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The raw material procurement at the Upper Palaeolithic settlements of the Côa Valley (Portugal): new data concerning modes of resource exploitation in Iberia

AUBRY TH., MANGADO J., FULLOLA J.M., ROSELL L., SAMPAIO J.D.

Studies of raw material procurement have proved themselves to be an excellent tool for the reconstruction of the economy and mobility of hunter-gatherer groups. The ongoing collaboration between the Côa Valley Park and the S.E.R.P of Barcelona University is based on a survey of geological formations containing flint, on geological characterisation and on comparisons with archaeological pieces found in the Upper Palaeolithic settlements of the Côa Valley. The aim is to connect the pieces discarded in these settlements with areas defined by geological resources, and to try to reconstruct the ways in which they were moved and used. Flint is always used in small quantities, associated with local siliceous rocks. The varieties used show petrographic features of oceanic and lacustrian sedimentary formation, which do not exist in the Côa Valley basin. These first results are drawn from various points from within a vast area. This procurement-area for raw material was used in all stages of the Upper Palaeolithic. We are attempting to interpret these sources in terms of mobility.

Key words: Upper Palaeolithic, raw material, Côa Valley Park

Introduction

The discovery, battle for the preservation of, and current research on the Côa valley rock-art complex have made an important contribution to the recognition of the utilisation and preservation of Palaeolithic representations on open-air rock surfaces (Bahn 1995, Zilhão 1995, Zilhão et al. 1997 a, 1997b, Baptista 1999, Sacchi 2000). The chronological attribution of engravings preserved in the open-air is a real problem, and in the Côa valley the process has been the subject of a vigorous debate. Like a large majority of paintings or engravings preserved in caves and shelters of the Franco-Iberian region (Lorblanchet 1995), the representations at the 7 open-air sites known have been attributed to the Upper Palaeolithic by many rock art specialists on the basis of stylistic parallels. The rock art of the Côa Valley has been compared with the engraved and painted slabs recovered in the Parpalló sequence, and it has been pointed out that the bestiary depicted is similar to the species represented by faunal remains in the Upper Palaeolithic sites of Portugal (Zilhão 1995, 1997b).

The Côa's discovery, and the search for an archaeological context for this rock art, has enabled us to reveal an occupation of this interior region of Iberian Peninsula during a long period of the Upper Palaeolithic (Zilhão 1995, Zilhão et al. 1997b). The chronological attributions, based on diagnostic lithic tools, have been fully confirmed by TL dating of burnt quartzites in stratigraphic association with the lithic remains (Mercier et al.i.p, Valladas et al. 2001).

In the Côa valley, one attempt to date the engravings produced recent Holocene ages as interpreted by Watchman (1996) and Bednarik (1995). Zilhão (1995) has pointed out the wide distribution of the results and the characteristics of the natural supports and mineral accretion of the surfaces. They correspond to flat slickenslides formed during the main tectonic phase of fracture in the region. They were progressively exposed during the hydrographic incision process of the Côa and subject to a constant process of re-deposition of the siliceous and metallic films that cover the surface. The results of the test for the maximum ages (Chlorine-36) revealed that the panel faces were available during the Upper Palaeolithic (Philips et al. 1997). Dorn (1997) explained the results he obtained by radiocarbon measurement as evidence for contamination of the rock coating by older and younger sources, thus confirming arguments advanced by Zilhão. More recently, in spite of non-applicability of radiocarbon for these engravings dating, their stylistic attribution as the Upper Palaeolithic was confirmed archaeologically. Vertical engraved panel, covered by sterile fluvial deposits, intercalating with occupation levels, containing Upper Palaeolithic lithic remains in a primary position was detected (Aubry i.p.b, and Aubry and Baptista 2000).

The geomorphic conditions of preservation of the archaeological record and the thin acid soils are not conducive to the conservation of animal remains and macroscopic plant remains (Sellami 2000). Excavations being undertaken in the region have so far only yielded heavily fragmented burnt bones and teeth, which are not sufficient for reconstructing the palaeo-environment, the animal and plant resources exploited, and the settlement systems. For this reason, the study of lithic remains, and specifically the raw material supplies and flaking

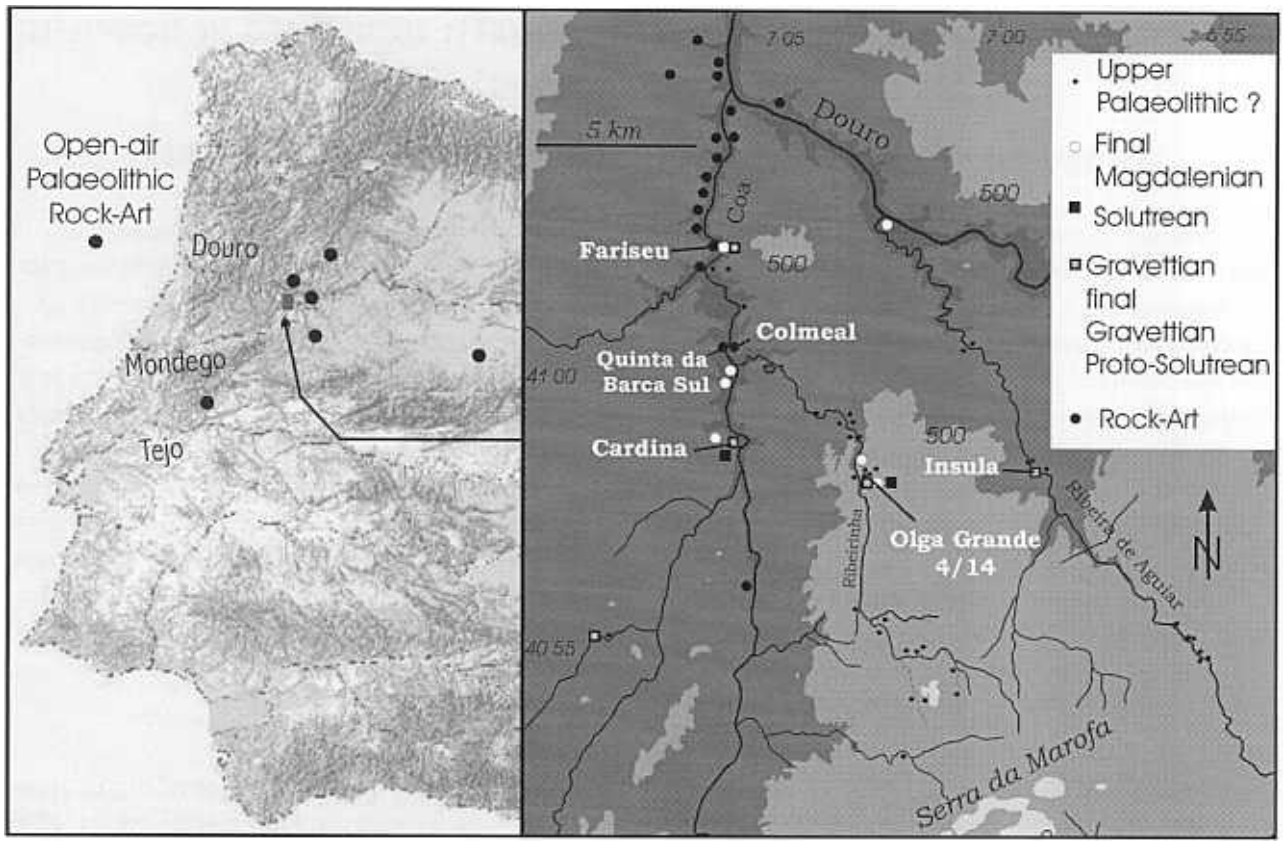

FIGURE 1. *Distribution maps of rock art and Upper Palaeolithic settlements in the Douro, Ribeira de Aguiar and the Côa Valley*

techniques, is one way to reconstruct the exploitation territories and mobility patterns. The reconstruction of the activities carried out at each settlement and the reconstruction of the territories exploited will allow us to obtain some idea about therelationship of the Palaeolithic hunter-gatherers and their natural environment, and the diversity of the Upper Palaeolithic rock-art.

Human occupation of the Côa Valley during the Upper Palaeolithic

The natural environment

The Côa Valley, a tributary of the Douro, flows from south to north. The unusual orientation of the drainage basin, 120 km long, is dictated and facilitated by the tectonic fractures in the main part of the drainage basin, which is made up of granite. Along the 100 km of this area, the valley is narrow and deeply incised, but wider in places where the river flows through metamorphic inclusions. In its last 15 kilometres, where the drainage basin is completely composed of metamorphic rocks, the river is wider and adopts a meandering pattern. The topography of the valley is characterised by a Quaternary incision of more than 400 metres at the confluence of the Côa and the Douro. All of the Côa basin's drainage is within the geographical zone of temperate continental climate with a Mediterranean tendency. Today, precipitation is less than 300 mm in the bottom of the valley in the metamorphic area where altitude is lower than 130 metres, and temperature can exceed 40° C during summer. At the valley mouth, as well as at mountain range crossing Iberia along the east–west axis, altitudes attain 1200 m and the annual range of precipitation is more than 900 mm. Zilhão (1997b) has suggested that Côa feeding was more regular during the course of the year, and this may have been a decisive factor in the human implantation during the Last Glacial Maximum. As a matter of fact, the model of palaeoenvironmental reconstruction available for southern Europe shows a precipitation level that ranged 30-50% lower than that of today.

In the region, the results obtained from the study of soils by thin section (Sellami 2000) indicate a temporary snow-cover on the plateau at altitudes higher than 450 metres. We have previously suggested that the melting of accumulated snow and of frozen earth permitted the accumulation of water reserves in topographic depressions, filled by sandy deposits on the granitic plateau (Aubry et al. i.p.). Correlatively, the highest levels of flooding observed in the stratigraphic sequence of Fariseu could be the result of this process, in the highest areas of the drainage basin.

Differential preservation of the archaeological record

The current systematic survey of the region has enabled us to establish a geomorphic model in order to detect

situations that are conducive to the preservation of Upper Pleistocene deposits and remains of human occupations (Zilhão et al. 1995, Aubry 1998, Aubry i.p.a and i.p.b,). So far, more than 30 settlements have been detected (Fig. 1).

In a topographic context with a high-gradient slope, and a Quaternary incision deeper than 400 metres, topographic platforms in the bedrock are propitious to the accumulation of fine-grained sediments through low-energy transportation. These locations are usually used for olives, almond trees or vineyard plantations. These two latter agricultural methods, which involve deep excavations for planting, could partially or completely overturn archaeological remains, but also permit easy detection during a superficial survey.

One of these structural levels, preserved at a relative elevation of 35-40 m above the present level of the Côa, is fragmentarily preserved on the left bank of the river as fluvial terrace deposits composed mainly of quartz and quartzite cobbles. This terrace level is better preserved along the Douro basin. On the basis of pebble tools, hand axes and cleavers discovered by surface survey, and displaying the same patina as the cobbles of the terrace, these deposits are probably related to a chronological phase of deposition during the Middle Pleistocene or an early phase of the Upper Pleistocene. These terraces are locally overlain by a red soil probably dating to isotopic stage 5e. The systematic survey of these topographic platforms has not enabled us to establish a later human occupation on the terrace during the Upper Palaeolithic.

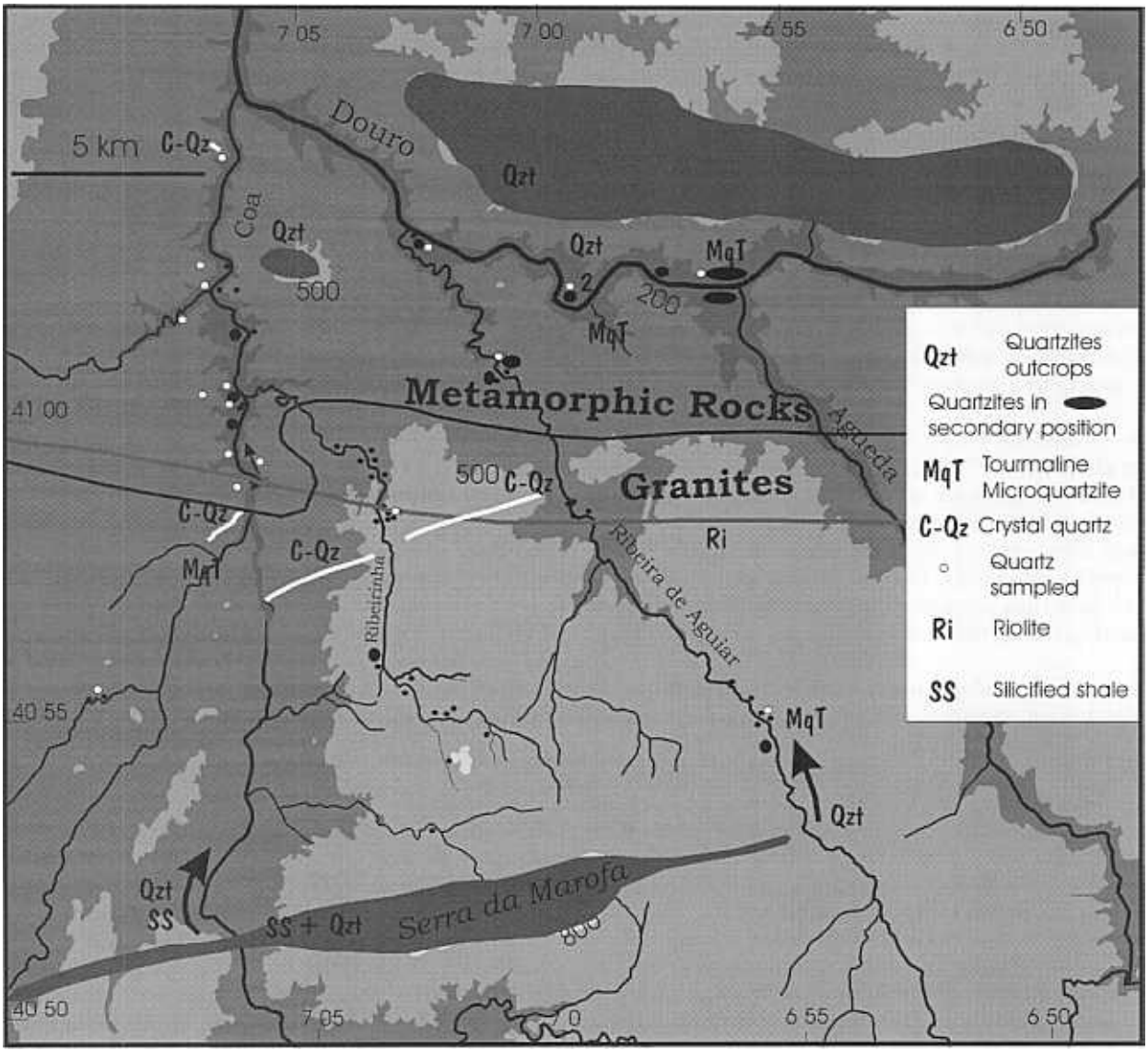

FIGURE 2. *Distribution map of local raw material resources detected in the survey.*

Excavations at the sites of Quinta da Barca (Zilhão et al. 1997b), Quinta da Barca Sul (Zilhão et al. 1997b) and Cardina (Zilhão et al 1995, Zilhão et al. 1997b) have shown that this geomorphic feature is also the result of a process of fluvial erosion of the bed-rock, ranging between isotopic stage 5e and the Last Glacial Maximum. The macroscopic study of the stratigraphic sequences at Quinta da Barca Sul and Cardina I reveals that Pleistocene remains are contained in fine-grained sediments deposited by low-energy transport, that are covered by catastrophic gravity deposits probably related to destabilisation of the slopes during Holocene forest clearance (Zilhão et al. 1997b). The current study of soil thin-sections from Cardina by M. Bergada (SERP, University of Barcelona) will improve these first observations.

The third geomorphic and geological situation conducive to the preservation of Pleistocene deposits and soils results from the alteration of the granitic plateau that corresponds to the flat Pliocene erosion surface of the Iberian Meseta. The granite sands resulting from the weathering of the bedrock are preserved in local geomorphic features, limited between granite outcrops and water courses, on topographic platforms at altitudes ranging from 400 to 600 m (Aubry 1998, Sellami 2000). The soil formation processes at the excavated sites of Olga Grande 4 and 14 have revealed relict buried palaeosoil horizons, which retain pedological features resulting from different phases of soil development. The micro-traces of human occupation during the Gravettian are locally well preserved (Sellami i.p.)

Chronostratigraphic sequence

The chronology of Upper Palaeolithic human occupation is based on diagnostic tools, especially on the microliths made on bladelets that were found during the survey of tested sites; and on the stratigraphic sequences of the excavated settlements. The first chronological attributions have been independently confirmed by T.L. dating of heated quartzites (Mercier et al. i.p., Valladas et al. 2001).

No lithic assemblage found so far displays the typo-technological characteristics of the Aurignacian phase. Human occupation, overlying Middle Palaeolithic occupation detected on the granite plateau, appears to have begun during the Gravettian. Level 3 of the Olga Grande 4 settlement, where five heated quartzite samples have been dated to between 26,800 ± 1800 B.P. and 30,000 ± 2400 B.P. (Mercier et al., i.p.; Valladas et al. 2001), corresponds to this first attested phase. The lithic assemblage includes backed bladelets and micrograveltes. The final Gravettian phase, characterized by an abundance of truncated or bi-truncated backed bladelets, has been identified at three locations. At the Cardina I site, five samples of heated quartzite are dated to between 26,500 ± 1800 and 30,100 ± 1500 B.P. They are recovered in an occupation level characterised by a depression filled by heated stones, associated with a lithic assemblage of this phase. Statistically it is similar to the Olga Grande 4 dating distribution. The interpretation of the results for these typologically different industries as being due to a variation in chronology or in activities is a problem, which needs to be resolved. The Proto-Solutrean, which has been radiocarbonicaly dated to approximately 21,500 B.P. at sites in central Portugal (Zilhão 1997b) is represented at the same location as the final Gravettian and at Olga Grande 14. The Solutrean is attested by the discard of Cantabrian-type shouldered points in the level that overlay Gravettian occupations at Olga Grande 4 and 14. One sample of heated quartzite associated with the heating structure of Cardina I had yielded a date of 20,700 ± 1300 B.P. and probably correspond to a fragment of a laurel leaf point. A possible early Magdalenian phase, associated with a well-preserved hearth structure, has been detected at the site of Cardina I. The final phase of the Magdalenian, characterised by the association of curved backed points, geometric microliths and 'thumbnail' scrapers, is attested at numerous occupations in various environmental contexts. Three samples of heated quartzite from a level associated with an accumulation of heated schist slabs, in the geological level 3 of Quinta da Barca, were dated by TL to 11,600 ± 1200 B.P., 12,100 ± 600 B.P. and 12,700 ± 1000 B.P. These dates are statistically similar to calibrated radiocarbon dates for similar industries in Portuguese Estremadura (Zilhão 1997)

Distribution pattern

The distribution map of currently known Upper Palaeolithic rock-art sites and dwellings that are reveals some factors that exerted a direct influence (Fig. 1). As argued elsewhere (Zilhão et al. 1997b, Aubry i.p.b) the distribution pattern of rock-art seems to be correlated with the limits of the geological formations. The contact between Pinhão and Rio Pinhão schist formations forms the southern limit, at Quinta da Barca and Penascosa, of the most important engraving clusters, while the Faia group is located on a Massueime variety of granite.

The distribution pattern of settlements is also dependent on the geology. The Rio Pinhão schist has been eroded mainly by fluvial processes, which have created an erosion terrace favourable for colluvium and the preservation of archaeological remains.

The sites are concentrating mainly along the Côa and its tributaries. They are crossing the granitic plateau, attitude of which is more than 400 m. Bearing in mind the process of fluvial erosion during the early Holocene in the bottom of the valley, the distribution indicates the use of this environment in the schist zone, mainly at the confluence of the tributaries, and in specific areas of the granitic plateau. These latter locations form some clusters at an altitude of more than 550 m, which cannot be explained only as a survey bias. Ribeirinha is located below 450 m, and contains some favourable topographic areas, but has not yielded any remains of occupation. The possible existence of seasonal snow-cover, and geomorphic features which permit the accumulation of

sand and the constitution of water reservoirs, could have played an important role in the location and movements of herds of herbivores hunted during the Upper Palaeolithic.

Study of raw material supplies

Methods

The reconstruction of exploitation territories for raw material supplies is based on the petrographic characterisation of the archaeological lithic assemblages and on comparisons with geological samples collected in a primary or secondary position. The geological survey of the region orientated by geological maps, at a scale of 1/50.000 (Ferreira da Silva, Ribeiro 1991) or 1/80.000, first enabled us to establish the region's local potential in siliceous rocks (Fig. 2). The comparison between the collected samples and archaeological remains made it possible to make a first assessment of resources used and not used, and to set apart categories of rocks that are present in the archaeological series but which have not been detected. A classification into 24 categories has been proposed (Table 1).

Two classes of microquartz, n° 13 and 14 (Table 1), were studied by methods other than macroscopic characterisation. For class 13, detected during the survey in secondary positions in the old and present-day fluvial deposits of the Douro, Massueime and Côa valley, the purpose was to distinguish between these geographical and geological groups and to compare them with archaeological remains. The 5 pieces analysed come from Olga Grande 6, a final Magdalenian site (2), pebbles from a fluvial deposit of the Douro basin (2) and a pebble from a current fluvial deposit of the river Massueime (Fig. 1). The samples were studied by XRD, SEM and EDX at the Optical Centre of the Beira Interior University (Covilhã) and reveal a similar composition of microquartz alpha and tourmaline, characteristic of the contact between metamorphic rocks and granite intrusions.

The analysis of 2 archaeological pieces of class 14, yet to be detected, together with a sample of rhyolite from a local vein (Fig. 2) has made it possible to exclude the initial macroscopic attribution to this origin and to characterise an exclusive alpha quartz composition.

TABLE 1. *Classes of raw material used in the Upper Palaeolithic sites of the Côa Valley.*

	Chronology	Middle Paleolithic			Final Gravettian			Proto-solutrean	Solutrean	Early Magd.	Final Magdalenian				
classes	description	O G 4	O G 1/2	O G 4	O G 14	Card I	Insula	O G 14	O G 14	card I	O G 2	OG 6	QBS	QB	Card
n°19	Quartzite	X	X	X	X	X	X	X	X	X	X	X	X	X	X
n°16	Quartzite Raña	X		X	X	X		X	X	X	X	X	X	X	X
n°20	Quartz 1	X	X	X	X	X	X	X	X	X	X	X	X	X	X
n°21	Quartz 2	X	X	X	X	X	X	X	X	X	X	X	X	X	X
n°22	Quartz 3			X	X	X	X	X	X	X	X	X	X	X	X
n°23	Crystal 1			X	X	X	X	X	X	X	X	X	X	X	X
n°24	Crystal 2			X	X	X	X	X	X	X	X	X	X	X	X
n°18	Micro gabbro			X	X	X	X	X	X	X		X	X	X	X
n°17	Riolite		X	X	X	X		X	X		X	X	X	X	X
n°13	MQzt green			X						X			X	X	
n°14	MQzt tour.				X	X	X	X	X	X		X	X	X	X
n°10	MQz iron			X	X	X	X	X	X				X		X
n°15	shale silicified			X	X	X	X	X	X	X			X	X	
n°11	sandstone 1														
n°12	sandstone 2			X	X	X									
n°1	flint 1			X	X	X	X	X	X	X	X		X	X	X
n°2	flint 2			X	X	X	X	X	X	X			X	X	X
n°3	flint 3			X	X	X	X	X	X	X			X	X	X
n°4	flint 4			X	X	X	X	X	X	X	X		X	X	X
n°5	flint 5			X		X	X			X			X		
n°6	flint 6					X				X					
n°7	flint 7			X		X				X					
n°8	flint 8			X											
n°9	flint 9					X									

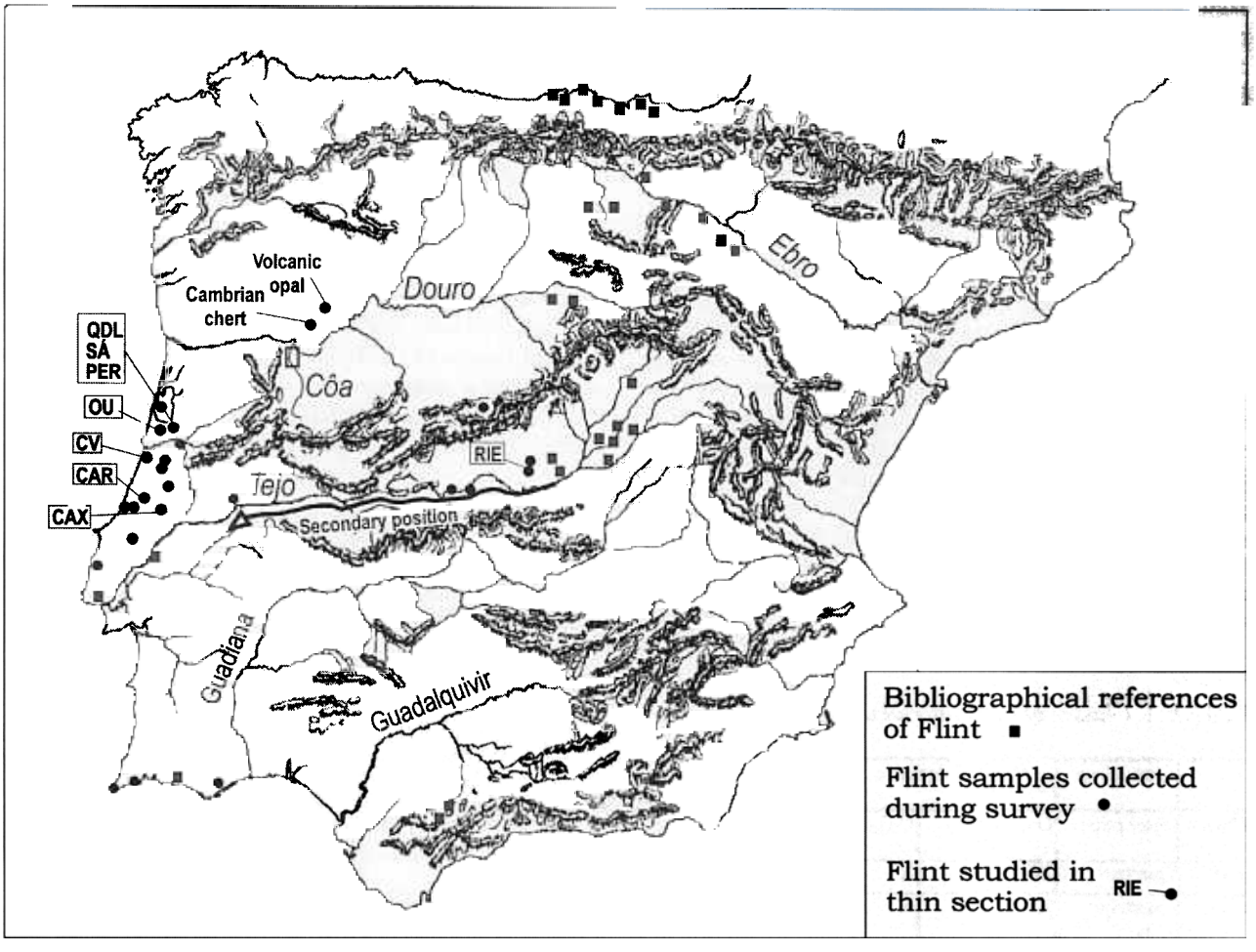

FIGURE 3. *Distribution map of recorded and studied flint.*

Flint archaeological remains were first characterised macroscopically, grouped into 9 categories, and were the subject of a detailed petrographical and micropalaeontological description in thin-sections at the Department of Geochemistry, Petrology and Geological Survey of Barcelona University by two of us (J.M and L.R.) (Table 2). This petrographic group was not detected during the geological mapping. During our survey of the Côa basin archaeological remains were compared macroscopically with samples collected by two of us (J.M. and T.A.) in outcrops, where flint is referred to in the geological bibliography, from various areas of the Iberian peninsula (Fig. 3). Selected samples were studied in thin-section (Table 3) and compared to geological descriptions.

Results

The raw materials used

At all sites and during the different phases of the Upper Palaeolithic the lithic industries are essentially made on quartz and quartzite, and to a lesser degree of rock crystal and fine-grained quartz vein (Table 1, Fig. 4 and 5). In all cases, these categories constitute nearly 99% of the assemblage. Flint is present, but never constitutes more than 2 % of the total weight of each assemblage. The survey was able to establish that the quartz used is local and available close to each site, in the form of irregular fragments resulting from the weathering of veins, formed by a hydrothermal process in schist and granite, or in a secondary position as pebbles (Fig. 2). This raw material is well represented in all the fluvial deposits observed in the region, of various ages. The samples collected in veins or secondary positions display a wide variation of petrographic and knapping qualities. Archaeological remains were grouped in 3 categories by function of grain size. The definition of limits between the 3 classes is often difficult and could be observed in the same vein.

The quartzite, originating from an Ordovician formation, is available in a primary position and forms the Marofa, São Gabriel and the right riverbank of the Douro reliefs (Fig. 2). The Marofa relief is crossed by the Côa, Ribeira da Aguiar and Ribeirinha rivers, and the observation of lithic remains shows that quartzite used at the sites was essentially collected in the form of pebbles. This kind of rock is more frequent in the older terrace levels. The movement of some fine-grained varieties of quartzite, not detected in the Ribeirinha fluvial deposits, is attested from the bottom of the valley to the plateau settlements, a distance of a few kilometres.

TABLE 2. *Petrographical and micro-palaeontological description by thin-section of selected archaeological samples into 9 macroscopic classes.*

Mq	mq	cq	l.fs	l.sl	Op	fss	Can	Cps	OFe	Evp	Trr	Por	Idn	class
10%	80%	no	5%	no	no	no	8%	-	2%	no	no	no	5.01	1
no	no	85%	5%	no	?	no	8%	-	2%	no	yes	yes	5.02	1
3%	no	80%	10%	no	2%	no	3%	-	2%	no	yes	no	5.03	1
3%	no	95%	2%	no	no	yes	1%	-	no	no	no	no	5.04	1
10%	no	80%	10%	no	no	?	No	-	yes	no	no	2%	5..05	1
Test	no	95%	4%	no	no	?	No	-	Test	no	yes	no	5.06	1
10%	no	75%	5%	no	no	No	10%	-	no	no	Test	no	5.07	2
5%	no	35%	10%	no	no	No	48%	no	2%	no	no	Yes	5.08	2
2%	no	38%	10%	no	no	20%	2%	no	30%	no	no	8%	5.09	2
No	no	40%	10%	no	no	No	40%	no	5%	no	yes	5%	5.10	3
No	80%	80%	10%	no	No	No	3%	no	2%	no	no	yes	5.11	4
No	No	70%	10%	no	?	No	10%	no	10%	no	yes	10%	5.12	4
No	No	60%	5%	no	15%	No	5%	no	5%	No	yes	15%	5.13	4
No	30%	35%	5%	no	5%	no	2%	no	15%	No	2%	5%	5.14	5
Test	no	30%	10%	no	10%	yes	30%	no	2%	No	8%	10%	5.,.15	6
no	50%	15%	5%	no	5%	no	no	no	20%	No	yes	2%	5..16	7
no	70%	70%	No	no	no	no	5%	no	5%	no	no	10%	5.17	7
2%	no	58%	10%	no	no	no	2%	no	25%	no	3%	no	5.18	8
20%	no	40%	TEST	30%	no	no	no	no	28%	?	Test	no	5.19	9

The crystal quartz could be found in local veins, less than 5 km from all the sites detected. It seems to be local and of small size (generally less than 3 cm long) in the late Glacial assemblages. The larger, more homogeneous and sometimes 'smoked' crystals used in Gravettian occupations were probably transported from regional sources.

The regional sources of flint and opal, detected on the right riverbank of the Douro in primary formations and in the Bragança volcanic group (Fig. 3), have not been yet detected in the studied archaeological assemblages.

The proposition of potential sources of non-local flint is based on the comparison with the flint selected in the collected samples and petrographical and micropalaeontological descriptions available in the bibliography (Fig. 6).

The flint survey has revealed silicifications with macroscopic characteristics similar to those of the archaeological remains, and enables us to establish an association of distinct macroscopic classes 4 and 8 in the same outcrops and in secondary positions in Pleistocene fluvial deposits of the Tagus Valley. However, class 3, well represented in Magdalenian levels on Cardina I settlement, has not yet been detected. Indications obtained through observation of the raw materials used in archaeological assemblages of the Neolithic and Chalcolithic of the Douro basin, as well as the geological bibliography, suggest the existence of a silicified, fresh water Miocene limestone, macroscopically similar to group 3, in the southern Valladolid Province (Fig. 3). The 5th type, quasi-exclusively represented in La Dehesa, a Magdalenian site in Salamanca province (Fabián García 1997), was detected in the form of small nodules, in secondary positions, near the city of Àvila (Fig. 3).

Petrographical and micro-palaeontological description through thin-Sections of 19 selected pieces of flint from the 9 macroscopic categories makes it possible to establish its formation in a sedimentary environment that does not exist in the Côa, Ribeira de Aguiar and Agueda drainage basin area (Table 2). These studies have enabled us to set them apart in 4 main groups corresponding to distinct formation environments (Table 4). The first two have characteristics of silicified marine limestone, and the latter two are silicified fresh water sediments. This verification of macroscopic grouping by microscopic observation has confirmed a marine ambience formation, but substantially modified the macroscopic attribution of archaeological remains to classes 1 and 2. Cenomanian flints, common in secondary positions in the Estremadura region in central Portugal, display a wide variability of pellet- and fossil-content, which converges with the characteristics of some bajocian silicified marine limestones of the northern part of this region (Table 2 and 3). A more detailed description of flint from marine formations of different primary and secondary locations is in progress.

The analysis of the proportions of each category of raw material, used during the Gravettian and final Magdalenian, is not revealing significant differences in

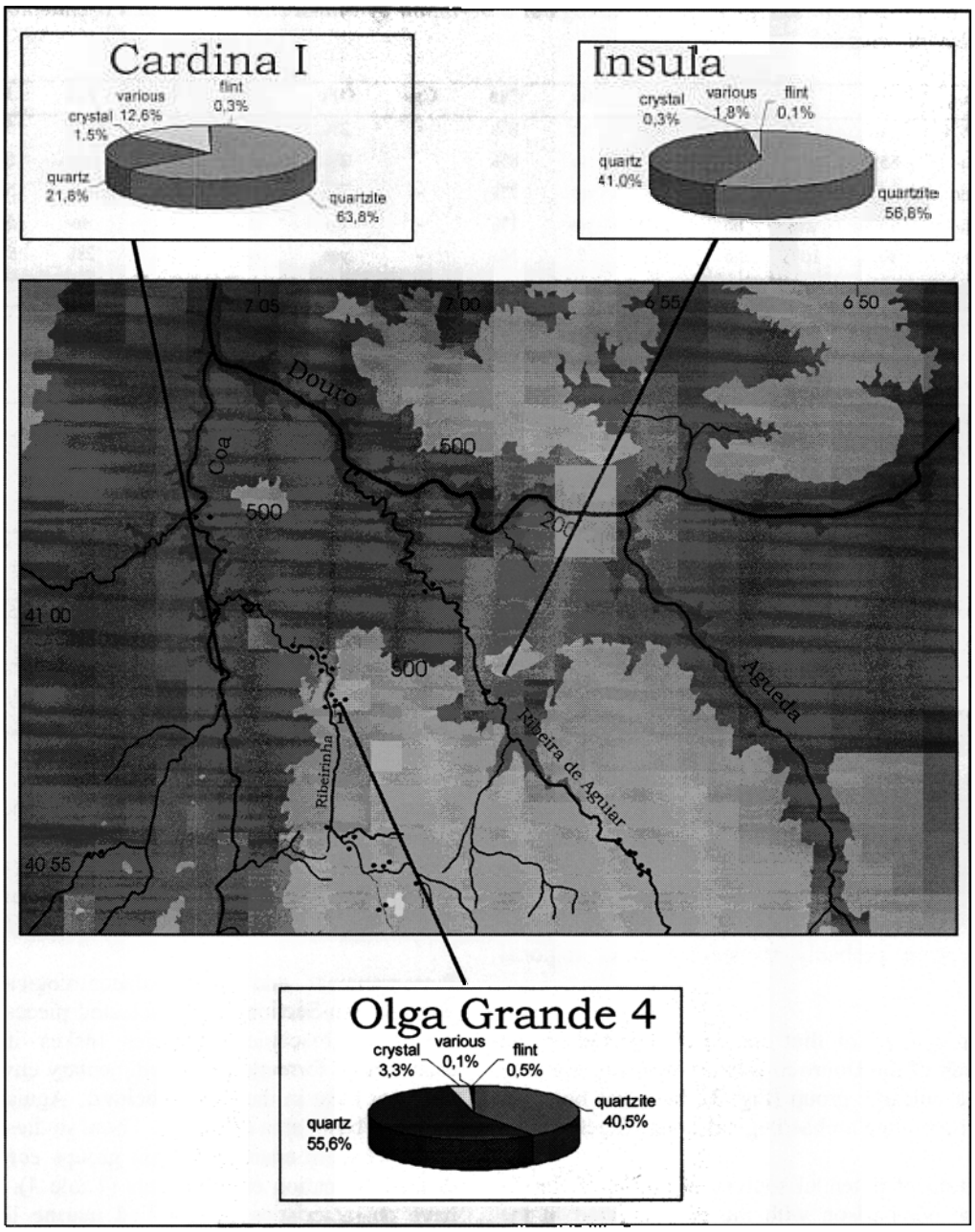

FIGURE 4. *Proportion of raw material used in the Gravettian sites.*

the supply of local rocks, which appears to be conditioned by local availability rather than by cultural choice. The proportion of flint of each class in 12 square metres of level 4 in the Cardina I sequence does not display any significant variation during the Upper Palaeolithic sequence (Table 5). The comparison with Holocene assemblages (Carvalho, 1999) reveals a better representation of quartzite during the Pleistocene.

The technological use of lithic resources.

All the assemblages described petrographically have been studied technologically, and placed into technological categories of the production sequence: block, nodule or entire pebble, cortical flake (more than 50 %), flake, chips, crested blade, core, core produced on anvil, blade, bladelet, retouched tool, retouched flake and fragment resulting from heating.

We cannot yet present a quantitative distribution of assemblages from the excavation project. However, a preliminary study reveals that the representation of pebbles or slabs displays the transportation of rock that was not used for knapping. Flat slabs of quartzite, apparently collected nearby from outcrops, have been discovered in the Gravettian occupations of Olga Grande 4, level 3, Olga Grande 14 level 2c, and at Insula II. The spatial distribution of these pieces and heating

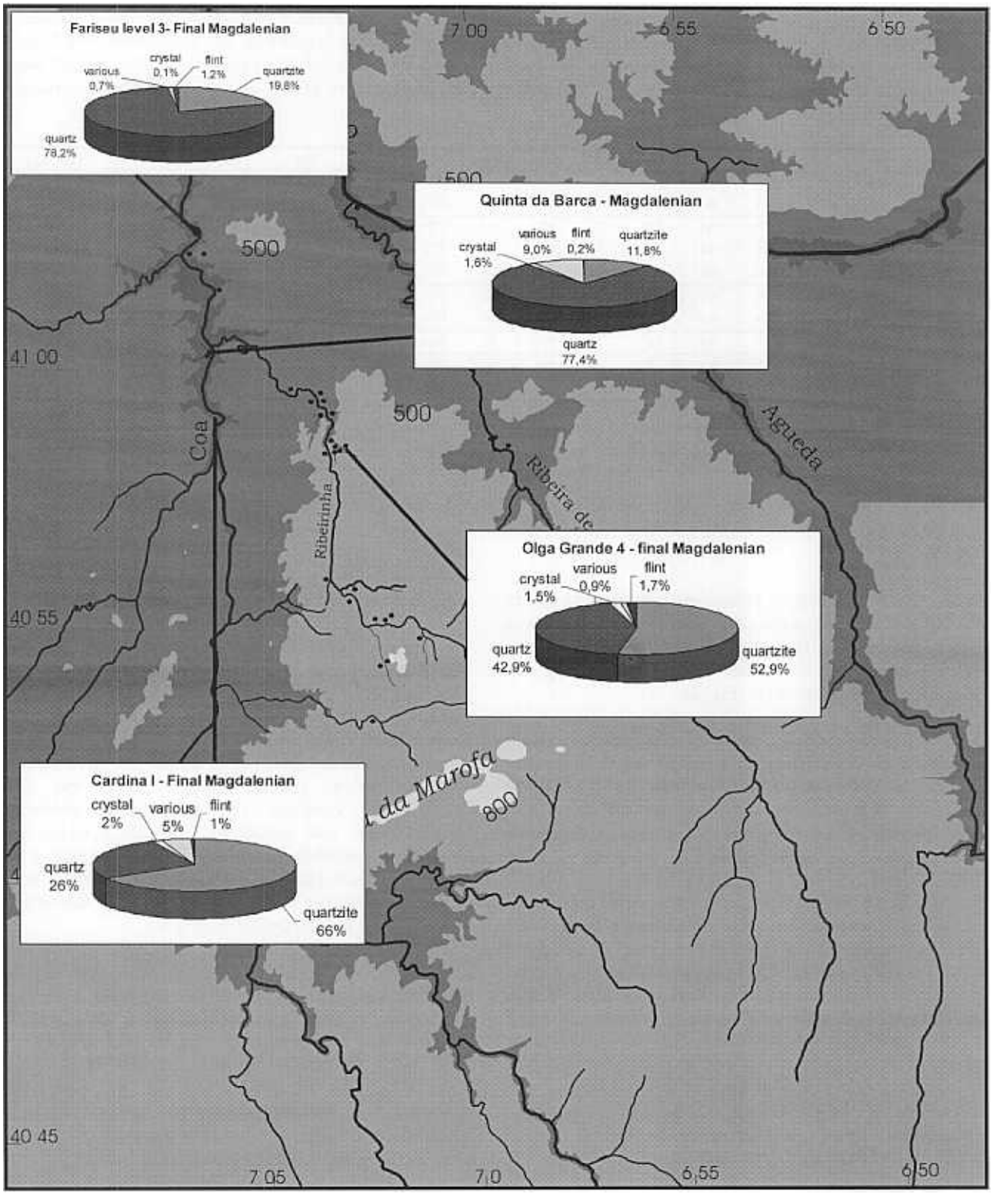

FIGURE 5. *Proportion of raw material used in the final Magdalenian sites.*

modification of refitted fragments suggests a use related to hearth structures.

Systematic refitting of parts of quartzite pebbles and quartz vein fragments broken naturally by heating from Olga Grande 4, 14 and Cardina I's final Gravettian level was realised. As a result, a selective use of these rocks with their rich silica content as accumulators in hearth structures, during the Gravettian phase was revealed.

TABLE 3. *Petrographical and micro-palaeontological description by thin-section of geological samples located in figure 3. Mq, megaquartz; mq, microquartz; cq, criptoquartz; l.fs, chalcedony length-fast; l.sl, chalcedony length-slow; op, opal; fss, siliceous fossiles; C an,carbonates (bioclasts, rhomboedric, micrite); C ps, carbonate after silicification; OFe, Iron oxides; Evp, evaporitic traces; Trr, terrigenous; Idn, identification of thin section; T.sil. flint macroscopic types;?, probable presence; Test, testimonial presence.*

Mq	mq	cp	l.fs	l.sl	Op	fss	Can	Cps	OFe	Evp	Trr	Por	Idn	Geology
10%	no	70%	2%	no	yes	no	10%	-	5%	no	5%	no	OU 12	Bajocian
no	no	60%	2%	no	no	no	30%	-	10%	no	no	no	OU 15	Bajocian
5%	no	75%	10%	no	2%	?	5%	no	2%	no	5%	2%	5.02 Cax	Cenomanian
2%	no	78%	5%	no	?	?	5%	no	5%	no	5%	no	5.03Acax	Cenomanian
5%	no	75%	10%	no	?	si	2%	no	5%	no	5%	Test	5.04 Cax	Cenomanian
5%	no	80%	5%	no	no	?	2%	no	5%	no	Test	no	5.05 Car	Cenomanian
2%	no	88%	5%	no	?	?	5%	no	Test	no	Test	no	5.06 Car	Cenomanian
10%	80%	-	5%	no	no	?	5%	Sí	Test	no	no	Test	Sá 3	Liassic
10%	-	80%	10%	no	?	-	no	no	6%	no	5%	Test	QDL.3	Liassic
no	-	80%	5%	test	yes	-	no	no	5%	no	5%	2%	C.V	Pliocene
Test	-	70%	10%	no	?		18%	no	2%	no	no	test	1.1 Rie	Miocene
no	-	70%	no	5%	yes		20%	no	no	no	2%	2%	1.4 Rie	Miocene
no		70%	no	20%	yes		10%	no	no	yes	no	test	2.2 Rie	Miocene

In these occupation levels, the pieces corresponding to this function always constitute the principal component in weight.

Schist from the Desejosa formation, extending to within the last 9 kilometres of the Côa valley, was transported as natural fragments or shaped pieces to Olga Grande 4 on a granitic formation or to the Cardina site during the Magdalenian and Gravettian (Fig. 2).

The preliminary setting apart of thousands of lithic remains has been made it possible to establish the production processes of different raw materials, their techniques and purposes, and the representation of each phase of the operative scheme of knapping. For local quartz and quartzite the production sequence is quite complete and essentially represented by the production of flakes. The method of flake production varies during this period. In Quinta da Barca Sul's occupation level of the final Magdalenian the Production of flakes on prismatic cores on quartz was aimed at the production of scrapers. In the Gravettian occupations, massive quartzite flakes and fragments delimited by natural fractures were used for the production of simple tools like side-scrapers or notches. The refitting carried out on these tools made of fine-grained quartzite from the bottom of the valley and discarded in Olga Grande 14's final Gravettian occupation, suggests a function as cores, and for the production of chips and short bladelets.

The small quantity of flint discarded at all the sites, except at Olga Grande 6 where the sample from 10 sq. m tests is not abundant (Fig. 4 and 5), corresponds essentially to the final phases of the production sequence. Fragments of microliths on bladelets showing diagnostic fractures, discarded after use as projectiles, dominate the flint assemblage during the Gravettian and final Magdalenian. However, the presence of extremely reduced cores and tablets in final Magdalenian and Gravettian assemblages indicates the production of bladelets by soft hammer percussion on prismatic cores or by anvil bipolar percussion on flake or fragmented tools made on blades, broken during use.

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The rock crystal and fine grained local and regional silicifications (groups 10, 11, 13, 14) were used as a substitute for flint, for the production of microliths (Aubry 1998). The production sequences of bladelets or small flakes are similar to those of flint. Usually, the different phases of production are not completely represented in the settlements, and some microlithic points discarded after breakage during projectile use are often the only examples of a raw material category.

Technological study of the Solutrean assemblages is not facilitated by an erosion problem that affects the soils of this phase. At Olga Grande 4 site, we observed the production of bladelets on prepared non-local flint cores, transformed into backed bladelets, while characteristic pressure-retouched flakes indicate the production on the site of shouldered points on flint blades transported from more than 250 kilometres away (Aubry 1998).

TABLE 4. *4 classes of formation ambience proposed for the archaeological remains studied in thin-section.*

Samples	Macro-Types	Main siliceous fabric	Relist Particles	Formation ambiences
5-01 to 5-06	T-1	microquartz mosaic fabric	foraminifera Ostrachoda Siliceous spicules	Relatively deep silicified marine limestone
5.07 to 5.08	T-2	microquartz mosaic fabric	Peloids bryozoa Shell fragments	Relatively rich in fossiles and peloid marine limestone
5.10	T-3	microquartz mosaic fabric	Gasteropoda Charophytae Ostrachoda	Non marine limestone Fresh water
5.19	T-9	criptoquartz	Iron oxides (Hematite) Terrigeneous quartz Pseudomorfs of lenticular gypsum	Evaporitic formation ambience high salinity waters

TABLE 5. *Distribution of flint classes in the Upper Palaeolithic sequence of level 4 of the Cardina I settlement. Each level (from 1 to 9) is an artificial unit of 5 cm. thick in the12 sq m excavated.*

	1	2	3	4	5	6	7	8	9	Total
C4d1	6	3	3	4	1	0	1	0	0	18
C4d2	1	2	4	9	0	0	0	0	0	16
C4d3	13	5	3	6	2	2	2	0	0	33
C4d4	19	16	8	24	2	0	2	0	1	72
C4d5	29	20	7	33	4	2	0	0	0	95
C4d6	21	23	10	30	7	5	5	0	0	101
C4d7	24	19	11	40	6	3	3	0	3	109
C4d8	32	31	9	48	8	4	4	0	2	138
C4d9	18	9	11	32	2	2	2	0	1	77

Interpretative model for raw material movement

The different categories of rocks used in the Côa valley settlements delineate 3 distinct scales of supply territories. There are local resources available within less than 5 km, regional resources from within territories of 50 km, and flint displaying petrographic and palaeontological characteristics that indicate a siliceous substitution of limestone, from sedimentary outcrops that cannot be found in the Côa basin drainage.

This last group of rocks occurs in all the sites and during all the phases of the Upper Palaeolithic. The potential origins proposed indicate movements ranging between 150 to 250 km and from very different geographical directions (Fig. 6). The nature of these movements and processes of discard of flint can be explained by two main exploitation models.

In the first, the low basin of the river Côa would have been the location for seasonal incursions from several human groups, originating from regions where flint resources are present.

In the second, a local group based on the Côa valley (and other tributaries of the left bank of the Douro) would have been joined temporarily by other groups at seasonal aggregation sites, or could have exchanged raw materials in the course of contacts at the limits of their territory.

The analysis of raw materials and of their technological use during the chronological phases defined is arguing in favour of the second hypothesis of a permanent local group.

The first argument we can put forward is the high density and wide distribution of sites detected in the prospected area. However, this factor can also be interpreted as the result of the low rate of soil formation and the orientation of the systematic survey by a geomorphic model.

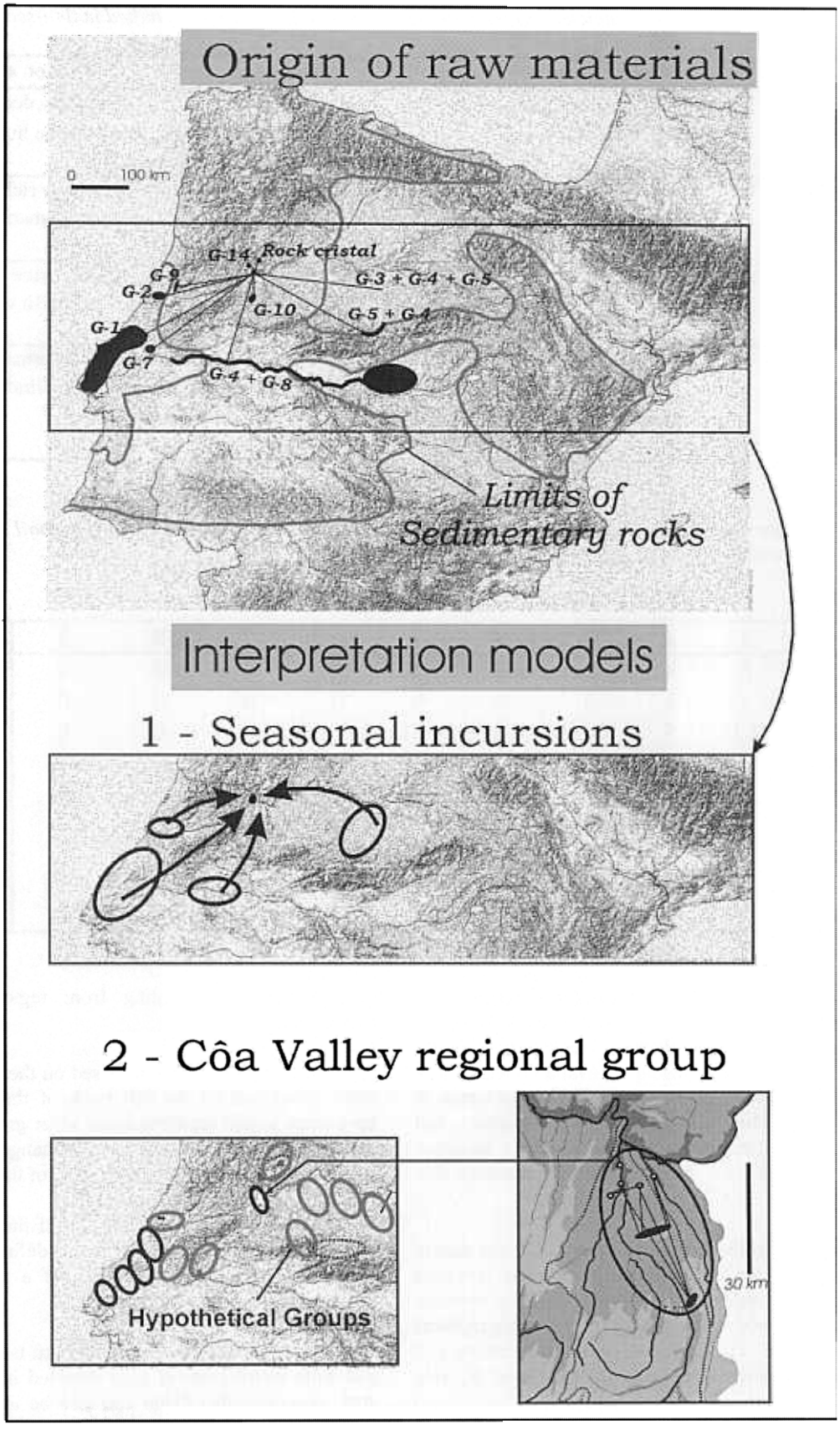

FIGURE 6. *Proposition for the origins of flint and two explicative models for the flint discarded in Upper Palaeolithic sites of the Côa Valley.*

The second is the comparison with the spatial range of raw material exploitation areas defined by Upper Palaeolithic settlements in the Portuguese Estremadura (Zilhão 1997). These areas are less than 50 km long, similar to the territory defined by the movement of the fine-grained vein quartz of the Almeida plateau, systematically transported from the upstream part of the Côa valley (Fig. 6).

The third is the systematic association of geological and geographical origins of flint discarded in all occupation level, independently of the interpretation in terms of activity proposed for each settlement. The varieties of flint used in short specialised occupations with a low density of remains are similar to those represented in dense residential bases of thousand of tools. In a logistic model, one might expect to find only one geographical origin of flint in a short-term occupation lithic assemblage. On the other hand, the variety of flint can reveal a logistical function of the plateau site for residential occupations, with a high density of remains, at the bottom of the valley.

Concluding remarks

The discovery of the Côa valley rock-art has not only transformed our conception of Upper Palaeolithic hunter-gatherers, but also bears witness to the systematic exploitation of the resources of the northern Meseta. The data obtained by a study of raw material supplies indicate relationships within an extensive territory of the Iberian Peninsula.

The reconstruction of the modes of human occupation and movement within this wide territory as defined by raw material lithic resources can be improved by a more accurate determination of the sources of discarded pieces of flint, and the development of a systematic survey of areas with flint outcrops. The data obtained will probably make it possible to establish the existence of other unknown Upper Palaeolithic groups, based on the exploitation of drainage basins containing flint resources, located on the northern and southern slopes of the central Iberian Cordillera.

In an attempt to reconstruct the various activities responsible for the constitution of lithic assemblages, and the extent and modes of resource exploitation, the data will make a new contribution to the interpretation of Palaeolithic social organization and the processes of diffusion of symbolic representations and technical innovations.

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