. Review of the Book N. Bakhtadze "The Genesis and Paths of Development of Rock-Cut Architecture in Georgia". Handwriting. Tbilisi. [in Georgian].

Kondakov N, 1902. Monuments of Christian art on Athos. St. Petersburg. [in Russian].

Kostof S, 1989. Caves of God. Cappadocia and its Churches. p. 370. New York-Oxford.

Ekonomcev I, 1989. Hesychasm and the Eastern European Renaissance. Theological Works, 29. Moscow. [in Russian].

Hirschfeld Y, 1992. The Judean Desert monasteries in the byzantine Period. New Haven and London, Yale University Press.

History and Eulogy of Soverigns, 1959. Kartlis Tskhovreba (History of Georgia), Vol. II. pp. 101-114.Tbilisi. [in Georgian].

Litvinski B, Pichikian 1986. Cave Cult Architecture 0f East Turkestan. East Turkistan and Central Asia. pp. 81-125. Moscow.

Melitauri K, 1961. Studies in the Architecture of Varzia and History of Its Construction. Tbilisi. [in Georgian].

Melitauri K, 1963. Vardzia. Tbilisi. [in Russian].

Melitauri K, 1975. Building and Architecture of Varzia. Tbilisi.

Merchule Giorgi, 1982. Living of st. Grigol Khandzteli. Tbilisi. [in Georgian].

Mroveli Leonti, 1955. The Life of the Georgian Kings. Chronicle of Kartli, V. 1. p. 378. Tbilisi [In Georgian].

Muskhelishvili L, Khidasheli S., Japaridze V. 1954. Gudarekhi I and II Archaeological Expeditions Report. TRbilisi. [in Georgian].

Privalova E, 1986. Vardzia. Tbilisi. [in Georgian].

Rodley L, 1985. Cave Monasteries of Byzantine Cappadocia. p. 432. Cambridge.

Zakaraia P, Tis is the Eighth Wonder of the World. Literaturuli Saqartvelo, 03.10.1986. [in Georgian].

Javakhishvili I, 1982. History of the Georgian People, Vol. 7. Tbilisi [in Georgian].

Ханджийски А, 1985. Обители скалите. София. [in Bulgarian].

HYDRAULIC UNDERGROUND WORKS

THE RESURGENCE NEAR YARIMBURGAZ CAVE

Şengül G. Aydıngün[1], Haldun Aydıngün[2], Metin Albukrek[3], Gülşen Küçükali Üstün[4], Berk Üstün[5]
[1] *Faculty of Arts and Sciences, Kocaeli Unversity, Kocaeli, Turkey, sengul19@gmail.com*
[2] *Çanakkale Onsekiz Mart University, İstanbul, Turkey, haldunaydingun@hotmail.com*
[3] *Galeri Cave Research Group, İstanbul, Turkey, malbukrek@gmail.com*
[4] *Galeri Cave Research Group, İstanbul, Turkey, gulsenhera@gmail.com*
[5] *Galeri Cave Research Group, İstanbul, Turkey, berguver@gmail.com*

Abstract

Yarımburgaz cave is situated on the european part of Turkey, approximately 22 km west of the city of Istanbul Bosphorus, ca. 1.5 km north of Küçükçekmece lagoon, on the northeastern side of the Sazlıdere stream. Yarımburgaz cave is a globally important fossil cave, which contains many traces of the earliest humans. Modern excavations in this cave between 1963 and 1990 unearthed evidence for occupation in Paleolithic, Neolithic, Chalcolithic and Roman-Byzantine periods.
A water resurgence is situated about 200 meters southeast of Yarımburgaz cave.
Lots of archeological reseaches and publications have been done about Yarımburgaz cave. However, this nearby water resurgence has only been mentioned shortly in very few publications. This resurgenge, providing clean water, should have played a vital role during the whole archaeological history of Yarımburgaz cave. Moreover, this nearby underground stream could be the stream, which could have initially formed Yarımburgaz cave, when the Sazlıdere riverbed was at a higher level than today.
Until a few years ago, this resurgence was being used by municipality to pump out water for the city use. During this time, entrance into it was not possible. However, in the last years, due to extensive underground water abstraction from the surrounding area, the resurgence totally dried out and man-made galleries were discovered.

Keywords

Yarımburgaz Cave, early humans, resurgence, drinking water, homo erectus, prehistoric

1. History and importance of the area

Yarımburgaz cave is situated on the european part of Turkey, approximately 22 km west of the city of Istanbul Bosphorus, ca. 1.5 km north of Küçükçekmece lagoon, on the northeastern side of the Sazlıdere stream. This natural cave, located at Altınşehir, within the borders of the Başakşehir district of İstanbul, has a special place in World's cultural history because it has the oldest traces of humanity in Europe. The cave was a shelter and a good settlement site thanks to its proximity to the Küçükçekmece Lagoon Lake and Sazlıdere (Antique Bathynias River) passing in front of it. The cave has two entrances. The higher one leads to a single large chamber 52 meters long with a ceiling 15 meters high and it is connected to the lower one which opens to a 700 meters long branching galleries system. This latter, starting with a narrow single gallery, leads to a wide chamber with stalactites and stalagmites.

Yarımburgaz Cave is very important for the researches of prehistoric ages. But the first scientific papers appearing one and a half centuries ago concentrated mainly on its geologic featutes, (Abdullah bey 1869,1870,1874), Rabius Bousquet (1900/1901: 295-302), Harun Reşit Kocacan (1921: 12-18), Raymond Hovasse (1927: 1-19, 396-422) and GE Hubbard (1932: 321-328). Hovasse is the first person to draw attention to the prehistoric settlement of this cave. The first archaeological investigations in the cave were carried out by Şevket Aziz Kansu in 1959 (Kansu 1966; 1972). Further information was obtained when the soundings opened by Ismail Kılıç Kökten (1963: 277-278) in 1963 and Şevket Aziz Kansu-Necati Dolunay (Kansu 1966: 491-492) in 1964-1965.

Two decades later, in 1986, Istanbul Archaeological Museums carried out excavations under the scientific supervision of Istanbul University's Prof. Dr. Mehmet Özdoğan who concluded that the first human presence in the cave belongs to Lower Paleolithic (Özdoğan 1988: 323-335).

It is understood that the prehistoric chronology of the cave covers the period from 600,000 BC up to Late Chalcolithic, 3200 BC.

In the Byzantine period, Yarımburgaz was organized as a large monastery complex.

The excavations resumed in the scientific supervision of Prof. Dr. Güven Arsebük during the seasons of 1988-90 (Arsebük and Özbaşaran 1994: 17-27; Özbaşaran 1995).

More recent archaeological fieldwork in the basin of the Küçükçekmece lake was initiated in 2007 as part of the Istanbul Prehistoric Research Project, under the directorship of Assoc. Prof. Dr. Şengül Aydıngün of Kocaeli University. The project has been carried out by an international team of researchers in conjunction with the Turkish Ministry of Culture and Tourism. Within the scope of these researches (Aydıngün 2016: 217-230).

The Yarımburgaz Cave is represented by a geological formation called Altınşehir formation, with reef limestone at the bottom and clayey limestone at the top (Meriç 2010: 28). It is located on the western slope, of a small rocky hill of Middle Eocene origin overlooking Sazlıdere stream, flowing into Küçükçekmece Lake. The cave is formed naturally in the fossiliferous Eocene limestone. It provides a karstic feature (Meriç 2010: 28). The cave is a Middle Pleistocene cavern formed about 1,000,000 years ago. It is understood that after approximately 400,000 years from the formation of the cave, human groups started to use the cave. It is believed that human traces date back to about 600,000 years ago.

Considering that historically, Küçükçekmece Lake was connected to the Sea of Marmara, Yarımburgaz cave situated near the Sazlıdere river and the surrounding area, was probably a very attractive area for human settlement (Figure 1).

Figure 1. Location of the Yarımburgaz cave and water resurgence (source: Google Earth).

2. The Resurgence

Clean and drinkable water sources near settlement areas are very important in human history because they are a key element for sustaining life.

Hovasse, who had investigated the cave in detail, is the first person pointing out that the cave was very suitable for prehistoric settlement. In his article printed in 1927 in Turkish and French language, (Hovasse 1927: 1-19; 396-422) he clearly mentions about two resurgences situated south of the Yarımburgaz cave. He mentions that the biggest of them is situated 100 m south of the cave entrance, with a flowrate of 1 m3/second in spring season and which never dries in autumn. He also mentions that local habitants named the resurgence as “Tuna water” or “Small Tuna”, probably due to the huge amount of water emerging even in the dry summer season.

In 1982, one of the authors of this article observed a pumping station located approximately 200 m south of the entrance of the Yarımburgaz cave. Most probably this place was one of the resurgences Hovasse was mentioning. The pumping station was being operated by the governmental body (İSKİ), responsible for water and wastewater management of Istanbul city. At that time the area was fenced and locked, it was not possible to see what was inside.

In the last decades, in parallel to the increasing population of Istanbul city, the surrounding area of the cave and resurgence became filled with mostly illegally 3-4 floor buildings. Lots of illegal wells were also opened from their gardens for water supply. Around a drill hole, observed on the ceiling of the right gallery inside Yarımburgaz cave, there is a collapsed part of the ceiling, which could be caused by one of the unsuccessful water drilling trials (Aydıngün 2016: 222-227). There are also visible tanker filling stations around (Figure 2)

Figure 2. Underground water is heavily abstracted from the ground (photo Metin Albukrek).

These uncontrolled water wells decreased the water level inside the porous limestone aquifer around the naturally resurgence over time. Eventually the resurgences dried out and the pumping station operated by the water management of Istanbul city was left in an abandoned state.

Now, it was our turn to enter and see what was inside this legendary resurgence.

3. The Tunnels

When entering the resurgence, we were hoping to explore new natural cave galleries.

However, we were surprised to have encountered man-made tunnels. It seemed that some natural galleries and cracks were followed and enlarged to increase the flowrate of the abstracted water.

The map of the resurgence is given in Figure 3. A total of 103 m long tunnels were surveyed.

The main entrance is where suction pipes were installed. (Figure 4). These pipes were leading to a nearby partly destroyed building outside of the tunnels which could have been used to install the pumps.

The rectangular chamber, at the entrance, was leading to two tunnels, namely the right and main gallery (Figure 5).

The main gallery had a left branch, which we named the

"left gallery" on the map (Figure 6).

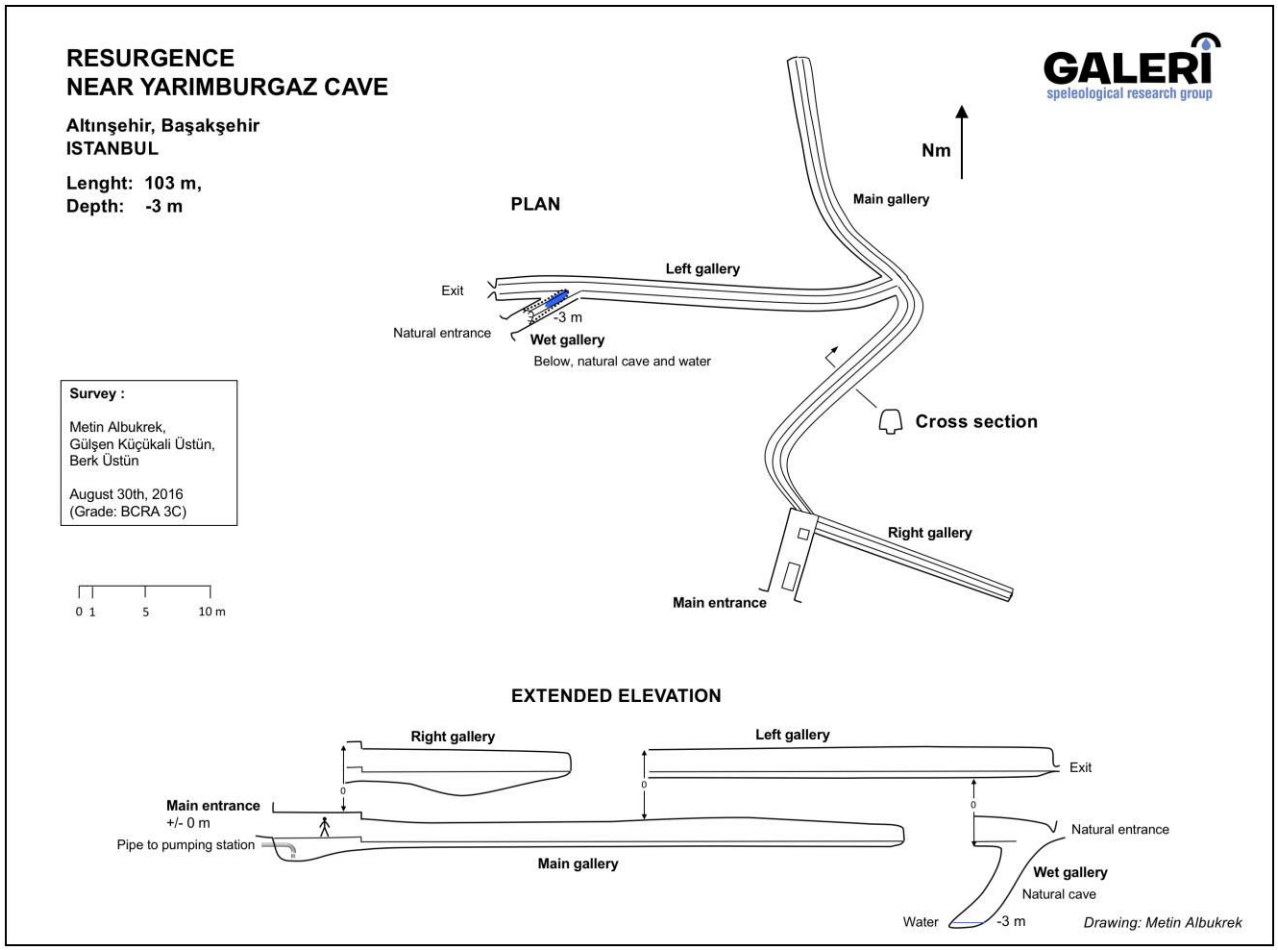


Figure 3. Map of the resurgence

originally covered with concrete slabs. These covers were most probably opened to check and clean the sediments accumulating over time.

Figure 4. Main entrance where suction pipes are located (photo Metin Albukrek).

Figure 5. Entrance to right and main galleries (photo Metin Albukrek).

To our surprise the "left gallery", and its new branch, which we named as "wet gallery", were both leading outside. The exit of these were initially closed by bricks, but now were broken by treasure hunters or had collapsed.

All galleries had 60-80 cm wide and 40-60 cm deep trenches on the ground, through which underground water was led to flow freely towards the main entrance. It could be observed that in many places, at the bottom of the trenches, there were natural cracks, through which underground water was emerging. These trenches were

In the "wet gallery" we encountered a natural part of the cave and descended down a 3 meter deep crack. There was a small lake below. Here was the only place we encountered water. The exit of this gallery to outside was not man-made and was seemingly a natural entrance.

This natural entrance, being closer to Yarımburgaz cave, most probably was the biggest resurgence mentioned by Hovasse, having a flowrate of 1 m3/second in spring

season, and never drying in autumn (Hovasse 1927).

The second resurgence mentioned by Hovasse might then be at the place of the “main entrance” as named on our map.

Figure 6. “Left gallery” joining the main gallery (photo Metin Albukrek).

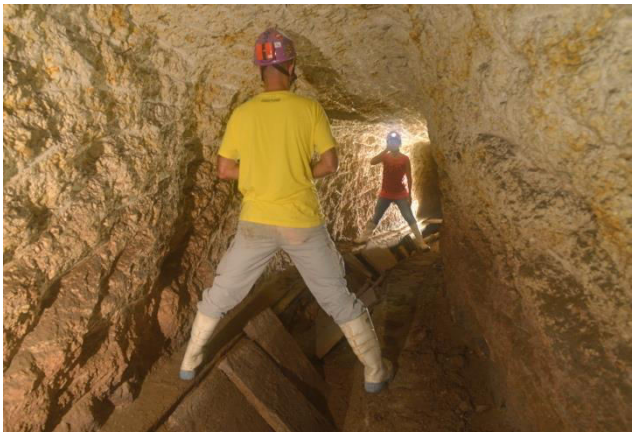


Figure 7. Mapping the “left gallery” (photo Metin Albukrek).

4. Discussion and Conclusions

In this study the resurgences mentioned by Hovasse were located. However, due to enlargement of the resurgence for water abstraction in the last century, the original shape of the resurgence could not be determined. Instead, 103 meters of man-made tunnels were mapped.

About 600,000 years ago, for some time, these resurgences were providing safe drinking water to inhabitants in the cave and in the surrounding area. The same resurgence was used in past decades by the water management of Istanbul city to provide water to the inhabitants.

Moreover, this nearby underground stream could be the stream, which could have initially formed Yarımburgaz cave, when the Sazlıdere riverbed was at a higher level than today.

Unfortunatelly today, because of overpopupation and extensive underground wells, the legendary resurgence is dry.

References

Abdullah-Bey, 1869. Die Umgebung des See’s Kütschücktschekmetché in Rumelien". Verhandlungen der K.K Geologischen Reichsanstalt, Vienna, 12, 263-265 (in German).

Abdullah-Bey, 1870. "Etudes géologique sur les environs de Constantinople, Yarim Bourgas, Macri Keuy-Sri Keuy". Gazette Médicale d‘Orient (in French).

Abdullah-Bey, 1874. “Yarımburgaz Mağarası-Sur Yarım Burgaz Cave” Gazette Médicale d‘Orient - Mecmua-ı Tıbbiye, 18-19 (in French).

Aydıngün Ş., 2016. Yarımburgaz Mağarasında Son Durum, Arkeoloji ve Sanat Dergisi, 152, 217-230 (in Turkish).

Arsebük, G., M. Özbaşaran, 1994. “Yarımburgaz Mağaraları Pleistosen’den bir Kesit” Türk Tarih Kongresi XI, Kongreye Sunulan Bildiriler, 1,17-27 (in Turkish).

Bousquet, R.,1900/1901. "Lesgrottes de Yarım-Bourgaz", Echosd‘Orient, 4, 295-302 (in French).

Hovasse, R., 1927. "La grotte de Yarim Bourgas", “Yarımburgaz Mağarası” Darülfünun Fen Fakültesi Mecmuası (İstanbul) 5:1-19 (French), 396-422 (in Turkish).

Hubbard, G. E., 1932. "Turkish Grottoes of Yarım Burgaz" Pan-American Geologist, 57, 321-328.

Kansu, Ş. A., 1963. "Marmara Bölgesi ve Trakya’da Prehistorik İskân Tarihi Bakımından Araştırmalar (1959-1962)". Belleten, XXVII, (108), 658-660 (in Turkish).

Kansu, Ş. A., 1966. Haberler-Kazılar ve Marmara ve Trakya Bölgesinde Tarih Öncesi Araştırmaları” Belleten, XXX (119), 491-492 (in Turkish).

Kansu, Ş. A.,1972. "Yarımburgaz (Küçükçekmece-İstanbul) Mağarası'nda Türk Tarih Kurumu Adına Yapılan Prehistorya Araştırmaları ve Tuzla Kalkolitiğinde Yeni Gözlemler ", VII. Türk Tarih Kongresi, Ankara,1, 22-30. Lev. 31-32 (in Turkish).

Kökten, İ.K.,1963."İstanbul’un Batısında Eskitaş (Paleolitik) Devrine Ait Yeni Buluntular” Dil ve Tarih Coğrafya Fakültesi Dergisi, Ankara, 20 (3-4), 277-278, lev.1 (in Turkish).

Kocacan, H.R., 1921. "Bir Mağara Nasıl Tetkik Olunur?", Tedrisat Mecmuası, 61, 12-18 (in Turkish).

Meriç, E., 2010. Jeoloji ve Arkeoloji İstanbul ve Yakın Çevresinin 8500 Yıllık Geçmişinden Kesitler, Mimarlar Odası Yayınları, İstanbul (in Turkish).

Özbaşaran M., 1995, Historic Background of Researches at the Caves of Yarımburgaz. In: Halet Çambel için Prehistorya Yazıları: Readings in Prehistory Studies Presented to Halet Çambel, Grapis Yayınları, Istanbul, pp. 27-39.

Özdoğan,M.,1988. “Yarımburgaz Mağarası 1986 yılı Kazı Çalışmaları” Araştırma Sonuçları Toplantısı, V(II):, 323-346 (in Turkish)

THE ARTIFICIAL DRAINAGE SYSTEM OF GABII (OR CASTIGLIONE) LAKE IN LATIUM, ITALY. A COMPARISON AMONG THE INVESTIGATIONS OF THE '90S AND A RECENT STUDY AIMING AT A POSSIBLE RESTORATION OF THE OLD LAKE BASIN

Vittoria Caloi[1,2], Carlo Germani[1,2], Carla Galeazzi[1,2]
[1] *Egeria Centro Ricerche Sotterranee, Via Nicola Nisco 2, 00179 Rome (Italy),*
[2] *Comm. Artificial Cavities of the Italian Speleological Society,*
vittoria.caloi@iaps.inaf.it - carlo.germani@gmail.com (reference author) - carla.galeazzi3@alice.it

Abstract
The present artificial outflow (drainage system) of the dried up Lake of Castiglione or of Gabi has been investigated in 1994 by Caloi *et al.*. This study could not solve all the questions posed by that complex structure, including the epoch of its making, the possible relations with the works carried out by the Borghese family in 1600 and 1800, the presence of tunnels - likely older - which cross the outlet. In recent times, the scholar Leonardo Lombardi has performed an accurate geological, hydrogeological and geochemical investigation of the area, in order to estimate the possibility of restoring the old lake basin. We exploited parts of this far reaching and complex work in the attempt of giving an answer to the unsolved questions mentioned before.

Keywords
artificial drainage systems, artificial underground outflow channel, Castiglione Lake, Gabi Lake, speleological investigations, geology, hydrogeology, geochemistry.

1. Foreword

The present underground outflow channel of the former Lake Castiglione - or Lake Gabi - has been investigated in 1994 by Caloi *et al*. and by Castellani (1999). These investigations left unanswered a few relevant points, among which the dating of the artefact, the relevance of the works by the Borghese family in the XVII and XIX centuries, the presence of tunnels which cross the channel.

In 2004 the geologist Leonardo Lombardi and collaborators (Lombardi *et al*., 2004) performed an accurate investigation - geologic, hydrogeologic and geochemical - of the zone of the former lake, the team having won the competition called by the VI Department of the Municipality of Rome in order to evaluate the possibility of restoring the former lake basin.

Their study involved researches in deep by means of soundings, water tapping, analysis of water quality, lithostratigraphy, geologic models, historical investigations, and more. For what concerns historic matters, Lombardi *et al*. report the results of the excavations in the so called necropolis at Osa, together with considerations and comments by past and present scholars.

Following Lombardi's prompting, we decided to exploit some of his extensive and complex work, which developed an investigation much more complete than the one performed in the years '90, with the aim of answering, if possible, some of the unresolved questions mentioned above.

2. Gabii and its lake: a few data

The Castiglione basin is located in a crater of explosive origin, at the border of the Volcanic District of the Alban Hills. The diameter at the crater brink is about 1.5 Km, the area of the plateau at the bottom is about 0.75 km^2. The maximum height of the steep crateric banks is of about 100 m in the eastern section, and the lowest altitude is found in the south-western section (49-51 m), being the crater bottom at about 45-46 m above sea level. It is not possible to establish whether this situation has changed over time.

In prehistoric times the basin of Castiglione was filled up with water, as shown by the geologic soundings performed in the years '80; these surveys have allowed to reconstruct the series of lacustrine deposits, dating the formation of the water basin at about 275.000 years ago (Lombardi *et al*., 2004).

The Latin town of Gabii was positioned on the eastern bank of the crater; it is quoted by Strabo (Geography, vol. V, par. VII), but without reference to a lake. Other ancient authors (Dionigi, Livy, Virgil) refer to a town of great importance in the long strife between Rome and the Tarquinii, a town in which, according to the legend, Romulus and Remus had been raised. Gabii was in a key location along the routes towards Campania, since it was positioned on the Prenestina way and was the only passage between the lake and the Pantano Borghese swamp.

The lack of reference to the lake makes Nibby[1] observes that: "It is surely worth remarking that while Gabii is quoted many times in classic texts, no mention is given of the lake located just under the town..." (Nibby, 1849).

[1] Antonio Nibby (Rome, April 14, 1792 - Rome, December 29, 1839) was an Italian historian, archeologist and topographer. His "Map of Roman surroundings" has been the first archeologic map of Latium made with trigonometric methods, in order to correctly position the various sites.

The lack of information is surely not a proof of the absence of the lake, but leaves open the possibility of its draining in antiquity.

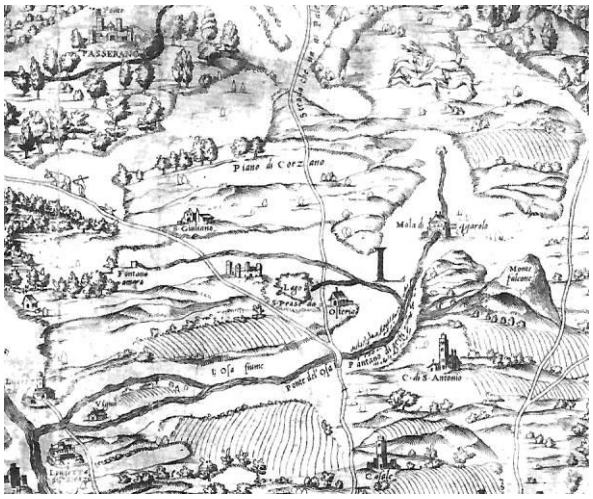


Figure 1. Map of Eufrosino della Volpaia, 1547 (detail), from Frutaz, 1972, n. 26.

Figure 2. Map of Giacomo Ameti, 1693 (detail), from Frutaz, 1972, n. 174.

A hint on its possible absence is given by the tracks of an old road which apparently enters the crater (Segre, 1972). As he writes: "...if, as it is believed, the lake did not exist, the route should continue buried under the most recent lake filling". Only further investigations could settle this important point.

The first mention of the lake dates back to the V cen., when S. Primitivo was beheaded and thrown into the lake, "*in lacum Gabiis*" (Tomassetti, 1910-1926). Afterwards, the references are many and with different names, such as Burrano or Bursano, S. Prassede, of Castiglione, Pantano dei Grifi; this last denomination is more generally referred to the Pantano Borghese, a large swamp very close by.

Furher information can be obtained from the maps of the locality, starting from the Renaissance. The map by Eufrosino della Volpaia (1547), the first map to give a realistic description of the geography around Rome, shows the lake with an outflow channel on the south side (figure 1); all later maps report the same situation, with the channel sometimes more to the east or to the west (figure 2). In 1845 the zone is described as "Campi Gabini former lake", but the drainage must have been incomplete, since the following maps report sometime a lake sometime a "dried up" lake until 1880, when the lake finally disappears (cfr. Table 1).

3. The fate of the lake in the course of time

The lake changed owner many times in its history. The take-over of the lake and of the nearby swamp by the Borghese family in 1614 marks a turning point in the fate of the site. Tomassetti (1910-1926) says that the lake was dried up by Cardinal Scipione Borghese, a claim contraddicted by the permanence of the water basin in the cartography until half of the XIX cen. What appears instead is that the Cardinal began the works of drainage of the Pantano swamp, located to the south of Gabii (Segre,1972).

However, some works may have been performed also in Lake Gabi, according to what related by Eschinardi (1750). This author, complaining about the situation of Lake Baccano (close to Lake Bracciano), a smelly swamp of stagnant water, suggests to operate on it as it was done by Prince Borghese in the "Pantano dei Grifi". He made there an outflow channel by means of a small opening, with little expense, obtaining "a real lake", that is, no more smelly air and stagnant waters[2]. We shall come back later on the question of the surface outflow channel.

In any case, the lake persists until the years '30 of the XIX cen (see Table 1) when, as stated by Nibby (1849), the lake was on the point of becoming a swamp. This fact is recorded, for example, by Westphal in 1827, who observes a lake with a reduced surface, surrounded by a swamp filled up by a cane thicket (Segre,1972); also the map of 1834 by Gell (see Table 1, n. 240) indicates a lake partially drained.

So again the Borghese family intervenes, and "Prince Francesco Borghese has the lake dried up by means of a *forma* which carries the waters into the Osa river...", remarking also that, in this way, fertile lands have been gained (Nibby,1849). The date of this operation is given at about 1838 and involved an unexpected occurrence.

The word "*forma*" generally refers to ancient (Roman) acqueducts, which mainly developed underground. In fact, in order to dry up the lake, it was necessary to tap water under the lowest altitude of the basin walls, and so an underground channel was required. During the works, an ancient tunnel was found (Canina, 1856; Ashby,1927)), a discovery which naturally arose great interest and discussions among archeologists and experts in antiquities.In 1845 the lake is mentioned as "dried up" (see Table 1) and described as "Gabini fields former lake". But the events were not quite straightforward, as also apparent from Table 1. The drainage was a slow matter:

[2] As mentionen before, the name "Pantano dei Grifi", in the confused situation of local names, is more frequently used for the swamp to the south of Gabii crater than for the lake in the crater. But the wording "...obtaining a real lake" appears more appropriate to the water basin in the crater rather than to a swamp which could hardly have been changed into a lake by a (partial) draining.

the maps alternate mentions of a lake and of a dried up lake, until about 1860, when the zone is acquired by the

Table 1. Data from a selection of the maps in Frutaz (1972). Indicated: year to which the map refers, the corresponding map number in Frutaz publication, the name of the lake on the map. A star marks the presence of an outflow channel.

Year	**ref. Frutaz, 1972**	**name on the map**
1547	26	*Lake S.Prassede* *
1604	54	*Lake S.Prassede*
1660	115	*Lake Pantano*
1666	47	*Lake Castiglione former Regillo* *
1674	156	*Lake S.Prassede-Regillo* *
1692	161	*Lake Castiglione former Gabinus* *
1693	174	*Lake Gabinus now Castiglione or Pantano* *
1699	182	*Lake S. Prassede* *
1755	199	*Castiglione*
1777	200	*Lake Gabinus* *
1798	219	*Castiglione or Lake Gabinus*
1803	225	*Lake Castiglione* *
1827	239	Lake with no name *
1827	243	*Lake Gabinus "Il Pantano"* *
1829	246	*Gabi* *
1834	240	*Lake Gabii partially drained* *
1837	241	Lake with no name *
1838	date of drainage (see text)	
1844	255	Lake with no name
1845	261 (268)	*Gabini fields former lake*
1850	274	Lake with no name *
1851	297	Lake with no name
1854	305	*Lake dried up*
1855	242	*Gabini fields former lake*
1858	307	*Lake dried up*
1875	333	*Lake Castiglione*
1877	359	*Lake Castiglione (dried up)*
1880	376	no lake reported

Torlonia. They have the floor of the underground emissary lowered, and after these final works, attested by an inscription dated 1890 and showing the name Camonzi (Caloi *et al*. 1994), the lake definitively disappears. Unfortunately, the destruction of most of the Torlonia archive in the earthquake of 1915 and in the bombing of the II World War prevents further knowledge on the subject.

4. The surface outflow channel

All the maps, from Eufrosino to the drying up of the lake, report a surface outflow channel in the south-west region of the crater, where Lombardi *et al*. (2004) notices a lowering of the crater belt, which turns out higher than the ditch flowing into the Osa. Beside, it is no more possible to identify the ancient meeting point of the two streams.

So, to reconstruct the history of the surface channel appears problematic. The height of the crater belt may have changed naturally, or may have been lowered artificially. In any case, Lombardi *et al*.(2004) claims that, in the present hydrogeologic situation and in absence of the underground outflow channel and of the surface channel, the whole plain would be flooded up to about 50 m above sea level, since the crater western side drops to about this altitude.

It appears reasonable to assume that a surface outflow channel has always been present, at an altitude that may have been changed by human doing. In any case, the surface channel did not empty the lake, at least from the V cen. on. Its presence ensured water exchange, a stable water level and possibly some fertile field. When Eschinardi mentions the opening of an outflow channel with little effort (the "small opening"), he is likely to refer to a lowering, widening or restoration of the channel found in Eufrosino's and following maps.

5. The underground outflow channel

The present underground outflow channel, as from the survey by G.Cappa *et al*. in 1992 (figure 3, 4), opens on the south-west side of the crater belt; it consists of two straight sections which meet at the point where a short descent still allows to enter the tunnel. The total length of the two branches is of about 450 m. The entrance ("incile") is located at between 44 and 45 m above sea level, allowing the complete emptying of the water basin, whose dried up plateau is at an altitude of 45-46 m above sea level, while the Osa stream flows at about 43 m above sea level. The description by Caloi *et al*. (1994) and Castellani (1999) is substantially complete for most of the tunnel, while the entrance is more precisely described by Lombardi *et al*. (2004). The latter authors report the presence of two entrances with a difference in altitude of about 7 m: the lower one is still operating, while the higher one had the function of a service tunnel, allowing to dig the main tunnel avoiding the water flow (figure 5).
In fact, the difference in level places the higher tunnel a little above the maximum expected level of lake waters (about 50 m above sea level). The remains of a shaft, used to line up the digging, are still visible.

It so appears that the tunnel has been dug according to a scheme well known and tested over the centuries, as exemplified by all the underground emissaries in central Italy (f.e., Caloi *et al*. 2012; Germani *et al*. 2012). Once entrance and exit have been set, an intermediate shaft is dug at the location of the present descent (the shaft having been likely closed, since the tunnel vault at the descent appears artificial). Afterwards, the digging advanced from

the shaft toward the entries and vice versa, according to the technique of the opposite fronts. Once the tunnel had the shaft toward the entries and vice versa, according to the technique of the opposite fronts. Once the tunnel had

been completed, the entrance ("incile") was lowered to the foreseen flow level. The work is surely old, as attested by the construction technique, by the *opus quadratum* of the outer wall at the exit, and by the intersection of two tunnels, of quite archaic appearance, which will be briefly described owing to their importance for the understanding of the structure.

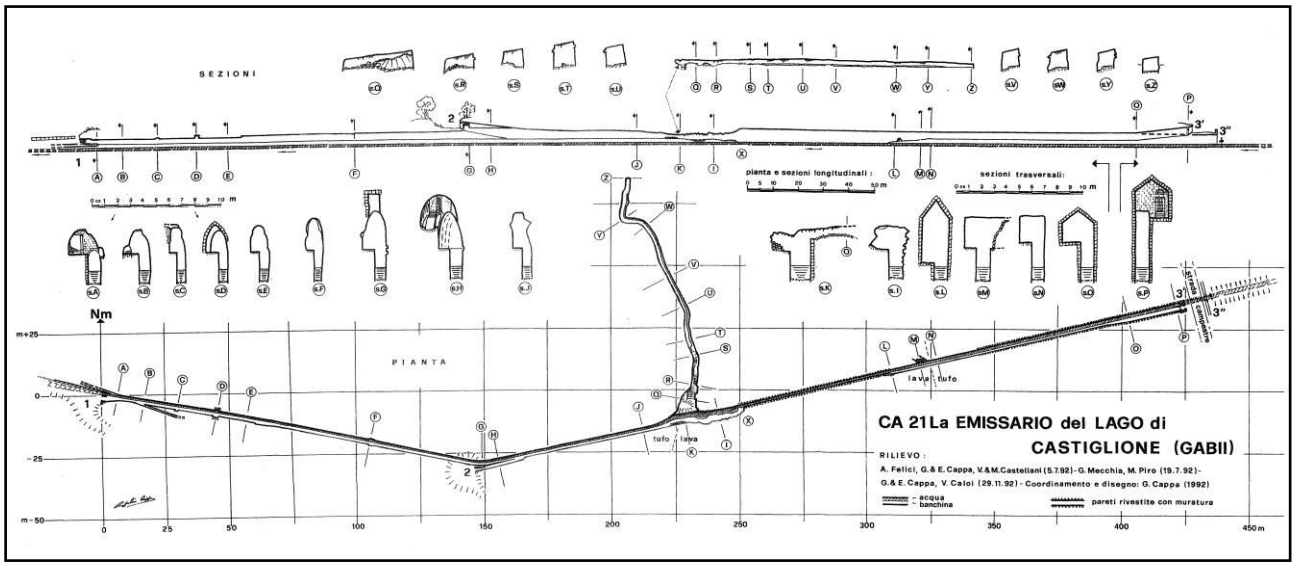


Figure 3. Plan and sections of the underground outflow channel (drawing by Cappa G., Felici A., Cappa E., Castellani V., Castellani M., Mecchia G., Piro M., Caloi V., 1992).

The firts one, close to the exit, crosses the emissary from the orographic right to the left, slightly out of axis compared to the tunnel direction (see figure 3, sect. A, B, C); it could represent an archaic attempt to regulate the lake, as suggested by its possible connection with the nearby Osa necropolis (IV-II cen. b.P.E.) (Bietti Sestieri, 1992). The second, at about 100 m from the entrance, is blocked by a wall over which lava fragments have been orderly placed; it could be a descent to the tunnel (see figure 3, sect. M).

Finally, a side branch develops on the right side, at about half the tunnel; it appears full of concretions and covered by silt deposits. Its purpose and time of construction are, at the moment, totally unknown (see figure 3, sect. O to Z).

6. History of the lake and its drainage

As mentioned before, information on the persistence over time of a lake in the Gabii crater, and on its drainage, is poor and indirect. Besides, no document reports the details of the final drainage of the lake basin. Therefore, in order to reconstruct an approximate and at least partially reliable sequence of the events involving Lake Castiglione, we have to consider circumstantial evidence from various sources, such as geology, cartography, a few historical data, hints from the studies on the other lakes in the Alban Hills.

Summing up, since the end of the volcanic activity in the Alban volcano, a lake filled up the Gabii crater; it was fed by rain water and by a few springs on the northern bank. No historic source mentions the lake in antiquity, while it is surely present from the V cen. until the XIX cen., when it was completely dried up (figure 6). During its existence, the lake had a surface ouflow channel located on the south-west side, which regulated the water level. It is not possible to ascertain whether the streamlet was natural or artificial.

Finally, still on the south-west side, an underground outflow channel is operating emptying the basin: its present conditions date to the XIX cen., but it is based on a much older structure, likely Roman. The scanty information mentioned before (Eschinardi, Nibby) attests that the water level in the basin changed substantially over time, so to make the surface emissary insufficient or useless.

The most straightforward interpretation of these facts suggests that the lake was dried up in Roman times, as it was the case with the other small water basins in the

Figure 4. The underground outflow channel (photo by C. Germani).

Figure 5. The "incile" of the underground outflow channel, from the inside (photo by C. Germani).

surroundings: Pantano Secco, the Prata Porci plane, Pavona (Lake Turnus), etc (see, f.e., Castellani and Dragoni, 1991). As Ashby (1927) states: "It is really difficult that the Romans did not carry out some hydraulic intervention on the lake, since it could become swampy very easy.

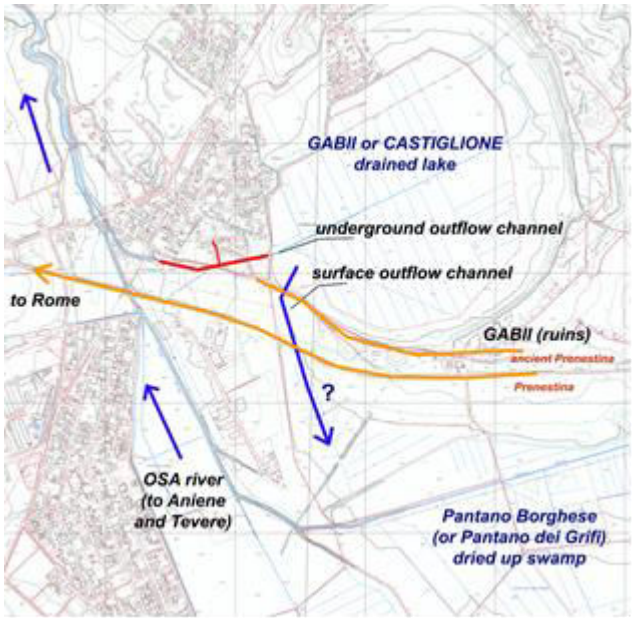


Figure 6. Plan of the area under examination (drawing by C. Germani).

Figure 7. The "incile" of the underground outflow channel, with the pumping system described in the text (photo by C. Germani).

The lack of maintenance or some natural event put out of use the underground channel, with the result of filling up again the basin: the lake reappears with its surface outflow channel, natural or (partially) artificial.

However, the possibility cannot be ruled out that the surface channel was made (or enlarged) by the Romans, in order to get a fluvial route to carry the *lapis gabinus* (a very good building material), mined from the quarries surrounding the lake (see fig. 13 in Quilici, 1977). This hypothesis requires that the outflow channel has been porposely blocked (Lombardi *et al*., 2004). It is important to note that the flow of the Osa stream was, before the drainage by the Borghese family, surely larger than the present one[3].

Finally, a curious coincidence deserves to be mentioned: in the same years in which the Roman tunnel reappeared at Gabii, a similar discovery was made at Pavona (Castelgandolfo, Rome), about 20 km to the south-south-west, on the slopes of the same volcanic structure (Caloi *et al*., 2017). In fact, between 1827 and 1850 the surface outflow channel which, at least since 1610 emptied the

[3] In 1587 the Felice Acqueduct was built, whose springs are found in the area of the Pantano Borghese in the Osa basin. Afterwards, the drainage completely diverted the Passerano ditch and the Corzano-Pallavicina ditch out of the basin.

ancient Lake Turnus, disappears from geographic maps; it seems that the function of regulating the basin water level has been shifted to an underground outflow channel surely of Roman times, still in operation. At variance with the case of Gabii, up to now we have not been able to find some historic report on the change from the surface to the underground channel.

7. Conclusions

Two outflow channels appear related to Lake Castiglione or Lake Gabii: an underground one able of completely emptying the basin, and a surface one which could set the water level at about 50 m above sea level.

The curious fact is that the first turns out clearly to precede the latter.

On the basis of the scanty historic documents it may be supposed that the lake, of volcanic origin and perhaps provided with a natural outflow channel at the lowest side of the crater belt, has been at first dried up at the same time with the nearby lakes of Turnus, Pantano Secco, etc (between the IV and II cen. b.p.E.).
Afterwards (I-IV cen. p.E.?) the channel is blocked by a natural event or, perhaps purposely, in order to have again a lake (possibly a smaller one) drained by a surface outflow channel.
Since the fall of the Roman Empire until 1600 the lake basin seems always present with a surface channel; the lake appears subject to substantial changes in the water level, both for climatic causes and for the absence of maintenance.
In 1614 the Borghese family acquires the area and at first restores the maintenance of the surface outflow channel; afterwards, in 1838, dries up completely the basin, likely reshaping the ancient underground channel just discovered. About 1860 the property is trasferred to the Torlonia family, that makes further interventions in the underground outflow channel, lowering the floor.

At present the area retains a rural appearance, with its wide cultivated fields and the drainage in operation. But the antropic pressure is strong: the urban settlements of Ponte di Nona and other, more or less unlawful townships are unfortunately very close by.

The underground outflow channel preserves its XIX cen. appearance (figure 7), but the lack of maintenance between the channel exit and the Osa river has forced the owners to install a pumping system to raise the level of the water from the drainage channels, in order to make the outflow easier.

References

Ashby T., 1927. The Roman Campagna in classical times. Ernest Benn Ltd., London 1927, La campagna romana nell'età classica, Longanesi ed., Milano 1982.

Bietti Sestieri A.M., 1992. La necropoli laziale di Osteria dell'Osa. Ed. Quasar, Roma.

Caloi V., Cappa G., Castellani V., 1994. Antichi emissari nei Colli Albani. Atti XVII Congresso Naz. di Speleologia, Castelnuovo Garfagnana, pp. 299-307.

Caloi V., Galeazzi C., Germani C., 2012, Gli emissari maggiori dei Colli Albani. Opera Ipogea 1-2012, pp. 29-40.

Caloi V., Germani C., Galeazzi C., 2017. Emissario del lago di Turno o di Pavona. Indagini speleologiche ed analisi delle antiche fonti iconografiche finalizzate alla ricerca di un possibile collegamento con l'emissario Albano. In Atti del III Convegno Regionale di Speleologia - Campania Speleologica 2017, 2-4 giugno 2017, Napoli, pp. 203-210.

Canina L., 1856**.** Gli edifizj di Roma antica : cogniti per alcune importanti reliquie / descritti e dimostrati nell'intera loro architettura dal commendatore Luigi Canina**,** vol.V. Bertinelli Ed., Roma.

Castellani V., Dragoni W., 1991, Opere arcaiche per il controllo del territorio: gli emissari sotterranei artificiali dei laghi albani. Gli Etruschi maestri di idraulica, Ed. Electa, Perugia.

Castellani V., 1999, Civiltà dell'acqua. Editorial Service System, Roma.

Eschinardi F., 1750. Descrizione di Roma e dell'agro romano fatta già ad uso della carta topografica del Cingolani, edizione riveduta e corretta da R. Venuti, Roma.

Frutaz A.P., 1972. Le carte del Lazio, Voll. II e III, Istituto di Studi Romani, Roma.

Germani C., Galeazzi C., Caloi V., Dobosz T., 2012. Gli emissari minori dell'edificio vulcanico Albano: laghetto di Monte Compatri, Pantano Secco, Pavona, Giulianello. Opera Ipogea 1-2012, pp. 29-40.

Lombardi L., Vitali A., Di Giusto P., 2004. Indagini geologiche, idrogeologiche e geochimiche con indicazioni sulla fattibilità tecnica relativa al ripristino dell'ex bacino lacustre di Gabii-Castiglione. Comune di Roma, Dipartimento VI – Politiche della Programmazione del Territorio.

Nibby A., 1849. Analisi storico-topografica-antiquaria della carta dei contorni di Roma, II edizione, Tipografia delle Belle Arti, Roma.

Quilici L., 1977. La via Prenestina, Bulzoni Ed., Roma.

Segre A.G., 1972. Morfologia e Quaternario della zona Osa-Castiglione, Bullettino di Paletnologia Italiana, XXIII, pp. 259-275.

Strabone. Della Geografia di Strabone, Volume 3. Sonzogno, 1833, on books.google.it (access February 2018).

Tomassetti, G. 1910-1926. La campagna romana antica, medievale e moderna, Vol.III, p.497, note 2 (1976, Forni Ed.)

WATER ITAKES AND SEWRAGE FACILITIES OF BULGARIAN ST.GEORGE THE ZOGRAF MONASTERY IN MOUNT ATHOS, GREECE

Alexey Zhalov[1], Konstantin Stoichkov[2]
[1] *Bulgarian Caving Society, Christo Belchev 45, 1000 Sofia, azhalov@gmail.com*
[2] *Caving Club "Helictite", Kiril I Metodii, 43, 1202, Sofia, Bulgaria, danailspeleo@abv.bg*

Abstract

During the researches on the artificial cavities during 2016-2018, in the region of the Bulgarian Saint George the Zograf Monastery a total of 32 artificial cavities (caves) were surveyed . From a functional point of view, they can be divided into 4 categories: Water intake galleries and karizes (qanats), drainage channels and galleries for sewerage water, fountains with attached karizes, reservoirs. The work describes the construction and architecture of the artificial cavities and analyze some of the most representative of them

Keywords

Water tanks,drainage galleries, reservoirs, Mount Athos, Greece

1. Introduction

In 2007 Bulgarian speleologists initiated a long-term international research project entitled "Exploration of the caves of Mount Athos as an integral part of the natural and cultural-historical heritage of Mount Athos". For the period 2007 - April 2017, 8 expeditions took place under our leadership and major participation. The research was carried out by speleologists from Bulgaria, Greece, Russia, Romania, Serbia, Turkey. A total of 209 underground sites were discovered, surveyed, mapped and described during that period. The achieved interim results have been referred to in more than 25 publications in collections of congress and conference materials, and in the specialized periodicals - mainly outside the country.

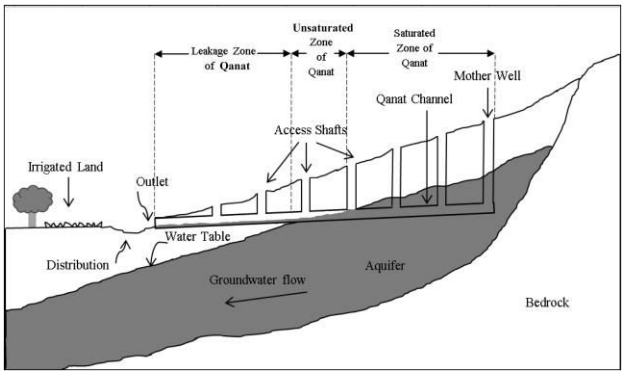


Figure 1. Principle scheme of Qanats

2. Resuls / Results and discussion

In the period 2016 - 2018 the researches focused mainly on the artificial cavities in the region of the Bulgarian Saint George the Zograf Monastery.
A total of 32 artificial cavities (caves) were surveyed and documented (mapped) during that period.
From a functional point of view, they can be divided into 4 categories: (Agapov, et al., 2016: 129-141)

1. Water intake galleries and karizes (qanats);
2. Drainage channels and galleries for sewerage water;
3. Fountains with attached karizes;
4. Reservoirs.

In this development we will try to make a brief review of the results achieved. Above all, however, we would like to clarify the meaning of the term "qanat".
Qanat/s (in Arabic: قانات – qanat, in Persian: زیراک – kariz) are artificial underground water supply channels. In the absence of springs and deepwater rivers, only groundwater can be used for water supply for drinking and irrigation purposes. Qanats are the facilities that make all the above possible. Their main advantage is that they maintain a continuous, albeit volatile flow of water. They are constructed with a gentle slope to provide a steady water flow. In most cases, they are a cross-sectional gallery allowing free passage of people (Fig.1)

According to Polybius, the first underground irrigation channels originated in ancient Persia during the Achaemenid Empire (550-330 BC). Gradually, this type of water supply spread across the Iranian Plateau, to the west through Mesopotamia to the shores of the Mediterranean, to the east - through Afghanistan and the settlements along the Silk Road - to India and China. The Arabs spread this technology to Algeria, Morocco, from where they enter Spain, and through the Spanish colonizers they also enter to the Americas. (Fig.2)

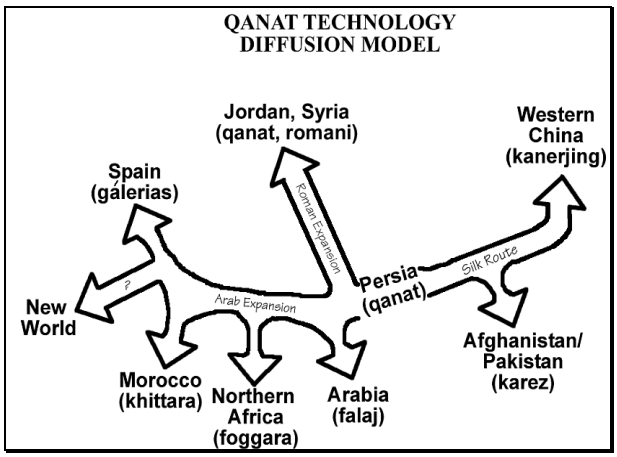


Figure 2. Qanat technology diffusion model

2.1. Water intake galleries

The Monastic Brotherhood calls these facilities “mothers”. In fact, in their structure, they are classical qanats, but in only a few of the cases, there are vertical shafts leading up to the surface, which will be referred to as “vents” below.

During the expeditions in the vicinity of the monastery, 16 sites of this type were surveyed. As has already become clear, they all have a water collection function. Their main difference, apart from the length, shape and dimensions of the cross section of the galleries and their internal channels through which the extracted water flows, is the construction method.

Based on the construction method, they can be classified into two types:

1. Tunnel-type
2. Ditch-type

For the first type of construction a tunnel is excavated underground, whereby the tunnel is lined and reinforced with quarry stone masonry bonded with cement or mortar alongside the excavation. All galleries of this type have semi-circular arches.

The construction method of the second type is different. Initially, a ditch is dug in the ground. Subsequently, the walls are reinforced in the way described above. The thus constructed ditch is covered with slabs (tiles), which are then covered with soil (earth).

As we have previously mentioned, another hallmark of the galleries is the manner of delivery of water extracted in the galleries to the surface. These are also two types. In the first case, water runs in a channel located in the centre of the gallery, which in some cases is lined with lead sheets. This enables water transportation, for cleaning purposes, etc., to be executed along the shoulders (platforms) formed on both sides of the channel.

In the other cases, the channels are taken out, and often elevated, along one of the gallery walls.

This development does not allow us to describe all structures of this type in detail, so we will only review 3 of them which are of the greatest length.

The longest water intake gallery is located in the monastery courtyard, it is 80 m long. At the same time, it is also the largest water intake gallery in Athos, surveyed by us since the beginning of the project. (Zhalov, 2017:272-278)

It is supposed to be constructed for the purpose of supplying water to the large reservoir, located in the basement of the main monastery building. This assumption has not yet been proven, but if it is true, then we can assume that now the channels discharging water to the said reservoir are clogged and the water runs out through the cracks outside the monastery. The second hypothesis is that this is not a water conduit, but rather a drainage channel for rain and snow waters that have fallen into the monastery courtyard. The first assumption is probably true, because at the end of the two galleries forming the facility there are small water sources (springs). In one of them were collected several specimens of blind amphipodas (crustacea with laterally compressed bodies of the Niphargus genus), which are still in the process of scientific determination. The attempt to follow the path of the water flowing through the gallery, by means of coloring, did not help to clarify the function of the gallery. The entrance is located at the western end of the monastery courtyard just before the door of the monastery refectory (dining room). It is a rectangular opening that rises at about 0.25 m above the courtyard. It is enclosed with an iron grid to capture twigs and foliage. This opening is used for drainage of the courtyard after rain and snowfall. There is a shaft with a rectangular section and a depth of 2.30 m below. At the bottom there is a small cement pool that drains inwards. On the right, the main gallery is revealed, which, shortly before the end, also has a branch on the right. It has a rectangular section and is arched. It is completely lined with well-formed quarry stones with cement bonding. Its width is 0.5 and its height is 1.4 m. Inside flows water with a flow rate of about 2-3 / sec., part of this quantity comes out from a small rectangular opening located on the right wall of the gallery immediately after its entrance. The water coming from the inside flows into a channel and runs in an unknown direction. As mentioned above, we can only assume where the water flows.

The water intake gallery, which we conditionally called “The Monastery Laundry 1862” (Fig. 3), where 1862 is the assumed year of construction, is the typical qanat specimen.

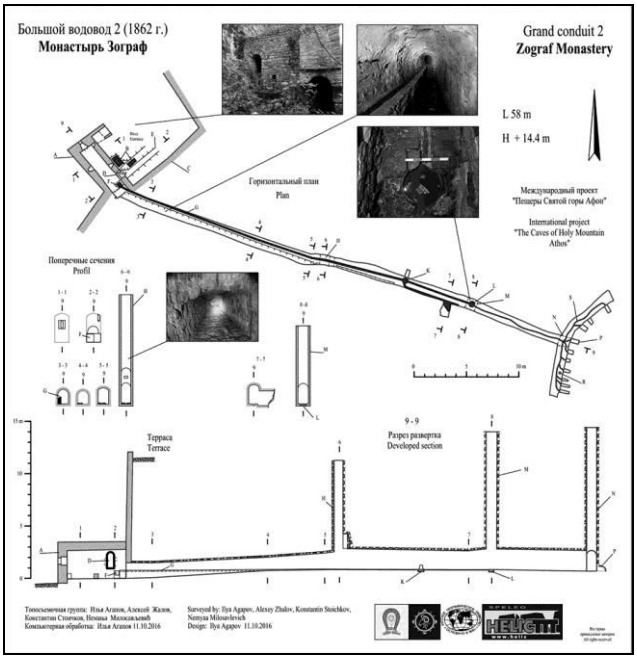


Figure 3. Map of Monastery Laundary 1962

Besides the gallery, it has three “vents” of varying heights, which probably serve as access points for cleaning and maintenance. The height of the vents (stacks) to the base (floor) of the gallery, is 5, 8 and 12 m, respectively. The underground structure is a tunnel type with a length of 58 m. The water collection section of the gallery is located at the rear (inside) half. The water is then “captured” and inserted into a channel located on the right side of the gallery, which serves to discharge the water to the outside. The discharged water supplies the so-called washing

machine. It was a covered room with a U-shaped form, whose roof is now missing. Along one side of its walls even now there are stone sinks positioned next to each other. Each of them has a plug through which the water runs into a masonry channel located below. The gallery is the habitat of a large bat colony.

The water intake gallery called "Areoto" (Fig.4) is the third longest gallery. It is located about 360 m northeast of the monastery to the left of the road to Vatopedi Monastery. It is also a tunnel type gallery. Unlike the structures described above, the gallery has a pronounced slope at the end. The water is discharged through a central channel. In the past, it was transferred to the monastery through lead pipes. We must note here, that the water from all such galleries located away from the monastery was transferred thereto in the same way. Now this way has been modernized and the lead pipes have been replaced with PVC pipes. According to the inscription at the beginning of the gallery, the water intake was renovated in 1879 during the leadership of Archimandrite Clement, but apparently it was built earlier!

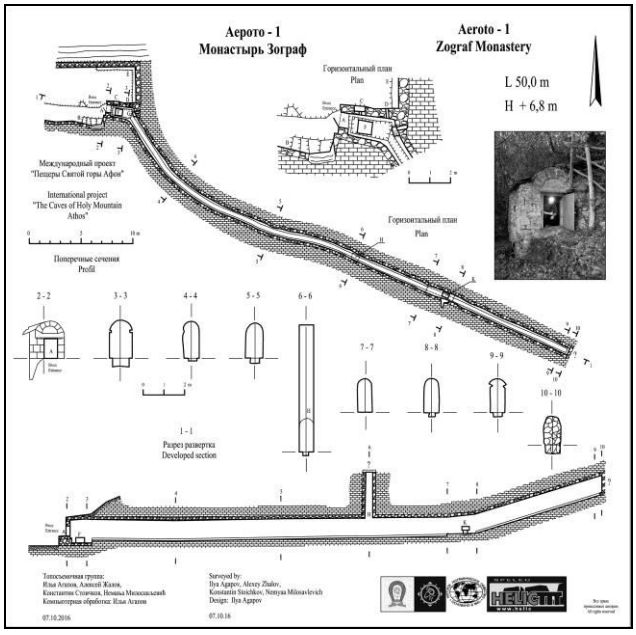


Figure 4. Map of Areoto gallery

2.2. Drainage and sewerage galleries

One drainage facility has been surveyed, combining surface channels and relatively short underground tunnels. It drains the area (square) in front of the entrance of the monastery and its adjacent buildings if necessary (in the event of rains, floods, etc.). It is used to discharge sewerage water flowing thereto through pipes.

Sewerage (faecal and other waters) are discharged from the monastery by 3 main and 1 small peripheral facility. All of them are of the tunnel type, but unlike the water intake galleries described above, the main tunnels are concreted. The only exception is the longest one, which will be described below. This is the so-called "Great Sewerage Monastery Tunnel" (Fig.5).

It is used for drainage of surface water, faeces and sewerage from the southern wing of the monastery. With a length of 144 m, and a displacement of +57 m, it is the longest artificial underground facility studied so far in Mount Athos. The tunnel has two entrances, upper and lower ones. The lower entrance is to the southwest of the monastery on the right and below the stone road leading to the harbor. It has a semi-elliptical shape and dimensions of 1.80 x 1.25 m. It marks the beginning of an upward corridor with a rectangular section, which subsequently becomes semi-oval. 64 m from the entrance there is a rectangular "room" with dimensions of 3.15 x 4.00 m. PVC pipes are discharged to the ceiling, which are connected to the toilets and bathrooms located in the southern tower of the monastery. On the opposite wall, from the entrance, there is the entrance to a much narrower gallery. Its length is about 36 m, a distance which can be covered by crawling! This area is lined with quarry stones. In the next 30 m the gallery becomes ~ 1 m higher and the it can be covered in a semi-stooping position. In the ceiling of this section there are 3 holes artificially opened during the renovation of the monastery. Now they have already been concreted. At the very end the gallery rises up again and can be covered by crawling. It ends with a very narrow impassable vertical stretch through which the fecal waters from the upper floors of the second southern tower have been discharged in the past. The gallery ends with a channel used to capture and conduct rainwater, which subsequently collects behind the eastern façade of the monastery. The upper "entrance" of the facility is located here, which is too small and virtually impassable to man.

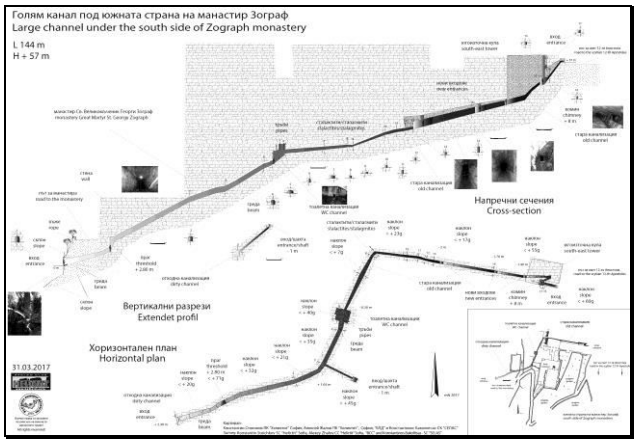


Figure 5. Map of Areoto gallery

2.3. Fountains with attached karizes

The water supply of fountains through water intake galleries is a common practice. Five underground facilities of this type have been studied in the area of Zograf. There are two types of fountains. With the first type, the water intake gallery is located just behind the "Vikentiy fountain", "Upper and lower troughs", "The fountain on the Hilendar path", and with the second type the gallery is at a certain distance thereof, as the water is trasferred to the reservoir behind the fountain through pipes ("Little Fountain 1900") (Fig.6)

From a functional point of view, two of them are used only for the drinking water by the monks, and the other 3 are polyfunctional - ie. they were also used to water the animals in the past, but not nowadays.

A typical example of a facility of the first type is the

"Vikentiy fountain" (Fig.7). According to the inscription of the façade of the fountain, it was completed on 18 August 1841. On the side of the façade there is a small

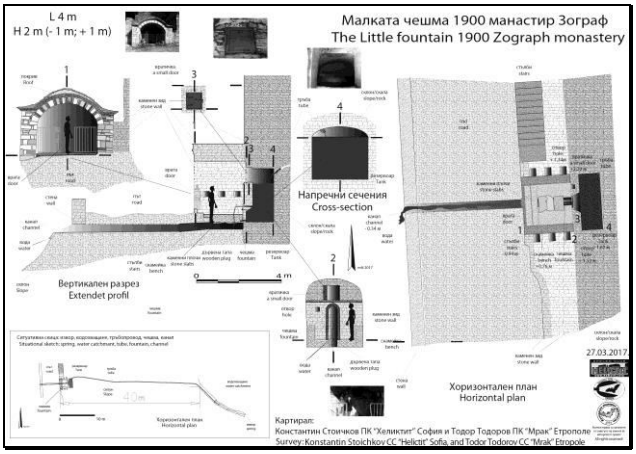


Figure 6. Map of the Little Fontain 1900

door that leads to the water intake gallery behind the fountain. The length of the underground facility is 28 m. The first half of the tunnel is of the channel type and the second one of the tunnel type. The water was discharged through a central channel while now it flows through a PVC pipe. There is a long stone trough in front of the fountain.

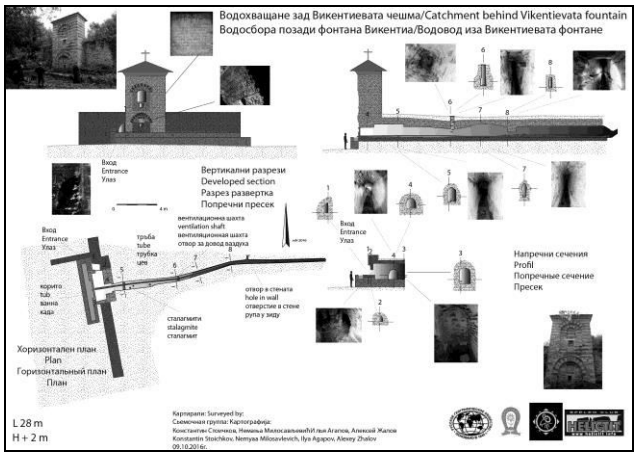


Figure 7. Map of "Vikentiy fountain"

Perhaps "Upper troughs" water supply system is the most prominent example of the second type of structure. It consists of a water intake gallery 14 m long and a displacement of +3 m, a water intake gallery 51 m long and a displacement of +6 m and an underground channel connecting the two facilities 33 m long. Three vents are built along the channel. It should be emphasized that the first gallery is located 11 m higher than the second one, which provides a gravitational flow of water to the second one. The water extracted from the two galleries is stored in a small reservoir behind the stone fountain, which has a 6-metre stone trough in front.

2.4 Reservoirs

Many different types of underground reservoirs (tanks) have been found on the territory of the monastery and its surroundings. Three reservoirs were studied in detail. One of them is the "Shrouded reservoir" (Fig. 8), which is located 70 m to the east of the monastery over the orchard. The reservoir is excavated in the gorund. It has a rectangular shape and an external dimension of 6.30 x 4.50 m. The section above the ground is made of quarry stones of mortar bonding. The wall thickness is 0.50 m and its height is 1.60 m. On top there is a double-pitched roof covered with stone slabs (tiles). Inside, the underground part of the facility is covered with special plaster. The pool is -2.93 m deep and its useful volume is 44.30 m^3.

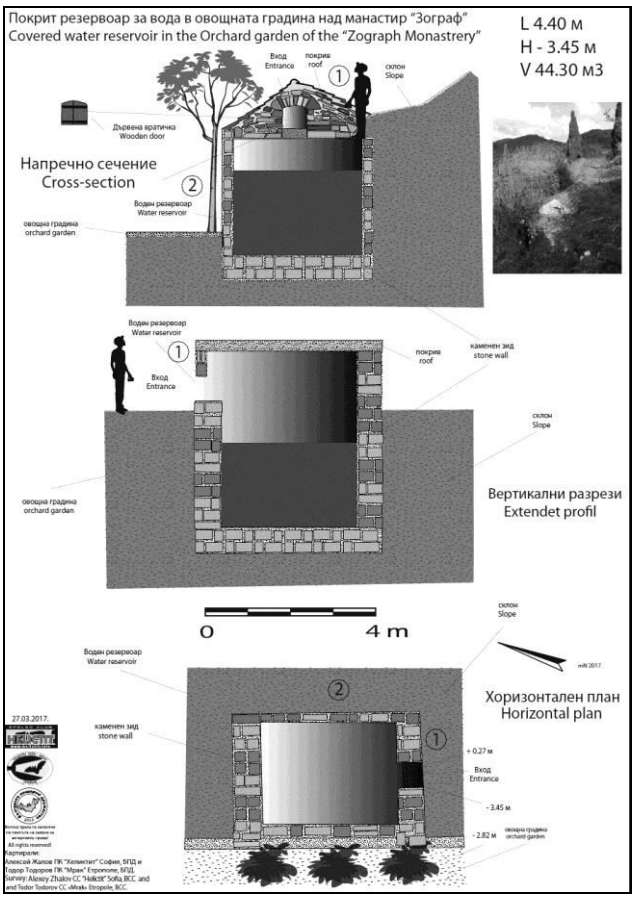


Figure 8. Map of "Shrouded reservoir"

The largest reservoir studied so far by us is located about 700 m northeast of the monastery near the St. Stephen's Chapel (Fig.9).

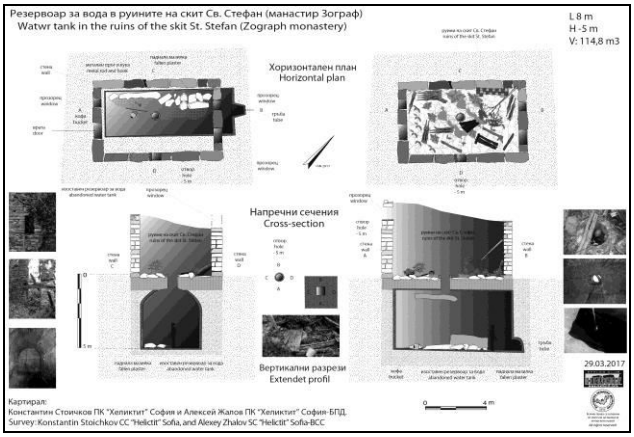


Figure 9. Map of St.Stephen reservoir

It is situated in the ruins of a complex consisting of two stone houses and one tower. On the floor, almost in the middle of one of the houses, there is a circular opening

with a diameter of ~ 0.5 m. Below there is a vertical shaft with a cylindrical shape and a depth of 1 m which opens in the ceiling of the underground reservoir. Its height is 4.13 m. The bottom is rectangular with a slight slope to the northeast. The length of the facility is 8.40 m and its width is 3.90 m, therefore it is about 33 m2. Considering that the shape of the reservoir is not an ideal cube, its useful volume is calculated to be 114.8 m^3.

The research works in Mount Athos still continue.

References

Agapov – Zhalov- Stoichkov- Miloslavlevich, 2016: Agapov – Zhalov- Stoichkov- Miloslavlevich, The caves of Mount Athos (Greece). Brief review of the results of the 5th international speleoexpedition in October 2016.- Speleology and spelestology. Collection of materials of the VII International Scientific Conference. – Naberezhnye Chelny, 129 - 141

Zhalov- Stoichkov - Kirov, 2017: Zhalov- Stoichkov - Kirov, The caves of Mount Athos (Greece). Brief review of the 6 and 7 international speleoexpedition in 2017.- Speleology and spelestology. Collection of materials of the VIII International Scientific Conference. - Naberezhnye Chelny, 272 – 278

https://en.wikipedia.org/wiki/Qanat.

MINING WORKS

IRON HEARTH: THE RE-EXPLORATION OF THE OLD MINE "MANINA" (ITALY)

Giovanni Belvederi[1*], Maria Luisa Garberi[1*]
[1]*Gruppo Speleologico Bolognese – Unione Speleologica Bolognese (GSB-USB) Piazza VII Novembre 1944, 7 - 40122 Bologna –* giovanni.belvederi@regione.emilia-romagna.it , marialuisa.garberi@regione.emilia-romagna.it
*,*Commissione Cavità Artificiali SSI*

Abstract

The old mining complex of Manina opened trought a lot of mouths around Nona in the Scalve Valley (BG); other entrancies are around Lizzola in the close Seriana Valley (BG). The mine exploited an iron ore over about four hundred years. The mining complex is abandoned from the half seventies of the last Century and consists of twelve levels. The entrances are between 1434 and 1760 meters above sea level. These days, the situation within the galleries avoid the possibility to visit several of these levels. The re-explorations started in 2010 and are still in progress: few visits every year in the period June – November. The snow makes difficult the access in the winter and spring.
The paper presents the results of the re-exploration of seven levels of the mine, during these jobs the speleologists taken topographic measures, photos and video shots.
Using the specific function Resurvey of the software cSurvey, it is possible the computation of a polygonal from an already done cave survey: the original minerary maps of 1956-59 and specific field measurements, performed during the re-exploration.
The result is the 3D reconstruction of this impressive mining complex, that includes also very big rooms over 30 meters high. The final target is a complet documentation of the Manina mine.
To explore and survey today these places, it means: to avoid oblivion; to preserve memory and to pay homage to miners, who worked hard to supply row materials to our stile of life, which is probably too hungry of them.

Key words

Scalve Valley, Seriana Valley, Lombardia, Mine, Manina, Iron, siderite, Survey, 3D reconstruction).

1. Introduction

The authors are studing the complex of the Manina Mine from almost 8 years. The re-exploration is slow, because the height 1720 meters up the see level allows a short time to visit the mine. The mines are presently abandoned but a research claim of Cooperativa Ski Mine of Schilpario has been issued by Lombardia Regional government. The Cooperativa manages a few touristic mines inside the Andrea Bonicelli Mining Park in Schilpario and the Lupi Level in Valbondione.

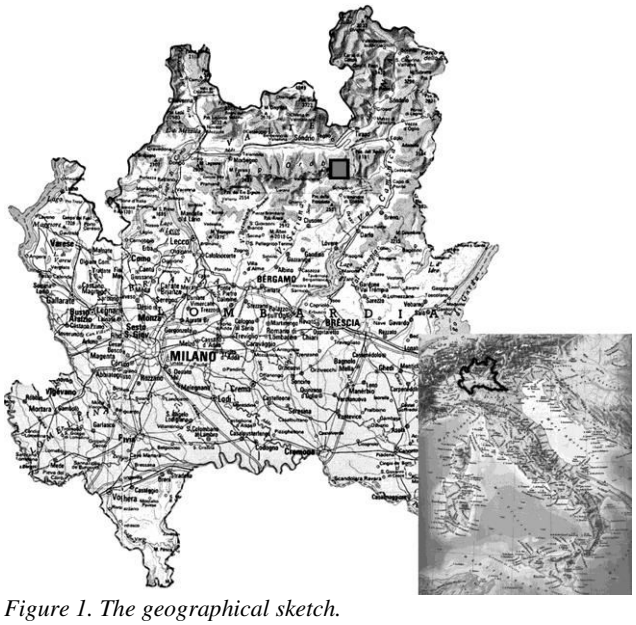


Figure 1. The geographical sketch.

This paper describes the activities performed in partnership with the manager Anselmo Agoni.
The target of the study is the 3D reconstruction of the mining complex to document the present state of the mining galleries and to preserve the historic memory of this important mine. The mine was the single survival source for the local people over four hundred years.

2. Geographical framework

The old mining complex of Manina opens in the Bergamo province, in the Lombardia region. Most of the mouths of old Manina mines are in Nona, Vilminore municipality, in the Scalve Valley (BG). The lower level, named Lupi, opens in Lizzola, Valbondione municipality, in the close Seriana Valley (BG).

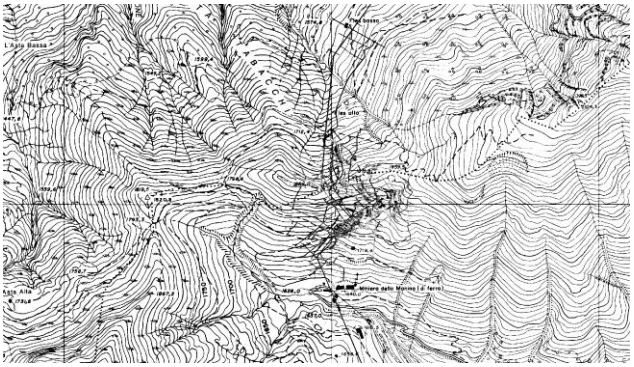


Figure 2. The localization in the CTR of Lombardia region..

The underground galleries links together the two valleys, while outside they connect through the Manina Pass. The

Scalve Valley is a tributary of Olio River and it is carved in the Orobic Alps.

3. Geological framework

The geological characteristics of the territory under study, located in the north of Bergamo province, are identified of rocks from late Permian to early Triassic age. The Manina Mine opens mainly in the geological formation Servino. The formation includes pelites, sandstones and reddish to greenish laminates marl, often micaceous with intercalations of hybrid limestones and dolostones. The bed thickness ranges from 40 to 80 cm on average. The middle part of the units is typically characterized by reddish (Fe rich) to greyish limestones, with oolites, intraclasts and frequently Bivalves and Gasteropods. Mineralized strata, mainly siderite and sometimes ematite are associated. The Fe minerals are in a quartz-silicate gangue with stratabound bodies.
The unit deposited in a coastal plan with mixed sedimentation. The thickness reaches 100-150 metrs. The formation dates to the Early Triassic, Induan – Olenekian P.P. (Berra, 2011).

4. Historic framework

In 300 – 400 B.C. the Scalve valley was colonized probably from inhabitants of the neighbor Valcamonica. A roman exploitation of its iron orebodies it's still not sure, and consequently we cannot state that the valley was an internment place for "damnata ad metalla" (Morandi A., 1993). Certainly, it's common to find old tunnels, that had dug without gunpowder before seventeenth Century.
Old documents (tenth – eleventh Century) contains news about iron ores and iron commerce in Scalve valley.

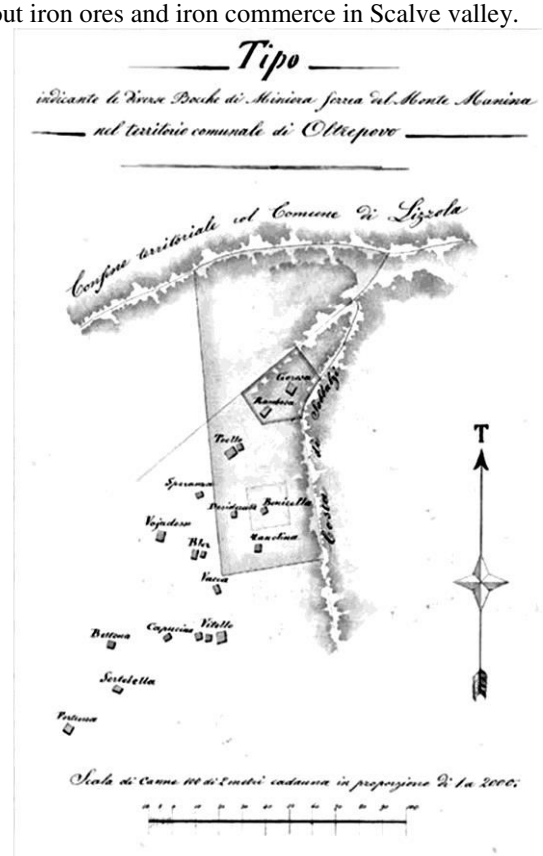


Figure 3. Old cadastral map (end 1800s) with mines claims.

The Holy Sacred Emperors dominated the valley and granted its inhabitants with the free iron commerce in the whole area of the empire. Then the local people wrote an independent statute. In the fifteenth Century the valley fell under the dominion of Venezia Republic until the Napoleonic age. The Venetian period was difficult for the mining extraction, because the Republic imposed high duties, taxes and prohibitions on the self-made gunpowder.
Both Napoleonic and Austrian laws hindered the extraction in the Scalve valley: in particular the Austrians hampered the Italian production to defend the production of Carinzia, which was sent in Lombardia to produce weapons (Morandi A., 1993).
In 1788 Maironi da Ponte wrote that the Manina was the more important mine of Lombardia. In this age twelve mining mouths were opened along the slope of Scalve valley (Maironi da Ponte G., 1788). Few local families owned the mines; they worked with underdeveloped tools, during a little time in the year and added the iron's income to the scarce farming profits (Maironi da Ponte G., 1819).
After the genesis of the Italian State, the Sardinian law on mine and mining (1861) introduced a new element: the law didn't give any right to the land owners, when a mining research was authorized (Morandi A., 1993). At the end of the nineteenth century the Gregorini Family, from Vezza d'Oglio (BS), becomes the owner of the mines in the Scalve valley. They were iron and weapon industrialists. The Gregorini enhanced the mines activities and in 1901 they built a cableway to transport the mineral to Teveno in the valley floor. In 1902 the mine produced every month 1,500 ton of iron mineral (Morandi A., 1993). Later Gregorini joined with Franchi, a family that managed the mines in the Seriana valley slope thus founding the Consorzio Minerario Blesio.

The first world war improved a lot these mining activities: the war industry needed always a large quantity of iron. The end of the war caused the first big crisis in the Manina mines and the Gregorini family left the consortium. In 1928, after a relatively extended period of inactivity, the consortium re-obtained the mining permission. In 1930 the Ilva company from Genova annexed the consortium: at that time some 3,000 iron's ton of iron mineral were deposited in the service area. Finally, in 1936 mining works restarted and, after few years of maintenance, also the cableway became operative. In 1937 the mine was ready: the haulages and the slants were reactivated. A new house for miners, the electric line and the street were built. In 1939 the Ilva stopped its activity and gave away the consortium to Ferromin.The Second World War induced new activities in the mine. A new section of the cableway reached Ponte Formello and Darfo. The German troops controlled and fortified the mine, but in September 1944 the partisans conquered the area and destroyed most of the plants.

At the end of the war end no more mining activities were active in the Manina mine. Thus, most of the inhabitants emigrated due to lack of local earnings source. Mining activities restarted in 1951, but in 1957 a new crisis arose: stakeholder decided to buy the iron from India, even if the

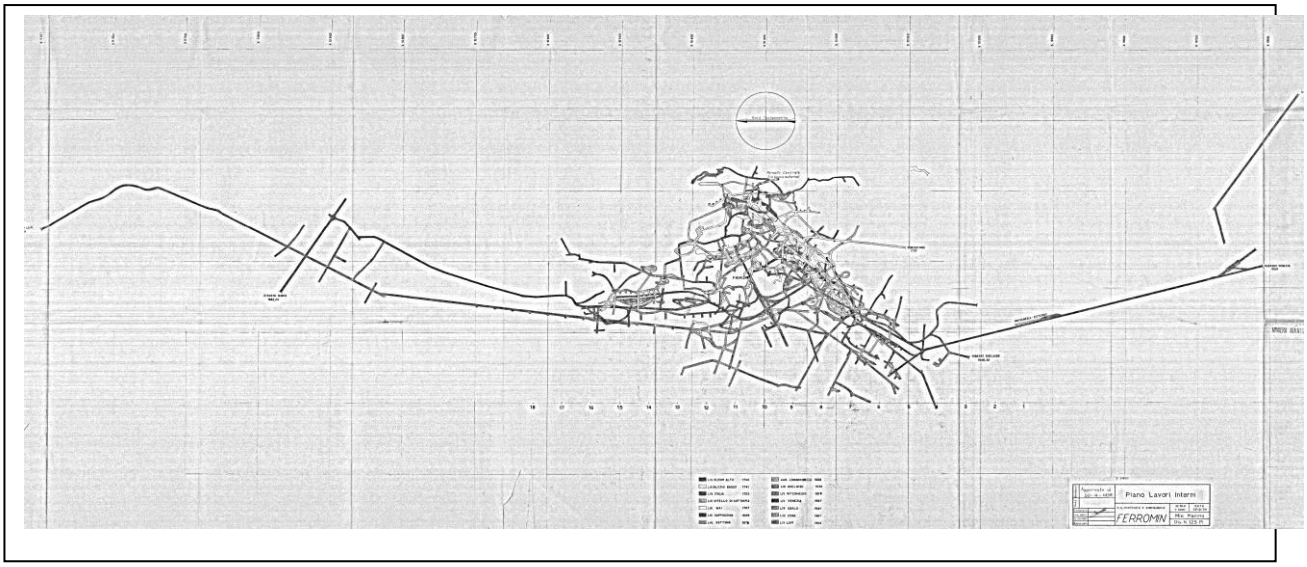


Figure 4. The map of Manina Mine 1959, scale 1: 1,000.

5. Re-exploration

The re-explorations started in 2010 and are still in progress: few visits every year in the period June – November. The snow makes difficult the access in the winter and spring, because the entrance elevations range from 1434 to 1760 meters above sea level. Belvederi G., Garberi M.L. (GSB-USB), Allieri F. (GS Val Seriana Talpe), Gonella S., Rossi G. (RSI), Bocchino B., D'Arienzo R. (GSNE) carried out the explorations in the mine.

5.1. TheVenezia Level

The exploration started from the pedestrian entrance of Ribasso Venezia (1434 m. asl), even if a landslide has partially blocked this tunnel and filled the dewatering canal. The tunnel is flooded for four hundred meters and the water height is variable from one meter to thirty centimeters. Usually the progression is made with the aid of waders and the cavers trail a rubber boat with inside the equipment along the flooded path.

The Venezia level was the main haulage of the mine with a separate entrance for the cableway, today totally destroyed. The level presents few wide tunnels, with three different rails to transport the mineral, electric plants and air pipes. The rails intersect each other's with complicated switch. Few tunnels show hoppers, that allowed the mineral dumping from the upper levels.

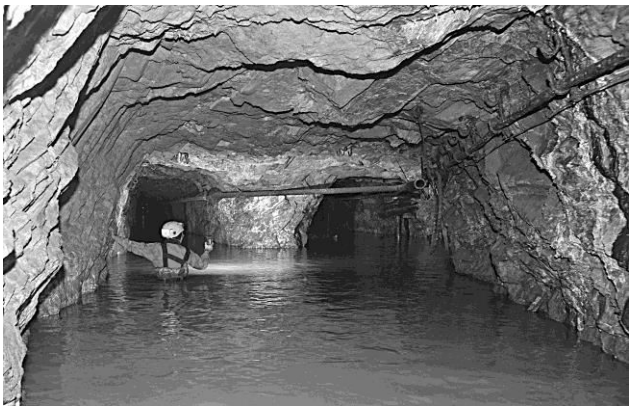


Figure 6. The flooded path.

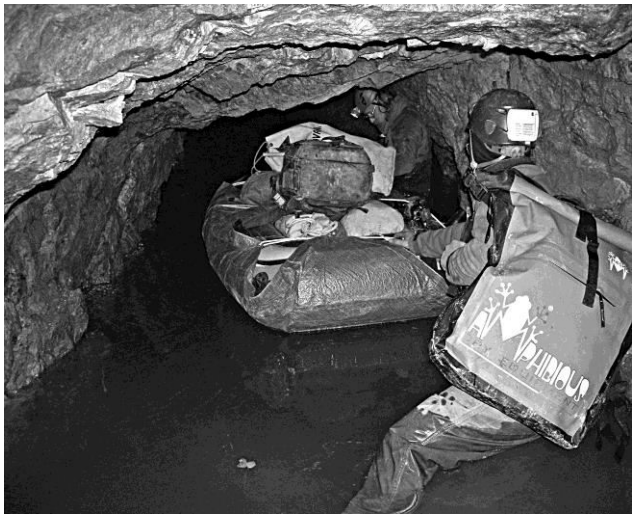


Figure 5. The rubber boat.

Figure 7. Examples of "exploitation voids".

Within the Venezia level there are gigantic rooms "exploitation voids", corresponding to the original ore bodies. These rooms may reach twenty meters in height and fifty meters in length. In the room walls it is still possible to see the wooden stick used by miners. The total development of the Venezia level is 3,632 meters.

5.2. The Venezia Pit

The Venezia Pit, about one hundred and fifty meters deep, and a winze, dug in the deposit, connects directly the Venezia level with three lower levels. This winze isn't walkable today. The level connects with the upper level by a lot of slants, which will re-be visited during the next re-explorations in the Manina mine. The miners dug the Venezia level in the first years of Twentieth Century, but the pit date back to 1953. The pit operations lasted very few, this because the company Ferromin took off the winch just in 1959. Presently in the pit station there are the two lift cages: one is outside the pit and the other is still in its original position supported by wood sticks.

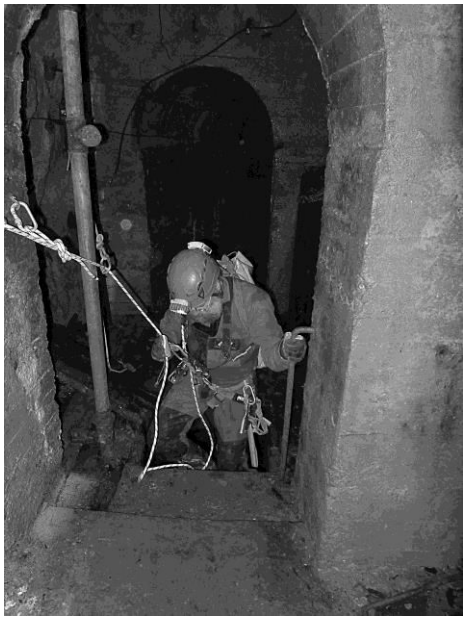


Figure 8. The Venezia Pit descent from Pit station.

Cavers went down in the Venezia pit to reach to Carlo Level, fifty meters below the mouth of the pit. The pit without the cage isn't safe, because some of the wooden equipment fell down, partially obstructing it. On the contrary, the iron service stairs of the pit are safe enough; the stairs are fixed to the wood structure of the pit and have been somewhere interrupted by the collapse of part of the wooden structure. The descent was done along the stairs, with self-made hooking by Shunt blocker.

5.3. The Lupi Level

The Lupi Level opens in Seriana Valley, in the Lizzola village, Valbondione municipality. The level is just a long haulage (1810 meters). The cross-sections are narrower if compared to those of Venezia and Carlo levels. The tunnel contains a narrow gage rail (500 millimeters). The miners dug the tunnels broadening older galleries. Laterally it is possible to see galleries very old with ogival section and little recesses for the oil lamps. The shaft base is similar to those of the other levels, but with narrow cage rail (600 millimeters).

5.4. The Carlo Level

The Carlo level is less developed than to the Venezia one (1651 meters) and also it does not host big exploitation rooms. At the beginning of the Sixties of the last Century the mine company took all rails and air pipes off from this level. Today the Carlo level exhibits a lot of white carbonate speleothems growing over red iron and black manganese oxides spots. Unfortunately, it was impossible to go down further to reach the Zera level, because all the pit was filled by the material fallen down along the shaft. The Zera polygonal (852 meters) is only based on the map and the bibliographic descriptions of its cross-sections.

Figure 9. The Carlo Level.

5.5. The Halfway Level

The Intermediate level does not communicate with the outside and spread 29 meters above the Venice, it can be reached by a still practicable slant, going up the old stairs, with protections placed by the first ascent. The level has a development of 1683 meters and alternates between carreggio tunnels and yards of considerable size, more than fifty meters deep, that descend to the hoppers of Carlo Level, where the material was loaded.

Figure 10. The "excavation voids" of Halfway Level.

5.6. The Adelaide Level

The Adelaide level is held 30 meters above the intermediate level and was reached by speleologists from a rise still equipped with a walkable ladder. The re-exploration of this level is still ongoing. the cavers found a

relatively well-preserved reserve of explosives. The level is strongly compromised by a large landslide which, for now, prevents the progression. It will be very important for the exploration the attempt, planned for the summer 2018, to descent of a great void of cultivation that unites the Adelaide level with the above Mai level.

5.7. The Mai Level

The Mai level opens to the outside at an altitude of 1707 meters with a long haulage gallery, which reaches a deep void of cultivation. The void reaches, on the mining maps, the underlying Adelaide Level. The level has a development of 592 meters.

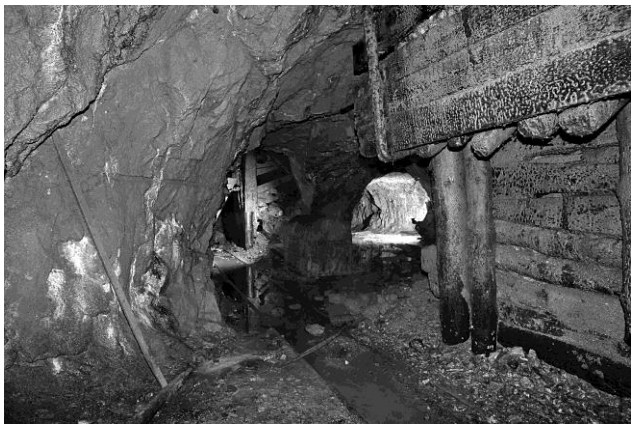


Figure 11. The Mai Level.

6. Re-construction 3D

The software cSurvey was created several of years ago, following an important project, promoted by the Federazione Speleologica Regionale dell'Emilia-Romagna. This software is an open project for the caver community. It was realized with the ambition to be an integrated system to produce the final map and cross sections of a cave just starting from the field data. The system is based on another important data processing tool: Therion. This software is extremely efficient but unfriendly and therefore scarcely utilized. The union between cSurvey and Therion allows to overcome the Therion hostility, because the user interface is friendly and integrate. cSurvey contains also an elaborate graphic engine to produce vectorial sketch; this helps cavers in all activities related with maintenance and upgrade of any underground survey. It's possible to assume the control about graphic primitives and to automate all changes of the polygonal data.

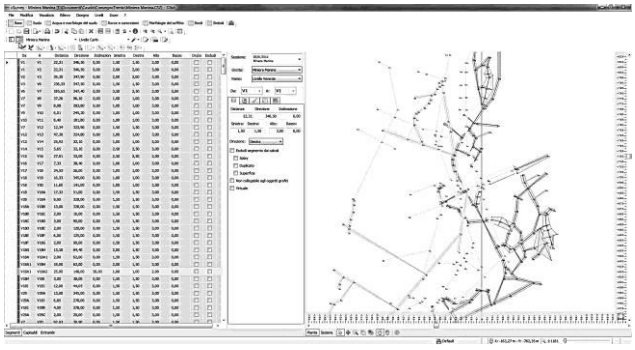


Figure 12. The user interface of Survey.

The software contains also a lot of function: how 'Resurvey', that was essential to mine reconstruction. The Resurvey task allows the computation of a polygonal from plants and cross-sections of a cave. It's a simple mathematical function with a friendly interface. The first step consists in scanning the cave maps and sections. Then the plan and section bench marks should be defined, and it must be decided the "origin" (first bench mark) of the future polygonal. Then the program will create the links between the consecutive bench marks. These links will correspond to the points of the reconstructed polygonal. The resurvey function allows also to translate of the original bench marks: it's necessary to choose a couple of coordinates, that are of service how reference to calculation go. Of course, the accuracy of the obtained data corresponds to that on of original bench marks and scale references. The resurvey function can analyze the drawing automatically and recognize the cave dimension. Finally, it passes the obtained data to cSurvey. The resurvey was fundamental to re-construct the survey of Manina mine, but same changes were needed, because the cross-sections of the mine were not available. Up to present it was impossible to survey the whole mine complex and the utilized strategy was a mix of field measures and work by means of cSurvey.

6.1. Methodology

To take advantage of Resurvey possibilities, it was necessary to define exactly every level plan. So, the old original map (scale 1:1,000) was scanned. Each level has been marked with an assorted color, then each level has been separated from the others and vectorially processed. The Resurvey function was modified due to the lack of the cross-sections. All bench marks and the scale references were placed just in the plan. Due to the lack of cross-sections the polygonal calculations resulted without any altitude profile: practically the reconstructed tunnels were all at the same level. The Venezia entrance was fixed as the main entrance in the cSurvey reconstruction. Other entrances were located by means of a GPS. In this manner it was possible to verify the map altitude and the cartographic morphology utilizing the Carta Tecnica Regionale (CTR) of Regione Lombardia. Later the Therion engine automatically modifies the obtained polygonal to make it coherent with these reference points. The Carlo, Zera and Lupi levels lay below the Venezia level. Their polygonals have been linked each other starting from their physical contact point: the Venezia pit. During the pit re-exploration along the service stairs, the related gap between levels have been measured, resulting fifty meters. In this way the first bench marks of the next polygonals have placed as "virtual point" in the pit stations. The Carlo and the underlying levels have been connected to Venezia level and to each other trough the service slants. During the re-exploration the authors measured a few tunnel sections and big room heights trough laser tool. The mine shapes are very regular; therefore, it was easy to define the relative bench mark. The obtained 3D model had still a last defect: the level was correctly placed with respect the surface, but it resulted horizontal. The mine map contains a few vertical measures; therefore, it was somehow possible to calculate

the estimated altimetry. Once defined the geographic coordinates for these points, it was possible to assign a very real 3D aspect at the mine.

7. Results

The present paper presents a result of 3D re-construction of the mine, which will be completed, when all the upper

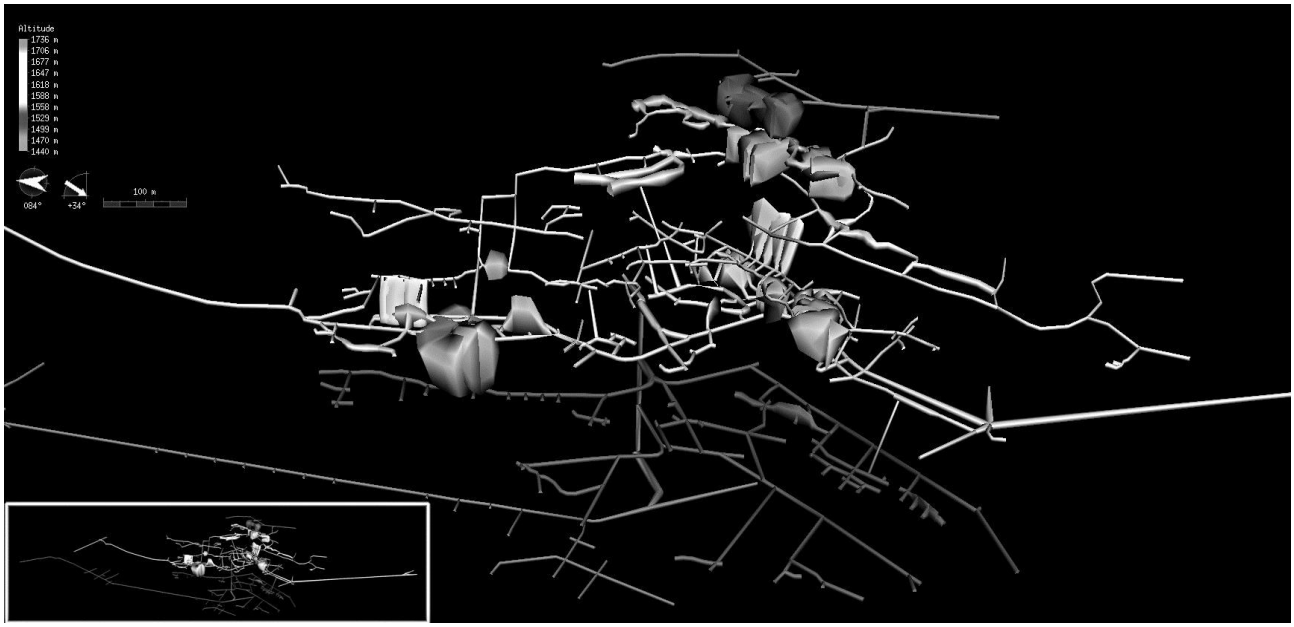


Figure 13. The user interface of cSurvey.

levels will be explored. The artificial gallery re-construction is easier compared to that of a natural cave. Anyway, at least theoretically, this method may be applied also to natural caves. The function Resurvey allows to reconstruct the polygonal, starting only from the single map with cross sections. The availability of the field book will improve the accuracy of the process and increase the details of the polygonal. The 3D geo-referred re-construction supports the study of mine structures; in this case permits: to evaluate the actual preservation of the mine; to document clearly the dimensions of the mine voids and to document the large efforts needed to create such giant underground artificial voids. The giant "exploitation vacuums": originally were filled by and iron ore body, which was totally extracted by miners.

8. Conclusions

This research wants be a test for the applicability of cSurvey to complex artificial cave. Above all it's also a "Dark Memories" contribution: these memories don't contain only the galleries, the equipment, the cars, the lifts, but also the exploitation history from the scarce number of mining company if compared to the thousands of men, which worked and died there. The mining job was the main source to survive for people living inside the valley and it strictly controlled their culture and way of life. For example, Valbondione was named the "widows

valley", the males mortality was very rated due to silicosis. To explore and survey today these places, it means: to avoid oblivion; to preserve memory and to pay homage to miners, who worked hard to supply row materials to our stile of life, which is probably too hungry of them.

Acknowledgment

The authors thank Anselmo Agoni, manager of Ski Mine for his support and competence.

References

Berra F, 2012. Successione triassica delle alpi meridionali. In Note illustrative della carta Geologica d'Italia, Foglio 57 Malonno, pp. 66-67.

Cendron F, 2012. Il Progetto cSurvey, in: Federazione Speleologica Regionale dell'Emilia-Romagna, Speleologia Emiliana n°3, Anno XXIII, Serie V. Ed., pp. 36-45.

Ferromin 1956. Miniera di Manina, piano dei lavori interni, scala 1:500, Genova.

Ferromin,1959. Miniera di Manina, piano dei lavori interni, scala 1:1.000, Genova.

Forti P, Lucci P, 2010. Il progetto Stella-Basino, Società Speleologica Italiana, pp. 29-34.

Maironi da Ponte G, 1788. Memoria orografico-mineralogica delle montagne spettanti LLW Valli di Scalve e Bondione, in: Memorie di matematica e fisica della società italiana Tomo IV, Verona.

Maironi da Ponte G,1819 Dizionario odeporico o sia storico – politico – naturale della provincia bergamasca, Stamperia Mazzoleni ,Bergamo.

Maironi da Ponte G, 1825. Sulla geologia della provincia bergamasca, Stamperia Mazzoleni, Bergamo.

Morandi A, 1993. "Il traffico di cavar la vena". Le miniere di Manina, in Havvi gente buona et laboriosa, Vilminore nel novecento, Il filo di Arianna, Bergamo.

Morandi A, 2002. A 1750 metri sul livello del livello del mare. Le miniere della Manina , Il filo di Arianna, calendario 11, Bergamo.

SASSO RANCIO: AN IRON MINE ON LAKE COMO (ITALY)

Graziano Ferrari[1], Elena Rognoni[1], Giovanni Belvederi[2], Maria Luisa Garberi[2]
[1]*Speleo Club Valle Intelvi, via Colleoni 2, I-22020, Colverde (Como), Italy, gwferrari@gwferrari.it*
[2]*Commissione Cavità Artificiali SSI, Gruppo Speleologico Bolognese -Unione speleologica Bolognese*

Abstract

A 1847 guidebook provided scant information about an iron mine located on the shore of Lake Como (Lombardia, Northern Italy). Few more 19th century references were collected, but no modern relevant information is present in the Internet. A lucky reconnaissance on April 2017 revealed the lower entrance of an iron mine established in 1786 and dismissed in 1864. Exploration and documentation is ongoing; presently, the surveyed development reaches 1441 m. The cavity contains an 80 x 30 x 25 m room and several minor ones, on four levels. Some areas are nicely decorated with white limestone and red, brown and black iron flows. We cleared a rock slide on level 2 and succeeded in reaching an upper entrance from inside the mine. A strong breeze blows between the two entrances, but further upper air sources led to a higher third entrance, a level 3 and a set of loops. Some areas still await exploration and documentation.

Keywords

Dismissed mine, metal mine.

1. Introduction

For more than 10 years, one of the authors has been developing a virtual distributed library about caves in Lombardia (Northern Italy) (Ferrari, 2013). A nineteenth century guidebook reported about "deep caves, winding, raising, lowering, burrowing through the mountain" at Sasso Rancio, on the Como Lake (Cantù, 1847, p. 78). Amazingly, no natural cave or artificial cavity was known in the place. We were able to find few more 18th-19th century references to an iron mine in the area, but no modern information was found, either on paper or on the web. On April, the 17th, 2017, a lucky reconnaissance on the area discovered the entrance of the Sasso Rancio mine, as a gated doorway from which a strong breeze blew.

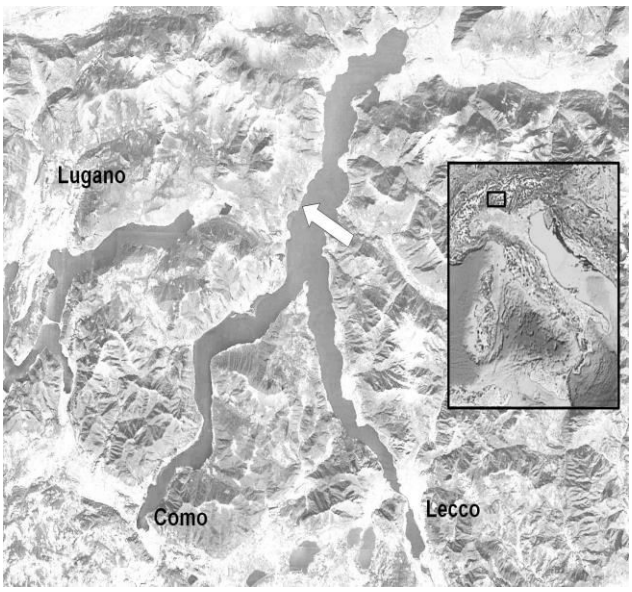


Figure 1. Mine position on Como Lake

2. Geographical framework

Sasso Rancio is a small mountain on the Como Lake west shore (Lombardia, Northern Italy) (fig. 1). Its steep slopes rise from the lake shore (elevation 199 m a.s.l.) to a top at 863 m elevation. The cliffs hindered communications between the northern and the southern sides of the lake shore. An ancient dangerous path still runs over the cliffs. It was called "Via Regina" (Queen Road). On 1902, a narrow road was carved along the lake shore. Finally, in the last decades of the twentieth century, a series of road tunnels bypassed the Sasso Rancio cliffs. The 1902 road was then arranged as a cycle road.

The Sasso Rancio mine opens on the western side of the cycle road, with an iron gate. A lakeshore villa with garden, terraces and a small harbour rises on the eastern side of the road, on the place of the old miners' house. The mine opens in a private owned land.

Despite archive researches, no map of the mine is known. State Archive in Como holds an 1830 surface map, showing the lakeshore miners' house and a raising pathway leading to other miners' houses and to two more mine entrances, scattered on the slope side (fig. 2).

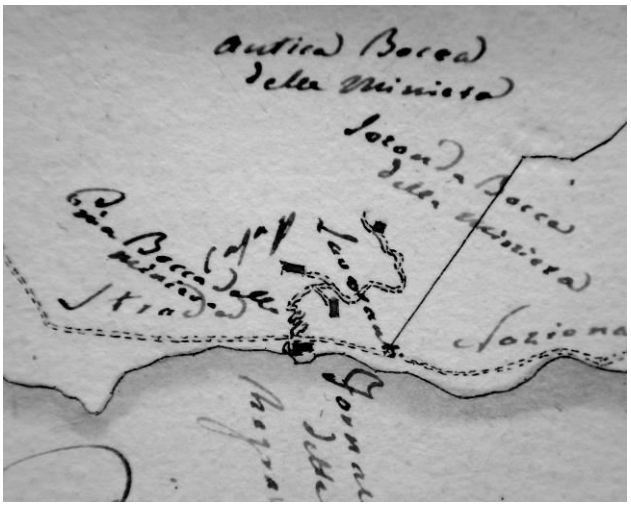


Figure 2. 1830 surface map of the Sasso Rancio mine (Archivio di Stato di Como). North is at the right.

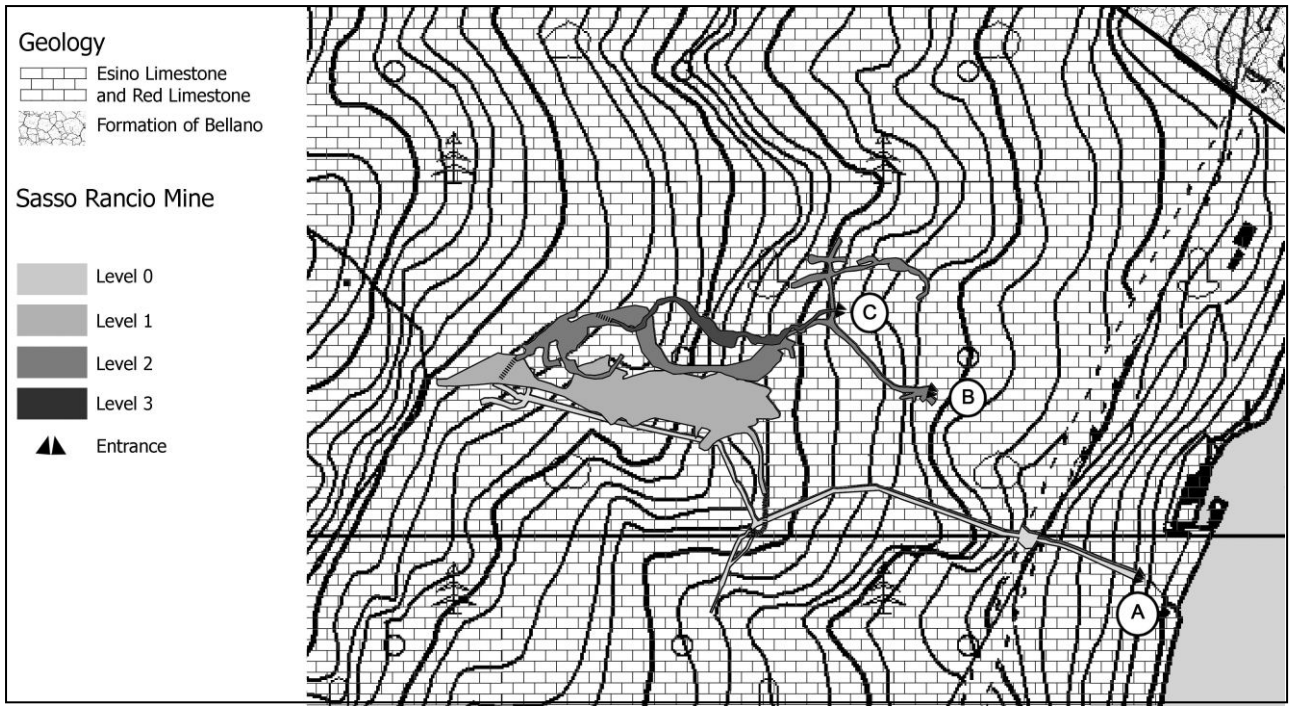


Figure 3. The mine levels over a geological schema.

3. Geological framework

The geological characteristics of the territory under study, located within the southern Pre-Alps (Alpi Lepontine), are identified by a succession of older rocks located in the North and constituted by the late Permian crystalline basement, to more recent rocks towards the South, such as the carboniferous series, the Mesozoic carbonate series and finally the succession of rocks belonging to the Tertiary era. The Sasso Rancio Mine opens in the Mesozoic carbonate sequence: exactly in the top of the Esino Limestone geological formation (fig. 3). The formation includes grey to brownish limestones, often dolomitized, massive or coarsely bedded. In the top it presents the "breccia" belonging to the Red Limestone. The Red Limestone formation includes limestones and dolostones, locally characterized by mineralization, with interposed paleosols and "terra rossa". The maximum thickness reaches 800 meters. Esino and Red limestones are a significant example of a peritidal carbonatic platform, characterized by emersion phases. The formation dates to the middle Triassic (Michetti et al., 2012).

4. Literature and history

The first known reference to the Sasso Rancio mine appears in a manuscript by the naturalist Domenico Agostino Vandelli (1735-1816). In 1763 the Austro-Hungaric government charged him with the task to investigate natural resources in the Como Lake surroundings. In the Sasso Rancio area, he reports about three passageways reaching ochre iron ores. The passages were decorated with black iron stalactites (Vandelli, 1763).

On 1782, the Austro-Hungaric government charged the naturalist Ermenegildo Pini (1739-1825) with the supervision of mines in the Lombardia region. He supported and improved the mining industry, even providing money for new mines and melting plants. The Campioni family already owned iron mines in the area north-west of Como Lake, at Dongo and in the Cavargna valley. In 1786 they officially established the new Sasso Rancio mine. The ore was brought to the lake side and moved by boat to the nearby Menaggio, where the mineral was melted. The resulting cast iron was sold in Lecco, in Milano and in Switzerland. However, the mineral extraction and casting was expensive in comparison with other mines in Italy and in Europe. In 1864 a new ownership dismissed all mines in the area. Archive documents about Como Lake mines opening, management and dismissal are reported by Grandi (2004). Sasso Rancio mine exploitation was briefly resumed in 1902, since the mineralogist Emilio Repossi (1876-1931) studied the Sasso Rancio minerals and claimed that pyrite ore could be extracted in order to produce sulphur (Repossi, 1904). During our explorations, we noticed traces of visits by mineral collectors, dating back to 1960-1970.

5. Description

The mine develops on four levels, with three known entrances (fig. 3). The lower entrance (fig. 3, A) opens on the old lakeside road, at 211 m a.s.l. elevation (position: 46.044213 °N, 009.253099 °E). Level 0 is a 250 m long haulageway in an overall N287° direction. After 40 m, a modern road tunnel cuts the mine passage floor. A small stream runs along the passage, toward the entrance. An artificial basin collects the water and results in a 38 m long lake, decorated with ochre underwater limestone deposits (fig. 4). After 150 m, the haulageway crosses the bottom of a first dropping chute, choked with boulders. The choke in the passage dams a second lake, 28 m long and filled with mud. The haulageway reaches a four-ways

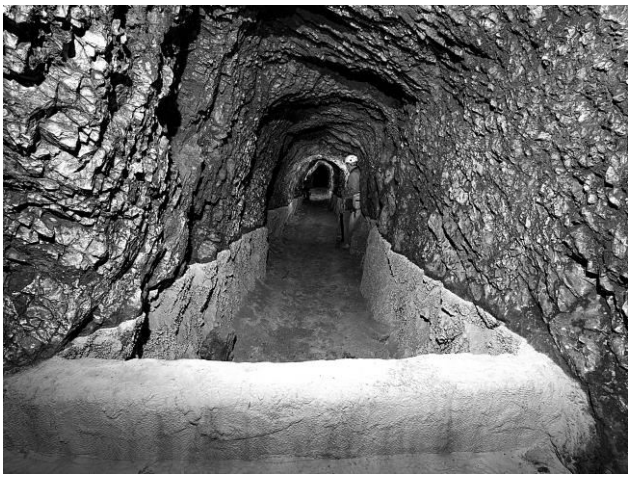


Figure 4. The first lake, in empty state.

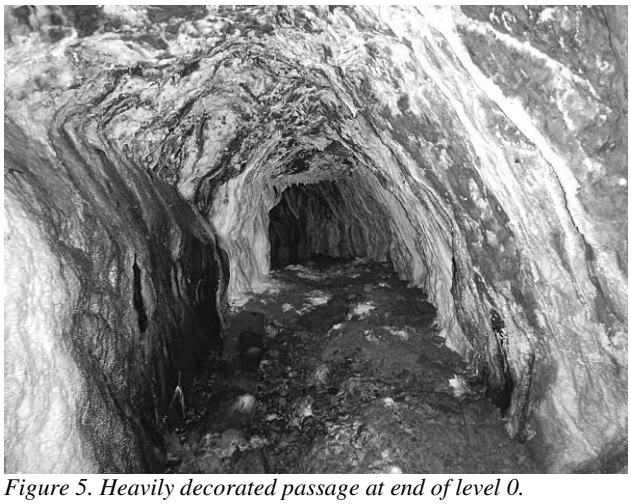


Figure 5. Heavily decorated passage at end of level 0.

crossing, heavily decorated in white, ochre, red and black (fig. 5). A second dropping chute rises at the end of the haulage way.

At 140 m in the main passage, a side passage opens to the left, leading to a slant with stone steps, that connects with a short horizontal passage, placed at 255 m elevation. The first dropping chute opens on the floor of this passage. A strong breeze comes from a boulder choke that leads to the a drop funnel, placed at the bottom of a large room, 80 m long, 30 m large and more than 25 m high (fig. 6 and 7). We named the room after Ermenegildo Pini. The room floor is a huge filling of waste rocks. Dry-stone walls support pathways (fig. 8). The Pini room lays on mine level 1, at about 280 m elevation, that includes also a second room, 35 m long and 10 m wide, named Bucket room after a miner's bucket left on the floor.

From the Bucket room, a short raise sided by a dropping chute leads to level 2, placed at about 300 m elevation. The level includes a large passageway with several side branches and connections to level 1. A 20 x 7 m room, which we named after Domenico Vandelli, opens on level 2. A winding pathway crosses the room, supported by nice dry-stone walls (fig. 9). The level 2 passageway runs toward the hillside, till a boulder choke from which a moderate breeze blows. We opened a passage in the choke and we were able to reach a second entrance from the inside. The entrance opens in the wood at 290 m elevation (fig. 3, B). A 60 m long haulageway connects the choke with the entrance. A maze of passages opens on the North side of level 2 haulageway. Several vertical or inclined passages rise over the inner part of level 2.

Figure 6. The middle section of the Pini room.

Figure 7. The Pini room full length. Note the cavers' sizes.

Since the breeze entering from the second entrance was evidently lesser than the one exiting from the first entrance, we explored the raising passages in search of the lost breeze. We finally succeeded to reach a third entrance, again from the inside. This entrance opens in the wood, at 332 m elevation (fig. 3, C). A level 3 runs from the third entrance toward the core of the hill. It includes a main passageway, a maze of side passages and many ore

Figure 8. Dry-stone walls in the Pini room.

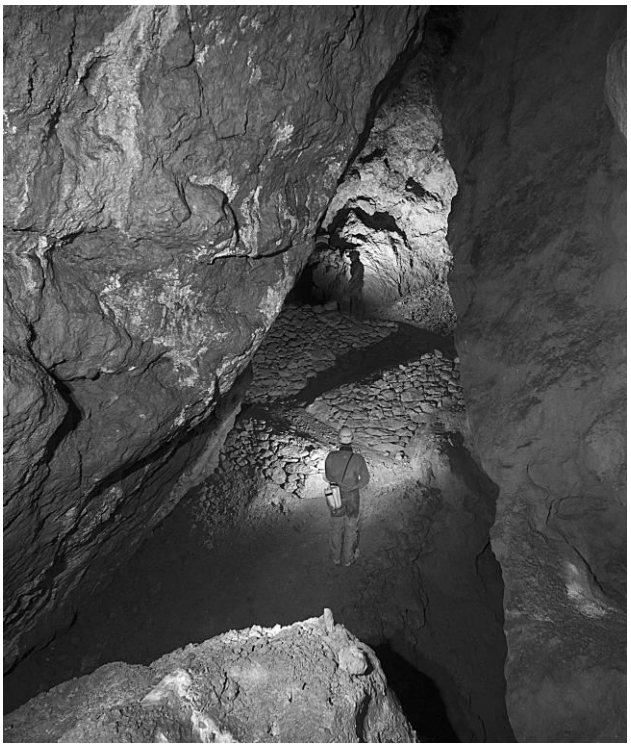


Figure 9. Dry-stone walls in the Vandelli room.

pockets. Level 3 connects in several places with the passages over level 2, so as to provide further ways for breeze circulation.

4.1 Meteorology

Since the mine has at least three connections with the atmosphere at different elevations, it naturally behaves as a chimney flue. In winter, cold air enters in the lower access and runs through level 0 and up the slant to level 1. Its course is lost in the Pini room vast volume. Part of the breeze runs through level 2 toward the second entrance and part further rises through a number of passages in level 3 toward the third entrance. In summer, the air course reverses and a very strong breeze blows through the lower entrance. Occasionally, a weak breeze enters the second entrance in winter, joins the stronger breeze from the first entrance and both reach the upper entrance. Up to now, there is no evidence for further air circulation.

4.2 Hydrology

The cavity shows a quick response to external rainfall. A large number of drippings appear shortly after rain, especially in places near to the surface; they dry up during droughts. A fair-sized waterfall is present in the Bucket room. The resulting stream disappears under the room floor filling. It probably reappears under the Pini room, falls in a drop chute and reaches level 0, where it runs toward the first entrance. A modern wall retains the first lake, which holds about 20,000 litres. Excess water flows over the wall and forms small lakes on the extrados of the underlying road tunnel. During droughts, the lake dries up and cavers can manage it without waders.

A small dripping, active even during droughts, appears in the four-ways crossing at the end of level 0. Its water runs on the main passage and forms the second lake, which is retained by a rubble choke. Its excess water joins the main stream and runs to the first lake. During droughts, the second lake dries up, leaving a 28 m long mud pool.

4.3 Other mine sites in the area

The geologist Giulio Curioni mentions a vertical mine called Cava degli Spini (Thorns quarry), positioned about 300 m over the lake, that is at about 500 m elevation (Curioni, 1840, p. 500). The site has not been identified yet. The mineralogist Emilio Repossi mentions two tunnels mined at the beginning of the 20th century, at about 250 m over the lake, in order to mine pyrites, but they were shortly dismissed (Repossi, 1904, p. 423). One of them could be an adit we found in the wood at 425 m elevation (position 46.046638 N, 9.250683 E, WGS84). It is a passage with two branches and an overall development of about 40 m. A similar passage, a single 43 m long tunnel, opens 70 m South-West from the Sasso Rancio mine first entrance and 45 m higher (position 46.043977 N, 9.252401 E, elevation 256 m a.s.l.). Finally, an entrance, soon filled with rubble, opens in the wood 50 m North-East from the second entrance (position 46.045122 N, 9.252417 E, elevation 289 m a.s.l.). Presently, it is just 2,8 m long.

Figure 10. Draperies and helictites on level 0.

6. Discussion

The Sasso Rancio mine revealed itself as a very nice artificial cavity. The overall development is not a huge one, as compared with other very complex mines. However, the large rooms, the nice dry-stone walled pathways, the pure white limestone draperies and helictites (fig. 10), the ochre, red, brown and black iron flows contribute to a very nice and attractive cavity. Furthermore, in contrast with several old dismissed mines, the Sasso Rancio enclosing rock is quite strong and safe.

As of June, the 30th, 2018, 1,441 m were surveyed, but many side passages and ore pockets still await exploration and survey (fig. 11). Up to eight survey loops were closed, with results from good to fair. Attention was paid to possible ill effects on the compass due to mineral contents in the rock, but in very few occasions we noticed small compass deviations.

Acknowledgments

Mr. Giacomo Pezzi, on behalf of the property, allowed access on the land and into the cavity. Mr. Orazio Garovo showed us the 425 m elevation adit, which was otherwise impossible to identify.

Many caver friends helped in the exploration: among them Fabio Rognoni, Simona Rognoni, Marco Sonvico (Speleo Club Valle Intelvi), Lorenzo Ambrosino, Fulvio Berra, Marco Fasola, Mario Noseda Pedraglio (Gruppo Speleologico Comasco CAI), Veronica Sgroni (Gruppo Grotte Milano – SEM-CAI) and Cristina Ciapparelli (Gruppo Speleologico Varesino CAI).

Finally, the library of the Istituto Lombardo Accademia di Scienze e Lettere in Milan, the State Archive in Como and several digital libraries on the web provided paper and virtual information about the mine.

References

Cantù C, 1847. Guida al Lago di Como ed alle strade di Stelvio e Spluga. Ostinelli, Como.

Curioni G, 1840. Sopra alcuni fatti geologici interessanti l'industria che si osservano presso Menagio sul lago di Como. Il Politecnico, 3 (18), 497-508.

Ferrari G, 2013. A virtual distributed caving library. Proceedings of the 16th International Congress of Speleology, Brno, Czech Republic, 21-28 July 2013, v. 1, pp. 332-335.

Grandi G, 2004. Il travaglio del ferro in val Cavargna e dintorni: miniere, forni, fucine, boschi e carbonaie: materiali per una storia delle antiche attività minerarie e siderurgiche nel Settecento e Ottocento. Associazione Amici di Cavargna, Cavargna.

Michetti AM, Bernoulli D, Livio F, Sciunnach D, Berlusconi A, 2012. Successione sedimentaria delle Alpi Meridionali. In Note illustrative della carta Geologica d'Italia, Foglio 75 Como, pp. 45-48.

Repossi E, 1904. Su alcuni minerali della Gaeta (Lago di Como). Atti della Società Italiana di Scienze Naturali, 43, 422-436.

Vandelli D, 1763. Saggio d'istoria naturale del lago di Como, della Valsasina e altri luoghi lombardi. Padova: ff. 165. Manuscript at the Library of the Istituto Lombardo di Scienze e Lettere in Milan (B.10.11.8). Printed in: Vandelli D, 1989. Saggio d'istoria naturale del lago di Como, della Valsasina e altri luoghi lombardi (1763). Jaca Book, Milano

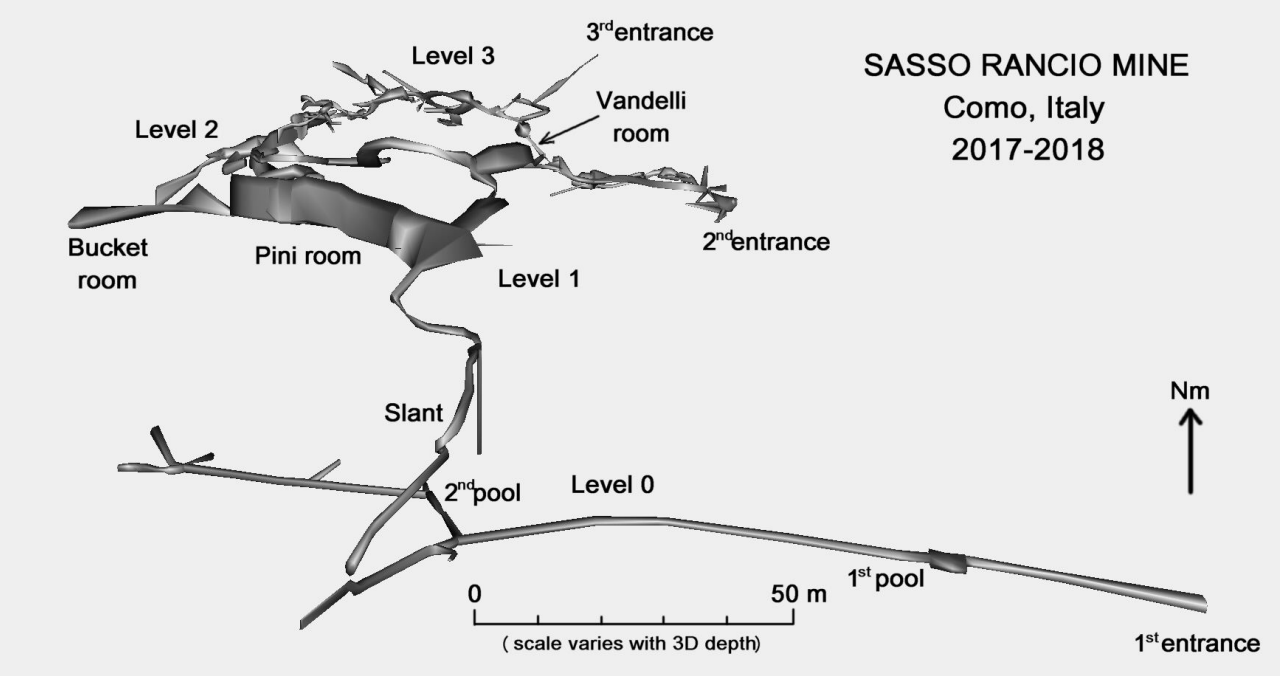


Figure 11. 3-D rendering of the mine survey.

UNDERGROUND LIMESTONE QUARRIES IN TULA REGION, VENYOV DISTRICT (RUSSIA)

Dmitry Garshin[1], Yulia Garshina[2], Stanislav Strukov[3], Yury Dolotov[4]
[1]Mosenergo PJSC/CHPP-17 – 142800, Russian Federation, Stupino, Frunze-3-1-56 – sso.tetis@gmail.com
[2] "Tethys" Stupino Speleological Society – 142800, Russian Federation, Stupino, Andropova-23n-9 – rastarasta30990@mail.ru,
[3] "Tethys" Stupino Speleological Society – 142800, Russian Federation, Stupino, Timiryazeva-9-18 – mrrover1586@mail.ru
[4]Russian Geographical Society – 142280, Russian Federation, Protvino, Pobedy-2a-70 – dolotov@yandex.ru

Abstract

Several underground limestone quarries are known in Venyov district of Tula region. These quarries overview is presented in the paper.
Venyov district is situated in about 150 kilometers to the south of Moscow. Lower Carboniferous limestones lay near the surface there. They fit well for construction needs. It is supposed that limestone production in the vicinity of Venyov started in the 16th century along with Tula defensive structures construction.
Large peasant quarries operated on the banks of the Osyotr river by the end of the 19th century. A quarry system, situated near Byakovo village, is the largest known peasant quarry in Central Russia. The Byakovo quarry system is a combination of several quarries, randomly connected to each other and forming a complex labyrinth structure. Its total length is more than 40000 meters. The history of limestone production in Venyov district is described in the paper, based on archive and literary sources. Known underground quarry cavities are described following the modern spelestological zoning scheme (Spelestology is a term for speleology and caving in artificial underground cavities, used in Russia and several other countries). The authors also tried to restore the limestone production technological process of the 19th century, based on several remains and archive sources
.

Keywords:

limestone production, limestone quarries, peasant quarries, the Osyotr, Venyov district, Tula region, Byakovo, spelestology

Introduction

Venyov district is located in the north-eastern region in Tula region in the midst of Srednerusskaya sublitity, bordering forest-steppe zones. The topographic pictures show the typical rolling plain, divided by deep river corridors [Garshin et al. 2016], scouring the stratum of Lower Carboniferous limestones. Venyov region has been the center of the stone-breaking business craft since the ancient times. Here are the largest peasant underground limestone quarries located in Russia in all. Nevertheless, the region has not been studied in the context of the mining art history; the publications witnessing has not been saved thoroughly. This extract, we point out the first review of the famous underground quarries in the Osyotr river valley, showing off the investigation results.

Russian underground quarries in the context of construction history

As we know the most ancient Russian buildings were built of timber. The Russian territory was mostly covered by thick forests, and Russians, as they are, preferred to build wooden houses, including the areas beyond the forest zones (Bromley and Podolny 1984). The monumental buildings (for religious purposes) had not been constructed in the consequences of local Pagan population who devoted their praying to the natural forces (Yanovskaya and Garshin 2015).

The Kieven Rus (the name of the Medieval Russian state, also Ancient Rus is often used) architecture style has totally changed its image after the conversion to Christianization in the 10th century.

Rus decorated itself with heavy trends of Christianity such as limestone temples and churches, mainly built of raw bricks (plinthiform bricks). That technology was delivered from Byzantium through Khazaria (Formozov 1974).

First limestone churches appeared in the north-east and south-west Rus in the 12th century. Limestone as construction material is much worse than ordinary bricks. A limestone structure is pretty much costly than a one built of bricks: a limestone laying is less well resisting the environment influences, and losing its outward relatively quick. However, the Vladimir-Suzdal and the Galician Principality gave the precedence to particularly this fabric. Highly likely, a huge role was considered the matter of monumental buildings, which were risen up from the limestone material, predominantly located in the centers of the European civilizations. Anew from the beginning, Russian limestone construction was headed as a prestige matter, the demonstration of the state strength and the influence, as well as the accessory the Ancient Rus to the European civilization (Zagrayevsky 2001).

It is supposed that the first Russian architects were taught the lithology in Europe, the similarity of structural engineering is proving that fact (the Russian churches were risen up using stone-faced rubble masonry method with the wooden connections) as well as the style choice connecting close to romanticism and the early Gothic. Well known are the facts of inviting the Italian architects to the most important objects construction (Zagrayevsky 2008).

In the late 15th – early 16th centuries there happened a quick, ubiquitous pass to the brick construction (Zagrayevsky 2001). However, this only increased the demand of quarry output. The lime demand was respectively high in the brick constructioning and the decoration works. Quite often the lime, rubble and ballast were the main products of Russian quarries. The brick constructions demanded the stone foundations up to the invention of the cheap cement that produced the steady demand on hearth and mounting bases. Consequently, it is conceivable that the first specialized Ancient Rus limestone quarries appeared not earlier than 11th century (The stone production in the quarries near Moscow not later than 12th century is proved by the architecturally-lithological researches [Florensky, 1984].

Apparently, the original stone developments were quite little, being conducted in the surface of the limestone's exposures. And right after the production of the most accessible stone deposits, there happened a pass to getting the stones by the tunnels. Subsequently, the huge open pits are excavated in the same deposits in the 19th-20th centuries, which partially broke up the oldest underworkings. There are not much historical evidence of the ancient quarries saved. The first authentic description of the underground limestone workings near Moscow as well as the technological processes of stone production process are listed in the 18th century (Zuyev 1787).

By the mid-19th century the wooden era of the construction has stopped its existence; cheap brick construction took place widely, which demanded a huge amount of limestone for lime calcination, foundations construction and decorative architectural elements production (Dolotov 2010).

By the end of the 19th century the fashion on limestone architectural details has spread over – ladders, window-sills, frontal sculpture, decorative insertions, etc. Limestone also suited well for burial monuments production. This led to the widening of the quarry business, first of all, on the private conditions, which was mostly in the occupation of peasants, as well as the merchant class. Most of the limestone produced in the underground quarries was mined exactly by the peasants (Viktorov and Zvyagintsev 1989).

Appearingly, all famous and well-known quarries in Moscow and Tula regions were operated particularly in this time period.

Limestone quarrying is becoming the most important peasants craft business, particularly, in winter time. The industrial quarries have been working the whole year around (Azancheyev 1894).

In 1920-1930 almost all underground quarries stopped production in the central region of Russia. The technical progress and the labor mechanization have discovered the open-pit quarryind methods in a more safe and cheap way, rather than the underground quarrying.

The History of Venyov District

There is no much information known about the ancient history of Tula region, for the reason there are few written and published archaeological sources.

This territory was the Pagan Vyatichs tribe union place of settlement in the 9th-10th centuries. By the 11th century the lands on the Osyotr and Venyovka rivers were included to Chernigov Principality and later to Ryazan Principality.

Considering the fact of the remained literary sources, the region has suffered a lot in the 13th-15th centuries from the nomad raids, and was depopulated. The population partly is coming back in the 14th century; a lot of cities and villages are appearing, including Venyov itself. The next stage of the region repopulation is happening in the end of the 15th – the beginning of the 16th centuries (Fomin 1997).

Due to the aggressive actions of Crimean Tatars and Nogais, tree entanglements and fortification construction started in the 16th century, including the strong Tula Kremlin (fortress) construction, finished up in 1520.

This fortress was built partially of limestone, as well as the Zaraysk Kremlin downstream of the Osyotr. The construction material choice is likely explained by the usage of local stuff and the architects, managing with this method, presence, as the factors, speeding up the construction.

The Time of Troubles period started in the 17th century, and the Tula region became one of the main theatres of the peasant wars (a series of rebellions). Tatars invasion have continued as well. That time Venyov was a war-constructed town, primarily, despite of the fact that its military value had decreased due to the shift of the borders of the Moscovian state to Kursk, Kharkov and Voronezh.

Merely with Peter the First enthronement, the economic growth has begun. However, by the end of the 18th century Venyov was still a hick town. (Atlasov 1959).

In the 20th century the district was industrialized, which included coal and limestone mining development.

Limestone quarrying in Tula and Kaluga regions along the Oka river and its tributaries is considered start the 16th century (Leonenko and Grokhovskiy 1974). The exact date of limestone quarrying start is unknown and was estimated on the base of the potential use of the white stone in the building construction in this region. Based on the assumption of history reality, it is worthwhile to note, that the permanent military tension could not promote the underground quarrying and limestone construction.

According to the local history literature, the limestone quarrying first mentions date from 1514-1520, the period when the stone was used for the Tula Kremlin construction (Makhel 2004). First documentary reference on local stone craft is fond in Ivan Zavalishin's note dated from 1764, but the analysis of the limestone buildings construction is witnessing, that limestone rock mining had been existed long time before that (Taran 1997). Limestone excavation along the Osyotr river banks was held by the peasants workgroups (*artel's*). While the General Land-Survey the local peasants tried to hold the quarries, as the first thing, providing with their main income, in the prejudice of the arable lands (Pokhvisnev 1852).

According to local legends, the French prisoners of war worked in some quarries after 1812, and some convicts labor was used in the *Lisyi Nory* quarry system. Nowadays the similar statements seem to be the naive. Although there are some facts saved about the efforts of French captives on the mansion construction in Khruslovka (Konovalova 2016).

There is a piece of information in the Economical annotation to the General Land-Survey Plan of 1825 proving the fact, that there was a stone hill in the villages of Byakovo, Sosyonki and Khruslovka, where limestone was quarried for various construction needs and than it is transferred to different places. These villages belonged to the same landlords I.I. Uvarov and P.N. Sumorokov; therefore the information could be mistakenly mixed up; it's complicated to conclude – if the same stone hill is discovered or the different ones (Economical annotation… 1833)

By the mid-19th century the limestone craft produced an important part of peasants, living on the Osyotr banks, income. The stone was mined with underground galleries, sawn up into bricks or stones and was sold out just at the quarries entrances, or delivered according to the contracts allover Tula Principality. The defected production was taken out to Venyov by the trading day sold out for a very cheap price. The local historian Pokhvisnev wrote that all the Tula town, including the weapons plant, is built out of the stone, produced in Venyov quarries, which origin is hidden in hoary antiquity (Pokhvisnev 1852). The quarrying was carried out only with hand tools, without using any explosive materials (Case over… 1880).

The underground quarrying was best developed in lhe late 19th – early 20th century with machines rarity, and simultaneously with a relatively big demand for limestone and logistics development.

In 1863 P.P. Semyonov-Tyan-Shansky, mentions inter alia the Byakovsksya quarry being operated (Semyonov 1863). Its also known that limestone blocks, used for the Spas-Detchin (Moscow region Kashira district) church foundation construction in 1873, was bought in the vicinity of Khruslovka village in Venyov district. However all the rubble was found nearby the church (Golubev 2010).

According to Y.D. Azancheev's report dated 1894., up to twenty thousand limestone foundation blocks were produced and sold in the nearby cities per year around the settlements of Guryevo, Byakovo and Sosyonki (Azancheyev 1894). Brockhaus and Yefron dictionary mentions sales of quarry products in Tula (Brockhaus and Efron 1892).

In the early 20th century open pits appeared on the right bank of the Osyotr river. The first of them appeared in 1929. The limestone produced there went to the Moscow metro construction (Mosmetrostroy). Quarrying changed the terrain and scenery a lot, as well as destroyed the monuments located there, including the ancient Venyov settlement place, and presumably, the existing underground quarries (Garshin et al. 2016).

Venyov spelestological[1] region

Venyov spelestological region is situated on the upper reaches of the Osyotr river with its tributaries (Fig. 1). Lower Carboniferous Upper-Visean substage Venyov horizon limestones lay near the surface and crop out on the slopes here. The limestones form natural and artificial (in open pits) exposures. A significant amount of large limestone deposits is known in the vicinity of Venyov in the Osyotr basin. Venyov limestones have been quarried here with either open pits or underground quarries during hundreds of years.

Venyov limestones are light gray, partially spotted, organogenous-detrital isotropic close-grained massive rocks. The Venyov horizon thickness fluctuates from 10 to 12 meters in stratotypes near Venyov town. It is covered with Jurassic and Upper-Cretaceous sand and clay formations and sometimes Steshevian clays (Leonenko and Shik 1971).

The upper (Western) border of the Venyov spelestological region lays along the Osyotr river downstream of Chertovoye village. Venyov limestones can be found along the whole Verkusha (the left tributary of the Osyotr) and Polosnya (the right tributary) valleys. These limestones also expose along the Venyovka river with its tributaries up to Beryozovo village (the Southern border of the spelestological region). The region lower (Eastern) border is the Osyotr river near Boksha village in Moscow region.

Spelestologically, Venyov spelestological region belongs to North-Eurasian spelestological land Middle-Russian spelestological province Tula spelestological division.

A short description of the Venyov region known artificial underground cavities is presented below according to the modern spelestological zoning scheme.

Fig.1. Venyov spelestological site on the map of Russian Federation. Based on Bing Maps.

[1] *Spelestology* is a term for speleology and caving in artificial underground cavities used in Russia and several foreign countries.

Kislovka natural bondary (“*Urochische Kislovka*”)

A famous Russian geographer P. Semionov-Tien-Shansky mentions the villages of Sosionki, Khruslovka and Kislovka in his “Russian Empire Geographical-Statistical vocabulary” as the places where the best limestone quarries are situated (Semyonov 1863). The situation of the disappeared Kislovka village is well-known, but no underground quarries signs have ever been found there. It seems that Semyonov mistook describing this region. Although the limestone quarrying signs could be destroyed by natural processes.

Venyov-Monastyr spelestological site. (The Osyotr left bank).

The limestones were excavated with open pits in different times here.

Osetrovskoye Lesnichestvo spelestological block is situated in the vicinity of Osetrovskoye Lesnichestvo village. Its borders are unidentified.

Several old abandoned open quarries are situated in the forest upstream of the village. Several crack-carst cavities were opened in one of these pits on the left bank of the Osyotr. A small 8 meters long artificial gallery, named *Osyotr-2*, is also situated there (Fig. 2).

The entrance to the gallery is enlarged like a grotto with its width of 3.5 meters and length less than 0.5 meter. An 1 meter wide (maximal width near the roofing) and 0.8 meters high gallery runs from the entrance. There is a big niche, partially backfilled with rubble, in the left wall in about 3 m. from the entrance. One can enter the niche through a narrow passage in the backfilling, but there is no continuation. The gallery deviates to the right after the niche, becomes narrow (about 0.7 meters wide and 0.6 meters high) and finishes with the face in a crack. Probably the mine adit was driven along a natural cavity looking alike the nearest ones. The cavity walls are eroded, there are no tool marks inside. However, the cavity strict shape and its rather large volume, comparing to the neighboring caves, indicate its artificial origin.

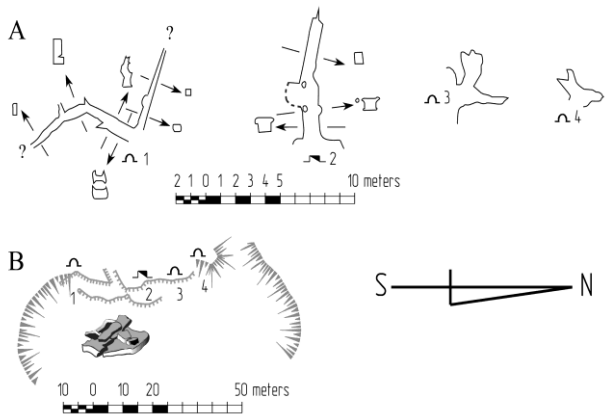


Fig. 2. The Osetrovskoye Lesnichestvo spelestological block cavities. A. The cavities plans. B. The open pit quarry croquis by Yu.A. Dolotov (1979). 1) Osyotr-1 natural cavity, mapped by Yu.A. Dolotov (1979); 2) Osyotr-2 artificial cavity, mapped by Yu.A. Dolotov (1979); 3) Osyotr-3 natural cavity, mapped by S.O. Ivaschenko (1996); 4) Osyotr-4 natural cavity, mapped by S.O. Ivaschenko (1996). Design by D.I. Garshin (2018).

Guryevo spelestological site (The Osyotr left bank)

Upper-Guryevo spelestological block (upstream of Metrostroyevsky and Guryevo villages).

The block upper border is an old ravine near the M4 (E115) “Don” highway. The lower border is a small ravine near Guryevo village.

The Osyotr river becomes rather broad and shallow after the Verkusha river mouth. This part of the Osyotr is called the *Razliv* (the Flood) lake by the locals. The qarrying signs can be found on the both Osyotr banks. There are several abandoned pits on the right bank.

The Osyotr left bank has a high steep slope with limestone rocks in its lower part. Two artificial underground cavities, called Razlivnaya-1 and Razlivnaya-2, were discovered in these rock exposures. These cavities have been well-known to the locals for at least 40 years (Fig. 3).

The situation of the entrances, laying above the original ones as a result of gravity drift, seems very unusual. They are situated in about 3-5 meters above the Osyotr low-water mark. As the locals reported, the Osyotr water level had been even higher before the Osetrovskoye Lesnichestvo dam was constructed. Accordingly, the cavities could be periodically flooded while being in operation. The entrances are situated in the lover part of a limestone rock exposure. Large limestone blocks can be found in front of the entrances.

There is a series of large sinkholes in the woodline above the bank slope. They appeared probably as a result of unknown underground cavities collapses. Unfortunately the cavity excavations from these sinkholes seem prospectless because of large overburden thickness.

Razlivnaya-1 (Verhneguryevskaya-1, Flood-1, Upper Guryevo-1) is a remained entrance part of an underground limestone quarry. Its total length is about 6 meters. The cavity sill is partially covered with clay, so the roofing is not more than 1.5 meters high. A monolith pillar and rubble backfilling can be easily seen in the left wall. The marks of some sort of a pickaxe remained on the pillar.

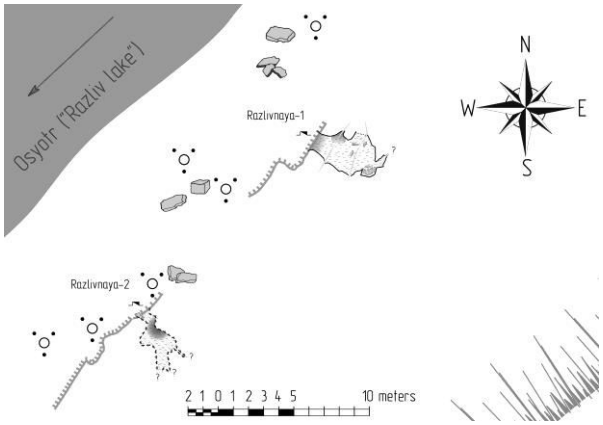


Fig.3. The Upper-Guryevo quarries (Razlivnaya-1 and Razlivnaya-2). Mapped by D.I. Garshin and S.S. Stroukov (2018).

The backfilling is made of rather large rectangular blocks having equal size and shape.

The cavity right wall consists of eroded limestone monolith without any tool marks. The cavity ends with a narrow, probably animal hole with strong air draught from it.

Razlivnaya-2 (Verhneguryevskaya-2, Flood-2, Upper Guryevo-2) is a gravity drift[2] cavity appeared after an ancient quarry entrance part had collapsed. The cavity is partially filled with clay and damaged with collapses. Only 4 meters are accessible for a man. The continuation can bee seen through the debris and air draught is also felt from there.

Special survey has never been conducted in Razlivnaya-1 and Razlivnaya-2, so the unknown spaces can be found with underground excavations.

Byakovo (Upper Guryevo) spelestological block is situated in the vicinity of Metrostroyevsky and Byakovo villages. It spreads from a small ravine near Guryevo village to a ravine upstream of Khruslovka outskirts.

The Byakovskaya (Byaki, Byakovskaya-1, Guryevsky quarries) quarry system is one of the most famous underground mine workings in Tula region for its touristic popularity (Garshin and Garshina 2016). It is also the largest peasant limestone quarry in Central Russia and one of the longest Russian spelestological objects at all (Dolotov and Sokhin 2001). At least a part of its underground space seems to have always been accessible since the limestone production stopped there.

The Byakovskaya modern entrance is situated in the central part of the Osyotr bank high slope, near the village of Byakovo. Local cavers and tourists often believe that in the past it was an extra entrance or some sort of a ventilation shaft. Really a series of entrances existed from contemporary Metrostroyevsky village to Khruslovka outskirts. Most of them are not available and partially destroyed nowadays.

The archaeologist O.N. Zaidov reported that limestone production started in Byakovskaya not later than in the 16th century. Unfortunately, the archaeologist left no papers and his archives and finds were lost so now it is unknown what his dating is based on. However the quarries are mentioned in the Economical Comments to the General Land-Survey Plan in 1825 (Economical Annotation… 1833).

The quarry was driven moving the working face, leaving protective pillars and partially backfilling the mined-out spaces with rubble and defect production. This mining method is similar to the one used in Moscow region (in the vicinity of Podolsk and Domodedovo) peasant workings (Yanovskaya and Garshin 2015). Independent parts of the quarry system developed as rather straight and wide main galleries with bowed irregular in plan branches, connecting with other main galleries branches (Pokrovsky 1890).

The limestone production lasted till 1929 and was stopped as the open pit quarrying started on the opposite side of the Osyotr. As a local elder I.E. Savinov reported in the 1970s, local peasants worked in the Byakovsaya quarry system and limestone production was a local family tradition. Savinov helped his father to work underground when he was nine years old in 1912. The miners used kerosene lamps for lighting (Grechenko et al. 1976).

Several independent family workgroups (*artel's*) worked in the Byakovskaya quarry system at the same time and each had its own work area. By the early 20th century the quarry system featured a rather complicated labyrinth so sometimes the miners could start work in wrong area that caused conflicts and fights. Savinov also remembered that the quarry system sometimes was flooded and they had to work mid-leg in water.

O.N. Zaidov identified several big flood periods when the limestone production stopped for a rather long time.

The Byakovskaya entrance was known by the tourists since at least 1969. Most of the Byakovskaya underground space was discovered in 1973 as a result of P.E. Nikolayev's group research. His group was the first one to survey the system.

Later the quarry system was surveyed by the Novomoskovsk Speleological Section, Voronezh Speleological Section and speleologists from Moscow in 1975-1985. The quarry has become quite popular among tourists and cavers since the mid-1980s. They continued surveying it. Cavers organized underground base camp places and constructed art-objects. Some parts of the quarry system were reconstructed for touristic needs, but mainly the system is not damaged. Most of the toponyms were created by these cavers.

Byakovskaya full semi-instrumental topographic survey was conducted in 1993-2008 by S.O. Ivaschenko group (Fig. 4). According to the survey results the quarry system total length reached about 40 kilometers. The usual galleries roofing height is about 1.5 meters in Byakovskaya. The rubble backfilling between some neighbouring galleries has settled down and there is often enough space to pass through between the rubble walls and the roofing. These holes have never been maped out, however their total length can be sighnificant.

During the last several years the entrance part roofing height was noticed to have decreased. Several collapses facing up to divide the main volume from the entrance have also occurred. Probably soon tne new entrance excavations can be strictly needed.

The whole quarry system underground space is usually divided into subsystems. Such division is more subjective than morphological, as the full Byakovskaya map was not available to most of the cavers until 2010. The borders between the subsystems are not strict.

The proposed quarry system division into subsystems is proposed, based on S.O. Ivaschenko's description.

[2] The *gravity drift* is a natural process of cavity rising as a result of rock falling from its roofing to the sill.

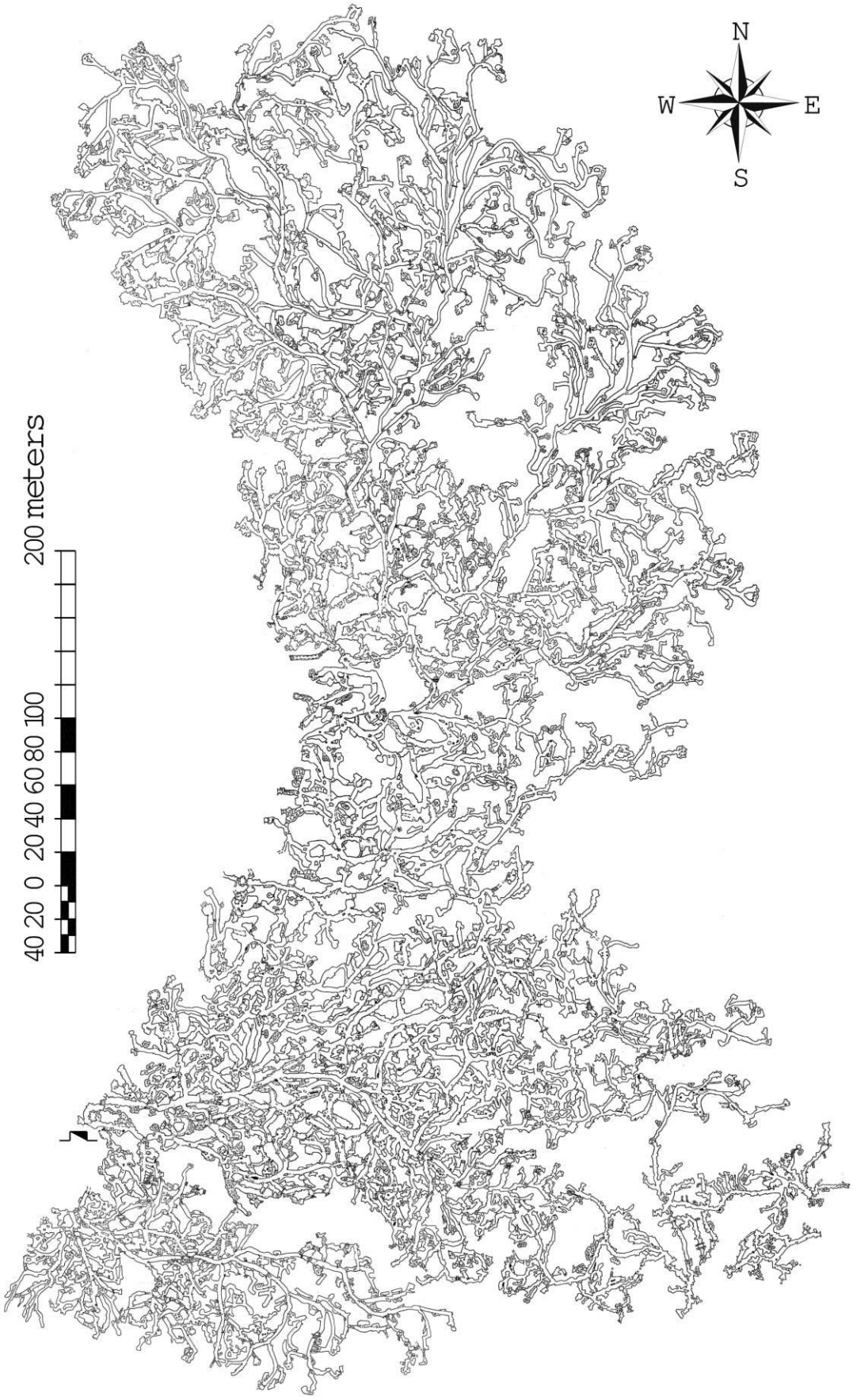


Fig. 4. The Byakovskaya quarry system. Mapped by S.O . Ivaschenko's group (1993-2008)

.

The Byakovskaya Southern part

The Red Dog (Krasnaya Sobaka)

This subsystem was named after the "Red Dog" (in English) inscription on a limestone block in its central gallery. It is a large dendritic gallery system with its total length of more than 7 kilometers. The Red Dog is connected to the other part of the whole quarry system with only one passage. This part of Byakovskaya is heavily damaged with collapses. Speleothems can be found in this subsystem. Red Dog is considered to be the most ancient part of Byakovskaya for its condition. Morphologically this subsystem consists of a winding main gallery with multiple branches, crossing with each other, and differently directed working faces.

The Byakovskaya part to the East of its entrance. This part of Byakovskaya is usually assumed as some sort of transit area by the cavers (except the White subsystem, which is a popular point of interest) as there are very few organized base camp places there, so the division of this part is not strict.

The Central Rhombus (Tsentral'ny romb) is approximately the center of the announced part. The subsystem developed around one main gallery from which multiple branches were driven. Branch galleries intersect at acute angles there so the subsystem features a very complicated labyrinth. The most dense galleries network is situated in the Central Rhombus.

The Strange Spot (Mutnoye Pyatno)

This subsystem was distinguished during the topographic survey. This area located near the Central Rhombus is a very complicated passage crossing very hard to be mapped out.

The Refridgerator (Kholodil'nik) system is located between the Central Rhombus and the White System. Strong air draught from the White System is felt here, so the air temperature is quite low.

The "Caesar" system consists of two separated groups of galleries. This is the most Eastern part from the modern Byakovskaya entrance. It is called for the graffiti by a caver nicknamed Caesar, that can be often found there.

The Belaya (White) system is an independent quarry (a quarry system), connected to the entire Byakovskaya system. The Belaya system entrances were located to the South-East of Byakovo village. Their collapsed portals can be easily seen along the Osyotr bank from Byakovo to Khruslovka even nowadays. The walls and roofing of the system are wite, they are not covered with lamp black. Belaya is heavily damaged with collapses, most of the passages are very tight and low. This system is a series of main galleries connected in their faces line. The system may spread to Khruslovka but this part is now unavailable.

The Byakovskaya central part

The Pillared Hall (Kolonny Zal, Kolonnik) is situated in the Byakovskaya central part near its main historical entrance. It seems that a part of rubble backfilling (wall enforcement) was brought to the surface during the last stage of limestone production. As a result of this process a group of halls with monolith protective pillars. Also there could be no backfilling at all as the halls are not too large. Several significant production pieces have remained in this subsystem. They are limestone circles about 1.5-2 meters in diameter. Probably they are millstones or pillar foots. The most used entrances leaded to the Pillared Hall subsystem.

The Stupino Base/The Cat's house (Stupinskaya baza/Koshkin dom) is a long stand-alone gallery with its branches developed to the East from Byakovskaya center and finishing with working faces. It is partially damaged with collapses and crosses clay lenses in several places. It was named as tourists from Stupino town liked to base there.

The Byakovskaya Northern part seems to be the most modern part of the entire system. It was impossible to organize new entrances while mining in this part of the limestone deposit due to the Osyotr bank shape. Miners had to start their new galleries from the Pillared Hall, deviating them to the North. Mainly the Northern galleries are more strict than the Southern ones, there are less crossings and rubble walls are made more carefully.

Glinyanaya/ Shokoladka (The Clay system/ The Chocolate system). This subsystem develops to the North from the Pillared Hall. It is located near the river so it was often flooded. Constant water drip is noticed in Glinyanaya. The subsystem is partially filled with black and brown clay. Its entrance was situated in the Pillared Hall and some of the working faces direct to the Osyotr.

The Chyornaya System (Black) is the North-Eastern part of Byakovskaya. It is named for widespread dark bloom on the walls and roofing. It is thought to be lamp black of poor quality oil lamps and splinters. However this subsystem galleries are typical for the Byakovskaya Northern part.

The Shtany (Trousers): Levaya Shtanina and Pravaya Shtanina (Left Trouser Leg, Right Trouser Leg). Te Shtany is a vast area in the Byakovskaya Northern part. It developed in two main directions, deviating and turning back to the center: from the center to the North and from the center to the North-East. Two main galleries with their outgoing interconnected branches with working faces develop in these directions. The distance from some of the farthest faces to the main entrance in the Pillared Hall reaches 1 kilometer, what is not typical for the 19th century peasant quarries (it is believed that transporting something including produced limestone underground for the distance of more than 300 meters was economically unadvisable before transfer mechanisms became widespread). The North-Western part of Shtany is partially flooded. This area is called *Ozero (the Lake).* It is one of the most famous Byakovo point of view and the main drink water source underground. Some black organic layer looking like lamp black can be found on the roofing near Ozero.

Large (up to 20 meters long) carst and tectonic cavities were crossed by the quarry galleries. The largest of them became popular touristic points of interest. While

surveying Byakovskaya multiple artifacts were found. These are tool marks, cut out and sawn limestone blocks and round stone elements, multiple splinter remains and their coal, splinter marks on the walls, pottery fragments, horse traces on the floor. When Belaya System was discovered a lot of tin kerosene lamps without glasses looking like small cups with wicks in their conic caps were found there. A 4-meter long iron saw blade without teeth for limestone sawing was found in the Byakovskaya south-eastern part. There were also multiple finds of round and (rarely) rectangular wine bottles underground.

O.N. Zaidov reported that he had found a leather hat which was similar to Dutch miners' hats of the 16th century.

Timber support was used very rarely in Byakovskaya and there are few remains of it.

Paskhalnaya (Easter cave, Byakovskaya-2)

Special relief forms looking like abandoned pits and collapsed quarry entrances can be found along the Osyotr bank from Byakovo to Khruslovka. Sinkholes and limestone exposures witness of underground quarries existence. Different groups of surveyors tried to conduct excavations here in different times, looking for unknown quarries or the continuation of the Byakovskaya quarry system but nobody succeeded. Nowadays only one small cavity named *Paskhalnaya* is known there. This cavity is about 10 meters long. It is situated approximately on the opposite side of the Osyotr from the Khruslovka estate (Fon Mekk's estate). Paskhalnaya is a gravity drift cavity. Its entrance is placed under a limestone rock which is also situated in the left wall of a small ravine. It is thought to be a destroyed quarry entrance as heaps of rubble and ground lie near this ravine. The cavity consists of a single passage deviating to the right and finishing in the collapsed dead-end. The excavations in the collapse seem too dangerous. It is considered that due to its situation the cavity has no concern with the closed quarry and is an occasional cavity in the rubble heaps, which was enlarged by research excavations.

Byakovskaya-3 (Zashkol'naya / Behind the School) quarry system.

A quarry system called Zashkol'naya was discovered by P.Nikolayev's group in 1970-1971. Its entrance was opened in a trench situated in a ravine near the Metrostroyevsky village school. Nowadays the entrance is lost and the quarry system situation is forgotten and unknown even to the locals. The quarry system has never been mapped out.

Some spelestologists doubt the quarry system existence as all the information on it is got from P.Nikovayev's private messages. P.Nikolayev described this cavity as a small underground quarry consisted of a single gallery with several offshoots. The quarry total length is about 300-1500 meters. Its roofing is rather low.

Several unremoved sawn limestone blocks and timber remains were found inside. The residents interrogation provided by P.Nikolayev resulted the quarry had been operated till the early 20th century. Limestone blocks were sawn underground with special hand-made saws with small teeth. The production was sold near the quarry entrance, in the marketplace near the modern school building.

Sosyonki spelestological site (the Osyotr right bank).

A series of small open pits is located on the right bank upstream of the Metrostroyevsky pit.

Karpovo (Metrostroyevsky) spelestological block (in the vicinity of Karpovo village)

The large Metrostroyevsky open pit is situated in this block. The block borders can't be identified as the relief has been changed greatly by limestone production. The upper border can be marked upstream of the pit. The lower one should go across the Lesnoi pond. The locals and the pit workers reported ancient quarries galleries were sometimes opened by the Metrostroyevsky pit. Unfortunately spelestologists and other surveyors could not observe these discoveries and nowadays they are completely lost.

Sosyonki spelestological block (in the vicinity of Sosyonki village).

The upper border is not clear due to a strong landscape changing at the pit excavation, it should be possibly drawn in the Lesnoi pond area. It is limited in the bottom with a ravine Sosyonki village is standing on.

This territory above the high right bank of the Osyotr river features abundant funnels, cavings and destroyed entrance portals indicating large underground workings were present here. The block landscape has been significantly changed with pits and railways laying in the first half - middle of the 20th century.

Five underground cavities are known to exist now at the block territory (Fig. 5).

Limestone open excavation was started in 2017 near the caves. All Sosyonki block stone quarries are likely to be lost soon.

Sosyonkovskaya-1 (Lisyi Nory, the Fox Holes, Lisya cave, the Fox cave).

Lisyi Nory stone quarries system is the remaining north-western part of a larger working destroyed by collapses and later open excavations. According to some findings and mentions in literature sources limestone mining was commenced here in the 19th century. A horseshoe, a 1829 coin, a pickaxe and

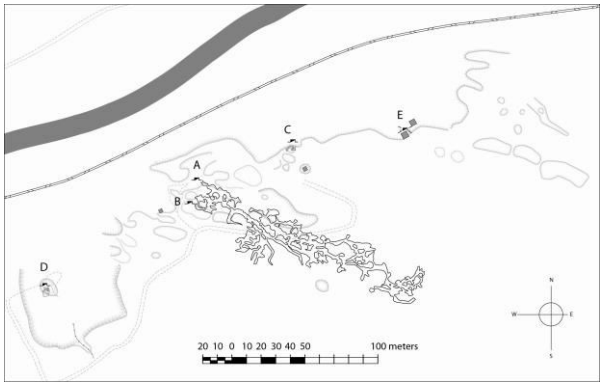


Fig. 5. The Sosyonkovsky spelestological block limestone quarries in 2016. Underground surveying by D.Albov, D. Garshin, Yu. Garshina. Surface surveying by D.Garshin, S. Stroukov, A. Shepelkov, Yu. Garshina, Yu. Ershov. Design by D. Garshin, V. Bulatov, D. Albov (2016). On the plan: A) Sosyonkovskaya-1 (Lisyi Nory); B) Sosyonkovskaya-2 (Ledyanoy Grot); C) Sosyonkovskaya-3 (Obvalnaya); D)

Sosyonkovskaya-4 (Parovozyi Nory); Sosyonkovskaya-5 (Myshinaya).

numerous iron tools chippings and horseshoe nails were found here in the hoisted material - typical findings for the Moscow region limestone quarries.

The quarry is well known to tourists and locals. The local placename *Lisyi Nory* or *Lisya* cave exists at least since 1970s. The entrance to it was uncovered by P.E. Nikolayev's group in 1968-1969 in the lower part of limestone ledge rock.

Morphologically the stone quarry is a combination of galleries and pillared halls (rings). Galleries in the quarry are low, not exceeding 1.6-1.7 m in the highest places (except domes formed above large collapses). The average height of the stone quarry galleries in its modern state can be estimated as less than 1.5 m.

In the north the stone quarry is limited with a shallow ravine. All galleries aimed this way end with faces. The southern part is limited with cavings and collapsed areas.

The layer in which the stone quarry is driven is dissected with a series of large cracks with karst holes developed along some of them. Apparently development here was started from cracks and was somewhat chaotic: the direction was changing towards the best or most simply mined limestones. The mining process was dangerous and accompanied with roof collapses. This is indicated by the remaining thick columns made of quarry stone loaded by the roof. The quarry volume is now mostly filled with rbble and quarry stone used by workers to support the roof. Judging by the preserved remains wooden support was used rarely in a form of individual supports. No remains of T- or U-shaped supports were found.

Quarry stone filling is virtually absent in the area of the quarry modern entrance. Most likely this is due to the latest quarry stone mining. Due to this the entrance part is a pillared hall with a complex layout strongly damaged by collapses. The next part of the system is separated from the entrance part by a collapse dome. Quarry stone is present here, the central gallery is well-seen with side branches leading to pillared halls near faces and to the non-extant part of the system.

The central part of the quarries system is damaged with cavings, a large dome is located close to its geometrical center. This part of the cavity is invaded with sand. Another part of Lisyi Nory is located beyond the dome with relatively well-preserved galleries. This part is also a chamber and pillar working with the free space filling with quarry stone. Here most driven galleries forks are aimed away from the modern entrance at sharp angles which indirectly indicates the presence of an unknown part of the stone quarry in the south. The left (northern) part ends with faces. The right (southern) part is mainly limited with cavings.

The stone quarry main products were bas wall blocks with about 30x7x70 cm dimensions. Judging by distinctive tool markings in faces and on pillars breaking was performed using steel wedges driven to pre-cut sockets. In haulage galleries ceilings could have been snubbed with pikeaxes. Judging by rejected slabs with cutting marks found in backfilling slabs cutting, sawing and possibly rough grinding was performed underground. Products haulage was performed by horses using slushers (*volokooshas*).

The stone quarry used wicker lighting. This is indicated by numerous signs of soot on walls and ceilings, wickers remains and their cutting marks in a form of chaotic

streaking. Wickers were inserted directly to convenient cracks in walls or to quarry stonework crevices without specialized holders. Wicker ash was also used to mark up cutting sockets preserved in a part of faces.

The stone quarry is often visited by foxes. Also it is inhabited by a colony of bats (Garshin et al. 2016).

Sosyonkovskaya-2 (Ledyanoy Grot, Ice Grotto) - a small gravity drift cavity (occasional cave) about 5 m long formed by a collapse of Lisyi Nory stone quarry hall below.

The entrance to the cavity is inclined and is located in a sinkhole in about 20 m to the south from Lisyi Nory entrance. The cavity walls are vertical. A relatively smooth floor of the entrance part is covered with washed up clay. The ceiling consists of large rocks in balance.

Sosyonkovskaya-2 floor is 6 m above Lisyi Nory level 5 m from the entrance the cavity is blocked with large limestone chunks followed by a riser washed through clay and impassable for a human.

Sosyonkovskaya-2 is located in the upper part of the crack which is well-detected in the entrance part of Lisyi Nory stone quarry (Garshin et al. 2016).

Sosyonkovskaya-3 (Obvalnaya, Collapsed Cave)

A series of grinding ditches is located downstream Lisyi Nory along the Osyotr river with dumps traces. The first one has an entrance to Sosyonkovskaya-3 cavity under the limestone exposure, this entrance has been known for a long period of time. The limestone rock housing the cavity is dissected with a series of cracks and has funnels directly above it. There are two more funnels in the field about 20 m away from the entrance, one of them had an active sink hole, the funnels partially continue to grow. All this allowed to suggest a large stone quarry existence to the east from Lisyi Nory.

After passages clearing the cavity length was about 10 m. Sosenkovskaya-3 is a gravity drift cavity limited with collapses.

Sosyonkovskaya-4 (Parovozyi Nory, Locomotive's Holes).

A small cavity - Sosyonkovskaya-4 (Parovozyi Nory) was uncovered in a vast depression to the west from Lisyi Nory entrance in a small sinkhole with an active water flow. It was named due to narrow gauge railway parts found in the sinkhole.

Sosyonkovskaya-4 is a small hall created as a result of a gravity drift. The entrance part is presented with a

small creephole going through a large-chunk heap along the water flow. A small dome is located to the right from the entrance creephole in a chunk heap in which the 2nd water flow hole can be seen.

The cavity main hall ceiling is formed by a large slab dissected with a crack.
Due to this its northern part closest to the entrance is inclined and touches the floor.
The sink holes water flow is well-traced in the western part of the cavity. Water was going down to a crack in the wall. The crack has a strong air draft. Sosyonkovskaya-4 floor is strongly washed-up with clay, further works on its clearing require arrangement of an entrance sufficiently wide for the dump removal.

The collapsed space was probably a part of Lisyi Nory stone quarry.

In 2017 the sinkhole housing the cavity entrance was completely filled with a dump from the new pit.

Sosyonkovskaya-5 (Myshinaya, Bat Microcavity).

A hole was driven in 2017 along the rock sediment near the large cavings line to the east from Lisyi Nory entrance. The hole uncovered a gravitational drift cavity less than 3 m long filled at the further hole driving. Distinctive features suggest availability if a strongly collapsed gallery in this location however it could not be accessed (Garshin et al. 2016).

Malo-Khruslovskiy spelestological block (across Khruslovka village, near Malaya Khruslovka village).

It is limited on top with a ravine Sosyonki village is standing on, it obviously flattens out to the bottom. Stone mining was performed at the sides of the modern railway bridge. According to local old residents reports mining was performed in the first half of the 20th century using exclusively open method there.

Khruslovka historical estate is also located here with preserved underground household facilities.

Venyov spelestological site (the Osyotr right bank and the Venyevka lower reaches)

There is fragmentary information on limestone mining using underground method at the territory of present Venyov town and in its close area. However no stone quarries or positive signs of their existence have been found here.

Schukino spelestological site (The Osyotr left bank)

Kamennaya Gorka spelestological block **(upstream Prichel village).**

It is limited on top with the Tulubeika creek and in the bottom with a ravine entering the Osyotr valley across Prichel village. A limestone rock stands near the Tulubeika mouth with an ancient settlement on top and a cave driven in the rock massif.

Kamennaya Gorka 1. It is mentioned in literature and tourist reports under names Kharinskaya cave, Sokolovka, Schuchyinskaya, Kamennaya Gorka, Prichelskaya, Shyuchye Gorodishe Cave (Schuchye hillfort cave), Starets cave (The Elder One's Cave) (Fig. 6).

The material culture history institute (IIMK) records have information on inspection of a cave near Schuchye village: "The entrance hole to the cave is in the south-western corner of the mountain among huge chunks of stone hiding the entrance very well. Stones weighing up to 1600-2400 kg fallen from above are scattered near this hole at the Osyotr river bank level, these very probably were previously used to close the cave entrance. The hole is about 440 mm wide and up to 0.7 m high. A sort of a corridor starts here and goes to the right among piled up rocks. This entrance is about 2.8 m long, it ends with a cave about 1.75 m high, about 2.8 m wide and of the same length <…> A careful probing of this sedimentation with an iron bar indicated it is at least 1.05 m thick.

The cave is with light coming through the entrance hole. Independent entrances to other adjacent caves go from this first cave" (IIMK f.1 d.91 1904). The explorers created a rather detailed description of the cave volume and mistakenly made a conclusion it was used as a shelter by stone age humans.

The cave was further visited and studied by various spelestological groups.

The cavity is undoubtedly a stone quarry. This is indicated both by the working configuration and distinctive marks of tools used for stone mining. The cavity is a volume of about 4x10 m dimensions and up to 2 m high separated with columns and stone heaps into several parts usually perceived by visitors as independent chambers. According to I.Yu. Prokofiev's suggestion particularly based on locals' beliefs the stone quarry was later used as a chapel or a hermit's cell.

The cave does have two icon arcs (a poorly preserved one on the wall to the right from the entrance and a well-preserved one in the "left" chamber), also there are signs of a door installation in the entrance aperture and the second entrance hole which could be used as a skylight. However icons could be installed during the stone quarry mining period (Dolotov 2011).

A large abandoned open pit is located directly below Kamennaya Gorka 1 cave (Prichelskiye stone quarries). It obviously mined out a large underground stone quarry as remains of destroyed galleries are still visible in its slopes located away from the river.

Kamennaya Gorka 2. It is a fragment of a gallery about 6 m long, 1.5-2 m wide subparallel to the pit slope. In the south-east the gallery opens into the Osyotr river valley with a rather wide aperture overlaid with debris several meters from it. The second exit is formed near debris to the left (Fig. 6).

A small natural cavity named *Kamennaya Gorka-3* has also been found in the described block (Fig. 6).

Polosnya spelestological site (The Polosnya river right bank)

There are basseting limestones near Lishnyagi village in the lower part of a high river bank. Limestone was also mined here in open pits not long ago.

Lishnyagi spelestological block (upstream Lishnyagi village) Borders have not been detected. Basseting limestones are seen along the steep river bank together with its mining signs including several small caves which are apparently pocket-type galleries (Roschin 2015).

Stone mining process reconstruction

The process of stone mining in Russian stone quarries is currently poorly studied. There is no workers' labor description for peasant quarries, they were not included to official reports. However detailed descriptions of processes in several industrial stone quarries of Moscow region are extant and some similarities can be drawn (Dementiev 1883; Martynov 1977)

Stone quarries miners mainly used splinter lighting. Splinters were inserted to convenient cracks and fissures in walling without specialized holders. Splinters remnants and traces of their scraping are widely encountered in quarries and their coal was found in floor sediments. Kerosene lamps were used in the latest period. There is information on utilization of primitive makeshift carbide lights in the beginning of the 20th century (Martynov 1977).

Entrances to future quarries were made in steep slopes of ravines and river banks along ledge rocks. Mining was started from the main gallery and along its outgoing branches crossing with adjacent main galleries branches (Pokrovsky 1890).

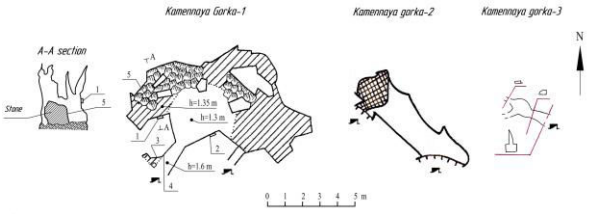


Fig. 6. Kamennaya Gorka cavities. Kamennaya Gorka-1 mapped by Yu. Dolotov and M. Stepanov (2006), A-A section and small parts by I.Agapov, S. Kaminsky (2010). Kamennaya Gorka-2 and Kamennaya Gorka-3 mapped by Yu.Dolotov, V. Baybikov (2006). On the plan: 1) icon niche, 20x20x5 sm, in 90 sm above the floor, carved with some impact tool, the wall with speleothems; 2) icon niche, 20x20x2 sm, in good condition, in 95 sm above the floor, a crack in the ceiling above the niche; 3) a vertical slot 10x75x5 sm (triangular in section) ; 4) rectangular carving, 15x5x05 sm, in 90 sm above the floor; 5) a vertical slot in a stone.

A part of rocks were not mined creating safety pillars. Along with the face advancement some quarry stones and rejected products were put to walls leaving only a passage of sufficient width for workers and products moving. Capital pillars were made of quarry rocks to support the ceiling in especially dangerous locations. Wooden support was used very rarely. Galleries directions were not thoroughly followed and mine workings were following solids of greater quality rather than being developed under some plan. Numerous passages crossings created complex labyrinths of passages crossing each other at acute angles and pillar halls leading to the impossibility to trace individual stone quarry systems.

Apparently stone mining was started from cracks in the solid. Upper soft layers were mined out with picks. Workers marked the future section with splinter coal and made special sockets along the mined block borders with a special chisel (a *zholno* or a *paznik*). In case of Byakovskaya quarry and Sosyonkovskaya's quarries these sockets were elongated narrow dents about 10 cm deep. Then steel plates were inserted to these sockets with massive steel wedges between them. Workers were synchronously hammering these wedges cracking the solid and breaking out stone pieces (Martynov 1977). The sockets have left a distinctive comb pattern.

Judging by the sockets signs on the ceiling in some parts of Byakovskaya and Lisyi Nory a face was completely mined out and base ore was not broken out. The quarries height in the face was about 2 m or less. Ceilings were cut out with pickaxes to provide sufficient passage for people and horses.

Exploratory holes were driven in the central part of Lisyi Nory and in Stupinskaya base area of Byakovskaya system by the authors. They indicated the floor structure had been created by natural accumulation of trash and dust, quarry stones were not put on the floor like in Moscow region quarries. The working face height in Lisyi Nory (from the monolith floor to the roofing) reached 1,7 meters. The height from the cart trace in the covering clay layer to the roofing was only about 1,35-1,5 meters (Garshin at al. 2016).

Produced blocks were cut, sawed and if required grinded directly in the underground area of stone quarries as there were no surface structures (Dementiev 1883).

Products and overburden were hauled using slushers or small carts dragged by small-size horses. After haulage to the surface limestone blocks were dried in specially constructed driers and than were sent to consumers or sold.

Stone quarries also produced quarry stone used as rubble and for lime calcination. Lime was burnt in special furnaces arranged on the surface. There are no known remains of driers and furnaces in Venyov region. However such structures are known to have been near other stone quarries. Driers were brickwork furnaces with a system of tubes and blocks placed on steel rails above them (Garshin at al. 2017), or massive crude iron plates with fire burning underneath and blocks placed on top on dry cushions for further drying. In summer the produced blocks could be dried with sunlight in open air (Pokrovsky 1890).

Kilns for lime calcination were laid with limestone near entrances as needed and were usually completely disassembled after the process (Pokrovsky, 1890).

Conclusion

Despite a poor spelestological exploration degree Venyov region is one of the key areas for understanding of a history and technology of Russian traditional stone mining process. Further wide studies of this region are required.

Acknowledgements

The authors are very thankful to Igor Chizhov (Moscow) and Elena Murzina (Stupino) for their help in translating this paper.

References

Atlasov A., 1959. Venyov. The historical-economical overview. Tula book publishing house, Tula (in Russian).

Azancheyev Yu.D., 1894 Quarries and mining of simple minerals in Russia. Mining department, St.Petersburg. (in russian)

Brockhaus F.A., Efron I.A., 1892. F.A. Brockhaus and I.A. Efron Encyclopedic Dictionary. Vol. 5A. I.A. Efron's typo-lithography, St.-Petersburg. (in Russian).

Bromley Yu.V., Podolny R.G., 1984. Created by the Humanity. Politizdat, Moscow (in Russian).

Case over information provision by district police officers on explosives utilization at stone mining in Tula Province, 1880. /a fragment of/ GATO F.90 op.1 t.41 d. 33969 (in Russian)

Dementiev E.M., 1883. The collection of statistical information about Moscow province. Medical statistics section. Vol.3. Publication 8. Podolsk uyezd factory works medical survey by E.M. Dementiev. Published by Moscow gubernskoye zemstvo. A.Kartsev and D. Egorov's typography, Moscow (in Russian).

Dolotov Yu.A., Sokhin M.Yu., 2001. The problems of Spelestology. In: The Caves. The interacademic collection of studies. Perm University, Perm, pp. 83-97 (in Russian).

Dolotov Yu.A., 2010. Principles of spelestological zoning. Speleology and spelestology: development and interaction of sciences. Proceedings of the international scientifical and practical conference. NGPI, Naberezhnye Chelny, Russia, pp. 272-286 (in Russian).

Dolotov Yu.A., 2011. The Moscow region underground cult structures overview. In: Christianity in the regions of the world (The Christian antiquity). Asian studies in St.-Petersburg, St.-Petersburg, pp. 197-214 (in Russian).

Economical annotation to the General Land-Survey Plan of 1825, 1833. RGADA f.1355 d.1833 (in Russian).

Florensky P.F., 1984. Living stone of the monuments. Priroda, 5, pp. 85-98 (in Russian)

Fomin N.K., 1997 Contribution to the settling of Tula territory in the 16th century. The materials of the historical-archaeological local conference in memory of Troitsky N.I., Tula, Russia (in Russian).

Formozov A.A., 1974. Archaeological travelling. Nauka, Moscow (in Russian).

Garshin D.I., Garshina Yu.V., Strukov S.S, 2016. Underground quarries of the Sosyonki spelestological block, Tula region, Venyov district (According to research data of 2015-2016). Speleology and spelestology: Proceedings of the VII International Scientific Correspondence Conference. NGPU, Naberezhnye Chelny, Russia, pp. 210-216 (in Russian).

Garshin D.I., Garshina Yu.V., 2016. Uncontrolled caving in Moscow region. Tourism in the remotest parts of Russia. Proceedings of the 4th All-Russian Scientific Seminar (24-28.07.2016). Perm, Russia, pp. 135-150 (in Russian).

Garshin D.I., Garshina Yu.V., Laskin V.A., Besstrashnov D.O., 2016. Kaznacheyevsky quarry: underground workings and "Tarussa marbles" production process. Speleology and spelestology: Proceedings of the VIII International Scientific Correspondence Conference. - NGPU, Naberezhnye Chelny,Russia, pp. 332-341 (in Russian).

Grechenko A., Prokhorov V., Dolotov Yu., 1976. One more time about Arapovsky caves. Novomoskovskaya Pravda, 5.01.1976 (in Russian)

Golubev A.A., 2010. Kashira territory and Znamenskoye village settlement history from ancient times to the early 20th century. Knizhny mir, Moscow (in Russian)

IIMK f.1 d.91, 1904 (in Russian)

Konovalova E.V., 2016. Osyotr the forbidden. Borus-press LLC, Tula (in Russian).

Leonenko I.N., Shik S.M. /edited by/, 1971. USSR Geology. Vol. 4. The USSR European part center. The geological description. Nedra, Moscow (in Russian).

Leonenko I.N., Grokhovsky L.M. /edited by/, 1974. USSR Geology. Vol. 4. The USSR European part center. Mineral deposits. Nedra, Moscow (in Russian).

Makhel D., 2004. Byakovo village. The guide for the Venyov district points of interest. Venyovsky uezd, http://www.veneva.ru/bykovo.html (in Russian)

Martynov M.P., 1977. To know and love your own local territory. Municipal budget institution of culture "Aleksin Art and Culture Museum" f.1 op.1 d.39 l.4-24 (in Russian)

Pokhvisnev D.V., 1852. Venyovsky uezd from the geographical, agricultural and all other industrial points of view. University typography, Moscow.

Pokrovsky E.T., 1890. About Podolsk construction materials production and processing. In: A journal of Emperor's Society of Devotees of Science, Anthropology and Ethnography at the University of Moscow. Vol. 62. Publication 1. The Moscow Museum of Application Knowledge. Sunday Explanations. The collection of the Polytechnic Museum (the 12th year). 1888-1889. Moscow (in Russian)

Roschin A., 2015. The Osyotr river: sights, natural landmarks and other objects. Posmotrel.net, http://posmotrel.net/osyotr/osyotr.html

Semyonov P.P., 1863. Russian Empire Geographical-Statistical vocabulary. Vol. 1. V. Bezobrazov & co typography, St.-Petersburg (in Russian).

Taran M.I., 1997. The white stone of Venyov (based on Byakovo quarries materials). The materials of the historical-archaeological local conference in memory of Troitsky N.I., Tula, Russia, pp.30-32 (in Russian).

Viktorov A.M., Zvyagintsev L.I., 1989. White stone of Moscow region. Nedra, Moscow. (in russian).

Yanovskaya E., Garshin D., 2015. Underground history of Domodedovo district. Hypogea 2015. Proceeding of International Congress of Speleology in Artificial Cavities. March 11/17 – 2015. Rome, Italy, pp. 85-96

Zagrayevsky S.V., 2001. Yury Dolgoruky and the ancient Russian limestone construction. ALEF-V, Moscow (in Russian).

Zagrayevsky S.V., 2008. The new research of Vladimir-Suzdal reserve museum architecture monuments. ALEF-V, Moscow (in Russian).

Zuyev V., 1787. Travel notes from St.Petersburg to Kherson in 1781 and 1782. The Emperor's Academy of Sciences, St.Petersburg. (in Russian)

LIMESTONE MINES NEARBY VILLAGE MALEEVO RYAZAN REGION

Michael Leontev[1],
[1] *Speleo-group "Styx", Ryazan, Russia*
mihrzn@gmail.com

Abstract

The underground complex of limestone mines located in Ryazan region, Russia. This mines were excavated by local peasants during 18th-19th centuries. They sold stone plates for building and other purposes. As a result, they created a lot of undergrounds galleries. Today this complex abandoned and forgotten. Since 2010, our group "Styx" has been exploring it.

Keywords

Limestone, mine, archeology, cave.

1. Introduction

Kasimov district of Ryazan region is located in the Central Russia, on the banks of Oka river. This area is rich in limestone deposits. Limestone has formed 300 million years ago in this area (Carboniferous period). The stone lies at a small depth from 2 to 20 meters, in some sites - up to 26 meters [2].

People started using the limestone for buildings in the epoch of the Kasim Khanate in the XV century [2]. In 1768, the German scientist and traveler Peter Simon Pallas visited Kasimov and noted that despite the abundance of stone on the banks of Oka river the town was constructed in wood, by the Russian tradition. However, even at that time there were already several buildings in Kasimov which were built with the use of local stone taken from suburbs of Maleevo village. One of these buildings is a minaret of the old Tatar mosque founded in the XV century, as khan Kasim reigned. There is also the Muslim tomb of "Tekie Shakh-Ali" erected in 1556. Same as the mosque minaret, the tomb is built with large surface-tooled white stones (limestone).

People began to use the stone for construction of the Orthodox churches in the neighborhood right after abolition of the Kasim Khanate in 1681. The historians assume that the recommendation to use the local limestone for construction purposes was given by Peter I, who visited Kasimov twice, while making a tour along Oka river. During his first visit in 1695, the erection of Epiphany (now St. George) church in the territory of the ancient Epiphany monastery has already begun. Tsar was pleased with the church and the place where it was erected. This is how the first stone church behind the Tatar mountain appeared in the town in 1700 [2,3].

The scientists do not find any historical records on stone excavation technique in the XVII and earlier centuries in this region. Probably, the stone was obtained by open mining at that time, since there were rich stone deposits along the banks of Oka river. Underground excavation began in the XVIII century. Iron works dam in Batashev's (big Russian industrialist of 17th century) estate on Gus river (today Gus-Zhelezny) was erected in stone. The Church of the Life-Giving Trinity in this town is also decorated with white stone. The stone from this area lies in the walls of many cities including Ryazan and the White-Stoned city - Moscow.

In 1911, Ryazan province took the second place by limestone extraction after Moscow, providing about 20% of the total limestone production in Russia. In the XX century, as the industrialization proceeded, the underground mining reduced, giving way to open pits.

A group of speleologist from Ryazan called "Styx" had to explore and assess the current state of stone quarries in the area of Maleevo village in the vicinity of Kasimov.

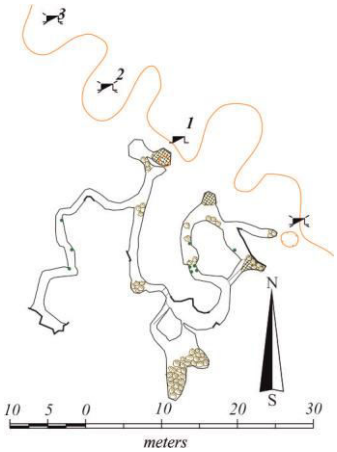


Figure 1. Limestone mine Maleevskaya (drawing Michael Leontev).

Maleevo village situated on the right bank of Oka river had the excellent location for transportation of stone to Gus-Zhelezny, Kasimov, Murom, and Nizhny Novgorod [1]. There are 2 pit complexes with different time of extraction and different topology here.

The first complex of caves is located along the river banks. There are many outcrops on the slopes here. Most of them are destroyed now. We managed to explore 6 separate caves of this complex (fig.1).

The first cave is located at the outskirts of Maleevo village, near the old school building (currently closed). The cave has several narrow gangways used for taking the stone out from the working faces. There are some landslides in the southeastern part.

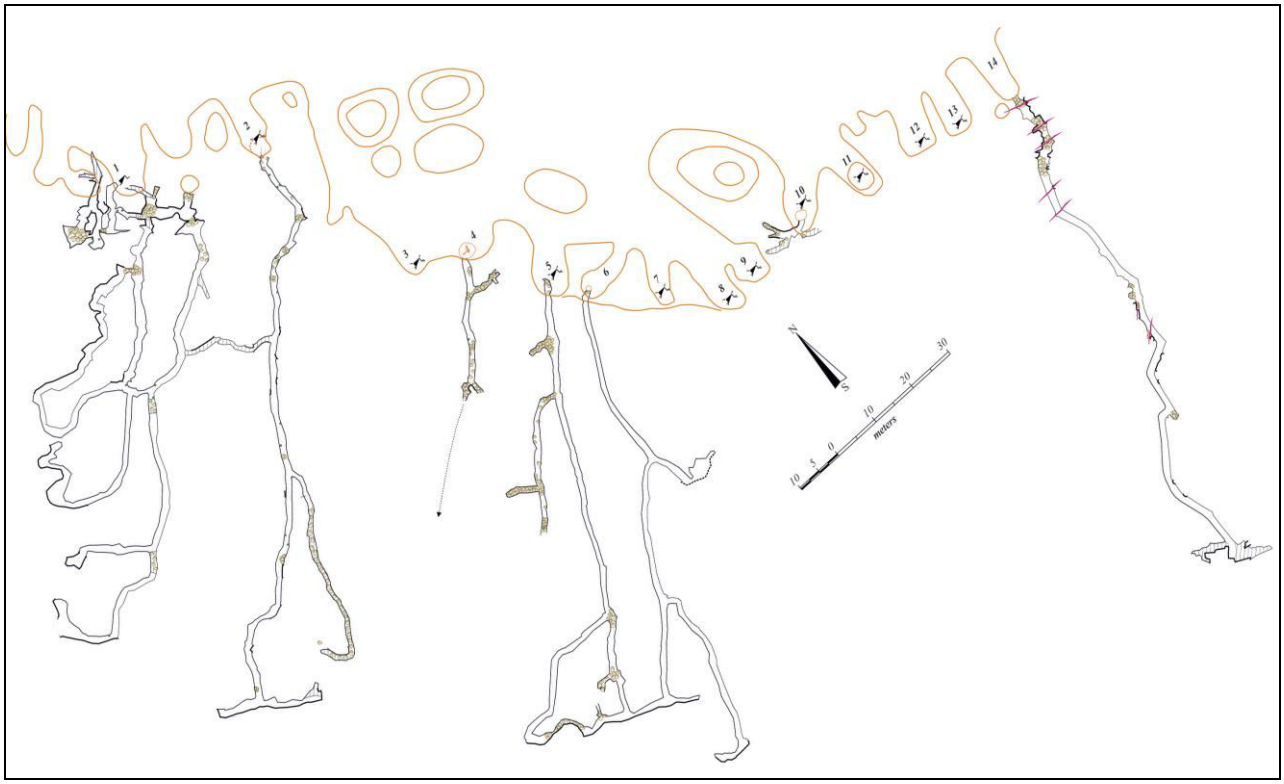


Figure 2. Limestone mines Verkhnemaleev (drawing Michael Leontev).

There is a face with signs of quarrying in the southwestern part. The gangway walls are built in rubble stone. The total length of this cave makes 125 meters. Further along the shore, there are many grinding ditches with caved in entries. The site stretches for almost 500 meters upstream of the river, up to the ravine.

The next block of pits starts beyond the ravine. Our group (Styx) has explored 5 caves in this area in 2013-2017. "Sezam" cave (14 on the fig.2) is a narrow tunnel. laid with rubble stone and having the length of 80 meters. There is a small working face at the end of the tunnel.

The entrance to "Zheleznodorozhnaya" (1 on the fig.2) cave was discovered by Ryazan group “Indrik” on May 5, 2013. The cave is notable for the fact it is the last one in the complex. The corridor stretched along the western side of the cave has a monolithic wall. The cave features the most branched structure of all the caves of this complex and the greatest length – 357 meters.

"Dvukoleinaya" (2 on the fig.2) cave was discovered by "Styx" group on July 26, 2014. It is 181 m long. Same as in other caves, there is narrow passage with walls laid with rubble stone starting from its entrance. The passage forks on the half way to the working face. The left passage is full of stones and barely passable. It ends with a deadlock, not a face. Over the period of extraction, the empty space was filled with stone fragments in order to spare forces required for taking them to the surface. With this excavation technique, the workers have left almost no supporting columns. The walls laid with rubble stone served as support for the ceiling. The distant passage ends with a working face.

“Entuziastov” cave was revealed by our group on July 27, 2014. This cave differs from the others with its structure - 2 faces from different gangways connect here. Thus, the second part is accessible through this connection. The total length of this cave makes 332 meters.

In general, we can state this site has been developed over a long period of time. The stone was large and had certain size and superior quality. Almost all fragments were used for filling the mined-out empty space. Stone excavation is a tough and painstaking work requiring much time. The yield of stone was about 10% [2]. Torch of splinters were used for lighting (we have found several). The cave floors were covered with rubble stone, leaving just enough space for one short horse. The clay covered stones on the floor and was watered to ease the motion of stone drags [1]. Entries from the surface under the ground are inclined downwards.

The second complex of caves in Maleevo is located in the old ravine, 500 meters to the West from the village. Both sides of the ravine have signs of excavation, craters and grinding ditches. We discovered three open entries (Fig.3). The local gangways differ from those of the first complex: the passages are much bigger and feature topology of labyrinth type.

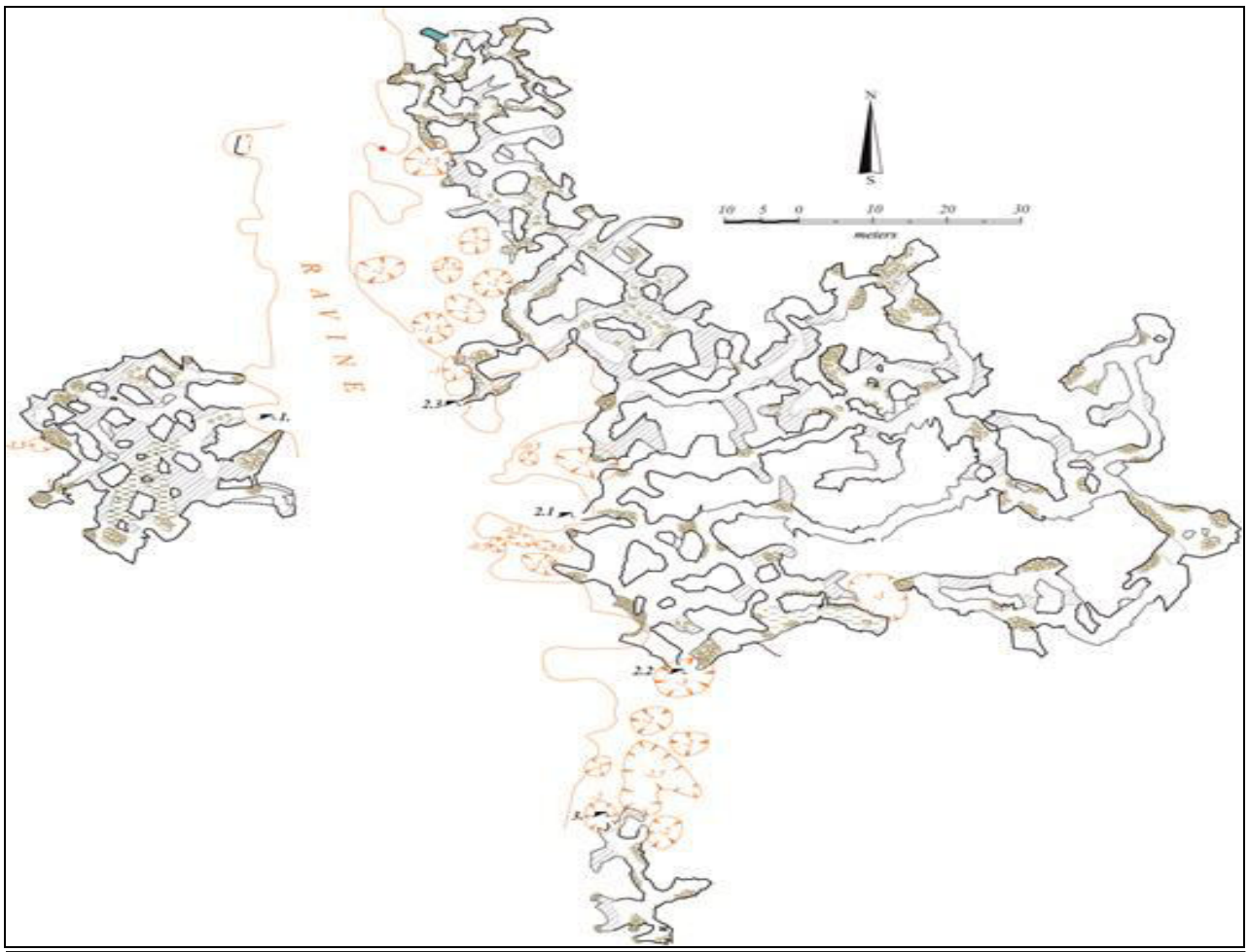


Figure 3. Group of limestone mines in Pronin ravine (drawing Michael Leontev

The largest passage in this complex has the length of 1042 meters. The width varies from 2 to 6 meters. There are working faces in the part which is the most remote from the slope. Development was carried out in a manner similar to the first complex, but we found less rubble stone left here. The faces are large. In the southern part of the cave, there is a blockage preventing further exploration. From the outside, there is an entry to the cave in one of the sinkholes. This part is surrounded by collapse sinkholes from all sides. The length of this fragment is 56 meters.

Another one cave is located on the opposite side of the ravine. Entrance to this cave is in good condition and has almost no stones. The gangways form a small labyrinth. They have even less rubble stone. Perhaps the crushed stone was removed in the later period. The cave length makes 232 meters. There is a column hall in the center of the cave.

300 meters downwards in the ravine, there is another quarry. All its entrances are blocked; we found only one small entry with length of about 6 meters, ending with blockage.

Obviously, the quarry complex in the ravine was built in the later period, perhaps, in the late XVIII - early XIX centuries, when the demand for stone increased significantly.

Complexes of the underground mines in vicinities of Maleevo form a unique historical sight of white stone excavation in the territory of Ryazan region.

In the first half of the XX century, as industrialization developed, people started open mining of stone in Kasimov district. A large modern quarry lies to the East of Maleevo village. Underground mining passed into history.

References

Zagraevsky S.V. The organization of extraction and processing of a white stone in Ancient Russia. In: Russian Society of Speleological Research. - M., 2008. P. 5-28

Rodin N.A. Kasimov - Gorodets Meshchersky. Historical and ethnographic studies. - Ryazan: Uzoroch'e, 2000. – 225p.

Mansurov A. Peter the Great in the city of Kasimov // Russian archive. - 1895. - Book. 2. - Issue. 6. - P. 132-138. - The network version - M. Voznesensky 2006

THE GEOSITE OF TABUNA AND STREPPENOSA ASPHALT MINES (RAGUSA, SOUTH-EAST SICILY)

Rosario Ruggieri[1] , Salvatore Tricomi[2]
[1]*Hyblean Center of Speleo-Hydrogeological Research, Scientific Commission of Gosites, Sicily Region via Torrenuova 87, 97100 Ragusa, Italy, info@cirs-ragusa.org*
[2]*Register of the industrial experts in the Province of Enna, via Generale Ciancio, 47, 94015 Piazza Armerina, Italy,* saltri436@gmail.com

Abstract

With the Law n° 25 of 2012 the Sicilian Region has instituted the "Geosite Register", a regulatory instrument aimed at the census, the knowledge, the awareness, the protection and development for tourism of geological, geomorphological and geo-anthropological singularities. In this context the Hyblean Center of Speleo-Hydrogeological Research of Ragusa has proposed the institution of the Geosite "Tabuna and Streppenosa Asphalt mines" located in the Ragusa mining area in south-east Sicily. The aforementioned sites are fully included in the context of the mining history of Sicily and therefore of Italy, with production of sulfur, bituminous rocks and salt in nineteenth century Sicily. The first quarries for the extraction of asphalt as a building material in Ragusa date back to 1767, but only in 1868 did real exploitation begin. These mines managed mainly by foreign companies, provided an enormous quantity of asphalt mainly used as road surfacing. For example, in 1900 the city of Berlin had one million square meters of asphalt paved road, mostly coming from the territory of Ragusa. From a geological point of view, the geosite is characterized by the lower levels of the Irminio Member of the Ragusa Formation, consisting of calcarenites and calcirudites of the lower Aquitanian-Burdigalian age, impregnated with bitumen. The mines of Tabuna, partly open pit, are located south-east of the town of Ragusa, and occupied an area of about 2 km^2. The mine of Streppenosa, is instead located on the left bank of the Irminio River; it is completely underground, and consists of a series of high galleries, with a total development of about 1600 m, carved into the black asphaltic limestone, with castings and singular stalactites of solidified pitch on the walls and ceilings. These evocative black environments in places are brightened by calcite flowstones and stalactites of various colors, calcite crusts and rimstone pools full of pisolites, which make these galleries look like a large and captivating karst cave. On some walls fossils can be observed impregnated with bitumen and whitish silty-clay deposits like moonmilk. A large sector of the mine is taken up by a black lake feed by the infiltration of rainwater. These mines have certainly played a leading role in the supply of building stones after the disastrous earthquake of 11 January 1693, which caused thousands of deaths and destroyed many towns of south-east Sicily. The geosite of "Tabuna and Streppenosa Asphalt mines" is of particular importance for the study of the genesis of bituminous rocks, the genesis of oil and for the paleontological aspects, given the wealth of fossils that it continues to give. Finally, it offers significant insights into an example of mining industrial archeology and as a site of high tourist importance in the context of the Hyblean Baroque, the latter a UNESCO World Heritage Site.

Keywords

Sicily, Ragusa, Tabuna, Streppenosa, asphalt mines.

1.Introduction

The first quarries for the extraction of asphalt as a building material in Ragusa date back to 1767, but only in 1868 did the real exploitation begin. The mines of Ragusa, managed mainly by foreign companies, provided a large quantity of this material mainly used as road surfacing. As an example, in 1900 the city of Berlin exceeded one million square meters of asphalt- paved road, mostly coming from the territory of Ragusa. After the interruption during the last war, the mines given in concession to the English companies "Limner and Val de Travres" were seized, the concessions were transferred to the Italian company A.B.C.D., then returned to them in 1945, after the Allied landing in Sicily. In 1951 the British will definitely go in favor of the Italian company by decision of the Regional Council of mines, that in 1956 will allow A.B.C.D. to build the cement factory (Spadola 1977; Ancione and Varani 2002; Giavarini et al. 2003).

In the Ragusa basin, the mining of the asphalt was undertaken mainly in the open pit, even if there were examples of extraction in tunnels, as in the case of the Tabuna and Streppenosa mines, described below.

2. Geographical, geological and climatic framing

The geominerary asphalt basin of Ragusa is located in south-eastern of Sicily, and is part of the more general geographical context of the central-southern sector of the Hyblean Plateau, bordered to the north by the northern watershed of the Irminio River basin and the southern slopes of Mount Lauro volcano, to the west by the structural depression of the Comiso-Vittoria plain, to the south by the Mediterranean sea and to the east by the valley of the Tellaro River (fig. 1).

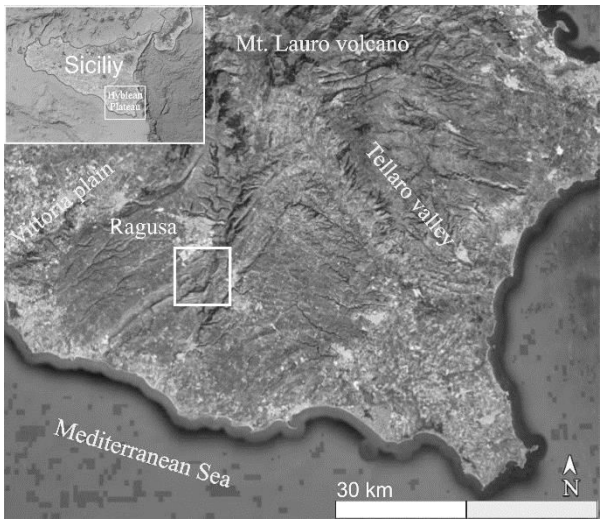


Figure 1. Map of the south-east Sicily where is located (in the box) the mining area of Ragusa.

The aforesaid territory is characterized by a slightly hilly morphology in the summit areas, generally flat in the sector bordering the coast, all dissected from north to south by a dendritic network of deep valleys. The stratigraphic sequences in this Plateau, consist mostly of carbonatic and carbonatic-marly sediments ranging from the Late Cretaceous to the Pleistocene (fig. 2). The subsoil data gives direct information up to the middle-upper Trias, reached through the AGIP Vizzini 1 well at a maximum depth of 6,000 meters.

Geophysical data indicate the presence of a magnetic base with high susceptibility at an average depth of 10 km, in the central areas of the Plateau. High susceptibility suggests an essentially basic constitution of the basement but there is still no direct information either on the rocks that form the basement or on the sedimentary succession underlying the dolomites of the upper-middle Trias (Lentini et al. 1987; Grasso et al. 2000).

From the climatic point of view, according to the climatic classification index of Thornwaite (1948), the province of Ragusa is characterized by a dry sub-humid climate in the mountain-hill sector and by a semi-arid climate in the coastal plain, with an average annual rainfall of 513 mm and an average annual temperature of 16 ° C (Sicilian Region, 1998).

3. The mines of asphalt

3.1 Tabuna mine

The site of the Tabuna Mine occupies an area of about 2 km^2, south-east of the built-up area of Ragusa, included approximately in the range of longitude E WGS 84 475440- 476440 E and latitude N 4083810-4085810. The aforementioned area faces the right bank of the Irminio River.

From the geological point of view, the site in particular is affected by the lower levels of the Irminio Member of Ragusa Formation, consisting of calcarenites and calcirudites white-greyish or white-yellowish of medium hardness in layers of variable thickness up to 10 meters, separated by thin sandy-marly levels. Locally it presents cross stratification with *herringbone* or *hummochy* structures. The maximum thickness in outcrop does not exceed 75 meters. It contains, above all in the upper part, a phosphatiferous hard-ground with a thickness of a few centimeters up to a few decimeters, of a brownish yellow color.

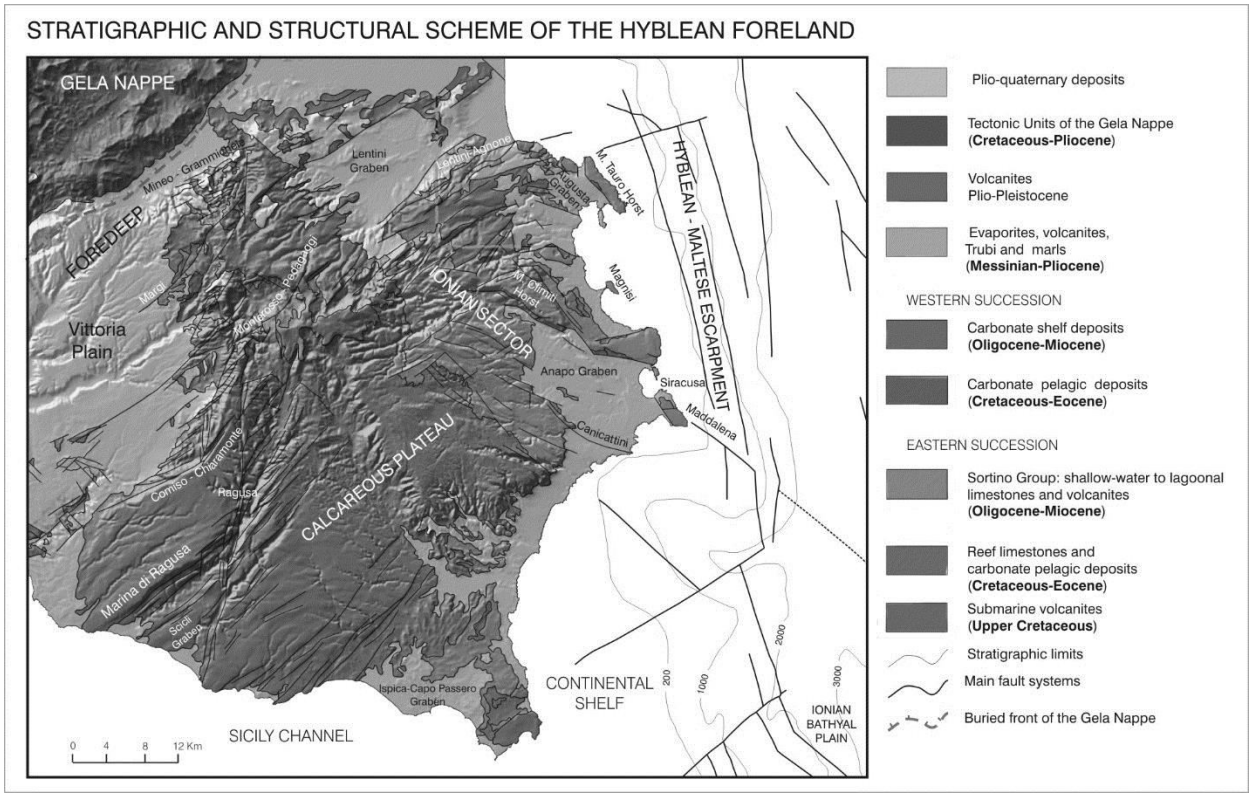


Figure. 2. Geostructural map of the Hyblean Plateau.

From a paleontological point of view, it contains scarce non-determinable microfaunas except for *Miogypsina* sp. and *Amphystegina* sp. and rare echinoids (*Schizaster*

parkinsoni). The age is lower Aquitanian-Burdigalian. In the area in question and in the area of Streppenosa these levels have been subjected to bituminous impregnation.

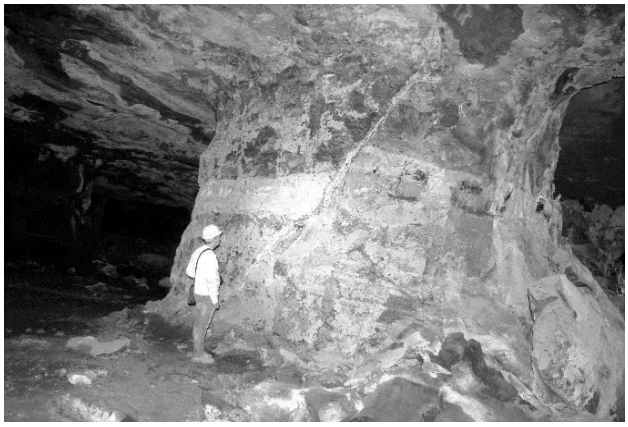


Figure 3. Large pilar dissected by a fault

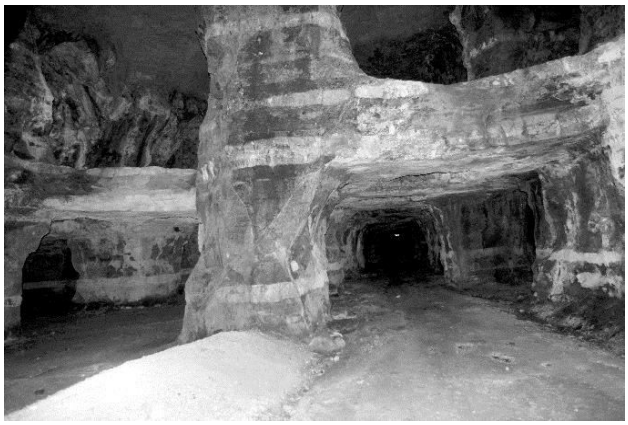


Figure 4. Galleries in two levels of Tabuna mine.

3.2 Description

The asphalt rock mine of the Tabuna, resulting from the union of the eleven former English mines, today consists of the union of the Fossitella and Rinazzo mines covering an underground area of five hectares. Howevr, it is the first evidence of the mining presence of the Ragusa *pitch stone*.

The subsoil is characterized by a chessboard of rooms and pillars from one to two levels of extraction. The size of the pillar type is 5x5 m, with 4 m high (fig. 3) in the part where it was extracted at 50% in two levels, characteristic of the *Rinazzo* section. In the *Fossitella* section, the type pillar is 5x5 m with high 4 m in the southern area at two levels (fig. 4), and 8 m high in a single level in the northern area, with the extraction pushed to 70%. Also in the *Fossitella* section, there is a south inclined plane and an entrance shaft to the north with a reinforced masonry gallery, with the year of construction engraved in the vault dating back to 1904.

The mining section cultivated at 70%, foresaw the filling, which for unknown reasons, was never completed. Since the floor is not all at the same level, dry stone walls can be seen, on the model of land boundaries, in order to create security barriers. The mines also testify to the presence of an electrical lighting system, based on the model of external lighting in residential areas, which is also characteristic.

In 1898 the text by Leon Malo, entitled "L'Asphalte, Son Origin, Sa Preparation, Ses Applications", pg. 337 and 338, shows essential features of the geominerary, of only four Ragusa mines at a world level.

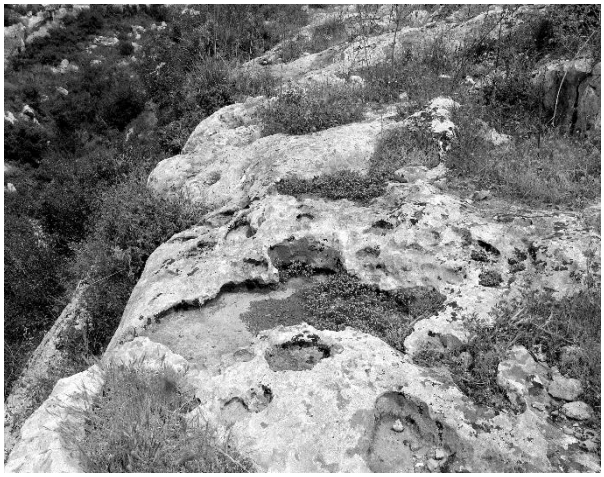


Figure 5. Solution pools in the area of Streppenosa mine.

3.3 Streppenosa mine

The Castelluccio - Streppenosa asphalt area since 1904 was the object of interest of foreign companies. The Streppenosa mine, located for the most part in the Ragusa area, was managed for a very limited period by the English company "Val de Trevers", which also had a concession for the Tabuna-Cortolillo mine, both of which were worked underground.
The original entrance to the Streppenosa mine was a descent operated by a coal-fired boiler, while the ventilation of the tunnels was guaranteed by a second well. Following a short path, flanked by a rich series of karren surface karst morphologies (fig. 5), such as rillenkaren and solution pans (Ruggieri et al. 2009), we reach the entrance which is now closed by a gate.

3.4 Description

From the entrance, through a horizontal tunnel, the extracted material came out with wagons. The overall development of the galleries is about 1,600 m with widths ranging from a few meters to 5-7 meters and with heights of up to 10 meters (fig. 6). Going through the entrance tunnel you can immediately see the black calcarenite walls impregnated with bitumen with solidified pitch castings. This vision becomes more spectacular with the presence of flowstones of calcite of various colors on the walls, stalactites on the ceiling, calcite crusts and rimstone pools with pisolites on the floor, rendering these environments like a fascinating karst cave (fig. 7). On some walls there are fossils impregnated with bitumen (fig. 8) and whitish silty-clay deposits of plastic consistency, like moonmilk. The mine has also an extensive area affected by a black underground lake formed by the infiltration of rainwater from the ground (fig. 9).

Figure 6. Large and high gallery in the Streppenosa mine.

Figure 7. Calcite flowstones and pitch castings on the walls of the mine.

4. Conclusions

The mining sites, thus described, are fully classified in the context of the mining history of Sicily and therefore of Italy. Considering the primates of sulfur, bituminous rocks and salt in the nineteenth century of the island of Sicily and the autarchy for Italy in the twenty years of fascism. In this regard, these mines lend themselves to the study of the genesis of bituminous rocks, the genesis of oil and the possible synthetic reproduction of it. In particular, the Tabuna mine was certainly a key player in the supply of building stones after the earthquake of 11 January 1693.

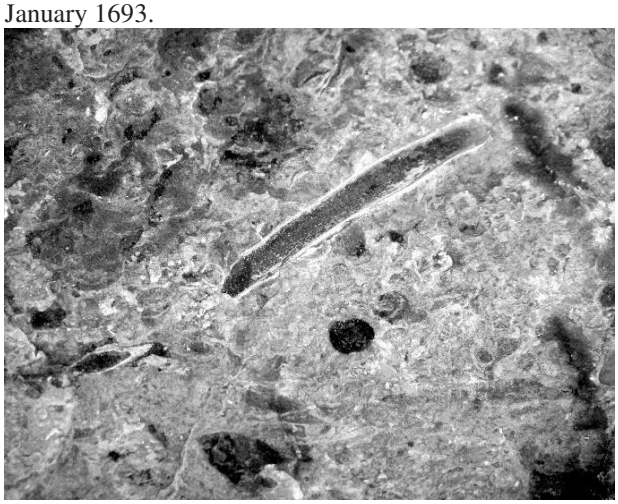


Figure 8. Fossils impregnated with bitumen in a wall of the mine.

Figure 9. Black lake in the mine of Streppenosa.

Among the most prestigious scientists who were interested in the site, the name of the Dolomieu stands out. Moreover, given the wealth of fossils that this area continues to give, the interest in the study of paleontology is still alive.

The mining site of Tabuna, will eventually face total closure through the depletion of its mineral resources. Therefore, one must think in advance of the future destination of the mining area. In this regard, as the site offers significant insights into an example of mining industrial archeology and as sites of high tourist value, in the context of the hyblean Unesco world heritage baroque site, the Association CIRS - Hyblean Center for Speleo-Hydrogeological Researchof Ragusa has presented to the Sicilian Region a proposal for the institution of the *Geosite of the asphalt mine of Tabuna*, in accordance with the Regional Law 25/2012, for the valorization, protection and fruition of a mining site of national importance.

Acknowledgments

We thank the Colacem Spa Company which manages the last asphalt mines in Ragusa, for the support given to us during the inspections carried out in the site mines of Tabuna.

References

Ancione G, Varani E, 2002. Pirriatura, Picialuori e … Soc. Coop. C D B a.r.l. - Ragusa.

Giavarini C, Rovigati P, Zipelli C, 2003. L'asfalto italiano. In: Rassegna del bitume n. 45, Edit. SITEB Srl - Roma.

Grasso M, Pedley H.M, Maniscalco M, Ruggieri R, 2000. Geological context and explanatory notes of the "Carta Geologica del settore centro-meridionale dell'Altopiano Ibleo" - Mem. Soc. Geol. It., 55 (2000), 45-52, 1 tav. f.t.

Lentini F, Grasso M, Carbone S, 1987. Introduzione alla geologia della Sicilia e guida all'escursione. Università degli Sudi di Catania, Società Geologica Italiana - Catania.

Malo L, 1898. L' Asfalte, Son Origine, Sa Preparation, Ses Applications (1898) - Kessinger Publishing - Printed in the USA.

Regione Siciliana, 1998. Climatologia della Sicilia, Volume 2, Assessorato Agricoltura e Foreste, Palermo.

Ruggieri R, Galletti I, Savasta G, 2009. In: Speleologia Iblea, Vol. XIII, pp. 101-114 - Ragusa.

Spadola M, 1977. L'asfalto. Volume I, EREA 1977 - Ragusa.

Thornwaite C. W, 1948. An approach towards a rational classification of climates. Geogr. Review, 38/1; 55-94, New York.

THE PROBLEM OF ABANDONED MINES – ONLY HAZARDS? A CASE STUDY FROM THE NÍZKÝ JESENÍK UPLAND (CZECHIA)

Kristina Schuchová[1], Jan Lenart[1], L. Falteisek[3], J. Bílá[1], J. Kupka[2]

[1] Department of Physical Geography and Geoecology Faculty of Science, University of Ostrava, Ostrava, Czech Republic, kristyna.schuchova@osu.cz, jan.lenart@osu.cz, jana.bila@osu.cz

2 Department of Environmental Engineering, Faculty of Mining and Geology, VŠB – Technical University of Ostrava, Ostrava, Czech Republic, jiri.kupka@vsb.cz[3]Department of Ecology, Faculty of Science, Charles University, Prague, Czech Republic, lukas.falteisek@natur.cuni.cz

Abstract

Abandoned and derelict historical mines may present future geohazards for the landscape, urban residences, and other buildings. On the other hand, they could have potential use as tourism objects, science laboratories, museums, historical monuments, etc. The Nízký Jeseník Upland in the Czech Republic (Europe) is an area well known for historical clayey slate processing (mainly between the 18th and 20th centuries). In this case, we present a study from Odry, where the abandoned Flaschar's slate mine is situated. This mine is one of the largest slate mines in the Nízký Jeseník Upland. Geologically, the slate has been greatly affected by tectonic forces, as can be proven by the existence of folds and hydrothermal mineralization (Q-veins with Pb-Ag mineralization) within the mine. The dip direction and dip angle of the unfolded beds are generally 304/32. Within Flaschar's mine, various processes have been revealed, such as weathering and gravitational processes including exfoliation of the walls, rockfall, subsidence, collapse, and degradation of the pillars. Therefore, we can document results from long-term geologic processes and from short-term geomorphic processes. The mine provides information, as well. Flaschar's mine reveals rich geo-diversity and more or less bio-diversity. There are phenomena such as karstification and deposit formation (dripstones or sinters), secondary mineralization (pyrite, gypsum, calcite, etc.) and Fe oxide (limonite) formation occurring in the mine; these phenomena might have a biogenic origin. Due to the air circulation within the mine, a dynamic microclimate developed. Flaschar's mine provides a shelter for various types of overwintering bats. It is a suitable habitat for a population of insects, fungi and microbial life. In Flashar's mine, it is possible to observe an example of the processes and changes that could occur in an abandoned mine without human influence. This research was carried out before the locality was open to tourists. In addition to its scientific importance, the mine may also serve as an instrument through which visitors can be educated about the emerging bio- and geo-diversity in a previously unknown part of the biosphere.

Keywords

abandoned mines, slate mine, microclimate, geodiversity, biodiversity, petrography, Nízký Jeseník Upland

1. Introduction

In many cases, abandoned mines present increasing environmental risk known as geohazards. Geohazards include natural or anthropogenic processes that have the potential to cause slope deformation, landslide, subsidence, collapse and environmental damage and to impact urban areas and nature (Jordan et al., 2017; Moréno-Martínez et al., 2016; Waltham et al., 2011; Culshaw et al., 2000). Unknown and unmapped mines do not represent the only hazard and dangerous element in the landscape. The subterranean environment, including abandoned mines, adits, shafts, tunnels or bunkers, could have similar environmental conditions (microclimates) as natural caves; these conditions include light deficiency, constant high relative humidity or thermic stability (Isaia et al., 2011; Masing et al., 2009; Brack, 2007; Tuttle and Taylor, 1998). The abandoned mines are used by various species of cave bats, during critical times in their lives, such as during hibernation and for roosting or reproducing. These abandoned mines begin to function as refuges or shelters (Angel et al., 2015; Kurta and Smith, 2014; Ingersoll et al., 2010; González and Morales, 2004; Whitaker and John, 1996).

The article is focused on an abandoned slate mine (Flaschar's mine), which is located near Odry (Nízký Jeseník Upland, Czech Republic). In Flaschar's, multidisciplinary research was conducted that included mapping underground spaces, monitoring relative temperature and humidity, petrography, and biodiversity research. The results of the research provide a reason to avoid damaging technical interventions. The products of tectonic forces, mineralogical and biogeochemical processes and increasing biodiversity have a significance for scientific purposes and the expansion of tourist tours.

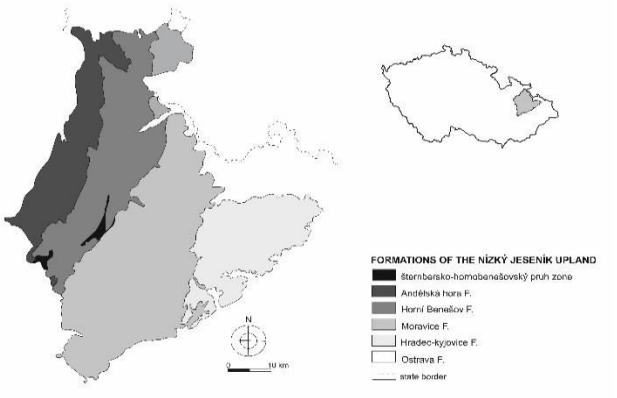


Figure 1. Geology of the Nízký Jeseník Upland

2. Geography and geology

From a geography point of view, Nízký Jeseník Upland is situated in the northeastern part of the Czech Republic. It is part of Bohemian Massif (more precisely, it is part of the Moravosilezikum), and it is also the largest geomorphic unit in the country. The internal structure corresponds to an accretionary wedge. In the Neogene, the crust broke into several blocks as a response to Alpine folding because the Alpine orogeny started to push on the older Bohemian Massif. Due to high pressure, his rigid block cracked. Faults were revived or new faults formed (Janoška, 2011; Lenart, 2016). This area includes various geologic and geomorphic objects, such as tertiary volcanos or deeply incised valleys, in contrast with the planation surface (Lenart, 2016). This area includes four formations (Hradec-Kyjovice f., Moravice f., Horní Benešov f., Andělská Hora f.) (Fig. 1), which primarily consist of Carboniferous and Devonian rocks such as sandstone, slate, conglomerate, siltstone and limestone (Chlupáč et al., 2011). The mining industry has a long tradition in the Nízký Jeseník Upland area. Between the 11th and 12th centuries, mining of hydrothermal veins containing galenite with an admixture of silver was conducted in some places, and in the early 18th century, cleavage slates were mined in the area. Extensive mining in Nízký Jeseník Upland is reflected by monumental dumps of slates and more than 100 abandoned mines. Flaschar's mine is situated in the Hradec-Kyjovice f. It is

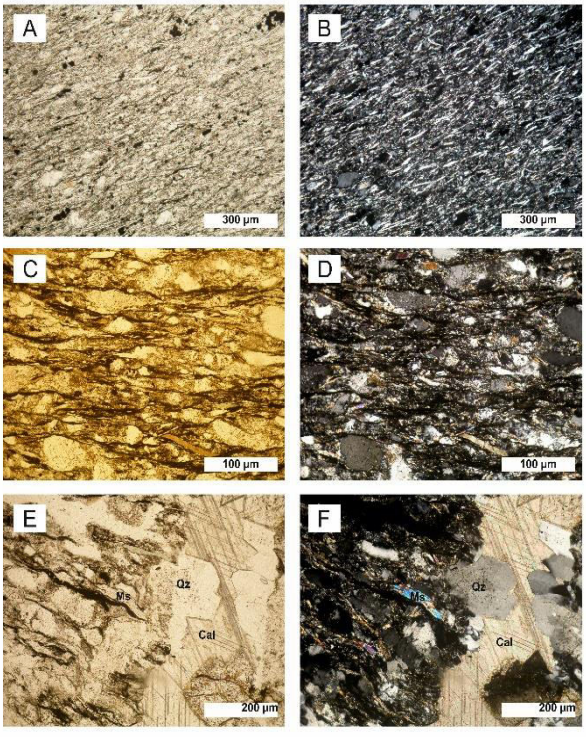


Figure 3. Petrographical composition of slate: A –structure of slate (PPL), B –structure of slate (XPL), C – the structure of phyllitic slate (PPL), D –structure of phyllitic slate (XPL), E - quartz-calcite vein (PPL), F -quartz-calcite vein (XPL)

situated approximately 2 km near the town of Odry on the eastern slope of Veselský hill (557 m a.s.l.). This location is surrounded by three gorges, which are terminated by an alluvial cone. Extensive dumps are located not too far from the mine entrances. In Flaschar's mine, slate was mined, and due to the presence of abundant quartz veins, it is possible to assume that silver was also extracted here.

3. Methods

Mapping of Flaschar's mine was conducted with a laser range-finder Leica DistoX310 with an incorporated Disto X2 component provided by Beat Heeb.

The mine temperature was detected by 6 dataloggers that were spread out within the mine in Hortense Stollen and Johannes Stollen. These instruments detected temperature every hour from 4th April 2017 to 5th April 2018.

A mechanical anemometer M309 from company TFA was used to monitor air flow in Flaschar's mine. This device is suitable for measuring thermodynamic temperature. The flowing air in the mine was measured around the entrances (Hortense and Johannes Stollen) to the mine and around the shaft connecting Hortense Stollen and Johannes Stollen.

For identification of the fungi taxonomy, the sequence of a portion of the genetic complex that encodes the ribosomal RNA was used: ITS1-5,8S rDNA-ITS2. The DNA segment was amplified by PCR from a small part of the trunk. The extracted DNA was sequenced in the DNA sequencing laboratory at the Faculty of Science, Prague, using the Sanger method from the primer ITS mykoR.

The mineral composition of the slates was studied by using the polarizing microscope Olympus BX 50 in the Department of Geology, Palacký University, Olomouc.

4. Results

4.1. Mapping of Flaschar's mine

Flaschar's mine belongs to the largest slate mines in the Nízký Jeseník Upland. This mine has three levels and is approximately 600 metres long. Level Hortense Stollen and Johannes Stollen are connected by the shaft (Fig. 2). Johannes Stollen is the lowest level and functions as a drainage adit. In Hortense Stollen, the main chamber is covered by debris. In Flaschar's mine, it is possible to observe remnants of historical techniques of mining, such as side stopping and a filled stope method. The results of these techniques are large chambers, adits and stacked barren rock shafts. During mapping, different forms and processes were observed. Many large chambers collapsed or are subject to subsidence. There are unstable walls and ceilings, and in some cases, there is unstable stowing. The main factor of these processes is weathering or gravitational processes. Processes such as rockfall, subsidence or wall exfoliation are observed in the chambers. The evidence is various geomorphic forms such as debris, talus deposits or blocks of slate on the floor. Processes such as subsidence or degradation of timber support in the adit are also observed. The results of these processes could be lowered ceilings and debris on the floor.

4.3. Petrography

For the detection of the mineral composition, two samples

were taken from the mine. The first was unweathered slate without hydrothermal veins. Then, a sample of slate in contact with a calcite-quartz vein was taken. The

unweathered slate is dark grey to black, has a fine-grained structure, and has a foliated texture. The individual crystals cannot be observed macroscopically. Slate is

mainly composed of quartz, mica (muscovite and biotite), plagioclase, clay and opaque minerals (Fig. 3A, B). Picture A is the sample under plain light (PPL), and sample B is under crossed-polarized light (XPL).

The sample of rock (Fig. 3C, D) in contact with the hydrothermal vein (calcite-quartz vein) categorises as a metamorphic rock-phyllitic slate. Picture C is under PPL, and picture D is under XPL. This rock type is similar to a slate but are related to higher temperatures and pressures. The phyllitic slate is a characteristic glossy sheen. Individual crystals cannot be distinguished macroscopically. Under the microscope, the lepidoblastic structure was observed. The mineral composition is the same as that of slate, but these samples record the effects of pressure during Alpine folding. In Fig. 3E and F, one can observe undulose extinction of quartz (Qz), twinning-lamellae in calcite (Cal) and flection of muscovite (Ms) (abbreviation by Whitney and Evans (2010)).

4.4. Microclimate

The direction and wind velocity were monitored during the 2017-2018 period. The average temperatures are obtained from all the meters. In April 2017, the air speed was 2.2-5.8 km/h, and the temperature ranged from 8.6 to 12.8°C. The direction of air stagnated during this period. In August 2017, the airflow exhibited a downward airflow, which is typical for the summer time regime in underground systems. The wind speed was 2,6-7,3 km/h, and the average temperature was approximately 22°C. In November 2017, cold air was sucked by the lower entrance (Johannes Stollen), and warm air was conveyed through the upper entrance (Hortense Stollen). The speed of air was between 4,1-4,6 km/h. The temperature of warm air in the mine was 13°C, whereas the temperature outside was -1,2°C. The monitoring ended in February (2018). The temperature outside was -14,6°C. The air speed was approximately 15,5 km/h, and the temperature air in the mine was in the range of 2,7-3,4°C.

4.5. Geodiversity

In Flaschar's mine, it is possible to observe various types of geologic forms and phenomena that could have resulted from tectonic action (faults, folds, cleavage, hydrothermal veins, metamorphism), gravitational processes (tallus, debris on the floor), weathering (exfoliation, films of limonite), secondary crystallization (calcite dropstones, sinter films, limonite films on the slate, gypsum crystals on the walls, pyrite crystals), passive processes (fault polish , sole markings), and anthropogenic processes (adits, chimneys, chambers, dumps, etc.).

Flaschar's mine is relatively shallow and located under the original groundwater level in the oxidation zone. These conditions are a significant element for bio-mineralizing processes. Biogenic oxides of Fe or Mn form in the mine coatings on the slate or fill spaces between rock layers (Fig. 4G). Continuous layers of Fe are below the supergene process, where Fe^{2+} is transmitted from anoxic and weakly oxidized environments. The mine water has a neutral pH. The Fe^{3+} is not very mobile in this environment due to its location on top of the iron dropstones in the shaft (Fig. 4H). In Hortense and Johannes Stollens, some places exhibit walls, roof or individual stones covered by calcite. In Johannes Stollen, formations of karst speleothems are present (Fig. 4I). In the connection between Hortense Stollen and Johannes Stollen, the walls of the shaft are covered by calcite. Calcite reveals different colour variations (Fig. 4K, L).

4.6. Biodiversity

An abandoned mine provides an acceptable condition for biogeochemical processes. These areas are important for underground and surface ecosystems and their proper functioning. They also provide specific underground conditions that are able to support life (Falteisek, 2017).

The macroscopic organisms found in Flaschar's mine include vertebrates (*Rana temporaria*), spiders (*Metellina merianae, Meta menardi*), beetles (*Anoplotrupes stercorosus*), diptera (*Trichocera regelationis, Culex pipiens, Culiseta annulata, Heleomyza cf. modesta*, *Scoliocentra villosa*), butterflies (*Triphosa dubitata, Scoliopteryx libatrix*), caddies (*Stenophylax permistus*), crustaceans (*Porcellio scaber, Niphargus sp.*), molluscs (*Arion silvaticus, Alinda bibplicata, Macrogastra plicatula, Arianta arbustorum, Arion fuscus, Vitrina pellucida, Monachoides incarnates*) and fungi (*Xylamia sp., Pholiota, Coprinopsis lagopus*), which are obligingly bound to wood. In the mine, rhizomorphis (*Phlebiella, Armillaria gallica*) and bacteria (*Actinobacteria*) are the abundantly microscopic organisms (Fig. 4J, L).

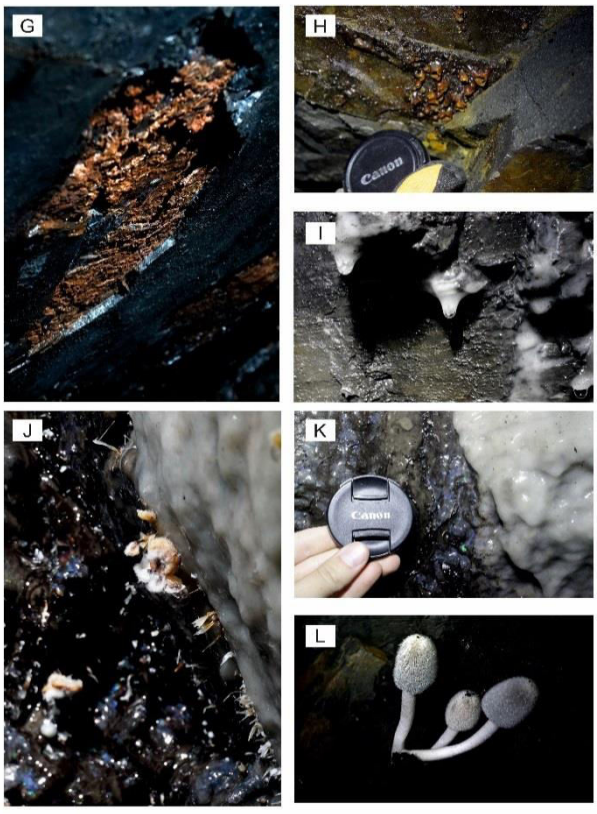


Figure 4. G - Biogenic oxides of Fe or Mn, H - iron dropstones, I – karst speleothems, J – inlay of Armillaria gallica, K - colour variation in calcite; L - Coprinopsis lagopus on wood

Table 1. Number of bats during hibernation in the period 1995-2017.

Flaschar mine	*26.1.2011*	*26.1.2013*	*8.3.2014*	*10.1.2015*	*19.12.2015*	*4.2.2017*
Rhinolophus hipposideros	*3*	-	*15*	*21*	*15*	*16*
Myotis myotis	*8*	*21*	*18*	*19*	*24*	*38*
Myotis emarginatus	*19*	*18*	*14*	*12*	*30*	*30*

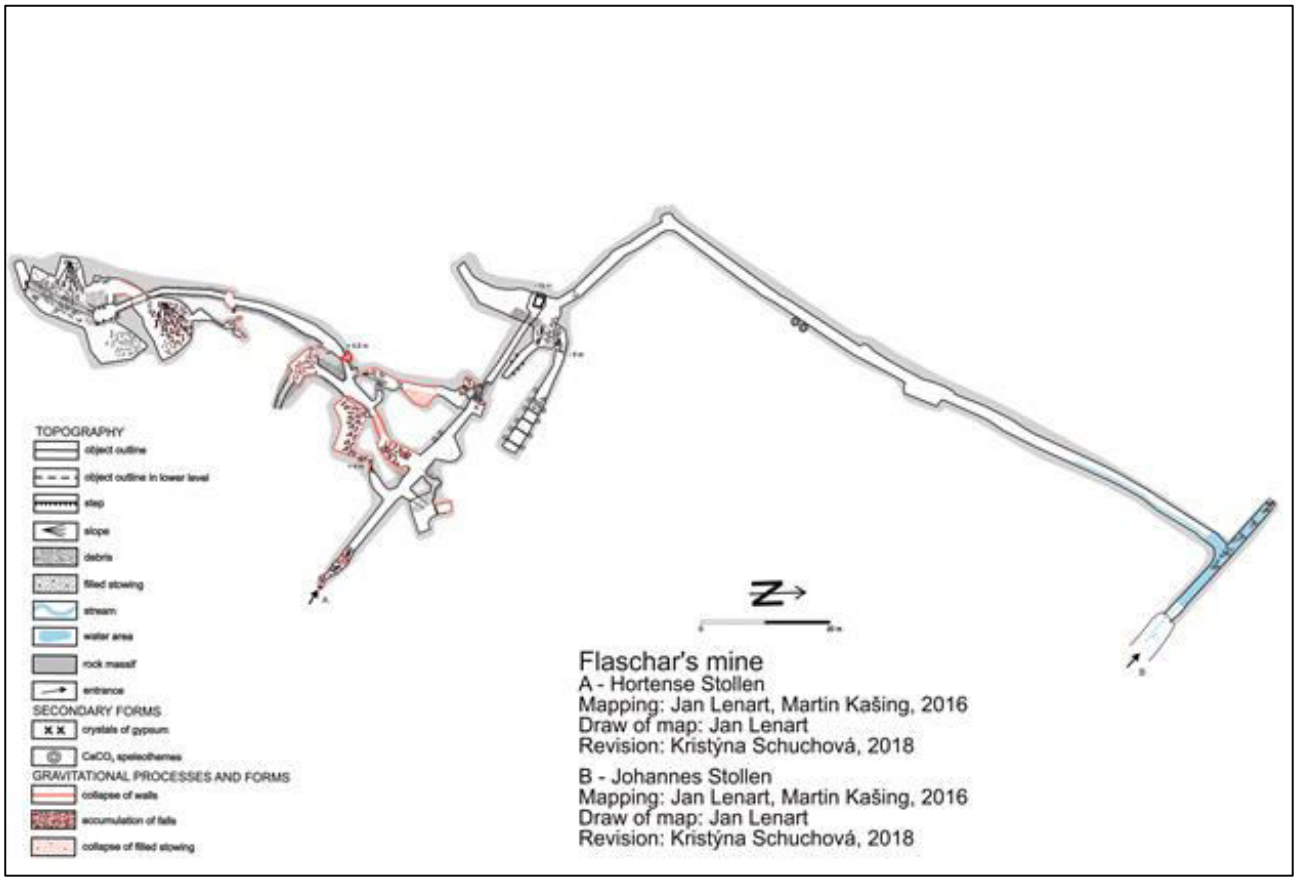


Figure 2: Map of the Flaschar's slate mine

5. Discussion

Petrography shows that tectonic forces cause weak metamorphosis of clayey slate to phyllitic slate. Additionally, in the mine, hydrothermal quart-calcite veins that could possibly be rich in or an admixture of galenite formed; however, not proven. Based on historical records, the slate was mainly mined. Kašpar (2018) found archive records from 1899, in which Karl Flaschar was mentioned. The historical document recorded the start of mining to be in 1903.

Microclimate is of significance for the study of underground flora and fauna (Freitas, 2010), which are bound to specific microclimatic conditions within the underground. The term microclimate usually emerges as a tool for the management of protected areas and biota. In the case of mines, various speleothems, secondary mineral deposits, geomorphic forms, and unique processes could exist (Serrano et al., 2007).

Created forms such as speleothems and minerals (Fe and Mn) grow very fast. Secondary minerals can grow usually very quickly within the mines, along with the effect of weathering, leakage of water, alteration, etc. (Rybikova and Rybikov, 2017; Filippi, 2004). Microorganisms such as bacteria participate in the process of mineral precipitation, inducing biomineralization and the alteration of the rock substrate. Microorganisms usually grow on walls in the mine or occupy acidic mine water (Czerwik-Marcinkowska et al., 2017; Rowe et al., 2007; Johnson et al., 2001). In Flaschar's mine, the water temperature is 8,4 °C, and the pH is 6,65. The microbial life is represented by rhizomorphs (*Phlebiella, Armillaria gallica*) and bacteria (*Actinobacteria*). Fungi such as *Xylamia sp., Pholiota* and *Coprinopsis lagopus* feed on wood and are rarely incrusted by calcite.

The abandoned mines could be used by various species of cave bats during some critical times in their lives, such as during hibernation and for roosting or reproducing. The mine has become a possible refuge or shelter (Angel et al., 2015; Slade and Law, 2007; González and Morales, 2004). From Tab. 1, it is obvious that the number of bats is increasing during winter for hibernation. They usually hibernate in the ceiling or on the walls. The results of monitoring from 1995-2017 suggest that the number of

bats hibernating in the mine is increasing. Flaschar's mine could also have a positive scientific benefit from

geodiversity, for which there are various processes and forms.

6. Summary

Multidisciplinary research proves that abandoned mines do not represent only hazards and dangers. It is important to view the mine as a self-contained system. There is not necessarily a way to secure or dispose of an abandoned mine.
We observe various processes and forms within the mine. There is evidence of processes such as weathering, erosion (collapses, exfoliation of walls, scraping of debris), and formation and crystallization of secondary minerals or diverse organisms (bacteria, fungi or bats). We observe exposed fold and faults, hydrothermal veins, excavations from historical mining (adits, shafts, stopes, stowings and chambers), karst, Fe and Mn rock coatings, and other forms such as debris on the floor. The results from this research could provide protection for the mine. The mine provides long-term refuge and a place for hibernation for various types of organisms. It could have a positive significance for scientific research and for touristic utilization, diversifying the tourism in this area.

Acknowledgments

This research was supported by SGS05/PřF/2017-2018 project.

References

Angel MGL, Ahiezer TR, Sulim JEC, Samantha BLG, Manuel LChG, Lissette AL, 2015. Abandoned Mines Used as Roosts for Reproduction by Townsend´s Big-Eared Bats (Corynorhinus townsendii) in a Protected Area in the Central Highlands of Mexico. Animal and Veterinary Sciences, 3, pp. 13-21.

Brack V, 2007. Temperatures and Locations Used by Hibernating Bats, Including Myotis sodalist (Indiana Bat), in a Limestone Mine: Implication for Conservation and Management. Environmental Management, 40, pp. 739-746.

Culshaw GM, McCann MD, Donnelly JL, 2000. Impacts of abandoned mine workings on aspects of urban development. Mining Technology, 109, pp. 132-139.

Czerwik-Marcinkowska CJ, Pusz W, Zagoždžon P, 2017. Cyanobacteria and Algae in an Old Mine Adit (Marcinków, Sudety Mountains, Southwestern Poland). Journal of Cave and Karst Studies, 79, pp. 122-130.

Falteisek L, 2017. Zpráva za geomikrobiologický průzkum Flascharova dolu u Oder (Czech)

Filippi M, 2004. Oxidation of the arsenic-rich concentrate at the Přebuz abandoned mine (Erzgebirge Mts., CZ): mineralogical evolution. Science of the Total Environment, 322, pp. 271-282.

Freitas D. Ch, 2010. The role and importance of cave microclimate in the sustainable use and management of show caves. Acta Carsologia, 39 (3), pp. 477-489.

González LC, Morales TL, 2004. Use of abandoned mines by long-eared bats, Genus Corynorhinus (Chiroptera: Vespertilionidae) in Durango, Mexico. Journal of Mammalogy, 85, pp. 989-994.

Chlupáč I, Brzobohatý R, Kovanda J, Stráník Z, 2011. Geologická minulost České republiky (Czech). Academia, Prague, 436 p.

Isaia M, Giachino MP, Emanuele S, Casele A, Badion G, 2011. Conservation value of vartificial subterranean systems: A case study in an abandoned mines in Italy. Journal of Nature Conservation, 19, pp. 24-33.

Janoška M, 2001. Nízký Jeseník očima geologa (Czech). Palacky university Olomouc, 64 p.

Johnson BD, Rolfe S, Hallberg BK, Iversen E, 2001. Isolation and phylogenetic characterization of acidophilic microorganism indigenous to acidic drainage waters at an abandoned Norwegian copper mine. Environmental Microbiology, 3, pp. 630-637.

Jordan H, Cigna F, Bateson L, 2017. Identifying natural and anthropogenically-induced geohazards from satellite ground motion and geospatial data: Stoke-on-Trent, UK. International Journal of Applied Earth Observation and Geoinformation, vol. 63, pp. 90-103.

Kašpar, Gold P. and K, 2018. Příspěvek k historii zaniklé těžby břidlice na oderském katastru v lokalitě Odry - Nový svět (Czech): Záznam z bádání pro OKŠ Odry. Odry.

Lenart J, 2016. Nízký Jeseník – Highland with Abandoned Deep Mines. Landscapes and Landforms of the Czech Republic, pp. 305-314.

Masing M, Baranauskas K, Siivonen Y, Wermundsen T, 2009. Bats hibernating in Kaunas Fortress, Lithuania. Estonian Journal of Ecology, 58, pp. 192–204.

Moréno-Martínez JF, Zaldívar-Galindo J, Castillo-Gonzáles L, Azañón MJ, 2016. Collapse susceptibility map in abandoned mining areas by microgravity survey: A case study in Candado hill (Málaga, souther Spain). Journal of Applied Geophysics, 130, pp. 101-109.

Rowe FO, España-Sánchez J, Hallberg BK, Johnson BD, 2007. Microbial communities and geochemical dynamics in an extremely acidic, metal-rich stream at an abandoned sulphide mine (Huelva, Spain) underpinned by two functional production systems. Environmental Microbiology, 9, pp. 1761-1771.

Rybnikova SL, Rybnikov A. P. 2017. Hydrogeochemistry of the abandoned sulphide mines. Procedia Earth and Planetary Science, 17, pp. 849–852.

Serrano E, Flaño-Ruiz P, Valladolid, 2007. Geodiversity. A theoretical and applied concept. Geographica Helvetica, 62, pp. 140-147

Slade Ch, Law B, 2007. Seasonal changes in bats at a derelict mine in southern New South Wales. Zoologist, 34, pp. 173-180.

Tuttle DM, Taylor RAD, 1998. Bats and Mines. Bats Conservation International, Inc. 3, 50 p.

Waltham T, Park HD, Suh J, Yu MH, Kwon HH, Bang KM, (2011). Collapses of old mines in Korea. Engineering Geology 118, pp. 29-36.

Whitaker JO, Stacy O, 1996. Bats of Abandoned Coal Mines in Southwestern Indiana. Proceeding of the Indiana Academy Science, 105, pp. 277-280.

Whitney LD, Evans WB, 2010. Abbreviations for names of rock-forming minerals. American Mineralogist, vol. 95, pp. 185–187.

MILITARY AND WAR WORKS (DEFENSIVE)

SECOND WORLD WAR AIR-RAID SHELTERS IN GENOA (ITALY): KNOWLEDGE, PROTECTION AND USE OF AN UNDERGROUND HISTORICAL AND CULTURAL HERITAGE IN URBAN ENVIRONMENT

R. Bixio[1], F. Faccini[1], L. Perasso[1], P. Piana[2], S. Saj[1], M. Traverso[1]
[1] *Centro Studi Sotterranei, Corso Magenta 29/2, 16125 Genoa, Italy, cssgenova2018@gmail.com*
[2] *University of Nottingham, School of Geography, Clive Granger Building, UK, pietro.piana@nottingham.ac.uk*

Abstract
During the Second World War several air-raid shelters were built for civilians and military purposes; their construction was conditioned by the geological and geomorphological features of Genoa.
Since the end of the war only a minor part of these artificial cavities has been partially reused; many of them are still abandoned and almost forgotten in the Genoese urban fabric.
This paper presents an overview of air raid shelters in Genoa through archival research and speleological surveys.
Over 150 artificial cavities have been identified; these are mainly concentrated in the historical 'morphological amphitheatre' of the city
This first database provides new insights into specific urban planning interventions aimed at the conservation and management of air-raid shelters, which represent a cultural and landscape value.
These artificial cavities can be classified either in terms of potential impact determined by building activities, or for the associated geological risk due to underground instability.

Keywords
Air – raid shelters, protection, urban environment, Genoa

1. Introduction

Due to the overlap of urban periods, particularly since the medieval age, regional planning in Mediterranean cities is complex. In the underground there are many artificial cavities as aqueducts, tanks, canals, quarries, places of worship, etc, which represent important elements of cultural heritage. In general, their distribution and characteristics are hardly known, but their knowledge is essential for regional planning. Artificial hypogea offer a double interpretation in terms of risk: they are a vulnerable element for construction activities, but at the same time they represent a potential risk for settlements and infrastructures above them (Beck, 1984).

In Italy dangers connected to artificial cavities are often underrated, but they can cause significant economic damages. In the last years, many underground cavities' vault collapsed with consequent damages. According to the Società Speleologica Italiana database (http://catastoartificiali.speleo.it), Liguria has more than 400 artificial cavities, of which 200 are in Genova Municipality: these are hydraulic works, civil, worship and military buildings, extractive settlements and infrastructures. In Genova around 60 war settlements have been listed, including defensive constructions, galleries and walkways, mine and countermine galleries, shooting posts, and shelters (Brandolini et al. 2018).
This work presents an overview of air-raid shelters built in Genova during the Second World War, when air-naval incursions damaged a part of the city. Through archival research and original surveys, more than 150 artificial cavities have been registered, mainly located in Genoa's morphologic amphitheatre and in the surrounding areas. Their construction was conditioned by geological and morphological conditions. Since the 1960s, the territory has undergone great urban transformations. Today several air-raid shelters are used as public lifts, parking garages and galleries, but many are of difficult access and often no more visible, hidden by the urbanisation.

2. Geography and geology

The municipality of Genoa is a 240 km^2 wide and 42 km long strip of land which stretches along the coast: 580.000 inhabitants are concentrated in the urban area, which measures 7.5 km^2. The natural amphitheater where the old port and the historical center lie, is surrounded by a mountain ridge that peaks with Monte Sperone (489 m). The two main streams are located at the E and at the W of the historical amphitheater: these are the Bisagno (E) and the Polcevera (W). Several secondary streams cross the districts of Genoa: they are short and characterized by high steepness, with small and intensively urbanized coastal plains, often exposed to risk of flooding. Coastal plains, except the major river axes, have a width which is rarely greater than 1 km, while the steep mountain belt behind reaches its highest elevation at Bric del Dente (1109 m a.s.l.).

Along the slopes there are many landslides with different kinematisms and state of activity, often triggered by short and intense rainfall events that increasingly characterize this territory. The municipality of Genoa has a particular geological structure: it is crossed by the Sestri-Voltaggio tectonic line, identified as the separation between the Alps and the Apennines, and it is characterized by high lithological variety and exceptional geodiversity.
Calcareous-marly or argillitic sedimentary formations are found in contact with igneous rocks belonging to the oceanic crust, to the continental margin or to the mantle, with different degrees of metamorphism. The slopes and the coastal and alluvial plains are characterized by quaternary deposits, now largely obliterated by anthropic

interventions (APAT, 2008; AA VV, 2008). The complicated geological and tectonic structure and the geographical position of the territory involve a complex hydrogeological picture, characterized by the frequent combination of permeable rock formations with other less permeable ones, up to substantially impermeable stone masses.

3. Methods

The work consists of different steps; first, historical documents on artificial cavities, particularly anti-aircraft shelters, were collected in Genoa Municipality and Liguria Regional Authority historical archives.

Subsequently, preliminary evaluations were carried out on the geometric and geological characteristics of each underground shelter; a data base was then produced for the census of each site, also aimed to provide a valid tool for territorial planning, particularly the preliminary assessment of risks and impacts.

The census and georeferencing of the war tunnels was then divided into several phases.

1) Preparation of a survey form based on the Italian Speleological Society inventory for artificial cavities, which includes the following items: denomination of the cavity, geographical location, cartographic location (references on Regional Technical Maps and those of the Military Geographical Institute, geographical coordinates, kilometric network), accessibility, geological nature of the substratum, name of the Formation, state of knowledge, masonry, age, speleometry, general conditions of the structure, other entrances, level of documentation.

2) Direct surveys aimed at the census and mapping of anti-aircraft tunnels for each district: the relative form has been filled out and a reliable cartographic location is shown for each shelter.

3) Analysis, re-elaboration and interpretation of data for the creation of an illustrative map showing two shelters categories: 1) "existing"; 2) "destroyed or obliterated by urbanization".

4) Georeferencing and creation of a database using a Geographic Information System with the information acquired for each individual artificial cavity.

Table 1. List of surveyed air-raid shelter (for civil purposes).

N.	LOCATION	GEOLOGY	LENGTH	N.	LOCATION	GEOLOGY	LENGTH	N.	LOCATION	GEOLOGY	LENGTH
1	VIA AMEGLIA	marly limestone flysch	97	23	VIA SAPETO	stiff fissured clays	150	44	VIA REGGIO	calcitic schists	56
2	VIA E. MELEN	ophiolites	155	24	VIA P. PINETTI	marly limestone flysch	121	45	VIA DES GENEYS	marly limestone flysch	190
3	PALAZZO TURSI	stiff fissured clays	n.r.	25	VIA PIACENZA	marly limestone flysch	n.r.	46	VIA A. GIANELLI	marly limestone flysch	70
4	GALLERIA BIXIO	stiff fissured clays	38	26	V.LE CALASANZIO	ophiolites	90	47	VIA S. ILARIO	marly limestone flysch	80
5	V.LE G.FRANCHINI	marly limestone flysch	316	27	VIA CORONATA	siltstones and shales	n.r.	48	VIA VERNAZZA	stiff fissured clays	n.r.
6	VIA C. VIANSON	calcitic schists	273	28	VIA VADO	calcitic schists	178	49	P.zza ACQUAVERDE	marly limestone flysch	n.r.
7	VIA MERANO	calcitic schists	170	29	VIA VADO	calcitic schists	178	50	C.SO ITALIA	marly limestone flysch	105
8	VIA G.B. MONTI	silty shales	240	30	V.VILLINI NEGRONE	calcitic schists	127	51	VIA G. BRUNO	marly limestone flysch	275
9	C.SO O. SCASSI	silty shales	230	31	V. BRIG. SALERNO	marly limestone flysch	62	52	V.GIRO DEL VENTO	siltstones and shales	260
10	VIA NAPOLI	marly limestone flysch	250	32	VIA ALASSIO	calcitic schists	145	53	VIA C. VARESE	marly limestone flysch	109
11	C.SO FIRENZE	marly limestone flysch	109	33	VIA V. MAGGIOLO	marly limestone flysch	110	54	V. DEL CAMPASSO	silty shales	218
12	VIA PONTEROTTO	marly limestone flysch	102	34	FOSSATO CICALA	marly limestone flysch	n.r.	55	P.LE CAMIONALE	marly limestone flysch	n.r.
13	VIA BRIG. LIGURIA	marly limestone flysch	115	35	VIA MOLASSANA	marly limestone flysch	175	56	V.PORTA SOPRANA	stiff fissured clays	n.r.
14	VIA R.SAVELLI	marly limestone flysch	127	36	VIA A. PEDULLÀ	marly limestone flysch	115	57	PASSO BORGO INCROCIATI	marly limestone flysch	55
15	C.SO MAGENTA	marly limestone flysch	n.r.	37	VIA SAN QUIRICO	siltstones and shales	n.r.				
16	VIA P. CAMBIASO	clay shales	100	38	VIA P. PASTORINO	siltstones and shales	60	58	VIA TORTONA	marly limestone flysch	75
17	GALLERIA MAMELI	stiff fissured clays	n.r.	39	VIA D. MEIRANA	siltstones and shales	104	59	VIA DELLA MARINA	marly limestone flysch	75
18	VIA DIGIONE	marly limestone flysch	230	40	V.LUNGOBISAGNO ISTRIA	marly limestone flysch	n.r.	60	CORSO FIRENZE	marly limestone flysch	156
19	VIA P.della CELLA	marly limestone flysch	95					61	V. MONTEZOVETTO	marly limestone flysch	232
20	C.SO ARMELLINI	marly limestone flysch	92	41	VIA PEGLI	calcitic schists	134	62	VIA G. ARRIVABENE	stiff fissured clays	175
21	V.del CHIAPPAZZO	marly limestone flysch	64	42	VIA G. SETTE	stiff fissured clays	164	63	C.SO F. PERRONE	siltstones and shales	120
22	VIA FEREGGIANO	marly limestone flysch	140	43	VIA GIAFFA	marly limestone flysch	178	64	C.SO SOLFERINO	marly limestone flysch	140

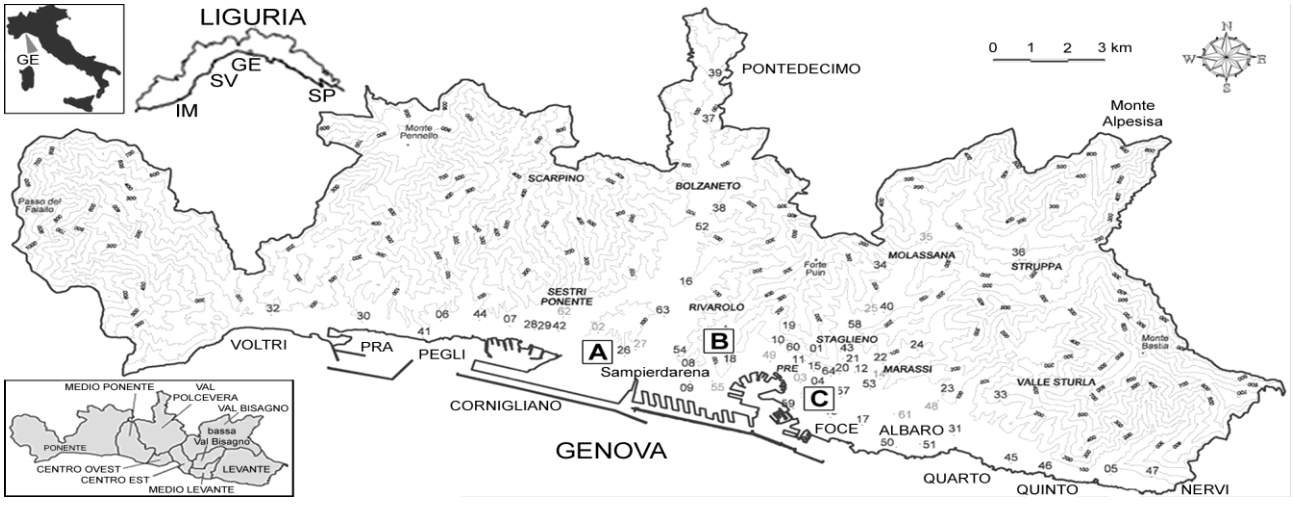


Figure 1. Air-raid shelter sketch map in Genoa municipality (for civil purposes); the numbers are referred to Table 1 list: black numbers indicate the existing air-shelters; grey numbers show the dismantled tunnels due to urban modifications. Case-studies: A = Campi; B = Via Digione; C = Villetta Di Negro.

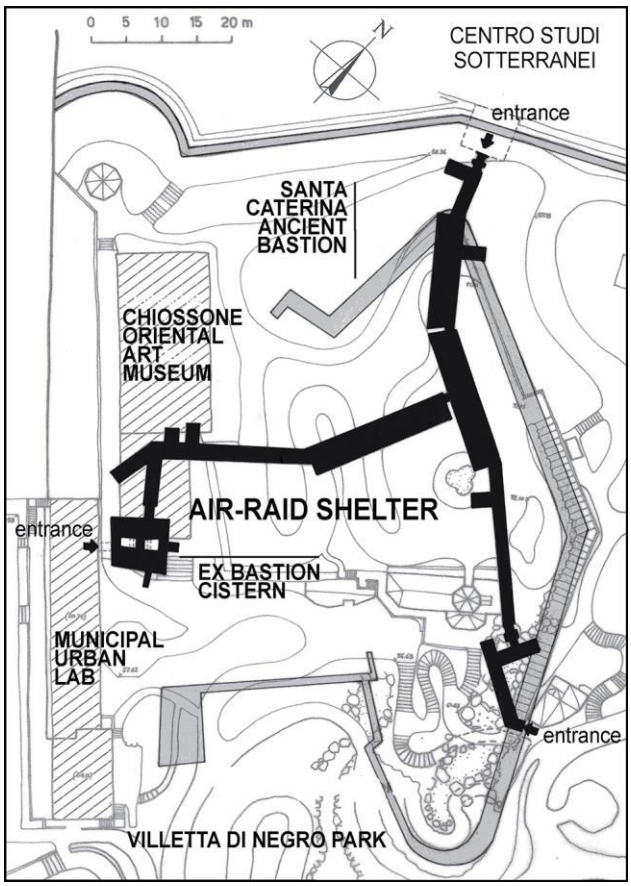


Figure 2 (left). Overlap of current toponymy on the hypogea map (in black). Location of the 17th century bastions (in grey) and buildings (in cross-hatching) on the surface (elaboration T. Bonassi, S. Saj – base drawing R. Bixio, 1999).

Figure 3 (above). Anti-gas sealed security doors (photo: M. Traverso).

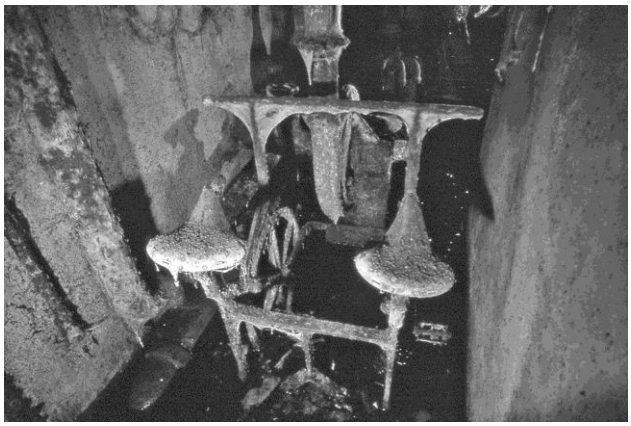


Figure 4. Stationary bicycle which, in an emergency, operated the forced ventilation system of the purified air (photo: M. Traverso).

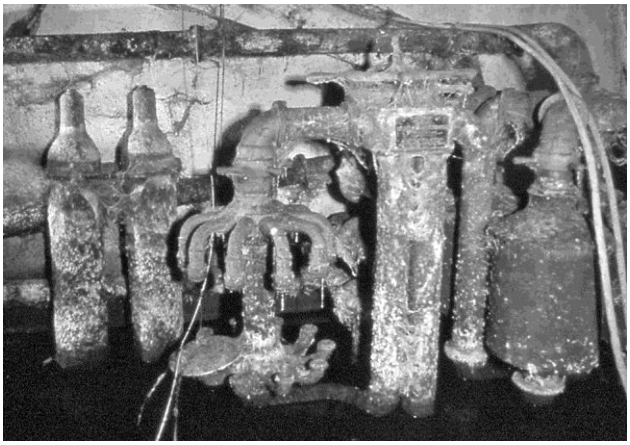


Figure 5. Detail of filtering of the underground shelter. In the event of the gas throwing, it went into operation (photo: M. Traverso).

4. Results

Between 1941 and 1943 several institutions, including the Municipality of Genoa, the German Todt Organization (O.T.) and the Fire Brigade, designed and built over 150 air-raid. At that time, Genoa had a population of c. 600,000 inhabitants. The shelters were built/excavated in the city and in the historical centers of the borough, once autonomous municipalities, annexed to the 'Great Genoa' in 1926. Many air-raid shelters were designed according to specific uses, close to schools, barracks and industries. Their total surface covered an area of c. 120,000 m^2 distributed over more than 30 km of tunnels that could exceptionally accommodate over 100,000 people. Sixty-four shelters are registered for civil use for the protection of the population (tab.1, fig.1).

Many war industries and the related underground shelters for workers were located in the Polcevera Valley; these were tunnels that could accommodate over 4000 people.

Galleria delle Grazie was built as a railway connection between Calata delle Grazie, in the harbor, and Brignole railway station; during the conflict it was used as an air-raid shelter with several accesses along a 5 km long tunnel. A stairway from S. Andrea's external floor reached the tunnel, more than 20 meters underneath the surface: during one of the frequent air alarms, more than

500 people died due to the crowding caused by panic. Today the tunnel is used for the subway.

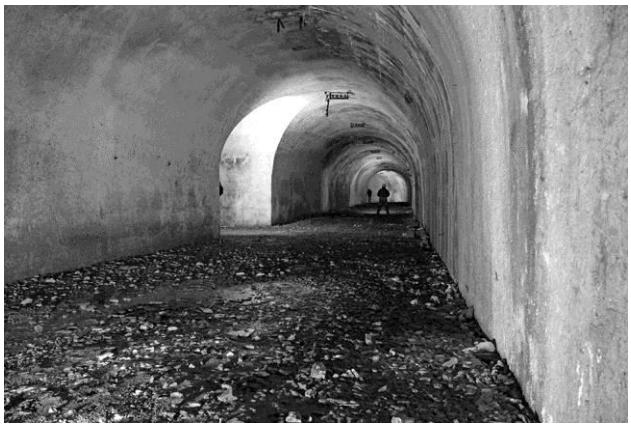


Figure 6. Via Digione air-raid shelter (photo:M. Traverso).

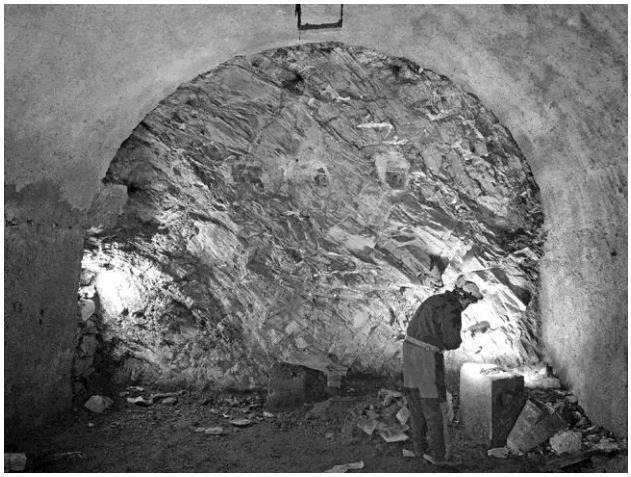


Figure 8. Via Digione: the rock wall inside the shelter (photo: L. Perasso).

The Genoese Fire Brigade built 6 tunnels to serve the headquarters (Via della Marina) and the detachments of Borzoli, Molassana, Fegino, Prà and Albergo dei Poveri.

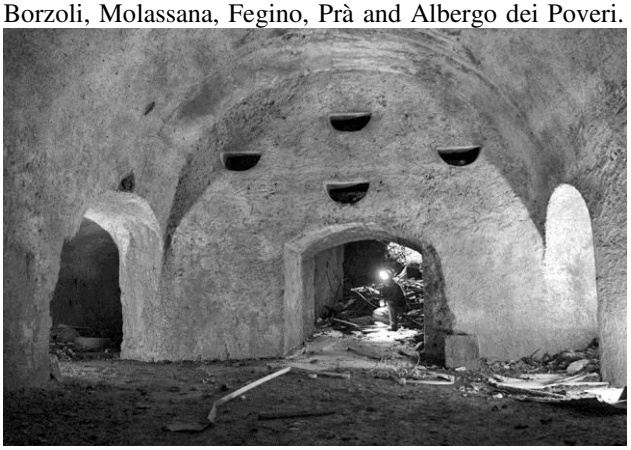


Figure 7. Entrance protection devices (photo:M. Traverso).

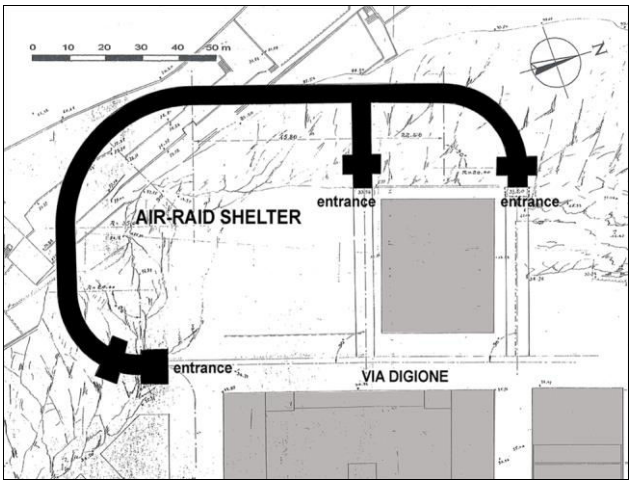


Figure 9. Via Digione air-raid shelter general plan (processing T.Bonassi, S.Saj – base map Archivio Storico Regione Liguria).

The tunnel of Via della Marina could accommodate 400 people and was equipped with an operations room for the Command.

The anti-aircraft tunnels are mostly concentrated in the districts of Foce, Prè-Molo-Maddalena, Castelletto, Staglieno, Marassi, Sestri Ponente and San Pier d'Arena. The shelters are owned by the Agenzia del Demanio (State Property Agency). A significant part of them is used as a garage or warehouse, occupying only a minimal part of the underground development. Less than a fifth of shelters today constitute road, rail or metropolitan links, while 6% is used as a public car park and as municipal workshop. About 5% of refuges was destroyed in the post-war urbanization, 9% is closed or have invisible entrances, 3% is used as a public lift.

The tunnels lenght is often significant: almost 2/3 of them develop between 100 and 200 m and 1/5 over 200 m. The width varies between 4 and 6 m, while the height is between 2 and 5 m. The vertical distance between the tunnel vault and the external surface is variable depending on the topography: we notice that they usually have fairly moderate thicknesses, between 10 and 20 m, but often reduced to only a few meters.

The resistance and deformability of rocks in the Genoese area have quality levels from bad to fair. The tunnels are often covered with concrete and their general conditions appear to be fair to good, although there are cases in which displacements and collapses of the vault are observed. Occasionally, during their construction, subsidence in the cap and instability of the abutments occurred, as in the case of the tunnels in the Polcevera Valley.

Most of the tunnels surveyed have been dug in the "Limestones of Monte Antola"; shelters are also observed in quaternary deposits, in mudstones, in over-consolidated clays, in ophiolites and in schists. Almost all the tunnels show underground water circulation and many tunnels dug into limestone show concretions.

5. Three case-studies

5.1. Villetta Di Negro air-raid shelter

Villetta Di Negro is a public park in the heart of the city. The area was purchased in 1802 by Marquis Gian Carlo Di Negro who built his villa and the park: on October 22, 1942, the villa was destroyed by allied air-raids.

Works for the construction of the shelter started in 1934; for this purpose an ancient cistern no longer in use was reused (fig. 2). The remaining parts of the bunker were excavated and arranged into two series of tunnels, placed orthogonally to each other, with a linear development of 161 meters and a total area of 810 square meters (Bixio et al. 2011).

It was possible to access the shelter from three different points, of which only one is accessible today (fig. 3).

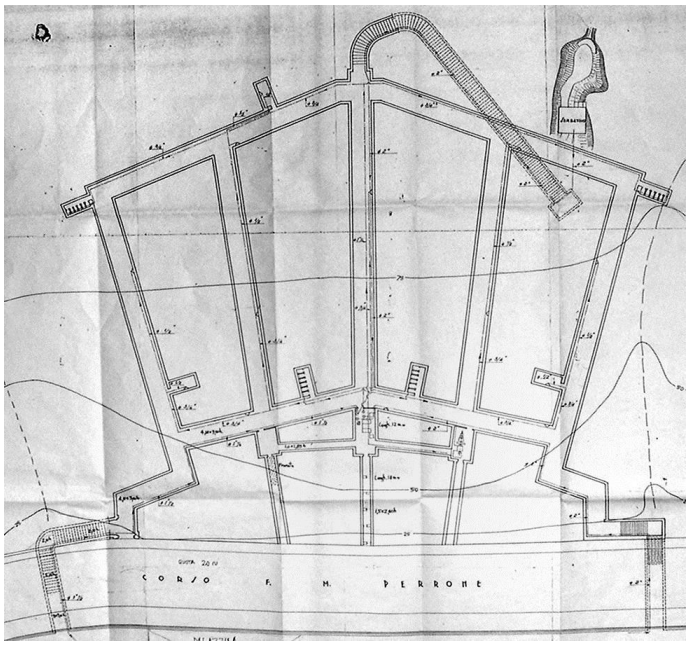


Figure 10 (above). Anti-aircraft tunnel (1943), S.I.A.C., general plan (Regione Liguria historical archive).

Figure 11 (right). Mechanical vemntilation pumps (photo: M. Bertagna).

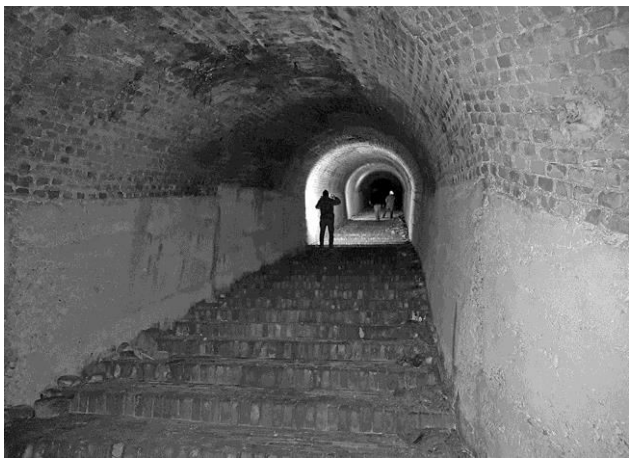


Figure 12. The long staircase to the hill of Coronata (photo: M. Traverso).

Figure 13. One of the turnstiles used to regulate the people flow (photo: M. Bertagna).

The shelter was equipped with double anti-gas sealed doors (fig. 3), double lighting system, telephone lines, toilets, drinking water reserves, a ventilation system which was activated in case of emergency with particular "exercise bikes" (fig. 4) and air filtering systems (fig. 5).

This shelter was reserved for the offices of the C.P.P.A. - Provincial Committee of Anti-aircraft Protection and in case of danger it had to host the Prefect with his staff from the close Prefecture building (Bixio et al. 2012).

5.2 Via Digione air-raid shelter

The air-raid shelter of Via Digione was built in 1943 for the population of San Teodoro. The rocky wall of the Collina degli Angeli was dug to obtain a large tunnel of a section 5x4 m, and approximate length of 230 meters. The internal surface is about 1,200 square meters (fig. 6), with a semi-ring plan (fig. 9).

The tunnel was excavated by using explosive charges, and about 35,000 cubic meters of limestone were dug out (fig. 8).

The shelter was equipped with a double lighting system, drinking water, toilets and it had three different entrances. Each entrance was built according to precise schemes to prevent the spread of splinters inside the shelter and the

shock wave caused by explosions (fig. 7).

The shelter may have been one of the causes of the landslide of the rocky ridge, occurred in 1968, which destroyed a building of Via Digione with 19 victims.

5.3 Campi air-raid shelter

Since 1935 the steelworks of Campi had produced military equipments and constituted a crucial target. A wide air-raid shelter was built between 1942 and 1943 to protect up to 4.500 people. Its plan has a rough pengagon-like shape (fig. 10). The tunnels develop for c. 1 km with a total surface of 2,800 m^2. They had armored sealed doors (fig. 14), a ventilation system (fig. 11), a double lighting system, potable water and toilets. Workers could access the shelter from the squares outside the factory through corridors and staircases under the road. A 25 meters high staircase constituted a safety exit to the fields (fig. 12). Today limestone concretions due to water infiltration are visible at the bottom of the staircase (fig. 16). In the shelter, turnstiles (fig. 13) and written instructions (fig. 15) were used to manage the people flow (Saj et al., 2018).

6. Conclusion

The historical research and survey of Second World War air-raid shelters in Genoa allowed us to produce a thematic database which offers new insights into the conservation and knowledge of these historical heritage features. Public institutions have paid little attention to hypogea, with consequent deterioration of the tunnels and the increased risk of anthropogenic sinkholes (Catenacci, 1992). However, air-raid shelters represent an element of public interest and they need specific conservation and improvement policies, similarly to what happened in Milan, Turin, London and Paris. In Genoa only a minor part of this patrimony is regularly exploited for guided tours organised by the 'Centro Studi Sotterranei' association.

The underground vaults location in relation to the surface topography appears of essential important for future urban planning. An underground areas master plan, like in other European cities (eg. Helsinki) would allow the sustainable urban planning of the city of Genoa, even in terms of geo-hydrological risk mitigation.

For these purposes, and for a correct and sustainable tourist development of this patrimony, the expertise and knowledge of qualified speleologists appears of essential importance.

References

APAT, Regione Liguria, 2008. F. 213230 "Genova" della Carta Geologica d'Italia alla scala 1:50.000. Selca Ed., Firenze.

AA VV, 2008. Note Illustrative del Foglio 213-230 "Genova" della Carta Geologica d'Italia alla scala 1:50.000. APAT Regione Liguria, Selca Editore, Firenze.

Beck B. F., 1984. Sinkholes: their geology, engineering & environmental impact. Proc. First Multidisciplinary Conference.

Bixio R, Saj S, Traverso M, 2011. Air-raid shelters of the second world war in Genoa: the bunker of Prefecture. VIII Conv. Nazionale di Spleleologia in Cavità Artificiali, Ragusa, Italy, Speleologia Iblea, 15-2011/13, pp.171-178.

Bixio R, Saj S, Traverso M, 2012. Il bunker della Prefettura di Genova. La Casana, 2/2012, pp. 18-23.

Brandolini P, Faccini F, Paliaga G, Piana P, 2018. Man-Made landforms survey and mapping of an urban historical centre in a coastal Mediterranean environment. Geogr. Fis. Din. Quat., 41, 97-102.

Saj S, Taccani G, 2018. Storie del periodo bellico dal sottosuolo di Genova: il rifugio antiaereo della S.I.A.C. a Campi. Il Geometra Ligure 3-2018, pp. 7-12.

Figure 14. Sliding armored door that sealed one of the accesses to the shelter (photo: M. Bertagna).

Figure 15. One of the prescriptive pictograms placed at the access points (photo: G. Barranco).

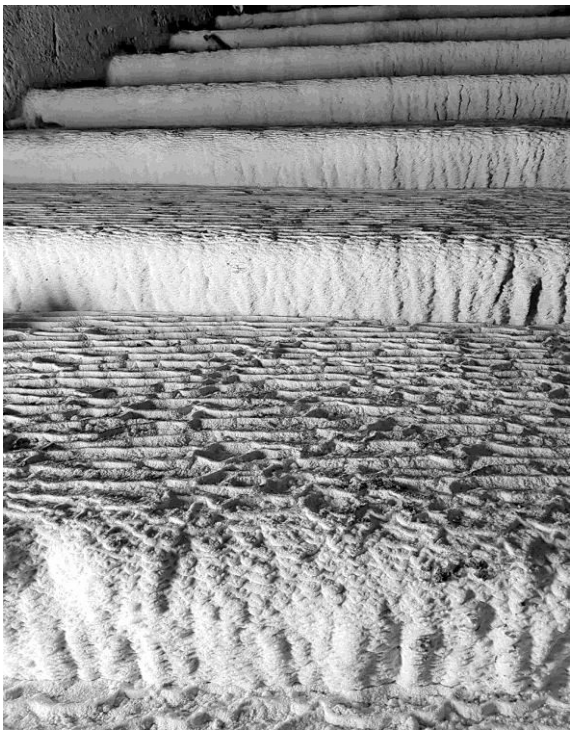


Figure 16. Detail of white calcareous concretions that covered the staircase (photo: S. Saj).

UNDERGROUND MILITARY OBJECTS IN SERBIA

Nemanja Milosavljevic

Speleological Commitee of the Mountaineering Association of Serbia, nemanja84@hotmail.com

Abstract

Due to its political and geostrategic position, The Socialistic Federative Republic of Yugoslavia (SFRY), constrained by the two blocks of the Cold War period, made considerable investments in developing underground military facilities as a strategic means of protecting the country. Each of the Yugoslav republics had many objects of different purpose, ranging from general headquarters, storehouses and atomic shelters to underground airports and weapon factories.

Keywords

Atomic shelters, storehouses, headquartes, weapon factories

1. Introduction

Due to its political and geostrategic position, The Socialistic Federative Republic of Yugoslavia (SFRY), constrained by the two blocks of the Cold War period, made considerable investments in developing underground military facilities as a strategic means of protecting the country. Each of the Yugoslav republics had many objects of different purpose, ranging from general headquarters, storehouses and atomic shelters to underground airports and weapon factories. SFRY had inherited the historical legacy of fortification architecture as well as underground military architecture from the Habsbourg Monarchy and, in recent history, the Kingdom of Yugoslavia, and in a considerable number of objects from the Nazi occupying forces in its very capital – Belgrade.

After the breakup of SFRY in the nineties, due to general economic conditions and a new policy of Serbia as a transitional society at the beginning of the 21st century, many underground objects either became abandoned from the army or had their function changed, which made them more accessible to potential explorers. The object which have been explored so far are located at different strategic locations, in different stages of construction, from excavations to finished and used objects. They provide a complete picture of the underground military architecture in its function and form within the context of historical and political events in Serbia.

2. Underground Military Complex in G.gorge

The German occupation government in Serbia was planning the construction of the railway through the Gornjak gorge which would link the town of Petrovac na Mlavi with the copper mine in the town of Bor. During the realization of that project, in the year of 1942, a construction of underground facilities for purposes of military industry was begun in the vicinity of the G.Monastery *. The construction works were undertaken by the German company TOT. After the liberation of the area, the unfinished project was continued by the Yugoslav army. After the Resolution of the Information Bureau, the underground complex was supposed to become the headquarters and military base for fighting the potential Russian aggression. The objects were abandoned in 1953 when the relations between USSR and Yugoslavia improved again. The object 1 was intended to serve as a production facility or the warehouse, while the object 2 was intended to accommodate people.

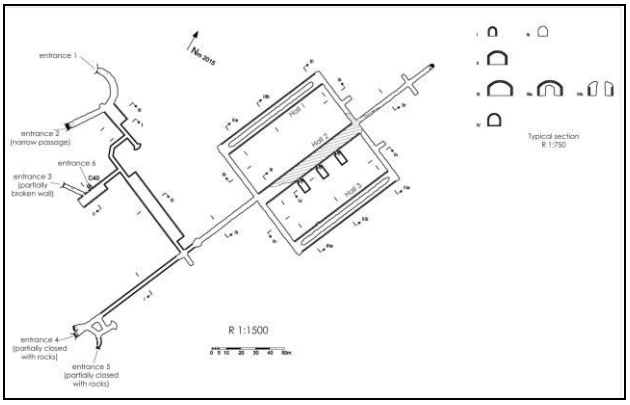


Figure 1. Plan of Underground Object1 at G.gorge (arch. of SOB (Drawing by N.Bozovic)

Figures 2,3. Unfineshed and Finshed Halls in Object 1, G.gorge, photoes by Zoran Simic

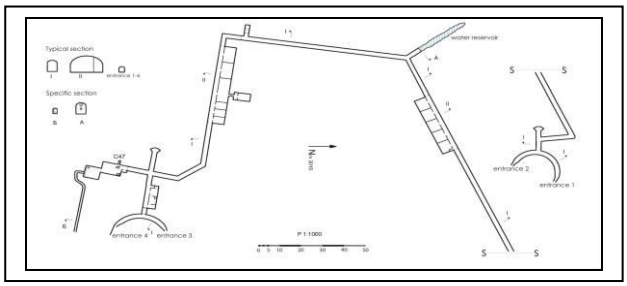


Figure 4. Plan of Undergound Military Object 2 at G.gorge, archive of SOB (drawing N.Bozovic)

3. Military Headquarters of Karageorgievic

The mines at M.Z.* on the river Drina were built for purposes of the king's war headquarters by order of King Alexander I Karadjordjevic. The construction began in 1931 and was stopped in 1934 due to the assassination of King Alexander in Marseilles, France. The facility was used only once, in April 1941, when the young King Petar II Karadjordjevic spent his last night before he became a refugee. The object has a total length of 1500m, out of which two thirds are finished, there are more entrances and facilities of different purposes, such as an orthodox chapel or a well with drinking water, among others.

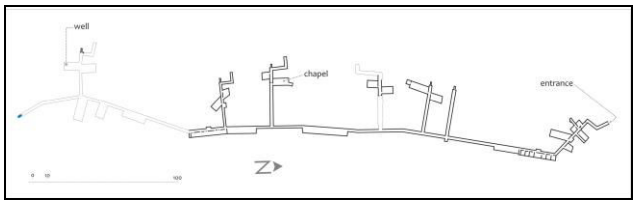


Figure 5. Plan of Karageorgievic's underground passages: Archives of SOB (darwing by N.Bozovic)

4. Underground Military Objects at South Serbia

Object 1 in the village K.* in the South Serbia is a completely built object on two levels, with three entrances and a production facility, and was intended for accommodating people and equipment. Object 2 in the village M.* was built in the same manner as Object 1 but remains unfinished. Within the object there is a secured drinking water source. It used to serve as a mushroom farming site. The primary purpose of both objects is not known.

*the names of locations are listed in the initials for security reasons

5. Military factory in K

The construction of the underground object near K.* was stopped in the excavation phase and early phase of concrete halls erection. The object is a good example for studying the process of construction and excavation methodology. The main tunnel (twin tunnels) had a tendency to dig through the hill and connect to the military ambulance facility on the surface.

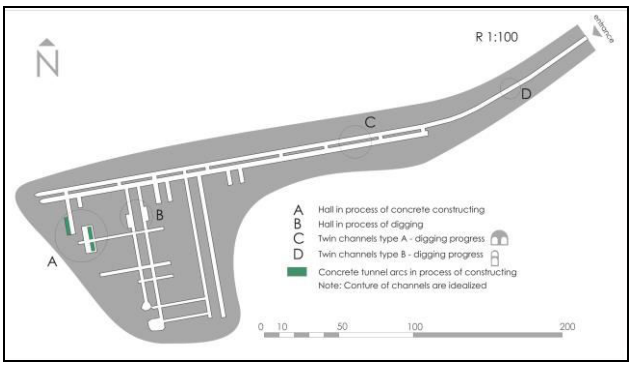


Figure 6. Plan of Military factori in K.- progect of outhor

Figure 7. In Object 1, village K. archive of PSK DVIG

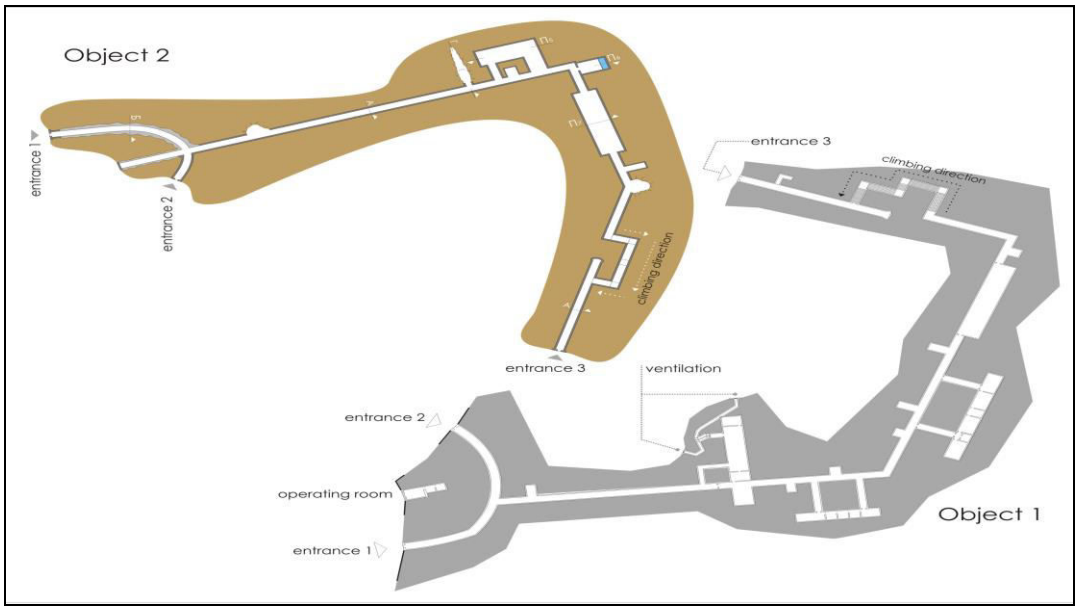


Figure 8. Plans of two objects of undefined function: project author

INDEX OF AUTHORS

AGAPOV Ilya 69
ALBOV Dmitry 57
ALBUKREK Metin 139
ANGELINI Andrea 88
AYDINGÜN Şengül 139
BAKHTADZE Nodar 131
BELVEDERI Giovanni 154, 160
ÜSTÜN Berk 139
BÍLÁ J. 186
BIXIO Roberto 191
BOBROVSKI Timur 12. 28. 8.3
CALO Stefano 1
CALOI Vittoria 143
CANAVAS Constantin 7
CARNEVALI Laura 88
CARPICECI Marco 88
DELL'AQUILA Franco 39
DERAZZA Aniello 59
DOLOTOV Yury 166
FACCINI F. 191
FALTEISEK L. 186
FERRARI Graziano 94. 160
FOSCHINO Francesco 39
GALEAZZI Carla I. 143
GARBERI Maria Luisa 154. 160
GARSHIN Dmitry 166
GARSHINA Yulia 166
GARZIANO Giuditta 59
GASPARYAN Boris 57
GENTILE Mimmo 59
GERMAN Carlo 143
GHEORGHE Postica 83
GREK Igor 12. 28
ÜSTÜN Gülşen 139
GUNKO Alexander 100
GUNKO Alexey 75. 100
AYDINGÜN Haldun 139
IANOVSKAIA Ekaterina 116
KLEIN Eitan 51
KLONER Amos 125
KONDRATEVA Sofia 75. 100
KUPKA J. 186
LAMAGNA Raffaella 94
LANGA Francesca 59
LENART Jan 186
LEONTEV Michael 178
MARGIOTTA Stefano 33
MARTELLOTA Mariangela 1. 33
MILOSAVLJEVIC *Nemanja* 197
PAOLICELLI Raffaele 39
PARISE Mario I.33. 59
PASTURA Giancarlo 21
PERASSO L. 191
PIANA P. 191
RIDUSH Bogdan 83
ROGNONI Elena 94. 160
RUGGIERI Rosario 181
SAJ Stefano 191
SALKIN Asen 45
SANNICOLA Gianclaudio 59
SANTARCANGELO Samanta 59
SCHUCHOVÁ Kristina 181
SHAHINYAN Samvel 65. 75
SHIROKOV Mykhailo 28
STEPKIN Vitaly 110
STOICHKOV Konstantin 106. 121.149
STRUKOV Stanislav 166
TESSICINI Letizia 21
TRAVERSO M 191
TRICOMI Salvatore 181
VIVA Marco 59
VOLPINI Elena Alma 1
ZHALOV Alexey 121. 149
ZISSU Boaz 51.125

PRELIMINARY PROGRAM OF THE CONGRESS - OVERVIEW

Time	Monday 20 –th May
9:00	Opening Congress Office
10:00 – 14:00	General Registration (Congress Office)
1 4:00	Opening Ceremony – Congress Hall in Municipality of Dobrich
	1-st Congress Session
19:00	Dinner
	Tuesday 21-st May
9:00 – 10:00	Morning Session
10:00 – 11:00	Break
11:00 - 12:00	Morning Session
	Lunch
14:00 – 20:00	Guided tour of Millstone Quarry & Aladzha Rock Cut Monastery
20:00 – 22:00	Welcome Party at place
	Wednesday 22-nd May
10:00 – 11:00	Morning Session
	Break
11:30 – 12:30	Morning Session
	Lunch
14:30- 15:30	Afternoon Session
	Break
16:00-17:00	Afternoon Session
	Dinner
	Thursday 23-rd May
9:00 – 10:00	Morning Session
	Break
10:30-11:30	Morning Session – 3 x 20 min
13:30 – 20:00	Guided tour " Early byzantine cave monastery's colony
	Dinner
	Friday 24-th May
9:00- 10:00	Morning Session
	Break
11:00-12:00	Morning Session
	Lunch
14:00 – 15:00	Afternoon Session
	Break
16:00 – 17:00	Poster Session
19:00	Gala Dinner
	Saturday 25-15 May
9:00- 19:00	Guided tour " Yailata cave city "
	Sunday 26-th May
9:00 – 18.00	Guided tour " Ivanovo & D.Besarbovski rock cut monasteries:“

	PROGRAM OF PRESENTATIONS
Time	**Monday 20 –th May**
	M.PARISE &ALL: The international congresses Hypogea/UIS 2015-2021
	SESSION : CADASTRE OF ARTIFICIAL CAVITIES / HYPOGEAN CIVILIAN DWELLINGS
14:00	**S.CALO &ALL:** Cave settlements in southern Apulia. DDACO – the dynamic database of the artificial caves of Otranto
*	**C. CANAVAS:** Tunnels of awe, justice and freedom: underground structures in modern literature
	COFEE BREAK
17:10	**T.BOBROVSKYY &ALL**: Artificial cave shelters of the Phrygian highland (Turkey): defensive devices and principles of organisation
	Y.SHIVTIEL: Underground and Above-Ground Aqueducts from the Roman and Mamluk Periods in the Ancient City of Safad
	Tuesday 21-st May
	T.BOBROVSKYY &ALL: The patterns of development of cave shelters in Cappadocia
	G.PASTURA &ALL : Orte (vt) – a complex hypogean heritage. New acquisition data
9:00	**S.MARGIOTTA &ALL:**Inventory and analysis of underground oil mills in the territory of Lecce (Apulia, Southern Italy)
*	**COFEE BREAK**
	F.DELL'AQUILA &ALL: Rock settlements on vertical cliffs in Matera
12.00	**A.SALKIN:** Ancient man-made rock structures along the Black sea coast of Dobrudzha
	E.KLEIN&ALL: Excavations and surveys of underground cavities at Hurbat husham, Judean foothills
	Wednesday 22-nd May
	SESSION: GEOLOGY, GEOMORPHOLOGY, ENVIRONMENTAL HAZARDS
	D.ALBOV Dmitry &ALL: Natural radioactivity in some caves of the Vayots Dzor province, Armenia
	M.PARISE &ALL: Knowing the underground, as the first step for hazard management: an experience in southern Italy, in the aftermath of a catastrophic collapse
10:00	**S.SHAHINYAN :** The new policy of the government of the Armenia on protection of underground cultural and natural monuments
*	**COFEE BREAK**
	SESSION: RELIGIOUS STRUCTURES
12.30	**I.AGAPOV:**Underground complex of Pskovo-pechersky dormition monastery (Pskov region, Russia)
	A.GUNKO&ALL : Central complex of Gochants cave monastery
	B.RIDUSH&ALL: Rock-cut caves of medieval Orhei (Republic of Moldova)
	LUNCH BREAK
	L.CARNEVALI &ALL: Hypogea of San Pietro in Vincoli at Sant'Angelo in grotte
	G.FERRARI&ALL: Crypta Neapolitana (Naples, Italy) A multidisciplinary underground heritage site
14:30	**A.GUNKO&ALL**: Cave complex in Valuiki
*	**COFEE BREAK**
	K.STOICHKOV : Creation of new map documentation of the rock cloisters on the periphery of Shumen's plateau 2012 - 2019
17.30	**V.STEPKIN :** Via Crucis in the caves of Divnogorsky monastery in Voronezh region, Russia
	E.IANOVSKAIA: Architectural peculiarities of religious cavities complex in the Ihlara valley (Cappadocia)
	Thursday 23-rd May
9:00	**A.ZHALOV&ET ALL :**Cave necropolis in the vicinity of Kizilin village, Adiyaman province, Turkey
*	**B.ZISSU &ET ALL :**Underground explorations at Horvat Qasra, southern Judean foothills, Israel
	N.BAKHTADZE: New considerations on the architectural structure of the Vardzia rock-cut ensemble and peculiarities of the ongoing monastic life
	COFEE BREAK

	Thursday 23-rd May
	SESSION: HYDRAULIC UNDERGROUND WORKS
	Ş. G. AYDINGÜN&ALL: The resurgence near Yarimburgaz cave
11:30	**V.CALOI&ALL:** The artificial drainage system of Gabii (or Castiglione) lake in Latium, Italy. A comparison among the investigations of the '90s and a recent study aiming at a possible restoration of the Old lake basin
	A.ZHALOV&ET ALL: Water itakes and sewrage facilities of Bulgarian St.George the Zograf monastery in Mount Athos, Greece
	Friday 24-th May
	SESSION: MINING WORKS
	G.BELVEDERI &ALL: Iron hearth: the re-exploration of the old mine “Manina” (Italy)
9:00	**G.FERRARI &ALL:** Sasso rancio: an iron mine on Lake Como (Italy)
	D.GARSHIN &ALL: Underground limestone quarries in Tula region, Venyov district (Russia)
*	**COFEE BREAK**
	M.LEONTEV : Limestone mines nearby village Maleevo Ryazan region
11.30	**R.RUGGIERI&ALL:** The geosite of Tabuna and Streppenosa asphalt mines (Ragusa, South-east Sicily)
	LUNCH BREAK
14:00	**K.SCHUCHOVÁ &ALL:** The problem of abandoned mines – only hazards? A case study from the Nízký jeseník upland (Czech)
*	**SESSION: MILITARY AND WAR WORKS (DEFENSIVE)**
15.30	**R.BIXIO &ALL:** Second world war air-raid shelters in genoa (Italy): knowledge, protection and use of an underground historical and cultural heritage in urban environment
	POSTER SESSION


СКАЛНИ ЦЕРКВИ И МАНАСТИРИ В БЪЛГАРИЯ
THE ROCK MONASTERIES AND CHURCHES IN BULGARIA
Видин
Vidin
Враца
Vratsa
Годеч
Godech
Калотина
Kalotina
София
Sofia
Мездра
Mezdra
Роман
Roman
Луковит
Lukovit
Никопол
Nikopol
Русе
Ruse
Цар Калоян
Tsar Kaloyan
Разград
Razgrad
Попово
Popovo
Шумен
Shumen
Каспичан
Kaspichan
Търговище
Targovishte
Силистра
Silistra
Алфатар
Alfatar
Дулово
Dulovo
Добрич
Dobrich
Шабла
Shabla
Нос Калиакра
саре Kaliakra
Провадия
Provadia
Аврен
Avren
Варна
Varna
Дългопол
Dalgopol
Хасково
Haskovo
Свиленград
Svilengrad
Константца
Konstantsa
Скални манастири и килии
The Rock monasteries and cells
Варна
1.Аладжа манастир
Aladzha manastir
2."Св.Георги"
„Sv.Georgi"
3.Китен
Kiten
4.Рояк
Royak
5.Аврен
Avren
6.Кривня
Krivnia
7.Манастир
Manastir
8.Петров дол, „Св.Георги"
Petrov dol, „Sv.Georgi"
9.Неново
Nenovo
10.Невша
Nevsha
11.Скален манастир „Св.Петър"
Rock monastery „Sv. Petar"
Русе
12.Иваново , „Св.Арх. Михаил"
Ivanovo, „Sv.Arhangel Mihail"
13.Басарбово, „Св.Димитър Басарбовски"
Basarbovo, „Sv.Dimitar Basarbovski"
14.Кошов, „Гръмовец", „Чиплийско"
Koshov, „Gramovets", „Chipliisko"
15.Червен
Cherven
16.Божичен
Bozhichen
17.Красен
Krasen
18.Нисово
Nisovo
19.Сваленик
Svalenik
20.Върбино
Varbino
21.Алфатар
Alfatar
22.Голеш
Golesh
23.Кривня
Krivnia
24.Сеново
Senovo
25.Цар Калоян
Tsar Kaloian
Видин
26.Градец, Алботински манастир
Gradets
Търговище.
27.Крепча
Krepcha
Разград
28.Дряновец
Dryanovets
Шумен
29.Дивдядово,
Divdyadovo
30.Мадара
Madara
31.Хан Крум
Han Krum
32.Осмар
Osmar
33.Троица
Troitsa
34.Могила
Mogila
Враца.
35.Царевец
Tsarovets
Търговище.
27.Крепча
Krepcha
Разград
28.Дряновец
Dryanovets
Шумен
29.Дивдядово,
Divdyadovo
30.Мадара
Madara
31.Хан Крум
Han Krum
32.Осмар
Osmar
33.Троица
Troitsa
34.Могила
Mogila
Враца.
35.Царевец
Tsarovets
Добрич.
36.Камен бряг
Kamen bryag
37.Тюленово
Tulenovo
38.Бакалово, „Гяур евлери"
Bakalovo, „Gyaur evlery"
39.Балик, „Асар кале"
Balik, Asar kale"
40.Калиакра, Яйлата
Kaliakra, Yailata
41.Никопол
42.Басараб (Мурфатлар)
Basarab (Murfatlar),
Скални черкви
The Rock churches
София.
43.Разбойще, „Св.Богородица"
Razboishte, „Sv.Bogoroditsa"
Русе
44.Алеково
Alekovo
45.Беляново
Belyanovo
46.Ветово
Vetovo
Хасково.
47.Михалич , „Айпандо"
Mihalich, „Aipando"
48.Маточина
Matochina
Ботевград
49.Боженица
Bozhenitsa
Луковит.
50.Карлуково,
„Св.св. Безсребреници Козма и Дамян"
Karlukovo, „Sv.sv. Cozma I Damyan"
51.„Св.Григорий"
„Sv. Grigorii"
52.„Св.Марина"
„Sv.Marina"
53.Калиакра
Kaliakra
Легенда:
Legend:
Скални манастири и килии
The Rock monasteries and cells
Скални черкви
The Rock churches

HYPOGEA

BULGARIAN CAVING SOCIETY
БЪЛГАРСКО ПЕЩЕРНО ДРУЖЕСТВО

EUROPÆ SPELÆOLOGICA FŒDERATIO

ДОБРИЧ

РЕГИОНАЛЕН ИСТОРИЧЕСКИ МУЗЕЙ ДОБРИЧ

ROUSSE REGIONAL MUSEUM OF HISTORY

Varna Museum of Archaeology