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THE CÔA VALLEY (PORTUGAL)
Lithic raw material characterisation and the reconstruction of Upper Palaeolithic settlement patterns

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Abstract. The scientific study of lithic raw materials provides the best way to reconstruct mobility, resource management strategies and settlement patterns of hunter-gatherer societies during the Upper Palaeolithic. Our project is based on a survey of geological formations containing chert, petrographic characterisation of these sources, and finally, their comparison with archaeological remains found in the Upper Palaeolithic sites of the Côa Valley. The aim of this research is to establish the geological sources (primary or secondary outcrops) for lithic remains discarded at archaeological sites for both siliceous and non siliceous rocks. The results define a vast procurement area for siliceous raw materials at all stages of the Upper Palaeolithic. We define raw material sourcing in terms of mobility and social interactions, taking into account the fact that siliceous rocks appears systematically on each archaeological site, even though they are always represented in small quantities.

Résumé. L'étude de l'approvisionnement en matières premières lithiques est une des meilleures voies pour reconstituer la mobilité, les modalités d'exploitation des différentes catégories de ressources et les contacts entre des groupes de chasseurs-cueilleurs du Paléolithique supérieur. Cette analyse est fondée sur la prospection des formations géologiques susceptibles de contenir des silex, la caractérisation pétrographique des échantillons récoltés et leur comparaison avec des pièces archéologiques découvertes sur des occupations datant du Paléolithique supérieur de la vallée du Côa. L'objectif de ce travail est d'établir les relations entre toutes les catégories de vestiges lithiques, taillés ou non, abandonnés sur ces niveaux d'occupation et des sources géologiques en position primaire ou secondaire et d'en caractériser techniquement leur transformation. Les résultats obtenus permettent de restituer un vaste espace géographique d'approvisionnement, pendant tous les stades du Paléolithique supérieur. Nous tentons d'interpréter ces déplacements en terme de modalité d'approvisionnement et de contacts sociaux en prenant en compte que les silex déplacés apparaissent en très faible quantité, mais systématiquement, et en association sur tous les niveaux d'occupation des différentes catégories fonctionnelles des sites.

Introduction

The open air engravings of the Côa Valley were discovered in the mid nineteen-nineties, in a region where no previous evidence of Upper Palaeolithic human occupation had been reported (Zilhão 1995; Zilhão *et al.* 1997). The search for an archaeological context for this rock art has enabled us to reveal significant occupation in this region of the Iberian Peninsula during the Upper Palaeolithic. To date, more than 15 archaeological sites have been identified and excavated (fig. 1). The chronological attributions of the sites were originally based on typo-technological characteristics of diagnostic lithic tools (Zilhão 1995). The original dates were confirmed by TL dates obtained from stratigraphic profiles (Valladas *et al.* 2001). None of the lithic assemblages found to date display the typo-technological characteristics of the Aurignacian. Human occupation of the region appears to have begun during the Gravettian, and continued during the Proto-Solutrean, Solutrean, early and late Magdalenian (Aubry 2001).

As discussed below, the history of human occupation of the Côa Valley during the Palaeolithic force us to revise our understanding of Palaeolithic behaviour in relation to settlement patterns (Aubry *et al.* 2004). The Côa Valley is just one example of how erroneous our conception about palaeolithic way of life in Western Europe can be, because it has been largely based on research in calcareous and/or littoral regions.

The natural environment of the Côa river

The Côa river, a left tributary of the Douro, flows towards the north (fig. 1). The unusual orientation of the drainage basin is related to tectonic fractures in the main part of the basin, which is composed of granite. The river valley, about 120 km long, is narrow and deeply incised due to the granitic context. The river widens and meanders along the last 15 km of its course as a result of the presence of pre-Ordovician metamorphic rocks. The river basin extends over 2,419 sq. km. The topography of the valley is characterised by a Quaternary incision more than 400 m deep, at the confluence of the Côa and the Douro (Aubry *et al.* 2002). Present-day precipitation levels are less than 300 mm at the bottom of the valley in the metamorphic area, which lies less than 130 m above mean sea level. At the rivermouth, the annual range of precipitation is more than 900 mm. Zilhão (1997a) has suggested that, in the past, the rate of flow of the Côa was probably more regular

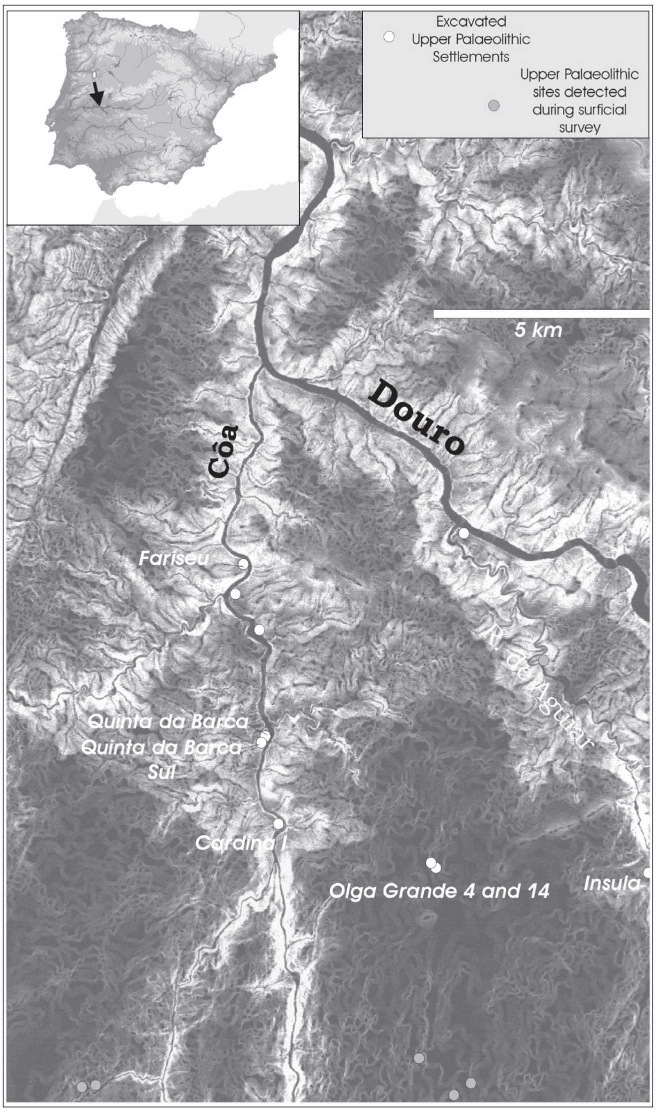

Figure 1. Location of Upper Palaeolithic settlement of the Cõa Valley (Portugal).

during the year, and this may have been a decisive factor in the human implantation during the Last Glacial Maximum.

The thin, acid soils and general geomorphic conditions are not conducive to the preservation of bones and macrobotanical remains (Zilhão 1997a; Sellami 2000). The archaeological sediments have only yielded a few burnt bones, tooth fragments and poorly preserved charcoal remains - and these elements are not sufficient to reconstruct the paleoenvironment or the management of biotic resources. For this reason, the reconstruction of settlement and mobility patterns of prehistoric hunter-gatherers of the Côa Valley can only be done with the aid of petrological characterisation of the lithics and technological analysis. The reconstruction of activities carried out at each site, in relation to the territories exploited, enables us to investigate the relationship between Upper Palaeolithic communities and their environment.

The study of raw material sources

The scientific study of prehistoric lithics for the purpose of reconstructing raw material sourcing and circulation patterns must be done by systematically describing and comparing two kinds of samples, geological and archaeological, taking into account two different scales of analysis (both macroscopic and microscopic) (Mangado 2004).

A geological survey of the region concerned must be conducted beforehand using geological maps, which allows us not only to identify potential sources of raw material (outcrops) available in the regional and local areas, but also to determine their position (primary or secondary), their accessibility, and many other parameters related to the raw material characterisation such as their morphology and quantity (fig. 2A).

A comparison between samples collected during field work and lithics recovered from archaeological levels makes it possible to make a first assessment of patterns of resource use. Our work in Côa valley reveals that some regional raw materials were not used in prehistoric times; this is the case for some very localized sources of precambrian chert and volcanic opal. These raw materials have been detected on the right bank of the Douro, in primary position outcrops, and in the Bragança volcanic group, but they have not yet been identified in the archaeological record (fig. 2B).

A lithic classification comprising 24 categories, proposed for the Côa Valley by Aubry *et al.* (2004) was used in this research. At all of the sites studied, and during the different phases of the Upper

	Quartzite	Quartz	Rock Cristal	flint + hydrothermal silicifications	total
Olga Grande 4 level 3	971	7557	967	288	9783
Olga Grande 14 level 3	174	25	105	48	352
Olga Grande 14 level 2c	61	1314	92	82	1549
Cardina I level 4/10	11946	9817	5564	948	28275
Cardina I level 4b	8251	5967	3411	672	18301
Insula II level 2	242	836	142	53	1273
Fariseu level 3	9	91	1	2	103
Fariseu level 4	13	71	6	4	94
Fariseu level 4e	33	267	72	4	376
Fariseu level 6 and 7	40	235	21	1	297

Table 1. Proportion of distinct siliceous raw material in the lithic assemblages of the Cõa Valley Upper Palaeolithic settlements.

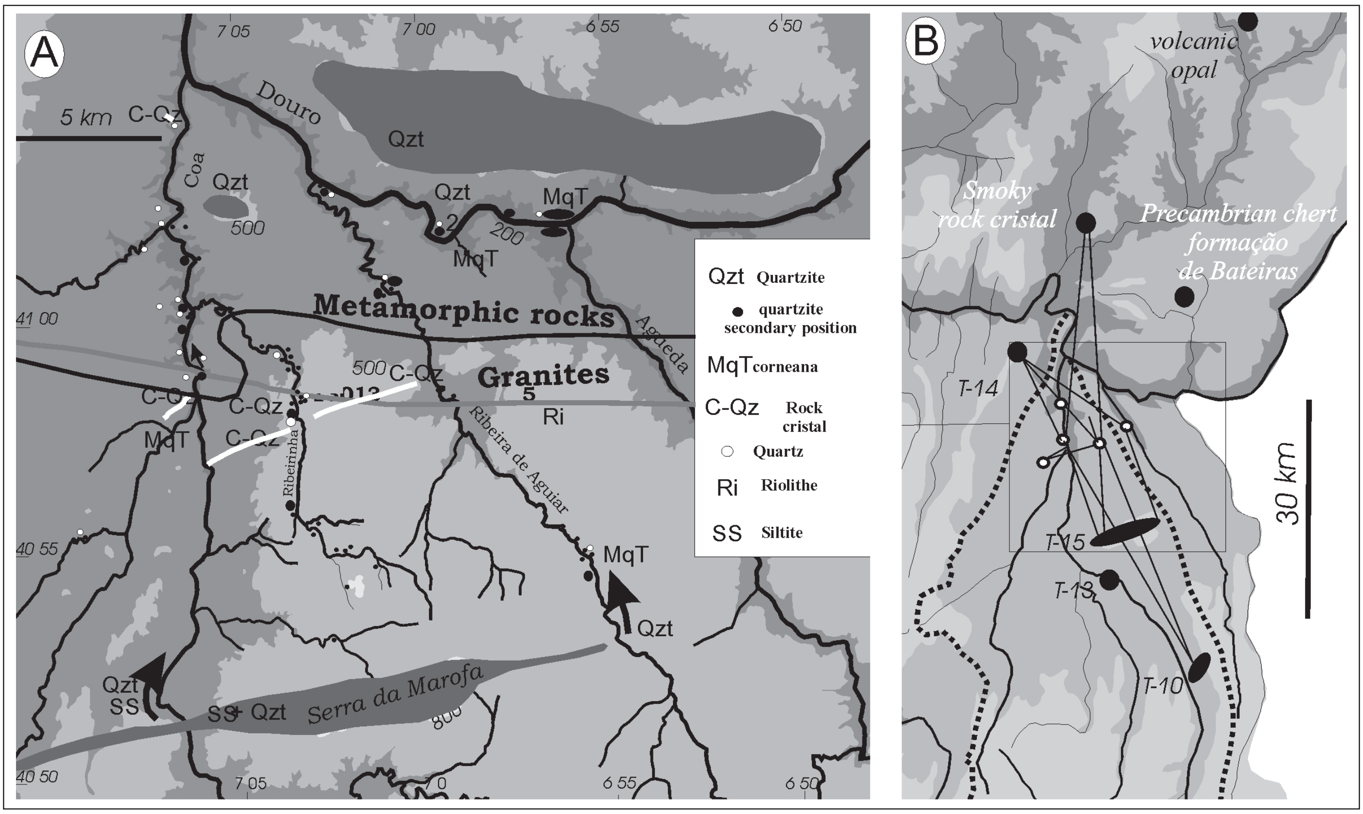

Figure 2. Location of siliceous raw materials sampled, resources not used and displacements of regional fine grained siliceous resources on the gravettian settlements.

Palaeolithic, lithic industries are based essentially on quartz and quartzite, and to a lesser degree on rock crystal and fine-grained quartz vein. In all the cases, these categories represent nearly 99% of the assemblages (tabl. 1). Quartz, quartzite and rock crystal were obtained locally (a few kilometres from the sites) and other raw materials, such as hydrothermal silicifications or "smoky" rock crystal, come from sources less than 50 km from the archaeological sites (Aubry *et al.* 2004).

Flint is not available in geological contexts lacking sedimentary rocks. Nevertheless, flint occurs systematically in all archaeological sites in the Côa valley, throughout the Upper Palaeolithic, albeit as a very small percentage of the raw materials used (tabl. 2).

The origin of the flints used was determined by preliminary macroscopic examination, taking into account as many parameters as possible (colour, type of inclusions, etc). The macroscopic characterisation allowed us to define intra-outcrop variability, and to identify several inclusions in the flints, such as some macro and meso fossils and mineral particles. Nine types of flint were macroscopically determined. We then undertook petrographical analysis (mineralogy, texture, micropalaentological contents) of both archaeological and geological samples (fig. 3), collected from the different sedimentary basins analysed for this research (Mangado 2002; Aubry & Mangado 2003). Microscopic examination reveals the texture of the rock, the presence of microscopic inclusions, and allows us to characterise the depositional environment and diagenetic processes. LA-ICP-MS analyses were also carried out (Carvalho 2001). Systematic comparison between geological and archaeological samples allows us to confirm the use of flint varieties from sedimentary environments located at least 150 km away from the archaeological sites during the Upper Palaeolithic in the Côa Valley. For the time being, the petrographic and micropalaeontological analyses allow us to characterise several depositional environments and 7 types of sedimentary siliceous rocks related to the archaeological materials.

Lower Jurassic flint (Liasic)

The primary position outcrops (fig. 3, Tj- 1/6) are located in the neritic-lagoonal deposits in the Anadia region (Portugal). We could identify two types of silifications, both synsedimentary and contemporaneous to their host-rock (sandstones) (Soares de Carvalho 1946).

- Post-hettangian flint: (Sá outcrop). Highly fractured. This type of flint was not used during the Upper Palaeolithic of the Côa Valley.
- Pre-hettangian flint: (Quintela de Lapas and Pereiros outcrops). This flint is characterised by detrital crystals of quartz and feldspath, length-fast chalcedony and a high percentage of iron oxydes (dendritic hematites). These petrographical characteristics are consistent with archaeological raw material type number 9 from the Côa Valley.

Middle Jurassic flint (Dogger)

These are silicifications related to marine limestones at the Bajonian/Bathonian boundary. Flint appears in primary

		1	2	9a	7	3	4a	5	6	8	9b	11	12	10	10b	13	14	15	?	burnt	rhiolite
		Flint										**Hydrothermal**									
Cardina	**C4/6**	21	42	1	4	10	44	8	1	0	0	5	4	9	3	0	5	2	0	0	0
	C4/7	22	73	5	5	19	86	8	1	0	0	11	1	14	12	0	4	5	0	0	0
	C4/8	21	48	4	4	13	63	15	4	0	0	9	3	21	3	0	7	8	0	0	0
	c4/9	18	60	2	8	29	91	4	2	0	0	8	1	14	0	0	2	3	0	0	0
	c4/10	96	45	8	16	134	395	49	32	7	11	22	1	9	2	2	5	7	96	20	0
	c4/11	81	24	2	9	85	331	30	9	0	9	10	0	8	4	6	0	3	62	81	0
Insula	**Insula c2**	11	4	0	0	2	15	9	0	0	1	0	0	0	0	1	1	2	0	2	48
Olga Grande 4	**Og 4 c3**	14	8	0	31	18	127	7	0	17	0	6	1	20	0	0	3	26	0	0	19
Olga Grande 14	**Og 14 c3**	5	2	0	0	5	16	4	0	0	0	0	0	8	0	3	0	5	0	0	0
	Og 14 c2c	8	6	2	17	4	17	3	0	0	0	2	0	0	0	25	0	19	2	2	19
Quinta da Barca Sul	**QBS**	3	2	1	0	7	8	2	0	0	0	0	0	32	0	8	22	0	0	0	3
Fariseu	**Farc2b**	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	1	0	0	0	0
	Farc3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
	FarC4ab	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
	FarC4e	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
	FarC5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
	FarC6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	FarC7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0

Table 2. Proportion of flint and fine grained hydrothermal local and regional silicifications used in Upper Palaeolithic settlement of the Côa Valley.

position in the outcrops located not far away from the Mondego river outlet in the region of Cantanhede (fig. 3, J2-1/15). From a petrographical point of view, the flint samples studied in thin section present a high number of bioclasts, mainly: Foraminifera, Bryozoa, Ostracoda, shell fragments, monoaxon siliceous spicules associated with micritic mud and to a well preserved pelletoidal texture. All of these elements define a microfacies of marine sedimentary environment (relatively deep) consistent with characteristics of archaeological raw material type 2.

Upper Jurassic flint (Malm)

These silicifications are related to a marine sedimentary environment (Middle Oxfordian) changing to a continental environment (Upper Oxfordian). Primary and secondary outcrops have been sampled in the North of the Tomar region, in the Nabão valley and in its tributaries (fig. 3, J3-1/3). Petrographically, thin sections present a high quantity of Gasteropoda, Ostracoda and Charophyta algae fragments. Mineralogically, dolomite and mica crystals have been identified too. All these characters allow us to relate these geological samples to archaeological ones, corresponding to raw material type 7.

Upper Cretaceous flint (Cenomanian)

These Cenomanian flints have been sampled in secondary outcrops in the region of the portuguese Estremadura (fig. 3, C2s-1/11). Silicification is related to a marine sedimentary environment. In this case the host-rock is a limestone rich in fossils. In some samples a pelletoidal texture has also been identified. Pelletoidal texture does not appear systematically, but when it does, it is well preserved. From a petrographical point of view, the mineralogy is characterised by a high quantity of detritic quartz and mica crystals. The micropalaeontological content shows the presence of Foraminifera, shell fragments, and monaxon siliceous spicules. No Bryozoa or Ostrachoda have been identified. Macroscopic and petrographic criteria indicate that this Cenomanian flint is consistent with the characteristics of archaeological raw material type 1.

Neogene flint

Two different Neogene epochs (Miocene and Pliocene) have been sampled (fig. 3, Mc-1/4, E-1/4, Valdeparada, Mu-1, Pa-1/4, Rie).

• **Miocene flint**. Field work carried out in the Tertiary sedimentary basin of the River Tagus, in Portugal and in the south-western region of the Central Spanish Plateau, resulted in the sampling of several different primary and secondary outcrops. Different types of silicification are described. One flint variety, not in use during the Upper Palaeolithic in the Côa Valley, is characterised by a large quantity of opal and some microscopic remains of vegetal tissues. Mineralogically, the length-slow chalcedony is the only fibrous quartz texture present in the samples. Micritic mud and sparry calcite crystals are also present. No micropaleontological contents have been documented. The sedimentary environment of these silicifications must be related to diagenetic processes in subarid conditions (Arbey 1980; Bustillo 1976).

A second Miocene flint variety, clearly in use during the Upper Palaeolithic in the Côa Valley, is also described.

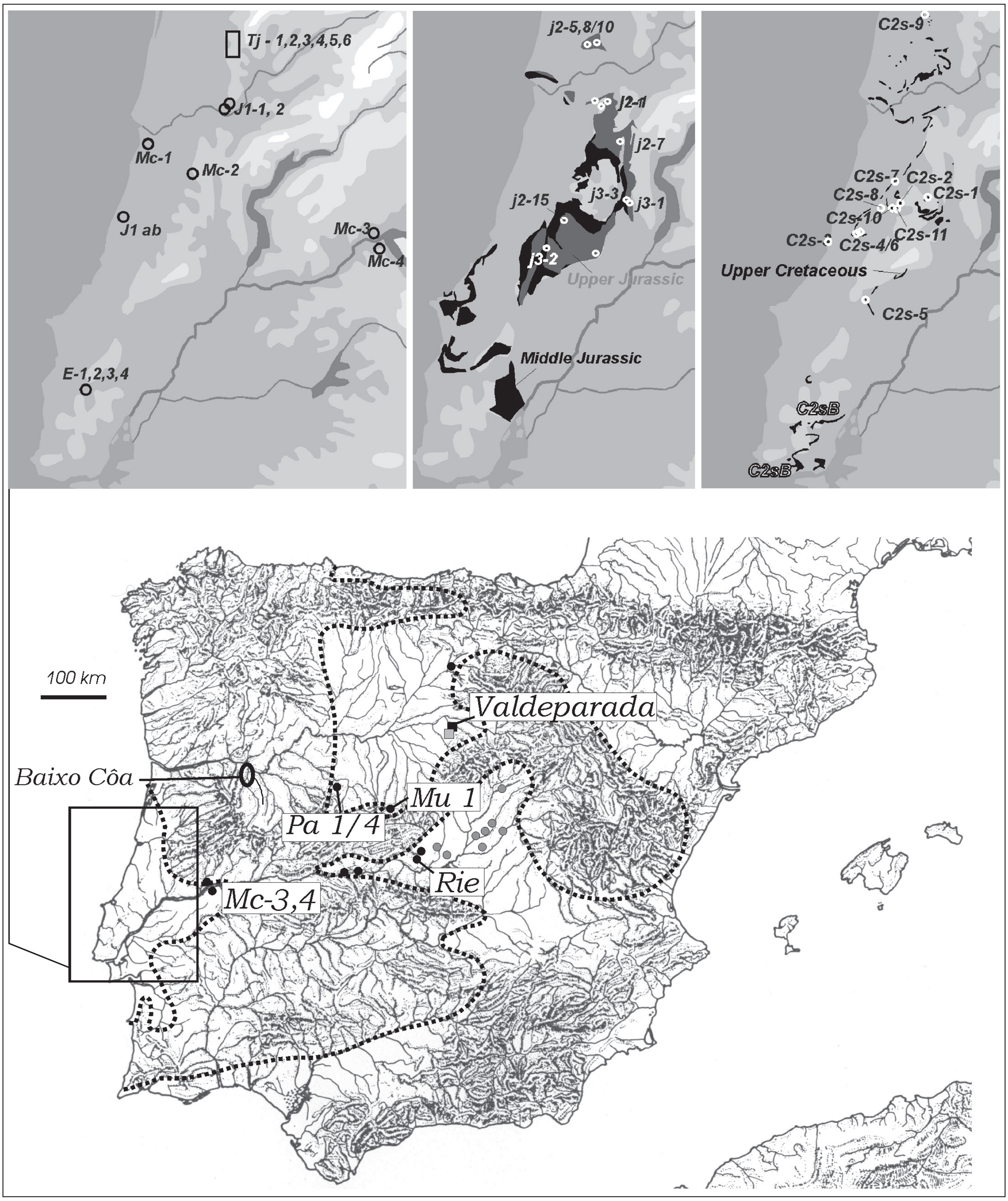

Figure 3. Location and geological attribution of the geological samples collected during the survey.

Petrographically, these cherts are related to diagenetic processes in evaporitic conditions, as revealed by the presence of length-slow chalcedony, acicular crystals of anhydrite and pseudomorphs of lenticular gypsum. Sparry calcite and dendritic manganese are also present in lower amounts. These cherts possess characteristics that are closely related to those of archaeological types 3, 4 and 5. Nevertheless, similar macroscopic and petrographical facies have been discovered in the Miocene limestones of the Douro basin, in Valladolid, in the north-western region of the Central Spanish Plateau (Armenteros 1986); this is known as a convergence of facies. At this point in time, no valid criteria (macroscopic or microscopic) exist to enable us to differentiate flints derived from either of these geographic sources.

• **Pliocene flint**. Pliocene flint was sampled in secondary outcrops from the southern part of Figueira da Foz region (fig. 3, Mc-1). This flint was not used during the Upper Palaeolithic in the Côa Valley. Petrographically, the flint is rich in opal and porosities. Mineralogically, length-slow chalcedony and fibrous-laminar hematites define a sedimentary environment related to evaporitic conditions (Bustillo 1976).

Raw materials and settlement patterns: interpretative models

The archaeological lithic assemblages have been studied technologically and classified into a technological scheme (from block, nodule, or pebble, to retouched flakes and tools) in order to establish the production sequence for each of the raw materials identified, the techniques associated with their use and their purpose.

The occurrence of different local or regional raw materials during the Gravettian and final Magdalenian in the Côa Valley (e.g., at the sites of Olga Grande 4 and 14, Cardina I and Fariseu, tabl. 1) do not reveal significant differences in their supply, which seems to be governed more by local availability than by cultural choices (Aubry *et al*. 2004). For local quartz and quartzite, the production sequence is quite complete, and basically is represented by the production of flakes to be retouched as end-scrappers and side-scrappers. Pebbles, blocks or cores from such production were also used as heat accumulators on the firepits.

The small quantity of flint discarded at all sites corresponds essentially to the final phases of bladelet production sequences (fig. 4). However, taking into account the function of the site we can establish some differences in these sequences. In the granitic plateau sites (Olga Grande 4 and 14), the fragments consist basically of retouched bladelets, showing diagnostic fractures due to their use as projectiles. The spatial organisation of the sites, based on refitting analyses of knapping debris including stones used in the hearths, reveals the presence of different types of flint, spatially associated in low densities, associated with short term logistical occupations – specialised hunting camps - probably related to the seasonal presence of water on the granitic plateaux (fig. 5).

At sites located at the bottom of the valley (Cardina I), the high quantity of extremely reduced cores and the presence of technological pieces, like tablets, indicate the production, on the site, of bladelets by soft hammer percussion on prismatic cores. The production of bladelets is also related to anvil bipolar percussion on flakes, or on fragmented retouched small blades. These blades, retouched or not, had been introduced in the Côa Valley as part of tool-kits and were reused after breakage. We interpret Cardina I as a residential site, a hut with frequent re-occupations of the same spatially delimited area, due to the presence of several firepits and to a high density of lithic remains: heated materials are associated with retouched tools essentially composed of quartz scrapers and broken, backed bladelets.

Rock crystal and fine grained, local and regional silicifications have been interpreted as substitutes for flint for the production of the retouched bladelets (Aubry 1998). The production sequences of bladelets or small flakes are similar to those of flint (fig. 6). The exploitation of regional, fine grained siliceous resources of poor quality at all sites

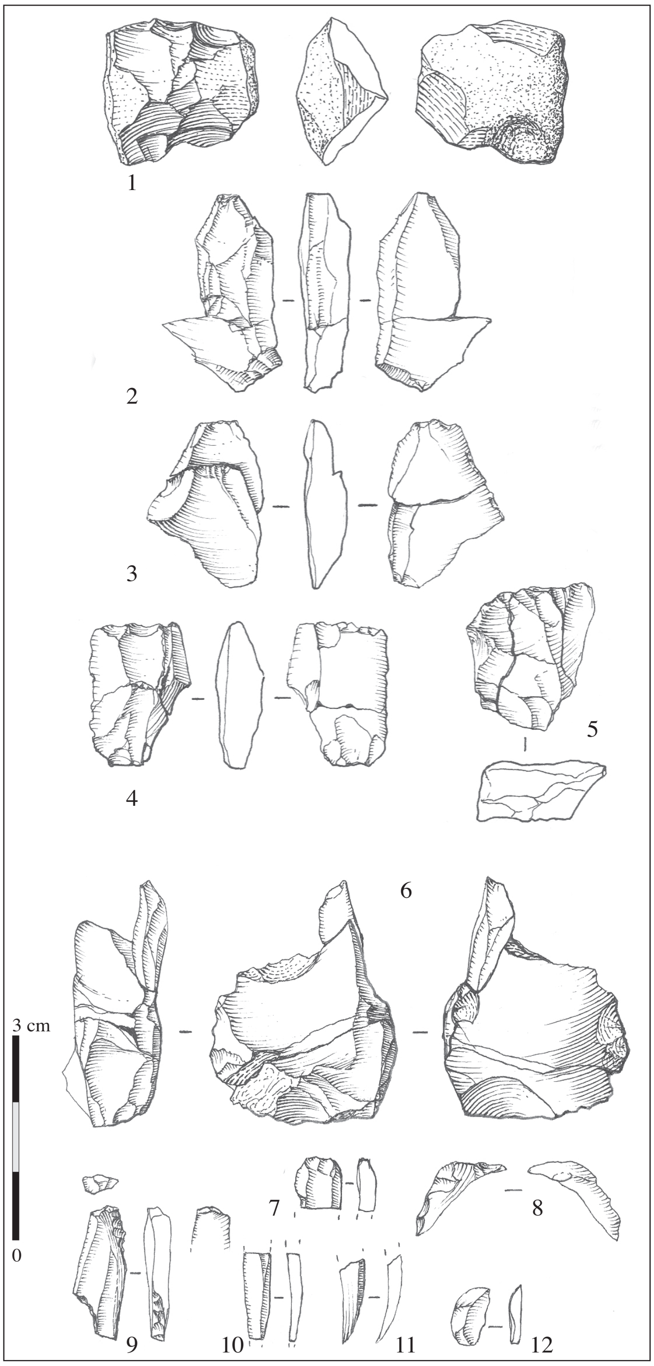

Figure 4. Production sequence of bladelets and small flakes production on Miocene flint discarded on the Olga Grande, level 3 occupation.

during all phases of the Upper Palaeolithic suggests the displacement and exploitation of resources on a regional scale of approximately 500-2000 sq. km. The exploitation of geographical spaces of this magnitude has already been reported for flint raw material transfers in central Portugal for the same time periods (Zilhão 1997b; Aubry & Mangado 2003). This fact makes us wonder about the existence of a local group in the Côa Valley.

But how can we explain the stratigraphic association of flint remains covering more than 40.000 sq. km? Several interpretative models can be suggested (fig. 7). The first

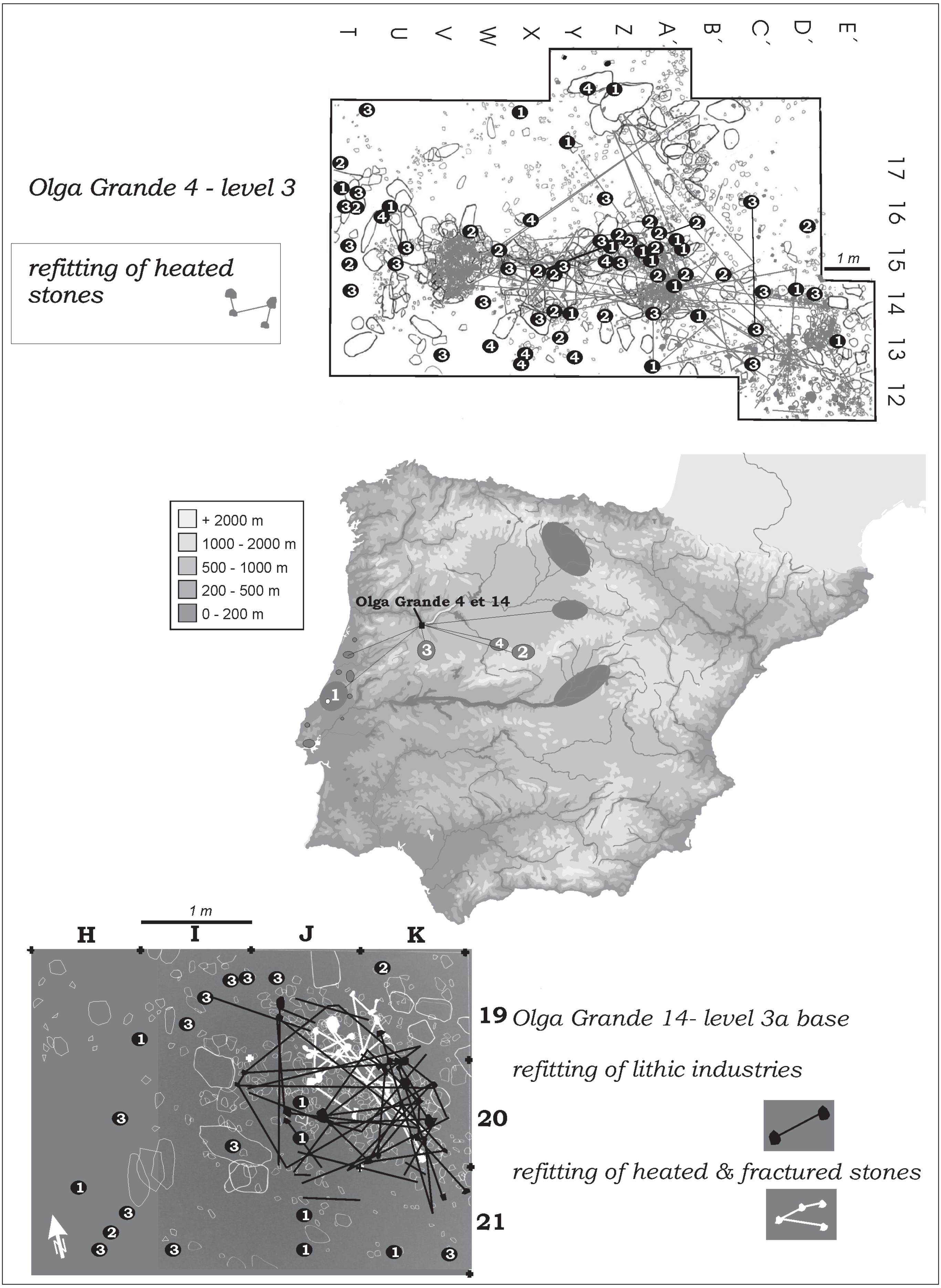

Figure 5. Distribution and origins of flint and fine grained hydrothermal silicifications discarded at Olga Grande 4 (level 3) and Olga Grande 14 (level 3) gravettian occupations.

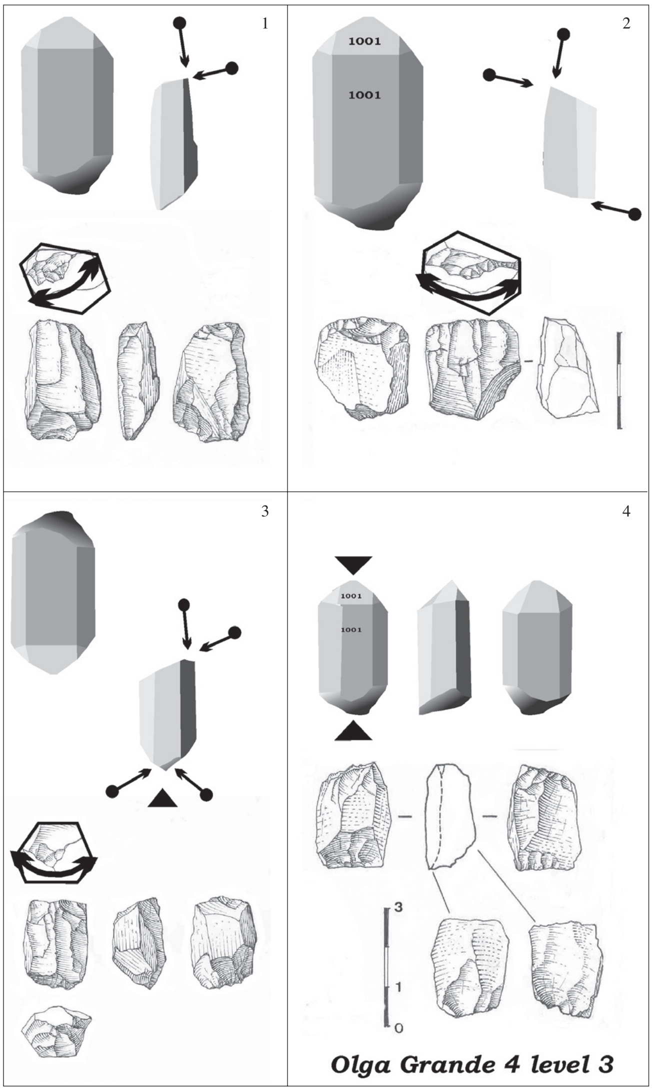

Figure 6. Rock cristal cores for the production of bladelets, discarded on the Olga Grande level 3 occupation.

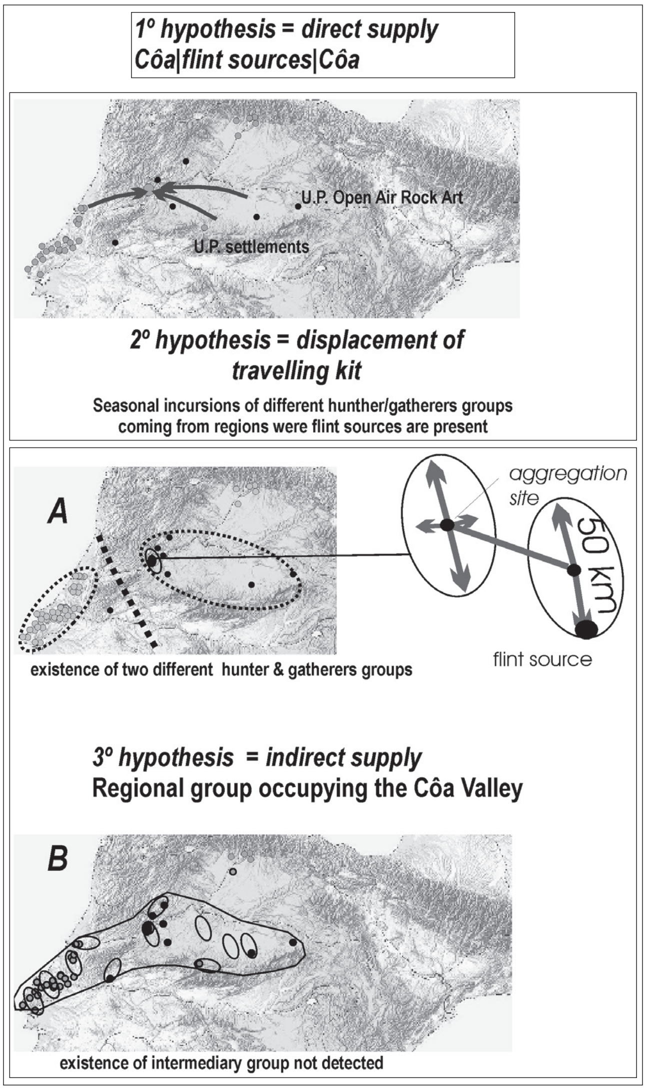

Figure 7. Interpretative models to explain the flint discarded on Upper Palaeolithic settlement of the Côa Valley.

hypothesis postulates direct supply by a regional group occupying the Côa Valley, but is not supported by the geographic diversity of resources encountered, covering much more territory than ethnological and archaeological data usually admit for hunter-gatherer societies (40.000 sq. km).

Similarly, an hypothesis of separate, seasonal incursions into the valley by different hunter-gatherer groups coming from regions where flint resources are present and carrying with them their own flint artifacts, does not explain the systematic presence, in short-term sites or residential occupations, of several kinds of flint in stratigraphic association. The varieties of flint used in short, specialised occupations with a low density of remains are similar to those represented in dense, residential bases containing thousands of tools. In a logistical model, one might expect to find flint from only one geographic origin in assemblages associated with short-term occupations, however.As a result, we interpret these data as evidence for the indirect supply of flint, and the existence of a regional group exploiting the Côa Valley region (500-2000 sq. km). How does this indirect supply, or exchange, take place? On one hand, it could be related to the existence of "visiting zones", within the limits of their territory (Binford 1983), where the Côa Valley hunter-gatherers obtained flint through exchanges with other groups (intermediary groups or groups with regional territories presenting flint resources). On the other hand, it could also be related to the existence of social interactions taking place within the Côa Valley. The Côa Valley could be considered as an area of "aggregation sites" (due to the high density of rock art and residential occupations) where several groups (from regional territories where flint resources are present) temporarily joined the local group based in the valley.

Taking into account the relative percentages of flint from different sources represented in the archaeological sites, we observe a better representation of Tertiary miocene silicifications derived from eastern sources. In fact, we think that it is possible to interpret this situation as proving the existence of two different and complementary types of exchange.

Our hypothesis suggests the existence of at least two different human groups, inhabiting the two main geographic units that comprise this part of the Iberian Peninsula: one unit lies to the west, between the Tagus river and the Mondego river (on the coast of Portugal); the other unit lies next to Central Iberian Range. Hunter-gatherers from the Côa Valley might have exchanged lithic materials with people living in either of these areas. A large number of Upper Palaeolithic sites have been excavated since the XIXth century in the central coast region of Portugal. Our archaeological knowledge of this region is therefore quite good, enabling us to suggest that raw material transfers between the central coast region to the Côa Valley could be related to a pattern of exchanges between two groups. Archaeological knowledge of the Central Iberian region, on the other hand, is quite poor and sites (rock-art engravings or settlements) are scarce. We think that this is due to an absence of field work focussed on open-air sites, however. We are confident that future survey in this area will change the situation, providing a better understanding of the distribution of open-air sites in Central Iberia and, consequently, giving evidence for the existence of intermediary groups in this territory. In which case, the transfer of flint to the Côa valley could prove to be related to social processes of aggregation and dispersal involving populations interacting over the entire territory. One paramount fact to bear in mind is that territories are, above all, spaces of social interaction.

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