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## **TEPHROFACTS AND THE FIRST HUMAN OCCUPATION OF THE FRENCH MASSIF CENTRAL**

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Mots-clés : Massif Central, tephrofacts, pétrographie, Paléolithique ancien.

Key-words: France, Massif Central, Tephrofacts, Petrography, Lower Palaeolithic.

Résumé: Les auteurs examinent la production par le volcanisme de pseudo-artéfacts. L'existence de ces téphrofacts doit être prise en compte pour l'analyse des outillages réputés très anciens. Dans l'état actuel des recherches, seul le site de Soleilhac offre les meilleures garanties d'une présence humaine très ancienne (0,5-0,6 Ma ?) dans le Massif Central français.

Abstract: This paper examines the production of pseudo-artefacts by vulcanism and discusses their presence in supposedly ancient sites in the French Massif-Central. At this time, only the site of Soleilhac offers sufficient evidence for very ancient human occupation of the region (0.5-0.6 Ma ?).

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## **Introduction**

The production of geofacts, objects resulting from natural fracture and imitating artefacts (HAYNES, 1973), is a phenomenon long recognized in many different sedimentary contexts (PEI, 1937; MORTELMANS, 1947; BREUIL, 1955; CLARK, 1958; BOURDIER, 1967; FOURNIER, 1971; RAYNAL et TEXIER, 1989; RAYNAL *et al*, 1990). A number of works analyse these, particularly for flint, and try to elaborate a method which distinguishes clearly between intentionally flaked objects and products of nature (BOULE, 1889, 1905, 1921; HAWARD, 1911; MOIR, 1911; WARREN, 1914; GRAYSON, 1986; SCHNURRENBERGER and ALAN, 1985; PEACOCK, 1991).

The Massif Central in the central mountainous region of France experienced active vulcanism during the Miocene (15-20 M.a) and several glacial events during the Pleistocene. Because vulcanism and frost action generate rock fracturing, there is thus a high probability of the natural occurrence of pseudo-artefacts in this area. Discovery of flint pseudo-tools confused a number of archaeologists during the nineteenth century beginning with TARDY (1869), who reported the discovery of Miocene eoliths from Le Puy Courny in the Cantal. More than fifty years afterwards, MARTY was still arguing for this interpretation (CAPITAN et MARTY, 1924).

The Massif Central region is well known for important excavations from the Upper Palaeolithic and has considerable archaeological potential for sites yielding material from the Lower and Middle Palaeolithic. During the last twenty years, much research has been undertaken in the region towards discovering traces of the first human occupation of Europe. These investigations have been concentrated in Velay, a province to the south of Auvergne which is rich in Plio-Pleistocene fauna occurring in between volcanic sediments which offer the possibility of obtaining a long sequence of palaeomagnetic and radiometric dates. Basse-Auvergne and Bourbonnais have yielded a number of classic Acheulian bifaces lacking stratigraphic context and in surface complexes of the Allier tools made on quartz cobbles have been discovered.

The lithic series discovered in the Massif Central, principally in Velay, has been classified under the name "Most Ancient Palaeolithic" (BONIFAY and BONIFAY, 1983) and has been proposed as resolving the question of the time of the initial human occupation of Europe (BONIFAY, CONSIGNY, LIABEUF, 1989; BONIFAY, 1981, 1983, 1989a, b, c, 1991). This perspective, which is of considerable conceptual importance and thus must be founded on decisive arguments, is not accepted unanimously by the scientific community, as doubts have been expressed in many publications (DELSON, 1989; BOEDA, 1990; VILLA, 1991; FARIZY *in* DIAZ, 1993).

We report here some results of an examination of the production of geofacts by vulcanism. We will refer to these as **tephrofacts**. These pseudo-artefacts are fashioned in materials other than flint which occur in the local environment of supposedly ancient archaeological sites. Our observations, begun in 1989, are founded on the

examination of a number of volcanic structures and the deposits and epiclastites associated with these structures (figure 1). These investigations were aimed at elucidating the possible presence of hominids in the Upper Pliocene and Lower Pleistocene of this part of France. Special attention has been given to the site of Blassac and part of the abundant series of supposed artefacts discovered in an ancient context there and also to the site of Soleilhac, yielding the strongest evidence for an ancient occupation of Velay.

## 1 - THE PRODUCTION OF TEPHROFACTS

The production of pseudo-artefacts or tephrofacts in volcanic contexts, is known to have occurred in pyroclastites of the Eifel in Germany (BOSINSKI *et al.*, 1986). We collected some tephrofacts on the site of Kärlich and in strombolian lapilli of the Schweinskopf volcano in the company of G. BOSINSKI in 1992. These tephrofacts superficially resemble human artefacts and their differentiation from the latter is difficult when they are discovered apart from the primary volcanic context. (KULEMEYER, 1986).

In Velay, many Pleistocene maar tuff-rings (La Sauvetat, Les Farges, Saint-Eble, Soleilhac, Senèze, Blassac/Les Blanches), basanitic breccias (Sainte-Anne) and one strombolian cone have yielded tephrofacts with various petrological origins. Moreover, many other geofacts have been collected in a large number of volcanic sediments (Saint-Vidal, Vals, Brioude).

Among these are a number of flakes and some objects with multiple flake scars with apparent ordered intent: None of them would be discarded out of hand if they occurred in archaeological contexts. *However, they are undoubtedly tephrofacts which have resulted from several mechanical and thermal actions during various different eruptive stages of volcanic events.*

## 2- PETROGRAPHY OF THE TEPHROFACTS

The raw material of the tephrofacts collected come from the regional basement or from the Plio-Pleistocene sedimentary formations which have been altered by the volcanic eruptions. Some of these materials still outcrop in the immediate environment of the volcanic formations investigated. The following diverse rocks have been identified : vein quartz, pegmatitic quartz, fine grained granite, oriented granite, migmatitic gneiss with sillimanite, lamprophyre and various basalts.

The Blassac-Les Blanches tuff-ring has yielded seventy-two tephrofacts. The distribution of petrographic types does not vary significantly between the chunks, flakes or pseudo-artefacts (figure 2). *The strong representation of materials of mediocre quality for flaking (granites and gneiss) and the absence of flint is a distinct characteristic of this series.*

### 3 - NATURAL FLAKES

In this paper we do not discuss the classic "pot-lid" flake form well known to occur as a result of thermally induced reduction sequences. We note however the absence in the literature of observations concerning the characteristics of these thermal fracture features when they occur adjacent to the edges of irregular chunks. The natural flakes derived from these situations exhibit a pseudo-striking platform produced when the fracture surface intersects an adjoining edge. Although these objects may be superficially identified as humanly produced flakes, this position can be readily discarded for flint when none of the other features of humanly produced flakes can be identified (point of percussion, ventral bulbar scar, radial stress marks, etc).

Fifty natural flakes were collected for study from the tuff-rings of Blassac-Les Blanches, La Sauvetat and Soleilhac (figure 3). Some of them were in juxtaposition with the pseudo-core.

Of these, fifteen (30%) exhibit cortical striking platforms. These can be subdivided into those with a total or partial cortical dorsal surface extending to the edges (11) and those with non cortical edges (4). In the case of a series produced by intentional flaking, these objects would be considered of primary and secondary generation.

Flakes without cortical striking platforms represent 70% of the total (35 objects) and this group is composed of those with cortical dorsal surfaces (8) and those with non cortical edges (27). In a series produced by intentional flaking, these would be considered third generation flakes.

Pseudo-retouch sometimes appearing contiguous can be seen on numerous flakes and is comparable with the utilized or retouched edges of humanly produced artefacts (figure 3).

The proportion of types of naturally produced flakes in this series is very different from that obtained from our experiments with quartz pebbles. They also differ from those of the flaked quartz assemblages collected from the upper and middle terraces of the Allier in Bourbonnais: *an assemblage of tephrofacts is characterized by an overrepresentation of flakes with non cortical striking platforms and non cortical edges and an underrepresentation of flakes with cortical striking platforms and edges totally or partially cortical* (figure 4).

Pseudo-flakes have a weight below 150g in more than 96 % of cases and rarely exceed 500g (figure 5). A few exceptions exist, represented by very large individuals which weigh over 2000g.

The weight criterion is not a discriminating factor between tephrofacts and artefacts. The distribution of weight ratios of pseudo-flakes and flakes manufactured and recovered in primary position (whether in eruptive breccias, archaeological layers, or by experimentation) is identical. This distribution differs from those observed on collections from surface sites: for the flakes collected in Bourbonnais on the surface of

the upper and middle terraces of the Allier for example, the weight ratio distribution can be explained by the removal of the smaller flakes through natural processes and selective collection (figure 5).

This natural organization of a succession of flake scars produces flakes of several types and results from repetitive uni-directional stresses, both mechanical and thermal.

#### 4 - NATURAL OBJECTS WITH MULTIPLE FLAKE SCARS.

Events leading to the natural flaking of fragile source rocks are diverse in nature and may result in an apparently organized series of flake scars. The order in which these flakes are removed largely determines the morphology of each tephrofact. The organization of the natural flake scars on the blocks parallels the morphology of objects recognized among prehistoric archaeological assemblages.

The number of flake scars on the tephrofacts (between 1 and 22) is comparable with that observed on prehistoric objects and their random organization is comparable to the sequences observed on manufactured objects. However, contrary to what is evident on prehistoric objects, the detachment points of flakes observed on tephrofacts are very often impossible to determine and most flake scars occur in random arrangements.

On 34 faces of objects with multiple flake scars (9 uniface and 26 bifaces) there is a linear system of "working" arranged from right to left for three flake scars in two cases and in the remaining cases the working system is non linear with a maximum number of seven flake scars originating from one edge. In general, pseudo-working identified on the tephrofacts is mainly non-linear in arrangement.

The associations of flake scars on edges are shown in the following table:

Number of flake scars	1	2	3	4	5	6	7	Sample
Unifacially "flaked" objects	1	2	1	3	0	2	0	9 faces
Bifacially "flaked" objects*	2	3	6	5	4	3	4	27 faces

\*(each face is considered separately)

Some natural objects appear similar to unifacially flaked choppers and bifacially flaked chopping tools in that they exhibit the transformation of a natural edge with at least two adjacent flakes (figure 6, n° 1, 2, 4, 5; figure 7, n° 1; figure 8, n° 5; figure 10, n° 2).

Natural multidirectional flaking around the periphery of various chunks and pieces produces objects which are similar to invasively flaked tabular cores and discoïdal cores (figure 7, n°s 3; figure 10, n° 3; figure 9, n° 1, 2). Sometimes the natural morphology is

similar to that seen on bifacially flaked artefacts (figure 6, n° 3; figure 8, n° 1; figure 9, n° 3; figure 10, n° 1).

Other tephrofacts look similar to flaked polyhedrons. These globular objects have a large number of flake scars from which were removed flakes with a high number of non-cortical striking platforms (figures 7, n° 2, 4; figure 8, n° 3, 4; figure 10, n° 4; figure 11).

*As if the distinction between tephrofacts and intentionally manufactured objects was not difficult enough, the case is further complicated by the poor raw materials in which they occur.* This observation has already been discussed in other works attempting to distinguish between geofacts and artefacts (WATSON, 1968), even though some progress has been made in the case of flint (PEACOCK, 1991), a raw material for which there is today a considerable amount of information on its flaking properties.

## 5 - DISTINGUISHING BETWEEN TEPHROFACTS AND HUMANLY PRODUCED OBJECTS.

We have had recourse to a statistical approach to solve this problem, the details of which will be presented elsewhere. Between 24 and 62 tephrofacts, according to the number in each sample, have been added to a series of humanly produced lithics. The criteria used for describing the two groups were published by J. COLLINA-GIRARD (1975, 1986). We have discarded some of those criteria, calibrated some of his non-metrical observations and added some of our own (weight and number of flake scars).

Factorial analysis of correspondences reveals that the inclusion of the tephrofacts destroys the coherence of the assemblage. The presence of two discrete and distinct groups is readily observed in each series.

In the case of a principal component analysis, taking all the characteristics except the number of flake scars into account, no true distinction can be made between tephrofacts and humanly produced objects. The natural trend in tephrofacts is towards a spherical or sub-spherical shape, which most effectively resists further natural attrition. Human intervention interrupts this trend towards a globular form. However, industries containing a preponderance of polyhedrons cannot be discarded out of hand as having a natural origin and should be studied according to the scheme suggested above.

*Parametric characteristics often used for studying a humanly produced lithic assemblage, when applied to tephrofacts, do not permit any distinction between the two.* The results, rather than showing the differences, confirm the similarities between tephrofacts and manufactured objects, rendering the method useless.

## 6 - REMARKS ON TWO REPUTEDLY ANCIENT SITES.

### 6.1 - BLASSAC-LES BATTANTS.

A series collected at Les Battants by F. CARRE (1978, 1983, 1991) is dated by a number of Potassium/Argon determinations on the basaltic lava-flow overlying the assemblage, which indicates an age around or beyond 2 M.a.. However, the fauna of Blassac-La Girondie, in an analogous stratigraphic position, seems to be much more recent, belonging to the Peyrolles biozone and probably dating from around 1.2-1.4 Ma (J. COUTHURES, 1982; F. CARRE et J. COUTHURES, 1982; J. COUTHURES et J.F. PASTRE, 1983; M. FOURIS, 1989; BONIFAY, 1991; CARRE, 1991).

A series of 278 lithic objects has been examined. This study is incomplete, however, because the matrix has been left on several objects. Observations to date are as follows :

- Most objects are on crystalline rocks with natural cleavage planes and the fractures in general follow these planes. This gives the pieces an appearance of being partly or intentionally flaked debitage. However, most of the flakes do not have normal feathered terminations.

- From the evidence of the flake scars, the angle of detachment approaches 90°, which is not usually encountered in intentional flaking.

- Several objects have gross crystalline irregularities which render them inappropriate raw materials for flaking.

- Flakes do not exhibit clear points of percussion.

- Some objects exhibit obvious thermal fractures.

- On many objects, the flake scars appear to originate from well outside the remaining volume. Objects of similar form, and the flakes removed from them by thermal action, have been collected from the tuff-ring of Blassac-Les Blanchés. In several cases, these pseudo-nuclei and their conjoining flakes were found in primary position within the tuff with the flakes barely removed from the parent chunk.

- Several objects of very poor flaking quality show a number of repetitive flake scars, which is an unlikely occurrence even in a primitive series of intentionally flaked objects. Moreover, within the same stratigraphic level, materials with far better flaking properties are present.

- Finally, the petrographic nature of the series presents a distribution comparable to that of tephrofacts (figure 12).

The geological characteristics of the site of Blassac-Les Battants deserve a full scale discussion too extensive for this paper. *We simply note here the undeniable*



*inclusion of naturally fractured objects and the resemblance to the petrographic suite occupied by tephrofacts.*

## 6.2 - CHILHAC III

The fossil locality of Chilhac III is known for a rich Villafranchian fauna (BOEUF, 1983) and lithic objects (GUTH, 1974; GUTH et BOEUF, 1977; GUTH et CHAVAILLON, 1985) which occur in a level whose age is presumed to be in the vicinity of 1.8-1.9 M.a., a date arrived at through palaeontological comparisons and extrapolation from absolute dates on a lava flow close to the site.

This stratigraphy exhibits deformations interpreted as resulting from solifluxion (TEXIER, 1985) or soil slips (CHAVAILLON, 1991). Many visits to the site during the excavations have convinced us of the existence of syn-sedimentary slumpings and removals. This clearly demonstrates dynamism of a kind known to occur on the margins of lacustrine systems and we postulate the likelihood of the existence here of an ancient phreatomagmatic structure. In this dynamic situation, the presence of relatively recent tools on quartz cobbles in adjacent localities (LE GALL et RAYNAL, 1986) renders likely a mixture of such objects with the ancient fauna.

We have not examined closely the complete series of objects discovered in a stratigraphic context (ensembles B to K) apart from those published by J. CHAVAILLON (1991). Except for the resemblance between retouched flakes and some tephrofacts (figure 3), *we note that the petrographic nature of the objects offers a distribution identical to that of tephrofacts and of the series of pseudo-artefacts recovered at Blassac-Les Battants* (figure 12).

A detailed examination of the site and its environment would clarify without doubt the archaeological and geological processes which resulted in the production of these objects and their association with the faunal remains.

## 7 - COMPARISON WITH THREE ARCHAEOLOGICAL SERIES.

We have chosen three archaeological series to illustrate the fundamental differences which exist between the petrography of tephrofacts and that of prehistoric tools from Velay. In the latter, the petrography clearly demonstrates human selection.

- At Nohac, apart from exceptional flint objects, quartz was the principal material chosen (RIO CARRA, 1991; BONIFAY, 1991),

- In Soleilhac-Centre, quartz, basalt and flint are in that order the three dominant materials (BRACCO, 1991),

- In level J1 in the cave of Sainte-Anne 1 at Polignac, provisionally reported at isotopic stage 6, basalts, phonolite, flint and quartz were in that order the materials worked.

The petrography of tools from the prehistoric sites is clearly different to that of the tephrofacts and *is characterized (outside the constant presence of flint) by a choice of materials which does not include those with poor flaking characteristics like granites and gneiss* (figure 13).

## 8 - CONCLUSIONS

### 8.1 - TEPHROFACTS ARE WIDELY DISTRIBUTED.

It is more than reasonable to assume that tephrofacts were produced in great numbers in the Massif Central during the numerous volcanic episodes which occurred since the Miocene. Without doubt, they were subsequently eroded out of their primary position and widely dispersed in the environment on numerous occasions.

*The discovery in geological layers of some broken or apparently flaked pieces, flakes or objects exhibiting a more complex pattern of flake scars is therefore not considered a sufficient criterion for characterizing human activity, particularly in this region.*

### 8.2 - NECESSARY RE-EXAMINATION OF SITES.

Sites considered indicative of human activity demonstrated by the presence of a series of supposedly humanly worked pebbles and cobbles demand a close scrutiny of all the available evidence, especially in the case of Blassac and Chilhac III.

Sites which have yielded a limited number of doubtful artefacts, tephrofacts or geofacts need further detailed discussion. This is the case for Perrier-Etouaires in Puy-de-Dôme (G.U.E.R.P.A., 1984), Saint-Eble (BONIFAY, 1989a), le Coupet (BONIFAY, 1989a) and La Roche-Lambert (BONIFAY, 1981) in Haute-Loire.

For some sites, association of lithic objects with fragmented faunal remains is not decisive anyway. The various models of fragmentation and preservation of the bones do not give at present sufficient evidence to identify any human involvement.

From the evidence, it must be recognized that there is considerable doubt concerning a very ancient human presence in the Massif Central.

In addition to the taphonomic approach, it is necessary to consider the following points carefully and systematically for all localities:

- Is there a possibility of pseudo-artefacts being produced?

- If so, what are the likely characteristics of these objects ?
- Is there a geological explanation for the introduction of naturally flaked objects into the site ?
- Are lithic objects preferentially distributed in the supposed archaeological layer ? Is there a natural explanation for this ?
- Do conjoinable objects exist in the site, and do they occur adjacent to each other ?
- Are the flake scars observable on the objects arranged in a technologically "logical" sequence ?
- Are natural objects mixed with artefacts ?
- Are the faunal remains and the associated objects both in primary position ?
- Does the taphonomic history of the site provide any explanation for possible association of numbers of objects of different ages, for example reflecting periglacial phenomena ?

### 8.3 - OPPORTUNISTIC EXPLOITATION ?

Can we discard out of hand sites where only a few objects have been found ? The utilization of materials of poor flaking quality in these sites may simply be an example of human opportunism according to the law of least effort. Additionally we have the complicating factor among ancient assemblages of the likelihood of opportunistic exploitation of naturally fractured pieces which will occur anyway as a part of the site's assemblage. *While these questions have already been discussed for several African archaeological sites, it is no doubt useful to consider the "advantage of thinking small as archaeology explores the most ancient spans of prehistory"* (G. ISAAC *et al.* , 1981).

### 8.4 - THE TIME OF FIRST HUMAN OCCUPATION.

Only the sites where unquestionable archaeological elements have been discovered in a well documented long sequence should be considered to elucidate this problem. In the absence of precise dating elements for the site of Nohac, only Soleilhac "the most recent of the very Lower Palaeolithic sites" (BONIFAY, 1991) remains to give an idea of the temporal remoteness of the human presence in Velay.

The age of Soleilhac has been established by biostratigraphic criteria (BONIFAY and BONIFAY, 1981), palaeomagnetic determinations (THOUVENY, 1983; THOUVENY and BONIFAY, 1984) and morphostratigraphy (BONIFAY and MERGOIL, 1988). Soleilhac-

Centre has also been studied from a sedimentological and palynological point of view (RAYNAL, 1987 and unpublished). However, the fauna of Soleilhac belongs to the "transition fauna" which covers a broad time spectrum (BONIFAY, 1987). Furthermore, the sedimentological and palynological characters do not allow reliable dates to be determined and the paleomagnetism of the complete sequence has not been studied because of the unsuitability of some layers for the application of this method (THOUVENY, op. cit., p. 81). Most interest has been generated by the tephrostratigraphy reported by A. TEULADE (1985, 1988, 1989) and determined from cores (BONIFAY and MERGOIL op. cit.).

A direct pumice ash-fall has been identified in the lake series underlying archaeological layer C. These tephra correlate with the "upper pumices of Sancy" (CANTAGREL and BAUBRON, 1983) and most particularly with the pumice of Neschers. A number of dating methods place the Neschers pumice around 0.8 M.a. (TEULADE, 1989, p. 145). More recently, however, a  $^{40}\text{Ar}/^{39}\text{Ar}$  age of  $0.58 \pm 0.02$  M.a. has been obtained (LO BELLO *et al.*, 1987), which has been confirmed by a thermoluminescence date of  $0.52 \pm 0.04$  M.a. obtained by the quartz red peak TL method (PILLEYRE, 1991). *Thus, the tephrostratigraphy contradicts the paleomagnetic data and necessitates consideration of a date around 0.5-0.6 M.a. for Soleilhac-Centre.* This last date is in agreement with a late Cromerian age for the fauna, as suggested by VAN KOLFSHOTEN (ROEBROEKS and VAN KOLFSHOTEN, this volume).

## 8.5 - DIRECTIONS OF FUTURE RESEARCH.

If we discard all the doubtful ancient sites occurring in the Massif Central, the earliest settlement history of the region must be rewritten. However, all is not lost yet. The evidence for the earliest occupation of Auvergne and Velay can be revisited, evaluated and carefully dissected avoiding the traps of their geological context. Paradoxically, in the final analysis it would be this last which furnishes a detailed chronology of the human presence in the region. Directions for future research are clear. Parallel to an examination of the physical and biological characteristics of the palaeoenvironment, the close study of pseudo-tools will doubtless provide much discussion and food for thought. *But clearly for each supposedly ancient site a multidisciplinary and broadly based study is absolutely necessary, and not only for the region discussed here.*

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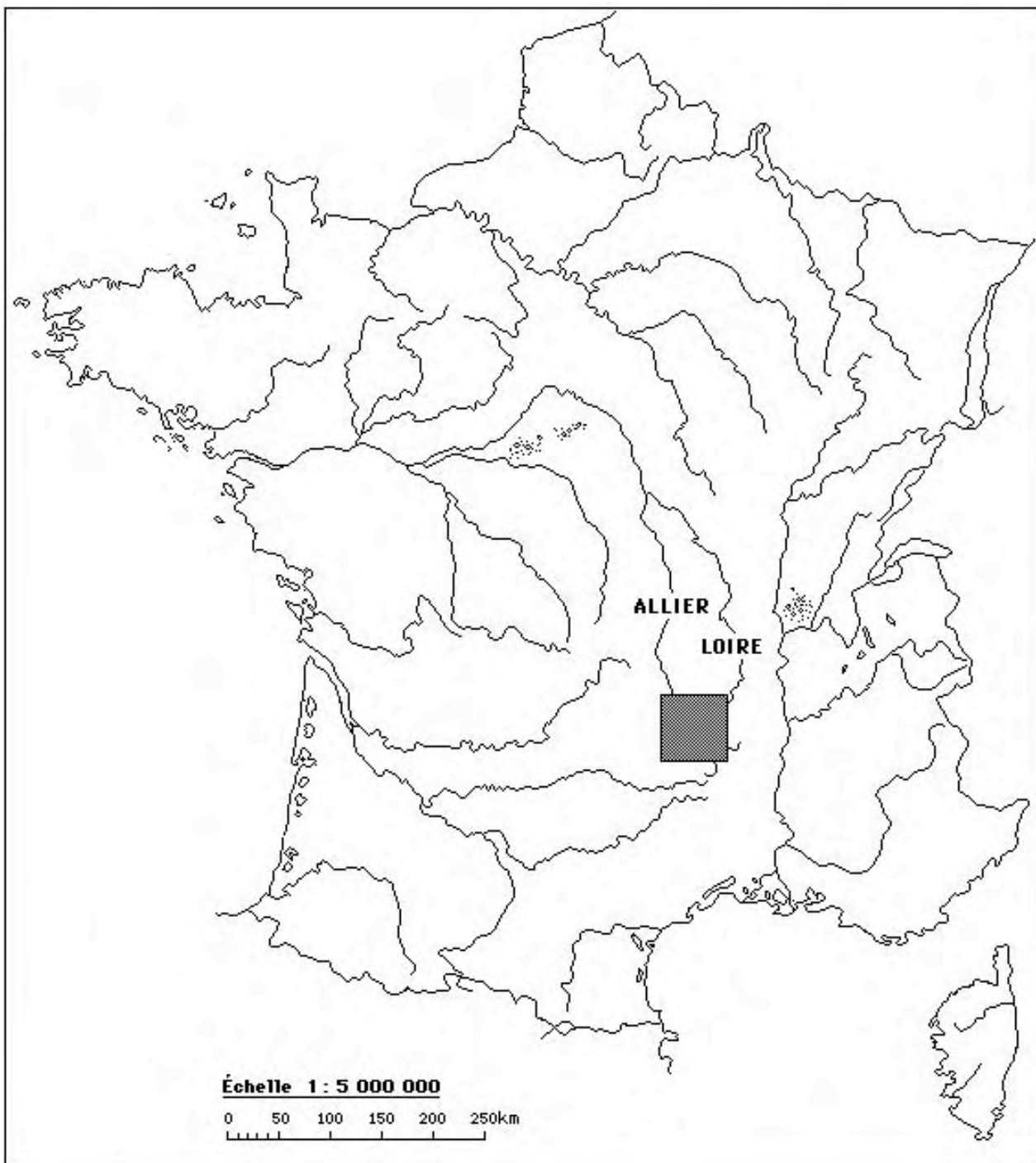


Figure 1 - Study area.

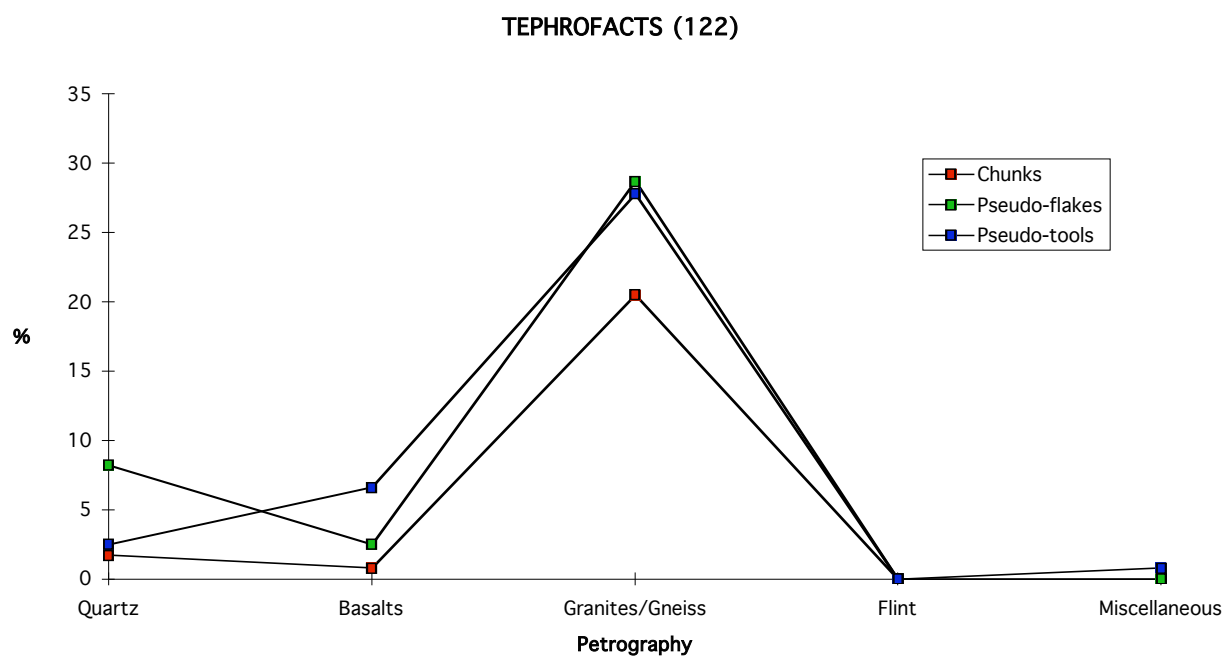


Figure 2 - Petrography of tephrofacts.

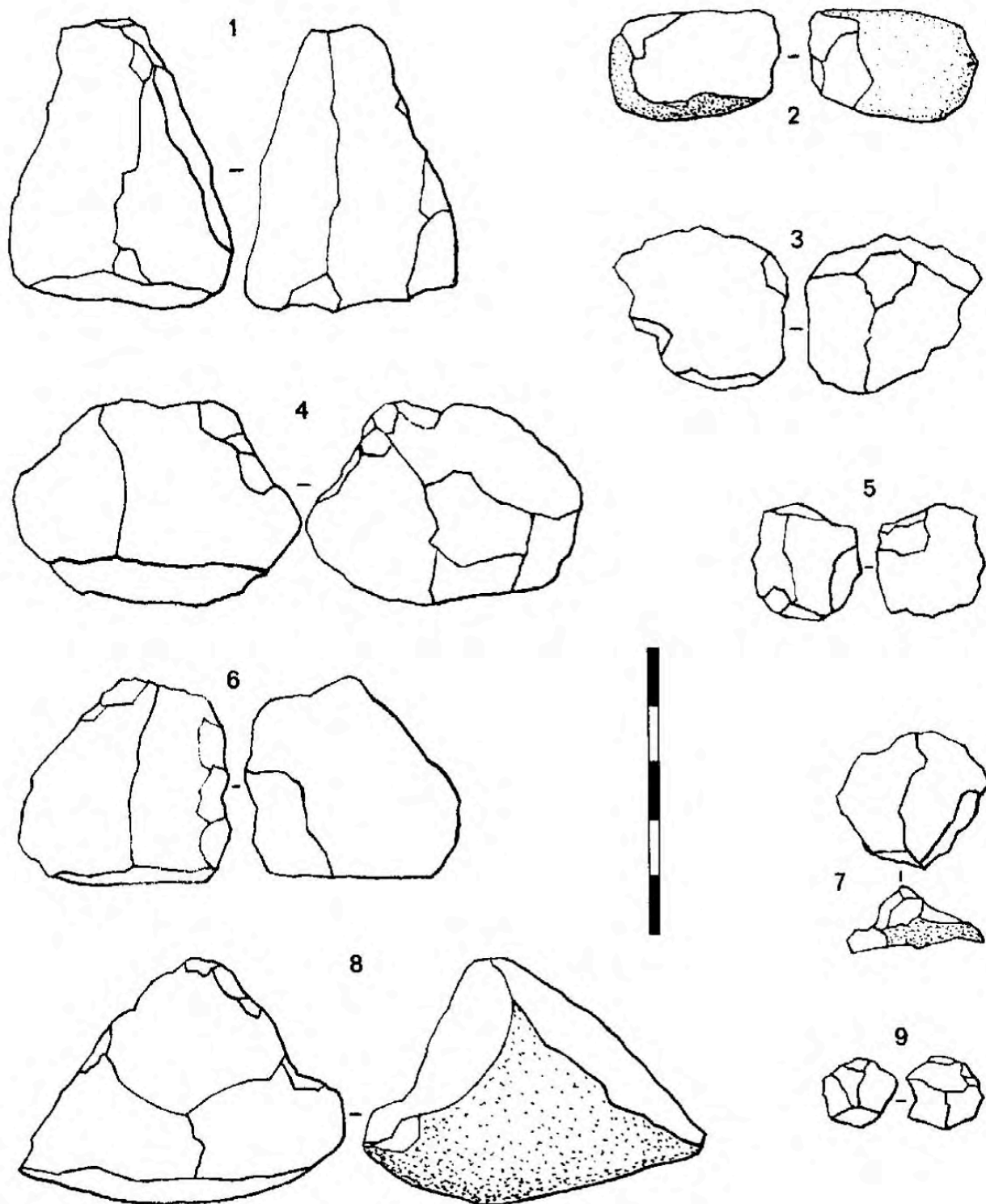


Figure 3 - EXAMPLES OF TEPHROFACTS (Arrows indicate clear directions of flaking) - Blassac-les Blanchs Haute-Loire, pyroclastites - 1 : Partially cortical backed pseudo-flake and non cortical striking platform, fine grained granite. 2 : Partially cortical backed pseudo-flake and cortical striking platform, quartz. 3 : Partially cortical backed pseudo-flake and non cortical striking platform, fine grained granite. 4 : non-cortical backed pseudo-flake and non cortical striking platform, pegmatitic quartz. 5 : Partially cortical backed pseudo-flake and cortical striking platform, fine grained granite. 6 : pseudo-flake with non cortical edges and cortical striking platform, fine grained granite. 7 : pseudo-flake with non cortical edges and non cortical striking platform, pegmatitic quartz. 8 : Partially cortical backed pseudo-flake and cortical striking platform, fine grained granite. 9 : pseudo-flake with non cortical edges and non cortical striking platform, quartz.

#### TYPES OF PSEUDO-FLAKES AND FLAKES

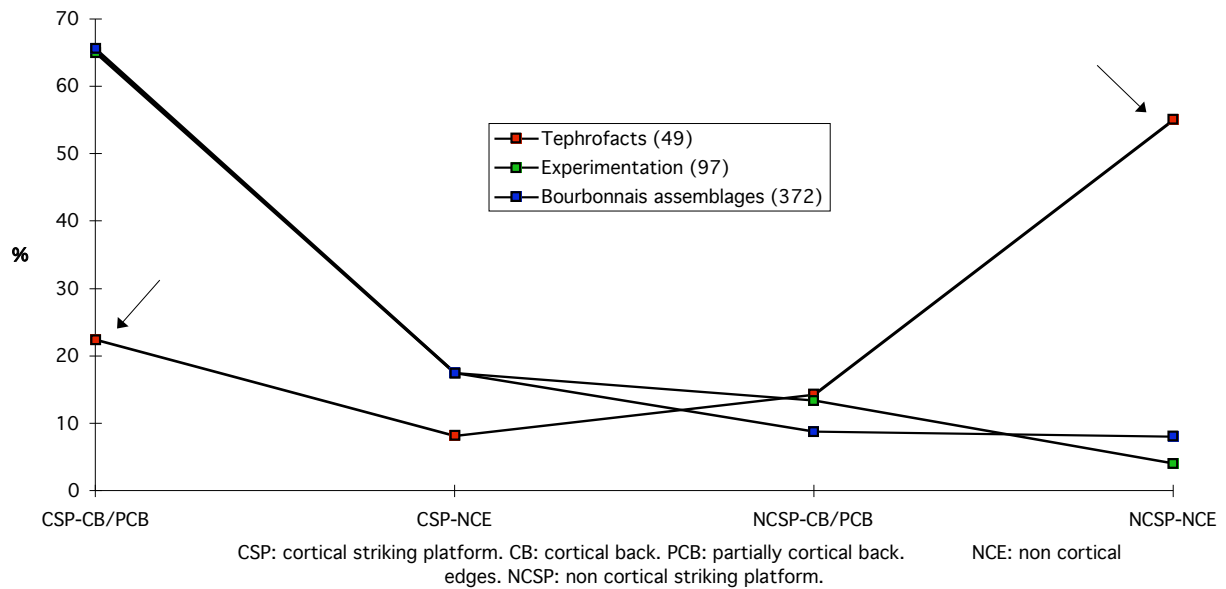


Figure 4 - Types of pseudo-flakes compared to types of flakes from archaeological and experimental series.

#### WEIGHT OF PSEUDO-FLAKES AND FLAKES

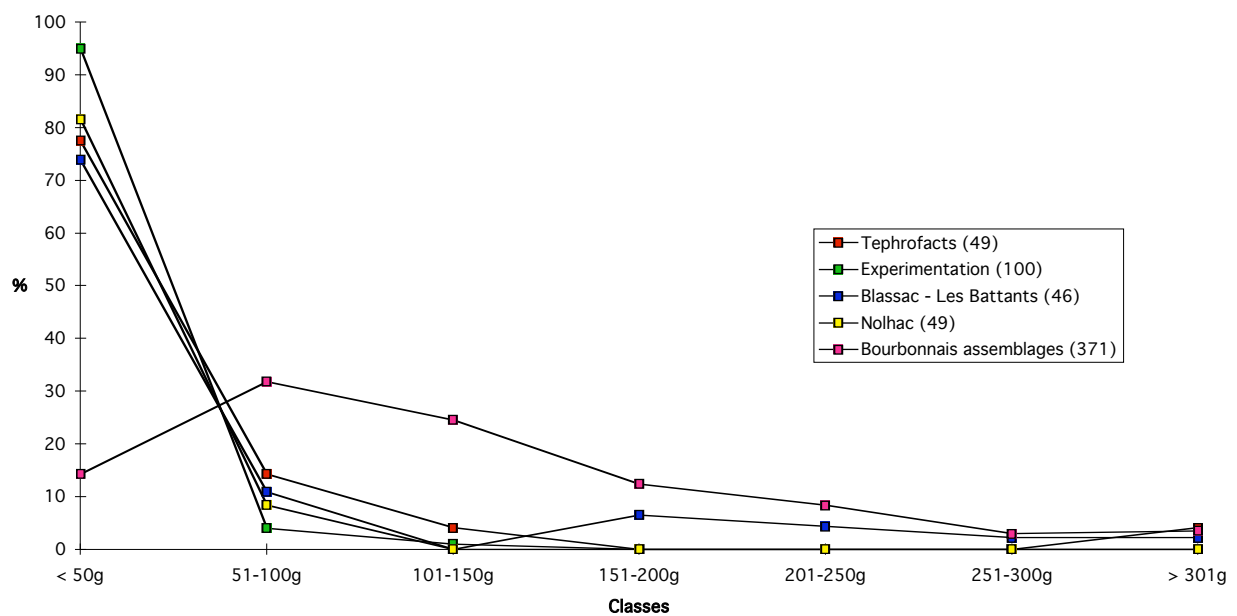


Figure 5 - Weight of pseudo-flakes compared to those of archaeological and experimental series.

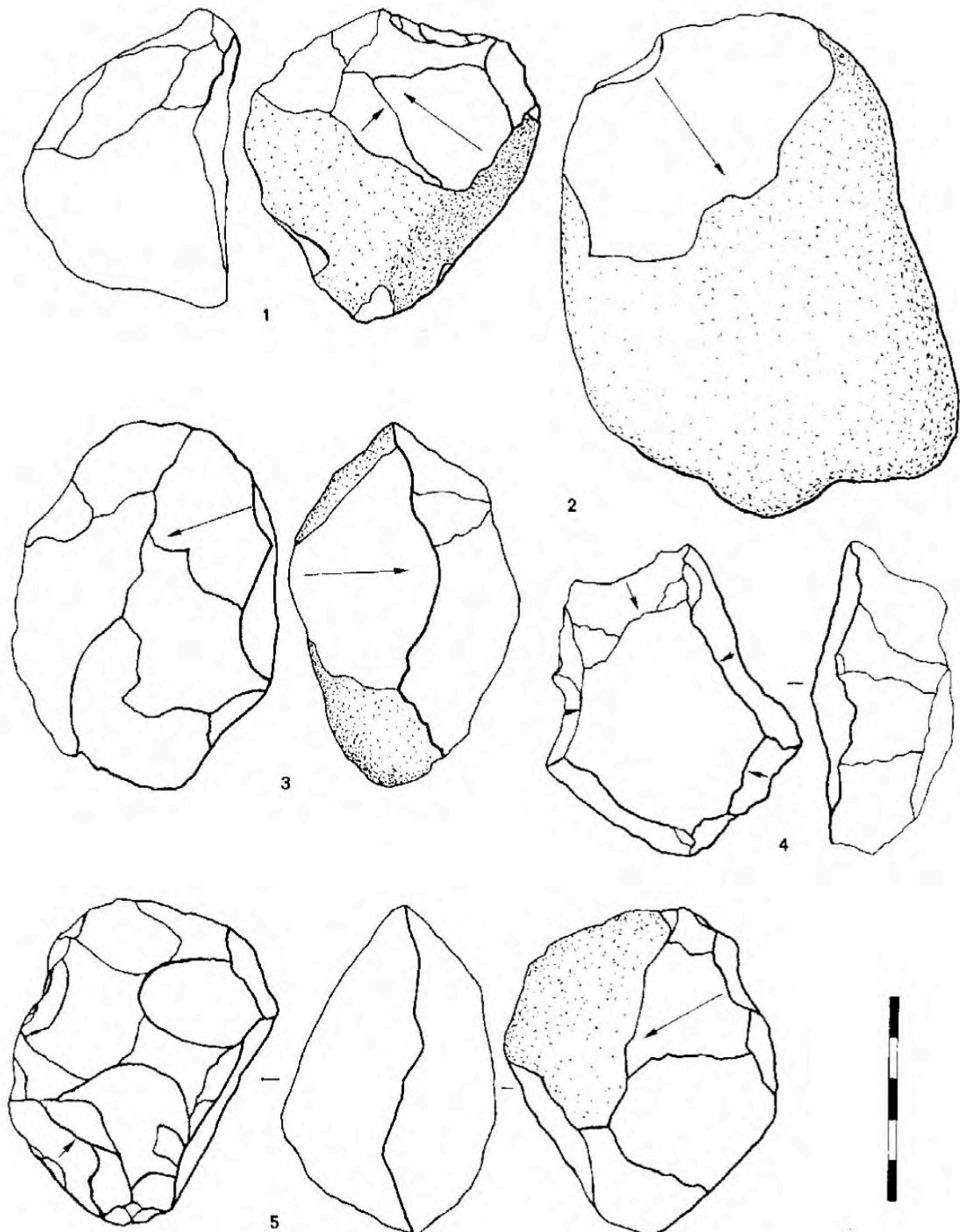


Figure 6 - EXAMPLES OF TEPHROFACTS (Arrows indicate clear directions of flaking) - Miscellaneous from Haute-Loire - 1 : pseudo-chopper, basalte, Blassac-les Blanches pyroclastites. 2 : pseudo-chopper, lamprophyre, Blassac. 3 : pseudo-biface-like piece, basalte, Blassac-les Blanches pyroclastites. 4 : pseudo-chopper, basalte, Blassac-les Blanches tuff-ring. 5 : pseudo-chopping-tool, migmatitic gneiss, Senèze tuff-ring inférieur.



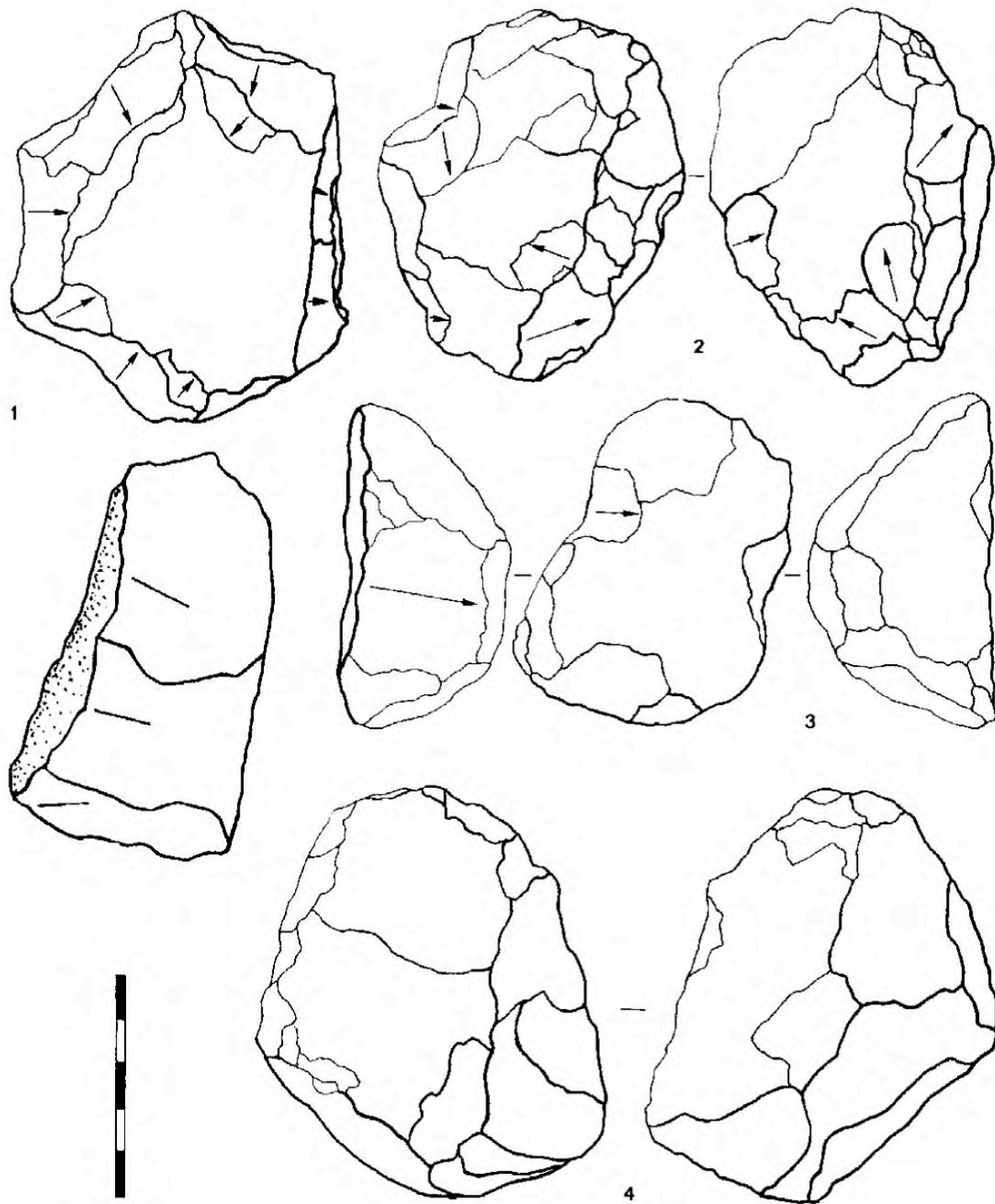


Figure 7 - EXAMPLES OF TEPHROFACTS (Arrows indicate clear directions of flaking) - Miscellaneous from Haute-Loire - 1 : peripherally flaked pseudo-chopper, granite, La Sauvetat tuff-ring. 2 : pseudo-polyhedron, pegmatitic quartz, Blassac-les-Blanches pyroclastites. 3 : pseudo-invasively flaked tabular piece, granite, La Sauvetat tuff-ring. 4 : pseudo-polyhedron, granite, La Sauvetat tuff-ring.

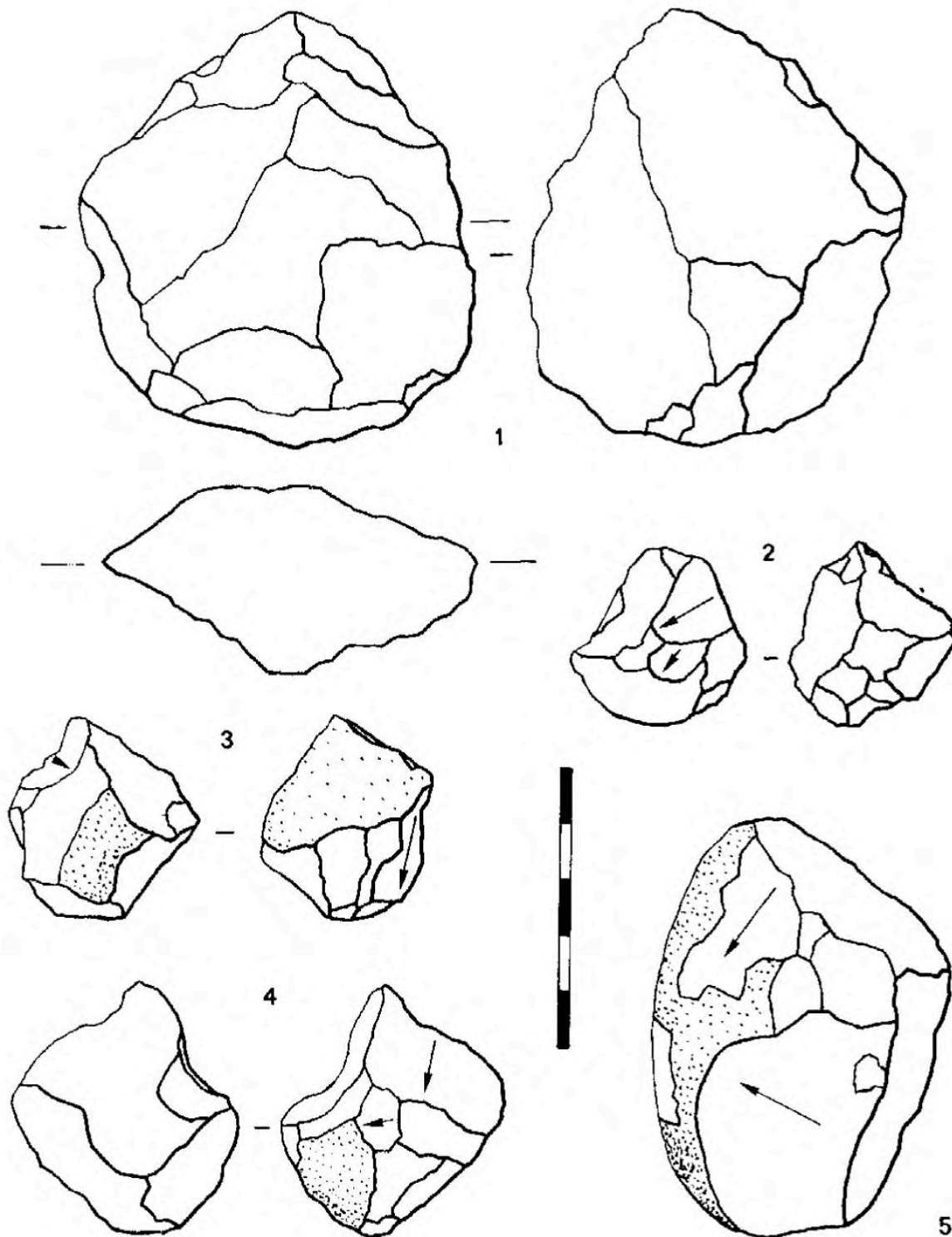


Figure 8 - EXAMPLES OF TEPHROFACTS (Arrows indicate clear directions of flaking) - Blassac-les Blanches Haute-Loire, pyroclastites - 1 : pseudo-partially bifacial discoid piece, migmatitic gneiss à sillimanite. 2 : regular pseudo-polyhedron, quartz. 3 : regular pseudo-polyhedron, quartz. 4 : regular pseudo-polyhedron, oriented granite. 5 : pseudo-chopper, fine grained granite.

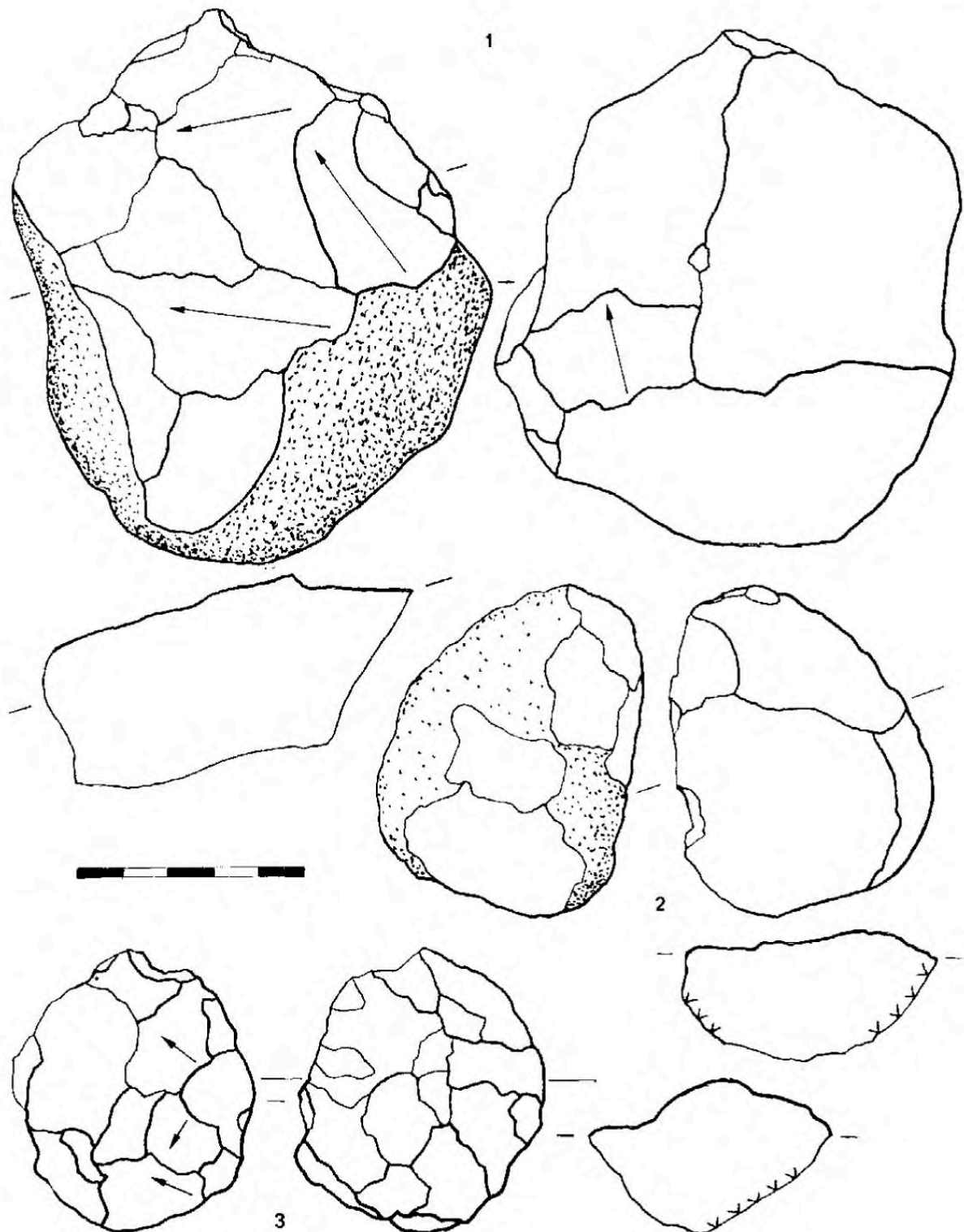


Figure 9 - EXAMPLES OF TEPHROFACTS (Arrows indicate clear directions of flaking) - Miscellaneous from Haute-Loire - 1 : pseudo-invasively flaked tabular piece, granite, Blassac-les Blanches pyroclastites. 2 : pseudo-invasively flaked tabular piece, basalte, Blassac-les Blanches tuff-ring. 3 : pseudo-bifacially flaked discoidal piece, basalte, Blassac-les Blanches tuff-ring.



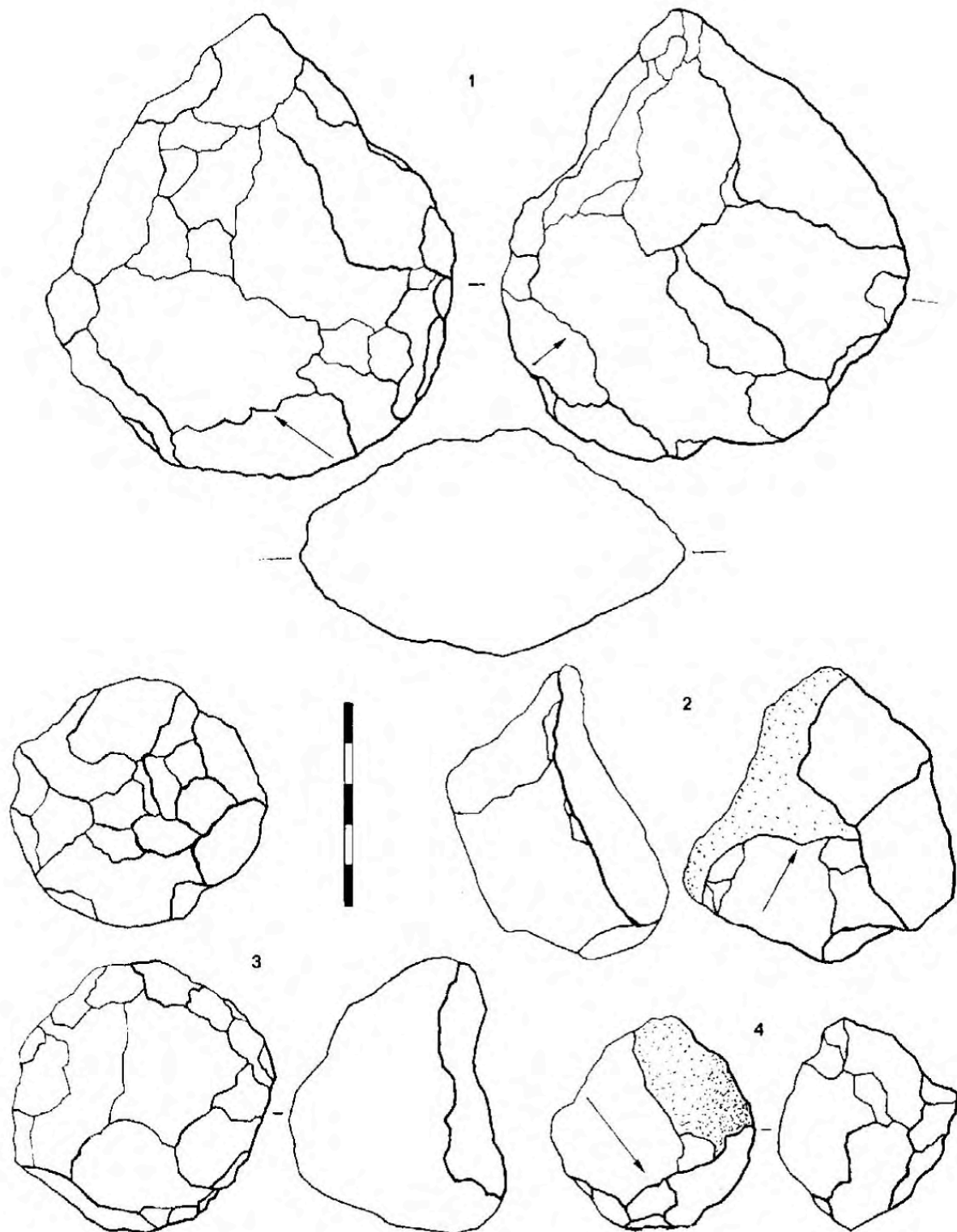


Figure 10 - EXAMPLES OF TEPHROFACTS (Arrows indicate clear directions of flaking) - Miscellaneous from Haute-Loire -  
 1 : pseudo-biface-like piece, granite d'anatexie, La Sauvetat tuff-ring. 2 : pseudo-chopper, basalte, La Sauvetat tuff-ring.  
 3 : pseudo-invasively sub-discoïd flaked tabular piece, oriented granite, Blassac-les Blanches pyroclastites. 4 : regular pseudo-polyhedron, fine grained granite, La Sauvetat tuff-ring.

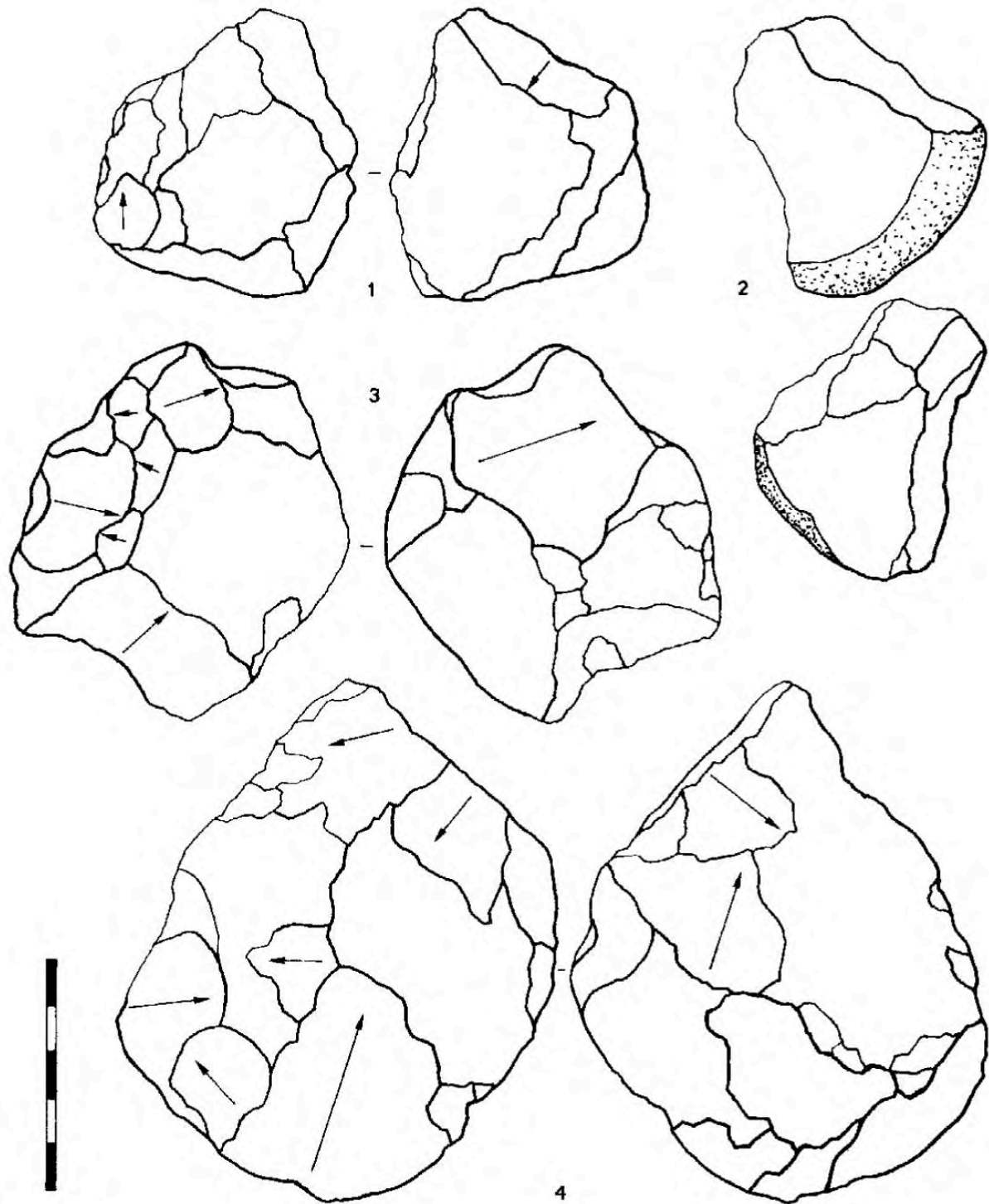


Figure 11 - EXAMPLES OF TEPHROFACTS (Arrows indicate clear directions of flaking) - Miscellaneous from Haute-Loire -  
 1 : pseudo-polyhedron, granite, La Sauvetat tuff-ring. 2 : pseudo-polyhedron, granite, Blassac-les Blanches pyroclastites.  
 3 : pseudo-polyhedron, granite, Blassac-les Blanches tuff-ring. 4 : pseudo-polyhedron, granite, La Sauvetat tuff-ring.

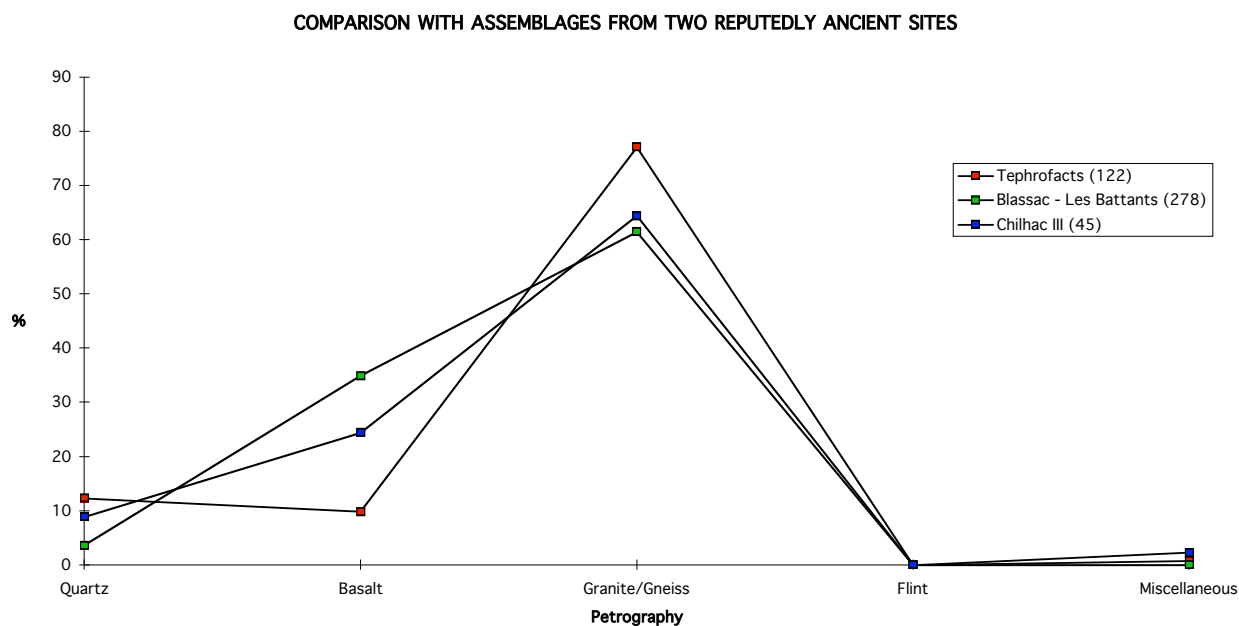


Figure 12 - Comparison with lithic series from two reputedly ancient sites.

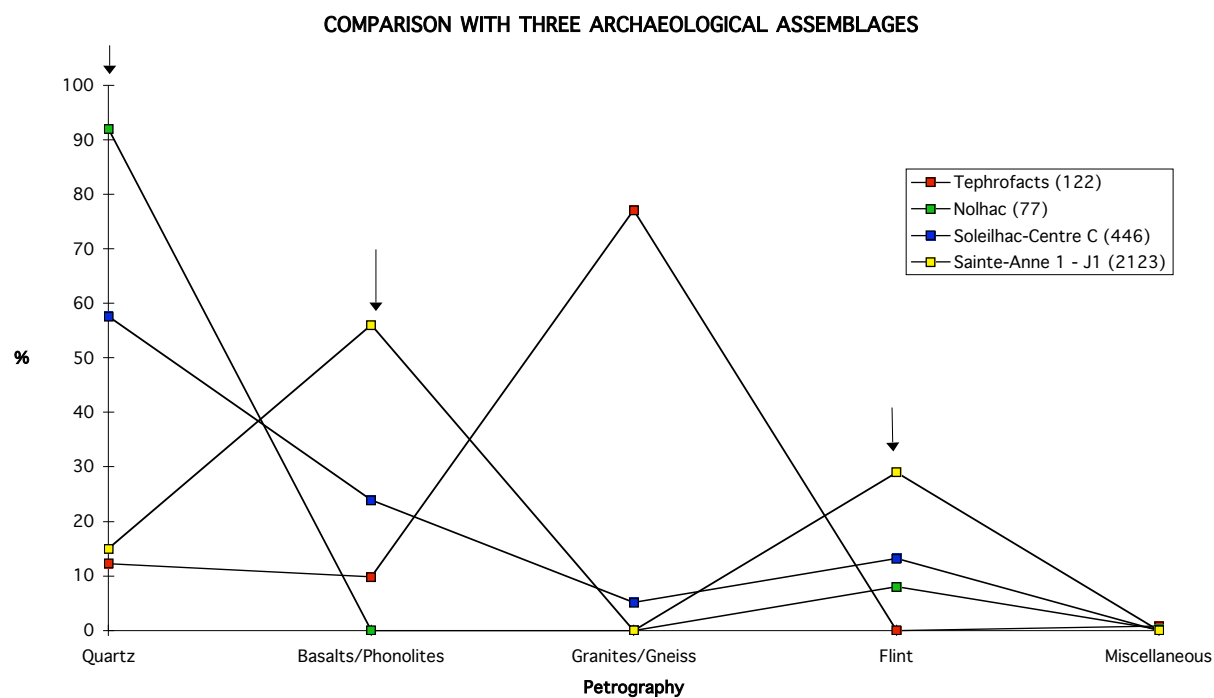


Figure 13 - Comparison with three archaeological series.