Early Prehistoric Flint Mining in Europe: a Critical Review of the Radiocarbon Evidence

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Abstract: This paper presents the first comprehensive database for radiocarbon dates from European flint mines, result of reviewing a considerably dispersed literature. The database contains 476 radiocarbon dates relating to 56 mines in 14 European countries. Out of all, we have selected the earliest dates in order to review their quantity and quality. Our analysis suggests that Mesolithic and early Neolithic radiocarbon dates for European flint mines are few in number, many have unclear or poorly reported contexts, and most have samples of questionable quality. We conclude that efforts should be directed towards obtaining a better radiocarbon dataset, based on contextual precision, sample quality, and statistical robustness of radiocarbon sequences.

Keywords: radiocarbon chronology, flint mine, Prehistoric Europe, Mesolithic, Neolithic.

Introduction

The archaeological record of flint mining is one of the most extended of prehistoric Europe in both space and time. Research in this area goes back to the 19th century, and today a large body of literature exists that contains excellent regional (e.g., Barber *et al.* 1999; Tarantini and Galiberti 2011) and case studies (e.g. Bostyn and Lanchon 1992; Galiberti 2005; Longworth *et al.* 2012; Marcigny 2010; Oliva 2010). The specificity of this research has favoured the development of a certain coordination at the European scale, as highlighted by the nine *Flint Symposia* (1969 to 1999) and the work of the UISPP *Flint Mining during Pre- and Protohistoric Times* Commission since 2006. However, with some few notable exceptions (*e.g.*, Di Lernia and Galiberti 1993; Wheeler 2011; Lech 2013; Baczkowski 2014), this coordination has not favoured comparative studies on a continental scale. Although homogeneity of the flint mining archaeological record (result of similar mining techniques being used) could have encouraged trans-regional comparisons, the overall duration of the activity (extending from prehistoric to modern times) and the extraordinary diversity of different regional cultural contexts have no doubt hindered the undertaking of such studies (Capote and Díaz-del-Río 2015).

The present work reviews the quantity, quality and spatial distribution of radiocarbon dating results for flint mining in prehistoric Europe. Several facts commonly render this method as the only way to approach the age of a mine pit. First, diagnostic remains are generally missing and, when recovered, may not be coeval to the context: the nature of mining actions frequently involves the successive disturbance and redepositing of soil. In mining contexts, the probability of residual finds increase exponentially. Unfortunately, this *caveat* can be extended to any possible radiocarbon dated element recovered from mine pit fillings. Secondly, extraction techniques are extremely homogenous through time and, on their own, cannot be considered a reliable means of dating mines. Third, residues found in shafts and galleries, such as the operational chain for the production of flint tools or axe roughouts, rarely give solid chronological clues.

Certainly, most of the determinations at our disposal refer to mines in which the only datable elements have been pieces of bone, antler or charcoal fragments. Thus, unlike in other archaeological contexts with more extensive ranges of examinable materials, such as settlements or burial areas, any discussion on the chronology of prehistoric mining relies heavily on the results of radiocarbon dating.

It is the purpose of this paper to review the quantity and quality of these results with three purposes. First, presenting an updated database and general discussion for most of the published radiocarbon dates recovered from flint mining contexts in Europe. Secondly, examining if and where does the radiocarbon chronology support the existence of pre-Neolithic flint mining activity. Finally, reviewing the earliest flint mining dates for the Neolithic in each European region in order to determine the likelihood of a connection between mining and the earliest Neolithic traits.

Radiocarbon data: quantity and quality.

The data analysed were gathered into what is here named *C14 Flint Mine* (access at http://www.casamontero.org/rec_publi.html) – a database result of collecting the considerably dispersed literature on flint mining in Europe. It contains 476 radiocarbon datings relating to 56 mines in 14 European countries (Tab. 1).

Fig. 1. Map of Europe with the distribution of radiocarbon dates compiled for this paper. Figures in each country represent number of dated mines/total number of dates. Drawn: S. Consuegra and P. Díaz-del-Río.

These datings are not homogeneously distributed over the continent. Twelve countries from South-eastern Europe have no radiocarbon dates, even though many of these nations are home to the oldest evidence of the continent's Neolithic settlement and are known for the quality of their raw materials. Some 51% of the datings come from the United Kingdom and France (Fig. 1), and just 12 mines or mining districts concentrate 60% of the available data. Further, nearly 30% refer to Grime's Graves, making this the best dated prehistoric flint mine in the world (Longworth *et al*. 2012).

The mean of the standard deviations is 71 years, while 81 datings (17%) have a standard deviation of over 100 years. This suggests that an important amount of dates have been performed before the generalization of AMS dating procedures in our discipline.

Most of the samples dated were fragments of charcoal (n=258, some 54%), followed by bone and antler (n=194, some 41%). The nature of the dated sample was not reported in 23 cases (5%). England (110), France (38), Belgium (27), and the Netherlands (9), concentrate 95% of all short life samples (bone or antler). That is, considering the possibility of 'old wood effects', the overall quality of dated samples is best in the Atlantic façade, an area that is likely to be the latest in the European chronological sequence. Clearly stated, Southern, Central and Eastern Europe have less and worse dates.

Another key issue is the quality of the contextual evidence accompanying the publication of the radiocarbon date. We have information on the nature and location for 86% of the samples. Only 11% of the total (54 dates) lack contextual data. As to the rest, the most frequent information is the code number for the pit where the sample was obtained, followed by details such as its location inside the pit. Again, the frequent lack of diagnostic remains makes these samples the

Table 1. Distribution of radiocarbon dates for European flint mines by country. For details, see supplementary material.

Country	# mines	# determinations
Germany	5	13
Austria	1	3
Belgium	7	39
Belorus	2	10
Spain	2	15
France	7	78
Hungary	2	4
Italy	9	28
Netherlands	2	19
Poland	6	50
United Kindom	9	168
Czech Republic	2	37
Sweden	1	7
Switzerland	1	4
Total	**56**	**475**

best – if not the only – alternative for dating mining activity.

In order to organize geographically our data we have divided it into three regions: the Mediterranean (Italy and Spain), Continental Europe (Hungary, the Czech Republic, Switzerland, Germany, Austria, Poland and Belarus) and the Atlantic (Belgium, Holland, France, the United Kingdom and Sweden). They broadly reproduce the different phases/areas of expansion of the earliest Neolithic. The entries in the database examined in the present work were only those reporting an age of >3000 BP (n=434). As already noted, the regional imbalance in terms of the number of datings was substantial, with the number available for each mine increasing exponentially along a south-northwest axis.

A broad comparison of the summed calibrated date probability distributions (SCDPD; Shennan *et al.* 2013; Fig. 2) clearly reveal a temporal gradient between the 'Neolithisation' of the Continental Europe/ Mediterranean regions and the Atlantic region. The increase in mining activity in each of these regions was largely contemporaneous with the appearance of the earliest Neolithic 'things and practices' (Whittle *et al.* 2011: 1). At first glance, there would therefore appear to be sufficient evidence to defend a link between flint mining and the first Neolithic groups in each region, together with some previous and occasional Mesolithic mining activity.

Mesolithic flint mining: the radiocarbon evidence.

In the SCDPD for the Atlantic and Continental Europe regions, the exponential increase of radiocarbon dates during the Neolithic is preceded by small peaks, suggesting that Mesolithic groups did engage in deep mining practices. The possibility of such activity is not really surprising given the importance of flint as an abiotic raw material throughout prehistory. Many scholars believe such mining likely occurred in Europe, although they accept that the evidence provided by the archaeological record is scant, geographically disperse, and commonly ambiguous (Field 2011; Lech 2013).

Indeed, of the 475 datings collected, just 10 correspond to pre-Neolithic times (Tab. 2), and their link with mining activities is either questionable or inexistent (see below). Among the latter are the two oldest datings for Grime's Graves. Both correspond to charcoal samples that date a small pit and a hearth, neither of them with described associated artefacts (Longworth *et al.* 2012: 46, 49). Certainly, as Alex Bayliss *et al.* (2011: 730) indicate 'there is no evidence for deep shafts being used for flint extraction in the southern British Mesolithic'. In addition, the Jablines mine, some 30 km east of Paris in the Marne Valley, provides three pre-Neolithic datings obtained from charcoal that their very reporters regarded as being unlikely to be correct (Bostyn and Lanchon 1992: 217). A single result from the 'chocolate' flint mine of Tomaszów (Szydłowiec, Mazovia) in Poland dates a surface concentration of material, reflecting flint-working by Mesolithic groups of the area. However, the provider of this information indicates 'there were no Mesolithic shafts found at the mine' (Schild 1995: 464); there is therefore no evidence for pre-Neolithic deep mining activity at this site.

The remaining four datings, again made on charcoal, come from the Krumlovský Les mine in the Czech Republic (Oliva 2010: 266), and are the oldest for the entire continent. One of these (GrA–34410: 9410 ± 50 BP) is at least 2000 years older than the first datings for the late Mesolithic from the same mine, and indeed of all Europe. The sample was obtained from 'a small fireplace with red-burnt sand in the narrowed mouth of shaft I–12 [...] so that in relation to mining it undoubtedly represents a 'terminus cum quem' or 'ante quem' (Oliva 2010: 355). Together with the remaining three dates, they are the only Mesolithic datings available for Europe whose age has not been put into question. The excavator specifies that 'the Mesolithic chipped industry is very indistinct, with regard to local conditions relatively small-shaped, with irregular as well as parallel cores. In its dimensions it differs from collections of all so far investigated shafts' (Oliva 2010: 355). If so, the evidence suggest that Mesolithic mining at Krumlovský Les was, in the best of cases, an activity isolated in time and space, difficult to associate with

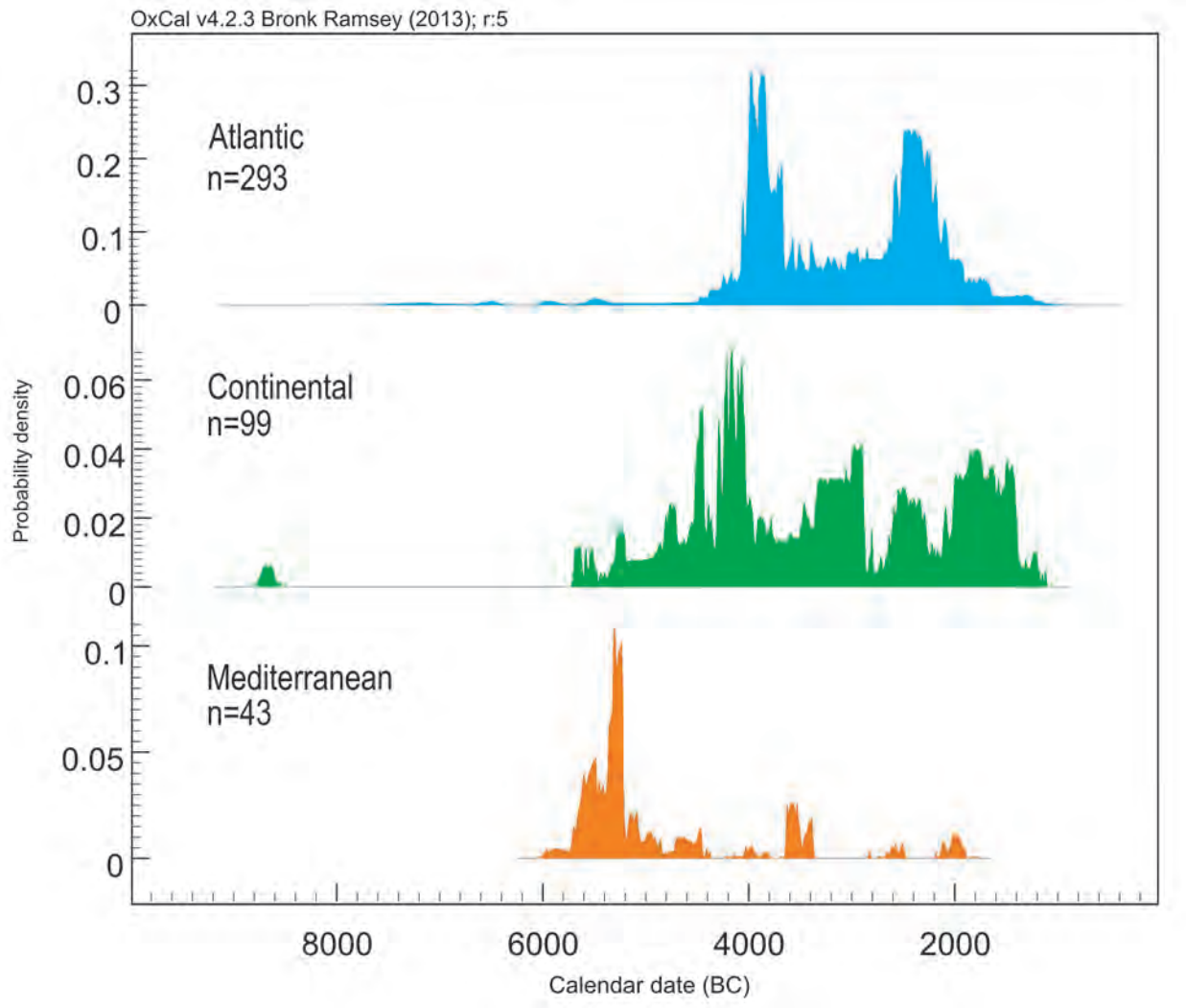

Fig. 2. Summed calibrated date probability distributions for the radiocarbon dates for each three regions of Europe: Mediterranean, Continental and Atlantic.

Table 2. Pre-Neolithic radiocarbon dates from European flint mines.

Country	Mine	Lab code	BP	SD	Material	1σ	2σ
Czech Republic	Krumlovský Les	GrA-34410	9410	50	Charcoal	8750 to 8630	8810 to 8560
England	Grimes Graves	BM-989	8200	309	Charcoal	7550 to 6770	7970 to 6440
France	Jablines	Gd-4675	8150	130	Charcoal	7450 to 6860	7500 to 6700
England	Grimes Graves	BM-990	7614	80	Charcoal	6570 to 6410	6640 to 6260
France	Jablines	Gd-5812	7010	60	Charcoal	5990 to 5840	6010 to 5750
Czech Republic	Krumlovský Les	OxA-22462	6970	35	Charcoal	5900 to 5790	5980 to 5750
Czech Republic	Krumlovský Les	GrA-38110	6775	40	Charcoal	5710 to 5640	5730 to 5620
Czech Republic	Krumlovský Les	OxA-18595	6612	32	Charcoal	5620 to 5520	5620 to 5490
Poland	Tomaszów	GrN-7051	6555	45	Charcoal	5550 to 5470	5620 to 5460
France	Jablines	Gd-5817	6500	60	Charcoal	5520 to 5370	5610 to 5330

Table 3. List of the earliest Neolithic radiocarbon determinations quoted in text.

Country	Mine	Lab code	BP	SD	Material	1 σ	2 σ
France	Jablines	Gd-4674	6140	150	Charcoal	5300 to 4850	5470 to 4720
France	Longrais	Gif-2315	6490	160	Charcoal	5620 to 5310	5730 to 5060
Czech Republic	Krumlovský Les	GrA-45664	6270	40	Charcoal	5300 to 5220	5330 to 5070
Poland	Tomaszów	Gd-4166	6260	210	Charcoal	5470 to 4990	5620 to 4720
Poland	Tomaszów	GrN-7591E	6145	70	?	5210 to 5010	5300 to 4910
Italy	Defensola A	Utc-1342	6990	80	Charcoal	5980 to 5790	6020 to 5720

any general pattern for European Mesolithic groups. We should nevertheless consider the possibility that these dates may be a result of dating residual samples or perhaps of an 'old wood effect', something that could only be solved by dating short life samples (that may just not be available) or increasing the amount of dates from the alleged Mesolithic contexts in order to obtain a more statistically robust sequence. The existing data, the stratigraphical complexity of the site, and the long term period of mining documented at Krumlovský Les (lasting until *ca*. 600 cal BC), suggest that the possibility of a deep flint mining activity during the Mesolithic would be in need of further support.

The earliest Neolithic flint mining: the radiocarbon evidence.

The radiocarbon evidence relating the earliest Neolithic groups in the different parts of Europe to flint mining is not very abundant and frequently problematic (Tab. 3). Just five datings from three sites exist that are contemporaneous with the first evidence of the *Linearbandkeramik* (LBK) groups: two from the Atlantic and one from the Continental Europe region, all dating charcoal samples. The former two come from the Jablines (Île-de-France, Seine-et-Marne), and Longrais mines (Calvados, Lower Normandy; Bostyn and Lanchon 1992: 217; Desloges *et al.* 2010: 6). While the Jablines sample might be contemporaneous with the start of the *Rubané* in the Paris Basin (*Rubané récent du bassin parisien* [RBBP]; Allard 2007), its predicted median age (5080 cal BC) precedes the start of mining activity (4160/4010 cal BC) in the area by 1000 years. Even the researchers who dated the Jablines sample regarded the results as being very unreliable (Bostyn and Lanchon 1992: 217), perhaps a result of an 'old wood effect'. If it really does represent mining activity by the first groups in the area during the *Rubané* period, one would have to concede that it reflects an occasional activity that can be no further generalised.

The oldest dating from the Longrais site (Calvados, Lower Normandy), which was performed on a charcoal fragment stuck to some Danubian pottery, is even more problematic. A review of the old excavation undertaken by Desloges *et al.* (2010) is inconclusive regarding any link with mining activity. It should be remembered, however, that an ancient Neolithic site exists in the Department of Calvados: that of *Le Lazarro*, dated to the end of the RBBP or the beginning of the Villeneuve-Saint-Germain (Guesquière *et al.* 2000; Billard *et al.* 2004). This village must have been regionally isolated from others of the time, since Lower Normandy was neolithised after the date accepted for the Paris Basin. Thus, while the first groups of the *Rubané* may have been involved in mining, the available radiocarbon evidence suggests this to be improbable.

Only one dating contemporaneous with the Central European LBK is available, again from the Krumlovský Les mine. Certainly, the date obtained for this charcoal sample (GrA–45664: 6270 ± 40 BP) is contemporaneous with the range for the LBK de Vedrovice (Znojmo, South Moravian) cemetery obtained by short life sample dating, i.e., 5400–5250 cal BC (Oliva 2010: 355; Bentley *et al.* 2012: 3926). However, this mine has provided 36 dated samples from a very wide study area, and this particular charcoal dates from some 900 years before the next known mining activity dated at 4300 cal BC, in the period regionally referred to as the late Lengyel (Oliva 2010: 356). The radiocarbon data therefore suggest that, as for the Mesolithic, the mining activity of the earliest Neolithic in Central Europe was (in the best of cases) occasional and isolated in both time and space. There is no strong evidence to support a generalised pattern associated with the earliest LBK groups.

The oldest flint mine on the north-eastern border of the LBK is that of Tomaszów in Mazovia Province. The earliest radiocarbon date belongs to Shaft 3, Gd–4166 6260±210, although the high standard deviation gives a considerable uncertainty, resulting in a broad range of 5470–4990 cal BC (1σ). Nevertheless, Shaft 6 showed an age of 6145±70 (GrN–7591), 5300–4910 cal BC (1σ). This may fall within the dates accepted for the expansion of the LBK communities in the south and centre–north of Poland (Whittle 1996: 157; Werra 2010). These two datings lend some support to the affirmation of Lech

(2008: 283) that 'mining [...] was a constant element of the culture of Danubian communities in Little Poland from the time of the LBK settlements'. The possibility needs to be taken into account, however, that both datings are the result of an old wood effect since they are the only samples of this age among the 51 from Poland's flint mines that have been radiocarbon dated. In fact, an old wood effect seems to lie behind the datings for two samples (GrN–7592E: 5990 ± 110 BP and GrN–7592R: 5715 ± 65 BP) from shaft 10 at Tomaszów, the only shaft to provide two radiocarbon dates. Their median calibrated dates have a difference of some 330 years (4890 and 4560 cal BC). Thus, it would appear that the evidence for the involvement of LBK groups in flint mining, and the intensity of that activity, should rely on the distribution of 'chocolate' and Jurassic-Cracow flint from sites south of the River Vistula (Lech 2008), and not on the available radiocarbon chronology, which is still too weak to be conclusive.

In the Mediterranean region, the start of mining activity is based on a single radiocarbon dating of a charcoal sample from the Defensola A mine in the Gargano Peninsula (Utc–1342: 6990±80 BP = 5980–5790 cal BC 1σ). It has been reasonably accepted as the oldest evidence for mining activity in the Gargano peninsula for two reasons: the sample was recovered from an internal area of the mine (corridor C) and the resulting date is coherent with the chronology suggested by the complete archaic impressa ware vessel recovered in the so-called 'ambiente A4' (Muntoni and Tarantini 2011: 44). As has been noted (Muntoni and Tarantini 2005: 172), this dating is coherent and contemporaneous with a number of early Neolithic sites in La Puglia, such as the most northerly of Masseria Giuffreda or Rendina. Sixteen datings are available for Defensola A, all on charcoal, with a distribution indicating an exploitation period of 5870–4600 BC (medians). The *terminus ante quem* for deep mining at the site is marked by two samples recovered inside pots that where left *in situ* by the last miners to enter these galleries (LTL–438A: 6417±55 and LTL–437A: 6334±50). The combined results suggest 5470–5310 cal BC as the most probable end for deep mining at Defensola A. This leaves 9 earlier dates obtained from samples recovered inside the galleries. All except for Utc–1342 fall after 5730–5620 cal BC. Consequently, it would be reasonable to keep the one and only early date for Defensola A in quarantine, until further contextual data or radiocarbon support becomes available. In the meantime, there seems to be no compelling radiocarbon evidence to support that the first generation of Neolithic groups in Italy engaged in deep flint mining.

Finally, 13 radiocarbon datings are available for Casa Montero, to date the oldest mine in the Iberian Peninsula (Díaz-del-Río and Consuegra 2011; Consuegra and Díaz-del-Río 2015). All the samples tested were charcoal, except for a bone of *Ovis aries*, a species that did not exist in the region previous to the Neolithic. Together, they reflect a similar pattern to that seen for Defensola A. One dating (of a charcoal sample) stands out owing to its apparently greater age (Beta–232890: 6500 ± 40 BP), but this reading is thought to have been influenced by an old wood effect. Indeed, this hypothesis was confirmed by dating a short life sample (Beta–295152: 6200 ± 40 BP on *Ovis aries*) from the same shaft. A Bayesian modelling of these dates (except Beta–232890) suggests that mining activities at Casa Montero started between 5380/5320 cal BC, and ended between 5290/5180 cal BC (1 σ). Thus, to date, the complete radiocarbon series for Casa Montero is coherent and displays a statistical consistency of both short and long life samples.

The almost complete lack of datings from Early Neolithic domesticated species (animals or plants) in the interior of the Iberian Peninsula prevents an assessment of whether mining activity at Casa Montero was undertaken by the first generations of Neolithic groups in the region. The closest and best dataset comes from the sites of La Lámpara and La Revilla (Soria; Rojo *et al.* 2008) about 130km to the northeast. Bayesian modelling of the dated domesticated species at these sites suggests that occupation began sometime around 5320/5250 cal BC, and ended between 5280/5200 cal BC (1 σ). This range is contemporaneous to Casa Montero, all of which suggests that mining activity in the interior of the Iberian Peninsula may well have been performed by the first generations of Neolithic groups in the region.

This interpretation of Iberian data is similar to that suggested by Alex Bayliss *et al.* (2011: 731) for the British Isles, where the radiocarbon dates obtained from bone and antler samples recovered from some of the well-known Sussex flint mines (Barber *et al.* 1999) currently provide the earliest dates for Neolithic activity in the region (Whittle *et al.* 2011: 257).

Thus, the earliest Neolithic radiocarbon dates for European flint mines are few in number, many have unclear or poorly reported contexts, and most belong to samples of questionable quality. Indeed, the majority have been performed on long-lived items or composite samples – the least reliable according to the 'sample logic' proposed by João Zilhão (2001) for determining the beginning of the European Neolithic. There seems to be enough evidence to support the contemporaneity of mining activity and the earliest presence of Neolithic traits in both southeast England and central Iberia. It is nevertheless not so clear in other regions of Europe. This could simply be a result of the quality of the radiocarbon series, although one should not rule

out the possibility of multiple and diverse regional phenomena.

Conclusions

The pattern that emerges from the present analysis raises doubts about the existence of pre-Neolithic flint mining in Europe, and about the degree of general involvement in this activity by the continent's first generations of Neolithic groups. The actual radiocarbon dataset for European flint mines will unlikely solve these issues. Consequently, those scholars working in the subject matter should direct their efforts towards obtaining a better radiocarbon dataset, based on contextual precision, sample quality and statistical robustness of radiocarbon sequences.

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