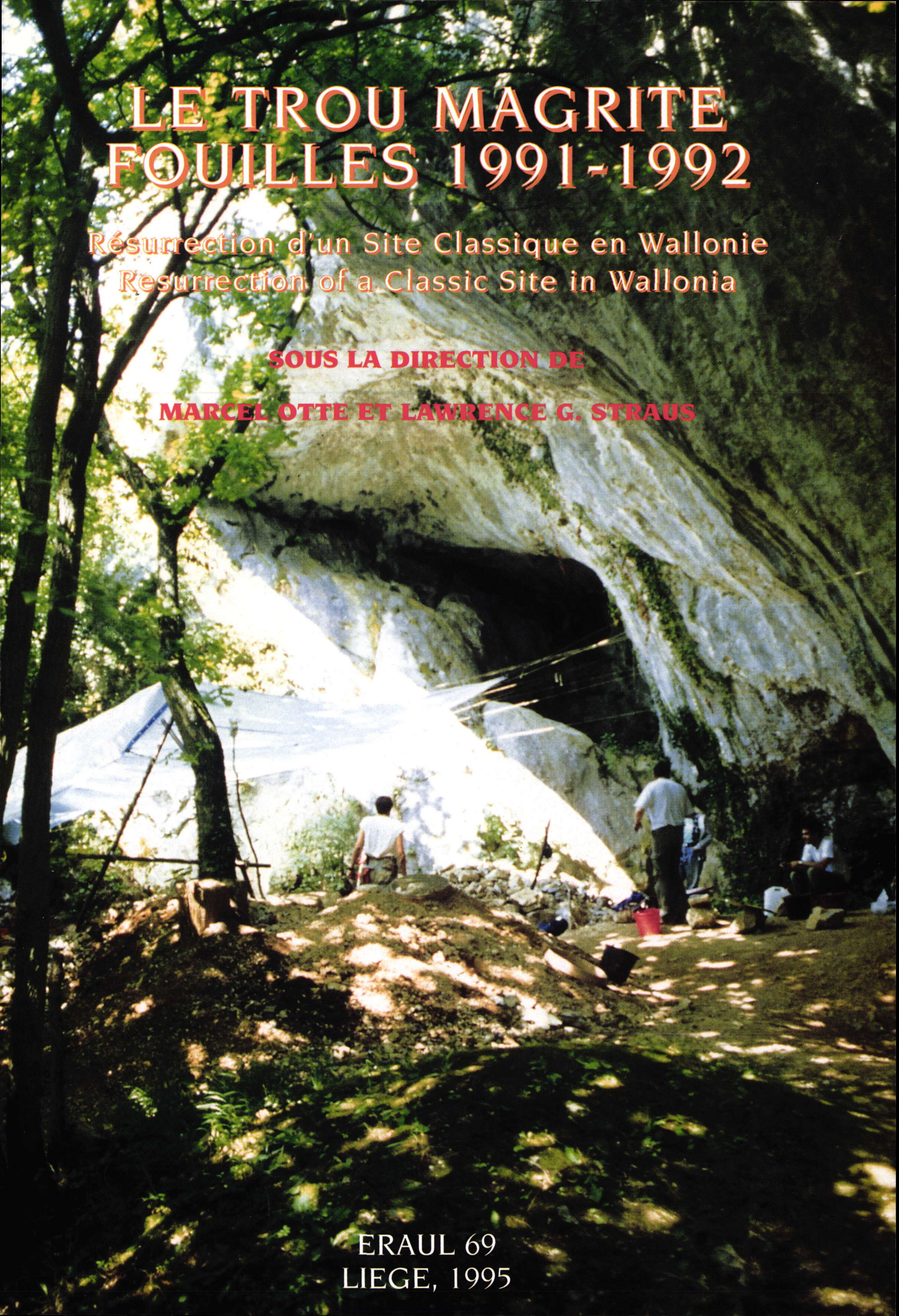

LE TROU MAGRITE FOUILLES 1991-1992

Résurrection d'un Site Classique en Wallonie
Resurrection of a Classic Site in Wallonia

SOUS LA DIRECTION DE

MARCEL OTTE ET LAWRENCE G. STRAUS

ERAUL 69
LIEGE, 1995

ETUDES ET RECHERCHES ARCHEOLOGIQUES DE
L'UNIVERSITE DE LIEGE

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Couverture : Photo : L.G. STRAUS
Dessin : M. OTTE

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Dépôt légal : D/1995/0480/32

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REMERCIEMENTS

Nous voudrions chaleureusement remercier Madame la Baronne et Monsieur le Baron de Radzitzky d'Ostrowick pour l'autorisation de fouiller au Trou Magrite dans leur domaine de Walzin et pour leur hospitalité et intérêt dans nos travaux.

La fouille fut également autorisée par la Commission Royale des Monuments, Sites et Fouilles de la Région Wallonne.

Ces recherches furent subventionnées par la National Science Foundation (USA) (bourses BNS-9002839 et DBS-92088-32 administrées avec sagesse par John Yellen), par la L S B Leakey Foundation, par le Service de Préhistoire de l'Université de Liège et par le Service de Fouilles de la Région Wallonne.

Bien que ses centaines d'échantillons se sont avérés presque complètement stériles, nous remercions vivement Claudine Schutz pour ses grands efforts palynologiques au Trou Magrite et dans d'autres de nos fouilles wallonnes.

Nous remercions pour leur travail les équipes de fouilles de 1991 et 1992, venues des Universités du Nouveau Mexique et de Liège, ainsi que d'autres institutions. L'équipe fut composée de K. Akoshima, V. Ancion, K. Fuller, V. King, I. López-Bayón, A. Martínez, R. Miller, J. Niles, P. Noiret, K. Richter, J. Sims, E. Teheux et J. Veser. Ph. Lacroix ("Bibiche") a fait la magnifique cartographie de la grotte et a été un membre essentiel des équipes. Les dessins des outillages furent réalisés par K. Akoshima et J. Veser, et mis au propre par Y. Paquay-Baele à Liège. A. Martínez a fait les analyses statistiques à Albuquerque.

Enfin, nous remercions tout spécialement le Ministère de la Région Wallonne, Direction Générale de l'Aménagement du Territoire, et Monsieur le Ministre A. Baudson.

A tous et à toutes, nos remerciements.

INTRODUCTION

En dépit de leur richesse potentielle, le bassin de la Lesse et, plus généralement, le sillon mosan ont relativement peu fait l'objet de recherche systématique durant ce siècle. Des découvertes fameuses y avaient pourtant été réalisées au XIX^{ème} siècle par les pionniers de la Préhistoire. Dans les années 1820, Ph. Ch. Schmerling découvre les crânes d'Engis; vers 1860, Ed. Dupont établit la chronologie des grottes mosanes et, en 1886, M. De Puydt découvre les "hommes de Spy". Devant une telle masse documentaire, le monde scientifique s'est quelque peu assoupi au cours du XX^{ème} siècle. C'est pourquoi un nouveau programme de recherche dans les grottes préhistoriques belges fut établi dans les années 1980 par l'Université de Liège, en collaboration avec diverses institutions dont le FNRS et le Ministère de la Communauté Française. Depuis quelques années, cette activité s'est doublement enrichie. D'abord par le soutien constant du Ministère de la Région Wallonne (Messieurs les ministres R. Collignon puis A. Baudson), ensuite grâce à la collaboration féconde avec l'Université du Nouveau Mexique à Albuquerque sous la responsabilité du professeur L.G. Straus. Plusieurs travaux ont paru dans des revues scientifiques, présentant succintement les apports principaux de ces recherches. Le recul opéré depuis lors a permis de concevoir, pour l'une de ces grottes, une monographie synthétique telle que celle-ci. Le site est prestigieux car il a livré les premières oeuvres d'art préhistorique connues en Belgique. Il a aussi fournit la clef chronologique liant plusieurs stades de cette longue période.

L.G. STRAUS M. OTTE

M. OTTE et L.G. STRAUS (dir.), *Le Trou Magrite. Fouilles 1991-1992*. Liège, E.R.A.U.L. 69, 1995

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LE SENS DE LA STRATIGRAPHIE DU TROU MAGRITE

Marcel OTTE

INTRODUCTION

La stratigraphie du Trou Magrite présente une importance particulière à plusieurs titres.

Historiquement d'abord, la définition correcte des relations entre les ensembles industriels qu'elle contenait a donné la clef de l'évolution culturelle paléolithique pour l'ouest de l'Europe.

Son étude critique permet aussi d'attribuer les manifestations plastiques, parmi les plus anciennes du continent, à une tradition culturelle.

Enfin, aujourd'hui encore, les informations recueillies jadis quant à la chronologie, à la composition géologique des couches et à leur contenu en vestiges techniques permettent de mieux interpréter les observations réalisées lors des fouilles récentes.

Il nous paraît donc nécessaire et utile d'en présenter un aperçu.

DESCRIPTION

Ed. Dupont visite le Trou Magrite pour la première fois en été 1864. Le vaste abri et sa terrasse ont déjà été largement nivelés afin d'en faciliter l'accès. En effet, il constituait alors un but de promenade touristique à partir d'un hôtel proche où s'amorçait un chemin taillé en terrasse à mi-hauteur de la falaise. C'est sous ce chemin que nos propres fouilles furent réalisées fructueusement. Ed. Dupont semble en effet avoir respecté cet endroit dont l'aménagement précédait selon lui "d'environ trente ans" son intervention. Il constate alors que la couche supérieure des dépôts avait été en grande partie déblayée. Elle correspond, dans sa propre classification géologique, aux "dépôts à cailloux anguleux" reconnus fréquemment au sommet des formations en grottes mosanes. Dès cette époque, il y récolte semble-t-il des vestiges préhistoriques, mais n'y entreprend pas de fouilles (Ed. Dupont, 1865).

Elles débuteront en 1867 et fournissent alors une succession géologique en trois unités assez classiquement reconnues ailleurs par Ed. Dupont (1867a) aux entrées des cavernes :

I. argile à blocaux (environ 1m).

II. dépôts argilo - sableux stratifiés (2,50 m).

III. cailloutis roulés ardennais (1m).

A l'intérieur de l'entité médiane (B) de ce complexe, 4 "niveaux ossifères" (= archéologiques) sont définis et numérotés. Rétrospectivement, il paraît curieux que l'*ordre* de cette numérotation n'ait pas été précisé clairement par Ed. Dupont (1868-1869). Il est pourtant crucial car il permet de situer des éléments culturels essentiels tels que la pointe d'Aurignac, dont il donne une illustration par ailleurs, et surtout les objets d'art mobilier devenus si célèbres entretemps (chapitre ci-après).

Plusieurs interprétations de l'ordre de ces niveaux archéologiques ont été proposées (Otte, 1979, p. 117). Celle établie par Michel Dewez nous paraît la plus vraisemblable. Elle est fondée sur l'analyse critique des publications d'origine et sur les habitudes prises par Ed. Dupont en matière d'approche archéologique, différentes de celles apportées aux dépôts sédimentaires (Dewez, 1985). Il semble donc que la numérotation des niveaux archéologiques, exprimée en chiffres arabes, progresse *de haut en bas,* à l'inverse de celle réservée aux formations géologiques. Ceci est crucial pour l'interprétation de l'âge des oeuvres d'art, donc de l'origine même des expressions plastiques en Europe comme nous le verrons plus loin.

Pour ce qui concerne la chronologie des *industries*, cette hésitation est relativement moins importante car Dupont (1867b) a groupé les 4 "niveaux ossifères" en 2 ensembles désignés de manière non ambiguë : inférieur (B) et supérieur (A). Toutes les interprétations ultérieures relatives à la succession culturelle du Trou Magrite se sont fondées sur cette "macro-stratigraphie", ne laissant aucun doute quant à sa diachronie.

D'autres fouilles furent menées ultérieurement au Trou Magrite par A. de Loë en 1908 puis par A. Rutot en 1913 et 1914. Elles n'apportèrent apparemment pas de complément à ces informations stratigraphiques. Plus récemment, d'autres sondages ont été réalisés, probablement dans des dépôts remaniés, par Louis Eloy (1960-1962) puis par Michel Toussaint.

ATTRIBUTIONS

L'interprétation culturelle de cette séquence est fondée à la fois sur les descriptions d'Ed. Dupont, les planches qu'il a produites et les études menées ultérieurement sur son matériel (M. Ulrix-Closset, 1975; M. Otte, 1979; D. de Sonneville-Bordes, 1961).

Les niveaux "ossifères" inférieurs contenaient des "pointes triangulaires" et des "pointes en bois de renne". Les planches jointes montraient clairement qu'il s'agit de pointes moustériennes et de pointes d'Aurignac (fig. 1.2). Les deux niveaux supérieurs comportaient un débitage à longues lames étroites et minces ainsi qu'une pointe pédonculée. A nouveau, l'illustration permet d'attribuer cette pièce : il s'agit d'une pointe de la Font-Robert.

Les nombreuses publications ultérieures permirent, de proche en proche, de définir les différentes composantes de l'énorme matériel archéologique issu du Trou Magrite. Le produit des fouilles de Dupont est conservé à l'Institut Royal des Sciences Naturelles à Bruxelles, mais de nombreuses autres séries sont dispersées dans différents musées belges et dans plusieurs collections privées (voir M. Otte, 1979, p. 119).

En résumé et nous fondant sur la littérature citée ci-dessus, la succession suivante peut être aujourd'hui proposée à titre de synthèse des informations antérieures à nos propres fouilles.

épaisseurs approximatives	formations géologiques	niveaux archéologiques	attributions culturelles
1 m	argile à blocaux	-	Magdalénien ------------------------ Mésolithique ou postérieur
2,5 m	dépôts argilo- A.	1. ------------------- 2.	Périgordien supérieur à pointes de la Font-Robert ------------------------ Aurignacien évolué
	sableux stratifiés B.	3. ------------------- 4.	Aurignacien ------------------------ Moustérien
-	cailloutis roulés ardennais	-	-

INTERPRETATION

A partir de ses fouilles au Trou Magrite, Dupont définit un stade propre qu'il désigne "niveau du Trou Magrite" et qu'il inclut bientôt dans son cycle culturel (Ed. Dupont, 1867b, p. 131; 1868-1869, p. 33). Son raisonnement est très précurseur car il se fonde sur une approche multidisciplinaire avant la lettre : la faune, intermédiaire entre celles du mammouth et du renne, la géologie (sommet des couches fluviatiles) et l'archéologie (industrie de type Laugerie-Haute). Il bâtit ainsi une séquence en quatre stades à l'intérieur du Paléolithique supérieur dans laquelle les niveaux supérieurs du Trou Magrite viennent prendre rang taxonomique : Montaigle, Trou Magrite, Goyet, Chaleux.

Rétrospectivement, ceci correspond à la succession : Aurignacien, Périgordien à Font-Robert, Périgordien à éléments tronqués, Magdalénien. L'ordre correct des industries occidentales était donc établi longtemps avant les controverses entre Breuil et de Mortillet ou, davantage encore, les séquences établies par D. Peyrony entre les deux guerres.

A. Rutot (1903-1904) a compris le premier l'intérêt d'une telle succession. Il était aussi, en tant que belge, le plus proche des travaux de Dupont et, ayant le goût du voyage, c'est lui qui les a diffusés, fécondant ainsi la réflexion française. Il montre l'analogie entre le "type de Pont-à-Lesse" (synonyme de "Trou Magrite") et le second niveau de Goyet (tous deux "périgordiens") puis "exporte" la comparaison vers le Sud-Ouest français (Congrès de 1906).

A cette occasion, H. Breuil (1906) trouve l'argument nécessaire pour combattre la classification de G. de Mortillet et pour placer une phase intermédiaire entre le Moustérien et le Solutréen. Le terme d'*Aurignacien*, proposé par A. Rutot (1906a et b), est aussitôt adopté pour désigner cette phase nouvelle du "début de l'Age du renne". Bientôt, la division quadripartite de Dupont est affermie et diffusée, mais en utilisant les désignations françaises, jusque là maintenues en équivalence avec celles de Belgique. L'Aurignacien "moyen" correspond aux niveaux inférieurs du Trou Magrite, donc à celui de Montaigle. L'Aurignacien supérieur ou, selon les cas, "le passage entre l'Aurignacien et le Solutréen" ou encore le "Pré-Solutréen", est rendu équivalent aux niveaux supérieurs du Trou Magrite, dit "Magritien" (Breuil, 1907, p. 14; Rutot, 1910).

La chronologie du Trou Magrite est à nouveau utilisée au stade ultérieur de développement de la recherche, dans les travaux de D. Peyrony (1948). Celui-ci en effet, cherchant à étendre et à conforter ses observations périgourdines, montre l'existence au Trou Magrite de l'"Aurignacien I" (pointes à base fendue, niveaux inférieurs) et du "Périgordien V" (pointes pédonculées, niveaux supérieurs).

L'aspect particulier de ce "Périgordien supérieur" (le "Magritien" est désormais oublié) est souligné par Louis Eloy (1956) qui en montre les affinités "proto-solutréennes" par l'importance prise par les retouches plates sur les limbes des Font-Robert et sur les lames appointées. Ces caractères non seulement confirment la proximité du Périgordien supérieur et du Solutréen évoquée par H. Breuil, mais aussi annoncent les découvertes, bientôt réalisées à Maisières, où le faciès septentrional de ce "Fonti-Robertien" (H. Delporte) va être défini.

L'étude du matériel belge par Madame D. de Sonneville-Bordes (1961) fournit l'interprétation suivante : Moustérien, Aurignacien "typique", Périgordien "évolué de type Font-Robert", puis peut-être Mésolithique. Madame M. Ulrix-Closset (1985) précise l'attribution du niveau inférieur qu'elle place dans le "Charentien" défini par F. Bordes dans le Sud-Ouest. Nos propres observations proposent l'existence du Magdalénien et d'un Aurignacien évolué complémentairement à ces unités (Otte, 1979).

L'ensemble de ces observations stratigraphiques, de ces interprétations et de ces analyses aboutit au tableau synthétique présenté ci-dessus. Largement fondé sur la réflexion critique proposée par M. Dewez (1985), il fournit les propositions aujourd'hui les plus "économiques" de cette importante séquence bien qu'elles ne soient pas nécessairement définitives (nous espérons beaucoup encore de datations par l'accélérateur). Si cette séquence est correcte, les oeuvres d'art du Trou Magrite (fig. 1.2) se placeraient dans un courant très ancien de manifestations esthétiques du Paléolithique supérieur européen. Elles viendraient alors compléter les rares objets attribués à cette phase en Europe Centrale (Vogelherd, Geissenklösterle) et participeraient à ce premier courant de réalisation d'images artificielles et "transposées" de la nature par l'esprit humain en une création autonome.

On le voit, la séquence du Trou Magrite, qui a joué aux origines de la Préhistoire un rôle si crucial, conserve aujourd'hui encore une possibilité informative et réflexive considérable.

REFERENCES

BREUIL H., 1906,
Les gisements présolutréens du type d'Aurignac. Coup d'oeil sur le plus ancien Age du Renne, *Congrès International d'Anthropologie et d'Archéologie Préhistorique*, 13, Monaco, I, p. 323-346.

BREUIL H., 1907,
La question aurignacienne, Etude critique de stratigraphie comparée, *Revue Préhistorique*, 2, 6-7, p. 173-219.

DEWEZ M., 1985,
L'art mobilier paléolithique du Trou Magrite dans son contexte stratigraphique. *Bull. soc. roy. belge d'anthropologie et de préhistoire*, 96, p. 117-133.

DUPONT Ed., 1865,
Etudes sur les cavernes des bords de la Lesse et de la Meuse explorées jusqu'au mois d'octobre 1865, *Bull. Acad. roy. des Sc., des Lettres et des Beaux-Arts de Belgique*, 2e série, t. XX, p. 844.

DUPONT Ed., 1867 a,
Découverte d'objets gravés et sculptés dans le Trou Magrite à Pont-à-Lesse, Bull. Acad. roy. des Sc., Lettres et Beaux-Arts de Belgique, 36, 2e série, t. XXIV, p. 129-132.

DUPONT Ed., 1867b,
Etude sur cinq cavernes explorées dans la Vallée de la Lesse et le ravin de Falmignoul pendant l'été de 1866, *Bull. Acad. roy. Sc., Lettres et Beaux-Arts de Belgique*, 2e série, 23, p. 244-265.

DUPONT Ed., 1868-1869,
L'homme pendant les âges de la pierre dans les environs de Dinant. Première partie, *Annales Soc. Archéol. de Namur*, 10, p. 1-50.

ELOY L., 1956,
Le Proto-Solutréen dans le bassin de la Meuse en Belgique, *Bull. Soc. Préhist. Française*, LIII, p532-539.

ELOY L., 1960-1962,
Canine de renard encochée ayant été utilisée comme objet de parure au Paléolithique supérieur, *Bull. Chercheurs de la Wallonie*, 18, p. 254-257.

LOË A. de, 1908,
Rapport du Service des fouilles de l'Etat, 1e semestre 1908, *Archives des Musées royaux d'Art et d'Histoire*, p. 3-4.

OTTE M., 1979,
Le paléolithique supérieur ancien en Belgique, Bruxelles, Musées du Cinquantenaire, 684p.

PEYRONY D., 1948,
Le Périgordien, l'Aurignacien et le Solutréen en Eurasie, d'après les dernières fouilles, *Bull. Soc. Préh. Fr.*, *45*, p. 305-328.

RUTOT A., 1903-1904,
Sur les gisements paléolithiques de loess éolien de l'Autriche-Hongrie, *Bull. Soc. Anthr. Bruxelles*, 22, Mémoire VII, 36 p.

RUTOT A., 1906 a,
Le Présolutréen en Belgique, fait suite à la communication de H. Breuil, *Congrès Inter. d'Anthro. et Archéo. Préhist.*, 13, Monaco, vol. I, p. 347-350.

RUTOT A., 1906 b,
Les aspects nouveaux de la Préhistoire en 1906, *Bull. Acad. royale de Belgique, Classe des Sciences*, p. 915-960.

RUTOT A., 1910
Qu'est-ce que l'Aurignacien ? *Congrès Préhistorique de France*, 6e session, Tours, p. 129-149.

SONNEVILLE-BORDES D. de, 1961,
Le Paléolithique supérieur de Belgique , *L'Anthropologie*, 65 (5-6), p. 421-443.

ULRIX-CLOSSET M., 1975,
Le Paléolithique moyen dans le bassin mosan en Belgique, Universa, Wetteren, 221p.

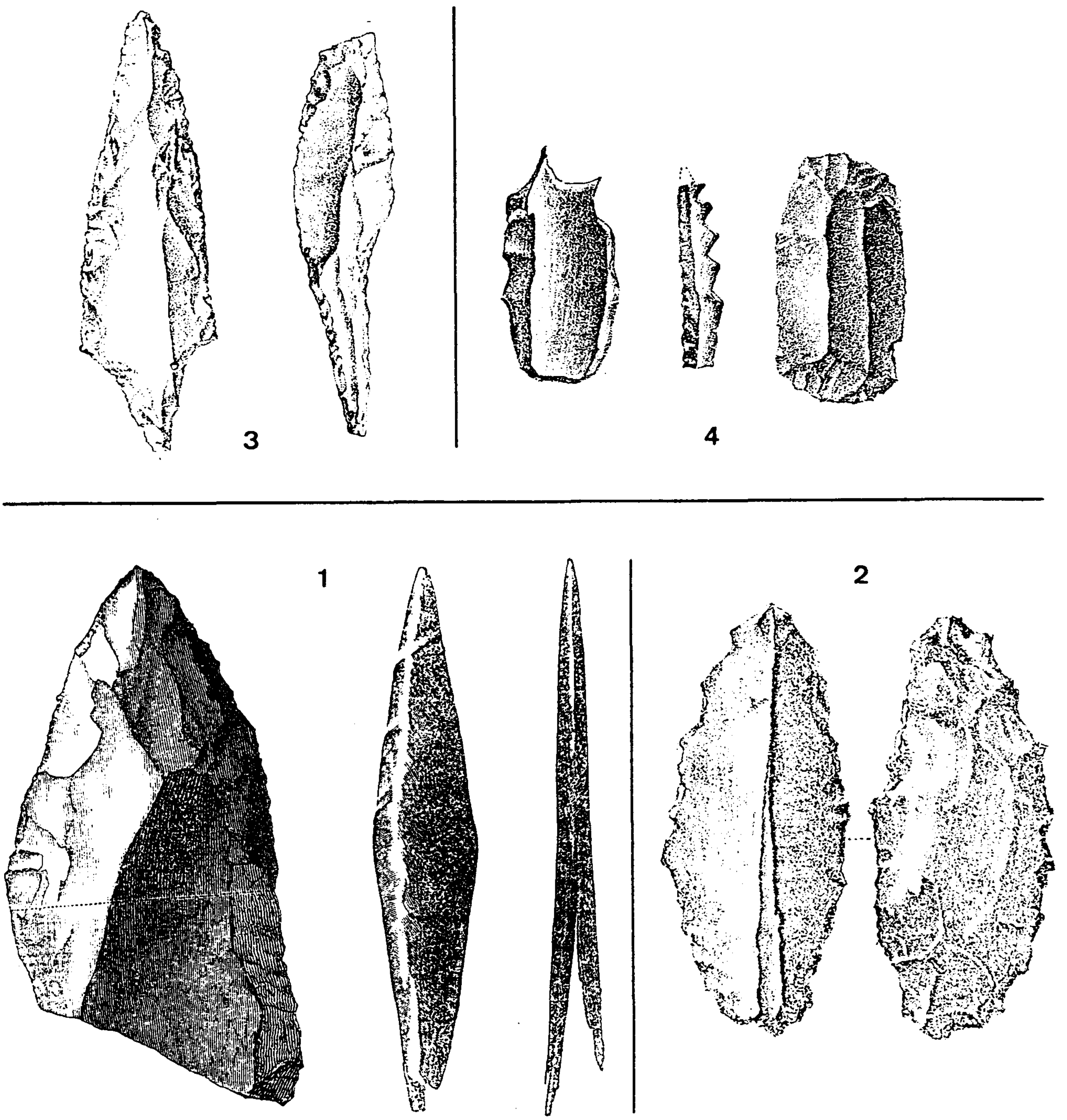


Figure 1.1 : reproduction des outils-types figurés par Ed. Dupont dans ses travaux des années 1860 et 1870 afin d'établir la chronologie des groupes culturels du bassin mosan. 1 : pointe moustérienne et sagaie d'Aurignacien (Montaigle); 2 : pointe foliacée biface du début paléolithique supérieur (Goyet); 3 : pointes pédonculées de type Font-Robert (Trou Magrite); 4 : outillage lithique magdalénien (Chaleux).

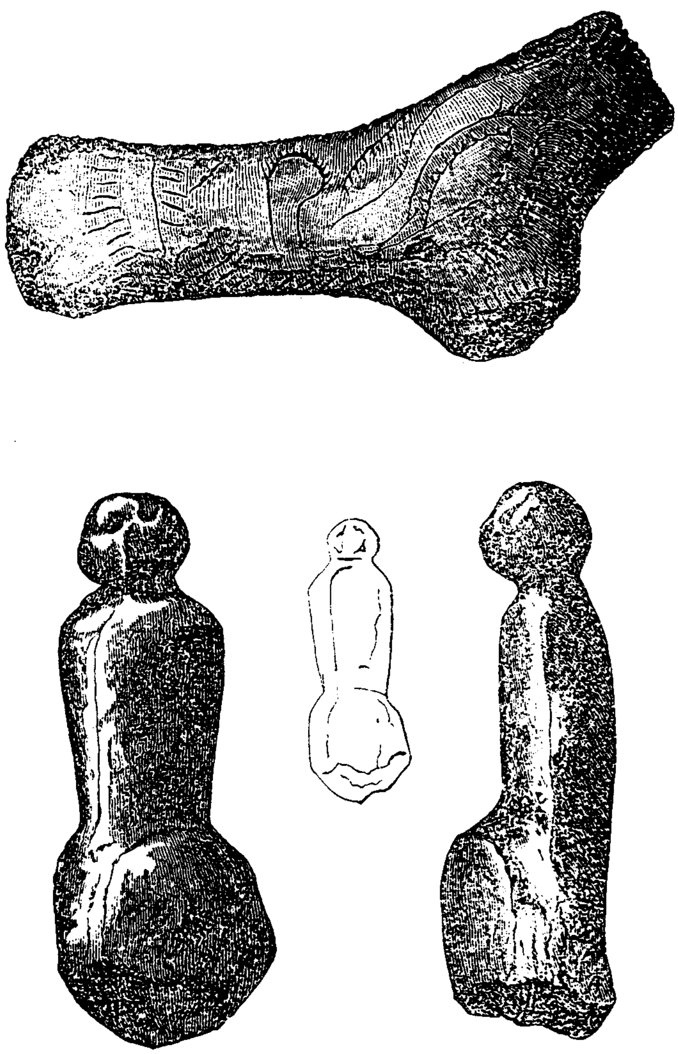


Figure 1.2 : premières découvertes belges d'oeuvres d'art mobilier, découvertes et publiées par Ed. Dupont dans les années 1860.

M. OTTE et L.G. STRAUS (dir.), *Le Trou Magrite. Fouilles 1991-1992*. Liège, E.R.A.U.L. 69, 1995.

2

THE 1991-1992 EXCAVATIONS

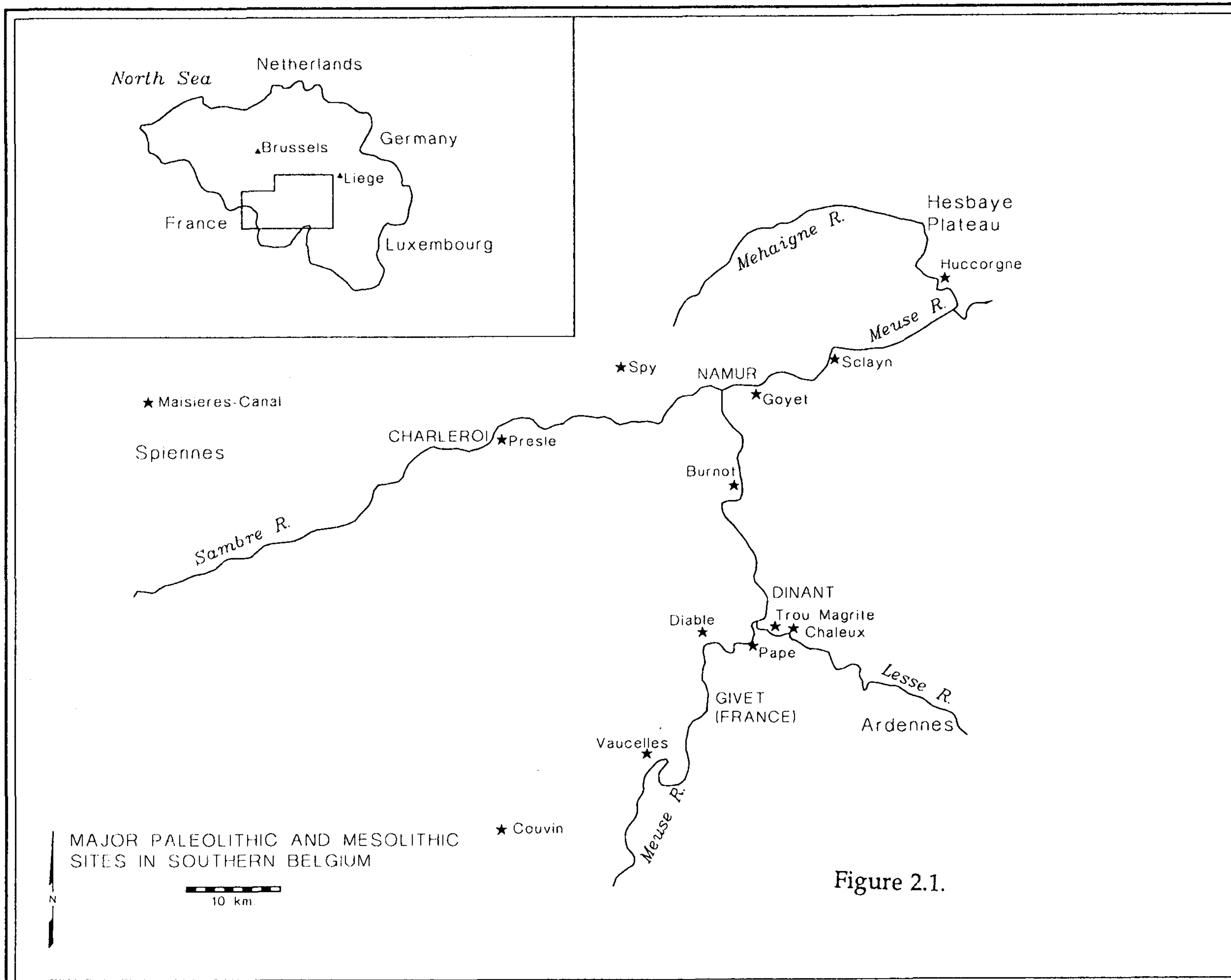
Lawrence Guy STRAUS

INTRODUCTION

One hundred and twenty-five years after the excavations of E. Dupont in le Trou Magrite, and 85-80 years after the excavations of Loë/Rahir and Rutot respectively, and after the clandestine diggings of countless amateurs and looters in this famous Belgian cave, could any intact Paleolithic deposits have survived and, if so, what information could they possibly yield? As recently as 1976, M.Toussaint (Dewez 1985; Toussaint, personal communication) dug a sondage in the center of the front of the Trou Magrite terrace and failed to find remnant Stone Age strata.

As shown by Otte in Chapter 1, le Trou Magrite had produced one of the most complete stratigraphic sequences for the Upper Pleistocene in Belgium (or, for that matter, western Europe) including Mousterian, Aurignacian, Gravettian, Magdalenian and Mesolithic levels. The Early Upper Paleolithic of le Trou Magrite was known to have contained both tanged (Font-Robert) and invasively retouched "points". The presence of the latter type of pieces had caused the site to be mistakenly attributed to the Solutrean (="Magritian") especially in the late 19th and early 20th centuries (Smith 1966). Le Trou Magrite served as one of the chief extra-Dordogne sources of confirmation for the classic Upper Paleolithic subdivision scheme of H.Breuil (1912). Yet, as it has come more recently to be understood, this cave and other Belgian sites such as Spy, Goyet, Maisières and Couvin (Fig. 2.1), constitute part of a wider techno-cultural phenomenon: leaf point industries dating to the period from ca.40-30 kya, characteristic of northwest Europe (Otte 1981,1988). In addition, le Trou Magrite was one of the first (and still one of the relatively few) Belgian Upper Paleolithic sites to yield significant mobile art objects.

Despite the excellence of his excavations (especially considering their very early date), aspects of Dupont's stratigraphic description were somewhat unclear, while his successors' diggings were only minimally (if at all) published. Surviving museum collections are unfortunately curated with only minimal provenience indications and are generally mixed (Ulrix-Closet 1975; Dewez 1979; Otte 1979).



MAJOR PALEOLITHIC AND MESOLITHIC SITES IN SOUTHERN BELGIUM

Figure 2.1.

If any intact deposits could be found at le Trou Magrite, a new excavation could clarify details of the stratigraphy, attempt to subdivide and characterize the Early Upper Paleolithic (EUP) levels and their assemblages and try to place the famous "Venus" figurine and engraved antler in stratigraphic context. Most importantly, even a limited, but carefully controlled excavation could provide chronostratigraphic information, chronometric dates, paleoclimatic, taphonomic, faunal and seasonality evidence, as well as at least small samples of artifacts from known provenience that could be analyzed by modern methods (e.g., spatial, technological, microwear and residue analyses). Any results from le Trou Magrite could especially shed on the critical problem of the Middle to Upper Paleolithic transition in Europe, still so heavily biased toward evidence from SW France. It was already known that almost all the Mesolithic and Magdalenian, and even the top of the EUP deposits had been removed from the terrace in the 1830's to make the cave accessible for early touristic promenades some 30 years before Dupont's arrival at le Trou Magrite. Thus any new excavation would concern only the timespan of the EUP and underlying Middle Paleolithic (tentatively classified as Quina Charentian and Mousterian of Acheulean Tradition by Ulrix-Closet [1975]).

DESCRIPTION OF THE SITE

Le Trou Magrite is a karstic cave formed in a Lower Carboniferous (Viséen) limestone cliff along the northern edge of the valley of the Lesse River between Pont-à-Lesse and Walzin (Dinant, Namur, Province, Wallonia, Belgium) (Fig. 2.2). It is at 4 55'E longitude and 50 13' N latitude, Lambert coordinates x=189, y = 101.25. The cave is situated 3 km. upstream of the confluence of the Lesse and the equally deeply entrenched Meuse River. It lies at an elevation of about 125 m. above present sea level and 26 m. above the course of the Lesse. The cave faces southwest : an ideal solar orientation, especially for winter habitation when the light grey limestone rockface would have stored and radiated considerable warmth; the cave is also protected from north winds. It dominates a 250 m. wide meadow valley floor. The present meander pattern has the riverbed at the opposite cliff edge of the valley. The gorge narrows to chokepoints both up- and downstream of le Trou Magrite at Walzin/Roche al Pène and Pont-à-Lesse, respectively. There are fords at these three locations, all within 1 km. of le Trou Magrite. Immediately upstream of the cave there is a stream (Fosse de Chawia) that provides easy access to the 290 m. summit of the Condroz plateau interfluve between Furfooz and Dinant. Le Trou Magrite is thus a highly sheltered and strategic location.

The Lesse valley is a major avenue of communication between the Ardennes and the Meuse (the main river of southern, central and eastern Belgium)---a fact testified to by the existence of a major railroad line the length of the Lesse. Just downstream of le Trou Magrite is the site of le Trou Abri and within 5 km. upstream are the Trous de la Naulette, Baleux, Chaleux, Poterie, Frontal, Nutons and Reuviau. This wealth of Stone Age sites is further evidence of the favorable characteristics of the lower Lesse valley, both for residence and subsistence.

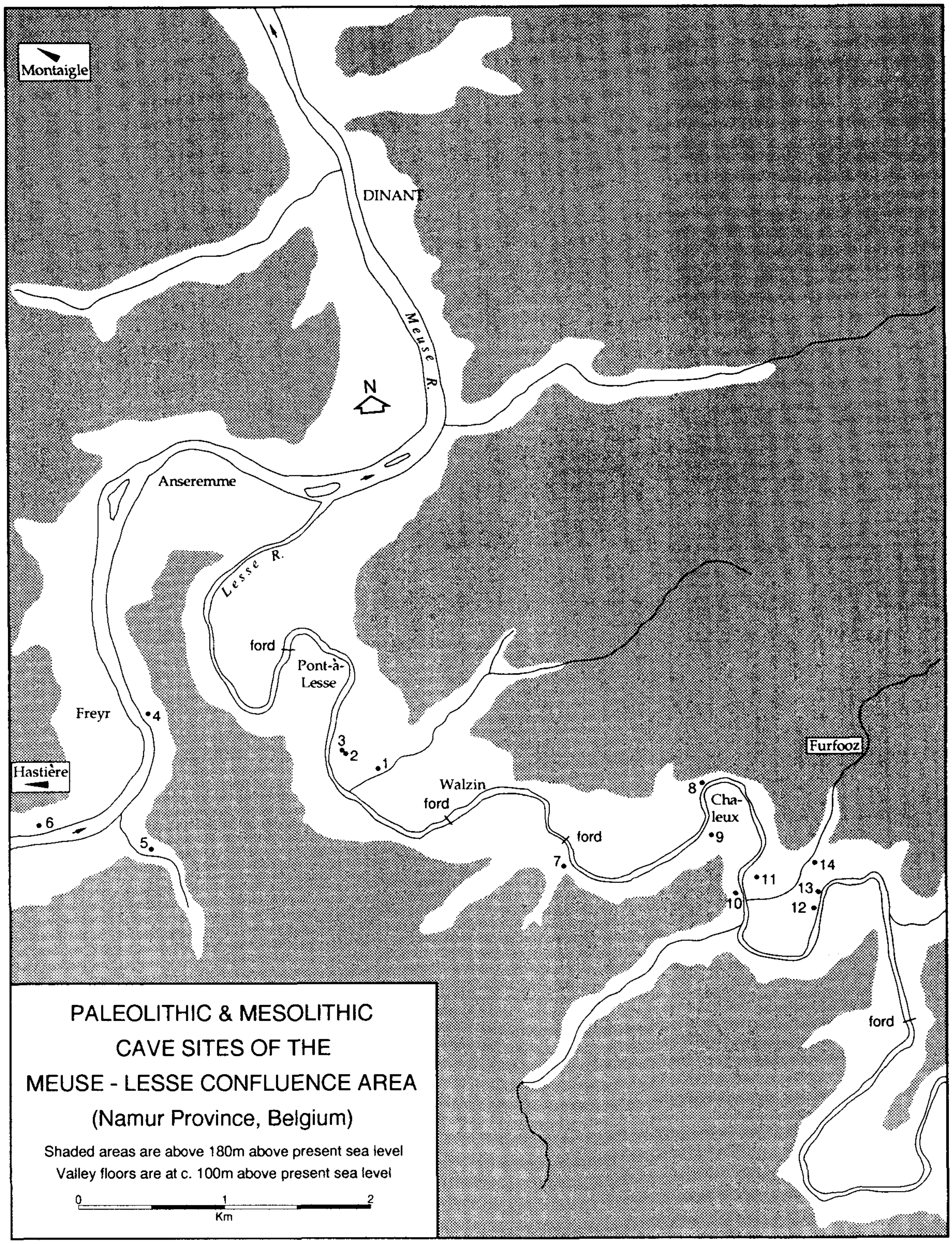


Figure 2.2 : Excavation of the terrace. 1. Trou Magrite; 2. Grotte Martina; 3. Trou Abri; 4. Abri du Pape; 5. Grotte Margaux; 6. Trou Da Somme; 7. La Naulette; 8. Trou de Chaleux; 9. Trou Balleux; 10. Abri de la Poterie; 11. Trou du Renard; 12. Trou du Frontal; 13. Trou des Nutons; 14. Trou Reuviau.

Le Trou Magrite consists of 1.) a large terrace (15x13 m.) largely covered by a high (6-8 m.) overhang (in effect, a deep rockshelter), 2.) a relatively low (2.5 m.), narrow (6 m.) terrace-level cave mouth (and an upper mouth which overlooks the terrace), (photo 2.1), 3.) a small (7x7 m.) sunlit vestibule, 4.) a capacious but dark, high-ceiling, inner chamber (6x12x5 m.) southeast of the cave mouth axis, and 5.) a vertical chimney at the rear which is presently blocked by sediments from the plateau above (Fig. 2.3-2.4-2.5).

In June, 1991, we mapped and gridded the terrace area of le Trou Magrite. All depths were established relative to a datum consisting of a bolt in the east wall of the rockshelter (near the dripline, at a height of 82 cm. above present ground surface). The datum bolt (probably placed by Toussaint) is marked by a "0" in red paint. Secondary datum points were placed as needed. All "z" coordinates are given in cm. below the principal datum.

EXPLORATORY TRENCHES

Since the cave appeared to have been totally excavated and then refilled with mixed sediments, and since M.Toussaint had already demonstrated that no intact Paleolithic deposits remained in the front center of the terrace, we decided to dig trial trenches (A and B) at the extreme west and east edges of the terrace respectively. These trenches, each 2 m. wide x 3.5 m. long, were dug at the spots where the cliff projects outward at the sides of the cave mouth overhang. Each trench ran from the cliff-face to the abrupt break-in-slope at the top of the steep talus slope. A 1x1 m prolongation of Trench B extended beyond the retaining wall and was dug through the talus deposit 170 cm. down to bedrock. Our hope was that archeological deposits had been (although cut into) essentially preserved by the 1830's promenade (with its massive retaining wall) and spared from excavation because of the peripheral locations.

Trench B (Fig. 2.6) : Below a 4-20 cm. thick surficial layer of humus, Trench B revealed 50-80 cm. of loose, mixed and possibly colluviated rubble fill, including blocks and mottled loamy sand. This fill was certainly derived from the cave entrance (most of whose stratigraphy already had been lowered by about 1 m. at the time of Dupont's arrival at le Trou Magrite in 1864; the cave deposits were "quarried" to ease access to the interior and to build the promenade). A second layer of rubble fill (yellowish brown clayier silt with chunks of broken cave travertine, but fewer limestone blocks) continues downward another 50-100 cm. in the area abutting the retaining wall. The Trench B rubble yielded a large, partially bifacial Mousterian sidescraper (Fig. 2.7) at a depth of 67 cm. below ground surface and above blades and bladelets of possibly Magdalenian or Mesolithic age, together with a few ceramic and metal objects, recent and Pleistocene faunal remains (including cave bear). The patchiness of the rubble fill is suggestive of wheelbarrow load dumping. At the base of the retaining wall, the redeposited material overlies a 25 cm. layer of intact, archeologically sterile, dark brown, pebbly sandy loam that in turn lies directly atop bedrock. In the area directly abutting the cliff face, the upper rubble unit is underlain by 60 cm. of the sterile, intact stony loam and finally 80 cm. of sterile, compact, yellowish brown

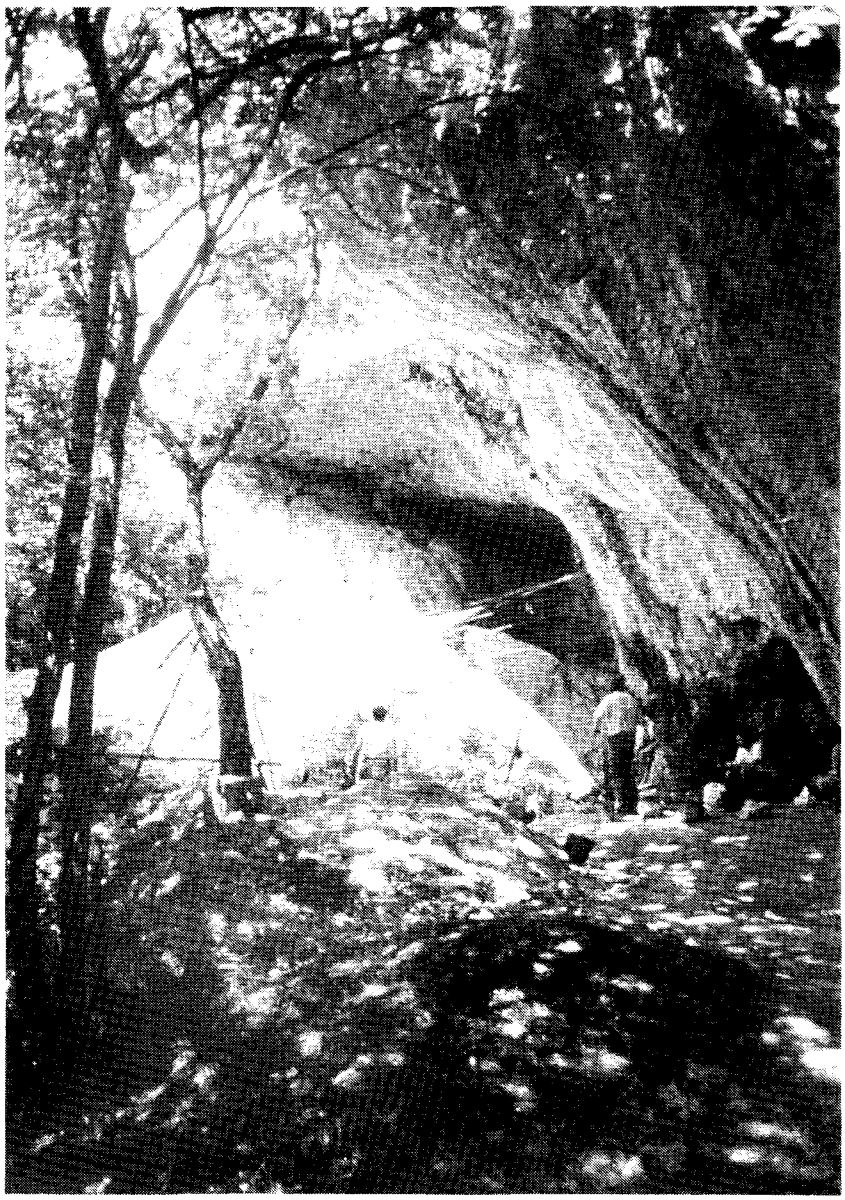


Photo 2.1 : General view of the terrace.

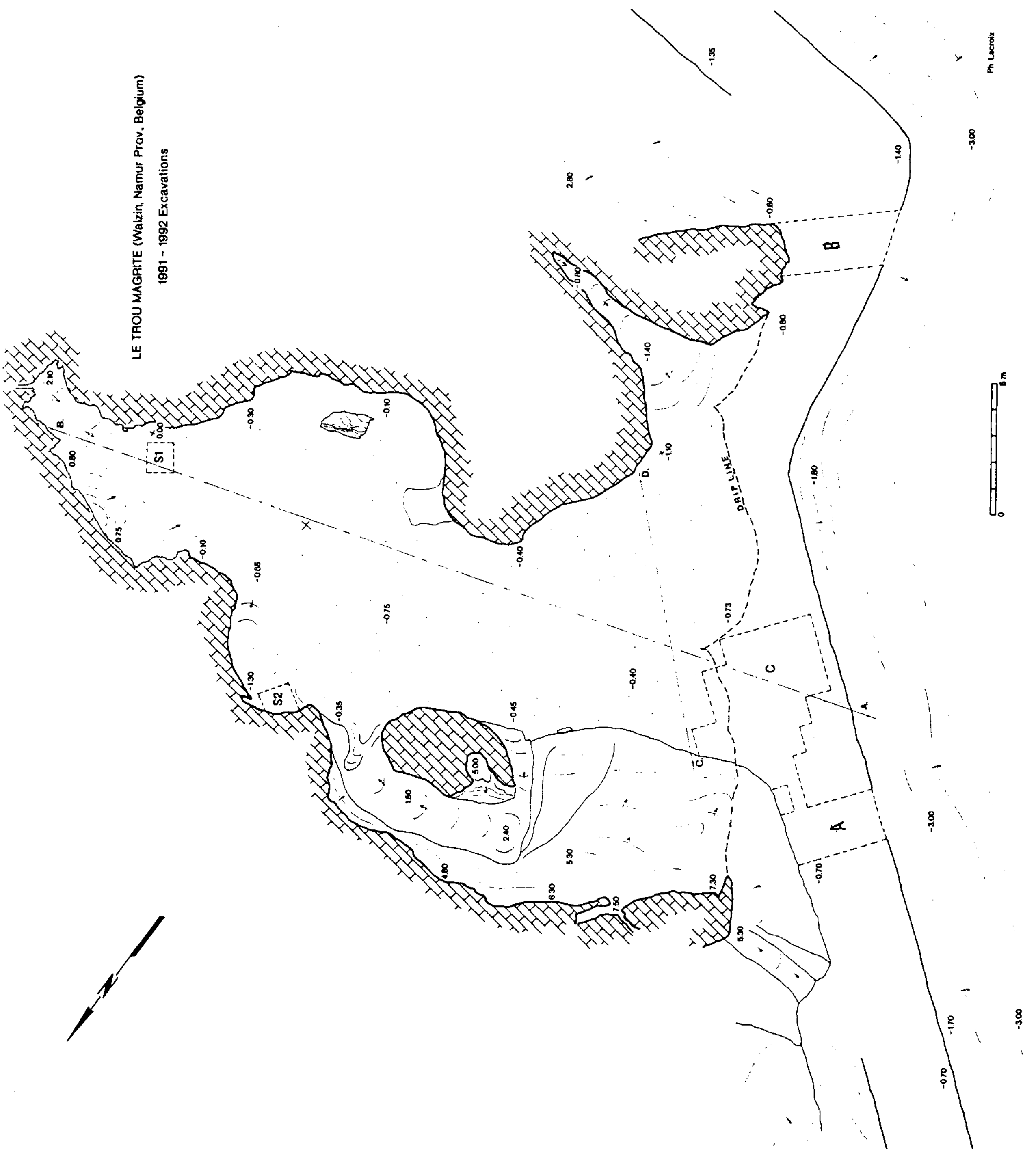
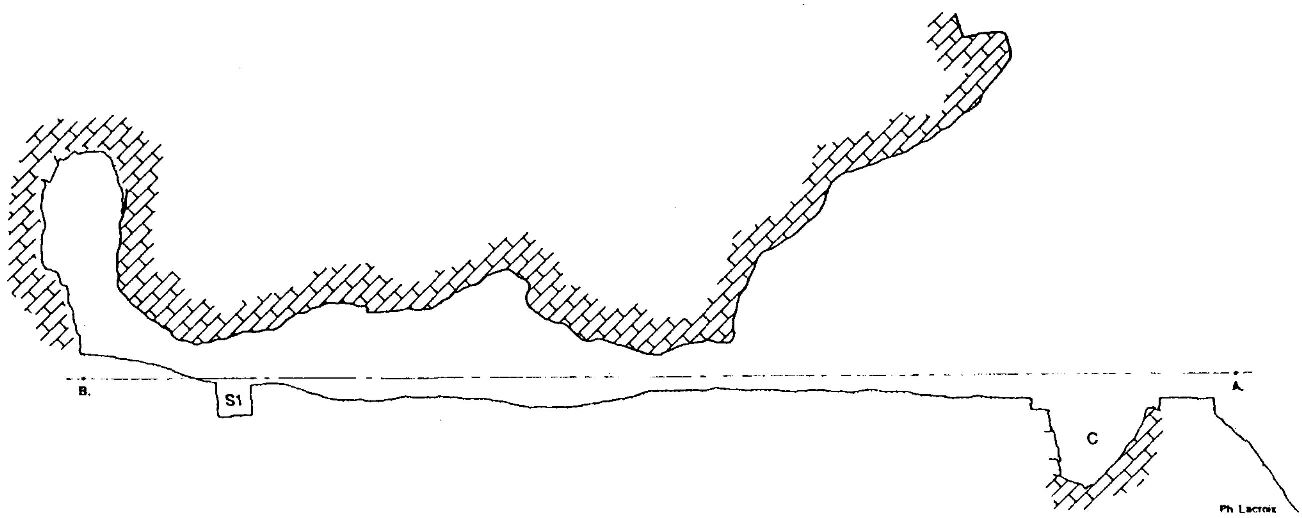
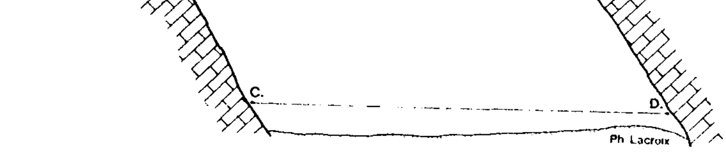

LE TROU MAGRITE (Walzin, Namur Prov, Belgium)
1991 - 1992 Excavations
DRIP LINE
S1
S2
A
B
C
Ph. Lacroix
5 m

Figure 2.3.



LE TROU MAGRITE Longitudinal Section, A–B

Figure 2.4



LE TROU MAGRITE Sagittal Section, C–D

Figure 2.5.

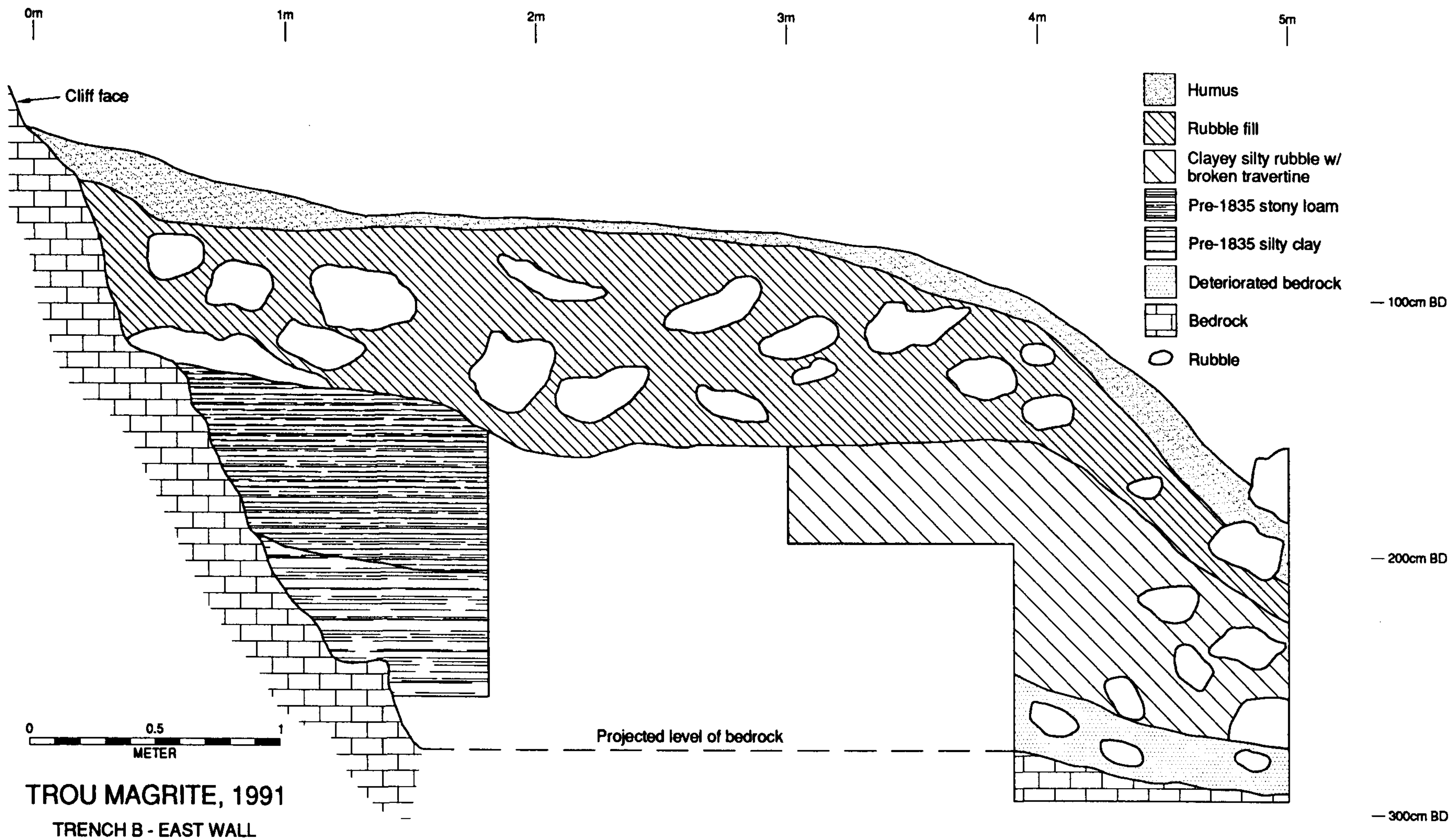

0m
1m
2m
3m
4m
5m
Cliff face
Humus
Rubble fill
Clayey silty rubble w/ broken travertine
Pre-1835 stony loam
Pre-1835 silty clay
Deteriorated bedrock
Bedrock
Rubble
— 100cm BD
— 200cm BD
— 300cm BD
Projected level of bedrock
0
0.5
1
METER
TROU MAGRITE, 1991
TRENCH B - EAST WALL

Figure 2.6.

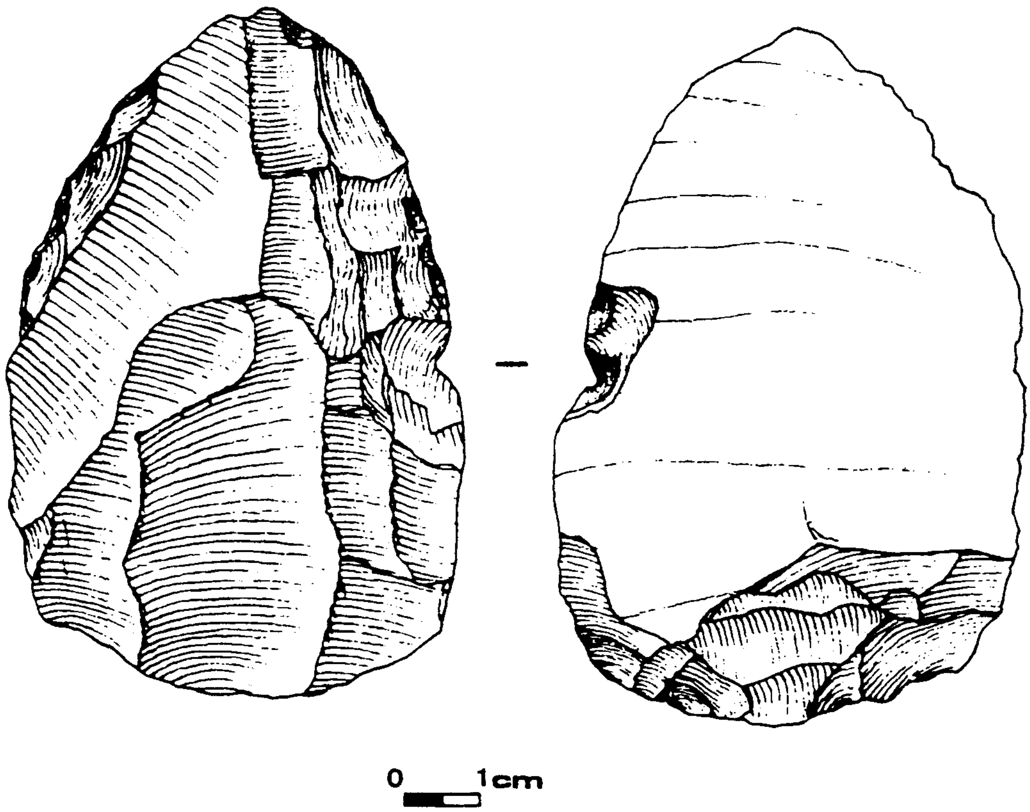


Figure 2.7.

silty clay atop bedrock. Clearly, the promenade had been constructed by cutting upslope along the edge of the cliff and filling downslope along the top of the talus.

Trench A (Fig. 2.8): The surface of the promenade at the west edge of the cave mouth consists of 5-50 cm. of humus. It overlies a wedge of mixed rubble fill, 30 cm. thick against the cliff and 80 cm. abutting the retaining wall. The rubble yielded limited numbers of flint artifacts and submodern objects (sherds, brick, tile, bolt), some as deep as 80 cm. The rubble overlies 10-20 cm. of sterile, intact, stony, silty clay, in turn resting atop a gently sloping bedrock shelf like that at the east edge of the cave entrance. Paleolithic or Mesolithic deposits do not extent laterally from the sides of the Trou Magrite entrance.

Trench C: In a final attempt to locate intact archeological strata, a 1x1 m. sondage was dug 4 m. east of Trench A, just west of the axis of the cave mouth and about 4 m. west of Toussaint's sondage at the front center of the terrace. Trench C was situated immediately north of the promenade retaining wall. Beneath a 30-70 cm. wedge of blackish brown humic topsoil and backdirt from earlier excavations (Stratum 1), we encountered a layer of fine gravels (Stratum 2). Due to percolation from above, the top of this gravel deposit had a dark loamy matrix, but below the infiltration zone the gravels were yellowish beige in color and rather "washed" out, with little fine matrix. These angular gravels yielded abundant flint artifacts (including Upper Paleolithic tools, among them the tip of a unifacial foliate point), but no modern objects. The deposit appeared to be intact and *in situ*.

Upon the discovery of intact deposits, Trench C was expanded in 1991 first to an area of 3 sq.m. and finally 7.75 sq.m (photo 2.2). Fully controlled excavation was begun with the initial expansion of the sondage. In addition, a 0.5 m.-wide slit trench was dug in the "J" row to connect Trenches A and C and to extend eastward toward the area of Toussaint's sondage. Only Stratum 1 humus/ backdirt was dug until either intact Stratum 2 gravels or mixed fill was encountered along the slit trench in order to ascertain the extent of the area of intact Paleolithic deposits. Based on the findings of this east-west slit trench, the excavation area was extended again in 1992 to encompass all the remnant intact infilling in the west front sector of the cave entrance. Thus, *in situ* archeological deposits dug in Trench C ended up totalling 22 sq.m. in area, a respectable area for a site that had long thought to have been completely excavated. The excavation block consisted of all or part of the following meter squares: G5-7, H5-8, I4-9, J4-9, K6-9 and L7-9 (Fig. 2.9).

In 1992, Ph.Lacroix dug two sondages of 1x1 m. each in the cave: S1 at the rear of the inner chamber in front of the chimney base; S2 at the rear of the vestibule directly back from the principal cave mouth. Below a surficial deposit of mixed fill, he uncovered archeologically sterile clayey silt with cobbles and a few cave bear bones in S1. This sondage was terminated at a 1.1 m. below surrounding cave floor surface when huge brecciated blocks were hit. Probably all the archeological deposits had been removed by Dupont and/or successive excavators and S1 may have cut into pre-Mousterian sediments. S2 yielded a mixture of artifacts of Upper and Middle Paleolithic aspect and a variety of fauna,

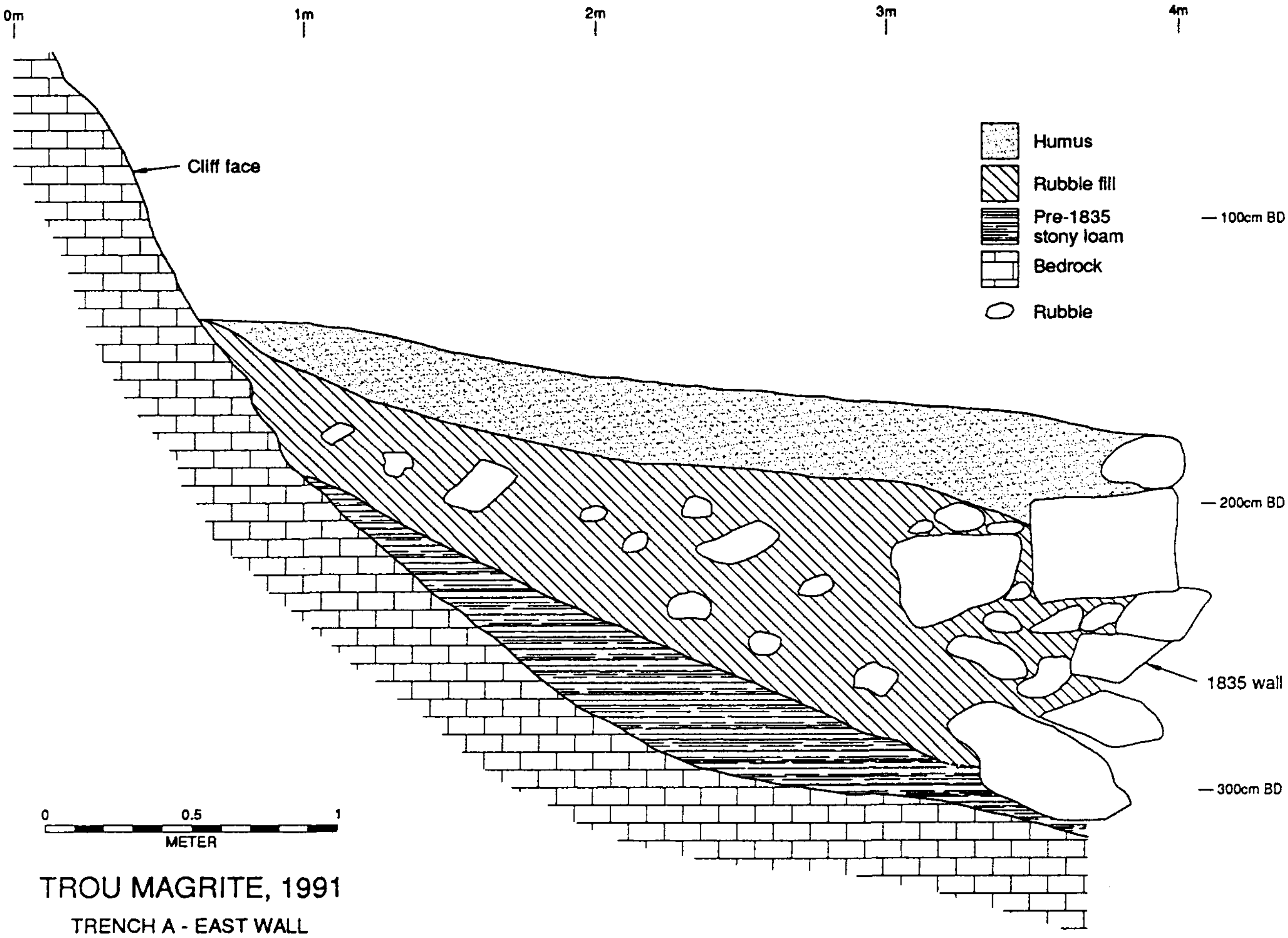

0m
1m
2m
3m
4m
Cliff face
Humus
Rubble fill
Pre-1835 stony loam
Bedrock
Rubble
— 100cm BD
— 200cm BD
1835 wall
— 300cm BD
0
0.5
1
METER
TROU MAGRITE, 1991
TRENCH A - EAST WALL

Figure 2.8.

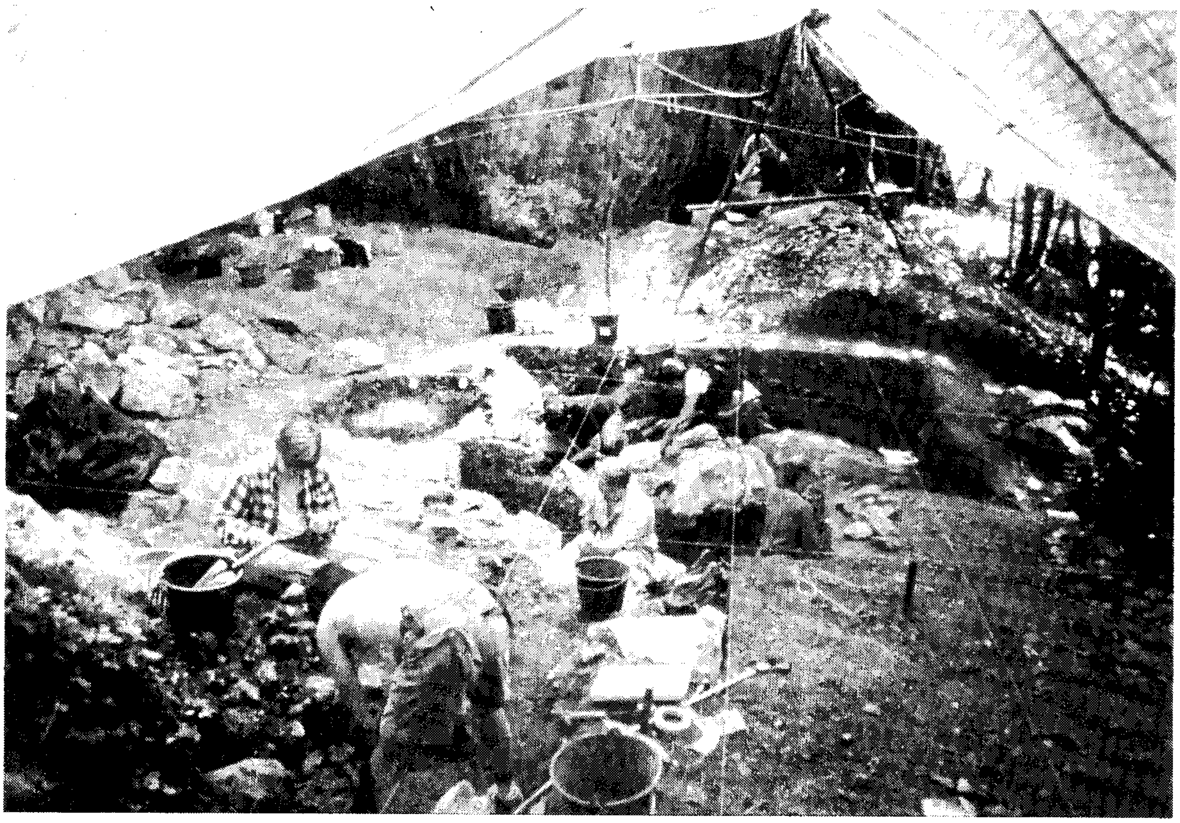


Photo 2.2 : Excavation of the terrace.

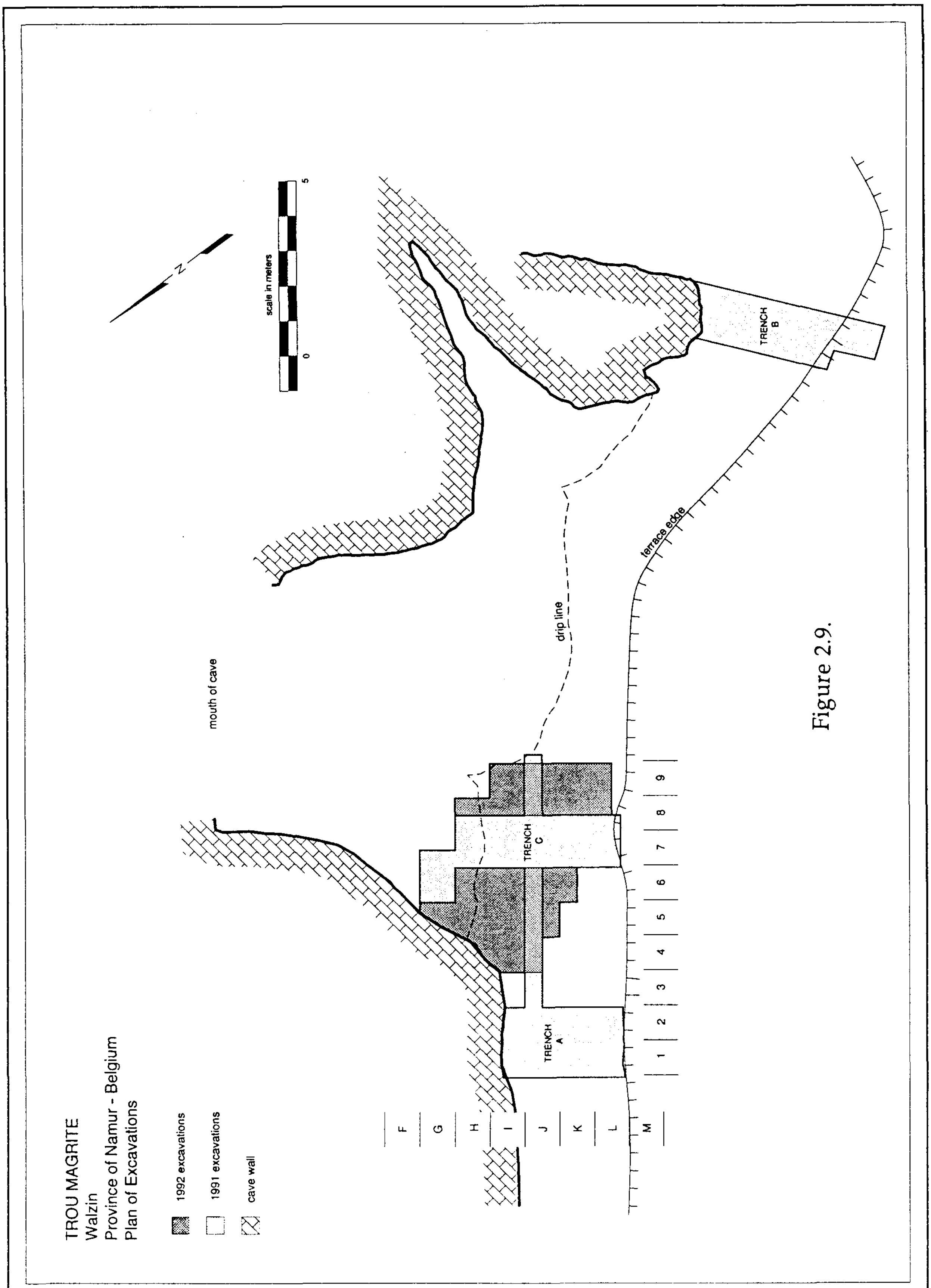

TROU MAGRITE
Walzin
Province of Namur - Belgium
Plan of Excavations
1992 excavations
1991 excavations
cave wall
scale in meters
0
5
N
mouth of cave
drip line
terrace edge
TRENCH A
TRENCH B
TRENCH C
F
G
H
I
J
K
L
M
1
2
3
4
5
6
7
8
9

Figure 2.9.

including a fragment of hippopotamous tusk (see Gautier, this volume). This find confirms one made by Rutot and indicates that there must have been deposits in le Trou Magrite that were formed during the Last Interglacial (oxygen isotope stage 5e). However it is clear that S2 was excavated (to a depth of ca. 1 m.) in totally mixed backdirt from old diggings. It is believed that very little or no archeological material remains in situ inside the cave per se.

METHODOLOGY

In general, the excavation and recording methods used were those that are currently standard in European Paleolithic excavations. For the purposes of the excavation grid and measurements, fictive north is oriented toward the cave mouth (in reality, this is northeast). Each meter square is subdivided into four subsquares of 50x50 cm. The northern two subsquares are labelled "A" and "B" from west to east and the southern ones, "C" and "D". All lithic artifacts longer than 1 cm. and all faunal remains that are either readily identifiable or longer than 5 cm. are individually recorded with their three-dimensional coordinates. Orientation and inclination are measured for all elongated objects (e.g., long bones, blades) with a compass and clinometer respectively. Piece-plotted objects are numbered from 1 to infinity for each meter square (irrespective of stratum attribution). Thus, the provenience information written on each piece-plotted object consists of site ("TM"), square and item number.

Normal excavation was conducted by small trowel, brush, knife and dental pick. However, sediments indurated with calcium carbonate and travertine layers had to be excavated by hammer and chisel, leading to unequal recovery between these areas (at the northern end of Trench C) and the rest of the excavation, where the sediments were unconsolidated. All fill is screened through 2.5-3 mm. mesh; this proved satisfactory because the fine sediments are silts and sands with little or no clay. The major practical problem was posed by the presence of large limestone blocks, not surprising due to the location of Trench C under and just in front of the present rockshelter dripline. Insofar as possible, blocks were dug around and removed, either whole or in pieces. Block breaking was done with sledge hammers, wedges and an electric drill and pneumatic hammer powered by a gasoline generator. Even with this equipment, some blocks were simply too big to be removed, a fact which greatly limited the area of the Mousterian strata that could be excavated.

Excavation was conducted following the lay of the natural stratigraphy in each square. We use thin, arbitrary levels ("spits": normally 5-8 cm. thick, except during major block removal episodes) within natural strata that are defined primarily by color, texture and granulometric content. Archeological content was of secondary consideration in stratum definition. Spits are numbered from "1" at the surface to infinity (irrespective of strata attribution). Thus, items found in the screen (unless retroactively assigned individual item numbers---in the cases of small retouched tools) have bag provenience consisting of site, square, subsquare, spit, stratum and a bag number from the same series of item numbers used for piece-plotted objects from the square in question (i.e., an item number can refer to either a piece-plotted object or a bag of objects found in the screen. For analytical purposes, the latter items can be given decimal designations (e.g., 12.1, 12.2, 12.3, etc.). All piece-plotted objects (artifacts, faunal remains, manuports) are individually weighed; objects found in the screen are weighed collectively by type (and raw material class for lithics) per provenience unit. Potential lithic microwear and residue samples were individually bagged unwashed, with minimal handling.

Two complete columns of continuous pollen samples were taken from the Trench C east and west stratigraphic sections by Claudine Schutz (Institut de Paléontologie Humaine, Paris). Geological samples were taken by Paul Haesaerts (Institut Royal des Sciences Naturelles, Brussels). Both specialists made observations of the stratigraphy and site environment during both excavation seasons. Unfortunately, despite treatment of 36 pollen samples (out of a total of 170 collected), there are no meaningful palynological results from le Trou Magrite. Most of the samples are completely sterile. Only 25 samples yielded any pollens or spores, but with numbers of grains only ranging from 1 to 58 (Cl.Schutz, personal communication). Tree pollens are almost always absent or extremely rare (i.e., 1 pollen per sample), with one minor exception: a sample from Stratum 2 with 5 tree pollens, including 2 of pine and 1 each of hazel, alder and juniper. But this sample may have been disturbed by rootlets.

The following is a composite description of the 2.5 m.-deep stratigraphy in Trench C uncovered in 1991-92 (Figs. 2.10-2.11-2.12-2.13-2.14).

STRATIGRAPHY

Stratum 1 is composed of mixed fill (most certainly derived from the cave and used to construct the talus-side part of the promenade along the retaining wall), backdirt from excavations and humus. It is dark grey-brown in color and is rich in artifacts of many periods up to the present. No modern artifacts were found below Stratum 1, however. Stratum 1 is maximally 60 cm. thick adjacent to the retaining wall, but elsewhere it is generally only about 10 cm. thick (and only about 5 cm. adjacent to the cliff face).

Stratum 1.1 is fine, pure, light brown silt infilling a pit of post-Paleolithic age in parts of squares I8-9 and J8-9 (Fig. 2.15). It seems to have continued at least slightly into J10 and K10, although these squares were not excavated due to evidence of massive disturbance, huge blocks and proximity to Toussaint's sondage, where intact Paleolithic deposits were known not to have been present. The top of the Stratum 1.1 pit measured over 1.5 sq. m. in area. The pit, with sloping sides, had been cut through Stratum 2 and possibly into Stratum 3. It contained a half dozen medium size limestone blocks, as well as artifacts of possibly Iron Age, Neolithic, Mesolithic and even Magdalenian attribution. Similar kinds of artifacts are said said to have been found by Toussaint (personal communication) in his adjacent sondage.

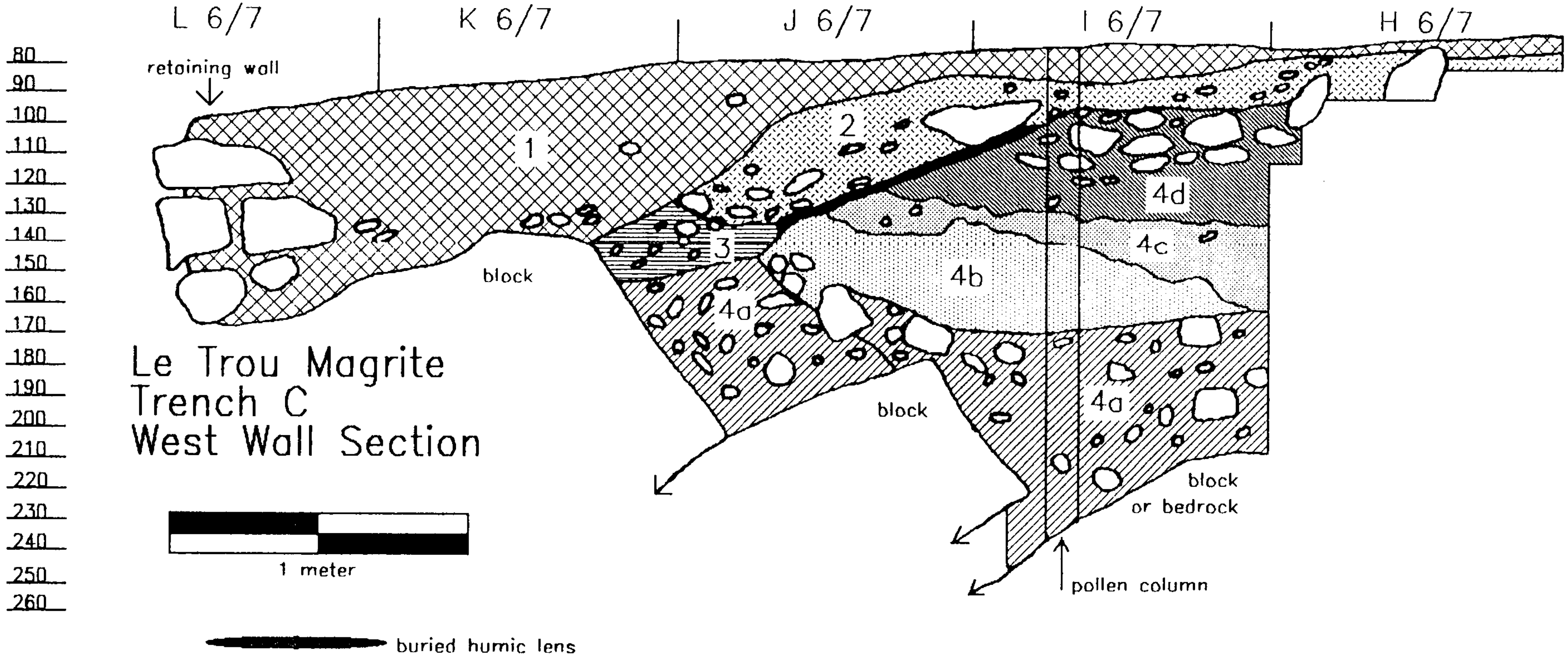

L 6/7
K 6/7
J 6/7
I 6/7
H 6/7
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
250
260
retaining wall
1
2
3
4a
4b
4c
4d
block
block
block
or bedrock
pollen column
Le Trou Magrite
Trench C
West Wall Section
1 meter
buried humic lens

Figure 2.10.

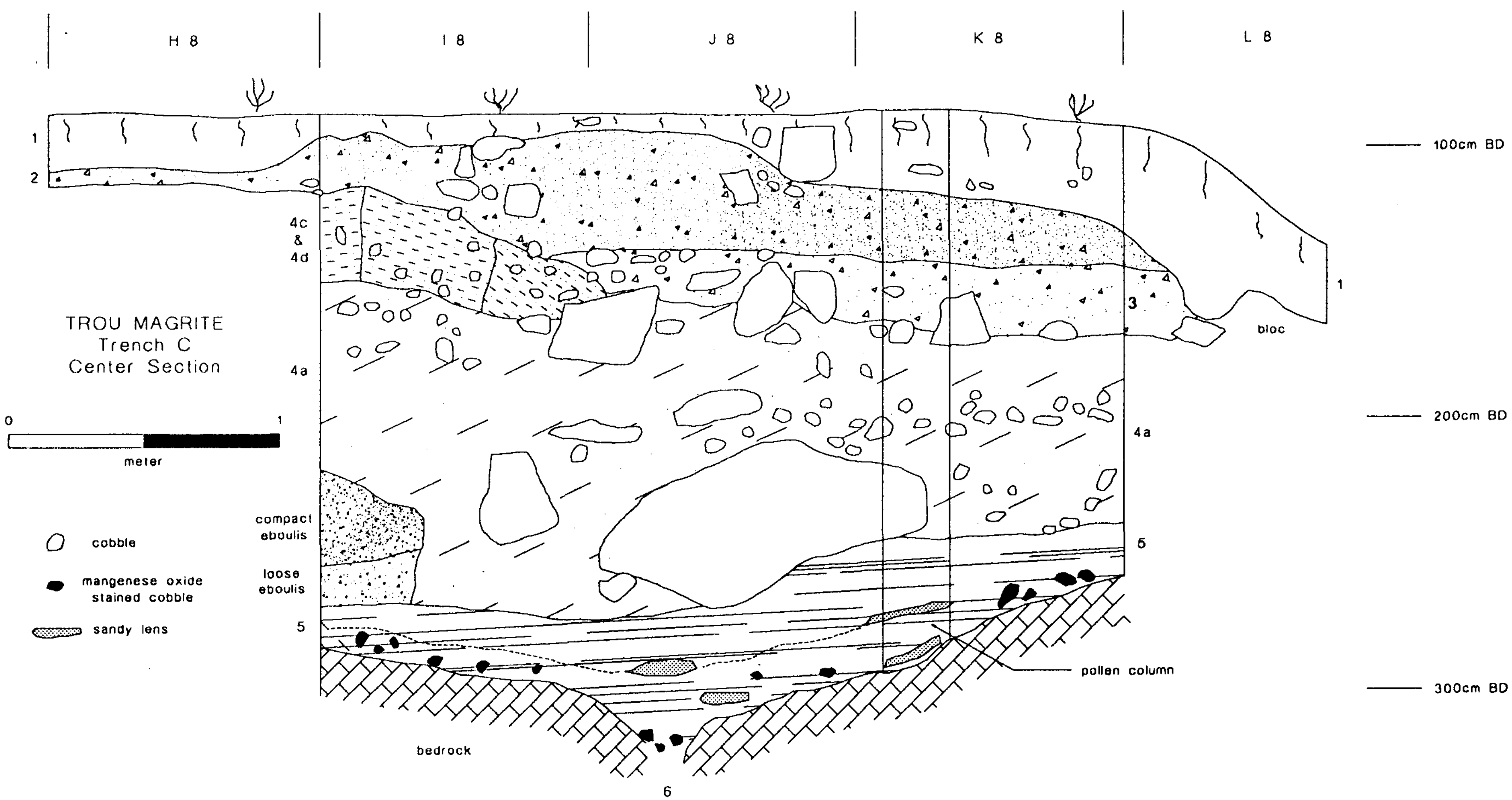
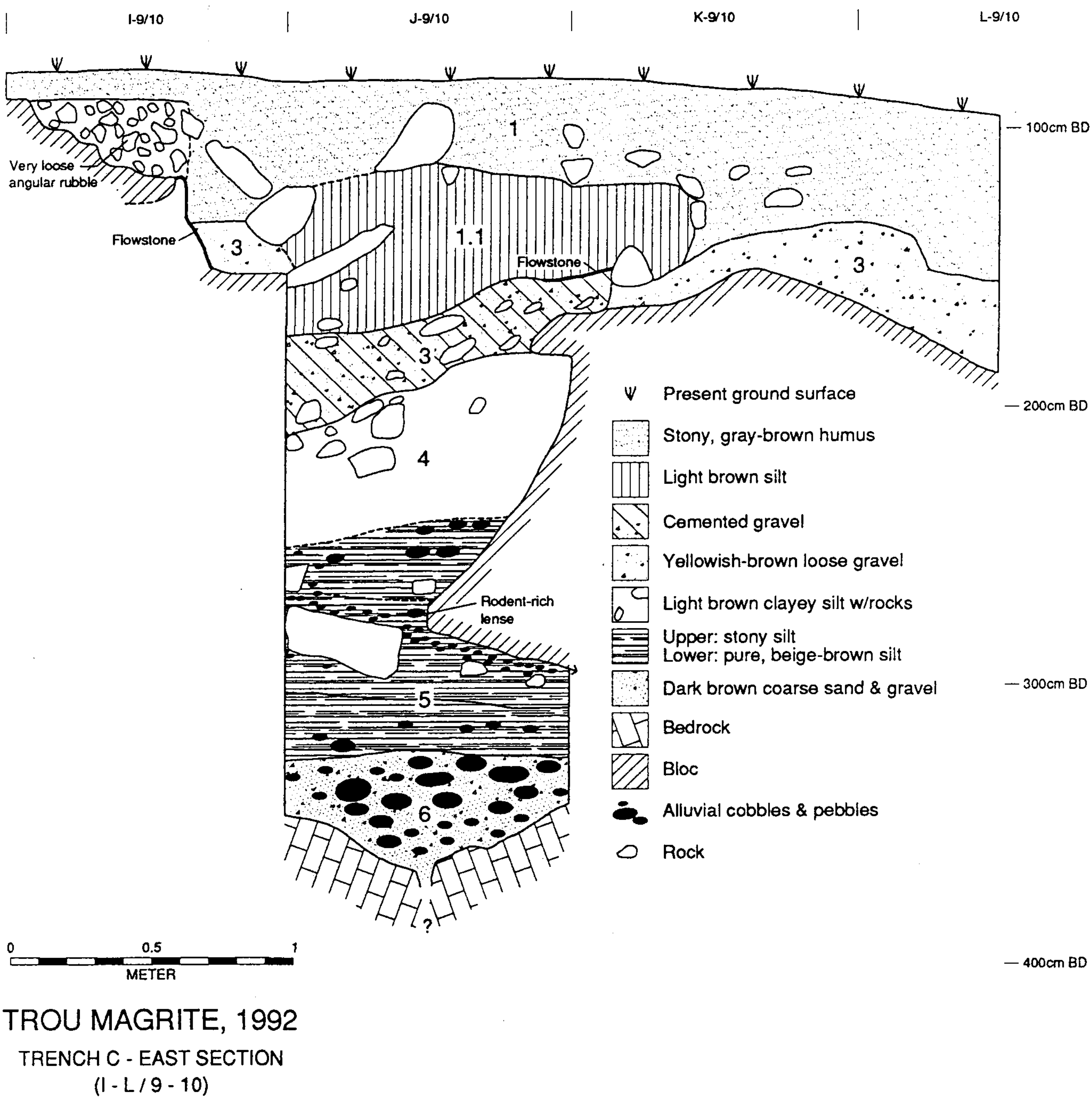

H 8
I 8
J 8
K 8
L 8
1
2
4c
&
4d
4a
compact
eboulis
loose
eboulis
5
3
bloc
6
bedrock
pollen column
100cm BD
200cm BD
300cm BD
TROU MAGRITE
Trench C
Center Section
0
1
meter
cobble
mangenese oxide
stained cobble
sandy lens

Figure 2.11.



I-9/10
J-9/10
K-9/10
L-9/10
100cm BD
200cm BD
300cm BD
400cm BD
1
1.1
3
4
5
6
Very loose angular rubble
Flowstone
Flowstone
Rodent-rich lense
Present ground surface
Stony, gray-brown humus
Light brown silt
Cemented gravel
Yellowish-brown loose gravel
Light brown clayey silt w/rocks
Upper: stony silt
Lower: pure, beige-brown silt
Dark brown coarse sand & gravel
Bedrock
Bloc
Alluvial cobbles & pebbles
Rock
0
0.5
1
METER
TROU MAGRITE, 1992
TRENCH C - EAST SECTION
(I - L / 9 - 10)

Figure 2.12.

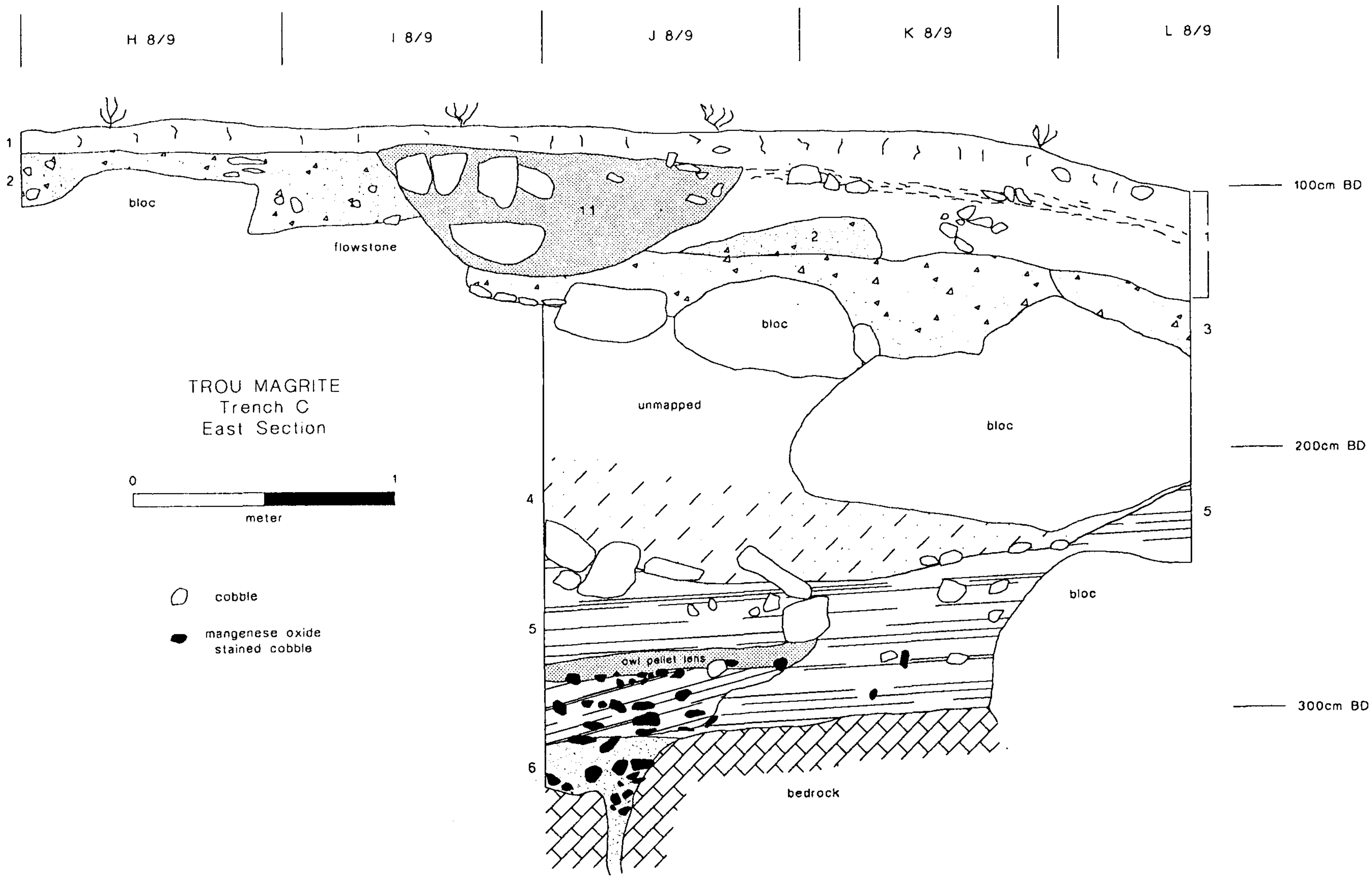
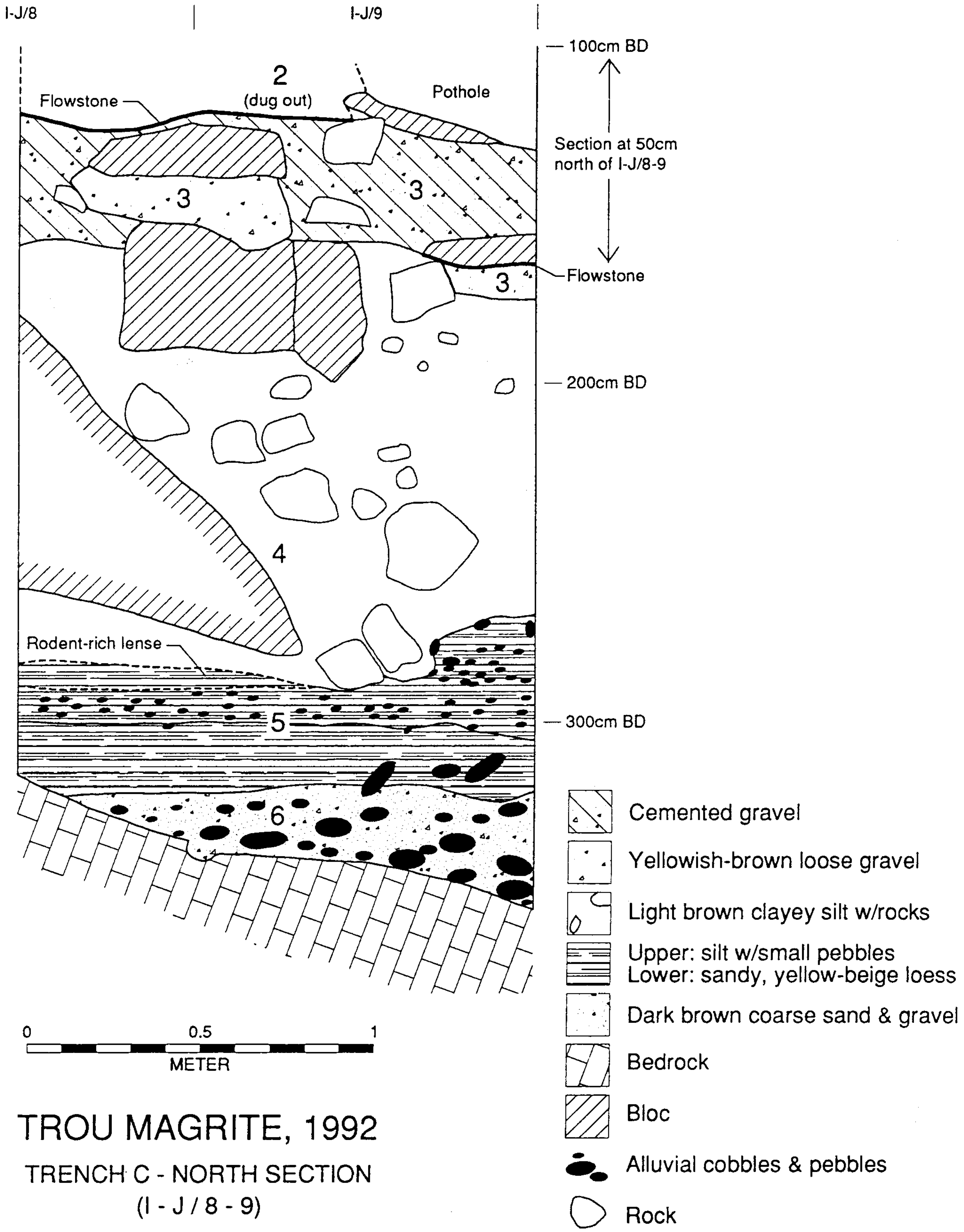

H 8/9
I 8/9
J 8/9
K 8/9
L 8/9
1
2
bloc
flowstone
11
2
bloc
3
unmapped
bloc
100cm BD
200cm BD
300cm BD
4
5
5
6
bloc
owl pellet lens
bedrock
TROU MAGRITE
Trench C
East Section
0
1
meter
cobble
mangenese oxide
stained cobble

Figure 2.13.



I-J/8
I-J/9
100cm BD
200cm BD
300cm BD
Section at 50cm north of I-J/8-9
Flowstone
2
(dug out)
Pothole
3
3
3
Flowstone
4
Rodent-rich lense
5
6
0
0.5
1
METER
Cemented gravel
Yellowish-brown loose gravel
Light brown clayey silt w/rocks
Upper: silt w/small pebbles
Lower: sandy, yellow-beige loess
Dark brown coarse sand & gravel
Bedrock
Bloc
Alluvial cobbles & pebbles
Rock
TROU MAGRITE, 1992
TRENCH C - NORTH SECTION
(I - J / 8 - 9)

Figure 2.14.

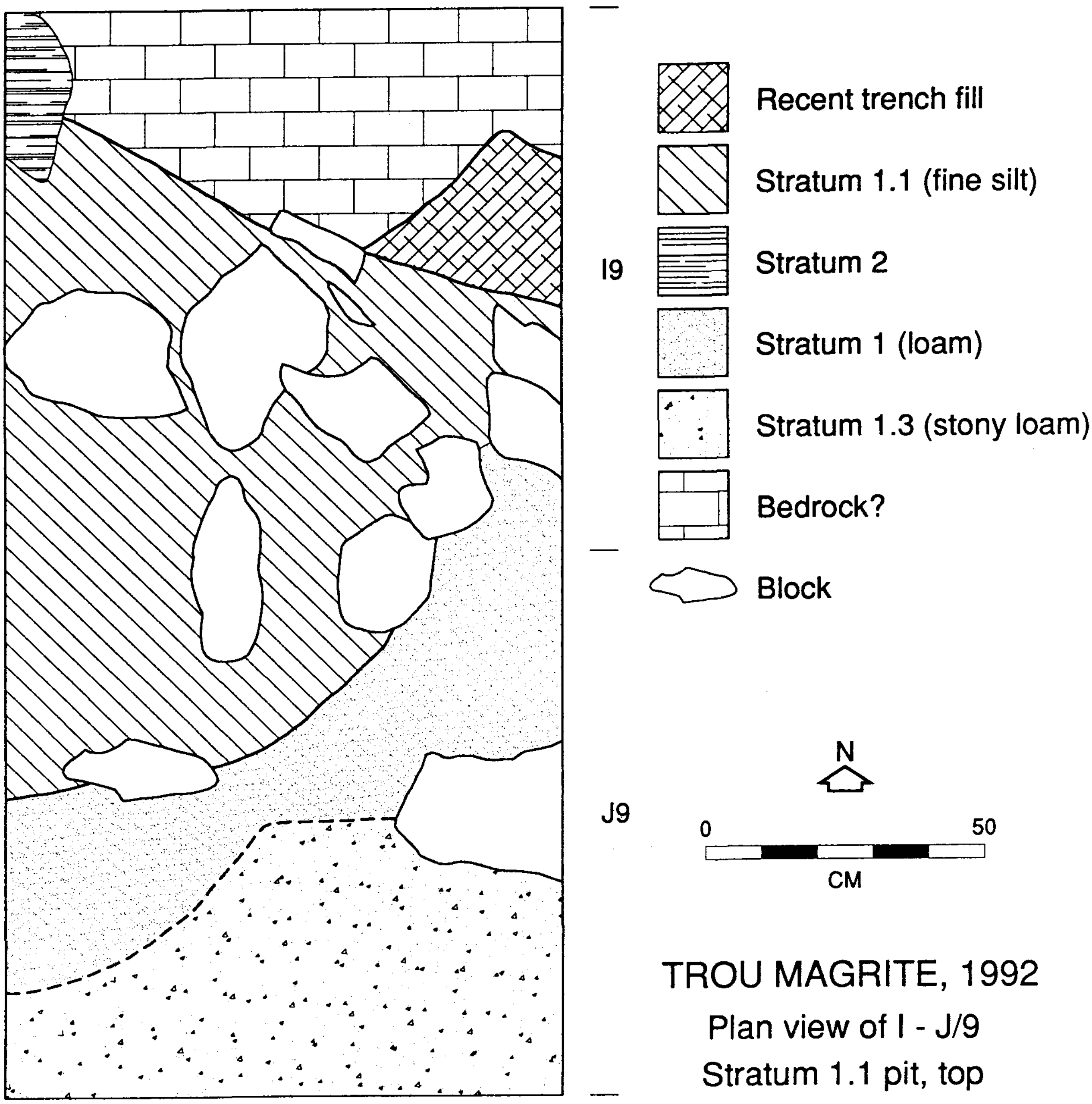

Recent trench fill
Stratum 1.1 (fine silt)
Stratum 2
Stratum 1 (loam)
Stratum 1.3 (stony loam)
Bedrock?
Block
I9
J9
N
0
50
CM
TROU MAGRITE, 1992
Plan view of I - J/9
Stratum 1.1 pit, top

Figure 2.15.

In J9 subsquare D, there was a tiny remnant of a gravelly deposit adjacent to the 1.1 pit. Called Stratum 1.3, this unit yielded a microlithic perforator, a thumbnail endscraper and an endscraper on a flake all artifacts which could be Mesolithic.

The contact with Stratum 2 is an abrupt uncomformity, as this unit is composed of small, angular cryoclastic eboulis gravels of yellowing beige color. The gravels are generally no more than about 2 cm. in size, though there are limited quantities of 4-5 cm. blocks. The comminuted gravel deposit is very homogeneous, although, despite the presence of extraneous artifacts, the top several centimeters are stained with dark humus that has percolated downward from Stratum 1. In some areas the gravels are quite "washed" out and loose, with scant interstitial silt. However, toward the cliff face, there is a zone where Stratum 2 is cemented by flowstone (calcium carbonate). The flowstone crust dips down away from the cliff in the eastern sector, indurating the lower part of Stratum 2 at the Stratum 3 contact. The top of Stratum 2 slopes down at the top of the talus in the K and especially L rows (where it is covered by a thick layer of promenade fill), but it is quite flat in the J, I, H and G rows, as if it had been cut into and levelled for construction of the promenade in the 1830's. Stratum 2 pinches out in the L row at the edge of the talus---apparently eroded away. Otherwise this layer is 20-45 cm. thick. It grades into Stratum 3 in such a fashion that the distinction between the two layers is often unclear and somewhat arbitrary.

Stratum 3 is also composed of cryoclastic eboulis, but contains many larger blocks and slabs in a gravel matrix. The gravels, which are generally larger than those of Stratum 2, are angular and yellowish beige in color and have minimal interstitial silt. However, like Stratum 2, this unit slopes and is locally cemented by precipitated calcium carbonate, especially in the northern end of Trench C, toward the cave mouth and cliff face. Generally Stratum 3 is 30-35 cm. thick, but locally pinches down to as little as 10 cm, notably atop huge boulders outcropping from Stratum 4. The larger blocks and slabs within Stratum 3 generally measure 10-20 cm in length, with a few being bigger than this (30 cm.). There is a localized 2-3 cm. thick humic lense at the base of Stratum 3. Unlike the gradational boundary between Strata 2 and 3, there is an abrupt break in granulometry and color between Strata 3 and 4.

Stratum 4 is a massive deposit of light (yellowish) brown clayey silt in which are embedded large to very large roof-fall boulders (photo 2.3). Some of these blocks measure in excess (or much in excess) of 1 m in length. There are no apparent surfaces within this unit, which is horizontally bedded, although there are patches or layers of denser blocks. The northern part of Stratum 4 is brecciated, especially along the western part of Trench C.

Haesaerts observed granulometric variations within Stratum 4, including the presence of waterworn cobbles in the upper-middle zone ("4c") and a sandier matrix of fines at the base of "4a" near contact with Stratum 5. Once again, this stratum is locally cemented by calcium carbonates that precipitated after at some time(s) since deposition of the silts (colluvial loess).

Photo 2.3 : Trench C.

Stratum 5 is also horizontally bedded and, although heterogeneous in composition, was clearly for the most part waterlain. Although excavated in a very limited area, due to the presence of huge, unbreakable and unmovable blocks, we were able to determine that Stratum 5 can be subdivided into three subunits.

The upper part is a stony, light brown-beige silt/loess that contains a few medium-size angular blocks and scattered waterworn cobbles/pebbles. Below this is a fairly well defined, more-or- less continuous lens extraordinarily rich in microfaunal (notably rodent) remains. This lens (ca. 10 cm. thick) is gritty loess, blotchy light beige-white in color, and clearly the result of owl regurgitation pellet deposition. Below this is pure yellowish beige-brown silt, locally (channel fill?) with stones and cobbles. The base of Stratum 5, which grades into Stratum 6, is increasingly sandy, with waterworn pebbles. There are localized lenticular pure sand deposits and clayey patches. Stratum 5 underlies the huge roof-fall boulders of Stratum 4. In its aggregate it is generally 50-80 cm. thick, but as little as 30 cm. in some places, especially under some of the Stratum 4 boulders and where Stratum 5 lies directly atop high areas of bedrock.

Stratum 6 was recognized as distinct in 1992 when the still restricted area of the base of Trench C could be enlargened somewhat. It is best defined in a "crevice" that runs east-west either through bedrock or between bedrock (to the north) and a huge boulder (to the south). Stratum 6 is composed of dark brown gravel, coarse sand and water-worn cobbles. In general, the cobbles, which are stained black (manganese oxide?), increase in size and density toward the base of the deposit. Some reach 15 and even 20 cm. in size, testifying to the velocity and force of the running water that laid down Stratum 6. The deposit measures 20-50 cm. thick and is the only unit to be totally sterile, both archeologically and paleontologically.

REFERENCES

BREUIL H., 1912,
Les subdivisions du Paélolithique supérieur et leur signification. *XIV Congrès International d'Anthropologie et d'Archéologie Préhistoriques*, vol. 1, pp.165-238.

DEWEZ M., 1979,
Note sur des documents encochés du Magdalénien de Chaleux et du Trou Magrite. *Quartär* 29/30:157-162.

DEWEZ M., 1985,
L'art mobilier paléolithique du Trou Magrite dans son contexte stratigraphique. *Bull.Soc. roy. belge Anthrop. Préhist.* 96:117-133.

OTTE M., 1979,

Le Paléolithique Supérieur Ancien en Belgique. Musées Royaux d'Art et d'Histoire, Bruxelles.

OTTE, M. 1981.

Les industries à pointes foliacées et à pointes pédonculées dans le nord-ouest européen. In *Préhistoire de la Grande Plaine de l'Europe* (J.Kozlowski, ed.), UISPP, Crakow, pp.95-166.

OTTE,M., 1988

Les origines du Paléolithique supérieur européen. *Antiquités Nationales* 20:17-18.

SMITH P.E.L., 1966,

Le Solutréen en France. Delmas, Bordeaux.

ULRIX-CLOSET, M. 1975,

Le Paléolithique Moyen dans le Bassin Mosan en Belgique. Universa, Wetteren.

M. OTTE et L.G. STRAUS (dir.), *Le Trou Magrite. Fouilles 1991-1992*. Liège, E.R.A.U.L. 69, 1995.

3

LE REMPLISSAGE DE LA TRANCHEE C DU TROU MAGRITE

Paul HAESAERTS

INTRODUCTION

On sait le caractère restreint de l'approche sédimentologique et stratigraphique des dépôts de remplissage de bords de cavités où peuvent interférer apports liés au réseau karstique et apports extérieurs. De plus dans le cas présent, la dimension restreinte des sondages effectués à hauteur du porche du Trou Magrite lors des fouilles de L.G. Straus et de M. Otte en 1991 et 1992 ne permet guère de contrôler la géométrie d'ensemble des quelques unités sédimentaires qui constituent l'essentiel du remplissage encore accessible. Néanmoins, à la demande de L.G. Straus, nous avons examiné les dépôts recoupés par les parois ouest et est de la tranchée C qui semblaient présenter l'enregistrement le plus "explicite". A cette occasion une dizaine d'échantillons pour analyse sédimentaire ont été prélevés en juillet 1991.

DESCRIPTION DES UNITES (Fig. 3.-1)

COUPE H-L/6-7 (de haut en bas)

Couche 1: Limon grumeleux, gris, avec nombreuses racines et petits blocs dispersés; se superpose aux Couches 2 et 3 qu'il recoupe en oblique.

Couche 2: Plaquettes centimétriques et petits blocs calcaires (4 à 5 cm) avec matrice limoneuse jaune; présence localement de poches humiques venues d'en haut. L'ensemble est relativement compact, mais non-cimenté.

Couche 3: Dépôt comparable à celui de la Couche 2 avec néanmoins une plus forte proportion de blocs décimétriques pouvant atteindre 20 à 30 cm; présence d'un petit horizon humifère centimétrique à la base du dépôt en Ja et Ic 6/7. Les Couches 2 et 3 se disposent légèrement en oblique par rapport au sommet des Couches 4d à 4a sous-jacentes.

Couche 4d: Plaquettes anguleuses de calcaire de 2 à 3 cm disposées plus ou moins sub-horizontalement avec une faible matrice limoneuse. L'ensemble est

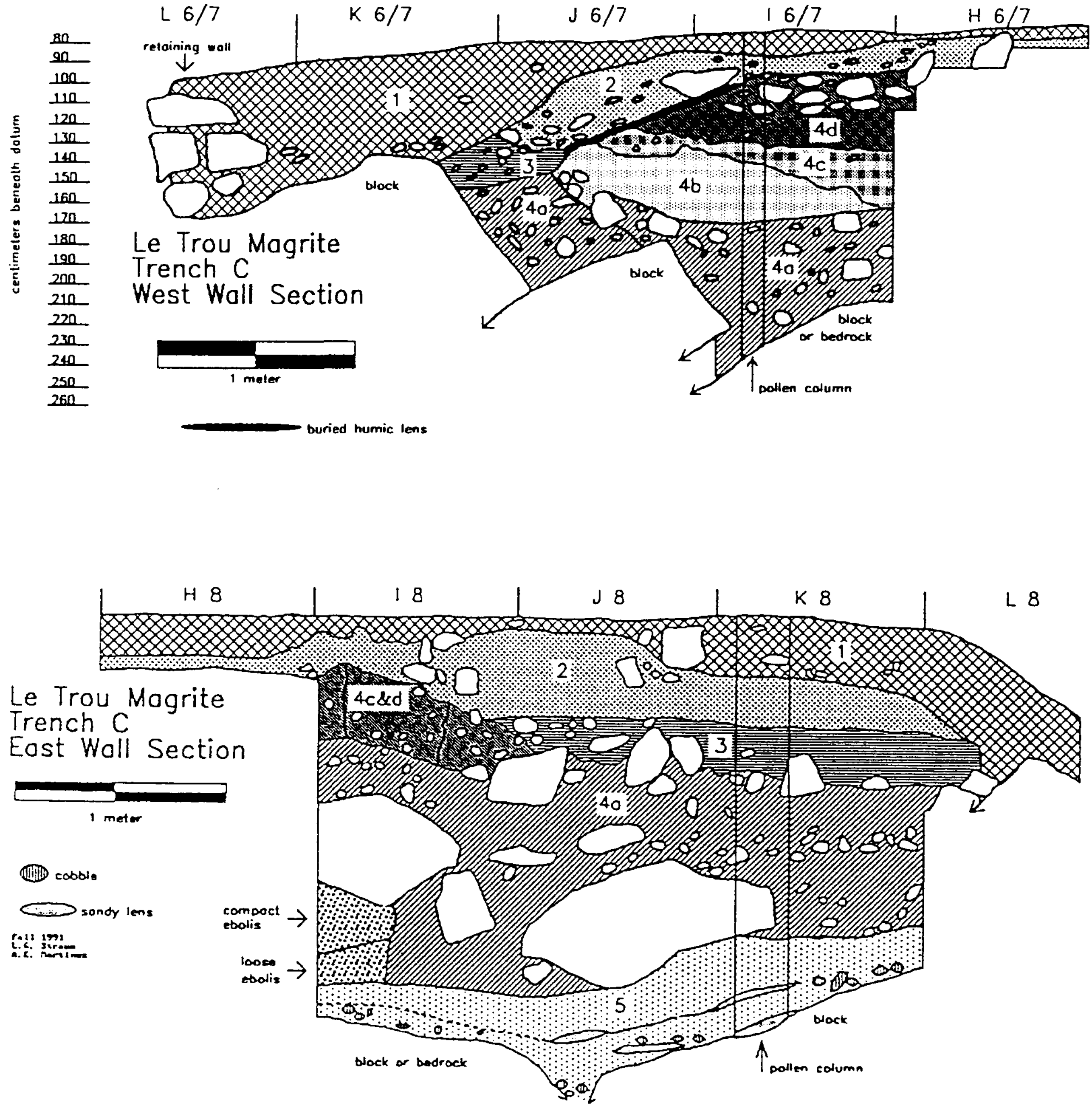


Fig. 3.1 : Coupes stratigraphiques de la tranchée C (d'après M. OTTE *et al.*, 1991).

très compact et fortement concrétionné par des carbonates.

Couche 4c: Limon jaune-beige avec abondants fragments de calcaire de 1 à 3 cm dispersés (sans orientation) et des petits galets (y compris calcaires) de 2 à 3 cm. La partie supérieure de la Couche 4c est encore concrétionnée sur 20 cm d'épaisseur.

Couche 4b: Limon meuble très carbonaté, avec petites concrétions; rares fragments de calcaire dispersés.

Couche 4a: Limon brun-ocre avec abondants fragments de calcaire dispersés sous la forme de blocs décimétriques et localement de très grands blocs (>100 cm). La partie inférieure est plus sableuse, plus brune et contient une plus forte proportion de plaquettes de calcaire.

COUPE L-H/8

Idem. Mais la Couche 4b est absente.

Couche 5: Dépôt hétérogène comprenant des lentilles de limon brun verdâtre, des limons sableux et, surtout en bas, des lits plus sableux avec manganèse et galets de quartzite et roches mosanes.

Couche 6: Sables et graviers à enduit de manganèse contenant une bonne proportion de galets de roches mosanes pouvant atteindre 20 à 30 cm de diamètre.

DONNEES GRANULOMETRIQUES

Distribution des échantillons et choix des paramètres.

Le calcul des différentes fractions granulométriques reprises ici (Tableau 3.1) a été effectué sur le poids du sédiment inférieur à 2,00 mm, après extraction de la matière organique et des carbonates. Parmi les neuf échantillons analysés, sept proviennent des Couches 4d à 4a (échantillons II a VIII), les deux autres des Couches 2 et 5 (échantillons I et IX). Comme paramètres granulométriques, nous avons considéré respectivement les teneurs en sable (fraction supérieure à 53 microns) et en argiles (fraction inférieure à 2 microns), ainsi que le degré de classement et le caractère uni- ou bi-modal des courbes cumulatives.

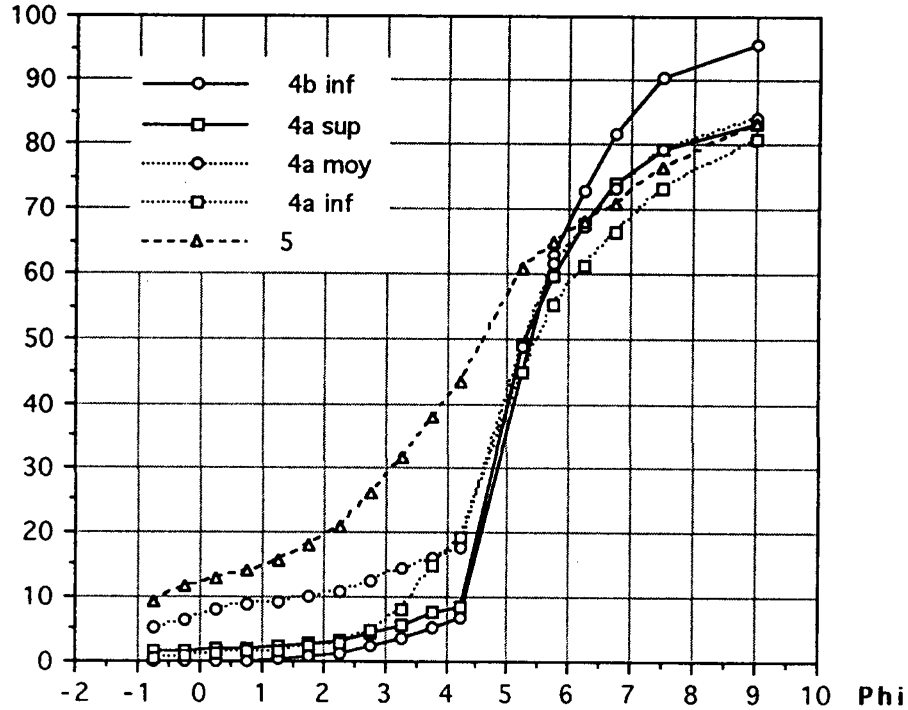
Catégories sédimentologiques (Fig. 3.2a et 3.2b.)

Echantillons I et IX (Couches 2 et 5)

Selon le schéma proposé ci-dessus, on peut distinguer les échantillons appartenant aux Couches 2 et 5 des sept autres échantillons, d'une part du fait de leur teneur élevée en sable (26 et 43%) et en argile (20,6 et 16,8%), et d'autre part

Echantillons	2	4 d	4 c	4 b sup.	4 b inf.	4 a sup.	4 a moy.	4 a inf.	5
Mat. org. et Carb.	38,2	32,6	54,9	56,0	37,4	31,5	29,5	18,0	2,0
> 1.100	0,0	0,0	0,0	0,0	0,0	1,7	6,4	0,9	11,4
> 841	0,1	0,1	0,1	0,0	0,0	2,0	7,8	1,2	12,8
> 595	1,1	0,5	0,4	0,1	0,1	2,1	8,6	1,4	14,1
> 420	3,5	1,0	1,3	0,2	0,2	2,3	9,2	1,7	15,7
> 297	6,0	1,7	4,1	0,8	0,6	2,8	10,1	2,2	18,0
> 210	9,3	2,5	6,7	1,0	1,2	3,3	10,8	2,9	20,6
> 149	14,5	3,8	10,8	3,6	2,3	4,3	12,5	4,9	25,9
> 105	19,2	5,0	14,2	5,4	3,6	5,7	14,5	7,9	31,4
> 80	24,3	5,9	16,9	7,4	5,1	7,4	16,1	14,7	37,8
> 53	26,2	6,7	18,0	9,6	6,8	8,4	17,4	19,2	43,4
> 25	46,8	86,8	48,3	42,0	45,1	49,4	49,0	45,2	60,8
> 20	54,9	88,5	58,7	58,5	63,0	59,6	61,9	55,5	65,1
> 15	60,6	90,0	64,9	67,4	73,1	67,8	67,3	61,2	68,2
> 10	66,3	91,2	70,6	75,1	81,8	74,0	73,4	66,6	71,0
> 5	72,9	92,9	75,6	84,5	90,5	79,2	79,1	73,3	76,6
> 2	79,4	94,5	80,1	91,9	95,8	83,2	83,9	81,0	83,2
1.100 - 53	26,2	6,7	18,0	9,6	6,8	8,4	17,4	19,2	43,4
53 - 2	53,2	87,8	62,1	82,3	89,0	74,8	66,5	61,8	39,8
2 - 0	20,6	5,5	19,9	8,1	4,2	16,8	17,2	19,0	16,8

Tableau 3.1 : Composition granulométrique des sédiments du Trou Magrite exprimée en % (les fractions granulométriques sont exprimées en micromètres).



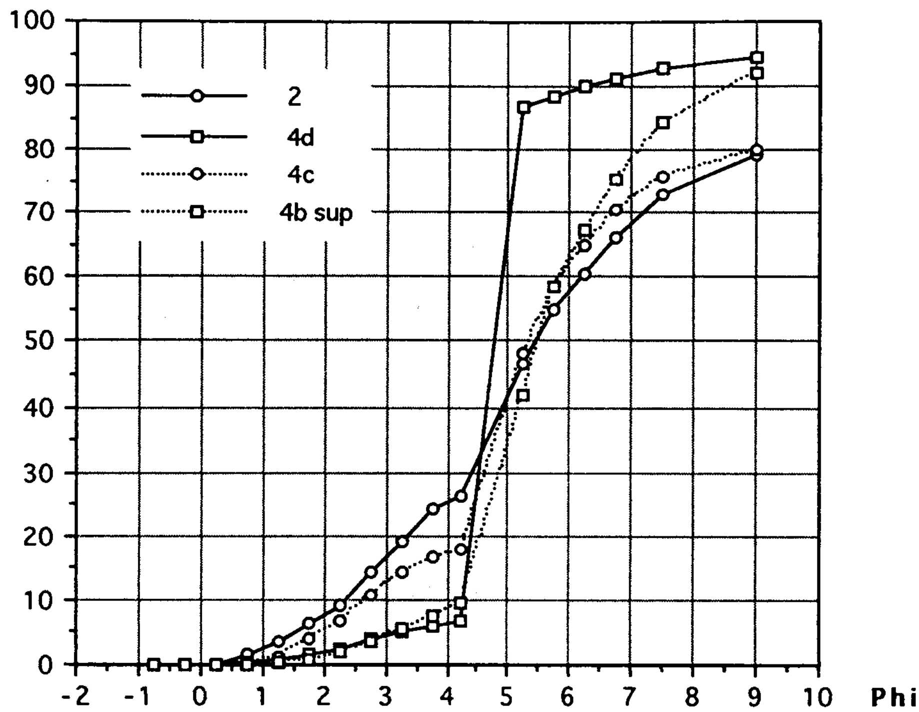


Fig. 3.2a et 3.2b : Courbes granulométriques cumulatives des sédiments du Trou Magrite.

du fait de leur très faible degré de classement. Ces deux échantillons évoquent chaque fois un sédiment hétérogène largement remanié, assurément mis en place par ruissellement, dans un contexte climatique nettement humide. Compte tenu de la position de la coupe par rapport à l'entrée de la grotte, il est probable qu'il s'agisse d'apports ayant transité par le réseau karstique; c'est le cas en particulier de la Couche 5, dans la mesure où celle-ci surmonte la Couche 6, à laquelle correspond à un dépôt graveleux distinctement remanié en conduite forcée à partir de lambeaux de terrasses de la Lesse préservés plus haut sur le plateau.

Echantillons II, IV et V (Couches 4d et 4b)

Ces trois échantillons ont en commun des teneurs en sable et en argile inférieures à 10%, mais aussi un excellent degré de classement associé à une courbe uni-modale bien exprimée; de ce fait ils s'apparentent à des loess purs. En particulier, le faible taux d'argile évoque des apports extérieurs en provenance d'une source de sédiments meubles relativement proche (Balescu et Haesaerts 1984). En conséquence, on est en mesure de rapporter les sédiments des Couches 4d et 4b du Trou Magrite à une sédimentation éolienne extérieure au système karstique, sous climat froid et sec.

Echantillons III, VI, VII et VIII (Couches 4c et 4a)

Les sédiments provenant de ces deux couches se caractérisent par des teneurs en argile voisines de 20% et par des teneurs en sable comprises entre 8 et 20%; l'ensemble de ces échantillons présente un degré de classement intermédiaire entre les loess purs et les limons colluviés. C'est le cas en particulier de la Couche 4c, dont la forte teneur en sable et le caractère nettement bi-modal de la courbe cumulative impliquent une origine mixte, associant une sédimentation loessique et un remaniement par ruissellement. Par ailleurs, la Couche 4a dans son ensemble, par sa teneur croissante en fraction grossière, évoque un même processus sédimentaire et rejoint de ce fait la Couche 5 dont la composition granulométrique implique assurément une origine mixte comparable. Le contexte climatique de ce type de dépôts n'est guère aisé à préciser; tout au plus peut-on supposer un environnement relativement humide, comme l'indique la part prise par le ruissellement dans le processus sédimentaire.

INTERPRETATION DES DONNEES

Comme nous l'avons souligné précédemment, l'interprétation paléoclimatique et chronostratigraphique des dépôts préservés dans la tranchée C au Trou Magrite est extrêmement aléatoire, car ceux-ci n'enregistrent que des événements sédimentaires discontinus et de courte durée, séparés par des hiatus dont la position et l'importance échappent le plus souvent. Néanmoins les quelques éléments dont on dispose ici peuvent cependant être situés, en première approximation, par rapport à la séquence du Pléistocène supérieur de nos régions, compte tenu des données fournies par la paléontologie, l'archéologie et les datations C14.

Ainsi, les sables et cailloutis présents dans la partie inférieure de la tranchée C (Couche 6) occupent-ils une position comparable à celle des dépôts graveleux de la base de la séquence sédimentaire de la Grotte Scladina à Sclayn (30 km au nord du Trou Magrite) attribués au début de l'Eemien (sous-stade isotopique 5e) en raison de leur contenu pollinique (Haesaerts 1992; Bastin 1992). Comme c'est le cas à Sclayn, il s'agit également ici d'apports ayant transité par le réseau karstique, issus des lambeaux de terrasses anciennes de la Lesse préservés plus haut sur le plateau.

Quant aux limons hétérogènes de la Couche 5, ils sont distinctement associés à une phase de sédimentation par ruissellement; ils représentent un épisode climatique relativement humide que la microfaune permet de rapporter à l'épisode froid de Melisey II (stade isotopique 5b) de la séquence de la Grande Pile par comparaison avec Sclayn (J-M. Cordy, ce volume).

Les Couches 4a à 4d enregistrent une transition vers une sédimentation progressivement plus homogène, devenant nettement loessique dans la partie supérieure (Couches 4b et 4d); elles pourraient de ce fait correspondre au début du Pléniglaciaire inférieur (stade isotopique 4). La présence d'un premier dépôt de blocs cryoclastiques au sommet de la Couche 4d est également en accord avec cette interprétation.

La discordance géométrique qui se marque à la base des Couches 2 et 3 traduit probablement un hiatus de temps relativement important; de fait, les dépôts cryoclastiques qui constituent l'essentiel de ces deux couches peuvent être rapportés à des épisodes froids et sans doute relativement humides de l'Interpléniglaciaire, comme l'indiquent leur contenu archéologique et les datations C14 les plus anciennes. La présence d'un petit horizon humifère à la base de la Couche 3 et la nature plus hétérogène de la matrice fine de la Couche 2 sont également en accord avec le caractère contrasté du climat de cette longue période correspondant au stade isotopique 3 (Haesaerts 1984).

REFERENCES

BALESCU S. and HAESAERTS P., 1984,
The Sangatte raised beach and the age of the opening of the Strait of Dover. *Geologie en Mijnbouw*, 16, p. 355-362.

BASTIN B., 1992,
Analyses polliniques des sédiments détritiques, des coprolithes et des concertions du site préhistorique de la grotte Scladina. In *Recherches aux Grottes de Sclayn*, vol.1, M. Otte (éd.), ERAUL 27, Liège, pp. 59-77.

HAESAERTS P., 1984,
Aspects de l'évolution du paysage et de l'environnement en Belgique au Quaternaire. In *Peuples Chasseurs de la Belgique préhistorique dans leur cadre naturel*, D. Cahen et P. Haesaerts (éds.), Institut Royal des Sciences Naturelles de Belgique, Bruxelles, pp. 27-39.

HAESAERTS P., 1992,
Les dépôts Pléistocènes de la terrasse de la Grotte Scladina à Sclayn. In *Recherches aux Grottes de Sclayn*, vol.1, M. Otte (éd.), ERAUL 27, pp. 33-55.

OTTE M., STRAUS L.G., LEOTARD J.-M., GAUTIER A. et HAESAERTS P., 1991,
Fouilles dans le Paléolithique moyen et supérieur de Belgique méridionale. Rapport 1991. *Notae Praehistoricae*, 11, p. 3-28.

M. OTTE et L.G. STRAUS (dir.), *Le Trou Magrite. Fouilles 1991-1992.* Liège, E.R.A.U.L. 69, 1995.

4

ARCHEOLOGICAL DESCRIPTION OF THE STRATA

Lawrence Guy STRAUS

The nature and composition of the cultural remains of each stratum are described individually in this section. Included here is discussion of the preservation, context, distribution and classification of the artifacts within the distinctive stratigraphic units. Later sections provide discussions of lithic raw materials, inter-strata comparisons and aspects of technological operatory systems/reduction sequences (*chaînes operatoires*). Detailed statistical comparisons and three dimensional spatial analyses, as well as faunal analyses, are provided in separate chapters (see Miller and Mishoe, Martinez, Gautier, Cordy, this volume).

STRATUM 1

Stratum 1 as noted above, contains a mixture of modern, submodern and Paleolithic artifacts and faunal remains. It is the product of erosion and scattering of backdirt from "generations" of excavation and looting in the cave, as well as humus and incipient topsoil formation. Possible testimony to the existence of the now totally destroyed Gravettian or Magdalenian deposit is the discovery of a mesial fragment of a narrow backed blade that could have been a Gravette point (Figure 4.1). Such pieces are absent from Strata 2 and 3.

STRATUM 1.1

Stratum 1.1 is a large pit feature as described above and probably relates somehow to the Iron Age and Mesolithic materials apparently found by Toussaint just to the east of our Trench C (Figures 2.12 & 2.15). This pit is apparently intrusive into Aurignacian Stratum 2 and bottoms out on Stratum 3. It probably had also cut through overlying later Paleolithic levels, although we do not specifically know that the Gravettian and Magdalenian deposits had originally extended this far forward toward the top of the talus in front of the cave. Maximum extant depth in the J9/10 section is 55 cm. The pit fill is distinguished by a fine, powdery, brown silt and a number of medium-size limestone blocks. Actual age, original size and function of this large feature are

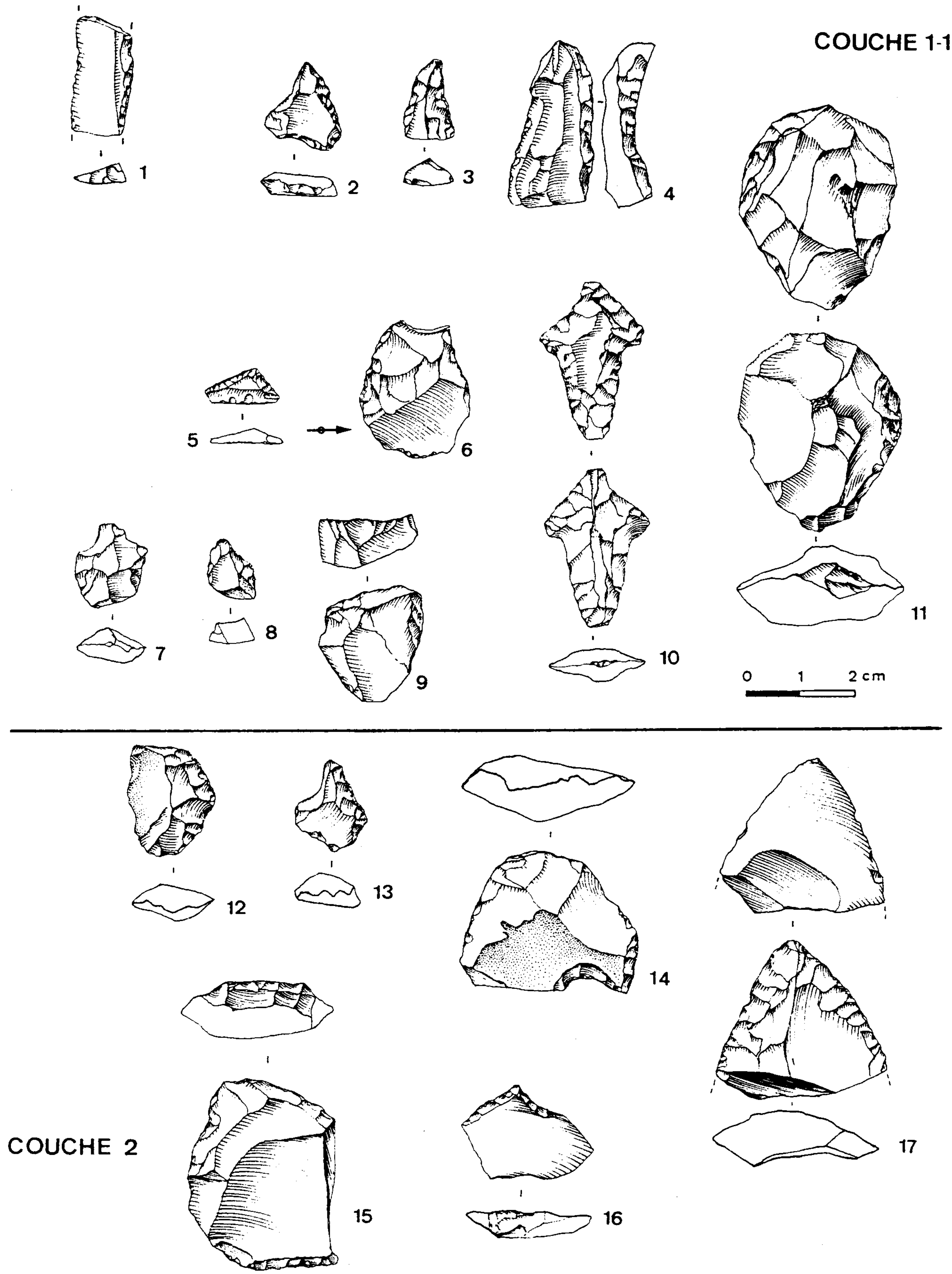


Figure 4.1. 1-11 : stratum 1.1; 12-17 : stratum 2 (for details, see captions after References).

unclear, although use as an *in situ* combustion structure can apparently be ruled out. No modern or submodern objects were found in the Stratum 1.1 pit, so it probably does not represent a recent excavation. This conclusion is supported by the fact that it is overlain by Stratum 1 humus and backdirt. Given the absence of Mesolithic, Neolithic and Iron Age materials elsewhere in the Trench C area, it would seem likely that the pit is of early-mid Holocene age. The fact that the pit seems to have cut through an intact Mesolithic level (represented by the Stratum 1.3 remnant deposit), suggests that the pit's inception dates to at least the Neolithic, but probably later. There are areas of recent excavation to the north and east of the Stratum 1.1 pit, the latter possibly the edge of Toussaint's sondage.

Archeological contents of the Stratum 1.1 pit are clearly mixed. They include a Neolithic arrowhead (plus another similar piece from Stratum 1 sediments nearby) (Figure 4.1 : 2-11), a geometric triangle, Mesolithic-type perforator-bec, another perforator similar to ones of Magdalenian age at nearby Chaleux, a small bifacial ("mini-Levallois") flint core, vitrified slag, bits of brick (or other fired clay), and a few sherds of Iron Age and even possible Medieval date from contexts that could be either Stratum 1 or 1.1 (identifications by E.Teheux). Altogether there are 13 lithic tools from Stratum 1.1 (Table 4.1). (As noted above, the small remnant of Stratum 1.3, through which the 1.1 pit was cut, yielded 3 tools of apparent Mesolithic age.) In Stratum 1.1, 71 items of debitage were also recovered mainly flakes, plus a few blades and bladelets and several chunks (Table 4.2). The pit fill also included teeth of boar or domesticated pig, wolf and possible hyena, and remains of sheep/goat, ibex and possible horse clearly a mixed fauna (see Gautier, this volume).

STRATUM 2: ARCHEOLOGICAL CONTEXT

Stratum 2 is archeologically and paleontologically the richest level in the Trench C area of le Trou Magrite. Despite the facts that it had apparently been cut into during the promenade construction of the 1830's and that much of it was shielded from the modern surface by only a thin mantle of recent humus and backdirt from generations of diggings in the cave mouth, Stratum 2 and its contents are remarkably intact and uncontaminated. Human occupation residues (including possible remnants of living surfaces) dating from 30-27,000 years ago have been lying undisturbed and apparently in place within a few centimeters of a surface that had been walked on and in an area adjacent to zones of massive excavation and disturbance during a period of more than a century.

There are several cases in point of the remarkable preservation of Stratum 2, despite proximity to the base of the 1830's promenade leveling and considerable subsequent disturbance. In G6 a virtually complete reindeer maxilla (5 teeth and parts of the alveolus) was found in Stratum 2 gravels only a few centimeters below the duff, humus and backdirt of Stratum 1 near the eastern cave mouth wall. In I6A, within partially loose, partially cemented Stratum 2 gravels, 7 incisor teeth of a juvenile cervid were found next to one another (5 of which were still lined up in anatomical position, although the alveolar bone had disintegrated at some time after deposition). In I6C+D several large cervid molars

TABLE 4.1 :
TROU MAGRITE (1991-1992)
UPPER PALEOLITHIC TOOLS

Strata

	1.1		2			3			4	
TYPE	No.	%	No.	%	cum. %	No.	%	cum. %	No.	%
1	1	7.7	1	0.8	0.8	1	0.8	0.8		
2			4	3.3	4.1	3	2.5	3.3		
3						2	1.7	5.0		
4						2	1.7	6.7		
5			4	3.3	7.4	6	5.0	11.7		
6			1	0.8	8.2					
8	(1)		14	11.5	19.7	4	3.4	15.1		
10	(1)		2	1.6	21.3	1	0.8	15.9		
12			1	0.8	22.1	7	5.9	21.8		
13			1	0.8	22.9	1	0.8	22.6		
14						2	1.7	24.3		
18			2	1.6	24.5					
19						2	1.7	26.0		
21			1	0.8	25.3					
23	2	15.4								
24			1	0.8	26.1	2	1.7	27.7		
25	1	7.7	1	0.8	26.9					
26	(1)		2	1.6	28.5	1	0.8	28.5		
27						1	0.8		1	20.0
30			1	0.8	29.3	3	2.5	31.8		
31						1	0.8	32.6		
44									1	20.20
58						1	0.8	33.4		
62						1	0.8	34.2		
65	1	7.7	26	21.3	50.6	21	17.6	51.8	2	40.0
66			9	7.4	58.0	5	4.2	56.0		
67			2	1.6	59.6					
69			2	1.6	61.2					
70						1	0.8	56.8		
74	3	23.1	17	13.9	75.1	32	26.9	83.7	1	20.0
75	2	15.4	14	11.5	86.6	12	10.1	93.8		
76						1	0.8	94.6		
77			15	12.3	98.9	4	3.4	98.0		
78	1	7.7				2	1.7	99.7		
79	1	7.7								
90			1	0.8	99.7					
92	1	7.7								
			2							
TOTAL	13	100.0	122	100.0		119	100.0		5	100.0
SAGAIE			2							

N.B. Numbers in () are from stratum 1.3

UPPER PALEOLITHIC TOOL TYPES

1	Single endscraper
2	Atypical endscraper
3	Double endscraper
4	Ogival endscraper
5	Endscraper on retouched flake/blade
6	Endscraper on Aurignacian blade
8	Endscraper on flake
10	Unguiform endscraper
12	Atypical carinated endscraper
13	Thick nosed endscraper
14	Flat nosed/shouldered endscraper
17	Endscraper-burin
18	Endscraper-truncated piece
19	Burin-truncated piece
21	Perçoir-endscraper
23	Perçoir
24	Bec
25	Multiple perçoir/bec
26	Microperçoir
27	Straight dihedral burin
30	Angle on break burin
31	Multiple dihedral burin
35	Burin on oblique retouched truncation
44	Plan burin
48	Gravette point
58	Completely backed blade
62	Concave truncated piece
65	Piece with continuous retouch -1 edge
66	Piece with continuous retouch -2 edges
67	Aurignacian blade
69	Solutrean type pices
74	Notch
75	Denticulate
76	Splintered piece
77	Sidescraper
78	Raclette
79	Triangle
90	Retouched (Dufour) bladelet
92	Other

TABLE 4.2
TROU MAGRITE LITHIC DEBRIS (1992)

Strata

	1.1		2		3		4		5	
TYPE	No.	%	No.	%	No.	%	No.	%	No.	%
1	17	23.9	1042	20.0	564	21.6	18	12.8	5	4.5
22			11	0.2	1	0	1	0.7	1	0.9
2	4	5.6	649	12.5	117	4.5	7	5.0	1	0.9
23			4	0.1	1	0				
3	24	33.8	2413	46.4	1489	56.9	70	49.6	49	44.5
4	1	1.4	49	0.9	21	0.8	2	1.4	3	2.7
5	2	2.8	115	2.2	46	1.8			9	8.2
6	3	4.2	159	3.1	73	2.8	7	5.0	7	6.4
24	3	4.2	223	4.3	63	2.4	5	3.5		
7	1	1.4	13	0.2					1	0.9
8	1	1.4	20	0.4	3	0.1				
27	1	1.4	4	0.1	8	0.3	1	0.7		
9	2	2.8	76	1.5	58	2.2	1	0.7	2	1.8
25	2	2.8	63	1.2	8	0.3				
28			4	0.1						
29			2	0	2	0.1				
10	1	1.4	6	0.1	2	0.1				
11										
12			2	0	1	0				
13	2	2.8	10	0.2	8	0.3	1	0.7	4	3.6
14			1	0						
15										
16										
17			1	0						
18			18	0.3	1	0			1	0.9
19	7	9.9	273	5.2	115	4.4	25	17.7	21	19.1
20			31	0.6	17	0.7	1	0.7	5	4.5
21			15	0.3	16	0.6	1	0.7	1	0.9
							1	0.7		
Total	71	100.0	5204	100.0	2614	100.0	141	100.0	110	100.0

LITHIC DEBRIS TYPES

1	Non-cortical Trimming Flake	≤ 1 cm w/Hertzian morphology w/o cortex
22	Cortical Trimming Flake	w/some cortex on dorsal surface
2	Non-Cortical Shatter (small angular debris)	≤ 1 cm w/o Hertzian morphology w/o cortex
23	Cortical Shatter	w/some cortex
3	Plain Flake	> 1 cm, no cortex
4	Primary Decortication Flake	cortex covers dorsal surface
5	Secondary Decortication Flake	some dorsal cortex
6	Whole or Proximal Plain Blade	> 2 cm twice as long as wide - whole or proximal fragment (w/definite butt), no cortex
24	Broken Plain Blade	w/o cortex-mesial or distal fragment
7	Whole or Proximal Primary Decortication Blade	L≥ 2 x W & L> 2 cm, cortex covers dorsal surface
8	Whole or Proximal Secondary Decortication Blade	L≥ 2 x W & L> 2 cm, some dorsal cortex
27	Medial/Distal Cortical Blade	like #24, but w/some cortex
9	Whole or Proximal Plain Bladelet	≤ 2 cm long, narrow, & thin - whole or proximal fragment, w/o cortex
25	Broken Plain Bladelet	like #9, but w/o cortex - mesial or distal fragment
28	Medial/Distal Cortical Bladelet	w/some cortex

29	Whole/Proximal Cortical Bladelet	like #9, but w/some cortex
10	Burin Spall	tri - or quadrangular section, thick
11	Unidirectional Crested Blade	crest formed by flake scars perpendicular to blade axis in both directions
12	Bidirectional Crested Blade	ditto-but in only one direction
13	Flake Core	core with only flake removals
14	Prismatic Blade Core	cylindrical core with only blade removals
15	Pyramidal Blade Core	pyramidal core with only blade removals
16	Prismatic Bladelet Core	cylindrical core with only bladelet removals
17	Pyramidal Bladelet Core	pyramidal core with only bladelet removals
18	Mixed Core	both flake and blade/bladelet removals
19	Non-cortical Chunk (large angular debris)	> 1 cm, w/o flake morph., (ie. no bulbs) includes core remnants & fragments of exhausted cores, w/o cortex
26	Cortical Chunk	like # 19, but w/some cortex
20	Platform Renewal Flake	has lip of platform, nibbling-core preparation
21	Pièce Esquillée (splintered)	bipolar flake or core remnant

and premolars were found together in anatomical order with bits of mandibular bone under and next to them. In this same area (I-J6), where cultural and faunal remains were distributed particularly densely on distinct ancient land surfaces, there were several limestone blade fragments, two of which (from I6) refitted (despite rock surface erosion) and others of which almost conjoined. Square I5 produced two plain flakes that were also refitted by A.Martinez.

Although Stratum 2 faunal elements are dominated by denser, more durable teeth and bones and the proportion of bones too fragmented to be identifiable is very high, there are some relatively fragile bones that are preserved (rib, pelvis), again testifying to the intact state of Stratum 2. (Among the faunal remains in the dense clusters of I6 is a relatively fragile mammoth molar enamel plate.) There is a total of 6,833 mammal remains, 206 of which are identifiable (3%). Total bone weight is 6,934 gm., for an average weight of 1.0 gm., showing that most of the faunal remains are small bone splinters resultant probably from both human processing and geological crushing. The ratio of lithic artifact (108,980 gm.) to faunal weight is a high 15.7 to 1, probably testimony to the length and intensity of human occupation/ activity at le Trou Magrite at this time, despite the relatively good faunal preservation. Cut marks (11 bones) and burning traces (16 bones) are relatively frequent, although there are also 28 carnivore-gnawed bones. Cave bear, badger, wolf and especially two species of fox are present in Stratum 2.

Artifacts in square I6 and elsewhere in Stratum 2 consistently have calcium carbonate crust <u>on the bottom only</u>, indicating that the pieces have been lying undisturbed at least since the time of CaCO3 precipitation. As noted earlier, this precipitation affected the base of Stratum 2/top of Stratum 3 at the northern edge of Trench C, and created a "flowstone" deposit that generally slopes down away from the cave and cliff toward the talus, permeating even areas of Stratum 4 especially in the western sector of the excavation zone.

Despite the existence of distinct lenses of well-preserved materials within the gravels of Stratum 2, not only in I-J6 but also elsewhere throughout much of Trench C, we did not detect any traces of features (pits, hearths, postholes, etc.). However this may be due to the relatively small and peripheral area of the once large site that we excavated, particularly, since at the time of Stratum 2 deposition, most of the Trench C area would have been in front of the dripline and exposed to the elements (as it is today). The area concerned may have been one of activities requiring open space (butchering, tool manufacture), but it may also often have been simply a dumping zone for the disposal of bulky or noxious waste (notably animal carcass parts) from the more intensive activity areas in the covered cave entrance and interior.

CHRONOSTRATIGRAPHIC POSITION

The cryoclastic nature of the Stratum 2 eboulis suggests that the deposit was formed under freeze-thaw conditions, implying cold and some degree of humidity certainly much colder, but also somewhat drier than during the times of formation of Strata 4 and 5 (see Haesaerts, this volume). The fauna of Stratum 2 also imply the existence of cold and not very humid climatic conditions, with open, arctic steppe/tundra vegetation (arctic fox, mammoth, woolly rhino, horse, ibex and dominant reindeer absence of red or roe deer). However the modest presence of boar (8 remains) suggests that conditions were not too extreme and that there were at least local gallery thickets along the Lesse and the southfacing side of its valley, despite the overall rigor of conditions at 50 degrees North latitude during Stratum 2 times (see Gautier, this volume).

The presence of Upper Paleolithic types of blades and tools (notably types attributable to the Aurignacian techno-complex) suggests that Stratum 2 should lie in the late part of oxygen isotope stage 3, toward the end of the Würm Interpleniglacial.

Five radiocarbon dates are available from Stratum 2 (Table 4.3). Together with the dates from Stratum 3, the 3 bone gelatin dates give a credible (albeit less than optimally precise) estimate of the age of Aurignacian occupations of le Trou Magrite. For Stratum 2, the accelerator date of 17.9 kya was done on many small flecks of charcoal and must be contaminated with bits that had percolated from above including perhaps some from the now absent Gravettian, Magdalenian and even Mesolithic levels. This would be easy to understand given the coarse, open nature of the Stratum 2 gravel deposit and the fact that the aggregate sample came from the upper part of the level. All the conventional bone dates were done on pooled unidentifiable bone splinters from individual or adjacent squares and spits. The date of 22.7 kya is on bone apatite, generally considered an unreliable fraction for dating. The total bone gelatin from the same sample yielded a date of 26.6 kya which, given the large standard deviation of 1.3 ky, would seem to be a reasonable end date for Aurignacian occupation of le Trou Magrite. Total bone gelatin dates of 30.1 and 34.2 kya from the lower part of Stratum 2 which, with their large standard deviations, could well imply an age of around 32 kya and confirm a conclusion that this deposit was probably formed between about 32/34-28 kya. Given the thickness of the deposit and its chronometric age range, Stratum 2 clearly represents a significant palimpsest of many human occupations, as well as a lengthy period of meteorization of the cave roof.

The Stratum 2 dates are very similar to two conventional dates from the upper of two Aurignacian levels (B) at the site of le Trou Walou in eastern Belgium, currently under excavation by M.Dewez. These dates are 29.8+0.8 and 29.5+0.6 kya (Lv-1587 and 1592)(Dewez 1989). Chronologically Trou Magrite Stratum 2 immediately precedes the Gravettian occupations at the major open-air localities of Maisières-Canal near Mons (some 70 km. to the west-northwest) and Huccorgne near Huy (45 km. to the northeast). Although there are several dates from Maisières, with some incoherence among them, the archeological horizon is generally thought to be best dated by a determination of 28 kya (GrN-5523)(Haesaerts and Heinzelin 1979; Dewez 1989). The Gravettian of Huccorgne is now dated by several determinations ranging from 28-23 kya (Noiret, Otte, Straus *et al.* 1994). Stratum 2 at le Trou Magrite thus seems to mark the end of the Aurignacian techno-complex and the development of the artifacts (especially the

TABLE 4.3 :

RADIOCARBON DATES FROM LE TROU MAGRITE

Stratum	Material Dated	Method	Lab No.	Date BP	± 1 SD	Range @ 2 SD
2 top	charcoal	AMS	OxA-4040	17,900	200	18,300-17,500
2	bone apatite	Conv	GX-17017A	22,700	1150	25,000-20,400
2	bone gelatin	Conv	GX-17017G	26,580	1310	29,200-23960
2 base	bone gelatin	Conv	GX-18538G	30,100	2200	34,500-25,700
2 base	bone gelatin	Conv	GX-18537G	34,225	1925	38,075-30,375
3	bone gelatin	Conv	GX-18540G	27,900	3400	34,700-21,100
3	bone gelatin	Conv	GX-18539G	>33,800	-	-
3 mid	aspartic acid*	AMS	CAMS-10352	41,300	1690	44,680-37,920
4a	aspartic acid*	AMS	CAMS-10358	30,890	660	32,210-29,570
4a	aspartic acid*	AMS	CAMS-10362	21,550	190	21,930-21,170
5	aspartic acid*	AMS	CAMS-10356	12,450	250	12,950-11,950

T. Stafford observations on protein preservation in CAMS samples :

+ : very well preserved bone : % Nitrogen = 1.74;
protein preserved almost like modern protein;

* : very poorly preserved bone : protein leached out.

lithic weapon tips) characteristic of the Gravettian techno-complex in this part of Europe.

THE ARTIFACT ASSEMBLAGES

Stratum 2 yielded 5204 items of knapping debris: 30 cores, 304 chunks and 4870 flakes, blades and bladelets of various kinds (Table 4.2). It also produced 122 retouched tools classified within the standard typology of D.de Sonneville-Bordes and J. Perrot (Table 4.1) and two fragments of different antler sagaies.

The ratio of debris to tools is a fairly high 42.7 to 1. The lithic tool assemblage is dominated by non-local, good- quality flint (69% by count, 44% by weight), with a minority of tools being made on hard local limestone (22% by count, 48% by weight). In contrast, the knapping debris (cores plus debitage) has proportionally less imported flint (59% by count, 11% by weight) and more limestone (33% by count, 86% by weight)(see Chapter 5 Appendix for ad hoc descriptions of lithic types).

Fully 33% of the Stratum 2 debris are small (<1 cm.) trimming flakes (chips) and pieces of shatter (small angular debris), i.e., microdebitage. Another 50% are regular flakes (plain and cortical). Regular blades and bladelets make up only 11% of the total (bladelets=3%). Cores per se make up only slightly more than 0.5%, while chunks (large angular debris that may be fragments of cores or exhausted cores in some cases) equal slightly less than 6% of the knapping debris total. In addition there are 2 bidirectional crested blades and 15 platform renewal flakes, together accounting for only slightly more than 0.3%.

Debitage with any cortex makes up only 4.3% of the total debris. However, nearly 15% of the tool blanks have cortex, suggesting great economization of hard-to-obtain flint which was favored and imported for tool manufacture. The ratio of large debitage (excluding trimming flakes and shatter) to cores+chunks is 9.5:1. Among the cores there are only one pure blade and pure bladelet core each, but mixed cores (with scars from the removal of flakes and blade[let]s) outnumber plain flake cores by 1.8 to 1. The abundance of microdebitage implies the existence of in situ knapping.

It would seem that all phases of lithic reduction took place at le Trou Magrite during Stratum 2 times, however primary decortication was a relatively unusual activity (at least at the front of the terrace). Much of the non-local flint, in particular, may have been imported to the cave in the form of cores that had often already been decorticated elsewhere (namely at quarry source locations) and especially blanks (blades, large flakes). In reality, however, there are very few (3) cores on clearly non-local flint; most cores are limestone or a black flint that may be of a sort found within the limestone around the cave. So the imported flint essentially seems to have reached le Trou Magrite in the form of mainly decorticated flakes and blades.

Blade technology, while definitely present and well developed, is relatively simple in execution and modestly represented in quantitative terms in Stratum 2. Among the formal, retouched tools, 24% are made on blades, 71% are on flakes and 5% are on chunks.

There are 122 stone tools from Stratum 2 made on 110 blanks; that is to say, there are a dozen tools with multiple retouched edges not accounted for by the composite types listed in the de Sonneville-Bordes/Perrot typology (Figures 4.1-4.2-4.3-4.4).

Nearly one quarter (23%) of the tools are endscrapers notably 14 classified as endscrapers on flakes (plus other types also on flake blanks). There is one thick nosed and atypical keeled endscraper each and one endscraper on an Aurignacian scalariform retouched blade. There is also one Dufour bladelet and among the numerous continuously retouched pieces (29.3%), there are 2 with scalariform, "Aurignacian" retouch. The four perforators equate to 3.2% of the tool assemblage. There is only one burin, an angle burin on a break (0.8%). Yet there are 6 burin spalls. Stratum 2 (like Stratum 3 and many other Belgian assemblages of this age) has fragments of foliate (leaf) points, in this case 2 unifacial points. The rest of the assemblage is rather "Mousterian" in composition: 17 notches and 14 denticulates (25.4%) and 15 sidescrapers (12.3%). There are no backed knives, blades or bladelets, and no truncation burins.

Stratum 2 also yielded two sagaie fragments. One is a mesial segment of a subcircular cross-section point made of antler. The other is a double-bevel (chisel-point) tip fragment (probably basal) of subquadrangular cross-section, either antler or bone. The latter piece is heavily polished; one face is slightly grooved. Neither sagaie fragment has any decoration (other than polishing striae). These are the only organic artifacts from the stratum and, indeed, from the Trench C excavation of 1991-92.

Although classic Aurignacian fossil directors are scarce, Gravettian ones are totally absent. Stratum 2 is assignable in a traditional sense to the Aurignacian on the basis of the presence of keeled and nosed endscraper types, a Dufour bladelet and scalariform retouched blades, and on the absence of backed pieces and truncation burins. This attribution is concordant with the radiocarbon dates centering on 32-30 kya.

STRATUM 3: ARCHEOLOGICAL CONTEXT

It was far more difficult to devine the existence of occupation surfaces in Stratum 3 than in overlying Stratum 2. A major part of the problem is the presence of large and medium size blocks within the cryoclastic composition of Stratum 3, together with the outcropping at this level of numerous huge boulders that had fallen from the cave roof during Stratum 4 times. The inhabitants of the cave entrance in Stratum 3 times encountered and dealt with a ground surface that was "structured" by these boulders. By Stratum 2 times these boulders had been covered over by small eboulis, sandy silt and anthropogenic

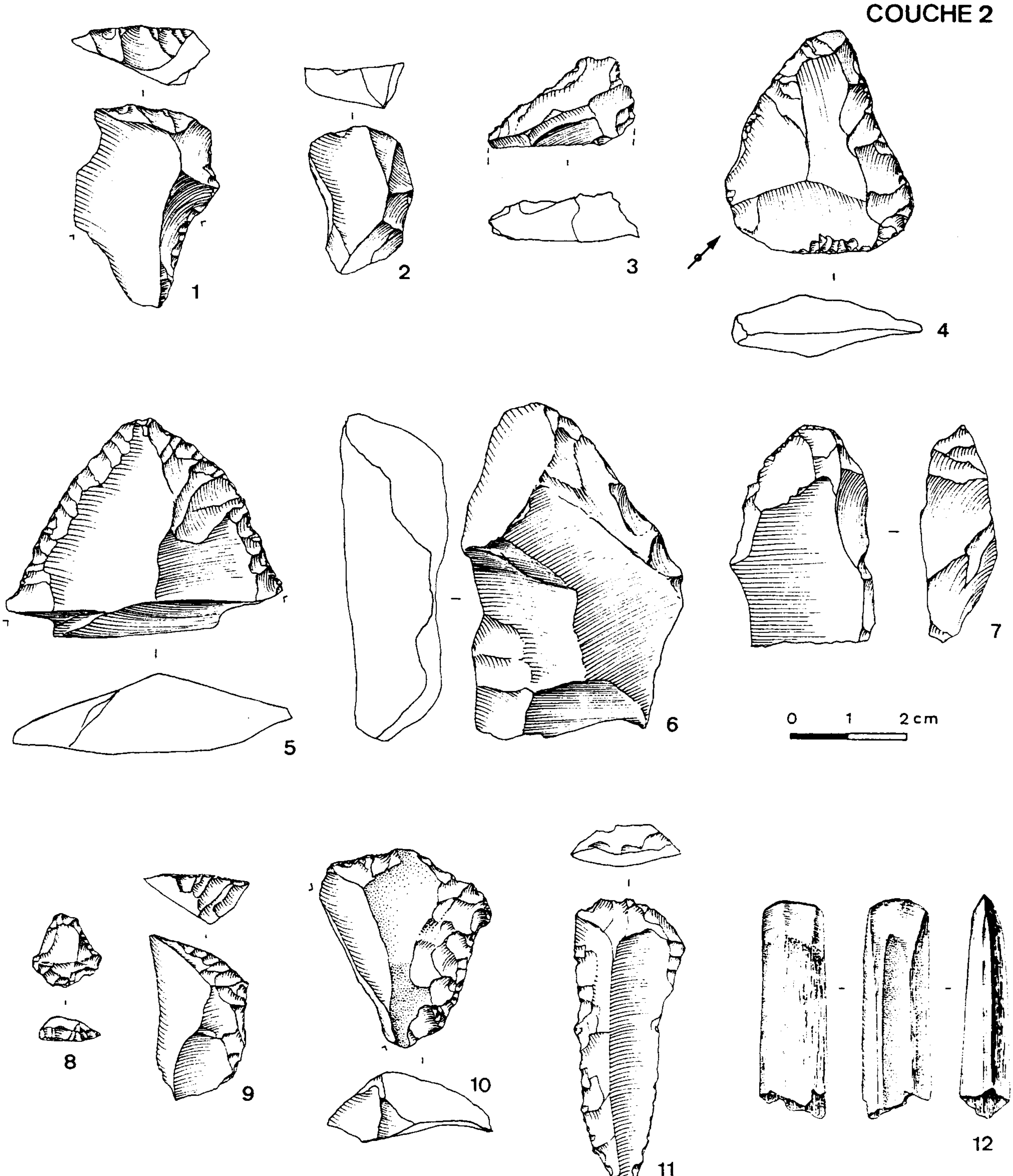


Figure 4.2. Stratum 2 (for details, see captions after References).

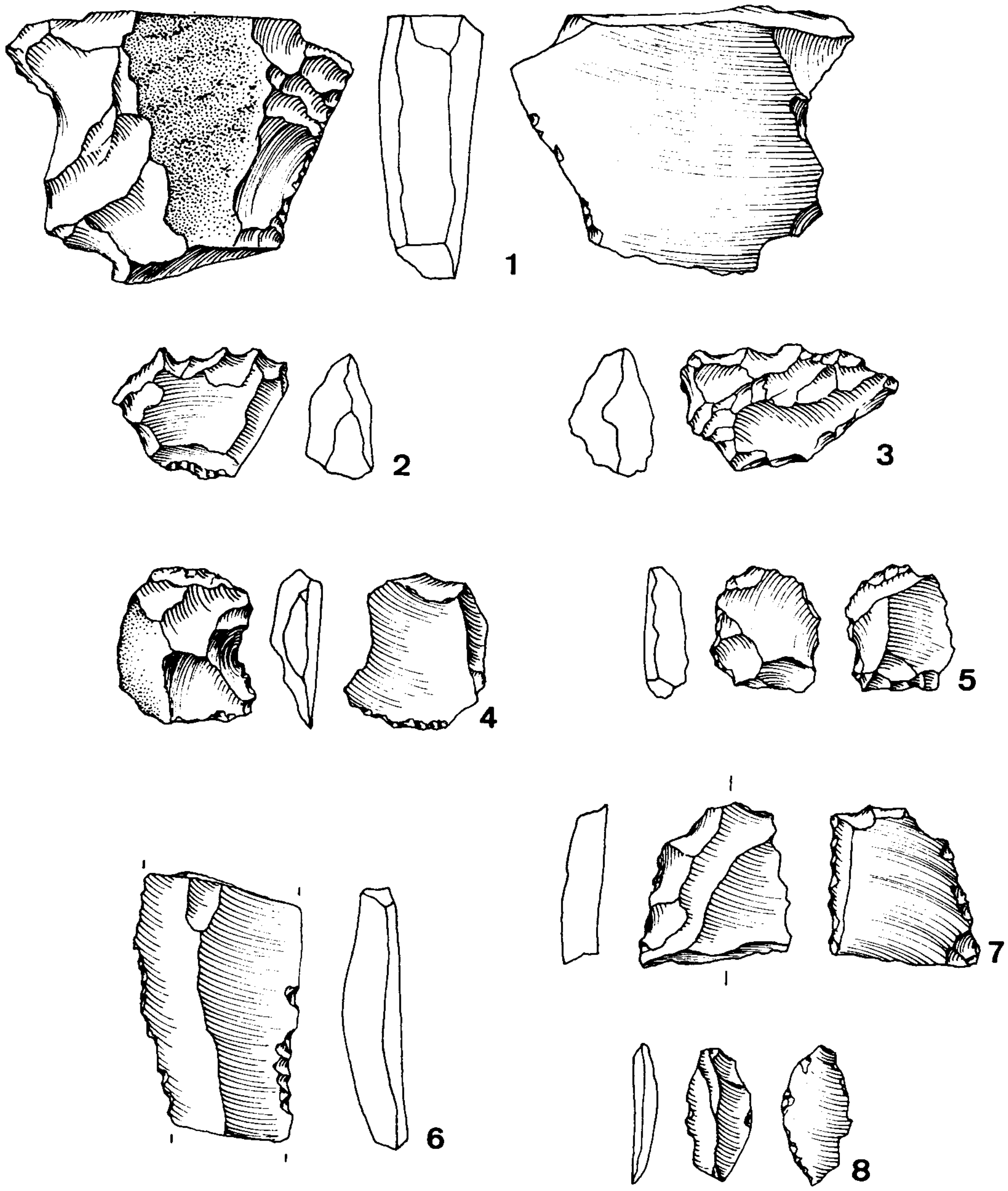


Figure 4.3(a). Stratum 2 (except 7 : stratum 5) (for details, see captions after References).

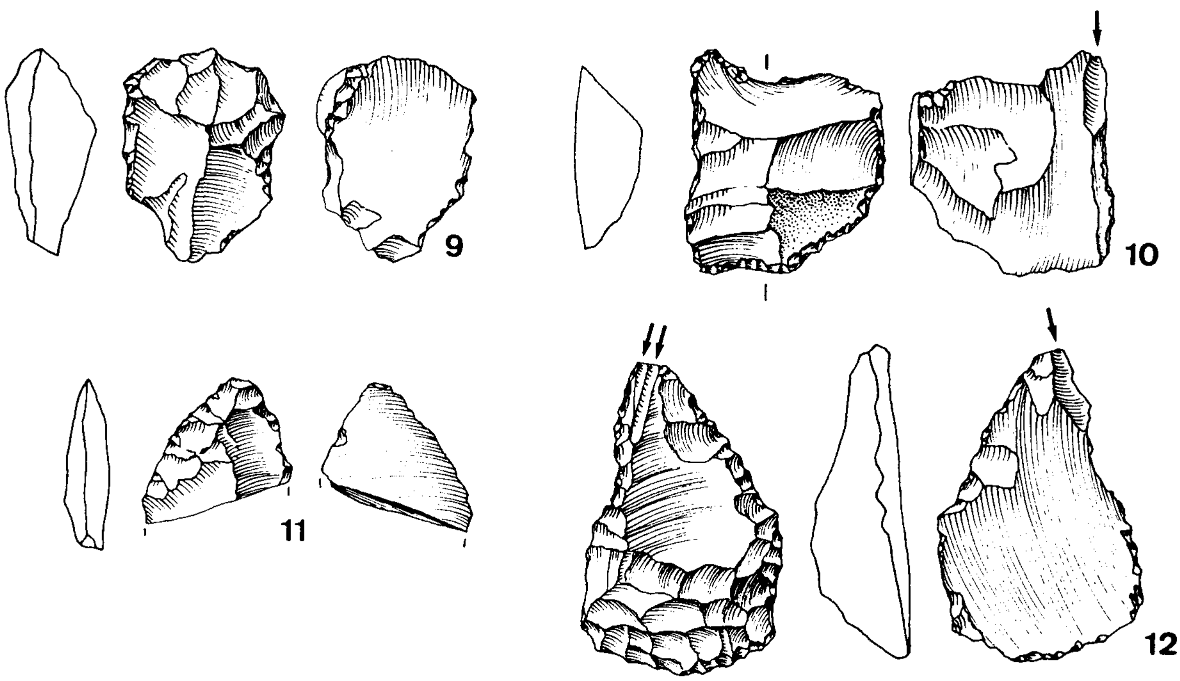


Figure 4.3(b). Stratum 2 (except 10 : stratum 2/3) (for details, see captions after References).

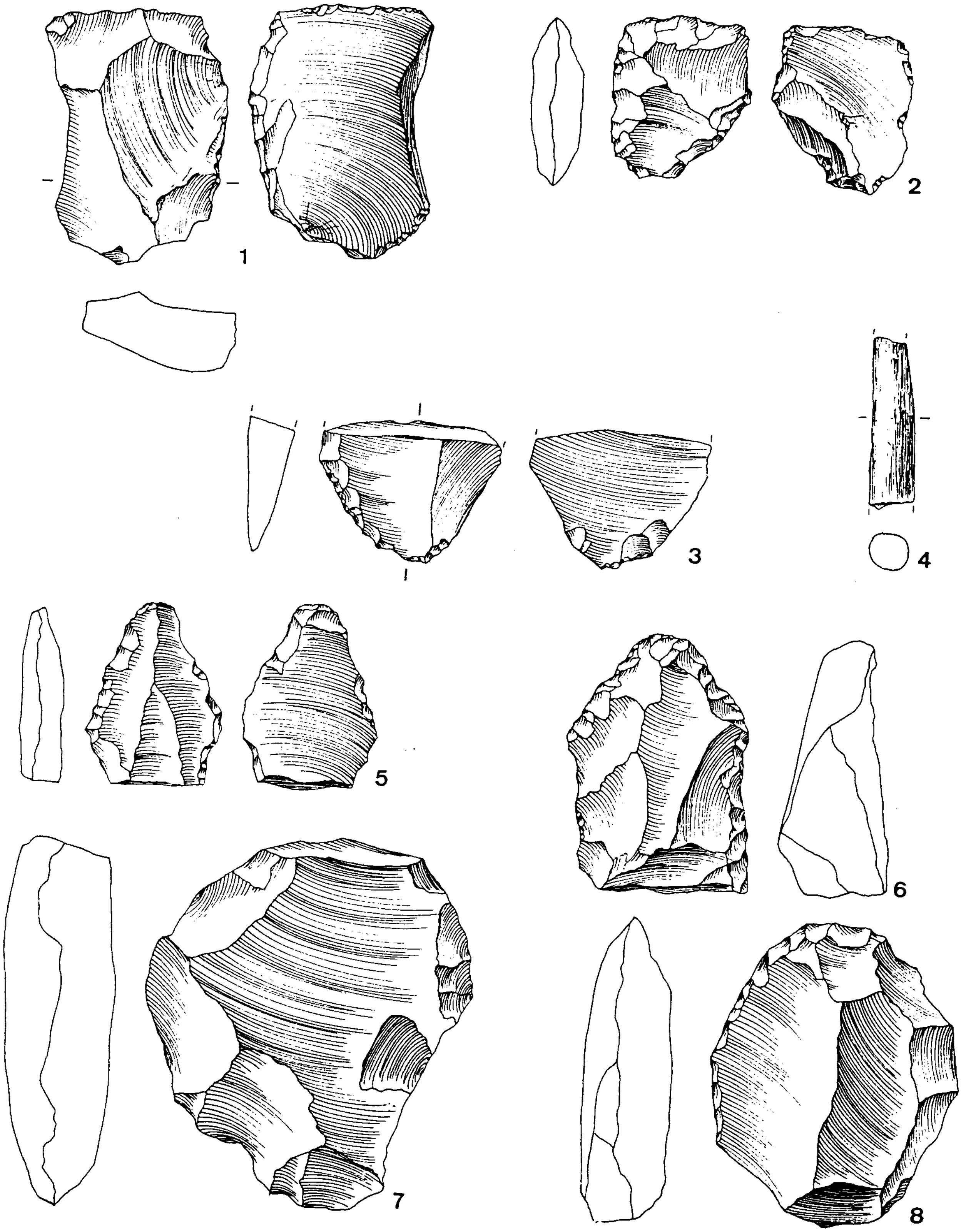


Figure 4.4. Stratum 2 (for details, see captions after References).

residues, leaving a more open, unobstructed surface for human use. The upshot of the block and boulder littered surface in Stratum 3 times was that cultural and faunal remains were per force concentrated in little clusters among the rocks. Although the area of Stratum 3 that we were able to excavate was virtually as large as that of Stratum 2 (i.e., ca. 20 sq.m.), much of the Stratum 3 area consisted of rocks, hence devoid of artifacts and bones. The patches of finds correspond largely to inter-block spaces and crevices. Although some of these patches may indeed correspond to the residues from activity areas, they are no doubt largely the product of structuring imposed by the blocks. And we excavated too small a proportion of the cave entrance area (though it was all that remained to be excavated) to see anthropogenic structuring (i.e., how people potentially made use of the boulders as natural partitions for redundant activity segregation) on a meaningful scale. There is one case of 4 horse teeth from the same jaw that were found together in square I4 evidence of at least local intactness.

Preservation of finds is similar in both Strata 2 and 3, including remarkably good faunal preservation despite the open nature of the eboulis and the shock of frequent rockfall. The ratio of lithic (53,871 gm.) to faunal (3,590 gm.) weight is 15.0 to 1, almost identical to that of Stratum 2 again indicative of heavy human activity at the site. Bones with burning traces (2) and cut marks (6) are relatively common, although 5 gnaw marked bones (plus the presence of a few fox and wolf remains) indicate a continued carnivore role between human occupations. Although the total number of identified faunal remains is less than half that of Stratum 2 (78 versus 206), the <u>percentage</u> of identified remains is the same (3%) in both strata (see Gautier, this volume). There are large quantities of well preserved but triturated bones (probably in part by human processing for marrow and fat extraction). With 2,834 faunal remains, the average weight for Stratum 3 is 1.27 gm. (The average weight for the 11 faunal remains from Stratum 2/3 is 1.6 gm.) The smaller amounts of faunal remains and of artifacts in Stratum 3 are possibly just reflections of the smaller volume of non-block sediments that we could excavate.

CHRONOSTRATIGRAPHIC POSITION

The environmental conditions promoting meteorization of the limestone overhand of the cave mouth must have been broadly similar during Strata 2 and 3 times, but with some differences that led both large blocks and small gravels to be produced during the latter. Conceivably the <u>alternation</u> of freeze and thaw conditions may have been more frequent during Stratum 2 times, causing the high degree of comminution that is seen among the Stratum 2 gravels. This is, however, speculative. In general, climatic conditions seem to have been relatively cold but not very dry. The fauna include marmot, woolly rhino and mammoth (only one remain each), dominant reindeer, followed by horse and ibex (plus solitary chamois and <u>Bos/Bison</u> remains). Again as in Stratum 2, boar is represented (two co-articulating bones), suggesting that it was humid and sheltered enough along the south-facing edge of the Lesse valley for there to be some wooded areas, despite the cold but fluctuating climate. An age late in oxygen isotope stage 3 was predicted on the basis of the early Upper Paleolithic typology of the stone tools recovered, despite a scarcity of blade technology (see below).

Three radiocarbon dates are available from Stratum 3 (Table 4.3). The total bone gelatin date of 27.9 kya is out of stratigraphic order with the acceptable dates from Stratum 2, but at plus one sigma a date of 31.3 kya is more reasonable and at plus two sigma, 34.7 kya would be completely in line with a basal Stratum 2 age on the order of 32-34 kya. This would seem to be confirmed by a second conventional determination on whole bone gelatin of greater than 33.8 kya for upper Stratum 3. A similar date (33.8+1.7 kya---Lv-1641) has recently been obtained for the lower Aurignacian level (A) at le Trou Walou, 70 km. to the northeast (Dewez 1989). However, middle Stratum 3 at le Trou Magrite yielded an AMS date of 41.3+1.7 kya on bone gelatin. This particular sample was extremely well preserved, with protein content nearly as great as that of modern bone (T.Stafford, personal communication). Chances of contamination seem slight, as the sample came from 20 cm. above the top of Stratum 4. Even at minus 2 standard deviations, this date would place mid Stratum 3 at around 38,000 radiocarbon years, making it one of the oldest Aurignacian deposits in western Europe, on a par with the recently run dates for the sites of El Castillo, L'Arbreda Reclau Viver, and Romani in northern Spain (see Straus 1994, with references).

ARTIFACT ASSEMBLAGES

Stratum 3 produced 119 stone tools (virtually the same number as Stratum 2), but only 2614 knapping debris (almost exactly half the amount as Stratum 2). The ratio of debris to tools is a low 22.0 to 1 (Tables 4.1 & 4.2). There are no osseous artifacts. The tools are made on non-local flints (43% by count, 25% by weight) and local limestones (39.5% by count, 55% by weight), with a number of pieces made on other non-local and local rocks, such as Brussels sandstone and poor-quality black flint respectively. In contrast, the knapping debris are made less on imported flints (31.5% by count, 6% by weight) and much more on locally available limestone (56% by count, 89% by weight) than the tools, demonstrating a clear selectivity for high-quality flint in tool-making. This is also reflected in the heavy use of even cortical flint blanks to make tools. As detailed in Table 4.2, 26% of the lithic debris are trimming flakes and shatter (i.e., chips that are smaller than 1 cm. and evidence of in situ knapping). Nearly 60% of the debris are flakes and only slightly more than 8% are blades (including 2.6% that are bladelets). There is only one crested blade. Cores are also scarce (n=9; 3%) and chunks too are even fewer than in Stratum 2 (5.1% versus 5.8%). However, platform renewal flakes are nearly equal in quantity and proportionally twice as important (0.6%) as those of Stratum 2. Slightly less than 10% each of the tools are made on blades and on angular debris, and the other 81% are on flakes. This is a rather non-laminar industry, despite the clear presence of many Upper Paleolithic tool types.

Only 3.1% of the debris are cortical, but fully 16.5% of the tools are on cortical blanks. The ratio of large debitage (not including trimming flakes and shatter) to cores + chunks is 12.7 to 1. All the indicators (relatively low amounts of microdebitage and cores, low ratio of debris to tools, low ratio of large debitage to cores) are suggestive of a relatively low importance of in situ knapping in at least the area of Stratum 3 that we were able to excavate. In addition, the slight amounts of cortical debris, crested blades, as well as cores and chunks, all indicate that primary reduction was especially rare here, with tools perhaps manufactured on blanks that had been made elsewhere. Of course, such a conclusion can be only most tentative, given the small fraction of the potential site area that was excavated for Stratum 3. Nonetheless a valid comparison with Stratum 2 certainly can be made since the same area was dug for both units.

Almost one quarter (24.3%) of the 119 formal retouched tools are endscrapers (Table 4.1; Figures 4.5-4.6). Aurignacian types (keeled, thick and thin nosed endscrapers) represent 8.4% of the tool total. Perforators represent 2.5% and burins 4.2%. The 5 burins are all dihedral types, mainly angle burins on breaks. There are 2 burins spalls. Stratum 3 contained one backed blade fragment and one piece with concave truncation each. Continuously retouched pieces (that do not include any with scalariform retouch) amount to 22% of the tools and there is a fragment of a bifacial foliate point. Mousterian tool types are particularly abundant : 44 notches and denticulates (37%), 6 sidescrapers and raclettes (5.1%). There is also a pièce esquillée. There is a <u>balance</u> in Stratum 3 between tool types typical of the Middle and Upper Paleolithic, with no indication that the former are clustered near the base of the stratum or vice versa. There are even fewer clear Aurignacian diagnostic artifacts in Stratum 3 than in Stratum 2, but, despite the presence of the solitary backed and truncated pieces, this assemblage could traditionally be assigned to that techno- complex.

STRATUM 4: ARCHEOLOGICAL CONTEXT

Stratum 4, dug in about 11 sq.m. (including limestone blocks), is significantly different from overlying Strata 3 and 2 both geomorphologically and archeologically. Unlike those units, Stratum 4 is a very thick horizon, possibly formed over a very long period of time during oxygen isotope stage 4, and deposited in part by running water (colluvially redeposited loess) and in part by wind (pure aeolian loess)(see Haesaerts, this volume). The stratum is also characterized by the presence of several huge roof-fall boulders, seriously limiting the inhabitable area at least at the front of the cave (a phenomenon also found by Toussaint a few meters to the east [M.Toussaint, personal communication]). The few artifacts and bones are <u>scattered</u> in the spaces among the boulders throughout the full thickness of Stratum 4 with no significant concentrations or hints of living floors, unlike in the cases of Stratum 3 or especially Stratum 2. If this area of the cave were visited by hominids, it seems to have been rarely. Despite the great thickness of the deposit, a mere 282 faunal remains were found, only 17 (6%) of which were identifiable (see Gautier, this volume). Still, the ratio of lithic (1,884 gm.) to faunal (755 gm.) weight is very low (2.5 to 1), suggesting how slight human tool use/discard activity was in the site at this time. There are 2 bones with carnivore gnaw marks, 2 with cut marks, but none with traces of burning. In Stratum 4 there is a clear tendency for only large, massive faunal remains to have been preserved: average bone weight is 2.7 grams, versus 1.3 gm. for Stratum 3 and 1.0 gm. for Stratum 2. The smaller bones, so abundant in Strata 2 and 3, may

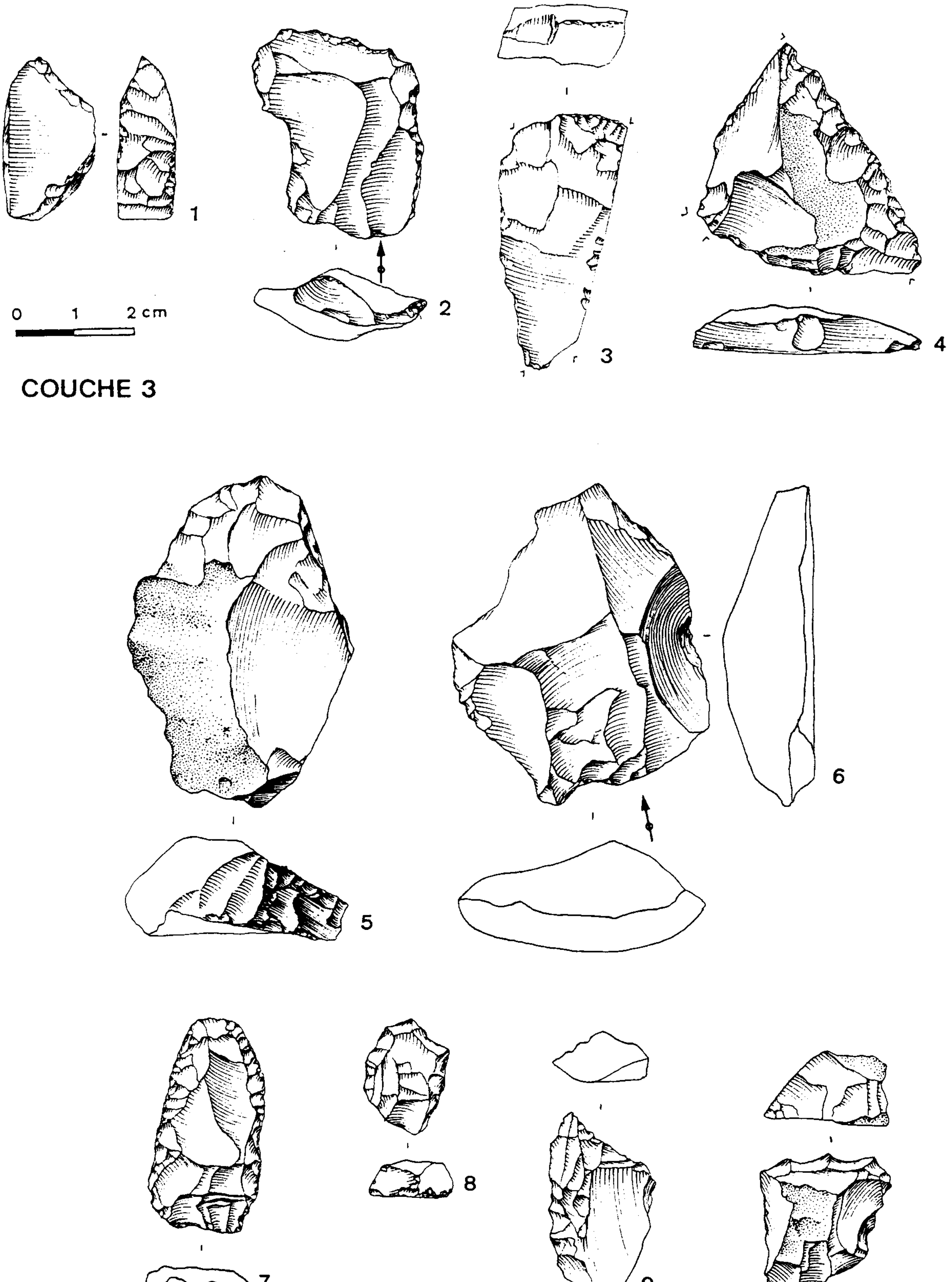


Figure 4.5. Stratum 3 (for details, see captions after References).

COUCHE 3

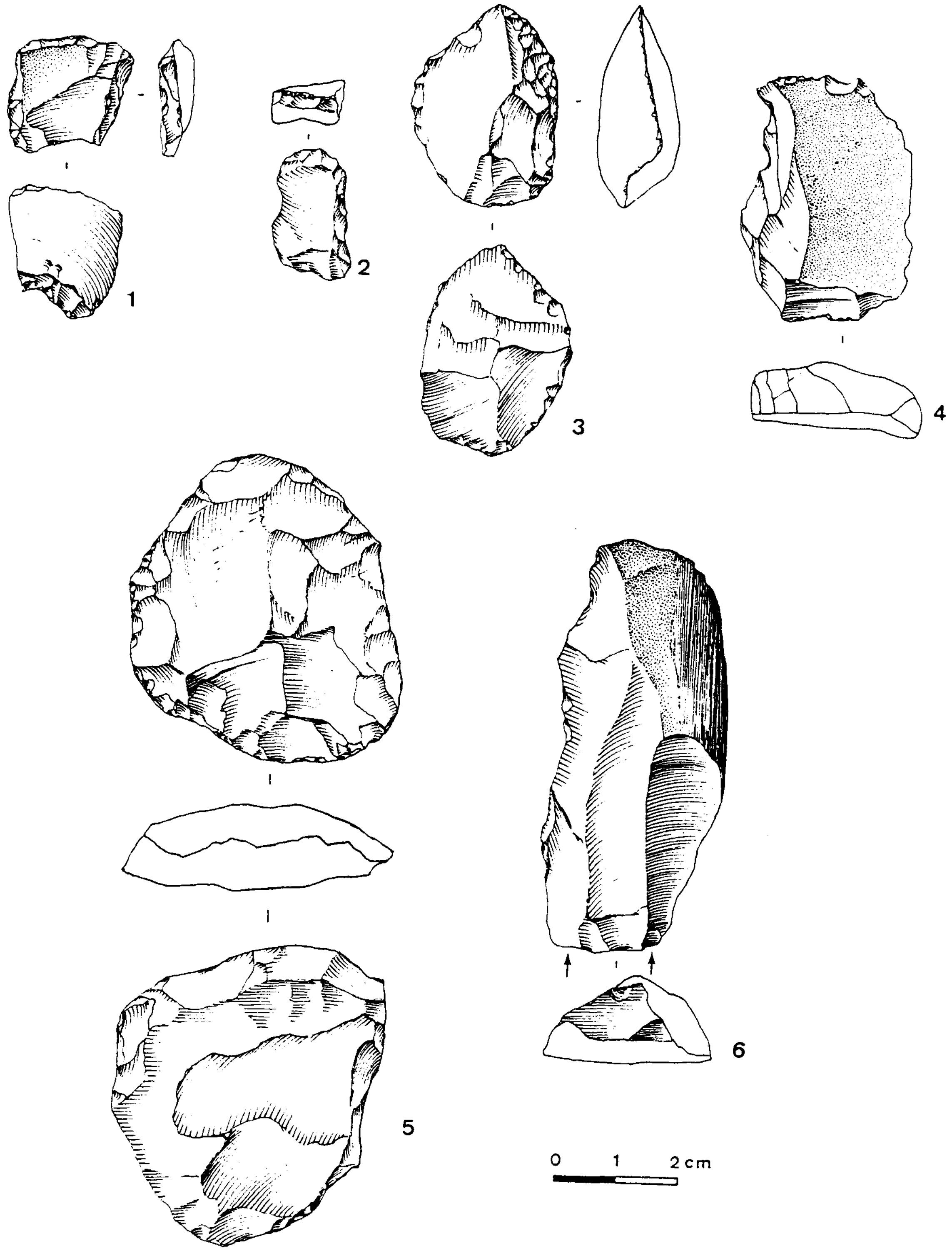


Figure 4.6. Stratum 3 (for details, see captions after References).

simply have been destroyed by soil acids in the loess as well as by alternating wet-dry, freeze-thaw processes. There is some evidence of disturbance and intrusive fauna (i.e., the greater part of an unfossilized badger skeleton found in a burrow).

CHRONOSTRATIGRAPHIC POSITION

Dating of Stratum 4, while most important, is very difficult. Several attempts to obtain radicarbon dates by accelerator mass spectrometry have been unsuccessful, because even the large, dense and solid-looking rhino and mammoth bones selected for dating, proved to preserve inadequate collagen. Although zones of the Stratum 4 loess are cemented by precipitated calcium carbonates, there are no travertines of sufficiently pure quality to attempt uranium-series dating.

P.Haesaerts' (this volume) analyses demonstrate that the loess sediments of Stratum 4 had been alternately deposited by two processes: 4d (top of the stratum) and 4b (lower middle) are the result of aeolian deposition under cold, dry climatic conditions; 4c (upper middle) and 4a (base of the stratum) were colluvially redeposited under more humid conditions. Whether the huge rock falls can be tied to specific climatic conditions is unclear. Clearly, freeze-thaw processes must have cracked the limestone overhang in a fairly massive way, and then either simply gravity or a seismic event may have triggered a vast collapse early in Stratum 4 times. It is likely that conditions included humidity and intense freezing alternating with thawing. Whether these conditions occurred during oxygen isotope stage 3 (Würm Interpleniglacial) or (more likely) late in stage 4 (Würm Lower Pleniglacial) cannot be definitively determined. The fact that the limited faunal assemblage nonetheless includes pika, woolly rhino, mammoth, reindeer and horse, indicates the existence of cold climatic conditions. Either stage 4 or early cold phases of stage 3 are conceivable for the age of Stratum 4.

ARTIFACT ASSEMBLAGES

Only 141 lithic debris were recovered from among the boulders of Stratum 4 (Table 4.2). Non-local, good-quality flint makes up 20% of the debris by count but only 3% by weight (so the flint flakes etc., are obviously quite small). Local limestone makes up 59% by count and 83% by weight. There are also items made on probably local poor-quality black flint and crystal quartz, as well as one item each on non-local phtanite and Brussels sandstone. Three quartzite items could have been procured in the Lesse River bed. With 10 retouched tools, the ratio of debris to tools is an extremely low 14.1 to 1. This gives an impression of little in situ knapping and the importation of tools to the site.

This impression is somewhat supported by the relatively low frequency of microdebitage (18.5%). Flakes equal to or larger than 1 cm. make up 51%. The few blades make up 9.2% of the total debris and there is a single item that can be classified as a bladelet (<2 cm.).(Total laminar index=10%.) There is only one core (a Levallois flake core, onto which a possible frost spall found nearby could be refitted)(Figure 4.7.1). In addition Stratum 4 yielded one pièce esquillée (which could be a bipolar core remnant). Chunks, however, are relatively abundant (n=26, 18.4%). The ratio of large debitage to chunks(+cores) is 3.3 to 1. This abundance of chunks is hard to explain in light of the scarcity of large debitage and the near absence of cores, facts which also suggest the conduct of little knapping at least in the front area of the cave (which would have been the best lit and most suited to knapping!). There is only one platform renewal flake and there are only 4 items of debitage with cortex (2.8%).

None of the retouched tools is made on non-local flint, although there is a sidescraper that is on a material that may be Brussels sandstone from central Belgium. One notch is on black flint of possibly local origin and one dihedral burin is on chert, also of poor quality. The other tools (including the piece esquillee) are on local hard limestone. As with the debitage, the small number of tools are made on a surprising diversity of raw materials. Two notches and one plane burin are made on blades; the other tools are made on plain flakes and chunks. None of the blanks are cortical.

Five tools were classified according to the de Sonneville- Bordes/Perrot Upper Paleolithic typology (Table 4.1) and 5 others according to the typology of F. Bordes for the Middle Paleolithic (Table 4.4; Figures 4.4.6 & 4.7). There are two burins: a straight dihedral (Figure 4.7.2) and a flat burin. (There are no burin spalls.) Half of the 10 tools are retouched notches. There are two flakes with continuous retouch on one edge and one simple straight sidescraper (Figure 4.4.6). In sum, there is little about this assemblage that would indicate a simple Upper Paleolithic attribution: blades are few, blade cores absent, there is only one truly convincing burin. Mousterian type tools are present, so this could be considered a transitional industry. However the artifacts are too few and too scattered throughout a thick, archeologically undifferentiated deposit to make any kind of definitive determination. There is no evidence that the putative Middle Paleolithic tools were found stratigraphically lower than the "Upper Paleolithic-type" tools or the blades. In fact, the flat and dihedral burins were at 182 and 192 cm. below datum respectively, and the sidescraper was at -190 cm.

STRATUM 5 : ARCHEOLOGICAL CONTEXT

Hominid activity seems to have been even slighter in Stratum 5 times than in Stratum 4 and non-hominid activity was greater. It is also clear that the Trench C zone was inside a covered cave area in Stratum 5 times, rather than at or just outside the dripline as it was in Strata 4, 3 and 2 times, since a major retreat of the overhang occurred with the large scale rockfalls in Strata 5 and 4 times. Stratum 5 silts and sands were largely deposited by running water flowing through an active karstic system. As a result, there may have been only restricted times during which the cave was habitable and it may have been relatively unpleasant.

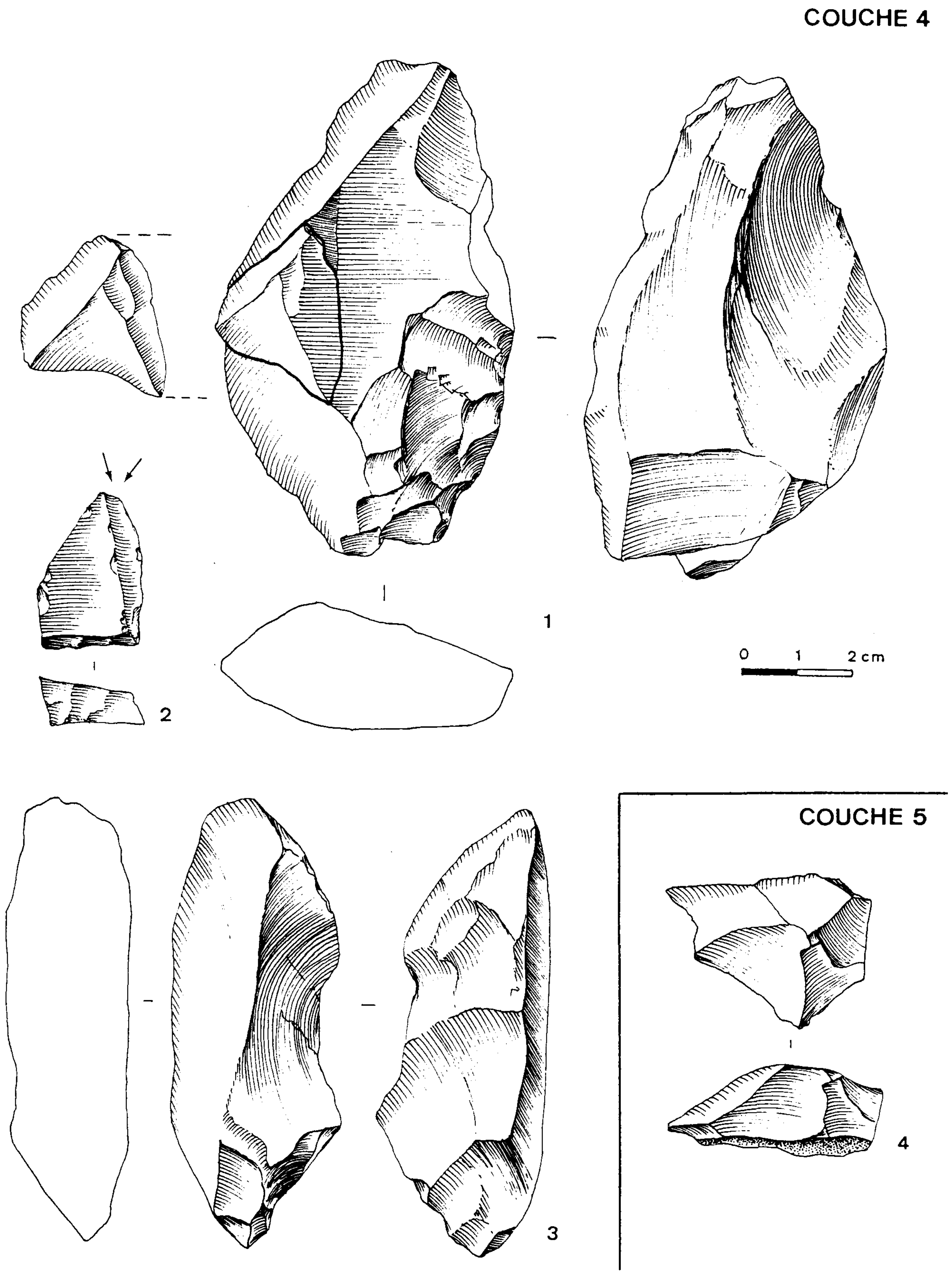


Figure 4.7. 1-3 : Stratum 4; 4 : stratum 5 (for details, see captions after References).

TABLE 4.4.

TROU MAGRITE (1991-1992)

MIDDLE PALEOLITHIC TOOLS

Strata

	4		5	
TYPE	No.	%	No.	%
2			1	14.3
9	1	20.0	2	28.6
33			1	14.3
39			1	14.3
42	4	80.0		
43			2	28.6
TOTAL	5	100.0	7	100.0

MIDDLE PALEOLITHIC TOOLS TYPES

2 Atypical Levallois flakes

9 Sidescrapers, simple, straight

33 Atypical burins

39 Raclettes

42 Notched tools

43 Denticulate tools

Of the 75 identified bones and teeth (3.2%, out of a total of 2,328 large mammal remains), 22 (29.3%) are of carnivores: foxes, cave bears and especially weasels. The foxes include the common and/or arctic species. There are 33 remains of hare (possibly including arctic hare) and 2 of pika. The few identifiable ungulate remains (mainly teeth or very dense bone fragments) are of woolly rhino, horse and reindeer (5 each) and 1 of ibex (see Gautier, this volume). Most of the rest of the faunal remains are obviously tiny, unidentifiable splinters, weighing on average 0.8 gm. the smallest average bone weight for any level at the site. Given the scarcity of evidence of hominid activity, it is likely that many/most of these animals died naturally in the cave or were the prey of carnivores. The rhino, horse and reindeer could be exceptions, although it is possible that their few, isolated remains had washed into the cave from the plateau via the chimney at the rear of le Trou Magrite. Bone surface condition is too poor to judge exact taphonomic processes, but running water and carnivore activity are possibilities. Carnivore gnaw marks are present on at least 4 bones; cut marks and evidence of burning are virtually absent (1 each). The lithic (1,989 gm.) to faunal (1,881 gm.) weight ratio is 1.1 to 1, indicative of the very slight human presence in the site.

The lense of nearly solid rodent bones in the upper middle part of Stratum 5 is clear testimony to the intensive, continuous use of the cave mouth as a roost by owls during part of the time that Stratum 5 was formed. This must have been a time when hominids visited the cave little or not at all. No artifacts were found in the pasty, blotchy white rodent bone lense. This owl regurgitation layer is also clear proof that the cave roof overhang had extended at least this far southwestward toward the talus in Stratum 5 times.

The artifacts in Stratum 5 are extremely few (only 115 altogether) and scattered, with no hint of any occupation surfaces. The artifacts occur singly or in very small "clusters" amidst the blocks that forced reduction of the excavation area to a mere 8 squares (and in reality much less than 8 sq.m. of loess and sand). Many may be in at least slightly secondary position. But one hint of at least local intactness is the existence (in square J8) of two secondary decortication flakes that refit.

The paleontological and archeological materials suggest that hominids were only occasional visitors to le Trou Magrite at this time and that, at least at the front of the cave, these visits were quite ephemeral.

CHRONOSTRATIGRAPHIC POSITION

The macrofauna referred to above are suggestive of cold climatic conditions during the formation of at least parts of Stratum 5. However, the sandy silt matrix was apparently redeposited, washed in by water through the karstic system, implying at least periodic high local humidity (see Haesaerts, this volume). The archeology provides little chronological evidence, since the Mousterian artifacts could date to early oxygen isotope stage 3, stage 4 or stage 5.

AMS radiocarbon dating was attempted on a bone sample, but original protein from bone collagen was essentially absent, so the determination is meaningless.

The microfaunal spectrum from the owl pellet lens in upper middle Stratum 5 provides some interesting clues as to the age of this Stratum. In his careful analysis of the extremely rich rodent assemblage, Cordy (this volume; see also 1992) finds several detailed, unique similarities with the microfauna of Couches Vg/4 in nearby Sclayn Cave. The Sclayn deposit (bracketted by radiometric dates) is assigned to the Melisey II pollen zone of the Grande Pile core in NE France. This pollen zone is well correlated with oxygen isotope stage 5b, dated to ca.95-85 kya. The rodents include a number of cold steppe forms (various lemmings, pika, Nordic vole, etc.). Cordy extrapolates the existence of generally dry, cold, open steppe environments, but with considerable winter snowfall and significant spring snow melt causing runoff and redeposition of fine sediments.

The only hint of semi-credible palynological information on vegetation and environment in the Trou Magrite sequence comes from two samples at the middle of Stratum 5, with pollen sums of 50 and 58 pollens and spores, and 5 and 10 taxa respectively.

Both samples are overwhelmingly dominated by Cyperaceae (sedges) and Pteridophytes (ferns). Despite the local humidity indicated by the ferns, trees are not represented (except for 1 pine pollen) and Poaceae (grasses) are relatively abundant. The presence of 2 pollens of Selaginella (a fern) is indicative of a cold climate (Cl.Schutz, personal communication). Despite all the necessary caveats about small sample sizes, these results seem to confirm the geomorphological and paleontological evidence of a cold, arctic steppe environment, but with local/seasonal humidity during the time of at least mid-Stratum 5 formation.

Underlying Stratum 6 was formed by even more dynamic (at times violent) water flow through the Trou Magrite karstic system, with coarse sands, water-worn gravels, pebbles and very large cobbles. Haesaerts (this volume) believes that these sediments derive from ancient fluvial terrace deposits atop the plateau, and were washed into the cave through the chimney by strong currents. This high humidity could pertain to one of the wetter phases of oxygen isotope stage 5, such as 5e or 5c. As noted above, this deposit is archeologically and paleontologically sterile.

If these interpretations are correct, the base of the Trou Magrite entrance infilling would date back to oxygen isotope stage 5. Then there seems to have been a significant hiatus, but its exact temporal extent and placement are uncertain. Stratum 4, with evidence of a cold climate and at least periodic, local humidity, alternating with dry conditions, might date to oxygen isotope stage 4. It was definitely truncated by a major episode of erosion, followed by precipitation of calcium carbonate that cemented part of the remaining Stratum 4 deposit. Strata 3 and 2 represent a major change in fundamental deposition, from waterlain to cryoclastic. Formed principally by extensive gelivation, these levels represent much colder overall conditions than the underlying strata. Strata 3 and 2 date to late oxygen isotope stage 3. They were later partially cemented with calcium carbonates precipitated from water percolating from the cave. The rest of the (oxygen isotope stage 2) deposit was eliminated in the 1830's.

ARTIFACT ASSEMBLAGES

Stratum 5 produced only 110 lithic debris and 7 tools. For their small number, the debris are of a surprisingly wide diversity of raw material types. Non-local, good-quality flints make up 22% by count and 4% by weight; local limestones make up 48% and 70% respectively. Poor-quality, black flint (present in the local limestone) and chert (source unknown) make up 28% of the debris by count and 11% by weight. Probably local crystal quartz makes up 6% by count and 5% by weight, with traces of phtanite, fine-grain quartzite and other stones. This same diversity is reflected among the few tools. Only two tools are on non-local flint. Our observations on lithic diversity confirm those of Ulrix-Closet (1975:41) in her study of the large Dupont and other Mousterian collections from the cave.

Among the Stratum 5 debris, 12.7% have some cortex (Table 4.2; Figure 4.7.4). There are only 5 cores (4.5%) and 26 chunks (24%), as well as one platform renewal flake. The ratio of large debitage to cores+ chunks is a low 2.3 to 1. Microdebitage is scarce (7 trimming flakes and shatter=6%). While small chips (and even some of the flakes larger than 1 cm.) may have been disproportionally removed by erosion, the rest of the evidence does tend to suggest some in situ knapping, especially of the local limestone (virtually none of the non-local flint pieces are cortical). The majority (55%) of the debris are large flakes. There are 8 items classified as blades and 2 as bladelets (total laminar index=9%). All the nuclei are flake cores except one classifiable as a bladelet core.

The items classifiable by F.Bordes' Middle Paleolithic typology include an atypical Levallois flake, 2 simple straight sidescrapers, an atypical burin, a raclette and 2 denticulates (Table 4.4; Figure 4.3.7). These tools are made on flakes and large angular debris, but the burin is made on a blade. There are no bifaces or Quina transversal sidescrapers, both so abundant in the old Trou Magrite collections studied by Ulrix- Closet (1975) and which she thinks are evidence of two distinct Mousterian occupations. Note that Ulrix-Closet also found numerous denticulates and raclettes.

Stratum 6, fluviatile deposits, is utterly devoid of biotic remains. The cave became inhabitable (by animals and hominids) only under at least episodically drier conditions after oxygen isotope stage 5e, but Neandertals seem to have been only occasional visitors to the area of the southwestern area of the cave mouth. They clearly were absent during significant periods of time when mammalian carnivores and raptorial birds were the main occupants of le Trou Magrite.

The chronostratigraphy of le Trou Magrite, as constructed from the 1992-93 excavations, is presented in Table 4.5.

TABLE 4. 5 :

SUMMARY OF THE TROU MAGRITE CHRONOSTRATIGRAPHY

Stratum	Industry	Radiocarbon	Microfauna	Sedimentology
1.1 pit	Meso/Neolithic			
(Hiatus due to removal of Gravettian & Magdalenian in A.D. 1830)				
2 3	Aurignacian	34 ± 2 ka 41 ± 2 ka		Ox. isot.stage 3
(Hiatus/erosion in late Oxygen isotope stage 4 or early stage 3)				
4	Mousterian			Ox. isot. stage 4
5 up/mid	Owl/rodent lens		Ox. isot. stage 5b	
5	Mousterian			Ox. isot. stage 5
6	Sterile, fluviatile			Ox. isot. stage 5e

REFERENCES

CORDY J-M., 1992,
Bio et chronostratigraphie des dépôts quaternaires de la Grotte Scladina a partir des micromammifères, In *Recherches aux Grottes de Sclayn* (M. Otte, ed.), vol. 1, pp. 79-125. ERAUL 27, Liège.

DEWEZ M., 1989,
Données nouvelles sur le Gravettien de Belgique. *Bulletin de la Société Préhistorique Française* 86:138-142.

HAESAERTS P. and de HEINZELIN J., 1979,
Le Site Paléolithique de Maisières-Canal. Dissertationes Archaeologica Gandenses 19, Brugge.

NOIRET P., OTTE M., STRAUS L., *et al.*, 1994,
Recherches paléolithiques et mésolithiques en Belgique, 1993. *Notae Praehistoricae* 13:45-62.

STRAUS L., 1994,
Upper Paleolithic origins and radiocarbon calibration: more new evidence from Spain. *Evolutionary Anthropology* 3, 6 : 195-198.

ULRIX-CLOSSET M., 1975,
Le Paléolithique Moyen dans le Bassin Mosan en Belgique. Universa, Wetteren.

FIGURES CAPTIONS

Figure 4.1 : Stratum 1.1 : 1. Completely Backed Blade; 2. Multiple Perforator /Bec; 3. Multiple Perforator/Bec; 4. Denticulate; 5. Triangle; 6. Perforator & Piece with Continuous Retouch -1 Edge; 7. Microperforator; 8. Thumbnail Endscraper; 9. Endscraper on Flake; 10. Neolithic Arrowhead; 11. Flake Core; Stratum 2 : 12. Endscraper on Flake; 13. Multiple Perforator/Bec; 14. Bec; 15. Perforator-Endscraper; 16. Microperforator; 17. Unifacial Foliate;

Figure 4.2 : Stratum 2 : 1. Simple Endscraper; 2. Limestone Flake; 3. Sidescraper; 4. Sidescraper; 5. Sidescraper; 6. Limestone Blade; 7. Thick-Nosed Endscraper; 8. Thumbnail Endscraper; 9. Atypical Endscraper; 10. Endscraper on Retouched Flake; 11. Endscraper on Retouched Blade; 12. Sagaie, distal fragment.

Figure 4.3(a) : Stratum 2 : 1. Aurignacian Blade Fragment; 2. Denticulate; 3. Denticulate; 4. Notch and Piece with Continious Retouch - 1 Edge; 5. Thumbnail Endscraper; 6. Denticulate; 7. Raclette (Stratum 5); 8. Dufour Bladelet. 4.3(b) : Stratum 2 : 9. Endscraper on Retouched Blade; 10. Sidescraper (with invasive retouch and possible burin) (Stratum 2/3); 11. Unifacial point; 12. Burin/Endscraper;

Figure 4.4 : Stratum 2 : 1. Denticulate; 2. Piece with Continious Retouch-1 Edge; 3. Piece with Continious Retouch-1 Edge; 4. Mesial Sagaie Fragment; 5. Piece with Continous Retouch-1 Edge; 6. Simple Straight Sidescraper & possible Nosed Endscraper; 7. Limestone Flake Core; 8. Sidescraper.

Figure 4.5 : Stratum 3 : 1. Atypical Carinated Endscraper; 2. Notch and Denticulate; 3. Completely Backed Blade and Sidescraper; 4. Burin - Truncated Piece; 5. Double Endscraper; 6. Flat Nosed/Shouldered Endscraper; 7. Piece with Continuous Retouch-2 Edges, Splintered Piece; 8. Raclette; 9. Concave Truncated Piece; 10. Thick Nosed Endscraper.

Figure 4.6 : Stratum 3 : 1. Piece with Continuous Retouch-1 Edge & Denticulate & Sidescraper; 2. Double Endscraper; 3. Ogival Endscraper; 4. Bec; 5. Biface; 6. Multiple Dihedral Burin.

Figure 4.7 : Stratum 4 : 1. Levallois Core with Refitted Flake; 2. Straight Dihedral Burin; 3. Notch. Stratum 5 : 4. Levallois Flake.

M. OTTE et L.G. STRAUS (dir.), *Le Trou Magrite. Fouilles 1991-1992*. Liège, E.R.A.U.L. 69, 1995.

5

ARCHEOLOGICAL COMPARISONS

Lawrence Guy STRAUS

UTILIZATION OF LITHIC RAW MATERIALS AT LE TROU MAGRITE

One of the clearest temporal trends in the Trou Magrite sequence is the increase in use of non-local flints (see Chapter 5 Appendix for lithic raw material descriptions, and Table 5.1 for principal raw material data). The most common of these flints is a shiny, fine-grain, slightly translucent, grey (dark or blueish grey) flint that patinates whitish grey. It has a chalk cortex. It is believed that this flint comes from the famous Maastrichtian (Upper Cretaceous) chalk limestone outcrops of the Spiennes area, near the city of Mons, about 70 km. west-northwest of le Trou Magrite (Caspar 1984; J-M. Léotard and D.Cahen, personal communications). Although attribution to Spiennes is not yet absolutely certain, we will hereafter refer to the high- quality, fine-grain, grey flint as "Spiennes flint". There is also a medium-grain flint that is matte, opaque, greyish in color and with a slightly rough surface. Its source is unspecific Cretaceous beds that are not local, although waterworn cortex indicates that it occurs secondarily in river beds. It patinates white. Generally the flints at le Trou Magrite are quite patinated. This confirms the observations of Ulrix-Closet (1975) and Otte (1979) on the old collections from this site.

Limestone was significantly used for artifact production at le Trou Magrite. The use of local non-flint materials at this site was first observed by Dupont (1873) and confirmed by Ulrix- Closet (1975). In fact, Dupont (1867:131) observes that use of limestone was more commonly used in the early ("Mammoth Age") levels than later ("Reindeer Age"). He even points out that in the later levels, humans developed techniques to economize the scarce flint resource, which was so difficult to procure (Dupont 1873:90).

There are two common limestone types in our collections from le Trou Magrite. First there is a medium-grain, "soft" limestone, which is grey-black in color. Second there is a fine- grain, hard, silicified limestone, which is black with white/yellowish flecks. It intergrades with what we called "black flint"a flint that occurs in the local limestone. Both limestones are matte, with rare inclusions and conchoidal fracture pattern, and both patinate grey. In fact, the two limestones tend to intergrade. There is a third limestone that is relatively common only in Stratum 5: crystallized limestone, also probably local. In the ensuing discussion, relative proportions of lithic types are given as two figures,

TABLE 5.1 :

TROU MAGRITE (1991-1992)
RELATIVE FREQUENCIES OF MAJOR LITHIC RAW MATERIALS

ARTIFACTS	FINE-GRAINED SPIENNES FLINT		MEDIUM-GRAIN FLINT		MEDIUM-GRAIN FLINT LIMESTONE		TOTAL n	
	% Count	% Wt.	% Count	% Wt.	% Count	% Wt.	% Count	% Wt.
STRATUM 2								
Plain Flakes	31.9	5.2	10.0	1.7	43.1	90.5	2,474	94,491
Cortical Flakes	57.3	35.2	17.4	13.6	9.1	26.7	164	988
Plain Blades	36.4	11.9	7.9	1.5	46.9	65.2	382	2,036
Cortical Blades	54.1	51.8	8.1	2.9	13.5	4.7	37	170
Bladelets	54.5	41.4	22.1	14.9	14.5	33.5	145	215
Cores	10.0	5.2	-	-	23.3	44.7	30	718
All Debris	44.0	8.7	2.5	28.2	28.2	84.9	5,205	107,926
All Tools	61.1	35.7	7.4	7.0	17.6	44.2	108	1,054
STRATUM 3								
Plain Flakes	18.2	3.2	2.1	0.2	61.2	92.6	1,488	45,158
Cortical Flakes	34.3	9.7	4.5	1.2	14.9	21.5	67	671
Plain Blades	19.1	9.0	2.9	0.5	58.8	77.7	136	792
Cortical Blades	50.0	9.0	12.5	1.0	25.0	6.0	11	87
Bladelets	63.2	57.0	7.4	4.7	20.6	32.7	68	107
Cores	100.0	100.0	-	-	-	-	1	76
All Debris	29.2	5.8	2.2	0.2	50.8	87.2	2,612	52,608
All Tools	37.5	21.5	4.8	3.2	33.7	50.2	104	1,263
STRATUM 4								
Plain Flakes	8.6	0.8	10.0	2.2	57.1	82.8	70	1,122
Cortical Flakes	-	-	-	-	-	-	-	-
Plain Blades	8.3	1.6	-	-	50.0	62.2	12	127
Cortical Blades	-	-	-	-	-	-	-	-
Bladelets	100.0	100.0	-	-	-	-	1	1
Cores	-	-	-	-	100.0	100.0	1	103
All Debris	13.5	1.5	6.4	1.6	48.9	72.3	141	1,754
All Tools	-	-	-	-	50.0	59.2	8	130
STRATUM 5								
Plain Flakes	16.3	3.6	-	-	22.4	8.3	8	33
Cortical Flakes	16.7	20.4	-	-	-	-	12	54
Plain Blades	-	-	-	-	42.9	58.3	7	72
Cortical Blades	-	-	-	-	-	-	1	4
Bladelets	-	-	50.0	20.0	-	-	2	5
Cores	-	-	-	-	20.0	3.1	5	484
All Debris	13.5	3.5	0.9	0.1	18.9	7.4	111	1,901

the percentage by count and the percentage by weight ("n/N"). This way one gets a quick idea of the size of the objects and of the significance of potential transport problems.

In Stratum 5, the knapping debris (weighing a total of 1,901 gm.) principally includes medium-grain limestone (19/7), crystallized limestone (19/43) and Spiennes flint (14/4), while the tools included these types in the following relative amounts: 17/25, 33/15, 17/21. In Stratum 4 the debris (total weight=1,754 gm.) is mainly distributed among medium-grain limestone (49/72), Spiennes flint (14/2) and medium-grain flint (6/2). No tools are made on imported flint; 50% by count and 59% by weight are on medium-grain limestone. In general, imported flint is relatively scarce in the basal (Mousterian and transitional?) levels at le Trou Magrite.

The most interesting comparisons are between Strata 3 and 2 because the samples of artifacts are large and because typologically both levels can be assigned to the Aurignacian. The main raw material compositions of the debris and tools from these strata are summarized in Table 5.2.

TABLE 5.2a : Strata 3 & 2 Lithic raw materials of Knapping debris

	Spiennes Flint		Medium-Grain Flint		Medium-Grain Limestone	
	% by Count	% by Wt	% by Count	% by Wt	% by Count	% by Wt
St. 3	29	6	2	<1	51	87
St. 2	44	9	3	28	28	85

TABLE 5.2b: Strata 3 & 2 Lithic raw materials of retouched tools

	Spiennes Flint		Medium-Grain Flint		Medium-Grain Limestone	
	% by Count	% by Wt	% by Count	% by Wt	% by Count	% by Wt
St. 3	38	22	5	3	34	50
St. 2	61	36	7	7	18	44

Two trends are apparent: 1.) Flint is in general more abundant in Stratum 2 than in Stratum 3; 2.) Flint was differentially selected for the manufacture of formal tools in both levels, but especially so in Stratum 2. In addition, it is apparent that flint debris and tools are lighter (hence smaller) than limestone ones---a reflection, no doubt, of the imported nature of the flint and the local provenience of the limestone.

TABLE 5.3

TROU MAGRITE (1991-1992)

AVERAGE WEIGHTS (GRAMS)

OF COMMON DEBRIS TYPES FOR MAJOR RAW MATERIAL TYPES

	Spiennes FLINT		MEDIUM-GRAIN LIMESTONE	
Debris Type	Stratum 2	Stratum 3	Stratum 2	Stratum 3
Plain Flake	6.41	5.36	82.19	45.45
Plain blade :				
Whole/prox.	2.26	2.96	5.42	9.06
Mesial/distal	2.57	1.0	8.52	6.57
Plain bladelet	1.29	1.46	4.71	2.5
Flake core	18.5	-----	54.75	-----
Chunk :				
Non-cortical	23.46	3.5	35.23	16.67
Cortical	3.33	10.17	91.0	7.0

TABLE 5.4 :

TROU MAGRITE (1991-1992)

AVERAGE LENGTHS OF COMMON DEBRIS TYPES (mm) FOR MAJOR RAW MATERIAL TYPES

	STRATUM 2	
DEBRIS TYPES	SPIENNES FLINT	MEDIUM-GRAIN LIMESTONE
Plain Flake	18.8	30.0
Primary Decort. Flake	24.0	29.0
Secondary Decort. Flake	28.8	38.0
Whole/Prox. Plain Blade	26.7	42.2
Non-Cortical Chunk	28.8	41.4
Cortical Chunk	31.5	61.5
Flake Core	40.0	46.2
	STRATUM 3	
Plain Flake	20.3	25.4
Primary Decort. Flake	18.8	35.3
Secondary Decort. Flake	19.9	31.4
Whole/Prox. Plain Blade	28.9	36.7
Non-Cortical Chunk	24.0	33.5
Cortical Flake	30.7	-----
Flake Core	------	-----

Table 5.3 presents detail on the average weights of the main large debris (cores, chunks, flakes, blades, bladelets) for Spiennes flint and medium-grain limestone in Strata 3 and 2. Table 5.4 gives average lengths for these debris categories by the two main raw material types for the same two "Aurignacian" levels. Both tables show that the flint debris items are consistently smaller and especially lighter than the limestone ones. Again this is probably a reflection of the differential transportation problems affecting the imported flint and the local limestone. Relatively small pieces of flint were brought to le Trou Magrite and then reduced to the maximum. In Stratum 2 the hominids were clearly acquiring more Spiennes (and other good-quality) flint and working it heavily. Whether this was directly procured in logistical trips or during the course of an extended annual round, or via trade/exchange, cannot be determined confidently at this time.

Tables 5.5 and 5.6 present the data on the relative frequencies (in terms of counts and weights) of some of the major debris classes for Strata 3 and 2 respectively.

TABLE 5.5 : Stratum 3 Lithic raw material percentages for major debris types

Lithic Types	Spiennes Flint		Med-Grain Flint		Med-Grain Limestone	
Debris Types	% Count	%Weight	% Count	%Weight	% Count	%Weight
Plain flakes	18	3	2	<1	61	93
Cortic.flakes	34	10	5	1	15	22
Plain blades	19	9	3	1	59	78
Cortic.blades	36	10	9	1	18	7
Bladelets	63	57	7	-	21	33
Cores	11	13	-	5	33	22*

*Fine-grain + crystallized limestone (no medium-grain l.s.).

TABLE 5.6 : Stratum 2 lithic raw material percentages for major debris types

Lithic Types	Spiennes Flint		Med-Grain Flint		Med-Grain Limestone	
Debris Types	% Count	%Weight	% Count	%Weight	% Count	%Weight
Plain flakes	32	5	10	2	43	91
Cortic.flakes	57	35	17	14	9	27
Plain blades	36	12	8	2	47	65
Cortic.blades	54	52	8	3	14	5
Bladelets	55	41	22	15	15	34
Cores	10	5	-	-	23	45

Unfortunately it is very difficult to identify limestone cortical debitage with certainty, so the high relative frequencies of cortical flint may be overstated. It is notable that flint cores are far less well represented than limestone ones. This might suggest that flint transport tended to be in the form of flakes and blades for reasons of weight and bulk, whether in direct procurement or in exchange systems. There was a clear selection of flint for making bladelets, which, in any event, are relatively rare in these contexts. Flint increases from Stratum 3 to Stratum 2 in relative importance in all the major debris categories except bladelets and cores (which are affected by small sample sizes).

DEBITAGE AND BLANK TYPES AT LE TROU MAGRITE

Differential depositional characteristics make it difficult to compare Strata 5 and 4 on the one hand (alluvial and colluvial deposition) with Strata 3 and 2 on the other hand (cryoclastic deposition). There may have been a winnowing effect, removing light debitage and leaving heavier cores and chunks in the strata where running water was a major force. Yet the Stratum 5 and 4 artifacts are not heavily rolled or battered, so it is also possible that the excavation trench simply did not correspond with Mousterian knapping areas, but rather with a dump zone among the blocks. The evidence from Strata 3 and 2 is much more clearly indicative of in situ activity areas (including lithic working) in the Trench C zone. Both the nature of the setting ("crevices" among blocks versus a more open level space) and of the hominid occupation also clearly influenced the composition of the lithic debris that were left behind. Table 5.7 summarized the relative frequencies of the major grouped categories of lithic debris per stratum.

TABLE 5.7 : Summary of Major lithic debris categories

Stratum	Microdébitage*	Flakes	Blades/Bladelets	Cores	Chunks
2	32.8	49.8	11.0	0.5	5.8
3	26.1	60.1	8.2	0.3	5.1
4	18.5	51.7	9.9	1.4#	18.4
5	6.3	55.4	9.1	4.5	23.6

*=trimming flakes + shatter
#: includes 1 pièce esquillée

With the caveats stated above, there are trends of increasing relative frequency of microdébitage and decreasing relative frequencies of cores and chunks through time. The percentage of flakes is fairly constant, around 55 %. The presence of blades in the basal strata is undeniable, although in absolute terms, their numbers in Strata 4 and 5 are very small. The relative frequency of blades does not increase in Stratum 3, if fact it actually decreases. Only in Stratum 2 do blades (plus a few bladelets) surpass 10% of the debris assemblage. Of note are the absence of crested blades and burin spalls in Strata 5 and 4, and their presence (albeit slight) in Strata 3 and 2. Finally, a comparison can be made of the kinds of blanks used to manufacture tools at le Trou Magrite (Table 5.8).

TABLE 5.8 : Relative frequencies of blank types used to make tools

Stratum	Flakes	Blades	Bladelets	Chunks	Number of tools*
2	72.2	22..2	0.9	4.6	108
3	80.5	9.7	-	9.7	104
4	50.0	30.0	-	20.0	10
5	57.1	14.3	-	28.6	7

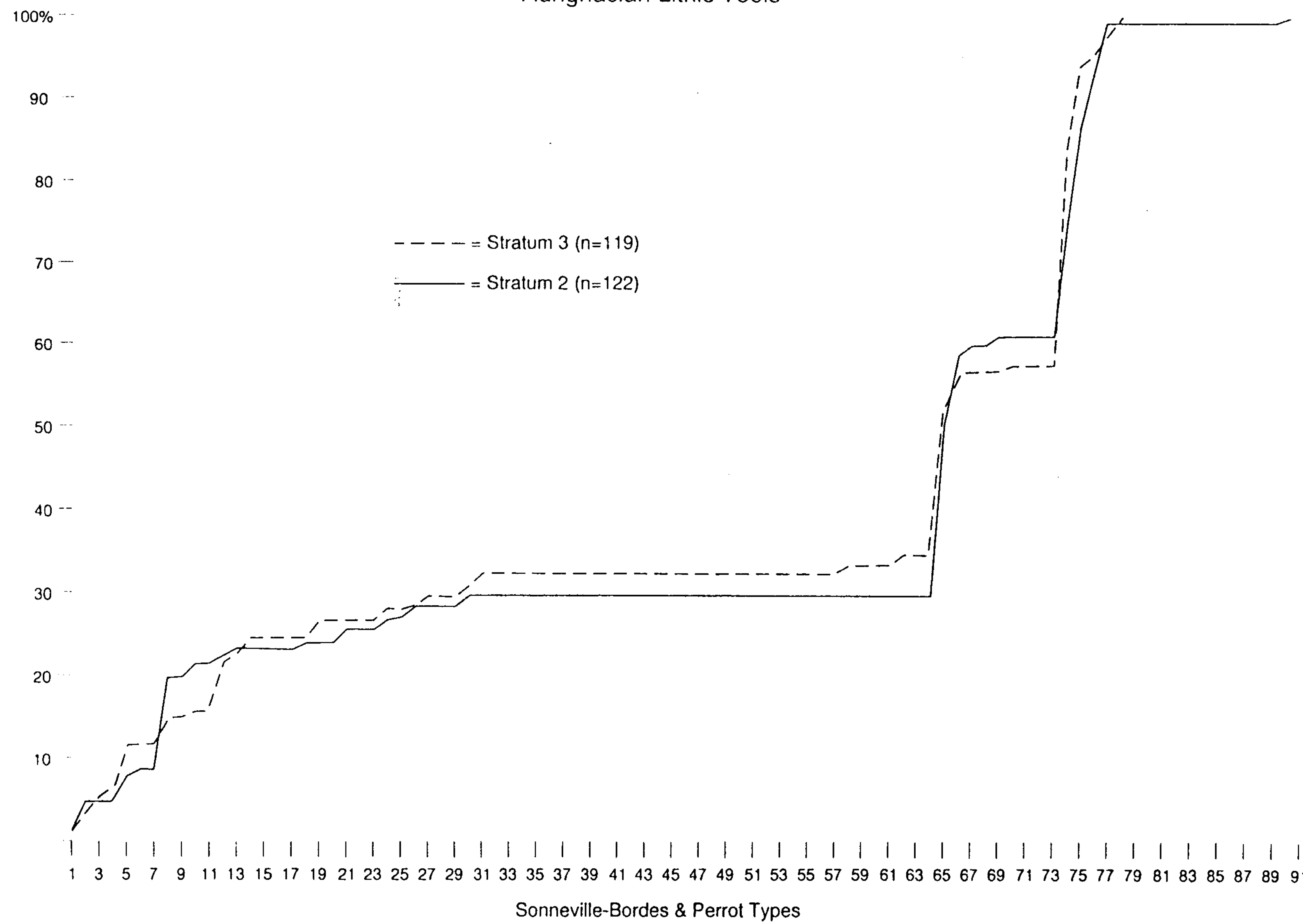
* Tools with multiple worked edges not listed as composite types in Sonneville-Bordes/Perrot typology are counted only once here.

The numbers of tools in Strata 5 and 4 are too small to make any kind of meaningful comparison for the basal levels. One can note, however, that flakes are dominant, but chunks (large angular debris) and even blades were used to make the tools of these levels. The striking and more significant differences lie between Strata 3 and 2, both classifiable on typological grounds as "Aurignacian". The tools of the older level are almost all made on flakes, with very few on blades and none on bladelets. In Stratum 2, while flake blanks remain dominant, there is a more than 100% increase in blade (and bladelet) blanks. While the blades of Strata 5 and 4 are mostly made on limestone (and almost none are made on imported flint), there are many flint blades in the upper pair of levels and their relative number and weight increase from Stratum 3 to Stratum 2, as the number and weight of limestone blades decrease. Flint was increasingly being selected, including for the manufacture of blade blanks used to make tools. While none of the Trou Magrite assemblages is very laminar and while tools were always mainly made on blades and chunks, probably for raw material economization reasons, Stratum 2 does stand out. As imported flint became more abundant, blades increased, even though flakes were still used so as to not waste this high-value resource. And the flint débitage items were always small in average size and weight. The Spiennes flint blades from both levels are on average quite short (29 mm. for Stratum 3; 27 mm. for Stratum 2) and while the limestone blades are somewhat longer (37 mm. and 42 mm. respectively), they too are generally broad. But there is a clear technological difference between Strata 3 and 2. This difference may have been conditioned by greater access to high-quality flint, presumably from the sources around Spiennes.

STRATA 3 & 2 TOOL TYPOLOGICAL COMPARISONS

While Strata 3 and 2 are typlogically very similar (Table 5.9; Figure 5.1), there are interesting and probably correlated differences in raw material and blank utilization. Although typologically "Upper Paleolithic" (and having at least one crested blade), Stratum 3 shares several characteristics in terms of raw

Figure 5.1 TROU MAGRITE, 1991-92
Aurignacian Lithic Tools



Of the 75 identified bones and teeth (3.2%, out of a total of 2,328 large mammal remains), 22 (29.3%) are of carnivores: foxes, cave bears and especially weasels. The foxes include the common and/or arctic species. There are 33 remains of hare (possibly including arctic hare) and 2 of pika. The few identifiable ungulate remains (mainly teeth or very dense bone fragments) are of woolly rhino, horse and reindeer (5 each) and 1 of ibex (see Gautier, this volume). Most of the rest of the faunal remains are obviously tiny, unidentifiable splinters, weighing on average 0.8 gm. the smallest average bone weight for any level at the site. Given the scarcity of evidence of hominid activity, it is likely that many/most of these animals died naturally in the cave or were the prey of carnivores. The rhino, horse and reindeer could be exceptions, although it is possible that their few, isolated remains had washed into the cave from the plateau via the chimney at the rear of le Trou Magrite. Bone surface condition is too poor to judge exact taphonomic processes, but running water and carnivore activity are possibilities. Carnivore gnaw marks are present on at least 4 bones; cut marks and evidence of burning are virtually absent (1 each). The lithic (1,989 gm.) to faunal (1,881 gm.) weight ratio is 1.1 to 1, indicative of the very slight human presence in the site.

The lense of nearly solid rodent bones in the upper middle part of Stratum 5 is clear testimony to the intensive, continuous use of the cave mouth as a roost by owls during part of the time that Stratum 5 was formed. This must have been a time when hominids visited the cave little or not at all. No artifacts were found in the pasty, blotchy white rodent bone lense. This owl regurgitation layer is also clear proof that the cave roof overhang had extended at least this far southwestward toward the talus in Stratum 5 times.

The artifacts in Stratum 5 are extremely few (only 115 altogether) and scattered, with no hint of any occupation surfaces. The artifacts occur singly or in very small "clusters" amidst the blocks that forced reduction of the excavation area to a mere 8 squares (and in reality much less than 8 sq.m. of loess and sand). Many may be in at least slightly secondary position. But one hint of at least local intactness is the existence (in square J8) of two secondary decortication flakes that refit.

The paleontological and archeological materials suggest that hominids were only occasional visitors to le Trou Magrite at this time and that, at least at the front of the cave, these visits were quite ephemeral.

CHRONOSTRATIGRAPHIC POSITION

The macrofauna referred to above are suggestive of cold climatic conditions during the formation of at least parts of Stratum 5. However, the sandy silt matrix was apparently redeposited, washed in by water through the karstic system, implying at least periodic high local humidity (see Haesaerts, this volume). The archeology provides little chronological evidence, since the Mousterian artifacts could date to early oxygen isotope stage 3, stage 4 or stage 5.

AMS radiocarbon dating was attempted on a bone sample, but original protein from bone collagen was essentially absent, so the determination is meaningless.

The microfaunal spectrum from the owl pellet lens in upper middle Stratum 5 provides some interesting clues as to the age of this Stratum. In his careful analysis of the extremely rich rodent assemblage, Cordy (this volume; see also 1992) finds several detailed, unique similarities with the microfauna of Couches Vg/4 in nearby Sclayn Cave. The Sclayn deposit (bracketted by radiometric dates) is assigned to the Melisey II pollen zone of the Grande Pile core in NE France. This pollen zone is well correlated with oxygen isotope stage 5b, dated to ca.95-85 kya. The rodents include a number of cold steppe forms (various lemmings, pika, Nordic vole, etc.). Cordy extrapolates the existence of generally dry, cold, open steppe environments, but with considerable winter snowfall and significant spring snow melt causing runoff and redeposition of fine sediments.

The only hint of semi-credible palynological information on vegetation and environment in the Trou Magrite sequence comes from two samples at the middle of Stratum 5, with pollen sums of 50 and 58 pollens and spores, and 5 and 10 taxa respectively.

Both samples are overwhelmingly dominated by Cyperaceae (sedges) and Pteridophytes (ferns). Despite the local humidity indicated by the ferns, trees are not represented (except for 1 pine pollen) and Poaceae (grasses) are relatively abundant. The presence of 2 pollens of Selaginella (a fern) is indicative of a cold climate (Cl.Schutz, personal communication). Despite all the necessary caveats about small sample sizes, these results seem to confirm the geomorphological and paleontological evidence of a cold, arctic steppe environment, but with local/seasonal humidity during the time of at least mid-Stratum 5 formation.

Underlying Stratum 6 was formed by even more dynamic (at times violent) water flow through the Trou Magrite karstic system, with coarse sands, water-worn gravels, pebbles and very large cobbles. Haesaerts (this volume) believes that these sediments derive from ancient fluvial terrace deposits atop the plateau, and were washed into the cave through the chimney by strong currents. This high humidity could pertain to one of the wetter phases of oxygen isotope stage 5, such as 5e or 5c. As noted above, this deposit is archeologically and paleontologically sterile.

If these interpretations are correct, the base of the Trou Magrite entrance infilling would date back to oxygen isotope stage 5. Then there seems to have been a significant hiatus, but its exact temporal extent and placement are uncertain. Stratum 4, with evidence of a cold climate and at least periodic, local humidity, alternating with dry conditions, might date to oxygen isotope stage 4. It was definitely truncated by a major episode of erosion, followed by precipitation of calcium carbonate that cemented part of the remaining Stratum 4 deposit. Strata 3 and 2 represent a major change in fundamental deposition, from waterlain to cryoclastic. Formed principally by extensive gelivation, these levels represent much colder overall conditions than the underlying strata. Strata 3 and 2 date to late oxygen isotope stage 3. They were later partially cemented with materials (heavy use of local limestone) and débitage (very high percentage of flakes, few cores) with Strata 4 and 5. Although it has higher percentages of so-called Aurignacian tool types and burins than Stratum 2, in a few respects, Stratum 3 actually "looks" more Mousterian than the two basal levels: lower percentage of blades, lower percentage of blades used as tool blanks, higher percentage of flakes used as blanks), but not much should be made of this due to the small sizes of the samples from Strata 5 and 4. However, both Strata 3 and 2 do have significant numbers of notches, denticulates, sidescrapers and raclettes: 42% and 38% respectively. And the laminar index of even Stratum 2, at around 30,000 years ago, is quite low, no doubt as a result of the site's distance from good flint sources.

TABLE 5.9 : Principal tool group indices for strata 3 & 2

Stratum	E/S	Burin	Perforator	Composite tools	Backed+Trunc.	GM	GA
2	22.9	0.8	3.2	2.4	-	37.7	4.0
3	24.3	4.1	2.5	1.7	1.6	42.1	8.4

E/S=Endscraper
GM=Mousterian tools (sidescrapers, denticulates, notches, raclettes)
GA=Aurignacian tools (Aurignacian blades, keeled & nosed endscrapers)

Both Strata 2 and 3 are rich in endscrapers, Mousterian-type tools and continuously retouched pieces (29% and 22% respectively). Both are poor in burins, perforators. Both have a few foliate point fragments: 2 unifaces in Stratum 2 and 1 biface in Stratum 3. In this last aspect, they share a characteristic of several Early Upper Paleolithic assemblages in Belgium: both ones classified as Aurignacian and others classified as Gravettian sensu lato.

THE OLD "AURIGNACIAN" COLLECTIONS FROM LE TROU MAGRITE

M.Otte, in his thesis on the Early Upper Paleolithic of Belgium, analyzed the extant collections (principally those of Dupont and Rutot at the Institut Royal des Sciences Naturelles de Belgique (IRSNB), plus smaller collections of Loe and of subsequent amateur excavators)(Otte 1979). Unfortunately the collections conserve no indications of stratigraphic provenience that would permit objective differentiation materials from the the Aurignacian and Gravettian levels as presently defined. Otte separated the lithic and osseous artifacts that are traditionally thought to be typical of each period and then characterized the Aurignacian and Gravettian components of le Trou Magrite (obviously a circular procedure, but unavoidable under the circumstances). Even so, Otte admits that very many of the 916 stone tools and 114 bone/antler/ivory/tooth artifacts cannot reasonably be attributed to one or the other of the components. (There are even some Magdalenian tools mixed in with the IRSNB collections---adding to the confusion and to the hypothetical nature of many of the cultural attributions of artifacts from this site [Dewez 1979:161].) Even further complicating the situation is the fact that Otte (1979) believes that more than one Aurignacian facies is represented in the old Trou Magrite collections (see Dewez 1985:121). Otte (1979) notes that there are two types of blades among the 58 surviving in the IRSNB collections: short, wide ones with thick bulbs presumed to be Aurignacian and long, narrow ones with diffuse bulbs and small butts presumed to be Gravettian. The blades from the new excavations correspond to the former type.

Apparently, limestone artifacts from the EUP deposits at le Trou Magrite were not saved, as Otte (1979:119) only mentions flints (fine and coarser grain, usually patinated white. The fine grain flint comes from Upper Cretaceous chalk deposits, while the coarser grain flint (our "medium-grain" type) has cobble cortex and may come from conglomerates or river beds.

The artifacts from the old Trou Magrite collections that Otte (1979) considers to be Aurignacian are keeled and nosed endscrapers, busked and keeled burins and a split-base sagaie. There are also numerous Aurignacian-type blades (invasive scalariform retouch), some of which have been worked into burins and endscrapers. And there are lozange shaped "Aurignac" sagaies, ivory rods and an ivory ring fragment, like those of the Aurignacian of Spy.

By analogy with Spy, le Trou du Renard and la Grotte de la Princesse, Otte attributes the dihedral, flat, busked, and keeled burins in the Trou Magrite collections to the Aurignacian. Otte (1979:169) tentatively assigned the 7 unifacial foliate points with invasive flat retouch in the old collections to the Gravettian (probably because the tanged Font-Robert points have similar invasive retouch). However, in the conclusions of his thesis, he observes that one of the "facies" of the Belgian Aurignacian (represented at Spy and Goyet) also contains unifacial and bifacial foliate points (Otte 1979:603). Otte, based on the very large samples (including whole points) from Spy and Maisières, distinguishes two types of foliates, whose stratigraphic positions are relatively clear at Spy and very well controlled at Maisières-Canal. Since the few points from the new excavations at le Trou Magrite are small fragments, it is impossible to place them securely within Otte's typology, especially since the two types appear to overlap. However Otte's Aurignacian type seems to be made on thicker, more massive blanks and is characterized by marginal, often scalariform retouch that can be unifacial, bifacial or inverse. The Gravettian/ "Maisièrian" type seems to be made on more elongated blades, with flatter, more invasive retouch always only on the dorsal surface and a special burination-like method of distal resharpening. By and large, and especially since one of the newly discovered Trou Magrite points (from Stratum 3) is bifacially worked, Otte's description of the Aurignacian foliates seems to better fit the 1991-92 finds. It should be noted that several other pieces with invasive retouch, while classified by us as other types, might also be included in the foliate category.

The remarkable characteristic of the new Trou Magrite collections (from both Strata 2 and 3) is the virtual absence of burins. Burins (285) and burins spalls (257) are extremely common and classic in forms. The burins outnumber endscrapers by more than 2 to 1 in the lumped IRSNB collections from le Trou

Magrite. How many of them come from the lower part of Dupont's EUP bed is, of course, unknown and unknowable with certainly. Some classic Aurignacian types are, however, among them: notably the abundant keeled and busked burins such as those illustrated by Otte (1979: Figures 36-38). Nothing like these were found in the new excavations.

Burins are quite abundant in other old Belgian Aurignacian collections, often outnumbering endscrapers. The problem with the main Aurignacian collections studied by Otte (e.g., Goyet, Spy) is that there were other levels in the same sites, but the collections had not been kept separate or that the levels had been at least partially mixed in excavation. Otte includes numerous burin types besides keeled and busked burins in his listings for the Aurignacian, including both dihedral and truncation burin categories. In at least three cases of single-component Aurignacian sites (le Trou du Diable à Hastiéres, Grotte de la Princesse à Marche-les-Dames and la Grotte de la Cave à Ben-Ahin), it seems clear that relatively abundant burins including those on truncation can be associated with classic Aurignacian endscrapers, blades and osseous artifacts. Burins in fact outnumber endscrapers at these three sites. At another site, le Trou du Renard à Furfooz, there is no Gravettian layer overlying the Aurignacian and the Magdalenian collection was kept separate (Otte 1979). Here too burins outnumber endscrapers in the small Aurignacian lithic assemblage and there are many burin spalls. However most of the burins are busked or carinated, with no truncation burins. There are no classic Aurignacian osseous artifacts and curiously the "Aurignacian" level has recently been dated on bone collagen to 24,530+470 BP (Otte 1979:102), which would place it squarely in the Gravettian time range.

Despite the problems discussed above, it would seem that burins of a variety of types (and not just busked and carinated burins) are common or even very frequent elements of the Aurignacian lithic industry in Belgium. Their near-absence from two strata dated to the Aurignacian timespan in Trench C at le Trou Magrite is surprising, especially since they seem to have been abundant in the areas of the cave dug by Dupont and Rutot. The only plausible explanation for this contrast would be to evoke an argument for activity area differentiation between the cave and the front of the terrace. Perhaps whatever activities were conducted with burins (bone/antler/ivory-working, etc.?) were done (and the worn burins then discarded) in the sheltered part of the cave, not in the area exposed to the elements beyond the dripline. Note that Trench C was virtually bereft of osseous artifacts (or even debris from their manufacture), while the old collections from the cave are very rich in bone/antler/ivory/ tooth artifacts and fabrication debris. This fact, together with the extreme scarcity of burin spalls in Trench C, supports the hypothesis of an activity area differentiation between the covered and uncovered areas of the Trou Magrite site during Aurignacian time. Finally, special sturdy types of "perforators" that have also shown by microwear studies to have been often used in boneworking, are present in the old collections from the cave (Otte 1979), but absent from the front terrace area.

On the other hand, if we can assume that endscrapers were used to scrape hides (which microwear analyses have consistently shown in numerous cases), such an activity, requiring a large, open space, might well have taken place in front of the cave, where it would not interfere with residential, cooking and manufacturing activites within the sheltered areas. This would explain the high frequency of endscrapers (as well as of side- scrapers, raclettes, and continuously retouched pieces, many of which may functionally have been cutting and scraping tools) in Trench C. Likewise, woodworking would require a great deal of unencumbered open space (albeit close to the living site), hence, perhaps, the relatively large numbers of denticulates and notches in the Trench C area.

COMPARISON AND CORRELATION WITH E.DUPONT'S STRATIGRAPHIC SCHEME

E.Dupont published his stratigraphic descriptions and designations for le Trou Magrite in several articles and books between 1867 and 1874. Despite some contradictions and occasional lack of clarity, these are remarkable documents for their time. Dupont not only was an astute observer of stratigraphy at individual sites, but he also did some perspicacious correlation of deposits among caves, based on geological and paleontological characteristics. He established a regional sequence in Wallonia that paralleled the classic sequence of southern France: Mousterian, Aurignacian, Gravettian and Magdalenian.

Dupont's various descriptions of the sequence for le Trou Magrite have been admirably pieced together, synthesized, reconciled and reconstructed by M.Dewez (1985). It is clear that Dupont found remnants of a Magdalenian at the base of his uppermost bed, called "C" by Dewez: "l'argile à blocaux", which had largely been removed by the promenade construction and cave entry clearance before Dupont's research. The bed below "C" (Dewez's B) is Dupont's "depot argilo-sableux". Dupont divided this into 4 "fossiferous levels", beginning with No.1 at the top. Parts of levels B1 and even B2 had also been removed by the 1830's construction. Bed B measured 2.5 m. thick according to Dupont, although he does not say where he made this measurement (in the cave rear chamber, vestibule or entrance area).

Dewez correlates the uppermost fossiferous level of Bed B (B1) with the Gravettian/Maisiérian component. B2 he assigns to an late Aurignacian, B3 to a typical Aurignacian (in line with Otte's idea that there are more than one Aurignacian facies at le Trou Magrite), and B4 to the Mousterian.

The base of Dupont's sequence was called "cailloux roulés ardennais" (rolled Ardennes cobbles) (Dewez's A), which measured 1 m. thick and was archeologically and paleontologically sterile.

Correlations to our strata seem apparent:

B2=Stratum 2, late Aurignacian;
B3=Stratum 3, early Aurignacian;
B4=Strata 5+4, Mousterian (+Middle-Upper Paleolithic transition?)
A=Stratum 6, sterile.

Note that the total depth of our stratigraphy is 2.5 m., whereas Dupont's total (presumably in the cave interior) was 3.5 m. below the "argile à blocaux". However, given the fact that the 1830's work had removed not only the "argile à blocaux", but also the first fossiliferous level of the "argilo-sableux" bed and part of the second in most of the cave, the remaining deposit thickness would be closer to ours. As noted above, we found no remnant of the Gravettian level (B1) and observed that the top of our Stratum 2 had been cut into and levelled by promenade construction. As cited by Dewez (1985:118-119), Dupont clearly states that the "Reindeer Age" (i.e., Magdalenian) materials came from the base of the "argile-à-blocaux" (pace Ulrix-Closet 1975: 40, who cites an unpublished note in which Rutot argued that the Magdalenian had been in the topmost of the fossiliferous levels: B1). Otte (1979:168) had also reached the conclusion that the Magdalenian level had been in the "argile à blocaux".

One possible complication with the correlation suggested above is the fact that Ulrix-Closet (1975:46) argues for the exsistence of two Mousterian occupations at le Trou Magrite: Mousterian of Acheulean Tradition at the base, followed by a Quina Charentian. This conclusion is based on typological considerations-not on any stratigraphic distinctions existing in the IRSNB collections. Hence, there are arguments for subdividing the Aurignacian on the one hand (Otte 1979), and the Mousterian on the other hand.

In addition, Dupont (1873:88) states that the lower fossiliferous levels (i.e., B3+B4) yielded "triangular flints" and "antler points" like those from Montaigle: "Mammoth Age", a mixture of Mousterian and Aurignacian in modern terms. Dupont further observes that the contents of his four fossiliferous levels intergrade, that is to say, he saw no abrupt breaks between levels, although the artifacts (and fauna) of the topmost level are quite different from those of the bottom level. He saw change as having come gradually, leading to notable changes in technology by the time of the latest level, namely, the Gravettian, with its long, narrow blades, "peeled like an onion" from "circular" (i.e., prismatic) cores (Dupont 1873:90-a description accompanied by a figure of a Font-Robert point and a narrow, elongated, denticulated blade).

Dupont's description of gradual change and intergradation between the Mousterian and Gravettian corresponds well with the nature of our Aurignacian assemblages: many Mousterian artifacts, short blades, heavy use of local limestone, few leptolithic and bone tools. In fact, while our Stratum 5 seems to be "purely" Mousterian, there are hints that Stratum 4 represents a transition to Upper Paleolithic technology. Keeping in mind that Dupont's uppermost fossiliferous level (B1) is missing in the Trench C area, our Stratum 3 can also be seen as "transitional", especially in terms of the slight manufacture and use of blades. Our Stratum 2 is even more "Upper Paleolithic" in its technological characteristics. And, based on the "Gravettian" artifacts published by Otte (1979), it is clear that the leptolithization process continued in B1, as heralded by Dupont. In sum, the Dewez (1985) reconstruction of Dupont's Trou Magrite stratigraphy squares well with the sequence uncovered in 1991-92, although it can never be positively ascertained as to whether B4 equals our Strata 5+4 or B2 equals our Strata 3+2. We favor the former scenario (Dewez's). Hence, the famous pair of works of mobile art (the engraved antler and the "Venus" figurine) from

Dupont's third fossiliferous (B3) level probably correspond to our Stratum 3, early Aurignacian, as convincingly argued by Dewez (1985) on both stratigraphic and comparative stylistic grounds. This would make these art objects, at >34 kya and possibly as old as ca.38-41 kya, among the oldest in Europe or the world, as old or older than those of the early Aurignacian at Das Geissenklösterle, Hohlenstein-Stadel and Vogelherd in SW Germany, which date to around 36-30 kya (Hahn 1986, 1988; personal communication; Bosinski 1982).

REFERENCES

BOSINSKI G., 1982,
Die Kunst der Eiszeit in Deutschland und in der Schweiz. Habelt, Bonn.

CASPAR J-P., 1984,
Matériaux lithiques de la préhistoire. In *Peuples Chasseurs de la Belgique Préhistorique dans leur Cadre Naturel* (D.Cahen and P.Haesaerts, eds.), pp.107-114. Institut Royal des Sciences Naturelles de Belgique, Brussels.

DEWEZ M., 1979,
Note sur des documents encochés du Magdalénien de Chaleux et du Trou Magrite. *Quartär* 29/30:157-162.

DEWEZ M., 1985,
L'art mobilier paléolithique du Trou Magrite dans son contexte stratigraphique. *Bull.Soc.roy.belge Anthrop.Préhist.* 96:117-133.

HAHN J., 1986,
Kraft und Aggression. Archaeologica Venatoria 7, Tübingen.

HAHN J., 1988,
Die Geissenklösterle-Höhle im Achtal bei Blaubeuren, vol. 1. Theiss, Stuttgart.

OTTE M., 1977,
Le Paléolithique Supérieur Ancien en Belgique. Musées Royaux d'Art et d'Histoire, Brussels.

ULRIX-CLOSSET M., 1975,
Le Paléolithique Moyen dans le Bassin Mosan en Belgique. Universa, Wetteren.

APPENDIX

LITHIC RAW MATERIAL LIST

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New List (1992-1993)

10. Fine-grain flint: fine grain; shiny, smooth surface; opaque to slightly translucent; blue-gray original color; patinates white; chalk cortex; inclusions rare; conchoidal fracture pattern. Source: Cretaceous of Hesbaye and Spiennes. Intergrades with 12.

11. Fine-grain flint: fine grain; shiny, smooth surface; opaque to slightly translucent; brown-yellow color; patinates white; chalk cortex; occasional inclusions; conchoidal fracture pattern. Source: Cretaceous of North Belgium.

12. Medium-grain flint: medium grain; matte, slightly rough surface; opaque; occasional inclusions; gray color, patinates white; water worn cortex; conchoidal fracture pattern. Source: Cretaceous, occurs in river beds.

13. Fine-grain flint: fine grain; shiny, smooth surface; opaque; dark brown color with occasional yellow bands; does not patinate; water worn cortex; inclusions rare; conchoidal fracture pattern. Source: Tertiary of North Belgium.

14. "Pseudo" flint: fine grain; shiny, orthogonal surface; translucent to slightly opaque; light brown to dark gray, mottled; does not patinate; water worn cortex; inclusions rare conchoidal fracture pattern. Age and source unknown.

15. Black flint: See 12, except very matte; with some rare inclusions. Source: in local limestone.

16. Black flint: very fine grain; opaque; homogeneous; no inclusions; conchoidal fracture; orange-ish chalk cortex, smooth and shiny. Source: possibly Obourg or, at Huccorgne, a local (Hesbaye) Cenomanian flint (like "Brandon" flint).

18. Patinated "Hesbaye".

19. Other flint.

20. Chert - general, non-cortical: fine to medium grain; matte or shiny, smooth surface; opaque to slightly translucent; wide color range; dies not patinate; cortex absent; inclusions rare; mainly orthogonal fracture pattern. Cretaceous, source unknown.

Chert with unworn cortex: Same as above, but with unworn cortex. Occurs in Cretaceous geological beds.

Chert with water worn cortex: Same as above, but with water worn cortex. Cretaceous. Found in river beds.

30. Phtanite: medium-grain; matte or shiny surface; opaque; jet black to grayish black; does not patinate; gray cortex with occasional metal adhesions; no inclusions; conchoidal fracture pattern. Source: Cretaceous. Occurs in geological bed at Ottignies, Central Belgium.

40. Medium-grain limestone: medium grain; soft, matte surface; opaque; gray-black; patinates gray; cortex impossible to distinguish; inclusions rare; conchoidal fracture pattern; violent reaction with acid.

41. Fine-grain limestone: fine grain; hard, matte surface; opaque; black with white-yellow flecks; light gray patina; cortex impossible to distinguish; inclusions rare; conchoidal fracture pattern; mild reaction with acid. Silicified limestone. Cretaceous. Intergrades with 15.

42. Crystallized limestone: fine to medium grain; hard, matte surface; opaque; gray-white, mottled; does not patinate; cortex impossible to distinguish; occasional inclusions; mainly conchoidal fracture pattern; mild reaction with acid ("limey chert"). Cretaceous.

50. Medium-grain quartzite (includes quartzitic sandstone): medium grain; matte to shiny surface; opaque; wide color range; does not patinate; cortex water worn; no inclusions; conchoidal fracture pattern. Occurs as cobbles in river beds.

51. Fine-grain quartzite/siltstone: fine grain; matte surface; opaque; tan-brown color with occasional bands; does not patinate; cortex water worn; manganese inclusions; conchoidal fracture pattern. Source: Paris Basin; occurs as river cobbles.

52. Quartz crystal: fine to medium grain; shiny surface; translucent to opaque ("milk quartz"); milky-white to yellow; does not patinate; cortex unworn; no inclusions; ortho-conchoidal to planar fracture pattern. Occurs in geological beds (included in the local limestone).

53. Sandstone.

54. Brussels sandstone.

55. Psammite: light brown with manganese oxide stains; medium-coarse grain (looks like quartzite); opaque; occurs in Lesse river valley and at Gendron railroad station. In the form of tabular plaquettes. Sandstone with quartz grains and mica inclusions.

56. Calcite.

90. Ochre/hematite.

99. Other stones.

M. OTTE et L.G. STRAUS (dir.), *Le Trou Magrite. Fouilles 1991-1992*. Liège, E.R.A.U.L. 69, 1995.

6

A STATISTICAL COMPARISON OF AURIGNACIAN AND MOUSTERIAN ASSEMBLAGES

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SUMMARY

There are four archaeological strata at Le Trou Magrite, two identified as Aurignacian and two as Mousterian. The goal of this analysis is to compare the lithic components of each pair of strata in order to identify similarities and differences with respect to raw materials utilized, kinds of debitage produced on different raw materials or by potentially different techniques (e.g., flake versus blade blank production and use), and kinds of tools produced. This study demonstrates similarities between and variability within technological aspects of typologically-defined industries, which may be affected by factors related to quality and abundance of different kinds of raw materials.

DESCRIPTION OF DATA AND VARIABLES

The data analyzed are the lithic components from Strata 2-5. Briefly, the data include two types of observations : 1) piece-plotted artifacts and 2) artifacts collected by spit and quarter meter square as "spit bag contents". Piece-plotted artifacts are generally artifacts greater than or equal to 1 cm that are individually plotted in three dimensions, and then individually weighed, measured, and classified. During laboratory field analysis, spit bag contents are sorted according to raw material type, portion, and debitage type and then weighed as sub-groups and counted.

Categorical variables include the following : 1) raw material type, 2) Upper Paleolithic tool type, and 3) blank, debris or debitage type. Raw material for each artifact was identified using a geological list of raw material types which were then grouped into seven classes (Table 6.1). For those artifacts which are retouched tools, the de Sonneville-Bordes/Perrot typelist was used to identify 'Upper Paleolithic tool types' which were then further grouped into seven broad tool classes (Table 6.2). 'Blank, debris or debitage type' refers to the kinds of lithic debitage produced during reduction sequences, such as cortical flakes, trimming flakes, flake blanks, blade blanks, or cores.

Table 6.1: Raw material types

1	flint
2	chert
3	phtanite
4	limestone
5	quartzite
6	ochre/hematite
7	other

Note: type 7 was excluded from analysis.

Table 6.2: Grouped Upper Paleolithic tool types

1	endscrapers
2	burins, percoirs, becs
3	blades, continuously retouched pieces
4	notches and denticulates
5	sidescrapers, raclettes
6	composite tools
7	diverse

Note: diverse tools (consisting of Late Upper Paleolithic tools in secondary context) were excluded from analysis.

Table 6.3: Grouped blank or debitage types

1	trimming flakes
2	shatter
3	flakes
4	blades
5	burin spalls
6	cores
7	chunks
8	fire-cracked rock

Note: fire-cracked rock was excluded from analysis.

Artifacts were categorized into 30 types, which were then further grouped into eight broad classes (Table 6.3).

Three variables - length, width, and thickness - were measured on piece-plotted artifacts as indicators of size. For spit bags, artifacts were grouped by raw material/debitage type combinations and then weighed by groups.

All statistical analyses were performed at the 95% significance level and utilize frequency rather than weight data.

SUMMARY OF ANALYSES PERFORMED

Part 1 : Comparison between strata of frequencies for each categorical variable (raw material, tool[1], and debitage classes).

Part 2 : Comparison between strata of frequencies for cross-tabulated categorical variables :
- -tool class and raw material class
- -tool class and debitage class (see Part 3)
- -debitage class and raw material class

Part 3 : Comparison of size variables between tools made on flakes or blades and flake/blade blanks (debitage types 3 and 4)

Part 4 : Inter-strata analysis of whole blades :
- -comparison of frequencies of raw materials producing blades
- -comparison of size of whole blades
- -comparison of size of blades between raw material classes

Part 5 : Inter-strata comparison of cortical vs. non-cortical flint debitage

Part 6 : Analysis of variability of edge angles for endscrapers

RESULTS

Part 1 : Comparison between strata of frequencies for each categorical variable (raw material, tool, and debitage classes).

1 Comparison of tool classes is between Strata 2 and 3 only because of the small sample size for Strata 4 and 5.

Table 6.4. Raw Material Frequencies: Strata 2-5

----------------------- STRATUM=2 -----------------------

Grouped Material

MATCODE	Frequency	Percent	Cumulative Frequency	Cumulative Percent
flint	3188	61.2	3188	61.2
chert	131	2.5	3319	63.8
phtanite	38	0.7	3357	64.5
limestone	1711	32.9	5068	97.4
quartzite	137	2.6	5205	100.0

----------------------- STRATUM=3 -----------------------

Grouped Material

MATCODE	Frequency	Percent	Cumulative Frequency	Cumulative Percent
flint	936	35.8	936	35.8
chert	114	4.4	1050	40.1
phtanite	17	0.6	1067	40.8
limestone	1458	55.7	2525	96.5
quartzite	92	3.5	2617	100.0

----------------------- STRATUM=4 -----------------------

Grouped Material

MATCODE	Frequency	Percent	Cumulative Frequency	Cumulative Percent
flint	36	24.3	36	24.3
chert	8	5.4	44	29.7
phtanite	1	0.7	45	30.4
limestone	89	60.1	134	90.5
quartzite	14	9.5	148	100.0

----------------------- STRATUM=5 -----------------------

Grouped Material

MATCODE	Frequency	Percent	Cumulative Frequency	Cumulative Percent
flint	26	23.4	26	23.4
chert	21	18.9	47	42.3
phtanite	1	0.9	48	43.2
limestone	52	46.8	100	90.1
quartzite	11	9.9	111	100.0

Percent Raw Material
Strata 2-5

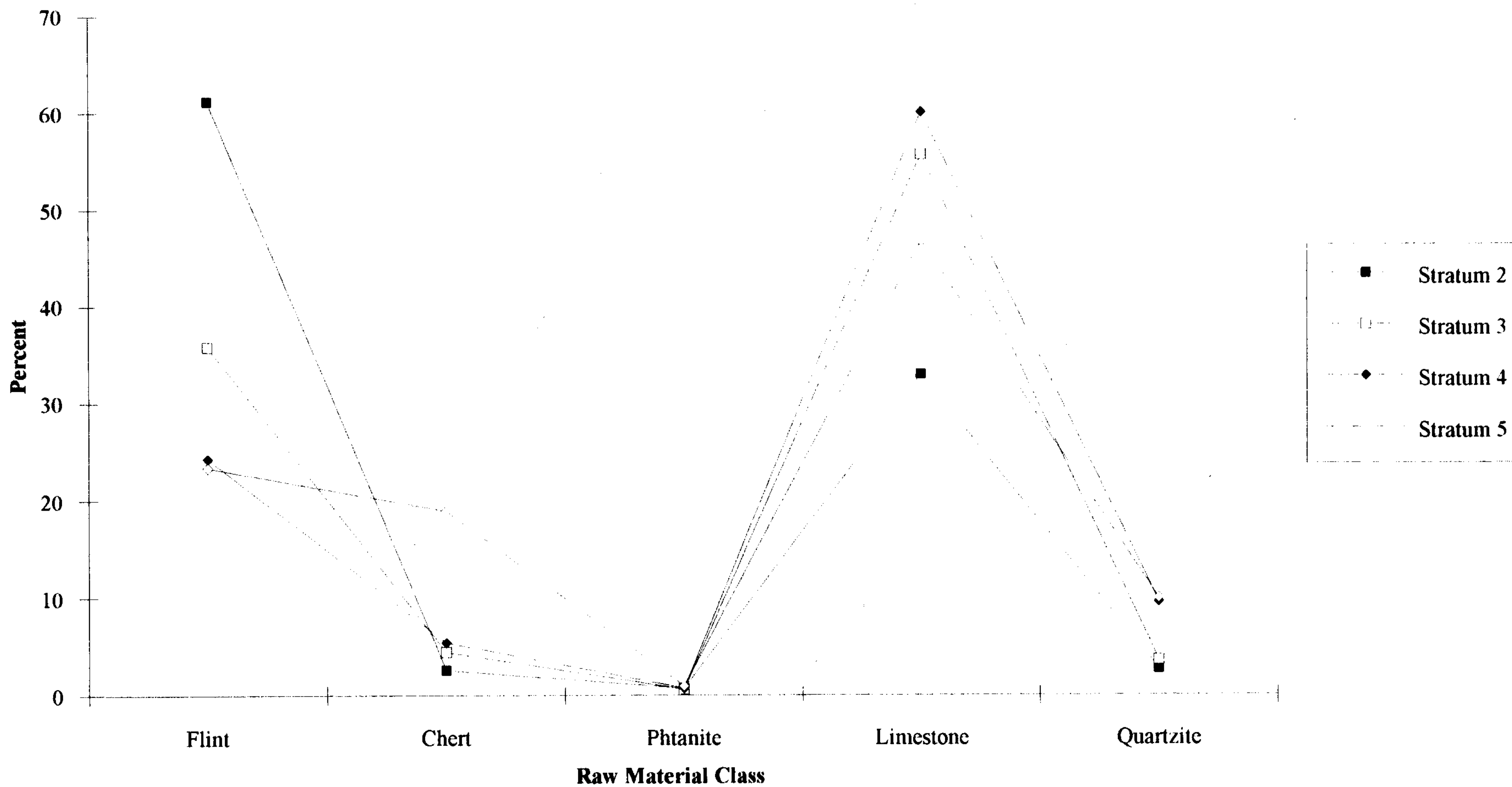


Figure 6.1

1) Raw material class (Table 6.4, Figure 6.1)

Strata 2 and 3. Comparing Strata 2 and 3, the p-value for the chi-square test is 0.000 (df=4, value=462.334, n=7822). Strata 2 and 3 are significantly different with respect to frequencies of raw materials by count. They differ in use of flint and limestone while use of chert, phtanite and quartzite is not significantly different between strata. Stratum 2 has a much higher relative frequency of flint than Stratum 3 (61.25% vs. 35.77%). Stratum 3 has a higher relative frequency of limestone than Stratum 2 (55.71% vs. 32.87%).

Strata 2 and 4. Comparing Strata 2 and 4, the p-value for the chi-square test is 0.000 (df=8, value=113.904, n=5353). Strata 2 and 4 are significantly different with respect to use of flint (61.25% vs. 24.32%) and limestone (32.87% vs. 60.14%).

Strata 2 and 5. Comparing Strata 2 and 5, the p-value for the chi-square test is 0.000 (df=10, value=331.364, n=5464). Strata 2 and 5 differ primarily with respect to use of flint (61.25% vs. 23.42%), chert (2.52% vs. 18.92%), limestone (32.87% vs. 46.85%), and quartzite (2.63% vs. 9.91%).

Strata 3 and 4. Comparing Strata 3 and 4, the p-value for the chi-square test is 0.001 (df=8, value=239.062, n=2765). Strata 3 and 4 are also significantly different with respect use of flint (35.77% vs. 24.32%) and quartzite (60.14% vs. 55.71%), while chert, phtanite and limestone were not significantly different.

Strata 3 and 5. Comparing Strata 3 and 5, the p-value for the chi-square test is 0.000 (df=4, value=63.379, n=2728). Strata 3 and 5 differ with respect to use of flint (35.77% vs. 23.42%), chert (4.36% vs. 18.92%), limestone (55.71% vs. 46.85%), and quartzite (3.52% vs. 9.91%).

Strata 4 and 5. Comparing Strata 4 and 5, the p-value for the chi-square test is 0.010 (df=5, value=15.088, n=261). Strata 4 and 5 differ with respect to limestone (60.1% vs. 46.0%) and chert (5.41% vs. 18.58%). They are not significantly different with respect to flint, phtanite, and quartzite.

Figure 6.1 shows the frequencies for Strata 2-5 and indicates that Stratum 3 is more similar to Stratum 4 than to Stratum 2 with respect to raw material. There is a general trend from Stratum 5 to Stratum 2 reflecting an increase in the use of flint and a decrease in chert and quartzite. For limestone, the frequency increases from Stratum 5 to Stratum 4, followed by a decreasing trend through Stratum 2, with a substantial decrease between Strata 3 and 2.

Flint is from non-local sources, Obourg flint near Mons, and Maastrichtian flint in eastern Belgium and southern Holland. Phtanite is found near Ottignies. Limestone is local, found in the limestone cliffs. Quartzite is also locally available in the form of river cobbles. Both flint and phtanite are of good quality, suitable for a range of reduction techniques. Limestone and quartzite are of lesser quality, but are still useable.

2a) Upper Paleolithic tool type (Table 6.5, Figure 6.2)

Comparing Strata 2 and 3, the p-value for the chi-square test is 0.191 (df=5, value=7.430, n=208). The two strata are not significantly different with respect to tool types present. However, Figure 6.2 shows the existence of some minor differences in frequencies of blade tools, notches and denticulates, and sidescrapers. There is an inverse relationship between blades and notches/ denticulates. Stratum 2 has a higher frequency of blades while Stratum 3 has a higher frequency of notches/denticulates. Stratum 2 also has a higher frequency of sidescrapers/raclettes while Stratum 3 has a higher frequency of burins/perçoirs/becs; however, these differences are not statistically significant.

2b) Middle Paleolithic tool type (Table 6.5a)

The small sample size of Mousterian tools from Strata 4 and 5 prevents statistical comparison of these strata. Table 6.5a summarizes their frequencies.

3) Blank or debitage type (Table 6.6, Figure 6.3)

Strata 2 and 3. Comparing Strata 2 and 3, the p-value for the chi-square test is 0.000. The two strata are significantly different with respect to blank or debitage type. They primarily differ in relative frequencies of shatter, flakes, and blade blanks. Stratum 2 has a higher relative frequency of shatter than Stratum 3 (12.55% vs. 4.51%) as well as a slightly higher frequency of blade blanks (10.84% vs. 8.22%). Stratum 3 has a higher relative frequency of flakes than Stratum 2 (60.02% vs. 49.81%).

Strata 2 and 4. Comparing Strata 2 and 4, the p-value for the chi-square test is 0.000 (df=7, value=80.937, n=5346). Stratum 4 has a higher relative frequency of cores and a lower relative frequency of trimming flakes and shatter while Stratum 2 has an opposite relationship.

Strata 2 and 5. Comparing Strata 2 and 5, the p-value for the chi-square test is 0.000 (df=14, value=366.102, n=7933). Stratum 5 has the lowest relative frequency of trimming flakes, and shatter, and a higher relative frequency of flakes and chunks relative to Stratum 2.

Strata 3 and 4. Comparing Strata 3 and 4, the p-value for the chi-square test is 0.000 (df=7, value=49.828, n=2758). The two strata are also significantly different with respect to blank or debitage type, primarily trimming flakes and flakes. Stratum 3 has a higher frequency of trimming flakes then Stratum 4 (21.60% vs. 14.08%) and a higher frequency of flakes (60.02% vs. 51.41%). Stratum 4 also has a higher frequency of cores than either Stratum 3 or Stratum 2.

Strata 3 and 5. Comparing Strata 3 and 5, the p-value for the chi-square test is 0.000 (df=7, value=136.629, n=2729). The differences are similar to the comparison between Strata 2 and 5.

Table 6.5: Upper Paleolithic Tool Classes - Strata 2 and 3

STRATUM=2

TOOLSM1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
endscrapers	27	25.5	27	25.5
burins/perçoirs/becs	4	3.8	31	29.2
retouched blades, CRPs	37	34.9	68	64.2
notches/denticulates	25	23.6	93	87.7
sidescrapers/raclettes	11	10.4	104	98.1
composite	2	1.9	106	100.0

STRATUM=3

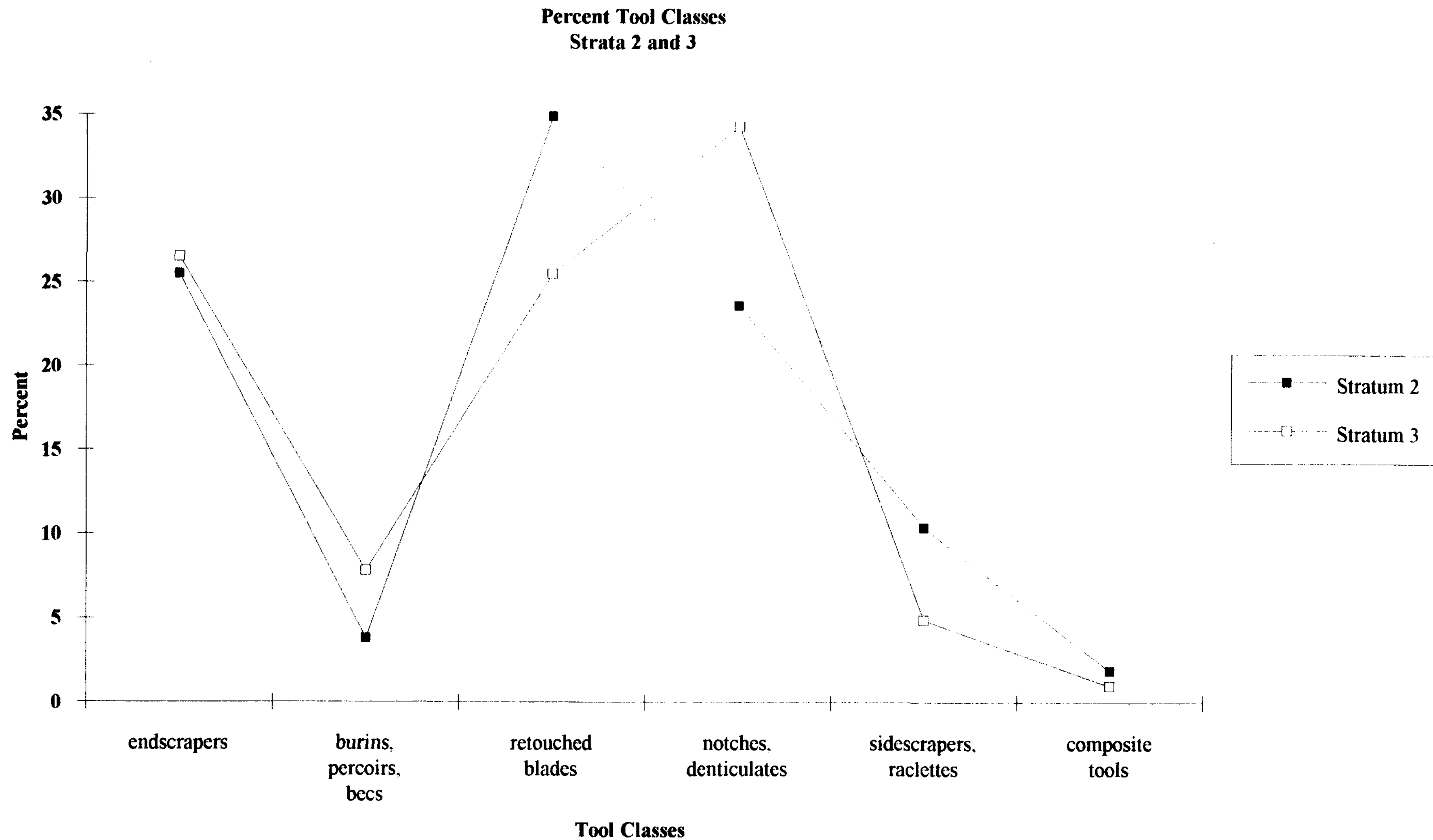
TOOLSM1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
endscrapers	27	26.5	27	26.5
burins/perçoirs/becs	8	7.8	35	34.3
retouched blades, CRPs	26	25.5	61	59.8
notches/denticulates	35	34.3	96	94.1
sidescrapers/raclettes	5	4.9	101	99.0
composite	1	1.0	102	100.0

TABLE OF STRATUM BY TOOLSM1

STRATUM TOOLSM1

Frequency
Expected
Deviation
Percent
Row Pct
Col Pct

STRATUM	endscrap	burins	blades	not/dent	sidescrp	compos	Total
2	27	4	37	25	11	2	106
	27.519	6.1154	32.106	30.577	8.1538	1.5288	
	-0.519	-2.115	4.8942	-5.577	2.8462	0.4712	
	12.98	1.92	17.79	12.02	5.29	0.96	50.96
	25.47	3.77	34.91	23.58	10.38	1.89	
	50.00	33.33	58.73	41.67	68.75	66.67	
3	27	8	26	35	5	1	102
	26.481	5.8846	30.894	29.423	7.8462	1.4712	
	0.5192	2.1154	-4.894	5.5769	-2.846	-0.471	
	12.98	3.85	12.50	16.83	2.40	0.48	49.04
	26.47	7.84	25.49	34.31	4.90	0.98	
	50.00	66.67	41.27	58.33	31.25	33.33	
Total	54	12	63	60	16	3	208
	25.96	5.77	30.29	28.85	7.69	1.44	100.00



Percent Tool Classes
Strata 2 and 3
Percent
35
30
25
20
15
10
5
0
endscrapers
burins, percoirs, becs
retouched blades
notches, denticulates
sidescrapers, raclettes
composite tools
Tool Classes
Stratum 2
Stratum 3

Figure 6.2

Table 6.5a. Frequencies of Middle Paleolithic Tools for Strata 4 and 5

STRATUM=4

MPCODE1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Sidescrapers	1	33.3	1	33.3
Notches	2	66.7	3	100.0

STRATUM=5

MPCODE1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Levallois flake	1	16.7	1	16.7
Sidescrapers	2	33.3	3	50.0
Burins	1	16.7	4	66.7
Raclettes	1	16.7	5	83.3
Denticulates	1	16.7	6	100.0

Table 6.6. Debitage Frequencies: Strata 2-5

STRATUM=2

Grouped Debitage

DEBCODE	Frequency	Percent	Cumulative Frequency	Cumulative Percent
trimming flakes	1053	20.2	1053	20.2
shatter	653	12.5	1706	32.8
flakes	2592	49.8	4298	82.6
blades	564	10.8	4862	93.4
burin spalls	6	0.1	4868	93.5
cores	32	0.6	4900	94.2
chunks	304	5.8	5204	100.0

STRATUM=3

DEBCODE	Frequency	Percent	Cumulative Frequency	Cumulative Percent
trimming flakes	565	21.6	565	21.6
shatter	118	4.5	683	26.1
flakes	1570	60.1	2253	86.3
blades	215	8.2	2468	94.5
burin spalls	2	0.1	2470	94.6
cores	10	0.4	2480	94.9
chunks	132	5.1	2612	100.0

STRATUM=4

DEBCODE	Frequency	Percent	Cumulative Frequency	Cumulative Percent
trimming flakes	20	14.2	20	14.2
shatter	7	5.0	27	19.1
flakes	73	51.8	100	70.9
blades	14	9.9	114	80.9
cores	1	0.7	115	81.6
chunks	26	18.4	141	100.0

STRATUM=5

DEBCODE	Frequency	Percent	Cumulative Frequency	Cumulative Percent
trimming flakes	6	5.5	6	5.5
shatter	1	0.9	7	6.4
flakes	62	56.4	69	62.7
blades	10	9.1	79	71.8
cores	5	4.5	84	76.4
chunks	26	23.6	110	100.0

Table 6.6, continued

TABLE OF STRATUM BY DEBCODE

STRATUM — DEBCODE(Grouped Debitage)

STRATUM (Frequency / Percent / Row Pct / Col Pct)	trimming	shatter	flakes	blades	Total
2	169 4.94 8.64 57.29	99 2.89 5.06 63.87	1103 32.21 56.42 54.02	377 11.01 19.28 66.73	1955 57.10
3	106 3.10 8.35 35.93	51 1.49 4.02 32.90	839 24.50 66.06 41.09	165 4.82 12.99 29.20	1270 37.09
4	15 0.44 14.15 5.08	4 0.12 3.77 2.58	54 1.58 50.94 2.64	13 0.38 12.26 2.30	106 3.10
5	5 0.15 5.38 1.69	1 0.03 1.08 0.65	46 1.34 49.46 2.25	10 0.29 10.75 1.77	93 2.72

STRATUM — DEBCODE(Grouped Debitage)

STRATUM (Frequency / Percent / Row Pct / Col Pct)	burinspl	cores	chunks	Total
2	6 0.18 0.31 75.00	21 0.61 1.07 56.76	180 5.26 9.21 55.90	1955 57.10
3	2 0.06 0.16 25.00	10 0.29 0.79 27.03	97 2.83 7.64 30.12	1270 37.09
4	0 0.00 0.00 0.00	1 0.03 0.94 2.70	19 0.55 17.92 5.90	106 3.10
5	0 0.00 0.00 0.00	5 0.15 5.38 13.51	26 0.76 27.96 8.07	93 2.72
Total	8 0.23	37 1.08	322 9.40	3424 100.00

Percent Debitage Classes
Strata 2-5

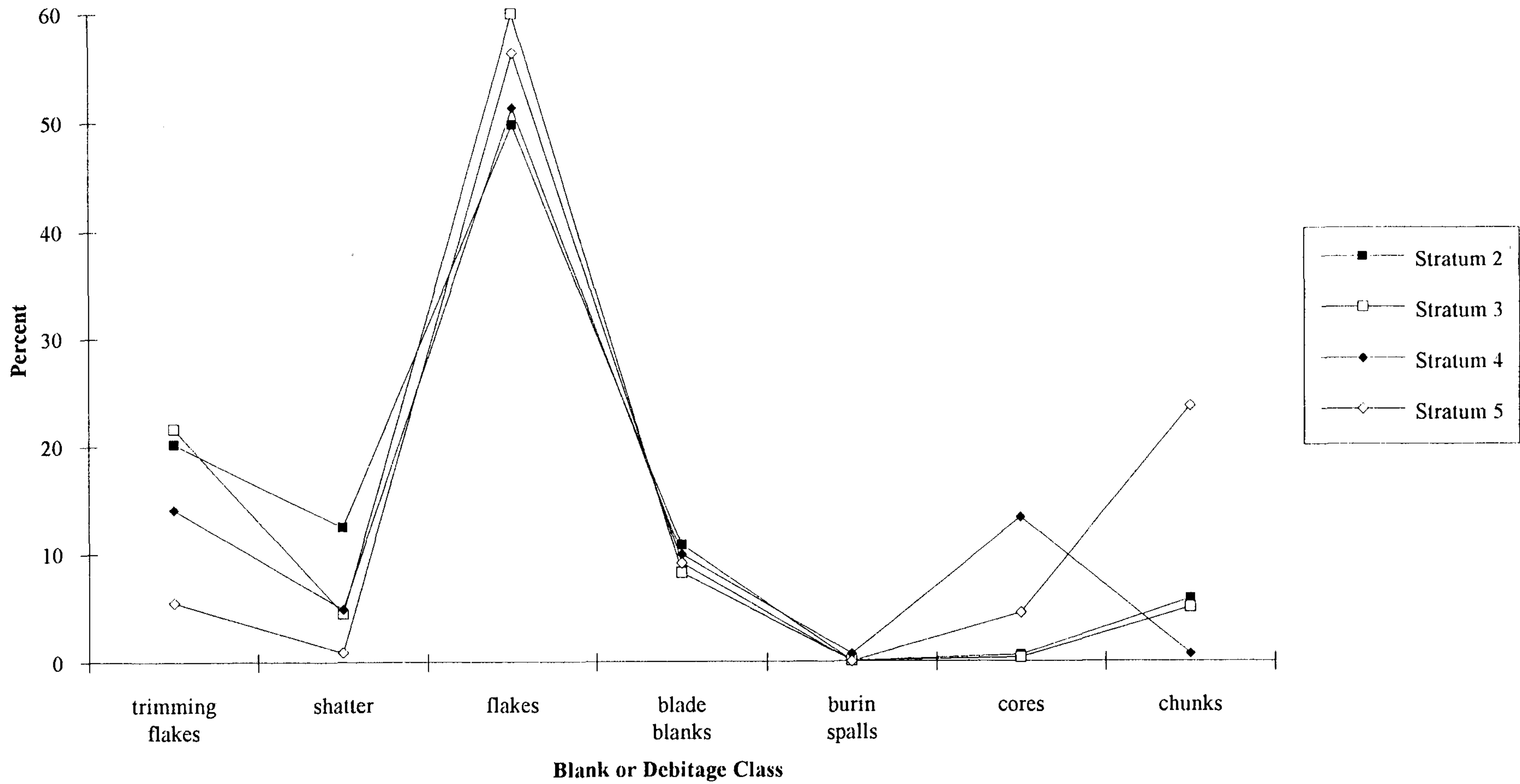


Figure 6.3

Figure 3

Strata 4 and 5. Comparing Strata 4 and 5, the p-value for the chi-square test is 0.028 (df=6, value=14.153, n=255). The two strata are significantly different with respect to trimming flakes (14.08% vs. 5.31%), shatter (4.93% vs. 0.88%), cores (0.70% vs. 4.42%). They are similar with respect to flakes, blades, and chunks.

Figure 6.3 shows the frequencies for Strata 2-5 and indicates that with respect to debitage frequencies, Stratum 3 is more similar to Stratum 2 than to Stratum 4, an interesting fact since Stratum 4 may be assigned to the "Mousterian" while Strata 3 and 2 are assigned to "Aurignacian" on the basis of retouched tool assemblages. Interestingly, there is *not* a significant increase in the frequency of blade blanks from Stratum 5 through Stratum 2. The relative frequency is very gradually decreasing from Stratum 5 to 3, with a slight increase (0.65 to 0.73) from Stratum 3 to Stratum 2. For flake blanks, there is a decrease from Stratum 5 to 4, an increase from 4 to 3, followed by a substantial decrease from 3 to 2, which perhaps corresponds to the increase in blades.

Part 2: Comparison between strata of frequencies for cross-tabulated categorical variables :

1) Tool class and raw material class (Tables 6.7 and 6.8, Figure 6.4)

Due to small sample sizes for retouched tools, this analysis can only be used to compare Strata 2 and 3.

No tools were produced on phtanite in Stratum 3 and very few in Stratum 2. Therefore, the chi-square test was performed with phtanite excluded.

For Stratum 2 (phtanite excluded), the p-value for the chi-square test is 0.349 (df=15, value=16.516, n=102). When phtanite is included, similar results are obtained. Different tool types are not being made preferentially on different raw materials. However, Table 7a shows that far more tools are being produced on flint and limestone than on chert, phtanite, or quartzite. The general pattern is one in which flint and limestone are chosen over other materials, but where specific tool types are not made preferentially on different materials.

For Stratum 3, the p-value for the chi-square test is 0.426 (df=15, value=15.364, n=102). Tools are again produced non-differentially on different raw materials.

Figure 4 shows side-by-side frequency charts for Strata 2 and 3.

2) Debitage class and raw material class (Tables 6.9 and 6.10, Figures 6.5 and 6.6)

Stratum 2. For Stratum 2 (Table 6.9), the p-value for the chi-square test is 0.000 (df=24, value=928.131, n=5204). The range of debitage types produced is non-randomly distributed across raw material types. For flint, frequencies of trimming flakes and shatter are higher than expected, and frequencies of flakes, blades, and chunks are lower than expected. For limestone, the exact opposite is true, possibly due to lack of

Table 6.7. Tool Class*Material Class: Stratum 2

TABLE 1 OF TOOLSM1 BY MATCODE
CONTROLLING FOR STRATUM=2

TOOLSM1 MATCODE(Grouped Material)

TOOLSM1	Frequency / Expected / Deviation / Percent / Row Pct / Col Pct	flint	chert	phtanite	limestne	quartzte	Total
end-scrapers	Frequency	23	0	1	2	1	27
	Expected	19.358	0.7642	0.5094	5.8585	0.5094	
	Deviation	3.6415	-0.764	0.4906	-3.858	0.4906	
	Percent	21.70	0.00	0.94	1.89	0.94	25.47
	Row Pct	85.19	0.00	3.70	7.41	3.70	
	Col Pct	30.26	0.00	50.00	8.70	50.00	
burins, perçoirs, becs	Frequency	4	0	0	0	0	4
	Expected	2.8679	0.1132	0.0755	0.8679	0.0755	
	Deviation	1.1321	-0.113	-0.075	-0.868	-0.075	
	Percent	3.77	0.00	0.00	0.00	0.00	3.77
	Row Pct	100.00	0.00	0.00	0.00	0.00	
	Col Pct	5.26	0.00	0.00	0.00	0.00	
retouched blades	Frequency	27	2	1	7	0	37
	Expected	26.528	1.0472	0.6981	8.0283	0.6981	
	Deviation	0.4717	0.9528	0.3019	-1.028	-0.698	
	Percent	25.47	1.89	0.94	6.60	0.00	34.91
	Row Pct	72.97	5.41	2.70	18.92	0.00	
	Col Pct	35.53	66.67	50.00	30.43	0.00	
notches, denti-culates	Frequency	14	0	0	10	1	25
	Expected	17.925	0.7075	0.4717	5.4245	0.4717	
	Deviation	-3.925	-0.708	-0.472	4.5755	0.5283	
	Percent	13.21	0.00	0.00	9.43	0.94	23.58
	Row Pct	56.00	0.00	0.00	40.00	4.00	
	Col Pct	18.42	0.00	0.00	43.48	50.00	
side-scrapers	Frequency	7	1	0	3	0	11
	Expected	7.8868	0.3113	0.2075	2.3868	0.2075	
	Deviation	-0.887	0.6887	-0.208	0.6132	-0.208	
	Percent	6.60	0.94	0.00	2.83	0.00	10.38
	Row Pct	63.64	9.09	0.00	27.27	0.00	
	Col Pct	9.21	33.33	0.00	13.04	0.00	
composite tools	Frequency	1	0	0	1	0	2
	Expected	1.434	0.0566	0.0377	0.434	0.0377	
	Deviation	-0.434	-0.057	-0.038	0.566	-0.038	
	Percent	0.94	0.00	0.00	0.94	0.00	1.89
	Row Pct	50.00	0.00	0.00	50.00	0.00	
	Col Pct	1.32	0.00	0.00	4.35	0.00	
Total		76	3	2	23	2	106
		71.70	2.83	1.89	21.70	1.89	100.00

Percent Tool Types by Raw Material (phtanite excluded)
Strata 2 and 3

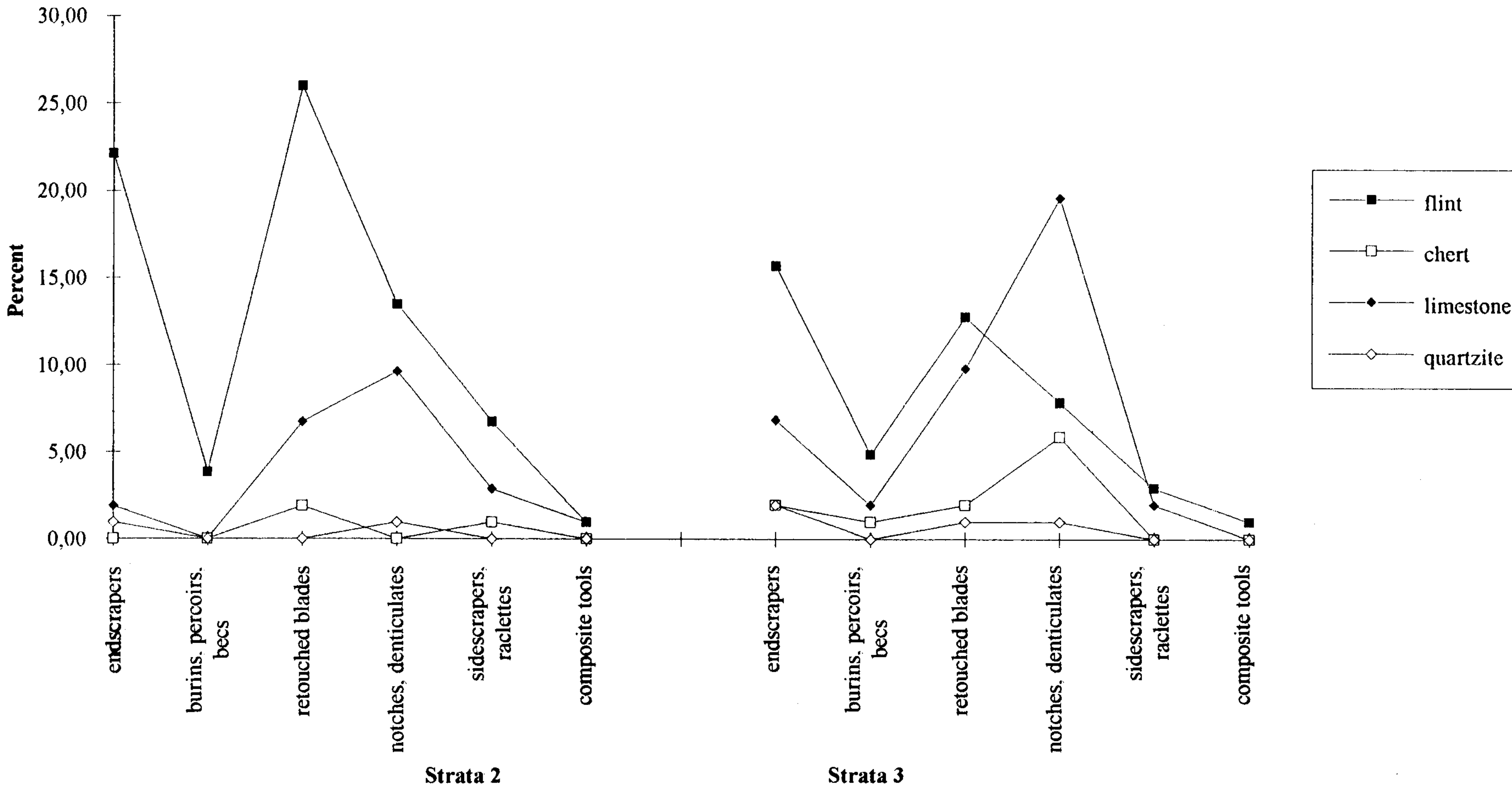


Figure 6.4

Table 6.8. Debitage Class*Material Class: Stratum 2

TABLE 1 OF DEBCODE BY MATCODE
CONTROLLING FOR STRATUM=2

DEBCODE(Grouped Debitage) MATCODE(Grouped Material)

Frequency / Expected / Deviation / Percent / Row Pct / Col Pct	flint	chert	phtanite	limestne	quartzte	Total
trimming	948	12	3	85	5	1053
flakes	645.07	26.305	7.6891	346.21	27.721	
	302.93	-14.3	-4.689	-261.2	-22.72	
	18.22	0.23	0.06	1.63	0.10	20.23
	90.03	1.14	0.28	8.07	0.47	
	29.74	9.23	7.89	4.97	3.65	
shatter	587	12	0	53	1	653
	400.03	16.312	4.7683	214.7	17.191	
	186.97	-4.312	-4.768	-161.7	-16.19	
	11.28	0.23	0.00	1.02	0.02	12.55
	89.89	1.84	0.00	8.12	0.15	
	18.41	9.23	0.00	3.10	0.73	
flakes	1205	67	25	1201	94	2592
	1587.9	64.75	18.927	852.21	68.237	
	-382.9	2.2498	6.073	348.79	25.763	
	23.16	1.29	0.48	23.08	1.81	49.81
	46.49	2.58	0.96	46.33	3.63	
	37.80	51.54	65.79	70.19	68.61	
blade	274	19	7	239	25	564
blanks	345.51	14.089	4.1184	185.44	14.848	
	-71.51	4.9108	2.8816	53.565	10.152	
	5.27	0.37	0.13	4.59	0.48	10.84
	48.58	3.37	1.24	42.38	4.43	
	8.59	14.62	18.42	13.97	18.25	
burin	5	1	0	0	0	6
spalls	3.6756	0.1499	0.0438	1.9727	0.158	
	1.3244	0.8501	-0.044	-1.973	-0.158	
	0.10	0.02	0.00	0.00	0.00	0.12
	83.33	16.67	0.00	0.00	0.00	
	0.16	0.77	0.00	0.00	0.00	
cores	16	1	1	11	3	32
	19.603	0.7994	0.2337	10.521	0.8424	
	-3.603	0.2006	0.7663	0.4789	2.1576	
	0.31	0.02	0.02	0.21	0.06	0.61
	50.00	3.13	3.13	34.38	9.38	
	0.50	0.77	2.63	0.64	2.19	
chunks	153	18	2	122	9	304
	186.23	7.5942	2.2198	99.951	8.0031	
	-33.23	10.406	-0.22	22.049	0.9969	
	2.94	0.35	0.04	2.34	0.17	5.84
	50.33	5.92	0.66	40.13	2.96	
	4.80	13.85	5.26	7.13	6.57	
Total	3188	130	38	1711	137	5204
	61.26	2.50	0.73	32.88	2.63	100.00

Table 6.9. Debitage Class*Material Class: Stratum 3

TABLE 2 OF DEBCODE BY MATCODE
CONTROLLING FOR STRATUM=3

DEBCODE(Grouped Debitage) MATCODE(Grouped Material)

Frequency Expected Deviation Percent Row Pct Col Pct	flint	chert	phtanite	limestne	quartzte	Total
trimming	340	6	2	210	7	565
flakes	202.25	24.659	3.6773	315.38	19.035	
	137.75	-18.66	-1.677	-105.4	-12.04	
	13.02	0.23	0.08	8.04	0.27	21.63
	60.18	1.06	0.35	37.17	1.24	
	36.36	5.26	11.76	14.40	7.95	
shatter	63	6	2	46	1	118
	42.24	5.1501	0.768	65.867	3.9755	
	20.76	0.8499	1.232	-19.87	-2.975	
	2.41	0.23	0.08	1.76	0.04	4.52
	53.39	5.08	1.69	38.98	0.85	
	6.74	5.26	11.76	3.16	1.14	
flakes	404	74	9	1015	68	1570
	562	68.522	10.218	876.36	52.894	
	-158	5.4778	-1.218	138.64	15.106	
	15.47	2.83	0.34	38.86	2.60	60.11
	25.73	4.71	0.57	64.65	4.33	
	43.21	64.91	52.94	69.62	77.27	
blade	94	7	1	107	6	215
blanks	76.962	9.3836	1.3993	120.01	7.2435	
	17.038	-2.384	-0.399	-13.01	-1.243	
	3.60	0.27	0.04	4.10	0.23	8.23
	43.72	3.26	0.47	49.77	2.79	
	10.05	6.14	5.88	7.34	6.82	
burin	1	0	0	1	0	2
spalls	0.7159	0.0873	0.013	1.1164	0.0674	
	0.2841	-0.087	-0.013	-0.116	-0.067	
	0.04	0.00	0.00	0.04	0.00	0.08
	50.00	0.00	0.00	50.00	0.00	
	0.11	0.00	0.00	0.07	0.00	
cores	1	5	0	3	1	10
	3.5796	0.4364	0.0651	5.5819	0.3369	
	-2.58	4.5636	-0.065	-2.582	0.6631	
	0.04	0.19	0.00	0.11	0.04	0.38
	10.00	50.00	0.00	30.00	10.00	
	0.11	4.39	0.00	0.21	1.14	
chunks	32	16	3	76	5	132
	47.251	5.7611	0.8591	73.681	4.4472	
	-15.25	10.239	2.1409	2.3185	0.5528	
	1.23	0.61	0.11	2.91	0.19	5.05
	24.24	12.12	2.27	57.58	3.79	
	3.42	14.04	17.65	5.21	5.68	
Total	935	114	17	1458	88	2612
	35.80	4.36	0.65	55.82	3.37	100.00

Table 6.10: Flake/Blade Blanks versus Tools: Stratum 2

------------------------------ STRATUM=2 ------------------------------

TABLE OF TOOLSM1 BY DEBCODE

TOOLSM1 DEBCODE(Grouped Debitage)

Frequency / Percent / Row Pct / Col Pct	flakes	blades	Total	
.	1025 69.26 74.38 92.93	353 23.85 25.62 93.63	1378 93.11	<- Blank sample
end-scrapers	21 1.42 80.77 1.90	5 0.34 19.23 1.33	26 1.76	<- Tool sample to end of table
burins, perçoirs, becs	4 0.27 100.00 0.36	0 0.00 0.00 0.00	4 0.27	
retouched blades	22 1.49 68.75 1.99	10 0.68 31.25 2.65	32 2.16	
notches, denti-culates	19 1.28 76.00 1.72	6 0.41 24.00 1.59	25 1.69	
side-scrapers	9 0.61 81.82 0.82	2 0.14 18.18 0.53	11 0.74	
composite tools	2 0.14 100.00 0.18	0 0.00 0.00 0.00	2 0.14	
diverse	1 0.07 50.00 0.09	1 0.07 50.00 0.27	2 0.14	
Total	1103 74.53	377 25.47	1480 100.00	

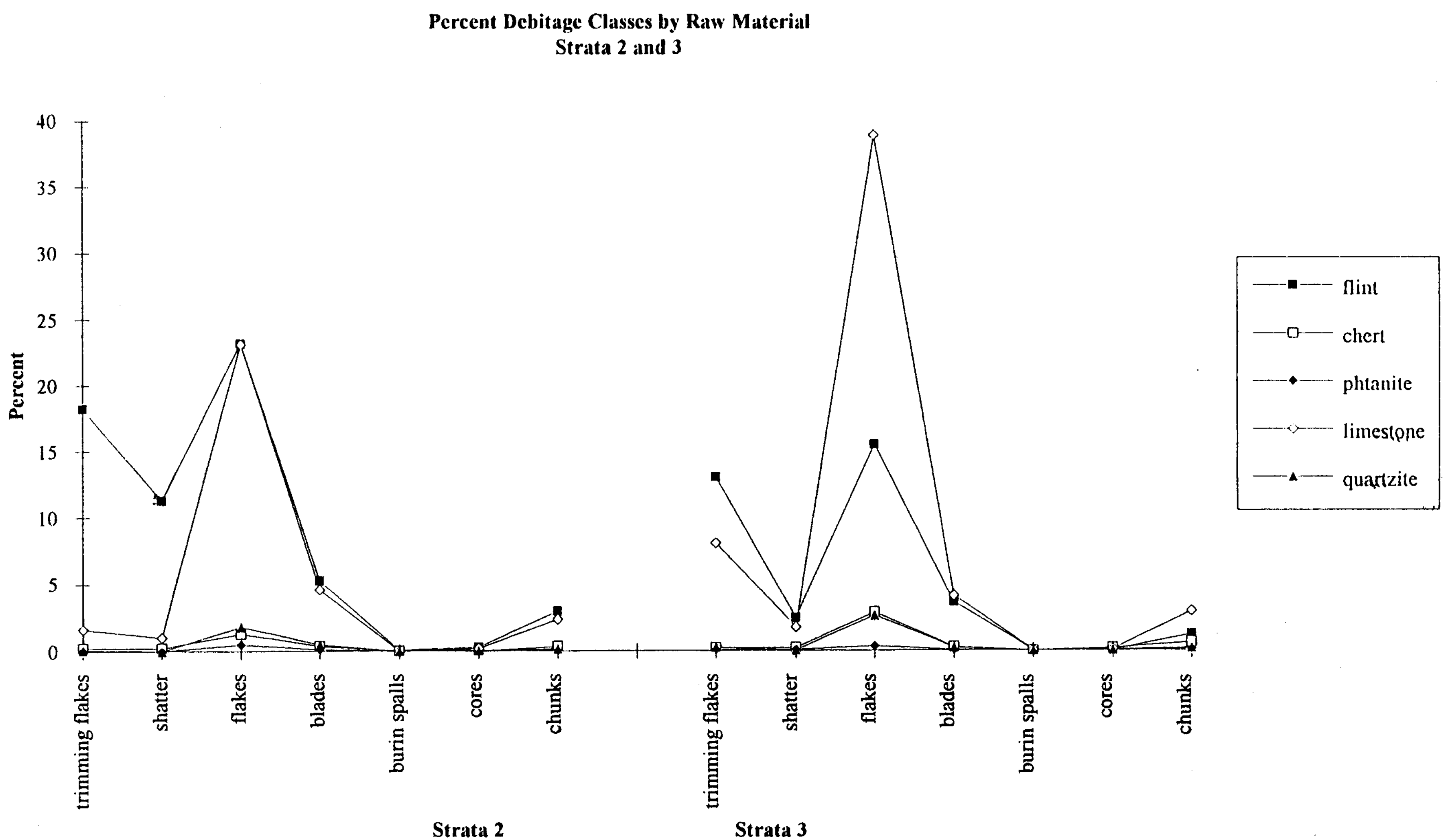

Percent Debitage Classes by Raw Material
Strata 2 and 3
Percent
40
35
30
25
20
15
10
5
0
trimming flakes
shatter
flakes
blades
burin spalls
cores
chunks
trimming flakes
shatter
flakes
blades
burin spalls
cores
chunks
Strata 2
Strata 3
flint
chert
phtanite
limestone
quartzite

Figure 6.5

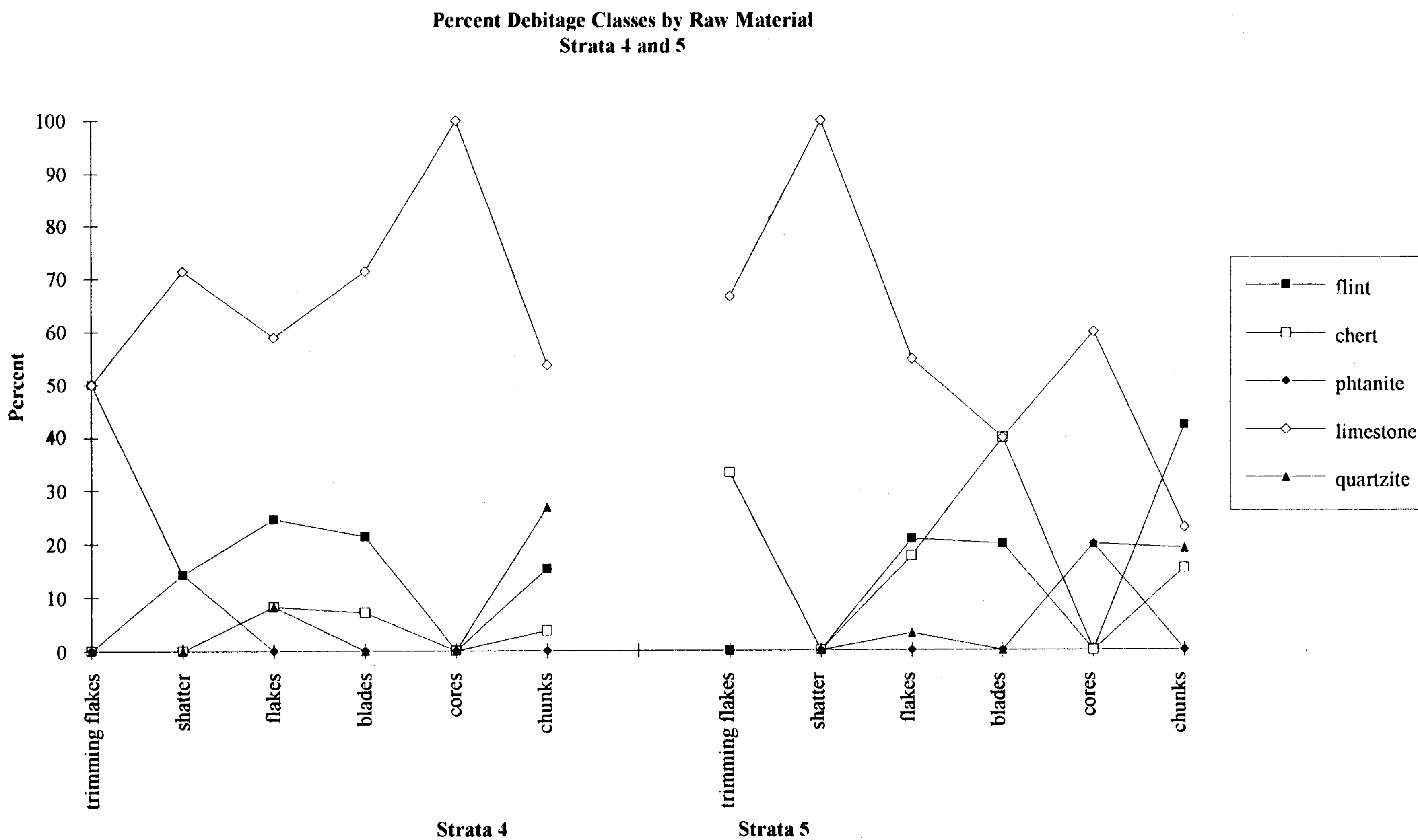

Percent Debitage Classes by Raw Material
Strata 4 and 5
Percent
100
90
80
70
60
50
40
30
20
10
0
trimming flakes
shatter
flakes
blades
cores
chunks
Strata 4
Strata 5
flint
chert
phtanite
limestone
quartzite

Figure 6.6

identification of limestone shatter which look like natural roof fall spall and which erode more than flint shatter. For chert, frequencies of trimming flakes are lower than expected and frequencies of chunks are higher than expected. For all other debitage classes, flint and limestone are similar and differ as a group from chert, phtanite, and quartzite.

Stratum 3. For Stratum 3 (Table 6.10), the p-value for the chi-square test is 0.000 (df=24, value=330.460, n=2612). The range of debitage types produced is again non-randomly distributed across raw material types. For flint, frequencies of trimming flakes, shatter, and blades are higher than expected and frequencies of flakes and chunks are lower than expected. For limestone, the frequency of flakes is higher than expected and frequencies of trimming flakes, shatter, and blades are lower than expected. For chert, the frequency of trimming flakes is lower than expected.

Figure 6.5 shows side-by-side frequency charts for Strata 2 and 3.

Stratum 4. For Stratum 4, the chi-square test was not performed due to small sample size. Qualitatively, the following is observed. For trimming flakes, 50% were produced on flint and 50% on limestone. For flakes, 58.9% were produced on limestone and 24.6% on flint. for blades, 71.4% were produced on limestone nd 21.43% on flint.

Stratum 5. For Stratum 5, the p-value for the chi-square test is 0.000 (df=3, value=75.362, n=113). For trimming flakes, 66.7% were produced on limestone and 33.3% on chert. For flakes, 54.8% on limestone and 20.9% on chert. For blades, 40% on limestone, 40% on chert, and 20% on flint.

Figure 6.6 shows side-by-side frequency charts for Strata 4 and 5.

Part 3 : Comparison of size variables between tools made on flakes or blades and flake-blade debitage (types 3 and 4) (Table 6.11)

This section compares the size measurements (length, width, and thickness) between flake and blade blanks and tools made on flakes and blades for Strata 2 and 3 only. In Table 6.11, the frequency tables show the samples being compared. Tests of normality for each of these variables showed that none were normally distributed, and that log transformation was necessary. Two-sample t-tests (alpha = .05) between blanks and tools were performed for each variable, using piece-plotted artifacts, and the results are summarized below. A similar analysis was attempted to compare core tools with cores/chunks; however, the small sample size for core tools prevented reliable results from being obtained.

Strata 2 and 3 are similar for the logs of all three size variables, with the pattern in both strata that tools are significantly different from unretouched flake and blade blanks in log(length) and log(thickness) but similar in log(width)[2]. For all variables and

2 While the results of t-tests on the original variables are given, the results are spurious because the assumption of normality is not met.

Table 6.11: Flake/Blade Blanks versus Tools: Stratum 2

-------------------------- STRATUM=2 --------------------------

TABLE OF TOOLSM1 BY DEBCODE

TOOLSM1 DEBCODE(Grouped Debitage)

TOOLSM1	Frequency / Percent / Row Pct / Col Pct	flakes	blades	Total	
	Frequency	1025	353	1378	<- Blank sample
	Percent	69.26	23.85	93.11	
	Row Pct	74.38	25.62		
	Col Pct	92.93	93.63		
end-scrapers	Frequency	21	5	26	<- Tool sample to end of table
	Percent	1.42	0.34	1.76	
	Row Pct	80.77	19.23		
	Col Pct	1.90	1.33		
burins, perçoirs, becs	Frequency	4	0	4	
	Percent	0.27	0.00	0.27	
	Row Pct	100.00	0.00		
	Col Pct	0.36	0.00		
retouched blades	Frequency	22	10	32	
	Percent	1.49	0.68	2.16	
	Row Pct	68.75	31.25		
	Col Pct	1.99	2.65		
notches, denti-culates	Frequency	19	6	25	
	Percent	1.28	0.41	1.69	
	Row Pct	76.00	24.00		
	Col Pct	1.72	1.59		
side-scrapers	Frequency	9	2	11	
	Percent	0.61	0.14	0.74	
	Row Pct	81.82	18.18		
	Col Pct	0.82	0.53		
composite tools	Frequency	2	0	2	
	Percent	0.14	0.00	0.14	
	Row Pct	100.00	0.00		
	Col Pct	0.18	0.00		
diverse	Frequency	1	1	2	
	Percent	0.07	0.07	0.14	
	Row Pct	50.00	50.00		
	Col Pct	0.09	0.27		
Total		1103	377	1480	
		74.53	25.47	100.00	

for both strata, tools are larger than flake and blade blanks. Thus, even accounting for possible reduction of tools in resharpening and use, tools are still larger than blanks. There seems to be selection by size of blanks for retouch into tools. The similarity between blanks and tools for width may be due to side edge retouching on tools. One hypothesis is that the original blanks selected for sidescrapers may have been selected for size, but edge resharpening would reduce the width of tools to be comparable to that of unretouched blanks.

TABLE 6.12

STRATUM 2

Variable	p-value	Results	Blanks vs. Tools
length	0.0615	Ho accepted	
width	0.2095	Ho accepted	
thickness	0.0389	Ho rejected	T>B
log (length)	0.0131	Ho rejected	T>B
log (width)	0.2836	Ho accepted	
log (thickness)	0.0041	Ho rejected	T>B

STRATUM 3

Variable	p-value	Results	Blanks vs. Tools
length	0.0004	Ho rejected	T>B
width	0.1796	Ho accepted	
thickness	0.0003	Ho rejected	T>B
log (length)	0.0001	Ho rejected	T>B
log (width)	0.3300	Ho accepted	
log (thickness)	0.0005	Ho rejected	T>B

When flake and blade blanks and tools made on flake and blade blanks are pooled (that is, pooling all artifacts of debitage types 3 and 4, whether they are tools or not) to compare size differences between strata, the following results are obtained. Strata 2 and 3 are significantly different with respect to log(width) and log(thickness) such that blanks and tools in Stratum 2 are wider and thicker. Even in variables where the null hypothesis is accepted, the means of measurements of artifacts in Stratum 2 are slightly higher.

TABLE 6.13

COMPARISON OF STRATA 2 AND 3 :

Variable	p-value	Results	2 versus 3
length	0.2536	Ho accepted	
width	0.0000	Ho rejected	2>3
thickness	0.0096	Ho rejected	2>3
log (length)	0.2363	Ho accepted	
log (width)	0.0000	Ho rejected	2>3
log (thickness)	0.0207	Ho rejected	2>3

Part 4 : Analysis of whole blades :

A series of analyses on whole blades were also performed in order to describe the similarities or differences in whole blades between Strata 2 and 3, examining the raw materials on which blades were produced, the overall size difference in blades between the two strata, and a comparison of the size of blades between raw material types. The data set was composed of all lithics with debitage type 4 (blades) and with portion equal to "W" (whole).

1) comparison of frequencies of raw materials producing blades between strata

Comparing Strata 2 and 3 (see Figure 6.5), the p-value for the chi-square test comparing between strata was 0.290 (df=3, value=3.749, n=82). Therefore, the null hypothesis is accepted that the two strata are not significantly different with respect to the distribution of blades across raw material types. The distribution of blades across raw material types is similar for both strata. There is an inverse relationship between flint and limestone that is not statistically significant.

2) comparison of size of whole blades

Two-sample t-tests were performed for each size variable to compare the two strata. There are no significant differences between the two strata for any size variable.

3) comparison of size of blades between raw material types

Two-way MANOVA analysis was performed to compare the log-transformed size measurements on whole blades to determine similarities or differences in size due to stratum or raw material. The results show that only log(length) and log(thickness) are significantly different among blades and that the differences are due only to raw material and not to differences between strata. Multiple comparisons using least-squares means additionally showed that the only differences are between flint and limestone. This likely reflects differences in original raw material size.

Part 5: Inter-strata comparison of cortical versus non-cortical flint debitage

This section compares cortical versus non-cortical flint between Strata 2 and 3. The p-value for the chi-square test is 0.021 (df=1, value=5.297, n=1392), indicating that the two strata are significantly different. Stratum 2 has more cortical flint debitage than expected while Stratum 3 has less.

Part 6: Variability of edge angles for endscrapers (Figures 6.7 and 6.8)

This section examines the edge angles of the retouched edge of endscrapers to determine if patterning exists. In order to determine if thickness affected edge angles, a regression analysis was performed. This resulted in a p-value of 0.0187 (alpha=.05), indicating that thickness was a predictor of edge angle. However, the R^2 was only .1077, indicating that thickness only accounts for 10.77% of the variability in edge angle. Figures 6.7 and 6.8 show the edge angles for endscrapers from Strata 2 and 3. The samples are too small to produce statistically significant results. Qualitatively, however, type 8 endscrapers in Stratum 2 (n=13) show a range of variability from 25-90 degrees. Comparing Strata 2 and 3, the ranges seem to be similar.

DISCUSSION

The comparisons of raw material frequency between strata show an increase in the use of flint from Stratum 5 to Stratum 2, with a substantial increase from Stratum 3 to Stratum 2. For limestone, there is an increase from Stratum 5 to Stratum 4, followed by a decrease to Stratum 2 and is most common in Strata 4 and 5. Quartzite is present in similar frequencies for Strata 4 and 5 and in similar frequencies for Strata 2 and 3 with a decrease from 4/5 to 2/3. Chert is most common in Stratum 5 with a decrease to similar frequencies for Strata 2-4. Phtanite is negligible in Strata 4 and 5 and in very low frequency in Strata 2 and 3.

These changes in frequency suggest an increased utilization of non-local raw material (flint) as opposed to locally available chert, limestone, and quartzite river cobbles. The Mousterian levels have higher frequencies of local raw material while non-local flint predominates the Aurignacian levels.

Edge Angle for Endscrapers
Stratum 2

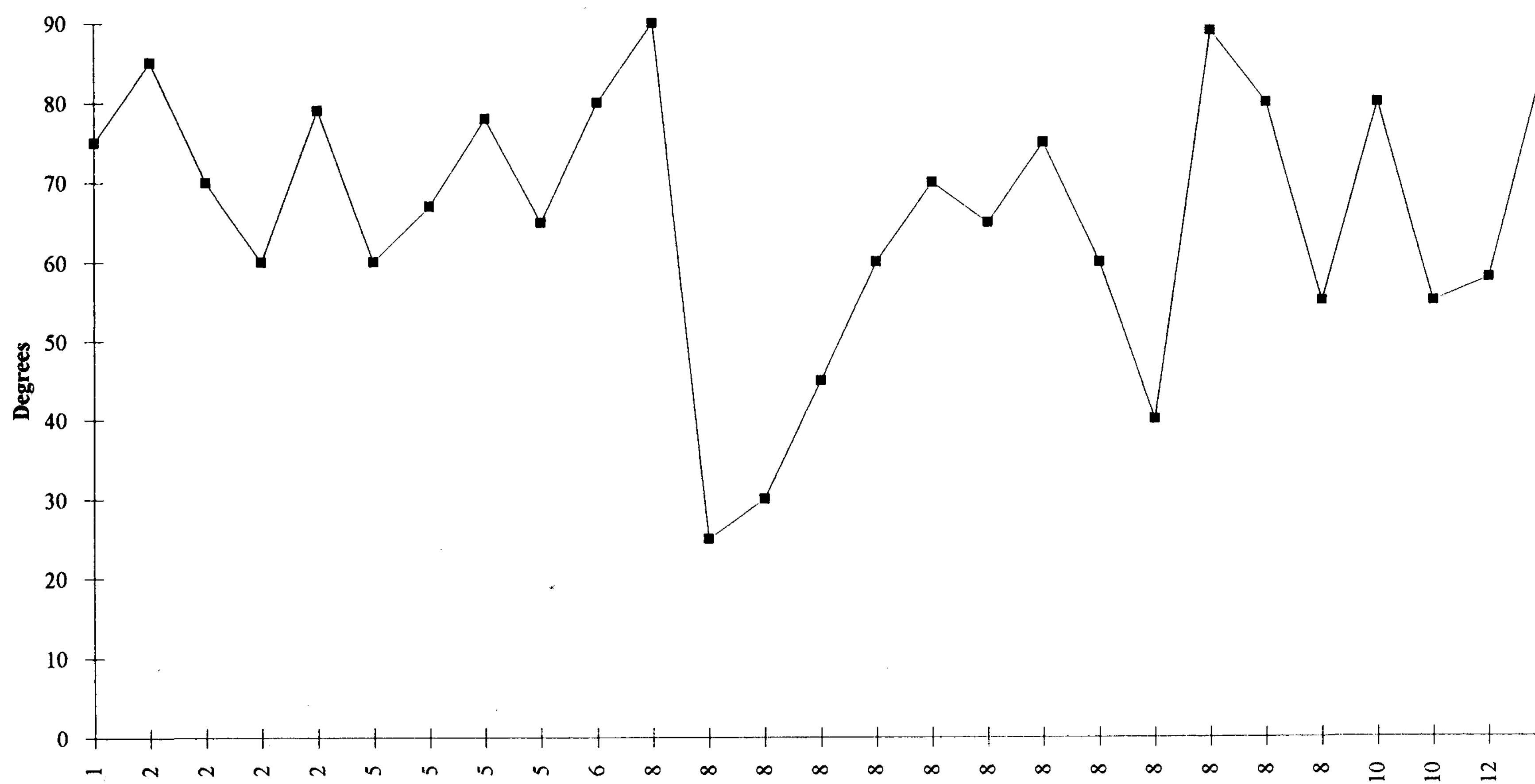


Figure 6.7

Edge Angles for Endscrapers
Stratum 3

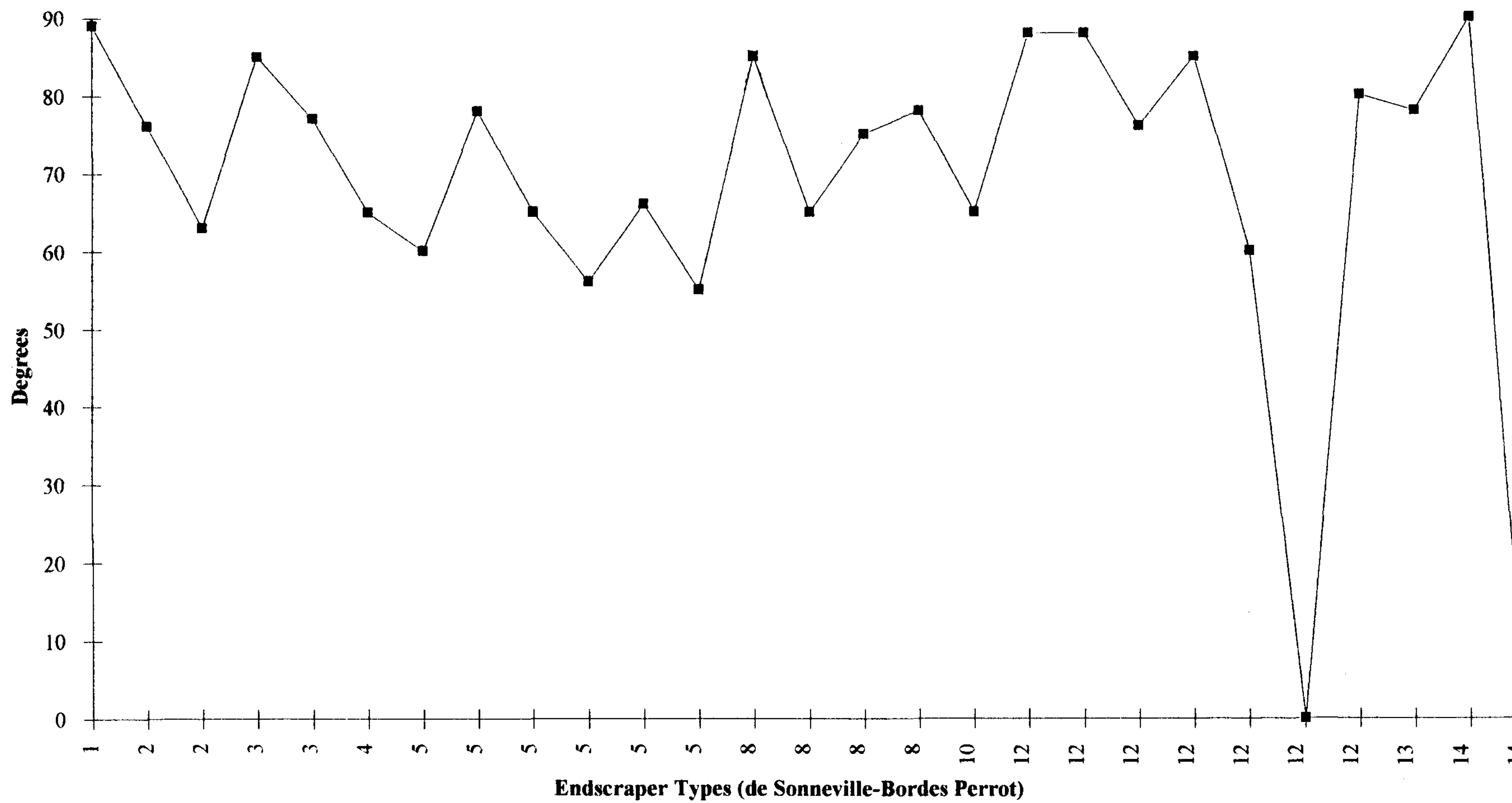


Figure 6.8

Comparison of the tool classes for Strata 2 and 3 show that they are not significantly different. However, there is an inverse relationship between blades and notches/denticulates and of the other tool classes, endscrapers are most common.

Comparison of the debitage classes between strata show that flakes have the highest frequency for all four strata and they are not substantially different. The frequency of blades does not increase in time and remains low in relation to flakes. Trimming flakes show some increase from Stratum 5 to Stratum 2. Cores and chunks are most common in Strata 4 and 5 and decrease in Strata 2 and 3. The relative frequencies of trimming flakes/shatter versus cores/chunks indicate that core reduction and blank production may have occurred at the site for Strata 4 and 5 while tool production from cores or blanks prepared elsewhere occurred at the site for Strata 2 and 3.

Flint is the raw material of choice for all tool classes in Stratum 2 and predominates in Stratum 3 except for notches and denticulates which are made in highest frequency on limestone. Limestone is the second most common raw material for all tool classes in both Strata 2 and 3.

Flint and limestone are again most common across all debitage classes in Strata 2 and 3 with a much higher frequency of limestone flakes in Stratum 3. For Strata 4 and 5, limestone is the raw material of choice across all debitage classes, and in much lower frequency, flint and chert are utilized. The primary shift from Strata 4 an 5 to Strata 2 and 3 is a decrease in limestone and an increase in flint, although both continue to be the two highest.

The comparison between flake/blade blanks and tools made on flakes and blades shows that tools are thicker and longer than blanks in Strata 2 and 3. This indicates that there is selection by size of removals for retouch into tools. Thus, even with resharpening of endscrapers (which are predominant in Strata 2 and 3), tool length is still longer than blank length. When flake/blade blanks and tools are pooled, those of Stratum 2 are wider and thicker than those of Stratum 3.

Comparison of frequencies of whole blades between Strata 2 and 3 shows that they are not significantly different and that they are not produced differentially on raw materials. A two-way MANOVA on the size measurements with both stratum and material class as factors showed that differences in log(length) and log(thickness) were due only to differences in material. However, the differences in material are only between flint and limestone which have the highest frequency in both strata. These differences are also very slight and may not be behaviorally significant.

Acknowledgements : Dr. Edward Bedrick (University of New Mexico, Mathematics Department), for assistance with statistical analyses; Anthony Martinez, for assistance in preparing the data set.

M. OTTE et L.G. STRAUS (dir.), *Le Trou Magrite. Fouilles 1991-1992*. Liège, E.R.A.U.L. 69, 1995.

7

THE FAUNAL REMAINS OF TROU MAGRITE
(Namur Province, Belgium)

Achilles GAUTIER

1. INTRODUCTION

The faunal material analyzed in this paper was collected during recent excavations (1991-1992) in the archeological deposits at the front of Trou Magrite. Trou Magrite is a large cave opening out onto a broad terrace and steep talus, half way up the SSW-facing limestone cliff-side of the Lesse River valley. It lies about 25 m above the valley floor at a point 3.5 km from the Lesse confluence with the Meuse, just upstream of Dinant. The deeply entrenched Lesse valley is a major avenue of communication between the Ardenne plateau and the Sambre-Meuse valley system and northern natural regions at lower altitude. The Lesse valley contains several important cave sites in NW-Europe, many of which, including Trou Magrite, were first archeologically excavated by Edouard Dupont (OTTE 1979; DEWEZ 1987). Preliminary results of the faunal analysis given in two previous papers dealing with the recent excavations (STRAUS *et al.*, 1992, 1993) are incomplete and contain minor errors. For detailed descriptions of the site and its archeology the reader is referred to the other contributions in this volume.

The faunal remains have been grouped according to the stratigraphical units recognized by the excavators and a short description of those yielding faunal remains follow.

Stratum 1 : Top soil and backdirt from previous excavations.

Stratum 1.1 : A pit filled with fine dark grey silt, containing some possibly Mesolithic artefacts, a Neolithic arrowhead and a few pot sherds of possibly Iron Age date.

Stratum 2 : Compact fine cryoclastic gravel, partly cemented by calcium carbonate; many bone remains and artefacts assignable to the late Aurignacian.

Stratum 3 : Cryoclastic gravel and larger blocks, in part cemented by calcium carbonate; a substantial amount of bone remains and an artefact assemblage assignable to the Aurignacian with leaf points.

Stratum 4 : Redeposited, colluvial, reddish-brown, clayey silt/loess with limestone blocks of which the upper part is calcified; few bones and artefacts, mostly perhaps attributable to the Middle Paleolithic. A depositional hiatus separates this deposit from the underlying one.

Stratum 5 : Redeposited loess, with water worn pebbles; the bone assemblage includes a substantial number of micromammal remains; a small artefact assemblage can be assigned to the Mousterian.

Stratum 6 consists of waterlaid sands, gravels and clays which are archeologically and paleontologically sterile.

2. THE FAUNAL COLLECTIONS

The qualitative and quantitative composition of the fauna is given in Table 7.1. Table 7.4 gives an inventory of the skeletal parts of the most frequently found animals. As can be seen in Table 7.1, the identification rate (ratio identified remains/total number of remains) in the Pleistocene strata is extremely low. Collection was done by handpicking *in situ* or sieving in a screen with mesh size 2.5-3 mm, and most remains consist of small fragments and splinters, as the bones have been subject to marked fragmentation and collagen destruction. A total of 12,519 osseous remains were found (not including the small rodents), but only 486 were identifiable. Among the identified remains, those of teeth and other dense skeletal elements predominate, and few remains have maximum lengths exceeding 6 cm. A few clusters of teeth demonstrate differential destruction of maxillar or mandibular bones leaving behind but the teeth they originally held. In the strata 1 and 1.1, the identification rate is much higher, as a result of reworking, the addition of Holocene remains and perhaps less complete sampling. The collection will be deposited in the reserves of the Service de Préhistoire in the University of Liège.

The first column in Table 7.1 is based on the faunal data provided by DUPONT (1867; 1871, list in text and table in the back of the book) and by RUTOT (1910). Unfortunately DUPONT does not give separate lists for the four fossiliferous horizons he distinguishes, but he mentions that horse and especially reindeer are more frequent in the upper horizons than in the lower ones. Also his three lists show differences in composition of the fauna. The list by RUTOT again differs somewhat from previous ones, perhaps because of a reanalysis by DUPONT of the collections (*ibid.* : 16, infrapaginal note). In the first column of Table 1, some finds have been added, resulting from two small test excavations in 1992 of the back of the cave, in deposits which appear to be backdirt of the older excavations. The faunal finds include : bear, hare, woolly rhinoceros, horse, ibex and a large cervid (either giant deer or moose). The RUTOT list includes a quite unexpected animal, hippopotamus, represented by an incisor fragment. Surprisingly one of the test pits yielded a tusk fragment also attributable to hippopotamus. In Belgium, fossils of this southern mammal have been recorded from fluviatile deposits of the Last Interglacial but precise data are lacking. RUTOT (*ibid.*) suggests that people picked up a fossil hippo tusk and brought it to the cave.

3. IDENTIFICATION AND SYSTEMATICS

The identifications of the vertebrates found in 1991-92 were made with the aid of our comparative collection and various books and papers dealing with the diagnostic characters of Quaternary mammals (see references). As to the

Table 7.1 : Absolute frequencies (specimen counts) of animal remains in Trou Magrite

Assemblage / Animal	(a)	1	1.1	2	3	4	5	Total
Landsnails								
Pomatias elegans	?	1	-	4	1	-	-	6
Clausilia dubia	?	-	-	1?	-	-	-	1?
Discus rotundatus	?	-	1	14	-	-	-	15
Oxychilus cellarium	?	1	-	3	-	-	-	4
Fruticicola fruticum	?	1	-	-	-	-	-	1
Monacha cantiana	?	-	-	-	-	1	-	1
Zenobiella incarnata	?	-	-	1	-	-	-	1
Helicodonta obvoluta	?	-	1	-	-	-	-	1
Helcogona lapicida	?	1	-	2	-	-	-	3
Helix pomatia	?	1	-	-	-	-	-	1
Fish	+	-	-	-	-	-	1	1
Amphibians	-	-	3	2	-	-	-	5
Birds								
Wild duck *(?Anas platyrhynchos)*	+	-	-	-	-	-	-	-
Ptarmigan *(Lagopus mutus)*	+	-	-	-	-	-	-	-
Black grouse *(Lyrurus tetrix)*	+	-	-	-	-	-	-	-
Capercaillie *(Tetras urogallus)*	+	1	-	-	-	-	-	1
Partridge *(Perdix perdix)*	-	-	1	-	2	-	-	3
Jackdaw *(Corvus monedula)*	-	1	-	-	-	-	-	1
Not identified	+	3	-	1	-	-	1	5
Insectivores								
Mole *(Talpa europaea)*	-	-	1	-	-	-	-	1
Hedgehog *(Erinaceus europaeus)*	+	-	-	-	-	-	-	-
Lagomorphs								
Snowhare *(Lepus timidus)*	+	-	-	-	-	-	1?	1?
Common hare *(L. Capensis)*	-	1	-	-	-	-	-	1
Hare *(L. timidus/L. capensis)*	-	3	-	1	1	-	32	37
Pika *(Ochotona pusilla)*	-	-	-	-	-	1	2	3
Rabbit *(Oryctolagus cuniculus)*	-	10	-	-	-	-	-	10
Rodents								
Marmot *(Marmotta marmotta ?)*	+	-	1	-	1	-	-	2
Squirrel *(Sciurus vulgaris)*	-	1	-	1	-	1	-	3
Common hamster *(Cricetus cricetus)*	+	-	-	-	-	-	-	-
Beaver *(Castor fiber)*	+	-	-	-	-	-	-	-
Small rodents *(Rodentia* spp.) (b)	+	RR	RR	RR	RR	-	FF	FF
Carnivores								
Arctic fox *(Alopex lagopus)*	+	-	-	2	-	-	1	3
Common fox *(Vulpes vulpes)*	+	-	-	1	2	2	-	5
Fox *(A. lagopus/V. vulpes)*	-	1	-	4	2	1	1	9
Wolf *(Canis lupus)*	+	1?	2	3	-	-	-	6
Wild cat *(Felis silvestris)*	+	2	-	-	-	-	-	2
Lynx *(Lynx lynx)*	+	-	-	-	-	-	-	-
Cave lion *(Felis leo spelaea)*	+	-	-	-	-	-	-	-
Weasel *(Mustela nivalis)*	+	-	-	-	-	-	15(c)	15
Stoat *(M. erminea)*	+	-	-	-	-	-	-	-
polecat *(M. putorius)*	+	-	-	-	-	-	-	-
Beach marten *(Martes foina)*	+	-	-	-	-	-	-	-
Badger *(Meles meles)*	+	3	1	4	1?	3	-	12
Cave bear *(Ursus spelaeus)*	+	1?	-	7?	-	-	5	13
Brown bear *(U. arctos)*	+	-	-	-	-	-	-	-
Cave hyena *(Crocuta crocuta spelaea)*	+	4	1?	-	-	-	-	5
Proboscideans								
Mammoth *(Elephas primigenius)*	+	-	-	3	1	1	-	5
Perissodactyls								
Wooly rhinoceros *(Coelodonta antiquitatis)*	+	3	-	7	1	1	5	17
Horse *(Equus cf. germanicus)*	+	13	1?	39	17	1	5	76
Artiodactyls								
Hippopotamus *(Hippopotamus* sp.)	+	-	-	-	-	-	-	-
Wild boar (*Sus scrofa*)	+	5?	-	8	2(d)	-	-	15
Roe deer *(Capreolus capreolus)*	+	-	-	-	-	-	-	-
Reindeer *(Rangifer tarandus)*	+	11	-	91	36	3	5	146
Red deer *(Cervus elaphus)*	+	1?	-	-	-	-	-	1?
Giant deer/moose *(Megaceros giganteus/Alces alces)*	+	-	-	-	-	-	-	-
Chamois *(Rupicapra rupicapra)*	+	-	-	-	1	1	-	2
Ibex *(Capra ibex)*	+	12	2	31	10	2	1	58
Steppe wisent/wild cattle *(Bison priscus/B. primigenius)*	+	-	-	1	1	-	-	2
Domestic animals								
Cat *(Felis silvestris* f. catus)	+	1	-	-	-	-	-	1
Dog *(Canis lupus* f. familiaris)	+	-	-	-	-	-	-	-
Pig *(Sus scrofa* f. domestica)	-	1	4?	-	-	-	-	5
Sheep/goat *(Ovis ammon* f. aries/*Capra aegagrus* f. hircus)	+	2	10	-	-	-	-	12
Cattle *(Bos primigenius* f. taurus)	+	2	-	-	-	-	-	2
Total identified bones (e)		83	27	206	78	17	75	486
not identified bones		120	6627	2768	265	2253		12033
Total bones (e)			230	6833	2846	282	2328	12519

(a) finds known from the older excavations (DUPONT 1867, 1871; RUTOT 1910) and a few finds of unknown original provenance collected during the recent excavation (see text); (b) see CORDY (this volume); (c) corresponding to a few individuals; (d) co-articulating; (e) not including the small rodents.

terrestrial mollusks, they were labeled with the aid of our comparative collections of recent Belgian snails and ADAM (1960), but Dr. J. DE CONINCK (Ghent) verified and completed some of our identifications. A few comments on the vertebrates follow.

The vertebrate fauna contains fish, amphibians and birds, but most of the osseous remains are derived from mammals. Fish is represented by one small vertebra in layer 5; no doubt it pertains to a freshwater species. Some long bones represent amphibians, frogs or toads, but the material is too fragmentary and not distinctive enough for further identification. The bird remains also are rather fragmentary and were not identifiable with the comparative material at my disposal, except for a humerus of jackdaw (*Corvus monedula*) in stratum 1. The identifications were completed by Mr. Johan Deville during his stay as an Erasmus student in the archeozoological laboratory of the Universidad Autonoma de Madrid (Prof. A. Morales), where an extensive comparative collection of birds is available.

Most of the larger lagomorph remains could not be identified to species, but one lower incisor from stratum 5 has a rather squarish cross section and may represent a snow hare (*Lepus timidus*). In layer 1, one bone of hare, which show the same preservation as those of the rabbit, represents of necessity the common hare (*L. capensis*). The marmot is very probably the so-called alpine marmot, most commonly found in the Pleistocene of Western Europe, but two incisor fragments and one jugal tooth are the only elements representing this large rodent; the color of the incisor fragments is orange, as is usual in the alpine marmot. As to the squirrel, a mandible with jugal teeth (stratum 4) and two fragments of a right humerus in stratum 1 and 2, probably derived of the same bone, testify to the presence of this arboreal rodent not frequently found as a fossil. The remains of smaller rodents include maxillae, mandibles, loose teeth as well as postcranial bones; the cranial elements found are dealt with in a separate paper (CORDY, this volume). Some remains of fox were separated into Arctic fox (*Alopex lagopus*) and common fox (*Vulpes vulpes*) on the basis of their difference in size, but most could not be attributed. The ursid remains consist mainly of tooth fragments and represent most likely the bear very frequently encountered in European Upper Pleistocene cave faunas, *Ursus spelaeus* (the cave bear).

As is well known, the scholars dealing with the Pleistocene equids of Eurasia have different views on the history and systematics of this difficult group (see for example FORSTEN 1988, AZZAROLI 1990, EISENMANN 1990). The material from Trou Magrite consists mainly of fragmented teeth and a few postcranial fragments (see Table 7.4), no doubt representing a true horse of medium size. In strata 4 and 5, some sturdy splint bones could be derived from individuals measuring about 150 cm at the withers. A navicular from stratum 3 with a transverse diameter of 60 mm is also derived from a large animal. An upper M1/2 found in stratum 5 has an occlusal length, taken following EISENMANN and collaborators (1988), of about 28.2 mm; in stratum 2 a comparable jugal tooth measures 26.0 mm. These few vague osteometric data point to a horse which can be labeled *Equus* cf. *germanicus* following EISENMANN (1990). According to this specialist, *E. germanicus* is the typical

European horse from about 100.000 to 15.000 B.P. CORDY (1976) identified *E. caballus* cf. *gallicus* in the Aurignacian fauna of the Trou du Renard at Furfooz. This would be a somewhat smaller and later form than typical *E. germanicus*, but EISENMANN (*ibid.*) includes *E. gallicus* in *E. germanicus*. There is evidence that the *germanicus*-horses not only underwent size decrease through the course of time, but also that geographical size gradients existed, which still have to be unraveled (GAUTIER in preparation).

The cervid remains appear all referrable to reindeer (*Rangifer tarandus*) but among the caprid remains two lower molars show clearly the diagnostic features of chamois (*Rupicapra rupicapra*). Some other poorly preserved remains attributed to ibex (*Capra ibex*) could also represent the same ruminant. Recently CREGUT-BONNOURE (1992a, b) has described different dental morphotypes of Upper Pleistocene ibexes from southern France, which she arranges in two lineages related to *C. ibex* and *C. pyrenaica* considered as separate species. A upper third molar from stratum 2 in Trou Magrite has a marked metastylar wing and the distal interstylar surface is distinctly broader than the mesial one, as in the *ibex* lineage established by CREGUT-BONNOURE. The larger bovid remains consist of two large teeth. On paleosynecological grounds and size, I would refer them to steppe wisent (*Bison priscus*) : wild cattle prefers lush grazing and is therefore an interstadial and interglacial ruminant. The domestic fauna was recognizable on the basis of small size, lesser bone density and different preservation, but the definite attribution of some of the caprid and suid remains in strata 1 and 1.1 was difficult. Possibly too many caprid and suid remains from these strata have been accorded wild status, where in fact they represent domestic pig and goat.

Since the collection consists of much fragmented material, the search for *post mortem*-modifications due to living agents did not provide reliable results. No clear evidence of butchering marks, gnawing by rodents or the activity of hyena (gnawing, crushing, etching by gastric acid, etc.) occurs; hyena coprolites were also not present. However, some remains show breakage patterns one associated normally with bone smashing for marrow extraction. As a whole, the collection has little potential for the elaborate and detailed analyses archeozoologists sometimes subject their study material. The following evaluation is of necessity based on simple comparisons in the light of our general knowledge of Paleolithic cave faunas and the analyst's personal experience with various faunal contexts.

4. TAPHONOMY

The faunal assemblages found belong to the typical, polygenetic occurrences known from many caves and illustrated by SUTCLIFFE (1970). Such assemblages can generally not be divided exhaustively in the various taphonomic groups, *i.e.* groups of remains with comparable death-to-burial-history one normally finds in archeological sites (GAUTIER 1987). These generally include consumption refuse, workshop refuse and reworked, penecontemporaneous and late intrusives; the latter categories refer to those remains which are not the intentional result of human behaviour or were brought to a site by agents other than man. In the case of Trou Magrite, the attributions to the various taphonomic groups is hampered by the small size and low number of the remains.

The assemblages of strata 4 and 5 are very limited, so we will concentrate on the Aurignacian strata, which do moreover present evidence of quite intensive human occupation. As to the mixed upper strata (1 and 1.1), the contents are very comparable with those of the immediately underlying ones, as shown by the predominance of horse, reindeer and ibex. In the cave, remnants of strata have been recorded attributable to the Gravettian and the Magdalenian (DEWEZ 1987). The Pleistocene faunal contents of strata 1 and 1.1 may therefore represent a mixture of Aurignacian and later Upper Paleolithic phases. To the reworked Pleistocene material, Holocene elements of various age have been added either as a direct result of human activity or by other means. These include livestock remains and others of wild animals, the preservation of which indicates recent age, such as those of jackdaw (*Corvus monedula*) and common hare (*Lepus capensis*); these species can still be seen in the region. A datable very late addition is the rabbit, which reached Belgium probably in Medieval times only; the domestic cat is likely also a quite recent addition (GAUTIER 1990).

Since few remains of larger carnivores, especially the cave hyena, and no clear traces of carnivore activity occur, I am confident that most of the herbivore game, especially in strata 2 and 3, represents consumption refuse left by people. The penecontemporaneous intrusives include no doubt most of the landsnails, the single fish find from stratum 5, the frogs or toads, and the micromammals. In stratum 5, the latter occur in a kind of lense, no doubt derived from regurgitation pellets produced by an owl or owls roosting at the cave entrance. In the same layer, we note a high number of hare remains, and perhaps these animals also arrived in the cave through the action of a larger raptorial bird such as the eagle owl (*Bubo bubo*) (ANDREWS 1990:189). Birds and larger rodents may have been killed and collected by people, but could also have reached the cave by their own means or as prey of various non-human predators. Paleolithic humans did sometimes include marmot on their menu and PATOU (1987) has provided means, based on the frequency of age categories, skeletal elements etc., to establish whether the marmot remains in a site represent individuals that lived on the site, prey of non-human predators or small game of people. Unfortunately, the few marmot remains from Trou Magrite, already inventoried in a previous paragraph, do not allow the application of the proposed taphonomic analysis.

Cave bear and cave hyena used caves very regularly; therefore, it is likely that their remains are penecontemporaneous intrusives. Various other carnivores may have visited or lived on the site for various reasons, but some may have been killed, especially for the particular raw materials they could provide. In stratum 4, the excavators found badger remains in what was left of a burrow obviously made by the animal, proving that this individual lived on the site. Badgers may occupy a same burrow for many generations and thus contribute appreciably to the disturbance and bioturbation of archeological deposits (GAUTIER 1987). In the Trou Magrite, they may be responsible for the odd distribution of the squirrel remains. This arboreal rodent is not frequently found in archeological sites; apparently it avoids well the predators that could introduce its remains into such contexts. Moreover the prevalence of open (not wooded) biotopes during glacial times restricted the number of potential squirrel fossils (CHALINE 1972). In our site, the Interpleniglacial stratum 4 yielded a mandible of the species; a humerus fragment comes from stratum 2 and combines probably with another humerus fragment in the reworked stratum 1. Most likely, the few squirrel remains come originally from stratum 4.

Table 7.2 : Simplified table of possible and actual game brought to the cave by people(a).

Assemblage / Game Animal	R(b)	2	3	4	5
bird(s)	5/?	1/1	2/1	-	1/1
hare	3/1	1/1	1/1	1/1	33/4
marmot	1/1	-	1/1	-	-
fox	1	7	4	3	1
wolf	3/1	3/1	-	-	-
wild cat	2/1	-	-	-	-
woolly rhinoceros(?)	3/1	7/1	1/1	-	5/1
horse	14/1	39/2	17/1	1/1	5/1
mammoth(?)	-	3/1	1/1	-	-
wild boar	5?/1?	8/2	2/1	-	-
reindeer	11/1	91/7	36/1	3/1	5/1
red deer	1?/1?	-	-	-	-
chamois	-	-	1/1	1/1	-
ibex	14/1	31/1	10/1	2/1	1/1
large bovid (probably steppe wisent)	-	1	1	-	-

a : the first number gives the specimen count, the second the minimum number of individuals (see text); b : R = reworked material, stratum 1 and 1.1.

Table 7.2 summarizes in a simplified form the assemblages which I think could have been caused by the direct activity of people. Other animals listed in the first column of Table 7.1, but not found in the new excavations, should probably be added, such as beaver or roe deer. The beaver is a eurythermic aquatic species which may have built its dams accross the Lesse; roe deer may have shared localized wooded areas with wild boar.

For those interested, minimum numbers of (hunted) individuals (MNI) have been added in Table 7.2. These are derived from all the material that could be combined into individual skeletons, based on size and age. This technique, only applicable for small samples, gives higher MNI-estimates than the pairing techniques generally used, but as known, in the majority of cases MNI's represent but a very small fraction of the real numbers of animal carcasses or parts brought to a site (GAUTIER 1984). In our case, very low MNI's were obtained, because of the restricted and very fragmentary nature of the samples. Reindeer in strata 2 and 3 are represented by some 7 and 13 individuals, while horses, which are the second most important group according to the specimen counts, have been reduced to a few individuals. The marked fragmentation which turns the teeth and bones of larger animals more often into poorly characterized fragments seems to be the main cause of the discrepancy. In what follows, I will discuss only specimen counts.

5. PALEOECOLOGY

The landsnails are concentrated in stratum 2 and the overlying reworked deposits. Stratum 3 shows clear evidence of marked cryoclastic activity with large block having fallen down from the cave ceiling. This change in topography of the cave probably allowed plants and landsnails to colonize the excavated locus. The arrival of frogs or toads on the locus may be explainable in a comparable way. The assemblage of mollusks of stratum 2 contains several species also found in the layers with mixed Aurignacian and post-Paleolithic artefacts excavated on the terrace of the Grotte de la "Princesse" (DE CONINCK 1981). All the molluscan species found in stratum 2 occur today in Belgium, but have a wide distribution in Europe (ADAM 1960) and the warm microclimate of calcareous substrata no doubt permits many, if not all, to live in quite cold conditions (HUBENDICK 1948). The few finds of the lower strata add nothing to the foregoing. In the reworked strata, we note the presence of *Helicodonta obvoluta* and *Helix pomatia,* which have a more southern distribution than the other species encountered; these snails may represent the minimal post-Paleolithic component of the snail assemblages in the reworked strata.

Some climatic parameters for the Aurignacian strata can be estimated on the basis of data for recent species such as marmot, wild boar, reindeer, chamois and ibex, summarized by HOKR (1951) and BONIFAY (1982). The average January temperature would have been between -10 and -20°C, while the July average could have been as high as around 16°C, if we assume that reindeer lived permanently in the region. CORDY (1976) arrived at the same estimates for the Aurignacian level of Trou du Renard at Furfooz, which produced a comparable faunal assemblage, with the addition of saiga antelope (*Saiga tatarica*). The annual precipitation would have been between 300 and 500 mm. Except for the reindeer, all the mammals cited avoid regions with permafrost (HOKR *ibid.*). Moreover, the mobility of wild boar, chamois and ibex is impeded by a thick snow cover; in the case of ibex, its thickness should not exceed 40 cm

(WENIGER 1982). If reindeer were not permanently present and came in winter in from the north or from the south in summer, the summers and winters respectively may have been warmer than estimated, because reindeer in general prefers lower temperatures than the other species. As to horses, the Mongolian horses (*Equus przewalskii*) surviving in the wild, tolerate extreme conditions, with very high summer and very low winter temperatures differring as much as 75°C. The precipitation in their arid homeland does not exceed 100 mm; moreover nine tenths of it occurs in summer (MOHR & VOLF 1984). The former range of these horses and their extinct European relatives as well as the distribution of feral horses, indicate that horses lived and live generally well in less extreme conditions, but great speed and stamina make horses very mobile herd animals (WENIGER 1982); this mobility and capacity for long distance migrations increase no doubt their ecological tolerance.

Marmots prefer open, preferably rather flat, terrain providing possiblities to establish the burrows for their colonies. Fossil marmots are very often found in cave faunas, among others because they may build their intricate burrows in cave deposits (ABEL 1935:407-415). All Belgian finds come from caves, with the exception of a recent find at the Upper Paleolithic site of Huccorgne, where a more or less complete skeleton was collected apparently from a burrow in loess deposits (GAUTIER unpublished data). The wild ruminants of Trou Magrite also prefer biotopes with restricted tree cover and their diet includes grasses, herbs, shrubs and, in the case of reindeer, even lichens. The latter lives preferentially in very open biotopes, while present day ibex and chamois prefer rocky, accidented terrain. Horses are typical grazers, but may include some herbs and shrubs in their diet; they seem to prefer flat to gently hilly terrain. Unlike ruminants, horses have a monasacculated stomach, allowing for rapid digestion of low quality food, but requiring regular intake. As a result, horse can inhabit areas with poor vegetation, but must maintain low population densities (OLSEN 1989:317) and are, as already said, probably rather mobile. The wild boar is a typical omnivore, including in its diet nuts, fruits, herbs, bulbs and other subterranean plant parts, small mammals etc. It prefers to live in deciduous forests with shrub in the vicinity of lakes, marshes and grassland. However, it adapts to very dry conditions, in which case the animals may show evidence of dwarfing (FAURE & GUÉRIN 1983). The suid remains of Trou Magrite are of normal size. As to the two birds identified, partridge is an indicator of open biotopes, while capercaillie would prefer slopes wooded with conifers; both species still occur in many regions of Europe, including Scandinavia (PETERSON *et al.* 1962).

Our knowledge of the ecological requirements of the extinct components of the assemblages is less direct. KUBIAK (1982) summarized the morphological characters of the mammoth and their inferred significance for the adaptation of this specialized proboscidean to cold and open biotopes, with a diet including grasses, sedges, mosses, the twigs of willows and other trees, perhaps even pine. Various features of the woolly rhinoceros indicate a comparable specialisation and essentially grazing habits (KURTÉN 1968). The steppe bison can be compared with the modern European and American bisons, but its large size made it probably more tolerant of colder climates. The present European bisons form a relict group adapted to forest and some American bison live in the boreal forest.

The large size of the steppe bison points to its probable preference for open grazing grounds; it may also have led to and permitted more extensive migrations.

On the basis on the foregoing observations, we can sketch the region around Trou Magrite during the Aurignacian as a steppic environment without permafrost and with restricted snowcover in winter. Wooded areas existed in valleys such as that of the Lesse and perhaps in other special azonal situations. In this landscape, animal species met and lived which today have more northernly, more continental or high altitude ranges, together with some temperate taxa. This fits in the recently developed concept of the mammoth steppe (see for example GUTHRIE, 1984), the open and cold landscape that stretched over large parts of northern unglaciated Eurasia and Alaska during the Last Glacial and in which plant and animal species now living in separate biotic zones cohabited and for which no modern analog exists. Within this mammoth steppe, temporal, regional and local factors created conditions of diversity and mosaic partioning. Many more data are necessary if we want to reconstruct precise vegetational history in the deeply entrenched valleys of the region around Trou Magrite.

6. HUNTING AROUND TROU MAGRITE

The faunal spectra and their taphonomic evaluation suggest that the Aurignacians of Trou Magrite hunted mainly reindeer, horse and ibex. The quantitative data on these animals are repeated in Table 7.3. This table indicates that the game bags of strata 2 and 3 are basically the same, suggesting the persistence of comparable local faunas and human habits of game procurement during the Aurignacian occupations of the cave. In earlier periods, these same animals may have been on the menu of Neandertal.

Table 7.3 : Major game animals in Trou Magrite (NISP).

	R(a)		2		3		4	5
	n	%	n	%	n	%	n	n
reindeer	11	28.2	91	56.5	36	57.1	3	5
horse	14	35.9	39	24.2	17	27.0	1	5
ibex	14	35.9	31	19.3	10	15.9	2	1
total	39	-	161	-	63	-	6	11

(a) R = reworked, strata 1 and 1.1.

According to the data available in the literature (for example WENIGER 1982), reindeer live in herds of 10 to 50 animals, but larger mixed herds have been counted. During their annual migrations, herds of more than 1,000 heads may form. Horses live in small herds of 5-20 heads, but do not concentrate in larger aggregates during their annual migrations. Most likely both animals were attacked when they passed through the Lesse valley, perhaps during their yearly migrations in spring or fall or while sheltering in the valley in winter. Ibex is the third important game animal, no doubt living on the rocky valley slopes and the plateau. This herbivore forms normally herds of some 3 to 40 animals, with restricted mobility. In winter the animals descend to lower altitudes, but distances between winter and summer grounds do not exceed 30 km.

The Aurignacians no doubt had access to other game (see Table 7.2), but these animals were probably hunted only on an opportunistic basis : game birds, hare, marmot, several carnivores, wild boar, probably steppe wisent and others not recorded in the faunal samples studied here but known from the older excavations within the cave (beaver, roe deer, giant deer or moose etc.). In Table 7.2, mammoth and rhinoceros are also listed as possible game. GUÉRIN and FAURE (1983) have argued convincingly that the means Paleolithic men had at their disposal were far from sufficient to deal with adult rhinoceroses in good health. Therefore, only defenseless individuals, either juveniles, wounded, diseased or moribund adults, would have been attacked; moreover scavenging of carcasses may have occurred. The evidence for hunting mammoth and related heavy-weights has been reviewed recently by HAYNES (1991), with the conclusion that the available data are at best tenuous. Again the opportunistic dispatching of handicapped animals and scavenging can explain most of the remains of mammoth among the consumption refuse of our distant ancestors. In the Trou Magrite assemblages studied here, both pachyderms are represented respectively by fragments of jugal teeth and possibly a rib (rhinoceros) and by fragments of jugal teeth and tusk (mammoth). Tusks could have been brought to the cave as raw material for artefact making, and the rib may be a remnant of a butchered rhinoceros. However, why people would have brought jugal teeth, cranial fragments or parts of heads of rhino or mammoth to the cave is difficult to understand. I feel we should look for other taphonomic agents to account for the remains of both pachyderms, and I wonder if they are not remnants of animals that fell down the chimney located at the rear of the present Trou Magrite. In general, too little attention is paid to this way of introducing large mammals into cave systems.

Immunological analysis of organic residues on some lithic artefacts from strata 2 and 3 suggest that respectively a bovine, a lagomorph, and a rodent immunologically related with guinea-pig have been skinned or butchered with the implements (NEWMAN, this volume). Likely candidates are the large bovid (steppe wisent ?) and hare, both present in stratum 3. Perhaps beaver may be added; as already noted this larger rodent is recorded in the older faunal collection.

Table 7.4 gives the intraskeletal distributions of the three major game species. As noted in the introduction, the original thanatocoenoses have suffered severely from differential destruction caused by the degradation of the collagen.

Table 7.4 : Skeletal distribution of the major mammals in Trou Magrite.

	Reindeer						Horse						Ibex					
Assemblage ---------------- Skeletal element	1	2	3	4	5	T	1	2	3	4	5	T	1(a)	2	3	4	5	T
skull	-	-	-	-	-	-	-	1	-	-	-	1	-	1	-	-	-	1
mandible(b)	-	5	1	-	-	6	-	-	-	-	-	-	-	1	-	-	-	1
loose tooth/ teethfragment	3	23	20	-	1	47	11	38	15	-	4	69	6	23	10	1	-	40
rib	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
scapula	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1
humerus	-	3	1	-	-	4	1	-	1	-	-	2	1	1	-	-	-	2
radius	1	6	-	-	-	7	1	-	-	-	-	1	1		-	-	-	1
cubitus	-	2	2	-	1	5	-	-	-	-	-	-	-	-	-	-	-	-
innominate bone	1	1	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
femur	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
tibia	-	4	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-
carpals/ tarsals etc.(c)	1	7	-	1	1	10	-	-	1	-	-	1	2	-	-	-	-	2
sesamoids	-	1	-	-	1	2	-	-	-	-	-	-	1	-	-	-	-	1
metapodials	2	36	10	2	-	50	-	-	-	1	1	2	-	1	-	-	-	1
Ph. 1	-	1	1	-	-	2	-	-	-	-	-	-	1	2	-	1	-	4
Ph. 2	2	-	1	-	-	3	-	-	-	-	-	-	1	2	-	-	1	4
Ph. 3	-	1	-	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-
Totals	11	91	36	3	5	146	13	39	17	1	5	76	14	31	10	2	1	58

(a) includes material from assemblage 1.1; (b) series of teeth of one jaw were counted as jaws; (c) includes patella and malleolar bone.

People no doubt smashed up bones for the extraction of the marrow, but other taphonomic agents (weathering, trampling, rock fall, weight of overburden) contributed to the marked fragmentation and ensuing degradation leaving behind mainly teeth and other dense remains. Anyhow, the anatomical spectrum of the reindeer remains suggests that complete animals were originally brought to the cave, since various elements pertaining to both the head and the postcranial body have been recognised. The very high number of metapodial remains is in part due to the fact that these elements are easily recognised (the identification factor of BOUCHUD 1970). Reindeer weigh about 100 to 150 kg and, no doubt, the smaller ibex, weighing 40 to 120 kg, could also be brought whole to the site; indeed this herbivore is also represented by skull and various postcranial elements, including distal leg bones.

In the distribution of the equid remains, teeth clearly dominate, suggesting that at least heads were brought to the cave. The few postcranial elements found in strata 2 and 3 include elements of the foreleg (humerus, radius) and a tarsal (navicular). The severe fragmentation has no doubt rendered irrecognisable most postcranial remains and the small identifiable residue is therefore difficult to interpret. However, equid cannonbones and phalanges are generally not smashed up for marrow extraction and do not fragment easily. Their virtual absence may therefore indicate that terminal leg elements were not included in what was brought to the cave and that some butchering was done at the kill sites. The foregoing appears reasonable, for horses weighing a few hundred kg are considerably heavier than reindeer or ibex. The fact that the butchered horse carcasses would still include the head when they arrived at the site, is intriguing, but perhaps the brain and tongue were special treats.

The macro-archeozoological analysis cannot tell us much about seasonality or the annual round of the Trou Magrite Aurignacians, again because the material is too scarce and the ageing on the basis of tooth wear too imprecise. The few well enough preserved reindeer teeth from stratum 2 may represent a fawn of two or three months old, two animals about two and half years old, some eight animals in their prime and two older individuals; these age estimates given are based on the replacement and wear data provided for reindeer by BOUCHUD (1966). In stratum 3, fewer teeth are in good enough condition for ageing, but three fawns appear to be present, respectively about four, six and fifteen months old, three prime individuals and a quite old one. The ages attributed to the fawns suggest killing in the last third of the year, i.e. mainly in autumn since reindeer calve from May to July, with a peak in June (WENIGER 1982). Cementum analyses of two mandibles of prime individuals from stratum 2 yielded unambiguous results : winter-late winter kills (STUTZ *et al.*, this volume). Cementum "winters" are the period of arrested growth of the tissue, beginning in fall and lasting until spring. The combined evidence therefore suggests that the Aurignacians hunted reindeer mainly in that period.

The few well enough preserved horse teeth all seem to be derived from adults, except for an upper milkmolar fragment in stratum 1. Among the teeth attributed to ibex, no milk molars seem to be present. Also, cementum and dentine analysis of one tooth from stratum 2 yielded discordant results. The animal would have been killed between late spring and fall according to the thick section method, or between winter and early spring according to the thin section method. A bison tooth from stratum 3 gave a winter cementum reading (STUTZ *et al.*, this volume).

The admittedly scarce data on seasonality suggest that Aurignacians used the cave as a cold season residential site from which reindeer were hunted when passing through the entrenched Lesse Valley during their migrations early and late in the cold season; animals sheltering in the valley may also have been available in the same season. Something comparable could have happened with respect to horse, although on a much smaller scale. In fact, the aged reindeer remains fit in a catastrophic mortality age distribution and may indicate ambushing of reindeer herds. The absence of juvenile horses suggests more selective hunting of this larger species. As to ibex, hunting parties may have come to bag this non-migratory herbivore in the warm season.

7. COMPARISONS WITH OTHER BELGIAN SITES.

In addition to Trou Magrite, some 11 cave sites in Belgium present evidence of occupation by Aurignacian people; open air sites have not yet been recognized (OTTE 1979 : 582, fig. 248). The list of the fauna from these occurrences (*ibid.* : 600) is basically the same as the one given in the first column of Table 7.1. This list, based on excavations which were not followed by a detailed archeozoological analysis, provides us only with a general idea of the game world with which the Aurignacians were acquainted.

CORDY (1974, 1976) reanalysed the Aurignacian faunas excavated in the Grotte Princesse Pauline at Marche-les-Dames and in the Trou du Renard at Furfooz. His temperature estimates made on the basis of the assemblage in the latter cave have already been discussed. The assemblage of the Grotte Princesse Pauline comprises willow grouse (*Lagopus lagopus*), hare, cave bear, fox, mammoth, rhinoceros, horse, red deer, reindeer and ibex. Cave bear dominates (71.5%) and the frequency of juveniles is very high (97%). Traces left by flint tools would be visible on some ursid bones and two mandibles show evidence of exposure to fire. The foregoing led to the hypothesis that Aurignacians came to the Grotte Princesse Pauline and hunted hibernating bears, especially the vulnerable cubs (CORDY 1974). However, the jaws may have been exposed to fire accidentally and the few cut marks found could have resulted from trampling (BEHRENSMEYER *et al.* 1986; OLSEN and SHIPMAN, 1988). It seems more likely that the Grotte Princesse Pauline was used by hibernating bears, as well as by people hunting mainly horse, ibex and reindeer. An antler fragment of the latter herbivore found in the cave, seems to be derived from an individual whose antlers were not completely calcified. This would mean the animal was killed at the end of the spring or in summer (CORDY *ibid.*). Excavations of the terrace in front of the Grotte Princesse Pauline provided evidence of post-Paleolithic and Aurignacian occupations, but the faunal samples of the latter contexts are mixed (GAUTIER 1981). The following list gives the faunal elements found in the terrace deposits which are or could be Aurignacian : various birds and micromammals including Norway lemming (*Lemmus lemmus*), fox, cave bear, badger, mammoth, rhinoceros and ibex; among the macromammals only the cave bear is well represented.

The revision of the Aurignacian fauna excavated in the Trou du Renard provided the following list : hare, cave bear, fox, cave hyena, badger, a mustelid, rhinoceros, horse, wild boar, red deer, reindeer, ibex and saiga antelope (CORDY 1976). In a recent paper, KAHLKE (1992) argues that the saiga antelope expanded into Western Europe only during the very late Pleistocene (Dryas). He was apparently not aware of the Belgian saiga record attributed to the Aurignacian; a re-investigation of the find is called for. Anyhow, well represented are cave bear, horse, reindeer and ibex. RAHIR (1914) wrote in his report on the excavations that horse and reindeer predominate, particularly the latter. Apparently the Aurignacians of the Trou du Renard concentrated on the same game species as those of Trou Magrite and presumably those of the Grotte Princesse Pauline.

Preliminary results of excavations in the Trou Walou Trooz (DEWEZ *et al.* 1993) in the valley of the Magne River, a tributary of the Vesdre, reveal the presence during the Aurignacian (layer C6c) of the cave bear, hyena, wolf, fox, red deer, reindeer, roe deer, large bovids, mammoth, woolly rhinoceros and horse (SIMONET 1993). Most prominent are cave bear (55.5%) and reindeer (20.5%) but strangely enough the assemblage contains but two remains which were apparently not identifiable. The Aurignacians hunted reindeer and the other cervids but the large bovid and horse are thought to belong essentially to the taphonomic category of remains due to hyena activity, for etching traces caused by the passage through the digestive tract of carnivores would occur almost exclusively on bones of the latter. The antler remains of reindeer and red deer suggest occupation of the cave between early winter and early summer. The landscape is described as steppic with limited extensions of wood, the climate as cold but temperate.

8. SUMMARY AND CONCLUSIONS

The recent excavation in the archeological deposits at the front of Trou Magrite in the Lesse Valley yielded faunal remains of which the inventory is presented in Table 7.1 together with a list of finds known from the older excavations. Most of the recent finds are attributable to the Aurignacian occupations evidenced by strata 2 and 3. Upper Paleolithic remains mixed with Holocene elements occur in the top stratum (strata 1 and 1.1), while the sediments underlying the Aurignacian levels contain a Middle Paleolithic faunal assemblage (strata 4 and 5). As is often the case in caves, the intrusive faunal component is generally considerable, comprising mainly landsnails, amphibians, small mammals which were prey of various predators, these predators themselves and other visitors to the cave. The anthropogenetic component comprises the various animals people had access to and which they brought to the cave, complete or partially. The penecontemporaneous faunal spectra in strata 2 and 3 point to an open environment without permafrost and with restricted snow cover (less than 40 cm) and annual precipitation (300-500 mm). Wooded areas existed no doubt in valleys such as that of the Lesse and other azonal situations. This picture fits in with the recently developed concept of the mammoth steppe, the open, dry and cold steppic landscape that would have stretched over large parts of unglaciated Eurasia and Alaska during the Last Glacial. Micromammals are well represented in the lowest Middle Paleolithic layer (stratum 5), of which the ecostratigraphical significance is discussed elsewhere (CORDY, this volume). The game bag of the Aurignacians included mainly reindeer, horse and ibex (Table 7.3), other animals were no doubt taken in a more opportunistic, haphazard fashion (Table 7.2). Such opportunistic hunting or scavenging may have given people limited access to mammoth and rhinoceros, but the remains of these pachyderms may as well derive from animals that fell down the chimney in the back of the cave. The Middle Paleolithic game bag seems to have contained a comparable animal spectrum, but the evidence is very restricted. The marked fragmentation and low number of the game remains preclude an in-depth analysis of differential transport of game, but people probably brought complete carcasses of reindeer to their dwelling, while those of horses arrived there without terminal leg elements, but with the heads. Ibexes may also have been brought to the cave complete. The data regarding the ageing of reindeer fawns from the Aurignacian strata on the basis of tooth eruption and wear can be combined with cementum analysis for the same species and lead to a scenario in which Trou Magrite would be a cold-season residential site from which reindeer moving through or in the valley were hunted. Horses may have been hunted in the same manner, but as these herbivores do not congregate in large herds (and are much more mobile than reindeer), they occur much less frequently in the game bag. One tooth of ibex provides discordant histological evidence : the animal may have been killed in the colder period of the year or during the warm season; mayby people visited the site in summer to hunt this non-migratory herbivore. Aurignacian faunas from several Belgian caves have not been studied following modern archeozoological methods. However, their combined not quantified faunal spectrum does not show fundamental differences from the one known from Trou Magrite. The faunal finds from the Grotte Princesse Pauline (Marche-les-Dames) and from the Trou du Renard (Furfooz) and the Trou Walou Trooz received better treatment and could indicate that the Aurignacians of these sites also regarded reindeer, horse and ibex as their main quarry.

REFERENCES

ABEL O., 1935,
Vorzeitliche Lebensspuren. Jena : Fischer.

ADAM W., 1960,
Faune de Belgique. Mollusques. I : Mollusques terrestres et dulcicoles. Bruxelles, Institut Royal des Sciences Naturelles de Belgique.

ANDREWS P., 1990,
Owls, Caves and Fossils. London : British Museum (Nat. Hist.).

AZZAROLI A., 1990,
The genus *Equus* in Europe. In : *European Neogene Mammal Chronology* (E.H. LINDSAY *et al.*, eds), pp. 339-356. New York : Plenum Press.

BEHRENSMEYER A.K., GORDEN K.D. & YANAGI G.T., 1986,
Trampling as a cause of bone surface damage and pseudo-cutmarks. *Nature* 319, 768-771.

BONIFAY M.-F., 1982,
Paléoclimatologie quantitative : méthode fondée sur les grands mammifères quaternaires et première application aux régions sud de la France. *Palaeogeography, Palaeoclimatology, Palaeoecology* 38, 207-226.

BOUCHUD J., 1966,
Essai sur le renne et la climatologie du Paléolithique moyen et supérieur. Périgueux : Magne (Thèse de doctorat, Université de Paris, 1959).

BOUCHUD J., 1970,
Les apports de la paléontologie du Quaternaire à la connaissance de l'homme fossile. In : L'homme de Cro-magnon (G. CAMPS & OLIVIER, G., eds), pp. 213-218. *Mém. hors Série C.R.A.P.E.* (Paris).

CHALINE J., 1972,
Les rongeurs du Pléistocène Moyen et Supérieur de France. Cahiers de Paléontologie. Paris : CNRS.

CORDY J.-M., 1974,
La faune aurignacienne de la Grotte Princesse Pauline à Marche-les-Dames. *Bull. Soc. Roy. belge anthrop. Préhist.* 85, 243-252.

CORDY J.-M., 1976,
La faune aurignacienne du Trou du Renard à Furfooz (Province de Namur). *Bull. Soc. roy. belge. Anthrop. Préhist.* 87, 141-146.

CREGUT-BONNOURE E., 1992a,
Pleistocene Tahrs, Ibexes and Chamois of France. In : Proceedings of the International Symposium "Ongulés-Ungulates" (1991) (F. SPITZ, G. JANEAU, G. GONZALEZ & S. AULAGNIER, eds), pp. 49-53. Paris/Toulouse : S.F.E.P.M.-I.R.G.M.

CREGUT-BONNOURE E., 1992b,
Intérêt biostratigraphique de la morphologie dentaire de *Capra* (Mammalia, Bovidae). *Ann. Zool. Fennici* 28, 273-290.

DE CONINCK J., 1981,
La faune malacologique. In : Sondages à Marche-les-Dames. Grotte de la "Princesse", 1976. (M. OTTE), pp. 44-47. *ERAUL* 2.

DEWEZ, M. 1987,
Le Paléolithique Supérieur Récent dans les Grottes de Belgique. Université Catholique de Louvain.

DEWEZ M., COLLCUTT S.N., CORDY J.M., GILOT E., GROESSENS-VAN DYCK M.-CL., HEIM J., KOZLOWSKI S. et LACROIX E., D. & SIMONET P., 1993,
Recherches à la grotte Walou à Trooz (Province de Liège, Belgique). Premier rapport de fouille. *Mém. Soc. Wall. Palethnologie* 7.

DUPONT E., 1867,
Découverte d'objets gravés et sculptés dans le Trou Magrite à Pont-à-Lesse. *Bull. Acad. Roy. Sc. Lett. et Beaux-Arts de Belg.* 36, 2e sér., 24, 149-152.

DUPONT E., 1871,
Les temps préhistoriques en Belgique. L'homme pendant les âges de la pierre dans les environs de Dinant-sur-Meuse. Bruxelles.

EISENMANN V., 1991,
Les Chevaux quaternaires européens (Mammalia, Perissodactyla). Taille, typologie, biostratigraphie et taxonomie. *Geobios* 24(6), 747-759.

EISENMANN V., ALBERDI M.T., DE GIULI C. & STAESCHE U., 1988,
Methodology. In : *Studying Fossil Horses* (M. WOODBURNE & P. SONDAAR, eds), vol. I, 71 pp. Leiden : Brill.

FAURE M. & GUÉRIN C., 1983,
Le *Sus scrofa* (Mammalia, Artiodactyla, Suidae) du gisement pléistocène supérieur de Jaurens, à Nespouls, Corrèze, France. *Nouv. Arch. Mus. Hist. nat. Lyon* 21, 45-63.

FORSTEN A., 1988,
The small caballoid horse of the upper Pleistocene and Holocene. *Journ. Anim. Breed. Genet.* 105(1987), 161-176.

GAUTIER A., 1981,
Ossements fossiles (Dernier Glaciaire et Holocène). In : Sondages à Marche-les-Dames, Grotte de la "Princesse", 1976 (M. OTTE), pp. 35-44. *ERAUL* 2.

GAUTIER A., 1984,
How do I count you, let me count the ways? Problems in archaeozoological quantification. In : Animals and Archaeology : 4. Husbandry in Europe (C. GRIGSON & J. CLUTTON-BROCK, eds), pp. 237-251. *BAR International Series* 227.

GAUTIER A., 1987,
Taphonomic groups : How and Why ? *ArchaeoZoologia* I(2), 45-52.

GAUTIER A., 1990,
La domestication. Et l'homme créa ses animaux. Paris : Errance.

GUÉRIN Cl. & FAURE M., 1983,
Les hommes du Paléolithique Européen ont-ils chassé le rhinocéros? *Mém. Soc. Préhist. française* 16, 29-36.

HAYNES G., 1991,
Mammoths, mastodonts, and elephants. Biology, behavior, and the fossil record. Cambridge : Cambridge Univ. Press.

GUTHRIE R.D., 1984,
Frozen Fauna of the Mammoth Steppe. The Story of Blue Babe. Chicago/London: University of Chicago Press.

HOKR Z., 1951,
A method of the quantitative determination of the climate in the Quaternary period by means of Mammal associations. *Sb. ustred. Ustavu geol., odd. paleont.* 18, 209-219.

HUBENDICK B., 1948,
On Northern isolated occurrences of certain terrestrial molluscs in the Baltic area. *Journ. Conch.* 88, 145-149.

KAHLKE R.-D., 1992,
Repeated immigration of saiga into Europe. *Courier Forsch.-Inst. Senckenberg* 153, 187-195.

KUBIAK H., 1982,
Morphological characters of the mammoth : an adaptation to the arctic-steppe environment. *Paleoecology of Beringia 17,* 281-289.

KURTEN B., 1968,
Pleistocene Mammals of the Old World. London : Weidenfeld & Nicolson.

LAVOCAT R., 1966,
Faunes et flores préhistoriques de l'Europe occidentale. Paris : Boubée.

MOHR E. & VOLF J., 1984,
Das Urwildpferd. Wittenberg/Lutherstadt : Ziemsen.

OLSEN L.S., 1989,
Solutré : A theoretical approach to the reconstruction of Upper Palaeolithic hunting strategies. *Journ. Hum. Evolution* 18, 295-327.

OLSEN S.L. & SHIPMAN P., 1988,
Surface modification in bone : trampling vs butchery. *Journ. Arch. Sci.* 15(5), 535-553.

OTTE M., 1979,
Le paléolithique supérieur ancien en Belgique. *Monographies d'Archéologie Nationale* 5, 684 p. Bruxelles : Musées royaux d'Art et d'Histoire.

PALES L.S. & GARCIA M.A., 1981a,
Atlas ostéologique pour servir à l'identification des mammifères du Quaternaire. II. Tête-Rachis. Ceintures scapulaire et pelvienne. Membres. Carnivores. Homme. Paris : CNRS.

PALES L.S. & GARCIA M.A., 1981b,
Atlas ostéologique pour servir à l'identification des mammifères du Quaternaire. II. Tête-Rachis. Ceintures scapulaire et pelvienne. Membres. Herbivores. Homme. Paris : CNRS.

PALES L.S. & LAMBERT Ch., 1971a,
Atlas ostéologiques pour servir à l'identification des mammifères du Quaternaire. I. Les Membres. Carnivores. Paris: CNRS.

PALES L.S. & LAMBERT Ch., 1971b,
Atlas ostéologiques pour servir à l'identification des mammifères du Quaternaire. I. Les Membres. Herbivores. Paris: CNRS.

PATOU M., 1987,
Les marmottes : animaux intrusifs ou gibiers des préhistoriques du Paléolithique. *ArchaeoZoologia* 1(1), 93-107.

PETERSON R., MOUNTFORT G. & HOLLOM P.A.D., 1962,
Guide des oiseaux d'Europe. Paris: Delachaux & Niestlé.

RAHIR E., 1914,
Découvertes archéologiques faites à Furfooz de 1900 à 1902. *Bull. Soc. Anthrop. Brux.* 33, 16-65.

RUTOT A., 1910,
Note sur l'existence des couches à rongeurs arctiques dans les cavernes de la Belgique. *Bull. Acad. roy. Belg.* 5, 335-379.

SIMONET P., 1993,
La grande faune de la couche aurignacienne de la grotte Walou à Trooz (Province de Liège, Belgique). Etude préliminaire. In : Recherches à la grotte Walou à Trooz (Province de Liège, Belgique). Premier rapport de fouille. (M. DEWEZ, S.N. COLLCUTT, J.M. CORDY, E. GILOT, M.-CL. GROESSENS-VAN DYCK, J. HEIM, S. et E. KOZLOWSKI, D. LACROIX & P. SIMONET), pp. 51-60. *Mém. Soc. Wall. Palethnologie* 7.

STRAUS L., OTTE M., GAUTIER A., HAESAERTS P., MARTINEZ A., NEWMAN M. & SCHUTZ C., 1993,
1992 Paleolithic excavations in Belgium by the universities of New Mexico and Liège. *Old World Archaeology Newsletter*, 16(2), 1-11.

STRAUS L., OTTE M., LÉOTARD J., GAUTIER A. & HAESAERTS P., 1992,
Middle and Early Upper Paleolithic Excavations in Southern Belgium: A Preliminary Report. *Old World Archaeology Newsletter* 15(2), 10-18.

SUTCLIFFE A.J., 1970,
Spotted Hyaena : Crusher, Gnawer, Digester and Collector of Bones. *Nature* 227, 1110-1113.

TOEPFER V., 1963,
Tierwelt des Eiszeitalters. Leipzig : Geest & Portig.

WENIGER, G.-Ch., 1982,
Wildbeuter und ihre Umwelt. *Archaeologica Venatoria* (Tübingen) 5, 228 p.

M. OTTE et L.G. STRAUS (dir.), *Le Trou Magrite. Fouilles 1991-1992*. Liège, E.R.A.U.L. 69, 1995.

8

ETUDE DE RESTES MICROFAUNIQUES PROVENANT DU TROU MAGRITE (PROV. DE NAMUR, BELGIQUE)

Jean-Marie CORDY

1. INTRODUCTION

De 1991 à 1993, des fouilles de contrôle ont été menées conjointement par les Universités de New Mexico et de Liège dans plusieurs gisements préhistoriques de Belgique, dont le Trou Magrite dans la vallée de la Lesse (Straus *et al.*, 1991, 1993a et 1993b). A cette occasion, des analyses pluridisciplinaires ont été entreprises dans les restes de couches encore vierges qui subsistaient au devant de la grotte. Dans ce cadre, la recherche de fossiles de micromammifères a également été entreprise à la suite de la découverte d'une "couche à rongeurs" dans la partie supérieure d'un niveau d'époque "moustérienne".

2. MATERIAUX

Les matériaux microfauniques ont été recueillis par tamisage par l'équipe de fouilles dirigée par L.G. Straus. Le tri des refus de tamisage a été réalisé à l'Université de Gent (A. Gautier). Les matériaux qui nous ont été confiés sont donc constitués essentiellement par des mandibules et des dents isolées, auxquelles s'ajoutent des maxillaires en moins grand nombre. L'échantillonnage a été réalisé classiquement suivant les couches lithologiques, à l'exception de la couche 5 qui a été subdivisée en 4 sous-couches. La technique de prélèvement suivant une colonne biostratigraphique avec échantillonnage décimétrique continu (voir par exemple Cordy, 1992) n'a pas été retenue par les fouilleurs et les dents étudiées proviennent vraisemblablement de plusieurs carrés différents.

3. METHODES

Compte tenu de l'abondance des restes dentaires dans certaines échantillons, il était possible de réaliser le décompte des micromammifères uniquement sur les premières molaires inférieures (M/1). Toutefois, la richesse des échantillons supérieurs de la couche 5 a fait apparaître l'existence d'espèces rares, mais très informatives paléoécologiquement. Dès lors, afin de quantifier précisément l'importance relative de ces espèces, le décompte traditionnel a été

Taxons / Couches	1.1		2		5 sup.		5 moyen sup.		5 moyen inf.		5 inf.	
	N	%	N	%	N	%	N	%	N	%	N	%
Lagurus lagurus	-	-	-	-	1	0,11	6	0,13	-	-	-	-
Cricetulus migratorius	-	-	-	-	6	0,68	3	0,06	-	-	-	-
Ochtotona pusilla	-	-	-	-	3	0,21p	12	0,15p	-	-	-	-
Dicrostonyx gulielmi	-	-	-	-	10	1,1	94	2,0	-	-	1*	(16,7)
Lemmus lemmus	-	-	-	-	-	-	3	0,06	-	-	-	-
Microtus gregalis	-	-	1*	-	339*	74,3	1212*	73,1	5*	-	4*	(66,6)*
Microtus oeconomus	-	-	-	-	95*	20,8	400*	24,1	-	-	1*	(16,7)
Microtus agrestis ?	-	-	-	-	13*	2,8	6*	0,4	-	-	-	-
Microtus sp.	-	-	-	-	414	-	2988	-	-	-	-	-
Apodemus cf. sylvaticus	1*	-	-	-	-	-	-	-	-	-	-	-
TOTAL	1*	-	1*	-	881	100	4724	100	5*	-	6*	(100)

Tableau 8.1 : Liste qualitative et quantitative des micromammifères du Trou Magrite (Fouilles L.G. Straus et coll.)

* = décompte réalisé uniquement sur les M/1;
p = pourcentage pondéré.

complété par un décompte de l'ensemble des molaires supérieures et inférieures. Dans ce cas, les molaires du genre *Microtus* autres que la M/1, qui n'ont pu être déterminées spécifiquement, ont été rassemblées dans la catégorie dénommée *Microtus* sp. Pour le calcul des pourcentages, le nombre de dents indéterminées du genre *Microtus* a alors été subdivisé et réparti dans le décompte de chacune des espèces de ce genre au prorata du dénombrement des M/1. Cette méthode a permis de valoriser l'analyse de la représentativité de tous les micromammifères qui n'appartiennent pas au genre *Microtus* puisque, dans le cas de ces espèces, la détermination spécifique ne nécessite pas obligatoirement l'emploi de la première molaire inférieure.

Dans le calcul des pourcentages, un facteur de pondération a été utilisé pour corriger la représentativité relative du petit Lagomorphe *Ochotona pusilla* ; ce facteur tient compte du plus grand nombre de dents jugales caractérisant cette espèce (5 au lieu de 3 chez la plupart des Rongeurs).

La systématique des Rongeurs employée ici est classique. Il est à noter toutefois que *Dicrostonyx gulielmi* est employé de préférence à *Dicrostonyx torquatus*, que "*Microtus agrestis* ?" s'applique à des formes intermédiaires entre *Microtus gregalis* et *Microtus agrestis*, et que l'emploi de la dénomination *Apodemus* cf. *sylvaticus* n'exclut pas totalement l'attribution à l'espèce *Apodemus flavicollis*.

La technique de visualisation des résultats consiste à disposer les pourcentages de réprésentativité des différentes espèces rencontrées sur un diagramme multigraphique. Ainsi, la figure 8.1 présente de gauche à droite :

1) par rapport à l'ensemble des micromammifères, les pourcentages cumulés de cinq ensembles d'espèces caractéristiques globalement a) d'un climat tempéré à biotopes ouverts (*Microtus arvalis* et *Microtus agrestis*), b) d'un climat steppique (*Ochotona pusilla*, *Cricetulus migratorius* et *Lagurus lagurus*), c) d'un climat contiental humide (*Microtus oeconomus*), d) d'un climat continental sec (*Microtus gregalis*), e) d'un climat polaire ou subpolaire (*Lemmus lemmus* et *Dicrostonyx gulielmi*);

2) les pourcentages simples des espèces les mieux représentées;

3) les pourcentages amplifiés des espèces rares.

4. INTERPRETATIONS GENERALES

Comme l'indique le tableau 8.1, très peu de restes déterminables ont été récoltés en dehors des lentilles fossilifères de la moitié supérieure de la couche 5 ; plusieurs couches sont même inexistantes du point de vue de l'analyse microfaunique. La technique de récolte et de tamisage peut expliquer éventuellement cette grande pauvreté, mais il reste clair que toutes ces couches étaient relativement pauvres en micromammifères. Le contraste avec le dessus de la couche 5 s'explique par l'habitat prolongé d'un ou de Rapaces nocturnes qui ont accumulé au pied de leur poste de guet ou de leur nid des pelotes de réjection; après dislocation de ces pelotes, les petits ossements et restes dentaires ont constitué des lentilles extrêmement riches au sein du dépôt sédimentaire.

Malgré son extrême pauvreté, il est possible de distinguer l'échantillon de la couche 1.1. En effet, il est le seul à conserver un Rongeur typiquement sylvicole de climat tempéré tel que le Mulot, *Apodemus* cf. *sylvaticus*. De plus, l'os présente un aspect relativement frais. Ces données sont parfaitement en accord avec l'âge Holocène de cette couche humifère sommitale.

Tous les autres échantillons ne comportent ni restes de Rongeurs tempérés, ni Insectivores, ni Chiroptères. Au contraire, si l'on fait exception de la présence incertaine du Campagnol agreste, *Microtus agrestis*, toutes les autres espèces sont étrangères à la microfaune actuelle de la Belgique. La couche 2 et les couches inférieures sont donc anté-Holocènes et appartiennent à des épisodes de dégradation climatique de type glaciaire. Enfin, le Campagnol des hauteurs, *Microtus gregalis*, apparaît comme l'élément majeur de la microfaune.

5. DESCRIPTION DE LA MICROFAUNE DE LA COUCHE 5

Les différents échantillons de la couche 5 paraissent très homogènes entre eux. La microfaune est chaque fois constituée essentiellement d'espèces allochtones avec le Campagnol des hauteurs, *Microtus gregalis*, tout à fait prédominant ; de plus, les espèces sylvicoles tempérées, les Insectivores et les Chiroptères sont totalement absents. Cette homogénéité est tout à fait frappante lorsque la comparaison est réalisée entre les deux échantillons de la couche 5 supérieure et 5 moyenne supérieure. Cette très grande ressemblance indique certainement que la couche 5 correspond à une période paléoclimatique unitaire et indique peut-être également que la sédimentation a été relativement rapide.

Le spectre microfaunique peut donc être défini comme suit :

a) Pour l'essentiel, la microfaune est formée par deux Campagnols (*Microtidae*) qui constituent ensemble plus de 95 % de l'ensemble des micromammifères. Parmi ceux-ci, le Campagnol des hauteurs, *Microtus gregalis*, est l'élément tout à fait prédominant puisqu'il constitue quasiment les 3/4 de la microfaune. Toutefois, le Campagnol nordique, *Microtus oeconomus*, est loin d'être négligeable puisqu'il forme plus de 20 % de la microfaune.

b) A côté de ces deux Rongeurs, la présence du Campagnol agreste, *Microtus agrestis*, qui vit toujours dans nos contrées, reste incertaine car les morphotypes évoquent le *Microtus gregalis*; même si l'attribution spécifique s'avère exacte, la présence de ce Rongeur est néanmoins très faible. De même, le Lemming à collier, *Dicrostonyx gulielmi*, est très peu représenté (1 à 2 %).

c) Enfin, la microfaune est encore caractérisée par quatre espèces dont la représentativité est inférieure à 1 %. La présence conjointe du Lemming gris, *Lagurus lagurus*, du petit Hamster migrateur, *Cricetulus migratorius*, du petit

Lièvre siffleur, *Ochotona pusilla*, et du grand Lemming, *Lemmus lemmus*, est toutefois extrêmement instructive.

d) Les absences sont également tout à fait caractéristiques et sont validées par le grand nombre des déterminations effectuées. En particulier, il faut noter l'absence des genres *Apodemus, Clethrionomys, Arvicola* et peut-être également du groupe *Microtus arvalis-agrestis.* A cela, s'ajoute l'absence d'Insectivores (Taupe, Musaraignes) et de Chiroptères.

6. INTERPRETATION PALEOECOLOGIQUE DU DEPOT DE LA COUCHE 5 ET ESSAI DE BIOCHRONOLOGIE

Cette association très typée de micromammifères atteste un climat franchement continental. La prédominance absolue du *Microtus gregalis* par rapport à *Microtus oeconomus*, ainsi que l'absence d'*Arvicola terrestris*, accentuent le caractère continental du climat, mais soulignent, avant tout, son aridité. Le climat était également froid et surtout rigoureux en hiver ; toutefois, le très faible pourcentage du Lemming à collier et du grand Lemming indique que la température moyenne n'était pas celle d'un pléniglaciaire ou même celle d'un stade glaciaire tel qu'un Dryas. Enfin, la présence même très peu marquée du Lemming gris, du Hamster migrateur et du Lièvre des steppes confirment par leur répartition géographique actuelle dans les steppes d'Asie centrale le climat continental aride. Dans ce contexte climatique et avec la présence conjointe des trois dernières espèces, il paraît évident que le paysage était essentiellement découvert et typiquement steppique.

Ces déductions paléoécologiques s'accordent très bien avec la nature loessique de la couche 5 (Straus *et al.*, 1992) : un environnement steppique et aride devait en effet permettre et favoriser la formation de loess. Toutefois, l'aspect lité par ruissellement de ce loess a également été mis en évidence et a permis aux auteurs d'envisager une relative humidité du climat. Afin d'accorder ces observations avec les données microfauniques qui soulignent plutôt l'aridité climatique, il paraît raisonnable d'envisager un dépôt saisonnier de loess ruisselés lors de la fonte printanière des neiges hivernales, le bilan annuel des précipitations restant néanmoins très faible. Notons encore que les restes microfauniques ne présentent aucun signe d'érosion mécanique important et qu'ils ont donc été progressivement enfouis par un dépôt de ruissellement de très faible compétence.

D'un point de vue biochronologique, le profil général de cette association microfaunique paraît récurrent en Belgique. Une microfaune formée essentiellement par *Microtus gregalis* et *Microtus oeconomus*, le premier étant tout à fait prédominant, a déjà été observée à la grotte de Sclayn (Cordy, 1992) dans la biozone Sclayn V gris rapportée à Melisey II et dans la biozone Sclayn I rapportée à une phase antérieure au complexe interstadiaire d'Hengelo-Les Cottés (biozone Sclayn I), ainsi que dans la grotte Walou dans la biozone Walou CMFI rapportée au début du Dryas II (Cordy 1991). Il n'est pas impossible que ce type d'association apparaisse également dans d'autres phases du Pléistocène supérieur qui n'ont pas encore été décrites du point de vue microfaunique. Toutefois, la présence concomitante d'espèces typiquement steppiques comme *Cricetulus migratorius, Lagurus lagurus, Ochotona pusilla,* accompagnées par le grand Lemming, *Lemmus lemmus,* atteste d'un paléoclimat très particulier qui a conduit à des immigrations singulières. De tels cortèges migratoires n'ont été reconnus jusqu'à présent en Belgique que pour les stades chrono-isotopiques 3 et 5b (Cordy, 1992). En outre, dans ces deux derniers cas, seul le stade 5b (Melisey II) semble caractérisé par la migration du petit Hamster migrateur, *Cricetulus migratorius.* Dès lors, dans l'état actuel de nos connaissances, l'hypothèse la plus économique de datation est de corréler la couche 5 du Trou Magrite à la biozone Sclayn V gris, c'est-à-dire à la période de dégradation climatique de Melisey II au sein du dernier interglaciaire (*sensu lato*).

7. EVOLUTION PALEOECOLOGIQUE DE LA MICROFAUNE DANS LA COUCHE 5

L'évolution stratigraphique des associations microfauniques dans la couche 5 est peu perceptible (Fig. 8.1). D'une part, les sous-couches inférieures sont très pauvres en restes déterminés. Néanmoins, la présence d'un Lemming à collier, *Dicrostonyx gulielmi,* sur une petite dizaine de restes de Rongeurs, pourrait indiquer que ce Rongeur était plus fréquent dans la partie inférieure de la couche que dans la partie supérieure où il n'atteint au plus que 2 %. Il est donc possible que le climat était plus froid et rigoureux dans cette première phase de dépôt éolien.

Dans la partie supérieure de la couche 5, les associations de micromammifères sont très similaires et leurs différences pourraient être liées au hasard. Fort heureusement, le très grand nombre de déterminations lève probablement en partie cette incertitude. En outre, des modifications corrélables peuvent être discernées (Fig. 8.1). Ainsi, une légère accentuation du caractère continental aride du climat semble découler de l'augmentation du pourcentage de représentativité du *Microtus gregalis* accompagné logiquement par ceux des micromammifères typiquement steppiques, *Lagurus lagurus, Cricetulus migratorius* et *Ochotona pusilla.* A l'inverse, le Campagnol nordique, *Microtus oeconomus,* caractéristique des climats continentaux humides, diminue corrélativement. Enfin, la régression des Lemmings, *Dicrostonyx gulielmi* et *Lemmus lemmus,* qui va dans le prolongement de ce qui a été envisagé pour la partie inférieure de la couche, semble confirmer l'hypothèse d'une régression du froid au profit d'un climat un peu moins rigoureux, mais plus continental et plus aride.

En conclusion, les dépôts de la couche 5 sont hypothétiquement contemporains d'une phase de relative amélioration climatique en fin d'épisode stadiaire. Ce climat de transition de type continental, aride et de milieu steppique peut être rapporté à titre d'hypothèse au stade isotopique 5b, c'est-à-dire au stade pollinique de Melisey II.

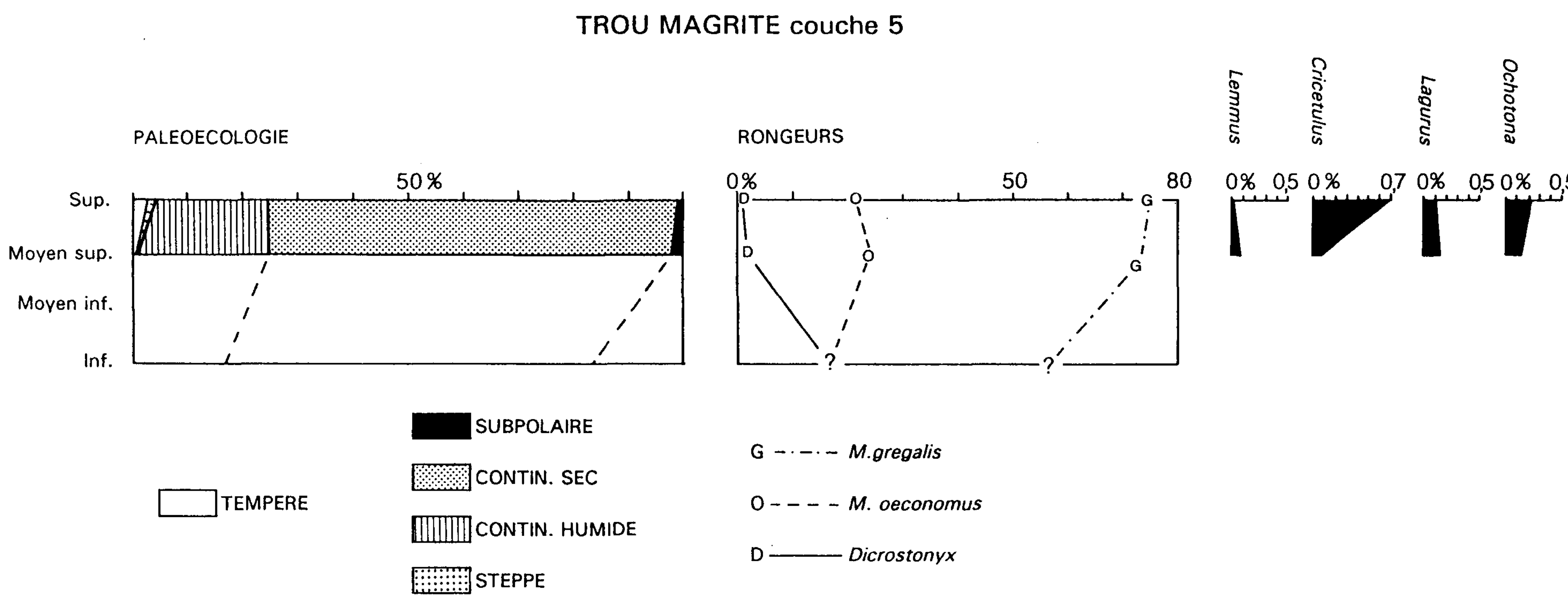


Figure 8.1 : Diagramme microfaunique de la couche 5 du Trou Magrite selon les différentes sous-couches. Pour la définition des composantes du diagramme, voir le texte.

REFERENCES

CORDY J.-M., 1991,
Palaeoecology of the Late Glacial and early Postglacial of Belgium and neighbouring areas. in : Barton, N., Roberts, A.J. and Roe, D.A. (Eds.), The Late Glacial in north-west Europe, *C.B.A.Research Rep., 77* : pp. 40-47.

CORDY J.-M., 1992,
Bio- et chronostratigraphie des dépôts quaternaires de la grotte Scladina (Province de Namur, Belgique) à partir des micromammifères, in M. Otte (Ed.), *Recherches aux grottes de Sclayn. I : Le contexte,* Liège, E.R.A.U.L. 27, pp. 79-125.

STRAUS L.G., OTTE M., LEOTARD J.-M., GAUTIER A. et HAESAERTS P., 1991,
Middle and Early Upper Paleolithic Excavations in Southern Belgium : A Preliminary Report, *Old World Archaeol. Newsl., 15,* 2 : pp. 10-18.

STRAUS L.G., OTTE M., GAUTIER A., HAESAERTS P., MARTINEZ A., NEWMAN M. et SCHUTZ C., 1992 - 1993,
Paleolithic excavations in Belgium by the Universities of New Mexico and Liège, *Old World Archaeol. Newsl., 16,* 2 : pp. 1-11.

STRAUS L.G., OTTE M., CORDY J.-M., LEOTARD J.-M., NOIRET P., GAUTIER A., HAESAERTS P. et LACROIX Ph., 1993,
Paleolithic & Mesolithic research in Belgium : le Trou Magrite, Huccorgne & l'Abri du Pape, *Old World Archaeol. Newsl., 17,* 1 : pp. 17-24.

M. OTTE et L.G. STRAUS (dir.), *Le Trou Magrite. Fouilles 1991-1992*. Liège, E.R.A.U.L. 69, 1995.

9

TOWARD A RECONSTRUCTION OF SUBSISTENCE ECONOMY IN THE UPPER PLEISTOCENCE MOSAN BASIN: CEMENTUM INCREMENT EVIDENCE

Aaron J. STUTZ, Daniel E. LIEBERMAN, Arthur E. SPIESS

INTRODUCTION

Cementum is the bone-like tissue that surrounds the roots of teeth. In most ungulate species it grows in roughly semiannual increments, which record an individual's season of death and age at death. Since the late 1960's, archaeologists have examined cementum increments to generate seasonality and mortality profiles of prehistoric hunter-gatherer prey populations (Bourque *et al.* 1978; Burke 1992; Gordon 1988; Lieberman 1993b, 1993c; O'Brien and Miracle 1994; Pike-Tay 1991; Saxon and Higham 1968; Spiess 1976, 1978, 1979, 1990; Stutz 1993). In this chapter we report the results of cementum increment analysis of a small sample of ungulate teeth (n=7) from strata 2 and 3 at Trou Magrite. These cementum increment results complement the seasonality information that has been generated from Trou Magrite juvenile reindeer tooth eruption profiles. We discuss the cementum increment and tooth eruption data from Trou Magrite in the context of cementum increment data from three other Upper Pleistocene deposits in the Mosan Basin: a mixed Mousterian and Aurignacian stratum from Trou du Diable à Hastière-Lavaux (n=10); a mixed Aurignacian and Perigordian stratum from Trou Reuviau àFurfooz (n=2), and a sealed Mousterian living floor in le Grotte de Sclayn (n=5) (Stutz 1993). From this basis we discuss the strengths and limitations of our seasonality and mortality data. We also outline some problems for future research on Upper Pleistocene hominid subsistence economy in northwestern Europe. We conclude by offering one possible reconstruction of Mosan Basin hunter-gatherer mobility patterns and hunting strategies across the Middle-Upper Paleolithic transition.

MATERIALS AND METHODS: PREPARING AND INTERPRETING CEMENTUM INCREMENT SPECIMENS

Several interrelated factors, physiological, functional, and environmental in nature, underlie cementum's utility as a source of mortality and seasonality information. Cementum functions to anchor an animal's tooth roots into the gum (periodontal ligament). This is accomplished as cementoblast cells deposit a mixture of collagen fibers and hydroxyapatite crystals around collagen bundles (Sharpey's fibers) that originate in the periodontal ligament and extend to the root (see Fig. 9.2). The cementoblasts are located along the periodontal ligament, so that they secrete cementum matrix from the gum onto the root's surface. Growth occurs in this manner--with new cementum constantly forming on the outer surface of the root--throughout the lifetime of the individual (or tooth).

Recent research indicates that diet is the factor that determines the rate of formation, density, and Sharpey's fiber orientation of newly deposited cementum (for details see Lieberman 1993a, 1994; but see also Burke 1992). Thus, ungulates that regularly alternate between winter and summer diets will grow two seaonally distinct types of cementum. The regular changes in cementum growth appear as distinct tree-ring-like increments that surround the tooth root. A ground thin section of a tooth, when viewed in the microscope in transmitted cross-polarized light, reveals cementum increments as alternating translucent and opaque bands.[1] This pattern of banding is most clearly seen in the area of cementum around the gum line. This region is marked by the juncture of four histological features: the alveolar bone, the enamel, the dentine, and the cementum (see Fig. 9.1). Along this portion of the tooth root, the cementum grows at a slow, roughly constant rate. As a result, seasonal increments are sharply discernible. The cementum near apical extent of the enamel is classified as "acellular cementum" because it does not exhibit the lacuna-traces of cementoblasts. This histology contrasts with that of the "cellular cementum" that pads the root apices and furcation; such cementum is very thick, irregularly banded, and dotted with cementoblast lacunae (cf. Lieberman and Meadow 1992).

Incremental structures have been documented in the cementum of most ungulate taxa, including those species included in our archaeological sample: reindeer/caribou (*Rangifer tarandus*), red deer (*Cervus elaphus*), bison (*Bison* cf. *priscus*), and ibex (*Capra ibex*) (see, e.g., Spiess 1976). Analysis of modern *Rangifer* and *C. elaphus* field specimens of known age and season of death demonstrates that populations of these species throughout North America and Europe--regardless of latitude, altitude, or microhabitat--exhibit growth of "translucent" cementum from late April-early May through late December, and of "opaque" cementum from January through April (Gordon 1988; Grue and Jensen 1979; Pike-Tay 1991; Spiess 1976, 1979).There is no comparable documentation of the timing of growth of translucent and opaque cementum in modern ibex and bison. However, ibex and those bison inhabiting cool, continental regions survive winter under stressful dietary constraints comparable to those confronted by reindeer and red deer. Because

1 On a thick polished section viewed under reflected light, the cementum increments appear "in negative." Thus, bands that are translucent under a transmitted polarized light appear dark under a reflecting-light microscope because the light source is not reflected back through the objective lens to the viewer. For the same reasons, bands that are opaque under transmitted light appear bright under the reflected light. Throughout this chapter, unless otherwise indicated, "translucent" and "opaque" will refer to increments that appear as such on ground thin sections under a transmitting polarized light microscope. This is because the bulk of the data presented below was obtained from analysis of thin sections viewed under transmitted light.

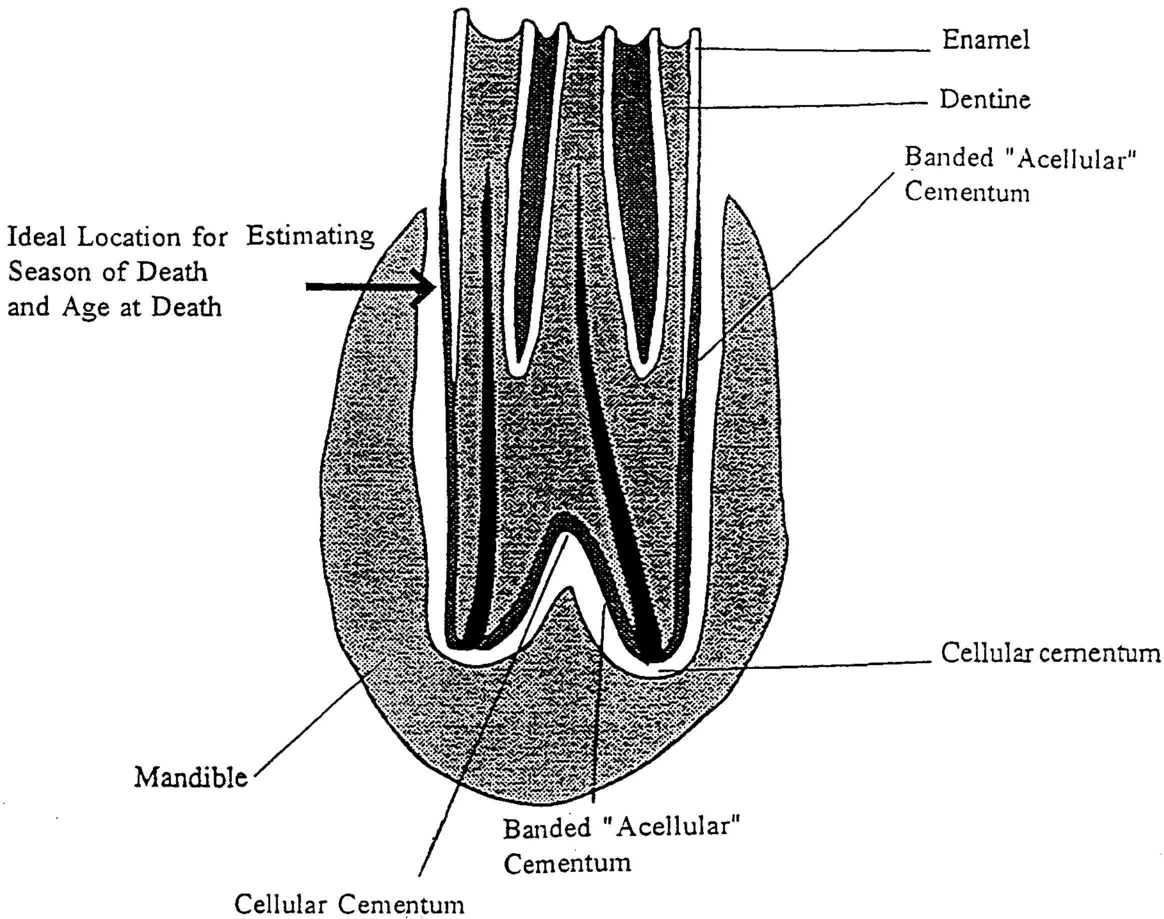


Figure 9.1 : Idealized Cross-Section Through Gazelle M_1. The best region of cementum for determining the individual's age at death and season of death is around the cementum-enameldentine junction, just below the gum line (From Lieberman 1993b : 195).

we know how such winter constraints affect the process of cementogenesis, we can use data on ibex and bison seasonal nutrition cycles to predict reliably the timing of growth of opaque and translucent cementum bands in these species.[2]

Beginning around January and continuing as late as May, populations in each of these taxa survive on protein-poor graze and browse, and depending on the temperature and snow cover, they must often rely on physically hard, tough bark and twigs (cf. Spiess 1979:31, 254-263). The low availability of dietary protein means little material for collagen synthesis by cementoblasts and the fibroblasts that deposit Sharpey's fibers. The winter decrease in dietary minerals is not as significant as that in protein, though, so that normal amounts of calcium phosphate (hydroxyapatite) precipitate in a smaller volume of new cementum, forming denser tissue.[3] In transmitted light the dense winter cementum appears relatively opaque. In contrast, cementum that grows from late spring through the fall is less dense and appears relatively translucent because it corresponds to a period with higher amounts of dietary protein.

Winter forage is also typically harder than the relatively protein-rich summer-fall graze, so that the animals need to produce more force during mastication. This places more compressive strain on a tooth, and Sharpey's fibers respond to this occlusal strain by growing in a more oblique orientation, acting as an occlusal "shock absorber." Under cross polarized light this winter cementum will bend polarized light differently than adjacent, more horizontally oriented summer-fall cementum (see Fig. 9.2). All other factors being equal, any given band, regardless of season of formation, may appear as either translucent or opaque, depending on its orientation relative to the polarized light source in the microscope. However, the hypermineralized (dense) winter-early spring increments always appear relatively opaque, regardless of the orientation of polarized light. The summer-fall bands, then, can only be differentiated from winter cementum when they are in an orientation that transmits the polarized light. In summary, for the reasons given above, opaque bands in ibex and bison almost certainly formed from about January through April, give or take one month depending on the species' seasonal foraging patterns and the local climate (cf. Spiess 1979:261-2, 1990:31).

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2 Several sources of data suggest that bands in cementum form in response to regular seasonal shifts in diet. Controlled feeding experiments on domesticated Nubian goats (Capra hircus) illustrate how changes in the physical and nutritional qualities of diet affect cementum increment formation (Lieberman 1993a, 1993b, 1994). Keeping in mind the results of the feeding experiments, we can examine ecological data on annual foraging cycles (and possibly endocrine-related physiological cycles, and periodicity in mating and birth events) to infer the parameters on the rate of cementum growth, its composition, and Sharpey's fiber orientation (cf. Lieberman 1993a; 1993b, 1994; Lieberman and Meadow 1992; Spiess 1990). Finally, we can utilize analyses of cementum increments in the teeth of modern wild ungulates of known age and season of death (e.g., Burke 1992; Gordon 1988; Grue and Jensen 1979; Klevezal 1988; Lieberman 1993b, 1993c; Pike-Tay 1991; Spiess 1976, 1990); these results reveal that the timing of formation of these semiannual cementum increments corresponds to the timing of seasonal changes in diet.

3 An additional factor may catalyze the hypermineralization of winter cementum in northern-latitude ungulates: "To survive this winter period, deer must build up substantial fat reserves in late summer and fall. Lipogenesis (fat formation) is under endocrine control triggered by decreasing day length and is physiologically obligatory" (Spiess 1990:31). The diversion of dietary resources for building up fat reserves would compound the late fall and winter reduction in protein intake.

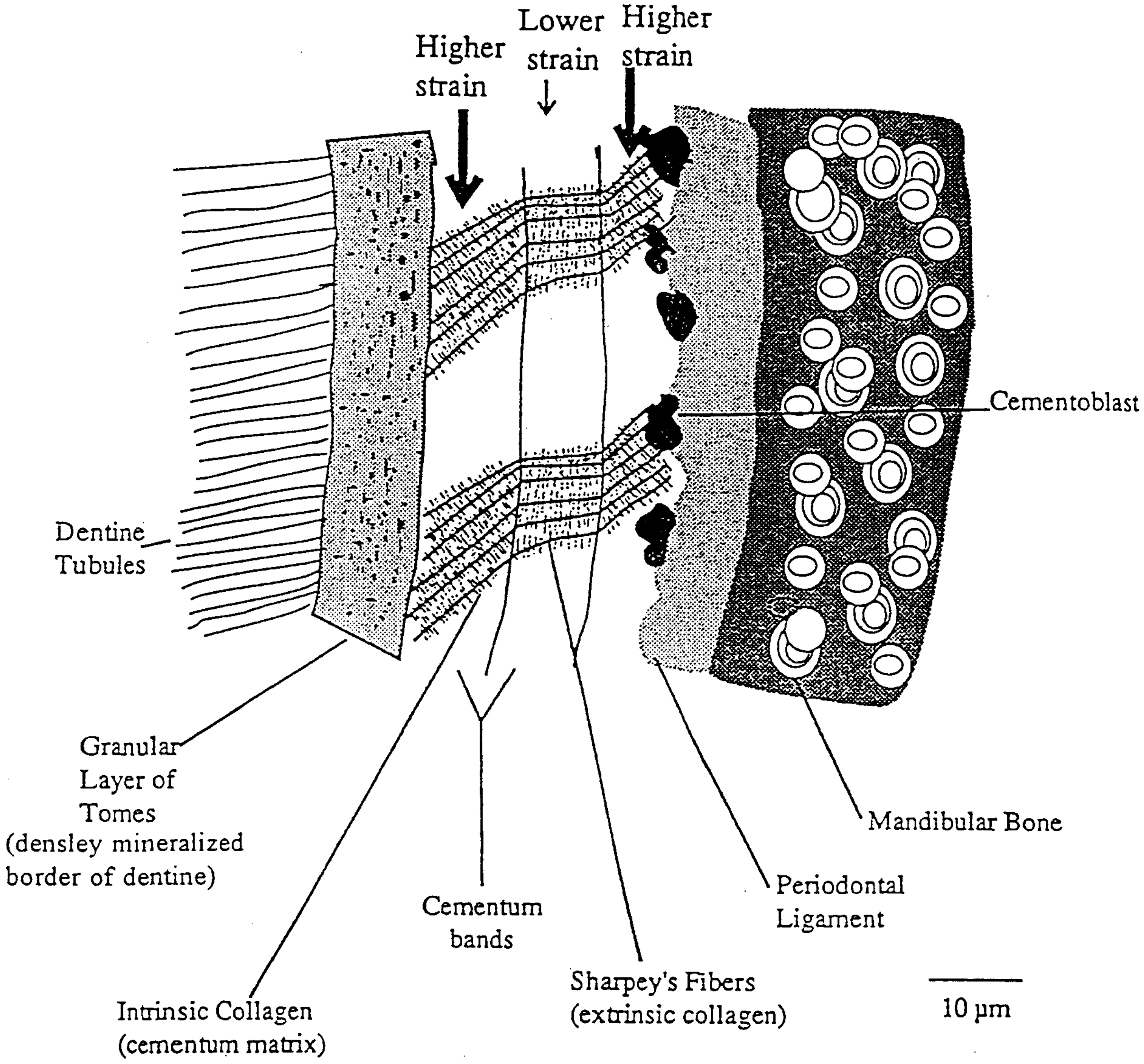


Fig. 9.2 : Schematic View of Variations in Sharpey's Fiber Orientation in Response to Changes in Occlusal Strain (From Lieberman 1993b : 175).

Interpreting Cementum

These seasonal effects of diet on acellular cementum histology are basically what archaeologists exploit in estimating an animal's age at death and season of death. Since cementum begins to accrue when a tooth erupts into occlusion, age at death is calculated by counting the total number of bands, dividing the sum by the number of increments per year (n=2), and adding the age of eruption (see Hillson 1986). Season of death is approximated by assessing the optical nature of the tooth's youngest, outermost acellular cementum band. As discussed above-and this cycle characterizes only those ungulate populations occupying temperate and arctic habitats--an opaque outer increment indicates that the animal died in winter or early spring; a translucent outer band demonstrates a death in late-spring, summer, or fall. It is also possible to infer season of death more precisely. The rate of growth of cementum for a given individual may slightly vary through time, but on a population-wide level the thickness of an outer increment correlates closely with the amount of time that the band had been growing (Lieberman 1993b; Spiess 1990). Based on this statistically significant pattern, one can maintain confidently, for example, that a *Rangifer* molar with a very thick outermost translucent band (e.g., >15 μm) died near the end of that growth phase, or, conservatively, between October and December.

It is stressed that because of variations in the rate of cementogenesis, precise season of death determinations can only be made when the outermost band is either very thick or very thin. In making such determinations, we estimate the width of the outermost band relative to that of the same band (translucent or opaque) from the previous year (cf. Spiess 1990). Table 9.1 shows the seasonal relationship between "thin," "normal," and "thick" outer bands and season of death. A normal band is approximately the same width as the previous year's band; a thin band exhibits <50% of the width of the previous year's band; and a thick increment is >150% of the previous year's band. The width assessments represent an increment's width relative to the thickness of the same band (translucent or opaque) from the previous year. We also caution that precise determinations of season of death in subadults (3 years) display relatively high error ranges, because young animals are most likely to undergo fluctuations in growth rates from year to year (Spiess 1990).

Specimen Preparation and Analysis

In order to "read" the cementum bands the researcher requires a method of obtaining a cross-section view of the tooth and a means of observing and assessing the cementum itself. Lieberman (DEL) and Stutz (AJS), on the one hand, and Spiess (AES), on the other, employed slightly different preparation and analysis techniques. The former followed the "thin section" procedure described in Lieberman *et al.* (1990), and the latter utilized "thick section" approach outlined in Bourque *et al.* (1978) and Spiess (n.d.). Both methods involve some destruction of the archaeological materials. Before each maxillary and mandibular fragment and isolated tooth was prepared for analysis, standard anatomical measurements were

Tableau 9.1 : Cementum Increments and Season of Death

Cementum Increment (appearance and Width)*	Season of Death	Approximate Months **
Thin Opaque	Winter	January-March
Normal Opaque	Winter-early Spring	January-April
Thick Opaque	Late Winter-Early Spring	February-April
Thin Translucent	Late Spring-early Summer	May-July
Normal Translucent	Summer-Fall	June-December
Thick Translucent	Fall	October-December

* The "opaque" and "translucent" terminology refers here to thin section analysis under transmitted cross-polarized light.

** See Gordon 1988; Pike-Tay 1991; Spiess 1976, 1979.

taken, and the sample was photographed from buccal, lingual, and occlusal views. In addition, the degree of crown wear was estimated for each tooth as light, medium, or heavy.

The Thin Section Method.

For all specimens prepared by Stutz and for most of those by Lieberman, the tooth was in articulation in the alveolar bone, which protects the cementum from physical diagenetic processes. This increases the likelihood that the preserved cementum includes an accurate record of season of death (Lieberman *et al.* 1990:520). When these fragments included several teeth in articulation, one tooth was chosen for analysis and removed with a hand-held Dremel high-speed rotating saw. Mandibular first molars were preferred, because they exhibit a very narrow population-wide range of eruption age values, allowing the most precise age estimations (Hillson 1986). If the fragment contained a relatively complete tooth row, the most mesial or distal tooth was usually removed in order to minimize further fragmentation.

The selected tooth was embedded in Epotek 301™ epoxy resin. Once dry, the epoxy block was cut along the mesiodistal plane with a high-speed Raytech Gem Saw™; this cut revealed the cementum tissue around the margins and the furcation of the roots. One half of the block was polished successively on 70 µm and 15 µm Buehler diamond grit polishing wheels, and it was then affixed with Epotek 301™ to a glass slide. After the epoxy dried, the block was cut to a thickness of about 300 µm using either a Buehler Isomet™ low-speed rotating saw or a Buehler Petrothin™ high-speed thin-sectioning machine. The remaining portion on the slide was ground on the Petrothin to a thickness of about 40-70 µm. Finally, the slide was polished on the 15 µm wheel until microscopic histological features of the tooth, including cementum, dentine tubules, and osteons in the alveolar bone, could be seen clearly. The slides often varied in their final thickness, depending on the quality of preservation of the histology.

The thin section of the tooth was then examined at magnifications of 50x, 100x, and 200x under transmitted cross-polarized light through an Olympus™ BH-2 bifocal microscope. The cementum tissue was examined along all cross-sectional margins of the roots. This "total-sample approach" emphasizes the general state of preservation of the tooth, facilitating the identification of locations where the cementum has physically and chemically deteriorated. In turn, this reduces the possibility of counting "false" bands or of overlooking bands that through diagenesis have become discontinuous along the root.

The Thick Section Method.

The fragmented tooth specimens prepared by Spiess were sectioned by utilizing fortuitous fractures or with a jeweler's saw. Tooth fragments that preserved coronal portions of tooth roots and the lower portions of enamel were preferred for sectioning, because incremental structures appear very clear and regular in this region of the tooth, around the cementum-dentine-enamel juncture. The pieces chosen for sectioning were coated with a dilute B-76 resin dissolved in acetone (this is a museum conservation glue that inhibits penetration of the tooth by epoxy during the mounting stage). The tooth fragments were subsequently mounted in West System 105 epoxy and hardener. The appropriate longitudinal section was ground through the tooth fragment with a series of finer and finer-grit sandpapers on a Buehler grinding wheel, followed by a final polishing of the thick section. The thick sections were observed in reflected light under a binocular microscope at magnifications of 40x and 100x.

MATERIALS : THE ARCHAEOLOGICAL CONTEXT

Our cementum increment analysis assemblage focuses on ungulate teeth recovered from Aurignacian strata 2 and 3 in trench C during the 1991 and 1992 field seasons at Trou Magrite (Straus *et al.* 1992, 1993a, 1993b). Radiocarbon assays date these materials to ca. 34.0-27.0 Ka (Straus *et al.* 1993b). Stratum 3 is represented by only one specimen: a bison (*Bison* sp.) maxillary molar. The stratum 2 sample is comprised of six specimens, including reindeer (*Rangifer tarandus;* n=2), ibex (*Capra ibex;* n=3), and horse (n=1; probably *Equus* cf. *germanicus* [Spiess n.d.]). The total stratum 2 "cementum assemblage" represents a minimum of three individuals (MNI=3).

The rest of the "cementum assemblage," providing a broader--although still highly limited--interpretive context for the Trou Magrite remains, includes reindeer, red deer (*Cervus elaphus*), and ibex teeth from Sclayn, Trou du Diable à Hastière-Lavaux, and Trou Reuviau à Furfooz. The Sclayn V_b teeth (n=5; MNI=3) are associated with Middle Paleolithic artifacts from what may have been a discrete living floor; this material dates to the end of the last interglacial (ca. 80.0 Ka) (Otte 1990; Otte *et al.* 1988). The Sclayn I_a tooth is from a late Mousterian context, dating to 38.0 Ka (Otte 1984b).

The two samples from Trou Reuviau (MNI=2) and the ten teeth from Hastière (MNI=5) were excavated by E. Dupont during the late 19th century (Dupont 1872). Although Dupont defined geological and archaeological strata during his excavations, he clearly conflated cultural layers at these two sites (Otte 1979; Sonneville-Bordes 1961). Consequently, the samples from Reuviau are associated with either Aurignacian or Perigordian artifact assemblages (Otte 1979). No radiocarbon dates have been obtained from this site; on typological grounds the Reuviau teeth may date from 34.0 Ka-20.0 Ka. The Hastière material is from Dupont's stratum 2, which is a *mélange* of Mousterian and Aurignacian lithics. Recent excavations provide a secure radiometric date of 46.0 Ka for the Mousterian deposits at Hastière (Toussaint 1988). The Aurignacian materials are dated by typological associations to the Arcy oscillation, an episode of climatic amelioration from 31.0 to 29.0 Ka (Otte 1984a). The teeth from Hastière may be associated with either of these two periods of occupation. Consideration of these materials from Reuviau and Hastière requires an additional qualification about context; these faunal assemblages have not been re-analyzed systematically, and consequently, carnivore activity cannot be excluded as a depositional agent at the two sites.

RESULTS

The results of analysis are presented in Tables 9.2-9.3-9.4. Three specimens from Trou Magrite strata 2 and 3 exhibited very poorly preserved cementum, and in certain locations on the roots the cementum had been entirely removed by diagenetic processes. These specimens, for which no seasonality and mortality results were obtained, represent isolated teeth, unprotected by alveolar bone. Only one tooth yielded a reading from both Lieberman and Spiess, resulting in mutually contradictory interpretations. This contradiction is not surprising considering the relatively poor condition of preservation of the tooth (Spiess n.d.).

In all other cases--for the reindeer samples from Trou Magrite and for the other three sites--the outer cementum band was positively identifiable. In most, but not all, of these samples, the number of increments was exactly identified; for some samples, though, post-depositional degradation of the collagen in the cementum blurred originally distinct bands, allowing only an estimation of the number of bands. Overall, the results allow us to infer a "revised MNI" for each site, because teeth from potentially complementary elements (e.g., right and left mandibles) that exhibit different season of death and/or age at death in their cementum cannot be from the same individual (cf. Pike-Tay 1991). The revised MNI numbers are presented in Tables 9.2-9.3-9.4. The seasonality and mortality patterns are treated below for each separate site.

Trou Magrite

With the exception of Spiess's finding on the ibex M^2 (TM-I6-54), the strata 2 and 3 data exhibit reindeer, ibex, and bison kills between January and April. A. Gautier has provided additional seasonality information from his assessment of tooth eruption patterns in juvenile reindeer mandibles from strata 2 and 3 (L. G. Straus, personal communication). From his stratum 2 sample (n=3) Gautier determined that one reindeer fawn was taken in early fall and two killed during winter. The stratum 3 tooth eruption assemblage (n=3) reveals one fawn killed during the fall, one yearling taken in early fall, and one fawn hunted during the winter. Thus, the cementum and tooth eruption data now available hint that fall, winter, and early spring kills predominate the Aurignacian strata at Trou Magrite. The mortality information from the cementum increment analysis reveals that four prime adults were taken during the Aurignacian occupations at Trou Magrite. Also,

Tableau 9.2 : Le Trou Magrite-Aurignacian

Revised MNI = 4

Sample		Stratum	Species	Bone	Tooth	Wear	No. of Bands	Outer Band	Est. Age at Death	Est. Season of Death
TM3	(DEL)	3	*Bison cf. priscus*	max	M1?	H	4	thin-normal opaque	2.5-3.5?	winter
TM-I6-54	(AES)	2	*C. ibex*	I. max	M2	H	7	thin "opaque"*	4.5-5	late spring-fall
TM-I6-54	(DEL)	2	*C. ibex*	I. max	M2	H	8	normal opaque	5.0?	winter-early spring
TM-G6-2	(AJS)	2	*R. tarandus*	r. max	M2	L-M	4	thick opaque	3.0-3.5	late winter-early spring
TM-I7-19	(AJS)	2	*R. tarandus*	I. mand	M2	M	10	normal opaque	6.0-6.5	winter-early spring

* This sample was analyzed under reflected light; "Opaque" here is equivalent to translucent in all other samples.

Table 9.3 : Le Trou du Diable a Hastière (IRSNB # 3868) - mixed Mousterian and Aurignacian

Revised MNI = 8

Sample		Stratum	Species	Bone	Tooth	Wear	No. of Bands	Outer Band	Est. Age at Death	Est.Season of Death
HAS 1	(AJS)	2	*R. Tarandus*	r. mand	P4	M-H	8-12	normal-thick opaque	6.0-9.0	late winter-early spring
HAS 2	(AJS)	2	*R. Tarandus*	r. mand	M1	L-M	3	normal translucent	2.0-2.5	summer-fall
HAS 3	(AJS)	2	*R. Tarandus*	I. max	P4	M	12	normal opaque	8.0-9.0	winter-early spring
HAS 4	(AJS)	2	*R. Tarandus*	I. mand	P2	M	12	thick opaque	8.0-9.0	late winter-early spring
HAS 5	(AJS)	2	*R. Tarandus*	r. mand	P3	M	13	normal-thick translucent	8.5-9.5	late summer-fall
HAS 6	(AJS)	2	*R. Tarandus*	I. mand	P3	M	20-24	normal opaque	12.0-15.0	winter-early spring
HAS 7	(AJS)	2	*R. Tarandus*	I. mand	M2	L	6	normal-thick opaque	4.5	late winter-early spring
HAS 8	(AJS)	2	*C. ibex*	r. mand	M1	L	7	thick translucent	4.0-4.5	fall
HAS 9	(AJS)	2	*C. ibex*	I. mand	M1	H	16	normal opaque	8.5-9.0	winter-early spring
HAS 10	(AJS)	2	*R. Tarandus*	I. mand	P2	L	5	normal-thin translucent	4.5-5.5	late spring-summer

Table 9.4 : Le Trou Reuviau (IRSNB # 2668) - mixed Aurignacian and Perigoridian

Revised MNI = 2

Sample		Stratum	Species	Bone	Tooth	Wear	No. of Bands	Outer Band	Est. Age at Death	Est. Season of Death
TR1	(AJS)	n/a	*R. tarandus*	I. mand	P4	L-M	2	normal opaque	0.5-1.0	winter-early spring
TR2	(AJS)	n/a	*R. tarandus*	I. mand	M1	L-M	5	normal translucent	3.0-3.5	summer-fall

La Grotte de Sclayn-Mousterian

Revised MNI = 6

Sample		Stratum	Species	Bone	Tooth	Wear	No. of Bands	Outer Band	Est-Age at Death	Est. Season of Death
SC-D15-5Vb	(AJS)	Vb	*R. tarandus*	r. mand	M3	L-M	9	normal translucent	6.0-7.5	summer-fall
SC-82-337	(AJS)	Vb	*R. tarandus*	r. mand	M1	M	6	normal opaque	3.5-4.0	winter-early spring
SC-83-81VB	(AJS)	Vb	*R. tarandus*	I. mand	P4	L	4	thin-normal opaque	1.5-2.0	winter
SC-83-90Vb	(AJS)	Vb	*C. elaphus*	r. mand	P3	L	4	normal opaque	2.0-2.5	winter-early spring
E19167	(AJS)	Vb	*C. elaphus*	r. max	P3	L	3	normal-thick translucent	1.5	late summer-fall
SC-82-246Cla	(AJS)	Vb	*R. tarandus*	r. max	M1	L	8	normal opaque	4.5-5.5	winter-early spring

Gautier has identified an additional minimum of 8 additional prime reindeer from stratum 2 (L. G. Straus, personal communication). The six tooth eruption samples reflect that juvenile animals were also hunted, but the available sample indicates a prime-dominated mortality profile.

Trou du Diable-à-Hastière-Lavaux

In contrast to the Trou Magrite results, the samples from the mixed Mousterian and Aurignacian deposits at Hastière indicate clear evidence of summer kills (see Table 3: HAS10 and possibly HAS2). However, the prevailing pattern remains one of fall, winter, and early spring kills (October-April), with two specimens (revised MNI=2) providing strong evidence for fall kills and six teeth (revised MNI=5) suggesting winter-early spring hunting. The mortality profile reveals a bias toward old individuals; four of the reindeer and one of the ibex taken were eight years or older at death, and an additional reindeer may have been as old as nine years. HAS2 represents the only sub-adult in the assemblage.

Trou Reuviau-à-Furfooz

Not enough data from the Aurignacian-Perigordian deposits at this site are available to suggest any apparent seasonality and mortality patterns.

Le Grotte de Sclayn V_b

The Mousterian data from Sclayn V_b reveal a pattern that is consistent with the focus on fall-winter kills evident from the cementum and tooth eruption data for Trou Magrite and Hastière. Three individuals (revised MNI=3) from Sclayn V_b were taken between January and April. The other two specimens (a reindeer mandibular molar and a red deer maxillary deciduous premolar) could have been taken at any time between May and December. If the Mousterian foragers at Sclayn followed the same fall-early spring seasonality pattern that we have suggested for the other sites, then these latter two specimens would have been hunted during the fall. However, the data from Sclayn does not preclude the alternative interpretation that about half of the specimens represent winter-early spring kills and the other half show summer kills. The mortality profile reveals three juveniles, one prime adult, and one old prime adult.

DISCUSSION

The cementum increment data from the Mosan Basin, along with complementary tooth eruption information, clarify an important, but very general point. The simple presence of winter kills implies that during the Upper Pleistocene, in all but the most extreme arctic climatic oscillations, the Meuse River drainage and its adjoining tributary valleys provided adequate cold-season resources and shelter to support small groups of hominid foragers. The spectrum of faunal species present in

Middle and early Upper Paleolithic deposits in Mosan Basin caves indicates clearly that a variety of winter microhabitats survived along the river valley ecotone. Ibex would have inhabited the steep, rocky cliffs that frequently line valley margins in southern Belgium, and red deer and other cervid species would have occupied floodplain gallery forests and sheltered forest patches on talus slopes (cf. Spiess 1979). In addition, the Mosan Basin foragers appear to have taken advantage of caves with south-facing mouths, which provide maximum winter solar radiation exposure for the inhabitants (cf. White 1985).

For addressing more specific issues of hominid subsistence economy, the data we have presented do suggest new hypotheses, although they are not statistically sufficient to test them. For instance, the seasonality data presented in this chapter are consistent with the hypothesis that from the last interglacial to the early Upper Paleolithic (ca. 80.0-20.0 Ka), caves in the Mosan Basin were mainly occupied during the fall and winter seasons (October-April), and more specifically, most activity occurred during the winter and early spring. Yet, our data do make it evident that Upper Pleistocene hominids hunted in the Mosan Basin during the summer at least occasionally. The low frequency of summer kills apparent in our preliminary analysis, then, raises the unanswered the question of where these hunter-gatherers settled from May through September. We will mention three possibilities. First, hunter-gatherer groups may have occupied open air sites within the Mosan Basin during the summer as part of a year-round occupation of the river valleys. Second, these groups may have moved seasonally out of the valleys to hunt reindeer, horse, and other gregarious species that would have migrated to upland or open regions, such as the plains toward the Atlantic to the west and northwest (it should be kept in mind, though, that settlement patterns probably varied through time and that the Mosan Basin may not have been occupied continuously from the Last Interglacial through the early Upper Paleolithic). Third, it is conceivable that summer kills were originally present at the Mosan Basin cave sites but have not yet been uncovered or by fluke have not survived. The mortality profiles we have presented, like the seasonality information, may also reflect a statistical peculiarity caused by our small sample size. In general, cementum increment analysis provides accurate seasonality and mortality profiles, and we hope that future research will yield robust representative samples.

CONCLUSION

In looking toward future investigations, we propose that the cementum increment data presented above may reflect two evolutionarily important trends:

(1) Middle Paleolithic and early Upper Paleolithic hominids occupied the Mosan Basin primarily during fall and winter.

(2) By the early Upper Paleolithic, hominid foragers in the Mosan Basin

(for example, those occupying Trou Magrite in stratum 2 times) regularly procured prime adult herbivore prey. In contrast, their Mousterian antecedents (including those occupying Hastière and Sclayn 5_b) focused on juvenile and/or elderly prey.

If future research demonstrates that the second hypothesis is correct, then it would suggest an increase in foraging efficiency across the Middle-Upper Paleolithic transition. In turn, such a temporal development would imply some important behavioral and/or technological adaptation. In particular, the Mosan Basin mortality profiles *might* reflect a temporal development similar to that which Stiner (1990) identifies in the Upper Pleistocene of west-central Italy (see also Stiner and Kuhn 1992). She presents evidence to suggest that the old-dominated mortality profiles of early Mousterian faunal assemblages from Italian sites represent a significant amount of scavenging behavior, while late Mousterian and Upper Paleolithic prime-dominated profiles reveal increasing frequencies of the ambush hunting. If our first hypothesis also proves to be correct, then we might explore possible factors of seasonal weather patterns, spatial and temporal food resource distribution, population density, and regional social networks; one or more of these variables may help reveal how a change in foraging efficiency occurred while a significant temporal continuity in seasonal mobility patterns was maintained.

ACKNOWLEDGMENTS

We thank L. G. Straus and M. Otte for providing the tooth samples for analysis and for their encouragement and thoughtful feedback. We are also grateful to M. Germonpré and A. Gautier for their assistance in Belgium, and to O. Bar-Yosef for advice and encouragement. R. H. Meadow kindly made the wear estimates for the *Rangifer* specimens from Trou Magrite and the samples from Sclayn, Reuviau, and Hastière. J. D. Speth provided thoughtful feedback on drafts of this paper. A. M. Burke gave additional clarifying comments. This research was partially funded by the American School of Prehistoric Research (Peabody Museum, Harvard University), the Harvard University Department of Anthropology, and the National Science Foundation.

REFERENCES

BOURQUE B. J., MORRIS K. and SPIESS A., 1978,
Determining the season of death of mammal teeth from archeological sites: a new sectioning technique. *Science* 199(3):530-1.

BURKE A. M., 1992,
Prey Movements and Settlement Patterns During the Upper Palaeolithic of Southwestern France. PhD dissertation, New York University. University Microfilms International, Ann Arbor.

DUPONT E., 1872,
L'Homme Pendant les Ages de la Pierre dans les Environs de Dinant-Sur-Meuse. Librairie de la Cour et de S. A. R. le Comte de Flandre.

GORDON B., 1998,
Of Men and Reindeer Herds in French Magdalenian Prehistory. BAR International Series 390.

GRUE H. and JENSEN B., 1979,
Review of the formation of incremental lines in tooth cementum of terrestrial mammals. *Danish Review of Game Biology* 11:1-48.

HILLSON S., 1986,
Teeth. Cambridge University Press, Cambridge.

KLEVEZAL G., 1988,
Recording Structures of Mammals in Zoological Investigations. Nauka, Moscow.

LIEBERMAN D. E., 1993a,
Life history variables preserved in dental cementum microstructure. Science 261:1162-4.

LIEBERMAN D. E., 1993b,
Mobility and Strain: The Biology of Cementogenesis and its Application to the Evolution of Hunter-gatherer Seasonal Mobility during the Late Quaternary in the Southern Levant. PhD dissertation, Harvard University. University Microfilms International, Ann Arbor.

LIEBERMAN D. E., 1993c,
The rise and fall of seasonal mobility among hunter-gatherers: the case of the southern Levant. *Current Anthropology* 34(5):599-631.

LIEBERMAN D. E., 1994,
The biological basis for seasonal increments in dental cementum and their application to archaeological research. *Journal of Archaeological Science* 21:525 539.

LIEBERMAN D. E., DEACON T. and MEADOW R. H., 1990,
Computer image enhancement and analysis of cementum increments as applied to teeth of *Gazella gazella*. *Journal of Archaeological Science* 17:519-533.

LIEBERMAN D. E. and MEADOW R. H., 1992,
The biology of cementum increments (an archaeological perspective). *Mammal Review* 22:57-77.

O'BRIEN C. and MIRACLE P., 1994,
Hominid Prey Acquisition in the Balkan Late Pleistocene. Paper presented at the 59th Annual Meeting for the Society for American Archaeology, Anaheim, California.

OTTE M., 1979,
Le Paléolithique supérieur ancien en Belgique. Monographies d'Archéologie Nationale 5.

OTTE M., 1984a,
Paléolithique supérieur en Belgique. In *Peuples Chasseurs de la Belgique Préhistorique dans leur Cadre Naturel,* edited by D. Cahen and P. Haesaerts. Institut royal des Sciences naturelles de Belgique, Brussels. pp. 157-179.

OTTE M., 1984b,
Sol d'occupation du Paléolithique Moyen aux grottes de Sclayn (Belgique). *L'Anthropologie* 88(1):115-7.

OTTE M., 1990,
L'Occupation moustérienne de Sclayn (Belgique). *EAZ Ethnogr.-Archäol. Z.* 31:78-101.

OTTE M., EVRARD J.-M., and MATHIS A., 1988,
Interprétation d'un habitat au Paléolithique moyen: la grotte de Sclayn, Belgique. In *Upper Pleistocene Prehistory of Western Eurasia,* edited by H. Dibble and A. Montet-White. The University Museum, Philadelphia. pp. 95-124.

PIKE-TAY A., 1991,
Red Deer Hunting in the Upper Paleolithic of South-West France: A Study in Seasonality. BAR International Series 569.

SAXON A. and HIGHAM C., 1968,
A new research method for economic prehistorians. *American Antiquity* 34(3):303-11.

SONNEVILLE-BORDES D. de, 1961,
Le Paléolithique supérieur en Belgique. *L'Anthropologie* 65(5-6):421-443.

SPIESS A. E., 1976,
Determining season of death of archaeological fauna by analysis of teeth. *Arctic* 29:53-5.

SPIESS A. E., 1978,
Zooarchaeological evidence bearing on the Nain area Middle Dorset Subsistence Settlement Cycle. *Arctic Anthropology* 15(2):48-60.

SPIESS A. E., 1979,
Reindeer and Caribou Hunters: An Archaeological Study. Academic Press, New York.

SPIESS A. E., 1990,
Deer tooth sectioning, eruption, and seasonality of deer hunting in prehistoric Maine. *Man in the Northeast* 39:29-44.

SPIESS A. E., n.d.,
Notes on preservation and annual layers: five teeth from le Trou Magrite. Unpublished manuscript.

STINER M. C., 1990,
The use of mortality patterns in archaeological studies of hominid predatory adaptations. *Journal of Anthropological Archaeology* 9:305-351.

STINER M. C. and KUHN S. L., 1992,
Subsistence, technology, and adaptive variation in Middle Paleolithic Italy. *American Anthropologist* 94:306-339.

STRAUS L. G., OTTE M., LÉOTARD J.-M., GAUTIER A. and HAESAERTS P., 1992,
Middle and Upper Paleolithic excavations in southern Belgium: a *preliminary* report. *Old World Archaeology Newsletter* 15(2):10-18.

STRAUS L. G., OTTE M., GAUTIER A., HAESAERTS P., MARTINEZ A., NEWMAN M. and SCHUTZ C., 1993a,
1992 Paleolithic excavations in Belgium by the Universities of New Mexico and Liège. *Old World Archaeology Newsletter* 16(2):1-11.

STRAUS L. G., OTTE M., CORDY J.-M., LÉOTARD J.-M., NOIRET P., GAUTIER A., HAESAERTS P., and LACROIX Ph., 1993b,
Paleolithic & Mesolithic research in Belgium, 1993: le Trou Magrite, Huccorgne, and l'Abri du Pape. *Old World Archaeology Newsletter* 17(1):17-24.

STUTZ A. J., 1993,
Settlement Patterns in Late Glacial Northwestern Europe: the Example from the Lesse Valley Magdalenian. Unpublished BA thesis. Harvard University, Cambridge.

TOUSSAINT M., 1988,
Fouilles 1978-1981 au Trou du Diable à Hastière-Lavaux, province de Namur, Belgique. *Helinium* 28(1):35-43.

WHITE R., 1985,
Upper Paleolithic Land-use in the Perigord: a Topographic Approach to Subsistence and Settlement. BAR International Series 253.

M. OTTE et L.G. STRAUS (dir.), *Le Trou Magrite. Fouilles 1991-1992.* Liège, E.R.A.U.L. 69, 1995.

10

ORGANIC RESIDUE ANALYSIS OF LITHIC ARTIFACTS FROM LE TROU MAGRITE

Margaret E. NEWMAN

Recent studies have demonstrated that lithic artifacts often retain traces of organic residue resulting from their original use (Briuer 1976; Broderick 1979; Downs 1985; Hyland *et al.* 1990; Kooyman *et al.* 1991; Newman 1990; Newman and Julig 1989; Shafer and Holloway 1979; Yohe *et al.* 1991). Through the use of immunological and biochemical techniques the animal of origin can be identified to at least the family level of identity. This information can be used in the reconstruction of prehistoric subsistence patterns and possibly in identifying artifacts used for specific tasks.

Immunological tests have been used for many years to characterize bloodstains in medico-legal work. Since the introduction of the precipitin test for the medico-legal identification of bloodstains at the turn of the century (Culliford 1964; Gaensslen 1983), several new techniques have been introduced. However, the basis of all subsequent tests is the antigen-antibody reaction first observed in the classic precipitin test (Gaensslen 1983:53). The successful identification of such residues is dependent on the amount and condition of antigen retained in the stain. However, forensic studies have demonstrated that blood proteins can generally withstand harsh treatment and still be identified (Gaensslen 1983; Macey 1979; Sensabaugh *et al.* 1971, among others). The sensitivity and specificity of precipitin reactions makes them an extremely effective method for the detection of trace amounts of protein (Kabat and Meyer 1967:22).

MATERIALS AND METHODS

The method of analysis used in this analysis is cross-over immunoelectrophoresis (CIEP). This is based on the work of Culliford (1964) with minor changes made following the methods of the Royal Canadian Mounted Police (RCM Police) Serology Laboratory (Ottawa) and the Centre of Forensic Sciences (Toronto). The test is extremely sensitive and can detect 10^{-8}g of protein (Culliford 1964:1092). The procedure is discussed fully in Newman and Julig (1989).

Eighteen lithic artifacts from le Trou Magrite Cave, a Palaeolithic site in southern Belgium, were submitted for immunological analysis. Two control soil samples from the site were also sent for analysis. It is important that site soil samples are tested as contaminants in the soil, such as bacteria, tannic acid and iron chlorates, may result in nonspecific precipitation of antisera thus giving false positive results (Gaensslen 1983).

Possible residues were removed from the artifacts by the use of a 5% ammonium hydroxide solution. This has been shown to be the most effective extractant for old and denatured bloodstains and does not interfere with subsequent testing (Dorrill and Whitehead 1979; Kind and Cleevely 1969). Artifacts were placed in shallow plastic dishes and 0.5 cc of the 5% ammonia solution applied with a syringe and needle. Initial disaggregation of residue is carried out by floating the plastic dish and its contents in an ultrasonic cleaning bath for two to three minutes. Extraction is continued by placing the boat and contents on a rotating mixer for thirty minutes. The resulting ammonia solution is removed with a pipette and placed in a numbered plastic vial and refrigerated prior to further testing. Approximately 1 ml of Tris buffer (pH 8.0) was added to each of the soil samples. Samples were mixed well then allowed to extract for 24 hours at 4^0C to prevent bacterial contamination. The resulting supernatant fluids were removed and tested against pre-immune serum.

Artifact and soil samples were first tested against pre-immune serum (i.e., serum from a non-immunized animal). A positive result against pre-immune serum could arise from non-specific protein interaction not based on the immunological specificity of the antibody (i.e., nonspecific precipitation). No positive results were obtained. All artifact extracts were then tested against the antisera shown in Table 10.1. Duplicate testing is carried out on all positive reacting specimens.

Except where noted, the animal anti-sera used in this analysis are primarily obtained from commercial sources and are developed specifically for use in Forensic Medicine. These anti-sera are polyclonal, that is they recognize epitopes shared by closely related species. For example, anti-deer will give positive results with other members of the Cervidae family such as deer, moose, elk and caribou as well as with pronghorn (Antilocapridae family). Three additional antisera, bison, elephant and elk, were raised at the University of Calgary. The bison antiserum was raised against modern species (*Bison bison bison*), however, the immunological relationship between extinct and extant forms is very close so that all will be detected. Similarly, the elephant antiserum was raised against modern African elephant but will elicit a positive reaction with extinct forms of the Order Proboscidea such as mastodon and mammoth (Lowenstein 1986). The elk antiserum was raised against modern elk (*Cervus elaphus*) and is species-specific. Immunological relationships do not necessarily bear any relationship to the Linnaean classification scheme although they usually do (Gaensslen 1983).

Table 10.1 : Antisera used in analysis

ANTISERA	SOURCE
anti-bear	Organon\Teknika
anti-bovine	Forensic Medicine
anti-cat	"
anti-chicken	"
anti-deer	"
anti-dog	"
anti-human	"
anti-rabbit	"
anti-sheep	"
anti-guinea-pig	Sigma Scientific Co.
anti-horse	"
anti-mouse	"
anti-rat	"
anti-swine	"
anti-bison	University of Calgary
anti-elephant	"
anti-elk	"

RESULTS

The results obtained in CIEP analysis are presented in Table 10.2 and discussed below.

Positive results to bovine anti-serum were obtained on two artifacts, a retouched flake and a keeled endscraper, from Trou Magrite. Positive results to this anti-serum occur with members of the Bovini and Ovibini tribes of the Bovidae family, such as bison (extinct and extant forms), cattle and musk-ox. Cross-reactions with other orders do not generally occur.

A positive reaction to rabbit anti-serum was also obtained on the keeled endscraper. Other members of the order Lagomorpha (rabbits, hares, pikas) may be represented by this result but cross-reactions with other orders are not known to occur. This result implies the processing of lagomorphs or that rabbit sinew or blood was used in a hafting process.

Positive results to human antiserum were obtained on two artifacts from Le Trou Magrite (152 and 71). A positive result to guinea-pig antiserum was also obtained on artifact # 71. Positive reactions to human antiserum occur only with humans and apes. Unless these results indicate prehistoric crime, the most likely explanation is that they represent accidental cuts incurred during use and/or manufacture of the artifacts. It is also possible that skin oils or perspiration from recent handling are responsible for these results, however, if this were true then more positive results would be expected. Strong positive results to porcupine (Erethizontidae) are known to occur with this antiserum while weak reactions to beaver (Castoridae) and squirrel (Sciuridae) also occur.

The absence of identifiable proteins on other artifacts may be due to poor preservation of protein or that artifacts were used on species other than those covered by the anti-sera used. It is also possible that the artifacts were not utilized.

Table 10.2 : Results of CIEP Analysis

Artifact #	Stratum	Artifact type	Result
TM-I7-33	2	Retouched flake	Bovine
TM-I8-23	3	Keeled endscraper	Bovine, rabbit
TM-J7B-79.1	5	Sidescraper	Negative
TM-J8C-110	5	Flint chunk	Negative
138	2	Endscraper	Negative
145.1	2	Sidescraper	Negative
152	2	Endscraper	Human
114	3	Bec	Negative
89	3	Truncation	Negative
71	3	Endscraper	Human, guinea-pig
102	3	Endscraper	Negative
317	5	Denticulate	Negative

REFERENCES

BRIUER F. L., 1976,
New Clues to Stone Tool Function: Plant and Animal Residues. *American Antiquity* 41:478-484.

BRODERICK M., 1979,
Ascending Paper Chromatographic Technique in Archaeology. In: *Lithic Use-Wear Analysis*, edited by B. Hayden, pp. 375-383. Academic Press, New York.

CULLIFORD B.J., 1963,
Precipitin Reactions in Forensic Problems. *Nature* 201:1092-1094

DORRILL M. and WHITEHEAD P.H., 1979,
The Species Identification of Very Old Human Bloodstains. *Forensic Science International* 13:111-116.

DOWNS E.F., 1985,
An Approach to Detecting and Identifying Blood Residues on Archaeological Stone Artifacts: A Feasibility Study. Ms. on file. Center for Materials Research in Archaeology and Ethnology. M.I.T., Cambridge.

GAENSSLEN R.E., 1983,
Sourcebook in Forensic Serology, Immunology, and Biochemistry. U.S. Department of Justice, Washington, D.C.

HYLAND D. C., TERSAK J.M., ADOVASIO J.M. and SIEGE lM.I., 1990,
Identification of the Species of Origin of Residual Blood on Lithic Material. *American Antiquity* 55:104-112.

KABAT E.A. and MEYER M.M., 1967,
Experimental Immunochemistry. Thomas, Springfield, Illinois.

KIND S.S. and CLEEVELY R.M., 1969,
The Use of Ammoniacal Bloodstain Extracts in ABO Groupings. *Journal of Forensic Sciences* 15:131-134.

KOOYMAN B., NEWMAN M.E. and CERI H., 1992,
Verifying the Reliability of Blood Residue Analysis on Archaeological Tools. *Journal of Archaeological Science* 19(3):265-270.

MACEY H.L., 1979,
The Identification of Human Blood in a 166-Year-Old Stain. *Canadian Journal of Forensic Sciences* 12(4):191-193.

NEWMAN M.E., 1990,
The Hidden Evidence From Hidden Cave, Nevada. Ph.D dissertation on file, University of Toronto, Canada.

NEWMAN M.E. and JULIG P., 1989,
The Identification of Protein Residues on Lithic Artifacts from a Stratified Boreal Forest Site. *Canadian Journal of Archaeology*: 13:119-132.

ROYAL CANADIAN MOUNTED POLICE, 1983,
Methods Manual, Serology Section. Ottawa, Ontario.

SENSABAUGH G.F., WILSON A.C. and KIRK P.L., 1971,
Protein Stability in Preserved Biological Remains. *International Journal of Biochemistry* 2:545-568.

SHAFER H.H. and HOLLOWAY R.G., 1979,
Organic Residue Analysis in Determining Stone Tool Function. In: *Lithic Use-Wear Analysis*, edited by B.Hayden, pp. 385-399. Academic Press, New York.

YOHE R., NEWMAN M.E. and SCHNEIDER J. S., 1991,
Immunological Identification of Small-Mammal Proteins on Aboriginal Milling Equipment. *American Antiquity* 56(4): 659-666.221.

M. OTTE et L.G. STRAUS (dir.), *Le Trou Magrite. Fouilles 1991-1992*. Liège, E.R.A.U.L. 69, 1995.

11

SPATIAL ANALYSIS OF LE TROU MAGRITE

Anthony E. MARTINEZ

ABSTRACT

The site of Trou Magrite was examined for the presence or absence of spatial structure. Data results indicate that a high degree of site integrity is present in some portions of the excavated area while evidence for potential stratigraphic disturbance is present along the edge of the cave talus.

INTRODUCTION

As described in Chapter 1, le Trou Magrite has historically served as a key site in developing the general chronology for much of the Paleolithic record of Europe. Since the first excavations at Trou Magrite in the mid-1800's, changes in theoretical orientation and numerous methodological developments lead us to ask new kinds of questions about this site. These range from broad issues of the site's place within long-term temporal and regional frameworks, to more specific issues of changes in the nature of the site occupation and activity organization in three-dimensional space.

The spatial analysis of archaeological remains recovered from excavations reported in this monograph will serve as a valuable complement to the data and site interpretations of past researchers. Analysis of the spatial properties of le Trou Magrite suggests a number of insights into the spatial dynamics at this site during < periods of human occupation. It also addresses the question of periods of human absence.

From the standpoint of the analysis of site structure, le Trou Magrite presents some interesting challenges. First, the total excavation area is relatively small (approximately 22 square meters). Second, excavation areas contained significant quantities of cave roof-all, especially in the lower strata, with bedrock outcrops at the base. These limestone boulders could have be expected to have impacted human usage of the site in a variety of ways. As elements which are, in some cases, over a cubic meter in size, they certainly constituted 'site-furniture', serving, for example, as surfaces for food preparation, seating, partitions, and *de facto* windbreaks.

To the analyst of archaeological site structure, the rockfall at le Trou Magrite is a distributional 'blanking' area. On the one hand it restricts the distribution of artifacts to areas that were associated with periods of human occupation. On the other hand, it also serves to 'funnel' artifacts into crevices among blocks, elongating the vertical distribution of artifacts affiliated with periods of human habitation. Finally, rockfall can be expected to have altered the archaeological landscape by crashing many meters down onto occupation surfaces littered with archaeological material. While rockfall can compact an archaeological layer and literally destroy artifacts and bones, it also serves to 'seal' layers into definable periods of geological activity within the cave.

Relative to these issues, this chapter asks the following questions.

1) Can the relative integrity of the different strata be evaluated objectively? If so, what is the evidence for intactness vs. disturbance?

2) Is there evidence for the survival of distinct 'living' surfaces in the excavated area of the site?

3) What role might carnivore activity have played in the accumulation of faunal remains among the strata?

In response to these questions, I present the results of spatial analysis using several methods which may assist in the interpretation of sites like le Trou Magrite. These include 1) maximum deviation functions for plotting data collected on a grid (meter square) basis, 2) lithic refit analysis, and 3) ISODATA2 clustering accompanied by vector quantization for classifying high dimensional relationships in archaeological data.

MATERIALS AND METHODS

Data Collection and Database Construction

Field provenience data used in this study are of two types. Artifacts and teeth ≥ ca. 1cm and bones ≥ 5cm in length were plotted in three dimensions relative to Cartesian space while smaller finds were collected in arbitrary 5-8cm levels (spits) and 50 x 50 cm subsquares. Stratum, excavation square, sub-square, and spit were recorded for all artifacts. For those items piece-plotted, orientation relative to magnetic north and inclination of primary and secondary axes relative to the horizontal level were also recorded.

Following construction of a database containing field provenience and laboratory analysis information, data were re-coded into new variables using several criteria. First, lithic raw material types were collapsed into a new dataset containing general probable source and material information in such a fashion that the full analytical list in Chapter 5 was condensed into :

flints/cherts
phtanite
limestone
sandstone/siltsone
other stones

Next, due to small sample sizes for some categories, a similar process was used to lump debris categories in Tables 4.1-4.2 into:

all micro debitage (< 1cm)
non-cortical angular debris
cortical angular debris
non-cortical flakes
cortical flakes
non-cortical blades
cortical blades
bladelets
cores & platform renewal flakes
Upper Paleolithic tools
Mousterian tools

For faunal data, identifications provided by A. Gautier (Chapter 7, this volume) were integrated with artifact provenience information and preliminary observations on modification. This resulted in the following database:

Artifact provenience
Faunal taxon
Element
Portion
Modifications

In order to utilize the full potential of the Trou Magrite dataset, non-piece plotted artifacts were tested against a maximum deviation function described by Martinez (n.d.). This function evaluates the relative departure of a given artifact's Cartesian coordinates relative to the scale of collection in horizontal and vertical dimensions against the size of the excavation or artifact scatter. A randomly assigned Cartesian coordinate within space constrained by the excavation limits of a 50 x 50cm subsquare, 5 centimeters thick is within approximately 25 cm horizontal space and 2.5 cm of vertical space of where it could be expected to have been found had it been individually plotted. This is a conservative estimate based upon the square of the hypotenuse of the excavation plane in XYZ dimensions. It has been suggested by Kroll & Isaac (1984) that a more realistic estimate of variation from actual location is . the square of the hypotenuse. In the case of artifacts at Trou Magrite, this suggests that had non-piece plotted artifacts been piece-plotted, they would have a statistical likelihood of being within 12.5 centimeters in horizontal space and 1.25 cm vertical space from a space-constrained randomly assigned Cartesian coordinate. Relative to; 1) the number of artifacts collected, 2) the size of the excavation area, and 3) the type of spatial analysis performed in this study, even a conservative estimate of maximum spatial deviation of a re-plotted artifact becomes statistically insignificant. Non-piece plotted artifacts were, therefore, assigned space-constrained random Cartesian coordinates resulting in a single dataset containing values for: X,Y,Z, and Artifact Type.

Data Visualization

As a first step to data analysis, artifact distributions were mapped as two dimensional plan maps and three dimensional point clouds. In addition, three-dimensional 'fence' plots were constructed from stratigraphic data collected in the field (see Figs. 11.1-11.2-11.3-11.4-11.5). These plots were then inspected for general trends in the distribution of data relative to 1) other artifacts, 2) limestone rock-fall and bedrock, and 3) stratigraphic membership.

Lithic Refit Analysis

During the course of general lithic analysis several observations were made which assisted the refit analysis of Trou Magrite. These observations included the systematic inspection of chipped stone raw material, size, shape, debitage type, color, patination, cortical surface, grain size, and inclusions. Pieces were then conjoined on the basis of any attributes of Hertzian morphology that might indicate a direct correspondence.

Vector Quantization

Vector Quantization (VQUANT), is a classification algorithm that examines and classifies high-dimensional similarity. Its use and application are, at present, restricted to engineering and industrial applications such a ion beam configuration (Wilson 1990) and digital signal compression (O'Rourke & Sloan 1984; Heckbert 1982). As a mathematical algorithm, however, I believe that it holds significant potential for application within archaeological analysis of site structure and offers certain advantages over many commonly used techniques. Unlike clustering methods such as K-means or simple ISODATA, VQUANT is extremely robust in dealing with high-dimensional space. Eight dimensional limitations as described by Fukunaga (1972), frequently reached in archaeological applications, are generally avoided, while meaningful classification results have been reported in as many as 32 dimensions (Heckbert 1982).

Describing its usage might be made more clearly by example. If one visualizes a three-dimensional point cloud representing artifacts in different stratigraphic layers, a number of data relations may be present. Some artifacts could be clustered in groups about particular site features, while others may be dispersed about the periphery of the site. The orientation of the point cloud may be along a particular plane, indicating either post-depositional differences in site usage, natural dispersion process, or an effect of data recovery methods. The inclination of the point cloud may suggest that artifacts are arranged along potential living surfaces, or that they are distributed along a prehistoric slope.

VQUANT analysis begins with the question, along what axis does one wish to begin examining the data? Possible options are: 1) along the axis which follows the maximum data span (in the archaeological example, along the plane

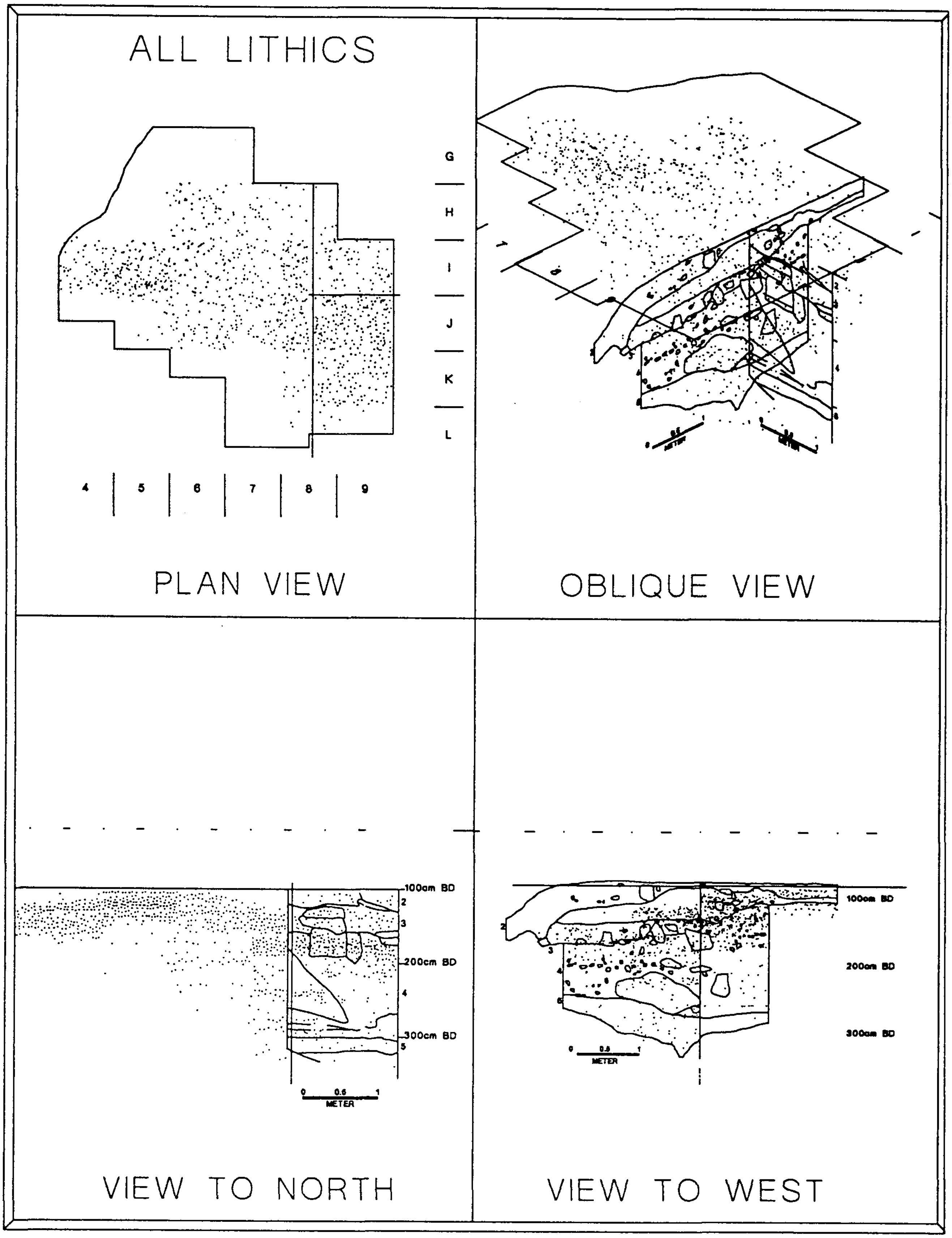
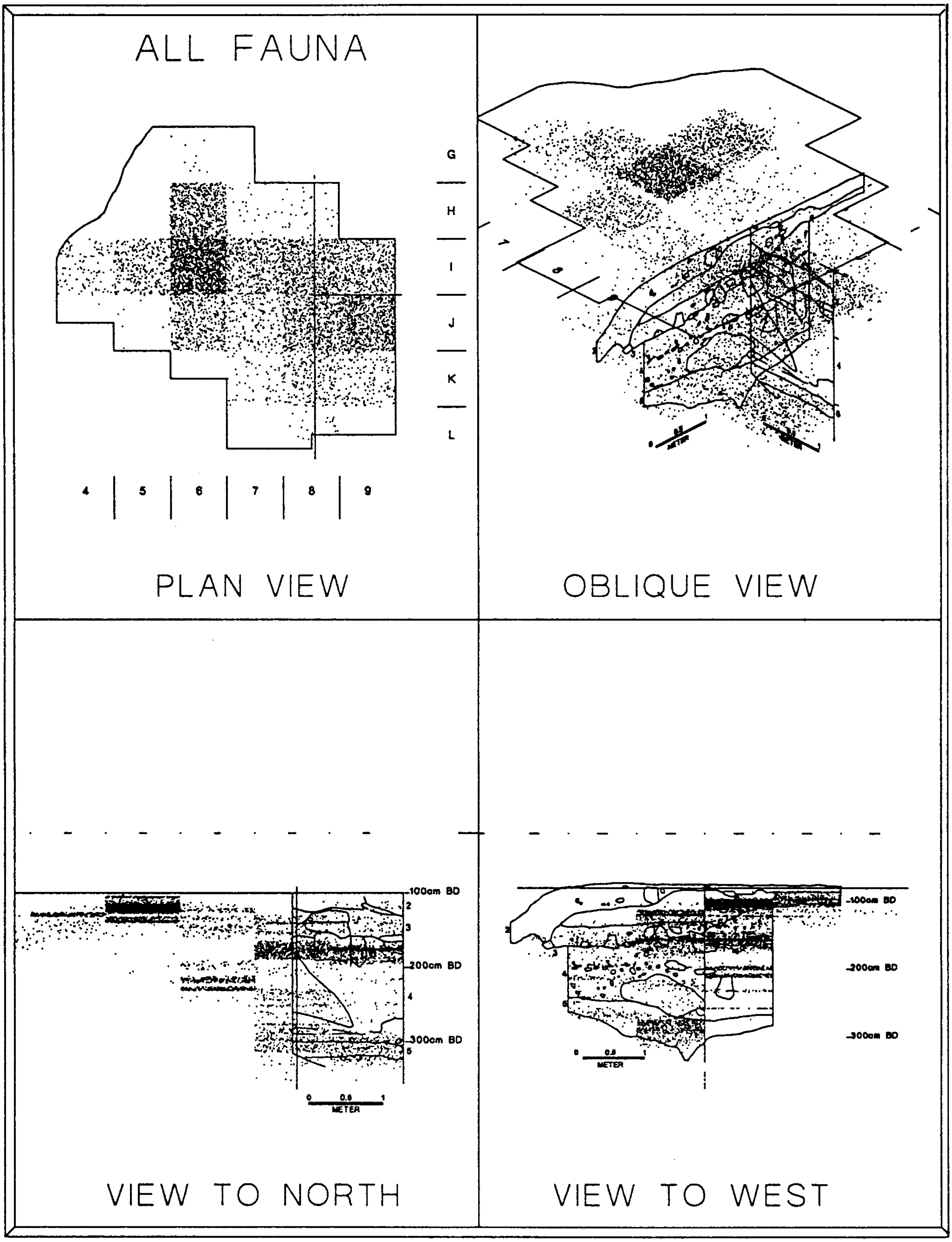

ALL LITHICS
G
H
I
J
K
L
4
5
6
7
8
9
PLAN VIEW
OBLIQUE VIEW
100cm BD
200cm BD
300cm BD
METER
VIEW TO NORTH
VIEW TO WEST

Figure 11.1


ALL FAUNA
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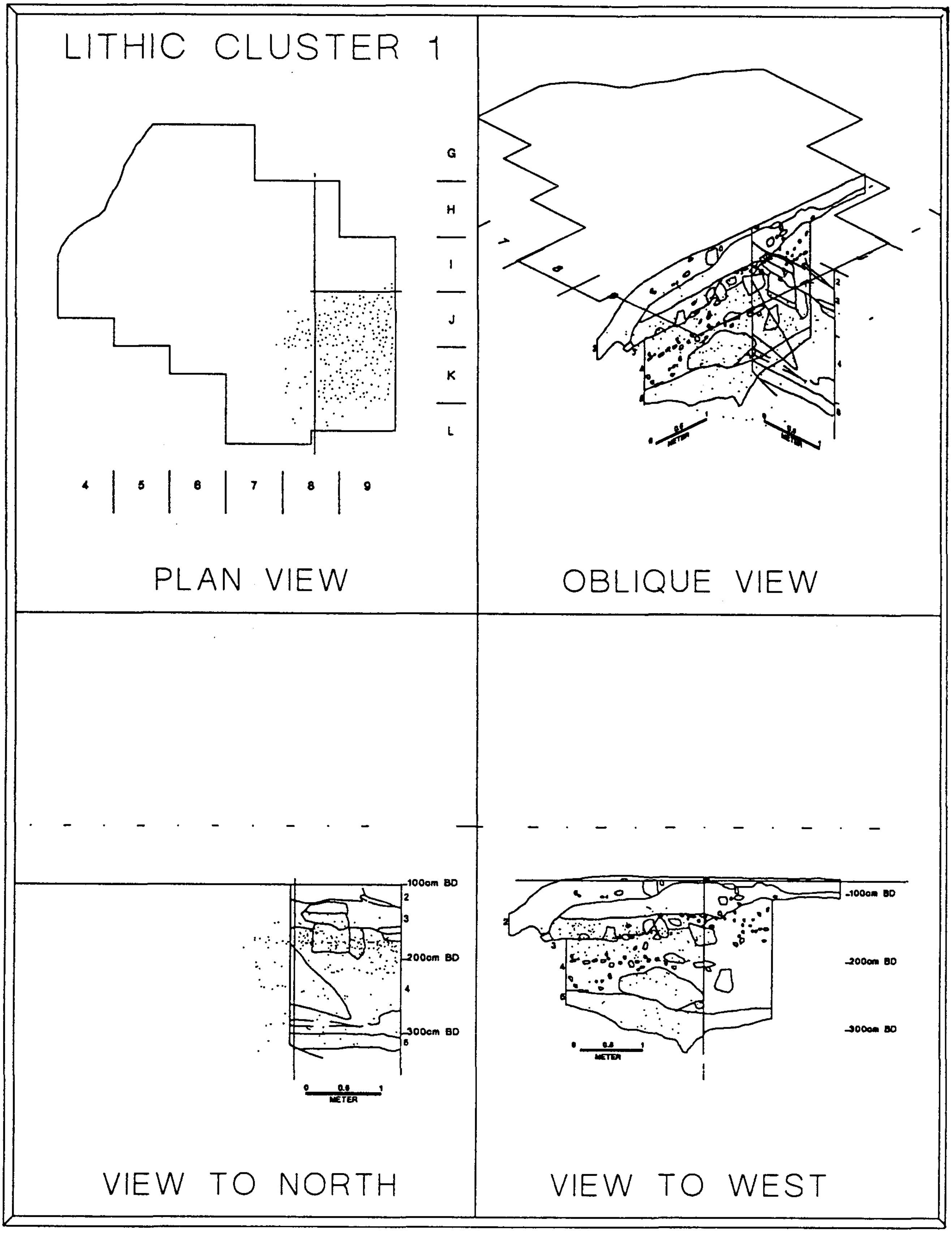
PLAN VIEW
OBLIQUE VIEW
100cm BD
200cm BD
300cm BD
0 0.5 1
METER
VIEW TO NORTH
-100cm BD
-200cm BD
-300cm BD
VIEW TO WEST

Figure 11.2


LITHIC CLUSTER 1
G
H
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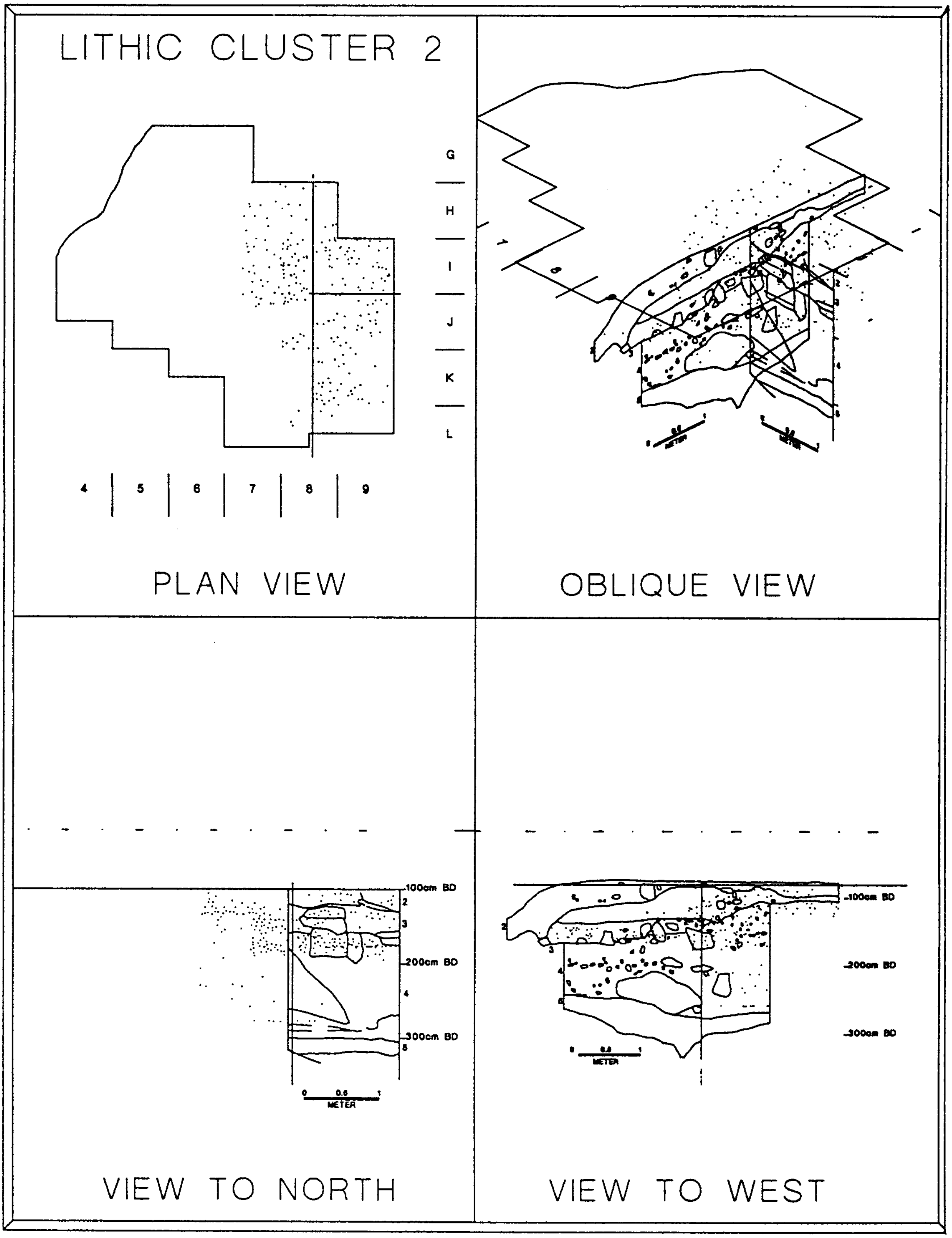
PLAN VIEW
OBLIQUE VIEW
100cm BD
200cm BD
300cm BD
METER
VIEW TO NORTH
VIEW TO WEST

Figure 11.3


LITHIC CLUSTER 2
G
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PLAN VIEW
OBLIQUE VIEW
100cm BD
200cm BD
300cm BD
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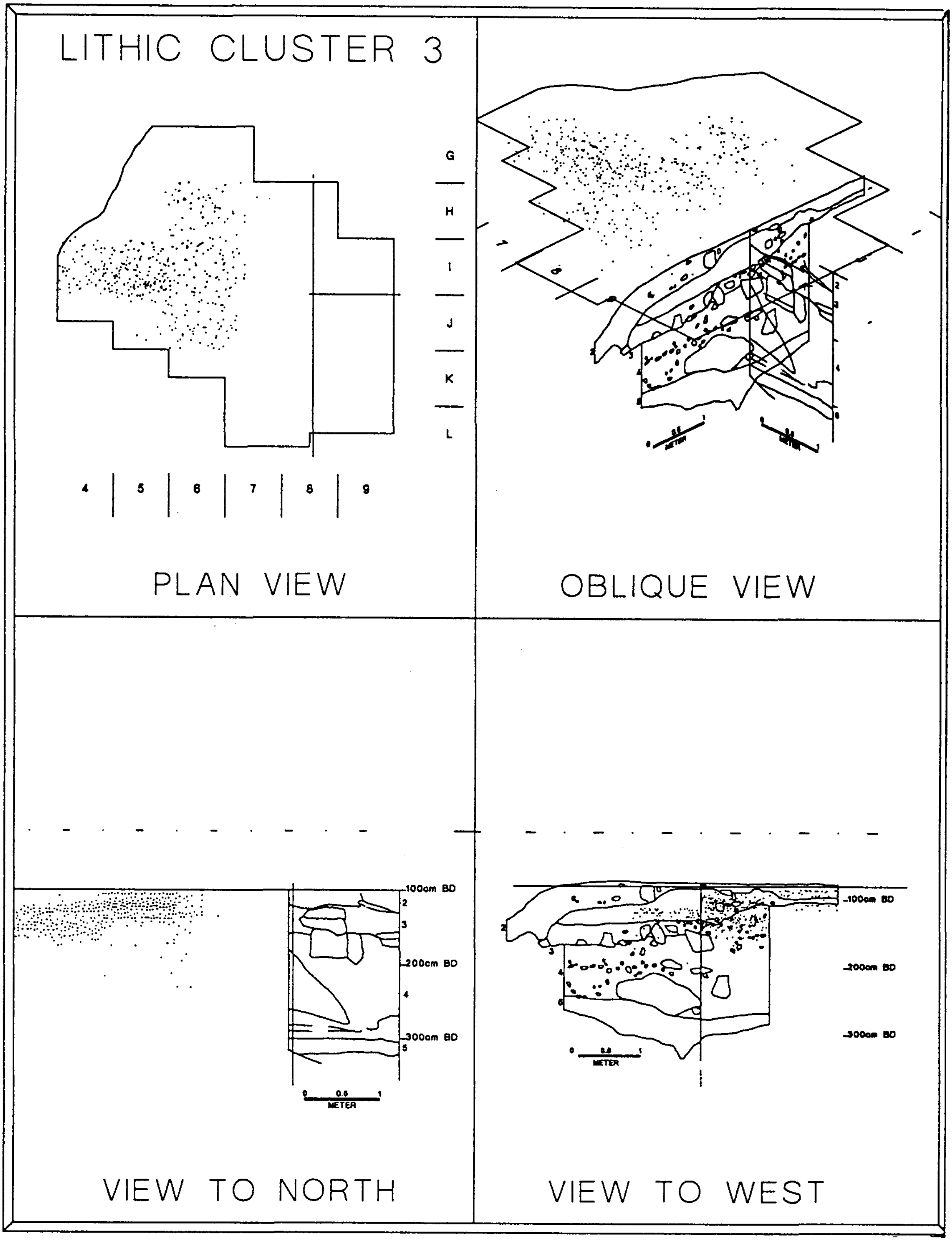
METER
VIEW TO NORTH
VIEW TO WEST

Figure 11.4



LITHIC CLUSTER 3
G
H
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J
K
L
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5
6
7
8
9
PLAN VIEW
OBLIQUE VIEW
100cm BD
200cm BD
300cm BD
METER
VIEW TO NORTH
VIEW TO WEST

Figure 11.5

of the most artifacts), 2) along the axis of greatest data variance (along the axis of greatest differences in numbers or types of artifacts, or 3) along the principal eigenvector of the data (along the axis which intersects the greatest number of significantly meaningful clusters of artifacts).

Next, the number of clusters present in the dataset are needed. While this may seem like a ridiculous requirement (if we knew how many clusters were present in the data why would we bother clustering them?), VQUANT establishes where data clusters are and what high-dimensional relations are present within cluster zones. One of the most robust and intuitive approaches to determining number of clusters is provided by a refined ISODATA algorithm, also known as ISODATA2. This technique 'reads' a data set and determines the minimum and maximum number of clusters possible given the contents and interrelationships of a dataset. In practice, ISODATA2 matches the sum of squared Euclidian distance against the smallest possible variance in the location of cluster centroids. This is a technique quite similar to that used by a MAXCLUST function in K-means analysis, however, the ISODATA2 function is a heuristically based, automatic classification algorithm. This translates to an ISODATA2 algorithm is 'smart' enough to determine how many cluster are present in the data without the user having to 'guess' a reasonable starting number for the maximum number of clusters.

As a next step, VQUANT can take the data provided by ISODATA2 regarding minimum number of significant clusters and begin high-dimensional analysis of data relations. In the archaeological example, following ISODATA2 analysis, we now know the general number of clusters that can reasonably be expected to be present given the number, type and position of our artifacts. Using VQUANT, we can now begin to ask the question, "Where are the artifacts and what associations of artifacts are there relative to the rest of the site?" This in turn helps answer along which type of axis to split the data. Our options, again, are 1) maximum span, 2) maximum variance, or 3) principal eigenvector. Given that we are interested in examining intra as well as inter-relationships between strata 2-5 at Trou Magrite, VQUANT splitting along the principal eigenvector was chosen so that cluster region identification would be primarily a function of similarity of relative position, number and type of artifacts distributed about the excavation area. Applied to the Trou Magrite dataset, VQUANT and ISODATA2 analysis was carried out using the KHOROS program developed at the University of New Mexico. In order to determine the geographic location and orientation of clusters, a KHOROS post-processor developed by Scott Wilson was used to evaluate the position, inclination and contents of each cluster region.

RESULTS

Data Visualization

Data visualization at Trou Magrite suggests a number of patterns. The western portion of the excavation area (G-K/4-6) is characterized by a tight vertical distribution of both lithic and faunal data. The faunal distribution in the northeastern portion of the excavation (J-H/7-9) seems to be substantially less dense in this portion of the site than in the area to the immediate south. As this area is 1) directly beneath the present-day drip line, and 2) was found in excavation to be largely indurated with flowstone, I suspect that this is a function of bone preservation rather than an actual characteristic of the data. Lithic artifacts in the southern portion of the excavation area (J-L/7-9) appear to be dispersed in vertical space, while faunal data are generally clustered in this part of the site into stratigraphically superimposed layers of artifacts that overlap the lithic distribution (see Figs 11.1 & 11.2). This 'layering' of faunal remains in the southern portion of the excavation area may well be a product of accretional deposition of bones on the talus slope of the cave, interspersed by periodic deposition and erosion of lithics on and from the exposed talus.

Lithic Refit Analysis

Analysis of the Trou Magrite data for lithic refits was largely unsuccessful. Of the 4000+ chipped stone items in the assemblage measuring greater than 1cm, 15 items were found to directly refit (see Table 11.1). Two major obstructions to refit analysis were encountered. First, the high incidence of limestone artifacts prevented large-scale study of the assemblage, as the surface of these artifacts was consistently eroded. Second, the strategy for lithic reduction at Trou Magrite appears to have been highly intensive, with a premium placed on the conservation of lithic raw materials (especially cryptocrystalline ones). As a result, few artifacts remained which had enough definable features to 'put back together'. All artifact refits are restricted in vertical space, and are located in portions of the site that on the basis of visual inspection (above) and vector quantization (below) appear to be stratigraphically intact.

Vector Quantization

VQUANT analysis of Trou Magrite revealed a number of statistical problems with the data, but also suggests a number of patterns. Initial inclusion of combinations of lithic and bone data in combined analysis runs suggests that the shear frequency of unidentifiable bone fragments (nearly 8000) filters out the determination of patterns among other types of artifacts. Removal of this item as a category helps, however. The remaining small number of faunal remains that are definable with respect to element and location are spatially dispersed, and seem to exhibit no significant clustering with respect to horizontal space. Relative to vertical space, identifiable faunal remains are virtually restricted to strata 2 and 3. This is likely a function of preservation factors as strata 2 and 3 contained a higher frequency of artifacts and bones than strata 4 or 5 with general preservation of bones being generally better in upper strata.

Lithic artifacts, however, do exhibit significant spatial structure and clustering. VQUANT analysis indicates the existence of 5 distinct clusters definable on the basis of 1) artifact type, 2) raw material type, and 3) spatial location. In evaluating these clusters, it became clear that several phenomena describe the nature of the lithic clusters distribution. First, these clusters were characterized by properties of being constrained or dispersed in Cartesian space. Second, these clusters are formed of assemblages composed of the following artifact and raw material categories:

TABLE 11.1: Artifact Refit Sets

ARTIFACT#	ARTIFACT TYPE	STRATUM
I4-85	non-cortical flake	3
I4-86	non-cortical debris	3
I4-87	non-cortical debris	3
I4-88	non-cortical flake	3
I5-62	non-cortical flake	2
I5-64	non-cortical flake	2
I6-93	non-cortical debris	2
I6-97	cortical blade	2
I6-98	cortical blade	2
I6-192	non-cortical blade	2
I6-194	non-cortical blade	2
J8-231	core	4
J8-231.1	non-cortical flake	4
J8-305	cortical flake	5
J8-306	cortical flake	5

1) cryptocrystalline materials with a predominance of Upper Paleolithic tools

2) limestone, sandstone (including quartzites) and other raw material categories with a general predominance of Mousterian tool types.

These properties with respect to lithic raw material and artifact type suggest that the lithic data might also be thought of in terms of being dispersed or constrained within a domain defined by material type, frequency of blades, and Upper vs. Middle Paleolithic tool types.

Lithic Cluster 1

The first VQUANT lithic cluster is characterized by several properties. Geographically, it is restricted in horizontal space to squares J-L/7-9 (Fig 11.3). In vertical space, however, it cross-cuts strata 3 through 5, but with the greater part of its constituent artifacts being from strata 3 and 4. Cluster 1 contains 3 phtanite flakes, including one Upper Paleolithic tool, but no other cryptocrystalline materials. This assemblage is essentially made up of limestone, sandstone, and other less lustrous raw material types. Tools within this group include 15 limestone Upper Paleolithic tools, 1 sandstone Upper Paleolithic tool, and 4 limestone Mousterian tools. Technologically, this assemblage represents the gamut of lithic reduction sequence, and contains cores, cortical and non-cortical debris and debitage, blades, and tools. Based upon 1) this cluster's cross-cutting of stratigraphic boundaries and 2) presence of both Mousterian and Upper Paleolithic tool types, lithic cluster 1 is clearly mixed.

Lithic Cluster 2

In contrast to lithic cluster 1, lithic cluster 2 is characterized by an abundance of cryptocrystalline materials, including 30 Upper Paleolithic tools, no Mousterian tools, 4 flint cores, and most stages of the lithic reduction process. Located in squares J-H/7-9 (Fig 11.4), lithic cluster 2 is reasonably well-constrained within strata 2 and 3 in a dispersed distribution. Approximately two dozen isolated artifacts seem to have moved down through crevices in rock-all into stratum 4, but relative to the total size of the distribution in cluster 2, this appears to not be significant.

Lithic Cluster 3

This cluster contains products of the full range of technological reduction strategies and lithic raw material types. Occupying squares G-K/4-6 (Fig 11.5), cluster 3 is highly restricted in vertical space within strata 2 and 3. Some evidence for artifacts 'dribbling' down crevices between rock boulders along the 6-7 square line is present in the form of less than a dozen outlier flakes in stratum 4. Relative to the nearly 3000 items in this roughly 3 x 4 meter area, however, these artifacts represent only a fractional percentage of the cluster population. This cluster contains 42 flint Upper Paleolithic tools, 16 limestone Upper Paleolithic tools, 1 siltstone Upper Paleolithic tool, and no Mousterian tool types. Of particular note is that this cluster contains nearly three times as many blades and bladelets than any other identified group.

Lithic Cluster 4

Lithic cluster 4 partially overlaps with lithic cluster 2 (Fig 11.6), and is characterized by an absence of flint or chert artifacts, abundant limestone flakes, cores, and blades, 21 limestone Upper Paleolithic tools, and significant quantities of sandstones & siltstones (including 4 quartzite Upper Paleolithic tools and 1 quartzite Mousterian tool). Lithic cluster 4 is fairly well constrained in stratum 2, 3 and the upper part of stratum 4. It also has, however, a vertical 'tail' that extends into the upper portion of stratum 5 in the form of numerous artifacts that had slipped downwards. Its horizontal distribution is also somewhat dispersed, as it occupies squares H-K/6-9.

Lithic Cluster 5

Lithic cluster 5 closely overlaps lithic cluster 1 (squares J-L/7-9) (Fig 11.7), and, like lithic cluster 2, is dispersed in vertical space over stratum 3 through stratum 5. Its artifact assemblage is composed of abundant flints and cherts, no limestone or sandstones, 45 Upper Paleolithic tools, and 1 Mousterian tool.

Summary of Patterns

In general, visual inspection, lithic refit analysis, and VQUANT analysis all suggest that the western portion of the excavation area (G-K/4-6) is substantially intact and the northeastern region (J-H/7-9) is largely intact. Analysis also suggests that the southern portion (J-L/7-9) may be the product of episodic deposition of lithics and fauna down a talus slope. With respect to all artifacts and the total excavation area, lithic and faunal data generally overlap in areas of the site that appear to be stratigraphically intact. In areas where VQUANT analysis suggests lithic artifacts are of mixed provenience, faunal data are observed to be clustered into overlapping layers.

DISCUSSION

The general spatial pattern displayed by the Trou Magrite data is complex. Squares G-K/4-6 are definable as a space-constrained area in which the artifact categories are characterized by an abundance of raw material types, but a general tendency to be include artifacts that are Aurignacian / Upper Paleolithic types. This is consistent with an interpretation of this portion of the site as being stratigraphically intact. Examination of the artifact distribution in the this portion of the site with respect to Cartesian space also indicates lenses of artifacts suggesting multiple occupations and/or 'living surfaces'.

Squares J-H/7-9 appear to be largely stratigraphically intact, though the vertical distribution of artifacts within this area were somewhat elongated and 'dribbles' from strata 2 & 3 into portions of stratum 4. Faunal data are less

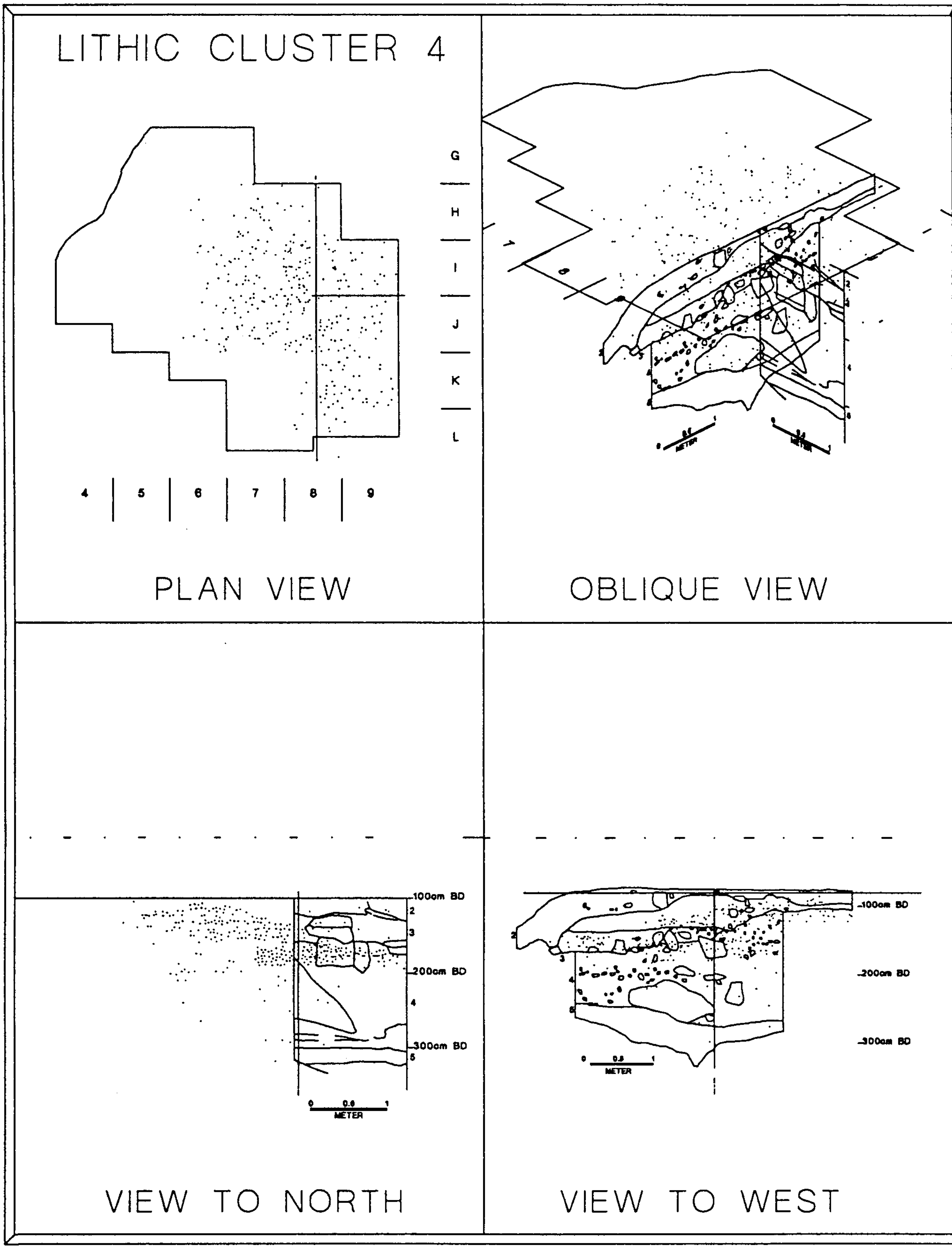
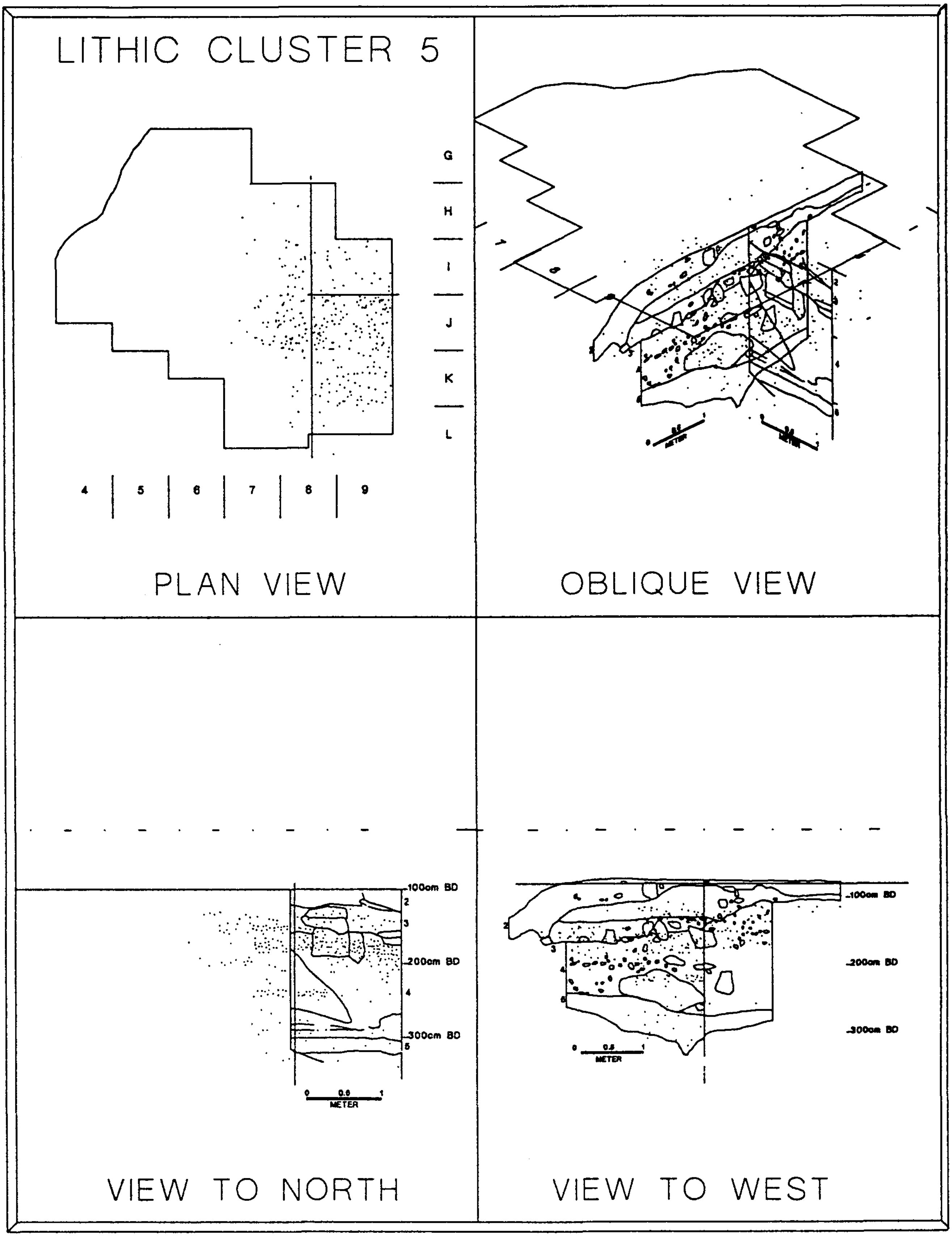

LITHIC CLUSTER 4
G
H
I
J
K
L
4
5
6
7
8
9
PLAN VIEW
OBLIQUE VIEW
-100cm BD
-200cm BD
-300cm BD
METER
VIEW TO NORTH
VIEW TO WEST

Figure 11.6



LITHIC CLUSTER 5
G
H
I
J
K
L
4
5
6
7
8
9
PLAN VIEW
OBLIQUE VIEW
100cm BD
200cm BD
300cm BD
METER
VIEW TO NORTH
VIEW TO WEST

Figure 11.7

frequent here than in the rest of the excavation area, but I suspect that this is a function of preservation factors rather than real activity distributions. Like the western portion of the site, artifact clusters are characterized by a diversity of raw material types, blades, and Upper Paleolithic tools. This evidence suggests that this portion of the site is of Aurignacian affiliation, though it is somewhat less intact than the western portion of the site with respect to its vertical and perhaps horizontal axes.

Squares J-L/7-9, near the talus edge, seem to be characterized by a dispersed lithic assemblage overlapping clustered zones of bones in vertical space. Some elements of the clusters defined by VQUANT analysis in the southern excavation area suggest that artifacts of Aurignacian affiliation are present (i.e., large number of cryptocrystalline materials, blades and Upper Paleolithic tools). The association of these items, however, with; 1) a lithic raw material diversity that is a mix of types found in upper <u>and</u> lower strata, 2) a vertical distribution of lithic clusters that cuts across strata 2 through 5, and 3) the co-occurrence of both Upper and Middle Paleolithic tool and debitage types is consistent with an hypothesis of stratigraphic disturbance of this portion of the site.

The faunal distribution in the southern portion of the site can be broken into 4 distinct clusters in vertical space which overlap one another in horizontal space. Of these layers, only a single lithic cluster is definable in vertical space that overlaps this bone distribution. It is characterized by being in stratum 4, and contains a high incidence of limestone debitage and a relatively low frequency of blades.

The co-association of clustered zones of bones in vertical space with a dispersed lithic distribution in the southern excavation area invites speculation. As this portion of the site is located along the talus of the prehistoric cave mouth, it is not unreasonable to suppose periods of episodic deposition and erosion resulting in a dispersed distribution of lithic artifacts. This may, in turn, also account for the clustered bone layers in this area of the excavation. A distributed lithic distribution containing successive layers of bone accumulation is consistent with a hypothesis of periodic alternation of human and animal occupation of the site.

CONCLUSION

Data visualization, lithic refit analysis and vector quantization analysis were employed in the spatial analysis of strata 2-5 at Le Trou Magrite (Table 11.2. Spatial structure is present in the form of discrete clusters of artifacts of Aurignacian affiliation in the western and northeastern portion of the excavated area in strata 2 and 3. These clusters are definable into lenses of artifacts that may be associated with occupation surfaces and considerable site integrity in this portion of the excavation area. The southern portion of the excavation area, along the prehistoric talus, seems to exhibit less evidence for spatial integrity, and is instead characterized by overlapping faunal distributions that may be

TROU MAGRITE
Summary of Lithic Cluster Memebership

	CLUSTER					Total
	1.00	2.00	3.00	4.00	5.00	
ARTIFACT TYPE						
flint/chert debitage < 1cm		261	938		300	1499
flint/chert non-cortical debris		25	74		25	124
flint/chert cortical debris		7	11		6	24
flint/chert non-cortical flakes		244	614		255	1113
flint/chert cortical flakes		31	50		32	113
flint/chert non-cortical blades		33	71		24	128
flint/chert cortical blades		12	8		4	24
flint/chert bladelets		53	52		19	124
flint/chert cores & platform renewal flakes		4	10		10	24
flint/chert Upper Paleolithic tools		30	42		45	117
flint/chert Mousterian tools					1	1
phtanite debitage < 1cm		1	1		3	5
phtanite non-cortical debris		2			1	3
phtanite non-cortical flakes	1	1	10		2	14
phtanite non-cortical blades		1	2		2	5
phtanite cores & platform renewal flakes	1					1
phtanite Upper Paleolithic tools	1					1
limestone debitage < 1cm	43		66	139		248

(continued)

TABLE 11.2 .

TROU MAGRITE
Summary of Lithic Cluster Memebership

	CLUSTER					Total
	1.00	2.00	3.00	4.00	5.00	
limestone non-cortical debris	32		50	44		126
limestone cortical debris	5		4			9
limestone non-cortical flakes	293		704	630		1627
limestone cortical flakes	9		7	14		30
limestone non-cortical blades	22		127	80		229
limestone cortical blades			1	3		4
limestone bladelets	2		15	16		33
limestone cores & platform renewal flakes	9		12	7		28
limestone Upper Paleolithic tools	15		16	21		52
limestone Mousterian tools	4					4
sandstone/siltstone debitage < 1cm			3	1		4
sandstone/siltstone non-cortical debris	1		1	1		3
sandstone/siltstone non-cortical flakes	11		33	38		82
sandstone/siltstone cortical flakes	3		5	21		29
sandstone/siltstone non-cortical blades	2		8	9		19
sandstone/siltstone cortical blades				2		2
sandstone/siltstone cores & platform renewal flakes	1			2		3

(continued)

TABLE 11.2 .

TROU MAGRITE
Summary of Lithic Cluster Memebership

	CLUSTER					Total
	1.00	2.00	3.00	4.00	5.00	
sandstone/siltstone Upper Paleolithic tools	1		1	4		6
sandstone/siltstone Mousterian tools	1			1		2
other stone debitage < 1cm	2		3	1		6
other stone non-cortical debris	5			5		10
other stone cortical debris	1		1			2
other stone non-cortical flakes	11		10	3		24
other stone cortical flakes	2		1	1		4
other stone non-cortical blades			2			2
other stone bladelets				2		2
other stone cores & platform renewal flakes	1					1
Total	479	705	2953	1045	729	5911

TABLE 11.2 .

consistent with a hypothesis of alternating periods of human and carnivore use of the cave.

ACKNOWLEDGEMENTS

Many thanks to Scott Wilson and Greg Donohoe with assistance in writing KHOROS workspaces for ISO2 and VQUANT. Thanks to Jim Ebert and Eileen Camilli for use of computing resources, and to Rita for her tolerance of too many late nights and early mornings. Extra special thanks to Lawrence Straus and Marcel Otte for allowing me to use their data, and for their immoderate patience in getting my analysis results. I claim responsibility for any errors in this analysis, its interpretation, or presentation.

REFERENCES

DUDA RO. and HART P., 1973,
Pattern Classification and Scene Analysis. New York : John Wiley & Sons.

FUKUNAGE K., 1972,
Introduction to Statistical Pattern Recognition. New York : Academic Press.

HECKBERT P., 1982,
Color Image Quantization for Frame Buffer Display. *Computer Graphics,* 16(3).

KROLL EM. and ISAAC GI., 1984,
Configurations of Artifacts and Bones at Early Pleistocene Sites in East Africa. In: H. Hietala (ed.), *Intrasite Spatial Analysis in Archaeology,* pp. 4-31, Cambridge, Cambridge University Press.

MARTINEZ AE., (n.d.),
Towards a Consensus of Methodology: Field and Laboratory. Techniques for the Analysis of Archaeological Site Structure. Ph.D. Dissertation, University of New Mexico (in prep.).

O'ROURKE J. and SLOAN KR. Jr., 1984,
Dynamic Quantization: Two Adaptive Data Structures for Multidimensional Spaces. *IEEE Transcripts of Pattern Analysis and Machine Intelligence.* 6(3) pp. 266-279.

TOU JT. and GONZALEZ RC., 1974,
Pattern Recognition Principles, 4th ed. Applied Mathematics and Computation, 7. Reading, Massachusetts: Addison-Wesley Publishing Company.

WILSON SR., 1991,
A Vector Quantization Approach to the Restoration of Space Varying Blurs with Application to Ion Beam Optical Figuring. Ph.D. Dissertation, University of New Mexico.

M. OTTE et L.G. STRAUS (dir.), *Le Trou Magrite. Fouilles 1991-1992*. Liège, E.R.A.U.L. 69, 1995.

12

APPORT DES FOUILLES RECENTES A L'ATTRIBUTION CULTURELLE DES TEMOINS D'ART MOBILIER PROVENANT DES FOUILLES ANCIENNES DU TROU MAGRITE (PONT-A-LESSE, BELGIQUE)

Marylise LEJEUNE

Les fouilles effectuées en 1867 par E. Dupont au Trou Magrite mirent au jour une cinquantaine de témoins d'art mobilier comprenant des pendeloques diverses (dents perforées, anneau en ivoire, pièce bilobée à double perforation) (fig. 12.1), des pièces osseuses incisées (fig. 12.2 et 12.3) et surtout les deux plus anciennes oeuvres d'art actuellement connues en Belgique : une petite statuette en ivoire et un fragment de bois de renne gravé (fig. 12.4).

La petite statuette anthropomorphe a été taillée dans un bâton d'ivoire, puis polie. Haute de 38 mm, elle est dépourvue de membres mais sa petite tête arrondie et bien dégagée possède un certain modelé suggérant un nez et des yeux. Le tronc présente des épaules bien marquées et un rétrécissement vers le bas suggérant la taille. La partie inférieure, plus large, est constituée d'un petit bloc cylindrique sans indication de détail anatomique. Aucun caractère sexuel n'est figuré.

Trouvé dans la même couche, le fragment de bois de renne, long de 92 mm, possède un décor original composé de deux figures emboîtées. Deux ovales inscrits l'un dans l'autre se prolongent à une extrémité par deux lignes parallèles qui, après un coude à angle droit, se rejoignent en formant un petit cercle. Une figure fusiforme vient s'emboîter au niveau de ce coude. De nombreux petits traits sont incisés perpendiculairement, tant sur certaines parties du tracé abstrait que sur les bords de la pièce. Sur l'autre face, on remarque principalement, une ligne sinueuse portant de petites incisions perpendiculaires. Diverses interprétations ont été proposées : "dessins fantaisistes" (A. Rutot, 1903, p. 202), représentations pisciformes (H. Breuil et R. Saint-Perier de, 1927, p. 50 et 52), cygne (H. Angelroth, 1937, p. 149), idéogramme (F. Twiesselmann, 1951, p. 7), représentations sexuelles (P.A. Janssens, 1970, p. 42 et M. Otte, 1979, p. 166).

Malheureusement, la stratigraphie établie par E. Dupont peut prêter à confusion selon que l'on envisage la numérotation des couches archéologiques de bas en haut ou de haut en bas. Les attributions culturelles - par comparaisons stylistiques notamment - de nos deux "pièces-clés", ont varié au cours des temps. En effet, si E. Saccasyn-della-Santa place la statuette à l'"Aurignacien supérieur" ou au Solutréen ancien (1947, p. 151) et F. Twiesselmann à l'"Aurignacien terminal" (1951, p. 26), A. Leroi-Gourhan considère que les statuettes occidentales

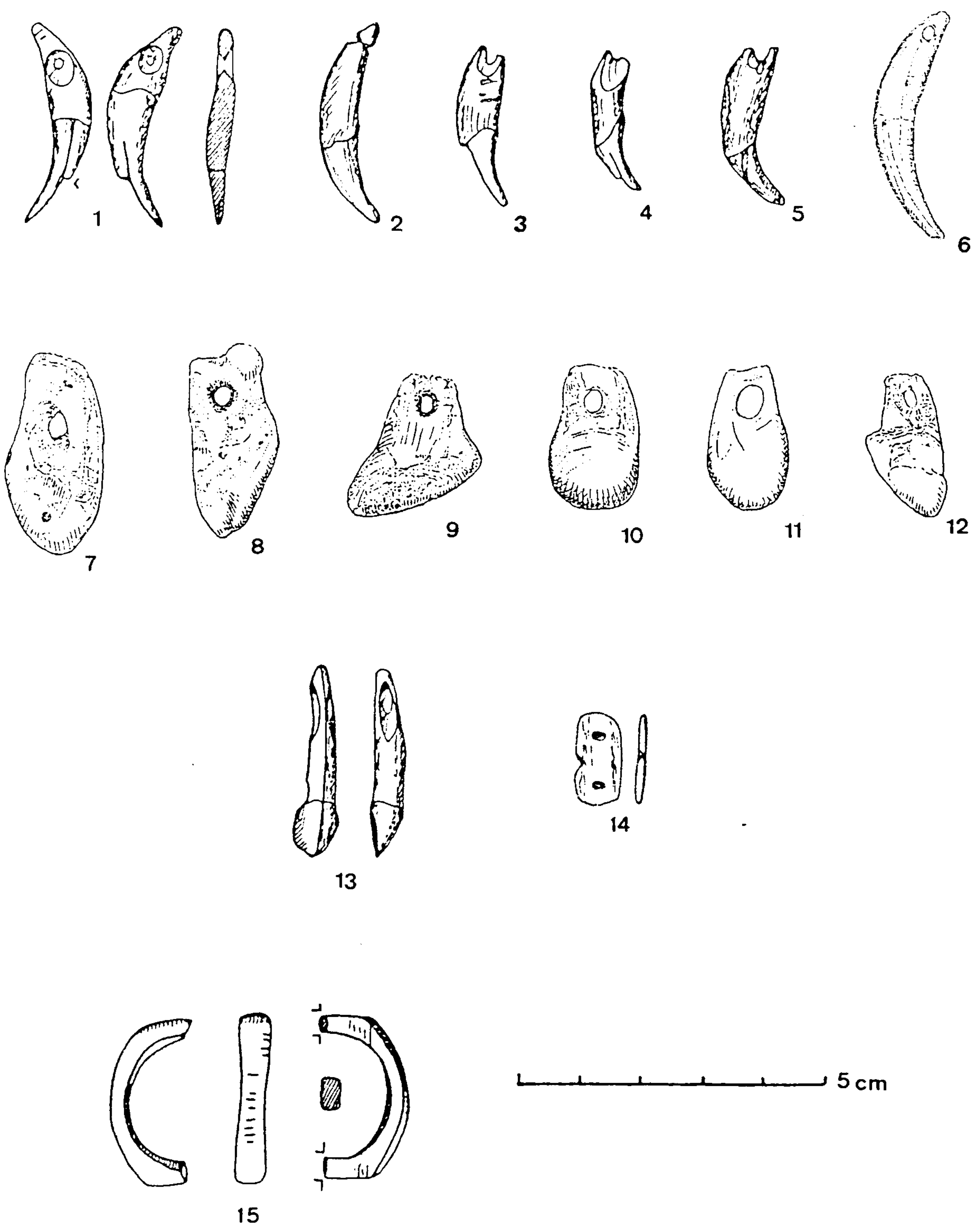


Figure 12.1. Trou Magrite. Aurignacien. Pendeloques. Canines de renard perforées (1 à 6), croches de cervidés perforées (7 à 12), incisive de cervidé (13), pendeloque bilobée à double perforation, en ivoire (14), anneau en ivoire (15). (1, 2, 3, 4, 5, 13, 14, 15 : d'après M. Otte, 1979 et 6, 7, 8, 9, 10, 11, 12 : d'après M. Lejeune, 1987).

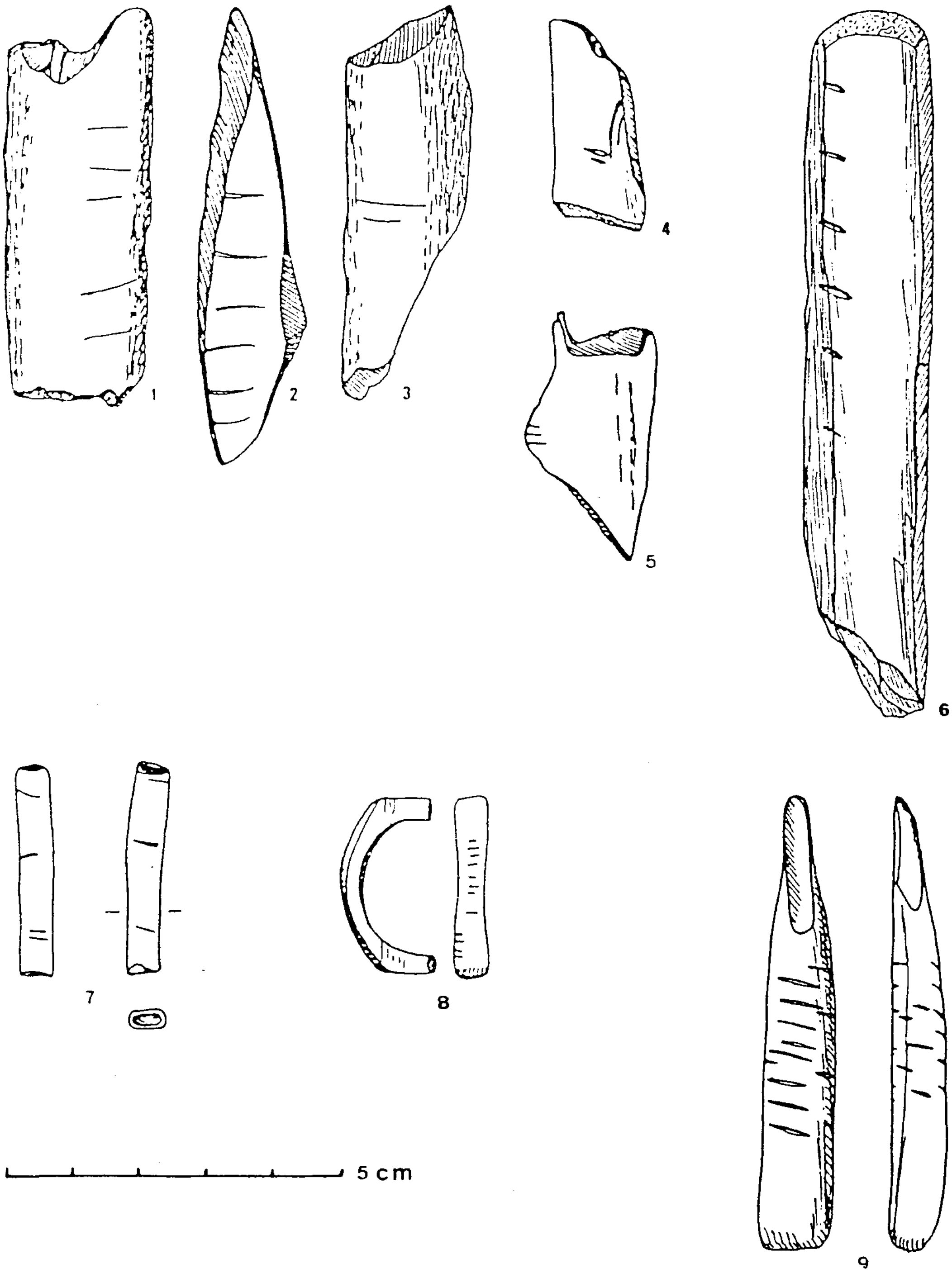


Figure 12.2. Trou Magrite. Aurignacien. Pièces incisées. Traits rectilignes parallèles transversaux (1 à 5 : esquilles osseuses, 6 : bâton de bois silicifié, 7 : os d'oiseau, 8 : fragment d'anneau en ivoire). Traits rectilignes parallèles transversaux alternés (9 : fragment d'os) (d'après M. Otte, 1979).

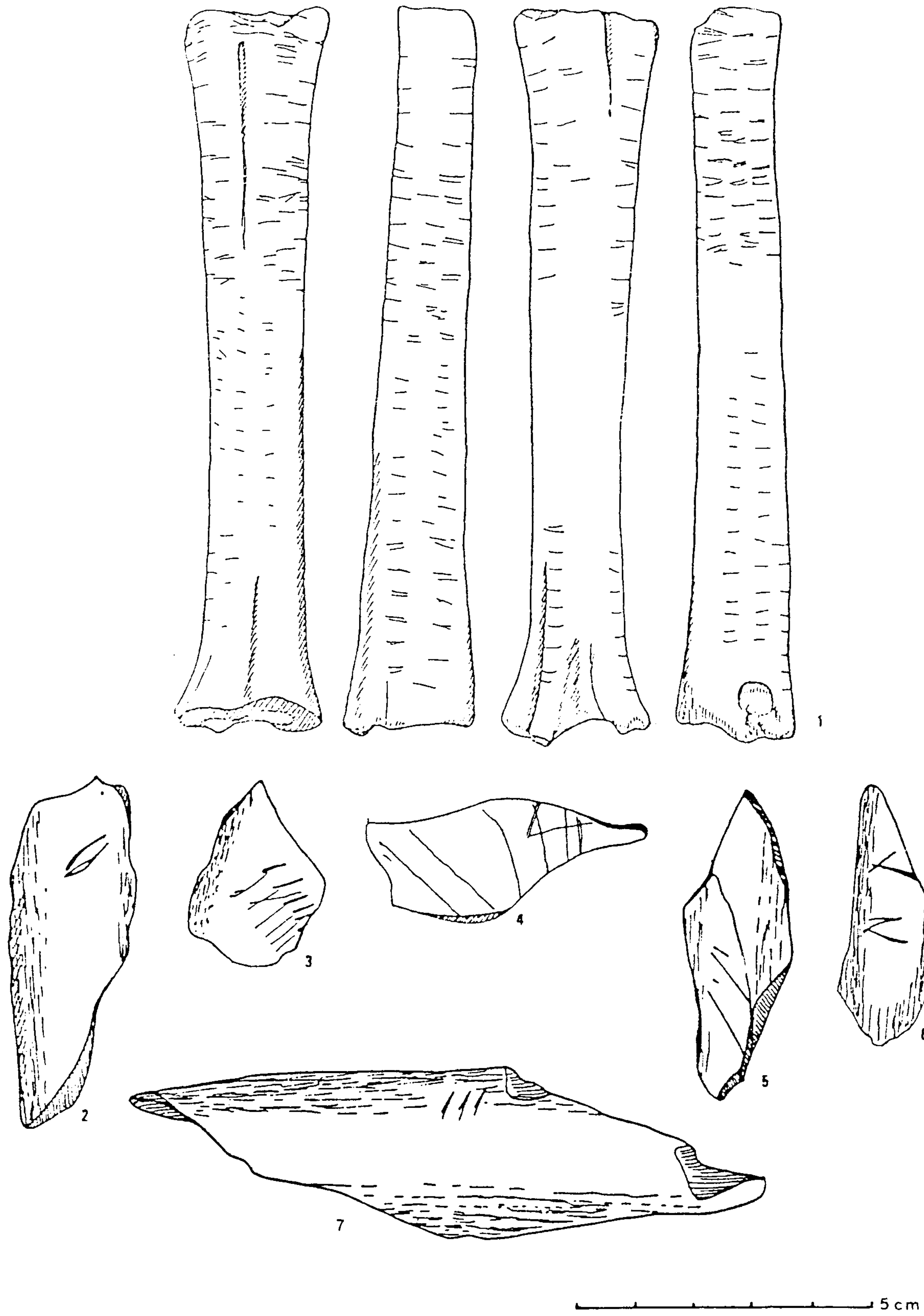


Figure 12.3. Trou Magrite. Aurignacien. Pièces incisées. Bandes parallèles de petits traits rectilignes, parallèles et transversaux (1 : diaphyse découpée). Traits convergents, parfois courbes (2 à 7 : esquilles osseuses) (d'après M. Otte, 1979).

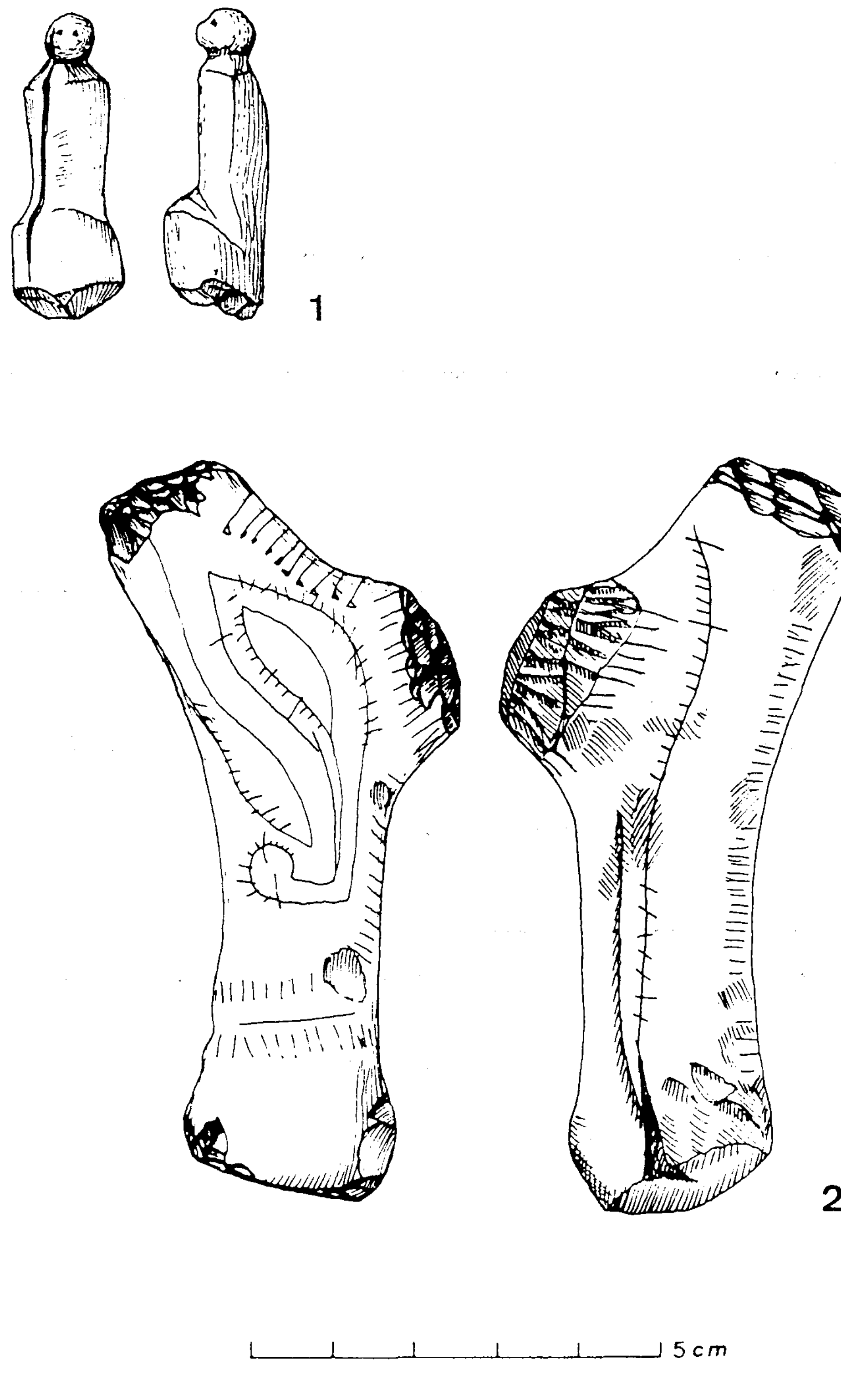


Figure 12.4. Trou Magrite. Aurignacien. 1 : statuette anthropomorphe en ivoire, 2 : bois de renne découpé et gravé de motifs abstraits (dessins M. Otte, 1979, p. 164).

se situent "entre Gravettien et Solutréen" (1965, p. 66). M. Otte adopte l'attribution de H. Delporte (1962, p. 54) qui place notre statuette au Périgordien supérieur (1979, p. 164) mais en émettant certaines réserves : la statuette "bien que participant à la tradition des représentations féminines du Périgordien supérieur d'Europe occidentale, se rapproche davantage par sa composition et son style des statuettes de Moravie, sans d'ailleurs que ces comparaisons soient tout à fait satisfaisantes" (M. Otte, 1979, p. 622).

Reprenant les publications de E. Dupont, M. Dewez en fait une analyse minutieuse et propose une reconstitution raisonnée de la stratigraphie du site (tableau 12.1).

Argile à blocaux	C	Age du Fer		
		Mésolithique		
		Magdalénien		-ca 13.000 B.P
Limon fluviatile stratifié	B	Maisièrien	1	-ca 23.000 B.P
		Aurignacien tardif	2	-ca 25.000 B.P.
		Aurignacien typique	3	
		Moustérien	4	
Cailloux roulés	A	Stérile		

Tableau 12.1. "Reconstitution de la stratigraphie en tenant compte des textes de Dupont, des recherches récentes sur la documentation et de la fouille de contrôle de Toussaint" (M. Dewez, 1985, p. 119).

E. Dupont ayant signalé que la statuette provenait de la "3^{e} couche ossifère" (Dupont, 1872, p. 93), M. Dewez considère qu'il s'agit de "la 3^{e} couche du niveau fluviatile stratifié (formation B) en faisant commencer les couches par le haut, comme le fait normalement Dupont" (1985, p. 123). Il nous dit également que "c'est à ce 3^{e} niveau ossifère que nous proposons d'attribuer l'Aurignacien typique. Dupont lui-même (1872b : 88) avait fait le rapprochement entre une pointe de sagaie à base fendue en bois de renne du Trou du Sureau et une autre, dans le même matériau, provenant des "niveaux inférieurs" du Trou Magrite, c'est-à-dire des niveaux 3 et 4" (Dewez, 1985, p. 121). La statuette anthopomorphe ainsi que le fragment de bois de renne gravé trouvé dans la même couche sont donc attribués à l'Aurignacien typique.

Malheureusement, aucune datation absolue de cet Aurignacien n'était établie jusqu'à ce que les fouilles menées par les universités de Liège et du Nouveau-Mexique en 1991 et 1992 livrent du matériel dont les déterminations radio-carbone sont les suivantes :

Couche	Attrib. cult.	Dates	N°lab.	Matériel	Méthode
2	Aurignacien	17900 ± 200	OxA-4040	charbon (pouss.)	AMS
2	Aurignacien	22700 ± 1050	Gx 17017 A	os (apatite)	conv.
2	Aurignacien	26580 ± 1310	Gx 17017 G	os (gélatine)	conv.
2	Aurignacien	30100 ± 2200	Gx 18538 G	os (gélatine)	conv.
2	Aurignacien	34225 ± 1925	Gx 18537 G	os (gélatine)	conv.
3	Aurignacien	27900 ± 3400	Gx18540	os (gélatine)	conv.
3	Aurignacien	>33800	Gx18539 G	os (apatite)	conv.
3	Aurignacien	41300 ± 1690	CAMS-10352	os (collagène)	AMS*

Tableau 12.2. Dates radiocarbone du Trou Magrite (Noiret P., Otte M., Straus L.G. *et al.*, 1994, p. 46, et ce volume*).

Outre la dernière datation fournie(*), L.G. Straus me signale que "la datation de CAMS (tandétron de Berkeley - Lawrence - Livermore) est la plus fiable pour cette couche et la datation de 34225 ± 1925 BP est la plus fiable pour la couche 2. Donc, les objets d'art auraient entre 38000 - 34000 ans au moins", ce qui les placerait parmi les témoins les plus anciens actuellement connus en Europe.

Les témoins d'art mobilier trouvés dans la couche 3 seraient donc bien aurignaciens. En outre, ils participent de "l'esprit" de cette culture : par la technique de la ronde-bosse (attestée dans des oeuvres mobilières aurignaciennes provenant notamment du Volgelherd, de Geissenklösterle, de Hohlenstein-Stadel et par les représentations de symboles sexuels tels qu'on peut en voir sur des blocs gravés de la Ferrassie, de l'abri Blanchard, de l'abri Castanet, de l'abri Cellier ou en ronde-bosse à l'abri Blanchard (phallus). Les pendeloques aurignaciennes en forme d'oreille provenant de la grotte de la Betche-aux-Rotches à Spy (M. Dewez, 1985) et la plaquette façonnée et gravée d'un motif serpentiforme de ponctuations provenant de l'abri Blanchard, pourraient aussi être prises en considération (fig. 12.5 et 12.6). Si M. Otte considère que la statuette appartient au "Périgordien supérieur", essentiellement par comparaison de la forme avec celle des cinq statuettes de Predmost (fig. 12.5, n° 6), il émet cependant certaines réserves : "Il est difficile de placer cette oeuvre d'art dans l'ensemble des statuettes de la fin du Gravettien d'Europe. Celles-ci sont, en effet, la plupart du temps beaucoup plus figuratives et souvent plus adipeuses (...). En accord avec

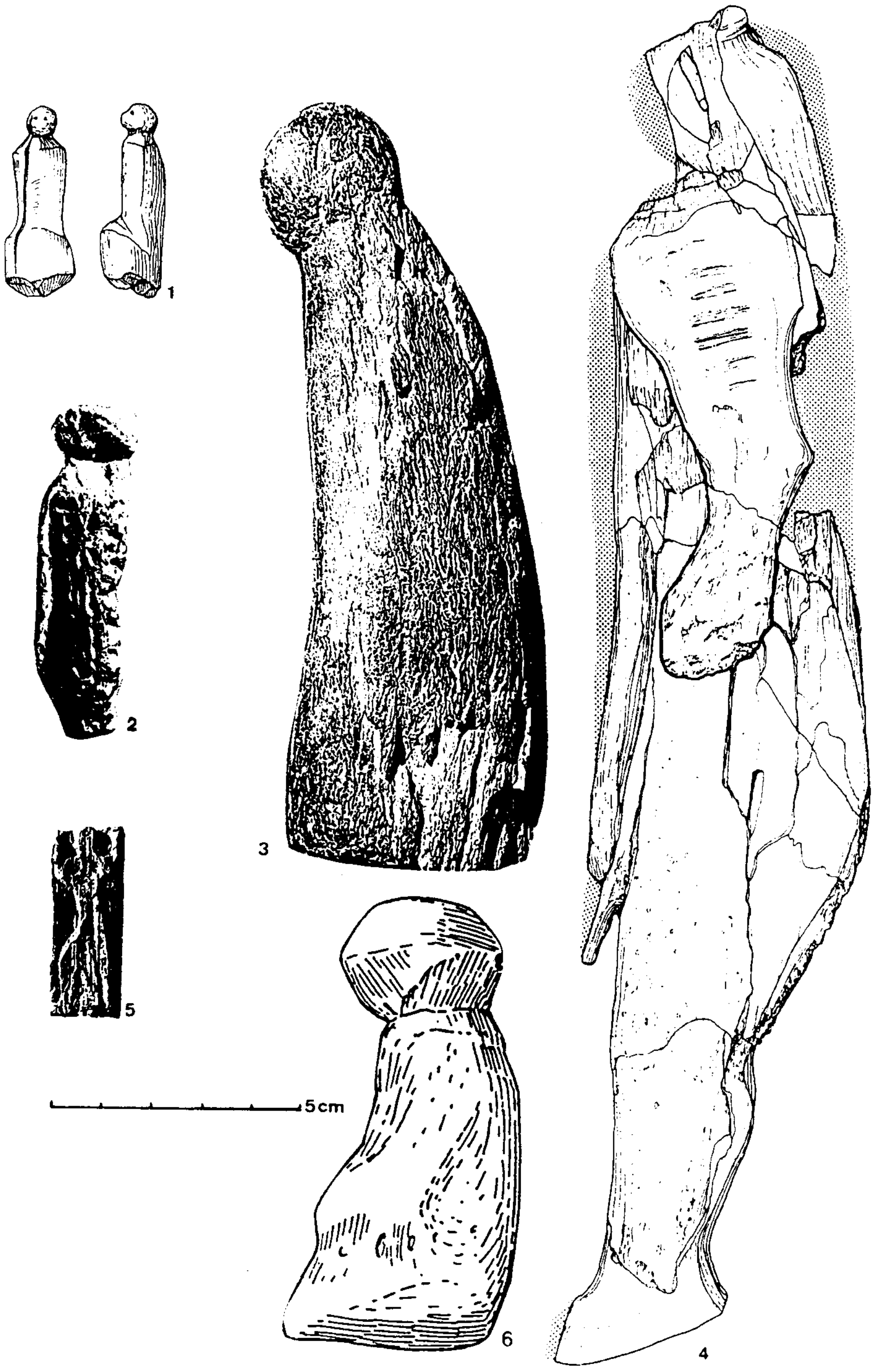


Figure 12.5. Aurignacien. 1 : Trou Magrite : statuette anthropomorphe en ivoire. 2 : Vogelherd (Bade - Wurtemberg) : statuette cylindrique anthropomorphe en ivoire. 3 : Abri Blanchard (Dordogne) : phallus sculpté dans la cheville osseuse d'une corne de bovin. 4 : Hohlenstein - Stadel (Bade-Wurtemberg) : statuette anthropomorphe à tête de lionne. 5 : Geissenklösterle (Bade-Wurtemberg) : plaquette en ivoire ornée d'une représentation humaine. 6 : Predmost (Moravie) : figurine sur métacarpien de mammouth (Gravettien) (1 : d'après M. Otte, 1979, 2, 4 et 5 : d'après G. Bosinski, 1982, 6 : d'après H. Delporte, 1979).

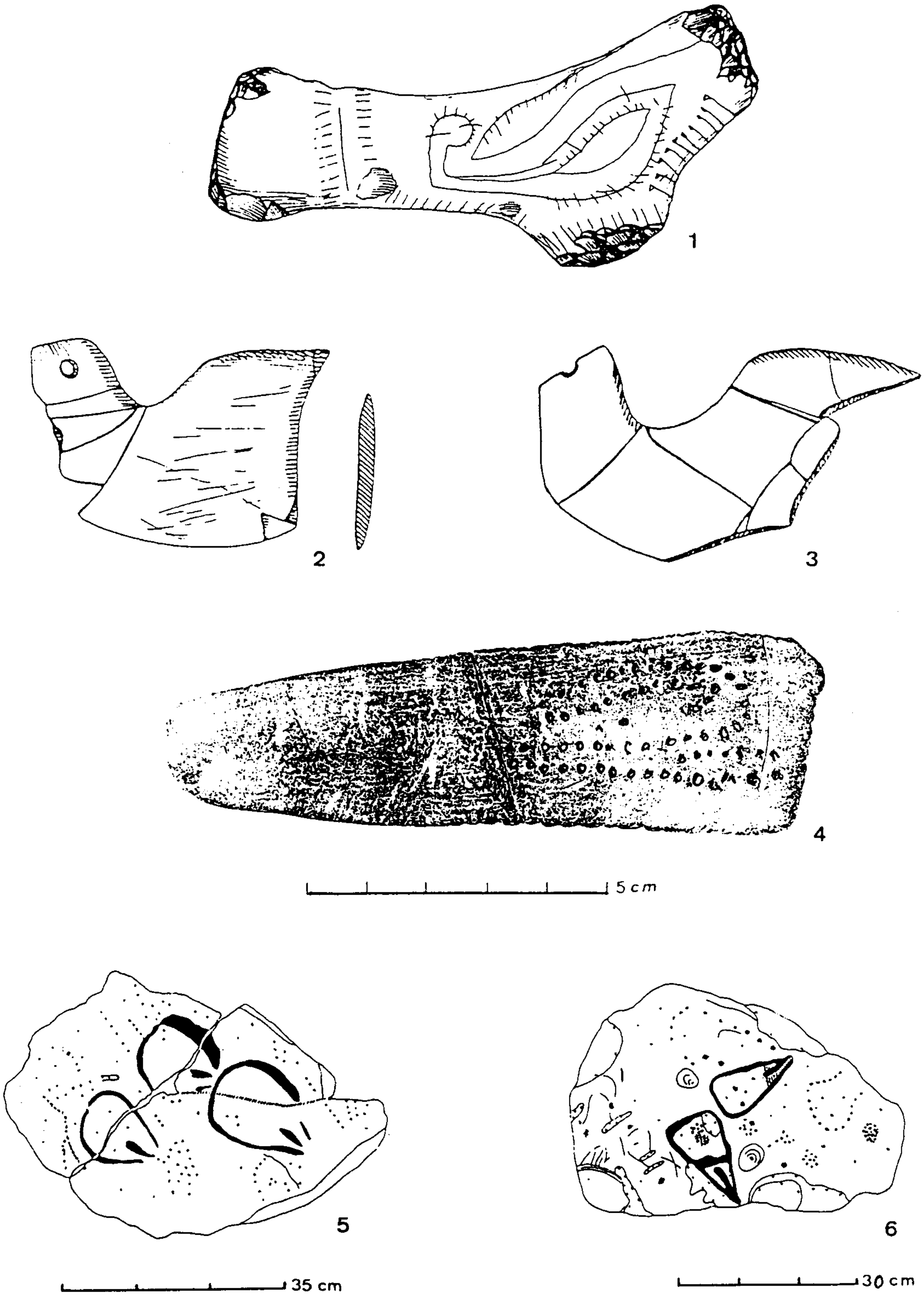


Figure 12.6. Aurignacien. 1. Trou Magrite : bois de renne découpé et gravé de motifs abstraits. 2 et 3 : Spy, grotte de la Betche-aux-Rotches : pendeloques ocrées en ivoire en forme "d'oreilles". 4 : Abri Blanchard : plaquette osseuse façonnée et gravée d'un motif serpentiforme de ponctuations. 5 : Abri Blanchard (Dordogne) : bloc rocheux gravé d'images vulvaires. 6 : La Ferrassie (Dordogne) : bloc rocheux gravé d'images vulvaires (1, 2 et 3 : d'après M. Otte, 1979; 4, 5 et 6 : d'après B. et G. Delluc, 1978).

l'attribution qu'en a donnée H. Delporte (1962, p. 54) nous considérons que la statuette du Trou Magrite dois se placer *probablement* elle aussi dans le Périgordien supérieur" (Otte, 1979, p. 164). Dans ses conclusions, il signale aussi "que la statuette, bien que participant à la tradition des représentations féminines du Périgordien supérieur d'Europe occidentale, se rapproche davantage par sa composition et son style des statuettes de Moravie, sans d'ailleurs que ces comparaisons soient tout à fait satisfaisantes (taillées dans une phalange, elles sont plus grossières et de plus grandes dimensions" (M. Otte, 1979, p. 622). Pour M. Dewez, ces comparaisons avec les figurines sur phalanges du Pavlovien de Predmost, seraient plutôt "un élément qui montre l'influence d'un concept aurignacien dans le Pavlovien" (Dewez, 1985, p. 128).

C'est donc sous le double aspect de représentation en trois dimensions et d'intérêt pour les représentations d'organes sexuels qu'il faut envisager les comparaisons proposées par M. Dewez avec la figurine anthropomorphe du Vogelherd ou avec la représentation phallique de l'abri Blanchard. En effet, des comparaisons stylistiques au sens strict ne sont pas entièrement convaincantes. Dans le premier cas, notre témoin ne possède pas de rétrécissement marquant une amorce de jambes et dans le second, bien que présentant une certaine allure phallique, il montre un élargissement très net au niveau des épaules.

Quant aux pièces osseuses décorées d'incisions rectilignes et aux pendeloques diverses, elles sont également très fréquentes à l'Aurignacien.

REFERENCES

ANGELROTH H., 1937,
Pointes de type de la Font-Robert découvertes en Belgique, *Bull. Soc. roy. belge Anthrop. Préhist.*, 52, p. 141-159.

BREUIL H., 1907,
La question aurignacienne, *Rev. Préhist.*, 6-7, p. 173-219.

BREUIL H. et SAINT-PERIER de R., 1927,
Les poissons, les batraciens et les reptiles dans l'art quaternaire. Archives de l'Institut de Paléontologie Humaine, 2, Paris.

BOSINSKI G., 1982,
Die Kunst der Eiszeit in Deutschland und in der Schweiz, Bonn.

DELLUC B. et G., 1978,
Les manifestations graphiques aurignaciennes sur support rocheux des environs des Eyzies, *Gallia Préhistoire,* 21 (1), p. 213-332 et 21 (2), p. 333-438.

DELPORTE H., 1979,
L'image de la femme dans l'art préhistorique, Paris.

DEWEZ M., 1985,
L'art mobilier paléolithique du Trou Magrite dans son contexte stratigraphique. *Bull. soc. roy. belge d'anthropologie et de préhistoire,* 96, p. 117-133.

DUPONT E., 1867a,
Découverte d'objets gravés et sculptés dans le Trou Magrite à Pont-à-Lesse, *Bull. Acad. roy. Sci., Lettres et Beaux-Arts Belgique,* 2e série., 24, p. 129-132.

DUPONT E., 1867b,
Etude sur cinq cavernes explorées dans la vallée de la Lesse et le ravin de Falmignoul pendant l'été de 1866. *Bull. Acad. roy. Sci., Lettres et Beaux-Arts Belgique,* 2e sér., 23, p. 244-265.

DUPONT E., 1872a,
Les temps préhistoriques en Belgique. L'homme pendant les âges de la pierre dans les environs de Dinant-sur-Meuse, Bruxelles, 2e éd.

DUPONT E., 1872b,
Classement des âges de la pierre en Belgique. *Congr. intern. Anthrop. Archéol. préhist.* , 6e Session, Bruxelles, p. 459-469.

HAHN J., 1972,
Aurignacian signs, pendants and arts objects in Central and Eastern Europe. *World Archaeology,* 3, p. 252-266.

JANSSENS P., 1970,
Palaeopathology, Diseases and injuries of prehistoric man, Londres.

LEJEUNE M., 1987,
L'art mobilier paléolithique et mésolithique en Belgique, Artefacts 4, Treignes-Viroinval.

LEROI-GOURHAN A., 1965,
Préhistoire de l'art occidental, Paris.

NOIRET P., OTTE M., STRAUS L.-G., LEOTARD J.-M., MARTINEZ A., ANCION V., NEWMAN M., LACROIX Ph., GAUTIER A., CORDY J.-M. et HAESAERTS P., 1994,

Recherches paléolithiques et mésolithiques en Belgique, 1993 : Le Trou Magrite, Huccorgne et l'Abri du Pape", *Notae Praehistoricae,* 13, p. 45-62.

OTTE M., 1979,

Le Paléolithique supérieur ancien en Belgique, Bruxelles.

ROUSSOT A., 1994,

L'art préhistorique, Bordeaux.

RUTOT A., 1903,

Le Préhistorique dans l'Europe Centrale. Coup d'oeil sur l'état des connaissances relatives aux industries de la pierre en 1903, à l'exclusion du Néolithique, *F.A.H.B.*, 17, Dinant, p. 3-255.

SACCASYN-della-SANTA E., 1946,

La Belgique Préhistorique, Bruxelles.

TWIESSELMANN F., 1951,

Les représentations de l'homme et des animaux quaternaires découvertes en Belgique, Mémoire n°113, Inst. Roy. des Sciences Naturelles de Belgique, Bruxelles.

M. OTTE et L.G. STRAUS (dir.), *Le Trou Magrite. Fouilles 1991-1992*. Liège, E.R.A.U.L. 69, 1995.

13

CONCLUSIONS ET RESUME

Marcel OTTE et Lawrence G. STRAUS

I. CHRONOSTRATIGRAPHIE

A. La séquence représentée dans les fouilles récentes au Trou Magrite couvre les stades isotopiques 3, 4 et 5. Cependant, les données sédimentaires, chronologiques et fauniques y indiquent d'importants hiatus. Par exemple, une coupure s'observe entre les couches archéologiques du Moustérien récent (n°4 de notre séquence) et de l'Aurignacien ancien (n°3).

B. Bien que limitée spatialement, cette fouille manifeste une grande variété dans les processus sédimentaires représentés sur la terrasse. Selon les dépôts, on observe en effet des agents de nature alluviale, colluviale, éolienne, cryoclastique et anthropique.

C. Datation

1. D'après l'étude micro-faunique (J.-M. Cordy, ce volume) et par comparaison avec la séquence de Sclayn, la partie médiane et supérieure de la couche 5 peut être attribuée à la phase dite de Melisey II, soit au stade isotopique 5b, situé vers 90.000 ans.

2. Datations C14

a) Les datations "récentes" des couches 2 et 3 semblent dues soit à la percolation de petits fragments de charbons de bois (dates OXA), soit à la très mauvaise conservation des protéines dans la majorité des ossements (dates GX et CAMS). Seules les dates vieilles sont, en principe, les plus fiables.

b) Les dates anciennes obtenues pour la couche 3 semblent les meilleures: 41.000 ± 1700 B.P. et plus de 34.000 B.P. Elles furent en effet réalisées sur des ossements dont les protéines étaient très bien conservées. Nous proposons donc un âge probable d'environ 38.000 ans B.P. Cette estimation est comparable à celles obtenues dans de nombreux autres ensembles aurignaciens à travers l'Europe : Romaní Reclau Viver, l'Arbreda et El Castillo en Espagne, Willendorf en Autriche, Istallosko en Hongrie, Geissenklösterle en Allemagne.

c) L'ancienneté des dates obtenues pour la couche 2 tend à confirmer l'option choisie pour celles de la couche 3. Elles se situent entre 30 et 34 mille ans B.P. Cette fourchette chronologique s'accorde avec les résultats obtenus pour d'autres séquences aurignaciennes réparties à travers l'Europe : Willendorf, Bacho Kiro, Trou Walou, Cueva Morín, Abri Pataud, La Ferrassie, Le Flageolet, Les Cottés, Istallosko, Lommersum, Geissenklösterle, Mitoc (voir tableaux, pl. 13.1 à 13.3).

II. TAPHONOMIE

Selon les unités stratigraphiques, divers agents semblent être intervenus dans la formation des dépôts.

a) L'influence des ours des cavernes et des carnivores apparaît relativement importante, particulièrement à la base de la séquence.

b) Les oiseaux rapaces, probablement les hiboux, ont joué également un rôle non négligeable, surtout marqué dans la partie supérieure de la couche 5.

c) Les plus importants apports sont toutefois liés à l'activité humaine, surtout dans les couches aurignaciennes. Ils sont toutefois toujours liés à des vestiges d'origine naturelle tels que ceux dus à l'ours ou aux carnivores. Les apports anthropiques semblent moins importants à l'entrée de la grotte durant le Moustérien par rapport à ceux d'origine animale.

III. INDUSTRIES

A. Matières premières lithiques

1) L'usage du calcaire, strictement local, se retrouve dans chaque couche, contrairement à ce qui fut observé précédemment. Son emploi est toutefois nettement plus important dans les ensembles moustériens et, dans une moindre mesure, dans l'Aurignacien ancien.

2) On observe l'augmentation du silex d'origine extérieure (probablement du Hainaut) au cours de l'évolution stratigraphique; il est particulièrement important dans l'Aurignacien récent.

3) Ce silex exogène est surtout employé pour la réalisation d'outils et de lames.

4) Par opposition au calcaire, le silex est principalement réservé pour la fabrication de petits outils.

B. Chaînes opératoires

1) On constate la production locale d'outils en calcaire dont toutes les phases techniques sont représentées. Il s'agit d'outils de fortune, non stéréotypés, limités au façonnement d'un bord tranchant.

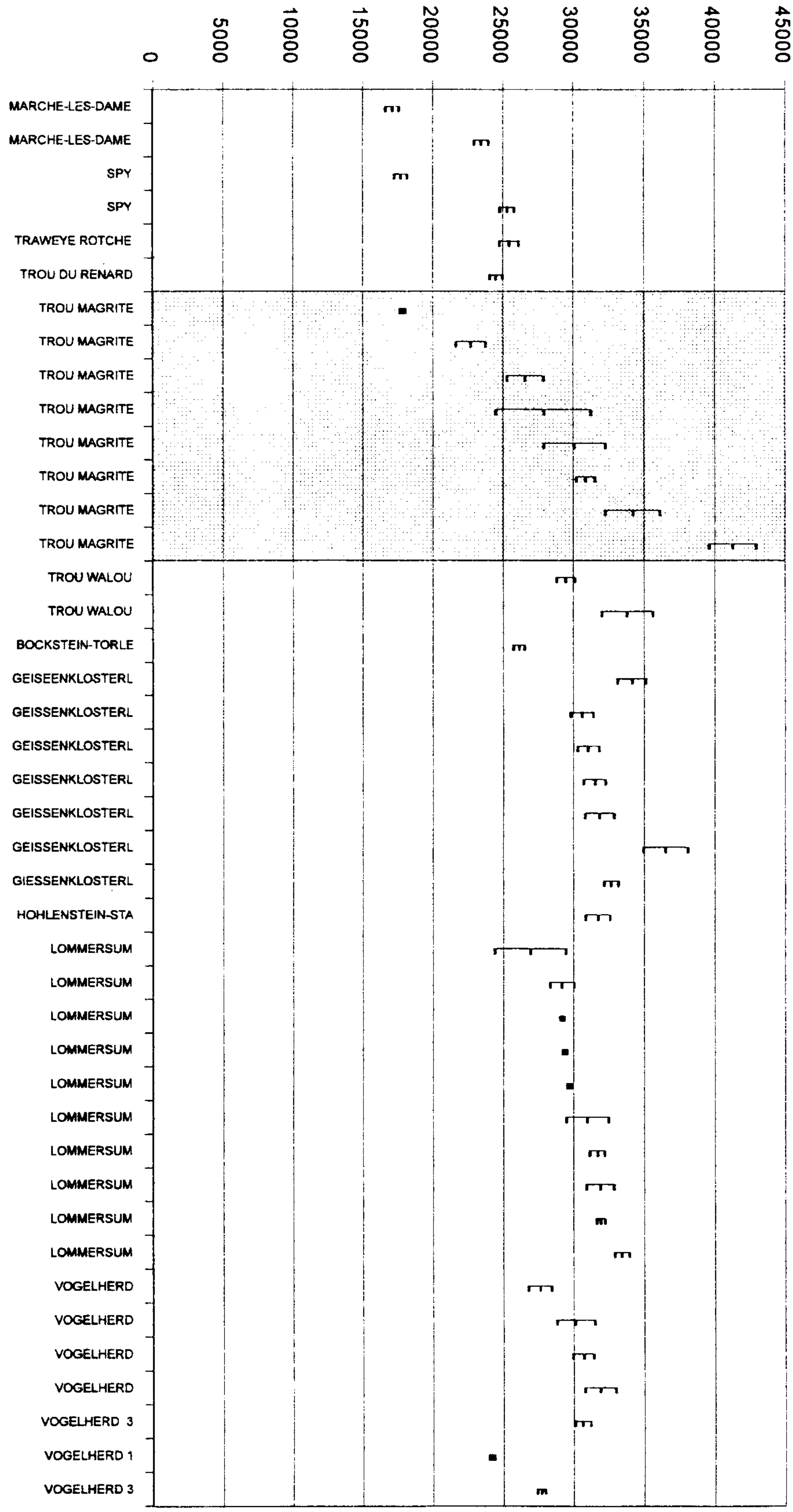


TABLEAU 13.1.
Datations non calibrées du Trou Magrite (en grisé) comparées à l'Aurignacien belge et allemand.

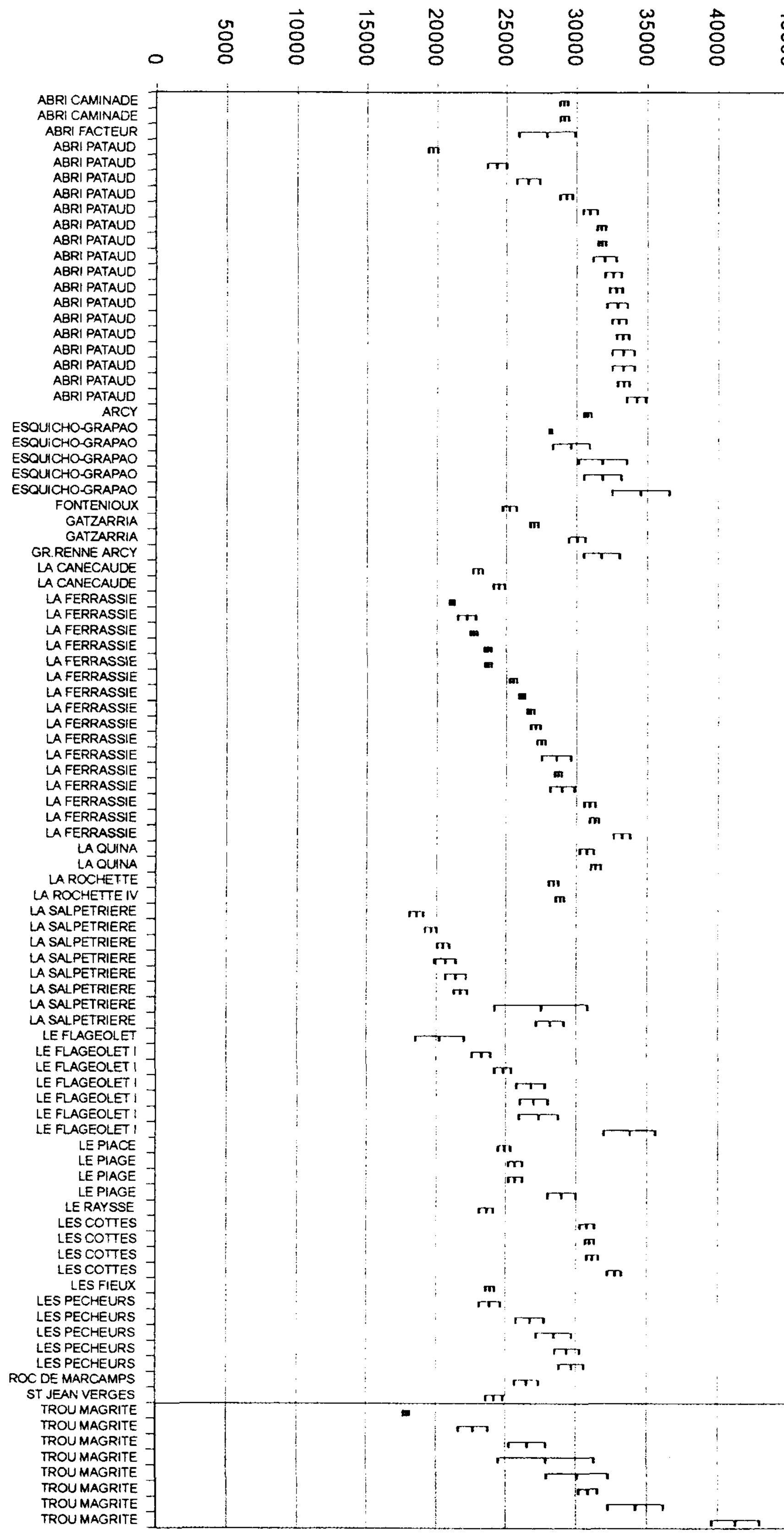


TABLEAU 13.2
Datations non calibrées du Trou Magrite (en grisé) comparées à l'Aurignacien français

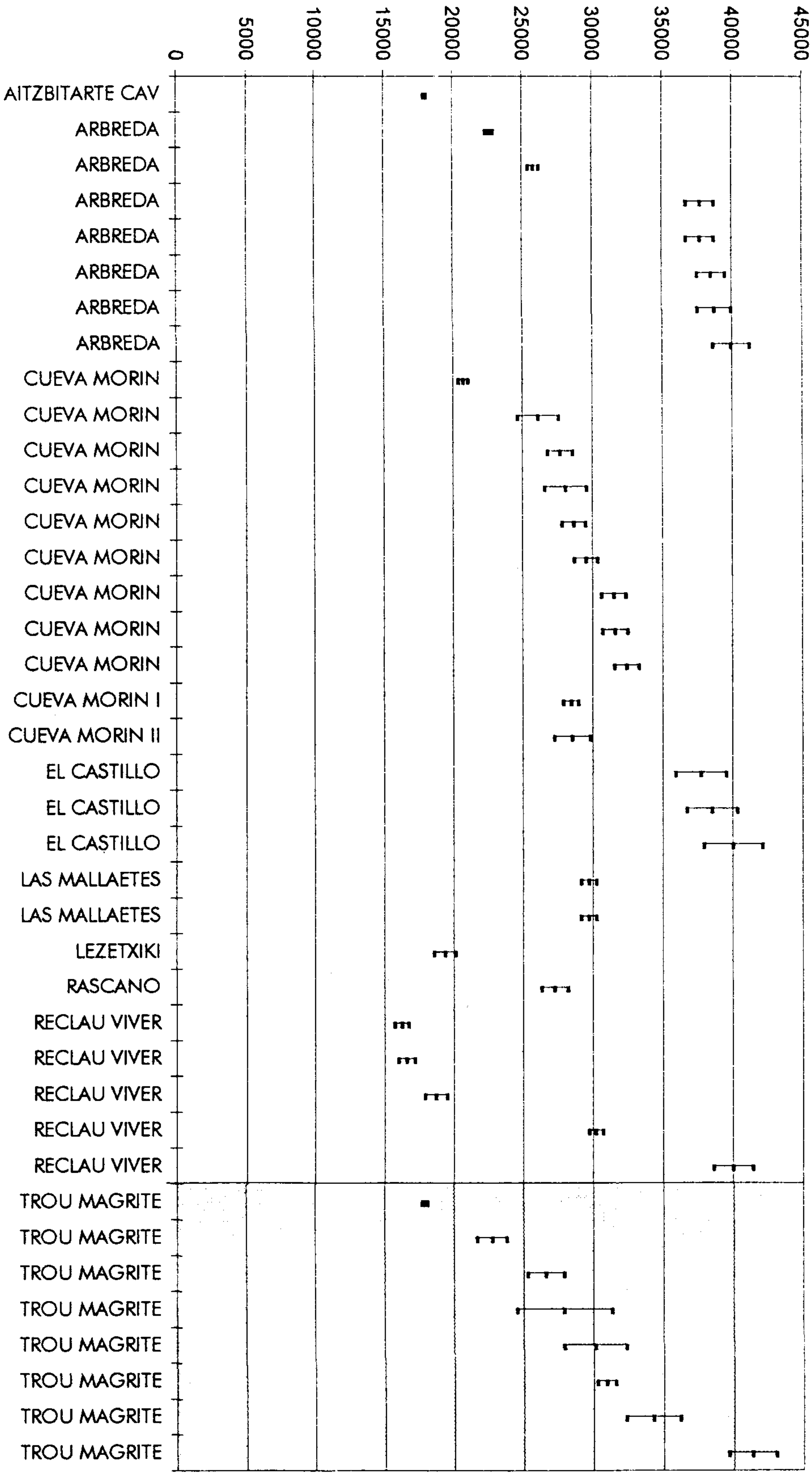


TABLEAU 13.3.
Datations non calibrées du Trou Magrite (en grisé) comparées à l'Aurignacien espagnol

2) Le silex de bonne qualité et exogène (60 à 70 km) est importé toujours davantage sous forme de supports débités. Les rares nucléus en silex retrouvés sont de très petites dimensions et épuisés. Les plages corticales sont rares sur ce matériau bien que les autres éléments de débitage soient représentés : éclats, esquilles et lames. Le silex est donc apporté au site sous une forme déjà élaborée et postérieure au débitage.

C. Malgré les analogies typologiques entretenues entre les deux couches aurignaciennes (3 et 2), de profondes différences les séparent quant à la technique et à l'emploi des matières premières. Les mêmes différences s'observent entre les ensembles moustériens (4 et 5) et l'Aurignacien récent (2). De la même manière, les décomptes typologiques issus de nos fouilles se distinguent de ceux fondés sur les collections d'Ed. Dupont. Cette discordance s'explique peut-être par une localisation des activités sur la surface d'occupation de la grotte. Dans la séquence aurignacienne, la typologie des deux couches (2 et 3) reste semblable tandis que le cortège des matériaux employés diffère en même temps que les lames sont plus utilisées comme supports en couche 2 qu'en couche 3. La signification de ces différences sera testée quant à son rapport à la saisonnalité.

D. Malgré l'excellente conservation des restes animaux, on constate la carence de l'outillage réalisé en matières osseuses, à nouveau à l'inverse des observations d'Ed. Dupont (1867, 1872).

E. Dans la zone que nous avons fouillée, on observe une abondance de grattoirs et de pièces à retouches continues compensée par une carence des burins.

IV. SUBSISTANCE

A. Les données quant aux ressources alimentaires au Moustérien sont très limitées. Par ailleurs, certains restes animaux semblent d'origine naturelle soit parce que ces espèces ont vécu dans la grotte, soit parce que leurs vestiges s'y sont précipités peut-être du sommet du plateau par la cheminée au fond de la grotte (os de mammouths ou de rhinocéros laineux).

B. A l'Aurignacien, la chasse est surtout orientée vers le renne et le cheval et, secondairement, vers le bouquetin. Les rennes sont représentées par tous les éléments du squelette, indiquant une prédation à proximité.

Le cheval au contraire n'est représenté que par certains fragments et a fait l'objet de partages peut-être liés à l'éloignement de son lieu d'abattage.

C. L'étude de la saisonnalité indique une occupation surtout durant la saison froide, autant pour la couche 2 que pour la couche 3.

V. NATURE DES OCCUPATIONS

Pour le Moustérien, les données disponibles tendent à indiquer la répétition de visites éphémères.

Au cours de l'Aurignacien, par contre, il s'agirait d'occupations plus durables et plus importantes, apparemment hivernales. La disposition topographique du Trou Magrite, favorisant l'insolation et la protection des vents, a permis ces occupations hivernales, même durant les phases rigoureuses du stade 3. Ceci explique peut-être, parmi d'autres facteurs, l'existence d'une résidence à plus long terme qu'au Moustérien et par une population plus large. De plus, si on compare les inventaires publiés par Ed. Dupont à ceux issus des fouilles récentes, il semble se dessiner une organisation spatiale régissant les activités variées menées par ces groupes. Puisque, apparemment, une seule partie du cycle saisonnier y est représentée, on peut reconstituer un cycle plus général dans lequel prendraient place par exemple les visites aux gîtes d'approvisionnement en matériaux lithiques tels que la région de Mons en Hainaut.

VI. IMPLICATIONS ARTISTIQUES

Les deux œuvres majeures découvertes par Ed. Dupont au Trou Magrite ont été classiquement attribuées au Gravettien ou "Périgordien supérieur" attesté au site en abondance (H. Delporte, 1979; D. de Sonneville-Bordes, 1961; M. Otte, 1979). La proposition émise par M. Dewez (1985) et fondée sur une interprétation des observations faites par Dupont, avait déjà sérieusement mis en doute cette assertion. Par ailleurs, autant les comparaisons stylistiques de la statuette (Vogelherd, Abri Blanchard) qu'iconographiques sur le bois de renne gravé (La Ferrassie, Abri Cellier) soutiennent une attribution de ces deux pièces à l'Aurignacien.

La stratigraphie, assortie des nouvelles datations issues de nos propres fouilles, permet, dans cette hypothèse, de situer la phase ancienne de l'Aurignacien (notre couche 3 et la couche 3 de Dewez) à laquelle ces deux pièces figurées appartiendraient. En effet, si l'on peut établir une équivalence entre les deux niveaux aurignaciens de Dupont (suivant la logique de M. Dewez) et les deux observés dans nos fouilles, ces deux objets "artistiques" sont alors datés de bien plus de trente mille ans. Ceci s'aligne avec cohérence sur les dates proposées ou obtenues pour les créations mobilières analogues du Jura Souabe (J. Hahn, 1986; G. Bosinski, 1982). Le "Trou Magrite" vient alors complèter une succession géographique de manifestations plastiques à la fois très novatrices et destinées à se poursuivre dans tout l'art quaternaire occidental (M. Otte, 1990).

VII. COMPARAISONS EUROPEENNES

Dans ce chapitre, nous nous limiterons à cette partie de l'Europe concernée par nos travaux en renvoyant aux synthèses et monographies plus générales éditées par ailleurs (J. Hahn, 1977; J.K. Kozlowski, 1993; J.K. Kozlowski et M. Otte, 1994). A plusieurs reprises, l'un d'entre nous a tenté d'établir la ventilation en trois phases de l'Aurignacien belge (M. Otte, 1976, 1979). Ces trois groupes se distinguent d'abord au titre de "faciès", soit d'aspects technique et typologique assortis de facteurs économiques et esthétiques (pendeloques, armes, environnements). Plusieurs datations C14 sont venues récemment supporter l'interprétation chronologique d'une telle subdivision (M. Dewez, 1992; M. Toussaint, 1986; M. Otte, 1991 et 1993). Les deux phases aurignaciennes représentées au Trou Magrite s'inscriraient donc assez naturellement dans la phase ancienne (Spy, Goyet) et moyenne (Marche-les-Dames) de cette division tripartite dont elles précisent ainsi indirectement l'extension chronologique.

Situé dans le contexte nord-occidental, le faciès "ancien" trouve de nettes comparaisons autant en Rhénanie (Wildscheuer, J. Hahn, 1977) qu'en Angleterre (Kent's Cavern, R. Jacobi, 1980). La "masse continentale", alors formée par la dessication de la Mer du Nord, de la Manche et d'une partie de l'Atlantique, constituait donc durant le pléniglaciaire une sorte de "province" aurignacienne à la limite de l'extension ethno-culturelle du groupe, quelqu'en soit le sens. En position centrale dans ce tableau et ce scénario expansif, le Trou Magrite donne très simplement une clef à cette compréhension dont il enrichit le sens. Les sites anglais sont en effet extrêmement altérés par le second pléniglaciaire. La Rhénanie n'a pas fourni de sites majeurs (malgré l'excellence de leur étude). Et dans le nord de la France, complétant la partie continentale, les sites sont réduits à l'état de traces en l'absence d'abris naturels (J.P. Fagnart, 1993).

REFERENCES

BOSINSKI G., 1992,
Die Kunst der Eiszeit in Deutschland und inder Schweiz, Bonn.

DELPORTE H., 1979,
L'image de la femme dans l'art préhistorique, Paris, Picard.

DEWEZ M., 1985,
L'art mobilier paléolithique du Trou Magrite dans son contexte stratigraphique dans *Bulletin de la Société Royale Belge d'Anthropologie et de Préhistoire*, 96, Bruxelles, p. 117-133.

DEWEZ M., 1992,
La grotte Walou à Trooz (Province de Liège, Belgique), présentation du site, dans *Cinq millions d'années, l'aventure humaine*, Liège, E.R.A.U.L. 56, p. 311-318.

DUPONT E., 1867,

Découverte d'objets gravés et sculptés dans le Trou Magrite à Pont-à-Lesse dans *Bulletin Académie Royale des Sciences, des Lettres et des Beaux-Arts de Belgique*, 36, 2e session, tome XXIV, p. 129-132.

DUPONT E., 1872,

Classement des âges de la pierre en Belgique, C.I.A.P., 6e session, Bruxelles, 462 p. et pl. 42-44.

FAGNART J.P., 1993,

Le Paléolithique Supérieur récent et final du Nord de la France dans son cadre Paléoclimatique, tome II, 567 p.

HAHN J., 1977,

Aurignacien das Ältere Jungpaläolithikum in Mittel-und Osteuropa, Köln Wien, 355 p.

HAHN J., 1986,

Kraft und Aggression, Tübingen.

JACOBI R.M., 1980,

The Upper Palaeolithic of Britain with special reference to Wales, dans *Culture and Environment in Prehistoric Wales, Select Essays*, BAR Bristish Series 79, 99 p.

KOZLOWSKI J., 1993,

L'Aurignacien en Europe et au Proche Orient, Actes du XIIe Congrès International des Sciences Préhistoriques et Protohistoriques, tome 2, Bratislava, p. 283-290.

KOZLOWSKI J. et OTTE M., 1994,

Il Paleolitica superiore in Europa, dans *Storia d'Europa, vol II : Preistoria e antichita*, Einaudi, p. 29-102.

OTTE M., 1976,

L'occupation Aurignacienne du Trou du Renard (Furfooz), dans *Bull. soc.roy.belge Anthropologie Préhistorique*, tome 87, p. 117-139.

OTTE M., 1979,

Le Paléolithique Supérieur ancien en Belgique, Monographies d'Archéologie Nationale 5. Musées Royaux d'Art et d'Histoire, Bruxelles, 684 p.

OTTE M., 1990,
Relations transculturelles et transrégionales dans l'art mobilier, dans *L'art des objets au Paléolithique* (actes du colloque de Foix-Le-Mas d'Azil, novembre 1987), p. 185-194.

OTTE M., 1991,
Paléolithique Supérieur de Belgique, Rapport d'Activités : 1986-1991 dans *Le Paléolithique Supérieur Européen. Bilan Quinquennal,* Bratislava, p. 99-108.

OTTE M., 1993,
L'Aurignacien au Nord-Ouest de l'Europe, dans *Aurignacien en Europe et au Proche Orient,* Actes du XII^{e} Congrès International des Sciences Préhistoriques et Protohistoriques, tome 2, Bratislava, p. 187 à 192.

SONNEVILLE-BORDES D. de, 1961,
Le Paléolithique supérieur en Belgique, *L'Anthropologie,* t. 65, p. 421-443.

TOUSSAINT M., BONE E., GILOT E., HEIM J., LAWARREE G., SABLON R., VAN GOETHEM J.L., 1986,
Paléoenvironnement du Paléolithique Supérieur ancien de la caverne de la Traweye Rotche à Sprimont (Province de Liège), dans *Bulletin de la Société Royale Belge d'Anthropologie et de Préhistoire,* 97, 132 p.

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I. ERAUL

N°12 P. HOFFSUMMER, Etude archéologique et historique du château de Franchimont à Theux, 1982, 106 p., 62 fig., 2 dépliants. (B: 400 FB - E: 500 FB).

N°13 M. OTTE (édit.), Actes des réunions de la Xe Commission "Aurignacien et Gravettien" U.I.S.P.P., (1976-1981), 1982, vol. 1, 321 p. (B: 430 FB - E : 600 FB), **vol. 2, 378 p. (B: 430FB - E: 600FB, épuisé) et vol. 3: 83 p. (B : 230 FB - E : 300 FB).**

N°15 M. OTTE (édit.), Rapport préliminaire sur les fouilles effectuées sur la Grand-Place à Sclayn en 1982-1983, 54 p., 21 pl., (B: 280 FB - E: 350 FB).

N°16 A. HAUZEUR, La Préhistoire dans le Bassin de la Berwine, 1983, 43 p., 23 pl., 1 tabl. (B: 230 FB - E: 300 FB).

N°17 J.-M. DEGBOMONT, Le chauffage par hypocauste dans l'habitat privé. De la place Saint-Lambert à Liège à l'Aula Palatina de Trèves, 1984, 240 p., 330 fig., 4 hors -texte (B: 850 FB - E: 950 FB). Réédition.

N°18 M. OTTE (dir.), Les fouilles de la place Saint-Lambert, I, 1984, 323 p., 186 fig., 10 hors-texte (B: 950 FB - E: 1.150 FB).

N°19 L. MOLITOR, Le groupe de Blicquy, 1984, 60 p., 13 pl. (*B: 230 FB - E : 300 FB).

N° 20 P. VAN OSSEL et J.-P. LENSEN, Le Pré Wigy à Herstal - Recherches sur l'occupation humaine d'un site mosan, 1984 (B: 330 FB - E: 400 FB).

N°21 D. CAHEN, J.-P. CASPAR, M. OTTE, Industries lithiques danubiennes de Belgique, 1986, 89 p. 14 tabl., 38 fig. (B: 350 FB - E: 450 FB).

N°22 M. OTTE et J. WILLEMS (édit.), La civilisation mérovingienne dans le bassin mosan, 1986, 300 p., fig. et pl. (B: 850 FB - E: 950 FB).

N°23 M. OTTE (dir.), Les fouilles de la Place Saint Lambert à Liège, II, Le Vieux Marché, 1988, 254 p., 150 fig. (B: 850 FB - E: 950 FB).

N° 24 M. OTTE (dir.). Le paléolithique supérieur européen, bilan quinquennal 1981-1986.

N°25 M. OTTE (ed.), De la Loire à l'Oder, actes du colloque "Les civilisations du paléolithique final en Europe du nord-ouest", 1985, 2 vols. (B: 3.000 FB - E: 3.200 FB).

N°26 Fr. VERHAEGHE et M. OTTE (ed.), L'archéologie des Temps Modernes, actes du colloque, 1985, 367 p. (B: 950 FB - E: 1.050 FB).

N°27 M. OTTE (dir.) Recherches aux grottes de Sclayn, vol. 1, Le contexte, 1992, 178 p. (B: 1400 FB -E : 1500 FB).

N°28 M. OTTE et H.P. SCHWARCZ (ed.) - L'homme de Néandertal, Centenaire de la découverte de l'Homme de Spy, Actes du Colloque international, 1986, vol. 1, LA CHRONOLOGIE, 141 p. (B: 900 FB - E: 950 FB).

N°29 M. OTTE et H. LAVILLE (ed.) - L'Homme de Néandertal, vol. 2, L'ENVIRONNEMENT, 1988, 222 p., 45 ill. (B: 1.100 FB - E: 1.150 FB).

N°30 M. OTTE et TRINKAUS E. (ed.) - L'Homme de Néandertal, vol. 3, L'ANATOMIE, Liège, 1988, 144 p., 25 ill. (B: 900 FB - E: 950 FB).

N°31 M. OTTE, L. BINFORD et J.-Ph. RIGAUD (ed.) - L'Homme de Néandertal, vol. 4, LA TECHNIQUE, 1988, 217 p., 105 ill. (B: 1050 FB - E: 1100 FB).

N°32 M. OTTE et BAR-YOSEF O. (ed.) - L'Homme de Néandertal, vol. 5, LA PENSEE, 1988, 124 p., 40 ill. (B: 900 FB - E: 950 FB).

N°33 M. OTTE, M. PATOU et L.G. FREEMAN (ed.)- L'Homme de Néandertal, vol. 6, LA SUBSISTANCE, 1989, 178 p., 50 ill. (B: 950 FB - E: 1.000 FB).

N°34 M. OTTE et B. VANDERMEERSCH (ed.) - L'Homme de Néandertal, vol. 7, L'EXTINCTION, 1989, 129 p., 40 ill. (B: 1.000 FB - E: 1.050 FB).

N°35 M. OTTE et J. KOZLOWSKI (ed.) - L'Homme de Néandertal, vol. 8, LA MUTATION, 1988, 288 p., 125 ill. (B: 1.150 FB - E: 1.200 FB).

N°36 M. ULRIX-CLOSSET et M. OTTE (éd.), "La civilisation de Hallstatt", Actes du colloque international 22-24 novembre 1987, 1989, 367 p.(B: 1.100 FB - E: 1.200 FB).

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