



Raw materials in the Neolithic-Aeneolithic of the Iberian Peninsula

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Introduction

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The Iberian Peninsula, with an extension of 581.600 km², a great geological diversity and hundred of archaeological sites with recent prehistory chronologies, results an interesting territory for the lithic raw materials study and their use and distribution paths along the different historic periods.

This indubitable interest contrasts with the scantiness of studies about the raw materials used in the lithic industries of the prehistory, especially in the Neolithic-Aeneolithic period, where the lithological diversity is usually bigger than in the Palaeolithic.

This fact has carried out to the practical "inexistence" of this extensive territory, in a lot of the publications that has been realised over this thematic up to date in Europe, Cummins (1983).

In this chapter, we can only pretend to give first ideas of the types of raw materials that appear with a greater abundance in the Iberian Peninsula, making a balance of the published results just to date; the general characteristics of the Iberian geology and what possible trade and distribution routes have followed many of these materials at the Neolithic-Aeneolithic in this area.

It is plain that the great number of archaeological sites and chronologies known in this territory, their vast cultural, geographical and geological diversity, and the great variety of sites (caves, open air settlements, burials, villages, megaliths, etc.), make that the investigation task still outstanding is enormous and undoubtedly a challenge for the future researchers.

The Neolithic in the Iberian Peninsula has been submitted at very traditional focussing and basically dominated by the cultural change in the ceramics explanations. It was believed that their provenance from the Middle Orient and the diffusionist type explanations

were reinforced, in contrast with the ligurian cave of Arene Candide (Italy). In the 60th-70th decades, Pellicer (1967) considered a tripartite scheme (Old, Medium, Recent) on the basis of the studies of caves as Carigüela de Pinar (Granada) or Nerja (Málaga).

The studies of the Valencian caves (Or, Cocina, Cendres) questioned the basis of the dual model that domains as paradigm in the functionalists explanations, recycled in explications of diffusion. A wave of advance from Middle Orient was considered, that provide the Neolithic to SW Europe and go to acculturate to the old hunter-gatherer populations. It is considered that the Neolithic arrived associated to the cardial ceramic horizon, with groups that behaved the agriculture and the cattle raising.

Other studies in caves as Fosca (Castellón) studied by Carmen Olarí and Francesc Gusi, already questioned the Levantine model and proposed chronologies previous to the Vth millennium B.C. for the first groups of producers. The excavations of Pellicer and Acosta in the caves of Dehesilla, Parralejo and Nerja in the 80th provided already previous chronologies, dated at VIth millennium for the Neolithic in the Occidental Subbetic. This fact carried to a restatement of focusing to positions more autochthonists, Pellicer (1995).

Recent studies in archaeological sites of the Cadiz and Algeciras Bays, as in Embarcadero del Rio Palmones and El Retamar, questioned the advance wave models, and confirm the specific weigh of the lithic technology with a Epipalaeolithic tradition (geometric microliths). In the VIth and even VIIth millennium B.C., it is possible to observe the wide paper of the vegetal resources, the importance of the fishing practices and a growing increase of the animals domestication (bovids, caprids), together with the hunting maintenance, Ramos and Lazarich (2002), such as reflects the Portuguese sea shell accumulations from the Bays of Lisboa, Setúbal and the Algarbe (Lagos area).

Geological context of the Iberian Peninsula

The Iberian Peninsula, formed by Spain, Portugal and Andorra and placed at the SW extreme of Europe, is a complex territory with a great variety of geological domains, ages and lithologies. Their geological materials included materials from the Precambrian or Upper Proterozoic (more that 600 million years), to the Holocene, grouped in great units. These Units are: the Hespérico or Hercynian Massif, the Alpine cordilleras (Pyrenees, Betic Cordilleras), Cantabrig Cordillera, Iberian System and Costero-Catalana Cordillera (Fig. 1).

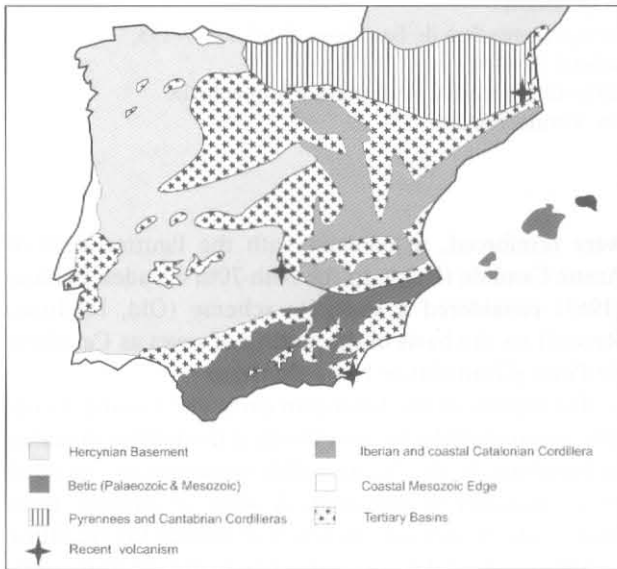


Fig. 1. Geological synthesis of Iberian Peninsula.

In these units, we can differentiate two great groups of materials: the ones that formed the Hespérico or Iberian Massif, that cover almost the west half of the Iberian Peninsula, formed fundamentally by premesozoic materials, in general metamorphic and plutonic rocks, and affected by the Hercynian or Variscan orogeny, being a basement that corresponds with an old mountain chain formed in the Upper Carboniferous and after eroded; and the ones that form a second group of materials that appear in the Peninsula and is constituted by Mesozoic and Cenozoic rocks, generally sedimentary.

The geological evolution of the Iberian Peninsula has been developed during a period of 250 m.y., and has been produced fundamentally by compressive forces, on the Iberian microplate, between the European and African tectonic plates, in general with materials of marine origin. The main characteristics of each of these great units are briefly, the following:

The Hespérico Massif was divided in 6 zones by Lotze (1945), after in 5 different zones by Julivert (1979), with limits between them subjects at controversy, Dallmeyer-Martinez, (1990). These zones are: the Central Iberian Zone and four more zones: Astur-Occidental/Leonese Zone and the Cantabrian Zone at the North, and Ossa-Morena and South Portuguese zones, at the South.

In the *Central Iberian Zone (CIZ)*, the more extended (North of Portugal, Galicia, Castilla and León, Madrid, Castilla-La Mancha, Extremadura and a portion of N. Andalusia). Present Palaeozoic and Upper Proterozoic rocks, nearly always metamorphic from lower to high grade (migmatites in Central System) and an abundance of granitic intrusions. In the North occidental area (Galicia) appears a series of allochthonous nappes or ophiolitic fragments of exotic terrains, the catazonal complexes of Cabo Ortegal, Ordenes, Lalin, Braganca, Morais and the blastomylonitic band. These units appear constituted by eclogites, metagranulites, metaperidotites, metasediments and amphibolites. Metamorphosed basaltic rocks also appear, Gil Ibarra & Arenas (1990). Metaperidotites are spinel-bearing harzburgites, dunites and pyroxenites. In the lower zone of the epizonal units, present in this ophiolites, appear greenschist facies. Other lithologies are metabasites and blueschist (in the Morais-Braganca area).

The *Astur-Occidental/Leonese Zone* and the *Cantabrian Cordillera* are placed between the Hercynian Massif materials of Galicia and the Pyrenees. The metamorphism grade and number of plutonic intrusions increased towards the West. Present sedimentary rocks from the Lower Palaeozoic (slates, quartzites, etc.), and Precambrian rocks in two antiforms: Narcea and Ollo de Sapo.

The Cantabrian cordillera has its origin in the folding of a Mesozoic basin, during the Alpine orogeny. The result of this process is a mountain chain parallel to the coast of the Cantabrian Sea. They present materials from the Triassic to the Tertiary; evaporites and detrital materials from the Triassic; carbonated marine sediments from the lower and middle Jurassic; fluvial and deltaic detrital materials from the upper Jurassic and Cretaceous. Reef facies are also present at the end of the lower Cretaceous and typical facies of the continental platform in the upper Cretaceous, and after a transgressive period, turbidites and abyssal deposits. In the lower Tertiary, are present limestones with organic materials and detrital sediments. In the Eocene the main orogenic folding was produced; in the Oligocene, a molasse sedimentation was produced into inner isolated basins just to the medium Miocene, with the deposit of post-orogenic sediments.

The *Ossa-Morena Metavolcanic Zone*, is characterized by materials from the Precambrian to the Upper Palaeozoic, and metamorphic and granitic rocks. Near the limit between the Central Iberian Zone and the Ossa-Morena Zone, a big batholith is placed, the Batolito de los Pedroches. Between this area and the South Portuguese Zone appears a narrow band or suture zone, with ophiolite type materials in which dunite, serpentinite, metabasalt of a Precambrian age and other rocks as granites are present, with a great nappe structure. The metamorphism of these rocks produces greenschist with chlorite and amphibolites with garnet-staurolite, Quesada & Munha (1990).

In the *South Portuguese Zone*, one zone sutured in the South, along of the Pulo do Lobo ophiolite, outcrop flysch type materials with a low metamorphism, from final Palaeozoic (Devonian and Carboniferous), intercalated with volcano-sedimentary materials of a felsic volcanism, and associated with great deposits of polymetallic sulphides (Pyritic Belt).

The Alpine Cordilleras: This orogenic belt that extends from Asia Minor to Gibraltar Strait, is present in the geological history of Iberia in the last 200 m.y., from the end of Palaeozoic to the present. The two great Alpine cordilleras in the Iberian Peninsula are:

The *Pyrenees*. (Figs. 1 and 4.B) This mountain chain, that separates Iberia from France, is constituted by a nucleus of materials that was affected by the Hercynian orogeny and later by the Alpine orogeny. In its Palaeozoic nucleus the metamorphic lithologies are dominant, deformed by the Hercynian orogeny and forming the basement and the maximal heights of these mountains. At the North and South of this nucleus, Mesozoic-Palaeogene sedimentary materials appear, that together with the basement were deformed by the Alpine orogeny and which form the marginal Sierras, in general of carbonates lithologies. This chain is basically formed during the Eocene, by a contact between the Iberian microplate and the Euro-Asiatic plate, which generates great compressive forces due to the lithosphere shortness and with a big folding and fracturation. The chain, with a WNW-ESE direction, appears divided in two, north and south zones, separated by a faulted zone. This transform fault affects to the lithosphere and has played an important role in the Iberian plate movement in front to Europe.

We can separate two zones in the Pyrenees: the Occidental or Basque-Cantabrian Pyrenees, and the Central and Oriental Pyrenees, with two zones, one southern or South-Pyrenean and other northern or North-Pyrenean, which extends up to Aquitaine. In the axial zone predominates the metamorphic rocks and granitoids, the north and south Pyrenean zones (Pre-Pyrenees) are constituted by sedimentary rocks of different lithologies, specially the Mesozoic carbonates.

The *Betic Cordillera*. (Figs. 1 and 7) This cordillera formed in the Alpine orogeny, is extended from Gibraltar to the Balearic Islands, as well as symmetrically by the North of Africa. The South of Iberia presents a Neogene sedimentary material band that constituted/formed many sedimentary basins as the Guadalquivir river basin, Vera (1988). Other band of Mesozoic and Cenozoic sediments, placed on a metamorphic plate of the Iberian Massif. These materials can be grouped in two great groups: the Prebetic and the Subbetic-Penibetic, the first ones with shallow sedimentary marine materials and the second ones with deep marine sediments, in both cases very tectonised, with nappes and folds. At the west of the chain appear the Campo de Gibraltar Units, formed by turbiditic materials of flysch type, Gutierrez Mas *et al.*, (1991). In the central part and the east of the

chain, appear the metamorphic materials of the inner zone, the Domain of Alborán. This region has been divided in many units: Malaguides, Alpujarrides and Nevado-Filabrides, Vera (1994), Martín-Algarra (1987). In these, appear premesozoic and Mesozoic metamorphosed rocks, with high pressure and low temperature facies (Nevado-Filabrides) or high grade rocks (Alpujarrides) (eclogites, amphibolites, gneiss, schist, etc.). In the central part, a great block of ultrabasic rocks (peridotites from Ronda) appears.

The *Iberian Cordillera*. (Fig. 1) This cordillera presents a basement of metamorphic rocks, that belongs to the Hercynian Massif and outcrops in many sites of the cordillera, over this appears a launching level with facies formed by marls and gypsums of Triassic age, over this appears in discordance, a group of sedimentary rocks of Mesozoic age, in general carbonates, that was extended from the Cantabrian Cordillera to the Valencia Gulf, in the Mediterranean Sea.

Many intercalated volcanic rocks occasionally appeared. In general metamorphism doesn't exist. Finally, and due to a process of distension, along their evolution, little basins filled of Tertiary materials have been formed, as occurs in Almazan, Ateca or Teruel.

The *Catalonian Coastal Cordillera* (Fig. 1 and 4) presents two alignments parallel to the Mediterranean coast, from the Rosas Bay to the delta of the Ebro River, in the NE of Spain. It is an Alpine cordillera with Mesozoic materials in discordance over a Hercynian nucleus. In many areas of the Cordillera appear tectonic depressions (graben) filled by tertiary sediments. In the central area, a tectonic accident, the Llobregat fault, cut in two parts the mountains alignments; at the northeast area the Palaeozoic materials predominate and in the Southwest area, the Mesozoic presents a progressive development up to the Ebro River delta.

Alpine sedimentary Basins. They were formed in the process of opening of the Atlantic Ocean and the movement of the Iberian microplate to the east generating the alpine mountains, originated in the inner intracratonic basins, that quickly started to eroded, and foreland basins in the marginal zones of the continental margin. From the first group are the Duero and Tajo Basins and from the second, the Guadalquivir and Ebro Basins.

The volcanism in the Iberian Peninsula. A Cenozoic volcanic activity appears, which seems to be of the intraplate type, with activity areas between the Upper Miocene and the Quaternary, in three zones: Olot, at NE Spain, Campo de Calatrava, in the central region of Spain and Cabo de Gata, at the SE of the peninsula. Volcanic materials vary from the quaternary basalts in Olot, to the olivine basalts - olivine leucitites and olivine nephelinites from the Campo de Calatrava; with a volcanism of andesites and rhyolites, abundance of pyroclastic episodes and the presence of domes and outflows in the Cabo de Gata area (Fig.1).

Northwest of Iberian Peninsula, Galicia - W. Spain, Extremadura

In these regions, with an abundant Megalithic phenomenon and different archaeological sites of the recent prehistory, the petrological and mineralogical studies of polished industries are practically inexistent. Only many brief descriptions of the rocks in the lithic industry of many sites have been made just to this moment, Fábregas (1992), in Galicia. Mineralogical and chemical analysis of Neolithic green beads from Galicia were made by Guitián and Vazquez Varela (1975), Vazquez Varela (1975). In Extremadura region, an area with an important megalithic phenomenon, Enriquez Navascues (1995), Bueno (2000), Bueno et al. (2000), archaeometric analysis of lithic industry are not made just to date and are now in course.

North of Iberian Peninsula. Basque Country, Navarra, Aragón

Andoni Tarrío

Introduction

From the beginning, the raw materials in which are manufactured the prehistoric polished materials to attach attention, principally because they evidenced a great lithological diversity that seems evocated very different provenances.

So, from the end of the XIXth century and the beginning of XXth, geologists have worked with the prehistorians in the examination of archaeological materials that composed these lithic elements to attempt the characterization of the constituent rocks and their geological and geographical origin. Among the pioneer studies in Spain, we can cite the works of Quiroga (1880) and of San Miguel de la Cámara (1918 and 1919).

But these petrographical studies were not continued for many reasons since this information could not be correlated with that one given by the geological outcrops, mainly because the basic geological works had not been done, which would have given an adjudication of the analysed rock type with a definite geological outcrop. At that time, works of geological cartography were beginning to start, with the creation of the Commission of the Geological Map of Spain. On the other hand, in those days, a great number of prehistorians still considered more important the object itself than its archaeological significance.

To these obstacles we also have to add the fact that the analysis methods were expensive and destructive. It is not till the 80 and 90 decades of the XXth century that more or less systematic petrographic studies will return, in this type of materials in Spain.

We found materials that generally present an external aspect different to the fresh sample of the same rock when the lithic raw materials identification of the polis-

hed implement manufactured are approached. These lithic evidences have undergone important surface modifications, that masked the mineralogical and textural criteria that usually serve for its identification due firstly to all the transformations derivate from the mechanical abrasion during the object manufacture phases (picking and polishing fundamentally) and, secondly to all the post-depositional processes that have been affected to the rock during their burial: patination, oxidations, dissolutions, recrystallizations, etc. in the rock-sediment interaction (fig. 2.B).

These circumstances have motivated that it has been necessary to recur to physico-chemical techniques of characterization, with more or less precision for the determination of mineralogical and textural features of the rocks and minerals that composed the archaeological objects. Their classification are based in mineral percentages and also in chemical analysis, after a geochemical and a petrographic study.

Raw materials in the Basque Country, Navarra and Aragón regions

In the Basque Country, Navarra and Aragón, a great vacuum exists in relation with the raw materials determinations in which polished implements are made in the recent prehistory. A scarce number of publications exists on this line of investigation, so systematic studies have been done instead. The oldest reference that approach the nature of the prehistoric polished objects from the Pyrenean region, was realized by Mortillet in 1889: "Dans la région des Pyrénées, les haches sont en pierres de cette chaîne de montagnes, parmi lesquelles on remarque les ophites".

A great part of the polished artefacts proceeds from the casual discoveries or particular collections, generally without a complete information about their chronologies and context.

BASQUE COUNTRY

In the Basque country, data about the petrological features of the polished prehistoric industry are also very scarce, and sometimes, the determinations are not very reliable. One of the first works that compile polished materials from the Basque Country prehistoric cultures are the publication of Apellaniz (1973). Later, Arribas and Berganza (1984) studied 11 polished axes from different provenances in Gipúzcoa and Bizkaia, that just this moment are unpublished. These authors concluded that dolerites are the more habitual lithology in this group.

It is necessary to wait to the 90 decade to encounter an exhaustive work, that define, with certain warranties, the materials from which the implements are elaborated, in this region. This is the case of Ormazábal et al, (1994), that studied a total of 70 polished objects, collected in surface around the Urrúnaga reservoir (Álava). From this collection, 55 are identified and 15 objects and fragments are not identified. In this case, implements made

Fig. 2. A.- Perforated Axe from the Dolmen de Balenkaleku Norte (Altzania). (Barandiaran and Vallespi, 1984)

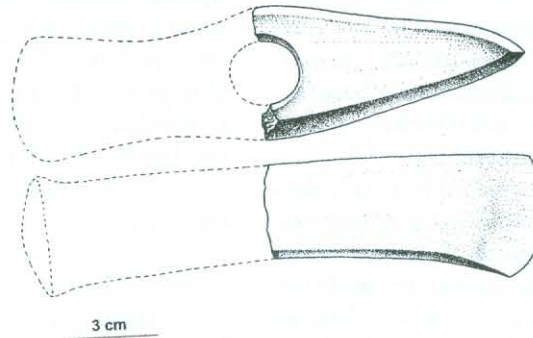


Fig. 2.B.- Micrograph of a tin section of a dolerite type object. It is possible to observe an alteration layer in the surface (in black and reddish colours) of 0,7 to 1,0 mm. Thickness. Parallel polars. Width of photo = 2,5 mm.

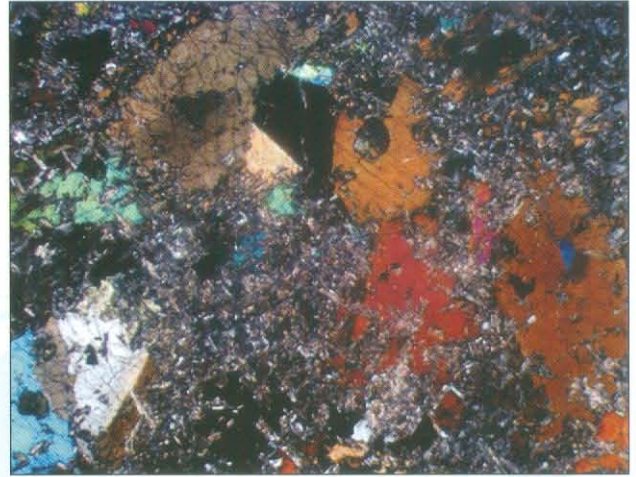


Fig. 2.C.- Dolerite type rock, with a medium to fine grain size. Crossed polars. Width of photo = 2,5 mm.



Fig. 2.D. - General view of the texture present in a vulcanite object. Crossed polars. Width of photo = 2,5 mm.



Fig. 2.E. - Siliceous mudstone with abundant and little detrital quartz fragments and micaceous minerals (5-10 microns in diameter). Parallel polars. Width of photo = 2,5 mm.

on sedimentary rocks are dominant, with a 77,12 %. Metamorphic rocks (quartzites and sillimanite-andalusite nodules) and igneous rocks (basically dolerites), with a 11,42 % in both cases, complete the register.

Another group of polished industry, has recently been studied by Fernández Eraso et al, 2003) where 34 axes and adzes, completes or fragmented, came across in 13

sites from Álava and the Condado de Trevino, in general from surface prospections.

Ten of these samples were analysed by means of petrographic microscope and their mineralogical composition and texture have been characterised. This is a group basically constituted by igneous rocks (79,4 %), with

a 64,7 % of dolerites (Fig. 2.C) and volcanites - basalts (Fig. 2.D). Sedimentary rocks are the second group, with a presence of 14,7 % (shales, mudstones - Fig. 2.E - and flint). Finally, the metamorphic rocks are less represented, with only an 5,9 %, that correspond with sillimanite-andalusite samples, aluminium nesosilicates, typical from the thermal or contact metamorphism.

Most of these materials could proceed from the outcrops that exist in the alavese diapires, in short from the ophitic masses that exist in the Salinas de Anana, Maestu and/or Penacerrada diapires. As soon as, the more volcanic rocks, although their provenance is less evident, we can find very similar outcrops, both in the vizcaine Synclinorium as well as in the Palaeozoic from the Pyrenean occident (east of Gipuzkoa and north of Navarra).

Non volcanic lithologies present are the flint, that proceed from the Trevino outcrops and the mudstones that can proceed from siliceous-carbonated nodules, very abundant in the Cretaceous formations of the North of the Basque Country.

In relation with the polished implements made on sillimanite-andalusite metamorphic porphyroblasts, we can find the more neighbouring outcrops in the metamorphic aureole of the Penas de Aya Massif. Other possibility of source area, with good samples of this nature, can correspond with the contact aureoles of the granitoids from the Orient of Asturias, Fernández Eraso et al, (2003), with a farther provenance and so, their origin in these outcrops are much less probably.

NAVARRA

An important old compilation of data exist for the Navarra territory, in relation with the polished materials, realized by González Sáinz (1979) where it is summarized the collection of these materials known to the date. It is composed of a total of 257 implements and polished fragments. The petrological composition is hardly mentioned, the only identified material is the dolerite. This is a material that is abundant in this territory that appears associated to the diapiric terrains from the Keuper facies

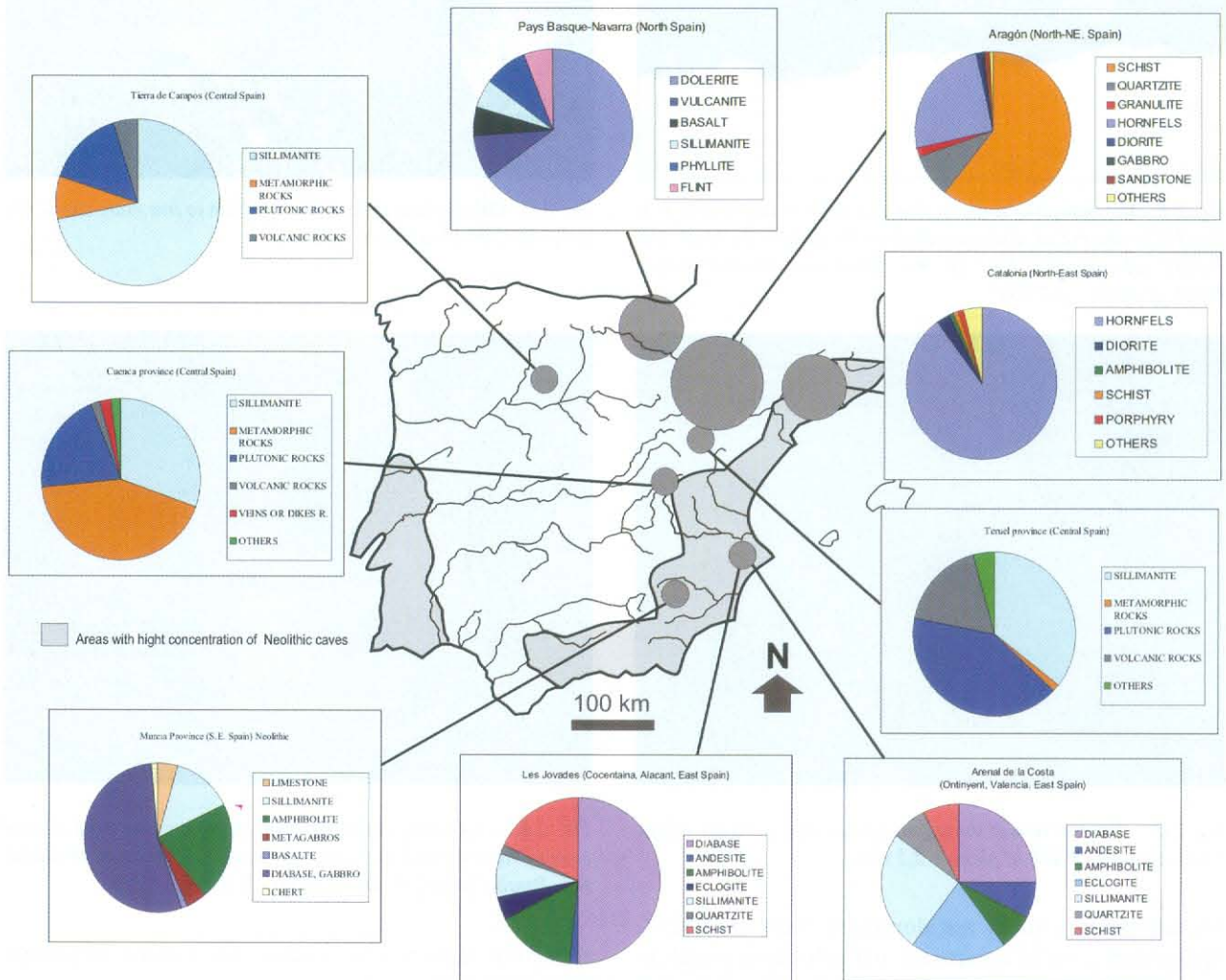


Fig. 3.- Statistical diagram (Quantitative percentages of lithologies in this polished industry) of rock groups from the polished lithic industry from Basque Country, Navarra, Aragón (North Spain); Cuenca and Teruel provinces; Catalonia, Pais Valenciano and Murcia province. (After data from Tarrina, Clop, Barrera et al., Orozco et al.), and two of the areas with a big concentration of caves with Neolithic-Aeneolithic sites.

and Triassic age that outcrop mainly in the Salinas de Oro, Larraun, Azpiroz y Ayos region.

Although the geographical distribution of the polished implements is very wide inside the Navarre territory, however, a larger density of findings can be appreciated in the medium-occidental Navarre, that is to say, in the nearest zones to the principal diapiric outcrops.

One of the more interesting examples of the polished objects from Navarre is the perforated axe (fig. 2.A) from the Balankaleku N. dolmen (Sierra de Alzania, Alsasua) which was recovered in the archaeological survey that in 1919, D. José Miguel de Barandiarán together with T. Aranzadi and E. Eguren carried out, whose data were published later (Aranzadi et al, 1921). Subsequently this finding is cited in a great number of occasions, Barandiarán (1934); Elósegui (1953); Maluquer de Motes (1962); Apellániz (1973); Vallespi (1974); Andrés Rupérez (1977); González Sainz (1979) and Barandiarán & Vallespi (1984). This type of axes are in general, frequent in Brittany and in the centre and north of Europe. Typologically it appears to have a clear relation, when it is compared with the series studied by Ch. T. Le Roux (1975) in Brittany and the Sena and Loira Basins.

A petrographic study of this axe, was realised by the Prof. San Miguel de la Cámara, which determined that it is an "ophite" (dolerite), and published a photography of the analysed sample by (Aranzadi et al, 1921). The macroscopic examination reveals that this is a basic rock with a dark green colour and a microcrystalline texture. With the summarized data it is possible to conclude that it is a rock with a doleritic composition and ophitic texture, of fine grain and compatible with the basic rocks that outcrop from the North of Iberian Peninsula to the North and centre of France and Europe (diabases and dolerites) so a far origin is not discarded.

ARAGÓN

In the Prehistory and Archaeology Atlas of Aragón exist a recompilation in where are placed, in a general mode, the polished materials found in this region up to date, Utrilla (1980). At the same time, the most important general works are referenced, that contains more or less extend repertories of polished lithic products, Bosch Gimpera (1923); Ripoll (1953); Beltrán (1955) and Atrián (1960). But it is not just to the eighties when a monographic work about the polished implements of the medium course of the Cinca river (Monzón, Huesca), classifies the raw materials of the objects, in series of archaeological sites placed in this area, Mazo and Roda-nés (1986).

In this collection with a total of 158 studied samples, 120 of these are classified. Practically the total (97,5%) of the samples are metamorphic rocks, from a regional metamorphism origin, in general schist and quartzites; a 25 % of hornfelses and a 3,3% of igneous (diomite and

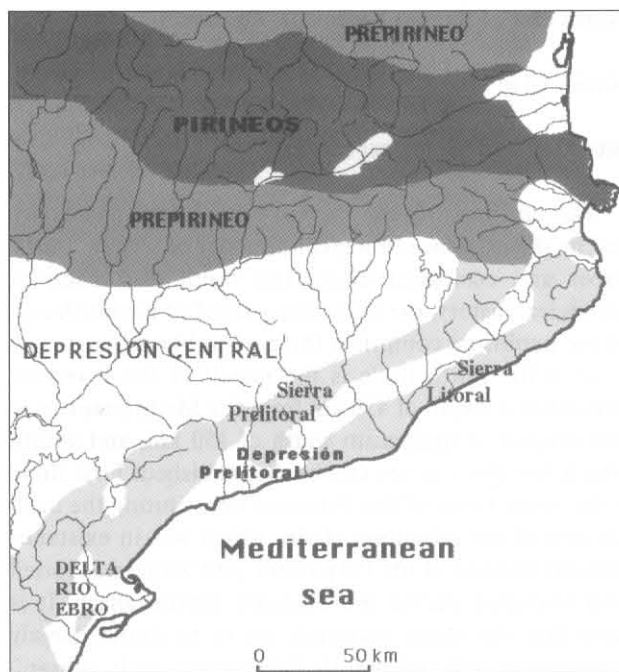


Fig. 4.A.- Geographical map of the North East area of the Iberian Peninsula

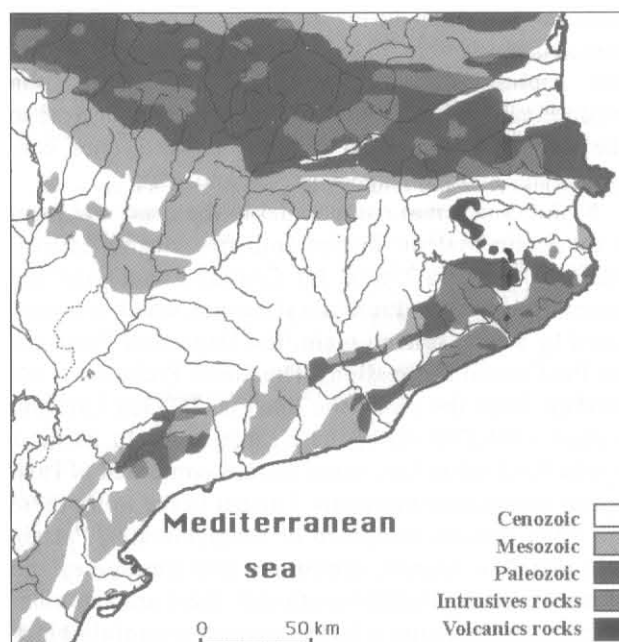


Fig. 4.B.- Geological synthesis map of the same area.

gabbro) and sedimentary rocks (sandstone). Without more definitive data about their petrological composition, these authors proposed a Pyrenean origin, compatible with the raw materials that appear in the Pleistocene gravels from the Cinca River terraces (slates, schists, hornfelses, volcanic and granitic rocks, sandstones), that were eroded and transported from the Pyrenean massifs (Fig. 2).

North east of Iberian Peninsula. Catalonia

Xavier Clop

Situation and geological context

The north-east of the Iberian Peninsula is characterised by the existence of a great diversity of terrain, landscapes and ecological units. The result of a complex geological history, the present-day relief of the north-east of the peninsula comprises three main blocks:

a) to the north there is the massif of the Pyrenees, which has a length of 450 km from the Mediterranean to the Atlantic, a maximum width of 150 km, and within which two main zones can be distinguished. First there is the main range of the Pyrenees, constituting the central axis of the mountain chain, which was in existence towards the end of the Palaeocene and which was raised and fractured during the orogenic Alpine phase. It is here that the oldest materials are to be found, largely metamorphosed and mainly Palaeozoics, such as granite, gneiss, slates, schists, marbles, etc. Then there are the Pre-Pyrenees, which comprise the relief on either side of the central Pyrenees and which were formed from the materials laid down during the Mesozoic and early Cenozoic and which were folded and raised during the orogenic Alpine phase. Limestones are clearly the predominant material, although in some sectors close to the main Pyrenean range we also find sandstones, conglomerates and red clays (Figs. 4.A and 4.B);

b) the ranges that run parallel to the coast and form a mountain system divided into two clearly defined chains: the Sierra Litoral (or Coastal Range) and the Sierra Prelitoral (or Pre-Coastal Range), which are separated by a long sunken plain, the Depresión Prelitoral (or Pre-Coastal Depression). The Sierra Prelitoral is the furthest from the coast, the longest (280-320 km) and highest (700-1700 m) of these three units. In its most northerly third we find some massifs composed of Palaeozoic and granite materials. Further to the south there are other massifs composed of conglomerates, Palaeozoic materials (slates), sandstones and limestones and Mesozoic marls. Further south still, there are a number of ranges comprising a fairly compact mountain block of quite abrupt relief, where limestones and sandstones are predominant, with a huge mass of "licorellas" (slates) and granites in the centre. Finally, as we get right down to the Ebro, we have one of the most abrupt massifs of the north-east of the peninsula, formed by limestones and Mesozoic dolerites. As for the Sierra Litoral, it forms a mountain range running along the coast itself, short in length (150-160 km) and narrow (10-15 km), with altitudes varying between 300-600 m. It is largely formed by granites and slates. South of the Llobregat, however, there are the ranges of the Garraf and the Ordal, formed by huge limestone masses. Between these, the Depresión Prelitoral forms a low-lying sunken sector some 200 km in length by 20-25 km wide,

where there are principally clays and conglomerates (Figs. 4.A and 4.B);

c) the Central Depression, which lies between the Pyrenees and the Sierra Prelitoral and which is formed by series of eroded basins separated by different high plateaus and by an extensive plain that opens towards the west. Between the Pyrenees, the Iberian System and the coastal ranges there is the Central Depression, an extensive area sunk in the early Tertiary era, sloping towards the west and progressively filled by materials from the neighbouring hills. Towards the centre of the depression, blue and grey marls were deposited. Towards the west large quantities of gypsum were deposited. On top of these evaporitic rocks were laid significant layers of materials brought down by rivers and streams and which constituted alternating layers of sandstone and clays (Figs. 4.A and 4.B).

The hydrological network of the north east of the peninsula has clearly defined traits. The western portion of the zone is occupied by the Ebro basin, which collects the streams of numerous tributaries to its left bank, that of the Segre -its source in the Pyrenees- being of particular importance. Of the other basins, only those of the Llobregat and the Ter are of any significant extent.

The human communities (5700- 2000 BC)

The first Neolithic communities of the north east of the peninsula have been documented to the first half of the sixth millennium BC. They are communities that, given their main material elements, fall within the set of cultural groups producing the impressed pottery of the western Mediterranean, specifically of cardial pottery. In the Early Neolithic of the north east of the Iberian Peninsula three phases are normally distinguished, according to the changes in the decoration of pottery: the cardial Early Neolithic (cca 5700-4400 BC), the epicardial Early Neolithic (cca 5100-4000 BC) and the post-cardial Early Neolithic (cca 4900-3500 BC).

In the early stages of the Neolithic in the region, usually termed the cardial Early Neolithic, the human communities were probably formed by small groups of individuals who established themselves both in open air sites (La Draga, Plansallosa, Barranc d'en Fabra, Guixeres de Vilobí...) and in caves and shelters (Cova de Fontmajor, Cova del Frare, Cova Gran, Cova Freda, Bauma del Serrat del Pont,...). These communities, sedentary or semi-sedentary, were farmers and herders, their subsistence activities being characterised by the variety of species exploited in each case. Hunting and gathering, of progressively diminishing importance, would have complemented their diet. Although burial remains of the period are scarce, it should be noted that towards its end we find the first evidence of megalithic structures, well documented in the megalithic burial site at Tavertet.

Their material culture was largely composed of clay pots, varying in size, for cooking, storage or transporting different food products; a largely laminar stone-working

industry, with which they produced arrow-heads, awls, sickle blades, etc.; a considerable number of elements that come under the term polished tools, such as axes, chisels, planes, etc.; a bone industry comprising needles, spatulas, bradawls, etc.; a significant number of ornamental objects, made from different raw materials, such as bone, shell and different minerals, etc.

The Middle Neolithic (cca 4400-3200 BC) was the real "Golden Age" in the recent prehistory of the north east of the Iberian Peninsula. For one thing, it saw the abandonment of the most mountainous areas and the concentration of population on the most fertile plains of the region. Sites such as Bobila Madurell and Ca N'Isach enable us to determine the characteristics of open-air settlements, as well as the main traits of their subsistence activities, with agriculture and herding now well-established. Significant developments in burial practices are well-documented both in open-air burial sites such as Bobila Madurell and Cami de Can Grau and in the development of megalithic barrow burials in the extreme north-east of the region and in the cysts of the central plateau.

The materials of the Middle Neolithic enable us to observe that the region was fully integrated in the major networks of the circulation of goods that existed at this time in the western Mediterranean and which permitted the distribution of different types of elements of mineral origin such as flint, obsidian and possibly certain types of rocks used in the making of polished tools, such as jades. The north-east of the peninsula was able to bring to these trade networks variscite, a mineral element used in the production of ornamental objects and which was obtained from the mines at Gava (Barcelona), undoubtedly one of the most important sites of recent prehistory, not just in the peninsula north-east but also in Western Europe.

Both the sum of burial evidence known in the whole of the region as well as the presence of its own mines allow us to argue that by this stage there was already a certain amount of development of internal social differences.

The Late Neolithic and the Chalcolithic extend from the final centuries of the sixth millennium to *circa* 2000 BC. The human communities appear to have broken down again into units of smaller size and occupy the whole of the region, including mountainous areas, again. The large number of sites documented suggests that significant demographic growth occurred. Apart from that, while it seems that there were no great changes in the architecture of living structures, which were very simple in nature and following the traditions begun in the Early Neolithic, as far as burial practices were concerned we see a spectacular increase in the number of burial structures, among which the most significant fact, apart from the extent of collective burials, is probably the diverse typology of burial sites. Different types of megalithic and para-megalithic burials were used: caves and natural shelters, structures of originally domestic use, etc.

Of particular note in the material culture is, first of all, the development of metal-working, with simple technology, for the production of sumptuary items. But we should also note the presence of a series of objects making up what has been called the Campaniform "pack", chief among which is Campaniform pottery. The Campaniform phase (circa 2800-2200 BC) shows that the region continued to be party to contemporary phenomena occurring in large areas of Europe.

Raw materials used in making polished tools

From the beginnings of prehistoric scientific research in Catalonia, researchers were aware of the importance of determining the raw material used in the making of polished tools and its possible origins. However, despite the fact that some prehistorians were fully aware of the importance that ought to be given in this sense to both petrographic analysis and the necessity of collaborating with specialist geologists, Serra-Rafols (1930), for decades the determination of raw materials, when it was carried out, was done so at macroscopic levels and invariably for a small number of polished tools. It was not until the 1980s that some researchers began to carry out studies of a certain rigour, using proper analytic methods, particularly taking thin sections, Bosch (1984); Alvarez (1986-1989). The characterisation of raw materials via the taking of thin sections has been up until now the most widely used analytic practice, Alvarez & Clop (1994) and (1998); Clop & Alvarez (1998); Clop/Alvarez/Reche (2000); Casas (2000). Only in the occasional relatively recent study, and in very specific cases, have other sorts of analysis been made, such as X-ray diffraction and microprobe analysis, Clop & Alvarez (1998); Casas (2000).

The work carried out in the last twenty years provides us with an overview that, although it still leaves many questions unanswered, allows us to put forward a number of working hypotheses based on very significant data obtained in the different studies made, often methodological practices of considerable variety.

Thus, on the one hand, we have the studies made during the 1980s of extensive collections of polished tools that made it possible to observe the possible diversity of raw materials used, as well as to clarify a number of specific questions such as the possible use of volcanic materials in the making of polished tools, an assertion that had been repeatedly made and which these studies made it possible to discard, Bosch (1984); Alvarez (1986-1989). The problem that these studies of large collections of polished tools raise is that the material elements analysed do not come from known, well-documented archaeological contexts, which places major restrictions on their use with regard to concrete historical knowledge of the human societies that produced and used them.

During the 1990s, a major change in strategy was proposed, with the study of sets coming from particular sites being tackled. We now have studies of the characteristics

of the polished tools of some of the most important Neolithic sites excavated in the late 1980s, such as the lake settlement of La Draga (Girona), Clop/Alvarez/Reche (2000), Bosch et al., (2000), the open air Neolithic settlement of Plansallosa (Girona), Clop & Alvarez (1998) and the Gava mines (Barcelona), Alvarez & Clop (1994 and 1998), Bosch and Estrada (1994). It should be noted that in the case of Plansallosa a possible "workshop" for the making of polished tools was located, as appeared to be indicated by the finding of prototypes at different stages of production, Bosch et al., (1998). The study of the materials recovered from a Catalan Middle Neolithic burial structure should be added to the mentioned studies, although it is rather less significant, Casas (2000). These studies together mean that we have well-defined sets which can be situated in precise historical contexts.

All in all, although the list of studies made so far is not particularly long one, the known data mean we can establish which were the main raw materials used and which raw materials were in minority use, establish in some cases the possible zone of origin and what may have happened during certain chronological periods, such as in the final stages of the Early Neolithic and the Middle Neolithic. Apart from that, however, there are still many other aspects to be clarified, such as what happened during the Late Neolithic and during the Calcolithic, and determining with a high degree of certainty the possible origins of many particular materials, etc.

For the north-east of the Iberian Peninsula we have altogether, at this time, published data referring to a total of 409 tools which can be included under the term polished tools, with the characterisation of their raw materials based on rigorous scientific analysis.

The studies of the characteristics of all of these stone tools have permitted the identification of 16 rock types. This significant variety, however, has to be qualified when it is observed that of the 409 tools studied 365 were made from rocks of metamorphic origin, which means an almost total predominance of material of this sort as opposed to the possible use of rocks of igneous or sedimentary origin (Fig. 3, Catalonia). If the materials used are analysed in further detail, it can be seen that hornfelses are undoubtedly the characteristic material for the making of polished tools in the north-east of the Iberian Peninsula (Fig. 5.A). A 90% of the individual items analysed were made from hornfelses. The next most used rock type, diorites, account for just 3% of the total so far analysed, while the remaining rock types are present in proportions that, at most, account for 1% of the sample. The huge predominance in the use of hornfelses is reflected both in the study of large collections of materials and in some of the particular sites studied, as in the open-air settlement of Plansallosa and in the Gava mines. In the latter case, for example, hornfelses were the raw material used in the production of 90 of the 104 tools so far studied, which include both classic forms of polished tools and types more specifically related to mine-workings (mining picks, hammers,...). Hornfelses

are also present, although on a very much minority scale, at the La Draga site and is absent at Bobila d'en Joca.

Hornfels is a rock of metamorphic origin formed of fine-grained detritic rocks to be found on the edge of Hercynian granite massifs. It is a very hard, non-schist rock, fine grained and of concave cleavage, composed of a mosaic of grains of more or less similar size of no particular orientation. It displays abundant biotites and opaque minerals such as ilmenite and some iron oxides. The hornfelses analysed show, in general, the typical mineralogical characteristics, with enough AIO to be able to form cordierite and andalusite crystals. In fact, the presence of these two minerals has often been considered sufficiently important to be able to defined specific subgroups in the study of the raw materials of sites like those of Minas de Gava and Plansallosa. Hornfelses often reveal porphyroblasts which give them a mottled appearance (Fig. 5A). This fact, together with the appearance that tends to have been produced by hammering during the process of manufacturing, meant that for many years researchers confused this material with basalt, "de visu" only identification having been made. This confusion, which began to be eliminated in the 1980s, Maluquer (1979-1980), Valdés (1981-1982), Álvarez (1986-1989), still persists in the imagination of some researchers who mechanically repeat erroneous conceptions that, like this, are inherited from research that was marked for a long time by the use of procedures lacking in scientific rigour.

Hornfels is a rock that is relatively frequent in the north-east of the Iberian Peninsula. It can be found irregularly distributed along the fringes of the central axis of the Pyrenees and of the mountain chains close to the coast in the region (Figs. 4.A and 4.B). It can also be found in the form of erratic pebbles in the detrital formations originating in the transport and sedimentation of materials in many beds of many rivers originating in the Pyrenees, such as the Segre and the Ter and many of their main tributaries.

It is interesting to note that hornfels seems to be the characteristic material in the making of polished tools in the peninsular north-east, when it is to be found much less in neighbouring regions in which extensive study has been made of polished tools, Ricq-De Bouard (1996), Orozco (2000). To date, however, the studies of characteristics made in the north-east of the peninsula have not permitted the location of any possible specific source or area of origin for hornfels, a task which it is to be hoped will be tackled in the not too distant future in order to clarify whether there was extensive exploitation or whether, on the contrary, it was concentrated in very precise points, as well as whether or not use was made of materials found in secondary positions or whether materials in primary positions were exploited. As regards its possible circulation, in the region of the Valencian Levant the possibility has been raised that the hornfels tools that have been identified may have been produced from raw material originating in the coastal mountain chains close

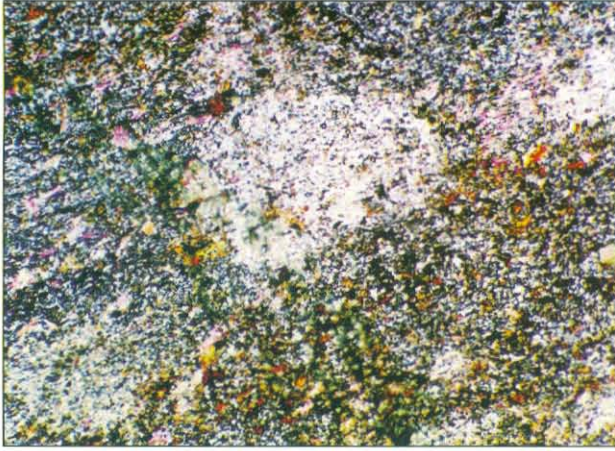


Fig. 5.A.- Micrograph of a hornfel with large andalusite crystals. Crossed polars. Width of photo = 6 mm.; Sample from a mining pick from Minas de Gava (Barcelona).

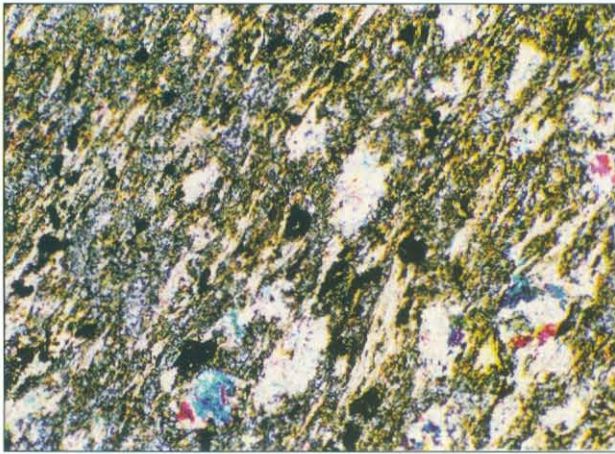


Fig. 5.B.- Micrograph of a calcitic amphibolite. Sample from a plane from Minas de Gava (Barcelona). Crossed polars. Width of photo=6 mm.

to the Ebro, a hypothesis that should also be examined in the future, Orozco (2000).

Diorites comprise, quantitatively, the second group of materials identified, although they represent just 3% of the total of the samples analysed to date. Diorite is an intrusive magmatic rock which displays plagioclases and hornblendes as its essential components. Diorites form accumulations on the margins of zones of igneous rocks, particularly granites and granodiorites or transitional facies on the edge of gabbroic masses. It is, in general terms, a very rare rock, generally originating in the hybridisation of more basic rocks. It is to be found in geological regions similar to those in which hornfelses are to be found.

In the case of the archaeological materials of the peninsular north-east it is interesting to note that diorites have been identified in the Minas de Gava, at Bobila d'en Joca and in two finds included in the collections studied during the 1980s. To date, from the data available, it seems that its presence is concentrated particularly along the Catalan coast and central pre-coastal zone. It is

interesting to note that the diorites identified have been used in the production of axes but their use has not been identified so far in the production of items specifically for mining tools at the Gava mines.

The third group in importance of materials is comprised by the amphibolites. This term is used to indicate certain rocks produced by a medium grade metamorphism that display, as their principal components, amphibolites and plagioclases. Their identification as a raw material used in the making of polished tools in the north-east of the Iberian Peninsula, it should be said, is recent, since the end of the 1990s. Since their initial identification in the region, the presence of amphibolites has been shown to be recurrent in all the sites specifically studied. Thus we find items made from amphibolite at La Draga, Plansallosa, Minas de Gava and Bobila d'en Joca. To be more precise, and as seems to be indicated by X-ray diffraction in the cases of Plansallosa and Bobila d'en Joca, these are generally calcite amphibolites (Fig. 5.B).

Determination of their possible origin involves, at present, great difficulties. While amphibolites have been found on the southern side of the Pyrenees in the form of radial disseminations of low-grade metaphoric rocks and retrograde metaphoric rocks, large specimens in sufficient volume for making polished tools have not been found. We know that amphibolite was a raw material used significantly during the early stages of the Neolithic in neighbouring areas in the south of France, Ricq-De Bourard (1996) where, however, despite extensive prospective work, neither primary or secondary deposits have been found from which pieces of the necessary size for the making of polished tools could have been obtained.

Particular comment should be made regarding the polished tools made from jades. In one of the first scientifically rigorous studies made in the region, Alvarez (1986-1989), attention was drawn to the use of such raw material, although the affirmation was based on "visu" determinations given the difficulties posed by carrying out analysis, however small, of archaeological pieces. The study made at Bobila d'en Joca, Casas (2000) included the analysis of two pieces made from jades of great purity and whose possible source area is still to be determined. In any case, determining more precisely the quantitative importance of the presence of items made from jades as well as establishing their possible origin, is surely one of the central issues in the development of future studies in the region.

The list of the other materials identified so far allows us to observe both their diversity as well as their apparently relatively scarce presence. The materials are as follows (in parenthesis, the number of tools identified to date):

- Metamorphic rocks: schist (5), fibrolite (2), diabase (1), calcium silicate skarn (1), slate (1), phyllite (1), calcoschists (1); quartzite (1).
- Igneous rocks: porphyry (5), dolerite (2), microtonalite (1);
- Sedimentary rocks: sandstone (3).

The materials study made from particular sites (La Draga, Plansallosa, Mines de Gava and Bobila d'en Joca) allows chronological evaluation to be made. In the first place, the absence of data on the precise timing of the earliest polished tools in the region should be noted, as well as on the characteristics of its early stages. Secondly, the studies carried out at La Draga and Plansallosa provide data on the epicardial Early Neolithic (circa 5100-4000 BC). In these sites there is a clear predominance of the use of raw materials of metamorphic origin, principally hornfelses and schists, with amphibolites also being present.

Data from the Minas de Gava and Bobila d'en Joca give us an idea of the raw materials used during the Middle Neolithic (circa 4400-3200 BC). Raw materials from metamorphic rocks continue to predominate, particularly hornfelses. However, a certain amount of difference according to the specific use of the archaeological site can be proposed, as suggested by the absence of hornfelses in a burial site like that of Bobila d'en Joca. The possible difference depending on the social use of each site is also a line of work to be developed more fully in the future. Apart from that, it should be noted that amphibolites continued to be used and we now find tools made from jades which, according to the schemes currently in use, may have reached the north-east of the peninsula within the extensive trade zones of the different types of products that have been documented during the fourth and third millennium BC in western Europe. In this sense, it is interesting to note that amphibolites were used extensively during the Early and Middle Neolithic in the south of France, Ricq-De Bouard (1996).

East of the Iberian Peninsula, País Valenciano

S. Domínguez-Bella

Geographical context

The País Valenciano or Levante, is a geographical region that occupies a band along the Spanish Mediterranean coast. Their geology is based in the presence of materials from the Iberian Cordillera (Fig. 1), and a predominance of sedimentary Mesozoic rocks, in general of carbonated lithologies (in many cases karstified, Fig.3), with the occasional presence of little outcrops of Palaeozoic materials and igneous rocks. These last ones are of two types: subvolcanic rocks as dolerites or diabases, related with Mesozoic episodes; and a recent volcanism, with quaternary basalts.

Archaeological sites from the Neolithic-Aeneolithic of Levante, East Spain

The archaeological register of the recent prehistory presents different levels from the Neolithic I (7000-5800

B.P. cal.); Neolithic II (5500-4000 B.P. cal.); and a Campaniform Horizon, (4000-3890 B.P. cal.); in Orozco (1998), and a great number of caves. Dolerites - diabases, with holocrystalline, fine or medium grain and inequigranular (large crystals of pyroxene enclosing, either wholly or partially, laths of plagioclase feldspar) ophitic-subophitic texture, are found in the archaeological register of this region, Orozco (1993) and (2000). The metamorphic lithologies, with much more diversity than igneous rocks, present amphibolites, eclogites, schist and objects made in sillimanite, a high metamorphic grade typical mineral, Orozco (1993 and 1998). Dolerites or diabases outcrops are present in many points of this Mediterranean band, intruded in sedimentary evaporitic sediments of Triassic age (Keuper facies). Other igneous materials present in the regional geology are the quaternary basalts, not employed as raw material in the Prehistory of this area, Orozco (1993). The local metamorphic materials outcrops, placed at the North of this region, present petrological and mineralogical features that do not correspond with those of the archaeological materials, so the origin of these raw materials can be allochthonous to this area. Materials as the schist bracelets are common in the Neolithic I phase and disappear in subsequent stages, Orozco (1998). In the Neolithic II phase, the lithological diversity is much more extended in the zone, as result not only of a catchment of local lithologies if not by interchange along trade routes, of allochthonous products as sillimanites, eclogites, amphibolites s.s. and calcium amphibolites, that the geological features of the studied materials suggest to Bernabeu & Orozco (1989-90) a great similarity with the high grade metamorphism from Southeast Spain areas, in the inner domains of the Betic Cordilleras. In the Campaniform horizon this tendency is increased. As example of the lithological abundances in this geographical region, in Orozco (1993) are published the study of two archaeological sites with a chronology of III rd millennium B.C., the villages of Jovades (Cocentaina, Alacant) and Arenal de la Costa (Ontinyent, Valencia) (Fig. 3., East Spain).

Central Iberian Peninsula, Castilla-La Mancha & Murcia

S. Domínguez-Bella.

Situation and geological context

In this geographical area, we have only information about raw materials of archaeological sites in the Cuenca, Madrid and a part of Murcia provinces, placed in the central-SE part of Iberian Peninsula. The geological substrate of these areas is constituted by the Iberian Cordillera materials, in general of carbonated character and Mesozoic age and by the Tajo Basin materials, a Tertiary basin of the central Spain (Fig. 1).

Archaeological sites from the Neolithic-Aeneolithic in Central Spain

In this area, with a great potentiality of lithological resources for the tools manufacture, as occurs with the sillimanite and other lithologies metamorphic and igneous, works about raw materials characterization in polished industry of the recent prehistory hardly exist. We only can cite the papers of Atrian (1960), Delibes (1974), Barrera and Navarrete (1980) Barrera (1984), Barrera et al. (1987), about the polished lithic industry from Teruel, the Tierra de Campos area in Castilla, sites from Cuenca, Madrid and Murcia provinces, respectively. In the Fig. 3 appears the different lithologies and percentages of these materials cited by these authors. In the sites from **Cuenca province**, attributed to a recent prehistory (Barrera & Navarrete, 1980), axes and mazes are present, in them we can observe the presence of metamorphic, plutonic, volcanic, in veins and others rocks. Among the lithologies more usually appeared: amphibolites, thermal metamorphosed or speckling slates, sillimanite, sandstone, meta-gabbro, quartz dolerite, limburgites. The limburgites, volcanic rocks formed by iddingsitized olivine phenocrystals, in a matrix of clinopyroxene, opaque minerals and interstitial zeolites and carbonates. Its origin is clearly related with the alkaline volcanism of Campo de Calatrava (Ciudad Real), 200 km. to the SW. The metagabbros, equigranular with medium and fine grain, very homogeneous, formed by very abundant amphiboles, plagioclase, garnet and residual clinopyroxene, with accessories: epidote, muscovite, chlorite, opaque, albite, clinozoisite and carbonates. A second group of metagabbros do not present garnet; in both cases they seem allochthonous lithologies that can come from the Sierra Nevada materials, placed more than 300 km at the south. Amphibolites, many times very rich in actinolite, are in this case orthoderivates of igneous basic rocks, with a great quantity of opaque minerals, their mineralogy are formed fundamentally by amphibole (hornblende-actinolite)(this one between a 50 and a 90 %) and plagioclase, with opaque minerals, sphene and rarely quartz, zircon, epidote, clinozoisite, biotite and chlorite. The possible source areas for these rocks are Sierra Nevada at the south or the Hesperico Massif at the west. Other metamorphic lithology are the chistolitic slates, typical of the contact or thermic metamorphism, where andalusite and cordierite appear, with a quartz-micaceous matrix of fine grain, porphyritic texture, quite schistose. The most similar lithologies to these and with more geographical proximity, are the metamorphic outcrops around the granitic Batolito de los Pedroches, in the North of Andalusia (aprox. 250 km to the SW), even though they could proceed from other zones of the Hesperico Massif, in the western peninsular part. As rock in veins, only has appeared a quartz-dolerite or quartz-diabase, with clinopyroxene and plagioclase, opaque minerals and quartz as accessories; and fine grain diabase texture. Its origin could be regional, in the Iberian Cordillera. Sillimanite objects, very abundant in these sites,

present whitish, greenish, bluish, yellowish and brownish colours, always with the typical fibrous aspect (fibrolite) and made from mineral nodules of relative size. These authors proposed for these axes a allochthonous origin, in the Somosierra area, Central System of Spain, even though other possible source areas can exist in the Hesperico Massif or Hercynian basement (Galicia, Portugal, Salamanca, Zamora, Pyrenees) (Fig.1).

Cueva de Juan Barbero (Tielmes, Madrid).

The petrological analysis results published by Barrera (1984), in this settlement from the early metallurgical period of Central Spain, show the presence of sillimanite, metadiabase with prismatic plagioclase aggregates and amphibole crystals, pseudomorphizing at pyroxenes, with opaque minerals. Metagabbro, of medium-fine grain, equigranular, formed by plagioclase, greenish amphibole and great opaque minerals. Quartz greywackes, with light schistosity, elongated quartz, rock fragments and tourmaline, zircon, opaque minerals, chlorite and muscovite-sericite as accessories, also appear.

Northeast of the Murcia province (Cehegín-Caravaca-Moratalla area). Central Spain.

Barrera et al., (1987), studied a group of archaeological sites, which included caves, open air villages and one dolmen, probably with Aeneolithic chronologies. The polished lithic industry is formed by axes, chisels, mazes, mill hands, ball, pendant, chisel and others. As result of petrologic analysis that these authors carried out, appears: sedimentary rocks, fossiliferous limestones and calcarenites; metamorphic rocks of sillimanite type, amphibolites and garnet metagabbros; volcanic rocks of basalt type; rocks plutonic and subvolcanic, of diabases type, quartz diabases gabbros and quartz gabbros and finally a sample of chert. (Fig. 3, Murcia).

In relation with the raw materials provenance in this area, these authors proposed an autochthonous origin for the carbonated lithologies (fossiliferous limestones and calcarenites) and the plutonic and subvolcanic rocks (dolerites "ophites", diabases), present in the local geology. Chert sample are of unknown origin. The metamorphic lithologies as sillimanite have an allochthonous origin, probably from the Central System or other western areas of Hercynian Massif. Amphibolites have also a non local origin, probably from Sierra Nevada, at the South. Finally, the unique sample of olivine basalt is also allochthonous, very similar to the volcanic materials of the Campo de Calatrava area, 190 km at the West of this region.

Portugal

David Calado and Joao Luis Cardoso

THE ALGARVE AND EXTREMADURA REGIONS

The distribution of exogenous artefacts in settlements and graves previous to the middle of the Vth millennia BC in SW Atlantic Europe seems to be limited to the exchange of some specific elements, Calado et al. (2003). The

polished stone artefacts seem to follow a pattern of production over other stones existing nearby.

In the Caldeirao cave, in Estremadura, Central Portugal, Zilhao, (1992), the sole artefacts with a proven distant origin are the marine shell beads used for necklaces. The polished stone beads recovered at Caldeirao, which could be from distant origins, are made of variscite and muscovite. Variscite may perhaps be found at the Silurian strata from the Zézere river basin, some 20 km away from the cave, Real (1992) and the muscovite may also be found at a relatively short distance away, Real (1992). However, at the moment the nearest place where variscite was positively recorded is in the Carboniferous metavolcanic complex of Ossa-Morena. Also, we have no

everyday use (Fig. 6), consist of axes in basanite, alkaline basalt and greywacke, all of them very common lithologies within a radius of a few km from the settlement site. Arm rings in bituminous black slate constitute the adornment artefacts. The black slate was never identified in the Algarve Palaeozoic strata, the nearest known place with this kind of rock being the Devonian carboniferous strata from the Bordeira antiform, 20 kms NW of the settlement site. The surface-polished large phallic standing stones (menhirs) with high relief symbolic decorations are a product of oolitic Jurassic limestone from the Dogger (Aalonian-Batonian), which occurs within a couple of km from the settlement site, Calado *et al.* (2001).



Fig. 6.- Geographical map of Portugal with the archaeological sites cited. Stone axes of basalt and limestone and arm ring of black slate from Quinta da Queimada (South Portugal), VI-V millenniums B.C.

evidence of variscite mining in SW Iberia before the last quarter of the IV millennium BC. Thus, we may assume that the artefacts in variscite and muscovite might have been produced from surface-collected small blocks of these minerals. The polished stone implements of everyday use, like axes and adzes, are made of stones common to this region.

In the Algarve, Southern Portugal, an analysis was made from all the stone implements collected at the VIth millennium BC settlement site with standing stones at the Quinta da Queimada. The polished stone artefacts of

Between the middle of the V and the middle of the IVth millennia BC, the period usually called "Middle Neolithic", there has been until now an important gap in the knowledge of SW Iberian prehistory with special emphasis to Portugal. In the Algarve, knowledge about this period is restrained to the second phase of the already destroyed settlement site of Caramujeira, Gomes *et al.* (1978); Calado (2000a) and (2000b). However, in La Dehesa, a settlement site from the neighbouring Spanish province of Huelva, which has similar characteristics to the second phase of Caramujeira, we observed at the sur-

face fragments of chert and red jasper, which could only come from the Palaeozoic strata, 40 kms to the North.

From the middle of the IVth millennia it is regarded in the archaeological data from SW Iberia strong evidence of social stratification that culminates in the middle of the IIIrd millennia in pristine centralized political organizations in Andalusia and Algarve. Together with the increase of political centralism and social stratification, it has been verified that existed the development of a stable and complex distribution system of exogenous artefacts, embodying an exchange network that stretches, at least, over the whole of Iberia and North Africa.

The artefacts made from exogenous materials from far away regions are common in the megalithic graves in littoral Algarve (Fig. 6), like Cacela and Alcalar, Veiga (1886, 1889): black slate, amber, amphibolite, serpentine, variscite, marble, cherty oolitic limestone, gold, copper and ivory. The nearest place where black slate occurs naturally is in the Ossa-Morena complex, more than 100 km to the North, or in the Bordeira antiform. The amber, recovered in Alcalar, is very seldom found in Iberia, just occurring in the Cretaceous formations from Álava (Basque Country), Navarra, Cantabria, Asturias, Aragón, in general almost 1000 km to the NW. The amphibolite, a widely used rock in the production of polished adzes and axes during this period, seems to be nonexistent in the Algarve and its origin may have been the already described Ossa-Morena complex. The serpentine, known from polished beads, might have come from Ronda Massif or Sierra Nevada Betic Units, in Andalusia; or Ceuta, in North Africa, but it may also have existed in the Ossa-Morena complex. The variscite, widely used in the production of beads, occurs in the Ossa-Morena region, prehistoric mines being known of at Encinasola, Andalusia, Nocete and Linares (1999). The fine marble, used mainly for the production of small polished vessels is unknown in the Algarve, its possible origin being in central Portugal or in Sierra de los Filabres area, at the East of Andalusia. From the middle of the IIIrd millennium BC onwards the flint seems to be widely substituted by cherty oolitic limestone for the production of broad blades. The cherty oolitic limestone is presently known to occur only in the zone of Estepa - Morón de la Frontera, in Andalusia, Nocete et al. (1995). The gold may also have come from Andalusia (Spain), since Cala - Almadén de la Plata area, in Sierra Morena, at the North of Seville and Huelva provinces, is the closest place with mineral veins of a calibre good enough to produce artefacts by cold hammering like the ones existing in Alcalar. Other possible provenance area is the North of Extremadura region (Spain), with presence of native gold nuggets in many rivers. However, the possibility cannot be excluded that after the IIIrd millennium BC the local populations already knew the technique of gold smelting. The copper is common in the Palaeozoic strata from inland Algarve and was extensively mined. The ivory, unquestionably African in origin, is known from the megalithic graves from Cacela (Fig. 6).

In Estremadura, central Portugal, the set of artefacts from graves and settlements from the middle of the IV millennia BC onwards includes axes and adzes in amphibolites and fibrolite, beads in variscite, lignite, fluorite and calcite, micro blade cores in rock crystal and artefacts in copper and ivory. The amphibolites from the axes collected north of the Tejo River seems to come from the Montemor-o-Novo / Abrantes region, while the amphibolites from the polished axes south of the river show a basaltic-andesitic composition with a low degree of metamorphism, being similar to the rocks of the same type from the Ossa-Morena complex. However, the rock used in the adzes is composed of a fine texture, probably correspondent with basic vulcanite found within the veins of the Sines massif. The fibrolite, a mineral with a high degree of metamorphism is unknown in Portugal, Ferreira (1953), seeming, however, to exist in the Spanish part of the Ossa-Morena complex and other places in Spain, specially in Guadarrama massif. The variscite beads, Canelhas (1973), at least the ones of larger calibre, seem incompatible with the thin mineral veins identified in the metasedimentary Silurian geologic formations from Northern Portugal, Meireles et al. (1997). References exist of variscite mines in use during the Roman epoch nearby Zamora, Campano et al. (1985). However, the only registered prehistoric variscite mines in SW Iberia are in Encinasola, Andalusia, Nocete (2001); Dominguez Bella et al. (2002). The fluorite is known from two large beads found at the Lapa do Bugio, Cardoso (1992) and the Casa da Moura caves, Carreira and Cardoso, (2001/2002). This mineral not exists in the region, its probable origin being the granite - pegmatites from Panasqueira. Also the large rock crystal cores may come from the granite - pegmatites at Beira Alta. The lignite and the calcite, also used in the production of beads are common all over Estremadura. The copper is common in the fortified settlements Leceia type from the middle of the IIIrd millennium BC onwards, Cardoso et al., (1995), Cardoso and Guerra (1997-98; Fig. 6). The chemical analysis from Leceia copper confirms an origin from the metallic polysulphides pyrite belt that stretches from the Algarve to the Alto Alentejo. The territorial range enclosed in this complex system of artefact and raw materials distribution is well exemplified by the African ivory pin found at Leceia site in levels from the first half of the IIIrd millennia B.C., Cardoso (1997), Cardoso (1999-2000).

In conclusion, in Portugal, before the middle of the V millennium BC a pattern clearly emerges of extensive use of local rock types for the production of polished implements. During the second half of the V and first half of the IVth millennia BC it is possible to identify a pattern of use of some raw materials collected some dozens of km from the settlements. From late IVth millennia BC onwards an intricate exchange network of allochthonous materials stretching through Iberia and North Africa was developed. The extent of this exchange network is well exemplified by the amber found at the

Alcalar graves, in the Algarve, only evident in geological outcrops of many areas of Iberia (Basque Country, Aragón, Cantabria, Asturias) or in far away European regions; and the ivory, undoubtedly of African origin, found at Leceia, in the Estremadura and Cacela, in the Algarve (Fig. 6).

South of the Iberian Peninsula, Andalusia

S. Domínguez-Bella

Situation and geological context

The South of the Iberian Peninsula, placed at the north of Gibraltar Strait, the occidental Mediterranean Sea and the Atlantic Ocean, present three great morphologic units, practically coincident with the geological units: Sierra Morena, at the North and NE, with a medium level of 600 m and maximums just to 1323 m; the Guadalquivir Basin, along the Guadalquivir river fluvial plain, from Sierra de Cazorla to Donana salt marsh and the Betic Cordillera, a mountainous relief with the maximum altitudes of the Iberian Peninsula, in Sierra Nevada (Mulhacén, 3481 m). The geological features and materials of these zones are described before (Fig.1 and Fig. 7).

Raw materials used in making polished tools and provenance areas

Archaeological sites from the Neolithic-Aeneolithic of West Andalusia

– El **Jadramil** (Arcos de la Frontera, Cádiz), is basically an agricultural settlement Lazarich (2003), of the III-II millenniums B.C. in the Campina area of Cádiz. Between 1980 and 1998 a great number of silo type structures, silo-artificial caves and pits, have been excavated. The polished lithic industry recovered represents a total of 85 objects, with presence of axes, chisels, grooved mining stone hammers, percutor, smoothers, mullers, loom weights, idols, pendants, archer bracelets and one stone coup that have been studied by Domínguez-Bella (2003). The petrologic study of these materials reveals a great diversity of raw materials, with the presence of dolerites, sandstones, amphibolites, limestone-dolomite, biocalcarenite, marls, micaceous shale and flint (Fig. 7 El Jadramil). Dolerite, is the most common raw material in this archaeological site (55,29 %), with this material is elaborated the grooved stone hammers (Fig.8.C), the great axes (Fig. 8.A), wedges, mullets, etc. Amphibolites: (represents the 5,88 %), many types of amphiboli-

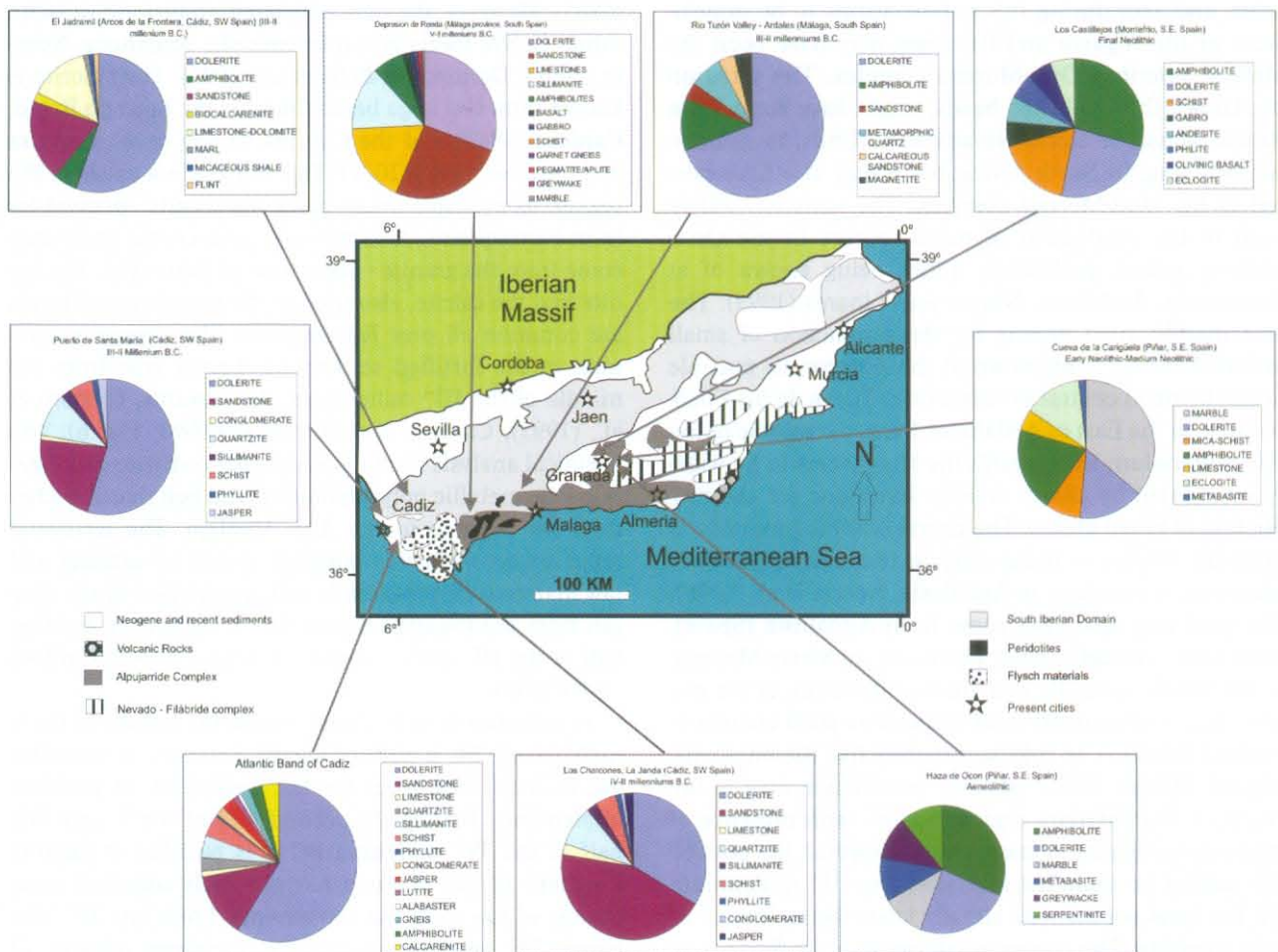


Fig. 7.- Geological synthesis map of Andalusia (South Spain) and percentages of lithologies in many archaeological sites of this geographical area (after data from Carrion et al.; Domínguez-Bella; Domínguez-Bella et al.; Sierra et al.).



Fig. 8.A.- Dolerite axe. El Jadramil. Arcos de la Frontera, Cadiz (SW Spain).



Fig. 8.B.- Group of amphibolite and dolerite adzes. El Jadramil. Arcos de la Frontera, Cadiz (SW Spain).



Fig. 8.C.-Dolerite grooved mining hammer. El Jadramil. Arcos de la Frontera, Cadiz (SW Spain)

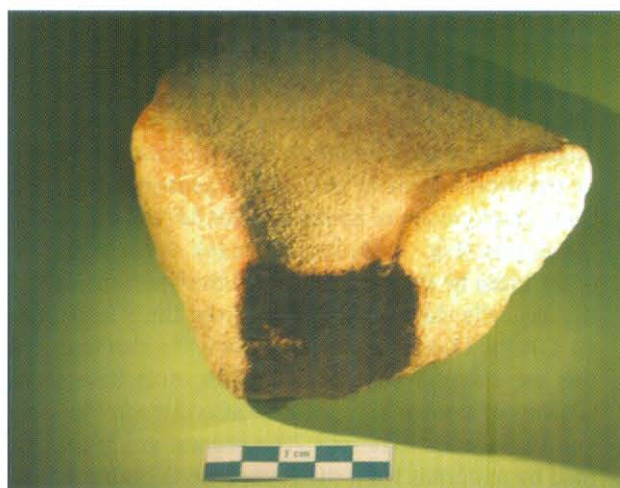


Fig. 8.D.- Great plate of sandstone. El Jadramil. Arcos de la Frontera, Cadiz (SW Spain). (III-II millennium B.C.)

tes appears especially in the manufacture of polished axes, adzes (Fig.8.B), and chisels. Sandstone (18,82 %); they are present in palettes or great size plates (Fig.8.D), and many other objects as mullets, loom weights, pendants and idols. Limestones-dolomites (14,12 %), in this kind of materials appears elaborated objects as smoothers, idols, palettes and a stone coup made by turning. Flint: only an object, probably used as smoother, represent the 1,18 % of the total. Micaceous slate, marl - marly limestone and biocalcarenite present low percentages. Moreover of these lithologies appear pendants, bracelets, etc., made in bone or shell, as well as many metallic objects.

The utility of the grooved stone mining hammers, continue to be an incognita in this site. These hammers, habitual in mining activities in the recent pre-history of Europe, Craddock (1995), results strange in a theoretical agricultural site, so their use, in a mining activity, related with the vertical pits of this site, appears to be quite possible in relation with the extraction

of a type of raw material, a compact biocalcarenite (Dominguez-Bella, 2003).

In relation with the possible source areas for the raw materials of the polished industry, we can differentiate the mentioned lithologies. Amphibolites, with greenish to blackish tones, normally are utilised in the elaboration of axes and they are rocks with a clear allochthonous character in this site, while as possible source areas we can suggest the Palaeozoic materials from the Ossa - Morena zone, at the north of the Guadalquivir valley, in the actual provinces of Huelva and Badajoz, or the centre and south of Portugal, Read et al. (1997), Lillios (1997). Dolerites, which appear as the most important lithology and constituting an important part of the axes and practically the totality of the grooves mining hammers, are rocks with a possible local origin, associated to the Mesozoic dolerites placed into Triassic materials (Keuper facies) outcrops in this area.

Sandstones are present in the mills, mullets, palettes or great size plates, and many other objects as loom weights, pendants and idols. They are Aljibe Sandstones, materials of Miocene age that are abundant in this region. Limestones are of different types and origins; their uses are concentrated in the smoothers for ceramic manufacture and in the elaboration of stone mortars or vessels, present in other zones of the SW as Huelva province, Nocete et al. (1995) with an origin probably allochthonous. Biocalcarene, are probably a local raw material, from the Upper Miocene outcrops, frequent in the geological context of this area. Other lithologies, minority in the polished industry of this site, such as slate, phyllite, flint, etc., are Palaeozoic materials and their origin can be related with imported materials or with the catchment of a rolling stone or pebble of these, from the quaternary terraces levels, and flint related with Mesozoic carbonated outcrops in the Betic Cordillera.

- The **Atlantic Band of Cádiz** area (SSW Spain) placed between the Gibraltar Strait and the mouth of the Guadalquivir River, in the western end of Betic Cordilleras, is a limit zone with the Guadalquivir Basin, as the North limit of this. Their geology comprised three great groups of materials with different ages and lithologies (Fig. 7: Geological map). First group are constituted by the materials from the Medium Subbetic, basically clays and gypsums from the South-Iberian Triassic (Keuper facies) in which are also frequent the presence of subvolcanic rocks, dolerites (rocks commonly known as "ophites"), also intrudes Jurassic and Cretaceous materials. The second group are formed by materials from the Campo de Gibraltar Units, constituted fundamentally by the "Aljibe Sandstones", with clayey intercalations, of Miocene age, placed specially in the East area of this zone (territory of La Janda). Finally, post-orogenic materials, of Miocene-Pliocene age (basically biocalcarenes), distributed in different outcrops and which, in general, produces table relieves.

Archaeological materials (polished lithic tools) from San Fernando, Chiclana de la Frontera, Conil de la Frontera, Medina Sidonia and Vejer (surface surveys), Ramos et al., (1998) and from the stratified levels of two excavations of open air settlements: El Estanquillo (with chronologies between IVth and IInd millenniums B.C.) (Ramos, 1993), and the sites of Las Vinas and Cantarranas, in El Puerto de Santa Maria (Cádiz), Valverde (1993); Ruiz Fernández (1986); are studied (mineralogical, petrological and archaeological characterization) by Domínguez-Bella (1999); Domínguez-Bella et al., (2000), Domínguez-Bella et al. (2002b), Ramos et al., (1997).

The petrological study of these materials reveals that igneous, metamorphic and sedimentary rocks appear: Igneous rocks: In the studied polished industry only fine-medium grain dolerites ($\phi < 1$ mm) have been identified, as many cases of coarse grain size

($\phi > 2$ mm); in general, with ophitic texture, clinopyroxene partially altered to actinolite; plagioclase, also partially transformed in epidote; titanomagnetite or leucosene as accessory (Fig. 9.A).

Metamorphic rocks: Many types of metamorphic lithologies are present in this study. Amongst them detach the artefacts made in amphibolites, quartzites, mica-schists, metapelites (s.s.) and orthogneis. Implements made in sillimanite (var. fibrolite) are also present and relatively frequent.

Sedimentary rocks: Both detrital rocks (lutites, sandstones and conglomerates) as well as carbonated rocks (limestones s.s. and nummulitic calcarenites) are identified. Sandstones present in general quartz predominance, with the presence of feldspars, and clay minerals, oxides, zircon and tourmaline, as accessory minerals (Fig. 9.B). Furthermore, many smoothers made in green jasper and many fragments of black jasper, are documented.

- Alberite I Dolmen (Villamartín, Cádiz). Neolithic. V-IV millenniums B.C. This dolmen is a good example of the Megalithic phenomenon in the South of Iberian Peninsula. It was excavated in 1993 by Ramos-Munoz and Giles (1996) and shows a typical corridor structure, oriented E-W, and a final chamber with only two inhumations. Walls are decorated in relief and painted with red pigments. The materials recovered from this excavation consist in a necklace with 1200 beads of shell, bone, stone (130 green beads of variscite and two beads in amber). Polished axe, adze and gauge, many big flint knives (20 cm in long), one idol in stone, one big crystal of quartz, a stone palette and a mullet for pigment preparation, with presence in it of powdered hematite and cinnabar. Materials and possible provenance areas are studied by Domínguez-Bella and Morata (1995 and 1996), and they confirm the existence in this geographical area of a developed network of interchange for a great number of exotic materials, Domínguez-Bella et al. (2002a), related with a peculiar status of prestige in many individuals of the social groups that live in this area at V-IV millenniums B.C. Petrological characterization of these materials give as result the presence of dolerite in a big axe (aprox.: 50 cm long) and the palette and mullet for pigment preparation; an amphibolite axe-adze (Fig. 9.C); a gauge made in metavolcanic tuff (Fig. 9.D); variscite, limestone and amber beads, a big crystal of quartz and certain quantity of powdered red ochre (hematite and cinnabar). The raw material sources for the majority of these materials present an origin at hundred or more kilometres of distance at the North of Cádiz, Domínguez-Bella and Morata (1995, 1996).

Archaeological sites from the III-II millennium transition in Central Andalusia. Province of Jaén

In this geographical area, in the centre of **Guadalquivir Valley**, a lot of important archaeological sites exist, in

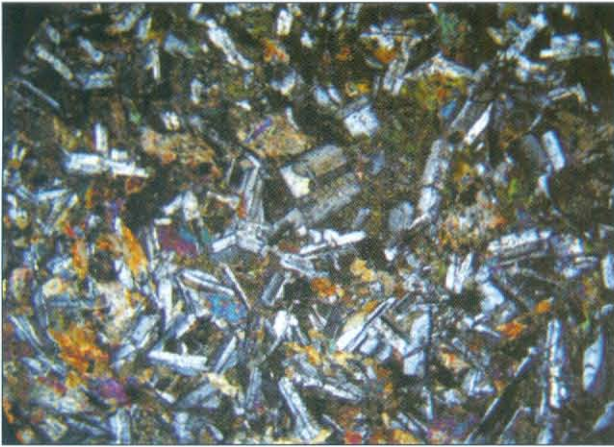


Fig. 9.A.- Micrograph of a tin section of a dolerite axe. Atlantic Band of Cádiz (SW Spain). Crossed polars. Width of photo = 6 mm.

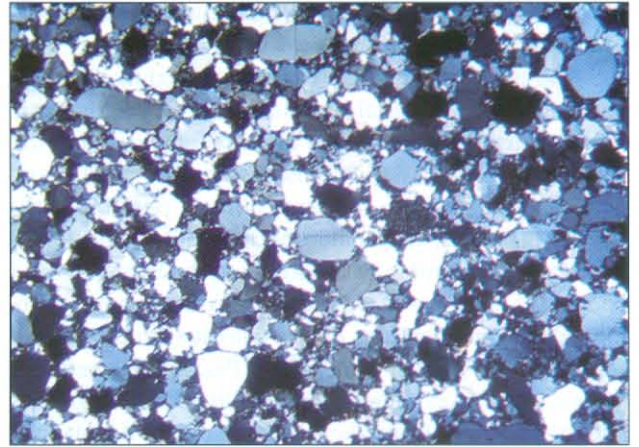


Fig. 9.B.- Micrograph of a mullet made in sandstone. Las Vinas, Cádiz (SW Spain). Crossed polars. Width of photo = 6 mm.

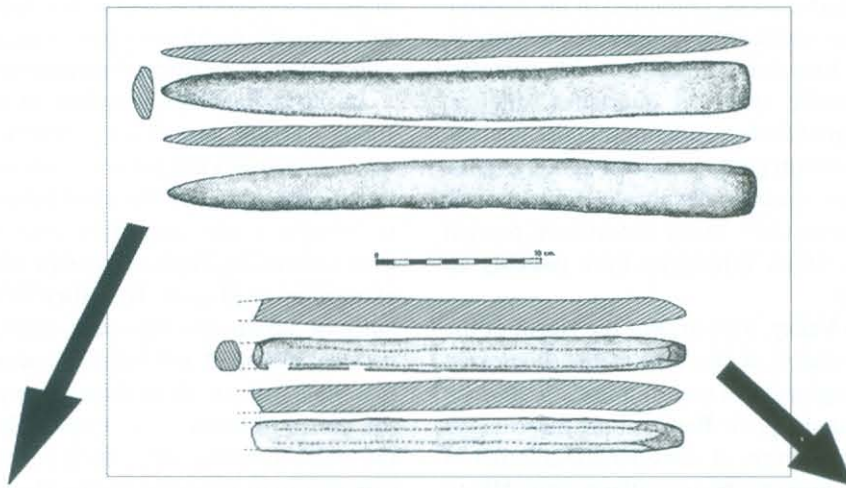


Fig. 9.C.- Micrograph of a tin section of an amphibolite axe. Alberite I Dolmen, Cádiz (SW Spain). Crossed polars. Width of photo = 6 mm.

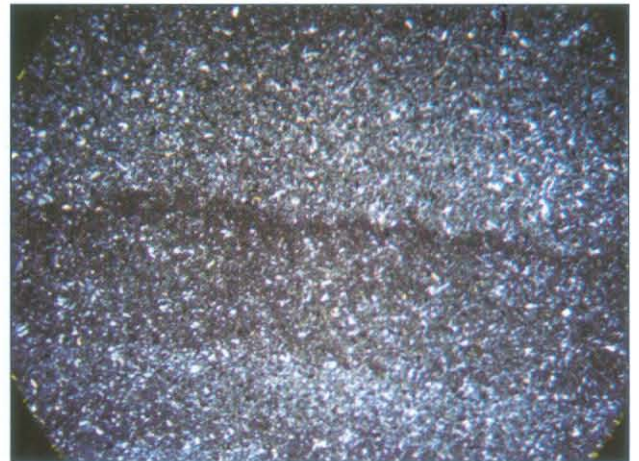


Fig. 9.D.- Micrograph of tin section of a gauge made in a volcanic tuff, lightly metamorphized. Alberite I Dolmen. Neolithic. Crossed polars. Width of photo = 6 mm.

general open air settlements and villages, as occur in El Berral site, (Porcuna, Jaén); with the presence of sedimentary (red, brown and grey sandstones and many flint); metamorphic (quartzite) and igneous (dolerites), in general of local origin (dolerite from outcrops placed

at the South of El Berral) and quartzites, sandstones and flint of local secondary origin, associated to quaternary fluvial deposits of the Salado river, near the archaeological site, Sanchez and Domínguez-Bella (2001).

Archaeological sites from the VI-II millenniums in Central Andalusia. Malaga Province

– The **Ronda Basin** area (Málaga), is slightly placed at the South of the Central Andalusia, over a postorogenic sedimentary basin, formed by molasses, generated by the fast erosion of the Betic alpine chain. The most abundant materials are the molasses of the Upper Miocene; flysch materials, dominated by the Aljibe sandstones, limestones, dolomites and marls from the Subbetic and Penibetic, with ages from Jurassic to Cretaceous; dolomites, clays and gypsums of the Triassic (Keuper facies), with dolerite outcrops included, Palaeozoic materials (slates, greywackes, limestones, phyllites, schists, gneises and migmatites) from the Malaguide and Alpujarride and the peridotites of the Serranía de Ronda.

A study of Sierra et al. (1994), on a sample of 250 stone objects shows the presence of dolerites as predominant igneous-subvolcanic rocks, employed in the elaboration of big axes; also sedimentary rocks as sandstones, limestones (detrital limestone, limestone with microfossils); and metamorphic rocks as quartzites, gneises, schist, sillimanite, amphibolite and amphibolite gneises. Basalt, gabbro, gneiss with garnet, marble, aplite, pegmatite, and quartz-schist, occasionally appear (Fig. 7 Ronda Basin). Dolerites, sandstones, many limestones, present a clear local origin. Other lithologies have possibly an allochthonous origin.

Ardales - Río Turón Valley. This area of the North of the Malaga province is placed at the East of the Depresión de Ronda, in a strategic path of communication between the coast and the Guadalquivir Basin, along the Guadalteba and Guadalhorce Rivers. A considerable number of open air settlements, workshops and villages from IIIrd to IInd millenniums, with silos, artificial caves, etc. are documented. The polished industry present a dominance of igneous subvolcanic rocks, with a 70 % of dolerites, with typical mineralogical and textural features of these rocks associated with Triassic materials in the Betic cordilleras. Amphibolites represent a 11,54 %. Sandstones, calcareous sandstones, milky quartz from metamorphic rocks veins and a mullet of magnetite also appear, Dominguez-Bella et al., (2001c; Fig. 7: Ardales). Other prestige materials as green micas or marble appear in collar beads and stone bracelets (Fig. 10.C-D). Peridotites are not present in the archaeological register even though there are outcrops of this material present in this area.

Archaeological sites from the Neolithic-Aeneolithic of East Andalusia. Province of Granada.

This geographical area, placed near the central part of the Betic Cordillera, is dominated by the Sierra Nevada mountains and many planar alluvial extensions in La Vega, etc. A good example of the petrological studies applied to the characterization of polished industries in the recent prehistory of this area, are the studies of Carrion

and Gomez (1983). The dominant lithologies in this area, in the different periods of Neolithic and Aeneolithic, can be seen in (Fig.7 Montefrío, Cariguella and Haza de Ocon, S E. Spain), in which three examples of archaeological sites appear from three different chronologies (Early-Medium Neolithic, in Cueva de la Cariguella, Pinar); (Final Neolithic in Los Castillejos, Montefrío) and (Aeneolithic in Haza de Ocon, Pinar), all in Granada province (S E. Spain). Dolerites and amphibolites are the dominant lithologies, with a great use of metamorphic rocks as schists, eclogites, and phyllite, all with a regional origin, associated to the nucleus zone of the Betic Cordillera, in Sierra Nevada. It is remarkable the presence of serpentinite in the last periods of the recent prehistory, a material also present in the area of Sierra Nevada and of volcanic rocks as the olivine basalts, andesites, metabasites and gabbros. Finally, the presence of marble in the Early Neolithic and in the Aeneolithic of this area, and its highly relation with the bracelets and collar beads elaboration, is an interesting question.

In the archaeological register of the Cueva de la Cariguella, Carrion and Gomez (1983) estimated that two types of marbles are present; one of these with a provenance centred in the Nevado-Filabride Complex, in Sierra Nevada, a very important zone of marble outcrops, with famous localities of ancient and actual production of marbles, as Macael. The other 50 %, according to these authors, has an allochthonous origin, in the Sierra Morena area, placed at 150 km to the west. Dolerites are also materials with an allochthonous origin, placed as well in the Sierra Morena area. Amphibolites are also used in the artefact manufacture, their petrological features indicate an origin placed at Sierra Morena, with a poor quality and a bad finished, and an other group with an origin in Sierra Nevada, with best quality in the raw material.

In the Middle Neolithic, marbles, amphibolites and eclogites have a regional origin, in Sierra Nevada area, with metabasites-metagabbros from the Subbetic Units and many "ophites" from Sierra Morena.

In the Late Neolithic of the Los Castillejos village, the amphibolites are the most used lithologies, with a local origin; the rest of lithologies, have a great variety and proceed from Sierra Morena, Subbetic and Alpujarride (schists), Carrion and Gomez (1983).

In the Aeneolithic of the Haza de Ocon (open air settlement) and other sites as Pena de los Gitanos, amphibolites are abundant, with dolerites, schists and olivine basalts that proceed from the Campo de Calatrava volcanic area, in Central Spain, placed many hundreds of km at the North. Other sedimentary lithologies as limestones and greywacke are also present in these industries. This temporal continuous relation between Sierra Morena and Granada area is an interesting question to develop future investigations about the trade routes for this circulation of lithic materials along the prehistory.



Fig. 10.A.- Sillimanite little adze. Cadiz province (SW Spain). Neolithic. (4 cm. long).

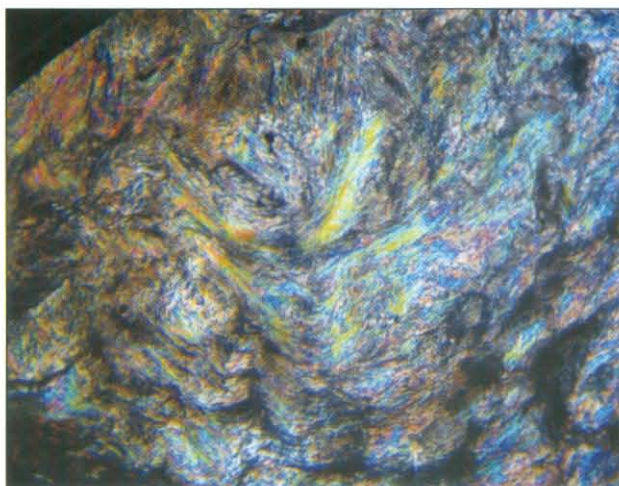


Fig. 10.B.- Micrograph of a tin section of the same object, with the typical fibrolite nodules aspect. Crossed polars. Width of photo = 1,5 mm.



Fig. 10.C.- Marble bracelet. Ardales (Málaga, SW Spain)(aprox. 9cm. diameter)



Fig. 10.D.- Micrograph of a thin section of this bracelet. Crossed polars. Width of photo = 8 mm. Neolithic.

General remarks about raw materials use in Spain

S. Domínguez-Bella

From the statistical studies made on the possible relations between the lithology and the typology of the lithic implements, we can deduce as first conclusion, the existence of a predominance of lithologies with high resistance to the wear and a good mechanical behaviour (not fragile, high or medium-high hardness, good polish, etc.), Domínguez-Bella et al. (2000).

Among this type of lithologies, igneous rocks predominate, in general dolerites (Fig. 9.A) and diabases, widely distributed by all the Iberian Peninsula and specially in the Triassic units of the External Zones of the Betic Cordilleras, Morata (1993). This type of igneous rocks are frequent practically in many zones of the Iberian Peninsula, specially in South and SE Spain, Domínguez-Bella and Morata (1998), Domínguez-Bella et al. (2002b), Carrion and Gomez (1983), Pérez Rodríguez et

al, (1998), etc. However, in many geographic areas and for many temporal periods of the recent Prehistory, it is not strange the presence of olivine basalts type volcanic rocks, as the ones proceeding from the Campo de Calatrava volcanic area, Central Spain. The basalts, reported by Philips (1975), are also very abundant in the axes manufacture in the Barcelona region or the volcanic metatuffs as the one appeared in the Dolmen of Alberite I (Neolithic), surely coming from the volcano-sedimentary materials of the Ossa-Morena Zone, at the South of Hesperico Massif (Fig. 9.D).

In same cases these lithologies are used in the manufacture of objects as the grooved mining hammers, Nocete and Linares (1999), Domínguez-Bella (2003; Fig.8.C), of great resistance to the mechanical impact, generally made in dolerites or porphyry dolerites, as occurs in the copper mining activity of the recent prehistory in Sierra Morena area (North Andalusia), Domínguez-Bella et al., (2001b). Prestige objects also were made in dolerite, such as the plate or palette, for red pigments preparation,

from the burial chamber of the Alberite I dolmen.

The peridotites, a high hardness lithology, as they appear in the Serranía de Ronda, in Andalusia, have hardly been utilised as raw material in the prehistory, perhaps because in the surface of the outcrops, the rocks appeared strongly serpentinized, Sierra et al., (1994).

Pegmatites and aplites have identical or similar uses to the already mentioned for the subvolcanic rocks, it is also possible to quote other materials as the massive quartz from hydrothermal veins, that are very used in the recent Prehistory, specially in the manufacture of objects related with the milling processes, as we can observe in Neolithic-Aeneolithic sites as Ardales (Málaga).

The metamorphic lithologies are also very abundant in the raw materials register of the peninsula, being dominated by the amphibolites (Fig.9.C), of different types and origins, specially in the East part of Portugal and West Spain, also in other outcrops of the inner zones of the Betic Cordillera. They appeared in the archaeological register of almost all the Iberian Peninsula, existing an important distribution phenomenon of this type of materials, Philips (1994), as was deduced from the source areas and archaeological distribution correlation, Carrion and Gomez (1983), Cardoso et al., (1995), Read et al., (1997), Risch (1995). These lithologies are very employed for the cutting tools manufacture, made by the polishing technique (axes, adzes, chisels, gauges, etc.). Other metamorphic lithologies as are the schist and slates (black slates, chiastolitic slates, etc.) appear equally very distributed, they are specially used in the manufacture of certain objects such as "archer bracelets", typical in the West and South of Iberian Peninsula or the stone bracelets, very abundant in Andalusia and Levant, having been localized areas of supply raw materials and of transformation of the same, as occurs with the slates extraction and manufacture area of Cabecicos Negros in Almería, (SE Spain), Goni et al., (1999). Eclogite appears almost exclusively in the manufacture of axes and adzes, in areas of the SE peninsular, in relation with the source areas of Sierra Nevada, in the inner of the Betic Cordillera; other possible source areas are the outcrops from the NW of the peninsula. Hornfelses are an abundant lithology in many areas, as occur in the NE of the peninsula, where they were employed in the manufacture of mining picks, etc., Alvarez and Clop (1994 and 1998).

On the other hand, many lithologies a bit less frequent, as the sillimanite, generally correspond with tools of little size and a very good finishing (Fig. 10.A-B), although in many cases were elaborated with this lithology "prestige or ceremonial" axes, as the ones that appear in the Cantabrian Cornice and in the East of France, and with a wide geographical distribution.

Quartzites, a geologically very abundant material in the Iberian Peninsula, are not very frequent in the polished lithic industry, appearing occasionally in adzes or little axes; it is more abundant their presence in tools related with the milling processes.

Marble, appears with quite frequency, specially in the

south half of the Peninsula, as one of the raw materials basic in the elaboration of stone bracelets (Fig. 10.C-D), whose aesthetic change along the Neolithic and Aeneolithic, or idols and pendants.

Sedimentary rocks are widely extended in the peninsular archaeological register; they could be lithologies generally utilised in the manufacture of objects for milling works (Fig.8.D; sandstones, conglomerates, greywackes, bio-calcarenites – Fig.9.B), decorative or of personal adornment (collar beads in limestone). Also in objects associated to other activities as the loom weights (limestones, dolomites), the "archer bracelets" (sandy limestones, slates, schists), the smoothers for ceramic (limestones, flint, jasper), idols (alabaster, limestones), stone cups or mortars (marmoreal limestones) Nocete et al., (1995), Domínguez-Bella (2003), etc.

Jaspers, with different colorations and textures, appear in tools, usually of little size and with a wide and varied distribution, in general around or near the possible source areas, as the Ossa-Morena Zone, in the SW peninsular. It is very scarce in the Betic Cordillera geological materials, with a probably allochthonous origin in many archaeological sites of the South; probably in the Hercynian Massif. It is also cited in other Iberian zones as Catalonia.

Other minerals, rocks and fossil resins, as the variscite, jet or amber, appear with certain frequency in the recent Prehistory of the Iberian Peninsula. The most frequent is the variscite, Munoz-Amilibia (1971) Salvado Canêlhas (1973) Fernández and Pérez Canamares (1988) Blasco et al., (1992) Domínguez-Bella and Morata (1995 and 1996) Guerra et al., (1995) Rojo et al., (1995) Edo et al., (1997) Domínguez-Bella et al., (2002a) Pozo et al., (2002), already treated in extension in an other chapter of this book.

Amber, although not very studied in the Iberian Peninsula (Domínguez-Bella and Morata 1995), has been cited in many megalithic burials as the Dolmen of Alberite I in Andalusia, where two recovered collar beads made in amber have been identified as Simetite, an amber variety original from the Simeto river (Sicily), after their comparative study with many geologic reference materials from Europe and Iberian Peninsula, Domínguez-Bella et al., (2001a). Other collar beads are found, still in study, Domínguez-Bella (in press), proceeding from burials in tumulus of the Valle de las Higueras (Toledo, Central Spain), Bueno et al., (2000) and a great number of collar beads found in the North Spain, Portugal, Guadalquivir Valley, etc., but they have not studied up to the moment.

The same occurs with jet, which appears in many Neolithic and Aeneolithic sites, but which has not been archaeometrically characterised. Many analytic studies have been made on the collar beads, both in green stones that correspond with muscovites, chlorites, talc, etc. (Huet B. Gonçalves and Reis (1982), Fernández and Pérez (1988)) as well as with other new samples, recently recovered in archaeological surveys, with the presence of

raw materials as clinochlore, idocrase, etc., Domínguez-Bella (in press), not cited till the moment in the archaeological materials of Iberian Peninsula.

In general, a great proportion of analysed lithic resources, employed for the polished lithic instruments production in the Iberian Peninsula, have a local origin.

Quarry activities for igneous and metamorphic rocks extraction are rarely documented to date in this geographical area, with many exceptions, Linares et al., (1997), Nocete and Linares (1999). The catchment of these raw materials should have been easy in many geological contexts, in which appear stone blocks formed by natural fracturation (for example, the numerous dolerite outcrops of the SSW of Andalusia and Levant) Morata (1993). The polished lithic instrumental production process, related to the catchment of raw material phase, was probably easily realised. In the dolerite and other igneous rocks outcrops, it is habitual the existence of natural blocks, originated by diaclasas or disjunction natural processes, that facilitate the obtaining of the blocks for ulterior working.

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References

- Alvarez A. & Clop X. 1994: Estudi petrogràfic de la indústria lítica i del macrotallatge lític. In: Bosch/Estrada, 1994: pp. 231-254.
- Alvarez A. & Clop X. 1998: Determinación de la materia prima del tallatge minero de las minas neolíticas de Gava (Barcelona). In: BOSCH/TERRADAS/OROZCO, 1998: pp. 145-152.
- Alvarez A. 1986 - 1989: Tipología petrogràfica de les destrals polides de Catalunya. *Empúries*, 48-50, 1: pp. 18-25.
- Andrés Rupérez, T. 1977: Las estructuras funerarias del Neolítico y Eneolítico en la Cuenca media del Ebro. *Consideraciones críticas*. Príncipe de Viana, pp. 146-147.
- Apellániz, J.M. 1973: Corpus de materiales de las culturas prehistóricas con cerámica de la población de las cuevas del País Vasco Meridional. *Munibe*, suplemento no 1.
- Aranzadi T., Barandiarán J.M. & Eguren E. 1921: Exploración de ocho dólmenes de Altzania, San Sebastián.
- Arribas J.L. & Berganza E. 1984: Algunos útiles pulimentados del País Vasco. *Munibe*, 36, pp. 59-66.
- Atrián P. 1960: Repertorio de hachas pulimentadas de la provincia de Teruel. *Teruel*, 24, pp. 199-208.
- Barandiarán J. M. 1934: El hombre primitivo en el País Vasco. Ed. Itxaropena. San Sebastián.
- Barandiarán I. & Vallespi E. 1984: Prehistoria de Navarra. *Trabajos de Arqueología Navarra*, 2, pp. 1-253.
- Barrera J. L. & Navarrete M. I. 1980: Un enfoque interdisciplinar: el estudio de las hachas pulimentadas del Museo de Cuenca. *Cuenca*, 17.
- Barrera J. L. 1984: Estudio petrológico de las hachas pulimentadas de la Cueva y Cerro de Juan Barbero (Tielmes, Madrid). In: Martínez Navarrete M.I. El comienzo de la metalurgia en la provincia de Madrid. La cueva y cerro de Juan Barbero (Tielmes). *Trabajos de Prehistoria*, no 41. Madrid. pp 92-93.
- Barrera J. L., Navarrete M. I., San Nicolás M. & Vicent J. M. 1987: El instrumental pulimentado calcolítico de la comarca noroeste de Murcia: algunas implicaciones socioeconómicas en el estudio estadístico de su petrología y geomorfología. *Trabajos de Prehistoria*, 44. pp. 87-146.
- Beltrán A. 1955: La edad de los metales en Aragón. Zaragoza.
- Bernabeu J. & Orozco T. 1989-90: Fuentes de materias primas y circulación de materiales durante el final del Neolítico en el País Valenciano. Resultados del análisis petrológico del utillaje pulimentado. *Cuadernos de Prehistoria de la Universidad de Granada*, 14-15. pp. 47-65.
- Blasco A., Edo M., Fernández Turiel J. L., Gimeno D., Plana F. & Vilalba J. 1992: Aplicación de técnicas geológicas al estudio de materiales arqueológicos: el ejemplo de las cuencas de variscita catalanas y el complejo minero de Can Tintorer (Gavá, Barcelona). *Cuaternario y Geomorfología* 6, pp. 71-80.
- Bosch A. 1984: Les destrals polides del nord de Catalunya: tipologia i petrologia. *Fonaments*, 4: pp. 221-245.
- Bosch A. et al., 1998: El poblament neolític de Plansallosa. L'explotació del territori dels primers agricultors-ramaders de l'Alta Garrotxa. *Publicacions Eventuals d'Arqueologia de la Garrotxa*, 5; Museo Comarcal de Olot; Olot (España).
- Bosch A., Chinchilla J., Tarrús J. (coords.) 2000: El poblament lacustre neolític de la Draga. Excavacions de 1990 a 1998. *Monografies del CASC*, 2; Museu d'Arqueologia de Catalunya; Girona (España).
- Bosch Gimpera P. 1923: Notes de Prehistoria Aragonesa. *Bulletí de l'Associació Catalana d'Antropologia, Etnografia i Prehistoria*. Barcelona.
- Bosch J., Estrada A. (eds.) 1994: Rubricatum, 0. El Neolític Postcardinal a les Mines Prehistòriques de Gava (Baix Llobregat). *Revista del Museu de Gava*; Gava (España).
- Bosch J., Terradas X. & Orozco T. (eds.) 1998: Rubricatum, 2. Actes de la 2o Reunió de Treball sobre Aprovisionament de Recursos Lítics a la Prehistoria. *Revista del Museu de Gava*; Gava (España).
- Bueno P. 2000: El espacio de la muerte en los grupos neolíticos y calcolíticos de la Extremadura española: las arquitecturas megalíticas. *Extremadura Arqueológica*, VIII. El Megalitismo en Extremadura, Mérida. pp. 47-65.
- Bueno P., Balbín R. & Barroso R. 2000a: Valle de las Higueras (Huecas, Toledo, España). Una necrópolis ciempozuelos con cuevas artificiales al interior de la Península. *Est. PRE-HISTORICOS*, VIII. Centro de Estudios da Beira Alta. *Viseu*. pp. 49-80.
- Bueno P., Balbín R., Barroso R., Aldecoa A. & Casado A. B. 2000b: Dólmenes en Alcántara (Cáceres). Un proyecto de consolidación e información arqueológica en las comarcas extremeñas del Tajo. Balance de las campañas de 1997 y 1998. *Extremadura Arqueológica*, VIII. El Megalitismo en Extremadura, Mérida. pp. 129-168.
- Calado D. 2000a: Menhires y poblados. Interfluvio Bensafirim-Odiáxer, Lagos - Portugal. Unpublished thesis. University of Huelva. Spain.
- Calado D. 2000b: Poblados con menhires del Extremo SW Peninsular. Notas para su cronología y economía. Una aproximación cuantitativa. *Revista Atlántica-Mediterránea de Prehistoria y Arqueología Social*. Vol. III
- Calado D., Nieto J.M. & Nocete F. 2003: Menires, Símbolos e Organización Social. *International Conference Megaliths and Rock-art in Atlantic Europe*. Ed. Manuel Calado. Évora 2003.
- Calado et al. 2001: Quinta da Queimada 2000. Unpublished excavation report. Instituto Portugues de Arqueologia, Lisboa.
- Campano A., Rodríguez J.A. & Sanz C. 1985: Apuntes para una primera valoración de la explotación y comercio de la variscita en la

- Meseta Norte. Anuario Instituto Estudios Zamoranos Florián de Ocampo. Zamora. 13-22.
- Canelhas 1973: Estudo radiográfico de "calaites" portuguesas. Revista de Guimarães, 83.
- Cardoso & Guerra 1997/98: Análises químicas nao destrutivas do espólio metálico do povoado pré-histórico de Leceia, Oeiras e seu significado no quadro da intensificação económica calcolítica da Estremadura portuguesa. Estudos Arqueológicos de Oeiras, Oeiras 7
- Cardoso J. L. 1997: O povoado de Leceia (Oeiras), sentinela do Tejo no terceiro milénio a.C. Museu Nacional de Arqueologia / Câmara Municipal de Oeiras. Lisboa/Oeiras.
- Cardoso J. L. 1992: A Lapa do Bugio. Setúbal Arqueológica 9/10.
- Cardoso et al. 1995: Estudos petrográficos de artefactos de pedra polida do povoado pré-histórico de Leceia (Oeiras). Estudos Arqueológicos de Oeiras. Oeiras 5.
- Cardoso J. L. 1999/2000: Os artefactos de pedra polida do povoado pré-histórico de Leceia (Oeiras). Estudos Arqueológicos de Oeiras. Oeiras 8
- Carreira & Cardoso 2001/2002: A gruta da Casa da Moura (Cesareda, Óbidos) e a sua ocupação pós-paleolítica. Estudos Arqueológicos de Oeiras. Oeiras 10.
- Carrión F. & Gomez Pugnaire M. T. 1983: Análisis petroarqueológico de los artefactos de piedra trabajada durante la prehistoria reciente en la provincia de Granada. Cuadernos de Prehistoria de la Universidad de Granada, 8, pp. 447- 477.
- Casas J. 2000: Análisi de primeres materies del Neolític mig de Catalunya: el sílex melat. Trabajo de Investigación de Tercer Ciclo; Universidad de Barcelona; (unpublished).
- Clop X. & Alvarez A. 1998: Estudi petrogràfic de les eines amb tall i de la indústria macrolítica. In: BOSCH et alii, 1998: pp. 82-86.
- Clop X., Alvarez A. & Reche J. 2000: Els recursos minerals. In: Bosch/Chinchilla/Tarrús (coord.) 2000. pp. 123-129.
- Craddock P. T. 1995: Early Metal Mining and Production. Edinburgh University Press.
- Cummins W.A. 1983: Petrology of stone axes and tools. In: The Petrology of Archaeological Artefacts. Kempe, D.R.C. and Harvey, A.P. (eds.). Oxford Science Publications. Oxford. pp. 171-226.
- Dallmeyer R.D. & Martínez García E. (eds.) 1990: Pre-Mesozoic Geology of Iberia. Springer-Verlag, Berlin.
- Delibes de Castro G. 1974: Contribución al estudio de las funciones del hacha pulimentada. Resultado de la aplicación del sistema Semeñov a 130 ejemplares de la Tierra de Campos. Zephyrus, XXV, pp.151-154.
- Dominguez-Bella S., Morata D., Montanés M., García Pantoja, M.E. & Llanderas A. 2001b: Útiles mineros en la Prehistoria del S.E. de Extremadura. Análisis Petroológico y Geoquímico y determinación de las áreas-fuentes de las materias primas. In: Gomez Tubio, Respaldiza & Pardo (Eds.): III Congreso Nacional de Arqueometría. Universidad de Sevilla / Fundacion El Monte. Sevilla. pp. 611-620.
- Dominguez-Bella S. & Morata D. 1998: Estudio analítico de los materiales del Dolmen del Cerro de la Corona. Técnicas experimentales y su aplicación a los estudios arqueológicos. In: Recio, A.; Martín, E.; Ramos Munoz, J.; Dominguez-Bella, S. Morata, D., y Macías, M. "El Dolmen del Cerro de la Corona de Totalán. Contribución al estudio de la formación económico-social tribal en la Axarquía de Málaga" pp. 53- 61. Diputación Provincial de Málaga
- Dominguez-Bella S. & Morata-Céspedes D. 1996: Caracterización mineralógica y petrológica de algunos objetos del ajuar y de los recubrimientos de las paredes y suelos de la cámara (materiales líticos y ocre). In J. Ramos Munoz y F. Giles Pacheco (eds.), El dolmen de Alberite (Villamartín). Aportaciones a las formas económicas y sociales de las comunidades neolíticas en el NW de Cádiz, Servicio Publicaciones Universidad de Cádiz (Spain), 187-206.
- Dominguez-Bella S. & Morata-Céspedes D. 1995: Aplicación de las técnicas mineralógicas y petrológicas a la Arqueometría. Estudio de materiales del dolmen de Alberite (Villamartín, Cádiz). Zephyrus, XLVIII, pp.129-142.
- Dominguez-Bella S. 1999: Los recursos líticos de las sociedades prehistóricas. Aplicación de las técnicas geoarqueológicas y arqueométricas. El caso de La Mesa y otros ejemplos de la banda atlántica de Cádiz. In: Ramos Munoz, J. et al. (eds.) Excavaciones arqueológicas en La Mesa (Chiclana de la Frontera, Cádiz). Aproximación al estudio del proceso histórico de su ocupación. Campana de 1998. Ayuntamiento de Chiclana / Vipren / Universidad de Cádiz. pp. 165-182.
- Dominguez-Bella S. 2003: Arqueometría de la industria lítica de El Jadramil. Caracterización petrográfica de los productos tallados y pulimentados y posibles áreas fuente de las materias primas. In: Lazarich, M. (Ed.) El Jadramil (Arcos de la Frontera). Estudio arqueológico de un asentamiento agrícola en la Campina gaditana. Ed. Ayuntamiento de Arcos de la Frontera, Cádiz. pp. 277-286.
- Dominguez-Bella S., Morata D., De la Rosa J. & Ramos Munoz J. 2002: Neolithic trade routes in SW Iberian Peninsula?. Variscite green beads from some Neolithic sites in the Cádiz province (SW Spain): Raw materials and provenance areas. Proceedings of 32 International Symposium on Archaeometry. México D.F. 2000. Electronic Book. Universidad Nacional Autónoma de México. México D.F.
- Dominguez-Bella S., Morata D., De la Rosa J. & Ramos Munoz J. 2002a: Neolithic trade routes in SW Iberian Peninsula?. Variscite green beads from some Neolithic sites in the Cádiz province (SW Spain): Raw materials and provenance areas. Proceedings of 32 International Symposium on Archaeometry. México D.F. 2000. Electronic Book. Universidad Nacional Autónoma de México. México D.F.
- Dominguez-Bella S., Pérez M. & Morata D. 2000: Mineralogical and petrological characterization of polished lithic material from La Vina-Cantarranas Neolithic/Aeneolithic site (Puerto de Santa María, Cádiz, Spain). Krystalinikum, 26, pp. 57-65.
- Dominguez-Bella S.; Álvarez Rodríguez Ma. A. & Ramos Munoz J. 2001a: Estudio analítico de las cuentas de collar de ámbar del dolmen de Alberite, (Villamartín, Cádiz). Naturaleza química y mineralógica e implicaciones sobre su origen.". In: Gomez Tubio, Respaldiza y Pardo (Eds.) III Congreso Nacional de Arqueometría. Universidad de Sevilla / Fundacion El Monte. Sevilla. pp. 621- 630.
- Dominguez-Bella S., Ramos Munoz J., Morata D., Pérez M. & Castaneda V. 2002b: Raw materials, source areas and technological relationships between minerals, rocks and prehistoric non-flint stone tools from the Atlantic Band, Cádiz province, SSW Spain". in Proceedings of the 31st International Symposium on Archaeometry. 1998, Budapest (Hungary). (ed. Jerem & Biró), Brit. Archaeol. Rep. Archaeolingua Central European ser., Archaeopress. Oxford-Budapest. pp. 723-728.
- Dominguez-Bella S., Ramos Munoz J., Cantalejo P., Espejo M.M., Castaneda V. & Durante A. 2001c: Lithic resources in the prehistoric societies of the III-II millenniums B.C. in the Río Turón Valley (Ardales, Málaga, Spain). Slovak Geological Magazine, vol. 7, 4. Bratislava, pp. 319-328.
- Edo M., Fernández Turiel J.L., Villalba M.J. & Blasco A. 1997: La Calaita en el cuadrante NW de la Península Ibérica. In: Balbin and Bueno (eds.). Actas del II Congreso Peninsular de Arqueología. T. II. Fundación Rei Henriques. Zamora. pp. 99-121.
- Elosegui J. 1953: Catálogo dolménico del País Vasco. Pirineos, 28-30, pp. 229-374. Zaragoza.
- Enriquez Navascues J.J. 1995: Del Paleolítico a la Edad del Bronce. Extremadura Arqueológica, IV. Junta de Extremadura y Univ. Autónoma de Madrid. pp. 13-34.
- Fabregas Valcarce R. 1992: Nuevos útiles perforados del interior de Galicia: una reflexión sobre el momento epimegalítico. Espacio, Tiempo y Forma, Serie I. Prehist. y Arqueología, t. V, pp. 265-280.
- Fernández Vega A. & Pérez Canamares E. 1988: Los objetos de adorno en "piedras verdes" de la Península Ibérica, en Espacio, Tiempo y Forma. Serie I. Prehistoria, I, pp. 239-252.
- Fernánsez Eraso J., Tarrino A. & Eguiluz L. 2003: Nuevos instrumentos pulimentados procedentes de conjuntos de superficie en el territorio de Álava. Estudios de Arqueología Alavesa, (en prensa).
- Ferreira O. 1953: Os instrumentos de fibrolite do Museu dos Serviços Geológicos. Anais da Faculdade de Ciências do Porto.
- Gil Ibaguchi J.I. & Arenas R. 1990: Metamorphic evolution of allochthonous complexes from the northwest of the Iberian Peninsula. In: Pre-Mesozoic Geology of Iberia. Dallmeyer, R.D. & Martínez García, E. (eds.). Springer-Verlag, Berlin. pp. 237-246.
- Gomes, Monteiro & Serrao 1978: A Estação Pré-histórica da Caramujeira. Trabalhos de 1975-76. Actas das III Jornadas Arqueológicas, 1977. Lisboa.

- González Sainz C. 1979: Útiles pulimentados prehistóricos en Navarra. *Trabajos de Arqueología Navarra*, 1, pp. 149-203.
- Goni A., Rodríguez A., Camalich M.D., Martín D. & Francisco M.I. 1999: La tecnología de los elementos de adorno personal en materias minerales durante el Neolítico Medio. El ejemplo del poblado de Cabecicos Negros (Almería): II Congreso del Neolítico a la Península Ibérica. SAGUNTUM-PLAV, Extra, 2, pp. 163-170.
- Guerra M., Delibes G., Edo M. & Fernandez Turiel J.L. 1995: Adornos de calaita en los ajuares dolménicos de la provincia de Burgos. Apuntes sobre su composición y procedencia. I Congreso del Neolítico de la Península Ibérica. Gavá-Bellaterra. Rubricatum, 1, pp. 239-250.
- Gutiérrez Rivera, F. & Vázquez Varela, J.M. 1975: Análisis radiológico de cuentas de "calaita" gallegas. *Boletín de la Comisión de Monumentos de Lugo*, T. 9, pp. 81-84.
- Gutiérrez Mas J.M., Martín A., Domínguez-Bella S. & Moral J.P., 1991: Introducción a la geología de la provincia de Cádiz. Servicio de Publicaciones, Universidad de Cádiz, 315 pp.
- Huet B. Gonçalves A. & Reis M. 1982: Estudio mineralógico de elementos de adorno de cor verde provenientes de estaciones arqueológicas portuguesas. *Trabalhos do Instituto Antropologia Mendes Correa* 43, pp. 1-18.
- Julivert M. 1979: A cross section through the northern part of the Iberian Massif: its position within the Hercynian fold belt. *Krystallinikum* 14, pp. 51-67.
- Kempe, D.R.C. & Harvey, A.P. (eds.) 1983: *The Petrology of Archaeological Artefacts*. Oxford Science Publications, Oxford.
- Lazarich, M. (Ed.) 2003: *El Jadramil (Arcos de la Frontera)*. Estudio arqueológico de un asentamiento agrícola en la Campina gaditana. Ed. Ayuntamiento de Arcos de la Frontera, Cádiz.
- Le Roux C.T. 1975: Fabrication et commerce des haches en pierre polie. *Les dossiers de l'Archéologie*, 11, pp. 43-55.
- Lillios K.T. 1997: Amphibolite Tools of the Portuguese Copper Age (3000-2000 B.C.): A Geoarchaeological Approach to Prehistoric Economics and Symbolism. *Geoarchaeology*, vol. 12, no 2, pp. 137-163.
- Linares J.A., Nocete F. & Sáez R. 1997: Aprovisionamiento compartido versus aprovisionamiento restringido: los casos de las canteras del III milenio a.n.e. del Andévalo (Huelva). In: Bosch, J.; Terradas, X.; Orozco, T. (eds.) 1998. *Rubricatum*, 2. Actes de la 2o Reunió de Treball sobre Aprovisionament de Recursos Lítics a la Prehistoria. *Revista del Museu de Gava; Gava*.
- Lotze F. 1945: Zur Gliederung der Varisziden in der Iberischen Meseta. *Geotektonische Forschungen* 6, pp. 78-92.
- Maluquer de Motes J. 1962: Notas sobre la cultura megalítica navarra. *Príncipe de Viana*, 92-93, pp. 63-107.
- Maluquer J. 1979-1980: Notes de prehistoria catalana: una industria lítica de la comarca de la Noguera. *Pyrenae*, 15-16: pp. 251-266.
- Martin-Algarra A. 1987: Evolución paleogeográfica alpina del contacto entre Zonas Internas y las Zonas Externas de la Cordillera Bética. Tesis, Universidad de Granada, 1171 pp.
- Mazo C. & Rodanés J.M. 1986: *Corpus de útiles pulimentados de la comarca de Monzón (Huesca)*. Colección de Estudios Aragoneses, 11. Huesca.
- Meireles, Ferreira & Reis 1987: Variscite occurrence in silurian formations from northern Portugal. *Comunicações dos Serviços Geológicos de Portugal*.
- Morata D. 1993: Petrología y geoquímica de las ofitas de las Zonas Externas de las Cordilleras Béticas. Tesis Doctoral. Univ. Granada. Inédita. 342 pp.
- Mortillet 1889: *La Préhistorique antiquité de l'homme*. Paris
- Munoz-Amilibia A. M. 1971: La "calaita" en el País Vasco. *Munibe* 23, 347-354.
- Munoz-Amilibia A. M. 1965: La cultura neolítica catalana de los sepulcros en fosa. *Ins. Arq. y Preh. Universidad de Barcelona*.
- Nocete et al. 1995: Estudio del material arqueológico de la primera campana de excavación de Cerro Juré (Alosno, Huelva). *Proyecto Odiel. Anuario Arqueológico de Andalucía vol. II, 1998*. Sevilla.
- Nocete F. & Linares J.A. 1999: Las primeras sociedades mineras de Huelva. In *Historia de Huelva*. Editorial Mediterráneo, pp. 49-64.
- Nocete F. 2001: Tercer milenio antes de nuestra era. Relaciones y contradicciones centro / periferia en el Valle del Guadalquivir. Barcelona.
- Ormazábal A., Pastor, B. & Urigoitia T. 1994: Ensayo de estudio analítico del instrumental lítico pulimentado. Su aplicación al conjunto de superficie de Urrúnaga (Álava). *Munibe*, 46, pp. 87-110.
- Orozco Köhler T. 1990: Aplicaciones de la Petrología en Arqueología Prehistórica: el estudio del utillaje lítico pulido. *Saguntum*, 23. Universidad de Valencia. pp. 77-87.
- Orozco Köhler T. 1993: El utillaje pulimentado y el instrumental de molienda. In: Bernabeu (dir.) *El III milenio a.C. en el País Valenciano*. Los poblados de Jovades y Arenal de la Costa. *Saguntum*, 26. Universidad de Valencia. pp. 99-108.
- Orozco Köhler T. 1998: Algunas consideraciones sobre el suministro de recursos líticos a lo largo del Neolítico en el País Valenciano. In: Bernabeu, Orozco & Terradas (eds.) *Los recursos abióticos en la prehistoria. Caracterización, aprovisionamiento e intercambio*. Universidad de Valencia. 127-138.
- Orozco Köhler T. 2000: Aprovisionamiento e intercambio. Análisis petrológico del utillaje pulimentado en la Prehistoria reciente del País Valenciano (España). *BAR International Series 867*, 219 p. Archaeopress, Oxford.
- Orozco T. 2000: Aprovisionamiento e intercambio. Análisis petrológico del utillaje pulimentado en la Prehistoria Reciente del País Valenciano (España). *BAR International Series 867*, 219 páginas. Archaeopress, Oxford.
- Pellicer M. 1967: Las civilizaciones neolíticas hispanas. In: Gomez Tabanera (Ed.): *Las Raíces de España*, pp. 27-46. Madrid.
- Pellicer M. 1995: Las culturas del neolítico-calcolítico en Andalucía Oriental. *Espacio, Tiempo y Forma, Serie I. Prehistoria y Arqueología*, t. 8, 81-134.
- Pérez Rodríguez M., Domínguez-Bella, S., Morata-Céspedes, D. & Ramos Muñoz, J. 1998: Análisis mineralógico y petrológico del instrumental lítico no tallado en la Prehistoria reciente de la Banda Atlántica de Cádiz. Estudio de áreas fuentes y relaciones entre litología y yacimientos. *Cuaternario y Geomorfología*, 12 (3-4) pp. 57-67.
- Phillips P. 1975: *Early farmers of West Mediterranean Europe*. Hutchinson. London.
- Phillips P. 1994: El análisis científico y el comercio en el Neolítico Europeo. *Spal*, 3, 87-94. Sevilla.
- Pozo M., Casas J. & Medina J.A. 2002: Estudio mineralógico de componentes ornamentales pétreos procedentes de un yacimiento de la Cultura del Argar (Fuente Álamo, Almería). *Boletín Geológico y Minero*, vol. 113, no 2, pp. 14-26.
- Quesada C. & Munha J. 1990: Metamorphism. In: *Pre-Mesozoic Geology of Iberia*. Dallmeyer, R.D. & Martínez García, E. (eds.). Springer-Verlag, Berlin. Pp. 314-320.
- Quiroga F. 1880: Sobre el jade y las hachas que llevan este nombre en España. *Anales de la Sociedad Española de Historia Natural*. Tomo X, pp. 5-13.
- Ramos-Munoz J., Domínguez-Bella, S. & Morata, D. 1997: Alternativas no adaptativas para la integración de técnicas mineralógicas y petrológicas dentro de una Arqueología como proyecto social. *Revista Atlántica - Mediterránea de Prehistoria y Arqueología Social (RAMPAS)*, 1, pp. 182-200. Cádiz.
- Ramos-Munoz F. & Giles F. (eds.) 1996: *El dolmen de Alberite (Villamartín)*. Aportaciones a las formas económicas y sociales de las comunidades neolíticas en el NW de Cádiz. Servicio Publicaciones Universidad de Cádiz. 366 pp.
- Ramos-Munoz F. & Lazarich M. (eds.) 2002: Memoria de la excavación arqueológica en el asentamiento del VI milenio A.N.E. de "El Retamar" (Puerto Real, Cádiz). *Arqueología, Monografías*. Junta de Andalucía. Sevilla. 198 pp.
- Ramos-Munoz J. 1993: El hábitat prehistórico de "El Estanquillo" (San Fernando, Cádiz). *Fundación Municipal de Cultura*. Ayuntamiento de San Fernando.
- Ramos-Munoz J., Domínguez-Bella S., Morata D., Pérez M., Montanés M., Castaneda V., Herrero N. & García Pantoja M.E. 1998: Aplicación de las técnicas geoarqueológicas en el estudio del proceso histórico entre el V y III milenios a.n.e. en la Comarca de la Janda (Cádiz)". *Trabajos de Prehistoria*, 55, pp. 163-176.
- Read C., Grapes R. & Lillios K. 1997: Petrography and chemical analyses of prehistoric amphibolite artefacts from Portugal and possible source rocks from Western Iberia. *Analytical Facility Publication No 19*. Victoria University of Wellington. New Zealand. pp. 1-19.

- Real F. 1992: Estudio mineralógico de adornos de cor verde do Neolítico Antigo da Gruta do Caldeirão. In Gruta do Caldeirão. O Neolítico Antigo. Ed. Joao Zilhao, Lisboa.
- Recio A., Martín E., Ramos Muñoz J., Domínguez-Bella S. Morata D. & Macías M. 1998: El Dolmen del Cerro de la Corona de Totalán. Contribución al estudio de la formación económico-social tribal en la Axarquía de Málaga. Diputación Provincial de Málaga. Málaga. pp. 53- 61.
- Ricq de Bouard M. 1996: Pétrographie et sociétés néolithiques en France méditerranéenne. Monographie du CRA, 16; CNRS Éditions. Paris.
- Ripoll E. 1953: Hachas pulimentadas de El Mortero (Alarcón). Teruel, 10, pp. 243-247.
- Risch R. 1995: Recursos naturales y sistemas de producción en el Sudeste de la Península Ibérica entre el 3000 y 1000 A.N.E. Tesis Doctoral Universidad Autónoma de Barcelona. Bellaterra.
- Rojo M. A., Delibes de Castro G., Edo M. & Fernández Turiel J. L. 1995: Adornos de calaíta en los ajuares dolménicos de la provincia de Burgos: apuntes sobre su composición y procedencia. Rubricatum, 1, pp. 239-250.
- Ruiz Fernández J.A. 1986: Informe de excavaciones de urgencia. Pago de Cantarranas-La Vina. El Puerto de Santa María". Anuario Arqueológico de Andalucía, vol. III, Actividades de Urgencia, pp. 95-100. Junta de Andalucía.
- Salvado Canêlhas M.G. 1973: Estudio radiográfico de "calaïtes" portuguesas. Rev. Guimarães LXXXIII, 125-144.
- San Miguel de la Cámara M. 1918: Estudio petrográfico de tres hachas neolíticas pulimentadas, de la colección de D. L. Mariano Vidal, procedentes de Villahermosa (Ciudad Real). Boletín de la Real Sociedad Espanola de Historia Natural. Tomo XVIII, pp. 156-162.
- San Miguel de la Cámara M. 1919: Estudio petrográfico de siete hachas neolíticas de la colección de D. L. Mariano Vidal. Boletín de la Real Sociedad Espanola de Historia Natural. Tomo XIX, pp. 170-179.
- Sánchez Liranzo O. & Domínguez-Bella S. 2001: Productos líticos del yacimiento prehistórico de El Berral, Porcuna (Sevilla). Análisis de materias primas y estudio morfotécnico y tipológico de las industrias talladas y pulimentadas. Anuario Arqueológico de Andalucía 1997. Actividades sistemáticas, Junta de Andalucía, Sevilla. pp. 118 - 131.
- Serra Rafols J. de C. 1930: El poblament prehistoric de Catalunya. Geografia General de Catalunya, Valencia i Balears, vol. II; Editorial Barcino; Barcelona.
- Sierra de Cozar G., Aguayo P. & Moreno F. 1994: Aproximación al suministro de rocas para la fabricación de útiles durante la Prehistoria reciente en la Depresión Natural de Ronda. In: J.F. Jorda Pardo (ed.) Geoarqueología. Actas de la 2a Reunión Nacional de Geoarqueología. Madrid 1994. pp. 325-333.
- Utrilla P. 1980: Hachas pulimentadas. Dir. A Beltrán Martínez. En: Atlas de Prehistoria y Arqueología aragonesas, pp. 18-21. Institución Fernando el Católico (CSIC). Excm. Diputación Provincial. Zaragoza.
- Valdés L. G. 1981-1982: Informe sobre talleres de útiles pulimentados en la comarca de l'Alt Urgell (I.-Peramola). Pyrenae, 17-18: 83-103.
- Vallespi E. 1974: Investigación de la prehistoria navarra. Historiografía y Bibliografía. Príncipe de Viana, 138-139.
- Valverde M. 1993: El taller de Cantarranas (El Puerto de Santa María, Cádiz). Un ejemplo para la transición Neolítico-Calcolítico. Servicio de Publicaciones. Universidad de Cádiz.
- Vázquez-Varela J. M. 1975: Cuentas de "calaíta" en la Península Ibérica. Datos para la revisión del problema. Gallaecia 1, pp. 25-30.
- Veiga E. 1889: Antiguidades Monumentais do Algarve Vol. III. Lisboa.
- Vera J.A. 1988: Evolución de los sistemas de depósito en el margen ibérico de las Cordilleras Béticas. Rev. Soc. Geol. Espana, vol. I. pp. 373-391.
- Vera J.A. 1994: Geología de Andalucía. In: VIII Simposio sobre Enseñanza de la Geología, Cordoba. Espana. Enseñanza de las Ciencias de la Tierra, vol. 2.2 y 2.3. pp. 1-9.
- Zilhao J. 1992: Gruta do Caldeirão. O Neolítico Antigo. Lisboa.