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EARLY NEOLITHIC PIONEER MOBILITY
Raw material procurement in layer 58 of the Gardon cave (Ambérieu-en-Bugey, Ain, France)

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Abstract. Geological surveys in the Bugey and provenance studies using petrographic techniques have allowed the attribution of the flints used in layer 58 of the Gardon cave to various regional and extra-regional sources. In addition, techno-economic patterns of raw material transport have been defined for each of the seven procurement zones identified. The combined results of these complementary approaches are interpreted in terms of pioneer mobility and used to investigate the process of expansion of the Early Mediterranean Neolithic into the upper Rhône basin.

Résumé. Les prospections géologiques et les études de caractérisation pétrographique menées dans le Bugey ont permis de déterminer les provenances régionales et extra-régionales des matériaux lithiques utilisés dans la couche 58 de la grotte du Gardon. Une approche techno-économique par type de matière première en fonction des provenances conduit par ailleurs à poser l'hypothèse d'une mobilité de type pionnier, précisant ainsi les modalités d'expansion du Néolithique ancien méridional dans le haut bassin Rhodanien.

Introduction

It is now common practice for behavioural perspectives in archaeology to incorporate approaches that draw heavily upon the combined results of stone raw material provenance studies and of techno-economic analyses of lithic assemblages. Raw material transport patterns can give us insights into both individual and group mobility, social networks, the extent of exploited or known territories, in sum into the way man interacts with his environment and other human communities.

This paper deals with questions related to the process of expansion of the Early Mediterranean Neolithic into the upper Rhône basin. It substantiates the case for migration, and investigates the way landscape and resources are approached by colonizing populations, metaphorically sandwiched between late hunter-gatherers and fully settled farmers.

Chronological and material culture context

According to a recent overview by Th. Perrin (2003), the picture during the later part of the sixth millennium can be summarized as follows (fig. 1). This is the time when, in the Languedoc, the early Cardial develops into the late Cardial and the Epicardial. In the upper Rhône basin, a handful of sites (Grande-Rivoire layer B2a and possibly B2b, Gardon layer 58, Les Perches, and perhaps also Seuil des Chèvres), whose material culture strongly recalls the Early Mediterranean Neolithic, suggests a northward expansion of this cultural entity along the Rhône valley. In the Jura itself however, the evidence points to the enduring presence of Mesolithic groups. On the grounds of lithic technology and typology, it has indeed been suggested (Voruz *et al.* 2004) that the Gardon cave, located in the Bugey region, was

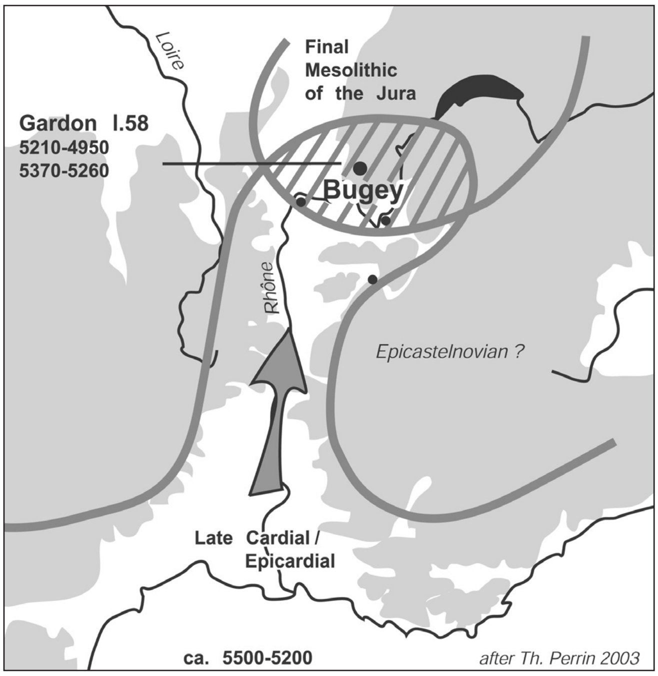

Figure 1. The expansion of the Early Mediterranean Neolithic into the upper Rhône basin.

alternately occupied by Neolithic people (layers 58 and 56) and by indigenous groups displaying technical practices of Mesolithic tradition (layers 57 and 54). Provenance studies conducted for these layers (Féblot-Augustins 2002, 2005, and s.p.b) certainly show significant differences between layers 58 and 56 on the one hand, and layer 54 on the other hand, thus supporting the suggestion that the latter represents an occupation by distinct cultural groups. While the small sample size of layer 57 (14 pieces) precludes meaningful comparisons with layer 54 in terms of raw materials, it is worth noting that layer 57 provenances are roughly similar to those of layer 54, and therefore also different from those of layers 58 and 56. However, although layers 58 and 56 share some provenances, they are also characterized by the use of specific flint sources, and in terms of raw materials layer 58 has a distinctive profile.

Whatever the cultural status of the overlying layers, layer 58, the first well characterized occupation dated 5300 to 4900 BC[1], is unquestionably Neolithic. Although there are hardly any indications of agricultural practices (Voruz *et al.* 2004), the rest of the integrated Neolithic package is present, notably domesticated animals (mainly caprines and some large bovids, Chaix & Nicod 1991) and pottery. Moreover, layer 58 is identified with the Early Mediterranean Neolithic, essentially on the grounds of the lithic technology and typology (Perrin 2003): the coexistence of flake and blade reduction sequences, carried out respectively on medium quality flints (here mainly middle Jurassic) and high quality flints (here mainly Cretaceous); the bending initiated fracture on small regular blades obtained by indirect percussion; a particular type of geometric arrowhead with inverse bi-truncation and flat facial retouch (BG32, *flèche de Montclus*). Other arguments include the presence of a *Columbella rustica* sea shell, cut marks on human bones and the very high proportion (> 86%) of hunted animals. Among the latter, boar and red deer are dominant, and several species such as roe deer, bear and lynx suggest a heavily forested environment, of unmodified mixed oak forest type (L. Chaix, P. Chiquet, S. Thiébault, cited in Voruz *et al.* 2004).

The homogeneous character of layer 58 points to a process of migration/colonization by Neolithic agro-pastoralists; however, the modalities of this process remain entirely elusive. Given the socio-economic context of these Early Neolithic people - tenuous agricultural practices and a heavy reliance on hunting for subsistence purposes - the repercussions on their mobility, territorial exploitation patterns and interaction networks need to be investigated.

The study of raw material distribution from a techno-economic perspective has long proved a fruitful approach to address these questions. In the present case, research has involved the following steps: 1) assessing the Bugey's regional affordances in siliceous raw materials through systematic geological surveys, and acquiring a knowledge about major extra-regional sources through sample exchanges with colleagues[2]; 2) provenancing the archaeological artefacts; 3) defining techno-economic patterns of transport for each of the lithic procurement zones identified.

Geological surveys in the Bugey

Bounded on the west by the Revermont and the alluvial plain of the Ain River valley, on the south and east by the Rhône River, on the north by the transverse *cluse de Nantua*, the Bugey covers the greater part of the southern Jura mountain range. As a result of the intense Oligocene and Miocene erosion processes, late Cretaceous (Senonian) limestone formations are almost entirely lacking. The major remaining geological formations belong to the middle (Dogger) and late (Malm) Jurassic, and to the early Cretaceous (Neocomian). All these formations are known to yield flints in primary contexts, but flints derived from a variety of formations, including the eroded late Cretaceous, and subsequently amalgamated into aggregate deposits can also be found as reworked material in secondary contexts.

Geological surveys oriented to the identification of lithic raw material sources were conducted over a period of several years (Féblot-Augustins 2001, s.p.a), resulting in the identification of over 70 such sources (fig. 2). The collected samples were characterized using a combination of petrographic techniques such as macroscopic characterization and microfacies analysis (Riche & Féblot-Augustins 2002), an approach that developed in the 1980's (*e.g.* Séronie-Vivien & Séronie-Vivien 1987) and has increasingly been used since (*e.g.* Riche 1998; Affolter 2002; Bressy 2003). In the case of samples from secondary contexts, the help of a micro-palaeontologist was sought in order to check the geological age of the flints[3]. The entire geological database is now available on-line at the following address: http://www.flintsource.net/flint/infF_bugey.html

The range of raw materials that can be found today in the Bugey is quite wide: Bajocian and Bathonian flints from the Dogger, Kimmeridgian flints from the Malm, Valanginian, Hauterivian and Urgonian flints from the early Cretaceous, Senonian flints mostly of Campanian age from the late Cretaceous, and some rare Cenozoic flints. Although samples of Campanian flints were collected in the northern primary outcrops of Leyssard and Solomiat, the bulk of the Senonian samples was found in very localized secondary deposits, where they occur in combination with raw materials derived from other formations. Campanian nodules and pebbles are particularly abundant and varied in the clays-with-flint, Pleiocene, fluvio-glacial and Wurmian deposits of the north-west Poncin sector (Féblot-Augustins 1996). In the north-east Bellegarde sector, rounded Campanian pebbles were recovered

[1] Two reliable radiocarbon dates determined on bone are available for layer 58: 5210-4950 cal BC (6124±42 BP, Ly 5513) and 5370-5260 cal BC (6325±40 BP, Ly 8422).

[2] I am indebted to C. Bressy and C. Riche for showing me samples from the Chartreuse and the Drôme regions.
[3] I am grateful to A. Arnaud Vanneau (Laboratoire de Géodynamique des Chaînes Alpines, Grenoble) and to M. Caron (Friburg University) for their determination of the planktonic foraminifera occurring in Campanian flints.

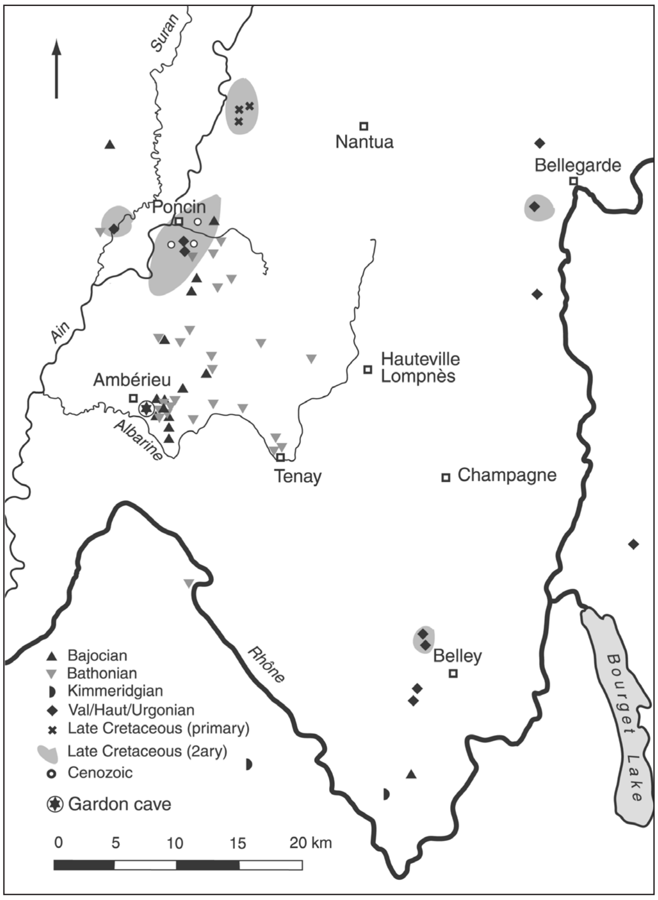

Figure 2. Lithic raw material sources from primary and secondary contexts identified in the Bugey. Fruitless geological surveys are not included.

on the Michaille plateau from Burdigalian (early Miocene) mollassic deposits (Masson 1985; Fillion *et al.* 2000). Further south, in the Belley basin sector, Senonian nodules also occur in a small conglomeratic deposit of Oligocene age (Féblot-Augustins 2002). It should be emphasized that all Senonian flints from these three geographical sectors can be distinguished by either macroscopic or microscopic criteria (Riche & Féblot-Augustins 2002), thus ensuring the accurate sourcing of corresponding flint artefacts.

Provenancing the flint artefacts of layer 58

Just under a thousand pieces larger than a centimetre were examined under a stereo binocular microscope (magnification x 40)[4] and characterized using the same analytical techniques applied to the geological samples (Féblot-Augustins s.p.b). Provenances were determined for 75% of the material, the remaining 25% being accounted for mainly by burnt or weathered flints (tabl. 1), 65% of these being Dogger flints. The great majority of the artefacts could be identified with raw material types composing the geological dataset. Only a few pieces (n=46) find no equivalent within the collected samples, but this does not necessarily mean they are all extra-regional. These flints correspond to 17 distinct types, coded X, for most of which a geological age and a provenance could be determined. Thus X4 is a local type of calcedonic material, X2, X6 and X11 are regional Senonian flints, X13, X14 and X15 are regional Hauterivian varieties, X1, X12 and X17 are Senonian flints from the Chartreuse, X5 is a type of Urgonian flint from the Drôme. Three types, X3, X10 and X16, could neither be identified nor sourced.

Procurement zones

Seven procurement zones, two of them extra-regional, were defined (fig. 3 and tabl. 1). The first five zones are regional. Zone 1 is local (< 1 km), yielding mainly Dogger flints. These are predominantly linked to flake production, but some finer grained specimens were used for blade *débitage*[5] (Perrin 2003). Sub-local zone 2 (0-12 km) is associated with a Bathonian flint (Bt2) when a local origin from secondary contexts cannot be ascertained for this particular type. Zone 3 corresponds to the north-west sector of the Bugey (Suran valley, Chenavel, Poncin, Leyssard); it includes mainly good quality Senonian flints (CN types) used for blade *débitage*, complemented by various Valanginian and Hauterivian materials, some Cenozoic flints (T) and a few X types. Associated distances range between 12 and 15 km north of the Gardon cave, with a maximum of 25 km for primary context Campanian flint. Zone 4, located 15 to 30 km south of the Gardon, has yielded a variety of raw materials: a type of Bathonian flint (Bt4), some Kimmeridgian flint from the Ile Crémieu, different types of Senonian flints (CC types) and a single item (X13) in early Hauterivian flint from the Belley basin. Zone 5 corresponds to the north-east Bellegarde sector (34-37 km), yielding mainly Senonian flints (CE types), with the addition of a single Hauterivian item (X15). Zones 6 and 7a are extra-regional. Senonian flints from the Chartreuse sources of zone 6 were transported over 60 to 75 km, while some Urgonian flints can be sourced to zone 7a in the Drôme, 170 km distant from the Gardon cave.

The specificity of layer 58

The technological and typological aspects of the industry pointed out by Th. Perrin (2003) highlight the peculiarity of layer 58. This layer also has a distinctive profile in terms of raw materials.

In the first place, layer 58 exhibits the highest number of procurement zones in the entire Early Neolithic and Middle I Neolithic sequence. Particular emphasis is laid on the fact that two of these zones, the Bellegarde and Chartreuse sectors, are exclusive to layer 58. Various quantities were introduced into the Gardon cave from the different zones, the bulk of the raw material coming from the three closest ones (82%), among which zone 3 Senonian sources are well represented (34.6%). Beyond zone 3, there is a high imbalence in favour of the combined regional and extra-regional southern sources, the materials from

[4] Chips < 1 cm (n=558) were also examined, but their small size precludes the attribution of all of them to identified types.

[5] The word *débitage* is used here in its original French meaning as a reflection of a specific reduction process, not as the residue of production.

Zones	Raw material types	N	Untested blocks	Initial reduction	On-site knapping	Blanks	Cores	Tools
1 (45.3 %) < 1 km	Siliceous limestone	71	•		•			
	Bj4a (flake prod.)	56	•	•	•	•	•	
	Bj4a (blade prod.)		•	•	•		•	
	Bt4 (flake prod.)	180	•	•	•	•	•	•
	Bt4+4f (blade prod.)		•	•	•		•	
	Bj1	4	•					
	Bt1 (several distinct nodules)	10	•	•		•		
	Quartz/calcite	3						
	Silicified wood	1						
	X4	1						
2 (2 %) 0-12 km	Bt2	15		•	•	•		
3 (34.6 %) 12-15 km	CN2a	64		•	•	••	•	
	CN2b	46		•	•	•	•	•
	CN1a	35		•	•	•		•
	CN2c	19		•	•	•		
	Ht1	8		•	•	•		
	CN3b	6		•	•		•	•
	CN1b	9			•	•	•	•
	CN4c	6			•	•	•	•
	CN3a	5			•		•	•
	Ht3	16			•	•		
	CN4a	5			•			•
	CN8a	10			•			
	X6	1			•			
	CN4b	3			•			
	<u>X2</u>	2		•				
	T2	1		•				
	Val	1					•	
	T3	1					•	
	CN8b	5				•	•	
	CN5	4				•		
	X11	1				•		
	X14	1				•		
4 (11.5 %) 15-30 km	Bt4 (Tenay)	3					•	•
	Km1	4			•		•	
	<u>Km2</u>	2			•			
	CC2	27			•	•	•	•
	CC3a (core on flake)	9		•	•		•	
	CC4a (core on flake)	29		•	•	•	•	
	CC4b	8		•	•	•		
	X13	1				•		
5 (2 %) 34-37 km	*CE2*	9			•		•	
	CE2/CE5	2			•		•	
	CE1b	1					•	
	CE5	1					•	
	X15	1				•		
6 (2.9 %) 60-75 km	*X1*	14			•	•		•
	X12	2				•		
	X17	5				•		•
7a (1.7 %) 170 km	X5 (several distinct nodules)	12			•		•	• •
Total determined origins: 720 / 957 (75.2 %)								
Unknown origin	<u>X3</u>	1						
	<u>X10</u>	3						
	X16	1						
	Burnt/weathered flints	232						
Total unknown origins: 237 / 957 (24.8 %)								
Total pieces > 1 cm: 957 (100 %)								

Table 1. Raw material types of layer 58 per procurement zone, and associated modes of exploitation. Bj: Bajocian, Bt: Bathonian, Km: Kimmeridgian, Val: Valanginian, Ht: Hauterivian. CN, CE, CC: late Cretaceous from the North, East and Centre of the Bugey, T: Tertiary. X: types not represented in the geological dataset, but with known geological ages and provenances. Italicized types: specific to layer 58. Underscored types: specific to layer 58 and related, very poor, Neolithic underlying layers.

zones 4, 6 and 7a being far better represented (16%) than those from the regional Bellegarde zone to the north-east (2%).

Secondly, raw material types and sources are extremely varied within each zone. Artefacts made from almost all the rock types available locally (zone 1) were identified. This holds true for the flints associated with nearby zone 3 and the more distant regional zones 4 and 5. In addition, Chartreuse zone 6 has yielded three distinct flint types, possibly from different sources.

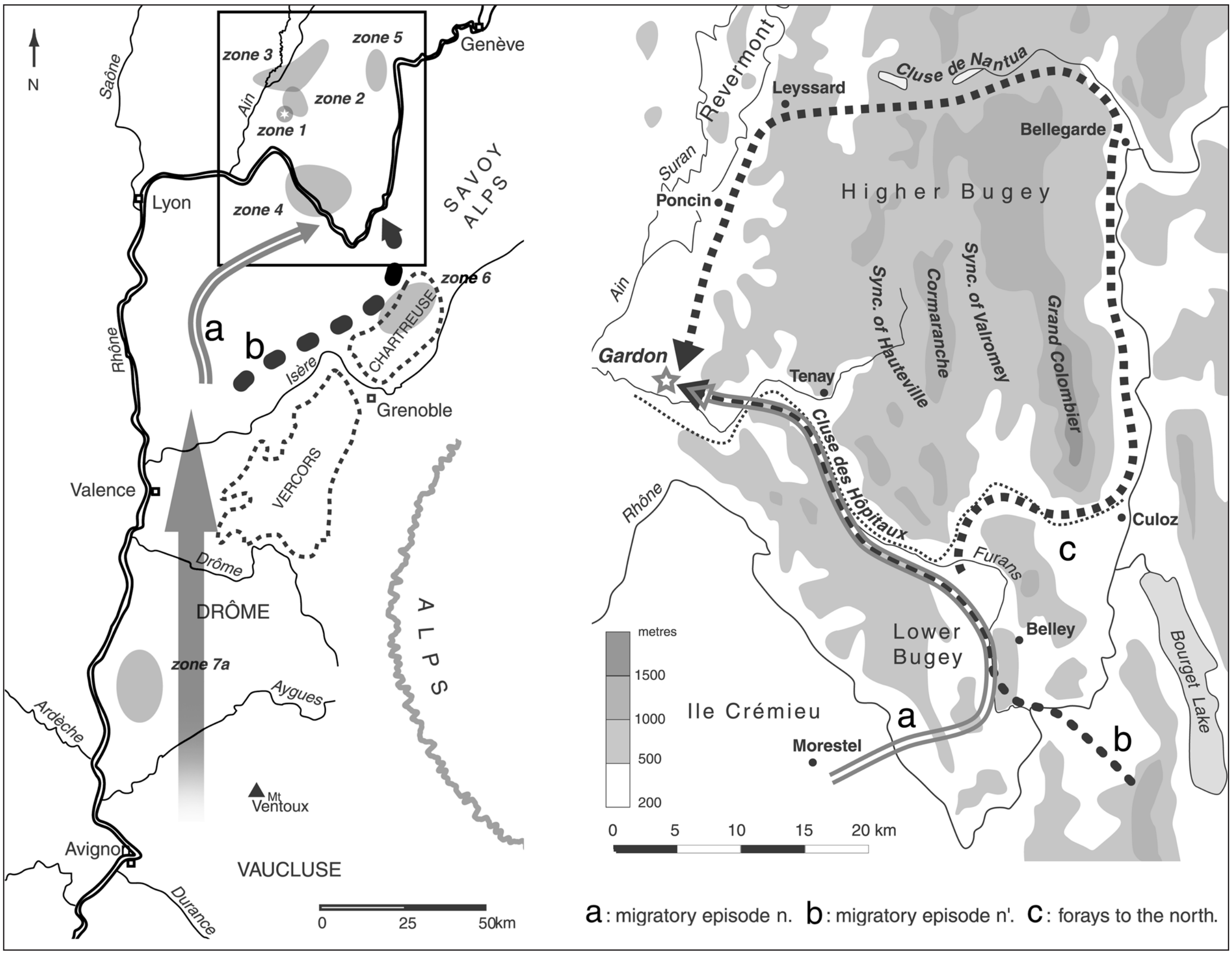

Figure 3. The scenario for pioneer mobility into the upper Rhône basin, following natural routes and involving the transport of various raw materials to the Gardon cave from the different procurement zones.

Most importantly, well over a third of the flint types identified occur only in layer 58 (n=18, italicized in table 1), or in layer 58 *and* the related, very poor, Neolithic underlying layers (n=4, underscored in table 1). Among these, several X types are represented by single end-products. Indeed, the presence of specific raw materials finds an echo in Th. Perrin's typological observations (2003) about the existence of several tool types that are exclusive to layer 58.

Techno-economic patterns of transport

In addition to sourcing and quantifying lithics, the mode of exploitation associated with each type of raw material must also be assessed, in order to define patterns of transport per procurement zone. Because of the richness and reliability of the excavated sample, this type of analysis is justified in the case of layer 58. For general purposes, it draws upon the reconstruction of the flake and blade reduction sequences proposed by Th. Perrin (2003).

Based on the concept of *chaîne opératoire*, the mode of exploitation is a compound notion (Féblot-Augustins 1997), which refers to three complementary aspects for a given raw material: 1) the stages of manufacture in which lithics are introduced (whole unmodified nodules or tested nodules, prepared or partially reduced cores, end-products only); 2) the processing stages that subsequently occur on-site; 3) the additional import of end-products or their departure from the site.

Table 1 expresses in terms of tendencies the modes of exploitation for the various raw materials issuing from the different zones. Initial on-site processing stages are inferred from the presence, for a given raw material, of first flakes with a cortical butt and/or of flakes with a high cortex covering and noncortical butts; the raw material is assumed to have been introduced as unmodified or tested nodules. The absence of such flakes points to the introduction of already shaped out or partially reduced cores. On-site knapping is testified to by the presence of core preparation and/or maintenance flakes, such as crested blades and blades with traces of crested preparation, core platform rejuvenation and other rejuvenation flakes, plunging flakes detaching cortical portions of nodules, flakes or blades displaying hinged removal scars and cortex remnants on their upper faces or removal scars implying a change of flaking direction. Other indicators of on-site knapping include flakes with a low cortex percentage, waste material and chips < 1 cm. The headings for blanks, cores and retouched tools in table I refer to the presence or absence of such items. For instance, for a given raw material, the

Stages of introduction	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7a
Untested blocks *no knapping*	Bj1 Bj4a Bt1 Bt4/4f Limestone						
Whole or tested nodules *on-site knapping*	Bj4a Bt4/4f	Bt2	CN1a CN2a CN2b CN2c CN3b Ht1				
Partially reduced nodules *on-site knapping*			CN1b CN3a CN4a CN4c Ht3	Km1 CC2 CC3a CC4a	CE2 CE2/CE5	X1	X5
End-products	Bt1		CN5 CN8b X11 X14	X13	X15	X12 X17	X5

Table 2. Stages of introduction per procurement zone, showing contrasts between zones 1 to 3 and zones 4 to 7a.

core may be missing although other technological remains indicate on-site knapping and blade production. Blade blanks can also be missing, or to the contrary be over-represented for a particular raw material. Conversely, some types may be represented solely by blade blanks, blade tools or even cores.

As suggested by the data summarized in table 1, the results of the techno-economic analysis carried out for each type of raw material highlight both differences in stages of introduction and a mobility of specific components, blade end-products and cores.

Stages of introduction

Contrasting stages of introduction were identified between zones 1, 2, 3 on the one hand, and the more distant zones 4, 5, 6 and 7a (tabl. 2).

The more distant raw materials are brought as partially reduced cores, or even very flat cores worked from flakes as in the case of types CC3a and CC4a. They are subsequently knapped on-site, as inferred from the presence of characteristic flakes, end-products of blade *débitage* or cores, although the last two categories are not systematically represented (see below). In addition, some of these distant raw materials are represented only by end-products: single blade blanks for X13 and X15; a bladelet and a mesial blade fragment from a phase of *plein débitage* (i.e. main blank production phase) for X12; three blade fragments and two blade tools for X17; a proximal blade fragment also from *plein débitage*, an arrowhead and a wide pressure-retouched (J. Pelegrin, oral comm.) blade for X5. This last type of raw material exhibits some variability, and these three end-products relate to distinct nodules, which differ from the bulk of X5 flint recovered at the Gardon.

Conversely, raw materials from the closest zones 1, 2 and 3 are predominantly introduced as whole or tested nodules before being knapped on-site. This is particularly evident for the first two zones (see also tabl. 1). A peculiarity of local zone 1 is the presence of a large number of untested and unmodified blocks in all the documented types of raw materials. These may have been a supply of raw material for future use. The flaking qualities of Bj4a and Bt4/4f types are eminently variable, and gave rise to different kinds of attitudes on the knappers' part. Some of the blocks were tested on-site and obviously rejected as inadequate, while others were selected and subsequently knapped. The more homogeneous chunks alone were used for blade *débitage*, while the others were used for the production of flakes. Contrary to what obtains in zone 1, the presence of untested and unmodified nodules is not documented for sub-local zone 2 and nearby zone 3, suggesting that provisioning the site with potential supplies was deemed worthwhile only when the effort expended was minimal. Zone 3 raw materials, mostly collected between 12 to 15 km north of the cave, display the most varied stages of introduction: whole, tested or partially reduced nodules, as well as single end-products, and two rather special cores (Val and T3 types) that will be returned to later. On-site knapping is testified to for most flint types (tabl. 1), even if sometimes in a somewhat fragmentary fashion, but once again end-products or cores may be missing. Four flint types are represented only, or predominantly, by end-products: three bladelets and a small piece of waste for CN5, single unretouched blades for X11 and X14, four irregular blade blanks for CN8b. A core in CN8b was also recovered, but it was discarded after a failed preparation in view of blade *débitage* (Perrin 2003) and cannot therefore be related to the other four products. Thus, the mode of introduction associated with end-products alone is not peculiar to the more distant zones. It is actually also documented for a zone 1 type of raw material, Bt1. The small set consisting of two unmodified tectofracts, several second rate flakes, some waste material and chips suggests discontinued flaking attempts on a mediocre material, locally available in secondary context. However, a short noncortical blade attributed to the same type is of higher quality and was possibly introduced as a previously manufactured item.

Mobility of end-products		Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7a
Export		Bj4a Bt4/4f		CN3a CN3b CN4a	Km1 CC3a	CE2 CE2/CE5		X5
Import	Additional			CN2a				
	Exclusive	Bt1		CN5 CN8b X11 X14	X13	X15	X12 X17	X5

Table 3. Mobility of the end-products of blade *débitage* in terms of export and import.

Mobility of end-products

The mobility in terms of export or import of the desired end-products of blade *débitage* is documented for all zones except zone 2 (tabl. 3), and these contrasting movements - departure from and introduction into the cave - can be viewed as complementary aspects of the same behaviour.

For a given raw material, the probable departure of end-products from the Gardon cave is suggested by the absence or near-absence of such items when other technological remains indicate on-site knapping from either tested nodules or partially reduced cores. Evidence of this was found for most zones, and has indeed been indicated by Th. Perrin (2003) for the local Dogger material of zone 1. While blade *débitage* is documented by bladelet cores for Bj4a and Bt4/4f, blade blanks and tools in Bj4a are entirely missing, and there are only six unretouched blades in Bt4/4f, which do not belong to a phase of *plein débitage*[6]. In contrast, flake production for these raw materials is well represented, flakes having been used, retouched and discarded on-site (Perrin 2003). Departure from the site of blade blanks associated with zone 3 raw materials is documented for three types of flint, CN3a, CN3b and CN4a, for which there are traces of on-site knapping, including blade cores for the first two. While tools (one per type) are present, blade blanks are missing. Blade blanks as well as tools are also lacking for Km1 and CC3a types from zone 4, in spite of traces of on-site knapping, including discarded cores. The same hold true for zone 5 CE2 type, and possibly also for CE2/CE5: the latter is represented by a spent blade core and a thick slightly hinged maintenance flake, plus one identified chip. X5 type from zone 7a is represented by 12 pieces > 1 cm and 11 identified chips, among which several tiny retouch flakes. A spent blade core, a broken flake and a fragment of endscraper on a flake could belong to the same nodule. These, as well as other various flakes, waste material, cortical and noncortical chips, testify to some on-site knapping. Blade production is poorly represented by two small noncortical bladelets, but the endscraper was possibly produced and retouched in the cave. The mode of exploitation of this distant raw material is therefore quite complex: in addition to the introduction of a partially reduced core, there are some arguments for both the departure of end-products from the site and the transport of blade blanks and retouched tools (see above) over a distance of 170 km.

Concerning imports of end-products, there are two possibilities: additional and exclusive imports. Exclusive imports have been dealt with in the above section, where it was shown that some raw materials were represented exclusively by a very small number of blade blanks and tools, introduced from the various zones. Additional imports imply that for a given raw material knapped on-site end-products are over-represented, suggesting that previously manufactured blades or bladelets were introduced in addition to nodules in the same raw material. This can only be tentatively argued for one raw material from zone 3, CN2a (n=64), brought as small whole or tested nodules, possibly three considering the number of cores. Two of these, one of them spent and the other discarded following hinged removals, display undisputable traces of blade production. It is however debatable whether the two cores can account for the 28 blade products, 16 of which belong to a phase of *plein débitage*. The blank-to-core ratio is higher than for other well represented raw materials knapped on-site when this ratio can be calculated (e.g. CN2b, CC2, CC3a), a rare possibility owing to the relatively frequent absence of cores.

Mobility of cores

The section devoted to stages of introduction (tabl. 2) has illustrated that in some cases, mainly associated with distant zones 4 to 7a, partially reduced cores were brought to the cave and subsequently knapped.

A complementary pattern involves the departure of cores from the site, whether the raw material was introduced as tested nodules or partially reduced cores (tabl. 4). For a given raw material, this is suggested by the absence of cores when other technological remains indicate productive on-site knapping. This pattern can only be significantly shown for zones 3, 4 and 6, and it comes as no surprise that it should be more frequent for zone 3 raw materials.

In addition, a couple of raw materials from zone 5 are represented only by a spent core each, discarded in the cave. Indeed, procurement from zone 5 is characterized by an over-representation of cores (4 blade cores for a total of 14 pieces),

[6] Fifteen small blades in Dogger flint are burnt. In spite of their altered aspect, it was possible to exclude them from Bj4a flints, but they could belong to either Bt4 or Bt2 types. Anyway, most of them do not belong to a phase of *plein débitage*, supporting the assumption that these products were removed from the cave.

Mobility of cores	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7a
Export after on-site knapping of tested nodules			CN1a CN2c Ht1				
Export after on-site knapping of partially reduced nodules			Ht3 CN4a	CC4b		X1	
Import of spent cores					CE1b CE5		

Table 4. Mobility of cores in terms of export and import.

which are no longer serviceable, and an under-representation of blade products. The picture that emerges is that of an import of heavily reduced cores from which (e.g. CE2, CE2/CE5) a few last blades are detached on-site but not used on the premises, before the cores are finally discarded.

Discussion

Group mobility

The complementary patterns of mobility, in terms of import and export, highlighted for the cores and the end-products of blade *débitage* associated with most procurement zones suggest that such components were moved about as people went along. Indeed, on a large scale, the connection can be made between the departure from the site of blade blanks made from local zone 1 raw materials such as Bj4a and Bt4/4f and the introduction into the cave of similar blanks made from more distant raw materials. At some point in time in zones 3 to 7a (tabl. 3), these blanks were also part of a "local" production. The same holds for cores brought in partially reduced or nearly spent. Their presence in the cave is echoed by the departure from the Gardon of cores that have been productively knapped on-site (tabl. 4). The transfers associated with these specific components, end-products and cores, can therefore be viewed as archaeological correlates of group or individual mobility, rather than as reflecting the extent of interaction networks. This is borne out by the contrasting stages of introduction between the closest zones 1, 2 and 3, and those further away. In this respect, it is noteworthy that the more distant flint types, from zones 6 and 7a in particular, were not introduced solely as end-products but also as partially reduced cores (tabl. 2). An additional argument can be found in the fact that beyond zone 3 quantities decrease roughly in relation to distance travelled (tabl. 1).

The three closest zones are the most intensively exploited for raw materials (82%), predominantly brought in as whole or tested nodules. Sources lie mainly in the forested hills north and east of the cave at an elevation of 400-700 m, but also in the alluvial plain to the northwest. Their location is consistent with the exploitation of a restricted territory for its wild fauna (boar, red deer) by people for whom hunting is still a major activity. The Gardon cave (360 m), located at the base of a Bajocian limestone cliff, lies at the boundary between the geographical zones from which the largest amount of raw material was collected (fig. 3). It possibly represented a focal point, which sediment analyses (Sordoillet 1999) suggest was intermittently occupied by pastoralists. This territory was widely roamed over, as indicated by the variety of sources and raw material types, and also by two interesting cases of opportunistic collecting. A single large Upper Palaeolithic blade-core made from a distinctive Valanginian raw material (Val type) was abandoned in the cave after having been recycled off-site (there are no matching products) as a bladelet core by the Neolithics. The raw material is very common in an Upper Palaeolithic cave site 15 km north of the Gardon (Féblot-Augustins 2002). The core must have been picked up by one of the Neolithics, recycled at some point, and carried back to the Gardon where it was used as a pounding implement before being discarded. Along the same lines, a single large flake-core (T3 type) displaying hinged removals was brought in from 12 km to the north. The raw material is very resistant, and since the core displays battering marks and was no longer serviceable as a core it was possibly brought back for use as a hammerstone. The scavenging of the Upper Palaeolithic core indirectly shows that other cavities may have been used occasionally, and is not an isolated occurrence in the Neolithic. In a different geographical but broadly contemporaneous context, it has indeed been suggested that at Vaux-et-Borset and Darion, in Belgian Hesbaye, the Blicquy Group scavenged some lithic material from earlier nearby occupations by the Linear Pottery Culture (Caspar & Burnez-Lanotte 1998; Jadin *et al.* [dir.] 2003).

In contrast to the amount of raw material collected in the routinely exploited territory, far smaller quantities are introduced from the more distant zones, as partially reduced cores, cores made from flakes - possibly in order to minimize weight - or even spent cores, and individual end-products. This is what might be expected when people move about equipped with a few tools, or carrying small supplies of raw material that are reduced as they go along: a pattern surprisingly reminiscent of the Palaeolithic.

Pioneer mobility

Working on the assumption of group mobility, the combined quantities of southerly provenance (16%), and in particular the flints from zone 7a (1.7%), bear out Voruz et *al.*'s (2004) suggestion of a northward low-altitude colonization by Mediterranean pastoralists. When source locations, quantities and natural routes are taken into consideration, the following scenario, involving several migratory episodes, meets the available evidence.

One episode (itinerary *a* in fig. 3) follows the course of the Rhône towards Lyon, and cuts across the Ile Crémieu plateau where some Kimmeridgian flints are collected from the small Morestel deposit. The Rhône is easily crossed at Glandieu, another possible source of Kimmeridgian flint in the lower Bugey. From there the Belley basin is reached, and various Senonian and Hauterivian flints are picked up. After travelling upstream along the Furans, the narrow *Cluse des Hôpitaux* is a compulsory route, which cuts deep into flint rich Bathonian formations, sampled on the way at Tenay. Beyond Tenay, the Albarine watercourse leads out of the *Cluse des Hôpitaux* and more or less directly to the Gardon cave.

Another episode (itinerary *b* in fig. 3) branches off to the east after following the course of the Rhône. During this episode, the north-west slopes of the Chartreuse massif are explored, and small amounts (2.9%) of various Senonian flints are collected, possibly from the Gerbaix secondary deposits (*ca* 600 m elevation). The Balmettes rock shelter, for which no dates are available but where some Early Neolithic artefacts were recovered (Perrin 2003), is located on the southwest border of the massif, also at an elevation of 600 m, and could be related to this or another such episode. From the Chartreuse, the route leads once more to the Belley basin and its flint sources. Indirect evidence of several passages through the Belley basin is be found in the relatively larger quantities of raw material introduced from this area into the Gardon cave (10.3% out of a total of 11.5% for zone 4). Beyond the Belley basin and as detailed above, the *Cluse des Hôpitaux* offers straightforward access to the Gardon.

During either of these episodes, people may have branched off and explored to the north (itinerary *c* in fig. 3), following the Rhône to Bellegarde and picking up small quantities (2%) of Senonian and Hauterivian flint on the Michaille plateau, bordered immediately to the west by impressive ranges of hills. From there, the *Cluse de Nantua* can be followed, and leads to the north of zone 3 where some primary context Campanian flint is collected. Skirting the western foothills of the Bugey along the Ain, an easy route then leads straight down to the Gardon.

Conclusion

Given that the more mountainous Chartreuse and Bellegarde zones are exclusive to layer 58, the associated raw material transfers point to exploratory forays into areas that are not yet settled by the Neolithics, but will be so a few hundred years later. Thus, the Early Neolithic raw material procurement of layer 58 stands as an example of pioneer mobility, to be followed by infill movement into more marginal or specialized areas. In the Chartreuse, for instance, the Mesolithic/Neolithic transition has been recognized at the Aulp du Seuil, in the heart of the massif at an elevation of 1700 m (Bressy 2003). However, the first Early Neolithic occupations are dated 4700 to 4400 BC, a few centuries later than Gardon layer 58. In the Bellegarde area and a little further south along the Rhône, the sparse available evidence points to even later occupations: during the Middle Neolithic at Génissiat (Sauter & Gallay 1960), the Middle and Final Neolithic at Bassy (Fillion & Vilain 2001), the Final Neolithic at Villes and En Chatanay on the Michaille plateau (Fillion 2002; Fillion *et al.* 2000) where intensive archaeological surveys have failed to find any traces of earlier occupations.

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