International Erasmus Mundus Master in

Quaternary and Prehistory

Documentation on Schematic Rock Paintings in Cascata Rock Shelter in Lousã, Central Portugal.

Negasi Awetehey Nega

Advisors: Sara Garcês

Co-advisor: Hugo Gomes

The academic year 2021/2023

Abstract

This dissertation primarily aims at the documentation of the Schematic Rock Paintings in Cascata Rock Shelter in Lousã (Central Portugal) with a systematic and updated approach using digital techniques. The main rationale for choosing this site is the presence of post-Paleolithic art, which is ascertained as 'Schematic Art' in the Rock Shelter.

The work includes using digital technology for the recording techniques on-field and off-field for these paintings. As these sites contain paintings, they encompass the use of digital photography accompanied by software known as DStretch ®, which is a plugin for ImageJ application. The images are then processed in the lab with the use of Adobe Photoshop® to create digital decals. Methodologically, the work also includes planimetry work to locate and identify the surface collections, and the panels as well as delimit the floor contours and settings.

The study in the shelter came up with surface archaeological material (lithics, ceramics, beadlike stones, and one iron piece) and three schematic rock art figures in the ceiling of the shelter. Chronologically, due to the lack of elements for direct dating and bearing in mind that we can only make a chronological approximation through stylistic comparison, a chronology between the Neolithic to the Iron Age is suggested. The presence of art and diachronic materials in the rock shelter of schematic art could be the result of the intensive humanization of the landscape by pre-historic (Holocene Period) communities. The rock shelter and its art are in very bad conservation condition that needs urgent measure. Finally, an archaeological excavation is recommended to fully understand and reconstruct the chronology and function of the shelter and its art.

Keywords: Cascata Rock Shelter, Schematic Art, Digitizing Rock Art, Lousã Pre-History;

Acknowledgments

First and foremost, I would like to thank my two supervisors, Professors Sara Garcês and Professor Hugo Gomes who have stayed positive, helpful, and available throughout the whole process. They are both characterized by their teamwork spirit, punctuality, and to-the-point corrections. I am glad that I worked with you! The thesis would not have been at this stage without your intimate and caring support.

Thanks to Filipe Paiva, who first identified the shelter and has been providing information throughout the fieldwork and afterward.

A special reference must be given to Hipólito Collado Giraldo, and Sara Garcês, who did the larger part of the onsite documentation. A special thanks also goes to professional photographer João Corvo from the Polytechnic Institute of Tomar. My gratitude also goes to Professor Fernando Coimbra who helped me with the preliminary identification of the archaeological material collections.

The assistance of Professors Luiz Oosterbeek, Pierluigi Rosina, and Virginia Lattao during the master's was priceless.

Thanks to all in Instituto Terra e Memória (ITM) and Museu de Arte Pré-Histórica e do Sagrado do Vale do Tejo in Mação.

Finally, I thank my family and friends for their unconditional support all this time.

ሳሷኹም፤ ካብ ልበይ የመስግነኩም!

Foi por tua causa que eu atingi o objetivo e é imensa a minha gratidão.

INDEX

Table of figures

List of Tables

1. CHAPTER ONE

Introduction

This thesis primarily aims at the documentation of the Schematic Rock Paintings in the Cascata Rock Shelter in Lousã (Central Portugal). It contextualizes the specific site in the larger context and accesses the archaeological potential of the shelter for future research. It documents what is available in the shelter (arts and archaeological collections) and the shelter itself. Methodologically, it uses advanced techniques of DStretch, and Adobe Photoshop. In the end, the study reveals the potential of the site for future research and conservation.

Rock arts in the Iberian Peninsula have been used for the understanding of human dynamics in the landscape along with other studies that detailed the analysis of other types of evidence (Garcês, 2017). Hence, new rock art documentation like the Cascata Rock Shelter in Lousã (Central Portugal) contributes to the state of knowledge.

1.1. Structure of the Thesis

This thesis will have six chapters. The first chapter contains Introductory contents: thesis structure, Problem, and objectives, the geographic and Geomorphological setting of Lousã, and the Archaeological Research History of Lousã. The second chapter: the review of related literature on Post-Paleolithic Art: Pre-schematic Art, and Schematic Art in the context of the Iberian Peninsula. The third chapter contains the materials and methods used to achieve the objectives and obtain the needed results. The fourth chapter presents the results i.e., archaeological collections, typology, description of the figures, panels, and the shelter contextualization. The fifth chapter is a discussion of style, chronological proposals, and interpretation. The sixth chapter presents the conclusion and way forward.

1.2. Problematic and Objectives

Problem

The Iberian Peninsula is an interesting region to research schematic rock art which is also dominant and known across vast areas of Western Europe (Behrmann et al. 2007). It has been a trend that schematic rock art of the Iberian Peninsula has been a subject that received lower attention especially as compared to other types of prehistoric art particularly Levantine rock Art and Paleolithic rock Art which entertained better interpretative and artistic research. For several decades, the main problematic affecting rock art research in Iberia (particularly Portugal) has been the lack of advanced documentation (Alves, 2009:383). As an encouraging trend, however, today there is an increase in the amount of research, which is contributing to addressing questions of its origin, chronology, and meaning in its sociocultural context (e.g. Martins 2014; Figueiredo, 2013; Garcês, 2017; Santos, 2017).

The Cascata rock-shelter is the first painted rock art discovery in the municipality of Lousã, in the mountains of Candosa. This research can be seen within this background and its need is justified from two points. First, to contribute to the knowledge of schematic art of the Iberian Peninsula in general and central Portugal and for plausible interpretation, the rock art paintings must be documented in sequential and thorough methodological ways that maximize the retrieval of information. That implies temporal, conceptual, and/or topographic articulation of the rock art site, the relationship between iconography and the site is a pre-requite for advanced explanation at the site as well as the Iberian level. Lara Bacelar Alves (2021) states there are many explanations for the dynamics of Late Prehistoric rock art traditions in Iberia. Being the period of rock art under study post-paleolithic (specifically Late Prehistory), which is characterized by socio-cultural dynamism and revolutions, it will have its share in contributing data and interpretations. Hence, the detailed study of art, along with other archaeology conducted in Lousã, significantly will help understand and define peoples of the time: behavior, relationship, and territory. Second, the rock shelter and its paintings are in bad preservation condition due to natural hazards, particularly forest fires. This has affected the paintings and there is a clear danger forthcoming if documentation of surviving information and data is not urgently documented. Hence, this project fulfills the demand for research and rescue (intervention) works of Portuguese national heritage.

The presence of rock shelter was identified by chance by Filipe Paiva (2008/9) who documented the overall archaeological and geological makeup of the area and finally came up with Lower Paleolithic evidence.

Objectives

The objective of the research is to document the Schematic Rock Paintings in Cascata Rock Shelter in Lousã, Central Portugal. The specific objectives were to:

- ✓ Digitally document in 2D and describe the figures, panels, and the rock shelter.
- ✓ Frame the styles of the paintings and the chronology of the site.
- ✓ Contextualize an interpretation of the site and its art in the larger context.
- ✓ Access the archaeological potential of the shelter for future research.

1.3. Archaeological research history of Lousã

Until 2008/9, Lousã had been considered as devoid of tangible prehistoric archaeological evidence. This assumption was supported by the fact that the majority Lousã geology is schists dominated, which is not fit for megalithic monuments and shelters with less probability to survive and retaining the archaeological record. Álvaro Viana Lemos known for work "*Lousã and its country*" dated in 1956 and edited in 2001 also supports this assumption. Before the exploration by Filipe Paiva under "*Subsídios para a Carta Arqueológica do Concelho da Lousã"* the area was only known for Roman Age and Bronze Age and following period heritages. As cited in Filipe Paiva (2008/9), prospection work was carried out in the 1980s (Corte-Real, A. 1984) and 1990s. There are also active research and monitoring projects. Especially, the project (PNTA 09) elements of the archaeological charter of Lousã aiming to build a database of Pleistocene and Holocene contributes much to the knowledge of the territory.

The work of Filipe Paiva (2008/9) "*Contribution to the study of the Prehistory of Vale do Ceira History of Ceira Valley: The lithic industries of Quinta do Conde de Foz de Arouce*"opened a new chapter for the prehistory of Lousã. His findings contradicted the previous assumption mentioned above that Lousã is bare of prehistory. The author came up with 67 lithic tools findings. Methodologically, used prospection, excavation (small scale in some spots), techno-morphological analysis, traceological analysis, and phytolith analysis. His analysis confirmed prehistoric (particularly Pleistocene) exploitation and occupation of the area. He also forwarded recommendations for further studies in the area.

1.4. Geography, geology, and geomorphology of Lousã municipality

Geography

The municipality of Lousã is in the center of Portugal, bordering other municipalities such as Coimbra to the north-west, Vila Nova de Poiares to the west, Góis to the south, Castanheira de Pêra to the east and Miranda do Corvo to the north-east. Lousã municipality is the seat of a county of 6 parishes: Lousã, Casal de Ermio, Serpins, Vilarinho, Foz de Arouce and Gândaras. The landscape of Lousã is characterized by hills and mountains that form part of the Serra da Lousã, an extension of the Serra da Estrela. This mountainous topography offers panoramic views and opportunities for outdoor activities such as hiking and nature tourism. The municipality is crossed by several watercourses, such as the Ceira River, which is important for the region's water supply and agricultural activities. Lousã has a Mediterranean climate, with hot, dry summers and mild, rainy winters. These climatic conditions favor agriculture and the production of wine, olive oil, and other agricultural products.

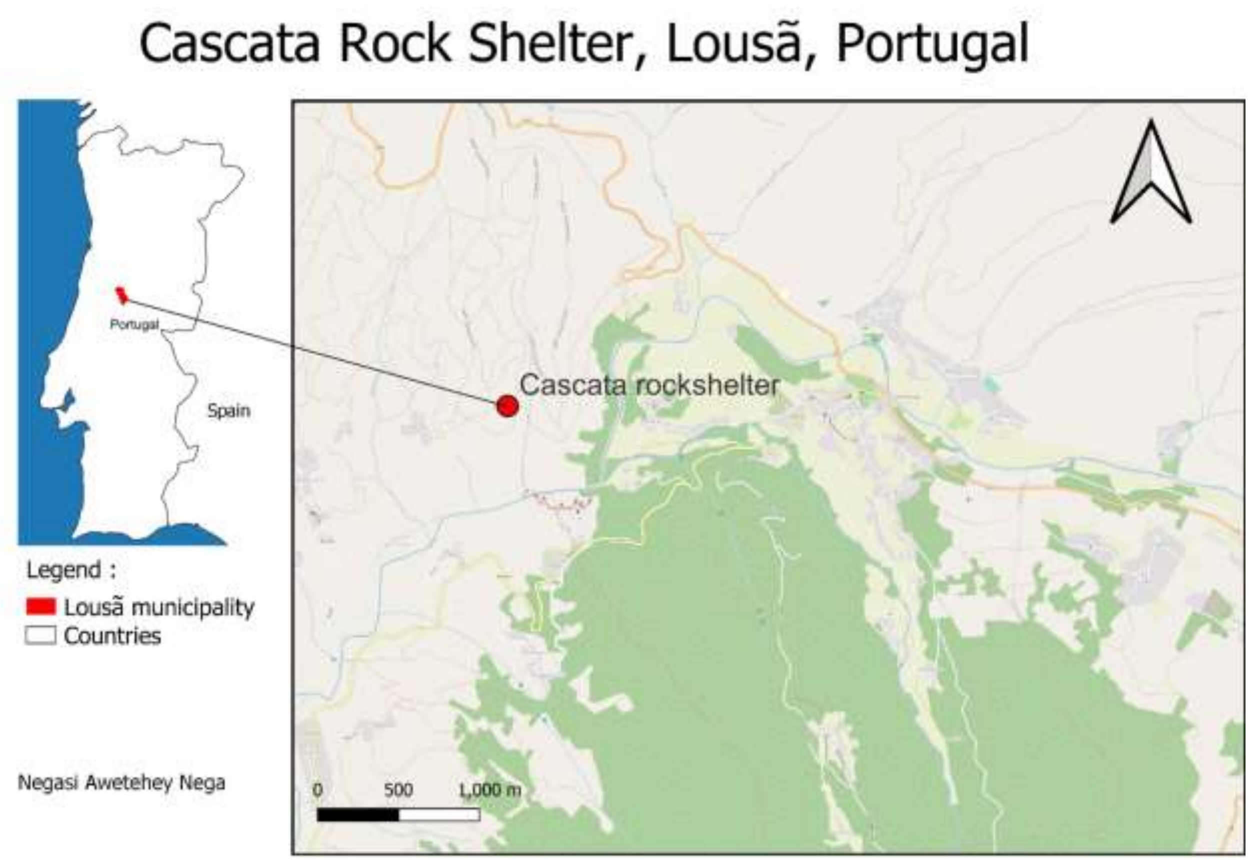


Figure 1 Location of Cascata Rock-shelter, Lousã, central Portugal (Negasi Awetehey, 2023).

Geology

Geologically, Lousã presents a wide variety of lithologies formed because of dynamisms, for example, Beiras Group and the Coentral granite. The predominant ones are metasediments belonging to the Beiras Group (Soares et al. 2007). It has a basin that is part of the northern edge of the cordillera central and its mountain range which has highest peak of 1204m. It covers about a third (75%) of the area of Lousã. It is composed of schists and ante-Ordovician Grauwacks and frequently crossed by quartz veins with various directions and thicknesses (from a few millimeters to more than 20cm). The mountain ranges from Hesperic massif of a variscan tectono-structural structure in the western edge of the massif is in the Porto-Coimbra-Tomar sheer zone. It is documented that neoprotereozoic metasediments of the shist greywacke complexas well as meta-sedimentary outcrops of late Paleozoic specifically, Ordovician, Silurian, and lower Devonian ones (Pereira et al. 2004).

In the southern part of the Lousã mountain (Serra da Lousã) and in the northern part of the study areais a sandstone. In the extreme east, however, there are some important quartzite alignments, that go from the Penedos de Góis to the Serra do Buçaco. These elongated reliefs, with NW-SE orientation, generally rise 200 to 300 meters above the surrounding schist valleys and where are the formations of the Quaternary formations resulted of the fluvial network (Cunha et al., 1997).

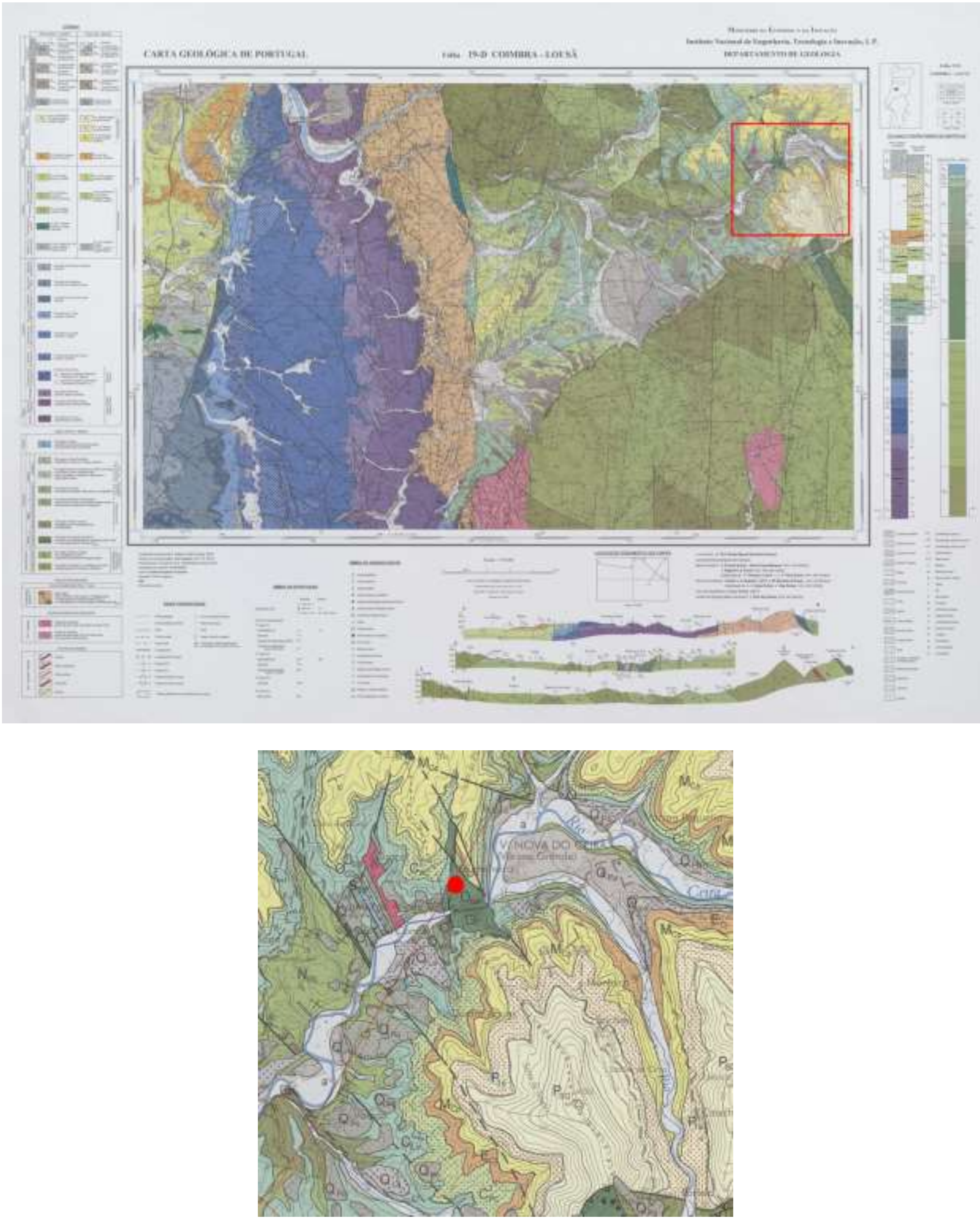


Figure 2 Geological map Coimbra-lousa (top) and location quartzite shelter (below)

A significant feature of Lousã is Ceira Valley which is one of the geomorphologically prominent settings. It is one of the main tributaries of the Mondego River; it crosses the right shear of Porto-Coimbra-Tomar. The Ceira River passes through areas filled with Cretaceous Units of the continental basin of Lousã and conglomerates deposits of Pleistocene fluvial fit (Rocha et al., 2020). The area has multiple fluvial terraces (Cunha et al., 1997). Throughout the fluvial terrace, were found, archaeological artifacts like pebbles of rolled quartz, and pebbles made of shale, sandstone, and a lot of quartz mostly hyaline quartz, with some blocks having considerable dimensions and already very rolled (Paiva, 2009).

The landscape of Senhora de Candosa in which the Ordovician quartzites of the Hesperic massive are predominantly found in a deeper setting; Ceira River itself; Cabril of Ceira in the depression that can be seen from Senhora da Candosa, and the Cabril Ceira where the valley presents itself embedded in the Ordovician quartzites (Rocha et al., 2020).

To sum up, geologically, the studied area shares the scenario that two very different morpho-structural units coexist, the Mesocenozoic Sedimentary rim (1) and the Iberian Ancient /Hesperian Massif (2), which present rocks from quite different lithologies and different chronologies**.** To make a detail, the Mesocenozoic Sedimentary rim is dominated by sedimentary formations primarily consisting of sandstone, conglomerates, limestones, dolomitic, marl, sandstones, and sands. The Iberian Massif, however, predominates crystalline formations, consisting mainly of magmatic rocks based on granitoid and metamorphic rocks, consisting of schists, greywakes and quartzites (Daveau,1985/86). Specifically, the area where the Cascata rock shelter is found the rock support is quartzite.

2. CHAPTER TWO – IBERIAN PENINSULA SCHEMATIC ROCK ART – THE CONTEXT

2.1. Schematic Rock Art: An Introduction

There are various ways of classifying and naming post-paleolithic rock art in the Iberian Peninsula. According to Behrmann et al. (2017), there is a classic and foundational concept of categorization: macro-schematic and Levantine art which is in favor of long-duration graphic expressions found all over the Iberian Peninsula. Not only that but rock art package in the Iberian Peninsula has through time entertained different types of classifications. Dominantly classification is based on style or stylistic tradition, the ways things are done, and to a lesser degree by chronometric dating and excavations. For example, Rey et al. (2022) to date schematic rock art, excavated stratified deposits that give a potential date to a period of Early Neolithic and late Neolithic/ copper age.

The traditional difference between paleolithic and post-paleolithic (sometimes post-glacial) art has been based on their locations, the former was found in enclosed spaces i.e., caves whereas the latter is in the open air. This is an obsolete one as we obviously have paleolithic graphic sequences that are also found in the Tagus and Côa rivers basin in engraved outcrops in the same space as panels of schematic art (Gomes 2001). Rock shelter sites have been used for continuous occupation. The intensity and frequency of occupations of certain areas can be witnessed from the numerous rock shelters with Levantine and Schematic Art in the area like Cueva de los Lefreros and Cueva Chiquita. Chalcolithic occupations were the result of previous knowledge and marking of the territory based on their use by upper paleolithic hunters (Behrmann et al. 2017: 119). The same author adds in areas near Cadiz corpus of rock art, a paleolithic one is found in the same panels with schematic art which is further evidence of graphic marks and their permanence in the traditional territory. Alves (2009) who intensively studies northern Portugal mentions this part of Iberia as an area of confluence of two arts: Atlantic art and Schematic Art especially in Northwest Iberia. Hence, it is commonly understood that there are cases in which schematic art panels share the same surfaces or panels used by Paleolithic hunters. The Mediterranean Spain schematic art shares the same territory as Levantine art (Hernandez, 2006; Behrmann et al. 2017). Some regions could even have rock art of all time and types. For example, Andrea Martins (2018) states rock arts in southwestern Portugal are several chronologies from the Paleolithic to modern times. A newly identified rock art in Sever River (Montalvão, Nisa), contains rock art of both ancient and modern ones (Chulem-Chaya**,** 2022). The Côa rock art is also complex the oldest rock of the upper Paleolithic and schematic rock art (Zilhão et al. 1997; Sanches et al. 2022).

Despite the shared nature of both arts, the endeavor to characterize the graphic transition of paleolithic to post-paleolithic has begun to be formed because of stratigraphy, radiocarbon dates, as well as direct chronometric dates in caves, and analysis of graphic sequence on the same surfaces (Behrmann et al. 2017).

The post-paleolithic groups in the Iberian Peninsula are useful to define ancient artistic groups through their technical, characteristics, iconography, and geographical distribution. Between the 6th and 3rd millennia BC, the various agropastoral communities created different schemes for the anthropization of the landscape by making their own iconography in certain places which overlap chronologically and territorially. Schematic art due to its heterogeneity character is divided into several cycles defined by technical and geographical parameters that are given different nomenclatures such as megalithic art, black subterranean schematic art, abstract schematic or linear schematic, Atlantic art, Galician art, etc., (Martins, 2015). For this thesis, the Iberian post-paleolithic schematic art is presented.

The evolution of the Neolithic era within the Iberian Peninsula, as mentioned above, displayed a diverse array of rock art styles, one of which was the Schematic Art. It underwent several phases, initially emerging alongside livestock and agriculture during the Neolithic's egalitarian and tribal societies, then evolving through the hierarchical societies of the Bronze Age, before eventually declining (Martinez-García, 2018). Its complexity arises from the diverse composition of elements, including anthropomorphic and zoomorphic figures, sun-like shapes, as well as more recent additions like bi-triangular motifs, deer depictions, and sun-eyed figures, among other figures (Perelló, 1993; Collado et al. 2015). These images have been approached from various angles, such as symbolic and social, often serving as important indicators of communication routes within their geographic contexts. Many scholars view schematic art as a form of symbolic expression, divorced from reality and entirely abstract. This style exhibits a gradual reduction of intricate details, ultimately resulting in highly condensed patterns. This perspective is shared by authors like Acosta Martínez, 1968; Martins, 2014, 2015; Collado, 2016; Garcês 2017; Martínez García, 2006; 2018).

Figure 3 the most representative painted schematic motifs in Passos mountain rock shelters. (Sanches et al. 2013)

Some images of the different figures that can appear in schematic rock art.

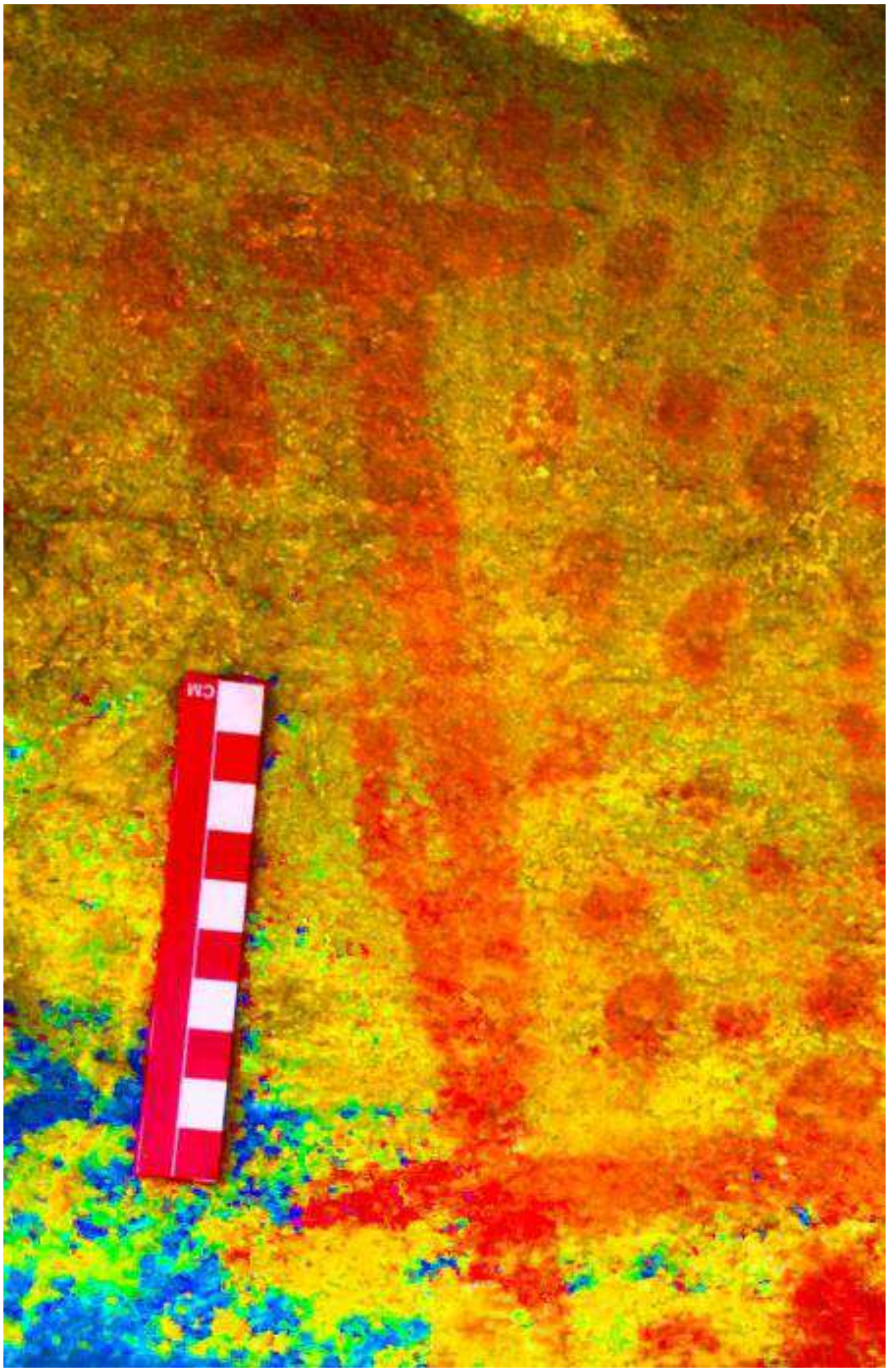


Figure 4 Lapa dos Gaivões (Martins 2015).

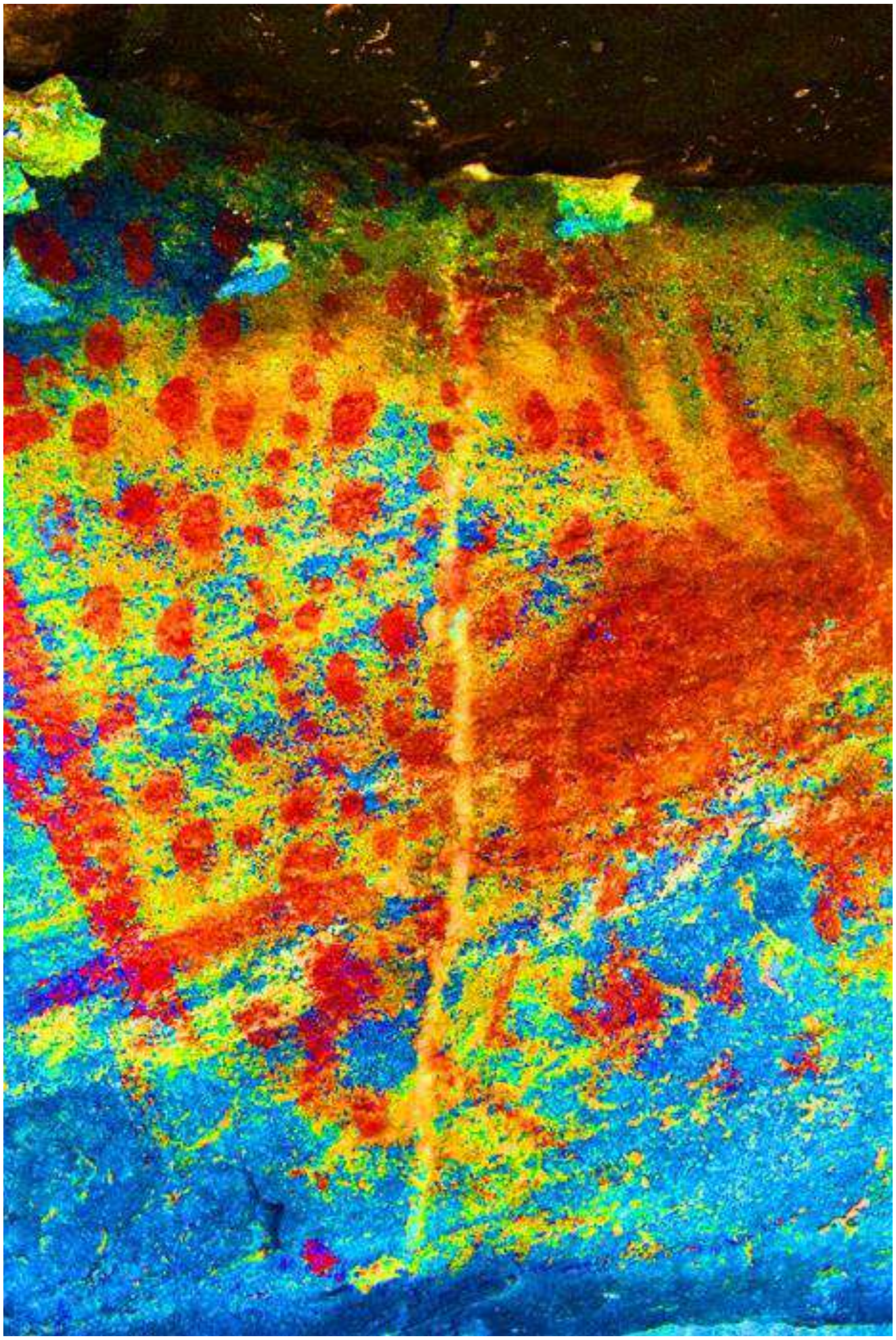


Figure 5 Lapa dos Gaivões (Martins 2015).

2.2. History of Research

Research on schematic art in the Iberian Peninsula has a long tradition starting in the first decades of the last century (Breuil, 1933). During this, more than a century of research, different documentation methods have been implemented while interpretive trends were applied along various stages of investigation (Collado, 2016). Sanches (2012) mentions that each chapter of rock art research history reflects the contemporary value that was given to art.

Despite early descriptions of sites, only from the 1st decade of the 20th century is considered the beginning of schematic research as part of Iberian prehistory (Saura et al. 2014) specially after the Breuil works (Collado 2016). Scholars like Henri Breuil are considered as the pioneers (1933-35). Historiographical analysis of schematic rock art research in the case of Badajoz, Spain, shows that research on schematic art began with an interest to understand post-paleolithic rock art (Collado 2016). At the Iberian level, in recent years, especially in 2000-2010 the schematic art phenomena has got great attention to understanding a broader vision and knowledge (Dominguez-Garcia et al. 2010). It already has become part of the archaeological heritage and research of the Iberian Peninsula. Throughout the 20th century post-paleolithic rock art research was dominated by perspectives that privileged the analysis, description, and classification of individual motifs and their statistical treatment as an end approach like that on artifacts. In fact, research on schematic art has grown diverse in methods and approaches. For example, Reus et al. (2017) sees rock art as a reflection of art, architecture, and landscape that requires a dialogue approach of three levels: figure, site, and landscape (Reus et al. 2017). Currently, there are numerous studies and publications on unique schematic rock art sites or regions approached as a whole, especially in Spain with a greater number of researchers and a greater number of sites of the same art (Martins, 2013). Regarding its interpretation and correct integration into artistic cycles frequent attempts were made but still need work (Martins, 2011). Only in the last decade, research on post-paleolithic art has adopted an exhaustive approach providing a sociocultural interpretation of the art and proposing time frames (Martins, 2019, 2020; Collado 2016).

2.3. What is schematic Art?

Schematic art is an artistic tradition that exists throughout the Iberian Peninsula and has technical, morphological, and chronological particularities (Hernández Pérez, 2006; Martínez García, 2005; Collado Giraldo, 2006; Garcês, 2017; Martins, 2020). It is a phenomenon that includes numerous post-paleolithic figurative horizons of various chrono-different territorial distributions and different technical systems where the common denominator is the production of their motifs through a scheme. The unifying characteristics of the formal simplicity of anthropomorphic and zoomorphic representations are reduced to their basic characteristics. Geometric and abstract figures become the majority. It includes geometric designs predominant with varying patterns such as ladders, angular lines, zigzags, crosses, grids, meanders, handprints (Perelló, 1993; Alves, 2005; Collado 2016). In schematic rock paintings, one of the most striking characteristic elements of the motifs is their small size which for the most part ranges from 10 to 15cm and the colors in which they are painted: flat paintings in predominantly reddish colors which varies from wine red to blood red or light red followed by oranges and yellows (Sanches et al. 2022). As compared to Paleolithic art created by mobile and roving societies, the schematic art of neolithic/chalcolithic period had star-shape-like motifs which became a symbol of a new cultural dimension, time as a calendar, and a new cultural tool (Fernandez Quintano, 2013).

2.4. Distribution, Chronology, and style

Schematics art includes megalithic art and arts on objects like ceramics which are common in some chalcolithic contexts.

Schematic art style attained a larger geographic range and can be found throughout the Iberian Peninsula, from the Mediterranean coast to the Atlantic in the lands around Cadiz to the northern reaches of Castilla-Leon (Mateo Saura, 2014: 169). Its concentration takes place spatially occupying a riveting position or along with geographical units towards the basin of the Southern half of the Peninsula (García Arranz, 2018). Schematic rock art appears as paintings and engravings on all spaces: shelters, caves, mobile supports, artifacts, and megalithic monuments. It can be found can be found in almost the entire peninsula territory (Andrea Martins, 2013; 2015). In the eastern façade of the Iberian Peninsula only there are 500 sites mentioned, Alicante, Valencia, Castellon, Murcia, Albacete, Cuenca, Aragon, Catalunya (Pérez, 2006). It is concentrated in the central mountain ranges of serra Morena and mountain ranges of the Tagus, Guadiana, Guadalquivir, and Douro valleys, and appears in Cantabrian belt, in the Meseta Norte and in entire Levantine area (Martins, 2020). Collado Giraldo and Garcia Arranz (2012), mention

Iberian peninsula's hunter-gatherer societies of the Holocene epoch cover grand expanse of the length and breadth of the peninsular territory.

With regards to chronology, they are labeled also as "later prehistoric rock art" according to Dominguez Garcia et al. (2010). She also states that Schematic Rock Art has a wider span of time and evolution from the very ancient phase of the final neolithic to much more recent phases of the final bronze age (Garcês, 2017; Collado, 2016) and reflect different conventions of the paintings.

Similarly, Martins (2013) justifies the combined iconographic, stylistic, and archaeological evidence allows us to frame the art in the schematic rock art style which is associated with recent prehistory. These are the expressions used by the 1st farmers' or herders' communities, where the symbolic subsystem has undergone a deep change compared to the predecessor's one-paleolithic art. In other words, they are manifestations and symbolic subsystems of the social and economic rapture that occurred after the transition to the Holocene period (Martins, 2015; Alves, 2012).

Stage	Type-name and chronology	Typology	Characteristics
I	Ancient Schematic (Early Neolithic)	Symbolic	• Dots, • Line(s) • Sun, • Figures
II	Medium Schematic	Symbolic, Iconographic Scenographic	• Animal and human figures • The scenography of the panels
III	Recent Schematic	Thematic, Scenographic, Iconographic, Symbolic	Similar to the older chronology
	(End of Bronze age)	Ethnographic	• Weapons • Horned helmets • Chariots

Table 1 Scheme proposed for the three different stages of schematic art a figurative diachronic sequence (Collado, 2016).

Type of Sites	Morphological classification	Visual context and typology	Themes
Concentration sites	▪ very big. ▪ >10 m in height.	▪ Strategic ▪Presence of superimposition	▪ Iconic ▪ Anthropomorphic ▪ Zoomorphic ▪ Abstract
Indicator sites	▪ Not more than 10 m ▪ Small areas ▪ Leaning walls	▪ Spacious ▪ Occasionally invisible because of vegetation ▪ Mainly red pigment ▪ Constrained use	▪ Schematic ▪ The rare appearance of anthropomorphic or zoomorphic motifs
Moment shelters	▪ Smooth walls leaning slightly ▪ Not exceedingly more than 10m	▪ Main indicator as transit through the territory ▪ Possible access, not so complicated ▪ Seasonal shelter utility	▪ Repetitive alignment of vertical strokes ▪ Anthropomorphic and zoomorphic figures accompanied by symbolism.
Intimacy sites	▪ Small protective areas ▪ Small cavities ▪ A small dimension not suitable for human	▪ Reduced visibility ▪ Not useful as shelters ▪ A not a large number of figures	▪ Diversity of techniques with thin and thick strokes ▪ Red chrome as well as black and white ▪ Single iconography ▪ Absence of zoomorphic ▪ Anthropomorphous and schematic ▪ Singular depictions without any typological classification

Table 2 Functional classification for schematic rock art proposed by Hipólito Giraldo Collado (2016)

2.5. Context and Interpretation

Martins (2019) underscores that the 3rd millennium BC is a moment of deep changes in contemporary society as can be seen from settlement and funerary spaces, material culture perhaps simultaneous with the boom of arts as a unifying element. This is a perspective that sees the symbolic objects and the sites with rock art as part of the same chalcolithic conceptual universe. It implies that this time had a revolution traditionally characterized as technological and economic, the symbols seem to be preponderant being side by side with all the evolution as well as consequent collapse.

In the Iberian Peninsula, for example, in Portugal territory, schematic art is helpful in defining typological characteristics, chronology, and geography (Martins, 2011). Sara Garcês (2017) states that Portuguese territory has at least 70 painted schematic art sites. Their iconography is basically, despite some variations, homogeneous with the engraved ones. That is a result of communities unifying the conceptual universe that lived in those territories during recent prehistory.

Out of the whole schematic rock art, the schematic painting art is also emerging as one of the best styles known in Portuguese territory. In fact, it yet needs a particular synthesis. There are shelters with schematic painted art throughout Portuguese territory whose typological and morphological characteristics fit several prehistoric periods and communities (Martins 2015). The life of prehistoric populations from the Early Neolithic to late Chalcolithic can be achieved after a comprehensive study of certain symbols expressed in schematic painting art.

Different site or region-level research on schematic art dealt with contextualizing and integrating the art. For instance, Alves (2009) dealt with how the material and immaterial properties of rocks relate at art sites and discuss the extent to which such analysis may inform us about the social roles that art had through time. Sanches (2022) mentions recent perspectives and how schematic rock art can be interpreted:

- When was it made?
- Which people or individuals made it?
- How did they live?
- Were they hunter-gatherers?
- Were they farmer herders or metal workers?

- What are the origins of these people?
- What did they draw? Or paint? Their everyday lives? Their myths?
- What are the representations that as discoveries emerge are shown stylistically to make a way from the naturalism of the upper paleolithic especially animals and tend to move towards geometric drawings?

2.6. Schematic Art in a Landscape Context

According to Alves (2005), Schematic Art in a landscape context can be characterized by taking the example of Schematic art in painted rock shelters considering the following criteria:

- Locations that are enclosed or with the dominant landmark of a wider landscape encompass a concentration of schematic rock art shelters.
- Even though the indicators of the geomorphological features are visible from a distance, there is a sort of curtailment on the outer view of the rock shelter.
- Even though the rock shelters have a pronounced location, the valleys, and basins can be accessible and contribute to a major route of movement through the landscape.
- The placement of rock art itself in such sites is usually near the entrance proffers an outlook of open space since it directs one to look outwards.

3. CHAPTER THREE

Methodology

The shelter size is very big and 18 meters deep. The height from the soil decreases as it goes from entrance to end; it has converging ends. It is very spacious and with a variable depth which makes photography and photogrammetry reconstruction difficult. The methods used for the shelter and the rock art are justified below.

3.1. Field sheet

When one locates a rock art site, it is necessary to record it thoroughly considering all the basic information provided. To have a customized recording sheet is necessary to follow internationally or nationally standardized recording sheets. The goal is to ensure better compatibility when one creates a database that covers all the basic information (Smith *et al.* 2017). These recordings also help in knowing about the status of preservation or variables in case of fractures, conservation issues, and geomorphological changes in the shelter. This could also help overcome, be a backup, the shortcomings of other digital recording methods. To have transparency in recording and preparing reports, customized field sheets were already in the kit.

In the rock shelter under study, we used the following standardized sheets which share common variables with other sheets used by other rock art researchers. The field form was prepared in Spanish and then filled out in the field and translated into English (check table 1).

3.2. Planimetry of the shelter

The topography of the rock shelter, which is exceptionally wide, is done as part of the documentation. First, the shelter was divided into two halves (Sections A and B) that form the baseline for points to be taken on both sections. The points taken were the contour of the floor ends. The other half for better management was again divided into two created new section of A-B. Hence, the same points were taken from this arbitrarily established line. From the entrance point (the zero) where the baseline starts, the archaeological materials and panels are mapped in the paper. In taking distance points from the baseline reading, prism light was used. This method is a simulation of the archaeological excavation gridding. All are recorded on drawing paper with a common scale of 1:50.

This planimetry was to locate and identify the surface collections, the panels and delimit the floor contours. Given the shelter was so large that it was necessary to make a planimetry for the left half of the shelter and another for the right half of the shelter and another in the middle to be able to put the whole drawing together in the laboratory.

<table>
<tr><td rowspan="3">Name of Rock Shelter:</td><td rowspan="3">Coordinates</td><td colspan="4">X:</td></tr>
<tr><td colspan="4">Y:</td></tr>
<tr><td colspan="4">Z:</td></tr>
<tr><td rowspan="5">Municipality:</td><td rowspan="5">Type of rock shelter:</td><td colspan="4">Cave:</td></tr>
<tr><td colspan="4">Shelter:</td></tr>
<tr><td colspan="4">Vertically inclined wall:</td></tr>
<tr><td colspan="4">Small room:</td></tr>
<tr><td colspan="4">Dihedral Vertical walls:</td></tr>
<tr><td rowspan="3">Mountain:</td><td rowspan="3">Dimension:</td><td colspan="4">Length:</td></tr>
<tr><td colspan="4">Height:</td></tr>
<tr><td colspan="4">Depth:</td></tr>
<tr><td rowspan="3">Rock shelter visible</td><td>Entrance or nearby:</td><td rowspan="3">Intervisible with:</td><td>shelters</td><td></td><td>General orientation:</td></tr>
<tr><td>Medium:</td><td rowspan="2">Villages</td><td rowspan="2"></td><td rowspan="2">Open from:</td></tr>
<tr><td>Far away:</td></tr>
<tr><td rowspan="7">Panel sketches</td><td colspan="4">Visibility from the shelter</td><td></td></tr>
<tr><td colspan="4">Large:</td><td rowspan="3"></td></tr>
<tr><td colspan="4">Medium:</td></tr>
<tr><td colspan="4">Reduced:</td></tr>
<tr><td rowspan="3">Panel no.</td><td colspan="3">Color</td><td rowspan="3"></td></tr>
<tr><td colspan="3">Orientation:</td></tr>
<tr><td colspan="3">Inclination:</td></tr>
</table>

<table>
<tr><td rowspan="8"></td><td colspan="3" rowspan="3"></td><td colspan="2">Altitude:</td><td rowspan="2"></td></tr>
<tr><td colspan="2">(width):</td></tr>
<tr><td colspan="2">Hight from the soil:</td><td></td></tr>
<tr><td colspan="3">Conservation</td><td colspan="2" rowspan="4">Factor/ cause:</td><td rowspan="4"></td></tr>
<tr><td colspan="2">Good</td><td></td></tr>
<tr><td colspan="2">Regular</td><td></td></tr>
<tr><td colspan="2">Bad</td><td></td></tr>
<tr><td colspan="6">Localization of the panel</td></tr>
<tr><td rowspan="5"></td><td colspan="5">Number of figures</td><td rowspan="5"></td></tr>
<tr><td rowspan="3">Type:</td><td colspan="4">Anthropomorphic:</td></tr>
<tr><td colspan="4">Zoomorphic:</td></tr>
<tr><td colspan="4">Schematic:</td></tr>
<tr><td>Color/es</td><td colspan="4"></td></tr>
<tr><td rowspan="6"></td><td rowspan="2">Superposition</td><td>Si</td><td>No</td><td colspan="2" rowspan="2"></td><td rowspan="6"></td></tr>
<tr><td></td><td></td></tr>
<tr><td rowspan="4">Conservation</td><td colspan="2" rowspan="2">Good:</td><td colspan="2">Cause</td></tr>
<tr><td colspan="2" rowspan="3"></td></tr>
<tr><td colspan="2">Regular:</td></tr>
<tr><td colspan="2">Bad:</td></tr>
</table>

Table 3 format of the field form used for the panels

Figure 6 The shelter and its width at the entrance (Photo by Hipolito 2023).

Figure 7 Planimetry via simulation of the archaeological excavation gridding (Photo by Hipólito Collado, 2023)

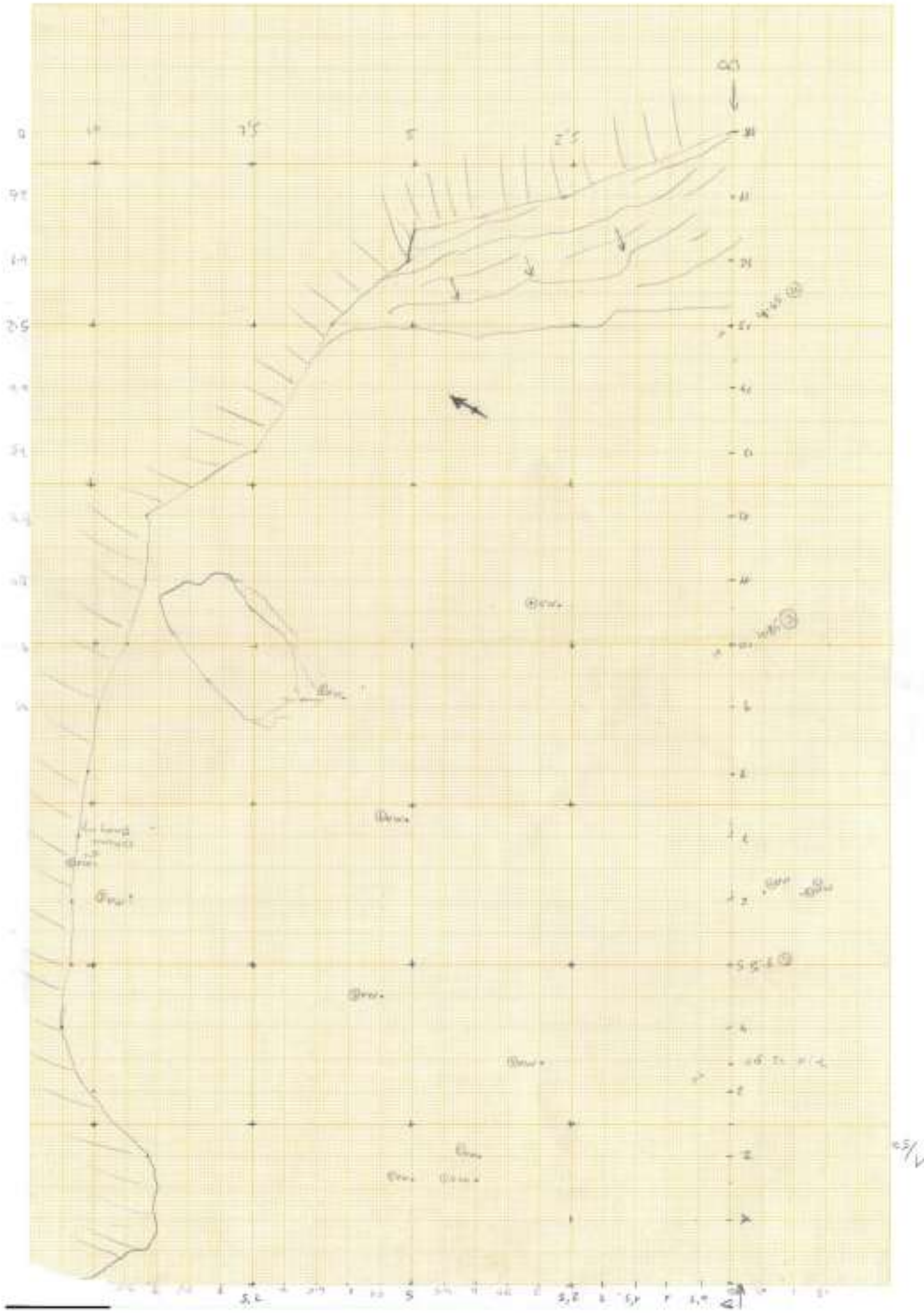


Figure 8 Section A of the Shelter via graph paper.

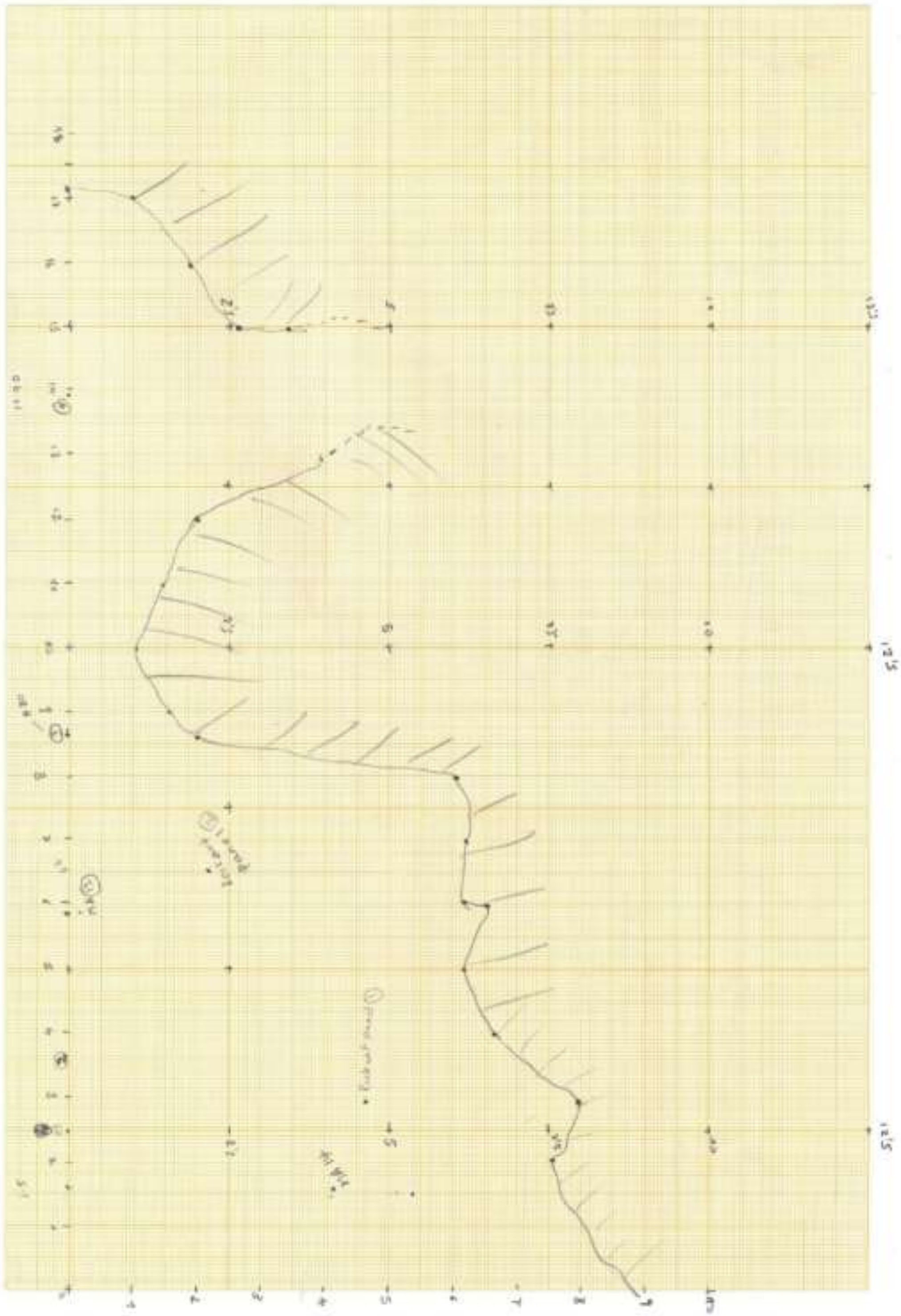


Figure 9 Section B of the Shelter via graph paper

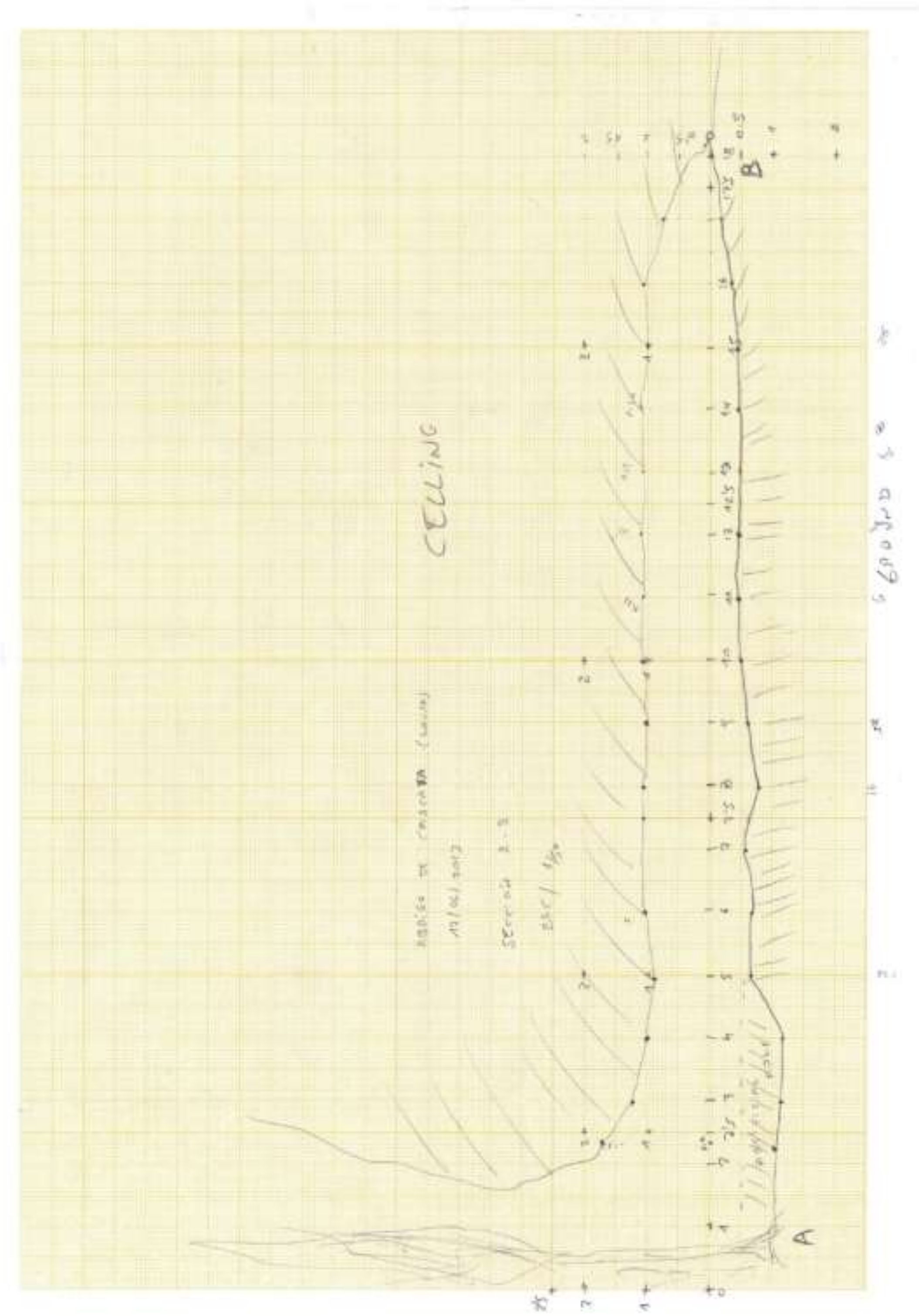


Figure 10 Section A-B of the Shelter via graph paper

Because of the fact that 3D photographic reconstruction was impossible due to the unmanageable size of the rock shelter, paper-based-planimetry was supported by digital tracing in Adobe Photoshop. The drawing was digitally redrawn and compiled into a single record.

3.3. Photography

It may be thought photography results in the same results of resembling what human vision and eye create. But a photograph, a widely used tool, contains more heavy information than can be detected by the human eye. But it is also noteworthy that photography is in tune with human vision and does not mean that it is objective (Bednarik 2007:77). More importantly, with the advancement in such a digital world and its ability to adapt to artificial lights and settings, digital photography has carved its niche and retained to be one of the principal methods of documentation (Domingo Sanz, 2014).

One of the most important aspects of rock art research is the documentation of a site, its motifs and panels, and its surrounding environment. For decades, researchers have sought ways to accurately record these elements using systematic methods. These endeavors have resulted in an enormous body of literature relating to the various tools and strategies available to the researcher in their quest to produce a 'complete', or as close to complete as possible, record of a rock art site. Two major periods of rock art recording can be discerned in the literature: a pre-digital phase in which recording projects relied primarily on manual methods (e.g., sketching, rubbing, tracing) combined with film photography, and the digital era that includes the use of high-resolution digital cameras, laser scanners, and image enhancement and manipulation software while still incorporating aspects of manual documentation (Brady et al. 2017). Cameras are useful to generate both accurate and dense DEMs and orthophotographs which can record detailed morphology and generate three-dimensional visualizations (Chandler and Fryer 2005).

The photographs taken are landscape photography, rock shelter photography, panel photography, and microphotography or figure-level photography. In addition, sample findings collected from the shelter and activities of the documentation by the team are photographed.

Figure 11 : Photography showing the extent of the mouth of the rock shelter (Photo by: Collado 2023).

Figure 12 landscape photography (Photo by: Collado, 2023).

In the photographic documentation rock art and shelter, we used the camera CANON EOS 6D MARK IID and lens CANON EF 24/105. The photographs of the rock art panels were taken by archaeologist Hipólito Collado (PhD). The camera was installed with the DStretch® which enabled to find new panels as well. Besides, the location of the painting was such that one could not stand and fix a tripod in most of the photo shots on account of its spatial dispersal.

For the lithic and ceramic collections of the shelter, it was used CANON EOS 5D SR and lens CANON macro lens EF 100mm. The photographs were taken in the photography laboratory of the Polytechnic Institute of Tomar with the support of professional photographer João Corvo.

3.4. Pigment sampling

Gomes et al. (2015) explored the chemical and mineralogical qualities of sampled pigments from a selected number of sites within Spain and Portugal and found that pigmentation was more than just applying paint to rock. This implies a tiny pigment gives a dozen pieces of information which in turn addresses dozens of environmental, cultural questions, and operational chain questions.

With the main purpose of exploiting maximal information from material data, the advancement of the microscope is advantageous for archaeology. It is highly useful for art (Portable and rock art) analysis.

The study of rock art from the archaeometry point of view can provide contributions to the understanding of technological and cultural aspects. Analytical research on the pigments is to identify their chemical-mineralogical components. Because knowing the raw materials that were used in pigments in turn allows for understanding the technological innovations, essential for the development of human society adaptation strategies (Gomes et al. 2013). Pigment analysis has been used on a wide range of substances, such as paints, inks, dyes, and pigments. In some instances, a combination of both inorganic (mineral pigments) and organic (dyes) elements may be used to provide the color qualities. Several destructive and non-destructive procedures can be employed to analyze the pigment, depending on the chemical makeup of the pigment and its binder (Gomes et al. 2013). For example, the recent work of Garcês et al. (2022) identification of organic material in rock shelters is one example.

As is common for many rock arts, the pigment composition of the red paintings might suggest the use of red ochre, as widely evidenced in several studies on prehistoric rock art (see: Iriarte et al. 2009; Rosina et al. 2019). Gomes et al. (2013) state the archaeometry analyses carried out in different environments (the Iberian Peninsula and Africa: Ethiopia, Angola), using a micro-Raman spectrometer and X-micro fluorescence on pigment and ocher samples, showed that there are some elements that are common (iron oxides, mainly hematite) and others that are specific areas. We hypothesize this scenario will also work for Lousã rock shelter paintings too.

3.5. Sampling Protocol and ethical considerations

Before going to field work for sampling, an application was submitted to “Direção Regional do Património Cultural” (Regional Directorate for Cultural Heritage) to get permission for the level of study in the objective i.e. documentation. After granting permission we did the fieldwork. The Instituto Terra Memoria (ITM) in Mação is the responsible institution for the samples and publication of the results.

The sample collection is done using non-contact ethical extraction techniques in compliance with national and international guidance on sampling, to assure that the integrity of the paintings will not be compromised. Sample collection is undertaken using ethical extraction techniques followed by European Standards concerning sampling for the investigation of cultural heritage (EN 16085:2012). The panels and walls are all covered by soot and smoke from the forest fire. Hence, each sample, weighing between 10 and 100 mg, is extracted from areas where the pigment is observable from eye and DStretch® filter. It is in consideration that each sample is obtained by using a sterilized tungsten scalpel and inserted into 0,5 ml microcentrifuge tubes (we can see: e.g. Rosian et al. 2019; Groenen et al. 2016).

Samples were taken from two spots. One from the figure and the other from non-art but the same color. The goal is to check if both belong to the same raw material for example, or if both are the same as ochre.

With regards to the photography protocol for sampling, photos before and after sampling is taken. The exact spot where the samples are taken also is documented.

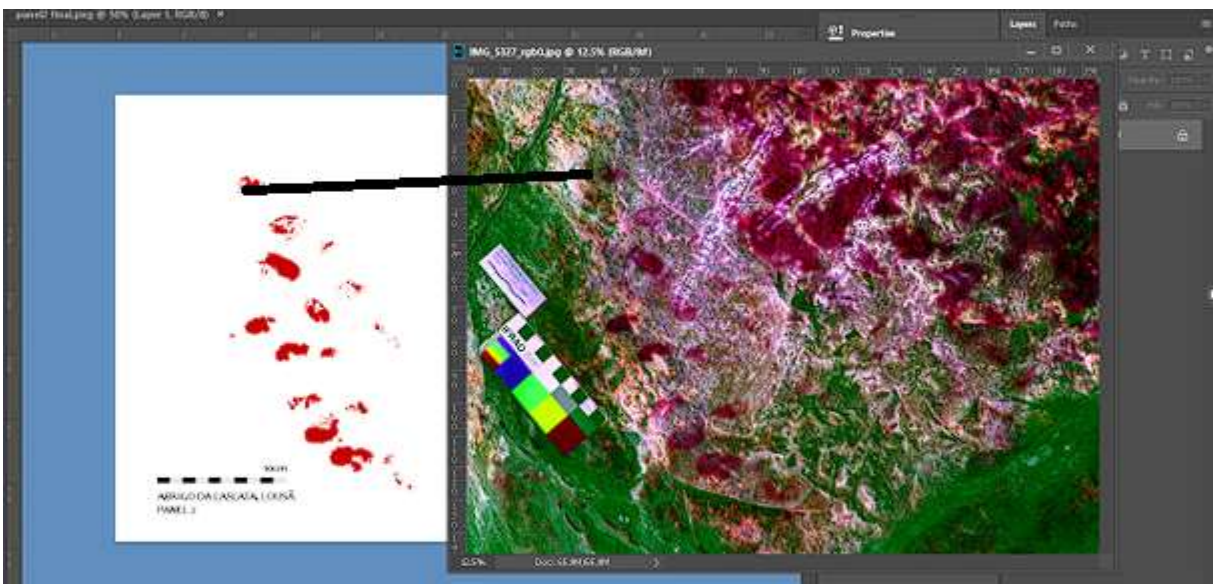


Figure 13 A spot where small sample of panel 2 pigments is taken (Photo by Hipólito Collado 2023).

For the analysis and characterization of the sampled pigment, Raman spectroscopy and FTIR spectroscopy will be used in complementarity. This, however, is not in the scope of this thesis.

3.6. Decorrelation DStretch Program

Principles and features

DStretch, an acronym for decorrelation stretch, is an image enhancement program. It is a plugin to another program called ImageJ© (a full-featured imaging program) and uses a technique called decorrelation stretch (Harman 2005). According to Gunn et al. (2010), this technique uses a multivariate Karhunen-Loève transformation, which is similar basics to Hotelling transformation and principal component analysis (PCA). The essence is that colors are usually highly intercorrelated in digital images captured also known as inter-channel- or band-to-band correlation, in which small differences between similar color hues may be difficult to distinguish or make contrast with the human eye (Harman, 2015). Hence, DStretch® in turn uses decorrelation to remove color correlation and highlight differences between hues.

It was developed by the Jet Propulsion Laboratory (JPL); the technique was first used to enhance remote multispectral images such as those taken by the Mars Rover. It has pre-set or default filters (IDS, IRE, YRD, YRE, YYE), in fact, could also be customized (Caldwell and Botzojorns, 2014). It is the perfect example that digital imaging has revolutionized rock art documentation (Quesada and Harman 2019). It is one of the most efficient, versatile, and feasible tools for digital rock art enhancement and deciphering faint paintings and sometimes engravings (Le Quellec et al. 2015). In actual terms, DStretch has been the standard for the enhancement of faint red ochre rock art images (Andrews and Brink, 2022).

On how it works, for accuracy we quote DStretch Algorithm Description or Harman, J., 2008. There are over 20 color spaces built into the DStretch and the decorrelation stretch algorithm produces different results in each of them. Moreover, it is crucial to note that enhanced images can be further edited by a range of color adjustment tools, which allows for modifying the vibrant colors of the enhancements or improving contrast, among other possibilities (Quesada and Harman 2019:4).

The "general enhancers" including LAB, LDS, RGB, YBR, YDS, and YDT, will improve the general hue contrast between colors, meaning that they will enhance multiple colors without suppressing others (Harman 2015).

Red: The LDS and YDT color channels are good at distinguishing between different hues of red (Harman 2015). If the focus is only on red, YRE works better than YRD. LRE, CRGB, RGB00, and LDS also work well, although they cannot distinguish between different red shades. YRE is sensitive to faint red, and YRD produces more natural images of red colors. When targeting red hues, the flattening option (Flat button) in DStretch® is not necessary.

Yellow: YYE is extremely effective at enhancing yellow hues, which will be transformed into distinct browns in the generated colorspace while suppressing black and red colors.

Black/white: Both blacks and whites are difficult for DStretch® to process due to a lack of actual color information. However, most archaeological objects do not display uniform blacks or whites. Color channels like YBK and LBK that suppress other hues can reveal good results for blacks, whereas LAB, LWE, and YWE can be useful for whites.

Application and Roles

DStretch can be used alone or in complementarity with others like digital epigraphy and gigapixel imaging, and retroReveal (see: Andrews and Brink, 2022) (a web-based program that has been used primarily for providing improved visibility of documents with faint text, including stamps, currency, etc). For example, Gonzalez et al. (2019) with the final goal to obtain precise documentation on post-firing painted pottery of the Late Bronze Age and Early Iron Age in the Atlantic façade of the Iberian Peninsula, uses all the methods: photogrammetry, DStretch, and the finally 3-D Modelling. To evaluate effectiveness, Domingo Sanz et al. 2015 explores the potential of two advanced digital image enhancement decorrelation techniques, principal components analysis (PCA) and decorrelation stretch (DS) to facilitate and accelerate motif recognition on visible digital images.

It is useful to check episodic superimpositions registered from the panels (see: Carden and Miotti 2020) and enhance the visualization of the overlapped motifs, rectifying some initial interpretations, and detecting new cases. DStretch® enhanced photographs of painted surfaces on Egyptian wall paintings (e.g. see Evans and Mourad 2018). Jacqueline DiBiasie Sammons (2020) applied to Campanian graffiti or dipinti with the goal of re-reading a painted Inscription from Herculaneum.

Reis et al. (2017) states the application of a new digital method of visualization of paintings, the DStretch maximizes the discovery of figures. For example, in panel 1 of Lapas Cabreiras, which visually seemed to be limited to more than half a dozen motifs and various incomprehensible stains, DStretch revealed approximately 180 different images, in a set anthropomorphic figure, groups of bars, hands, animals, various abstract figures and a solar figure. Helped to isolate overlaps and the use of different pigments and techniques, in what is undoubtedly one of the main schematic arts painted on Portuguese territory. Vahdati (2021) in his newly found rock painting work in northeast Iran states the application of a decorrelation stretch (DStretch) plugin allowed him to bring out more of the details of the depictions where images were faint and almost invisible to the naked eye previously.

Limitations

DStretch as a tool has become well-known in rock art research. However, it has limitations and serious disadvantages. It has limitations to the size of the pictures that can be read, primarily due to the use of 32-bit signed integers in Java to index the points. Generally, pictures about 1,6 GB can be easily handled with DStretch if working with x64 version of ImageJ. This is, therefore, a serious disadvantage for enhancing a complete gigapixel panorama with the plugin, since an image small enough to get used in ImageJ would be greatly compressed and resolution would be lost from the original image. A significant size reduction of the image in turn involves degradation of the color information and could negatively affect the enhancements Mark and Billo, (2002) cited in Quesada and Harman (2019). Also, Le Quellec et al. (2015) warn that despite the advantages, users must keep in mind that the final tracings are always subjective and biased by personal perceptions.

3.7. The use of DStretch in the Cascata Rock Shelter

Without the use of DStretch which we used both on-site on in the laboratory, confirming the presence and/or absence of panels as well as figures in the panels would not have been possible.

Seemingly blank panels or hard to visualize with our naked eye (e.g. figures in panel I) after trying many filters finally was decorrelated by labi filter that gave the white color of the figures.

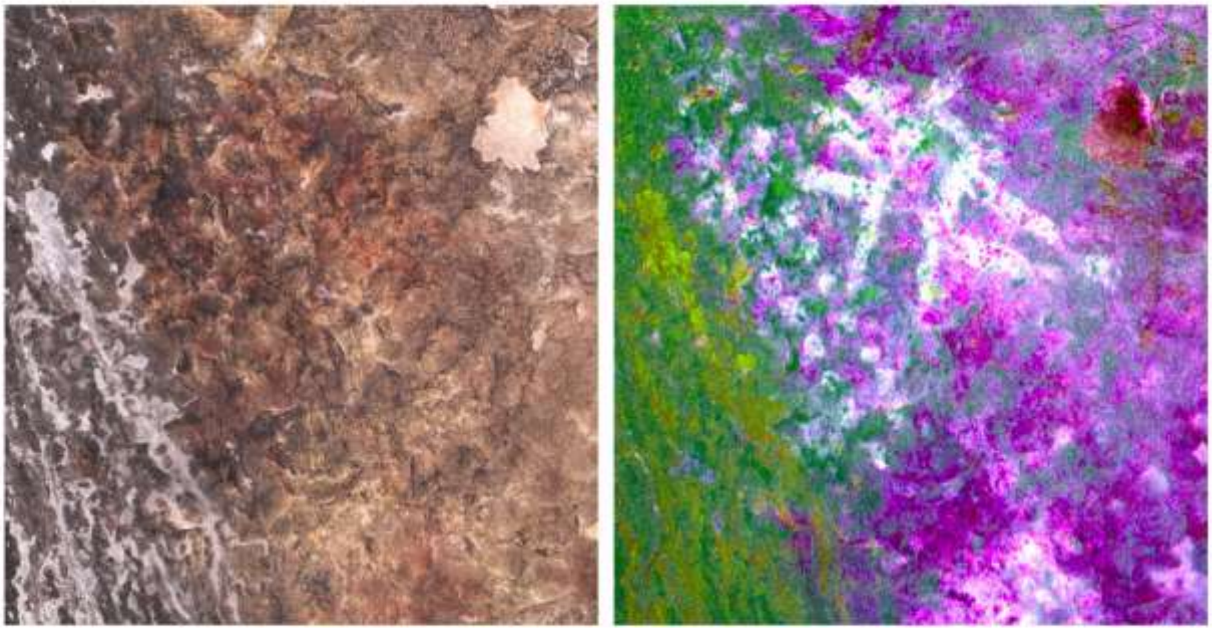


Figure 14 Panel I original Photo of panel I and its labi filter.

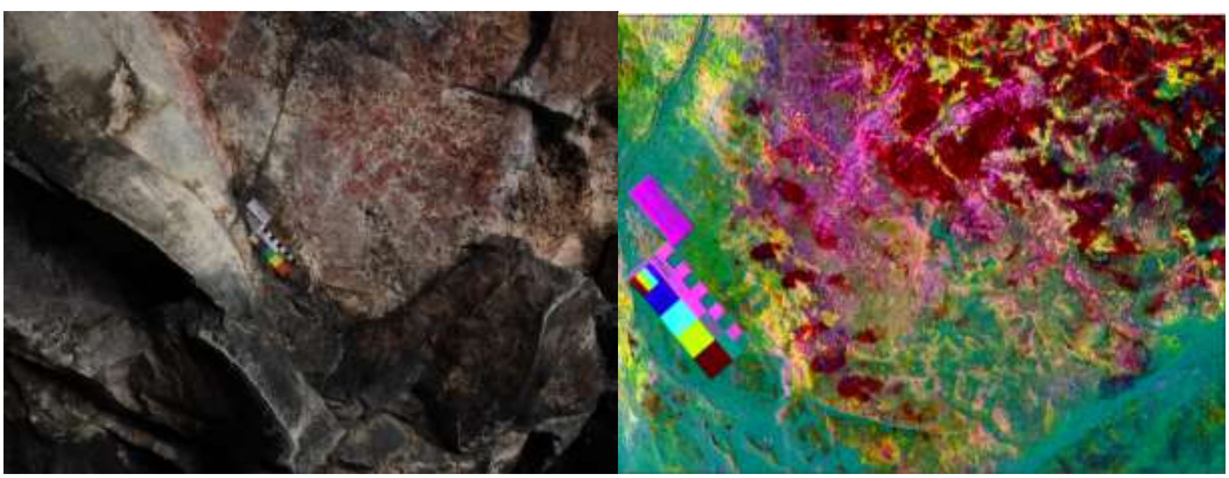


Figure 15 Panel II original photo; (B) DStretch result in RGB filter.

3.8. Adobe Photoshop®

Rock art is produced on active rock surfaces (affected by running water, surface exfoliation, etc.), which are constantly exposed to different natural and human altering agents gradually threatening and degrading the art. Today many researchers are using photo editing techniques to produce digital tracings of both rock art paintings and engravings. That is to maximize the information to be retrieved from the art and its material.

The common aim is to provide accurate working documents including interpretative readings of all the motifs, preserving their scale, regardless of their degree of preservation, visibility, or spectacularism. Furthermore, graphic recording also seeks to show visually the relationships among motifs (whether they are isolated or included in some sort of scenic or non-scenic compositions, as well as interpretative readings of superimpositions and the possible relations with the rock surface) (Domingo Sanz, 2015).

Adobe Photoshop® is a format that can preserve Photoshop data, such as layers, alpha channels, notes, and spot color. It is done by conventional tools which are present in software such as Adobe Photoshop®. The conventional tools are digital manipulators and contain various options such as Saturation, Brightness, Contrast, etc. It works on the macro aspect and isolates the motif depicted from the rock surface on which it is present; Pivots on the detailing (Domingo Sanz et al. 2015) and facilitates description and comparison with similar ones (Domingo Sanz 2013). The major tools used in digital tracing while using Adobe Photoshop® are:

- **Color range and magic wand tool:** It is one of the color selection tools which helps to extract the pigments from a certain range based on their values of color or tones. The selected areas are reduced by selecting their fuzziness value (Colour range) and tolerance value (Magic wand) until the exact tracing is obtained.
- **Lasso tool:** To attain better results, it is necessary to work on smaller portions of the image, it is necessary to manipulate the figure by using the Lasso tool, instead of selecting the entire figure at one time.
- **Eraser tool:** The selection for reduction includes the selection of area that has been taken that needs human intervention including pixels from shadows, and cracks in the wall with a chromatic range in the motifs. Hence, it is necessary to use the eraser tool by comparing the tracing with the original image.

- **Zoom tool:** it magnifies and reduces the view of an image.
- **Paint bucket tool:** it fills similarly colored contiguous areas with the foreground color.
- **Pencil tool:** makes and changes paths or shapes with anchor points and handles.
- **Rectangular marquee tool:** it is a tool to make rectangular selections from layers.
- **Eye dropper tool**: samples colors from an image.
- **Pencil tool:** paints hard edges brush strokes.
- **Eraser tool:** changes pixels to the background color or makes them transparent.
- **Set foreground color:** it sets the color of the foreground in the target layer.
- **Horizontal type tool**: it adds horizontal type and it is a writing tool.

Rasterizing layers

Rasterizing a Photoshop layer converts a vector layer to pixels. Vector layers create graphics using lines and curves, so they maintain their clarity when you enlarge them, but this format leaves them unsuitable for artistic effects that use pixels. To add any of these filters, one must first rasterize the layer.

Copy-paste: The layer containing DStretch® image is copied (<Rectangular Marquee Tool>) and pasted which forms a new layer and it is important to be placed under the white background.

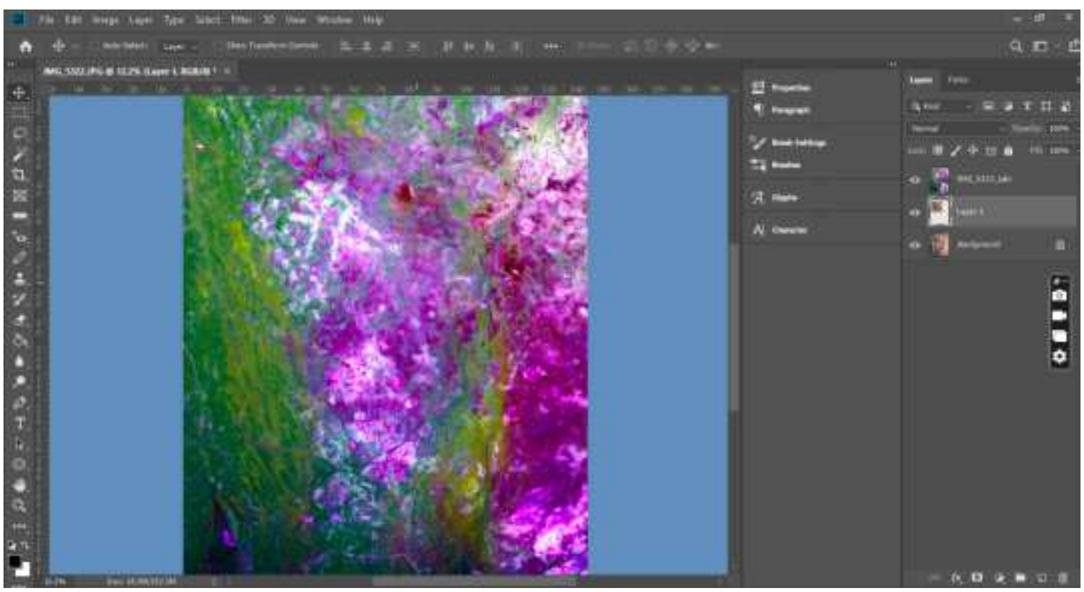


Figure 16 Copy-Paste results

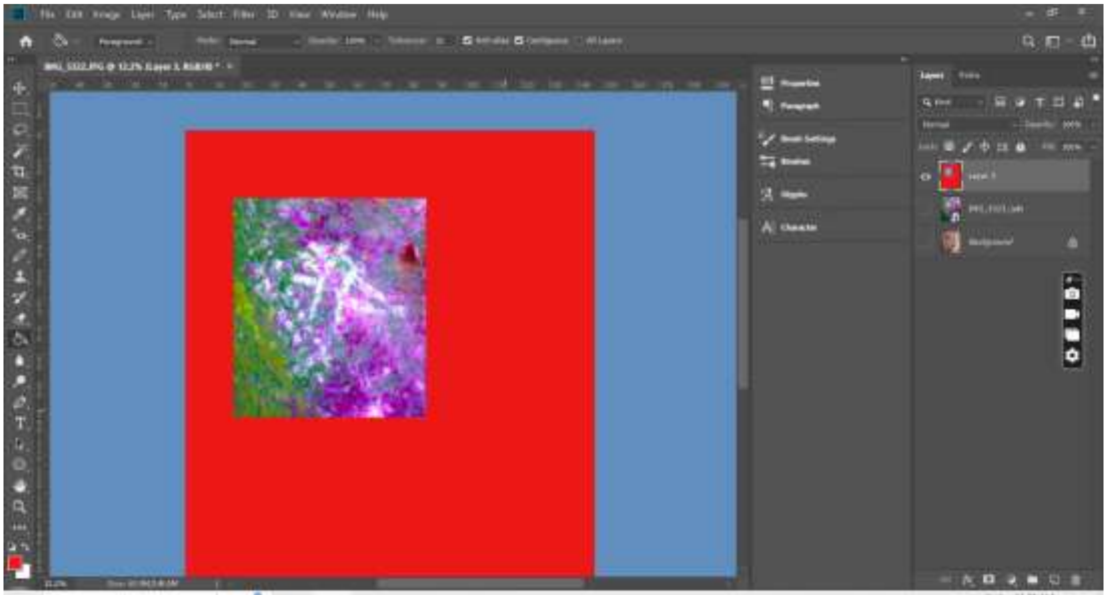


Figure 17 labi Dstretch Result of the panel I after copy-paste

Reduction: Color range is an effective tool to select when there is a distinctive difference between the selected target and the remaining layers. One can adjust the fuzziness as per the requirement by dropping the color of the image in the range box. The color reduction process is the vital one that needs multiple try and error. <Select> <Color Range> <Highlight> <Inverse>

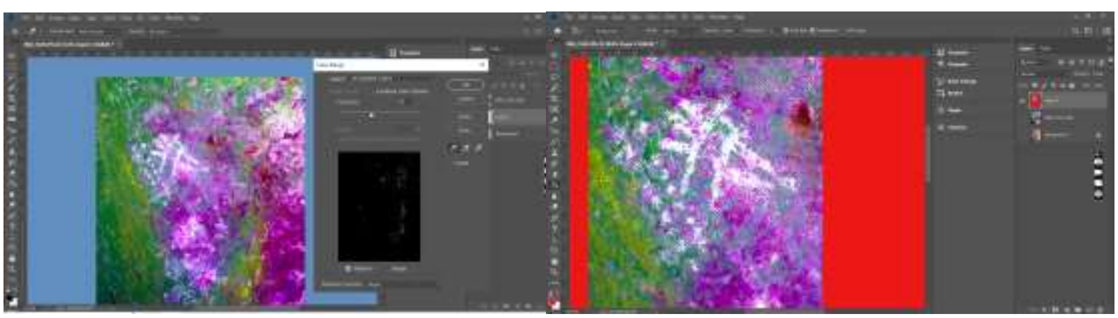


Figure 18 Color reduction

Eraser Tool: it is found in the toolbar. It changes the pixels either to transparent or in case the background color. The capacity ranges from 1pt to 5000pt in the case of the normal eraser. Also, it is necessary to lock the layer before working so as not to lose the pixels which can be erased transparently.

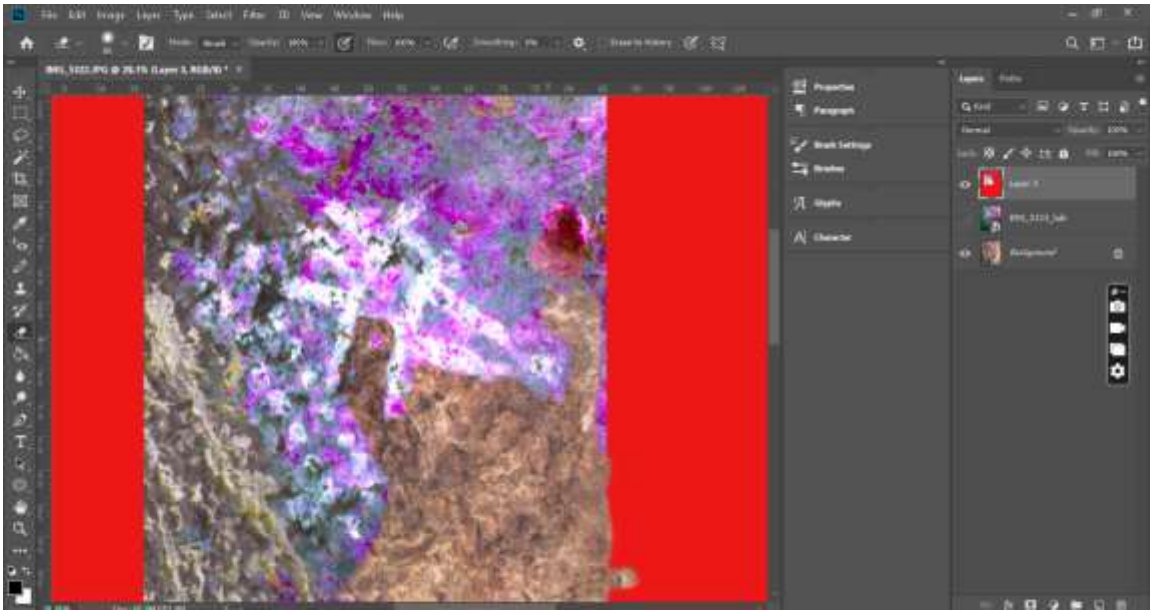


Figure 19 Role of eraser tool

Color retention: There are two ways in which the colors can be retained. It tries to maintain the authenticity of the color found in the painting.

Creating an artificial protocol: One can customize the protocol for every color by creating a color code in case there are various colors. The color code created for red is (c80000): Red (200) Green (0) Blue (0).

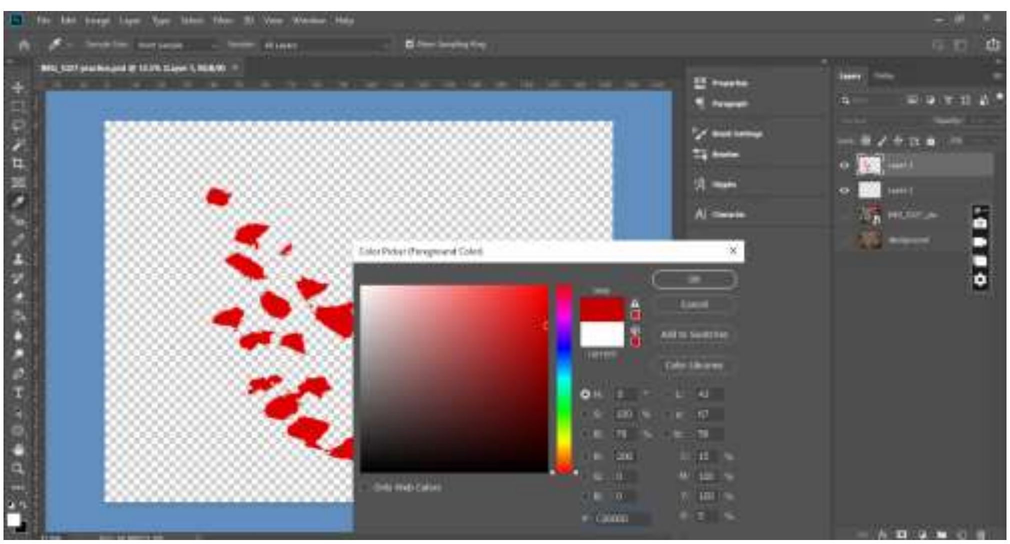


Figure 20 color retention

Scaling: this very important task in the process. The reading for the image size of the selected photo in the <Image>. The photo size of the scale is also measured by the ruler icon (<Ruler Tool>) of Photoshop. This leads to the conversion of the scale-based image.

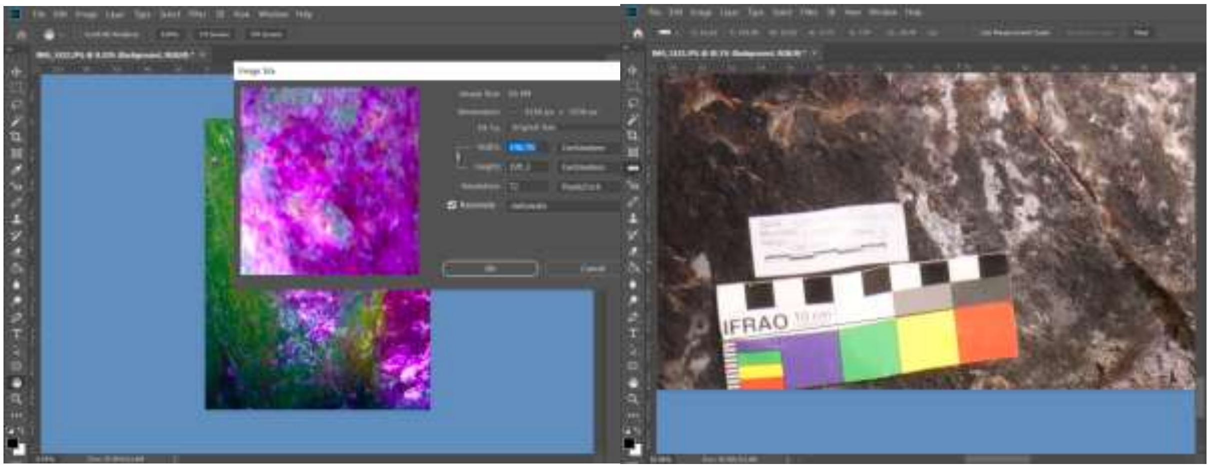


Figure 21 scale production

Fractures and tracings

Cracks which are one of the important fractures contribute to the weakness of the rock. They often affect the rock art sites because water seeps in through these cracks and causes further erosion (Green, 2018). These fractures need human intervention and can be drawn only by creating a new layer and placing it under the background as it is a transparent layer. Also, the point used for drawing fractures must range from 1 to 3.

Figure 22 Panel I and its fracture traced (right)

4. CHAPTER FOUR

Results Presentation

4.1. The Rock Shelter

The quartzite shelter is situated at the waist of the mountain of Candosa (Serra da Candosa). It has bushes, grasses, and trees grown on the shelter as well as its surroundings.

The name has nothing to do with the shelter and its anthropic value. It is arbitrarily named by the researcher Filipe Paiva who first discovered it and did an investigation in the area. It is because there is a waterfall (Cascata) draining by the shelter.

It is very spaciously big in size and extent. Its entrance is much wider and converges and narrows at the far end of the shelter. The average distance between the ceiling and the floor varies at different locations but is shorter as goes deep inside.

The floor has uneven levels, but a larger portion has huge deposits with some rocky floors, boulder stones, and outcrops. At the end portion near the tunnel that infinitely goes on the right side of the shelter, there is (visited during the June season) still water dropping while in the winter season, the depression of the floors is seen as waterlogged (see: figure 28 and figure 29).

On the right side of the shelter, there is an excavated surface; it does not seem natural, but people excavated and piled deposits beside the trench. It seems people at some point excavated it so that the accumulated water flows down or perhaps for treasure hunting. At the maximum end of the shelter is a bulk of soil with red ochre which perhaps is formed due to oxidation. Another depression is at the entrance, which was seen as water-filled during the rainy season, which seems like a recent excavation.

4.2. Archaeological Material (MA) Collections

A tentative and observational description of the surface collection (supported by Professor Fernando Coimbra) is done. The acronym MA in the graph paper and index stands for material or archaeological material. They are annexed at the end of the paper (see: Annex 1).

The collection has 28 lithics and 1 grinding stone fragment; 15 ceramics; 1 iron fragment (MA 10) and beadlike stones (MA 4). They are already mapped in the graph paper as can also be seen in the trace papers. Regarding the raw material of the manual miller and the lithics, 13 are quartz, 6 quartzites, 8 flints, and 1 unidentified quartz (?) or quartzite (?).

The ceramic collection is diverse in age. The majority falls in the Chalcolithic, Bronze Age, and Iron Ages. MA1a, MA6a, and MA6b are described as parts of modern pottery. MA14e is an undetermined age, or hard to give a tentative period. The lithics are dominated by flakes and it is hard to put in the time frame.

4.3. The Panels

Panel I

Unlike the common appearance that rock panels on walls of rocks, the panels of Cascata are on the overhead ceilings.

Figure 23 Panel I (photo by Collado G. Hipolito 2023)

<table>
<tr><td rowspan="3">Name of Rock Shelter: Cascata Rock Shelter</td><td rowspan="3" colspan="2">coordinates</td><td colspan="4">X:</td></tr>
<tr><td colspan="4">Y:</td></tr>
<tr><td colspan="4">Z:</td></tr>
<tr><td rowspan="5">Municipality: Lousã</td><td rowspan="5" colspan="2">Type of rock shelter</td><td colspan="4">Cave:</td></tr>
<tr><td colspan="4">Shelter: yes</td></tr>
<tr><td colspan="4">Vertically inclined wall:</td></tr>
<tr><td colspan="4">Small room:</td></tr>
<tr><td colspan="4">Dihedral Vertical walls:</td></tr>
<tr><td rowspan="3">Mountain: a mountain of Candosa</td><td rowspan="3" colspan="2">Dimension:</td><td colspan="4">Length:</td></tr>
<tr><td colspan="4">Height:</td></tr>
<tr><td colspan="4">Depth:</td></tr>
<tr><td rowspan="3">Rock shelter visible</td><td colspan="2">Entrance or nearby: yes</td><td rowspan="3">Intervisible with:</td><td>shelters</td><td></td><td>General orientation: 160-340</td></tr>
<tr><td colspan="2">Medium:</td><td rowspan="2">Villages</td><td rowspan="2"></td><td rowspan="2">Open from: West 250</td></tr>
<tr><td colspan="2">Far away:</td></tr>
<tr><td rowspan="15">Panel sketches</td><td colspan="4">Visibility from the shelter</td><td colspan="2"></td></tr>
<tr><td colspan="4">Large:</td><td rowspan="3" colspan="2"></td></tr>
<tr><td colspan="4">Medium:</td></tr>
<tr><td colspan="4">Reduced:</td></tr>
<tr><td rowspan="5" colspan="2">Panel no.I</td><td colspan="2">Color: Black</td><td rowspan="5" colspan="2"></td></tr>
<tr><td colspan="2">Orientation:355</td></tr>
<tr><td colspan="2">inclination: -13</td></tr>
<tr><td colspan="2">Altitude: 120cm</td></tr>
<tr><td colspan="2">(width):100</td></tr>
<tr><td colspan="2"></td><td colspan="2">Hight from the soil:239</td><td colspan="2"></td></tr>
<tr><td colspan="2">Conservation</td><td rowspan="4" colspan="2">Factor/ cause: fire smoke and its combustion</td><td rowspan="4" colspan="2"></td></tr>
<tr><td>Good</td><td></td></tr>
<tr><td>Regular</td><td></td></tr>
<tr><td>Bad</td><td>bad</td></tr>
</table>

<table>
<tr><td></td><td>Number of figures</td><td></td></tr>
</table>

	Type:	**Anthropomorphic:**			
		Zoomorphic:			
		Schematic: yes			
	Color/es	Red			
	Superposition	yes	No		
	Conservation	**Good:**		**Cause**	
				Fire smoke and other natural agents	
		Regular:			
		Bad: yes			

Table 4 panel and shelter I information.

Panel II

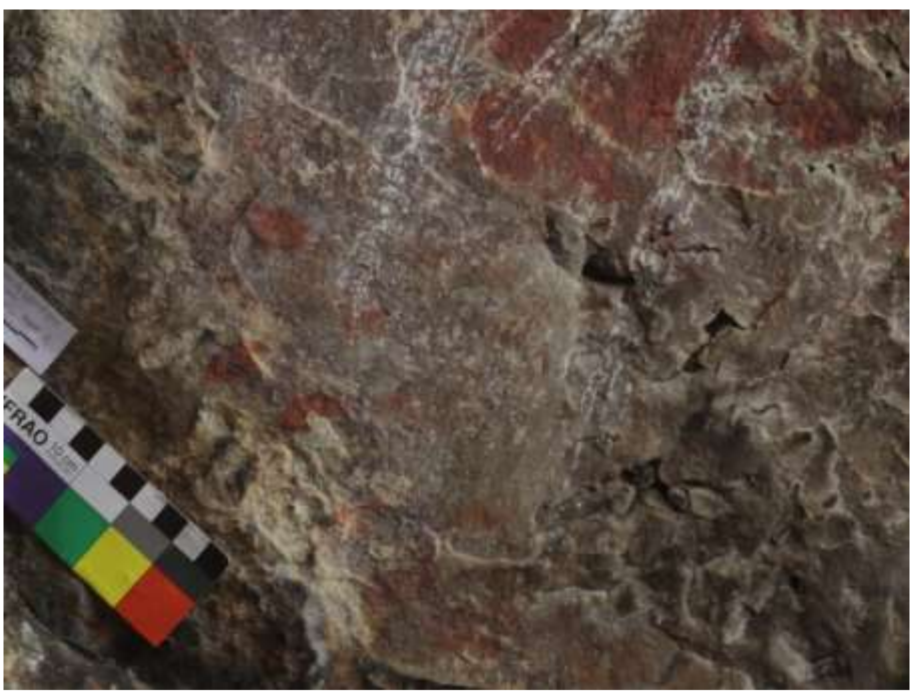


Figure 24 Panel II original photo (Collado, 2023)

<table>
<tr><td rowspan="3">Name of Rock Shelter: Cascata Rock Shelter</td><td rowspan="3">coordinates</td><td colspan="4">X:</td></tr>
<tr><td colspan="4">Y:</td></tr>
<tr><td colspan="4">Z:</td></tr>
<tr><td rowspan="5">Municipality: Lousã</td><td rowspan="5">Type of rock shelter:</td><td colspan="4">Cave:</td></tr>
<tr><td colspan="4">Shelter: yes</td></tr>
<tr><td colspan="4">Vertically inclined wall:</td></tr>
<tr><td colspan="4">Small room:</td></tr>
<tr><td colspan="4">Dihedral Vertical walls:</td></tr>
<tr><td rowspan="3">Mountain: mountain of Candosa</td><td rowspan="3">Dimension:</td><td colspan="4">Length:</td></tr>
<tr><td colspan="4">Height:</td></tr>
<tr><td colspan="4">Depth:</td></tr>
<tr><td rowspan="3">Rock shelter visible</td><td>Entrance or nearby: yes</td><td rowspan="3">Intervisible with:</td><td>shelters</td><td></td><td>General orientation: 160-340</td></tr>
<tr><td>Medium:</td><td rowspan="2">Villages</td><td rowspan="2"></td><td rowspan="2">Open from: West 250</td></tr>
<tr><td>Far away:</td></tr>
<tr><td rowspan="6">Panel sketches</td><td colspan="3">Visibility from the shelter</td><td colspan="2"></td></tr>
<tr><td colspan="3">Large:</td><td colspan="2" rowspan="3"></td></tr>
<tr><td colspan="3">Medium:</td></tr>
<tr><td colspan="3">Reduced:</td></tr>
<tr><td rowspan="2">Panel no.II</td><td colspan="2">Color: Reda and Black</td><td colspan="2" rowspan="2"></td></tr>
<tr><td colspan="2">Orientation:355</td></tr>
</table>

<table>
<tr><td rowspan="8"></td><td colspan="2" rowspan="3"></td><td colspan="2">Inclination: -97</td><td rowspan="3"></td></tr>
<tr><td colspan="2">Altitude: 80cm</td></tr>
<tr><td colspan="2">(width): 66 cm</td></tr>
<tr><td colspan="2"></td><td colspan="2">Hight from the soil:220cm</td><td></td></tr>
<tr><td colspan="2">Conservation</td><td colspan="2" rowspan="4">Factor/ cause: fire smoke and its combustion</td><td rowspan="4"></td></tr>
<tr><td>Good</td><td></td></tr>
<tr><td>Regular</td><td></td></tr>
<tr><td>Bad</td><td></td></tr>
<tr><td rowspan="5"></td><td colspan="4">Number of figures</td><td rowspan="5"></td></tr>
<tr><td rowspan="3">Type:</td><td colspan="3">Anthropomorphic:</td></tr>
<tr><td colspan="3">Zoomorphic:</td></tr>
<tr><td colspan="3">Schematic: yes</td></tr>
<tr><td>Color/es</td><td colspan="3">Red</td></tr>
<tr><td rowspan="5"></td><td>Superposition:</td><td colspan="3">no</td><td rowspan="5"></td></tr>
<tr><td rowspan="4">Conservation</td><td rowspan="2">Good:</td><td colspan="2">Cause</td></tr>
<tr><td colspan="2" rowspan="3">Fire smoke and other natural agents</td></tr>
<tr><td>Regular:</td></tr>
<tr><td>Bad: yes</td></tr>
</table>

Table 5 panel II information.

4.4. The figures

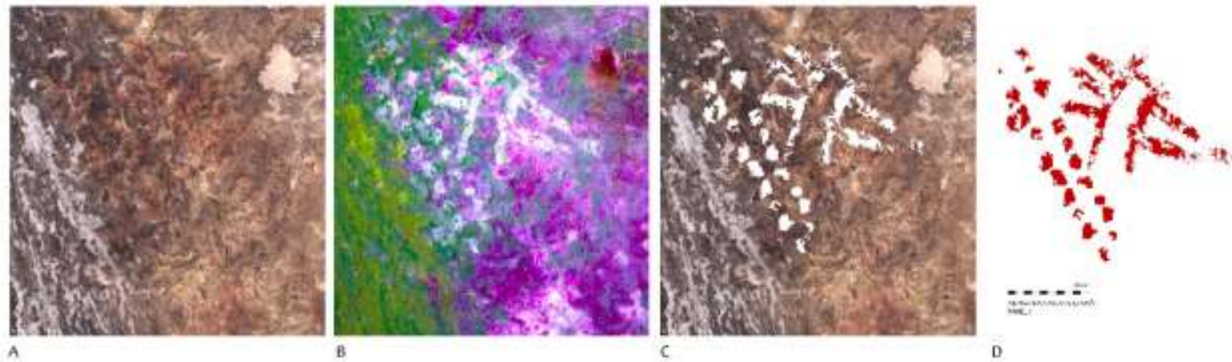


Figure 25 Figure of panel I original photo, DStretch results, and an adobe photoshop result respectively.

A Schematic figure (Panel I): geometric or ramiform

Like the other figures in the panels, it is a monochromic and schematic red figure. It is not perpendicular to the panel but slanted or tilted to the right side of the panel. It has a body part of two parallel lines with a line crossing and connecting them at their top ends. Both have branched parts. The left line has three branches while line on the left has two branches. The reconstruction shows a non-representational motif. Also, it is faded and has no presence of superimposition. It is a monochromic red figure. The depictions of body parts and branches have various sizes due to the nature of the art and the impact of low preservation conditions.

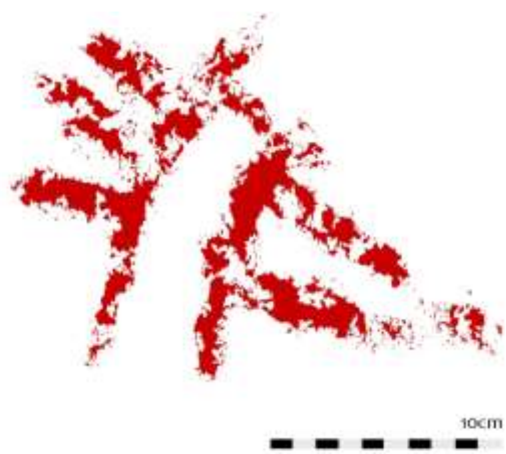


Figure 26 figure 1 of panel I.

Lines of dots or digit marks/ Fingerprints (Panel I)

When we see the figure as not part of the other figure in the same panel or not scenographic, the figure is two lines of dots or digit marks. It is not perpendicular to the panel but slanted or tilted to the left side of the panel. The figure is placed in the top part of the panel. It is depicted beside the other figure (Figure 2), on the left side to the interior side of the panel or the shelter. Also, it is faded and has no presence of superimposition. It is a monochromic red figure.

Figure 27 figure 2 of panel I.

Lines of dots (set of dots) digit marks (Panel II)

The dots have various sizes and shapes due to the nature of the art and the impact of low preservation conditions. The DStretch and Adobe Photoshop reconstruction gives a total of 21 dots or digit marks. The line on the left has ten (10) dots while the other line has eleven (11) dots. The distance between the two lines is 1.47cm and the length of the figure is 26.10cm.

Figure 28 Figure 1 of Panel II.

The figure can be described as triple lines of dots or fingerprints. It is not perpendicular to the panel but slanted or tilted to the left side of the panel. The figure is placed in the middle part of the panel a bit far from the center. The dots have various sizes and shapes due to the nature of the art and the impact of low preservation conditions. It is a monochromic and abstract red figure.

4.5. Preservation condition of the rock shelter

Rock art is a vital research resource we have in paleoart studies in general. Consequently, it is among the most important scientific evidence available to the species known as *Homo sapiens*. It is a major component of evidence to understand how that species constructed the conceptual artifact. Hence, it is reasonable to demand that the preservation and curation of this irreplaceable resource be afforded considerably more priority than has been given to it so far (Bednarik 2007: 85).

Both human and natural agents are causing deterioration to the rock walls, the deposit, and the paintings. The natural and biological agents causing deterioration are fire, plants, water, and small animals like birds whereas the cultural activities affecting are vandalism, graffiti, and firing. There has occurred smoke from forest firing and people temporarily making hearth inside.

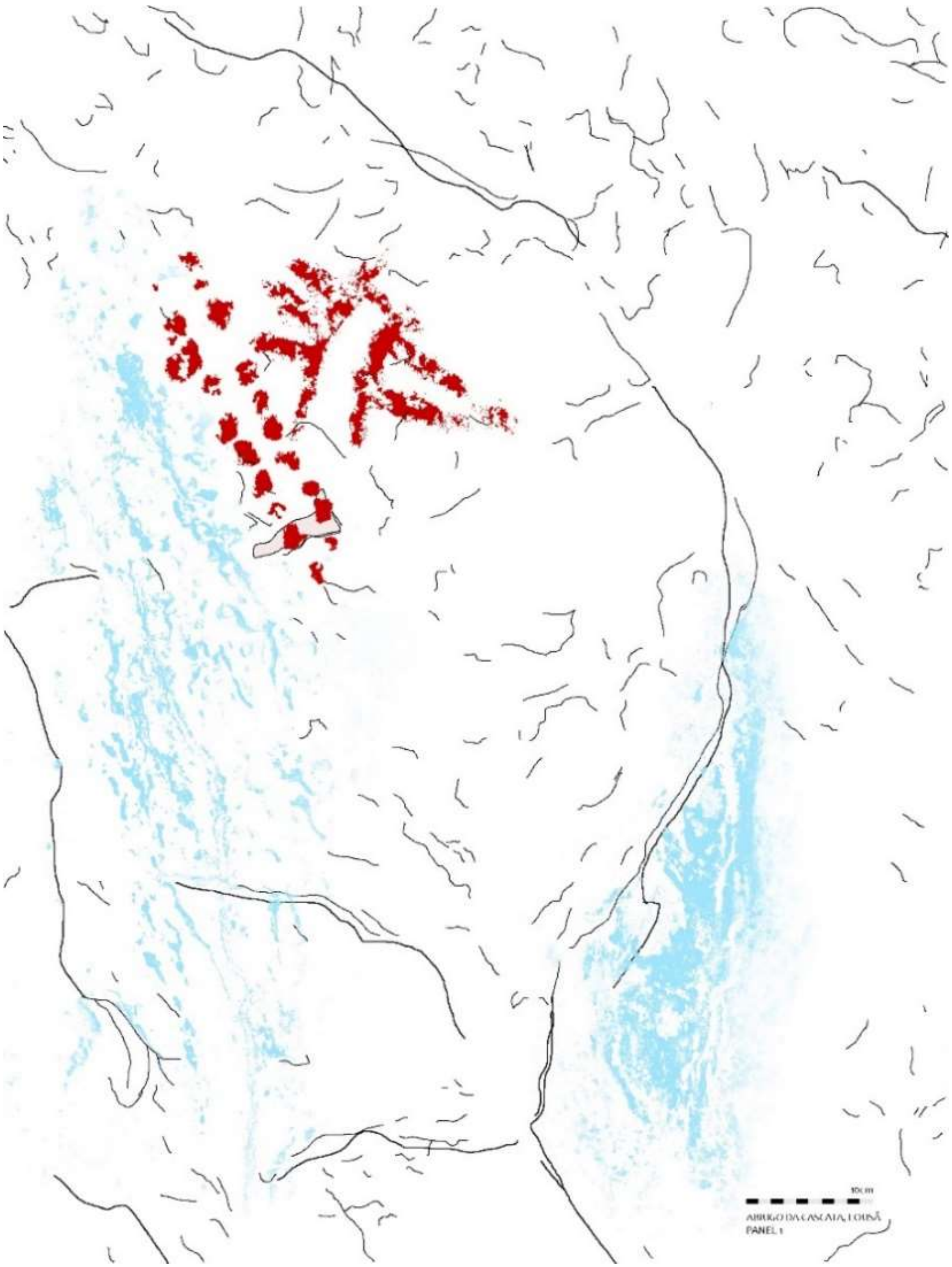


Figure 29 Panel I the figures, water stains, and fractures.

Figure 30 Panel II the figure, fractures, and vandalism

The firing hazards put the rock paintings in peril. Especially at the entrance part of the shelter, we see thermoclastics while thick smoke and soot cover most of the ceilings. It seems many are gone forever due to this factor. It is observable that it caused chemical and physical changes in the rock materials.

Figure 31 Impact of fire on the panels (Hipolito 2023).

Figure 32 The waterlogged floor during the rainy season (Hipolito 2023)

The shelter weakened by forest firing factors is also becoming increasingly fragile due to the groundwater, waterfall, slopping process, and gravity. Even in the non-rainy season, the floor is muddy as water drops and percolates from the ceilings.

Figure 33 The waterlogged floor and its ceiling during the rainy season (Hipolito 2023).

Figure 34 Impact of water percolating on the panels (Hipolito 2023).

As part of the vandalism, on the right side of the floor, near the tunnel, there is an excavated depression which people excavated it. Excavated deposit is piled beside the depression. This could perhaps be to either search for treasures or to channel the water flowing from the tunnel on the corner and water droppings from the ceiling. Perhaps, this caused context disturbance of the deposit.

5. CHAPTER FIVE

Discussion

5.1. Dots and Fingerprints: Analogies

Dots and fingerprints are among the known typologies in the rock arts of Paleolithic and post-paleolithic rock arts**.** Decal of Lapa dos Gaivões made by Henri Breuil of 1930´s comprises dots (Martins, 2018) and indicates this theme is one major aspect of the schematic rock art of Iberia.

The package comprises isolated dots, lines of dots, groups of dots, dots associated with other figures, or dots as the constructing elements of a motif. For instance, a panel of Calco, shelter of quebrantahuesos (Collado et al 2015) shows a random set of dots concentrated in the center of the panel while two are each depicted on the far sides of the panel.

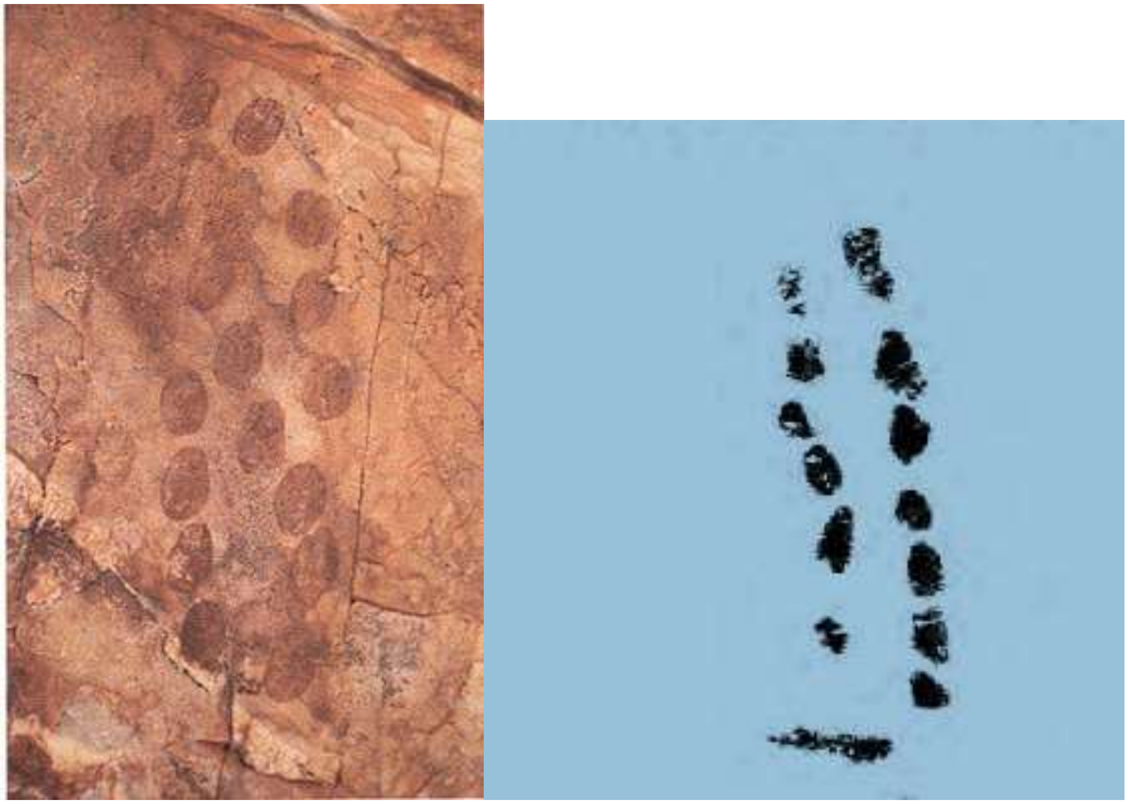


Figure 35 . Dots in the shelter of El Barquito (Collado and García Arranz, 2005) (Left) lines of dots (Hipolito , et al. 2015: figure 367 (Right).

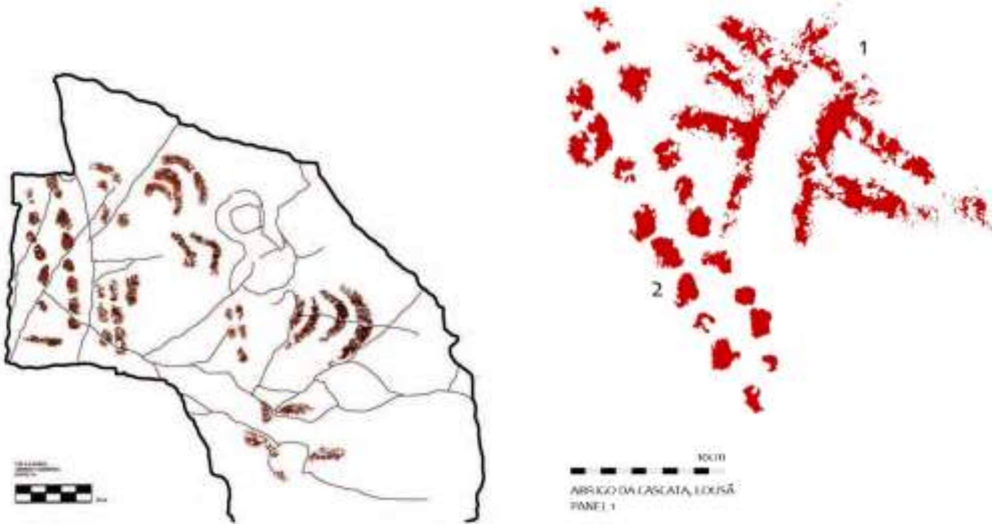


Figure 36 La Calderita 1. Tracing of panel 7A (Collado and García Arranz, 2017) and dots associated with another figure in Panel I of Cascata rock shelter

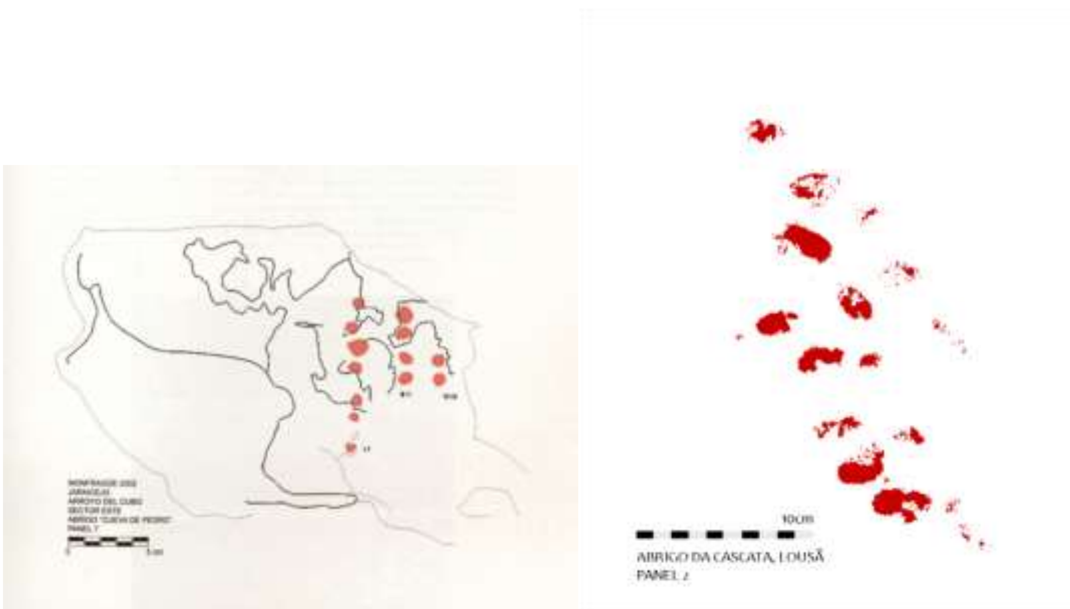


Figure 37 Dots figure of Cueva de Pedro shelter (Hipolito, 2005: 201) and figure 1 of Cascata Panel II.

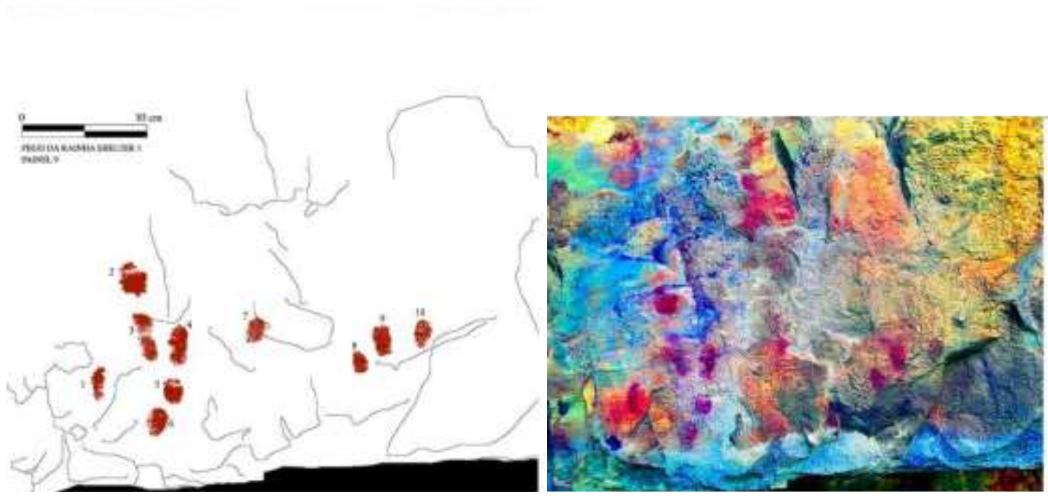


Figure 38 Panel 9 from Pego da Rainha (left) DStretch® version of the panel 9 of Pego da Rainha (right) (Pillai, 2019).

Figure 39 Panel II with ybr DStretch filter(left) and its Adobe Photoshop result (right).

Figure 37 of Panel 1 of the shelter of del Peine; Figure 64 of the same panel contains 1 dot isolated, and two others separated. Similarly, panel 5 of Castillo de Monfragüe contains all types: isolated, associated with other figures, lined, and as dots forming motifs (Collado et al. 2015: 99).

There is also a variety of colors: greyish, red, and black in the dots and fingerprints. For the greyish, dots in panel 5 of Cueva del Castillo de Monfragüe are examples. However, dominant dots and fingerprints are red and black in many cases (e.g. take those in Monfragüe of Extremadura, Collado et al. 2015). In rock art in Benquerencia La Serena Spain dots have both red and black colors (Rosina et al. 2019).

Superposition also occurs in panels with dots and fingerprints. For example, , Panel 1 of Los Puntos Rock Shelter contains superimposed dots of black and red coloration. The red dots form a scene, and an anthropomorphic figure is (re)constructed from that (see: Collado et al. 2015:127). Panel 1A from Cave of Bercialejo in Spain Extremadura has also black dots (Pillai, 2019).

Dots and fingerprints also vary in size and shape. For example, figure 18 and 6 panel 2 of Cave of murciélagos are among the smallest sets of dots (Collado et al. 2015:51). There is, however, a possible distinction between dots and fingerprints: dot marks and specifically fingerprint. The distinction comes from what material is used to apply the paint. The fingerprints morphologically (e.g. see: Figure 23 of Cueva de los murcielagos) portray finger-tip shapes (Collado et al. 2015:54). Even the fingerprints also have typologies. Some show solely the tip of the finger while others show a print of the distal phalanx of fingers.

Cognizant of the fact that the fingerprints are significant and very informative for many research inquiries, there are emerging advanced studies for instance of palaeodermatoglyphs to determine age and sex (e.g. Martinez-Sevilla et al. 2020). This tells their significance is beyond the art value.

5.2. Geometrics or Ramiform

Geometric and abstract figures become the majority in schematic arts. It includes geometric designs predominant with varying patterns such as ladders, angular lines, zigzags, crosses, grids, meanders, and handprints (Perelló, 1993; Alves, 2005).

*Ideomorphic refers to a varied typology of schematic signs of a geometric nature - points, bars, circles, suns, structures-, which perhaps come from the extreme schematization of some real element of the artist's environment, or, more probably, abstract representation of certain ideas or mental concepts of their creators. Some of them may have a symbolic religious meaning (*García Arranz, 2006: 9).

Ramiform figures have been documented in many sites of schematic rock art (e.g. Central Sector of the Monfragüe National Park) as isolated and associated or linked to a motif (Collado et al. 2015). Ramiform type is very frequent in this area and is especially abundant in shelters located in El McNon being represented on shelters I, II, III, and IX; in shelters of I, IV, and VI of Los Buitres. For the interpretation, these motifs have polysemic meanings as they are taken by many as phytomorphs, anthropomorphes or as abstractions. Usually, the associations are: ramiform-bars, ramiform-ramiform, ramiform-points, ramiform-pectiniforms, ramiform-mesteliform and ramiform-serpentiform (Perelló, 1993: 114). Therefore, it is not only a schematic anthropomorph but also an idiomorph.There are typological parallels in many sites. For example, Lapa dos Coelhos ramiforms are dated between the beginning of the chalcolithic period and the beginning of the Bronze Age, that is during the 3rd millennium BC (Martins 2007).

Figure 2 of Panel I in Cascata is either a ramiform or any geometric motif as ramiforms could have different forms and styles. For example, figures of Castanareja rock shelter contain different styles of the same ramiform which in turn has parallels in other sites (see: Klink et al. 2017: 72).

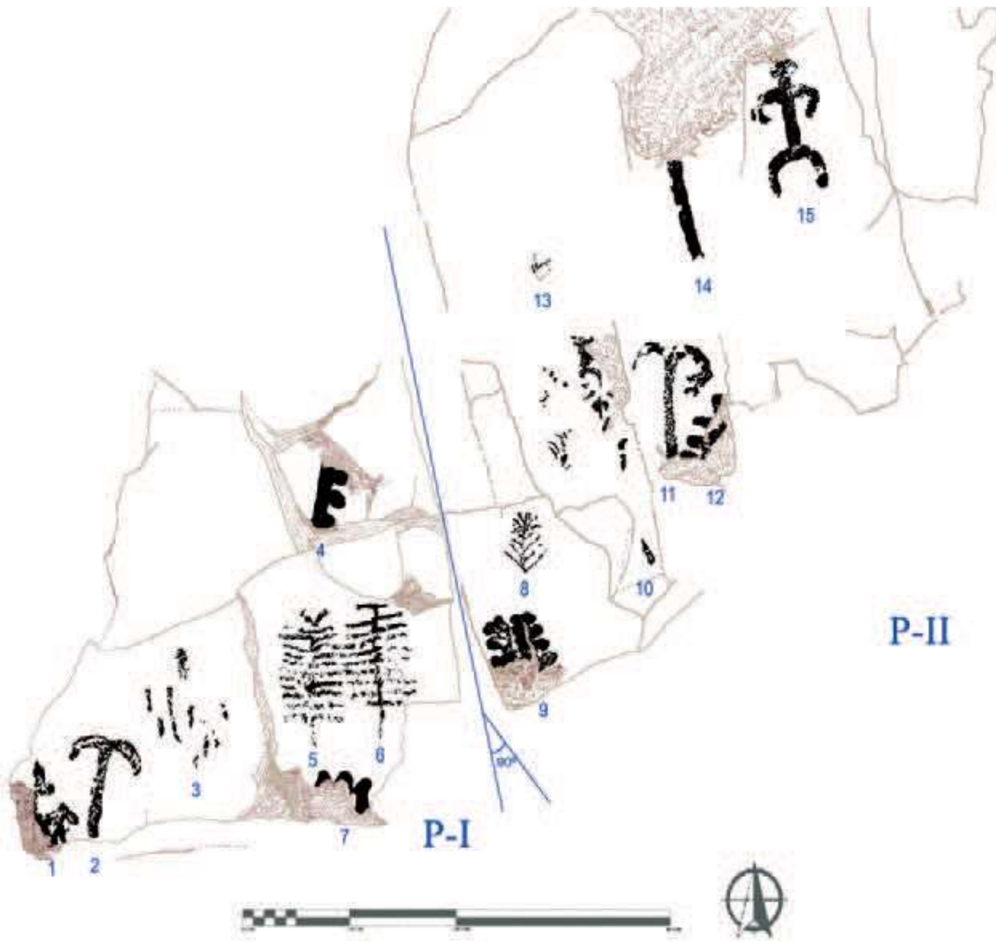


Figure 40 Ramiform figures (5 , 6, 8, 9, and 12) of panels I and II of Arroyo del Castanareja rock shelter.

5.3. Chronology

The question of chronology in rock art remains a complex and delicate subject to be approached. The signs generally occupy a completely marginal place. The priority of dating works on animal figures, whether it is by direct or indirect dating or a stylistic approach. Nevertheless, by their number, and their morphological variety, the signs and geometrics constitute an important group in the graphic universe. Whether simplest or most complex, the abstract forms can reflect a common fund of prehistory as well as punctual behavior but also constitute image references for a region or period, sometimes well confined (Petrognani and Robert 2009).

During the Neolithic age, there was a new cycle of post-Palaeolithic rock art Schematic rock art in the Iberian Peninsula. This rock art style is said to date from the 6th millennium BCE until the end of the Bronze Age (around the transition between the 2nd and 1st millennium BCE) (Collado 2016).

Within the post-Paleolithic schematic art, long duration there were changes in themes. The Trás-os- Montes, which is corroborated by archaeological materials were produced between the early Neolithic and the late Chalcolithic (6000-2000bc). During the neolithic 6000bc-300bc, the motifs represented were human figures depicted in simple ways sometimes associated with animals such as deer, abstract and geometric signs. In the Chalcolithic period, schematic paintings changed. That is zoomorphs tend to disappear (Figueiredo, 2020).

There is no possibility of putting an absolute date for the shelter and its art. But we can situate this rock art within the so-called Schematic Rock Art style, which is connected to a Recent Prehistory chronology (neolithic to Iron Age), according to a combination of stylistic, iconographic, and archaeological evidence.

5.4. Contextualizing and Interpretation

Andrea Martins (2015) analyzed some shelters with paintings and natural spaces are the target of a selection process based on the territorial strategy of each community/group. After this choice, they are transformed into a cultural space where cave paintings are made. Andrea Martins (2011) defines three types of cultural strategies to modify a previous natural landscape turning it into a symbolic space where the second category comprises the site of passage or limited view located on the banks of streams with a few iconographic manifestations and economic implications. The Cascata rock shelter fits into this category type of anthropized space.

Hipólito Giraldo Collado (2016) based on morphological criteria of the places where schematic rock art was discovered, established five basic formats of rock art shelters:

1. Big shelters, above 10 m in length, height, and depth. They are easily perceptible in the landscape and their access does not usually present much difficulty.
2. Shelters with a certain spaciousness and a variable depth, although not exceeding 10 m. They can be easily used as a shelter for one or more people.
3. Smooth walls leaning slightly. Only this slight inclination allows the preservation of motifs in inclement Weather.
4. Sites located in small, protected areas inside big fallen blocks in zones with granite outcrops).

The Cascata rock shelter fits with the first format (number 1) because it has an 18-meter length comparable to its width.

For rock art to be expected in a certain space and time, there must be at least two grounds (Anati, 2004; Brandt and Carder, 1987): human access to the area with geological availability and people with rock art tradition. Regarding the first requirement, the metamorphic rock shelters in the area could be opportunities for the existence of such arts. Collado (2016) has proposed an interpretative approach from landscape archaeology and schematic type of art could have functional character, landscape marker, and reflect intimate connections between the places chosen as a support for schematic depictions and ones with several resources or communication routes between territories. A similar case scenario could be suggested for the Cascata rock shelter site.

Schematic Rock Painting is a well-defined rock art cycle in Portuguese territory, with shelters from north to south, with a very diverse iconography, execution techniques, and implantation patterns. These manifestations of agro-pastoral societies often include scenes or mythographies, related to everyday aspects, real or symbolic (Martins, 2021). The localization and typology of the rock shelters of schematic art is also the result of the humanization of the landscape by pre-historic communities. The newly found schematic rock art is located isolated in the Portuguese territory. This adds significance to the finding.

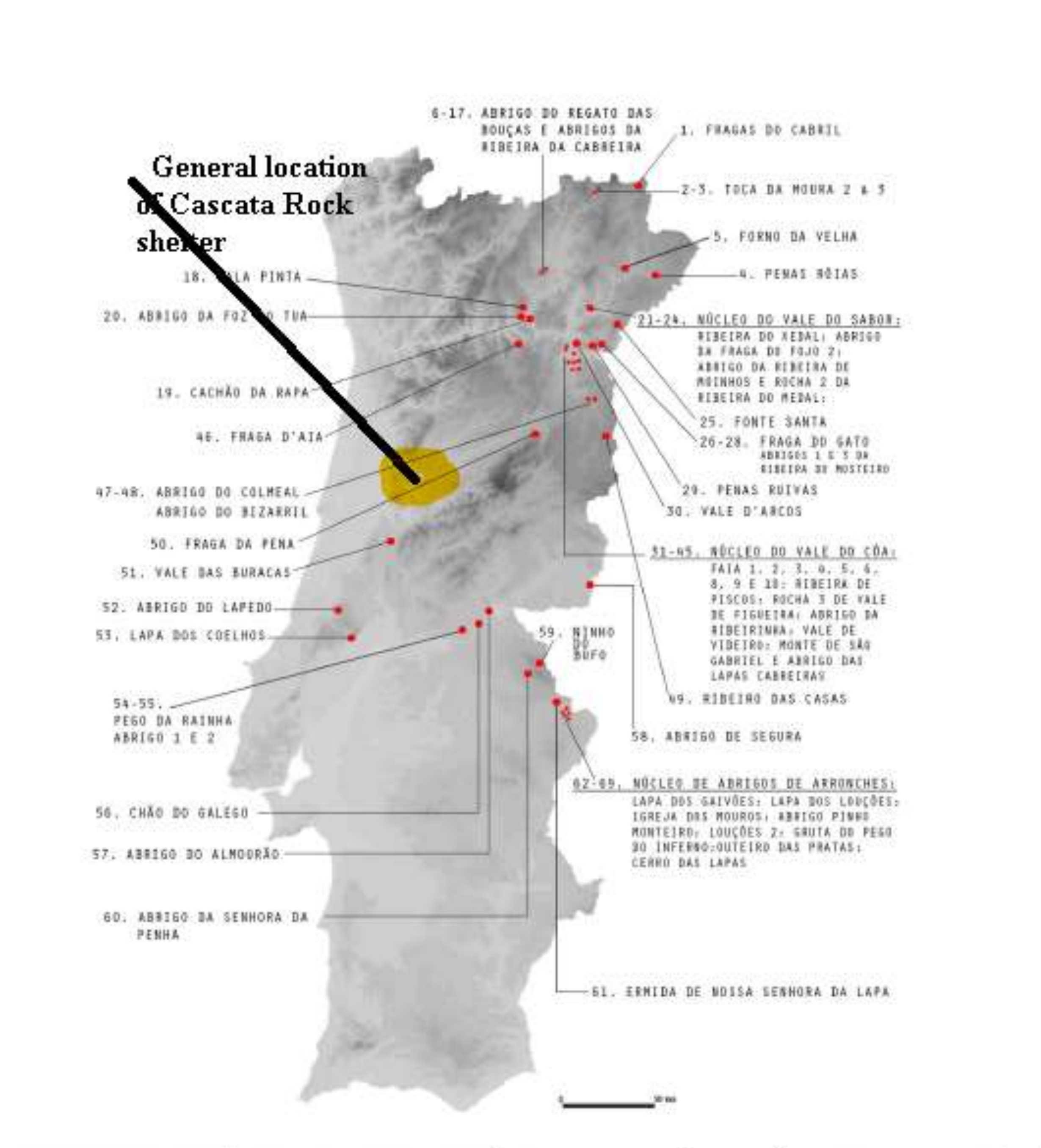


Figure 41 map distribution of known schematically painted shelters in the Portuguese territory (Garcês, 2017) yellow spotted location of the Cascata rock shelter.

The frequency of graphic representations in the Neolithic and Chalcolithic indicate the coherence of great population growth associated with a more stable economic system. Similarly, growing research in neolithic, megalithic, and chalcolithic settings within the Iberia setting suggested demographic abundance and entirely unknown symbology, continuing settlement of all the inner ranges and values (Behermann et al. 2017). One can hypothesize that the area of the rock shelter could have been contemporaneously inhabited.

There is a general explanation by Maria de Jesus Sanches (2022); *"In schematic rock paintings, one of the most striking characteristics of the motifs is their small size which for the most part ranges from 10 to 15 (sometimes may reach 25 to 30cm) and the colors in which they are painted: flat paintings in predominantly reddish colors which range from wine red to blood red or light red, followed by oranges and yellows."*

The measurement of figures in the study area fits the above-quoted statement: the length of Figure 1 in Panel I is 26.10cm and Figure 2 is 15.12cm. The length of the figure of panel II is 24.55.

The site is rich in archaeological evidence: rock art, archaeological materials, and promising reflecting options for anthropizing the landscape by prehistoric communities. According to Martins (2015), the economic and social rupture that occurred after the transition to the Holocene period is clearly visible at the level of the symbolic system. In this tradition, rock art has a predominant role. These graphic manifestations show a new conceptual model of the anthropization of landscapes and territory, giving rise to several artistic cycles with their own characteristics by making their own iconography in certain places.

In the Neolithic strong relations between schematic paintings and valleys, rivers, and megalithic tombs are suggested. They have always been used as passageways in highland regions. Societies were having signs along the paths to mark. For instance, places where supplies could be found; and places that could function as spaces for social cohesion; and communication systems (Figueiredo, 2020). This theory could also work for the Cascata rock shelter which has potteries of certainly different ages and perhaps of functions too.

The third millennium BC corresponds to a period of deep changes in society conspicuous in settlement and funerary spaces, material culture but also true symbolic explosion which could be the unifying element of these communities. The sites that exhibit rock art are part of the same chalcolithic conceptual universe (Martins, 2019). The Cascata rock shelter in Lousã which can be assigned to a long chronology fit into this general explanation.

6. CHAPTER SIX

Conclusion and Recommendation

6.1. Conclusion

As Andrea Martins (2011) emphasizes, the approach to the everyday life of prehistoric populations from early Neolithic to late Chalcolithic could be achieved through the study of certain symbolic programs expressed in schematic art. The site of Cascata and its art add value to this demand in the Iberian Peninsula in general and Portuguese territory in particular. Besides being the first rock art shelter with prehistoric art in a large area in north-central Portugal, the combined stylistic, iconographic, and archaeological evidence allows us to frame this rock art within the so-called Schematic Rock Art style, which is associated with a Recent Prehistory chronology.

This thesis is the outcome of the author's training in rock art documentation, analysis methods, and interpretation. The case study is the new schematic rock art panel from Lousã, central Portugal.

The shelter low preservation conditions surely hamper conclusions on the theme, subject, and significance of the rock paintings. They do suffer such a degree of fading as they are usually visible to the naked eye.

The thematic, stylistic, and archaeological evidence indicate that rock art and its archaeological context are to be chronologically placed within the Neolithic to Iron Age period.

6.1. Recommendation

The shelter is potential and promising for further excavation; to fully reconstruct the absolute chronology and function of the rock shelter, multidisciplinary team research is needed.

The site should be designated as a nationally protected area by fencing and sheltering to minimize the impact of natural and anthropic agents. Moreover, specific mechanisms to avoid the impact of forest firring and water drainage should be diverted.

Educate the local people about the significance of the rock paintings and create awareness to stop defacement and destructive types of intervention on the art and the floor.

Make the rock shelters accessible by accommodating foot tracks for tourists and researchers. Awareness of the significance of rock arts should be made to tourist guides. Hence, this site should be included in the tourist map of Portugal after conservative, archaeological and visitations measurements.

Since the landscape setting has inseparable significance from the paintings, its wilderness should be retained both for environmental management and long life of the hill site.

7. BIBLIOGRAPHY

Anati, E. (2004). Introducing the World Archives of Rock Art (WARA): 50.000 years of visual arts.

Alves, L. Bacelar (2021). On Identity and Otherness. Reshaping the dynamics of Late Prehistoric rock art traditions on northern Portugal, in Lopes, S.S., Gomes, S. A. (eds), Between the 3rd and the 2nd millennia BC: Exploring Cultural Diversity and Change in Late Prehistoric Communities, chapter 3. Oxford: ArchaeoPress: 49-65.

Alves, L. Bacelar (2009).O sentido dos signos. Reflexões e perspectivas para o estudo da arte rupestre do pós-glaciar no norte de Portugal IN Arte Prehistóricoal aire libreen el Sur de Europa.

Alves, L. Bacelar (2020) "LandCRAFT. A arte da Pré-história Recente no Vale do Côa". *Kairós*. Coimbra. 5: 4-19. Disponível em *https://bit.ly/3JjGNo3*.

Alves, L. Bacelar; Candosa, João Muralha; Reis, Mário e Carvalho, Bárbara (2014). "ART-FACTS: uma investigação sobre os contextos arqueológicos da Arte Esquemática no vale do Côa". *Côavisão*. Vila Nova de Foz Côa. 16: 101-106. Disponível em *https://bit.ly/3pfYqNx*.

Alves, L. Bacelar (2005). The architecture of the natural world: rock art in western Iberia. In *Monuments and Landscape in Atlantic Europe* (pp. 63-81). Routledge.

Alves, L. Bacelar (2009). Signs on a Rock Veil: work on rocks, prehistoric art and identity in North-West Iberia.

Alves, L. Bacelar (2012). "The circle, the cross and the limits of abstraction and figuration in north-western Iberian rock art". In Cochrane, A. and Jones, A. (eds.): *Visualizing the Neolithic: abstraction, figuration, performance, representation.* Oxford: Oxbow, pp. 198-214.

Andrews, T. D., & Brink, J. W. (2022). Using retroReveal as a Complement to DStretch for Enhancing Red Ochre Pictographs. *Canadian Journal of Archaeology*, *46*(1).

Arranz, J.J., Giraldo, H.C., & Nash, G.H. (2012). The Levantine Question: Post-Palaeolithic Rock Art in the Iberian Peninsula.

Brandt, S. and N. Carder (1987). ‘’Pastoral Rock art in the Horn of Africa: Making sense of Udders chaos,’’ *World Archaeology*, 19 (2): 194-213.

Barcia-García, Camilo, Mas-Cornellà, Martí, Castillejo, Alfredo M. Maximiano, Pardo, Jesús F. Jordá. (2023). Dots, circles and horses: New rock art evidence through image-based digital methods in Moro Cave (Tarifa, Spain), Journal of Archaeological Science: Reports, Volume 47, 103826, ISSN 2352-409X, https://doi.org/10.1016/j.jasrep.2023.103826.

Bradley, R., & Valcarce, R.F. (1998). Crossing the border: contrasting styles of rock art in the prehistory of north-west Iberia. *Oxford Journal of Archaeology, 17*, 287-308.

Bednarik, R.G., (2007). *Rock art science: the scientific study of palaeoart. Aryan Books International.*

Brady, L.M., Hampson, J., & Sanz, I.D. (2017). Recording rock art: Strategies, challenges, and embracing the digital revolution.

Beatriz C. Rey and Lara Bacelar Alves (2021). Colóquio Internacional Romper fronteiras, atravessar Territórios. Identidades e intercâmbios durante a Pré-história recente no interior norte da península ibérica. Porto: Centro de Investigação Transdisciplinar ‘Cultura, Espaço e Memória (CITCEM).

Beatriz C. Rey, Lara Bacelar Alves, Juan Francisco Gibaja, and Vera Moreira Caetano (2022). O Penedo Gordo Intervención arqueolóxica nun abrigo con pintura rupestre esquemática da Galicia suroriental.

Breuil, H. (1933-35). Les peintures rupestres schématiques de la Péninsule Ibérique, vol. I-IV, Fondation Singer-Polignac, Lagny.

Balbín-Behrmann, R., Bueno-Ramírez, P., Barroso-Bermejo, R., Villanueva-Ortiz, P., (2017). Images of the Past in the Lands of Antequera, Málaga, Spain. Palaeolithic to Post-Palaeolithic Transition in Southern Europe. Journal volume & issue. Vol. 68- pp. 115 – 133.

Collado H. Giraldo. (2016). A Mark along the Way: Schematic Rock Art and Communication Routes. *The Artist and Journal of Home Culture, 5*, 6.

Coulson, D. and Campbell, A. (2001). *African Rock Art: Paintings and Engravings on Stone*. Harry N. Abrams incorporated publishers.

Collado H. Giraldo. y García Arranz, J.J. (2005). Arte rupestre en el Parque Natural de Monfragüe: el sector oriental. En Collado, H. y García, J.J. (coords.): *Corpus de Arte Rupestre en Extremadura*, vol. I. Consejería de Cultura. Junta de Extremadura. Mérida.

Collado H. Giraldo, José Julio García Arranz (2017). Corpus de arte rupestre en extremadura. Vol iv. Arte rupestre en la cornisa de la calderita.

Collado H. Giraldo, Jose Julio Garcia Arranz, Juan Carlos Aguilar Gomez (2015). Corpus de arte rupestre en rupestre en extremadura. VOL III. Arte rupestre en el parque nacional de monfrague: El sector central (termino municipal de torrejon el rubio)

Collado H. Giraldo, Bea, M.M., Ramos-Muñoz, J., Cantalejo, P., Domínguez-Bella, S., Bello, J.R., Angás, J., Miranda, J.V., Prieto, F.J., Fernández-Sánchez, D.S., Aranda, A.P., Luque, A.J., Arranz, J.J., & Aguilar, J.C. (2019). Un nuevo grupo de manos paleolíticas pintadas en el sur de la Península Ibérica. La cueva de Las Estrellas (Castellar de la Frontera, Cádiz). *Zephyrvs*.

Chandler, J.H., & Fryer, J.G. (2005). Recording aboriginal rock art using cheap digital cameras and digital photogrammetry.

Cunha, P.P., Sequeira, A.J.D. & Sousa, M.B. (1997). A reactivação das falhas, no intenso contexto compressivo desde meados do Tortoniano, na região de Espinhal - Coja - Caramulo (Portugal Central). Comum. Instituto. Geológico. e Mineiro, 1997, t. 83: 95-126.

Domingo Sanz, I., Carrión-Ruiz, B., Blanco-Pons, S., & Lerma, J.L. (2015). Evaluating conventional and advanced visible image enhancement solutions to produce digital tracings at el Carche rock art shelter. *Digit. Appl. Archaeol. Cult. Heritage, 2*, 79-88.

Duncan Caldwell, Ulrika Botzojorns, (2014). A historic sign, possible Mesolithic menhir, DStretch, and problems in dating rock art to the Sauveterrian in the Massif de Fontainebleau, Journal of Archaeological Science, Volume 42, 2014, Pages 140-151, ISSN 0305-4403, https://doi.org/10.1016/j.jas.2013.09.023.

Garcês, S., Collado, H., Rosina, P., Gomes, H., Nash, G., Nicoli, M., & Vaccaro, C. (2022). Identification of organic material in Los Buitres 1 rock art shelter, Badajoz, Spain. Complutum.

García Arranz, José Julio (2006). El Risco de San Blas, Alburquerque (Archaeological guides of Extremadura, 6).

Garcês, S. (2017). *Cervídeos: Símbolos e Sociedade nos primórdios da agricultura no Vale do Tejo.* Doctoral dissertation, Universidade de Trás-os-Montes e Alto Douro.

Gonzalez Esther Rodríguez, Pastor Sonia Carbonell , Casals Josep R. (2019). Lost colours: Photogrammetry, image analysis using the DStretch plugin, and 3-D modelling of post-firing painted pottery from the southwest Iberian Peninsula. Digital Applications in Archaeology and Cultural Heritage xxx (xxxx) xxx.

Green, S.M (2018). Rock Art: The Meanings and Myths Behind Ancient Ruins in the Southwest and Beyond, Rowman & Littlefield, U.S.A.

Gunn, R.G.,Ogleby,C.L.,Lee,D.,Whear, R.L., (2010). A method to visually rationalise superimposed pigment motifs. RockArtRes27(2),131–136.

García, J.M. (2018). Artes esquemáticos de las sociedades ágrafas en la Prehistoria reciente ibérica.

Gomes, M.V., (2001). Arte rupestre do vale do Tejo (Portugal). Antropomorfos (estilos, comportamientos, cronologías e interpretaçoes). Semiótica del arte prehistórico. Servicio de estudios valencianos. Serie Arqueológica 18, 53-88.

Daveau, S., Birot, P., Ribero, O. (1985/86). "Les bassins de Lousã et d'Arganil: recherches géomorphologiques et sédimentologiques sur le massif ancien et sa couverture à l'Est de Coimbra." Vol. I- Le Bassin Sédimentaire; Volume II - L'évolution du relief. *Memórias Centro Estudos Geográficos*, vol. 8, Lisboa, pp.1-450.

Hernández Pérez, M. (2006). Arte Esquemático en la fachada oriental de la Península Ibérica: 25 años después. Zephyrus: Revista de prehistoria y arqueología, ISSN 0514-7336, Nº 59, 2006, pp: 199-214

Hugo Gomes; Rosina, Pierluigi; Martins, Andrea; Oosterbeek, Luiz (2013). Rock Paintings: Raw Materials, Techniques and Territory Management, Quaternary Studies, 9, APEQ, Braga, 2013, pp. 45-55.

Harman, J., (2005). Using Decorrelation Stretch to Enhance Rock Art Images. Poster presented at American Rock Art Research Association Annual Meeting in Reno, NV, 28 May

Harman, J., 2008 [2005]. Using Decorrelation Stretch to Enhance Rock Art Images. http ://dstretch.com/AlgorithmDescription.html. accessed 6/10/23.

Iriarte E, Foyo A, Sanchez MA, Tomillo C, Setien J (2009). The origin and geochemical characterization of red ochres from the Tito Bustillo and Monte Castillo caves (northern Spain). Archaeometry 51(2):231–251. https:// doi. org/ 10. 1111/j. 1475- 4754. 2008. 00397.

Jean-Loïc Le Quellec, Frédérique Duquesnoy, Claudia Defrasne, (2015). Digital image enhancement with DStretch®: Is complexity always necessary for efficiency?, Digital Applications in Archaeology and Cultural Heritage, Volume 2, Issues 2–3, 2015, Pages 55-67, ISSN 2212-0548, https://doi.org/10.1016/j.daach.2015.01.003.

Klink, A.C., García, L.M., & Fraile, F.J. (2017). Las pinturas rupestres postpaleolíticas del Arroyo del Castañarejo (Viso del Marqués, Ciudad real) / The Postpaleolithic Rock Paintings Of Arroyo Castañarejo (Viso Del Marqués, Ciudad Real).

Lima, P. (2006). "Artefactos do Bronze no Concelho da Lousã", Instituto de Arqueologia da FLUC, Coimbra (policopiado).

Martinez Garcia, J. (2011). Arte rupestre en Los Vélez. Patrimonio Mundial. En: Parque Natural Sierra de María-Los Vélez. Centro de Estudios Velezanos. Ayuntamiento de Velez, 166-175.

Martins, Andrea (2011). "Shelter with schematic painted arte in Portugal – Territories and symbologies", El Legado artistic de las Sociedades Prehistóricas – Nuevos paradigmas de análisis y documentación, S. P. Universidade Zaragoza, pp: 111- 113.

Martins, A. (2021). Schematic rock art paintings in Portugal: an approach to the female universe at Lapa dos Gaviões. *Cuadernos de Arte Prehistórico*, *11*, 19-44.

Martins, A. (2018). 20 anos de arte rupestre no Sudoeste de Portugal: um percurso com alguma água à mistura, Atas do VIII Encontro de Arqueologia do Sudoeste Peninsular, Câmara Municipal de Serpa, pp. 289-313.

Martínez-Sevilla, F., Arqués, M., Jordana, X., Malgosa, A., Lozano Rodríguez, J., Romero, M., . . . Rus, J. (2020). Who painted that? The authorship of Schematic rock art at the Los Machos rock shelter in southern Iberia. *Antiquity, 94*(377), 1133-1151. doi:10.15184/aqy.2020.140.

Martins, A. (2011). Arte esquemática em Portugal: um projecto em construção, IN: OrJIA (Coord.) Actas de las II Jornadas de Jóvenes en Investigación Arqueológica (Madrid, 6, 7 y 8 de Mayo de 2009), JIA 2009, Tomo II, pp. 815-818.

Martins, A. (2012). Antropização de um território: Arte Esquemática e povoamento no Arrife da Serra de Aire e Candeeiros – dados preliminares, Actas das IV Jornadas de Jovens em Investigação Arqueológica - JIA 2011, Vol. I, Universidade do Algarve, Promontoria Monográfica, 16: 147-153.

Martins, A. (2013). A Pintura Rupestre Esquemática em Portugal: muitos sítios, mesmas pessoas? IN: Arnoud, José; Martins, Andrea; Neves, César (Coord.) Arqueologia em Portugal - 150 anos, Associação dos Arqueólogos Portugueses, pp. 495-505.

Martins, A. (2014). A Pintura Rupestre do Centro de Portugal. Antropização simbólica da paisagem pelas primeiras sociedades agro-pastoris. [Tese de Doutoramento]. Faculdade de Ciências Humanas e Sociais, Universidade do Algarve. 2vols. 552p.

Martins, A. (2015). E no Médio Côa? A arte esquemática que ainda resiste: o Abrigo do Ribeiro das Casas (Almeida), Revista Portuguesa de Arqueologia, vol. 18, pp. 41-54.

Martins, A. (2021). "Iconography of the third millennium BC in Western Iberia: the representations of deer". Adoraten.

Miguel Ángel Mateo Saura, Isidoro Gil Leiva, Antonio Pulgarín Guerrero (2005). Analysis of the authorship of the scientific output on Levantine and Schematic post-Paleolithic rock painting in Spain (1907-2010), Investigación Bibliotecológica: Archivonomía, Bibliotecología e Información, Volume 29, Issue 67, Supplement, 2015, Pages 167-199, ISSN 0187-358X, https://doi.org/10.1016/j.ibbai.2016.04.008.

McBrearty, S., and Brooks, A. S. (2000). The revolution that wasn't: a new interpretation of the origin of modern human behavior. *Journal of Human Evolution*, 39(5), 453-563.

Ontanton Robert and Morlote Jose Manuel (2018). Cueva Auria (Peñarrubia, Cantabria, Spain): a new cave with Palaeolithic rock art in Northern Spain. International Newsletter on Rock Art. 80 (11-18).

Paiva, Filipe (2009). *Contribuição para o Estudo da PréHistória do Vale do Ceira. As indústrias líticas da Quinta do Conde de Foz de Arouce.* [Dissertação de Mestrado]. Mestrado Internacional Erasmus Mundus em Quaternário e Pré-História consórcio entre a Universidade de Trás-os-Montes e Alto Douro, Instituto Politécnico de Tomar (Portugal), Univerisità Degli Studi di Ferrara (Itália), Universitat Rovira i Virgili de Tarragona (Espanha) and Muséum National D'Histoire Naturelle de Paris (França), 349p.

Pereira, L.C.G., Sequeira, A.J.D., Gomes, E.M.C. (2004). "A deformação varisca do Maciço Hespérico na região da Serra da Lousã (Portugal central)." *Cadernos do Laboratório Xeolóxico de Laxe*, vol. 29, pp.203-214.

Pillai, Sujitha Ajithkumar (2019). New schemes for old schemes : Recent studies in Pego da Rainha (Portugal) and Cueva del Bercialejo (Spain): Technical, iconographic and chronological implications. An MA thesis submitted to Universiti degli studi de ferrara.

Petrognani, S., & Robert, É. (2009). About the chronology of paleolithic signs. Constancy and emergence of symbols. *Anthropology, 47*, 169-180.

Perelló, M.I. (1993). The schematic cave painting in the eastern part of the province of Badajoz : state of the art. *Space, Time and Form. Series I, Prehistory and Archaeology*, 97-132.

Quesada, E., & Harman, J.G. (2019). A step further in rock art digital enhancements. DStretch on Gigapixel imaging. *Digit. Appl. Archaeol. Cult. Heritage, 13*, 00098.

Ruiz, Juan. Del macro-estilo al micro-estilo (2012). Análisis de la técnica del arte levantino como factor discriminante estilístico | From macro-style to micro-style. Analysis of Levantine Art technique as a stylistic discriminant factor. In: Arranz, José Julio García; Collado, Hipólito; Nash, George, editors. The levantine question | La cuestion levantina. Budapest Cáceres: Archaeolingua; 2012. p. 323-344.

Reis, M., Alves, L.B., Cardoso, J., Carvalho, B. (2017). Artfacts - os contextos arqueológicos da Arte Esquemática no Vale do Côa. Techne 3 (1), pp 97-111 97.

Rosina P, Collado H, Garces S, Gomes H, Eftekhari N, Nicoli M, Vaccaro C (2019). Benquerencia (La Serena - Spain) rock art: an integrated spectroscopy analysis with FTIR and Raman. Heliyon 5 (June):e02561. https:// doi. org/ 10. 1016/j. heliy on. 2019. e02561.

Smith, A.L., Cornelissen, E., Gosselin, O.P. and MacEachern, S., (2017). *Field Manual for African archaeology*. Royal Museum for Central Africa.

Rodrigo de Balbín Behrmann, Primitiva Bueno Ramírez Rosa Barroso Bermejo(1) And Piedad Villanueva Ortiz (2017). Images of the Past in the Lands of Antequera, Málaga, Spain. Palaeolithic to Post-Palaeolithic Transition in Southern Europe. *Munibe Antropologia-Arkeologia 68, 2017 pp.115-133.*

Sanches, M.D., Morais, P., & Teixeira, J.D. (2016). Escarpas rochosas e pinturas na Serra de Passos/Sta Comba (Nordeste de Portugal).

Sanches, Maria de Jesus , Joana Castro Teixeira **,** and Julián Bécares Pérez (2022). entre espanha e portugal: a arte esquemática na média e baixa bacia do douro.

Sanz, I.D., (2014). Rock art recording methods: from traditional to digital. *Encyclopedia of global archaeology*, pp.6351-6357.

Figueiredo, Sofia Soares de, Xavier, Pedro, Silva, Andreia, Neves, Dário, and Domínguez García, Isabel (2014). The holocene transition and post palaeolithic rock art from the sabor valley (trás-os-montes, portugal)

Rocha, F. A., Gama Pereira, L., Callapez P. M. and Gomes C.R., (2020). Places of geomorphological interest in the Ceira valley, central Portugal Atas / Proceedings I Encontro Luso-Brasileiro de Património Geomorfológico e Geoconservação.

Soares A.F., Marques, J.F., Sequeira, A.D. (2007). *Notícia Explicativa da Carta Geológica de Portugal na escala 1:50.000 – folha 19-D, Coimbra-Lousã*. INETI, Lisboa.

Vila, R. & Lima, P. (2008). *A Idade do Bronze no Museu Municipal da Lousã, Prof. Álvaro Viana de Lemos*. Câmara Municipal da Lousã, Separata da Revista Beira Alta, Vol. LXV, 2006.

Vahdati Ali A. (2021). Newly found rock painting sites in the Upper Atrak Valley, Northern Khorasan, North-eastern Iran, Archaeological Research in Asia, Volume 28, 2021, 100317, ISSN 2352-2267, https://doi.org/10.1016/j.ara.2021.100317.

Zilhão, J., Aubry, T., Carvalho, A.F., Baptista, A., Gomes, M.V., & Meireles, J. (1997). The Rock Art of the Côa Valley (Portugal) and its Archaeological Context: First Results of Current Research.

8. Annex 1.

MA 1

a. Pottery sherd: Modern-age pottery

b. Quartz certainly bronze age earlier phase as it has a grain of quartz. Because Iron Age potteries do not have such quartz.

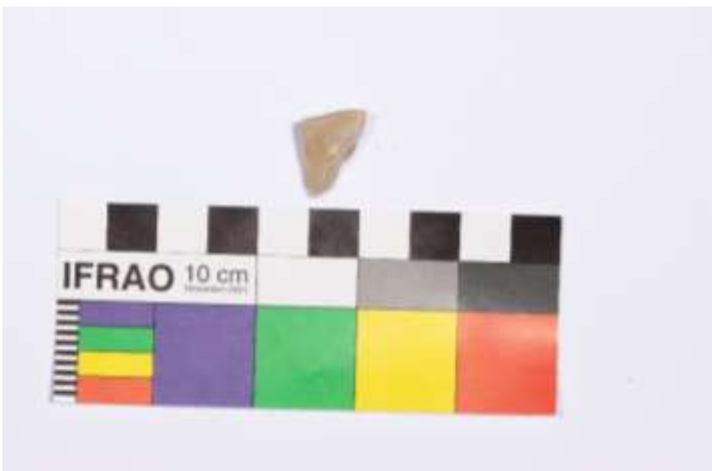
MA 2

a. Flint debitage

b. Late bronze age (?) early iron age (?)

c. Quartz debitage

d. Quartz debitage

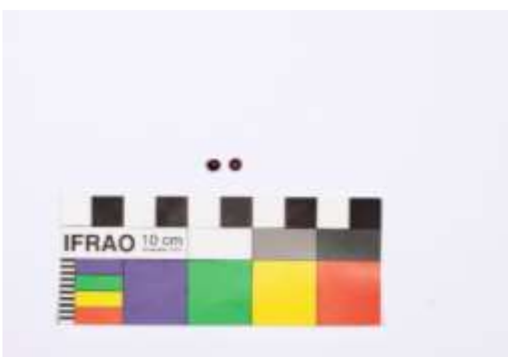


MA 3

a. Flake stone undetermined age

MA 4

a. Unknown beadlike stones (probably precious stones)



b. Quartzite flake (small)

c. Flint debitage

d. Quartz debitages

MA 5

a. Quartz debitage

b. Not lithic but rock.

MA 6

a. Modern pottery, perhaps.

b. Modern pottery, perhaps.

MA 7

a. Pottery base: late bronze age or Iron age cooking pottery.

MA 8

a. Early Bronze Age or Late Chalcolithic pottery (?)

b. Early bonze age or late chalcolithic pottery (?)

MA 9

a. Quartz debitage

b. Red Flint debitages (2)

c. Micro potsherd.

MA 10

a. Iron fragment (?)

b. Flint debitage

MA 11

a. Crystal quartz -debitage

b. Grey pottery-early bronze age (?)

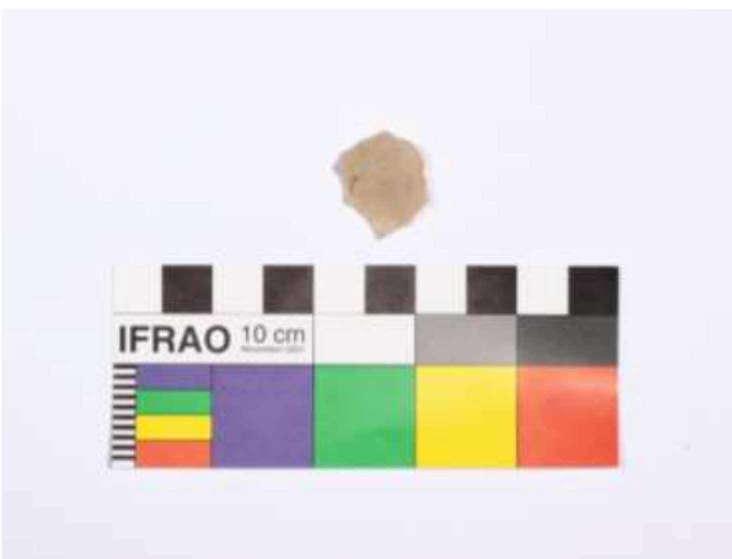
c. Flint debitage

MA 12

a. Flake Flint

MA 13

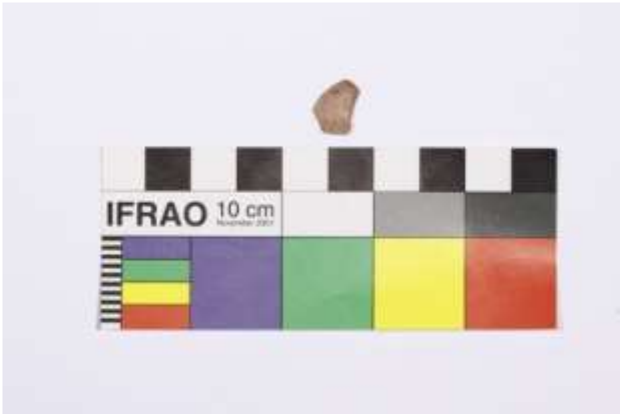
a. White quartz debitage



b. Grey quartz debitage

c. Debitage flint

d. Debitage flint



e. Pottery, perhaps bronze age

MA 14

a. Quartzite flake tool perhaps for cutting

b. Bi-product or debitage quartz

c. Debitage mix quartz or quartzite.

d. Debitage quartz

e. Pottery grey (dark grey) of the undetermined period.

MA 15

a. Pottery? With white varnish- early Iron Age or Roman Age.

b. Fragment of granite artifact (manual miller)

c. Thin pottery of the Late Bronze Age.

d. Copper age ceramics


IFRAO 10 cm


IFRAO 10 cm