

TURNING STONE TO BREAD

A Diachronic Study of Millstone Making in Southern Spain

Timothy J. Anderson



CATALOGUE
OF SITES

HP

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PART II : CATALOGUE Of sites

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Catalogue of Millstone Quarries in Southern Spain

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Andalusia	330
Granada (GR)	330
Almería (AL)	377
Jaén (J)	402
Córdoba (CO)	419
Málaga (MA)	454
Cádiz (CA)	471
Seville (SE)	503
Huelva (HU)	525
Murcia (MU)	537
Castilla La Mancha	547
Ciudad Real(CR)	547
Albacete (AB)	561
Toledo (TO)	566
Cuenca (CU)	570
Guadalajara (GU)	573
Valencia	586
Alicante (A)	587
Valencia (V)	590
Castellón (CA)	597
Extremadura	603
Badajoz (BA)	604
Cáceres (CS)	614
Madrid (M)	626

Introduction

This catalogue of sites consists of a brief description of each of the quern or millstone quarries identified in southern Spain in the framework of the monograph entitled *Turning Stone to Bread: A Diachronic Study of Millstone Quarries in Southern Spain*.

The number of pages for each entry varies according to the data available. The length of the entries of the sites surveyed in the field is, for obvious reasons, greater than the length of the entries based exclusively on secondary sources such as written references.

The structure of the catalogue follows the present political boundaries of Spain beginning with Andalusia, the largest autonomous community. Andalusia is subdivided into its eight provinces: Granada (GR), Almería (AL), Jaén (J), Córdoba (CO), Málaga (MA), Cádiz (CA), Seville (SE) and Huelva (HU). This is followed by Murcia (MU), a small mono-provincial community. Murcia is followed by the large Community of Castilla La Mancha with its five provinces: Ciudad Real (CR), Albacete (AB), Toledo (TO), Cuenca (CU) and Guadalajara (GU). This is followed by the Community of Valencia with its three provinces of Alicante (A), Valencia (V) and Castellón (CS) and Extremadura with the provinces of Badajoz (BA) and Cáceres (CC). The catalogue ends with the mono-provincial Community of Madrid (M).

The codes attributed to each site that appear throughout this work are on the upper left of each entry and are based on the official abbreviations of the provinces. The site "GR-1" is hence millstone quarry 1 of the Province of Granada (GR).

The name of the municipality where the millstone quarry is located appears at the top of each entry. The name of the site, often a place name gleaned from either a cadastre (land registry) or a geographical or geological map, is in *italics* below the municipality. There are a few cases in which the name stems from a different source, such as an explanatory panel or from a local oral tradition.

Some entries do not include a place name because of lack of information. Other sites with little geographical information, such as Mérida (BA-6), Fuente Obejuna (CO-17), Linares (J-7), are accompanied by the term "district". This indicates a reported production, probably in the form of a number of small quarries, in an area most likely covering more than one municipality.

The geographical coordinates and the altitude are below the name of the sites. The absence of geographical coordinates indicates that the precise location is not known.

When possible and when relevant, the entry is accompanied by topographical, cadastral (SEC) and geological maps (IGME), satellite or aerial photographs (SIGPAC, Google Earth or Google Maps). For example, there are certain sites that I have only been able to "approach" by means of Google Maps Street View.

A large section of the catalogue is dedicated to photographs taken either during a field survey or received from a local contact. Each entry usually begins with a general view of the surroundings of the site to illustrate the geographical setting. Photographs also are chosen to illustrate different types of extraction and fashioning techniques, as well as the typology of abandoned products.

A few sites such as Punta Camarinal (CA-2a), Paloma Alta (CA-2b), Cerro Bellido (SE-4) and Posadas (CO-8), are not millstone quarries. These Roman construction quarries appear in this work, nonetheless, because their products, mostly cylindrical column segments, are reported to have been recycled in later periods into millstones. The rock type and the extraction techniques of these sites are also similar to those observed at millstone quarries.

The nature of the product of some sites presented in this catalogue is sometimes dubious. The main product of Cobeta (GU-9), for example, was probably sharpening stones and not millstones as reported in certain sources.

The descriptive fields

The following fields were retained for the descriptions of each quarry. So as to avoid an extremely rigid system that might create repetition, the fields are sometimes grouped under one heading. When the information is missing, the heading is eliminated.

Location: General geographical information.

Generalities: The field applies to general aspects of the site and replaces the field of **location** in the cases where the whereabouts of the site is not known.

Source: This field describes the source of information on the site, whether it be a written text, information from the Internet or a personal communication.

Toponymy: Place names play a primordial role in the identification of millstone quarries and are mentioned in this field. The most common millstone place names derive from the Latin *mola* (*molares, moles, mola, molar ...*) meaning millstone or from the Spanish word *cantera* meaning quarry.

The quarry: General description of the type of site, its dimensions and the state of conservation.

Techniques: This field briefly surveys the extraction technique, whether it be true extractive or block detachment, and possible tool marks.

Product(s) and quantification: This field describes the product or products of each site and, when possible, quantifies their number.

Transport and distribution: This field indicates both the presence of nearby paths or roads, as well as the presence of rivers or seas that could have served for maritime transport.

Dwelling: This field indicates if there is evidence at the site of hovels or huts where the quarrymen could have resided.

Bread: This field is completed when there is a mention in the source of the type of flour yielded from the millstones produced at the quarry, such as *pan moreno* (dark bread) or *pan blanco* (white bread).

Dating: This field is one of the more difficult to complete. Sites can be dated by means of an old text or record in an archive. At times, the typology of the product or the rock type suggests the date.

Rock type: The main source of this field is the data interpreted from the maps and explanatory booklets of the Geological Survey of Spain (*Instituto Geológico y Minero de España - IGME*). This source, often based on research dating from the 1970s and 1980s, reveals the general geological

tendencies of the outcrops in the area and cannot to be taken as the exact petrographical definition of the rock exploited.

Each quarry entry is accompanied by an extract of a geological map, and a few comments from the caption of the map of the explanatory booklet (downloaded from the IGME website). In some cases, when the rock type indicated by the geological map does not correspond to that of the quarry, this information is ignored.

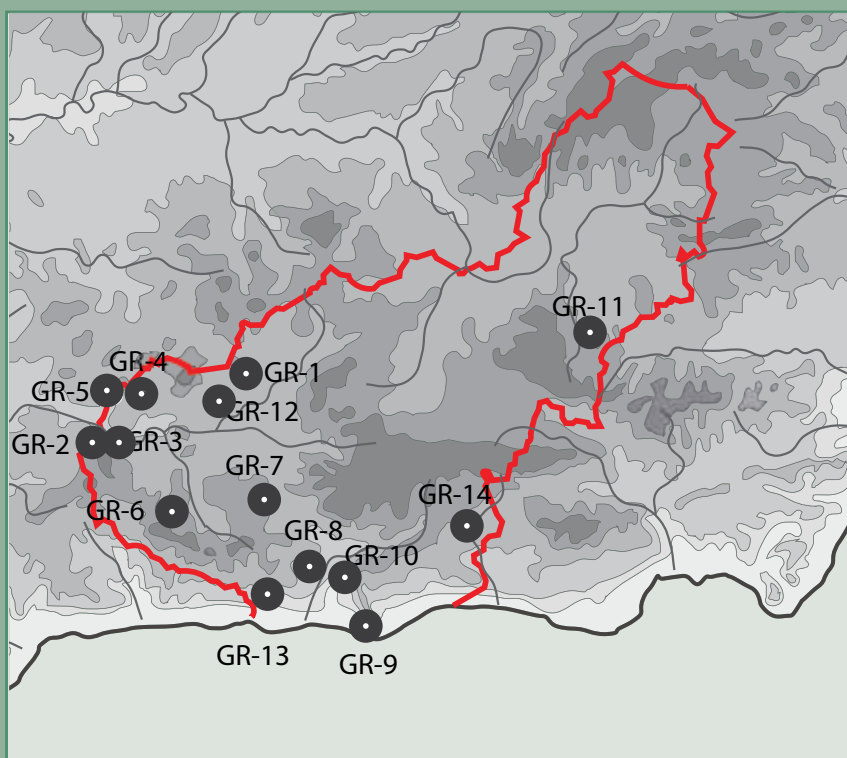
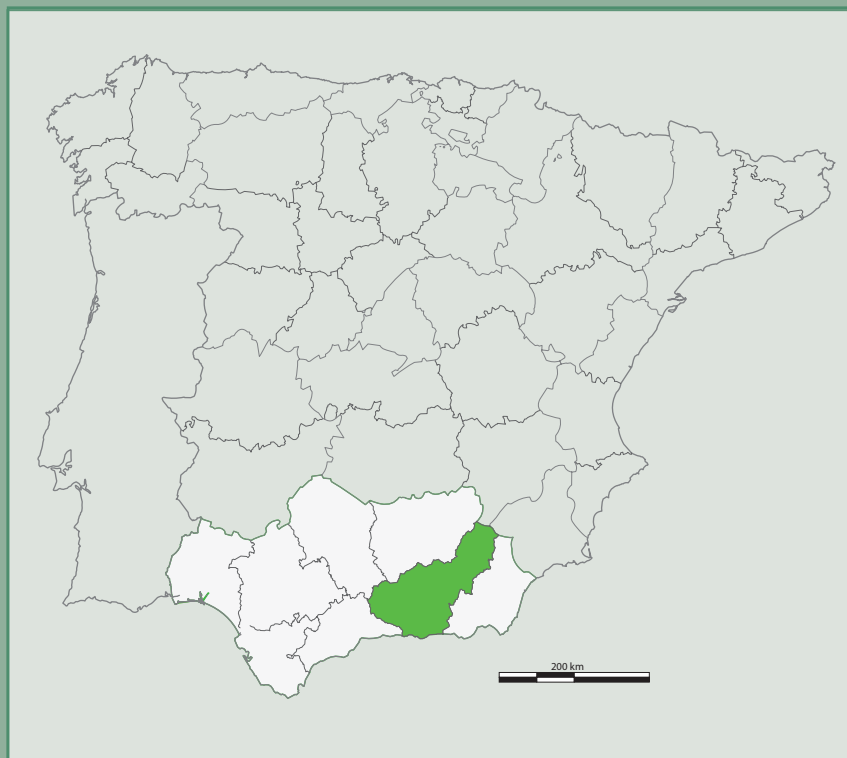
The IGME data is completed, in a few cases, with petrographical portraits undertaken by professional geologists (for example, from the University of Granada or the Norwegian Geological Survey). In these cases the authors of the analysis are cited. The petrography of the rock is also at times based on local geological case studies published in articles. The general geological data is also contrasted with the petrographical descriptions from old geographical or geological sources. The accuracy of many of these early descriptions, dating from a time when geology was still in its infancy, is surprising. Finally, this field is completed by my own observations.

To facilitate consultation, each entry of the catalogue with the information of the **source(s)** consulted (for the most part Internet sites) and the traditional **bibliography**. The many people who acted as guides to the sites or provided information or photographs for the catalogue are recognised in the **acknowledgements**.

Finally, many entries regarding sites not identified in the field are incomplete or present, at best, scanty information. For example I often propose, based the examination of place names and other data, potential locations of the sites. Although not confirmed in the field, they are nonetheless left in the catalogue and should be taken as working hypotheses that require future verification.

ANDALUSIA

GRANADA (GR)



GR-1a Moclín

Canteras

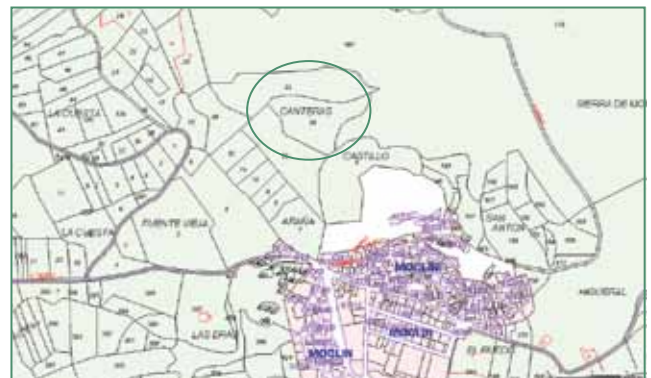
Latitude: 37° 20' 48,60"N
Longitude: 3° 47' 14,10"W
Altitude: 1140 m



Location: The millstone quarry of Moclín is in the southern sector of the Sierra del Marqués on a narrow promontory just a stone's throw north-west of the town of Moclín, famous for its Moorish castle.

Sources: In his general account of quarry work in the Province of Granada, the 19th-century geographer Pascual Madoz cites the "excellent millstones" from Moclín (Madoz 1847, Vol. 8: 480). A second author echoes the words of Madoz 20 years later in a general chronicle of the resources of the Province of Granada (de Dios 1869: 16).

Toponymy: The place name *Canteras* (quarries) on the cadastre coincides with the millstone workings. The name *Los Agujerones* (large holes) to the north could be related to the circular extraction hollows.



Extract from the cadastre with the toponym Canteras (SEC).



View of Moclín from the north-west.



View from the south-west of the Moclin millstone quarry. Working debris from the northern sector is visible on the slope, to the left.

The quarry: From tip to tip, this site measures about 250 m in length and 20 to 25 m in width. It can be divided roughly into three main sectors.

As one enters the quarry from the town, the southern sector, detached from the rest, is to the right of the path. The quarry face here has multiple vertical tubular extractions along the ridge under the walls of the Moorish Castle. The extractions here correspond to millstones larger than one metre in diameter.

Along the path, between the southern and the central sectors, a portion of the site has been destroyed by a mechanical digger that has left scars of its teeth on the rock face.

The central sector comprises horizontal tiered extraction hollows. Long vertical tubular hollows are absent because the terrain is jumbled with irregular "karstic" outcrops. This sector, unfortunately, is partly filled with modern waste.

The northern sector, the most spectacular area of the quarry, is marked by a massive layer of homogeneous bedrock at least five metres thick, permitting the mill makers to superimpose a series of circular extractions, resulting in a pit quarry with imposing vertical tubular faces. The faces are covered with well-preserved diagonal pick marks. This part of the workings is dotted by defensive features (trenches, bunkers) dating, presumably, to the Spanish Civil War.

Well-conserved multiple diagonal tool marks are organised in patterns with opposite orientations. These marks are clear indicators of trenching with picks. The subsequent technique of splitting the cylinders from the bedrock is not visible because the quarry floor is either too weathered or covered with debris. I assume the workers employed metal wedges lodged in holes to split the cylinders. One cylinder in a



View of the southern sector of the quarry.

very advanced state of manufacture, perched high in the quarry, has been moved slightly with levers from its original extraction position, and raised by slipping several rocks below it. It is in this raised position, resting on rocks, that the cylinder was abandoned in the final stages of fashioning.

Extraction in the northern sector produced an immense volume of rock debris. A part of this white-coloured waste can clearly be seen strewn along the western slope of the promontory. The quarrymen were obliged to discard the debris outside the workshop to continue the progression downwards.

Products and quantification: The majority of the products visible are large millstones destined, according to texts, for watermills. They measure between 1.00 to 1.20 m in diameter. It is apparent that Moclin, in its later phases, produced hundreds of these large models.

An aspect worth mentioning is that these products, although reputed as among the best bread millstones in the province, required dressing on a daily basis (Reyes Mesa 2000a: 49).

In addition to the large extractions, there are smaller millstones and quern extractions measuring respectively 80 cm and 40 cm in diameter. These products indicate an earlier phase of exploitation dating possibly from Medieval times. It is plausible to suppose that more recent quarrying erased most of the traces of the older phases of work.

Transport, distribution and bread: Due to the steep slopes to each side of the site, the path leading from the edge of town is the only practical means of evacuating the millstones. Some large extractions, perched on high tiers of the quarry, must have been winched down the slope with ropes to join the path.

It is worth noting that the perforation of the eye is a feature that certainly helped keep the millstones attached to their means of transport. An elderly local resident, "Niño Ernesto", told me that the cylinders were rolled down the hill by several men by means of placing a wooden beam through the eye like an axle. A variation of this method is illustrated in the study of the watermills of the Odiel River in the Province of Huelva (Gómez Ruíz 2003: 84).

As to commerce, a study of mills in the Alpujarra Mountains states that the white Moclín millstones were marketed as far as the south of the Province of Granada, a distance of about 60 to 80 km (Rodríguez Monteoliva 1989: 705).

Dwelling: The proximity of the quarry to the town, less than a few minutes walk, would have permitted the millstone makers to reside in town.

Dating: The different models extracted from this quarry suggests a long period of activity. "Niño Ernesto" recalls that the quarry was still active in the early part of the 20th century. The reference by Madoz pushes production back by at least a century. Based the number of extractions at the site, it is safe to assume that production took place decades before the Madoz reference. The smaller extractions measuring approximately 80 cm in diameter suggest a Medieval phase. The rotary hand-querns around 40 cm in diameter take the site back to at least Medieval times. A Roman exploitation would not seem probable due to the absence of querns of this rock type in Roman contexts.

Rock type: Limestone and dolomite (Geological map, 991, Izaloz, 1988). The stone is compact and homogeneous, although its surface is greyish when weathered, freshly broken samples are bright white.



Views of the central sector of the quarry.



View from the south of the northern sector of the quarry. Working debris from the main workshop covers the slope.



View from the north-west of the main quarry "pit" in the northern sector. The concrete construction is probably a defensive position dating from the Spanish Civil War. The Medieval Moorish ramparts can be seen to the left in the background, on the top of the hill.



View of one of the working faces of the northern sector of the quarry where millstones were extracted on superimposed levels leaving diagonal pick marks.

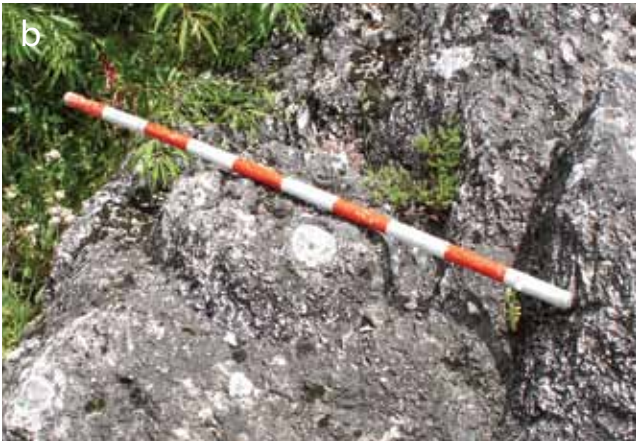


Detail of the northern sector of the millstone quarry with high quarry faces covered with diagonal pick marks.



View from the south-east of the northern sector of the quarry. The eye of the abandoned millstone is perforated.

Opposite page: a-b) Details of unfinished rotary querns measuring 40 cm in diameter; c-d) details of medium-sized millstones and extraction hollows measuring approximately 80 cm in diameter; e-h) views of the larger millstone measuring between 1.00 and 1.20 m in diameter.

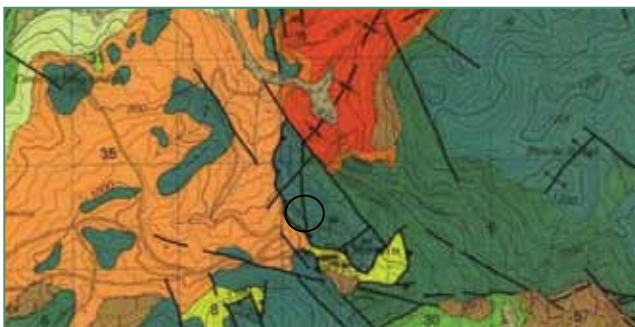




Examples of pierced millstones that decorate the public spaces of Moclín.



Detail of the working debris. The freshly broken rock is white, while the weathered surface is greyish.



Extract from geological map 991 (IGME). The quarry exploited a unit of hard limestone or dolomite (dark green).

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Gr-1b Moclín

Las Pedrizas

Latitude: 37° 20' 59,49" N

Longitude: 3° 47' 50,98" W

Altitude: 840 m



View from the south of Pedriza quarry. Millstones were scored from detached boulders at the foot of the hill (Google Maps Street View).



Extract of the cadastre. The place name "La Pedriza" is indicative of an area with boulders (SEC).



Vertical millstone extractions on a boulder at the base of the Cerro de la Fresnedilla.

Location and Toponymy: This small millstone quarry is about 1.5 kilometres north-west of the main millstone quarry of Moclín, on the road to the hamlet of Tózar, at the foot of the Cerro de la Fresnedilla. The place name *La Pedriza* is usually equated with a terrain covered with blocks, as is the case here.

The quarry: Instead of exploiting bedrock, the millstone makers worked large detached boulders detached from the adjacent cliff face.

Techniques: Due to the position of the boulder after its fall, its natural bedding plane was no longer horizontal. The millstone makers were therefore obliged to carve the cylinders along vertical planes. The pick marks, identical to those at the quarry of Moclín, are very well preserved.

Transport and distribution: The quarry, next to the road between Moclín and Tózar, could have benefited from the distribution network of the large quarry of Moclín.

Products and quantification: The site is modest, comprising only about a half dozen extraction hollows corresponding to millstones between 1.10 and 1.20 m in diameter.

Dating: There is only evidence of the production of large millstones, presumably for hydraulic mills. The diameter places the workings in recent times, probably contemporary to the later phases recognised at the neighbouring site of Moclín (GR-1a).

Rock type: Limestone or dolomite (Geological map 991, Izallos, 1988). This rock is hard and white, identical to that of the main quarry at Moclín (GR-1a).



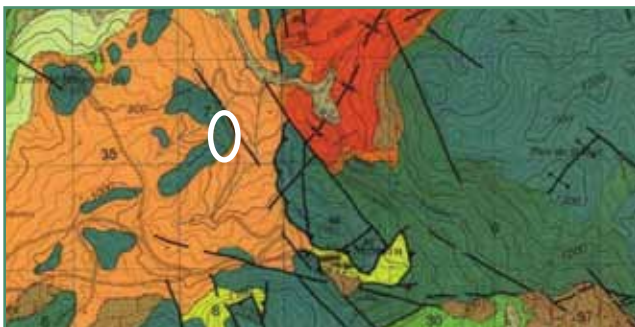
View of the block with the vertical extraction hollows.



Detail of a block with the vertical extraction hollows.



Detail of the vertical quarry face with well-preserved parallel pick marks.



Extract from geological map 991 (IGME). The quarry exploited a unit of hard limestone or dolomite (dark green).

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GR-2 Loja

Cerro de Fuensanta

Latitude: 37° 10' 21' 28"N

Longitude: 4° 10' 25' 20"W

Altitude: 520 m



View from the south-east of the low mound in the middle of the Loja Valley with the two sectors of the Cerro de la Fuensanta millstone quarry.

Location and sources: Loja is a city on the western fringe of the Province of Granada along the natural passageway between eastern and western Andalusia. The first source citing millstone workings in Loja dates to 1502, ten years after the fall of Islamic rule. It is a *pregón*, that is, a Municipal Ordinance delivered orally, prohibiting the extraction of millstones without permission from the authorities. The punishment for this infraction was the confiscation of both the millstones and the oxen used to haul them, as well as a fine of 600 *maravedís* (Pregón 1502).

Madoz, several centuries later, records the existence of white or rose *panalizo* exploitations in Loja specifically for bread mills (Madoz 1847, Vol. 10: 360). *Panalizo* is an old Spanish term that designates a rock that is soft at the moment of extraction but becomes extremely hard when dry (Ximenez de Guzman 1796). Neither source mentions the precise location of the millstone workings.

Quarries and techniques: From the texts we can assume that millstone extraction around Loja was intensive. Nonetheless, both of the quarries we have identified in the surroundings of the city of Loja are small and probably only represent a fraction of the original workings. The first, the Cerro de la Fuensanta (GR-2), is two kilometres west of the centre of the city. The second, Puente Quebrado, Camino del Calvario, is perched on a karstic slope just north of the city (see GR-3).

The workings on the Cerro de la Fuensanta are on the southern slope of a low mound located in the middle of the Loja Valley. This small site is apparently subdivided into two areas separated by about 100 m. The first, in the western sector, is a bench quarry located beside the path leading to the top of the mound and covers a surface of approximately 12 x 10 m. It consists of a series of circular, tiered extractions.

The millstones were hewn directly from the bedrock following the horizontal bedding planes. At least three different tiers are now visible, with the smallest, at the base in the central area, now overgrown with grass. Diagonal linear marks are visible on some of the extraction faces, showing that they were cut directly into the bedrock by means of picks.

The second extraction area is located on the same slope of the mound about 100 m to the east. This quarry is smaller and of the dispersed “karstic” type. It comprises a group of less than a half dozen extractions clustered in an area about 100 m², as well as a couple of isolated extractions elsewhere on slope. In spite of the weathered surface of the rock, it is possible to distinguish the typical marks of trenching with a pick. A singular aspect of this quarry is that its floor bears traces of wedge holes used to split the cylinder from the bedrock. These regularly spaced holes are trapezoidal and measure a length of about 15 cm.

Products and quantification: Both sectors produced large millstones measuring about 1.30 m in diameter destined for watermills. In the western sector there is a smaller, thick cylinder measuring 90

cm in diameter that could be an edge roller for olive oil production. A total of about 100 millstones were produced between the two sectors.

Transport and distribution: The ordinance of 1502, with its reference to oxen, provides a clue to the method of transport. As to the later productions referred to by the 19th-century geographer Madoz, I can imagine a similar type of transport. In any case, hauling the millstones from these quarries was not a major task on account of the absence of major natural obstacles. Distribution was probably local or regional.

Dating: The ordinance places activity in millstone production from at least the time of the *Reconquista* of the city (1486). It is perfectly conceivable that production continued at least until the first half of the 19th century, as evidenced by the Madoz reference. In spite of Loja’s rich flint mining tradition dating to prehistory, I have not come across any evidence of millstone production preceding the Catholic reconquest.

Rock type: White limestone (Geological map 1008, Montefrío, 1985).



View from the west of the western sector of the Cerro de Fuensanta site.

The Ordinance of 1502

1502, enero, 10. Loja.

Pregón de la ordenanzas de Loja sobre no sacar piedras de molino.

(Cruz). En X de enero de IUDII años se pregonó lo sigiente por aquerdo del alcalde mayor e Diego Rodrigues e el lyçençado Morales.

Que ninguna persona sea osado de sacar pyedras de molyno de los terminos desa çibdad sin lyçençia del cabildo, so pena quel lo saqare que pyerda los bueyes con que los saqare; el maestro que lo hysiere que aya caydo en pena de DC maravedis e más las pyedras perdydas por sacar fuera de la çibdad.

Pregonose por Diego de Meryda, pregonero.

Testigos: el alcaýde Inesta, e alcaýde Herrera e otras mucha personas.

(AML, Leg. 49, p. 9. 1 cuartilla + 1: <http://www.reocities.com/tdcastros/Historyserver/Fuentes/DocMunic/DOCLOJA.6.htm>).



Details of extraction hollows producing large millstones. Diagonal pick marks are clearly visible.



Views of a smaller abandoned cylinder measuring 90 cm in diameter.



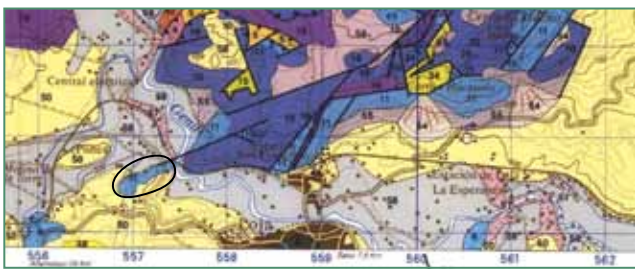
View from the west of the cluster of extractions of the eastern sector of the Cerro de Fuensanta millstone quarry.



Detail of a "solitary" unfinished cylinder near the eastern sector of the quarry.



Details of traces of wedge holes to split the cylinder from the bedrock.



Extract from geological map 1008 (IGME). The quarry exploited a unit of white limestone (blue).

Source

Loja Ordinance: Pregón 1502, enero, 10. Loja, Pregón de la ordenanzas de Loja sobre no sacar piedras de molino. AML, Leg. 49, p. 9. 1 cuartilla + 1: <http://www.reocities.com/tdcastros/Historyserver/Fuentes/Doc-Munic/DOCLOJA.6.htm> [accessed February 9, 2013].

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GR-3 Loja

Camino del Calvario

Latitude: 37° 10' 21" 28"N
 Longitude: 4° 10' 25' 20"W
 Altitude: 605 m



Location: Loja's second quarry is perched above the city on the rugged, karstic southern slope of the Puente Quebrado Mountain. The site is on both sides of the Camino del Calvario, a road that winds up the mountain. Modern work on this road has destroyed part of the site and displaced some of the millstones.

Sources: See GR-2.

The quarry: The site is presumably an extensive dispersed exploitation. It is plausible that surface boulders were also exploited in this rugged landscape.

Techniques: The surface of the unfinished extractions are extremely weathered and do not show the original tool marks. It is probable that they were cut by pick and split with wedges.

Products and quantification: Large millstones measuring over one metre in diameter were scored.

Transport and distribution: If the modern road was founded on an older thoroughfare, this road could have served to transport the millstones downhill to the city.

Dating: From the size of the extractions, this quarry could well be one of the exploitations cited by Madoz for the early part of the 19th century.

Rock type: Limestone (Geological Map 1025, Montefrío, 1985). White and homogeneous.



View from the south-west of the position of the Camino del Calvario quarry on the slope of the Puente Quebrado mountain.



View from the south of the karstic landscape of the site with an unfinished millstone still in connection with the bedrock (see detailed views on next page).



View from the north of a solitary unfinished millstone.



Detail of a solitary extraction measuring 1.30 m in diameter.



View of an unfinished millstone.



View of a cylinder displaced during road work.



Extract from geological map 1008 (IGME). The quarry exploited a limestone unit (blue).

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GR-4a Loja

La Merced 1

Latitude: 37° 15' 41.57" N

Longitude: 4° 9' 13.47 W

Altitude: 845 m



View from the north of the quern extractions along the bed of the ravine.



Detail of the small cluster of quern extractions.

Location: La Merced 1 is the smallest of three quarries on the south-western edge of the La Merced Mountain in the northern district of the Loja Municipality.

The quarry: This site, directly in the bed of a ravine, consist of only three surface extraction hollows. They are cut into the same inclined layer of rock exploited in the nearby subterranean millstone quarry La Merced 2 (60 m downhill, see GR-4b).

Products and quantification: The extractions correspond to rotary handmills measuring about 50 cm in diameter. This is one of the few “quarries” that could fall into the category of a “prospecting” site to test the quality of the stone (Grenne *et al.* 2008, 51).

Transport: The site is along the road linking Loja to Algarinejo.

Dating: Based on the size of the extractions, the site dates to the Medieval period.

Rock type: Bioclastic calcareous sandstone (Geological map 1008, Montefrío, 1988; Cambeses 2011, unpublished).

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Acknowledgements

I thank Juan ORTÍZ, historian from Algarinejo, for leading me to the different sites of La Merced.



Extract from geological map 1008 (IGME). The quarry corresponds to a bioclastic calcareous sandstone unit (orange with circles).

GR-4b Loja

La Merced 2

Latitude: 37° 15' 46,11" N

Longitude: 4° 9' 10.68" W

Altitude: 835 m



View from the south of the subterranean millstone quarry of La Merced 2 (from Google Maps Street View).

Location: La Merced 2 is at the base of the mountain beside the road that links the towns of Ventoros de San José and Algarinejo.

The quarry: This is the only subterranean millstone quarry documented thus far in southern Spain. The cavern, in part destroyed by road work, is relatively small, measuring 9 m wide and 3.5 m deep. Its ceiling today, partially caved in, is about 2.5 m high.

Techniques: The quarrymen exploited a specific stratum of brownish massive sandstone directly beneath a layer of brittle rock. On account of the thick overburden (more than 10 metres) atop the desired stratum, it would have been impossible to attain this layer by any other means than that of tunnelling. Millstones were extracted directly from bedrock by means of trenching, presumably with a pick. Several tiers of extraction hollows are visible. It is possible that the lower tiers, at the mouth of the site, were destroyed during recent road work. Tool marks are not conserved.

Products and quantification: Two models of millstones were extracted. The first, more frequent, were cylinders measuring approximately 60 to 70 cm in diameter. The second corresponds to larger millstones about 1.10 to 1.20 m in diameter. This second production is presumably contemporary to the large extractions outside the cavern (see La Merced 2, GR-4b).

Transport: The site is along the road linking Loja to Algarinejo. The millstone makers probably benefited from an earlier phase of this road for the transport of the millstones.

Dating: The two different models of cylinders point to two chronological phases. The smaller cylinders could be Medieval while the larger models could indicate a more recent, Modern or Contemporary, production.

Rock type: Bioclastic calcareous sandstone (Geological map 1008, Montefrío, 1988; Cambeses 2011, unpublished).



View from the south of the mouth of the subterranean millstone quarry.



Views of the northern (left) and southern (right) halves of the quarry. The homogenous sandstone stratum (a) exploited for millstones is below a brittle, unserviceable layer (b).



Detail of the extractions at the southern end of the quarry corresponding to small millstones approximately to 60-70 cm in diameter.



Detail of the extractions at the northern end of the quarry corresponding to small millstones approximately to 60 to 70 cm in diameter. The extraction under the ranging rod corresponds to a larger cylinder between 1.10 and 1.20 m in diameter.



Extract from geological map 1008 (IGME). The quarry corresponds to a bioclastic calcareous sandstone unit (orange with circles).

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GR-4c Loja

La Merced 3

Latitude: 37° 15' 44,36" N
Longitude: 4° 9' 19,31" W
Altitude: 850 m



View from the south-west of the position of the large millstone extraction hollows.



View from the west of the seven contiguous millstone extraction hollows.

Location: The third millstone workings at the Merced Mountain is an open-air quarry that exploited a specific stratum of sandstone on the slope about 10 m above the underground quarry (La Merced 2, GR-4b).

The quarry: This edge quarry presents an extended face about 15 m in length. It comprises seven contiguous tubes of two to three superimposed, horizontal extractions. In this area, there is also a single extraction hollow a few meters downhill from the edge quarry.

Techniques: The rock surface is too weathered to observe any tool marks. These tubular hollows are, nonetheless, typical of the technique of extracting cylinders from the bedrock with a pick.

Product and quantification: The size of the hollows corresponds to millstones about 1.10-1.20 m in diameter. The production here is estimated to be about 20.

Transport and distribution: The site is along the road linking Loja to Algarinejo. As in the case of the adjacent underground quarry, the quarrymen would have benefited from an earlier phase of the road to transport the millstones.

Dating: The dating of this site is uncertain. Judging from the size of the extractions, it could range from Medieval to Contemporary times.

Rock type: Bioclastic calcareous sandstone (Geological map 1008, Montefrío, 1988; Cambeses 2011, unpublished).



Detail of the tube-shaped superimposed hollows.



Detail of the tube-shaped hollow.



View of a solitary extraction below the main cluster of tubular hollows.



Detail of an unfinished cylinder.



Extract from geological map 1008 (IGME). The quarry exploited a bioclastic calcareous sandstone unit (orange with circles).

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GR-5 Zagra

La Atalayuela

Latitude: 37° 15' 44,97" N

Longitude: 4° 9' 49,08" W

Altitude: 740 m



View from the east of the promontory with the Atalayuela quern quarry.



View from the north of the northern sector of the rotary quern quarry. In the background (indicated with the arrow) is the promontory with the ruins of a Medieval settlement.

Location and generalities: The rotary quern quarry of the Atalayuela is in the Municipality of Zagra, one kilometre west of the La Merced workings (see: GR-4a-c). The quarry exploited a sandstone outcrop overlooking the Pesquera de Genil Valley. The site is unique in that it is, to date, not only the largest true extractive quern quarry in southern Spain, but shares the same outcrop with a small Medieval cemetery with a dozen rock-cut inhumation chambers.

Source: The site was made known by a video posted on the Internet (Video Foro Montefrío). Quern workings are also cited in passing in a study of the Medieval cemetery (Jiménez Puertas 2002: 224).

The quarry: The site can be divided roughly into four sectors. The northern sector, a bench-type quarry, presents numerous horizontal circular small quern hollows, side by side and organised on several tiers.

The southern sector, also of the bench type, has small rotary quern extractions. The quarry face here comprises multiple superimposed extractions

forming vertical “tubes” with at least three levels of extraction. The quarry floor in this sector is, for the most part, overgrown with vegetation.

The western sector corresponds to a large block about 4 x 4 m at the point of the promontory that juts out above the valley. Here there are two small clusters of the hand-quern hollows, as well as a single large unfinished cylinder (1.20 m in diameter) surrounded by a trench 25 to 30 cm wide. The motive for the abandonment of the cylinder, the only large roughout at the site, remains a mystery because the rock does not present any flaws.

The eastern sector of the site consists of a Medieval cemetery with nine trapezoidal and rectangular chambers hewn directly into the rock. From their typology, these features date roughly to the Visigothic period (6th-7th centuries) (Jiménez Puertas 2002: 226). Most of the potsherds collected during the surface survey, however, date from the 10th to the beginning of the 12th century (Jiménez Puertas 2002: 226), a period corresponding to Islamic rule.

Techniques: Severe weathering of the rock has erased most of the tool marks. The circular trenches were either cut by pick or chisel. As to the technique of cylinder splitting, I observed a few cases of regularly spaced marks along the periphery of the cylinder that could have been made by a chisel. One option is that the carving of these holes sufficed to split the cylinders. Another option is that the holes were cavities meant to lodge small wedges or pegs.

Products and quantification: The extractions correspond to rotary hand-querns measuring 50 cm in diameter. The only exception is the single large unfinished extraction (1.20 in diameter) in the western sector.

Transport and distribution: The quarry is above the Pesquera de Genil River Valley, a tributary of the Genil River, five kilometres to the south-west, that flows through the natural passage linking eastern and western Central Andalusia. The large number of querns scored at the site suggests a production destined beyond the local sphere. The modern road linking Zagra to Alarinejo, probably a new phase of an older thoroughfare, passes directly beside the site.

Dating: The size of the querns (50 cm in diameter), suggest a Medieval date. The chronological relationship with the nearby Medieval cemetery is

not clear. It is difficult to conceive, nonetheless, that the cemetery, a consecrated ground, and the rock workings, a mundane craft, were contemporary. There is, however, no visible direct contact between the tombs cuttings and the quern extractions to establish a relative chronology.

A study of the morphology of the funeral chambers suggests a 6th-7th-century date for the cemetery, while the pottery collected on the surface (no proper excavation was undertaken) dates between the 10th and the beginning of the 12th centuries (Jiménez Puertas 2002: 226). Since the pottery does not concord with the typology of the chamber tombs, it is plausible that it is related to the quarry. If this is the case it would place the quern production well under Islamic domination.

The large isolated and unfinished extraction measuring 1.20 m in diameter is certainly later than the rest of the extractions and could date from the Late Medieval period to Contemporary times.

Rock type: Bioclastic calcareous sandstone (Geological map 1008, Montefrío, 1988); Cambeses 2011, unpublished.



View from the south-west of the northern sector of the quarry.



Views of the rotary quern quarry's northern sector.



View of the southern sector.



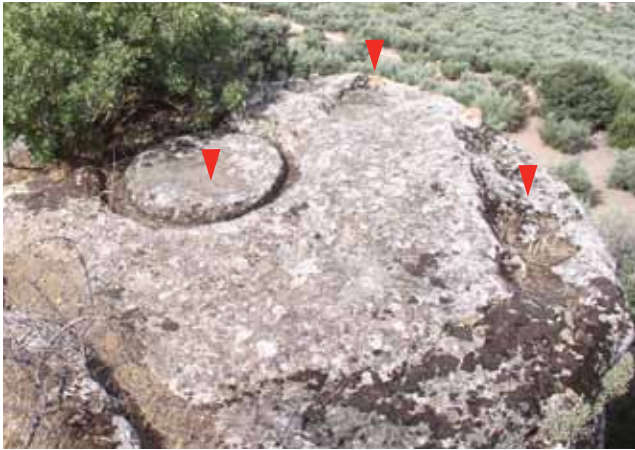
View of the quarry face of the southern sector.



Details of rotary quern extraction hollows.



Detail of a rotary quern extraction hollow with poorly conserved splitting marks.



View of the quarry's western sector with a single large unfinished cylinder and two clusters of rotary quern extraction hollows.



Detail of a solitary unfinished millstone corresponding to a later phase than that of the quern extractions. Diameter 1.20 m.



Detail of a rock-cut tomb dating presumably to the 6th or 7th century. The nine tombs of the cemetery are located in the site's eastern area.



Extract from geological map 1008 (IGME). The quarry is in a bioclastic limestone/sandstone unit (orange with circles).

Sources

Video of the Foro of Montefrío: <http://www.foromontefrio.com/index.php?topic=846.0> [accessed November 23, 2012].

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Acknowledgements

I sincerely thank Juan ORTÍZ, historian from Algarinejo, for leading me to the site.

GR-6 Alhama de Granada

Fuente de los Morales

Latitude: 36° 59' 59,73"N
 Longitude: 3° 56' 44,67"W
 Altitude: 1090 m



View of the Fuente de los Morales millstone quarry from the west.

Location, source and bread: *Fuente de los Morales* is in the Sierra de Tejeda Mountains about three kilometres east the city of Alhama de Granada. This exploitation is one of the more important quarries of the western area of the Province of Granada, considering that the 19th-century geographer Madoz records that it produced excellent millstones that yielded flour for white bread.

Toponymy: The term *morales*, meaning mulberry, could be a variation of *mola*res, the toponym *par excellence* of millstone quarries. Another place name about 1.5 km north-west of the site, *Las amoladeras*, is normally linked to whetstone (*piedras de amolar*) workings. However, as there is no indication of whetstone production, the name might also be a variation of *mola*res. A third toponym, *Lomas de la Cantera*, meaning "hills of the quarry", might evoke the large mounds of millstone working debris.

The quarry: The site is an edge quarry about 150 m long with a face several meters high.

Techniques: The quarrymen carved millstones from previously detached angular blocks. They followed two superimposed layers of hard, white limestone (each about 30 - 40 cm thick). The large heaps of working



Aerial view of the quarry. The white mounds of working debris are plainly visible (SIGPAC).

debris at the foot of the outcrop, visible from afar, are probably the result of millstone fashioning adjacent to the quarry face.

Production and quantification: The abandoned monolithic cylinders spread throughout the quarry and along its lower terrace range between 1.10 and 1.20 m in diameter. Besides the monolithic models, this is the only site to date with evidence in the field of millstone segments (halves, quarters) meant to be assembled with mortar and metal belts tightly fitted around their girth.

The size (150 m) of the quarry and the volume of the working debris mounds suggest a large production. The manufacture of millstone segments significantly increased the volume of production.

Transport and distribution: The site could have been serviced by the current road leading to the city of Alhama de Granada. An abandoned millstone (see photo) about half-way along this road reinforces this idea. A second option is the old road 1.5 km north of the site also connected to Alhama de Granada. Its name, *Camino de las Amoladoras*, suggests it could have serviced the site.

Madoz indicates that these millstones were commercialized all over the area, even to towns in the Province of Málaga, *i.e.* about 20-30 km to the southwest, on the other side of the Málaga mountains (Madoz 1847, Vol. 8: 216).

Dating: There is no evidence of any workings earlier than the date indicated by the Madoz reference.

Rock type: Limestone/breccia unit (Geological map 1025, Loja, 1985; 1040, Zafarreja, 1978).



View of the northern quarry face.



View of the southern quarry face.



View of the mounds of working debris.



Detail of the two compact layers detached for millstones. The southern end of the quarry begins behind the tree.



Abandoned monolithic millstone in the heart of the extraction zone.



Abandoned semi-circular millstone segment.



Abandoned semi-circular millstone segment.



Abandoned semi-circular segment.



Abandoned quarter segment. The unfinished curvilinear edge to the left indicates that the interior angle was carved before the outer edge.



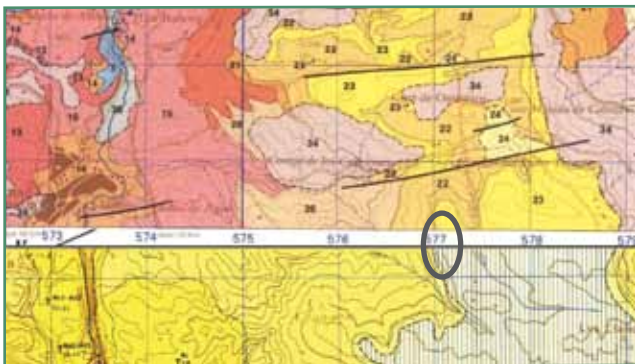
Abandoned quarter-circular segment.



Abandoned quarter-circular segment.



Abandoned monolithic cylinder (ø: 1.10 - 1.20 m) on the road between Alhama de Granada and the millstone quarry (in 2015 this millstone was not longer in place).



Montage of extracts from the geological maps 1025 and 1040 (IGME). The quarry exploited a limestone or limestone breccia unit.

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GR-7 Padul*Barranco de los Guillares*

Latitude: 36° 59' 43,00"N
 Longitude: 3° 44' 30,66"W
 Altitude: 1160 -1170 m



View of the quarry from the north-east. In the centre, behind the vegetation, is the ravine with a great number of extraction hollows. The quarry continues to each side of the ravine.

Location: The Barranco de los Guillares millstone quarry is along a ravine near the hamlet of Ventas del Fraile, about 15 km east of the town of Padul (Anderson & Scarrow 2011: 264).

Source: The quarry is identified in a web site related to the historical heritage of the Padul Municipality. The web site is accompanied by many photographs. With its monumental size and imposing extractions, the absence of any old written source is surprising.

The quarry: The site is basically a T-shaped edge quarry exploiting both faces of the ravine before opening up laterally at the mouth of the ravine along the north-west and south-east faces.

Techniques: Along with Moclín (GR-1a) and the Cantera de Los Frailes (CO-1), this is an excellent example of superimposed horizontal extractions, like stacks of coins, producing tubular quarry faces. The millstone makers cut large, deep trenches around

the cylinders leaving numerous parallel diagonal pick marks clearly visible today on the extraction faces. The means of splitting the cylinder from the bedrock is not clear. In one area of the quarry, to the north beyond the mouth of the ravine, there is a group of extractions on vertical planes, indicating that the rock in this sector of the quarry was sufficiently homogenous to permit extraction along a plane opposite to the natural horizontal bedding of the rock.

Products and quantification: Only large cylinders (between 1.00 and 1.30 m in diameter) were produced at the site. There appear to be hundreds of extractions.

Transport and distribution: Millstones could have been hauled eastwards down the path from the base of the quarry (see orthophoto) that leads to the Camino de la Cabra, an old thoroughfare two kilometres away linking Granada and its plain with the Mediterranean coast.

These millstones were certainly widely distributed in the region. The nearby Valle de Lecrín, a fertile valley with a mild micro climate, was known to have had many flour mills.

Dating: The absence of written sources complicates the dating of this site. A Roman date, suggested by the website, can be excluded based on the large size and morphology of the millstones. It is more likely that the site was exploited during a period ranging from the Late Medieval to Contemporary times.

Rock type: Bioclastic calcarenite or limestone (Geological map 1041, Dúrcal, 1978). The petrography is confirmed by the geologist Joaquín Sánchez, a millstone specialist from Menorca.



Orthophoto of the position of the quarry (a) and the path leading downhill from the base of the quarry.



Detail of a series of tubular extraction hollows along the southern face of the ravine.



View of the tubular extractions on the northern face of the ravine.



Views of tubular extraction hollows in different sectors of the quarry. Pick marks are well visible in the bottom right view.



Views of abandoned cylinders varying in diameter from 1.10 to 1.30 m.



View of the quarry's western sector.



Detail of an abandoned horizontal cylinder in the western sector.



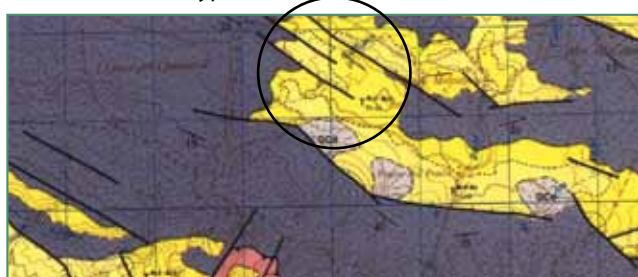
Detail of vertical extraction hollows in the western sector.



Detail of an abandoned vertical cylinder in the western sector.



Detail of the rock type.



Extract from geological map 1041 (IGME). The quarry exploited a unit of bioclastic limestone (yellow).

Sources

Padul Municipal web site: Cantera de Piedras de Molino: <http://www.adurcal.com/enlaces/cultura/zona/historia/padul/cantemolin/index.htm> [accessed November 7, 2012].

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GR-8 Los Guájares

Los Mochos, Guájar Faragüit

Latitude: 36° 50' 39,96" N

Longitude: 3° 35' 6,09" W

Altitude: 350 m



View from the north of several extraction hollows beside a farm house.

Location: The site is in the rugged Guájares mountains on the slope of the Rio de la Toba Valley. It is less than a kilometre north of the town of Guájar Faragüit, beside the Mochos *Finca*, a country house among fruit plantations.

Source: The web site of the town of Guájar Faragüit, no longer available on the Internet, mentions an ancient millstone quarry along a hiking itinerary.

The quarry: The site is very small and has only two levels of extraction. Its southern sector, beside the house, it is overgrown and filled with water.

Techniques: Parallel diagonal lines on the face of one of the extraction hollows indicate that the cylinders were cut out of the bedrock with a pick.

Product and quantification: The quarry comprises less than a dozen circular hollows that measure approximately 1.60 m in diameter, corresponding to finished millstones between 1.10 and 1.20 m.

Transport and distribution: The few millstones made here were probably destined to local watermills.

Dating: The size of the extraction suggests a date from Late Medieval to Modern times.

Rock type: Conglomerate (Geological map 1075, Dúrcal, 1978).



Details of millstone extraction hollows measuring approximately 1.10 to 1.20 m in diameter.



Extract from geological map 1075 (IGME). The quarry exploited a conglomerate unit (orange).

Source

Los Guájares Municipal website "Ruta Avices, Pie Moro y Minchal"
<http://www.losguajares.es/turismorural.html> [accessed in 2008, web-site no longer available].

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ANDERSON, Timothy, SCARROW, Jane H. Millstone Quarries in Southern Spain: Preliminary Pinpointing of Provenance and Production - Exploiting the Internet. In: WILLIAMS, David, PEACOCK, David (eds), *Bread for the People: The Archaeology of Mills and Milling, Proceedings of a Colloquium Held in the British School at Rome, 4th-7th November, 2009*, University of Southampton Series in Archaeology, no. 3, Archaeopress, Oxford. 2011, p. 259-275.

GR-9 Motril*Playa de Carchuna*

Latitude: 36° 41' 41.30"N
 Longitude: 3° 26' 17.42"W
 Altitude: 0-1 m



View from the west of the coastal millstone quarry of Carchuna.



Detail of the Carchuna quarry (photograph by Antonio Quesada).

Location and generalities: This quern and millstone quarry is located on the coast at the Playa de Carchuna, about 200 m west of the Fort of Carchuna. This fort, dating to the 18th century, was erected to protect the coastal area from marauding pirates. It is also known as the scene of a daring rescue of Republican prisoners in 1938 during the Spanish Civil War.

Source: Knowledge of this quarry comes from I. Toro, director of the Archaeological Museum of Granada.

The quarry: The site is a small contiguous surface quarry (only one level of extraction) that comprises about 20 large circular cavities spread along the coastline measuring about 50 m long. As one of the older local residents of the area noted, there the rocks have hollows "scooped out like balls of ice cream". It is reasonable to assume that some inland sectors of the quarry are now covered by sand and gravel.

Techniques: Owing to the alteration of its surface by the constant pounding of waves, it is not possible to make out tool marks. It is, nonetheless, safe to assume that the cylinders were cut with picks. In several large cases the trenches are up to 40 cm wide.

Products and quantification: The extraction hollows are for the most part between 1.80 and 2.00 m in diameter corresponding to millstones approximately 1.50 m. In one area, adjacent to the several large extractions, there are three contiguous small rotary quern extractions measuring 40 cm in diameter.

Transport and distribution: The sea could have facilitated transport by boat. Since the production appears to be small, I cannot conceive that these millstones travelled beyond a local sphere.

Dating: I have not identified any old texts mentioning this site. The smaller quern extractions suggest an early date (Medieval?). The large extractions, among the largest known in the south of Spain, fall into a date ranging from the Late Medieval to Contemporary times.

Rock type: Conglomerate (Geological map 1056, Albuñol, 1972). The clasts are rounded and measure up to 7-8 cm.



Large millstone extractions corresponding to millstones approximately 1.50 m in diameter (photograph by Antonio Quesada).



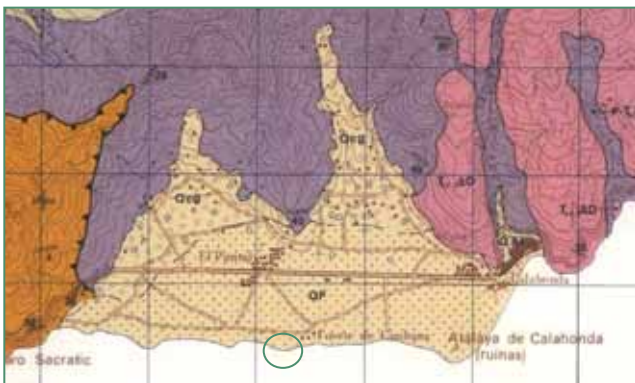
Large millstone extractions corresponding to millstones approximately 1.50 m in diameter.



Three contiguous extractions corresponding to small hand-querns measuring 40 cm in diameter.



Detail of a rotary quern extraction hollow (40 cm in diameter).



Extract from geological map 1056 (IGME). The conglomerate quarry layer is too restricted to appear on the map along the coast (beige with dots represents beach sands). Conglomerates, however, do appear inland (beige with circles).

Acknowledgements

I thank Isidro TORO, director of the Archaeological Museum of Granada, for knowledge of the site and Antonio QUESADA for details of its exact location.

GR-10 Vélez de Benaudalla

Barranco de las Piedras

Latitude: 36° 50'42,27''N

Longitude: 3° 30'8,44''W

Altitude: 340-350 m



View of the millstone quarry from the west.

Location: The Barranco de las Piedras quarry is 15 kilometres from the Mediterranean coast in the rugged slope above the Valley of the Guadalfeo River. It is on the edge of Vélez Benaudalla, a town known traditionally for its numerous natural springs and watermills.

Source: In his description of the millstone quarries of the Province of Granada, Madoz mentions Vélez Benaudalla, along with Moclán (GR-1) and Loja (GR-2), as the more important millstone quarries (Madoz 1847, Vol. 8: 490; Madoz 1847, Vol. 10: 464; Madoz 1848, Vol. 11: 637). De la Rada, in his general chronicle of the Province of Granada 20 years later, echoes the words of Madoz (de la Rada 1869: 16).

Toponymy: The toponym *Barranco de las Piedras*, meaning "ravine of the stones" most likely is related to the ancient millstone production.

The quarry: The site is a combination of an edge and talus quarry: extractions cut directly into the rock toward the top of the slope and surface blocks exploited at its base. The site is about 100 m long. Working debris abandoned millstone drums are strewn about the base of the site.

Techniques: Parallel diagonal lines on the quarry face indicate the use of picks to cut the circular channels around the future millstones. Due to the high number of natural fissures, the millstone makers

applied different techniques. Some blocks were pried out while others were cut in true extractive fashion. Most of the extractions, as usual, followed the natural horizontal bedding plane of the rock. One attempt at a vertical extraction on a displaced boulder was aborted.

Products and quantification: The abandoned cylinders measure between 1.20 and 1.30 m in diameter. It is difficult to estimate the number of extractions. Based on the size of the outcrop, it would have been possible to remove several hundred cylinders.

Transport and distribution: An abandoned stone along a path leading along the quarry's base suggests it could have serviced the site. The Madoz reference suggests the quarry benefited from a wide distribution. The products could have travelled up and down the Guadalfeo Valley without any major obstacles.

Dating: The reference of the geographer Madoz places this site in the first half of the 19th century. There is no evidence of earlier production.

Rock type: Dolomites and limestones (Geological map 1042, Lanjarón, 1978).



View of the quarry from the south. The Guadalfeo River Valley is seen in the background.



View from the summit (east) of the quarry. Three abandoned millstone extractions are seen on different tiers of the quarry.



Detail of an abandoned millstone.



Detail of contiguous extraction hollows with faces bearing diagonal pick marks.



Detail of an abandoned millstone extraction. The trench cut to the right of the cylinder is between 25 and 30 cm wide.



Abandoned millstone in an advanced state of manufacture. The eye is pierced.



Abandoned millstones a few hundred meters away from the quarry along a road.



Extract from geological map 1042 (IGME). The quarry is located in a unit of dolomites and limestones.

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GR-11 Caniles

Rambla de las Canteras

Latitude: 37°29'21.18"N

Longitude: 2°37'45.20"W

Altitude: 930 m



Aerial view of the trench quarry of Rambla de las Canteras (Orthophoto, SIGPAC).

Location: The Caniles millstone quarry is nine kilometres north-east of the city of Caniles along a dry riverbed called the *Rambla de las Canteras*. This riverbed winds roughly from east to west through the flatlands of the Hoya de Baza plateau.

Source: 19th-century geographer Madoz (1846, Vol. 5: 461) identifies this quarry.

Toponymy: The word *cantera* (quarry) appears both in the name of the site (*Rambla de las Canteras*, meaning "dry riverbed of the quarries") and in the name of the nearby farm (*Cortijo de las Canteras*). Although unaware of the presence of a millstone quarry, Pedro Rodríguez Sánchez, a resident of the neighbouring hamlet of El Francés, informed us that the name of the area where production took place is commonly known as *Piedras de Molino* (millstones).

The quarry: The working surface corresponds to approximately 4000 m². A conglomerate layer about one metre thick, exposed along the edge of the dry riverbed, was exploited in two long parallel trenches. The millstone makers presumably pried out rough blocks with levers, a technique that has left no visible traces on the quarry face.

The principal features of the site are the long, parallel cordons of working debris four to five metres wide and up to two metres high arranged along the edges of the trenches and resulting from the millstone fashioning process.

Products and quantification: I have identified only one abandoned cylinder measuring about 1 m in diameter and 40 cm thick. It shows traces of fashioning only on one of its sides. It is difficult to quantify the production of this site. From the height and length of the waste cordons, I can imagine a production in the hundreds.

Transport and distribution: The site is easily accessible and there are no natural obstacles for transport. This site therefore probably served both local and regional demands.

Bread: It is noteworthy that Madoz specifies that this quarry produced millstones for *pan moreno* (dark bread) (Madoz 1846, Vol. 5: 461). It is therefore possible to assume that grinding with this type of rock (pebble conglomerate) yielded a type of flour that retained the bran. Following this logical sequence, it is therefore possible to speculate that millstones from other pebble conglomerate outcrops also yielded dark flour. This detail relates to the preoccupation of the ancient society with the colour of bread.

Dating: The Madoz reference indicates that the site was exploited in the first half of the 19th century. In view of the quarry's size, work appears to have lasted many years.

Rock type: The rock is a conglomerate with pebble inclusions up to 2 cm in a calcite matrix (unpublished report by Juan Soto, Geology Department, University of Granada). The geological map (IGME 994, Baza 1978) does not indicate this rock type at this location. It is probably a very local facies.



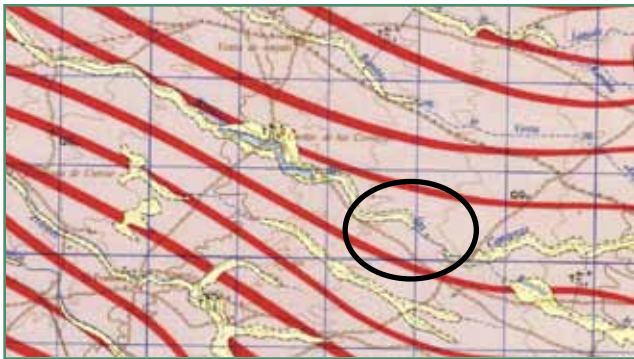
View of one of the conglomerate outcrops along the river bed edge. The stratum is approximately 1 m thick.



Different views of the cordons of working debris along the edge of the Caniles trench quarry.



Partial view of a millstone about 1.00 m in diameter in vertical position. In the photograph on the right, one can discern the fashioning of its right half.



Extract from geological map 994 (IGME). The conglomerate exploited does not conform to the yellow unit of loams and limestones on the map.

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Acknowledgements

I would like to thank Juan SOTO of the Geology Department of the University of Granada for his description of the rock.

GR-12 Pinos Puente

Cantera de Zujaira

Latitude: 37° 15' 53,41" N
Longitude: 3° 48' 14,35" W
Altitude: 690-700 m



View from the west of the modern quarry of Zujaira.



An example of a saddle quern from the settlement of Los Pensadores, probably originating from a nearby calcareous sandstone outcrop.

Location: The quarry of Zujaira is at the mouth of a ravine a few hundred metres north of the town of Zujaira.

The quarry: Local residents informed me that this quarry provided rock for the construction of the local church. This modern exploitation has left a horseshoe hollow in the ravine and could have destroyed earlier workings.

Prehistoric saddle querns brought to light during the recent archaeological excavations of nearby Late Neolithic settlements of Los Pensadores (1.5 km) and Las Rajas (200 m) (Anderson 2010, unpublished) were possibly fashioned from Zujaira rock. Furthermore, this rock was the basic construction material for at least two oval prehistoric cabins at Las Rajas. About a half dozen prehistoric "beehive" chamber tombs, probably contemporary to the Las Rajas settlement (about 200 m away), were carved into the rock farther up the ravine. The cutting of these subterranean chamber burials reveals an early mastery over this rock.

Extraction techniques: Rough, angular surface slabs were probably easily detached following the bedding planes of the rock. These extractions would leave little, if any, marks. Larger debris from the cutting of the tombs could have also been used to fashion querns.

Products, distribution and dating: Besides the prehistoric saddle querns (Late Neolithic), a Roman rotary quern fragment of this rock type was found in a wall of the site of El Tesorillo, a Roman Villa in the lowlands about three kilometres south-west of Zujaira. I suppose, without any evidence except the petrography, that the rotary quern was also Zujaira material as this rock type is not available in the plain. In any case, neither hypothetical extraction phase (Prehistoric and Roman) would have served more than local needs.

Rock type: Bioclastic calcareous sandstone (Geological map 1009, Granada, 1985). From my observations, the rock is a yellowish, coarse sandstone.



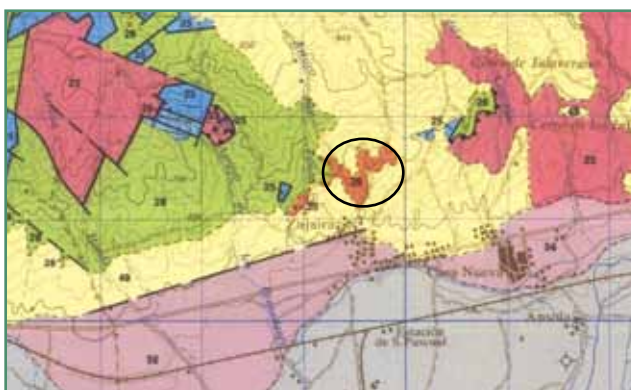
View from the south-east of the modern quarry (left). To the right in the background is the Prehistoric rock-cut cemetery. In the foreground is a sector of the excavation of the Chalcolithic settlement of Las Rajas.



Orthophoto with the locations of the a) the quarry b) Las Rajas c) Los Pensadores and d) the cemetery.



Example of a Prehistoric subterranean chamber burial cut directly into the bedrock.



Extract from geological map 1009 (IGME). The rock exploited is a unit of bioclastic calcareous sandstone (orange). The surrounding yellow unit corresponds to clays, silts and conglomerates.

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GR-13 Otívar



Location: Otívar is a small town deep in the western Alpujarra Mountains between the city of Granada and the Mediterranean coast. The town is on a steep slope above the Jete River. In spite of inquiries with a local historian, I was not able to identify the location of this quarry.

Source: In his study of the watermills in the Province of Granada, Reyes Mesa (2000b) refers to Otívar's millstone quarries. His source is the 18th-century survey by the geographer and cartographer Tomás López whose unpublished survey recorded that the Otívar quarries supplied millstones to the watermills along the Jete River.

Transport and distribution: Millstone transport in this rugged terrain would have been difficult. Reyes Mesa observed that this quarry also furnished stones to many other local watermills in the Sierra de Cázulas (Reyes Mesa 2000b).

Bread: This quarry is important because there is written data regarding the colour of the flour resulting from grinding with these millstones. According to Tomás López, the quarry yielded "*pedra basa*" millstones (Reyes Mesa 2000b), a term,

according to Reyes Mesa, not related to "*pan baxo*" (meaning low, flat bread), but *pan "moreno"* (dark bread). The dark bread was made with "*harina baxa*", that is, flour ground by "*piedras baxas*", millstones that are not capable of separating the bran from the endosperm.

Dating: Production is dated by the Tomas López reference to the second half of the 18th century (Reyes Mesa 2000b). The site is not mentioned a century later in the study by Madoz.

Rock type: The rock type is not known. The geology of the area is dominated by schists and marbles (Geological map 1055, Motril, 1972). Since these stones are not traditionally worked for millstones in this part of Spain, it is more probable that the millstone makers exploited outcrops of conglomerate found to the east of the Otívar.

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Extract from geological map 1055 (IGME). The town of Otívar is indicated by the arrow. The vast purple and orange rocks are units of marbles and schists. The hatched light green units to the east indicated by the small arrow are conglomerates (the more likely millstone sources).

GR-14 Ugíjar

Las Canteras

Latitude: 36° 56' 16,68" N

Longitude: 3° 2' 38,58" W

Altitude: 450 m



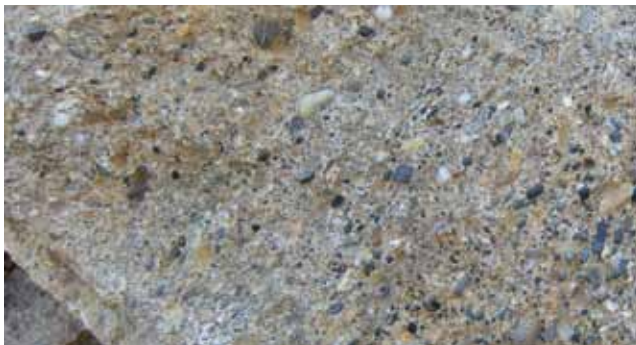
Location: The site of Ugíjar, visited in December, 2015, is in on the slope of a steep valley along a narrow road leading to the Canteras (the quarries) hamlet. The conglomerate outcrop, mixed with strata of pinkish limestone, is small and has been for the most part destroyed during modern roadwork.

Sources and toponymy: The quarry is cited in the study of the Alpujarra watermills (Cara Barrionuevo *et al.* 1999, 153) and in a newspaper article.

Transport and products: According to long-term residents of Las Canteras, blocks were pried from the outcrop, dragged to town by oxen and assembled by means of iron bands into both composite millstones or monolithic oil rollers.



View of the quarry from the south.



Detail of the conglomerate with clasts that measure, on an average, between 2 and 3 cm.



Extract from geological map 1043 (IGME). The conglomerate outcrop is inside a unit of limestones and dolomites (pink).

Distribution: The outcrop's limited size and its remoteness indicate a local production.

Dating: Long-term residents place production in the first half of the 20th century.

Rock type: Conglomerate (Geological map 1043, Berja 1977).

Source

GAN QUESADA, Rafael, "La Comarca de Ugíjar: Tierra de Contrastes": http://sp.ideal.es/municipios/rutas-com.php?id_ruta=4&id_comarca=3&pageNum_rutas=8 [accessed February 2, 2012].

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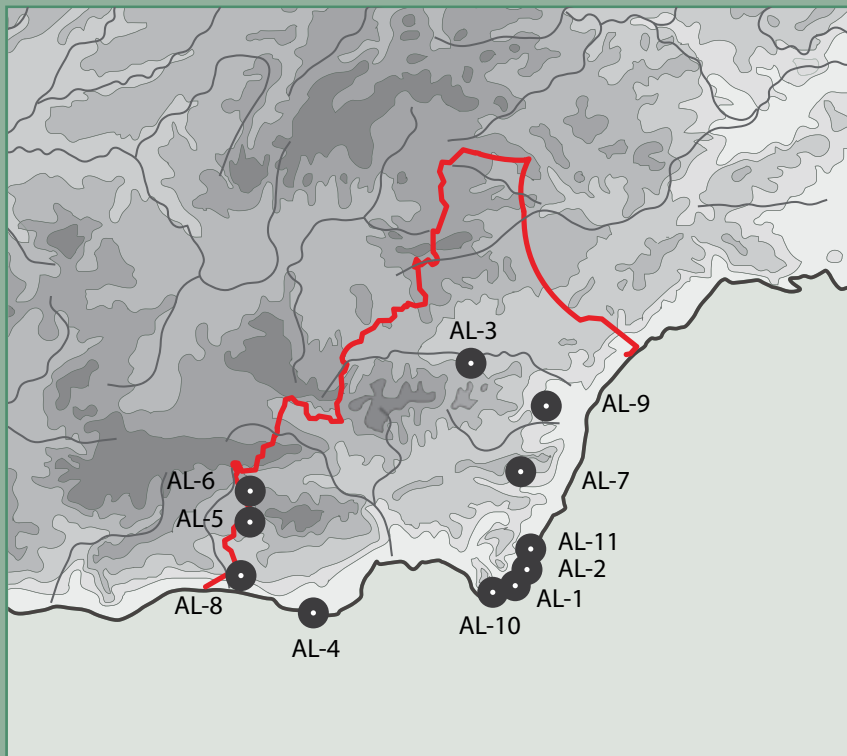
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I thank Francisco MORENO and Aurelia FERNÁNDEZ, long-term residents of Las Canteras.

ANDALUSIA

ALMERÍA (AL)



AL-1 Níjar

Cerro de Limones

Latitude: 36° 48' 35.45" N

Longitude: 2° 6' 46.06" W

Altitude: 365 m



View from the south of the Cerro de Limones. The Garbanzal caldera is in the background (to the left).

Location and sources: The Roman quern quarry of Cerro de Limones is in the South-Eastern Spanish volcanic district. The site, an hour hike uphill from the town of Presillas Bajas, is on the southern plateau of the Cerro de Limones mountain, beside the Garbanzal volcanic dome. Although protected in the National Park of Cabo de Gata, the site has suffered from years of plundering. Most of the better conserved querns decorate the gardens of houses in the neighbouring towns.

This is the first Roman quern quarry identified in the field in the Iberian Peninsula. It was presented in the proceedings of two specialised colloquia (Anderson *et al.* 2011; Anderson 2011: 265).

Toponymy: The name *Limones* is curious as lemons do not grow naturally in the arid climate of the Cabo de Gata. If at some point in time there was an inversion of the first two syllables of the word "*limones*", then the name would have been "*molinos*" (meaning mills).

The quarry: The site is littered with hundreds of broken or unfinished rotary querns and working debris. The quern makers had the choice of working either surface blocks collected from the nearby talus or detaching blocks from bedrock. Part of this extraction process could have taken place along the southern slope where columnar jointing is visible. Another part certainly took place on the top of the mountain where blocks were extracted in large shallow pits that are now backfilled with working debris.



View from the north-east of the plateau on the top of the Cerro de Limones.

Techniques: After detaching (probably with levers) or collecting surface material, querns were fashioned (either by knapping or with a hammer and chisel) into a rough cylindrical shape. The eye of upper stones (*catilli*) were perforated at the quarry itself, a step that resulted in many breaks. There is also evidence that radial handle fittings, an important typological feature of these mills, were also at times cut at the site. The protuberance of lower stones (*metae*) was also roughly carved into shape resulting in a form like a Mexican *sombrero*. There is no indication, however, that the eye of the lower stone was hollowed at this stage. In general, the process of fashioning produced a large quantity of flakes concentrated, for the most part, in the extraction pits, but also over the whole of the top of the hill.

Product and quantification: The production consisted exclusively of rotary querns measuring between 35 and 42 cm in diameter. There are hundreds of fragments both on the top of the hill and on the southern slope overlooking the coastal town of San José. There are also many querns, plundered from the site, that now decorate the houses of the nearby town of Presillas Bajas, as well as other country houses in the area.

Considering the high number of discards, the original production could have attained the thousands. Based on the size and the fittings, production of these querns appears to be standardised. There is no evidence of any other type of mill (for example ring-mill) other than that of the small hand-operated rotary quern.

Transport and distribution: A high concentration of roughouts on the south-eastern slope, to the south of a sharp ravine, suggest that the stones were hauled down this smooth slope toward the Mediterranean coastline (4 km away). The small bays on the coast where boats could have docked would have facilitated maritime transport. The extension of the distribution of this product, a project that must be pursued, is still not determined. In any case, the great number on the site suggests a wide distribution. The quern makers could have easily benefited from well-established ancient trade routes over land and water.

Dating: The production dates, according to the typological features (radial handle fittings and protuberance around the eye of the lower stone), to Roman times. Many identical querns recovered in Roman contexts are known in museum depositories throughout the south of Spain.

Rock type: The rock is a reddish-brown, hard and slightly porous biotite dacite (Geological Map 1060, Poza de los Frailes, 1978). Samples from this site have been the subject of geochemical analyses (Anderson *et al.* 2011).



Talus containing abandoned querns along the south-west slope. The Mediterranean Sea is in the background.



Columnar jointing on the southern slope.



View of a large shallow pit interpreted as a pit quarry. The pit is filled with working debris.



Examples of abandoned rotary querns on the plateau of the Cerro de Limones.



Abandoned rotary querns. Upper stone eyes are pierced. Lower stones bear a central protuberance. This group was probably gathered to be plundered.



Detail of a concentration of working debris interpreted as a workshop.



Examples of discarded rotary quern fragments.



An example of a cylindrical blank destined to be an upper stone.



The piercing of the eye of the upper stone took place from both surfaces.



Example of a broken upper stone. This quern is located on the south-eastern slope of the mountain.



Example of a broken upper stone with an abandoned radial handle slot cutting.



View of an abandoned lower stone (meta) with its central protuberance.



Detail of an abandoned lower stone (meta).



View of a house in the town of Presillas Bajas. Its outer wall is decorated with rotary querns plundered from the Cerro de Limones quarry.



Extract from geological map 1060 (IGME). Biotite dacites (light green).

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Acknowledgements

I thank Loic MARTÍNEZ for indicating the location of the site and Gurli MEYER, Tor GRENNE and Tom HELDAL of the Geological Survey of Norway (NGU) for accompanying me during the first visit and for the petrographical analyses undertaken at the NGU. I also thank Juan Manuel FERNÁNDEZ SOLER of the Department of Geology of the University of Granada for his analyses and contributions.

AL-2 Níjar

La Hoya del Paraíso

Latitude: 36° 49' 23.31" N

Longitude: 2° 4' 0.60" W

Altitude: c. 90-120 m



View from the west of the valley floor with the parallel lines of retaining walls. The Mediterranean Sea is in the background.

Location and sources: The Roman rotary quern quarry of Hoya del Paraíso, like the Cerro de Limones (AL-1) four kilometres to the south-west, is in the South-Eastern Spanish Volcanic district. It is between the caldera of the Majada Redonda, one of the more visible volcanic craters of the Cabo de Gata, and the Isleta del Moro, a small fishing town on the Mediterranean (Anderson *et al.* 2014). The site was pointed out to me by Antonio Hernández.

The quarry: This site is not centralised in a single sector, but spread over a vast surface comprising both the valley floor and slope of the hill to the east leading to the Majada Redonda caldera. In this sense, it differs from the nearby Cerro de Limones quarry, that is concentrated on the top of the mountain.

The most visible sector is on the valley floor. Quern production is evidenced by a large number of unfinished or broken querns strewn about the surface. Many have been recycled in a series of parallel ill-constructed linear features, retaining walls for agricultural fields.



Example of an abandoned rotary quern roughout in the Hoya del Paraíso quarry.

From the large number of abandoned querns still in the field, in addition to the better preserved pieces that were moved to a nearby townhouse, I deduce that the bottom of the valley was once the location of a large workshop where blocks were gathered and fashioned into querns.

In contrast to the Cerro de Limones, there is no evidence of extraction in pits in the area. The querns appear to have simply been collected on the surface among the talus or possibly from columnar jointing further up the hill to the east of the valley. The valley, however, is very large and has not been systematically explored. Further systematic fieldwork will certainly provide more information about extraction techniques and the organisation of the quarry.

Product and quantification: The type of quern produced at this site is identical to that of the Cerro de Limones, *i.e.*, upper stones with pierced eyes and *sombrero* lower stones with the protruding knob on the top around the future eye of the spindle. As in the case of Cerro de Limones, there is no evidence of

production of any other type of millstone at this site. In terms of quantity, although production must have been in the hundreds, possibly more, it appears to be more modest than that of the Cerro de Limones.

Transport and distribution: The proximity of the Mediterranean Sea, less than two kilometres away, would certainly have facilitated the distribution of these products up and down the coastline. Like the Cerro de Limones, production would have benefited from the long-standing network of Antique trade routes.



View from the east of the Hoya del Paraíso. Abandoned querns are found on the slope.



Example of a broken upper stone quern placed in a retaining wall on the valley floor.



Detail of abandoned querns on the valley floor.

Dating: Based on the observation of identical querns from Roman contexts in museum depositories, the production is Roman.

Rock type: Dacite-rhyolite (Geological Map 1060, Poza de los Frailes, 1978). Reddish-violet surface, but interior is light grey. Not highly vesicular. On the surface, the appearance is identical to the production of Cerro de Limones (AL-1).



Columnar jointing on the hill adjacent to the Majada Redonda caldera.



Detail of a retaining wall on the valley floor containing abandoned quern fragments.



Detail of abandoned querns on the valley floor.



Detail of an abandoned cylindrical blank on the valley floor.



Detail of a broken cylindrical blank on the valley floor.



Detail of a broken upper stone (catillus).



Detail of an abandoned sombrero type lower stone (meta) on the slope of the hill.



Extract from geological map 1060 (IGME). The Majada Redonda volcanic caldera is to the west of the site. The querns are found in the dacite-rhyolite unit (brown, 4) and in the biotite dacite - red violet amphibolite unit (light green, 15).

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Acknowledgements

I thank Antonio Hernández for indicating the location of this site.

AL-3a Albox

Cantera de la Rambla Honda

Latitude: 37° 24' 18.99" N

Longitude: 2° 7' 18.19" W

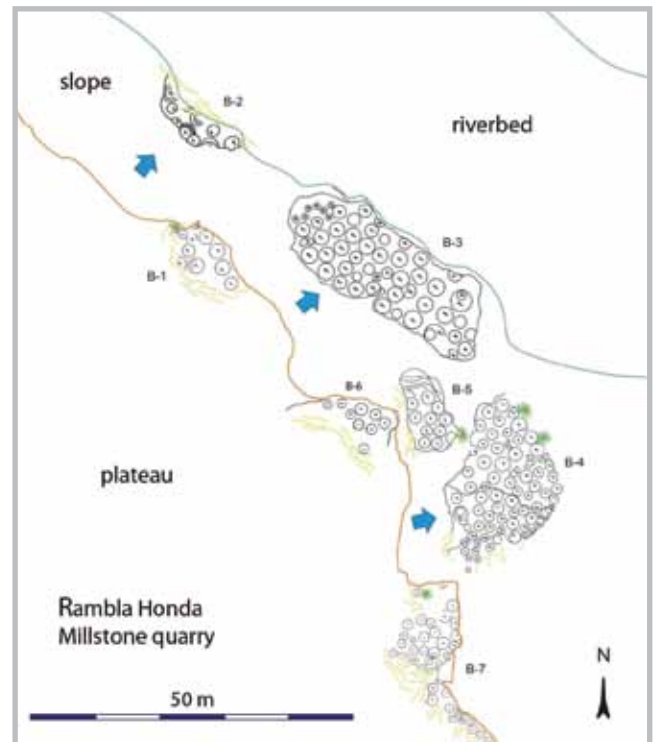
Altitude: 460 m



View from the north-east of the central area of Sector 1 of the millstone quarry (photograph by Francisco Martínez).



View from the east of a part of Sector 1. The arrows facing down indicate blocks on the plateau in their original position. The arrows facing up indicate displaced blocks.



Sketch of Sector 1 of the Rambla Honda quarry (from Martínez et al. 2011). The arrows indicate the blocks that have been displaced from their original position.

publication. Since the original publication, the site has been re-examined and published a second time (Martínez et al. 2011).

Location: The quern and millstone quarry of the Rambla Honda (meaning deep, dry riverbed) is in the heart of the wide and flat Almanzora Valley about two kilometres north-east of the city of Albox. It is along a dry riverbed that winds through the region.

Sources: An article about this site appeared in the transactions of a molinological conference (Martínez & Granero 2005). This is the first millstone quarry in southern Spain to be the subject of a specific

The quarry: The exploitation has two main sectors. Sector 1, to the south (100 x 30 m), by far the largest, is a true extractive surface quarry spread over seven large blocks. The contiguous extraction hollows follow horizontal planes on one, rarely two, levels. Several of the blocks have been detached from a main stratum of bedrock along the upper plateau by the action of torrents that periodically rush through the riverbed. They have either slid to their current resting place on the slope or to the edge of the riverbed. The latest flash flood, a veritable disaster in the area, dates to 1970.

The second sector is found about 100 m to the north on the opposite side of the riverbed. It comprises only a few “isolated” extractions.

Techniques: Tool marks are rarely visible so it is not possible to establish the extraction techniques with precision. I suppose the trenches around the cylinders were cut with a pick. Wedge holes, in a few instances, are visible at the base of a cylinder. I do not know, however, if the wedges were of iron or wood.

Products and quantification: The site produced a variety of cylinders of different size, from small rotary querns 40 cm in diameter to large cylinders up to 1.40 m in diameter. Of the approximately 150 extractions sufficiently clearly marked and measurable, four groups of cylinder sizes stand out (A: 40 cm; B: 90 cm; C: 1.10-1.20 m; D: 1.30 m). The most common diameter by far, with about 30 examples, is 1.10 m. This corresponds to millstones destined to either animal-driven mills, windmills or watermills.

Transport and distribution: The Almazora Valley does not present major natural obstacles for distribution. The large number of extractions suggest more than a local production.

Dating: The precise date of the quarry is not certain. Although the differences of diameter suggest different phases of work, this cannot be proved. On the large displaced block (B-3), now in the riverbed, extraction hollows are on two different extraction planes suggesting two phases of work. The marks on what is now the diagonal face, and partially covered by alluvial deposits, probably date to when the block was in its original horizontal position on the plateau. The horizontal extractions on the summit of the block, on the other hand, probably took place in a later phase, after the block was displaced.

The small concentration of rotary quern extractions on the north-western edge of Block 3 could be interpreted as the initial phase of work, probably Medieval since conglomerate is not known to have been worked in Roman times. This dating would seem to be corroborated by handmill extractions elsewhere at the site, interspersed with the larger hollows, as if they were extracted at the same time. The medium-sized extractions (80-90 cm) also point to a Medieval date. The largest extractions, well over a metre in diameter, could also be Medieval or later (Modern or Contemporary).

Rock type: Conglomerate with large rounded clasts (Geological map 996, Huercal-Overa, 1978).



Detail of the north-western end of Block 3 where both small rotary querns and millstones were extracted.



Panoramic view of the detached block (Block 3) partially buried in the alluvial deposits in the riverbed. The smaller handmill extractions are concentrated on its north-western end, to the right (photograph by Francisco Martínez).



View of Block 2, displaced by a torrent into the riverbed.



View of Block 2 with wedge holes along the base of several extraction hollows.



Detail of a wedge hole.



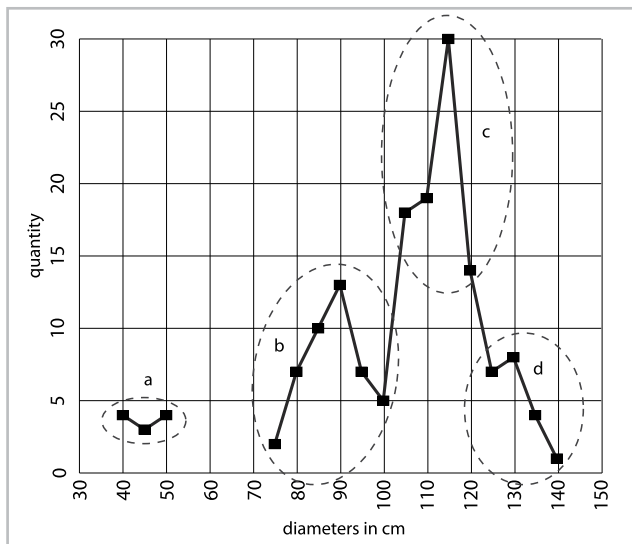
Extraction hollows following two different extraction planes (horizontal on summit, diagonal on inclined face) suggesting two chronological phases of work.



View from the south of Sector 2 of the quarry.



Detail of the extraction hollow of Sector 2.



Line graph of the number of millstone extractions according to their diameter measured in cm (from Martínez et al. 2011).



Detail of the rock revealing the form of the clasts.



Extract from geological map 996 (IGME). The quarry exploited a conglomerate unit (beige - QG2). Red stripes represent a glacial pavement.

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AL-3b Albox

Los Leonardos

Latitude: 37° 24' 33.07" N

Longitude: 2° 7' 30.32" W

Altitude: 485 m



View from the north of a sector of the quarry of Los Leonardos. To the left can be seen an unfinished trench for a block.

Location: The Leonardos quarry is about 200 m north of the Rambla Honda by a bend in the ravine. Most of the workings in this area correspond to building blocks. The date, according to oral tradition, to the middle of the 20th century (Francisco Martínez, pers. comm.). There is also a modest millstone production.

The quarry: The site appears to be a surface quarry limited to several small bedrock outcrops.

Products and quantification: There are six cylinders or extraction hollows corresponding to millstones measuring 70 and 130 cm destined for animal-driven mills, windmills or watermills.

Transport and distribution: This production is probably contemporary to that of the nearby Rambla Honda and would have benefited from its network of distribution.

Dating: The medium-sized models (70 cm) are probably Medieval while the large models are Contemporary.

Rock type: Conglomerate with large rounded clasts (see AL-3a).



View of a block with several large extraction hollows corresponding to millstones about 1.30 m in diameter.



Detail of an unfinished millstone measuring 1.30 m in diameter.



Detail of an abandoned millstone measuring 1.30 m in diameter.



Detail of an abandoned cylinder measuring 70 cm in diameter.



Extract from geological map 996 (IGME). The quarry exploited a conglomerate unit (beige - QG2). The red stripes represent a glacial pavement.

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AL-4 El Ejido

Guardias Viejas

Latitude: 36° 41' 59.82" N

Longitude: 2° 51' 5.88" W

Altitude: 20 m



View from the north of the conglomerate outcrop. The millstone extractions are clustered toward the end of the outcrop. In the background is the Mediterranean Sea.

Location and Source:: The site of Guardias Viejas is located on the coastline of the Bahía del Castillo near a fortification dating to the 18th century. The site is identified in a molinological study (Cara Barrionuevo *et al.* 1999: 154).

The quarry, products and quantification: The site is small with about a dozen extractions measuring between 1.25 and 1.40 m hewn directly from the bedrock. It is halfway between a pocket quarry and an edge quarry. The horizontal hollows are on tiers and in only one case are superimposed. In spite of its eroded surface, it is possible to observe parallel diagonal lines on the quarry faces indicating that trenching was carried out with picks.

Transport and distribution: The millstones could have travelled either by land or by sea. The site presumably only served a local demand.

Dating: Medieval to Contemporary.

Rock type: Conglomerate (Geological map 1057, Adra and 1058 Roquetas del Mar). The workers concentrated work in a sector of the outcrop with round small, regular pebbles (up to 2 cm), mostly fine-grained quartzites in a matrix of sand and calcite (petrographical description by Tor Grenne of the Norwegian Geological Survey).



Orthophoto of the site (SIGPAC). The quarry is at a conglomerate outcrop between the fortification and the coast.



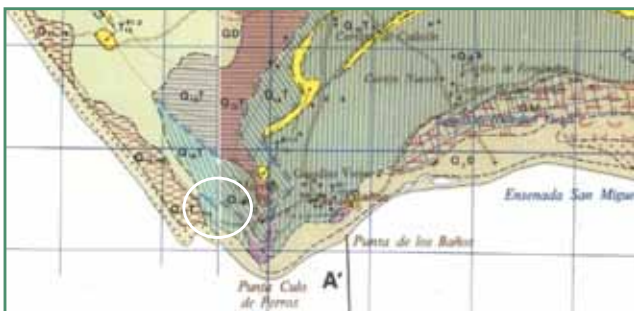
View of the quarry from the south-west.



View of the quarry from the north.



Detail of an unfinished cylinder.



Montage of extracts from the geological maps 1057-1058 (IGME). The quarry exploited a unit of conglomerate (light green).



Detail of the quality of the rock.

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Acknowledgements

I thank Tor GRENNE of the Norwegian Geological Survey (NGU) for accompanying me to the site and defining the rock.

AL-5 Alcolea*Barranco Baena-Barranco Pedreros*

View from the west of the Baranco Baena from the road AL-6400 (from Google Maps Street View).

Sources: Millstone production at the Barranco Baena is cited in two different millstones studies (Rodríguez Monteoliva 1989: 705; Cara Barrionuevo *et al.* 1999: 153).

Location and toponymy: The Barranco Baena is a steep and rugged ravine running westward into the Adra River Valley just to the north of the Benímar Dam. There is a discrepancy as to the quarry's location. In the geographical map (SIGPAC), the Barranco Baena is to the east of the road linking Darrical and the coast. The ravine in the cadastral map (SEC), in turn, is about 400 m to the south. Furthermore, in this second map the site corresponds to the *Barranco de los Pedreros* (ravine of the quarry men) and ends at the place name *El Pedregal* (terrain of loose stones). All of these names are perfectly compatible with millstone production.

Products and quantification: Millstones for watermills. The quantity is unknown. Rodríguez Monteoliva (1989: 705) indicates that these millstones were "*bazas*" (i.e. lower stones) and that they were coupled with upper stones from Moclín (see GR-1).

The quarry: The ravine is full of loose surface boulders. Since I have not surveyed the quarry, I do not know if the quarrymen extracted the millstones directly from bedrock or if they simply fashioned surface boulders.

Transport and distribution: The quarry was connected to the hamlet of Darrical by means of a narrow path or lane (Cara Barrionuevo *et al.* 1999: 153). Rodríguez Monteoliva (1989: 705) mentions the technique of "rolling" the millstone with an axle in the middle of the eye from the site to the

nearby towns. According to Cara Barrionuevo and his team (1999: 153), this quarry equipped the watermills of the towns of the central Alpujarra Mountains.

Dating: Medieval to Contemporary.

Rock type: The rock is a conglomerate made up of metamorphic and quartz clasts in a calcite matrix that also includes fossils (Cara Barrionuevo *et al.* 1999: 153). The geological map indicates conglomerates, limestones and sandstones in the ravine (Geological map 1043, Berja, 1977).



Cadastral maps (SEC) of the Barranco Baena. The map to the right is the detail of the rectangle highlighted on the first map. The place name Barranco Baena in this map differs by several hundred metres (to the south on the left map) from that of the geographical map (SIGPAC). In the cadastral map, the ravine is called Barranco de los Pedreros (Ravine of the quarry men) and El Pedregal (an area of surface stones), names consistent with millstone production.



Extract from geological map 1043 (IGME). The pink unit is marble limestone and dolomites. The rock exploited for millstones, according to Cara Barrionuevo (1999), corresponds to the orange spotted unit of conglomerates.

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AL-6 Bayárcal

Barranco de Palancón



Location and source: The millstone quarry of the Barranco de Palancón (Ravine of Palancón) is in the heart of the Sierra Nevada Mountain National Park near the mountain pass of Puerto de la Ragua. Cara Barrionuevo and his team state that the quarry is found above the watermills of the town of Bayárcal (Cara Barrionuevo *et al.* 1999: 153).

Toponymy: To the east of the ravine is an area with the place name *Dehesa Molla*. Dehesa is indicative of a meadow and *Molla* could be a variation of *mola*, from the Latin “mill”.

Dating: Medieval to Contemporary.

Rock type: The Palancón ravine is dominated by mica schists (Geological map 1028, Aldeire, 1978). It is not known if the quarry exploited schist or another facies of rock (conglomerate, for example) that is not indicated on the map.



Extract from geological map 1028 (IGME). The violet unit corresponds to schists.

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AL-7 Sorbas

Los Loberos

View from the south of the Los Loberos hamlet.

Location: Los Loberos is a hamlet on a steep slope on the southern fringe of the Sierra de Cabrera Mountains in the north of the Almería Province. It is 12 kilometres south-east of Sorbas, famous for its karstic caves. The exact location of the quarry is not known.

Source: The only mention of the quarry is a passing reference in a study of the watermills of the Níjar region (Torres Montes 1993: 272).

Toponymy: There are several places in the mountains in the surrounding area to the north-west of Los Loberos associated with the name *Molata*, possibly a variation of *moleta*, meaning a stone either for

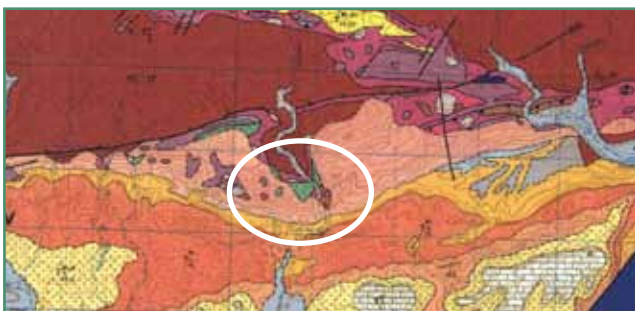


Orthophoto of the hamlet of Los Loberos (SIGPAC).

grinding pigments or for pharmaceutical use. These names, however, cannot be related with any degree of certainty to millstone workings.

Dating: The source provides no information about the date of the workings.

Rock type: The rock type is not recorded. The quarry is in fact somewhere along the border of the Alpujárride and Nevado-Filábride geological complexes in a sector dominated by schists and micaschists. It is more likely, however, that the quarry exploited a local sedimentary outcrop, possibly the green carbonate rock, since I have never seen Contemporary millstones of schist or mica schist in the south of Spain (although schist was a common source for millstones in Contemporary times in Central and Northern Europe, for example, in Norway).



Extract from geological map 1031 (IGME). The reddish units are varieties of schist. The green unit a carbonate rock.

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AL-8 Adra*Cerro el Chispas*

Latitude: 36° 45' 33.79"N

Longitude: 3° 0' 13.45"W

Altitude: 40-50 m



View of the western slope of Cerro el Chispas with an outcrop of a layer of conglomerate.

Location: The Cerro el Chispas quarry (or simply Cerro Cantera) is located to the north-east of the coastal city of Adra on the western slope of a foothill bordering the coastal plain.

Sources: Madoz, in his description of the productions of Adra, refers to a millstone quarry "half an hour to the east" of Adra (Madoz 1845, Vol. 1: 88). This allusion coincides roughly with the location of the Cerro el Chispas quarry.

The site is described by Cara Barrionuevo (1999: 153) as an open-air quarry with four unfinished millstones cut directly into the bedrock and separated by a trench measuring 14 cm wide.

The quarry: Unfortunately, during my visit, I was not able to identify the site described by Cara Barrionuevo. With the large amount of construction since the 1990s, these workings have possibly been destroyed. There are, however, two small extraction hollows along the edge of the conglomerate layer that could correspond to rotary quern hollows.



Elsewhere, along the western and southern slope, there are several craters surrounded by what appear to be spoil heaps. These could be vestiges of millstone pit workings.

Products, quantification and distribution: The 1999 research records that the four abandoned millstones measure between 1.00 and 1.20 m in diameter. Production is estimated at about 30 millstones, indicative of local demand.

Dating: Based on the diameter (1.00 and 1.20 m) and the 1845 reference by Madoz, the site dates from Contemporary times. The smaller 40 cm extraction hollows point to an earlier Medieval phase.

Rock type: Conglomerate with large rounded pebbles (Geological map 1057, Adra, 1983). Conglomerate from the Tertiary (Cara Barrionuevo *et al.* 1999: 153).



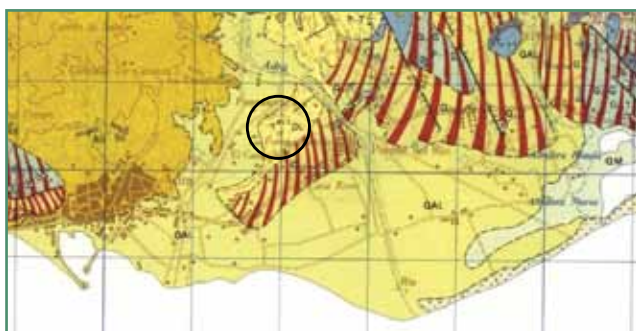
One of several large pits. The exposed rock shows signs of trenching. It is possible that millstones were extracted from this pit.



Detail of the cuttings of the outcrop at the base of the pit.



Two extraction hollows along the edge of the conglomerate layer corresponding presumably to rotary quern extractions.



Extract from geological map 1057 (IGME). The yellow unit corresponds to conglomerates, sands and silts.

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AL-9 Vera



Location: Vera is in the northernmost municipality of the Almería Province bordering the Community of Murcia. It is by the Mediterranean coast and covers a surface of almost 60 km². Although it contains a few modest elevations with potential outcrops, most of the municipality is formed by lowlands that are part of the flood plain of the Almanzora River.

Source: The only information of millstone production in this municipality is in a brief reference by Madoz (1850, Vol. 15: 670). The geographer simply states that one or more millstone quarries are located in Vera and that they produce *ruedas de molino* (millstones).

The quarry: I have not been able to identify these sites in the field. I suspect that they are either at one of the hills in the area or along a stratum of rock exposed along the edge of a riverbed, like the sites of Caniles (GR-11) and the Rambla Honda (AL-3). Furthermore, local molinologist (Domingo Ortiz Soler) is not aware of any millstone workings, so it is most likely that they are covered or have been destroyed. In any case, no evidence of quern or millstone workings was noted during a recent visit to the volcanic outcrops (notably Cerro Cabezo María) of the municipalities of Vera and Antas with Jane Scarrow, geologist of the University of Granada.

Product: The term *ruedas de molino* suggests products destined for flour mills and not *almazaras* (oil mills).

Dating: Middle of the 19th century.

Rock type: Judging from the Contemporary date, the quarrymen most likely exploited sedimentary rocks (conglomerates or sandstones) and not volcanic material, a rock type present in the municipality (Cambeses 2010).

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Acknowledgements

I thank Domingo ORTIZ SOLER for information about the situation of quarries in the Municipality of Vera.

AL-10 Níjar

El Barronal

Latitude: 36° 44' 9.97" N

Longitude: 2° 7' 18.30 W

Altitude: c. 30 m



View from the north of the Barronal point.

Location: The Barronal quarry is associated with Chalcolithic and Bronze Age settlements identified during a surface survey in the south-eastern point of the Cabo de Gata Natural Park. The site is on a volcanic mound that juts into the sea.

Source: The stone workings are identified in several archaeological articles about the exploitation of georesources in the Cabo de Gata in Late Prehistory (Carrión *et al.* 1993).



Extract from geological map 1060 (IGME). The quarries are found in brownish unit of rhyodacites.

Quarries: The workings are presumably small pit quarries exploiting the summit of volcanic columnar jointing.

Products and distribution: Saddle querns and other stone tools. Manuel Ramos, of the Archaeological Museum of Almería, has informed me that querns of volcanic rock (as well as garnet schists) are known at the Chalcolithic settlement of Los Millares about 50 km to the west of El Barronal. It is not possible, however, to affirm that the volcanic rocks come from this site.

Dating: Chalcolithic and possibly Bronze Age.

Rock type: Rhyodacite (Geological map 1060, El Pozo de los Frailes, 1983).

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Acknowledgements

I thank Manuel RAMOS of the Museo Arqueológico de Almería for pointing out this site to me.

AL-11 Níjar

Rodalquilar district



Location and generalities: A stack of nine whole or fragmented Roman rotary quern roughouts and blanks cemented together decorates a street in the town Rodalquilar in the heart of the Cabo de Gata volcanic district.

All of these unfinished or broken querns are identical to the querns produced at Cerro de Limones (AL-1) and Hoya del Paraíso (AL-2) just a few kilometres to the south. The sole exception is the uppermost cylindrical blank measuring 40 cm in diameter. Its colour, grey to black, differs from that of the reddish-brown productions. This suggests a third, still unknown, Roman quern production in the Cabo de Gata.

Dating: Roman

Rock type: Volcanic.



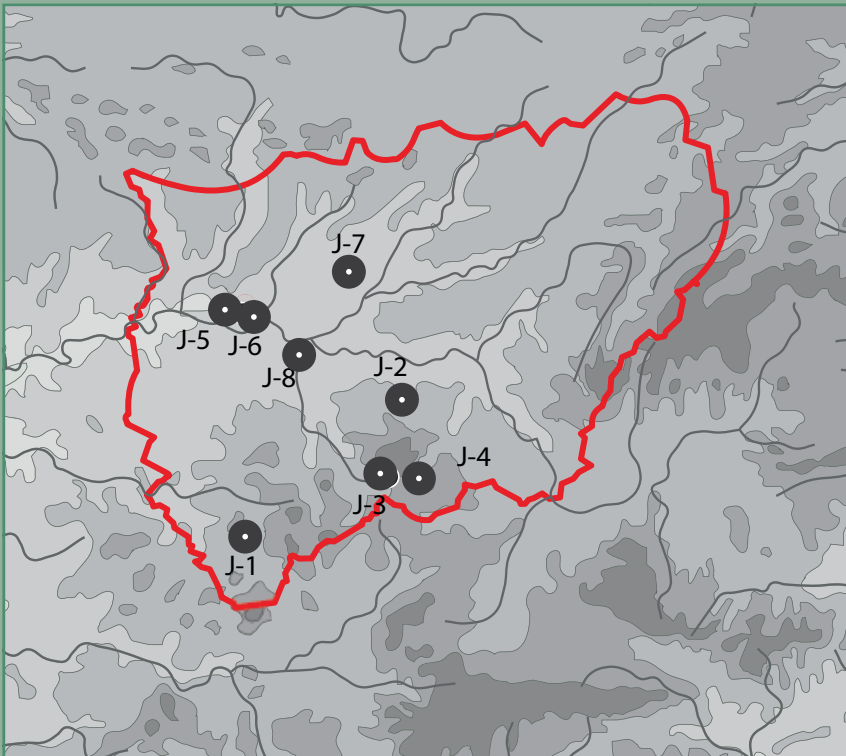
Detail of the upper most rotary quern blank that, due to its dark colour, suggests the presence of a third Roman quern quarry in the Cabo de Gata district.

Acknowledgements

I thank David PEACOCK of the University of Southampton, UK, for confirmation of this petrographical observation.

ANDALUSIA

JAÉN (J)



J-1 Castillo de Locubín

Las Canteras

Latitude: 37° 30' 29,90" N

Longitude: 3° 58' 8,71" W

Altitude: 900-910 m



View from the south-west of the millstone quarry of Castillo de Locubín.

Location: The Canteras quarry is in the south-western corner of the Municipality of Castillo de Locubín along a ravine, uphill from the main road linking the cities of Castillo de Locubín and Alcalá la Real.

Sources: There are several written references to this millstone quarry. The first dates to 1792 and simply indicates the manufacture of millstones of various sizes (*Encyclopedia Metódica* 1792: 461). The second is a brief note in the Miñano geographical dictionary (1826, Vol. 2: 477). Neither of these texts indicate the site's precise location. Twenty years later, it is identified at the base of the *Acamuña* (today *Camuña*) Mountain by Madoz (1845, Vol. 1: 382). Although the geographical information by Madoz is accurate, the site is not, as he states, in the Municipality of Alcalá

la Real, but in neighbouring Castillo de Locubín. The error is likely due to the proximity (500 m) of the border between the two municipalities. A fourth source, 20 years after Madoz, is a catalogue listing the products from Castillo de Locubín presented at the 1867 Universal Exposition of Paris (*Catálogo General de la Sección Española* 1867: 190).

Toponymy: The place name *Canteras* (quarries) is common for both construction and millstone quarries.

The quarry and techniques: The workings are along the north-western base of a cliff. This quarry is the only site, to my knowledge, that combines three different extraction techniques. A small sector corresponds to an edge quarry where millstones

were scored directly from the rock face. This technique is characterised by several vertical extraction hollows along the base of the cliff. A second sector shows millstones hewn from large, detached surface blocks in a talus along the base of the slope. A third technique is that of prying out angular blocks with levers from the cliff face. This sector is characterised by different colouration of the rock along its quarry face.

Products and quantification: The abandoned cylinders measure between 1.10 and 1.30 m in diameter. This is presumably the size of stones displayed at the 1867 Universal Exposition of Paris at the price of 70 *escudos* (Comisión Régia, *Catálogo* 1867: 190) correspond to this model.

It is noteworthy that there is a small rotary quern blank measuring 50 cm in diameter among the discarded millstones.

Transport and distribution: The position of the site along the thoroughfare connecting Castillo de Locubín and Alcalá la Real would have facilitated transport. The display of millstones from this quarry in the Universal Exposition of Paris of 1867 suggests the product was coveted and probably was marketed throughout the region or beyond.

Dating: The written sources place production from the end of the 18th century throughout the 19th century. The small rotary quern cannot be dated precisely. From its size (50 cm), it appears to be Medieval. It could, however, be the blank of a Contemporary animal fodder quern.

Rock type: The geological map indicates units of calcarenites, breccias, conglomerates (no. 28) and loams (no. 29) (Geological map 968, Alcaudete, 1988). From my observations, the rock is yellowish, coarse and homogeneous, probably a calcarenite.



View from the west of the quarry of the Castillo de Locubín. In the forefront is the talus where surface blocks were exploited and in the background is the cliff where millstones were taken by either true extraction (vertical hollows) and by prying out angular blocks with levers.



Views of vertical circular extractions along the base of the cliff.



View of the base of the cliff. In this sector, angular blocks were detached with levers from the rock face by profiting from natural fissures.



View from the west of the talus and working debris.



Views of abandoned millstones in different stages of manufacture.



Millstone propped upright during the final phase of fashioning. The original yellow colour of the rock is conserved because it is sheltered from weathering by an overhanging rock.



Lateral view of the millstone that was abandoned after fashioning one face.



Views of a small rotary quern blank measuring 50 cm in diameter.



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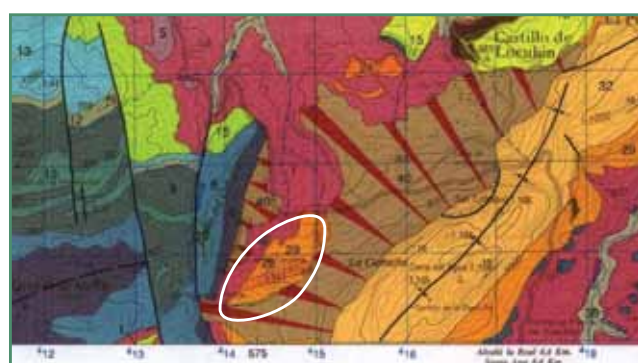
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Acknowledgements

I kindly recognise José MARQUEZ for leading me to the quarry site.



Extract from geological map 968 (IGME). The quarry exploited unit 28 (darker orange), a unit of calcarenite, breccia or conglomerate. The surrounding lighter orange unit (no. 29) corresponds to varieties of loam.

J-2 Jimena

El Lachar

Latitude: 37° 49' 19.98" N
 Longitude: 3° 29' 29.50" W
 Altitude: 950-980 m



View of site's location from the south-east.



Orthophoto of the two parallel quarry trenches (SIGPAC). Trench A is to the north; Trench B to the south.

Location and generalities: The millstone quarry of El Lachar (at times written Lanchar) is in the Natural Park of the Sierra Mágina, perched on the upper plateau of an elongated mountain above the town of Jimena. To the south-east of the plateau, along a steep ravine, are what the locals call the “*viejas canteras*” (old quarries), corresponding to the millstone exploitation. The site is not to be confused with a long modern (probably 20th century) trench quarry with vertical faces about 10 m high that crosses the plateau about one kilometre to the west, on the opposite side of the mountain.

Sources: This is one of the few quarry exploitations in southern Spain recorded in an official, state-sponsored hiking itinerary.

Toponymy: The name *Lachar* signifies a quarry where *lanchas* (large, naturally flat slabs) are extracted. The name is appropriate for this specific millstone production due to the technique of detaching angular blocks.

The quarry: The site comprises two separate parallel trenches several metres deep. The longer trench (A), to the north, measures about 300 m,

while the second (B) is about 50 m. Both exploited a specific homogeneous layer of massive limestone. Working debris was accumulated in cordons along each side of the trench.

Techniques: Blocks were split from the rock layer, probably with wedges, before being hewn into cylinders.

Products and quantification: The dozen unfinished or broken millstones strewn about the site measure between 1.00 and 1.30 m in diameter. Upper stones are cylindrical. Lower stones present a flat base and a slightly convex grinding surface.

Transport and distribution: In the western sector of the quarry several drystone walls are backfilled with debris. These features could have served both as pathways to descend into the trench and slipways to facilitate the removal of the cylinders. About 100 m from the quarry there is a path that curves around the southern and eastern edge of the mountain. This was probably used to descend the products to the town of Jimena. From the quantity of rock extracted, this quarry certainly provided stones to more than the local watermills.

Dating: From the sizes of the cylinders and the “whiteness” of the rock, the site appears to date to the Modern or Contemporary period.

Dwellings: Several “*caracolas*” can be seen in both the quarry and in the surrounding area. *Caracolas* (literally “snails”) are very small (2-4 m²) circular drystone wall hovels that are known as temporary dwellings for livestock herders (López & González 2005: 68). Several were built inside the trench with quarry debris. Judging from their position, I assume that they served as provisional shelters for the millstone makers.

Rock type: White limestone and calcarenite (Geological map 927, Baeza, 1987; Geological map 948, Torres, 1988). From my observations, the rock exploited is a white limestone.



View from the west of a sector of Trench A.



Views of the western sector of Trench B. This trench is shorter and shallower than Trench A.



Views of the deep eastern sector of Trench A.



Detail of the massive, homogeneous layer exploited for millstones (Trench A).



View of the rock layer exploited for millstones.



Different views of a detached, roughly rectangular block along the edge of Trench A. The block was first split (probably with wedges) before being fashioned with a pick (parallel tool marks) into a rough cylindrical shape.



Examples of abandoned millstones measuring between 1.00 and 1.30 m in diameter.



Detail of a slightly convex lower stone measuring about 1.15 m in diameter.



View of two cylindrical upper stones beside a hovel.



Detail of an upper stone beside the hovel.



Views of the western sector of Trench A.



Detail of a "caracol" (hovel) beside the quarry trench in the western sector.



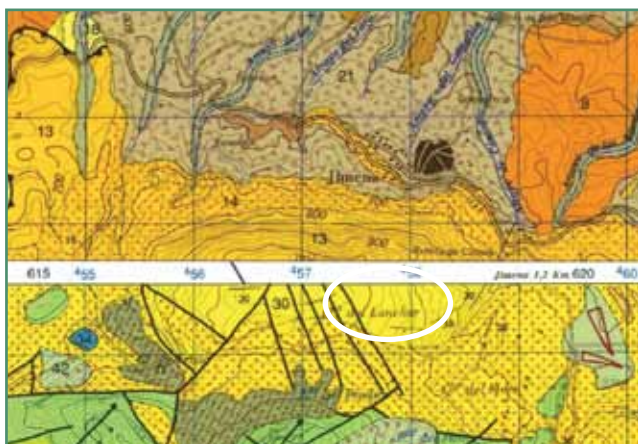
View of a retaining wall in the western sector of Trench A that served as access to the trench's lower level of the.



Explanatory panel at the Lachar millstone quarry.

Con la denominación de *chozos*, *caracoles*, *monos* o *cuevas* se designan en las poblaciones de la comarca de Sierra Mágina a las construcciones que forman un pequeño habitáculo de falsa bóveda, con muros y cobertura de piedra caliza sin labrar y sin ningún tipo de argamasa. Los hay de diferentes altura y planta, desde el que escasamente cabe un cuerpo a gachas para entrar, hasta los que presentan una puerta de entrada, que suelen ser más excepcionales. Se encuentran dispersos por el entorno rural de la sierra. **Estos refugios recuerdan un pasado ganadero, aunque más tarde hayan sido utilizados y contruidos también por canteros como habitáculo de los peones en el lugar de trabajo (canteras de piedra de Jimena o del Mercadillo en Pegalajar), y por agricultores cuando los cultivos se extendieron por la sierra.** Son en Sierra Mágina muy abundantes. Los materiales utilizados se encuentran alrededor de la obra y por la sencillez de su construcción, sin argamasas de unión, están plenamente integrados en el paisaje.

(from López Cordero 2005: 68)



Montage of extracts from the geological maps 927 and 949 (IGME). The quarry is located in a unit of white limestone and calcarenite (yellow).

Sources

Jimena, El Lachar, Hiking itinerary "Los Caracoles": <http://www.turjaen.com/dondeiryquever/senderismofamiliar/sierramagina/ruta-caracoles.php> [accessed November 9, 2012].

Hiking itinerary "Rutas por Sierra Mágina (Jaén)". El blog de Manuel: <http://www.rutasyfotos.com/2012/03/pinar-de-canava-los-caracoles.html> [accessed November 10, 2012].

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J-3 Huelma-Solera

Las Canteras

Latitude: 31° 39' 24.67" N
Longitude: 3° 24' 16.04" W
Altitude: c. 1155 m



View of the Las Canteras mountain from the north-west.

Location: Las Canteras is at the Cerro de la Cantera Mountain four kilometres to the east of Huelma, along the southern edge of the Sierra Mágina range. The site, unfortunately, is on private property and not possible to visit.

Source: The geographer Madoz records that both millstones and other (unspecified) products were manufactured at the place name *canteras* (Madoz 1947, Vol. 9: 260). Ángel del Moral Gómez in a recent blog places millstone workings 1.5 kilometres to the south-east of the Cerro de la Cantera on the adjacent El Viento mountain. This could be an extension of the same site.

Toponymy: The name *canteras* (quarries) on the geographical map is clearly indicative of stone work. In the cadastre, however, the place name



Extract from geological map 970 (IGME). The quarry is located in a unit of bioclastic sandstone (orange).



does not appear. In its place is *Campo Moral*, which, after inverting the consonants "r" and "l" is *molar*, a toponym at times associated with millstone workings. This may simply be a coincidence.

Dating: Middle of the 19th century.

Rock type: Bioclastic sandstone (Geological map 970, Huelma, 1988).



Unfinished millstone on the El Viento Mountain (photograph by Ángel del Moral Gómez, from <http://fotosangelbase.blogspot.com.es/2013/11/el-misterio-de-la-piedra-de-parrilla.html>).

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J-4 Cambil

Arbuniel - Los Batanes

Latitude: 37° 38' 4,26" N
Longitude: 3° 31' 38,43" W
Altitude: c. 830 m



Location: This small millstone exploitation, about one kilometre north-east of Arbuniel, is at the foot of the Cerro Vilches Mountain near an old fulling mill (*Molino de los Batanes*) on the Arroyo del Muerto stream. The site was, unfortunately, not accessible during my visit.

Source: The site is cited in a general study of the cultural heritage of the town of Arbuniel (López & Cabrera 2004: 209-210).

The quarry: The quarry comprises what appears to be a single unfinished millstone carved into a large block, probably detached from a crag located uphill.

Product and quantification: The single millstone measures approximately 1.50 m in diameter and 44 cm thick.

Transport and distribution: The millstone was probably destined for a nearby watermill.

Dating: Based on the size of the cylinder, the site could date anywhere from the Medieval to Contemporary times.

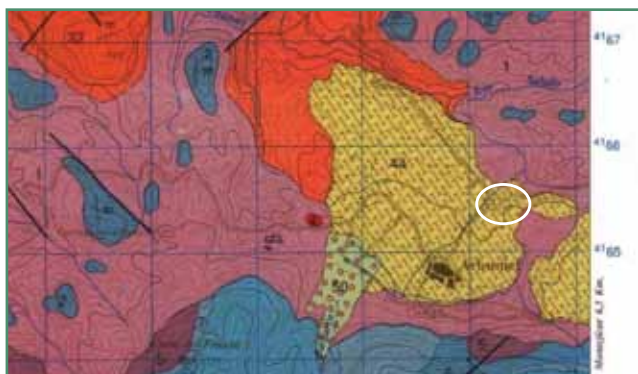
Rock type: Limestone tufa or travertine (Geological map 969, Valdepeñas de Jaén, 1988).



Photograph from http://www.pegalajar.org/articulos/0_patrimonio_arbunielx.htm.



Photograph by Francisco Merino (from <http://www.redjaen.es/francis/?m=c&o=105719>).



Extract from geological map 969 (IGME). The block is associated with a unit of limestone tufa or travertine.

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J-5 Andújar

Los Morales

Latitude: 38° 6' 24.50 N

Longitude: 4° 1' 17.43 W

Altitude: c. 669 m



Location: The only *Morales* place name in the Municipality of Andújar is the *Peñascal de Morales*, a mountain about six kilometres north of the city of Andújar.

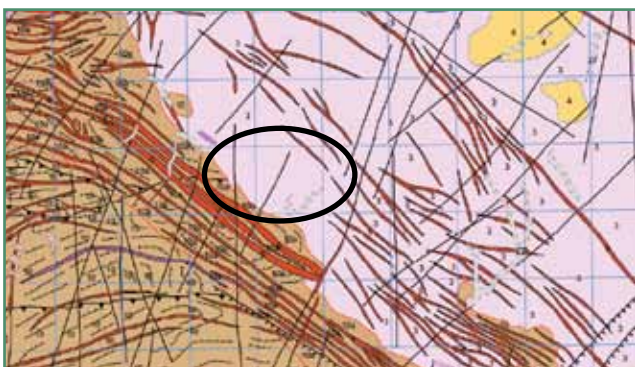
Source: Millstone exploitation is cited in passing by Madoz. He wrote that although there were “innumerable granite quarries” in the area for both “*molinos de pan y de aceite*” (flour and oil mills), the only quarries open at that moment he was writing were at *Morales* and *Pedroso* (see J-6) (Madoz 1845, Vol. 2: 305).

Toponymy: The place name *Morales* (mulberries) could derive from *Molares* (millstone quarry) after inversion of the consonants “r” and “l” (typical in spoken Andalusian). A few hundred metres to the

north-east is a *cortijo* with the name *Villa Molero* (*molero* meaning millstone maker). This toponym reinforces the idea of the presence of millstone workings in the surroundings.

Dating: The Madoz references places the site in the mid-nineteenth century.

Rock type: Porphyric biotite granite (Geological map 904, Andújar, 1992). The geological map concurs with the Madoz description.



Extract from geological map 904 (IGME). Peñascal mountain is on the southern border of a vast unit of porphyric biotite granite (light purple) beside a large unit of slates and greywackes (light brown).

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J-6 Andújar

El Pedroso

Latitude: 38° 5' 35.81" N
Longitude: 3° 57' 12.48" W
Altitude: c. 330-340 m



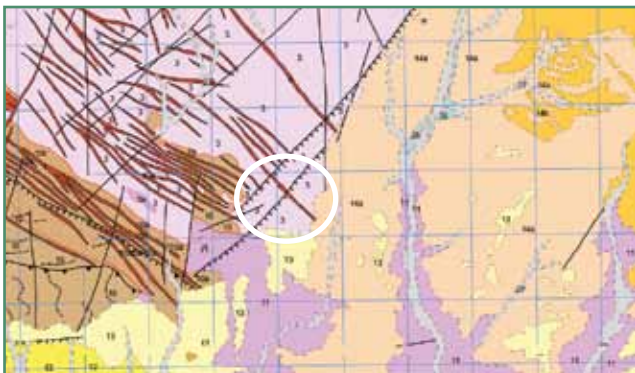
View from the south-east of the Pedroso area (extract from Google Maps Street View).

Location: El Pedroso is 10 kilometres north-east of the city of Andújar at the foot of the Cerro de los Zumacares. Besides the place name, there is no other evidence of millstone workings in this area.

Source, products and toponymy: Madoz states that although there are "innumerable" granite exploitations in the area for both "*molinos de pan y de aceite*" (flour and oil mills), the only exploitations working at the time were those of *Morales* (see J-5) and *Pedroso* (Madoz 1845, Vol. 2: 305). Although the name *Pedroso* is indicative of a rocky terrain, there is no other indication of millstone workings in the area.

Dating: The Madoz references place the workings in the mid 19th century.

Rock type: Porphyric biotite granite (Geological map 904, Andújar, 1992). The position of the Pedroso toponym on the geological map 904 (IGME) coincides with this rock and with the description of the rock by Madoz.

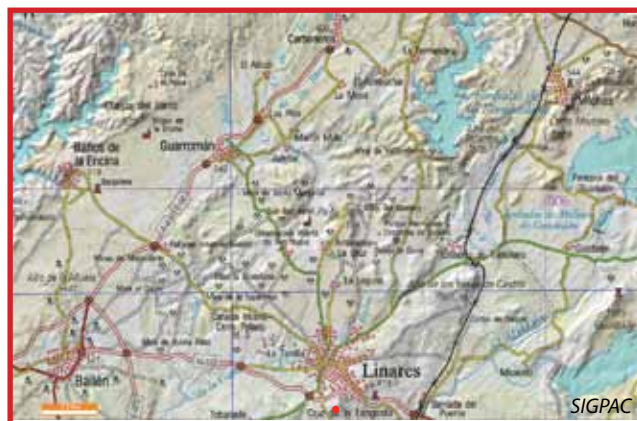


Extract from geological map 904 (IGME). The Pedroso toponym coincides with a unit of porphyric biotite granite, the presumed location of the quarry (light purple) and a unit of siliceous conglomerates and calcarenites (beige).

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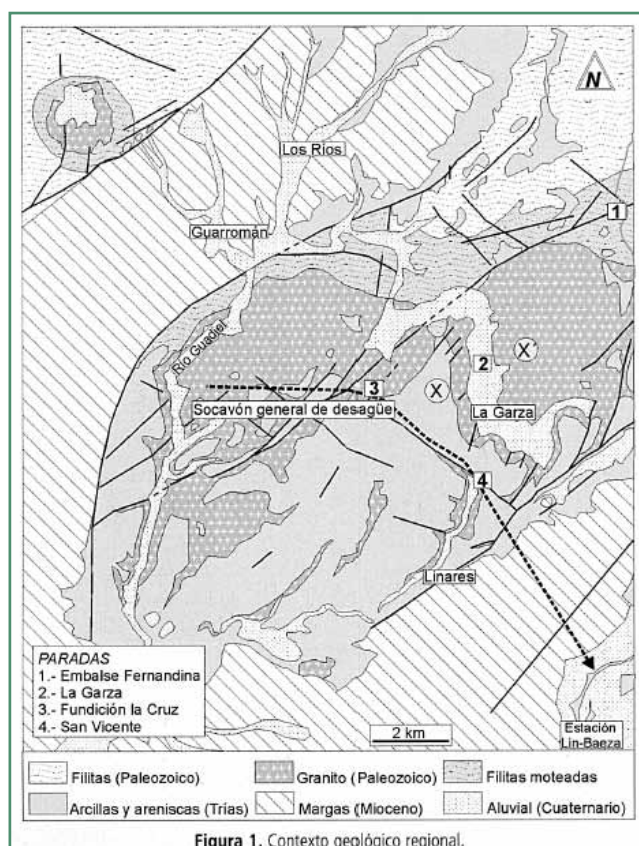
J-7 Linares district



Location and sources: Millstone and olive oil roller production in the granite districts near the city of Linares are mentioned in two 19th-century descriptions of the stone work in the Province of Jaén (Madoz 1847, Vol. 10: 290; Lozano Muñoz 1867: 17). There are, in fact, two large granite units to the north between Guarromán and Vilches. Granite surface blocks or bedrock could have been exploited in this large sector. None of these millstone workings, however, have been identified in the field.

Dating: The texts place millstone workings in the middle 19th century.

Rock type: Granite.



Map of the two vast granite units in the region north of Linares. Geological map, Jaén (Hidalgo Estévez et al. 2002: 310, fig. 1).

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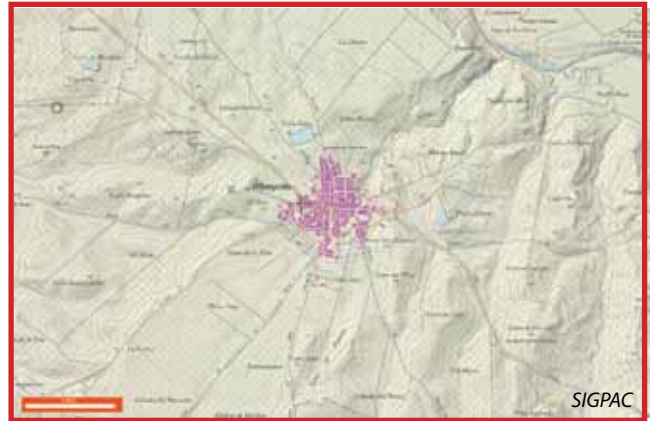
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J-8 Villatorres

Villargordo



Location: Villargordo is a municipality about 20 kilometres north of the city of Jaén. The exact location of its millstone quarry is not known.

Source, transport and distribution: This site is identified in a notarial protocol stored in the Archives of the Province of Jaén (1499.11.26, AHPJ, PNJa, 9, 415r) published by Córdoba de la Llave (2003: 306, footnote 26). The archive records that Pedro Martínez (either a stone cutter or a cart driver) must deliver eight days before Christmas a lower stone measuring 7 *palmas* in diameter (about 1.47 m) and 2 *palmas* in thickness (about 42 cm) to Diego Fernández de Ulloa for the Molino Nuevo (new mill) presumably in the city of Jaén. The archive specifies that the stone must be extracted from the *molar* (quarry) of Villargordo.



Extract from Geological map 926 (IGME). Conglomerate (unit 13, in yellow) appears to be the only rock suitable for millstone production in the vicinity of Villargordo.

Dating: Late Medieval to Early Modern.

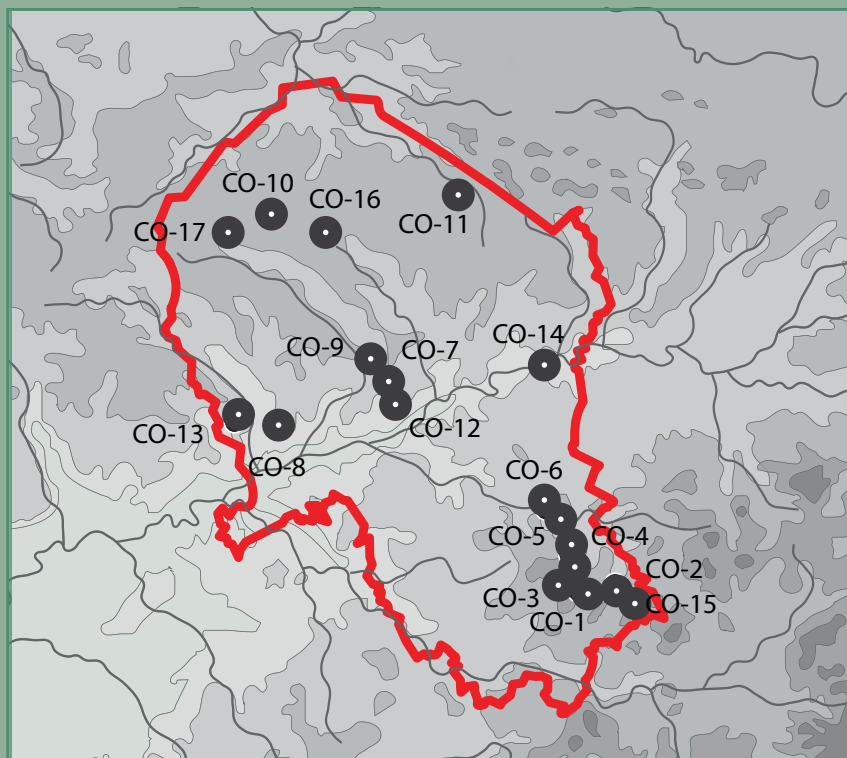
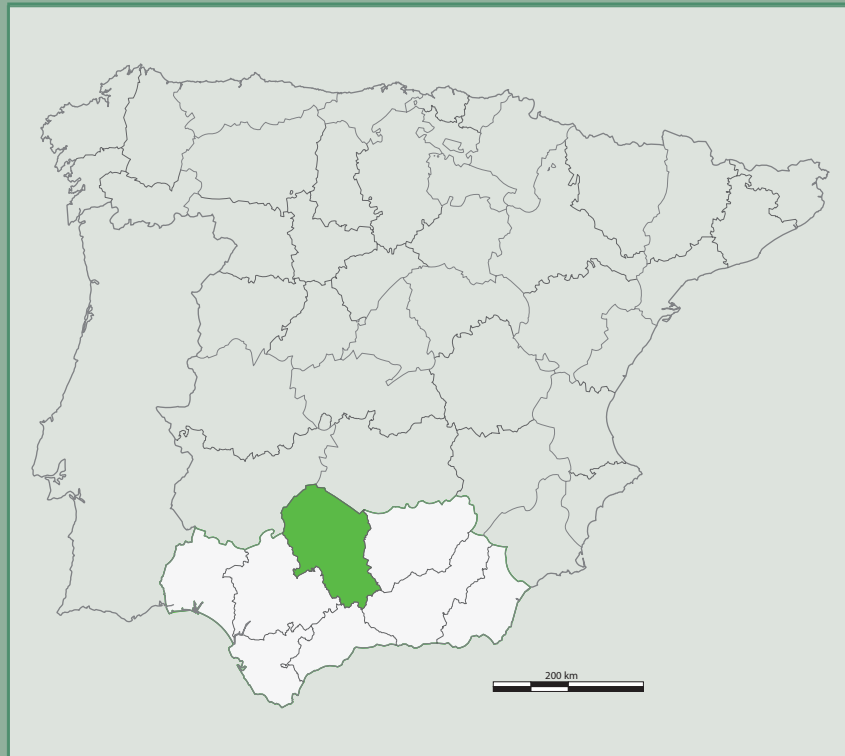
Rock type: Based on the geological map, the most likely source is a conglomerate (unit 13, yellow). The other surrounding units (clays, alluvial deposits) do not correspond to outcrops suitable for millstone production (Geological map 926, IGME, Mengibar, 1987).

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ANDALUSIA

CÓRDOBA (CO)



CO-1 Cabra

Cantera de los Frailes

Latitude: 37° 28' 3.10" N
Longitude: 4° 23' 30.33" W
Altitude: 685-700 m



View from the south of part of the millstone quarry of Cantera de los Frailes, Cabra. The vertical "baulk" is possibly a marker of the limit between concessions to different teams of millstone makers.

Location and generalities: The Cantera de los Frailes is one of the largest (15,000 m²) millstone exploitations in southern Spain and one of the most spectacular. It is located along the Frailes Stream in the National Park of the Subbetic Sierras, five kilometres east of the town of Cabra.

Sources: The geologist Ezquerro del Bayo refers to the site in two different publications in the middle of the 19th century. The first dates to 1847 and records an important millstone production "a league east of Cabra" (Montero 2008: 168), a distance that coincides perfectly with the site. 10 years later the geologist



Extract from the cadastre (SEC) with the place name Cantera de los Frailes (quarry of the Friars).

refers to “a vast and long established millstone exploitation that supplies millstones throughout the region” (Ezquerro del Bayo 1856: 384-385). The main source of information about this site, however, is a recent article about watermills in the city of Córdoba (Montero 2008), published in the proceedings of a molinological colloquium. It is astonishing that there is no mention of this site in the geographical dictionary of Madoz.

Toponymy: The name *Los Frailes* (the Friars) relates to the farmhouse uphill from the site and is possibly related to the Hermitage of Our Lady of the Sierra at the peak of the mountain. It is not clear if the name is indicative of ownership of the quarry by members of the clergy.

The quarry: The site is a classic example of a bench quarry cutting into the side of a hill. The cylinders were hewn directly from bedrock (true extraction) resulting in many vertical tubular hollows with well-preserved tool marks.

A unique feature of this site is the series of square “compartments” of multiple extractions clearly seen in the aerial views. These compartments could be indicative of the boundaries of different concessions.

There is also a high towering vertical “baulk” in the middle of the extraction area. This curious type of feature is known in other quarries (especially construction quarries), for example at *Sisapo* (CR-1) or at the celebrated site of El Mèdol in Tarragona. This feature has been interpreted as a limit between concessions, a sort of “display case” for potential customers to observe the strata of the rock, and a point from which to measure the volume of extraction.

Techniques: The quarry faces are covered with multiples diagonal lines resulting from cutting circular trenches with picks. Quarry floors are covered with debris or vegetation, hence splitting techniques cannot be determined.

Product and quantification: The site shows hundreds of extractions. Although some are large (1.40 m diameter), most are about 1.00 m in diameter. Contrary to the nearby site of the Cortaores (CO-2), which also served to extract blocks, only millstones were produced here.

Transport and distribution: The site is divided into two parts by an old road. Along the road is a group of millstones “waiting” to be loaded for transport. It



View of a group of abandoned millstones at the “entrance” of the quarry.

is, however, not certain if this is an original staging area or loading zone.

Ezquerro del Bayo (1856: 385) comments that the Cabra millstones were commercialised throughout the region and even reached the city of Málaga, 85 kilometres to the south (as the crow flies). In any case, petrographical research indicates that Cabra stones reached the watermills of Córdoba, 60 kilometres to the north-west (Montero 2008).

Dating: In spite of evidence of Roman extraction of construction material in the region, in particular at Los Cortaños (Padilla 1999: 276) (see CO-2), there is no evidence of Roman quern or millstone workings. The work of the geologist Ezquerro del Bayo places the production in the middle of the 19th century. It is reasonable to assume that production was even

older, at least from the beginning of the 19th century, based on Ezquerro's statement that Los Ffraisles was already a long-established millstone quarry.

The passing reference to a "*Cabreña*" (meaning "from Cabra") millstone at the watermill in Aguilar de la Frontera (25 km away) in a 1904 notarial protocol (Córdoba de la Llave & Varela 2011: 335) places production as late as the early 20th century. This could coincide with several larger millstone models about 1.40 m in diameter abandoned at the site.

Rock type: In early 19th-century literature the rock is defined respectively as a sandstone, breccia and limestone. It is in fact a pinkish nodular limestone with sporadic ammonite fossils (*Rosso Ammonitico* facies) (Geological map 989, Lucena, 1988).



View of a quarry face in the north-western sector with high, tubular extraction hollows bearing multiple diagonal pick marks.



View from the north-east of the southwestern area of the quarry with the "balk" and the road that leads to Cabra.



Detail of the southwestern area of the quarry and the road.



View of the north-western quarry face and the "balk" (to the right).



Detail of the north-western quarry face.



Views of the south-eastern sector of the quarry.



Views of the compartments along the eastern edge of the quarry that could correspond to concessions.



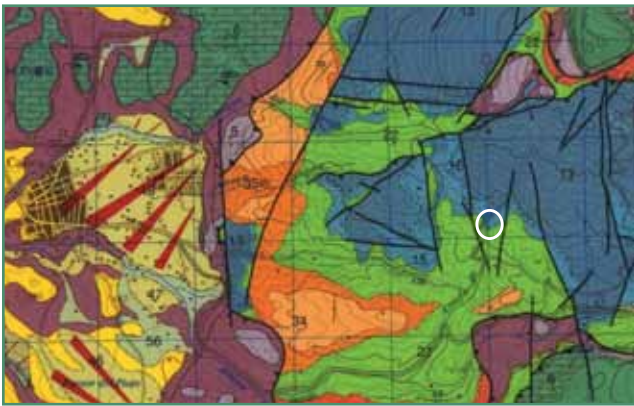
View of a group of abandoned millstones along the eastern quarry face. This group, along the road, may have been ready to be hoisted on carts for transport.



Views of abandoned millstones. Most of the abandoned cylinders measure about 1 m in diameter. The few are larger (1.40 m) examples could correspond to a later phase of production.



Orthophotos of the Frailes quarry (SIGPAC). a) A modern gravel (?) exploitation is seen on the upper right side of the general view; b) Detail showing the quarry boundaries and compartments (concessions?) and the roads.



Extract from geological map 989 (IGME). The blue with dots represents a characteristic pink limestone with ammonites.

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Acknowledgements

I thank Rafael CARMONA, director of the Municipal Museo de Priego de Córdoba, for leading me to this site.

CO-2 Cabra

Los Cortaores

Latitude: 37° 27' 48.95" N
Longitude: 4° 22' 38.03" W
Altitude: 720 m



General view of the quarry from the south-west.



Orthophoto of the northern sector of the site (SIGPAC).

Location and generalities: *Los Cortaores* ("the cutters") is about one kilometre to the east of the *Cantera de los Frailes* (see CO-1). It is found on both sides of the main road linking Cabra to Carcabuey. On the cadastre (SEC) the zone is called *Lanchar*, a place name indicating where "*lanchas*" (slabs) are extracted. A very large modern rock exploitation is about one kilometre north-east of the old quarry site.

Sources: The site is mentioned in articles by Padilla (1999) and Montero (2008).

The quarry: The workings correspond to an extended, shallow surface quarry where products were scored with picks directly from bedrock.

Products and quantification: Millstone production is modest at the site. There are a few extraction hollows and abandoned cylinders measuring about 1.00 m in diameter. The volume of millstone

workings here is far from the production of the nearby *Cantera de los Frailes* (CO-1). In Roman times, blocks were extracted for sculpture, architecture and for epigraphic inscriptions (Padilla 1999: 276). An example bearing an inscription is exposed in the Municipal Museum of Priego de Córdoba.

Transport and distribution: This site benefited from the adjacent road.

Dating: The millstone production could date from Medieval to Contemporary times. Block extraction is Roman.

Rock type: Pinkish nodular limestone (*Rosso Ammonitico* facies) (Geological map 989, Lucena, 1988) (see CO-1).



View of one of the quarry areas in the northern sector. The abandoned square block on the left is Roman.



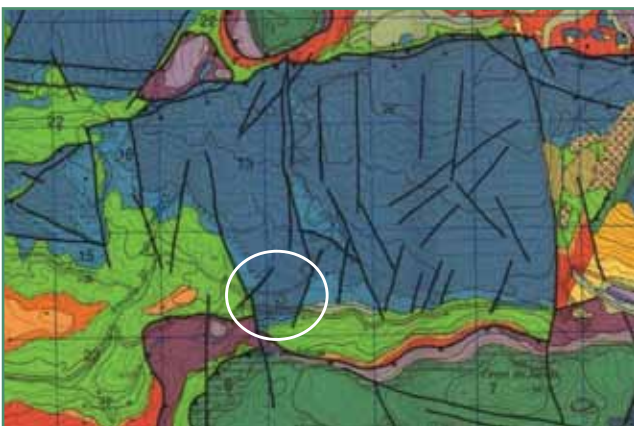
Detail of an abandoned roughout in the northern sector of the quarry.



Detail of a low cylindrical millstone extraction in the southern sector (to the south of the road).



Detail of an abandoned high, slightly trunco-conical, cylinder extraction in the southern sector. This piece was probably destined as a roller, probably for the oil industry.



Extract from geological map 989 (IGME). The blue with dots represents a pink limestone unit with ammonites.

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PADILLA MONJE, Aurelio. Consideraciones en Torno a la Explotación del Mármol en la Bética Durante los Siglos I-II. *Habis*, 30. 1999, p. 271-281.

Acknowledgements

I thank Rafael CARMONA, director of the Municipal Museo of Priego de Córdoba, for guiding me to the site.

CO-3 Carcabuey

Cudillas

Latitude: 37° 28' 47.98"N

Longitude: 4° 18' 0.84"W

Altitude: 620 m



General view of the quarry from the south.

Location: The millstone quarry of *Cudillas* is about four kilometres north-west of the town of Carcabuey at the foot of the Lobatejo mountain.

Sources. To my knowledge, this site is not mentioned in any written source.

The quarry: The quarry face is about 40 m long and between 3-4 m high. The upper layers are extremely brittle (overburden). Millstones were scored from a compact stratum about 80 cm thick along the base of the quarry face. This layer distinguishes itself from the upper strata by a different, less weathered, patina.

Techniques: The absence of tool marks and circular hollows along the quarry face suggests that the quarrymen detached angular blocks with levers prior to fashioning. Fashioning took place opposite the quarry face as seen by a number of abandoned cylinders in different stages of manufacture.

Wedge holes are visible on some of the larger blocks among the debris. These holes suggest that unwanted material was cut away by wedging before fashioning.

In the immediate area, in a radius of a few hundred metres, there are several abandoned millstones that show an advanced state of manufacture. They are indicative of the exploitation of other modest local outcrops or detached surface blocks.

Production and quantification: The millstones manufactured at this site measure between 1.10 and 1.20 m in diameter. Based on the length of the quarry face (40 m), and considering that two millstones could be hewn from a layer 80 cm thick, production could have totalled about 50 millstones.

Transport and distribution: The present dirt path that leads to the quarry is probably the same path that was used in the past to transport the millstones. Based on this small estimate, production was probably limited to the local sphere.

Dating: From the size of the products, they could date from Medieval to Contemporary times.

Rock type: Limestone (Geological map 989, Lucena, 2988).



View of the quarry face and working debris. The workers exploited a homogenous layer along the base of the quarry.



View from the south-west of the quarry face and working debris.



Detail of the layer exploited for millstones.



Detail of an abandoned cylinder.



Detail of a broken millstone.



Detail of an abandoned cylinder.



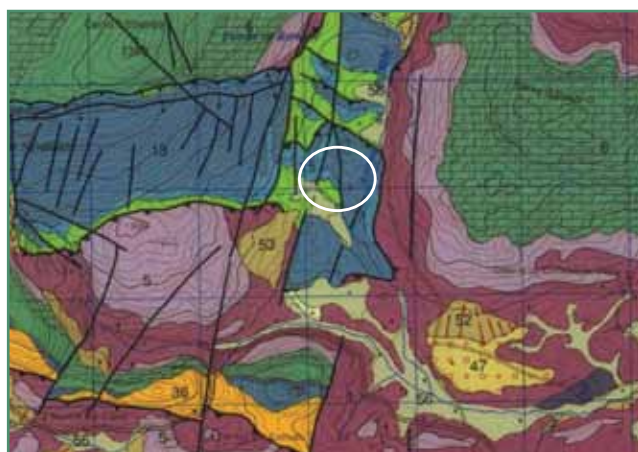
Examples of abandoned and aborted millstones among the debris contiguous to the quarry.



Examples of wedge holes for rock splitting on working debris.



Examples of abandoned millstones in the fields near the quarry.



Extract from geological map 989. The green and blue units correspond to different facies of limestone.

Acknowledgements

I thank Rafael CARMONA, director of the Municipal Museo of Priego de Córdoba, for information about this site.

CO-4 Priego de Córdoba

Vega de los Morales

Latitude: 37° 30' 41.39" N

Longitude: 4° 10' 58.02" W

Altitude: c. 470 m



View of the millstone quarry of Vega de los Morales (photograph by Rafael Carmona).

Location: Vega de los Morales is along the northern border of the Municipality of Priego de Córdoba (bordering the Municipality of Luque).

Toponymy: The place name *Morales*, meaning “mulberry” is possibly an inversion of the syllables “r” and “l” (typical in spoken Andalusian) of “*Molares*”, the toponym par excellence of millstone quarries.

The quarry: The exploitation is very small, consisting, to my knowledge, of only two aborted cylinders carved directly into a small rock outcrop.

Product and quantification: The larger, trunco-conical cylinder is possibly an unfinished oil roller. The second roughout, a low cylinder, probably corresponds to a millstone.

Dating: The diameters of the millstones, approximately one metre, is compatible with a Medieval to Contemporary production.

Rock type: The source could be a block detached from an uphill sandstone outcrop (Geological map 967, Baena, 1985).



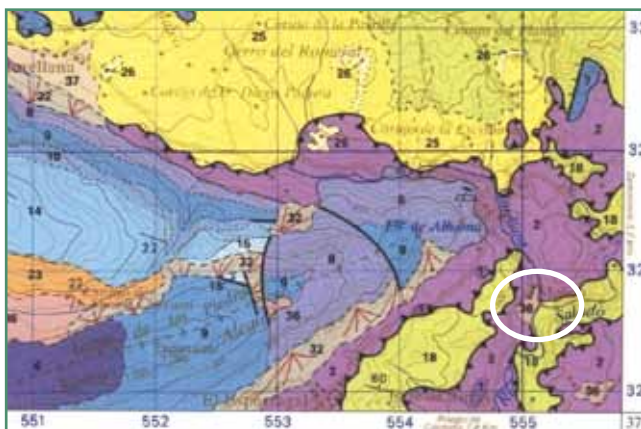
Details of the abandoned cylinders (photograph by Rafael Carmona).



Details of the abandoned cylinders (photograph by Rafael Carmona).

Acknowledgements

I thank Rafael CARMONA, director of the Municipal Museo of Priego de Córdoba, for the photographs and information about this site.



Extract from geological map 967. The area of the quarry corresponds to the beige unit (no. 36), an area of landslides probably originating from sandstone outcrops (purple).

CO-5 Baena

Molino de la Piedra

Latitude: 37° 35' 56.01" N
Longitude: 4° 18' 58.54" W
Altitude: 380 m



View from the north of the Marbella River Valley and the Molino de la Piedra beside the boulder.

Location: The small millstone quarry of the Molino de la Piedra (or Peña) is two kilometres south of the town of Baena at a bend along the Marbella River. The name of the site comes from the adjacent watermill.

Source: The quarry is cited in passing in a recent study of old hydraulic mills along the Guadajoz Valley (Córdoba de la Llave & Varelo 2012: 101-102).

Toponymy: The name "*Piedra*" meaning rock, refers to a huge block or outcrop (*peña*) a few steps away from the *molino* (watermill).

The quarry: The top of this boulder bears a straight quarry face presumably corresponding to a small construction material exploitation. To the west of the block, above the mill, is a single circular extraction hollow corresponding to what appears to a millstone cylinder over one meter in diameter. Tools marks are no longer visible.

Dating: The Molino de la Piedra is dated to the 19th and 20th centuries. The older version of installation, called the Molino de la Peña (*Peña* meaning rock or crag) is dated by a notarial protocol dating to 1557 (Córdoba de la Llave & Varelo 2011: 25). The date of millstone extraction falls, presumably, between these two dates.



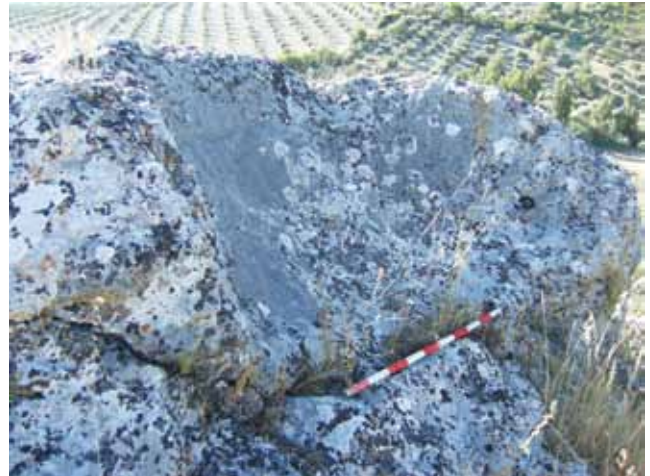
The millstone extraction is located on the boulder beside the Molino de la Piedra watermill (from Córdoba de la Llave & Varelo 2011: 99).

Transport and distribution: The single extraction was probably intended for one of the nearby watermills.

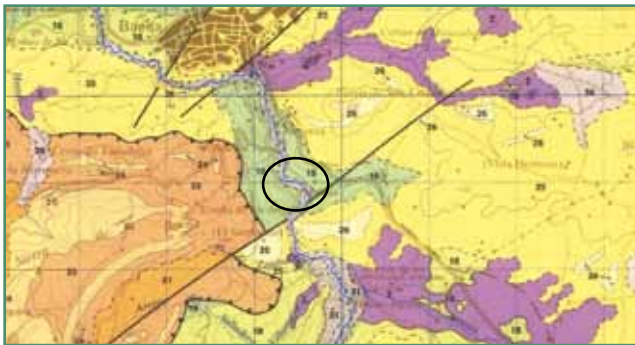
Rock type: The rock appears to be block displaced during a landslide. It could be a bioclastic limestone (yellow) or sandstone (orange) (Geological map 967, Baena, 1985). From my observations, the rock is a limestone.



Vertical face of what appears to be a block quarry at the summit of the block.



Highly weathered circular hollow. The extraction corresponds to a millstone with a diameter over one meter.



Geological map 967 (IGME). The source of the displaced boulder could be either the limestone (yellow) or sandstone (orange) unit.

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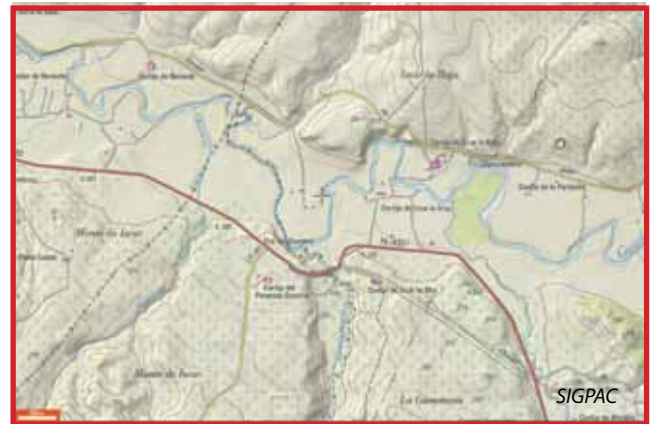
CO-6 Baena

Monte de Iscar (Izcar)

Latitude: 37° 40' 28.28" N

Longitude: 4° 24' 2.02" W

Altitude: 270 m

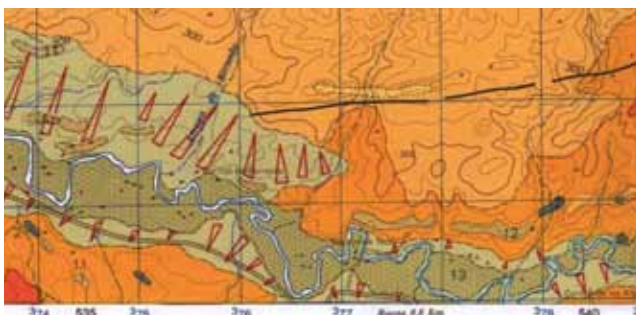


Location and toponymy: The Monte de Iscar (now spelled Izcar) is about eight kilometres north-west of Baena. The site is just north of the Guadajoz River, near the Cortijo de Iscar. *Iscar* is a diminutive of the name *Lentiscar* designating a type of shrub and has no relation with stone work.

Source and dating: The site is related directly to the Molino de la Piedra, a watermill located south of the city of Baena (see CO-5). A notarial protocol dating to 1557 conserved in the Archives of Córdoba convened that Miguel Ruiz de Lucena, a quarryman and resident of Baena, deliver to Andrés López, also from Baena, deliver by the day of St. John (28th of June) two millstones measuring “*seis cuartas y media en ancho y dos de alto*” (i.e. a diameter of 1.40 m and a width of 42 cm) from the quarry of *Iscar* (Córdoba de la Llave & Varelo 2011: 106).

The quarry: The outcrop forms a rugged promontory about 60 m long. An abandoned slightly trunco-conical cylinder about 70 cm in diameter, possibly an oil roller) is the only certified evidence of millstone making. Toward the base of the site what appears to be an extraction hollow.

Transport and distribution: The distance of the Izcar Mountain to the Molino de la Piedra is between eight and nine kilometres. The two are linked by a road following the Guadajoz and Marbella River Valleys.



Geological map 945 (IGME). The small limestone promontory is not indicated on the map.

Rock type: The Geological map 945, Castel del Río, 1987, does not indicate the outcrop. The general unit (orange) is a combination of clays and marls with occasional blocs. From my observations the outcrop is a hard limestone.



Unfinished slightly trunco-conical cylinder measuring about 70 cm in diameter. Its thickness, 60 cm, suggests an oil roller.



A possible extraction hollow toward the base of the site.

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CO-7 Córdoba

Santa Ana de Albaida

Latitude: 37° 54' 18.48" N
Longitude: 4° 40' 43.47" W
Altitude: c. 400-420 m



View from the south-east of one of the sectors of the Santa Ana de Albaida quarry. In this sector, a pit quarry, there is no evidence of millstone extractions.

Location and generalities: The quarry complex of Santa Ana de Albaida is four kilometres north-west of Córdoba at the foot of the Sierra de Córdoba. It covers a surface of almost 100,000 m² and is divided into a series of open-air pits and subterranean galleries. These workings provided the city of Córdoba with construction material for centuries (Penco Valenzuela, *et al.* 2004). The exact location of the millstone workings is not known.

Source: Millstone production is corroborated by a notarial protocol dating to 1486 (Córdoba de la Llave 1988: 843, footnote 23; Córdoba de la Llave 2003: 306, footnote 26). Montero, echoing Córdoba de la Llave, states that Albaida was the source of millstones for the city of Córdoba before the arrival of the *rosso ammonitico* stones from Cabra (see C0-1) (Montero 2008).

Production and quantification: The 1486 protocol details that millstones scored at Albaida be of two segments, and, once joined, measure “ocho palmos” (1.60 m) in diameter. This is one of the earliest written sources identifying a quarry producing segmented millstones. I do not know the volume of production of the site. In any case, it could have been great considering the large number of watermills in the city of Córdoba along the Guadalquivir River. It is also worth noting that this quarry is reputed to have produced only lower stones (Córdoba de la Llave 2003: 305).

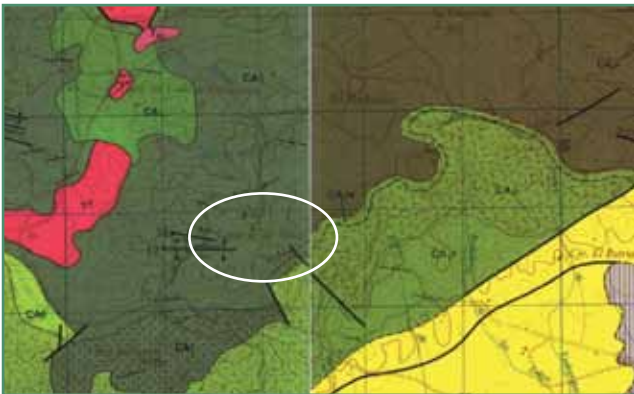
Transport and distribution: The quarry certainly benefited from the transportation network for construction material for the city of Córdoba. It would have taken a cart less than a day to cover the few kilometres to the city. If production was great, then the city of Córdoba could have served as a springboard for export to other regions.

Dating: Late 15th century (Late Medieval to Early Modern), based on the notarial protocol.

Rock type: The geological maps indicate dolomite rocks and limestones (Geological map 922, Santa María de Trassierra, 1972; Geological map 923,



View of the Albaida quarry faces (photograph by Jose Manuel Borja, www.eltiempo.es).



Montage of geological maps 922 and 923 (IGME). The quarries of Albadia are in a unit of limestone and dolomite (hews of green).

Córdoba, 1973). According to the study of the quarry the rock exploited was a calcarenite sandstone (Penco Valenzuela, *et al.* 2004: 233).



View of the Albaida quarry faces (photograph by Jose Manuel Borja, www.eltiempo.es).

Sources

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CO-8 Posadas

Cantera Honda

Latitude: 37° 49' 21.25" N
Longitude: 5° 9' 15.19" W
Altitude: c. 220 m



View of the Cantera Honda quarry (photograph by Vértice Córdoba, <http://www.flickr.com>).



View of abandoned cylinders at the Cantera Honda quarry (photograph by Vértice Córdoba, <http://www.flickr.com>).

Location: The Cantera Honda (deep quarry) about five kilometres north-west of Posadas, near Los Rubios de Paterna.

Source: The site is mentioned briefly in an archaeological study of Roman amphorae. The author notes the presence of abandoned “drums” in the quarry and suggests they are roughouts for millstones (Berni Millet 2008: 459).

It is more reasonable, based on the monumental nature of the site, that the “drums” were in fact Roman column segments. This site is retained in this study, nonetheless, because the cylinders, like those of Cerro Bellido in the Province of Seville (SE-4), could

have been recycled in later times into millstones. In any case, the rock (limestone or dolomite) is perfectly compatible with that of millstone workings.

The quarry and extraction techniques: From the photographs, it is obvious that the cylinders were hewn directly from the quarry face through true extraction, leaving high tubular hollows.

Dating: Roman, possibly later (Medieval?).

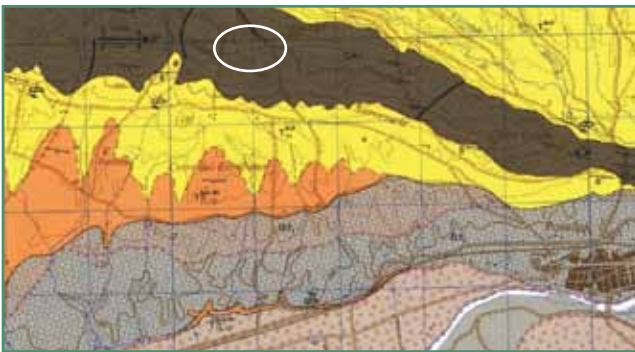
Rock type: Limestones or dolomites (Geological map 943, Posadas, 1973).



View of the Cantera Honda quarry face with high, vertical tubular hollows, probably for column drums (photograph by Vértice Córdoba, <http://www.flickr.com>).



View of the Cantera Honda quarry face with an in situ abandoned drum (photograph by Vértice Córdoba, <http://www.flickr.com>).



Extract from geological map 943 (IGME). The quarry is in the dark brown unit of dolomites and limestones.

Source

Vertice photos: <http://www.flickr.com/photos/vertice1/2561950036/in/photostream/> [accessed November 12, 2012].

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CO-9 Córdoba

Los Arenales



Location: Los Arenales is about six kilometres north of the town of Santa María de la Trassiera on the northern border of the Córdoba Municipality. The exact location of the quarry is not confirmed.

Source: Madoz, in his description of the town of Santa María de la Trassiera, records a millstone quarry at *Los Arenales* (849, Vol. 15: 136). This place name appears on the maps where a bridge crosses the Guadiato River.

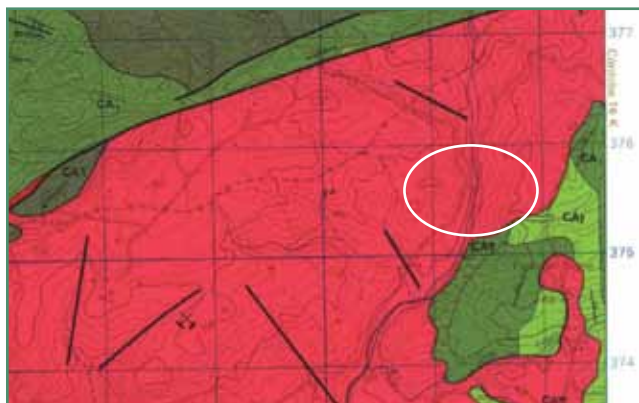
Toponymy: *Los Arenales* means a large sandy area. The name is compatible with a sandstone outcrop.

Production and quantification: I have no knowledge of either the extraction techniques or the number of millstones produced at this site.

Transport and distribution: The location of the site along the road linking the cities of Córdoba and Villaviciosa de Córdoba would have facilitated the transport of millstones.

Dating: Middle of the 19th century.

Rock type: Sandstone or conglomerate (Geological map 922, Santa María de la Trassiera, 1972).



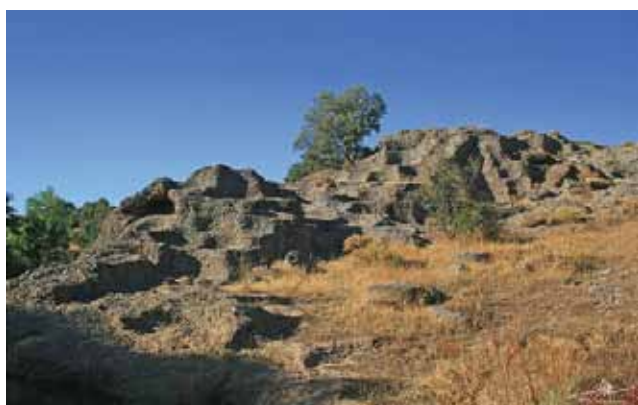
Extract from geological map 922 (IGME). The quarry is in the unit of sandstones and conglomerates (red).

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CO-10 Belmez

*La Pedrera,
Arroyo Albardado*



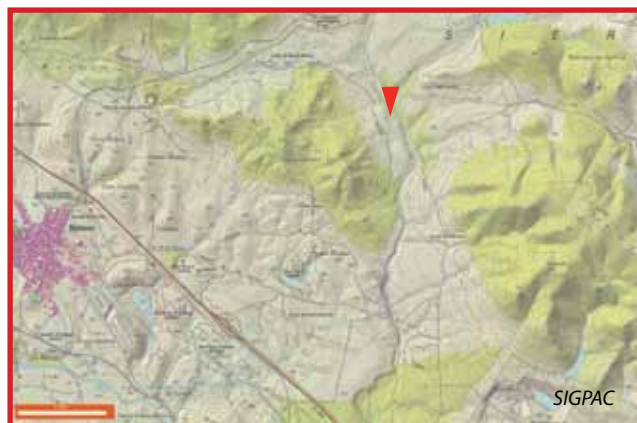
View of the Albardado millstone quarry (photograph by Manu Elviar, <http://www.flaickr.com>).

Location: This site is along the bed of the Albardado Stream a few kilometres east of Belmez. The stream flows from north to south over a distance of about seven kilometres before joining the Guadiato River.

Sources: The earliest references to this site, a series of notarial protocols dating to the early 17th century, were identified during research carried out by secondary students and their teacher of a school at Pozoblanco and published in their school Internet site (González Peralbo 2008). Their research revolves around the story of the stone mason Juan de Bargas.

The first reference to Juan de Bargas is a notarial contract from 1606 that states that he and María de Moya [or Misas] acquired from Pedro Martín Cejudo, native of Hinojosa, a millstone extracted and made in the quarry of Belmez from the “Alvarado” Stream.

The second document, dating a decade later, is a contract binding Juan de Bargas to fashion a millstone extracted from the quarry of Belmez (1616). It is interesting to note that the archives record that Juan de Bargas not only extracted millstones, but also building blocks, notably for the chapel of the hermitage of Nuestra Señora de la Luna.



Extract from the cadastre of Belmez with the Camino de Pedrera (quarry road) crossing the Albardado stream flowing N-S (SEC).

Madoz, two centuries later, cites the Albardado production twice. In his description of the Guadiato River, he records that the Albardado stream is noteworthy for its millstone quarries (1847: Vol. 9: 39). In the description of the surroundings of Belmez, he also specifies that *piedra basta* (coarse stone) was worked for millstones along the Albardado (1846, Vol. 4: 131).

The quarry: In the few photographs can be seen large extraction hollows indication a true extractive quarry.

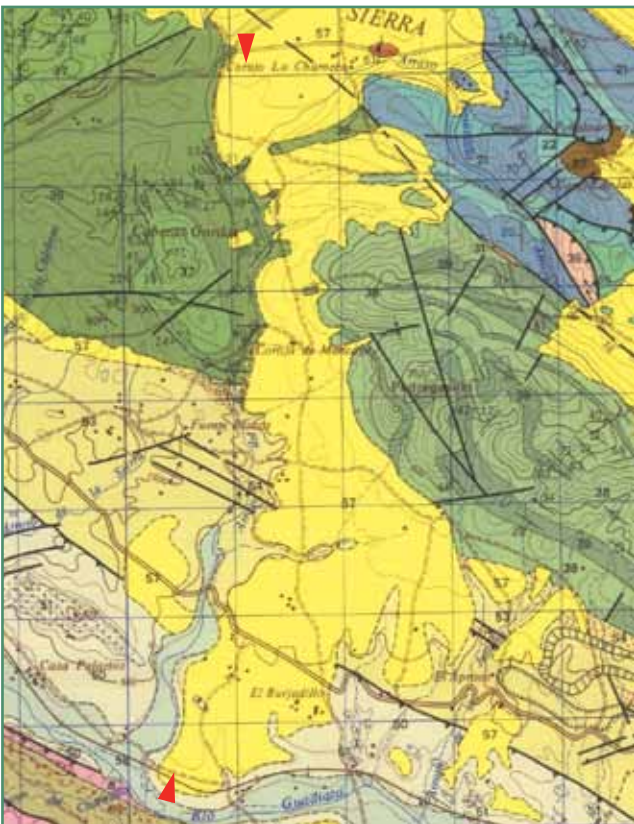
Toponymy: The name *Camino de las Pedreras* (road of the quarries) leading from Bélmez to the *Albardado* is probably related to the millstone work.

Production: The 1606 archive indicates that the millstone measures “*seis cuartas de vuelo y una tercia de grueso*” (about 1.20 m in diameter).

Transport and distribution: Madoz states that the quarry supplied the nearby towns, as well as other towns farther away (1846, Vol. 4: 131).



Detail of an extraction hollow (photograph from the website 30 Grados).



Extract from geological map 880 (IGME). The Albardado Valley runs north-south and is marked by units of conglomerates (both hews of yellow), the probable source of the quarries.

Dating: The notarial protocols place the quarry in the early 17th century. The references by Madoz indicate the site was still active in the middle half of the 19th century. Finally, in an article about hydraulic works in the Province of Córdoba, Hernando Luna associates the quarry with recent watermills along the Albardado stream (Hernando Luna 1989: 275) suggesting the quarry could have still been active the early 20th century.

Rock type: Conglomerate (Geological map 880, Espiel, 1982). This type of rock, with rounded quartzite clasts up to 10 cm in length, is confirmed by Antonio Dasa of the Escuela Politécnica de Minas of Bélmez, and is compatible with the term “*pedra basta*” stated by Madoz.

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Acknowledgements

I thank Antonio DASA of the Escuela Politécnica de Minas of Bélmez for information regarding the rock type.

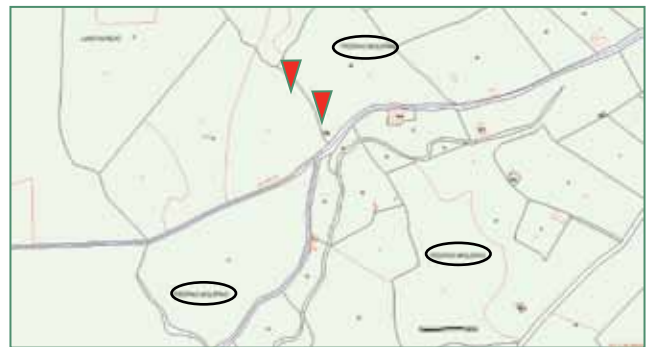
CO-11 Villanueva de Córdoba

Piedras Moleras

Latitude: 38° 18' 31.45" N
Longitude: 4° 38' 39.83" W
Altitude: 670-700 m



View from the north-east of the Piedras Moleras (extract from Google Maps Street View).



Extract from the cadastre (SEC) showing with circles the large area falling under the place name Piedras Moleras and the precise location of the two extractive sectors.

Location: The quarry is about 1.5 kilometres south-west of the town of Villanueva de Córdoba on and around a hillock called *Piedras Moleras*.

Source and toponymy: The site is identified by the toponym *Piedras Moleras* (millstone quarries) stones, an unequivocal indicator of millstone production. Although the existence of rock extraction at the site is confirmed by Silverio Gutiérrez, director of the Historical Museum of Villanueva de Córdoba, there is no physical evidence of millstone production.

The quarry: According to Silverio Gutiérrez, the site has two extraction sectors. The quarry face of sector 1 has vertical drilling marks, indications very recent workings. Sector 2, however, is a tiered quarry face with angular extraction hollows.

It is possible to either imagine superficial millstone workings in these areas leaving little or no trace, or that recent extractive work has erased all traces of earlier millstone work.

Products and dating: The vertical drilling marks are probably contemporary. The angular block extractions, however, could be Roman or Medieval. Millstone workings (still to be confirmed), judging from the post-Islamic place name, could date from the Late Medieval or Contemporary period. Roman and Medieval granite querns stored in the Historical Museum of Villanueva de Córdoba bear witness to local production. There is no evidence, however, that they were made at this site.

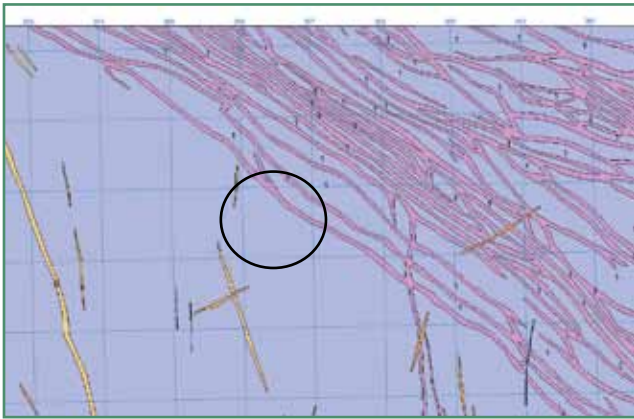
Rock type: Granite. The site is in the heart of the vast Pedroches granite unit (Geological map 881, Villanueva de Córdoba, 1989). According to Silverio Gutiérrez, pink-coloured granite from this site is much harder than white granite and would thus have been better suited for millstone production.



View of extraction sector 1 of the quarry. This quarry face bears scars of long vertical drilling holes indicating very recent work probably with black powder (photograph by Silverio Gutiérrez).



View of extraction sector 2 (photograph by Silverio Gutiérrez). To the left can be seen the hollow of a rectangular extraction.



Extract from geological map 881 (IGME). The Piedras Molares site is in the heart of the vast granite Pedroches unit (purple). The reddish-purple diagonal lines are adamellitic-rhyodacitic-rhyolitic porphyries that probably correspond to the two exploited sectors.

Acknowledgements

I sincerely thank Silverio GUTIÉRREZ, director of the Archaeological Museum of Villanueva de Córdoba, for the photographs and the valuable oral information.

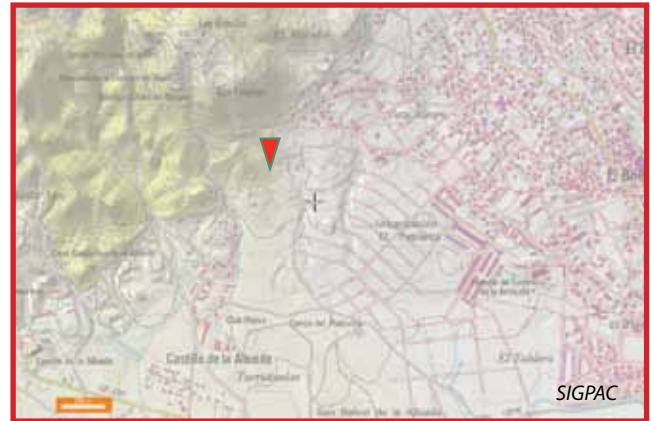
CO-12 Córdoba

El Patriarca

Latitude: 37° 54' 33.15" N

Longitude: 4° 48' 53.81 W

Altitude: 205 m



Detail of an unfinished cylinder measuring 90-95 cm in diameter (from Altamirano & Antón 2012: 334, Lám. 6).



Detail of an unfinished cylinder measuring 1.27-1.29 m in diameter (from Altamirano & Antón 2012: 334, Lám. 7).

Location and source: El Patriarca is on the north-western outskirts of the city of Córdoba at the foot of the Sierra Morena range. The site is the object of a case study in a recent article (Altamirano & Antón 2012). To my knowledge the site is not cited in any 18th- or 19th-century geographical work.

The quarry: The site comprises a series of extraction hollows and more than a dozen cylinders abandoned in different stages of manufacture. It appears to be an extended shallow surface quarry. There is no evidence of multiple extractions producing deep tubular quarry faces.

Products and distribution: Although the extractions range in diameter from 90 cm to 1.30 m, most fall into a category of 1.20 to 1.30 m (Altamirano & Antón 2012: 335).

Techniques: The authors describe abundant parallel, diagonal lines on quarry faces (Altamirano & Antón 2012: 334), indicators of true extractive work with picks.



Abandoned millstone (from Altamirano & Antón 2012: 334, Lám. 8).

Dating: Medieval or Contemporary.

Rock type: Conglomerates and sandstones (Geological map 923, Córdoba, 1973). The rock is a coarse conglomerate with large clasts (Altamirano & Antón 2012: 333).



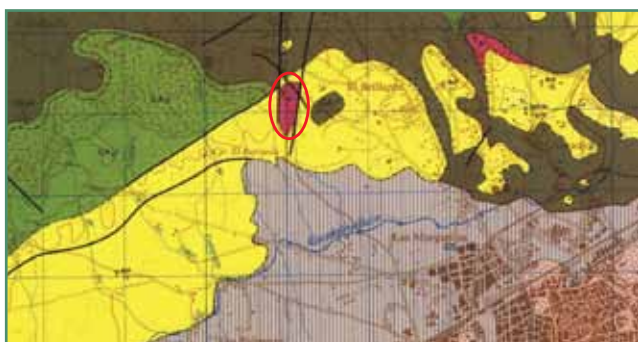
Unfinished cylinder measuring about 1.10 m in diameter.



Extraction hollow of a large cylinder.



Detail of the coarse conglomerate with rounded pebbles exploited at the quarry (from Altamirano & Antón 2012: 333, Lám. 1).

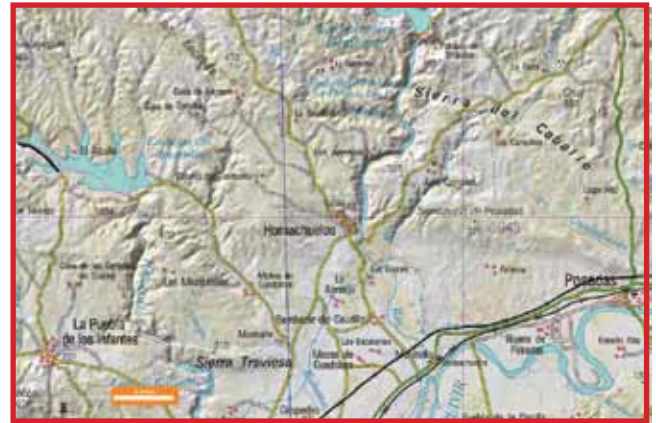


Extract from geological map 923 (IGME). The quarry is in a unit of conglomerates and sandstones (red) surrounded by a unit of sandy loams, biomicrites and other sandstones (yellow).

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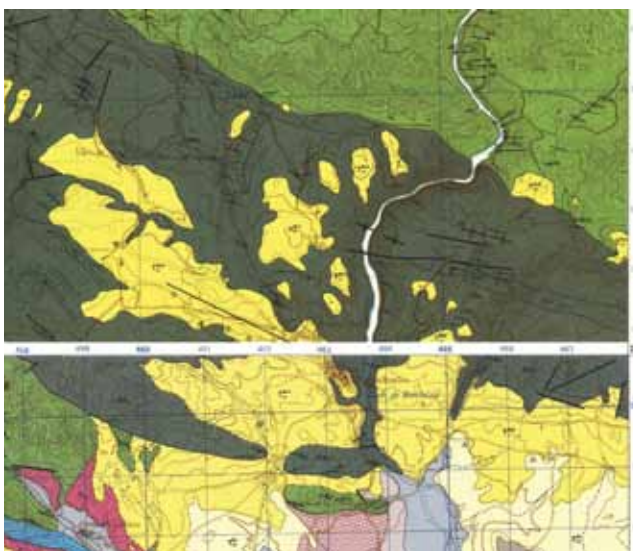
CO-13 Hornachuelos



Location: Hornachuelos is a large municipality (990 km²) in western Córdoba at the foot of the Sierra Morena. I have not been able to identify the precise location of its millstone quarry.

Source: Two protocols recording millstone workings at Hornachuelos are cited in an article about the 15th-century milling industry in Córdoba (Córdoba de la Llave 1988: 843, footnote 24; Córdoba de la Llave 2003: 306, footnote 26). The first, dating to 1481, notes that Alfonso Fernández, a *molero* (millstone maker) from Hornachuelos, received an advance payment of 350 *maravedis* from Antón López for an upper stone measuring 8 *palmas* to be scored at the quarry of Hornachuelos (1481.02.18, AHPC, PNCó, 14-17,3, 73r). The second, from 1486, relates that the carpenter Pedro from Vado del Aladid orders an upper stone from the quarry measuring 8 *palmas* (1486.04.02, AHPC, PNCó, 14-21, 1, 44r).

Products and quantification. The two protocols indicate that the stones are upper stones (*blancas*)



Extracts from geological map 942 and 921 (IGME). The quarry is probably to be found in the limestone (yellow) unit.

measuring about 1.60 m in diameter. The scale of production at the site remains unknown.

It is worth noting that this quarry is reputed to have produced only upper stones (Córdoba de la Llave 2003: 305).

Transport and distribution: It is conceivable that the products were ferried from Hornachuelos to Córdoba, a distance of 40 kilometres, by the Guadalquivir River.

Dating: Late 15th century.

Rock type: Limestones and dolomites are abundant in the immediate surroundings of Hornachuelos (maps 921 and 942, IGME).

En 1481 Alfonso Fernández, molero de Hornachuelos, recibió de un molinero de Córdoba la cantidad de 350 rns. como parte del pago de una piedra blanca para aceña de ocho palmas en ancho “de las del molar de Hornachuelos” (1481.02.18, AHPC, PNCó, 14-17,3, 73r); pocos años después eran colocadas en una aceña del Vado del Aladid, situado sobre el Guadalquivir unos 2 km al este de Córdoba, una piedra bermeja de dos pedazos del heredamiento del Albaida, de tres palmas y medio de gordura y ocho palmas de campo, y una piedra blanca de Hornachuelos de ocho palmas, buena y de buen grano (1486.04.02, AHPC, PNCó, 14-21, 1, 44r).

(from Cordoba de la Llave 2003: 306, footnote 26).

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CO-14 Montoro district



Location: Montoro is a large municipality (589 km²) in western Córdoba beside the Guadalquivir River. It has a long tradition of exploiting a fine reddish sandstone called “*piedra molinaza*”.

Sources: The medievalist Córdoba de la Llave, based on a protocol dating from 1481 (1481.26, APC, 14-5, 3, 38 r.), notes that a lower stone (*bermeja*) for a mill in Córdoba was brought from a millstone quarry in Montoro (Córdoba de la Llave 1988: 843, footnote 22). Although there is no indication of the stone type, it is probably made from the predominant “*molinaza*”.

The quarries: Several small pocket exploitations are recorded in the list of archaeological sites of the Municipality of Montoro (del Pino Cutillas: no date). From the photographs it appears that the products were hewn from detached blocks. Outcrops of this rock are common so quarries could have been widespread.

Transport and distribution: The Guadalquivir River is the largest inland waterway in Andalusia. Products from Montoro could have been ferried downstream to Córdoba (about 40 km).

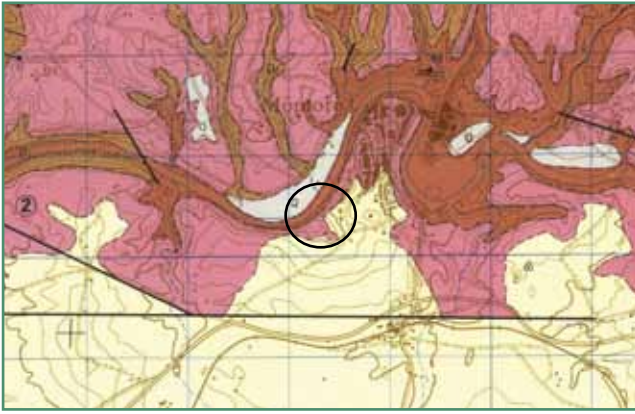
Rock type: “*Piedra molinaza*”, the predominant rock in the area, is a reddish sandstone (*Buntsandstein* facies), (Geological map 903, Montoro, 1973). The rock’s name presumably has an origin in the Latin *mola* meaning millstone. The stone workings of Montoro, however, are not known for their millstones or oil rollers, but for their sharpening stones (Clementson 2012: 3-5). The historical archive does, nonetheless, reveal that this stone was scored for millstones at the end of the 15th century. It is worth noting that along the upper banks of the Rhine River, in Switzerland, Germany and France, a rose-coloured *Buntsandstein*, certainly bearing properties similar to those of the Montoro stone, was exploited for grain mills since Antiquity (Anderson *et al.* 2003: 64-65).



Detail of a small “*piedra molinaza*” cylinder. Quern or sharpening stone? (from del Pino Cutillas, no date: 178).



Views of different “*piedra molinaza*” quarries identified recently in the surroundings of Montoro (from del Pino Cutillas, no date: 178).



Extract from geological map 903 (IGME). The reddish unit is a red sandstone (Buntsandstein). The yellow unit is a combination of conglomerates, calcarenites and loams.

Source

del PINO CUTILLAS, María Teresa, *et al.* *Carta Arqueológica de Montoro*. http://www.juntadeandalucia.es/cultura/publico/BBCC/Carta_arqueologica_Montoro.pdf [accessed June 6, 2013].

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CO-15 Almedinilla district



Source and generalities: The excavations at the Iron Age site on the top of the Cerro de la Cruz, east of Almedinilla, have revealed a sudden and violent end of an Iberian Culture settlement (middle of the 2nd century BC) at the hands of the Roman Army (Quesada *et al.* 2010). As a result of the sudden end of the site, a series of mills were brought to light in their original working position. Their rock type suggest the presence of a local quarry.

Products, the quarry and dating: Two types of mills have been identified at the site: a) hand-driven querns about 40 cm in diameter and b) Iberian rotary pushing mill measuring more than 60 cm. This second type was found at times on podiums.

The millstones are of a highly porous limestone known locally as “travertine”. The exact source is not known. It is plausible that they come from one of a series of outcrops on the outskirts of Almedinilla, along the western bank of the Almedinilla River. A clue to the location of their source is the recent discovery of a Roman ashlar travertine quarry in a river valley about one kilometre south of the Cerro de la Cruz (Muñiz *et al.* 2012: 165).

Late Iron Age and Roman querns and millstones of highly porous limestones are common in Andalusia. An upper stone on display in the Museum of Alcalá la Real (Jaén) is presumably from an Iberian settlement at La Ribera Alta (to the east of Alcalá la Real), a site that is also perched on or very near another travertine outcrop (Anderson *et al.* 2014). Besides the Iron Age models, there are also examples of Roman querns and millstones of travertine in the Almedinilla Museum.

Distribution: Since travertine outcrops are available throughout Andalusia, distribution of millstones was probably limited to the local, at best, regional, sphere.

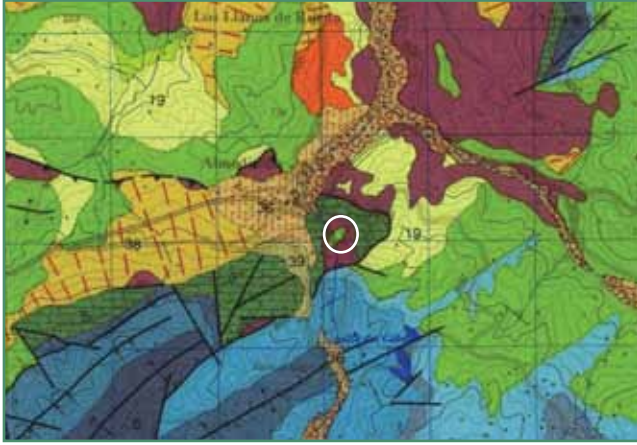


Example of a highly porous “travertine” lower stone of an Iberian pushing mill in its original working position on a low, stone-built, circular podium (photograph by T. Anderson).



Examples of “travertine” Iberian pushing millstones. The ring-shaped upper stone of the mill in the background is broken and has slipped down to the level of the base of its lower stone (from <http://www.rutasconhistoria.es/loc/poblado-ibero-el-cerro-de-la-cruz>).

Rock type: Cream-coloured, porous limestone tufa and travertine (Geological map 990, Alcalá la Real, 1980).



Extract from geological map 990 (IGME). The Cerro de la Cruz Iron Age settlement is indicated by the circle. The millstone quarry is probably to be found in unit 36 (limestone tufas and travertines) west of Almedinilla.

Source

Almedinilla: General information and photograph of the site: <http://www.rutasconhistoria.es/loc/poblado-ibero-el-cerro-de-la-cruz> [accessed March 10, 2010].

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I thank Ignacio MUÑIZ, director of the Historical Museum of Almedinilla, for guiding me to the site of Cerro de la Cruz. I also thank Eduardo KAVANAGH and Fernando QUESADA for the photographs of millstones in chapter 3.

CO-16 Minas de Espiel district



Source and generalities: The Cuenca de las Minas de Espiel, traditionally a rich mining area, is a narrow basin in north-western Córdoba, roughly 50 kilometres in length and only a few kilometres wide. It stretches between the cities of Fuente Obejuna, Bemez and Espiel. Madoz records the presence in the area of a layer of sandstone exploited for millstones (1849, Vol. 14: 387). He unfortunately provides no detailed information as to the location of the millstone workings.

Rock type: Sandstone according to Madoz.

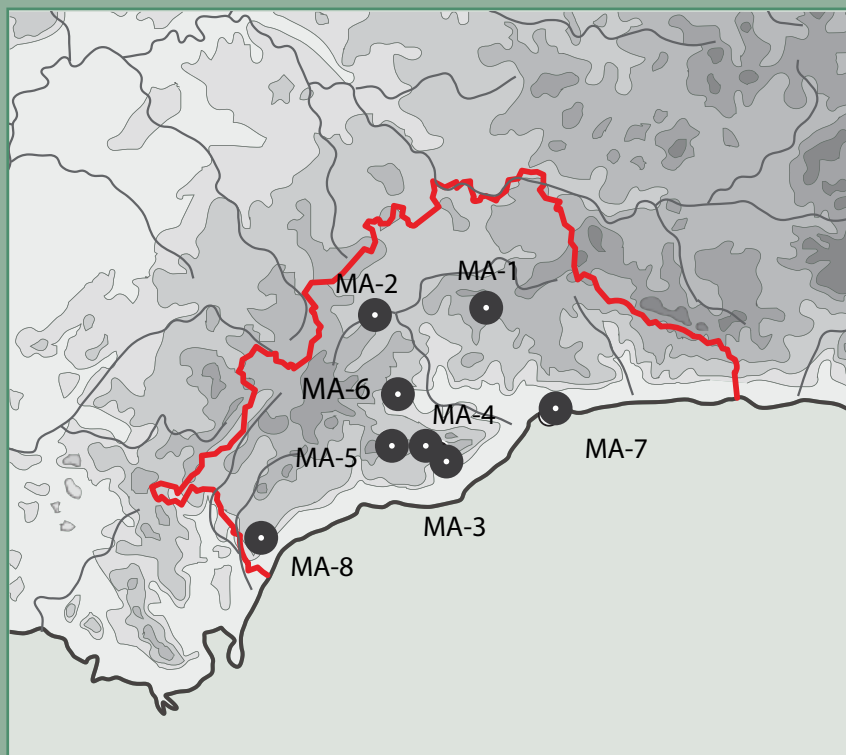
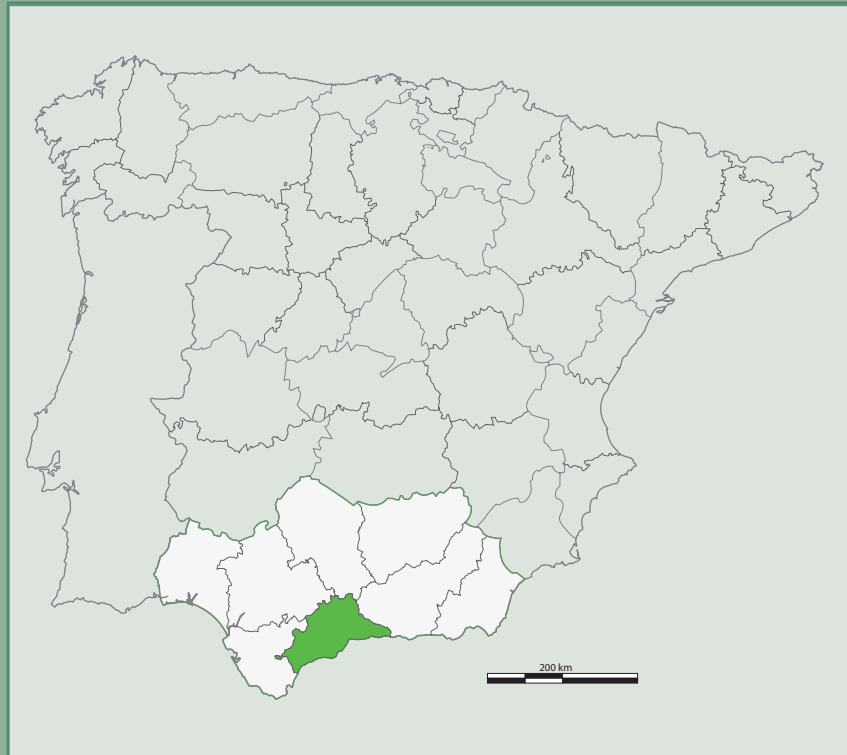
CO-17 Fuente Obejuna Judicial District



Source and generalities: The Judicial District of Fuente Obejuna is a very large area in north-western Córdoba. Madoz records two “very useful” quarries for millstones and animal-driven mill along the Rivers Guadiato and Suja (Madoz 1847, Vol. 8: 230). This information is too vague and it is not possible to advance any further information about these quarry sites.

ANDALUSIA

MÁLAGA (MA)



MA-1 Antequera

El Torcal Bajo

Latitude: 36° 58' 27.91" N
Longitude: 4° 32' 29.20" W
Altitude: 950-1050 m



View from the east of the rugged, karstic landscape of the northern plateau and slope of El Torcal.

Location: The Torcal Bajo quarry is six kilometres south of the city of Antequera at the Torcal Mountain. Owing to its unique geological formations sculpted by erosion over millions of years, El Torcal was declared a Natural Park in 1989. A visitor's centre and most of the more spectacular karstic formations are at the *Torcal Alto* on the southern side of the mountain. The millstone workings, however, are at the *Torcal Bajo*, off the visitor's track, on the northern slope.

Sources: The earliest millstone workings are identified in an historical archive (1500) cited in a study of Medieval mills (Fernández López 1982: 222-223). The archive records a conflict between the

councils of the cities of Antequera and Málaga (30 km to the south) that found its way to the court the Catholic Monarchs Queen Isabella I of Castile and King Ferdinand II of Aragón. The contention, formulated by the Antequera residents, was that the *Málagaños*, due of the poor quality of their own stones, intruded into their territory and extracted millstones for their flour mills. A second archive dating to 1508 reveals that millstones from Antequera travelled up and down the Málaga coast.

Three centuries later, a writer recorded that the *piedra tosca* (coarse) millstones of El Torcal, destined for flour mills, were "very good" (García de la Leña 1789: 106).



Orthophoto of the rugged quarry area (SIGPAC).



View of an unfinished millstone (standing vertically) among the karstic formations. The surface slabs and boulders are often detached from the bedrock by natural processes.

A fleeting mention by Marzo in his description of the history of the province of Málaga is a fourth reference (Marzo 1851: 496).

The quarry: The main extraction area of this “karstic” site is the plateau and slope on the northern side of the mountain. Here the quarrymen had a wide choice of surface material to exploit among the naturally sculpted surface slabs, often disconnected from the bedrock.

The workings are not concentrated at a single point but extend over several thousand square metres. Numerous aborted millstones are abandoned throughout the area. The location of the individual extractions depended on the size, shape and quality of the loose boulder or the bedrock.

Techniques: Since the tool marks are poorly preserved, it is not possible to define precisely the techniques put to use. Millstones were most likely cut into a rough shape with picks. Since many of the slabs were already naturally detached or practically loose from the bedrock, they were probably pried out with levers. This is seen in the case of one block that was poised upright so as to carve its base.

Dwellings: There are several primitive rock hovels in the area that might have served as shelters either for millstone makers or shepherds.

Products and quantification: Many of the abandoned millstones measure about one metre in diameter. Several thicker models might have been destined as rollers for the oil industry.

In this area there is also evidence of ancient ashlar extraction (Roman?), as well as modern block extraction (vertical boring marks for black powder). This recent extractive work is recorded in the Geological map booklet (1978: 49).

Transport and distribution: The document relating the conflict between the locals and the intruding *Malagueños* reveals that these stones travelled to the coast of Málaga shortly after the fall of Islamic rule. They would have been transported by carts through the mountains 30 kilometres to the south along a long-established trade route linking the two cities. A second archive dating to 1508 (Fernández 1982: 221) points out that four millstones, presumably also from El Torcal, were ferried along the Mediterranean coast by Francisco Martín from the Cala del Moral to Torre de Vélez in a boat leased from Pedro de Baena and Juan de Montilla (Fernández 1982: 221).

Dating: The oldest historical archive places production firmly to at least the end of the 15th century. The later written sources (1789 and 1851) suggests exploitation persisted, possibly continuously, for at least three centuries. It is interesting that Madoz is silent about the site.

Rock type: *Rosso Ammonitico* (Geological map 1038, Ardales, 1982). The rock is a fossiliferous pink limestone. The description by García Leña as a “*tosca*” rock (García de la Leña 1789: 106), meaning coarse and porous, is incorrect. In the Torcal area there are also white limestone outcrops.



Examples of unfinished or aborted millstones. The lower right example broke during the piercing of the eye.



Examples of abandoned cylinders. The example to the left was propped upright for carving. The cylinder to the right was probably aborted due to a central fissure that developed along the bedding plane.



Examples of thick abandoned cylinders that might have been destined as rollers for the oil industry.



Views of solitary abandoned cylinders. The example to the left is among debris of modern quarry work.

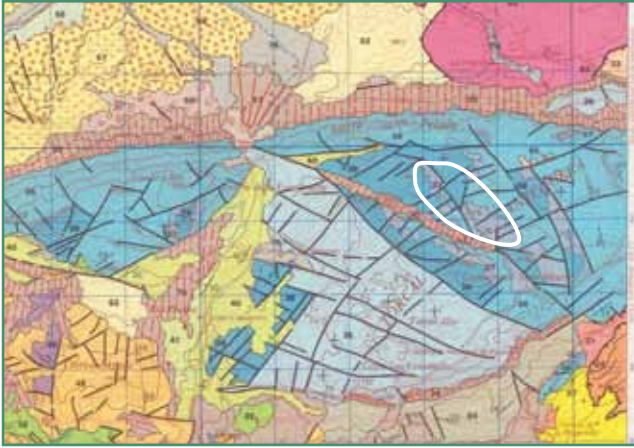


Example of one of several drystone hovels (left) that could have served as shelters for the quarrymen. This shelter is associated with both abandoned millstones and an enclosure wall (right).

A.G.S R.G.S. XII, 1500: *Sobre la escacez de la piedras de molino para pan en la tierra de Málaga.*

Don Fernando e donna Ysabel y etcetera. A vos el conçejo justicia regidores cavalleros escuderos ofiçales y omess buenoss de la çibdad de Antequera, salud e graça. Sepades que Diego Roman e Françisco de Alcaraz regidores y vezinos de la çibdad de Malaga en nonbre del conçejo della nos fizieron relaçion por su petiçion diziendo que en las syerras e treminos comunes desa dicha çibdad de Antequera ay muchas piedras para molinos de pan e que en termino de la dicha çibdad de Malaga non las ay que sean tan buenas para los dichos molinos e diz que vos el dicho conçejo justicia e regimiento de la dicha çibdad de Antequera non les dexays nin consentis sacar ni levar de vuestros terminas las dichas piedras en lo qual diz que sy asy pasara la dicha çibdad de Malaga e vezinos della resçibirian mucho danno e agravio, por ende que nos suplicavan e pedian por meçed çerca dello mandasemos proveer mandando vos que pues las dichas piedras estan en las syerras e terminos comunes desa dicha çibdad e del sacar dellas non resçiben danno esa dicha çibdad les dexasedes e consintiesedes sacar e levar de los dichos vuestros terminas las dichas piedra libremente syn ge lo inpedir o como la nuestra meçed fuese. Lo cual visto en el nuestro consejo fue acordado que deviamos mandar dar esta nuestra carta para vosotros en la dicha rason e nos tovimoslo por bien, porque vos mandamos que cada e quando qualesquier vezinos de la dicha çibdad de Malaga o de su tierra fueren o enbiaren a esa dicha çibdad a conprar qualesquier piedras para sus molinos ge las vendades e consintades vender a qualesquier personas que las tovieren o fizieren por presçios justos e razonables syn ge las encarescer e non ge lo defendades ni sobre ello fagades ligas ni defendimientos algunos e vos las dichas justiças fagades que asy se faga e cunpla e guarde de como en esta nuestra carta se contiene e contra el tenor y forma della non vayades nin pasedes ni consintades yr ni pasar e los unos i los otros e etcetera. Pena X mili maravedis con enplasamiento en forma. Dada en Granada a XXXI dias de dixienbre de mill DI annos.

Archive dating to 1500 describing the contention between the councils of Málaga and Antequera (from Fernández López 1982: 222-223).



Extract from geological map 1038 (IGME). The quarry exploited a unit of rosso ammonitico (pink or white ammonitic limestone, light purple). White limestone (blue) was possibly also worked.

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MA-2 Teba

El Tajo

Latitude: 36° 57' 58.28" N
Longitude: 4° 56' 54.03" W
Altitude: 650-670 m



Location of the quarry of El Tajo on the Lentejuela hill. The city of Teba is to the left of the photo.

Location and toponymy: El Tajo quarry is perched on the Lentejuela mound three kilometres south-west of Teba. The word *tajo*, in geographical terms, means ravine or gorge and could refer to the feature that cuts through the hill from east to west. A second definition of *tajo*, meaning a mine or quarry, could allude to the millstone production. The Madoz reference below suggests other quarries in the area.

Sources: Written sources date to 1833, 1848 and 1849. The first notes that Teba supplied millstones to the surrounding towns (*Diccionario Geográfico Universal*, 1833: 608). The second records that *Tera* (a the former spelling), with its population of 1000 souls, has nothing "notable except a castle in ruins, a new church and millstone quarries" (Espinosa 1848: 265). The third notes that *Teva* produces millstones from flour mills and *tahonas* that are extracted from 10 quarries of white and reddish "*jaspes*" (Madoz 1849, Vol. 14: 752).

The quarry: The site is spread over a surface of about 5000 m² along the eastern edge of the top of the hill. Like El Torcal (MA-1), the landscape is karstic and strewn with either rounded surface boulders or small bedrock outcrops.



Aerial view of the site of Teba showing the rough, karstic surface formations (SIGPAC).

Techniques: The quarrymen cut the boulders with picks. To facilitate fashioning, they were propped up on small blocks.

Product and quantification: There are a dozen abandoned cylinders measuring systematically 1.00 to 1.10 m in diameter. The eyes of some in a more advanced state of manufacture are pierced. The site had the potential to produce a great number of millstones. Madoz indicates they are destined to watermills and *tahonas* (Madoz 1849, Vol. 14: 752).

Transport and distribution: The stones were probably hauled down to the plain along the less steep western slope. A “*Cañada Real*”, a traditional route for the seasonal migration of livestock, passes nearby and could have facilitated the transport to Teba and beyond.

Dating: The texts suggest working at the site in at least the first half of the 19th century.

Rock type: White limestone (Geological map, 1037, Teba, 1980).



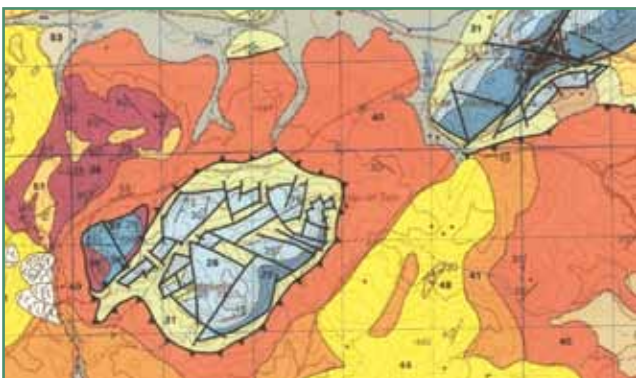
Views from the west of the quarry area on the hilltop. In the background is the town of Teba (on the mountain).



Examples of abandoned millstones in different stages of manufacture.



Examples of abandoned millstones in different stages of manufacture.



Extract from geological map 1037 (IGME). The quarry is in a unit of white limestone (light blue).

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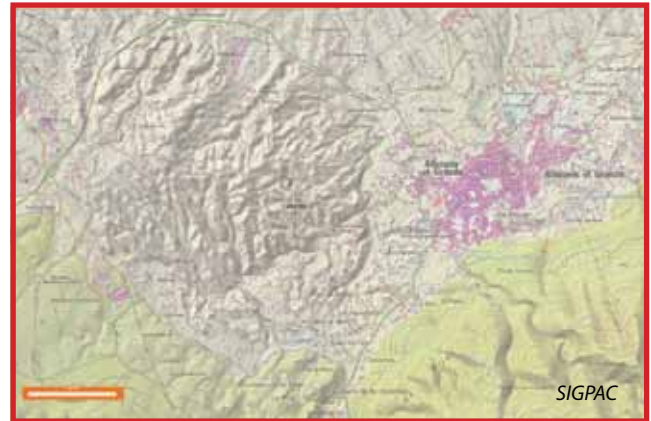
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MA-3 Alhaurín el Grande

Las Canteras



Location: Alhaurín el Grande is a town at the northern foot of the Sierra de Mijas about 10 kilometres from the Mediterranean coast. The location of the millstone quarry has not been identified.

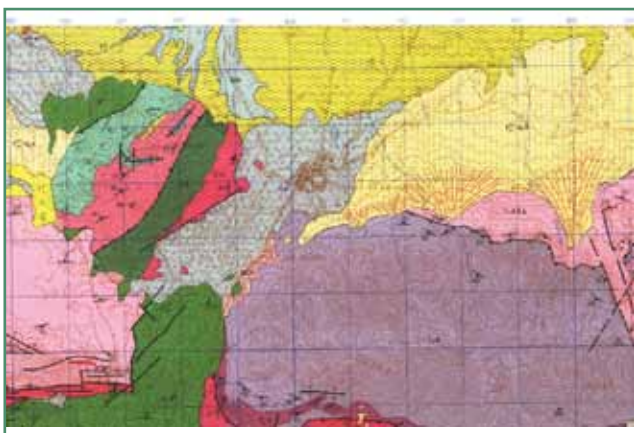
Sources and Toponymy: There are three written sources, spanning almost a century, that point to millstone production at Alhaurín.

The first mentions an exploitation of “*piedras toscas*” (coarse, porous limestones) at the place name “*Canteras*” (quarries) (García de la Leña 1789: 106). Madoz records several “granite” exploitations near Alhaurín el Grande (Madoz 1845, Vol. 1: 604). Finally, Marzo records millstone workings of “*almendrilla*” rock at *Las Canteras* (Marzo 1851: 426). These texts create a certain confusion. In fact, two towns, Alhaurín de la Torre and Alhaurín el Grande, about 10 kilometres apart, share the same name and the place name *Canteras*. I assume the millstone workings are

in Alhaurín el Grande because the second and third references refer to the *Cantera* site in Alhaurín de la Torre as a marble or breccia exploitation.

Dating: The written documents place the exploitation from at least the end of the 18th to the middle of the 19th century.

Rock type: The three texts are contradictory from the point of view of petrography. The first refers to “*piedra tosca*”, meaning coarse limestone, a type of stone that is in the surroundings of the town. The allusion to granite by Madoz is erroneous because granite is absent from the region. *Almendrilla*, associated with the third reference, is the diminutive of “*almendra*” (almond), and corresponds to oval-shaped clasts of coarse conglomerates or puddingstones, rocks that are also common to the region. Either limestone tufa or conglomerate (Geological map 1066, Coín, 1977).



Extract from geological map 1066 (IGME). The grey unit in the immediate surroundings of Alhaurín el Grande is limestone tufa and travertine and coincides with the text from 1789. The reference to conglomerates in the text of 1851 is not possible to pinpoint on the map.

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MA-4 Coín*Sierra Gorda*

Latitude: 36° 39' 0.78" N
 Longitude: 4° 45' 41.70" W
 Altitude: 330 m



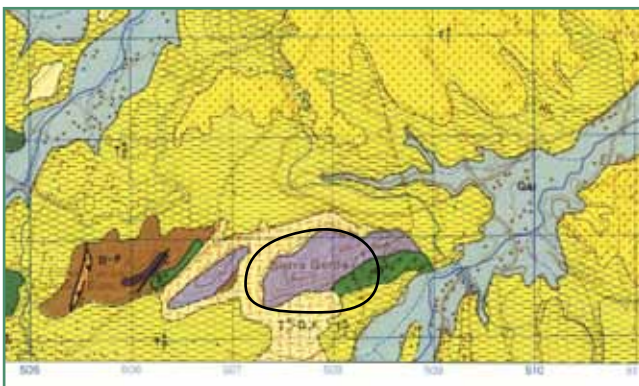
Location and source: Sierra Gorda is a hill four kilometres north-east of Coín. It should not be confused with the Sierra Gorda Mountains in the western region of the Province of Granada. García de la Leña makes a fleeting reference to a millstone quarry on this hill in his general description of the uses of "*piedra tosca*" (coarse, porous limestone) in the Province of Málaga (García de la Leña 1789: 106). The location of the quarry is not assured. It might be at a karstic outcrop (visible on the orthophotos) on the south-western slope of the hillock, near a series of houses.

Dating: The text places the millstone workings toward the end of the 18th century.

Rock type: Coarse, porous limestone, according to García de la Leña (1789: 106). Geological map, IGME, Alora 1052, 1978.



Sierra Gorda as seen from the south-west (Google Maps Street View).



Extract from geological map 1052 (IGME). Neither the purple unit of layers of white marble nor the green unit of peridotite seems to correspond to the description of a coarse limestone. The karstic zone seen on the orthophoto is in the white marble unit.

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MA-5 Guaro



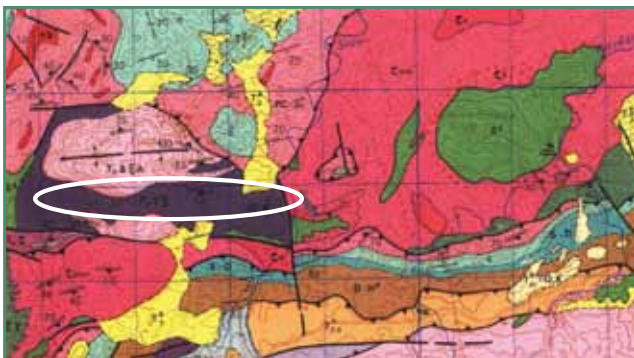
Location: Guaro is a small town in the Sierra of Mijas. The millstone production is presumably on the southern slopes of the Sotornil mountain.

Sources: The first reference to millstone workings is from Madoz who specifically cites a millstone quarry for flour mills in the Guaro Municipality (Madoz 1847, Vol. 9: 56). A second study specifies twice that millstone quarries exploited a reddish sandstone in the Guaro mountains (Marzo 1851: 400, 427). A third geographical study, published twenty years later,

also records millstone extraction (Bautista 1861: 277). A last study, published still a few years later, corroborates the millstone workings (Bisso 1869: 20).

Dating: The texts suggest working at the site throughout a good part of the 19th century.

Rock type: A unit of reddish sandstone, clay and conglomerate is recorded to the south of Guaro (Geological map 1066, Coin, 1977).



Extract from Geological map 1066 (IGME). The quarry is probably located in the reddish sandstone unit (purple) on the mountain south of the town.

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Acknowledgements

I thank José NARANJO, historian and resident of Guaro, for his precious information about the millstone quarry of Guaro.

MA-6 Alozaina

Mulera

Latitude: 36° 44' 13.01" N

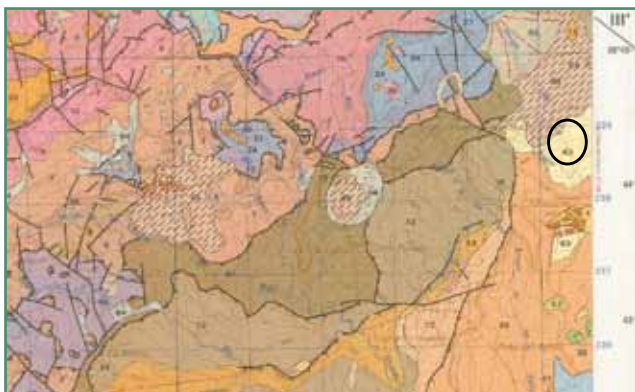
Longitude: 4° 51' 33.75" W

Altitude: c. 450 m

Location: The *Mulera* millstone quarry is less than one kilometre north of Alozaina on the southern slope of the Peñones mountain.

Sources: The geographer Madoz records that the millstone workings of "Alozayna" were of "particular merit" (Madoz 1845, Vol. 2: 186). A few years later, Marzo specifies that these millstones were hewn from a "common" rock called "*almendrilla*" (Marzo 1851: 429) meaning "almond stone" (conglomerate). This is then echoed twenty years later by Bisso (1869: 20).

Toponymy: The 19th-century authors do not pinpoint the location of the quarry. Francisco Sánchez of the Municipality of Alozaina has informed me that there are large abandoned cylinders and animal troughs about one kilometre north of the town at *Mulera*, a name that is probably a derivation of *Molera* (millstone quarry).



The quarry is in a unit of conglomerates, sandstones and clays (yellow). The rock exploited is conglomerate.



The location of the place name *Mulera* on the cadastre (SEC) on the northern outskirts of Alozaina.

Dating: The texts place the site in the middle of the 19th century.

Rock type: Conglomerate (Geological map 1051, Ronda, 1981). "*Almendrilla*" is a common name for conglomerate or puddingstone owing to the inclusions of rounded pebbles about the size of "almonds".

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Acknowledgements

I thank Francisco SÁNCHEZ of the Municipality of Alozaina for indicating the location of the site.

MA-7 Málaga

El Jabonero



Location: The Jabonero Valley stretches 10 kilometres from north to south through the Málaga Mountains before attaining the Mediterranean coast a few kilometres east of downtown Málaga. The location of the quarry is uncertain. With all the construction in this area over the last decades, it is unlikely that it is still conserved.

Source: García de la Leña is extremely laconic in his description of the uses of the “*piedra tosca*” (coarse, porous stone) in the Province of Málaga. He simply records that this type of rock was exploited for “*baza*” millstones in the Jabonero (García de la Leña 1789:106).

Toponymy: Toward the junction of the Jabonero Valley with the coast is the *Pedregalejo* neighbourhood. The term *pedregal* means a terrain covered by loose rocks. A quarry along the nearby slopes of the *San Telmo* hill is known to have supplied rock for the construction of the Málaga harbour (cf. website: Por las Piedras de la Historia). There is no evidence, however, that this quarry also supplied millstones.

Dating: The text dates the quarry to the end of the 18th century.

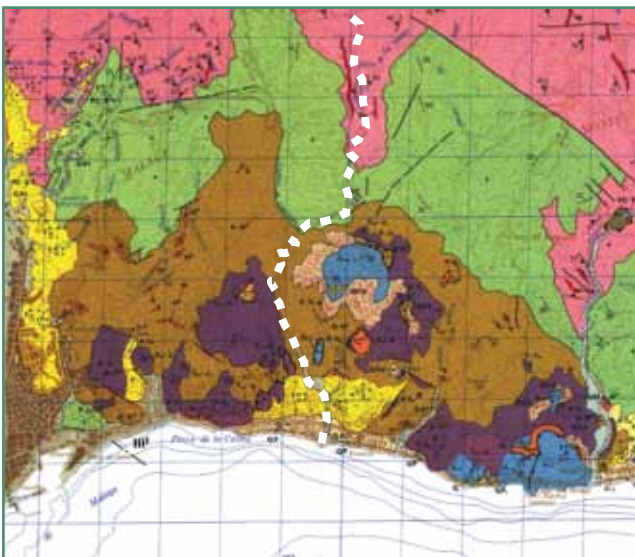
Rock type: “*Piedra tosca*” and “*baza*” (coarse limestone). Geological map 1053, Málaga, 1978.

Source

Website: Por las Piedras de la Historia, Recorrido por Málaga: <http://www.alhaurin.com/alandalus/Municipios%20andaluces/Malaga/Recorrido2.htm> [accessed November 13, 2012].

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Extract from Geological map 1053 (IGME). From north to south, the Jabonero Valley (white broken line) crosses units of a) phyllites and meta sandstones (pink); b) limestones (green); c) greywackes and phyllites (brown); d) sandstones, conglomerates, gypsum and loams (purple); e) piedemonte (mountain foot) rocks devoid of calcareous crust (yellow); f) alluvial (light grey); and g) undifferentiated (beige). The site could be anywhere in the a, b, d and e units.

MA-8 Casares

Sierra de Utrera Karst

Latitude: 36° 24' 38.92" N

Longitude: 5° 16' 33.09" W

Altitude: c. 200-250 m



Location: The Sierra de Utrera is a mountain (4 x 3 km) in the south-western corner of the Province of Málaga. It presents a rugged, karstic surface similar to the sites of El Torcal (MA-2) and Teba (MA-2). The millstone quarry is in the northern sector of the mountain.

Sources: The Royal Survey of Tomás López (1780), transcribed by Javier Martos, is the oldest written reference to the site. It records two quarries: one of white rock for the columns of an important church in Cádiz and one for millstones to flour mills.

A second source, a geological study, notes that the Utrera mountains are spotted with *piedras caballeras* that served for millstone making (Gómez Zotano 2003: 140). *Piedras caballeras* are rounded boulders resulting from a process of dissolution in which the boulders end up perched on a smaller rock base.

The quarry: The site is an extensive discontinuous exploitation, much like that of other karstic sites such as El Torcal (MA-1) and Teba (MA-2). The millstone makers had the choice of exploiting either individual surface boulders or bedrock.

This production should not be confused with the celebrated whetstone workings from the neighbouring Municipality of Manilva cited in a number of texts from the 18th and 19th centuries.

Dating: The written sources indicate millstone production at the end of the 18th century.

Rock type: Limestone. The geological map is not available.



Orthophoto of the Sierra de Utrera. The millstone quarry is to the north of the mountain. The modern workings are visible at the bottom of the picture (SIGPAC).

Extract of the Survey of Tomás López (1780)

"... tiene Cantera para sacar piedras para molinos de pan, tira de Jaspe blanco""otra cantera de la que se sacaron las cuatro columnas que adornan el frontispicio de la portada de la Santa Iglesia de Cádiz" (transcription by Javier Martos).



View from the south of the Sierra Utrera millstone quarry.



View of a sector of the Sierra Utrera millstone quarry.



Details of abandoned millstones in different stages of production (all photographs by Javier Martos).



Sources

Tomás López Survey answers in: http://www.iluana.com/galeria_ficha.asp?idgaleria=82&size=large&idfotografia=10129 [accessed October 22, 2012].

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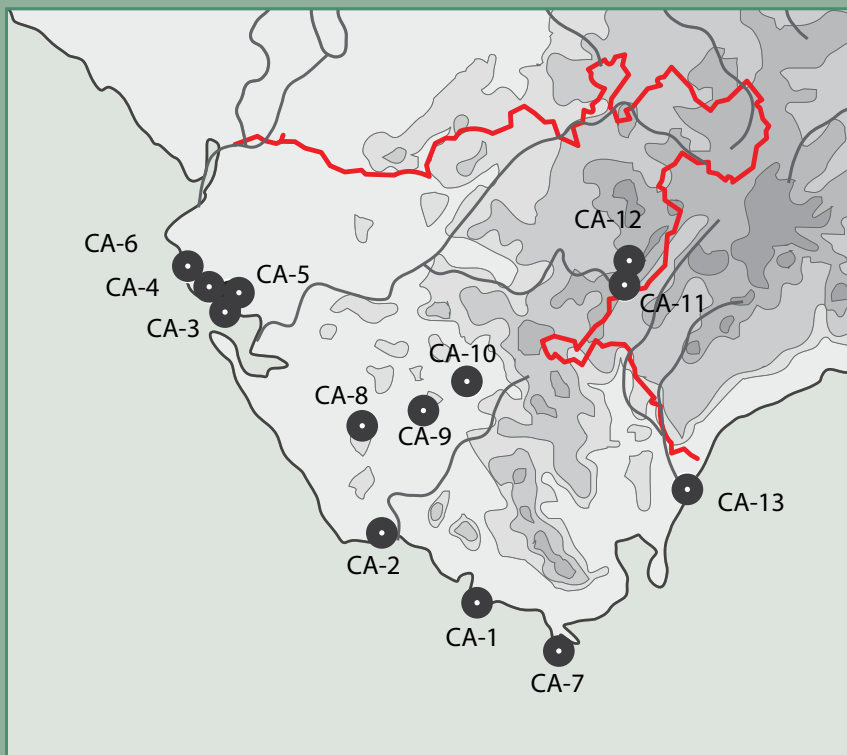
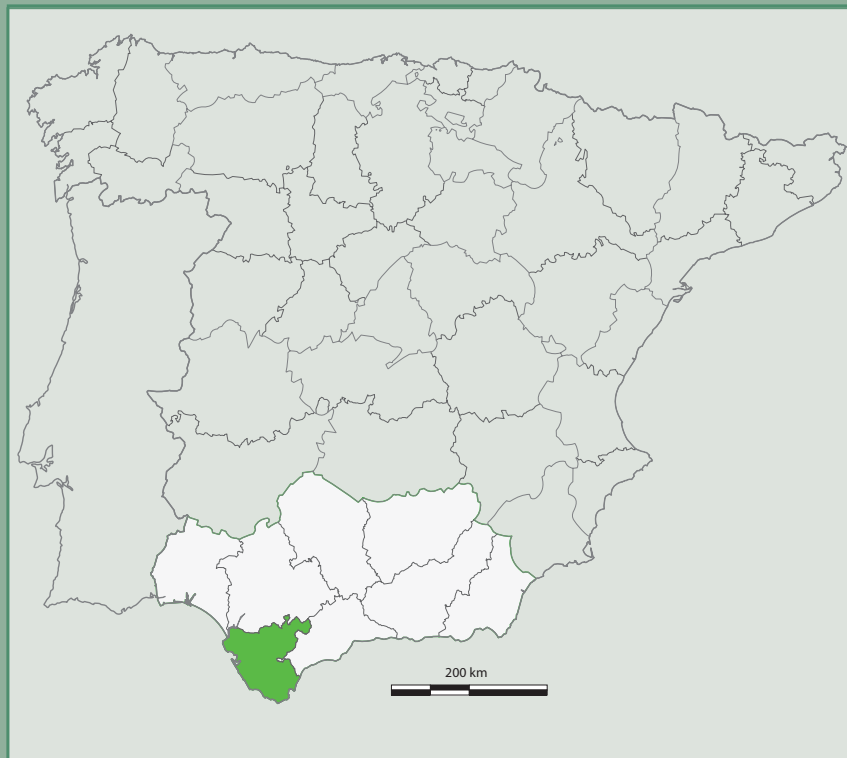
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Acknowledgements

I thank Javier MARTOS for information about this site and the photographs.

ANDALUSIA

CÁDIZ (CA)



CA-1 Barbate

*Bay of Trafalgar,
Playa del Faro*

Latitude: 36° 10' 55.16" N

Longitude: 6° 1' 49.75" W

Altitude: 0-1 m



View from the west of the eastern sector of the Trafalgar quern quarry.

Location: The quern and millstone quarry of Trafalgar is along the Atlantic coast at the Bay of Trafalgar, scene of the famous naval battle of 1805.

Source: The site, brought to the attention of Alain Belmont by a French geologist, is not recorded in any of written source. Since my first visit several years ago, I have cited the site in several articles (Anderson 2011: 231-232, 236; Anderson & Scarrow 2011: 267-268).

The quarry: This shallow surface quarry can be divided roughly into two major sectors. The eastern sector, limited to a surface of about 150 m², presents many small contiguous hollows corresponding to small rotary hand-quern extractions. The rest of the site, on a surface of about 100 x 20 m and partially under water during out visit, shows larger millstone

hollows. Owing to erosion by wind and water, the quarry's extraction hollows are smoothed over and reveal no tool marks.

Products and quantification: The querns from the eastern sector measure about 40 cm in diameter. Their number is in the low hundreds. The rest of the quarry produced hundreds of discs measuring between 80 cm and 1.10 m in diameter. These correspond, presumably, to millstones for either wind, water or animal-driven mills.

Transport and distribution: The location of the site on the coast, and certainly under water at high tide, facilitated maritime transport. Rotary querns of this characteristic rock are found on Roman settlements both up and down the Atlantic and part of the Mediterranean coast.

Dating: The date of the different sectors is impossible to determine with confidence. Rotary querns of similar dimensions have been brought to light at the Roman cities of *Baelo Claudia*, *Carteia* and *Iulia Traducta*.

The target diameter (80 cm to 1.10 m) and discoidal shape of the extractions of the second sector suggest

a Medieval date. But, once again, the chronology is not secure. In any case there is no evidence of more recent extractions surpassing a diameter of one metre.

Rock type: Shell-rich conglomerate (Geological Map 1076, Barbate, 1983). This facies is very similar to the yellowish, porous *piedra ostionera* ("oyster stone").



Details of the circular hollows corresponding to rotary querns measuring approximately 40 cm in diameter. The extractions follow the inclined bedding plane of the bedrock.



Views of the larger extraction hollows corresponding to millstones measuring approximately 80 cm in diameter.



Views of the larger extraction hollows corresponding to millstones measuring approximately 80 cm in diameter.



Before and after views the western sector of the quarry illustrating the shifting sand deposits that periodically cover the quarry floor.



Detail of the ostonera (biocalcarente) rock.



Extract from geological map 1076 (IGME). The light grey unit (no. 29) is a conglomerate with shells.

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Acknowledgements

I thank Alain BELMONT for relaying the information of this site's existence.

CA-2a Tarifa

Punta Camarinal

Latitude: 36° 5' 1.23" N
 Longitude: 5° 47' 14.95" W
 Altitude: 1-30 m



View from the west of one of the faces of the monumental Roman Punta Camarinal block quarry (photograph by Manuel L., <http://www.rutasyfotos.com/2011/09/duna-de-bolonia-punta-camarinal-cabo-de.html>).

Location: The Punta Camarinal is on the eastern edge of a point that juts into the Atlantic about one kilometre west of the Roman city of *Baelo Claudia* (Bolonia). The site was exploited both on the coast and inland mound at the Monte Camarinal.

Sources: The quarry is described briefly in the book about the Roman city of *Baelo Claudia* (Sillières *et al.* 1997: 71-72).

The quarry and products: The site is a monumental exploitation with extensive vertical quarry faces. This *ostionera* sandstone quarry, along with the limestone *jabaluna* quarry of San Bartolo (about five kilometres to the south-east), provided most of the building material of the Roman city of *Baelo Claudia*.

This quarry delivered ashlar, jambs, and column drums and capitals to *Baelo Claudia* (Román 2007: 21). There is, however, no direct evidence of millstone production. It is, nonetheless, probable that at least a part of the 40 *ostionera* rotary querns in the local *Baelo Claudia* depository (*Centro de Interpretación*) come from Punta Camarinal. In any case, there is

evidence that certain millstones in the Roman city were recycled from construction material originating at Punta Camarinal (see also CA-2b). An example is a circular hollow, corresponding to the size of a rotary quern, carved into a construction block.

A second example of re-use of construction material is an unfinished Pompeian upper stone discovered in an old excavation (Anderson *et al.* 2012, submitted).

Transport and distribution: Transport from the Punta Camarinal by water was facilitated by its position along the coast.

Dating: Saddle querns were produced presumably from these outcrops since late Prehistory (Torres Abril *et al.* 2003: 66). Large scale production only took place since Roman times.

Rock type: *Piedra ostionera* facies, a yellowish, porous, shell-rich rock (Geological Map 1077, Tarifa, 1983).



Example of a circular extraction (quern?) scored from a block in the Roman city of Baelo Claudia (photograph by Ivan García).



Example of an unfinished upper stone (catillus) at the Roman city of Baelo Claudia, probably recycled from construction material.



Extract from geological map 1077 (IGME). Unit 22 is conglomerate containing shells cemented together.

Sources

Photograph of the quarry from blog of Manuel L.: <http://www.rutasy-fotos.com/2011/09/duna-de-bolonia-punta-camarinal-cabo-de.html> [accessed October 20, 2012].

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Acknowledgements

I would like to thank Ángel MUÑOZ (director) and archaeologists Ivan GARCIA and Franciso ROJAS of the *Baelo Claudia* Centre of Interpretation for information about the local quarries and for opening up the depository of the centre to study the querns and millstones.

CA-2b Tarifa

Paloma Alta

Latitude: 36° 4' 21.78" N
Longitude: 5° 43' 52.79 W
Altitude: c. 150 m



Location and generalities: The Paloma Alta quarries are five kilometres south-east of *Baelo Claudia*. Most of the extraction took place on the upper slopes overlooking the coastline. Other work took place along the coast. Millstone workings are not certified. However, this quarry, along with that of Punta Camarinal (CA-2a), is a possible source of building material for *Baelo Claudia* that could have later been recycled into millstones.

Source: This quarry is mentioned in the study of *Baelo Claudia* (Sillières *et al.* 1997: 71-72). Unfortunately,

like the site of Punta Camarinal, no formal study of the quarry has been undertaken. Pictures are posted in a hiking itinerary available on the Internet (see source).

The quarry, products and dating: True extractive quarry for construction blocks and drums for columns. The drums are extracted both on horizontal and vertical planes. Roman.

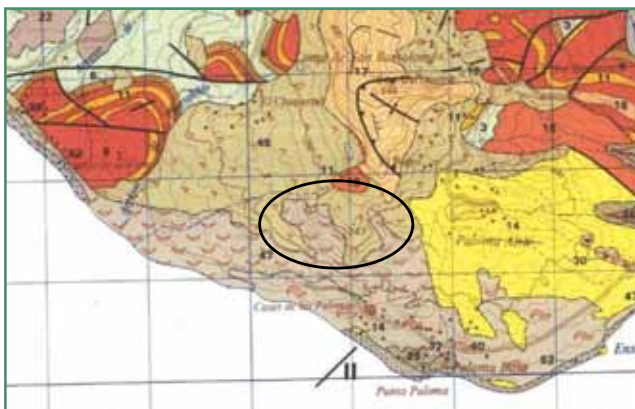
Rock type: Calcarenrite or *ostionera* (Geological Map 1077, Tarifa, 1983).



Abandoned column drum measuring about 1 m in diameter. This drum was cut on a vertical plane in the upper sector of the quarry (photograph from the blog *Canteras Romanas de la Paloma Alta*).



Abandoned drum in the lower sector of the quarry carved on a horizontal plane (photograph from the blog *Canteras Romanas de la Paloma Alta*).



Extract from geological map 1077 (IGME). The calcarenite outcrop does not correspond with the geological map (dunes).

Source

Hiking itinerary: "Canteras Romanas de Paloma Alta": <http://dcaminata.wordpress.com/2013/01/08/canteras-romanas-de-paloma-alta/> [accessed December 28, 2012].

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CA-3 Rota

Playa de la Costilla

Latitude: 36° 37' 9.18"N
Longitude: 6° 21' 51.23"W
Altitude: 0-1 m



View from the south-east of the Playa de la Costilla where abandoned quern and millstone extractions emerge at low tide (photograph by T. Anderson).



Example of an unfinished hand-quern (photograph by Prudente Arjona).

Location and generalities: Millstone workings took place on the *ostionera* outcrops along the Atlantic coast on both sides of the present lighthouse of Rota at the *Playa de la Costilla* and the *Playa del Rompidillo*. The construction of the new port between these two beaches, according to Prudente Arjona, destroyed part of the quarry.

Sources: The information and photographs gathered about this site come from a report on the Internet by the local historian Prudente Arjona. Further information from old legal archives was provided by José Antonio Martínez, the chronicler of the city of Rota.

Martínez's research in the archives has brought to light records narrating a contention dating to 1719 between the governor José de Velasco y Montoya and the residents Pedro Martín Pimienta and Juan de Vargas for extracting millstones illegally from the Rota beach. Furthermore, this research has revealed that in 1745, the municipal authorities reinforced the prohibition of millstone extraction without payment of a tax.

The quarry: The site, only visible at very low tide, falls into the category of a shallow surface quarry. Extractions are not concentrated in one single area, but spread out along the different outcrops.

Products and quantification: Both handquerns and millstones were produced. The querns measure approximately 40 cm in diameter. The millstones are much larger, measuring more than a meter.

Transport and distribution: In his report about flour mills in Rota, Arjona cites a source (Ponce 1981) that relates that two 19th-century Portuguese ships ("*Felicidade*" and "*O que Deus Quera*") sailed from their home port to acquire millstones at Rota. This information indicates that the Rota production was highly prized and circulated beyond the local sphere.

Large millstones, probably from recent times, are reported at a shipwreck south of this site (Martí & Rodríguez 2003:412-413). Although the authors suggest that they come from a quarry at the Punta de Nao (City of Cádiz), it cannot be excluded they come from Rota.

Dating: The hand-querns are probably Roman or Medieval. The millstones, based on the written sources, date from Modern and Contemporary times.

Rock type: The shell-rich *ostionera* rock facies is a yellowish, porous conglomerate (Geological Map 1061, Cádiz, 1984). The hardness of the stone is

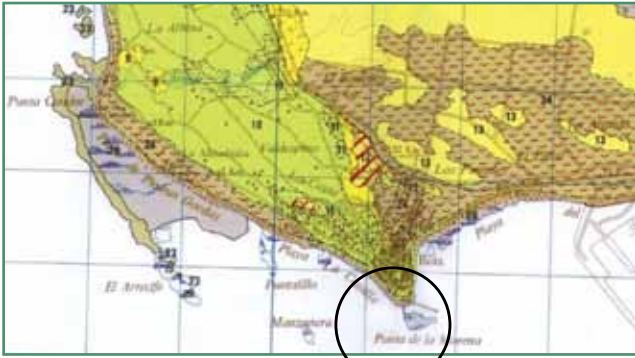
illustrated by the anecdote by Prudente Arjona that during recent construction of the port, the tools to drill the vertical holes often had to be replaced due to the rock's hardness.



Examples of large millstone extractions (all photographs by Prudente Arjona).



Examples of small rotary quern extractions (photos by Prudente Arjona).



Extract from geological map 1061 (IGME). The green unit (no. 10) is a shell-rich conglomerate. The dotted strand along the shoreline are the sands and shells of the present beaches.

Source

Prudente ARJONA LOBATO, *Historias Populares de Rota: Molinos, Tahonas y Tahoneros (II)*, *Cosas de Andalucía*: <http://www.cosasdeandalucia.com/web/index.php/memoria-historica/nuestros-ayeres/1658.html> [accessed November 25, 2012].

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Acknowledgements

I thank Prudente ARJONA, local historian, and José Antonio MARTÍNEZ, city chronicler, for information about these quarries and for authorising the use of their photographs.

CA-4 Rota

Playa de Aguadulce

Latitude: 36° 40' 17.48" N
Longitude: 6° 24' 37.20" W
Altitude: 0-1 m



Location: Playa de Aguadulce is on the Atlantic coast about seven kilometres north of the quern and millstone workings at Rota (CA-3).

Source and the quarry: José Antonio Martínez, the chronicler of the city of Rota, reports that an older resident of the city recalls that his father, a miller, placed an order for a millstone extracted at the Playa de Aguadulce. No quarry has been identified at this location. This extraction was probably isolated and production at this location never reached a large scale.

Dating: The extraction cited in the anecdote dates to the middle of the 20th century during the period of economic hardship after the Spanish Civil War.

Rock type: *Piedra ostionera* facies (conglomerate rich in oyster shells), Geological Map 1061, Cádiz, 1984.



Extract from geological map 1061 (IGME). The green unit (no. 10) corresponds to the shell-rich conglomerate. The dotted unit along the shoreline corresponds to the sands and shells of the present beaches.

Acknowledgements

I thank José Antonio MARTÍNEZ, Chronicler of the city of Rota, for taking the time to interview a group of older residents of Rota and gather precious oral information about local *ostionera* millstone production.

CA-5 Rota

Roa Martín (Ramos Martín)

Latitude: 36° 39' 55.95" N

Longitude: 6° 22' 53.05" W

Altitude: 20 m



Location and generalities: The quarry of Roa Martín (or Ramos Martín) is two kilometres from the Atlantic coast near the present military base. In the middle of the 18th century it was exploited for construction material. Two centuries later, however, it became a source of composite millstones.

Toponymy: The names *Canteras* and *Pedreras* (both meaning quarries), adjacent to the place name *Roa Martín*, appear respectively on the geographical map and the cadastre.

Sources and the quarry: A municipal record dating to 1756 (conserved in A. H. N. A. H. N., Nobleza, Osuna, libro 19, 104), studied by José Antonio Martínez, the chronicler of the city of Rota, states that due to the scarcity of rock in the town of Rota, the town authorised builders to extract stones at *Ramos Martín*.

Millstone workings, however, are only recorded in the 1940s-1950s, according to oral information collected by José Antonio Martínez. A local craftsman (possibly called Miguel Laínez Ruiz) assembled millstones of different sizes with rock fragments recovered at Roa Martín. He cut the rocks into segments and bounded them in moulds with concrete. This type of local production, probably following the example of composite French burrstones, is not surprising considering the harsh post-Civil War years.

Product and quantification: Composite or segmented millstones. This site is an example of a very modest local production.



The place name Pedreras (quarries) appears in place of Canteras (extract from the cadastre (SEC)).

Dating: The block quarry dates to the middle of the 18th century. Millstone production, however, is only recorded in the 1940s-1950s.

Rock type: According to the Geological map, the rock at *Roa Martín* is the shell-rich, *ostionera* conglomerate (Geological Map 1061, Cádiz, 1984). J. A. Martínez, however, notes that the *Roa Martín* rock is a reddish sandstone corresponding to unit 13 on the Geological map 1061 (IGME).



Extract from geological map 1061 (IGME). The quarry exploited a shell-rich conglomerate (yellow with reserved T symbol). The information provided by José Antonio Martínez would point to a reddish sandstone corresponding to the yellow 13 unit.

Source

Prudente ARJONA LOBATO, *Historias Populares de Rota: Molinos, Tahonas y Tahoneros (II)*, *Cosas de Andalucía*: <http://www.cosasdeandalucia.com/web/index.php/memoria-historica/nuestros-ayeres/1658.html> [accessed November 25, 2012].

Acknowledgements

I would like to thank José Antonio MARTÍNEZ and Prudente ARJONA for their valuable information about this site.

CA-6 Chipiona

Playa de las Canteras

Latitude: 36° 44' 20.26" N
Longitude: 6° 26' 30.27" W
Altitude: 0 m



View from the south of the millstone quarry of Chipiona. At the moment of the photograph the quarry was covered by tidewater. In the foreground are undated rectangular extractions and in the background the Roman fish corrals.

Location: This quarry is on the coast of the city of Chipiona between the lighthouse and the ancient fish corrals. During high tides it is completely covered by water.

Toponymy: Although the place name *Las Canteras* no longer appears on the geographical map, it remains on the cadastre as the name of a street. It is, nonetheless, not known if the name is related to the millstone or the block exploitation.

Sources: The site is identified as a millstone quarry in a study of a Roman villa (Ramos & Riesco 1983: 387). A more recent study interprets the circular hollows as basins to evaporate sea water to harvest salt (Alonso Villalobos *et al.* 2003: 322). Due to the existence of numerous *ostionera* querns and millstones on settlements along the Atlantic coastline, I lean toward the first interpretation. Holes in the bedrock could have served as receptacles to evaporate sea water for salt. But here it seems improbable due to regular flooding during high tides. Besides, most of the extraction hollows are along to the edge of the rock and without rims never could have held water.



The place name *Las Canteras* persists as the name of a street near the quarry (extract from the cadastre, SEC).

The quarry: Like other coastal exploitations, this is a true extractive, shallow, extensive surface quarry.

Product and quantification: The hollows and abandoned millstones correspond to cylinders measuring 1.20 - 1.25 m in diameter. Due to the difficult conditions of observation, their number is not possible to quantify. If the outcrop originally extended to the north, an area now devoid of rock, then production could have been great. There is no evidence of quern extractions, as is the case of other *ostionera* quarries.

Transport and distribution: These workings on the coast benefited from maritime transport.

Dating: The size of the extractions suggests an exploitation that could date from Medieval to Contemporary times.

Rock type: *Piedra Ostionera* (Geological Map 1047, Sanlúcar de Barrameda, 1984). Yellow, shell-rich sandstone.



Views of extraction hollows and abandoned cylinders corresponding to millstones measuring approximately 1.20 -1.25 m in diameter.



Extract from geological map 1047 (IGME). The quarry is in the thin shoreline ostonera unit (no. 12).

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CA-7 Tarifa

Isla de la Paloma

Latitude: 36° 0' 13.16" N
Longitude: 5° 36' 23.73" W
Altitude: 0-5 m



Location: The Isla de la Paloma is a minute island (500 x 400 m) linked by a jetty to the port of Tarifa. It is the southernmost extension of the Iberian Peninsula and features a lighthouse, an 18th-century fortification and a number of quarries where building material was scored since Roman times.

Sources: A scuba diving itinerary (Magariño & Sánchez 2007: 369) reveals the presence of several millstones in the waters along the eastern coast of the island that presumably come from a nearby coastal quarry.

The quarry: There are a number of *ostionera* block quarries recorded along the coast of the island. One is opposite the location of several sunken millstones. There is, however, no evidence of millstone workings at these sites. A hypothetical earlier millstone quarry could have disappeared in the 19th century during the massive workings to build the fortification.

Product: The dimensions of the millstones are not recorded.



View from the north of the island (extract from Google Maps Street View).

Transport and distribution: The presence of sunken millstones is evidence of maritime transport.

Dating: Unknown.

Rock type: A geological study identifies the rock as a shell-rich sandstone *piedra ostionera* (Román 2007). This coincides with the data of the Geological map (Geological Map 1077, Tarifa, 1983).



Extract from geological map 1077 (IGME). The quarries exploited a shell-rich conglomerate (unit 22). The yellow unit (no. 14) is made up of loams and mica sandstones.

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Acknowledgements

I thank Iván GARCÍA, archaeologist at the *Centro de Interpretación* of the Roman city of *Baelo Claudia*, for information about this site.

CA-8 Medina Sidonia

El Berrueco

Latitude: 36° 27' 4.89" N
Longitude: 6° 2' 20.30" W
Altitude: 70-100 m



View from the hilltop town of Medina Sidonia of the Berrueco mountain. The city of Chiclana on the Atlantic coast is in the background to the left and the Bay of Cádiz is to the right.



Orthophoto of the Berrueco Mountain (SIGPAC).

Location: The Berrueco mound is halfway between the hilltop town of Medina Sidonia and Chiclana, a city on the Atlantic coast.

Toponymy: The toponym *Berrueco* is generally associated with granite, a rock that is not known south of the Guadalquivir River Basin. It is, however, often identified with granite quarries elsewhere on the Iberian Peninsula, for example, at the town of Berruecos, Madrid (see M-1). Due to the rarity of this toponym in this region, I assume that the name was imported from the north of Spain after the fall of Islamic rule.

Sources: This site is one of the few that benefits from more than a simple passing written reference. There are several different sources spanning almost a century.

The oldest record of this quarry comes from a historical archive of Vejer de la Frontera dating to 1509, which indicates that Berruecos furnished the watermill "La Teja" with a millstone (http://www.patrimoniojandalitoral.es/f_vai_8.htm).

An indirect reference to the site comes in the response to the Census of the Marqués de Ensenada (1750-1754) that records that in Medina Sidonia, there are eleven millstone makers (six are *oficiales* and five *maestros*). Although not confirmed from the text, these men probably worked at the Berrueco quarry.

A third reference is a late 18th-century historical treatise penned by the priest of Medina Sidonia (Martínez y Delgado 1875). It is important to note that this work was only published in 1875, about a century after the author's death. The events taking place in the account, however, are set toward the end of the 18th century.

The local priest recorded that there was a vast "mine" of white, grainy stone exploited to equip both mills and "*atahonas*" (animal-driven flour mills). He also records that the quarry furnished stones to the mills of cities and towns of the region, granting the millstones makers, residents of Medina Sidonia (9 km away), an "advantageous" daily wage (Martínez y Delgado 1875: 129).



View from the east of the Berrueco quarry site. The installations of the 1960s for block extraction and quicklime production are in the centre at the foot of the mountain.

A generation later Cruz y Bahamonde, in a treatise on the commerce of Cádiz, noted that at the top of the Berrueco mountain there were dwellings that accommodated about 50 millstone makers. These workers made millstones that were favoured over those from other quarries. He also identifies the owner of the quarry as the Duke of Medina Sidonia who received 18 millstones a year in exchange for the concession (Cruz y Bahamonde 1813: 91, note 1).

The geographer Madoz alludes to the site on three occasions. Two are simple fleeting references (Madoz 1846, Vol. 5: 139-140; Madoz 1848, Vol. 11: 343), whereas the third reveals that the quarry was made up of five different workshops with 23 men who resided at the site. These millstone makers retained the right to bear “arms” (explosives) not only because they had the obligation to level some crags around the city of Medina Sidonia, but because they chased down the “*rateros*” (thieves) that at times appeared in the area (Madoz 1846, Vol. 4: 290).

The quarry: There are no longer traces of the millstone production. The installations visible today on the eastern slope correspond to the last phase of work at the site dating to the 1960s when blocks were extracted for the construction of the port of Rota (or crushed for quicklime production). The heart of the mountain is now a vast crater, indicative of a vast pit exploitation.

Product and quantification: I have not identified any abandoned millstones at the site. Later workings probably destroyed all traces of the earlier millstone workings. According to Madoz the yearly production consisted of 64 millstones for water or windmills and 480 “*granos*”, a term that specifically designates stones destined for animal-driven flour mills. The author

specifies that the stones were rounded at the site and sold ready for use (Madoz 1846, Vol. 4: 290). It is not clear if these final workings included carving the cuttings for rynds.

Berrueco millstones were obviously of superior quality and their production could be numbered in the thousands. I have no information as to their size. Since Madoz clearly indicates a difference between those for water or windmills and those for animal-driven mills, then it would appear that they differed in size and thickness.

Transport and distribution: According to the different sources, Berrueco millstones were traded over all of the region. The oldest reference, cited in a website about the history of Vejer de la Frontera, indicates Berrueco millstones arriving at the town in 1509. The transport of these products to Puebla de Guzman (Garrido 2001: 167), 170 kilometres away, is evidence that they were commercialised beyond the local sphere. The position of the quarry along the road linking Medina Sidonia to Chiclana would have facilitated land transport to the port of Chiclana where they could have been loaded on boats for maritime transport.

Dating: This sites was presumably active, based on old written sources, in early 16th century and then in the 18th through at least the middle of the 19th century. It is conceivable that it operated continuously between those dates.

Bread: Martínez y Delgado suggests that the Berrueco rock yielded a white flour in his description of the quarry of La Pila de Casares (see: CA-9), (Martínez y Delgado 1875: 129).

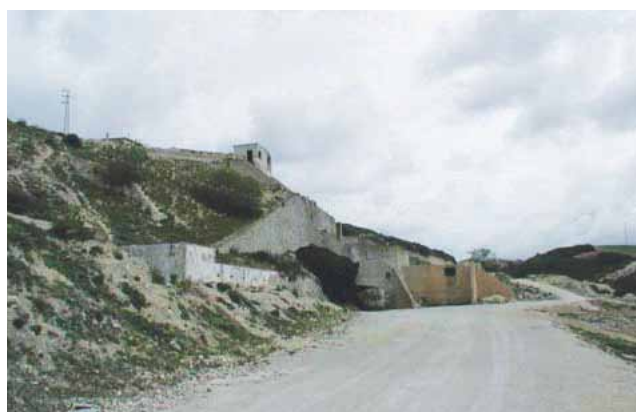
Rock type: Dolomite or limestone (Geological Map 1069, Chiclana de la Frontera, 1983). This is compatible with the description by Madoz that the stone is a hard, white rock (Madoz 1846, Vol. 4, 290).



View from the east of the emptied interior of the Berrueco mountain.



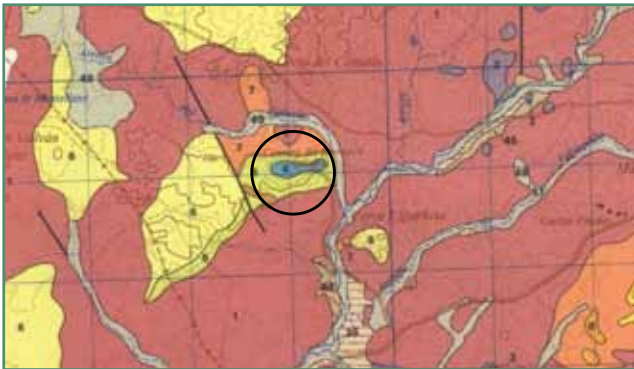
View of a working area on the north-eastern edge of the mountain. There is, however, no evidence of millstone extraction in this sector.



View of the modern industrial installations on the eastern slope.



Limestone millstone in the town hall of the city of Medina Sidonia. This upper stone (Ø: 1.10 m), possibly from the quarry of El Berrueco, equipped a windmill or tahona in Medina Sidonia, a city perched on the top of a mountain without sources of running water to power watermill.



Extract from geological map 1069 (IGME). The Berrueco quarry is a unit of dolomites and limestone (blue) surrounded by a unit of loamish limestones and white loams (yellow).

Source

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CA-9 Medina Sidonia

Pila de Casares

Latitude: 36° 27' 4.89" N
Longitude: 6° 2' 20.30" W
Altitude: 70-100 m



View from the north-west of the quarry of La Pila, now a vast exploitation site of limestone for lime.

Location: The quarry of La Pila de Casares is on a low mound about five kilometres south-east of Medina Sidonia. It is now a vast exploitation for construction material.

Source: The site is recorded in a local history of Medina Sidonia penned by a priest in the late 18th century (Martínez y Delgado 1875). The work was only published about a century after his death, placing the site toward the end of the 18th century. This site is not mentioned by any other 19th-century geographer (e.g. Madoz).

The quarry: The present industrial activity at this site has probably obliterated all traces of the ancient workings. Unfortunately the site is fenced off and impossible to survey. A local resident informed me that a millstone, now vanished, once decorated the entrance of the industrial site.

Product and quantification: Martínez y Delgado's history specifies that millstones for "*molinos y*

atahonas" (mills and animal-driven mills) were manufactured at this site (1875: 129). The author, unfortunately, does not designate if there are differences between the two types of millstones. Quantification of the production remains unknown.

Dating: The account of Martínez y Delgado places production toward the end of the 18th century.

Rock type: Dolomites and limestones or sandy limestones (Geological Map 1069, Chiclana de la Frontera, 1983).

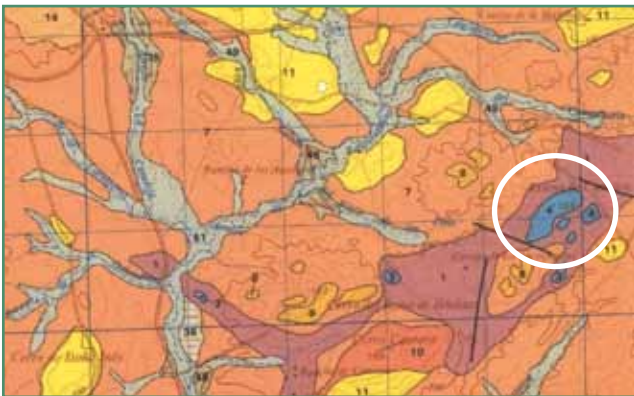
Bread: Martínez y Delgado provides rare insight into the quality of the rock and its influence on the flour it ground: "This rock is not as white as that of the Berrueco, but it is sharper and grinds better ... and although it yields more flour from the same proportion of grain, the flour is darker and the bread is somewhat browner (Martínez y Delgado 1875: 129). The allusion is to the nearby millstone quarry of El Berrueco, 15 kilometres to the west (see CA-8).



Views of the modern industrial exploitation.



Orthophoto of the modern industrial exploitation (SIGPAC).



Extract from geological map 1069 (IGME). The quarry is in the dolomite and limestone unit (blue) surrounded by clays and sandstones (purple).

"Esta piedra no es tan blanca como la de Berrueco, pero es más cortante y muele mejor... y porque aunque saca más harina de igual porción de trigo, sale prieta y queda el pan algo moreno."

(from Martínez y Delgado 1875: 129).

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CA-10 Alcalá de los Gazules

Peña Arpada

Latitude: 36°30'02.07" N
Longitude: 5°47'47.24" W
Altitude: c. 200 m



View from the south of the summit of the Peña Arpada mountain.



Orthophoto of the Peña Arpada mound (SIGPAC).

Location: *Peña Arpada*, as its name *peña* (rock or crag) suggests, is an elevation with a rugged peak. The site is off the main road between the towns of Paterna de Ribera and Alcalá de los Gazules. It is a biotope for a particular type of flower and a place of interest for both ornithologists and rock climbers.

Sources: Madoz, in his description of the productions of Alcalá de los Gazules, records that the millstone quarry at "*Peña-Jarpa*" specifically made millstones for flour mills (Madoz 1845, Vol. 1: 376).

A very recent survey of the mound by geologists and historians (Giles *et al.* 2011) certifies the millstone workings at the top to the crag and brings to attention a neighbouring outcrop of ophite-dolerite at the hill's base (the summit of a volcanic dyke) that was exploited for pounders and possibly rubbers (*manos*) used with saddle querns since prehistoric times (Giles *et al.* 2011: 117-118).

The quarry: Due to the limited size of the crag (less than 5000 m²), the quarry is not extensive. Extraction took place on at least three different levels. On the two lower levels, one can distinguish several tiers of true extractive horizontal extractions. At the upper level, near the summit (difficult to attain), several extractions took place on vertical planes. Scoring vertically suggests that the rock is very compact and homogeneous.

At the lower level, on the same plane as a series of Medieval drywall features, there is an area of about 100 m² with an unfinished millstone in its centre. This area, flanked by extraction hollows, could have served as a millstone fashioning workshop.

It is also conceivable that millstones were hewn from blocks that were naturally detached or loosely connected to the bedrock.

Products and quantification: There are several unfinished or broken millstones strewn about the site. One, with a pierced eye, is 1.27 m in diameter and 50 cm thick. Other fragments are comparable in size. At least two cylinders, more than a metre in diameter and almost a metre thick, could be oil rollers. The number of extractions is difficult to quantify. From the space available I estimate production to have been between 50 and 100.

Techniques: Tool marks, in general, are poorly visible. Multiple diagonal lines in one sector reveal trenching with a pick.

Transport and distribution: The task of lowering the heavy millstones through the rugged outcrop and down the slope would have been complicated. Once at the foot of the mound, the cylinders would have been ferried by cart along the road linking Paterna to Alcalá de los Gazules.

Dwelling: The architectural features toward the top of the mound correspond to either a watchtower or fortification (Giles *et al.* 2011). These could have served as a refuge for the quarrymen.

Dating: Based on the Madoz text, the quarry dates at least to the first half of the 19th century. From the size of the extractions, work could have taken place since Medieval times. The pounder (ophite-dolerite) exploitation, at the base of the mountain, is Prehistoric.

Rock type: Dolomites and limestones (Geological Map 1063, Algar, 1984) for millstones. Ophites (dolerite) for Prehistoric pounders.



View of an unfinished millstone in an open space that was could have served as a workshop.



A vertical extraction hollow toward the top of the site.



Examples of horizontal extraction hollows in the lower levels of the quarry.



View of an unfinished millstone with a pierced eye.



Examples of abandoned millstone fragments.



Examples of abandoned thick cylinders, possibly oil rollers.



Feature of a Medieval defensive structure or observation post. This old construction was probably used as a refuge for the millstone makers.



Extract from geological map 1063 (IGME). The quarry is in an isolated limestone and dolomite unit (blue).

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I thank Antonio Manuel de la VEGA DURAN for leading me to the site.

CA-11 Ubrique

Salto de la Mora

Latitude: 36° 41' 16.02"N

Longitude: 5° 26' 49.65"W

Altitude: 580 m



View from the town of Ubrique of the Salto de la Mora mountain (photograph by Manuel Cabello Izquierdo).



Circular hollows toward the summit of the Salto de la Mora mountain (photograph by Manuel Cabello Izquierdo).

Location: Ubrique is a town in the mountains of Grazalema. It is known traditionally for its leather products. The quarry is toward the summit of the Salto de la Mora Mountain, just north of Ubrique, inside the ancient walls of the Roman settlement of *Ocuri*.

Sources: The site is identified through the Internet blog of Manuel Cabello and Ester Izquierdo. Although I have not identified any mention of millstones workings in old texts, the town is known for its whetstone production (García de la Leña 1789: 106-107; Madoz 146, Vol. 5: 140).

The quarry: The authors of the blog label the features "*cunas*" (nests) and interpret them either as basins to collect rainwater or millstone hollows. From the photographs, the site appears to be a pocket quarry.

Techniques: Multiple diagonal marks indicating pick work are clearly visible on the quarry faces.

Product and quantification: From the photographs the millstones seem to measure about a metre in diameter. The authors of the blog do not indicate the number of extractions.

Transport and distribution: Owing to the difficult access of the site, production was probably local.

Dating: Although the site is inside the ancient Roman settlement of *Ocuri*, it is not Roman. From the size of the cylinders, it was probably exploited sometime between Medieval and Contemporary times.

Rock type: Dolomite (Geological map 1050, Ubrique, 1980).



Detail of an abandoned cylinder (photograph by Jesús Ortíz).



Extract from geological map 1050 (IGME). The quarry is in the unit of dolomite (grey, no. 51).



Detail of an extraction hollow (photograph by Manuel Cabello).

Sources

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CA-12 Benaocaz

El Esparragal

Latitude: 36° 41' 54.92" N
Longitude: 5° 26' 50.80" W
Altitude: c.. 570 m



View from the south-east of the El Esparragal hill (photograph by Leandro Cabello).

Location and source: The Esparragal quarry is in the Grazalema Mountains on a conical mound about two kilometres north of Ubrique along the road leading to Benaocaz (see CA-12). It is identified in the Internet blog by Manuel Cabello and Ester Izquierdo of Ubrique.

The quarry: The extraction hollow seen in one photograph indicates a true extractive site, probably a pocket quarry.

Products and quantification: I do not know the exact size of the millstones or the number produced. From the photographs they appear to be around one metre in diameter.

Transport and distribution: The author of the blog records an anecdote, related to him by local resident, of how a millstone was transported from this site to Ubrique. Juan Pino met three people on the road to Benaocaz who were transporting a millstone

from the meadow along a path beside the Laguna. Intrigued as to how the heavy millstone was moved along the stone-paved road, the men replied that they inserted a pole through the hole permitting two of them to hold the millstone upright while the third pushed the millstone forward or slowed it down, depending on the terrain.

Dwelling: The authors of the blog say that a *covacha* (hovel) in the area could have provided temporary shelter for the quarrymen. Their permanent residence was probably in Ubrique, a few minutes downhill from the site.

Dating: The anecdote indicates the quarry was active in the first half of the 20th century.

Rock type: Limestones or oolites (Geological Map 1050, Ubrique 1980). This rock is also compatible with the type of material necessary for the nearby lime kiln reported in the blog.



Abandoned unfinished millstone (photograph by L. Cabello).



Circular extraction hollow toward the summit of the Salto de la Mora mountain (photograph by L. Cabello).



Stone covacha (hovel) that could have provided cover for the millstone makers (photograph by L. Cabello).



Extract from geological map 1050 (IGME). The quarry is in a unit of limestone or oolite.

A anecdote about how to transport a millstone

“Como anécdota [Juan Pino] recordaba que un día se encontró en la carretera de Benaocaz más arriba de Santa Lucía a tres personas que traían una piedra de molino desde la zona del hondón y habían pasado por una vereda que esta junto a La Laguna. Al preguntarle intrigado como la trasladaban, teniendo en cuenta que era un camino empedrado y el peso, la respuesta: Pues le habían puesto una viga en el agujero y la sujetaban entre dos, el tercero la empujaba o la frenaba según el terreno”.

(from Leandro Cabello in the blog of M. Cabello and E. Izquierdo, October 27, 2010).

Source

Leandro CABELLO, ¿Como se puede trasladar una piedra de molino? in the blog of M. CABELLO and E. IZQUIERDO, October 27, 2010: <http://manuelcabelloyesperanzaizquierdo.blogspot.com.es/2010/10/como-se-puede-trasladar-una-piedra-de.html> [accessed November 6, 2012].

CA-13 San Roque

Las Canteras - Guadalquítón

Latitude: 36° 16' 28.71"N
Longitude: 5° 19' 48.23"W
Altitude: c. 40-70 m



Location: The Las Canteras millstone quarry is in the Guadalquítón basin along a stream bearing the name *Arroyo de las Canteras*. It is about 10 kilometres north-east of the city of San Roque and three kilometres from the Mediterranean coast. Most of this area has in the last few years been built over during urban expansion.

Sources: The site is mentioned briefly in several articles about the local history by Benoso Santos.

Toponymy: *Las Canteras* (the quarries) is a place name frequently associated with millstone extraction.

The quarry: The exact location of the site is not known. If it is still preserved, it could be along the stream in the tree line between a golf course and a series of houses.

Products, quantification and distribution: Benoso notes that these millstones, known popularly as "*guadalquitonas*," were the main source of stones for local mills (Beneroso 2011, 499, note 18). This suggests a modest production.

Dating: According to Beneroso, the quarry was in use as late as the 1960s (Beneroso 2011: 498, note 18). There is no evidence indicating an earlier use.

Rock type: Lumachella limestone (Geological Map 1075, San Roque, 1980).



Abandoned millstone (from Beneroso 2007:15, photograph by Manuel L. Pérez Serralbo).



Extract from geological map 1075 (IGME). The quarry is in a unit of lumachella limestone (orange no. 13).

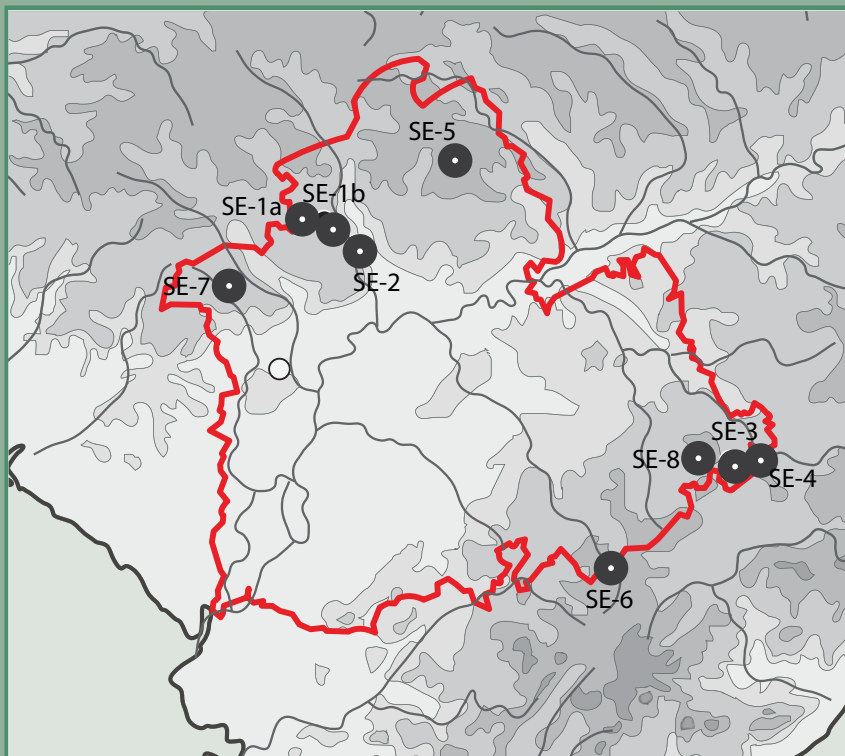
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ANDALUSIA

SEVILLE (SE)



SE-1a Almadén de la Plata

Arroyo de las Calzadilla 1

Latitude: 37° 51' 37.54" N

Longitude: 6° 1' 2.45" W

Altitude: 260-270 m



View from the south of the quern quarry along the bed of the ravine uphill from the Calzadilla stream.

Location and generalities: The Calzadilla quern quarry is six kilometres east of the town of Almadén de la Plata along the Calzadilla stream. It is in the Andalusian Natural Park of the Sierra Norte, a region with great geological diversity that was recently selected as a member of the network of European Geoparks.

Source: The site was discovered by workmen clearing brush during forest fire prevention. They originally interpreted the circular extraction hollows as “jellyfish fossils”. The site was publicised through a television interview with archaeologist Miguel Ángel Vargas (available on Youtube). Since then it has been recorded in an article submitted to the proceedings of the Bergen Colloquium (Anderson *et al.* 2014).

Toponymy: The place name “Calzadilla” is the diminutive of “calzada”, meaning road, and is associated with a commercial thoroughfare that follows the waterway and dates presumably to Antiquity.

The quarry: The largest sector of this site is a shallow surface quern exploitation in the bed of a lateral ravine about 100 m uphill from the stream. Depending on the time of the year, certain extractions are under water. In the lower part of the ravine there are isolated or clustered quern workings. Other hollows are possibly hidden under a thin layer of topsoil.

Techniques: Extraction was restricted to layers of micro-conglomerate containing small homogeneous pebbles. The outcrops with larger pebbles (1 cm)

were avoided. Extreme weathering of the rock surface renders the extraction techniques difficult to interpret. From what I have observed, a circular trench was first cut around the cylinder with a pick applying the technique of three “passes”. To split the cylinder from the bedrock, the quarryman cut about 30 small holes with a pointed chisel at regular intervals (every 6 - 7 cm) along the cylinder’s perimeter. These holes are directed to the centre and their traces resemble the dial of a clock. The impacts from cutting these holes was probably sufficient to split the cylinder and wedging (with iron wedges or wooden pegs) was not necessary.

Products and quantification: The cylinders correspond systematically to discoidal rotary querns measuring 50 cm in diameter. There is no deviation in size. This indicates a standardised product.

Transport and distribution: The nearby *Calzadillas* road facilitated transport. From the number extracted, less than 50, it is doubtful that the product was commercialised over very long distances

Dating: Quarries producing these types of querns (at 50 cm in diameter) are rare in the Iberian Peninsula. Based on my research on rotary querns, these discoidal stones are larger and thinner than their earlier Iron Age and Roman counterparts. They are also notably thinner than Contemporary animal fodder querns. Therefore this quarry must date to Medieval times, possibly to the period of Islamic domination.

Rock type: Conglomerate (Geological map 919, Almadén de la Plata, 1972). In the words of the geologist Alberto Gil: “The rock is a brownish, coarse micro-conglomerate containing rounded clasts (<1 cm). The Viar basin is a continental basin from the Lower Permian Age (300 million years) to presumably the Lower Triassic Age (235 million years). The deposits are fluvial conglomerates constituted of a mixture of local scree and braided conglomeratic sandstones, red beds, and acidic volcanoclastic deposits.”



View of the quern quarry with the shallow surface extraction hollows.



Detail of the extraction hollows corresponding to rotary querns measuring about 50 cm in diameter.



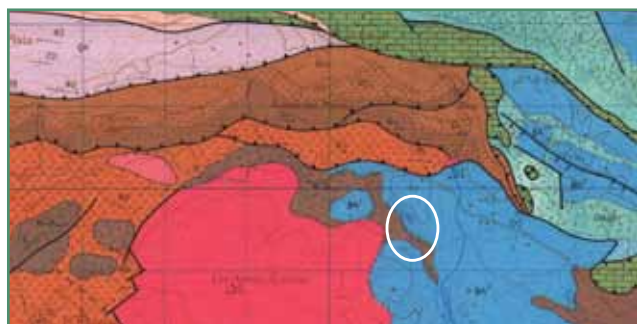
Detail of a small group of quern extractions downhill from the larger extraction sector.



Detail of a partly covered, unfinished cylinder.



Detail of the micro-conglomerate.



Extract from geological map 919 (IGME). The quarry is in a unit of conglomerate (brown with circles) and not the spilites, altered basalt units (in blue).

Source

Television interview with Miguel Ángel VARGAS: http://www.canalsur.es/portal_rtva/web/noticia/id/112752/portada/hallada_una_cantera_de_epoca_romana_en_almaden [accessed November 12, 2011].

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Acknowledgements

I thank the archaeologist Miguel Ángel VARGAS (PRODETUR) and the geologist Alberto GIL TOJA (TRAGSA) for guiding me to the site.

SE-1b Almaden de la Plata

Arroyo de las Calzadilla 2

Latitude: 37° 51' 31.99" N

Longitude: 6° 1' 5.66" W

Altitude: 250 m



View from the east of an outcrop of conglomerate in the heart of the Calzadillas stream with both quern and small millstone extraction hollows.

Location and generalities: This quern and millstone quarry is directly in the bed of the *Calzadilla* stream, about a hundred metres below the quern extraction sector (see SE-1a). Here the dominant product is the medium-sized cylinder (80 cm) destined for either watermills or animal-driven mills.

The quarry: The site is an extensive shallow surface quarry. It comprises a series of discontinuous outcrops spread along the riverbed over about 150 m. In winter, during the rainy season, the extractions are covered by water. This accounts for the extreme weathering of their surface that has erased most of the tool marks.

Product, quantification and dating: The extraction hollows correspond to millstones measuring about 80 cm in diameter, a size that points to a very old exploitation probably contemporary to the querns (Medieval). The total production is modest, probably fewer than 50. The scoring techniques of both the querns and millstones (true extraction) are identical, suggesting that they are contemporary.

Rock type: Micro-conglomerate (see SE-1).



Examples of extraction hollows corresponding to small millstones measuring approximately 80 cm in diameter.



Examples of extraction hollows corresponding to querns measuring approximately 50 cm in diameter (all photographs by T. Anderson except 3-4 by Alberto Gil Toja).



Detail of the conglomerate (photograph by Alberto Gil Toja).

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Acknowledgements

I thank the archaeologist Miguel Ángel VARGAS (PRODETUR), the geologist Alberto GIL TOJA and the biologist Rafael PÉREZ de GUZMÁN PUJA (TRAGSA) for guiding me to the site.

SE-2 El Pedroso

El Castillejo

Latitude: 37° 46' 26.02"N
Longitude: 5° 52' 27.33"W
Altitude: 95 m



View from the south of the sandstone outcrop bearing the quern extractions.

Location: The quarry of *Castillejos* is in the Sierra Norte National Park in the Viar River Valley about 15 kilometres south-west of the *Calzadillas* site (SE-1). Since it is not accessible (behind a fence), it is not possible to ascertain if the extractions are isolated or part of a larger exploitation.

The quarry: This shallow surface quarry comprises, from what can be observed, only two small, extremely weathered hollows.

Products and quantification: The cylinders correspond to discoidal handquerns measuring about 40 cm in diameter.

Dating: Although the diameter of 40 cm suggests a Roman date, the modest width points to the Middle Ages.

Rock type: Conglomerate (Geological map, 940, Castilblanco de los Arroyos, 1975).



Detail of the two weathered extraction hollows.



Extract from geological map 940 (IGME). The quarry is in the heart of a conglomerate unit (brown).

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Acknowledgements

I thank the archaeologist Miguel Ángel VARGAS (PRODETUR), the geologist Alberto GIL TOJA and the biologist Rafael PÉREZ de GUZMÁN PUJA (TRAGSA) for guiding me to the site.

SE-3 Lora de Estepa

El Hacho

Latitude: 37° 17' 56.11"N

Longitude: 4° 50' 18.44"W

Altitude: 390-400 m



View from the north of the extremity of Hacho Mountain. The millstone quarry is on the slope in the oak forest above the olive orchard.

Location: This site covers a surface of about half a hectare on the slope at the northern extremity of the *Sierra del Hacho*, beside the road linking the town of La Salada to the city of Estepa.

Source: According to Madoz, the material is a "*piedra bravía, blanca y apropiado para molinos de harina*" (coarse, white rock appropriate for flour mills) (Madoz 1847, Vol. 7: 690).

The quarry: Since the outcrop is in a fractured, karstic terrain, the site is organised in a series of small pockets covering a surface of less than 100 m².

Techniques: From the few visible tool marks, it appears that cylinders were cut directly into the bedrock along horizontal planes. The hollows are at times superimposed on up to three levels. It is also possible that part of the production was scored from detached blocks.

The rough cylinders were fashioned beside the extraction zones, propped up on rocks that served as pedestals. These small workshops can at times be made out, despite the absence of a cylinder, from a cluster of larger pedestal rocks surrounded by an "aura" of finer fashioning debris.

Each extraction workshop is accompanied by a mound or cordon of working debris. The spoil, always downhill, appears at times to have backfilled earlier extraction sectors.

Products and quantification: The cylinders measure between 1.00 and 1.20 m in diameter. A very thick example might be for an oil roller. A local resident informed me that most of the better preserved cylinders were removed and now decorate the gardens of private residences. Production here is quantified roughly to between 50 and 100 cylinders.

Transport and distribution: Export of the product to local mills would have been facilitated by the nearby road linking La Salada and Estepa.

Dating: The Madoz reference places the site toward the middle of the 19th century.

Rock type: Limestone (Geological map 1006, Benamejí, 1983). Madoz specifies that the quarry exploited a white, "*bravia*" (meaning rough or coarse) rock.



General views and details of different pocket extraction workshops.



Examples of cordons of working debris in front of the workshops.



Examples of cordons of working debris in front of the workshops.



Examples of abandoned millstones measuring between 1.00 and 1.20 m in diameter. The cylinders are at times propped on rocks (pedestals) to facilitate their fashioning.



Extract from geological map 1006 (IGME). The quarry is at the northern fringe of the a limestone (blue) outcrop.

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SE-4 Casariche

Cerro Bellido

Latitude: 37° 16' 57.20" N
Longitude: 4° 45' 44.36" W
Altitude: 350-358 m



View from the north of the Cerro Bellido quarry.

Location and generalities: The Roman Cerro Bellido drum column quarry is on a hillock south of the town of Casariche. This one of the best preserved and most spectacular cylinder extraction sites of southern Spain and one of the few that is officially protected and provided with paths and explanation panels.

Although not technically a millstone quarry, it is retained in this catalogue because it is presumably the source of millstones found in old mills along the nearby Yeguas River. It appears that abandoned Roman drums at this site were recycled into millstones in more recent times. It must be noted that the rock is a hard, porous limestone that is known elsewhere to have been exploited for millstones.

A second Roman extraction site, *La Canteruela* (meaning small quarry), about one kilometre to the north-east, is identical to that of Cerro Bellido. Unfortunately, this "twin" quarry did not benefit from the attention granted to Cerro Bellido and is now a landfill.

The quarry: The site is a deep open-air pit where large cylinders were scored directly from a massive limestone stratum. This resulted in a great number of tubular quarry faces.

Extraction marks are very well conserved. Because of the significant width of certain cylinders, up to about a metre, the parallel pick lines visible on the quarry



View of the Cerro Bellido quarry from the west.



View of the Cerro Bellido quarry from the east.

faces take on the shape of arcs. This indicates a semi-circular trajectory of the pick when cutting into the deep circular trench around the cylinder.

The drums were split by means of wedges placed in a single large wedge hole (about 25 cm long), as seen along the base of an abandoned drum. Extraction here therefore did not require cutting multiple wedge holes around the cylinder's perimeter.

Products and quantification: There is no indication that the quarry produced anything but cylindrical column drums measuring about one metre in diameter and one metre thick. Hundreds of drums were scored at this site.

Transport and distribution: The drums are reputed to have been transported to the Roman city of *Corduba* (Córdoba) for use in monumental buildings.

Dating: Roman. There is no evidence of more recent extractions.

Rock type: Rough, porous limestone (Geological map 988, Puente-Geníl, 1988).



Detail of a tubular quarry face with parallel tool marks revealing an arc-shaped trajectory of the pick used to cut the circular trench.



Orthophoto of the Cerro Bellido quarry (SIGPAC).



Examples of abandoned Roman column drums. The example on the lower left has a large, single wedge hole along its base. These types of Roman column drums would have easily been recycled into millstones in later periods.



Extract from geological map 988 (IGME). The limestone outcrops in the circle (in yellow) correspond to a Roman exploitation.

The “twin” quarry Las Canteruelas, 1 kilometre north-east of Cerro Bellido, that is now a landfill (photo by Franciso, <http://historiadecasariche.blogspot.com.es/p/23-cerro-bellido.html>).

Sources

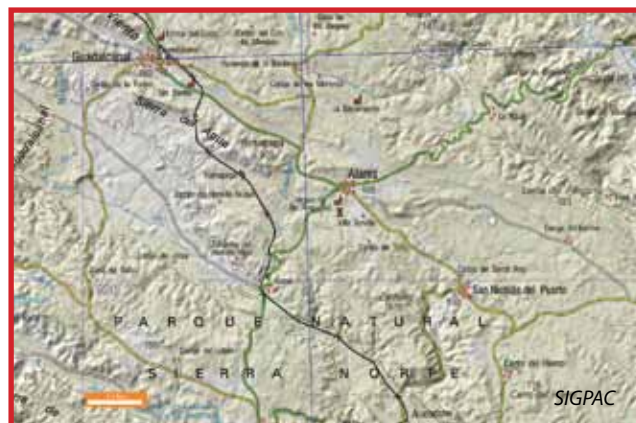
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Francisco ESTEPA: <http://historiadecasariche.blogspot.com.es/p/23-cerro-bellido.html> [accessed October 14, 2012].

Acknowledgment

I thank F. ESTEPA, local historian, for information about this site.

SE-5 Alanís



Location and generalities: Alanís is a large municipality (280 km²) along the northern border of the Province of Seville toward the edge of the Sierra Morena mountains. Research of millstone quarry toponyms and inquiries among local authorities did not yield any data as to the location of these sites. The rock type remains unknown.

Source: Alanís is cited since the 18th century in several geographical dictionaries for its whetstones to sharpen razors. Beside the whetstone production, Madoz also briefly mentions millstone workings (1845, Vol. 1: 190). This author, unfortunately, throws no light on any particular aspect or location of the site.

Dating: Middle of the 19th century.

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SE-6 Villanueva de San Juan



Location: Villanueva de San Juan is a small municipality (34 km²) in the rolling hills north of the Sierra de la Rábida in the south-eastern area of the Province of Seville (bordering the Provinces of Cádiz and Málaga).

Source: Madoz records that “...there is a millstone quarry that is not exploited for lack of a road” (Madoz 1850, Vol. 16: 207). Madoz goes on to specify that all the roads in the municipality are “local” and “bad”. He provides no clue as to the site’s location and leaves us with the doubt if millstone workings ever took place. In any case, I have not identified any place name in the municipality indicative of millstone production.

Transport: Madoz’s text highlights the importance of a network of roads to facilitate the trade of millstones.

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SE-7 Gerena district



Location, sources and generalities: Gerena is in the heart of a granite district north of Seville at the foot of the Sierra Morena. It has a long tradition of granite quarrying. In Antiquity Gerena presumably supplied granite for constructions in the Roman city of *Italica* (12 km away). A small museum (*Museo del Cantero*), dedicated to the legacy of stonework (cobblestones, building stones, oil rollers), was inaugurated in Gerena in 2007. Among the different materials, the museum contains granite handquerns that firmly place local granite workings in Roman and Medieval times.

The town is especially well known for its cone-shaped rollers for olive oil *almazaras*, one of the main industries of Andalusia (Madoz 1847, Vol. 8: 348). Examples of these rollers can be seen in a series of old photographs presented in this catalogue entry (Acuña Carabantes 2004). In one photograph, among the conical roller workings and construction material, there is what appears to be a large cylindrical millstone roughout propped on rocks and in the process of fashioning.

Lucas Acuña Carabantes, author of a history of Gerena (2004), notes the presence of larger granite millstones in old flour mills. It is perfectly conceivable that these large millstones were made in the same quarries that yielded the conical rollers and blocks for construction.

Toponymy: Several place names in and around Gerena relate to rocks and rock working (*Las Canteras*, *Las Perreras*, *El Berrocal*). Yet none of these toponyms can be specifically linked to cylindrical cereal grinding millstone workings.

The quarries: The quarries of Gerena such as *La Rodadera* in the middle of town are deep open air pits where large blocks were detached before being fashioned. Since the quarry floors cut through the level



Orthophoto indicating the exploitations inside Gerena. The different pits to the north-east of the Fuente Santa quarry are now filled with water. The other two quarries are backfilled. The Tajo of Pepe Luis (centre) is now a heliport, and Los Rodaderos (bottom left) is integrated into an urban park (SIGPAC).

of the water table, rising water had to be constantly removed. Water penetration explains why some of these sites today are either under water, or completely backfilled with earth and rubble, as in the case of the *Tajo of Pepe Luis*. Old photographs (Acuña Carabantes 2004) offer an impression of the arduous working conditions, as well as the rugged aspect of the quarrymen.

Products and quantification: Gerena products included conical oil rollers, cobblestones, and diverse construction material such as columns for buildings in both Seville and Cádiz (blog of G. Herdugo). In spite of the scant photographic evidence, it is perfectly plausible that cylindrical millstones, much simpler to fashion than conical oil rollers (due to their more simple form), were also produced in the area. In any case, Gerena's homogenous and compact granite was perfectly suitable for the production of a wide array of products.

Transport and distribution: Genera is one of the few quarry districts that benefited from a special rail link (6,8 km long) built in 1911 to connect its granite quarries to the mining district of Aznalcóllar to San Juan de Aznalfarache on the Guadalquivir River near Seville (33 km). Several old photographs show rock products being loaded onto a train at Gerena (website of El Ferrocarril De Aznalcóllar - Guadalquivir). Once again, there are no old photographs indicating millstone transport.

Dating: There is evidence that millstone production ranged from Roman until Contemporary times.

Rock type: Granite (Geological map 962, Alcalá del Río, 1972). The Granite of Genera is reputed to have been particularly hard, a feature necessary

for millstones. According to oral information, this hardness, ironically, was the cause of the demise of Genera's quarries because their exploitation became too costly.



Views of the backfilled pit quarry called the Tajo de Pepe Luis (Kini SANTOS: http://gerenaverde.blogspot.com.es/2010/10/el-pgou-desprotege-las-canteras-reduce_26.html).



View of the Tajo de Barriales and Tajo de Los Meino pits of the Fuente Santa quarry (photograph by L. Acuña Carabantes).



Detail of a working area of a quarry in Gerena. Among the conical oil rollers and construction material there is what appears to be a cylindrical millstone roughout (photograph from Acuña Carabantes 2004).



View of the deep pit quarry called the Tajo de Pepe Luis in 1950s. About a dozen stone cutters are seen spread out throughout the pit (from Acuña Carabantes 2004).



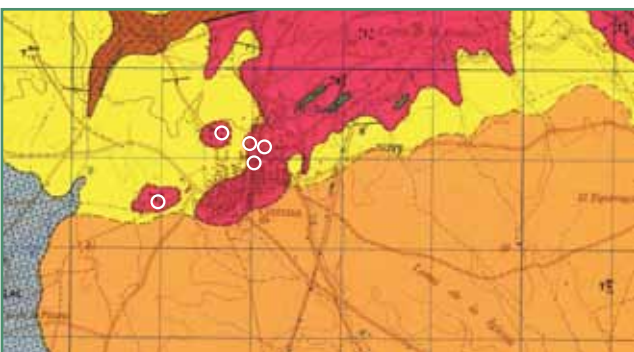
View of the fashioning conical oil rollers in the area of Gerena. The quarry is not identified. The quarry produced both conical oil rollers and rectangular blocks for construction (from Acuña Carabantes 2004).



Photograph from the 1920s of Gerena quarrymen working building material. One appears to be removing a shard from the eye of the other. A boy is sitting in the background (left) (photograph from Acuña Carabantes 2004).



Example of a granite millstone in a local Gerena watermill. The stone, dressed with arc-shaped furrows, is presumably from a local quarry (photograph by Lucas Acuña Carabantes).



Extract from geological map 962 (IGME). The quarries coincide with the plutonic (granite) outcrops in red.



View of the rail station of Gerena in service since 1911. Granite blocks were loaded on the wagons. Conical oil rollers (and millstones?) were also transported by rail (from the Website El Ferrocarril De Aznalcóllar - Guadalquivir).

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SE-8 Estepa

Raja de Gilena

Latitude: 37° 17' 7.82"N
Longitude: 4° 53' 45.09"W
Altitude: 610 m



View of the site from the north-west. The arrow above a broken roughout indicates the main extraction sector.

Location and source: Raja de Gilena, identified in the Internet blog of Juan de Dios Yanez, a local historian, is on the western edge of the town of Estepa on a small promontory below the Tajo Montero.

The quarry and products: The site comprises a half-dozen dispersed millstone extractions measuring 1.40 m in diameter. The stones are hewn directly from small outcrops of bedrock. Tool marks are not visible.

Dating: The large diameter of the millstones indicates a Contemporary production.

Distribution and transport: The small number of extractions and the absence of old written sources suggest a local production. The site is perched a few meters above a path (now a road) that served to transport the stones.

Rock type: Limestone or dolomite rock (Geological map 1005, Osuna, 1986).



View of the quarry from the south-east.



Detail of an abandoned cylinder measuring 1.40 m in diameter.



Detail of an abandoned millstone measuring 1.40 m in diameter. The eye is partially perforated.



Lateral view of the abandoned millstone. The unworked lower half is marked by a slight bulge.



Extract from geological map 1005 (IGME). The quarry coincides with a limestone or dolomite unit (light blue).

Source

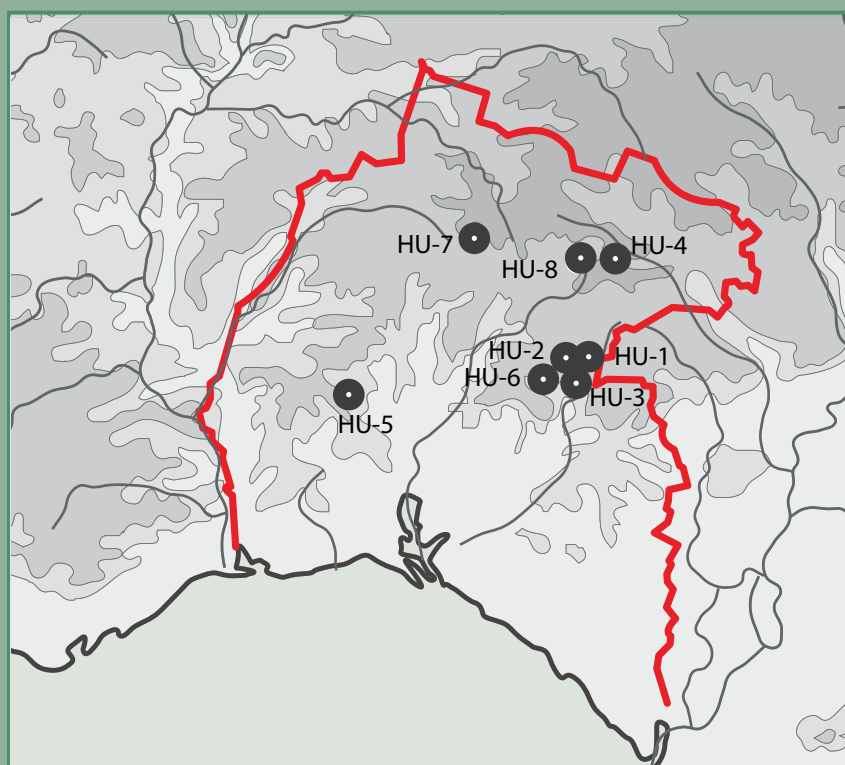
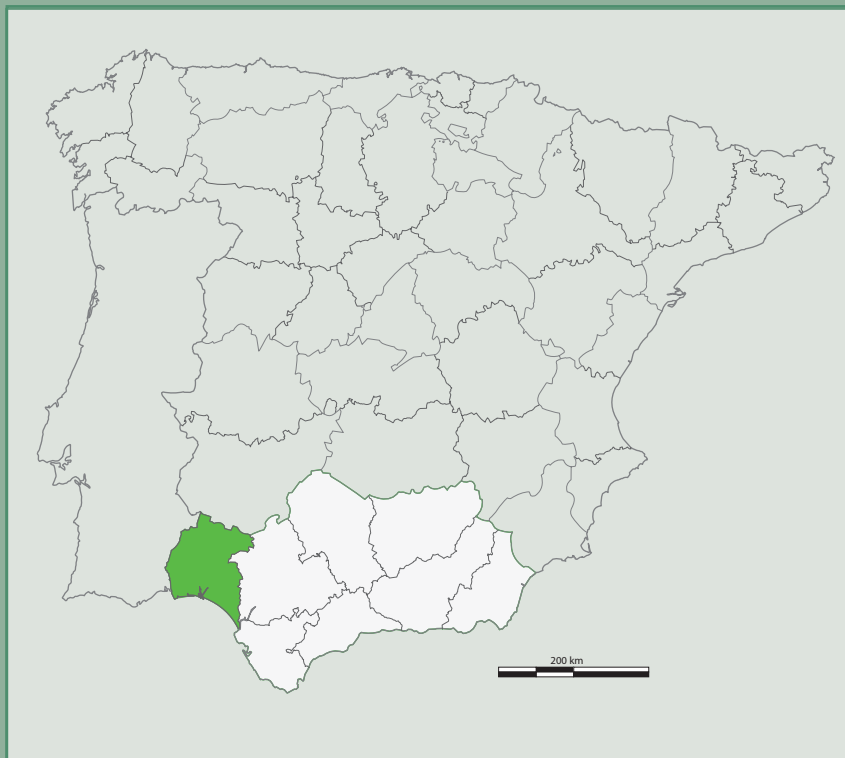
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Acknowledgment

I thank Manuel MERAT of Estepa for leading me to the site.

ANDALUSIA

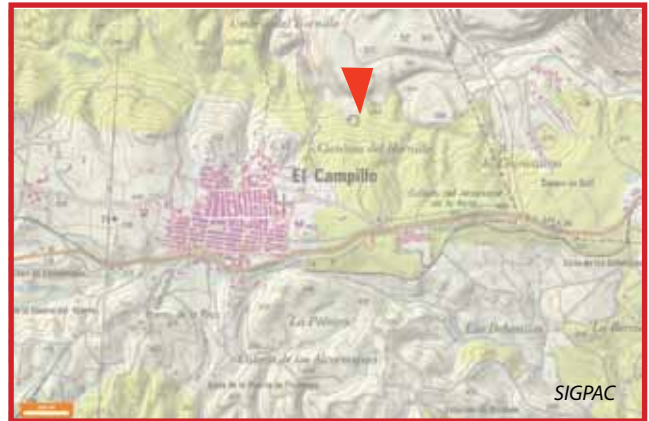
HUELVA (HU)



HU-1 El Campillo

Umbría del Hornillo

Latitude: 37° 41' 56.87" N
Longitude: 6° 37' 15.60" W
Altitude: C. 400 m



View of a sector of inclined schist surface blocks exploited for millstones (photograph by Alonso García Veiga).



Example of an abandoned vertical extraction. The lines on the edge of the millstone indicate that the cylinder was scored with a pick (photograph by Alonso García Veiga).

Location: The *Umbría del Hornillo* millstone quarry is 500 m east of El Campillo on a slope near the border with the Municipality of the Minas de Río Tinto, famous for its mines. The site is in a forest and partly covered by vegetation.

Source: The quarry is identified in the study of the watermills of the Odiel River by Ricardo Gómez Ruiz (2003: 85-86). Although divided into 3 sectors in the study, the site can be considered a unit.

Toponymy: The term *umbrías* refers to a shady area while *hornillos* signifies a small oven. *Hornillos* can also mean the holes or cavities that were carved in mines to lodge powder for blasting. Although there is no evidence of blasting in this area, the term could possibly evoke the wedge holes carved to split cylinders from the rock.

The quarry and techniques: The workings are spread over a surface of several hundred metres along a slope covered with a combination of large, loose surface blocks and large, highly inclined slabs. A sector to the south is now under a rubbish heap or destroyed by work related to

a skeet shooting range. Most of the extractions took place on vertical or inclined planes following the rock's original natural bedding plane. Trenches cut around the cylinders at times reveal linear pick marks.

Product, quantification and dating: According to Alonso García, the diameters of the cylinders vary between 1.10 and 1.26 m. These diameters suggest a dating ranging from Medieval to Contemporary times. The number of extractions is probably about 50.

Distribution: The sphere of distribution was probably local.

Rock type: The site straddles a unit of volcano-sedimentary flow, tuff and slate (light violet) and a unit of agglomerate of acidic schists and intermediate volcano-sedimentary flows (green) (Geological map 938, Nerva; 1978). The department of geology of the University of Huelva (Gómez Ruiz 2003: 85-86) determined that the millstone rocks are 1) altered feldspar tuff, 2) greenish silicious chloritic tuff and 3) silicious chloritic tuff.



General view from the south of slope with the millstone quarry. The gigantic heap in the background is spoil from the Río Tinto exploitation.



View of the quarry landscape with numerous loose surface blocks.



Views of abandoned cylinders attached to the rock mass.

Detail of the wedge holes to detach the cylinder (all photographs by Alonso García Veiga).



Details of vertical extraction hollows.



Detail of an extraction hollow.



Detail of an abandoned, partially fashioned, cylinder.



Extract of the geological map 938 (IGME). The site straddles units of volcanic sedimentary flows, tuffs and schists (light violet) and conglomerates/schisty acid and intermediate volcano-sedimentary flows (green). The quarry exploited schists of the second unit.



Detail of a cylinder attached to the rock mass.



Detail of an abandoned cylinder (all photographs by Alonso García Veiga).

Source

GARCÍA VEIGA, Alonso. *Canteras Medievales de El Campillo, Canteras Medievales de Piedras de Molino. Las Piedras Molares*. <http://alongarvi.blogspot.com.es/2009/11/canteras-medievales-de-el-campillo.html> [accessed November 12, 2012].

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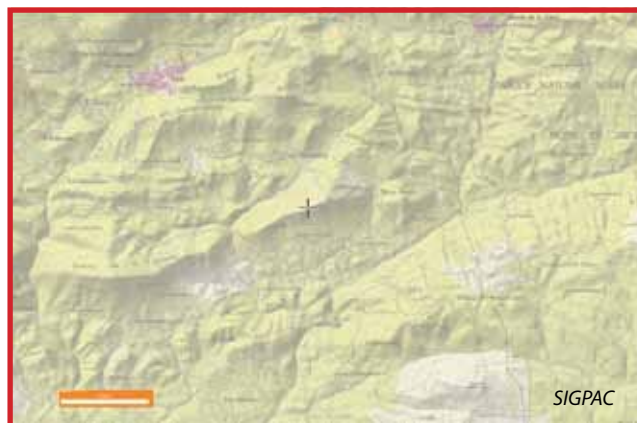
GÓMEZ RUIZ, Ricardo. *Molinos en el Río Odiel. Un Estudio de Arqueología Industrial en los Límites de El Andévalo*. 2003, 138 p.

Acknowledgements

I warmly thank Alonso GARCÍA VEIGA, the author of the photographs, for valuable information about this site.

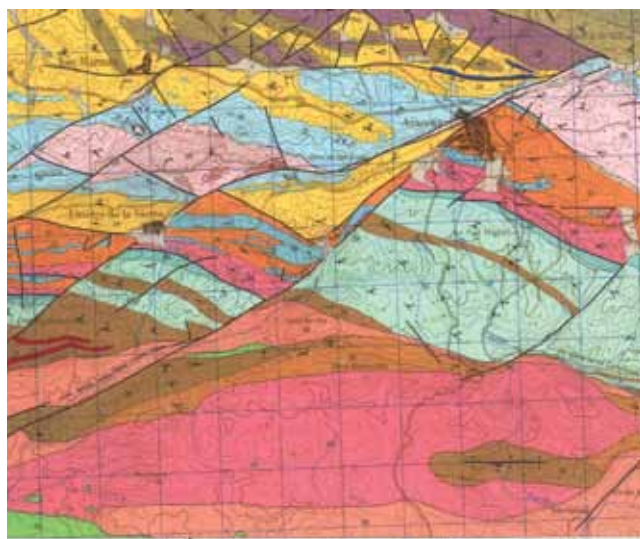
HU-2 Linares de la Sierra

EL Prao de Abad I-II



Location and source: The Prao de Abad I-II millstone workings are identified in the study of the watermills along the Odiel River by Ricardo Gomez Ruiz (2003: 85-86). There is, nonetheless, confusion as to their location. They are reputed to be in the mountains of the Municipality of Alájar. However, from my inquiries, they appear to be in the Municipality of Linares de la Sierra.

Product, quantification and dating: Millstones for watermills. Neither the sizes or the number of extractions are known. The date of these workings, from to the size of the products, ranges from Medieval to Contemporary times.



Extracts from the geological map 917 (IGME) The site is probably to be found in the granite and porphyric granite units south of the Linares de la Sierra and Aracena (units 38 and 39, pink and reddish hues). The green unit can be excluded (gabro).

Distribution: From the little that can be gathered about this site, it must have only served local mills.

Rock type: Biotite granite (Gómez Ruiz 2003: 85-86). Analyses undertaken by the department of geology of the University of Huelva. Abad I is characterised by black crystals while the crystals of Abad II are rose.

Source

GARCÍA VEIGA, Alonso. Canteras Medievales de El Campillo, Canteras Medievales de Piedras de Molino. Las Piedras Molares. <http://alongarvi.blogspot.com.es/2009/11/canteras-medievales-de-el-campillo.html> [accessed November 12, 2012].

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HU-3 Linares de la Sierra

Las Malenas I-II

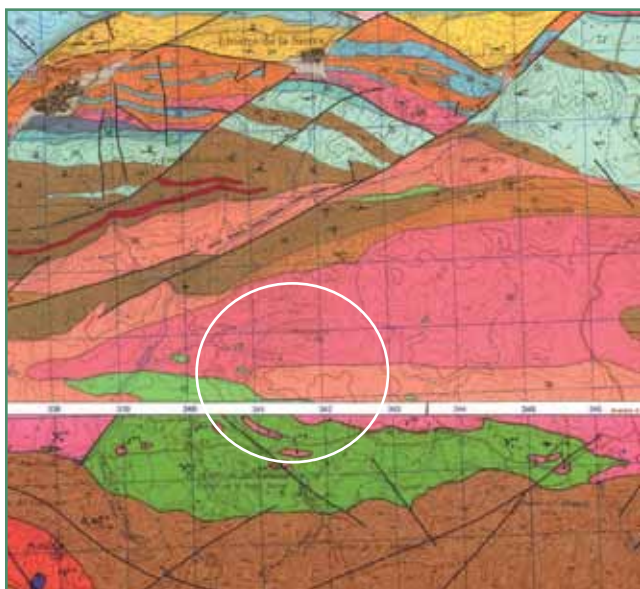


Location and sources: The millstone quarries of *Las Malenas* are recorded in the study of the watermills along the Odiel River by Ricardo Gomez Ruiz (2003: 85-86). As in the case of the Prao del Abad (HU-2), I was not able to pinpoint the site's position. Although reported in the Municipality of Alájar, it is probably, from my inquiries, in the neighbouring Municipality of Linares near the place name *Los Indios*.

Product and dating: Millstones for watermills. The date of these sites, according to the size of the millstones, ranges from Medieval to Contemporary times.

Distribution: There is no data indicating this is not more than a local millstone production.

Rock type: White biotite granite. The analyses were undertaken by the Department of Geology of the University of Huelva.



Extracts from the geological maps 917 and 938 (IGME) The site is probably to be found in the granite and porphyric granite units south of the town (units 38 and 39, pink and reddish hues). The green unit can be excluded (gabbro).

Source

GARCÍA VEIGA, Alonso. Canteras Medievales de El Campillo, Canteras Medievales de Piedras de Molino. Las Piedras Molares. <http://alongarvi.blogspot.com.es/2009/11/canteras-medievales-de-el-campillo.html> [accessed November 12, 2012].

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HU-4 Aracena

La Obra Pía

Latitude: 37° 49' 34.38" N
Longitude: 6° 34' 22.05" W
Altitude: c. 530 m



Location and Toponymy: The Obra Pía millstone quarry is about 10 kilometres south of the city of Aracena near the Obra Pía *cortijo* (farm house) in a landscape of rolling hills at the foot of Cantaelgallo Mountain.

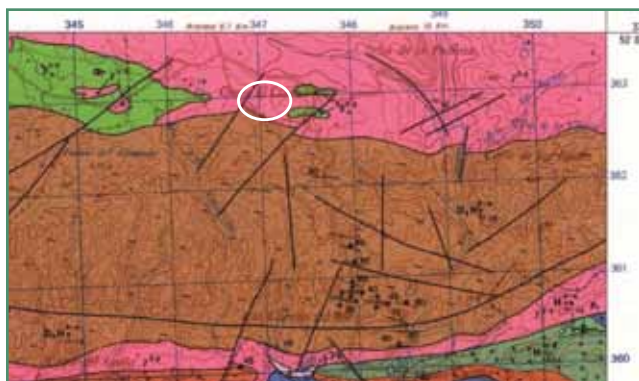
Sources: The quarry is recorded in the study of the watermills along the Odiel River (Gómez Ruiz 2003: 85-86).

The quarry: According to Ricardo Gómez Ruiz, the site exploited surface blocs. Some of the larger blocks yielded more than one millstone.

Distribution: Production was probably destined for local watermills.

Product and dating: All of the millstones measure about one metre in diameter. Their dating ranges from Medieval to Contemporary times.

Rock type: Granite or biotite granite. Geological map 938, Nerva, 1979. Altered granite according to analyses undertaken by the Department of Geology of the University of Huelva (Gómez Ruiz 2003: 86).



Extract of the Geological map 938 (IGME). The quarry is in the reddish unit (granites). The greenish zones to the east are gabbros and the brownish areas to the south are schists or greywackes.

Source

GARCÍA VEIGA, Alonso. *Canteras Medievales de El Campillo, Canteras Medievales de Piedras de Molino. Las Piedras Molares*. <http://alongarvi.blogspot.com.es/2009/11/canteras-medievales-de-el-campillo.html> [accessed November 12, 2012].

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Acknowledgements

I sincerely thank the historian Ricardo GÓMEZ RUIZ for information about this site.

HU-5 Puebla de Guzmán

Cerro del Águila

Latitude: 37° 36' 4.34" N
Longitude: 7° 12' 11.87" W
Altitude: 350-390 m



Old photograph of the rocky Cerro del Águila (photograph from <http://www.pueblos-espana.org/andalucia/huelva/puebla+de+guzman/galeria-fotografica/>).



Orthophoto of the Cerro del Águila (SIGPAC). Millstone exploitation probably took place on rocky north-eastern face of the mountain.

Location: The Cerro del Águila (or Virgen de la Peña), is a rocky mound four kilometres south-east of Puebla de Guzmán. It has a tradition of occupation dating since the Bronze Age and is now the site of a hermitage (Ermita de la Virgen de la Peña).

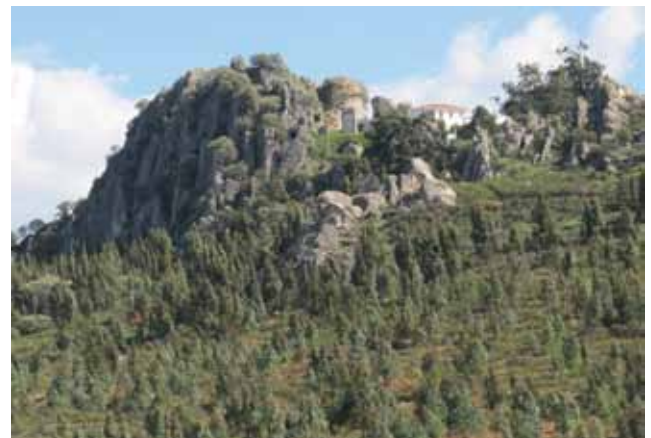
Sources: Millstone production at the outcrop is mentioned briefly in an article about the local windmills (Garrido 2001).

The quarry and techniques: The rugged surface of the outcrop can be made out from the photographs. The quarrymen probably fashioned millstones from surface boulders.

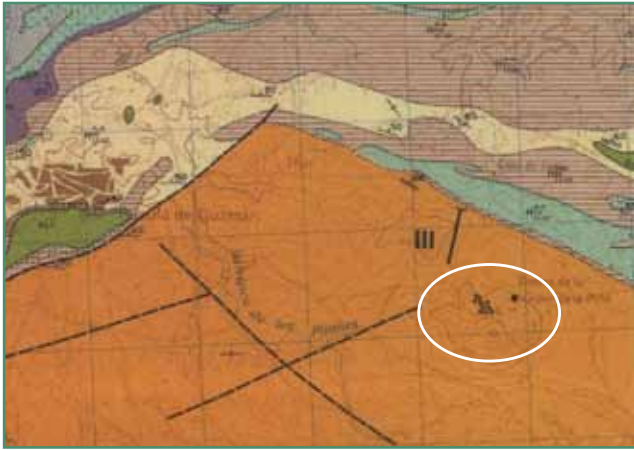
Product and distribution: The Cerro del Águila production was probably a local alternative to imported millstones such as those in the area brought from Medina Sidonia (see El Berrueco, Cádiz, CA- 8), about 170 kilometres away (Garrido 2001: 167) .

Dating: Contemporary. The visit to the site recorded by Garrido (2001) took place in the 1950s. The author adds that millstones were fashioned by "Uncle Paulino", an old quarryman, until the introduction of imported French millstones (Garrido 2001: 167).

Rock type: A recent geological study of the hill (Alonso *et al.* 2008) indicates that the surface boulders are principally quartzites. The geological map indicates the presence of sandstones and schists (Geological map 958, Puebla de Guzmán, 1982). The exact rock that served for millstones is not known.



Detail from the northern rugged face of the Cerro del Águila (photograph from <http://montesysenderos.wordpress.com/2012/04/18/minas-de-tharsis-y-ermita-de-la-virgen-de-la-pena/>).



Extract of the Geological map 958 (IGME). The orange unit is dominated by quartzites, schists and sandstones.

Sources

Hiking itinerary: <http://montesysenderos.wordpress.com/2012/04/18/minas-de-tharsis-y-ermita-de-la-virgen-de-la-pena/> [accessed November 16, 2012].

Anonymous black and white photograph: <http://www.pueblos-espana.org/andalucia/huelva/puebla+de+guzman/galeria-fotografica/> [accessed January 7, 2013].

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GARRIDO PALACIOS, Manuel. Julio Caro Baroja y los Molinos de Puebla de Guzmán, *Revista de Folklore*, Vol. 21a, no. 45, 2001, 164-167. <http://www.funjdiaz.net/folklore/07ficha.cfm?id=1945> [accessed November 20, 2012].

HU-6 Zalamea la Real



Location and source: Zalamea la Real is a municipality that covers a surface of 239 km². Madoz records several millstone quarries inside its borders (Madoz 1850, Vol. 16: 450). The author, unfortunately, provides no other relevant information.

Toponymy: The place name *Las Moladeras* three kilometres west of the town of Zalamea la Real suggests either millstone or whetstone workings. The outcrops at this place name, greywackes and slates, point more to whetstone workings.

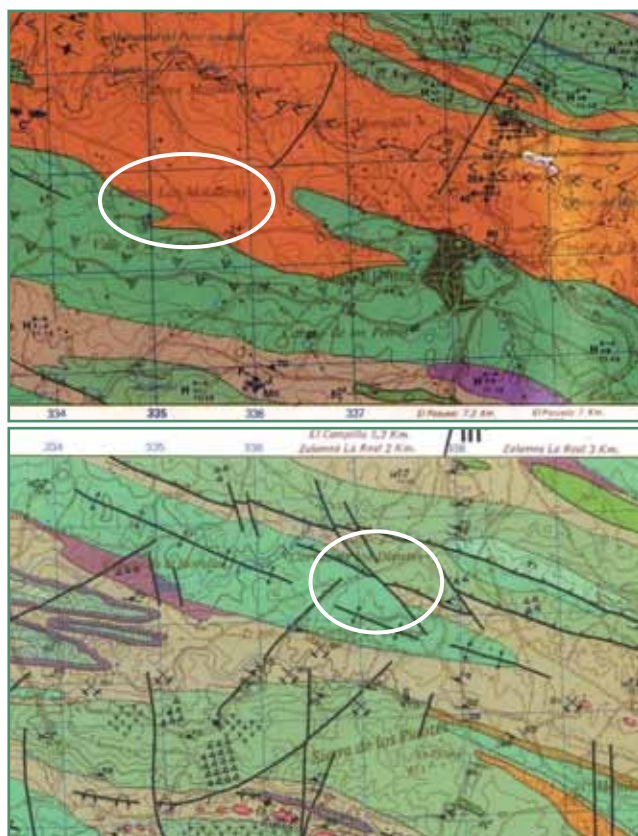
A second potential location of the millstone workings is at the *Cabezo del Berrocal* or *Los Berrocales*, 2.5 kilometres south-west of Zalamea. Although these place names are most often synonymous with granite, in this specific case, they are volcanic tuffs or tuffites (also potential sources of millstones).

Dating: Middle of the 19th century (based on the Madoz reference).

Rock type: Not determined.

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Extracts from the Geological maps 938 and 960 (IGME). The moladeras place name west of Zalamea la Real, associated with a unit of greywackes and slates, is more likely to correspond to whetstone workings. The Berruecos place names to the south are, in this case, not related to granite, but to tuff and tuffites.

HU-7 Aroche

Fuente de la Aliseda

Latitude: 38° 0' 22.06" N
Longitude: 6° 51' 54.03" W
Altitude: 456 m



Location: The Fuente de Aliseda millstone quarry is near the medicinal Aliseda springs about 10 kilometres north-east of Aroche in a circular basin between the Sierra of Aroche and the Sierra of Castaña.

Sources: Millstone production is cited in a late 18th-century treatise about the Aliseda medicinal waters (de Dios 1794: 100). The author states that the local folk extracted millstones from the “abundant” granite outcrops.

Dating: According to Padilla (1999: 278), the granite quarries of the Municipality of Aroche were probably exploited since Antiquity. Millstone workings are only documented in the late 18th century.

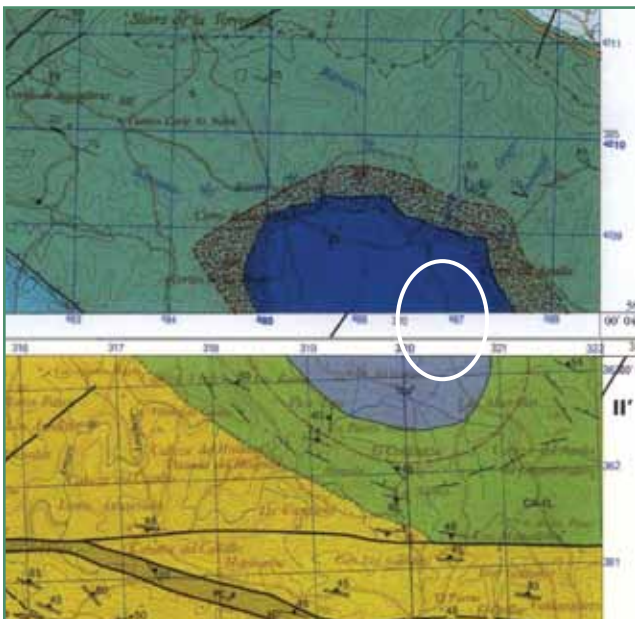
Rock type: Granite (Geological maps 895, Encinasola, 1987/1988; 916, Aroche 1979, IGME).

The 18th-century author de Dios Ayuda (1794: 100) defines the rock as “*sal y pez*” granite. The colour white is inferred from *sal* (meaning salt) and black from *pez* (meaning tar, not fish in this case), suggesting a white granite speckled with black dots (probably biotite granite).

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PADILLA MONJE, Aurelio. Consideraciones en Torno a la Explotación del Mármol en la Bética Durante los Siglos I-II. *Habis*, 30. 1999, p. 271-281.



Extracts of the Geological maps 895 (top) and 916 (bottom). The quarry exploited a granite unit (blue).

HU-8 Almonaster la Real

Los Molares

Latitude: 37° 52' 25.73" N
Longitude: 6° 44' 59.78" W
Altitude: c. 585 m



Location and toponymy: *Los Molares* millstone quarry is on the eastern edge of the Sierra de Alcalaboza, three kilometres east of Almonaster la Real. The millstone quarry place name was adopted as the name of the hamlet.

Sources: This quarry is cited twice in written sources. The first, a doctoral thesis on the Roman period in Huelva, notes the presence of large aborted millstones (Vidal Teruel 2001: 1170). The second reference is an item in the archaeological inventory of the Province of Huelva (see website).

Toponymy: *Los Molares* is the toponym par excellence of millstone quarries. In the cadastre (*SEC*) it corresponds both to the area around the hamlet, as well as to a parcel in the neighbouring Municipality of Santa Ana la Real. It is therefore possible that the quarry was shared by the two municipalities.

The quarry, products and quantification: The archaeological inventory records millstone extraction hollows measuring between 27 cm and 1.30 m in diameter, indicating a true extractive quarry. The smaller model (27 cm) is not likely to

correspond to querns. The larger model is indicative of millstones for watermills. The document provides no information as to the number of extractions.

Distribution: There is no data as to the distribution of these millstones.

Dating: The sizes of the larger extractions suggest a Medieval to Contemporary date.

Rock type: Anatectic granite with charnockitic (orthopyroxene-bearing) affinity (Geological map 917, Aracena, 1979).



Extract from the cadastre with the place name *Los Molares* stretching across the Municipalities of Almonaster la Real (left) and Santa Ana la Real (right) (*SEC*).

Source

Archaeological inventory of the Province of Huelva: Patrimonio Inmueble de Andalucía, Denominación: Molares, Código: 01210040006, Caracterización: Arqueológica, Provincia: Huelva, Municipio: Almonaster la Real; <http://www.iaph.es/patrimonio-inmueble-andalucia/resumen.do?id=i14744> [accessed November 20, 2012].

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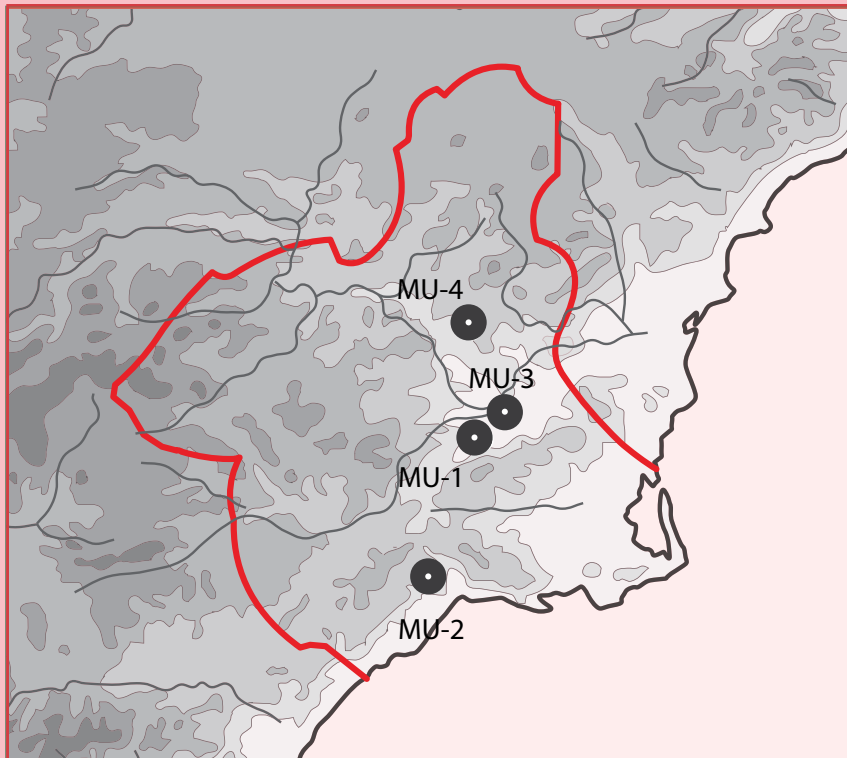
VIDAL TERUEL, Nuria de la O. *El Modelo de Implantación en el Extremo Occidental de la Baetica. Doctrina y Praxis en la Ocupación del Territorio Onubense*. Tesis doctoral. Universidad de Huelva, 2001, 1170, p. <http://rabida.uhu.es/dspace/handle/10272/2630> [accessed February 13, 2013].



Extract from geological map 917 (IGME). The quarry of *Los Molares* is in a granite unit (pink).

MURCIA

MURCIA (MU)



MU-1 Murcia

Puerto de la Cadena / Casas del Portazgo

Latitude: 37° 54' 31.58" N

Longitude: 1° 9' 53.11" W

Altitude: 190 m



Location and generalities: The name of the site comes from a *portazgo* (toll) at the northern entrance of the Puerto de la Cadena near the Castillo de la Asomada, a military construction dating to the 12th century. This mountain pass has been recognised as an important thoroughfare dating since Antiquity connecting the plain of Segura (and the city of Murcia) with the Campos of Cartagena and the city of Cartagena along the Mediterranean.

Source: The quern and millstone quarry is identified in a hiking itinerary posted on the Internet. No old written reference has been identified.

The quarry: The site is a shallow extensive surface quarry evidenced by numerous extraction hollows cut into the bedrock along the base of a ravine at the northern end of the Pass (near the A-30 motorway).

Techniques: The quarrymen cut trenches (probably with picks) around the future cylinders. Due to weathering, tool marks are not visible.

Products and quantification: A wide variety of millstones were produced. There appear to be fall into three categories according to their diameters: small rotary handquerns measuring between 40 and 50 cm; medium-sized millstones between 70 and 80 cm; and large millstones from 1.00 to 1.20 m.

Transport and distribution: The quarry would have benefited from the road through the mountain pass to trade their products either to the plain of Murcia or to the coastal plain of Cartagena. The road, as the name of the site indicates, is known to have had tolls. It is not known, however, if the tolls were contemporary to the millstone production.

A section of the road has ruts cut directly into the bedrock. These ruts, about 1.20 m apart, might have served to guide carts along the slope loaded with



View from the Cabezo del Puerto (south-east) of the final stretch of the Cadena Pass. The position of the quarry is indicated by the arrow. The plain of Segura is in the background (from the hiking itinerary: <http://senderosdecartagena.wordpress.com/2010/12/16/cabezo-del-puerto-de-la-cadena/>).

heavy products such as millstones. Rutted roads are documented in millstone quarry context elsewhere in Spain (Cisneros *et al.* 1985: 144-145, 158-159) and in France (Belmont *et al.* 2011: 219-220).

Dating: The date of the exploitation remains uncertain. It is reasonable to assume that the mixture of querns with medium and large millstones places it in the Medieval period, probably during the Islamic domination. The absence of any toponym related to millstone or quarry work also suggests an early date. Madoz's exclusion of this vast site in his description of the natural resources of the Cadena Pass also suggests that it was not being exploited the middle of the 19th century (Madoz 1848, Vol. 11: 729-730).

The presence of a small handquern extraction in the heart of a larger abandoned millstone patently reveals that rotary querns were produced simultaneously or after larger millstones. This is

another argument favouring a Medieval date of at least part of the exploitation. The larger extractions, exceeding a metre in diameter could correspond to Modern or Contemporary phases.

Rock type: Conglomerate with large rounded clasts. This must be a very local geological facies because the geological map does not indicate conglomerates in the area (Geological map 934, Murcia, 1974).



View of the Cabezo del Puerto. The Medieval Castillo de la Asomada is perched on the top of the mountain in the background.



View from the north of a sector of the millstone quarry in the bed of the ravine.



Millstone hollows along the western edge of the ravine.



Examples of the large extraction hollows (1.70 -1.80 m in diameter) corresponding to cylinders measuring between 1.00 and 1.20 m in diameter.





Examples of abandoned millstones measuring between 1.10 and 1.20 m in diameter.



Examples of abandoned millstones measuring between 70 to 80 cm in diameter.



Examples of abandoned rotary querns measuring between 40 to 50 cm in diameter.



Quern and millstone extractions. The quern cut into the heart of an abandoned cylinder (right) indicates that handmills were produced simultaneously or after large millstones (photograph bottom right from the hiking itinerary: <http://senderosdecartagena.wordpress.com/2010/12/16/cabezo-del-puerto-de-la-cadena/>).



The tracks of the road cut into the bedrock (from hiking itinerary, Senderos de Cartagena: <http://senderosdecartagena.wordpress.com/2010/12/16/cabezo-del-puerto-de-la-cadena/>).



Extract from geological map 936 (IGME). Although the quarry exploited a layer of conglomerate, this type of rock is not present in the geological map. The area is dominated by a unit of argillite (purple).



Detail of the rock showing the form and size of the clasts.

Source

Senderos de Cartagena hiking itinerary: <http://senderosdecartagena.wordpress.com/2010/12/16/cabezo-del-puerto-de-la-cadena/> [accessed October 18, 2012].

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MU-2 Mazarrón

Cabezo de la Oliva

Latitude: 37° 36' 13.03" N

Longitude: 1° 15' 13.9" W

Altitude: c. 260 m



Location and generalities: The Cabezo de la Oliva is about four kilometres east of the city of Mazarrón near the town of Las Balsicas. The quarry is reputed to have been on a slope (along a volcanic flow) called the *Ladera Mala*, an area destroyed during mechanical excavations to fashion terraces in the framework of a reforestation programme. According to Saturnino Agüera, this site is the source of the abandoned volcanic querns collected at Los Ceniceros, a Roman villa on a low mound about three kilometres to the south-east. The Ceniceros mound is a limestone outcrop and therefore cannot be the source of volcanic querns.

Source: The *Ladera Mala*, identified as site by Saturnino Agüera in the middle 1970s, is listed in the inventory of archaeological sites of Murcia (Agüera *et al.* 1999).

Product: This site is said to have produced both saddle querns and rotary querns. The rotary quern roughouts stored in the Murcia museum depository are analogous, from the typological standpoint, to those found at the Roman quern quarries of the Cabo de Gata (see AL-1 and AL-2), notably the “sombbrero” lower stone type (Anderson *et al.* 2014).

Dating: The saddle querns are Pre- or Protohistoric, while the rotary querns, from their typology, are Roman.

Rock type: A petrographic thin-section study of four of the five querns collected at the Ceniceros villa (in the Murcia museum depository) reveal that they are lamproites (analyses by Jane H. Scarrow and Aitor Cambeses, University of Granada). This rock type coincides with the *Ladera Mala* on the geological map (Geological map 976, Mazarrón, 1973).



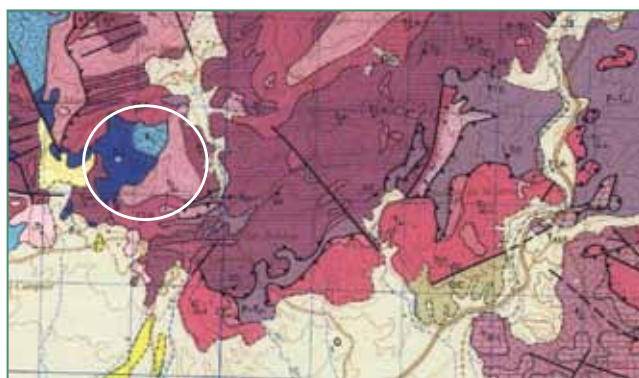
View from the west of the Cabezo de la Oliva Mountain (extract from Google Maps Street View).



The quern roughouts were discovered at the Roman settlement of Los Ceniceros (left). The probable source of these querns is the volcanic Cabezo de la Oliva Mountain (centre).



Unfinished broken rotary querns (lamproites) from the Roman villa of Los Ceniceros stored in the depository of the Museum of Murcia.



Extract from geological map 976 (IGME). The Ladera Mala zone is made up of units of marble and dolomite (pink and purple), as well as igneous (lamproite) outcrops (blue hues).

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Acknowledgements

I thank María MARTÍNEZ ALCALDE, director of the Archaeological Museum of the Mazarrón, and Saturnino AGÜERA for oral information about the site. I also thank Luis de MIQUEL (dir.) and Fátima GIMENO, of the Museum of Murcia for access to the millstones in the depository of Beniahán. The geological analyses are the work of Jane H. SCARROW and Aitor CAMBESES of the University of Granada.

MU-3 Murcia

Cantera de los Porches

Latitude: 37° 56' 20.93" N

Longitude: 0° 57' 54.78" W

Altitude: 240 -250 m



Location and source: The millstone quarry of Los Porches is in the Sierra de Ataona massif, about 15 kilometres south-west of the city of Murcia. The site, identified in a brochure of a hiking trail, is on the south-eastern slope of the mountain.

Toponymy: *Ataona* (or *Altahona*) is a variation of the Arabic word designating *tahona*, a term associated both with animal-driven flour mills and bakeries. I do not know, however, if in this case the name is related to a local mill or to the millstone workings.

Product and dating: The only information furnished by the brochure is that the millstones manufactured at the site are large, suggesting a Medieval to Contemporary date.

Rock type: Sandstones or conglomerates (Geological map 934, Murcia, 1974).



Detail of a pierced, broken millstone (from https://www.murciaeduca.es/cpntrasradefatimamurcia/sitio/index.cgi?wid_news=75&wAccion=news).



Extract from geological map 934 (IGME). The orange area corresponds to sandstones, micro-conglomerates and loams.

Sources

Brochure: Donde Vive el Buho. Finca Municipal los Porches. Programa de custodia del territorio entre el Ayuntamiento de Murcia y la Asociación Vecinal para el desarrollo sostenible de Garruchal (ADESGA). <http://www.magrama.gob.es/es/ceneam/programas-de-educacion-ambiental/programas-de-otras-entidades/murcia.aspx> [accessed November 13, 2012].

https://www.murciaeduca.es/cpntrasradefatimamurcia/sitio/index.cgi?wid_news=75&wAccion=news [accessed April 19, 2015].

MU-4 Fortuna

Sierra de los Baños

Latitude: c. 38° 13' 31,42" N

Longitude: c. 1° 7' 30.39" W

Altitude: c. 300-350 m

Location: Sierra de los Baños is a mount to the west of the town of Los Baños. Most of the quarrying for construction material is found on its eastern slope, above a Roman settlement. Millstone production took place elsewhere, on the northern slope along an ancient path leading to the hamlet of Caprés.

Source: The site is identified in a brief study of oil roller quarry (Matilla Seiquer 2001). It is noteworthy that this article is one of the first scientific studies addressing specifically the question of grinding stone production in southern Spain.

The quarry: The research by Matilla Seiquer singles out what appears to be an abandoned Roman ring-mill upper stone (*catillus*) (Matilla Seiquer 2001: 273, photograph 7; 274) among a group of modern unfinished conical oil rollers scored from surface blocks (Matilla 2001: 272).

Products: The unfinished ring mill upper stone is, according to the author, 80% complete (Matilla 2001: 273, photograph 7; 274). Its dimensions (60 cm in diameter; 43 cm in interior diameter and 45 cm thick) and its "rosco" (i.e. "doughnut") shape are characteristic of Roman ring-mills, common in the south of Spain and northern Morocco, notably at the Roman city of *Volubilis*.

Dating: There are similar ring-mill fragments in the depository of the Archaeological Museum of Murcia (nos. 30-31, Anderson *et al.* 2011: 16). One is volcanic (lamproite), while the other, also about 60 cm in diameter, is conglomerate.

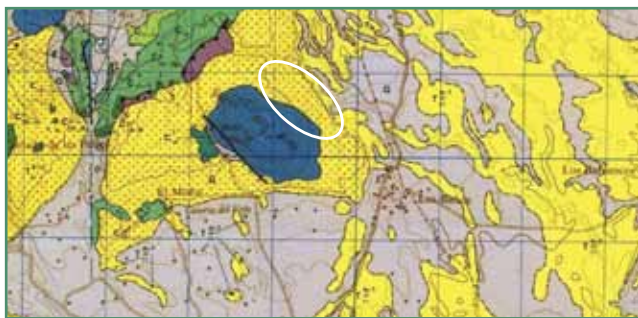
Rock type: Matilla Seiquer does not specify the rock type of the ring-mill. Due to the absence of volcanic outcrops in the immediate area, there is less chance that it is a lamproite. It is more likely, like the conical rollers, a local conglomerate, sandstone or limestone (Geological map 892, Fortuna, 1973).



View of the eastern slope of Sierra de los Baños (extract from Google Map Street View).



Ring-type upper stone fragment (from Matilla Seiquer 2001: 273, photo 7).



Extract from geological map 892 (IGME). The limestone unit is in blue. The conglomerate and sandstone units are in dotted yellow.

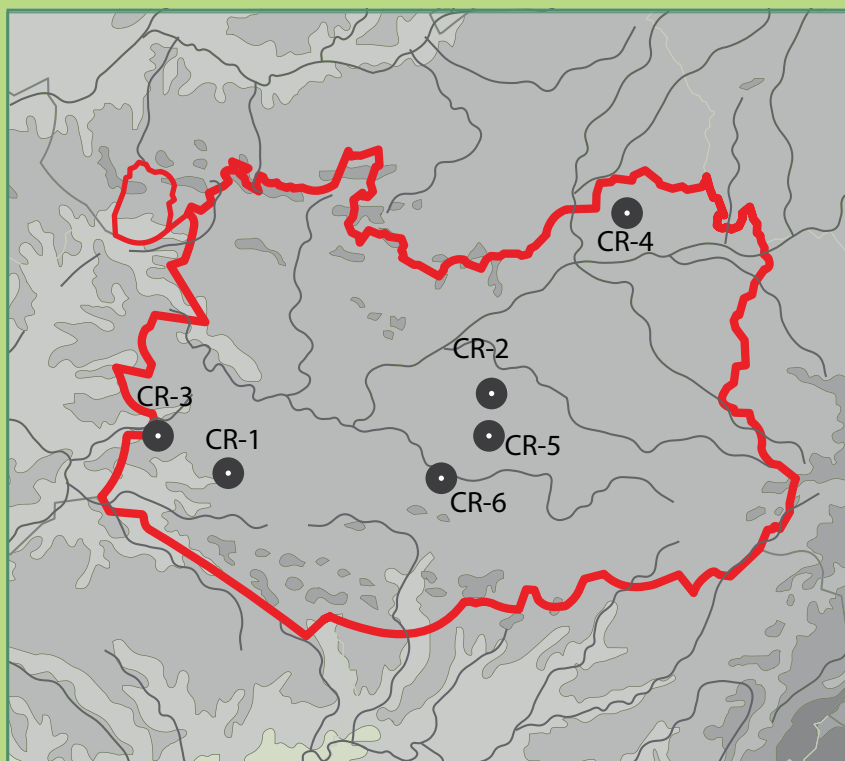
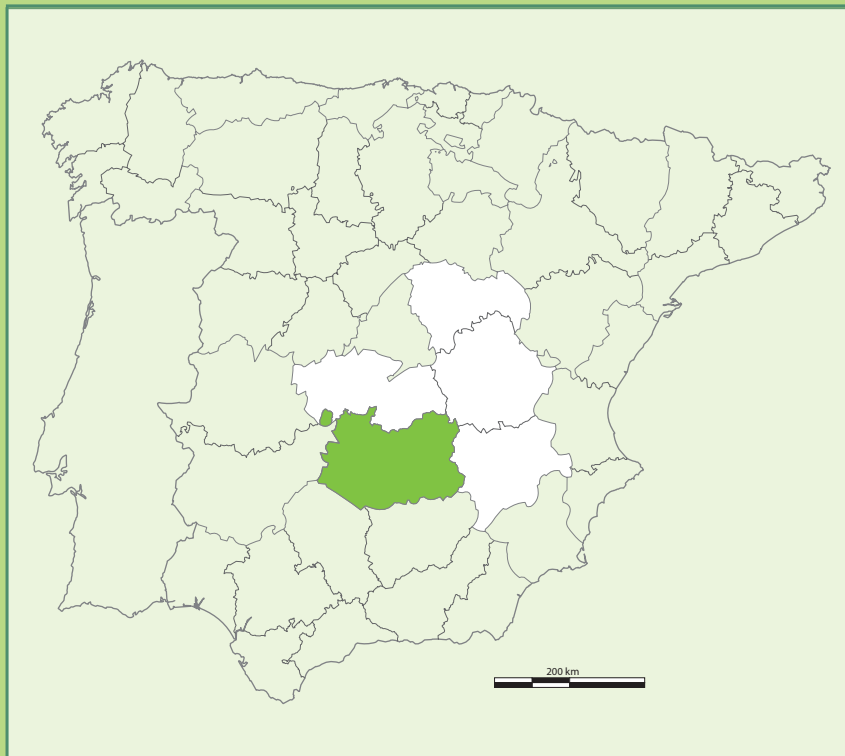
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CASTILLA LA MANCHA

CIUDAD REAL (CR)



CR-1 Almodóvar del Campo

*Sisapo /
Castillejo de la Bienvenida*

Latitude: 38° 39' 1.80"N
Longitude: 4° 31' 17.91"W
Altitude: 710-720 m



View from the south-east of the excavations of the Roman city of Sisapo. In the background are the volcanic domes where construction blocks and millstones were exploited.

Location: The quarry of *Sisapo*-Castillejo de la Bienvenida is 500 m to the north-west of the Roman city of *Sisapo* in the heart of the vast plain between the mountain ranges of the Sierra de la Solana and the Sierra de la Umbría. The quarry occupies three small volcanic domes that are the south-western-most volcanic outcrops of the vast (approx. 5000 km²) Campo de Calatrava volcanic district.

Source: Although the site has been identified as a quarry (Fernández Ochoa *et al.* 2002: 151), quern and millstone production has only confirmed during a field survey in company of Tor Grenne of the NGU. The results of this first survey were presented in the millstone colloquium of Rome (Anderson *et al.* 2011).

The quarry and techniques: The millstone workings correspond to a true extractive quarry where cylinders were hewn directly from the lava flow producing multiple circular hollows. This technique differs from prying out angular blocks from volcanic columnar

jointing, the technique identified at other volcanic rock exploitations (see AL-1 or Harms & Mangartz 2002). Extractions are both grouped and isolated.

On one of the rare visible quarry floors there are large, single trapezoidal cuttings along the perimeter of the base of the cylinder. These cavities lodged wedges, possibly of wood, to split the cylinders from the lava flow.

Adjacent to the millstone workings is a block quarry (ashlars) with a rectangular baulk in its centre. A similar quarry feature is known at the Frailes millstone quarry of Cabra (CO-1). A much more spectacular version of this type of feature is the "pinnacle" in the Roman block quarry of El Mèdol in Tarragona in Catalonia. The nature of these features is still a question of debate (fixture from which to measure the quantity of extracted stone (Gutiérrez García-Moreno 2009: 156-157). The feature could also simply mark limits between different concessions.

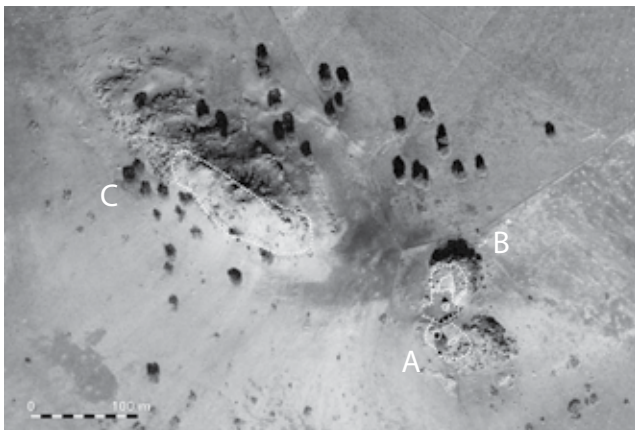
In some sectors, large parts of the bedrock are missing. Since they are grown over, it is not possible to determine what type of product were scored from these areas.

Products and quantification: The querns extracted measure 40 cm in diameter, while the diameter of the larger extractions, most presumably ring-mills, range from 70 to 90 cm. There is no indication of production of other Roman millstone types (e.g. Pompeian mills). The site could have potentially produced hundreds of querns and millstones.

Transport and distribution: The site obviously would have served the needs of the city of *Sisapo*. It certainly could have also exported its products far beyond the city, profiting from vast inland trade network known in Roman times.

Dating: The sizes of the extractions, the proximity of the Roman city and the propensity of the Romans for volcanic millstones, point to a Roman dating.

Rock type: The rock is a hard, dark grey, vesicular olivine melilitite (Anderson *et al.* 2011). According to the geological maps 834, San Benito (1983) and 835, Brazatortas (1989), the rock is a basalt.



Detail of the three volcanic domes labelled A,B and C (SIGPAC).



View from the south-east of the largest volcanic dome (C).



View from the south (from Dome A) of Dome B. In the forefront, covered by vegetation, is the block quarry (1) with the central baulk (2). On the slope of Dome B is the quern and millstone quarry (3).



View from the north-east of the sector of Dome B with multiple, contiguous quern extractions.



Extraction hollow of a rotary quern measuring 40 cm in diameter.



Abandoned broken cylinder of a rotary quern measuring about 40 cm in diameter.



Defective extraction of a millstone measuring about 80 cm in diameter.



Extraction hollow of a millstone measuring 80 cm in diameter.



Extraction hollow of millstone measuring about 80 cm in diameter. In the background is a defective extraction.



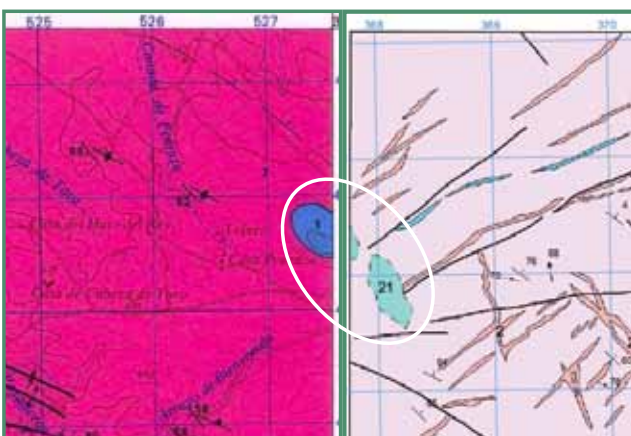
Example of an abandoned millstone extraction (probably the lower stone of a ring-mill) on Dome C.



Abandoned millstone measuring about 80 cm in diameter. The cavity visible on the upper face is indicative that this cylinder was destined to be a ring-type upper stone (from Fer-nández Ochoa et al. 2002: 121, fig. 6: 4).



Abandoned quern roughouts measuring about 40 cm in diameter (from Fernández Ochoa et al. 2002: 121, fig. 6: 5).



Extract from geological maps 834 and 835 (IGME). The quarry coincides with basaltic outcrops (blue on left map and turquoise on right map) in the heart of a unit of slate and greywacke (pink).



View from the north of the quarry between Domes A and B. This large area with a central baulk was probably exploited for construction blocs.

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Acknowledgements

Tor GRENNE of the Norwegian Geological Survey accompanied me to this site.

CR-2 Bolaños de Calatrava

Cantera de las Herrerías

Latitude: 38° 53' 22.41"N
Longitude: 3° 38' 55.51"W
Altitude: 660 m



Orthophoto of the quarry of Las Herrerías (SIGPAC). The black colour of the workings reflects the colour of the volcanic rock.

Location: *Las Herrerías* is about 1.5 kilometres south-west of Bolaños de Calatrava. It is currently a vast exploitation for construction material. In the eastern sector of the modern quarry, the workmen salvaged 10 unfinished or aborted Roman millstones brought to light during their work.

Source: The millstones were identified during a geological survey by the geologist Aitor Cambeses of the University of Granada.

Toponymy: The name *Las Herrerías*, meaning smithies, is associated with quarry work because of the stone worker's need of a blacksmith for tool maintenance. This place name could therefore be indicative of the presence of old smithies. There is, however, no evidence at this site of a direct relation between the presumed smithies and the Roman millstone workings.

The quarry: I have no information about the original Roman millstone exploitation, its size and extraction techniques. Its features have probably been obliterated by the recent work undertaken at the site.



View from the north-east entrance of the modern industrial quarry of Las Herrerías (extract from Google Maps Street View).

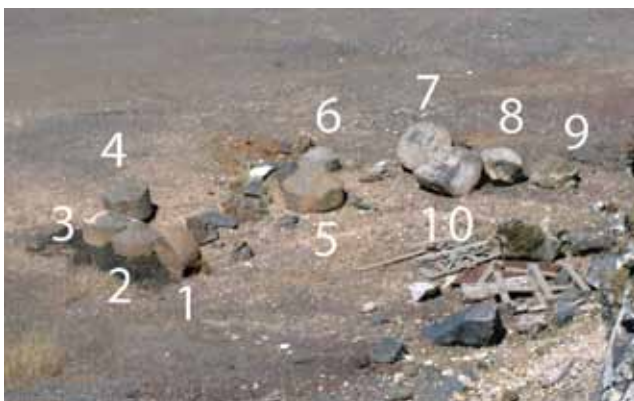
Products and quantification: Most of the abandoned stones appear to be parts of man- or animal-driven mills. It is possible that the smallest, no. 6 (see drawings), is a rotary quern roughout. There is no indication of piercing of lower stones that could be indicative of millstones for watermills.

The scale of production cannot be determined. I can imagine that the present workmen only retained the more recognizable and better-conserved stones. A large number of smaller fragments have probably been destroyed. In any case, the outcrop had the potential for a huge production.

Transport and distribution: This quarry certainly exported its products long distances by means of a long established inland Roman network known in the area.

Dating: Roman, based on typological criteria.

Rock type: Dark, vesicular volcanic rock. Nephelinite olivine lava or olivine melilitite lava (Geological map 785, Almagro, 1985).



View of the 10 Roman millstones salvaged by the workers of the present-day rock quarry.



Detail of an unfinished ring-shaped upper stone (10).



Left to right: 2, 3, 4 and 5 (foreground).



Left to right: 9,8,10



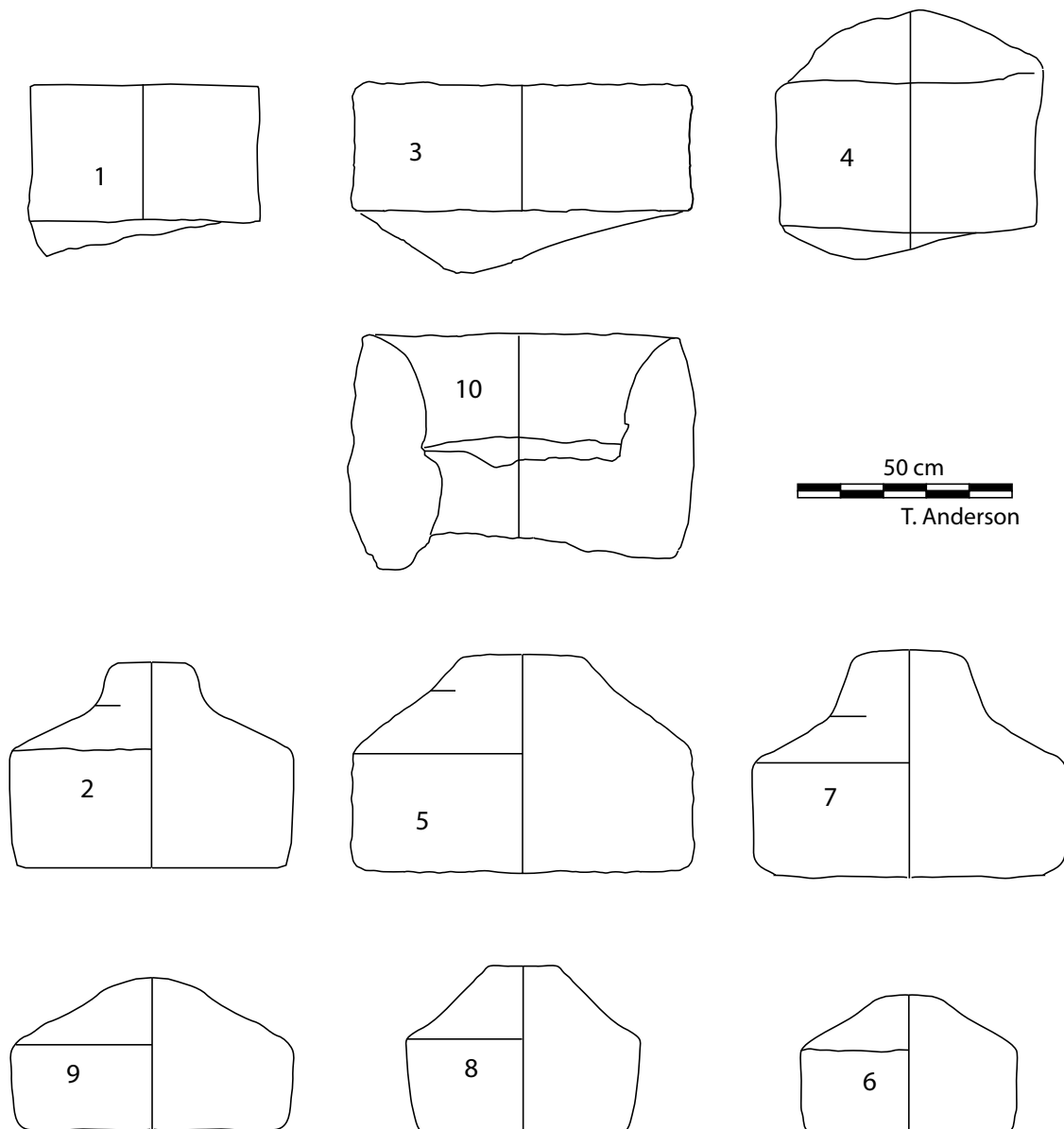
Left: 5 right (background); right 7 (upside down).



Abandoned millstone roughouts (1-3 from right to left).



Foreground: 6; background: 5.



Rough sketches of the sections of unfinished or broken querns and millstones. Nos. 1, 3, 4 and 10 are upper stones (catilli); 2, 5, 7, 9, 8, and 6 are lower stones (metae). All, except possibly no. 6, correspond to man- or animal-driven mills. Number 10 is a ring-mill upper stone (catillus) fragment (drawings by T. Anderson).



Extract from geological map 785 (IGME). The quarry is located in the unit of nephelinite olivine lava (green). There are equally olivine melilitite lavas (pink) in the sector.

Acknowledgements

My warm thanks go to Aitor CAMBESES, Department of Geology, University of Granada, for alerting me to the presence of these millstones.

CR-3 Chillón district



Generalities: The Municipality of Chillón covers a surface of over 200 km² in the south-west of the Province of Ciudad Real along the border of Extremadura. This is a region with a long history of mining, notably the cinnabar mines at Almadén.

Source: Madoz records a granite millstone quarry (Madoz 1847, Vol. 7: 326-327). Yet the geographer does not provide any other information concerning the site or its location.

Dating: Middle of the 19th century.

Location and rock type: According to the IGME geological maps, there are no granite outcrops inside the current boundaries of the Municipality of Chillón. If Madoz is right in his description of the rock, the nearest source is about 12 kilometres to the west, at the eastern extremity of the Garlito granite-diorite outcrop, outside the Chillón municipal border (in neighbouring Extremadura). This outcrop is now partially under the waters of the Serena dam (Geological maps 807, Chillón; 808, Almadén; 781, Siruela; and 782, Valdemanco del Esteras, IGME).

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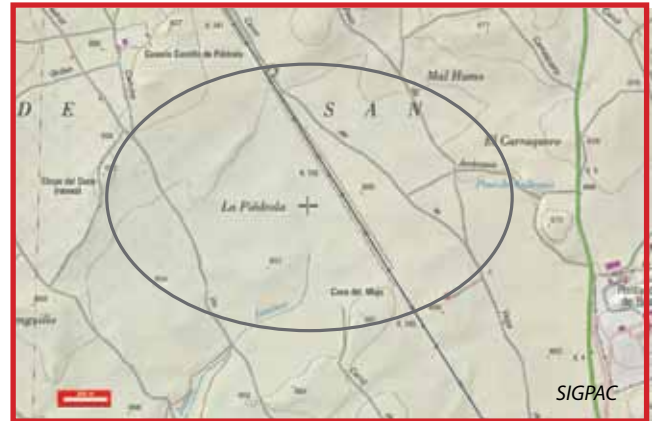
CR-4 Alcázar de San Juan

Pedrizas de Piédrola

Latitude: c. 39° 26' 24.54" N

Longitude: c. 3° 15' 1.94 W

Altitude: c. 650 m



Location and generalities: *Pedrizas de Piédrola* is in a plain a few kilometres north-west of Alcázar de San Juan, in the heart of La Mancha, a region made famous by the tale of Don Quixote. White windmills, like the “giants” the errant knight grappled, dot the local landscape, notably at the Cerro San Antón south of Alcázar.

Source and distribution: In a municipal report regarding the potential of “valorising” the windmills of Cerro San Antón (Sánchez Ruíz 2009), the Piédrola site is cited as the most productive of all millstone quarries in the Mancha. This suggests its production circulated beyond the local area dominated by windmills. A photograph of an abandoned unfinished millstone at the quarry was recently posted on the blog “Antrophistoria”.

Toponymy: *Pedrizas* means a surface covered naturally by rock. The name *Piédrola* also certainly derives from “rock”. Both names are evocative of rock work.

The quarry and dating: Now under “Special Protection” of the Alcázar de San Juan Municipality, the site presents abandoned millstones in different stages of production. According to José Sánchez Ruíz, the abandoned millstones are large, about one metre in diameter, suggesting a Medieval or Contemporary dating.

Rock type: Sandstones or dolomites (Geological map 713, Alcázar de San Juan, 1991). The exact nature of the rock is not confirmed.



View of an unfinished millstone (from CABEZAS VIGARA, José Antonio, Blog Antrophistoria, <http://antrophistoria.blogspot.com.es/2014/03/descubiertos-restos-de-seis.html>).



Extract from the geological map 713 (IGME). The quarry is a unit of sandstone and dolomite (purple).

Source

SANCHEZ RUÍZ, José Fernando. Centro de Interpretación “Molinos de Viento” del Cerro de San Antón y paisaje Manchego. Patronato Municipal de Cultura, Ayuntamiento de Alcázar de San Juan. Anteproyecto de Musealización. 2009. http://www.alcazardesanjuan.es/gestor/RecursosWeb/DOCUMENTOS/1/0_3061_1.pdf [accessed the October 17, 2012].

CABEZAS VIGARA, José Antonio, Blog Antrophistoria, <http://antrophistoria.blogspot.com.es/2014/03/descubiertos-restos-de-seis.html>

Acknowledgements

I thank José SANCHEZ RUÍZ of the Municipality of Alcázar de San Juan for information regarding the site.

CR-5 Granátula de Calatrava

Las Canteras

Latitude: 38° 46' 1,22" N
Longitude: 3° 43' 30,33" W
Altitude: 640 m



Location: This millstone quarry is beside the Jabalón River, 2.5 kilometres south-east of Granátula de Calatrava at the place name *Las Canteras*. It is on the opposite shore of the Jabalón dam to the archaeological site of Oreto y Zuqueca. During my visit, no extractions were visible because they were flooded by waters of the Jabalón dam.

Sources: The quarry was filmed in a television documentary available on the Internet (Labordeta, *Un país con la mochila*; see sources). It also is cited briefly in a website about the windmills of the area (J. J. Donoso, *Molinos de viento*).

The quarry and products: From what can be gathered from the film and several photographs posted on Google Maps, the quarry appears to be a shallow surface exploitation with large cylindrical hollows carved into bedrock.

Transport and distribution: This site, on the banks of the Jabalón River, and could have benefited at one time from fluvial transport. A railway station, now abandoned, is also beside the site. I do not know, however, if the quarry and the railway were contemporary.

Toponymy: *Las Canteras* (the quarries) is a common place name for millstone quarries.

Dating: The large extractions, at least one metre in diameter, indicate an exploitation dating from Medieval to Contemporary times.

Rock type: Limestone (Geological map 61,1:200000, Ciudad Real, 1970, IGME). From the photographs, the limestone appears to be extremely porous. This quarry an excellent example of a non-volcanic rock exploited in the heart of a volcanic district (Anderson *et al.* 2011: 163).



View of a sector of the millstone quarry. Waters of the Jabalón Dam are seen in the background (from Google Maps, Jumadogo).



Detail of an extraction hollow (from Google Maps, Jumadogo).



Detail of an unfinished cylinder attached to the bedrock (photograph from the website Molino de Viento, Juan Jesús Donoso: <http://granatula.com/del-pueblo/granatula-y-sus-molinos/molino-de-viento>).



Extract from geological map 61, Ciudad Real, 1970 (IGME). The quarry is in the unit defined as limestone (yellow). The adjacent blue units are volcanic basalt.

Source

Juan Jesús DONOSO website Molino de Viento: <http://granatula.com/del-pueblo/granatula-y-sus-molinos/molino-de-viento> [accessed November 12, 2012].

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Acknowledgements

I thank Juan Manuel DONOSO GÓMEZ, archaeologist from Granatula de Calatrava, for oral information about the quarry. I also thank Juan Jesús DONOSO AZAÑÓN for his photographs of the site.

CR-6 Granátula de Calatrava

Cerro Columba

Latitude: 38° 46' 0.68" N

Longitude: 3° 46' 5.34" W

Altitude: c. 780 m



Examples of broken volcanic roughouts at the archaeological site of Oreto y Zuqueca.



View towards the north-west from the top of the Cerro Columba. The presumed quarry is near the modern bridge seen in the background crossing the Jabalón River Dam.

Location, dating and generalities: Cerro Columba is a large, low volcanic dome along the Jabalón River, three kilometres west of the Roman and Medieval settlement of Oreto y Zuqueca. It is also near the presumed location of the Roman city of *Oretum* (at the neighbouring Cerro Domínguez). The Jabalón River at this point presents a wide bend provoked by an ancient lava flow. The presence of a quarry is based on four aborted volcanic quern roughouts that stand out among a dozen Roman millstones at Oreto y Zuqueca (Aguirre Andrés 1948: 121). These types of unfinished, broken millstones are indicative of the existence of a nearby quarry. The site was identified in a field survey in the company of Tor Grenne of the Norwegian Geological Survey (NGU).

Sources: Information about this site was provided by the archaeologists Juan Manuel Donoso Gómez and Helena Romero Salas. The site was presented in the millstone colloquium of Rome (Anderson *et al.* 2011: 159-161).

The quarry: It is generally accepted that a scarp was created where the northward lava flow from the Cerro Columba intersected with, and displaced, the Jabalón

River. At this point the lava flow presents columnar jointing. The outcrop was reputedly exploited for construction material for the city of *Oretum* (2 km to the east) and for a Roman bridge (Alañón 1982: 230), adjacent to the quarry, crossing the Jabalón River. Columnar jointing is a geological feature known to have been exploited elsewhere for millstones in Roman times (for example, in the Eifel in Germany; Harms & Mangartz 2002). Confirmation of millstone workings cannot be undertaken as the outcrop is now under water.

It cannot be excluded that the unfinished querns of Oreto y Zuqueca come from a millstone quarry elsewhere, for example, Las Herreras (see CR-2) or some other unidentified outcrop. The rock of both exploitations is olive basalt. I suppose, however, as in case of Cerro Columba, that millstone makers would have given preference to a local rock (4 km) over one located 17 kilometres away.

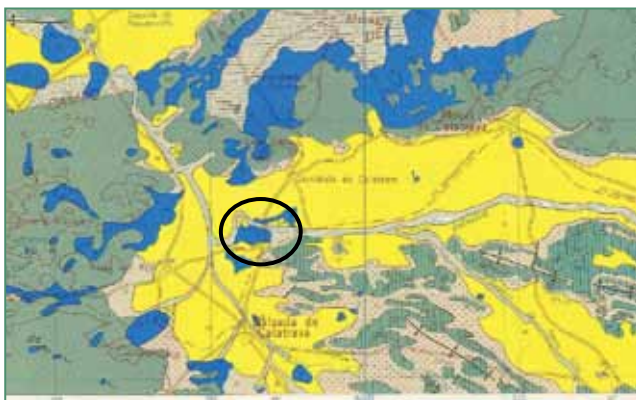
Transport and distribution: The site certainly produced building stones for the city of *Oretum* and would have profited from the Jabalón River to transport its products.

Products: Querns and millstone workings are yet to be confirmed .

Rock type: Olivine basalt (Geological map 61,1:200000, Ciudad Real, 1970, IGME), Anderson *et al.* 2011: 159-161).



Prominent columnar jointing at the Cerro Columba (from the website of the Geomorfología, Territorio y Paisaje en Regiones Volcánicas research group: <http://www.uclm.es/profesorado/egcardenas/columba.htm>).



Extract from geological map 61, Ciudad Real, 1970 (IGME). The Cerro Columba is in the blue volcanic basalt unit.

Source

Website of the research group “Geomorfología, Territorio y Paisaje en Regiones Volcánicas”, University of Castilla La Mancha, Columba, El Cabezuelo, las Cuevas: <http://www.uclm.es/profesorado/egcardenas/columba.htm> [accessed May 23, 2012].

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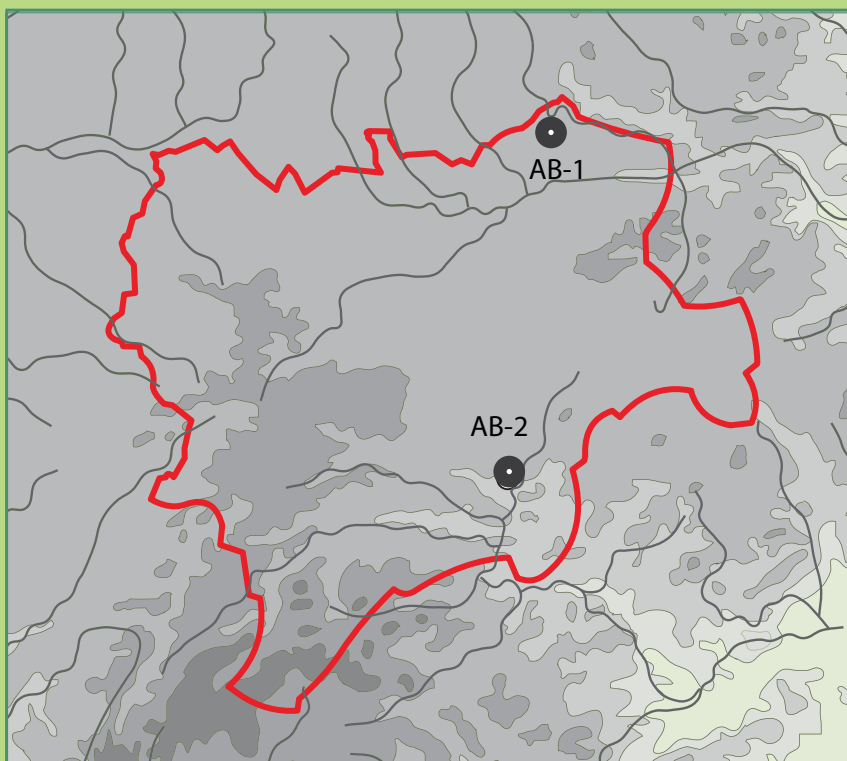
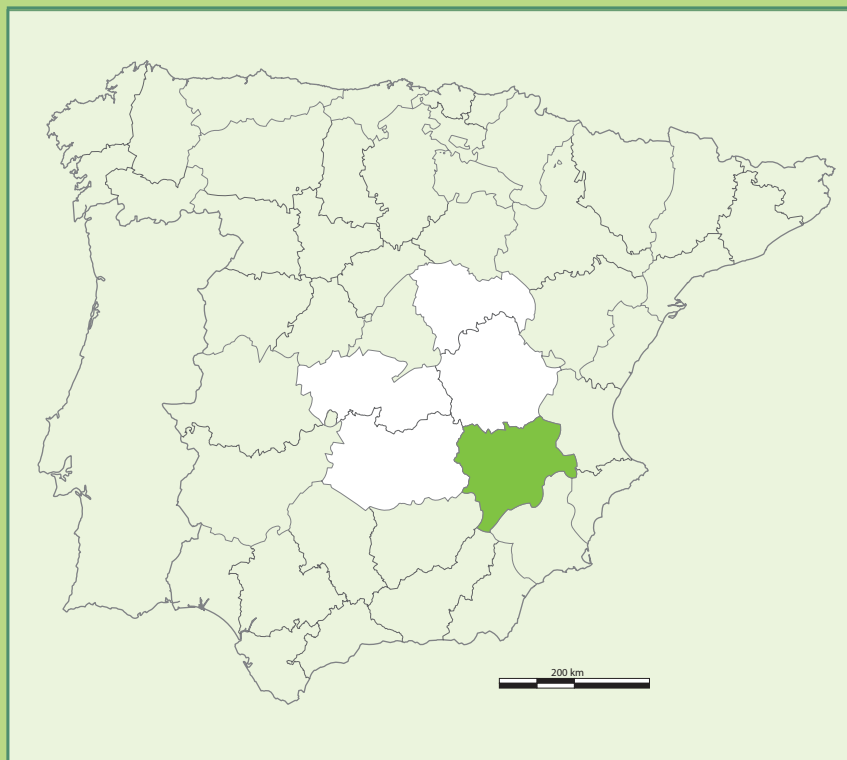
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I thank the archaeologists J Helena ROMERO SALAS and Juan Manuel DONOSO GÓMEZ, archaeologist from Granatula de Calatrava, for oral information about this site and Tor GRENNE of the Norwegian Geological Survey for accompanying me to the site.

CASTILLA LA MANCHA

ALBACETE (AB)



AB-1 Fuentealbilla

El Molar

Latitude: 39° 14' 9.98"N
 Longitude: 1° 32' 48.41"W
 Altitude: c. 640 m



Location and generalities: The millstone quarry of *El Molar* is on the north-eastern slope of a hill near the Ermita de San Isidro in the Municipality of Fuentealbilla. It is in the north-east of the Albacete Province, halfway between the towns of Fuentealbilla and Abengibre. It is interesting to note that the coat of arms of Abengibre includes a silver millstone in its upper field, possibly an allusion to the tradition of millstone production.

Sources: The earliest reference to millstone working comes from the *Survey of the Marques de Ensenada* (1750-1754) which lists a *picapedrero de molinos* (millstone maker) among the residents of Fuentealbilla. Madoz, a century later, cites the millstone workings twice, in descriptions of the towns of Abengibre (Madoz 1845, Vol. 1: 51) and Fuentealbilla (Madoz 1845, Vol. 1: 256).

What is interesting about Madoz' reference is that the Fuentealbilla rock is described as having a grain that is not as compact and not as "appreciated" as that of the sandstone millstones from Barcelona. This is a reference to the celebrated millstone quarry of Montjuïc that traded its products along the north-eastern coastline of Spain, the Balearic Islands, and even to France and Italy (Capmany 1779; Barbera Miralles 2003: 194; Español 2009: 966-967).

The quarry: Francisco Castillo of Fuentealbilla notes that abandoned and broken millstones are still present at the site and that there are circular hollows in the bedrock, indicating true extractive work.

Toponymy: The place name "*molar*", deriving from the Latin "*mola*" (millstone), is at times associated with millstone production.

Products and quantification: The site produced large millstones for watermills (and possibly windmills).

Distribution: Because of the existence of several different written references, and its comparison with the quarry of Barcelona, it is conceivable that the Fuentealbilla quarry traded its millstones beyond the local area.

Dating: The reference in the *Survey of the Marques de Ensenada* (1750-1754) establishes production in the middle of the 18th century, whereas the Madoz references confirms workings a century later.

Rock type: Limestone (Geological map 743, Madrigueras, 1977).



Coat of arms of the town of Abengibre with a silver millstone (from <http://es.wikipedia.org/wiki/Abengibre>).



Extract of the Survey of the Marqués de la Ensenada (1750-1754) of the town of "Avengibre" (modern Abengibre). Among the professions of the town is that of "Picapedrero de molino" (millstone maker) (from Catastro de Ensenada, <http://pares.mcu.es/Catastro/servlets/ServletController>).

Transcription of the extract about the millstone maker from the Survey of the Marqués de Ensenada:

"Pedrero: Un Pica Pedrero de Molino que el dia que se ocupa en dicho exercicio, gana quatro Reales, y dos de Costta todos Seis Reales".

Section 32 (pages 83-84).



Sources

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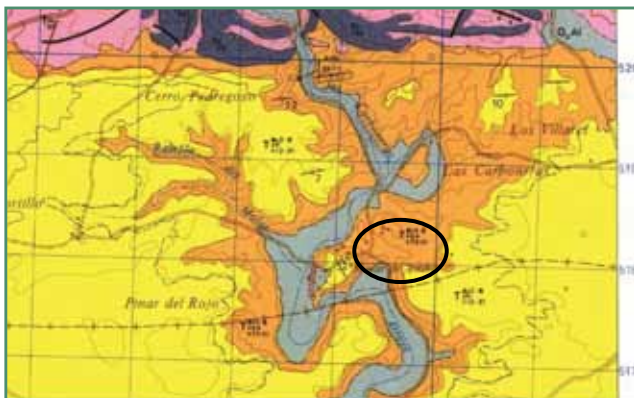
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Acknowledgements

I would like to thank Francisco CASTILLO of the Municipality of Fuentealbilla for his oral description of the site.



Extract from geological map 743 (IGME). Limestone (orange).

AB-2 Hellín

Pitón de Cantarix

Latitude: 38° 25' 1.08" N
 Longitude: 1° 35' 37.58 W
 Altitude: c. 590 m



Location: The Pitón de Cantarix is a volcanic dome in the centre of the Sierra de las Cabras, about 12 kilometres south-east of Hellín, near the border of the Autonomy of Murcia (Castaño *et al.* 1985).

Sources and products: The authors a study of the Roman settlements of La Horca and El Tolmo of the Minatda-Agramón Valley record the presence of volcanic querns and suggest they come from the nearby Sierra de las Cabras dome at Cancarix (Jordan *et al.* 1984: 222-223, 227).

Cobblestone workings from recent times are reported along the prominent columnar jointing of the dome's southeastern flank (<http://jumillanatural.blogspot.com.es/2013/01/volcan-de-cancarix.html>; IGME 868: 41). My recent field survey of this sector, although confirming the quarry work of detached blocs and some extractive work (presumably by blasting), did not confirm Roman quern or millstone workings. More fieldwork focused on other sectors of the site is needed to test the hypothesis of Roman quern workings.

Dating: Finds of volcanic querns in nearby Roman settlements date the potential quarry to Antiquity. According to Jordan (1997: 17), quernstones (for animal fodder) of this material are also known in local 20th-century farms.

Rock type: Jumillite volcanic rock (Geological map, 868, Isso, 1980). In more recent studies, the geological unit is classified as a dark lamproite with hexagonal columnar jointing (see Guía Geológica). From a macroscopic point of view, the rock is grey is and not highly vesicular. The site is one of the northern-most volcanic outcrops of the S-E Spanish Volcanic District.



View of the columnar jointing along the southeastern flank of the Pitón de Cantarix (from <http://jumillanatural.blogspot.com.es/2013/01/volcan-de-cancarix.html>).



Detail of the columnar jointing along the southeastern face. Quarry work was profited from the many detached blocks.



Example of a modern working sector littered with working debris.



Large blocks were reduced by wedging before being hewn into cobblestones.



Extract from geological map 868 (IGME). The dark unit is "Jumillita" volcanic rock and is the presumed location of the quarry. More recent geological research defines the rock as a lamproite, a type known to have been exploited since Roman times for querns and millstones.

Sources

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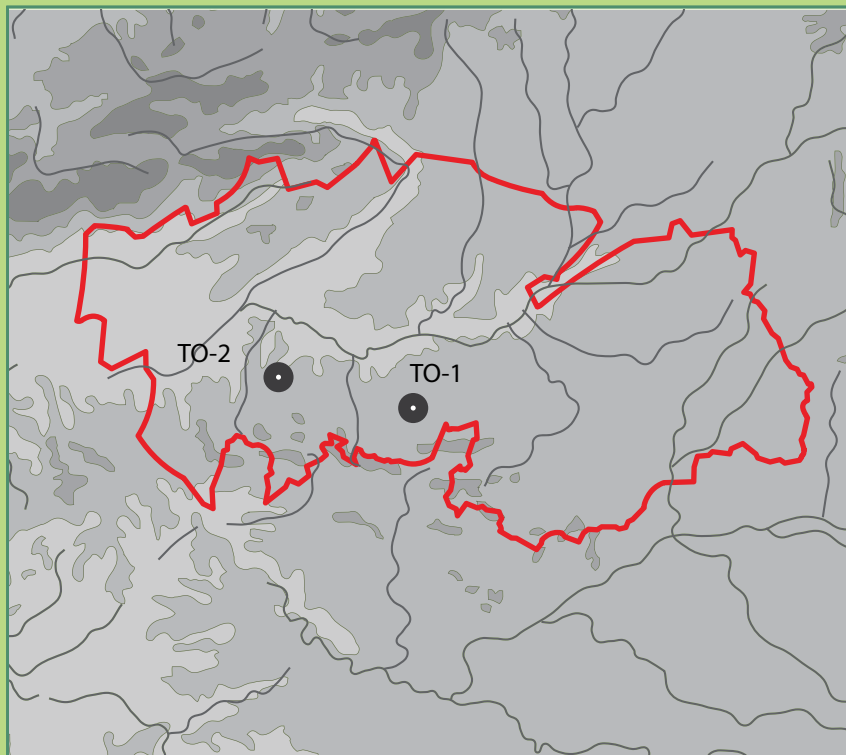
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Acknowledgements

I thank Tom HELDAL of the Norwegian Geological Survey for accompanying me to this site.

CASTILLA LA MANCHA

TOLEDO (TO)



TO-1 Torrecilla de la Jara



Location: Torrecilla de la Jara is a small town in south-western Toledo in the Valle de los Castaños.

Source: The sole reference to millstone production is the response dating to the 9th of May, 1782, by Lucas Fernandez de la Sierra, the village priest, to a questionnaire from the Archbishop Lorenzana of Toledo concerning the natural resources of the town. His answer to question 14: "(the town) only has a few boulders from which millstones were hewn for flour mills".

The quarry: The use of the term "cantos" is an allusion to the surface boulders that abound in the area.

Distribution: From the written sources, the production was destined for the local mills.

Dating: End of the 18th century.

Rock type: The main lithic material in the surroundings of Torrecilla is granite. Blocks of quartzite or breccia, in the plains beyond the town, could also have been exploited (Geological map 655, Navalmales, 1990).



View from the west of the town of Torrecilla de la Jara (extract from Google Maps Street View).

The response to the questionnaire of 1782 of the Archbishop Lorenzana of Toledo

"A la 14.ª [sic] pregunta debo decir no tener este pueblo aguas minerales ..., si solo tiene algunos cantos que sirven para sacar piedras para los molinos de pan ..."



Extract of the geological map 655 (IGME). The granite unit is in pink. The other units in the surroundings (cream, beige, blue) correspond to surface blocks of quartzite and breccia.

Sources

The responses to the questionnaire of Archbishop Lorenza of Toledo (1782) for the town of Torrecillas de la Jara were consulted at: <http://www.torrecilladelajara.com/historia.htm> [accessed October 15, 2012].

TO-2 Las Ventas con Peña Aguilera



View of the Cerro del Águila, one kilometre to the east of the centre of Las Ventas con Peña Aguilera. This photograph illustrates the numerous surface boulders of granite that are typical of the region (photograph by David Miguel Rubio).



View of the courtyard of the Hermitage on the Cerro del Águila with granite troughs and, in the foreground, what appears to be an unfinished millstone (photograph by David Miguel Rubio).

Location: This Municipality of Ventas con Peña Aguilera is in the south of the Province of Toledo. It appears that there were millstone workings at the Cerro del Águila, a hill one kilometre to the east of the centre of the town. Since granite surface boulders are ubiquitous in the area, there were probably many different millstone workings.

Sources: The response to question 28 of the *Survey of Philip II* (1576) records that Ventas con Peña Aguilera quarries furnished not only stones for the Cathedral and the Alcázar (fortress) of Toledo, but “the best granite millstones in all of Spain” (Viñas & Paz 1951: 216).

A second reference to millstone production dates to a protocol in 1587 (leg. 313/2 a). It records that the millstones for a restored watermill in Colmenar de Oreja (Madrid) must be of “*pedra berroqueña*” (granite stone) from Las Ventas con Peña Aguilera (Baltanas 1998: 36-37). The distance between the quarry and the mill is about 100 km. It is interesting to note that these stones were chosen over the local Colmenar de Oreja white limestones, a famed, nearby millstone production (see M-2).

A third reference is a report drawn up in 1821 and presented to the authorities in Madrid regarding the ownership, boundaries and qualities of the terrain, population and administration of 16 towns in the Mountains of Toledo (López & Martínez 1821). For Las Ventas con Peña Aguilera the report states that it has the best granite quarries of the Province of Toledo and that, besides the construction material for important buildings, the quarries produced millstones for mills spread out over the whole of the province (López & Martínez 1821: 17-18).

A last reference, published shortly after the third in a geographical dictionary, echoes that the town has many granite or “*berroqueño*” quarries that supply millstones beyond the distance of 30 leagues (between 120 and 210 km) (Miñano 1828, Vol. 9: 286).

It is worth noting that several decades later, Madoz records the numerous granite quarries of the locality, but does not mention millstone production.

Toponymy: There are many place names spread across the municipality related to granite outcrops (*Berrueco*, *Cantos Blancos*, *Cantera...*). None of these place names, however, can be directly related with millstone production.

The quarry: The millstone makers could have exploited both surface blocks (*bolos*) and bedrock. A modern granite exploitation, possibly concealing older workings, is one kilometre north of the town at the place name *Berrueco*.

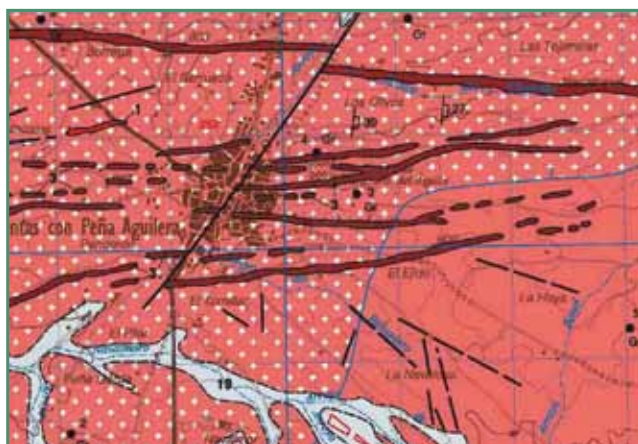
Transport and distribution: This is one of the rare sites with information from old written sources related to the subject of the millstone export. Three of the 19th-century reports coincide that Las Ventas con Peña Aguiler supplied millstones beyond the local sphere, up to a distance of about 165 km. The oldest text (1576) stresses that the stone was the “best” in all of Spain, suggesting also that it was widely distributed.

Dating: The site spans the Modern to Contemporary periods.

Rock type: Granite (Geological map 684, Navahermosa, 1990).



Detail of the granite surface boulders (bolos) at the Cerro del Águila (photograph by David Miguel Rubio).



Extract from geological map 648 (IGME). Millstones could have been produced at a number of sites in the granite unit (red with white crosses). The darker horizontal bands are pyroclastic granite dikes.



Detail of the Cerro del Águila hill with a small block extractive granite quarry. The product of this quarry is not known (photograph by David Miguel Rubio).

Source

Photographs by David Miguel Rubio from the blog: <http://elrealdesanvicente.blogspot.com.es/2015/05/las-ventas-con-pena-aguilera-toledo.html>. [accessed June 6 2015].

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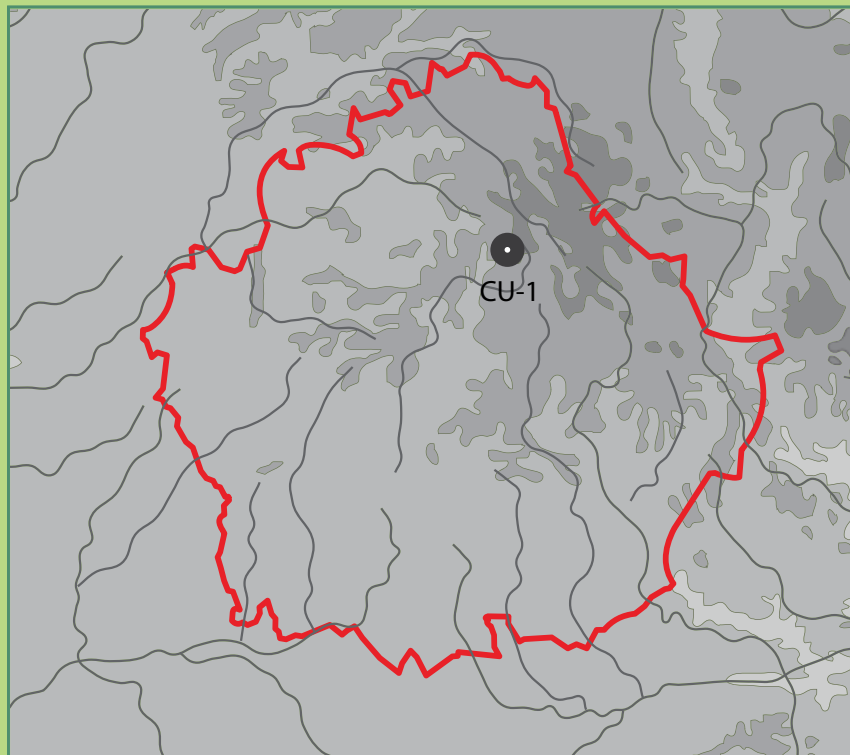
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CASTILLA LA MANCHA

CUENCA (CU)



CU-1 Portilla

Los Molares

Latitude: 40° 17' 54.32" N

Longitude: 2° 2' 44.08" W

Altitude: 1350 m



View of the quarry (from the website CampiSierra: http://www.campisierra.org/portal/lang__es-ES/p28615__2/tabid__11980/default.aspx).

Location: The only millstone quarry identified in the Province of Cuenca to date is halfway between the towns of Portilla and Las Majadas.

Source: The site is recorded in the hiking itinerary posted on the Internet (PR-CU 30, Serranía de Cuenca - Ruta del Gollizno y de Las Canteras - Portilla; see source). Its altitude, 1350 m, makes it, for the moment, the highest site identified in this survey.

Toponymy: *Molares*, deriving from the Latin "*mola*", is the place name *par excellence* for millstone workings.

The quarry: Based on the photograph posted on the Internet, the site appears to be a bench quarry where millstones were hewn from previously detached slabs.

Product and dating: With the exception of the photographs, there is no data available about the production of the site. The millstones appear to be large (about 1 m in diameter), probably for watermills. Dating is probably from Medieval or Contemporary times.



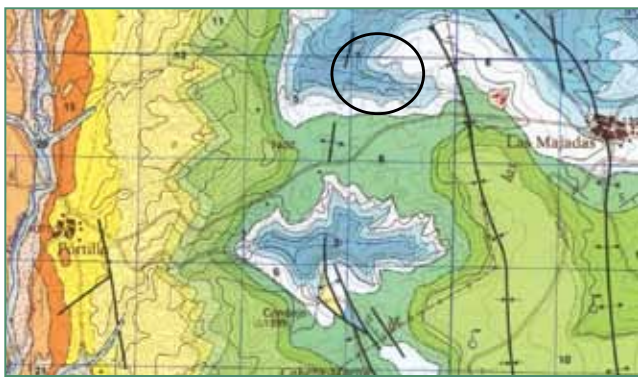
Abandoned millstone at the quarry (from the website CampiSierra).



Abandoned millstone (from the website CampiSierra).

Transport and distribution: The hiking path that passes by the workings was probably the same road used to transport the old millstones. This isolated quarry probably only supplied local mills.

Rock type: From the geological map, the rock is a dolomite or limestone (Geological map 587, Las Majadas, 1986). From the photographs, however, the rock appears to be a conglomerate with pebble clasts.



Extract from geological map 587 (IGME). The site is associated with dolomite or limestone unit (blue).

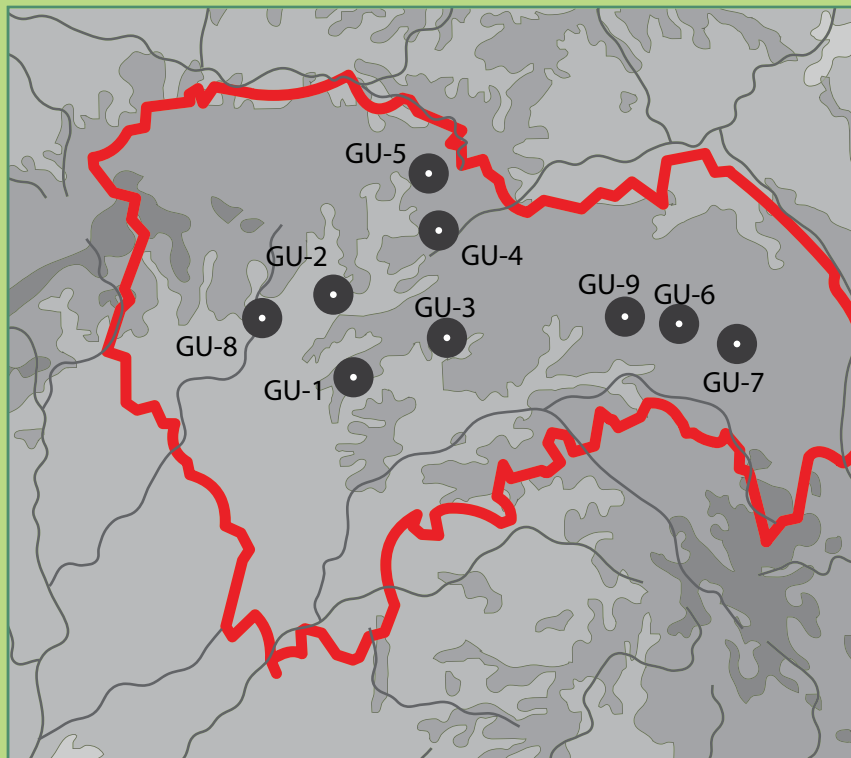
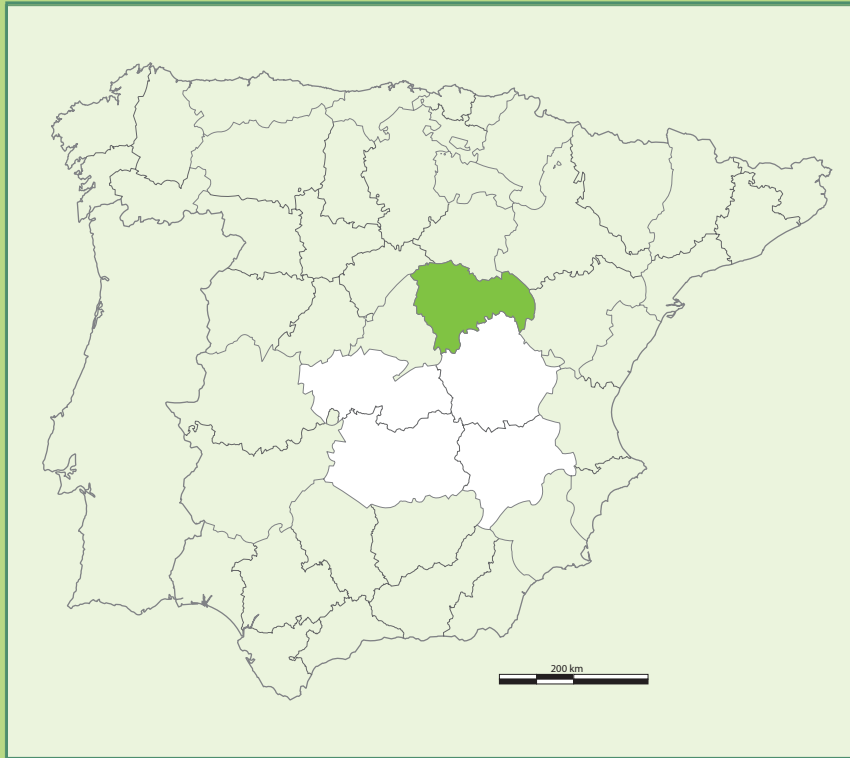
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Photographs from "CampiSierra": http://www.campisierra.org/portal/lang__es-ES/p28615__2/tabid__11980/default.aspx [accessed November 2, 2012].

CASTILLA LA MANCHA

GUADALAJARA (GU)



GU-1 Brihuega



Location and source: The Municipality of Brihuega is divided roughly into two main geographical areas: a high plateau to the north-west and mountains to the south-east. A “pumice” millstone quarry is recorded in a 19th-century treatise on the subject of hydraulic power (Vallejo 1833: 387). Its location, unfortunately, is not specified.

Toponymy: A place name *El Molar* in the cadastre (SEC) is about three kilometres east of Brihuega, whereas the name *Pedrero* (quarryman) is three kilometres to the south-west. Both of these sites coincide with limestone tufa “pumice” outcrops and are potential locations of the quarry.

Product and quantification: The treatise on hydraulic power states that Brihuega millstones could grind for 16 hours a day and required dressing every four hours (Vallejo 1833: 387).

Bread: Vallejo (1833: 387) records that the Brihuega millstones yielded a flour as white as that of the millstones of Colmenar, a reference to the site of Colmenar de Oreja in Madrid (M-2).

Dating: First half of the 19th century.

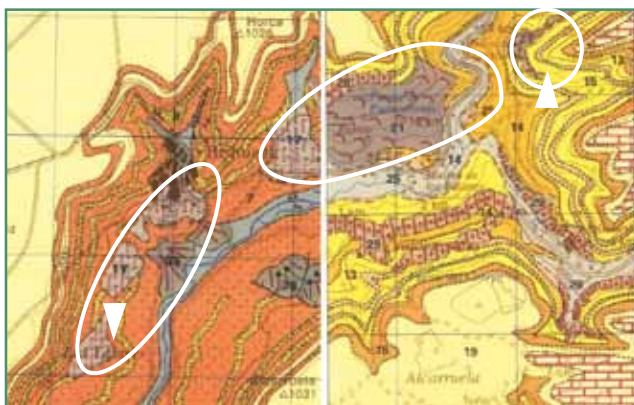


Extract from the cadastre (SEC) with the location of the place name El Molar.

Rock type: The term “pumice” suggests a porous limestone tufa (Geological map 511, Brihuega, 1984; 512, Cifuentes, 1989).

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Extract from geological maps 511-512 (IGME). Limestone tufa outcrops are units 17 and 21.

GU-2 Pinilla de Jadraque

Monasterio de San Salvador

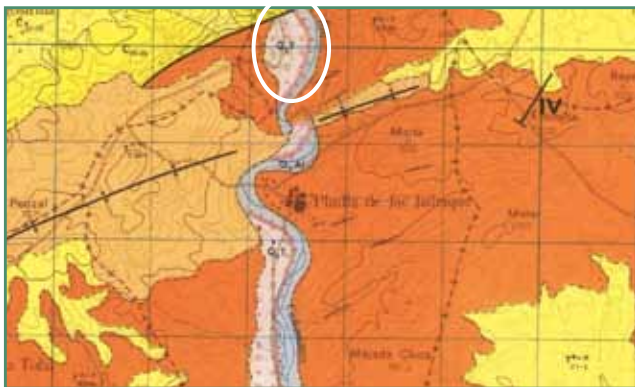
Latitude: 41° 2' 2.93" N
Longitude: 2° 56' 39.40" W
Altitude: c. 860 m



Location: This millstone quarry is reported to be 1.5 kilometres north of Pinilla de Jadraque (also known as *Pinilla de las Monjas*) along the Cañamares River beside the “Monastery of the Nuns” (San Salvador).

Sources: The geographer Miñano specifies that “very good” millstones are extracted from this “beautiful quarry” (Miñano 1827, Vol. 4: 24).

An old geological treatise seconds the existence of the quarry and states that its millstones were hewn from “hard rock, like those of Tobes” (see GU-5) (Castel 1881: 157-158).



Extract from geological map 460 (IGME). The rock type is tufa limestone according to the handbook of the geological map.

Distribution: Miñano indicates that these millstones were commercialised to the surrounding towns (Miñano 1827, Vol. 4: 24).

Rock type: The stone “near Tobes” is a presumably a *toba* (limestone tufa). This coincides with the description in the old geological study (Castel 1881: 22) and the geological units to the north of the town on IGME map 460, Hiendelaencina, 1980.

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GU-3 Cifuentes

Ruguilla

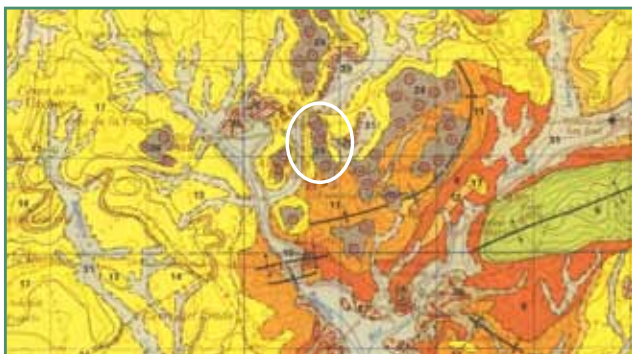


Location and source: Ruguilla is a hamlet surrounded by mountains five kilometres south-east of the town of Cifuentes. The quarry is cited in an Internet hiking itinerary posted by Oscar Quirós and, more recently, in an Internet blog recording the history of the surroundings of Cifuentes. The site is about two kilometres to the south of Ruguilla in the direction to El Bujedal.

The quarry: The itinerary describes a quarry with extraction hollows and abandoned millstones in different stages of manufacture.

Product, quantification and dating: Quiros indicates there are dozens of enormous and heavy extractions, suggesting an exploitation of large millstone dating from Medieval to Contemporary times.

Rock type: Limestone, according to Quiros. The geological map 512 shows units of limestone tufa in the area.



Extract from geological map 512 (IGME). The probable source is limestone tufa (brown with circles, 24). The rock could also be one of several varieties of sedimentary stones (yellow or orange).



Detail of an abandoned millstone (Photograph from <http://patrimoniocifuentes.blogspot.com.es/2015/03/de-sotoca-huetos-por-ruguilla.html>).

Sources

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Patrimonio natural y cultural de Cifuentes: <http://patrimoniocifuentes.blogspot.com.es/2015/03/de-sotoca-huetos-por-ruguilla.html> [accessed April 9, 2015]

GU-4 Sigüenza

La Cuerda



Location: The site is about two kilometres south-east of Sigüenza at the place name “*La Cuerda*”.

Source: The quarry is identified in a website recording aspects of the history of the town of Sigüenza.

Toponymy: The toponym *La Cuerda* in northern Spain coincides with several millstone quarries (Pascual & García 2011: 286). In southern Spain, however, this name does not seem to be a reliable indicator of millstone workings.

The quarry and techniques: This appears to be a isolated extraction, possibly a “prospecting” site, to test the quality of the outcrop. Multiple diagonal lines on the extraction face point to the pick as the tool to cut the trench. To facilitate splitting, the millstone maker profited from the edge of the rock to attain the base of the cylinder.

Product and quantification: The millstone extracted probably measured about 1.00 m in diameter. The author of the blog only mentions a single extraction hollow suggesting a local, isolated exploitation.

Dating: The extraction could date from Medieval to Contemporary times.

Rock type: According to the geological map the rock is a dolomite or sandstone (Geological map 461, Sigüenza 1978). From the photographs it appears to be a conglomerate with pebble clasts.



View of Sigüenza from the south, the approximate location of the quarry (photograph by Marcos Nieto, from Histgueb website: http://www.histgueb.net/minas_petroleo/lazona.htm).



View of the single millstone extraction along the edge of an outcrop (photograph by Marcos Nieto, Histgueb website).



Details of isolated extractions (photograph by Marcos Nieto, Histgueb website).



Extract from geological map 461 (IGME). The potential sources are dolomites (pink hatched) or sandstones (pink).

Source

Histgüeb, "Paseando entre antiguas minas": http://www.histgueb.net/minas_petroleo/lazona.htm [accessed November 2, 2012].

Acknowledgements

I thank the historian Marcos NIETO for information about the site and permission to use the photographs from his website.

GU-5 Sienes

Tobes

Latitude: 41° 11' 36.36" N

Longitude: 2° 39' 41.51"W

Altitude: c. 980 m



Semi-circular stones (possibly millstone segments) used as window frames in the abandoned hamlet of Tobes (photographs by Faustino Calderón <http://lospueblosdeshabitados.blogspot.com.es/2010/05/tobes-guadalajara.html>).

Location and sources: The hamlet of Tobes, now abandoned, is one kilometre south-west of Sienes. A millstone quarry is identified in or near this hamlet both in a 19th-century geological treatise (Castel 1881: 158-159) and in a website.

Toponymy: The name *Tobes* is probably a derivation of “*toba*”, meaning limestone tufa. According to a geological study, the town is built on a thick stratum of this rock (Castel 1881: 158). The website indicates the presence of the place name *Molares*, typical for millstone quarries. This name, however, was neither confirmed on the geographical map or on the cadastre. To the north-east of the town, the name *Moralejo*, close to the term *Molares*, might be related to the millstone workings.

Dating: The geological treatise places the site in the second half of the 19th century.

Rock type: Castel (1881:158) indicates that the rock is a hard limestone tufa. The geological map, however, identifies conglomerate as the dominant rock in the area (Geological map 434, Barahona, 1978).



Extract from geological map 434 (IGME). Conglomerate (in beige).

Source

<http://www.pueblos-espana.org/castilla+la+mancha/guadalajara/tobes/> [accessed November 12, 2012].

Faustino CALDERÓN: <http://lospueblosdeshabitados.blogspot.com.es/2010/05/tobes-guadalajara.html> [accessed November 12, 2012].

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GU-6 Corduente



Location and source: Corduente is a large municipality (232 km²) in the Gallo River Valley in the Natural Park of the Alto Tajo. Madoz records that Corduente has quarries of “good millstones” (Madoz 1847, Vol. 7: 9). The writer, unfortunately, provides no other data as to the location of the quarries or the type of rock.

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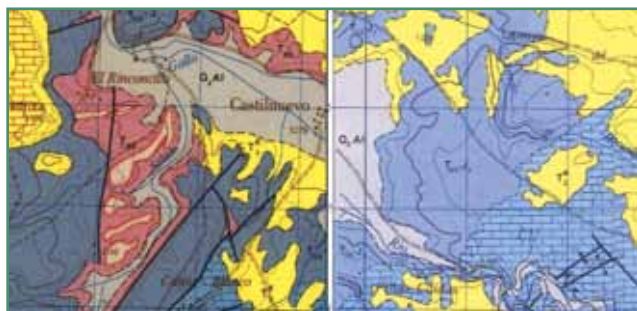
GU-7 Castilnuevo



Location and source: The Municipality of Castilnuevo, on the banks of the Gallo River, is very small (less than 20 km²). Madoz cites several millstone quarries of “*piedra tova*” (tufa limestone) that supply stones to the flour mills of the area (Madoz 1847, Vol. 6: 172).

Dating: First half of the 19th century, based on the text of Madoz.

Rock type: According to the geological maps, there are no limestone tufa outcrops in the surroundings of Castilnuevo (Geological map 514, Taravilla 1980; Geological map 515, El Pobo de Dueñas, 1979). The rock referred to by Madoz could turn out to be a rough limestone, an outcrop that is common in the surroundings of Castilnuevo.



Extracts from geological maps 514 and 515 (IGME). There are no “*toba*” (limestone tufa) outcrops indicated on these maps in the surrounding of Castilnuevo. The quarries are probably to be found somewhere in the blue limestone units.

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GU-8 Montarrón

Los Morales (Los Molaes)

Latitude: 40° 54' 28.32" N

Longitude: 3° 6' 25.13" W

Altitude: 877 m



View from the north-west of the Cerro del Prado promontory outside of Montarrón. The place name Los Morales is on the northern edge of the hill (Google Maps Street View).

Location, source and toponymy: An exploitation of “*pedras arineras*” (flour millstones) is recorded in Response 24 of the *Royal Census of Philip II* (1574-1578). There is confusion as to the exact location of the millstone quarry. A photograph from Google Earth shows a roughout on the Cerro de la Atalaya, just to the south of the present town. This location seems to concord with the information from a study of Medieval constructions at the site that records abandoned millstones in different stages of manufacture (Pavón 1984: 94).



View of millstones on the (photograph by Benjamín M. M., Google Maps, <http://www.panoramio.com/photo/115351019>).



Detail of the Cerro del Prado cadastre with place name Los Molaes (SEC).

The place name *Los Molaes* (millstone quarry) indicates a potential second location of the quarry on the northern point of the Cerro del Prado, a hill just to the east of Cerro de la Atalaya. In any case, it is perfectly feasible to imagine millstone workings at both sites as they share the same geology.

The situation of this place name illustrates perfectly the problem of the inversion of the syllables “r” and “l” in the terms *Morales* and *Molaes*. The geographical map (SIGPAC) uses *Morales* (meaning the “mulberry trees”), whereas the cadastre (SEC) uses *Los Molaes*, from the Latin *mola* (millstone).

It is worth noting that on the second hill there are also several toponyms related to iron working. These are *Las Fraguas* (the smithies) and *Las Herraduras* (the horseshoes). These names might reflect work related to the maintenance of the millstone quarry tools.

The quarry: From Pavón’s description, it appears that millstones were hewn from detached angular blocks.

Products and dating: Pavón records two millstones sizes. Unfortunately the exact dimensions of each model are not cited. Large models, presumably water millstones, were cut from “enormous blocks” (Pavón 1984: 92). Their dating is not certain (Medieval to

Contemporary?). The smaller models could be older medium-sized millstones or possibly rotary querns (Pavón 1984: 92).

Rock type: According to the geological map, both hills to the south of Montarrón share the same sandstone, conglomerate or limestone units (Geological map 486, Jadraque, 1983).



Extract from geological map 486 (IGME). Both hills share a red unit comprising sandstones, conglomerates and limestones.

Source

Relaciones Topográficas de los Pueblos de España de Felipe II, 1574-1578.
Montarrón: http://www.uclm.es/ceclm/b_virtual/libros/relaciones_gu/MONTARRÓN.htm [accessed November 17, 2012].

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GU-9 Cobeta

Barranco de Arrandilla

Latitude: 40° 51' 46.55" N

Longitude: 2° 7' 55.83" W

Altitude: 1140 m



Location and Source: The quarry is on the outskirts of the town of Cobeta in the Natural Park of the Alto Tajo. It is recorded in a geological guide (Carcavilla *et al.* 2008: 143).

The quarry: The photograph shows a true extractive quarry with multiple, contiguous extractions.

The product: The cylinders in the photograph measure c. 80 cm in diameter. Although millstones are known to have been extracted from reddish sandstone in southern Spain (see for example Montoro, C-14), the extractions in the photograph could also correspond to cylindrical sharpening stones.

Dating: Without knowing the true nature of these products, it is not possible to propose a date.

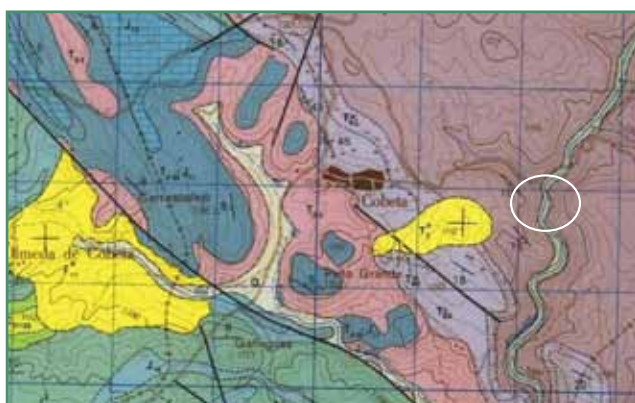
Rock type: Red sandstone (Geological map 489, Molina, 1979).



*View of the quarry with cylindrical extractions measuring about 80 cm in diameter. The extractions, from their size and stone type, could be sharpening stones (from Carcavilla *et al.* 2008: 143; <http://es.scribd.com/doc/48886123/GUIA-P-N-ALTO-TAJO-I-carcavilla-total>).*

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Extract from geological map 489 (IGME). The quarry is in the red sandstone unit (purple) to the east of Cobeta.

VALENCIA

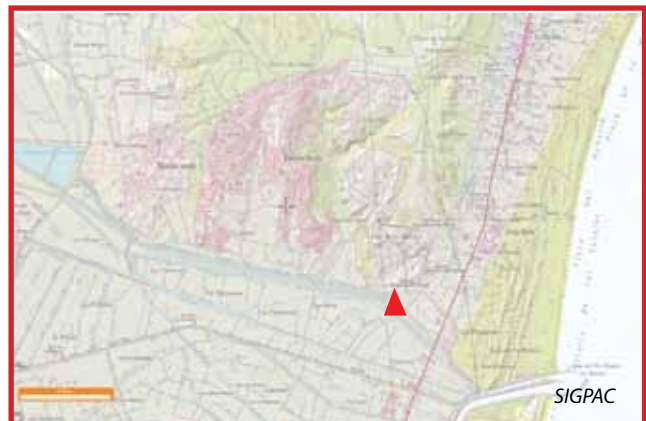
ALICANTE (A)



A-1 San Fulgencio

Sierra del Molar

Latitude: 38° 7' 32.95" N
 Longitude: 0° 39' 46.38" W
 Altitude: c. 20-50 m



Location and generalities: The *Cueva de los Cochinos* (or *Marranos*, meaning the cave of the swine) is at a low mound called *Sierra Molar* beside Marina-Oasis, an urbanisation on the Segura coastal plain, less than two kilometres from the Mediterranean coast. In spite of the term "cave" (cueva), there is no indication that the quarry was subterranean.

Sources and toponymy: The site is first recorded in the 1950s in an archaeological inventory of the Elche Municipality. The author associates the *Molar* toponym with millstone working (Ramos Folques 1953: 347). A more recent archaeological field survey backs up the notion of a millstone quarry but does not furnish concrete evidence (Gutiérrez Lloret *et al.* 1999: 38).

The quarry: Nothing remains today of the possible quarry owing to the modern exploitation of cement (Gutiérrez *et al.* 1999: 38).

Dating: The date of the site is unknown.

Rock type: Sandstone or calcarenite (Geological map 914, Guardamar del Segura, 1972).



Orthophoto of the modern cement exploitation that has destroyed the site (SIGPAC).



Extract from geological map 914 (IGME). The site is in a unit of sandstones and calcarenites (yellow).

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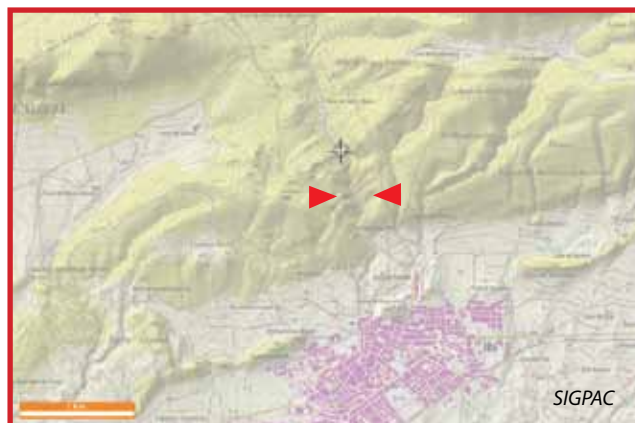
A-2 Ibi

Barranco de los Molinos

Latitude: 38° 38' 29.60" N

Longitude: 0° 34' 44.12" W

Altitude: c. 900 m



Location: This quern quarry, 1.5 kilometres north of the town of Ibi, is divided into two different sectors over 100 metres apart on opposite slopes of the *Barranco de los Molinos* (ravine of the mills).

Sources and toponymy: The site is cited fleetingly in an article by Ágata Marquiegui about the old hydraulic works (watermills, fulling mills) in the valley. Otherwise it is not recorded in any old written sources. The valley's name probably derives from the mills in the valley and has no relation with the ancient quern workings.

The quarry and techniques: The site is an extensive shallow surface quarry comprising numerous contiguous extraction hollows. Extraction took place on a very inclined, at times almost vertical, plane. This probably obliged the quern makers to erect some kind of scaffolding. Working debris would have naturally tumbled downhill. Due to extreme weathering of the rock surface, tool marks are poorly visible.

Product and quantification: Production, in the hundreds, is limited to querns about 40 cm in diameter.

Distribution: This site probably served the needs of local settlements.

Dating: The site, from the site of the querns, could date anywhere from the Late Iron Age to Medieval times. The scale of production would lean the balance toward a Roman date. An earlier Iron Age (Iberian Culture) date, based on the ratio diameter/thickness of the cylinders, cannot be discounted.

Rock type: Limestone or dolomite rock (Geological map, 846, Castalla, 1977). The quarrymen exploited a specific limestone layer with a rough aspect and intentionally avoided a finer, homogenous (probably less abrasive) adjacent limestone stratum (Ágata Marquiegui, pers. comm.).



View of the western sector of the quern quarry (photograph by José Lajara).



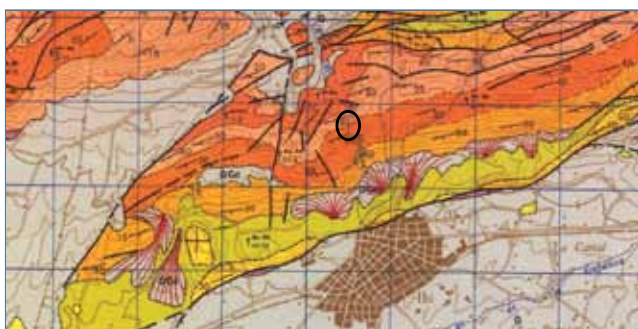
View of part of the eastern sector of the quern quarry (photograph by José Lajara).



View of part of the eastern sector (photograph by José Lajara).



Detail of a quern extraction (photograph by Ágata Marquiegui).



Extract from geological map 846 (IGME). The quarry corresponds with a limestone and dolomite unit (light orange).



Detail of contiguous extraction hollows of small rotary querns (photograph by José Lajara).

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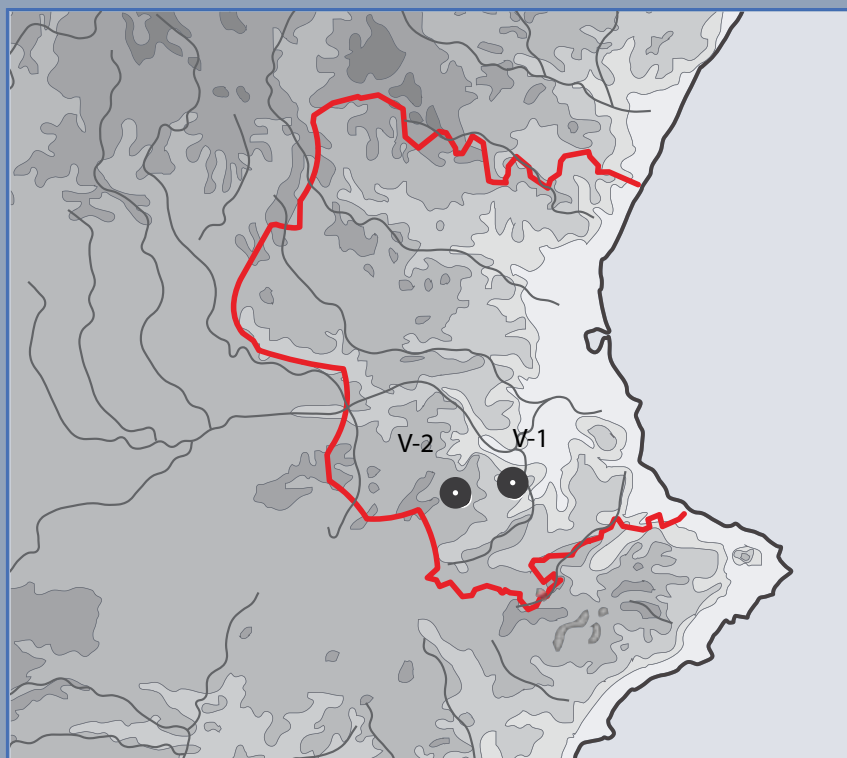
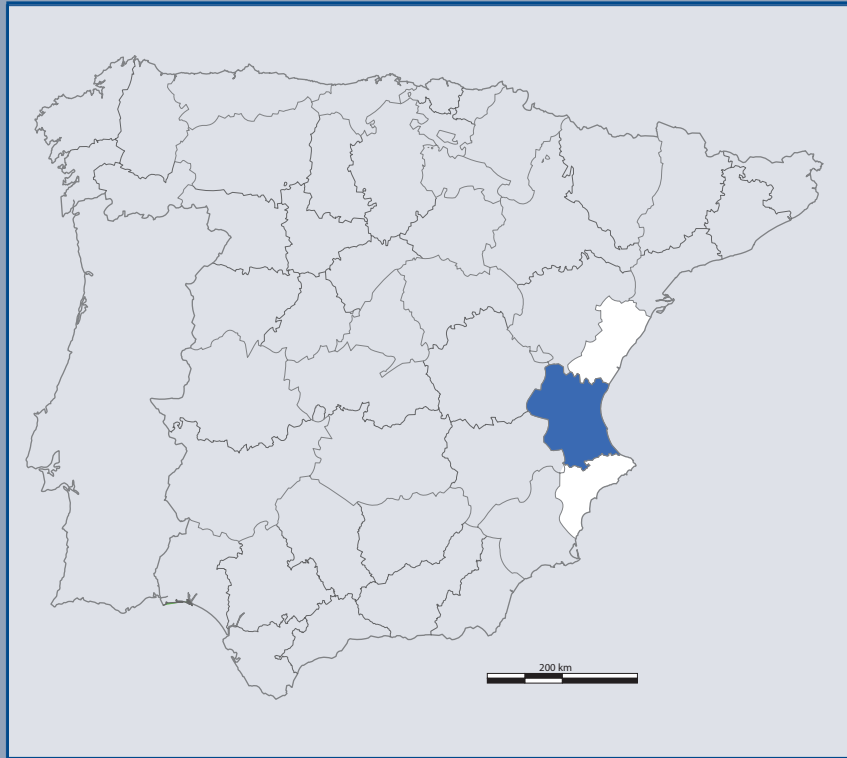
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Acknowledgements

The information of this site and the photographs are from the historian Ágata MARQUIEGUI SOLOAGA and the archaeologist José LAJAR MARTÍNEZ. I sincerely thank them for their assistance.

VALENCIA

VALENCIA (V)



V-1 Canals

Les Moles

Latitude: 38° 56' 49.23" N

Longitude: 0° 36' 0.42" W

Altitude: c. 150 m



Location: The millstone quarry of *Les Moles* is in the riverbed of the Canyoles River to the south-west of the town of Canals.

Source: The site is recorded in the website of the Municipality of Canals.

Toponymy: *Les Moles*, deriving from the Latin *mola* (mill), appears as the name of a town house, a local road and an industrial quarter south-west of Canals. 2.5 kilometres farther south-west is *Els Canteressos*, possibly deriving from *cantera* (quarry).

The quarry, products and quantification: The site appears either as a pit or a pocket quarry, with extraction hollows corresponding to cylinders over a metre in diameter.

Distribution: The site is very small according to José Antonio Polop. It therefore must have only supplied local mills.

Dating: Medieval to Contemporary.

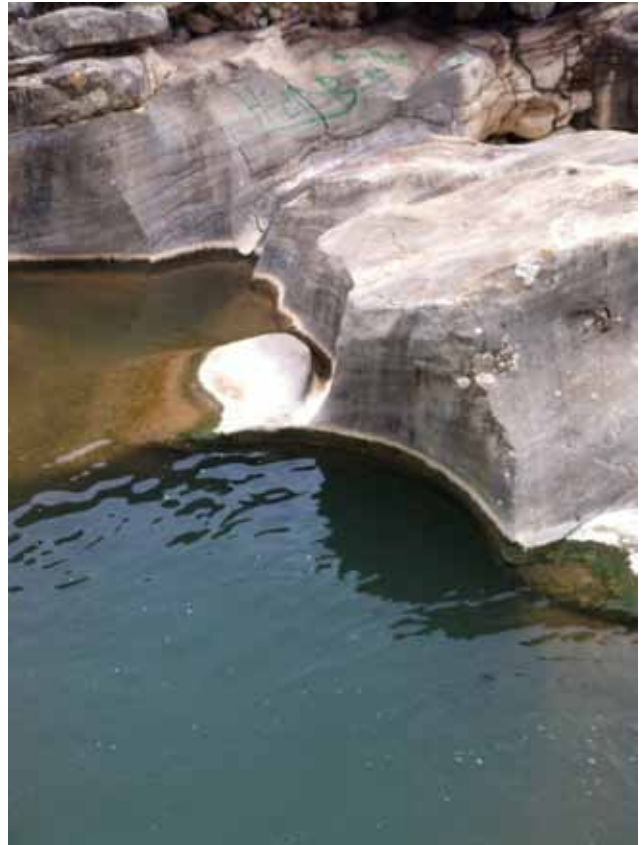
Rock type: Limestone (Geological map 794, Canals, 1976).



View of the Canyoles River (from Google Maps Street View).



View of the quarry (photograph by Juan García Cerdá).



Different views of the Canals millstone quarry. The white ruler corresponds to 30 cm (all photographs by Juan García Cerdá).



View of an abandoned cylinder (photograph by Juan García Cerdá).



View of a broken cylinder (photograph by Juan García Cerdá).



Extract from geological map 794 (IGME). The rock is probably a limestone.

Source

Website of the Municipality of Canals: <http://www.canals.es/canals/index.php/ciudad/paisaje.html> [accessed November 22, 2012].

Acknowledgements

I thank José Antonio POLOP of the Town Hall of Canals for general information about the site and Juan GARCÍA CERDÁ for the photographs.

V-2 Montesa

La Mola

Latitude: 38° 57' 5.89" N

Longitude: 0° 39' 9.62" W

Altitude: c. 340-380 m

Location: The millstone quarry at Montesa is spread out along the southern flank of the *Mola* plateau, from the fortification to the east, to the crag to the west, today a haven for rock climbers.

Source: Circular extraction hollows are described in an anonymous travel blog on the Internet. The website, however, does not identify them as a quarry.

Toponymy: The name *La Mola*, from the Latin *mola* (millstone), in the Valenciano language, designates, as is the case here, a hill with a flat top.

The quarry: Extraction hollows, according to Juan García Cerdá, are spread out in different sectors. To the east is an edge quarry comprising superimposed extractions forming a high, tubular quarry face that today reaches the foot of the castle. Other extractions are either isolated or clustered in benches.

Product, quantification and distribution: Based on the photographs, I assume that both rotary querns (around 50 cm) and millstones (over a metre in diameter) were scored. Medium-sized extractions are also possible. The number of extractions is difficult to estimate. The impression, however, is that of a production destined to regional mills.

Dating: The sizes of the smaller quern extractions suggest a Medieval, or possibly Roman, date. The stratigraphical relationship between the tubular edge quarry and the foundations of the fortification is not clear. I doubt, for reasons of stability, that extractions would have been permitted if the foundations were already in place. It is thus likely that the quarry is older than the earliest phase of the fortification dating to the Islamic domination (Guichard 2001: 248). The larger extractions elsewhere on the hill could range from Medieval or Contemporary times.

Rock type: Bioclastic calcirudite (Geological map 794, Canals, 1974).



View from the south of the Mola hill north-west of Montesa (Google Maps Street View).



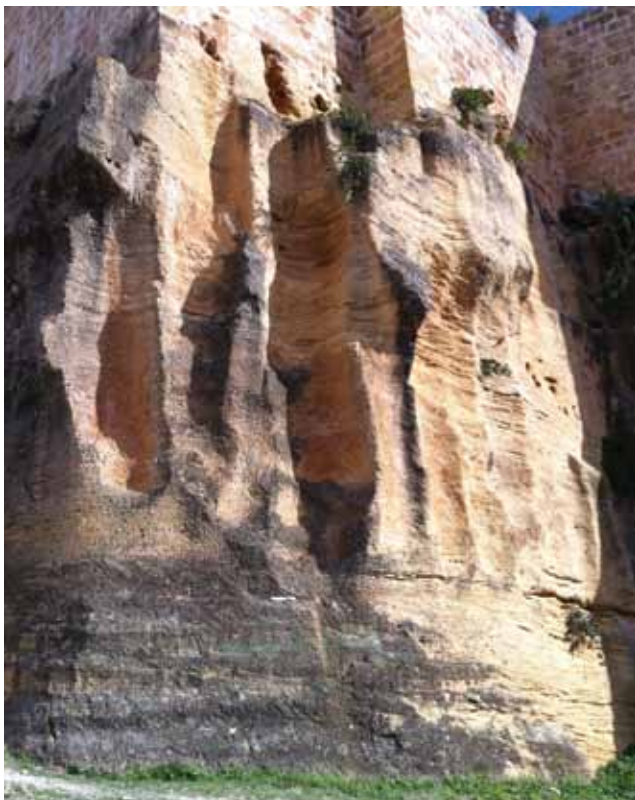
Aerial view of the Montesa plateau and castle (to the right) (SIGPAC). The arrows indicate the exploited areas.



Extract of the cadastre (SEC). The place name mola is at the area on the top on the slopes of the plateau, as well as at the parcels of the fortification (28, 163, 164).



View of the tubular quarry face at the base of the western perimeter of the Castle of Montesa (from Google Maps Street View).



Detail of the edge quarry with vertical tubular extraction hollows at the base, and apparently cut, by the fortification.



Extraction hollow of a cylinder measuring approximately 1.10 m in diameter.



Isolated extraction hollow of a rotary quern measuring about 50 cm in diameter.



View of a group of large extraction hollows (approx. 1 m) on four different levels.



Extraction hollow of a cylinder measuring approximately 1.20 m in diameter (all photographs, except when indicated, by Juan García Cerdá).



Extract from geological map 794 (IGME). The quarry corresponds to the bioclastic calcirudite outcrop (orange). The surrounding unit (yellow) is loam.

Source

Anonymous travel blog "Montesa, Enclave Megalítico": <http://viajesmagicosporiberia.blogspot.com.es/> [accessed January 7, 2013].

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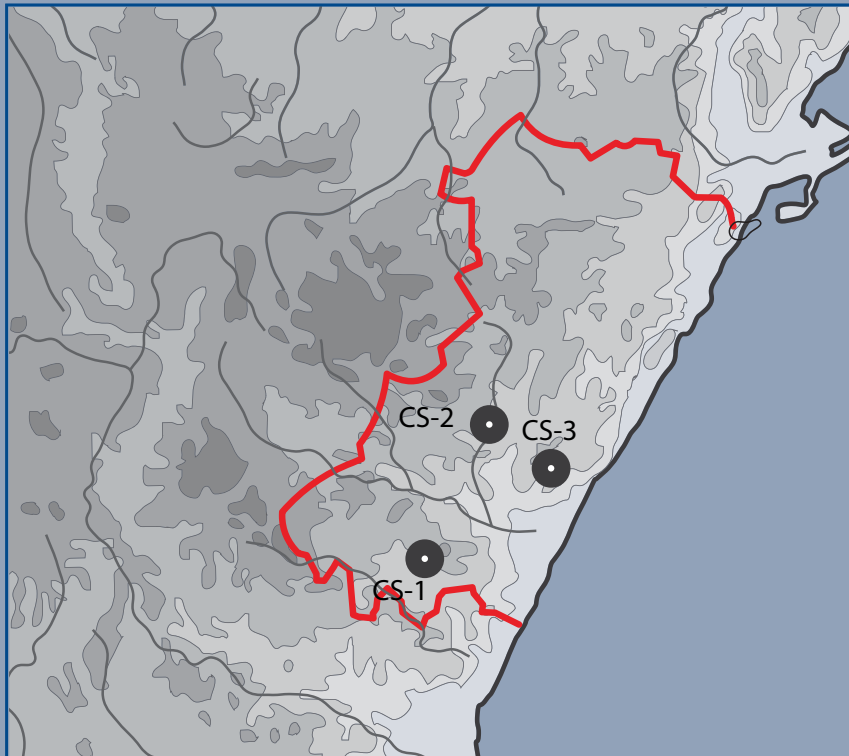
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Acknowledgements

I sincerely thank Juan GARCÍA CERDÁ, the mayor of Montesa, for the photographs and information about the site.

VALENCIA

CASTELLÓN (CS)



CS-1 Soneja

Los Arenales

Latitude: 39° 48' 52.96" N
Longitude: 0° 19' 56.92" W
Altitude: 460 m



Location: The *Arenales* millstone quarry is on the summit of a mountain in the Soneja Natural Park near the La Laguna de la Dehesa.

Sources: The site is mentioned briefly in an article about the mills of the Province of Castellón (Barberá 2003: 194). It is also included in several different hiking itineraries on the Internet and appears in a short video and photographs by David Molina.

The quarry: The presence of angular blocks in the photographs suggests that millstones were fashioned from detached blocks.

Product, quantification and distribution: Large millstones for watermills or windmills. The site is modest and meant for local mills.

Dating: The diameter of the product suggests a dating ranging from Medieval to Contemporary times.

Rock type: Argillite or sandstone (Geological map 668, Sagunto, 1972).



Orthophoto of the millstone quarry seen in the clearing of the forest near the hiking trail (SIGPAC).



View of the millstone quarry (photograph by David Molina).



View of an abandoned cylinder surrounded by working debris (photograph from blog "Andamontes" <http://andamontesenblog.blogspot.com.es/2013/03/laguna-de-la-dehesa-paraje-natural.html>).



Views of abandoned cylinders and working debris (from a Youtube: <http://www.youtube.com/watch?v=yFdj83OQTe0>).



Examples of abandoned millstones in different stages of manufacture (photos by David Molina).



Extract from geological map 668 (IGME). The pink unit in the centre corresponds to sandstones.



View of the carved outline of a future millstone on a detached block (from <http://bikepedalvalencia.blogspot.com.es/2013/07/alfara-de-la-baronia-sot-de-ferrer.html>).

Sources

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Acknowledgements

The photographs are the property of David MOLINA. I kindly thank him for permitting me use them in this study.

CS-2 Lucena del Cid



Location and source: Lucena del Cid is a municipality (137 km²) in the central mountains of Castellón. Millstone production is cited briefly in the study of old mills in the Province of Castellón (Barberá 2003: 194). The author provides no other information about the site.

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CS-3 Borriol



Location and sources: Borriol is a municipality of 62 km² in south-eastern Castellón in the Castellet Mountains. Millstone production is mentioned briefly in the study of old mills (Barberá 2003: 194).

From the study of maps, there are a number of potential quarries exploiting limestones or conglomerates in the municipality: Pedrera de l'Abeller, Pedrera Vella, Pedrera Morinbou and Pedrera de la Joquera (Allepuz 2003: 216-217). Millstone working, however, cannot be confirmed at any of these sites.

The absence of mention in the dictionaries of the 19th century suggests a modest site.

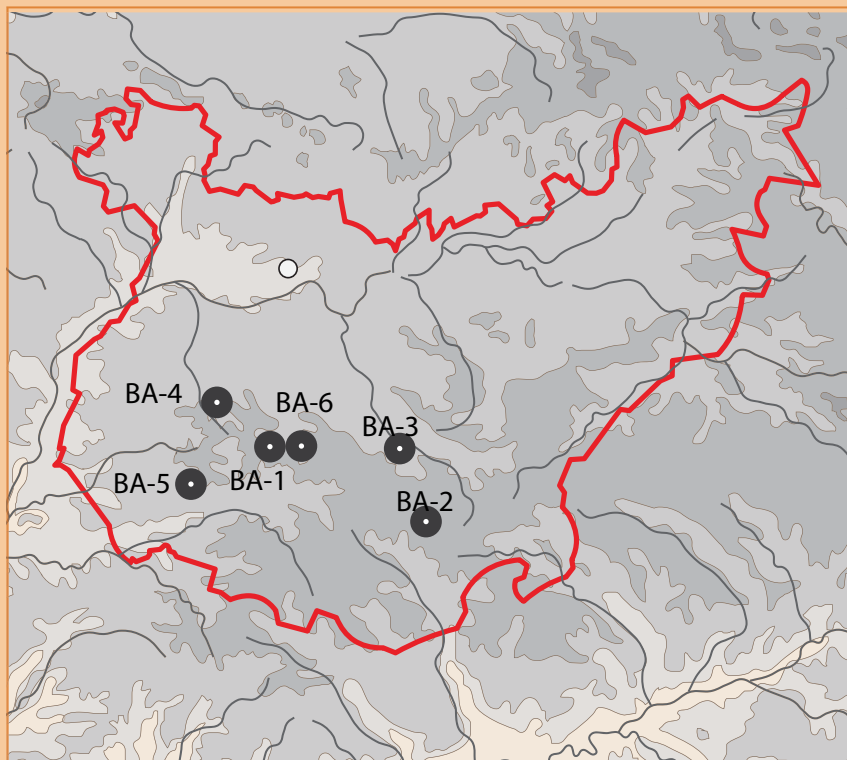
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EXTREMADURA

BADAJOS (BA)



BA-1 Alconera

Las Pedreras

Latitude: 38° 25' 1.12" N
Longitude: 6° 28' 47.32" W
Altitude: c. 470-500 m




Location and sources: The town of Alconera is in the Sierra of Alconera in southern Extremadura. It has a long tradition of working limestone and breccia for construction material spanning from Roman (Padilla 1999: 278) to recent times (Gascón 1904: 381).

Millstone production is reported in the study by Caso Amador of the ancient watermills in the south of Extremadura. The site is located at the *Dehesa de Abajo*, two kilometres north of Alconera, at the foot of the Sierra Gorda (Caso Amador 2008: 132). This location is now part of a vast modern cement exploitation. In the cadastre (SEC) this location coincides with the name *Pedreras* (quarries). Other quarries both south and west of the town are recorded on the geographical map. Their place names, however, evoke marble and quicklime workings.

The oldest source is the responses to the Royal Census of 1791 (Caso Amador 2008: 133):

- 1: After describing the livestock and the absence of mineral exploitations, the census notes quicklime and millstone production (specifically for flour mills).
- 2: The author of the note in the census frets that the agricultural potential of the town is not exploited to its maximum because millstone makers and brick/tile makers neglect their duties in the field.
- 3: The census repeats that the town's agricultural potential, although not important, is diminished by the neglect of the 162 souls who devote most of their time to brick/tile production and the prosperous "millstone factory".
- 4: The census records that the stone yielded a white flour for bread.



Datos del Bien Inmueble	
Referencia catastral	06008A002000320000QU  Obtener etiqueta
Localización	Polígono 2 Parcela 32 PEDRERAS. ALCONERA (BADAJOZ)
Clase	Rústico
Coefficiente de participación	100,000000 %
Uso	Agrario

Extract of the cadastre (SEC). Parcel no. 32 (surrounded by the blue line) corresponds to the place name *Pedreras* (quarries).

A second, more recent, written source is the list of products penned by the Chief Engineer of Mines of Badajoz for the Universal Exposition of Paris (1867). The list itemizes limestone millstones at a cost of 16 to 20 *escudos* (Comisión Régia, *Catálogo* 1867: 182, entry 13-57).

Toponymy: The name *Pedreras* (quarries) is associated with stone exploitations for both construction material and millstones.

Dating: The Royal Census of 1791 dates the production to the second half of the 18th century. Although both 19th-century geographers Miñano and Madoz cite stone extraction around the town, they do not specifically mention millstone work. Nonetheless, the production must have endured - and even flourished - a century later judging by the millstones sent to the Universal Exposition of Paris of 1867.

Dwelling: Several rock huts similar to the dwellings at El Lachar, Jimena (JA-2) in Jaén stood near the quarry. Unfortunately, these constructions, possibly temporary dwellings of the quarrymen, have been destroyed by the cement factory (Website Patrimonio del Pueblo).

Bread: The Royal Census of 1791 records that the Alconera millstones yielded a flour for white bread (Caso Amador 2008: 133).

Extract from the Responses to the Royal Census of 1791

Extract 1 : Concerning production of the town

*“En esta villa ai cria de ganado de zerda en corto numero y su destino es engrosar para las matanzas de casa los nezesarios en otra jurisdizion por que aqui no ay montes, aunque pudiera aberlos como llebo espuesto. Ai tambien cria de ganado bacuno en mui corto numero, de modo que no basta para el uso de la agricultura; ai tambien cria de ganado lanar basto en mediano numero por tres ganaderos y lo mismo de cabras por otros tres y el numero de cabezas de todas espezes asziende a dos mil, poco mas o menos. **No ai minerales algunos en esta villa, pero ai canteras de piedras de cal y de muelas para molinos de harina, de que se haze el huso correspondiente**”*

Extract 2: concerning agriculture

*“Por lo que respecta a la agricultura aunque las tierras y suelo de este pais son de mediana calidad y estar cansadas con las continuas labores, a motivo de no aver mas que dos ojas para semvrrar por la cortedad del termino, no obstante si los vezinos tuvieran mas zelo en cultivarlas y benefziarlas a tiempo, lograran maiores y mas sazonados frutos en toda especie de granos, **pero con la favrica que avunda en este pueblo de piedras de molino y canteria de otra maior avundancia que lo es de ladrillo y teja, se olvidan de la labores, asistiendo haltas, tarde, sin tiempo y tal vez sin cultivar las tierras con los barvechos nezesarios, por estar ocupados la mayor parte de jornaleros en estas favricas, motivo porque estan mui de cayda las labores**”.*

Extract 3: concerning the population (from website)

Rock type: Limestone (Geological map 854, Zafra, 1980). The term “concha” (shell) of the survey extract 4 suggests a sedimentary stone containing shells. The item from the Catalogue of the Universal Exposition of Paris confirms that it is a limestone.

*“El termino de esta villa es proporcionado a su poblacion de 162 vecinos y seria mas productivo si hubiese caudales para hacerlo fructificar. Hai algunas tieras cercadas con malas cercas de piedra, las cuales se siembran todos los años, cultivandose a dos hojas las que no están cercadas, cuya diferencia es una prueba de la ventaja de los cerramientos. Sus principales frutos son trigo, zebada, aceite y vino, sin haber sobrante para vender a no ser de trigo en años de cosecha abundante. Lo que se vende y es su comerzio activo son algunas almendras y sus buenas frutas, **a cuyo dinero se agrega el producto de sus fabricas de ladrillo y texa, y de las estimadas piedras que sacan para molinos harineros, que es en lo que consiste toda la industria de este lugar**”.*

Extract 4: concerning holidays and commerce

*“No se zelebran en esta villa ferias ni mercados, ni son nezesarios por estar una legua distante de la villa de Zafra, donde se zelebran a el año tres ferias y su gran comercio es un continuo abundante mercado, de donde todos los vezinos de esta villa se surten de todo lo nezesario sin mucho quebranto en ir a comprarlo. **Ai trafico de sacar y cortar en algunos vancos de piedra, de la que llaman aqui de concha, muchas muelas para molinos de trigo de que resulta harina para poder sacar pan blanco, donde sepan azer el uso bueno que requiere; pero los // trabajadores en dicha piedra que no forman compañía, no la hazen de continuo por que en tiempo de la siega de mieses, o quando lo exige la atenzion de su propia sementera o cosecha, tienden a esta como negocio de primera nezesidad**»*

(Extracts 1-3 from the website of the Alconera; extract 4 from Caso Amador 2008: 132-133)



Extract from geological map 854 (IGME). The reputed location of the millstone quarry is in the light blue limestone unit. The green unit (slates and greywackes) do not conform to the information from the old texts.

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BA-2 Llerena

El Molar



Location: The millstone quarry of Llerena is in the flat lands near the Madrona Spring about four kilometres south-west of Llerena.

Sources: The first record of the site is in a Municipal Ordinance dating to 1566 in which the authorities prohibit “foreigners” from extracting millstones unless they, like the locals, pay the official tariff (Chapter CXCVII of the ordinances; Maldonado Fernández Internet website).

The Royal Census of Extremadura of 1791 also records a millstone quarry at Llerena that supplied stones to the mills of the surrounding area (Caso Amador, 2008).

Toponymy: The exploitation, according to a local historian Mena Cabezas, is at the place name *Molar*, from the Latin *mola* (mill) (Mena Cabezas 2001: 246). This name, although no longer conserved on the geographical map, is recorded in the cadastre. Mena Cabezas denounces the deteriorated state of the site (turned into a landfill) and solicits the local authorities to remove the refuse, excavate the features and incorporate the site into a project of valorisation in the framework of a series of other local historical sites.

Dating: Production is certified by the written sources in the 16th century and at the end of the 18th century. It is conceivable that the site was exploited continuously between these two dates.

Rock type: Limestone, arkose and limestone tufa outcrops (Geological map 877, Llerena, 1981). The exact type of rock exploited is uncertain.

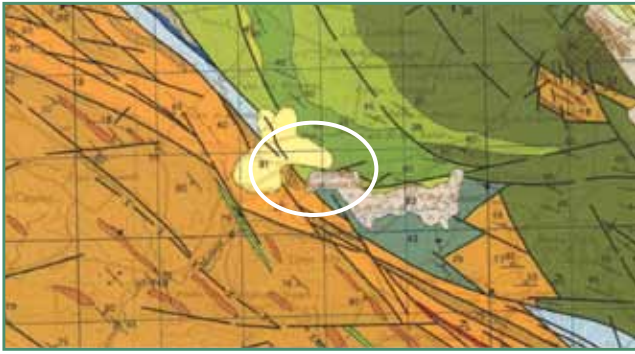


Extract of the cadastre (SEC) with the place name El Molar.

Extract from the Responses to the Royal Census of 1791

“No hay minerales ni canteras de marmol, jaspe, ni yeso, pero si para fabrica de cal y piedras de molinos de que se surten muchos pueblos de esta zircunferencia”

(from Caso Amador, p. 133, footnote 47).



Extract from geological map 877 (IGME). The quarry could have exploited one of several deposits: 81, yellow, limestone tufa; 20, orange hatched, limestone marble; 40, green limestone; 42: blue-green, arkose).

Sources

1566 List of ordinances MALDONADO FERNÁNDEZ, Manuel: http://manuelmaldonadofernandez3.blogspot.com.es/2010_04_01_archive.html [accessed October 25, 2012].

El Molar blog by MENA CABEZAS, Juan Eugenio : <http://juaneugeniomena.blogspot.com.es/2010/12/etnologia-para-mejorar-la-oferta.html> [accessed October 25, 2012].

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MENA CABEZAS, Juan Eugenio. La Ribera de los Molinos. Referencias Históricas y etnográfica para Futuras Actuaciones. In: LORENZANA de la PUENTE, Felipe, MATEOS ASCACIBAR, Francisco (coord.). *Actas de la II Jornada de Historia de Llerena*, Llerena. 2001, p. 245-260.

BA-3 Llera



Location and source: Llera is a small municipality (71 km²) in the south of the Province of Badajoz. The response to the Royal Census of 1791 records that in its surroundings there are quarries particularly apt for flour mills and quicklime (Caso Amador, 2008: 133, footnote 48). Unfortunately the precise location of these quarries is not known.

Dating: End of the 18th century.

Rock type: Although the type of millstone rock is not recorded, from the mention of quicklime in the response of the census, the most suitable material would be limestone. This rock, however, is not present on the geological map (Geological map 855, Usagre, 1980).

Extract from Responses to the Royal Census of 1791, Partida de Llerena, p. 605.

*“No hay minerales de ninguna especie, solo hay algunas canteras o **piedras proporcionadas para moler en los molinos arineros** y para hazer cal, de las que se haze uso quien las nezesita”.*

(from Caso Amador 2008: 133, footnote 48).



Extract from geological map 855 (IGME) with the location of Llera. No outcrop on this map corresponds to the description given by the Responses to the Royal Census of 1791.

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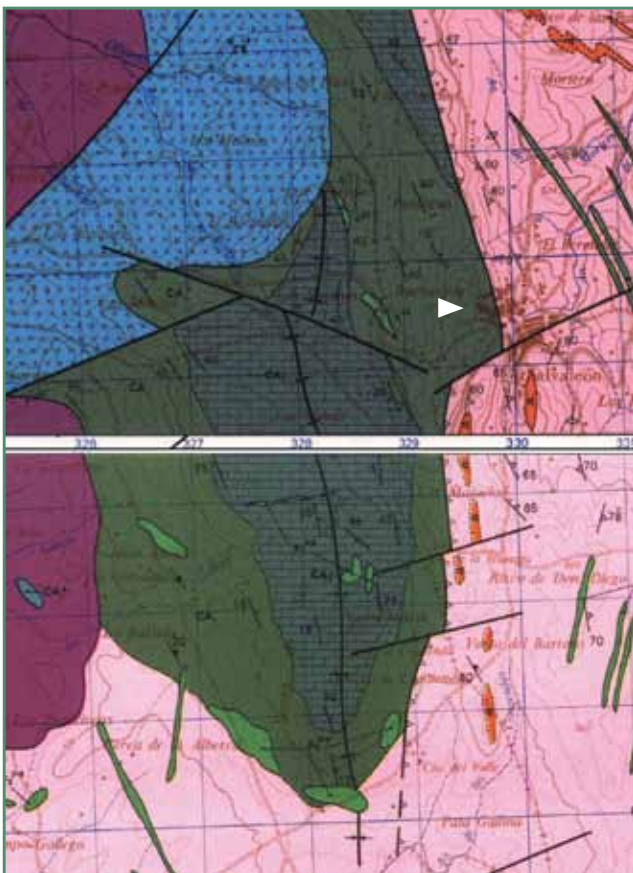
BA-4 Salvaleón



Location and sources: Salvaleón is a municipality covering a surface of about 70 km² in the south-west of the Badajoz Province on the edge of the Sierra Morena. The first reference to the production of “excellent” millstones comes from the early 19th-century *Diccionario Geográfico Universal* (DGU, Vol. 8, 1833: 542). Madoz, a quarter century later, echoes the information and specifies that the quarry exploited a white stone for “*piedras de molino*” (Madoz 1949, Vol. 13: 711). The exact location of the quarry is unknown.

Dating: First half of the 19th century.

Rock type: The use of the word “white” to describe the millstones suggests limestone. Outcrops of limestone are to the west of Salvaleón (Geological map 828, Barcarrota, 1975; Burguillos del Cerro 853, 1975).



Extracts from geological maps 828 and 853 (IGME). White limestones are in the dark green unit to the west of Salvaleón (CA1). The blue and pink units are granites.

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BA-5 Jerez de los Caballeros

Cerro de Berrocal
Dehesa Boyal



Location and source: Jerez de los Caballeros is a large municipality (740 km²) in the south of Badajoz. Madoz provides interesting details about several of its millstone quarries. He states that the workings comprise both “dark” and “white” stones for bread mills (1847, Vol. 9: 627). Unfortunately he does not offer any other information about the sites.

A hiking itinerary posted on the Internet mentions millstone workings at the Berrocal. The likely location of this site is about two kilometres south of Jerez de los Caballeros at the Cerro del Berrocal and Dehesa, Boyal, locations that coincide with a vast outcrop of granite.

Dating: Middle of the 19th century.

Rock type: Granite (Geological map 875, Jerez de los Caballeros, 1981).



View from the north-west of the Cerro Berrocal (from Google maps Street View).



Extract from geological map 875 (IGME). The Dehesa Boyal and Berrocal place names are associated with the oval granite outcrop (pink) south of the town of Jerez de los Caballeros.

Source

Forum of the Comarca de Jerez de los Caballeros: <http://www.foros.net/search.php?mforum=jerezhabla> [accessed July 3, 2012].

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BA-6 Mérida district



Location and generalities: The Roman city of Mérida (*Augusta Emerita*) was founded in 25 BC along the Guadiana River. Most of its monumental structures were erected with granite extracted from local quarries (de la Barrera 2000).

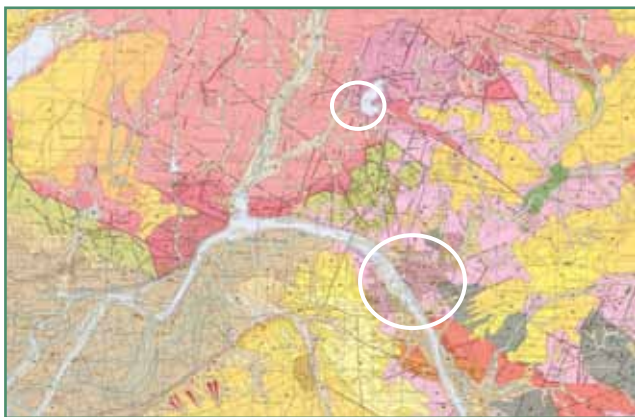
The Museo Nacional de Arte Romano conserves a large number of Roman rotary querns and ring-mills in its depository. There are also what appear to be several later Medieval millstones that could have equipped watermills.

Most of the grinding stones are of granite, like the city's monuments. Although no millstone quarry has been identified near Mérida, the extensive granite fields north of the city, could have been a source. An example of a granite quarry is this area is the Proserpina Dam. This dam was only identified as originally a quarry in 1990 when its waters were drained (de la Barrera 2000: 193).

Rock type: Granite (Geological map 777, Mérida, 1990).



View of the querns and millstones (and other artefacts) stored in the basement of the National Museum of Roman Art in Mérida. Most of the millstones, from a typological standpoint, are Roman and made of granite.



Extract from geological map 777 (IGME). The area to the north of the city of Mérida is dominated by granitoid units (pink, red and light violet). The still active Roman dam of Proserpina, about five kilometres from the city, was the site of a building block quarry. No quern or millstone quarry has been identified.



Detail of a granite Roman ring-mill.

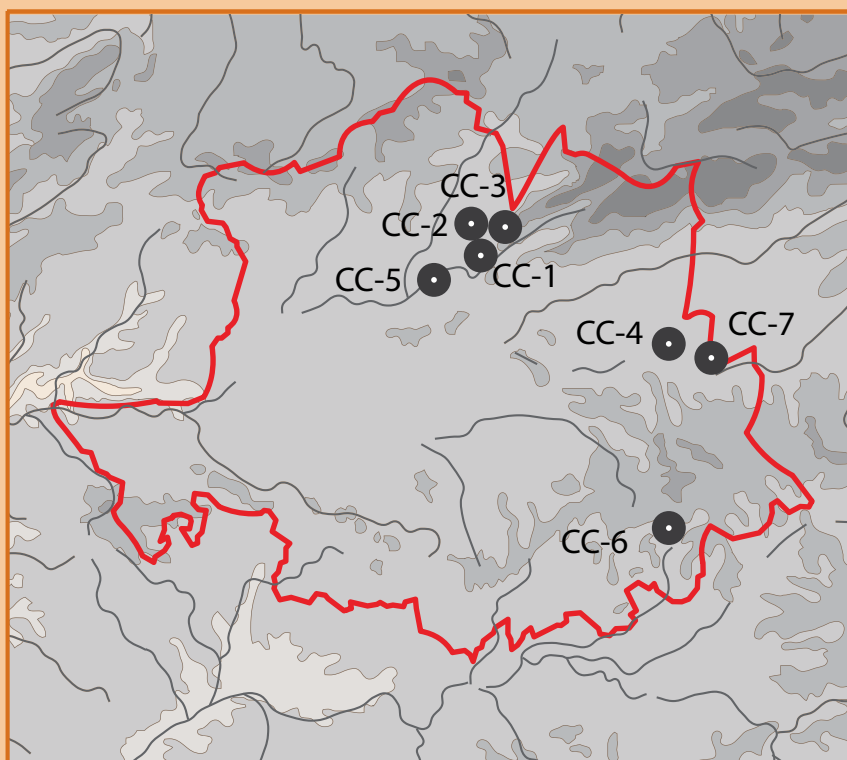
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de la BARRERA, José Luis. *La Decoración Arquitectónica de los Foros de Augusta Emerita*, Volumen 25 de *Bibliotheca archaeologica*. 2000, 487 p.

EXTREMADURA

CÁCERES (CC)



CC-1 Plasencia

Barrio del Pilar

Latitude: 40° 2' 13.09" N

Longitude: 6° 5' 22.99" W

Altitude: c. 400 m



Orthophoto of the millstone quarry of Plasencia in the park to the west of the municipal bullring (SIGPAC).



View of the millstone quarry from the north-east (photograph by Mara Pulido).

Location: Plasencia is small city in the Jerte River Valley between the Sierra of Berenguel and the Sierra Gorda. The millstone quarry, beside the municipal bullring, is one of Europe's rare urban exploitations and is now officially protected as a *BIC* (*Bien de Interés Cultural* - Heritage of Cultural Interest).

Source: The site is recorded in an Internet blog by Montaña Domínguez. The author notes, based on the local municipal archives, that the millstone workings possibly stretched to river, about one kilometre to the south-west.

The quarry: The site is a shallow surface quarry with both contiguous and single extraction hollows.

Products and quantification: All of the extractions are large, with a diameter corresponding to that of hydraulic millstones. Montaña Domínguez informs me that she recalls about 100 extractions.

Transport and distribution: This quarry probably supplied the watermills built along the Jerte River.

Technique: Cylinders were scored by direct extraction, probably with picks. From the photographs it appears they were split by means of a single long channel cut along its base (instead of the regularly spaced wedge holes).

Dating: The extraction hollows correspond to millstones about 1.00 m in diameter. This size suggests a date spanning from the Medieval to Contemporary times.

Rock type: Granite (Geological map, 598, Plasencia, 1984).



Examples of shallow extraction hollows (photograph by Mara Pulido).



View of a sector of the quarry with the Municipal bullring in the background (photograph by Montaña Domínguez).



Base of an extraction hollow. The cylinder was split from the bedrock by means of wedges set in what appears to be a continuous channel cut along its base (photograph by Montaña Domínguez).



Abandoned cylinder (photograph by Montaña Domínguez).



View of an extraction hollow. The parallel lines suggest the trench was cut with a pick (photograph by Mara Pulido).



Examples of extraction hollows cut into outcrops of bedrock (photographs by M. Domínguez).



Extract from geological map 598 (IGME). The quarry is in a granite unit (orange).

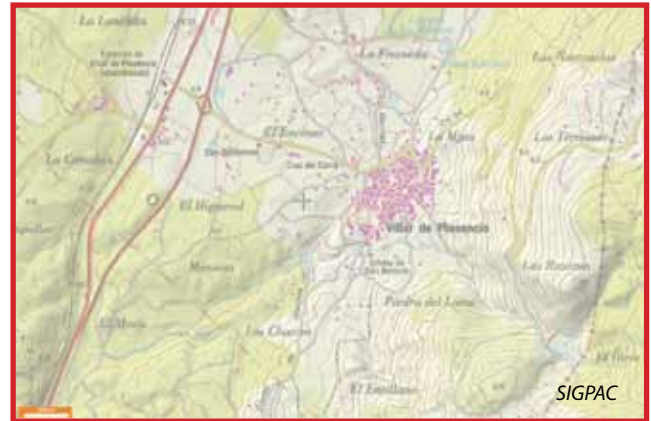
Source

Montaña DOMÍNGUEZ CARRRO: <http://blogs.hoy.es/geografiainterior/2012/10/01/una-cantera-unica-en-espana-en-pleno-barrio-del-pilar> [accessed December 25, 2012].

Acknowledgements

I kindly thank Montaña DOMÍNGUEZ and Mara PULIDO for the use of their photographs.

CC-2 Villar de Plasencia 1



Location and source: Villar de Plasencia is 13 kilometres north of Plasencia along the edge of the Llanos de Jarrilla Plain at the foot of the Montes Tras la Sierra. Miñano records that millstones were extracted from the many surface boulders "... and transported up to four and six leagues away" (Miñano 1828, Vol. 9: 433). The author, however, provides no clue as to the location of the quarry.

Product and quantification: Although Miñano does not specify the product, I assume that the stones were destined for the watermills along the nearby streams that run down the mountain.

The quarry: The town is in the heart of a vast granite district. I therefore assume that the millstones were scored from either surface blocks or shallow extractive quarries.

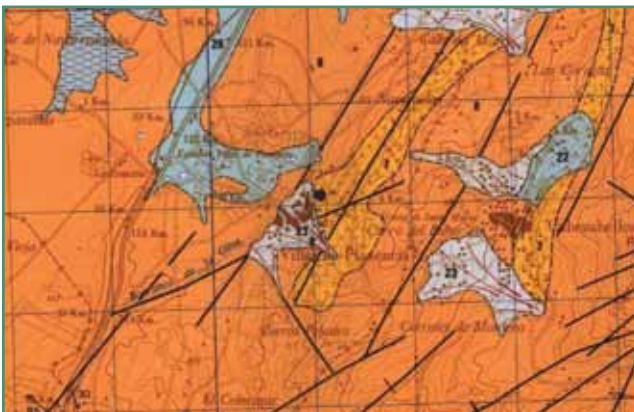
Transport and distribution: The town is on the *Via de la Plata* (Silver Way), a well-known ancient north-south thoroughfare. The statement by Miñano detailing the distances of four to six leagues, roughly 16/24 to 24/36 kilometres, indicates that these quarries could have supplied millstones slightly beyond the local sphere.

Dating: First half of the 19th century.

Rock type: Granite (Geological map, Plasencia 598, 1984).

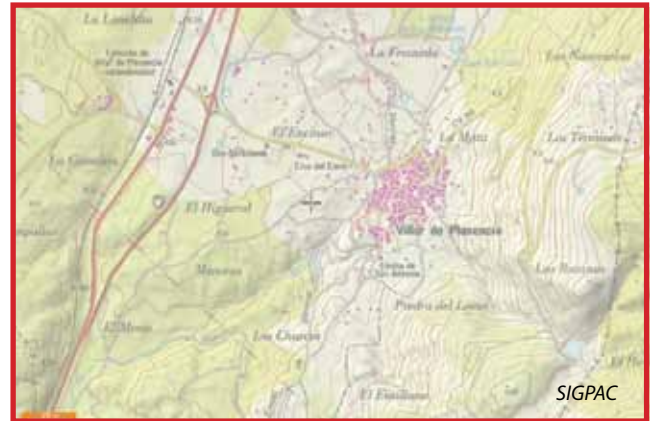
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Extract from geological map 598 (IGME). The surroundings of Villars de Plasencia are dominated by granites (oranges). The grey units are recent alluvial deposits unfit for millstone production.

CC-3 Villar de Plasencia 2



View of circular carving in the surroundings of Vilar de Plasencia. The beginning of a trench is seen on the right of the image (photograph by Inma Estévez).

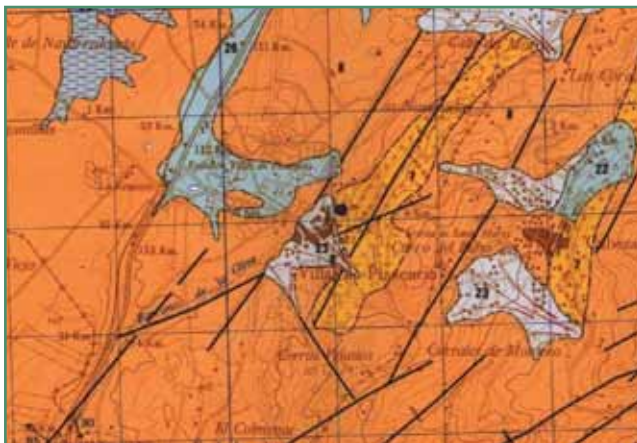
Location and source: These small circular extractions are identified in an archaeological forum on the Internet by Aníbal Clemente. According to the author, the interconnected holes are receptacles for water. Although the extractions certainly served to collect water, I propose the cuttings were intended for rotary querns. This is yet to be confirmed.

The quarry: Cylinders appear to have been scored directly from the rock by means of narrow circular trenches. An unfinished trench is visible to the right on the first photograph. One of the better preserved hollows shows at its base, along the circumference, a series of what appear to be wedge holes or other types of cavities for splitting the cylinder.

Product, quantification and distribution: The extractions are relatively small, about 40 cm, corresponding to rotary querns. Although the number of extractions is not indicated, from the pictures, the impression is that of a very modest, local exploitation.

Dating: The size and relative thickness of the cylinders suggest a pre-Medieval date, possibly Roman (or even Iron Age).

Rock type: Granite (Geological map, Plasencia 598, 1984).



Extract from geological map 598 (IGME). The surroundings of Villars de Plasencia are dominated by granites (oranges). The grey units are recent alluvial deposits (certainly unfit for millstone production).



Detail of a circular carving. Along the circumference are what appear to be chisel or wedge holes (invaded by moss) to split the cylinder (photograph by Aníbal Clemente).

Source

Forum Arqueólogos: <http://www.historiayarqueologia.com/photo/cazoletas-en-villar-de-7> [accessed February 11, 2013].

Acknowledgements

I thank Aníbal CLEMENTE for the use of his photographs.

CC-4 Bohonal de Ibor

Molino Gualija

Latitude: 39° 46' 21.10" N

Longitude: 5° 24' 29.34" W

Altitude: c. 320 m



Location and sources: In his description of Bohonal de Ibor, Madoz records that "... there are many *berrocales* (granites) and quarries of a very hard rock where very good millstones are extracted" (Madoz 1846, Vol. 4: 376).

The site of Molino Gualija, identified in a blog by Javier Pérez Ross, probably coincides with one of these workings. The quarry is beside the ruins of the Gualija Molino, at a bend of the River Gualija about six kilometres south-east of Bohonal de Ibor. It is beside an ancient thoroughfare marked by a Medieval stone bridge.

The quarry: The site comprises a series of extraction hollows carved directly into small granite surface outcrops.

Products, quantification and distribution: The few millstone extractions correspond, most likely, to the demands of the adjacent Molino Gualija. Stones of this type, according to Javier Pérez Ross, are still visible in the mill. If the quarry ever supplied millstones farther away, the nearby road and bridge would have facilitated transport.

Toponymy: The eastern bank of the Gualija River in the Municipality of Paraleda de San Román, corresponds, according to the cadastre, to the place name *Los Berrocales*, a term designating granite outcrops and, at times, associated with millstone workings.

It cannot be excluded that other millstone workings alluded to by Madoz are now under the waters of the large Valdecañas dam in the northern area of the municipality.

Dating: First half of the 19th century.

Rocktype: Granite (Geological map, 653, Valdeverdeja, 1978).



Aerial view of the Gualija Molino quarry area with the many granite (berrocal) outcrops spread along the Gualija River bank (SIGPAC). The quarry is between the old mill (a) at the river bend and the bridge (b).



View from the north of the abandoned Gualija watermill (photograph by Javier Pérez Ross).



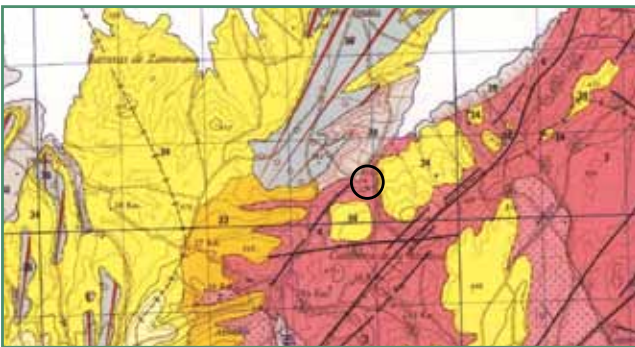
Detail of an extraction hollow. The old bridge crossing the Gualija River is in the background. Circular tool marks suggest the use of the pick to cut the trench around the cylinder.



Detail of an cylindrical extraction hollow.



Detail of two extraction hollows (all photographs by Javier Pérez Ross).



Extract from geological map 653 (IGME). The rock is a coarse grained granite (pink, unit 4). The yellow unit (34) is a combination of conglomerate and arkose, rocks that are also known to have been exploited for millstones.

Source

Javier PÉREZ ROSS. "Cosas de un Extremeño: <http://extremadurene.blogspot.com.es/2012/06/molino-gualija-peraleda-de-san-roman.html> [accessed February 15, 2013].

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Acknowledgements

I thank Javier PÉREZ ROSS for the information and photographs.

CC-5 Guijo de Galisteo

Dehesa Boyal

Latitude: c. 40° 5' 52.16"N
Longitude: c. 6° 23' 31.46 W
Altitude: c. 420-440 m



Location: The millstone quarry is in the flat Dehesa Boyal east of Guijo de Galisteo.

Source: The quarry is identified by Elema Garrido and Miguel Ángel in a website relating to the places of interest around the town of Guijo de Galisteo.

The quarry: The exploitation is an extensive, shallow surface quarry with cylinders cut along horizontal planes. The hollows are either isolated or in small groups.

Product: According to the authors of the website, the quarry comprises between 20 and 30 large extractions about a metre in diameter (for watermills). There is no indication of any other types of products.

Distribution: This small quarry probably only supplied the local mills. This is reinforced by the absence of old written texts.

Dating: This site could date from Medieval or Contemporary times.

Rock type: Two-mica porphyric granite (Geological map, Montehermoso, 597, 1984).



Views of abandoned millstones in different phase of work at Guijo de Galisteo (all photographs by Miguel Ángel López).



Views of extraction hollows at the quarry of Guijo de Galisteo (all photographs by Miguel Ángel López).



Extract from geological map 597 (IGME). The orange unit is granite (2 micas).

Source

Internet photographs: <http://www.pueblos-espana.org/extremadura/caceres/guijo+de+galisteo/galeria-fotografica/> [accessed February 13, 2012].

Acknowledgements

I warmly thank Cándido RODRÍGUEZ HERNÁNDEZ, Elena GARRIDO and Miguel Ángel LÓPEZ for the information and the photographs.

CC-6 Logrosán

Sierra de San Cristóbal

Latitude: 39° 19' 32.29" N
 Longitude: 5° 30' 23.49" W
 Altitude: c. 660-670 m



Location: The town of Logrosán is at the foot of the *Sierra de San Cristóbal*, a mountain with a history of exploiting tin dating from the Bronze Age until the 1950s.

Sources: Madoz records that many millstones, bases of wine presses and construction blocks were scored from a "*piedra de grano*" (coarse grained rock) on this mountain (Madoz 1847, Vol. 10: 355).

Merideth, in the synopsis of his doctoral thesis about protohistoric tin exploitation, specifies that *"...within this central summit area on the upper south side is a granite area which has been used to quarry millstones, a couple of which are partially cut out and still remain in their original settings"* (Merideth 1998: 67). Although the author does not specify the sizes of the extractions, he notes that they were probably Medieval or later.

Transport and distribution: A road or path that zigzags down the northern slope of the mountain from the quarry is clearly visible on the aerial photograph. This road would have been the most



View from the north-west of the southern summit of the Sierra of San Cristóbal Mountain (extract from Google Maps Street View).

simple course to transport the cumbersome millstones from the mountaintop to the town of Logrosán.

Dating: 19th century.

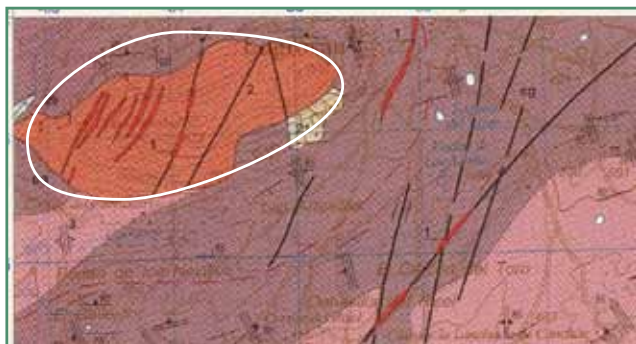
Rock Type: Coarse grained two-mica granite (Geological map 732, Valdecaballeros, 1995). This definition coincides perfectly with that of Madoz in 1847).

Source

Geological website by Juan GIL MONTES: <http://jugimo.blogspot.com.es/2010/12/las-villuercas-lugares-de-especial.html> [accessed October 25, 2012].

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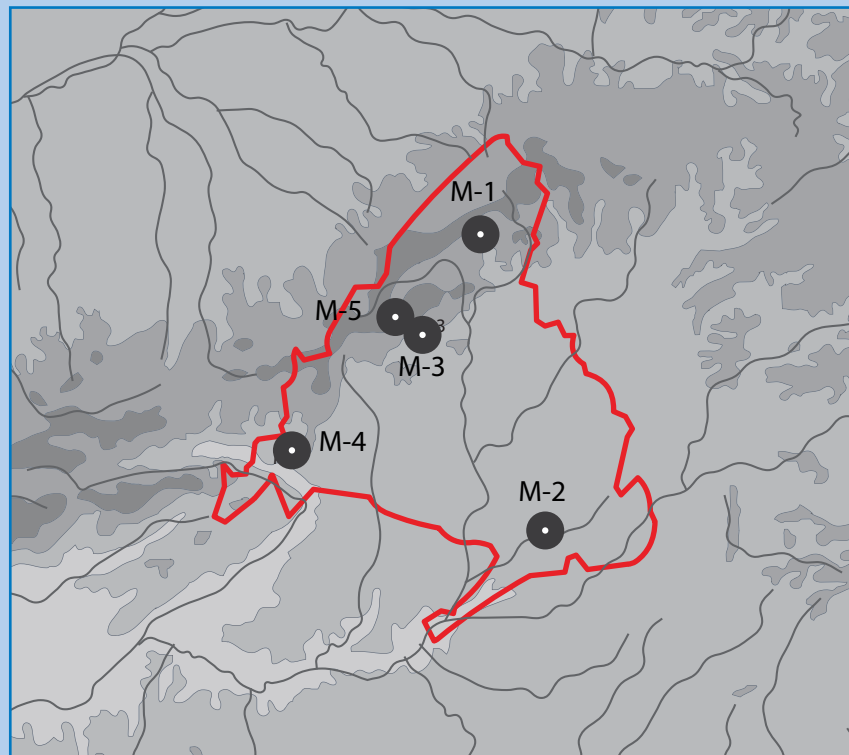
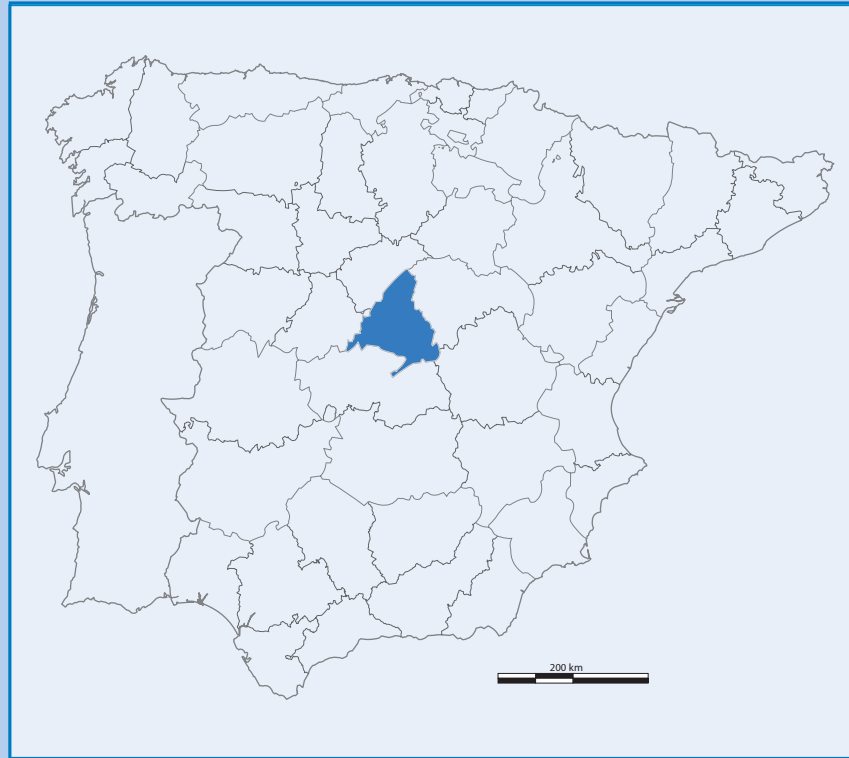
MERIDETH, Craig. La Mina El Cerro de San Cristobal: a Bronze Age Tin Mine (Extremadura, Spain). *PIA Papers from the Institute of Archaeology* 9. 1998, p. 57-69.



The quarry is in a unit of coarse-grained, two-mica granite (orange). The red strips are veins of quartz.

MADRID

MADRID (M)



M-1 El Berrueco



Location and generalities: El Berrueco is a small town in the north of the Community of Madrid at the foot of the Guadarrama mountains. Since 2001, the town honours its long tradition of stone working with a display in its streets of products from its old quarries (basins, feeding troughs, jambs, lintels, threshing rollers and millstones).

Source: Information about this site comes from a geological itinerary through the north of the Community of Madrid (Días Martínez & Rodríguez Aranda 2006: 53-55).

Toponymy: The name *Berruecos* (Pre-Roman, possibly of pre-Indo-European origin) is very often synonymous with granite (Llorente Pinto 2011: 75).

The quarry and techniques: There is no specific information about the millstone production of this site. The half-carved cylinder exhibited in town appears to be fashioned from a previously detached angular block. Granite outcrops and surface boulders abound in the area. It is therefore possible to imagine a variety of quarry types, from surface boulder workings, to block detachment or true extractive quarries.

Products, quantification and distribution: Only one millstone (exhibited) is certified. I suppose, owing to the accessibility of the rock, that many more were produced in the municipality. They probably supplied the watermills along the local streams.

Dating: From the diameter of the roughout (about one metre) production took place any time between Medieval or Contemporary times.

Rock type: Granite (Geological map 484, Buitrago del Lozoya, 1988). The geological itinerary notes two units of granite in the surroundings of El Berrueco. The first (leucogranite) is reddish, with a fine texture,



An unfinished millstone exhibited at the open air museum of the town of Berruecos (photograph by Gloria Gómez Trape-ro from <http://prejubiladasinfronteras-glo.blogspot.com.es/2012/10/el-berrueco-madrid.html>).

and is more resistant to weathering. The second (monzonite) is a darker red colour with coarser grains, and is more subject to weathering. It is the second, according to the geologists, that was more often in the form of naturally rounded surface boulders (Días Martínez & Rodríguez Aranda 2006: 53-55). Due to the hardness and finer texture, millstone makers probably exploited the first of these two types.



An example of the granitic landscape on the western outskirts of El Berrueco (extract from Google Maps Street View).



Extract from geological map 484 (IGME). The reddish zones are granite units. The cream-coloured unit immediately surrounding the town corresponds to alluvial deposits.

Sources

Website Gloria GÓMEZ TRAPERO, <http://prejubiladasinfronteras-glo.blogspot.com.es/2012/10/el-berrueco-madrid.html>. [accessed December 7, 2013].

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Acknowledgements

I thank José Manuel DELGADO of the Municipality of El Berruecos for oral information about the site.

M-2 Colmenar de Oreja

Las Canteras

Latitude: c. 40° 7' 26.75" N
 Longitude: c. 3° 22' 59.53" W
 Altitude: c. 770 m



View from the west of the quarries of Colmenar de Oreja (from Google Maps Street View).

Location and generalities: Colmenar de Oreja is 50 kilometres to the south-east of the city of Madrid in the Madrid Basin. It prides itself of its large *tinajas* (clay vessels) and "*piedra de Colmenar*" (Colmenar stone).

Toward the middle of the 16th century, the quarries of Colmenar de Oreja were acquired by King Philip II for construction of the Royal Palace of Aranjuez, 16 kilometres away (Website of the Community of Madrid). Other illustrious buildings in Madrid were also built with this stone. Today the site is a vast quicklime exploitation.

Sources: The responses of a local cleric to the Survey of Tomás López in 1788 recorded that "white stone" quarries in the plain to the north of Colmenar de Oreja yielded material for buildings in Madrid and Aranjuez. The source also specified that many "factories" of this white stone made millstones for "*atahonas arineras*" (animal-driven flour mills) (Puche & Mazadiego 1999: 93).

A second reference to the millstone workings is in a treatise about hydraulic power that describes the dressing of Colmenar millstones (see extract below) (Vallejo 1833: 387).



Orthophoto of the Colmenar de Oreja quarries (SIGPAC). The extractions today, to the south, are destined to the plaster industry.

Two decades years later Madoz recorded that the Colmenar workings were in decline except for the production of baths and white millstones for *tahonas* in Madrid (Madoz 1847, Vol. 6: 525).

About 50 years later an anonymous report in the *Revista de Obras Públicas (ROP, 1896)* places the millstone workings to the north of the city and offers very detailed information about the different rock layers (see below).

Toponymy: The *Canteras* (quarries) place name is recorded to the north of Colmenar on the geological map. Although the name no longer appears on the geographical map (*SIGPAC*), it is plausible that the name of a road leading to the area (*Camino de las Canteras*) alludes to the old rock workings.

The quarries: From the *ROP* report I gather that the first two layers of rock (respectively 28 to 84 cm and 28 to 36 cm thick) are not necessarily exploited for

millstones due to their mediocre quality. The third layer called the *sobrebanco* (upper layer), however, is 56 to 84 cm thick and served both for building stones and millstones (*Revista de Obras Públicas* 1896: 145).

Extraction at Colmenar is recorded in part to have taken place underground. However, from the detailed description of the different strata (*ROP* 1896), it can be assumed that the millstone workings were shallow and open air. Otherwise, it is unclear if extraction consisted of detaching angular blocks or scoring cylinders directly from bedrock.

Products and quantification: Vallejo records that Colmenar millstones measure one *vara* (between 76.8 and 91.2 cm) and can grind for six straight hours before they must “rest and be dressed” (Vallejo 1833: 387). The author explains that in an interval of 24 hours they could grind for two six-hour stretches, and, on occasion, grind up to three six-hour stretches because dressing required two hours (Vallejo 1833: 387).

Transport and distribution: These quarries certainly supplied millstones to the surrounding areas. For more long-distance export, the production would

have benefited from the network of transport of construction material to Madrid. The *Camino de las Canteras* road leads from the quarries to the town of Chinchón to the north-west. From Chinchón there was no major geographical obstacle to attain Madrid, about 50 kilometres to the north-west.

Dating: Building block workings are recorded since the 16th century. Millstone work, however, is only certified by written sources from the late 18th century to the end of the 19th century. It is of note that the millstones of a watermill restored in 1587 in Aldehuela, 10 kilometres to the south of Colmenar, were not extracted at Colmenar, but at Ventas con Peña Aguilera (TO-2), a granite quarry about 100 km to the south-west (Baltanás 1998: 36-37). This suggests that the early Colmenar workings in the 16th century were probably only dedicated to construction material.

Rock type: White limestone (Geological map 606, Chinchón, 1977).



Millstones in the Malasaña neighbourhood of Madrid reputed to be “tahona” millstones (animal-driven flour mill) from Colmenar Oreja (photograph by Carlos Osorio, *Caminando por Madrid*: <http://caminandopormadrid.blogspot.com.es/2012/02/dos-ruedas-de-molino-en-una-corralla-de.html>).



Extract from geological map 606 (IGME). Although the yellow unit is a combination of limestones, sandstones and conglomerates, the rock exploited in the quarries is unquestionably a white limestone.

Sources

"Canteras Históricas de la Comunidad de Madrid" website: <http://www.madrimasd.org/cienciaysociedad/patrimonio/rutas/geomonumentales/rutas/canteras/calizas.asp?pest=3> [accessed October 26, 2012].

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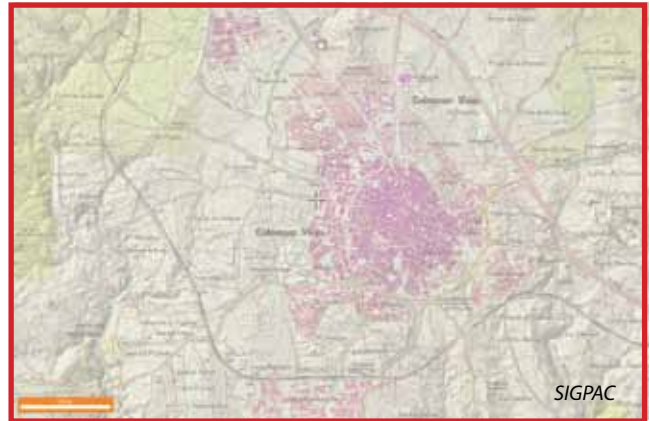
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Acknowledgements

I thank Carlos OSORIO the photographs of the millstones in Madrid.

M-3 Colmenar Viejo



Location and generalities: Colmenar Viejo (not to be confused with Colmenar Oreja, M-2) is 20 kilometres north of Madrid in the Manzanares Basin at the foot of the Sierra de Guadarrama. It has a long tradition of working granite both for construction (building blocks and cobblestones) and millstones. Colmenar Viejo is among a number of regional towns (e.g. Alpedrete, Zarzalejo, Morazarzal and Cadalso de los Vidrios) where granite was exploited on a large scale.

Sources: A number of *berroqueño* (granite) millstone workings are recorded in the Survey of King Philip II (1574-1578) (García Valcárel *et al.* 1998: 49). Madoz, three centuries later, also referred to granite millstones quarries for flour mills (Madoz 1847, Vol. 6: 530). A second geographical dictionary two years later echoes the notions of Madoz (Fernández de los Ríos 1849: 118).

A series of postcards from the beginning of the 20th century illustrate granite workings.

The quarries: Granite in this region was exploited, as seen in the postcards, in the form of surface workings and deep pit quarries.

Dating: Millstone production is recorded at the end of the 16th century and in the 19th century. It is reasonable to assume it continued uninterrupted between these dates.

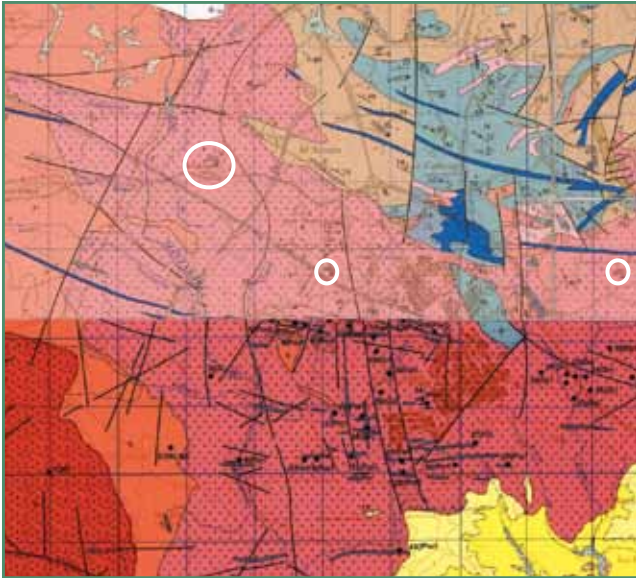


Old postcard illustrating a surface block quarry scene from the surroundings of Colmenar Viejo (from Todo Colección website).



Old postcard illustrating a deep pit quarry in Colmenar Viejo (from Tesoros de Ayer website). The product of this quarry was probably building material.

Rock type: Granite (Geological map 534, Colmenar Viejo, IGME, 993 and Geological map Torrelaguna, IGME, 509, 1986-87). According to the website recording the historical quarries in the Community of Madrid (Canteras Históricas de la Comunidad de Madrid), the granite extracted in Colmenar Viejo is grey with regular-shaped grains measuring between 1 and 5 mm.



Montage of geological maps 534 and 509 (IGME). Granite units (reddish hues) dominate the surroundings of Colmenar Viejo. The circles indicate the abandoned quarries. Millstone production, however, has not been pinpointed in the field.

Sources

Canteras Históricas de la Comunidad de Madrid website: <http://www.madrimasd.org/cienciaysociedad/patrimonio/rutas/geomonumentales/rutas/canteras/calizas.asp?pest=3> [accessed December 22, 2012].

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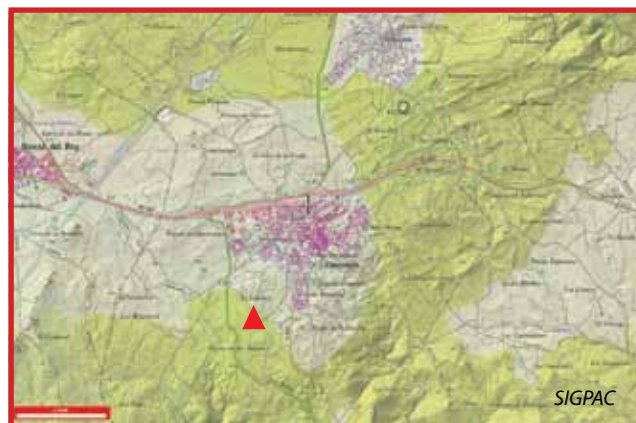
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M-4 Chapinería



Location and source: Chapinería is a small municipality to the west of Madrid at the foot of the Sierra de Guadarrama Mountains. The town is surrounded by a *berroqueño* (granite) landscape. Quarries for building material and millstones are mentioned by Miñano (1826, Vol. 3: 83). The author, however, provided no information as to their whereabouts.

The quarry and toponymy: From the orthophotos (SIGPAC) and the geological map (IGME 557), there is a large abandoned granite exploitation at the place name *El Lanchar* (meaning place where slabs are extracted) on the south-western outskirts of the town. This site could have yielded millstones. Another option is that they were scored from *piedras caballeras* and *bolos* (naturally detached and rounded surface blocks), a common geological feature in the area.

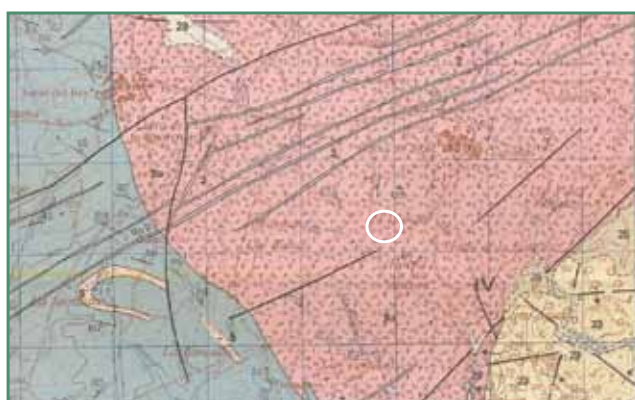
Product and distribution: Millstones for watermills. There is no evidence of distribution beyond the local sphere.

Dating: First half of the 19th century.

Rock type: Granite (Geological map 557, Valdeiglesias, 1988).



Orthophoto of the granite exploitation at El Lanchar, south-west of the town (SIGPAC).



Extract from geological map 557 (IGME). Both the pink (granite) and the yellow (granite and gneiss surface boulders) units are potential millstone sources. The circle indicates the Lanchar workings.



View from the west of the granite exploitation at El Lanchar (Google Maps Street View).

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M-5 Miraflores de la Sierra

Cerca de la Rama

Latitude: 40° 46' 39.74" N

Longitude: 3° 48' 32.74" W

Altitude: c. 1030 m



View of a partially cut trench around a cylinder (photograph by Fernando Colmenarviejo).

Location: The quarry of *Cerca de la Rama* is on a hillock near the Escaramujal stream at the border between the Municipalities of Miraflores de la Sierra and Soto del Real along the southern border of the Guadarrama Mountains.

Source: The site was brought to my attention by the archaeologist Fernando Colmenarviejo during my inquiries about millstone production at Colmenar Viejo (M-3).

Toponymy: In the surroundings of the town there are several place names that are evocative of both granite and surface outcrops where millstone workings could have taken place: *Berrocoso* (granitic), *Tolmo* (surface boulder) and *Canchal* (rock, crag).

The quarry: The site comprises abandoned millstones in different stages of production. Some are still in connection with the rock and others are in the process of fashioning.

Techniques: From the photographs both true extractive and block detachment techniques can be discerned.



Unfinished cylinder (photograph by Fernando Colmenarviejo).

Products and distribution: The millstones range in diameter from 1.25 to 1.40 m and are between 27 and 34 cm thick. Production is modest, probably limited to a local level.

Dating: The size of the millstones suggests a production that could date in the time frame between the Medieval and Contemporary periods.

Rocktype: Granite (Geological map 509, Torrelaguna, 1987).



Examples of millstone scoring directly from granite bedrock.



Angular extraction hollow where a square block was presumably detached along natural fissures to be fashioned into a millstone.



Broken millstone in an advanced state of fashioning (eye at least partially pierced) (all photographs by Fernando Colmenarviejo).



Extract from geological map 509 (IGME). The site coincides with the red granite unit.

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