

<i>MANUSCRIT AMB CORRECCIONS</i>			
<b>The Exploitation of Local Stone in Ancient Times: The Case of Northeastern Spain</b>			
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<b>Revista</b>	<a href="#">World Archaeology</a> Volume <a href="#">43</a> , 2011 - Issue <a href="#">2</a> .		
<b>DOI</b>	<a href="https://doi.org/10.1080/00438243.2011.586201">https://doi.org/10.1080/00438243.2011.586201</a>		
<b>Disponible en línia</b>	14/07/2011	<b>Data de publicació</b>	2011
<p>Per citar aquest document:</p> <p>Gutiérrez Garcia-Moreno, A. (2011), "The Exploitation of Local Stone in Ancient Times: The Case of Northeastern Spain", <i>World Archaeology</i>, 43/2, p. 318-341.  <a href="https://doi.org/10.1080/00438243.2011.586201">https://doi.org/10.1080/00438243.2011.586201</a>.</p>			
<p>Aquest arxiu PDF conté el manuscrit amb correccions per a la seva publicació.</p>			

# THE EXPLOITATION OF LOCAL STONE IN ANCIENT TIMES: THE CASE OF NORTHEASTERN SPAIN<sup>1</sup>

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## **Brief background**

The growing attention attracted by stone materials and their use in ancient Spain during the recent decades have helped to make clear the importance of stone extraction and its related activities in this territory. Despite the existence of some pioneering work which represented the turning point that marked the beginning of a new sensitivity on the part of Spanish archaeologists (Canto 1978; Grünhagen 1978), it was during the decade of the 80s and in particular late 90s that the number of studies devoted to the identification of marble or other stones increased significantly in Spain. The multidisciplinary approach has consolidated over recent decade, which has witnessed an increasing collaboration between archaeologists and geologists or other scientists with copious results (see, for example, Àlvarez *et alii*, 2009a, 2009b, 2009c; Gutiérrez Garcia-M., 2009a; Lapuente *et alii*, 2002; Lapuente and Blanch, 2002; Nogales y Beltrán, 2009; Nogales *et alii*, 1999; Rodà, 1998, 2004 and 2005).

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<sup>1</sup> The research from which this paper results has been undertaken within the R+D projects *Materiales lapídeos de Hispania septentrional y su comercio* (HUM2005-03791) and *Explotación, uso e intercambio de materias primas inorgánicas entre el Norte de Hispania, el Sur de la Galia y los puertos de Roma* (HAR2008-046000/HIST) funded by the Ministerio de Innovación y Ciencia of the Spanish Government.

However, within the overall picture, the areas of procurement (i.e. the quarries) have been less addressed<sup>2</sup>.

The research into Roman quarries in northeastern Spain has been mainly restricted to the territories surrounding some of the main Roman urban centres, i.e. the towns of Tarraco (modern Tarragona), the former capital of the Citerior and later Tarraconensis provinces, and Emporion/Emporiae (modern Empúries), a major urban centre from the time of the arrival of the Phocaeans in the early sixth century BC, as well as smaller towns such as Gerunda (modern Girona), Barcino (modern Barcelona), Dertosa (modern Tortosa) and Aeso (modern Isona) with the addition of some particular quarries that, due to its importance, could not be left out (Fig. 1). The research on previous works together with the field survey and analysis of the fronts led to the compilation of numerous data that, combined with the data from the stone artefacts and buildings, give a greater understanding of the exploitation of this region's stone resources in Roman times.

[insert Fig. 1 here]

### **The chronological framework of stone extraction**

#### *The evidence from the quarries*

The first and main factor, which stood out above all the others because the whole of the following discussions rested upon it, was the location and dating of the quarries. As in many other areas, the resumption of quarrying during later periods led either to the destruction of the ancient remains or their concealment under debris, which determines the evidence visible today. Further data,

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<sup>2</sup> With the exception of very recent works presented in nacional conferences (Garcia-Entero in press; Nogales and Beltrán 2009) and in the IX International Conference of the ASMOSIA, held in Tarragona in June 2009.

particularly from archaeological excavations, is key to decipher first of all which of the quarries are indeed Roman and which of them resulted from post-Roman working<sup>3</sup>. Nevertheless, a close analysis of the data available (e.g. extraction traces preserved at the sites, presence/absence of Roman buildings or monuments nearby, location of the quarry in relation to the road network of coastal transport, etc) enabled to venture a chronological framework for most of the quarries.

Archaeological evidence to confirm a Roman date is only available for 3 out of 40 quarries considered<sup>4</sup>: a small quarry at the site of Olèrdola, a Roman military site (14), Pedrera Romana at Montjuïc (12) (Fig. 2) and PERI2-Lots 18 and 21 (31), which were discovered due to urban development at Barcelona and Tarragona. However, Els Munts, Clot del Mèdol and Punta de la Creueta (23, 25 and 27), near Tarraco, were also exploited in ancient times, as their direct link to Roman monuments or buildings attests.

[insert Figs. 2 and 3 here]

On the other hand, a large group of quarries or individual quarry sites are of possible ancient date, although no evidence other than the extraction traces preserved at the sites and the confirmation of the use of their stone during ancient times supports this assumption. This is the case of the outstanding quarries of Clots de Sant Julià and Puig d'en Torró (5 and 6), one of the sites at El Mèdol (25) (Fig. 3), Coves del Llorito (29) and most of the Coves de la Pedrera sites (32), as well as smaller quarries scattered throughout the territory such as Sant Martí d'Empúries (2), Puig de Serra (4), one of the sites at

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<sup>3</sup> As already stated by J.-C. Bessac, 'the lack of remains that are possible to date during the field survey does not rule out the possibility of ancient working, only archaeological excavation allows us to be more affirmative in this respect' (Bessac 2002c: 42).

<sup>4</sup> A number for each quarry, related to those used in Fig.1, is provided next to them each time they are mentioned in the text in order to facilitate their location on the map.

Domeny (8), Antic Camí de Sant Salvador (10), La Rierussa (13), part of the larger site of Roda de Berà (15), Marítima Residencial (19), Platja dels Capellans (22), three of the sites located at Mas del Marquès (26), Platja de l'Arrabassada (30), most of Pedreres de l'Aqüeducte sites (33), the smallest site of Mas dels Arcs (34) and Mas d'en Dolça (35) (Fig. 4).

[insert Fig. 4 here]

The first and most important aspect in determining the probable ancient origin of a quarry site was to verify the use of its stone in ancient times. Although this was not always possible, as for instance in the area of Tarragona, where many of the quarries supplied a very similar type of stone, it was one of the main factors for not ruling out a possible Roman date. However, alternative factors based on the extraction patterns or strategies observed at other well-dated Roman quarries were used in an attempt to discern whether they were the result of Roman working or later extraction activity.

Thus, strict regularity of extraction regardless of the stratigraphic bedding, when found together with generally large-scale blocks and intensive use of the site, the presence of rounded/subrounded wedge holes, that were most likely employed with wooden wedges, or rounded elements were considered a strong indicator of early modern extraction. Likewise, due to the identification of some underground quarries as being result of the reuse of Roman opencast quarries in later times<sup>5</sup>, the few examples of subterranean extraction were closely examined. Therefore, many of the studied sites were considered very likely of post-Roman date, and in particular the result of early modern quarrying, which was a quite important industry in the study area in sixteenth, seventeenth and

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<sup>5</sup> In particular the quarries of Glanum (modern La Lie, France) (Bessac 1999, 2003: 36-37, 2006: 21-22) or Puerto de Santa Maria (Cadiz, southern Spain) (López Amador *et alii* 1991).

especially early to mid eighteenth century, when a period of economic prosperity led to a building boom, both in the private and public spheres.

In quite a large number of cases neither the extraction traces nor the extraction pattern were enough to tip the balance in favour of an ancient or later date. Nevertheless, there are some cases for which an ancient date is very plausible, even though the remaining evidence is more in keeping with post-Roman rather than with ancient working (see Fig. 1, quarries of uncertain date –in green-). Therefore, only these three groups, i.e. quarries of ancient date, quarries of probably Roman date and quarries of uncertain date, were taken into account when discussing the stone industry in this territory while the ones of probably post-Roman date were ruled out.

#### *The evidence from archaeological artefacts*

More precise chronological inferences cannot be made from the quarrying evidence, as most of the techniques changed little over the centuries until the introduction of explosives to quarrying, which in this region took place during the first half of the twentieth century. Nevertheless, the dating of archaeological artefacts helps to identify the lifespan of those quarries whose stone was used in ancient times.

The main types of local stone used in Roman times in northeastern Spain are summarized in the following table (Table 1):

[insert Table 1 here]

Common name	Type of stone	Geological date	Quarries	Use	Places of use
Empúries limestone	Limestone	Cretaceous (Upper Albian –Cenomanian)	Santa Margarida and Santa Magdalena (1), Sant Martí	Building, epigraphy, sculpture	Emporiae

d'Empúries (2)					
Clots stone	Sandstone	Eocene (Bartonian)	Clots de Sant Julià <sup>6</sup> (5), Puig d'en Torró (6), Domeny (8)	Building, architectural elements, epigraphy	Emporiae, Gerunda, and the area in between
Girona stone	Nummulitic limestone	Eocene (Lutecian)	Les Pedreres (7)	Building, epigraphy	Gerunda, Emporiae
Isona limestone	Limestone	Cretaceous (Santonian?)	Unknown (probably erratic blocs)	Epigraphy (pedestals)	Aeso and its territory
? (Aeso type)	Very shelly /nonshelly limestone	Cretaceous (Maastrichtian)	Antic Camí de Sant Salvador (10), Gafans (11)	Building	Aeso
Montjuïc sandstone	Sandstone	Upper Miocene	Pedrera romana (12)	Building, architectural elements, epigraphy, sculpture, portraits	Barcino
Coves stone	Calcsiltite (limestone)	Miocenic	Coves de la Pedrera (32)	Building	Tarraco
Llorito stone	Calcsiltite	Miocenic	Coves del Llorito (29)	Building and sarcophagi	Tarraco
Mèdol stone	Calcarenite (limestone)	Miocenic	El Mèdol (25), Mas del Marquès (26), Punta de la Creueta (27), Platja de l'Arrabassada (30), PERI2-lots18-21 (31)	Building, sarcophagi, sculpture, epigraphy and architectural elements (such as columns and capitals)	Tarraco and its hinterland
<i>Soldó</i>	Calcarenite (limestone)	Miocenic	Mas dels Arcs (34), Aqüeducte (33), Torre d'en Dolça/Vila-seca (35); upper layers of El Mèdol (25), Mas del Marquès (26), Coves de la Pedrera (32) and Coves del Llorito (29)	Building, sarcophagi, sculpture, epigraphy and <i>cupae</i>	Tarraco and its hinterland
Altafulla stone	Calcarenite (limestone)	Miocenic	Altafulla (24), Els Munts (23), Platja dels Capellans/de Canyadell (22), Punta de la Llança (21), Roca Foradada (20), Marítima Residencial (19)	Building	Northern coastline of the territory of Tarraco
? (Roda de Berà type) <sup>7</sup>	Calcarenite (limestone)	Miocenic	Roda de Berà (15), Corral del Xim (16), Mas de Nin (17), L'Aguilera (18)	Building	Northern <i>territorium</i> of Tarraco
Savinosa or Aigüeres stone	Limestone	Miocenic	La Savinosa (28)	Building, epigraphy, quicklime?	Tarraco
Santa Tecla stone	Limestone	Cretaceous	El Llorito (36), La Salut (37)	Epigraphy and ornamental purposes (wall veneers, pavements, <i>opus sectile</i> , architectural elements).	Mainly Tarraco but also in other places throughout northeastern Hispania, and Caesar Augusta and Carthago Nova
<i>llisós</i>	Limestone	Lower Cretaceous-Upper Jurassic	El Llorito (36), La Salut (37)	Epigraphy and ornamental purposes (wall veneers, pavements) and	Tarraco

<sup>6</sup> A thorough study of these quarries and Clots stone is provided by Rocas, Roqué and Pallí (2002).

<sup>7</sup> No specific name is known for the stone from the Roda de Berà area but, as already set out, it can be distinguished from the other types on geological basis

sarcophagi					
Alcover stone	Mudstone	Upper Muschelkalk	La Lloera (38)	Epigraphy, wall and floor panelling, tombstones	Tarraco and its hinterland
<i>Broccatello</i> (or jaspi de la Cinta)	Limestone	Lower Cretaceous	Barranc de la Llet (39)	Epigraphy and ornamental purposes (wall veneers, pavements, <i>opus sectile</i> , architectural elements)	Dertosa, most of Hispania, central Italy (Rome and Lazio) and north African coast <sup>8</sup>

**Table 1.** Summary of the main local stones of northeastern Hispania, their provenance and use.

Apart from Empúries and Clots stone, which were used since pre-Roman times, the introduction of local stone exploitation was gradual over a period of about two centuries and, despite a general decrease from the latter stages of the early Imperial period, the abandonment of most local stones was also progressive (Table 2). The reasons for the differences on the chronology of each type of stone lie not only in the specific circumstances of each town and its surrounding area, where it was mostly used –especially the non-ornamental one-, but also in the many other factors involved in the stone industry, such as their quality, its uses and the area of diffusion. Thus, as the examples of Santa Tecla stone and, especially, *broccatello* show, the more ornamental and unique a stone was, the longer it was in use.

TYPE OF STONE	BC			AD				
	Mid third c.	second century	first century	first century	second century	third century	4 <sup>th</sup> century	fifth century
Empúries stone	■	■	■	■	■	■	■	■
Clots stone	■	■	■	■	■	■	■	■
Girona stone	■	■	■	■	■	■	■	■
? (Aeso st.)	■	■	■	■	■	■	■	■
Isona limestone	■	■	■	■	■	■	■	■
Montjuïc stone	■	■	■	■	■	■	■	■
Santa Tecla st.	■	■	■	■	■	■	■	■
Llisós	■	■	■	■	■	■	■	■
Savinosa	■	■	■	■	■	■	■	■
Mèdol st./soldó	■	■	■	■	■	■	■	■
Coves/Llorito st.	■	■	■	■	■	■	■	■
Altafulla stone	■	■	■	■	■	■	■	■
? (Roda de B. st)	■	■	■	■	■	■	■	■

<sup>8</sup> For the updated distribution map of this stone, see Gutiérrez Garcia-M. 2009, 237, fig. 268.





On the basis of the chronological framework proposed, other aspects of local stone extraction have been considered

*Tools, extraction techniques and strategies*

Despite the bias of the data and the erosion of the traces preserved, which makes impossible a proper metrological analysis, analysis of direct evidence of the extraction, especially traces of tools and components, has revealed several aspects. Firstly, the total absence of circular elements against the predominance of the extraction of rectangular blocks, but no pattern has been identified based on strict metrological the Roman unit of measurement. This fact confirms that, as has already been proposed in other studies (Bessac 1994, 1999, 2003; Dworakowska 1983), measures of the stone blocks were non-ornamental basically determined by the presence of natural fractures and planes of deposition, if any, and the purpose for which it was intended when they were determined by the previous point.

Aeso quarries (10, 11) and Lloera (38) in the hinterland of Tarraco are clear examples of the former, while the quarries of Montjuic (12) and Olèrdola (14) are illustrative of the second case since, despite the lithological uniformity of the outcrop, the blocks are not uniform in sizes and do not strictly correspond to multiple values of the Roman foot.

The predominance of square-section trenches over the wedge-section (V) ones, which are found only occasionally in quarries of ancient date, is worth noting. As already indicated by J.-C. Bessac (1996: 212, 1999: 21-22), the presence of different types of trenches seems to rely exclusively on the type of peak used, yet the use of different types of peak in the same quarry in what seems to be

coetaneous extractions still wants an explanation. However, the width of the trench documented in northeastern Spain does not appear to respond to chronological factors. Indeed, the comparison between the trenches at Olèrdola (14) (Batista-Noguera et alii 1991: 393-394), where accurate measurements were taken, and the ones at the quarry of Mathieu, southern France, (Bessac 1996: 208) reveals that the chronological implications observed at southern Gaul quarries do not seem to apply to the northeastern Spain ones.

The marks preserved on the horizontal surfaces of the fronts confirm that basically rectangular cutting-edged picks (dolabra) were used, and pointed cutting-edge picks were employed only when the hardness of the stone demanded it. However, most of the pick evidence is preserved as grooves on the vertical walls of the fronts and, while not possible to infer what kind of pick was used, they show the method by which the blocks were separated from the bedrock. Basically, these grooves follow three different patterns (Fig. 5):

- 1) spike pattern, very regular and resulting of two lines of similar length that meet at right or nearly right angles;
- 2) diagonal, characterized by fairly regular, long, parallel lines that run in the same direction;
- 3) random, which is results from the combination of diagonal and almost horizontal strokes randomly directed and positioned

The spike-pattern traces, when matching with the small ledges resulting from the extraction, give a fairly reliable guidance about the size of the blocks, but can not be considered indicators of Roman extraction as less systematic patterns (diagonal and random) are also clearly visible in quarries for which has

dating based on archaeological excavations, e.g. Pedrera Romana at Montjuïc (12). In fact, the different patterns seem to result from the changes introduced on the picks in late first–early second century AD, which modified the angle and position of the quarrymen (Fant 2008: 129).

Wedges (*cunei*) are the other tool whose use is most documented. Indeed, not only they were used for extraction following the most common method of cutting narrow trenches and using wedges to tear off the blocks from the bedrock, but were also essential for extraction by taking advantage of the geological bedding planes and natural fractures in the rock. This second, time-saving technique was used, for example, outside the quarry and the quarry Olèrdola (14) and Aeso (10, 11). Thus, although actual number of wedges found is rather limited<sup>9</sup>, the evidence of its use through the negatives of the holes where they were inserted provides valuable information. Two different types were recorded at the quarries: a rectangular and elongated, and another oval-shaped one, yet only the first type matches in size and outline with other well-attested Roman wedge holes documented from the western Mediterranean area (Bedon 1984, Bessac 1996, 1999, Dworakowska 1983, 1988a and b). These parallels prove that, indeed, the iron wedges were employed at the quarries of northeastern Hispania.

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<sup>9</sup> The only examples have been found in Empúries and The Maçana (Guardiola de Font-Rubó), an Iberian settlement near Olerdola and La Rierussa quarries (13, 14). They are three iron wedges; the first two are incidental findings but keep a strong resemblance to other Roman iron wedges (see Bessac 1996: 214-216, fig. 136, Dworakowska 1983: 74-87; González Tascón 2002: 137, even though this last one has been considered a mining tool); and the third one is pre-Roman and has a very particular triangular cutting-edge (Sanahuja 1971: 66, 82, 100-101, fig. 26).

As for the strategies of extraction, the opencast quarries prevail overwhelmingly. Among them, the intensive, pit-type quarries are the most numerous, the best examples of which are the large-size pit of Clot del Mèdol (25), the smaller one of PERI2-Lots 18-21 (31), and some fronts at Puig d'en Torró (6) and Clots de St. Julia (5), although the oval and concave walls of the latter ones make them significantly different from the rest. Trench-type quarries and extraction in terraces, both considered as intermediate strategies between extensive and intensive extraction, are the next most recorded. The first ones, whose main feature is their location on a mountain or hill slope where a trench or multiple trenches are cut inwards, is well represented by Maritima Residencial (19). The progression of quarries 'in terraces', however, is characterized by several planes of extraction on the slope in which the blocks extraction takes place simultaneously ; a clear example of this type of quarry is that of Pedrera Romana (12). Other than that, there is a quite homogeneous distribution among the rest of the types of opencast extraction, with examples with similar features to those of "*extraction en conque*" quarries as described by Bessac (Bessac 1999, 2003) even though they are opened on hill slopes, such as some fronts at Puig d'en Torró (6); examples of extraction by wearing down or on the exterior of defensive structures, as the 'exterior' front at Olerdola (14), or a possible use of erratic blocks at the area of Aeso where high vertical cliffs of Isona stone provide large chunks of stone naturally.

The case of the underground quarry deserves a separate mention. In first place, there are only two examples, Coves del Llorito (29) and Coves de La Pedrera (32), immediately adjacent to Tarraco. However, underground extraction was a

much less common strategy in Roman times for non-ornamental stones, as is the case<sup>10</sup>, and the existence of documents proving their use in the eighteenth century suggests that the current appearance of these quarries is most likely due to post-Roman works even though extraction there began in Roman times as their characteristic calcisilitite stone was already employed at the Roman wall (Bermúdez et alii 1993).

Nonetheless, the case of two fronts of Clots de Sant Julià (5) is exceptional as their concave section ends at the top with a kind of thin roof where a quadrangular hole, probably a ventilation or lighting aperture, is partially preserved (Fig. 6). If we also take into account the presence of long, narrow, descending corridors that allow access to their interior, it seems clear that at some point in their history, these fronts were subterranean or semi-subterraneously exploited. Although it has not been possible to identify which strategy extraction was carried out there, Clots de Sant Julià is a very interesting case to which more attention needs to be paid in future research because of its uniqueness and the fact that its stone has been well documented in various sites nearby.

[insert Fig. 6]

By looking at other features, another pattern of exploitation at the quarries of northeastern Hispania comes to light. It consists by two main types of quarry:

- small, short-lived quarries, probably opened for a very specific purpose and thus linked to a particular monument or building, such as Punta de la Creueta (27), which was opened to build the funerary monument of

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<sup>10</sup> Underground extraction was restricted to very special cases of highly-prized stone, such as the lichinites marble of Paros (Dodge 1991) or to specific conditions, such as the volcanic tufa quarries of the Rhineland (Röder 1957) or the lapis specularis ones, near Segóbriga (Spain), (Bernardez and Guisado 2002).

Torre dels Escipions, or the quarries around the roman aqueduct of Tarraco (33), and

- large quarry areas that resulted from extraction undertaken over a long period of time and usually with more than one exploitation front and a substantial volume of extracted stone. They are less in number but, in terms of volume of extraction, their contribution was significantly greater (Fig. 7).

[insert Fig. 7 here]

#### *Quarry management: organisation, debris management and block transfer*

There is little information in the archaeological record about quarry management in Roman times. In fact, the evidence basically consists of the few letters carved on already roughly-hewn blocks from Montjuïc, near Barcino and similar carved letters on the bedrock of some cuts recently found within the urban center of modern Tarragona. Despite the disparity of their provenance, they are very uniform, 'Q IV', 'Q V', and 'Q VII' on the blocks (IRC IV 304) and 'Q · III', and they probably indicate the area of extraction within the quarry (Gutierrez Garcia-M. 2009: 275). Therefore, the organisation of quarrying at Montjuïc and Tarraco in several areas of extraction (at least seven at Montjuïc and three in Tarraco) is attested.

Nevertheless, other aspects such as debris management and the handling of the extracted material remains mostly unknown due to the lack of solid evidence and only hypothesis based on nearby parallels can be attempted.

#### *Labour organization and ownership*

Similarly, the evidence regarding these aspects is almost non-existent and only make general inferences can be made. As for many of the previous aspects, labour organisation at the quarries was not static, but could vary significantly depending on several intrinsic factors.

The obvious likeness of northeastern Spain quarries to those quarries in southern France rather than the large, imperial quarries of, for example, Egypt (Maxfield and Peacock 2001; Peacock and Maxfield 1997), it seems plausible that the same model of small teams of freemen workers (Bessac 1996: 297-298) apply to our quarries.

Of the main types of ownership (state-owned, Imperial property, municipal property and private property), neither of the first two seem to have been the case in northeaster Hispania quarries. Stone from the latter types could not benefit from the official distribution channels and therefore even those used for ornamental purposes usually did not attain the same degree of diffusion and distribution as the Imperial *marmora*. This would probably be the case of the *broccatello* quarries near Dertosa, which were probably municipal property (Mayer and Rodà 1999: 50). This would also have been the case of the Empúries limestone quarries, most of those in the hinterland of Tarraco<sup>11</sup> and particularly the sandstone quarries at Montjuïc (near Barcino). The parallels in nearby well-studied stone industries, such as the sarcophagi production of Lourdes (French Pyrenees), are significant; the local diffusion of these objects has been interpreted as possibly corresponding to a public or semi-public quarrying complex within the administrative confines of the town of Bigerriones

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<sup>11</sup> Probably Santa Tecla quarries and the larger sites, such as El Mèdol, that supplied construction materials for the large monumental buildings in the town itself.



(Boudartchouk 2002, 60). Also, A. Dworakowska reached the conclusion that, generally, many common stone quarries situated around various towns and supplying them would have been under municipal ownership; in addition there was a practice of leasing municipally-owned quarries (Dworakowska 1983: 29, 31). Therefore, there is some basis for considering a similar arrangement for the most important types of stone in northeastern Hispania.

As for the ownership of the smaller building-stone quarries, the grounds on which any conjecture can be based are even fainter. Although we cannot rule out that some of them were in private hands, this cannot be confirmed with the evidence we have to date.

## **Conclusions**

The amount of evidence on quarrying in ancient times in northeastern Spain is indeed significant. Although only a small number of the quarries can be dated with certainty to Roman times, there are many that have a high possibility of having originated in ancient times. However, the available data is still very limited, as it has not been thoroughly investigated. In fact, archaeological excavations are needed not only to complete our understanding of these sites, but also to determine their chronology. Only on the basis of material from archaeological contexts and exhaustive observations of currently covered quarry faces will we be able to draw a picture of the real extent and methods of quarrying in Roman times.

Nevertheless, the current evidence is enough to show that local stone exploitation was strongly determined by the development of the urban phenomenon that was part of the whole Romanisation process of this territory.

Although stone was indeed used prior to the arrival of the Romans, its use was only occasional or, when employed as a building stone, without a specific extraction pattern. The paucity of pre-Roman sites is eloquent, as is the strong link between the presence of quarries and newly-founded Roman towns. On another level, there are smaller, short-term quarries that are not directly related to a population centre, but to the use of the natural resources and a new configuration of the territory, such as those specifically opened to build the Roman aqueduct of Tarraco or *villae*, or the specific constituents of a Romanised monumental landscape.

The general chronology of stone extraction is also closely related to the development of the Roman towns. Although pre-Roman extraction has been attested, it is rare (only for Empuries limestone and Clots de Sant Julià sandstone) and concentrated in the north-eastern corner of the territory, where the influence of the Greek colony at Emporion had a greater effect on the earlier development of traditions tending towards the classical by the native people than in other parts of the studied territory. It is not surprising therefore that the identified quarrying areas probably thus dated are next to a large Iberian settlement (Clots de Sant Julià, next to Ullastret site) or related to the Greek town of Emporiae (Sant Martí d'Empúries, 2). Thus, quarrying remained a minor, sporadic activity and little is known about the technology.

More quarries were opened between the late third and the late first centuries BC, although the numbers were still not large. They were mainly opened for military purposes, such as at Olèrdola or the Tarraco ramparts<sup>12</sup>, or for building new towns, such as Tarraco or initially the Roman town of Emporiae (on the site

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<sup>12</sup> Calcisiltite from Coves del Llorito, Coves del Pedrera as well as Mèdol stone type from undetermined quarries (El Mèdol quarry being the most likely, although other closer quarries cannot be dismissed).

of the earlier *praetorium* and the modifications undertaken at the Neapolis)<sup>13</sup> and later Gerunda and Aeso. The techniques applied varied significantly depending on the lithology of each particular site, although the introduction of the systematised, organised extraction characteristic of the Romans is an important feature. As early as this time the same local stone used for building purposes, in particular Mèdol stone, was used to carve sculptures, portraits, epigraphy and for luxury uses.

The most intensive period of quarrying was, however, between the late Republic and the early Empire (first to mid third century AD). The initial and final dates for each quarry, although most remain uncertain, depended very much on the particularities of their use (i.e. as building material for the foundation or transformation of a town, the presence or absence of a strong sarcophagus industry, the importance and range of the distribution in the case of ornamental stone, etc.). From Augustan to Flavian times there was a progressive proliferation of stone extraction; new quarries were opened and extraction intensified at those already in use. The new quarries supplied stone either to the last Roman foundation (Barcino<sup>14</sup>) or for the urban development of already founded towns, while alluring stones began to substitute the plainer ones for sumptuous and ornamental purposes.

This tendency not only applied to imported marbles, but also local ones such as *broccatello* and Santa Tecla stone. The Flavian period saw the culmination of this process. The intensive extraction noted during this period through the epigraphy and building activity in north-eastern Hispania was not an exception to the rest of the scene in the Roman Empire. The large monumental

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<sup>13</sup> In addition to the use of the same limestone from where the town was founded (Empúries limestone), the general use of Clots stone at Empúries dates from this period.

<sup>14</sup> Barcino (modern Barcelona) was founded c. 15-10 BC.

programmes already initiated needed large amounts of both building and decorative stone. Tarraco in particular is illustrative, as a major reorganisation and monumentalisation of the town was undertaken to give it the appropriate appearance for the status of a provincial capital. The main reorganisation of the Imperial marble distribution system, which became more centralised, was in line with this general increase in production and probably also affected the organisation of stone extraction and distribution in our area. The only exception is the decline experienced by Emporiae, which, as it lost out in importance to Barcino and large parts of the town were progressively abandoned, the need for stone also decreased. The evidence of quarries from this period is scarce, although the intensification also meant that the process became highly standardised and blocks were almost mass-produced, thus providing the huge amounts of stone needed for the large-scale urban transformations.

The changes that occurred in the Roman world at the end of the early Imperial period were reflected in the quarries, which entered a major period of recession, as can be deduced from the quantitative slow-down in local stone use. This recession was not simultaneous at every site<sup>15</sup>, but clearly happened in the third century AD. This same pattern has been recognized in other parts of the Mediterranean Arc, such as southern France, and the progressive deterioration of the general organisation of the work and technique recorded, together with an appreciable reduction in production, probably occurred in the area of study as well. To understand the exceptional continuation of *broccatello* use, we have to look at the Mediterranean context as a whole. The progressive weakening of

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<sup>15</sup> The differences may lie in the degree of precision about the monuments or buildings marking the final use of each kind of stone, which directly depends on whether they have been subjected to recent comprehensive research or not. The case of the wall at Barcino is illustrative (it was originally dated to the third century AD, then to the fifth century AD and is currently considered to be from the first half of the fourth century AD (cf. Puig and Rodà 2007).

Imperial cohesion also affected stone industry. The late Severian period witnessed a radical change in *marmora* distribution and management following Constantinus' transfer of the capital to Constantinople and with it the power centres linked to the Imperial residences; at this time the amount of oriental marble imported by Rome fell considerably. Thus, western ornamental stones, which until then had only been used on a regional or provincial basis, gradually took on the Imperial market as well; this was the case of *broccatello*.

Therefore, the adoption of the Roman stone exploitation strategy not only meant a change in the scale on which stone was used and, as a consequence, quarried, but also in the techniques used. Moreover, it meant a great deal of planning prior to extraction, which had to be undertaken both quantitatively (the amount of stone) and qualitatively (the intended uses) by the Roman quarrymen. This was particularly true when they had to supply material for the monumental building programmes of the provincial capital (Tarraco) and the other towns of the region (e.g. Barcino). All these changes were only possible thanks to a firmly consolidated regional economic and political power structure. Only in this way were they able to count on a solid road infrastructure and powerful engines that enabled the continuous movement and transport of the large blocks. Likewise, Spain's entry into the sphere of Roman control, under a single, strong political authority, is what allowed it to develop the full economic potential of the stone industry in the northeast, i.e. the full exploitation of building stone and the regional, provincial and even Mediterranean-wide distribution of Santa Tecla stone, Clots stone and *broccatello*, respectively.

It is important to highlight the existence of an extraction strategy significantly different to the rest, at Clots de Sant Julià and Puig d'en Torró (5, 6). The pattern they show and the overall shape of the quarries do not match those opened on similar geological layers (i.e. Montjuïc sandstone), neither do they have the characteristic orthogonality of Roman works; although some faint parallels have been found so far, it is a point that still requires further investigation.

Despite the present shortcomings of the research, it is clear that these quarries exploited a variety of stone that, in spite of the fact that they were almost all non-ornamental, they actually present significant differences in terms of appearance and properties. These differences are also reflected in the quarry sites. In fact, the combined recording of both the archaeological and geological features during the survey showed that not only the geological properties and lithology of an outcrop, but also its location within the natural topography (accessible situation, availability of water, etc.) and the human landscape (towns and villages, the road network, landmarks such as monumental tombs or triumphal arches, large luxurious *villae*, etc.) were factors in the shaping of the organisation of the stone industry in the northeastern corner of Spain in Antiquity.