# First Obsidian in the Northern French Alps during the Early Neolithic

Pierre-Yves Nicod, Thomas Perrin, François-Xavier Le Bourdonnec, Sylvie Philibert, Christine Oberlin, Marie Besse


Routledge
Taylor & Francis Group

Journal of Field Archaeology

ISSN: 0093-4690 (Print) 2042-4582 (Online) Journal homepage: https://www.tandfonline.com/loi/yjfa20

# First Obsidian in the Northern French Alps during the Early Neolithic

Pierre-Yves Nicod, Thomas Perrin, François-Xavier Le Bourdonnec, Sylvie Philibert, Christine Oberlin & Marie Besse

**To cite this article:** Pierre-Yves Nicod, Thomas Perrin, François-Xavier Le Bourdonnec, Sylvie Philibert, Christine Oberlin & Marie Besse (2019) First Obsidian in the Northern French Alps during the Early Neolithic, Journal of Field Archaeology, 44:3, 180-194, DOI: 10.1080/00934690.2019.1580077

**To link to this article:** https://doi.org/10.1080/00934690.2019.1580077



Published online: 20 Mar 2019.

JOURNAL OF FIELD ARCHAEOLOGY
2019, VOL. 44, NO. 3, 180–194
https://doi.org/10.1080/00934690.2019.1580077



# First Obsidian in the Northern French Alps during the Early Neolithic

Pierre-Yves Nicod [a], Thomas Perrin [b], François-Xavier Le Bourdonnec [c], Sylvie Philibert [b], Christine Oberlin [d], and Marie Besse [a]

[a]University of Geneva, Geneva, Switzerland; [b]Université de Toulouse Jean Jaurès, Toulouse, France; [c]Université Bordeaux Montaigne, Pessac, France; [d]Université Lyon, Villeurbanne, France

**ABSTRACT**
An exceptional discovery was made in 2013 in the northern French Alps, at the Grande Rivoire site in Sassenage (Isère department): an obsidian bladelet from Sardinia was found in a cultural horizon dated to about 5360–5210 CAL B.C. The abundant arrowheads found with it are characteristic of the Early Neolithic in the South of France (Cardial/Epicardial). Yet there was no pottery or domestic fauna, and only discrete markers of farming. The typological, technological and micro-wear analysis of this bladelet, as well as the determination of the origin of the raw material, open new avenues of reflection for the neolithization of the northern Alps, in particular concerning the role played by the Early Neolithic cultures of northern Italy.

**KEYWORDS**
Early Neolithic; Alps; obsidian; typology; technology; micro-wear; raw material

## Introduction

In the northwestern Mediterranean, the first signs of the Early Neolithic are dated to 5800–5600 CAL B.C. and are linked to the Italian Ceramica Impressa culture (Guilaine and Manen 2007). Evidence of this culture is present along different areas of the coastline, but thus far absent in the northern zones (FIGURE 1). In the northern French Alps—a mountainous region not very conducive to agriculture apart from its alluvial plains—the agro-pastoral economy only emerged later, alongside the development of the southern Cardial and Epicardial cultures, between 5600 and 5000 CAL B.C. (Nicod and Picavet 2003; Perrin 2008).

To date, no indication of the Early Neolithic has been discovered at low altitudes in the north Alpine alluvial plains (FIGURE 1), perhaps due to the thick overburden of Holocene sediments. However, several middle and high-altitude sites have yielded remains from this period, in particular in the sub-Alpine Vercors Massif (FIGURE 2) (Nicod and Picavet 2003). These are, on the one hand, caves and rock shelters situated on the edge of the massif, and on the other hand open-air sites at high altitudes. All of these sites were excavated some time ago and/or present poorly developed stratigraphic contexts, and indications of the agro-pastoral economy (domestic fauna and cereal remains) and characteristic Neolithic artifacts (pottery and polished stone) are rare, or absent, whereas remains indicative of hunting practices (wild fauna and/or flint arrow heads) are abundant (Nicod and Picavet 2003). It is difficult to ascertain, based on current data, if these are newly founded agro-pastoral communities, with a southern origin, who adapted their economy to the mountainous environment, or native populations, rooted in the local Mesolithic, who partially and/or progressively adopted Neolithic elements as a result of interaction with southern farming societies.

Over the past few years, excavations at the Grande Rivoire site, in substantial stratified sedimentary deposits, have renewed interest in this debate. Indeed, at this site, it is now possible to identify traits pointing to continuities (spatial and hunting organization of the occupations) and traits pointing to cultural ruptures (evolution of the lithic industries, appearance of domestic fauna) between the Second Mesolithic and the Early Neolithic (Nicod et al. 2012). In this context, the exceptional discovery of a bladelet made of Tyrrhenian obsidian in the Early Neolithic levels (5350–5100 CAL B.C.) came as a real surprise. Although, at the present time, this discovery is a *unicum*, it opens new avenues for the interpretation of the processes of north Alpine neolithization. Indeed, through it, we obtain information on the contacts and exchange networks between the first agro-pastoral communities of both sides of the Alpine massif.

## Discovery Context: The Grande Rivoire Site

The Grande Rivoire archaeological site is located near the town of Grenoble (Isère department), in the Furon Valley of modern day France, which forms the main access route to the sub-Alpine Vercors Massif from the Cluse de l'Isère (FIGURE 2). It is a rock shelter at an altitude of 580 m, at the foot of a south-facing Senonian limestone cliff (FIGURE 3). It is relatively small, with a ground surface of about 80 $m^2$ (FIGURE 4). The site was discovered in 1986, after quarry works dislodged the adjacent slope deposits. Five salvage excavation campaigns were carried out by Régis Picavet between 1986 and 1994 (Picavet 1999). Research-driven excavation began in 2000 and has continued since under the direction of P.-Y. Nicod.

The current understanding of the stratigraphy is that the deposit is over 5 m thick, and can be subdivided into three distinct sequences. The silty and gravelly upper sedimentary sequence comprises levels from the Gallo-Roman, the Metal Ages, and the Bell Beaker culture (2500 CAL B.C.–500 CAL A.D.). The occupation of the rock shelter was sporadic during these periods, and comprised diverse activities linked to

**CONTACT** Pierre-Yves Nicod pierre-yves.nicod@unige.ch University of Geneva, Department F.-A. Forel for Environmental and Aquatic Sciences, Earth and Environmental Sciences, Laboratory of Prehistoric Archaeology and Anthropology, 66 Boulevard Carl Vogt, 1211 Geneva 4, Switzerland.

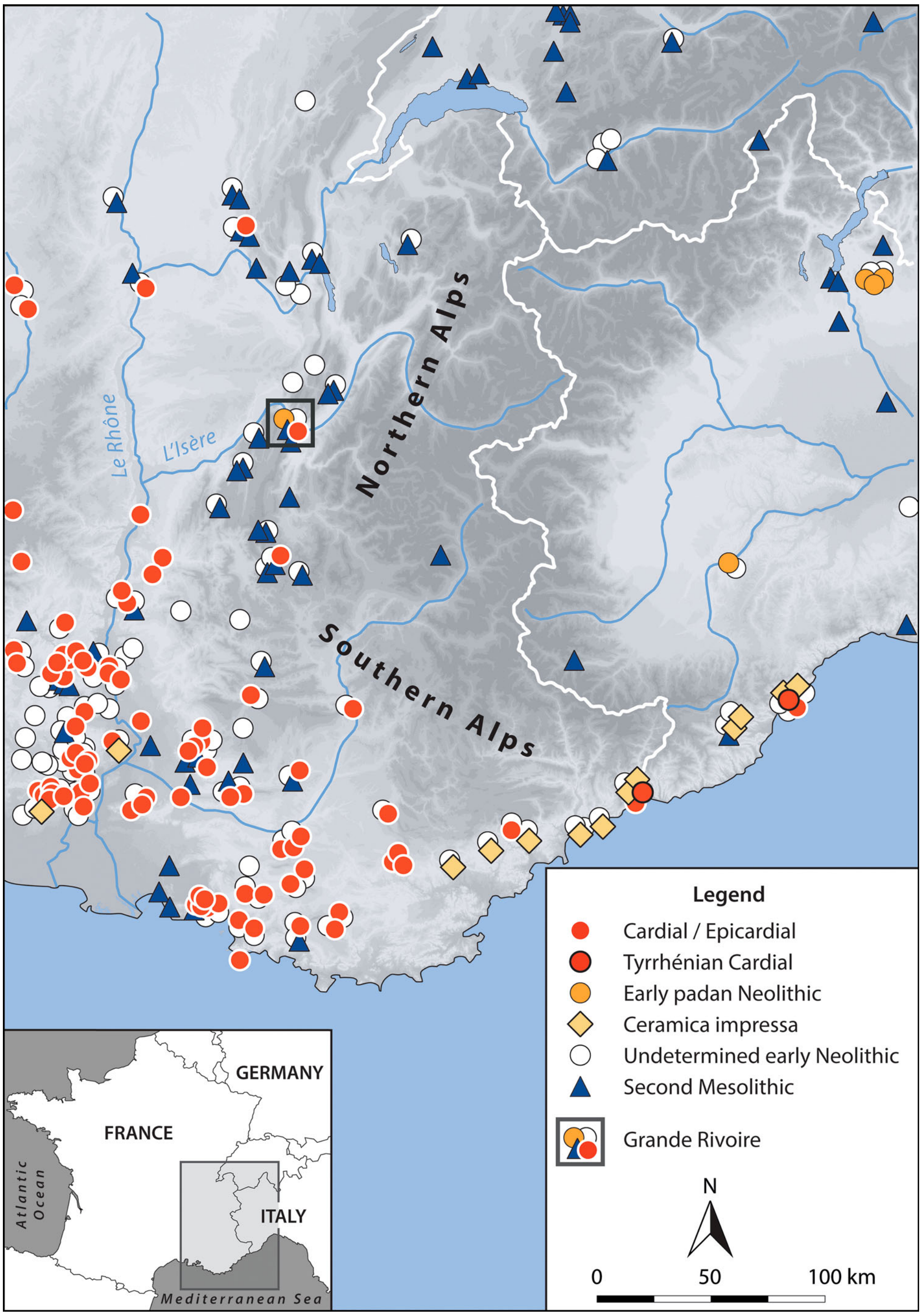


**Figure 1.** Distribution map of the Second Mesolithic and Early Neolithic sites in the Western Alps and surrounding areas. CAD by T. Perrin.

combustion structures and periodic livestock penning (Nicod et al. 2010).

The middle sedimentary sequence contains levels from the Late Neolithic, the Middle Neolithic, and the Early Neolithic (5100–2500 CAL B.C.). This is a sheepfold sequence with a complex interstratification of wood ash layers and fossil dung strata (Nicod et al. 2010). The archaeobotanical analyses (Delhon et al. 2008) illustrate the use of leafy and flowering tree branches as fodder, and suggest that some species were used for special purposes in relation to the tending of livestock (e.g., litter, dietary supplements, veterinary practices).

The lower sedimentary sequence (FIGURE 5) comprises levels from the early Neolithic, the Second Mesolithic, and the First Mesolithic (8400–5100 CAL B.C.). This constitutes a series of predominantly grey-colored strata rich in wood ash and/or organic matter (Nicod et al. 2012; Angelin et al. 2016). The richness of these levels in terms of number of archaeological finds provides insight into the lives of the hunter-gatherer societies of the Mesolithic, and of the first agro-pastoral societies of the Early Neolithic.

The obsidian bladelet, the focus of this article, comes from the top part of the lower sequence. Its location within the stratigraphy is indicated in Figure 5 by the red square in layer "d138", which is attributed to the Early Neolithic without pottery. We now turn to the detail of the Second Mesolithic and Early Neolithic levels prior to livestock penning (henceforth referred to as "pre-pen" levels).

### *The sedimentary context*

The obsidian bladelet was discovered in the excavated sector NR16-21, in the central part of the shelter, well protected by the rocky cliff overhang (FIGURE 4). The Second Mesolithic and pre-pen Early Neolithic layers extend over a thickness

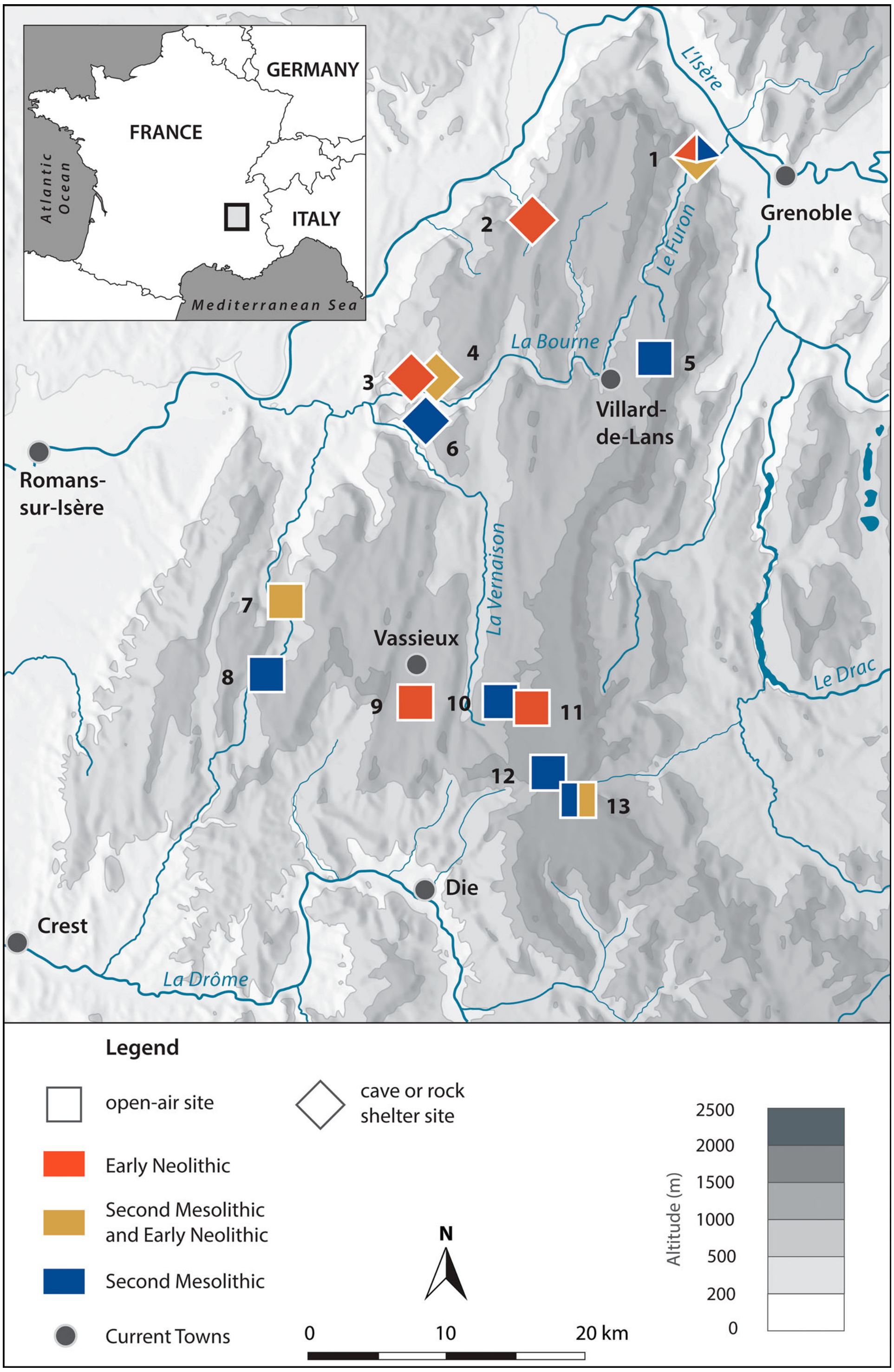


**Figure 2.** Geographic location of the sites from the massif of Vercors with elements from the Second Mesolithic (in blue), mixed Second Mesolithic and Early Neolithic (in beige) and Early Neolithic (in red). 1) Grande Rivoire (Sassenage, Isère, 580 m). 2) Pas de l'Echelle (Rovon, Isère, 980 m). 3) Balme Rousse (Choranche, Isère, 650 m). 4) Coufin 1 (Choranche, Isère, 550 m). 5) Machiret (Villard-de-Lans, Isère, 1265 m). 6) Pas de la Charmate (Chatelus, Isère, 1100 m). 7) Bouvante (Drôme, 585 m). 8) Ferme d'Ambel (Omblèze, Drôme, 1300 m). 9) Vassieux-en-Vercors (Drôme, 1000 m). 10) Fontaine de la Baume (Saint-Agnan-en-Vercors, Drôme, 1515 m). 11) Gerland (Gresse-en-Vercors, Isère, 1520 m). 12) Pré-Peyret (Gresse-en-Vercors, Isère, 1610 m). 13) Pas de l'Aiguille (Chichilianne, Isère, 1650 m). CAD by C. Bernard (AVDPA), and P.-Y. Nicod.

of about 80 cm (FIGURE 5); they were excavated in 25 successive layers (layers d127–d151).

The sedimentological analyses confirm that these sediments are mainly anthropic and that they are primarily composed of wood ash (Nicod et al. 2012); these sediments are the subject of ongoing study by Bernard Moulin and Jacques-Léopold Brochier. In addition, in the Early Neolithic levels, we also identified coprogenous elements indicating the presence of herbivores (e.g., spherulites, beds of organic matter, plant debris, stones impregnated with organic matter), but in much lower quantities than in the overlying pen sequence (Nicod et al. 2010). Therefore, based on current data, we cannot ascertain whether they are related to domestic animal species accompanying humans in the shelter, or to wild species sheltering independently of a human presence.

## *The cultural context*

The archaeological material demonstrates abundant faunal remains and knapped lithic components in flint and rock

**Figure 3.** A view of the rock shelter at Grande Rivoire. Photograph by P.-Y. Nicod.

crystal. What is more, there is good evidence of bone industry and adornments, as well as limited pottery, in the most recent levels. Based on the current data, we propose a chrono-cultural division into four horizons (FIGURE 5).

The first horizon is from the Second Mesolithic (sector NR16-21, layers d151–d145). It is characterized by flint debitage focusing on the production of very regular bladelets, which were then fractured with the microburin technique to make trapezoidal or triangular armatures (type BG1 according to Perrin [2001]). It also yielded notched bladelets (so called "Montbani bladelets") and truncated blades and bladelets, as well as abundant burnt hazelnut shells. This horizon can be attributed to the Castelnovian culture, which corresponds to the Second Mesolithic in southeastern France and Italy (ca. 6700–5500 CAL B.C.) (Perrin and Binder 2014).

The second horizon is a mixed complex (layers d142–d143) with an association of lithic elements traditionally attributed to the Second Mesolithic (trapezoidal type BG1 armatures according to Perrin [2001]) and the Early Neolithic (Cardial and Epicardial type cutting arrow armatures, type BG3 according to Perrin [2001]). This association of culturally distinctive elements probably results from taphonomic events and therefore does not appear to correspond to a prehistoric reality (Nicod et al. 2012).

The third horizon belongs to the Early Neolithic without pottery (layers d141–d133), within which the obsidian bladelet was found. This horizon contains a lithic toolkit clearly dominated by Cardial and Epicardial type cutting arrow armatures (type BG3 according to Perrin [2001]). Apart from these armatures and very few cereal grains, Neolithic components seem to be absent from these levels (absence of pottery and domestic fauna).

Finally, the fourth horizon corresponds to an Early Neolithic horizon with pottery (layers d132–d127), prior to pen occupations. It yielded numerous cutting arrow armatures (type BG3 according to Perrin [2001]) and the faunal remains of predominantly wild animal species. This demonstrates that hunting was still actively practiced. Nonetheless, a few

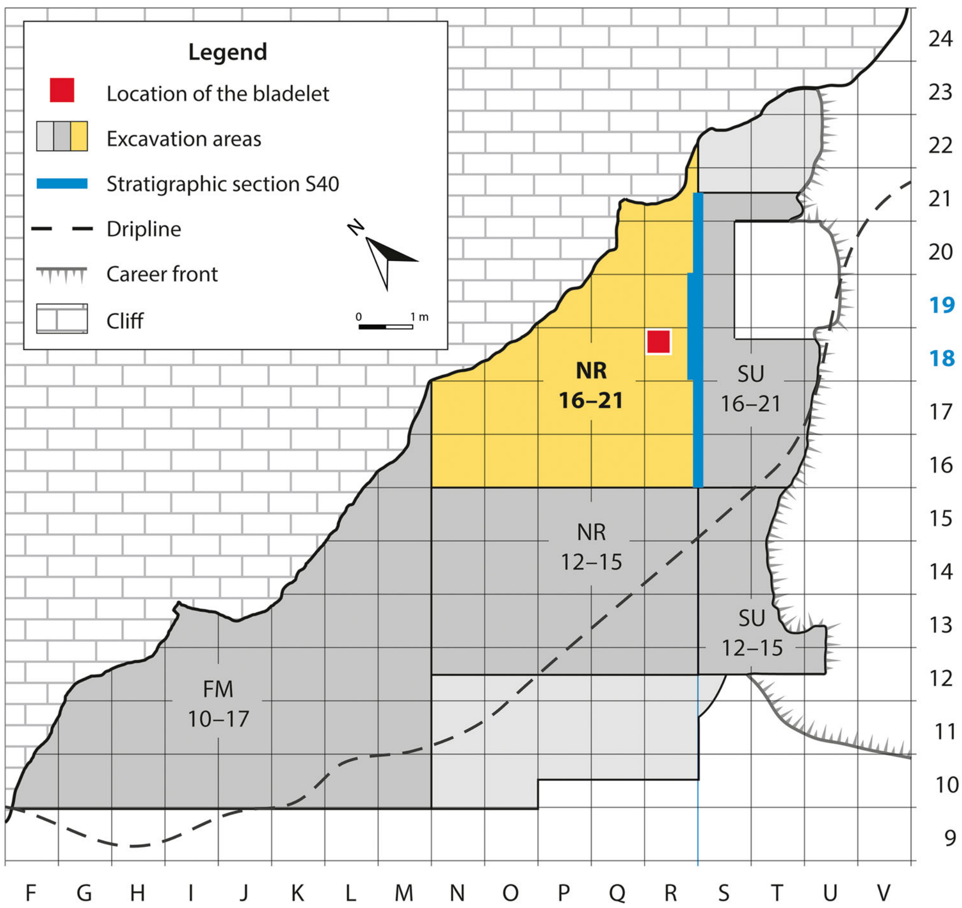


**Figure 4.** Plan of Grande Rivoire showing the main excavation sectors, the position of stratigraphic section S40 and the location of the obsidian bladelet. CAD by C. Bernard (AVDPA) and P.-Y. Nicod.

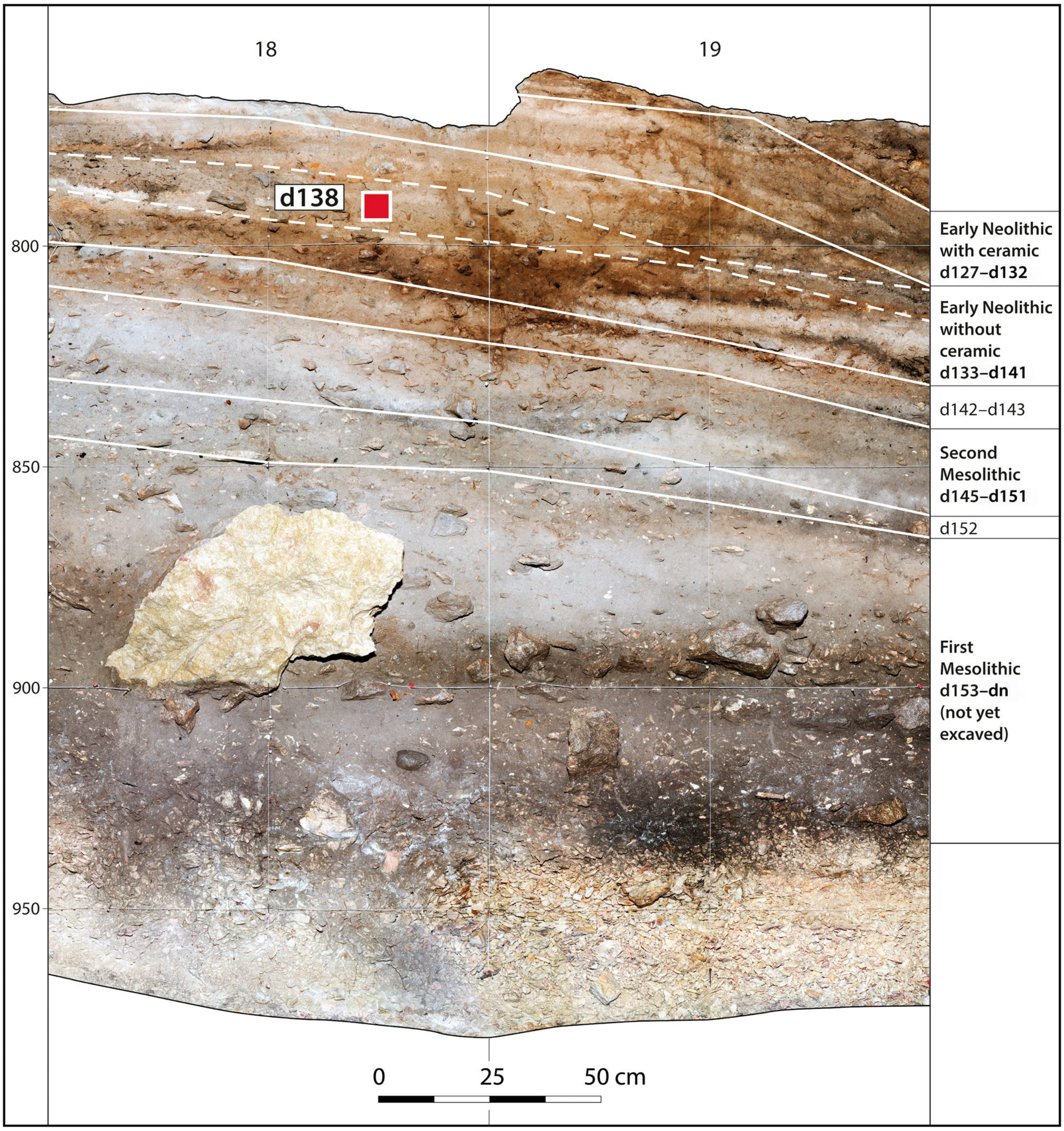


**Figure 5.** Photomontage of the stratigraphic section S40 in R18–19 at Grande Rivoire. Continuous white lines show the limits of the different chrono-cultural horizons identified in sector NR16–21 (layers d127–d153). Dotted white lines show the upper and lower limits of layer d138, which yielded the obsidian bladelet. The red square indicates position of the obsidian bladelet. Photographs and CAD by C. Bernard (AVDPA) and P.-Y. Nicod.

domestic fauna bones and cereal grinding elements point to an agro-pastoral economy. Pottery is present but remains discreet. The cutting arrow armatures, meanwhile, still suggest affinities with the southern Early Neolithic (Cardial and Epicardial), whereas some pottery elements evoke northern Italy (Fiorano culture).

### *The radiocarbon dates*

The prehistoric occupations of the Grande Rivoire site are currently sequenced by nearly 80 radiocarbon dates. Fourteen of them concern the levels under scrutiny and were measured on bone collagen or carbon (TABLE 1). The date Lyon-11556 (SacA-39073) corresponds to the level of the obsidian bladelet (sector NR16-21, layer d138). After the Bayesian modeling of these measurements with stratigraphic constraints, we propose the following milestones for the different cultural horizons (FIGURE 6). The earliest horizon, attributed to the Second Mesolithic, dates to 6610 and 6160 CAL B.C. (a posteriori maximum at 95%). The mixed Second Mesolithic/Early Neolithic complex dates to between 5500 and 5400 CAL B.C., after a hiatus of several centuries. The Early Neolithic horizon without pottery, which contained the obsidian bladelet, is dated to between 5360 and 5210 CAL B.C. Finally, the Early Neolithic with pottery dates to between 5170 and 5090 CAL B.C.

### *The lithic flint assemblage associated with the obsidian bladelet*

The lithic assemblage from layer d138 in sector NR16-21 yielded a total of 1728 elements (TABLE 2). The majority of these (1302 elements, or 75%) are debris or fragments. This data points to an alteration of the objects linked to trampling, but also shows that at least some of the knapping activities

**Table 1.** Grande Rivoire in Sassenage (Isère, France): calibration of the available radiocarbon dates for the Second Mesolithic and Early Neolithic pre-pen levels from sector NR16-21 (layers d127–d152) and from sector SU16- 22 (layers d15–d34). Calibration was performed with the "IntCal13" curve (Reimer et al. 2013).

| Sector | Phases (Cultural) | Split | Sample Reference | Type | Laboratory Reference | Result (B.P.) | Calibration (95%) |
|---|---|---|---|---|---|---|---|
| NR16-21 | Early Neolithic with pottery | d127 | GR12.P17.d127.192.LBC(R) | Burnt bone | Lyon-11557 (SacA-39059) | 6185 ± 35 | −5284 / −5021 |
| | | d129 | GR12.P17.d129.264.LGM/LN | Burnt bone | Lyon-11726 (SacA-39760) | 5925 ± 35 | −4898 / −4717 |
| | | d131 | GR12.Q19.d131.403.LGC(M) | Bone (collagen) | Lyon-11554 (SacA-39071) | 6255 ± 35 | −5316 / −5076 |
| | | | GR12.Q18b.d131.LBI(B) | Burnt bone | Lyon-11553 (SacA-39070) | 5995 ± 35 | −4981 / −4795 |
| | Early Neolithic without pottery | d134 | GR12.R18.d134.213.LGC(B) | Bone (collagen) | Lyon-11555 (SacA-39072) | 6180 ± 40 | −5286 / −5002 |
| | | d137 | GR13.Q18.d137.419.LGM/CX | Burnt bone | Lyon-11727 (SacA-39761) | 6240 ± 40 | −5311 / −5066 |
| | | d138 | GR13.R18b.d138.LBI(B) | Burnt bone | Lyon-11556 (SacA-39073) | 6150 ± 35 | −5212 / −5004 |
| | | d140 | GR13.P17.d140.349.CX/LSGM | Bone (collagen) | Lyon-11551 (SacA-39068) | 6415 ± 40 | −5472 / −5325 |
| | Second Mesolithic–Early Neolithic (mixed) | d142 | GR13.R19.d142.564.CX/LBC | Burnt bone | Lyon-11552 (SacA-39069) | 6490 ± 35 | −5517 / −5371 |
| SU16-22 | Second Mesolithic–Early Neolithic (mixed) | d26 | GR08.S17.d26.486.LSBMG | Bone (collagen) | Beta-282246 | 6510 ± 40 | −5546 / −5374 |
| | | d28 | GR08.S16.d28.409.LSBM | Bone (collagen) | Beta-255118 | 6430 ± 50 | −5480 / −5320 |
| | | | GR08.T17.d28.554.LGM(F) | Bone (collagen) | Beta-282247 | 6490 ± 40 | −5527 / −5367 |
| | Second Mesolithic | d30 | GR08.T17.d30.614.LSBM | Bone (collagen) | Beta-255119 | 7310 ± 40 | −6237 / −6072 |
| | | d34 | GR09.S17.d34.LGM(C) | Bone (collagen) | Beta-282248 | 7790 ± 40 | −6688 / −6506 |

took place on site. The presence of several technical elements (in particular, core tablet trimming flakes) confirms the latter hypothesis. However, the absence of cores and the low number of primary flakes suggest that not all the debitage took place in the shelter and that the production chaîne opératoire probably took place in different areas. The diversity of the raw materials also supports this likelihood. Some raw material is present nearby, including in the shelter walls. However, this flint is of mediocre and variable quality and was not frequently used (18% of the assemblage excluding debris and fragments). The raw material for knappers mainly came from regional sources, from several kilometers to several tens of kilometers away. The Vercors plateaus and the neighboring regions, such as Chartreuse to the north and Diois to the south, contain many high-quality flint deposits (Riche 2002; Bressy 2003) and were widely used in all the Grande Rivoire occupations (Angelin 2017). The detailed analysis of raw material provenance has not yet been completed but these exotic materials represent nearly 80% of the debitage products.

Local flints were mainly used for flake production, generally with simplified operating modes and by direct hard hammer percussion. The main aim of lithic production was to obtain regular bladelets with one or two facets. Regional flints comprise over 20% of lamellar products, generally obtained by indirect percussion. Rock crystal is also used occasionally and these artifacts show an in-depth knowledge of the crystalline Alpine massifs, the nearest of which are about twenty kilometers from the site.

Fifty-nine retouched objects were gathered in this horizon, including 55 (93%) in exotic flints, and 45 (76%) on lamellar blanks, illustrating the main production aim. The typological

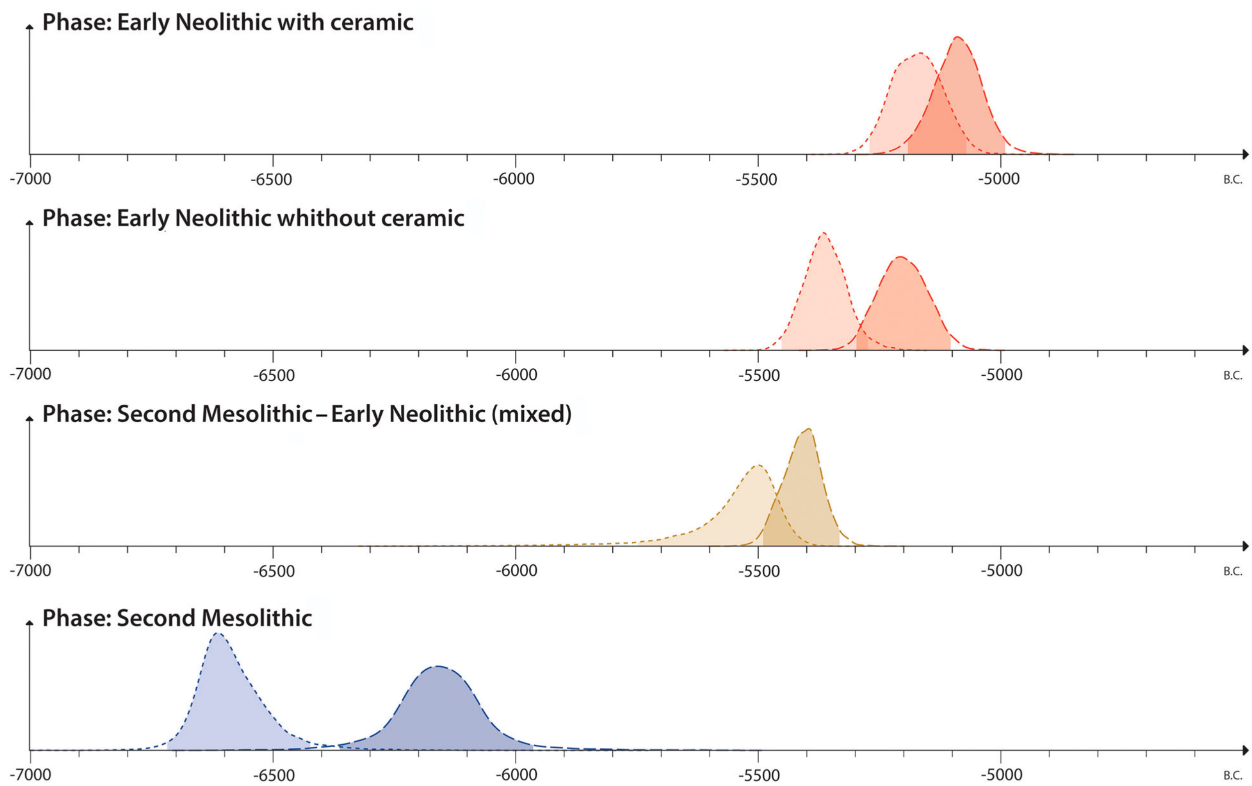


**Figure 6.** Extract of the overall Bayesian modelling of the radiocarbon measurements carried out for the Second Mesolithic–Early Neolithic sequence of Grand Rivoire. The 14 dates involved have been grouped into four successive phases (TABLE 1). The modeling was carried out based on stratigraphic observations with the ChronoModel v.1.5 software (https://chronomodel.com/; Lanos et al. 2015). The two probability density curves obtained for each of the predefined phases correspond to the HPD (Highest Probability Density region) at 95% from the beginning and the end.

**Table 2.** Grande Rivoire in Sassenage (Isère, France): general characterization of the lithic assemblage from layer d138 from sector NR16-21 by morpho-technical categories and raw materials groups.

| NR16-21.d138 | Flint | | | Obsidian | Rock Crystal | Total |
|---|---|---|---|---|---|---|
| | Local | Regional | Indeterminate (burnt) | | | |
| Blocks | | | | | | 0 |
| Chips | 133 | 873 | | | 6 | 1012 |
| Debris | 68 | 208 | 4 | | 10 | 290 |
| Total | 201 | 1081 | 4 | 0 | 16 | 1302 |
| Flakes | | | | | | |
| Complete | 54 | 135 | 1 | | 2 | 192 |
| Proximal fragments | 6 | 23 | | | 1 | 30 |
| Other fragments | 9 | 55 | | | 1 | 65 |
| Blades | | | | | | |
| Complete | 2 | 20 | | | 2 | 24 |
| Proximal fragments | 1 | 23 | | 1 | 3 | 28 |
| Mesial fragments | 1 | 45 | | | 3 | 49 |
| Distal fragments | 3 | 35 | | | | 38 |
| Cores | | | | | | 0 |
| Total | 76 | 336 | 1 | 1 | 12 | 426 |
| Overall total | 277 | 1417 | 5 | 1 | 28 | 1728 |

range displays little variation (TABLE 3), and comprises four end scraper fragments, a side scraper, two truncations, two fragments of backed elements, four used non-retouched elements, and eight tool fragments that are too small to identify tool type. The remaining 38 objects (64%) are projectile armatures (FIGURE 7). They are all of symmetric trapezoidal or triangular shape (BG category according to Perrin [2001] and Perrin and colleagues [2017]). The most represented type is the geometric with inverse bitruncations and direct flat retouch (sub-type BG32, or "Montclus arrowheads"), with a total of eight objects. These armatures, and more generally, all of the BG3 type armatures (geometrics with inverse bitruncations), are frequent at all the Early Neolithic Cardial and Epicardial sites in the South of France (Binder 1987) and are also well represented in all the Early Neolithic levels of the Grande Rivoire site (NR16-21, layers d116–d142).

The predominance of projectile armatures in the assemblages, the variety of the raw materials used and the presence of only part of the chaîne opératoire at the site (or at least in the excavated part of the site) imply that these occupations were relatively temporary or seasonal and largely organized around hunting.

**Table 3.** Grande Rivoire in Sassenage (Isère, France): typological distribution of retouched and/or used artifacts from layer d138 from sector NR16-21. The typological codes refer to Perrin (2001). The letter "f" at the end of the typological codes indicates that the tools are too fragmented to identify type accurately.

| Type | Codes | Number |
|---|---|---|
| Artifacts with normal truncation | TR22 | 2 |
| Other geometrics with direct, asymmetrical bitruncations | BG21 | 2 |
| Other geometrics with direct, symmetrical bitruncations | BG22 | 5 |
| Fragments of geometric bitruncations | BG3 f | 2 |
| Geometrics with inverse bitruncations | BG31 | 6 |
| Geometrics with inverse bitruncations and direct flat retouch | BG32 | 12 |
| Geometrics with alternating bitruncations | BG33 | 9 |
| Geometrics with direct and bifacial truncations | BG41 | 1 |
| Geometrics with inverse and bifacial truncations | BG42 | 1 |
| End scraper on thick flake | GR1 f | 1 |
| End scraper on thin flake | GR2 f | 2 |
| Thin short end scraper | GR21 | 1 |
| Notched bladelet ("Montani") | BA25 f | 1 |
| Fragment of a large backed artifact | BA3 f | 1 |
| Scraper on thick flake | RA11 | 1 |
| Fragment of undetermined tool | IND | 8 |
| Flakes with irregular removals | IR21 | 2 |
| Bladelets with irregular removals | IR22 | 2 |
| Total | | 59 |

## Analysis

The subject of this work, namely the obsidian bladelet (FIGURE 8), comes from layer d138 from excavation sector NR16-21 (FIGURE 4). It was discovered in a compact level of wood ash dated with certainty to the Early Neolithic without pottery (FIGURE 5). The full reference of this object is GR13.R18a.d138.LBl(B).

### *Morphological and technological analysis of the bladelet*

The methodology used for the technical analysis of this bladelet is based on principles that have been commonly used in France for the past few decades (Tixier et al. 1980). The piece is analyzed for specific marks on its surface, which provide information that allows us to put the object back within its life history process, from its acquisition as raw material to its abandonment. The typology follows that established by D. Binder (1987) for the Early Provencal Neolithic, and subsequently modified by T. Perrin (2001; Perrin et al. 2017). It is based on a tool classification that depends on prioritized characteristics (e.g., type of blank, position of retouch, direction and extent of retouch) and not on assumed tool function.

The bladelet presents three facets and is from the full debitage phase. Even though it is retouched, particularly on the distal part, it is almost whole, and the original length must only have been reduced by a few millimeters. It is 25.1 mm in length, 10.5 mm wide, and 3 mm thick (FIGURE 8), and weighs 0.9 g. The bladelet is relatively arched and presents slight thickening in the distal part. Lines linked to the propagation of the shock waves are clearly visible over the whole length of the lower surface. The butt is smooth and concave, and is 6 mm long and 2 mm thick. It is very tilted towards the back, by about 70°, and outlines a very slight lip. The edge is only very slightly or not abraded, and the bulb is diffuse. The upper surface bears scars of four previous lamellar removals, with similar characteristics to the bladelet.

All these observations suggest that the debitage of this bladelet was carried out with an indirect percussion technique. The relative irregularity of the bladelet, the thickness, the

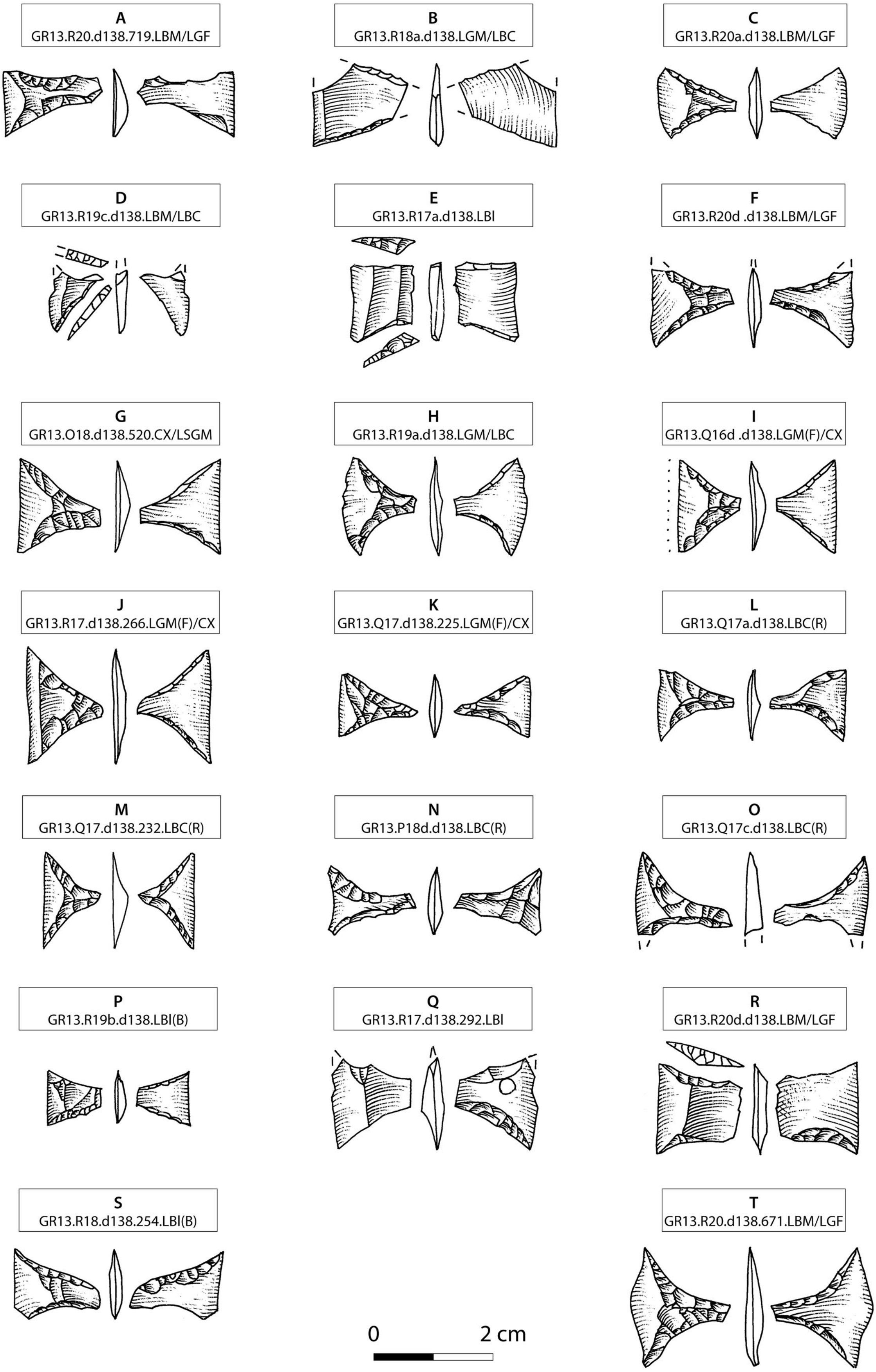


**Figure 7.** Selection of flint arrow armatures from layer d138 from sector NR16–21 at Grand Rivoire: A) a short asymmetric geometric with direct bitruncations (BG21B for Perrin [2001] and Perrin and colleagues [2017]); B) a long geometric with direct bitruncations (BG22A); C–D) short geometrics with direct bitruncations (BG22B); E) a trapezoidal geometric with inverse bitruncations (BG31A); F–J) trapezoidal geometrics with inverse bitruncations and flat direct retouch (BG32A); K–M) triangular geometrics with inverse bitruncations and flat direct retouch (BG32B); N–R) trapezoidal geometrics with alternating bitruncations (BG33A); S) a trapezoidal geometric with direct and bifacial truncation (BG41A); and T) a trapezoidal geometric with inverse and bifacial truncation (BG42A). Drawings by R. Picavet.


**Figure 8.** Views of the obsidian bladelet GR13.R18a.d138.LBI(B) discovered in layer d138 of sector NR16–21 at Grand Rivoire. Photographs by T. Perrin.

width of the butt, and especially the very acute angle do not appear to be compatible with pressure flaking. This analysis points towards indirect percussion.

The distal end of this small bladelet was shaped by abrupt retouch. This orthogonally truncated the bladelet and also slightly affected its left edge. From a strictly typological point of view, this is a thin object with a normal long truncation (type TR22B [Perrin 2001]) associated with a partial backed edge. Two very slight lateral notches are located opposite each other on the proximal part. With the exception of the retouched parts, practically the whole object presents clearly rounded, even abraded ridges, on both surfaces and edges.

### *Microwear analysis of the bladelet*

Microwear studies of obsidian are still not common today, but it is generally agreed that the characterization of diagnostic use traces is relatively similar to those observed on flint: scars, striations, blunting/abrasion, and micropolish (Keeley 1980; Anderson-Gerfaud 1981; Plisson 1985; Van Gijn 1990; González Urquijo and Ibáñez Estévez 1994; Gassin 1996).

However, the experimental obsidian corpuses described in the literature on which our identifications are based reveal several specific characteristics inherent to the properties of the rock (Hurcombe 1992; Rodriguez Rodriguez 1998; Anderson-Gerfaud and Formenti 1996; Astruc 2011; Clemente Conte et al. 2015). In fact, apart from blunting and abrasion, which develop in a similar manner on flint and obsidian, micropolishes and their attributes (e.g., layout, limit, etc.), are less visible due to the high reflectivity of obsidian. Its relative fragility also influences the speed of formation of striations and chipping. This volcanic glass is also slightly more sensitive than flint to post-depositional mechanical and chemical alterations such as micro-retouches, microscopic dissolution of the surface, and star-shaped alterations.

The macroscopic and microscopic observations were made with a Nikon Z800 stereomicroscope (6×–50×) and a Nikon Eclipse LV150 metallographic microscope with reflected light (50×–200×). The photographs were taken with a Nikon DS-Fi2 camera and NIS software. The different kinds of microwear observed on our bladelet seem to correspond to distinct and successive processes. Blunting is visible with the naked eye or at low magnifications on most of the edges and ridges, as can be seen in Figure 9. The cutting edges are rounded, symmetrical, or slightly oriented towards the inverse surface, with blunting of variable intensity, but particularly well developed on the proximal quarter of the right and left edges (Figure 9d). At a microscopic scale, the Grande-Rivoire bladelet's blunted surface presents a grainy, coarse, and matte surface, with no striations or indication of direction (Figure 9h). On the ridges and the lower edge of the butt, the flatter morphology of the blunting in places seems to correspond to more marked abrasion (Figure 9e). This wear is also visible on the percussion bulb. Several streaks of shiny coalescence were identified on the proximal part of the left edge and rare spots of slightly shaped to flat micropolish were observed on the proximal zone of the central ridge (Figure 9g).

The morphology and the distribution of these traces suggest several hypotheses. A taphonomic origin of the blunting was initially considered, yet further macro- and microscopic observation of the surface of the obsidian and the cutting edges revealed a rather satisfactory conservation status. Nothing seems to indicate that the bladelet underwent any substantial mechanical, chemical, or thermal post-depositional damage. Damage to the edges is very limited and the micro-surface of the object presents no particular alteration (e.g., dissolution, disorganized striations).

In the same way, it is unlikely that a hafting system caused the blunting. Experimental flint reference collections show that effective hafting, when the tool is sufficiently well inserted into the handle, generates practically no rounding of the edges and the ridges (Rots et al. 2002; Rots 2010). Although we cannot directly extrapolate these data to raw materials other than flint, it is possible to assume that hafting marks on obsidian tools are similar, at least for the formation of blunting.

Unlike hafting, transport in a dangling leather bag causes traces similar to those observed on the obsidian bladelet. Indeed, after several days, rounding, which can be very intense, forms uniformly, but preferentially on the dorsal ridges. It is generally associated with an abrasion polish and spots (Rots et al. 2002). We can thus suggest that the bladelet may have been transported in a leather bag. What is more, the distribution of the blunting, which is much more accentuated in the proximal part of the lateral edges, suggests that it was also used, probably for scraping a material such as hide, which produces rounding of the active edges and a matte and rough-textured micropolish.

This evidence points to one conclusion: the bladelet appears to have been recycled. Indeed, the distal and distal-lateral retouches and the notches on the right and left edges clearly cut into the blunting and therefore occurred after it. In these retouched parts, the cutting edges and the ridges of the removal scars are sharp and present a fresh aspect, contrasting with the rest of the object (Figure 9b and c). The main type of microwear observed on these specific areas of the bladelet was striations. On the inverse surface of the right notch, they are clustered together, with a perpendicular to slightly oblique orientation (Figure 9f). Other deep, wide, and oblique striations are located on the lower surface of the distal truncation where they are associated with slight abrasion of the edge and could be attributed to the transverse working of a hard material with an abrasive component (Figure 9a). However, due to the absence of visible traces on the retouch scars, it is not possible to describe this

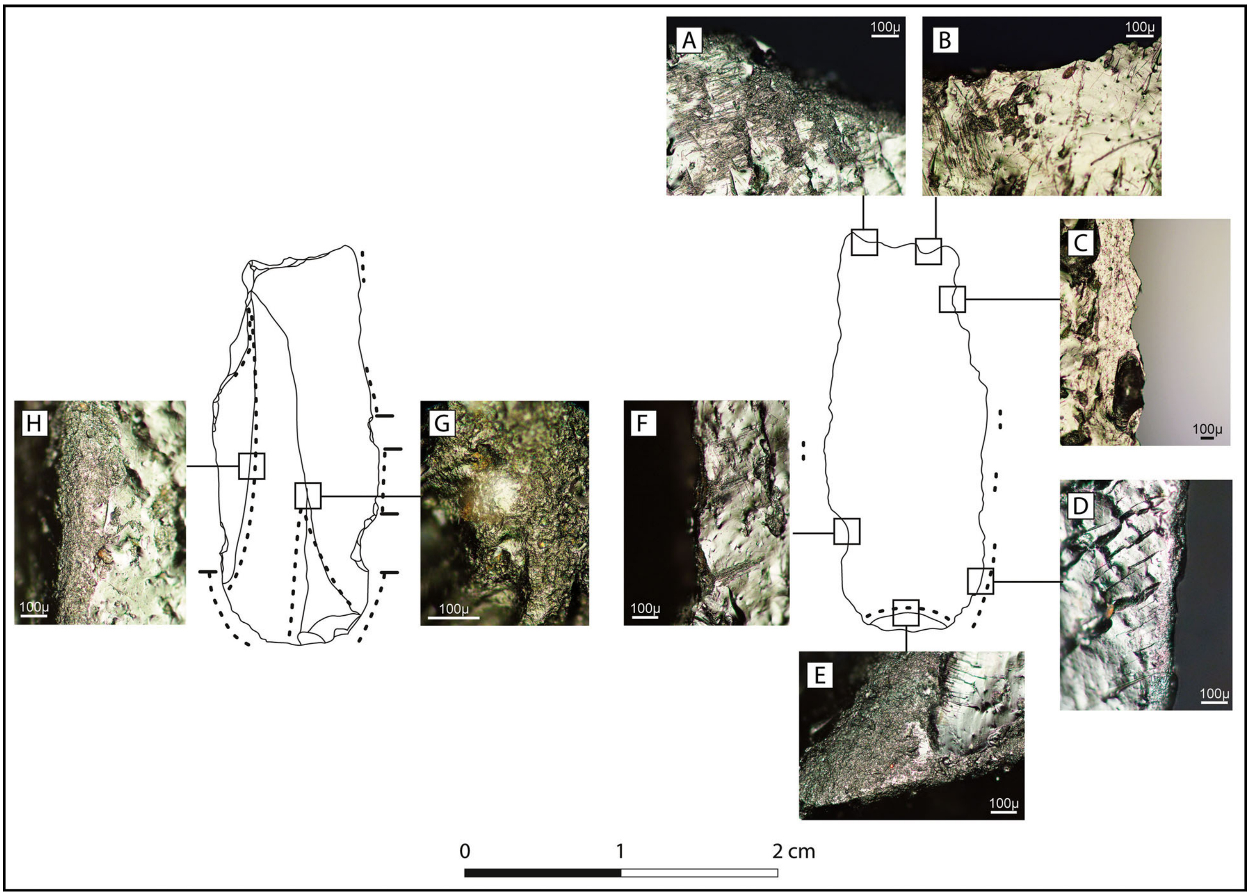


**Figure 9.** Views of the use-wear of the obsidian bladelet GR13.R18a.d138.LBl(B) under the microscope. Photographs by S. Philibert.

technical gesture. Due to the singular nature of this obsidian bladelet and the fact that it is an isolated object, it is difficult to interpret the traces. However, the multiple marks of wear and their chronology, which is probably linked to the transport of the bladelet, as well as the use of the proximal part, and the recycling of the object itself, all bear witness to its intensive use, and to a life cycle that was voluntarily prolonged. This lithic object therefore had a very long lifespan, allowing us to put forward that it probably held a particular status, such as a special economic, social, or symbolic value.

### *Obsidian sourcing*

The study of the raw material provenance was carried out at the Institut de recherche sur les Archéomatériaux – Centre de recherche en physique appliquée à l'archéologie (IRAMAT-CRP2A, UMR 5060, Pessac). Geochemical analyses by energy dispersive x-ray fluorescence (EDXRF) allowed for preservation of the bladelet. These were non-destructive, as is possible with the Seiko SEA6000vx microanalyser. The Rh source (50 kV/1 mA) and the high resolution SDD Vortex detector allow for the detection of at least 17 minor elements and trace elements (Leck et al. 2018). Eight elements (Mn, Fe, Zn, Ga, Rb, Sr, Y, and Zr) are systematically measured in obsidian analyses (D'Anna et al. 2015; Orange et al. 2017). The dimension of the collimator (3 × 3 mm) used in our analysis and the number of punctual measurements (9) taken for the sample reduce the effect of any potential local heterogeneity, such as the presence of crystalline inclusions.

The geochemical analyses on the bladelet (TABLE 4) were compared to the data obtained in similar conditions on obsidian from potential "source-islands" in the Western Mediterranean (Lugliè et al. 2014). The results demonstrate the Sardinian origin of the obsidian found at Grande Rivoire, and exclude the islands of Lipari, Palmarola, or Pantelleria as sources. In addition Figure 10 shows, based on log(Zn/Rb) and log(Zr/Rb), that the raw material of this artifact belongs to the SC type geochemical group from the Sardinian volcanic complex of Monte Arci (Tykot 1997; Lugliè et al. 2006, 2011).

## Discussion

### *Cultural components of Early Neolithic in northern Italy and southern France*

In northern Italy as in southern France, the neolithization process takes place during the 6th millennium B.C. (FIGURE 1). The first evidence, dated to ca. 5800–5600 CAL B.C., is attributed to the migration of small colonizing groups, directly issued from the Ceramica Impressa culture of central

**Table 4.** Results of the EDXRF analyses carried out on the obsidian bladelet from Grande Rivoire (GR13.R18a.d138.LBl(B)). All measurements are in µg/g (ppm).

| | MnO | $Fe_2O_3$ | Zn | Ga | Rb | Sr | Y | Zr |
|---|---|---|---|---|---|---|---|---|
| 1 | 476 | 19831 | 73 | 25 | 213 | 183 | 30 | 261 |
| 2 | 451 | 19372 | 75 | 26 | 208 | 179 | 31 | 258 |
| 3 | 449 | 18529 | 75 | 24 | 202 | 168 | 29 | 249 |
| 4 | 432 | 18003 | 71 | 25 | 197 | 166 | 30 | 247 |
| 5 | 454 | 18861 | 73 | 25 | 203 | 176 | 29 | 254 |
| 6 | 478 | 19180 | 76 | 25 | 205 | 178 | 31 | 253 |
| 7 | 419 | 18404 | 69 | 23 | 200 | 167 | 29 | 248 |
| 8 | 470 | 19721 | 76 | 24 | 205 | 174 | 28 | 255 |
| Average | 454 | 18988 | 74 | 25 | 204 | 174 | 30 | 253 |
| Standard Deviation | 21 | 651 | 3 | 1 | 5 | 6 | 1 | 5 |

Italy (Guilaine and Manen 2007). Despite possessing the technical skillset of the Neolithic (e.g., ceramics, agriculture, animal husbandry, polished stone axes, sedentary habitats), their lithic industries demonstrate some affinities with previous Mesolithic productions, suggesting contacts and technological transfers between these groups during the formation of the Ceramica Impressa (Perrin 2009). The current state of the research on these first agro-pastoral implementations indicates that they were short-lived and seem to have remained without offspring.

One or two more centuries pass before numerous Neolithic settlements are identified. Just as before, the implementation takes place mainly on the seaside, but rapidly develop inland, occupying very diverse grounds from a geographical point of view (FIGURE 1). Agricultural practices and in particular the cultivation of domestic cereals are well documented both by the presence of seeds and by storage structures and harvesting tools (such as flint sickle blades). Domestic animals for which there are no wild local ancestors are observed, especially goats, and the same scenario is found with cereals. The settlements are composed of oval or rounded houses, with earth walls on wooden frames grouped into small villages. Caves and shelters remain exploited as annexes to a settlement or as temporary pit stops. All these groups mainly exploit local (< 5 km) and regional (up to about 40 km) resources, as shown in particular by the various raw materials used. Contacts at very long distances (> 100 km) remain very scarce.

In northern Italy, the Early Neolithic, or "Ancient Padan Neolithic", is identified from 5600–5400 CAL B.C. through several micro-regional aspects. It is principally centered around the Adige valley (Gaban group), the middle Pô valley (Fiorano and Vho groups), and the Mediterranean coast (Ceramica Impressa ligure) (Perrin 2005). In the western Italian Alps the occupations dated to the first Neolithic are rare, and are all later than 5200 CAL B.C. (e.g., Isolino group). This indicates that, before this date, it is highly unlikely that any agro-pastoral group ever crossed the Alps through an east-west passage.

In southern France, the Cardial and Epicardial constitute the two major cultural entities of the Early Neolithic (Guilaine and Manen 2007; Manen and Perrin 2009). This distinction between both is essentially based on the typology of the techniques used to manufacture and decorate ceramics. They appeared around 5500 CAL B.C. on the Mediterranean shores, and while their expansion towards the west was swift, it was even quicker towards the north, following the Rhône axis (Perrin 2013). In the high Rhodanian basin, the Gardon cave (Ain department) demonstrates the presence of Neolithic groups belonging to this cultural sphere as early as 5350–5000 CAL B.C. (Voruz 2009), at a time during which Mesolithic groups were still present, suggesting a co-existence between the two on the same territory (Perrin 2003).

The chronocultural dynamics within this geographical area therefore suggest that the neolithization of northern French Alps was undertaken from the South of France and followed the Rhône valley, rather than through the Italian side of the massif.

## *Exploitation and diffusion of obsidian in the northwestern Mediterranean during the 6th millennium*

In the western Mediterranean, the island obsidian sources of Pantelleria, Lipari, Palmarola, and Sardinia were clearly

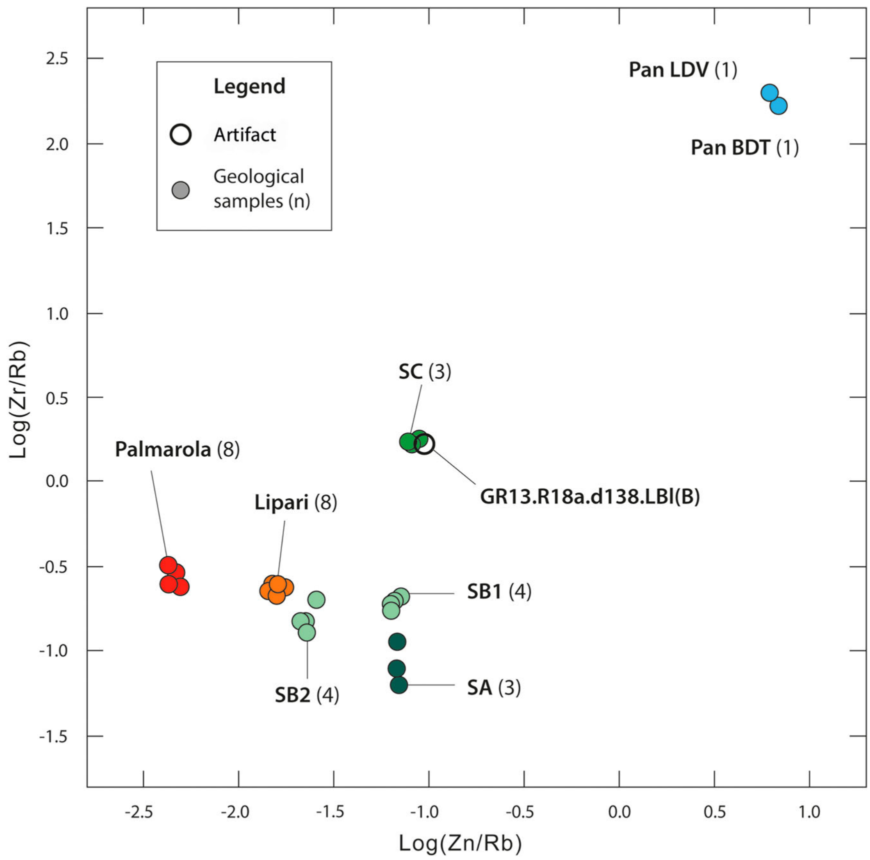


**Figure 10.** Diagram comparing the log(Zn/Rb) and log(Zr/Rb) for the obsidian GR13.R18a.d138.LBI(B) from Grande-Rivoire and those from the Mediterranean sources of Lipari, Palmarola, Pantelleria (BDT: Balata dei Turchi; LDV: Lago di Venere), and Sardinia (SA, SB1, SB2, and SC). The indications between brackets (n) represent the number of geological samples. For the mathematic justification of the use of log ratios as part of the analysis of compositional data, see, among others, Aitchison (1982). CAD by F.-X. Le Bourdonnec.

exploited from the beginning of the Neolithic (FIGURE 11). It is not impossible that they may have been exploited during the previous Palaeolithic and Mesolithic periods, but this remains uncertain (Vaquer 2007; Poupeau et al. 2010).

The Ceramica Impressa (6000–5600 CAL B.C.) Neolithic culture appeared in the south of Italy at the beginning of the 6th millennium and used these obsidian sites (FIGURE 11A). The first exploited sources (Lipari and Pantelleria) are the nearest to the first peninsula dwellings, but more distant sources (Palmarola and Sardinia) were also used shortly after that and their products were diffused over long distances, as far as pioneering Impressa installations in Liguria (Arene Candide) and the South of France (Guilaine and Manen 2007), dated to around 5800–5600 CAL B.C.

While previously present in the Impressa assemblages from southern France, obsidian disappears from this territory during the Cardial and Epicardial phases, between 5600 and 5000 CAL B.C. (FIGURE 11B). During this period, it is solely found in Italy and Corsica, in cultural contexts attributed to the Tyrrhenian Cardial (the ones of the Isolino di Varese site [Tykot 1995] could not be considered as reliable due to the stratigraphical context and are probably related to the Middle Neolithic). The only obsidian object found outside of this cultural context is the bladelet from the Grande-Rivoire.

## *Chrono-cultural attribution of the bladelet from Grande Rivoire*

From a morpho-typological point of view, unfortunately, the characteristics of the Grande Rivoire tool—a normal truncation on a bladelet—are not specific to a given period or culture. Indeed, this type of tool is widespread in the Castelnovian Second Mesolithic, Neolithic Impressa, Cardial, and Epicardial cultures (Binder 1987: 45, fig. 19), as well as in diverse groups of the Early Padanian Neolithic (Perrin 2005). However, although the bladelet itself is not discriminating, the raw material and the usewear further guide analysis. Data confirms that the source of the obsidian is southern Sardinia, some 700 km due south of the site it was found at. This location makes primary procurement by those at the Grande Rivoire unlikely. It was thus probably extracted by Early Neolithic Tyrrhenian groups (Ceramica Impressa or Tyrrhenian Cardial) and then carried for some time (leading to wear of the object), before being recycled (leading to fresh retouch) and finally abandoned at the Grande Rivoire site.

These observations suggest two hypotheses for reconstructing the history of the bladelet. The first would be a very early production, attributable to the Ceramica Impressa culture (6000–5600 CAL B.C.), with a geographic extension incorporating the South of France around 5800–5600 CAL B.C. It would then have circulated for several centuries, either among the last contemporaneous native Mesolithic groups until being brought to Grande Rivoire, around 5300 CAL B.C., or a fully Neolithic group of hunters or a group in the neolithization process (i.e., Early Neolithic horizon without pottery). The marked use of the bladelet could support this hypothesis, but the absence of any comparable elements in North Alpine Mesolithic and Early Neolithic assemblages, as well as in the French Cardial and Epicardial, caution against this hypothesis.

The second hypothesis is more coherent from a chronological point of view and would suggest that this bladelet was produced during the early phases of the Tyrrhenian

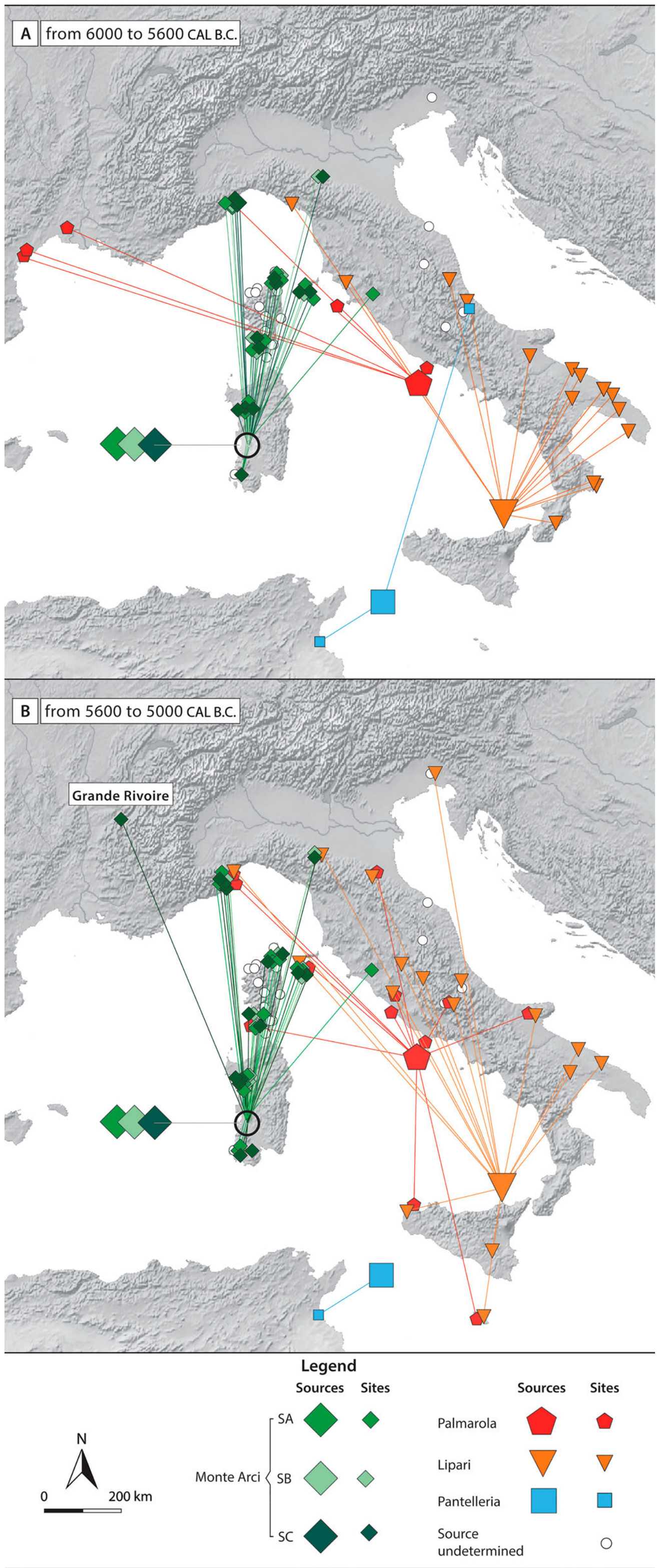


**Figure 11.** Distribution maps of the obsidians from the Western Mediterranean during the Early Neolithic (small symbols) and of obsidian sources (large symbols). A) Shows data from 6000–5600 CAL B.C., and B) shows data from 5600–5000 CAL B.C. Only reliable sites (dated or contextualized) are presented on these maps, excluding surface finds or other incidental or isolated discoveries. CAD by T. Perrin and E. Gutscher.

Cardial (5600–4800 CAL B.C.), at a time when other obsidian deposits were exploited and their products circulated in Corsica and Italy. The presence of this artifact at Grande Rivoire, around 5300 CAL B.C., points to transalpine contacts with Italian Neolithic communities, in parallel with strong links with farming communities from the South of France via the Rhone corridor (Cardial/Epicardial). In this case as well, the marked use of the bladelet reflects the long lifespan of the object, from its extraction in Sardinia to its abandon at the Grande-Rivoire site 700 km to the north.

## Conclusion: Contribution of the Discovery to Reflections on the North Alpine Neolithization Process

The first signs of the Neolithic to appear in the northern French Alps around 5500–5200 CAL B.C., apart from several charred cereal grains, are flint lithic assemblages that are clearly related to agro-pastoral societies from the South of France (Cardial/Epicardial). The absence of pottery and domestic fauna in these Alpine horizons suggests that these are either new southern Neolithic communities who adapted their economy to the mountainous environment (hunting activities), or native Mesolithic populations undergoing the acculturation process.

In this context, the discovery of a bladelet made of Sardinian obsidian does not enable us to settle on one of these two hypotheses, but it adds to the debate on the process of regional neolithization. Indeed, no obsidian artifacts had yet been discovered in North Alpine Mesolithic or Early Neolithic assemblages, or in Cardial and Epicardial contexts from the South of France. Therefore, the presence of this exotic element at Grande Rivoire broadens our study focus and raises questions about the role of Early Neolithic Italian cultures in this process.

The presence of this obsidian bladelet at Grande Rivoire could reflect a certain permeability of the Early North Alpine Neolithic culture to Italian influences. This contrasts sharply with the well-defined cultural boundary perceptible further south between the Cardial/Epicardial sphere (numerous BG3 type arrow armatures and absence of obsidian) and the Early Neolithic from the Tyrrhenian area (rarity of type BG3 arrow armatures and presence of obsidian). These first, discreet contacts between the northern French Alps and Italy could represent the initial stages of subsequent transalpine circulation, which then developed during the Middle and Final Neolithic.

Future research at the Grande Rivoire site, and more generally throughout the French north Alpine massifs, should thus work on tracking North Italian cultural components in Early Neolithic horizons, in order to accurately define the role played by transalpine cultures in regional neolithization. The discovery of new Tyrrhenian obsidian objects would allow us to confirm that the first agro-pastoral societies of the northern French Alps maintained regular contacts with the communities of northern Italy. On the other hand, should the discovery of the Grande-Rivoire remain a *unicum*, our perception of this object would change. It would then represent a truly exotic piece, one that was probably considered precious and potentially passed as an heirloom of sorts from one generation to the next.

## Acknowledgments

The authors would like to take this opportunity to thank the various funding organizations that contributed to this research (see funding below) as well as everyone who participated in the Grande Rivoire excavation.

## Funding

This work was supported by the French department of Isère, the French Ministry of Culture and Communication, and the University of Geneva (Switzerland). It also benefitted from funding from the French state managed by the National Research Agency as part of the Future Investment Programme, reference ANR-10-LABX-52, and the backing of the Regional Council of Aquitaine.

## Notes on Contributors

*Pierre-Yves Nicod* (MSc 1991, University of Geneva), is a scientific collaborator in the Prehistoric archaeology and anthropology laboratory, in the Department F.-A. Forel for Environmental and Aquatic Sciences, section of Earth and Environmental Sciences, Science Faculty, University of Geneva. He works on the prehistoric occupations of the Alpine region.

*Thomas Perrin* (Ph.D. 2001, Université Paris I Panthéon-Sorbonne) is a CNRS researcher in the TRACES laboratory of Toulouse. He works on the relationships between the last foragers and the first Neolithic people in the frame of the Western Mediterranean basin.

*François-Xavier Le Bourdonnec* (Ph.D. 2007, Université Michel de Montaigne Bordeaux 3) is an associate professor in Archaeological Sciences at the Université Bordeaux Montaigne. He works on the sourcing of lithic raw materials during Prehistory.

*Sylvie Philibert* (Ph.D. 2000, École des Hautes Études en Sciences Sociales) is a CNRS researcher in the TRACES laboratory of Toulouse. She works, through use-wear analysis, on the diversity and the techno-economic changes of the last foragers and the first Neolithic societies in the frame of the Western Mediterranean basin.

*Christine Oberlin* (DEA 1988, Institut national des sciences appliquées de Lyon) is a research engineer at the CNRS. Since 2003, she is responsible for the Lyon Radiocarbon Datation Center (UMR 5138 « Archéologie et Archéométrie »). As a specialist in $^{14}C$ dating, she works on site chronology with many archaeologists.

*Marie Besse* (Ph.D. 2001, University of Geneva), was named professor in 2003 and is the current director of the Department F.-A. Forel for Environmental and Aquatic Sciences, section of Earth and Environmental Sciences, Science Faculty, University of Geneva. She is also the head of the Prehistoric archaeology and anthropology laboratory of the same institution, and her work focuses on the functioning of Neolithic societies within the Alps and in Europe.

## ORCID

*Pierre-Yves Nicod* http://orcid.org/0000-0001-8771-4361
*Thomas Perrin* http://orcid.org/0000-0002-8788-3437
*François-Xavier Le Bourdonnec* http://orcid.org/0000-0002-1051-5337
*Sylvie Philibert* http://orcid.org/0000-0002-2389-0355
*Christine Oberlin* http://orcid.org/0000-0002-5535-6181
*Marie Besse* http://orcid.org/0000-0002-4752-9070

## References

Aitchison, J. 1982. "The Statistical Analysis of Compositional Data." *Journal of the Royal Statistical Society* Series B (Methodological): 139–177.

Anderson-Gerfaud, P. 1981. "Contribution Méthodologique à L'analyse des Microtraces D'utilisation sur les Outils Préhistoriques." Ph.D. diss., Université de Bordeaux I.

Anderson-Gerfaud, P., and F. Formenti. 1996. "Exploring the use of Abraded Obsidian 'Cayönu Tools' using Experimentation, Optical and SEM Microscopy, and EDA Analysis." In *Archaeometry 94. Proceedings of the 29th Symposium on Archaeometry (Ankara, 9–14 May 1994)*, edited by S. Demirci, A. M. Özer, and G. D. Summers, 553–566. Ankara: Tübitak.

Angelin, A. 2017. "*Le Mésolithique des Alpes françaises du Nord: synthèse d'après l'étude des industries lithiques de l'abri-sous-roche de la Grande Rivoire (Isère, France)*." Ph.D. diss., École des Hautes Études en Sciences Sociales.

Angelin, A., A. Bridault, J. L. Brochier, L. Chaix, L. Chesnaux, B. Marquebielle, L. Martin, P. Y. Nicod, R. Picavet, and D. Vannieuwenhuyse. 2016. "The First Mesolithic in the French Alps: New Data from La Grande Rivoire Rockshelter (Vercors Range, Isère, France)." *Quaternary International* 423: 193–212.

Astruc, L. 2011. "Du Gollü Dağ à Shillourokambos: de l'utilisation d'obsidiennes anatoliennes en contexte insulaire." In *Shillourokambos, un établissement Néolithique pré-Céramique à Chypre. Les Fouilles du Secteur 1*, edited by J. Guilaine, F. Briois, and J.-D. Vigne, 727–744. Paris: Errance, Efa.

Binder, D. 1987. *Le Néolithique ancien provençal: typologie et technologie des outillages lithiques*. Supplément à Gallia Préhistoire 24. Paris: Centre National de la Recherche Scientifique.

Bressy, C. 2003. *Caractérisation et gestion du silex des sites mésolithiques et néolithiques du Nord-Ouest de l'arc alpin: une approche pétrographique et géochimique*. BAR International Series 1114. Oxford: Archaeopress.

Clemente Conte, I., T. Lazuén Fernadez, L. Astruc, and A. C. Rodriguez Rodriguez. 2015. "Use-Wear Analysis of Non-Flint Lithic Raw Materials: The Case of Quartz/Quartzite and Obsidian." In *Use-wear and Residue Analysis in Archaeology*, edited by J. M. Marreiros, J. J. Gibaja Bao, and N. Ferreiro Bicho, 59–81. Manuals in Archaeological Method, Theory and Technique Series 10. Cambridge: Springer.

D'Anna, A., C. Bosansky, L. Bellot-Gurlet, F.-X. Le Bourdonnec, J.-L. Guendon, A. Reggio, and S. Renault. 2015. "Les Stèles Gravées (Anthropomorphes?) Néolithiques de Beyssan à Gargas (Vaucluse)." *Bulletin de la Société Préhistorique Française* 112: 761–768.

Delhon, C., L. Martin, J. Argant, and S. Thiebault. 2008. "Shepherds and Plants in the Alps: Multi-Proxy Archaeobotanical Analysis of Neolithic Dung from 'La Grande Rivoire' (Isère, France)." *Journal of Archaeological Science* 35 (11): 2937–2952.

Gassin, B. 1996. *Évolution socio-économique dans le Chasséen de la grotte de l'Église supérieure (Var): apport de l'analyse fonctionnelle des industries lithiques*. Monographie du CRA 17. Paris: Centre National de la Recherche Scientifique. Centre de Recherche Archéologique (Valbonne, Alpes-Maritimes).

González Urquijo, J.-E., and J.-J. Ibáñez Estévez. 1994. *Metodologia de Analisis Functional de Instrumentos Tallados en silex*. Cuadernos de Arqueología 14. Bilbao: Universidad de Deusto.

Guilaine, J., and C. Manen. 2007. "Du Mésolithique au Néolithique en Méditerranée de l'ouest: aspects culturels." In *Pont de Roque-Haute: Nouveaux Regards sur la Néolithisation de la France Méditerranéenne*, edited by J. Guilaine, C. Manen, and J.-D. Vigne, 303–322. Toulouse: Archives d'Ecologie préhistorique.

Hurcombe, L. 1992. *Use-wear Analysis and Obsidian: Theory, Experiments and Results*. Archeological Monographs 4. Sheffield: University of Sheffield.

Keeley, L. H. 1980. *Experimental Determination of Stone tool uses, a Microwear Analysis*. Prehistoric Archeology and Ecology Series. Chicago: University of Chicago Press.

Lanos, P., A. Philippe, H. Lanos, and P. Dufresne. 2015. *Chronomodel: Chronological Modelling of Archaeological Data using Bayesian Statistics*. (Version 1.5). Available from https://chronomodel.com.

Leck, A., F.-X. Le Bourdonnec, B. Gratuze, S. Dubernet, N. Ameziane-Federzoni, C. Bressy-Leandri, R. Chapoulie, S. Mazet, J.-M. Bontempi, N. Marini, M. Remicourt, and T. Perrin, 2018. "Provenance d'artefacts en rhyolite corse: évaluation des méthodes d'analyse géochimique." *Comptes Rendus Palevol* 17: 220–232.

Lugliè, C., F.-X. Le Bourdonnec, and G. Poupeau. 2011. "Neolithic Obsidian Economy Around the Monte Arci Source (Sardinia, Italy): The Importance of Integrated Provenance/Technology Analyses." In *Proceedings of the 37th International Symposium on Archaeometry (13th-16th May 2008, Siena, Italy)*, edited by I. Turbanti-Memmi, 255–260. Berlin, Heidelberg: Springer.

Lugliè, C., F.-X. Le Bourdonnec, and G. Poupeau. 2014. "Caratterizzazione elementare e provenienza delle ossidiane mediante analisi non distruttiva PIXE e EDXRF." In *La Memoria del Passato: Castello di Annone tra Archeologia e Storia*, edited by M. Venturino Gambari, 333–336. Archeologia Piemonte 2. Alessandria: LineLab.edizioni.

Lugliè, C., F.-X. Le Bourdonnec, G. Poupeau, M. Bohn, S. Meloni, M. Oddone, and G. Tanda. 2006. "A Map of the Monte Arci (Sardinia Island, Western Mediterranean) Obsidian Primary to Secondary Sources: Implications for Neolithic Provenance Studies." *Comptes Rendus Palevol* 5: 995–1003.

Manen, C., and T. Perrin. 2009. "Réflexions sur la genèse du Cardial 'franco-ibérique'." In *De Méditerranée et D'ailleurs … : Mélanges Offerts à Jean Guilaine*, 427–443. Toulouse: Archives d'Ecologie préhistorique.

Nicod, P.-Y., T. Perrin, J. L. Brochier, L. Chaix, B. Marquebielle, R. Picavet, and D. Vannieuwenhuyse. 2012. "Continuités et ruptures culturelles entre chasseurs mésolithiques et chasseurs néolithiques en Vercors: analyse préliminaire des niveaux du Mésolithique récent et du Néolithique ancien sans céramique de l'abri-sous-roche de la Grande Rivoire (Sassenage, Isère)." In *Dynamismes et Rythmes évolutifs des Sociétés de la Préhistoire Récente - Actualité de la Recherché. 9e Rencontres Méridionales de Préhistoire Récente (Saint-Georges-de-Didonne, 8 et 9 Octobre 2010)*, edited by T. Perrin, I. Senepart, J. Cauliez, É Thirault, and S. Bonnardin, 13–32. Toulouse: Archives d'Écologie Préhistorique.

Nicod, P.-Y., and R. Picavet. 2003. "La stratigraphie de la Grande Rivoire (Isère, France) et la question de la néolithisation alpine." In *ConstellaSion: Hommage à Alain Gallay*, edited by M. Besse, L.-I. Stahl Gresch, and P. Curdy, 151–172. Cahiers d'archéologie romande 95. Lausanne, Switzerland: Cahiers d'archéologie romande.

Nicod, P.-Y., R. Picavet, J. Argant, J. L. Brochier, L. Chaix, C. Delhon, L. Martin, B. Moulin, D. Sordoillet, and S. Thiebault. 2010. "Une économie pastorale dans le nord du Vercors: analyse pluridisciplinaire des niveaux néolithiques et protohistoriques de la Grande Rivoire (Sassenage, Isère)." In *Economie et Société à la fin de la Préhistoire – Actualité de la Recherche. Rencontres Méridionales de Préhistoire Récente, 7 (Lyon, 3-4 nov. 2006)*, edited by A. Beeching, E. Thirault, and J. Vital, 69–86. Documents d'archéologie en Rhône-Alpes et en Auvergne 34. Lyon: Association de liaison pour le patrimoine et l'archéologie en Rhône-Alpes et en Auvergne / Publications de la Maison de l'Orient et de la Méditerranée.

Orange, M., F.-X. Le Bourdonnec, L. Bellot-Gurlet, C. Lugliè, S. Dubernet, C. Bressy-Leandri, A. Scheffers, and R. Joannes-Boyau. 2017. "On Sourcing Obsidian Assemblages from the Mediterranean Area: Analytical Strategies for their Exhaustive Geochemical Characterisation." *Journal of Archaeological Science: Reports* 12: 834–844.

Perrin, T. 2001. *Évolution du silex Taillé Dans le Néolithique haut-Rhodanien Autour de la Stratigraphie du Gardon (Ambérieu-en-Bugey, Ain)*, 3 vols. Lille: Presses Universitaires du Septentrion.

Perrin, T. 2003. "Mesolithic and Neolithic Cultures Co-Existing in the Upper Rhône Valley." *Antiquity* 77 (298): 732–739.

Perrin, T. 2005. "Nouvelles Réflexions sur la Transition Mésolithique Récent - Néolithique Ancien à L'abri Gaban (Trento, Italie)." *Preistoria Alpina* (Rendiconti della Società cultura preistorica tridentina, 41): 89–146.

Perrin, T. 2008. "La néolithisation de la vallée du Rhône et de ses marges." In *Mountain Environments in Prehistoric Europe: Settlement and Mobility Strategies from the Palaeolithic to the Early Bronze Age. XVe Congrès Mondial de l'UISPP (Lisbonne, Portugal, 4-9 Septembre 2006)*, edited by S. Grimaldi and T. Perrin, 121–130. BAR International Series 1885. Oxford: Archaeopress.

Perrin, T. 2009. "New Perspectives on the Mesolithic/Neolithic Transition in Northern Italy." In *Mesolithic Horizons, vol. II*, edited by S. McCartan, R. Schulting, G. Warren, and P. Woodman, 514–520. Belfast: Oxbow Books.

Perrin, T. 2013. "Potentialités de contacts entre mésolithiques et néolithiques dans le sud de la France." In *Transitions, Ruptures et Continuité en Préhistoire : [Volume 1 : Évolution des Techniques - Comportements funéraires - Néolithique Ancien], Congrès Préhistorique de France. Compte Rendu de la 27ème Session, Bordeaux 2010 [Session H]*, edited by J. Jaubert, N. Fourment, and P. Depaepe, 357–372. Paris: Société préhistorique française.

Perrin, T., A. Angelin, and E. Defranould. "Liste Typologique Pour les Industries de Pierre Taillée de la Préhistoire Récente Européenne." Accessed November 2017. https://hal.archives-ouvertes.fr/hal-01638819.

Perrin, T., and D. Binder. 2014. "Le Mésolithique à trapèzes et la néolithisation de l'Europe sud-occidentale." In *La Transition Néolithique en Méditerranée. Actes du Colloque International « Transitions en Méditerranée ou Comment des Chasseurs Devinrent Agriculteurs (Epipaléolithique, Mésolithique, Néolithique Ancien) », Toulouse, 14-15 Avril* 2011, edited by C. Manen, T. Perrin, and J. Guilaine, 271–281. Arles et Toulouse, Errance / Archives d'Ecologie Préhistorique.

Picavet, R. 1999. "Les niveaux du Mésolithique au Néolithique de l'abri de la Grande-Rivoire (Sassenage, Isère, Vercors, France)." In *L'Europe des Derniers Chasseurs: Épipaléolithique et Mésolithique. Ve Congrès International UISPP, XIIe Commission (Grenoble, 18-23 Septembre*

*1995)*, edited by P. Bintz, and A. Thévenin, 617–625. Grenoble, France: Universités Joseph Fourier et Pierre Mendès France, Paris.

Plisson, H. 1985. "Etude Fonctionnelle D'outillages Lithiques Préhistoriques par L'analyse des Micro-Usures: Recherche Méthodologique et Archéologique." Ph.D. diss., Université de Paris I Panthéon Sorbonne.

Poupeau, G., C. Lugliè, A. D'Anna, T. Carter, F.-X. Le Bourdonnec, L. Bellot-Gurlet, and C. Bressy. 2010. "Circulation et origine de l'obsidienne préhistorique en Méditerranée: un bilan de cinquante années de recherches." In *Archéologie des Rivages Méditerranéens: 50 ans de Recherche. Colloque (Arles, 28-30 Octobre 2009)*, edited by X. Delestre and H. Marchesi, 183–191. Paris: Errance.

Reimer, P. J., E. Bard, A. Bayliss, J. W. Beck, P. G. Blackwell, C. Bronk Ramsey, C. E. Buck, H. Cheng, R. L. Edwards, M. Friedrich, P. M. Grootes, T. P. Guilderson, H. Haflidason, I. Hajdas, C. Hatté, T. J. Heaton, D. L. Hoffmann, A. G. Hogg, K. A. Hughen, K. F. Kaiser, B. Kromer, S. W. Manning, M. Niu, R. W. Reimer, D. A. Richards, E. M. Scott, J. R. Southon, R. A. Staff, C. S. M. Turney, and J. van der Plicht. 2013. "IntCal13 and Marine13 Radiocarbon Age Calibration Curves 0–50,000 Years cal BP." *Radiocarbon* 55 (4 'IntCal13'): 1869–1887.

Riche, C. 2002. "Les ateliers de taille de silex de Vassieux-en-Vercors (Drôme) : exploitation des gîtes et diffusion des produits." In *Les Industries Lithiques Taillées Holocènes du Bassin Rhodanien: Problémes et Actualités. Table Ronde (Lyon, 8-9 Décembre 2000)*, edited by M. Bailly, R. Furestier, and T. Perrin, 51–58. Préhistoires 8. Montagnac: Éd. Monique Mergoil.

Rodriguez Rodriguez, A. C. 1998. "Traceología de las Obsidianas Canarias: Resultados Experimentales." *El Museo Canario* LIII: 21–58.

Rots, V. 2010. *Prehension and Hafting Traces on Flint Tools: a Methodology*. Leuven: Leuven University Press.

Rots, V., L. Pirnay, P. Pirson, and O. Baudoux. 2002. "Traces Expérimentales D'emmanchement: Identification et Carcatérisatiques." *Bulletin des Chercheurs de la Wallonie* XLI: 115–125.

Tixier, J., M. L. Inizan, H. Roche, and M. Dauvois. 1980. *Préhistoire de la Pierre Taillée I : Terminologie et Technologie*. Valbonne: Éd. Centre de Recherche et d'Etudes Préhistoriques.

Tykot, R. H. 1995. *Prehistoric Trade in the Western Mediterranean: The Sources and Distribution of Sardinian Obsidian*. Cambridge: Harvard University, Department of Anthropology.

Tykot, R. H. 1997. "Characterization of the Monte Arci (Sardinia) Obsidian Sources." *Journal of Archaeological Science* 24: 467–479.

Van Gijn, A.-L. 1990. *The Wear and the Tear of Flint: Principles of Functional Analysis Applied to Dutch Neolithic Assemblages*. Analecta Praehistorica Leidensia 22. Leiden: University of Leiden.

Vaquer, J. 2007. "Le rôle de la zone nord tyrrhénienne dans la diffusion de l'obsidienne en Méditerranée nord-occidentale au Néolithique." In *Corse et Sardaigne Préhistoriques : Relations et échanges Dans le Contexte Méditerranéen, 128ᵉ Congrès Nationaux des Sociétés Historiques et Scientifiques (Bastia, Avril 2003)*, edited by A. D'Anna, J. Cesari, L. Ogel, and J. Vaquer, 99–119. Documents préhistoriques 22. Paris: Éditions du Comité des travaux historiques et scientifiques CTHS.

Voruz, J.-L., ed. 2009. *La grotte du Gardon (Ain): Volume 1 : Le site et la séquence néolithique des couches 60 à 47*. Toulouse: Archives d'Ecologie Préhistorique.