



**HAL**  
open science

## The archaeology of quarries and rock-cut sites

Anaïs Lamesa, Jean-Claude Bessac, Claudia Sciuto

► **To cite this version:**

Anaïs Lamesa, Jean-Claude Bessac, Claudia Sciuto. The archaeology of quarries and rock-cut sites. Claudia Sciuto, Anaïs Lamesa, Katy Whitaker and Ali Yamaç. Carved in Stone. The Archaeology of rock-cut sites and stones quarries, BAR Publishing, pp.1-8, 2021, 9781407358093. halshs-04443009

**HAL Id: halshs-04443009**

**<https://shs.hal.science/halshs-04443009>**

Submitted on 7 Feb 2024

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

# The archaeology of quarries and rock-cut sites.

*Jean-Claude Bessac<sup>1</sup>, Anais Lamesa<sup>2</sup>, Claudia Sciuto<sup>3</sup>*

*1 CNRS Montpellier, France*

*2 CNRS Paris*

*3 Department of Civilizations and Forms of Knowledge, University of Pisa*

## Abstract:

To fully appreciate the contributions of archaeological studies devoted to the understanding of quarries and rock-cut structures, it seems advisable to focus the attention over the human, geological and technical aspects that are common to this kind of site. Such conceptual bonds became evident to archaeologists only recently, after a long theoretical and methodological development of research in the field. For a long time, studies of quarries and rock-cut monuments have been carried out independently, often underpinning different research goals. A brief overview of research approaches and bibliographical references on these specific subjects allows us to better appreciate the direction of the current investigations.

This paper is divided into three sections: a general overview of the field of studies; a focus on quarries and, finally, the outline of recent advances in the study of rock-cut sites. Studies on ancient quarries are numerous and closely connected with the analysis of the nature of the stone itself whereas research on rock-cut sites remains somehow neglected and scattered, since it drew scholars' attention only during the 21<sup>st</sup> century.

## KEYWORDS:

Quarries, rock-cut sites, history of techniques, historiography

### 1 General context

The large quarry basins which have marked monumental architectural history are generally quite distant from the most famous rock-cut complexes, both geographically and chronologically. The areas that have been the most targeted by archaeological research on ancient quarries are mainly distributed around the Mediterranean Sea and its eastern islands (Pentelicus, Euboea, Paros, Thasos, Marmara, etc.).<sup>1</sup> Scholars have focused mostly on the Greco-Roman phases of activity of these quarries. Early research on the theme of stone extraction and supply converged on hard, so-called "noble", or ornamental rocks (marbles, granites, porphyries and other decorative hard rocks), because of their ostentatious character of status display and their prestige for powerful ancient clients and art lovers of all times. On the other hand, "ordinary stone" quarries (used to build all sorts of architecture) have never benefited from such enthusiasm, even when they were located adjacent to large rock-cut monuments, such as in Petra (Rababeh 2005, 49-60; Bessac 2007, 77-88).

In terms of rock-cut architectures, a few sites are located in geographic areas neighbouring the large historic marble supply area of the Mediterranean basin, notably on the west coast of Asia Minor, while the largest part of these hewn complexes is scattered around its periphery (Saudi Arabia, Jordan, Turkey, France, Italy) and even well beyond (Persia, Afghanistan, India, Egypt, Ethiopia, Mexico). Apart from rare exceptions, such as Naqsh-e Rostan near Persepolis whose tombs are carved out of hard limestone, most of these features are cut out in relatively soft rocks, such as sandstones, volcanic tufa and more or less chalky limestones. Furthermore, the chronology of carving for the great rock-cut complexes goes far beyond Antiquity and extends diachronically from Prehistory (Sardinia, France, Ireland, England) to the Middle Ages (Italy, Turkey, India, Ethiopia). Despite these general chronological, geographic, and structural differences between the broad categories of quarries and rock-cut sites, we wish to draw attention to a technical aspect that is common to all these features: the process of carving the rock itself. Despite a possible shared methodological approach, research on these two types of sites

---

<sup>1</sup> As in the acts of the ASMOSIA congress, the first of which was published in 1988 (Herz and Waelkens 1988).

followed different paths from the very beginning, and it is only recently that scholars have started reflecting on a common ground.

## **2 Quarries: a research closely connected to the nature of the rock**

The archaeological and historical interest around ancient quarries did not begin until the end of the 19th century. Historians and epigraphists were pioneers in this field, such as Luigi Bruzza, interested in marbles, Charles Dubois, working on all ornamental stones, and Hugo Blümner, who wrote more generally on the technical vocabulary of craftsmanship (Bruzza 1870; Blümner 1884; Dubois 1908). The investigations carried out back then were essentially historical, based on the epigraphic study of inscriptions on semi-finished or rough blocks found in the great imperial quarries, known for the extraction of prestigious materials, and supplied throughout the Roman empire. Early studies were approaching quarries, especially those active in the Greco-Roman period, as a sort of “ancillary” production site, essentially a variety of mines (Léger 1875,704-706). It was only later on that archaeologists started to take into account the differences between the technical activity of the miner, who crushes the mineral ore without worrying about its final destination, and that of the quarryman, who produces blocks whose technical, dimensional and aesthetic characteristics are chosen and / or determined according to their final use (Bessac 1996, 397).

It was not until the last third of the 20th century that the theme of quarries took off again, under the pressure of disciplines related to archaeology, such as the archaeology of buildings or the anthropology of techniques (Bessac 1986a; Balfet 1991; Arlaud and Burnouf 1993; Rockwell 1993). However, at that time research was still dominated by epigraphers and historians, who had little training in the practical and material approach to extraction sites while the contribution of field archaeologists remained relatively marginal. In this scenario, some researchers started approaching the technical and economic aspects of ancient quarries, opening up a new research perspective (Ward-Perkins 1972; Dworakowska 1983; Bedon 1984; Dodge and Ward-Perkins 1992). Starting from the last quarter of the 20th century, the interest towards extraction techniques increased as a consequence for the involvement of different specialists in the study of ancient quarries, such as heritage curators, architects, engineers, and geologists. Already in the 1950s, a pioneer, Josef Röder, initiated the analysis of the technical processes of stone carving and directed excavation campaigns in quarrying sites with the aim of studying exploitation strategies, collecting ancient tools, and observing their traces on the rock surface. Röder started by working on the Roman quarries of volcanic tufa in Rhineland (Röder 1957), before plunging in the study of ornamental stone mining in Turkey, Egypt and Tunisia. His approach to the study of quarries constituted a major innovation but, unfortunately, this new perspective was not really developed and integrated in the archaeological discourse until a few decades later. Since these early studies, various research strategies were tested, together with the development of new methods and research questions, tailored to the specificity of each site (Bessac 1986b). Unlike central Mediterranean and European regions, in the Eastern Mediterranean and the Near East, the study of ancient stone quarries has often been limited to a few superficial observations and epigraphic notes, collected in the context of general archaeological surveys. As specified above, only the marble quarries and other ornamental stones attracted the attention of archaeologists, however without really inspiring them to undertake systematic excavations of production areas, except for some ancient exploitation sites dug in the Egyptian Desert during the last two decades of the twentieth century (Maxfield and Peacock 2001). However, in the last twenty years, it became clear to archaeologists that the understanding of the design and logic behind the creation of ancient buildings, as well as the techniques and the economy of their construction, was lacking without linking it to the organization of the extraction sites.

From the end of the 1970s, European researchers started adopting systematic methods for surveying rocky outcrops as well as considering the idea of conducting excavations in quarry sites. In North Africa and Asia Minor, the investigation of sites for the extraction of ornamental rocks benefitted from these new approaches, such as at Mons Claudianus in Egypt, and Dokimeion in Phrygia (Waelkens, Herz, and Moens 1992; Maxfield and Peacock 2001). Nevertheless, these operations were often aimed at unearthing the outcrops, collecting inscriptions, lapidary elements, and antique tools from contemporary quarrymen, rather than documenting the complete stratigraphic sequence (Fant 1989; Asgari 1995). During the same years, in the western areas of the Mediterranean basin, researchers began to take an interest also in the exploitation of “ordinary” rocks, while these studies often remained superficial or linked to fortuitous discoveries.

The stratigraphic method was introduced gradually in the study of old quarries. From the 1980s, the archaeological authorities, particularly in France, began to support quarry investigations by integrating them into national research planning (Programmation 1981, 73). Most of the field operations were still linked to fortuitous

discoveries and rescue operations, such as in Saint-Boil, near Autun (Monthel and Pinette 1977). The study of the buildings themselves often prompted scholars to study provenance and production of building materials, as in the case of Cap Couronne, near Marseille, where research on the Hellenistic city walls induced archaeologists to investigate the traces of ancient coastal quarries (Guery, Trouset and Hallier 1985). A long-term study program on a vast limestone outcrop in the Bois des Lens, in the region near Nîmes, began in 1978 (Bessac 1996). The project continued for more than twenty years, gradually considering the relationship between quarries, and built monuments, but this kind of approach remained an exception. Between 1980 and 2000, a research project focused on the mapping of the ancient and medieval quarries in France (specifically in Gaul) (Bessac and Sablayrolles 2002). Despite their relative limitations, these early surveys and excavations produced sets of innovative data encompassing technology, economics, socio-cultural phenomena, and even worship (Röder 1975, 213-271; Bessac 1996; Bessac and Sablayrolles 2002). Interest in and recognition of the potential of such research has recently led to the development in England of a multi-period research agenda for extractive industries (Newman 2016).

The early 2000s was also a favourable moment for the development of multidisciplinary studies in archaeology. Research on stone quarrying around the Mediterranean basin became a relevant topic for all archaeologists, not only mining and quarrying specialists, while a major revolution for the subject was due to the cooperation with researchers from the natural sciences (Waelkens, Herz and Moens 1992; Benoit *et al.* 2000). Until then, there were few chemists, physicists, geographers and especially geologists involved in quarry research. This is particularly relevant for the study of antique and medieval quarries, while prehistoric archaeologists could count on a longer tradition of provenance studies (i.e., Clough and Cummings 1979). The methodological and theoretical gap had to be filled and, from the end of the 20th century, a new scientific paradigm for the study of extraction sites took over. The number of detailed geochemical analyses of rock samples and the extensive survey and sampling campaigns increased significantly and aimed, above all, at identifying the outcrops supposed to have supplied large construction sites.

In the last ten years, studies have benefitted from those earlier experiences, by applying protocols that are the result of the integration of different methods: archaeological survey, geological mapping and sampling, and geochemical analyses. The result of that are local studies that focus on a particular stone type or a quarrying basin, functional to a better understanding of local economies of stone supply (Gluhak and Hofmeister 2009; Mascione and Camporeale 2010; Pearson *et al.* 2015; Pruno 2018; Roubis and Sciuto 2019).<sup>2</sup> Moreover, several reference datasets, both analogue and digital, are now available for learning and teaching to recognize and classify tool-marks (Bessac 1986a; Wootton *et al.* 2013; Lavigne 2018).

Currently, in the Mediterranean Basin, a major long-term archaeological excavation project in an ancient extraction site has just ended: the ancient quarry of megaliths in Baalbek, Lebanon.<sup>3</sup> Elsewhere, for Antiquity, there has been a marked decrease of scheduled excavations for the benefit of rescue and survey operations.<sup>4</sup> Quarry sites dated to the early Middle Ages have lately been the target of a more sustained research, in particular the underground exploitation of sarcophagi, which is considered to be the most important extraction activity known for this period. Underground quarries, dated to the Medieval and modern periods have also been mapped and investigated, with physical limits due to the difficulties in accessing some subterranean areas, while excavations in these contexts are rare.<sup>5</sup>

### 3 Rock-cut monuments: still a study niche?

As for stone quarries, research on rock-cut sites encompasses the analysis of both the underground features and/or the rock surface. The study of sites hewn in the bedrock began with the Napoleonic expedition to Egypt, in the dim light of the Pharaonic monumental tombs. From the very beginning of the investigations, the artistic riches of the tombs' content and their decorations eclipsed the technical and human aspects of these majestic

---

<sup>2</sup> Such as the proceeding of the conferences dedicated to quarries and construction sites published in the Spanish journal "Arqueología de la Construcción", the proceedings of the CTHS: "Carrières et constructions en France et dans les pays limitrophes", issued since 1991 or the proceeding of the conference "Montagne incise, pierre incise" (Stagno 2013).

<sup>3</sup> Excavations of the Deutsches Archäologisches Institut led by Jeanine Abdul Massih.

<sup>4</sup> For example, the Italian sites site of Fossacava (Paribeni 2020), while the scheduled excavation of the stone quarries in the area of Populonia have provided important data for understanding the exploitation and supply of calcareous stones between the Etruscan and Roman period in southern Tuscany (Mascione and Camporeale 2010).

<sup>5</sup> One notable exception: Morleghem 2018

rock-cut structures. Similar was the destiny of other iconic monuments, such as the Sphinx and the temple of Abu Simbel, where the exceptional architectural and sculptural apparatus have largely monopolized the direction of the studies. In 1812, the discovery of Petra in the middle of a rocky desert, by Johan Ludwig Burckhardt, caused a general astonishment for the richness of its rock-cut architectural decorations but ignoring all questions about their practical realization. Later, the few texts engraved on the monuments in Petra caught the interest of explorers and researchers. At the beginning of the 20th century, two Dominican brothers, J. Jaussen and R. Savignac, began the study of the numerous inscriptions in the rock tombs of the Nabataean city of Hegra, in Saudi Arabia (Jaussen and Savignac 1997). Most inscriptions mentioned the names of the craftsmen who created the monuments, extremely rare and precious information (Nehmé 2007, 7-27); in the light of that discovery, even if the study of techniques was not yet on the archaeological agenda, scholars could no longer ignore the important craftsmanship of the workforce of specialists active in this extraordinary work.

Despite the early interest shown, more than a century ago, in the work of past craftsmen (Jerphanion 1925-1942; Fonseca 1970), the archaeology of rock-cut monuments remained for long time confined to general architectural typology and, more particularly, to the analysis of stylistic features (McKenzie 1990; Thierry 1983-1994). Art historians were the first to approach the study of these monuments, seeking to date the rock complexes and setting up typo-chronologies often based on masonry-built references. Likewise, the rare technical considerations proposed about stonework in rock-cut sites were strongly influenced by the conventions of monumental construction (which always develop from the bottom up, whereas in rock-cut architectures the procedure is generally reversed, since the rock is carved from top to bottom). Unlike buildings, rock-cut monuments were seen as architectures frozen in the rock, and therefore made in one piece. Carving phases, whether contemporary or spaced over a long-time span, were generally not mentioned.

It was not until the 21st century that the understanding of rock-cut monuments changed. For instance, the rejection of the general scheme of a bottom-up realization of most rock-cut monuments happened very gradually (Bessac 2007, 89-109). The descriptive vocabulary also evolved and improved; initially modelled on that of traditional construction, it adapted to the jargon of quarrymen, miners, stonemasons and sometimes sculptors, closer to the actual practices of rock cutting (Bessac 2007, 566-568; Dehijia and Rockwell 2016). Following the example of studies on quarries, but well after them, research on rock-cut monuments really took off in the last 15 years. Monuments were integrated into archaeological research as a source for understanding the landscape and its transformations over time (Fauvelle *et al.* 2010; Crescenzi 2012; Sogliani 2018, 2020), but unfortunately, hardly any excavation is currently carried out in these complexes.<sup>6</sup>

The contribution of digital technologies should also be mentioned. An overview of documentation methods that involve 3D modelling, stratigraphy and speleology was recently written by Giancarlo Pastura (2020). Photogrammetry represented an important breakthrough for the survey of rock-cut monuments, allowing researchers to better capture the volumes of the sites, in order to understand their evolution over time, and the directions in digging (Angelini 2018). Plans and cross sections, easily extracted from 3D models, also support a better understanding of the workers' technical skills in achieving perfect right angles. Moreover, the combination of photogrammetry and 3D GIS could allow an analysis of the monument within the outcrop itself, observing the position of the carved spaces within the geological layers, and understanding technical and architectural choices that are conditioned by geomorphology. Finally, Virtual Reality is also becoming an interesting immersive medium for exploring undergrounds and sharing the process of interpreting the space according to carved features (Sciuto *et al.* forthcoming). The application of these methods contributed to the renewed interest for the study of rock-cut monuments, developed in recent years (Carpiceci, Inglese and Colonese 2015). The general understanding of rock-cut features, entailing its qualitative and quantitative aspects, should, above all, benefit from the methodological revolutions begun in the last decades.

#### **4 Towards new research perspectives**

Until the beginning of the 21<sup>st</sup> century, the links between the activity of quarrymen and rock-cut architectural productions was not always evident to scholars interested in monumental archaeology, nor to the general public. The aspects that are common to these two types of features began to emerge only recently, in all their technical and anthropological complexities.

---

<sup>6</sup> Except for the research carried out by the international team at Lalibela, which has been conducting excavations on this exceptional rock site for several years now (Bosc-Tiessé and Derat, 2019; Derat *et al.* 2021).

Even in rock-cut sites, depending on the various types of architecture and rock concerned, the share of work needed for extraction is predominant, compared to that of the architectural decor. This extraction can be destructive, crushing the rubble, especially in soft rocks such as the volcanic tufa of Cappadocia (Lamesa 2018) or conducted in such a way as to provide ashlar for construction, as with the sandstone of Petra. In many cases, quarries and rock-cut sites are overlapping, located on the same outcrop, and probably some of the workers were involved in both activities. If in rock-cut sites the extraction activity is undeniable, it must be considered as closely associated, even mixed, with certain quarrying techniques and particularly with some special and complex stone carving processes, since it lacks the guide given by the natural alignment of the depositional joints. These are compelling socio-economic aspects which have barely been investigated and remain to be developed, especially through ethnoarchaeology and experimental archaeology (Lamesa 2011; Porqueddu 2018; Lamesa and Hailay Atsba Hailu 2020; Robin and Adams in this volume).

A reflection about the technical means adopted both in quarries and rock-cut sites for coping with the characteristics of the rock, and the agency of the stone itself, can be made by examining the quarrymen's know-how. Even though rock craftsmen are usually quite versatile, it is in the everyday practice of their work that they first discover hidden defects of the rock: cracks, harder layers, stratification joints, etc. They are the ones who judge how to get around or integrate these features into the general stylistic choices of the block/monument, knowing that the slightest error in this groundwork activity of carving and sculpting can wreck the work, and even determine its abandonment (Lamesa 2020). Similarly, the methodological challenges in the study of rock-cut sites are different from those of free-standing constructions because of this powerful agency of the bedrock itself. For example, while in standing monuments built within the classical tradition, archaeologists can easily assess the respect of proportions as compared to the rules defined by Vitruvius, in hewn monuments, even when actual formal reference models exist, the craftsmen must comply with the litho-stratigraphic peculiarities of bedrocks that they often discover as their work progresses down and deep into the layers they carve (Bessac 2009).

The works collected in this volume aim at adopting a holistic approach to the study of quarries and rock-cut sites, by overcoming the old typo-chronological studies and embracing a truly transdisciplinary resolution. This work is part of a more environmental and anthropological perspective, which aims at balancing different approaches by applying them to various landscapes and features, taking into account the mind and the work of the professionals who carried out these activities as well as their manifold relationships with bedrocks.

## List of references

- Angelini, Andrea. 2018. *Tecniche di rilevamento e metodi di rappresentazione per l'architettura rupestre: il monastero benedettino di Subiaco*. Oxford: BAR Publishing.
- Arlaud, Catherine, and Joëlle Burnouf. 1993. "Introduction". In *L'archéologie du bâti médiéval urbain*, eds. Catherine Arlaud and Joëlle Burnouf, 5-6. Paris: Editions Errance.
- Asgari, Nuşin. 1995. "The Proconnesian Production of Architectural Elements in Late Antiquity, Based on Evidence from the Marble Quarries". In *Constantinople and its Hinterland. Papers from the Twenty-seventh Spring Symposium of Byzantine Studies*, Oxford April 1993, eds. Cyril Mango, Gilbert Dagron, and Geoffrey Greatex, 263-288. Aldershot; Brookfield (Vt): Variorum.
- Balfet, Hélène, ed. 1991. *Observer l'action technique: des chaînes opératoires, pour quoi faire?* Paris: Edition du Centre national pour la recherche scientifique.
- Bedon, Robert. 1984. *Les carrières et les carriers de la Gaule romaine*. Paris: Picard
- Benoit, Paul, Annie Blanc, Jean-Pierre Gély, Ania Guini-Skliar, Daniel Obert, and Marc Viré. 2000. "La pierre de Paris. Méthode d'étude de la pierre à bâtir depuis son extraction jusqu'à sa mise en œuvre". In *La pierre dans la ville antique et médiévale*, eds. Jacqueline Lorenz, Dominique Tardy, and Gérard Coulon, 121-158. Argenton-sur-Creuse: musée d'Argentomagus.
- Bessac, Jean-Claude. 1986a. *L'outillage traditionnel du tailleur de pierre: de l'Antiquité à nos jours*. Paris: Edition du Centre national de la recherche scientifique.

- Bessac, Jean-Claude. 1986b “La prospection archéologique des carrières de pierre de taille: approche méthodologique”. *Aquitania* 4:151-171.
- Bessac, Jean-Claude. 1996. “La pierre en Gaule narbonnaise et les carrières du Bois des Lens (Nîmes).” *Journal of Roman Archaeology Supplementary series* 16: 319.
- Bessac, Jean-Claude. 2007. *Le travail de la pierre à Pétra: technique et économie de la taille rupestre*. Paris: Editions Recherche sur les Civilisations.
- Bessac, Jean-Claude. 2009. “Construction en pierre et taille rupestre monumentale antique au Proche et Moyen-Orient: les différences”. In *Marbres et autres roches de la Méditerranée: études interdisciplinaires*, ed. Philipps Jockey, 565-582. Paris: Maisonneuve et Larose.
- Bessac, Jean-Claude, and Robert Sablayrolles, 2002. “Recherches récentes sur les carrières antiques de Gaule. Bilan et perspectives”. *Gallia* 59: 175-188
- Bruzza, Luigi. 1870. *Iscrizioni dei marmi grezzi*. Rome: Salviucci.
- Blümner, Hugo. 1884. *Technologie und Terminologie der Gewerbe und Künste bei Griechen und Römern*. Leipzig: Teubner.
- Bosc-Tiessé Claire, and Marie-Laure Derat, eds. 2019. *Lalibela, site rupestre chrétien d’Ethiopie*. Toulouse: Presse universitaire du Midi.
- Carpiceci, Marco, Carlo Inglese, and Fabio Colonese. 2015. “Potential and Limitations of New Technologies for the Survey of Morphology and Colour of Rupestrian Habitat”. In *Hypogea 2015. Proceedings of International Congress of Speleology in Artificial Cavities* (Rome March 11/17, 2015), eds. Mario Parise, Carla Galeazzi, Roberto Bixio, and Carlo Germani, 304-312. Urbino: AGE.
- Clough, Timothy H., and William Arthur Cummins. 1979. “Stone Axe Studies. Archaeological, Petrological, Experimental, and Ethnographic”. *GBR*, n. 23: 1–137.
- Crescenzi, Carmela. 2012. *Rupestrian Landscape and settlements. Workshops and Survey Results*. Firenze: DAdsp-Unifi.
- Dehejia, Vidya, and Peter Rockwell. 2016. *The Unfinished. Stone Carvers at Work on the Indian Subcontinent*. New Delhi: Roli books.
- Derat, Marie-Laure, Claire Bosc-Tiessé, Antoine Garric, Romain Mensan, François-Xavier Fauvelle, Yves Gleize, and Anne-Lise Goujon. 2021. “The rock-cut churches of Lalibela and the cave church of Washa Mika’el: troglodytism and the Christianisation of the Ethiopian Highlands”. *Antiquity* 95: 1-20.
- Dodge, Hazel, and Bryan Ward-Perkins, eds. 1992. *Marble in Antiquity*. London: British School at Rome.
- Dubois, Charles. 1908. *Étude sur l’administration et l’exploitation des carrières: marbres, porphyre, granit, etc. dans le monde romain*. Paris: A. Fontemoing
- Dworakowska, Angelina. 1983. *Quarries in Roman Provinces*. Wrocław: Zakład Narodowy im Ossolińskich.
- Fant, Clayton J. 1989. *Cavum Antrum Phrygia. The Organization and Operations of the Roman Imperial Marble Quarries in Phrygia*. Oxford: Bar International Series 482.
- Fauvelle-Aymar, François-Xavier, Laurent Bruxelles, Romain Mensan, Claire Bosc-Tiessé, Marie-Laure Derat, and Emmanuel, Fritsch. 2010 “Rock-cut Stratigraphy: Sequencing the Lalibela Churches”. *Antiquity* 84 (326): 1135-1150.
- Fonseca, Damiano. 1970. *Civiltà rupestre in terra ionica*. Roma: Ed. Bestetti.
- Gluhak, Tatjana Mirjam and Wolfgang Hofmeister. 2009. “Roman lava quarries in the Eifel region (Germany): geochemical data for millstone provenance studies”. *Journal of Archaeological Science* 36 (8): 1774–82.
- Guery, Roger, Pol Troussset, and Gilbert Hallier. 1985. “Des carrières de la couronne aux vestiges de la Bourse: techniques d’extraction et de construction”. In *Histoire des techniques et sources documentaires: méthodes*

*d'approche et expérimentation en région méditerranéenne*. Acte du colloque du GIS, Aix en Provence. Cahier du GIS 7: 25-52.

Herz, Norman, and Marc Waelkens. 1988. *Classical marble: geochemistry, technology, trade*. Dordrecht - Boston: Kluwer Academic Publishers.

Jaussen, Antonin, and Raphaël Savignac. 1997. *Mission archéologique en Arabie*. Le Caire: Institut français d'Archéologie Orientale.

Jerphanion De, Guillaume. 1925-1942. *Une nouvelle province de l'art byzantin: les églises rupestres de Cappadoce*. Paris: P. Geuthner.

Lamesa, Anaïs. 2011. "Détermination des intervenants lors de chantiers d'églises rupestres en Cappadoce médiévale (VIIe-XIIIe siècle): méthodes d'analyses croisées". In *Carriers et bâtisseurs de la période préindustrielle: Europe et régions limitrophes: Actes du 134e Congrès national des sociétés historiques et scientifiques "Célèbres ou obscurs, hommes et femmes dans leurs territoires et leur histoire"*, organisé par le C.T.H.S. à Bordeaux du 20 au 25 avril 2009, eds. Jacqueline Lorenz, and Jean-Pierre Gély, 177-190. Paris: édition du CTHS.

Lamesa, Anaïs. 2018. "Rock-cut Tombs and Churches in Cappadocia during the Roman and Byzantine Periods. The Analysis of Châsses Opératoires to Understand the Economy and Sociology of the Building Sites". In *Merging techniques and Cultures*. IFEA Archaeological Meeting, 2015 November 24-25, ed. Martin Godon, 75-83. Istanbul: Institut français d'études anatoliennes.

Lamesa, Anaïs. 2020. "Methods for rock-hewn worksite analysis: case study of Göreme's n°4b (Cappadocia) "thwarted" worksite". *Anatolia Antiqua* 28: 23-45.

Lamesa, Anaïs, and Hailay Atsbha Hailu. 2020. "Church Worksites in Eastern Təgray (from the Middle Ages to the 21st Century): Technical-economic and Ethno-archaeological Analyses of local Rock-hewn Practices". *Un œil sur la Corne*. Blog scientifique du CFEE. <https://cfee.hypotheses.org/7349>

Lavigne, Olivier. 2018. "New typology for Old, Middle Kingdom stone tools: Studies in the Hatnub quarries in Egypt". In *Building knowledge, constructing histories, 6th International Congress on Construction History (6ICCH 2018)*, July 9-13, eds. Ine Wouter, Stephanie Van de Voorde and Inge Bertel, 857-862. Boca Raton, London, New York, Leiden: Taylor & Francis Group.

Léger, Alfred. 1875. *Les travaux publics, les mines et la métallurgie aux temps des Romains: la tradition romaine jusqu'à nos jours*. Paris: J. Dejeu.

Mascione, Cynthia, and Stefano Camporeale. 2010. "Dalle cave ai cantieri : estrazione e impiego della calcarenite a Populonia tra periodo etrusco e romano". *Arqueologia de la construcció. Los procesos constructivos en el mundo romano: Italia y provincias orientales* 2: 153-72.

Maxfield, Valerie A., and David Peacock. 2001. *The Roman Imperial Quarries Survey and Excavations at Mons Porphyrites 1994-1998*. Vol. 1, Topography and Quarries. London: Egypt exploration Society.

McKenzie, Judith S. 1990. *The architecture of Petra*. Oxford: Oxford University Press

Montel, Gérard, and Matthieu Pinette. 1977. "La carrière gallo-romaine de Saint-Boil". *Revue archéologique de l'Est et du Centre-Est* 28 (1-2): 37-61.

Morleghem, Daniel. 2018. "Apports de la 3D numérique à l'étude des carrières de sarcophages du haut Moyen Âge." In *Méthodes de relevés numériques en archéologie et en architecture: applications*, eds. Christophe Colliou, and Nicolas Morelle, 125-28. Rouen: CRAHN.

Nehmé, Leila. 2007. "Préface". In *Le travail de la pierre à Pétra: technique et économie de la taille rupestre*, ed. Jean-Claude Bessac, 7-27. Paris: Editions Recherche sur les Civilisations.

Newman, Phil, ed. 2016. *The Archaeology of Quarrying and Mining in England. A research framework for the extractive industries in England*. Matlock Bath: National Association of Mining Historians.



Paribeni, Emanuela. 2020. "La cava romana di Fossacava (Carrara): labra, blocchi e sigle da uno scavo archeologico". In *Forme e modalità di gestione amministrativa nel mondo greco e romano: terra, cave, miniere*, eds. Michela Faraguna, and Simonetta Segenni, 122-146. Milano: Ledizioni.

Pastura, Giancarlo. 2020. "Archeologia, speleologia e moderne tecnologie. Un dialogo metodologico". In *Il rupestre e l'acqua nel Medioevo Religiosità, quotidianità, produttività*, eds. Elisabetta De Minicis and Giancarlo Pastura, 13-18. Sesto Fiorentino: All'Insegna del Giglio.

Pearson, Mike Parker, Richard Bevins, Rob Ixer, Joshua Pollard, Colin Richards, Kate Welham, Ben Chan, Kevan Edinborough, Derek Hamilton, and Richard Macphail. 2015. "Craig Rhos-y-felin: a Welsh bluestone megalith quarry for Stonehenge". *Antiquity* 89 (348): 1331–52.

Porqueddu, Marie-Elise. 2018. "Lo studio delle tecniche di escavazione degli ipogei funerari preistorici: un nuovo approccio metodologico a S'Elighe Entosu". In *Usini. Nuove ricerche a S'Elighe Entosu. Sassari*, ed. Maria Grazia Melis, 139-171. Sassari: Quaderni del LaPArS 2.

Programmation. 1981. *Programmation de la recherche archéologique de terrain en France*, Paris: Ministère de la Culture, Direction du Patrimoine, Sous-Direction de l'Archéologie.

Pruno, Elisa. 2018. *Cave e petriere nell'Amiata occidentale. Lo sfruttamento delle risorse lapidee per la produzione edilizia medievale*. Firenze: All'Insegna del Giglio.

Rababeh, Shaher M. 2005. *How Petra was built: an analysis of the construction techniques of the Nabataean freestanding buildings and rock-cut monuments in Petra, Jordan*. Oxford: Archaeopress.

Rockwell, Peter. 1993. *The Art of Stoneworking: a Reference Guide*. New York: Cambridge University Press.

Röder, Joseph. 1957. "Die antiken Tuffsteinbrüche der Pellenz." *Bonner Jahrbücher des Rheinischen Landesmuseums*". In *Bonn und des Rheinischen Amtes für Bodendenkmalpflege im Landschaftsverband Rheinland und des Vereins von Altertumsfreunden im Rheinlande* 157: 213-271.

Roubis, Dimitris, and Claudia Sciuto. 2019. "Origin and Circulation of Calcarenite Artifacts in the Area of Montescaglioso between 6th and 3rd Century BC: An Interdisciplinary Approach". *Heritage* 2 (1): 467–89.

Thierry, Nicole. 1983-1994. *Haut Moyen-âge en Cappadoce: les églises de la région de Çavuşin*. Paris: P. Geuthner.

Sciuto Claudia, Anna Foka, Mattis Lindmark and Jim Robertsson. Forthcoming. "Exploring Fragmented data: Environments, People, and the Senses in Virtual Reality". In *Capturing the senses: digital methods for sensory archaeologies*, eds. Giacomo Landeschi, and Eleanor Betts. Berlin: Springer.

Sogliani, Francesca, ed. 2018. *VIII Congresso nazionale di archeologia medievale 3. Sezione V, Archeologia degli insediamenti rupestri*. Sesto Fiorentino: All'Insegna del Giglio.

Sogliani, Francesca. 2020. "Progetto DARHEM digital atlas of rupestrian heritage of Matera. La forma dell'acqua nei contesti rupestri". In *Il rupestre e l'acqua nel Medioevo Religiosità, quotidianità, produttività*, eds. Elisabetta De Minicis, and Giancarlo Pastura, 113-122. Sesto Fiorentino: All'Insegna del Giglio.

Stagno, Anna Maria, ed. 2013. *Proceedings of the conference «Montagne Incise, pietre incise»*, Borzonasca 20-22 Ottobre 2011. *Archeologia Postmedievale*. All'Insegna del Giglio: Firenze.

Ward-Perkins, Bryan. 1972. *Quarrying in Antiquity: Technology, Tradition and Social Change*. London: Oxford University Press.

Waelkens, Marc, Norman Herz, and Luc Moens. eds. 1992. *Ancient Stones: Quarrying, Trade and Provenance. Interdisciplinary Studies on Stones and Stone Technology in Europe and Near East from the Prehistoric to the Early Christian Period*. Leuven: Leuven University Press.

Wootton, Will, John Bradley, and Benjamin Russell 2013. "Making the Art of Making in Antiquity (version 1.0)". *The Art of Making in Antiquity: Stoneworking in the Roman World*. Accessed on Oct 21, 2020. <http://www.artofmaking.ac.uk/content/essays/1-making-the-art-of-making-in-antiquity-w-wootton-j-bradley-b-russell/>.