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Raw material procurement and use at Gargas Cave (Hautes-Pyrénées, France):a Pyrenean-foothill economy during the Gravettian period

La gestion des matières premières à la grotte de Gargas (Hautes-Pyrénées, France): une économie de piémont pyrénéen au Gravettien

La gestión de las materias primas en la cueva de Gargás (Hautes-Pyrénées, Francia): una economía de valle pirenaico en el Gravetiense.

PALABRAS CLAVES: Gravetiense, Pirineos, gestión de materias primas, análisis arqueozoológico, industrias óseas y líticas, adornos personales.
GAKO-HITZAK: Gravettiarrak, Pirinioak, lehengaiak, hornikuntza, azterketa zooarkeologikoak, hezurrari lotutako industriak eta industria litikoak, pertsonentzako apaingarriak.
KEY WORDS: Gravettian, Pyrenees, raw material procurement, zooarchaeological analyses, bone and lithic industries, personal ornaments.
MOTS-CLÉS: Gravettien, Pyrénées, gestion des matières premières, analyses archéozoologiques, industries osseuse et lithique, parures.

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RESUMEN

Situado en el centro de la cadena de los Pirineos, la cueva de Gargás – complejo de arte parietal y sitio de hábitat- ha sido objeto de nuevas investigaciones desde 2004. A partir de estudios interdisciplinares sobre las materias primas utilizadas en las series óseas, líticas y de adornos personales, además del análisis arqueozoológico de los vestigios de fauna, se ha podido percibir mejor el panel de recursos movilizados por los grupos gravetienses que ocuparon el yacimiento entre 28 000 y 25 000 BP. El marco económico se inscribe en un contexto de valle, entre la media montaña y las llanuras aluviales del Garona y la Neste, tanto en lo relativo a los recursos bióticos (fauna cazada, recogida de astas de desmogue) como los minerales (cuarcitas aluviales, silex del Flysch y de las sierras de Petites Pyrénées).

En este medio natural particular, se abordan las estrategias de abastecimiento en sílex adoptadas por los Gravetienses, dada la carencia de esta materia prima en un radio entre 25-45 km alrededor de la cueva.

Si el modelo económico de los Gravetienses de Gargás se desarrolla de forma prioritaria en el entorno del valle próximo, se pude apreciar una ampliación de los ámbitos de explotación / intercambio de recursos hasta el Atlántico y la región del Périgord, perceptible a través del origen de los elementos de adorno sobre conchas perforadas y de ciertos sílex alóctonos.

LABURPENA

2004tik zenbait ikerketa egin dira Gargas, Pirinioetako mendikatearen erdialdean dagoen koba gune apainduan. Litiozko eta hezurrezko tresnak eta pertsonentzako apaingarriak egiteko erabiltzen zituzten lehengaiei buruz egindako azterlan konbinatuetan oinarrituta eta fauna-hondakinen azterketa zooarkeologikoak ere aintzat hartuta, ezagutza sakonagoa dugu orain Gravettiar kulturako taldeek erabiltzen zituzten baliabideen inguruan. Estrategia ekonomiko hori mendiaren erdialdeko eremuen eta Garonne eta Neste ibaien lautada alubialen arteko mendi-hegaletan gauzatzen zuten, animalia-baliabideak (fauna ehizatua, basahuntzen adarrak) eta baliabide litikoak (kuartzita alubiala, Flysch eta Petites Pyrénées xilexak) eskuratzeko.

Testuinguru berezi horretan, Gravettiarrek silexak eskuratzeko zer estrategia erabiltzen zituzten aztertuko dugu, ez baitzegoen lehengai hori haitzulotik 25-45 km-ko tartean.

Eredu ekonomiko hori, batez ere, mendi-hegalean izan zuten arren, ekonomia Gravettiarra eta eremu soziala eskualde Atlantikora eta Perigord eskualdera hedatu zela ikusi dugu. Hala erakusten du apaingarritarako (zulatutako oskolak) erabiltzen zituzten materialek eta silex aloktono batzuek.

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ABSTRACT

Since 2004, new research has been conducted at Gargas, a decorated cave site located in the center of the Pyrenees mountain chain. Based on combined studies of the raw materials used to manufacture lithic and bone tools and personal ornaments, along with a zooarchaeological analysis of the faunal remains, we have obtained a more thorough understanding of the resources used by the Gravettian groups that occupied the cave from 28,000 to 25,000 BP. This economic strategy was practiced in a foothill environment between the mid-mountain zones and large alluvial plains of the Garonne and Neste rivers, in order to procure both animal (hunted fauna, collection of shed cervid antler) and lithic (alluvial quartzites, Flysch and Petites Pyrénées flints) resources

In this particular context, we will address the flint procurement strategies employed by the Gravettians, given the absence of this raw material within a range of 25-45 km around the cave.

While this economic model existed mainly in this foothill environment, we nonetheless observe an extension of the Gravettian economic and social spheres into the Atlantic and Perigord regions, represented by the materials used for personal ornaments (perforated shells) and some allochthonous flints.

RÉSUMÉ

Situé au centre de la chaîne des Pyrénées, le site de Gargas – grotte ornée et habitat – fait l'objet de nouvelles recherches, depuis 2004. A partir des études croisées des matières premières utilisées pour les assemblages lithiques, osseux et les parures, ainsi que de l'analyse archéozoologique des vestiges de faune, nous avons obtenu un meilleur aperçu des ressources mobilisées par les groupes gravettiens ayant fréquenté cette grotte entre 28 000 et 25 000 BP. Le cadre économique s'inscrit dans un environnement de piémont, entre moyenne montagne et grandes plaines alluviales (celles de la Garonne et de la Neste) tant dans les ressources vivrières (faune chassée, ramassage des bois de chute des cervidés) que lithiques (quartzites alluviaux, silex du Flysch et des Petites Pyrénées).

Dans ce contexte particulier, nous aborderons les stratégies d'approvisionnement en silex mises en œuvre par les Gravettiens, étant donné l'absence de cette matière première aux alentours de la grotte dans un rayon de 25-45 km.

Si le modèle économique des Gravettiens de Gargas se développe principalement dans la zone de piémont, on perçoit toutefois un élargissement des sphères économiques et sociales jusqu'à l'Atlantique et le Périgord, à travers l'origine des supports des parures (coquillages percés) et de certains silex allochtones.

1.- INTRODUCTION

Gargas Cave, famous since 1906 for its red and black hand stencils (RÉGNAULT 1907) and engraved animal depictions (CARTAILHAC & BREUIL 1910), also contains Gravettian, Aurignacian, Chatelperronian and Mousterian occupations, first revealed through excavations by É. Cartailhac and H. Breuil in 1911 and 1913 (note 1).

Since 2004, a new research program has been undertaken (FOUCHER *et al.*, 2008, 2011, 2012; SAN JUAN & FOUCHER, 2010). This project takes an integrated approach to the double nature of the site as a decorated cave and a Gravettian occupation site in order to better understand the functional, spatial and chronological characteristics of its frequentation by the authors of its parietal art. The new excavations are combined with a revision of the ancient collections, some of which are unpublished.

The three test-pits opened in Salle I (fig. 1) are strategically placed so that they link to the previous excavations and enable a broad evaluation of the space occupied by the Gravettians. The first test-pit (GES) is located at the limit of the previous Cartailhac-Breuil excavations, in the distal part of the rockfall scree cone that obstructed the prehistoric entrance. The second one (GPO) is located in the proximal zone of this rockfall debris, around fifteen meters ahead of the first test-pit in a chamber corresponding to the vestibule of the ancient prehistoric porch. The third test-pit (GPA) is situated in the center of Salle I, between the Great Wall of Hands and the second Cartailhac-Breuil excavation pit (FERRIER, 2008; FOUCHER *et al.*, 2008a).

The ^{14}C data indicate that the cave was occupied by Gravettians between 28,000 and 25,000 BP (32,000 – 28,800 calBP), and we observe a more intensive occupation period between 27,000 and 25,000 BP (31,200 – 28,800 calBP). From a chrono-cultural perspective, we observe a first early Gravettian phase with Noailles burins from 28,000 to 27,000 BP (32,000 – 30,900 calBP) and a second one with an identical facies between 27,000 and 25,000 BP (31,200 – 28,800 calBP).

The cave opens onto the first foothills of the northern slope of the central Pyrenees (450 m above sea level). Its geographic position gives it a dominant view across the entire lower valley of the Neste River and its confluence with the Garonne. Its inhabitants thus had rapid access to very diverse ecological niches on the plain or in the mountains.

In this specific context, it is interesting to analyze the economic strategies of the Gravettian occupants of Gargas and to more clearly identify their technical traditions and links with other Gravettian groups in neighboring regions. Other questions are raised as well, such as their reason for frequenting this unique gathering place and investing it with strong symbolic meaning, in a mountain foothill environment with a rigorous climate, intensified by the nearby presence of the large Garonne glacier (note 2).

2.- HUNTING RESOURCES, CONSUMPTION AND SEASONALITY

2.1. Zooarchaeological data

Zooarchaeological analyses were made of the Gravettian faunal remains recovered during the excavations by Cartailhac-Breuil, as well as those from the GES (level 2) and GPO (level 1b and 2) loci of the recent excavations (tabl. 1), for a total of 17,075 remains (VERCOUTÈRE report 2011). The higher number of remains in locus GPO is not due to a greater density of bones in

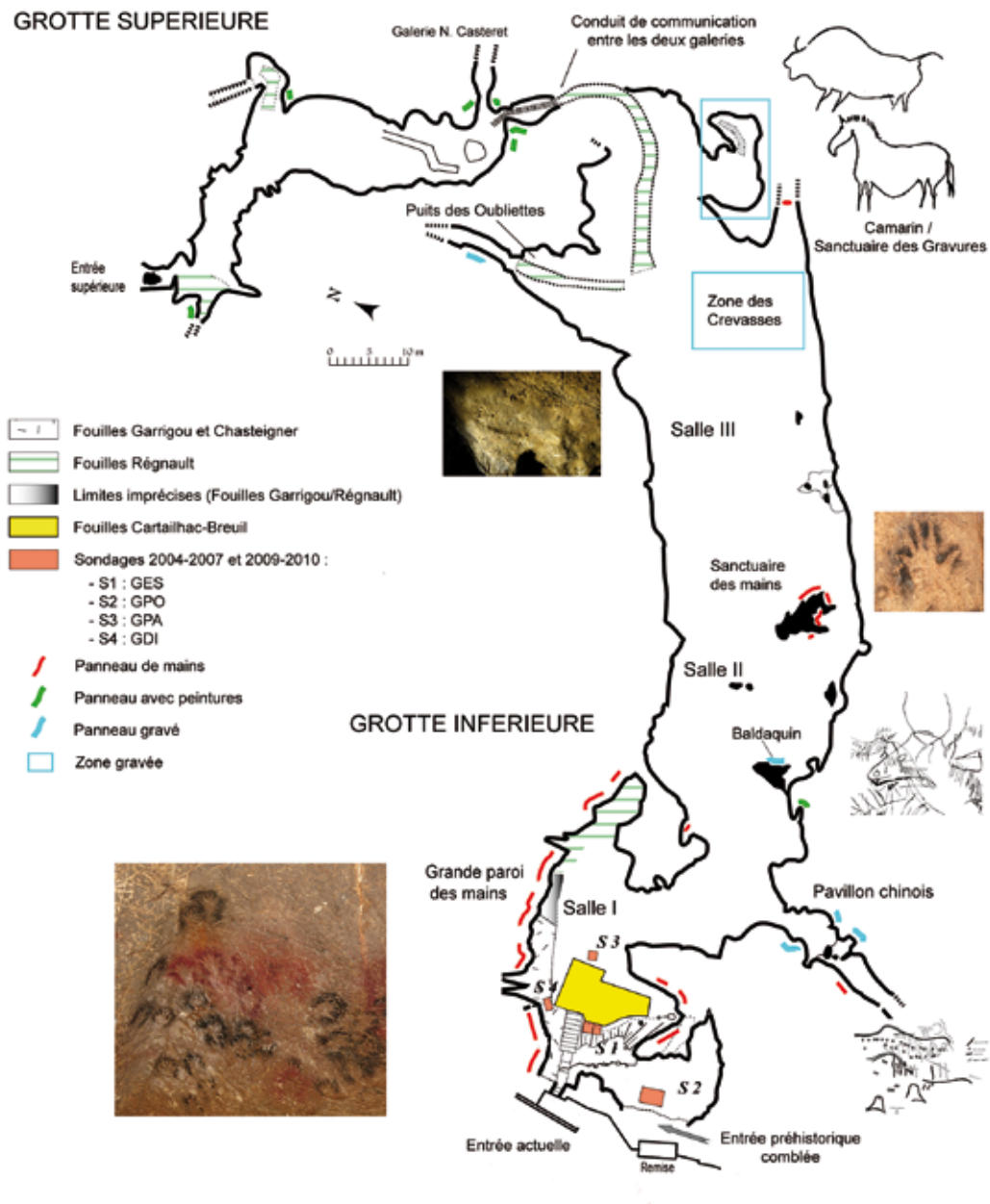

Fig. 1. Plan de la grotte de Gargas avec l'emplacement des panneaux ornés, des fouilles anciennes et récentes (d'après Barrière 1984 ; modifié Foucher, Texier 2004) / Plan of Gargas cave showing the location of painted cave walls and both former and recent excavations (after Barrière 1984; modified by Foucher, Texier 2004).

Locus	NRT	NRD	NRI	% NRI brûlés
Coll. C.-B.	1137	1074	63	14,3
GES (niv. 2)	5675	304	5371	59,4
GPO (niv. 1b & 2)	10263	525	9738	64,3
Total	17075	1903	15172	62,4

Tabla 1: Dénombrement des restes fauniques issus des niveaux gravettiens de la grotte de Gargas (Coll. C.-B.: Collection Cartailhac-Breuil; NRT: Nombre de Restes Total; NRD: Nombre de Restes Déterminés; NRI: Nombre de Restes Indéterminés; % NRI brûlés: proportion des restes indéterminés brûlés). / Number of faunal remains from the Gravettian levels of the Gargas Cave (Coll. C.-B.: Cartailhac-Breuil Collection; NRT: Total number of remains; NRD: Number of identified remains; NRI: Number of unidentified remains; % NRI brûlés: proportion of the burned unidentified remains).

this sector of the cave near the entrance, but to its larger excavation surface. Moreover, though the ancient excavations yielded a smaller number of remains (NRT), their rate of determination (ratio NRD/NRT) is higher. This is typical of early excavation methods, which involved the nearly exclusive recovery of determinable remains, and a very small number of small bone chips (NRI). In contrast, the high proportion of undetermined remains in loci GES and GPO is representative of the extensive fragmentation of the remains. Furthermore, most of the bone chips are burned (tabl. 1) and small, and could thus be interpreted as combustion residues resulting from the intentional use of bone as a fuel for fires. It has indeed been shown that bone combustion results in a very high rate of fragmentation (STINER *et al.*, 1995; THÉRY-PARISOT *et al.*, 2004). Though no organized combustion features were found in the Gravettian levels in the recently excavated sectors, the presence of conglomerated combustion elements (burned bone, ash, charred cobbles) consolidated by stalagmitic concretions and found among the spoil from the ancient excavations in sector GES, indicates that they existed in the center of Chamber I (FOUCHER & SAN JUAN-FOUCHER, 2005: 7 and fig. 5A). Finally, a taphonomic analysis of the osseous remains revealed a very low degree of carnivore actions, the presence of striations created by butchery activities, and the use of cervid antler and bone for technical purposes, showing that humans were the main agents responsible for the accumulation of the Gravettian osseous assemblages in Gargas Cave (FOUCHER *et al.*, 2008a). The preliminary results for the Gravettian level in sector GPA are similar, with indications of butchery activities and numerous burned chips.

In both sectors, the faunal spectrum is relatively diverse (11 herbivore species and 5 carnivore species; tabl. 2). Herbivores are dominant in both the number of

Espèce	COLL C.-B.		GES		GPO		Total Gravettien	
	NRDT	%NRDT	NRDT	%NRDT	NRDT	%NRDT	NRDT	%NRDT
Coelodonta antiquitatis	-	-	-	-	1	0,4	1	0,1
Bison priscus	17	2,1	-	-	-	-	17	1,4
Bos primigenius	11	1,3	-	-	-	-	11	0,9
Boviné	84	10,3	35	21,6	25	9,3	144	11,6
Boviné/Equus sp.	-	-	7	4,3	5	1,9	12	1,0
Equus sp.	52	6,4	12	7,4	20	7,5	84	6,7
Megaloceros giganteus	5	0,6	-	-	-	-	5	0,4
Cervus elaphus	43	5,3	6	3,7	4	1,5	53	4,3
Rangifer tarandus	268	32,8	36	22,2	19	7,1	323	25,9
Rangifer tarandus/ Capra ibex	-	-	1	0,6	-	-	1	0,1
Cervus elaphus/ Rangifer tarandus	-	-	-	-	2	0,7	2	0,2
Capra ibex	2	0,2	1	0,6	-	-	3	0,2
Rupicapra pyrenaica	52	6,4	15	9,3	68	25,4	135	10,8
Rupicapra pyrenaica/ Capreolus capreolus	-	-	4	2,5	9	3,4	13	1,0
Capreolus capreolus	2	0,2	-	-	-	-	2	0,2
Mammuthus primigenius	1	0,1	1	0,6	-	-	2	0,2
Total herbivores	537	65,8	118	72,8	153	57,1	808	64,8
Ursus spelaeus	235	28,8	14	8,6	11	4,1	260	20,9
Ursus sp.	16	2,0	-	-	-	-	16	1,3
Crocuta crocuta	2	0,2	-	-	-	-	2	0,2
Hyenidae	3	0,4	-	-	-	-	3	0,2
Panthera pardus	1	0,1	-	-	-	-	1	0,1
Canis lupus	14	1,7	-	-	3	1,1	17	1,4
Vulpes vulpes	3	0,4	11	6,8	64	23,9	78	6,3
Vulpes/Alopex	3	0,4	16	9,9	25	9,3	44	3,5
Total carnivores	**277**	**33,9**	**41**	**25,3**	**103**	**38,4**	421	**33,8**
Lepus sp.	**1**	**0,1**	**3**	**1,9**	**12**	**4,5**	16	**1,3**
Oiseau	**1**	**0,1**	**0**	**-**	**-**	**-**	1	**0,1**
TOTAL	**816**		**162**		**268**		**1246**	

Tabla 2: Spectre faunique des niveaux gravettiens de la grotte de Gargas (Coll. C.-B.: Collection Cartailhac-Breuil; NRDt: Nombre de Restes Déterminés totalement) / Faunal list for the Gravettian levels of the Gargas Cave (Coll. C.-B.: Cartailhac-Breuil Collection; NRDt: Number of remains determined totally).

remains and the number of individuals. Some species, however, such was wooly rhinoceros (*Coelodonta antiquitatis*) and wooly mammoth (*Mammuthus primigenius*), are represented by only one or two pieces. The carnivores are mainly represented by cave bear (*Ursus spelaeus*), fox (*Vulpes vulpes and Vulpes/Alopex*) and wolf (*Canis lupus*). The recent excavations also yielded bird remains (study in progress by V. Laroulandie). In general, the species identified in the Gravettian levels of Gargas Cave suggest a relatively cold but non-arid climate and the presence of varied biotopes near the cave: open zones, forests and more steep/rocky zones.

Among these species, the most consumed in all sectors are: reindeer (*Rangifer tarandus*), chamois (*Rupicapra pynenaica*) and bovids (*Bison priscus / Bos primigenius*), followed by horse (*Equus* sp.) and smaller numbers of red deer (*Cervus elaphus*) (tabl. 3). We observe that while chamois remains are present both inside the cave (MNIc: 15 for the ancient excavations and the GES sector) and in the porch zone (MNIc: 7 in the GPO sector), most of the reindeer bones are located in the main chamber (MNIc: 23 for the ancient excavations and the GES sector, versus an MNIc of 2 for the GPO sector). This could correlate at least partially with the hunting seasons of these species. Therefore, though we have few indices of the seasons during which Gravettian groups occupied the cave, the seasonality of the different animal species is very different, with reindeer being hunted in winter and chamois in summer (tabl. 3).

In addition to their dietary contribution, reindeer, red deer, bovids and horse also provided most of the blanks for tool and personal ornament manufacturing (*cf. infra*).

A detailed study of the osseous remains originating from the excavated sectors, along with observations of the materials sieved from the backdirt of previous excavations, will enable us to refine these preliminary conclusions.

2.2. Osseous industry and personal ornaments

Our study of the archaeological materials recovered during the recent excavations enabled us to complete the preliminary technical analysis of the early collections, composed mainly of selected characteristic objects (spear points, perforated batons, smoothers, awls),

Taxon	NMI	Saisonnalité
Rangifer tarandus	25	hiver
Rupicapra pyrenaica	22	été
Boviné	17	?
Equus sp.	10	printemps
Cervus elaphus	7	automne – hiver

Tabla 3: Saisons d'abattage des principales espèces consommées par les Gravettiens de Gargas (NMI: Nombre Minimum d'Individus; Boviné: *Bison priscus/ Bos primigenius*) / Seasons of slaughter for the mains species eaten by the Gravettian people at Gargas (NMI: Minimal Number of Individuals; Boviné: *Bison priscus / Bos primigenius*).

and to confirm that projectile armatures were manufactured from cervid antler (reindeer and red deer) at the site. The presence of debitage by-products was also observed in the chamber of the ancient, now filled-in, porch (GPO sector), where the first researchers did not excavate (fig. 2). Smoothers and awls, often associated with hide working and clothing fabrication, are among the best represented osseous tools. There is also a relatively high number of used rib portions ("pickaxes" on herbivore ribs) and retouchers on diaphysis flakes used to manufacture and maintain lithic tools.

More precise descriptions and a comparative analysis of the osseous industry, beyond the *"Sagaies d'Isturitz"* ("Isturitz Spear Points") previously studied (SAN JUAN-FOUCHER & VERCOUTÈRE, 2005), enable the identification of technical traditions that seem to be unique to the Pyrenean region (fig. 6). For instance, in the Gravettian levels at Gargas around a dozen used ribs with two different types of incised decorations were observed; one with long and thin lines on the body of the rib, and the other with short and deep incisions on the edges of the proximal area. These two types of osseous tools, also discovered in other Gravettian sites in the region, have a different territorial distribution, the first being limited to strictly north-Pyrenean sites (La Tuto de Camalhot, Gargas, Isturitz), and the second corresponding to traditions shared on a larger scale, including the eastern part of the northern Iberian coast and all of the Aquitaine region (SAN JUAN-FOUCHER, 2006, 2011, 2013). On the other hand, based on recent discoveries and a new inventory, the "Isturitz Spear Points" do not appear to have been diffused beyond the eastern zone of the Cantabrian coastline (RIOS-GARAIZAR & GARATE, 2014). Finally, decorated ivory objects ("waterskin plugs", "bands", pendants) are found only at Perigordian sites and at Brassempouy (SAN JUAN-FOUCHER, 2013).

Concerning the personal ornaments (fig. 3), we were able to identify *in situ* manufacturing sequences for ornaments on animal teeth, partially corresponding to the hunted animal species (red deer, bison/aurochs, horse, common fox and polar fox), as well as to the skeletons of cave bears found in the cave chambers or in the ancient clay fill in the cave. Most of the perforated teeth, or those in the process of manufacturing, display clear marks created during the perforation process: thinning of the root by scraping (creation of flat or concave surfaces) or an initiation of the perforation consisting of repeated incisions (fig. 3a, b and c), followed by a perforation by rotation using flint perforators or points. The initiating incisions are still visible on most of the pieces (fig. 3d, e and f) and the perforating tools sometimes left circular marks on the perimeter of the hole. The pieces are not very carefully finished and on most of the teeth the preparation before perforation was not very careful, with the exception of two red deer deciduous canines, which were polished over their entire surface and perforated by a different technique, probably drilling.

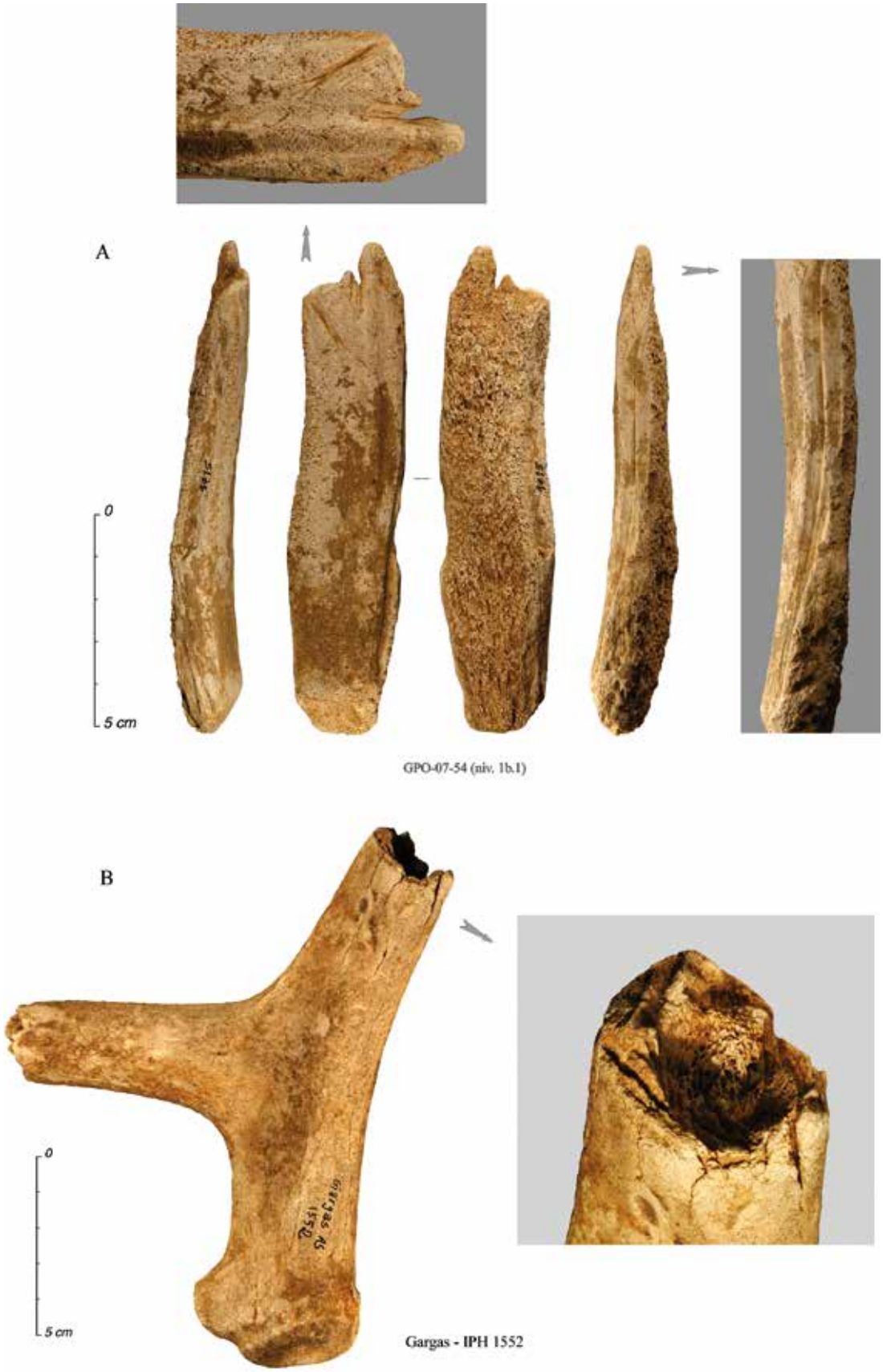

Fig. 2. Éléments techniques du débitage du bois de renne. A: support rectiligne (baguette) obtenu par double rainurage. B: tronçonnage de la perche (bois de chute) par entaillage périphérique / Technical pieces associated with antler working. A: straight blank (rod) produced by doubling grooving. B. Sectioning of a beam (shed antler) by peripheral scoring.

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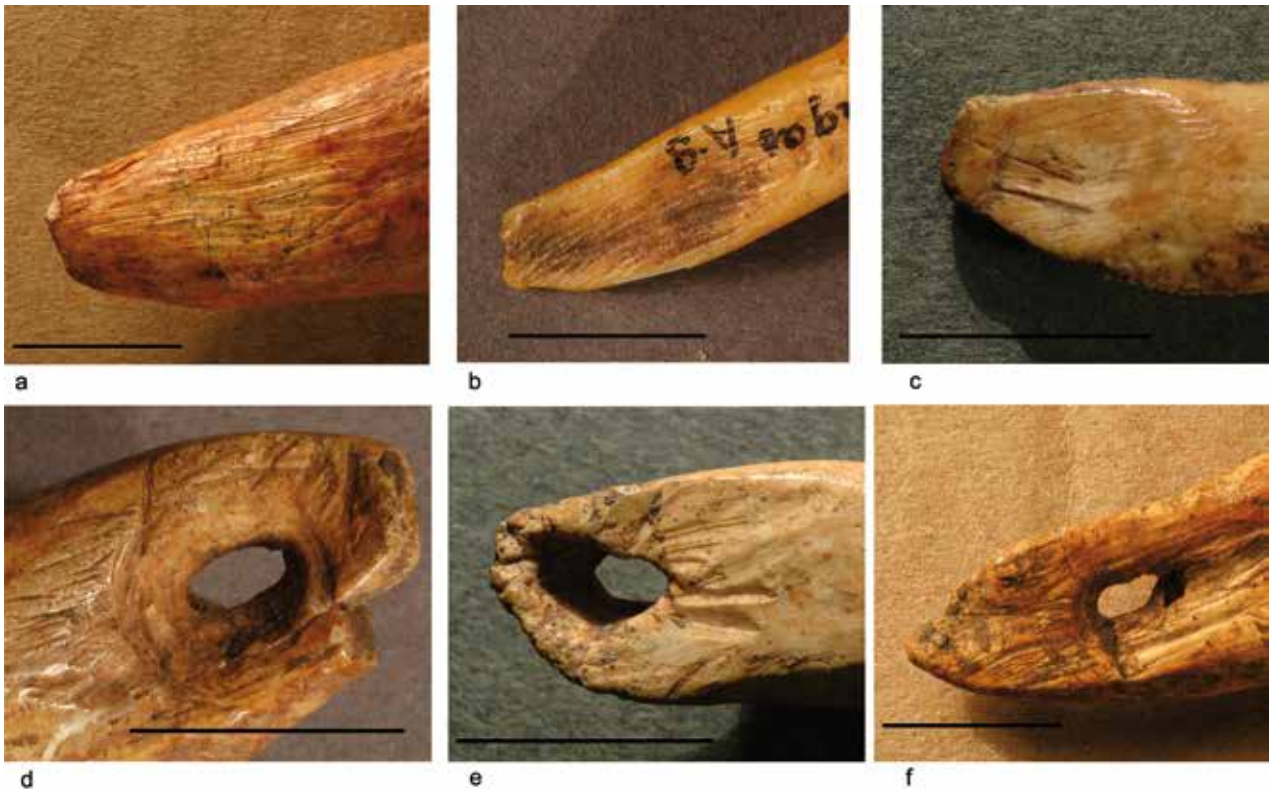

Fig. 3. Éléments de parure sur dents perforées d'animaux. Différents états de la chaîne technique de fabrication :
a, b: préparation de la surface de la racine par grattage ;
c: incisions d'amorce de la perforation ;
d, e, f: différents types de perforation par rotation avec traces de l'outil employé.
Personal ornaments on perforated animal teeth. Stages of the technical sequence of manufacturing:
a, b: preparation of the root surface by scraping;
c: incisions to initiate the perforation;
d, e, f: different perforation types by rotation, with marks made by the tool employed.

In addition to hunted animal bones and fossil bones collected in the cave (VERCOUTÈRE *et al.*, 2006), other animal materials, such as pierced shells, were used as personal ornaments. The original source locations of these materials provide information on the movements of human groups and exchanges between them.

Eighteen shells have thus been identified at Gargas (GES and GPO sectors and backfill), including five fragments and thirteen perforated pieces. Among the latter, all gastropods, the identified species are: *Littorina obtusata, Littorina littorea, Patella vulgata, Nucella lapillus, Trivia europea, Neritina fluviatilis, Neritina picta* and *Pirenella plicata* (FOUCHER & SAN JUAN-FOUCHER, 2008; SAN JUAN-FOUCHER & FOUCHER, 2010; SAN JUAN-FOUCHER, 2011).

Several perforation techniques were used: percussion, rotation from the upper face, with or without preparation (incision or small gorge serving as a guide to wedge a point turning in a circular motion), and incision/abrasion. The resulting holes are of varied shapes: quadrangular (more or less regular), sub-circular, ovular and fusiform. The diameters or main axis of the perforations ranges from 1.5 to 5.5 mm.

Except for one poorly preserved piece, all of the perforated objects display usewear or stigmata typically created when an object is suspended for a long period of time. Two of the perforated shells belonging to the *Nucella lapillus* taxon display overall natural wear that sometimes erased the relief of the shell bands.

Most of these shells originate from the Atlantic coast, with the exception of *Neritina picta* and *Pirenella plicata*, which are common in the sandy fossil deposits of the Lower Miocene in the Aquitaine region and rather frequent in the Bordeaux and Landes (between Dax and Mont-de-Marsan) zones, and in the Béarn region (Orthez and Salies-de-Béarn). The potential origin of the latter is situated between the Adour and Gave de Pau basins, which is also the origin of the Lepidorbitoide flints imported to Gargas.

3.- SILICEOUS RAW MATERIAL ECONOMY

3.1. The procurement and use of siliceous raw materials

Our study of siliceous raw materials is based on information on the Pyrenees region constituted by L. Mé-

roc (1947, 1953) and R. Simonnet (1999 and 2003), as well as on the petrographic methods initiated by M. and M.-R. Séronie-Vivien (1987) and further developed by A. Morala (1990, in press), P.-Y. Demars (1994) and A. Turq (2000, 2005). This methodology is based on detailed petrographic descriptions of siliceous stones (archaeological and geological), along with field verifications of the geomorphological contexts of raw material source sites. This approach was recently revised by P. Fernandes (2012, 2014) to include the degree of alteration of the material in order to achieve a more accurate determination of the origins of flints, not only from a stratigraphic point of view, but from a geographic one as well. For these methods to be efficient, they must be applied in a broad geographic context (Aquitaine, Pyrenees-Cantabria, Languedoc) and within a network of collaborations and exchanges among researchers. Researchers who have contributed to our work in this framework are Ch. Normand (1987), S. Lacombe (1998, 1999), A. Tarriño (2006, 2014), D. Millet (1999), F. Briois (2005), S. Grégoire and F. Bazile (2009), C. Bressy (*et al.* 2010), X. Mangado (2005), L. Montes and R. Domingo (2016), and M. Sanchez de la Torre (2014, *et al.* 2014).

The main flint procurement sources of the Gravettians at Gargas were:

- Pyrenean Flysch flint, particularly in the Montgaillard/Hibarette zone, where the Hibarette workshops are located (BARRAGUÉ *et al.*, 2001; cf. infra). But other sources, such as the Adour river bed, are also possible and will be investigated in future research;

- Tertiary outcrops (Danian), the closest of which are located in the Montmaurin and Lespugue massifs, but we cannot exclude the possible sources in the Courensan region (Gers);

- Lepidorbitoide flints, which have more than one source (SÉRONIE-VIVIEN & FOUCHER, 2006). The Chalosse region is one, but the Boussens cross-river is now another possibility. It is interesting that these two zones are located in opposite directions from Gargas. In addition, the recent discovery of several alluvial sites in the south of the Gers department (SÉRONIE-VIVIEN *et al.*, 2012) increases the complexity of questions concerning this raw material type. Another site located in the north of this department was also recently noted (COLONGE *et al.*, 2011) and the first results of surveys by Th. Minet in the Gers and Haute-Pyrénées departments (2015) support these observations;

- Allochthonous sources. It is certain that we have a few tool blanks in Gavaudun flint. The first observations that we have made relative to the proveniences of flint from the Périgord department (Bergerac and Gray-black Senonian) will be further analyzed in the future. We also discovered several laminar flakes in Jasperoid rocks characteristic of the infra-liasique limit that connects Nontron to the Brive Basin. Finally, four blanks could originate from the Èbre Basso, (A. Tarriño, oral communication).

In terms of the statistical evaluation of each broad raw material type and their relative importance in the economic choices of the Gravettians at Gargas, we believed it was most useful to consider the numbers of tools, rather than the weight of the flaked materials, given the typo-technological characteristics of the lithic industry (a majority of tools and blanks introduced directly into the cave, minimal flaking activity: cf. infra). The data in fig. 4 clearly illustrate the major role of Danian and Flysch flints (50% of the tools) in the Gravettian procurement

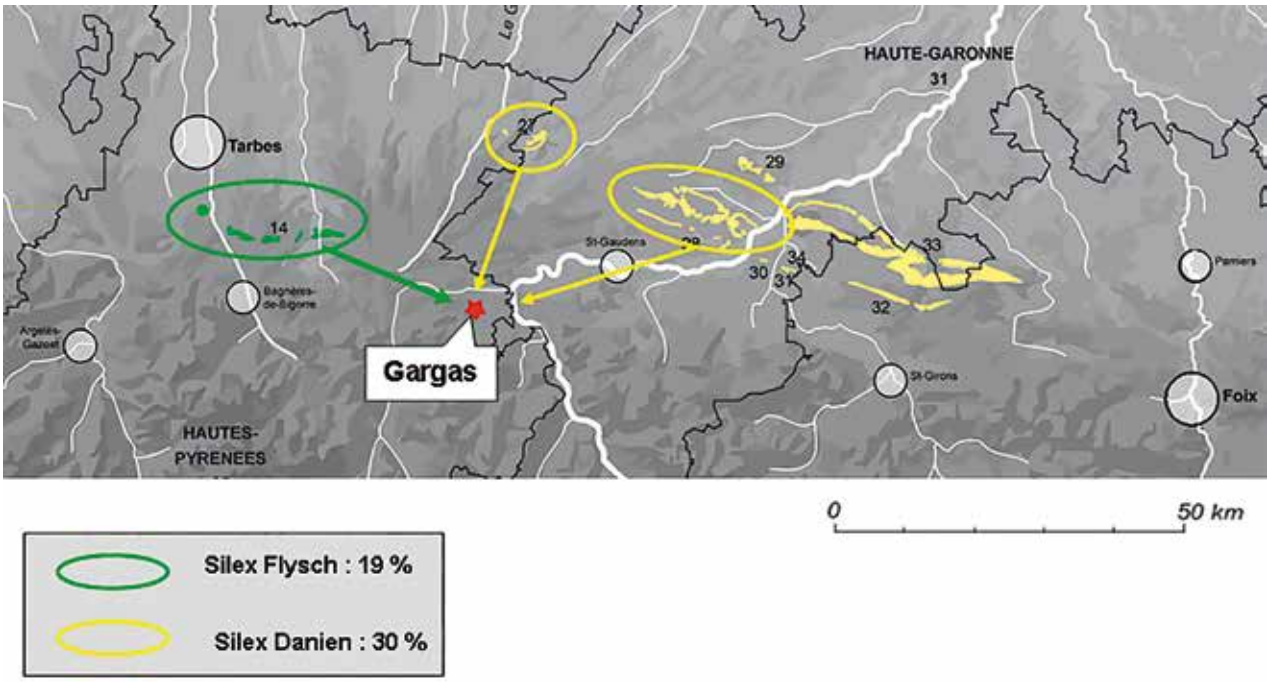

Fig. 4. Gîtes d'approvisionnement en silex pyrénéens. / The Petites Pyrénées flint sources.

strategies. We should emphasize that the two main Danian flint zones are located at about the same distance from Gargas (more than 25 km away), one to the north and one to the north-east. The Hibarette workshops are located a bit further away, at 42 km and in a different direction, to the north-west.

While the Flysch flint sources are relatively confined around Hibarette (but other possibilities may exist in the eastern zone of the Flysch outcrops), the Danian flint sources are distributed over a much larger area: Courensan region and the part of the Petites Pyrénées located to the west of the Boussens cross-valley. This multiplied the choices and procurement modalities available to the Gravettians. Whatever the case, and given the conditions of the availability of Pyrenean siliceous raw materials, two essential parameters become apparent: first, the Gravettians had to anticipate their immediate needs before coming to Gargas (prepare a large stock or tool kit), and second, to continue their stay at the site for a longer duration, they needed to organize and manage their procurement strategies, knowing that it would require one long day of walking to reach the Danian flint sources, and two days to reach the Flysch sources.

3.1.1. Flysch flint in the Montagaillard-Hibarette zone

The discovery of Paleolithic flaking workshops to the east of Hibarette (Hautes-Pyrénées) by J. and T. Barragué in the 1980s (CLOTTES, 1985, 1989) and the analysis of part of this industry (JARRY, 1992) revealed the importance of these flint sources to the south of Tarbes. Though the existence of flint in this zone has been known since the 19th century (FROSSARD 1880: 20), Simonnet was the first to identify this raw material in the lithic assemblages of Magdalenian sites, such as Labastide cave (SIMONNET *et al.*, 1991), followed by a more detailed analysis by Barragué *et al.* (2001) which led to the distinction of several microfacies. But this latter study was still not able to determine their precise stratigraphic origin, nor the geological history of these rolled blocks following their detachment from their parent rock.

A new research program (surveys and analyses) was initiated in order to precisely describe the flints in primary position and to decipher their evolution in the different types of superficial formations, from the most proximal to the most distal. This procedure led to the discovery of two formations in which these flints were formed:

- a rather uniform turbidite complex, sandy-marl in Turonian calcarenites (levels 3-5F);

- a rather uniform turbidite complex, sandy-marl to marl with carbonated lenses in the Upper Flysch in Campanian blue marls (levels 6-7F) cf AZAMBRE *et al.*, 1989, map: BRGM Bagnères-de-Bigorre, 1053.

Turonian flints (fig. 5: 1-3)

We found two types of silicifications in two different parent rocks. The first in the form of decimetric beds, incompletely silicified in gray sandy-marls, the other in centrimetric slabs sometimes joined with decimetric nodules at the transition and in the underlying beige calcarenites that characterize the base of the Turonian Flysch. Only the latter, corresponding to true flints, were studied. This is a gray laminated and graded flint with partial brown impregnations containing peloid forms and variably rich in spicules or echinoderms associated with a few filaments and planktonic foraminifera. The Fucoids and Globotruncanas present in the Pyrenean Flysch limestones have not been reliably identified in the samples studied. The sandy, millimetric cortexes are equivalent to the structure of the parent rock.

Campanian flints (fig. 5: 4-6)

These are large, flat, brownish, decimetric to metric nodules with a laminated and graded structure. In contrast to the flint from the Turonian quarry, most of the clasts are sub-angular and peloid forms are rare. There is a larger number of detrital quartz elements > 100µm. The micropaleontological components nonetheless remain very similar to that of the Turonian flints. The cortexes are sandy-marly, matching the structure of the parent rock.

Though the number of samples is still insufficient (for both the geological formations and the workshops), this preliminary study has yielded several results that merit further study. Some petrographic features enable distinctions between the samples according to their stratigraphic position. The Turonian flints have a sandier cortex and their matrix contains more peloid forms and filaments, as well as fewer detrital quartz elements, than the flints originating from the Campanian levels. Further research is nonetheless necessary to evaluate the natural dispersion zone for each genetic type originating from the turbidite formations in this sector of the Pyrenees, and thus to define the available mineral domain and evaluate the existent variability.

3.1.2. The granular rocks of the Pyrenees

Other than flint, the main rocks collected by the Gravettians were a large range of quartzites and other slightly metamorphic arenites, spotted schists, volcanic rocks, and quartz.

The true quartzites, or graywackes, are dark in color, ranging from gray to brown. These rocks are most often fine-grained with constituents that are infra-millimetric or just above one millimeter. They are mostly, or only, composed of angular quartz grains, which are isodiametric or slightly elongated. These grains, mostly fused, often display a siliceous growth halo on their periphery. Several petrographic facies are represented, particularly one that is characterized by the presence of abundant transparent quartz grains that are easily recognizable by their very dark appearance. This latter results from the optical effect produced by the surrounding material. The constituents sometimes show a slight

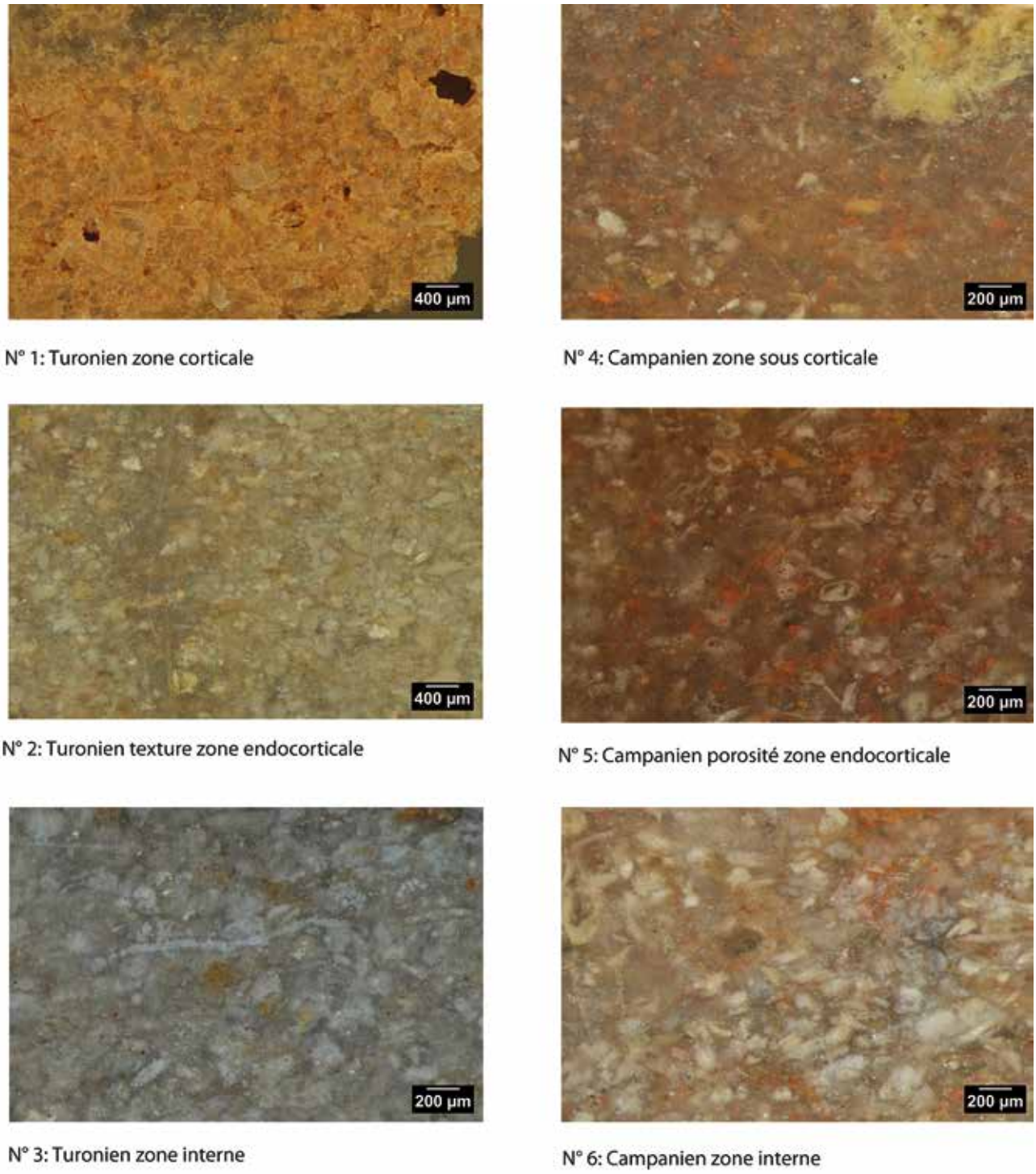

Fig. 5. Variabilité des faciès du silex du flysch pyrénéen. 1 à 3 silex du Turonnien. 4 à 6 : silex du Campanien / Facies variability of Pyrenean Flysch flint. 1-3: Turonian flints. 4-6 Campanian flints.

preferential orientation. One of the pieces collected displays a micaceous layer (probably muscovite). In only one case, the quartz grains are associated with the debris of rocks or crystals of a volcanic origin (grawaycke or litharenite).

The color of the spotted schists ranges from gray to greenish-gray, and is usually dark. Blackish spots are present within a very fine matrix. Their more or less defined contours have diverse forms: ovular, circular, square or irregular. Their dimensions are usually less than

one millimeter. Their density is highly variable from one sample to another. These metamorphic rocks generally outcrop in the external part of the metamorphic contact halo that envelopes the granitic batholiths. Most of the rocks in this category originate from the axial zone of the Pyrenees.

We were able to show the existence of three fragments of a volcanic rock. The break is scaled. With a very fine mesotase, gray on its surface, black crystals can be seen with the naked eye. They are isodiametric or elongated, with rounded, rectangular or, less often, irregular contours. The size of the latter is between 0.05 mm and 0.5 mm. This volcanic rock probably originates from the range of magmatic flows that developed during the Cretaceous.

The quartz pieces probably originate from nodules that initially came from the Paleozoic formations of the Hercynian platform in the Pyrenees, and were then rolled by fluvial actions. This mineral is slightly banded with colors ranging from white to gray to brown.

All of these petrographic categories are present in the intact or disturbed alluvial layers on the river plain and in its vicinity during the Upper Pleistocene. Gargas Cave is today located just over one kilometer from the Neste River, and around two kilometers from the Garonne. The Gravettian groups thus had no difficulty accessing this nearly inexhaustible natural source of pebbles accumulated and exposed in a river and stream bed.

3.2. General typo-technological features of the flint industry

Because the study of the lithic industry is still in progress, the results presented here are preliminary. The production of lithic blanks does not appear to have been predominant among the technical activities of the Gravettians at Gargas. There is nonetheless a relatively large number of tools and finished products in the early and recently excavated assemblages (excavations Cartailhac-Breuil: cf. FOUCHER, 2004, FOUCHER *et al.*, 2008). We can deduct from this that most of the tools and blade blanks were imported to the site. Most of the flaking activities attested in the occupation levels correspond to tool maintenance and a secondary bladelet production. The lithic assemblage seems to be homogenous in the three excavation sectors (GES, GPO et GPA). We nonetheless observe variability in the typological structure of each sector, which should be confronted with other archaeological data to search for possible explanations.

The tools are dominated by Noailles burins (between 22 and 37%), followed by retouched blades (between 10 and 24%), splintered pieces (between 5 and 17%), retouched flakes (between 5 and 16%), and burins on truncation (between 5 and 11%). Very few endscrapers were found during the recent excavations (between 3 and 5%), while they attain 14% in the assemblages of the Cartailhac-Breuil excavations. The statistical variation of Gravette Points is high, ranging from 2 to 16% in the different excavation sectors, and backed bladelets range from 0 to 4%.

These typo-technological characteristics are coherent with the Noailles facies of the Gravettian (FOUCHER, 2013), with a tendency toward microlithization reflected in the presence of Noailles burins and retouched bladelets.

It is significant that Noailles burins are present in all of the excavated sectors and throughout the Gravettian sequence (lower and upper levels). This challenges the idea of two distinct and superposed Gravettian levels, one with a Noailles facies and the other with only Gravette Points, proposed by H. Breuil (1953) following the 1911-1913 excavations. This information is not surprising in itself since the authors of previous excavations already observed accumulations of this characteristic tool type in other loci in Chamber I (BREUIL & CHEYNIER, 1958). It in fact reflects a spatial distribution of the tools for functional and/or technical reasons that we hope to clarify through future research.

Finally, the homogeneity of the lithic industry throughout the Gravettian sequence and the associated radiocarbon dates indicate both the presence of a very old Gravettian with a Noailles facies, dated to approximately 28,000 BP (32,000/31,500 calBP), and a continuation of lithic technical traditions during the 3,000 years of the site's occupation.

3.3. General typo-technological features of the granular rocks

A total of 56 Pyrenean granular rock artifacts have been recovered (tabl. 4). The raw materials are diverse relative to the lithological materials present in the Neste and Garonne rivers. They generally correspond to the rocks best suited to flaking among those present in the axial Pyrenean chain. They were collected as pebbles or natural fragments (there are no large flake-supports), attested by the presence of fluvial neocortex on half of the pieces in the assemblage. Mousterian artifacts were also collected, either in the cave or outside of it, and reused by the Gravettians.

<u>The use of fluvial pebbles (or fragments)</u>

While the presence of micro-artifacts indicates that granular rocks were worked in the cave, it is also possible that products and finished tools were brought into the site, though the small sample sizes, due to the surface areas excavated, do not permit reliable quantifiable analyses. Whether at the procurement site or the occupation site, natural matrices from fluvial contexts were preferentially used.

The diagnostic pieces, meaning those other than the small flaking debris, show that the flaking quality of the materials collected, even if they were intentionally selected, was relatively mediocre; this includes most of the

	Quartzites			Sch. tâchetés	Quartz	Basalte	Autres	
	Zt +	Grauwacke	Moustériens					Total
Eléments < 20 mm	4						7	11
Eléments < 20 mm	4						7	11
Cupule thermique	1							1
Percuteur	1							1
Débris / casson	3	1		2		2	3	11
Fragments d'éclats	8	4	1	3	2		2	20
Eclats	2	1	1	1	1	1	1	8
Nucléus			2					2
Macro-outillage sur galet		1		1				2
Total	**19**	**7**	**4**	**7**	**3**	**3**	**13**	**56**

Tabla 4: Décompte des matières premières par sondage / Inventory of raw materials per test-pit.

micaceous quartzites (cf. greywacke) and schists with marked schistocites. The systematic presence of a fluvial neocortex, often prominent, and the fact that the most of the elements that do not have it are smaller than 20 mm, indicate that the reduction sequences were short. The flaking methods were simple: centripetal flaking on an anvil. The products are only slightly standardized in both their morphology and in the configuration of their partial or peripheral cutting edges; they therefore appear to be only slightly predetermined, or not at all. The butts, generally thick, are simple and neocortical, but also often smooth, which does not facilitate flaking. At present, eight pieces can be considered as tools: two light retouched flakes, two macro-tools and four pieces with clear usewear.

The reuse of ancient artifacts

All of the reused artifacts are made from a very high quality, fine-grained quartzite and include all of the structured cores in the assemblage. From a technological perspective, these pieces correspond to the emblematic methods of the Mousterian: mostly Discoid *stricto sensu* (i.e. pseudo-Levallois points), along with one Levallois flake fragment. There is an equal number of flaking products and exhausted cores.

These artifacts have variable patinas, the "freshest" of which are located on their robust dihedral protrusions (back ridge, ridge between two flake scars, Siret fracture terminations). These features correspond to the crushing of these dihedrals, obtained or not by percussion, but more likely during a contact movement (longitudinal or circular), leading us to interpret these pieces as Mousterian artifacts reused by the Gravettians for specific tasks.

The use of granular materials can be resumed as followed. The Gravettians collected materials which, even if they were selected, were of a mediocre quality. The technical skill employed to work them also appears limited. It consisted of the most "simple" methods (or the most easily accessible through a direct empirical approach), applied in the realization of centripetal flaking and/or flaking on an anvil, in short sequences with no predetermination. They thus obtained a few flakes with edges of varying lengths. The flaking actions were executed with little precision and often lead to counterproductive complications. The blank transformation phase was limited to awkward retouching on heterogeneous blanks, resulting in light, atypical tools. There are also some heavy tools that correspond to an opportunistic use of crenelated edges resulting from flaking difficulties or the use of the resulting pieces (cores) for striking percussion on a hard, probably stone, material.

The Gravettians also collected Mousterian artifacts and used them in a specific manner, making use of their robust dihedral edges.

The tools in granular materials thus seem to have been used as a complement to flint tools, and were destined for specific activities. While the *chaîne opératoire* (reduction sequence) of the pebbles is similar to that known in other Upper Paleolithic contexts, the reuse of ancient pieces is more original and raises the question of how they were technically perceived by the Gravettians: as strangely fractured natural elements, or as pieces left behind by unknown ancestors?

4.- SYNTHESIS

Despite conditions that could be considered difficult (rigorous climate and close proximity to the Garonne glacier, absence of flint sources near the cave), Gravettians regularly occupied Gargas Cave over a period of more and 3,000 years (from 28,000 to 25,000 BP), and in all seasons.

Their subsistence economy was based on large prey hunting in two complementary ecological niches: the plains and mountains. In the middle foothill valleys of the Neste and Garonne rivers, they hunted reindeer (the most consumed species) and other herbivores, such as bison/aurochs, horse and red deer. In the middle mountains, probably during the warm season after the snow cover had melted (reliefs near Gargas at altitudes between 800 and 1200 m), they hunted chamois, the second most consumed species.

The combined data from the early and recent excavations indicate that Salle I of the Lower Gallery contained a large domestic occupation with all of the typical components: evidence for numerous fireplaces, and butchery and artisanal activity zones. The latter were focused on the manufacturing of tools from antler (spear heads) and bone (smoothers, awls, used ribs), as well as ornaments made from carnivore and herbivore teeth.

Due to the lack of flint sources near the cave, the occupants of Gargas developed specific economic strategies based on the anticipation of short and middle term needs, the adaptation of production modalities (importation of blade/tool blanks and a dominant production of bladelets), and the complementary use of local granular rocks (mainly alluvial quartzites) for specific activities.

To live for extended periods at Gargas, the Gravettian groups had no choice but to develop this specific foothill economy. It was nonetheless integrated within a much wider exchange network (fig. 6) that covered the Aquitaine Basin and the eastern Cantabrian zone, and concerned osseous and lithic industries, as well as shells (SAN JUAN-FOUCHER, 2010, 2013).

The symbolic dimension of the cave suggested by its parietal art and evidence for funerary practices (FOUCHER *et al.*, 2007, 2012) is obviously linked to an even broader cultural and geographic context that transcended the economic and material aspects of the daily lives of the Gravettians. The aim of our future research at Gargas is to identify all of the components of this prehistoric culture, which was very present in the Pyrenees, and to analyze their interrelationships and evolution at the European scale.

5. ACKNOWLEDGMENTS

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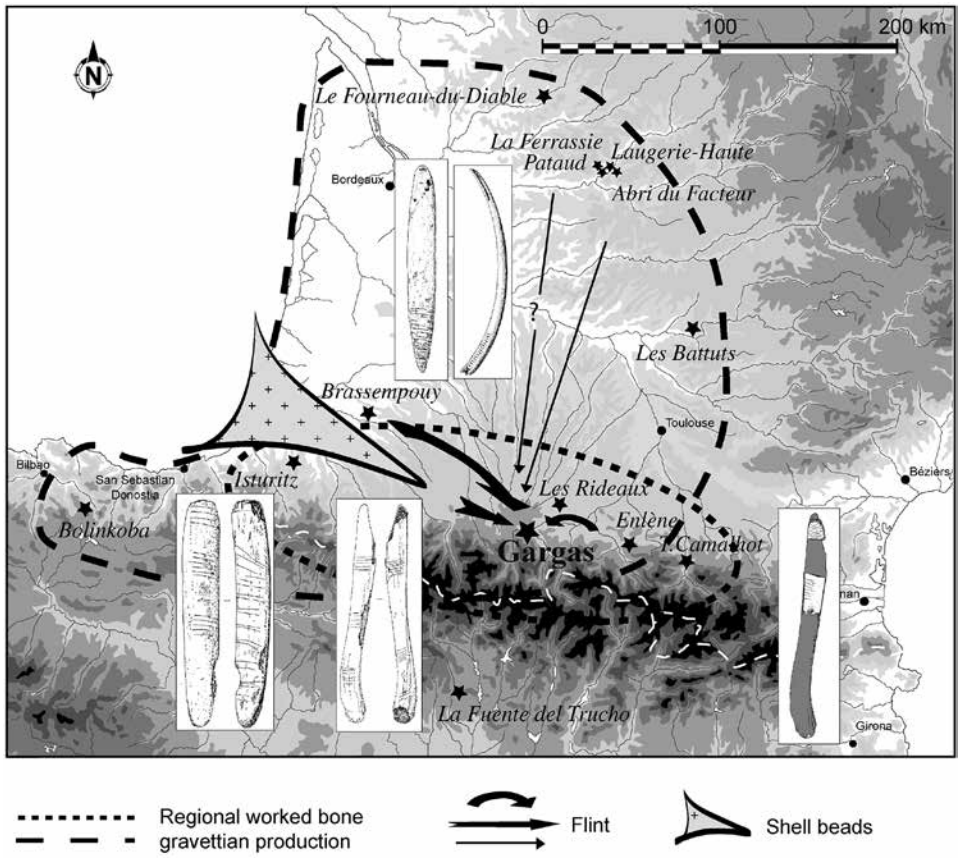

Fig. 6. Territoires économiques des Gravettiens de Gargas : traditions techniques et sources d'approvisionnement / Economic zones of the Gravettians at Gargas: technical traditions and procurement sources.

Note 1. – For a complete history of early research, see FOUCHER, 2004, 2015; FOUCHER *et al.*, 2007.

Note 2. – One of the last studies published on the Garonne glacier shows that at around 26,000 BP, the glacier front was located at Barbazan, eight kilometers from Gargas Cave (ANDRIEU *et al.*, 1988).

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