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Cover figure: Last mining event at Casa Montero, Madrid (c. 5200 cal BC). Illustration by Juan Álvarez-Cebrián

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Time for action. The chronology of mining events at Casa Montero (Madrid, Spain)

Pedro DÍAZ-DEL-RÍO and Susana CONSUEGRA

This day will last
A thousand years
If you want it to

Dawn is a feeling
The Moody Blues

Abstract

We present the radiocarbon dates for twelve charcoal samples covering the complete area of the mine field of Casa Montero (Madrid, Spain), a site with more than 4000 plotted shafts. The χ^2 test shows that eleven of them are statistically identical, with a 65% probability that all mining episodes occurred between 5337 and 5218 cal BC, a time span of approximately four generations. We test this probable hypothesis against other archaeological evidence and conclude that the comparatively large scale mining actions at Casa Montero would have necessarily required the mobilization of several small scale Early Neolithic groups into a succession of collective actions, probably performed in a seasonal manner. Neolithic flint mining in Europe was not a long term technical solution to a practical need, but an extraordinarily meaningful and timely -historically contingent- social activity. In order to understand mining actions in these terms, we would require a reevaluation of the statistical variability and meaning of series of radiocarbon dates already obtained at many other flint mines. When we do so, we might observe that, as in the case of Casa Montero, many of these radiocarbon dates actually represent sets of short term highly active 'generational' mining episodes separated in time.

Keywords

Early Neolithic. Flint mine. Central Iberia. Radiocarbon dates. Labor. Seasonality. Generational event.

1. Introduction

The general chronological framework of flint mining in Prehistoric Europe is as follows: there is scarce and occasionally ambiguous evidence for Pleistocene quarries (e.g., Baena *et al.* in this volume), some scanty Mesolithic mining evidence (e.g., Oliva in this volume), a few locations with sixth millennium BC Neolithic mines (Galiberti 2005; Díaz-del-Río *et al.* 2006; Schild 1995), and an important peak in the amount of evidence for mining activity for the late fifth through fourth millennia BC. Flint mining persists in certain regions of prehistoric Europe beyond those dates, with well-known cases such as the third millennium BC Grimes Graves (Longworth and Varndell 1996), while the social and economic transformations that took place during the Bronze Age modified the previous production, circulation and use of flint tools in much of the continent (e.g., Karimali 2005).

Beyond this impressionistic observation lie severe problems that have a direct effect on the possibility of establishing a comparative perspective on prehistoric flint mines. Among them is the lack of contextualized sets of radiocarbon dates for most known flint mines, particularly of dates from short-lived species, and when they do exist, the serious problems in establishing fine-grained sequences for each one of the individual sites, not to mention the difficulties of combining them at a regional or continental scale. One of the resulting problems of all this has been the limited opportunities for building the specific histories of mines in their local and regional contexts. Consequently, the assumption of long term procurement cycles for most mines, in many cases measured in millennia, has somehow restricted the possibility of developing historically informed interpretations. Not infrequently, the technical aspects of underground flint procurement have relegated mining to specialists, while the earliest monumental materialization of Neolithic societies has been used only as a secondary source for the interpretation of European prehistory.

This dynamic can only be subverted by increasing our interest in building historically contingent interpretations of mines. In order to do so we can begin by avoiding two assumptions. First, a set of radiocarbon dates does not define the length of a continuous exploitation of the mine, but the statistically determined chronological limits in which an unknown number of mining events actually occurred. This kind of reasoning ignores the probabilistic nature of radiocarbon dates, and circumvents the fact that all statistically identical dated events may (or may not) be dating the same mining episode.

The second aspect, in some way entangled with the previous point, is the acceptance of 'work-day per person' estimates as veracious reconstructions of past realities. These kinds of estimates are critical if we want to compare the labor deployed at different flint mines, or between different mining events. But, because the scale of these individual mining events is in most cases elusive to archaeologists, we not infrequently assume that these estimates do not just have a comparative purpose, but actually represent the scale and pace in which labor was effectively deployed. Thus, the most parsimonious interpretation of flint mines considers minimum cost in both persons and labor time. When we combine these figures with the long-term temporal range of most sites, we end up accepting that labor must have been deployed in small amounts, by small groups of people (male, of course –Gero 1991), for domestic or down-the-line exchange purposes, year after year, century after century, throughout millennia. This in fact was our initial hypothesis for Casa Montero.

Of course, all or parts of this interpretation may well have been the case. Archaeological interpretations are in most instances underdetermined: one can frequently build alter-

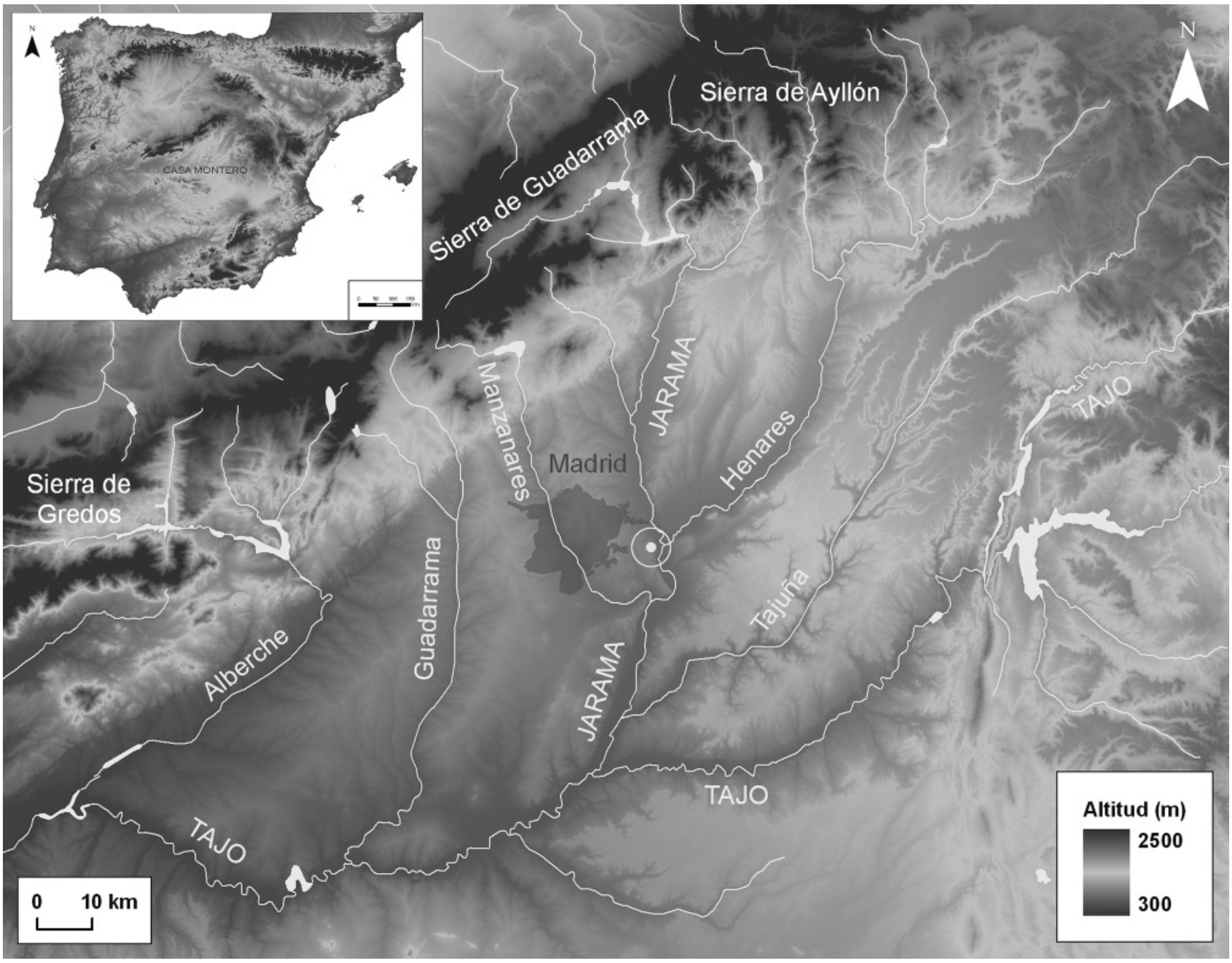

Figure 1. Location of the Early Neolithic flint mine of Casa Montero (Madrid).

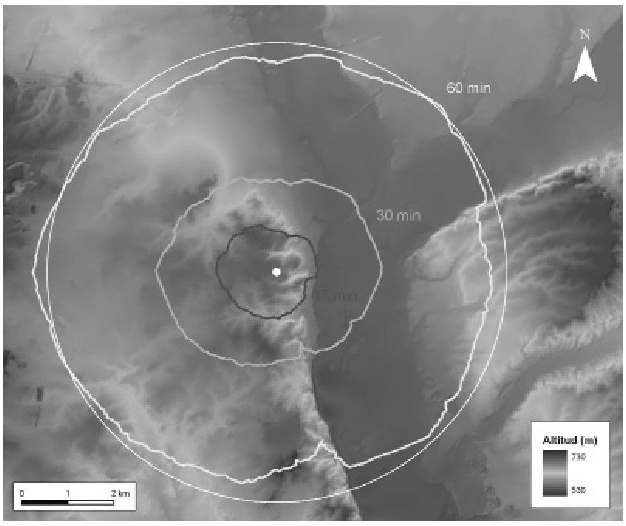

Figure 2. Area of intensive surface survey in the surroundings of the Early Neolithic flint mine of Casa Montero (Madrid).

native and reasonably parsimonious hypotheses with the same data sets. But our point is that this image of prehistoric flint mining frequently blurs the possibility of thinking about alternative social and political scenarios for each one of the subsequent mining events. To put it in other terms, it avoids the likelihood of diverse historically contingent mining circumstances. Yet, if we are able to build a solid and parsimonious alternative interpretation for at least one case study, then we may place ourselves in conditions to see and, most of all, think about Neolithic flint mining not as an homogeneous preindustrial activity, but as a varied set of historically dependent cultural practices.

2. Casa Montero

The Casa Montero flint mine is located on a bluff overlooking the confluence of two of the main rivers in the Madrid province, the Jarama and the Henares (Figure 1). The Neolithic mining complex occupies an extension of less than three hectares, almost completely mapped and partially excavated. Note that this is the correct extension of the site after the complete analysis of the existing evidence. We thus correct our previous publications where Casa Montero is said to have an extension of 6 to 8 hectares. The open area excavation revealed the existence of around four thousand cylindrical mining shafts, one meter mean in width and up to ten meters deep, none of which cut each other on the actual surface. Madrid's regional geology is known to have an abundant and ubiquitous presence of available flint. This fact makes the existence of mining activity in itself quite surprising, for both the region and time period of the events. During our regional Prehistory, flint was used at least from the Paleolithic up until the Bronze Age, when flint tools became extremely scarce. The peak of flint use seems to have been the Copper Age, when massive amounts of expedient tools were made out of local and, probably, secondary sources. The earliest Neolithic groups in central Iberia selected Casa Montero and not other primary or secondary deposits for flint procurement due to a combination of factors: geological (Bustillo *et al.* 2009), technological (Castañeda *et al.* 2008), locational and, most of all, social.

Our excavation design was specifically oriented towards the analysis of the potential variations in both the mining strategies and the chronology of mining events (Capote *et al.* 2008). Throughout the first two seasons we focused on defining the individual variability of shafts which later on allowed us to decide the best strategy for the third and final excavation campaign. For this last season, we designed and applied an aligned systematic sampling, digging all the shafts included in each one of the sixteen grid squares of ten by ten meters, regularly distributed throughout the site. The driving force behind this strategy was that comparing groups of shafts would be more enlightening than comparing randomly selected individual pits. And so it was.

The excavation was accompanied by a similar intensive surface sampling followed by a backhoe subsurface exploration in the two square kilometers west of the mining area, and an intensive surface survey in the 60 minute buffer zone (Figure 2). This allowed a more accurate image of the scale, temporality, and variability of flint mining techniques between Early Neolithic and Modern Era exploitations located in the vicinity of the excavated area. Sixty five tons of processed flint items were recovered during the excavation of 324 Neolithic shafts. The total amount of flint manipulated and discarded at the site during the Early Neolithic must have been more than 800 tons.

3. The radiocarbon dates

The excavations at Casa Montero have revealed few datable short-life organic remains. Animal bones are scanty, most of all rings recovered in various phases of production, from long bone shafts to final polished products (Figure 3) (Yravedra *et al.* 2008). We avoided using them as datable samples, mostly because of their scarcity in Neolithic Iberia and their potential museographic qualities.

In contrast, charcoal samples are comparatively abundant, the 3019 remains being the second biggest collection of identified charcoal in Early Neolithic Iberia. All the same, the deposits filling the mine pits were not rich in charcoal. Samples, mostly small scattered fragments of charred wood recovered by hand, were obtained from only 90 out of the 324 shafts excavated.

Charred remains were recovered from thirteen stratigraphic units filling five different shafts, all dug during the first field season. Remains were mainly *Quercus* ilex/coccifera. *Quercus* ilex (holm oak, carrasca in Spanish) is a large evergreen oak. *Quercus* coccifera (kermes oak, cos-

Figure 3. Bone industry recovered from different mine shafts of the Early Neolithic flint mine of Casa Montero (Madrid). So-called 'rings' on the lower left; bone shafts in various phases of production on the right.

coja in Spanish) is a large bush of the same genus, normally no more than 2 meters high with dense but superficial roots. The importance of these details relate to the debate concerning the use of long-lived organic remains for radiocarbon dating, and the frequent call to date short-life samples. While holm oak lives an average of 400 years, kermes oak rarely lives beyond 40. Unfortunately, both species are impossible to distinguish through a standard anthracological analysis. Nevertheless, some botanists suggest that soil conditions at Casa Montero would favor the presence of kermes oak, something that seems to be supported, among other things, by the fact that the excavated surface shows no evidence whatsoever of root alterations. As we will see below, it is not unlikely that most dated samples belong to the bushy short-lived species. However, short life samples dating to the same chronology are needed to reinforce this supposition.

Two individual fragments of *Quercus* Ilex/Coccifera from two different shafts were sent for radiocarbon dating (Figure 4; dates nº 1 and 2 published in Díaz-del-Río *et al.* 2006). Although we already expected an Early Neolithic chronology for most shafts, we did not anticipate such a date for both of them: at least two hundred years earlier than the earliest Neolithic date from the Madrid region. These dates are not unusual in other regions of Europe, such as Italy, where flint mines are one of the earliest Neolithic evidence. We did anticipate that both dates would be probably different since we assumed, based upon what we knew about other European flint mines, that the exploitation would have been prolonged in time. In any case, the resulting dates suggested that the two shafts were made at an interval of some centuries. Considering that the distance between these shafts was less than 25 meters, the expectations were that the more than 4000 shafts distributed throughout the four hectares under investigation would have been the result of a long term prehistoric exploitation. As a matter of fact, many of our colleagues openly expressed similar opinions, suggesting that the mine would have been in use until the third millennium BC. We knew, nevertheless, that the hypothesis of a long term use ran against other evidence, such as the lack of overlapping pits or the extremely consistent Early Neolithic chronology of all the scattered pottery fragments and other recovered artifacts.

Testing this alternative hypothesis required new contextualized and identified samples for dating. The rationale behind the second set of radiocarbon dates was precisely to confirm the complete time span of the mine and, if possible, observe the temporal growth of the mine field. In order to do so, we selected a collection of samples from eleven mine shafts covering 11 out of the 16 sampling units ('S.U.' in Figure 4). This essentially covered the entire extension of the site, north to south and east to west. The collection included 190 charred remains, 7 of which were not identified as to species, while the remaining 183 were assigned to only three taxa, in order of importance: *Quercus ilex/coccifera* (94%), *Juniperus Communis* (5%) and *Quercus* sp. (1%). We finally selected eight individual fragments of *Quercus ilex/coccifera* fragments, two of *Juniperus Communis* (common juniper) and a fragment of a bone shaft made out of a femur of *Sus* sp. for dating. Both the bone and the Juniper, another bushy species, where selected in order to evaluate the possible aging effect of old wood in the radiocarbon dates obtained from *Quercus* samples.

The complete set of radiocarbon dates are presented in Figure 4 and their spatial distribution in Figure 5. Unfortunately, the bone sample lacked enough collagen to be dated. The χ^2 test shows that all dates with the only exception of Beta-232890 are statistically identical. Beta-232890 dates the fourth stratigraphic unit filling pit 16.309, a mining pit that cuts through the filling of the only narrow and confined 'gallery' system at two depths documented at the site. Three alternative interpretations seem feasible. First, that the sample actually dates pit 16.309. It would then suggest the existence of an earlier phase of mining activity, previous to the main episode dated by the rest of the samples. Second, the date is slightly older than the rest because of an 'old wood effect'. Finally, it is a residual sample originally part of the infill of the gallery system, and would suggest that this system was the first technique to be applied at Casa Montero, a procedure quickly abandoned in favor of the more straightforward 'chimney' pit extraction method.

#	Lab Code	Sample #	S.U.	Shaft #	Strata #	Dated Material	Date BP	$^{13}C/^{12}C$	Cal BC 1 σ	Cal BC 2 σ
1	Beta-206512	CM/05/2384/2382	_	2384	2382	*Quercus ilex/ coccifera*	6400±40	-24.2 o/oo	5466-5325	5471-5318
2	Beta-206513	CM/05/2701/2229	_	2701	2229	*Quercus ilex/ coccifera*	6270±40	-26.2 o/oo	5300-5221	5324-5077
3	Beta-232884	CM/05/95/B1/7242/1	B1	7244	7242	*Quercus ilex/ coccifera*	6360±40	-25.4 o/oo	5462-5303	5469-5227
4	Beta-232885	CM/05/95/B2/7562/1	B2	7564	7562	*Quercus ilex/ coccifera*	6280±40	-24.9 o/oo	5303-5225	5359-5080
5	Beta-232886	CM/05/95/B3/7482/1	B3	7490	7482	*Quercus ilex/ coccifera*	6350±40	-25.6 o/oo	5452-5234	5466-5224
6	Beta-232887	CM/05/95/D1/7963/1	D1	7967	7963	*Juniperus Communis*	6290±40	-22.2 o/oo	5309-5225	5367-5085
7	Beta-232888	CM/05/95/D2/8142/1	D2	8147	8142	*Quercus ilex/ coccifera*	6240±40	*	5303-5081	5310-5066
8	Beta-232889	CM/05/95/ D3/15842/1	D3	15849	15842	*Juniperus Communis*	6290±40	-22.3 o/oo	5309-5225	5367-5085
9	Beta-232890	CM/05/95/ D4/16303/1	D4	16309	16303	*Quercus ilex/ coccifera*	6500±40	-25.6 o/oo	5512-5383	5534-5370
10	Beta-232891	CM/05/95/D5/8614/1	D5	8615	8614	*Quercus ilex/ coccifera*	6320±40	-26.2 o/oo	5338-5225	5460-5214
11	Beta-232892	CM/05/95/E3/9323/1	E3	9332	9323	*Quercus ilex/ coccifera*	6270±40	-26.2 o/oo	5300-5221	5324-5077
12	Beta-232893	CM/05/95/E4/9622/1	E4	9630	9622	*Quercus ilex/ coccifera*	6330±40	-25.6 o/oo	5363-5228	5463-5217
13	**	CM/05/95/ G3/16221/1	G3	16229	16221	*Sus sp.* Femur frag.	–	–	–	–

Figure 4. AMS Radiocarbon dates from Casa Montero (Madrid). Calibrations and χ^2 test performed with Calib 6.0.1. Samples number 1 and 2 were recovered during the first field season, and have been already published (Díaz-del-Río et al. 2006). S.U. Sampling Unit (*) "The sample was too small to do a separate $^{13}C/^{12}C$ ratio and AMS analysis. The only available $^{13}C/^{12}C$ ratio available to calculate a Conventional Radiocarbon Age was determined on a small aliquot of graphite. Although this ratio corrects to the appropriate Conventional Radiocarbon Age, it is not reported since it includes laboratory chemical and detector induced fractionation" (quoted from Beta Analytic report). (**) Not dated because of the lack of enough collagen in the sample.

Figure 5. Distribution of the dated samples in the excavated area of Casa Montero flint mine. Numbers refer to figure 4.

Concerning the remaining eleven statistically identical dates (Figure 6), the calibrated average of all of them would suggest that there is a 95% probability that there was a single mining event at Casa Montero between 5317 and 5230 cal BC (2 σ). If we assume the more plausible hypothesis of more than one mining event, we could then consider the sum of probabilities of all these events occurring in a certain period of time: there is a 65% probability that all mining episodes occurred between 5337 and 5218 cal BC (1 σ), a time span of approximately a hundred years. In short, the radiocarbon dates do not indicate in which direction did the mine field expand over time. We are thus left to accept that the main episode of mining activity at Casa Montero lasted no more than a single century, four generations. This interpretation is not just *possible*, it is *probable*.

4. Combining dates with other evidence

Following Doelman's (2008) analysis of New South Wales quarries, it would seem reasonable to accept that close in time mining expeditions would create a fairly even and homogeneous refuse pattern, while longer time spans would increase the variability of the recovered sample. In addition, the high probability of a short time use for Casa

Montero, as shown by the radiocarbon dates, should be reinforced with a limited variability of the archaeological record, and not just in the refuse pattern.

Perhaps the most obvious evidence for a short time exploitation of the mining complex is the lack of intersection between shafts. The high density of mining shafts, with nearest neighbors frequently as little as a meter apart, indicates that Neolithic miners saw and avoided previous extractions. Both the surface accumulation of soil and the topography of mining areas would have been visible enough to allow the selection of new mining spots. This system of digging numerous narrow but deep pits offered the miners a certain security against potential wall collapse, and was labor efficient, reducing the investment required in removing high amounts of soil. Shafts do have a considerable depth variation (474±194cm mean), something reasonable considering the variation in the depth of flint seams throughout the mining area, although this is not the case for their width on surface (112±28cm mean). That is, there is a reduced variability in the way that each one of the mining pits where designed and executed. This consideration is reinforced by the fact that other soil stripping methods where feasible, such as wider pits or quarry fronts, as observed in the modern flint mining evidence located throughout the immediate surroundings of the Neolithic mine.

The infills of extraction pits are also homogeneous in both geological and sedimentological terms: the qualitative variation recorded during the excavation process by multiple observers can be reduced to five major groups. Unlike other contemporary mines such as Defensola (Galiberti ed. 2005), at Casa Montero the raw material was both procured and processed on-site. This resulted in a massive amount of discarded flint that was dumped back into the mine pits with the extracted soil. Thus, mine pits and their infill are the result of short time mining occurrences. The possibility of estimating the minimum amount of pits open at a time has been possible through the refitting of quartzite pebbles (see Capote, this volume). At Casa Montero, quartzite pebbles were brought from the close river terraces by miners, and used as hammers for percussion activities during the excavation and production process. Many broke while being used, and became part of the infill of open shafts. The results reveal that many shafts in each ten by ten meter sampling unit were actually refilled in one only mining event. That pottery fragments recovered from two shafts approximately 60 meters apart also could be refitted suggests that at least some mining events may have been bigger than the evidence obtained from sampling units.

The fact that flintknappers at Casa Montero followed the same pattern throughout the lifetime of the mine offers an additional support to our hypothesis. The recovered lithic remains amount to 65 tons, more than 1.5 million items, while the total stone processed at the site may have been more than 740 tons (>17 million items). The majority of these remains are knapping residues. The main goal of these knapping activities was the production of blades and in less

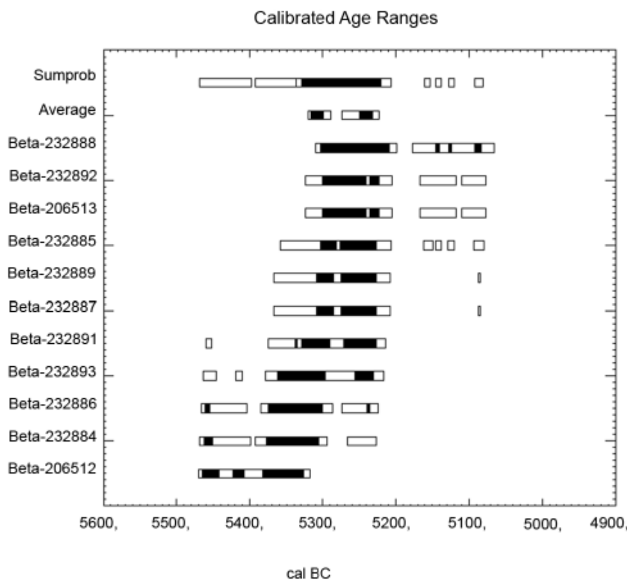

Figure 6. Plot of the eleven statistically identical dates from Casa Montero (Calib 6.0.1). The upper two represent the calibrated sum of probabilities and the calibrated average of all dates.

quantity bladelets, although flakes were also occasionally produced, the most common final product being blades with mean dimensions of 5x2cm. The analysis of knapping waste has determined that the operative chains at different mine shafts was much the same, involving the systematic repetition of a single procedure: the methodical removal of the external opal parts of nodules in order to produce tools out of the quartz inner part (Castañeda *et al.* 2008).

Other more circumstantial evidence for a short time exploitation of the mine comes from the faunal sample. Macrofaunal remains amount to 44 NR, more than 66% of which are bone industry (Figure 3). Out of this bone industry, more than 70% is represented by all the steps of ring production, from bone shafts to the final neatly polished rings. Remains of ring production were found throughout the excavated area. Bone shafts and their products are occasionally recovered from Early Neolithic sites in Iberia, although in small quantities except at a few Levantine sites (Yravedra *et al.* 2008). This kind of craft was somehow associated with the activities taking place during many mining events, and the homogeneity of its crafting followed the same pattern.

To sum up, most of the evidence recovered at the site suggests that the complete time span of Casa Montero may well have been a century. The timing of each one of these events could have been seasonal, perhaps spring, as suggested by Pete Topping for the English mines (Topping, this volume). At Casa Montero, timber or flint tools would have easily be blunted by muddy clay during the winter rainy season, while in summer drought-hardened soil would have increased the labor investment in the actual digging (as well as increasing the amount of water that had to be carried to the miners). In tactical terms, the best moment

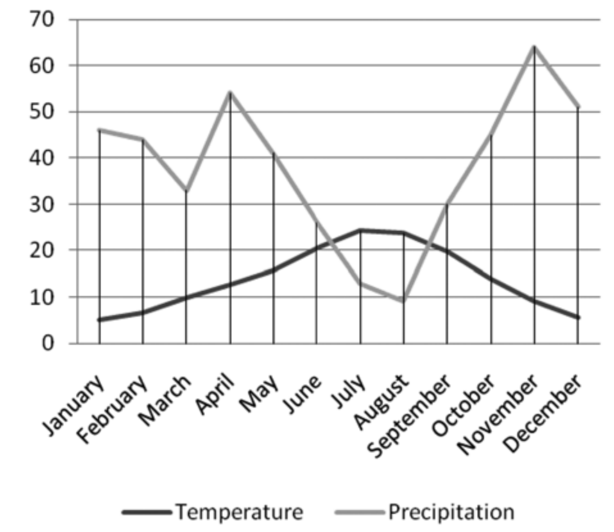

Figure 7. Mean rainfall (mm) and temperature (ºC) in Madrid. Source: Ministerio de Medio Ambiente. Instituto Nacional de Meteorología. Normal values of precipitation and temperature. 1960-1990.

to program such activity would either be spring (May to June), or fall (September to October), when the probability of rainfall is reduced and temperature has not reached its maximum (Figure 7). The recovery of a swallow in the lower stratigraphic unit of mine shaft nº 7209 would favor the former as a better hypothesis.

Additionally, the seasonal visiting of the mine would have avoided the 'who calls dilemma', that is how to concentrate enough labor force in a single spot in the context of a nonhierarchical decision making system. This is a reasonable scenario considering what we know about the amount and size of early Neolithic groups, and the possibly limited capacity of individuals to mobilize larger scale labor teams beyond the immediate domestic spheres. Early Neolithic evidence is scarce in the 8000 square kilometers Madrid region, an area where archaeological investigation is intense, although patchy. Only 13 locations are known to have Neolithic remains, six of which have been systematically excavated in recent times (only two have evidence of architectural remains, both unimpressive). Just one of these sites, has radiocarbon dates that may be contemporary to Casa Montero. Our project's survey of the sixty minute buffer zone surrounding Casa Montero has not increased the number of Neolithic sites. In fact, none have been recognized to date. While the mineralogical composition of pottery inclusions indicates the use of local clays, suggesting that those who mined at Casa Montero most likely dwelled in the region (Díaz-del-Río *et al.* 2011), the presence of cinnabar who's isotopic analysis refers to the Almadén district (200 km distance) points towards certain extra-regional connections. Early Neolithic groups were most probably very small and considerably mobile. If this was the case, the comparatively larger scale mining actions at Casa Montero would have necessarily required the mobilization of more than a few of these groups in a succession of collective actions presumably signaled through natural events (e.g., astronomical) that could allow the avoidance of the 'who calls dilemma'.

Casa Montero was abandoned sometime around 5200 BC. We have no other evidence of human activity for more than thirty centuries. In the second millennium BC some small group living nearby considered the previous mining area significant enough to use it as an occasional burial ground.

5. Coda

Throughout this paper we have argued that most mining events at Casa Montero took place during the lifetime of some few generations of Neolithic groups. Of course, the historical scenario in which flint mining occurred at Casa Montero does not necessarily parallel mining actions in other areas of Neolithic Europe. Many European flint mines were under exploitation for longer periods of time, or so it would seem from their radiocarbon dates. Nevertheless, one would have certain difficulties in deciding whether these radiocarbon dates actually represent thousands of years of small scale extractions or sets of short term highly active 'generational' mining episodes distanced in time. If so, flint mining may not have been a long term technical solution to a practical need, but an extraordinarily meaningful, timely and historically contingent social activity.

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