Cardiff University

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Recording Archaeological Senses in Subterannean Archaeological Sites

A methodological approach on Neolithic caves from the Western Balkans and Greece

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Abstract

Sensorial approaches in archaeology have been criticized due to the difficulty of the analytical documentation of the past senses. This thesis aims to correlate current trends on archaeological theory about non-rational decision-making factors in prehistoric communities (such as senses, emotions and feelings) with current mapping and geo-analytical techniques. The research introduces the idea of the "paleosensorial spectrum" of an archaeological site and proposed recording techniques using GIS and statistical software. For this research case study, paleosensorial spectra are drafted by using advance mapping techniques for capturing sensorial data in Neolithic caves from Greece and the Western Balkans and further correlating the field data with the archaeological evidence. Cognitive psychology frameworks have been used for grouping the field data and bridging the gap between the material and the immaterial worlds. Caves from the Balkans works as complimentary case studies but a discussion on how the application of the proposed methods can alter the current understanding of the human use of the Neolithic Balkan caves is taking place, in order to showcase if the "paleosensorial spectrum" approach can offer a better understanding of the past. As an outcome of the thesis, a step-by-step workflow is proposed on how we can record with digital tools paleosensorial spectra in subterranean environments and how these can be correlated with past activities.

To my grandmother Georgia "Boubou" Filippousi-Zarpa
who showed me the pathway

and

To my teacher George E. Baveas who taught me how to follow it

Στη γιαγιά μου Γεωργία «Μπουμπού» Φιλιππούση-Ζάρπα
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Και

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που με δίδαξε να το ακολουθώ

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Konstantinos P. Trimmis

Chapter 1

An Introduction to the ideas and scope of this thesis

…a giddiness overpowers all living creatures till they unite
in the sea, in caves, in the air, under the ground,
transferring from body to body a great, incomprehensible message…

N. Kazantzakis,
Askitiki, The Earth .16

Summary

In the introduction of the thesis, the notions of "space" and "place" are presented, when a thorough analysis on the importance of the understanding of the relationship that people built through time with space and place is given. The research question of the thesis is presented along with the research aims and objectives. Consequently, the research design is analysed and explanations are given about why Neolithic caves from the Western Balkans and Greece have been selected as case studies.

1.1 Places, spaces and people

Growing up on a remote Greek island, from early in my life I questioned why particular areas of the island had come to be characterised as "wild" for some people but "friendly" for others. Visiting Kythera island in southern Greece today, it is easy to observe that indeed the eastern part of the island is more heavily occupied by a human presence than its western half, even if in the latter there are areas with streams and year-round surface water. Later, once I started my studies in archaeology, I came upon the theoretical debate concerning the notions of space and place, and gradually I understood that the geographical characteristics of a place do not stand alone as the main reason for a location's human activities. The philosopher Yi Fu Tuan, during the 1970s, first explored the different meaning of space, place and environment. According to Tuan the difference between "space" and "place" can be described by the extent to which human beings have given meaning to a specific area. Meaning can be given or derived from an area, both in a direct and an intimate way, for example through the senses such as vision, smell, touch and hearing, and also in an indirect and conceptual way mediated by symbols, art and so on (Tuan 1977: 6). "Space", according to Tuan, can be described as a location which has no social connections for a human being. There are no values added to this space. According to Tuan (1977: 164-165), it is an open space but may be marked off and defended against intruders (Tuan 1977: 4). It does not invite or encourage people to fill the space by being creative. No meaning has been ascribed to it. It is more or less abstract (Tuan, 1977: 6).

On the contrary, "place" is more than just a location and can be described as a location created by human experiences. The size of this location does not matter and is unlimited. It can be a town, city, a region or a room. In fact, "places" exist in "spaces" that are filled with meanings and objects by the human experience in these particular places. Spaces are centres where people can satisfy their biological needs. (Tuan 1977: 4). According to Tuan (1977: 6) a "place" does not consist of observable boundaries and is, in any case, a visible expression of a specific time period. Examples are arts, monuments and architecture.

Following Tuan's ground-breaking ideas about humanistic geography, many others added their own perspectives on Tuan's theories. Most notably Edward Relph opposed Tuan's positions, and maintains the relation between space and place by presenting them as a single concept, which is shaped according to the human actions therein (Reiph 1976). In this debate, archaeologists have discussed how the human experience has shaped and continues to shape these notions. Archaeologists have also been influenced by many geographers and anthropologists (e.g. Blake 2002 Blake 2002; Cosgrove 1984; Foucault 1980, 1986; Lefebvre 1974; Low 2002; Rabinow 1984; Soja 1989; Tuan 1977), however, and to date no conclusion has been reached in the discussion of whether "space" and "place" are two distinct notions or one single idea that can be addressed differently (see Bradley 2000). In this thesis I will accept an idea closer to Tuan's perception that space is more of a location, whereas place can be viewed as somewhere that has been shaped through human actions and experience (see also Tringham 1991).

The question that remains and will be present throughout this thesis is "how" people shape "spaces" into meaningful "places". What are the actions that create “places” and how much are these actions influenced (or triggered) by the geographical characteristics of the place itself?

As many authors (see for example Hamilakis 2013; Tringham 2015; Zeelenberg et al 2008) have suggested in recent years, “senses” might be the driving force behind human action. People sense their surroundings and, as I will present in Chapter 2, construct their decision-making processes and thereafter act. These actions produce new sensorial stimuli that people send back to their central nervous system in order to alter their decision-making processes and produce new actions. Hamilakis (2013) and Skeates (2010) proposed coherent theoretical and methodological frameworks on how senses can be addressed in an archaeological context. However, as Tringham (2015) discussed in her book reviewing Hamilakis’ work, the actual demonstration of how these approaches could be applied in the field fell short of being convincing (see Chapter 2 for a further discussion). Additionally, what Zeelenberg *et al* (2008) demonstrated is that understanding the senses is not enough to understand human actions. For Zeelenberg et al, senses are the medium and not the actual force behind human decision-making; that is the rational–logical thoughts in correlation with emotions and feelings (see chapter 2).

As I will present in Chapter 2, starting out from Ingold’s ideas back in 2000 (Ingold 2000) human actions are derived from and shaped by their surroundings. Some archaeologists over the last few years have been working under the hypothesis that through understanding archaeological senses we can better discuss how people correlate, affect and become affected by their surroundings: ultimately how they were thinking and how they decided on and executed their actions.

Thus, a research question emerged; is there a way that archaeological senses can be recorded – mapped – in the field and afterwards correlated to the rest of the archaeological evidence? Also, is there any way that along with the sensorial recording we can equally record archaeological emotions and feelings so as to holistically understand the driving forces behind human decision-making? In the pursuit of these possible answers, this research will be developed using caves from the Neolithic Balkans as case studies (see chapter 5) and advanced mapping and statistical analysis as mediums (see chapter 4).

1.2 Research design

Aims and Objectives

Following the research question, the aim of this thesis is primarily to discuss and then to propose a methodology for how it would be possible to archaeologically record this relationship – rational and emotional – that people created with their natural surroundings using statistical analysis and advanced mapping techniques in a subterranean – cave – context. As case studies for this proposed methodology I selected caves from the area of the Western and Southern Balkans, for reasons that I will present later in this chapter.

In order to achieve the stated aim, I set three objectives that were organised in the context of a two-year research project – the Balkan Cave Archaeology project (see https://balkancavearchaeology.weebly.com).

The first objective was to create a database with all the excavated and published Neolithic cave sites of the Western Balkans and Greece. The database includes not only the archaeological information, but also the available microenvironmental characteristics of each site (entrance orientation, cave climate zones, altitude of the entrance). This dataset had the scope to provide a regional overview on the cultural and geographical characteristics of cave use in the Balkans, and to showcase any patterns on cave use that might exist. The correlation between the environmental and bibliographical archaeological data can display the extent to which the rational use of cave sites was influenced by the caves' geomorphological characteristics. The first objective is important because it highlights how important data in the literature can be for producing regional patterns on sensorially driven actions, when analysed appropriately.

The second objective was to visit four of these sites in order to investigate the intra-site spatial arrangements against the microenvironmental characteristics of the caves using Heeb's paperless mapping methodology (Heebs 2013). Micro-climatic data consisting of temperature, humidity, and luminance along with soundscapes of the four caves waere collected and then correlated with the available archaeological evidence to test the proposed geosophical approach to the interpretation of archaeological cave sites. The importance of the second objective lies in the field-testing of the proposed methodology and its applicability for previously excavated sites. The second objective provides evidence for how and how well the methodology works and if it is feasible to use it.

The third objective was to excavate a cave site based on the methodological and theoretical framework that this thesis suggests. I selected Mala Pećina cave in Croatia, which is located at the centre of the geographical extent of this thesis, so as to bridge objectives one and two, and to challenge the current theories on patterns in Neolithic Balkan cave use, through the application of a geosophical excavation approach that directs an archaeological excavation to search not only for artefacts but also senses, emotions and feelings.

Why the Balkans? Why caves?

The Balkan region has been selected to be the regional context for this thesis because it is simultaneously diverse and unified. As I will discuss in Chapter 5, after a long period of turbulence and war, finally, by the middle of the second decade of the 21st century, the Balkans seem more stable than they have ever been before The primary intention of this thesis is not only to consider any number of fairly modern ideas about differences or similarities, but mainly to try to exploit the current published data without filtering it through any political, national or social prism.

On a purely archaeological perspective, the Balkans is an interesting area, being as it is the point where Asia meets Europe and the Mediterranean connects with the North and the East. The Balkans has always been as much Mediterranean as continental and as much European as Oriental. Spyros Sfetas (2011) talks about the historic Balkans as an area of cultural amalgamation and cultural “trade”. Even if “the Balkans” as a historical term did not exist in the Neolithic, the idea of it being a point of “amalgamation” and “trade” seems to be supported by the interpretation of the prehistoric archaeological finds. This will be examined thoroughly in Chapters 3, 4 and 7 of this thesis.

In this research, I have chosen to examine the interaction between humans and the natural environment, and to test the proposed methodology by sketching the relationship between the individual and a dynamic environment: the cave, in our case. I will set this discussion accepting ideas closer to Pierre Bourdieu and his dialectic relationship between the human body and space (Bourdieu 1977). In the case of Bourdieu, the space is the built space, but as other researchers have noted (like

Whitehouse 2016), this dialectic approach can equally be applied to the natural environment and therefore to caves. As a note, caves are not the only dynamic environment. The sea, mountains, some lakes and rivers are also defined by environmentalists as dynamic environments (Gunnel 2014). What characterises an environment as dynamic is not how variable it is within a certain period of time, but how strongly (dynamically) the prevailing environmental conditions affect the humans who interact with it (Anthony et al 2014; Popov et al 2014).

Caves have been selected to be the case study of this thesis for their special and unique nature. Caves, as will be discussed in Chapter 2, are dynamic sensorial capsules. If an area in a cave is dark today, it can be easily discovered if it was dark in the past as well, thus we can map the human activities in these areas and see what kind of activities were happening in the well-lit parts of the cave and what was happening in the dark areas. The same situation, more or less, can also be observed for humidity, temperature and sound inside a cave. The natural environment that surrounds anybody today inside a cave has seen small changes since prehistory in comparison with most open-air sites. In the cave case the modern researcher can see, sense and feel a large extent of the same sensorial spectrum that a person in the past would have sensed. I need to say here that these, on some occasions, "fossilized" senses can only be observed in caves with mild speleogenesis and speleoapothesis[1], and always compared to open air settlements, where the natural environment and the landscape change rapidly every day.

Organising the research: limitations and logistics

My methodology, which is analytically presented in Chapter 4, is a combination of advanced cave mapping techniques and statistical analysis of the data using Geographical Information Systems (GIS) and R. For the purpose of this thesis, a research project has been organised partly in collaboration with the Archaeological Museum of Zagreb (Balkan Cave Archaeology project). The outcomes of this project, which I led and organised, are the main case studies of this thesis and are presented in

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Speleogenesis is the procedure of the "birth" of a cave and could be a combination of mechanical and chemical reactions. Speleoapothesis (or cave deposition) is the procedure of the deposition in caves of calcite and organic materials which creates the decoration (speleothems) of a cave.

chapters 6, 7 and 8. I executed the analysis of the datasets except where it is stated otherwise.

For the purpose of the first objective I visited libraries in Athens, Thessaloniki, Zagreb, Belgrade, London and Oxford in order to collect the literature-based datasets. The main research limitation for the first objective is the absence of a national or regional cave registry for any of the countries that lie in my research area. I contacted the major relevant caving clubs and the Balkan Speleological Union but with minimal results. Another limitation for achieving the first objective was the quality of the published information. Excavation reports cover a period of 140 years and on some occasions even lack the inclusion of a map of the site. As a result, from a region with around 18,000 recorded caveforms, only 112 can be identified from my literature review as having been excavated with certain Neolithic layers and an even poorer number of only 56 could provide the microenvironmental data that I needed for the further analysis of cave use patterns. In any case, in the context of the Balkan Cave Archaeology Project the number of sites analysed in regional terms are far greater than from any other Balkan-wide regional project (see for example EUROFARM and Balkan 3000, or the regional research on 24 caves published by Trantalidou et al 2010).

For the purpose of the second objective I selected caves from Greece mainly because I needed four well-published sites in order to test the methodology for the sensorial context, with a close distance between them so as to facilitate the tests with minimal travel between sites. Caves in Dalmatia or Montenegro could equally have been used but it was easier to obtain a permit from the Greek authorities. I needed caves where excavation had taken place in all three environmental zones of the site, the datasets had been published in international journals and had been peer-reviewed and were easily accessible to the University students that assisted on the fieldwork for health and safety purposes. The sites that were finally selected were Koromilia, in Northern Greece, Leontari and Kitsos in Attica and Antiparos in the Cyclades. Fieldwork took place during the summer of 2015 in the first three and in 2016 in Antiparos.

For the purpose of the third objective I aimed to excavate a cave with Neolithic strata following the sensorial – geosophical approach that the theoretical part of this thesis proposed. I targeted caves in the centre of the geographical context, where the Dinaric Alps merged with the Pindus Mountains. The caves of Tren in

Albania, Spila in Montenegro and Mala Pećina in Dalmatia were shortlisted. I chose Mala Pećina since the cave had never been excavated before and all the available data was based on surface finds. Mala Pećina is not only located at the centre of the context but also in a passage that leads from the Adriatic coast to the Balkan hinterland. Mala Pećina also offers a variety of cave morphology from large chambers to narrow passages and archaeological material that spans from the Early to the Late Neolithic. Again, as for the second objective, for the aim of the thesis I used Mala Pećina as a place to assess the proposed methodologies and to see if a geosophical approach to archaeology can be an integrated part of an excavation process. Excavations in Mala Pećina took place initially for the purpose of this thesis during the summer of 2016 and I aim to complete a second season in the summer of 2019. Excavations are supported by Cardiff University and the British Cave Research Association.

The thesis concludes with a final discussion (Chapter 9) on how successful the applications of the proposed research methodology were in the field and for the analysis of the literature evidence. Chapter 9 also explores the possible adaptation of these techniques to other archaeological contexts. There is also an evaluation of the case studies' outcomes in Chapter 9, with a further evaluation of how sensorial-based field research can alter or support existing interpretations on Neolithic cave use in the Balkans.

1.3 A summary of the thesis' scope

This research is about theory and methodologies. The thesis tries to correlate current trends in archaeological theory about non-rational decision-making factors in prehistoric communities with current mapping and geo-analytical techniques. Caves from the Balkans work complementarily as case studies, though a discussion on how the application of the proposed methods can alter the current understanding of the Neolithic in the Balkan caves will also take place, in order to examine if a geosophical approach can offer a better understanding of the past. A journey through theory, literature, excavation publications, technology and software and finally caves will follow as one reads.

Chapter 2

Exploring the notions of the “ –scapes” – Landscapes, Taskcapes, Sensescapes and Feelingscapes – and introducing caves as part of the archaeological evidence.

Summary

In this chapter the major theoretical norms behind the thesis ideas are presented. Initially the first applications on the sensorial ideas in archaeology, in the form of the early 1990s phenomenological influences in archaeology, are showcased when a quite extensive historiography is given. Then, the chapter progresses on presenting the most current approaches on the sensorial aspects in archaeology, when major publications are cited. The first part of the chapter concludes with a further discussion on the possible archaeological research for past emotions and feelings and how, cognitive psychology models can help towards this. The second part of the chapter introduces caves, as natural and anthropological sites, and discusses the role that caves play in the archaeological discourse.

2.1 Human-Landscape interaction in archaeological thought

A brief research overview

The concept of landscape had been incorporated into archaeological thought from a very early stage. From the 19th century, the Swede, Jens Worsaae noted that archaeological finds can only be interpreted through their relationship with the environment of the period to which they belong (Shaw and Jameson 1999). However, for more than 70 years, landscape archaeologists understood landscape more as a “canvas” where all human actions took place, shaping it accordingly. For example, Gordon Childe, in his legendary “The Danube in Prehistory” (1929), presented the landscape and the importance that plains and rivers may have had for the early Neolithic groups’ movement across Eastern Europe. Almost 25 years later, Mortimer Wheeler in his “The Indus Civilization” again recognizes the importance of the river in the emergence of the societies along the river banks (1953). Gordon Willey's (1953) pioneering settlement pattern study in the Virú Valley of Peru is one of the earliest efforts to move questions of place beyond the idea of place as an area that hosts human activities. Willey defines "settlement patterns" as "the way in which man disposed himself over the landscape on which he lived. It refers to dwellings, to their arrangement, and to the nature and disposition of other buildings pertaining to community life" (1953:1). To determine how "man disposed himself over the landscape" Willey analysed archaeological materials within an approximately 350 square kilometre area of the Virú Valley. The basic data for the analysis of settlement patterns were "the descriptive observations on archaeological sites or other prehistoric works in the Valley. These data were compiled as notes, maps, and photographs during the course of a 4-month survey of the Valley" (1953:2).

For the first time, though, the landscape was incorporated into archaeological interpretative attempts as space 'hosting' human actions (Binford 1962). Along with the archaeological dimension of the landscape, New Archaeology also highlighted the archaeological dimension of the environment. In fact, the environment, for the interpretative approaches of the time, was considered the definitive factor in the formation, transformation, change and, ultimately, evolution of human societies (Binford 1962; Evans 1978)

Analysing these concepts in the context of caves, according to the definitions of landscape given by natural geography, it can be noted that landscape is the total of the material and immaterial environment, as humanity perceives it. From a geological point of view, the cave belongs to the material part of the environment. By the geological definition, as an integral part of the earth, it is part of the natural world and is governed by the principles and rules that govern the changes and transformations of the planet (Klapsopoulos 1998). The importance that these characteristics of caves, as integral parts of the landscape, hold for the archaeological research of caves shall be analysed later. Yet what is immediately visible is that the natural characteristics, which alter the cave, also affect the human uses of the cave itself.

The contestation of this passive view of the landscape in the role it played in human societies occurred as a natural outcome of the changes brought about in archaeological thought by the interpretative approaches of post-processual archaeology. The shift of interest of archaeological interpretation from the level of socio-economic factors to that of the individual disengaged the natural environment from the role of passive receiver of human activities and brought it up to the role of co-creator (Ingold 1993).

However, from the beginning of the 1990s onwards, the phenomenological approaches which have begun to influence archaeological interpretations saw the landscape rise to become recognized as a crucial factor in shaping human activities. Landscape appears to 'embrace' each human action (Ingold 1993). People are not the centre of archaeological interpretation any more. The Cartesian perception of "receiver" changes and becomes an integrated element of the natural world. The world shapes humanity and is shaped by it (see Geertz 1973). Landscape becomes part of the social dimension of mankind (Ingold 1993; David & Thomas 2008).

Ingold suggests that human actions shape the geographical place (Ingold 1993). These actions have been demonstrated as a blend between human cognitive actions and environmental impact. This blend transforms passive landscapes into active taskscapes. The idea of the taskscape recognises that all tasks are interlinked and that other tasks are themselves seen and understood. Thus, the very notion of a taskscape as a continuous or seamless spread of heterogeneous events and experiences stands in opposition to the widespread practice of classifying activities into human-centred groups – such as economic or ritual (Darvill 2008). A taskscape then is a socially constructed space of human activity, understood as having spatial boundaries and delimitations for the purposes of analysis (Ingold 1993), or otherwise "the landscape as a whole must likewise be understood as the taskscape in its embodied form: a pattern of activities 'collapsed' into an array of features" (Ingold 1993:162).

Ingold's ideas have dominated archaeological perception of landscape since their appearance. However, from the time that I first came across Ingold's theories of "taskscapes" even if I, like the majority of archaeologists, found them to be satisfactory to "describe" a place or to "interpret" a landscape and how this changed through time, I have been questioning what the trigger was for these "tasks" that constituted the notion of the "taskscape". In other words, how did people in different areas perceive their landscapes, how much impact did a place have on the formation of an action, what are the cognitive-contextual aspects that make people act differently, and how were the outcome of these actions feeding back to the people in order to again shape new activities? More simply, my main question was – and still is – what happens before the creation of a "taskscape"; and if there is something there, how can we approach this in archaeology? Since humans perceive the world through their senses, I thought that this should be the first place to look for my answers.

The role of the senses

As Mills (2014:20) states, “it is now widely acknowledged that in all times and places sentient bodies are knowledgeable about their surroundings through engagement involving the whole body, the contents and configuration of their surroundings and cultural and historical contingency”. Senses are the means through which humans perceive their surroundings, the starting point of a behaviour which formulates in human brains, before feeding back again into the human surroundings, re-creating a new norm, through human actions.

This “chicken and egg” loop became the core of several archaeological discussions, particularly from the 1990s onwards (Mills 2014: 20). Archaeologists at the beginning of the 1990s tried to understand how behaviour and human actions changed based on sensorial experience using a phenomenological approach or even taking the researcher’s active perspectives as an interpretational tool (e.g. the works of Christopher Tilley and Michael Shanks 1987a, 1987b). The phenomenological approach in archaeology received strong criticism, mainly for the reason of using current active perspectives as a medium of interpretation for the past (e.g. Brück 2005; Johnson 2012). In recent years, there has been a focus in archaeology on the agency of materials and material aspects of the world. While tangible materials from the landscape certainly affect human behaviour, there are other elements of the environment that affect our senses such as light, wind, humidity and temperature and these also play a role in human behaviour and decision-making processes (Gunnell 2014). It is the interaction of the senses that allows humans to discern different aspects of the world around them. There is a historical western primacy given to the visual sense that is also centred on the experience of the individual (Hamilakis 2013: 21). This is something that is embedded in the language we use as we equate “seeing” a thing with understanding. Ethnographically, we find examples of people who give more emphasis to other senses such as taste and smell (e.g. the research on Papua New Guinean tribes by D. Howes (2003)). The interaction of bodily senses, synaesthesia, generates our perception of the world. As people move through the landscape, these different perceptions of place are created synaesthetically: "as places make sense, senses make place" (Fled cited in Mills 2014: 39)

Lefebvre's "The Production of Space" (1974)[2] postulated that all space is socially constructed and, while concentrated on urban settings, this holds true for our perceptions of all environments. While the landscape affects our conception of the world and how we interact with it, our synaesthetic conception is tangled with previous experiences and social conceptions. Regardless of conceptions of personhood, individuals do not and cannot frame their conception of the world outside of social relations with other people. These relations are constantly being developed and reworked through tradition, previous experiences and correspondence with the world. This leads us to the current idea about the senses, that people's sensorial spectrum is always *socially constructed* (Hamilakis 2013). However, this creates a paradox. If we need to understand the society in order to understand the sensorial spectrum, how can we use the senses to investigate the societies of the past? Hamilakis (2013) tackles this paradox to a point using the notion of "affect". He argues that interpreting the sensorial experience in a particular social context assists in the better understanding of this particular context itself (Hamilakis 2013).

Another issue regarding the senses in an archaeological context is the fragmentation of the sensorial spectrum. Standing in the centre of an archaeological site today, our senses will not be receiving the same stimuli as in the past. The surroundings, most of the time, will have significantly changed. Thus, the sensorial information is fragmented in the same way that the actual archaeological data is, and they are mixed with modern or current sensorial stimuli. Researchers should try to reconstruct the palaeo-sensorial spectrum in a way that reconstructs the palaeoenvironment of a site. More analytically, in the same way that we collect evidence such as pollen, sedimentological blocs, U-Th dating, and isotopes in order to recreate the natural environment of a particular era, we can also gather information about the luminence, sounds, humidity and temperature of the environments to which the people of the past were exposed. Following the aforementioned theoretical pathways, we can reconstruct the spectrum of sensorial stimuli that past people would have engaged with and correlate these stimuli with the archaeological evidence.

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This citation refers to the English edition of Lefebvre's book published by Blackwell publications in 1991.

Summarizing, the sensorial spectrum of the past – any past that particularly interests the researcher – seems to be a crucial factor for interpreting, understanding, reconstructing or even creating a narrative about the human-landscape relationship for this particular context. The sensorial spectrum of the past is the group of sensorial stimuli that a person perceived in a particular period. As with any other archaeological evidence, the sensorial spectrum tends to be fragmented and mixed with the current sensorial stimuli. Finally, senses are socially constructed but also affect the social context, shaping social and cultural relationships. Before proceeding to discuss the relationship between society and senses it is worth addressing the fragmentation of the senses and the way that we can reconstruct – to a point – the sensorial spectrum that people in the past used to perceive.

Reconstructing the palaeo-sensorial spectrum

Mainly based on a methodology that derives from Steve Mills' work on auditory archaeology (2014) and Robin Skeates' work on prehistoric Malta (2010), the reconstruction of the palaeo-sensorial spectrum is today at least theoretically possible. In Skeates' approach there are five principal steps that can be variously adapted in order to construct a sensory research (Skeates 2010: 5–8):

1) Reflexivity (reflecting on the assumptions and sensory biases inherent in research approaches).

2) Inventory (identifying and describing the range of resources and practices that constitute a culture's sensory profile).

3) Experimentation (multisensory fieldwork to test or demonstrate the potential and variables of sensory orders at specific locations).

4) Thick description (attempting to describe the significance of sensory resources for past cultures and variability in their use).

5) Creative writing (using imaginative writing and other media to stimulate thoughts and ideas about the senses in past ways of life).

For my approach, from Skeates' five methodological steps the most important are steps 1, 2 and 4. Reflexivity, generally, in archaeological research has been a central point of discussion either as a tool for interpretation (e.g. Halstead 2014; Hodder 2012) or mostly as a bias in the actual archaeological data (Hodder 1986). On both occasions the main argument was the reflection that archaeological materials/evidence/data had on the researcher. Can we use these as mediums of interpretation or do these reflections bias the data, adding an outdated and an out of context value? Probably none of the questions are really relevant though. As I stated earlier, the idea is to reconstruct the sensorial spectrum of the past and investigate that reflection on the past culture's point of view. And this is where steps 2 and 4 of Skeates' approach can prove valuable. Even if creating a culture's sensory profile (Inventory) is not an easy task, the thick description of the way that people interacted with sensorial resources is something that can be done and archaeologists have already attempted this kind of approach, using different senses as case studies (e.g. Mills' work on sounds and hearing (Mills 2014), Papadopoulos, Hamilakis, and Kyparissis' work on light (2015) and Parker-Pearson's work on vision and the cosmology of the roundhouses (Parker Pearson 1996). Thick description is not a novel idea in anthropological work. Since it was first introduced by C. Geertz (1973) as a way to describe a cultural phenomenon, evaluating the extent to which this phenomenon is 'meaningful' for the corresponding culture, it has dominated anthropological and archaeological theory, introducing the idea of the interpretation of the fact. With his work Geertz believes that standalone data is not sufficient for understanding social context and practices. Thus, a thick description is composed not only of facts but also of commentary, interpretation, and understanding of the context where the data is created.

Reviewing all the previous research attempts, the main difficulty for a sensorial approach in archaeology is the fragmentation of the palaeo-sensorial spectrum. When we are recording the sensorial spectrum in an archaeological context, this spectrum is heavily biased through the ages, due to the taphonomic situation of the area and the decomposition of the cultural elements that are incorporated into the natural environment in order to constitute the sensorial spectrum of the past. As an example, if we are trying to reconstruct the palaeo-sensorial spectrum in a Neolithic tell settlement, such as the Neolithic site of Paliambela Kolindros in Greece, we will easily end up at a dead-end. The local agricultural activity and the looting of the archaeological tell, along with the construction of the nearby village and the alluvial deposition of two streams, make it difficult to perceive and record the senses in the way that the Neolithic people would have perceived them.

The first tool for palaeo-sensorial spectrum reconstruction is the reconstruction of the palaeo-environment of a site. The second tool is to understand, based on the archaeological evidence, the way that people, from a certain culture in a certain era, perceived their surroundings. In order to group together this fragmented evidence, we could incorporate into the archaeological thought Gestalt grouping principles (Mills 2014:84). In the early 20th century Gestalt psychologists introduced a series of principles that explained why certain fragments of sensory evidence should be grouped together. The word "Gestalt" means "pattern" in German and exactly these perception patterns are probably the main tool that can help us to understand how people in the past perceived their surroundings and shaped certain behaviours and actions around these perceptions. Even if Gestalt theory pays particular attention to visual systems, I support Mills' idea (2014:84) that these principles can also be applied equally to the auditory system and it is still open to discussion if they are applicable to the other sensorial systems.

Gestalt principles of grouping are organized into six categories: Proximity, Similarity, Exclusive allocation and belongings, Continuity, Common Fate, and Good Form (Enns 2003). As my approach to the Gestalt principles merges the visual and the auditory approaches, the analysis of the categories is based on Mills' work (2014: 84–86) who provides the following:

"1) Exclusive allocation and belongingness: The principles of exclusive allocation *and belongingness state that the fragment of sensory evidence is always a property of some object or event and is never allocated to more than one object or event at a time but exclusively to one. In the sensory system this means that a fragment of sonic evidence, for example, loudness, cannot be understood on its own but must be assigned to an event in the world that produces this evidence (sound). Only through that association can the evidence have meaning. Furthermore, any single fragment of evidence can only be the property of one event and assigned to that event exclusively and without being associated with two separate events. This is the principle of exclusive allocation. In the world that people inhabit, there are distinct physical objects and events and it is therefore important that the evidence is divided and associated correctly. This dividing and associating of evidence ensures that ecological validity is maintained. Ecological validity means that the various fragments of evidence are correctly associated in accordance with how they originated in a person's surroundings.*

2) Proximity: The principle of proximity states that fragments of sensory evidence that are close together in space and/or time tend to be grouped together. In a sensorial system this means that different fragments of sensory evidence that are close to each other in space and/or time will become grouped together in a sensory stream. The gestalt psychologists likened this grouping process to a force of attraction between fragments of sensory evidence much like that of gravity. The greater the proximity between two fragments of sensory evidence the greater the force of attraction is. Therefore, in a mixture of many fragments of sonic or visual evidence, those that are closest together in space and/or time are more strongly attracted to each other. The principle of proximity also applies to frequency and amplitude as differences in both can be thought of in a spatial dimension. The degree of proximity between fragments of sensory evidence is dependent on the dynamics of the sensorial scene.

3) Similarity: The principle of similarity states that fragments of evidence that are similar tend to be grouped together. The principle is very close to that of proximity and the two often work well together. As with proximity, the greater the similarity between two fragments of sensory evidence, the greater the force of attraction between them and the tendency towards grouping is.

4) Continuity: The principle of continuity states that fragments of sensory evidence that follow the same direction tend to be grouped together. The principle of continuity operates in both the dimensions of space and time.

5) Common Fate: The principle of common fate states that fragments of sensory evidence that move together tend to be grouped together. In the sensory system if a number of similar fragments of evidence move in the same direction in space, for example, from left to right in relation to the sentient, then they are likely to have originated from the same event that is moving from left to right and they should be grouped together into the same sensorial stream.

6) Good Form or good Gestalt Principle: This principle states that fragments of sensory evidence tend to be grouped together if they are parts of a pattern which is a good Gestalt, meaning as simple, orderly, balanced, unified, coherent, and regular, as possible, given the input. In such cases, global regularity takes precedence over local relations. This principle is also called the "law of good form" or the "law of Prägnanz", a German word that translates roughly as salience, incisiveness, conciseness, impressiveness, or orderliness."

The sensorial systems employ the Gestalt principles to group fragments of sensory evidence into the correct sensory streams. The principles operate to ensure that when sensory evidence is mixed, those fragments that strongly resemble each other are grouped together as most probably having a common origin (Mills 2014:86). There is considerable overlap in the operation of the principles reflecting the nature of events in the world. As an event will tend to originate from the same place, it will exhibit similarity in how it generates sensory evidence and have some degree of temporal continuity or persistence; it is logical that the sensory system should develop principles that enable it to detect closely related and overlapping fragments of sensory evidence. Conceptualizing the grouping principles in terms of heuristics that aim to achieve ecological validity, the concept of scene analysis improves upon the research of the Gestalt psychologists. The Gestalt psychologists were concerned with forces of integration that unite sequences of sensory evidence in the whole. The process of grouping was considered a purely mental achievement. The emphasis placed on perception as a mental process, reinforcing the dichotomy between sensation and intellection, is the major limitation of Gestalt theorizing (Mills 2014:86).

Summarizing all the theories, the reconstruction of the palaeo-sensorial spectrum can be possible using Geographical Information Systems in a way that I will present thoroughly in Chapter 5. Briefly, for a designated archaeological site, such as caves for the purpose of this thesis, we can plot the fragmented archaeological evidence and describe the clusters and patterns that became apparent. Skeates' approach that involves thick description and creative writing can help to enhance the available evidence and provide meaningful interpretations of a place. In the same way, sensorial evidence from the same area can be mapped and plotted. Gestalt principles will help to group the fragmented sampling information into major sampling points that will provide equally enhanced sensorial evidence that correspond to particular areas of human activity. In other words, Gestalt principles can help to better describe the sensorial stimuli that a person perceived in a particular place. Correlating the spatial relationship between the archaeological material evidence and the archaeological sensory evidence in a digital environment, we can create heat maps of activities that will be associated with particular sensorial stimuli; as an example, areas in a house that can be interpreted as spaces for food production can be associated with certain light conditions. It is important that we are dealing with the sensorial spectrum as archaeological evidence now, and we are not referring to the contemporary researcher's biased sensorial perception as previous phenomenological applications in archaeology did. Papadopoulos, Hamilakis and Kyparissi's (2015) digital experiment on the light conditions in a Neolithic building from Koutroulou Magoula sets the tone for an approach that correlated archaeological evidence and sensorial data. In their example, light conditions in the house's interior were generated digitally, based on the house's possible reconstructed form, and light data was grouped and interpreted using light rendering software. In my cave-orientated approach, as I shall present analytically in Chapter 5, light (along with humidity, temperature, and auditory) conditions will be recorded onsite and grouped using the aforementioned Gestalt principles; then they will be interpreted using statistical (R) and spatial (QGIS) analysis software.

A note for an archaeology of feelings

Since the criticism of Tilley's phenomenology and of Shanks' ideas about a research-centred interpretation approach (e.g. Fleming 1999, 2005, 2006; Brück 2005; Hamilton and Whitehouse 2006), all the sensorial approaches in archaeology tend to be counted as "phenomenological" (see Harris and Cipolla 2017, review). Phenomenology in archaeology, is heavily based on Heidegger's ideas about 'being-in the world' - shaping relationships between human beings and objects. That leads to the theoretical norm that everybody experiences the world in different ways (Darvill 2008). In archaeology these ideas became popular in the early 1990s, first introduced by C. Tilley (1994) and involved a process of letting things reveal themselves by experiencing or re-experiencing objects and sites. In other words, a phenomenological approach in archaeology incorporates into the data interpretation the researcher's active perspective about the archaeological evidence. There are several archaeologists around the world, however, who support a "hard data" approach in archaeology (for an overview see Hamilton and Whitehouse 2006) and address a statement close to Wittgenstein's magisterial pronouncement "What we cannot speak about we must pass over in silence" (1922). Even if several archaeologists seem to believe that senses of the past are something that *we cannot speak about*, I stand by Hamilakis' ideas that archaeological senses are something completely different from the current researcher's sensorial perception (Hamiliakis 2013:31). The point that I am arguing for is that we need to find a theoretico-methodological approach in order to locate, record and interpret the sensorial evidence of the past. Current major works, such as those by Skeates, Hamilakis and Mills that have been referred to previously, address this issue. With my palaeo-sensorial reconstruction approach I am attempting to summarise their endeavours and move things a step forward. The discussion is still wide open, however. From any perspective, theoretical, methodological and even technical, there is a long way to go until we can finally archaeologically trace the triggers of Ingold's taskscapes and connect those triggers with the contemporary sensorial approach. My point here is that today, archaeological senses are definitely something that *we can speak about*. And our endeavour to find how *we can speak about* senses has just started.

But are the sensescapes the final frontier of archaeological thought? I believe the answer is a clear "no", because even deeper than the senses, the mediums behind human behaviour and actions, are feelings and emotions (Elster 2000). To date, emotion has been a somewhat marginal topic in archaeology, in part because it has appeared to involve an inaccessible world of subjective experience largely irrelevant to serious questions about social and political life (Tarlow 2000). However, in line with recent contributions (DeMarrais 2011; Foxhall 2012; Harris and Sorensen 2010; Harris and Cipolla 2017; Tarlow 2000, 2012), this study seeks to demonstrate the viability and broader relevance of paying attention to emotion in our efforts to understand the past. Feelings and emotions that are triggered by the senses are shaped through human tasks (Tarlow 2000). In 2013, in a talk at the University of Leicester, Sarah Tarlow stated:

"This talk will consider different approaches to the archaeology of emotion, considering what we can usefully learn from colleagues in other disciplines, and what we could maybe contribute. Some archaeological approaches assume that emotions are universal in humans and are biological phenomena. In other disciplines such approaches have been criticised by those who point out the cultural variability of emotional experience, but given the difficulty of accessing personal human experience in the remote past, are there approaches that archaeologists can usefully make to the subject? […] One way around this dilemma is to advance as the subject of study, social emotional values, rather than personal emotional experience. Another

approach might be to consider how material culture and space were manipulated to lend emotional force to particular moments, places and relationships”. [3]

It is probably not relevant to this thesis to state here all the different approaches on emotion that have been introduced by many psychologists, neuroscientists, sociologists and biologists. There are several relevant reviews available, such as the work of John Elster (2000). But I would like to point out two things that are crucial if we would like to incorporate emotions and feelings into archaeological discussion. Firstly, emotions usually come in “buckets” instead of abstract moods (Tarlow 2000:713). The abstraction and reification of a thing called anger or love or grief sets artificial limits on an experience, which is both variable and complex. Attempts at close definition of emotion or its distinction from associated concepts have only really proliferated in biology-based and functional studies (e.g., Batson’s et.al. 1992 attempt to differentiate between affect, mood, and emotion) and as Tarlow (2000: 714) states are ultimately unconvincing. Secondly, feelings can be seen as an outcome of the emotions instead of another word to describe emotions. As stated by Zeelenberg (et al 2008), emotions are linked with behaviour and decision-making, while feelings are associated with the actions, or simply “feeling is for doing”.

Reading archaeological publications, it would seem that the mental process of decision-making is (or should be) rational: a formal process based on optimizing utility. Rational thinking and decision-making do not leave much room for emotions or feelings. In fact, emotions are often considered irrational occurrences that may distort reasoning. Pfister and Böhm (2008) introduced a framework in order to explain how emotions affect the behaviour and decision-making process (Table 2.1). This framework will be implemented in Chapter 7 where I will discuss possible sensorial-feeling relationships in the context of the Neolithic use of caves.

Function	**Emotion type**	**Prototypes**	**Mechanisms**
Information	Reducible emotions	Joy, (dis)liking	Trade-offs
Speed	Affect-programs	Fear, disgust, sexual lust	Stimulus-specific response
Relevance	Complex discrete	Regret, envy, disappointment	Selective attention,

3

The lecture was held in Lecture Theatre 1 of the Ken Edwards Building, University of Leicester Main Campus, at 5.30pm on Tuesday, February 19. Tarlow’s quotation is based on the handout for the day.

	emotions		appraisal
Commitment	Moral sentiments	Guilt, love, anger	Social co-ordinations, perseverance.

Figure 1 Pfister and Böhm (2008:9) framework of how emotions are linked with behaviour

A supplementary point that needs to be stated is that emotions and feelings, like senses, are perceived differently between cultures and historical periods. Anthropological and historical research on emotion and feeling have presented reasons why emotion should or could be interesting for archaeologists (from Tarlow 2000: 718):

1) Emotion is not natural or precultural. Given that the attribution of emotional states to past people is widespread and inevitable in archaeology, a critical awareness of our assumptions about emotion in the past is necessary.

2) Emotion is absolutely central to human experience and the way society works.

3) Our understanding of volition and motivation requires the incorporation of emotion. Doing justice to people in the past means recognizing that they were complex, feeling, thinking humans and not automata responding to situations in predetermined ways.

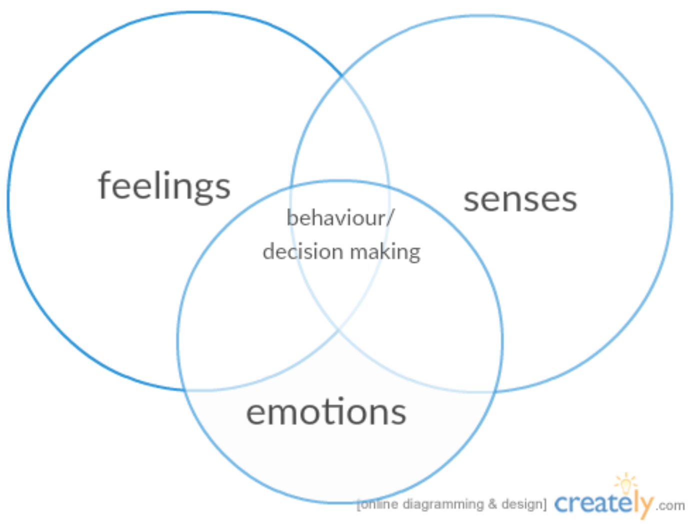
4) Critical awareness of the variability of emotion de-naturalizes some of our present emotional values; this has important political implications.

Continuing in her article, Tarlow presented different archaeological projects or archaeological perspectives that took emotion into account in their interpretations. She particularly examines and discusses Meskell's (1989) research that has tried to "produce archaeologies" which consider emotion, particularly through the consideration of Egyptian mortuary contexts. In particular, she has challenged the widespread assertion that the death of a child, especially in periods of high infant mortality, will provoke little ritual or emotion because child death is common, and children are not full members of society in material terms or in terms of their social roles; society, therefore, is not greatly troubled by their loss (Tarlow 2000: 725).

Merging Tarlow's approach on group emotions in archaeology, Hamilakis' social affect in the sensorial spectrum and Zeelenberg's approach of emotion-is-for-behaviour and feeling-is-for-doing, we can clearly state that social behaviour, decision-making and actions are shaped through cognitive thinking, human interaction, and feeling. Since, as we stated before, senses are something that can potentially be archaeologically investigated and function as archaeological evidence, emotions-feelings that are linked cognitively to the senses can be unearthed as well and they could also be quantified.

The link between senses and emotions has been clearly established by psychologists and neuroscientists over the last 20 years. Our emotional reactions can be guided by sensory information. Just because something looks gross, we may instinctively not like it. Thomson et al (2010) define this as a "conceptual association." In other words, what we sense triggers a feeling. For me, coffee is linked with a sense of energy, positive feelings, and it being essentially a hug in a cup. These associations can be activated by me seeing a cup of coffee, smelling it, hearing a coffee maker, or tasting it. Thomson et al (2010) studied what emotional words were chosen to describe various chocolates. It was found that we associate different emotional words with different sensory qualities. Levels of bitterness, sweetness, creaminess, and even colour impacted the participant's emotional interpretation of what was all just chocolate. Deeper down, our sensory brain areas are involved with emotion too.

Our emotions and sensory cortex can impact one another in both directions. A review by Vuilleumier (2005) explained that emotions provide a boost to our sensory cortices. Neuroimaging showed that in emotional response, our sensory cortices have increased activation. Vuilleumier (2005) hypothesized that this is due to learning from the sensory characteristics of emotional situations. Think about hearing a fire alarm or smelling smoke. These sensory cues mean its time to run (or walk safely to your nearest exit). Similar findings were present in the research of fear memory. Using fear conditioning, Sacco and Sacchetti (2010) found that sensory cortices affect emotional memory. Rats were trained to associate visual, auditory, or olfactory cues with an aversive stimulus. When the respective secondary cortex was subject to lesion, the cues that were previously learned were lost. This means that there is some storage in the secondary sensory cortices when it comes to emotional memory. Unless the ethical standards of human research change – and let's hope they do not – these findings cannot be replicated in humans. More research, perhaps with pre-existing lesions or artificial ones from other methods, would need to be done to see if we can generalize these findings. It is also problematic that neuroscience has not created a proper mechanism that can link senses with emotions and feelings. The lack of this kind of mechanism makes it very difficult for the time being to implement emotions and feelings in archaeological interpretation. However, at a theoretical level of human actions – such as the creation of an object – there are outcomes of collaborative work between our sensorial spectrum, emotions and feelings. And because all these are, to a point, socially and culturally contracted, the outcome – the object – resonates back in order to re-shape our feelings, through our senses (fig. 1). Elaborating on this graph, human decision-making and social behaviour are constructed as a combination of senses, emotions, and feelings. As I stated before, these three components work complementary to each other, feed each other and re-generate the others; but all three together work to create our decision-making behaviour. These are the outcomes of the correlation of feelings – senses – emotions. And these outcomes, expressed by humans in their everyday activities, interact with the natural surroundings and therefore craft Ingold's taskscapes; the outcome feeds back to the human brain, through the senses, and generates feelings first and then emotions, that blend together in order to generate behaviours again.



Taskscapes

Figure 2 Venn diagram showcases the relationship between human behaviour/decision making and tackscapes

Summarizing the discussion about senses, taskscapes seem to be a creation of addressed *sensescapes* or even *feelingscapes*, if we accept the theoretical bond between senses and feelings. In other words, people "feel" the world around them, through their senses. These feelings, according to Zeelenberg, are connected with people's actions. These actions, expressed in a place, transform passive landscapes into active taskscapes. If we accept the aforementioned theories of Hamilakis, Mills, and Skeates about the ways that we can trace senses of the past, the weak point in this logical construction is the correlation of particular sensorial stimuli with particular feelings – and then with particular actions. In this research approach I would like to trace the sensescapes in the Western Balkan Neolithic, trying to understand human relationships with their surroundings, and mainly adapting Zeelenberg's approach of emotion-is-for-behaviour and feeling-is-for-doing to the Pfister and Böhm (2008) mechanism to recreate the narrative of human-landscape interaction in the area, and further it as a research-model approach globally.

2.2 The cave – an overview of the definition

As case studies, my approach will use caves with evidence of human use during the Neolithic, located in the Western Balkans and Greece more: specifically, caves that have been created in the limestone massifs of the Dinaric Alps and Pindos Mountains. Even if I have already stated briefly in the introduction why I chose caves as case studies for my research on human-landscape interaction, I believe, before going through an analytical presentation about caves and their characteristics, that I should state something relevant to the previous discussion about the palaeo-sensorial spectrum reconstruction. Understanding senses as fragmented archaeological evidence, the cave is a capsule-enclosed landscape that keeps sensorial stimuli better preserved than an open-air site. Most of the time, perception of the visual and auditory systems will not have changed dramatically within a cave environment over the 7,000 years that separate us from the Neolithic, since the morphology of the cave will also have changed minimally as a "space" from the Neolithic to today. As we will see in the next paragraphs, the cave environment changes slower than the environment on the surface due to the low water flows, the slow cave depositional process and the equally slow speleogenesis. As I am going to present, caves are a dynamic environment since changes, when they occur, are intense (such as rockfalls or flood episodes) and the conditions are generally extreme (absolute darkness, stable temperature, high humidity) but the general perception of an enclosed, dark and humid environment stays stable when the human activity is usually less affective when compared to open-air sites. In this environment I will attempt to group or to "entrap" the senses using the Gestalt principles and to correlate these with the traditional archaeological evidence.

What is a cave? The anthropological and geomorphological dimensions

The notion of "cave" can be interpreted anthropologically even from its geological definition. According to the brief definition, a cave, in terms of natural geography is "*each natural hollow space on the surface of the earth to whose interior a person can enter*" (Bogli 1978). From the definition one can easily understand that the definition of "cave" has an anthropocentric dimension and hence bears anthropological interest. Once a hollow space is called "cave", it means that people have visited its interior. Hence the anthropological dimension of the cave begins simultaneously with its first visit by human. When, for example, we have several hollow spaces recorded as caves in an area, then automatically we have a number of recordings of human actions (visits to the hollow spaces), which have led to each of these spaces being named as a "cave".

Apart from the anthropocentricity of that brief definition, the detailed geological definition of the cave has a direct relation to the characteristics which determine the use of the cave environment by people. One of the best definitions for caves has been given by I. Ioannou (2000:104):

"Cave. The meaning of the word indicates an underground space naturally formed, of varying size and shape, empty or containing sporadic water, connected to the surface via an orifice-entrance or when it has no exit it becomes recognised after a landslide, erosion etc. or human works. We also consider as caves the cavities that were formed due to the activity of volcanic gases which are trapped in the exuded material, i.e. when, during the contraction of the liquid magma, gases escape which causes cavities-caves to be created. Cavities of significant size in rocks can be formed by wind activity, so-called 'aeolian' caves. Caves can also be created by the transition or undulations of rocks and earthquakes, which are 'tectonic' caves. The fall of huge rocks, especially at the feet of cliffs, creates 'clastic' caves in the space left between them and the cliff […]" [translation by the author]

One thing that arises from Ioannou's definition is the variability in form that caves can take. This variability appears to affect people's use of caves. This particular issue has not yet been specified in archaeological literature to this point (Guy Straus 1990). However, many researchers, across different parts of the world and in different periods, have begun to observe use differentiation of caves based on their geological characteristics (Grube 2012; Heydari 2007; Sampson 2007). We shall return to this point in a more systematic manner later in Chapters 6 and 7.

The variability of caves is real and observable, but it is worth noting that more than 90% of the total number of caves on the planet are formed in limestone and only 10% in other types of rock (Papadopoulou 2007; Veress 2010). Hence the research interest shall focus on limestone caves. Cases of speleogenesis in other rocks are considered rare and are examined as separate cases. In the Balkans this is even more evident as the percentage of caves formed in limestone rocks is almost 98% (Moundrakis 1985).

With regards to the cave environment, the cave, apart from being part of the landscape and natural environment, is also an enclosed, well-defined space, which has distinct characteristics and adheres to specific rules (Bogli 1978). What archaeological research overlooks on occasion is the factor of the enclosed space. Instead it often regards it as being the same as an open-air site. The failure to differentiate the cave as something distinct frequently leads archaeological research in caves to erroneous interpretative approaches (Stratford 2011).

But before we move on to the archaeological dimension of the interior of the cave, it is worth examining the characteristics that form and transform the cave environment. These characteristics relate to geology and biology. Included within the geological term 'cave', as previously noted, are cavities, which vary from the very small to the very large. Indicatively, the depth of a cave may range from 50 centimetres to some kilometres. This very general definition of the cave contains an important error, which may not be significant as far as geological research is concerned, but in the field of archaeology it complicates data and impedes data processing. This error becomes evident in the percentage of light coverage of the space and its influence from external environmental conditions, according to the size of the cave. In short, a very small cavity is generally well-lit during the whole day, and the micro-environmental conditions which would characterize a larger underground space cannot be recreated.

Therefore, it is obviously more convenient for people, although it does not present the natural advantages of the closed underground space (security, low temperature, high moisture, easy control of space, concealment). The need for differentiation produced the, almost experiential, definition of ‘rock shelter’. A rock shelter is either any cavity with a depth of less than ten metres or any cavity whose sides are open (i.e. a cavity created by a rock outcrop) (Goudie 2005). Throughout the present text the term cave shall refer to any natural cavity other than rock shelters. i.e. cavities deeper than ten metres, with at least one one-metre dark zone during the entirety of the day and with all the sides covered by natural rock except, of course, the entrances. As a geological formation, the cave is a “live system” which is governed by the dynamics of the earth and water. Therefore, it also comes under the fields of hydrogeology, geochemistry and tectonics (Bogli 1978).

Geologically, two main processes are taking place within caves, speleogenesis and cave deposition (speleoapothesis) (Farrand 2001). Both affect the depositional and post-depositional process within the space of the cave (Stratford 2011). Speleogenesis refers to the entirety of the physico-chemical and biological phenomena, which cause the creation of the first small cavity in a rock, which evolves into a cave with the procession of time (Giannopoulos 2000:16). Already by 1726 the first speleogenetic theories had begun to be formulated (Giannopoulos 2000:17). The aim of those theories was to provide an explanation for the creation and evolution of the karstic phenomenon: that is, the phenomenon of the corrosion of carbonate rocks.

The existence of a type of corrosion that involves the mixture of waters with varying solubility (Bogli 1964) for the first time offered a solution to the problem of the creation of caves in limestone. All other theories should be studied based on this theory, and also taking into consideration the different space in which each cave lies. In general, one theory cannot explain all the speleogenetic phenomena, given that there are too many factors of different natures, which are not constant in time, and affect karst morphogenesis in a variable way. Some of these factors include the atmosphere, surface vegetation, type of rock, water and others. Of course, in nature things are much more complicated, because, apart from these factors and their changes over time, they also interact between each other, which makes the whole speleogenetic process exceedingly complex (Giannopoulos 2000:17).

The created cavities may be 'blind', i.e. they might not have an entrance on the earth's surface, or they may connect with the surface, in which case we are dealing with caves and cracks in rocks that might be hiding a cave beneath. The speleogenetic process may be delayed or accelerated due to the differentiation in the intensity of parameters, yet it usually continues perpetually (Giannopoulos 2000). As a result, the characteristics which create a cave affect both its use by humans and the post-depositional processes. The rate at which this happens changes in each case. We shall presently examine how significantly the speleogenetic process affects the human depositional process, through the case study of the caves in the region of Kastoria, Greece. In conclusion, with regards to speleogenesis, although the belief that this process affects human uses is common among most archaeologists, its impact has not yet been fully examined (Heydari 2007; Grube 2012).

Cave deposition ensues from speleogenesis. The depositional process in a cave is equally complex and involves many different factors. In biological terms, it is directly linked with the organic material deposited in the cave due to the cave fauna and flora. Archaeologically, deposition is intertwined with the remains of human actions taking place inside the cave. On a geological level, the depositional process involves the different types of sediments which start to be deposited inside the cavity after its initial opening. As a general rule, this process is accelerated as soon as the process of speleogenesis begins to slow down (Giannopoulos 2000). Most important of all the deposition phenomena could be considered the deposition of calcium carbonate which occurs with the dissolution of limestone rocks. Calcium carbonate creates the well-known speleothems.

There are a wide variety of speleothems. The most common types are stalagmites and stalactites, although in cave archaeological research the most important role appears to be played by the 'crust' type flowstones, which can potentially cover entire surfaces, confusing the researchers who think they are working on a surface of natural rock (Stratford 2011). In general, the complexity, the inconsistency and the relationships of sediments are the most important problem in cave archaeological research (Farrand 2001). To sum up, a cave is an exceptionally geologically dynamic space, with high rates of variation compared to other geological environments (Farrand 2001). This variation greatly augments its difficulty as a field of archaeological research.

Discussing further on speleothems, the role and the impact they might have had on human–cave interaction are underdeveloped and understudied. Ethnoarchaeological work provides evidence that people, particularly when they are using a cave for cult or religious purposes, pay attention to stalagmite formations and use them as part of their activities (e.g. Andreassen et al 2009; Ishihara-Brito and Guerra 2012; Trimmis 2015b; Woodfill 2014). As an example, caves that are used as Catholic chapels in Guatemala and Mexico have stalagmite columns as places to hang crucifixes or stalagmites as altars (Ishihara-Brito and Guerra 2012; Woodfill 2014). In Kythera Island, Greece, gours where dripping water is collected have been characterized as sacred by locals and were previously used as sites for baptisms (Trimmis 2015b). In terms of archaeological thought, particularly for the period of study – the Neolithic – we do not have this kind of information. Limited information on the impact that speleothems had on cave use can be gathered from research into cult caves of Classical antiquity (Mavridis and Tae Jensen 2013).

As a biological space, the cave is a distinct microenvironment with stable and distinct characteristics. The main environmental characteristics of a cave are the absolute or almost absolute darkness of its interior, the minor temperature fluctuations depending on the season and high humidity (Coulver & Pipan 2009). These factors aid the development of specific fauna and flora, called troglofauna. Cave fauna falls into three broad categories: the trogloxene, the troglophile and the troglobite species (Coulver & Pipan 2009). Trogloxenes are species which live outside the cave but visit it for a specific purpose. Humans are considered trogloxene. Troglophiles are species which split their life between the cave and the exterior. One characteristic species are bats, which roost in the caves but feed outside of them. Troglobites are species which spend their entire life in the interior of the cave, usually in the dark zone. Due to the lack of light they are usually white or transparent and with restricted vision or are fully blind. One of the best known troglobites is the salamander *Proteus Anguinus*, found mostly in the caves of Dalmatia and Slovenia.

The cave fauna species affect the human uses in their own way and the post-depositional process. A characteristic example are the guano concentrations arising from bats, which, due to nitrogen osmosis, post-depositionally corrode and destroy ceramic materials and the potential clay constructions that may lie in a cave (Shahack-Gross *et al* 2004). The guano depositions and the bat populations within a cave also appear to affect the depositional process, although we do not have solid indications for that (Shahack-Gross *et al* 2004). However, there are recorded ethnographical examples of shepherds avoiding the bat-populated areas of caves, both due to superstition and out of fear that their animals might consume guano and get diseases.[4]

Intense taphonomic conditions that can be observed in caves are a result of all the aforementioned factors that create the distinct depositional environment and sediments that can be found in caves. Sediments can be of very different origins, clastic sediments derived from the collapse of cavern roofs, sediments transported into the cave by superficial and underground streams or accumulated under sinkholes, chemical deposition of minerals, like the previously mentioned speleothems, and sediments resulting from the accumulation of organic matter – biological factors – like the, also mentioned, guano (Bressan 2010).

In contrast to the taphonomy of the open-air sites, caves are, however, very stable environments - the transport of sediments in conduit systems is episodic with abrupt storm flow and little or no movement during low flow conditions (Bressan 2010; Coles et al 1989). Carcasses and bones can thus be transported into the cave by sudden flood events or mudflows and become accumulated during phases of decreased flow. As an example, two skeletons of *Australopithecus sediba*, described in April 2010, were discovered in a massive, up to 1.5m thick, stratigraphic unit filling a cave in the karst landscape of South Africa. The heterogeneity in the sediment-grains, ranging from sand to pebbles to larger boulders, and lacking sedimentary structures (like stratification), suggested the deposition of this unit as a single event, like a debris flow, maybe caused by a flood or a storm. The superb preservation and state of articulation of the fossil material also indicate rapid deposition, limited transport distance, and laminar flow conditions consistent with a debris flow (Bressan and Palma 2010).

Thus, taphonomic conditions in the dynamic microenvironment of a cave can be intense, but caves have characteristics that offer some advantages regarding the spatial analysis of datasets, such as the low water flows, the slow sediment depositional process and the minimal sediment alteration by anthropogenic and natural factors: compared to a site that has been, for example, cultivated, or used for animal grazing, or transformed into a cesspool.

4

These practices were recorded in two areas of the mountainous part of Crete, Greece, Malaki in Rethymno and Psarri Koryfi in Chania, where modern shepherds using the caves provided the information to members of the campaigns of the Hellenic Speleological Society, Malaki 2008 and Psarri 2009. The results of the ethnographic research in these areas are in progress.

Concluding the brief examination of the cave as a distinct, enclosed space with specific characteristics, it is worth exploring how this has been perceived in the past, and is still perceived, by humans. The absolute or almost absolute darkness in the interior of caves, the intense humidity, steady temperature, dripping, speleothems, as well as the uncommon fauna and flora of the cave, appear to affect humans and the way that cave space has been perceived (David 2004). Therefore, for humans, the cave acquires a transcendental meaning, as something outside and beyond the ordinary world that surrounds us, which promotes it as a space of ideological expression (Ustinova 2009). This is a diachronic and intercultural trait, stretching from Palaeolithic cave art to the sacred *cenote* of the Mayas, and from the Minoan cave sanctuaries to Byzantine hermitages and chapels[5].

Nevertheless, humans do not perceive the cave solely as a space of ideological expression. On the contrary, the need to secure specific goods that lie in its interior (e.g. water), as well as the desire to exploit its natural characteristics (such as humidity, darkness, stable temperature) lead humans to the interior of the cave, so they can use it for their practical needs (such as storage, stabling, refuge) (Bergsvik and Skeates 2011; Tomkins 2009). To finish, we can draw the conclusion that the cave as a place, with specific and distinct characteristics, is on the one hand used by humans, but it also affects this use itself. It is transformed by humans but it also transforms the characteristics of human actions. That is, a dynamic interaction arises, which requires a full examination of the concept of 'cave' in order to be interpreted.

Caves as case studies for landscape archaeology

Interaction between people and their surroundings has been studied using various case studies, from big monuments to large settlements and from big regional projects to small-scale excavations. Hamilakis (2013: 64) discusses the possibility of investigating the relationship between societies and the surrounding environment using as case studies social activities such as feasting and communal consumption/production of goods.

Caves in a local or regional setting have not commonly been used as case studies in investigating human-landscape interactions (see also Dowd 2016). Caves

5 In Dowd and Hensey: "The Archaeology of Darkness" (2016) a fair amount of the volume is dedicated to this discussion.

are usually considered as “enclosed” spaces with specific micro-environmental characteristics (Bergsvik and Skeates 2011). Mlekuž (2012) pointed out that caves are part of the landscape and are also an “enclosed” internal landscape themselves. Elaborating on Mlekuž’s idea, caves could be considered as monumental parts of the landscape, especially caves that have large entrances and overlook particular areas, such as Franchthi in Argolida (Gr) and Uzzo in Trapani (It), On the other hand, cave interiors are a ‘kind of’ landscape, which surround human actions. Moyes (2002) discusses the idea of an ‘enclosed’ landscape as well, supporting the idea that artefact distribution in caves could actually be studied in the same way that archaeologists investigate distributions in open air sites.

The idea of the cave as an enclosed landscape with certain characteristics, influenced D. Mlekuž (2012) in his “Notes from the Underground” to discuss “affordances of caves” and caves as enclosed places containing human and animal lives, having as case studies Neolithic cave sites of the Northwestern Balkans. The word “affordance” was coined in 1966 by the psychologist James G. Gibson (1966). It designates the possibilities afforded by a feature of the environment for particular uses by living creatures (trees afford nesting and roosting for birds, climbing and foraging for squirrels). Or in other words, “affordance” is what the environment offers the individual. In the human ecology, such uses proliferate because of the cognitive fluidity, the capacity for improvisation that constitutes the human evolutionary niche. Humans make tools, weapons, instruments of all kinds that help them to extend their reach into and control over the environment, including not only material instruments, but also ‘mental’ ones (language, concepts). The notion of affordance thus shares ground with ‘extended mind’ or ‘distributed cognition’, while avoiding the philosophical problems that arise with those expressions.

Even if Mlekuž’s ideas will be expanded upon further when evidence from the thesis case studies will be incorporated into the next chapters, his conclusions mark caves as active non-natural environments, where activities happening in caves should be connected with activities happening elsewhere (Mlekuž 2012: 208).

In Mlekuž’s theoretical sphere are the affordances provided by caves which contextualise the role that the caves themselves had for the lives of past people (Mlekuž 2012: 208). Elaborating on this idea, Mlekuž suggests that, by focusing on the affordances that caves provide, we can understand caves in terms of material culture where different forms of dwelling occur. By focusing on the process of dwelling they help us to challenge any dichotomies of the “natural and the cultural” or of the “profane and the sacred”. Following Mlekuž’s thought, caves provide affordances to people who engage with them and they also “act back” to people (Mlekuž 2012: 209). These affordances of a cave are shaped to a great extent by the natural environment of the cave. This thesis is exploring the impact that environment has on shaping each caves affordance and attempts to discuss further how these affordances may have influenced human activities.

Within Mlekuž’s theoretical sphere, caves are active and have their own biographies with human and non-human components (Mlekuž 2012: 209). He also briefly discusses the difference between caves and rockshelters as dwelling places, though without elaborating further on that (Mlekuž 2012:209). Particularly when discussing cave biographies with natural and anthropogenic components, almost at the same time as Mlekuž (2012), Mavridis and Tae Jensen (2013) present their own perception on how the biography of a cave should be investigated, taking into account the wider landscape and the general socioeconomic context of each period. Again, even if in theoretical discussion the natural microenvironment of a cave counts as an important factor that impacts the human activities inside caves, I believe that in field research it is highly underestimated (as I have discussed in the previous chapter) with minimal field applications scattered around the globe. This thesis will try to put the cave’s microenvironment and sensorial spectrum at the core of the analysis as an equal factor impacting the human use of caves.

Taking the aforementioned theories into account, caves’ interiors host people’s actions in an enclosed space with very distinct characteristics, such as darkness, speleothems, high humidity, stable temperature and dripping water. In the terms of Tilley’s (1994) and Ingold’s (1993; 2000) theoretical perspectives about powerful environments that shape people’s actions, caves are the most powerful of them all. Geomorphology, in the form of speleogenesis and speleoapothesis, is the medium that creates the dynamics in caves.

Concluding Chapter 2, caves matter for archaeology for one main reason; they host a variety of human activities that cover the whole spectrum from economic to ritual/cult. From the deepest events of human prehistory to modern times, caves have been used for ideological expression, cult, religion, burial, pen herding, storage, shelter, dwelling, craft production, industrial based production, tourism (Speleotourism/Caving), meditation and medication places (Speleotherapy), mining, quarrying, water sources and even as nightclubs, restaurants or theatres (e.g. Trimmis 2015a,b). Even if we have the knowledge and can index the way that people have used caves throughout time, we do not know exactly "why". All these activities are hosted in several other places and spaces overground during the same periods that people were going underground and using caves. Is it the convenience of an already constructed/protected closed space that can be easily managed? Or is it the superstition that the underground space creates in human minds (see also Ustinova 2009)? To reverse the question, the query of "who" is the cave user emerges. Referring back to the introduction, only correlated examination of this communication between the space (cave) and the person (human) can help to delineate both the relationship that the space and person had, and also examine how this relationship has been built in the past – and beyond.

Chapter 3

How do we record data in cave archaeological sites? A literature review and the missing parts.

Summary

Chapter 3 is extensively presenting the different approaches and methods that have been applied to the archaeological research of caves to date. The first part of the chapter covers the theoretical frameworks of how archaeological research in caves can be applied in an inclusive way, when the second part of the chapter is dealing with the theories that have been proposed for the better understanding and interpretation of the cave use strategies. Chapter 3 concludes with a summary of both methods and theories and showcases parts that have not been covered to date and this research aims to bring forward.

3.1 Introduction

As has been presented in the previous chapter, caves, due to their geomorphological and taphonomic conditions, are always challenging environments for archaeological research. Pengelly in his 1858 first excavation at Kents Cavern in England, first realised the problem and offered a solution (McFarlane and Lundberg 2005). As Pengelly (et al 1873: 482 – cited in McFarlane and Lundberg 2005) wrote: "*…The more effectually to guard against the chance of error, the materials were first carefully examined in situ, after which they were taken at once outside the cavern, where they underwent a further inspection. In no instance were they removed, for even temporary convenience, from one part of the cavern to another. Whenever a bone or other article worthy of preservation was found, its situation (that is to say, its distance from the mouth or entrance of the gallery in which it occurred, as well as its depth below the surface of the bed in which it lay) was carefully determined by actual measurement….".* Previously during his excavations in Brixham cave, Pengelly had developed a system to relate the origin of each fossil or artefact to its horizontal position along the length of the relevant gallery, and to its vertical level (McFarlane and Lundberg 2005: 40). Later in Kents Cavern Pengelly developed his system more, by introducing his still famous “prisms”: excavation blocks with certain dimensions (1 yardx1ftx1ft). Knowing the position of each block he could eventually locate every fossil or artefact accurately.

Since Pengelly’s times a lot has changed in the way archaeology is done in the field, except for the main idea that we need to know the exact location of every find, feature and, in the case of this thesis, sensorial stimuli. It is interesting that the birthplace of a “scientific” approach to archaeological fieldwork was a cave. In my view I believe this is equally an outcome of Pengelly’s perception on how archaeology should be done and also of the challenges that caves offer as archaeological contexts.

Gradually, archaeologists understood the taphonomic challenges that caves have (see Farrand 2001), and they also began to understand that a cave’s interior is not a single unified context but more of a confined micro-landscape, thus field cave archaeology techniques started to be developed with the aim of enabling better management of archaeological practice in caves and of getting a better understanding of the cave as a part of the archaeological evidence (see also Moyes 2002; Trimmis 2013).

In this chapter I will present the most recent research discoveries for how archaeological recording should be undertaken in caves and what theories archaeologists implement in order to interpret the use of a cave site. The missing parts will be highlighted, so that later, in Chapter 5, it shall be easier to discuss a proposed methodology that aims to fill these gaps.

3.2 Archaeological research in caves: the current knowhow

Archaeological recording strategies for cave sites have not been developed to address questions related to the nature of caves as a part of archaeological evidence. The absence of Cave Archaeology manuals in the literature makes it very difficult for a standardised methodology to be developed. Equally, there are no available guidelines from archaeological recording in caves, neither in South East Europe nor the UK and the West. However, the idea that an excavator needs at least two trenches in different parts of a cave to gain better understanding of the spatial arrangements in the interior, demonstrates that archaeologists understand that caves are microenvironments where certain dynamics develop.

This understanding, of the impact that a cave's microenvironment has on archaeology, is quite clear in the way that archaeologists approach cave contexts today. As examples, Pettitt (2016) and Skeates (2016) discuss light as being an important factor for cave research, while Dinnis et al (2010) in British caves and Heydari (2007) in Iran discuss the impact that cave geomorphology may have on cave research. Till (2014) records soundscapes in Palaeolithic caves in Northern Spain and showcases sound and acoustics as important factors. Gkioni (2005), in relatively unknown research, shows that the climate and the environment of the wider area of a cave might affect the character of the cave's usage and demonstrates the need for caves to be investigated in the context of their landscapes. Gkioni also suggests that a paleoenvironmental study of a cave and the surrounding area should be an important part of any research design in an archaeological cave site. Moyes (2002) acknowledges the importance that speleoapothesis (speleothems, crusts etc) might have on the way that people used the cave space. As a last example, Mavridis and Tae Jensen (2013) note the phenomenon in Crete where it is the dark, humid, confined, and cold caves in an area that have evidence of human use, while other more "suitable" sites for humans are avoided, and they conclude that the cave as a natural space may affect the way that people decided to use it.

The aforementioned approaches, even if they recognise the importance that the cave microenvironment may have on how caves were used, do not present a methodological approach for how we can incorporate these factors into a research design. Also, they tend to focus on one factor (light, sound, climate, or speleothems) and not on all the factors together as a force that drives and shapes human use of caves. I believe there are several reasons for this, but most importantly, to my understanding, is the absence in the literature of a standardised framework for how we should – as cave archaeologists – conduct research in a cave environment that will incorporate all – or at least a majority – of these micro-environmental factors into the research design.

Equally with cave excavation, in the literature to date there is no clear methodological framework for how we should undertake an archaeological survey/evaluation of archaeological cave sites and record artefacts, features, and sensorial spectrum in situ. Cave archaeologists, during research in cave sites, have to deal with issues of low ceilings and narrow passages, confined spaces with finds, darkness, high humidity, dust, and cave bioturbation factors such as stalagmite crusts, guano deposits and so on. These factors are not just methodological drawbacks, but as Moyes and Awe (1998) have pointed out, they have a severe impact on the physical and mental capabilities of the team members – such as claustrophobia, tiredness, and disorientation.

A second issue in cave archaeological surveys is the spatial recording of the surface finds and features. In caves, Global Positioning Systems (GPS) cannot operate due to the lack of satellite coverage. Geodetic Stations (GS) are also difficult to operate due to the narrow passages, high humidity, live water flows and also the need for constant moving of the station so as to keep up with the team. As in open-air site surveys, GS are not really suitable as recording teams move quickly from one area to another and the GS needs time to be recalibrated accurately at a new position. To the account of the GS's disadvantages we should add the operational cost and the bulk of the equipment that makes it difficult to be transported.

Prospection across large areas to identify caves with archaeological potential is also missing a standardized framework. Holderness et al (2006) propose a standardized framework for field archaeological prospection for caves in the Peak District and Yorkshire Dales areas in the UK. Their protocol records the cave location, setting, geomorphology, deposits, conservation status and the presence or absence of archaeological finds in a standardized form. However, the locations of the finds are not annotated. Dinnis et al (2010) suggest a methodological approach that assesses the deposits of the cave sites and evaluates their archaeological potential. As an example, for the Dinnis et al approach thick, undisturbed by bioturbation, flat, deposits have a higher potentiality to bear archaeological evidence compared to thin, "washed" deposits with high bioturbation factors (e.g. water-flows, guano). My previous research in Kastoria prefecture and Kythera and Santorini islands (2013, 2015, 2018), took advantage of the taphonomic status of the majority of the Greek caves – low bioturbation, minimal water flow, and the presence of surface finds – and recorded the archaeological evidence that could be spotted in situ without having to move or to collect any artefacts (such as surface pottery or standing structures) using Heeb's DistoX paperless mapping methodology. Heeb's technique uses a retrofitted Leica distance metre that incorporates a digital compass/clinometer (DistoX2, the current model), which sends the measurements using Bluetooth to a PDA computer, which runs the PocketTopo software. Thus, the researcher can collect the data and draw the basic map inside the cave in real time (see Chapter 4 for an analytical presentation of Heeb's technique and how it can be applied in Archaeology).

In Brady's (2012) edited volume on Mayan ritual cave use, three papers present cave survey research (Domenici and Pongetti 2012: 29-50; Ishihara-Brito and Guerra 2012: 51-60; Moyes 2012:95-110), but none of them present how they undertook the survey and how they recorded the location of the find concentrations. However, Domenici and Pongetti (2012: 36 37) present an application of GIS and -photogrammetry that correlates find locations and types with the cave's elements – such as stalagmite formations and water pools. Moyes (2002) in a similar application used cluster analysis in ArcInfo to analyse the relative location of artefact clusters to features in a Maya cave. Again, even if Moyes acknowledges the need for "*a high level of accuracy in mapping and analysis*" (2002: 10) she did not present a "know-how", a methodology, of how this can be achieved in a cave environment, but she proceeds with how GIS and spatial analysis can work in a cave environment.

Gkioni (2005), whose ideas about paleoenvironment and cave use are presented previously, wrote a methodological PhD on how archaeologists should undertake research that targets a cave's paleoenvironments. For Gkioni, caves need to be researched in their local geographical context. Even if Gkioni did not do any palynological or isotope analysis on speleothems and cave deposits, her methodological framework of paleoenvironmental research, based on archaeological finds, the climate record from the speleothems and the landscape position of the cave – altitude, entrance orientation, proximity to water sources – is sound and can be adapted to different cases. Gkioni uses GIS applications for the reconstruction of the wider landscape's paleoenvironment but she does not perform any survey inside the caves. Thus, her PhD does not offer both microenvironmental and intra-site spatial analysis. What Gkioni's model is also missing is the recording of the sensorial stimuli that might affect human decision making (as has been presented in the previous chapter); thus, there is no recording of acoustics, light, humidity, temperature, water and air-flows and, why not, kinaesthetic elements in the general context of a cave.

O'Connor et al (2017) acknowledge the importance of speleothems and cave breccias for the archaeological context of a cave and, using caves from Papua New Guinea, demonstrate how cave archaeological research should investigate these factors. However, their paper neither incorporates any guidelines on how the recording of speleothems and breccias should take place in an archaeological context nor correlates these factors with any sensorial or micro-climate factors that equally affect cave use.

In recent years Laser Scanners (LS) and Dense Stereo Matching (DSM) cloud 3D photogrammetric applications have become increasingly popular in cave archaeology just as they have in open-air sites (see Galeazzi et al 2014 for an overview). Applications of 3D photogrammetry in cave archaeology will be presented in both Chapter 4 in this thesis and also in Chapter 8, when my application of 3D photogrammetry in the excavation of the cave at Mala Pećina's will be analysed. In short, previous applications of DSM photogrammetry in the Las Cuevas cave site (Belize) that were conducted to compare both the accuracy and density reliability in cave environments between LS and DSM, demonstrated that DSM is the most economical, portable, and fine approach for the 3D documentation of archaeological cave sites (see Galeazzi et al 2014). In fact, DSM allows the 3D documentation process to be done more efficiently, reducing both data acquisition and processing time. Galeazzi et al focused only on using DSM for recording features in cave sites, while in Mala Pećina, as will be presented analytically in Chapter 8, I used DSM photogrammetry to record the morphology of the cave and to later correlate the environmental data. However, as the authors pointed out, and as will be presented later from my experiment in Mala Pećina, DSM photogrammetry in caves carries huge technical challenges mainly with regards to achieving proper and consistent lighting of the cave environment.

Finally, Till (2014) for the "Songs of the Caves" research project, which explores to "what extent it is possible to confirm the existence of a relationship between visual imagery and acoustic phenomena" in the Palaeolithic caves of northern Spain, proposes a sound methodological approach for archaeoacoustic research in caves. Till's approach takes into account factors such as cave shape and geomorphology but the "Songs of the Caves" project did not incorporate any of the other aforementioned cave "assets" such as humidity, luminence, orientation or altitude.

What is common between all these approaches is that they all focus their methodological approach on the recording of a single factor without taking into account the others. Thus Till, creates a strong coherent methodology, using cutting-edge technology for recording acoustics, but pays minimal attention to incorporating the other microenvironmental factors into his analysis. Similarly, Moyes and O'Connor acknowledge the importance of GIS in the intra-site spatial research of the caves, though leaving aspects of light distribution, acoustics, or climatic data out of the equation.

3.3 Interpreting the use of caves: different frameworks – same ideas

As a follow-up to the presentation of recording methodologies in archaeological cave sites, I am going to present how archaeologists interpret cave use practices and the relationship that humans build with the cave space. In this overview, only recent cave interpretation theories will be included, particularly theories that incorporate cave sensorial and microenvironmental factors into their development.

In this respect, caves and other natural sites are not different from any other monuments or human built environments (Barnatt and Edmonds 2002). Such an approach to the meaning of space is usually ignored, as the relationship between people and landscape is commonly influenced by positivist views; sites are mapped and measured as mere dots, while other qualities of the space remain completely untouched. Similarly, in caves, little attention is given to the qualities of the cave space that have been presented earlier – namely temperature, luminence, humidity – and how these affect the cave use.

Traditional approaches regard landscape in terms of demography, social interaction, economic resources, risk, land use, and topography (Brück and Goodman 1999, 7). In these approaches, the study of sites such as caves is very significant, as it indicates population movement in and between loci (Knapp and Ashmore 1999, 2). In the context of the Balkans, research by Trantalidou et al (2011) discusses the role that caves had for the MN groups in the Southwestern Balkans and Greece. After the examination of 26 caves in Greece and Albania, the authors summarize their outcomes in six main points (Trantalidou et al 2011:316): 1) All caves in the sample were marginal and peripheral to main village settlements; 2) The majority of the caves have been used for temporal/seasonal pastoral activities (pen herding, milking) and artefacts were usually manufactured elsewhere; 3) Hearth debris was present in all sites with different configurations: a. scatters of ash and charcoal; b. stone-lined hearths; c. ovens: e.g. at Alepotrypa in the Peloponnese. There is no demonstration of any relation between the length of occupation and the type of hearth. The number of hearths depends on whether the occupying group re-uses structures existing from previous occupants of the cave (e.g. at Piges of Angitis); 4) Sleeping arrangements could have been lodged (e.g. lateral niches at Alepotrypa; eventually by the wall of the cave at Koromilia). 5) Refuse disposal: No special concentration is referred to in the literature. Large numbers of bone fragments are discarded at random around the floors of the caves. At Angitis bones were found adjacent to the hearths. At Koromilia objects come up in small pits near the walls of the cave or the dry stones wall; 6) Activity areas based on the spatial distribution of finds have been found rarely. Alepotrypa gives the impression of being a rare example.

Trantalidou et al's research is highly significant as a description of the cave use strategies in the Neolithic Balkans and offers important points for discussion about the role of caves for Neolithic societies. However, the assessment offers only limited evidence on why people use these caves, how important caves were for them and their societies and which decision-making strategies were involved in the selection and utilization of these cave sites. Even in the case of the simple description, that Trantalidou et al (2011) achieve we still get only minimal information about why the aspects which are presented in the conclusion points emerge; for example, why activity areas are rarely found in the caves or why the sleeping arrangements or the hearths are found in certain areas of the caves.

Bergsvik and Skeates (2011) in the closing paragraph of the introduction of their edited volume suggest precisely that only a contextual approach for archaeological caves can actually help to interpret cave use. Their contextual approach incorporates ideas of chronological, intra- and inter-site spatial contexts, connectivity between people, caves and landscapes. They support an idea for a "more inclusive and sophisticated consideration of caves, and their sheltered contents (2011: 8).

Montello and Moyes (2012:394) in their interpretational framework focus particularly on the dark zone of the caves and discuss, based on previous correlations between environmental studies and cognitive psychology, how the marginal micro-environmental characteristics of the dark zones can alter human behaviour. As they suggest, "when taken to the extreme, the reduction in sensory stimulation found in many cave sites provides some of the conditions similar to isolation experiments. Especially in the remote dark zones of many caves, there is little or no light, sound or air movement. One may also be alone, lacking communication or social contact with others. Such conditions have been shown to produce a characteristic set of symptoms to accompany this sensory deprivation. For brief periods, sensory deprivation can produce relaxation and introspection, like a meditative state. For longer periods, it can lead to more radical psychological states, including delusion, hallucination, anxiety, increased suggestibility, or a variety of cognitive deficits such as memory loss" (Montello and Moyes 2012: 394). Either for a brief or a longer stay period, Montello and Moyes suggest that people could deliberately visit the dark zones in order to experience these situations. Further on the dark zone use of caves, Pettitt (2016) suggests that dark zones – as mentioned earlier – could offer a setting for performativity. A dark place under artificial light constantly changes forms. The shadows that prehistoric lamps created on the caves' walls generate illusions that could have altered people's feelings about a particular event.

Barker and Lloyd Smith (2012), on the other hand, suggest that cave sites used for profane purposes, tend to be relatively open and, in some cases, cave mouths may be quite large, well lit, and have open access so that they were not likely to entrap their inhabitants. Following the aforementioned model of Montello and Moyes (2012:393), ideas about environmental aesthetics such as the savannah hypothesis, prospect-refuge theory, and permeability theory all suggest that humans will feel safer in open, well-lit environments or in environments in which they may view the surrounding area without being seen.

Mlekuž (2012) in his "Notes from the Underground" about the Neolithic cave sites of the north-western Balkans discusses affordances of caves and caves as enclosed places containing human and animal lives. His conclusions mark caves as active non-natural environments, where activities that happened in caves should relate to activities that happened elsewhere – in a similar perspective to that previously mentioned by Mavridis and Tae Jensen (Mlekuž 2012: 208). Caves, for Mlekuž, are active and have their own biographies with human and non-human components (Mlekuž 2012: 209). He also briefly discusses the difference between caves and rock shelters as dwelling places, though without elaborating further on that (Mlekuž 2012:209).

Other frameworks for understanding decision-making and cave use are based mainly in archaeological ethnographic works that follow similar patterns globally. Archaeological ethnographic research on the modern use of caves can highlight the importance that caves have for local groups and what place they have in their lives – how they perceive and subsequently interact with cave space. Even if a direct analogy with the past is difficult to make, what can be observed is that people do indeed pay attention to the geomorphological characteristics of caves before they use and engage with the cave space. In an archaeological ethnographic research in Pelion mountain in Greece, Andreasen et al (2017) record 12 "categories" of modern use of caves: a) Dwelling: long-term occupation, one or more individuals b) Short-term shelter: during poor weather, overnight, c) Agropastoral: animal pen d) Storage e) Refuge f) Quarantine g) Mining/quarrying h) Spiritual: cave chapels, dwelling-place for hermits, i) Burial ground: human bones, grave offerings j) Shooting cover/hunting stand, k) Leisure: sight-seeing, caving, recreation, children's playground, and l) Research: archaeological, speleological and zoological interest, long-term. What stands out from Andreasen's survey is that there is no significant overlap between uses. This means that once a cave is used as an animal pen, it is not simultaneously used as a storage or spiritual site. However, in a cave's biography an animal pen cave can later be used as a storage site. The available information from the Mount Pelion caves project (see Andreasen et al 2017), shows that caves are indeed marginal sites of settlements, lying on the periphery of a main settlement's catchment area, but at the same time they are also sites in the centre of people's lives. Locals have extensive knowledge about the caves and what each cave can "offer" to them – what affordances each cave carries in Mlekuž's language. What has also been shown from an ethnographic overview in the caves of Kythera island (see Trimmis 2015a, 2015b), is that these affordances are also shaping people's perceptions about caves and the landscape – caves with water for example are usually perceived as "sacred" spaces and the water as "Holy".

Away from Europe and the Balkans, Murty in South India (see Murty 1985) observes similar patterns in the modern use of caves, where locals select caves to use based on the characteristics the cave has – mainly the location in the landscape and their relationship with open-air settlements. In similar ethnoarchaeological research in Guatemala, Ishihara-Brito and Guerra (2012: 51) base their interpretation of cave use on the cultural material and spatial arrangements inside the caves. In Ishihara-Brito and Guerra's framework, cave geomorphology can reveal the rational aspects of cave use. For example, in the area where the research was performed caves are used mainly for superficial cults and places to communicate with ancestors. The project's caves with evidence of cult are mainly narrow tunnels or deep rock shelters, with considerable presence of water – similar to Trimmis' (2015a) remarks on modern cult caves in Kythera, Greece. Again, in Guatemala, as in Kythera, Pelion, and South India, caves are important monumental parts of the landscapes; even though they may be marginal to the main villages or towns, their presence is strong in local knowledge and important to the local people's lives.

Moyes' and Stone's chapters (2012) in Brady's volume on ritual cave use in Mesoamerica offer insights into the interrelationship between artefact distribution and cave morphology. As Brady notes in the volume's introduction (2010: 9), these ideas are not new and can be dated back to the 1980s, when cave morphology had been taken into account in order to interpret use patterns in Mayan caves. Stone (2010) uses cognitive models to propose the intentional ordering of cave-spaces as a critical element in the structuring of ritual activities. In other words, Mayans took cave morphology into account during their decision-making process for selecting underground spaces for ritual use. For Stone this is rational thinking that incorporates the cave shape, orientation, the speleothems, and the water presence. For Moyes (2010), the spatial distribution of finds in a cave correlated with cave morphology can produce archaeological "signatures". According to Moyes – as had previously been supported in Stone's chapter – the repetitive characteristics of ritual behaviours are present in caves with certain morphology and characteristics – namely long tunnels following big chambers where water is present.

Reading Brady's (2010:9) assertion that the ideas of including cave morphology in the interpretation of cave use are not new, I began an endeavour to find previously applied frameworks. The most complete to date comes from Australia and a cave in New South Wales and it was part of a student dissertation (Theunissen 1996). Theunissen used GIS to correlate cave topography with artefact clusters to identify the spatial distribution of stone tools at Petzkes cave. In his GIS analysis he incorporated the ceiling high above the stone tool clusters. His research confirmed that the horizontal displacement of artefacts was greater in areas of the cave with a high ceiling.

All these different frameworks are actually based on the same ideas, that caves are monumental parts of the landscape and must be studied as such and that caves have characteristics that people not only utilize for their needs, but these characteristics also play a vital role in the way that people interact with the cave space. Even if researchers share these ideas, there is an absence from the literature of a methodological framework for how the “inclusive and sophisticated consideration of caves” (Bergsvik and Skeates 2011:8) can be achieved.

3.4 What affects the cave use phenomenon? The role of this thesis and the missing parts.

As a summary, from the current research there are five main factors that affect the character of the human use of caves diachronically from prehistory to the modern day:

a) The geomorphology of the cave itself: a stable monumental feature on the landscape, a space that is open and confined simultaneously; an enclosed micro-landscape with certain limits, which can be variable, with air and water flows, small passages, large chambers, wide or narrow entrances.

b) The caves taphonomic situation: even if cave shape and space in many sites are very similar to how they were in prehistory, ground taphonomic conditions in caves can be harsh due to bioturbation and speloapothesis. In most of the sites, though the taphonomy may indeed be complex, the stratigraphic conditions are better than most open-air sites, where archaeological strata are impacted by erosion, alluvial and colluvial depositions, and modern anthropogenic activities – such as farming or building (see also Farrand 2001).

c) Cave microclimate: the most stable of the factors from antiquity to the present day: cave humidity, temperature, air-pressure, and luminence, are less investigated by archaeologists, even if light and its impact on the sensorial perception of caves are increasingly part of the archaeological discussion.

d) Cave acoustics: as caves are an enclosed space, with areas isolated from the outside world, very distinctive and interesting soundscapes can be created. These can vary from the sounds that caves produce – water dripping, airflows through small passages, the flight of bats or sounds from other animals – to the sounds that people produce inside caves and the experience of the sound effects that the cave space and the rock/speleothem structures produce.

e) Location of the cave in the wider landscape: caves cannot be interpreted outside of their wider context. A landscape analysis and archaeological survey of a cave’s wider environment should be part of any study that would seek to identify the role that the cave had for a regional or local group of people.

These factors might have had different weight for human decision-making through different periods. For example, acoustics and light (if we combine the approach in Till 2014 and Pettitt 2016) might have been more important than cave shape or entrance orientation in the Palaeolithic caves of Northern Spain. Equally, the location of the cave in the wider landscape and cave geomorphology may have a larger impact than acoustics for the cave sanctuaries of Classical Greece (see Mavridis and Tae Jensen 2013). However, as an outcome of the presentation of the recording methodologies and interpretation frameworks for archaeological caves, two things emerge that would seem to be missing from the archaeological discussion: a) a standardized methodology for the recording and surveying of archaeological cave sites that will incorporate a cave's geomorphology and microenvironment and b) a theoretical framework that will understand and interpret the diachronic and global phenomenon of cave use, taking into account the monumentality of the cave space and its distinct micro-environmental characteristics. This PhD thesis will focus more on (a), the development and subsequent proposal of a methodology that will undertake an "inclusive" or "holistic" cave survey. Acknowledging the aforementioned research attempts, I am committed to demonstrating that a step-by-step, cave archaeological survey using a standardized methodology can be implemented with the highest accuracy and representation of the archaeological evidence, along with the simultaneous incorporation into the survey of the micro-environmental, geomorphological and sensorial factors that affect the cave use phenomenon. A detailed presentation of this approach will follow in the next chapter. The second need, (b) for a theoretical framework, I believe requires a different, separate, PhD thesis in order to be addressed. Here in the context of the Balkan Neolithic caves I will only gently touch upon frameworks that can incorporate the geosophical approach that I will introduce in the next chapter, with the aim of determining if the proposed recording methodology can be beneficial towards gaining a better understanding of the cave space and the cave – human relationship.

Chapter 4
Methodology and techniques: the “geosophical” approach.

Summary

In chapter 4 a thorough analysis of the methodological and technical innovations that this thesis proposes for an inclusive sensorial mapping on subterranean archaeological sites is presented. After a small theoretical introduction, a thorough historiography of the development of cave-specific mapping software is taking place, when contemporary applications are also showcased – like 3D dense point cloud photogrammetry and “smartphone” based applications. Challenges on the application of Geographical Information Systems and spatial analysis in subterranean sites are also presented in this chapter which concludes with a summary of the techniques that will be used further, in the following chapters, in the three different stages of applications.

4.1 Capturing the senses

In an attempt to highlight the interactive relationship between humans and the cave, the methodology of the research follows the theoretical discussion as laid out in Chapter 2. An attempt was made to record, map and analyse the various stimuli that humans received when they came into contact with the cave environment. Afterwards the stimuli will be analysed and correlated with the archaeological data that the caves present, with the aim of establishing the extent to which human activity in caves is influenced by them, as well as to what extent caves are influenced by human activity. The intention is to move from a classic geographical interpretation of the spatial data to a geosophical approach, which encapsulates the geographical information in a more phenomenological way of thinking (e.g. Fagance 2013; Gillings 2011, 2012). In order to make a transition from a purely quantitative approach, which correlates the geographical data with artefact clusters, to a qualitative methodology, we have to take into account the environmental values, sounds and people’s active perspectives

(Wheatley and Gillings 2002). The senses we can observe are the visual and auditory, so as to interpret what a user of the cave could see and hear. Next, by recording the humidity and the temperature in the caves, we will attempt to understand how a cave user was feeling physically in the various areas of the cave and whether these senses of cold or warm or humid affected the activities in the specific part of the space or not.

In the first part of the research, the uses of caves as the excavators have presented them will be recorded. After studying similar attempts in the Balkans (e.g. Sampson 2007; Tomkins 2009; Trantalidou et al 2010; Trimmis 2015a), researchers tend to divide the uses of the cave into two broad categories that include more specific groups. More specifically:

a) Economic uses: Caves that are used as permanent sheepfolds, as areas for periodic accommodation of herders and their animals, areas of seasonal accommodation of farmers, livestock farmers and fishermen, areas for the storage of goods and areas of secondary product processing (such as stone tools, textiles, dairy products).

b) Symbolic-social uses: Caves that are used as sanctuaries, burial spaces, areas of ideological expression and areas of social organization/initiation rites.

Whether these two broad categories happen to coincide or not, in the cases of some caves, has not been clarified by the researchers yet (Trantalidou et al 2010). However, it seems that when a cave is used for one particular activity, the other ones are excluded (Moyes 2012; Sampson 2007; Tomkins 2009; Trimmis 2012). More analysis of this "Durkheimian" differentiation of cave use, is given in Chapter 9.

For the purpose of this research, 61 caves with evidence of use during the Neolithic in the Western Balkans have been considered. The conclusions reached by each excavator about the use of the space have been accepted as valid by default by the writer and, as such, the material has not been re-examined. The data collected concerning these caves has been mainly geomorphological and environmental: entrance orientation, entrance altitude, the rock type in which the cave has developed, luminosity zone, and surface area. This data has been combined with the archaeological data and a statistical analysis has been made in order to quantitatively establish what kinds of caves the societies of the time preferred for each use and whether patterns were created in these choices through which social strategies of space exploitation can be highlighted.

The statistical software SPSS from IBM was used for the analysis of the first part. The above data categories were used as parameters in SPSS. In order to organize the database better, an indexing system was followed including the international initials of the country and then the Arabic numbering. For instance, the caves started with GR1 for Greece, HR1 for Croatia, AL1 for Albania etc. ESRI ArcGIS was used in a very simple application for the spatial presentation of the data and the checking of geographical patterns. More specifically the caves and the data that have been researched and gathered for statistical analysis were georeferenced on a geographical map of the Balkans.

Having already 'captured' the sensorial spectrum that a cave creates as a natural geoform, the research proceeds to the interior of the cave so as to quantify the data created by the cave as an internal, enclosed landscape. In this second part of the research the variation of the humidity in the interior of the cave, the variation of the temperature, the variation of the luminosity and the variation of the sounds were measured in four caves in Greece, Koromilia in western Greek Macedonia, Kitsos and Leontari in Attica near Athens and Antiparos on Antiparos island in the Cyclades. All of the above data was then plotted in the cave mapping software and a layer was created for each data category in ArcGIS. Due to the given difficulties created by the cave as an area (non-functioning of GPS, difficulty of using Total Station, darkness, humidity), a combination of traditional techniques and innovative approaches were applied when collecting data, which will be presented next in more detail.

4.2 Methodological problems of applying GIS in cave archaeology

As explained in the previous chapters and as recorded in the literature (Stratford 2011), due to the complexity of the cave as part of the archaeological material, the GIS could be considered a valuable tool for the management, analysis, study, interpretation and presentation of the data of an archaeological research in a cave. Additionally, because of the darkness of the interior of a cave, it is impossible for a researcher to have a total overview of the examined area in large chambers during field research. They can only see 'as far as their lights reach', usually at a restricted angle. The GIS enables the researcher to monitor the area as an ensemble on their screens. Nevertheless, the complexity of the cave as well as the extreme conditions of its interior has prevented the spread of GIS applications in cave archaeology (Moyes 2002: 9).

Although the archaeologists who conduct research in caves have used simple GIS applications in specific chambers and cave areas, it is practically impossible to create a two-dimensional presentation of the area with the finds georeferenced to it in a complex cave. This happens either because the finds are in chambers and tunnels that cover one another as layers or because, on many occasions, the material has been placed, either by humans or water, in natural caves, 'attics' and on different levels, all of them being in the same chamber. As such, a surface distribution of finds is recorded, which is not only horizontal but also vertical simultaneously (Moyes 2002). Every person who researches and studies caves from different scientific perspectives, such as geology and biology, or even those who just explore and map them encounter the same problem. The solution to this issue is still under discussion. Various methodologies and techniques have been proposed, none of which, however, have produced satisfactory results to date. Moreover, it is worth mentioning that no GIS software includes applications that can deal with this problem.

Theoretically, this problem could be resolved by creating a separate 'map' for every reference level and by presenting this map in a common software application. Afterwards the maps could be presented by layering one on top of the other. If the finds are reported in a single coordinate system, there could be correlations and further analysis. Nevertheless, this is not an ideal solution as it is not feasible to maintain the spatial correlations between objects, given that this method forces the user to make arbitrary decisions on where the space can be 'cut' into layers (Moyes 2002:11).

In order to facilitate quantitative analysis, it would be possible to create map projections of the areas that overlap in the same file, but something like that could negatively affect the presentation (Moyes 2002:11). While these suggestions could work theoretically, they cannot be applied in archaeology because they alter the spatial correlations of the objects and they distort their presentation. The archaeologists turned to two strategies to solve the problems mentioned above. The first one is the creation of Digital Elevation Models (DEM) in the interior of the caves (Moyes 2002) and the second one is the survey (mapping) of the cave and the finds with the use of Laser Scanning/scanners (Brown et al 2001). Both methods have produced excellent results in small caves and rock shelters. However, this was not the case when they were applied in larger caves (Stratford 2011). The reasons why the two methods were not efficient in large caves are related to the general difficulties encountered in cave mapping. For this reason, the issue of mapping caves and their finds will be discussed in more detail later.

Nonetheless the GIS is still considered to be a reliable tool for spatial analysis and general data management in most caveforms. The issue of the finds in vertical distribution in these cases can be dealt with simply, by separately introducing these finds into the system and on the condition that the researcher has made appropriate provision to integrate the positive ‘height’ of these objects as a factor in relation to the horizontal basic level of the floor of the cave. However, their development faces multiple technical difficulties, especially with regards to larger cave systems as opposed to a large rock shelter or a cave with only one spacious chamber. The morphology of the caves that will be examined next is such that it has allowed the development of simple GIS techniques.

When analysing more extensively the technical issues of the development of the GIS in archaeological positions in caves, more general difficulties related to the methodology and the techniques of cave mapping arise again. The data concerning the development of the GIS in open positions is now collected in total stations and is then immediately transformed through the survey processing software in combination with the GIS development software. The use of total stations in caves of a size such as in the present thesis is prohibitive for numerous reasons. Firstly, the almost extreme humidity (which very often reaches 99%) affects the geodetic stations and makes them malfunction in many cases. Raindrops or dripping water regularly threaten to affect the functioning of the instrument. Secondly, in cases of narrow passages or very low chambers it is not feasible to set the geodetic station on a tripod and to place it vertically. Thirdly, the geodetic station often has its position changed many times and as such its advantage of high precision in measurements[6] is minimized. These are the reasons why its use in large and complex caves has been avoided (Moyes 2002).

Up until the beginning of 2011 the only way of mapping a cave and its finds that can be found in literature was the traditional one, involving a compass and a tape measure (Stratford 2011). In this case the measurements are recorded by hand and are transported to the database. The mapping error rate in this case is quite large, although

6 About the accuracy, as will be presented in the next section, the methodology, and not the survey instruments, make the difference in cave mapping.

the results of this method whenever it was applied were satisfactory (e.g. Pratt 1998; Moyes 1998, 2001, 2002; Stratford 2011).

4.3 New ideas applied to old methodologies

Despite that, the technology has still significantly advanced. Over recent years there have been reliable solutions for cave mapping that cost less than geodetic stations, are more user-friendly, without adaptation problems for the cave environment and provide more precise measurements, if the correct methodology is followed.

However, what has changed is the now holistic perspective of the cave. The geological characteristics of the cave are included equally in the editing of the spatial analysis of the data, with the aim of better understanding the uses as well as the ways in which the cave-environment was altered by humans. In GIS applications with this theoretical background in archaeological positions in caves, mainly in Mesoamerica, it has been proven that GIS tools are extremely advantageous when it comes to attempts at interpreting the cave as has been discussed previously (cf. MacLeod and Puleston 1978; Moyes 2001, 2002).

Cave mapping. Definitions, methodology and techniques

It is imperative that cave mapping and its characteristics be defined before further analysis. Cave mapping is defined in literature in two distinct ways; either as a survey or as mapping (see Tarsoly 2006). Both terms are equally acceptable. As this thesis deals with archaeological data, the term 'mapping' will be used due to the fact that surface field research is characterized as a 'survey' in archaeological research.

A prerequisite for the success and accuracy of a mapping is the cave itself. The complexity of the space does not allow researchers to fully grasp the actual size of the dimensions. Nevertheless, the process of cave exploration as well as its systematic study requires the existence of an exhaustive and reliable background in an appropriate form and scale that responds to all the cognitive fields (Doggouris et al 1986; Kalogeropoulos et al 2008).

The mapping process is hindered by various factors, of which two are the most important. Firstly, the cartographer does not always work in ideal conditions because the environment is characterized by darkness, humidity, cold, etc. (Doggouris 1986).

As a result, mapping becomes challenging. Secondly, the complexity of the cave necessitates the mapping of parts that are situated on completely different levels. Consequently, the recording of information for a three-dimensional space is required.

The traditional mapping method includes the data collection about the map, that is to say the measurements from a mapping group at the first stage. This group consists of 3-4 people to maximize the time available, especially in large caves, although a group of two people tends to cooperate better (Judson 1974). The leader of the group determines the location of the stations for the measurements, records the data in their diary by drawing sketches of the cave and usually designs the map, as it is easier for them to read the notes of the diary. The other members handle the instruments and report the indications to the leader (Savvaidis 2007). Dealing with the instruments involves tape measurement of the distance from the station to the point in question, as well as the measurement of the corner that is formed between the station, the point and the magnetic north (azimuth). The station is the central point of the routing. Any routing can range from one to infinity, but a routing cannot exist without at least one station. The station can be set arbitrarily by the surveying group or be a set point in a general integrated geodetic reference system. The mapping procedure begins with the determination of a point-station (that either has specific coordinates according to a reference system or not). All of the other stations are determined in such a way that the shape of the cave is outlined. For every other station its distance from the previous one, the azimuth and the altitude range (that is the inclination) are measured and recorded. Using this information, the stations can be drawn on a certain scale and be orientated on paper. The procedure is repeated for as many stations as necessary. Nowadays, as will be demonstrated next, the mapping procedure has been simplified since 2008, as instruments that combine the capacities of a compass, a clinometer and a laser distance meter in an all-in-one device have been developed.

The measurements between the stations that take place for the collection of necessary data create a line in the cave that is called a routing. The routings can be open or closed. The beginning and the end of a closed routing coincide, whereas in an open routing they do not (Kalogeropoulos 2008). The former offers more accuracy in mapping as it enables the cartographer to identify possible mistakes (Dasher 1994). However, the disadvantages of an open routing can be minimized with the correct verification of distances between stations (Gazeas and Filippatou 2008). The routings that are applied in the cave mapping are categorized into four types: central routing, radial routing, circular routing and zigzag routing that are used depending on the shape and size of the space that needs to be recorded (Kalogeropoulos 2008). In central routing, a central line is created in the middle of the space by the stations, from which the distance of the walls on both sides is measured (Dasher 1994). The measurements on the sides are always made by measuring the azimuth. When the morphology of the cave allows it, the central line of the routing can be situated on one side of the passage in such a way that only the distance from the stations to one wall is measured (Dasher 1994). In special cases the central line is straight and the distances of the walls on both sides are measured vertically from points of the line without requiring the azimuth (Savvaidis 2007). In the case of a narrow passage the measurements can take place alternately from one side of the passage to the other forming a zigzag route. In this way, each wall of the cave is defined better. Several cartographers believe that this routing alters the length of the cave, although this technique offers more information to the final design (Dasher 1994). In radial routing the measurements arise from one station, in a central spot of the cave (or chamber), towards the borders of the space that is being mapped. The consecutive stations are radially positioned with regards to the central station. The radial routing is used in chambers where the space is almost circular and as such the central point is visible from all stations. In circular routing the measurements take place circumferentially by following the borders of the space being mapped. In this case the shape of the routing coincides with the shape of the space that is being mapped. Circular routing is mainly used in chambers that are almost circular. This facilitates the 'closure' of the routing by making measurements from the last station to the first one. Consequently, during the design the possible errors become discernible (Dasher 1994).

The question is whether there is one routing that outperforms the others when it comes to how accurately the space being mapped is attributed. In order to answer this question, in 2008, a group from the Aristotle University of Thessaloniki and the Local Department of Northern Greece of the Hellenic Speleological Society examined the accuracy of the routings by mapping an amphitheatre of the School of Science and its antechamber using all four methods (Kalogeropoulos 2008). The same instruments were used for the measurements, including a SUUNTO compass and an electronic telemeter/clinometer from the Department of Geology applied on a tripod. When we compared the results of the routings to the architectural designs of the chamber, it was proven that the radial routing was the most accurate while the zigzag routing was the least accurate (Kalogeropoulos 2008).

Certain basic conclusions were drawn from this comparison of routings in 2008. Firstly, maps with different methodologies are not directly comparable between each other. Secondly the most accurate method for the mapping of the characteristics of the caves is radial routing because the points depend on a steady station. Finally, in radial routing the errors were minimized and if the moving of the routing radial centre between the stations is verified through triangulation and by repetitions of the measurements (back and forward, between the stations), the errors become almost non-existent (for more information see also: Gazeas and Filippatou 2008).

As far as caves with archaeological finds are concerned, in literature it is recommended to apply one single method of cave mapping, where the most accurate instruments possible should be used and the stations should be limited to the bare minimum (Tarsoly 2006; Kalogeropoulos 2008). What the above statements clarify is that accuracy in the mapping of caves and their characteristics is not only accomplished through the quality of the instruments but mainly via correct methodology and the experience of the mapping group.

Errors

It has been observed that the error rate in cave mapping is far greater than in attempts at mapping in any other field (Tarsoly 2006). In a case where the purpose of the cave mapping is the examination of the spatial distribution and the spatial relations of its characteristics, the prediction as well as the correction of any errors is predominant (Tarsoly 2006). Errors during the mapping can alter the results by diverging them from reality. The errors can be grouped together in the following categories: random errors, errors due to deviation from the alignment, errors due to deviation from the horizontal position, errors due to the incorrect recording of the readings (Savvaidis 2007), systematic errors from deviation in the instruments due to their construction, errors due to the deviation from the prototype, errors due to the wrong strength being applied on the ends of the measuring tape during measurement and errors due to the deflection caused by the weight of the measuring tape (Kalogeropoulos 2008). All of the above can be predicted in many cases if they are taken into consideration before the beginning of the mapping. In addition, as will be shown in the next section, the use of technologically advanced instruments can practically eliminate errors arising from the use of an analogue compass/clinometer and measuring tape.

The errors that are harder to forecast are the ones that are related to human error. They are unpredictable and the result of inexperience or exhaustion, hypothermia, darkness and the difficulty of adaptation in the area. Up to a point, the newest mapping instruments and the measurement analysis software limit human intervention. Nevertheless, even this software is still being developed and is not considered to be fully automated. Thus, it is still required to be handled manually. All of the above errors contribute to the fact that different mappings of the same cave produce results with slight or insignificant differences between them (Kalogeropoulos 2008). These differences can be eliminated with the use of new technologies and software, provided that the stations and the points that were used in the first mapping are used in the following mappings as well.

Mapping instruments

The instruments that are widely used are the measuring tape and the telemeter/rangefinder for the measurement of distance, the compass for the measurement of the azimuth and the clinometer for the gradient of the ground (Tasroly 2006). The measuring tape is the basic instrument for the immediate measurement of lengths. They are made of various materials (metal and linen or plastic) and their lengths are usually 20, 25, 30 or 50m. The accuracy they offer is about 2-3cm/100m with regular towing force that is inscribed on the measuring tape and 20C temperature (Kalogeropoulos 2008).

The accuracy can be increased to within a tenth of a millimetre with the use of a distance meter. The distance is measured by targeting the point from the station. The rangefinder can operate from a tripod as well, in order to minimize errors. The fact that the rangefinder is much smaller in dimensions and lighter than the geodetic station automatically makes its tripod much smaller as well and as such it can work in any part of the cave. Greater accuracy is also achieved using a Laser distance meter as opposed to distance meters that operate using ultrasound (Kalogeropoulos 2008).

Compasses are used to measure the azimuth. The circle of the compass is subdivided in four ways. The first is from 0 to 360 grades (degrees) and gives the absolute corner (clockwise) with the north that is called azimuth. The second consists of four quadrants of 90 grades (southeast, southwest, northeast and northwest). The third is divided in 6400 mils and is used for military purposes. The fourth is subdivided in 400 grads. This one facilitates the comparison of the rear sight (Dasher 1994). The subdivision in degrees will be kept in the present thesis. An analogue compass with an eyepiece operated by an experienced user can achieve accuracy of ± 1 degree. A digital compass is the best solution, with which it is possible to achieve accuracy of up to two minutes of a degree.

Figure 3 Cave mapping with tape and compass

An essential part of mapping is the measurement of the gradient of the ground in order to calculate the differences in altitude. The instrument that records the gradients is the clinometer. Simple clinometers consist of a protractor and a plumb and can be found together with the compass. The analogue high accuracy clinometers can achieve accuracy of up to ± 1 degree. The accuracy is increased to within two minutes with the use of digital clinometers in this case as well. The geometric level is another method of altitude measurement, but the greater gradients make its application impossible (Doggouris et al 1986). Additionally, groups of Russian geologists have been experimenting since 2004 with a method of gradient measurements in caves with the use of altimeters. The results of this method have not yet been published (pers. com. Adamopoulos 2013).

Figure 4 The full variety of cave mapping instruments. From tapes and compasses to laser distance meters and PDAs

In recent years, various distance meters have been introduced to the market (such as Leica Disto X – figure 5), to which a digital compass and a clinometer can be included. These instruments have revolutionized cave mapping. They have reduced the members of the mapping group necessary, have increased the time of performance and have practically achieved accuracy in measurements, especially when operated on a tripod and aimed at a reflector. These instruments feature another comparative advantage. With the use of an industrial model for wireless personal computer networks (Bluetooth) they can send the data either to laptops or handhelds. These computers, equipped with suitable software, such as AURIGA and POCKET TOPO that will be presented in the following section, immediately analyse the measurements without human intervention. This leads to the direct limitation of human errors during the transcription of the measurements. Such systems were used during my PhD research, and will be presented in the following chapter (6) of this thesis.

Figure 5 Leica DistoX and PDA with Pocket Topo (image courtesy of B. Heebs)

Measurement analysis software and their relation to GIS applications in caves[7]

The first code for software that analyses the measurements in caves and supports the mapping procedure was written in the USA about 30 years ago. In most cases these early codes were developed by a solitary person, usually an amateur speleologist, who then offered them to the speleological community.

7 Information has been sourced from the official software websites at: paperless.bheeb.ch/, therion.speleo.sk/ και www.speleo.qc.ca/auriga/ (accessed 7/11/2016)

The first software that was functional and handy enough to be widely used was the Survey Manipulation and Plotting System (SMAPS) that was developed by Doug Dotson in the USA in early 1990s (Dotson 2002). SMAPS was designed in an MS-DOS environment. Its organization was sectoral, and it attempted to include and deal with all the aspects of the research in a cave as well as time management and its characteristics. In the sectoral form of the software the archives were filed according to the time sequence of the research and the time sequence of the special characteristics. Moreover, there was the possibility of adding information on the geographic reference of the recorded characteristic in the form of vector distances from one station of the mapping.

In newer versions of SMAPS, Dotson created an option for connecting the software with GIS software. The GIS enabled SMAPS to add directly georeferenced data to the mapping in connection with international coordinates systems, with an additional window for adding extra information on the spot. In this version, SMAPS provided the researchers with the possibility of printing their geo-referenced work while allowing the creation of separate files per characteristic finding and mapping.

The next significant attempt to create software that would facilitate the management and analysis of the measurements in speleological research was started in the 1980s by David McKenzie. McKenzie continued the development of the software for about 25 years (McKenzie 2006). The software was developed in C++ language for micro-computers in the 1980s. Later, it was modified accordingly to adjust to the Windows 95 platform. This is also how it got its commercial name “WALLS” that has accompanied it ever since. This particular software was initially used as an application in cave research in Latin America and Mexico. WALLS included the sectoral organization of data files and also used an adapted data base for the storage of spatial information. WALLS enabled the user to store a document in the form of notes for certain points of interest. Additionally, it enabled the highlighting of wider areas in the cave that were interesting to the researcher. In the middle of the 1990s, McKenzie cooperated with ESRI to try and provide cave researchers with an intra-site GIS. Within the framework of this cooperation, an extra addition was created in the ArcGIS of ESRI that integrated the information of WALLS, for when the user wanted to use ArcGIS for cave data analysis (McKenzie 2006). Although this particular application presented a complete GIS platform for applications in a cave environment for the first time, it was not able to resolve the technical and methodological problems of GIS application in caves. However, it did manage to supply cave researchers with a new graphic tool.

The next software that was developed for the editing of cave mapping data was the COMPASS software, which was, like the previous examples, developed in the USA. COMPASS does not significantly differentiate itself from WALLS. Its database is called CaveBase and works similarly to the database of WALLS. Moreover, both software systems coordinate with ESRI and provide information on the caves in the environment of ArcGIS in a 3D shapefiles format (Dotson 2002).

In Europe, the first software for cave mapping data analysis and presentation appeared in the mid-1990s and is nowadays the most commonly used software for speleological research. The two most renowned and widely used software systems are THERION digital cave maps and VISUAL TOPO. THERION is considered by many to be the most complete software for cave measurement analysis. Nevertheless, due to the fact that it is relatively difficult to use, and its spatial database is also relatively limited, it has not found particular applications in archaeological cave research. On the other hand, VISUAL TOPO has become the most popular application among researchers because of its much more user-friendly interface, its simple and handy database and the fact that it offers immediate application of GIS elements in the mapping (Adamopoulos 2002). VISUAL TOPO was the software that was used in the present research. For this reason, this specific software and its capabilities will be presented in a separate paragraph. Before the completion of the reference to the mapping data editing software, it is worth briefly presenting AURIGA and POCKET TOPO that were mentioned in the previous paragraph. Both of these software systems were developed to integrate with new mapping instruments (distance meters). These software packages aim to enable the user to directly transfer the data from the instrument to a handheld device (palm top) or a laptop (net book) either manually or wirelessly without requiring the data to be recorded on paper. This method, which is characteristically called paperless mapping, increases the mapping speed, minimizes errors and achieves greater accuracy in measurements. The data from both AURIGA and POCKET TOPO can then be directly used in measurement analysis software like the ones that were previously mentioned.

VISUAL TOPO was created by the French speleologist and software engineer Eric David in 1997. The current version, 5.04, is available in seven languages; Greek, French, English, Spanish, Catalan, Italian and Bulgarian. The software is available for free online, but it is not open-source software.[8] The measurements can be integrated into VISUAL TOPO in two ways. The first method is manually, by copying the notes that have been made in the cave. The second is the immediate output of the measurements by either AURIGA or POCKET TOPO, provided, naturally, that they have been used in the cave. The second method clearly outweighs the first one in speed, accuracy and error limitation in mapping.

VISUAL TOPO analyses the measurements that are collected from the cave and presents the points with geographical coordinates. The coordinates that are attributed by the software depend either on a more general coordinates system or on a specific local grid created by the user. The question is whether coordinates will be given from the point where mapping will begin or if this point will be considered as point x=0, ψ=0, z=0 for the local grid.

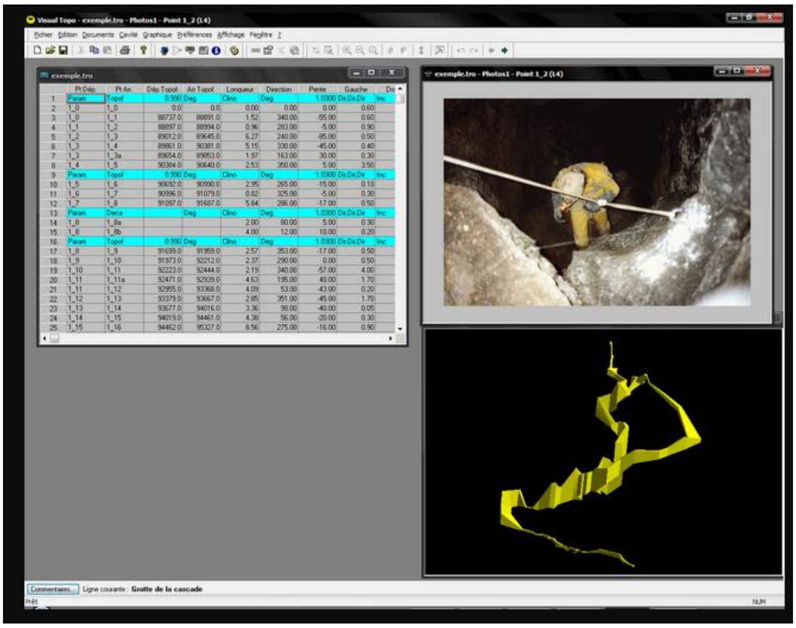


Figure 6 The Visual Topo interface (courtesy of www.topographie.net)

8 Information sourced from the software page: www.vtopo.free.fr (accessed 8/11/2016)

The software works with the analysis of vectors between points and stations. One can add a piece of spatial information to the interface of the software itself simply by selecting a point/station. In the window that the user opens, they can add a document, picture or link that refers to the particular spatial group (figure 6). In this way the information obtains a spatial entity in the form of a simple GIS application. Moreover, VISUAL TOPO can output data in ArcGIS as well as in Quantum GIS.

4.4 Creating and annotating the map

After the completion of the measurement analysis and the development of the stations and the points, what remains is the design phase. In simple cave mapping applications this part can be completed 'manually' in the form of a sketch. In other cases, the final design can be done with any CAD type design software. In a case where it is necessary to mention particular characteristics of the cave on the map, such as decoration, hydrogeology information, constructions, or finds this can be done either with the immediate depiction of the information on the map or with the creation of a GIS. In the case of the GIS the map is transformed in the GIS development programme in either vector or raster form. Next, the characteristics are introduced based on their geo-reference, either in a local or universal coordinates system. The basic information that should be mentioned on the map is what should be mentioned in any other mapping, that is to say scale, legend, creator's name, North arrow, mapping group, mapping instruments, measurement analysis software and date.

As far as the legend is concerned, various symbolisms have been put forward for the interpretation of the cave characteristics.[9] The ones that are widely used are two; the mapping symbols of the National Speleological Society of the USA (N.S.S. U.S.A.) and the mapping symbols of the *Universal Speleological Federation* (U.I.S.) (Dasher 1994). The U.I.S. symbols have been chosen in the maps of the present thesis, as will be examined in Chapter 6.

The present and the future of cave archaeological mapping

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9 Cave features are considered as all geological, biological and cultural evidence.

Before the completion of the presentation of the techniques and the cave mapping instruments, it is worth presenting the new software and applications that are gradually becoming available on Google Play and would seem set to dominate mapping in the future. While this thesis was being written, the long-awaited version of PocketTopo for Android had not yet come out. However, three independent applications with the same characteristics and similar interface are available. These are Qave, Abris and TopoDroid. All these three applications are available for free on Google Play and have been completely developed by cavers not seeking to make a profit. There are though, no respective versions of these applications available yet in Apple Store.

TopoDroid (sites.google.com/site/speleoapps/home/topodroid) was developed at the beginning of 2014 by an international group of speleologists. It is available in English, Spanish and French and is fully compatible with DistoX. Similar to PocketTopo the data is transmitted wirelessly and in real time from the rangefinder to the device. However, its complicated interface, as well as the fact that it needs various add-ons for additional functionality, have not made it particularly popular among researchers.

Abris (http://abris.shturmsoft.com/) started to be developed at the end of 2013. It is available in English and Russian and is not compatible with DistoX. As a result, the data must be inputted manually, which increases the possibility of errors. Nevertheless, among the three applications Abris has the most user-friendly interface and provides the greatest stability as an application. The sketches from Abris can be outputted as shapefiles (.shp) and the analysis of the measurements as a spreadsheet. Consequently, this is particularly useful when the final editing is to take place in a GIS environment. This is probably why this is the application with the most downloads according to Google Play.

It was more difficult to collect information on Qave as there is not an official webpage for the application. According to the page of the application on Google Play, it is compatible with DistoX. However, this does not seem to be the case as user comments mention that they have not managed to get a connection. Qave offers a reasonably user-friendly interface but it does not have the design capability of Abris and TopoDroid.

In this thesis, the capabilities of Abris and Qave in ideal conditions were compared during the mapping of the archaeology laboratory at Cardiff University.

The experiment showed that there was no accuracy difference in mapping between the two applications. However, because of the better interface, the mapping was completed faster with the aid of Abris while there were also fewer errors during the data input. Next, Abris was tested in the field when the palm PC failed to connect during the cave mapping in Koromilia and the mapping was completed without any problems with the use of the application on a Samsung Galaxy SIII mini phone.

The latest development in cave mapping and its finds is the portable cloud and its applications in the interior of the cave (see the website of the Cave Radio and Electronics group: http://bcra.org.uk/creg/). By creating a local Wi-Fi network the data from the mapping group can be transmitted directly to a central station, which will be equipped with an electronic computer and will not only perform real-time data processing but also real-time data analysis That is to say, the first data analysis will be done by the group while they are still in direct contact with the cave. As a result, errors will be detected immediately and whatever collection of additional data is required will be completed straight away. Errors will thus be reduced to the minimum, as there will be no time gap between the data collection and its analysis.

Another recent innovation, which ought to be noted here, as has been used as a pilot application in the Mala Pećina excavation (see Chapter 6 for more details), is the application of 3D photogrammetry in the cave (though not solely) archaeological survey. 3D dense cloud photogrammetry software like the Agisoft photoscan that is mostly used for archaeological applications (see the Agisoft webpage for more information: www.agisoft.com), are based on an advanced algorithm which creates a 3D point cloud mesh of an object based on photographs that have been taken from different angles of the object. In order for the photoscan software to align the photos and to generate the point cloud mesh, photos must have a 60 per cent overlay between them. Once the software has generated the 3D model, then a "texture" layer can be applied in order to recreate the feeling of a photograph. The real power of 3D photoscans is the ability to georeference the 3D model based on just four ground control points. In a cave environment the ground control points can be located using either a Total Station or any of the other aforementioned cave specialized techniques. Once the 3D model is georeferenced, then the user can extract geoTIFFs, photogrammetric plans, cross sections or simply measure distances under scale on the actual 3D model. For this particular research, 3D photoscan has been applied in Mala Pećina and in Koromilia. In Mala Pećina, Agisoft and 3D photoscan photogrammetry have been used as the main mapping and field recording techniques. Since it was the first time that Agisoft had been used in cave archaeology, all the challenges that a cave photographer faces worked as limitations for our methodology; e.g. the lack of good light sources, the difficulty of lighting large chambers and so on. In Mala Pećina, Agisoft models have been georeferenced using ground points that have been located using a Total Station. In Koromilia, ground points have been located using a Leica DistoX and Abris on a Samsung Galaxy SIII mini Android mobile phone.

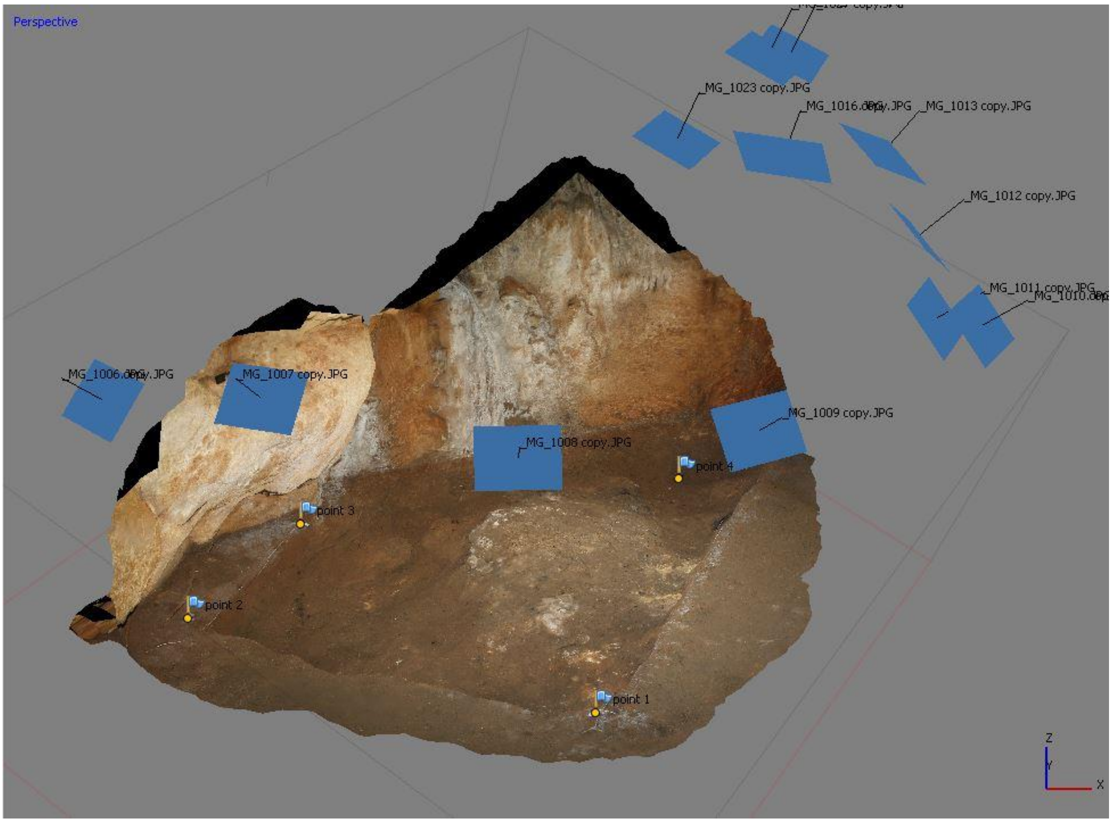

Figure 7 Agisoft printscreen during the alignment of images from Trench 1 in Mala Pećina cave

4.5 Mapping the senses in archaeological cave sites

The methodology for the field research in the present thesis was organized in the following way: right outside the entrance of the cave two fixed points were placed arbitrarily. The entrance point was marked in WGS 1984 with the help of a Garmin handheld GPS, which provided accuracy up to two metres. This point, at the entrance of each cave, has been annotated as the 0,0 for the routing. From this point, with the use of DistoX and the application of Pocket Topo on a palmtop PC the routing started. Radial routing was selected for its accuracy (as presented previously). Each station of the routing was marked with ‘mapping pyramids’ (Dasher 1994) that were later used as reference marks for the collection of environmental and recording data. The mapping pyramid is practically a metal pole that is placed in the ground of the cave and is framed by rocks so that it can be easily seen in conditions of limited luminosity. The stations were positioned every five metres with the first of them being obligatorily at the entrance of the cave. The number of the stations were noted separately in the form of OS Numbers that was running on an Apple iPad 2 for the immediate recording of the environmental data and the sound files codes, always with the aim of reducing errors from processing the data several hours after the collection. After the completion of the space mapping, the other sound and micro-environmental data were collected in the mapping stations.

Collecting the micro-climate data

There are no previous publications concerning the collection of micro-environmental data in caves and their correlation with archaeological finds. As such, the collection methodology that is followed by biologists concerning the study and the understanding of the microclimate of a cave was applied in the present research (e.g. Kennedy 2006; Romero 2009). So, in the development axis of the cave (or axes if the cave is divided and does not consist of a karstic conduit) the biologists take indications of temperature, humidity, barometric pressure, air streams and water flow every three or five metres. The humidity, the temperature and the luminosity were measured every five metres for the present research.

Two thermometers, one photometer and two hygrometers are placed in every mapping pyramid and then the research team either leaves the cave or moves to other chambers if the size of the cave allows it. It is imperative that the team move away from the point of measurements as, according to Romero (2009), a group of five people can alter the temperature of a chamber up to 1-3 ˚C and the humidity up to 5%. The measurements were then recorded in a spreadsheet as well as reported to the mapping station with the use of Visual Topo. The methodology that has been used in several microclimate studies was followed for the recording and storage of the humidity and temperature data (e.g. Kyoung-nam et al 2014). More specifically, the number (or the name) of the station is recorded and then the average indication of humidity, temperature and luminance.

Capturing sounds

In addition to the recording of environmental data, there are a lot of published works available concerning the methodology of sound data recording techniques and their correlation with archaeological evidence. As mentioned in Chapter 3, the methodology of recording and analysing sounds presented by Steve Mills (2014) was followed in this particular research. Three areas, one in each environmental zone (the light, twilight and dark zone of the cave), were chosen for the recording of the sound clips. A mapping station was selected as the recording area so that the sound data could easily be correlated with the microclimatic and archaeological data. The sound recording took place in all the caves during a summer, from June till the end of September. Therefore, in most cases, as far as the entrance zone was concerned, there were no sounds of extreme weather conditions (rain, wind, snow) while there were also no sounds of intense rain drops or air streams as far as the interior zones were concerned. There were two recordings in total, one at noon and one late in the evening in order to monitor alterations during the day if there were any. The altitude of the recording was one metre from the ground (roughly the height of a seated human) and each was recorded in a clip lasting three minutes. A digital sound recorder, an Olympus LS-12 2GB Linear PCM Recorder, was used for the recording. The open source software Audacity for Mac OS was used for the analysis of the sound clips.

A WAV file, which was analysed in individual auditory stream sources in Audacity, was derived from the recording (Mills 2014). The time duration of each stream source was added to the interface so that the sound percentage could be calculated in the recording and then analysed in the three basic categories of geophony, biophony and anthrophony. Geophony, biophony and anthrophony have been introduced by S. Mills (2014) and they are combinations of auditory stream sources grouped on the basis of a general similarity in physical characteristics (Mills 2014:96). The groups can be defined as follows (referring to Mills 2014):

Geophony is the totality of sounds associated with the physical, non-biological environment (e.g. weather, water, rock, soils; and seismic, volcanic and glacial activity.)

Biophony is the totality of sounds associated with non-human, living organisms (e.g. animals, plants).

Anthrophony is the totality of sounds associated with and generated by people. Sounds that can be grouped around anthrophony can arise from a wide range of processes and activities including, but not limited to, the following (referring to Mills 2014):

Physiological sounds, arising directly from the body (e.g. breathing, coughing, sneezing, talking, singing, whistling).

Intended or incidental sounds generated by activities and when engaging with materials of various kinds (e.g. walking, preparing and eating food, making and using tools, tending and feeding animals, using animals for traction or transport, building or modifying structures of various kinds, playing musical instruments).

Modern electromechanical sounds (e.g. aircraft, motorized vehicles, radios, generators, telephones, computers).

Finally, as Mills (2014:96) stated "*Considering and adopting different ways of categorising and organising sounds allows a flexibility in approach that can be tailored to the specific requirements of a given research project as determined by the research questions posed, the available evidence and logistical constraints".*

Two factors that tend to be rather insignificant in open-air locations play a primary role in a cave environment: echo and silence. Assuming that humans possibly chose specific parts of the cave for their absolute silence, the seconds of silence were considered as geophony and were calculated in the analysis in the present research. There are many contributions to the theory around silence that Mills has indexed in his textbook about Auditory Archaeology (Mills 2014). These theories vary in their understanding of silence from a human-made notion to describing the absence of sound to theories that recognize silence as another non-sound sound. Ihde's theorem (Mills 2014:50) that considers silence as the spatio-temporal horizon of sound has been adapted in this research in order to describe the possibility people have to "use" the absolute silence that parts of the caves provide in order to host particular activities.

Similarly, assuming that the use of a part of the cave is possibly affected by the echo that is created due to the morphology of the area, the echo was recorded as geophony, even if it was generated by human activity, wherever it was traced, and calculated in the total percentage of the seconds of recording.

Statistical and GIS data analysis

With the completion of the data collection, three large datasets will be created, which are each analysed separately as well as combined. The first dataset (A) features the geomorphological characteristics of the caves: entrance altitude, entrance orientation, rock and development axis, entrance width. The second dataset (B) includes the archaeological data: the use of the space as derived from the excavator's research, the dating, the various activities, the finds and the constructions. The third dataset (C) includes the micro-environmental characteristics, such as the indications of temperature, humidity, and luminosity as well as the auditory streams.

Dataset A consists of quantitative data, which was analysed with the use of IBM SPSS. The geomorphological characteristics were considered as parameters whereas the prime research question is whether caves that are preferred for human usage present similar natural characteristics or not. For instance, do they all have the same entrance orientation? This data was plotted with the use of ESRI ArcGIS with the aim of showcasing geographical patterns, i.e. whether or not there are local differentiations in the type of caves that are selected for human usage.

Dataset B mainly consists of qualitative data, as has been derived from the researchers' observations and conclusions. Again, the data was analysed statistically as well as spatially. As such, uses per period, collections of uses per area as well as groups of caves with similar characteristics were located.

Dataset C includes both quantitative and qualitative characteristics. The indications of temperature, humidity and luminosity, as they were recorded during fieldwork are considered as quantitative characteristics whereas the data that emerged from the auditory streams were considered as qualitative characteristics. Once more, the data was analysed both statistically and spatially in order to monitor the characteristics of caves that are used by humans, as well as whether or not there are groups of caves that share the same characteristics. Frequencies were used for the analysis of the datasets to calculate the number of appearances of a phenomenon. Cross-tabulation was used for the analysis of the relationships between the datasets.

4.6 Mapping the senses in subterranean environments. A methodology summary

As I mentioned in the introduction to this thesis, to create a new methodology for subterranean archaeological mapping is the main goal of this research; the piecemeal techniques of cave mapping, the variety of available software and the availability of mapping instruments creates a complicated environment for anybody who has a goal to map a cave for archaeological purposes. The situation gets more complex if the researcher would like to map and record the sensorial spectrum and the microenvironment of the cave.

I am obliged to go over all this information in order to clarify and select the best approach for the goals of my thesis. This process has been analysed step by step in the previous parts of Chapter 5. Here I would like to summarize the approach and offer to the reader a "manual" on how to replicate this methodology and use it for future adaptations. Some information about alternative ways to perform every step are also provided. Please note, that this "manual" is based on Heeb's paperless mapping techniques that have been extensively analysed previously in Chapter 5 and have been used for the thesis case studies I shall introduce in Chapter 6. The photogrammetric 3D photoscan techniques and software I have briefly presented in the previous paragraphs are not yet at a technological level to be useful in cave environments and to replace Heeb's approach. I do not doubt that in the near future cloud-based applications and photoscans will be the norm for underground archaeological mapping.

a) Instruments and mapping methodology.

Depending on the complexity of the cave, the first step is to select the best measuring instrument. EDM's are the best option for less complex caves without saturated environments and "letterbox" passages. For these caves, the best solution on the market at the moment is a retrofitted Leica Disto 2, which combines a distance meter with a compass and clinometer. Should any of the previous electronic instruments be unavailable the old "compass and tape" method can be adaptable in a semi-paperless mapping approach. On such occasions you will need to manually input the measurements into the data management software.

b) Data collection and management software

This step is provisional for situations where you are using Leica Disto or “tape and compass”. EDMs automatically collect and manage the measurements, thus there is no need for a second device and a second software; this is the major advantage of EDM’s against the other devices. Data from the other devices will be transferred either via Bluetooth (in the case of Leica Disto) or manually to a PDA which is running Pocket Topo. Alternatively, mobile applications (for the moment only for Android) like Abris or Quave can replace a PDA and Pocket Topo, for data collection and management.[10] One of the strong advantages, both for the Pocket Topo and the Android application is the ability that it offers to the user to sketch a map on the app in real time as they are mapping the cave. In such a complex environment this tool eliminates the use of paper blocks (that can get wet or muddy), accelerates speed and limits user errors. This is something that EDM’s do not offer; which means, as a result EDM’s are not preferable for a real paperless mapping approach.

For climatic data collection “collection stations” need to be arranged in different areas of the cave. These sampling stations need to be annotated in the mapping. In the present research, simple “weather stations” have been used for the collection of temperature and humidity, a SAMPO industrial photometer for the luminance, and an Olympus LS-14 audio recorder for the soundscapes. Advanced equipment for higher accuracy can be used if available but maintaining the same principles about correlation between the sampling points and the overall cave mapping.

c) Data analysis software

For the analysis of the data from the cave and the initial map drawing, any CAD or GIS software can be used. The dominant software for cave data analysis and mapping at the moment is Therion, a command-line interface software that combines measurement analysis abilities with an advanced map generator interface. Therion is compatible with GIS software but does not have a built-in database per point tool,

10 By the time that this chapter was being finished, a discussion in speleological forums had presented the idea of a Pocket Topo mobile application in the near future.

which is very helpful for both archaeological and microenvironmental mapping. This tool offers the user the ability to add specific qualitative and quantitative information for every point in the survey. Visual Topo, the software that has been used for this research offers this tool, but all the other limitations have made the software outdated and only a limited amount of people still use it.

Audacity is still the best available option for soundscape analysis. For the analysis of the microclimatic data any software that can correlate different datasets is equally good. Tableau, MS Excel and SPSS have been tested for this research, and SPSS was finally selected to due to its simplicity and available analysis options.

b) Spatial analysis software. Photogrammetric solutions

GIS software (either ESRI's ArcGIS or QGIS) is still the best solution for the spatial analysis of the data and the correlation between the micro-climatic – sensorial – data and the archaeological evidence. As I have previously stated, the application of GIS in cave archaeology has its own disadvantages (such as the lack of a truly three-dimensional correlation between the data). Even though the future is promising for 3D photoscan-based photogrammetry and spatial analysis, and the fact that in this research these techniques have been applied at the Mala Pećina excavation, GIS remains the main tool for spatial analysis due to the convenience that the interface offers and the almost unlimited spatial analysis toolbox that is available for the user. As is presented in the following Chapter 6, both ArcGIS and QGIS have been used in this research for the microclimatic data grouping, interpolation and projection.

d) Map and data presentation

The final step is the presentation of the data and map. In the case of a research without the analysis part, Therion offers a cave map-designing interface where the microclimatic data can be projected without the implementation of any other advanced software. In a case where another analysis software has been used, illustrator software like Inkscape, Adobe Illustrator or Affinity can be used for polishing the map and presenting the data. Affinity Designer has been used in this research mainly for availability and budget purposes. Any other illustrator can equally be used.

Chapter 5
The context for applying the proposed methodologies: the Balkans and their Neolithic caves

Summary

Chapter 5 introduces the geographical, chronological, and archaeological context in which this thesis aims to apply the proposed methodology. Balkans as a geographical area are presented, along with the Neolithic chronological and archaeological context of the area. The chapter continues with an extensive historiography on cave research in the area, where comments are made on how the research agendas are changing every major political change in the countries. A presentation of the current theories of cave use in the Neolithic Balkans is taking place when theories of cave use strategies in the wider geographical context of the Eastern Mediterranean and South East Europe are also mentioned.

5.1 Geography

The Balkan Peninsula is located in the southeast part of the European continent. Nowadays, 11 countries make up the total area of the Balkans, which covers more than 550,000 km^2. Its borders traditionally extend from the line of the Rivers Krka, Danube and Kupa to the southern capes of the Peloponnese in Greece (Beckinsale and Beckinsale 1975). From a historic point of view, Romania and Slovenia belong to the Balkans, although geographically speaking they seem more a part of Central Europe, but this is open to different interpretations (see Ager 1980; Beckinsale and Beckinsale 1975). This thesis will focus on the geographic core of the Balkans, which constitutes a single geographical entity and presents the most cultural similarities.

Analysing the term on the basis of a single geographical entity, the Balkans is divided into two basic geomorphological units; one in the east that includes the area of Thrace and Bulgaria and the other in the west which includes the Dinaric Alps, the Valley of Pelagonia and the Pindos Mountain range (Ager 1980). The western unit will be the core of this research as it presents some geographical features that create a unique single entity, such as the mountain ranges of the Dinaric Alps and Pindos Mountains and the deep valleys that connect the long Adriatic-Ionian coastlines with the Balkan hinterland. The basic geographical core of this geological unit according to Ager's distinction (1980: Dinarics-Greeks) are the large valleys that extend from the north Aegean (Valley of Macedonia) along the rivers Axios and Morava to the area of Vojvodina in the north of Serbia. These valleys, which constitute the Pelagonian Plate or, according to the geological terminology, Pelagonia and the Sub-Pelagonian Zone, create a single geographical area, rich in water, that is essentially only interrupted by low hills and small upland regions (Ager 1980; Moundrakis 1985). These valleys continue further to the west in the area of present-day Croatia and are a part of the valleys of Slavonia. In the west, the Pelagonian Zone is surrounded by the mountains of the Dinaric Alps and the Pindos mountain range. The natural eastern borders of the lowlands are the Rhodope Mountains and Osogovo (Ager 1980). Further to the west of the Dinaric Alps and the Pindos Mountain range, a narrow coastal plain is formed along the shores of the Adriatic and the Ionian Sea. East of the Rhodope Mountains stretch the valleys of present-day Bulgaria (Moundrakis 1985).

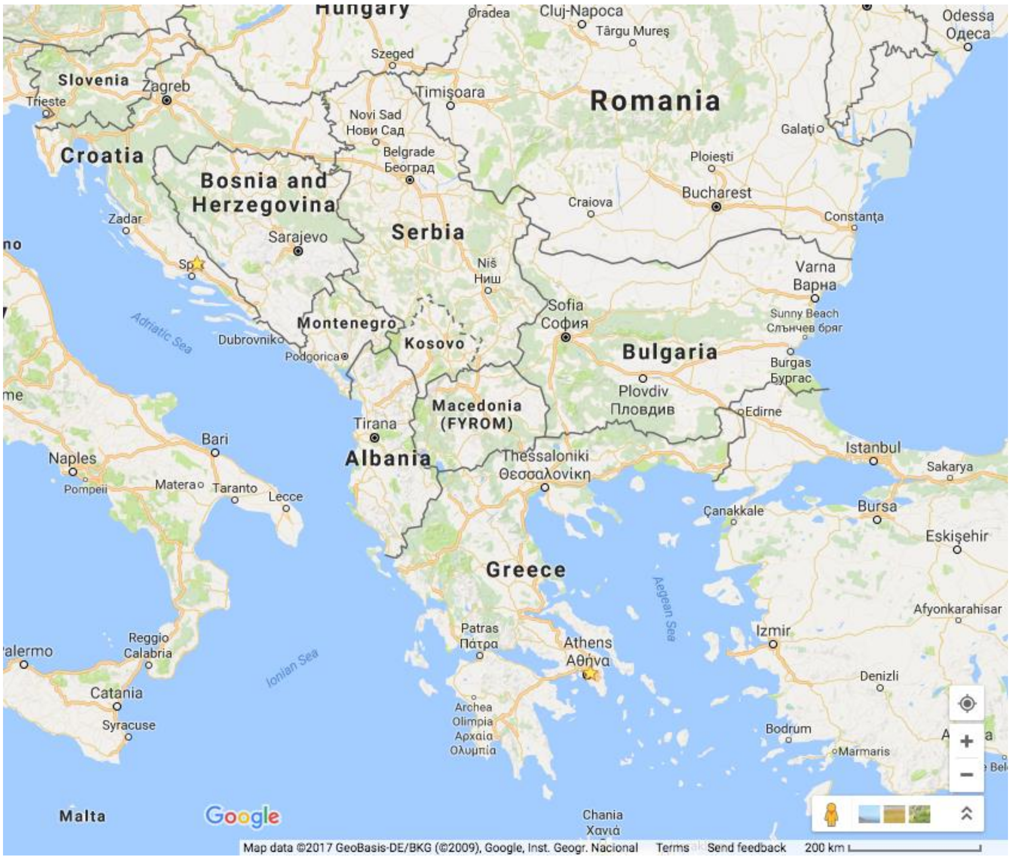

Figure 8 Google Maps view of the Balkan countries in March 2017. Current debates about the Balkans, such as the status of Kosovo and the name of FYROM, are visible.

The southern part of the Dinaric Alps, as well as the northern part of the Pindos mountain range, is mainly formed of limestone rock, which, as mentioned in Chapter 2, is favourable for the creation of caves (Bocheva et al 2009). The rocks that predominate the lower mountainous parts that separate northern FYROM from Serbia and Kosovo (Sharr Mountains, Preševo) (Alichanidis 2009) are also made of limestone. Among these limestone formations there are approximately 5,000 cave-forms, which can be found at various altitudes and describe every possible type of cave (from the deep potholes of the Astraka Plateau, in Epirus, northwestern Greece to the shallow, lake caves in the area of the large lakes straddling the borders of Greece, FYROM and Albania).

Figure 9 Balkan peninsula mountain range image (image courtesy of www.nasa.gov modified in Affinity designer by the author)

The final issue related to the geography of the area concerns the hydrographic network. Hydrographically speaking, the area is divided into three basic units. The key here is the flow of the Axios River, which, together with the lower reaches of the Morava River, unites the Aegean with the central Balkans (Grbić 1954: 99-100; Sanev 1994: 26). The Axios Valley played an important role later in the historical periods as well, as it was located at the crossroads of the main arteries of communication from the north to the south and from the west to the east along the Via Egnatia (Mitrevski 2003: 13). As mentioned before, the Morava Valley constitutes the northern extension of the Axios Valley and the main axis of the Pannonian Plain, the Danube and the region of Vojvodina. The third hydrographic unit is the area of the lakes in the southwest of the Sub-Pelagonian Zone. This area begins with Lake Ohrid at the borders of Albania and FYROM, continues through lakes Orestiada, Prespa, Great Prespa and Vegoritida and ends in the small lakes of Western Macedonia (Zazari, Cheimaditida, Petron).

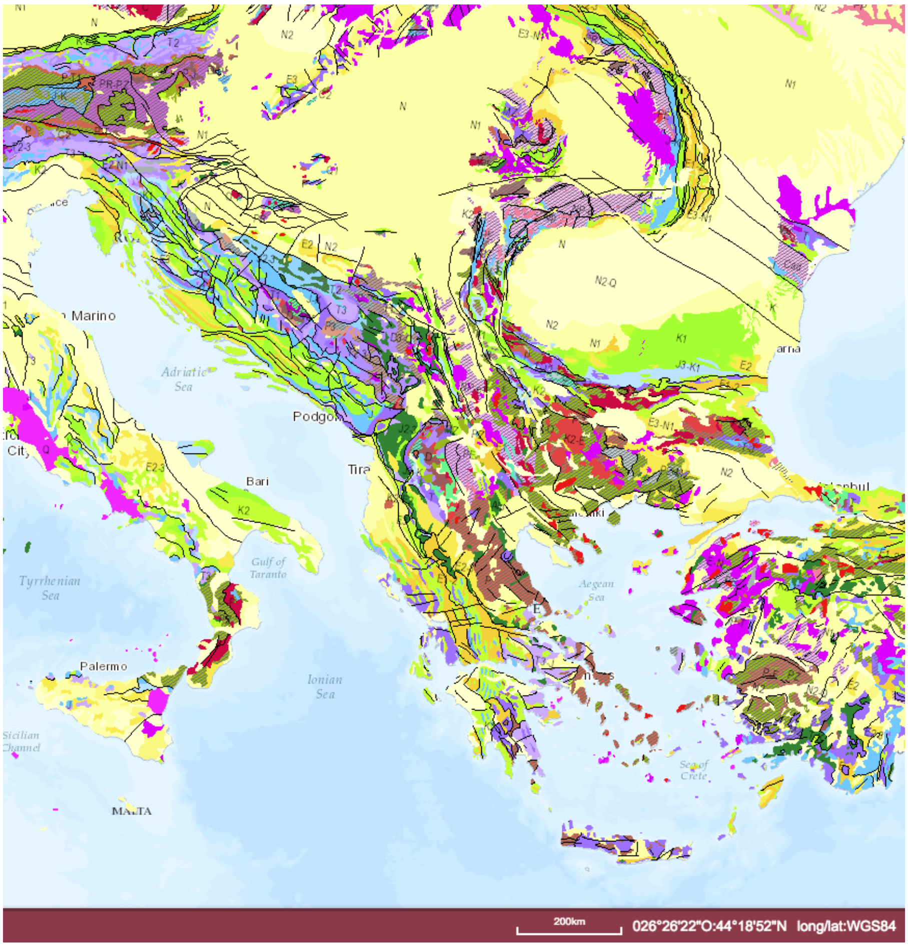

Figure 10 A geological map of the Balkans (courtesy of geoviewer.bgr.de modified by the author)

This geographical entity of the Western Balkans will constitute the study area of this thesis. This area has been a single cultural entity in modern history, after having been gradually shaped through the centuries of interaction of various ethnic groups with different languages (Slavs, Greeks, Turks and Albanians).

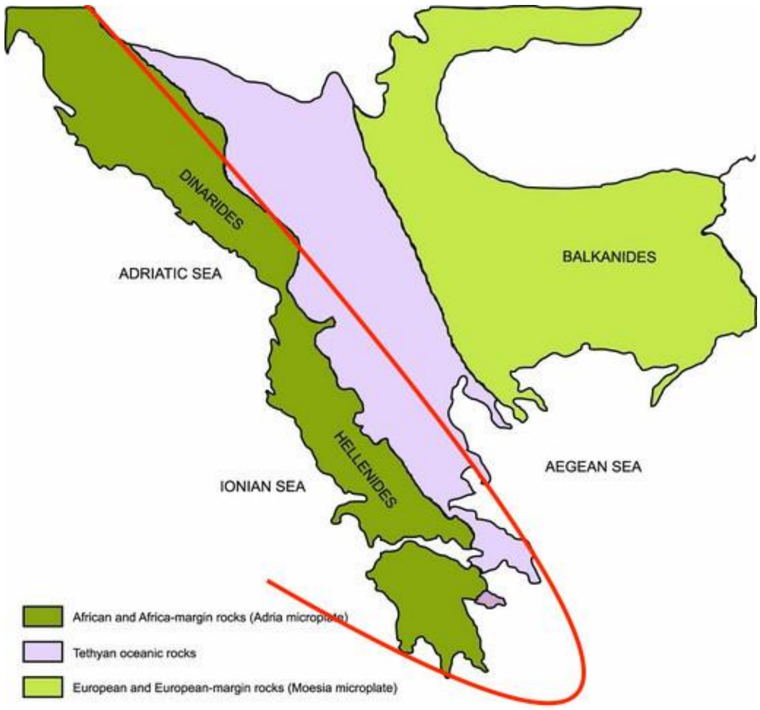

Figure 11 A simplified geological map of the Balkans which annotates the two main geomorphological units and the research area west of the red line (courtesy of Murienne et al 2009 – modified by the author.)

5.2 The origins of the Neolithic in the Balkans

Even if this thesis is not aimed at investigating and discussing the transitional process from the Mesolithic to the Neolithic in the Balkans, it is worth outlining this transition so that the particular features of the Balkan Neolithic can later be described. Between the Upper Palaeolithic and the Early Neolithic in the Balkans there is a distinct transitional stage (Boric 2005), which is accepted as “Mesolithic” for the purpose of this research.

There are specific and well-known models related to the various manners of appearance of the Neolithic way of life in the Balkans. The dispute between the migrationist/diffusionist and the indigenist theories is still active in archaeological discussion, with supporters of each idea presenting their own arguments (e.g. Ammerman 2010; Borić 2005: 17 Efstratiou 2007; Kotsakis 2003). The issue here is obviously far more complicated than a simple description of population movement. In order to create a new cultural identity – the “Neolithic” – a long-term procedure of cultural formation and transformation needs to occur (Whittle 1988). Therefore, the transition from the Mesolithic to the Neolithic in the Balkans was rather a combined procedure of imported elements and local features (Kotsakis 2003; Whittle 1996). Another question that remains open in the research is how the "Neolithic Package" was introduced to the Balkans. The most predominant theory supports the route through the Mediterranean and south Anatolia via Cyprus and Crete (Kotsakis 2003; Efstratiou and Mantzourani 1997; Efstratiou 2005). Despite the popularity of this theory, the archaeological data is limited and as such does not allow for a clear decision on whether the movement of the cultural elements and groups constitutes a single well organized and planned action (Broodbank and Strasser 1991; Broodbank 2006) or numerous small events, which extend to a broad time frame of gradual expansion (Broodbank 2006). This question is accentuated by the presence of dates that fall under the category of the very early stages of the Neolithic in various locations in the central and southern Balkans. Such are the cases of Lepenski Vir (see Borić 2016) in Serbia, of Sovjan (see Fouache et al 2010) in Albania and of the Cyclops and Franchthi caves (see Trantalidou et al 2010) in Greece.

Elaborating more upon the Mesolithic-Neolithic transition in the Balkans and how the Neolithic "arrived", recent research presents a more complicated transition model, compared to the traditional East-West movement. In Christiani et al (2016) the starch record trapped in dental calculus of Mesolithic teeth from the site of Vlasać, demonstrates that Mesolithic groups in the Balkans were eating domesticated grains, therefore the traditional idea that domesticated plants "arrived" in Europe as part of a "package" along with domesticated animals is challenged. Moreover, in Borić and Price (2013), collaboration as a model of co-existence between Neolithic farmers and local foragers is highlighted. This supports the older theory that Neolithic migrant groups might have taken advantage of the local forager groups in their environment. In relation to the caves that are the object of this thesis, the role of the indigenous Mesolithic groups that had good knowledge of their environment and the landscape in which they lived and acted, as well as the means by which this knowledge was passed onto the Neolithic communities is crucial for the understanding of the usage of caves in the Neolithic Balkans. More specifically, as mentioned in the previous chapter, caves are places with particular micro-environmental features. Humans use them in the general context of the utilization and exploitation of the landscape. During the Mesolithic in the Aegean as well as in the central Balkans, caves were widely used by the groups of that time as seasonal shelters (Sampson 2006; 2007). Based on this observation, the newcomers might have taken advantage of the existing knowledge concerning the landscape and the methods of its utilization in order to create new practices of landscape exploitation (Borić 2005). From the sites found in the Aegean, a continuation of usage of the cave sites that present deposits of the Mesolithic towards the earlier phases of the Early Neolithic is being outlined. Nevertheless, according to the same table, the number of caves that were being used increases significantly only after the middle of the Middle Neolithic and culminates in the first phases of the Late Neolithic. In southeastern Europe (and mainly in the Aegean Basin) caves seem to have a distinct role for the Mesolithic groups that continued into the early communities of the Neolithic. An essential contribution to the shaping of the identity of the members of new societies, through the transmission of the manner of utilization and exploitation of the cave environment becomes apparent.

5.3 The general chronological framework

In the case of the Neolithic in the Balkans, the issue gets more complicated as there is not a single chronological scale concerning the prehistory of the Balkans. The Neolithic in the Balkans seems to start at the turn of the seventh millennium and to end approximately at the turn of the third millennium[11] (Anthony and Chi 2010; Broodbank 2013; Bailey 2000; Papadimitriou 2010). Nevertheless, when it comes to the area that is the core of this research, the most ancient dates converge on the timeframe 7000–6500 cal BC, with the appearance of the cultural group of Sesklo (Broodbank 2013). As far as the issue of cultural groups is concerned, the system of integration of archaeological sites into groups and common cultural features is today still being used in the Balkans. The situation is differentiated in the Greek area, where the use of this method of classifying and dating sites has begun to fade, being replaced by an approach based on the archaeological era-period that each site occupies (Papadimitriou 2010). In other words, sites are still distinguished as being of the Starčevo or Vinča group in the Balkans whereas in the Aegean the distinction between the Sesklo or Dimini group has been replaced by determining the sites as being of the Early, Middle or Late Neolithic.

11 There is a problem here concerning the definition of the "Neolithic" as a chronological framework. In the southern Balkans, the transition period between the Neolithic and the Bronze Age, by the beginning of the 3rd millennium, is characterized as part of the Bronze Age. However, for the similar transition period in the central Balkans, the Chalcolithic is mainly incorporated as a part of Neolithic studies. This is a dynamic discussion, without a clear answer. This thesis is not aiming to take part in the debate.

Periods	Chronology (BC)	Thessaly	Central & Southern Greece	Cyclades Crete	Northern Aegean	Macedonia & Thrace	Balkan	Asia Minor Eastern Thrace
FINAL NL	3200 4500	Rachmani Pefkakia Petromagoula	Attica-Kephala Diros	Attica-Kephala Pyrgos Phaistos	Poliochni I Emborio VI-VII	Mandalo I-II Kritsana Sitagroi IIIB-C Makri	Karanovo VI Kodzadermen Bubanj Hum Ia Vinca C2/D Maliq IIa-b	Kumtepe Ib Kumtepe Ia
LATE NL II	4800	Classical Dimini Otzaki Agia Sophia	Nea Makri Gonia Corycian Cave Diros	Paros Naxos (Zas Cave, Grotta) Saliagos Knossos I Knossos II	Emborio VIII	Dispilio Makriyialos II Vassilika III-IV Olynthos 1-3 Dikili Tash IIB-C Makri Paradimi IV Sitagroi IIIA Dikili Tash IIA	Karanovo V Marica Vinca C1 Maliq I-Kamnik	Ilipinar V
LATE NL I	5300	Arapi Tsangli-Larissa	Nea Makri Kitos Cave Elateia Mattpainted ware	Saliagos Knossos III Knossos IV	Emborio IX-X Agio Galas "Lower Cave" II	Dispilio Makriyialos I Vassilika I-II Paradimi III Makri Sitagroi II Dikili Tash I Sitagroi I Paradimi I-II	Karanovo IV Karanovo III- Veselinovo Vinca B Porodin II Anza IV Vinca A	Ilipinar VI-VII Yarimburgaz 2-3
MIDDLE NL	5800	Zarko Sesklo I-III	Chaironeia Nea Makri Urfirnis ware	Knossos V-VII	Agio Galas "Lower Cave" I Agios Petros	Servia	Karanovo II Starcevo Anza I-III Porodin I Vashtemi-Podgorie	Ilipinar VIII-IX Yarimburgaz 4-5 Hacilar I-V
EARLY NL	6500	Presesklo Protosesklo Early Pottery	Franchthi Rainbow ware	Knossos VIII-IX	Agios Petros Yioura	Servia V	Karanovo I Cardium-Impresso	Ilipinar X Hacilar VI-IX
PRE-CERAMIC	6800	Argissa	Franchthi	Knossos X	Yioura			

Figure 12 Simplified chronological table of the Balkan Neolithic. The red box showcases the main timeframe of this thesis

When it comes to the classification of the Neolithic into Early, Middle or Late Neolithic, it should be mentioned that neither the classification itself is applicable across the entire area that is being analysed, nor are the terms common everywhere. As a general framework, the dates of the Early and Middle Neolithic coincide across all the central and southern Balkans. The Early Neolithic takes place in the period from the beginning of the seventh until the beginning of the sixth millennium and the Middle Neolithic, the period from the beginning of the sixth until the end of the sixth millennium (Anthony and Chi 2010; Papadimitriou 2010; Papathanasopoulos 1996). The situation gets more complex with the sub-periods that follow, particularly with the later stages of the Neolithic, in the southern Balkans–Aegean context a different chronological framework is used, compared to the central northern Balkans. There are several reasons for the existence of this dual framework; on some occasions this happens particularly because there are two different research traditions involved: the Greek-Aegean and the Balkan – something that I will analyse later in this chapter –

and on some occasions this happens due to the actual diversity of the material culture between the areas. A more in-depth analysis on the regional dating of the Balkan Neolithic, referring to the caves which are the case studies of this research, is presented in the second part of Chapter 4. The period(s) to which each site is dated (depending on the area where it is located), the cultural group in which it is included by the researchers and the absolute dating that is available will all be mentioned. In this study, the use of each cave will be studied in its own wider chronological context and the absolute dating as well as the cultural system of chronologically determining the archaeological sites will be used for the general overview.

5.4 A brief history of archaeological cave research in the Balkans and the political aspect.

The early research

Systematic archaeological research into the caves of the Balkans began in the middle of the 19th century. The first recorded systematic excavation took place in Greece, in the cave of Pan in Athens between 1841–1843 by K. Pittakis under the auspices of the Archaeological Society of Athens (Trimmis 2015a). The results of this excavation were published in *Archaiologiki Ephimeris*, the scientific magazine of the Archaeological Society that is still published to this day (Pittakis 1843).

About a hundred years would pass from Pittakis' research to the contemporary research into the caves of the Balkans. During this time, amateur European archaeologist-speleologists took over the research attempts. Some typical examples are the Italian Luigi Cardini with his researches in Albania from 1930 to 1939 and the Austrian doctor-anthropologist Albert Markowitz who studied caves in Greece from 1925 to 1940 (Francis 2005; Trimmis 2015a).

Prior to the presentation of these two researches, it is worth highlighting a characteristic of the research in the Balkans. As mentioned in the previous chapter, archaeological research in the western Balkans was deeply influenced by the political conditions of each period. As Novaković (2002:323) has characteristically mentioned, the archaeological research in the Balkans "reveals a pattern of sharp ruptures (both in infrastructure and in concept) concomitant with major political change". As such the present research inevitably consults the wider political background of the time as well as discussion of the archaeological research. In the same context, Cardini's and Markowitz's researches are integrated into the wider political climate of their time and have been moulded up to a point by it.

Luigi Cardini's researches in Albania

Cardini's diaries have been commented on by K. Francis (2005) and have been published by the British School at Athens. However, the largest part of Markowitz's archive material has been lost, while that which he donated to the Anthropological Museum of the University of Athens has not yet been published (Merdenisianos, pers. comm. 12.2016). Cardini arrived in Albania as a promising 32-year-old prehistorian (Gilkes 2005:2). He was a member of the Italian mission in Albania, which was organized by the Italians with the purpose of establishing and expanding Italian influence in Albania (Gilkes 2005:1). The young Luigi Maria Ugolini was the director of the mission. Apart from his archaeological studies at the University of Bologna, Ugolini had also served as a reservist in the elite Italian hand-picked Alpine Corps (Gilkes 2005:1). Although Cardini was chosen as a member of the mission, he was neither a member of the Fascist Party nor shared their particular political beliefs (Gilkes 2005:3).

Cardini visited Albania five times, twice in 1930 and once in 1935, in 1937 and in 1939 (Francis 2005). From the beginning, his research interest was focused on the caves of the coastal zone and mainly of the area from Saranda to Vlora. After documenting the caves that he visited and studied during these five trips, Gardini collected information on a total of at least 16 caves with Palaeolithic, Neolithic and Bronze Age findings (Francis and Gjipali 2005). Cardini did not conduct just a survey in the caves that he visited but excavated test trenches as well. In his diaries he recorded the location of the caves, the ways to access them, the finds and their relevant chronology. He also included a sketch of the cave in which he annotated the locations of the excavation trenches. The systematic classification of his records was valuable for re-locating the caves that were subsequently studied by K. Francis' team.

Adalbert Markowitz and early research on Greek caves

Adalbert Markowitz studied medicine in Graz, Austria, but his interest gradually shifted towards anthropology and archaeology (Pitsios 1996). Unfortunately, the biggest part of his work was lost as Markowitz was killed in an airplane accident on 28th October 1941 (Ioannou et al 1996). The part of his archive that has been saved is the one that he himself donated to the University of Athens, which has not been published yet, with the exception of one conference. What is deduced from the archive material is that Markowitz arrived in Greece as an envoy of the Austrian Academy of Sciences after an invitation from the Greek government (Pitsios 1996). Once more, politics played its part, as during this period the Greek government was trying to establish a relationship with the Central European countries (Austria-Germany), which had started to rise after their defeat in the First World War (Pitsios 1996). Markowitz recorded an estimated 500 caves in Greece, on which he wrote a complete speleological guide with pictures, sketches and information (Ioannou et al 1996). Archaeologically speaking, it is well established that he studied the caves of Attica and more specifically the caves that featured signs of worship of the god Pan, such as Zaimi Cave in Kakia Skala (on the borders of the prefectures of Attica and Corinthia) as well as the cave of Antiparos (Ioannou et al 1996).

Markowitz was not the only one who took an interest in Greek caves before the war. Prior to his work, the researches of the British School at Athens in the Kamares and Dikteon Andron caves in Crete (Ioannou et al 1996) as well as Ioannis Travlos' researches in caves with signs of worship of the god Pan in Dafni and Parnitha in the prefecture of Attica had taken place (Travlos 1937). However, all of those research attempts shared a fragmentary approach and although they were analytically published, they cannot be integrated into a wider framework.

Karl Ludwig Moser, Dragutin Gorjanovic-Kramberger and the beginning of archaeological research in the caves of the Dinaric Alps

Along the rest of the Adriatic coastline, on the coasts of Croatia and Slovenia, once more due to political circumstances, the archaeological researches began systematically quite early. Until the end of the First World War these countries were part of Austria-Hungary, whose scientific tradition shaped the research in the caves of the area (Prijatelj 2011). The first cave system to be excavated was Postojna Cave (Postojnska jama), where K. Freyer and F. Hochenwart, curators of the Provincial Museum in Ljubljana, provided the museum with bones of cave bears and examples of stalagmites in order to enrich its collections from 1819 (Prijatelj 2011:138). Nevertheless, about 90 years would pass by till the first systematic archaeological research in the caves of Slovenia by Karl Ludwig Moser, a professor from Trieste who took a strong interest in the prehistoric research of the caves (Prijatelj 2011). Since his work was funded by Vienna's Central Commission and Anthropological Society, he sent excavated artefacts to Vienna and thus came into open confrontation with others (namely Andrea Amorosa and Carlo Marchesetti) who were trying to secure the retention of finds in local or civic museums within the territory of the Littoral (Cunja, 1992:74). In 1899, Moser published his book *Der Karst und seine Hohlen* which includes a collection of his 23-year archaeological and palaeontological research on the caves of Slovenia. In spite of the critique that Moser's reports are mostly summaries that are of little use to archaeologists today (Cunja 1992: 73–74), his book constitutes a unique attempt to present the natural and cultural aspects of caves while taking into account the factors of time and place (Prijatelj 2011:139).

The dissolution of Austria-Hungary after the First World War and the integration of Slovenia into the first Yugoslavia had an immediate impact on the research of the caves, Trieste, which was the scientific centre, had been integrated into Italy and all the research programmes were put on hold (Prijatelj 2011:140). Almost ten years passed until the first Slovenian research attempt was made. In 1929, the Instituto Speleologico Italiano (ISI) that was funded by the institution of Postonja and in cooperation with the Slovenian archaeologists Bertarelli and Boegan, studied the caves in the area of Kras and published the findings in the ISI magazine "Le Grotte D'Italia" (Kranjc 1997).

In 1899, in Croatia, fossil remains of the *Homo sapiens neanderthalensis* species were found at the cave site located at the Hušnjak hill in the Krapina area. The excavations lasted six years and were supervised by Professor Dragutin Gorjanović-Kramberger, a palaeontologist and palaeoanthropologist from Zagreb (Drnić 2010). Altogether about 900 remains of fossilized human bones, dated to approximately 130,000–120,000 BP, belonging to several dozen different individuals, from 2 to 30 years of age, were found in the deposits, thus the cave in Krapina soon became one of the most important sites for studies on human evolution, where one of the largest and richest collections of Neanderthals has ever been found (Drnić 2010). Archaeological research in the caves of Croatia followed a parallel course with the research in Slovenian caves. After the dissolution of Austro-Hungary and the integration of Croatia into the Kingdom of Serbs, Croats and Slovenes research lessened, mainly due to the lack of funding and the absence of organized research centres.

After World War II

The Balkans were greatly affected by the Second World War, due to the fact that they had to face both the external invasion of Axis forces and the internal political conflicts which led Serbia to conflict between the Cetnik and the Partizans, as well as throwing Greece into civil war (1945–1949) (Mazower 2000). This instability and crisis annihilated every research effort and it took about 15 years for the countries to be reborn from their ashes. As has been analysed in the previous chapter, following the Second World War the Balkans was divided between Greece, which was aligned with the Western Bloc and NATO, and the other countries, which were initially aligned with the Warsaw Pact and the USSR. This separation did not only affect the regional approaches and interpretation, but also isolated archaeological research in a state-oriented context.

Albania

Archaeology in post-First World War Albania was mainly conducted by the Institute of Archaeology of the Academy of Sciences. Due to the fact that Albania was an isolated socialist state (isolated even from the USSR and the rest of the Eastern Bloc) Albanian archaeologists had to travel to China in order to be trained. The main figures of Albanian archaeology, which excavated the Blaz, Nezir, Dajc and Tren caves, M. Korkuti and F. Prendi had followed this career path (Perzhita et al 2014). Before 1990, all Albanian archaeological research in caves was published in *Illyria*, the National journal for archaeology, published in Albanian. After 1990, Albanian archaeologists (mainly M. Korkuti) began to publish reviews on Albanian prehistory in international journals in English.

Prendi excavated Tren between 1966–1967. The cave is located on the northwestern coast of the Great Prespa Lake in southeast Albania. The stratigraphy of the cave extends from the middle Neolithic to the Roman period. The earliest occupation (Tren I) presented impresso and Maliq I pottery, which is the pottery that characterizes the open-air sites of the Sovjan and Maliq areas on the Korçë plain (Korkuti 1995). After the initial excavations of the 60s there have been no other research attempts in the cave, but a re-examination of the cave pottery for the Koromilia cave project has related the cave with pastoral practices (Trantalidou et al 2010).

Prendi and Andrea first excavated Blaz cave between 1978 and 1980. The cave has presented two main Neolithic strata which cover the period of the Early and Middle Neolithic (Prendi and Andrea 1981). Again, there is no absolute dating of the cave and the chronology is based on pottery shapes, with an Early Neolithic stratum, characterized by impresso pottery and the Middle Neolithic by pseudo-barbotine (Prendi and Andrea 1981). Prendi supports the idea of a pastoral site which was used seasonally by herders (Prendi and Andrea 1981:20). A current project undertaken by the University of Tirana and the University of Cologne is focusing on the Epigravettian deposits of the site.[12]

In the same area as Blaz Cave in Central Albania, is the Nezir Cave. Nezir was excavated by the end of the 1980s and the pottery represents a timespan from the Middle Neolithic to the early Bronze Age (Korkuti 1995). Korkuti supports a model of seasonal habitation for Nezir Cave by herding groups (1995:224).

Dajc is located in northwestern Albania and was excavated by Muhamet Bela in 1986 and 1987. The cave presented strata from the Middle Neolithic to Eneolithic periods (Bela 1987) and again there is no absolute chronological data available. Korkuti and Petruso support a model of pastoral storage use for the cave (1993:712), similar to the model which was presented for the caves in Tren, Blaz and Nezir.

Former Yugoslavia

Work in Neolithic caves in Yugoslavia was geographically restricted to the area of the Dinaric Alps and the Karst region in Slovenia. As Slovenia is outside of the context of

12 Information mainly from the Academia profile of the excavator Rudenc Ruka: https://www.academia.edu/6624372/New_Palaeolithic_discoveries_in_Albania [accessed 15/11/2015].

this research we will focus on the Dinaric caves or, in other words, the caves located in Dalmatia, Montenegro and Bosnia-Herzegovina.

Spila cave near Perast, in the Kotor area in Montenegro was excavated by Č. Marković in 1974 (Marković 1985). A stratigraphic sequence that covers a timespan from the Early Neolithic to Eneolithic is present. The dating of Spila is mainly based on the typology of the pottery and there are no absolute dates available. After the re-examination of the cave stratigraphy and pottery for this PhD project, the cave was probably used by pastoral groups for occasional/seasonal dwelling.

Odmut Cave is the most important cave site in Montenegro, and one of the cave sites that present the best C14 dates sequence in the Western Balkans.[13] Odmut Cave was excavated between 1972–1974 prior to the construction of the Mratinje hydroelectric power plant and dam. 80% of the anthropogenic deposits of the cave were excavated (Marković 1985). “The cultural deposit was formed evenly and regularly, and the constituent layers lay almost horizontally, sloping only slightly towards the front of the cave. Seven layers, differing in colour, structure and types of finds, could be clearly distinguished” (Marković 1974:7). Even though Odmut is not a ‘real’ cave as it did not present a dark zone, it is a vital site for the understanding of cave usage in the Neolithic Balkans, due to the long stratigraphic sequence which spans from the Mesolithic to the Early Bronze Age and the thick cultural deposits.

Crvena Stijena and Koronina are two more cave sites in Montenegro that have been excavated by Marković before the collapse of Yugoslavia. Crvena Stijena is located in western Montenegro near the border with present-day Bosnia-Herzegovina. The cave had thick cultural deposits (max. 20m) that represent a period from the Middle Palaeolithic to the Early Bronze Age (Bakić et al 2009). Koronina is located northeast of Cetinje and had been excavated by Marković in a short season during 1977 (Marković 1985). The excavator briefly refers to the cave in his book about the Neolithic in Montenegro (1985:92) as a cave with mainly Middle Palaeolithic deposits with a short Middle Neolithic phase.

In Herzegovina, A. Benać excavated Zelena Cave in one short campaign in 1955 (Benać 1955). The cave is located at the source of the River Buna, southeast of the town of Mostar. There are actually two caves with Neolithic deposits in the area –

13 About the dating of the Odmut cave and the relationship between Odmut and the other cave sites in the Western Balkans see 4.2 ‘Dating the Balkan Cave Neolithic’

"Mala (Small) Zelena" and "Velika (Big) Zelena". Most prehistoric activity seems to have taken place in "Big Zelena" (Benać 1956). The excavator interpreted the cave as a temporary habitat used during winter days or when torrents swelled at the foot of the hill (Benać 1956). However, the large amount of ash and the even spread of it across the cave could be interpreted as the pastoral practice of the annual 'dung burning' (Trantalidou et al 2010). During the years between 1976 and 1979 the caves of Ravlića, Hateljska and Zukovica have been excavated in Bosnia-Herzegovina as well. Unfortunately, there is no further information available about the outcomes of these excavations.

The quantity and the quality of the available information, about archaeological excavations in Neolithic cave sites from the Former Yugoslavia, are far better in the Croatian context. In Croatia and particularly in Dalmatia, nine caves have been excavated with the research published in the period between 1950 and 1990. Research on specific caves is published in local journals, mainly in Serbo-Croatian. However, there are English and German summaries accompanying the publications.

S. Forenbaher excavated Vaganska in 1984 for one season (Forenbaher and Vranjican 1985). The cave is located on the coastal slope of Mt. Velebit and presented evidence from the Early Neolithic to the Eneolithic periods. The excavator proposes that the cave was a seasonal shelter for pastoral groups.

Vela Spila is located on the western end of Korčula Island, overlooking the Kale Cove arm of Vela Luka town. The entrance to the cave is 4m high by 10m wide, in a bent arch shape. The cave has a single, large chamber approximately 50m long, 30m wide and 17m high. The ceiling is shaped as a regular spherical dome. Vela Spila was first noted in 1835 and the first excavations were begun in 1949 by Marinko Gjivoje and continued in 1951 by Boris Ilakovac and Vinko Foretić (Novak 1954). G. Novak took over the excavations in 1951 to confirm links with other sites on the island (Novak 1954). Research in the cave has been continuing from 1974 to today, unearthing a site with continuous occupation from the Upper Palaeolithic to the Bronze Age (e.g. Čečuk and Radić 2005; Cristiani et al 2014; Rainsford et al 2014; Radić 2015). During the Mesolithic, Vela Spila was used mainly for seasonal hunting, collection of marine resources and as a burial site (Cristiani et al 2014). During the Neolithic, Vela Spila is one of the cave sites that seems to be used for multiple purposes – ritual and economic – (Radić 2005), but this is an issue that will be tackled in Chapter 7. Research in Vela Spila began during the 1970s but the scientific analysis on the finds and the absolute date sequences from the cave are outcomes of the research that has been undertaken during the 1990s and the 2000s.

Golupinjača Cave is located on the northwestern slopes of Mt. Velebit, 20km from Gospić town. The cave was originally overlooking the River Lika. The entrance into the cave is today 30m above the level of the artificial lake which was created at the end of 1970s. Because of the previously difficult access to the cave, it was used through the ages as a temporary shelter for local communities during wars or any other danger (Dreschsler-Bizić 1968). The only dating for the cultural layers of Golupinjača is sherds from the Danilo Middle Neolithic culture (Dreschsler-Bizić 1968). Unfortunately, there is no available information about the possible uses of the cave.

Ispod Sela Srbani is located near the village of Srbani, on the northern ridge of the Mirna Valley. The cave has two entrances (a vertical and a horizontal one) and two large chambers that are mutually connected with a low and narrow passage. In Ispod Sela Srbani, B. Baćić carried out small-scale rescue excavations in 1974 and 1975 (Cuka 2009). In accordance with a report issued in 1974 (cited in Cuka 2009), Baćić placed the test excavation far from the entrance, at the very end of the long chamber, alongside the edge of the bottom of the cave in the dark zone. During his excavations Baćić did not get to the end of the cultural layer and so it is feasible that the cave contains still older archaeological finds. Following Cuka's (2009) analysis of the pottery material from Ispod Sela Srbani, it was suggested that the cave was probably used during the Middle Neolithic by pastoral groups.

Vela Spilja Lošinj cave is located on the steep western slopes of Mt. Osorčica, below the highest peak Televrin, in the middle belt of rocks on the island of Lošinj (Komšo et al 2004). Although the cave is located just a few hundred metres away from the coast, the steepness of the terrain and dense underbrush hinder access to the sea. The cave was initially excavated in the early 1950s by Vladimir Mirosavljević, but in 2004, as part of a project "Palaeolithic and Mesolithic Sites in the North Adriatic", cleaning of the profiles of old test digs was carried out, and a small shovel test pit was dug, in order to obtain more detailed information about the stratigraphy of the deposits (Komšo et al 2004). From the first excavation during the 1950s the cave has shown evidence of occupation from the Upper Palaeolithic to the Middle Neolithic period (Komšo et al 2004).

Gospodska cave was first recorded and investigated by Lovrich in 1776 (Dinij and Manolović 1966). In 1874 J. Woldrich, during the first quaternary geological investigations in Croatia, excavated a test trench through several deposits – near the top of which were ceramics and ruminant faunal remains and cave bear cranial fragments in the lower deposits (Dinić and Manolović 1966). Speleological and archaeological investigations were carried out by Dinić and Manolović (1966) and Jalzić (1973a, 1973b, 1977a, 1977b) during the 1960s and 1970s. Evidence from the Late Glacial period down to the Middle Neolithic have been unearthed in Gospodska (Jalzić 1977b), but no current research has been conducted in the cave since the final season of 1977.

Despite the aforementioned Neolithic cave sites in Croatia there are few other caves that have been excavated during the Yugoslavian era and the available information is fragmented or limited. These are sites such as the caves of Pazanjanice, Markova (Čečuk 1974,1976; Novak 1974; Novak and Čečuk 1982) and Tamnica (Zekan 1977).

Greece

The post-First World War archaeological research in Greek caves was organized and conducted mainly by geologists and cavers and not by the State Archaeological Service and the universities. In 1950, the Hellenic Speleological Society (HSS) was founded in Athens by the geologist and speleologist Ioannis Petrocheilos and 30 other members (Ioannou 2000). For the following 30 years, the members of the HSS explored, mapped and published the caves of Greece mainly in the HSS journal the "Bulletin". Since the HSS consisted, and still consists, of various scientific experts as well as businesspeople, professionals and simply people who share a passion for caves, the quality of the information on the uses of the caves varies from recording to recording (Trimmis 2015a). However, the Bulletin and the Archive of the HSS is still a valuable source of archaeological information about Greek caves as it is the largest cave archive in Greece. Recent research in the archive and the Bulletin of the HSS highlighted more than 112 new caves with potential archaeological interest, mainly though for their late antique and medieval aspects.

During the Cold War era, there were two major archaeological cave research programmes, which heavily underline the importance of Greek caves for the archaeology of the country: the excavations of the American Archaeological School and the University of Indiana in the Franchthi Cave in Argolida and the systematic research of Paul Faure in the Minoan caves of Crete (Trimmis 2015a). These two research projects and their significant results introduced caves to the archaeological discussion on Aegean prehistory in a new and dynamic way.

Paul Faure’s research in Cretan caves with Late Bronze Age evidence spans a period of over 30 years, from the late 1950s to the early 1990s. Faure summarized his work in his legendary book, *Sacred Caves of Crete*, published in Heraklion in 1996 (Faure 1994). He had also published several papers and monographs from the very beginning of his research endeavour in Crete, mainly published by the French School in Athens in French (e.g. Faure 1961, 1963, 1964, 1965, 1969, 1971). Faure’s research is the first attempt in Minoan archaeology to study rural Crete, outside of the “palaces”. Faure highlighted the importance of caves for Minoan society and their ritual and economic life. His research had an impact on general speleological research in Greece, because he was the first to study caves in the archaeological context of a period and a particular cultural group.

Excavations in Franchthi Cave in the Argolid in the late 60s occurred due to a special interest by the American School of Athens (ASA) in the cave. The ASA had started a large-scale survey in Porto Cheli from 1965. The cave had been located by the research team and initially excavated during the years of 1967 and 1969 (Jacobsen 1981). The exceptional assemblage of finds and the importance of Franchthi for the understanding of the beginning of the Neolithic in Greece, made the cave a referencing site for the study of the Greek Neolithic (Zachos 2000). Franchthi proved that important information about the understanding of Neolithic societies is hidden underground.

The predominant need for their protection and study led to the foundation of the Ephorate of Palaeoanthropology and Speleology (EPS) by the Ministry of Culture in 1977 (Trimmis 2015a). The foundation of the EPS immediately resulted in an increase in archaeological research of the caves of the country. According to the official website of the EPS, 87 caves with archaeological evidence are currently published online on the EPS database.[14] In the online database a short description of the cave along with the archaeological data and its dates of occupation are presented.

14 There is no data available about how often the EPS database has been updated. The last update was in 2012.

However, only excavated caves have been added to the database. The information about caves that have been visited and evaluated by the EPS archaeologists is in an unpublished report format. As a result, the number of caves of archaeological interest, as noticed by the archaeologists of the ephorate, is far greater (Mavridis and Tae Jensen 2013 Trimmis 2015a). Even if the archaeological research into Greek caves has been boosted in the last 20 years and various sites have been located and excavated, we still only have information about the archaeology from a very poor 1.6% of the 11,000 recorded caves (Trimmis 2015a).

5.5 The dawn of the new state archaeologies and the current Neolithic cave archaeological research in the Westerns Balkans and Greece[15]

Neolithic cave archaeology research in the Western Balkans and Greece has been flourishing since the middle of the 1980s onwards[16]. In Greece, the rise of cave excavations is an effect of the establishment of the Ephorate of Speleology and Palaeoanthropology. Archaeology in Greece was – and still is – state organized and conducted. The foundation of a special branch of the state archaeological service with the aim of investigating karst areas had a significant impact on the increase in the sites that have been investigated over the past 30 years. In the Western Balkans the rise of cave archaeology was related to the emergence of the new states after the fall of Yugoslavia and Enver Hoxha's rule in Albania. It is not possible to state here all the cave sites that have been excavated throughout these countries and Greece between 1990 and 2010. There is a total of more than 130 cave sites, of which 56 better published sites are listed in the cave index appendix (II). A total of 112 cave sites can also be found on the Balkan Cave Archaeology project website.[17]

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A complete running list of the caves in the Balkans with evidence from the Neolithic is available in Appendix II. All the caves, along with their maps, photos and relevant information are also available online on the project's website at: http://balkancavearchaeology.weebly.com/.

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The majority of the information in this section, about the current research in Balkan Neolithic caves is not published yet in a final format. Most of the information retrieved is either from projects, official websites and blogs or from personal communication between the author and the researchers. For that reason, I would like to thank personally my colleagues Marc Vander Linden, Katarina Gerometta, Katerina Trantalidou and Gazment Elezi who have shared with me their ideas and preliminary outcomes about their projects.

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http://balkancavearchaeology.weebly.com/ [accessed 21/11/2015]

In Greece, the research projects that set the tone for Neolithic cave research are clearly the excavations of Theopetra Cave in Thessaly and of Alepotrypa Cave in Mani, Peloponnese. Theopetra is a shallow cave (max. 80m length) and is located on the west slope of Theopetra hill near the town of Kalambaka, in northwest Thessaly (Kyparissi- Apostolika 2000). The Neolithic layers include sherds, ornaments, figurines, spindle-whorls, loom weights, millstones bearing traces of ochre, ground stone tools and more. Skeletons excavated in the cave exhibit an absence of typically Neolithic pathological conditions such as anaemia or malnutrition (Tomkins 2009). Alepotrypa is located at the southern edge of the Peloponnese in the area of Mani. Alepotrypa contained a large Neolithic settlement with thick cultural levels. Along the 300m cave, different activity areas have been identified, including habitation and mortuary zones (Papathanasopoulos 1996). Papathanasopoulos supports the idea that the settlement disappeared due to a violent earthquake, which caused rocks to fall and block the entrance, trapping a large amount of the population inside. Skulls appear compressed between fallen rocks. The first modern visitors to the cave found articulated skeletons on the surface (Papathanasopoulos 2010. The entrance was narrow, however, when the Greek Tourism Organisation decided to open the cave to the public and the entrance was greatly enlarged using dynamite. To prevent destruction to more of the cave the Greek Archaeological Service of the Ministry of Culture assumed management of the site, halted public access and stopped any more potentially destructive activities. There were some very well-preserved tools, weapons, and jewellery and everyday vessels found whole in their original position as well as open hearths, baking ovens, silos and thousands of decorated objects of household and religious use (Tomkins 2009). The pottery is of a local style with lots of different shapes. Other artefacts include obsidian and flint lithic tools, hand axes and grind stones used for food preparation, bone needles, clay spindle whorls, shell and stone beads, silver jewellery items, and marble and clay figurines (Papathanasopoulos 1996). Outside the cave, there is evidence of huts. As well as for habitation, the cave was used for mortuary practices. Tomkins (2009) suggests that the remains of the inhabitants of the cave may have been trapped in the cave by rock falls. Papathanasopoulos (1996) suggested that it was a typical domestic practice to intermingle living areas with mortuary spaces (Papathanasopoulos 2011). Alepotrypa Cave shows a diverse amount of funerary customs, which is remarkable considering that it is a single site. Due to the specific sites of reburial, perhaps this cave is the beginning of the formalization and institutionalization of reburial as a cultural practice (Tomkins 2009). The cave was also used for craft activities, facilitating a maritime trade economy, and as a place of worship. The metal that was found is probably symbolic because the raw material originates from Balkan sources and would have travelled far down the coast (Papathanasopoulos 2011).

Koromilia cave is sometimes referred to as Piges Koromilia, meaning Springs of Koromilia (Trantalidou et al 2006). It is near the town of Kastoria, in west Greek Macedonia, located on the northern bank of the river Livadopotamos. There are two chambers; one is a main chamber and the other is considerably smaller. The maximum dimensions of this cave are 27m x 85m. The cave has a curved stairway in the limestone exterior (Trantalidou et al 2010). The excavation revealed four main floors, one on top of the other. The chronologically last floor, i.e. the one closest to the modern floor, presented 30 postholes. These are from different structures such as wooden frames or huts. These would have been necessary to protect the occupants of the cave from dripping water and would have probably formed a sleeping area for up to two people (Trantalidou et al 2011). Throughout each layer there is a lens of ash, burnt coprolites and sherds. The floors are not all just bare ground, some layers of rough stones have been placed horizontally in a circle or in more or less quadrilateral order to produce a stable and possibly dry level ground to function as a stable floor (Trantalidou et al 2011). Moving pastoral groups with their livestock may have used the cave, as the walk from Kastoria to Korytsa is nine hours long across the plain of Kastoria or the Grammos Mountains (Trantalidou et al 2006, 2011). Another piece of evidence that suggests this cave was used for seasonal habitation is the construction of different floors. These would have served different purposes and would have been used by different groups of people in different seasons (Trantalidou et al 2011).

A. Sampson's work on the caves of the Aegean islands and southern Greece, has spanned a period of 30 years since 1985 and it deserves to be cited here. Sampson, initially as a member of the Ephorate of Speleology and Palaeoanthropology of Southern Greece and then as an academic in the University of the Aegean has investigated more than 50 Neolithic caves in Greece (e.g. Sampson 1987, 1993, 1996, 1997, 1998, 2006, 2007, 2008a, 2008b). From his legendary work the excavations and publications of the caves at Kalythies and Koumelo on Rhodes (Sampson 2006), the Cave of Lakes in Kalavryta, Peloponnese (Sampson 1997), Sarakenos in Boeotia (Sampson 2006), Cyclops on Gioura (Sampson 2008a) and Skoteini in Euboea

(Sampson 1993) set a great standard. Again, information from all of these sites can be found in the Cave index of Appendix II, but it is worth mentioning here that Sampson was the first researcher in Greece who recognized the importance of cave sites for the understanding of the Aegean Neolithic. His regional work is one of the few that tried to contextualize cave use in the southern Balkans and to investigate the caves as part of a greater Neolithic "network" of "rural" sites and "urban settlements" (Sampson 2007).

There are also other interesting researches on Greek caves from the period between the 1990s and 2010s. Briefly, the excavations of Trantalidou at Aggitis Cave; Mavridis in Schistos, Ayia Triada, Antiparos; and Leontari and Stratouli in Drakaina Cave on Kephalonia are the most interesting case studies (for a research overview: Trantalidou et al 2011; Mavridis and Tae Jensen 2013).

In Albania, the main Neolithic cave research project is the investigation of the Konispol Cave in southwest Albania, near Konispol village, just a few kilometres from the Greek-Albanian border. Konispol was excavated by Muzafer Korkuti and Halil Shabani between 1989–1990, and by interdisciplinary teams jointly directed by Karl Petruso and Muzafer Korkuti in 1992, 1993, and 1994 (Ellwood et al 1996). The Early Neolithic pottery in Konispol was characterized by impresso and pseudo-barbotine wares which are characteristic of the Western and Central Balkans. The Middle Neolithic can be identified due to the very thick-walled vessels that were found. Two different types of pottery suggest occupation in the Late Neolithic. These are local and imported painted pottery of Maliq I style. The local pottery is rough and without much finish, whereas the imported pottery, although still containing sand as a temper, is competently fired and varies in colour from cream to grey unlike the local reddish colour. (Korkuti and Petruso 1993). Konispol, according to the excavators, may have been used by pastoral groups as seasonal shelter (Ellwood et al 1996).

In Croatia and particularly on the Dalmatian and Istrian coasts, stands the work of G. Boschian, T. Kaiser, P. Miracle and S. Forenbaher. Their work – either as collaborators or individually – particularly in the caves of Pupićina, Grapčeva and Vela Spila is a milestone for research in Western Balkan Neolithic caves.

Pupićina cave in Istria, formed along a fault with running water being prominent. The western part of the cave is moister and preserves more stalactite/flowstone formations. The cave ceiling gets steadily lower as one moves into the cave, reaching its lowest point some 15m from the entrance; ceiling height increases again to the north, forming a secondary chamber inside the cave. The accumulation of sediment restricted access into this secondary chamber to a crawl space in Medieval and later times. In the main area, the surface slopes gently from northwest to southeast. Pupićina Cave was probably used during the Neolithic for ritual, cult and mortuary practices.

Grapčeva cave is located on the south coast of the Dalmatian Island of Hvar. The cave has a small entrance and there is a single chamber, 25m wide x 22m long x 5m high. Stalagmitic pillars and curtains divide the cave into a number of unequally sized labyrinthine spaces. A passage, completely encased in stalagmitic crust, climbs steeply from the northern end of the chamber, terminating in a dead end after some 10m. 70 sq. m of the internal space is stalagmites. The cave was used during the Middle Neolithic for burial and ritual practices.

The current cave research archaeology projects in the Western Balkans and Greece can be clustered together into three categories. The majority of the projects are repeated excavations of previously researched caves. These projects are the sturdy foundations upon which this thesis is built. Archaeologists here are applying new analytical techniques and novel research approaches to caves, which were initially excavated between the 1960s and 1990s. The excavations of Vela Spila in Croatia,[18] in Crvena Stijena in Montenegro,[19] in Blaz in Albania[20] and in Alepotrypa in Greece (Papathanasopoulos 2011) are the best examples of these projects.

Regional projects, which work in several caves in a particular area are the second largest category. These projects mainly complete surface research and excavate test trenches in caves and do not focus on the archaeology of a particular cave, apart from the current excavations in Vrbićka cave in Montenegro (pers. comm. Borić 1.2017). The majority of those projects also evaluate open-air settlements and do not solely focus on cave sites. UCL EUROFARM,[21] the Hvar island project in

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Information about the current research in Vela Spila in Croatia at: http://balkancavearchaeology.weebly.com/vela-spila.html [accessed 8/11/2015]

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Information about the current research in Crvena Stijena in Montenegro at: http://www.ucl.ac.uk/archaeology/research/directory/eurofarm_vander_linden [accessed 8/11/2015]

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Information about the current research in Blaz in Albania at: http://balkancavearchaeology.weebly.com/blaz.html [accessed 8/11/2015]

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Croatia and the author's project in Kastoria, Greece (Trimmis 2013) are good examples of the second category.

Ethnoarchaeological research in the caves of the Balkans is less well known when compared to other parts of the world, such as Central America (e.g. Ishihara-Brito and Guerra 2012; Woodfill 2014), even if caves in the Balkans are still heavily used for several purposes by local communities. Currently in our research area there are only two ethnoarchaeological projects in caves, one at Mt. Pelion in Thessaly (Andreasen et al 2009) and the other on Kythera Island, Greece (Trimmis 2015b). Andreasen indexed caves into 12 main types of modern usage: a) Dwelling, b) Short-term Shelter, c) Agro-pastoral, d) Storage, e) Refuge, f) Quarantine, g) Mining/quarrying, h) Spiritual, i) Burial, j) Hunting Stand, k) Leisure, and l) Research (Andreasen et al 2009:180). The types of cave usage that Andreasen presented are the same types that archaeologists use to describe the Neolithic types of cave use (e.g., Sampson 2006; Trantalidou et al 2011; Trimmis 2013; Tomkins 2009; Mavridis and Tae Jensen 2013).

5.6 The current trends in Neolithic cave research in the Balkans, the Mediterranean, and beyond.

What stands out in the historiography of research into the Neolithic Balkan caves is that the majority of the interpretations of the cave sites did not take into account the microenvironment – the geomorphology of the cave as a place, and that a "dualism" of possible uses exists. Most of the researchers and excavators tend to characterize the use of a cave either as a site employed for economic/production uses or caves that bear a more symbolic character/used for cult/ritual purposes.

These dualistic interpretations are based on some particular characteristics, mainly in a cave's stratigraphy and spatial arrangements, and additionally on a cave's material assemblages. Combining Trantalidou et al 's (2011), Mlekuž's (2012), Angelucci et al 's (2009) and Falkenstein's (2013) discussions on the topic, caves that present a) consistent layers of animal dung (burnt or not) mixed with animal coprolites and vegetal remains, b) clay floors, c) postholes arranged in circular or

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Information about EUROFARM project at: http://www.ucl.ac.uk/archaeology/research/directory/eurofarm_vander_linden [accessed 8/11/2015] semi-circular shapes, d) arranged areas for everyday activities – such as cooking or sleeping, e) moderate amount of pottery and figurine finds, f) significant amount of lithics and, finally, g) a moderate amount of zooarchaeological remains, tend to be characterized as caves associated with agropastoral activities, shepherd movement, or small groups of transhumance communities.

On a different note, caves that present a) burials, b) not well-arranged areas for habitation, c) large amount of animal bones, d) large amounts of figurines and decorative pottery, and e) absence of animal dung and vegetal remains, tend to be characterized as caves that have been used for symbolic expression/cult practices.

This dualistic model is really well established in the literature that discusses the interpretation of Balkan Neolithic cave use. Case studies, that have been presented earlier in the historiography part of this chapter, such as the excavation in Mala Triglavska in the Karst area, the excavations of Grapćeva and Pupićina caves on the Adriatic coast, and the excavations in Alepotrypa and Sarakenos caves (Sampson 2006) in Greece, have had significant impact on the model. To a great extent these projects are the baseline for every other cave research in the Balkans, mainly because the few available regional reviews of Neolithic cave use in the area have been published by the excavators of these sites.

For example, A. Sampson, who has excavated the majority of the Greek Neolithic caves that have been excavated to date, in the review of Neolithic cave use in his book *Prehistoric Mediterranean Archaeology* (2006) categorizes caves along the Adriatic coast and Aegean as places for seasonal or periodical occupation by pastoral groups or places for spiritual/cult expression. Sampson also states a hypothesis concerning the environmental impact factor on Balkan caves, which is one of the core hypotheses for this research. He argues that people use different cave environments for different purposes. Thus, deep and dark caves have been used mainly for storage and ritual purposes and wide and light-full caves have been used as a temporary shelter for people and animals (Sampson 2006). Samson did not elaborate further on his arguments, neither supporting nor rejecting them with any particular research on the topic.

Aligned with Sampson's comments, Trantalidou et al (2011) discuss the role that caves had for the MN pastoral groups of the Southwestern Balkans and Greece. After the examination of 26 caves in Greece and Albania, the authors summarize their outcomes in six main points (Trantalidou et al 2011:316): a) All caves in the sample were marginal and peripheral to main village settlements; b) The majority of the caves have been used for temporal/seasonal pastoral activities (pen herding, milking) and artefacts were usually manufactured elsewhere; c) Hearth debris was present in all sites with different configurations: a. scatters of ash and charcoal; b. stone-lined hearths; c. ovens: e.g. at Alepotrypa in the Peloponnese. There is no demonstration for any relation between length of occupation and the type of hearth. The number of hearths depends on whether the occupying group re-uses structures existing from previous occupants of the cave (e.g. at Piges of Angitis); d) Sleeping arrangements could have been lodged (e.g. lateral niches at Alepotrypa; eventually by the wall of the cave at Koromilia). e) Refuse disposal: No special concentration is referred to in the literature. Large numbers of bone fragments are discarded at random between the floors of the caves. At Angitis bones were found adjacent to the hearths. At Koromilia objects come up in small pits near the walls of the cave or the dry stones wall; f) Activity areas based on the spatial distribution of finds have rarely been spotted. Alepotrypa gives the impression of being a rare example.

There is only one, similar to this thesis, previous attempt for a Balkan-wide review of the cave use strategies, during the Neolithic. In this review Falkenstein (2013) examines 44 sites with evidence of intense Neolithic occupation. As he comments in his text, a dual symbolic/profane model for cave use in the Neolithic Balkans may "seem" accurate but can actually be biased due to the quite often thin layers of occupation at the sites, selective recording and the presentation of finds by the excavators, and "mainly", as he says, a paucity in the recording of the cave's topographic information (Flakenstein 2013:130).

Interpretation of cave use in the Neolithic Balkans as a dual symbolic – economic phenomenon is not a unique example. In Anatolia, the West and Central Mediterranean and Eastern Europe, areas that surround the Balkans geographically, regional projects on cave archaeology may be limited (see Angelucci et al (2009); Skeates 2009, 2012, 2016 about the central Mediterranean, Peša 2011, 2013 about Anatolia and Matušek 1996, 1999; Peša 2011 on southern central Europe, Bohemia and Hungary) but they also lead to similar or quite similar interpretations.

In the Near East, caves are used for seasonal occupation and rituals throughout the end of the Late Paleolithic and also during the Natufian and the Pre-pottery Neolithic periods (Peša 2011). In terms of microenvironment, the preference was clearly for bright, spacious, and dry caves (see the caves of Kebara, Shuqba, Erq el

Ahmar, Hilazon Tachit) or the entrance areas of larger cave systems (see Raqefet Cave) (Peša 2013: 160). Cave cults – or caves exclusively used for ritual expression – seem to appear only during the end of the PPNB (most important being the example of Nahal Hemar cave, Bar-Yosef and Alon 1988).

A shift in the relationship between humans and caves can be noted in the Anatolian context between the Early Neolithic and the Middle Neolithic. Similar shifts can be noted both in Sardinia (see Skeates 2016) and the Balkans (see Chapters 6 and 7 of this thesis). My excavations in Mala Pećina in the Dalmatian hinterland for the purpose of this thesis – for detailed outcomes see Chapter 8 – also showcased a similar shift. In the Anatolian Middle Neolithic, larger and darker caves seem to have been used primarily for cult and ritual activities. As Peša notes, this might be connected with "*a general move towards the ritualization of the underground world, one possible example of which are the anthropomorphic cave speleothems from the shrine in Çatal Hüyük"* (2013: 160). On the other hand, in the landscapes of the Near East, rock overhangs and bright caves contain a limited range of finds, related by the archaeologists to a mobile way of life, along with the typical layers of ash left over from the burning of dung, associated more with a nomadic pastoralism (for an overview see Kuijt and Russell 1993 and also Peša 2013).

Leaving Anatolia, the karst of Hungary and southern Slovakia is also associated mainly with pastoralist activities during the Middle and Late Neolithic (Matušek 1999) Based on the study of the region's most important caves – Domica, Baradla and Ardovo – a hypothesis has been established regarding winter cave habitation with stabling for livestock (see Lichardus 1974 or Peša 2011 for more recent bibliography). The Hungarian and Slovakian hypothesis on the pastoral use of caves is not very different from the model that has been proposed for the Balkans. Again, in the Moravian and Bohemian karst, dark caves or caves with decorative cave formations appear to have been popular for cult and ritual purposes (see evidence from the caves of Koňská jáma and Výpustek – Peša 2011 for extensive bibliography).

In the central Mediterranean, research on the MN – LN caves showcases similar patterns with Anatolia and the Balkans on the microenvironmental aspects of cave use. Once more, dark and wet caves in larger cave systems have been interpreted as mainly cult and ritual sites (see Uzzo and Grotta Scaloria – Whitehouse 2016) and uses of well-lit cave entrances and rockshelters are associated with pastoral activities and animal herding (see Grotta dei Piccioni and Grotta Sant'Angelo, in Abruzzo, Grotta delle Mura, in Apulia, Riparo Gaban, in Trento, – Angelucci et al 2009). Skeates, in a preliminary report on the findings of the Seulo (Sardinia) project (2009: 131-132), states that "ritual use" for the caves in the area follow the same frameworks of interpretation in terms of spatial arrangements in the caves and the characterization of material culture. I will return in more detail later to regional similarities and differences between the central Mediterranean and the Balkans in terms of cave use strategies in Chapter 9. Incorporating the data from this thesis's research I would like to discuss how cave use models which have been proposed for Italy, can also be adopted to gain a better understanding of cave use in the Neolithic Balkans.

Closing this part here, I would like to make some comments regarding the phenomenon of cave use. Further outside the chronological framework of the Neolithic and the spatial context of the Mediterranean, a dichotomy approach on cave use is present. As an example, Kempe, back in 1988 in the only book-length review on the human use of caves, diachronically and globally, states in the conclusion that the habitation of caves as shelters, storage or pastoral sites ame first and was then followed by symbolic expression (Kempe 1988: 249). In a more recent example, in northern Tanzania, Clark (2009) records the use of caves in the context of the Chagga of Mount Kilimanjaro, who extensively utilized underground spaces, in precolonial times, as shelters during periods of conflict, and as places for ritual congregation and cult practices. In a similar review on the use of caves in Peninsular and Island Southeast Asia during the Holocene, Barker et al (2005: 19) state that it is commonly summarized that the cave use phenomenon in the first phase is distinguished by caves being places of habitation, followed by a second phase of caves as places of burial and cult. Even if Barker et al (2005:20) suggest that this tendency to interpret deposits as either "domestic" or "funerary" is overly simplistic they do not offer an alternative model for interpretation. As an example, they present the Niah cave, in Sarawak area in Malaysia, where some niches in the entrance area were reserved for burial by Neolithic people, but others were used for habitation, and in some places these activities overlapped, though whether Neolithic people here and elsewhere in the region actually camped around where they were burying their dead is unclear.

Is, then, the ritual/profane dichotomy real when it comes to interpreting cave use – in the context of the Neolithic Balkans, but also in general? Recent research suggests that it probably is not; Durkheimian orthodoxy has long been abolished from archaeological thought anyway. However, Holley Moyes (2012) stated in the introduction of her volume about “sacred caves”, that cave sites can be “ritual,” “sacred,” “ceremonial,” or “liminal” spaces— as having “non-habitational” use and thus stand in opposition to dwellings, though she does acknowledge that she suggests a Durkheimian sacred–profane dichotomy. While this type of binary opposition may be attractive to the Western mind, many have argued that it is too static and does not express the complexity of religious or symbolic expression in many non-Western societies. In the same volume, Clottes reminds us that in many cultures there is no dichotomy between the natural and the spirit world and we must keep in mind that what we call “ritual” is an “etic construct” (Moyes 2012:28). Moyes, with the acknowledgment of the problematic nature of ritual and how controversial it is as a notion in archaeological discussion, is set free by this admission to discuss and present the ritual evidence from caves worldwide, avoiding tackling the complex issue. In the same year, in a different edited volume, Bergsvik and Skeates (2011: 8) “advocate the continued production of contextualizing regional syntheses of archaeological caves” and recommend to scholars to “attempt to move beyond the traditional distinction between economic and ritual use of caves to a more inclusive and sophisticated consideration of caves […] as culturally valued practical and symbolic resources”. However, they also state that we must acknowledge spatial distinctions between different activities.

As a conclusion, a dichotomy on the character of cave use exists and dominates the research, even today. A recent publication by Dowd and Hensey (2016) on the archaeology of the dark zone of caves again praises the “ritual” or “symbolic” aspects of cave use without equal consideration of the possible economic factors. In this research I will consider the dichotomy on cave use as a research hypothesis that is still under discussion. As I mentioned earlier in the introduction, it is definitely not in the scope of this thesis to challenge this debate or to contribute to the theoretical aspects of the character of cave use. Even for the context of the Neolithic Balkans, this would require a thorough analysis of the datasets of the excavated cave sites, probably also analysis on raw materials and a different theoretical and methodological approach – most probably making an entirely different thesis. However, I felt that I should present as thoroughly as possible the current approaches to the interpretation of cave use, and, later in Chapter 9 I will discuss whether my paleosensorial recording can add anything to this discussion or not. Again, the scope of this present research remains methodological and the techniques presented can be adapted to other subterranean archaeological contexts around the world.

5.7 Dating the Balkan cave Neolithic

In order to create a regional dating model for the purpose of this review, a coherent regional dating database has been created in collaboration with the Research Laboratory for Archaeology and the History of Art at the University of Oxford (RLAHA), UK and the Ephorate of Speleology and Palaeoanthropology of Southern Greece.[22] The final dating table for the Neolithic cave sites of the Western Balkans and Greece is an outcome of correlation between calibrated absolute dates, Bayesian modelling and relevant chronologies, after the re-examination of the published pottery styles.

Dates have been collected from previously excavated and published cave sites, except for the dates from the Mala Pećina cave in Croatia, which have been produced in the context of the excavations in the cave that were part of the Balkan Cave Archaeology project. Published ^{14}C-dates from the sites have been gathered from excavation reports and excavation publications. On most occasions the context where the sample has been taken is not mentioned, and also 95% of the samples are of charcoal from open hearths, which makes it more difficult to find secure contexts. Also, a lot of the available dates can usually be characterised as "junk" chronologies with a high possibility of biased sampling, residual interference and/or the old wood effect. Thus, a new sampling and dating campaign is urgently needed in order to acquire a really robust chronological framework for the Balkan Cave Neolithic.

Due to these limitations, only 12 out of the 112 sites can provide samples that can be used for Bayesian modelling. Bayesian modelling of radiocarbon dates is based on the premise of the Bayes' theorem (Bayes 1973, cited in Whittle et al 2011:19). This approach is "fundamentally probabilistic and contextual" as stated in "Gathering Time" (Whittle et al 2011:19), and simply means that "we can analyse any data that we have collected about a problem in the context of our existing experience and knowledge about that problem" (Whittle et al 2011:19). In

22 For assistance with the dating techniques, the interpretation of the dates, the research for secure contexts and the Bayesian modelling I would like to thank Dr. Katerina Douka (Oxford University), Dr. Katerina Trantalidou (EPSSG) and the undergraduate student of Archaeology, Rosie Dyvig (Cardiff University).

archaeological terms, Bayesian modelling allows us to constrain the probability distribution for a group of absolute dates, using as 'prior beliefs' the archaeology of the context that these groups of dates belong to.[23] In the case of this thesis' case studies, the nine sites that could provide 'prior beliefs' are the caves of Kitsos, Skoteini, Konispol, Gudnja, Grapčeva, Nakovana, Sarakenos, Mala Pećina and Odmut. A total of 44 dates have been gathered by the Balkan Cave Archaeology research team[24] and processed by K. Douka in Oxford University using the OxCal v4.2.4 software (see figures 14 -21).

These twelve sites and the 44 dates work as "anchor" sites for the regional chronological model. The equal spread of these sites from North to South (4 in Croatia, 1 in Montenegro, 1 in Albania and 3 in Greece) and the correlation of the material culture between these sites and the other cave sites in their surrounding areas helped to "calibrate" the absolute chronologies of another 18 caves; Alepotrypa (Gr), Koromilia (Gr), Katarraktes (Gr), Pozar (Gr), Theopetra (Gr), Drakaina (Gr), Leontari (Gr), Cave of Lakes (Gr), Schistos (Gr), Franchthi (Gr), Cyclops (Gr), Kouveleiki A and B (Gr), Pupićina (Hr), Vela Spila (Hr), Jasmica, Gospodska (Hr) and Nakovana (Hr). The total of 27 caves creates the core chronological background for this research (Table 4.f). From the 112 excavated and published Neolithic caves of the area, these 27 are only 30% of the sites. But for the total of 52 caves, which have undergone detailed examination and been well published – as will be presented next in this paper – the percentage rises to 50% of the caves.

Cave	**Laboratory Code**	**Material**	**Sample Context**	**Sample Location**	**Zone**	**Radiocarbon Age BP**	**Date cal BC**
Kitsos_ Gr11	Gif-1280	Charcoal	'Dwelling' level, with seashell, FN pottery sherds, burnt bones.	Layer 3a, Trench 1		5470 ± 150	4460-4070
	Gif-1610	Charcoal	Hearth in homogeneous ashy layer corresponding to a dwelling level	Layer 3, Trench 2		5350 ± 200	4440-3960

23 For more information about Bayesian modelling and archaeology see also Whittle et al. 2011; Bronk Ramsey 1998, 2001; Bayliss and Bronk Ramsey 2004.

24 Katie O'Connell, Rosie Dyvig, Gemma Smith and the author. The author holds all responsibility for the data processing.

			with associated LN/FN pottery sherds.				
	Gif-1832	Charcoal	Hearth with human and animal bones, LN pottery sherds, stone and bone tools.	Layer 4, Trench 2		5650 ± 130	4650-4360
	Gif-1670	Charcoal	Rich 'dwelling' level with LN/FN pottery sherds, burnt bone (goat, hare, wild boar, deer), and stone tools, bones and antler.	Layer 4, Trench 2		5750 ± 130	4580-4240
	Gif-1612	Charcoal	Hearth in a 'dwelling' level.	Layer 4, Trench 2		5700 ± 140	4710-4370
Skoteini_ GR10	Dem-107	Charcoal	Charcoal from hearth on a floor surface. 1.90m depth. LNIb sherds.	Trench A Layer 13 square 3		5564 ± 276	4720-4060 5200-3790
	Dem-113	Charcoal	Charcoal from hearth on a floor surface. 2.75m depth. LNIb sherds.	Trench A Layer 21		5706 ± 64	4650-4460 4710-4370
	Dem-138	Charcoal	Charcoal from burial. Depth 0.50-0.60m. LNIb sherds.	Trench A Layer 4-5 square 8		5817 ± 37	4721- 4616 4779-4554
	Dem-143	Charcoal	Charcoal from floor surface with hearth. 3.20m depth. LNIb sherds.	Trench C Layer 24 squares 5-6		5738 ± 39	4680-4532 4692-4489
	Dem-103	Charcoal	Floor surface underlying hearth. 2.75m depth LNIb sherds, burnt bones.	Trench A Layer 12		5769 ± 89	4720-4520 4840-4400
	Dem-136	Charcoal	Charcoal from Hearth. 3.70m depth LNIa sherds.	Trench C Layer 28 Squares 3-4.		6163 ± 36	5207-5044 5219-4983
Konispol_ AL04	Beta-80003	Sediment	Hearth with associated LN pottery.	Trench XII / 12		5200 ± 80	4230-3800
	Beta-56417	Sediment	Ash lens with LN	Trench	W	5810 ± 120	4935-4375

			pottery.	IX / 13			
	Beta-80002	Sediment	Hearth with associated MN pottery.	Trench XII / 16		6470 ± 70	5495-5265
	Beta-56416	Sediment	Ash lens with associated EN pottery.	Trench IX / 18	W	6800 ± 140	5950-5440
	Beta-67802	Charcoal	Hearth with associated EN pottery.	Trench XXI / 29		6830 ± 80	5820-5575
	Beta-56415	Charcoal	Ashy layer with associated EN pottery.	Trench IX / 20	W	7060 ± 110	6115-5680
	Beta-79999	Charcoal	Ashy layer with microliths.	Trench XXI / 42		7410 ± 80	6400-6035
	Beta-67803	Charcoal	Hearth with associated EN pottery.	Trench XXI / 39		7510 ± 90	6465-6160
	Beta-80000	Charcoal	Hearth with microliths.	Trench XXI / 41		7550 ± 80	6475-6190
Gudnja_ Hr15	GrN-10315	Charcoal – from oak and elm wood.	EN – impresso culture pottery.	faza I/25	W	7170 ± 70	6156-5928 6207-5891
	GrN-10314	Charcoal – from oak and elm wood.	EN – impresso culture pottery - very few flint and bone artefacts.	faza I/24	W	6935 ± 50	5842-5731 5972-5717
	GrN-10311	Charcoal – from oak and elm wood.	EN – impresso culture pottery - simple decoration.	faza I-II	W	6560 ± 40	5599-5478 5614-5425
	GrN-10313	Charcoal – from oak and elm wood.	MN associated with a few specialized flint tools.	faza II/19	W	6520 ± 40	5507-5472 5601-5377
	Grn-10312	Charcoal – from oak and elm wood.	MN associated with thick and thin pottery styles.	faza II/17	W	6415 ± 40	5469-5322 5476-5304
Grapceva_ Hr02	Beta-103487	Charcoal	MN - depth of c. 2.4m. Associated with classic Hvar pottery, with modest decoration.	1390		6000 ± 80	4960-4780 5198-4712

	Beta-103486	Charcoal	LN - depth of c.2.3m. Associated with classic Hvar pottery with outlined decoration.	1370		5900 ± 60	4838-4712 4910-4617
	Beta-103485	Charcoal	LN - ring porous soft wood without resin. Depth of c.2m. also found a lentil seed, gymnosperm cone and an acorn fragment.	1350		6130 ± 80	5226-4861 5298-4806
	Beta-103484	Charcoal	LN - depth of c.1.9m. Associated with classic Hvar pottery with standard decoration. average sherd weight of 16g.	1330		5420 ± 70	4340-4167 4432-4045
	Beta-103483	Charcoal	LN - depth of c. 1.7m. 4 juniper berry cones along with Hvar style pottery with modest decoration.	1320		5720 ± 70	4686-4460 4769-4365
	Beta-103482	Charcoal	LN - ring porous wood, soft with resin canals. Depth of c.1.6m. Associated pottery of classic Hvar style with c. 3% decoration.	1310		5460 ± 60	4350-4249 4448-4055
Nakovana _Hr17	Beta-103479	Charcoal		1250		4510 ± 50	3352-3097 3366-3023
	Beta-103480	Charcoal		1262		4700 ± 100	3637-3363 3660-3104
	Beta-106625	Charcoal		1280		5210 ± 40	4041-3972 4218-3959
	Beta-1063481	Charcoal		1290		5650 ± 100	4584-4359 4767-4262
Sarakenos _GR08	Dem-671	Unidentified Bulk Charcoal	Depth 1.4m, dark brown soil, grey in places. Late	Trench A, Layer 7, Square	W	5820 ± 52	4770-4600 / 4790-4550

			Neolithic pottery with a considerable percentage of painted matt sherds.	3			
	Dem-815	Unidentified Bulk Charcoal	1.50-1.65m depth, charcoal from hearth, figurine.	Trench C, Layer 12	W	5874 ± 22	4775-4720 / 4795-4696
	Dem-1141	Unidentified Bulk Charcoal	1.65-1.80m depth. Obsidian and animal bones.	Trench C, Layer 13	W	5931 ± 25	4842-4777 / 4881-4724
Odmut_ Me01	Si-2222	Unidentified Bulk Charcoal	Grey ashy soil with Impresso ware pottery.	Trench II Layer IIB	TW	6900 ± 100	5984-5636
	Z-412	Unidentified Bulk Charcoal	Sample from Hearth. Grey ashy soil with Impresso ware pottery.	Trench II Layer IIB	W	6736 ± 130	5970-5393
	Si-2223	Unidentified Bulk Charcoal	Grey ashy soil with Impresso ware pottery.	Trench III Layer IIB	W	6530 ± 100	5637-5312

Figure 13 Dates from "secure" contexts from Neolithic caves in the Balkans

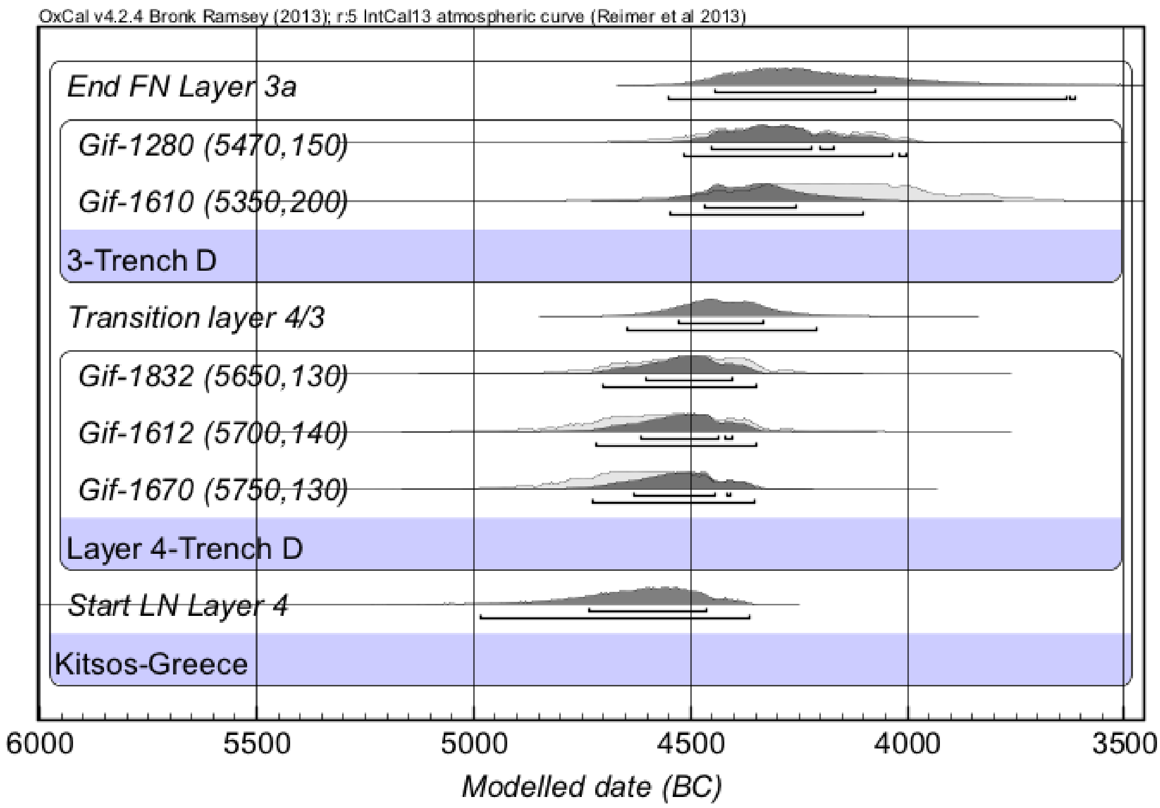

Figure 14 Chronological sequences of the available samples from Kitsos Cave in Greece

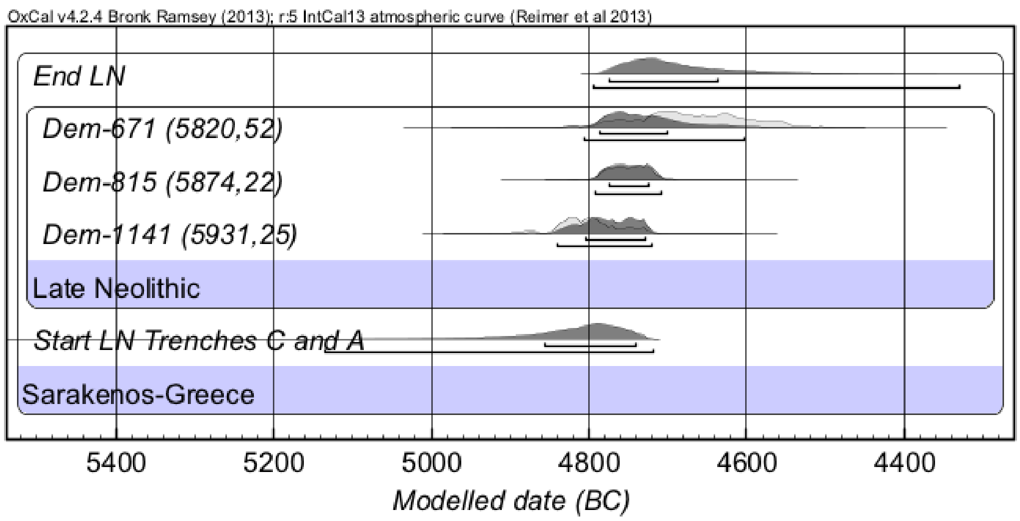

Figure 15 Chronological sequences of the available samples from Sarakenos Cave in Greece.

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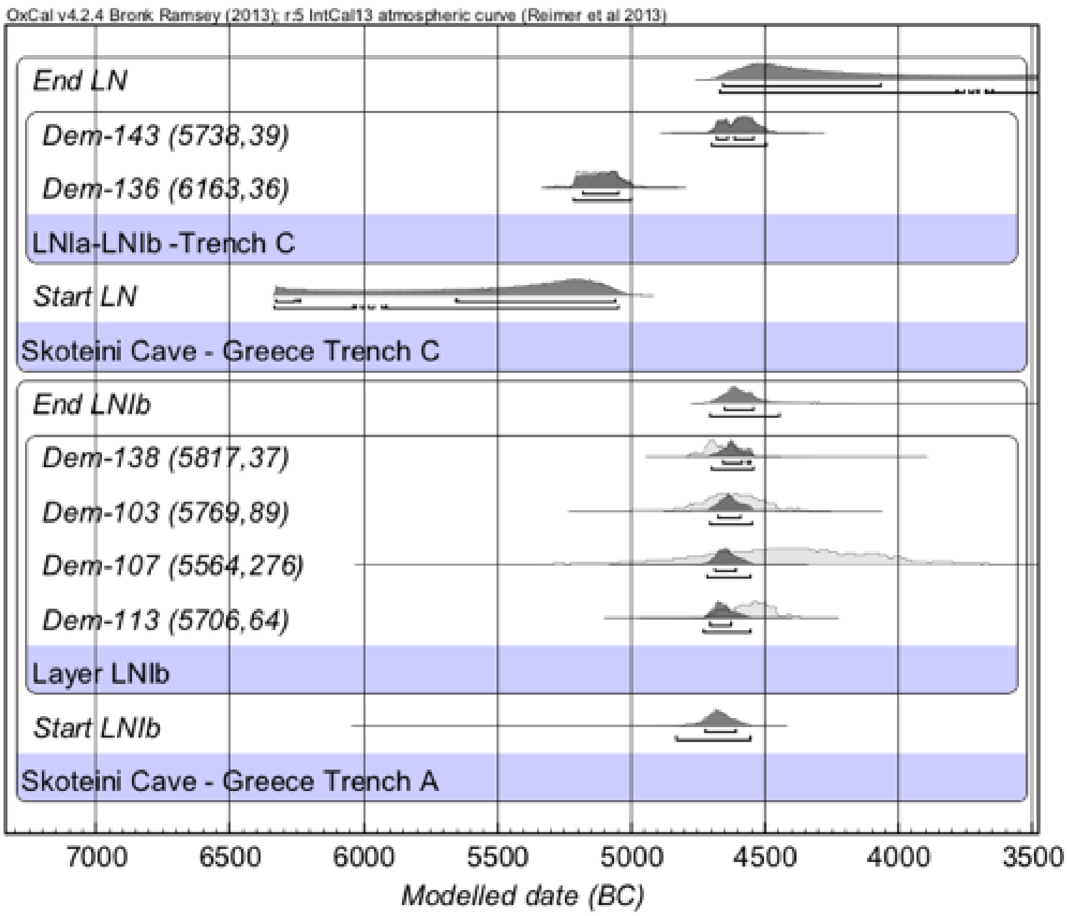


Figure 16 Chronological sequences of the available samples from Skoteini Cave in Greece

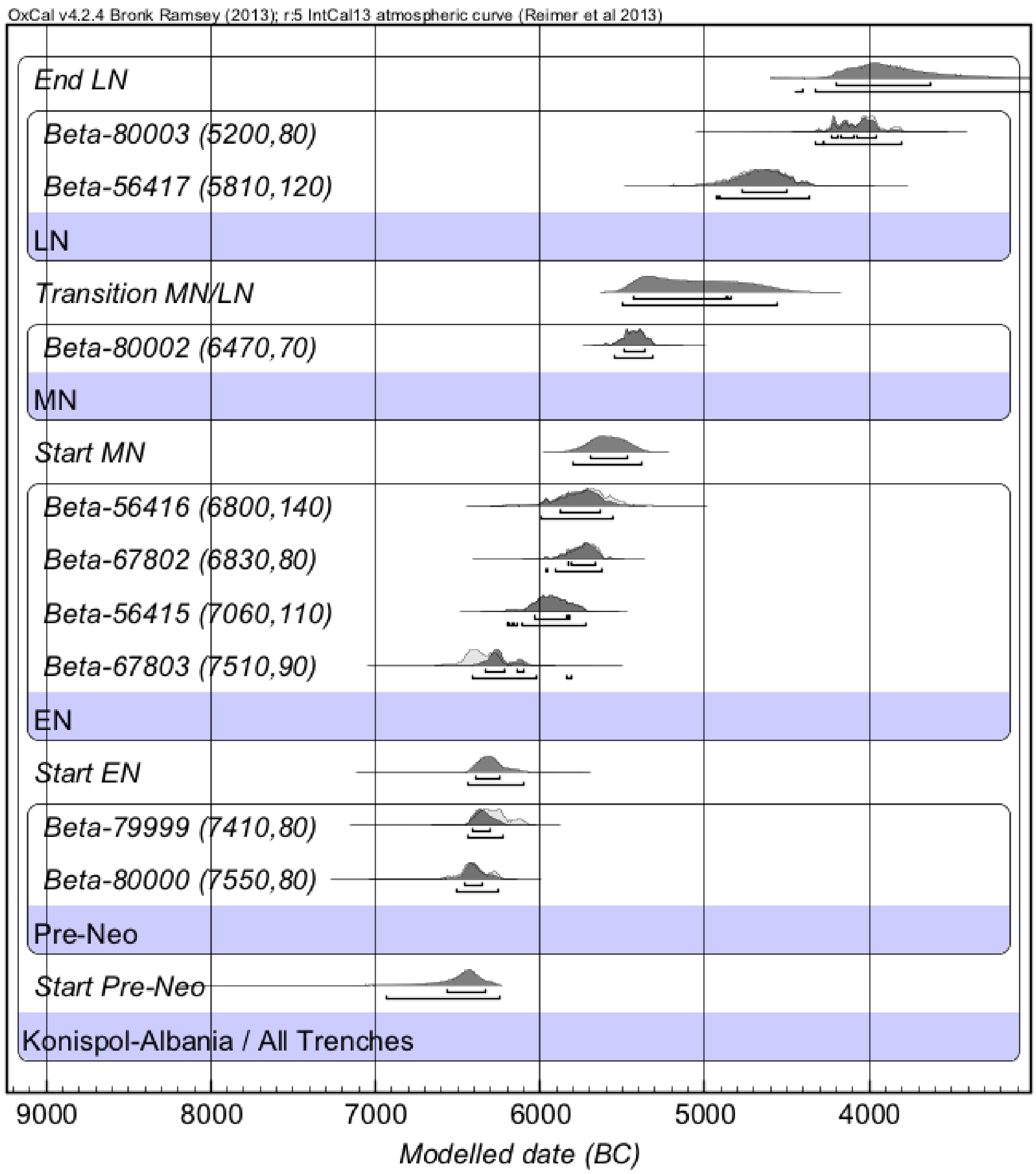


Figure 17 Chronological sequences of the available samples from Konispol Cave in Albania.

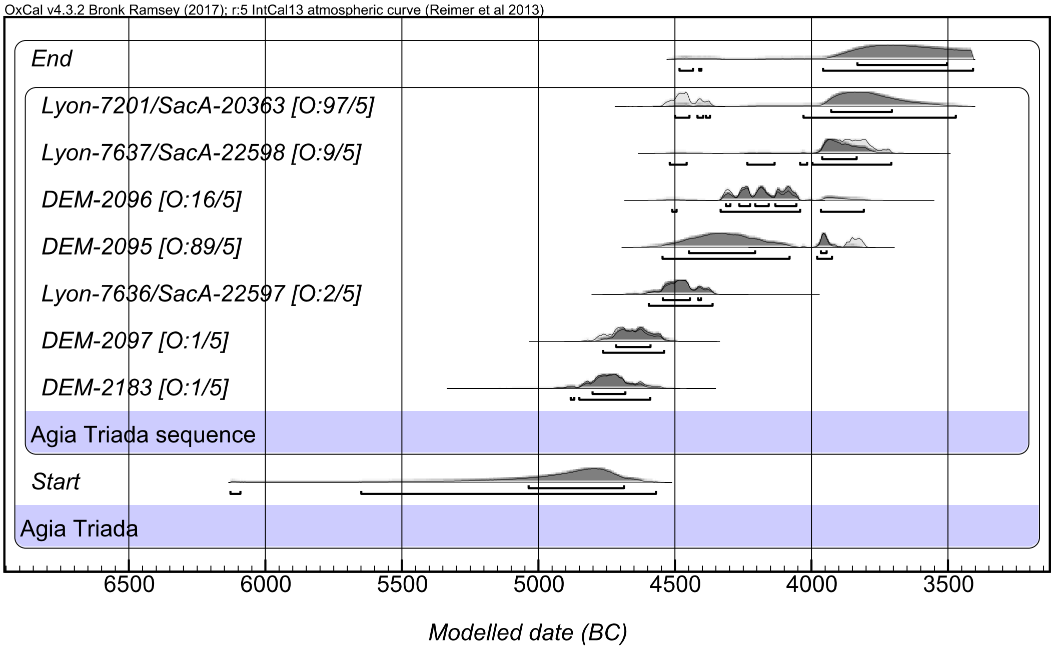


Figure 19 Chronological sequenses of the Agia Triada cave

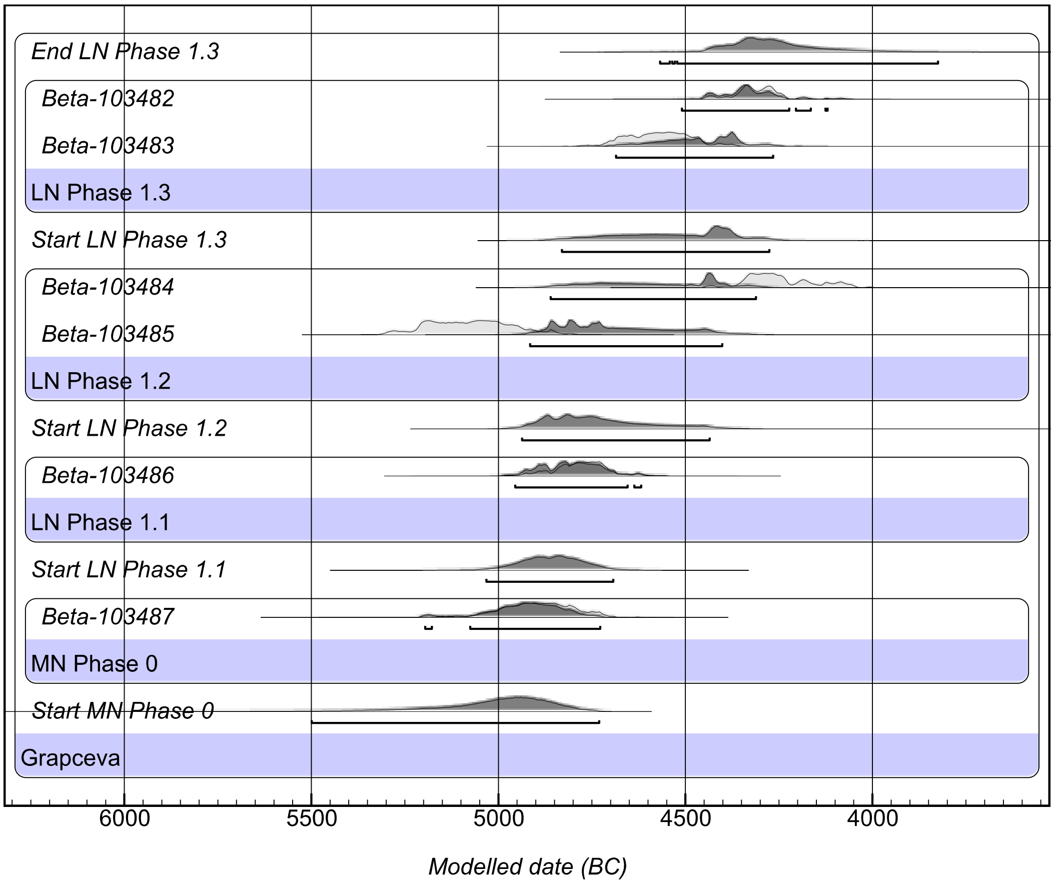


Figure 18 Chronological sequenses of Grapceva cave

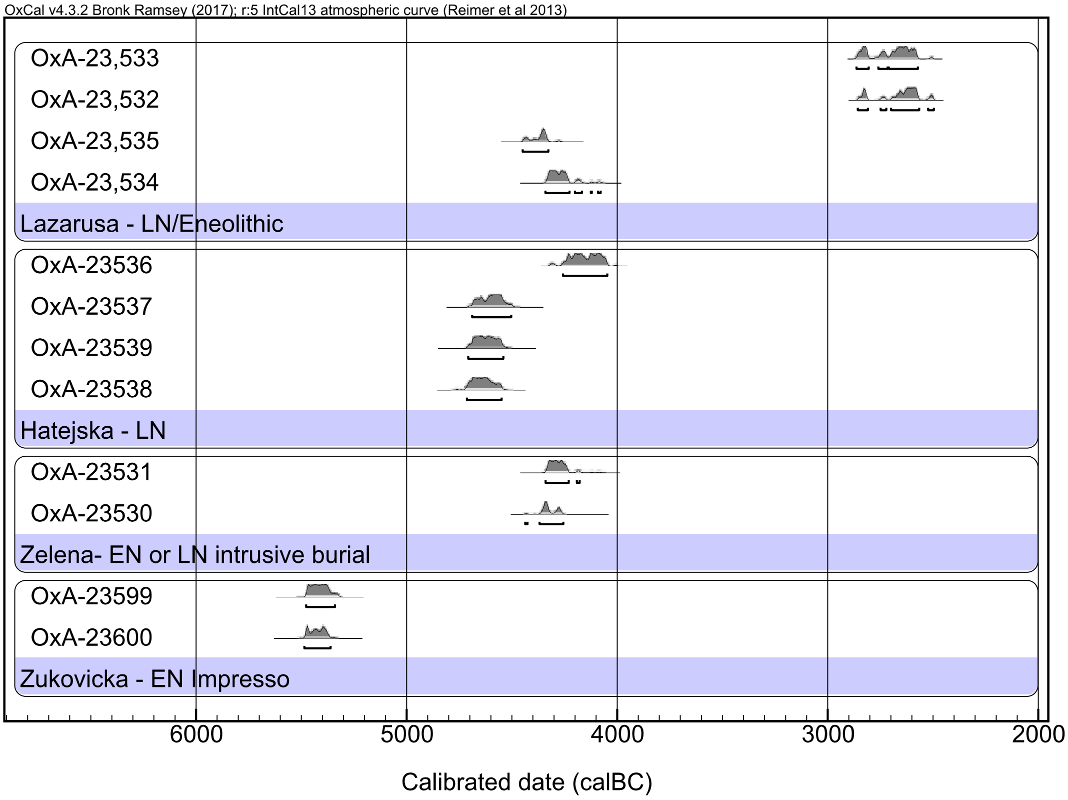


Figure 20 Chronological sequenses of Bosnian and Herzegovinian caves

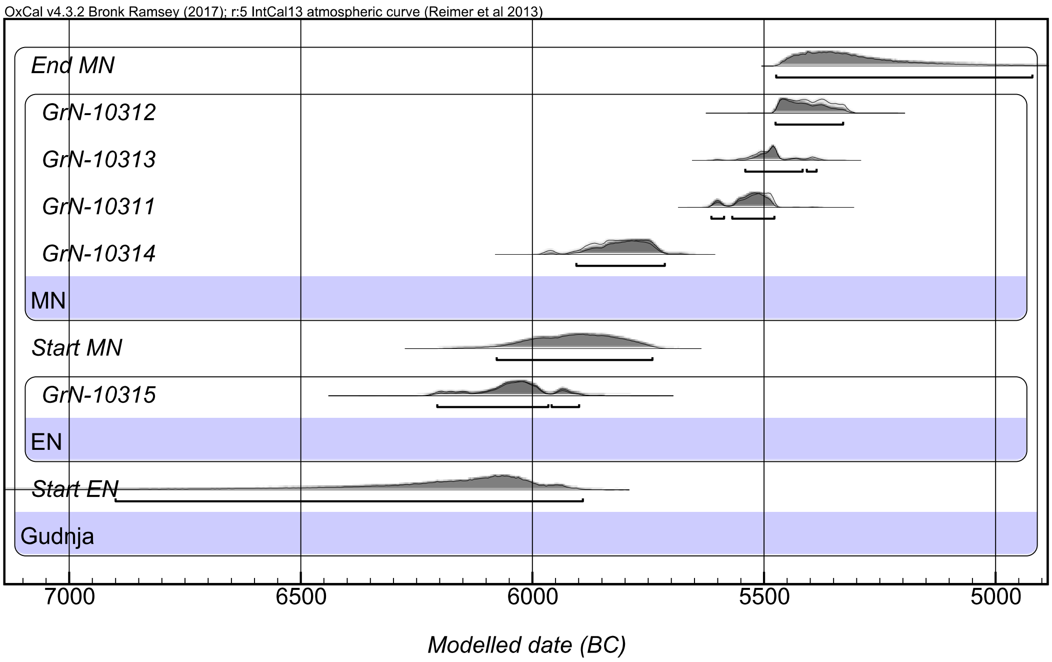


Figure 21 Chronological sequenses of Gudnja cave

Comments on the dating of cave use in the Neolithic Western Balkans.

Examining the chronologies from the cave sites of the Western Balkans and Greece, there are two points which seem worthy of further discussion. The first point is that the cave usage in the area is characterized by two major periods, through which people seem to have used caves extensively. The first period covers a timespan from 5700 to 5200 BC (Middle Neolithic) and the second a period between 4600–4100 BC (Late Neolithic). In general terms, the first phase corresponds with the peak of the MN in the Balkans and the appearance of the Starćevo main groups. The second phase aligns with the peak of the LNI and the emergence of "Classical Dimini" and Dispilio. However, there are more caves used in the Middle Neolithic than the Late Neolithic but as a general phenomenon these the caves that have been used in the MN have also been used in the LN. The reason for the chronological gap of almost 600 years in Western Balkans cave usage needs further investigation in the wider context but possibly marks a transition point between the MN and LN in the area.

The second point of discussion is the phenomenon of simultaneous use of caves for the same purposes across the Balkans. As an example, the most southerly cave in the region – Alepotrypa – presents a MN phase, which started around 5600 BC, almost simultaneously with the most northerly cave site of the regional context – Pupićina – that presents an initial MN date around 5750 BC. Even if we accept the current research for the area which stretches the chronologies of the Greek MN back to 6100 BC and creates a gap of 500 years between the Greek MN and the Adriatic MN (e.g. Broodbank 2013; Papadimitriou 2010), in the caves that gap does not exist. The reasons for this difference are not clear from this research and further examination of the cave sites in their wider regional context will probably present additional facts[25].

Putting the dates from the thesis case studies in the context of the Eastern Adriatic Neolithic it seems that the very early dates of the 6th millennium – between 6000 and 5500 – come from sites which present EN pottery wares such as Impresso and Danilo (Forenbaher et al 2013:597). Thus, the main argument is: whether the rise of cave usage started early in Dalmatia, in the late EN (around 6500 BC), and later in the southern Balkans (around 5800 BC), or whether Danilo and Impresso pottery styles represent a transition point between EN and MN or even a "primitive" Adriatic MN. It is a very difficult question to answer based only on the cave sites. However,

25 It is difficult to make a suggestion here, but either information in caves might be preserved better or the way that people use the caves has very few differences across the area.

chronological sequences clearly mark a period of 500 years – between 5700 and 5200BC – when the caves of the Balkans are used for the same purposes, by similar social groups, from the Aegean coast to Dalmatia.

Chapter 6

The regional context: recording sensorial patterns in the use of caves in the Neolithic Western Balkans

Summary

Chapter 6 begins with an introduction to the research project that has been organised as a platform for the three stages of application for the proposed methodology. Then chapter 6 presents the methodology of the first stage and the data collection strategy. After a presentation of the dataset, a spatial exploration and a statistical analysis of the caves' microenvironmental data are following. The chapter concludes with a discussion on the outcomes of a sensorial based research on Balkan caves and discusses how these are challenging the current understanding of the cave use strategies in the area during the Neolithic.

6.1 Introduction

Summarizing the ideas that I have outlined so far, this research aimed to investigate if we can employ a methodology in order to record archaeological senses in subterranean environments. I am using caves from the Southeastern European Neolithic as case studies with the aim of investigating if Neolithic peoples, when using a cave, paid attention to the climatic and geomorphological aspects of their environment, and if so, to what extent; and if their environment did affect their actions, in what way did it do so. In other words, did the "landscape" and the natural environment play a role in the way that Neolithic groups interacted with their surroundings, and did these stimuli play a role in decision making and behavioural practice? So far, I have discussed the theoretical ideas that have been raised over the last 50 years with regards to these questions and I have presented the different ways that researchers have tried to discuss the associated notions and arguments. I have also introduced the idea that caves are ideal case studies for these kinds of questions as they offer the intra-site variation of their three micro-environmental zones and sensorial stimuli from the past – such as in the deep dark areas of the caves – are still intact on certain occasions. In a previous chapter I have also presented the need for a novel approach to cave archaeological mapping in order to achieve the goals that I have set. I have extensively analysed how we can move to this novel "geosophical" approach of cave mapping using a combination of long existing cave-mapping methodologies along with current technological advantages.

The Balkan Cave Archaeology project

For the purpose of this thesis, I organised a three-year research programme in order to test methodologies and theories in the field and to evaluate firstly if the theoretical ideas can work in real case-based research and secondly if the methodology that has been introduced can work during a fieldwork expedition. Finally, I would like to personally investigate the theoretical questions about senses and feelings that I have outlined in Chapter 2, in the context of the Balkan Neolithic. The reasons that the Balkans have been selected as a target area have been explained in Chapter 3 as well as the Introduction. Research for this thesis has been organized in collaboration with the Archaeological Museum of Zagreb and funded by the British Cave Research Association. Research ran between June 2014 and January 2017 and has been organized into three main stages. The first stage of the research included the bibliographical and archival research, in order to gather information about previously excavated Neolithic caves from six modern-day countries of the Western and Southern Balkans: Greece, Albania, Montenegro, Bosnia and Herzegovina, Croatia and Slovenia. The main aim of this bibliographical research was to collect all the published Neolithic caves of the aforementioned countries in a single database.

The completion of the first stage of the research led to the construction of a database. This database can be found in Appendix II of this thesis. The second stage of the project included field testing the methodological approaches advocated in the thesis. Four caves were selected, all of which were in Greece. The last stage of the project was mainly characterized by the excavation at the Mala Pećina cave in the Dalmatian hinterland in Croatia. I set the target of excavating a site as the ultimate goal for this doctoral research, for the purpose of testing methodologies and theories against hard archaeological evidence, since all the research up until stage three had been based on previously excavated and studied sites. The presentation of the project and its data in this section of the thesis follows the progress of the research. The first part which is presented in this chapter covers the review work and the analysis that occurred. The second (Chapter 7) and third (Chapter 8) parts cover the research in the field, in the caves in Greece and the excavations in Mala Pećina respectively.

6.2 A geomorphology-based review

Overview and research methodology

The intention of this current project is to move away from a classic geographical interpretation of the spatial data to a more "geosophical" approach, which encapsulates the geographical information with quantitative and qualitative data (Gillings 2011, 2012). In order to make a transition from a purely quantitative approach, which correlates the geographical data with artefact clusters, to a qualitative methodology, we have to take into account the environmental values that shape people's perspectives and sensorial spectrum (Wheatley and Gillings 2002; Hamilakis 2013). In our case the qualitative data are the caves' microenvironmental zones, when the quantitative data that correlated with the archaeological evidence are cave entrance orientations and altitudes.

The idea is to correlate these datasets to challenge Sampson and Mlekuž's aforementioned theories about the possible impact of cave geomorphology and environment on human usage. Acceptance or rejection of these theories will then fuel a discussion on the extent of the geomorphological aspects that impacted cave use and if there is still room for other, more qualitative, interpretations of the cave use phenomenon.

Data was collected (archaeological, geological and spatial) from 112 excavated caves in the wider area of the Dinaric Alps and Northern Pindos mountains. Out of a total of 11,000 recorded cave forms in the area (see Trimmis 2015b) the 112 excavated Neolithic caves is a relatively small number – only just above 1%. Thus, any results can only be a prediction of the possible factors that affect cave use in the Neolithic Balkans rather than solid indications. Further field research is required for this dataset to be extended so that coherent conclusions to be drawn. This dataset is organized in a geo-referenced database, using QGIS, SPSS and R software, and I undertook a) an ANOVA type test between Altitude and Orientation, b) a Kruskal Wallis non-parametric test to challenge orientation and microenviroenment, c) a chi-square test for the orientation/ ‘proposed used’ relationsip, d) a chi-square test for the hypothesis test microenvironmental/’proposed use’ and e) a Cochran-Mantel-Haenszel test fot the ‘proposed used’/ orientation/ microenvironment hypothesis.

The statistical analysis was planned in order to answer the following research questions: (a) which areas of caves were used and for what purposes; (b) what micro-environmental zones in each case show greater density of use (based on the amount and type of archaeological data and its correlation with micro-environmental zones) and (c) what was the main particular use of each cave. The main question that I would like to discuss was whether the geomorphology of the caves shaped the way that people used them and if so, to what extent. As a secondary hypothesis we test the idea that wheather is a dualism in the cave use in the Western Balkans and Greece during the Neolithic, as has been discussed earlier.

The major issue on the data was the quality of the available information. The publications span across a 90-year period, from the 1920s to the present day. Archaeological methodology, recording and dating techniques have changed significantly during this time. In order to tackle this issue, especially regarding the chronology of the sites, we shortlisted 52 caves from Greece, Albania, Montenegro, Bosnia and Herzegovina, Croatia and South Slovenia. This sample represents just less than 50% of the available dataset and is equally clustered between the different regions, with 22 caves located in the northern part of the context and 30 caves in the southern. The sample makes us confident of projecting our results to the overall dataset of the 112 excavated caves. However, the results cannot be easily projected to the overall number of recorded caves in the region and only indications can be suggested. The 52 sites that have been selected to be evaluated in terms of the geomorphological impact on the use of caves all present a phase in the Middle (Balkan) Neolithic or Early Late (Aegean) Neolithic, with dates that span from 5,700–5,100 cal BC (see figures 22 ans 23).

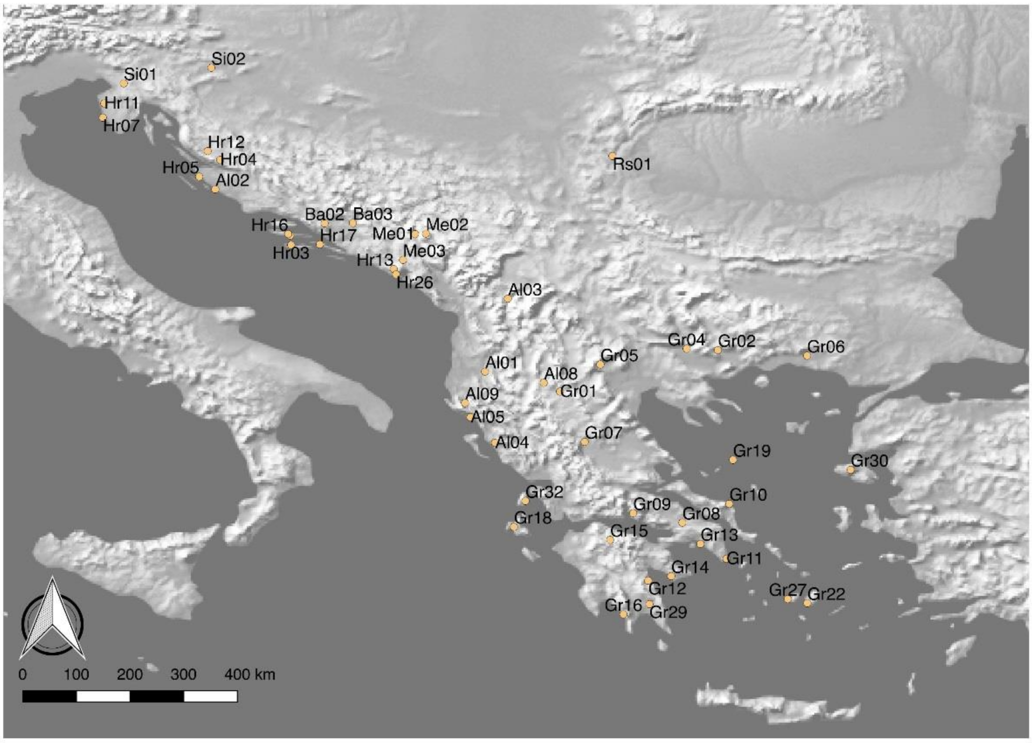


Figure 22 Distribution on the Dinaric Alps and Pindus mountain ranges of the caves analysed. Cave numbers on the map corresponds to the caves numbers in Fig. 23

The geomorphological attributes that we are checking are a) the altitude of the cave entrance, b) the orientation of the cave entrance and c) the distribution of human activities in the caves three main micro-environmental zones. Archaeologically I was analysing the occupation dates of the caves and the usage of caves as presented by the caves' excavators. The types of cave use have been reviewed for a variety of publications (e.g., Mavridis and Tae Jensen 2013; Sampson 2006; Tomkins 2009; Trantalidou et al 2010; Trimmis 2013) and have been considered as a) caves used as storage sites, b) caves for occasional or seasonal use by shepherds and hunters, and c) caves used for symbolic or cult purposes. From the 52 caves that were recorded in this research, only eight have been characterized as symbolic/cult places. A majority of 48 caves presented economic uses, mainly agropastoral (40 caves), but also as storage (seven sites) and hunting shelter (one) sites.

NO	NAME	ALT	OR	MICRO_ENV	Proposed_use
Me1	Odmut	558	SE	L / TW	Agropastoral
Me2	Crvena Stijena	700	SW	TW / D	Agropastoral

Me3	Spila	320	SW	L / TW / D	Agropastoral
Hr02	Grapceva	230	SW	D	Spiritual
Hr03	Vela Spilja	130	SW	L	Agropastoral
Hr04	Pazanjanice	320	S	TW / D	Spiritual
Hr05	Vaganska	700	S	L / TW / D	Agropastoral
Hr06	Laganisi	395	SE	L / TW / D	Agropastoral
Hr07	Vela Spilja Losinj	268	W	L / TW / D	Agropastoral
Hr11	Ispod Sela Srbani	48	S	L / TW / D	Storage
Hr12	Golubinjaca	558	SW	L / TW	Agropastoral
Hr13	Mala Pecina	488	SW	L / TW / D	Agropastoral
Hr26	Tamnica	355	SE	L / TW / D	Agropastoral
Al01	Katundas	450	E	TW / D	Spiritual
Al02	Blaz	NA	S	TW / D	Agropastoral
Al03	Dajc	1250	E	TW / D	Agropastoral
Al04	Konispol	400	SW	TW / D	Agropastoral
Al05	Himara	320	E	L / TW	Agropastoral
Al08	Tren	856	SE	TW / D	Agropastoral
Al09	Velce	NA	SW	NA	Agropastoral
Gr01	Piges (Koro)	850	S	TW / D	Agropastoral
Gr02	Piges (Aggitis)	129	SE	L / TW / D	Storage/Hunter stand
Gr04	Katarraktes	300	NW	TW / D	Storage
Gr05	Antarton Loutra	540	SW	TW / D	Agropastoral
Gr06	Polyphimos	150	SE	TW / D	Agropastoral
Gr07	Theopetra	280	N	TW	Agropastoral
Gr08	Sarekenos	180	SW	L / TW	Spiritual
Gr09	Korykeion Antron	1644	NA	L / TW / D	Agropastoral
Gr10	Tharrounia (Skoteini)	450	NE	TW / D	Spiritual
Gr11	Kitsos	288	E	L / TW / D	Agropastoral
Gr12	Leontarion	550	NW	TW / D	Spiritual
Gr13	Schistos	259	NA	TW / D	Agropastoral
Gr14	Franchthi	12	NW	L / TW	Agropastoral
Gr15	Cave of Lakes	800	SE	L /TW / D	Storage

Gr16	Alepotrypa	16	W	TW / D	Spiritual
Gr18	Drakaina	70	NW	L / TW	Spiritual
Gr19	Cyclops	150	W	L / TW / D	Storage
Gr22	Za	628	NA	TW / D	Spiritual
Gr27	Antiparos	171	SW	L / TW / D	Agropastoral
Si01	Mala Triglavca	435	N	L	Agropastoral
Si02	Ajdovska Jama	243	E	L / TW / D	Spiritual
Ba02	Ravlica	214	S	L / TW / D	Agropastoral
Ba03	Zelena	600	S	TW / D	Agropastoral
Gr28	Kouveileiki_A	350	W	L / TW / D	NA
Gr29	Kouveleiki_B	350	S	L / TW	NA
Gr30	Cave of Agios Vartholomaios	190	S	TW / D	Agropastoral
Gr32	Boliatso	NA	S	TW	NA
Rs01	Tabula Traina	91	W	L / TW / D	NA
Rs02	Pescara Mare	245	SW	L / TW / D	Agropastoral
Hr15	Gudnja	406	SE	TW / D	NA
Hr16	Markova	57	S	NA	NA
Hr17	Nakovana	400	SE	L / TW	Spiritual

Figure 23 Table with the caves that have been analysed for the first stage of the methodology application.

A spatial assessment of the dataset

The 52 caves that are the case studies for this review are mainly clustered on the slopes of the two main mountainous ranges of the area – the Dinaric Alps in the north and the Pindos Mountains in the south. From the 52 caves, 32 of them present a generally south-facing entrance orientation while only seven have a generally north-facing entrance. Six out of those seven caves are clustered in the southern part of the study area – modern-day Greece – with only one being located in modern-day Slovenia. There is also a higher range of altitudes present in the caves that lie in the southern half of the area compared to the north, the Adriatic and the Karst context. Most of the caves lie at altitudes up to 500m, with only 12 being observed at higher altitudes, the highest one being Korykeion Antron, which is located at an altitude of 1644m asl (see figure 24).

There are no obvious regional patterns for the use of the microenvironmental zones of the caves. Caves that have been proposed as “burial” or “spiritual” sites are mainly distributed near the coastal regions or at higher altitudes. On the other hand, caves that have been characterized as “agropastoral” or “storage” are scattered across the Balkans much more evenly. There are gaps in the distribution of the more widely used storage and agropastoral caves throughout the interior of the Pindos Mountains and the Dinaric Alps. This may be accurate, but it is more likely that it reflects a research bias in this area, due to recent political events and conflicts that have slowed field research in certain areas of the central and western Balkans. It is difficult to calculate the error margin since this research is mainly reviewing extant bibliographical data.

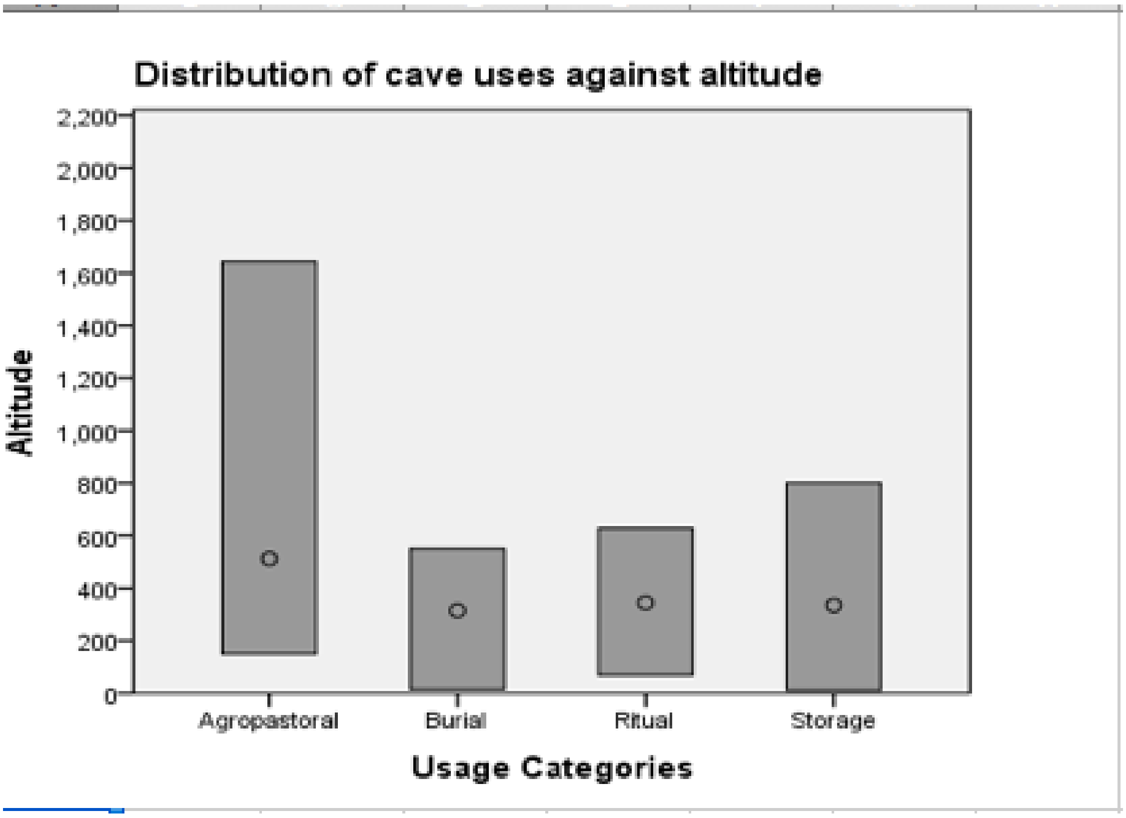
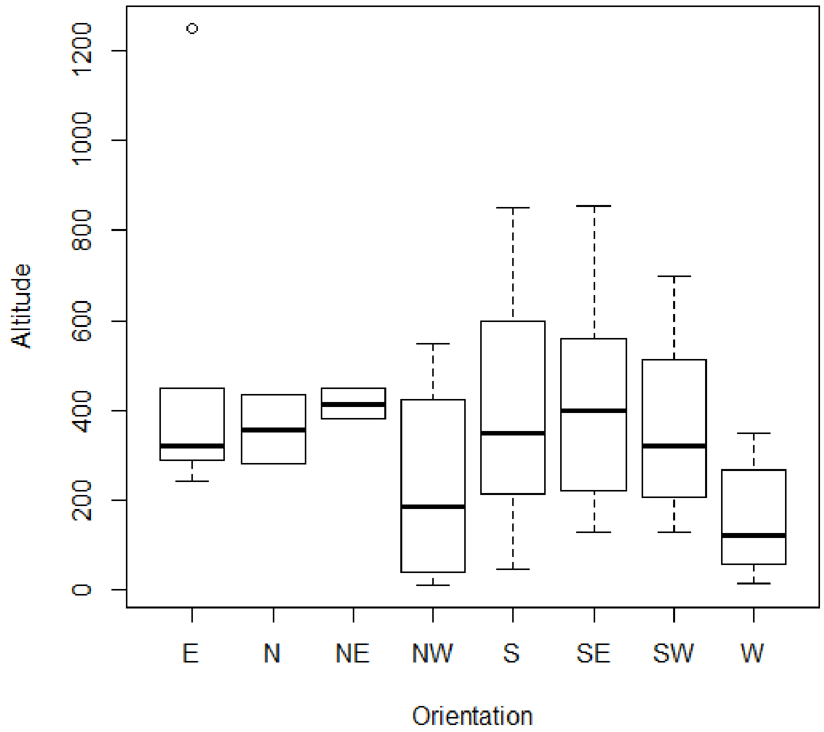


Figure 24 Distribution per altitude of the proposed uses for the caves that have been analysed.

The statistical analysis of the dataset

For the statistical analysis of the dataset I set out to explore six possible relationships; a) the relationship of the altitude of the caves with entrance orientation, b) the microenvironmental zones that present evidence of human occupation in relationship with the altitude, c) the microenvironmental zones that present evidence of human occupation relative to the entrance orientation, d) the relationship of the orientation of the cave entrance with the cave's "proposed use", e) the microenvironmental zones that present evidence of human occupation in relationship with the cave's "proposed use", and finally f) the "proposed use" of the cave relative to both the orientation and microenvironmental zones that have evidence of occupation.

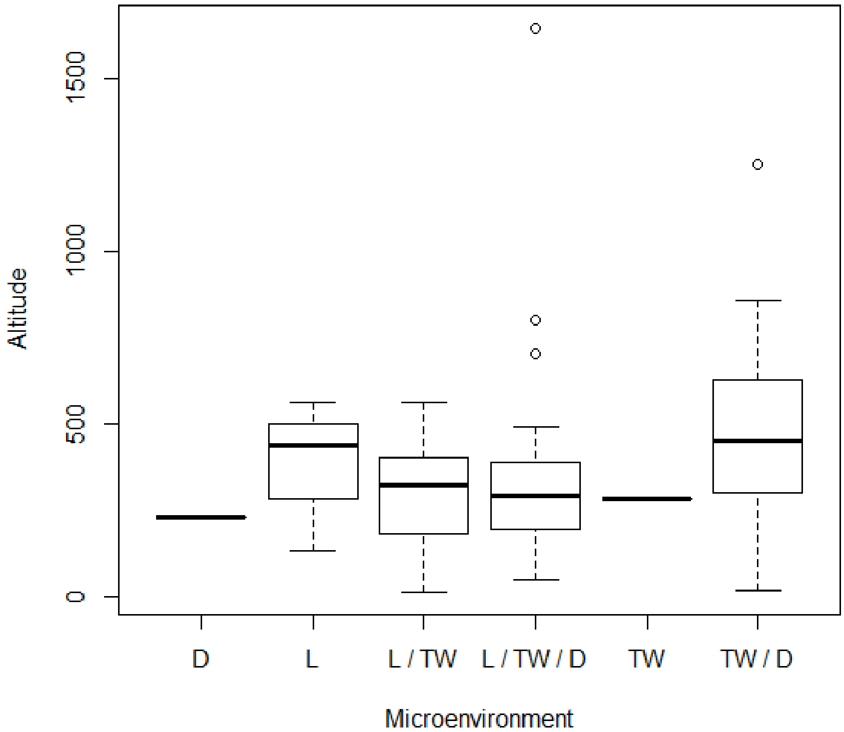
a. Altitude and orientation



To see if caves at different altitudes have different orientations, I ran an ANOVA type of test, which compares the mean altitude between eight orientations. Since normality cannot be assumed for the data in each orientation according to the Shapiro Wilk normality test, I ran the Kruskal Wallis nonparametric test, which gave a p-value of

0.2349, which implies that there are no statistically significant differences. Nevertheless, looking at the boxplots above, one can see that there are some interesting observations, i.e. there are no caves below 200m facing E, N, NE and no caves below 100m facing SE or SW. Also, with the exclusion of an outlier (Korykeion Antron) there are no caves above 500m facing E, N, NE and W and no caves facing NW above 600m. Also, the variability of the altitude of the caves facing E, N, NE is much smaller than the variability of altitude for caves facing in the other five directions.

b. Microenvironment and altitude



To see if caves at different altitudes have different microenvironmental zones used, I again ran a Kruskal Wallis nonparametric test (as the normality assumption had been violated), which with a p-value 0.37 indicates no significant differences. From the boxplots above we can see a few differences in the variability of altitudes for different microenvironments as well the fact that for all caves above 550m the "dark" zone of the cave was used.

c. Hypothesis test orientation / microenvironment

I used a chi-square test for independence to see if there was any dependence between orientation and microenvironmental zones and with a p-value of 0.32 we cannot reject the hypothesis of independence. Of course, the results of this test must be viewed with caution as the assumptions of a minimum number of caves within each condition are not satisfied, due to the small number of caves (52) and the large number of conditions (48).

d. Hypothesis test orientation/ "proposed use"

As above, I used a chi-square test for the independence between orientation and proposed use and with a p-value of 0.71 I cannot reject the assumption of independence. Although I had fewer conditions (16) I still did not satisfy the assumption of a minimum number of caves for each condition.

e. Hypothesis test microenvironment/ "proposed use"

This was checked using a chi-square test and I got a p-value of 0.20 which implies that the assumption of independence cannot be rejected. Again, I have (12) conditions but I were not able to satisfy the assumption of a minimum number of caves for each condition.

f. "Proposed use" against orientation and microenvironment

I used the Cochran-Mantel-Haenszel test to check whether, within each "proposed use" there is independence of the orientation and microenvironment**.** The Cochran-Mantel-Haenszel test is a test used to check the independence between two categorical variables, taking into account a possible stratification from a third categorical variable. In a sense it can be used when we analyse three categorical variables. It differs from a chi-square contingency table test of independence due to the inherited stratification from the third variable. Therefore, for each stratum we create a different contingency table and then we calculate the test statistic from all the contingency tables created.

If we have variable 1 with p categories, variable 2 with q categories and variable 3 (the one we will use for stratification with k categories), then I will create k tables of p x q dimensions. In each cell I calculate the expected (E) value as the (row total x column total)/grand total (which is the classic formula used to calculate expected values in the 2-way contingency tables for the chi-square test of the independence of two categorical variables); the test statistics are then given by:

$$CMH = G^T V_{CMH}^{-1} G$$

Where G=∑_h 〖B_h (n_h-m_h)〗 where h=1,…,k, n_h the k-dimensional vector number of observations in the k strata, m_h the k-dimensional vector of expected value of observations in each stratum, and B_h=C_h⊗R_h where C_h are the column totals and R_h the row totals. Finally, V_CMH is the covariance matrix of the expected value of observations m_h multiplied on both sides with B_h, that is V_CMH= B_h cov(m_h) B_h^T. There are a few references on the test. The interested reader is referred to Mantel and Haenszel (1959), Mantel (1963), Zhang, Boos (1996).

I found a weak relationship (p-value 0.098), which is significant with a test of size 0.1.

6.3 Outcomes

The only regional spatial pattern that can be observed is the clustering of north-facing caves in the southern part of the region. This, to an extent, might happen due to the general orientation of the main mountainous ranges in the areas under study. The Dinaric Alps for example have a more Northeast-Southwest development compared to North-South development of the Pindos Mountains. Thus, caves in the Dinaric Alps that face the coastal zone have a natural South to North orientation while caves in the Pindos Mountains may all have orientations from northeast to south and south east to northwest. However, the question that emerges is why there are no caves with Neolithic human occupation recorded on the northern slopes of the Dinaric Alps. This can either be understood as a possible ancient practice, i.e. people strategically selecting south-facing caves, or a research bias as the majority of the research in the

Dinaric Alps – both in caves and at open-air sites – tends to cluster along the coastal zone.

An interesting fact is also that the caves with extensive use of the dark zone tend to cluster at higher altitudes – with the exceptions of Alepotrypa and Nakovana. The microenvironmental zone that was used seems to also have a relationship with the orientation of the cave entrance. Even if the data is not strong enough to suggest a clear relationship it seems that caves with most extensive use of the twilight zone tend to face a southerly direction.

There is also evidence from this research that suggests that regardless of usage, orientation or altitude, the twilight zone of the caves is the most widely used and exploited zone. We need further evidence from each micro-environmental zone to be collected and, once processed, it should further help to determine why the twilight zone was so widely used. This paper's case study research is that people in the Neolithic Balkans seemed to "beware" the dark side of the caves. Most activities were concentrated in the twilight zone of the caves and only on rare – but important – occasions did they exclusively use the dark zone of the caves (e.g. Grapceva, Alepotrypa, Mala Pećina, Agia Triada). There is evidence to suggest that other micro-environmental factors also contribute to this trend. Collection of data such as temperature, humidity and soundscapes for more cave sites in the area will help to further investigate this trend.

Adding the – disputed – cave uses into the analysis, it seems that there is a relationship between the proposed use and the cave orientation and microenvironment; caves with proposed 'agropastoral' use, were shown to have more of a southerly entrance orientation, while the twilight zone was the zone mainly used. For more of the test outcomes, the real find was the actual Cochran-Mantel-Haenszel test and its applications to archaeology. Since archaeology usually correlates categorical or qualitative data, the Cochran-Mantel-Haenszel test can be a valuable tool in examining the validity of these relationships.

6.4 Discussion

The first thing that can be observed is that the microenvironmental zones used and the entrance orientation of the caves seem to dictate the use of the cave itself, if we accept the hypothesis of the "proposed uses". Nearly all the caves used for agropastoralism have a south-facing entrance and strong evidence of occupation in their twilight zones. Agropastoral caves also had an altitude that can range from 50m to above 1200m asl, whereas caves with other claimed uses, tend to cluster below 600m asl. Thus, the symbolic, storage, and burial cave sites in the region tend to be found at lower altitudes.

Extending the narrative, these patterns support further arguments that have been proposed by Trantalidou et al (2011) for seasonal movement of pastoral societies from lowlands to uplands; Sampson (2008) for communal ritual storage and deposition activities in caves close to lowland settlements; and Whitehouse's proposal for Neolithic groups in Italy that used caves' dark zones for cult practices based on the "experience of the darkness" by people who participated in them (2016:30).

To the modern mind these ideas may sound reasonable and logical, however, and, returning to our initial questions, can a review and analysis of the geomorphological factors of Neolithic caves support or reject these hypotheses of a) South-facing caves with extended light zones, at a variety of altitudes, being preferred for agropastoral activities, and b) of caves with larger, difficult to reach, dark zones being preferred for cult and symbolic expressions? Or in a more general view, were people in the Neolithic Western and Southern Balkans extensively scouting their surroundings with clear views of what they needed, and therefore selecting caves with particular characteristics? In a wider context, if this is true, Human-Landscape (Cave) interactions during the 6th millennium in the Balkans were a clear, rational social strategy–procedure, that was well-organized and executed.

The spatial arrangements in Alepotrypa cave in Diros, southern Greece, to an extent support a hypothesis like the one that we presented earlier. Reading Papathanasiou (2018:429) there is evidence from Alepotrypa for two different modes of space usage and for different contextual associations of the cave's assemblages with different use-areas. More analytically, Neolithic people carried out more "profane"/ "habitation" practices in the front chambers of the massive cave while more "symbolic"-oriented practices took place in the dark deep interior chambers of the cave. Alepotrypa also, for two millennia, showcased a remarkable persistence of certain activities such as pottery clay recipes, stone tool manufacturing techniques and spatial arrangements. We are referring to Alepotrypa here as this is the best possible studied and published cave from the context we are working with, but similar interpretations have been given to other cave sites' spatial arrangements such as

Koromilia (Trantalidou et al 2011), Mala Triglavca (Mlekuž 2009), Nakovana (Forenbaher and Kaiser 2008), and Sarakenos (Sampson 2008).

Our data analysis showcased that there is indeed a relationship observed between the proposed uses of space in the caves and the geomorphology of the cave itself (combining the factors of entrance orientation and the microenvironmental zone used). However, the data is not satisfactory enough to suggest a real dualism in the cave use. There is a strong pattern for the use of the twilight zone in caves with animal dung layers, that have been discussed earlier as possible evidence of rational thinking for the best exploitation of the cave space, and there is also a weak pattern for usage of the dark parts of the cave for more symbolic activities. However, we do not have enough data available to either reject or accept that there is a clear differentiation in the cave use strategies between profane and ritual. Even in caves with strong pastoral evidence like Koromilia or Mala Triglavca, seasonal use of the sites might have had a symbolic aspect for the pastoral societies and therefore that was exactly the reason they kept returning to the same sites for hundreds of years. The symbolic aspects of the "profane" or "everyday" activities in caves have been explored previously by Viteli (1993) and Stratouli (2006) who suggest that every cave, even those with no evidence of cult or symbolic artefacts, are indeed symbolic themselves as places of social congregation or "arenas" where people gathered for special occasions. Projecting these theories onto the caves with extensive layers of burnt animal dung, the burning can be, according to Trantalidou et al (2011) and Mlekuž (2009), an activity that marks the end of the seasonal occupation of the cave by the shepherds and their herds as a bi-product/cleansing of the cave for the next season while, for the theoretical sphere of Stratouli (2005) and Tomkins (2009), the ritual burning of the dung is what actually congregates the shepherds in the caves in the first place.

From this review we are more confident in suggesting that people seemed to consider the geomorphology of the cave for the selection of the cave sites; to an extent they did indeed scout for a cave to "fit their needs". In our theoretical view shepherds who visited a cave site either to create and then burn dung as a symbolic practice or in order to use the cave as shelter/habitation space, took into account the cave characteristics and tended to select south-facing sites with extensive twilight zones. Based on our research outcomes, if, for example we accept the idea of 'agropastoral sites', the geomorphology of the caves seemed to play a significant role in the selection of these caves. Pastoral movement was a social phenomenon. The social group – usually consisting of a few families – decided the time of the movement, the route and the stops that they had to make between the starting point of the main settlement and the seasonal dwelling place (Trantalidou et al 2011). A good knowledge of the geomorphology of the landscape, the potential dangers, and the availability of subsistence sources during the movement was crucial information for the decision-making process of the pastoral group. The geomorphological patterns presented in our research support the idea that carefully and socially selected cave sites were chosen by the pastoral groups to cover the needs of the group during their movement. They chose caves with southerly entrance orientations, probably to have as much light as possible during the day and to be protected from the cold north winds of the region. They tended to avoid the entrance area of the caves because it is exposed to the outer environmental conditions and is not protected from either natural or anthropogenic hazards. They also seemed to avoid the dark part of the cave, where the absence of light and the high humidity create an unpleasant area, even for occasional habitation.

Referring to Hamilakis' (2013) ideas about socially created senses, the sense spectrum of the caves influenced the synaesthetic perception that Neolithic groups in the Balkans had. People could feel the cave environment. They could feel the comfort of the slightly lit, not so humid, and stable temperature twilight zone of the caves. Then they passed that experience to their social groups. The natural aspect of the caves influenced a social "discussion" in order to select the best place to host the group that was moving from the lowlands to the uplands next spring. From a more general perspective then and as has been presented earlier, there is strong evidence for the deliberate selection of caves due to their entrance orientation and the extent of the twilight and (on certain occasions like Nakovana) dark zones in the western and southern Balkans during the Neolithic. This review can also confidently suggest that during the 6th and 5th millennium there is a context-wide persistent use of caves, and that the character of the use in each cave did not change – as possibly happened between the 7th and the 6th millennium (see Drnić et al 2018 for a discussion). Further research on the relationship between the cave sites and open-air settlements, and further analysis of rigorous analysis of new data might better illustrate the reasons behind this important phenomenon. That lasted for almost 2,000 years with only a small gap and it seems that it does not follow the general patterns of change that can be observed in open-air sites during the same period.

Chapter 7

Mapping the microenvironmental factors: testing the proposed methodology in four caves in Greece

Summary

In this chapter the second phase of the application of the proposed methodology is presented. In four previously excavated and thoroughly published Middle/Late Neolithic caves in Greece, micro-environmental recording took place in the summers of 2014 and 2015 with the aim to correlate the environmental data of the cave with the archaeological evidence. A presentation of the methodology, the fieldwork, and the analysis are followed by a discussion on the outcomes and the impact that these may have on the interpretation of the cave use strategies in the Neolithic Balkans.

7.1 Aims and objectives

The main aim for the field research of this thesis was to showcase that archaeological mapping and analysis of the paleosensorial spectrum is feasible in the archaeological discourse. The secondary aim is to present a possible way of understanding the dynamics behind the creation of the – cave – taskscape. What became obvious from the previous chapter was that cave geomorphology is related of aspects of cave use. Additionally it became evident the importance that cave orientation and the twilight zone had for cave use. The application then of the proposed methodology on these four sites tests in the field if the patterns emerging form the assessment and statistical analysis of the dataset can also be mapped and recorded on the ground.

In order to achieve this I set up three objectives; a) Visit four caves sites, map the archaeology inside and record the micro-climatic characteristics so as to produce sensorial stimuli maps according to the caves micro-environmental zones. b) Correlate spatially in a GIS environment the archaeology of the caves with their sensorial maps. c) Explore if there are any patterns on the spatial use of the cave space regarding the correlation between the archaeology and the sensorial data.

7.2 Methodology and Techniques

Fieldwork was conducted, during the summers of 2015 and 2016 by a small team from Cardiff University and the Hellenic Speleological Society, to four previously excavated Neolithic cave sites in Greece; Koromilia cave which is located in Kastoria prefecture in northwestern Greek Macedonia, Kitsos and Leontari in Attica near Athens, and Antiparos cave in the homonymous Greek island of Antiparos. The idea was to test in-cave if people used different areas of the cave space for different activities according to the microclimatic characteristics of this area.

These four case studies were selected for the quality of the available information and because they represent all three microenvironmental zones. Also, we were dealing with all the variants of cave usage, with the excavator supporting a symbolic cave use at Leontari and Antiparos, while Koromilia is presented as a herders' site; at Kitsos the excavator supports a theory of occasional occupation by hunters and herders.

The methodology for the field research was organized in the following way: With a Trimble TSC3 GPS two fixed points outside of the cave entrance were secured. These points, at the entrance of each cave, has been annotated as point zeros for the survey routing. From one of these points, with the use of DistoX2 based paperless mapping methodology (see chapter 4 for an analytical presentation of the mapping technic) the routing started. Radial routing was selected for its accuracy. Each station of the routing was marked with 'mapping pyramids' (Dasher 1994) that were later used as reference marks for the collection of environmental and recording data. The mapping pyramid is practically a metal pole that is placed in the ground of the cave and is framed by rocks so that it can be easily seen in conditions of limited luminosity. The stations were positioned every five metres with the first of them being obligatorily at the entrance of the cave. The numbering of the stations was noted separately on a spreadsheet that was running on an IPad 2 for the immediate recording of the environmental data and the sound files codes, always with the aim of reducing errors from processing data several hours after the collection. After the completion of the space mapping, the other sound and micro-environmental data were collected in the mapping stations.

7.3 Collecting the micro-climate data

There are no previous publications concerning the collection of micro-environmental data in caves and their correlation with archaeological finds. As such, the collection methodology that is followed by biologists concerning the study and the understanding of the microclimate of a cave was applied in the present research (e.g. Kennedy 2006; Romero 2009). So, in the development axis of the cave (or axes if the cave is divided and does not consist of a karstic conduit) the biologists take indications of temperature, humidity, barometric pressure, air streams and water flow every three or five metres. The humidity, the temperature and the luminosity were measured every five metres for the present research.

Two thermometers, one photometer and two hygrometers are placed in every mapping pyramid and then the research team either leaves the cave or changes chambers if the size of the cave allows it. It is imperative that the team moves away from the point of measurements as, according to Romero (2009), a group of 5 people can alter the temperature of a chamber up to 1-3 ˚C and the humidity up to 5 per cent. The measurements were then recorded in a spreadsheet as well as reported to the mapping station with the use of Visual Topo. The methodology that has been used in several microclimate studies was followed for the recording and the storage of the humidity and temperature data (e.g. Kyoung-nam et al 2014). More specifically, the number (or the name) of the station is recorded and then the average indication of humidity, temperature and luminance.

Capturing sounds

In addition to the recording of environmental data, there are a lot of published works available concerning the methodology of sound data recording techniques and their correlation with archaeological evidence. As mentioned in Chapter 3, the methodology of recording and analysing sounds presented by Steve Mills (2014) was followed in this particular research. Three areas, one in each environmental zone (the light, twilight and dark zone of the cave), were chosen for the recording of the sound clips. A mapping station was selected as the recording area so that the sound data could easily be correlated with the microclimatic and archaeological data. The sound recording took place in all the caves during a summer, from June till the end of

September. Therefore, in most cases, as far as the entrance zone was concerned, there were no sounds of extreme weather conditions (rain, wind, snow) whereas there were no sounds of intense raindrop and air streams either as far as the interior zones were concerned. There were two recordings in total, one at noon and one late in the evening in order to monitor alterations during the day if there were any. The altitude of the recording was one metre from the ground (roughly the height of a seated human) in a clip of three minutes each. A digital sound recorder, an Olympus LS-12 2GB Linear PCM Recorder, was used for the recording. The open source software Audacity for Mac OS was used for the analysis of the sound clips.

A WAV file, which was analysed in individual auditory stream sources in Audacity, was derived from the recording (Mills 2014). The time duration of each stream source was added to the interface so that the sound percentage could be calculated in the recording and then analysed in the three basic categories of geophony, biophony and anthrophony. Geophony, biophony and anthrophony have been introduced by S. Mills (2014) and they are combinations of auditory stream sources grouped on the basis of a general similarity in physical characteristics (Mills 2014:96). The groups can be defined as follows (referring to Mills 2014):

Geophony is the totality of sounds associated with the physical, non-biological environment (e.g. weather, water, rock, soils; and seismic, volcanic and glacial activity.)

Biophony is the totality of sounds associated with non-human, living organisms (e.g. animals, plants).

Anthrophony is the totality of sounds associated with and generated by people. Sounds that can be grouped around anthrophony can arise from a wide range of processes and activities including, but not limited to, the following (referring to Mills 2014): Physiological sounds, arising directly from the body (e.g. breathing, coughing, sneezing, talking, singing, whistling). Intended or incidental sounds generated by activities and when engaging with materials of various kinds (e.g. walking, preparing and eating food, making and using tools, tending and feeding animals, using animals for traction or transport, building or modifying structures of various kinds, playing musical instruments). Modern electromechanical sounds (e.g. aircraft, motorized vehicles, radios, generators, telephones, computers).

Two factors that tend to be rather insignificant in open-air locations play a primary role in a cave environment: echo and silence. Assuming that humans possibly chose specific parts of the cave for their absolute silence, the seconds of silence were considered as geophony and were calculated in the analysis in the present research. There are many contributions to the theory around silence that Mills has indexed in his textbook about Auditory Archaeology (Mills 2014). These theories vary in their understanding of silence from a human made notion to describing the absence of sound to theories that recognize silence as another non-sound sound. Ihde's theorem (Mills 2014:50) that considers silence as the spatio-temporal horizon of sound has been adapted in this research in order to describe the possibility people have to "use" the absolute silence that parts of the caves provide in order to host some particular activities. Similarly, assuming that the echo that is created due to the morphology of the area possibly affects the use of a part of the cave, echo was recorded as geophony, even if it was generated by human activity, wherever it was traced, and calculated in the total percentage of the seconds of recording.

7.4 The Caves

a) Kitsos

CAVE INDEX

Location: Eastern Slope of Mikro Ripari hill, Kamariza area, Lavrion, Attika, GR.

Entrance Orientation: Southeastern

Entrance Altitude: 288m asl

Cave Formation: Horizontal

Microenvironmental Zones: Light - Twilight – Dark

Dates of occupation during the Neolithic: 4900 – 4220 cal BC

Sampling in Kitsos took place on the 23rd June 2015 between 11.30 and 13.30

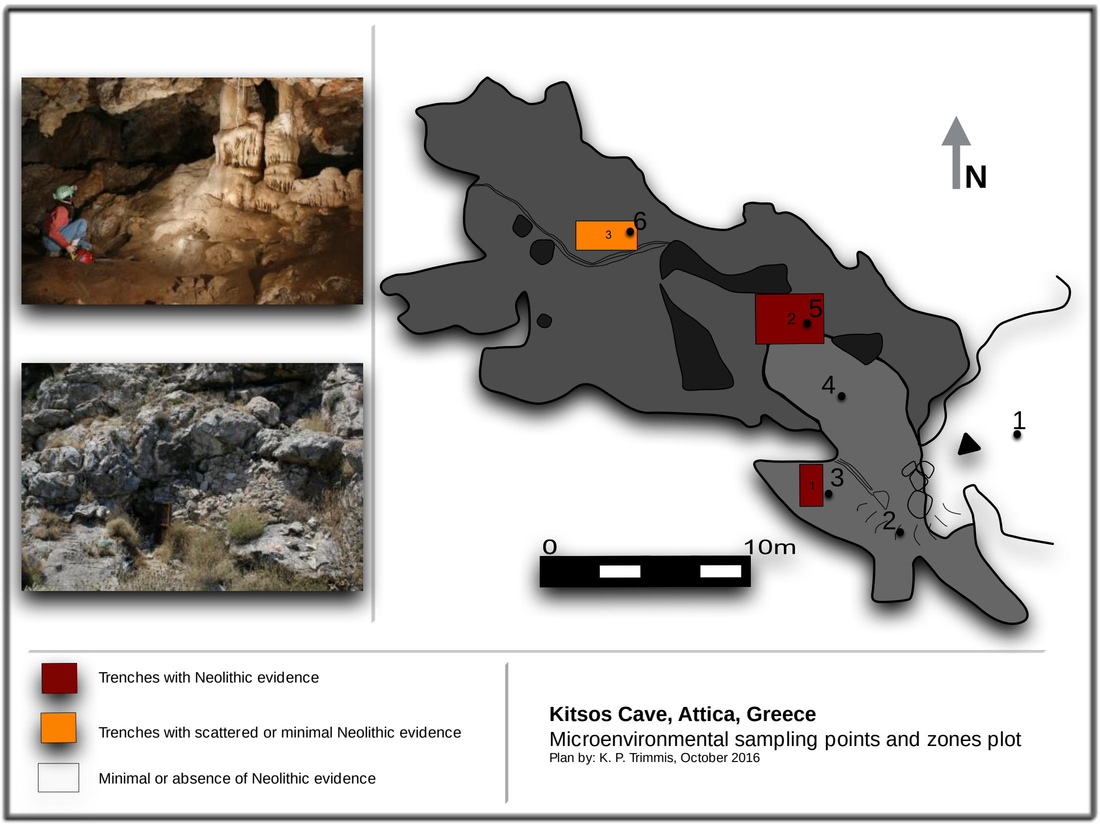


Figure 25 Plan of Kitsos cave where the microenvironmental zones, the sampling points, and the excavation trenches are annotated.

The cave is located on the eastern slope of Mikro Ripari hill in the area of Lavrio town in Easten Attica, and commands extensive views across the whole of eastern Attica and the islands of Euboea and the western Cyclades. The cave has two chambers; the main chamber is roughly 35x12m.

French archaeologists excavated the cave in the late 1960s and during the 1970s. The total depth of the deposits was 1.5m. A metal crucible was found, as well as a large group of LN II-FN pottery sherds. A rare flint arrowhead of great quality, together presumably with its shaft, appears to have been deliberately deposited in a fire. There is the presence of bone needles, colourants (malachite) and ground stone tools with traces of colourant on them. The excavator suggests that hunters and herders seasonally or occasionally used the cave. Later on, in the Mycenaean-Classical, Hellenistic-Imperial period, there seem to have been visitors to the cave for cult practices.

Archaeology in Kitsos cave is located in the main chamber of the cave or Chamber 1 and in the passage that connects the entrance with the main chamber. Limited archaeological evidence that can be dated to the Neolithic has been unearthed in Chamber 2. In the trench of Chamber 2, layer III was the layer that was dated to the Late – Final Neolithic. Scattered ash lenses and hearths that have been excavated, correspond to contexts 2 and 3 of layer III. Between the hearths and the ash lenses a large amount of cooking pots and fine pottery fragments have been found along with a large amount of wild animal bones.

Data about Temperature, Humidity and Luminance has been collected from several places in all three chambers of the cave, along with auditory recordings. Data has been grouped using the Gestalt principles in six main microenvironmental group-points (points 1,2,4,5,9 and 11 as presented in the table and the maps that are presented in this part).

All the activity inside the cave during the Neolithic period is concentrated in the area of point 5, which is the original twilight area of the cave (during the 19th century the cave was used as an outlaws' shelter. The outlaw groups had significantly altered the dimensions of the entrance of the cave. Thus point 5 has the temperature and the humidity of a twilight zone but not the luminance). Archaeology is also located at the area of sampling point 4, which marks the beginning of the dark zone of the cave. There is no Neolithic evidence in the dark part of the cave, which is marked by the sampling points 1 and 2 and only post-classical and modern evidence has been unearthed at the area of sampling point 9, which marks the light zone of the cave.

Sampling point	Archaeo_Context	Microenv_zone	Tem (C)	Hum(%)	Lum (Lux)
1 -	LNI	D	17.4	80	119
2 -	LNI	D	17.6	77.5	1.39
4 -	LNI	D	17.5	78	0.28
5 -	LNI	TW	20.7	66	0.05
9 -	LNI	L	33	27.1	1.7
11 -	Outside	28	42.4	935	

Sampling point	Archaeo_Context	Microenv_zone	Anthro (%)	Geop (%)	Bioph (%)
1	LNI	D	20	80	0

2	LNI	D	15	85	0
4	LNI	D	7	93	0
5	LNI	TW	10	90	0
9	LNI	L	95	5	0
11		Outside	55	05	

b) Koromilia

CAVE INDEX

Location: North cliff of Koromilia gorge, Kastoria, Greece.

Entrance Orientation: Southern

Entrance Altitude: 850m asl

Cave Formation: Horizontal

Microenvironmental Zones: Light - Twilight – Dark

Dates of occupation during the Neolithic: 5500 – 4900 cal BC

Sampling in Koromilia took place on the 20th June 2015 between 13.30 and 16.30

The cave is situated in a steep gorge, 9 km west of the Byzantine and modern town of Kastoria. The cave was mainly used during the Neolithic Age from at least 5600/5500 to 5000/4900 cal BC but later occupations, notably during the late Byzantine and post-Byzantine period, have also been revealed.

The excavation unearthed the following structures inside the cave: a) Recent stone hearth structures associated with charcoal were exposed on the surface level. b) Four clay floors, whose thickness was maximum 3 to 5cm, The fourth and latest was just underneath the surface sediments. The two deepest floors had rough stones of small to medium dimension, burnt clay and rarely sherds paved underneath the clay as a foundation layer for the clay floor. Clay floors seem to cover the majority part of the cave, except for the area towards the entrance. That area gave the most recent chronologies. c) Post-holes on the floors delimiting wooden frames or semi-circular huts which could have sheltered individuals from the continuous water drops and probably formed sleeping areas for up to two persons. d) Timber structures are visible in all carefully prepared rock surfaces. e) Burnt clay fragments bearing imprints of reeds were identified. Walls of rammed earth where branches and reeds were used as a frame could have been shaped in order to reduce needs for heating and separating areas inside the cave.

Data about Temperature, Humidity and Luminance has been collected from several places in every area of the cave, along with auditory recordings. Data has been grouped using the Gestalt principles in six main microenvironmental group-points (points 5D, G17, F28, E28, G22 and N outside the cave, as presented in the table and the maps that are presented in this part).

As in Kitsos, in Koromilia Neolithic evidence has been correlated with the Twilight zone of the cave. There is Bronze Age and Medieval evidence in both the dark and the light zone of the cave, but the Neolithic have been exclusively unearthed in the area of sampling point G17 that marks the twilight zone.

Sampling_point	Archaeo_Context	Microenv_zone	Temp (C)	Hum (%)	Lum (lux)
5D	MN	L	17.3	65	119
G17	MN	TW	14.8	78	1.39
F28	MN	D	13.9	90	0.28
E28	MN	D	16.4	81,5	0.05
G22	MN/LBA	TW	15.4	88	1.7
N: 40º32' 55.9" E: 021º11' 26.4"		Outside	32.6	31	

Sampling_point	Archaeo_Context	Microenv_ zone	Anthro (%)	Geop (%)	Bioph (%)
5D	MN	L	12	86	2
G17	MN	TW	22	78	0
F28	MN	D	7	93	0

E28	MN	D	8	92	0
G22	MN/LBA	TW	12	88	0
				8	
N: 40°32' 55.9" E: 021°11' 26.4"		Outside	5	13	

c) Leontari

CAVE INDEX

Location: East slope of Mount Hymettos, Attica, Greece

Entrance Orientation: Eastern

Entrance Altitude: 550m asl

Cave Formation: Horizontal

Microenvironmental Zones: Light - Twilight – Dark

Dates of occupation during the Neolithic: 4800–4200 cal BC

Sampling in Leontari took place on the 26th June 2015 between 10.30 and 13.30

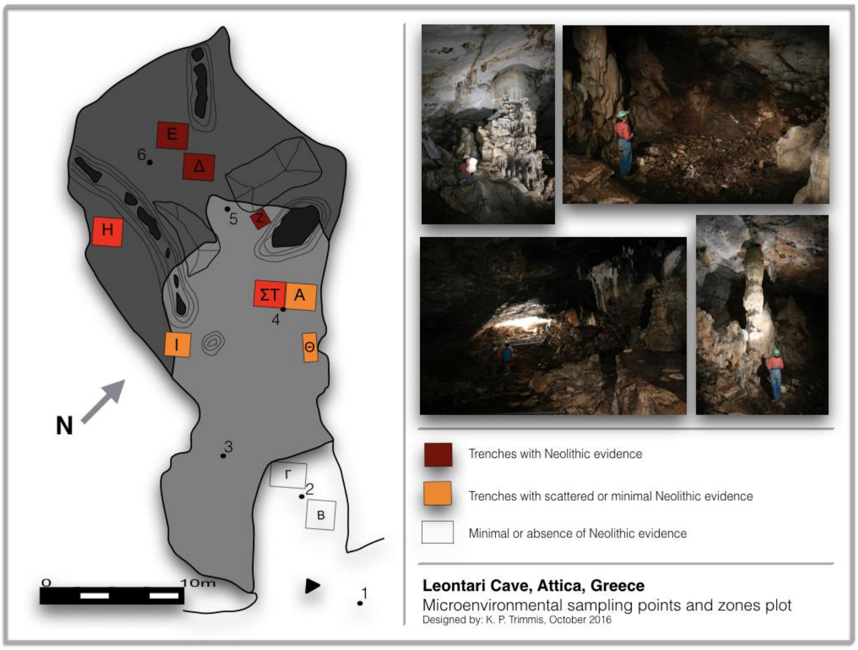


Figure 26 Plan of Leontari where microenvironmental zones, excavation trenches, and sampling points are annotated.

The Leontari (meaning Lion in Greek) cave excavations began in 2003 as a joint project of the Ephorate of Palaeoanthropology-Speleology of South Greece and the Department of History and Archaeology of the University of Athens. The site is situated on the east slope of Mount Hymettos in Attica and has an outstanding view of the Mesogaea plain. The cave consists of a single chamber divided into two main parts with some rock decoration.

Surface layers produced mixed material belonging mostly to the Classical, Hellenistic, Roman, Post-Roman and modern use of the cave. Several figurines and sherds of the Classical period indicate that the cave – mainly the inner chamber – was then used as a shrine, probably devoted to Pan. The material is very fragmentary and also includes some metal tools and coins.

The main use of the cave, though, is dated to the Neolithic period. The upper layers date to the so called LNIb phase with characteristic pottery categories such as incised, burnished and coarse wares and a few rolled rim bowls as well as red slipped and burnished sherds, horn and various others lugs and handles. Further below matt-painted wares dominate the assemblage. The bichrome variety is found together with other categories of material such as chipped and ground stone, bone tools, a few seashells and a fair amount of animal bones. This phase probably dates to the LNI phase, while some ceramic elements from the deepest levels of trench A seem to go back to the beginning of the LN. The cave was therefore used during parts of the 5th and 4th millennia BC (radiocarbon dates are not yet available). It should be mentioned that several stone and clay figurines were found in trench A under "floors" of stones, with most of the material almost in situ, a specific depositional practice which seems to continue in the adjacent trench ET, indicating a repeated pattern of space use which is of special interest. Compared to Kitsos and Koromilia, Neolithic evidence in Leontari has been unearthed in all three microenvironmental zones of the cave. However, the main activity area in the Neolithic, as the excavator presents, is the Dark part of the cave (pers. com. with F. Mavridis & Ž. Tankosić 2016).

Sampling_ point	Archaeo_Context	Microenv_zone	Temp. (C)	Hum (%)	Lum. (lux)
1		Outside	29	42	260
2	LNI	L	26	46.5	79.5

3	LNI	TW	19	59	108
4	LNI	TW	17	75	60.9
5	LNI	TW	17	86	3.42
6	LNI	D	16	89	0

Sampling_point	Archaeo_Context	Microenv_zone	Anthro (%)	Geop (%)	Bioph (%)
6	LNI	D	10	85	5
5	LNI	L	0	100	0
4	LNI	TW	0	100	0
3	LNI	TW	0	100	0
2	LNI	TW	0	100	0
1		Outside	35	16[illegible]	

d) Antiparos

CAVE INDEX

Location: South slope of Profitis Elias hill close to Eastern Coast of Antiparos Island

Entrance Orientation: South-Southwestern

Entrance Altitude: 171m asl

Cave Formation: Horizontal

Microenvironmental Zones: Light - Twilight – Dark

Dates of occupation during the Neolithic: 5000–4500 cal BC

Sampling in Antiparos took place on the 27th July 2017 between 10.30 and 23.45

The Cave of Antiparos is situated on the hill of Profitis Elias, close to the centre of the eastern coast of Antiparos – about 9 km south of its modern capital. The cave lies at

171m above sea level, at a site known either as Ayios Ioannis Spiliotis after a small, nearby chapel, or Maganies due to the manganese quarries of this area. The interior of the cave slopes down very steeply with terraces at intervals and it is today accessible by a concrete staircase. The cave has been exploited for touristic purposes since the 1960s. The present excavations were undertaken alongside a programme of visitor related improvement works, including the repair of damage to the cave which had occurred as a result of earlier interventions. A central paved yard is located next to the central gate of the site. The subsequent interior part descends to the cave's main chamber, which was the only possible area to excavate, with dispersed surface archaeological material.

C. Renfrew collected some sherds, which he correlated with the Saliagos Culture in the early 1950s. G. Bakalakis, who visited the cave in 1968, reported not finding any trace of the ancient inscriptions mentioned by earlier visitors. He found, however, many prehistoric sherds; pottery of Geometric, Archaic, and Classical date which, together with the inscriptions he makes reference to, indicate that the worship of Artemis (among others) took place inside the cave. Material of the Saliagos-Ftelia horizon has been reported by A. Sampson. All these brief discussion shows that no systematic research was ever conducted inside the cave. Especially in relation to prehistoric periods, there has been no secure evidence concerning chronology, and the character of the archaeological material has not been analysed.

Due to the disturbed character of the sediments, the archaeological material was studied on the basis of typological affinities for the construction of a basic typology and the different chronological periods represented in the cave. Due to the condition of the material, as described above, there is little evidence allowing for the construction of a more precise pottery chronology. This could be attempted on the basis of a limited number of rim fragments that belong to straight-sided bowls, everted rimmed and flaring rimmed bowls. Straight-sided and flaring rimmed bowls were most common at Saliagos, while bowls with everted rims and carinated shapes were rare in all strata. Straight-sided bowls at Saliagos are well-represented throughout, with some insignificant increases in later strata, while everted rimmed bowls were rare but present in all strata, and flaring rimmed bowls declined in Strata 2 and 3. At Akrotiri on Thera, rounded bowls and bowls with an S-shaped profile and an outward turning rim seem dominant.

The Antiparos Cave excavation has provided secure evidence for the Saliagos

Culture on the island of Antiparos, and raised the number of sites known with material of this type. Despite the fact that there were limited stratified deposits, white-on-dark ware and other elements indicate that the phase of Saliagos Culture, represented here, is most probably related to Akrotirion Thera and Saliagos Phase 3, or to elements from Grotta and Zas Cave Phase I Prehistoric pottery and miscellaneous finds

Microenvironmental sampling in Antiparos was conducted during the summer of 2017, under the permission of the Ephorate of Speleology and Palaeoanthropology of the Greek Ministry of Culture. A team from Cardiff University, Aristotle University of Thessaloniki and the Hellenic Speleological Society led by K. P. Trimmis took the micro-climatic data but auditory recordings were not collected due to the limited time. It is important to mention that the interior and the entrance of Antiparos Cave, as a showcave, has been significantly altered since the Neolithic. We had to visit the cave after hours, late in the night in order to manage to collect unbiased microclimatic data from the interior (since the visitors alter the temperature and the humidity inside the cave). We are grateful to the municipality of Antiparos and the guards of the cave who allowed us to visit the place after hours.

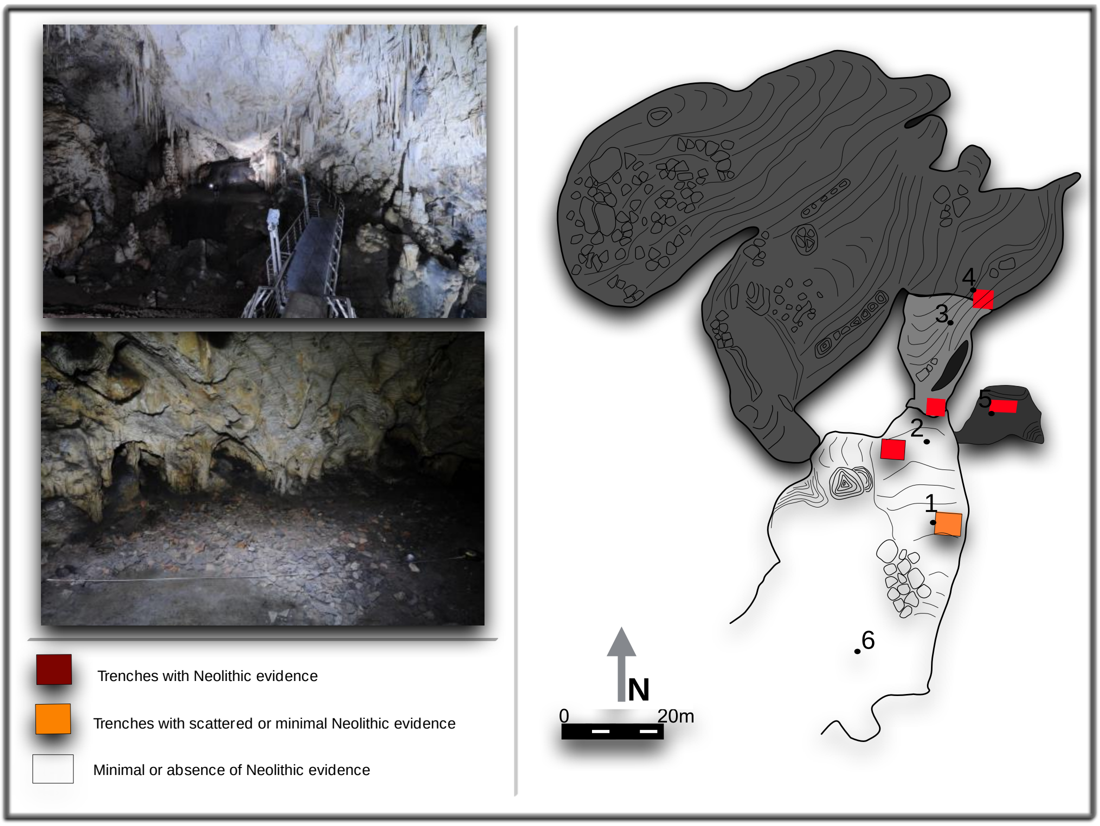


Figure 27 Plan of Antiparos cave where microenvironmental zones, excavation trenches, and sampling points are annotated.

Human prehistoric activity in Antiparos seems to be concentrated in the Twilight zone of the cave and in a small dark chamber just west of the passage that connects the entrance area with the main chamber. There is a very small squeeze that connects the twilight zone activity area with the chamber, and the overall spatial arrangement is similar to the Bronze Age cave sanctuaries with a large twilight zone activity area and a small "sacred" dark chamber (see Trantalidou et al 2017). It is very difficult to discuss aspects of cave use in Antiparos mainly because the entrance area of the cave is covered nowadays with slates and concrete, thus the archaeological evidence is limited.

Due to the aforementioned limitations it is also difficult to discuss the use of the cave during the Neolithic. The variety of the material inside the cave, mainly pottery from different islands and areas around the Cyclades and the little dark chamber with large quantities of pottery deposits could highlight the cave as an important site and that its "role" exceeds the limits of the local small island community. However, this could be just an exaggeration of the available information and the cave could equally have functioned as an occasional shelter for fishermen or sailor groups.

Sampling_point	Archaeo_Context	Microenv_zone	Tem(C)	Hum (%)	Lum (lux)
1	LNI	L	31	46	791
2	LNI	L	31	44	834
3	LNI	T	21	58	72.4
4	LNI	T	19	57	70.8
5	LNI	D	16	91	0
6		outside	39	56.4	1005

7.5 Data analysis

Following the framework that I presented earlier in chapter four, with the completion of the data collection, three large datasets are created. The first dataset (A) features the geomorphological characteristics of the caves: entrance altitude, entrance orientation, rock and development axis, entrance width. The second dataset (B) includes the archaeological data: the use of the space as it derives from the excavator's research, the dating, the various activities, the finds and the constructions.

The third dataset (C) includes the micro-environmental characteristics, such as the indications of temperature, humidity, and luminosity as well as the auditory streams.

Dataset B mainly consists of qualitative data, as has been derived from the researchers' observations and conclusions. The data was analysed spatially using QGIS. As such, uses per period, collections of uses per area as well as groups of caves with similar characteristics were located. Dataset C includes both quantitative and qualitative characteristics. The indications of temperature, humidity and luminosity, as they were recorded during fieldwork are considered as quantitative characteristics whereas the data that emerged from the auditory streams were considered as quantitative characteristics. The data was analysed both statistically and spatially in order to monitor the characteristics of caves that are used by humans as well as whether groups of caves that share the same characteristics are created or not.

In the second stage of the analysis the data from each cave was plotted in QGIS as different raster layers. As such, for each of the caves there was the basic layer of the map of the cave and then different layers for every phase of usage and different layers for every micro-environmental characteristic. So at least six data layers were created for every cave:

Base layer	Cave map
Phase layer	Archaeological data
Temperature layer	Temperature data
Humidity layer	Humidity data
Luminance layer	Luminance data
Auditory layer	Recorded auditory streams

The data levels increase depending on how many phases of usage there have been in the cave. Having created maps of humidity, luminosity, temperature and soundscape and having examined the archaeological evidence as opposed to the environmental and geomorphological characteristics, the next step was to demonstrate the activities in specific parts of the cave with specific characteristics. Afterwards, this was examined in all the caves of the sample in order to locate micro-environmental patterns. For instance, in the case of the cave of Koromilia, the above table is shaped as follows:[26]

Dark Zone

Phase layer	Middle Neolithic (5,500-5,320 Cal BC). Clay floors, post holes, hearths, large storage vessels. Area Usage: Storage area, living space
Temperature layer	14 ^{o}c
Humidity layer	92%
Luminance layer	0
Auditory layer	Geophony (Silence) 92%, Biophony (Bats) 8%

Twilight Zone

Phase layer	Middle Neolithic (5,400-5,280 Cal BC). Dung deposits, coproliths. Area Usage: Barn
Temperature layer	19 ^{o}c
Humidity layer	74%
Luminance layer	287
Auditory layer	Geophony (Silence) 75%, Biophony (outer nature sounds) 22%

Light Zone

Phase layer	No evidence for usage of the area during Neolithic.
Temperature layer	27 ^{o}c
Humidity layer	68%

26 An average of the humidity, luminance, and temperature recordings has been presented.

Luminance layer	678
Auditory layer	Geophony (Silence) 2%, Biophony (outer nature sounds) 98%

Each layer in all four caves has been plotted independently on the cave map. The layer constituted of several vector points that later where been group together in few environmental reference points using the Gestalt principles that I have presented earlier. For example, in Koromilia again, all temperature points with indications scattered around the 14 °c has been group together two sampling points. The main reason that grouping was needed is that according to psychological principles humans naturally perceived their environment as organised patterns. Thus, in the case of a cave environmental zone, human is difficult to understand micor differences in temperature or luminence, but it will understand if something is light or dark, wet or dry, cold or warm.

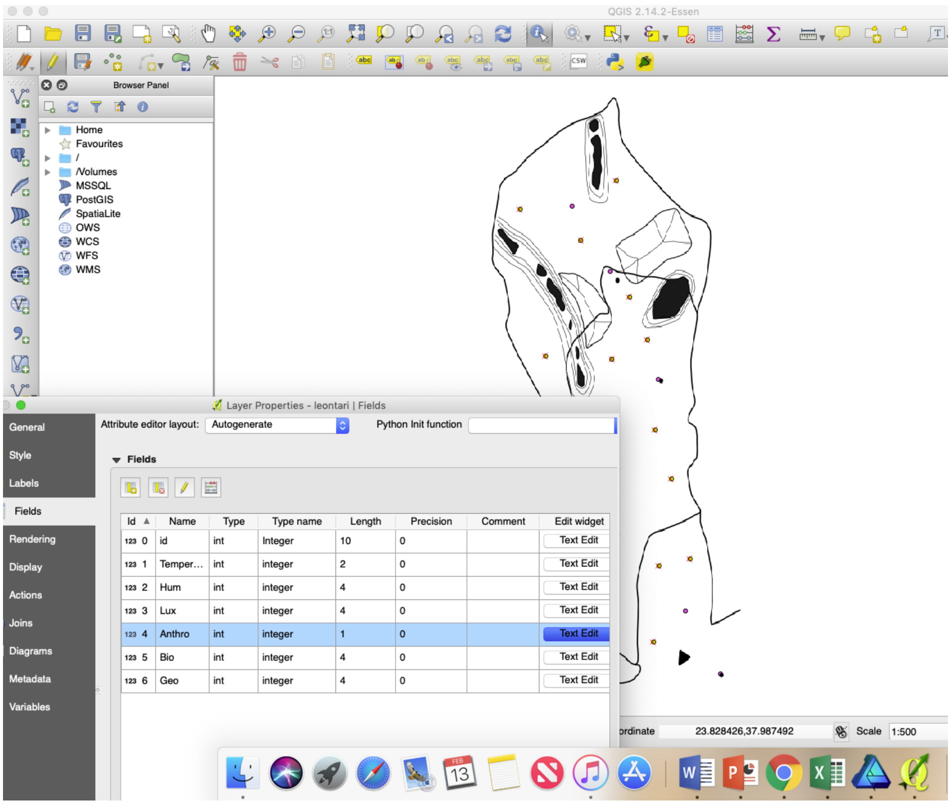


Figure 28 Print screen from QGIS interface showcasing the sampling points before these being grouped to the 6 main sampling stations with the use of the Gestalt principles. The attribute table is also visible in the left-hand side conrner of the image.

Rasterising the vector point layers and con14 ºc sewuently interpolating the data points, using 'Interpolation' plugin in QGIS. Interpolation is a commonly used GIS technique to create continuous surface from discrete points. Spatial interpolation can estimate the temperatures for example, at locations without recorded data by using known temperature readings at nearby survey stations. This type of interpolated surface is often called a statistical surface. Humidity and luminance are recorded on similar terms. A suitable interpolation method has to be used to optimally estimate the values at those locations where no samples or measurements were taken. The results of the interpolation analysis can then be used for analyses that cover the whole area and for modelling. There are many interpolation methods available however there are two that are used widely; the Inverse Distance Weighting (IDW) and thr Triangulated Irregular Networks (TIN).

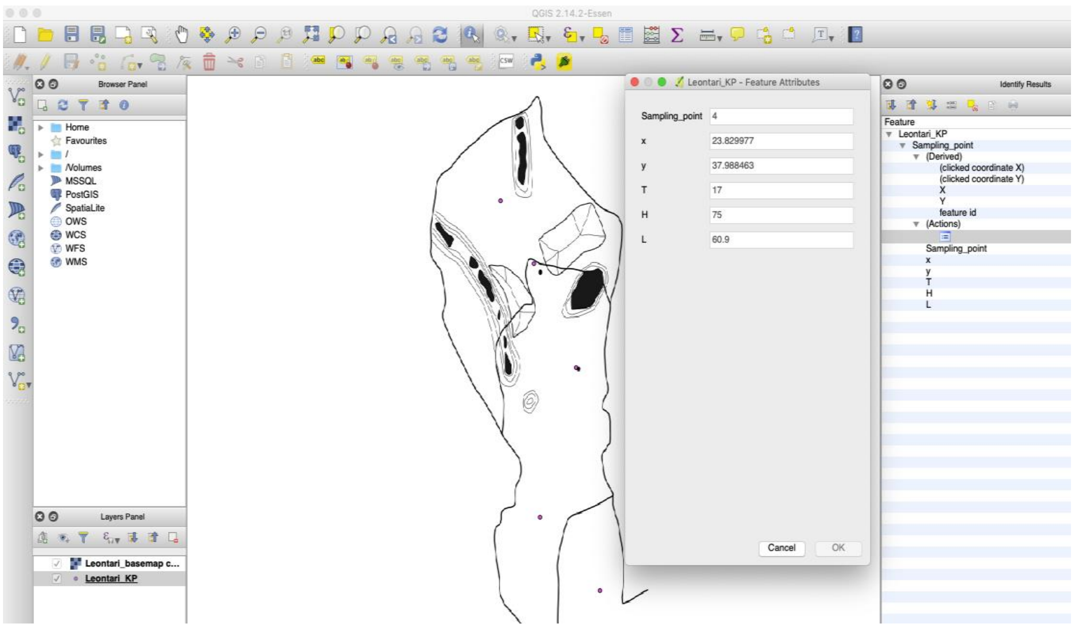


Figure 29 Print screen of QGIS interface with Leontari cave and the main sampling points annotated. Details of sampling point 4 shown in the right half of the screen before the interpolation of the values.

For the analysis purposes of this thesis the IDW method was used. In IDW, the sample points are weighted during interpolation such that the influence of one-point relative to another declines with distance from the unknown point you want to create. Weighting is assigned to sample points through the use of a weighting coefficient that controls how the weighting influence will drop off as the distance from new point increases. The greater the weighting coefficient, the less the effect points will have if they are far from the unknown point during the interpolation process. As the coefficient increases, the value of the unknown point approaches the value of the nearest observational point.

It is important to notice that the IDW interpolation method also has some disadvantages: the quality of the interpolation result can decrease, if the distribution of sample data points is uneven. Furthermore, maximum and minimum values in the interpolated surface can only occur at sample data points. This often results in small peaks and pits around the sample data points. However, grouping the sampling points in using the Gestalt principles – and particularly the principle of proximity – and undertaking the sampling in equall intervals (2m appart each measurement of the other) assisted significantly on redusing the error factor of the IDW.

In GIS the interpolation results are shown as 2-dimensional raster layers. In the case of this research the rester outputs did not present anything unexpected, however helped on the better and more precise mapping of the extent of the twilight zone that have been shown as an important aspect of the cave use during the first stage of analysis as this has been presented in the previous chapter. For a further analysis however, between the relationships that micro-environmental zones had with the areas of activity, I run a Principal Component Analysis (PCA) test using the QGIS plugin between the activity raster and the interpolated environmental rasters. The Principal Component Analysis (PCA) can help to enhance the understanding of hidden data and to reveal underlying information that influences your data fundamentally (see examples from Kitsos cave in figures 29-31).

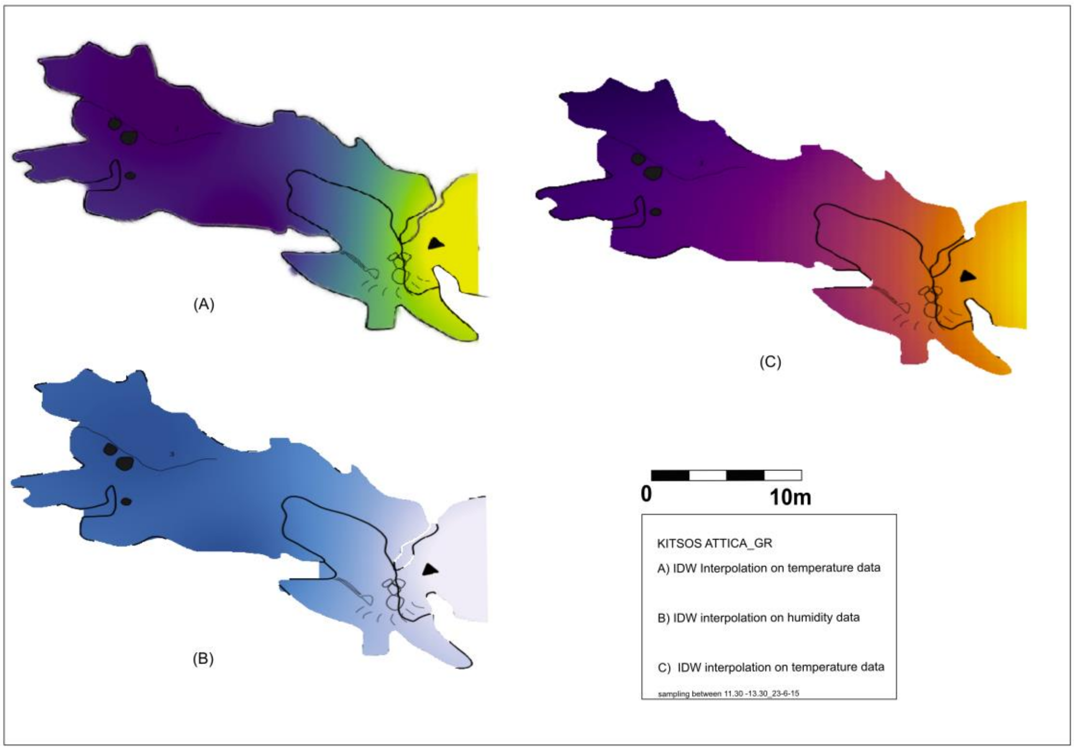


Figure 30 The interpolation outputs in Kitsos cave dataset. A – Luminence, B- Humidity, C- Temperature

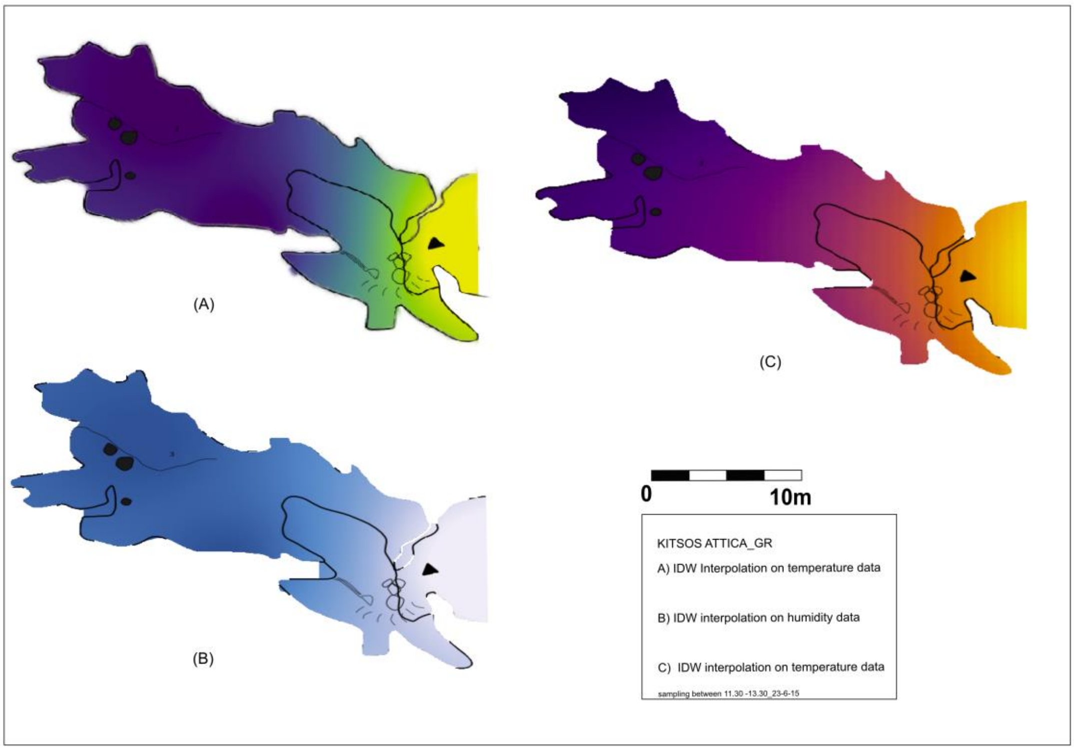


Figure 31 The interpolation outputs in Kitsos soundscape datasets. A- geophony, B- biophony, C- anthrophony.

PCA is a statistical procedure that uses an orthogonal transformation to convert a set of observations of possibly correlated variables (entities each of which takes on various numerical values) into a set of values of linearly uncorrelated variables called principal components. In the GIS environment PCA works having layer stacks of raster data that work as different Principal Componenets (PC) of the model. The outcome is a separate raster layer with the predictive model and a .txt file with all the statistical analysis information and the Eigenvalues of the PCs which are important in order to determine the quality of the model. In my case the underline information that I tried to showcase using the PCA test is, if there was an area in the cave that the anthropogenic activites were concentrated due to certain micronevironmental factors – as temperature, luminance, humidity. Additionally, PCA test, as I am going to present in the next chapter, can also work only with environmental data in order to predict if an area of the site is favourable for use and consequently should be targeted and mitigated archaeologically.

What PCA showcased in my research, is areas in the caves where all three microenvironemntal factors, luminance, temperature and humidity, in correlation showcased a normal distribution. The geomorphology of the caves, the sizes of the chambers and the entrances, the complexity of the interrrior spaces, the location on the wider landscapes, that characterise the microenvironments, are the same factors behind the normality areas in the PCA analysis. Consequently, a cave like Koromilia with a wide entrance and a small dark zone present high values in PCA at the extended twilight zone – but only in the area close to the western side of the main chamber, which is away of the entrance air streams. In comparison, Kitsos with the small entrance but with a quite wide main chamber partially on the twilight zone, showcased the high values in this mostly dark and humid part of the twilight zone. Leontari with a similar geomorphology like Koromilia, showcased its high values even deeper than Kitsos in the dark part of the cave but close to the edge with the twilight zone. Antiparos finally presented a clear high value area on the twilight zone of the cave.

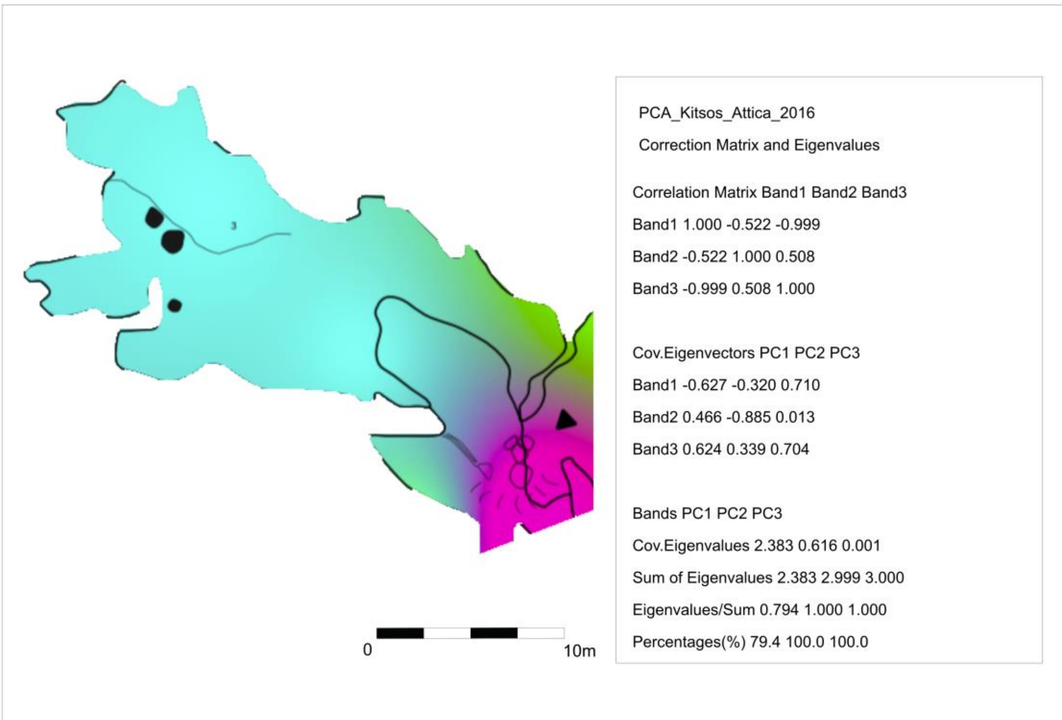


Figure 32 PCA outputs from Kitsos. The high values of the twilight zone are highlighted with purple colour.

Two things are standing out from the attempt to map the micro-environmental factors inside the caves. First, this mapping following the framework that was presented in chapter 4 is doable and can be of high value regarding both the understanding of the use of space and the recording of areas that all these factors create conditions more favourable for occupation. Second, it confirmed – with all the limitations that the size of the application offered – the indication that the regional review that was presented in the previous chapter showcased; a high value twilight zone which people mainly utilized for their activities in the caves. I will discuss more analytically in the final chapter of this thesis regarding the importance of the twilight zone that clearly emerges from this study, here I would like to focus in one particular example, the use of space in Koromilia cave.

In Koromilia, all the archaeology that have been excavated in the cave unearthed exactly form the two areas that PCA showed high values; the twilight zone and the very restricted dark zone of the cave. As ponted out the highest values comes form the twilight zone that the excavator characterises as the area for the animal pen, when in the dark part people seemed to have organised a little sleeping- storing area.

Correlating the outcomes of this survey with the excavator's interpretation for the use of space the narrative that occurs is that cave users, would like the flock to be in the shade, away from any weather impact (rain, heat, wind, hail, snow), within a cool atmosphere. At the same time the flock and the herders' installations are not visible from any group of people or carnivorous animals that may possibly be in the area. As well as that, living in the twilight zone still provides the flock and the herders with enough daylight to avoid undertaking all their activities (such as milking the animals, preparing meals, making tools or textiles) in complete darkness or only under limited artificial light. Avoiding the dark zone, also ensures the herders will be dealing with a relatively dry area without absolute humidity, water dripping or water flow.

In the final chapter of this thesis, chapter 9, I will evaluate further the possible narratives that emerge from the mapping of the caves' micorenvieontmal zones and how this can change our perception about the use of caves in the Neolithic Western Balkans and Greece. In the next chapter I will first present the ultimate application of the microenvironmental zone theory on cave research, the excavation in Mala Pecina cave in southern Croatia. In Mala Pecina, a cave with great micro-environmental variation, trenches opened in the areas that PCA showcased the higher values; in this case micronevironmental mapping was used as an archaeological prospection tool first, before we correlated the excavation outcomes with the micro-environmental evidence. The Mala Pecina application presented some interesting patterns on the cave use both for the Early and the Middle-Late Nolithic contexts.

Chapter 8

Testing the proposed methodology in a cave excavation in Croatia

Summary

In chapter 8 the outcomes of the third stage of the application of the proposed methodology are presented in the excavations in Mala (Nova) Pećina cave that is located in Croatia, in the Dalmatian Hinterland (Dalmatinska Zagora). Excavations in Mala Pećina uncovered an Early and Late Neolithic cave site that might be key for a better understanding of the relationship between the coastal groups and the communities of the western Balkan interior. This chapter presents the finds and contextual data from the 2016 excavations and the consequent 2017 study season. It presents an account of the pottery and lithic assemblages along with the zooarchaeological and archaeobotanical data from the cave. The excavation evidence and the consequent correlation of the excavation data with the microenvironmental factors have shown a possible distinction on the way that the cave was used between the Early and late Neolithic.

8.1 The Cave and the excavation

Mala Pećina (or Nova Pećina as it appeared with this name on late 19th century maps) is located in southern Croatia, in the hinterland of the Dalmatian region. The cave is located deep in the hills almost 1.5 km south of the road that connects the town of Sinj with the village of Gorni Muć, which is the main village of the area. Today the easiest way to reach the cave is to follow a track through deep vegetation for almost a kilometre, from the small settlement of Sutina which is the closest place that a vehicle can travel to.

The cave was discovered by Don Niho Granić a local priest from Gorni Muć. The cave was the first cave investigation to be published in Croatia and was forgotten and lost for more than 130 years. In 2010, a joint expedition of the Speleological Society for Filming and Surveying Karst Phenomena and the Archaeological Museum of Zagreb, re-discovered the caves after two days of exploration through the very thick vegetation of the area. The cave was finally discovered with the assistant of local herders (pers. com with Ivan Drnić and Boris Watz). The team, during the 2010 expedition, opened a test trench inside the cave in the area that trench B was located by the 2016 excavation. The 2010 team chose this area for a test square as a large amount of surface EN (Impresso) pottery was visible. An articulated bone from this test trench has been dated in the BETA Analytic laboratory in the USA, providing a provisional date from between 5780 to 5650 (Beta-287818).

The entrance of the cave is located in a small doline and is more of a narrow short shaft with dimensions of 1m x 1.5m and with 2m depth. The shaft leads to a small chamber 6m long to 4m width. At the end of the "hallway", as the chamber has been named by the members of the excavation team, is a narrow passage, that can be accessed only by crawling, that leads to the first chamber of the cave with maximum dimensions of 22m x 8m and a maximum height of 17m. At the southeast corner of chamber 1, another passage leads to the second chamber, which is the largest of the cave with maximum dimensions of 35m x 14m. 12m before the western end of the second chamber a low (1.10m maximum height) and long (22m) passage begins that leads north, to the third and final chamber of the cave. Chamber three is the smallest chamber of the cave with maximum dimensions 14m x 7m. However, chamber three is the tallest of the cave with a maximum height of 24m. At the top of this "chimney" there is a natural entrance to the cave that works as a "skylight" for chamber three.

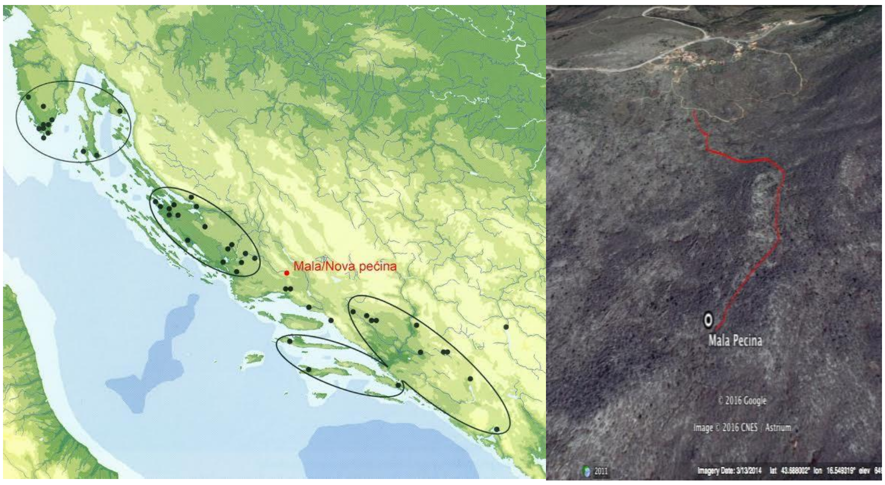


Figure 33 Location of Mala Pecina between the other excavated cave sites of Croatia and the position in the hills south of Sutina village

The excavation in Mala Pećina was conducted during the summer of 2016, between the 11th of June and the 8th of July and marked the third stage of this thesis case studies. The excavation has been supported by Cardiff University's Department of Archaeology student fieldwork scheme, the British Cave Research Association and the Archaeological Museum of Zagreb.

Microenvironmental-microclimatic sampling was conducted inside the cave, before the excavation team started operating, in order to locate the trenches in the most favourable for use areas, according to the model based on PCA of the temperature, luminance, humidity and air flows layers. Three trenches have been opened consequently in the three areas that the major trends appeared in the combined interpolated PCA layers; trench A at the end of the first chamber, trench C at the southern end of the second chamber and trench B at the point where the lower passage leads to the third chamber. This is also the same point where the 2010 team opened the test trench. Excavations at Mala Pećina were a tactical and logistical challenge due to rough terrain, the low temperature inside the cave, the high humidity (average 98.7%) and the absolute darkness. However, teamwork, collaboration, equipment and the technological advantages that 3D photoscans offered, proved valuable in order to surpass all the difficulties.

Figure 34 A 3D photoscan based image of the view of the 3rd chamber from the position of trench 2 in the lower passage.

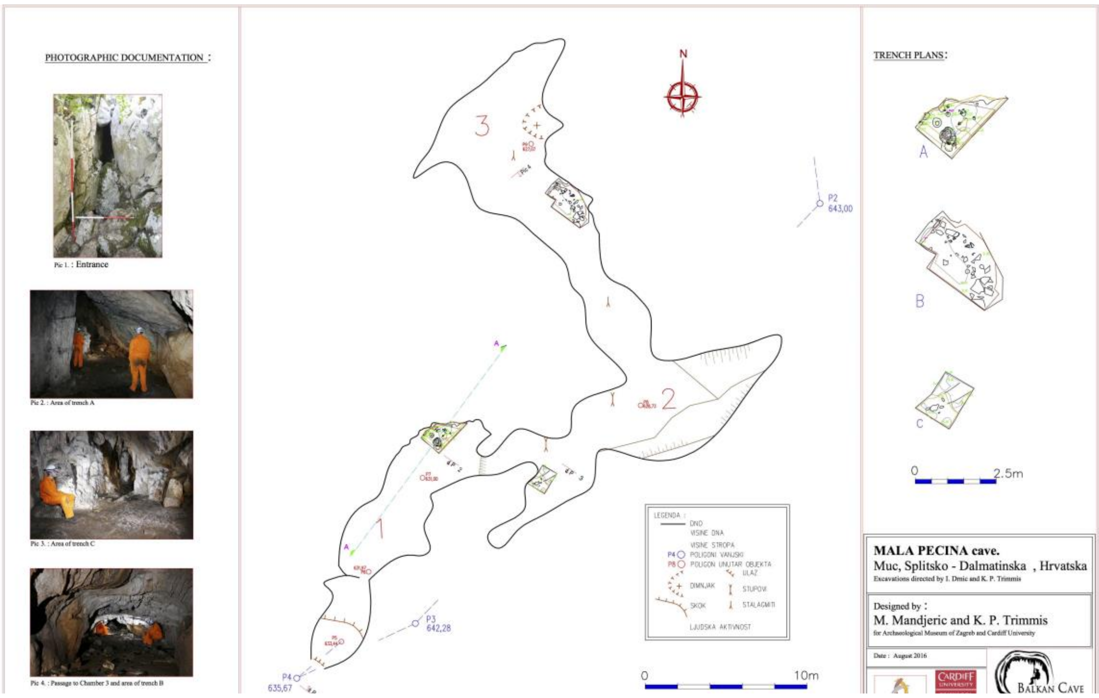


Figure 35 Ground plan of Mala Pećina cave with the excavaiton trenches annotated

8.2 The stratigrpahic narrative

Trench 1

Location

Trench 1 is located in the northwestern corner of chamber 1. The trench lies along the northwestern wall of the chamber, the floor of which slopes very gradually towards the short passage to chamber 2. The trench covers an area of 2.5m (N-S) and 1.5m (E-W) with no extensions. The trench is not symmetrical due to the location against the cave wall. Before excavation, the surface of the trench was covered with the usual cave deposits such as minor calcite formations and bat guano. There were no areas of disturbance, but there was a black mark on the part of the cave wall which arched over the trench, indicating that at some point a fire was present in the area of the trench, though whether or not this mark was modern or ancient is yet to be decided as local memory of the cave persists among the surrounding communities. Trench 1 is composed of 67 contexts, which includes three distinct features and covers the Early and Middle Neolithic.

Figure 36 A view of the excavation in the area of trench 1.

Stratigraphy

Layer MP1001 was a mostly sterile layer with a small amount of pottery and bones, between 0.05m and 0.07m in thickness and consisting mostly of a reddish-brown clay and crust mixture which was drier in the southwest corner against the cave wall, but as the layer moved further east and north the soil became wetter and thicker most likely due to the floor of water in the cave. There was a slight amount of charcoal present in the layer but the inclusion rate was less than 2%. Layer MP1002 was a stony, greyish layer which was drier across the trench than MP1001. Once again, there was a limited number of finds, but two special finds, SFMP1001 and SFMP1004, both of which were bone tools, were found in the northeast corner. The charcoal inclusions in this layer were less than 5% of the total soil content. Layers MP1003, MP1004, and MP1005 are part of Feature 2 and will be discussed in the following section.

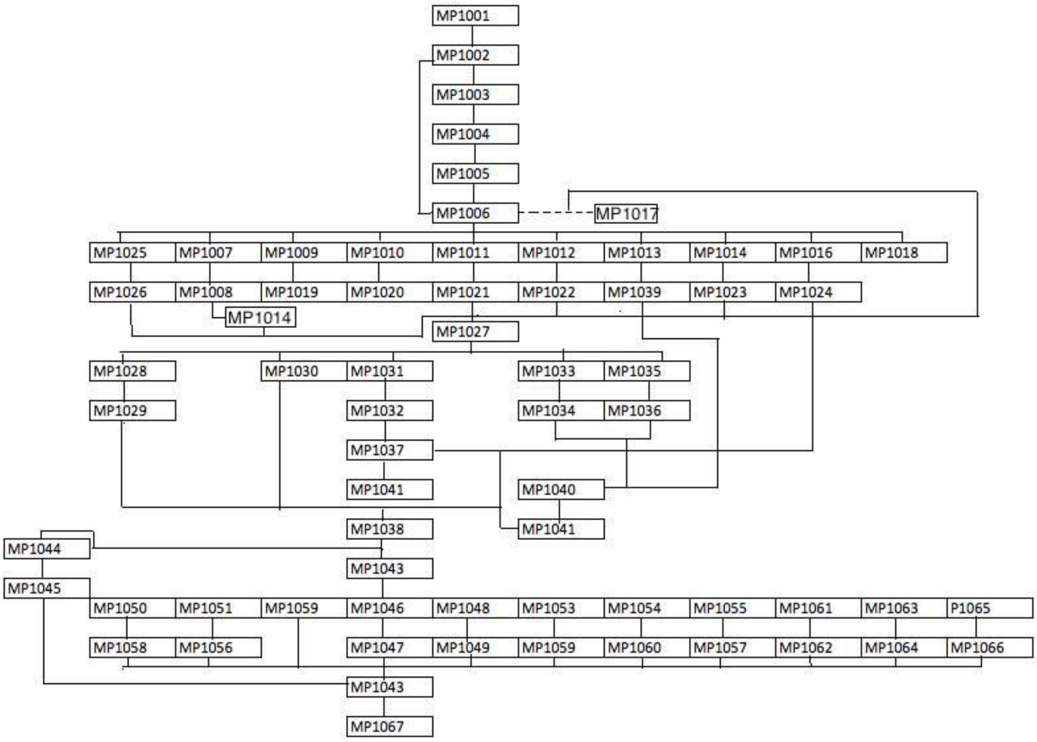


Figure 37Harris matrix of Trench 1.

MP1006 is the deposit around the hearth (Feature 2) and covered the entire trench as well as under Feature 2. This is the brown deposit between Feature 2 and Feature 1 and had one special find, SFMP1005 which was a bone tool found in the northeastern corner of the trench. Around 35% of the MP1006 had crust inclusions indicating a significant lapse of time between the disuse of Feature 1 and the creation of Feature 2. Pottery and bone were both found. Layer MP1006 is also layer MP1017; with MP1017 simply the cleaning layer around the various contexts that compose Feature 1. Feature 1 is composed of contexts MP1007 through MP1016, MP1018 through MP1026, MP1028 through to MP1037, and MP1042. Feature 1 will be discussed in the feature section after the stratigraphy section.

Figure 38 The Middle Neolithic hearth in trench 1.

MP1027 is a deposit layer beneath MP1006/MP1017. It was a yellowish-brown colour with a less than 5% charcoal inclusion rate. It is possibly the occupation layer which would have been associated with Feature 1 and produced three special finds. SFMP1008, a lithic found while sieving the soil from MP1027, SFMP1009 a bone tool, possibly a needle, which was found in the spoil from the northeastern corner of the trench, and SFMP1010, another part of bone needle, the rest of SFMP1009 as they fit together perfectly, found in the flotation and heavy fraction samples during the lab work back at base.

MP1038 is a sticky reddish dark brown clay that covers the entire trench beneath Feature 1. The layer was very deep and clay-like in texture but was drier in the southeast corner of the trench. A small collection of bones was found in the northeastern corner along with some Impresso pottery. There was burnt and crumbling bone throughout the trench that was not able to be salvaged and the whole layer had a charcoal inclusion rate of less than 5%. This layer is above the MP1043, which surrounds Feature 3. MP1044/MP1045 is a medium sized pit in the southwestern area of the trench that was 0.15m deep with one special find. SFMP1011, a lithic, was found during the excavation of MP1044, the fill of the pit, and pottery and bone were also found. There is no obvious feature to which the pit belongs as it sites between features 1 and 3.

MP1052 was a small portion of small rocks, no more than five or six rocks and all under 0.07m, which was wrapped by MP1043 on all sides. MP1043 was a mostly sterile layer that gave way to Feature 3 but also surrounds it on both sides. It was very similar in colour and consistency to context MP1001 but extended for around 0.30m from below MP1038 until MP1067 which is the end of the trench since MP1067 is the bare rocks on the cave floor which were covered by a slightly lighter orange colour transitionary stage before the black soil covering the white rocks.

Feature 1 is estimated, based on pottery style to be from the Middle Neolithic period and consists of 13 post holes (which will be denoted by fill/cut), one pit, a hearth, and a support layer of stones. The post holes are MP1009/MP1019, MP1010/MP1020, MP1011/MO1021, MP1012/MP1022, MP1014 (which is a cut of a post hole found after excavation of the pit), MP1015/MP1023, MP1016/MP1024, MP1025/MP1026, MP1030 (which was not given a cut due to the support layer of stones), MP1031/MP1032, MP1033/MP1034, MP1035/MP1036, and MP1040/MP1041. The post holes form a semi-circle, with MP1016, MP1025, and MP1030 probably banded together in the centre of the structure to support the roof. These three post holes are directly above the three layers of stone which comprised layer MP1037/MP1042.

Post hole cut MP1014 was found in the pit (MP1007/MP1008) which was at a 45-degree angle pointing towards the hearth (MP1013 and MP1039) and post hole MP1040/MP1041, which was located beneath the hearth, are speculated to be potentially related to food preparation instead of an element of structural support. The hearth, MP1013 and MP1039 is mostly composed of ash and charcoal (MP1013) as well as the burnt layer beneath the ash (MP1039), this hearth, however had no stones like Feature 2 had. The pit, MP1007/MP1008, had some pottery, including one piece which had a very interesting wavy decoration which is never seen again in Trench 1.

Feature 2 is comprised of stratigraphic layers MP1003, MP1004, and MP1005 and is a hearth, which is located in the centre of the trench. MP1003 is comprised mostly of a 0.02m thick layer of ash underneath a pale brown layer of soil where MP1002 and MP1003 meet. This layer had some pottery and small bone assemblages, which included SFMP1002 and SFMP1003 which are both burnt bones. This layer had a high charcoal inclusion due to the nature of the layer. MP1004, the next layer in the feature, is the burnt layer beneath the hearth. Layer MP1005 was the hearth stones underneath the burnt layers. SFMP1006, a lithic, was found in the sieve.

Feature 3 consists of a series of nine post holes and one pit. Due to the pottery found in this layer, it is estimated that this feature correlates to the Middle Neolithic period, since some Impresso pottery had been found within the layer. The nine post holes are context numbers: MP1046/MP1047, MP1048/MP1049, MP1051/MP1056, MP1053/MP1059, MP1054/MP1060, MP1055/MP1057, MP1061/MP1062, MP1063/MP1064, and MP1065/MP1066. Minimal charcoal, or none at all, was found in the post holes. Some of the post holes follow along the cave wall, while the others seem to lead to a point which meets with the first grouping. Due to the number and proximity of the post holes, it is unlikely that they were all created at the same time, meaning that Feature 3 could be more than one feature or could indicate a kind of cultural memory in the Neolithic people of the area. The pit, context MP1050/MP1058, produced a few pieces of pottery and a piece of bone, and appears to have to stake holes on either side of the pit, one on the north edge and one on the south edge.

Figure 39 West facing section of trench 1.

Discussion

Trench 1 had an abundance of contexts and I believe it would be beneficial to expand the areas of the trench, particularly towards the east to try to garner a better understanding of Feature 1 and Feature 3, since an expansion could show more of the post holes or features. It may also be beneficial to Feature 2, but I believe we have uncovered most, if not all, of Feature 2. It may also be worth expanding north, at least slightly, to see if Feature 3 extends further towards the stalagmite formations and towards chamber 2. In regard to Feature 1, an expansion of the trench is recommended to potentially uncover the whole of the feature. It would be interesting to see if the post holes do form a complete circle as a structure, or if they are only in a semi-circular pattern to simply protect against drips from the cave ceiling. It is suspected that Feature 1, when it fell into disuse, was burnt down due to the differences and great abundance of charcoal in the post holes, while the Feature 3 post holes did not have any charcoal.

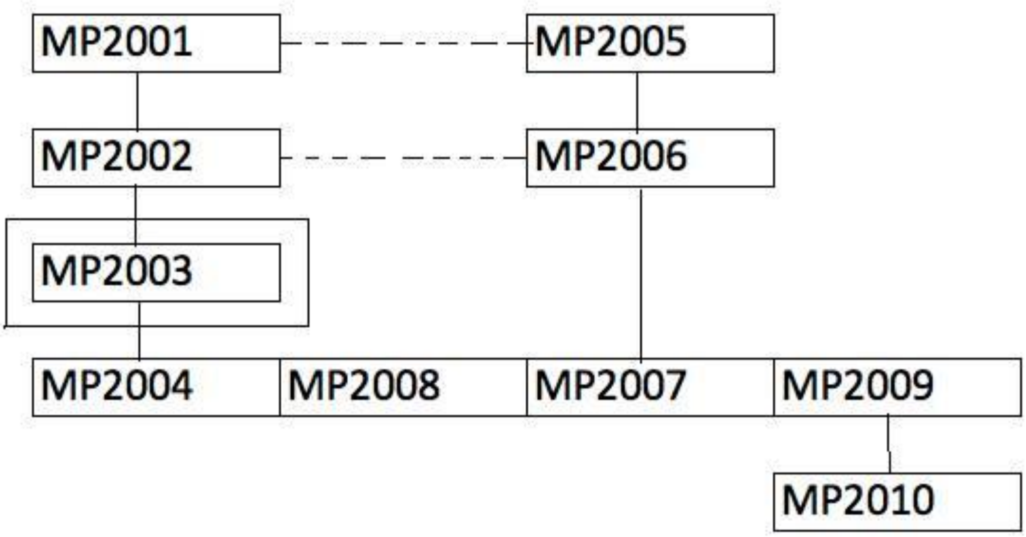
Trench 2

Location

Trench 2 is situated in the low passage that connects chambers 2 and 3 in the cave of Mala Pećina. The trench is located on the northern side of the passage and lies on the border between the passage and chamber 3. Here the ground in the passage has a very gradual slope down to chamber 3 (to the west). The trench covers an area of 3.07m (E-W) and 1.95m (N-S) with one rectangular indention in its southwest corner which extends 0.5m (E-W) and 0.75m (N-S) and a diagonal edge in the north which spans 1.47m. Before excavation the surface of the trench was covered in small rocks, stalactites in the southwest, and an area of disturbance, which is most likely due to animal activity, along the northernmost edge.

Stratigraphy

Trench 2 consists of 10 discrete contexts, context 1 is a mixed layer which has an average height of 628.924m (-0.194m to relative trench height). The context consists of a dark brown (Munsell 7.5YR 3/3) silty clay with around 15% charcoal inclusions, however this changes to a fully burnt charcoal layer at the border between contexts 1 and 2. Finds from this layer are mixed in age yet plentiful and are made up of pottery, bones and 2 lithics (SF001 flint, SF002 stone tool). The mix of periods of the finds is most likely caused by animal disturbance, such as seen in the trench's northern edge. Context 2 is a layer of red silty clay, which extends across the trench and has an average height of 627.392m (-1.338m relative to absolute trench height). Finds from this layer are again mixed and consist of pottery, bones and a single white flint (SF007). Yet the density of finds dramatically decreases deeper into the context and lessens to the point where the context could be called sterile. Its similarity in colour and texture to a sterile context in Trench 1 supports this idea and suggests that the layer is primarily made up of bat guano and soil, and that the finds occurring within it are related to animal activity.



Context 3 is a pit fill which sits within context 2 and is located in the southern sector of the trench. The fill is a dark grey brown and has around 35% charcoal inclusions, several small shards of pottery were found within this layer. Context 4 is a large burnt layer that is dark brown/black in colour and which is made up of both burnt geological cave crust and rocks. The layer extends across the trench at an average height of 626.975m (-1.755m to relative trench height) and has a defined border in the north which starts around 0.2m from the northern edge in the west and bends alongside context 8 before reaching the eastern trench edge. The layer is quite brittle and hard due to its burnt nature and only a small amount of pottery was found in its western sector.

Sitting on top of and somewhat within context 4 is context 8, which is a collection of burnt rocks and crust that run along the trench east to west. It shares the same colour and texture to context 4 so therefore is most likely related to the same event/series of events. Context 8 creates a structural feature, which could be interpreted as a wall or similar stone-built division, however there are no finds from this context.

Context 7 is a small deposit consisting of yellowish brown clay, which has large particles, this layer radiates from the southeast trench corner and extends up to the burnt contexts of 4 and 8. It is likely situated inside the enclosure of context 8's structural feature, one pottery shard was found within this layer. Context 9 is similar to 7 in its colour and texture but is situated in the central southern sector of the trench and sits on top of context 4, and features no finds.

Contexts 5 and 6 represent the trench's extension to the south by around 0.2m, context 5 is identical to context 1 whilst context 6 is the same as context 2. Finds from context 5 include pottery and bones while context 6 has no finds, which is somewhat expected if it is a sterile layer like context 2. Lastly, context 10 is a layer of brown sterile soil, which is clayey in texture and features mineral deposits. It is located within the test trench that was opened in the middle of the southern sector of the trench, which was opened to determine whether or not archaeological layers extended below the burnt layers of context 4 and 8.

Discussion

Contexts 4 and 8 are the most distinct and important features in the trench, as together they represent what is most likely a burnt, stone-built, and semi-circular early Neolithic structure. It is interesting to note the inclusion of crust and stalagmites in the structure, this points to the exploitation of pre-existing geological features in the cave. The pottery finds in the trench cover the early Neolithic period and showcases typical *impressa* decoration. The upper burnt layer of the border between context 1 and 2 represents an event which might not be related to the Neolithic as evidence of modern burning and use of the cave is present in chambers 1 and 2. However only ^{14}C dating of this layer will be able to confirm this theory.

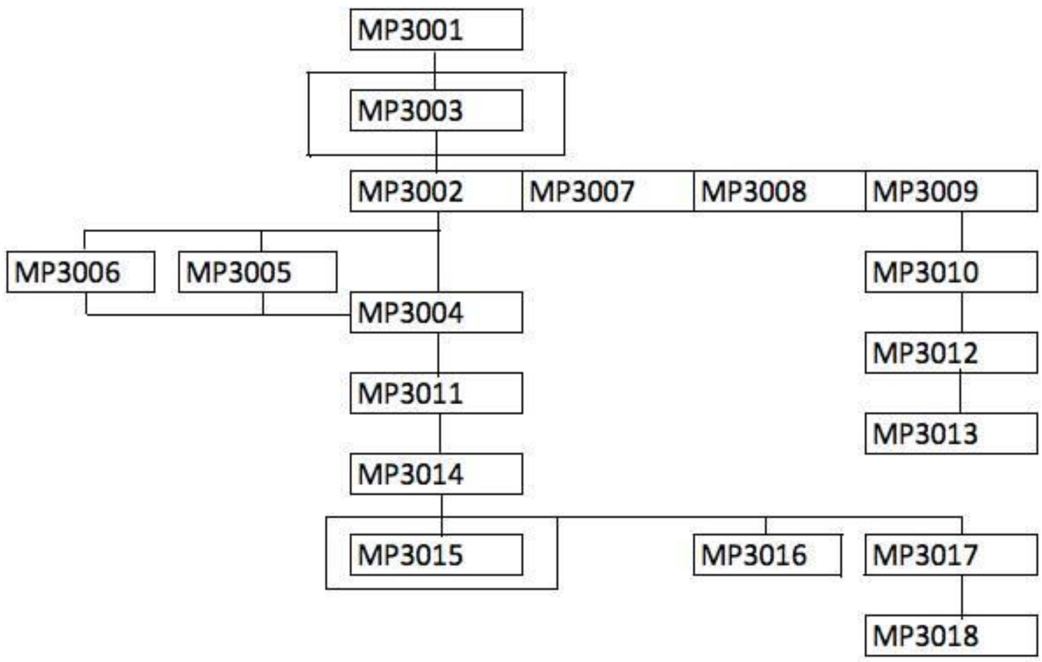
Trench 3

Location

Trench 3 was opened in chamber 2. It is accessible through chamber 1 and a large passage that connects the two chambers. It is situated to the right near the entrance of the chamber after a steep descent through the passage. It was placed on a flat surface behind a wall that divides the southernmost end of the chamber. The wall presents a good shelter from the natural elements. It measures 1.5m N-S and 1.3m E-W, although the western side of the trench is uneven due to the cave wall. The surface of the surrounding area contained a few pieces of as yet unidentified pottery.

Stratigraphy

Context 1 was covered by a white/grey rough thin crust (approximately 0.5cm or less) that broke easily. It contained charcoal inclusions speculated to be a result of recent human activity in the cave, attested by graffiti in this particular area. The top layer was reddish brown (5YR 4/4), very sandy and silty mainly due to the bat guano deposits in the area and varied in thickness (very thin on the northern side of the trench and thick on the southern side). A few pieces of bone and pottery were found in the context, including an impresso sherd, mainly closer to the surface and clustered in the northern part of the trench. On the SW side of the trench, a possible stalactite was included in layer 1, for it was covered by crust.



Context 2 was dark reddish grey in colour (2.5YR 4/1) and very clayey. Charcoal inclusions were approximately 15 per cent with a higher concentration towards the lower part of the deposit. It later turned out that this charcoal concentration was the top of the possible hearth (MP3008, MP3009). The layer itself covered the northern part of the trench extending over roughly 40% of the trench. A large amount of bones and pottery sherds was recovered from the layer, among them a sherd of Impresso pottery. Two charcoal samples for ^{14}C analysis were taken; SMP3002 and SMP3018, the latter from the lower part of the context.

Context 3 appeared in the southern half of the trench. The stratum is pure clay with no charcoal inclusions or finds. A similar situation was in context 4, covering the northern half of the trench with no finds. It was dark reddish brown (5YR 3/4) in colour and sandy. Two soil samples were taken (SMP3007, SMP3008) which only produced small amounts of charcoal. A charcoal sample for ^{14}C dating was also collected (SMP3010).

In context 4 on the northeast border of the trench, a possible post hole was spotted - MP3006. When excavated, sherds of pottery were found, however, the depth of the feature was less than 1cm. For its insufficient depth, it was not marked as a post hole. A possible relation to feature MP3005 in the central part of the trench was suspected. It contained 3 sherds of pottery. After the excavation, it became obvious both may have been lenses or a part of MP3002 that varied in depth throughout the northern part of the trench.

Context 7 was a clayey dark yellowish brown (10YR 3/4) with less than 5% charcoal inclusions. It had a form of two semicircles extending into the eastern edge outside the trench on the northern side. The thickness was less than 1cm. A sample was taken for flotation (SMP3009), however nothing was recovered from it.

As previously mentioned, underneath context 2, a possible hearth was uncovered. We were uncertain if layer 8 was a layer of ash. It is a creamy, hard but fragile layer of yellow (10YR 7/6). It was situated in the northwest corner of the trench. It was partially covered by layer 9 (MP3009), which was also the same level as context 8. Two samples were taken for flotation (SMP3011 and SMP3017). Only bone inclusions were uncovered with no pottery.

Context 9 was far more lucrative. The layer was black (5YR 2.5/1) with a high concentration of charcoal and small flakes of dark grey clay inclusions. It encompassed context 8 and partially covered it. Bone and 11 sherds of pottery were incorporated, of which 3 were Impresso pottery. Samples were taken for soil flotation (SMP3012, SMP3014, SMP3015) and two charcoal samples for ^{14}C analysis (SMP3013, SMP3016). During the soil flotation, a piece of flint was found.

The removal of context 9 uncovered a stratum of burned stones and bones referred to as context 10. It was a dry, crumbly layer, dark reddish brown (5YR 3/4) ending with a rounded edge from where context 9 was situated towards the southern and central part of the trench. Context 11 was an arbitrary cleaning layer of the south sector of the trench. It produced a bone and pottery sherds.

A feature of stones was uncovered in the northern sector of the trench and referred to as context 13 with its fill, context 12. The feature was originally discovered during the removal of context 10, when a stone with spirals, curves, lines, and possible red colouring (SF3001) was discovered in the centre of the feature. The stones were highly degraded and fragile (10YR 8/6 yellow). The fill of the feature was a brown (7.5YR 4/4), silty, slightly sandy soil. Several samples were collected (SMP3021, SMP3023, SMP3028), however, they appear to be sterile.

Context 14 was a cleaning layer of the southern half of the trench. While cleaning, several charcoal patches appeared in the layer, but did not form a feature (2.5YR 3/4 dark reddish brown). Small yellow clay lenses (10YR 7/6) were present in the layer. After the removal of context 13, context 14 was present across the entire trench. Darker sediments appeared (10YR 4/2) and were associated with patches of very pale brown clay (10YR 7/4) in the central area of the trench. Two charcoal samples for ^{14}C dating were collected (SMP3025, SMP3026). Pot sherds were among the finds, with a polished bone tool (SF3002) and an animal talon (MP3003). The latter was merely logged for the purpose of CAD height.

A very shallow posthole with a dark brown fill (10YR 2/2) was identified in the central-eastern part of the trench. It was entirely situated in context 14. A sample was collected for soil flotation (SMP3024). A sterile layer was uncovered under context 14 in the southeast corner of the trench, named context 16. It displayed no inclusions, lenses or finds (2.5YR 3/4 dark reddish brown). Context 17 is unnatural, arbitrary for the purpose of deepening and cleaning. It covers the entire trench and is the same in colour and texture as context 14. There were no inclusions in the layer, however, a jaw and a tooth (tusk) of a small animal were found (SF3005). Context 18 was also an arbitrary context created for the purpose of deepening and cleaning. It was the same in colour and texture as contexts 14 and 17. It was similar to the final context of trench 1, produced no inclusions or finds, thus, it was deemed sterile.

Discussion

There is a possible thin Neolithic occupational layer in the first two contexts, however, graffiti on the cave wall above the trench points to recent use. This makes it difficult to interpret the top layers, for they could have been disturbed by recent activities. One feature, a hearth (MP3008, MP3009) stands out and attests to the Neolithic occupation. Context 8 was a probable compressed ash layer and did not produce many finds. Context 9 however produced a large amount of animal bones, a piece of flint, and 11 sherds of pottery, of which 3 can easily be identified as Impresso. It may be associated with contexts 5 and 6 due to large charcoal inclusions and several pottery sherd finds. The other interesting feature is a layer of stones (MP3012, MP3013) that seems to form a circle or a spiral. Different interpretations were suggested, however, the soil flotation samples were sterile. The analysis of the stone with spirals and red pigment may provide some additional evidence for the interpretation. The bone tool and the animal jaw were found in earlier phases. All trenches had a few things in common; they all had hearths, the bottom layers were very similar, and flint was found in all of them. The smaller amount of bones in comparison to trench 1 and 2 with the lack of evidence of more permanent structures or shelters (post holes) may point to a short or seasonal occupation.

8.3 The microenvironmental sampling in Mala Pećina.

In Mala Pećina, microenvironmental sampling was conducted mainly by Cardiff University students under my supervision. We agreed that in order to have good corresponding sampling and at the same time to check the impact that our presence had on the cave environment, we had to perform sampling before the excavation begins and after the end of the excavation and to have constant logs of temperature and humidity at the areas of the trenches during the excavation. Apart from the usual temperature, humidity, luminance and soundscape recording which also took place in the other caves, in Mala Pećina we had the opportunity to record air and water flows inside the cave and to record our activity using a thermal camera, loaned from the Cardiff University Department of Engineering. Olja Mladjenović, a Cardiff University conservator undertook the task of the thermal photography with good outcomes regarding how human presence impacts the cave microclimate.

The microenvironmental sampling in Mala Pećina, provided some interesting outcomes. Apart from the "hallway" area, that for the case of Mala Pećina, counts as twilight zone, the rest of the cave is in reality a dark zone overall with a stable temperature of 10.1 degrees C throughout the cave, 0 Lux luminance and humidity that varies from 97.4 per cent on dry days to 99.2 per cent on the wet days. In the area around the small "skylight" a limited twilight zone is created, but only on the aspect of luminance which increases up to 110 Lux; the size and the position of the "skylight" does not allow the temperature or the humidity of the chamber to change.

Correlation between the archaeology and the combined microclimatic data from Mala Pećina presents two important outcomes: two different ways of engaging with the space between the Early and the Late Neolithic. The Late Neolithic occupation layer was unearthed in the driest, flat and warm part of the cave, away from air and water streams. On the other hand, the Early Neolithic occupation is present at the end of the low passage. A very wet (99.2 per cent average air humidity) cold (10.1 degrees C) and narrow position directly on the water and air stream. It is also interesting that just a few metres away from this point lie dry and slightly flat areas inside the third chamber, that are much more protected from the cold air stream and possible flooding.

8.4 The pottery assemblage

The author of this thesis undertook the entire recording, illustration, assessment and analysis of the pottery assemblage from Mala Pećina with some help towards the identification of certain Late Neolithic sherds from Dr Jaqueline Balen. The ceramic assemblage from the 2016 excavation has 410 pottery sherds from all three trenches. 142 sherds have been collected from Trench 1, 220 from Trench 2, and 48 from Trench 3. In the secondary analysis, 165 sherds have been processed with a minimum number of 48 vessels. 68 sherds have been collected from the Late Neolithic layer (structure 1 and the layer between LN and EN in Trench 1 – MP1 027), but only a few of them are diagnostic. The remaining 342 sherds represent Early Neolithic pottery styles. Open bowl-style vessels that can be identified as pottery for food production and consumption dominate the small LN assemblage. There are equal numbers of coarse and fine ware pottery and there is an absence of storing jars, pithoid vessels or cooking pots. Open vessels are also dominant in the EN assemblage but not exclusively. Based on the minimum number of vessels (MNV) from the EN strata, six closed pots – storage jars – can be identified. All of them are from Trench 2, from the interior of the (semi)-circular structure. Again, no cooking vessels have been identified. Several ring-like bottoms have been found in the EN layers in Trench 2. This constructional element is not very frequent in EN ceramic assemblages, but it is known from several, mostly north Dalmatian sites like Crno Vrilo, Pokrovnik, and Škarin Samograd (Müller 1994: Pl. 3: 15; Pl. 34: 7–8; Pl. 39: 12, 15–17; Marijanović 2009: Pl. 24: 2–4). One fragment of a bowl with slightly everted rim is decorated with a group of diagonal incisions, while a fragment of the body has a pattern with horizontal and vertical lines. Two sherds (a slightly everted rim and a fragment of a body) have a black burnished surface with horizontal, vertical and diagonal incisions (possible triangles!) with traces of white incrustation. This is the typical decoration of the Late Neolithic Hvar culture, with similar materials in several cave sites in the eastern Adriatic hinterland like Hateljska Pećina, Ravlića Pećina and Zemunica (Marijanović 1981; 2000: 80; Šošić-Klinđić et al 2015: 6, 17, 20).

The connection of Mala Pećina with the hinterland has also been confirmed by the find of a piece of conical neck of the pot from the hearth in Trench 1 (MP1 003) with burnished surface and thickened rim decorated with vertical incisions. The described shape and decoration are characteristic of the pots of the IIc sub-phase from the Ravlića Pećina site in western Herzegovina, which belongs to the late Hvar culture horizon (Marijanović 1981: 33, Pl. 28: 4–5). Considering that only a small number of diagnostic LN sherds were gathered in the 2016 excavation in Mala Pećina, it is important to mention that at least three sherds collected by D. Kliškić in the 1999/2003 survey could be attributed to the Hvar culture (Kliškić 2004: 100–104, 122–123, Pl. 1: 7–9), especially the piece with the “outlined” decoration combining incision, burnishing and red painting, characteristic for the classic phase of the Hvar culture (Forenbaher and Kaiser 2008: 69). The majority of the EN pottery is decorated with different motifs of impressed decoration (57%). If we include the Cardium pottery (27%) in the impressed styles, we get 84% as the total share of impressed pottery in the early Neolithic ceramic assemblage. Most of these decorations fit with the traditionally defined impressed A style, which was usually interpreted as coming earlier than the Impressed B style, but recent research has shown that the mentioned stylistic division has no firm chronological foundation (Forenbaher et al 2013: 603). A few sherds from Mala Pećina could be attributed to the group of EN monochrome pottery with burnished surface, known from the several EN cave sites in the eastern

Adriatic hinterland like Hateljska Pećina and Škarin Samograd (Batović 1979: 500, 505; Marijanović 2000: 73). In Mala Pećina a barbotine-style sherd was also unearthed in the EN context from Trench 2, which is quite interesting because barbotine pottery is generally absent from EN coastal sites, but is quite frequent in ceramic production of the continental communities within the Starčevo culture.

The variety of EN decorative motifs and styles in Mala Pećina could be interpreted as evidence of local people's movement from the hinterland to the Adriatic coast and vice versa. On one hand, there is a clear correlation with the pottery assemblages from Ravlića cave and Hateljska cave dominated by the impressed decoration made with various tools or fingers/nails, but on the other hand, relatively large numbers of cardium impressions or imitated shells could indicate stronger relations with the coastal communities. Additional evidence of the variety of the pottery assemblage from Mala Pećina is the different recorded types of tempering from the same contexts. For example, sherds of open bowls from MP2 02/05 contexts with similar impressed decoration have completely different tempering with different materials used, such as grog, limestone, and organic material. The absence of cooking vessels or large storage jars, and the presence of small consumption pottery and open vessels in equal measure, indicates that the cave was not used as a long term dwelling but rather as a temporary shelter, either for groups that were moving through the mountains or for groups that visited the cave for short term activities. Also, certain facts, like the morphology of the cave with three chambers and low passages, and the presence of the stone structure in the most inhospitable position in the cave with traces of fire and the highest number of EN pottery, could point to ritual activities taking place in Mala Pećina in the EN horizon.

8.5 The Zooarchaeological, Archaeobotanical and lithic assemblages from Mala Pećina

The analysis of the rest of the archaeological assemblages from Mala Pećina excavation has been undertaken by highly qualified specialists under the coordination and collaboration of the author of this thesis. Miss Alexandra Hale (with contributions and guidance by Dr Richard Madgwick and the author) undertook the assessment of the zooarchaeological assemblage from Mala Pecina. Dr Kelly Reed from the University of Warric studied the archaeobotanical material when Dr Antonella Barbir for the Institute of Archaeology in Zagreb studied the lithics. A short summary of their concluding remarks is included here, modified and enhanced with notes from the thesis' author.

Starting with the lithics, the entire assemblage discussed here comes from early Neolithic layers of the site. A total of 11 lithic artefacts (five flakes and six blades) were unearthed in the early Neolithic sequence of Mala Pećina. A total weight of the lithic assemblage is 25,07g. All the artefacts, except the chisel, are produced on tertiary nummulite flint that varies on colour from milky-white to yellowish light-brown and displays light spots in places.

Several nummulitid foraminiferans can be observed on artefacts. The closest sources of this raw material are found in the Split-Kaštela area, more precisely on the southern slopes of the Vlaška hill, Seget Donji, Opor, Kozjak, Mosor, the Marjan peninsula, Čiovo, and Baška Voda (Vukosavljević et al 2011). Raw material from which the polished chisel was produced could not be determined macroscopically, and a more detailed petrographic analysis is needed to address this question. Analyses of lithics from EN Dalmatia are still relatively rare, and the small quantities of artefacts found at this site limit the possible comparisons and larger conclusions. However, analogies can be drawn between the material from Mala cave and other contemporary sites in Dalmatia. Early Neolithic sites with similar lithic blade material include Smiličić (Spataro 2002: 73), Pokrovnik (Müller, 1994), Markova pećina on the island of Hvar (Čečuk 1974, 234-235), Vela Gromača near Kavran in Istria (Bačić 1973: 13), Vela Spila on the island of Korčula (Čečuk and Radić 2005: 71), Gudnja cave on the Pelješac peninsula (Marijanović 2005: 30), Odmut cave (Marković 1985: 38), Hateljska cave in Dalmatian hinterland (Marijanović 2000), Crno vrilo (Marijanović 2009), and Polje niže Vrcelja (Horvat 2015).

In general, the Mala Pećina assemblage contains a small number of tools – pieces with retouch, trapese, and a point. Sickle gloss seen on three blades is also of some interest, as it points to cutting of grasses (Semenov 1964). All three blades are smaller than 4cm. The fact that no cores, primary decortication flakes / blades, and retouch flakes were discovered at the site, and that cortex is present only on two artefacts could indicate that the artefacts were brought to the site and not produced in situ. Alternatively, the tool production could have been located on site, but at parts of the cave where no excavations took place, or in front of the cave, where the natural light is available.

During the 2016 excavation at Mala Pećina, 49 archaeobotanical samples were collected; 38 from Trench 1, four from Trench 2 and seven from Trench 3. A range of contexts types were sampled, including pits, post-holes, hearth and general occupation layers. Only 19 samples contained archaeobotanical remains, although seed density was very low with only 112 seed items being identified (not including unidentified plant fragments). The results are presented in archaebotanical report annex in the Appendix IV. Preservation was poor with many of the seeds being either fragmented or severely puffed and distorted. The samples were dominated by cereal grains, representing 72% of the assemblage (not including cerealia indet fragements), and included eight emmer (Triticum dicoccum), seven barley (Hordeum vulgare) and four einkorn (Triticum monococcum) grains. Two grains from Trench 2 were slightly smaller and narrower than the einkorn grains with a flat ventral surface and pointed apex, possibly indicating the presence of 2-grained einkorn (Kroll 1992). Four glume wheat bases were also identified from Trench 2, along with one poorly preserved lentil (Lens sp.). The first domestic crops and animals, originating from south-west Asia, spread by sea along the coast, reaching Dalmatia ca. 6000 cal BC (Chapman and Müller 1990; Forenbaher, Miracle 2005; Forenbaher et al 2013). These domestic crops are understood to consist of the eight 'founder crops' einkorn (Triticum monococcum), emmer (Triticum dicoccum), barley (Hordeum vulgare), pea (Pisum sativum), lentil (Lens culinaris), chickpea (Cicer arietinum), bitter vetch (Vicia ervilia) and flax (Linum usitatissimum) (Zohary et al 2012). At Mala Pećina four of the eight founder crops are represented within the assemblage and is comparable with other early Neolithic sites in the region (Reed 2015).

A small number of wild fruits species were identified including, six seeds of raspberry (Rubus ideaus) present from all three Trench's and one cornelian cherry (Cornus mas) stone from Trench 1 and some possible fragments from Trench 3. Only four wild or possible weed seeds were identified from Trench 1. These included singular finds of the common cereal crop weed fathen (Chenopodium cf. album) and knotweed (Polygonum sp.).

The form of preservation of the archaeobotanical remains at Mala Pećina was carbonisation or charring, which results from organic material being exposed to heat either accidentally or deliberately, such as cooking, burning rubbish or fuel (e.g. Hillman 1984; Miller and Smart 1984; Van der Veen 2007). Thus, carbonised plant remains will be heavily biased towards items that come into contact with fire more frequently and survive the charring process (e.g. Hillman 1981; Jones 1981; Boardman, 1990). The mode of deposition may also be inferred from the low density of remains and their poor preservation, possibly indicating that these plant remains resulted from different charring events conducted in the area that were then deposited over time within that different contexts. Looking at the distribution of plant remains between the trenches, Trench 2 contains the greatest number of identified crop remains. However, it is important to note that MP2 005 was identified as having mixed finds during the excavation and may indicate disturbance and possible inclusions within the plant remains. Due to the low numbers of remains it is difficult to determine whether there are any significant patterns in the distribution of the plants remains through the site.

Mala Pećina presented a modest and highly fragmented assemblage of animal remains. Because of the limited size, the isolated data collected from the assemblage has limited interpretative value in its own right, but can still make a valuable contribution to the limited corpus of material from the region. The animal bone from Mala Pećina was retrieved primarily by hand collection. All deposits were 100% sieved through a 10mm mesh and this augmented the faunal assemblage and promoted an excellent level of recovery. In total, 279 fragments were analysed in detail. Of the 279 fragments, only 118 were recorded to species; an additional 63 were recorded to unidentified mammal of a specific size class and 98 fragments were left unidentified due to size and the fragmentary nature of the assemblage. The assemblage comprises seven species of mammal and two avian species. The proportion of burnt bones varies across the trenches and features. Overall 57% of the assemblage is burnt. Trench 1, with 2 hearths had the most burnt material, followed by Trench 3, with no burnt material found in Trench 2.

Only 10 fragments in the assemblage displayed butchery. This may radically underestimate the presence of butchery evidence, as the relatively common occurrence of weathering and calcareous concretions mean that fine knife cuts would often be overprinted.

Domestic species dominated the assemblage. Cattle, sheep/goat, and dog are the main species represented, with wild species being wild boar, passerines, and rodent. Due to the small assemblage size, context and feature-specific MNI values are invariably for all taxa. There are only two exceptions to this, trench 1 contexts MP1 002, with a MNI of 2 for caprine, and MP1 004, with an MNI of 2 for cattle.

8.6 Discussion on the Preliminary data from Mala Pećina's excavation

In the case of this PhD research, there are observations regarding the methodology and the spatial arrangements inside the cave that worked quite well and an evaluation can back up the data that is presented from the previous two stages of thesis case studies.

Concerning the methodology, the application of the 3D point cloud photogrammetry using Agisoft in combination with EDM and Leica Disto X has proven valuable on the basis of the speed and accuracy of the data recording. In the difficult conditions of a subterranean research, complete paperless recording can minimize errors, fatigue and the recording team's workload. However, working with 3D photoscans in caves, creates a very difficult technical challenge of lighting properly and with consistency any area that is recorded. In Mala Pećina, working with portable battery based LED lights we failed to produce consistent textures for the photoscan. Thus, even if the recording was properly conducted, the presentations of the 3D records is not of the highest quality. This is not a photoscan or methodological problem though. It is a technical issue that can be tackled using different lighting techniques and/or more advanced equipment. Generally, following the methodology for the correlation between archaeological evidence and the micro-climatic data, which has been presented in Chapter 5 and also been applied in the four previously excavated caves which the Balkan Cave Archaeology team visited, we can now have a strong initial application of these techniques to raw excavation data that can guide future adaptations in larger projects.

Focusing on Mala (Nova) Pećina excavation, the cave presented two distinct phases of occupation; a later one, with the Late Neolithic Hvar Culture remains found only in Trench 1, and an earlier one from the Early Neolithic Impressed Ware Culture, found in all three trenches. A similar chronological sequence in the Neolithic period is attested by several cave sites in the Adriatic hinterland like Hateljska Pećina, Ravlića Pećina, and Zelena Pećina (Benac 1956; Marijanović 1981; 2000, for absolute dating see Vander Linden and Pandžić, Orton 2014: 18–19), but also by some coastal and island sites, as shown by the recent excavations in Grapčeva Špilja (Kaiser and Forenbaher 2008). In Mala Pećina, there is a clear differentiation between the occupation areas and the spatial arrangements inside the cave from the Early to the

Late Neolithic. At this point we can still discuss the position – awkward to the modern visitor – of the EN structure in Trench 2 at the end of the low passage, and the decision – again, wise to the modern perception – to use the driest and flattest part of the cave in the EN and LN periods. In other words, if we accept the preliminary hypothesis that the cave in the Early Neolithic had "profane" (shelter) and "ritual" use, compared to the Late Neolithic occupation of traveling shepherds for short periods, these two different groups were using the cave space somewhat differently. Furthermore, the EN groups used almost every part of the cave, including the inhospitable position in the area of Trench 2, deep in the lower passage between Chambers 2 and 3. The LN groups were using only the first chamber, close to the entrance at the limit between twilight and the dark zone. During the LN, visitors deliberately selected the flattest and driest space for occupation compared to the EN groups that used the whole cave, including the wettest, darkest and most confined spaces of the cave.

In conclusion we can state several facts resulting from the recent research in Mala Pećina:

1) Pottery finds and bones along with the modest settlement remains in the LN and EN layers in Trench 1 can support the idea that the cave was used as a temporary shelter for moving groups – probably shepherds and not hunters, based on the bone assemblage dominated by domesticated species.

2) The absolute date from the area of Trench 2 places the EN occupation in Mala Pećina in the first half of the 6th millennium (Beta-287818: 5780–5640 calBC) that fits well with the established chronological frame for the Impressed Ware culture in the eastern Adriatic (Forenbaher et al 2013). Furthermore, the presence of both coastal and hinterland impressed ware in the same contexts supports the assumption that the Adriatic EN is not isolated from the hinterland EN. On the contrary, the Neolithic groups in both areas might have been in mutual contact even from the very first centuries of the 6th millennium (Spataro 2008), and Mala Pećina might be the point in the region that connected the ecosystems separated by the Dinaric Alps – the coast and the hinterlands. As also presented in the short report of Drnić and Trimmis (2018), the Dinaric Alps might be that "marginal space" where different cultural groups were in contact and exchanged ideas and objects. This is still a research hypothesis mainly because the material from Mala Pećina looks overly "coastal" (e.g. lithics sourced in the Split-Kaštela area, impressed style pottery assemblage similar to

coastal sites such as the Zemunica cave). Isotopic studies on the animal bones could give additional evidence about the mobility of the aforementioned groups; however, the zooarchaeological assemblage of the cave at this stage of research is too small to support a comprehensive isotopic study. There are certain indications, though, that the groups that visited Mala Pećina in the first half of the 6th millennium were in contact with the groups that lived further inland. The similarities of certain impressed motifs with the material from Zelena and Hateljska caves in Herzegovina, the variety of tempering of the impressed pottery sherds, along with the presence of barbotine pottery in the same contexts with the typical coastal cardium impressed style, could be the supporting evidence.

3) The EN horizon in Mala Pećina has a typical EN "package" for the Eastern Adriatic region, with pottery, domesticated animals and plants, and one example of a polished tool. The EN groups, as presented by the pottery, lithics, plants, and bones assemblages, were neither living inside the cave nor staying inside for long periods. The visits were probably of short-term character. However, more research is required in order to investigate the patterns and the duration of these activities.

4) Some data gathered in the Mala Pećina excavation could indicate some sort of ritual activities in the cave in the EN period, as suggested for the LN phase of the Grapčeva cave on the island of Hvar (Forenbaher and Kaiser 2008: 141– 145). This is suggested by the complex morphology of the cave, with a narrow entrance and three chambers and low passages that support the idea of a "liminal zone between the everyday and underground worlds". In addition, the presence of a simple stone structure in Trench 2, placed in the most inhospitable position in the cave and accompanied by a much larger pottery assemblage (with a high percentage of decorated fragments), in comparison to the settlement layers in Trench 1, could fit into this working hypothesis. Again, it is important to emphasise that further excavations are required to confirm this claim! The behaviour of people selecting caves, or part of a cave, with particular microenvironmental characteristics in order to undertake particular activities, which are different for different environments, can be seen in the wider southeastern European context (the Balkans and Greece) (Sampson 2008; Trimmis 2018). There are certain indications that such a change in occupation patterns between the Early and Late Neolithic could also be observed in Mala Pećina, possibly reflecting at least a partial shift in social practices at the site.

Chapter 9
Can we archaeologically record sensorial spectrums of the Past? Discussion and concluding remarks

Summary

In this chapter the discussion about the cave use strategies in the Neolithic cave sites is summarised when an evaluation of the proposed methodology is presented. Theoretical, methodological, and technical challenges of the approach are presented and evaluated. The chapter continues with a summary and a step-by-step presentation of the "Paleosensorial Spectrum Reconstruction" method when possibilities for further development and adaptation of the method are mentioned. The thesis concludes with a sort summary of ideas how this methodology along with the outcomes of the Balkan case study and can further researched in the future.

9.1 Closing the Balkan research – things to take forward

Before we move forward to summarise the sensorial mapping in subterranean archaeological sites, and conclude on the technical and methodological outcomes of this thesis, I would like to make some remarks regarding the thesis case study; the use of caves during the Neolithic in the Western Balkans and Greece. So far, as has been earlier analysed extensively, in the aforementioned area, interpretation of cave use is generally influenced by two major theoretical streams: a) the use of caves either as places for worship/ritual/spiritual expression or as places for more mundane/profane uses and b) that the use of a cave, is based on the "affordances" that this cave offers. As it is already mentioned this research was not designed to sufficient contribute to these theoretical norms, but I believe is important to showcase what has been found from the application of the sensorial mapping methodology.

Regarding the first point that caves were used either as "ritual" or "profane" the thesis outcomes cannot contribute to this Durkheimian debate, and cannot support theories similar to these that have been proposed in Mesoamerica for example (see for example Thompson 1990; Moyes 2001; Morton 2018). In Mayan cave use, research suggests that caves are either places for cult/worship or places that host mundane needs (water collection for example). Morton (2018: 68-69) in his overview highlights the economic aspects of the ritual use of caves but seems to keep these two ways of using the cave space separate. But can the Mesoamerican theories be adopted for the Neolithic Balkan context?

Claiming that this thesis offers the first – and only to date – regional evaluation on the cave use strategies in the Neolithic Balkans, and this overview took place as a case study to showcase a research methodology, there is an enormous amount of work that can be undertaken in order to be more confident to propose a model for the cave use in the area. However, what it is presented from this thesis is that in the Neolithic Balkans, it is far more difficult to understand how the rituality was expressed compare to Mesoamerica and to Indonesia when cave use is very well studied. There are several ideas that have been presented on different occasions, providing interpretations that vary from caves as proper Neolithic sanctuaries to caves as places for spiritual expression, social cults and/or shamanism (e.g. Tomkins 2009; Moyes 2012; Dowd and Hensey 2016). The analysis of the Balkan Cave Archaeology datasets seems to support an idea that caves that did not clearly have a "utilitarian" or "ritual" use, and caves seems to be much more places for social congregation rather than underground Neolithic sanctuaries. According to Renfrew and his co-authors (2013), a place can be characterized as a sanctuary if all – or the majority – of the following factors are present: a) symbolic attractor b) centre of participating region c) monumentality or ritual deposition d) conceptualized "deity" e) pilgrimage f) evidence of "beyond mortality" ideas and g) sometimes a "hypaethral". In caves we can identify the monumentality of the actual natural structure and we can assume the evidence of "Beyond the Mortality" ideas at the burial sites but we cannot identify any of the other characteristics. Though in the same way that caves function on the periphery of settlements as "supporting" sites for the economy of the settlement, caves could also be places for social interaction and spiritual expression: places for congregation. A mass of people could gather inside the cave in order to take advantage of the sensorial impact that caves – and particularly the dark parts – would have had on their minds and perceptions (Whitehouse 2016). In these semi-lit areas a "spiritual" performance could take place, with the cave's "mysterious", "dark", and "humid" environment acting as the scenery for these performances. The cave could, at the same time, be the "meaningless object" that a bodily-based performance needs as “prop” in order to communicate the narrative to an audience and the actual scene where the performance take place.

Behind these faceless uses, there are hidden people who were visiting the caves, forming and making use of the sites. The issue of the identification of the user depends on two axes. The first is the society to which the user belongs and its structures. The second is the cave itself and how its features form its use. Starting from the second factor, the cave as a microenvironment is inhospitable and hostile for human activities. The darkness or semi-darkness, the very high humidity, the frequently large accumulations of guano, the speleodeposits, the decoration, the soggy ground and the flood episodes describe a discrete area. A human, looking to prevail over this microenvironment, should not only have the relevant knowledge in order to overcome the natural obstacles, to establish their power and use the area, but also a good knowledge of the cave as a natural feature, aiming not to be affected by the difficulties and to be able to exploit any advantages. This deep knowledge of an area can only be achieved through constant contact and practice with the microenvironment of the area. The acquired experience gives rise to norms regarding the organization and use of the area. We observe that these norms are present in excavations and in general terms they are repeated from cave to cave. The domination and codification of this experience by a society presuppose that the human, who uses the cave, should constantly be in touch with the cave environment. Moreover, it presupposes a consistency in the choice of the group, which will use the cave for a certain purpose.

The second fact, which emanates from the features of the cave has also a social connotation, related to the theory that the use of each cave, up to a point, depends on the distinctive advantages of this cave and the decision of a person to “use” it (Sampson 2008: 456). More analytically, it can be proposed according to Sampson, that the deep, wet and rather dark caves are more appropriate for storage, whereas the dry, well-lit and shallower caves are more appropriate as a temporary shelter for moving pastoralists or hunters. In a simple comparison among the caves (perhaps with the exception of Katarraktes cave in Sidirokastro), the data for the first phase and the second phase of analysis may support the above proposal since we have caves with uses concentrated on the twilight zone and cave where the activities were concentrated at the darker parts. This issue yet needs more investigation and analysis. However, if we accept the last theory, we could say that the choice of the appropriate cave for a special purpose, which every society needs, presupposes that there are people inside the community who have the relevant experience and have spent the necessary time to acquire it. In other words, it presupposes a form of specialization in the way that people in the Neolithic Balkans selected a particular natural space for their needs.

This leads me to emphasize here the importance that the twilight zone seems to have in comparison with the dark and the entrance zone. I analysed extensively in chapter 6 why this may be happening, but as a conclusion here, I would like to summarize that this twilight concentrated use may well be an outcome of a careful selection of the cave sites by the Neolithic groups according to caves' affordances. Since the twilight zone is the most suitable for long term stay, for the reasons presented earlier, people select caves with suitable twilight areas for their needs. Further research is needed in order to characterise precisely the character of cave use and the importance of the twilight zone. A tool for this research is the application to more sites of the mapping microenvironmental zone-based mapping that was presented in chapter 7 and which highlighted the areas with concentrated uses really well.

Two more things regarding the cave use in the Neolithic Balkans are indicated from the analysis of the case studies: the shift of the use strategies between early and Middle/Late Neolithic, and the increase of the caves used between the early and the later phases of the Neolithic. About the shift in the way the cave space is used, we can see a much more "rational" – to the modern observer's eyes – use of space between the different phases in the Neolithic which may well be correlated with the general socioeconomic shift between the early and the middle Neolithic in the Balkans. This shift is well documented in several large open-air settlements such as Maliq in Albania, and Sesklo and Paliambela in Greece and had been discussed extensively in review publications since the 1970s as a social change that occurred in the Neolithic groups and as a move towards more structured societies (see for example Bailey 2000; Papathanasopoulos 1996; Perlés 2001; Theocharis 1981). Since it is not the main purpose of the thesis to discuss the use of landscape in the Neolithic Balkans I do not want to elaborate further on the topic, but just to emphasize that from my regional review the shift of the use of space is also evident in the cave sites and not only in the open-air settlements. The second aspect, about the increase of the caves used between the early and the Middle/Late Neolithic, is something that is not well documented and clearly cannot be addressed in correlation with the number of open-air sites, a number that decreases during the final stages of the Neolithic. Personal communication with several researchers that are working on Neolithic Greek caves, such as Fanis Mavridis and Katerina Trantalidou, stressed that this is something that others have also observed but it is difficult to interpret. Thus, from major publications such as Mavridis and Tae Jensen (2013) on the cave archaeology in Greece an explanation of this phenomenon is avoided. Again, my regional approach highlights the phenomenon but since I used the caves just as case studies regarding the potentiality of a paleosensorial based review, I suggest that more research is needed in order to address sufficiently these research questions.

9.2 Sensorial driven archaeology; summarising the current discussion

Leaving behind now the use of caves in the Neolithic Balkans and the contribution that this thesis made to the topic, I would like to return to the main theme of the thesis and evaluate the contribution that this research has made towards sensorial driven archaeological research in subterranean archaeological sites, and also to discuss practically how my methodology can help such a research approach to take place. Referring back to the introduction of the thesis the research question is to explore a way that archaeological senses can be recorded – mapped – in the field and afterwards correlated to the rest of the archaeological evidence. Also, my question referred to the possibility of a method that along with the sensorial recording can equally record archaeological emotions and feelings so as to holistically understand the driving forces behind human decision-making. As I mentioned earlier in chapter 2, sensorial approaches to the archaeological data are not something new, and evidence of similar attempts can be found even in the late 1980s – early 1990s. However, these approaches have been heavily criticised as biased, again as I have presented in chapter 2, mainly because the recorders' active perceptions were also incorporated into the interpretation of the archaeological data.

Post 2010, archaeological senses re-emerged in the discourse mainly because of the publication of three books – as I have already mentioned earlier in chapter 2; Hamilakis' book on the Archaeology and the Senses (2013), Skeates' book on the Archaeology of the Senses and Mills' book on Auditory Archaeology. These publications have been welcomed by the research community for bringing back into archaeological discussion the sensorial spectrum of the past. They have also been praised for the way that senses have been described as part of a well-structured research framework. Tringham for example (2015:708) on Hamilakis' book says that the book will make a huge contribution to re-thinking this discipline, while Lilios (2013:253) characterises Skeates' approach as provocative and also evocative.

All these publications have also received certain criticism that can be summarised on the aspect of not putting into – conventional – practice the theoretical framework that they are proposing. Mills' book has a long section at the end when he is presenting three applications of his auditory methodology and to an extent, he tries to suggest a more "practical" – "field" – application of his sensorial methodology: in other words auditory research as part of a conventional archaeological research approach. However, both Hamilakis and Skeates to a great extent based their sensorial analysis on creative writing and long-form narratives that blend archaeological evidence with sensorial stimuli– see for example Skeates' discussion on the figurines' forms from Malta or Hamilakis on the Agia Triada sarcophagus.

Hamilakis after the first four chapters when he went on to present his approach according to Tringham, fails afterwards to convince the reader that a sensorial archaeology can be put into practice. Tringham believes that long-form narrative and creative writing are not the best ways to showcase such an approach and she suggests that recording archaeologically/practically the synaesthesia of the past societies, that Hamilakis introduces in his first part of the book so well, will need a great (but not impossible) effort (2015:708).

Lillios (2013) on her review on Skeates' book expresses similar ideas to Tringham. LIllios welcomes the fresh idea of using a multisensory approach as an interpretative tool and acknowledges the need for archaeologists to deploy more non-visual senses such as smell, hearing, taste, and touch. However, she acknowledges that "many archaeologists will be resistant to a multisensorial approach because of it apparent lack of rigour" (2013:255).

What both Lillios and Tringham suggest is that we need a multisensory approach for a better and less elusive understanding of the past, and both Skeates and Hamilakis managed to introduce this kind of approach, from different perspectives, but equally with freshness comparing to the early 1990s approaches to sensory archaeology. Both, however, seem reluctant to be convinced that such an approach can be delivered in the framework of a traditional quantitative approach. They also both suggest that creative writing may be powerful at distancing the current researcher from the past senses, but both Hamilakis and Skeates seem more to describe rather than record the sensorial stimuli.

In other cases, such as the aforementioned here case of Mills' research, or Tilley's and Hamilakis' research that has been presented in chapter three and five respectively, archaeologists have managed to map and record individual senses and to calculate their possible impact on past societies. Sound then, in the case of Tilley and Mills and light in the case of Hamilakis have been possible to be surveyed, analysed and then investigated for their impact. Thus, why not a multisensory approach?

9.3 Contributing to the discussion

The Paleosensorial Spectrum Recording (PSR) – evaluating the technical aspects

The methodology that I built up on theoretical grounds in chapter 2 and then on technical factors in chapter 4 can be named as "Paleosensorial Spectrum Recording (PSR)". My approach, instead of recording, as was happening in the early 1990s, the active perspectives of the observers of the past, or to incorporate the evidence with strong aspects of creative writing, is trying to record the fragmented but still original or "fossilised" sensorial stimuli of the past. Thinking further to the cave contexts that have been analysed extensively in this thesis, PSR means recording the luminence, the temperature, the acoustics, the humidity, the smells of a Mycenaean "tholos" tomb or the interior of a Medieval cellar; is recording the interiors of the well-preserved Greek Temples in south Italy; or the engine room of a WWI battleship.

In technical terms, in the strengths of the approach so far can be included the mapping speed and accuracy, the minimization of human made errors, the ability to handle qualitative data, the ability to support geo-spatial models based on qualitative data and the way that archaeological evidence can be discussed in correspondence with the micro-climatic data. Also, I should refer to the elasticity of the approach that makes it possible for it to be adapted for several different instruments (from a total station, to the traditional tape and compass mapping) and to be executed from several different software platforms as I have extensively presented In Chapter 5, where I discussed the aspects of mapping speed and accuracy and how the proposed method minimizes survey errors.

There is still a long distance to be covered on the technical aspects of the proposed methodology, particularly on the issues affecting the caves due to the lack of light, which is the main aspect for these techniques. Even with state-of-the-art LED powered lighting systems, it is still very difficult to achieve a consistent well-lit space for photogrammetric techniques. Also data loggers of humidity, temperature, acoustics and luminence sometimes do not offer accurate climatizations for the subterranean environment where the high-end data loggers used by the karstologists offer precise measurements, but that point of precision is not useful for archaeology since the human body cannot understand variations less than a half of a degree Celsius. Still also there is no software available in the market for data evaluation and analysis. Thus, Paleosensorial Spectrum Recording needs to rely still on off-the-shelf data analysis software such as all GIS suites.

Feelings and decision making – recording taskscapes as landscapes of emotions.

Returning to the goal that I set out for this PhD thesis, to explore if, through using advanced mapping, we can find a method to record the past senses in – mainly – underground archaeological sites, the sensorial sampling in the Balkan Caves and the excavation in Mala Pećina were organized around the idea that was developed in Chapter 2, that particular actions – activities – that were triggered under particular sensorial stimuli can be linked with certain emotions and feelings. Bringing in Zeelenberg's (2007, 2008) approach that feeling-is-for-doing, I would like to discuss how these activities are triggered, and if a methodology of recording the sensorial spectrum of the past in archaeological sites can be beneficial towards a better understating of people's behaviour and decision-making strategies.

Cognitive psychology understood early that emotion plays a large role in decision-making. Zeelenberg and his co-authors in a paper back in 2007 note that even from the late 18th century, theoreticians of the time like J. Bentham and A. Smith had recognised this and discussed it in some detail. The problem that psychology tries to solve is "how much" emotions and therefore feelings affect decision-making. For the second half of the 20th century psychology recognized emotion as a complementary factor to the decision-making process mainly on a positive-negative dimension (Zeelenberg et al 2007). Later psychology recognized the importance of emotion for decision-making, characterizing decision-making as an "emotional process" (Zeelenberg et al 2008:18). For psychiatrists, emotions have evolved because of their genotypic and phenotypic survival (see Ketelaar 2004). This means that they appear in evolution in order to help us to make better decisions and to overcome "cognitive limitations within ourselves and constraints placed upon us within the decision environment" (Zeelenberg et al 2008:18).

In Zeelenberg's approach – which is the approach that this thesis follows – emotions, along with feelings, thoughts, action tendencies, and actions, are the motivational factors behind a decision-making process. As I stated in Chapter 2, all these factors in my view stand as trigger factors behind Ingold's taskscapes. In archaeology we can trace actions, action tendencies, and on some occasions, we can assume thoughts. This thesis from the very beginning is in pursuit of the other two factors: emotions and feelings.

Therefore, it seems easy – connecting environmental science, cognitive studies, and archaeology – to imagine the feelings that people had, once they visited the dark zones of caves. In my approach, as I suggest in Chapter 2, I adopted Skeates' framework for sensorial research in archaeology in order to trace emotions.

The first step, reflexivity, refers to the assumptions and sensory bias inherent in research approaches. In this research I suggested in the second part of Chapter 2 that caves on several occasions minimise the sensory biases between past and present due to being an enclosed landscape-microenvironment. Other archaeological sites that have similar characteristics, natural or anthropogenic, can offer similar assets, such as underground necropolises, medieval cellars, interiors of buildings and old town neighbourhoods. In Chapter 4 I presented the assumptions as they reflect on my hypotheses and derived from recent cave research in Anatolia, the central Mediterranean and the Balkans. The second step, inventory, refers to the identification and description of the range of resources and practices that constitute the Neolithic groups' sensory profile. It is a major part of Chapter 6, as it is an inventory of Neolithic Balkan caves and the 'sensescapes' that people met when they visited them (e.g. sensorial spectrum associated with caves' entrance orientations, use per microenvironmental zone, altitude). The third step, experimentation, refers to multisensory fieldwork, performed to test or demonstrate the potential variables of sensory orders at specific locations. My experimentation step was the sensorial based fieldwork in the caves of Koromilia, Kitsos, Leontari and Antiparos and to an extent the excavation at Mala Pećina. I acknowledged earlier and I would like to mention here again that my experimentation step was very small in order to get strong results, but it helped to test a research methodology and to understand better the in-cave sensorial stimuli that Neolithic users perceived when they visited the caves.

The last two steps, thick description and creative writing, are the steps that I explored the least in this thesis. Creative writing has been addressed extensively both by Skeates and Hamilakis and I think it is valuable for the creation of narratives and also for the better understanding of the proposed concepts that derive from the Paleosensorial Spectrum Recording. As an example, the recording can showcase – in the case of this thesis' case studies – that the twilight zone in the Neolithic caves in the Balkans was heavily used; creative writing can be employed for a better exploration of the different scenarios of activities that might have taken place in these areas. Also, creative writing can help towards a better exploration of the cognitive psychology behavioural models in archaeology. Occasionally, as for example Hamilakis proposes, creative narratives can also help to overcome the 1990s bias of the observer that I have discussed extensively earlier; with creative writing the researcher-observer-author can change identity and became participant, in order to understand, explain, and then present aspects/actions of the past.

Paleosensorial Spectrum Recording is a tool that fits right between the methodology steps of thick description and creating writing. Once a sensory index has been achieved for the archaeological site under investigation, and once a good understanding of the present sensorial stimuli has been constructed, PSR aims to correlate all the available information and to create maps, as in the maps that have been produced for the caves in chapter seven of this thesis. These maps can showcase the sensorial stimuli that a person was perceiving in any particular point of the map. Thus, since archaeology can record the taskscapes of the past – based on the fragmented material evidence – it can now equally record the sensorial landscape – sensescape – of the past, equally based on the fragmented sensorial evidence. Paleosensorial Spectrum Recording, since it is recording the past senses, and not the current sensorial stimuli, can overcome both the bias of the subjectivity of the observer and also challenge the limitation of the application of behavioural models in archaeology, since again the PSR refers to behavioural models that links past senses (and thereafter emotions and feelings) with past actions – hence past behaviours.

From this point onwards it is a theoretical world, more psychological/sociological than archaeological, that can be explored with the models presented in chapter two and briefly earlier in this part of chapter nine, in order to link emotions with actions – behaviours (such as the way that Zeelenberg or Turner presented and have been showcased earlier). The ultimate idea is to describe – and why not record and understand – past decision-making strategies, as a blend of sensorial based perception of the world and accumulated emotions and feelings, which then lead to the creation of the archaeological evidence in the form of tasks/actions/activities. This is something that archaeology tried to achieve so far with the exploration of the material culture evidence and not with the investigation of the driving forces behind the creation of this material culture, which is the aforementioned triptych of senses/emotions/ feelings. What I tried to investigate was a methodology to start tackling the recording of these three and mainly the recording of the senses. The Balkan case study which has been presented earlier showcased that an application of a methodology like Paleosensorial Spectrum Recording is first feasible and second productive. Further applications of the method and further adaptation of the models can link to a better understanding of the method's dynamics in recording past landscapes of emotions.

9.4 Concluding remarks

Leading this thesis to a conclusion I would like to make some remarks regarding the proposed methodology and its possible adaptations.

The Paleosensorial Spectrum Recording for subterranean archaeological sites can be organised in four different steps:

A) Collection of the geographical information with thorough and detailed, bibliographical research and on the ground, survey of the subterranean sites and annotation of the sampling points. As presented in chapter 4, paperless mapping techniques, based either on advance laser distance measuring devices (such as DistoX2) or in EDMs/Total Stations, can be proved valuable in completing "Step A" with high accuracy and with minimum error in the difficult mapping environment of a subterranean site. 3D point cloud photogrammetry, even still in the early stages for subterranean application, can also be a valuable survey tool, as has been shown during the Mala Pećina excavations. The use of paperless mapping techniques offers also a centralised end-to-end management of both qualitative and quantitative data that might require to be correlated later with the relevant mapping points. For the bibliographical research “off-the-shelf” solutions, like “speleobase”, can be used for organising the data and any statistical software – like R or SPPSS – can be used thereafter for the further analysis.

B) Mapping/Survey data collection and management software that will correlate and analyse all the available, geographical, environmental, and sensorial data so as to lead to the re-creation of the paleosensorial spectrum. Cava data management software like Therion and Visual Topo are the current platforms for the data management and analysis but in the future more specialised archaeology-oriented applications need to be developed.

C) For spatial analysis and correlations between the paleosensorial data and the archaeological evidence GIS softwares are still the best available platforms. ArcGIS and QGIS can be equally used. Interpolation and then Principal Component Analysis (PCA) in QGIS was used for the purpose of this research, but other spatial analysis/ statistical tools can be tested in order to answer different questions. Python based algorithms that will correlate the paleosensorial data with the archaeological evidence in order to provide high and low possibility scenarios for the use of a particular space/area can also be developed and more advanced computer modelling can be introduced.

D) Further interrogation and final presentation of the mapping outcomes can take place following several different theoretical approaches. Creative writing or thick description as has been suggested by Hamilakis and mainly Skeates are one way. Further analysis, however, can happen if paleosensorial mapping metadata are analysed further through cognitive psychology models or anthropological approaches.

The Paleosensorial Spectrum Recording approach that was presented in this thesis contributes also to the issue presented in chapter 3. The lack of an end-to-end method for archaeological recording of archaeological caves’ microenvironments or in Mlekuž’s language, of the caves’ affordances. Other approaches took into account for example the acoustics, or the luminence of the cave space, and Mlekuž himself introduced the cave agency and the impact that cave space may have on people’s kinesthetics into the cave environment (Mlekuž 2012). However, this is the first time that a method correlates several of these aspects in a single factor that affect the cave users and shapes cave use strategies. The “PSR” also leaves space for other aspects to be included if that suits better the needs of different research approaches such as the kinesthetics of a subterranean space (see Mlekuž 2012, Pettitt 2016 about the kinesthetics in caves) or the smells (see Aiello et al 2016 for mapping smells).

Furthermore, as several other researchers noted previously (e.g. Hamilakis 2013; Whitehouse 2016) people’s decision making is not only guided by practical challenges but also by feelings and emotions that were cultivated on different occasions. Folllowing models such as Tarlow’s (2000) and Zeelenberg’s (2008) we can associate particular feelings with particular decision-making strategies. Knowing from frameworks, such as Pfister and Böhm’s (2008), that feelings are generated from particular sensorial stimuli, then we can understand feelings of past people and we can de-code their decision-making process as far as we have previously understood people’s actions and space sensorial stimuli – something the PSR approach achieved in its early application and that have been presented also through the case studies of this thesis.

As a final remark the “PSR” approach is an elastic methodology that can be applied in several different underground archaeological settings and not just in caves. With the “PSR” approach we can achieve better understanding of the use of space in human-made underground necropolises and burial spaces (like the catacombs), mines, dwelling spaces and so on. If adapted accordingly in various occasions it can be also applied for the better understanding of the use of space in standing archaeological structures such as castles, or the Aegean Bronze Age complexes and other built landscapes. Wherever there is an archaeological enclosed landscape that survives the sensorial stimuli of the past – as these have been presented both in chapter 2 and earlier in this chapter – this methodology can prove a valuable asset for the researcher, particularly having a low cost and low equipment needs.

9.5 Further research

The conclusion of this research created a wealth of questions that remain open and can be answered in the future. In this last part of the thesis I am going to present all the possible further directions in which research hypotheses outlined in the previous chapters can be enhanced and brought forward.

There is still a lot of work left to be done in order to get a clear picture about past behaviour and decision-making in the Neolithic Balkans and to clarify the cave use strategies. It is important to remember that there are many more caves - around 16,000 - compared to the 112 that have been evaluated for this research, that are recorded in the area of the Western Balkans and Greece and still awaiting their chance to be investigated for evidence of use. Whole regions, such as Greek Western Macedonia and Northern Albania, have limestone massifs with thousands of caves that remain unexplored. Most of the countries in the area of investigation do not have national registers for caves, excluding Croatia, so all the accounts are based on the caving clubs' archives which are not curated properly most of the time. In the case of Albania all records for cave sites are apparently based on Bulgarian expedition accounts with very limited national interest or input in this case. A first step towards a better understanding of the regional patterns of cave use could happen if in the Balkan Cave Archaeology database caves from the Eastern Balkans were included as well. Particularly Romania needs to be indexed as a large amount of around 100 caves with Neolithic deposits have been excavated and published. Romania, along with Greece and Croatia, are the countries with the largest amount of excavated Neolithic caves. Keeping Romania out of the equation, the picture of cave usage in the Neolithic of southeast Europe is fragmented, and no real "regional" interpretation for cave use strategies can be addressed.

As has been stated earlier in chapter five of this thesis, political tensions and the long Balkan tradition of non-co-operation between the countries have left the area with limited – or in cases nonexistent – regional models. The problems of dating the Balkan Neolithic are also an important drawback factor that needs to be challenged in the future with better chronologies to be produced and more regional interpretations between sites to be made. What this thesis has showcased is that Bayesian modelling can be a valuable medium in order to re-evaluate older dates but also to correlate those with more recent, better chronologies. Regional investigations of the patterns behind the use of caves, better chronological frameworks and more broad application of the sensorial approach that this thesis presented may help towards a better understanding of the cave use phenomenon and help to get away from the speculative dualistic model of ritual versus profane use of the cave sites. Indications of a change in social behaviour between Early and Middle-Late Neolithic contexts in Mala Pecina (and in other sites such as Alepotrypa) can also be investigated in relationship with the wider context and not only in caves, for a better understanding of how and why the social practices change between the two eras and which are the driving forces behind this change. Concerning the available data that was gathered for this thesis, as stated earlier in this chapter, computer-based modelling (along with 3D photogrammetry and rendering) can help towards a better understanding of the complexity of the cave use phenomenon. In these models, all the data that have been collected from the thesis case studies' research can be evaluated using different parameters: seasonal, occasional, and spatial. As pointed out earlier in the dataset, caves from Romania, Turkey and Bulgaria need to be added and analysed in order to highlight the regional differences and to connect the West with the East Balkan regions and to see the similarities and differences between the Neolithic groups around the main river networks of the Danube, Sava, Neretva, Struma, Axios, Evros, and Morava.

The main outcome of the thesis case studies, and the most coherent one, the importance of the twilight zone for the groups that were using the caves during the Middle and Late Neolithic, needs also further investigation in order to be better clarified and understood. The methodology that has been presented here in chapter 4 worked well both in the previous excavated sites in Greece and during the excavations in Mala Pecina cave in Croatia. I believe, however, that we need further applications in newly and previously excavated sites in order to be confident that my interpretations of the importance of the twilight zone are actual patterns that can be observed on the ground and showcase certain cave use strategies that emerged in the Middle Neolithic in the area.

However, when it comes down to the actual theoretical and methodological approach that this thesis built, I believe that I managed to set out a way to answer critiques like Tringham's on Hamilakis' book, as I argued earlier at the beginning of this chapter. Further application is now needed in even more complex underground spaces in order for us to be confident to suggest that at least in certain archaeological cases, the paleosensorial spectrum of the past can be recorded and correlated with the rest of the available archaeological evidence, towards a better and deeper understanding of the factors that drive and shape human actions in caves and beyond.

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Recording Senses in Subterranean Archaeological Sites

A methodological approach on caves of the Western Balkans and Greece

PART 2: APPENDICES

Prokopios Konstantinos Trimmis

Contents

1 Balkan Neolithic caves running list.

Full list of the caves that have been evaluated for the scope of the thesis. With light blue the caves that have not been included in the analysis for chapter 6.

NO.	NAME	ALTITUDE (masl)	ORIENTATION	MICRO-ENV	NEAREST TOWN	USES
Me01	Odmut	558	SE	L / TW	Pluzine	A.a - Agropastoral
Me02	CrvenaStijena	700	SW	TW / D	Bileca	A.a - Agropastoral
Me03	Spila	320	SW	L / TW / D	Perast	A.a - Agropastoral
Me04	Koronina	700			Cetinje	
Me05	Medena Stijena	558	S	L	Cehotina River	A.a - Agropastoral
Me06	Vruca Pecina			L/TW	Podgorica, Morača river	A.a.b - Agropastoral, Storage
Me07	Seocka Pećina					
Me08	Čaja Pećina					
Hr01	Pupicina	220	SE	L / TW	Vozilici	A.a - Agropastoral
Hr02	Grapceva	230	SSW	D	Grapceva	B.c.d - Spiritual, Burial
Hr03	VelaSpilja	130	WSW	L	Vela Luca	A.a.b - Agropastoral, Storage
Hr04	Pazanjanice	320	S	L		
Hr05	Vaganska	700	S	L / TW / D	Zadar	A.b - Storage
Hr06	Laganisi	395	SSE	L / TW / D	Oprtalj	A.a - Agropastoral
Hr07	Vela Spilja Losinj	268	W	L / TW / D	Losinju otoku	A.a - Agropastoral
Hr08	Jacmica	380	NE	L / TW / D	Buzet	A.a - Agropastoral
Hr09	Nugljanska	550	SW			

Hr10	Pavlova					
Hr11	Ispod Sela	48	S	L / TW / D	Srbani, Brtonigla	
Hr12	Golubinjaca	558	SW	L / TW	Peru Siia, Gospic	
Hr13	Mala Pecina	488	SSW	L / TW / D		A.a.b - Agropastoral, Storage
Hr14	Gospodska	430				A.a.b - Agropastoral, Storage
Hr15	Gudnja	406			Peljesac Island	
Hr16	Markova	57			Hvar Island	
Hr17	Nakovana	400	N	L / TW / D	Dubrovnik	Freast area, Hellenistic Ritual site
Hr18	Ravlica					
Hr19	Loza				Sapjane	
Hr20	Klanjceva Pec	828			Cicarija	
Hr21	Oporovina Pecina	325			Medveja	
Hr22	Podosojna	335			Moscenice	
Hr23	Vorganska Pec	380			Krk Island	
Hr24	Jamina Sredi				Cres Island	
Hr25	Zapadna Pecina				Drnis	
Hr26	Tamnica	355	SE	L / TW / D	Bitelica	
Hr27	Tradanj	40			Krka	
Hr28	Skarin Samograd				Mideno Mountain	
Hr29	Krcina Jama				Miholovici, Grlo	
Hr30	Kopacina Spilja				Brac	
Hr31	Pokrivenik Pecina	50			Hvar	
Hr32	Zukovica Spilja		NW		Korcula Island	A.a - Agropastoral
Hr33	Jakasova Spilja	50			Korcula Island	
Hr34	Raca Pecina	50			Lastova Island	
Hr35	Bozic					

Hr36	Brac?					
Hr37	Pazjanic					
Hr38	Velika Pecina	428			Gorani	
Al02	Blaz		S	L / TW / D	Lac / Bruc	A.a - agropastoral
Al03	Dajc	1250	E	TW / D	Has	A.a - agropastoral
Al04	Konispol	400	SSW	TW / D	Konispol	A.a - agropastoral
Al05	Himara	320	E	L / TW	Himara	A.a - Agropastoral
Al06	Kanalit	140	NE	L	Kanalit	
Al07	Nezir	400	S		Koder Lac	A.a.b - Agrapastoral, Storage
Al08	Tren	856	SSE	TW/D	Lake Prespa	A.a - Agropastoral
Al09	Velce		SW		Velca	
Gr01	Piges(Koro)	850	S	TW / D	Kastoria	A.a - Agropastoral
Gr02	Piges(Aggitis)	129	SE	L / TW / D	Drama	A.b.d - Storage, Hunting Stand
Gr03	Orpheus				Alisrati	A.a.b - Agropastoral, Storage
Gr04	Katarractes	300	NW	L	Siderokastron	A.b - Storage
Gr05	Antarton Loutra	540	SSW	TW / D	Loutraki	A.a.b - Agropastoral, Storage
Gr06	Polyphimos	150	SE	TW/D	Maroneia	A.a - Agropastoral
Gr07	Theopetra	280	N	TW	Kalambaka	A.a - Agropastoral
Gr08	Sarekenos	180	SSW	L / TW	Boeotia	A.b - Storage
Gr09	Korykeion Antron	1644	S	L / TW / D	Parnassus Mt.	A.a - agropastoral
Gr10	Tharrounia (Skoteini)	450	NNE	TW / D	Therrounia	B.c.d - Spiritual, Burial
Gr11	Kitsos	288	E	L / TW / D	Lavrion	A.a - agropastoral
Gr12	Leontarion	550		TW / D	Korakovounion	B.d - Burial
Gr13	Schistos	259		TW/ D	Keratsini	A.a, B.c - agropastoral, Spiritual
Gr14	Franchthi	12	NW	L / TW	Franchthi	A.a.b, B.c - Agropastoral, Storage
Gr15	Cave of Lakes	800	SE	TW / D	Kastria	A.b - Storage

Gr16	Alepotrypa	16	W	TW / D	Gulf of Diros	A.b B.c.d - Spiritual, Burial
Gr17	Kouveleiki	350	SE		Alepochori and Geraki	A.a - agropastoral
Gr18	Drakaina	70	NW	L / TW	Cephalonia	B.c - Spiritual
Gr19	Cyclops	150	W	L / TW / D	Yioura	A.b - Storage
Gr20	Koumelo	140	S		Archagellos	N/A
Gr21	Kalythies	140	WSW		Kalythies	A.a - agropastoral
Gr22	Za	628		TW / D	Naxos	B.c - Spiritual
Gr23	Taxiarches					
Gr24	Ayio Galas		S	L / TW / D	Chios	A.a - Agropastoral
Gr25	Charkadio					
Gr26	Ayia Triada		E	L / TW / D	karystos	A.a.d - shelter
Gr27	Antiparos	171	SSW	L/ TW/ D	Antiparos	A.a - agropastoral
Gr28	Rhodochori					
Gr29	Gerani				Crete	
Si01	Mala Triglavcka	435	N	L		A.a - agropastoral
Si02	Ajdovska Jama	243	E	L / TW / D		B.c.D - spiritual necropolis
Si03	Ciganska Jama		W		Kocevje, Zeljne	A.d B.d - shelter, Burial
Si04	Lukova	420			Podstene, Kostelu	A.a.b
Ba01	Hateljska				Stolac	
Ba02	Ravlica	214	S	L / TW / D	Pec Mlini	A.a - agropastoral
Ba03	Zelena	600	S	TW / D	Mostar	A.a - agropastoral
Ba04	Zukovick				Posusja	
Ba05	Hrustovac				Hrustovo	A.a-agropastoral
Ba06	Modric					
Ba07	Rastuša pećina	370			Teslic	
Ba8	Zukovicka Pećina				Vir	

Ba9	Zelena Pećina				Blagaj	
Ba10	Lazarasa				Stolac	
Ba11	Hateljska Pećina				Berkovići	
Rs01	Tabula Traina	90/91	W	L / TW / D	Golo Brdo	
Rs02	Pescara Mare	245	SSW	L / TW / D	Derjap	A.a - Agropastorial

2 Balkan Neolithic caves catalogue

A. Serbia

RS01. Tabula Trajana

Location: west of faca pesceri **Entrance orientation**: W **Entrance altitude**: 90/91MASL **Cave formation**: Horizontal **Main research years** 2004/2005-2008/2009-2013 **Occupation eras and dates** MP, UP, Late Copper Age, Iron Age **Sources** Milanovac, Donji. 2015. *Caves in the Djerdap National Park.* (ed) Calic, J. Republic of Serbia Ministry of Agriculture and Environmental Protection. pp84-89.	**Cave description** The entrance is about 4.5m high and 4m wide as the base, it has a small terrace in front of the entrance, the first 15m of the interior of the cave is relatively flat. Along the southern wall at 15m in from the entrance are two chimneys the first is 2m high and the second is 3m. the cave extends upwards toward the back of the cave and it extends steeply for about 6m. **Research Chronicles and data:** In the trench excavated in 2005, 5 layers were excavated: layer 1- grey black fine charcoal. Layer 2- karst rock fragments. Layer 3- small hearth feature. Layer 4- yellowish brown silt. Layer 5- large blocks of limestone rubble. A diagnostic find of a Dufour pointed bladelet is characteristic of the protoaurignacian taxonomic unit. **Cave uses:** It is very likely that apart from humans, predatory animals also contributed to the accumulation of this faunal assemblage. Excavator believe that the cave have been used as a pen.

RS02. Pescera Mare

Location: close to Lepenski Vir **Entrance orientation**: SSW **Entrance altitude:** 245m **Cave formation**: Horizontal **Main research years:** 2004, 2013 **Occupation eras and dates**: Late Prehistoric, Copper Age, Iron Age **sources**: Milanovac, Donji. 2015. *Cave in the Djerdap National Park.* (ed) Jalena, C. Republic of Serbian Ministry of Agricultural and Environmental Protection. pp. 51-55.	**Cave description:** The entrance has a half elliptical, inclined cross section, 10 meters at the base and a height of 9 meters. There is limestone bedding, which is visible, located in the zone of a small fold at the entrance part of the passage. The passage gently ascends and the walls are eroding. Array in the central passage has a width of 1.5 meters; the floor has a dusty-clayey material with debris fragments, up to 1.5 meters. **Research:** Excavations in 2004 and 2013 produced 5 test pits in different areas of the cave. Layer 1: Holocene layer, laminated grey/black fine coal. Layer 2: older yellowish brown sediment that covered the cave bedrock. Limestone panels located at vertical orientation to the cave walls at the entrance; various thickness, greatly deeper in the cave. **Cave uses:** A.a - This site is believed to have been used for the herding of sheep and goats, agropastoral.

B. Montenegro

Me01. Odmut

Location: Pluzine **Entrance Orientation**: SE **Entrance Altitude**: 558 asl **Cave Formation**: Horizontal **Main Research years:** 1972-1974 **Occupation Eras and Dates:** Meso 8000BC– B.A. 1750BC Meso Odmut Ia: c.8100-6700 uncal BC. Meso Odmut Ib: c.6700 – 5200 uncal BC Neo Odmut II: c.5035+/- 100 BC ; 5005 +/- 100 BC; 4950 +/- 110 BC. EBA Odmut VII: c.1710 +/- 80 BC **Sources:** Markovic, C. 1985. *The Neolithic of Montenegro.* Belgrade: University of Belgrade.	**Cave description**: "The width and height of the mouth of the cave is 20mX14M. The mouth opens up to the southeast, i.e. to the confluence of the Vrbnica and the Piva. The base of the cave is funnel-shaped. The base ends at a distance of 11 metres from the mouth, in a narrow and short channel (2.30m wide and 2.50m high). The cave is dry and, its floor is filled with aeolic and alluvial deposits. On top of these deposits is a cultural layer of an average depth of 4 metres." (Markovic 1974, 7) **Research Chronicles and data**: 65m squared was excavated between 1972-1974 prior to construction of the Mratinje hydro-electric power plant and dam. C. 80% of the cultural deposit was excavated. "The cultural deposit was formed evenly and regularly, and the constituent layers lay almost horizontally, sloping only slightly towards the front of the cave. Seven layers, differing in colour, structure and types of finds, could be clearly distinguished." (Markovic 1974, 7) Mesolithic - Odmut I - Faunal Remains: Ibex 65%, red deer 25% and fish. (Srejovic 1974, 3) - Stone Industry: Grey-green chert; grey or reddish stone; and flint. Mostly flakes. Some blade production from cores. Microliths. Hammerstones. Pestles. - Bone implements: awls and chisels. -Antler: harpoons – mostly flat and few cylindrical. Engraved bone object. Boulder decorated with ochre. (Srejovic 1974).

Markovic, C. 1974. The stratigraphy and chronology of the Odmut cave. *Archaeologia Iugoslavica* XV, 7-12. Srejovic, D. 1974. The Odmut cave – a new facet of the Mesolithic culture of the Balkan peninsula. *Archaeologia Iugoslavica* XV, 3-6.	Early Neolithic - Odmut II - Average thickness of about 0.70m - Faunal Remains: 14.5% domestic faunal remains and 85.5% wild. - Structures: Three circular fireplaces, two framed by broken stones and boulders. - Pottery: Pottery finds from Odmut IIa and IIb typologically belong to the Starcevo Culture and to the Adriatic Early Neolithic Culture Crvena Stijena III – Smiljcici type. Mostly coarse ware pottery. Only coarse ware decorated – Barbotine, Incised and Grooved. Fine monochrome ware smaller but same forms as coarse ware. IIa – 90% coarse ware. Deep, spherical pots with a short cylindrical neck and flat moulded rim. Silex implements based on Mesolithic forms. IIb – Oval pots without a distinct neck were characteristic of this layer. Neolithic forms. - Bone Implements: Only five implements – four awls and a burnisher. Late Neolithic - Odmut III Finds are “typologically related to the beginnings of the Early Neolithic, i.e. to the forms of the Vinca (Vinca A-B) and Kakanj Cultures. The flaked stone industry from this layer indicates cultural influences either from the Adriatic region or from central Bosnia” (Markovic 1974, 10). Several tongue-shaped ground stone axes were found in this layer. - Pottery: Fine ware with polished or burnished surfaces of grey, dark-grey, black or, occasionally brown colour. Biconical bowls were found in several variants. The decoration of the bowls consisted mainly of fluting although, incised decoration appears occasionally. Final Neolithic/Transition - Odmut IV

	Longer phase, local culture of the Final Neolithic. Associated with Vinca C. - Pottery: Undecorated coarseware. Fine ware, usually with polished surfaces but without sheen, grey, dark-grey, or brown in colour. Most common forms were deep, oval pots with or without an emphasised neck, biconical and conical bowls. Most decoration, incised or fluted, found on bowls. - Tools: Arrowheads and long blades. - Antler: Several antler implements, possibly awls. Endolithic - Odmut V Less pottery, not related to that of Odmut IV, close to ware from Morava and Danubian regions. Beginning of Eneolithic. - Pottery: Coarse ware with ring-like reinforcement. Some decorated with shallow circular depressions or impressions of nails or fingers. - Tools: Broad blades with retouch. Simple bone awls. Developed and Late Endolithic - Odmut VI "pottery with a roughened surface, made of insufficiently purified and poorly fired clay." (Markovic 1974, 11)The pottery is connected to the Lasinja Culture. There is an increasing amount of carved pottery characteristic of the Eneolithic of the Adriatic. - Coarse ware: large oval or large-bellied pots with or without distinctly marked neck. Only few decorated with fingers, incisions or grooves. Two fragments of coarse ware were found with cord ornaments. Fine ware: cups with vertical handle, deep biconical bowls, vessels with long cylindrical necks and flared rims. Incision, pricking, grooving and carving decoration. - Tools: Flaked stone tools rare. bone tools are slightly more numerous.

	Early Bronze Age - Odmut VII Possibly Early Bronze Age. 1710 +/- 80 BC. - Coarse ware: large undecorated pots, deep cups with vertical handles, large shallow bowls with a wide funnel shaped neck and four handles set crosswise. - Tools: Numerous bone implements – awl and wide spatulae.

Me03. Spila

Location: Perast, Kotor bay **Entrance Orientation**: SW **Entrance Altitude**: 320 asl **Cave Formation**: Horizontal **Main Research years:** 1974 **Occupation Eras and Dates**: Neolithic and Eneolithic **Sources**: Markovic, C. 1985. *The Neolithic of Montenegro.* Belgrade: University of Belgrade.	**Cave Description**: Karstic cave is 90m in length, and overlooks the bay of Kotor. The entrance is partially blocked by a modern drywall. **Research Chronicles and data**: "Soundings were dug in the Spila cave near Perast in the Boka Kororska bay in 1974 ... Three trenches were dug. Trench C, sunk furthest in the interior of the cave. Trench C, yielded the thickest and richest cultural layer. The deposit of Spila was 1.75m thick." (Markovic 1985, 91) Neolithic Stratum Ia - Faunal Remains: Domestic faunal remains. - Pottery: Large and small oval and globular coarse earthenware vessels decorated with impressed and incised ornaments; finer vessels with roughly polished unornamented surfaces. -Tools: there were few stone and bone implements.

Stratum Ib
- Pottery: coarse, medium-fine and fine. Medium fine sheaf-like decorations. Fine incised ornaments characteristic of Middle Neolithic of the Adriatic.

Stratum Ic
Late Neolithic of Montenegrian Coast and features associated with Hvar-Lisicici culture.
- Pottery: mostly medium-fine ware and few fine ware. The pottery was usually incised or painted. These techniques were rarely combined. The most common form was the bowl.

Stratum IIa - Endolithic.
 -Pottery: New Forms.The new forms were Large-bellied pots of medium-fine war and fine ware. There were Various bowl types of fine ware. Only decoration is broad, shallow fluting.

Stratum IIb
- Pottery: Mostly coarse ware with rare examples of fine ware. Various bowls and large-bellied pots with no decoration.

Stratum IIc
- Pottery: Coarse ware very rare. High pots with thickened or bevelled rim. Decoration below rim in form of molded bands with impressions made by fingers or some implement. Bowls were the most common form, but pots and shallow plates were also

	numerous. There was Rich decoration with techniques of incision, impression, pricking and grooving.

Me02. Crvena Stijena

Location: left bank of the Trebisnjica river **Entrance Orientation**: SW **Entrance Altitude**: 700 m asl **Cave Formation**: Horizontal **Main Research Years**: 1954 – 1956; 2004-2006 **Occupation Eras and Dates**: Mesolithic 8000 - 6460 cal BC **Sources:** Markovic, C. 1985. *The Neolithic of Montenegro*. Belgrade: University of Belgrade	**Cave Description:** The cave is located on the left bank of the Trebisnjica river, today Lake Bileca. The cave opens high on the limestone hill and has a mouth 26m wide. It is 15m wide toward the front of the cave and 20-25m at lower depths. The known archaeological layers reach a depth of 20m. **Research chronicles and data:** There are only Holocene layers near the entrance. Further into the cave are 20/30m thick deposits with 31 cultural layers forming 15 different strata. (Markovic 1985, 91). 256 1-2cm pot sherds were found through sieving the western part of site, which date to the Early and Middle Neolithic and to stratum I EBA/BA/EIA. Sieving produced over 3000 flaked lithic artefacts and several dozen bone and antler artefacts from the Western side of the shelter. Flakes predominate at 72% of the artefacts found and 11% tools. Of the bone and antler there were 12 points/awls, 14 projectiles, 2 polishing tools, 2 perforated bone items and a number of cervid/caprid antler/horn with traces of use. There was a large number of fragments of bone projectiles with elongated beveled bases similar to those found in earlier excavations.

Bakovic, M., Mihailovic, B., Mihailovic, D., Morley, M., Vusovic-Lucic, Z., Whallon, R. and Woodward, J. 2009. Crvena Stijena excavations 2004-2006, preliminary report. *Eurasian Prehistory* 6 (1-2), 3-31.	Stratum IV – Mesolithic Stratum III – Early Neolithic – Stage 1 of Adriatic Neolithic. Pottery. No remains of domestic animals. Stratum II – Middle Neolithic (of Montenegrian Coast or Dalmatia) Stratum I – EBA / developed BA / EIA Continuity between Mesolithic and Neolithic archaeological material. (Markovic 1985, 92)

C. Bosnia and Herzegovina

BA03. Zelena

Location: Mostar **Entrance Orientation**: S **Entrance Altitude**: 600 m asl **Cave Formation**: Horizontal **Main Research Years**: 1995	**Cave Description**: The cave is above the source of the river Buna, which is located South-east of the town of Mostar, in the cave there are two distinct caves, 'big Zelena' and 'little Zelena'. The front of the cave is wide and then it narrows towards the back. The front and rear chambers of the cave are marked by a large stone, this also marks the inhabited and uninhabited parts of the cave.

Occupation Eras and Dates: Sources: Benac, A. 1956. Prehistoijska gradina Zecovi kod Prijedora - Lad Gradina [rehistorique de Zecovi pres de Prijedor. Glasnik Zemaljskog Muzeja U Sarajevu XI, 147-166.	**Research Chronicles and Data:** Most prehistoric activity seems to have taken place in 'big Zelena'. Two trenches (E and F) were dug in the front part of the cave, in front of the large stone, but they were void of any archaeology and just contained layers of pebbles and dust. Trenches A and C at the very rear of the cave provided the best evidence of prehistoric activity, while trenches either side of the rear large stone had less. The large stone, for this reason, seems to mark a division of usage within the cave, although there does not appear to be a fixed focal point of the cave. The area behind the large stone slopes gently to the southwest. The depth of the cultural layers is 0.6-0.7m in trench A and 0.8-0.95m in trench C, cultural layers in trenches B and D are less than 0.4m. Trench C which was located behind the central rock had the largest ash pile. Stone and bone tools were very rare finds, a stone pestle was discovered and 10 fragments of millstones in the different layers. The lack of lithic debris, as well as stone and bone tools, indicates that this was not a normal domestic habitation site, however ceramic fragments do indicate a continuous usage of the site. In trench C, three strata were identified due to classification of pottery types- I, II, III. I- 0-0.25 m; coarse ceramics with no decoration in light or dark grey II- 0.25-0.40 m; Black ceramics, very smooth (rarely dark grey or brown), mostly high bowls with accentuated curves. Decorated with shaped garlands, half circles and stripes of different ribbons are incised or hollow. We also find red inserts and red painted bands.

	We usually find, next to these objects, the coarse ceramic such as that, decorated. III- 0.40-0.95 m; richest cultural layer; Impresso ware with rich diversity of decoration; find also monochrome objects but in lesser numbers. Cave Uses: Agropastoral (A.a) - The excavator interprets this cave as a temporary habitat used during winter days or when torrents swelled at the foot of the hill. However, the large amount of ash and the even spread of it across the cave indicates seasonal agropastoral usage in the regular burning of animal dung.

D. Albania

AL04.KONISPOL

Location: Konispol **Entrance Orientation:** SSW **Entrance Altitude:** 400m asl **Cave Formation:** Horizontal **Main Research Years:** 1989-2004	**Cave Description**: This is a typical Karstic cave and is 50m long and 6m high at its maximum. **Research Chronicles and Data**: It was excavated by Muzafer Korkuti and Halil Shabani between 1989-1990, and by interdisciplinary teams jointly directed by Karl Petruso and Muzafer Korkuti in 1992, 1993, and 1994.

Occupation Eras and Dates: 8500-2300 (possibly Late Paeliolithic) EN-LN, BA, IA, through till medieval. **Sources:** Korkuti, M and Petruso, K,M. (1993) 'Archaeology in Albania'. *The American Journal of Archaeology* 97, 703-716. Ellwood, B,B. Petruso, K,M. Harrold, F,B. Korkuti, M. (1996) 'Paelioclimate Characterisation and Intra-site Correlation Using Magnetic Susceptibility Measurments: an example from Konispol Cave': *Journal of Field Archaeology* 23 (3), 263-271.	The early Neolithic pottery was characterised by Impresso and Pseudobarbotine wares which are characteristic of the western and central Balkans. The middle Neolithic can be identified due to the exceedingly thick walled vessels that were found. Two different types of pottery suggest occupation in the late Neolithic. These are local and imported painted pottery of Maliq I style. The local pottery is rough and without much finish, whereas the imported pottery, although still containing sand as a temper, is competently fired and varies in colour from cream to grey unlike the local reddish colour.

AL02.BLAZ

Location: Between the towns of Lac and Bruc **Entrance Orientation:** S **Entrance Altitude:**	**Cave Description:** This cave is long and narrow, about 6m wide at the entrance. It is one long main chamber that has been excavated and published to date. **Research Chronicles and Data**: Excavated by F. Prendi between 1978-80. Excavations that occurred in the 1980's

Cave Formation: Horizontal
Main Research Years: 1978-1980
Occupation Eras and Dates:
Pre-neolithic, EN, MN, MBA,
Sources:
Prendi, F. Andrea, Z. 1981. Te Deheria Te Reja MBI Neolitin Ne Shqiperi. *Illiria* 2:20.

discovered a narrow Eneolithic stratum, in which a chisel, bronze axe and fluted black pottery.

At the caves entrance a small test pit 1.0 m by 1.0 m distinguished three cultural layers. The oldest of them, Blaz I, has been called Mesolithic layer. There were numerous flint blades and many animal bones, which were mostly split and show simple tool marks. Since no pottery was found, the excavator interpreted it as the remains of the Mesolithic horizon. However, it is emphasized that it would be necessary to examine a greater surface for a more precise chronology.

The excavators suspect that here was most likely a work space for flint since the blades found without retouch seem to be blanks and there is debitage material. Many blades are similar in shape and size those of the Early Neolithic.

Consequently, Blaz I and Blaz II were possibly consecutive and belonged to the Early Neolithic. Following Prendi and Andrea, Blaz II represents the Early Neolithic culture in the interior of Albania.
Blaz II is best represented at point B in an area of 13 square meters. The depth of the Eneolithic layer is 0.26m.

Among the finds, the pottery is predominant. It consists of relatively good sand clay, and shows occasional mica additive which is visible on the surface. It is most often gray, light brown or brick red and thick-walled ceramics are as rare as shiny black, brown or

	occasionally red goods. The main vessel forms are bulbous pots without necks with a thinner rim. Other types have a short, narrow rims. Pseudobarbotine ceramics account for only 5% of the decorated pottery. The Impresso ceramics by Blaz II are in several aspects comparable with the relevant ceramics of Podgorie I Vashtemi. In addition, there are analogies to Impresso ceramics from Zelena Pecina III, Obre I, Crvena Stijena III and Smilčić I and for Molfetta ceramic in South Italy and pre-Sesklo in Thessaly. Both authors date Blaz II relative chronologically as the same time as I Kolsh, ie in the Phase IIb Starcevo. Known as Blaz III, Middle Neolithic Culture, immediately following the Early Neolithic layers. It has a depth of 0.7m and provided a relatively rich material that show the characteristic elements of this phase. Among the pottery are vessels with thick, medium thick and thinner walls and in gray, black, brown, and less frequently in red colours.

AL01.KATUNDAS

Location: Berat **Entrance Orientation:** E **Entrance Altitude:** **Cave Formation**: Horizontal	**Cave Description**: This is a karstic cave and measures 24m at its maximum length and between 6-10m in width. **Research Chronicles and Data**: The occupation layer has a surface area of 40m squared, with a maximum depth of 3.6m in the part of the cave most adapted for

Cave Map: *pending* **Main Research Years:** 1986 **Occupation Eras and Dates:** EN-LN, CA, BA, IA, 2nd-3rd Century AD **Sources:** Bellai, P. and Starova S. 1983. Vendbamimi Shpellor I Katundasit. *Illiria.* Korkuti, M and Petruso, K,M. 1993. Archaeology in Albania. *The American Journal of Archaeology* 97, 703-716.	dwelling. There are three distinct periods of the Neolithic which were identified from the pottery found. The early Neolithic was represented by Impresso and Barbotine pottery, this fine black pottery found here is rarely found elsewhere. The Middle Neolithic was characterised by black ware and grey and black ware with incised geometric relief, of the Danuvec-Cakran type. Finally the late Neolithic was characterised by painted ware with coffee colour on a plain background, of the Maliq-Kamnik type. **Cave Uses**: Spiritual (B.c) - There is some evidence of ritual usage of the cave.

AL05.SPIL HIMARE

Location: Himara **Entrance Orientation:** E **Entrance Altitude:** 320m asl **Cave formation:** Horizontal **Main Research Years**:	**Cave Description**: This is the largest of three cavities in the low limestone outcrop along Spilë beach. Positioned at the base of a cliff, the Himara Cave is now c.30m high and 100m from the present day shoreline. The largest cavity is 30m long, with an opening that is 8m wide and 7m high. The cave was formed by Karstic Processes, and the entrance has become irregular through wave action. The cave extends 30m into the

Occupation Eras and Dates: EN **Sources:** Francis, K. 2005. *Explorations In Albania, 1930-39: The notebooks of Luigi Gardini prehistorian with the Italian archaeological mission.* London: The British School at Athens.	hillside. **Research Chronicles and Data:** Gardini discovered the five caves at himara, and in one of the caves alone excavated over 2m of stratified Eneolithic, Hellenistic and Roman deposits.

AL06.KANALIT

Location: Kanalit **Entrance Orientation**: NE **Entrance Attitude**: 140m asl **Cave Formation**: Rock Shelter **Cave Map:** *pending* **Main Research years**: **Occupation Eras and Dates**: Mesolithic Eneolithic	**Cave Description**: The rock shelter is located along the foot of a small limestone cliff. It consists of 4 main areas. The first and second areas extend away fom each other at the back of the cave, the third area is a small narrow chamber to the north west side and is only about 1m deep. The final area is the porch, which extends 10m outwards and is 50m in width created by the natural slope of the ground. **Research Chronicles and Data**: Gardini discovered early Neolithic flint tools, handmade ceramics, hearths and domesticated animal bones, however Gardini's investigations happened in 1939 on behalf of the Italian Archaeological Mission to Albania and much more work has been done on the site since 2001.

Sources: Francis, K. 2005. *Explorations In Albania, 1930-39. The notebooks of luigi cardini, prehistorian with the Italian archaeological mission.* The British School at Athens, London.

AL03.DAJÇ

Cave Map: **Location:** Has **Entrance Orientation:** E **Entrance Altitude:** 1250m asl **Cave Formation:** Horizontal **Main Research Years:** 1986-7 **Occupation Eras and Dates:** Eneolithic; EBA; LBA-IA **Sources:**	**Cave Description**: The cave's settlement of Dajc is located in the area of Has in the municipality of Kukes in north eastern North Albania. It has an elevation of 1,250m above sea level and is distinguished by its favourable location. The Dajc cave has the shape of an 80 m long corridor that is on average 3.5m wide and a maximum height of 4.5m. There are four chambers comprising the cave, of which only three (room A, B and C) have been used for habitation. **Research Chronicles and Data**: The cave was excavated by Muhamet Bela in 1986 and 1987. 75% of the pottery from the Eneolithic period has thick walls. The remaining 25% thin walled pottery is made from a fine clean clay mixed with sand, its surface is normally grey or black and occasionally brown.

Bela, M. 1897. 'Vendbanimi Shellor I Dajcit.'*Illyria* 2, 23. Korkuti, M and Petruso, K,M. 1993. Archaeology in Albania. *The American Journal of Archaeology* 97, 703-716. Korkuti, M. 1995. *Neolithikum und Chalkolithikum in Albanien.* Mainz am Rhein: Internationale Interakademische Kommission fur die Erforschung der Vorgeschichte des Balkans, Monographieren 4. 246-247.	The oldest cultural layer - Dajc I - belongs to the Chalcolithic period. This was in room A, about 0.2m thick and contained a small number of archaeological finds. There were very few tools found including, an oval flint scraper with flat retouch and a plurality of different artefacts from tubular bones, including a small bone chisel and a pipe bone bead. In addition, are the remains of grinding bowls. The characteristic ceramics of the Chalcolithic period are good quality and thin, black and gray-black pottery. These include the bulging biconical vessels, some of which are decorated with fluting. The pottery evident at Dajc seems to be related to Maliq IIb and Tren II in eastern South Albania. Although the archaeological material in Dajc limited, it has sufficient characteristics to be confident in an assertion of Chalcolithic occupation and classify it in the context of the remaining groups and Chalcolithic cultures of Albania. The find material is also of importance, since no Chalcolithic has been known from the northeastern North Albania. **Cave Uses**: Agropastoral, storage (A.a.b) -

AL07.NEZIR

Location: Koder Lac **Entrance Orientation:** S **Entrance Altitude:** 400 m asl **Cave Formation:** Horizontal **Cave map**: N/A	**Cave Description**: The Nezir cave is 45m long and the entrance is between 5-11m wide opening to the south. The cave has a 30m long corridor making it well suited for use as a residential site. The cave settlement of Nezir is located in Val-Tal, Bez, Burrel, near the village Koder Lac. The cave belongs to a group of local caves including the caves of Blaz and Keputa. All these caves are in the central highlands.
Main Research Years: **Prehistoric eras of occupation**: EN, MN, Ch, BA	**Research Chronicles and Data:** An area of 80 square meters was excavated. The 2.5m-4.35m thick cultural layer contains finds from three periods: the Neolithic, the Chalcolithic and the Bronze Age. The Neolithic is represented by remnants of two distinct phases, the Nezir I and the Nezir II or early to middle neolithic.
Sources: Korkuti, M. 1995. Neolithikum und Chalkolithikum in Albanien. Mainz am Rhein: Internationale Interakademische Kommission fur die Erforschung der Vorgeschichte des Balkans,	From Nezir I a few finds are known. Among the ceramics, thick-walled ware was found containing sand and small stones as temper. Grey, brown or red paint quite widely found and crafted pottery can be distinguished from pure clay which is usually polished and matt grey or light brown. Among the vessel forms, there are slightly bulged flatter or higher grades with slightly retracted edges, which can occasionally be notched or have a rim lip. Bulbous bowls come with straight neck-edge and can have a perforation at the edge and finger dots on the shoulder, and a wide mouth with thickened rim.

Monographieren 4. 84-85; 170-172.

These vessel shapes are generally quite common and also found at other known settlements.

Few vessel fragments were decorated, however Impresso ware was earliest, where the ornaments are made by pinching fingers or with a pointed instrument and distributed over the entire pot. The Barbotine decor is represented only on two fragments, one of which acts on the relief and applied as a decorative rosette.

Due to these small details, it is difficult culturally and chronologically to determine the cultural layers of the Nezir cave. The artifacts indicate parallels with Blaz, but also emphasize that in Nezir, Impresso ceramics which are characteristic are missing at Blaz.

From the Middle Neolithic (Nezir II) a few ceramic remains are preserved. Technically, consisting of pure clay, well fired ceramic is better than the work of Nezir I. It is dark grey, black or brown, rarely reddish. There are also fragments of small, high-gloss polished vessels. This pottery is characteristic of the Middle Neolithic in Albania.

There are also larger size shapes with more curved profiles. These are vessel forms, which are also known from other Neolithic settlements.

Decorating occurs mainly on broad incised bands, which are decorated with deep grooves. Stylistic dating was carried out according to the vessel forms, but particularly because of the decoration.

Cave Uses: Agropastoral (A.a) - Intermittently occupied.
Although from the Nezir Cave Neolithic finds are represented only in small numbers, it is nevertheless relevant that they are representative of both the early and the late Neolithic. Therefore, the excavators assumed that the cave was occupied during the whole Neolithic as a permanent settlement, however without much evidence of a dense occupancy shown in the stratigraphy.

The Excavator of the Nezir Cave believes that this was only seasonal habitation and by few people. this is because of the thin layer dated to Early and Middle Neolithic and the Middle Neolithic and Chalcolithic hiatus between. However, generally in this region, caves were also occupied in the late Neolithic so one can suggest that the cave was also occupied in the Late Neolithic and thus during the entire Neolithic period. However, there is no indication for a more intensive use. The situation changed only in the Chalcolithic period in which used the archaeological layer is greater and thus the archaeological material of this period is rich. The Chalcolithic legacies are marked by grey and grey-black polished, thick-walled ceramics. These features combine Nezir III culturally and chronologically with Maliq IIb, i.e. the final phase of the Chalcolithic.

AL09.VELCA

Location: Velca **Entrance Orientation:** SW **Entrance Altitude:** **Cave Formation:** Horizontal Karst **Cave Map:** N/A **Main Research Years:** 1939 **Occupation Dates and Eras:** Neolithic, Chalcolithic **Sources:** Korkuti, M. 1995. *Neolithikum und Chalkolithikum in Albanien.* Mainz am Rhein: Internationale Interakademische Kommission fur die Erforschung der Vorgeschichte des Balkans, Monographieren 4. 198-199.	**Cave Description**: The prehistoric cave settlement of Velca counted by the locals as one of the caves of Skota, is found near the village Velca that spreads on the western slope of Griba-mountain, on the right bank of Shushica Valley in Bez. Vlora. **Research Chronicles and Data**: At the beginning of the 1940's, D. Mustilli published a preliminary report and ten years later another article. Both, however, provide an insufficient picture about the settlement of Velca. The 1939 excavation found flint tools of good quality. Among the finds were blades, burins and two arrowheads. The flint tools including axes and wedges are known types of the Neolithic. The ceramic material is richly represented. It covers, first, the painted and otherwise decorated, and secondly, the undecorated pottery. The painted pottery has thin or moderate wall thicknesses and consists of pure, fine sand clay. It is occasionally polished. The ornamentation is filled with linear geometric ribbons or textures, like close zigzag and zigzag triangle motifs occurring in positive-negative combination. Of the painted colour pottery two different ceramic genera were formed. The first comprising of brown and reddish-brown pottery and the second painted pottery kind is black. Although the painted pottery of Velca can not be placed in direct relationship to other sites, there are some resemblances. A particular genus constitutes the black pottery of

Velca with the settlement Afiona on Corfu and the associate of H. Sotires on Leukas.

When comparing the Maliq I and Kamnik I-ceramic with from Velca, F. Prendi pointed out that on the painted pottery of Velca similar decorative elements occurred on the pottery of Maliq I, although visible differences existed. Entitling the excavators to believe that Velca was culturally different from Maliq I and Kamnik I, regardless of whether Velca was simultaneously of that cultural complex or not.

It is expected that future excavations in coastal plains, or on the coast of the Ionian Sea will provide new clues that allow a fuller understanding of the Neolithic and the characteristics. Then it would also be possible to more accurately classify the cave settlement of Velca culturally and chronologically.

Cave Uses: Agropastoral (A.a) - As a residential place served a south-west-facing cave with favourable living conditions.

E. Greece

GR01.KOROMILIA

Location: Livadopotamos gorge NW of Kastoria town
Entrance Orientation: S
Entrance Altitude: 850m asl
Cave Formation: Horizontal

Main Research Years: 2002-2008

Occupation Eras and Dates:
5606BC-5379BC, 5364-5081BC.
1662-1499BC.
1297-1408AD, 1290-1460AD, 1466-1641AD, 1445-1631AD, 1666-1953AD.

Sources:
Trantalidoy, K., Belegrinou, E., and Andreasen, N. (2010) Pastoral societies in the south Balkan peninsula: the evidence from caves occupied during the

Cave Description: This cave is sometimes referred to as Piges Koromilia, meaning springs of Koromilia. It is near the town of Kastoria, in West Macedonia, located on the northern bank of the river Livasopotamos. There are two chambers in this cave. One is a main chamber and the other can be seen to be considerably smaller. The maximum dimensions of this cave are 27m x 8.5m and has a curved stair way in the limestone exterior.

Research Chronicles and Data: The excavation revealed four main floors, one on top of the other. The chronologically last floor, i.e. the one closest to the modern floor, has just under 30 post holes. These are from different structures such as wooden frames or huts. These would have been necessary to protect the occupants of the cave from dripping water and would have probably formed a sleeping area for up to two people. On the most recent layer of the cave is a stone hearth.
There is a palisade hole on the deepest floor, i.e. the oldest, and three holes on the one above that. The excavation was restricted in some areas so the excavators placed a 1m x 1m test pit. They recorded burnt clay fragments bearing imprints of reeds probably used as a temper. Throughout each layer there is a lens of ash, burnt coprolites and sherds. The floors are not all just bare ground, some layers of rough stones have been placed horizontally disposed in a circle or in more or less quadrilateral order to produce a stable

Neolithic and Chalcolithic era. *ANODOS, studies of ancient world* 10, 321-334.	and possibly dry level ground, to make a stable floor. Cave Uses: Agropastoral (A.a) - This cave was used for shelter as there is evidence of human-made structures and deposition within the cave. However, the cave may have been used more specifically as a seasonal habitation pen for livestock. The cave may have been used by moving pastorals with their livestock, as the walk from Kastoria to Korytsa. This is a 9 hour long walk across the plain of Kastoria or the Grammos Mountains. Another piece of evidence that suggests this cave was used for seasonal habitation is the construction of different floors. These would have served different purposes and would have been used by different groups of people in different seasons.

GR02.AGGITIS

Location: Drama **Entrance Orientation:** **Entrance Altitude**: 129m asl **Cave Formation**: Horizontal **Cave Map**: *pending* **Main Research Years:** **Occupation Eras and Dates**: LN, EBA. 2900-2210BC, 1011-935BC/1041-924BC, 974-903/999-858BC,	**Cave Description:** This cave can also be called Piges Angitis. Piges meaning 'springs of'. The cave is located 25km to the west of the town of Drama, and located on the eastern bank of the river Angitis. It has only one chamber, of which the occupation area is 100m squared. This cave is the longest cave in Greece at about 14km long. **Research Chronicles and Data**: The main feature of the occupation area would be the four hearths. On each flat area within the cave, there are two hearths. They are fashioned from primitive stone circles however they seem to have been reused and looked after, as ash and charcoal have been found in or around the hearths suggesting that the structures had been cleaned. Also found were storage pots and vases used for transporting liquids and fragments of cooking vessels.

1516-1657AD. **Sources:** Trantalidou, K., Belegrinou, E., and Andreasen, N. 2010. Pastoral societies in the southern Balkan Peninsula: The evidence from caves occupied during the Neolithic and the Chalcolithic era, Phenomena of Cultural Borders and Border Cultures across the Passage of the Time. In *Anodos* 10, 295-320. Trnava University.	**Cave Uses**: Storage, Hunting Stand (A.b.d) - Due to the proximity to the river is would be easy to suggest that the cave was occasionally used by hunters or moving pastorals as they would have used the hearth. Occupation seems to have been longer than infrequent visits however as the hearths were reused by different groups of people. The large area of the cave may also suggest it was a storage place.

GR03.ORPHEAS

Location: Alisrati, Serres **Entrance Orentation:** **Entrance Altitude:** Cave Formation: **Cave Map:** **Main Research years**: ongoing	**Cave Description:** Orpheas is the biggest cave in a complex of nine other small caves and cavities. The largest dimensions of the cave is 300 x 30 m. It is located near the Gorge of the River Angitis. **Research Chronicles and Data:** The excavations in this cave are on-going. So far an area of 16 square metres has been excavated to reveal 12 post-holes. This limits the theory that this is a domestic settlement. **Cave Uses:** Agropastoral (A.a) - The smaller cavities and caves were probably just used

Occupation Eras and Dates: LN, EBA, 3085-2775BC	as animal pens due to their size and minimum security. Due to the size, this cave would make a good storage location, however the post holes uncovered reveal an enclosure too small for domestic living but may suggest mortuary practices.

GR08.SARACENOS

Location: Kopaïs Basin. Area of Akraiphion. Boeotia **Entrance Orientation**: SSW **Entrance Altitude**: 180m asl **Cave Formation**: Horizontal **Cave Map**: *pending* **Main Research Years**: Ongoing **Occupation Eras and Dates:** Mesolithic; EN; MN; LN Early Helladic; Mid Helladic. 8530-8340BC; 8450-8290BC.	**Cave Description:** The surface area of the cave is about 2400 sq m. **Research Chronicles and Data:** The deposit layer in the cave is 5m thick. In trench A the excavation was completed at 3.25m. The result of this was the identification of 11 floors. There are few floors from the Early Neolithic and Middle Neolithic periods however after this, the excavators found successive floors and hearths, some of which were defined by stones. During the most intensive period of the occupation of this cave during the 4th millennium B.C., an extended floor of hard-packed earth with five post holes were uncovered. These holes were between 5.5cm and 9cm in diameter at a depth of 2.26m, which may indicate that partitions were built inside the cave for keeping animals. **Cave Uses:** Storage (A.b.) - The cave was used for two main things; one being dwelling and storage. During the Middle Neolithic, it seems like the cave was used as seasonal habitation for herders as no large storage vessels were found. In the Late Neolithic there

Sources: Sampson, A. 2008. *The Sarakenos Cave at Akraephinion, Boeotia, Greece.* Athens: University of the Aegean.	are hints that ceremonial activities may have taken place and / or mortuary practices. There is evidence for long term habitation, and a pen for animals. Later on in the Late Neolithic the excavator proposes that the pattern of transhumant herders may have used the cave as a place for storage and dwelling, due to the caves helpful location via the Kifissos river valley, in Boeotia.

GR11.KITSOS

Location: Kitsos, 5km east of Laurion. **Entrance** Orientation: E **Entrance Altitude**: 288m asl **Cave Formation**: Horizontal **Cave Map:** *pending* **Main Research years**: **Occupation Eras and Dates:** MN; LN; FN; EBA; LBA. 4900-4220BC **Sources:** Tomkins, K. 2009. Domesticity by Default. Ritual, Ritualization and Cave-Use in the	**Cave Description**: The cave is located on the eastern slope of Mikro Ripari, and commands extensive views across the whole of eastern Attica and the Islands of Euboea and the western Cyclades. The cave has two chambers, the main chamber is roughly 35x12m. The cave gets its name from the bandit Kitsos who hid there with six other people in modern times. **Research Chronicles and Data**: The total depth of the deposits was 1.5m. Frequently caves are described as unsuitable for habitation because of their distance from agricultural land or water sources, however this is not the case with Kitsos Cave. A metal crucible was also found. A large group of LN II-FN pottery sherds have been found. Specifically CP20, which is a unique type of bowl that contained bones of hare and birds. A rare flint arrow head of great quality, together presumably with its shaft, appears to have been deliberately deposited in a fire. A group of brown polished vessels were found in association with a human bone. There is the presence of bone needles, colorants (malachite) and ground stone tools with traces of colorant on them.

Neolithic Aegean. *Oxford Journal of Archaeology* 28 (2), 125-153. Zachos, K.L. 1999. Zas Cave on Naxos and the Role of Caves in the Aegean Late Neolithic. In P. Halstead (Ed.) *Neolithic Society in Greece.* Sheffield: Sheffield Studies in Aegean Archaeology 2. 153-63.	Cave Uses: Agropastoral (A.a) - During prehistory the cave was seasonally occupied by hunters and herders. During the Neolithic period, a base of roughly 25 humans were dealing with husbandry and hunting. The crucible is an item of value, so it would suggest it was buried as part of a ritual or mortuary practice however there has been resistance to this theory (Zachos 1999) because any case of non-domestic usage of these caves has yet to be made. Later on, in the Mycenaean-Classical, Hellenistic-Imperial period, there seem to have been visitors to the cave for cult practices.

GR10.SKOTEINI THARROUNIA

Location: Euboea Island **Entrance Orientation**: NNE **Entrance Altitude**: 450m asl **Cave Formation**: Horizontal **Main Research years:** **Occupation Eras and Dates:** LNI-II; EHII; LHIII; LN. 5294-5208BC; 5217-5062BC; 4776-4628BC; 4711–4529BC; 3675-3528BC.	**Cave Description:** This cave is located SE of the town of Therrounia. It is positioned above the deep narrow gorge of the stream Hondros. **Research Chronicles and Data**: The depths of the deposits in this cave are about 3-4m, however in trench C, it increases to 4.35m. In trench C, 12 living floors were uncovered. In the LNI, several floors were discovered in close succession suggesting intensive use for a short period of time. On these floors ash hearths have also been excavated. Obsidian blades dominate the lithic industries, as well as at Kitsos (Gr11) and the presence of debitage suggests that some were worked onsite. **Cave Uses: Storage** (A.b) - This cave probably had seasonal usage, in that it was

Sources: Trantalidou, K., Belegrinou, E., and Andreasen, N. 2010. Pastoral societies in the southern Balkan Peninsula: The evidence from caves occupied during the Neolithic and the Chalcolithic era, Phenomena of Cultural Borders and Border Cultures across the Passage of the Time. In *Anodos* 10, 295-320. Trnava University.	occupied from spring to autumn. When the cave was not in use it was probably used for burials. In the Late Neolithic, the cave was used for the storage of food as evident from the finds of more than 700 pithoi. In LHIII, the classical period, there are some cult indications. Although there is no clear or definitive archaeological evidence about systematic cult practice in the late Neolithic, ritual ceremonies are not excluded. Figurines have been found, and could have had a variety of uses e.g. religious, sympathetic magic, or talismans. The final use of the cave seems to have been for keeping domestic animals, although seasonal pastoral use is not excluded. There is plenty of evidence for seasonal transhumance in recent times.

GR16.ALEPOTRYPA

Location: Gulf of Diros **Entrance Orientation:** W **Entrance Altitude**: 16m asl **Cave Formation**: Horizontal **Cave Map**: *pending*	**Cave Description**: This cave has numerous chambers, one of which is 280m long, in the largest chamber there is a lake of fresh water safe enough to drink. There are lots of small natural niches within the cave. The entrance is 50m from the modern shore line. The main chamber is 130 x 50m however there are a lot of passageways, smaller chambers and smaller lakes with brackish but potable water.
Main Research Years: ongoing	**Research Chronicles and Data:** This cave contained a large Neolithic settlement with thick cultural levels. Along the 300m cave, 50 sites of activity have been identified,

Occupation Eras and Dates: LN. 5300-3200

Sources:

Papathanassopoulos, G.A. 1996a. Neolithic Deros: the Alepotrypa Cave. In G.A. Papathanassopoulos (Ed.) *Neolithic culture in Greece* (Athens): 80-4.

Papathanassopoulos, G.A. 1996b. Burial Customs at Deros. In G.A. Papathanassopoulos (Ed.) *Neolithic culture in Greece* (Athens): 175-7.

Papathanassiou, A. 2001. *A Bioarchaeological Analysis of Neolithic Alepotrypa Cave, Greece.* Oxford, BAR International Series 961.

Tomkins, K. 2009. Domesticity by Default. Ritual, Ritualization and Cave-Use in the Neolithic Aegean. *Oxford Journal of Archaeology* 28(2), 125-153.

including habitation zones and mortuary. The settlement disappeared due to a terrible earthquake which caused rocks to fall and block the entrance, and trapped a large amount of the population inside. Skulls appear compressed between fallen rocks. The first modern visitors to the cave found articulated skeletons on the surface. The entrance was narrow, however when the Greek Organisation of Tourism decided to open the cave to the public, the entrance was greatly increased using dynamite. To prevent destruction to more of the cave the Greek Archaeological Service of the Ministry of Culture assumed management of the site, halted public access and stopped any more potentially destructive activities.

There are some very well preserved tools, weapons, and jewellery and everyday vessels found whole in their original position as well as pyres, baking ovens, holes for the storage of food and thousands of decorated objects of household and religious use. The pottery is of a local style with lots of different shapes. Other artefacts include obsidian and flint lithic tools, hand axes and grind stones used for food preparation, bone needles, clay spindle whorls, shell and stone beads, silver jewellery items, marble and clay figurines. Four copper daggers, unworked copper nuggets, and copper slag have been found on the upper layers suggesting that there may have been an emergence of local metallurgy industry at the advent of the Bronze Age. The quantity suggests that there were 100 or more families who lived in the cave. After testing, it is clear that of all the tested pottery sherds were made of the same local clay, indicating that pottery was made on site.

GR24.AYIO GALAS

Location: Chios **Entrance Orientation**: S **Entrance Altitude:** **Cave Formation**: Horizontal **Main Research Years**: 1938, 1936 **Occupation Dates and Eras:** **Sources**: Hood, S. 1981. Excavations in Chios 1938-1955. Prehistoric Emporio and Ayio Gala. The British School at Athens. Thames and Hudson. 11-73.	**Cave Description:** The cave itself lies 1 km inland from an inhospitable stretch of coast. The cave is made up of two chambers. The first is large and to the right of the steps that lead to the cave. An area of about 25 sq m was opened up, and the bed rock floor was detected at 7m below. There is also a chamber above. This lies above the cave and to the left. The entrance to the second chamber is through a chapel. The layer was smaller at only 4m deep. **Research Chronicles:** The cave was excavated by E. Eccles in 1938. The test trench allowed them to see that there was no stratification and layers defined by pottery were also not apparent as sherd of the same pot would appear in different archaeological layers. The lowest 3 m above the bed rock were almost entirely sterile. The upper cave contained many bone fragments. Some had been split to extract the marrow. Some bits of bone had also been burnt. **Cave Usage**: A.a - Agropastoral. There is no evidence of hearths or obvious floor levels. However the character of the pottery suggest that the upper cave was used for habitation.

	The evidence of ritual burning and possible consumption of humans may suggest the cave also had a spiritual use.

GR20.KOUMELO

Location: Archagellos, Dodecanese Islands **Entrance Orientation**: **Entrance Altitude**: 140m asl **Cave Formation:** Horizontal **Cave Map**: *pending* **Main Research Years**: **Occupation Eras and Dates**: Mid-Late Aegean Neolithic; LBA (briefly); Hellenistic Period. **Sources**: Trantalidou, K., Belegrinou, E., and Andreasen, N. 2010. Pastoral societies in the southern Balkan Peninsula: The evidence from caves occupied during the	**Cave Description:** The cave is located on the East coast of Rhodes, a precipitous location. The cave has 3 chambers. **Research Chronicles and Data**: The cave has been excavated to a depth of 2.6m. In that space, the excavators uncovered four floors, with post holes on the second floor and several hearths. What separates the Neolithic floors is a thin layer of rain-washed ash. This suggests that the cave was used periodically. Above the Neolithic levels within the cave, it seem that the cave was filled with a thick deposit of volcanic ash from the Santorini volcano. The tephra clearly came into the cave through the entrance and some holes in the roof as a result of the sudden and violent downpour. To determine what the cave was used for, the burnt layers of the floor should be re-examined, in order for us to determine whether the cave was used to hold animals, or something a bit different to the other caves in the Archagellos area. **Cave Uses**: Storage (A.b) - Due to the layers of rain-washed ash, the cave was used periodically, and could have been used as a temporary storage place. In the final late Neolithic there is evidence to suggest that the cave was used as a human shelter.

Neolithic and the Chalcolithic era, Phenomena of Cultural Borders and Border Cultures across the Passage of the Time. In *Anodos* 10, 295-320. Trnava University.	Probably 10 caves and rock shelters in the Archagellos area have been used as a pen for animals, however the entrance of this cave that would make this very difficult.

GR26.AYIA TRIADA

Location: Karystos **Entrance Orientation:** E **Entrance Altitude:** **Cave Formation**: Horizontal **Cave Map:** N/A	**Cave Description:** The cave is formed at the point where marble and schist meet along an underground river bed. The entrance to the cave is up a 50m path from the modern church. The surrounding landscape has been damaged by a natural landslide, which also disrupted a perennial spring. The cave has a narrow but high corridor, reaching 8m high at points, It has not yet been explored to its depths but the caves entrance and more forward chambers are regularly visited.
Main Research Years: 1964, 1985, 2007-8 **Occupations Eras and Dates**: LN I, LN II, FN, EBA	**Research Chronicles and Data:** Donald Keller and Adamantios Sampson explored the cave most thoroughly. They found white on dark pottery in the deep areas of the cave, close to an underground stream, This pottery is typical of the late Neolithic Aegean. Other pottery found includes monochrome sherds, clay that contains mica, schist and other rocks characteristic of local raw materials. Two trenches were opened in 2007; In trench 1 no stratigraphy was seen, due to water damage however in trench 2 it was. In trench 2, there was a circular feature found, layers of carbon and ash and several pot

Sources: F. Mavridids, Z. Tankosic. The Ayia Triadha Cave, Southern Euboea: finds and implications of the earliest human habitation in the area (a preliminary report).Mediterranean Archaeology and Archaeometry. (9.2) 47-59. A. Sampson. 1981. The Neolithic and Protohelladic I In Euboea, Athens.	sherds belonging to the LN. **Cave Uses**: Agropastoral, Shelter (A.a.d) -

GR27.ANTIPAROS

Location: East of Antiparos **Entrance Orientation**: SSW **Entrance Altitude**: 171 m asl **Cave Formation**: Horizontal **Cave Map:** N/A **Main Research Years**: 1965; 1968; 14th-30th March 2006 **Occupation Eras and Dates:** Late Neo	**Cave Description**: This karst cave is close to the hill of Profitas Elias, close to the centre of the eastern coast of Antiparos - about 9km south of its modern capital. The interior of the cave slopes down very steeply, with terraces at intervals. It is accessible by a concrete staircase. The entrance to the cave is 20 m wide and under 10 m high. Although there is no notable dripping of water through fissures in the rocks to increase its natural decoration, the cave's stalagmitic decor is impressive. A central paved yard is located next to the gate to the site. The original roof of the cave once extended over this area but is now collapsed. The interior descends into a main chamber.

I, Late Neo II, Bronze Age

Sources:

Mavridis, F. 2010. Salvage excavation in the cave of Antiparo, Cyclades: prehistoric pottery and miscellaneous finds. A preliminary report. Aegean Archaeology 9 2007-2008. Studies and monographs in Mediterranean archaeology and civilisation: Ser. 2 Vol. 10. Warsaw: Art and Archaeology. 9-30.

Research Chronicles and Data: Recent research excavations were undertaken alongside a programme of visitor related improvements for tourist purposes including repair of damage to the cave. Before the excavations, the cave was recently used as a shepherd's pen.

The main chamber was the only area possible to excavate and was scattered with dispersed surface archaeological material. The collapsed entrance may have contained archaeological strata but is now paved with slabs.

Markovits dug 2 trial trenches in areas 450 and 451 of the cave.cRenfrew (1965) collected sherds from surface and correlated these with Saliagos Culture. Bakalakis (1968) reported not finding any inscriptions but many prehistoric sherds of the Geometric, Archaic and Classical periods.

Salvage excavations in 2006 were focused on defining stratigraphy and character of archaeological remains in the steep area before the entrance to the main chamber. Six trenches were opened and labelled by letters of the Greek alphabet (A-ET). Pottery of the Archaic, Classical and later periods was found with modern material in disturbed upper layers.

Evidence for prehistoric use was found in almost all trenches within layers which contained many boulders. There were some layers of ash and burnt material that contained few remains, mainly animal bones, no clear-cut layer of prehistoric habitation (e.g. floors) were located.

Geological research confirmed excavators' interpretation that the sediments were quite disturbed. Thus, typological analysis of pottery finds was used to determine different chronological usages of the cave but the character of the occupation is difficult to establish.

Finds:
Pottery - 66 rim fragments, 33 body fragments, 26 lugs and other handles, and 5 bases. Sherds were fragmented and conservators were able to join few. Diameters 11-30cm most common.
LateNeo I: white on dark ware with a heavily burnished surface in shades of black-grey and brown. The majority of the sherds are thin-walled and very few seem to belong to vases with thick walls. Open shapes outnumber closed ones but few have been reconstructed. The decoration includes simple motifs in straight lines or bands, there are no curvilinear patterns apart from wavy lines. There are multiple chevrons in various arrangements and the butterfly motif is common - triangles connected at their upper corners, outlined and filled in with white paste. Red and white is a subcategory of the white-painted ware at Antiparos.

Late Neo II: There is no clear distiction between the phases, however, crusted and pattern-burnished wares are common and characteristic of later phase. Pottery with crusted decoration is relatively well-represented by carinated straight-sided conical and rounded bows and a rim fragment of a wide-mouthed vase.

Some stone, clay, bone, and organic finds were found.

Lithics: barbed and tanged points as well as ovate points were found. Retouched blades are present as well as parallel sided ones. There was also a scraper, a flake, a side scraper and a triangular point. Flakes predominate and cores are also present.

Bone: a small group of bone tools were found including a needle and two spatulas. Some bone and shell pieces bear evidence of polishing.

Clay and Stone: conical marble bowls were found made from striated raw material. A spoon fragment preserving part of a rounded lug and its hollow main body.

Faunal Remains: Numerous sea shells and bones of wild and domesticated animals were excavated. Ovis and Capra are almost equally represented also. The preservation of the remains suggest either the carcass was transported to site as a whole or the animals were kept in the cave.

Cave Uses: Agropastoral (A.a) - Reference to burnt and ashy layers with animals bones, few finds, and no floor surfaces suggest that the cave was used for agro-pastoral use i.e. shepherding and penning - possibly seasonally.

F. Croatia

HR05.VAGANSKA

Location: Zadar **Entrance Orentaion**: S **Entrance Altitude**: 700m asl **Cave Formation:** Horizontal **Main Research Years**: 1984 **Occupation Eras and Dates**: Mesolithic to Iron Age **Sources:** Forenbaher, S and Vranjican, P. 1985. Vaganacka pecina. *Opusc. Archaeolo.* 10, 4-21.	**Cave Description:** The cave is located on the coastal slope of the Velebit Mountain. The cave can be divided into three parts: the entrance area, the middle section and the final hall. Entrance area, dimensions 25x15 m is predominantly dry and well-lit living-light and very comfortable to stay. The ground is covered with a layer of culture, thick, about 4 m. In recent years, this is part of the rebuilt stone walls and even now occasionally serves as a corral for the sheep. By the second part of the cave comes to creep through a short, very narrow tubules. At a time when the first visitors had begun to hold in the caves made a whole from the entrance area. But as in one part of the ceiling of the cave significantly lowered, the gradual accumulation of material and the level of soil in the cave middle part completely separated from the entrance hall. The thickness of the cultural layer is that an average of about 3m and decreased towards the end of the channel. The final room of the cave, measuring about 15 x 20 m differs significantly from the previously described sections. The walls and ceiling are decorated with numerous stalactites and water constantly dripping with stalactites maintain a constant level in several large cistern that could supply a small group of residents. The ground is covered with a 10-20cm thick layer of clay Žitková in cave there is a level of culture in the true

	sense of the word, and pottery is scattered across the entire surface. In this part of the cave there is complete darkness. Suitable shape and position of the entrance area of the cave has been providing its inhabitants favorable conditions for the room. Inside part of the entrance, which is easy to hide the ideal space for refuge, it seems that for this purpose served at the end of the Bronze Age, as documented by numerous fragments of large vessels for stocks that were found in the final hall. Research Chronicles and Data: April 1984 limited excavations of 2% of total site area. Near back of cave. Cultural strata more than 4m thick. 8 successive phases of occupation. Phase 2 Early Neolithic including some cardium-impresso pottery sherds. Phase 3 Middle Neolithic Danile culture. Relative abundance and variety of flint objects. Phase 4 Hvar culture of late Neolithic. Phase 5 Eneolithic. **Cave Uses**: Storage (A.b)

HR02. GRAPCEVA

Location: Island of Hvar.
Entrance Orientation: SSW
Entrance Altitude: 230m+ above a freshwater spring
Cave Formation: Horizontal

Main Research Years:
Late 19th century;
1912, 1936-1939, 1947-1952, 1996

Occupation Eras and Dates:
Neolithic – Bronze Age
Late Neolithic – 4718-4553 cal BC; 4828-4624 cal BC

Sources:
Forenbaher, S., Kaiser, T. and Frame, S. 2010. Adriatic Neolithic Mortuary Ritual at Grapceva Cave, Croatia. Journal of Field Archaeology 35 (4): 337-354.
Forenbaher, S., Kaiser, T. and Miracle, P.T. 2013. Dating the East Adriatic Neolithic. European Journal of Archaeology 16 (4): 589-609.

Cave Description:
This cave is located on a the south coast of the Dalmatian Island of Hvar. The cave has a small entrance, that was once much larger – unknown situation in Neolithic. There is a single chamber, 25m wide x 22m long x 5m high. The cave is divided by stalagmitic pillars and curtains into a number of unequally sized labyrinthine spaces. A passage, completely encased in stalagmitic crust, climbs steeply from the northern end of the chamber, terminating in a dead end after some 10m. 70/390 sq m internal space is stalagmites.

Research Chronicles and Data:
This cave has seven Major phases:

Phase 0 – Ephemeral visits early – Mid Neolithic. Relatively scarce pottery but including sherd of Impressed Ware and sherds of Danilo-style incision, and a polychrome painted sherd of buff-yellow untampered, burnished, evenly fired fineware known as figulina.

Phase 1 – Late Neolithic – L.N. Hvar bowls – 4800-4300 calBC. More intensive and qualitively different use of site. Highest density of wood charcoal and plant macroremains. Pot sherds larger and more often

Forenbaher, S. and Kaiser, T. 2008. Grapceva spilja: pretpovijesni stan, tor I obredno mjesto. Split: Knjizevni krug. Forenbaher, S. and Kaiser, T. 1999. Grapceva spilja I apsolutno datiranje istocnojadransjog neolitika. Vjesnik za arheologiju I historiju dalmatinsku 92: 9-34.	decorated. Over 3200 sherds found, 445 diagnostic. Locally made. Wide shallow bowls mostly. 16 flaked lithic artefacts. Absence of debris. Wild plants outnumber domesticates. Human remains: 68/77 total disarticulated remains in cave found in this Phase. No complete individuals. Min. 7 individuals of range of ages but probably a few dozen because of disturbance. Gender of only 2 could be determined, one definitely female and one probably female. Phase 2 – End of 5th Mil. Cal BC - Plain, generic Hvar pottery, relatively highest amount of burnished pottery with channelled decoration. Phase 3 – Mid 4th Mil Cal BC – Late 4th Mil Cal Bc - Early Copper Age Phase 4 – Late Copper Age Phase 5 – Early Bronze Age/ Middle Bronze Age Phase 6 – backfill from Novak’s trench Cave Uses: B.c.d - Spiritual, Burial. Ritual, cult, mortuary practices.

HR01.PUPICINA

Location: The lower reaches of Vela Draga Canyon
Entrance Orientation: SE
Entrance Altitude: 220m asl
Cave Formation: Horizontal

Main Research Years: 1995 - 2002

Occupation Eras and Dates:
Mesolithic - youngest Radiocarbon dates 7400-8200 cal BC; 8249-7964 cal BC
Mid. Neolithic - Radiocarbon dates of 5520-5360 cal BC (OXA-8471); 5740-5300 cal BC (z2575)
- Radiocarbon dates of 5640-5480 cal BC (Beta 131625); 5370-5050 cal BC (Beta 131624)
- 5554-5377 cal BC; 5617-5486 cal BC
Late Neolithic; c.600 years - radiocarbon from upper part 4530-4250 cal BC (Beta 188917)
Mid Bronze Age - 350 years
Copper Age: 3959-3797 cal BC; 2571-2349 cal BC
Iron Age - 725 years
Roman.

Cave Description: Formed along a fault, running water prominent. Western part of cave moister and preserves more stalactite/flowstone formation. The cave ceiling steadily lowers as one moves into the cave, reaching its lowest point some 15m from the entrance; ceiling height increases again to the north, forming a secondary chamber inside the cave. The accumulation of sediment restricted access into this secondary chamber to a crawl space in Medieval and later times. In main area, the surface slopes gently from NW to SE.

Research Chronicles and Data:
(I)– Mid Neolithic earlier - Pottery: incised and impressed motifs; carinated profiles; rhyta, plates and excised spiral motifs – more characteristic of Early than Middle Neolithic but no Impressed Ware.
(H) – Mid Neolithic later – Pottery: most decorated phase; Mostly Incised decoration but also Impressed and Gouged. Diamond lattice amongst most common motifs then spirals, wheat stalks, hanging triangles, and angular geometrics.
(G) – Late Neolithic – obsidian; sherds of exotic long necked jar.
(F) – Mid Bronze Age, lower fill of Pit 3
(E) – Mid Bronze Age, upper fill of Pit 3
(D) – Late Bronze Age, fill of Pit 2 and mixed

Sources:

Boschian, G. 2006. “Geoarchaeology of Pupicina Cave” in P.T. Miracle and S. Forenbaher (eds.) Prehistoric Herders of Northern Istria, the archaeology of Pupicina cave, Vol 1. Pula: Arheoloski muzej Istre, 123-162.

Boschian, G. and Miracle, P.T. 2007. Shepherds and caves in the karst of Istria (Croatia). In Proceedings of the 2nd International Conference on Soils and Archaeology (ed. G. Boschian). AttiSocieta Toscana Scienze naturali, Mem., Serie A, 112(2007), 173–80.

Forenbaher, S., Kaiser, T. and Miracle, P.T. 2013. Dating the East Adriatic Neolithic. European Journal of Archaeology 16 (4), 589-609.

Miracle, P.T. and Forenbaher, S. 2005. Neolithic and Bronze-Age Herders of Pupicina Cave, Croatia. Journal of Field Archaeology 30 (3), 255- 281.

(C) – Iron Age
(B) – Iron Age)
(A) Roman and mix, fill of Pit 1, and mixed surface deposits. Lithics: black, grey or reddish chert available locally. Or non-local pale yellowish and brownish cherts. Fauna: Domestic: sheep, goat, cattle, pig and dog. Wild: red deer, roe deer, beaver, hare, rabbit, hedgehog, marten, badger, wild cat, fox, bear.

Cave Uses: Agropastoral (A.a) - During the Mid Neolithic - Shepherding: penning sheep and goats – possibly seasonally. Hearths. Flint knapping. Late Neolithic: Shepherding and penning. No flint knapping – use of prepared cores and finished artefacts. Mostly pastoral stabling use but with evidence of domestic activities.

Miracle, P. and Forenbaher, S. (eds.), Prehistoric herders of northern Istria: the archaeology of Pupicina Cave, vol. 1. Pula: Arheološki Muzej Istre.

HR03.VELA SPILJA

Location: Vela Luca, Korcula Island
Entrance Orientation: WSW
Entrance Altitude: 130m asl
Cave Formation: Horizontal

Main Research Years: 1951; 1974-1995; 1996-2006; 2007-Present

Occupation Eras and Dates:
Late Upper Palaeolithic – Bronze Age
Late Upper Palaeolithic A 17, 530-17, 190;
Late Upper Palaeolithic I 12,950-12,250;
Mesolithic B 7310-7038;
Mesolithic D 6360-6070;
Neolithic C 566-5530.

Cave Description: The cave is located on the western end of Korcula Island, overlooking the Kale Cove arm of Vela Luka. The entrance to the cave is 4m high by 10m wide, in a bent arch shape. The cave has a single, large chamber approx. 50m long, 30m wide, 17m high. Ceiling shaped as a fairly regular spherical dome. Two openings in the ceiling of the cave – Velo and Mao zdrilo 11m x9m and 5m x 4m respectively. All parts adequately lit for normal work and residence. 1100m sq. floor area.

Research Chronicles and Data: First noted in 1835 historically. First excavations 1949 (Marinko Gjivoje) and 1951 (Boris Ilakovac and Vinko Foretic). Grga Novak excavated in 1951 to confirm links with sites on Hvar. Systematic exploration by Institute of Archaeology of the Yugoslav (today Croatian) Academy of Science, headed by Grga Novak annually since 1974. During Mesolithic, used for seasonal hunting and collection of marine resources and also burial. Three child burials (age between 2-3) discovered between 1986 and 1998 in contracted position as part of younger Mesolithic. Igneous rock cobble in one burial indicative of sea

Sources: Cecuk, B. and Radic, D. 2005. Vela Spila: viseslojno pretpovijesno nalaziste – Vela Luka, otok Korcula. Vela Luka: Centar za kulturu “Vela Luka”. Cristiani, E., Farbstein, R. and Miracle, P. 2014. Ornamental traditions in the Eastern Adriatic: The Upper Palaeolithic and Mesolithic personal adornments from Vela Spila (Croatia). Journal of Anthropological Archaeology 36, 21-31. Novak, G. 1954. Arheoloska istrazivanja na otocima Jorculi I Hvaru u 1951. I 1952., Ljetopis JAZU, 59, Zagreb. Radic, D. 2005. Vela Spila: Preliminary analysis of early Neolithic and Mesolithic strata in test pit examined in 2004. Opvscula Archaeologica 29, 323-348. Rainsford, C., O’Connor, T. and Miracle, P. 2014. Fishing in the Adriatic at the Mesolithic-Neolithic	travel. Frequent large fish bones found, possibly indicative of deep-sea fishing. No break in stratigraphy between Mesolithic and Neolithic but also no continuation of material culture. Constant decline in use of shellfish, snails and fish as part of diet in Neolithic. Finds of sheep and goats in Mesolithic layers pre-Impressed Ware. VERA no. 2340, charcoal, ‘transition’ strata, 7200 +- 30BP, 6170-6130 Cal BC, 12.9%, 6100-5990 Cal BC, 82.5%. Same stratum: VERA 2342, animal bone, 7175 BP, 6160-5920 BC. Early stage of Impressed Ware culture. Early Neolithic: Ceramics varying thickness 0.4-1.4cm corresponding to other Impressed Ware culture sites. External side often coated and somewhat polished. Possible animal figurine. Punctures & incisions and incisions & imprints characteristic end of Impressed Ware. Flint: Approx. 70 flint items – mostly debitage, 11 blade fragments with trapezoidal or triangular cross-sections. Frequent traces of use, Sporadic traces of production. 2 scrapers. 3 tools with steeply retouched lateral side similar to a bore. Other: Green mould-shaped polished wedge with upper portion broken. Bone: 2 finely retouched needles. Obsidian.“Radiocarbon analysis of charcoal from Layer VI, section g x 19-21, some 60cm above the Mesolithic burials 1-3, provides a calibrated date of 6230-6000 (6150) BC. This date clearly indicates a time which postdates the Mesolithic as recorded (e.g. in Kopacina Cave on the island of Brac), where it was dated to 6680 BC (Muller 1994:351). It corresponds to the date from Mesolithic Layer 8 (Stratum I B) of the Odmut Cave and, what is particularly important, to the earliest pottery phase from Gudnja Cave on Peljesac peninsula (Chapman 1988:7-

transition: Evidence from Vela Spila, Croatia. Environmental Archaeology 19 (3), 311-320.	10). There is no doubt that Layer VI (from section g x 19-21) is the oldest pottery level in Vela Spila." (Cecuk and Radic 2005, 81) "Charcoal from Layer V, section g x 19-21, which was associated with finds of typical middle impresso stage, provided a date of 5855 BC." (Cecuk and Radic 2005, 81) Above the Impresso ware layers is a continuous transitioning from Early to Middle Neolithic. Compared to earlier and later phases, the Middle Neolithic phase is relatively poor in finds. Older phase dominated by monochrome burnished pottery and a younger phase dominated by trichrome painted pottery. Older phase: fine uniformly fired pottery with a usually black or sometimes grey or red burnished surface. Improved technology of production compared to preceding Early Neolithic phase. More careful preparation of raw material and use of kilns allowing thinner vessel walls and more complex shapes e.g. S-shapes and carinated pieces. Younger phase: dated to end of Middle Neolithic. Expansion of polychrome painting with mixed linear and spiral motifs, "under the influence coming from the Apennine Peninsula." (Cecuk and Radic 2005, 121) Late Neolithic and Hvar culture: layers up to 0.6-1m thick. Encountered at a depth of 1.6m in central part of the cave, directly overlying the strata with Vela Luka painted pottery. Huge number (several hundred thousand) potsherds, worked stones, bones and plentiful food remains – all kinds of human activities. Divided into four stages – early, classic, late and final. Hvar culture beings in the Late stage. Eneolithic Nakovana Culture. Immediately overlays previous Neolithic layers and

	underlays a compact Bronze Age layer. Unburnished vessels, often with light-coloured surfaces and slightly concave necks that join the shoulder at a sharp angle, herald the onset of a new culture. Cave visited more often during the younger stage. Huge numbers of sheep and goat bones with cattle remains also constituting a significant proportion of faunal remains. Early Bronze Age and Cetina culture.

HR09.NUGLJANSKA

Location: **Entrance Orientation**: SW **Entrance Altitude**: 550m asl **Cave formation**: Horizontal karst **Cave Map:** N/A **Main Research Years:** 19th century, 1998 **Occupation Eras and Dates:** Palaeolithic; Mesolithic. 12510 +- 55; 11520 +- 90;	**Cave Description:** Easy to access. Research Chronicles and Data: In1998 investigation occurred as part of the Pupicine Cave Project. One large trench with four quadrants was excavated against the eastern wall of the cave, covering an area of 4 m2 and reaching a depth of 2·5 m. All sediments were dry-sieved using a 6 mm mesh and flotation samples were taken. The excavated levels contained material from the Late Upper Palaeolithic and Mesolithic (15–8 kya). All post-Mesolithic deposits were likely excavated by Moser at the end of the 19th century. The lithic finds from the Mesolithic levels (n = 367) are typical for the time period and region, consisting of endscrapers and linear tools (Komšo 2006). There is evidence for hearths and a large number of faunal remains as well as a small amount of worked bone have been recovered (Miracle and Forenbaher 2000). There are no known human

11160+- 50; 8248 +- 39; 8170 +- 50; 8032 +- 38; 7992 +- 39 **Sources:** Pilaar Birch, S.E. and Miracle, P. 2015. Subsistence continuity, change, and environmental adaptation at the site of Nugljanska, Istria, Croatia. Environmental Archaeology 20 (1), 30-40.	burials. **Cave Uses**: Seasonal hunting site (A.c) -

HR11. ISPOD SELA SRBANI

Location: Srbani, Brtonigla **Entrance Orientation**: S **Entrance Altitude**: 48 m asl **Cave Formation**: Horizontal	**Cave Description:** The cave is located under the village. On the northern ridge of the Mirna Valley, in the cliffs, approximately 500 meters to the east from the hillock of Sveti Juraj. It is characterized by two entrances (a vertical and a horizontal one) and two somewhat larger chambers that are mutually connected with a low and narrow passage. THe vertical entrance is 1.2m wide and approx. 5-6m deep. The horizontal

Main Research years: 1974, 1975; **Occupation Eras and Dates:** Eneolithic; Bronze Age; Roman; Medieval **Sources:** Cuka, M. 2009. A typological analysis of selected prehistoric pottery fragments from Pecina Ispod Sela Srbani. Historia Archaeologia 40, 13-44.	entrance that is oriented towards the south is 4.7m long, 1.7m high, and gets smaller towards the interior. In front of the first chamber is an access area measuring 5 x 4 m, with a height of approximately 5 to 6 m, bearing in mind that it is diminishing towards the interior, and that it at the same time represents the bottom of the vertical entrance into the cave. The first chamber measures 10 x 4 x 5m, and the other smaller one 4 x 4 m, with a height of approximately 5 to 6 m. The corridor that connects the first and second chamber is approximately 1.5 m high. The total length of the cave measures approximately 35 to 40 m, however, we should stress that we can only speculate about its precise length as the cave was not speleologically explored and there exists a possibility that it extends itself towards the north. In its widened sections it is approximately 6 m high. The interior, almost level surface, and the fact that it is situated amongst cliffs make it impossible for water to collect and it is, therefore, almost dry notwithstanding that in some parts of the chambers there is water dripping in from the ceiling. Large stones that caved in from the ceiling cover the ground in the access area, whereas the remaining surface is covered mainly by loose earth. Animal traces are visible in the first chamber. The chambers are in total darkness as daylight enters only through the horizontal entrance. In the access area we witnessed recent traces of fire; graffiti from the 19th century are preserved on the chamber walls.

HR06.LAGANISI

Location: Laganisi, Oprtalj
Entrance Orientation: SSE
Entrance Altitude: 395m asl
Cave Formation: Horizontal
Main Research Years: 2004-2006 test pit. 2006 Survey vertical cave.

Occupation Eras and Years: Middle Neolithic - Late Neolithic, Copper Age, Bronze Age, Roman

Sources:
Komso, D. 2008. Laganisi Cave: a place of life and a place of death. Pula: Arheološki muzej Istre.

Cave Description: In a small karst valley 1.65km NE from Oprtalj, 350m SE of Laganisi village. The site is situated at the edge of a plateau whose peaks do not exceed a height of 500 m above sea level. The plateau is bordered by the rivers Mirna to the south, Bračana to the east, and Dragonja to the north. The central area of the plateau lies from Cape Savudrija in the west to Zrenj in the east. It is 35 km long and 4 km wide. The valley is 29m long and 12m wide and runs north-south. Cave system consists of adjoining caves located in a small karst valley, one of which has a vertical entrance. The archaeological site of Laganiši cave consists of a cave located in a small karst valley, and a nearby cave with a vertical entrance. The two caves form a single cave system, at present divided by a closed passage which might have been passable in prehistory. From the point of view of their use, the two caves can be distinguished as a place of life and a place of death. The pothole, vertical entrance, has probably been created due to subsidence of the ceiling since antiquity.

Cave is at maximum dimensions 22m long X 12m wide X 8m high.

The sinkhole, that is, a cave with a vertical entrance, has two small openings. The dimensions of the first are 1 m x 1 m, and the dimensions of the second are 30 cm x 40 cm. In order to reach the cave, you need to use the bigger opening, climb down vertically on a rope for 7 metres, then over a 5 metre tall stone slide, down to the cave room. The cave room lies in a southeast to southwest direction and is 25 m long, 10 m wide, and 7 m high at its highest point. The room is filled with moist clayish sediment. There are several other cave rooms located around this one. There is a small, low and dripstone covered channel on the south side of the room. The channel is 7 m long and 4 m wide, rising steeply upwards to the south. There is a room filled with moist clayish sediment to the west. The room measures 11 m x 6 m and is 4 m high. It is separated from the entrance room by a low ceiling and a drystone wall covered in dripstone. There is a large room to the northwest. The room is 16 m long, 16 m wide and 12 m high, with the smaller of the above-mentioned openings in its ceiling. There is a heap of stones in its centre which were thrown through the opening. The heap is 4 m tall and covers almost all of the room. To the east of the room there is a blocked passage, located only 3 m from the west wall of the cave situated in the valley. In the southeastern part, there is a channel covered with dripstone with a large amount of surface water. The channel is separated from the room by a low ceiling. It is 11 m long, 4 m wide and 4 m tall. The overall surface of the cave is 370 m2. There are numerous graffiti in the cave. They were mostly done by pen and pencil, while some were also incised in the dripstone. The oldest graffiti are from the end of the 19th century AD.

Research Chronicles and Data: Much destruction had occurred particularly to the south area of the cave where 12m2 had be dug to a depth of 60cm with bronze age pottery fragments visible in the sections. Large pottery fragments and human bone fragments were found in cave with vertical entrance.

Test trench excavated 2004-2006 was 12.75 m2 in size and consisted of two parts (3 m x 2 m, and 4.5 m x 1.5 m) in the shape of the letter L. The greatest relative depth of the trench was 4.05 m.

Among the rich archaeological finds, pottery is the most common. In addition, flint-stone and bone tools, animal and fish bones, and mollusc shells were also recovered. Traces of a large number of open fireplaces were observed in all layers, and different archaeological features were also seen. No traces of human activity were found in layers prior to the Neolithic. However, we cannot exclude human traces in the older layers, because the research has not been concluded, and the bedrock has not been reached in the studied area.

Neolithic: Numerous finds were recovered 3.20 m under the present cave floor level. Remarkable among them are pottery items with typical traits of the transitional period between the Middle and Late Neolithic. Several flint-stone tools were also recovered. Pottery items are very heterogeneous and exhibit rich decorations such as incised spirals, meanders and zigzag lines. Incisions are often filled with a red colour produced from ochre. Very remarkable is a perforated funnel-shaped vessel. The vessel was used as part of the equipment for producing dairy products, which indicates that milk production took place at the very site. Flint-stone tools were brought to the cave as finished goods. They were made entirely of high quality raw material originating in areas more than 100 km away from the site. The remains of animal and fish bones, as well as mollusc shells, are indications of the heterogeneous diet of the Neolithic inhabitants of

Laganiši. Traces of several open fireplaces were also recorded. The recovered finds tell us that a herding community used the cave, most probably during summer, in the transitional period from the Middle to Late Neolithic, about 5,000 BC. Dairy products were also made at the site.

Copper Age: Thick Copper Age layers were found above the Neolithic layers and yielded a somewhat smaller number of archaeological finds. Different pottery fragments were recovered from these layers. The most important among them are several fragments with distinct traits of the Ljubljana culture, a fragment of a ceramic loom weight, probably used as part of a loom or distaff, and some fauna remains.

A few features and traces of several open fireplaces should also be mentioned. A small cavity should also be singled out. It is 25 cm in diameter and has burned edges. It was located in the very vicinity of an open fireplace and was interpreted as a place where one or more meals were prepared. Archaeological finds from this historical period are roughly dated at the end of the Copper Age. They indicate that people repeatedly used the cave for habitation, even though less frequently than during the previous Neolithic period and the subsequent Bronze Age period.

Bronze Age: The Bronze Age layers are the layers with the highest number of archaeological finds of all recorded in Laganiši cave.

Vertical Cave: Detailed survey carried out in 2006 and resulted in finds of Bronze arrow,

	axe and dagger. Test-pit 2m X 1.5m in west room next to drystone wall. Late Middle - Late Bronze Age finds of unburied human remains and Bronze artefacts. Cave Uses: Agropastoral (A.a) - Neolithic: Production of dairy products. Herding. Seasonal (summer) Bronze Age: Necropolis

HR07.VELA SPILJA LOSINJ

Location: Mt. Ososcica **Entrance Orientation**: W **Entrance Altitude:** 268 m asl **Cave Formation**: Horizontal **Main Research years**: 1950s; 2004 **Occupation Eras and Dates:** Palaeolithic, Mesolithic, Early Neolithic, Middle Neolithic **Sources:** Komso, D., Miracle, P.T., and Boschian, G. Hrvatski arheoloski godisnjak 1/2004, 172-175.	**Cave Description:** On western slopes of Mt. Ososcica. Vela Cave is located on the steep western slopes of the mountain of Osorčica, below the highest peak Televrin, in the middle belt of rocks on the island of Losinj. Although the cave is located just a few hundred meters away from the coast, steepness of the terrain and dense underbrush hinder access to the sea. Its entrance is elongated and oval, the height of 8 m and a width of 7 meters, oriented to the west, at an altitude of 268m. The front room is composed of jargon channels total length of 26 m. The cave is the widest and the highest at the entrance, and the channel becomes progressively ears and lower the interior. At the end of the input channels, through narrow and low passage in the rock length 2.5m, has a less simple, the size of 6x4 m, of which the south continues to narrow and low channel visible length of 4 m. Deposited

sediments have been partially eroded in front of the cave .

Research Chronicles and Data: 1950s investigated by Vladimir Mirosavljevic. In 2004 as part of a project “Palaeolithic and Mesolithic Sites in the North Adriatic”, the cleaning of the profiles of old test digs was carried out, and a small shovel test pit was dug, in order to obtained detailed information about the stratigraphy of the deposits. Several Pleistocene layers were determined, from which finds of fauna and stone artefacts were taken. On these lies a layer with a great number of vineyard snails (Helix pomatia), generally classified into the Mesolithic. Above this is an early Neolithic level from which finds of impresso ceramics were collected, with fauna, and a few remains of stone artefacts. Above them lie several prehistoric layers, from which we collected finds of ceramics, fauna and stone artefacts. From all the layers, samples were taken for radiocarbon and sedimentological analyses.

The third horizon makes red-brown compact clay with rare small fragments of limestone. The thickness is 10 to 15 cm and zabilijezen exclusively in the first probes were collected fragments Impresso pottery from the Early Neolithic, some stone izradevina (including drill? The prismatic cutting edge), animal bones (two-thirds consists of the remains of goats / sheep, follow the remains of the boar / pigs, deer and small game fish), rare remains of vineyard land snails (collected mainly in contact with the Mesolithic horizon, which probably belong), relatively frequent remains of sea shells and a part of human children's calotte. The cave was probably used on many occasions as a short-term seasonal livestock habitat, with a large part of the economy based on hunting and fishing.

The second horizon consists of several layers of gray and white ash. Deblijine is 40 cm in the probe 1, about 60 cm in the probe 2 (the filling of the pit dug in the Pleistocene layers) and 20 centimeters in the probe 3. These layers, layers of very similar assemblage and other Istrian localities were probably deposited from the incineration animal faeces and suggest keeping animals in the cave. The horizon he frequently aberrantly animal channels and pits. Projiupljeni the remains of pottery from the Early Neolithic (Impressed Ware ceramics), but also a few fragments of pottery from the Middle Neolithic, perhaps from later periods, animal bones (mostly the remains of goats / sheep), a few remains of sea shells, very few remains of terrestrial snails, a few human remains and charcoal. Increased incidence remains goats / sheep and reducing the number compared to the wild animals to a third horizon, and their preservation in the cave, indicating a change in economic strategy. The problem of dating this horizon will clarify the results of absolute dating.

Cave Uses: Agropastoral (A.a) - Short-term Seasonal herding.

HR14. GOSPODSKA

Cave Description: The initial part of the cave has several lateral passages and canals branching off the shape of a spacious irregular hall with a total length of more than 500 metres. The floor of the hall is more or less horizontally filled with Quaternary sediments which are in places covered by stalagmites.

Research Chronicles and Data: First recorded and investigated by Lovrich (1776) and first quarternary geological investigations in Croatia took place in Gospodska Pecina in 1874 by J. Woldrich. Woldrich dug a test probe through several deposits – near the top of which were ceramics and ruminant faunal remains and cavebear cranial fragments in the lower deposits.

Recent speleological investigation was carried out by Dinic and Manolovic (1966) and Jalzic (1973a, 1973b, 1977a, 1977b). The investigations carried out in October 1977 were for quarternary geological, paleontological and Palaeolithic research purposes.

Along the eastern wall of the cave a test pit was excavated and eight stratigraphic deposits were identified. These sedimentary deposits date from the 3 warm stadial to the end of the Holocene and approximately cover the last 25,000 years. The deposits of the Late Glacial and early Holocene are particularly well documented palaeontologically.

A lithic artefact that is wide and flat was found in the end of the input cavity and interpreted as having been washed in. This artefact was attributed as a Levallois tip from the Lower Palaeolithic.

In the middle part of the stratum b an oven zone is embedded, which shares this deposit into an upper and lower part. The coal this hearth was studied with the method of radioactive carbon and the obtained value for the absolute age of 5,123 + - 85 years before the present time. This value obtained for the absolute age referred very well the time limit between the segregating and depositing the sintered deposit in the form of sg 'Mountain milk' the older and younger Atlantic climate phase, ie of the lower and upper part of the stratum b.

“This, as the other ceramics from the layer B, which the report also classify fragments in young Neolithic, perhaps it belongs to a previously undefined Neolithic phase between the end of the coastal production medium, ie the beginning of the later Neolithic and those in the hinterland, on the continent.

In favour of the assumption that some ceramic fragments were somewhat older cite two bone powers as are similar to those from Gospodska cave (Fig. 2 / 1-2) found in Smilcicu) and Obrima) in the layers of the Early Neolithic.

The discovery of the Neolithic stations in Gospodska cave as well as those in nearby Rudelić cave (hamlet Vukovici, both in v. Cetina), then Water caves and cave Dungeon (both in Bitelic, north c. Of Sinj) and two stations north of Split (Klis is Mosor) discovered recently) with all of insufficient exploration of the region in the Neolithic are certainly interesting contribution to better understanding of connections and relationships Adriatic Neolithic hinterland to the population of coastal areas such with those of central Bosnia…..” (Markovic 23)

The other sample in which the absolute age by means of the method of the radioactive carbon was examined, and the obtained, the lower part of the stratum c was removed. This stratum consists of burnt, sandy loam, which contains many coal particles in the lower part, further carbon splitter un dust and charred fragments of animal bones. The collected pieces of coal were used for analysis and by measurement of radioactive carbon, the absolute value of 7010 was + - 90 years won what marks the beginning of younger boreal climate phase in these regions. This deposit contained faunal remains of Cervus sp. and Capreolus sp.

Neolithic ceramic fragments were also found.

Startum a: humid soil is fine corrosive rounded stones, fragments of pottery

	and bones of various domesticated animals from faun community younger Holocene (canis familiaris of. intermedius, sus sp., Cervus elaphus, Bos taurus brachiceros, Capra hircus and Ovis aries), the thickness of 28cm - supboreal to suprecent. Stratum b: sintered plate extracted as 'mountain milk' with 5cm thick zone of homes in the middle, without findings, the total thickness of 25 cm - old and young Atlantic. Stratum c: scorched pjeskuljasta loam with lots of chunks of coal and slightly burned bones of wild boars, deer and roe deer, faun community elder Holocene extreme forest biotope (Lepus euopaeus, canis lupus, vulpes vulpes crucijera, sus scrofa, Cervus elaphus and Capreolus capreolus), the thickness of 15cm - young boreal Markovic: Neolithic horizon begins at a depth of 85 cm. In the lower part of the horizon, ie. 85-60 cm was found, compared to the upper layers, rather small number of ceramic fragments. I have the impression that the findings of this section, which stands as a layer-A, was somewhat older than those that follow, which are labelled as layer-B.

HR26.TAMNICA

Location: Bitelica
Entrance Orientation:
Entrance Altitude:
Cave Formation: Horizontal
Cave Map:

Main Research years: 1977

Occupation Eras and Dates: Neolithic

Sources:
Zekan, M. 1977. Novi Arheoloski Nalazi u Pecinama Srednje Dalmacije. Vjesnik Split 70-71, 137-47.

Cave Description: Tamnica Cave is located north of Sinj, on the other side of the river Cetina. After 250m of the highway that extends form Bitelic, the road separates into a dirt road to the east and leads up to a bridge. From there, the footpath runs along the canyon to the north of the Culak ruins. Opposite the north side Tamnica cave is located high up in the cliff. During the rainy period the entrance of the cave flows with spring water whilst a siphon lake appears at the end of the cave. From the cave entrance there are powerful and striking views of the surrounding landscape.

Research Chronicles and Data: The cave has three entrances, of which the largest and most accessible one and is situated northwest. The entrance points towards to the north end of the entrance leading to another venue. Near the beginning of the cave there are two sinter column. The first is the higher sinter column is a sleek stone block, probably created by humans. Two fragments of impresso ceramics were found between two pillars and the southeast wall of the cave. This shows the existence of a previously unknown style from the time of the Early Neolithic.

Pottery
1. Fragments of ceramics with reddish-brown exterior and a black interior surface were tempered with a mixture of smaller grains. Ornaments

	preserved on the outer surface of the pottery were in two parallel rows which were created by pressing bone onto the exterior. 2. Fragments of pottery of Cervena colour were found and contained a greater mixture of bigger grains in the temper. Three rows of impresso decoration which run parallel to one another where found on the pottery.

All research and cave pictures are courtesy of the author.

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Figure 9 The second chamber in Mala Pecina cave

Figure 10 East-facing section of trench 1 in Mala Pecina cave; the burnt layer corresponds to the Middle Neolithic occupation

Figure 11 The Middle Neolithic hearth

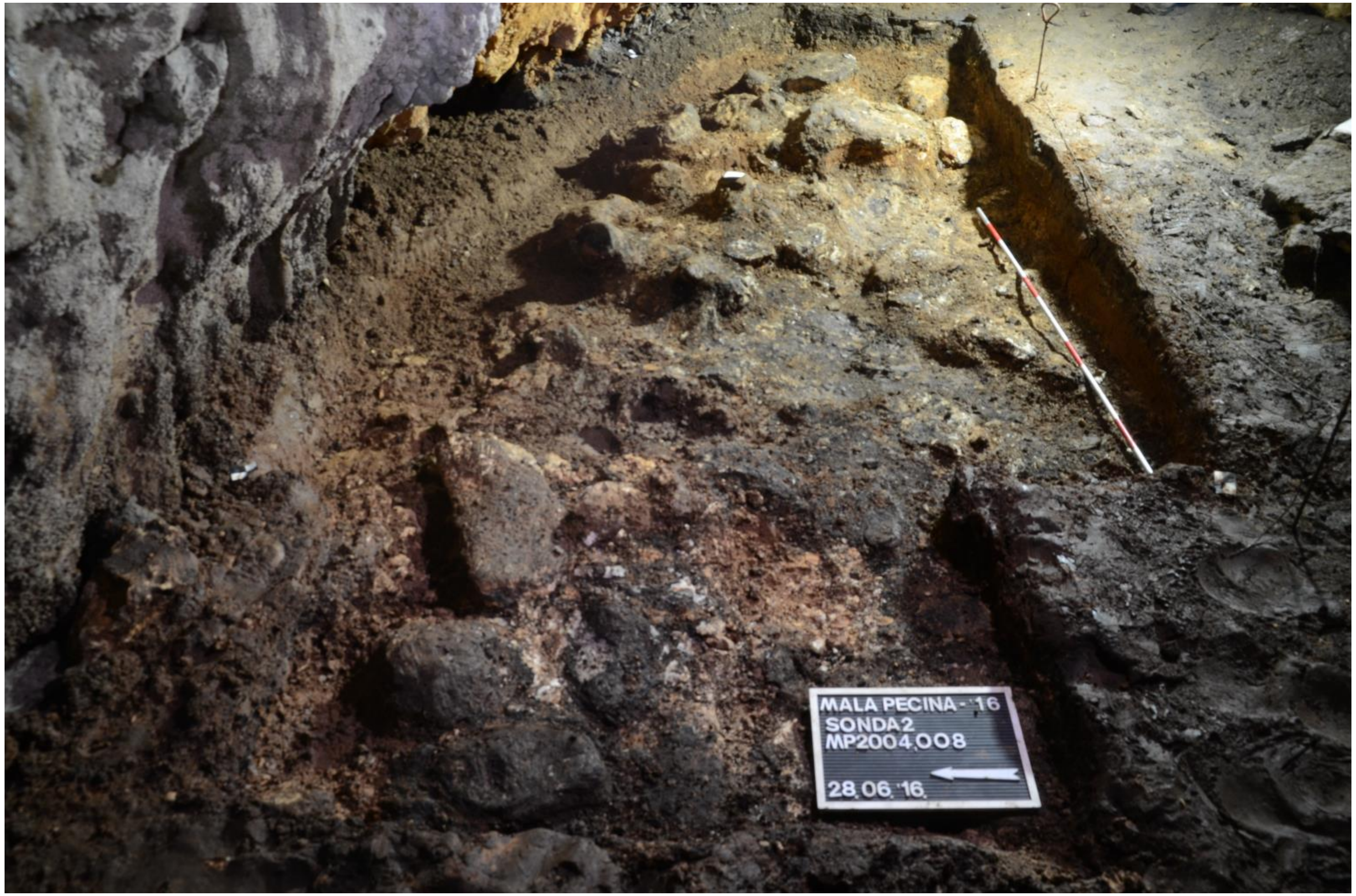


Figure 12 The Early Neolithic structure in 2 at Mala Pecina cave

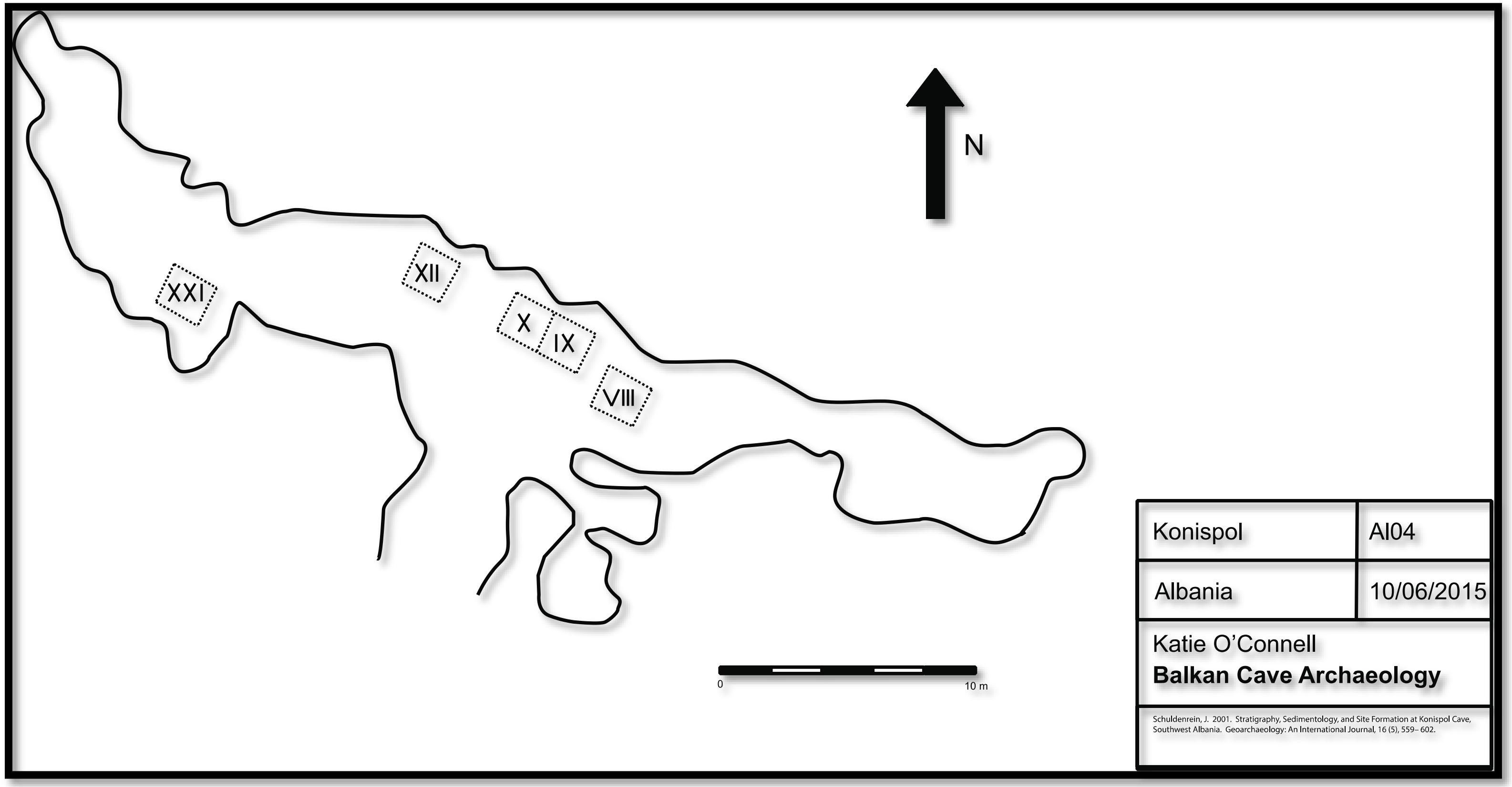
Figure 13 Excavating trench 2 in Mala Pecina

Figure 14 Excavating trench 1 in Mala Pecina

Figure 15 Real time 3D mapping in Mala Pecina

Figure 16 Excavating trench 3 in Mala Pecina

4. Cave plans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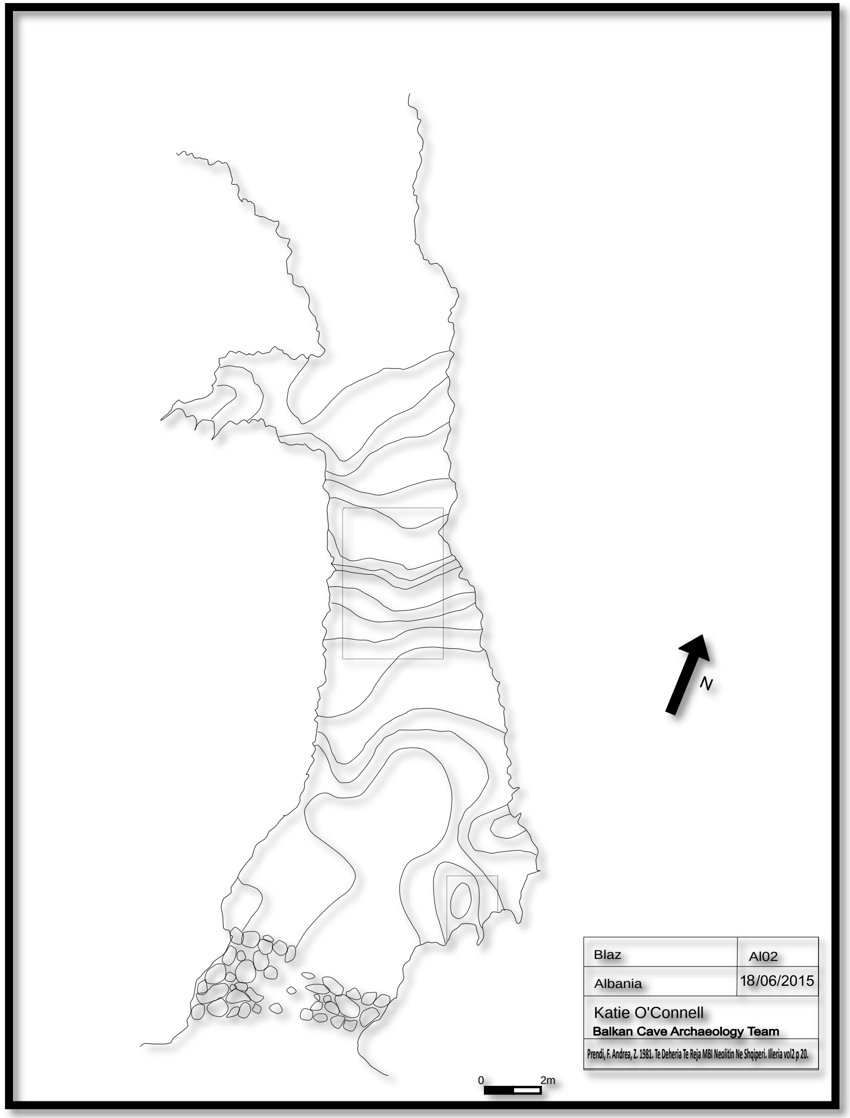
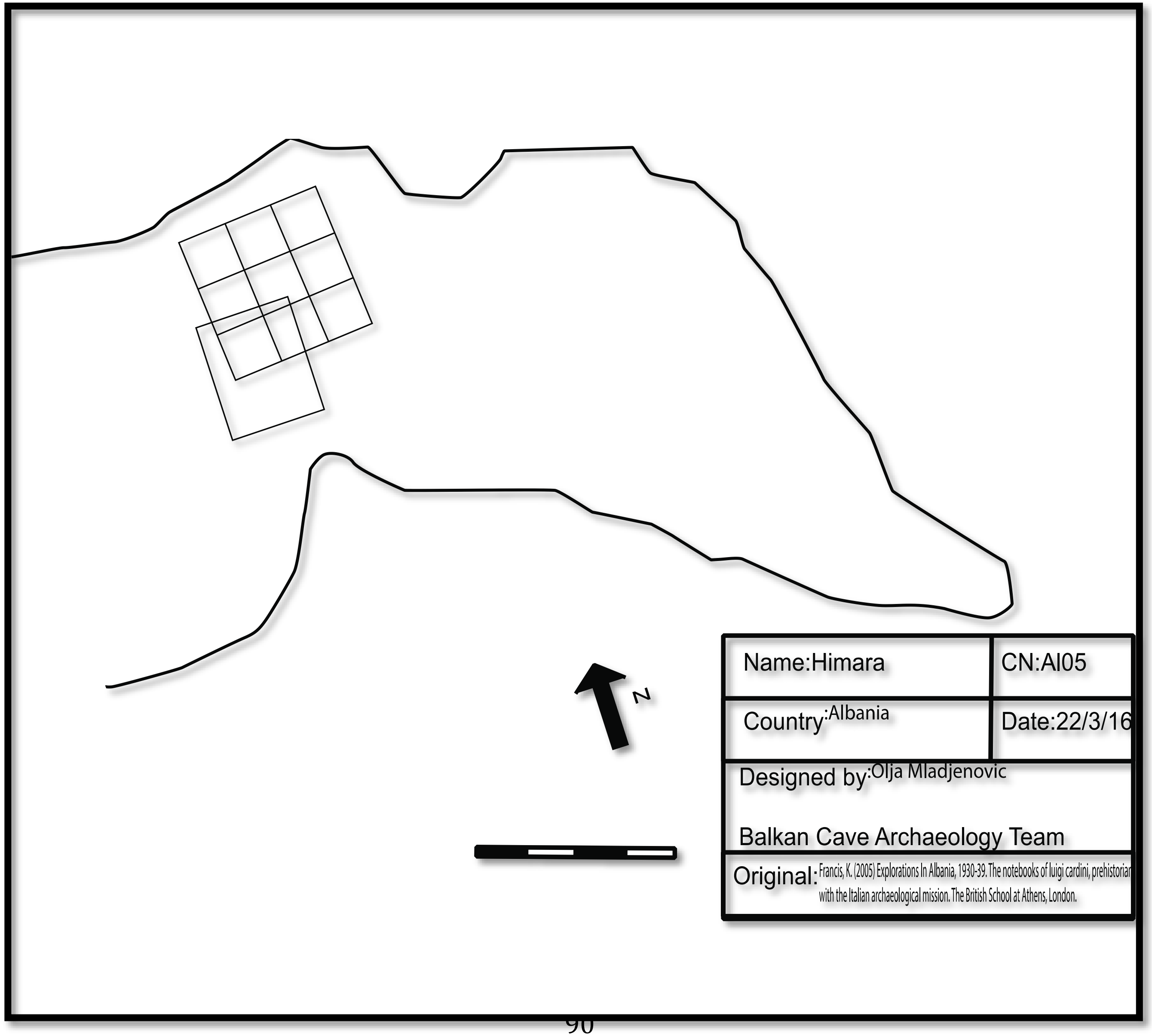
XXI
XII
X
IX
VIII
0
10 m
Konispol
AI04
Albania
10/06/2015
Katie O'Connell
Balkan Cave Archaeology
Schuldenrein, J. 2001. Stratigraphy, Sedimentology, and Site Formation at Konispol Cave, Southwest Albania. Geoarchaeology: An International Journal, 16 (5), 559– 602.


N
0
2m
Blaz
Al02
Albania
18/06/2015
Katie O'Connell
Balkan Cave Archaeology Team
Prendi, F. Andrea, Z. 1981. Te Deheria Te Reja MBI Neolitin Ne Shqiperi. Illeria vol2 p 20.



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Country:Albania
Date:22/3/16
Designed by:Olja Mladjenovic
Balkan Cave Archaeology Team
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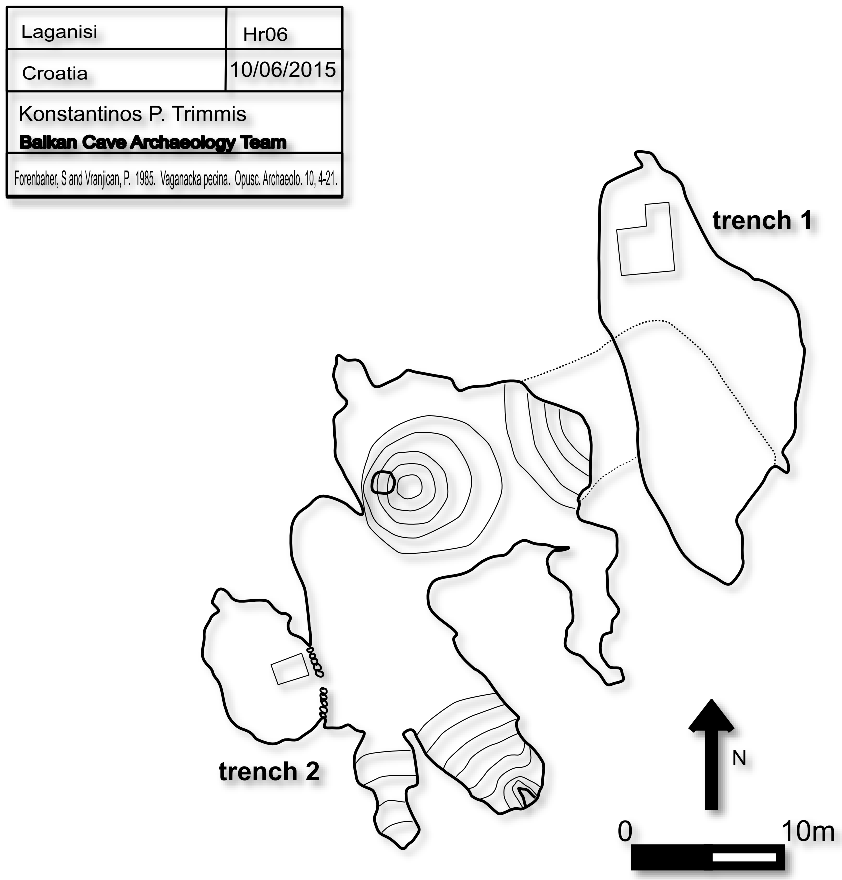
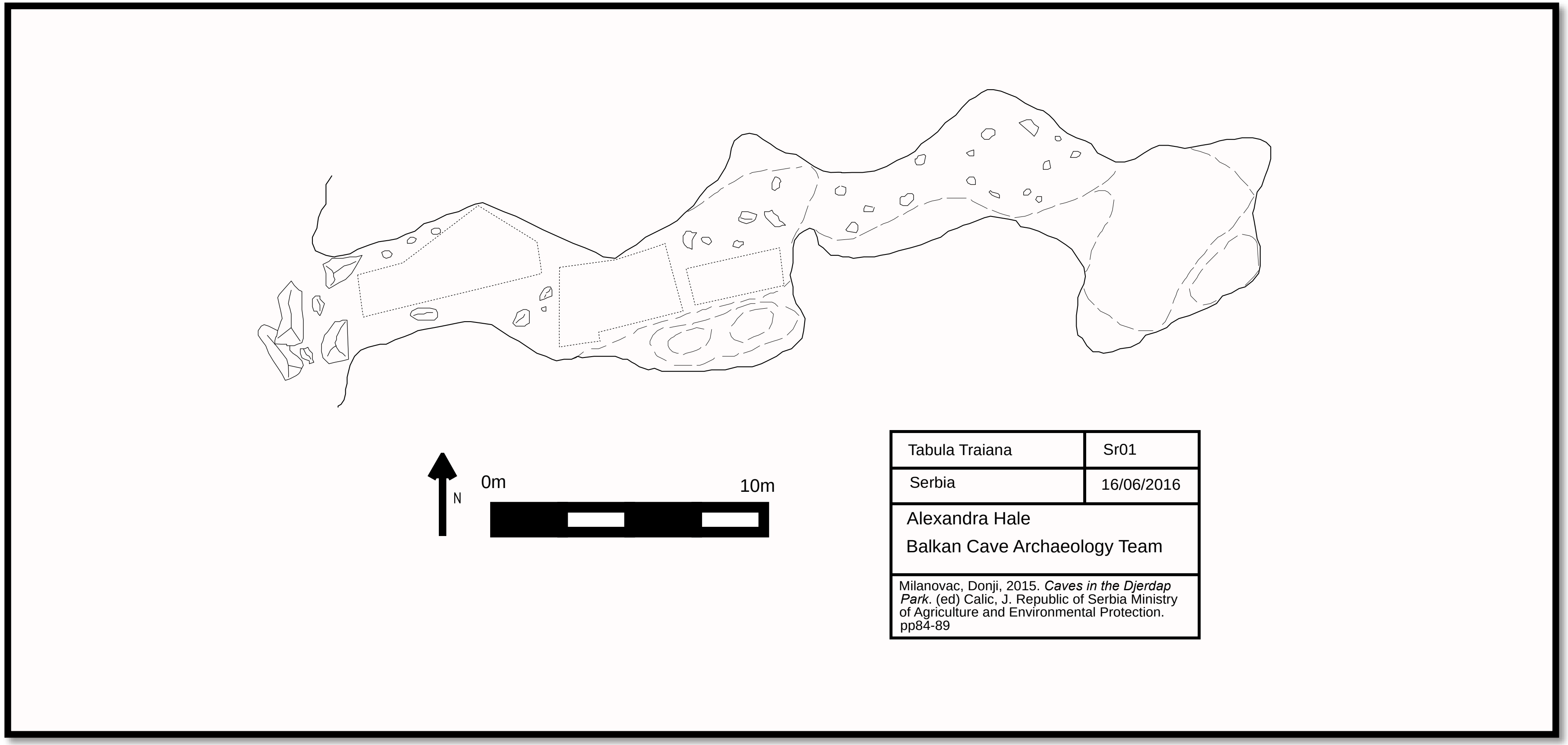
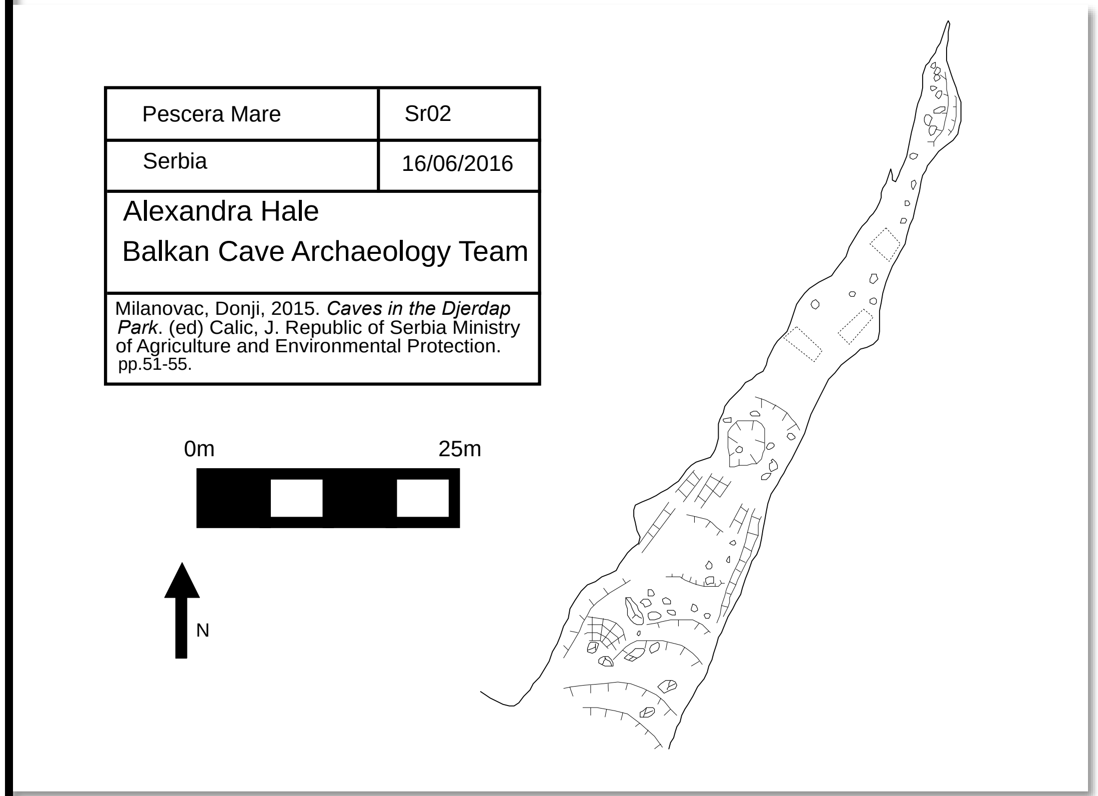
with the Italian archaeological mission. The British School at Athens, London.


Laganisi
Hr06
Croatia
10/06/2015
Konstantinos P. Trimmis
Balkan Cave Archaeology Team
Forenbaher, S and Vranjican, P. 1985. Vaganacka pecina. Opusc. Archaeolo. 10, 4-21.
trench 1
trench 2
N
0
10m



N
0m
10m
Tabula Traiana
Sr01
Serbia
16/06/2016
Alexandra Hale
Balkan Cave Archaeology Team
Milanovac, Donji, 2015. *Caves in the Djerdap Park*. (ed) Calic, J. Republic of Serbia Ministry of Agriculture and Environmental Protection. pp84-89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Sr02
Serbia
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Balkan Cave Archaeology Team
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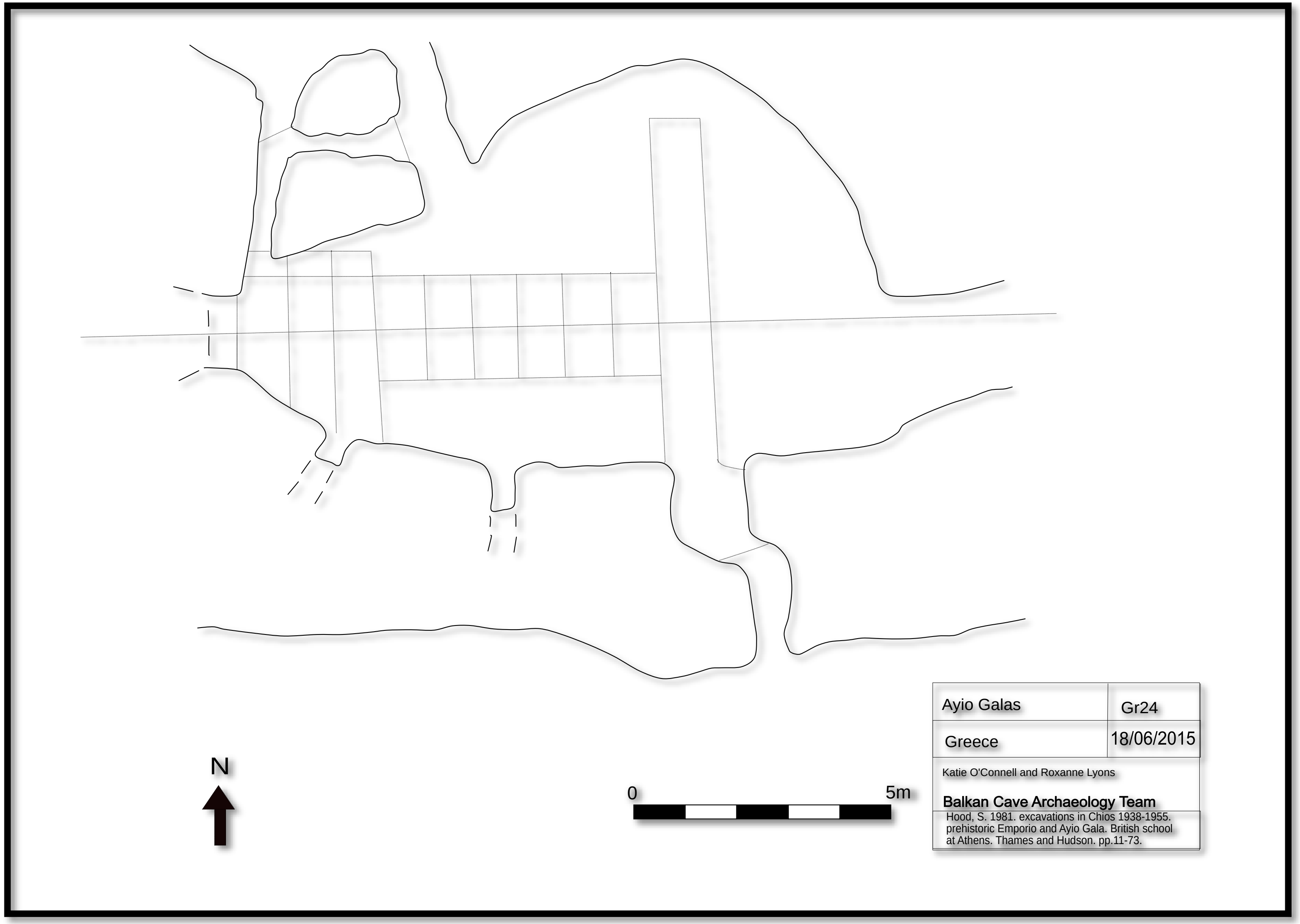
0m
25m
N



Ayio Galas
Gr24
Greece
18/06/2015
Katie O'Connell and Roxanne Lyons
Balkan Cave Archaeology Team
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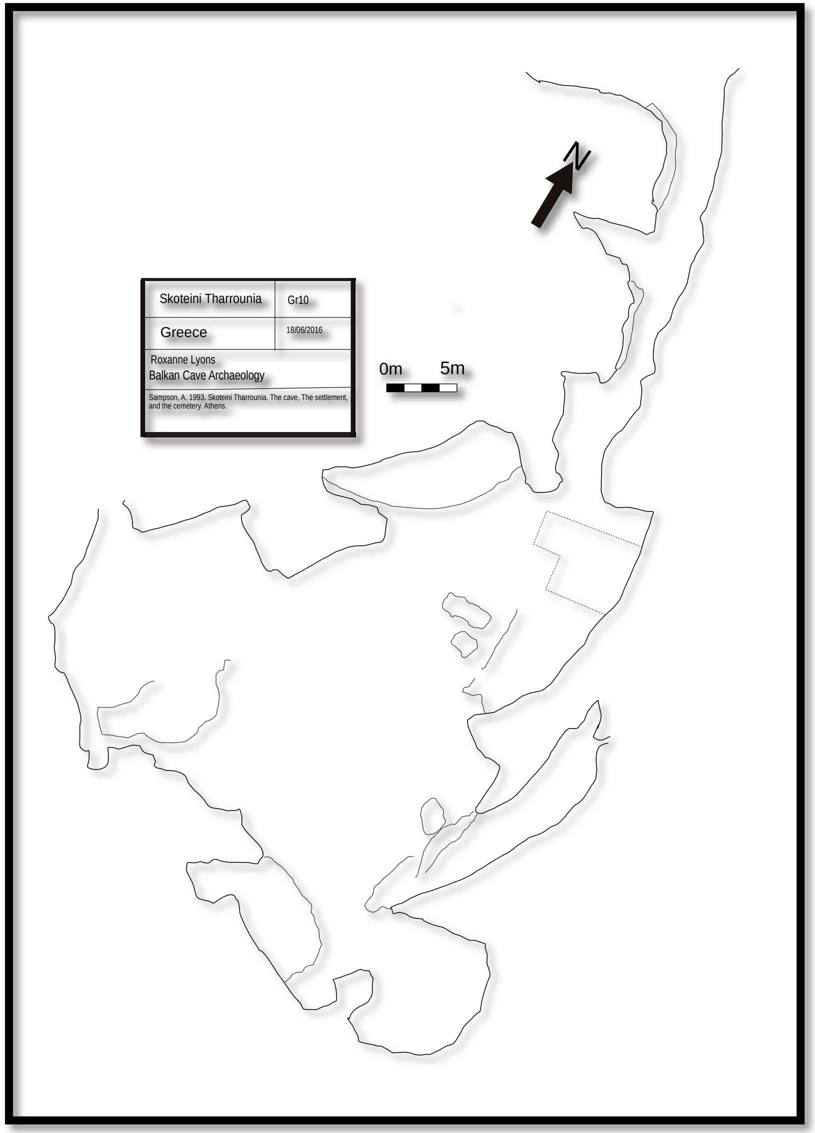
Skoteini Tharrounia
Gr10
Greece
18/06/2016
Roxanne Lyons
Balkan Cave Archaeology
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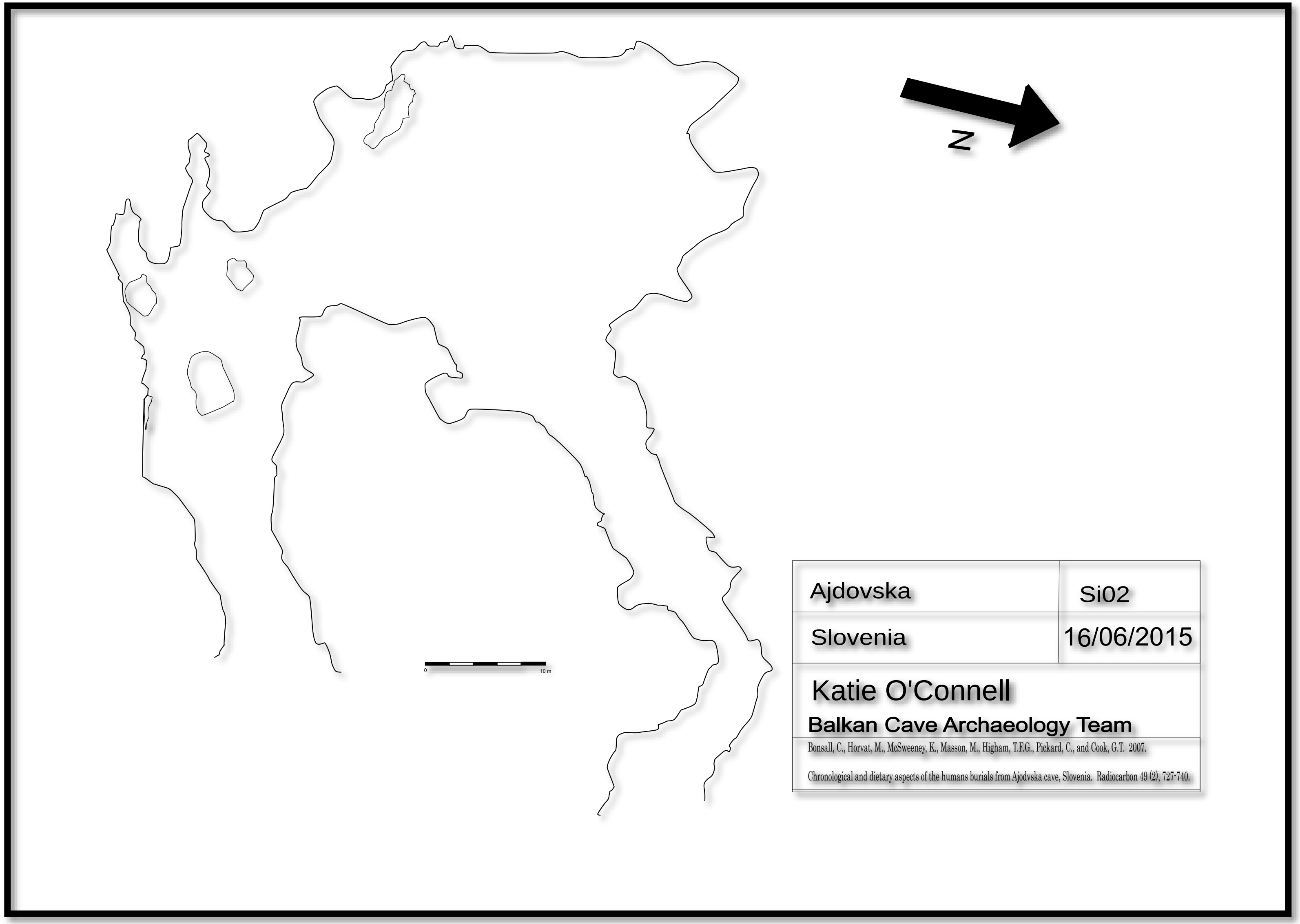
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Ajdovska
Si02
Slovenia
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Katie O'Connell
Balkan Cave Archaeology Team
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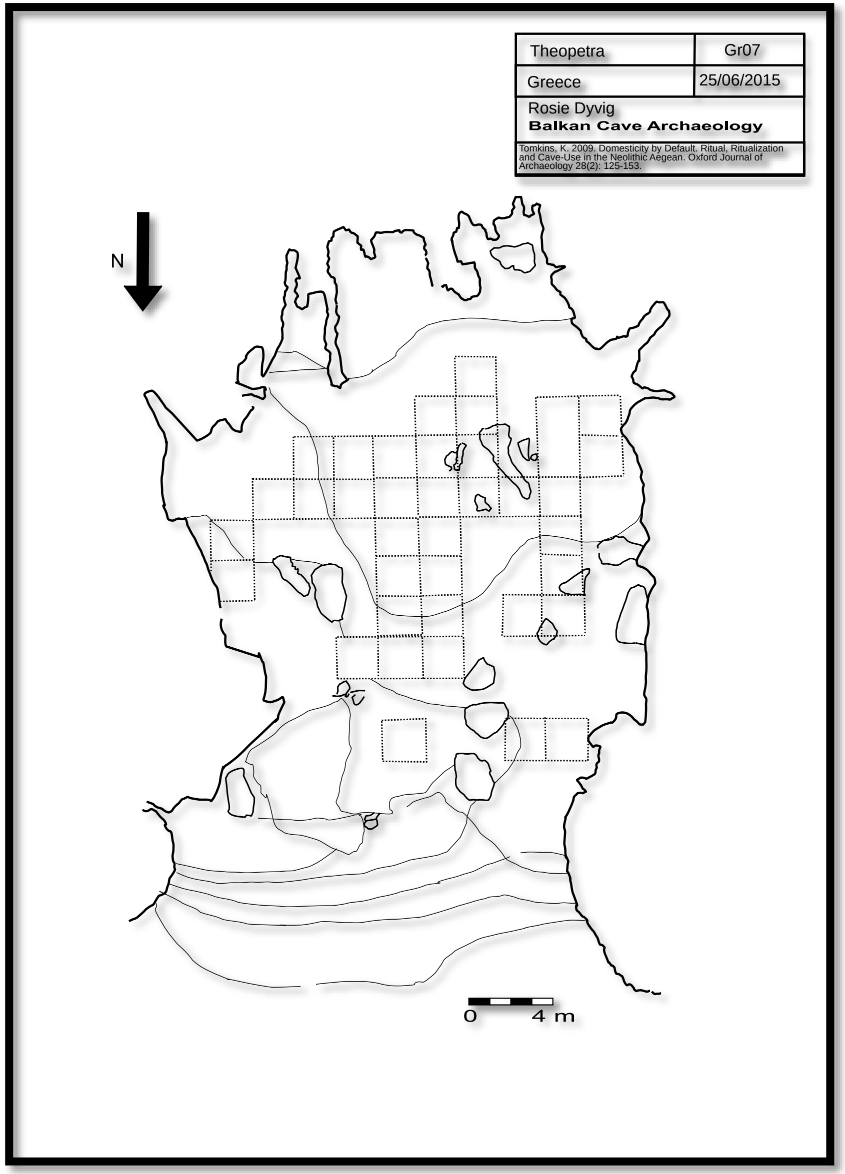
Chronological and dietary aspects of the humans burials from Ajodvska cave, Slovenia. Radiocarbon 49 (2), 727-740.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Rosie Dyvig
Balkan Cave Archaeology
Tomkins, K. 2009. Domesticity by Default. Ritual, Ritualization and Cave-Use in the Neolithic Aegean. Oxford Journal of Archaeology 28(2): 125-153.
N
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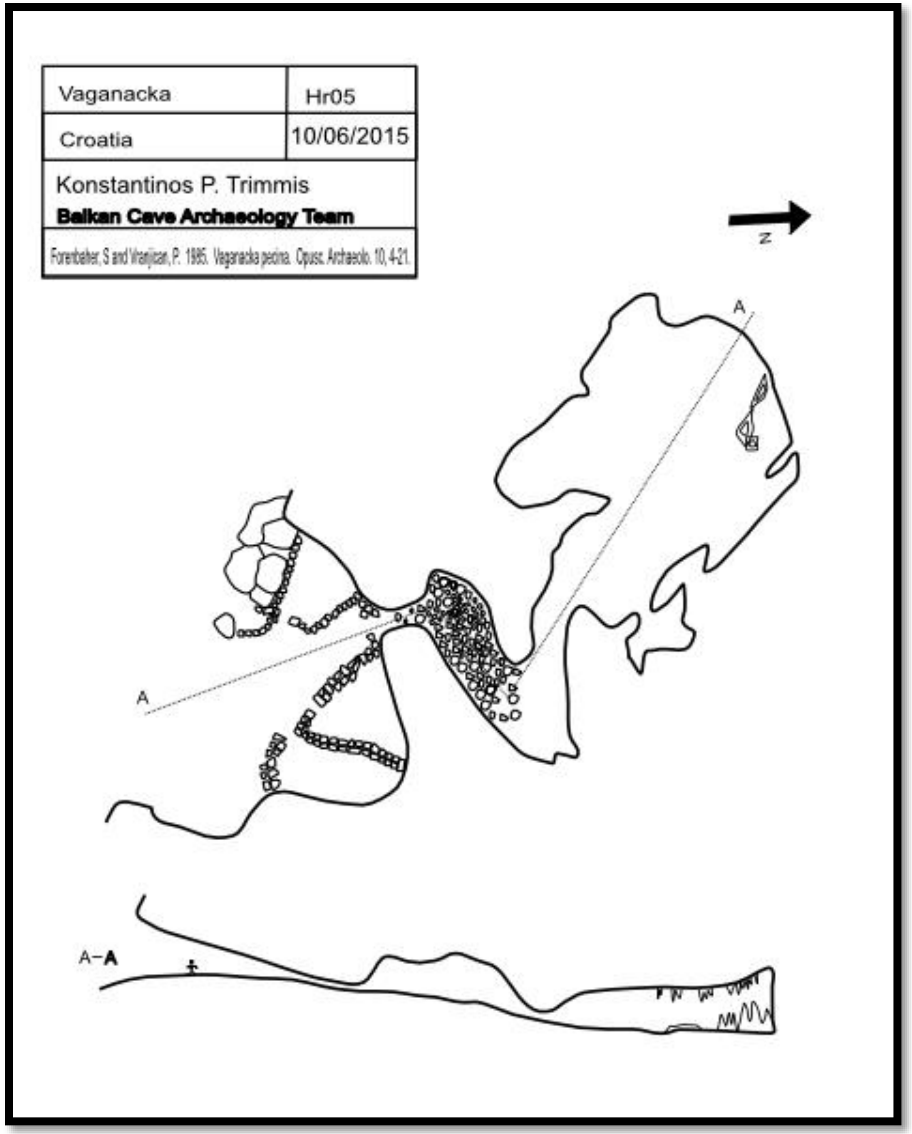
4 m



Vaganacka
Hr05
Croatia
10/06/2015
Konstantinos P. Trimmis
Balkan Cave Archaeology Team
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A
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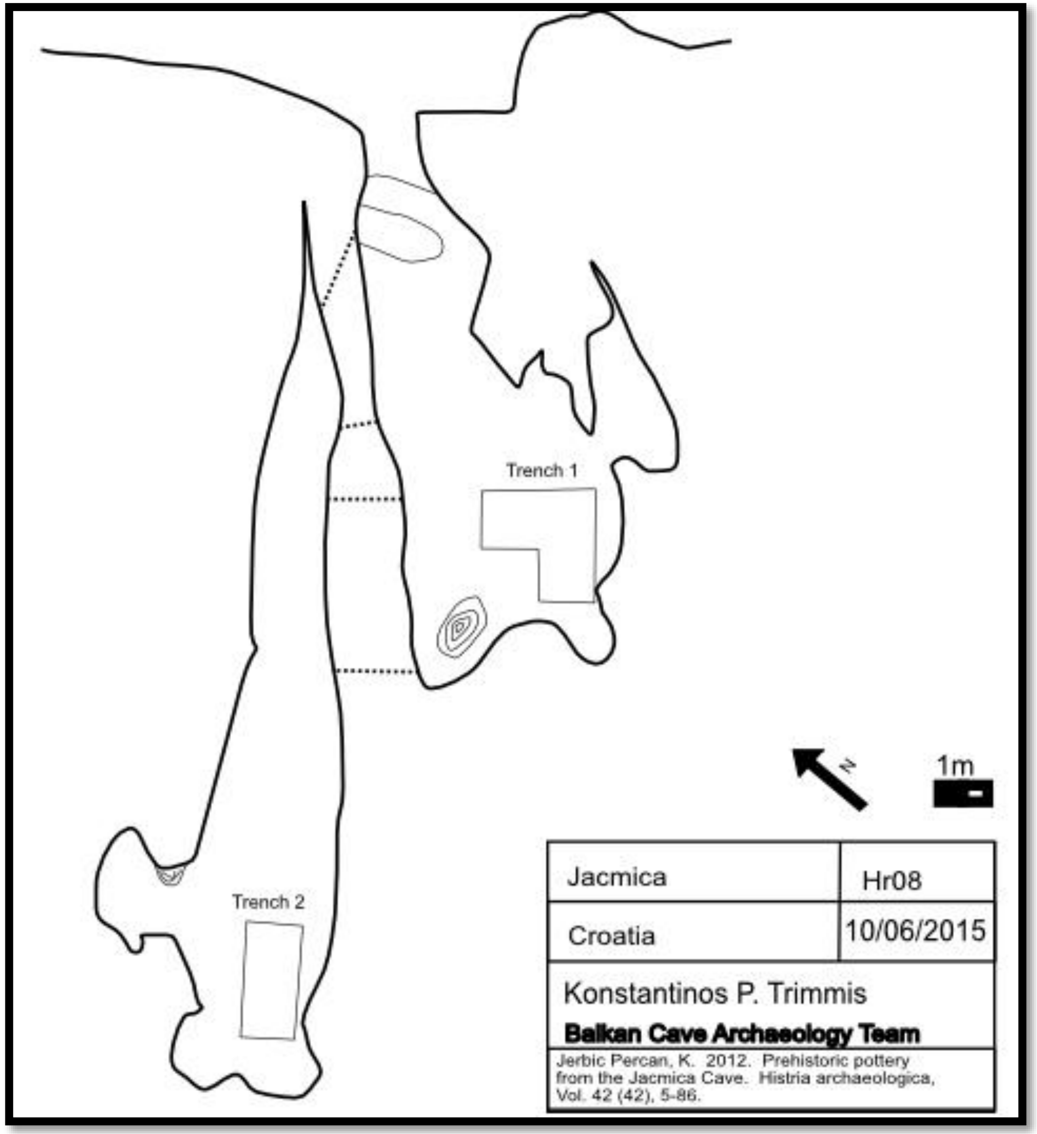
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Jacmica
Hr08
Croatia
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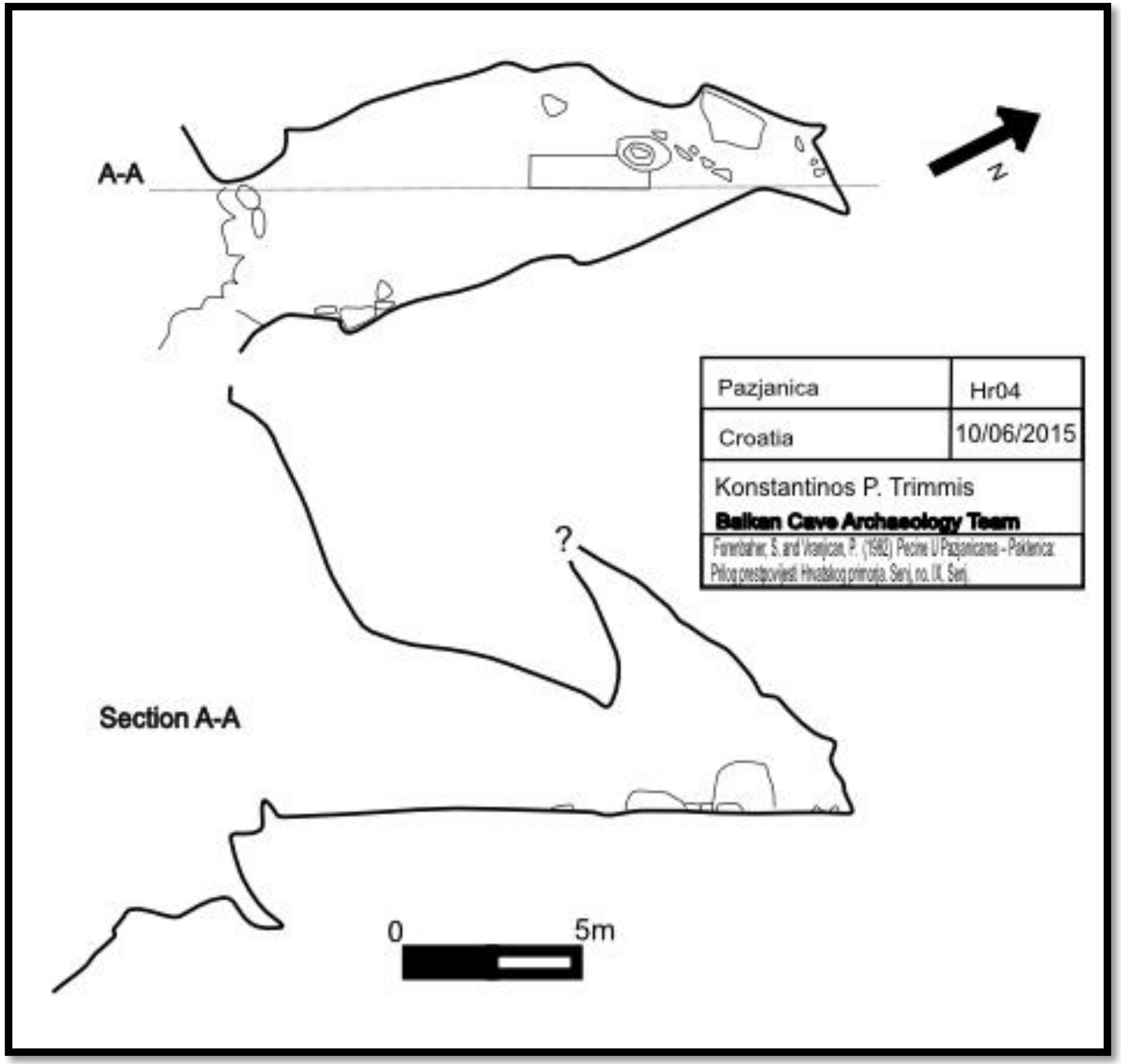
Konstantinos P. Trimmis
Balkan Cave Archaeology Team
Jerbic Percan, K. 2012. Prehistoric pottery from the Jacmica Cave. Histria archaeologica, Vol. 42 (42), 5-86.


A-A
Section A-A
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5m
?
N
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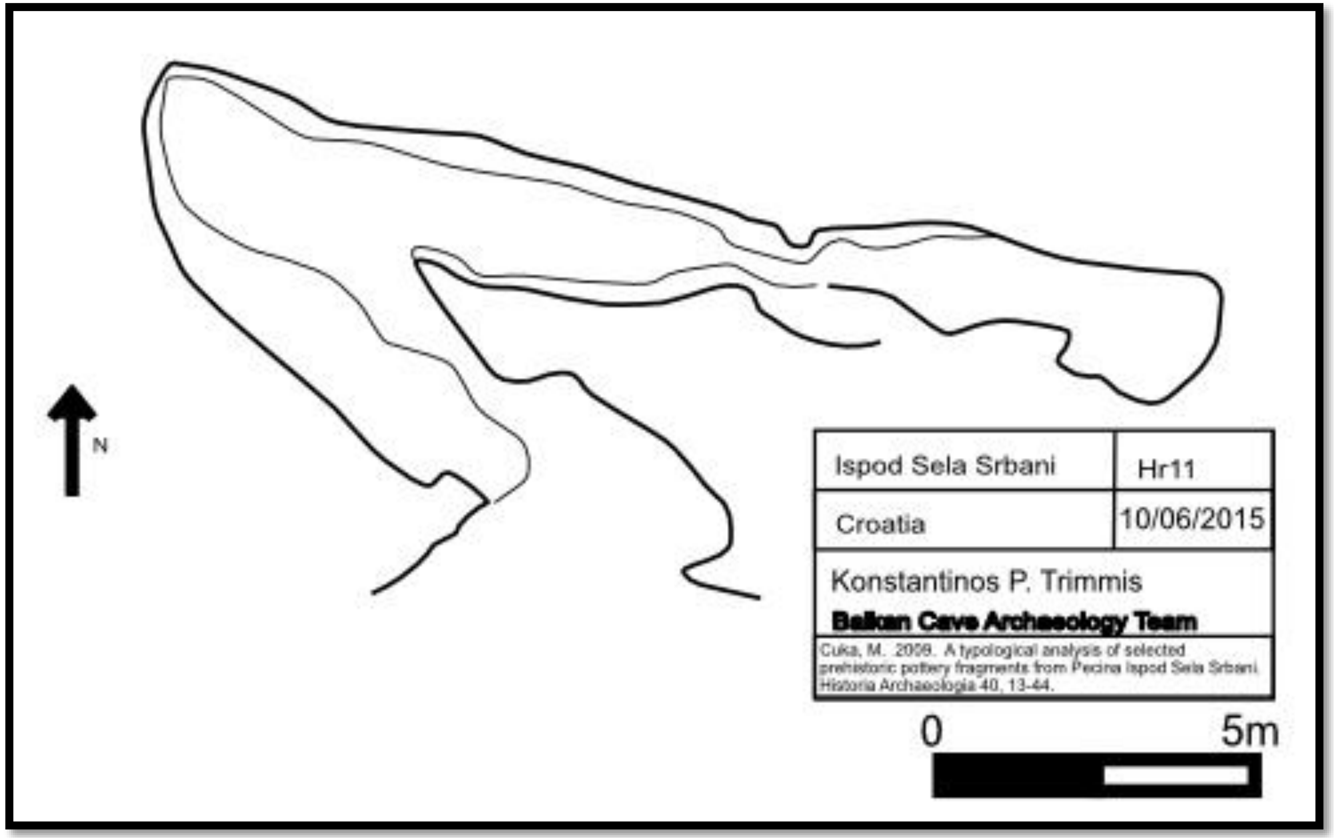
Croatia
10/06/2015
Konstantinos P. Trimmis
Balkan Cave Archaeology Team
Forenbaher, S. and Vranjican, P. (1982) Pecine U Pazjanicama – Paklenica: Prilog prestpovijesti Hrvatskog primorja. Senj, no. IX. Senj.



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Ispod Sela Srbani
Hr11
Croatia
10/06/2015
Konstantinos P. Trimmis
Balkan Cave Archaeology Team
Cuka, M. 2009. A typological analysis of selected prehistoric pottery fragments from Pecina Ispod Sela Srbani. Historia Archaeologia 40, 13-44.
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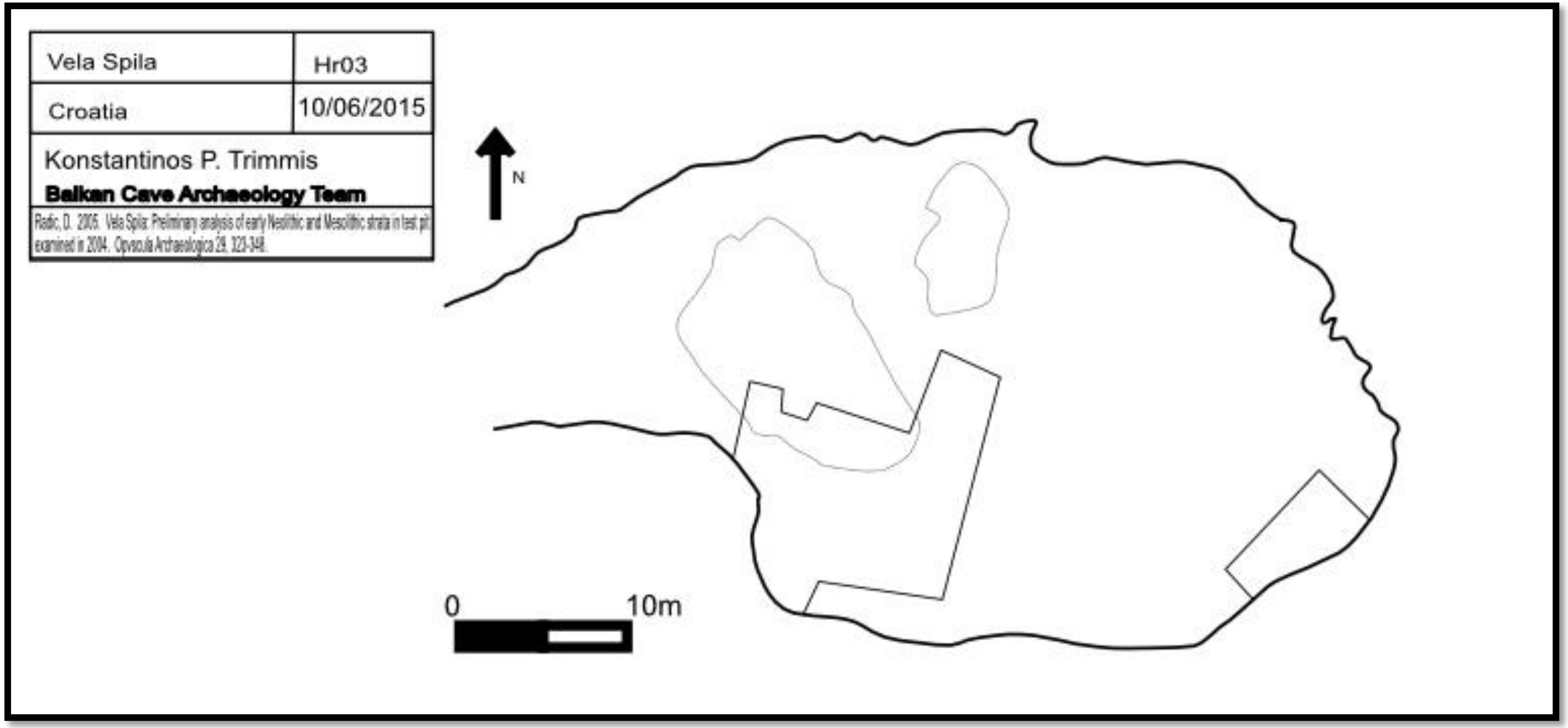
Vela Spila
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Konstantinos P. Trimmis
Balkan Cave Archaeology Team
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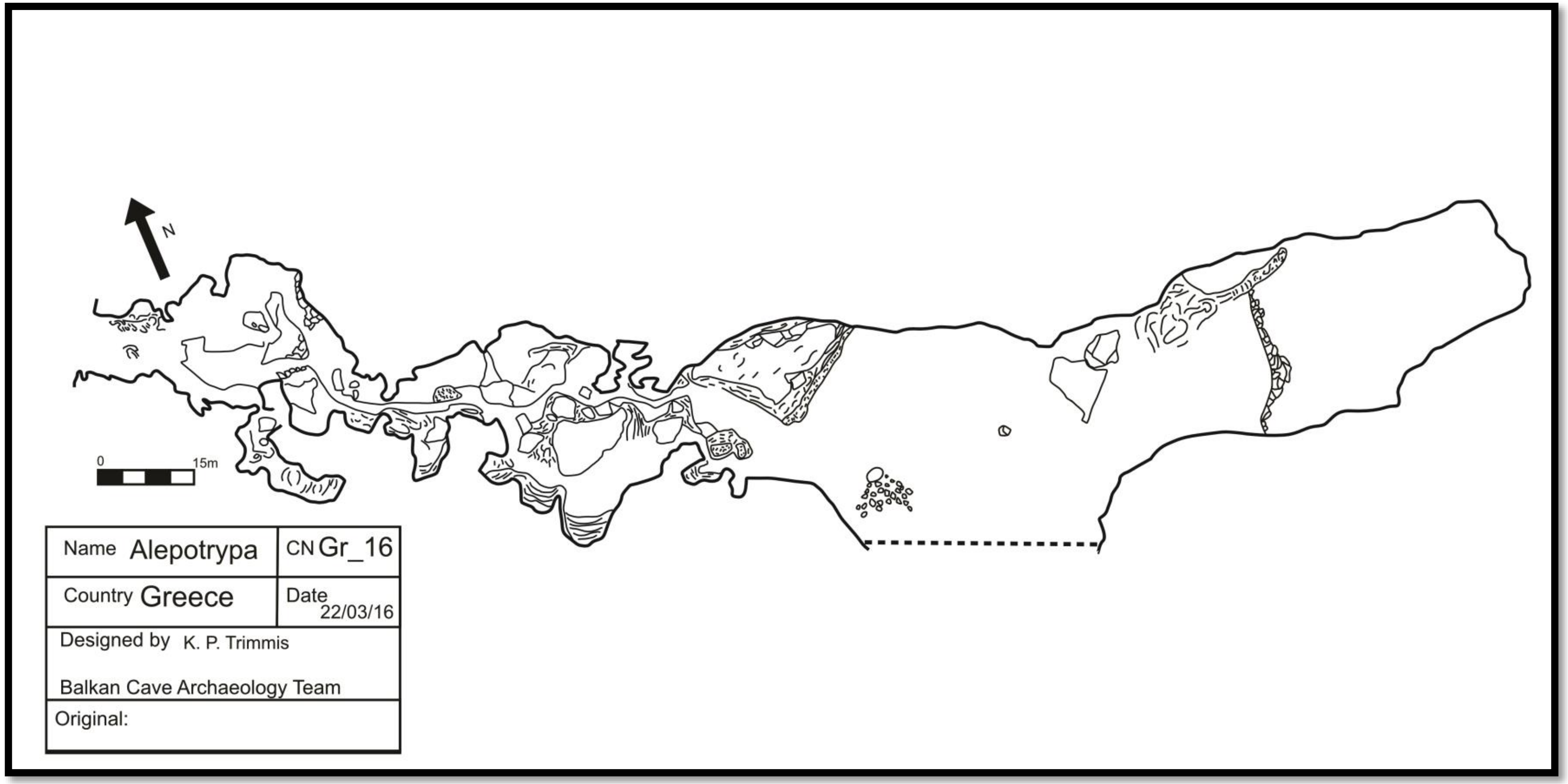
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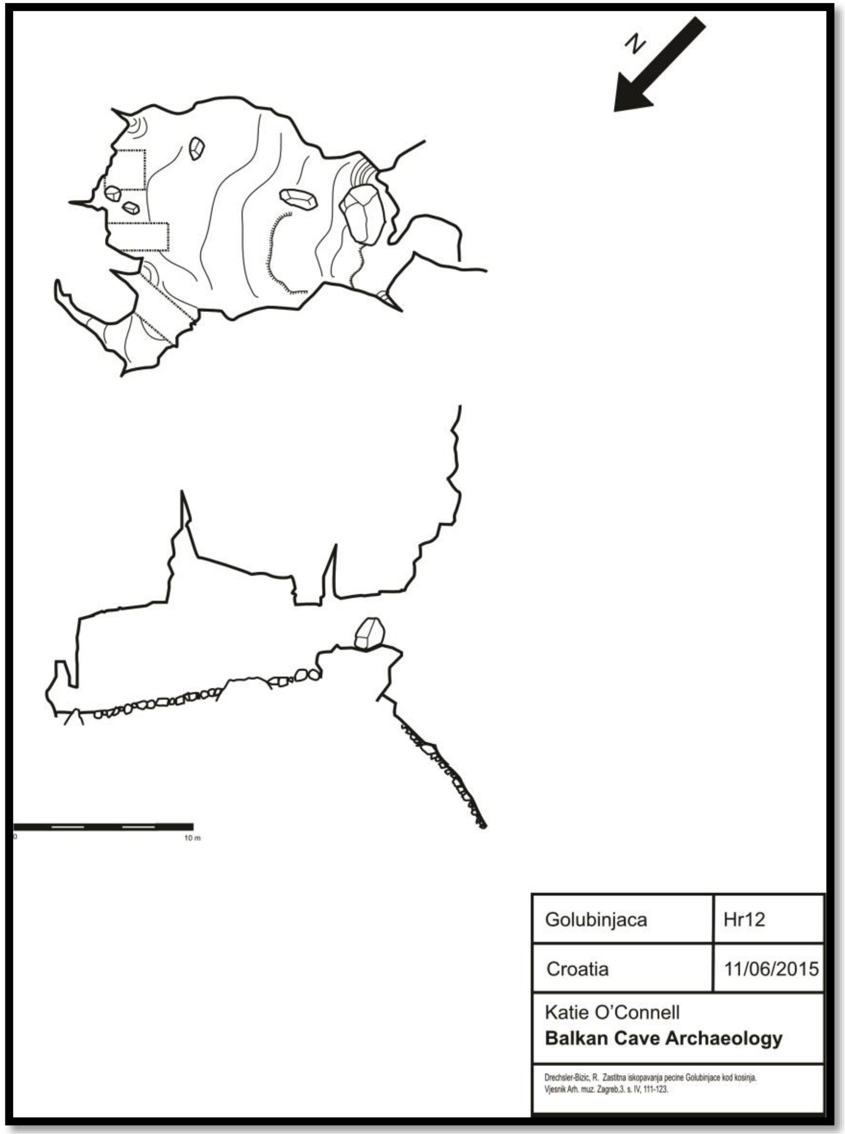
Country Greece
Date 22/03/16
Designed by K. P. Trimmis
Balkan Cave Archaeology Team
Original: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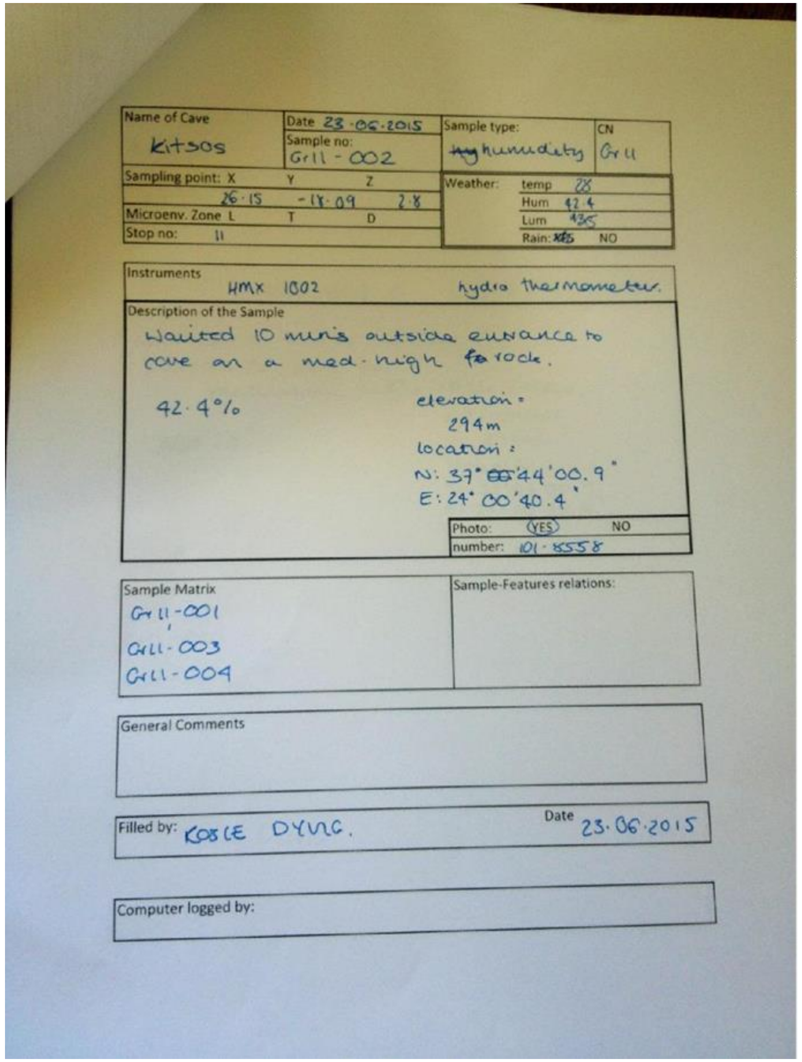
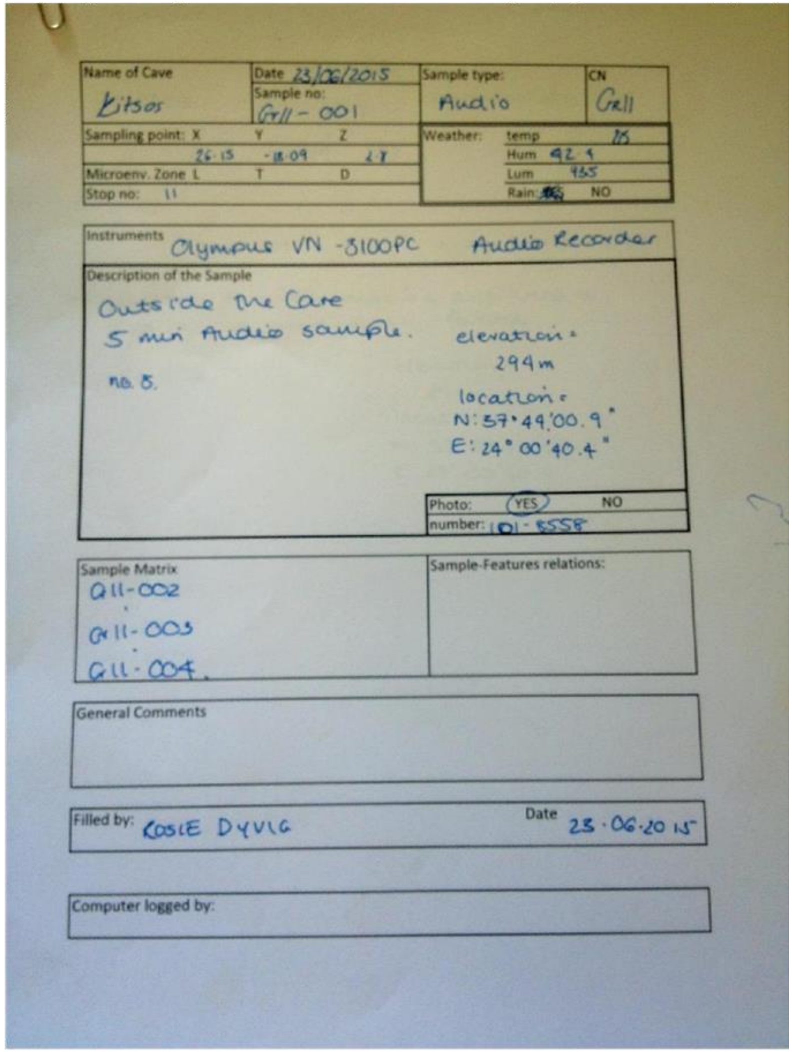
10 m
Golubinjaca
Hr12
Croatia
11/06/2015
Katie O'Connell
Balkan Cave Archaeology
Drechsler-Bizic, R. Zastitna iskopavanja pecine Golubinjace kod kosinja.
Vjesnik Arh. muz. Zagreb.3. s. IV, 111-123.

5. Examples of cave sampling sheets

Kitsos



Name of Cave: Kitsos
Date: 23-06-2015
Sample no: Grll-002
Sample type: ~~hy~~ humidity
CN: Grll
Sampling point: X 26.15 Y -18.09 Z 2.8
Microenv. Zone L T D
Stop no: 11
Weather: temp 28; Hum 42.4; Lum 435; Rain: YES NO
Instruments: HMX 1802 hydro thermometer.
Description of the Sample: Waited 10 mins outside entrance to cave on a med-high fa rock.
42.4%
elevation: 294m
location: N: 37° ~~00~~ 44'00.9" E: 24° 00'40.4"
Photo: YES NO
number: 101-8558
Sample Matrix: Grll-001, Grll-003, Grll-004
Sample-Features relations:
General Comments
Filled by: Kosie Dyvic.
Date: 23.06.2015
Computer logged by:



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Date: 23/06/2015
Sample no: Grll-001
Sample type: Audio
CN: Grll
Sampling point: X 26.15 Y -18.09 Z 2.8
Microenv. Zone L T D
Stop no: 11
Weather: temp 28; Hum 42.4; Lum 435; Rain: YES NO
Instruments: Olympus VN-8100PC Audio Recorder
Description of the Sample: Outside the Cave 5 min Audio sample.
no. 5.
elevation: 294m
location: N: 37° 44'00.9" E: 24° 00'40.4"
Photo: YES NO
number: 101-8558
Sample Matrix: Grll-002, Grll-003, Grll-004.
Sample-Features relations:
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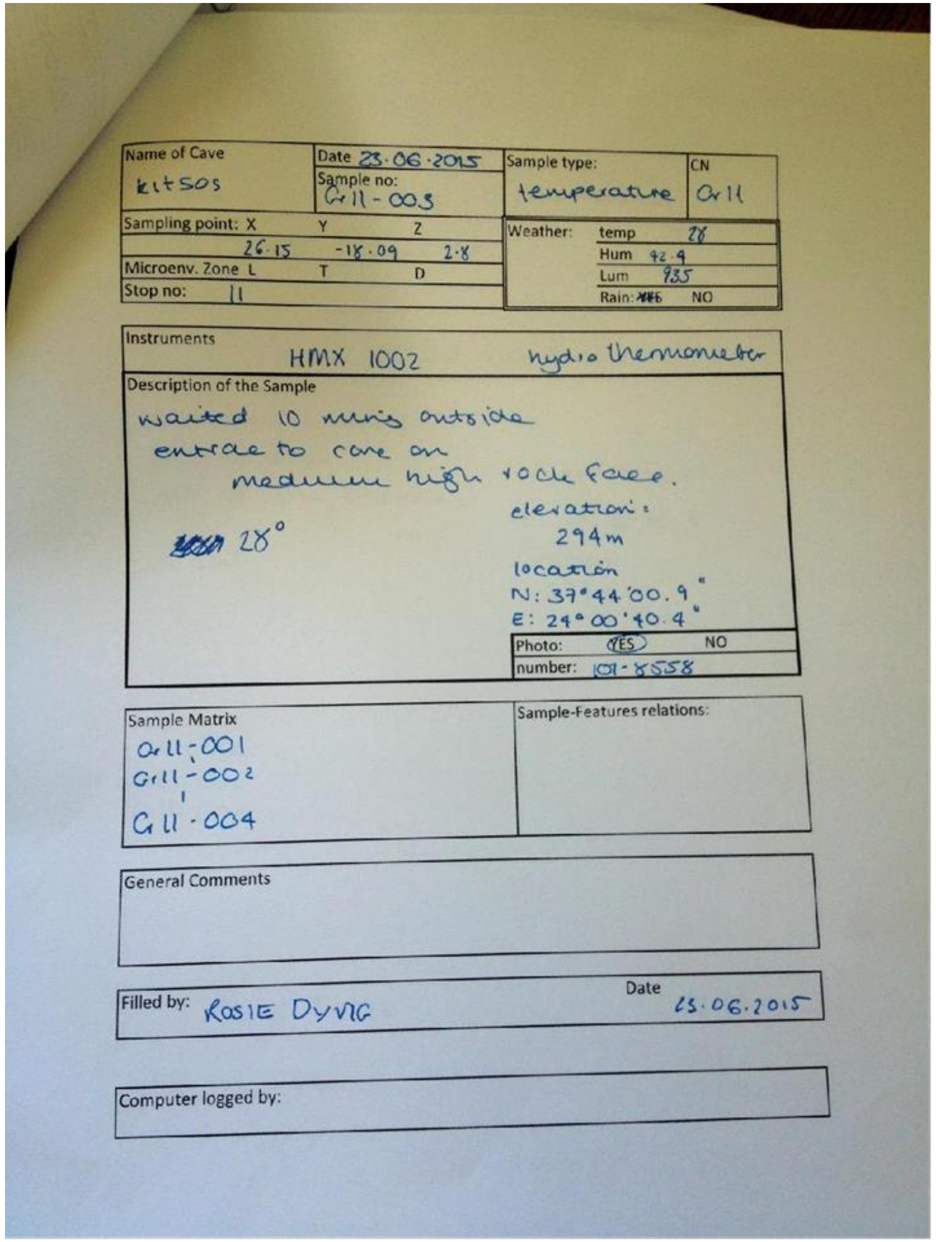
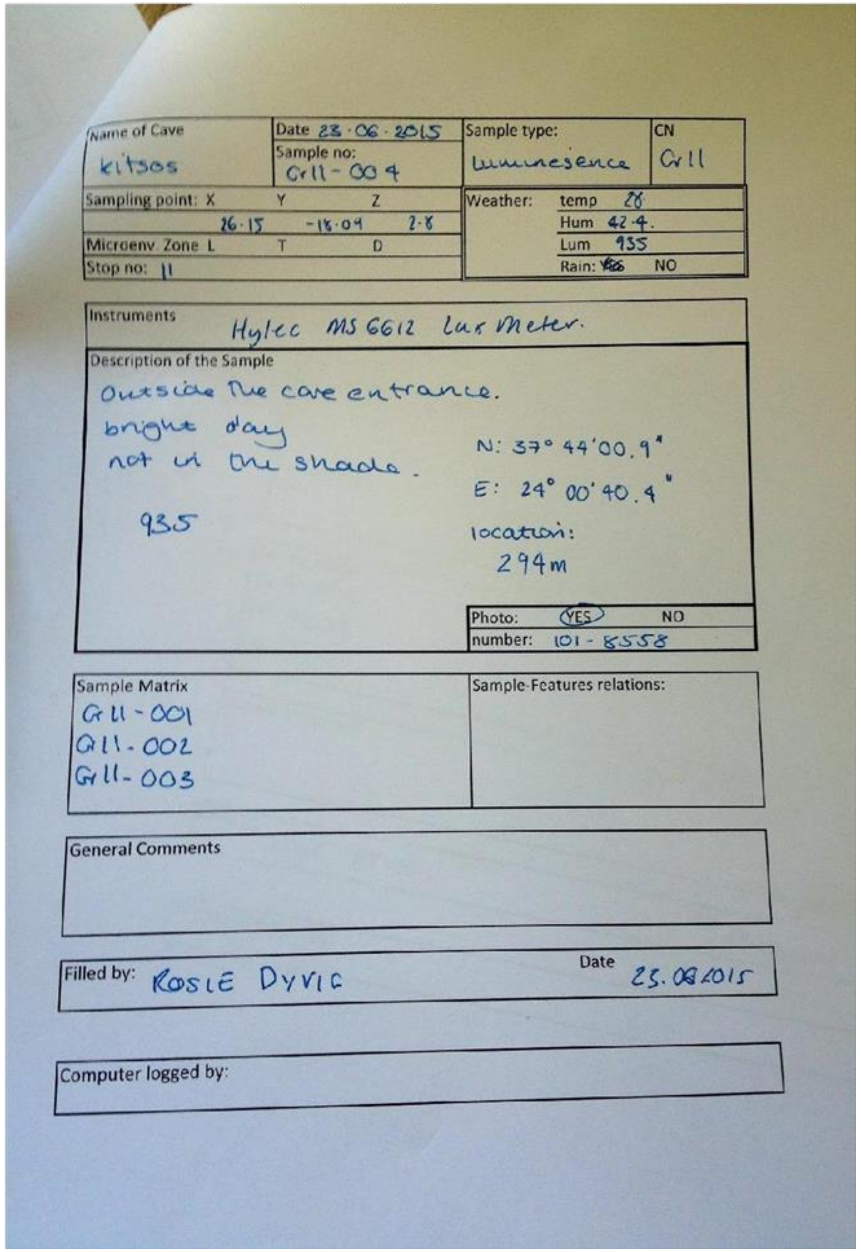
Filled by: Kosie Dyvic
Date: 23.06.2015
Computer logged by:


Name of Cave: kitsos
Date 23.06.2015
Sample no: Gr11-003
Sample type: temperature
CN: Gr11
Sampling point: X 26.15 Y -18.09 Z 2.8
Microenv. Zone L T D
Stop no: 11
Weather: temp 28
Hum 42.4
Lum 935
Rain: ~~YES~~ NO
Instruments: HMX 1002 hydro thermometer
Description of the Sample
waited 10 mins outside
entrance to cave on
medium high rock face.
elevation:
294m
~~[illegible]~~ 28°
location
N: 37°44'00.9"
E: 24°00'40.4"
Photo: YES NO
number: 101-8558
Sample Matrix
Gr11-001
Gr11-002
Gr11-004
Sample-Features relations:
General Comments
Filled by: ROSIE DYVIG
Date 23.06.2015
Computer logged by: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Date 23.06.2015
Sample no: Gr11-004
Sample type: luminesence
CN: Gr11
Sampling point: X 26.15 Y -18.09 Z 2.8
Microenv. Zone L T D
Stop no: 11
Weather: temp 28
Hum 42.4.
Lum 935
Rain: ~~YES~~ NO
Instruments: Hylec MS 6612 Lux Meter.
Description of the Sample
Outside the cave entrance.
bright day
not in the shade.
N: 37° 44'00.9"
E: 24° 00'40.4"
935
location:
294m
Photo: YES NO
number: 101-8558
Sample Matrix
Gr11-001
Gr11-002
Gr11-003
Sample-Features relations:
General Comments
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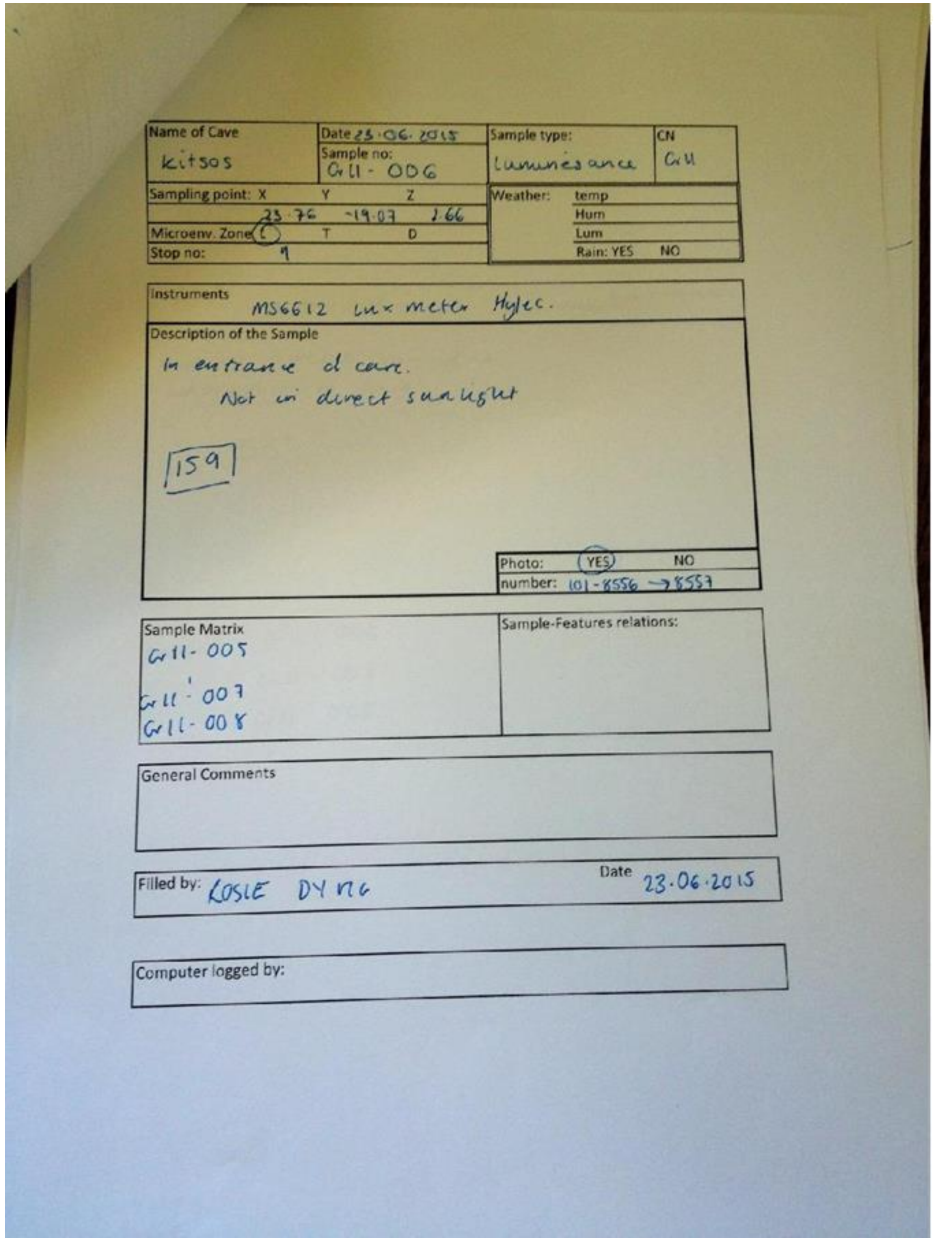
Date 23.06.2015
Computer logged by:



Name of Cave: kitsos	Date 23.06.2015 / Sample no: Gr11 - 006	Sample type: Luminescance	CN: Gr11
Sampling point: X 23.76 Y -19.07 Z 2.66		Weather: temp / Hum / Lum / Rain: YES NO	
Microenv. Zone L T D			
Stop no: 9			

Instruments: MS6612 Lux meter Hytec.

Description of the Sample:
In entrance of cave.
Not in direct sunlight

159

Photo: YES NO
number: 101-8556 → 8557

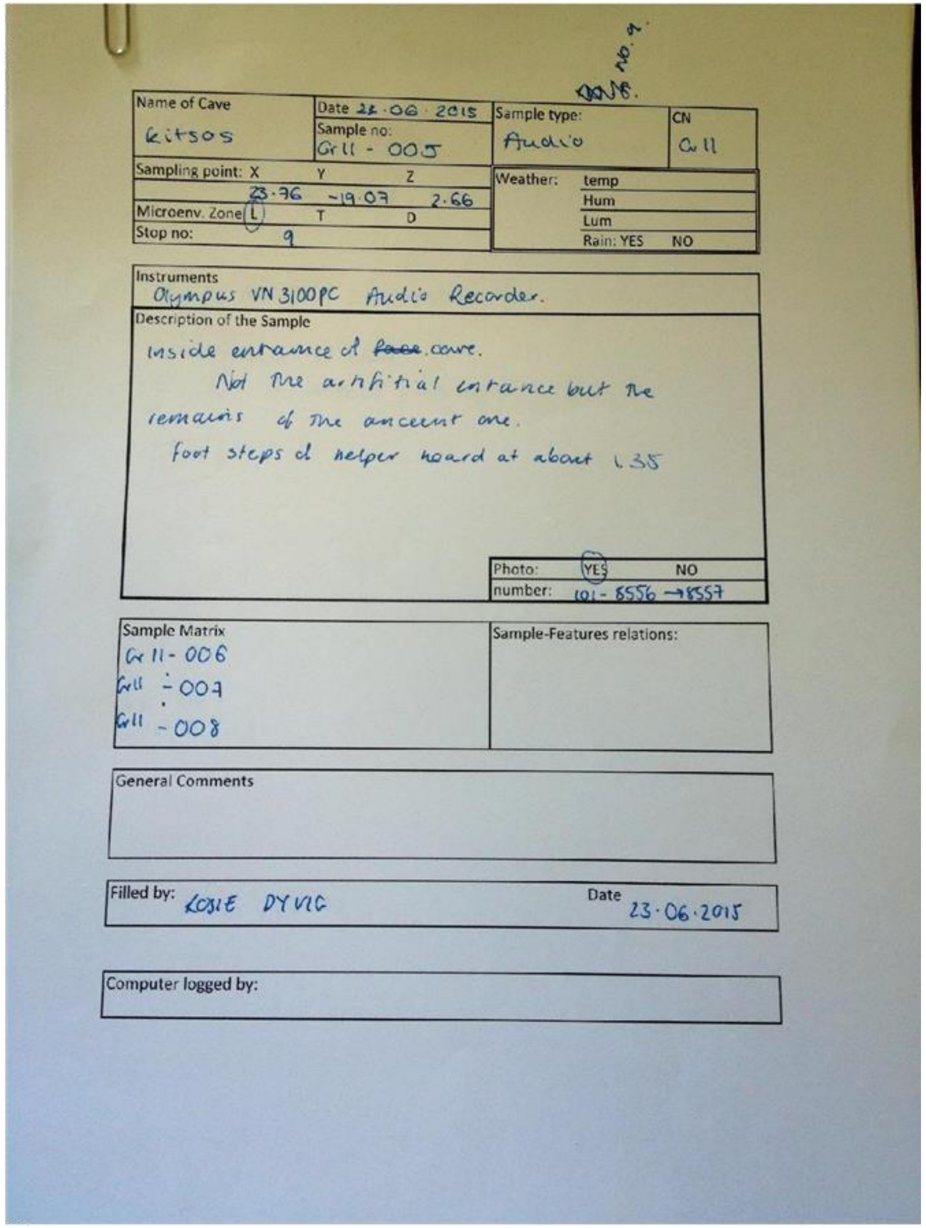
Sample Matrix:
Gr11-005
Gr11-007
Gr11-008

Sample-Features relations:

General Comments

Filled by: KOSIE DYVIG Date 23.06.2015

Computer logged by:



no. 9

Name of Cave: kitsos	Date 23.06.2015 / Sample no: Gr11 - 005	Sample type: Audio	CN: Gr11
Sampling point: X 23.76 Y -19.07 Z 2.66		Weather: temp / Hum / Lum / Rain: YES NO	
Microenv. Zone L T D			
Stop no: 9			

Instruments: Olympus VN 3100PC Audio Recorder.

Description of the Sample:
Inside entrance of ~~[illegible]~~ cave.
Not the artificial entrance but the remains of the ancient one.
Foot steps of helper heard at about 1.35

Photo: YES NO
number: 101-8556 → 8557

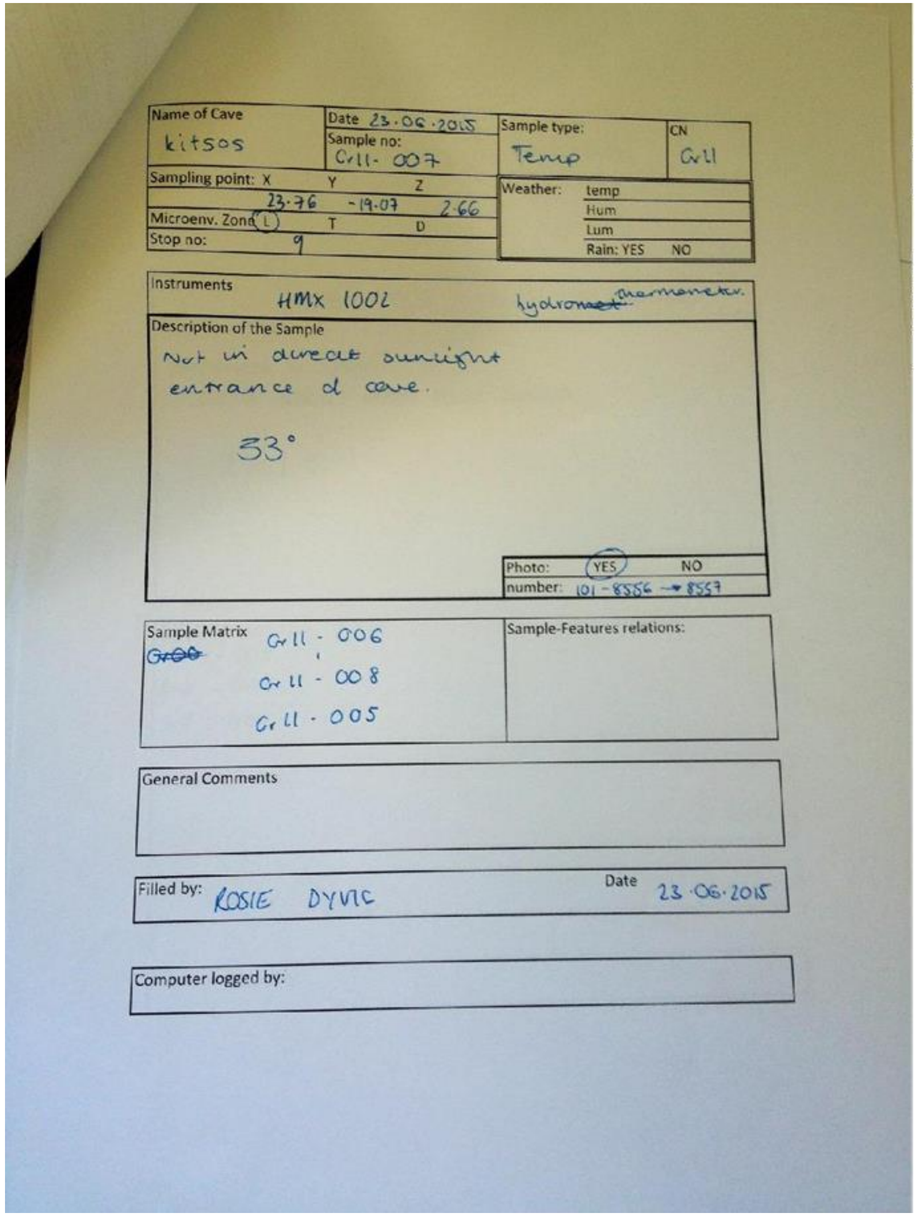
Sample Matrix:
Gr11-006
Gr11-007
Gr11-008

Sample-Features relations:

General Comments

Filled by: KOSIE DYVIG Date 23.06.2015

Computer logged by: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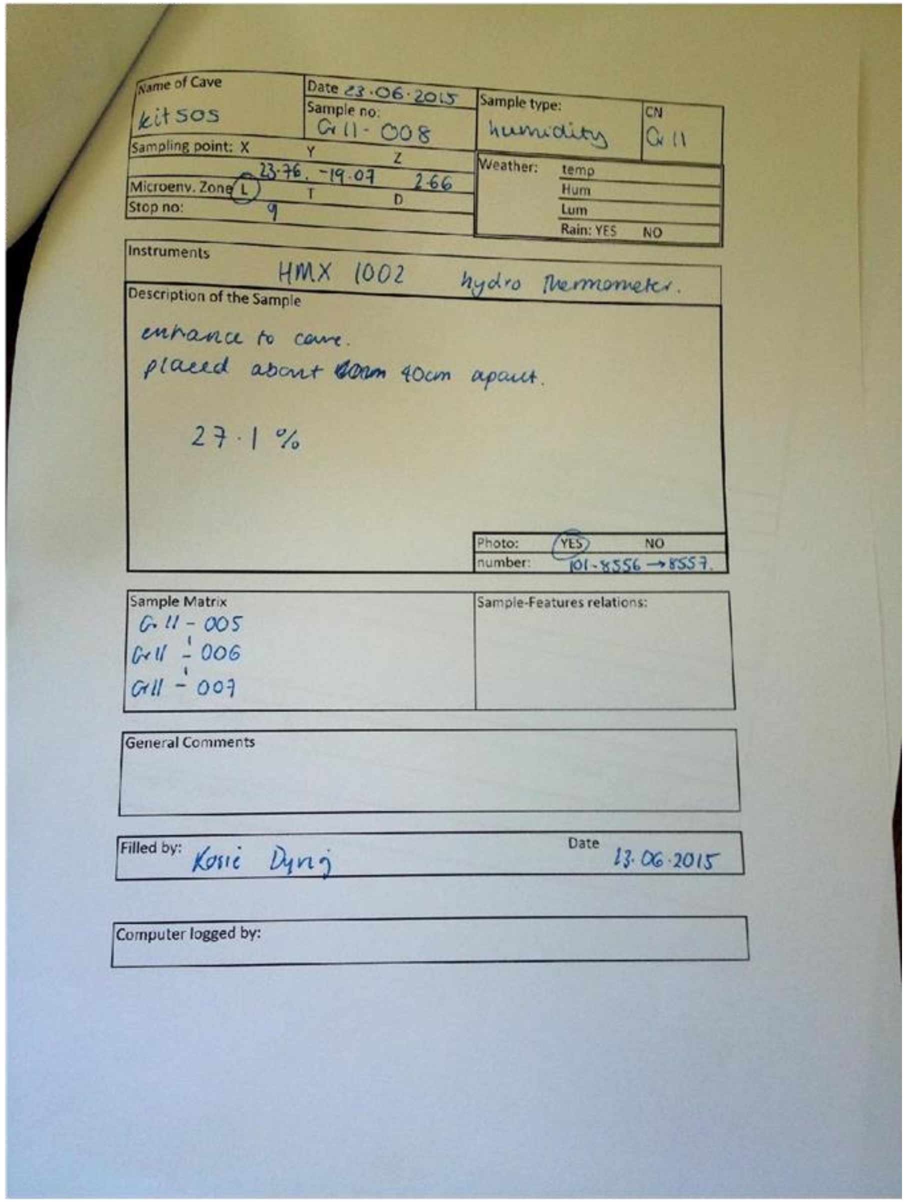
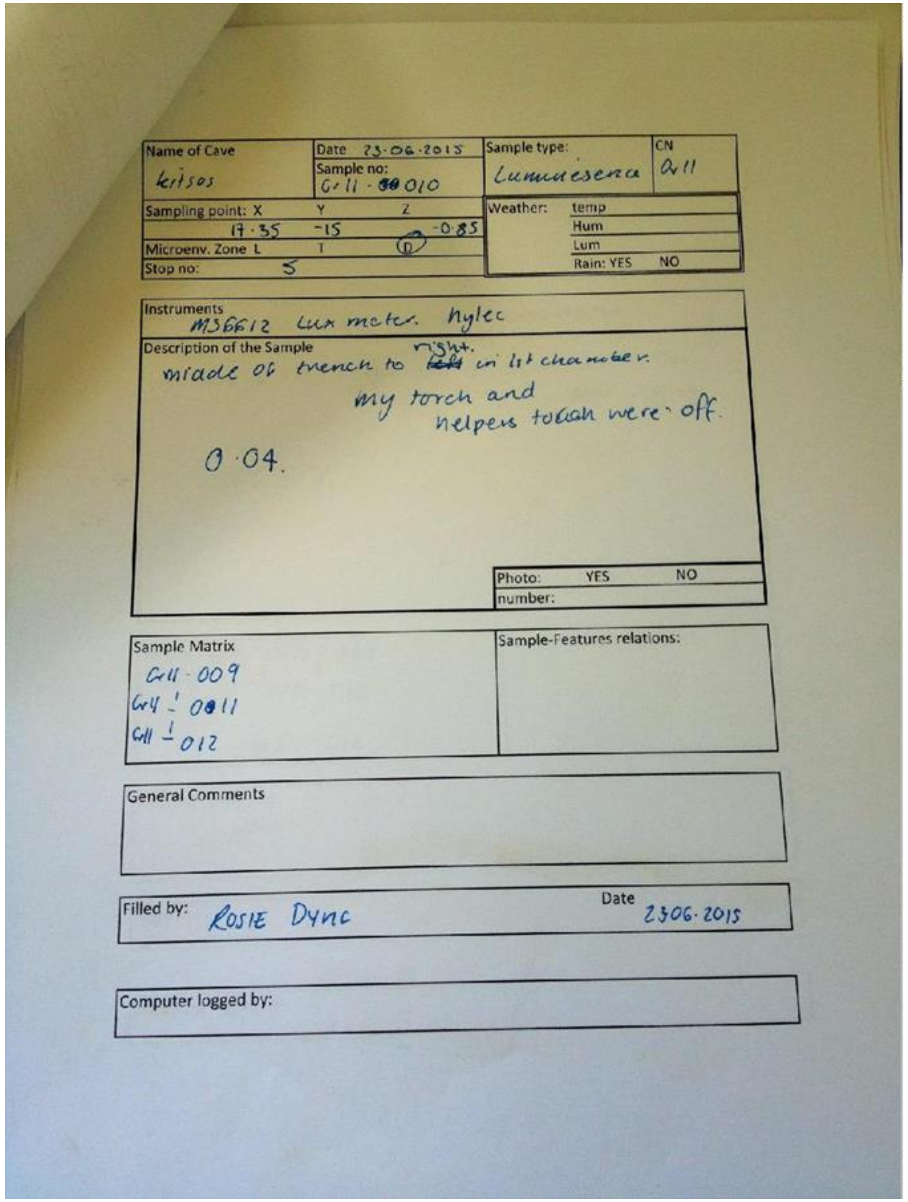
Date 23.06.2015
Sample no: Gr11- 007
Sample type: Temp
CN: Gr11
Sampling point: X Y Z
23.76 -19.07 2.66
Microenv. Zone L T D
Stop no: 9
Weather: temp
Hum
Lum
Rain: YES NO
Instruments HMX 1002 hydro~~met~~thermometer.
Description of the Sample
Not in direct sunlight
entrance of cave.
33°
Photo: YES NO
number: 101-8556 → 8557
Sample Matrix ~~Gr08~~ Gr11 - 006
Gr11 - 008
Gr11 - 005
Sample-Features relations:
General Comments
Filled by: ROSIE DYVIC
Date 23.06.2015
Computer logged by:


Name of Cave: kitsos
Date 23.06.2015
Sample no: Gr11- 008
Sample type: humidity
CN: Gr11
Sampling point: X Y Z
23.76, -19.07 2.66
Microenv. Zone L T D
Stop no: 9
Weather: temp
Hum
Lum
Rain: YES NO
Instruments HMX 1002 hydro thermometer.
Description of the Sample
entrance to cave.
placed about ~~[illegible]~~ 40cm apart.
27.1 %
Photo: YES NO
number: 101-8556 → 8557.
Sample Matrix
Gr11 - 005
Gr11 - 006
Gr11 - 007
Sample-Features relations:
General Comments
Filled by: Rosie Dyvic
Date 13.06.2015
Computer logged by:



Name of Cave	Date 23-06-2015	Sample type:	CN
kitsos	Sample no: Gr11 - ~~00~~ 010	Luminescence	Gr11
Sampling point: X 17.35	Y -15	Z -0.85	Weather: temp / Hum / Lum / Rain: YES NO
Microenv. Zone L	T	D	
Stop no: 5			

Instruments
M3GG12 Lux meter. hylec

Description of the Sample
middle of trench to ~~left~~ right in 1st chamber.
my torch and helpers torch were off.
0.04.

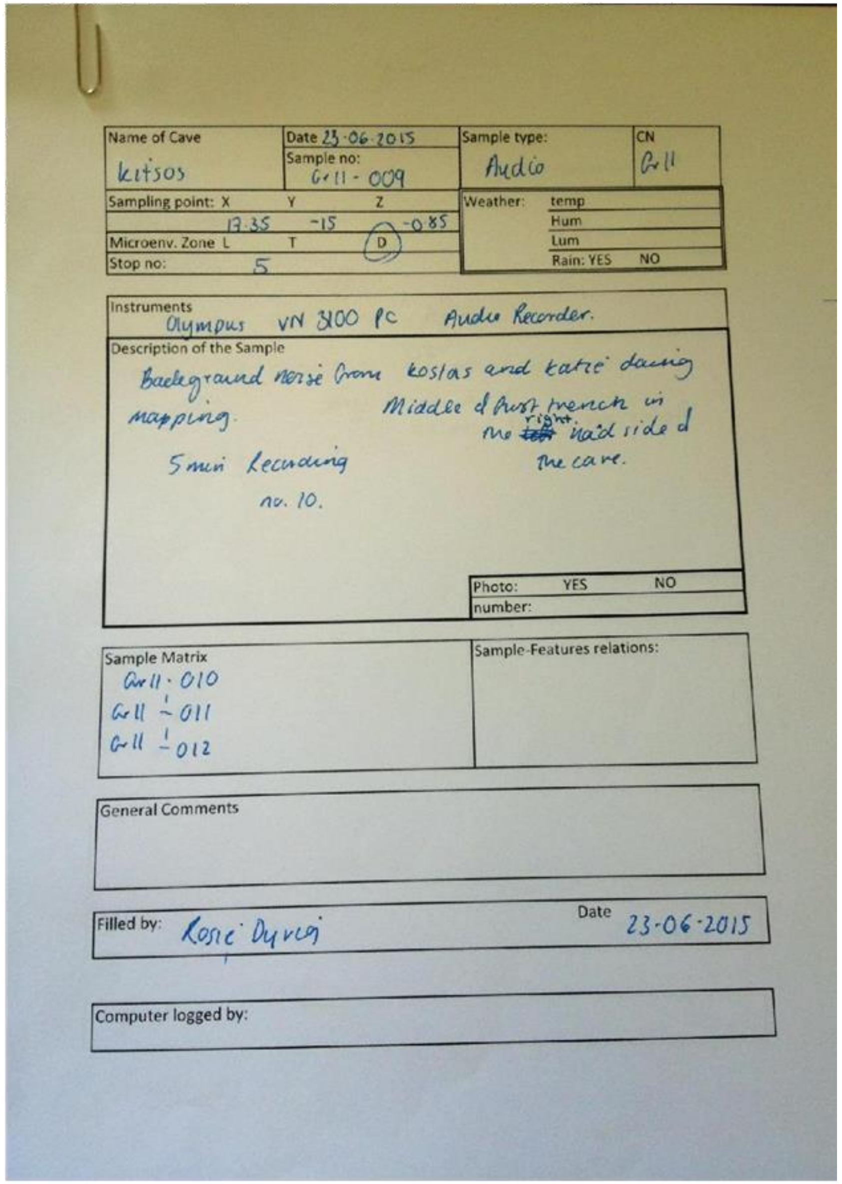
Photo: YES NO
number:

Sample Matrix	Sample-Features relations:
Gr11 - 009 Gr11 - 0011 Gr11 - 012	

General Comments

Filled by: Rosie Dync — Date 23 06 2015

Computer logged by:



Name of Cave	Date 23-06-2015	Sample type:	CN
kitsos	Sample no: Gr11 - 009	Audio	Gr11
Sampling point: X 17.35	Y -15	Z -0.85	Weather: temp / Hum / Lum / Rain: YES NO
Microenv. Zone L	T	D	
Stop no: 5			

Instruments
Olympus VN 8100 PC Audio Recorder.

Description of the Sample
Background noise from kostas and katie during mapping.
Middle of first trench in the ~~left~~ right hand side of the cave.
5 min recording no. 10.

Photo: YES NO
number:

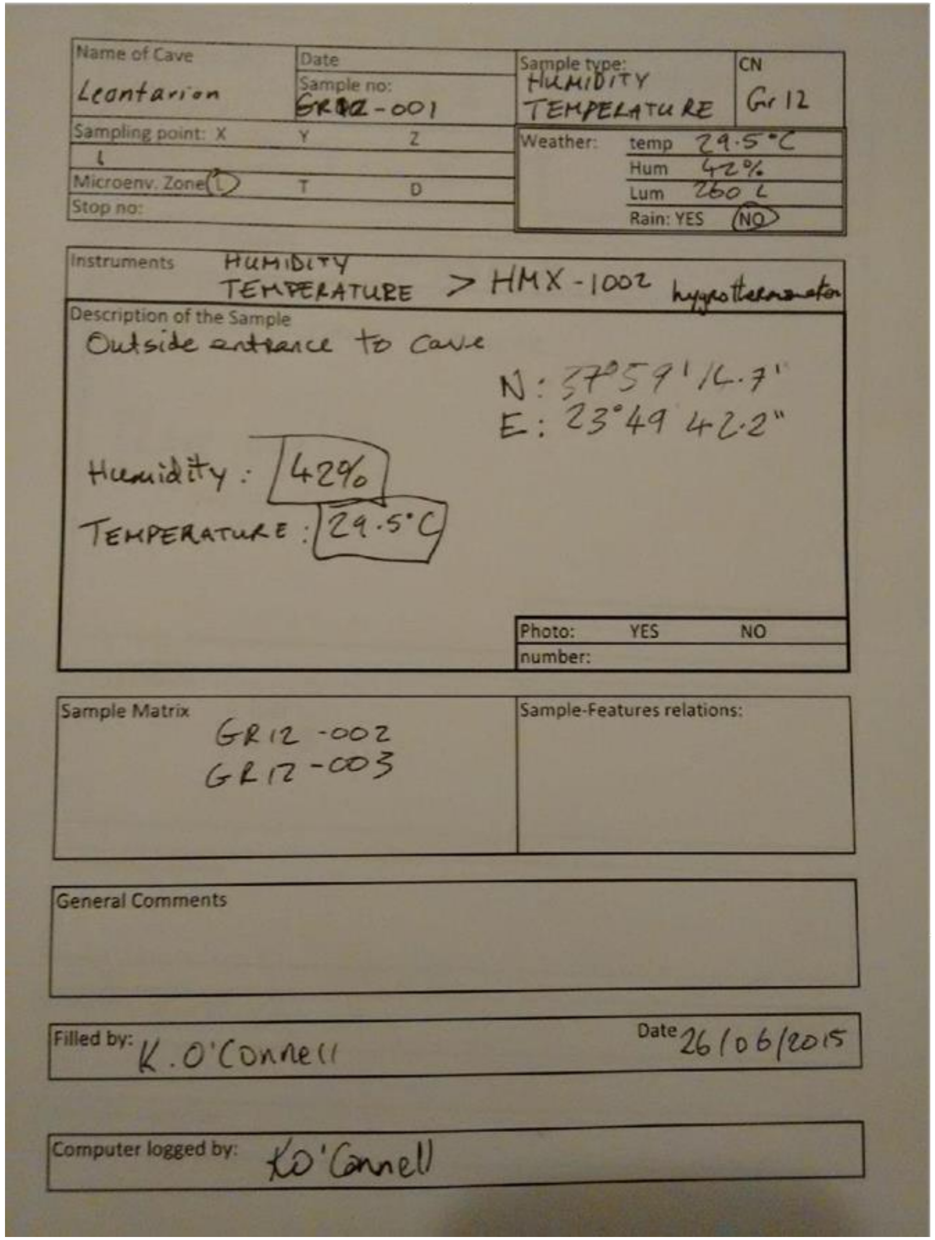
Sample Matrix	Sample-Features relations:
Gr11 - 010 Gr11 - 011 Gr11 - 012	

General Comments

Filled by: Rosie Dynes — Date 23-06-2015

Computer logged by:

Leontarion



Name of Cave: Leontarion
Date:
Sample no: GR12-001
Sample type: HUMIDITY TEMPERATURE
CN: Gr 12

Sampling point: X Y Z
L
Microenv. Zone: L T D
Stop no:

Weather: temp 29.5°C
Hum 42%
Lum 260 L
Rain: YES NO

Instruments: HUMIDITY TEMPERATURE > HMX-1002 hygrothermometer

Description of the Sample
Outside entrance to cave
N: 37°59'16.7"
E: 23°49'42.2"
Humidity: 42%
TEMPERATURE: 29.5°C

Photo: YES NO
number:

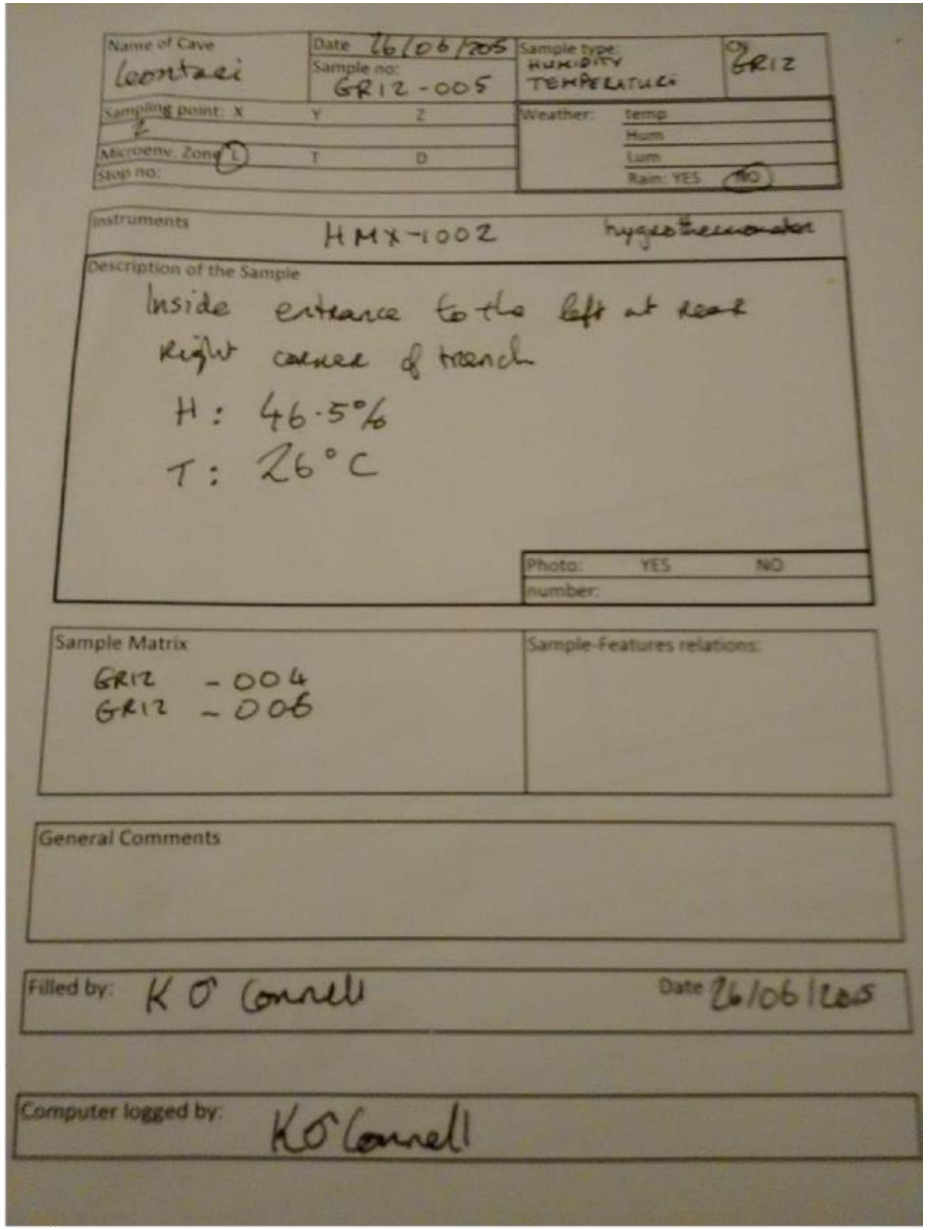
Sample Matrix
GR12-002
GR12-003

Sample-Features relations:

General Comments

Filled by: K. O'Connell Date 26/06/2015

Computer logged by: K O'Connell



Name of Cave: Leontari
Date 26/06/2015
Sample no: GR12-005
Sample type: HUMIDITY TEMPERATURE
CN: GR12

Sampling point: X Y Z
2
Microenv. Zone: L T D
Stop no:

Weather: temp
Hum
Lum
Rain: YES NO

Instruments: HMX-1002 hygrothermometer

Description of the Sample
Inside entrance to the left at rear right corner of trench
H: 46.5%
T: 26°C

Photo: YES NO
number:

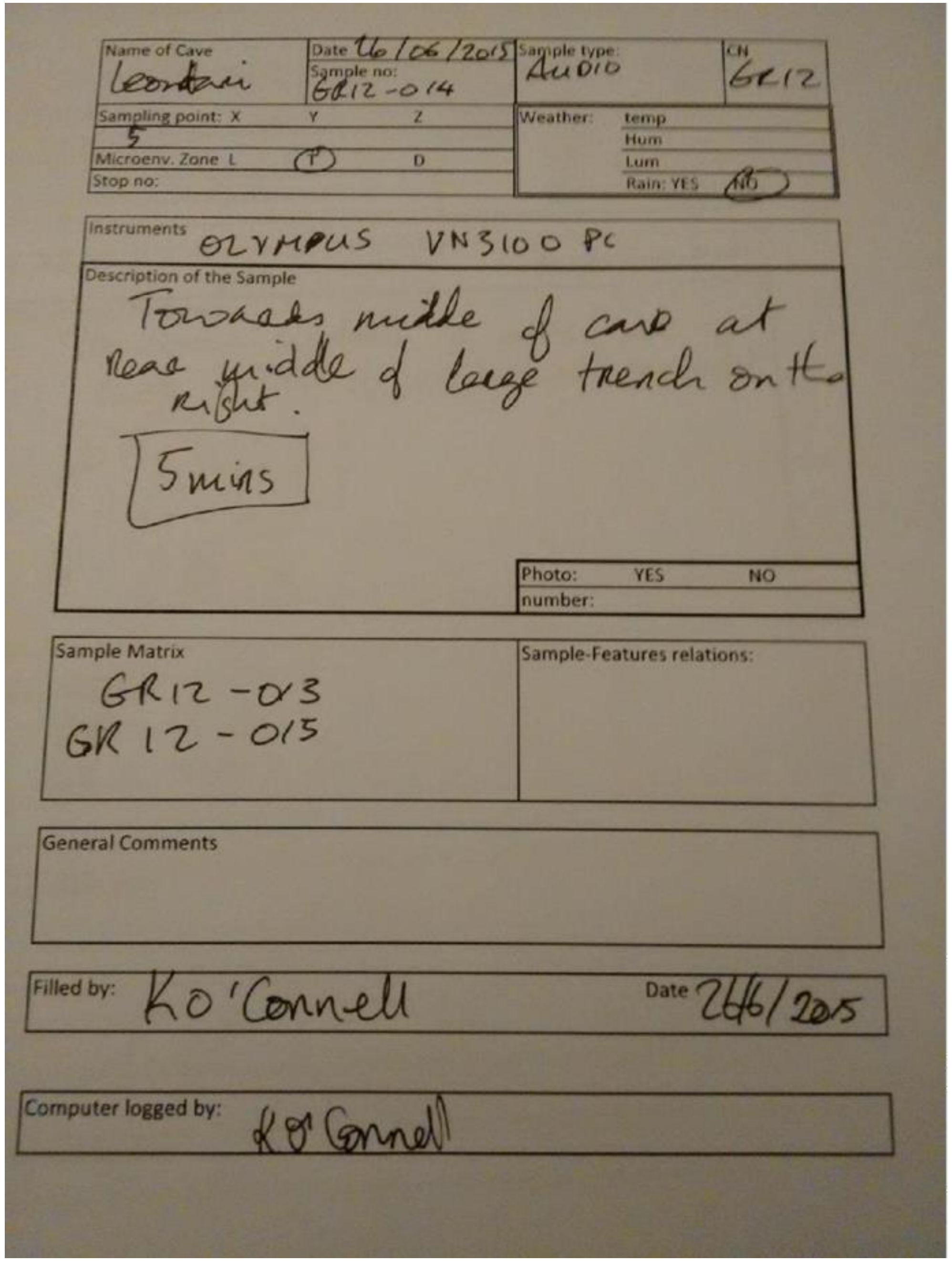
Sample Matrix
GR12-004
GR12-006

Sample-Features relations:

General Comments

Filled by: K O'Connell Date 26/06/2015

Computer logged by: K O'Connell



Name of Cave: Leontari | Date: 26/06/2015 | Sample type: AUDIO | CN: GR12

Sample no: GR12-014

Sampling point: X Y Z
5

Microenv. Zone: L T D

Stop no:

Weather: temp / Hum / Lum / Rain: YES NO

Instruments: OLYMPUS VN3100 PC

Description of the Sample:
Towards middle of cave at rear middle of large trench on the right.
$\boxed{\text{5mins}}$

Photo: YES NO
number:

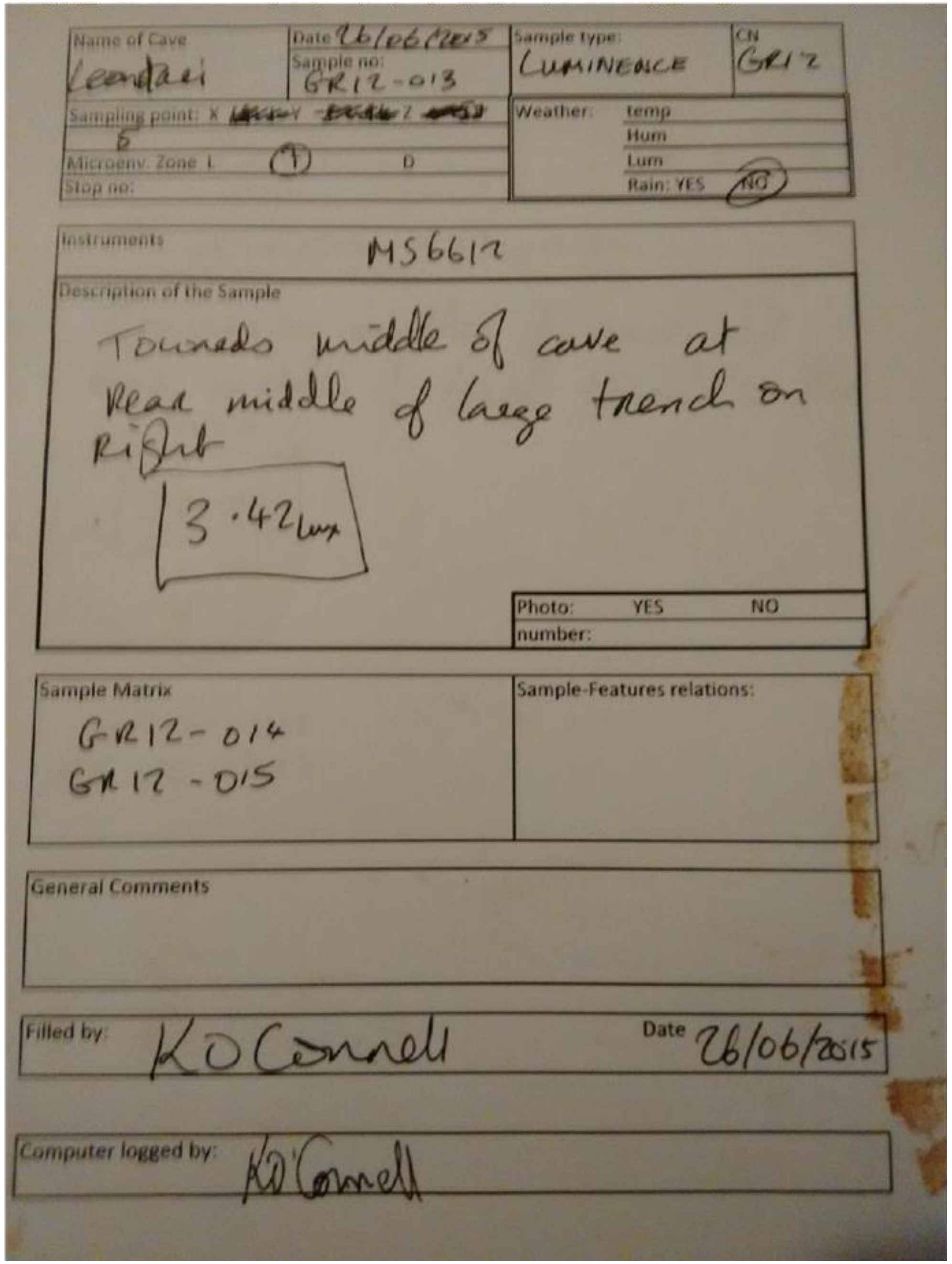
Sample Matrix:
GR12-013
GR12-015

Sample-Features relations:

General Comments:

Filled by: K O'Connell Date: 26/6/2015

Computer logged by: K O'Connell



Name of Cave: Leontari | Date: 26/06/2015 | Sample type: LUMINENCE | CN: GR12

Sample no: GR12-013

Sampling point: X Y Z
6

Microenv. Zone: L T D

Stop no:

Weather: temp / Hum / Lum / Rain: YES NO

Instruments: MS6612

Description of the Sample:
Towards middle of cave at rear middle of large trench on right
$\boxed{\text{3.42 lux}}$

Photo: YES NO
number:

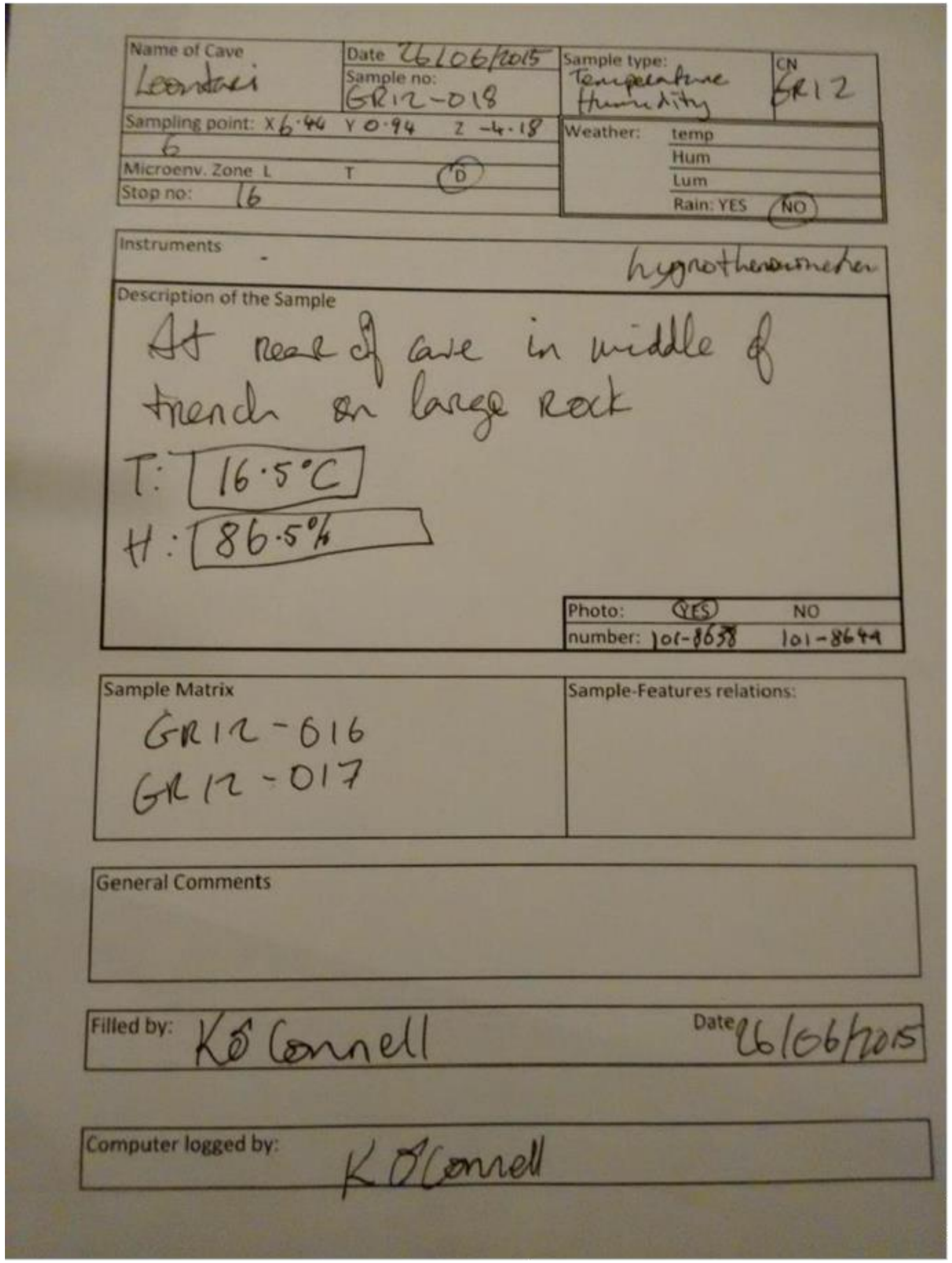
Sample Matrix:
GR12-014
GR12-015

Sample-Features relations:

General Comments:

Filled by: K O'Connell Date: 26/06/2015

Computer logged by: K O'Connell



Name of Cave: Leontari
Date: 26/06/2015
Sample no: GR12-018
Sample type: Temperature Humidity
CN: GR12

Sampling point: X 6.44 Y 0.94 Z -4.18
6
Microenv. Zone L T D
Stop no: 16

Weather: temp
Hum
Lum
Rain: YES NO

Instruments - hygrothermometer

Description of the Sample
At rear of cave in middle of trench on large rock
T: $\boxed{16.5°C}$
H: $\boxed{86.5\%}$

Photo: YES NO
number: 101-8638 101-8644

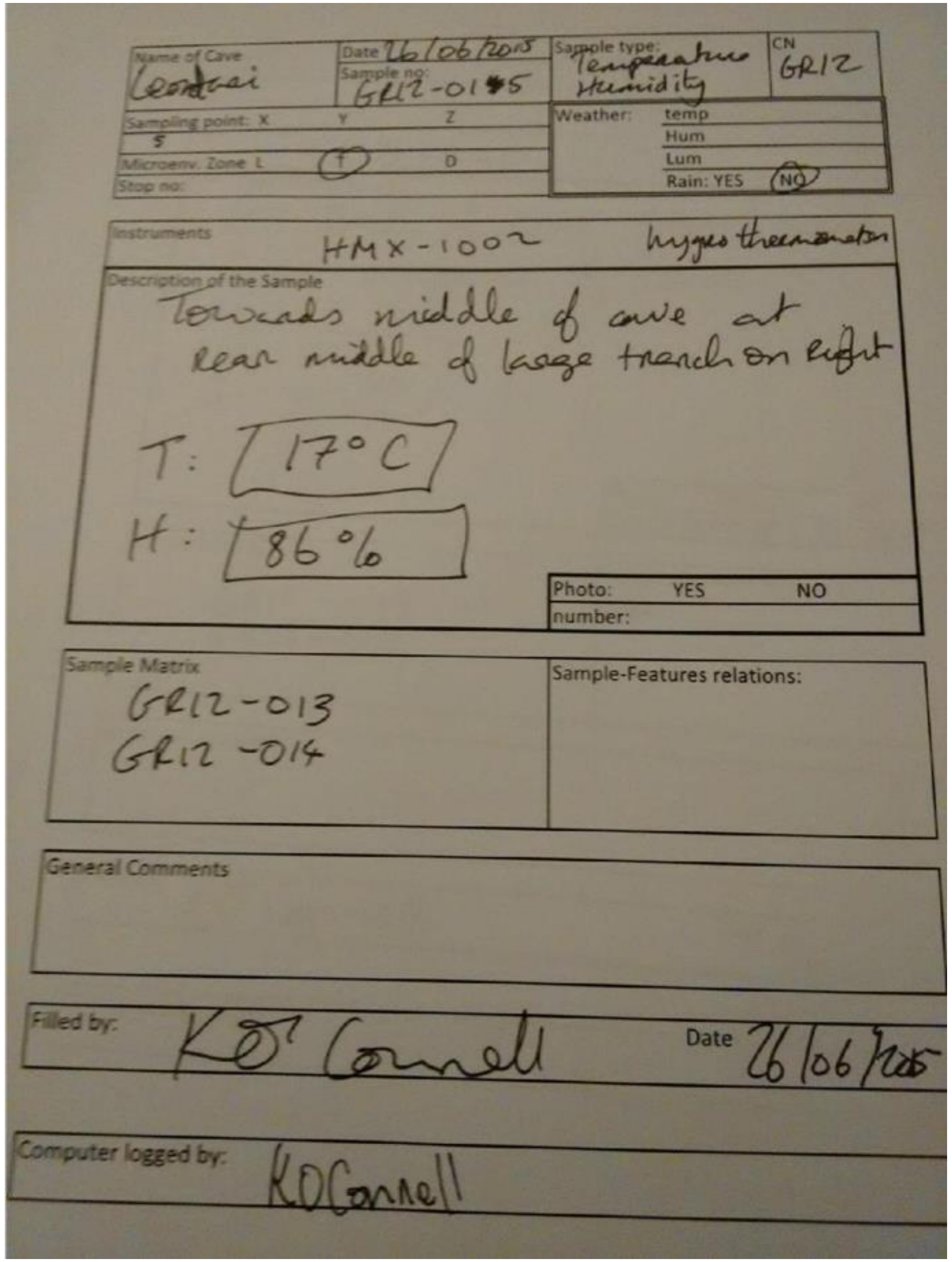
Sample Matrix
GR12-016
GR12-017

Sample-Features relations:

General Comments

Filled by: K O'Connell Date 26/06/2015

Computer logged by: K O'Connell



Name of Cave: Leontari
Date: 26/06/2015
Sample no: GR12-015
Sample type: Temperature Humidity
CN: GR12

Sampling point: X Y Z
5
Microenv. Zone L T D
Stop no:

Weather: temp
Hum
Lum
Rain: YES NO

Instruments HMX-1002 hygrothermometer

Description of the Sample
Towards middle of cave at rear middle of large trench on left
T: $\boxed{17°C}$
H: $\boxed{86\%}$

Photo: YES NO
number:

Sample Matrix
GR12-013
GR12-014

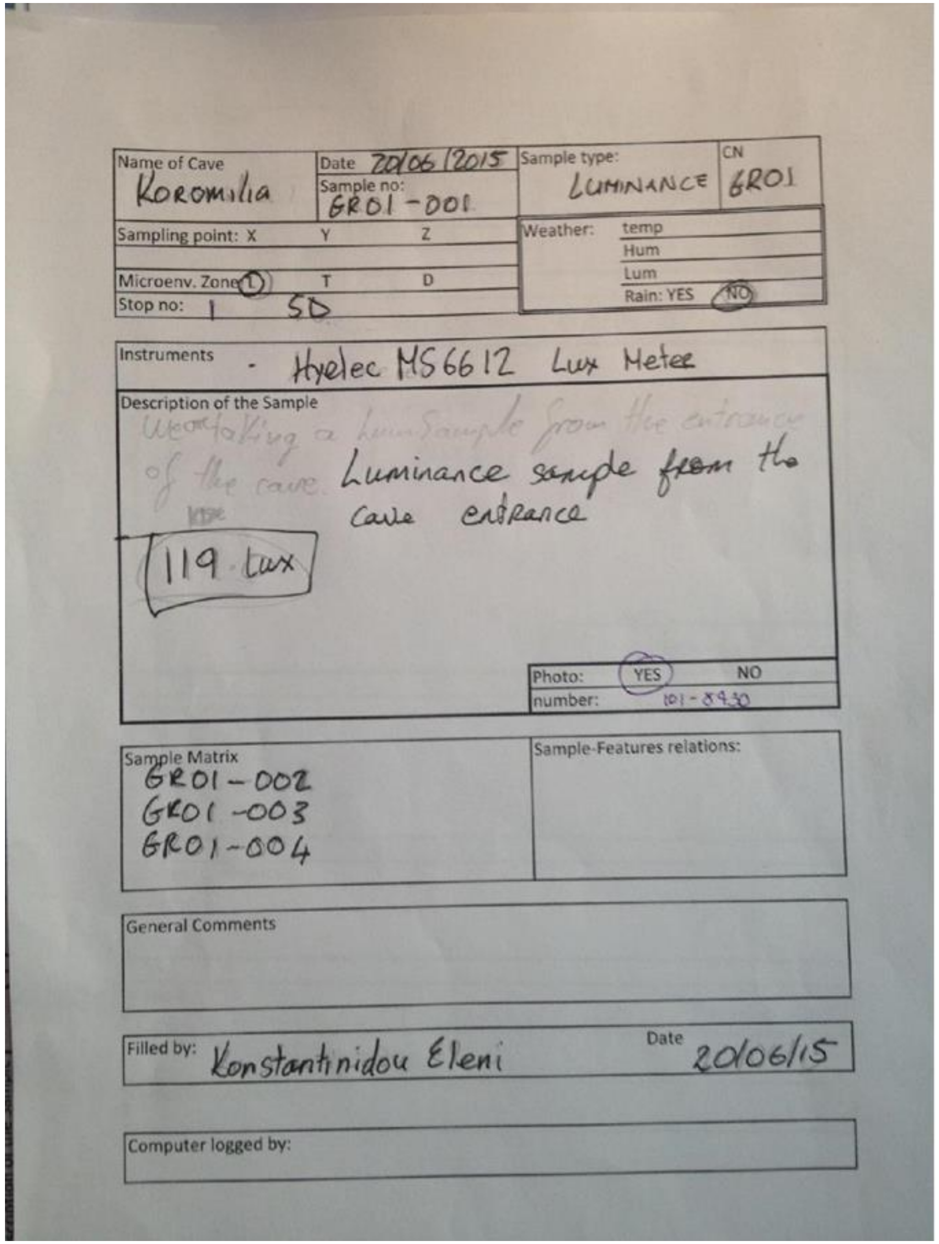
Sample-Features relations:

General Comments

Filled by: K O'Connell Date 26/06/2015

Computer logged by: K O'Connell

Koromilia



Name of Cave: Koromilia
Date: 20/06/2015
Sample no: GR01-001
Sample type: LUMINANCE
CN: GR01
Sampling point: X Y Z
Microenv. Zone: L T D
Stop no: 1 5D
Weather: temp / Hum / Lum / Rain: YES NO

Instruments - Hyelec MS6612 Lux Meter

Description of the Sample
~~We are taking a lum Sample from the entrance of the cave.~~ Luminance sample from the cave entrance
119 lux

Photo: YES NO
number: 101-8430

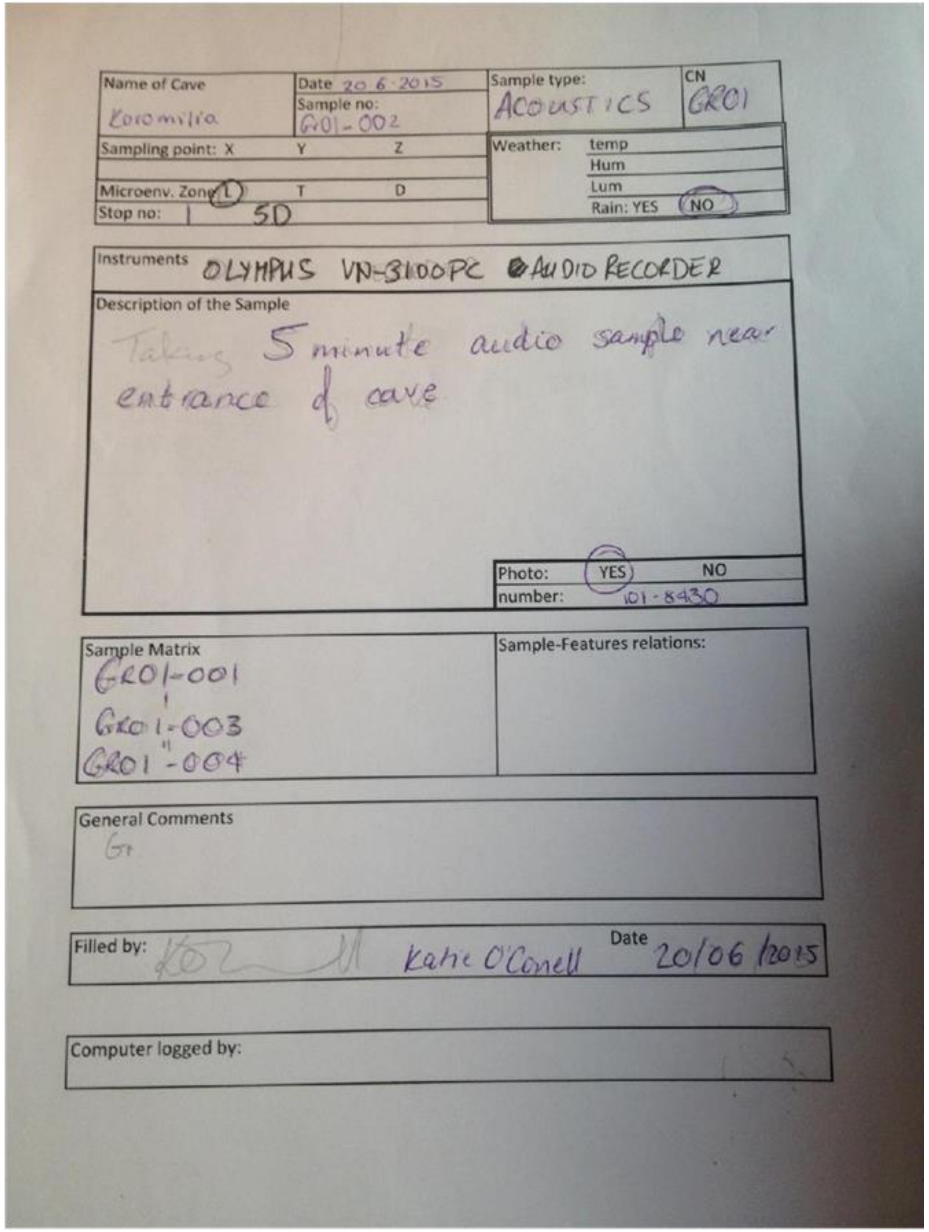
Sample Matrix
GR01-002
GR01-003
GR01-004

Sample-Features relations:

General Comments

Filled by: Konstantinidou Eleni Date 20/06/15

Computer logged by:



Name of Cave: Koromilia
Date: 20.6.2015
Sample no: GR01-002
Sample type: ACOUSTICS
CN: GR01
Sampling point: X Y Z
Microenv. Zone: L T D
Stop no: 1 5D
Weather: temp / Hum / Lum / Rain: YES NO

Instruments: OLYMPUS VN-3100PC AUDIO RECORDER

Description of the Sample
~~Taking~~ 5 minute audio sample near entrance of cave

Photo: YES NO
number: 101-8430

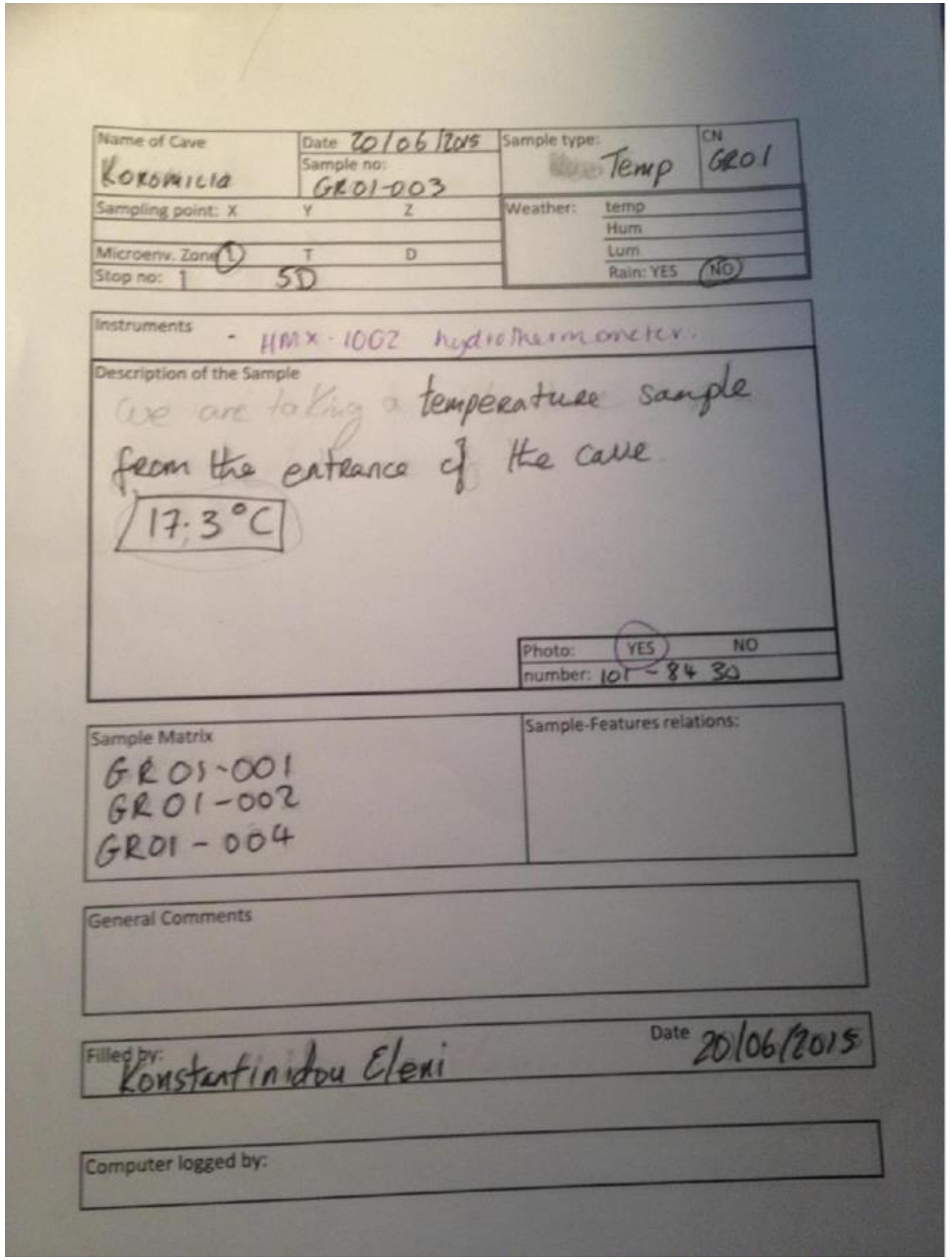
Sample Matrix
GR01-001
GR01-003
GR01-004

Sample-Features relations:

General Comments
Gr

Filled by: Katie O'Conell Date 20/06/2015

Computer logged by:



Name of Cave: Koromilia
Date: 20/06/2015
Sample no: GR01-003
Sample type: Temp
CN: GR01
Sampling point: X Y Z
Weather: temp Hum Lum Rain: YES NO
Microenv. Zone: L T D
Stop no: 1 5D

Instruments - HMX-1002 hydrothermometer.

Description of the Sample
We are taking a temperature sample from the entrance of the cave
17,3°C

Photo: YES NO
number: 101-8430

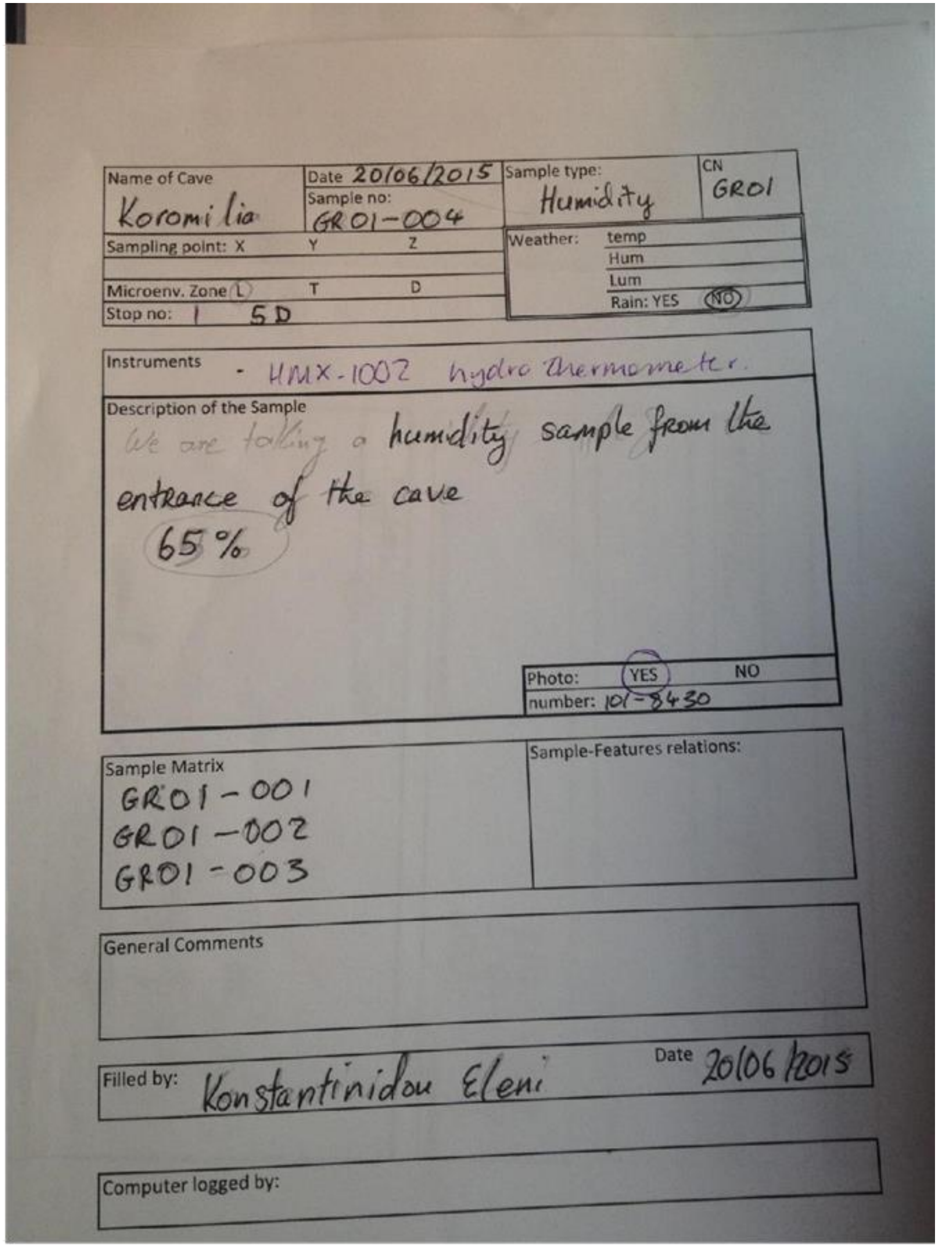
Sample Matrix
GR01-001
GR01-002
GR01-004

Sample-Features relations:

General Comments

Filled by: Konstantinidou Eleni
Date 20/06/2015

Computer logged by:



Name of Cave: Koromilia
Date: 20/06/2015
Sample no: GR01-004
Sample type: Humidity
CN: GR01
Sampling point: X Y Z
Weather: temp Hum Lum Rain: YES NO
Microenv. Zone: L T D
Stop no: 1 5D

Instruments - HMX-1002 hydrothermometer.

Description of the Sample
We are taking a humidity sample from the entrance of the cave
65%

Photo: YES NO
number: 101-8430

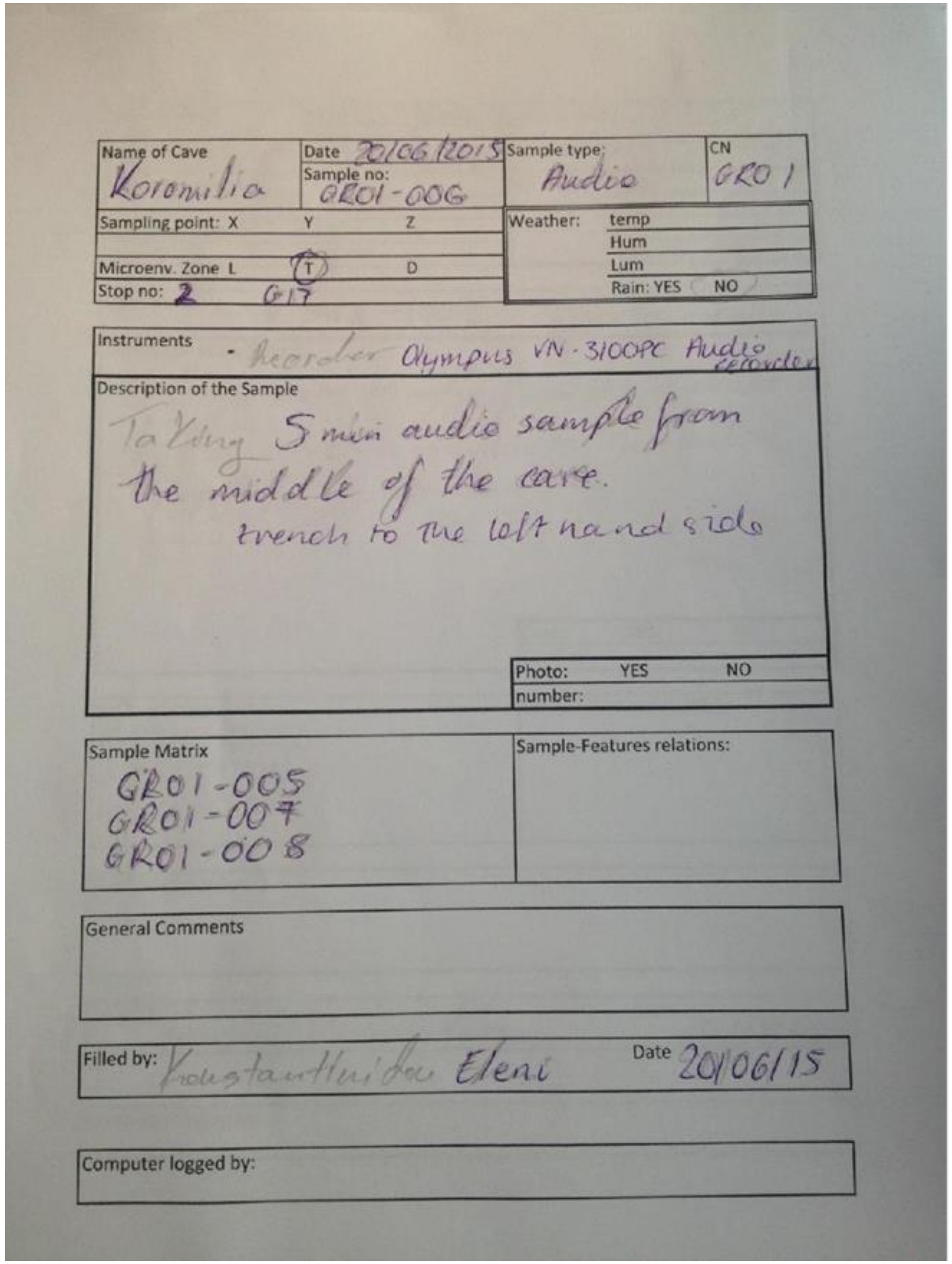
Sample Matrix
GR01-001
GR01-002
GR01-003

Sample-Features relations:

General Comments

Filled by: Konstantinidou Eleni
Date 20/06/2015

Computer logged by:



Name of Cave	Date 20/06/2015	Sample type:	CN
Koromilia	Sample no: GR01-006	Audio	GR01

Sampling point: X Y Z

Microenv. Zone L (T) D

Stop no: 2 G17

Weather: temp / Hum / Lum / Rain: YES NO

Instruments - ~~Recorder~~ Olympus VN-3100PC Audio recorder

Description of the Sample

Taking 5 min audio sample from the middle of the cave.
trench to the left hand side

Photo: YES NO
number:

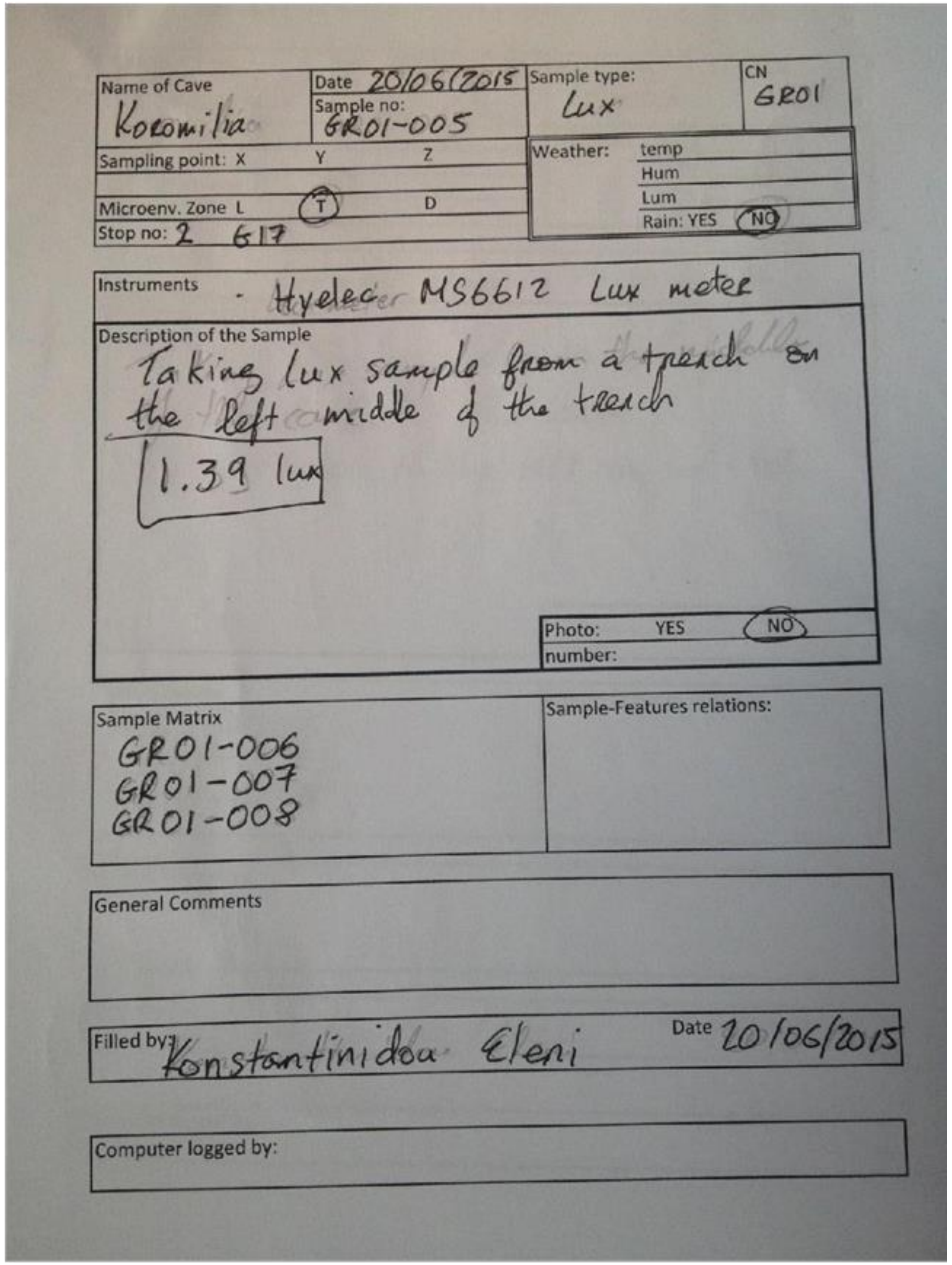
Sample Matrix
GR01-005
GR01-007
GR01-008

Sample-Features relations:

General Comments

Filled by: Konstantinidou Eleni Date 20/06/15

Computer logged by:



Name of Cave	Date 20/06/2015	Sample type:	CN
Koromilia	Sample no: GR01-005	Lux	GR01

Sampling point: X Y Z

Microenv. Zone L (T) D

Stop no: 2 G17

Weather: temp / Hum / Lum / Rain: YES (NO)

Instruments - Hyelec MS6612 Lux meter

Description of the Sample

Taking lux sample from a trench on the left middle of the trench

$\boxed{1.39 \text{ lux}}$

Photo: YES (NO)
number:

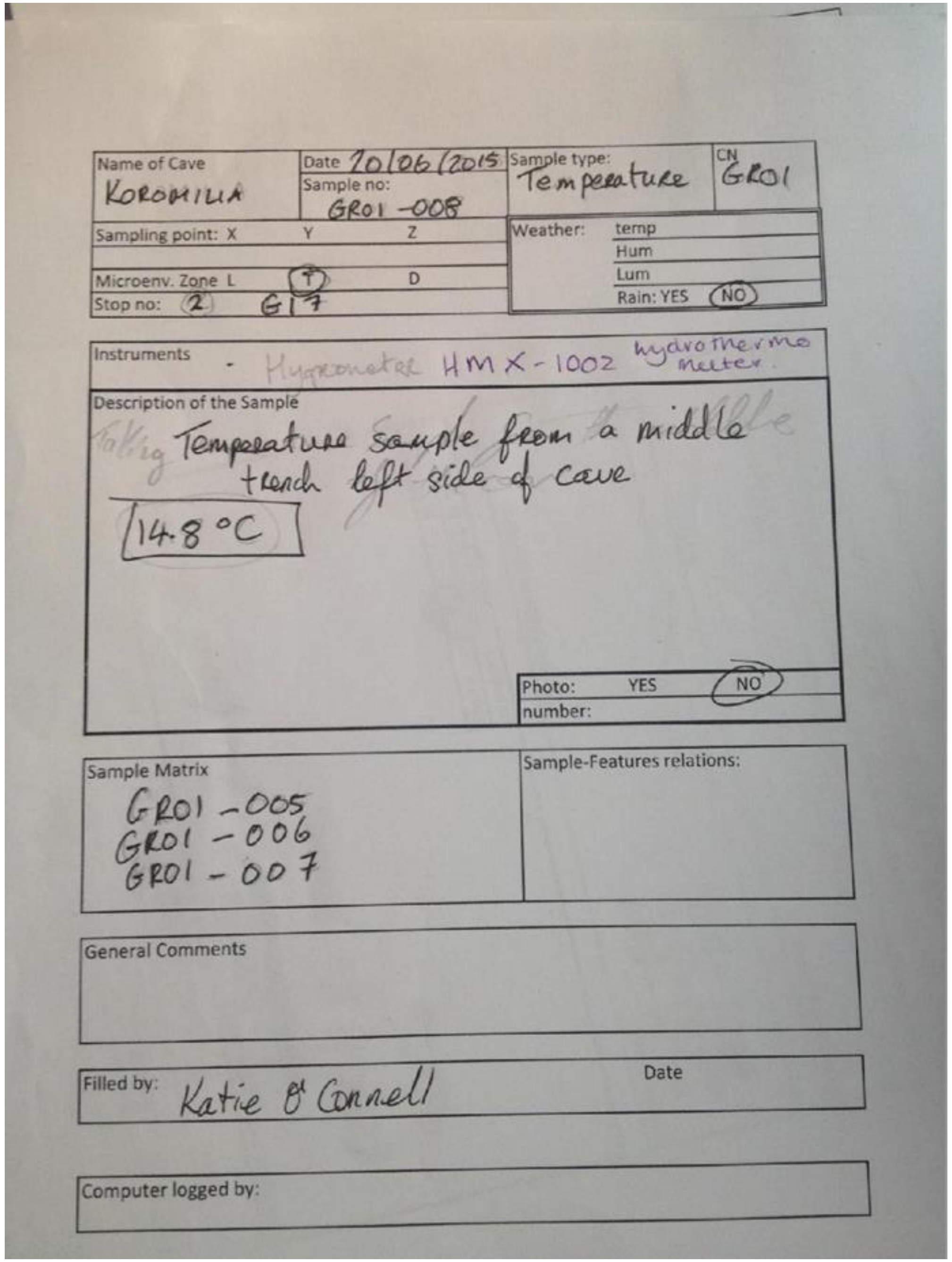
Sample Matrix
GR01-006
GR01-007
GR01-008

Sample-Features relations:

General Comments

Filled by: Konstantinidou Eleni Date 20/06/2015

Computer logged by:



Name of Cave: KOROMILIA
Date: 20/06/2015
Sample no: GR01 -008
Sample type: Temperature
CN: GR01

Sampling point: X Y Z
Microenv. Zone L T D
Stop no: 2 G17

Weather: temp
Hum
Lum
Rain: YES NO

Instruments - Hygrometer HMX-1002 hydrothermo meter

Description of the Sample
~~Taking~~ Temperature sample from a middle trench left side of cave
$\boxed{14.8\,°C}$

Photo: YES NO
number:

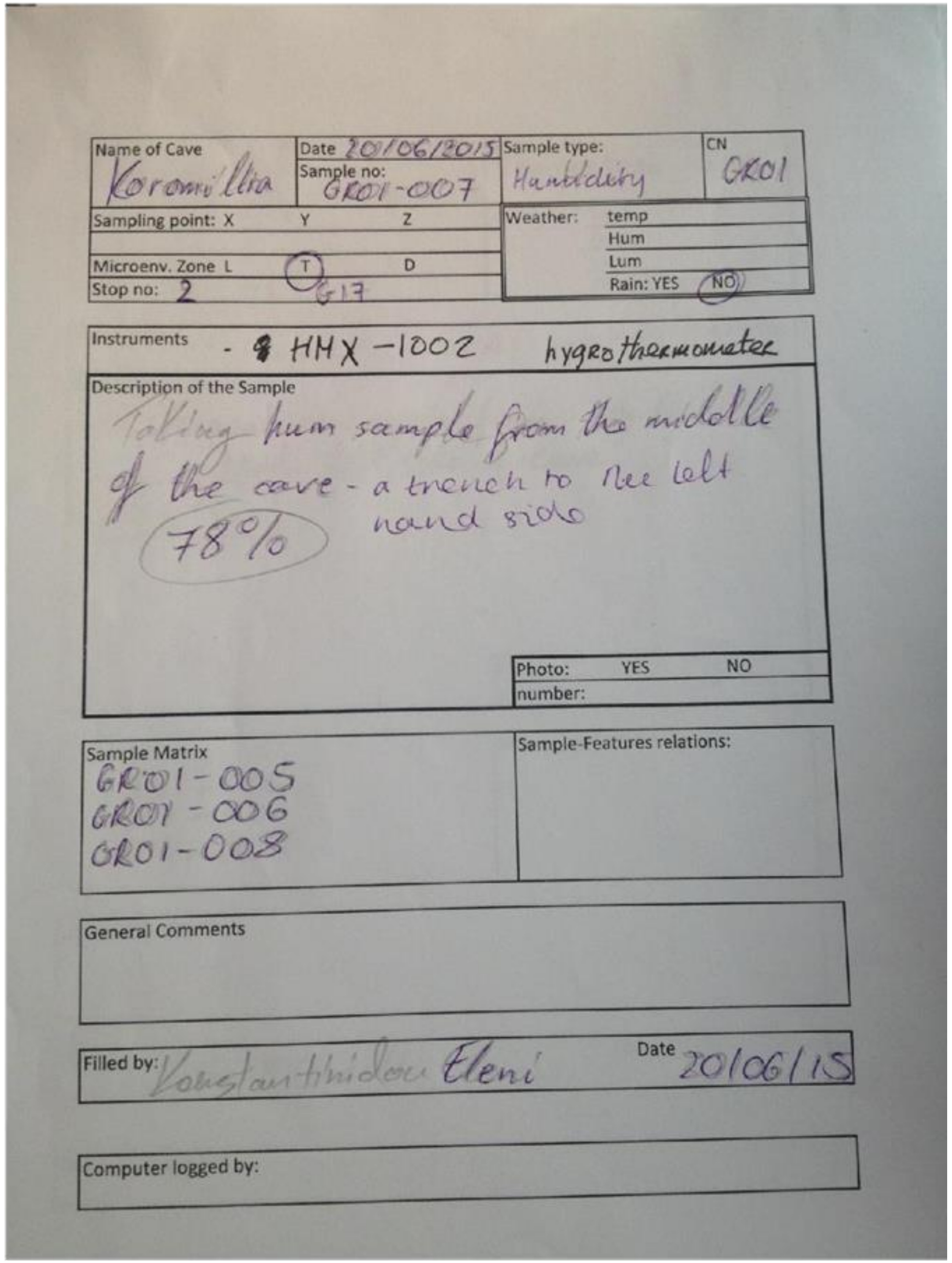
Sample Matrix
GR01 -005
GR01 -006
GR01 - 007

Sample-Features relations:

General Comments

Filled by: Katie O'Connell
Date

Computer logged by:



Name of Cave: Koromillia
Date: 20/06/2015
Sample no: GR01-007
Sample type: Humidity
CN: GR01

Sampling point: X Y Z
Microenv. Zone L T D
Stop no: 2 G17

Weather: temp
Hum
Lum
Rain: YES NO

Instruments - HMX -1002 hygrothermometer

Description of the Sample
Taking hum sample from the middle of the cave - a trench to the left hand side
78%

Photo: YES NO
number:

Sample Matrix
GR01-005
GR01-006
GR01-008

Sample-Features relations:

General Comments

Filled by: Konstantinidou Eleni
Date 20/06/15

Computer logged by:

Name of Cave	Date 20/06/2015	Sample type:	CN
Koromilia	Sample no: GR01-010	Audio	GR01

Sampling point: X Y Z

Microenv. Zone L T D

Stop no: 3 ~~F28~~ F28

Weather: temp / Hum / Lum / Rain: YES NO

Instruments ~~Audio Recorder~~ Olympus VN-5100PC Audio Recorder

Description of the Sample

Taking 5min audio from the deep point. Above a trench behind column.

Photo: YES NO
number: 101 - 8447

Sample Matrix
GR01-009
GR01-011
GR01-012

Sample-Features relations:

General Comments

Filled by: Konstantinidou Eleni Date 20/06/15

Computer logged by:

Name of Cave	Date 20/06/2015	Sample type:	CN
Koromilia	Sample no: GR01-009	Luminance	GR01

Sampling point: X Y Z

Microenv. Zone L T D

Stop no: 3 F28

Weather: temp / Hum / Lum / Rain: YES NO

Instruments ~~lux meter~~ Hyelec MS6612 lux Meter

Description of the Sample

taking a luminance sample from a trench at back of the cave

$\boxed{0.29 \text{ lux}}$

Photo: YES NO
number: 101 - 8447

Sample Matrix
GR01-010
GR01-011
GR01-012

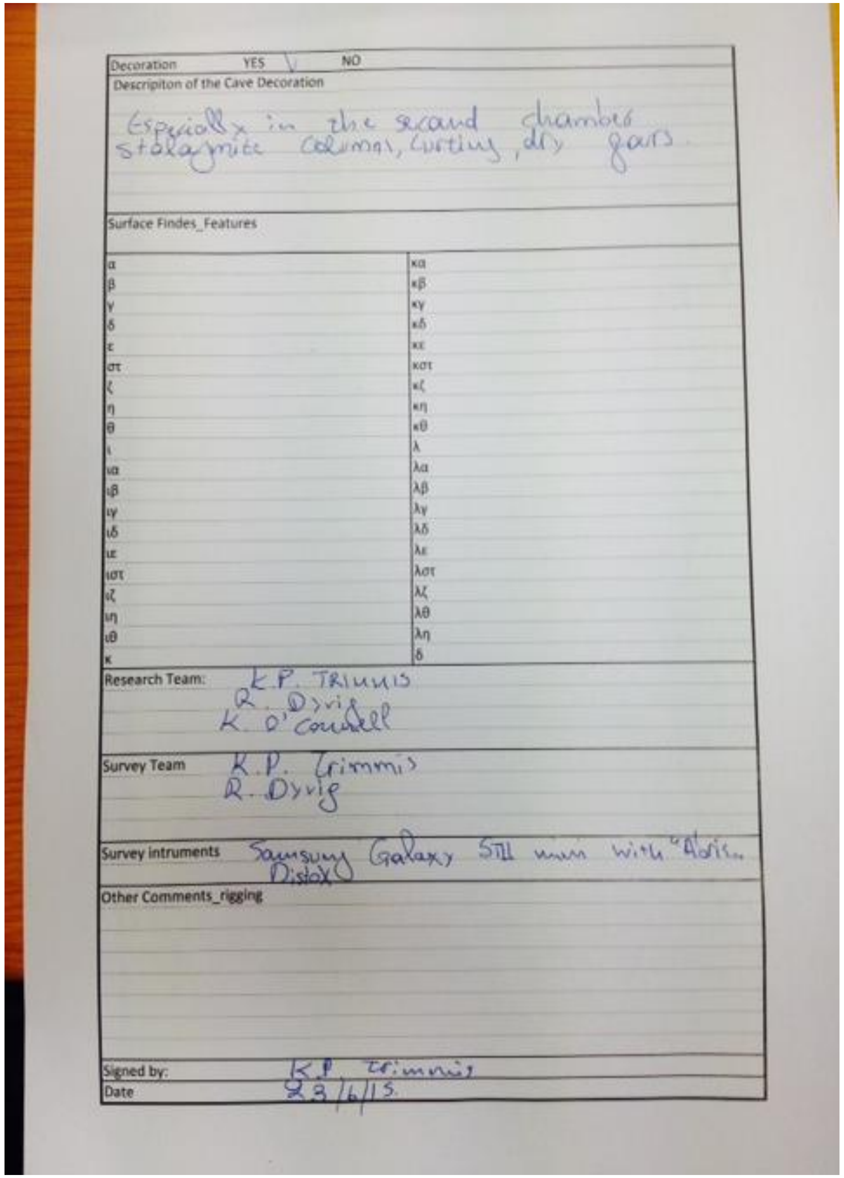
Sample-Features relations:

General Comments

Filled by: Konstantinidou Eleni Date 20/06/15

Computer logged by:

6. Examples of Cave Recording Forms



Decoration YES √ NO

Descripiton of the Cave Decoration

Especially in the second chamber stalagmite columns, curtains, dry gours.

Surface Findes_Features

α	κα
β	κβ
γ	κγ
δ	κδ
ε	κε
στ	κστ
ζ	κζ
η	κη
θ	κθ
ι	λ
ια	λα
ιβ	λβ
ιγ	λγ
ιδ	λδ
ιε	λε
ιστ	λστ
ιζ	λζ
ιη	λθ
ιθ	λη
κ	δ

Research Team: K.P. Trimmis, R. Dyvig, K. O'Connell

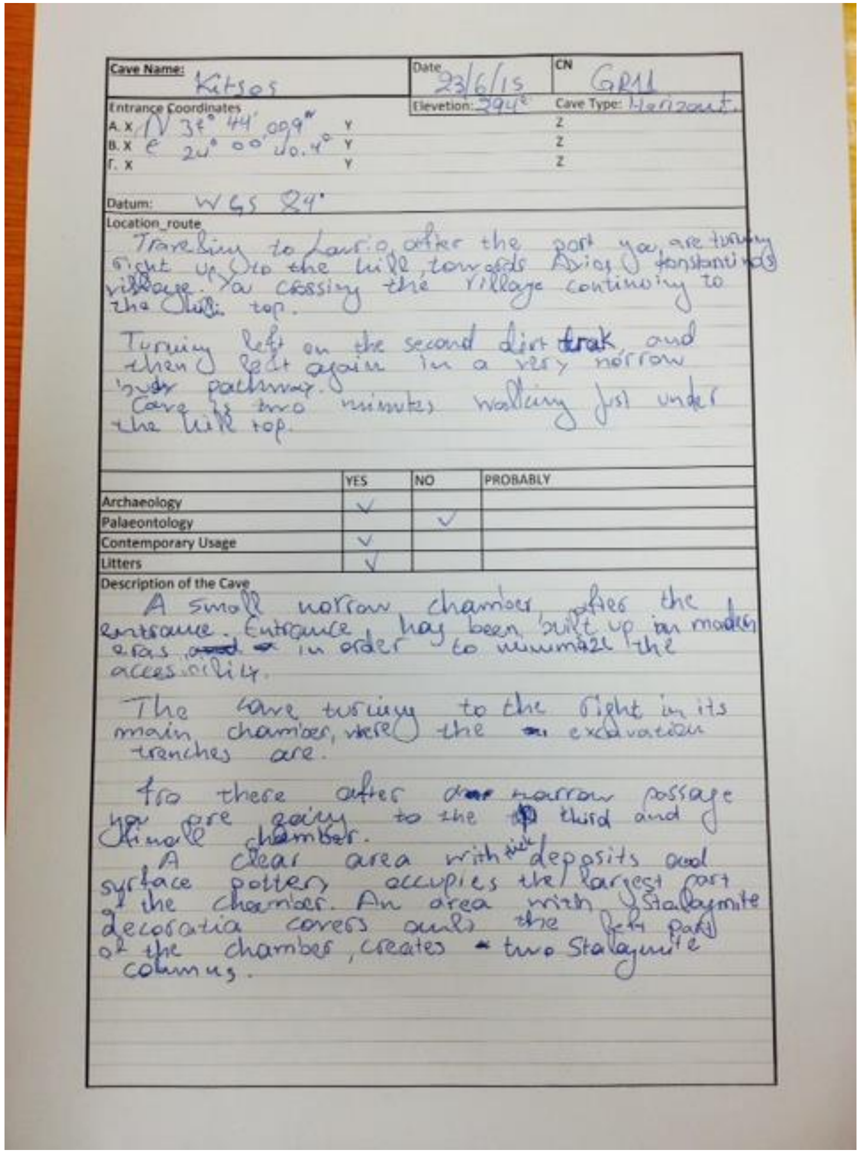
Survey Team: K.P. Trimmis, R. Dyvig

Survey intruments: Samsung Galaxy SIII mini with "Aoris... DistoX"

Other Comments_rigging

Signed by: K.P. Trimmis

Date: 23/6/15



Cave Name: Kitsos | Date: 23/6/15 | CN: GR11 [?]

Entrance Coordinates | Elevation: 394 [?] | Cave Type: Horizont.

A. X N 37° 44' 009" Y Z

B. X E 24° 00' 40.4" Y Z

Γ. X Y Z

Datum: WGS 84'

Location_route

Travelling to Lavrio, after the port you are turning right up to the hill, towards Agios Konstantinos village. You crossing the village continuing to the hill top.

Turning left on the second dirt track and then left again in a very narrow bushy pathway.
Cave is two minutes walking just under the hill top.

	YES	NO	PROBABLY
Archaeology	√		
Palaeontology		√	
Contemporary Usage	√		
Litters	√		

Description of the Cave

A small narrow chamber after the entrance. Entrance has been built up in modern eras in order to minimize the accessibility.

The cave turning to the right in its main chamber, where the excavation trenches are.

From there after narrow passage you are going to the third and final chamber.
A clear area with deposits and surface pottery occupies the largest part of the chamber. An area with stalagmite decoration covers only the left part of the chamber, creates two stalagmite columns.

7. Examples of sound recording analysis

SOUNDSCAPES analysis examples from Kitsos and Koromilia

Kitsos

KITSOS LIGHT – discarded.

KITSOS DARK (5.17.09)

Anthrophony –

Aeroplane 2.09.26 – 2.32.36 duration: 23.1 seconds

Biophony -

Dog 2.18.25 – 2.18.45 duration 0.2seconds

KITSOS DARK 2 (5.02.10)

Biophony -

Dog 2.18.30 – 2.18.50 duration 0.2seconds

KITSOS DARK 3 (5.34.48)

Anthrophony –

Aeroplane 2.07.04 – 2.32.80 duration: 25.76 seconds

Biophony -

Dog 2.18.14 – 2.18.34 duration 0.2seconds

KOROMILLIA DARK (5.02.10)

Geophony –

Wind	4.12 – 10.54	duration: 6.42 seconds
	40.67 – 42.40	duration: 1.73 seconds
	1.41.192 – 1.45.391	duration: 4.2 seconds
	1.52.308 – 1.55.03	duration: 2.72 seconds
	2.03.01 – 2.06.14	duration: 3.13 seconds
	2.20.22 – 2.23.43	duration: 3.21 seconds
	2.24.172 – 2.36.11	duration: 11.94 seconds
	2.41.628 – 2.48.21	duration: 6.59 seconds
	2.52.66 – 2.54.39	duration: 1.73 seconds
	4.07.26 – 4.17.14	duration: 9.88 seconds
	4.39.21 – 4.41.35	duration: 2.14 seconds

Biophony –

Birds	19.761 – 24.372	duration: 4.61 seconds
	37.134 – 37.71	duration: 0.58 seconds
	44.874 – 45.70	duration: 0.82 seconds
	1.00.27 – 1.01.75	duration: 1.48 seconds
	1.22.17 – 1.22.75	duration: 0.58 seconds
	1.32.22 – 1.32.79	duration: 0.58 seconds
	1.34.19 – 1.35.43	duration: 1.24 seconds
	1.39.79 – 1.40.20	duration: 0.41 seconds
	1.44.733 – 1.45.14	duration: 0.41 seconds
	2.17.17 – 2.22.86	duration: 5.68 seconds
	2.32.08 – 2.32.49	duration: 0.41 seconds
	3.47.49 – 3.49.23	duration: 1.73 seconds
	4.14.25 – 4.14.75	duration: 0.5 seconds
	4.31.47 – 4.33.36	duration: 1.89 seconds

Koromillia

KOROMILLIA DARK TWIGHLIGHT (5.02.10)

Geophony –

Wind	04.483 – 12.810	duration: 8.33 seconds
	1.43.12 – 1.44.72	duration: 1.6 seconds
	1.52.73 – 01.54.97	duration: 2.24 seconds
	2.02.50 – 02.06.18	duration: 3.68 seconds
	2.14.82 – 2.16.75	duration: 1.92 seconds
	2.21.39 – 2.55.34	duration: 33.95 seconds
	3.39.69 – 3.44.01	duration: 4.32 seconds
	4.06.59 – 4.19.56	duration: 12.97 seconds
	4.39.89 – 4.54.95	duration: 15.05 seconds

Biophony –

Birds	0.21.136 – 0.25.66	duration: 4.48 seconds
	0.44.51 – 0.46.12	duration: 1.6 seconds
	1.00.05 – 1.02.13	duration: 2.08 seconds
	1.21.98 – 1.22.78	duration: 0.8 seconds
	1.31.91 – 1.37.04	duration: 5.12 seconds
	1.39.92 – 1.40.72	duration: 0.8 seconds
	1.44.72 – 1.45.52	duration: 0.8 seconds
	2.16.11 – 2.28.28	duration: 12.17 seconds
	2.49.57 – 2.53.73	duration: 4.16 seconds
	3.09.74 – 3.12.47	duration: 2.72 seconds
	3.39.21 – 3.40.97	duration: 1.76 seconds