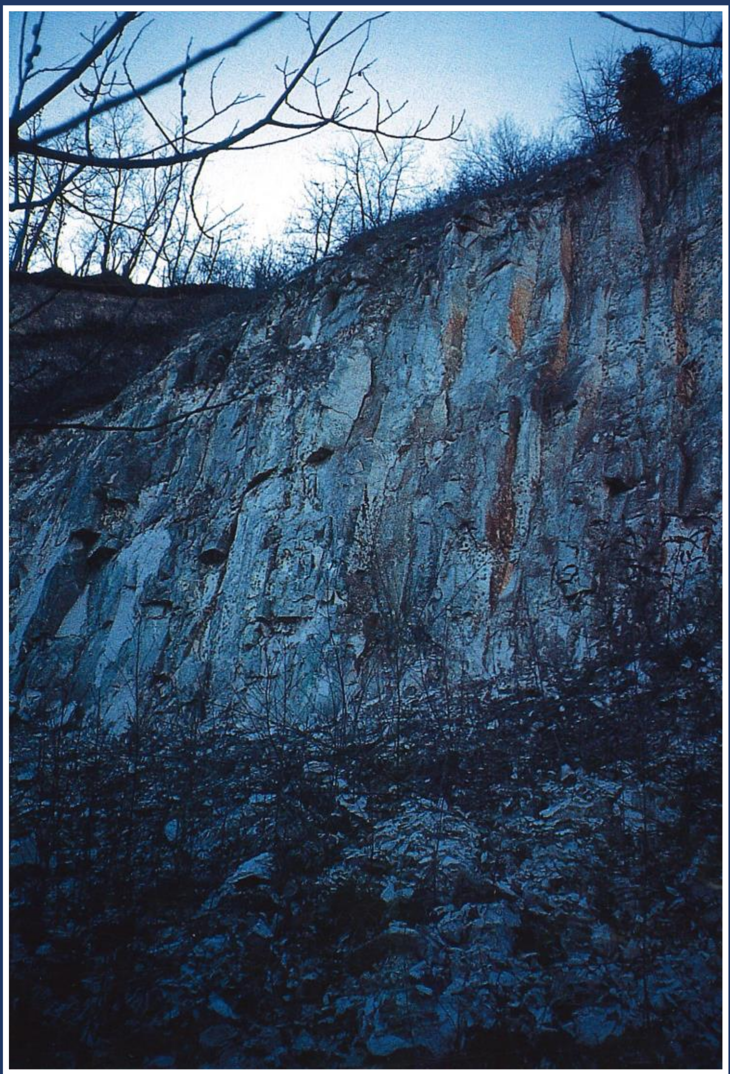
LITHIC RESOURCE MANAGEMENT DURING THE BELGIAN EARLY UPPER PALEOLITHIC

Effects of Variable Raw Material Context on Lithic Economy

REBECCA MILLER



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ÉTUDES ET RECHERCHES ARCHÉOLOGIQUES DE L'UNIVERSITÉ DE LIÈGE

LITHIC RESOURCE MANAGEMENT DURING THE BELGIAN EARLY UPPER PALEOLITHIC: EFFECTS OF VARIABLE RAW MATERIAL CONTEXT ON LITHIC ECONOMY

GESTION DES RESSOURCES LITHIQUES PENDANT LE PALÉOLITHIQUE SUPÉRIEUR ANCIEN EN BELGIQUE: EFFETS DES CONTEXTES VARIABLES DES MATIÈRES PREMIÈRES SUR L'ÉCONOMIE LITHIQUE

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avec l'aide de la Direction de l'Archéologie de la Région wallonne
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DEDICATION

To my parents, Patrick and Diane Miller, with love

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I was first introduced to Belgium and the Belgian Paleolithic by my participation in the South Belgium Paleolithic Project, thanks to the opportunity offered by Dr. Straus, and my interest in the subject of my dissertation was strongly influenced by the nature of the archaeological record in this region. Following the termination of my Fulbright fellowship in 1997, I was (and am) able to continue working in Belgium thanks to the support of Pr. Otte, who has engaged me as a researcher in the Service de Préhistoire. With his support, I was able to continue working on my dissertation and participate in ongoing research projects of the Université de Liège.

Several sources of funding made it possible to undertake this research in Belgium. First, the South Belgium Paleolithic Project, a five-year project on the Upper Paleolithic and Mesolithic in Belgium directed by Drs. Straus and Otte, was funded by the National Science Foundation, the National Geographic Society and the L.S.B. Leakey Foundation (Straus) and the Communauté française and the Région wallonne of Belgium (Otte).

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Finally, I would like to thank my parents, Pat and Diane Miller, my brothers and sisters, Amy, Dan and Nick, and my friends, Seema Chandnani and Cheryl Signore, for supporting me during the many years of study and research.

Rebecca Miller
Liège, Belgium
June, 2001

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PREFACE

It is a pleasure to write these words of introduction to the book that Dr. Rebecca Miller has produced from her doctoral dissertation. An academic advisor always feels great satisfaction when his student successfully completes a dissertation. In the case of Becky Miller, I have the additional satisfaction of having followed her development as a professional prehistoric archaeologist first hand for many years and nearly from the beginning of her career. Becky came to us at the University of New Mexico from my *alma mater*, the University of Chicago, where she had obtained a Bachelors degree in Anthropology and a Masters in Education. A member of my field crew in Belgium almost from the start, Becky quickly "learned the trade" and became one of my most valued assistants, both in the excavations of le Trou Magrite, Huccorgne, l'Abri du Pape and Bois Laiterie and in the analyses and publication thereof. Becky stayed on in Belgium, hired as a research assistant by my good friend and colleague, Professor Marcel Otte, who made her an integral member of his dynamic research team at l'Université de Liège.

Dr. Miller's dissertation, which has been revised and converted into the present book, is the fruit of several long years of analysis and writing – not to mention considerable personal sacrifice. The key data used in this work (from le Trou Magrite and Huccorgne) are derived from the excavations of the South Belgium Prehistoric Project, co-directed by Otte and me and supported by various grants from American and Belgian institutions and agencies (U.S. National Science Foundation, National Geographic Society, L.S.B. Leakey Foundation, University of New Mexico, Université de Liège, Regional Government of Wallonia, Belgian Science Foundation). In addition, Dr. Miller analyzed collections from the modern excavations of the Institut royal des Sciences naturelles de Belgique at Maisières-Canal, from the recent but limited excavations of l'Université de Liège at Couvin, and from old excavations at a number of classic cave sites in Wallonia (Spy, Goyet, etc.). She also took good comparative advantage of the just-published lithic studies from the Mousterian site of Scladina Cave (Sclayn), whose ongoing excavations are directed by Dominique Bonjean under the overall supervision of Otte.

The subject of Dr. Miller's work goes to the heart of the debate over the behavioral differences and changes across the transition from the Middle to the Upper Paleolithic. The study of lithic economy (sources, procurement, transport, transformation, reuse, final discard) has already been shown to be of great importance in the unraveling of this complex problem (I refer especially to the work of Wil Roebroeks and colleagues in Leiden and of Jehanne Féblot-Augustins working under the direction of Catherine Perlès in Nanterre). Becky has applied this methodology (combining geological sourcing information with lithic reduction sequence analysis) in the context of an anthropological appreciation of hunter-gatherer mobility theory in order to use the Wallonian record as a case study of the evolution of human planning, scheduling and movements during the critical millennia that witnessed the "replacement" (or transformation) of the Neandertal form by the Cro-Magnon form of *Homo sapiens* in Western Europe.

The South Belgian case is an interesting one because of the geographical juxtaposition of an upland area (the Ardennes Massif) with caves and deep, sheltered valleys but no good flint adjacent to a lowland area (the loess-covered plains of Middle Belgium north of the Sambre-Meuse axis) without much shelter but with abundant sources of excellent Upper Cretaceous chalk flint. This fundamental, geologically determined regional structure conditioned the adaptive possibilities of humans who lived by foraging during the different interglacial or interstadial episodes of human occupation of this northerly region. Whether Mousterian Neandertals or Aurignacian, Gravettian or Magdalenian Cro-Magnons, humans could either use both areas in coordinated fashion, or separately, or just use one of them exclusively; What Miller found is that the organized transport of good-quality flint from the Hesbaye of Hainaut sources does not seem to have existed either in the Middle Paleolithic *or* in the earliest Aurignacian. This rational inter-regional system of procurement developed only later in the Aurignacian and continued in the Gravettian. Most interestingly, after the human abandonment of Belgium (and the rest of NW Europe) during the Last Glacial Maximum (between 24-13 kya), the human re-colonizers in Upper Magdalenian times re-learned how to integrate the flint, food and shelter resources of Wallonia by means of an organized system of mobility and transport (probably on a seasonal schedule: warm season on the plains; winter in the uplands, as hinted at by preliminary dental analyses). The fact that this system was developed *after* the typological transition from Mousterian to Aurignacian (at le Trou Magrite, some time before about 38-41,000 radiocarbon years ago) and possibly after the appearance of *Homo sapiens sapiens* suggests a significant degree of initial behavioral continuity between the two adaptations and a lack of strict connection between behavior and anatomy. Miller's work is one more piece of evidence that begs the deconstruction or decoupling of the diverse elements (e.g., technology, artifact typology, subsistence, symbolism, artistic activity, social organization, functional morphology) that, over many millennia, made up the processual mosaic of bio-cultural changes that constituted the so-called "Middle to Upper Paleolithic transition", so over-simplified and converted into a brief "punctuation event" by many paleoanthropologists. As I see it, these are some of the implications of Miller's work, but even if I am wrong, along the way she has compiled and synthesized a substantial body of data, elucidating fascinating patterns both within and among sites, and made a significant contribution to the prehistory of Belgium.

Miller has profited from the extensive experience and lithic comparative collections of Professor Pierre Vermeersch (and colleagues) at the Katholieke Universiteit Leuven and Dr. Marjorie De Grooth at the Bonnefanten Museum in Maastricht, as well as the long-term, firstahdn lithic characterization and sourcing knowledge of numerous fieldworkers (notably Jean-Marc Léotard, Eric Teheux and other members of the Liège team).Otte (along with Professor Paul Haesaerts of the IRSNB) has made it possible for Miller to reopen the classic early Gravettian site of Maisières-Canal. It is my hope that this new excavation will shed further light on the strategies employed by humans to survive in the worsening climatic conditions of early isotope stage 2 on the northern frontier of settlement in Western Europe. As her professor, advisor and now colleague, I wish to congratulate Dr. Rebecca Miller on a job well done!

Lawrence Guy Straus
Santander, Spain
June 15, 2001

PRÉFACE

Entreprenante et avide de connaissances, Rebecca Miller s'est très vite adaptée au "climat belge", bien qu'étant issue d'un monde lointain, par l'espace et par la pensée. Devenue "Becky", elle a infiltré tout notre savoir et, progressivement, y a largement contribué. Souffle d'énergie et de réflexion, elle nous a en plus offert son inaltérable sourire : elle est devenue belge, sans le savoir.

Aux limites des aires centrale et occidentale de l'Europe, le "Nord-Ouest" doit être assumé dans son abondance, sa diversité et sa brume. Plus que d'être riche, son Paléolithique y est varié, changeant, tenant autant au nord qu'au midi, et toujours intermédiaire. Il nous force à tout savoir et à remettre en place les dogmes opposés qui, souvent, règnent sur l'une ou l'autre littérature archéologique.

À la fois tenace comme l'Allemagne, brillante comme la France et juste comme l'Angleterre, la préhistoire de Belgique n'existe que parce qu'elle respecte sans se laisser inféoder : nous assimilons ces oppositions et y ajoutons un grain de complicité.

La thèse de Rebecca Miller a rencontré et surmonté ces différences, manifestées soit entre les écoles, soit entre les données, soit encore à la rencontre des deux, aux sources de l'histoire des sciences. Cette articulation défie, en outre, le terme de passage si souvent utilisé jadis pour délimiter l'espèce humaine : entre Neandertal et Cro-Magnon. dans cette extrémité nord-occidentale, le contact semble brutal et irrémédiable. Or, toutes les plaines du nord, aux traditions culturelles si profondément autonomes, contribuèrent ensuite fondamentalement à la constitution du "Paléolithique supérieur moyen" (soit au "Gravettien"). Cette aire de contact ne fut donc pas seulement un réservoir aux Moustériens, mais aussi l'espace d'où ont pu naître populations et traditions nouvelles qui allaient devenir pleinement européennes.

Par ces données aussi concrètes, géologiques et indestructibles que furent les roches employées, Rebecca Miller montre les fines nuances d'adaptation, selon le temps, les traditions et les besoins. Le substrat minéral était multiple : il constituait une toile de fond idéale à l'approche de son interprétation. Rebecca en a tiré les leçons essentielles pour y lire les choix posés par chaque groupe, successivement installés dans le même paysage. Au-delà d'une leçon historique, c'est une manière de penser et d'agir en préhistoire du Nord-Ouest, qui nous est offerte par Rebecca Miller, dont nous sommes fier d'assumer l'édition et, espérons-le, d'en poursuivre le message.

Marcel OTTE
Liège, Belgium
June 26, 2001

SECTION 1

FORMULATION OF RESEARCH

CHAPTER 1
STATEMENT OF THE RESEARCH QUESTION

INTRODUCTION

Throughout the Paleolithic, beginning with the earliest tools made of stone in the Oldowan techno-complex (e.g., Isaac 1977, Potts 1988), archaeologists have observed the differential use of lithic raw materials, both in terms of the choice of reduction techniques used on specific materials and in the choice of tool forms produced on different lithic types. The relationship between raw material, technology and typology has been the focus of intense research over wide geographic areas and at different scales of analysis (e.g., Sieveking and Newcomer 1987; Montet-White and Holen (eds.) 1991; Féblot-Augustins 1997). Many archaeologists (Demars 1982, Munday 1976, Geneste 1985, 1988, 1990; Marks *et al.* 1991, Straus 1980, 1991, Straus *et al.* 1986, Schild 1987, Kuhn 1995, among others) have considered distances to sources of raw material, quality, abundance, and accessibility as complementary factors which played a role in determining how different materials were utilized. Others, primarily Dibble and Rolland (Dibble 1988, Dibble and Rolland 1992, Rolland 1990, Rolland and Dibble 1990), argue that such factors result in differential intensity of use, thus contributing to morphological variability in tool forms. Munday (1976) demonstrates that discarded core size decreases as distance from sources increases, a pattern which reflects increasing intensity of core reduction as material becomes more difficult to obtain. Tavoso (1984), for so-called Languedocian assemblages during the Middle Paleolithic, notes that good quality flint was reserved for Levallois methods of production while poorer quality quartzite was used for non-Levallois methods, thus evidencing differential use of materials based on quality.

Altogether, such observations show that these factors impact lithic economy at all stages: procurement and transport, choice of reduction techniques, tool production, use and re-use, and discard. These factors thus contribute to assemblage variability across space. Through time, reduction techniques (e.g., simple non-preformed flake, Levallois and prismatic blade/bladelet technologies) and the range of known strategies (e.g., trade and exchange networks, extraction sites, flint mining, etc.) vary as well. The interaction between the information possessed by prehistoric groups and the raw material context across the landscape (i.e., the lithic economy) thus takes on different forms.

The Middle to Upper Paleolithic (MP-UP) transition and the Early Upper Paleolithic (EUP) together constitute a particularly significant period in which to examine issues of lithic economy, because it is during this time, around 45,000-20,000 years BP, that one observes dramatic changes in techniques of manufacture, in particular the widespread adoption of prismatic blade technology. The Middle Paleolithic Mousterian industry is often (though not always) characterized by dominant flake technology, i.e., core reduction to produce variable flake blanks, or application of the Levallois method to produce flakes, blades and points of predetermined shape.

Early blade technology in the Mousterian, observed at such northwest European sites as Seclin, (Révillion and Tuffreau (eds.) 1994, Révillion 1988, 1993, Tuffreau 1983, Tuffreau and Révillion 1984/85, Tuffreau, *et al.* 1994), Riencourt-lès-Bapaume (Ameloot-Van der Heijden 1993), Rocourt (Otte *et al.* 1990), Tönchesburg (Conard 1992) and Wallertheim (Conard *et al.* 1995, Conard and Adler 1997), appears to be a geographically and temporally restricted innovation (but see Ronen 1992 and Meignen 1994, among others, for discussion of early blade technology in the Near East) which did not become widespread, as, in contrast, prismatic blade technology did at the onset of the Upper Paleolithic. Apart from a generalized flake-based technology, which produced flakes of variable size and morphology during the Mousterian, the Levallois concept of core reduction was applied to produce different kinds of predetermined flake forms, such as Levallois flakes, blades, and points (Boëda 1988, 1990, Van Peer 1992, Dibble and Bar-Yosef 1995).

During and following the MP-UP transition, one observes technological changes: a shift in the conception of core from surface to volumetric reduction (Boëda 1990), which results in the production of more blanks and increased useable edge length per core, and the development of Upper Paleolithic prismatic blade technology which produces morphologically similar blade blanks. Flake technology is not entirely abandoned, but blade technology is very common in most EUP industries.

The observation of such technological changes leads to the question of how changes in the lithic economy were affected by access to lithic raw materials of varying quality. Did the widespread adoption of new reduction techniques necessitate changes in procurement strategies, for example to reject formerly suitable poorer quality materials in favor of better quality flint? It is critical to examine the relationship between the lithic economy and a raw material context which varied across the landscape in order to determine how mobile groups during the Early Upper Paleolithic adapted to their environment in terms of exploiting lithic resources.

Prehistoric human groups generally had a standard set of *lithic needs*: 1) to have lithic material on hand to produce tools when needed, 2) to obtain material of suitable quality for the kinds of reduction techniques used, and 3) to obtain material of suitable quality to be effective and sufficiently durable in various expected activities. These needs were situated within a specific *raw material context*, which was site-based, defined on the basis of the quality and availability of local lithic resources and on the distance from each site to non-local flint sources. The interface between the needs of human groups and the lithic resources available across the landscape is termed the *lithic economy*, defined here as the range of known strategies employed within a given technocomplex for procurement, reduction, and utilization of lithic raw materials (Fig. 1.1). The lithic economy consists of a dynamic cultural interaction of evaluation and compromise between needs and resources which can change as a function of technology. Technology designates both the range of activities and the types of products produced to meet human needs and thus refers to both process and product. It is a facultative process of adaptation aimed at solving problems posed by the environment (Binford 1973, 1977, 1979; Otte 1991b; Kuhn 1995).

The broad question addressed by this research is the relationship between these three components. Specifically, given a set of lithic needs, placed in a given raw material context, and given a range of available strategies to employ (lithic economy), what strategies were actually selected? What economic decisions were made? How were raw material needs met in different contexts? How did raw material context affect such decisions? The aim is thus to explain technological and typological variability across space in terms of this tripartite relationship.

RAW MATERIAL CONTEXT	**LITHIC ECONOMY**	**LITHIC NEEDS**
-quality and availability of local lithic sources -distance to non-local flint sources	-flexible set of strategies to meet lithic needs in varying raw material contexts	-to have material available to make tools -of sufficient quality to apply reduction techniques -of sufficient quality to be effective in use

Figure 1.1. The role of lithic economy.

The primary aim of this research is to examine the lithic economy of the Middle to Upper Paleolithic transition and the Early Upper Paleolithic within varying raw material contexts in order to develop and test a general model of lithic economy. Such a model will identify specific factors affecting decisions made within a lithic economy, to predict when certain strategies would have been appropriate and when other strategies should be employed. Clarification of the nature of the lithic economy during the Early Upper Paleolithic has implications for ascertaining the degree of mobility of prehistoric groups. Strategies of procurement and transport can limit or expand the territory within which human groups lived, particularly in regions which lack lithic raw material, such as the Ardennes Massif in southern Belgium and the Grand Duchy of Luxembourg (hereafter "Luxembourg", not to be confused with the Belgian province of Luxembourg).

Two complementary aspects of the research question, discussed in more detail below, are addressed by this research: 1) how lithic economy varies across space, 2) how lithic economy varies through time, from the MP-UP transition to the end of the Early Upper Paleolithic. The relevance of this research is twofold. First, it demonstrates the utility of the application of raw material and debitage analyses to explain assemblage variability in terms of the effects of raw material factors on lithic economy. Assemblage variability, taking the assemblage as a whole and ignoring the range of raw materials present, can *in part* be explained in terms of technological and typological aspects. However, *within* an assemblage, taking into account the different kinds of raw materials used and distances to their sources, it can be seen that different materials were exploited differently, that their technological and typological structure is not similar across material types. Thus, raw material and debitage analyses clarify assemblage variability that is obscured when all materials are lumped together.

Second, as a geographically and temporally limited study – the Early Upper Paleolithic in Belgium –, research on the effects of raw material context on lithic economy contributes to the general question of prehistoric human adaptation to the natural landscape during and following the MP-UP transition in northwest Europe. If, as seems likely, the MP-UP transition in northwest Europe is due to gradual migration and subsequent occupation of Europe by early modern humans from the east and southeast, bringing with them a radically different prismatic blade-based technology, then analysis of early Aurignacian sites (e.g., Trou Magrite) and subsequent Aurignacian and Gravettian sites (e.g., Spy, Goyet, Maisières-Canal, Huccorgne) should clarify initial responses to a new environment followed by increasing familiarity and adaptation to or "mapping onto" (*sensu* Binford 1980) the environment. A regional study such as is presented here permits one to develop a more detailed, less general, interpretation of lithic economy during a certain period, which can then be utilized to make inter-regional comparisons. A Belgian study, for example, focuses on lithic economy in northwest Europe, but there are connections across the northern European plain that can be examined.

GEOGRAPHIC AND TEMPORAL LIMITS

This research focuses on a series of sites within Belgium, which, despite their relatively small number, cover a wide range of variability in terms of access to flint sources. Concentration of this work within a circumscribed region permits relationships between archaeological sites and geological sources exploited to be specifically recognized. Long-distance transport (>100 km) is not known for northwestern Europe during the Early Upper Paleolithic; thus, the range of materials exploited in Belgium can be used to set geographical limits for the study, although fossil shells from the Paris Basin were transported to both Belgian and the German Rhineland Magdalenian sites (Dupont 1872; Otte and Straus (eds.) 1997; Street, Baales and Weniger 1994; Bosinski, Street and Baales 1995; Rensink 1993). In contrast, flint was transported over greater distances in eastern Europe (see Féblot-Augustins' [1997] discussion and references for eastern Europe). Kozlowski (1989:430) states that 52.9% of flint in the early Aurignacian layer 11 at Bacho Kiro was imported from sources >120 km from the site. A study encompassing vast regions (e.g., at the scale of the European continent) and including inter-regional comparisons (e.g., Féblot-Augustins 1997) requires a substantial increase in data collection with a corresponding increase in generalization of conclusions.

Most archaeological sites dating to the Early Upper Paleolithic in Belgium are in caves found along the Meuse river valley and its tributaries, although two of the study sites, both Gravettian in age, are open-air sites near flint sources (Maisières-Canal and Huccorgne). A few open-air Aurignacian sites, mainly surface finds, have been found in the Hainaut Basin in western Belgium, close to the sources of Obourg and Spiennes flint (Fourny and Van Assche 1992). This Aurignacian occupation area is comparable to that found in northern France, described by Jean-Pierre Fagnart (1980, 1988). Few Upper Paleolithic sites have been found in Flanders (northern Belgium), in the higher altitudes of the Ardennes (southernmost Belgium), or in Luxembourg. The geological analysis herein concentrates on flint sources in Belgium, southern Netherlands, western Germany, and parts of north-central France which were exploited throughout the Paleolithic (see Rensink, Kolen and Spieksma 1991).

In terms of temporal limits, this research concentrates especially on the Early Upper Paleolithic, with two Gravettian sites (Maisières-Canal, Huccorgne), three Aurignacian sites (Trou Magrite Levels 2 and 3, Spy Level 2, Goyet Level 3.0), and one transitional or Late Mousterian site (Trou de l'Abîme [Couvin]). Trou Magrite (levels 4 and 5) and Goyet also have Mousterian assemblages, which will be compared with their Aurignacian assemblages to address the question of possible changes through time. However, the principal focus of this research is on spatial variability during the Early Upper Paleolithic. Limiting the study mainly to the Early Upper Paleolithic permits greater control over technical variability due to differences between flake-based and blade-based technologies, so that economic variability across space can be analyzed. Variability due to differences in reduction techniques is thus controlled for and variability due to access to flint sources is isolated.

It would be necessary to isolate two complementary mechanisms if one were to compare assemblages through time and across space simultaneously. First, reduction techniques changed radically during the range of the Paleolithic. Generalized flake and Levallois technology during the Mousterian have substantially different raw material requirements than Upper Paleolithic prismatic blade technology. Variability among assemblages through time could thus be due to factors relating to reduction techniques as well as to raw material context. When one limits the study to a period of time in which the technological base is similar (i.e., widespread use of prismatic blade technology), variability due to differences in reduction techniques is minimized. Quality requirements for reduction techniques used are thus substantially similar across space, with some slight differences appearing when one compares Gravettian and Aurignacian technologies. Variability in assemblages is due rather to differences in raw material contexts, that is, differential access to good quality flint. Raw material factors are isolated and their effects can be more clearly observed on lithic technology. Thus, the aim of this study is spatial variability during a restricted time period, with some limited discussion of temporal variability at stratified sites.

GOALS OF EXPLANATION

There are several layers of meaning addressed in this research: descriptive, functional, and explanatory. At the most basic level of analysis, that of assemblage structure in terms of raw material, technology and typology, the results are purely descriptive: identification of patterns of variability within and between assemblages. However, working within the realms of theory and methodology, utilizing both evolutionary theory and economic concepts, a general model for lithic economy is developed. Hypotheses or expectations regarding human technological behavior are derived from this model. Patterns observed in the archaeological record are interpreted within the context of the model developed, in order to test its validity, that is, whether the proposed factors influencing lithic economy are valid. At a theoretical level, a general explanation of variability in lithic assemblages across space as it relates to variability in access to lithic raw material can be attempted.

HOW LITHIC ECONOMY VARIES ACROSS SPACE: VARIABILITY IN LITHIC ECONOMY WITH RESPECT TO ACCESS TO LITHIC RAW MATERIAL

Assemblages vary across space in terms of their raw material contexts, and technological and typological structure as sites vary in access to lithic raw material sources. By recognizing the relationship between lithic economy and raw material context, we can get closer to an understanding of the flexibility of human behavior. Decisions are made within specific contexts, and problems imposed by the environment can be solved in a variety of ways. Strategies employed will necessarily be different at sites where local material is both of good quality and abundant, and at sites where raw material is of poorer quality or locally absent. Spatial variability, linked to variability in raw material context, can be explained in terms of an economic model (see chapter 2) identifying factors which influence decisions made.

The five main problems faced by a prehistoric group when deciding on site location are access to 1) shelter, 2) food, 3) lithic raw material resources 4) fuel and 5) water. During the Early Upper Paleolithic in Belgium, caves appear to have been preferred for shelter, with the majority of known sites being in caves along the Meuse River and its tributaries. However, this could also reflect bias in site discovery as caves were systematically explored in the 19th century, but open-air sites were only found by chance, due to modern construction activity. From such “residential” sites, small parties would have exploited the surrounding territory to obtain subsistence and raw material resources. Between these two types of resources, access to subsistence resources would have had higher priority when selecting a site location, because they may have been only seasonally available (e.g., migrating game herds, harvest of various plants) and more time and energy needed to locate them (in contrast to lithic sources whose locations would have been permanent in the landscape). Fuel and water would have been rare on the plateaux, but readily available along the protected tributary valleys south of the Meuse (i.e., wooded or partially wooded microenvironments along watercourses).

The need for *locally* available raw material would thus have had the lowest priority in the sequence of problems to be resolved. As a result, the provisioning of a site with lithic material and its utilization took place *under constraints* imposed by the need to first meet shelter and subsistence requirements. The raw material context was therefore rarely ideal. Observed patterning in the archaeological record reflects decisions made and shows how prehistoric groups adapted to varying conditions. For example, anticipatory strategies could adequately provision a group so that the lack of raw material in a region becomes largely irrelevant.

Economic models, by identifying factors influencing decisions and clarifying relationships between raw material context and lithic economy, permit the flexibility of human behavior to be understood. The assumption of economic models is that the primary goals driving behavior are to minimize expenses and maximize benefits of undertaking a certain activity (Winterhalder and Smith 1981, Smith and Winterhalder 1992, Smith 1991, Bettinger 1991, Boone 1992). However, there is not a *single* optimal strategy toward which humans are directed in all cases, but rather a range of strategies which would be optimal under different conditions. Indeed, as raw material context varies across space, compromises must be made between expenses and benefits, and a range of solutions is possible, with different solutions appropriate under different conditions. These solutions may be considered optimal (or at least adequate) for the conditions under which they have been selected. The threshold for the continuation or rejection of a particular strategy or behavior is not optimal/sub-optimal but sufficient/insufficient.

In order to explain why different strategies were used or were appropriate in different contexts, the archaeological record within different raw material contexts and thus the conditions under which decisions are made, must be evaluated to identify underlying economic principles. Starting with a general economic model, and taking a deductive approach, we can evaluate the use of one strategy versus another by estimating the net gain. Strategies can be ranked within a given raw material context and the highest ranked will be the one(s) which has/have the highest net gain.

The lithic economy at a given period is the pool of known strategies which a group could consider and evaluate within different contexts. These include different strategies of procurement, such as the use of specialized workshops to provision a region with raw material, long-distance transport, trade and exchange, etc., as well as knowledge and utilization of different reduction techniques. Valid archaeological correlates of such behavioral strategies must be identified. In this research, both correlates and strategies are fairly coarse-grained, but show clear patterns at a general scale. For example, a site could show 95% of its material as coming from the nearest flint source, and the remaining 5% could be non-local flint represented only by finished tools. Behaviorally, this could be interpreted as resulting from transport of finished tools and the replacement of a flint source used earlier, during occupation of a previous site, with the flint source which is now the closest. Transported tools would have been curated for use and discarded when new tools could be made to replace them. The use of the nearest flint source, as opposed to a more distant source of equivalent quality, is expected under the economic assumption of minimizing procurement expenses.

Within a prehistoric lithic economy, there was thus a range of possible strategies or options available from which choices could be made. Adequate or optimal choices would maximize the benefits from the raw material while minimizing time and energy expenditure for procurement, reduction, and use (see chapter 2).

HOW LITHIC ECONOMY CHANGES THROUGH TIME: TEMPORAL VARIABILITY DURING THE EARLY UPPER PALEOLITHIC IN BELGIUM

While the number of sites studied is small, some tentative conclusions can be made about changes in lithic economy through time, beginning with the MP-UP transition, followed by early Aurignacian, established Aurignacian, and Gravettian periods. Certain developments in lithic economy are suggested when the study sites are examined according to their chronology. It should be noted, however, that interpretations are provisional, based on the limited number of sites studied, particularly for the beginning of the sequence.

Temporal change during the Early Upper Paleolithic includes both technological and typological developments - the shift from the Aurignacian to the Gravettian technocomplex – but more importantly, as will be seen, the sequence of change reveals changes in lithic economy, including the establishment of a site distribution system that meets all of the needs of prehistoric groups and changes in procurement strategies, possibly related to changes in mobility.

CHAPTER 2
PRESENTATION OF A MODEL FOR LITHIC ECONOMY

COMPONENTS OF THE MODEL

The focus of the model presented here is on the relationship between lithic raw materials and lithic economy: how raw material context affects strategies for procurement, reduction, and utilization. The distinction between a generalized and a specialized economy is defined by the presence or absence of differential procurement, reduction, and utilization strategies. Therefore, the factors affecting such differentiation are related to variability in different aspects of raw material.

The main factors are identified as quality and abundance (including distance to sources and distribution). *Quality* is defined in relation to specific techniques of manufacture and is measured first by the ability of a material to produce the intended blanks and then by the productivity, or maximum potential, of blanks that can be produced. Blank-production can be size dependent: if there is a minimum size requirement or preference, then small nodules and cobbles are of relatively “poorer” quality. Three general techniques are defined based on the types of blanks produced: production of simple flakes, predetermined Levallois flakes, blades and points, and prismatic blades/bladelets. Ordinary flakes require a minimum of core preparation: cortex removal (optional) and the preparation of a striking surface. The Levallois method is defined on the basis of its elaborate processes of core preparation which permit the removal of blanks of predetermined shape. Here, after a removal or short series of removals, the core must again be prepared. Core preparation for prismatic blade technology occurs in the first stages but once the platform is prepared, a continuous series of blades can be produced, with trimming of the platform lip and ridges when necessary. For each technique, materials can be ranked by maximum potential in terms of number of useable blanks that can be produced. Maximum potential is thus a correlate or index of quality. It is independent of perceived needs and provides a means of ranking materials by quality.

Availability is defined in terms of distances from source(s) to a given site and is necessarily dependent on site location. The distribution of lithic resources across the landscape can be patchy or uneven (as is the case in Belgium) versus consistent or evenly distributed. As the distance between source and site increases, the material in question is defined as less available, with a corresponding increase in time and energy expenditure for procurement as a function of distance.

The interaction between raw material and techniques of manufacture is identified by strategies for procurement and reduction and there are costs associated with these strategies. *Procurement costs* are defined as time spent traveling to and from the source, plus handling (carrying) costs which would be measured in energy units. Because it is not possible to calculate actual time and energy costs (e.g., in calories, as is done in foraging models), the distance from source to site is the best available estimate for procurement costs. Absolute distances, taking into account local topography, provide a relative estimate of procurement costs between different sources to one site. Using proportional information from assemblage-specific data, distance can be multiplied by proportion within an assemblage to calculate procurement cost for different materials. Procurement cost for local materials can also be estimated and an overall assemblage procurement cost can be calculated by summing the individual costs.

Labor costs incurred during the process of reduction are defined as the amount of time and energy spent during blank-production sessions and as decreasing productivity of cores as they become smaller. The first includes decreased ability to reduce smaller cores and decreasing ability to prepare the core, where the assumption is that it becomes more difficult technically or more time-consuming to reduce very small cores to produce suitable blanks. The second includes decrease in the size of blanks produced, perhaps relevant to size needs for tools, and decrease in the number of blanks that can be produced from very small cores.

During the process of procurement and transport, costs or expenses are time and energy. Once material has arrived at the site, expenses are a function of quality. As relative quality of material decreases (e.g., if good quality material is unavailable and poorer quality materials must be used), expenses increase. These expenses can be summarized as follows:

procurement:
time spent traveling to and from a source
time spent searching for a source
time spent evaluating material at a source
energy expended in transporting material – under various forms – to a site

core preparation and blank production:
increasing labor effort as cores become smaller or if they are of poorer quality
increasing lack of control over fracture
increasing chance of failure to produce suitable blanks

blank selection for tool production:
increasing lack of suitable blanks as materials are of poorer quality
more time needed to shape more elaborate tools (i.e., those with higher shaping intensity)

tool use:
if material is soft, more frequent resharpening may be necessary
poorer quality material may cause tools to break more easily (due to contact fractures)

The model explores the relationships between the four components defined above (quality, availability, procurement costs, labor costs). It attempts to predict how quality and abundance affect these costs. It should thus be possible to predict what kinds of strategies are expected within different raw material contexts.

Procurement and reduction strategies also have benefits associated with them. The *procurement benefit* is defined as the satisfaction of raw material needs for a given technique. That is, the optimal relationship, the best quality material for that technique, is achieved. The *reduction benefit* is defined as the production of useable blanks and pertains equally (if obviously) to the first useable blank as it does to the last blank produced at maximum potential. Within a specific raw material context, the optimal strategy need not necessarily be one in which materials are reduced to exhaustion, for example, when material is abundant.

To summarize, quality and abundance are two aspects of raw materials the maximization of which reduces pressures on the raw material economy. When available materials are of good quality and abundant, there is no need for strategies to conserve raw material. Procurement and labor costs are aspects of the *chaîne opératoire* which should be minimized. A high procurement cost reflects a decreased ability to obtain the necessary material while a high labor cost reflects a decreased ability to produce suitable blanks from a core of given material. Procurement and reduction benefits are the outcome of the interaction between aspects of raw materials and strategies of procurement and reduction.

The optimal strategy in a given situation will be one that considers the specific conditions of the range of variability in quality and availability of raw materials, both locally and non-locally, and then chooses procurement and reduction strategies that minimize procurement and labor costs, while maximizing the benefits. A distinction can be made between a generalized economy, where there are few or no constraints on choices made, and a specialized economy, where quality and availability exert increasing pressure on choices as sources of good quality material become more and more distant.

When local material is both of good quality and abundant, as at Maisières Canal and Huccorgne, the status of non-local material is irrelevant. Here, quality and availability exert little or no pressure on the structure of the assemblage. Material is suitable for any reduction technique and for any types of tools. When local material is of poorer quality, or when flint sources are more than 5 km distant, both quality and availability begin to exert pressure to cause differential exploitation of a range of raw materials in the assemblage. At Goyet and Spy, the nearest flint sources are 20-40 km distant and local materials include chert, quartzite and sandstone, typically in the form of waterworn cobbles. At Trou Magrite, the nearest flint is at least 60 km distant, but limestone is locally available and abundant, along with cherts and quartzites on the plateau above the site. It can be seen that when quality and abundance needs can be met, their influence on assemblage variability and the relationship between material and technique become negligible. If one or both needs are not met, specialized strategies come into play to compensate for the pressures exerted in order to maximize return. It can also be seen that the presence of such pressures convert raw material from what can be seen as an inexhaustible resource to a finite resource. When good quality, materials are readily available and abundant, there is no pressure to maximize returns. When they are not readily available, it is necessary to use strategies which most efficiently utilize the available material.

Under any conditions, there may be differential selection of blanks, based on blank morphology, to produce different kinds of tools.

POTENTIAL STRATEGIES WITHIN A LITHIC ECONOMY

Table 2.1 is a non-exhaustive list of behavioral strategies, ranked according to time and energy investment required. Choices made from the range of potential strategies are not constant across space and time, but vary in response to the raw material context and technological needs. In this way, time and energy expenditures are minimized *within certain constraints*. What is appropriate at one place and/or time may be inappropriate at another. It should be noted, however, that some strategies may be roughly equivalent in rank (e.g., logistical and embedded procurement), and also that it is often not possible to distinguish between them archaeologically.

1) procure and use locally available material
2) transport of non-local material from a previously occupied site to the study site a) in unreduced form b) as prepared cores c) as prepared blanks d) as finished tools
3) logistical trips from study site to raw material source to obtain (and possibly reduce) material a) in unreduced form b) as prepared cores c) as prepared blanks
4) embedded procurement (collection of raw material while engaged in subsistence activities) a) in unreduced form b) as prepared cores c) as prepared blanks
5) increase intensity of reduction for non-local materials, thereby a) producing smaller, but more, blanks (cores, which would otherwise have been discarded before being exhausted when material is abundant, are here reduced to exhaustion) b) lowering the minimum blank size requirement (blanks deemed unsuitable when material is abundant, are now selected for retouch)
6) differentiation between materials for different techniques to maximize the number of useable blanks from good quality material
7) differentiation between materials to produce different types of tools (e.g., opportunistic tools versus more deliberately or intensely shaped tools intended to be curated) Also, tools varying in function may require different kinds of materials.
8) increased intensity of tool use: resharpening tools, reshaping broken tools; in sum, curating finished tools as long as possible
9) modify techniques of reduction to correspond to local conditions, e.g., if material is too poor to produce blades/control fractures, alter reduction techniques to produce flakes, where control over blank shape is less important

Table 2.1. Potential strategies within lithic economy (non-exhaustive), ranked by time and energy investment.

1) The exploitation of local material has the lowest time and energy expense for procurement, but quality of such materials must be evaluated in terms of suitability for reduction techniques used. If local material is of poorer quality than desired, the decision to exploit such material must be weighed against the distance to the nearest source of better quality material. If this distance is too great, the local material may be used despite its relatively poorer quality.
2) Transport of material from a previously occupied site to the study site would generally be transport of an active tool kit, including cores in active use, blanks and tools. Procurement expenses have already been "paid" at the earlier site.
3) and 4) Logistical and embedded procurement strategies are undertaken to provision the site currently occupied for both subsistence (hunting and gathering) and domestic activities, to supplement or replace material transported from a previously occupied site.
5) As distance increases from site to lithic source, material procured previously (strategy 2) and material procured to provision the site (strategies 3 and 4) will be more intensely reduced in order to maximize the number of blanks (and therefore tools) obtained. Labor expenses may increase as cores become smaller and more difficult to work, and tools may be less effective when they are made on smaller blanks, but procurement costs are minimized.

6) Similarly, as distance to good quality material increases, reduction techniques which produce more blanks per core (e.g., prismatic blade technology, bladelet technology) may be applied to good quality material, while flake technology is applied to poorer quality materials.
7) The use of different techniques on different kinds of raw materials permits good quality material to be reserved for certain tool types, particularly those requiring greater shaping. Poorer materials can be used for simpler tools, or for those tools which can be used and discarded after a short period of use.
8) As distances increase, it becomes necessary to maintain tools, to resharpen or reshape them into other tool forms, rather than discarding them. Again, this has the effect of maximizing the use life of the material and minimizing procurement costs.
9) At the most distant sites, where local material is of poorer quality and good quality material is too distant to exploit to provision the site, certain techniques become difficult to apply and other techniques, such as flake technology, are utilized.

OTHER BEHAVIORAL STRATEGIES

Other behavioral strategies result in modification of the specific conditions under which procurement and reductions strategies are determined. Some, such as increasing intensity of reduction and use, can be seen as compensatory strategies in response to specific conditions. Others have a more substantial impact on the overall organization of the hunter-gatherer group. These include changes in mobility strategies, such as increasing mobility within a territory or increasing the territory itself, and transport of prepared cores, semi-finished products, and tools. The second implies a degree of planning as opposed to opportunistic utilization of local resources and doing the best with what is available. Planning ahead or a contingency strategy prepares for future needs without having to rely on what is potentially available locally.

Site selection. One behavioral strategy would be to select sites strictly on the basis of the presence of local sources of good quality raw material. A generalized economy would then be the optimal strategy because there are no restrictions on choices of reduction techniques, etc. To determine whether such a site selection strategy was operating, it is necessary to observe the range of potentially available materials in a catchment area around each site (defined as roughly a one-hour walk from the site, or around 5 km) and the proportion of local and non-local materials, in order to determine if sites are situated where both quality and abundance pressures are minimized. If lithic resources were the only consideration in site selection, site location would be the only strategy necessary to minimize such pressures; sites would be always found near flint sources. In reality, numerous other factors more important (more directly relevant to survival) than raw material needs contribute to the process of site selection. These include need for water, shelter, fuel and the presence of subsistence resources, especially those which are migratory and/or seasonally available.

Intensity of reduction. Intensity of reduction refers to the degree to which a core is reduced, measured by the number and size of blanks produced. Increased intensity of reduction is a function of the balance between procurement and labor costs. If procurement costs are high, cores will be reduced more intensively.

Munday (1976) analyzed the size relationship between cores and debitage and the distance to sources for sites in the Negev (Israel). He argues that size of cores and debitage decreases as distance increases, thus indicating increasing intensity of reduction the further one gets from the source. This can be explained by the model: at places close to the source, the labor costs outweigh the procurement costs sooner and cores are discarded before being exhausted. As distances increase, procurement cost increases and it is less costly to continue to reduce the core than to obtain more material from the same source or to use a poorer quality material.

Intensity of use. Intensity of use refers to the degree to which a tool is used and resharpened before discard (Dibble 1985, 1988, Dibble and Rolland 1992, Rolland and Dibble 1990). Dibble (1985) observes that resharpening is a reduction process and that, as a tool is resharpened, its flake area decreases relative to platform area, which remains constant. An index of intensity is the ratio between flake area and platform area. Additionally, changes in the retouched edge angle and invasiveness of retouch are indicators of intensity, forming a continuum from low to high. He concludes that variability in Bordes' scraper types was due primarily to discard at different stages of use, rather than because they were discrete types. He further argues that the proportions of different kinds of scrapers in an assemblage reflect intensity of use: simple sidescrapers indicate low intensity while convergent sidescrapers indicate high intensity.

Mobility strategies. Mobility strategies all imply some degree of transport of various products and focus on including different sources of raw material within the mobility range. Here, a source is defined as being either an *in situ* geological locus or a secondary deposit, such as river terraces and slope erosion zones. Higher procurement costs due to increased mobility are offset by transport. If resources are obtained locally (with low procurement cost) in the ordinary course of movement and transported, then procurement cost becomes only the energetic cost of carrying products. At the actual place of reduction and use perhaps far from the source, the procurement cost would have been high; alternately, poorer quality materials would have been used if materials had not already been transported.

One strategy to ensure that material is available when needed is to increase mobility within a defined territory to more regularly visit flint sources. This can be observed archaeologically (assuming you have well-dated sites in a region) by documenting the relative proportions of different materials in assemblages through time. If a source is being used more frequently, its proportion will increase within assemblages. The range of actual materials used will remain constant. Mellars (1989a) notes that work in both France (Demars 1982, Geneste 1985) and in Central Europe (Hahn 1977, Kozlowski 1982, Svoboda 1983, 1988, Schild 1987, Roebroeks *et al.* 1988) shows a contrast between Middle and Upper Paleolithic procurement strategies for non-local materials. He states that the "significant contrast...seems to lie not so much in the *maximum* distances over which raw materials were transported...but in the relative scale on which these more distant sources were exploited" (Mellars 1989a:366, emphasis in original). This is also observable in other regions as well, such as Catalunya (e.g., Soler *et al.* 1990).

A second strategy to ensure material availability would be to configure the mobility range to include sources without necessarily increasing the size of the range. Archaeologically, this can be documented by observing the range of materials used in different assemblages from stratified sites. Distances shorten for procurement of some materials and increase for others; hence materials for which distances shorten should increase in proportion.

A third strategy would be to increase the mobility range in order to include additional sources within it. For example, if the territory is poor in lithic raw material, increasing the size of the territory will include a wider range of materials. Again, having materials available when necessary offsets the higher procurement cost. This can be observed archaeologically by documenting the range of actual materials used in assemblages through time. The range should increase as the territory increases.

Transport of products. The three strategies discussed above can all be evaluated by analyzing the raw material properties of a lithic assemblage. Mobility strategies imply the transport of products, which is itself a strategy to compensate for imperfect conditions at a new site. To determine if products were transported, and under what forms, it is necessary to use assemblage-specific information. Sourcing information for the raw materials of transported products is also very useful, but may not always be available. If it is available, then it is possible to analyze how far material has traveled, evaluate the intensity of use in relation to distance from source, etc. If exact sourcing information is not available, then it may still be possible to identify material as non-local, and thus transported.

To analyze transport of products, it is necessary to examine the non-local material in an assemblage. The most straightforward way of determining what was transported is to identify which stages of the reduction sequence are represented: initial core preparation, core reduction/blank production, tool production, tool recycling. For example, if only tools and resharpening flakes are present, one can infer that tools were transported to the site, resharpened and then discarded. The presence/absence of the different reduction stages can be used to infer at what stage of reduction non-local material was brought to the site.

QUALITY WITH RESPECT TO REDUCTION TECHNIQUES AND TOOL EFFECTIVENESS

For any Paleolithic time period or industry, prehistoric humans evaluated lithic raw materials in order to meet needs. Raw material needed to be of sufficient quality for 1) application of known reduction techniques (general flake, Levallois, prismatic blade, bladelet), and 2) tool effectiveness in expected activities.

Application of Reduction Techniques

For the first requirement cited above, the quality of material affects the ability to control fracture, to control the direction and force of fracture in order to produce the desired blanks. Non-Levallois flake technology, in this respect, is the most flexible and requires the least amount of control over the shape of the blank. Flakes of variable form and size are produced, from which blanks suitable for different kinds of tools could be selected. Almost any degree of quality is suitable for producing flakes, from quartz to flint. Levallois technology, in contrast, requires better quality material (Tavoso 1984, Boëda 1988, 1990, Van Peer 1992), and the elaborate method of core preparation helps to ensure that flakes of predetermined size and form (whether Levallois flakes, blades, or points) are produced. Finally, prismatic blade technology has the greatest need for control of fracture because the aim is to systematically produce long, narrow flakes (length $\geq 2 *$ width).

Raw material can be divided into two broad groups based on relative quality: 1) isotropic, fine-grained, few inclusions, and 2) orthogonal, coarse-grained, many or large inclusions. These characteristics affect the ability to reduce the stone.

With isotropic materials, the direction of fracture and shape of the blank can be more easily controlled (Cotterell and Kamminga 1979, 1987, 1990; Speth 1972; Tixier 1978; Tixier, Inizan and Roche 1980; Crabtree 1972; Luedtke 1992). *Homogeneity* of materials (fine-grained, absence of inclusions and flaws) permits the force of fracture to follow a certain direction without being deflected or slowed. Luedtke (1992:86) states that inhomogeneity results in “general unpredictability of flaking” and affects the controllability of fracture.

Other mechanical properties include strength, elasticity and hardness. *Strength* refers to the toughness or tenacity of the material and is a “measure of how much force must be applied to produce a fracture” (Luedtke 1992:87). Strength must be low enough to allow greater control of fracture but not too low so that the tool produced is effective. *Elasticity* is defined as “the ability to deform without a permanent change in shape" and affects the "ability of a material to resist unwanted fractures, such as end shock and hinge fractures " (p. 90). Finally, *hardness* is defined as "the resistance of a material to abrasion, scratching or penetration by an indenter" (p. 91). This affects the effectiveness of tools during use.

When collecting material, the raw material is tested and selected for mechanical properties so that only material of good quality is actually transported. There are two scales of assessing quality: variability between sources and variability within a source. The first is more critical in evaluating and time and energy expenses while the second is assessed after a source has been selected. Variability within a source can be easily tested with much less investment (e.g., breaking open a nodule, tapping for sound, producing test flakes).

In contrast, with orthogonal materials, there are inherent multiple structural planes which can arrest a fracture or deflect it so that the direction of fracture is less controlled. Coarse-grained materials contribute to deflecting the direction of fracture or slowing it. Greater force may be needed, but hinge fractures may also be more common. Large inclusions, which are commonly coarser-grained than the matrix, also contribute to deflection and slowing of the force of fracture.

When material is procured at a source, a process of selection must have certainly occurred, whereby unsuitable nodules/cobbles were rejected. Selection based on quality occurs within the variability of a single source. Additionally, selection based on quality also occurs between sources, for example, between local poorer quality and non-local materials of better quality. Here, procurement costs become a factor.

So, looking only at suitability for reduction techniques, lithic materials used prehistorically can be ranked by quality:

1) flint, phtanite, fine-grained quartzite (e.g., in Belgium, Wommersom quartzitic sandstone)
2) chert, medium to coarse-grained quartzite, sandstone, limestone
3) quartz

Flake technology can be applied to materials of all three ranks. Levallois and blade technology can be applied most easily to top-ranked materials, with more difficulty to materials ranked second. Quartz is relatively more difficult material to knap, although there are industries based on quartz even in areas where flint is available (albeit at a moderate distance), including quartz bladelets at the Mesolithic site of Vidigal in Portugal (Straus and Viera 1989).

Tool effectiveness

Tool use will not be specifically considered in this study but will be discussed briefly here, within the context of raw material quality. The main issues with respect to quality and tool effectiveness are: 1) sharpness of working edge for various activities (cutting, scraping, boring, etc.), 2) durability: how quickly a working edge becomes dull during use, requiring resharpening, and 3) brittleness: breakability during use (e.g., fracture upon impact, breakage under pressure).

First, the working edge must be suitable for performing a given activity (whether general or specific purpose). For example, one could create tools from a block of plaster, but the resulting tools would not be very effective.

Second, if an edge becomes dull quickly during use and requires frequent resharpening, the tool becomes exhausted more quickly and has a shorter use-life, since resharpening is also reductive. Such tools require more labor input and more time expense, during an activity, to maintain the tool.

Third, if a material is too brittle, it will break easily during use, essentially abruptly ending its use-life (or requiring further labor input to reshape it into another useable form). Brittleness dramatically affects the utility of projectile points (impact fracture, breakage of point tips) and perçoirs and burins (pressure fracture), among others.

In an archaeological assemblage with different types of raw materials present, we should expect to observe different types of tools produced on different quality materials, based on expected tool function. The same ranking can be made as for application of reduction techniques, however.

Blank shape is probably the most important aspect in tool effectiveness, where thickness can control for breakability, etc. In this way, the top-ranked materials are the most flexible for meeting tool effectiveness needs because blanks of different shape (long, thin blades, thick flakes, etc.) can be readily produced.

CHAPTER 3
HISTORY AND CURRENT STATUS OF SIMILAR RESEARCH

This research utilizes concepts and approaches applied to the study of prehistoric lithic economy, adapting them to examine the relationship between raw material context and strategies of lithic economy. With the general aim of explaining variability in lithic assemblages, considerable efforts have been made over the years to examine the effects of raw material factors on lithic economy. The problem has been approached from a number of different angles, discussed below.

A number of factors have been put forth to explain assemblage variability: style and ethnicity (Bordes and de Sonneville–Bordes 1970; Gould 1980; Sackett 1973, 1977, 1986a, 1986b; Wiessner 1983, 1984), function (Binford and Binford 1966; Binford 1973, 1989), intensity of reduction and progressive modification (the Frison effect) (Dibble 1988), raw material availability and quality (Dibble and Rolland 1992), temporal variability (Mellars 1969), and technological variability (Jelinek 1988), among others.

The first section presents a brief summary of lithic research, with the focus on the development of research directed at addressing the nature and role of raw material in studies of lithic assemblages. The second section focuses on the debate centered on the nature and process of change during and following the Middle to Upper Paleolithic transition.

HISTORY OF LITHIC RESEARCH

Lithic studies up to the 1960s were aimed primarily at classification of tools (e.g., the work of Breuil, Bordes, de Sonneville Bordes, and others), examining the morphology of tools to identify distinct types. These studies were essentially descriptive, and technological aspects of tool production were merely used as characteristics to construct typologies for the different industries of the Paleolithic.

In the 1960s and 1970s, lithic research expanded to address three separate areas: typology (e.g., Bordes, Brézillion, etc.), technology and techniques of reduction (e.g., Crabtree 1972, Tixier 1978; Tixier *et al.* 1980) and use–wear analysis (e.g., Semenov 1964, Hayden 1979, Keeley 1974, 1980; Shea 1992). These areas focus on different aspects of lithic assemblages – form, process, and use. The nature of the raw materials exploited was seen as secondary and was addressed only cursorily (e.g., treating all flint as essentially similar, equally susceptible to reduction techniques) or in general terms (e.g., that coarse–grained materials are more difficult to fracture than fine–grained materials). Raw material characteristics were not seen as relevant to the questions addressed until the 1970s, when sourcing studies made them the specific focus.

The Bordes–Binford debate concerning the meaning of variability in Mousterian assemblages centered on whether such variability was due to ethnicity or to function. The effects of raw material on assemblage variability were not explicitly addressed, although, as will be seen, later research demonstrated that various raw material factors contributed to assemblage variability and that the debate was more complex than a simple dichotomy between style and function. When raw material was considered, albeit in very general terms, research tended to focus on differences in quality and nodule size with respect to core reduction, such as the relative ability to produce Levallois products, prismatic blades and other blank forms.

Raw material itself was not explicitly considered, however, as a major factor contributing to assemblage variability, and studies of sites and regions tended to simply mention general observations in passing. Féblot–Augustins (1997) has recently made an exhaustive survey of raw material research in Africa and Europe for the entire Paleolithic, bringing together diverse references to raw material in assemblage–based research. It can be seen that raw material data was not systematically collected or quantified or even systematically examined qualitatively until the 1970s.

In the 1970s and 1980s, debitage analysis gained credence as a valuable tool in understanding lithic technology and assemblage variability. It was finally recognized that an assemblage contained more than formal tools, and that the by–products of reduction, combined with refitting of cores, could lead to a more detailed understanding of technological processes (see Csiezla *et al.* (eds.) 1990). Marks and Volkman (1983) amply demonstrate that morphologically identical blanks (in their study, Levallois points produced at Boker Tachtit) may be produced via entirely different reduction processes. In the early levels at the site, core reduction strategies were aimed at specifically producing Levallois points. Later, however, non–Levallois core reduction to produce blades also produced opportunistic Levallois points.

Another core analysis considered raw material factors (quality and abundance), at the Aurignacian site of Zwierzyniec I in Poland. Sachse–Kozlowska (1983) examined the stages of core working to interpret reduction processes and differential utilization of local material. The main raw material (Upper Oxfordian flint) was of relatively poor quality due to the presence of numerous inner flaws but was abundant locally. In this case, abundance compensated for the poorer quality, as new blocks could be used to make up for the relatively low number of useable blanks produced from each core. Cores, blanks and tools were analyzed and measured. Sachse–Kozlowska concluded that 1) six core types were divided into two size groups, meant to produce two kinds of blade blanks (wide and narrow), 2) wide, massive blades were selected for retouch, 3) smaller blanks were not selected for retouch but could potentially have been used unretouched, 4) core reduction involved shaping of the core when the natural form did not conform to planned shape, which was necessary due to the poor quality of raw material which often caused cracking of larger cores.

Analysis of tools alone may yield information about variability in blank selection or raw material selection for particular kinds of tools, but analysis of the entire lithic assemblage, whether analyzed by raw material group or not, yields information about the degree and kinds of reduction techniques employed as well. Classification of artifacts in an assemblage according to products and by–products of the reduction process permits inferences about the stages of the *chaîne opératoire* that are present or absent. Debitage analysis thus leads to 1) a technological description of reduction techniques, 2) identification of variability in reduction between raw materials present.

Beginning with the 1980s, research specifically addressing the role of raw materials in lithic economy began to proliferate, with studies such as Demars (1982) and Geneste (1985) focusing on changes in raw material procurement and utilization through time within a single region, and the elaboration of the concept of *chaîne opératoire* applied to lithic economy. The concept of the *chaîne opératoire* forms the basis of analyses of the technological structure of assemblages studied. It is defined as the series of activities involved in interaction with raw material from initial procurement to discard and include procurement and transport, reduction, use and re–use, and discard. Geneste (1985, 1988, 1990) utilizes this concept to examine lithic economy, slightly modifying the terminology of the sequence: acquisition, reduction, retouch, use, recycling, abandonment.

Svoboda (1983) defines a “lithic exploitation area” as a geographical region several km around a localized raw material source, or in places of concentration of non–localized raw material. This concept is then used to examine settlement patterns, raw material economy, technology, and typology in four different regions in Moravia.

Tavoso (1984) analyzed lithic exploitation for the Mousterian “Languedocian” sites in southwest France. He states that, at these sites, materials are of very variable quality, which creates significant technological differences in their exploitation. He proposes three hypotheses: 1) each type of material played a specific role within an assemblage, where flint and quartzite were complementary and reserved for the tool types for which they were most efficient, 2) the same human group made different toolkits when they utilized different materials: the difference between denticulate Mousterian and sidescraper–rich assemblages was due to the use of different materials, and 3) the typological composition of flint reflects their distant origin, and is due to curation of the most elaborate or most often used tools, but such materials were not exploited (i.e., reduced) at the site.

Such studies directly examined the relationship between raw material and technology, with the emphasis on how different materials were procured and reduced rather than on reduction techniques in general. This type of research focused attention even more on the role of raw materials within lithic economy. It both broadened the question by examining lithic economy as a whole and by placing raw material firmly within the ranks of potential factors to explain lithic assemblage variability.

With the emphasis on lithic economy, other researchers attempted to isolate specific raw material factors that could conceivably impact lithic economy (quality, abundance, distance to sources, etc.), affecting how material was procured and transported, reduced and utilized Dibble and Rolland examined intensity of reduction and use as a factor contributing to assemblage variability, arguing that intensity is correlated with raw material availability (Dibble 1988, Dibble and Rolland 1992, Rolland 1990, Rolland and Dibble 1990). Regional studies focused on distribution and transport patterns of raw material, and variability in raw material exploitation and tool production (e.g., Caspar 1982, 1984, Morala 1980, Valoch 1984, Straus 1980).

Lithic assemblages were studied within environmental contexts to explain lithic economy. The emphasis was shifted to explaining human behavior – organization of lithic economy in space and time – and not simply on describing tool form or technological reduction processes. The scale of explanation had changed and technological and typological studies, valuable in themselves, were now placed in a broader, more interesting, explanatory framework.

Geological sourcing studies were seen as an increasingly necessary basis for regional studies of lithic economy (e.g., Séronie–Vivien and Séronie–Vivien 1987) to trace the distribution of different raw materials across space (Caspar 1982, Demars 1982, Turq 1990, Takacs–Biró and Tolnai–Dobosi 1990). For the first time, the notion that different sources were exploited, and possibly exploited in different manners, was put forward. Lithic studies changed from looking at assemblages as a whole to looking at them as composed of a variety of different materials. Intra–assemblage variability was clarified.

Paralleling this sort of field survey and collection of lithic reference collections was the application of interdisciplinary analyses of flint for sourcing identification. Studies of mineral and chemical composition were aimed at making precise identification of flints from different sources. These analyses include trace–element analysis (e.g., Stockmans *et al.* 1981), neutron–activation analysis (Aspinall and Feather 1972), and atomic absorption and spectrophotometric emission analysis (Sieveking *et al.* 1972). If unique identifiers (such as particular minerals or configurations of several minerals) could be found, flint found in archaeological contexts could be analyzed and exact proveniences identified. In practice, such methods proved to be expensive for general application and results tended to show rather that variability within sources as well as between sources was much greater than expected, making precise identification of sources much more difficult, if not impossible. Samples taken from a single nodule proved to be very different in chemical and mineral composition. Such analyses, however, proved to be useful for identifying sources of very specific, highly localized variants, or for unique or unusual variants within an archaeological assemblage.

The late 1980s and 1990s brought further developments to the study of raw materials within the realm of lithic studies. More detailed analyses of raw materials have been undertaken (e.g., Andrefsky 1994, 1998; Floss 1991; Otte 1991a, Roth and Dibble 1998, Van Der Sloot 1997, 1998; Loodts 1998) at site and regional scales of analysis, in the recognition that raw material factors play an important role in shaping assemblage variability. Others examined the relationship between raw materials and mobility strategies (e.g., Féblot–Augustins 1993).

Hahn and Owen (1985) analyzed technological differences in the Aurignacian and Gravettian assemblages at Geissenklösterle Cave in southwest Germany. They note that the raw material context did not change – the same raw material types are used during both periods – but there are clear technological differences between the two technocomplexes. These include preferences of raw materials exploited (p. 70) as well as in the degree of core preparation and production techniques (p. 72–3). Given that raw material context remained constant, they interpret the observed differences as reflecting development in technology. During the Aurignacian, simplified core preparation took place, while Gravettian reduction is more complex, technologically more similar to the Magdalenian.

Turq (1990) examined the exploitation of raw materials in a series of Mousterian sites in the Dordogne and Lot valleys in southwest France. Flint sources were numerous in Cretaceous bedrock regions of the Périgord but rare in the Lot valley, where quartz cobbles were common. He analyzed the lithic assemblages from technological and typological viewpoints, as well as lithological, using macroscopic characteristics to identify materials. For Turq, distances to sources reflect differential use of territory, where short and medium distances (<5 km and 5–15/20 km) indicate the territory exploited by the groups during site occupation. Site location was selected in order to exploit the immediate area intensively and more distant zones sporadically. Turq also argued that non–local material (transported tools and prepared cores) could be seen as a "toolkit", indicating the zone of origin of the group or the region previously occupied. As will be seen in my research, data from Belgium support a similar interpretation for Rank 2 materials.

For Turq, conditions of procurement affected how different materials were exploited. When flint was available, quartz was used for hammerstones; when it was rare, as in the Lot valley, quartz was exploited as a raw material to produce tools and existing (transported) flint was economized. For other materials, quality, rather than distance, was a factor: good quality material was used for Levallois methods and a non–Levallois technique with facetted platforms while poorly silicified material was used for ordinary, non–facetted flakes. He concludes that raw material exploitation is based on quality of material and conditions of procurement (a term analogous to my definition of raw material context) and that utilization of different reduction techniques was based both on technological choice and lithological constraints. "Cultural" (e.g., the specific kinds of tools produced and their quality requirements) and functional needs drive humans to adapt to the mineral resources available, with the ultimate goal to eliminate superfluous energy costs in transporting material.

In site reports, there is a clear shift from a few brief lines about the kinds of raw materials used to presentation of results of detailed raw material analyses. Conferences devoted to raw material research addressed the subject from multiple approaches (e.g., Séronie–Vivien and Lenoir 1990, Montet–White and Holen 1991).

My research continues the focus on lithic economy, here in the context of the MP–UP transition and the Early Upper Paleolithic, a period of abrupt change in northwest Europe. EUP industries, radically different from local MP industries, require study from a raw material perspective for two main reasons. First, the use of different reduction techniques changes the raw material requirements to produce new kinds of blanks and tools, perhaps requiring a higher quality standard than for ordinary flake–based industries. Second, if EUP industries represent the "colonization" of northwest Europe by early modern humans replacing indigenous

Neandertal populations (perhaps gradual replacement over a few thousand years, with co–existence at the beginning of the EUP), then there would be a period of transition during which newcomers would become familiar with the landscape – the location of raw material resources, the nature and timing of availability of subsistence resources, the location of caves and water sources. Early Upper Paleolithic sites appear to be clustered in small regions (e.g., the Meuse Valley in Belgium: Ulrix–Closset 1975; Otte 1979; Ach valley [Geissenklösterle, etc.] and Lonetal [Höhlensteinstadel, etc.]: Hahn 1983a, 1983b; the Middle Rhineland: Bosinski 1988; Bosinski *et al.* 1995, Thuringia [Ranis, etc.]: Hülle 1935, 1936, 1938, in Germany). These micro–regions were typically river valleys, with access to caves for shelter and water and with raw material sources less than 40 km distant for the most part. This could indicate a relatively greater degree of semi–sedentism than previously thought, where seasonal mobility occurs within a more restricted geographic territory in which a variety of resources were available.

In this respect, the study of lithic economy of the Early Upper Paleolithic in Belgium has implications for the nature of the MP–UP transition to the Early Upper Paleolithic. A study such as the one attempted here demonstrates the variability in Early Upper Paleolithic adaptations to unknown environmental contexts.

THE MIDDLE TO UPPER PALEOLITHIC TRANSITION

The Middle to Upper Paleolithic transition, roughly 60–30,000 years ago, has been the subject of much research and often heated debate, particularly during the past twenty years. First, there are marked differences between Middle and Upper Paleolithic periods, in several domains (see below) and Neandertal anatomy disappears by the end of the transition. Researchers have attacked the related questions of what happened during the transition and why change occurred at this particular period from multiple domains: biology, technology, subsistence and cognition. The debate has focused on two opposing hypotheses which concern the evolutionary and behavioral relationships between Neandertals and early modern humans, the origins of modern humans and the origins of the Early Upper Paleolithic (see Allsworth–Jones 1993; Carbonell and Vaquero 1996; Clark 1989; Clark and Lindly 1989; Delporte 1968; Klein 1990, 1992; Kozlowski 1988, 1989; Marks 1983; Mellars 1973, 1989a, 1989b, 1990, 1991; Mellars and Stringer 1989; Akazawa *et al.* 1992, Akazawa *et al.* 1998; Nitecki and Nitecki 1994; Otte 1988, 1990a, 1990b, 1996; Straus 1983, 1990c; Straus and Heller 1988; Straus and Otte 1996; Straus *et al.* 1992; Stringer 1989; Svoboda 1986; Svoboda and Simán 1989; Tuffreau 1990; Valoch 1984; White 1982; Wolpoff 1989, among many others).

One hypothesis – *continuity* – argues for regional development of Early Upper Paleolithic behavior and evolution of early modern humans from local Middle Paleolithic populations. As will be seen in the following discussion, this is in part based on a lack of change or continuity in certain areas of behavior at the time of the transition, but which occurred later. Wolpoff's (1989) multi–regional hypothesis for the evolution of modern humans argues for parallel evolution, albeit with extensive inter–group gene flow, in various regions (Europe, the Near East, China), with modern humans evolving from regional populations and developing Early Upper Paleolithic behavior.

The opposing hypothesis, and one increasingly supported by multiple lines of evidence, is that of *replacement*. According to this view, early modern humans evolved independently of European Neandertal populations, probably in Africa or the Near East, and gradually migrated across Europe and Asia, replacing indigenous populations who eventually became extinct. This hypothesis has provoked further research into the nature of the presumed contact between Neandertals and early modern humans – whether or not there was interbreeding between the populations, exchange of ideas, peaceful co–habitation, acculturation (see Harrold 1989; d'Errico *et al.* 1998).

The discussion that follows examines the evidence from the four domains listed above – biology, technology, subsistence, and cognition – and discusses the implications of these results for the continuity and replacement hypotheses.

Biology

Near East skeletal remains of early modern humans and Neandertals show the co–existence of two different populations for at least 30,000 years. Early modern humans have been found at Skhul and Qafzeh and are dated by TL to around 100–90,000 years ago (Schwarcz *et al.* 1988; Valladas *et al.* 1988) while Neandertals have been found at Kebara, dated by TL to around 60,000 years ago (Bar–Yosef *et al.* 1992). Two points can be made based on this evidence. First, early modern humans could have evolved out of local Neandertal populations in the Near East, having had no contact with the European population, or have evolved in Africa and migrated first to the Near East. Second, Neandertals could have migrated eastward to the Near East after early modern humans had already colonized the region. Both populations shared Mousterian technology, although differences in hunting techniques are observable, particularly related to the seasonal hunting of gazelle (Lieberman and Shea 1994). Considering that both populations had similar lithic technology, the question of which population was responsible for Middle Paleolithic assemblages in the Near East becomes important. More detailed analyses of behavior, along the lines of Lieberman and Shea's ungulate dental cementum analyses study, are necessary to identify potential behavioral differences which would distinguish the two populations in the absence of human remains.

At any rate, the early presence of modern humans and the co–existence of the two populations suggest evolution of modern humans independently of the European Neandertal population.

In France, late Neandertals have been found at the sites of Saint–Césaire and la Grotte du Renne, dated to around 35,000 years (Lévêque and Vandermeerch 1980; Lévêque *et al.* 1993). The associated technocomplex – the Chatelperronian – is found in France and Spain and is noted for its Upper Paleolithic character. The makers of the Chatelperronian are seen as being Neandertals, and this suggests the survival of Neandertals in marginal areas or areas reached most recently by early modern humans, with co–existence for around 5,000 years until Neandertals became extinct. This situation parallels that of the Mesolithic–Neolithic transition in northwest Europe, France and Spain, where Neolithic farmers gradually but steadily occupied Europe. Full Neolithization is observed on the loess plains and along rivers of central Europe, but along the coastal margins and in northwest Europe, only part of the "Neolithic package" was adopted or Neolithization occurred very late, with co–existence of Mesolithic hunter–gatherers and Neolithic farmers (see Bar–Yosef 1994).

With regard to the MP–UP transition, this suggests that it took until around 35,000 years for early modern humans to reach France, therefore around 10,000 years if we go by the date of the earliest Aurignacian site – Bacho Kiro layer 11, Bulgaria, dated to >43,000 yrs BP (GrN–7545) (Kozlowski 1982).

The existence of the Chatelperronian technocomplex, limited to France and Spain, has provoked research on the possibility of acculturation of Neandertals in contact with early modern humans, because it contains elements similar in some respects to the Aurignacian: a blade–based lithic industry, the working of bone to make tools and ornaments. The exact nature of Neandertal–early modern human contact is still the subject of much research and debate (see d'Errico *et al.* 1998). Similar industries are not, however, found in the rest of Europe, indicating a localized “acculturation” phenomenon in France and Spain. What *is* seen, particularly in eastern and southeast Europe, during the Late or Final Mousterian and during the MP–UP transition, is a multiplicity of different industries characterized by different reduction techniques and new tool types, such as foliate points (e.g., Szeletian, Jerzmanowician, etc.) and foliate point industries in northwest Europe (observed at the Belgian sites of Couvin, Spy, Goyet, Trou Magrite, and British sites of Beedings and Kent’s Cavern), which could represent localized acculturation processes.

It is the co–existence of Neandertals and early modern humans in the Near East and the association of late Neandertals with the Chatelperronian technocomplex that makes these human remains relevant to the MP–UP transition. The most limited interpretation is that there were two separate human groups which co–existed for around 30,000 years, when something caused early modern humans to change their behavior, to migrate and to eventually replace Neandertals in Europe.

Another line of evidence focuses on the analysis of mitochondrial DNA in contemporary modern humans (Cann *et al.* 1987; Stoneking and Cann 1989; Stoneking 1997). This led to the “Out–of–Africa” hypothesis, which argued that modern humans evolved in Africa and migrated out of Africa (via the Near East into Europe and Asia) around 200,000 years ago. Despite statistical problems in the initial analysis (see e.g., Templeton 1996), recent studies have supported this view.

More recently, mtDNA extracted from Neandertal bones demonstrated that Neandertal genetic variability falls outside the normal limits of modern humans and thus that Neandertals did not contribute to the modern gene pool (Krings *et al.* 1997). This research is currently based on a single sample, but suggests that Europe was colonized by early modern humans who did not interbreed with indigenous Neandertals.

In sum, the biological evidence to date suggests a non–European, probably African, origin for modern humans who remained essentially similar in behavior to Neandertals in the Near East until around 60,000 years ago. Beginning at this time and continuing during the MP–UP transition, major behavioral changes began to occur, although not simultaneously, and early modern humans began to migrate into Europe and Asia, gradually replacing Neandertals as new patterns of behavior gave them a selective advantage over Neandertals.

An interesting question can be proposed with respect to the changes occurring in the Final Mousterian in eastern Europe between 60 and 45,000 years ago (see Svoboda 1986; Svoboda *et al.* 1996; Svoboda and Simán 1989; Allsworth–Jones 1986). If early modern humans were still using Mousterian technology, is it possible that they migrated out of the Near East into eastern Europe carrying this Mousterian technology and then were responsible for the variety of Final Mousterian industries there, leading to the origin of the Aurignacian? On a time scale, this would mean that early modern humans were in eastern Europe between 60 and 45,000 years ago, undergoing a period of experimentation with new techniques and tool types, finally developing the Aurignacian around 45,000 years ago, and then colonizing the rest of Europe from 45 to 35,000 years, transporting Aurignacian technology.

Technology

The differences between Middle and Upper Paleolithic technology, as noted by numerous researchers (e.g., Mellars 1989b), are striking: a change in techniques of manufacture and core preparation, from flake technology that produced ordinary and Levallois flakes to prismatic blade technology, a much greater diversity and standardization in formal tool types, the appearance of an elaborate bone/antler/ivory industry to produce tools, ornamentation (e.g., beads and pendants) and mobile art.

The first difference appears to reflect a change in how cores were perceived. Boëda (1990) argues that the change in core reduction techniques reflects a change from surface to volumetric conception of the core. Instead of shaping the core to extract a blank from the surface, as is done, for example, in Levallois technology, the core is prepared to produce a continuous series of similar blanks until the core is exhausted, without the need for intervening elaborate core preparation. Hayden (1993:118) argues that prismatic blade technology is "'incomparably easier' than the manufacture of a Levallois point." Prismatic blade technology is also seen as a more efficient core exploitation strategy: more blanks are produced per core and there is more useable edge on blades than on flakes. Finally, blade technology, by the serial sequence of production, permits the production of standardized blanks for easy hafting as interchangeable elements.

The second difference, greater diversity in tool types, appears, at first view, to contradict the standardization of blanks. However, while blade blanks are essentially similar in form (long, narrow, with roughly parallel lateral edges), it is the secondary treatment – retouch and tool shaping – that contributes to the diversity in tool forms. During the Middle Paleolithic, flakes could be retouched in a limited number of ways but during the Early Upper Paleolithic, new tool forms were developed that went beyond simple edge retouch.

This diversity has been interpreted as reflecting the development of special–purpose tools as opposed to general, multi–function tools (Straus 1990a, 1993; Peterkin 1993). More specifically, specialized tools appear to have been associated with different game hunted, most clearly around 20,000 years, at the Last Glacial Maximum and during the Late Upper Paleolithic. The development of burins and perçoirs (borers) has been seen as related to the appearance of a bone industry.

In contrast to such diversity and tool specialization, Mousterian assemblages are generally dominated by sidescrapers which were used for multiple purposes, as seen in the results of use–wear analysis (Beyries 1988, Anderson–Gerfund 1990).

The Early Upper Paleolithic is thus characterized by continued innovation and improvement. This is in marked contrast to the long period during which the Mousterian toolkit remained basically unchanged.

The most striking difference between Middle and Upper Paleolithic technology is the appearance of an elaborate industry exploiting bone, antler and ivory. For the first time, these materials form an important part of the raw materials exploited to produce tools. In addition, they were used to produce objects of art and ornamentation. While deliberately flaked bones have been found in Middle Paleolithic contexts, they are rare. The crucial difference, apart from the common use of these materials during the Early Upper Paleolithic, is that their physical properties are recognized and taken into account when worked. The earlier flaked bones appear to have resulted from attempts to flake bone as if it were stone.

Bone, antler and ivory were used to make tools and weapons, ever increasingly so during the Upper Paleolithic. Perhaps more importantly, from a cognitive or social point of view (see below), they were also used for art (carved figurines, engravings, etc.) and ornamentation (beads, pendants, etc.), unknown during the Middle Paleolithic.

Finally, this is probably the first time that stone tools were made for use in making other elaborate tools (apart from shaping wooden spears, digging sticks and the like).

All of these differences appeared with the earliest Aurignacian and became more and more elaborate during the Early Upper Paleolithic. They thus follow the MP–UP transition and indicate that something fundamental occurred during the transition to provoke such radical changes in social and technological behavior.

In sum, there is a radical change in technological behavior occurring at and subsequent to the MP–UP transition. This can be seen as abrupt, in marked contrast to the long period during which the Mousterian technocomplex remained unchanged, but it probably developed gradually in one particular area (perhaps eastern Europe) before becoming widespread across Europe and Asia as the Aurignacian technocomplex. Again, this is similar to the Neolithic: domestication of plants and animals occurred in the Near East, with major social changes and the development of an established sedentary farming culture before Neolithic populations began migrating across Europe. Bar–Yosef (1994) suggests that the MP–UP transition should be studied in a manner analogous to the way the origins of agriculture have been studied. The core area – the area of origin for Aurignacian technology – should be identified, followed by documentation of its spread and development during the Early Upper Paleolithic. Such a view would further support the replacement hypothesis.

Art and Ornamentation

I will discuss only briefly here the appearance of art and ornamentation during the Early Upper Paleolithic, as there is a voluminous literature devoted to all aspects of Paleolithic art. Here it suffices to observe that it is in the Early Upper Paleolithic that we first see cave paintings (e.g., Chauvet, dated to 30,000 years BP; Chauvet *et al.* 1995), mobile art (carved anthropomorphic and animal figurines, engraved bone plaquettes and atlatls) and body ornamentation (beads, pendants).

The existence of such art and ornamentation has been interpreted, in general, as serving symbolic, religious and social functions, and to transmit information (e.g., Mithen 1990). Whether or not we are able, today, to reconstruct past religious systems, the presence of art and symbols supports the interpretation that such systems did, in fact, exist.

Lindly and Clark (1990), arguing for the continuity hypothesis, compare the first early modern humans in the Near East and South Africa during the Middle Paleolithic with those of the Early Upper Paleolithic in order to identify whether or not symbolic behavior existed for the first modern humans, that is, whether symbolic behavior is linked to biological differences between modern humans and Neandertals. They find little evidence for symbolic behavior in the Middle Paleolithic and thus argue that the changes observed in the Early Upper Paleolithic are not related to a modern/archaic human dichotomy and that there is continuity across the MP–UP transition with respect to symbolic behavior. As will be seen below, Mithen suggests a cognitive explanation that accounts for this.

Subsistence

In contrast to technology, subsistence behavior does not appear to change greatly during the MP–UP transition but rather gradually over the course of the Early Upper Paleolithic, with the most marked changes occurring around 20,000 years BP, at the Last Glacial Maximum. Early modern humans continued to hunt animals individually or in small groups with no evidence of specialization until later in the Early Upper Paleolithic (see Enloe 1993, Pike–Tay 1991, 1993).

Chase (1989) surveys European data from the Middle and Upper Paleolithic to address whether the MP–UP transition was accompanied by a shift to specialized hunting, and whether there is evidence for planning and foresight during the Middle Paleolithic. He concludes that there is only sporadic evidence for specialized hunting during the Early Upper Paleolithic, with the major shift in hunting practices occurring around 20,000 years BP. It is at this period that there is a shift from hunting individual animals to mass hunting and the development of techniques aimed at hunting specific animal species, which become even more marked during the Late Upper Paleolithic (see for example, Straus 1992, Audouze 1987, Audouze and Enloe 1992).

For the MP–UP transition and the Early Upper Paleolithic, I would expect to see a process of change going through the following stages: invention of new technology – experimentation – adoption and maturation with associated changes in other areas of culture – establishment of culture – spread (migration and/or diffusion) with ongoing development and elaboration. During the MP–UP transition and the beginning of the Early Upper Paleolithic, one should expect to find the causes of observed change and only later would the effects of such initial innovation be observed. For each area discussed so far, one can see the initial appearance of new ideas and behavior, followed by their development and elaboration throughout the Early Upper Paleolithic.

The MP–UP transition can be seen as a germination period, with the Early Upper Paleolithic seeing the maturation and flowering of modern behavior. Radical or abrupt change did not occur in all domains simultaneously, and at different times in different regions of the world. The absence of immediate change in hunting behavior, while used as support for the continuity hypothesis, does not necessarily contradict the replacement hypothesis either.

I would argue that migration of early modern humans implies the continual encountering of new environments and unfamiliarity with the range and availability of subsistence resources. It is logical to assume that for each new region, there is a period of familiarization – mapping onto the landscape – followed by elaboration of hunting and gathering practices once the population had become established. If early modern humans reached France and Spain by around 35,000 years ago, familiarization and establishment would occur after this point, and at around 30,000 years, we see the appearance of the Gravettian technocomplex and changes in hunting strategies. In eastern Europe, where the Aurignacian was established earlier, establishment would also occur earlier.

Cognition

The observed changes during the MP–UP transition and the Early Upper Paleolithic, occurring over a period from 60–30,000 years ago, are found in different behavioral domains – technology, social structure, the development of art and ornamentation which probably served religious/ritual function and conveyed social information and eventually subsistence practices, all of which have been examined by archaeologists interested in the origins of the Early Upper Paleolithic (see, for example, White 1992, 1993; Klein 1990; Lindly and Clark 1990; Chase and Dibble 1987). Cognitive archaeologists view these changes as reflecting a fundamental change or evolution in the structure and organization of the human mind. I present here a discussion of Mithen's (1996) analysis of the evolution of the human mind.

Mithen (1996) argues that this change in the human mind is the evolution of “cognitive fluidity”, the integration of intelligence modules or domains devoted to specific kinds of information (technical, linguistic, social and natural history). In his book, *The Prehistory of the*

Mind, utilizing concepts from developmental and evolutionary psychology, he proposes three phases for the evolution of the mind:

> "Phase 1. Minds dominated by a domain of general intelligence – a suite of general–purposed learning and decision–making rules.
> Phase 2. Minds in which general intelligence has been supplemented by multiple specialized intelligences, each devoted to a specific domain of behaviour, and each working in isolation from the others.
> Phase 3. Minds in which the multiple specialized intelligences appear to be working together, with a flow of knowledge and ideas between behavioural domains (Mithen 1996:69).

Mithen compares the mind to a cathedral, with a "nave" of general intelligence, separate "chapels" devoted to specific domains of intelligence and possibly a "superchapel" corresponding to Sperber's (1994) "module of metarepresentation". Without going into detail here for the earlier phases (occurring earlier in human evolution), it is Phase 3 that Mithen sees as occurring at the MP–UP transition. It is at this point that the chapels, formerly isolated, are connected, permitting direct access between different domains (p. 76). Cognitive fluidity thus permits analogical thinking, imagination, creativity and innovation. It permits humans to see their world differently and to envision new solutions and behaviors that give them a selective advantage over populations lacking cognitive fluidity, such as the Neandertals.

The Neandertal mind, in Mithen's model, is still in Phase 2, possessing all of the domains which are isolated or only partially connected (Mithen 1996:163, Fig. 15). Early modern humans, first appearing around 90,000 years ago, start the process toward cognitive fluidity, with a connection between language, social and natural history intelligence but where technical intelligence is still isolated (Mithen 1996:206, Fig. 26). It is at the MP–UP transition, starting around 60,000 years ago, that cognitive fluidity begins to be achieved and all domains are connected (Mithen 1996:173: Fig. 17). In chapter 9, Mithen discusses in detail the various innovations in the Early Upper Paleolithic and explains them as resulting from the combined utilization of multiple domains of intelligence, from the advantages gained by cognitive fluidity (Mithen 1996:204, Fig. 25).

His explanation for why cognitive fluidity evolved in modern humans is based on the following (p. 221–2): increase in brain size around 500,000 years ago, which was related to the evolution of a grammatically complex social language that also included some non–social information; individuals who were able to exploit this non–social information gained a reproductive advantage; as social language switched to a general–purpose language, individuals acquired an increasing awareness about their own knowledge of the non–social world; consciousness adopted the role of an integrating mechanism for knowledge that had previously been 'trapped' in separate specialized intelligences.

Mithen argues that the "final step to a full cognitive fluidity occurred at slightly different times in different populations between 60,000 and 30,000 years ago. This involved an integration of technical intelligence, and led to the changes in behaviour that we refer to as the Middle–Upper Paleolithic transition. In other words, it created a cultural explosion: the appearance of the modern mind" (Mithen 1996:222). It is due to this "explosion" that research on change in the Early Upper Paleolithic is crucial: we are at the beginning of the modern human mind and can observe, via the archaeological record, how early modern humans first adapted to the range of environments in Europe, how their culture, in a broad sense, changed in now inter–related domains.

CHAPTER 4
METHODOLOGY

DEFINITION OF METHODOLOGY

The structure of scientific research includes three levels: theory, methodology, and technique. Theory is wholly ideational and is defined as a set of defined concepts and principles and the relationships or connections between them. An example is evolutionary theory, which, following this definition, consists of concepts such as variability, heritability and natural selection. Economic theory includes such concepts as costs and benefits. One can formulate research questions designed to explain particular phenomena within a given theoretical framework. There is currently no single unified theoretical framework in archaeology; rather, we have a series of competing (in my view, complementary) frameworks in the process of being formalized into archaeological theory (processual, evolutionary, post–processual approaches). The important thing is to work within a coherent, logical framework that structures research questions that can lead to explanation of phenomena.

At the opposite end, technique is defined as the analysis of empirical data, that is, the mass of information that can be obtained from the archaeological record (including interdisciplinary analyses of sediments, pollen, fauna, dating techniques, etc.). Technical analyses of all sorts are carried out in order to obtain the kind of information needed to address a given research question. Identification of raw material types, debitage types, recording of measurements, calculating distances to sources, etc., all fall within the realm of technique.

Methodology is the structural link between theory (ideational) and technique (empirical). It is within the realm of methodology that the research question is formulated, constructed within a theoretical framework and realized via technical analyses that are deemed relevant. In this way, a model can be constructed to test hypotheses and lead to explanations or, at the least, probabilistic interpretations of the data.

If one starts with technique, the result is an ever–increasing mass of information that is entirely descriptive. Such a collection of disparate facts is incomprehensible outside a theoretical and methodological framework.

MODEL BUILDING

The first methodological goal is thus to construct a model which clarifies the expected relationship(s) between raw material and lithic economy at a general scale of analysis. From the identification of raw material factors such as distance to flint sources and quality of material, and the various components of lithic economy (procurement and transport, reduction, blank selection, tool production, tool use and re–use), one can construct a testable model to interpret patterns of behavior, in this case, the phenomenon of lithic procurement and utilization. From such a model, we can then identify the variables relevant to testing the model and/or describing the phenomenon under study. Of the enormous body of data available, only certain kinds of data yield results which are appropriate to the research question. Each variable selected must be deemed relevant, i.e., it is necessary to ask what purpose each variable serves in testing the hypotheses presented by the model.

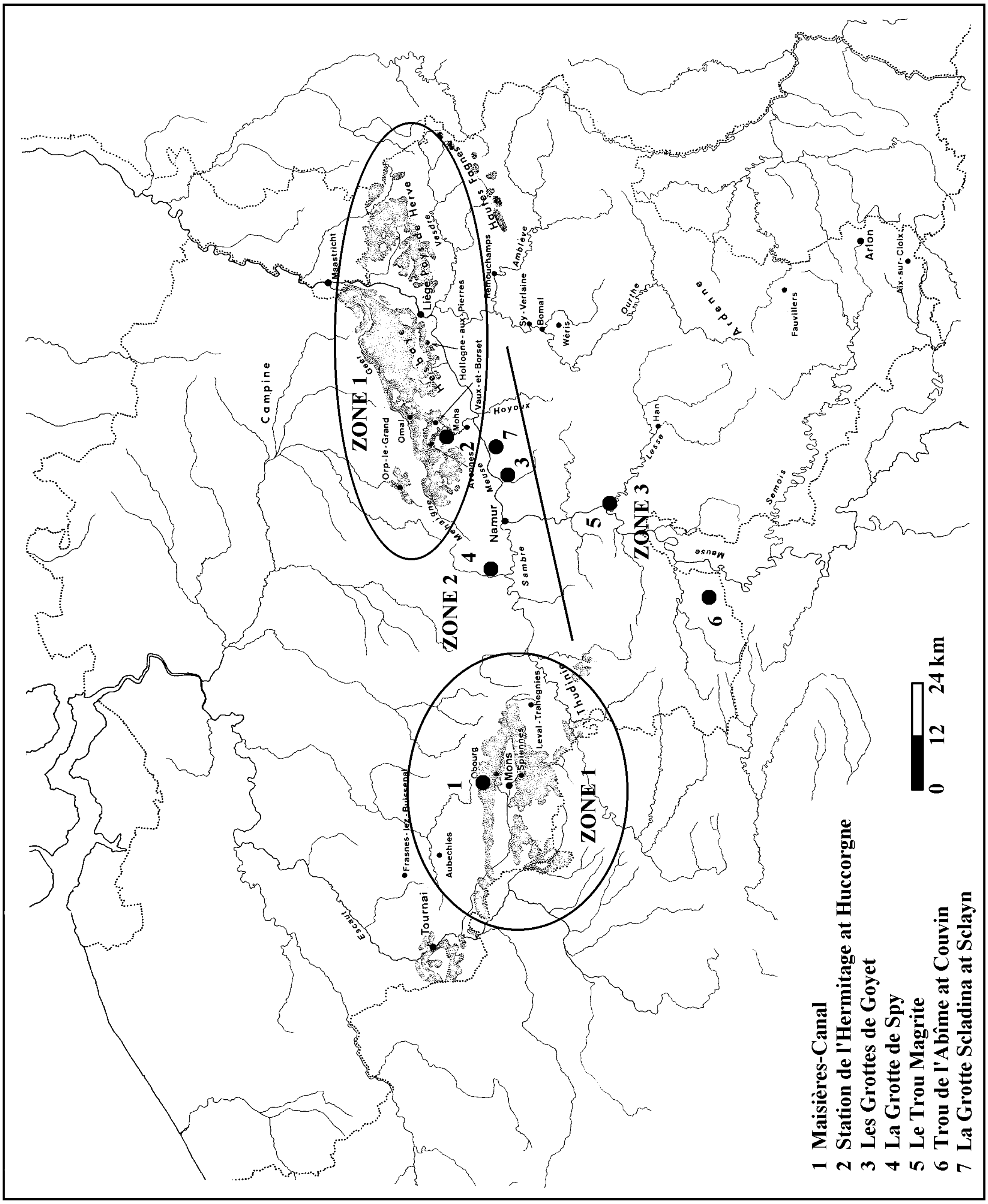

Figure 4.1. Base map showing location of study sites and raw material procurement zones.

CLASSIFICATION

Some variables, such as size measures, are straightforward, and simply require justification. These include measures of maximum length, width, thickness, weight, etc. Others require the construction of an analytical classification that is justified based on relevance to the research question. Debitage type, for example, is a variable used to identify different stages of the *chaîne opératoire* and general categories of reduction techniques employed. The kinds of debitage produced over the course of reduction must be classified with these goals in mind. In this way, the form and size of cores, blanks, and debris are relevant while artifact characteristics such as platform type may be too specific. Other research questions, more specifically focused on reduction techniques, may find appropriate various platform attributes, dorsal scars, termination types, etc.

SCALE OF ANALYSIS

The research question is phrased at a regional scale of analysis, comparing sites (albeit not strictly contemporaneous) within different zones defined on the basis of their distance to flint sources (local, intermediate, distant). However, to describe variability in raw material utilization, each site has been analyzed at the assemblage scale of analysis to identify the patterns occurring at each site. To analyze assemblages, relevant variables for the artifacts within the assemblages are identified (e.g., raw material type, debitage type, size, weight).

Archaeological analysis was first done at the scale of assemblages, examining raw material, technological, and typological variables. Such intra–assemblage analysis identified variability in procurement, reduction, and use of different raw materials.

Intra–assemblage analysis yields a description of variable responses to raw material context which can then be examined at a regional scale of analysis. Comparing variability in strategies of lithic economy across space permits one to interpret the specific patterns observed in each assemblage within the broader framework of variability in access to flint sources. Ultimately, the aim is to explain the relation between access to flint sources and changing strategies of procurement and use. Thus, comparison of assemblages in different raw material contexts, i.e., at a regional scale of analysis, is necessary.

SPATIAL DISTRIBUTION WITH RESPECT TO KNOWN FLINT SOURCES

Three spatial zones were defined on the basis of access to flint sources in order to compare lithic strategies across space (see Chapter 5 for more detailed discussion). In Zone 1, flint sources are local, within 5 km of the site. In Zone 2, flint sources are between 5 and 50 km distant. In Zone 3, the nearest flint sources are at least 50 km distant (and empirically, for the sites studied, maximally 70 km). Within Zones 2 and 3, local material (chert, quartzite, sandstone, limestone), if present, is of poorer quality than flint.

In Belgium, the distribution of flint across the landscape is uneven and the three zones described above can be fairly clearly demarcated (see map, Fig. 4.1). The two main source regions are the Hainaut Valley in the west (Obourg, Spiennes) and the Maastricht region in the east (many sources known from Neolithic mines as well as modern quarries and deposits on the Meuse terraces). These regions are part of a continuous band of Cretaceous deposits across Middle Belgium just north of the Meuse. While there are some sources of good quality in the intervening Hesbaye plateau region (e.g., the Magdalenian workshop site and Neolithic flint mine at Orp, and the Méhaigne river valley in which the site of Huccorgne is found), much of

Zone	Site	Geographic Location	Industry	Dates	Excavators	Context	Inferred function
1	Maisières-Canal[1]	Hainaut Valley	Gravettian	GrN-5523, 27965±260, Unité M.G. GrN-5690, 30780±400, Unité M.D.	de Heinzelin and Haesaerts 1966	open-air	short-term residential; workshop
1	Huccorgne[2]	Hesbaye Plateau	Gravettian	GrN-9234, 23170±160 (conv.) OxA-3886, 26300±460 (AMS) CAMS-5893, 24170±250 (AMS) CAMS-5891, 28390±430 (AMS)	Straus and Otte 1991-93	open-air	short-term hunting; workshop
2	Spy (DePuydt and Lohest)		Aurignacian			cave	residential
2	Goyet stratum 2.0[3]	Samson River	Gravettian		Dupont, 3rd cave	cave	residential
2	Goyet stratum 3.0		Aurignacian		Dupont, 3rd cave	cave	residential
2	Goyet stratum 3.1		Mousterian		Dupont, 3rd cave	cave	residential
3	Trou Magrite str. 2[4]	Meuse River, Dinant	Aurignacian	Gx-17017G, 26580±1310 (conv.) Gx-18538G, 30100±2200 (conv.) Gx-18537G, 34225±1925 (conv.)	Straus and Otte 1991-92	cave	residential
3	Trou Magrite str. 3[4]		Aurignacian	CAMS-10352, 41300±1690 (AMS) Gx-18539G, > 33800 (conv.)	Straus and Otte 1991-92	cave	residential
3	Trou Magrite str. 4		Mousterian		Straus and Otte 1991-92	cave	residential
3	Trou Magrite str. 5		Mousterian		Straus and Otte 1991-92	cave	residential
3	Trou de l'Abîme[5]	Couvin	Late Mousterian (transitional)	Lv-720, 25800±770 Lv-1559, 46820±3290	Cattelain and Otte 1984-85	cave	short-term hunting

Table 4.1. Summary information for study sites and assemblages.

Dates published in: 1 Maisières-Canal: Haesaerts and de Heinzelin 1979. 2. Huccorgne: Straus *et al.* 1997. 3. Goyet: Germonpré 1997. 4. Trou Magrite: Straus and Otte (eds.) 1995. 5. Trou de l'Abîme: Gilot 1984; Ulrix-Closset, Otte and Cattelain 1988.

the flint found during surface survey was of poor quality, unsuitable for reduction. Additionally, posterior geological deposition on the Brabant and Hesbaye Plateaux made access to much of this flint impossible, except where rivers such as the Méhaigne exposed Cretaceous formations. In northern Belgium, any possible flint sources, currently unknown for this reason, would also have been deeply buried by overlying geological deposits (sands). South of the Meuse, flint sources are virtually absent because the geological history of the Ardennes, more ancient than the Cretaceous, did not include conditions under which flint formation could occur. Other useable, but poorer quality, materials such as chert, quartzite, and limestone, can be found. Based on the distribution of flint, the three zones can be demarcated geographically as follows:

Zone 1: Hainaut Valley, Maastricht region (flint–rich)
Zone 2a: Brabant and Hesbaye Plateaus (some flint)
Zone 2b: region south of the Meuse and Sambre Rivers (no local flint)
Zone 3: southern Belgium, starting roughly parallel with Dinant (no local flint)

Sites have been selected for each zone, according to Table 4.1.

VARIABILITY IN SITES

In addition to geographic location and distance to flint sources, the six study sites vary in other ways which may obscure variability resulting from access to flint. First, both Aurignacian (earlier) and Gravettian (later) industries are represented in the sample. There are typological differences between the two industries, but both do utilize the prismatic blade production techniques as well as flake production ones, thus eliminating possible differences in quality requirements.

Second, the two Gravettian sites are open–air locations, while all of the Aurignacian sites studied are in caves. The open–air Gravettian sites were selected because of their proximity to flint sources in the Hainaut Valley and on the Hesbaye Plateau. There are very few open–air Aurignacian sites known and these are limited to the Hainaut Basin (Fourny and Van Assche 1992), while the rest are found in caves along the Meuse and its tributaries in Middle Belgium. Differences between open–air and cave sites and between Middle and South (Upper) Belgium may reflect differences in site function and seasonality.

Third, based both on the total weight and frequency of artifacts and on reduction stages present, sites vary in inferred function. This is a general distinction between sites which can be interpreted as "residential" or "logistical" (Binford 1979). Residential sites have a *relatively* longer duration of individual occupation, and include features such as hearths, activity areas (not studied at this scale of analysis), and show evidence of provisioning the site with flint and on–site reduction for use. Logistical sites are short–term, specialized–activity sites, with transport only of tools needed for particular activities (e.g., possibly Trou de l'Abîme) or intense reduction activity, at slightly longer–term sites combining subsistence and lithic resource procurement, with export of cores and/or blanks and tools (e.g., probably Maisières–Canal, Huccorgne). Analysis of the assemblages shows variability which can be attributed to site function as well as distance to flint sources.

ARCHAEOLOGICAL DATA

For analysis of assemblages, three categories of variables were used: 1) raw material variables, 2) technological variables, and 3) typological variables. The *raw material structure* of an assemblage refers to the distribution of different raw materials which have been used. The *technological structure* refers to debitage types present in an assemblage (cores, blanks, tools, debris) which can be used to make inferences about reduction techniques employed, intensity of reduction, etc. Additionally, it includes the *typological structure* of the tools present.

Raw material variables

Raw material variables (Table 4.2) were selected for three purposes. First, macroscopic attributes were used to identify different raw material types present within each assemblage. While such a method may be overly sensitive, artificially increasing variability within an assemblage by identifying several types which may come from a single source, in practice, it permits the identification of descriptive types which can then be compared with samples from known sources to identify provenience. Types which are fairly similar can also be grouped even if exact source is unknown. Second, the kind of cortex and cortex wear (e.g., fresh chalk versus waterworn cobble cortex) permits the identification of raw material procurement from primary or secondary geological deposits. Variability in such procurement contexts may have implications for the quality of material (decrease in size, damage due to movement by natural processes). Third, the proportion of cortex is used to identify reduction stage, such as primary reduction (cortex removal and initial core preparation). In this way, one can then make inferences about the form under which the material was transported to the site.

Raw material types are also used when analyzing technological structure of assemblages. Discussed in more detail below, patterns of intra–assemblage raw material variability can be identified with respect to form of transport, reduction strategies utilized, etc. More importantly, the raw materials transported to the site can be ranked by frequency and weight, revealing (in each site studied) clear differences in strategies of transport and utilization.

Variable	Purpose
cortex (presence/absence)	to identify possible relative nearness of material source
cortex type	to identify geological context and primary or secondary procurement context
cortex wear	to identify whether material was procured in primary or secondary context (fresh chalk versus waterworn)
proportion of cortex	to identify reduction stages (primary, secondary)
patina color	to attempt to identify correlations between a specific material and patina color (i.e., are there distinctive patinas that can be used to identify a material type?)
patina degree	to possibly identify different occupations or differential patination among levels or site areas
number of patina episodes	to identify the possible reuse of artifacts discarded earlier
unpatinated color	to identify material types
grain size	to identify material types
texture (matte, glossy)	to identify material types

Table 4.2. Raw material variables.

1) shatter: < 10 mm, lacks Hertzian flake morphology, angular	incidental debris produced during reduction / blank production
2) trimming flake: < 10 mm, shows Hertzian flake morphology	debris produced during tool production, when a tool is shaped or resharpened
3) flake: > 30 mm, shows flake morphology, non-Levallois	blank produced from flake reduction techniques
4) bifacial thinning flake: lipped platform, curved profile	debris produced when shaping the faces of a blank, can be a bifacial or unifacial tool, such as a biface or foliate point
5) Levallois flake: identified on the basis of dorsal and platform morphology (see Boëda, Van Peer, and others)	blank produced after deliberate core preparation to control form of blank
6) Levallois blade: same	same
7) blade: length is greater than or equal to width, commonly has dorsal blade scars with a central ridge (see 9)	blank produced from blade reduction techniques (e.g., prismatic)
9) unidirectional crested blade: same as blade (7) but dorsal morphology has a single blade scar on one side of the central ridge, a splintered (old platform) ridge, and a series of scars perpendicular to the ridge	blank (often selected for tool retouch) produced during the process of core preparation when a core is turned to remove a platform
10) bladelet: differs from a blade only in size, width is much more narrow in relation to length	blank produced during bladelet reduction techniques
11) chunk: amorphous piece which lacks clear core morphology but has faces which are remnants of removal scars	possibly exhausted core
12) core: nodule/cobble/block which has removal scars and/or platforms (subtypes based on core morphology also defined (coretype)	block of material which has been reduced
13) platform renewal flake: can be in tablet form (sausage slice) to rejuvenate the core platform	debris (sometimes also selected for tool production) produced during core preparation
16) small angular debris: 10-30 mm, lacks flake morphology, angular	incidental debris produced during reduction / blank production
17) small debris flake: 10-30 mm, shows flake morphology	flake removal during core shaping and preparation, not necessarily intended as a blank
17.1) small blade: 10-30 mm, same as blade (7)	probable blanks
18) Levallois point: see Boëda and others	blank produced after deliberate core preparation to control form of blank
19) large angular debris: > 30 mm, lacks flake morphology, similar to chunk (11) but less globular	incidental debris produced during reduction (versus an exhausted core lacking core morphology which would be a chunk, type 11)
20) large debris flake: > 30 mm, irregular	possible blanks but generally unsuitable for tool production based on irregularities in form or presence of inclusions and flaws
21) splintered piece: > 30 mm, edges are splintered and battered, may have been a core	
22) burin spall: not unlike a bladelet; narrow removal, quadrangular or triangular cross-section, often curved or twisted	removal during tool production to produce a burin

Table 4.3. Description of debitage types and probable production stage.

Technological variables

Technological variables were recorded to describe several features of the technological structure of assemblages: 1) transport form of material, 2) relative degree of reduction, 3) kinds of reduction techniques employed (kinds of blanks produced), 4) size and kinds of blanks selected for tool production, 5) differential selection of blanks for different tool types, 5) intensity of tool use, etc.

debitage type (Table 4.3)

A debitage classification was adapted from the existing typology developed by Straus *et al.* and used by the South Belgium Paleolithic Project in order to differentiate between the various products of reduction. The main difference here is that cortex was not used in the classification, but recorded separately. A general classification (variable "gensort") distinguishes between the major categories of reduction products:

1) cores: nodules, cobbles, or blocks or material from which flakes were removed
2) blanks: unretouched flake, blade, and bladelet removals (not necessarily useable, due to shape or size; also, may have been used unretouched)
3) debris: incidental shatter produced during reduction, either during core preparation or blank removal; also includes debris produced during tool production (trimming flakes, bifacial retouch flakes) (defined as less than 10 mm for maximum size, and therefore excluded from the pool of potential tool blanks, but also including type 20, large debris flakes of very irregular form that are not suitable for tool retouch)
4) tools: items with deliberate retouch (commonly flakes, blades, and bladelets, but can include cores, debris flakes, core preparation flakes)

A more detailed classification (variable "debtype") was constructed based on flake morphology, form, and size. This permits the kinds of reduction techniques employed to be identified (i.e., kinds of blanks produced).

Flake morphology: presence/absence of flake morphology, such as bulb of percussion, conchoidal fracture (separates incidental debris from deliberate removals, such as blanks and retouch trimming flakes).

Form/shape: length to width ratio (separates different kinds of blanks). For whole blades, maximum length is at least twice the maximum width. Partial blades can be separated from bladelets by their width. Bladelets can be subsumed within the blade category, but generally are much narrower with respect to length. For flakes, maximum length is less than twice the maximum width. (Refer to Table 4.2 below for more details on differences in form.)

Size: Three general size categories (Table 4.4) were defined (as a rule, these categories separate potentially useable blanks from unusable debris). It will be seen that most tools are made on blanks >30 mm long, although there are exceptions.

size gensort	< 10 mm	10–30 mm	> 30 mm
debris	1 – shatter	16 – small angular debris	19 – large angular debris
debris	2 – trimming flake	17 – small debris flake	20 – large debris flake
blanks		17.1 – small blade	3 – flake
blanks		10 – bladelet	7–9 – blades
blanks			5 – Levallois flake
blanks			6 – Levallois blade
blanks			18 – Levallois point
blanks			21 – splintered piece
Not grouped by size			
cores	11 – chunk	12 – core	
debris	13 – platform renewal flake	22 – burin spall	

Table 4.4. Debitage types by size grouping.

Other variables

Variable	Purpose
size (length following flaking axis, maximum width perpendicular to length, maximum thickness perpendicular to length, weight)	to identify potential blanks, to evaluate intensity of blank production, blank selection by size, etc.
portion (whole, proximal, mesial, distal)	to isolate whole artifacts from partial ones for certain analyses where portion affects size

Table 4.5. Other variables.

Finally, certain variables were recorded for supplemental analyses outside the scope of this research (Table 4.6). This was done because the artifacts were not individually numbered for several of the assemblages studied and it was considered practical to record certain characteristics along with those to be immediately analyzed. From personal experience, it is frustrating, if not impossible, to re–analyze a collection, adding new variables to be studied in relation to those already measured.

Variable	Purpose
platform type (plain, facetted, lipped, cortical...) platform length and width	to identify specific techniques of core preparation (a technical analysis at a different scale of analysis, not done in this research)
termination type (feather, hinge, bending, *outre–passé*, cortical)	same, but also to potentially evaluate workability of different materials (where hinge fractures would indicate failure to complete a removal)
dorsal face (kinds of scars, number of scars)	to evaluate reduction techniques (Levallois, flake, blade)
cross–section (triangular, almond, convex, concave, etc.)	to make inferences about standardization of blank form

Table 4.6. Other variables recorded for supplementary analyses.

Typological variables

In order to examine whether differential selection of blanks for different types of tools was practiced, or more generally, different types of materials for different types of tools, the de Sonneville–Bordes and Perrot typelist (1953) was used to classify tool types.

An additional variable, *shaping intensity* was also recorded to evaluate the relative intensity of tool shaping on a scale from 1 to 3, qualitatively recorded on the basis of retouch: fine, marginal retouch; more invasive (removing slightly large retouch flakes); and substantial modification (alteration of the perimeter, preparation of tangs, point tips, foliate points, etc.). This variable was based in general on work by S. Kuhn, who developed an index of resharpening which "estimates the amount of a blank removed by primary modification or resharpening" (Kuhn 1995:125) and H. Dibble (1985) who viewed the ratio between flake area and platform area as reflecting intensity of resharpening. A tool was seen as having low shaping intensity if retouch did not significantly alter the original perimeter of the blank. This would include marginal edge retouch. A tool had high shaping intensity if the form was substantially altered, for example carinated endscrapers, where the front has a particular, standardized form. Font–Robert points also have a high shaping intensity because the tang, or hafted end, in addition to the working edge, is deliberately shaped.

GEOLOGICAL DATA

Geological data collected and utilized in my research follows the reasoning of Demars (1982) and Geneste (1985). Detailed macroscopic descriptions make it possible to make probable, usually general (although not always exact) provenience or source identifications, even given overlap in material characteristics. This approach is accurate enough for the scale at which this research is conducted and probably for most archaeological questions. A lithic reference database, with detailed macroscopic descriptions and photographs for known geological proveniences can be used by any archaeologist without requiring a specialist and costly analyses.

Given the needs of my research for such geological data, I was fortunate to have been able to meet with Prof. Pierre Vermeersch (Katholieke Universiteit, Leuven, Belgium) and Dr. Marjorie de Grooth (Bonnefanten Museum, Maastricht, The Netherlands) and their raw material working group. Lithic reference collections were studied at both institutions, for a series of 346 samples from 52 proveniences in Belgium, southern Netherlands and bordering western Germany near Aachen (see Appendix 1). These were supplemented by additional field survey and sample collection by me in flint source areas and more locally around the study sites.

The following is a discussion of the applicability of such geological data in my research.

Distance from source to site

Identification, probable if not definite, of geological provenience or source regions, makes it possible to estimate distances from site to different sources of raw material found at the site. From the range of the dominant materials present in an assemblage, it is possible to make inferences about the procurement range of the group occupying the site. The *procurement range* is defined as the territory containing material sources actively exploited by the group during occupation of the site. It does not include the territory previously exploited and from which material has been transported as an active toolkit. The sources of such transported material are no longer being exploited.

Relative quality

As discussed in chapter 1, materials (ranging from flint to quartz) can be generally ranked by quality without needing to look at very specific attributes. However, the characteristics of different kinds of flints (e.g., kinds of inclusions) permit an evaluation of relative quality if necessary.

Sourcing

Sourcing of material found in archaeological contexts was done by comparison of the macroscopic attributes of the material with the range of geological samples (see Luedtke 1992, Séronie–Vivien and Séronie–Vivien 1987). In some cases, source identification is relatively simple, because the characteristics are distinctive and the sources are highly localized (e.g., phtanite, see Caspar 1982). In other cases, notably the range of gray flints which are found across Belgium, identifications rest probable but not definite, and are based on slight differences in inclusions, cortex, and color.

If a source cannot be identified, artifacts were grouped based on general similarity in macroscopic characteristics on the assumption that the material came from the same source, even if unknown. Thus, for each site, there is a series of material types that have known sources (Obourg, etc.) and a series that have unknown sources (black flints, brown flints, etc.).

Other approaches

If detailed identifications must be made (e.g., to make fine distinctions between gray flints), the macroscopic method can narrow the field of possibilities and specialized approaches can then be used to make positive identifications. However, researchers applying specialized techniques have encountered variable results.

Stockmans *et al.* (1981), examining 108 flint samples from Belgian and British quarry exposures, flint mines, and prehistoric sites, performed trace element analysis for 8 elements (phosphorus, aluminum, magnesium, iron, calcium, potassium, sodium and lithium), and then applied multivariate discriminant analysis to identify the variables which maximize group differences. The assumption of trace element analysis is that certain elements or combinations of elements may be sufficient markers of specific sources, making identification of flint sources in prehistoric contexts possible by comparison. While some general distinctions between groups could be made (e.g., layers 1–2 from layers 3–5 of the Craie d'Obourg at Harmignies, Stockmans *et al.* 1981, fig. 2), substantial overlap between specific groups remains. They conclude that "a difference may be seen in trace element contents, if one considers a limited number of mined layers in different areas, but if one compares different sampling places in the same area, no good distinction can be made from trace element constituents" (Stockmans *et al.* 1981:87).

However, Jack Rink's recent electron spin resonance study (pers. comm.) of an Iceland jasper found that jaspers are quite readily distinguishable and distinct, based on the ESR signature compared to known sources.

ANALYSES

Analyses at the assemblage scale of analysis

At the assemblage scale of analysis, comparison between material types was done to identify the range of materials present, to rank raw materials by count and weight, to identify form of transport of materials, reduction strategies employed, kinds of blanks selected for tool production, and kinds of materials selected for specific tool types. In sum, the aim of these analyses was to identify the *chaîne opératoire* for each material type within an assemblage. Chapters 6 through 11 present the results of these analyses for each of the study sites.

Range of materials present

The range of materials present is simply the number of different material types present, grouped and ungrouped. The range has implications for the size of the procurement territory, as reflected by the number and distance of multiple sources regularly exploited. In general, each study site had a single material type that was overwhelmingly dominant. For less common materials, the range may reflect mobility rate, as active toolkits are transported from site to site without being exhausted. For example, several types present as active toolkits from sources no longer exploited may reflect movement from several different sites in succession over a short period of time, with different sources actively exploited at each site.

Ranking of raw materials

Material types are ranked by both count and weight, although, in most cases, the rankings are similar by both measures. Ranking reflects the relative importance of a given material type in the assemblage. When this ranking is examined in conjunction with the technological structure for each material type and the sources of these materials, clear patterns emerge. Ranking of raw materials and technological structure for each of the materials present are independent: rank is based solely on frequencies by count and weight, while technological structure is based on relative frequencies of the defined debitage classes.

The correlation of distances to sources with raw material and technological structure shows that the ranking reflects variability in lithic economic strategies (transport, reduction, intensity of use) and not merely decreasing inclusivity in assemblage components due to ongoing reduction of the material. That is, when one looks only at technological structure for each material type, the components which drop out do not do so at random. When one adds distance to source as a factor, it is clear that strategies change as a function of distance. The pattern of decreasing inclusivity reflects different stages in the "life history" of the raw material type: top–ranked materials are "young", i.e., most recently obtained and actively exploited; low–ranked materials are "old", i.e., have been in the possession of the human group for the longest duration, and reflect the last vestiges of the material still in use by the group.

Two rankings are provided in the analysis chapters, one general and one collapsed. The general ranking gives percentages by count and weight for each of the grouped material types. The collapsed ranking groups material types with similar frequencies in an assemblage into three tiers: Rank 1 was generally > 50%, Rank 2 was 2–10%, and Rank 3 was <2%. (Spy–DPL is an exception, with Rank 1 at 31%, Rank 2 10–18%, and Rank 3 <10%, possibly due to the relatively high diversity in materials at Spy, which is, in my opinion, a reflection of multiple occupations lumped together in the old collections.)

Form of transport

Form of transport was inferred from cortex attributes, the presence of primary reduction debris, the size of cores, and the general technological structure (presence/absence of cores, reduction debris, blanks, tools). Material could be transported as unprepared blocs (high proportions of cortex, primary reduction flakes, relatively larger cores, reduction activity present), as prepared cores from an actively exploited source (lower proportions of cortex, reduction activity present), as an active toolkit (cores in active use but source is no longer exploited), or as blanks and/or tools only (cores absent, material represented by blanks, tools, and resharpening debris).

Core reduction/blank production

For each material, the relative frequencies of debitage types were calculated, to identify the different reduction techniques employed,. The kinds of cores present also provide information about reduction techniques (flake cores, prismatic blade cores, etc.). Comparison between materials identified possible patterns of differential blank production according to material quality and distance to source. Finally, the relative proportions of blanks and reduction debris permit inferences about the degree of reduction activity occurring for different materials.

Blank selection for tool production

A cross–table of debitage type and tool categories (grouped into general categories such as endscrapers, burins, etc., not by the original individual types) and χ^2 analyses tested whether specific debitage types were selected non–randomly for specific tool categories.

Material selection for specific tool types

Similarly, non–random selection of material types for specific tool categories was tested using χ^2.

Analyses at the inter–assemblage scale of analysis

Qualitative comparisons between assemblages were done to assess the variability in strategies of procurement, transport, and reduction strategies, and intensity of core reduction/blank production, tool production and tool utilization as sites vary in distance to flint sources. The results of these analyses are presented in Section 3.

CHAPTER 5
GEOLOGICAL CONTEXT AND PROCUREMENT ZONES

This chapter describes the geological context or Upper Pleistocene natural landscape in which prehistoric human groups found themselves, and in which they had to search for shelter and raw material resources. The relevant details of the geological composition of Belgium, in reference to prehistoric human needs, are summarized, primarily based on Aubouin, Brousse and Lehman (1978). The second section defines and discusses the procurement zones as conditioned by the uneven distribution of flint in this region. Appendix 1 contains a descriptive summary of the lithic reference collections while Appendix 2 contains lists and descriptions of raw material types found at each site.

GEOLOGICAL CONTEXT

Two major periods (Carboniferous and Cretaceous) during the geological history of Belgium were responsible for producing rock used prehistorically for shelter and lithic raw material. During subsequent periods, loess and sand covered limestone and Cretaceous flint in many parts of the Brabant and Hesbaye Plateaus, while dissolution processes produced caves in Carboniferous limestone along the northern flanks of the Ardennes.

Due to its geological history, karstic systems in which caves suitable for shelter are found only in certain parts of Belgium. Specifically, they are found along the Meuse and its tributaries. The original limestone deposits were formed during the Lower Carboniferous Period of the Upper Paleozoic Era, and were subsequently exposed to various natural processes which produced caves.

Likewise, flint is not evenly distributed across the landscape. Instead, it is found in an interrupted band of chalk across Middle Belgium, roughly from Mons to Maastricht, with the main flint-rich regions at each end: the Hainaut Basin in the west and the Maastricht Basin in the east (see Fig. 4.1). On the Brabant and Hesbaye Plateaus, flint is available, but is generally less accessible due to Tertiary deposits which covered many or most flint sources.

Primary or Paleozoic Era

Lower Paleozoic

According to Otte (1979:203-205), phtanite was formed during the Cambrian Period of the Lower Paleozoic (~570-500 mya), with a good quality variant being highly localized near Ottignies-Mousty (Caspar 1982, 1984). Phtanite is a homogeneous, isotropic material with no inclusions, and is similar in quality to flint. Poorer variants, which were rarely if ever exploited, are found in upland regions south of the Meuse and Sambre. The good quality variant was used prehistorically, but is never very common at EUP sites. It becomes much more common during the Neolithic when it was used to make polished adzes.

Upper Paleozoic

The karstic system of limestone was formed during the Lower Carboniferous, Dinantian and Viséen stages of the Upper Paleozoic between 340 and 325 mya (Ek 1976).

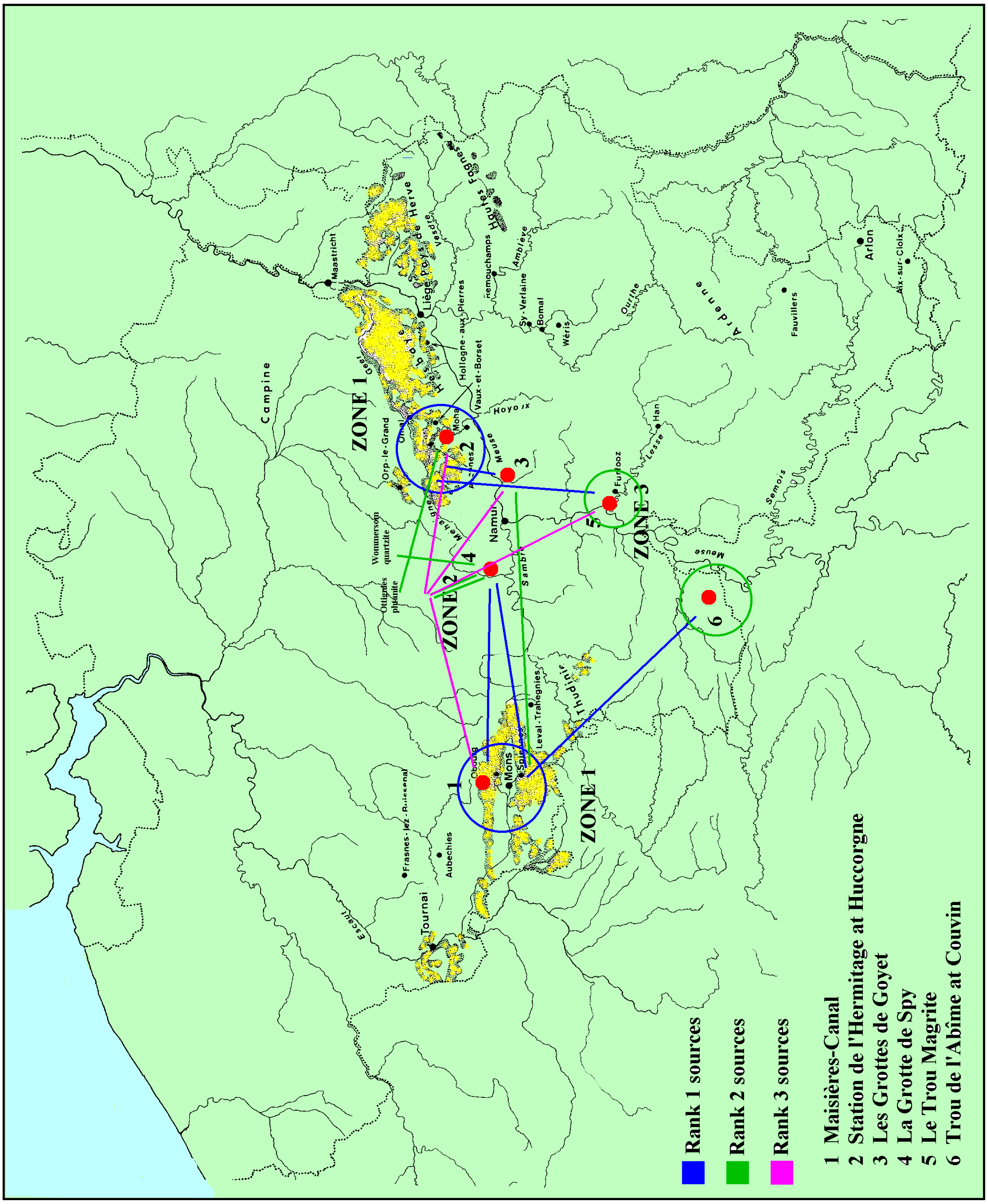

Figure 5.1. Map showing estimated distances to sources for study sites.

Caves forming later within this system include Le Trou Magrite, and were utilized prehistorically for shelter. This Viséen limestone includes the black limestone used at Le Trou Magrite as lithic raw material for toolmaking.

Secondary or Mesozoic Era
Cretaceous

Flint formation occurred during the Senonian stage, Coniacian-Santonian-Campanian-Maestrichtian sub-stages of the Upper Cretaceous ~88-65 mya, during the marine transgression which covered Belgium north of the Meuse. During this stage, thick chalk deposits were laid down on the sea floor, intercalated with layers of flint formed from diatomaceous or siliceous organisms deposited on the sea floor at various times (Aubouin *et al.* 1978).

Flint in Belgium was deposited primarily during the Maestrichtian stage, but also during the Campanian in the western region. According to Otte (1979:203-205), the black Obourg flint is Campanian, while the gray Spiennes flint found nearby is of Maastrichtian age. In the Lower Cretaceous, most of Belgium was exposed, but was covered again by sea during the Upper Cretaceous, when flint formation occurred.

Tertiary or Cenozoic Era

Eocene

At the beginning of the Eocene, Montien stage (Paléogène), the limestone of Mons was deposited, as the so-called Tertiary flint was formed (Aubouin *et al.* 1978). This flint was also used prehistorically, but has a much more localized distribution than the Cretaceous flint.

During the Middle Eocene, Bruxellian stage, Brussels sandstone was formed, ~49-43 mya. This was used prehistorically and has a localized distribution on the Brabant Plateau near Brussels.

DEFINITION OF PROCUREMENT ZONES

The uneven distribution of flint across the landscape of Belgium makes it possible to identify three zones of procurement on the basis of variable access to flint sources at each site. As summarized in Chapter 4, for sites found in Zone 1, flint sources are local, within 5 km of the site, in Zone 2, between 5 and 50 km distant, and in Zone 3, at least 50 km distant (see map, Fig. 5.1).

Zone 1 contains the two main regions of flint in primary geological context: the Bassin de Hainaut in the west (including the Obourg Chalk and Spiennes sources) and the Maastricht region in the east (including various proveniences mined during the Neolithic and flint sources found in modern quarries). It extends south to the Vesdre river valley, with the cave sites of Fond de Fôret and the Grotte Walou, where flint can be found locally. In addition to such primary sources in the Maastricht region, flint can be readily found in secondary context, eroding out of chalk formations and found near the primary source and also redeposited on ancient Meuse river terraces. According to Bosinski *et al.* (1995:834):

> "The Meuse has eroded these nodules from the Cretaceous chalk and reincorporated them in river gravels, where they become rolled and battered. This flint has a worn pebble cortex and is known as Meuse gravel flint. It can be found in the Rhine and Meuse terraces, which are widely distributed along the left (western) bank of the Lower Rhine region.

> During the Tertiary, the Tertiary ocean also eroded the chalk formations of the Meuse region. Meuse flint was redeposited on the beaches of this ocean in a highly rolled and reduced state. These Maaseier ("Meuse eggs") beach pebbles can be found on the remnants of these ancient shores in the Eifel foothills and the Bergisches Land. At a later date many of these Maaseier found their way into the gravels of the Meuse and Rhine."

Geneste (1985:164-167), among others, found it analytically useful to make a distinction between flint sources in primary and secondary position. Sources in primary position are those found *in situ* in the original geological formations (e.g., as veins and nodules in Cretaceous chalks and in limestone). Sources in secondary position are further subdivided into two groups. Sources in secondary position close to the original source (*position sécondaire proche*) are found not more than a few dozen meters from their initial geological position, for example, flint eroding out of chalk formation and found on nearby scree slopes. "Leur cortex est encore intact et crayeux et, dans ce cas, ils ne sont ni roulés, ni altérés, ni brisés, si ce n'est pas par des phénomènes périglaciaires en général d'âge quaternaire[1]" (Geneste 1985:166). Secondary sources in more distant position (*position sécondaire éloignée*) have been commonly transported by water and are found on alluvial terraces and in littoral deposits. "Leur cortex est alors totalement érodé, les formes émoussées et arrondies, ils peuvent être recouverts d'un néocortex ou d'une surface piquetée et étoilée sur les galets[2]" (Geneste 1985:167).

In Zone 1, sources in the Bassin de Hainaut are in primary position and nearby secondary position. Flint could be readily obtained from erosional slopes and eroding surface outcrops; we have no evidence for mining during the Early Upper Paleolithic, although there is an extensive series of Neolithic mines at Spiennes (Hubert 1992, among others). In the Liège-Aachen region (or the Lower Belgian/Upper Dutch Meuse Region), we have a series of sources in primary position, extensively mined during the Neolithic (e.g., Ryckholt mines on the Ryckholt Plateau), as well as in nearby secondary position. Sources in more distant secondary position are found on the Meuse terraces, but these do not appear to have been exploited in Belgian sites during the EUP. In general, as will be seen, flint utilized in the study sites has fresh cortex, indicating procurement most probably in secondary position near primary sources.

The study sites clearly in Zone 1 are Maisières-Canal in the Hainaut Basin, found within 4 km of the Obourg source and within 7 km of the Spiennes source, and Huccorgne, located in the Méhaigne Valley where the Méhaigne river cut through Cretaceous deposits, exposing good quality flint sources. A good dozen cave sites have been found clustered along the Méhaigne river valley (cave sites of Grotte du Docteur, Trou Sandron, Grotte de l'Hermitage, etc.) (Fraipont and Tihon 1889; Tihon 1890-91), as well as the open-air site of Huccorgne.

Zone 2 is the region where the majority of Early Upper Paleolithic sites are found, mainly due to the availability of caves for shelter along the Meuse and its tributaries, and where the nearest flint sources are between 5 and 50 km distant, more commonly near the more distant end of the range. Zone 2 is divided into 2a and 2b, divided by the Meuse. Zone 2a includes the Brabant Plateau and the extreme western part of the Hesbaye Plateau, where one finds phtanite, Wommersom quartzite, and rare Tertiary flint (E. Teheux, pers. comm.).

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[1] "Their cortex is still intact and chalky and, in this case, neither rolled, nor altered, nor broken, except possibly by general periglacial phenomena during the Quaternary."

[2] "Their cortex is totally eroded, and their forms are smoothed and rounded; they can be recovered with a neocortex or have a pecked and shattered cobble surface."

The relative lack of shelter in caves in the plateau regions contributes to the paucity of sites in Zone 2a. It is more probable that if sites were to be found in this zone, apart from the well-known cave site of Spy, they would have been logistical sites aimed at specific subsistence activities than for residence. This plateau region would have contained subsistence resources, with rare, localized lithic resources.

A further distinction can be made between Aurignacian and Gravettian settlement patterns: while Aurignacian and Gravettian components are both found in cave sites, the only open-air sites found are Gravettian (Maisières-Canal and Huccorgne). While the rarity of sites precludes one from drawing firm conclusions, it is possible that the pattern reflects a change in procurement strategies, with Maisières-Canal as a probable special purpose extraction site.

Zone 2b includes the region south of the Meuse, including the Condroz Plateau and extending south to the Lesse Valley, and east to the Hoyoux river, a tributary of the Meuse (thus including the site of Trou Al'Wesse). West of the Meuse, it includes the Couvin region (and the study site of Couvin, Trou de l'Abîme). The Condroz Plateau and the Ardennes region in general lack flint sources in either primary or secondary context. One can find poorer quality materials (chert, quartzite and limestone) but flint must be obtained by crossing the Meuse or following it to the Maastricht region, adding a degree of difficulty in obtaining non-local flint that is not a problem in Zone 2a. Zone 2b, however, includes the Meuse River and its tributaries, with the karstic system providing shelter in caves, and it is in Zone 2b that the majority of sites are found (study site Goyet on the Samson river and sites along the Meuse between Namur and Dinant, such as Bois Laiterie).

Zone 3 is defined by the lack of flint sources in the region and the distance from the nearest flint sources (> 50 km). The site of Le Trou Magrite, in the Lesse river valley, is located in Zone 3. Geographically, Zone 3 includes the southernmost part of Belgium, starting with the Lesse valley - the high Ardennes region - and continues into Luxembourg. During the Early Upper Paleolithic, at least, most of Zone 3 appears to be beyond the distance threshold for occupation, although it could have been exploited for subsistence resources from sites such as Trou Magrite. As discussed in more detail in chapter 12, EUP sites are rare or absent in southern Belgium, and there are only five sites (mostly in disturbed open-air contexts, and mostly Gravettian) in Luxembourg (Ziesaire 1994). It will be argued that existing procurement strategies and the need for good quality flint imposed a distance threshold on prehistoric groups, beyond which regions were not occupied. Later, for example, beginning in the Magdalenian, a change in strategies to include longer distance transport permitted this threshold of >40 km to be transcended. The absence of flint sources in Zone 3 was compensated by longer distance transport and exploitation of a previously unexploited source of silicified limestone near Cherleville-Mézières in the Champagne region of France (Miller *et al.* 1998).

In sum, the procurement zone of a given site is identified by its proximity to flint sources, whether or not these flint sources were actually used. The study sites have been selected to represent the range of variability in access to flint and thus the different zones defined, as summarized in Table 5.1.

Zone	**Site**	**Location**
Zone 1	Maisières-Canal	Bassin de Hainaut
Zone 1	Huccorgne	Hesbaye Plateau, Mehaigne River
Zone 2a	Spy	Brabant Plateau, Orneau River
Zone 2b	Goyet	Condroz Plateau, Samson River
Zone 2b	Couvin, Trou de l'Abîme	Couvin, Famenne
Zone 3	Trou Magrite	Ardennes, Lesse River

Table 5.1. Study sites and their raw material procurement zones.

Distances have been estimated from each site to source of each raw material source, where known or probable, by measuring "as the crow flies" (Table 5.2). Topographic variability has not entirely been taken into account, and actual transport or mobility routes probably followed rivers and valleys. For sources probably on the Hesbaye Plateau or in the Liège-Aachen region, where exact provenience is unknown, three estimates of distance have been given: a minimum which is the distance to the nearest part of the Hesbaye Plateau (with or without currently known flint sources), a distance to the Méhaigne river valley where flint sources are found, and a maximum distance to the Liège-Aachen region.

Site	**Maisières Canal**	**Huccorgne**	**Spy**	**Goyet**	**Le Trou Magrite**	**Couvin, Trou de l'Abîme**
Zone **Material**	**1**	**1**	**2a**	**2b**	**2b**	**2b**
1 - Obourg flint	1	85-90	50	75	75	60
2 - Spiennes flint	7	85-90	50	75	70	55
3 - Hesbaye flint	(80+)	1-5	20-35-75	5-20-60	35-40-80	(65-75-120)
4 - phtanite	49	45	25	40	55	(70)
5 - Wommersom quartzite	(85)	(30)	45	40	(65)	(90)
6 -tan flint	-	-	?	?	-	-
7 - black flint	-	?	?	?	-	-
8 - gray flint	?	-	?	?	?	-
9 - brown flint	?	-	-	?	-	-
10 - chert	local	local	local	local	local	-
11 - quartzite	-	local	local	local	local	-
12 - sandstone*	-	50	35	local?	65	?
13 - limestone	-	local	local	-	local	local?
14 – quartz	-	-	-	-	local	-
15 – chalcedony	-	-	?	-	-	-
16 – jasper	-	-	?	-	-	-
17 - olive-green flint	?	-	-	-	-	-

- not found at site, provenience unknown ? found at site, provenience unknown

( ) not found at site

* When material can be identified as Brussels sandstone, a distance estimate has been given.

Table 5.2. Distance table for raw materials found at each study site.

CHAPTER 6
MAISIÈRES-CANAL:
CHAMP DE FOUILLES AND
ATELIER DE TAILLE DE LA BERGE NORD-EST

BACKGROUND

Location of site

Maisières-Canal is an open-air site located near Mons in the Hainaut Valley (Fig. 6.1, 6.2, 6.3), near the ancient watercourse of the Haine River (Haesaerts 1978:123). It consists of two separate areas: Champ de Fouilles and Atelier de Taille de la Berge Nord-Est, separated by approximately 100 meters (Fig. 6.4). The occupation probably extended over the silty promontory toward the north slope of the Haine valley but much of this area has been destroyed due to canal work (Haesaerts 1978:123).

The Champ de Fouilles (CDF) concentration covers an area of 95 m². The main occupation horizon (sedimentary units M.G.-M.J.) yielded an abundant *in situ* lithic assemblage (n tools = 1556, n non-tools = 33,106, from the IRSNB excavations, de Heinzelin 1973:26), as well as objects made of bone, ivory and antler. The majority of this material comes from sedimentary unit M.H., with associated material from units below (M.G.) and above (M.I., M.J.). Above the occupation layer, units M.M.-M.O. are disturbed (*couches renversées et fluées*) but also contained archaeological material.

The Atelier de Taille (ATD) concentration (sedimentary unit N.D.C.) is a much smaller lithic assemblage which was found in a section of the talus on the north-east bank of the canal (n tools = 7, n non-tools = 630, de Heinzelin 1973:27). The artifacts appeared to have been redeposited within small water channels although the edges are still fresh (de Heinzelin 1973:25). The artifacts are slightly patinated, in contrast to the CDF assemblage.

Based on both pollen (Bastin 1970) and stratigraphic evidence (Haesaerts 1978; Haesaerts and de Heinzelin 1979:21), both concentrations appear to be part of the same occupation phase (i.e., contemporaneous).

Raw material context

Abundant, very good quality flint is found locally at Maisières-Canal, Obourg flint within 1 km and Spiennes flint within 7 km. The raw material context is therefore Zone 1. There are no pressures imposed on the lithic economy and procurement costs are at a minimum. Under these conditions, there should be no need to economize material. Cores could be discarded when they reached any minimally inconvenient size or shape. Only the most suitable tool blanks needed to be selected from the range of removals. Tools could also be discarded as soon as they became dull or broken, rather than being resharpened. It is also to be expected that blanks, and/or tools, as well as prepared cores, would have been exported, considering the high frequency of cores discarded at Maisières-Canal (137 cores in the sample studied, 293 cores for Champ de Fouilles [de Heinzelin 1973:24, Table VII]).

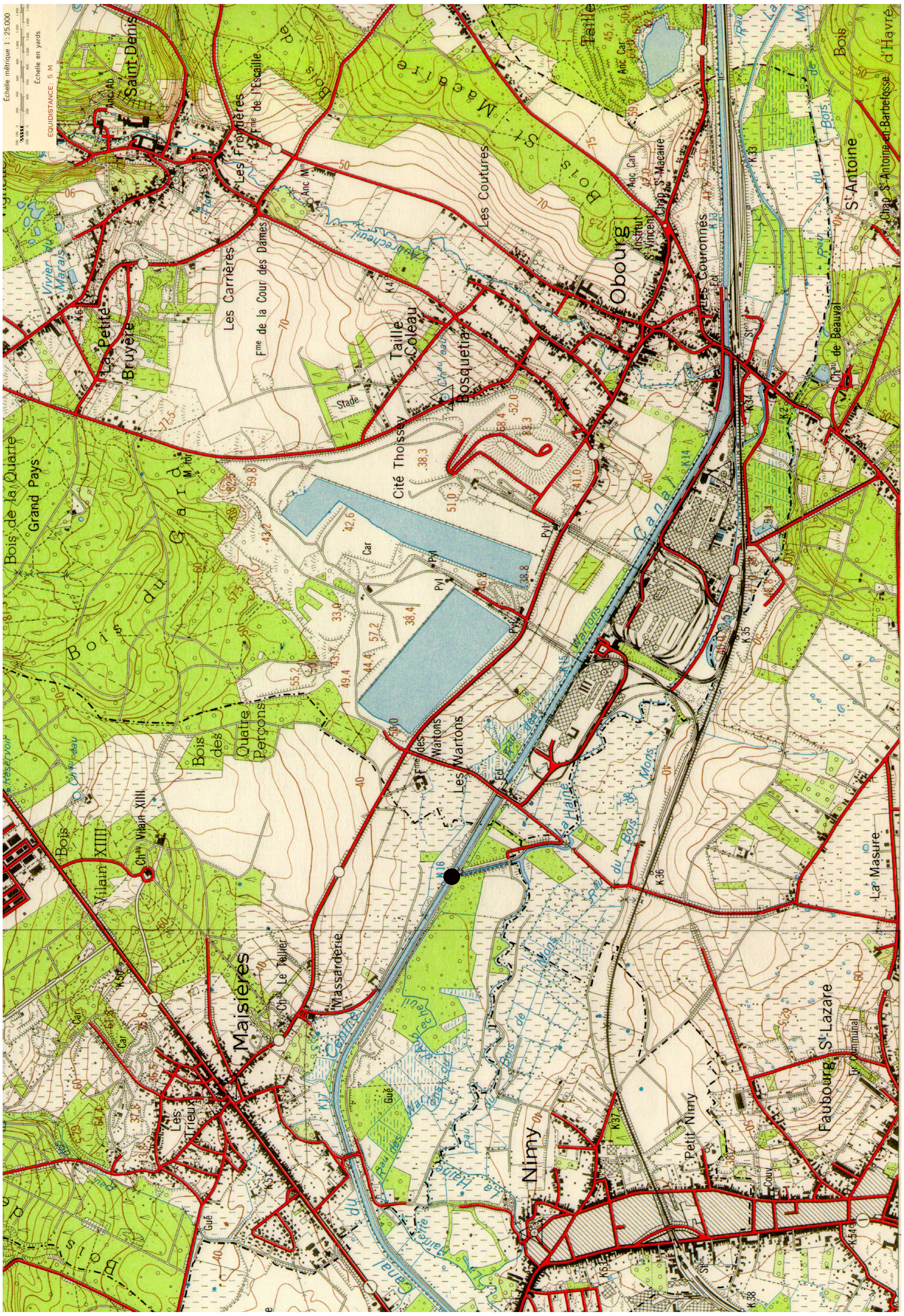


Figure 6.1. Maisières-Canal. Location of site.
(from Institut Géographique Militaire-Bruxelles, map no. 45/3-4, Jurbise-Obourg,;
scale: 1:25000).

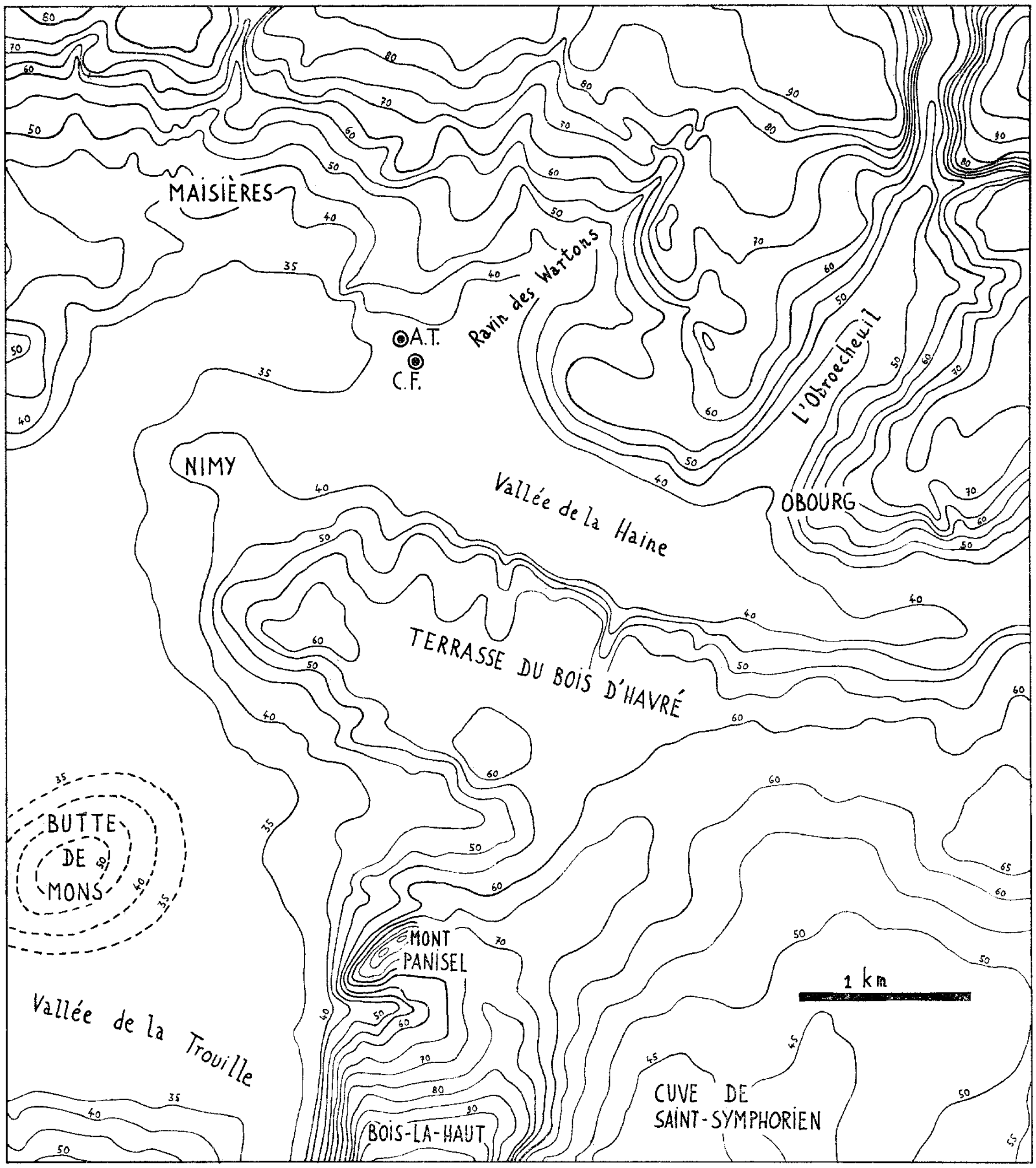


FIG. 13. — Carte hypsométrique complétée d'après la Carte topographique au 1/20.000e. A.T. = Atelier de Taille de la Berge N.E.—C.F. = Champ de Fouilles.

Figure 6.2. Maisières-Canal. Hypsometric map showing location of site. (after de Heinzelin 1973:40, Fig. 13).

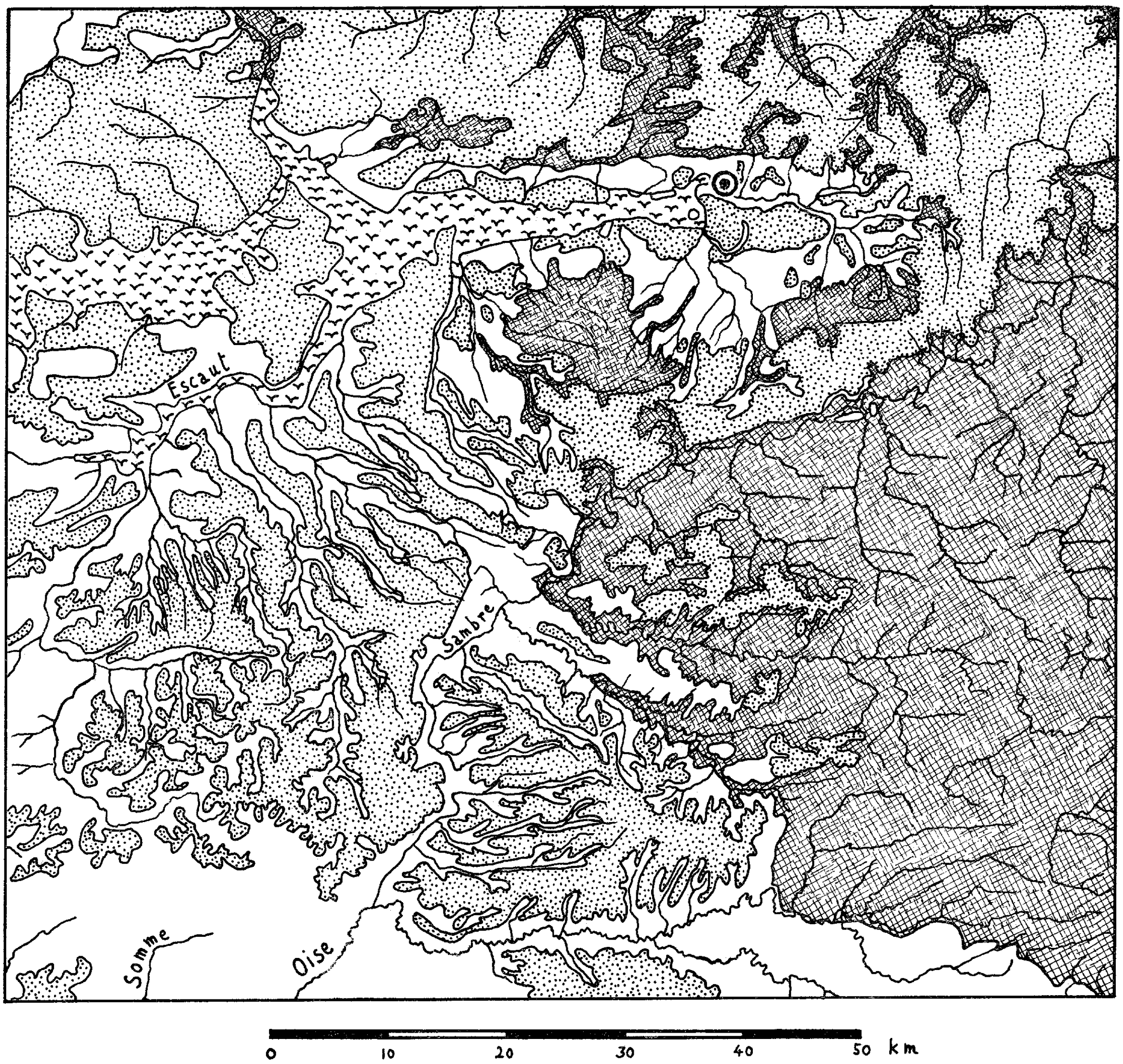


FIG. 14. — Maisières dans son contexte géologique régional.
Grandes unités géologiques, simplifiées d'après DE BÉTHUNE, *Atlas de Belgique*. V=expansions marécageuses. Pointillé=Tertiaire, sables et argiles. — Blanc=Secondaire, dont craie à silex. — Hachures=Primaire du Brabant et de l'Entre-Sambre-et-Meuse.

Figure 6.3. Maisières-Canal. Maisières in regional geological context.
(after de Heinzelin 1973:41, Fig. 14)

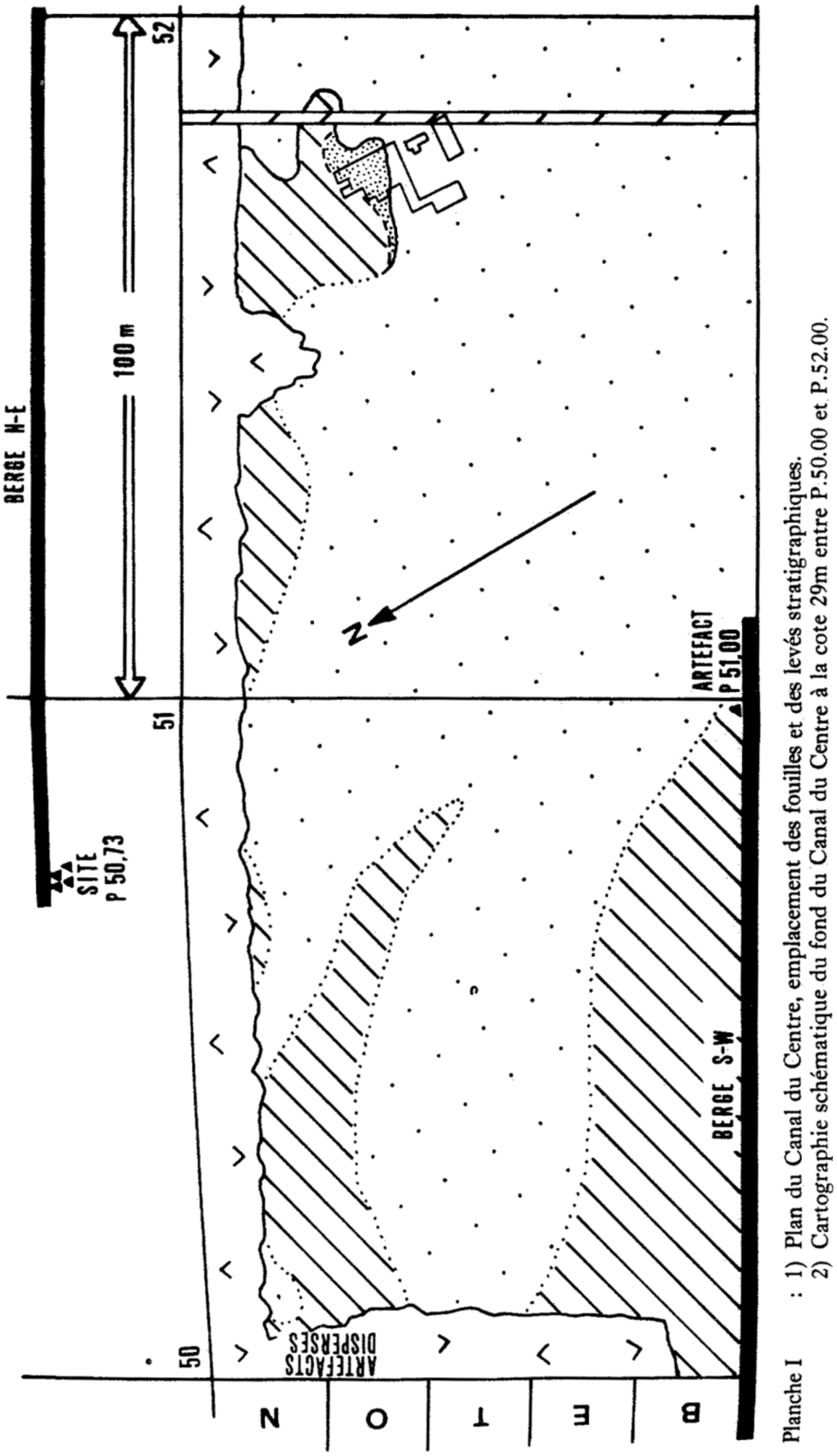


Figure 6.4. Maisières-Canal. Plan of excavations at Champ de Fouilles and Atelier de Taille de la Berge Nord-Est. (after de Heinzelin 1973: Planche I)

Excavation history

The site was first discovered by G. Bois d'Enghien in the 1940s and the Champ de Fouilles and Berge Sud-Ouest areas subsequently excavated in June-July 1966 by J. de Heinzelin, of the Institut Royal des Sciences Naturelles de Belgique (IRSNB) as a rescue excavation prior to construction of the canal. The Berge Nord-Est area was also discovered at this time and excavated in November-December 1966 and September-November 1968 by J. de Heinzelin and P. Haesaerts. Pollen columns were collected by B. Bastin and radiocarbon samples were collected (Haesaerts and de Heinzelin 1979:7).

Stratigraphy

P. Haesaerts (Haesaerts 1973, 1974, 1978; Haesaerts and de Heinzelin 1979) made a detailed study of the stratigraphy of Maisières-Canal to determine climatic sequences and to reconstruct environmental conditions and to place Maisières-Canal within a broader northwest European context (Fig. 6.5). The stratigraphy of Champ de Fouilles can be described as follows, from bottom to top (after Haesaerts and de Heinzelin 1979:14-16) (Figs. 6.6 and 6.7):

Champ de Fouilles stratigraphy:

M.C. rocky layer, compact and large-grained toward the base, sandier toward the top, containing phtanite, chalk and rolled flints; fluviatile deposits in cold conditions

M.D. dark gray to black silty sand, fine colluvium; less cold than Unit M.C. (corresponding to the Denekamp interstadial, Haesaerts 1978:120-123), dated to 30,780 ± 400 BP (GrN-5690)

M.E. homogeneous and unstratified clayey silt, representing the slow deposition of fine mud, probably a small pond in a local depression

M.F. gravelly and silty sand incorporating phtanite and chalk fragments, fluviatile deposits in cold conditions

M.G. dark brown-gray silty sand directly underlying the main occupation zone M.H., humiferous silt from M.G. dated to 27,965 ± 260 (GrN-5523), less cold (corresponding to the Paudorf interstadial, Haesaerts 1978:120-123)

M.H. dark gray sandy silt containing the main concentration of archaeological material (lithics and fauna) identified as a variant of Perigordian Va, in an occupation zone several centimeters thick, medium cold and humid climate

M.I. dark brown gray sandy silt overlying the occupation horizon, colluvial deposits

M.J. sandy silt with lenses of humic material, archaeological material common but stratum is not clearly defined, medium cold climate (Note: M.H., M.I., and M.J. are contemporaneous [Haesaerts and de Heinzelin 1979:16])

M.M. heterogeneous complex including both bedded deposits and allochtonous portions deposited en bloc, various facies contain gravels rich in chalk, sand, silt or humic material, corresponds to fluviatile deposits in rigorous conditions, contact between M.M. and underlying horizons is distinct and irregular

M.N. irregularly stratified heterogeneous complex with "tongues" of humic silt containing lithic artifacts, various facies identified, fluviatile deposits in rigorous but drier conditions than for M.M.

M.O. chalky deposits in contact with M.M. and M.N. with which it is at least in part contemporaneous

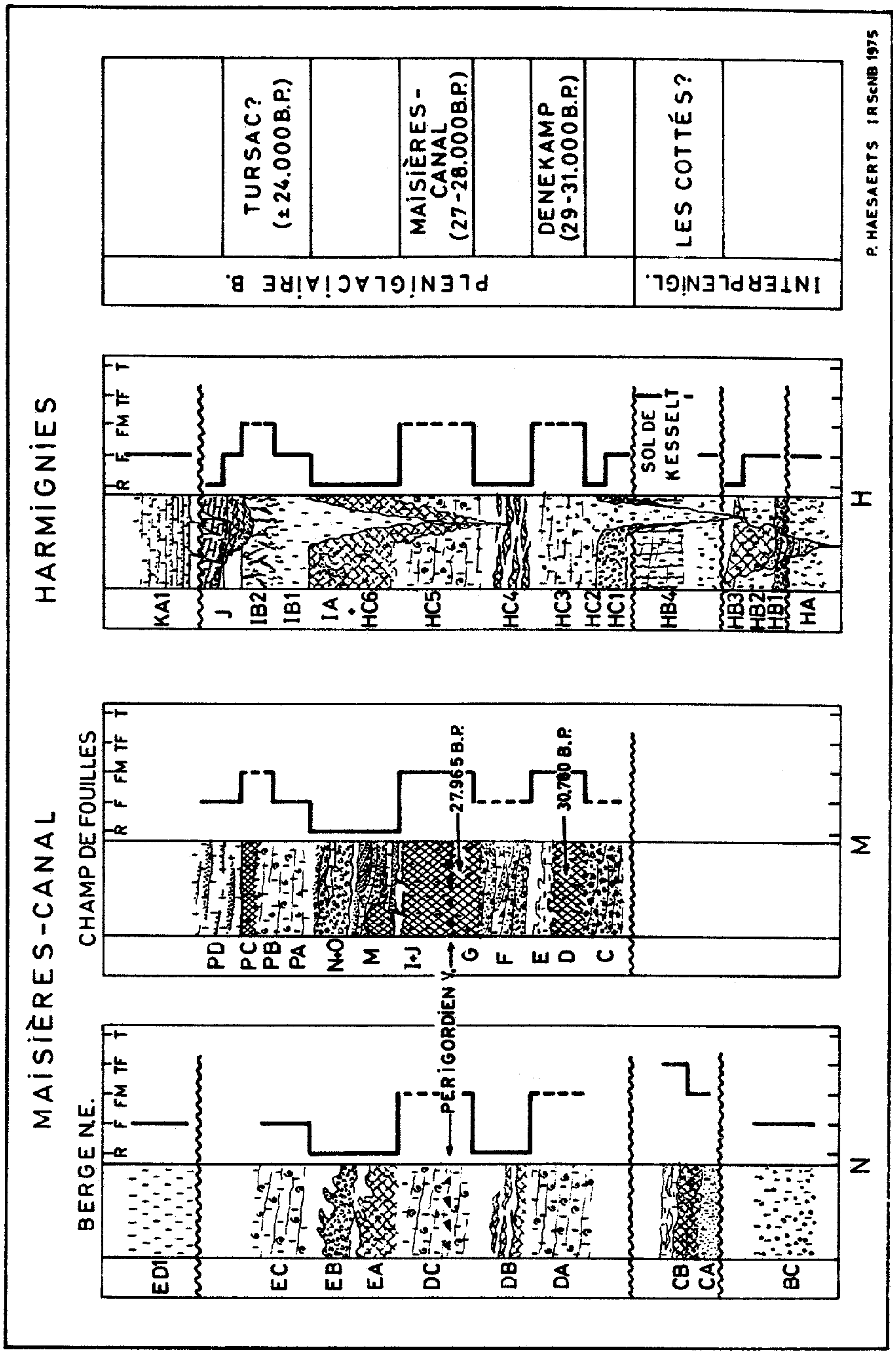


Figure 6.5. Maisières-Canal. Reconstructed climatic sequences for Maisières-Canal and Harmignies. (after Haesaerts 1978:122, Fig. 4)

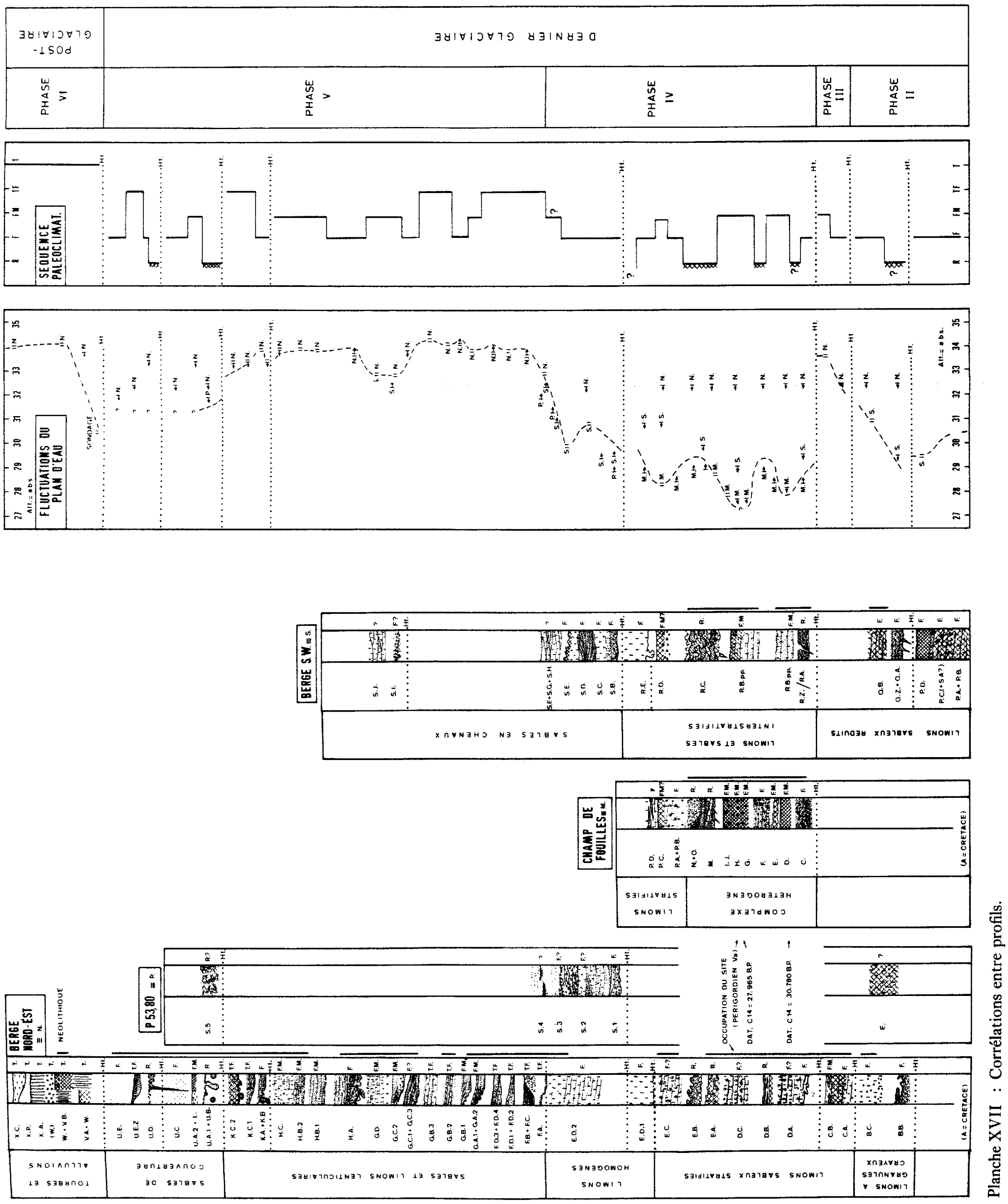


Figure 6.6. Maisières-Canal. Correlation between profiles. (after Haesaerts and de Heinzelin 1979, Planche XVII)

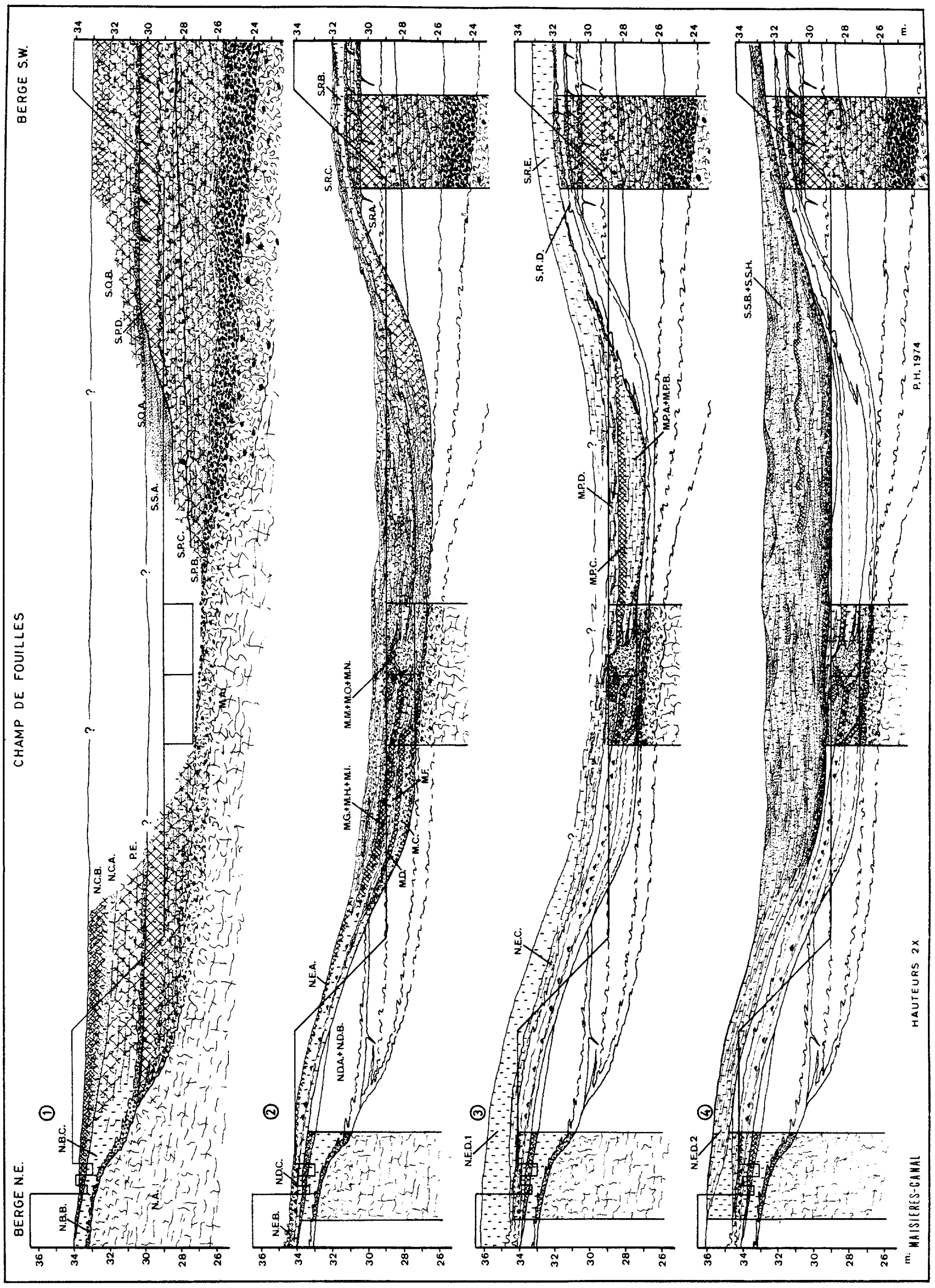


Planche XVIII : Profils synoptiques montrant les phases successives du colmatage de la vallée de la Haine au cours du Pléniglaciaire (Phases II à IV).

Figure 6.7. Maisières-Canal. Synoptic profiles demonstrating the successive phases of deposition in the Haine valley during the Pleniglacial (Phases II-IV). (after Haesaerts and de Heinzelin 1979, Planche XVIII)

At the Atelier de Taille concentration, six lithostratigraphic units were identified, from bottom to top: silt with chalky granules (B.A. to B.C.), stratified sandy silts (C.A. to E.C., and containing the archaeological horizon D.C.), homogeneous silts (E.D.1 to E.D.2), lenticular sands and silts (F.A to K.C.), covering sands (U.A. to U.E.), and peat and alluvion (V.A. to X.P). Only the sedimentary units of the stratified sandy silts are described here, from bottom to top, as the archaeological horizon is found within them (after Haesaerts and de Heinzelin 1979:18-22).

Atelier de Taille stratigraphy:

N.C.A/N.C.B. olive-colored sandy silt with interstratified beds of sand, colluvial deposits in a cold, relatively humid climate

N.D.A. light gray olive colored sandy silt with subangular fragments of phtanite, chalk and flint, colluvial deposits following an erosion episode, cold climate within a well-drained steppic environment

N.D.B. thin, subhorizontal bands of olive-gray sandy silt, iron content reduced due to solifluction of the upper part of a pergelisol along the slope of the depression during the reprise of colluvial deposition of overlying N.D.C., rigorous climate

N.D.C. well stratified sandy silt, similar to N.D.A., containing numerous fragments of flint, phtanite and chalk; at least two concentrations of artifacts are found within this unit, with the majority of lithic artifacts lying horizontal at the top of an olive-gray sandy silt layer, associated with a large quantity of small calcined bone fragments, slight amelioration of climate in comparison to the rigorous conditions of N.D.B. but cold and relatively humid; the iron-reduced summit of N.D.C evidences a stabilization episode of the topographic surface following the development of a pergelisol

N.E.A. olive gray sandy silt similar to N.D.C.

N.E.B. chalky packets mixed with silt and containing subangular chalk fragments and rare phtanite, deposited at the base of Cretaceous outcrops during the preceding rigorous climate of N.E.A. and then moved by solifluction along a small lateral valley at the end of the rigorous period

N.E.C. stratified, pale olive-gray sandy silt, better sorted than earlier levels, containing some rounded chalk fragments, degree of sorting suggests eolian silts disturbed by streams, gradually filling in a depression; evidences the development of a less rigorous climate.

Dating of the site

According to Otte (1976:335, footnote 3), the dates (Table 6.1) from the Université de Louvain radiocarbon laboratory (Gilot 1971) were obtained on humiferous sediments, but they provided results (Lv 305/1 and 305/2) which were incompatible with the stratigraphy. Gilot (1971) attributes the incompatibility to the influence of limestone in the area where the samples were collected and to perturbation of the sediments (Gilot 1984:120). However, the dates from the Groningen laboratory of Unit MH, just below the occupation layer MG (27,965 ± 260 yrs BP, GrN-5523) and the underlying Unit MD (30,780 ± 400 yrs BP, GrN-5690) appear to be valid.

Climate and Environment

The site was occupied during a short climatic oscillation (cold-temperate) which followed the so-called Stillfried B interstadial (de Heinzelin 1971:64). According to B. Bastin

(1971), pollen spectra indicate a cold steppe environment, with less than 10% tree pollen represented by pine, birch and alder (de Heinzelin 1971:65), yet some diversity of biotopes was available: a dominant cold steppe on the plateau with a mosaic of more humid habitats with some trees and shrubs along the Haine River (de Heinzelin 1971:66).

According to the faunal analysis of A. Gautier (in Haesaerts and de Heinzelin 1979:66-68), the animals hunted included *Lepus timidus*, *Ursus arctos*, *Alopex lagopus*, *Equus* sp., *Rangifer tarandus*, *Cervus elaphus*, and *Bos/Bison*.

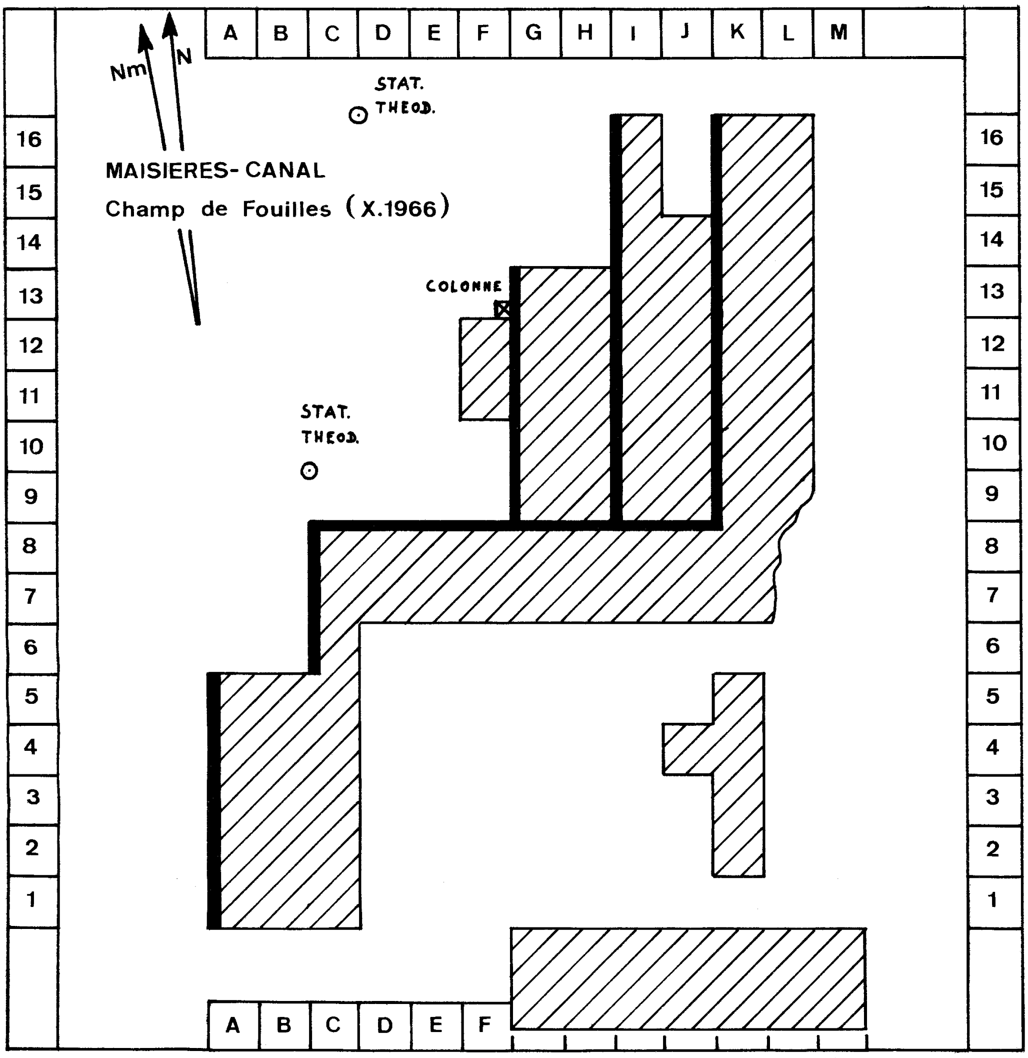


Planche II : 1) Plan du Champ de Fouilles; l'emplacement des coupes observées est indiqué par un trait renforcé.
2) Champ de Fouilles — Paroi F/G de 9 à 13. (J. de Heinzelin, 1966)

Figure 6.8. Maisières-Canal. Plan of Champ de Fouilles.
(after Haesaerts and de Heinzelin 1979, Planche II)

Radiocarbon dates: Champ de Fouilles	**Lab No.**	**Uncalibrated Dates**	**Sample**	**References**
Archaeological horizon:				
Unit M.G. (M.H. for de Heinzelin 1971)	GrN-5523	27,965 ± 260 yrs BP	humus	Bastin 1971; de Heinzelin 1971:64-65; Haesaerts 1985, p. 112
Unit M.D.	GrN-5690	30,780 ± 400 yrs BP	humus	Bastin 1971; de Heinzelin 1971:64-65; Haesaerts 1985, p. 112
Maisières 1 (M.G./H.)	Lv.304/1 LV.304/2	31,080 +2040/-1640 BP 30,150 +1890/-1540 BP	humiferous sediment	Gilot 1971, 1984
Maisières 2 (M.G./H., 12 cm above Lv.304)	Lv.305/1 LV.305/2	35,970 +3140/-2250 BP 24,100 +650/-610 BP	humiferous sediment	Gilot 1971, 1984
Maisières 5 (clay layer containing some cores)	Lv.353	25,280 +1040/-920 BC	humiferous sediment	Gilot 1971, 1984
Below archaeological horizon:				
Maisières 3 (M.D.)	Lv.306	24,400 +700/-640 BP	humiferous sediment	Gilot 1971, 1984
Maisières 4 (M.D., 1 cm above Lv.306)	Lv.307	23,160 +550/-510 BP	humiferous sediment	Gilot 1971, 1984

Table 6.1. Radiocarbon dates for Maisières-Canal.

Site occupation and function

According to de Heinzelin (1971:66), the duration of human occupation at Maisières-Canal was probably relatively short-term, a matter of a few weeks or a season, or even a single seasonal halt on a migratory trajectory. However, based on the abundant lithic material resulting from substantial reduction activity, it is more likely that the site represents a palimpsest of short-term seasonal occupations. Site function would thus reflect the procurement of seasonally available subsistence resources, perhaps migrating animals and/or the logistical procurement of high quality flint for transport to other sites of longer-term occupation. The site was relatively exposed and located next to a ford of the Haine, which would likely have been as important for migrating fauna as for humans (de Heinzelin 1971:73).

As will be discussed, the volume of the lithic assemblage and the relatively low proportion of tools within it reflect a high degree of core reduction and blank production activity with a lower than expected number of tools. This would be in accordance with a strategy of exporting the larger blanks and tools produced.

Description of assemblage and industry attribution

According to Otte (1976:336), core reduction at Maisières-Canal is primarily laminar. Removals were made from bi-directionally opposed cores with dorsal faces prepared by perpendicular removals. Certain flake cores, worked on two faces, with centripetal debitage, recall the Levallois technique (citing de Heinzelin 1973:17). Blades are relatively abundant, and crested blades are very common. Font-Robert points are abundant and serve as diagnostic indicators for industry attribution. Based on technological and typological characteristics, the industry was seen as similar to the Upper Perigordian of Southwest France, but certain unique characteristics are present which distinguish it (i.e., production of tanged Font-Robert points and use of flat or invasive retouch). The industry has been variously identified as Perigordian V or Périgordien Hennuyer.

Assemblage samples

There is a single cultural horizon at Maisières-Canal, based on stratigraphic and typological homogeneity. While the Champ de Fouilles and Atelier de Taille de la Berge Nord-Est assemblages are penecontemporaneous, they have been analyzed separately because they (probably) represent different activity zones at the site. The results of analyses for the Atelier de Taille assemblage are presented in a separate section following analyses for the Champ de Fouilles assemblage.

Given the large size of the Champ de Fouilles assemblage (around 36,000 artifacts), it was decided that only a portion of the collection would be studied. All artifacts found in rows G through K, 6-16 (excluding the trench along the southwest edge) were analyzed, while rows A through F were not analyzed (Fig. 6.8). This yielded a sample size of 6,662 stone artifacts, around 18% of the entire assemblage (Table 6.2). The entire assemblage from the Atelier de Taille was analyzed (n=630).

Expectations

Maisières-Canal is situated in very close proximity to geological sources of two very good quality flint types, namely, Obourg and Spiennes. Therefore, I expect that quality and abundance would have exerted little or no pressure on the raw material economy. The quality of material is so good that any reduction technique could have been utilized with no raw material constraints. The abundance of material (its ready availability close to the site) precludes the necessity for increased intensity of reduction and utilization of tools. Tools found at the site would be related to hunting and domestic activities during occupation, while the volume of material reduced could indicate the export of prepared cores and tools to other sites (Roebroeks n.d.), discussing the Gravettian occupation in Belgium, suggests that tools such as Gravette points made on Obourg flint (e.g., found in the Gravettian layer of Spy) may have been prepared at Maisières-Canal and exported. Given the proximity of flint sources, there should be very little non-local material present at the site, although some may be present in the form of finished tools or non-exhausted cores which would have been replaced by local material. Transported tools may also show an intensity of use that occurred before arrival at this site, but there should not be any evidence for tool resharpening at Maisières-Canal.

	Count		Weight	
Type	**n**	**%**	**wt in g**	**%**
1 - Obourg	6113	91.8	57230	79
2 - Spiennes	373	5.6	10723	14.8
4 - phtanite	9	0.1	104	0.1
8 - gray flints	104	1.6	849	1.2
9 - brown flints	11	0.2	28	0.04
10 - cherts	2	0.0	3	0.004
17 - olive-green flint	50	0.8	3483	4.8
Total	6662	100.0	72420 (n=2251)	100.0

Table 6.2. Frequencies of raw material types by count and weight (Champ de Fouilles).

Rank	Type	Count %		Rank	Type	Weight %
1	1 - Obourg	91.8		1	1 - Obourg	79
2	2 - Spiennes	5.6		2	2 - Spiennes	14.8
3	8 - gray flint	1.6		3	17 - olive-green flint	4.8
4	17 - olive-green flint	0.8		4	8 - gray flint	1.2
5	9 - brown flint	0.2		5	4 - phtanite	0.1
6	4 - phtanite	0.1		6	9 - brown flint	0.04
7	10 - chert	0.0		7	10 - chert	0.004

Table 6.3. Ranking of material types by frequency and weight (Champ de Fouilles).

Rank	No(s).	Type(s)	Count %	Weight %
1	1	Obourg flint	91.8	79
2	2, 8, 17	Spiennes, gray, olive-green flint	0.8-5.6	1.2-14.8
3	9, 4, 10	brown flint, phtanite, chert	< 0.5	< 0.5

Table 6.4. Collapsed ranking of material types (Champ de Fouilles).

CHAMP DE FOUILLES

RANKING OF MATERIALS BY FREQUENCY AND WEIGHT

Materials are ranked fairly similarly by count and weight (Table 6.3), with some minor reversals between the two measures of abundance: i.e., gray and olive-green flint, phtanite and brown flint. Obourg decreases in percent by weight while Spiennes increases, indicating that artifacts in Spiennes flint are, on average, somewhat larger. This ranking can be reduced to three tiers (Table 6.4).

SOURCES OF MATERIAL UTILIZED

Rank 1

Obourg flint (Type 1) is locally available, within 1 km of the site. It is found in primary geological context within the Craie d'Obourg (Campanian chalk bluffs) and in nearby secondary context due to erosion of the chalk formation. It is abundant, easily available and of excellent quality.

Rank 2

Spiennes flint (Type 2) is also locally available, but approximately 7 km to the south, in the Craie de Spiennes and Craie d'Harmignies chalk formations. They are today buried beneath loess deposits but were mined extensively during the Neolithic period.

Gray flints (Type 8) are distinct from what has been identified as "Spiennes" by differences in patina coloration. They have been studied separately from Spiennes flint but variability in macroscopic characteristics could fall within its range.

Type	Description
4	gray flint 1: very light gray without inclusions, translucent, brittle
6	gray flint 2: probably a variant of Obourg, but less translucent, more matte, homogeneous gray rather than brown or black, few inclusions but small gray spots
7	medium-grain gray flint: medium-grained, gray, opaque, matte, slightly rough fracture surface

The source for olive-green flint (Type 17) is unknown, but it too may be a variant of Obourg flint, although most Obourg flint is black or brown when the flake is thin enough to be translucent. The only olive-green flint in the Leuven-Maastricht lithic database comes from Gulpen in the Maastricht region, which would be too distant to be a likely source for Maisières-Canal.

Rank 3

Brown flint (Type 9) includes material from two probably different sources, both of which are as yet unknown.

Type	Description
5	brown flint: fine-grained, very translucent, brown with white flecks on surface, dark flecks within, glossy
8	brown-yellow flint: fine-grained, glossy, few inclusions, very different shade of brown from translucent Obourg, brighter and more yellow

Phtanite (Type 4) comes from the Ottignies-Mousty region, approximately 50 km to the northeast.

Chert (Type 10) is probably local, but there are only two pieces and thus are not a significant part of the lithic economy.

TRANSPORT OF MATERIAL

Cortex attributes (proportion of cortex, cortex wear) and general assemblage structure evidence were used to make inferences of transport form of material to the site (Table 6.5). A comparison between materials reveals interesting differences. Inter-site comparisons (chapter 12) show marked differences in transport form that reflect the increasing pressure on lithic economy as distance from flint sources increases.

Rank 1 material was obtained locally and transported as unprepared blocks and partially prepared cores, based on the high number of cortical pieces (41.5%).

Rank 2 materials, also used but to a much lesser degree than Rank 1, were transported as prepared cores. Cortical pieces are much less common (4-15%) except for Type 17 (52%), although even these cortical pieces have only small areas of cortex.

Rank 3 materials were transported only as finished tools and blanks.

Observation of cortex type indicates that all materials were obtained in primary context, which is more probably nearby secondary context on erosion slopes. Refits of certain artifacts were found during analysis of the collection, although a systematic refitting project was not undertaken. One series shows that primary reduction was present. Table 6.6 summarizes the cortex information.

EVIDENCE FOR REDUCTION OF MATERIALS AT THE SITE

The assemblage structure for each material type varies with rank, evidencing decreasing inclusivity of components (reflecting stages of the reduction sequence) as rank decreases.

Rank 3

Rank 3 materials appear only as blanks or finished tools (i.e., primary reduction is absent). Type 4 (phtanite) (n=9) includes six blades, one flake and two debris flakes, of which six are tools. All but one tool were made on blades and include two Font Robert points, one blade with continuous retouch on one edge, and one with continuous retouch on two edges (CRP2). The flake has continuous retouch on one edge. The blade tools are all long, particularly the Font Robert points (lengths are 91 and 109 mm). The second lacks proximal and distal ends, as does the CRP2, which is still 68 mm long. The three flakes average 20 mm in length. The artifacts are dispersed over several squares, that is, they are not especially associated with a single area.

Rank 1 material		
Type	**Assemblage structure**	**Brought to site as...**
1 - Obourg flint	102 cores, 444 tools, 2357 unretouched removals, 3210 debris (including 7 chunks*)	unprepared blocks and partially prepared cores
Rank 2 material		
Type	**Assemblage structure**	**Brought to site as...**
2 - Spiennes flint	22 cores, 7 tools, 238 unretouched removals, 106 debris (including 2 chunks)	prepared cores
8 – gray flint	1 core, 67 unretouched removals, 36 debris (including 1 chunk)	prepared core
17 - olive-green	12 cores, 2 tools, 27 unretouched removals, 9 debris	prepared cores
Rank 3 materials		
Type	**Assemblage structure**	**Brought to site as...**
9 - brown flint	1 tool, 6 blanks, 4 debris	finished tools and blanks
4 - phtanite	6 tools, 1 blank	Finished tools and blanks
10 - chert	2 debris	?

Table 6.5. Transport form of raw materials and general assemblage structure (Champ de Fouilles). * Chunks are probably core remnants.

		Cortex		Proportion		Primary Context		Secondary Context	
Rank	**Type**	**n**	**%**	**n < 50%**	**n > 50%**	**n**	**%**	**n**	**%**
1	1 – Obourg flint	2536	41.5	1522	271	2399		82	
2	2 – Spiennes flint	55	14.7	35	2	49		4	
2	8 – gray flint	4	3.8	1	1	4			
2	17 - olive-green flint	26	52.0	13	3	23		3	
3	9 – brown flint	0	0.0						
3	4 - phtanite	1	11.1		1			1	

Table 6.6. Procurement context: cortex data.

Material	Total n (blank pool)	flakes		blades		crested blade		Bladelets	
		n	**%***	**n**	**%**	**n**	**%**	**n**	**%**
1 – Obourg flint	2791	2063	74	635	23	56	2	37	1
2 – Spiennes flint	245	167	68	73	30	5	2	0	0
8 – gray flint	67	65	97	2	3	0	0	0	0
17 – olive-green flint	29	11	38	13	45	5	17	0	0

Table 6.7. Blank production by material type (Champ de Fouilles). *Percent of blank pool, not of assemblage of each material type.

Type 9 (brown flint) (n=11) includes three blades, four debris flakes 10-30 mm in length, and four flakes 30-40 mm in length. Only one tool is present, a small denticulated blade (whole but only 18 mm long). Type 10 (chert) (n=2) includes an irregular flake 30-40 mm long and a piece of angular debris 10-30 mm long, both unretouched.

Of these Rank 3 materials, only phtanite was transported to the site mainly as finished tools (6 of 9). Brown flint was transported from an unknown source in the form of blanks that remained unretouched. Chert does not form a part of the lithic economy. None of the tools made on phtanite are exhausted or heavily resharpened. They do evidence a relatively high degree of shaping intensity, particularly the Font Robert points.

Ranks 1 and 2

What blanks were produced?

Table 6.7 summarizes the kinds of blanks produced for each material type, including removals that could have been retouched into tools and those which were made into tools. Flakes are dominant but include many flakes produced during reduction that are unsuitable due to their morphology. Blades are common for Obourg and Spiennes flint, but only Obourg flint was used to produce a series of bladelets.

What blanks were selected for retouching into tools?

Table 6.8 indicates the number of tools made on the different kinds of blanks, with a clear pattern of blade preference for Obourg flint. Thus, although many flakes were produced during the reduction process, the majority were rejected.

What is the intensity of blank selection?

The intensity of blank selection refers to the ratio between tools and unused blanks: of the pool of potential blanks produced, what percentage was actually selected for tool retouch? (Table 6.9). For all materials, the ratio of tools to available blanks is extremely low, but this can be explained as due to the rejection of a wide range of flakes as unsuitable and to size selection of blanks. Additionally, as discussed later, if Maisières-Canal functioned as a logistical site where material was reduced for subsequent transport to residential camps, then the majority of blanks (probably blades) and tools produced, as well as prepared cores, would have been removed from the site.

Is there a size difference between blanks and tools?

At Maisières-Canal, because there are no raw materials constraints imposed on the lithic economy, tools used during occupation would have been discarded without substantial resharpening. A comparison of size of tools and blanks (unretouched flakes and blades) will thus clearly show which, if any, size parameters affected blank selection for tool production and size thresholds. T-tests were done to compare length, width and thickness for whole blade tools and whole unretouched blades, and for whole flake tools and whole unretouched flakes for Rank 1 material, Obourg flint (Table 6.10). For blades, length, width and thickness are all statistically significantly different where tools are longer, wider and thicker than unretouched blades. For flakes, only length is statistically significant between tools and blanks.

Material	Total n tools	Tools on flakes	Tools on blades	Tools on crested blades	Tools on bladelets	Tools on cores/ chunks	Tools on debris
1 – Obourg flint	444	141	283	8	3	3	5
2 – Spiennes flint	7	4	3				
8 – gray flint	0						
17 - olive-green flint	2	2					

Table 6.8. Blank selection for tool production by material type (Champ de Fouilles).

Type	n tools	n unused blanks	tools + blanks	Tool/blank ratio	% tools
1 – Obourg flint	444	2345	2791	0.19:1	16
2 – Spiennes flint	7	238	245	0.03:1	3
8 - gray flint	0	67	67	0	0.0
17 - olive-green flint	2	27	29	0.07:1	7

Table 6.9. Intensity of blank selection (Champ de Fouilles).

Rank 1 - Obourg flint - Comparison of tools and blanks, whole blades only.

Variable	Number of Cases	Mean	SD	SE of Mean
LENGTH Length (mm)			**p=.000**	
Blanks (unretouched)	326	55.2331	21.093	1.168
Tools (retouched)	283	63.6254	25.183	1.497
WIDTH Width (mm)			**p=.000**	
Blanks (unretouched)	326	18.5307	9.681	.536
Tools (retouched)	283	25.4523	9.722	.578
THICK Thickness (mm)			**p=.000**	
Blanks (unretouched)	326	6.6933	4.275	.237
Tools (retouched)	282	9.0674	4.456	.265

Rank 1 - Obourg flint - Comparison of tools and blanks, whole flakes only.

Variable	Number of Cases	Mean	SD	SE of Mean
LENGTH Length (mm)			**p=.021**	
Blanks (unretouched)	274	46.5839	19.598	1.184
Tools (retouched)	139	51.3741	20.383	1.729
WIDTH Width (mm)			**p=.521**	
Blanks (unretouched)	274	35.7737	15.185	.917
Tools (retouched)	139	36.7842	14.930	1.266
THICK Thickness (mm)			**p=.540**	
Blanks (unretouched)	261	9.5326	6.251	.387
Tools (retouched)	139	9.9209	5.570	.472

Table 6.10. t-tests comparing size of whole blanks and tools (Champ de Fouilles).

ATELIER DE TAILLE DE LA BERGE-NORD-EST

The Atelier de Taille assemblage is composed exclusively of Obourg flint (n=630, weight = 4923 g), corresponding to Rank 1 in the Champ de Fouilles assemblage. The assemblage structure is summarized in Table 6.11. 192 (30.5%) artifacts are cortical, with fresh chalk cortex, indicating that material was obtained in primary context but partially prepared at the source before transport to Maisières-Canal, where it was reduced in place.

The blank pool in the assemblage is flake-dominant, with only 53 blades present (Table 6.12). As the Atelier de Taille has been interpreted as a workshop area of the site, it is likely that the majority of blanks and prepared cores were exported. Thus, the blank pool remaining would represent flakes and blades that were rejected, either on the basis of size and/or shape. The number of cores (n=6, plus 9 chunks) is low.

Among the reduction debris, there are 7 platform renewal flakes, one crested blade, 34 angular debris, 193 debris flakes (> 20 mm in length), and 40 trimming flakes.

The 13 tools discarded at the site were made on 9 flakes and 4 blades.

Type	**Assemblage structure**	**Brought to site as...**
1 – Obourg flint	6 cores, 13 tools, 495 blanks, 116 debris, including 9 chunks	partially prepared cores

Table 6.11. Transport form of raw materials and general assemblage structure (Atelier de Taille). * Chunks are probably core remnants.

Material	**Total n (blank pool)**	**flakes**		**blades**		**crested blade**		**bladelets**	
		n	**%***	**n**	**%**	**n**	**%**	**n**	**%**
1 – Obourg flint	335	276	82.4	53	15.8	1	0.3	5	1.5

Table 6.12. Blank production by material type (Atelier de Taille). *Percent of blank pool, not of assemblage of each material type.

EVALUATION OF LITHIC ECONOMY WITH RESPECT TO RAW MATERIAL CONTEXT

The ranking of materials reflects distance in space and time (recent past of the group occupying Maisières-Canal). The Rank 1 material is the local Obourg flint, used both for activities at the site and probably for export. Spiennes flint, Rank 2, reflects local provisioning as well but material is transported to the site in the form of prepared cores with little cortex. The other Rank 2 materials, gray flint and olive-green flint, have a much more minor degree of reduction activity and could either reflect non-local material transported to the site, replaced upon arrival by Obourg and Spiennes flint, or they could in fact be variants of both Obourg and Spiennes. The Rank 3 materials, brown flint and phtanite, were transported only as finished tools and blanks, and thus reflect the end-products of material obtained and used prior to arrival. Given the local presence of flint, none of the other sources would have been further exploited, to minimize procurement costs.

Based on the volume of reduction activity, Maisières-Canal appears to have functioned as a logistical, short-term site, with possible multiple seasonal re-occupation, taking advantage of access to both subsistence and lithic resources in the Hainaut Valley. During occupation, subsistence activities would have occurred to maintain the group while they were engaged in lithic reduction activities. Prepared cores, blanks and tools were subsequently removed from the site and transported to a residential site where they were then used. Maisières-Canal can thus be seen as a logistical satellite site possibly attached to a longer-term residential site, or a summer residential camp associated with some winter residential site in the Ardennes/Condroz/Famenne regions.

Figure 6.9. Maisières-Canal, Champ de Fouilles. Obourg flint showing chalk cortex.

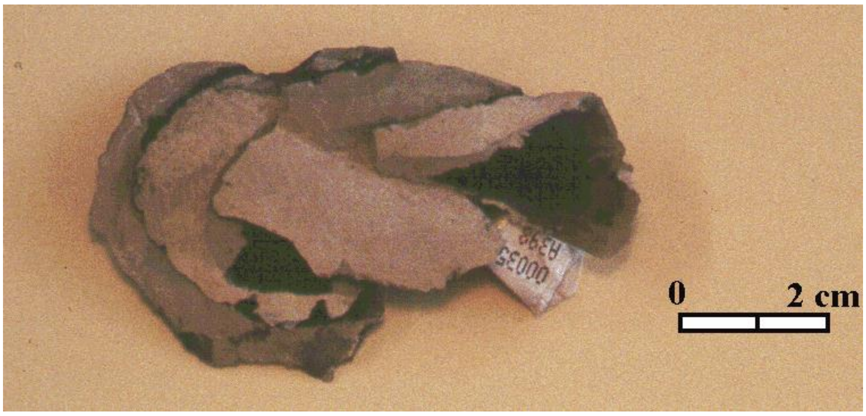


Figure 6.10. Maisières-Canal, Champ de Fouilles.
Refit series 1 (G12.133, G12.186b, G12.186a, G12.46).

Figure 6.11 Maisières-Canal, Champ de Fouilles. Font-Robert points.

Figure 6.12. Maisières-Canal, Atelier de Taille de la Berge Nord-Est. Tools.

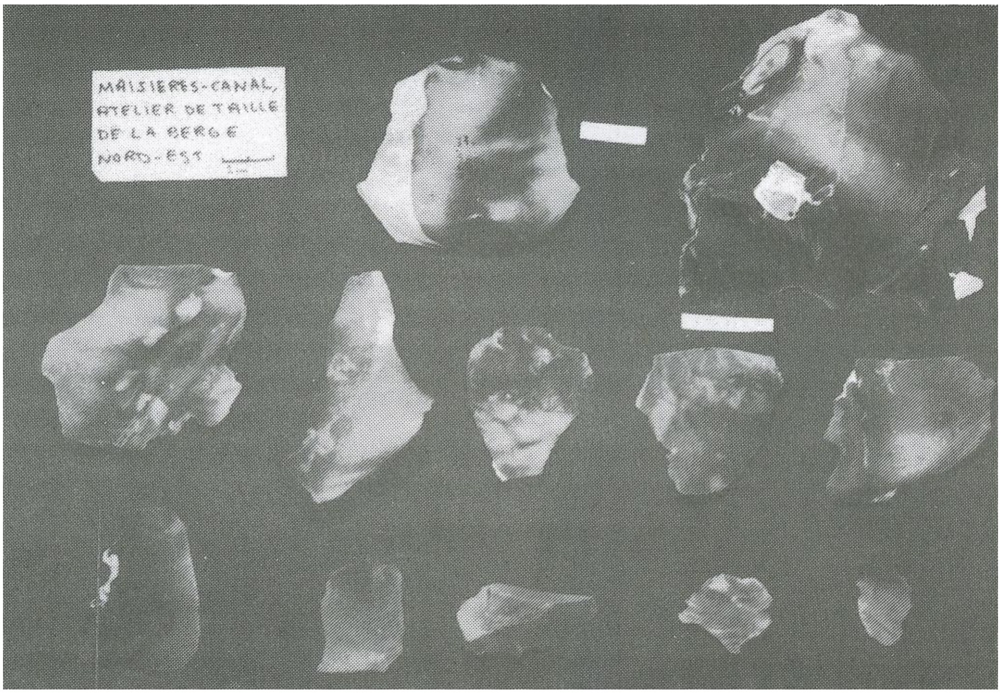


Figure 6.13. Maisières-Canal, Atelier de Taille. Flakes.

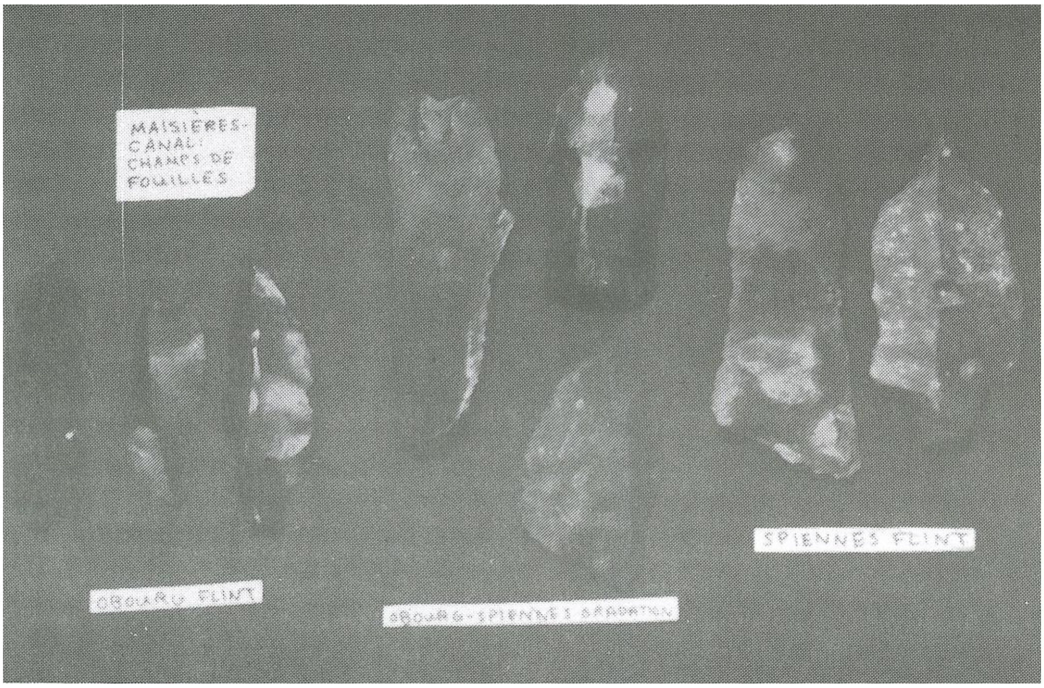


Figure 6.14. Maisières-Canal, Champ de Fouilles. Raw material types.

CHAPTER 7
STATION DE L'HERMITAGE AT HUCCORGNE

BACKGROUND

Location of site

Huccorgne (Station de l'Hermitage) (Straus *et al.* 2000) is a large open-air site located in the valley of the Mehaigne, a tributary of the Meuse (around 10 km distant) that drains from the Hesbaye Plateau (Figs. 7.1 and 7.2). The Mehaigne river valley appears to be one of the main areas with flint sources formerly exposed on the Hesbaye Plateau (along with other sources, such as Orp, exploited at least beginning with the Magdalenian period). Systematically surveyed in the 19th century by Fraipont and Tihon (1889), the Mehaigne valley yielded a dozen or so cave sites containing archaeological material from Middle Paleolithic to Neolithic.

Two collections were analyzed from different areas of the site, resulting from excavations by Haesaerts in 1976/1980 and by Straus and Otte in 1991-93 in the garden of M and Mme Dock (Fig. 7.3). The 1976/1980 excavations included two large trenches along 20 meters of the east side of road cut and a trench along the west side of the steep railroad cut, which was extended by the Straus/Otte excavations in 1991. The 1991 excavations included a block along the edge of the site (columns D-M, rows 5-6) and a test pit (columns Q-S, rows 25-26). 1992-93 excavations expanded along the railroad cut (columns H-L, rows 7-9) and included two test pits which yielded Mousterian material (Huccorgne-Smetz, not analyzed) across the road on the ridge crest of the oxbow meander of the Mehaigne River. The current railroad cut follows the ancient riverbed of the Mehaigne, which now meanders around a rock outcrop west of the site.

Raw material context

Primary sources of good quality flint were available locally in the Mehaigne Valley, from Cretaceous limestone deposits exposed by the Mehaigne River. Today these sources are no longer observable, buried beneath substantial loess deposits. However, worn nodules, heavily patinated and naturally broken, can be found in fields on the plateau and nodules have been found in gardens in the valley, evidencing the effects of erosion of flint from primary sources and redeposition within the loess.

Excavation history

The site was first discovered and excavated by M. De Puydt and M. Lohest in the 1880s and then excavated by F. Tihon in 1890. More recently, J. Destexhe excavated a portion of the site in 1969-70, followed by Haesaerts in 1976, Froment and Haesaerts in 1980, and finally by Straus and Otte in 1991-93.

Stratigraphy

The stratigraphic sequence of the Straus and Otte excavations in the main block excavation area (profile H-J/9-10) are the eastern end of the site, from top to bottom, has been described as follows (Fig. 7.4).

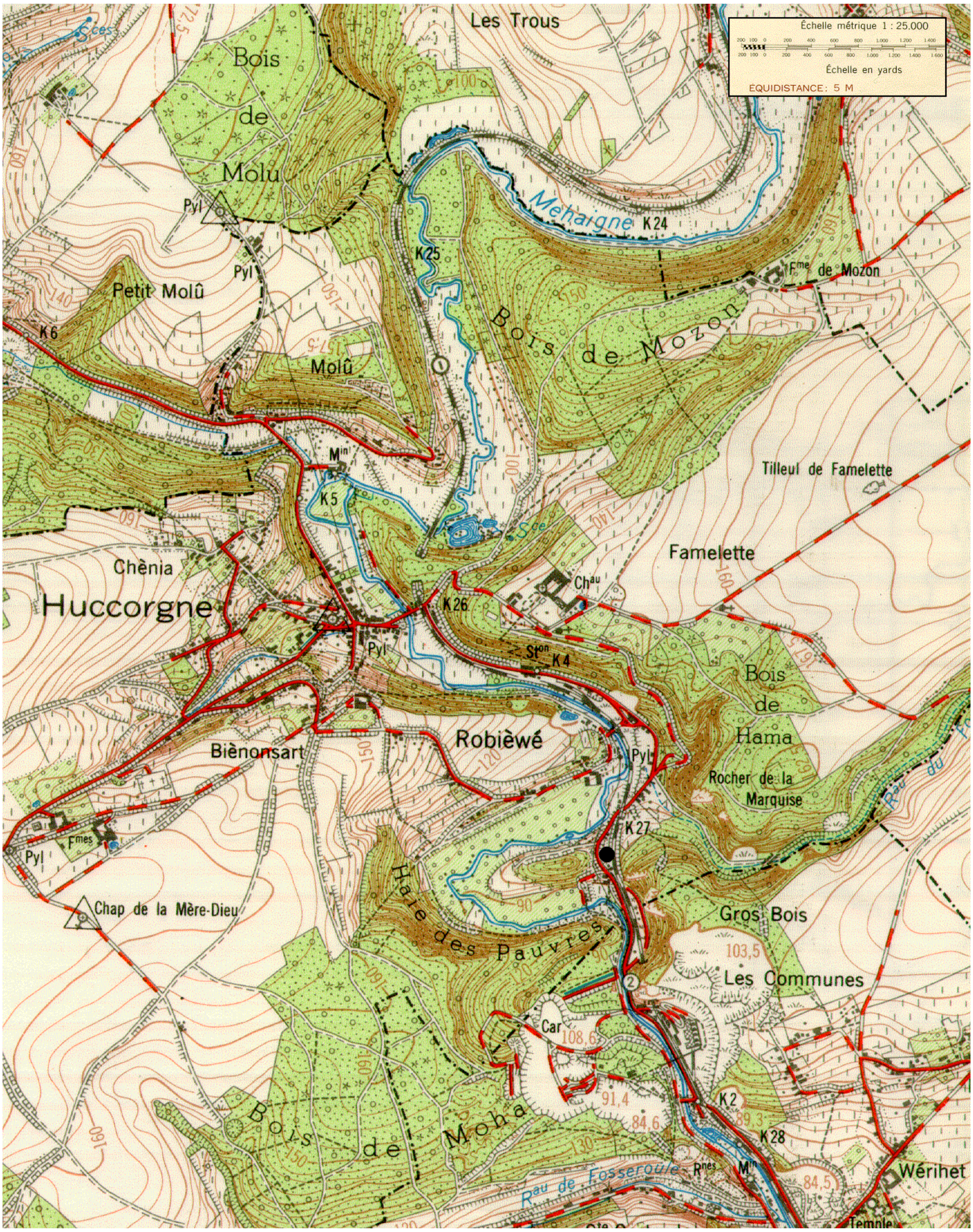


Figure 7.1. Huccorgne. Location of site.
(from Institut Géographique National map 41/5-6, scale 1:25000)

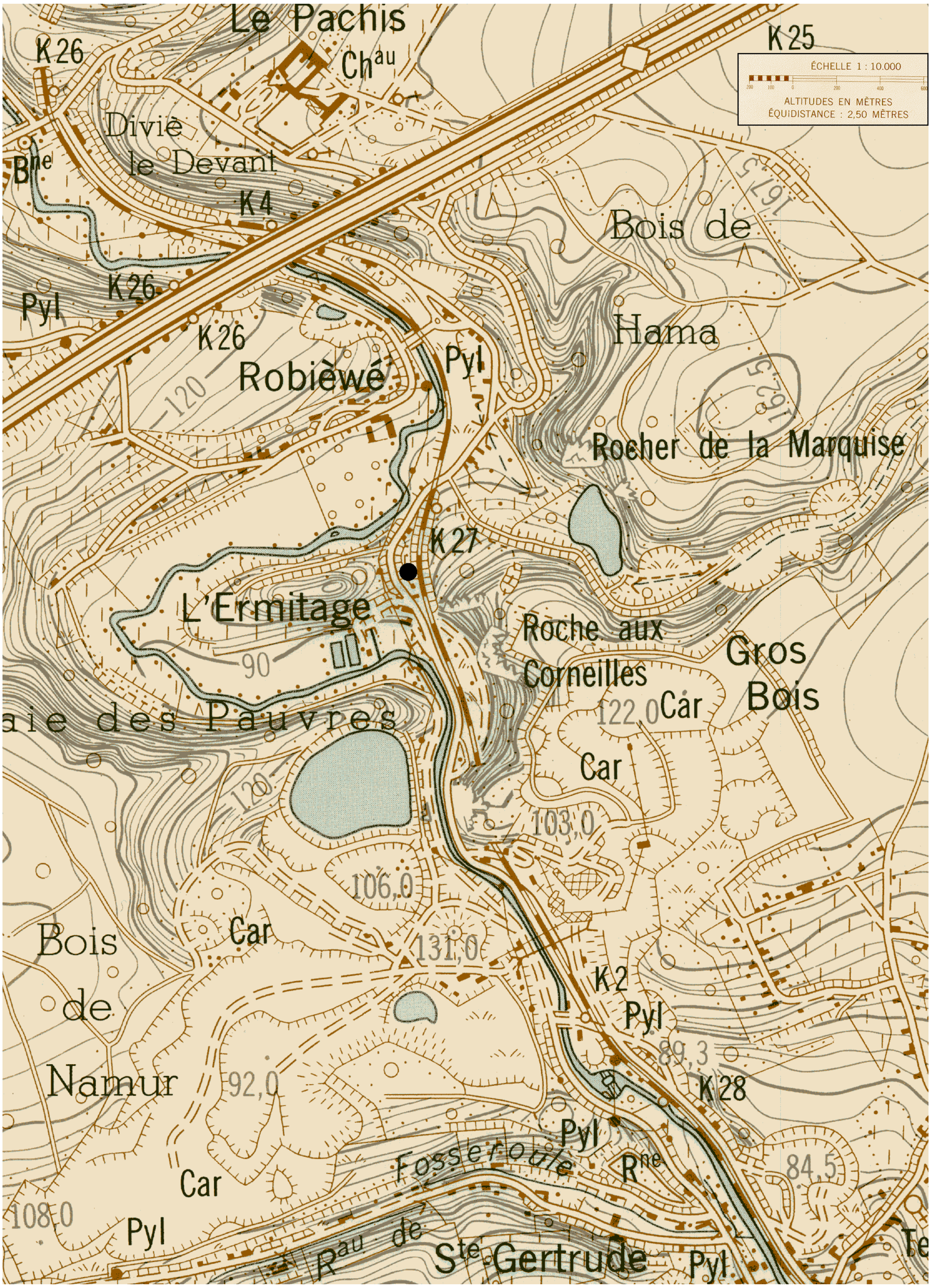


Figure 7.2. Huccorgne. Location of site.
(from Institut Géographique National map 41/6, scale 1:10000)

Stratum 1	humus and gray-brown loam	15-35 cm
Stratum 2	brown-orange silt, redeposited and stained	20-50 cm
Stratum 3	brown-red gravelly silt, locally interrupted	20-30 cm
Stratum 4	upper part: beige silt with gravel	10-25 cm
	lower part: light brown to beige loess	5-20 cm
Stratum 4.1	reddish loess	2-10 cm
Stratum 4.2	yellowish-beige silt with charcoal flecks	10-15 cm
Stratum 5	beige, very clayey silt with gravels and limestone blocks	25-35 cm
Stratum 6	pure beige clayey silt	

Archaeological materials are found primarily in Strata 4 and 4.1, with rare artifacts found in Stratum 3 due to perturbation by rodent activity, roots, and other natural agents (Otte *et al.* 1993:19). Strata 5 and 6 yielded highly altered reduction debris, primarily flakes.

Dating of the site

Huccorgne was first dated from the Destexhe 1980 excavations by conventional C14 to 23,160 ± 160 BP (GrN-9234). However, the Straus and Otte excavations, using the AMS method, yielded a series of dates ranging from 24-28,000 BP (Table 7.1). The dates support an interpretation of at least two occupations, one between 28-26,000 BP and the other around 24,000 BP (Straus *et al.* 1997:155). Stratigraphic data (see Haesaerts 2000 for discussion) suggest that Huccorgne was occupied around 26,000 years ago in comparison to around 28,000 years for Maisières.

Level	**Date**	**Lab No.**	**Material dated**	**Method**
4(?) (Destexhe exc.)	23160 ± 160 BP	GrN-9234	bone collagen	conventional
4	24170 ± 250 BP	CAMS-5893	mammoth bone collagen*	AMS
4	26300 ± 460 BP	OxA-3886	mammoth bone collagen	AMS
4	28390 ± 430 BP	CAMS-5891	mammoth bone gelatin*	AMS
4	26670 ± 350 BP	CAMS-5895	mammoth bone collagen	AMS
4.1	284 ± 52 BP **	GX-17016	charcoal flecks	AMS

Table 7.1. Huccorgne radiocarbon dates. (after Straus *et al.* 1997:153). * Same bone sample. ****** Contaminated due to downward movement of sub-modern charcoal.

Site occupation and function

With the case of Huccorgne, different excavations uncovered different parts of the site, which may or (more likely) may not have been contemporaneous. Its location on an oxbow ridge overlooking the Mehaigne River, not far from the Meuse, together with the local availability of flint, contribute to making the location one which would have been re-used, perhaps seasonally, probably over long periods, for flint procurement, and probably also for ambush hunting. As at Maisières-Canal, faunal remains are very poorly preserved in the loess matrix. There are, however, some bones and teeth of mammoth, horse and reindeer (Straus *et al.* 1997). In the main test pit at Huccorgne-Smetz, Mousterian material was found at c. 3 meters below surface. At Huccorgne-Dock (found by Tihon and Haesaerts in the railroad trench), Mousterian levels some 5 meters deeper remain to be excavated.

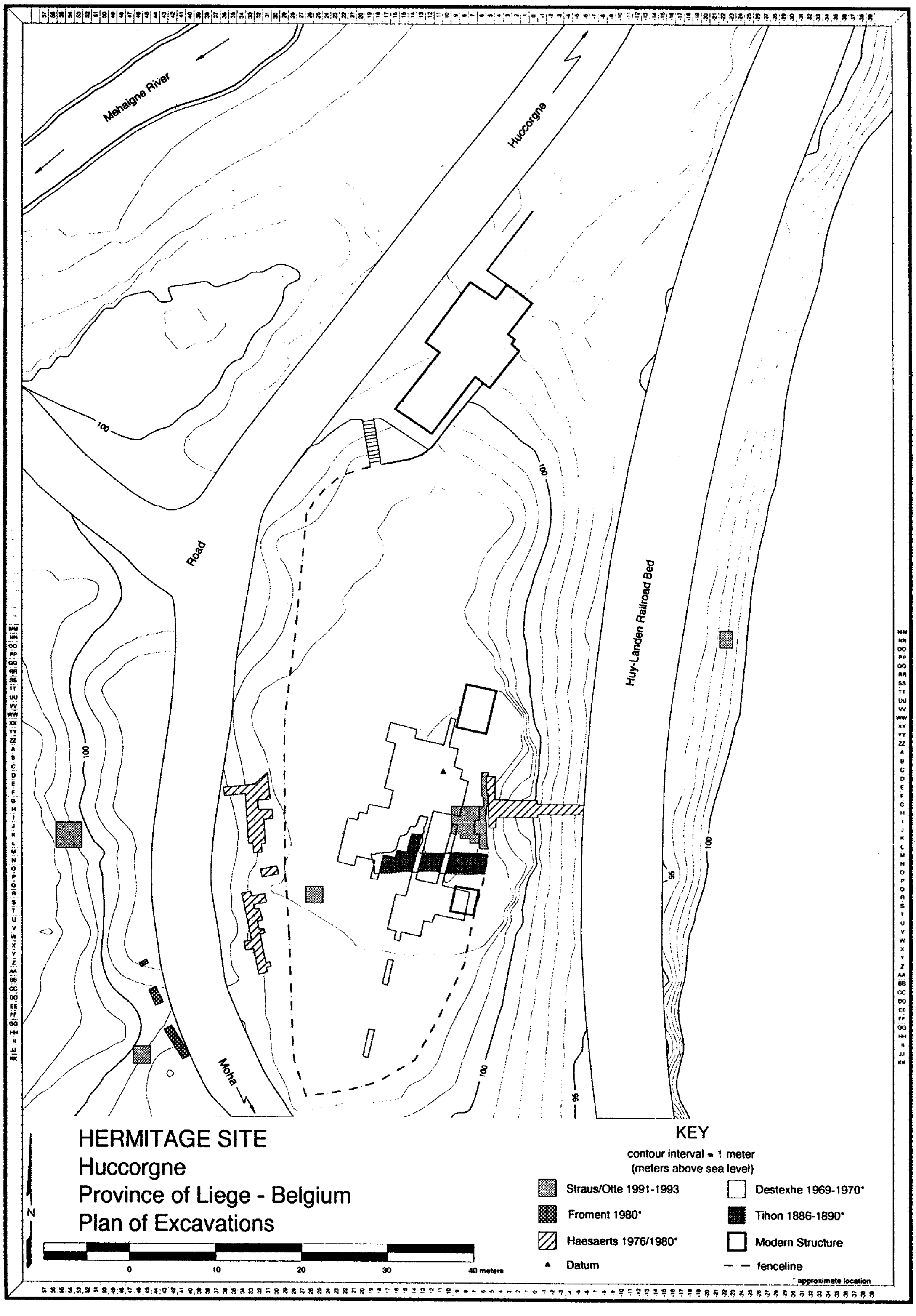


Figure 7.3. Huccorgne. Plan of excavations. (after Straus *et al.* 1997:172, Fig. 4)

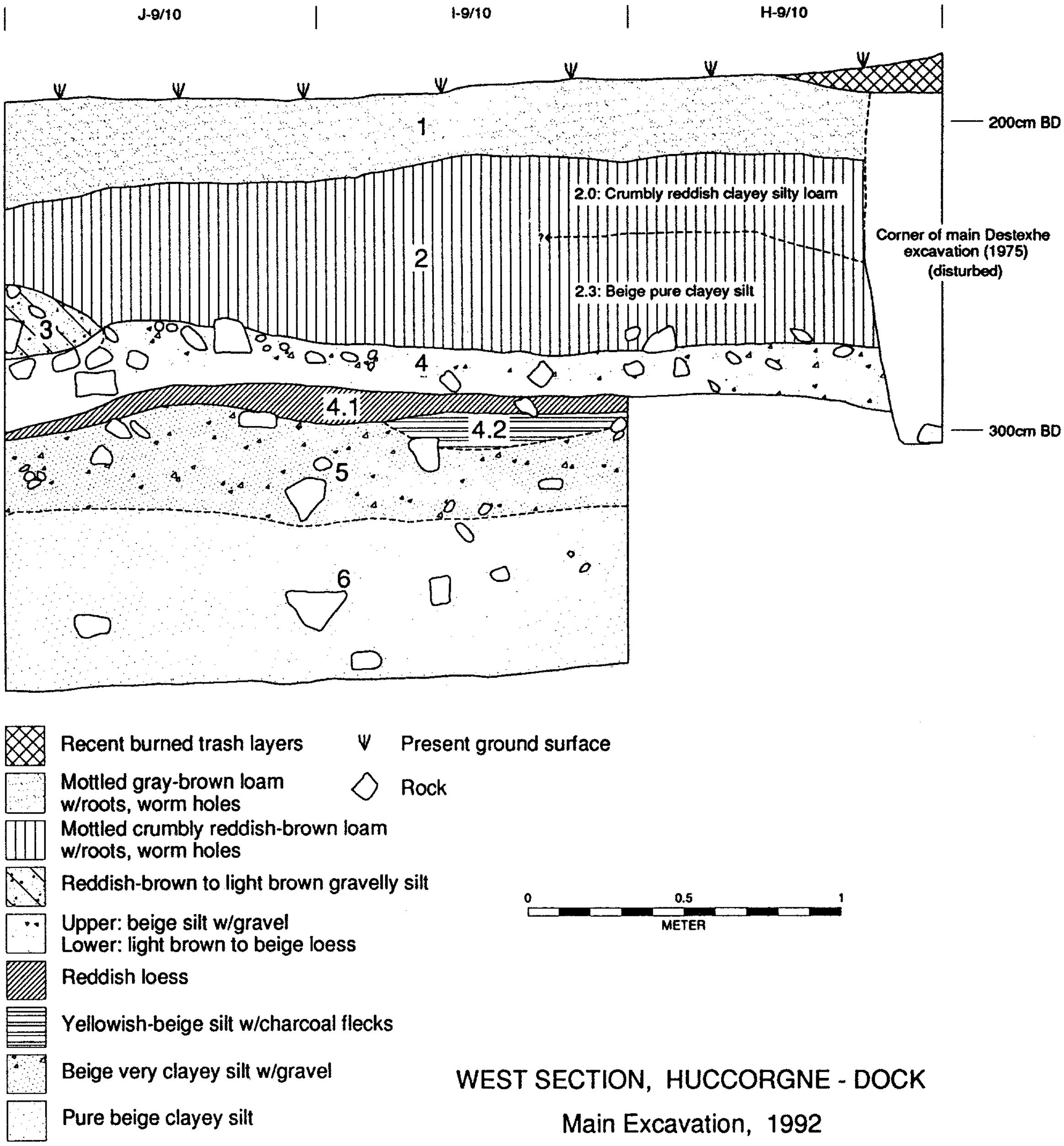


Figure 7.4. Huccorgne. West section, Huccorgne-Dock, main excavations 1992. (after Straus *et al.* 1997:174, Fig. 6)

Description of assemblage and industry attribution

The assemblage is typologically attributable to the Gravettian with tanged Font-Robert points, some of which were found in the older excavations (Otte 1979), though not in the 1991-93 or 1976-80 excavations. Radiocarbon dates tend to confirm the hypothesis of a Gravettian presence at the beginning of the Tursac oscillation (*sensu lato*).

Assemblage samples

The two collections studied are summarized below (Tables 7.2 and 7.3) with respect to frequencies of raw material types by count and weight. While the Straus and Otte collection is much smaller than the Haesaerts collection (n=2540 versus 5755) and Hesbaye flint is overwhelmingly dominant, there is greater diversity in the less common raw material types. In the Haesaerts collection, only 5 artifacts are made on materials (quartzite and sandstone) other than Hesbaye flint.

Expectations

As at Maisières-Canal, Huccorgne is located in the proximity of sources of good quality flint, found in Cretaceous outcrops along the valley of the Mehaigne. Quality and abundance are not expected to affect the lithic economy.

Section 2. Ranking of materials by frequency and weight

For the Straus and Otte collection, material types are ranked similarly by count and weight, except that the heavier limestone moves up to second place by weight (Tables 7.4 and 7.5). For the Haesaerts collection, Hesbaye flint is overwhelmingly dominant and the very rare quartzite and sandstone are considered Rank 3 (i.e., no Rank 2 materials are present) (see Table 7.3). This ranking can be reduced to three tiers (Table 7.5).

SOURCES OF MATERIAL UTILIZED

Rank 1

Hesbaye flints (Type 3) come from local Cretaceous flint outcrops exposed in the Mehaigne Valley. Four minor putative variants, differing slightly in grain size and patination, have been subsumed within Type 3. Refitting of a core by Martinez and Guilbaud (1993) shows that artifacts of these variants refit and thus are from the same source, thereby proving a degree of variability within the same source. When newly removed from sediment, many artifacts were dark blue, but patinated white or bluish-white in a matter of minutes. Inclusions are small ovoid spots and gray specks.

Rank 2

Brussels sandstone (Type 12) comes from a highly localized source on the Brabant Plateau, approximately 40 km west-northwest.

The geological source of black flint (Type 7) is unknown, but it is similar to that found in the Lanaye or Lixhe Gulpen proveniences (in the Maastricht region) and to Tertiary black flint found on the Brabant Plateau not far from the source of Brussels sandstone (sample from E. Teheux). It differs from the black Obourg flint in its greater opacity and less fine grain size.

Limestone (Type 13) is found locally and is abundant (cliffs of the Mehaigne gorge).

	Count		Weight	
Type	**n**	**%**	**wt in g**	**%**
3 - Hesbaye flint	2342	92.2	4459	90.4
4 – phtanite	3	0.1	3	0.06
7 - black flint	49	1.9	47	1.0
10 – chert	13	0.5	21	0.43
11 – quartzite	3	0.1	6	0.12
12 - Brussels sandstone	67	2.6	51	1.0
13 – limestone	37	1.5	268	5.4
100-ochre/other	26	1.0	76	1.5
Total	2540	100%	4931 g (n=1266)	99.89

Table 7.2. Frequencies of raw material types by count and weight (Straus and Otte collection). Note: The category ochre/other has been excluded from analysis but was used to calculate the percentage of the entire assemblage for the other raw material types.

	Count		Weight	
Type	**n**	**%**	**wt in g**	**%**
3 – Hesbaye flint	5750	99.9	10041	99.6
11 – quartzite	2	0.04	13	0.1
12 – sandstone	3	0.05	24	0.3
Total	5755	100.0	10077 (n=2172)	100.0

Table 7.3. Frequency of raw material types by count and weight (Haesaerts collection).

Rank	**Type**	**Count %**		**Rank**	**Type**	**Weight %**
1	3 - Hesbaye flint	92.2		1	3 – Hesbaye flint	90.4
2	12 - Brussels sandstone	2.6		2	13 – limestone	5.4
3	7 - black flint	1.9		3	12 – Brussels sandstone	1.0
4	13 - limestone	1.5		4	7 - black flint	0.95
5	10 - chert	0.5		5	10 – chert	0.43
6	11 - quartzite	0.1		6	11 – quartzite	0.12
6	4 - phtanite	0.1		7	4 – phtanite	0.06

Table 7.4. Ranking of material types by frequency and weight (Straus and Otte collection).

Rank	**No(s).**	**Type(s)**	**Count %**	**Weight %**
1	3	Hesbaye flint	92.2	90.4
2	12, 7, 13	Brussels sandstone, black flint, limestone	1.5-2.6	1-5
3	10, 11, 4	chert, quartzite, phtanite	< 1	< 1

Table 7.5. Collapsed ranking of material types (Straus and Otte collection).

Rank 3

Chert (Type 10) and quartzite (Type 11) could have been found locally on the plateau or on terraces of the Mehaigne River. Survey of the plateau region near the site yielded abundant but relatively poor quality chert on the surface.

Phtanite (Type 4) comes from a localized source on the Brabant Plateau, near Ottignies-Mousty, around 40 km to the west-northwest.

TRANSPORT OF MATERIAL

Tables 7.6 and 7.7 below summarize the transport form and general assemblage structure for the Straus/Otte and Haesaerts assemblages, respectively. Rank 1 material was acquired locally as partially prepared cores, still somewhat cortical, for reduction at the site. Although relatively rare, there were 94 primary decortication flakes from the Haesaerts excavations. For both excavations, about 21% of the Hesbaye flint was at least partially cortical. In comparison, about 42% of the local Obourg flint at Maisières-Canal was cortical. This indicates either an increase in core preparation prior to reduction at Huccorgne, or procurement of flint nodules or blocks that were less cortical to begin with. Rank 2 material was transported as exhausted cores (chunks) with very minor reduction activity occurring at the site. Rank 3 materials were transported (either from nearby [chert, quartzite] or non-locally [phtanite]) as blanks and tools with no reduction activity occurring at the site.

Given the rarity of cortex on any of the material, an assessment of procurement context is not productive. The following table (Table 7.8) summarizes the scanty cortex information.

EVIDENCE FOR REDUCTION OF MATERIALS AT THE SITE

The assemblage structure for each material varies with rank, with Rank 1 materials evidencing the majority of reduction activity at the site, with all stages of reduction present (apart from primary decortication), Rank 2 materials (in the Straus and Otte collections) reflect a much more minor degree of reduction. Rank 3 materials only appear as blanks or finished tools (with a few chunks).

What blanks were produced?

The following table (Table 7.9) shows the kinds of blanks (flakes, blades and bladelets; small debris is excluded) produced for each material type, for both assemblages. These are removals that could have potentially been retouched into tools. Many, however, may have been unsuitable for tools, in terms of shape and size, and were not selected for tool retouch.

From the Haesaerts collection, flakes and blades were produced in similar quantities (n=1120 versus 947), with significant bladelet production as well (n=432). 60 crested blades and 47 platform renewal flakes are present in the Haesaerts collection, indicating core preparation and renewal during secondary reduction. In contrast, only one crested blade and one platform renewal flake were found in the Straus and Otte excavations. This may be a result of the relative sizes of the areas excavated or intra-site activity differences. The Straus and Otte collection also shows the dominance of flakes produced on all material types. However, considering that most tools present were made on blades, the majority of these flakes, although considered *potential* blanks, are probably reduction by-products. This observation may be

Rank 1 material		
Type	**Assemblage structure**	**Brought to site as...**
3 - Hesbaye flint	4 cores, 32 tools, 1154 unretouched removals*, 1151 debris (including 198 chunks**)	partially prepared cores
Rank 2 material		
Type	**Assemblage structure**	**Brought to site as...**
12 - sandstone	36 blanks, 31 debris (including 4 chunks)	exhausted cores (chunks) and blanks
7 - black flint	1 core, 17 unretouched removals, 31 debris (no chunks)	nearly exhausted core
13 - limestone	29 blanks, 8 debris (including 4 chunks)	exhausted cores or blanks
Rank 3 materials		
Type	**Assemblage structure**	**Brought to site as...**
10 - cherts	1 tool, 6 blanks, 6 debris (including 3 chunks*)	blanks and tools
11 - quartzites	1 blank, 2 debris	blanks
4 - phtanite	2 blanks, 1 debris (chunk)	exhausted core and blanks

Table 7.6. Transport form of raw materials and general assemblage structure (Straus and Otte collection). * Chunks are probably core remnants.

Rank 1 material		
Type	**Assemblage structure**	**Brought to site as...**
3 – Hesbaye flint	8 cores, 142 tools, 2428 unretouched removals, 3172 debris (including 219 chunks)	partially prepared cores
Rank 3 material		
Type	**Assemblage structure**	**Brought to site as...**
12 - sandstone	1 tool, 2 blanks	tool and blanks
11 - quartzite	2 blanks	blanks

Table 7.7. Transport form of raw materials and general assemblage structure (Haesaerts collection).

		Cortex		Proportion		Primary Context		Secondary Context	
Rank	**Type**	**n**	**%**	**n < 50%**	**n > 50%**	**n**	**%**	**n**	**%**
1	3 – Hesbaye flint	486	20.8	54	22				
2	12 - Brussels sandstone	9	13.4						
2	7 - black flint	5	10.5						
2	13 - limestone	22	59.5						
3	10 - chert	4	30.7		1			1	
3	11 - quartzite	2	66.6						

Table 7.8. Procurement context: cortex data (Straus and Otte collection).

related to the export of the majority of blades that were produced, considering that most tools were made on blades.

Material	total n (blank pool)	flakes		blades		bladelets	
		n	%*	n	%	n	%
Straus and Otte							
3 – Hesbaye flint	1184	821	69.3	256	21.6	107	9.0
12 – Brussels sandstone	36	18	50.0	10	28.0	8	22.0
7 – black flint	17	9	52.9	6	35.3	2	11.8
13 – limestone	29	19	65.5	8	27.6	2	6.9
10 – chert	7	4	57	3	43	0	0
Haesaerts							
3 – Hesbaye flint	2559	1120	44	1007	39	432	17

Table 7.9. Blank production by material type. *Percent of blank pool.

What blanks were selected for retouching into tools?

The following table (Table 7.10) shows the number of tools made on the different kinds of blanks, with a clear pattern of blade preference for both excavations.

Material	n tools	flakes	blades	bladelets	chunks	PRF	debris
Straus and Otte							
3 – Hesbaye flint	32	6	22	2			1
12 - Brussels sandstone	0						
7 – black flint	0						
13 – limestone	0						
10 – chert	1		1				
11 – quartzite	0						
4 – phtanite	0						
Haesaerts							
3 - Hesbaye flint	142	41	74	16	7	3	1
12 – sandstone	1	1					

Table 7.10. Blank selection for tool production by material type.

What is the intensity of blank selection?

The intensity of blank selection refers to the ratio between tools and unused removals. Only Rank 1 material will be considered here. The ratio of tools to available blanks is extremely low: 32 tools out of 1184 potential blanks for the Straus and Otte collection and 143 out of 2559 for the Haesaerts collection. The low number of tools, cores and blade blanks remaining in the site may be due to the main function of the site as a flint workshop for the export of tools and prepared cores. Size would have had a crucial threshold for blank selection, Straus and Otte, whole blades, tools vs. blanks, Hesbaye flint

Variable	Number of Cases	Mean	SD	SE of Mean
LENGTH Length				**p=.098**
Blanks (unretouch	18	49.7778	20.724	4.885
Tools (retouched)	7	64.5714	14.397	5.442
WIDTH Width				**p=.061**
Blanks (unretouch	18	22.6667	6.903	1.627
Tools (retouched)	7	28.8571	7.426	2.807
THICK Thickness				**p=.173**
Blanks (unretouch	18	7.4444	3.899	.919
Tools (retouched)	7	11.4286	6.579	2.487

Straus and Otte, whole flakes, tools vs. blanks, Hesbaye flint

Variable	Number of Cases	Mean	SD	SE of Mean
LENGTH Length				**p=.000**
Blanks (unretouched)	107	18.5981	9.995	.966
Tools (retouched)	2	59.0000	21.213	15.000
WIDTH Width				**p=.000**
Blanks (unretouched)	107	17.5234	9.237	.893
Tools (retouched)	2	45.0000	21.213	15.000
THICK Thickness				**p=.000**
Blanks (unretouched)	107	3.9720	2.866	.277
Tools (retouched)	2	15.0000	4.243	3.000

Haesaerts, whole blades, tools vs. blanks, Hesbaye flint

Variable	Number of Cases	Mean	SD	SE of Mean
LENGTH Length				**p=.493**
Blanks (unretouched)	97	35.1856	10.641	1.080
Tools (retouched)	4	39.0000	16.269	8.134
WIDTH Width				**p=.319**
Blanks (unretouched)	97	14.6082	5.634	.572
Tools (retouched)	4	17.5000	6.351	3.175
THICK Thickness				**p=.101**
Blanks (unretouched)	97	5.0103	2.624	.266
Tools (retouched)	4	7.2500	3.403	1.702

Haesaerts, whole flakes, tools vs. blanks, Hesbaye flint

Variable	Number of Cases	Mean	SD	SE of Mean
LENGTH Length				**p=.005**
Blanks (unretouched)	541	26.3826	9.825	.422
Tools (retouched)	27	31.8519	11.733	2.258
WIDTH Width				**p=.207**
Blanks (unretouched)	541	23.6673	9.129	.392
Tools (retouched)	27	27.2222	14.148	2.723
THICK Thickness				**p=.021**
Blanks (unretouched)	541	5.7172	2.961	.127
Tools (retouched)	27	7.6296	4.001	.770

Table 7.11. t-tests comparing whole blades and blade tools, whole flakes and flake tools.

with the rest of the flakes and blades at the site having been rejected as too small. Some or even many of the blades and large flakes could have been used unretouched.

Is there a size difference between blanks and tools?

T-tests comparing size of tools and blanks are not valid, due to the limited sample of tools in comparison to the large numbers of unretouched removals Table 7.11). However, one can observe that, generally speaking, tools made on blades are longer than whole unretouched blades in the Straus and Otte assemblage while there is little or no difference for either blades or flakes in the Haesaerts assemblage. Flakes cannot be interpreted, due to sample size.

EVALUATION OF LITHIC ECONOMY WITH RESPECT TO RAW MATERIAL CONTEXT

The ranking of materials reflects distance in space and time (recent past of the group occupying Huccorgne). The “oldest” materials, the ones that had been transported the longest and furthest, have been completely exploited and all that remains are a few curated tools and blanks that were finally discarded. This is the case for the Rank 3 material phtanite. The other Rank 3 materials - chert and quartzite - were available locally, but were not significantly exploited, given the availability of the much better quality flint.

When one considers that the few Rank 2 materials arrived at Huccorgne nearly exhausted, one could argue that the flint sources in the Mehaigne valley were known, thus making it unnecessary to transport mobile toolkits to the site but merely a supply of blanks for possible use en route. Evidence of *at least* two separate occupations is given by the refitting of the core by Martinez and Guilbaud (1993), which shows two distinct stages: one of core reduction and one of attempted reduction at a later point in time which resulted in the shattering of a frost-affected core. Rank 2 materials include Brussels sandstone, black flint, and local limestone. If black flint can be identified as Tertiary flint from the Brabant Plateau and not as from the Maastricht region, the first two materials indicate movement from west to east. Limestone is a poorer quality material available locally that may have been used for some specific purpose that required softer stone. Rank 1 material reflects the primary function of Huccorgne as a flint workshop.

When the Straus and Otte collection is compared with the Haesaerts collection, that is, comparing different areas of the site, several comments can be made. The Haesaerts excavation covered more than twice the area of the Straus and Otte excavation (around 46 m^2 versus 18.5 m^2), resulting in a higher frequency of artifacts. However, the lithic assemblage is homogeneous with respect to raw material diversity, while the Straus and Otte assemblage contains a wider variety of Rank 2 and 3 materials. Additionally, the Destexhe excavations in the center of the site yielded a greater quantity of fauna as well as Font-Robert points. Such differences in archaeological material could conceivably reflect different activity areas or areas of differential discard.

CHAPTER 8
LES GROTTES DE GOYET: THIRD CAVE, STRATUM 3

BACKGROUND

Location of site

Les Grottes de Goyet (Figs. 8.1 and 8.2) are located within the limestone massif at the confluence of the Samson River, a tributary of the middle Belgian Meuse (3 ½ km distant), and the Strud, a small stream, both of which drain the Condroz Plateau. The site includes three separate areas which are of archaeological interest (Toussaint *et al.* 1997:33-34): 1) a group of four, large interconnected cavities opening onto a common terrace (Dupont 1872; Tihon 1895-96; Rahir 1908, 1910; Ulrix-Closset 1975; Otte 1979; Dewez 1987; Germonpré 1997), 2) Trou du Moulin, another cave around 120 meters from the main terrace (Danthine 1952), and 3) *abri supérieur* (upper rock shelter), located between the two, 50 meters northwest of the main terrace and about a dozen meters higher (Eloy and Otte 1995).

A fifth cave, called Trou du Moulin (Danthine 1952), is also included in the Grottes de Goyet designation, but does not form a part of the interconnected karstic cluster and is not included in this study.

Raw material context

From the Samson and the Strud, river cobbles of quartzite, chert, and sandstone would have been available locally, directly in front of the cave complex. The nearest flint sources were on the Hesbaye Plateau, in the Mehaigne River region approximately 20 km to the northeast. The Meuse itself is only 5 km downstream, via the valley of the Samson. Flint sources to the west (Obourg and Spiennes in the Hainaut Valley) are approximately 70 km away. Phtanite and Wommersom quartzite, highly localized sources on the Brabant Plateau, are approximately 40 km to the north. Flint sources in the Maastricht region (eastern part of the Hesbaye Plateau, the Pays de Herve, and the southern Dutch Limburg enclave of Maastricht) are at least 60 km to the northeast, but do not appear to have been exploited.

Flint sources are thus not local, but rather exist within the Zone 2, a 40 km radius that, as will be seen, was exploited to provision the site.

To summarize the raw material context at Goyet, then, local material would be rare and of poorer quality, consisting primarily of cherts and quartzites. The nearest source of good quality material is the Plateau de Hesbaye, north of the Meuse. Other known sources, such as Spiennes and Obourg, also used, are much more distant. Therefore, at Goyet, quality and distance to sources both exert pressure on the lithic economy, and distances from Goyet to various sources would have affected the nature in which each material was utilized.

Excavation history

The Grottes de Goyet were discovered and first excavated by Edouard Dupont in 1869 (Dupont 1869a, 1872). Dupont excavated in all four of the caves (numbered 2-5, with the Grotte du Moulin being identified as Number 1). In 1891, Tihon excavated the large terrace as well as intact remnants within the caves (Tihon 1895-96). From 1907-1909, de Loë and Rahir, for the Musées Royaux d'Art et d'Histoire (Cinquantenaire), excavated the third and fourth

Figure 8.1. Les Grottes de Goyet. Location of site.
(from Institut Géographique National map 48/5-6, scale 1:25000)

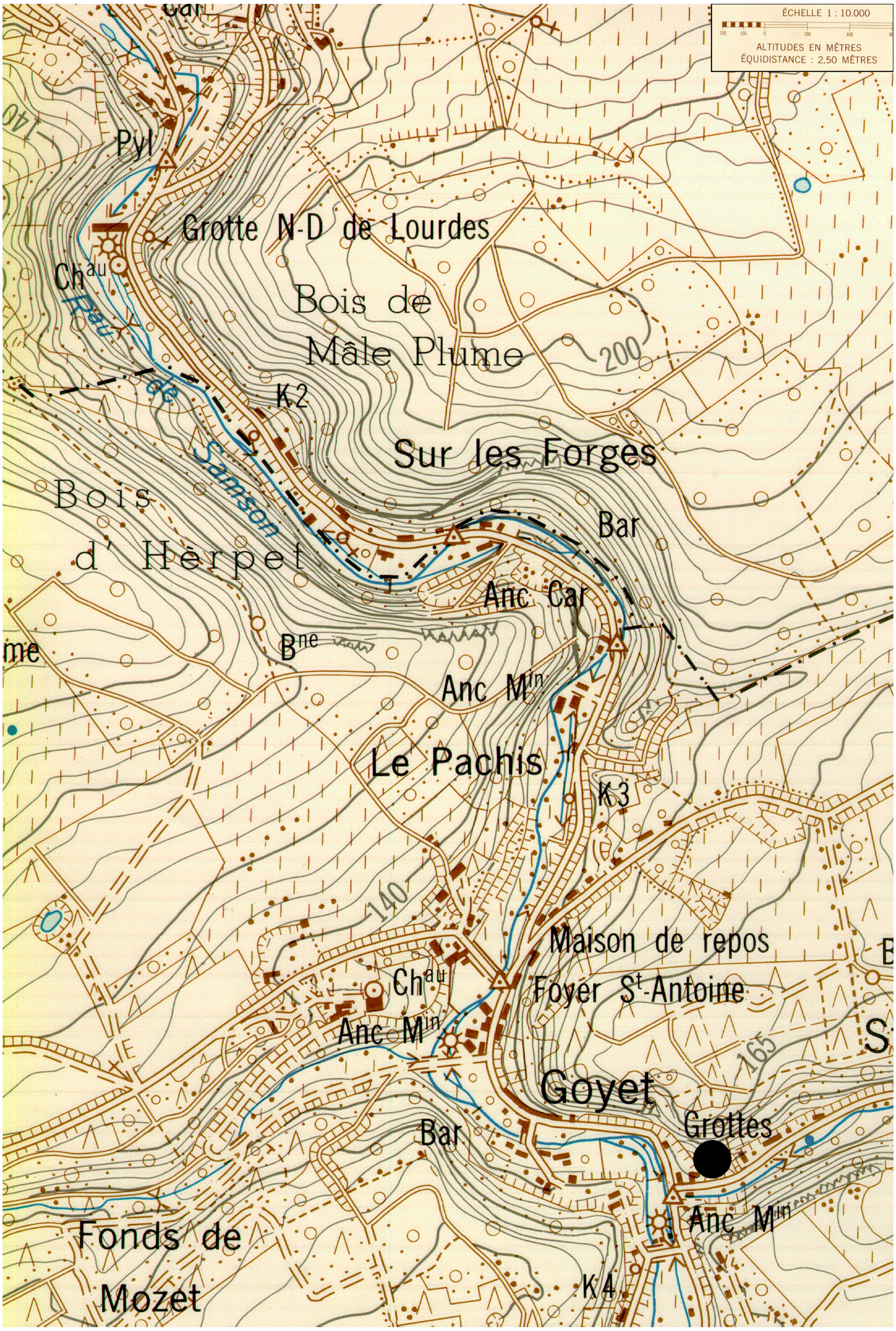


Figure 8.2. Les Grottes de Goyet. Location of site.
(from Institut Géographique National map 48/5, scale 1:10000)

caves (according to *their* numbering, which are equivalent to Dupont's Caves 2 and 3) as well as in the backdirt from previous excavations and a Neolithic burial (Rahir 1928). In the two caves, they found mainly mixed backfill, but also some Upper Paleolithic material in sediments somewhat perturbed by natural processes.

Subsequently, excavations were undertaken by various amateurs, as well as by Kaiser (de Bournonville 1955a) for the Institut des Sciences Naturelles de Belgique, who prepared the caves for touristic exploitation in the mid-1930s. In 1952, Louis Eloy excavated a nearby abri, the results of which have been only recently published (Eloy and Otte 1995).

The latest excavations directed by M. Toussaint and A. Becker (Toussaint *et al.* 1997; Toussaint *et al.* 1998; *Carnets de Patrimoine* 26, 1999) began in 1997 on the terrace, in remnant sediment deposits in Dupont's Cave 3, and in chambers newly discovered by Philippe Lacroix. The terrace was revealed to be an artificial accumulation of sediment consisting of backdirt from 19th century excavations and redeposition in the 1930s in preparation of the site for tourism. The intact Pleistocene sedimentary deposit is currently being analyzed (pollen and microfauna) to reconstruct the climatic sequence. The skeleton of a Late Neolithic child was found in the newly discovered chamber and anthropological analyses are in progress by Toussaint.

Stratigraphy

Because only the Dupont collection from Cave No. 3 has been analyzed for this study, only the stratigraphy from this cave will be discussed, based on Dupont's admittedly general and sometimes inaccurate description (Dupont 1872:106-119).

From bottom to top, Dupont identified five geological strata, three of which contained archaeological materials (Figs. 8.3 and 8.4). Stratum 5 contained a carnivore occupation, primarily cave lion and cave bear. Stratum 4 also contained a carnivore occupation, hyena and cave bear. Stratum 3 contained an archaeological assemblage that Dupont considered to be analogous to the industry at Montaigle. Analyses of this assemblage (e.g., Otte 1979, as well as my own study) show that the surviving assemblage at the IRSNB contains a mixture of Mousterian and Aurignacian materials, although it is not clear whether the material had already been mixed by natural processes before excavation or if Dupont's excavation techniques caused the lumping of multiple archaeological layers into one "stratum". Stratum 2 contained an archaeological assemblage analogous to those observed by Dupont at Montaigle and Trou Magrite, and is today considered to be Gravettian. Stratum 1 contained an assemblage analogous to Chaleux and Furfooz, and is attributable to the Magdalenian (Germonpré 1997).

Dating of the site

The two levels studied have not been dated, although recent dates have been produced for Dupont's Stratum 1 in the third cave (Germonpré 1997), which contains Magdalenian material. These dates are presented in Table 8.1. While the Magdalenian level does not form a part of this research, these recently obtained dates conform well to dates obtained at other Magdalenian sites in Belgium (Chaleux, Bois Laiterie, Trou Da Somme) and thus add to our understanding of the Magdalenian occupation of Belgium. The anomalous date (GrA-3239), as Toussaint points out (Toussaint *et al.* 1997:37), demonstrates once again the heterogeneity of the "strata" identified by Dupont.

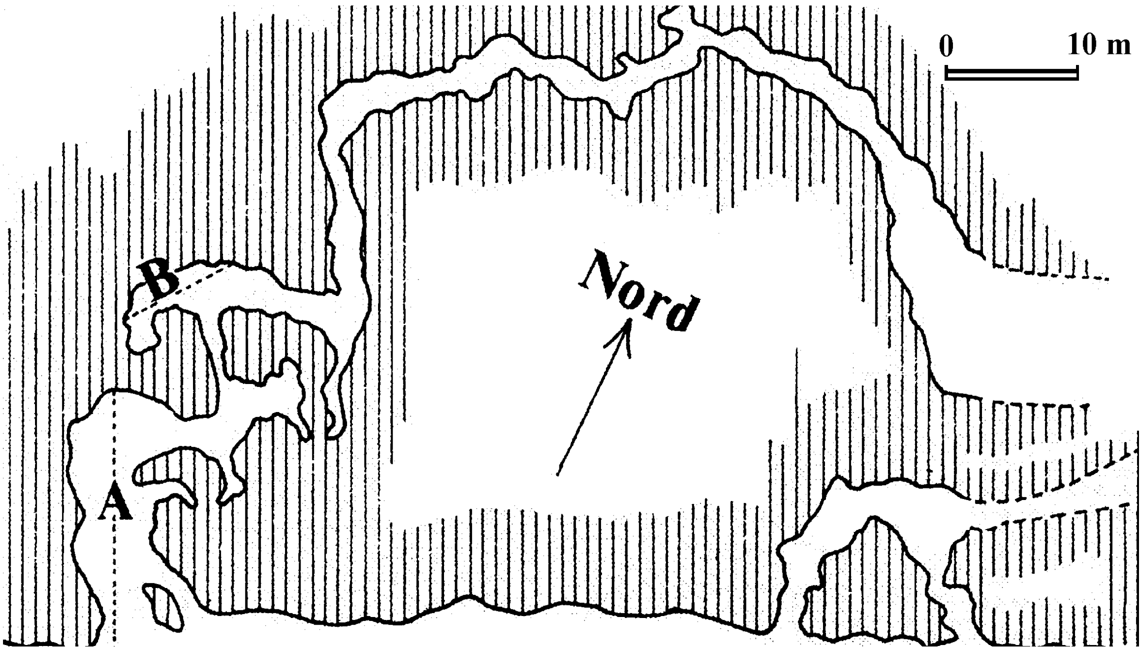


Figure 8.3. Les Grottes de Goyet. Plan of Cave no. 3 (after Dupont 1872:106, Fig. 12).

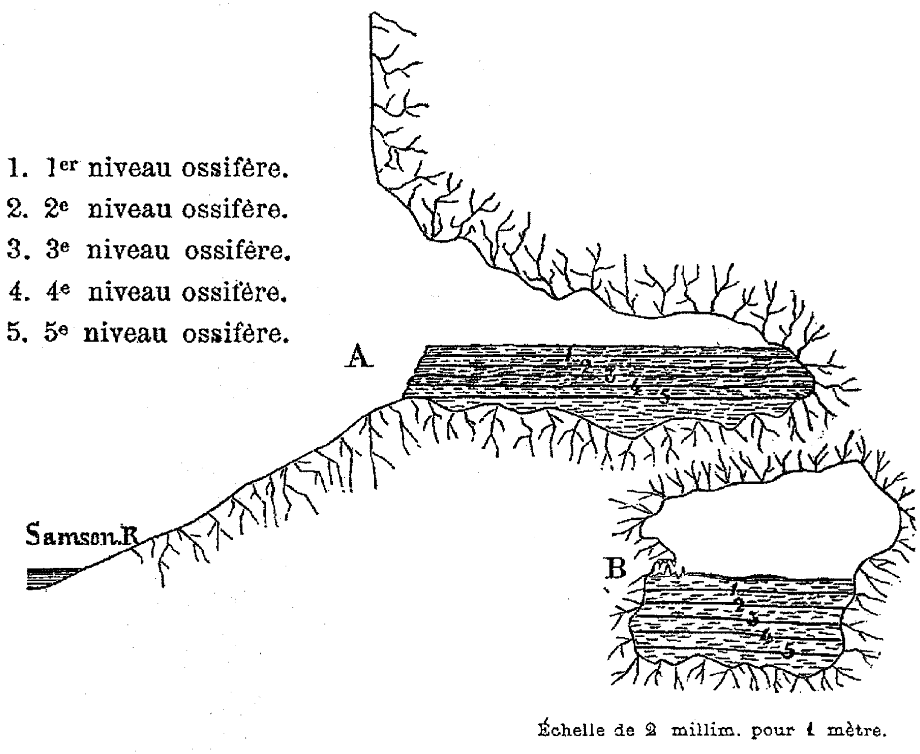


Figure 8.4. Les Grottes de Goyet. Dupont's stratigraphy of Cave no. 3 (after Dupont 1872:107, Fig. 13).

Method	Lab code	Date	Material
AMS	GrA-3237	12,770 ± 90 BP	worked bone
AMS	GrA-3238	12,620 ± 90 BP	worked bone
AMS	GrA-3239	27,230 ± 260 BP	unworked bone

Table 8.1. Goyet. AMS dates for Cave No. 3, Stratum 1 (Magdalenian) (Germonpré 1997).

Description of assemblages and industry attributions

The assemblage from Stratum 3 has been analyzed for this research. This stratum, as described above, contains a mixture of Mousterian and Aurignacian materials. In the holdings of the IRSNB, Stratum 3 was sorted at some point in the past, most likely at the beginning of the century, and material is stored in drawers labeled “Couche 3 - Aurignacien” and “Couche 3 - Moustérien”. It is not clear what criteria were used to make this separation. However, the separation has been provisionally used in this research to identify possible differences between the so-called Mousterian and Aurignacian components, but it is more prudent to ultimately consider the Goyet “Couche 3” assemblage as a whole, assuming that Stratum 3 is a vast palimpsest of multiple occupations spanning both Mousterian and Aurignacian periods.

Assemblage samples

Although many collections exist (in varying degrees of quality and availability) from the multiple excavations at Goyet, they come from different caves in the system, from the terrace, and from backdirt of preceding excavations. Dupont's assemblage from Cave No. 3 was selected for analysis for three principal reasons, although problems still exist with this collection (see below). First, Dupont was the first to excavate at Goyet; thus there is no possibility of mixture with backdirt coming from other areas of the cave complex. We can therefore say with reasonable confidence that the collection comes only from Cave No. 3. Second, the material recovered from the third cave was the most abundant and most important for interpreting the local Paleolithic cultural sequence. Third, considering the level of archaeological expertise in the 19th century and the less than scientific quality of most of the subsequent excavations by amateurs, it would be impossible to correlate the variously identified "strata" in order to study a complete archaeological level. The selection of a single collection, then, from the most important part of the site, controls for problems associated with the nature of excavations at Goyet. Frequencies by count and weight for the “Aurignacian” and “Mousterian” components of Stratum 3 are summarized in Tables 8.2 and 8.3 below.

Problems with assemblage and resolution of problems/justification for analyses

Several problems with this collection had to be addressed. First, as discussed above, the 19th century excavations were done by thick, artificial, composite layers that crosscut different occupation levels and even different industries. Recent analysis of the Dupont stratigraphy (Otte 1979) shows that the observed mixing of different industries was likely due to natural, post-depositional disturbance, as well as to the quality of excavations. If one accepts that an archaeological level represents multiple occupations and is time-averaged (or time-collapsed), analysis of raw material and assemblage structure may be able to untangle some of this mixing.

Second, there was clearly a bias against collection or saving of small debitage (almost a complete lack of any material less than one cm in length) by the early excavators. This problem prevents detailed assessment of the degree of *in situ* tool production and/or tool resharpening

	Count		Weight	
Type	**n**	**%**	**wt in g**	**%**
1	118	6.9	693	6.30%
2	30	1.8	287	2.61%
3	1149	67.5	6682	60.71%
4	3	0.2	2	0.02%
5	1	0.2	11	0.10%
6	157	9.2	1222	11.10%
7	67	3.9	363	3.30%
8	133	7.8	1182	10.74%
9	3	0.2	91	0.83%
10	7	0.4	187	1.70%
11	7	0.4	79	0.72%
12	1	0.1	4	0.04%
missing	26	1.5	204	1.85%
Total	1702	100.00%	11007	100.00%

Table 8.2. Stratum 3: “Aurignacian”. Frequency of raw material types by count and weight.

	Count		Weight	
Type	**n**	**%**	**wt in g**	**%**
1	39	5.2	435	2.9
2	28	3.8	541	3.6
3	392	52.5	7324	48.7
4	6	0.8	78	0.5
5	18	2.4	403	2.7
6	93	12.5	2007	13.3
7	17	2.3	376	2.5
8	73	9.8	973	6.5
9	14	1.9	401	2.7
10	51	6.8	1757	11.7
11	6	0.8	105	0.7
12	1	0.1	5	0.03
missing	8	1.1	624	4.2
Total	746	100.0	15029	100.0

Table 8.3. Stratum 3: “Mousterian”. Frequency of raw material types by count and weight.

Rank	No.	Type	Count %
1	3	Hesbaye flint	67.5
2	6	tan flints	9.2
3	8	gray flints	7.8
4	1	Obourg flint	6.9
5	7	black flints	3.9
6	2	Spiennes flint	1.8
7	10	cherts	0.4
7	11	quartzites	0.4
8	4	phtanite	0.2
8	9	brown flint	0.2
9	5	Wommersom quartzite	0.1
9	12	sandstone	0.1

Table 8.4. Stratum 3. “Aurignacian”. Ranking of material types by frequency and weight.

Rank	No.	Type	Count %
1	3	Hesbaye flint	52.5
2	6	tan flints	12.5
3	8	gray flints	9.8
4	10	cherts	6.8
5	1	Obourg flint	5.2
6	2	Spiennes flint	3.8
7	5	Wommersom quartzite	2.4
8	7	black flints	2.3
9	9	brown flint	1.9
10	4	phtanite	0.8
10	11	quartzites	0.8
11	12	sandstone	0.1

Table 8.5. Stratum 3. “Mousterian”. Ranking of material types by frequency and weight.

Rank	No(s).	Type(s)	Count %
1	3	Hesbaye	67.5%
2	6, 8, 1	tan, gray, Obourg	6-10%
3	7, 2, 10, 11, 4, 9, 5, 12	all others	0.1-4%

Table 8.6. Stratum 3. “Aurignacian”. Collapsed ranking of material types.

Rank	No(s).	Type(s)	Count %	Weight %
1	3	Hesbaye	52.5%	48.7%
2	6, 8, 10	tan, gray, cherts	6.1-10%	6-13%
3	1, 2, 5, 7, 9, 4, 11, 12	all others	0.1-6%	< 5%

Table 8.7. Stratum 3. “Mousterian”. Collapsed ranking of material types.

which would produce trimming flakes. However, the proportion of tools in relation to unretouched flake and blade blanks can attest to the relative intensity of tool production.

Third, the third archaeological level was more or less artificially separated into “Aurignacian” and “Mousterian” components (as discussed above). The majority of the smaller debitage appears to have been primarily assigned to the Aurignacian component, with debris (length 10-30 mm) categories elevated in the Aurignacian component and rare or absent in the Mousterian component. This has implications for assessing the relative degree of core reduction/blank production, but, in general, analysis of the larger flakes, blades, bladelets and cores is sufficient to interpret the kinds of reduction techniques used for different materials. It should be noted that both components are still somewhat mixed. I have provisionally accepted this division, despite these problems, and have analyzed the two components separately, to elucidate potential similarities and differences.

Expectations

Given that the Grottes de Goyet are found in Zone 2, the time and energy expenditure to regularly procure flint from non-local sources is expected to affect reduction and tool production strategies to some degree. However, the distance to the nearest flint source is not so great as to require substantial economization.

RANKING OF MATERIALS BY FREQUENCY AND WEIGHT

Stratum 3, as discussed above, has been analyzed as two separate components – "Mousterian" and "Aurignacian", where the terms indicate only that one or the other industry is typologically dominant in a mixed assemblage. Results are presented here in parallel and similarities and differences discussed within the context of each analysis.

In both components (Tables 8.4 and 8.5), the Rank 1 material is Hesbaye flint, followed by the first two Rank 2 materials (Type 6 – tan flints, and Type 8 – gray flints). However, Type 10 (chert), negligible in the Aurignacian component, was more commonly used in the Mousterian component (6.8 versus 0.4%) and moves up to Rank 2. Rank 3 materials (each less than 6% of the assemblage) are equally represented in both components, varying slightly in their order.

This ranking can be reduced to three tiers (Tables 8.6 and 8.7), indicating that Hesbaye flints are by far the dominant material, followed by much smaller percentages of tan flint, gray flint, and Obourg flint, with insignificant percentages of the other types (except when the material is represented by curated tools). This ranking is used in subsequent discussion.

SOURCES OF MATERIAL UTILIZED

Rank 1

Hesbaye flints (Type 3) come from the Hesbaye Plateau, with primary sources found in the Mehaigne river valley, approximately 20 km from Goyet. It is 60 km northeast to the heart of the Maastrichtian region, where flint is available on the Meuse river terraces and eroding out of chalk cliffs. Flints on the Hesbaye Plateau would have been the closest non-local source of good quality flint. One difficulty in procuring Hesbaye flint is that it would have been necessary to cross the Meuse River, although fords may have formerly existed before the river was dammed.

Rank 1 materials		
Type	**Assemblage structure**	**Brought to site as...**
3	34 cores, 161 tools, 361 blanks, 593 debris	partially prepared cores
Rank 2 materials		
Type	**Assemblage structure**	**Brought to site as...**
6	11 cores, 28 tools, 61 blanks, 60 debris	prepared cores
8	10 cores, 29 tools, 13 blanks, 81 debris	partially prepared cores
1	4 cores, 26 tools, 32 blanks, 56 debris	prepared cores
Rank 3 materials		
Type	**Assemblage structure**	**Brought to site as...**
7	1 core, 3 tools, 20 blanks, 43 debris	nearly exhausted core, blanks, curated tools
2	1 core, 8 tools, 14 blanks, 7 debris	nearly exhausted core, blanks, curated tools
10	1 core, 4 tools, 2 blanks	nearly exhausted core, curated tools
11	3 blanks, 4 debris	local
4	3 debris flakes	possibly intrusive from Stratum 2
9	3 tools	curated tools
5	1 tool	curated tool
12	1 debris flake	local

Table 8.8. Stratum 3. “Aurignacian”. Transport form of raw materials and general assemblage structure.

Rank 1 materials		
Type	**Assemblage structure**	**Brought to site as...**
3	11 cores, 182 tools, 166 blanks, 33 debris	partially prepared cores
Rank 2 materials		
Type	**Assemblage structure**	**Brought to site as...**
6	6 cores, 38 tools, 42 blanks, 7 debris	prepared cores and blanks
8	1 core, 24 tools, 43 blanks, 5 debris	prepared core and blanks
10	3 cores, 17 tools, 21 blanks, 10 debris	prepared cores (but with probable local primary reduction
Rank 3 materials		
Type	**Assemblage structure**	**Brought to site as...**
1	9 tools, 26 blanks, 4 debris	prepared blanks and tools
2	22 tools, 2 blanks, 4 debris	curated tools and blanks
5	15 tools, 3 blanks	curated tools and blanks
7	16 tools, 1 blank	curated tools and blanks
9	11 tools, 3 blanks	curated tools and blanks
4	4 tools, 2 blanks	curated tools and blanks
11	6 tools	curated tools
12	1 debris	local

Table 8.9. Stratum 3. “Mousterian”. Transport form of raw materials and general assemblage structure.

Rank 2

The geological source of the tan flints (Type 6) is unknown, but the lithic reference collection at Katholieke Universiteit (Leuven) has 11 samples from various proveniences in the Maastricht region (60 km NE) and 3 samples from the Hainaut region (74 km west). The tan flints are probably a subset of Hesbaye flints.

The geological source of the gray flints (Type 8) is also unknown. Observations of the lithic reference collection show that gray is the most common color of flints, and that gray flints are found in every region. Considering that Hesbaye flints are the most common and that clearly identifiable Obourg and Spiennes flints are rare or absent in the Goyet assemblages, it is reasonable to assume that the other gray flints were not procured in the Hainaut region, but on the Hesbaye Plateau.

The geological source of Obourg flint (Type 1) is located just north of Mons, in the Hainaut Valley, about 70 km west of Goyet. Spiennes flint is found south of Mons, also about 70 km west of Goyet. Both are non-local materials at Goyet and, of the known sources, are the most distant.

Rank 3

Of the other materials (each less than 4% of the assemblage), most can be regarded as insignificant, except for comments on the following:

Type 5, Wommersom quartzite, 1 tool, 40 km north (east of Tienen).
Type 9, which is a brown flint, represented by 3 tools.
Types 7 (black), 2 (Spiennes), and 10 (cherts): each has a single core and evidence of very minor reduction. The source of Type 7 is unknown, Type 2 is 74 km west, and chert was probably local.
Type 4 (phtanite) comes from the Ottignies-Mousty area, around 20-25 km to the north.

TRANSPORT OF MATERIAL

Using data from cortex and debitage attributes, presence/absence of stages of the chaîne opératoire was assessed (Tables 8.8 and 8.9).

The Rank 1 material in both components was transported to the site in the form of partially prepared cores and was then reduced *in situ* to provision the site with tools for various activities. Rank 2 materials, present in much lower percentages, evidence a minor degree of *in situ* reduction before being discarded and replaced by Rank 1 material. Rank 3 materials are represented by finished tools and blanks, and, in the Aurignacian component, three nearly exhausted cores.

The primary difference between Ranks 1/2 and Rank 3 materials for both components is that Ranks 1 and 2 show evidence of at least some blank production at the site, clearly present for Rank 1 and less intense for Rank 2, while Rank 3 materials consist of only curated tools and unused blanks which were not reduced at the site. (There are only 64 small debris items (8.6%) in the entire Stratum 3.1 assemblage, compared to 848 (50%) in Stratum 3.0. I would argue that this would not be representative of the original assemblages, due to at least two possible reasons. First, excavators finding many blade tools in Stratum 3.0 may have been more apt to collect blade-like debris and have a better eye for smaller debris. Second, the artificial division into Aurignacian and Mousterian components could have been biased to put more debris with the Aurignacian component.)

		Cortex		Proportion		Primary Context		Secondary Context	
Rank	**Type**	**n**	**%***	**n < 50%**	**n > 50%**	**n**	**%**	**n**	**%**
1	3 – Hesbaye flint	381	33.2	301	80	309	82.2	67	17.8
2	6 - tan flint	56	35.7	40	10	41	73.2	15	26.7
2	8 - gray flint	47	35.3	36	3	31	79.5	8	20.5
2	1 – Obourg flint	44	37.3		11	37	84.1	7	15.9
3	7 - black flint	26	38.8	20	5	21	84	4	16
3	2 – Spiennes flint	18	60	18		16	89	2	11
3	10 - chert	3	42.9	3		1	33	2	66
3	5 - Wommersom quartzite	1	100	1		1	100		

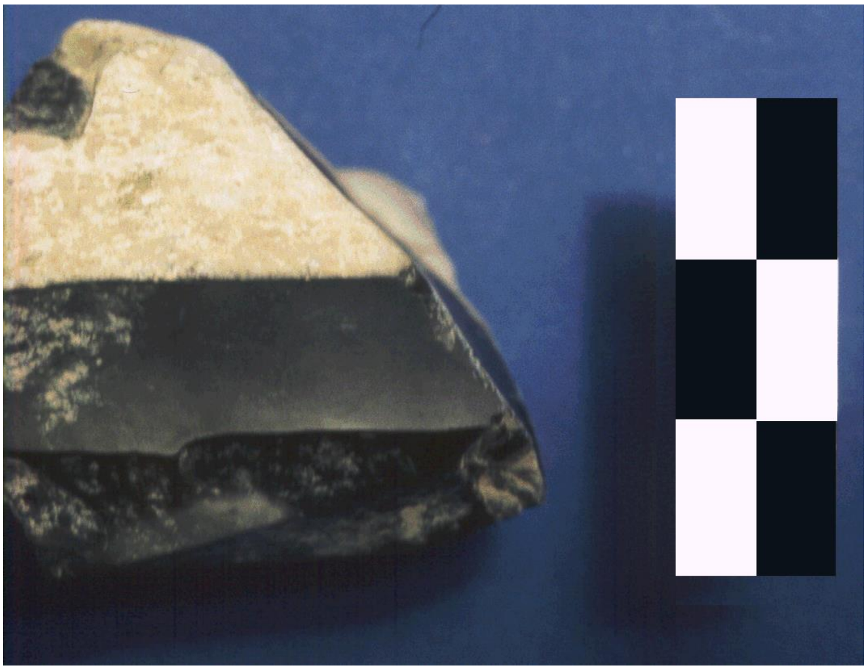
Table 8.10. Stratum 3. “Aurignacian”. Procurement context: cortex data. * Percentage of cortical artifacts for material type.

Rank	**Type**	**Cortex**		**Primary Context**		**Secondary Context**	
		n	**%***	**n**	**%**	**n**	**%**
1	3 - Hesbaye flint	143	34.5	99	69.2%	44	30.8%
2	6 - tan flint	35	37.6	20	57.1	15	42.9
2	8 - gray flint	17	23.3	11	64.7	6	35.3
2	10 - cherts	18	35.3	7	38.9	11	61.1
3	7 - black flint	8	48.1	4	50	4	50
3	1 – Obourg flint	19	48.7	11	57.9	8	42.1
3	2 - Spiennes flint	6	21.4	2	33.3	4	66.6
3	5 - Wommersom quartzite	9	50.0	5	55.5	4	44.4
3	7 - black flints						
3	9 - brown flint	7	50.0	6	86	1	14
3	4 - phtanite	2	33.3			2	100
3	11 - quartzites	2	33.3			2	100

Table 8.11. Stratum 3. “Mousterian”. Procurement context: cortex data. * Percentage of cortical artifacts for material type.

Stratum 3 Rank 3 Materials	**Mousterian component**		**Aurignacian component**	
cores	0	0.00	3	4.9
tools	83	69.1	19	32.7
blanks	37	30.8	38	63.9
TOTAL	120		60	

Table 8.12. Assemblage structure of Rank 3 materials, excluding debris.



a)

b)

Figure 8.5. Les Grottes de Goyet. Variability in cortex. a) Obourg flint with chalk cortex, b) local chert with waterworn cobble cortex.

The diversity of Rank 3 materials (seven material types, excluding the single sandstone debris flake) likely reflects the palimpsest nature of Stratum 3. It is argued in chapter 12 that Rank 3 materials most likely reflect the last vestiges of lithic materials obtained prior to occupation of the current site, although curation for non-technological purposes may have occurred (e.g., for the color, technical skill evidenced, etc.). Blanks and tools have been curated and transported from site to site, as the materials are reduced and move from Rank 1 (actively exploited sources to provision site), to Rank 2 (mobile toolkits), to Rank 3 (curated blanks and tools). The diversity of Rank 3 materials comes from sources in multiple directions from the site. This would suggest that each of the Rank 3 materials came with a different occupation of the site, not all at once.

Looking only at cortical artifacts, the kind of cortex and cortex wear indicate whether material was obtained from primary geological sources (fresh, unworn cortex) or secondary sources, such as river terraces (waterworn or cobble cortex) (Fig. 8.5). Tables 8.10 and 8.11 summarize cortical data for the two components, with non-cortical materials excluded. Primary procurement context dominates in both components but percentages for primary context are higher in the Aurignacian component. In addition, artifacts with greater than 50% cortex are rare in the Mousterian component while they are somewhat better represented in the Aurignacian component. In both cases, cores were prepared elsewhere, but Mousterian cores were either more exhausted or more intensely prepared (primary reduction) before arrival at the site.

Material in secondary context was largely ignored, possibly because primary sources were permanent locations on the landscape with good quality material that had not been affected by rolling, etc. The benefits of obtaining material in primary context are both a minimization of search time (because the location is known and material is abundant and readily available at the source) and maximization of quality (material has not been affected by rolling). The most suitable blocks can easily be selected from the available material at the source. In contrast, material may have been more difficult to find in secondary contexts because it was scattered across the landscape. In secondary contexts, material may be less abundant, smaller, and of poorer quality due to movement. The cost of obtaining material in non-local primary context is the time and energy spent in travel to and from the source, but this would have been a direct trip with little search time possibly embedded within subsistence activities on the Hesbaye Plateau. The cost of obtaining material in secondary context is an increase in search time, first to find a secondary source and then to evaluate the material.

EVIDENCE FOR REDUCTION OF MATERIALS AT THE SITE

Rank 3

The Rank 3 materials are represented only by finished tools and blanks, with three nearly exhausted cores in the Aurignacian component. Comparison of the Mousterian and Aurignacian components reveals a suggestive difference in the structure of Rank 3 artifacts: nearly all of the materials in the Mousterian component are tools with few blanks and no cores while tools are much less common in the Aurignacian component (Table 8.12). Excluding the debris, which appears to have been non-randomly included in the Aurignacian component, 32.7% (n=19) of the Aurignacian Rank 3 materials are tools in comparison with 69.1% (n=83) for the Mousterian component.

Provisionally accepting the division into two components as valid, this suggests that there were different behavioral patterns with respect to long-term curation of raw materials for Mousterian and Aurignacian groups occupying Goyet. Mousterian groups transported finished

Aurignacian component									
7 – black flint		2 – Spiennes flint		10 – chert		9 – brown flint		5 – Wommersom quartzite	
n=3		n=8		n=4		n=3		n=1	
UP	MP	UP	MP	UP	MP	UP	MP	UP	MP
8			**10**		**19-42**	8			**9**
77		11		13		**77-74**			
	8		**13-43**	**77**		**77**			
			19-42	**77**					
		5							
		5							
		65							
		65							
3 flakes		2 flakes 3 blades		3 flakes 1 blade		3 flakes		1 flake	

Table 8.13. Stratum 3. Aurignacian component. Tool types (de Sonneville-Bordes and Perrot and Bordes type lists) represented in Rank 3 materials. In bold: Mousterian types.

Aurignacian component						
	7-black flint	2-Spiennes flint	10-chert	11-quartzite	9-brown flint	5-Wommersom quartzite
flakes	11 (3)	6 (2)	5 (3)	2	3 (3)	1 (1)
blades	12	16 (6)	1 (1)			
cores	1	1	1			

Table 8.14. Stratum 3. "Aurignacian". Kinds of blanks present. Parentheses indicate number of tools included in total blanks.

Aurignacian component	
Length	**n**
20-30 mm	2
31-40 mm	2
41-50 mm	3
51-60 mm	5
61-71 mm	6
71-80 mm	1

Table 8.15. Stratum 3. "Aurignacian". Length of Rank 3 tools.

tools, curating such tools long after the core reduction phase for their materials had ended. Aurignacian groups, in contrast, transported blanks ready to be retouched into whatever tools were necessary. This in turn suggests differences in problem-solving strategies. One strategy was to have a series of tools always on hand, often composite (as will be seen below); the other strategy was more flexible, where blanks could be retouched into the appropriate tools as needed. Even if each component reflects a palimpsest of multiple occupation episodes (several Mousterian within the Mousterian component and several Aurignacian within the Aurignacian component), the interpretation still holds for the two periods.

If, however, one recognizes that the two components are artificially separated and come from Dupont's thick Stratum 3 (a single, mixed, unit), the two components can be seen to complement each other, one containing mainly tools and the other mainly blanks.

Because the issue involved here is curation of tools, it should be possible to use typology to verify that the Rank 3 materials in each component truly represent Mousterian and Aurignacian tools (regardless of whether or nor each component contains artifacts from multiple occupations). The Bordes and de Sonneville-Bordes type-lists were used to identify tools as Mousterian or Aurignacian.

In the Aurignacian component, 11 of 19 tools are actually “Mousterian” types, only three of which are made on blades (Table 8.13). Thus, the so-called Aurignacian component is probably quite mixed with Mousterian artifacts. Table 8.14 shows that the majority of blanks are blades, of which seven were tools.

Of the tools, only the two largest (lengths equal 69 and 81 mm) are whole, but most tools are greater than 40 mm (Table 8.15), and therefore were obviously larger when the blades were whole. They were probably curated due to their size (which gave them a longer use-life) and were apparently discarded when broken.

Table 8.16 shows that there are only 12 so-called Upper Paleolithic tool types (less than 10%) present in the Mousterian component, indicating that there is probably less mixing than in the Aurignacian component. All but one of the presumed “Aurignacian” tools were made on blades, and only three presumed “Mousterian” tools on blades. The blanks selected for tools are more diverse than in the Aurignacian component, with some tools made on chunks, a core, a crested blade, and a Levallois flake as well as ordinary flakes and blades.

Table 8.17 shows that the majority of “Mousterian” tools are between 31 and 60 mm in length. A relatively high frequency of whole tools is observed (39 of 83). These were discarded before being broken, either due to exhaustion or because they were replaced with new tools on higher ranked materials. Ten tools are composite tools, either due to reshaping of old tools or the production of multiple use tools. In either case, this indicates increased intensity of use.

The comparison of the Rank 3 materials typologically suggests that the Mousterian component is relatively less mixed than the Aurignacian component. Only 12 of 83 tools (around 15%) can be assigned to the Upper Paleolithic while 11 of 19 tools in the Aurignacian component are Mousterian types.

The Mousterian component also had many whole tools (39 of 83) as opposed to only 2 of 19 in the Aurignacian component. Such tools, discarded before being broken and often composite, would have been discarded either because they were exhausted or because they were replaced by tools made on Rank 1 materials.

The number of tools, whole tools and composite tools, along with the higher typological integrity of the Rank 3 Mousterian component, together suggest that Mousterian group(s) occupying Goyet transported finished tools, many reflecting long use, rather than blanks which could be shaped as needed.

The so-called Aurignacian component is more problematic. It is clearly more mixed. Of the blanks, 22 are unretouched blades and 16 are flakes. The simplest interpretation, excluding the 11 Mousterian tools and adding the 12 UP tools from the Mousterian component, is that

Mousterian component													
1 – Obourg flint		2 – Spiennes flint		5 – Wommersom quartzite		7 – black flint		9 – brown flint		4 – phtanite		11 - quartzite	
n=9		n=22		n=15		n=16		n=11		n=4		n=6	
UP	MP	UP	MP	UP	MP	UP	MP	UP	MP	UP	MP	UP	MP
	100	**27**			10		12		10-42		9		29
	13-42	**27**			13		100		13	**66**			35
	10-42	77			10		100		13	**58**			10
	9-42	77			18		19		26	**58**			16
	10		42-45		17		10		13				10
30			6		9		9		10				9
77			6		9		9	23-77					
	9-42		6		10		10	**27**					
27			100		9		9	77					
			100		17		7	74					
			11		9		10-42		13				
			10		12		10						
			17		26		100						
			10		10		30						
			9		100		9-42						
			10				17						
			10										
		29											
		44											
		23											
		1											
			100										
			100										
6 flakes 3 blades		16 flakes 4 blades 2 chunks		11 flakes 1 Lev. flake 1 blade 1 chunk 1 crested blade		14 flakes 1 chunk 1 blade		6 flakes 4 blades 1 core		1 flake 3 blades		5 flakes 1 chunk	

Table 8.16. Stratum 3. "Mousterian". Tool types represented in Rank 3 materials.
In bold: Upper Paleolithic types. 100 = throwing stone.

Mousterian component			
	Tools	**Whole tools**	**Composite tools**
Length	**n**	**n**	**n**
< 20 mm	1	1	1
20-30 mm	3	2	
31-40 mm	21	10	1
41-50 mm	25	7	3
51-60 mm	20	11	2
61-71 mm	10	6	3
71-80 mm	1	1	
81-90 mm	1	1	
91-100 mm			
101-110 mm	1		
TOTAL	**83**	**39**	**10**

Table 8.17. Stratum 3. "Mousterian". Length of Rank 3 tools, with breakdown of number of whole and composite tools.

Material	**Total n (blank pool)**	**flakes**		**blades**	
		n	%*	n	%
Aurignacian					
3 - Hesbaye	555	284	51	271	49
6 - tan flints	84	29	35	55	65
8 – gray flints	35	32	91	3	9
1 – Obourg flint	54	19	35	35	65
Mousterian					
3 - Hesbaye	340	209	61.5	131	38.5
6 - tan flints	80	65	81.2	15	18.8
8 - gray flints	65	61	93.8	4	6.2
10 - cherts	44	39	88.6	5	11.4

Table 8.18. Stratum 3. Blank production by material type. *Percent of blank pool, not of assemblage of each material type.

Material type	**Blank type**	**% of preferred blanks**
Aurignacian		% (n)
3 - Hesbaye	no difference (flake, blade, debris flake)	27-34% (54, 52, 44)
6 - tan flints	blade	44% (11)
8 - gray flints	debris flake 1-30 mm	45% (13)
1 - Obourg flint	blade	50% (13)
Mousterian		
3 - Hesbaye	flake, chunk, debris flake	63-89% (128, 11, 17)
6 - tan flints	flake	47% (27)
8 - gray flints	flake	75% (18)
10 - cherts	flake	94% (16)

Table 8.19. Stratum 3. Blank selection for tool production. Ranks 1 and 2.

Type	**n tools**	**n unused blanks**	**tools + blanks**	**tool/blank ratio**	**% tools**
Aurignacian					
3	161	361	522	.45:1	30.8%
6	28	61	89	.46:1	31.5%
8	29	13	42	2.23:1	69.0%
1	26	32	58	.81:1	44.8%
7	3	20	23	.15:1	13.0%
2	8	14	22	.57:1	36.4%
10	4	2	6	2:1	66.7%
11	0	3	3	0:1	0.0%
9	3	0	3		100.0%
5	1	0	1		100.0%
Mousterian					
3	182	166	348	1.1:1	52.3
6	38	42	80	.90:1	47.5
8	24	43	67	.56:1	35.8
10	17	21	38	.80:1	44.7
1	9	26	35	.35:1	25.7
2	22	2	24	11:1	91.7
5	15	3	18	5:1	83.3
7	16	1	17	16:1	94.1
9	11	3	14	3.7:1	78.6
4	4	2	6	2:1	66.6
11	6	0	6	-	100

Table 8.20. Stratum 3. Intensity of blank selection.

Aurignacian group(s) transported a few curated tools and a series of large blanks that could be shaped into whatever tools were needed, when needed.

If my hypothesis is correct that rank of raw materials reflects time (duration of possession of material), where material passes from material provisioning a site to an active toolkit to the last vestiges of the material in the form of blanks and tools, then the Rank 3 materials in the two components reflect different behavioral strategies – one geared to keeping a stock of finished tools and the other to keeping a stock of blanks ready to be shaped as needed, along with a few curated tools.

Ranks 1 and 2

What blanks were produced?

The following table (Table 8.18) shows the variability in the kinds of blanks produced during core reduction at the site, from which blanks were selected for retouch into tools. In the Aurignacian component, there is no significant difference in percentage of flakes and blades. Hesbaye flint was utilized to provision the site during occupation, and thus for various activities which may have had different blank form requirements. If different types of tools are made preferentially on different blank forms, it follows that different blank production techniques would also be used. As seen below, endscrapers were preferentially made on flakes, while blades were used for other types of tools. For tan flints and Obourg flint, blades are more common than flakes. For gray flints, flakes are much more common than blades. In the Mousterian component, flakes dominate for all material types.

What blanks were selected for retouch into tools?

The following table (Table 8.19), for the subset of tools in the assemblage, shows blank preference by material type for the two components. The pattern of blank selection reflects the kinds of blanks produced in the table above. For all materials, blanks selected for retouch come from the debitage category that is most common.

In the Aurignacian component, the dominant material (n=161), Hesbaye flint, shows almost no difference in percentage between flakes, blades, and debris flakes 10-30 mm. This is to be expected if Hesbaye flint is the most abundant and commonly used material in the assemblage: it would have been used for a wider range of tools for which flakes, blades, and debris flakes would have been appropriate. For tan flints (n=25) and Obourg flint (n=26), blades are the preferred blank type. This could possibly be explained as a technical strategy to maximize the number of tools obtained from rare, non-local flints. By employing blade-producing techniques, more blanks are produced from these materials. However, gray flint (n=29) differs from the others by primarily utilizing debris flakes 10-30 mm, possibly due to the kind of tools produced on this material (see below). In the Mousterian component, flakes dominate for all material types, regardless of material quality or distance to source.

What is the intensity of blank selection?

The intensity of blank selection refers to the ratio between tools and unused blanks. A high ratio, like those seen above, means that most blanks produced eventually became tools; few or relatively few were ignored. Intensity of blank selection is an index of how efficiently material was actually used. Local or abundant material may be used to produce many blanks, but only the “best” blanks need to be actually used, resulting in a low ratio of tool to unused

Aurignacian component, Rank 1, Type 3. Whole blades.

Variable	Number of Cases	Mean	SD	SE of Mean
LENGTH Length (mm)				**p=.298**
Blanks (unretouched)	19	62.6842	14.442	3.313
Tools (retouched)	7	56.4286	9.090	3.436
WIDTH Width (mm)				**p=.117**
Blanks (unretouched)	19	27.6316	11.026	2.530
Tools (retouched)	7	20.5714	4.685	1.771
THICK Thickness (mm)				**p=.549**
Blanks (unretouched)	19	8.6842	2.790	.640
Tools (retouched)	7	7.8571	3.805	1.438

Aurignacian component, Rank 1, Type 3. Whole flakes.

Variable	Number of Cases	Mean	SD	SE of Mean
LENGTH Length (mm)				**p=.564**
Blanks (unretouched)	4	55.2500	17.689	8.845
Tools (retouched)	9	49.4444	15.685	5.228
WIDTH Width (mm)				**p=.325**
Blanks (unretouched)	4	39.2500	14.080	7.040
Tools (retouched)	9	32.2222	10.121	3.374
THICK Thickness (mm)				**p=.360**
Blanks (unretouched)	4	9.2500	2.217	1.109
Tools (retouched)	9	11.1111	3.551	1.184

Aurignacian component, Rank 2: Types 6, 8, 1. Whole blades.

Variable	Number of Cases	Mean	SD	SE of Mean
LENGTH Length (mm)				**p=.444**
Blanks (unretouched)	18	61.1667	12.743	3.004
Tools (retouched)	4	56.0000	5.888	2.944
WIDTH Width (mm)				**p=.401**
Blanks (unretouched)	18	22.6111	5.761	1.358
Tools (retouched)	4	20.0000	3.742	1.871
THICK Thickness (mm)				**p=.356**
Blanks (unretouched)	18	6.7222	2.024	.477
Tools (retouched)	4	8.0000	4.082	2.041

Table 8.21. Size analyses. Stratum 3. “Aurignacian”.

Aurignacian component, Rank 3: Types 7, 2, 10, 11, 4, 9, 5, 12. All blades.

Variable	Number of Cases	Mean	SD	SE of Mean
LENGTH Length (mm)				**p=.353**
Blanks (unretouched)	7	48.7143	9.032	3.414
Tools (retouched)	7	54.7143	13.720	5.186
WIDTH Width (mm)				**p=.513**
Blanks (unretouched)	7	20.5714	6.051	2.287
Tools (retouched)	7	22.7143	5.851	2.212
THICK Thickness (mm)				**p=.628**
Blanks (unretouched)	7	7.4286	3.645	1.378
Tools (retouched)	7	8.4286	3.867	1.462

Aurignacian component, Rank 3. All flakes.

Variable	Number of Cases	Mean	SD	SE of Mean
LENGTH Length (mm)				**p=.920**
Blanks (unretouched)	3	54.6667	15.144	8.743
Tools (retouched)	10	55.5000	11.607	3.670
WIDTH Width (mm)				**p=.054**
Blanks (unretouched)	3	49.3333	15.948	9.207
Tools (retouched)	10	36.7000	6.378	2.017
THICK Thickness (mm)				**p=.364**
Blanks (unretouched)	3	11.6667	5.033	2.906
Tools (retouched)	10	14.7000	4.832	1.528

Table 8.21. Size analyses. Stratum 3. “Aurignacian”. (continued)

Mousterian component, Rank 1. Type 3. Whole blades.

Variable	Number of Cases	Mean	SD	SE of Mean
LENGTH Length (mm)				**p=.655**
Blanks (unretouched)	2	57.0000	9.899	7.000
Tools (retouched)	7	54.1429	7.198	2.721
WIDTH Width (mm)				**p=.526**
Blanks (unretouched)	2	25.0000	2.828	2.000
Tools (retouched)	7	22.4286	5.062	1.913
THICK Thickness (mm)				**p=.316**
Blanks (unretouched)	2	10.0000	.000	.000
Tools (retouched)	7	7.8571	2.673	1.010

Mousterian component, Rank 1. Type 3. Whole flakes.

Variable	Number of Cases	Mean	SD	SE of Mean
LENGTH Length (mm)				**p=.923**
Blanks (unretouched)	23	47.6696	13.591	2.834
Tools (retouched)	75	47.3840	12.045	1.391
WIDTH Width (mm)				**p=.096**
Blanks (unretouched)	23	41.1826	15.879	3.311
Tools (retouched)	75	35.0973	10.649	1.230
THICK Thickness (mm)				**p=.051**
Blanks (unretouched)	23	11.1348	4.003	.835
Tools (retouched)	75	13.1187	4.260	.492

Mousterian component, Rank 2: Types 6, 8, 10. Whole blades.

Variable	Number of Cases	Mean	SD	SE of Mean
LENGTH Length (mm)				**p=.111**
Blanks (unretouched)	4	56.5000	10.970	5.485
Tools (retouched)	1	84.0000	.	.
WIDTH Width (mm)				**p=.534**
Blanks (unretouched)	4	27.0000	3.830	1.915
Tools (retouched)	1	30.0000	.	.
THICK Thickness (mm)				**p=.664**
Blanks (unretouched)	4	10.5000	4.655	2.327
Tools (retouched)	1	8.0000	.	.

Table 8.22. Size analyses. Stratum 3. “Mousterian”.

Mousterian component, Rank 2. Whole flakes.

Variable	Number of Cases	Mean	SD	SE of Mean
LENGTH Length (mm)				**p=.666**
Blanks (unretouched)	13	42.5846	11.354	3.149
Tools (retouched)	41	44.0366	10.242	1.600
WIDTH Width (mm)				**p=.566**
Blanks (unretouched)	13	39.9462	13.029	3.614
Tools (retouched)	41	38.0024	9.715	1.517
THICK Thickness (mm)				**p=.168**
Blanks (unretouched)	13	11.2615	4.786	1.327
Tools (retouched)	41	13.3756	4.734	.739

Mousterian component, Rank 3: Types 1, 2, 5, 7, 9, 4, 11, 12. All blades.

Variable	Number of Cases	Mean	SD	SE of Mean
LENGTH Length (mm)				**p=.427**
Blanks (unretouched)	4	57.7500	24.295	12.148
Tools (retouched)	16	46.5625	7.330	1.833
WIDTH Width (mm)				**p=.216**
Blanks (unretouched)	4	18.5000	4.041	2.021
Tools (retouched)	16	22.5625	5.944	1.486
THICK Thickness (mm)				**p=.686**
Blanks (unretouched)	4	8.0000	1.414	.707
Tools (retouched)	16	8.5625	2.607	.652

Mousterian component, Rank 3. All flakes.

Variable	Number of Cases	Mean	SD	SE of Mean
LENGTH Length (mm)				**p=.072**
Blanks (unretouched)	9	40.9111	9.855	3.285
Tools (retouched)	55	48.5800	11.888	1.603
WIDTH Width (mm)				**p=.786**
Blanks (unretouched)	9	36.6000	6.400	2.133
Tools (retouched)	55	35.7473	8.966	1.209
THICK Thickness (mm)				**p=.023**
Blanks (unretouched)	9	10.6000	3.829	1.276
Tools (retouched)	55	13.5091	3.402	.459

Table 8.22. Size analyses. Stratum 3. “Mousterian”. (continued)

blanks. Non-local, good quality material would be expected to be maximized, using every possible blank produced, and therefore resulting in a higher ratio. In the following table, debris flakes and chunks are excluded from the category of potential blanks. Table 8.20 summarizes the number of tools and blanks, the tool to blank ratio, and the percentage of tools in the combined tool-blank pool.

In the Aurignacian component, for Ranks 1 and 2, roughly 30-45% of blanks were selected for retouch. Type 8 (gray flints) is an exception because it shows more intense blank selection (69%). For the Rank 3 materials, which are present only as blanks and tools, types 7, 2, and 10 show similar percentages to those in Ranks 1 and 2. Types 9 and 5 are present only as tools.

In the Mousterian component (as in the Aurignacian component), for Ranks 1 and 2, roughly 35-50% of blanks were selected for retouch. Type 1 (Obourg flint) is an anomaly because the majority of blanks were unused despite the transport distance. For the rest of the Rank 3 materials, each type consists of only tools and blanks, resulting in high percentages.

Is there a size differential between blanks and tools?

For Rank 1 and 2 materials, the sizes of whole blades and blade tools, and whole flake and flake tools. For Rank 3, all blanks and tools (whole or not), were compared to increase the sample size (Tables 8.21 and 8.22). Samples are small for whole artifacts in both components, but comparison of means shows that there is *no* statistically significant difference between blade and flake blanks and tools in either component.

EVALUATION OF LITHIC ECONOMY WITH RESPECT TO RAW MATERIAL CONTEXT

By sorting the materials by their distance from site to source (where it can be estimated), it can be seen that local materials were rarely used. The dominant material (Hesbaye flint) comes from the nearest known flint source region, although specific geological sources are not yet known. Rank 2 materials, substantially less common than Rank 1, come from the most distant source (Obourg) or are unknown. Rank 3 materials, apart from the local materials, come from at least 40 km away or are unknown. All Rank 3 materials came to the site as curated tools and blanks, except for black flint and Spiennes flint, which each included prepared cores.

The general pattern is that local materials were not used, while the dominant material comes from the nearest flint source region. Materials from greater distances came to the site as prepared cores and curated tools, and possibly represent the previous occupied region.

All cortical materials (except chert, with a sample too small to be meaningful) indicate that material was generally procured in primary context rather than secondary (70-80% of cortical pieces show primary context). As Demars (1982) and Geneste (1985) also argue, material in primary context is likely to be larger, more abundant, and less subject to damaging effects of transport, and therefore will be of better quality than material in secondary context.

The procurement range indicated by the ranking of materials shows that the Plateau de Hesbaye is dominant, while other materials were transported as prepared cores, blanks, and tools. That is, while the lesser-ranked materials were transported as curated materials, once at Goyet, material was obtained from a single source region either via logistical trips or embedded procurement.

Given the lack of good-quality local material as well as the distances to be covered to procure Hesbaye flint, it is unlikely that major export activities occurred at the site, as they would have been at a site like Maisières-Canal, where a large proportion of reduction activity was for transport and not for use at the site. Certain items, primarily prepared cores and tools, would likely have been curated and transported to the next site, as were the Rank 3 materials at Goyet from the previous sites. However, these would be transported as part of the active toolkit, not as deliberately produced items for export/transport.

CHAPTER 9
LA GROTTE DE SPY: STRATUM 2 (AURIGNACIAN) DEPUYDT AND LOHEST EXCAVATIONS

BACKGROUND

Location of site

The well–known site of Spy is a cave located in the Carboniferous (Upper Viséen) limestone cliff known as the "Betche–al–Rotche", in the valley of the Orneau river, a tributary of the Sambre (Fig. 9.1-9.2). The cave opens onto the east bank of the Orneau, with two entries onto a large terrace (11 by 6 m) (Otte 1979:195).

Raw material context

Spy is located between the main flint source regions, the Hainaut Basin (Obourg and Spiennes sources) around 50 km to the west, and the Hesbaye Plateau (Méhaigne Valley sources, Maastricht region sources) from 25 to 75 km maximum to the east. The localized source of phtanite at Ottignies–Mousty is within 25 km of the site. There is more evidence of phtanite exploitation than at the other study sites precisely because it is one of the nearest material sources. Flint cobbles were available in the Fond–des–Cuves area 1–2 km from the site, on the other side of the Orneau, but appear to have been rarely exploited. Rank 1 and 2 materials all appear to come from western sources (i.e., the Hainaut Basin). Like Les Grottes de Goyet, the lithic economy is under some pressure from lack of local sources, but flint sources are not too distant, unlike the case at Trou Magrite, so as to require intensification of reduction and tool resharpening. Excavation and curation biases, discussed below, prevent a clear picture of the raw material and assemblage structure of Stratum 2.

Excavation history

The site of Spy (Fig. 9.3) was first excavated in the 1870s by A. Rucquoy, who excavated sondages on the terrace, as well as in part of the interior of the cave (Rucquoy 1886–87). In 1885–86, M. De Puydt and M. Lohest began intensive excavations inside the cave (De Puydt and Lohest 1886), discovering a long stratigraphic sequence from Mousterian to Neolithic, and notably uncovering, by excavating a tunnel, two Neandertal skeletons in 1886. In 1905–9, A. de Loë and E. Rahir continued excavations for the Musées Royaux d'Art et d'Histoire (MRAH), excavating on the terrace and discovering Mousterian and Aurignacian levels (de Loë 1905, 1906, 1908; de Loë and Rahir 1911; Rahir 1925). In 1927, Hamal–Nandrin excavated at the back of the cave, uncovering an early Mousterian level (Hamal–Nandrin *et al.* 1932). From 1952 to 1954, a long trench extending from the terrace to the base of the talus slope was excavated by F. Twiesselmann for IRSNB. This work was not published, but M. Dewez *et al.* (1986) much later presented the results of their analyses of the Twiesselmann collection. In 1979–80, M. Dewez continued excavations at the base of the Twiesselmann trench (Dewez 1979, 1980, 1981a) as well as summarizing research at Spy over the last hundred years (Dewez 1981b).

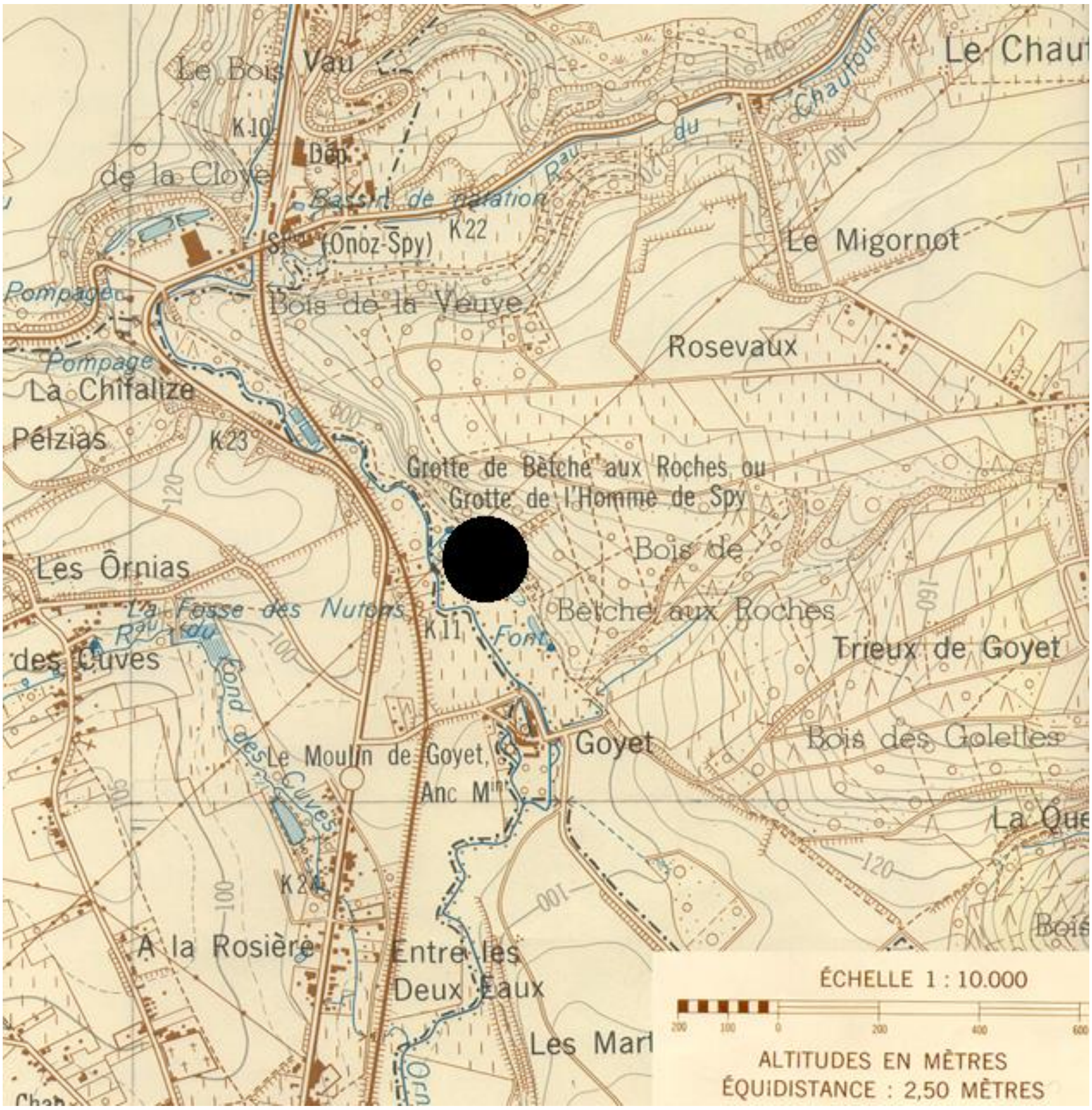
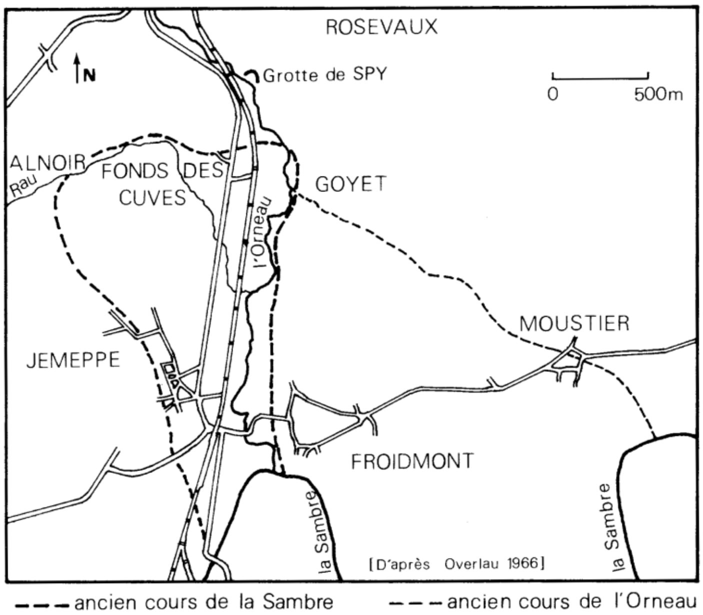
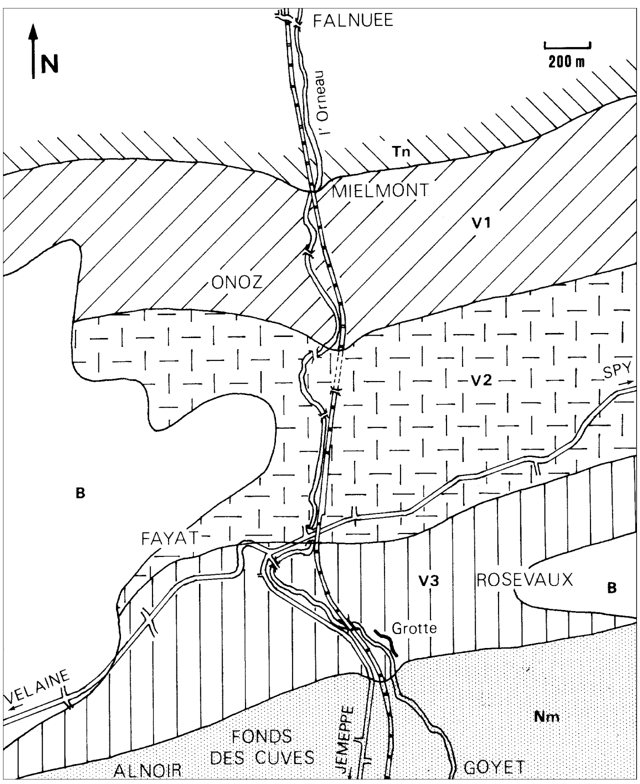


Figure 9.1. La Grotte de Spy. Location of site.
(from Institut Géographique National map 47/2, scale 1:10000)



a)



b)

Figure 9.2. La Grotte de Spy. a) Location of site, b) geological context (after Lacroix 1981:12, Fig. 3 and 8, Fig. 2)

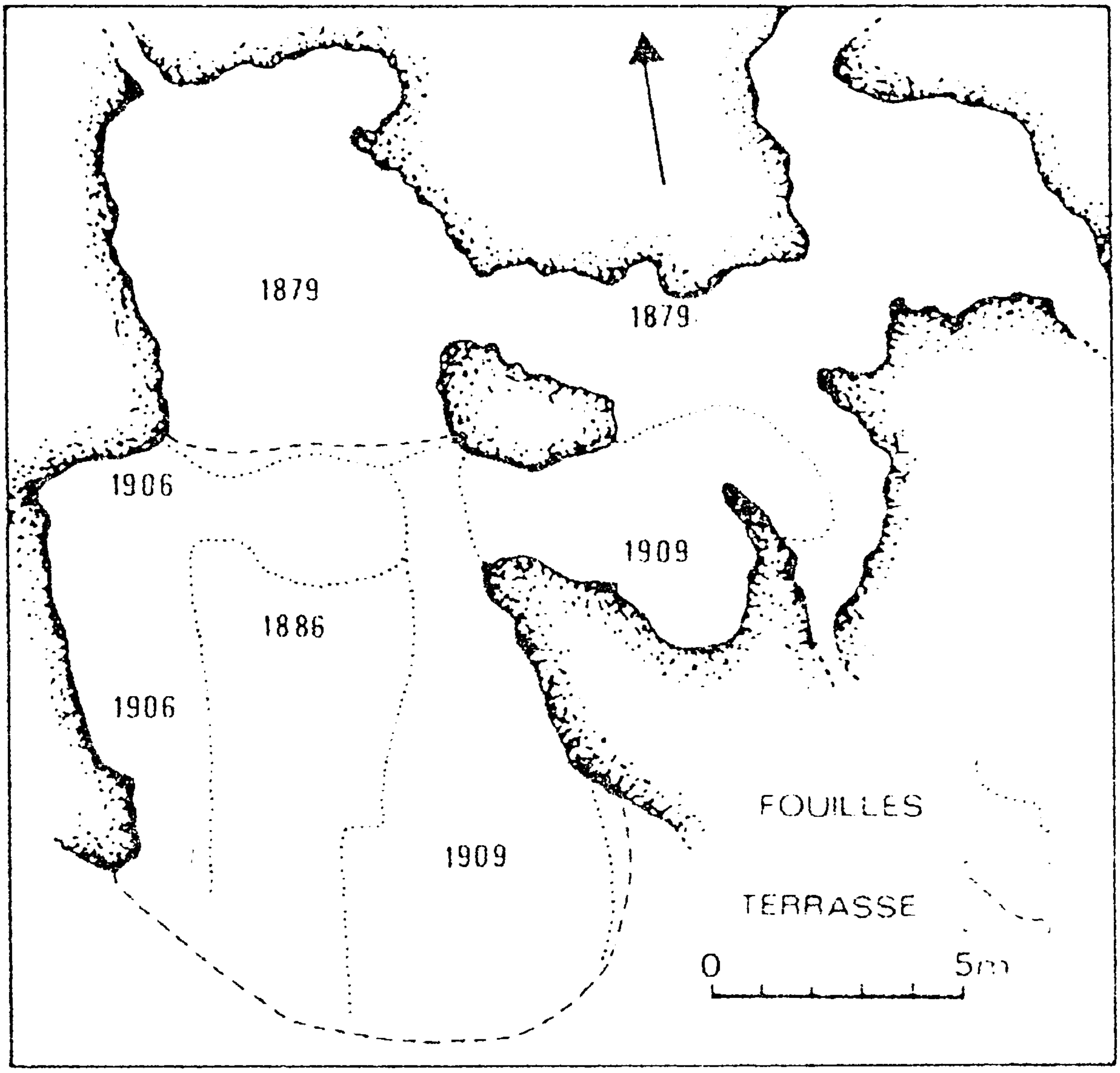


Figure 9.3. La Grotte de Spy. Plan of excavations.
(in Dewez 1980:40, Fig. 14, after de Loë and Rahir 1911)

Stratigraphy

The stratigraphic sequence of the De Puydt and Lohest excavations, from top to bottom, is described as follows (after DePuydt and Lohest 1885–86, DePuydt and Lohest 1886, and supplemented with recent re–interpretation by Dewez 1981b):

First geological layer: 0.25 to 3 m thick, brown earth, containing limestone blocks
Second geological layer: 0.80 to 1 m thick, chalky yellow earth

–includes *premier niveau ossifère* (first archaeological level, Stratum 1), containing a "hybrid" (according to DePuydt and Lohest, but actually mixed due to excavation techniques) industry containing Mousterian points, long thin blade debitage, elongated points, tanged points; not found across all excavated surface. Attributed to the Perigordian (i.e., Gravettian) period, but includes Aurignacian and Mousterian material (Dewez 1981b).

Third geological layer: 0.05 to 0.30 m thick, reddened earth containing angular limestone blocks, coloring due to abundance of oligiste (iron) dispersed throughout level, many hearths associated with flat burned stones of sandstone, industry

–includes *deuxième niveau ossifère* (second archaeological level, Stratum 2), containing includes numerous Mousterian tools (points, sidescrapers) and a blade industry on flint and phtanite, four fragments of pottery (supposedly found by miner Orban without DePuydt and Lohest's knowledge or presence and therefore not supposed to be from this level.). Primarily Aurignacian but contains some Mousterian material (Dewez 1981b).

Sterile level: not mentioned in first publication but added at the authenticity meeting of the skeletal remains to separate the third level from the fourth.

Fourth geological level: highly variable thickness from a few cm to 1 m, yellow sediment subdivided into two zones: upper zone is a tuf in which the skeletons were found at the top, lower zone is a brown clay containing angular limestone and some black veins, possibly indicating hearths.

–includes *troisième niveau ossifère* (third archaeological level, Stratum 3), containing a large number of debitage flakes, Mousterian points and sidescrapers, and "Chellean" bifaces. Attributed to Mousterian (Dewez 1981b).

Final level: a level made of limestone debris coming from the disintegration of the bedrock underneath, archaeologically sterile

Dating of the site

The only dates obtained from Spy come from Stratum 1 ("premier niveau ossifère") from the excavations of De Puydt and Lohest, a level attributed to the Perigordian V phase (Otte 1979). Two dates were obtained from a single bone sample taken from the De Puydt and Lohest collection, one from the burned portion and one from the unburned portion (Table 9.1). According to Gilot (1984:120), the unburned portion of the sample comes from the carbonate fraction and is *a priori* probably contaminated, and therefore too young.

Stratum	**Lab no.**	**Date**	**Sample**	**Reference**
Stratum 1 (De Puydt and Lohest)	IRPA–132	22,105 ± 500 BP	burned bone	Gilot 1984:120
Stratum 1 (De Puydt and Lohest)	IRPA–202	20,675 ± 455 BP	unburned bone	Gilot 1984:120

Table 9.1. Spy. Dates obtained. (Note: same bone sample used for both dates.)

Description of assemblage and industry attributes

The assemblage from De Puydt and Lohest's "deuxième niveau ossifère" is somewhat mixed, containing typical Aurignacian artifacts (carinated and nosed endscrapers [Otte 1979]), as well as Mousterian material that should probably be associated with the underlying level containing the Neandertal skeletons. This level also contained an abundant bone industry. The assemblage can be assigned typologically to Late Aurignacian, middle phase (Otte 1979).

Assemblage sample and problems

Of the several excavations undertaken at Spy, only the collection of De Puydt and Lohest for their "deuxième niveau ossifère" (Stratum 2) was selected for study (Table 9.2). Other, more recently excavated, collections were not studied for the following reasons. The Dewez collection contains material in largely secondary position at the base of the talus slope in front of the cave, near the river, and was seen as being less representative of the assemblage structure. Of the Twiesselmann collection, only the tools were studied by Dewez and the majority of the collection remains unwashed at the IRSNB. The time spent washing and labeling was seen as prohibitive and, in any case, also comes from in front of the cave rather than in situ deposits on the terrace or in the cave. A palimpsest problem exists, similar to that of the Grottes de Goyet, combining probably several Aurignacian occupations as well as Mousterian material. The Spy Neandertals were discovered just below Stratum 2, via a "mining tunnel" dug by Orban before Stratum 2 had been completely excavated. The Mousterian materials recovered in Stratum 2 thus properly belong to Stratum 3. There was also apparently an excavation bias against debitage and small debris. The collection at the Musée Curtius consists of 754 artifacts, and includes tools, cores, flakes and blades, indicating that the collection had probably been sorted at some point, with only the "best" pieces conserved. Technological analyses are thus limited, but certain general observations and interpretations can nevertheless be made with respect to raw material utilization.

	Count		**Weight**	
Type	**n**	**%**	**wt in g**	**%**
1 – Obourg flint	234	31.0	2657	20.7
2 – Spiennes flint	108	14.3	1640	12.8
3 – Hesbaye flint	22	2.9	283	2.2
4 – phtanite	90	11.9	2269	17.7
5 – Wommersom	59	7.8	1109	8.7
6 – tan flint	21	2.8	483	3.8
7 – black flint	41	5.4	1121	8.8
8 – gray flint	131	17.4	2245	17.5
10 – cherts	16	2.1	441	3.4
11 – quartzite	1	0.1	35	0.27
12 – sandstone	16	2.1	342	2.7
13 – limestone	1	0.1	14	0.11
15 – calcedony	13	1.7	95	0.74
16 – jasper	1	0.1	74	0.57
Total	**754**	**100.0**	**12807 (n=723)**	**100.0**

Table 9.2. Frequencies of raw materials by count and weight.

RANKING OF MATERIALS BY FREQUENCY AND WEIGHT

Materials are ranked similarly by count and weight, with a few reversals (e.g., types 4, 8, 2) (Table 9.3).

Rank	Type	Count %		Rank	Type	Weight %
1	1 – Obourg flint	31.0		1	1 – Obourg flint	20.7
2	8 – gray flint	17.4		2	4 – phtanite	17.7
3	2 – Spiennes flint	14.3		3	8 – gray flint	17.5
3	4 – phtanite	11.9		4	2 – Spiennes flint	12.8
3	5 – Wommersom quartzite	7.8		5	7 – black flint	8.8
4	7 – black flint	5.4		5	5 – Wommersom quartzite	8.7
5	3 – Hesbaye flint	2.9		6	6 – tan/brown flint	3.8
6	6 – tan/brown flint	2.8		7	10 – chert	3.4
7	10 – chert	2.1		8	12 – sandstone	2.7
7	12 – sandstone	2.1		9	3 – Hesbaye	2.2
8	15 – calcedony	1.7		10	15 – calcedony	0.74
9	11 – quartzite	0.1		10	16 – jasper	0.57
9	16 – jasper	0.1		10	13 – limestone	0.11
10	13 – limestone	0.1				

Table 9.3. Ranking of raw materials.

This ranking can be reduced to three tiers, as follows (Table 9.4):

Rank	No(s).	Type(s)	Count %	Weight %
1	1, 8	Obourg flint, gray flint	31.0	20.7
2	2, 4	Spiennes flint, phtanite	12–18	13–18
3	5, 7, 3, 6, 10, 12, 15, 11, 16, 13	Wommersom quartzite, black flint, Hesbaye flint, tan/brown flint, chert, sandstone, calcedony, quartzite, jasper, limestone	< 10	< 10

Table 9.4. Collapsed ranking of raw materials.

SOURCES OF RAW MATERIAL UTILIZED

Rank 1

Obourg flint (Type 1) comes from the Hainaut Basin ~50 km to the west.

Gray flints (Type 8) could come from either the Hesbaye Plateau or the Hainaut Basin, but are more likely to have come from the Hainaut Basin, based on the frequencies of Spiennes and Obourg flint, and would represent a variant of Spiennes flint.

Rank 2

Spiennes flint (Type 2) comes from the Hainaut Basin, ~50 km to the west.

Phtanite (Type 4), is fairly local, found near Ottignies–Mousty ~25 km north. Interestingly, Spy is the only site studied where phtanite shows evidence of reduction activity, rather than simply transport of finished tools.

Rank 3

Wommersom quartzite (Type 5) comes from a known localized source ~45 km to the east–northeast.

Black flint (Type 7) has an unknown provenience, but could be Tertiary flint from the Brabant Plateau.

Hesbaye flint (Type 3) could have come from a minimum of ~25 km to the east, ~35 km from the center of the Hesbaye Plateau, near the Méhaigne River, or a maximum of ~75 km (Maastricht region).

Tan/brown flint (Type 6) has an unknown provenience. Otte (1979:203–205) states that gray and dark brown flints which are coarser–grained and have cobble cortex, were obtained locally, at Fond–des–Cuves 200 meters west of Spy across the Orneau river (Fig. 9.2).

Chert (Type 10) is also likely to have a local source on terraces of the Orneau.

Sandstone (Type 12) has been specifically identified as Brussels sandstone, which has a known source 1–2 km west of Spy at Velaine. It was formed during the Eocene Bruxellian stage and is also known as *grés de Fayat*.

Calcedony (Type 15) has an unknown provenience, but is non–local according to the excavators (Otte 1979).

Quartzite (Type 11), like chert, probably comes from the Orneau valley, hence local.

Jasper (Type 16) has no known source in Belgium, but Otte (1979:203–205) states that it is xyloid jasper (siliceous with a zonal structure), which is found in the Paris Basin in the region of Meudon, just west of Paris. *If* this is actually the source, this is the only example from any of the study sites of truly long–distance transport of material. Possibly its uniqueness or distinctiveness (color) made it less likely to be discarded.

Limestone (Type 13) is probably local.

TRANSPORT OF RAW MATERIAL

Cortex attributes and debitage analysis to identify stages of the chaîne opératoire were used to make inferences of transport form of material to the site (Table 9.5). Ranks 1 and 2 have similar percentages of cortex, except for phtanite, which is generally non–cortical in its raw state. Material was transported as prepared cores, with Rank 1 material exhibiting the most reduction activity. Rank 2 materials were reduced to a lesser degree, at least as evidenced by the lower frequencies of tools. Rank 3 materials were transported as finished tools and blanks, along with 3 probably exhausted cores (in black flint, Hesbaye flint, and jasper).

Rank 1 material		
Type	**Assemblage structure**	**Brought to site as...**
1 – Obourg flint	2 cores, 180 tools, 40 blanks, 12 debris (including 1 chunk)	prepared cores
8 – gray flint	3 cores, 113 tools, 15 blanks	prepared cores
Rank 2 material		
Type	**Assemblage structure**	**Brought to site as...**
2 – Spiennes flint	1 core, 81 tools, 26 blanks	prepared cores
4 – phtanite	2 cores, 56 tools, 32 blanks	prepared cores
Rank 3 materials		
Type	**Assemblage structure**	**Brought to site as...**
5 – Wommersom	51 tools, 7 blanks, 1 debris	finished tools and blanks
7 – black flint	1 core, 39 tools, 1 blank	finished tools and blanks
3 – Hesbaye flint	1 core, 12 tools, 8 blanks, 1 debris	finished tools and blanks
6 – tan/brown flint	20 tools, 1 blank	finished tools and blanks
10 – chert	16 tools	finished tools
12 – sandstone	15 tools, 1 blank	finished tools and blank
15 – calcedony	11 tools, 2 blanks	finished tools and blanks
11 – quartzite	1 tool	finished tool
16 – jasper	1 core	exhausted core
13 – limestone	1 tool?	finished tool

Table 9.5. Transport form of raw materials and assemblage structure.

Analysis of cortex types (Table 9.6) indicates that sources in both primary (Types 1, 8, 7, 3, 6) and secondary context (Types 2, 5, 10); although Types 2 and 5 lack cortex, their surfaces evidence rolling (and were collected as waterworn cobbles). Rank 1 materials come mainly from primary contexts. Artifacts with greater than 50% cortex are present for Rank 1 materials, but are fairly rare, indicating that primary reduction occurred elsewhere.

		Cortex		Proportion		Primary Context		Secondary Context	
Rank	Type	n	%	n < 50%	n > 50%	n	%	n	%
1	1 – Obourg	85	36.3	56	17	54		30	
1	8 – gray flint	46	35.1	37	9	26		20	
2	2 – Spiennes	28	25.9	28	0	13		15	
2	4 – phtanite	6	6.7		1			6	
3	5 – Wommersom	35	59.3	29	6	12		23	
3	7 – black flint	14	34.1	12		9		5	
3	3 – Hesbaye	3	13.6	3		2		1	
3	6 – tan/brown flint	8	38.1	8		5		3	
3	10 – chert	6	37.5	5		2		4	
3	12 – sandstone	2	12.5	2				2	
3	15 – chalcedony	3	23.0	3				3	
3	11 – quartzite	1	100		1			1	
3	16 – jasper	1	100					1	
3	13 – limestone	0							

Table 9.6. Cortex data.

EVIDENCE FOR REDUCTION OF MATERIALS AT THE SITE

The assemblage structure for each material varies with rank, with decreasing inclusivity of stages of the *chaîne opératoire* as rank decreases. Rank 1 materials show evidence of blank production to provision the site. Rank 2 materials were reduced as well, but to a lesser degree than Rank 1 materials, and were replaced by Rank 1 materials. Rank 3 materials only appear as blanks or finished tools and reduction is absent.

Rank 3

The extreme diversity of the Rank 3 materials (ten different material types represented) reflects not only the palimpsest nature of the assemblage, but also from excavator or museum conservation bias towards tools and large blanks which excluded much of the debitage. If such debitage had been present, it is possible that certain of these materials would have been better represented and thus placed in Rank 2. However, the lack of such data makes placement in Rank 2 impossible.

The majority of Rank 3 artifacts are tools (87.4%, Table 9.7), but this may again reflects the excavator or conservation bias. A cross–table of rank by assemblage structure (Table 9.8) shows that tool frequencies are artificially inflated for all ranks, particularly for Rank 1 (80.3%), where it would be expected that there would be a large percentage of reduction debris and unacceptable blanks produced. Clearly, the absent debitage affects interpretation of the assemblage structure and many Rank 3 materials should probably have been placed in Rank 2. Based on the high tool counts, Type 5 (Wommersom quartzite) and Type 7 (black flint) are possible candidates for Rank 2.

General assemblage structure	n	%
cores	2	1.0
blanks	22	11.5
tools	167	87.4

Table 9.7. Assemblage structure for combined Rank 3 materials.

n row % col %	Rank 1	Rank 2	Rank 3	Row total
cores	5 50.0 1.4	3 30.0 1.5	2 20.0 1.0	10
blanks	67 45.6 18.4	58 39.5 29.3	22 15.0 11.5	147
tools	293 49.1 80.3	137 22.9 69.2	167 28.0 87.4	597
Column total	365	198	191	754

Table 9.8. Cross–table of rank by assemblage structure.

An examination of blank types shows differences among the Rank 3 materials. For Type 3 (Hesbaye flint) and Type 12 (Brussels sandstone), blades are more common than flakes. Calcedony shows the same structure with the addition of a small series of bladelets (n=4). Type 5 (Wommersom quartzite) and Type 7 (black flint) have similar frequencies for flakes and blades. Interestingly, these are the two materials with the most tools, and their blank structure may support a Rank 2 classification as well. Type 6 (tan/brown flints) show a slight dominance of flakes while Type 10 (chert), the poorest quality material present, is dominated by flakes. Quartzite and limestone, very rare, lack flakes and blades entirely.

Among the Rank 3 tools, 112 are Upper Paleolithic types and 55 are Middle Paleolithic types, probably indicating a certain degree of mixing between strata during the excavation. 15 of the tools are composite. Among the Upper Paleolithic tools, carinated burins are most common (n=27), followed by endscrapers. Among the Middle Paleolithic tools, Mousterian points are most common (n=12), followed by various sidescraper types.

Most of the tools fall within a size range of 41–70 mm (n=124, of which 67 are whole) but there are also 28 tools between 71–100 mm (of which 18 are whole). A total of 102 of the tools are whole, again reflecting excavator bias. The relatively large size of the tools could reflect either a preference for curating larger tools (indicating transport of Rank 3 materials as finished tools and/or blanks) or simply excavator bias towards collection of the larger artifacts.

Ranks 1 and 2

What blanks were produced?

The following table (Table 9.9) shows the kinds of blanks produced for each material type, removals which could have potentially been retouched into tools. Blades are dominant for all materials.

Material	**Total n (blank pool)**	**flakes**		**blades**		**crested blade**		**bladelets**	
		n	%*	n	%	n	%	n	%
1 – Obourg	216	34	15.7	176	81.5	1	0.46	5	2.3
8 – gray flint	128	37	29.0	86	67.2	2	1.6	3	2.3
2 – Spiennes	106	35	33	70	66	0	0	1	0.9
4 – phtanite	84	19	22.6	63	75.0	1	1.2	1	1.2

Table 9.9. Blank production by material type. *Percent of blank pool, not of assemblage of each material type.

What blanks were selected for retouch into tools?

The following table (Table 9.10) shows the number of tools made on the different kinds of blanks, with a clear pattern of blade preference for Hesbaye and flake for tan flint.

Material	n tools	flakes	blades	crested blades	bladelets	cores/ chunks	debris
1 – Obourg	180	33	140		3	2	2
8 – gray flint	113	35	74	2	1	1	
2 – Spiennes	81	35	45			1	
4 – phtanite	56	19	33			4	
5 – Wommersom	51	27	22			2	
7 – black flint	39	17	19			2	1
3 – Hesbaye	12	2	9			1	
6 – tan/brown flint	20	12	8				
10 – chert	16	11	5				
12 – sandstone	15	5	11				
15 – calcedony	11	1	6	1	3		
11 – quartzite	1					1	
16 – jasper	0						
13 – limestone	1		1				

Table 9.10. Blank selection for tool production.

What is the intensity of blank selection?

Because De Puydt and Lohest rejected most debitage (unretouched blades and flakes as well as reduction debris), the assemblage is not representative and it is not possible to address the intensity of blank selection. The analysis depends on a comparison of the pool of available blanks and tools, both in terms of percentage of blanks selected (e.g., a high percentage indicates high intensity) and size comparisons (where a lower size threshold would indicate higher intensity).

Is there a size difference between blanks and tools?

A comparison of blade tools and whole blade blanks showed that Rank 1 tools were slightly, but not statistically significantly, longer than blanks. In contrast, Rank 2 tools are significantly larger in length, width and thickness. For Rank 3 blade tools and all flakes, samples sizes were too small for t–tests.

Table 9.11. Size analyses. Results of t–tests.
Spy: Rank 1, whole blades.

```
                                Number
Variable                       of Cases        Mean           SD   SE of Mean
"""""""""""""""""""""""""""""""""""""""""""""""""""""""""""""""""""""""""""""""

LENGTH  Length (mm)                                                               p=0.13
Blanks (unretouch                 13         60,0000        7,371         2,044
Tools (retouched)                 64         67,4219       15,920         1,990
"""""""""""""""""""""""""""""""""""""""""""""""""""""""""""""""""""""""""""""""

WIDTH  Width (mm)                                                                 p=0.65
Blanks (unretouch                 13         20,0769        3,226          ,895
Tools (retouched)                 64         22,5313        7,487          ,936
"""""""""""""""""""""""""""""""""""""""""""""""""""""""""""""""""""""""""""""""

THICK  Thickness (mm)                                                             p=.213
Blanks (unretouch                 13          6,0769        2,362          ,655
Tools (retouched)                 64          7,4375        3,750          ,469
```

Rank 2, whole blades.

Variable	Number of Cases	Mean	SD	SE of Mean	
LENGTH Length (mm)					**p=.003**
Blanks (unretouch	19	58,0526	11,482	2,634	
Tools (retouched)	32	75,3438	22,150	3,916	
WIDTH Width (mm)					**p=.023**
Blanks (unretouch	19	22,3684	11,334	2,600	
Tools (retouched)	32	29,8438	10,765	1,903	
THICK Thickness (mm)					**p=.000**
Blanks (unretouch	19	5,8947	1,997	,458	
Tools (retouched)	32	10,2500	4,759	,841	

EVALUATION OF LITHIC ECONOMY WITH RESPECT TO RAW MATERIAL CONTEXT

The ranking of materials reflects differential utilization of flint sources separated in both space and time. The most recently procured flint, Rank 1 materials, comes from the nearest flint sources and secondary reduction occurred at the site. Rank 2 materials come from more distant sources (such as Obourg), and were obtained prior to occupation of Spy, but probably not obtained during occupation. Phtanite becomes relatively more important in the lithic economy because of its nearness to Spy, while it is rare in the other study sites. Rank 3 materials, I would argue, reflect the remnants of multiple occupations, with prehistoric groups coming to Spy at different times from different directions.

CHAPTER 10
LE TROU MAGRITE

BACKGROUND

Location of site

The site of Le Trou Magrite is a large cave located in the Lower Carboniferous (Viséen) limestone cliffs on the north face of the Lesse river valley, a tributary of the Meuse (Figs. 10.1-10.4). It is found about 25 meters above the current valley floor and faces south-southwest (Straus 1995:23). The Lesse Valley contains a series of important Paleolithic cave sites (including La Naulette, Chaleux, Trou du Frontal, among others). It marks the effective southern limits of Paleolithic occupation in Belgium, due most likely to a lack of cave shelters in southernmost Belgium (except for Couvin) and extreme distance to sources of flint north of the Sambre-Meuse rivers. It should be noted, however, that systematic survey of southern Belgium has not been done for Paleolithic sites, which would have been in the open-air (but see Ziesaire 1994 for a synthesis of such survey and excavation in the Grand Duchy of Luxembourg). In the Province of Luxembourg (the southernmost province of Belgium), only more recent periods are represented in the archaeological record, due to their obviousness on the landscape (e.g., megaliths and Roman architectural features).

Raw material context

Of the sites studied, Le Trou Magrite is the most distant from sources of flint (although Couvin comes in a close second, with Spiennes flint being around 55 km north). Western sources (Obourg, Spiennes) are 70-75 km northwest while sources on the Hesbaye Plateau (Orp, Méhaigne river valley) are around 50 km north and sources in the Maastricht region are up to 80 km distant. Such distances place Le Trou Magrite in Zone 3. Local material includes chert and quartzite cobbles available on the Lesse river terrace and also on the plateau above the site (observed during geological survey), as well as abundant limestone, which was relatively hard, sometimes silicified.

The raw material context thus exerts a stronger influence on the nature of the lithic economy at Le Trou Magrite than for sites in Zones 1 and 2. The distances to flint sources are too great to make regular visits to provision the site, even if raw material procurement was embedded in subsistence activities. Additionally, and more importantly, flint present in an active tool kit would be diminished en route to Le Trou Magrite, arriving at the site in a much reduced, possibly nearly exhausted, state. Luckily for the occupants of Le Trou Magrite, the local limestone, while of relatively poorer quality than flint, was abundant and adequate for producing blanks, including blades.

Excavation history

Le Trou Magrite was first excavated in 1867 by E. Dupont as part of his systematic survey and excavation of cave sites in the Lesse Valley (Dupont 1868-69, 1872). He first visited the site in 1864, noting that the cave and terrace had already been partially cleared (some thirty years before) to prepare a touristic promenade for a nearby hotel (Dupont 1865; Otte 1995:11). His excavations in 1867 yielded a long sequence covering the Middle and Upper

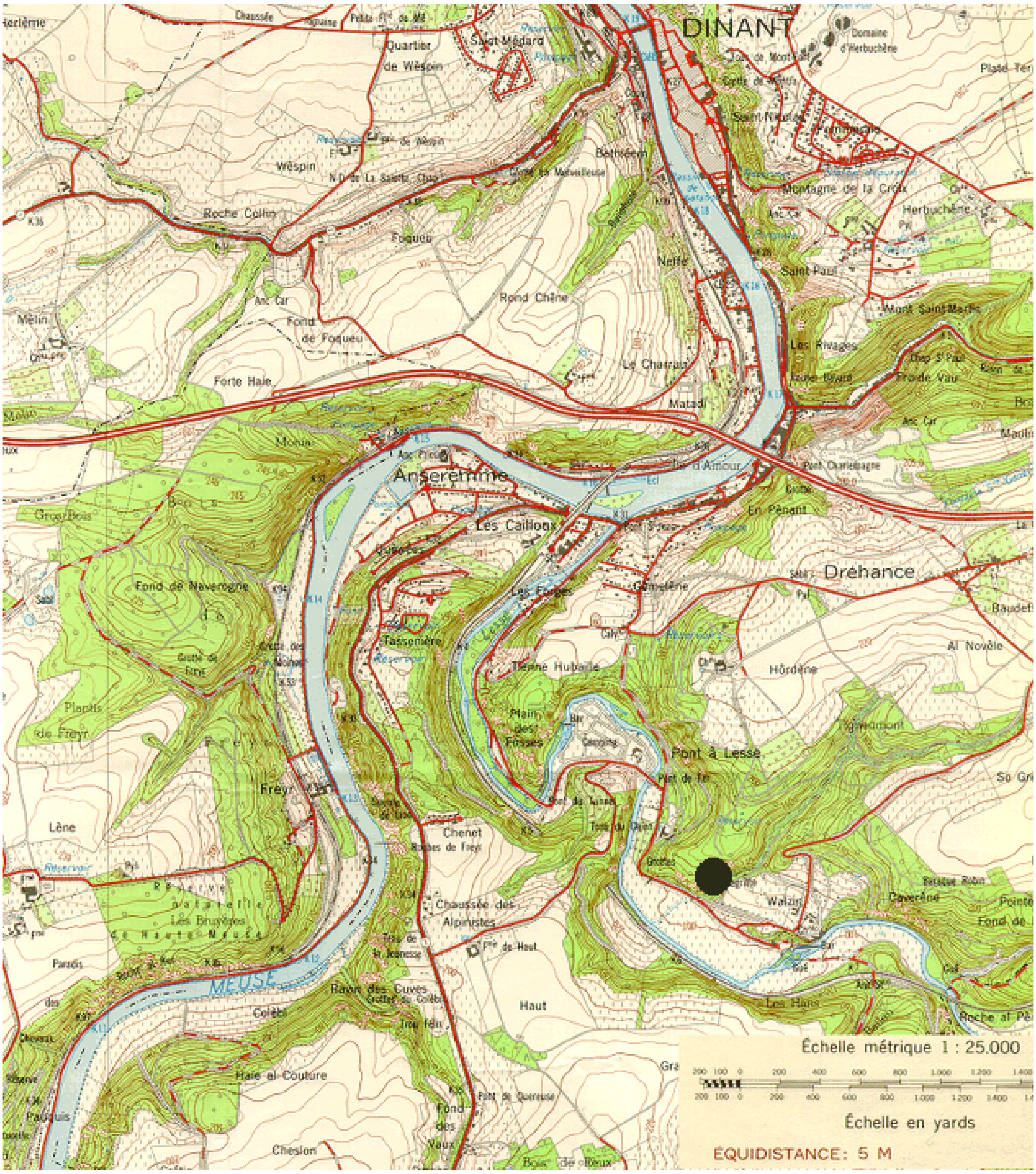


Figure 10.1. Le Trou Magrite. Location of site.
(after Institut Géographique National map 53/7-8, scale 1:25000)

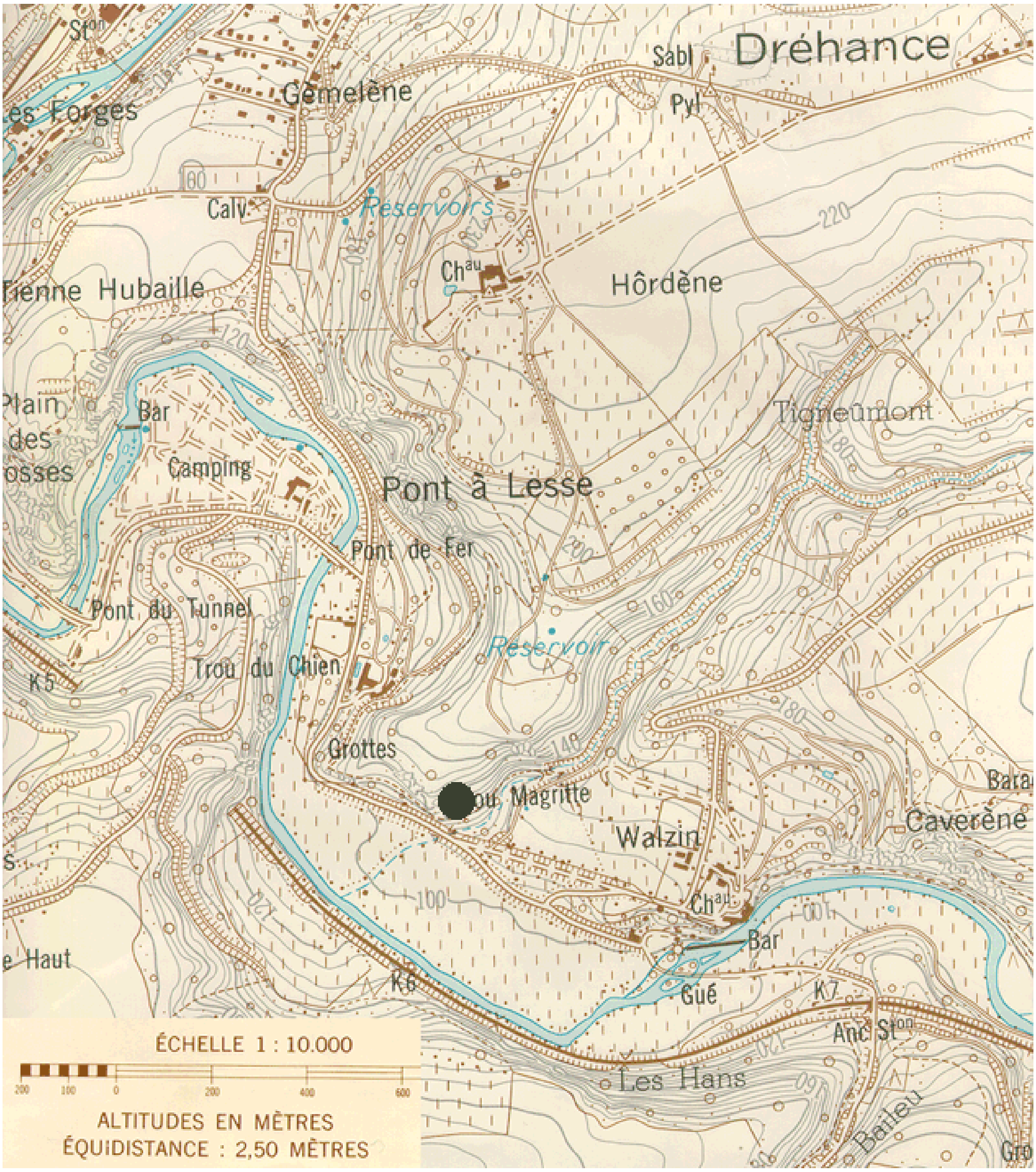


Figure 10.2. Le Trou Magrite. Location of site.
(after Institut Géographique National map 53/8, scale 1:10000)

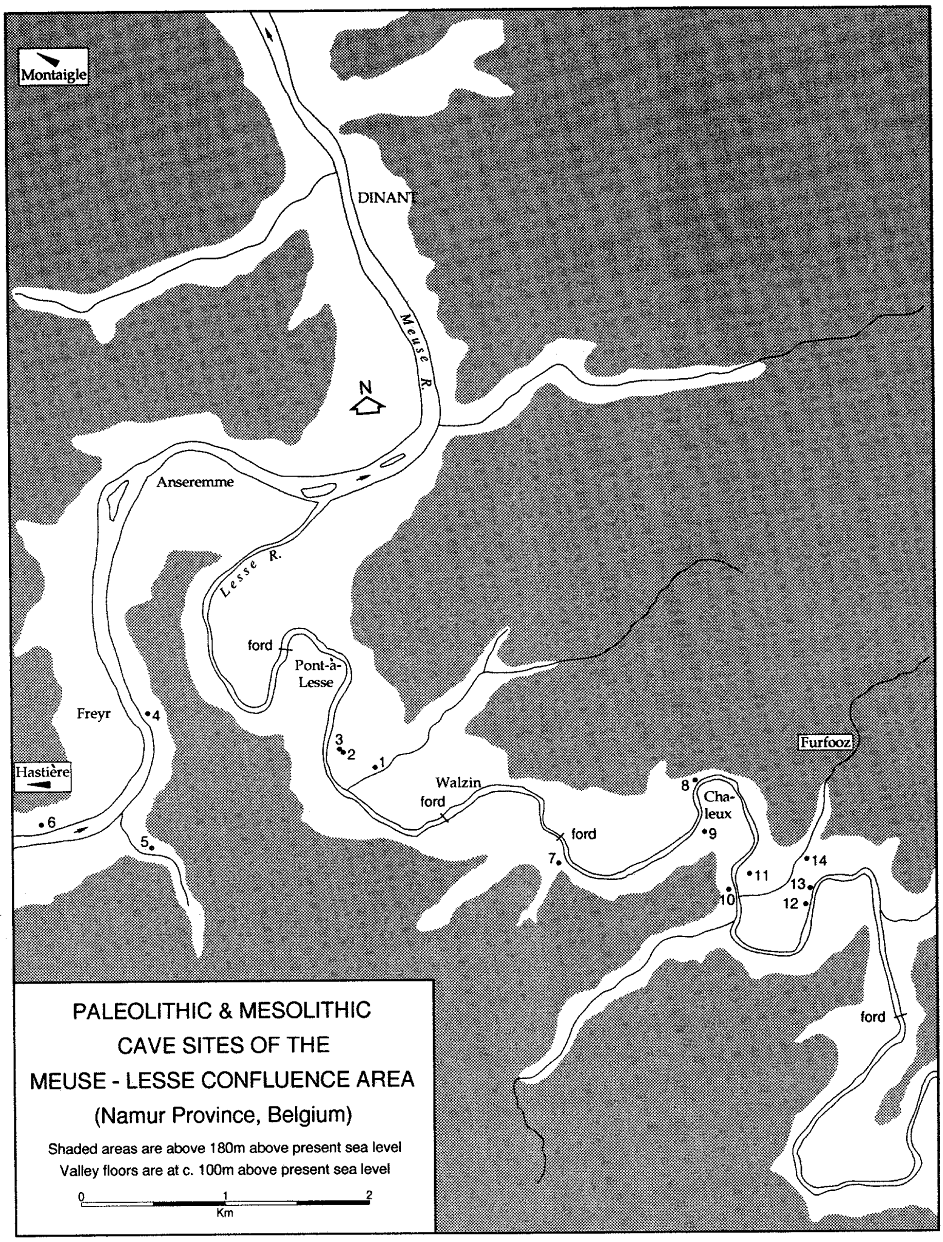


Figure 2.2 : Excavation of the terrace. 1. Trou Magrite; 2. Grotte Martina; 3. Trou Abri; 4. Abri du Pape; 5. Grotte Margaux; 6. Trou Da Somme; 7. La Naulette; 8. Trou de Chaleux; 9. Trou Balleux; 10. Abri de la Poterie; 11. Trou du Renard; 12. Trou du Frontal; 13. Trou des Nutons; 14. Trou Reuviau.

Figure 10.3. Le Trou Magrite. Paleolithic and Mesolithic cave sites of the Meuse-Lesse confluence area. (after Straus 1995:24, Fig. 2.2)

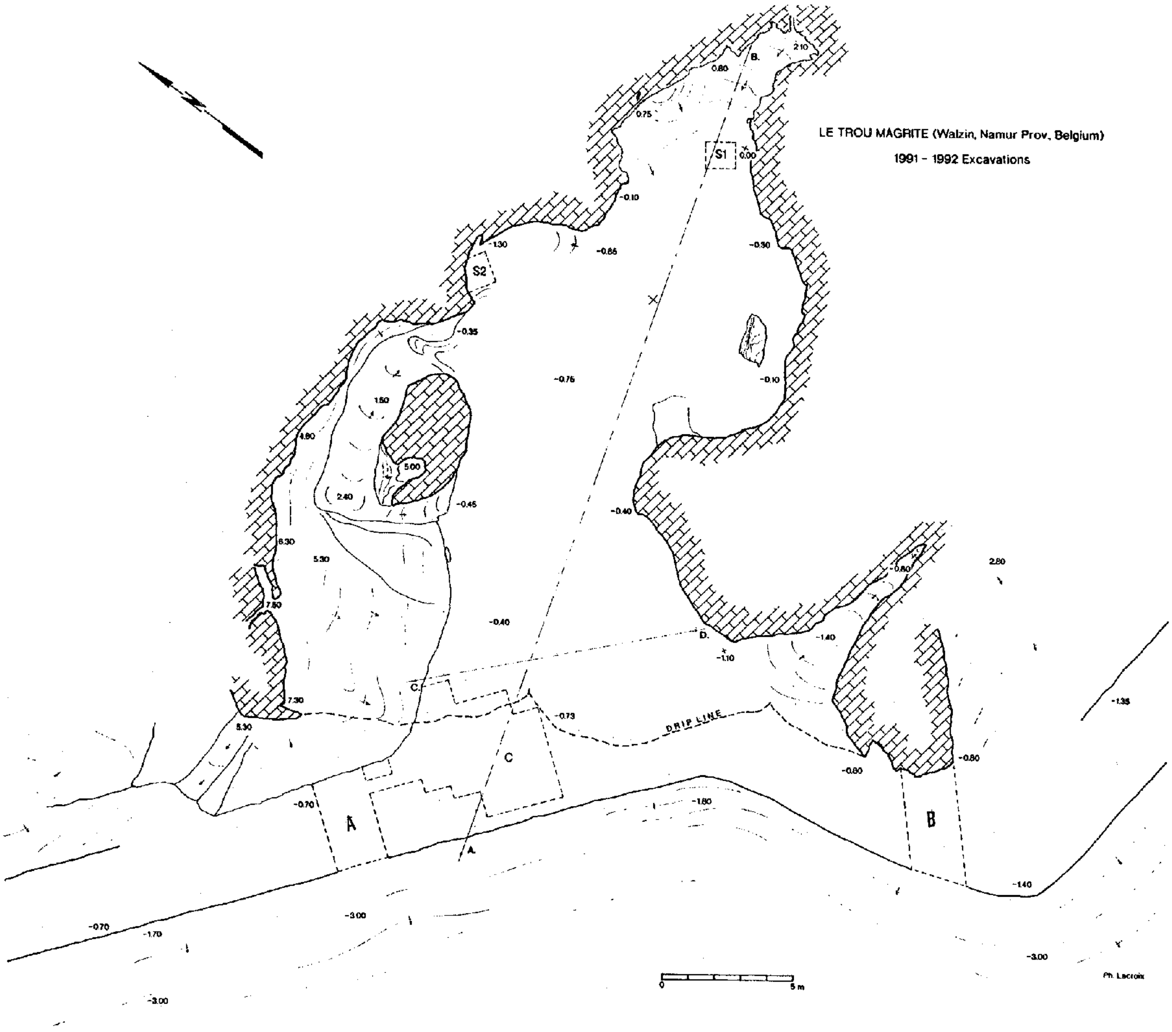


Figure 10.4. Le Trou Magrite. Plan of excavations. (after Straus 1995:27, Fig. 2.3)

Paleolithic, and included four identified archaeological levels which became a significant basis for his ordering of Paleolithic industries.

Subsequent excavations were undertaken by de Loë and Rahir (1908) and Rutot (1913-14) in remnants of intact sediments. More recently, L. Eloy (1960-62) and M. Toussaint (1976) excavated sondages in futile attempts to locate intact sediments.

The 1991-92 excavations directed by M. Otte and L. Straus uncovered an area on the terrace that had been in part protected by the supporting wall of the promenade. Thus, although the construction of the promenade destroyed the upper layers of the site, it protected the lower layers from further erosion down the talus slope.

Stratigraphy

The Dupont stratigraphy, due to its completeness, was extensively studied throughout the history of prehistoric chronological research and served as the basis for Breuil's chronological scheme for Paleolithic chronology (Dupont 1876b:131; Dupont 1868-69:33; Rutot 1906a; Breuil 1907:14; Rutot 1910; Peyrony 1948; Eloy 1956; de Sonneville-Bordes 1961; more recently by Ulrix-Closset 1975; Otte 1979; Dewez 1987). Otte (1995) recently summarized various interpretations of Dupont's stratigraphy and presented the currently accepted interpretation, due mainly to Dewez's (1985) detailed analysis. This interpretation is summarized below (Table 10.1) (after Otte 1995:13; Straus 1995c:101):

Appr. thickness	Geological formation	Archaeological level	Cultural attribution	Otte/Straus stratigraphy
1 m	clay with blocks	-	Magdalenian; Mesolithic or later	
2.5 m	clayey layer	A1	Upper Perigordian with Font-Robert points	
		A2	Evolved Aurignacian	Stratum 2
	stratified sandy layer	B3	Aurignacian	Stratum 3
		B4	Mousterian	Strata 4 and 5
	rolled Ardennes cobbles		sterile	

Table 10.1. Dupont stratigraphy, and correspondence with Otte/Straus stratigraphy.

For Dupont, the upper part of this sequence formed a major stage in his chronological ordering of Paleolithic industries (Montaigle = Aurignacian; Trou Magrite = Perigordian with Font-Robert points; Goyet = Perigordian with truncated pieces; Chaleux = Magdalenian) (Otte 1995:13-14).

The Otte/Straus stratigraphy on the terrace can be summarized as follows, from top to bottom (after Straus 1995a:36-45) (Figs. 10.5-10.8):

Stratum 1. blackish-brown humic topsoil and backdirt from earlier excavations (30-70 cm thick)
Stratum 1.1. light brown silt infilling a post-Paleolithic pit
Stratum 2. small, angular cryoclastic éboulis (25-40 cm thick)
Stratum 3. cryoclastic éboulis with larger blocks and slabs in a gravel matrix (generally 30-35 cm thick)

Stratum 4. light (yellowish) brown clayey silt containing very large roof-fall boulders
Stratum 5. waterlain deposits; upper: stony, light brown-beige silt; middle: owl regurgitation pellets; lower: pure yellowish beige-brown silt
Stratum 6. crevice between or through bedrock and boulders.

Archaeological and cultural attributions of the above strata are summarized as follows (after Straus 1995b:55-86) (Fig. 10.9):

Stratum 1. mixed modern, sub-modern and Paleolithic artifacts and faunal remains
Stratum 1.1. large post-Paleolithic pit, probably mid-Holocene
Stratum 2. richest archaeological layer, intact; Aurignacian, 30-27,000 yrs BP
Stratum 3. Early Aurignacian, 32-34,000 yrs BP, 41,000 yrs BP
Stratum 4. rare lithics and fauna, including five Upper Paleolithic and five Middle Paleolithic tools
Stratum 5. rare lithics and fauna, with lens of rodent bones (owl regurgitation pellets); Mousterian but non-diagnostic.

Dating of the site

One of the major benefits of the Otte and Straus excavations is the series of dates obtained on Strata 2 and 3, summarized in Table 10.2 below (after Straus 1995b:65). Briefly (see Straus 1995b:55-86 for more detailed discussion), for Stratum 2, the first date is contaminated and for the second, bone apatite has proven to be unreliable for dating. The remaining three dates give the best estimate of Stratum 2, roughly 32/34-28,000 yrs BP. For Stratum 3, the first date, at 2 standard deviations, is similar to basal Stratum 2, and is supported by the second date. The third date of 41,300 ± 1690, while unexpectedly old, appears to be the only reliable date. According to Stafford, it is the only sample dated by AMS on aspartic acid that is not contaminated. Additionally, the date was obtained using an individual amino acid that could have only come from the bone (Straus 1995b:73; Straus, pers. comm.). Bone samples taken from Strata 4 and 5 were unsuccessful due to lack of protein remaining.

Stratum	**Material dated**	**Method**	**Lab No.**	**Date BP**	**± 1 SD**	**Range @ 2 SD**
2 top	charcoal	AMS	Ox-A-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	29,200-23,960
2 base	bone gelatin	Conv	GX-18538G	30,100	2200	34,500-25,700
2 base	bone gelatin	Conv	GX-18537G	34,225	1925	38,075-30,075
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

Table 10.2. Radiocarbon dates obtained at Le Trou Magrite (Otte and Straus excavations).
+: very well preserved bone: % N = 1.74. *: very poorly preserved bone: protein leached out (according to T. Stafford).

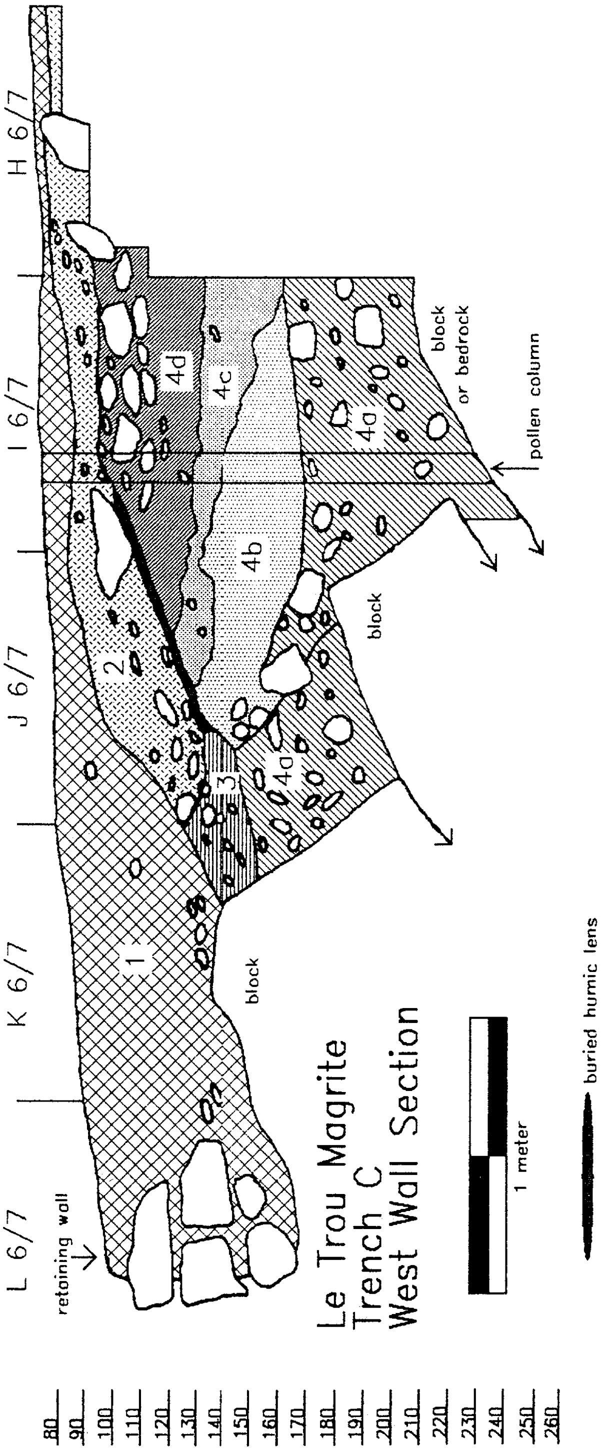


Figure 10.5. Le Trou Magrite. Trench C, West Section. (after Straus 1995:37, Fig. 2.10)

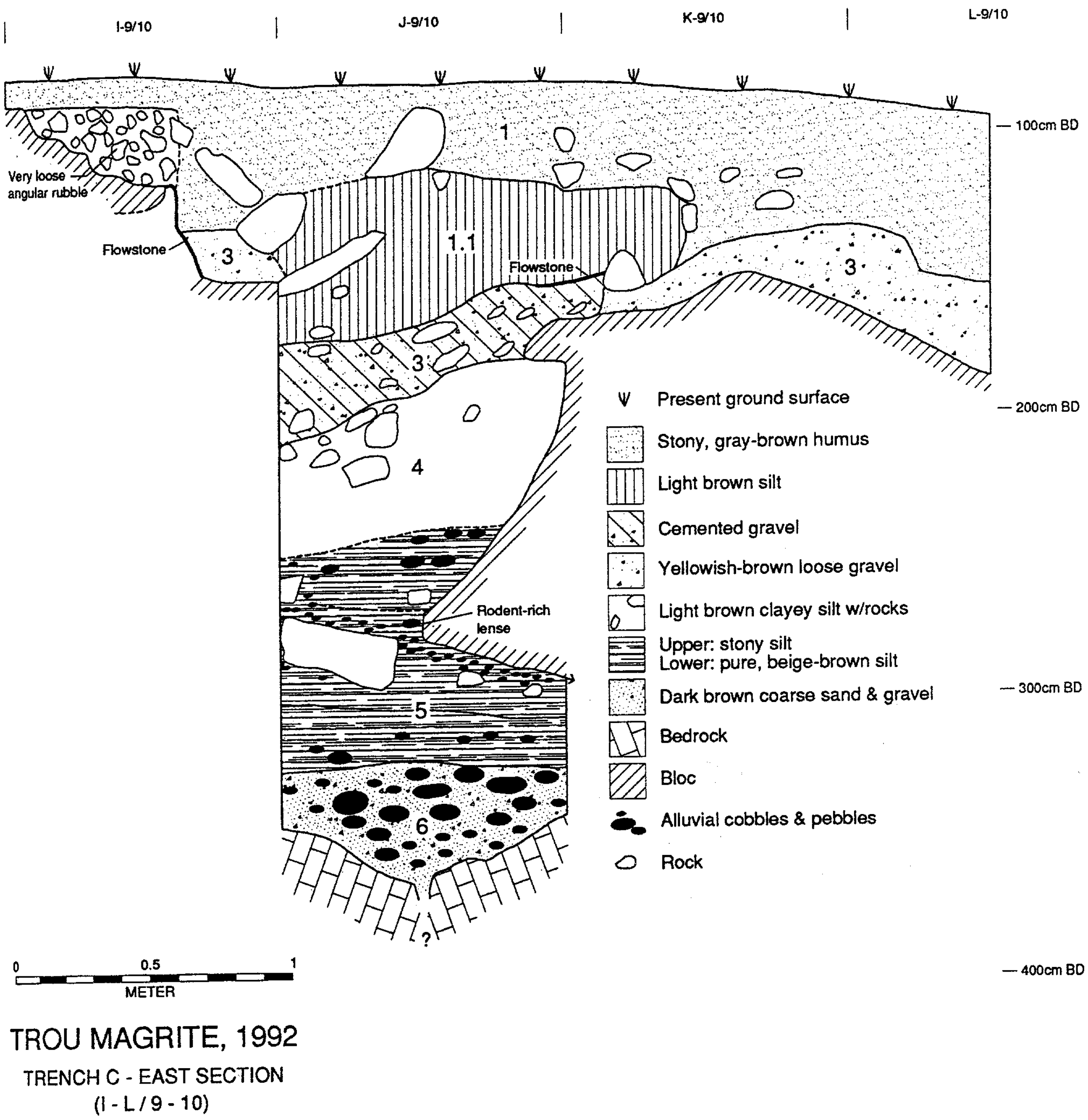


Figure 10.6. Le Trou Magrite. Trench C, East Section. (after Straus 1995:39, Fig. 2.12)

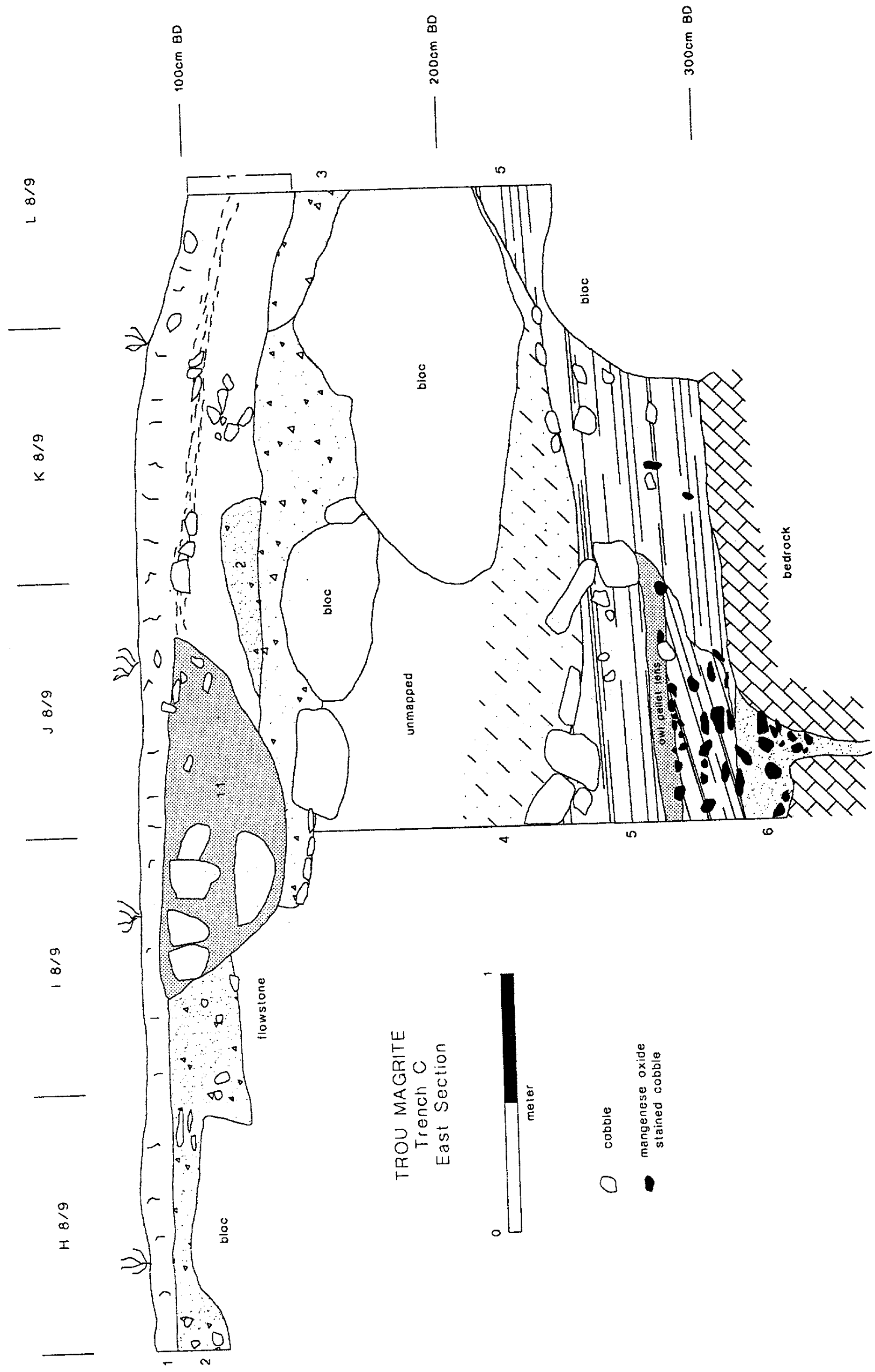


Figure 10.7. Le Trou Magrite. Trench C, East Section. (after Straus 1995:40, Fig. 2.13)

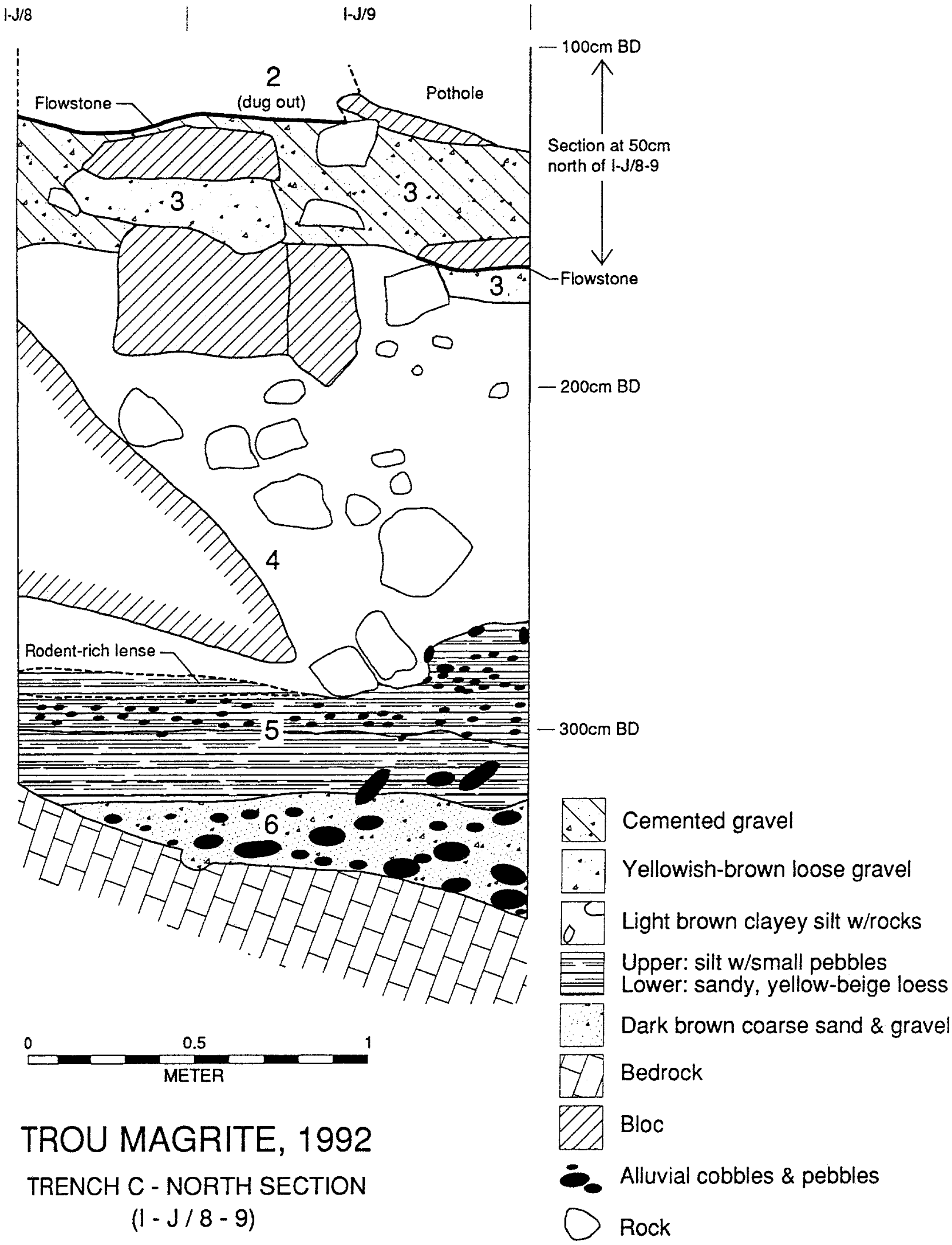


Figure 10.8. Le Trou Magrite. Trench C, North Section. (after Straus 1995::41, Fig. 2.14)

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

Figure 10.9. Le Trou Magrite. Summary of the Trou Magrite chronostratigraphy. (after Straus 1995::84, Table 4.5)

Climate and environment

From analyses of sediment and fauna, approximate climatic and environmental conditions have been reconstructed (Haesaerts 1995; Gautier 1995; Cordy 1995). Both Strata 3 and 2 were deposited under cold, somewhat humid conditions (late oxygen isotope stage 3), with evidence of freeze-thaw action. Stratum 3 appears to have been more humid. Stratum 4 contains loess deposited during alternating cold and dry conditions (4d-top and 4b-lower middle) and more humid conditions (4c-upper middle and 4a-base), by eolian and colluvial processes respectively. Based on the microfauna in the owl pellet lens, Stratum 5 was deposited in a cold climate; based on the presence of a sandy silt matrix deposited by water, there was "at least periodical high local humidity" (Straus 1995b:81; Haesaerts 1995). The microfauna shows similarities to Couche Vg/4 at Scladina Cave, located on the Meuse at Sclayn.

The macrofaunal faunal analysis by Gautier (1995) shows that the major game animals were, in decreasing order, reindeer, horse, and ibex, with similar percentages for Strata 3 and 2.

Seasonality studies by Stutz *et al.* (1995) on dental cementum revealed that winter kills were present, with most kills falling within fall and winter (October-April) and more commonly in winter and early spring (Stutz *et al.* 1995:181). An important point made was that "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" (Stutz *et al.* 1995:180).

These results have important implications for the degree of seasonal mobility and access to lithic resources for hunter-gatherers in the Early Upper Paleolithic. First, in my view, winter-spring occupations of caves suggests a degree of seasonal sedentism, that caves such as Le Trou Magrite, Goyet and Spy served as residential camps over a period of months because they provided shelter. Short-term hunting camps may have been used in the vicinity but caves would have been a more permanent location to which to return. Rigorous climatic conditions would limit mobility during winters. Second, such a limit on mobility would limit access to distant flint resources at sites such as Le Trou Magrite, where the nearest flint sources were at least 40 km distant, because travelling during winter would have been too difficult. Stutz *et al.* (1995:181) raise the question of where hunter-gatherers settled from May to September, and suggest three possibilities: "occupation of open-air sites in the Mosan Basin as part of a year-round occupation of the river valleys, … seasonal movement 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, … and summer kills were originally present at the Mosan Basin cave sites but have not yet been uncovered or by fluke have not survived."

Assemblage samples and problems

Only the assemblages recovered from the Otte/Straus excavations were selected for study, on the basis of the quality of data recovery with modern excavation techniques. The four assemblages come from Strata 5 and 4 (Mousterian) (Table 10.4 in Part B) and Strata 3 and 2 (Aurignacian) (Table 10.3). Although Dupont's excavation produced a long stratigraphic sequence, problems of correlating his stratigraphy with the Otte/Straus stratigraphy made it preferable to limit the sample to the modern excavation. First, Dupont's descriptions of the stratigraphic sequence (including geological and archaeological levels) were not always clear. Second, according to Straus, "surviving museum collections are unfortunately curated with only minimal provenience indications and are generally mixed" (Straus 1995a:21). Otte (1979) studied the Aurignacian and Gravettian components of the site, but found that, apart from certain diagnostic tool types, the majority of artifacts could not be attributed to one or the other of the components (Otte 1979; Straus 1995c:98).

	Stratum 2				Stratum 3			
	Count		Weight		Count		Weight	
Type	**n**	**%**	**wt in g**	**%**	**n**	**%**	**wt in g**	**%**
1 - Obourg	-	-	-	-	-	-	-	-
2 - Spiennes	-	-	-	-	1	-	12	0.12
3 - Hesbaye	3065	58.9	2580	16.9	830	31.7	1049	10.2
4 - phtanite	38	0.7	99	0.65	17	0.6	32	0.31
5 - Wommersom	-	-	-	-	-	-	-	-
6 - tan flints	-	-	-	-	-	-	-	-
7 - black flints	135	2.6	397	2.6	117	4.5	328	3.2
8 - gray flints	2	0	4	0.03	3	0.1	6	0.06
9 - brown flint	-	-	-	-	-	-	-	-
10 - cherts	131	2.5	561	3.7	123	4.7	1009	9.8
11 - quartzites	106	2.0	1341	8.8	55	2.1	535	5.2
12 - sandstone	3	0.1	19	0.12	12	0.5	35*	0.34
13 - black limestone	1698	32.6	10113	66.0	1440	55.0	6783	66.0
14 - quartz	24	0.5	96	0.63	17	0.6	129	1.3
missing	3	0.1	-	-	4	0.2	-	-
Total	**5205**	**100.0**	**15233 (n=1702)**		**2619**	**100.0**	**10259 (n=1252)****	**96.5**

* Two sandstone fire-cracked rocks weighing 235 g excluded.
** n=1252 but this includes records where count > 1 so actual n of artifacts =2619.
Table 10.3. Frequencies by count and weight for Strata 2 and 3 (Aurignacian levels).

PART A: STRATA 2 AND 3: AURIGNACIAN

RANKING OF MATERIALS BY FREQUENCY AND WEIGHT

Materials are ranked differently according to count or weight, which means that there is variability between material types in terms of size of artifacts. Flint is represented by numerous small and light artifacts (frequency % is greater than weight %), while limestone is represented by relatively fewer artifacts which are larger and heavier (weight % is greater than frequency %). The difference in ranking can also reflect differences in the raw materials itself: a kilogram of flint and a kilogram of limestone have different mass.

The order of ranking between count and weight measures changes more radically in Stratum 2 than in Stratum 3 (Tables 10.5 and 10.6. In Stratum 3, the top three materials are in the same order but limestone and chert are heavier per artifact and Hesbaye flint lighter. Ranks 4 and 5 reverse, where quartzites are heavier than black flints but black flints are more numerous than quartzites. Quartz remains in Rank 6. Ranks 7-8 and 9-10 are substantially identical.

In Stratum 2, the top two materials reverse positions, where limestone is much heavier than Hesbaye, but Hesbaye flint artifacts are much more numerous. Ranks 3-5 are similar in frequency for black flint, cherts, and quartzites, but vary in weight and are in reverse order. Ranks 6-9 do not vary in rank between frequency and weight.

Rank	Type	Count %		Rank	Type	Weight %
1	13 - limestone	55.0		1	13 - limestone	66.0
2	3 - Hesbaye	31.7		2	3 - Hesbaye	10.2
3	10 - cherts	4.7		3	10 - cherts	9.8
4	7 - black	4.5		4	11 - quartzites	5.2
5	11 - quartzites	2.1		5	7 - black	3.2
6	14 - quartz	0.6		6	14 - quartz	1.3
7	4 - phtanite	0.6		7	12 - sandstone	0.34
8	12 -sandstone	0.5		8	4 - phtanite	0.31
9	8 - gray flints	0.1		9	2 - Spiennes	0.12
10	2 - Spiennes	0		10	8 - gray flints	0.06

Table 10.5. Le Trou Magrite. Stratum 3. Ranking of material types by frequency and weight.

Rank	Type	Count %		Rank	Type	Weight %
1	3 - Hesbaye	58.9		1	13 - limestone	66.0
2	13 - limestone	32.6		2	3 - Hesbaye	16.9
3	7 - black	2.6		3	11 - quartzites	8.8
4	10 - cherts	2.5		4	10 - cherts	3.7
5	11 - quartzites	2.0		5	7 - black	2.6
6	4 - phtanite	0.7		6	4 - phtanite	0.65
7	14 - quartz	0.5		7	14 - quartz	0.63
8	12 -sandstone	0.1		8	12 - sandstone	0.12
9	8 - gray flints	0		9	8 - gray flints	0.03

Table 10.6. Le Trou Magrite. Stratum 2. Ranking of material types by frequency and weight.

When the ranking is collapsed (Tables 10.7 and 10.8), four ranks can be observed, although Ranks 3 and 4 can be combined, here being separated to show the extreme rarity of certain material types. Comparing Stratum 3 with Stratum 2, the collapsed ranking shows a clear and important reversal between Ranks 1 and 2, reflecting a reversal in the importance of the local limestone and the non-local Hesbaye flint. By count, the local limestone was dominant in Stratum 3, Hesbaye flint in Stratum 2. However, by weight, both strata would have similar rankings for the two materials, indicating that the artifacts on Hesbaye flint used in Stratum 2 were much smaller and in greater quantity than those in Stratum 3. This may be the result of the transport of an already greatly diminished supply of flint and an extreme increase in intensity of utilization of flint to maximize the small supply remaining.

Rank 3 (and 4) materials are nearly all local, apart from the very rare presence of Spiennes flint in Stratum 3 and gray flints in Stratum 2, both of which, it should be said, may represent variants of Hesbaye flint.

Rank	No(s).	Type(s)	Count %	Weight %
1	13	black limestone	55	66.0
2	3	Hesbaye flint	31.7	10.2
3	10, 7, 11	cherts, black flint, quartzites	2.1-4.7	3-10
4	14, 4, 12, 2	quartz, phtanite, sandstone, Spiennes	< 1.0	< 2.0

Table 10.7. Le Trou Magrite. Stratum 3. Collapsed ranking of material types.

Rank	No(s).	Type(s)	Count %	Weight %
1	3	Hesbaye flint	58.9	16.9
2	13	black limestone	32.6	66.0
3	7, 10, 11	black flint, cherts, quartzites	2.0-2.6	2.6-8.8
4	4, 14, 12, 8	phtanite, quartz, sandstone, gray flints	< 1.0	< 1.0

Table 10.8. Le Trou Magrite. Stratum 2. Collapsed ranking of material types.

SOURCES OF MATERIAL UTILIZED

Rank 1

Hesbaye flints (Type 3), likely comprising a variety of possible proveniences which patinate similarly, come from the nearest flint source region (Fig. 10.10). However, the Hesbaye plateau itself is at minimum 40 km distant (following the Meuse to the western part of the Hesbaye Plateau north of Andenne) and sources in the Méhaigne valley are at least 50 km distant, with a maximum around 80 km for sources between Liège and Maastricht.

Rank 2

Black limestone (Type 13) is local and abundant (Fig. 10.11).

Rank 3

Black flint (Type 7) is of unknown provenience, but is not found locally, and matches neither Obourg nor Lanaye samples in lithic reference collections. It could be Tertiary black flint from the Brabant Plateau near Ottignies approximately 55 km distant (based on a sample provided by Eric Teheux).

Cherts (Type 10) are local and similar samples have been found (through survey) in the plateau up and behind Trou Magrite (near Dréhance).

Quartzites (Type 11) could have come from local secondary deposits (banks, terrace) from the Lesse River which passes in front of Trou Magrite.

Rank 4

Phtanite (Type 4) of the type found here (and the type commonly found archaeologically) comes from a highly localized known provenience on the Brabant Plateau near Ottignies-Mousty, about 55 km distant.

Quartz (Type 14) was likely obtained in the form of quartz cobbles found, like quartzite, in local secondary deposits of the Meuse.

Sandstone (Type 12) does not include any examples of Brussels sandstone.

Gray flints (Type 8) have unknown provenience, but probably come from one of the Hesbaye sources.

TRANSPORT OF MATERIAL

Cortex attributes and debitage analysis to identify stages of the chaîne opératoire were used to make inferences of transport form of material to the site. Assemblage structure for Strata 3 and 2 are summarized in Tables 10.9 and 10.10.

Stratum 3

Rank 1 material		
Type	**Assemblage structure**	**Brought to site as...**
13 - limestone	3 cores, 37 tools, 1066 blanks, 334 debris (including 75 chunks*)	unprepared blocks of material
Rank 2 material		
Type	**Assemblage structure**	**Brought to site as...**
3 - Hesbaye flint	1 core, 45 tools, 382 blanks, 402 debris (including 25 chunks)	prepared cores or cores already in use
Rank 3 materials		
Type	**Assemblage structure**	**Brought to site as...**
10 - cherts	4 cores, 11 tools, 80 blanks, 28 debris (including 17 chunks)	prepared cores
7 - black flint	6 tools, 77 blanks, 34 debris (including 7 chunks)	nearly exhausted core(s), blanks
11 - quartzites	1 core, 3 tools, 44 blanks, 7 debris (including 3 chunks)	prepared core(s)
Rank 4 materials		
Type	**Assemblage structure**	**Brought to site as...**
14 - quartz	12 blanks, 5 debris (including 2 chunks)	blanks, possible chunk/core
4 - phtanite	10 blanks, 7 debris (including 3 chunks)	blanks
12 - sandstone	2 tools, 8 blanks	blanks and finished tools
2 - Spiennes flint	unretouched crested blade	crested blade

* Chunks are probably core remnants.

Table 10.9. Le Trou Magrite. Stratum 3. Transport form of raw materials (plus general assemblage structure).

The dominant material (Rank 1) in Stratum 3 is local black limestone, which is abundant and readily available although of poorer quality than flint. Transport costs are low. All stages of the reduction sequence are represented. Cortex attributes could not be used because cortex is not present on this material. Additionally, primary reduction or cortex removal from cores would not have been necessary. It is likely that many or most of the chunks are core fragments. The three recognizable cores are all flake cores.

The Rank 2 material, Hesbaye flint, comes from the nearest flint source region, but this source region is too far to regularly exploit to provision the site after arrival. This material would have been brought to the site as material already in use and conserved. Cortex is rare and cores reflect increased intensity of blank production to maximize the remaining material since new stock of flint could not be procured. Material came to the site as active cores, blanks, and finished tools. When it was exhausted, it was most likely replaced by black limestone.

Rank 3 material includes both local and non-local material which reflect a much more minor degree of reduction. The non-local material, black flint, lacks cores although there are seven chunks which could have been core fragments. Material would have been transported as nearly exhausted cores, blanks, and finished tools. As discussed in chapter 12, I argue that this material was procured prior to Hesbaye flint, both at previously occupied sites, and represents the last stages of an already dwindled supply. For the local materials, certain suitable chunks or cobbles could have been easily found and reduced, with cortex or cobble surface removed before transport, but were not extensively exploited. Chert and quartzite may have been more suitable for certain kinds of tools than the softer limestone.

Rank 4 materials are present only in very low percentages and were transported to the site as blanks and finished tools. No reduction occurred.

Stratum 2

Rank 1 material		
Type	**Assemblage structure**	**Brought to site as...**
3 - Hesbaye flint	3 cores, 76 tools, 1331 blanks, 1655 debris (including 137 chunks)	prepared, active cores
Rank 2 material		
Type	**Assemblage structure**	**Brought to site as...**
13 - limestone	11 cores, 24 tools, 1394 blanks, 269 debris (including 123 chunks)	unprepared blocks or shaped blocks
Rank 3 materials		
Type	**Assemblage structure**	**Brought to site as...**
7 - black flint	13 cores, 2 tools, 83 blanks, 37 debris (including 17 chunks*)	active cores close to the last stages of reduction
10 - cherts	3 tools, 90 blanks, 38 debris (including 16 chunks)	chunks
11 - quartzites	4 cores, 2 tools, 95 blanks, 5 debris (including 3 chunks)	prepared cores (= decorticated esp. if cobbles)
Rank 4 materials		
Type	**Assemblage structure**	**Brought to site as...**
4 - phtanite	2 tools, 32 blanks, 4 debris (including 2 chunks)	blanks and finished tools, possible exhausted core
14 - quartz	15 blanks, 9 debris (including 5 chunks)	blanks
12 - sandstone	3 blanks	blanks
8 - gray flints	2 blanks	blanks

* Chunks are probably core remnants.

Table 10.10. Le Trou Magrite. Stratum 2. Transport form of raw materials (plus general assemblage structure).

In Stratum 2, the dominant material is Hesbaye flint. Hesbaye flint is nearly twice as common as black limestone (by count) in Stratum 2 but has the same weight percentage as in Stratum 3. This is due to the much higher frequency of debris (trimming flakes and shatter): 1655 artifacts for Hesbaye flint versus 269 for limestone. Blanks and tools together are in similar frequency although there are more tools on Hesbaye flint than on limestone. There are only three recognizable cores (as opposed to one in Stratum 3), but there are 137 chunks (versus 25 in Stratum 3). More material was brought to the site during the Stratum 2 occupation than Stratum 3 (2580 g vs. 1049 g.). It is unlikely that this increase in quantity reflects logistical trips, while the site was occupied, to obtain flint, because the quantity of flint present is still low and inadequate to completely provision the site. The absence of recognizable cores makes it more likely that all of the material was transported as an active tool kit from a previous occupation closer to the Hesbaye Plateau. This could have been in preparation for an occupation of longer duration than that represented in Stratum 3 or could reflect some sort of change in transport technology which permitted the transport of more material.

Black limestone falls to Rank 2 by count in Stratum 2, roughly reversing percentages with Hesbaye flint, but has the same weight percentage as in Stratum 3. While more Hesbaye flint was available as compared to Stratum 3, it was still limited with no possibility of obtaining fresh flint when it was exhausted. Limestone continues to replace or supplement the flint supply. There are 11 recognizable cores (6 flake, 1 prismatic blade, 1 pyramidal bladelet, and 3 mixed cores) and 123 chunks as opposed to 3 cores and 75 chunks in Stratum 3. This increase in use of local material supports an interpretation of longer duration of occupation during the Stratum 3 occupation.

Rank 3 materials include black flint, chert, and quartzite. These are identically ranked in Stratum 3 and reflect a similar minor degree of use in comparison with limestone and Hesbaye flint. Percentages decrease due to the increase in use of Hesbaye flint but remain similar to those in Stratum 3. One major difference is that black flint includes 13 cores and 17 chunks in Stratum 2, as opposed to no cores and 7 chunks in Stratum 3. A working hypothesis (see chapter 12) is that black flint was obtained prior to Hesbaye flint, as in Stratum 3, but with a shorter length of time between procurement and arrival at Trou Magrite. While it is still nearly exhausted, the assemblage structure is more complete than in Stratum 3, with a series of cores present rather than simply blanks and tools.

In contrast, local chert is much rarer in Stratum 2 than in Stratum 3. There no cores and 16 chunks versus 4 cores and 17 chunks in Stratum 3. Quartzite is used slightly more than in Stratum 3. There are 4 cores and 3 chunks versus 1 core and 3 chunks in Stratum 3. Perhaps with more flint available, local chert was rejected.

Rank 4 materials include the same range of materials as in Stratum 3 - phtanite, quartz, and sandstone - with the exception that Spiennes flint (n=1 in Stratum 3) is now absent and only two artifacts in gray flint are present in Stratum 2. No reduction occurred and material was transported as blanks and finished tools, although there are some chunks in phtanite and quartz. Again, these materials represent the very last stages in the history of the material - cores have been exhausted prior to arrival at Trou Magrite and only blanks and tools remain. Local quartz was probably again rejected as unsuitable.

Overall, each material tends to include a wider range of assemblage components than in Stratum 3 (materials lacking cores in Stratum 3 *are* represented by cores in Stratum 2) and a greater quantity (more cores, more blanks, more tools). These observations have two implications. First, there could be shorter intervals between sites so that material such as black flint, obtained prior to Hesbaye flint, still contains cores and is less exhausted. Alternatively, this could reflect an increase in stockpiling so that more material is being transported than in earlier times. Second, the greater quantity of material in weight and count reflects both an increase in the amount of material procured for the site and an increase in reduction activity. The still substantial use of local limestone when flint was exhausted reflects a longer duration of occupation. It should be noted that the observed differences between Strata 3 and 2 could simply reflect differences in the spatial distribution of site activities using different materials.

Given the rarity of cortex on any of the material, an assessment of procurement context is not possible. Tables 10.11 and 10.12 summarize the cortex information for Strata 3 and 2.

		Cortex		Proportion		Primary Context		Secondary Context	
Rank	Type	n	%	n < 50%	n > 50%	n	%	n	%
1	13-limestone	-	-	-	-	-	-	-	-
2	3 - Hesbaye	50	6.1	43	7	20	40.0	4	8.0
3	10-chert	10	8.1	8	2	4	40.0	-	-
3	7 - black flints	6	5.1	4	2	1	16.6	1	16.6
3	11 - quartzites	10	18.2	5	5	-	-	-	-
4	14 - quartz	-	-	-	-	-	-	-	-
4	4 - phtanite	-	-	-	-	-	-	-	-
4	12 - sandstone	-	-	-	-	-	-	-	-
4	2 - Spiennes	-	-	-	-	-	-	-	-

Table 10.11. Le Trou Magrite. Stratum 3. Procurement context: cortex data.

		Cortex		Proportion		Primary Context		Secondary Context	
Rank	Type	n	%	n < 50%	n > 50%	n	%	n	%
2	3 - Hesbaye	200	6.5		20	51		26	
1	13-limestone	-	-	-	-	-	-	-	-
3	7 - black flints	10	8.3	7	3	2		3	
3	10-chert	9	6.8	7	2	4		1	
3	11 - quartzites	25	23.6	14	11			1	
4	4 - phtanite	-	-	-	-	-	-	-	-
4	14 - quartz	-	-	-	-	-	-	-	-
4	12 - sandstone	-	-	-	-	-	-	-	-
4	8 - gray flints	1	50.0		1	1			

Table 10.12. Le Trou Magrite. Stratum 2. Procurement context: cortex data.

EVIDENCE FOR REDUCTION OF MATERIALS AT THE SITE

The assemblage structure for each material varies with rank, with decreasing inclusivity of stages of the reduction sequence as rank decreases. Rank 4 materials only appear as blanks or finished tools (with a few chunks), and reduction is absent at the site.

Ranks 3 and 4

For Strata 3 and 2, the Rank 3 and 4 materials are the same, with the exception of the presence of Spiennes flint in Stratum 3 (n=1) and gray flint in Stratum 2 (n=2). The general assemblage structure for the combined Rank 3 and 4 materials (Table 10.13) shows that Strata 3 and 2 are essentially identical, apart from a slight increase in cores and decrease in tools in Stratum 2. A more detailed breakdown, by raw material type (Table 10.14), supports this observation, with a substantially similar pattern of distribution of assemblage components in both strata.

Rank 3 and 4 Materials	**Stratum 3**		**Stratum 2**	
	n	%	n	%
cores	5	1.70	17	4.34%
chunks	35	11.90	43	10.97%
tools	22	7.48	9	2.30%
blanks	232	78.91	323	82.40%
	294	100.0%	392	100.0%

Table 10.13. Assemblage structure of Rank 3 and 4 materials, excluding debris.

Stratum 3						**Stratum 2**					
Type	**total n**	**cores**	**chunks**	**tools**	**blanks**	**Type**	**total n**	**cores**	**chunks**	**tools**	**blanks**
10- chert	123	4	17	11	80	7	135	13	17	2	83
7- black flint	117		7	6	77	10	131		16	3	90
11- quartzite	55	1	3	3	44	11	106	4	3	2	95
14- quartz	17		5		12	4	38		2	2	32
4 - phtanite	17		3		10	14	24		5		15
12 - sandstone	12			2	8	12	3				3
2 - Spiennes	1				1	8	2				2
TOTAL	**342**	**5**	**35**	**22**	**232**	**TOTAL**	**439**	**17**	**43**	**9**	**320**

Table 10.14. Le Trou Magrite. Strata 3 and 2. Assemblage structure for Rank 3 and 4 raw materials.

In Stratum 3, the majority of the tools are made on flakes, with a few pieces made on small debris and chunks, and two blades. On chert, 8 of the 11 tools have low shaping intensity (that is, edge retouch with little alteration of the blank perimeter) and include notches, denticulates, and pieces with one continuously retouched edge. The other three tools are an endscraper on flake, an atypical carinated endscraper and an angle on break burin. Black flint (Type 7) shows the same pattern: 5 of 6 tools have low shaping intensity, with a single multiple dihedral burin on a blade. Quartzite (Type 11) includes a double endscraper, a flat-nosed, shouldered endscraper and a piece with one continuously retouched edge, all on flakes. Sandstone (Type 12) includes an endscraper on a retouched flake and a denticulate, both flakes. Cores are rare, but there are several chunks which could have been discarded core fragments.

In Stratum 2, tools are much less common, although there are more cores and more blanks were produced and/or transported. All tools were made on flakes, except for two chunks. Tools again appear to have low shaping intensity, and include notches, denticulates and continuously retouched pieces on one or two edges. There are two endscrapers.

In both strata, most of the blanks are flakes (Stratum 3: n=221; Stratum 2: n=266), with an increase in blades in Stratum 2 (n=53 versus 22). Crested blades and bladelets are rare.

The size distribution of blanks and tools, using length as an estimate (Table 10.15), shows that most artifacts fall within a 21-40 mm range, with a few larger pieces. In both strata, roughly half of the measured artifacts are whole, including the larger artifacts which are rare and maximally 61-80 mm long. This, along with the relative lack of cores, suggests that at least some of the blanks, the larger ones, were transported to the site.

	Stratum 3		**Stratum 2**	
Length	n	n whole	n	n whole
0-20	37	12	31	8
21-30	36	17	23	8
31-40	21	15	19	15
41-50	5	4	9	6
51-60	1	1	2	0
61-70	4	4	5	4
71-80			1	1
TOTAL	**104**	**53**	**89**	**41**

Table 10.15. Le Trou Magrite. Size distribution of Ranks 3 and 4 materials for Strata 3 and 2.

In general, the overall pattern for Rank 3 and 4 materials, in both strata, suggests the limited use of local material and transported flint, with only Rank 4 materials being transported only as blanks and rare tools.

Ranks 1 and 2

The following sections discuss in more detail patterns of reductions for Ranks 1 and 2.

What blanks were produced?

For Stratum 3, Table 10.16 summarizes the kinds of blanks produced for each material type, removals which could have potentially been retouched into tools. Flakes are overwhelmingly dominant for all materials, with blades slightly more common on the two types of flint (Hesbaye and black).

There are two factors limiting blade production for both strata. First, the poorer quality of materials (limestone, chert, quartzite) made it difficult to control fractures and to prepare cores for blade removals. Second, the small, nearly exhausted state of the available flint cores, made it difficult to produce blades, although bladelets were still possible, perhaps reflecting maximization of small flint cores.

Material	Total n (blank pool)	flakes		blades		bladelets*	
		n	%**	n	%	n	%
13 - limestone	1100	999	90.8	87	7.9	14	1.3
3 - Hesbaye flint	418	332	79.4	38	9.1	48	11.5
10-chert	87	78	89.6	7	8.0	2	2.3
7 - black flints	83	72	86.8	9	10.8	2	2.4
11 - quartzites	47	44	93.6	3	6.4	-	-

Table 10.16. Le Trou Magrite. Stratum 3. Blank production by material type.
*This category includes small flakes and blades >10 mm long, and bladelets, although for Stratum 3, only bladelets are present. It does not include trimming flakes and shatter.
**Percent of blank pool, not of assemblage of each material type.

For Stratum 2, Table 10.17 shows the kinds of blanks produced for each material type. As in Stratum 3, a low number of retouched tools were actually made (see next section), again possibly due to small size of the potential blanks or because they were used unretouched. Flakes are still dominant for all materials, but there is an overall increase in blades produced on all materials except black flint (6-11% in Stratum 3 versus 11-22% in Stratum 2). More bladelets were produced, but remain in percentages similar to Stratum 3, the increase in quantity paralleling the overall increase.

Blade production is still low, compared to other Aurignacian assemblages (see Straus and Otte 1996), but has substantially increased from Stratum 3. The same factors are present to limit blade production - poorer quality of materials and small size of flint cores - but to a lesser degree. Limestone blades increase from 7.9% of the blank pool to 14.9%. Quartzites and cherts show the same increase: 6.4% to 22.7% for quartzites and 8.0% to 17.8% for cherts. Such increase in quantities of blades produced on relatively poorer quality materials may indicate improvement in blade producing techniques. Interestingly, blades do *not* increase substantially for flints (9.1% in Stratum 3 to 11.2% in Stratum 2, for Hesbaye flints). The second factor - small size of flint cores - appears to continue to limit blade production although the increase in number of cores increases the raw counts of blades (so that there is no substantial increase in percentage of flint blades).

Material	Total n (blank pool)	flakes		blades		bladelets	
		n	%*	n	%	n	%
3 - Hesbaye flint	1397	1128	80.7	156	11.2	113	8.1
13 - limestone	1418	1180	83.2	211	14.9	27	1.9
7 - black flints	86	79	91.9	5	5.8	2	2.3
10-chert	90	72	80.0	16	17.8	2	2.2
11 - quartzites	97	75	77.3	22	22.7	0	0

*Percent of blank pool, not of assemblage of each material type.
Table 10.17. Le Trou Magrite. Stratum 2. Blank production by material type.

What blanks were selected for retouch into tools?

The following table (Table 10.18) shows the number of tools made on the different kinds of blanks for strata 3 and 2. With flake production dominant in all materials, it is not surprising that most of the tools were made on flakes. However, there is a clear increase in the number of blades used for tools in Stratum 2, particularly for Hesbaye flint, where almost a third of the tools made on this material are made on blades.

Material	**n tools**	**flakes**	**blades**	**bladelets**	**chunks**	**PRF**
Stratum 3						
13 - limestone	37	33	3			1
3 - Hesbaye flint	45	33	5		6	1
10-chert	11	8	1		2	
7 - black flints	6	4	2			
11 - quartzites	3	3				
Stratum 2						
3 - Hesbaye flint	76	50	20	1	4	1
13 - limestone	24	20	4			
7 - black flints	2	2				
10-chert	3	2			1	
11 - quartzites	2	2				

Table 10.18. Le Trou Magrite. Aurignacian. Blank selection for tool production.

What is the intensity of blank selection?

The intensity of blank selection refers to the ratio between tools and unused blanks. For all materials, the ratio of tools to available blanks is extremely low. As discussed above in the context of flake versus blade production, there are several factors affecting the suitability of blanks for formal tool production. As the small size of flint cores limited blade production, it would also affect the ability to control fractures to obtain flakes or blanks of acceptable shape for tool production. In this way, only blanks of appropriate shape were retouched into identifiable tools. The small size of flint blanks produced may also have necessitated their use unretouched, for usability: instead of shaping them into a tool that was too small to handle.

It should be noted that more retouched tools were made on Hesbaye flint than on black limestone in either stratum although limestone removals were almost three times more common in stratum 3 and flint and limestone removals were similar in Stratum 2 (Table 10.19). Given the relatively softer quality of limestone and its abundance, it is possible that many of the blanks produced were used unretouched, discarded when dulled or retouched for resharpening, which would account for the number of continuously retouched pieces and denticulates found. Blanks here refers to deliberately flaked flakes and blades and excludes reduction debris and trimming flakes. Of the 1066 unretouched blanks in Stratum 3 and 1394 in Stratum 2, many may have been utilized, but, unfortunately, use-wear analysis is impossible, given the physical properties of limestone.

Larger retouched tools that were made could have been curated for use on the way back to regions with flint, traveling north across the flint-free Condroz Plateau or west toward the Hainaut Valley.

Type	n tools	n unused blanks	tools + blanks*	tool/blank ratio	% tools
Stratum 3					
13 - limestone	37	1066	1103	.03:1	3.35
3 - Hesbaye	45	382	427	.12:1	10.5
10 - cherts	11	80	91	.14:1	12.1
7 - black	6	77	83	.08:1	7.2
11 -quartzites	3	44	47	.07:1	6.4
14 - quartz	0	12	12	0:1	0
4 - phtanite	0	10	10	0:1	0
12 - sandstone	2	8	10	.25:1	20.0
2 - Spiennes	0	1	1	0:1	0
Stratum 2					
3 - Hesbaye	76	1331	1407	.06:1	5.4
13 - limestone	24	1394	1418	.02:1	1.7
7 - black	2	83	85	.02:1	2.4
10 - cherts	3	90	93	.03:1	3.2
11 -quartzites	2	95	97	.02:1	2.1
4 - phtanite	2	32	34	.06:1	5.9
14 - quartz	0	15	15	0:1	0
12 - sandstone	0	3	3	0:1	0
8 - gray flints	0	2	2	0:1	0

*Numbers vary from table calculating blank pool because some tools were made on chunks and other pieces.

Table 10.19. Le Trou Magrite. Strata 3 and 2. Intensity of blank selection for tool production.

EVALUATION OF LITHIC ECONOMY WITH RESPECT TO RAW MATERIAL CONTEXT

The ranking of materials reflects distance in space and time (recent past of the group occupying Trou Magrite). The "oldest" materials, the ones which they had transported the longest and furthest, have been completely exploited and all that remains are a few curated tools and blanks which are finally discarded. These are the Rank 4 materials: phtanite, sandstone and Spiennes flint. Quartz is also in Rank 4, but reflects an attempt to exploit local material without much success.

The next "oldest" transported material is black flint, included in Rank 3, which would have been procured more recently than Rank 4 materials, but still far enough in the past so that most of the active reduction and use of the material had occurred at previous sites. At Trou Magrite, black flint is almost exhausted, and the last session(s) of core reduction occur and the material is finished. Chert and quartzite, also in Rank 3, show the same pattern of minor reduction activity, but reflect only a slightly more successful attempt to exploit local materials other than limestone. A few (14) tools were produced from this reduction. Given the low shaping intensity of the tools and the availability of local sources for most of the Rank 3 materials, it is more likely that these reflect half-hearted attempts to exploit local materials in the absence of flint.

The most recently exploited flint source, in both strata, is Hesbaye flint. This material is Rank 2 in Stratum 3, Rank 1 in Stratum 2, based on the more significant quantity present in the latter. It would have been procured prior to human arrival at Trou Magrite, during occupation of a site closer to the Hesbaye Plateau with regular access to the flint sources there. It had been actively used and had probably been the Rank 1 material at the site occupied by the group before they reached Le Trou Magrite. At Trou Magrite, the supply was diminished, and more intense reduction activity occurred to maximize the remaining supply because there are no flint sources available to replace this source. The Hesbaye source(s) are here too distant to make special trips to obtain more flint. It is likely as well that subsistence resources were found in a range around le Trou Magrite that included the river valley and plateau, but did not extend as far as the Hesbaye Plateau, particularly in winter. When the Hesbaye flint was exhausted, the local black limestone had to replace it.

The dominant material in Stratum 3 is local black limestone. In other raw material contexts where flint sources were non-local, but not too distant, black limestone might have been rejected. At Trou Magrite, however, the distance to the nearest flint source is exerting strong pressure on the lithic economy and the transported flint supply is already greatly diminished in contrast to a slightly larger supply in Stratum 2. Quality has been compromised to benefit from low procurement costs. It is adequate for tasks occurring at the site, but not for transport elsewhere.

A recent synthesis on Neandertal acculturation (d'Errico *et al.* 1998) comments on the nature of the assemblages excavated by Otte and Straus. Regarding an ivory ring found at Trou Magrite, they note, concerning Stratum 3: "The layer in question was excavated recently (Otte and Straus 1995). Its radiocarbon dating indicated an age of ca. 40 kyr BP but it yielded a non-diagnostic lithic assemblage hardly classifiable as Aurignacian, dominated by Mousterian elements and corresponding, in all likelihood, to an OIS 3 mixed context identical to that from Spy." I would argue (see also Straus 1999) that the Mousterian-like character of the lithic assemblage in general is due to differential use of non-local and local materials and the lack of good quality raw material. There is a clear differentiation in tool types made on local, poorer quality, limestone and non-local, good quality, flint.

Limestone is dominant in Stratum 3, and on this material, 21 of 37 tools are Mousterian types (14 notches, 5 denticulates, 2 sidescrapers). However, the non-local Hesbaye flint yielded 45 tools, the majority of which are clear "Aurignacian" types (only eight are Mousterian types [6 notches, 1 denticulate, and 1 sidescraper]).

The "Mousterianization" is actually a technical response to a raw material context lacking good quality material. On the transported, good quality flint, Aurignacian tool types dominate. Straus (pers. comm.) commented that we may in general have been too pessimistic about mixture of industries in assemblages resulting from 19th century excavations: a significant proportion of tools in the Ardennes Aurignacian may have actually been what we would typologically identify as "Mousterian".

Based on the stratigraphy, there is no directly underlying Mousterian; rather, there is large boulder roof-fall separating Stratum 3 from Stratum 4. Thus, there is little chance of contamination from Mousterian Stratum 4.

Even in Stratum 2, dated to around 30,000 yrs BP, 13 of 24 limestone tools are typologically Mousterian. On flint, only 19 of 76 tools are Mousterian types (8 notches, 5 denticulates, and 6 sidescrapers). This is the same pattern as in Stratum 3, dated to 40,000 yrs BP.

In summary, then, I disagree with the comparison of Le Trou Magrite to the mixed assemblages at Spy, mixed in large part due to the quality of the 19th century excavations. At Le

Trou Magrite, the excavations were carefully controlled and assemblage variability can be explained in terms of responses to a raw material context which imposed constraints on the lithic economy.

PART B: STRATA 4 AND 5: MOUSTERIAN

Strata 4 and 5 of Le Trou Magrite yielded small Mousterian assemblages (Table 10.4). While the assemblages are not typologically diagnostic, analyses of assemblage and raw material structure and comparison with the Aurignacian levels permit one to address the possibility of changes in lithic economy through time in a stratified site, where distances to flint sources, regardless of climatic conditions or seasonal accessibility, remained constant. Part B presents the results of such analyses.

Stratum 4					**Stratum 5**				
	Count		**wt**			**Count**		**wt**	
Type	**n**	**%**	**wt in g**	**%**	**Type**	**n**	**%**	**wt in g**	**%**
1 - Obourg flint	0	0	0	0	1 - Obourg flint	0	0	0	0
2 - Spiennes flint	0	0	0	0	2 - Spiennes flint	0	0	0	0
3 - Hesbaye flint	28	18.5	37	3.4	3 - Hesbaye flint	16	14.0	57	4.7
4 - phtanite	1	0.7	1	0.09	4 - phtanite	1	0.9	70	5.8
5 - Wommersom	0	0	0	0	5 - Wommersom	0	0	0	0
6 - tan flints	0	0	0	0	6 - tan flints	0	0	0	0
7 - black flints	8	5.3	40	3.7	7 - black flints	10	8.8	53	4.4
8 - gray flints	1	0.7	6	0.56	8 - gray flints	0	0	0	0
9 - brown flint	0	0	0	0	9 - brown flint	0	0	0	0
10 - cherts	10	6.6	79	7.3	10 - cherts	22	19.3	185	15.4
11 - quartzites	4	2.6	38	3.5	11 - quartzites	1	0.9	17	1.4
12 - sandstone	1	0.7	28	2.6	12 - sandstone	3*	2.6	7	0.6
13 - black limestone	87	57.6	776	72.1	13 - black limestone	52	45.6	603	50.1
14 - quartz	10	6.6	71	6.6	14 - quartz	7	6.1	206	17.1
missing	1	0.7			missing	2	1.8		
Total	**151**	**100.0**	**1077 (n=108)**	**99.85**	**Total**	**114**	**100.0**	**1203 (n=93)**	**99.5**

*All three sandstone artifacts in Stratum 5 are fire-cracked rocks and are excluded from analysis.

Table 10.4. Frequencies by count and weight for Strata 4 and 5 (Mousterian levels).

RANKING OF MATERIALS BY FREQUENCY AND WEIGHT

In both strata (Tables 10.20 and 10.21), the top-ranked material by count and weight is black limestone. Hesbaye flint is ranked third by count in Stratum 5 and second in Stratum 2, but in both strata consists of very small, light pieces and is ranked sixth by weight (as opposed to second by weight in Strata 3 and 2). Certain material types present in Stratum 4 (sandstone and gray flints) are absent in Stratum 5.

Rank	Type	Count %		Rank	Type	Weight %
1	13 - limestone	45.6		1	13 - limestone	50.1
2	10 - cherts	19.3		2	14 - quartz	17.1
3	3 - Hesbaye flint	14.0		3	10 - cherts	15.4
4	7 - black flints	8.8		4	4 - phtanite	5.8
5	14 - quartz	6.1		5	3 - Hesbaye flint	4.7
6	11 - quartzites	0.9		6	7 - black flints	4.4
6	4 - phtanite	0.9		7	11 - quartzites	1.4

Table 10.20. Le Trou Magrite. Stratum 5. Ranking of material types by frequency and weight.

Rank	Type	Count %		Rank	Type	Weight %
1	13 - limestone	57.6		1	13 - limestone	72.1
2	3 - Hesbaye flint	18.5		2	10 - cherts	7.3
3	10 - cherts	6.6		3	14 - quartz	6.6
4	14 - quartz	6.6		4	7 - black flints	3.7
5	7 - black flints	4.3		5	11 - quartzites	3.5
6	11 - quartzites	2.6		6	3 - Hesbaye flint	3.4
7	4 - phtanite	0.7		7	12 - sandstone	2.6
8	8 - gray flints	0.7		8	8 - gray flints	0.56
9	12 - sandstone	0.7		9	4 - phtanite	0.09

Table 10.21. Le Trou Magrite. Stratum 4. Ranking of material types by frequency and weight.

The collapsed ranking results in three tiers for each stratum (Tables 10.22 and 10.23), with a similar order in both, with the exception of chert in Stratum 5, which shares Rank 2 with Hesbaye flint by count. By weight (4.7%), Hesbaye flint would actually be in Rank 3. Ranking by count will be used in lithic analyses to parallel the analyses done for the Aurignacian strata.

Rank	No(s).	Type(s)	Count %	Weight %
1	13	black limestone	45.6	50.1
2	10, 3	cherts, Hesbaye flint	14-19.3	4.7-15.4
3	7, 14, 11, 4	black flints, quartz, quartzites, phtanite	0.9-8.8	1.4-17.1

Table 10.22. Le Trou Magrite. Stratum 5. Collapsed ranking of material types.

Rank	No(s).	Type(s)	Count %	Weight %
1	13	black limestone	57.6	72.1
2	3	Hesbaye flint	18.5	3.4
3	10, 14, 7, 11, 4, 8, 12	cherts, quartz, black flints, quartzites, phtanite, gray flints, sandstone	0.7-6.6	0.09-7.3

Table 10.23. Le Trou Magrite. Stratum 4. Collapsed ranking of material types.

TRANSPORT OF MATERIAL

Debitage analysis was used to identify stages of the chaîne opératoire and infer transport form of material to the site.

Rank 1 material		
Type	**Assemblage structure**	**Brought to site as...**
13 - limestone	3 cores, 2 tools, 36 blanks, 11 debris (including 6 chunks*)	cores or small chunks
Rank 2 material		
Type	**Assemblage structure**	**Brought to site as...**
10 - cherts	14 blanks, 8 debris (including 5 chunks)	blanks
3 - Hesbaye flint	2 tools (on chunks), 11 blanks, 3 debris (all chunks)	exhausted cores (=chunks)
Rank 3 materials		
Type	**Assemblage structure**	**Brought to site as...**
7 - black flint	1 tool, 3 blanks, 6 debris (all chunks)	exhausted cores (=chunks)
14 - quartz	1 core, 1 blank, 5 debris (all chunks)	exhausted cores
11 - quartzites	1 tool	finished tool
4 - phtanite	1 core	exhausted core

* Chunks are probably core remnants.

Table 10.24. Le Trou Magrite. Stratum 5. Transport form of raw materials (plus general assemblage structure).

In Stratum 5 (Table 10.24), the dominant material is local black limestone, but, unlike Strata 3 and 2, is not present in very substantive quantity. There are only three identifiable cores, along with 6 chunks which could be core remnants. Reduction activity was minor, much more similar to that on Rank 3 materials in Strata 3 and 2. Rank 2 materials include cherts and Hesbaye flint. This is the *only* stratum in which the top two materials (limestone and chert) are both local and of poorer quality than flint. Both chert and Hesbaye flint have similar assemblage structure: blanks and chunks, while there are two tools in Hesbaye flint. Any reduction activity occurred elsewhere, although chert could have been reduced nearby. Rank 3 materials include black flint, quartz, quartzite, and phtanite, all represented by exhausted cores and a few blanks or tools.

In contrast to later assemblages, the overall pattern of raw material assemblage variability in Stratum 5 is one of little reduction activity and near-complete exhaustion of non-local materials. None of the materials show much evidence of reduction: there are few cores, and low frequencies of each material type. This appears to indicate a short-term occupation, where transported (non-local) materials were nearly exhausted and represented only by blanks and tools. Even Hesbaye flint falls in this category, although there are five chunks (two retouched as tools). Local material (limestone, chert, quartz) dominates, but was not used to a great extent, which again supports interpretation of a short-term occupation(s).

Rank 1 material		
Type	**Assemblage structure**	**Brought to site as...**
13 - limestone	1 core, 4 tools, 53 blanks, 29 debris (including 14 chunks)	core(s)
Rank 2 material		
Type	**Assemblage structure**	**Brought to site as...**
3 - Hesbaye flint	15 blanks, 13 debris (including 1 chunk)	exhausted core (if chunk is core remnant)
Rank 3 materials		
Type	**Assemblage structure**	**Brought to site as...**
10 - cherts	9 blanks, 1 tool	blanks and finished tool
14 - quartz	4 blanks, 6 debris (all chunks)	blanks
7 - black flint	4 blanks, 1 tool, 3 debris (all chunks)	blanks and finished tool
11 - quartzites	3 blanks	blanks
4 - phtanite	1 debris piece (shatter)	mixed? mis-identified?
8 - gray flints	1 tool	tool
12 - sandstone	1 tool	tool

* Chunks are probably core remnants.

Table 10.25. Le Trou Magrite. Stratum 4. Transport form of raw materials (plus general assemblage structure).

In Stratum 4 (Table 10.25), the dominant material is also local black limestone. There is only one identifiable core, along with 14 chunks which could be core remnants. As in Stratum 5, reduction activity was quite minor. Hesbaye flint is in Rank 2, and appears to have been transported as blanks and possibly an exhausted core. There is no reduction activity present (except for the presence of a PRF) and a very slight indication of resharpening (10 trimming flakes). Rank 3 materials include all other materials and are present as transported blanks and tools, even local chert and quartzites. It is possible that tools on local materials were made nearby and transported to the site for use. As in Stratum 5, the overall pattern of raw material assemblage variability in Stratum 4 is one of little reduction activity.

EVIDENCE FOR REDUCTION OF MATERIALS AT THE SITE

In both strata, the assemblage structure for each material varies with rank, with decreasing inclusivity of stages of the chaîne opératoire as rank decreases. However, unlike the Strata 3 and 2 assemblages, all materials show depletion in assemblage components, with only 1 core present. Rank 1 and 2 materials here are comparable to Ranks 3 and 4 in later assemblages. Reduction activity was slight.

What blanks were produced?

Tables 10.26 and 10.27 show the kinds of blanks produced on Rank 1 and 2 materials in Strata 5 and 4. Flakes are typical although there is a small series of blades in each stratum.

Material	Total n (blank pool)	flakes n	blades n	bladelets n
13 - limestone	38	34	4	0
10-chert	14	10	3	1
3 - Hesbaye flint	11	10	0	1

Table 10.26. Le Trou Magrite. Stratum 5. Blank production by material type.

Material	Total n (blank pool)	flakes n	blades n	bladelets n
13 - limestone	51	43	8	0
3 - Hesbaye flint	15	13	1	1
10-chert	10	7	3	0
7 - black flints	5	4	1	0

Table 10.27. Le Trou Magrite. Stratum 4. Blank production by material type.

What blanks were selected for retouch into tools?

Table 10.28 summarizes the breakdown of tools made on different kinds of blanks in the two strata. For Hesbaye flint, it is possible that only chunks were large enough to be suitable for tool retouch. This exhibits the maximization of a very scarce material by using exhausted cores as tools before discarding them.

Material	n tools	flakes	blades	chunks
Stratum 5				
13 - limestone	2	2		
10-chert	0			
3 - Hesbaye flint	2			2
7 - black flints	1		1	
14 - quartz	0			
11 - quartzite	1	1		
Stratum 4				
13 - limestone	4	3	1	
3 - Hesbaye flint	0			
10-chert	1		1	
7 - black flints	1		1	
8 - gray flint	1			1
12 - sandstone	1			1

Table 10.28. Le Trou Magrite. Blank selection for tool production.

EVALUATION OF LITHIC ECONOMY WITH RESPECT TO RAW MATERIAL CONTEXT

For both Strata 5 and 4, it appears that all non-local materials (Hesbaye flint, black flint, phtanite) were nearly exhausted when they arrived at Trou Magrite. Most were transported as blanks or finished tools. Reduction activity is minor for Ranks 1 and 2, similar to the Rank 3 pattern in the upper strata. This supports an inference of short-term occupation.

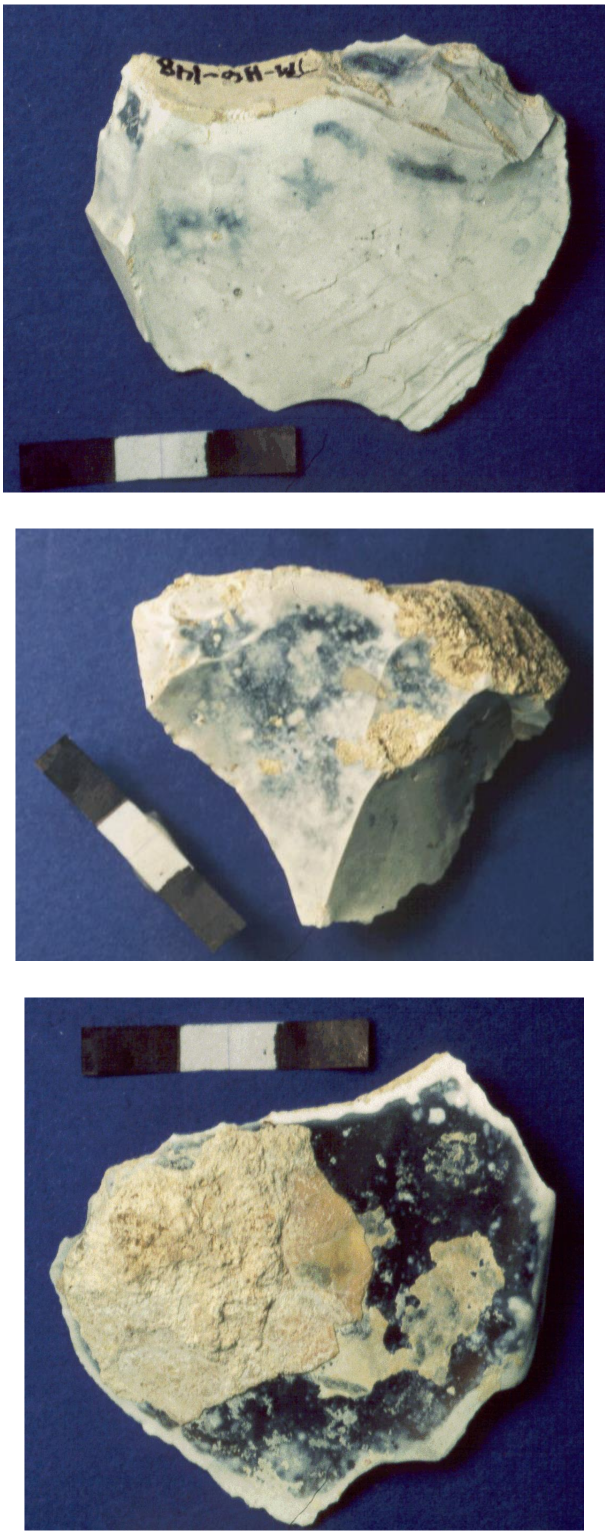


Figure 10.10. Le Trou Magrite. Non-local Hesbaye flint, showing different degrees of patination.

Figure 10.11. Le Trou Magrite. Local Viséen limestone.

CHAPTER 11
TROU DE L'ABÎME (COUVIN)

BACKGROUND

Location of site

The site of Trou de l'Abîme is located in the village of Couvin in southwest Belgium, on the right bank of the Eau Noire river (Figs. 11.1 and 11.2). It includes a large cave, which opens on the west face of the limestone cliff, and a terrace, which forms a large rockshelter 50 meters long and 5 meters deep (Cattelain *et al.* 1986:15).

Raw material context

There are no local flint sources in the region of Couvin. The nearest sources (Spiennes, Obourg) are 50-60 km to the north in the Hainaut Basin. Some 30 km south, in the Champagne region of France, silicified limestone, of similar quality to flint, can be found. Silicified limestone was exploited to some degree during the Magdalenian period in Belgium (e.g., particularly at Trou Da Somme, but also present at Bois Laiterie and Chaleux [Miller *et al.* 1998]) but is not yet known (or identified) in Early Upper Paleolithic sites. Unlike Trou Magrite, where local limestone was utilized, Couvinian limestone was not exploited at Trou de l'Abîme. Thus, all lithic material found at the site was imported. Depending on intended site function, the lack of local flint sources would impose severe constraints on the lithic economy as practiced at the site.

Excavation history

In 1888, the upper section of the cave was excavated by P. Gérard and then continued by Lohest and Braconnier (Lohest and Braconnier 1887-88). E. Maillieux conducted excavations in the same part of the site in 1902 (Maillieux 1903), but at the same time the site was prepared for touristic purposes. The lower cave appears to not have been excavated (Van den Broeck, Martel and Rahir 1910:341). It should be noted that the actual museum for the site is located within the cave (see Fig. 11.3).

In 1905, a series of sondages were excavated on the terrace by the Musées Royaux d'Art et d'Histoire (MRAH), by de Loë and Rahir in collaboration with Maillieux (de Loë 1906). One trench cut across earlier excavations (probably those of Lohest and Braconnier). Two trenches along the cliff face yielded mixed sediments containing medieval remains. A fourth trench near the cave was more fruitful with respect to the Paleolithic, yielding a stratum with worked flint and abundant fauna in addition to medieval and Roman levels.

In 1984-85, the Cercle Archéologique des Fagnes and the Université de Liège excavated a 2 by 3 meter sondage (Trench A) on the terrace near the 1905 excavation area, as well as two trenches (B and C) elsewhere on the terrace (Cattelain and Otte 1985, Cattelain *et al.* 1986, Ulrix-Closset *et al.* 1988) (Fig. 11.3).

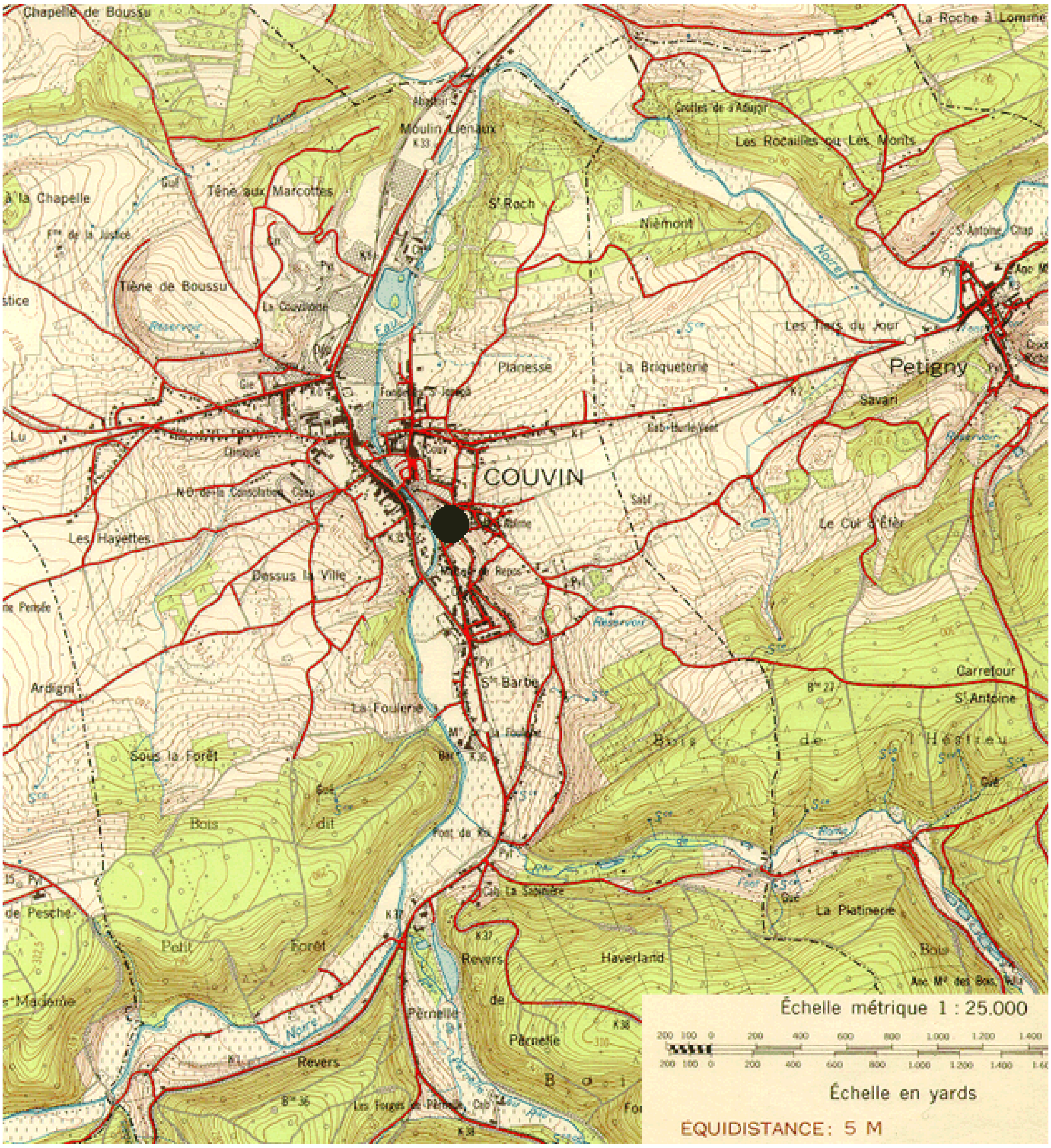


Figure 11.1. Couvin, Trou de l'Abîme. Location of site.
(after Institut Géographique National map 57/7-8, scale 1:25000)

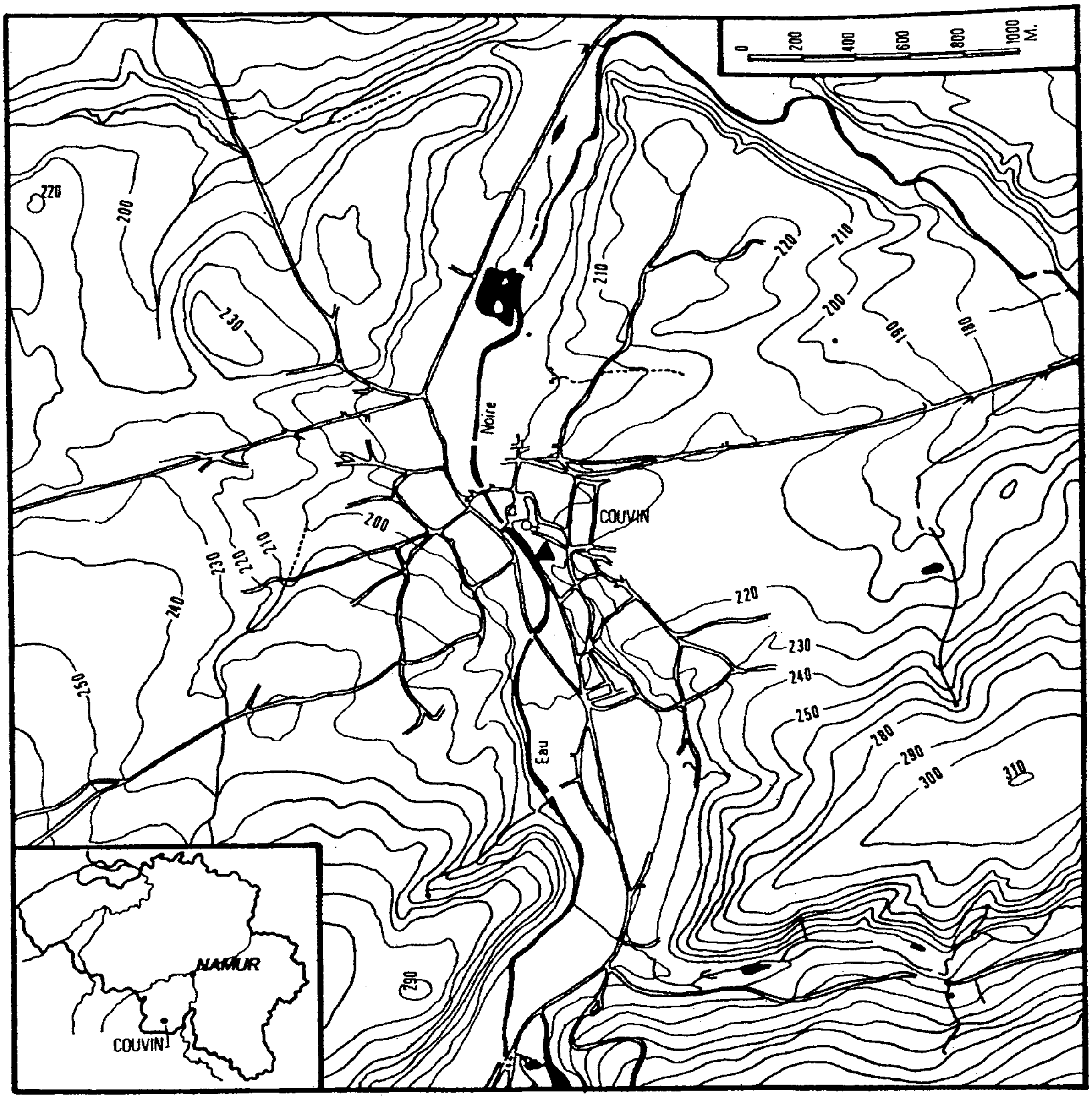


Figure 11.2. Couvin, Trou de l'Abîme. Location of site.
(after Cattelain and Otte 1985:124, Fig. 1)

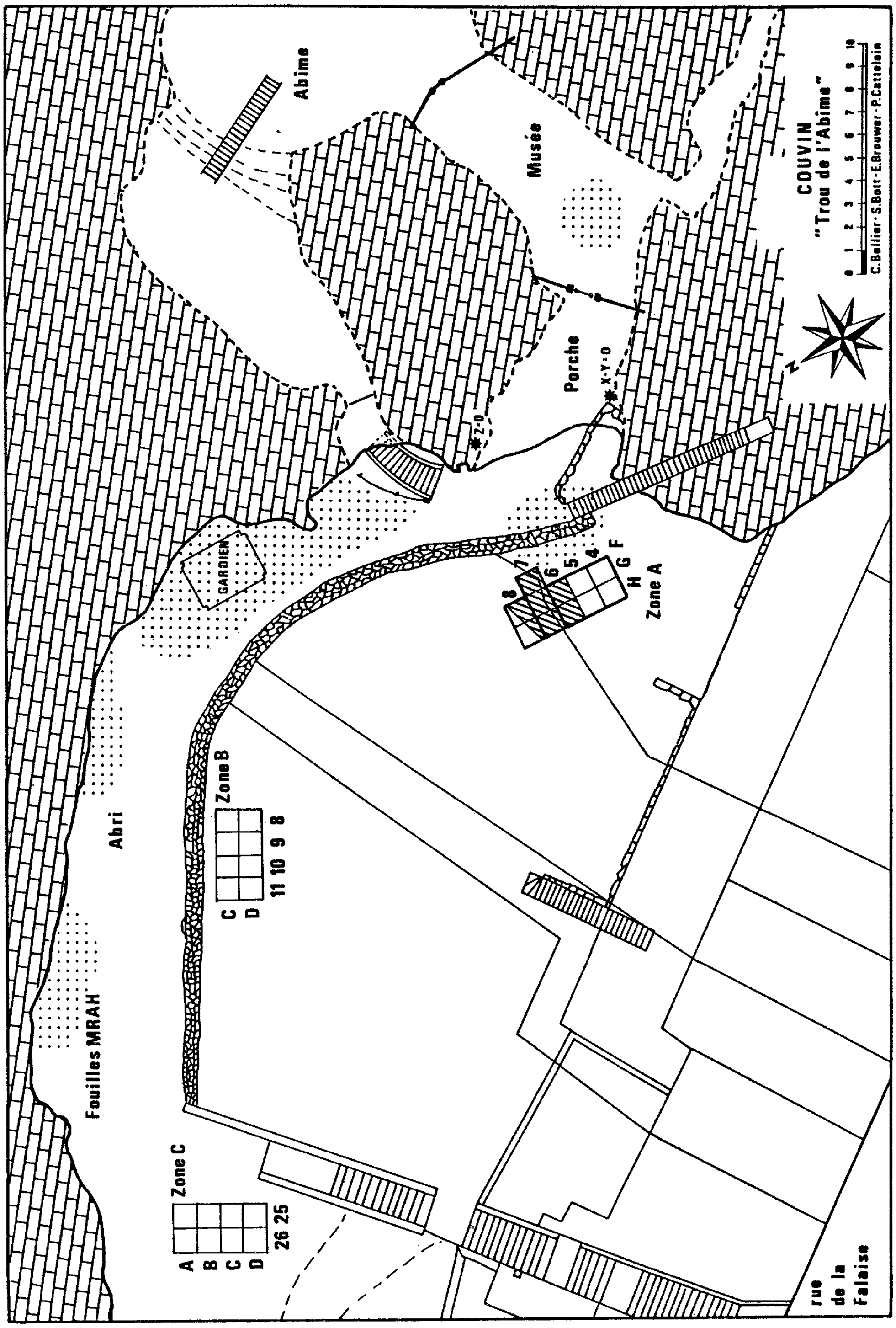


Figure 11.3. Couvin, Trou de l'Abîme. Plan of excavations.
(after Cattelain and Otte 1985:126, Fig. 2)

Stratigraphy

The 1905 MRAH excavation yielded the following stratigraphy; 1) "terrain remanié", a mixed layer coming in part from the cave, which included a medieval hearth at 80 cm below surface and a "Gallo-Roman" hearth at 2 meters below surface, mixed with worked flint, 2) pockets of intact sediment containing worked flint and abundant fauna, 3) a thick layer of large rockfall at 4 meters below surface (Cattelain *et al.* 1985:125).

The 1984-85 stratigraphy, summarized from Ulrix-Closset *et al.* (1988:227), is as follows, from top to bottom (Figs. 11.4 and 11.5):

VIII humus
VII gravel (floor of modern hen house)
VI medieval and modern backfill, brown to brown-black, heavily enriched by lime mortar, containing materials from the 14th to 20th centuries
V orange clayey silt, lacking blocks, sterile
IV orange clayey silt containing large éboulis with rare faunal remains
III very pure red clay, sterile
II yellow-green clayey silt, rich in lithic and faunal remains
Ia yellow clayey silt rich in calcite debris, sterile
Ib yellow clayey silt, sterile

The archaeological layer (II) appears to be in secondary position, possibly coming from the cave as a result of solifluction (Cattelain and Otte 1985:128).

Dating of the site

Two dates have been produced from bone samples coming from Stratum II, one from the 1905 MRAH excavation and the other from the modern excavations (Table 11.1). The dates are quite disparate, but the older date (Lv-1559) appears to be supported by the transitional nature of the technology and typology of the Stratum II assemblage, as well as by the discovery of a Neandertal deciduous tooth in the 1984-85 sondage. The younger date could result from museum curation conditions.

Lab no.	**Date**	**Sample**	**Excavation**	**References**
Lv-720	25,800 ± 770 BP	bone	MRAH, 1905	Gilot 1984:119
Lv-1559	46,820 ± 3,290 BP	bone	1984-85 sondage	Gilot 1984:119

Table 11.1. Dates obtained at Trou de l'Abîme.

Climate and environment

Microfaunal analysis by J.-M. Cordy supports the interpretation of a temperate climate, probably corresponding to an interstadial, in the lower part of Stratum II. The upper part of the stratum evidences a progressive cooling of the climate (Cattelain *et al.* 1986:17).

The large mammalian fauna (also analyzed by Cordy) include horse, cave bear, and a bovid. Butchery and cut marks are common. An analysis of such marks, as well as of the body parts represented, would be a useful study in order to clarify specific butchery and possible transport practices.

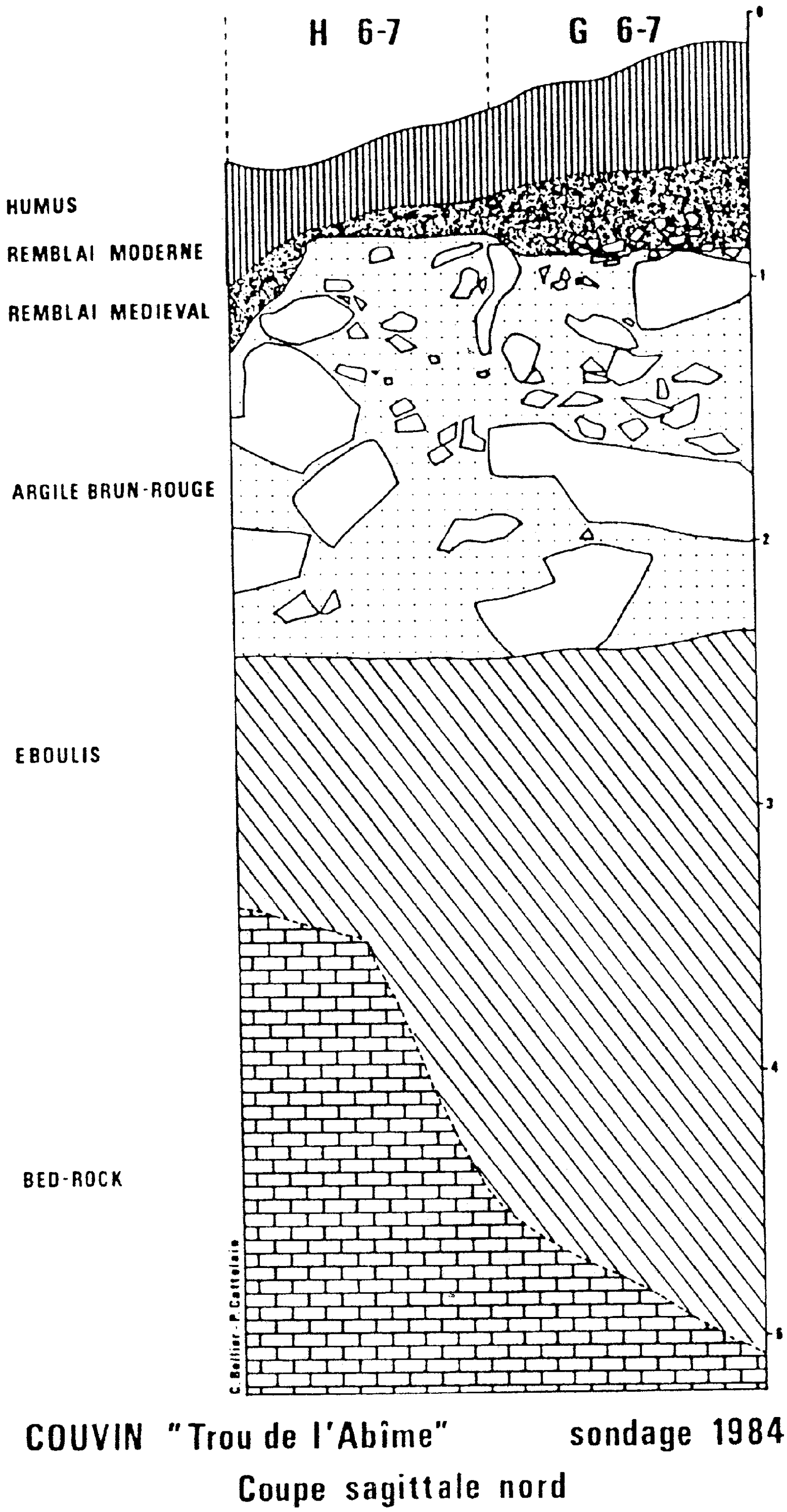


Figure 11.4. Couvin, Trou de l'Abîme. Stratigraphic sequence, north sagittal profile, G-H6-7. (after Cattelain and Otte 1985:127, Fig. 3)

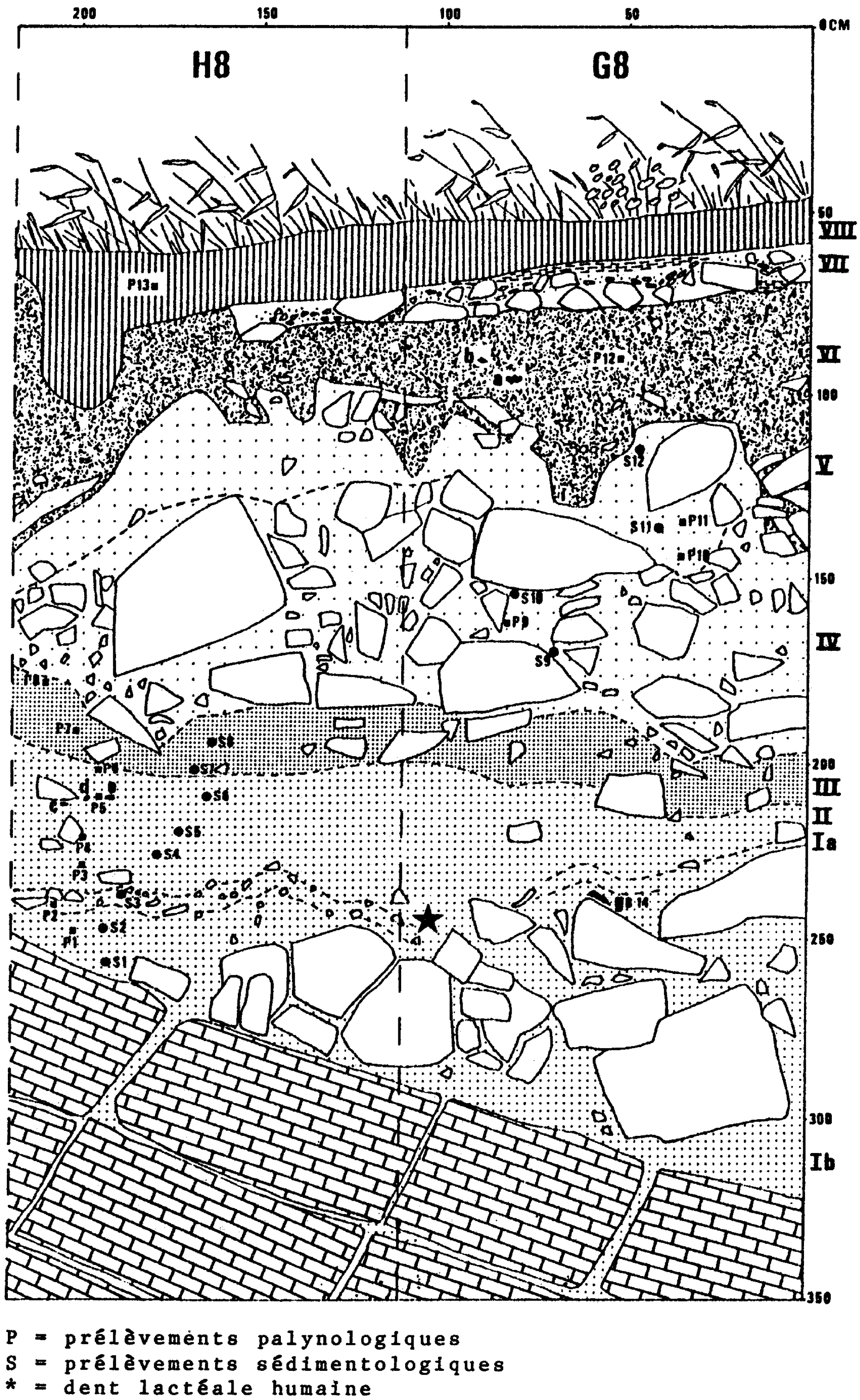


Figure 11.5. Couvin, Trou de l'Abîme. Stratigraphic sequence, G-H8.
(after Ulrix-Closset *et al.* 1988:235, Fig. 3)

Site occupation and function

Given the limited and as yet incomplete assemblage from the terrace (due to loss of part/most of the 1905 collection and the small area excavated in the 1984-85 sondage), any interpretations of duration of occupation and site function must be seen as provisional, particularly since the cave and rock shelter areas were probably also occupied.

However, an hypothesis can be put forward on the basis of assemblage structure, the nature of the toolkit, and the fauna recovered, at least for this section of the site. First, of the 538 artifacts (combining the two terrace-area collections), 263 – roughly half – are trimming flakes, and there are only three cores, all of which were retouched as tools. This would indicate that the sole technical activity at the site, in this area, was resharpening of already finished tools or shaping of transported blanks. Second, the presence of a substantial series of foliate points (n=11), more common here than at any other site in Belgium, could indicate that specialized activities occurred which required such a tool type. A specialized toolkit may have been transported to the site for a specific, anticipated, purpose. Third, on the large mammal fauna, butchery marks are common. One could thus interpret the site as a short-term hunting and butchery station, with little evidence of more long-term occupation. However, none of the materials recovered from within the cave, as opposed to the terrace, are available today and it is probable that the cave was used for shelter and possibly served as a more long-term camp.

Description of the assemblage and industry attribution

For the entire site, only two collections are today available: a small portion (n=45), mainly retouched pieces, from the 1905 MRAH excavation, and the material recovered from the 1984-85 sondage.

Technological analyses indicate the use of an advanced stage of the Levallois method (Cattelain *et al.* 1986:18). Both Levallois flakes and blades were produced. Unidirectional blades with the prismatic blade technique were also produced. The technology thus supports the interpretation of the industry as transitional (Cattelain *et al.* 1986:18-19).

Typological analyses indicate the use of flat, bifacial retouch to shape foliate points, which are common. Some of these pieces show affinities to the foliate points found in Mousterian contexts at Spy and the Grotte du Docteur (Ulrix-Closset 1975), while others are characteristics of those found at the beginning of the Early Upper Paleolithic at Spy and Goyet (Otte 1974, 1985). In addition, there is a blade with the base thinned using the “Kostienki technique” (inverse truncation used as a platform for longitudinal removals) (Cattelain *et al.* 1986:19).

Based on these analyses, which show elements belonging to both the Mousterian period and the Early Upper Paleolithic, Cattelain *et al.* (1986) conclude that an intermediary or transitional position between the two is indicated. If the >46,000 BP date is correct, this places Trou de l'Abîme in the early part of or just prior to the MP-UP transition in northwest Europe.

Assemblage samples and problems

A series of 45 artifacts at MRAH remaining from the 1905 collection and the 1984-85 collection conserved at the Musée du Malgré Tout in Treignes were available for study (Table 11.2). As discussed above, the limited size of the combined collection makes interpretation of analyses provisional. However, the rigorous excavation techniques for the 1984-85 sondage ensured that the maximum amount of archaeological material was recovered, along with detailed stratigraphic and spatial data.

	Count		Adjusted count	
Type	**n**	**%**	**adj n**	**%**
1 – gray flint	253	47.0	495	92.0
2 – brown/tan flint	10	1.9	19	3.6
3 – Spiennes flint	8	1.5	16	2.9
4 – quartzitic sandstone	3	0.6	6	1.1
5 – limestone	1	0.2	2	0.4
unidentified trimming flakes	263	48.9		
Total	**538**	**100.0**	**538**	**100.0**

*The 263 artifacts for which material is unidentified are all trimming flakes. It will be assumed that they reflect the proportions of the 5 different material types present. The formula (n non trimming flakes/total non trimming flake = x trimming flakes/total trimming flakes) was used to calculate the number of trimming flakes 'x') attributed to each material type. Therefore, adjusted count will be used.

Table 11.2. Frequencies of raw material types by count and weight.

RANKING OF MATERIALS BY FREQUENCY AND WEIGHT

Ranking changes slightly for count and weight, because artifacts in quartzitic sandstone and limestone are heavier than Spiennes flint artifacts, both due to the density of the material or the size of artifacts (Table 11.3).

Rank	Type	Count %		Rank	Type	Weight %
1	1 - gray flint	92.0		1	1 - gray flint	76.6
2	2 - brown/tan flint	3.6		2	2 – brown/tan flint	7.2
3	3 - Spiennes flint	2.9		3	4 – quartzitic sandstone	6.9
4	4 - quartzitic sandstone	1.1		4	5 - limestone	6.6
5	5 - limestone	0.4		5	3 - Spiennes flint	1.9

Table 11.3. Ranking of raw material types by count and weight.

The ranking can be collapsed into two ranks, which are more properly comparable to Ranks 2 and 3, or even simply Rank 3, in the other study sites (Table 11.4).

Rank	No(s).	Type(s)	Count %	Weight %
1	1	gray flint	92.0	76.6
2	2, 3, 4, 5	brown/tan flint, Spiennes flint, quartzitic sandstone, limestone	0.4-3.6	1.9-7.2

Table 11.4. Collapsed ranking of material types.

SOURCES OF MATERIAL UTILIZED

Rank 1

The source of the gray flints (Type 1) is unknown but all can probably be attributed to Spiennes sources, 50-60 km north.

Rank 2

Brown/tan flints (Type 2) can also probably be attributed to Spiennes, but the source is not clearly identified.

Type 3 is the only flint that can be definitively attributed to the Spiennes sources, based on its bluish-white patina which is common on both Spiennes and Hesbaye flints.

Quartzitic sandstone (Type 4) is probably local but source is unknown.

Limestone (Type 5) is abundant and local.

TRANSPORT OF MATERIAL

Cortex attributes and debitage analysis to identify stages of the chaîne opératoire were used to make inferences of transport form of material to the site (Table 11.5).

For Rank 1, there are three cores - all recycled as tools - and no chunks. Primary and secondary reduction stages are absent (i.e., there is no evidence of *in situ* blank production) and finished tools and/or blanks were transported to the site, where they were either initially shaped into tools or resharpened after use, given the proportion of trimming flakes present. Cortical pieces are also rare (7.3%), which is expected if tools or blanks were prepared prior to transport to the site.

Rank 2 materials were transported as finished tools and unretouched blanks as well, with no cores and no reduction debris.

Rank 1 material		
Type	**Assemblage structure**	**Brought to site as...**
1 – gray flint	56 tools, 38 blanks, 401 debris (primarily trimming flakes)	finished tools and blanks
Rank 2 material		
2 – brown/tan flint	2 tools, 8 blanks, 9 trimming flakes	finished tools and blanks
3 – Spiennes flint	1 tool, 7 blanks, 8 trimming flakes	finished tools and blanks
4 - quartzitic sandstone	1 tool, 2 blanks	finished tool and blanks
5 - limestone	1 tool	finished tool

Table 11.5. Transport form of raw materials and general assemblage structure.

Given the rarity of cortex on any of the material, an assessment of procurement context is not productive. The following table summarizes the scanty cortex information (Table 11.6).

		Cortex		Proportion		Primary Context		Secondary Context	
Rank	Type	n	%	n < 50%	n > 50%	n	%	n	%
1, 2	1-3 – flint	20	7.3	10		16		4	
2	4 – quartzitic sandstone	2	66.6	1	1			2	
2	5 – limestone	0							

Table 11.6. Cortex data.

EVIDENCE FOR REDUCTION OF MATERIALS AT THE SITE

At other sites, the assemblage structure for each material varied with rank, with decreasing inclusivity of stages of the chaîne opératoire as rank decreases. At Couvin, no reduction or blank production activity is evidenced; materials are present only as blanks or finished tools, comparable to Rank 3 and 4 materials at other sites. This pattern appears to be due to a difference in site function: where Trou Magrite was a more multifunctional, perhaps residential site, at least for Strata 2 and 3, where the frequencies of artifacts are much higher than in Strata 4 and 5. However, in all four strata at Trou Magrite, local limestone was exploited to produce blanks at the site while no blank production activity is evidenced at Trou de l'Abîme. Trou de l'Abîme was probably a logistical camp and only blanks or finished tools were transported for specific site activities (as at the Magdalenian site of Bois Laiterie [Otte and Straus 1997]).

The only technical lithic activity occurring at the site was retouching transported *flint* blanks into tools and/or resharpening tools after use. The few non-flint materials (in Rank 2) do not show evidence of retouch or resharpening. While the three cores were retouched as tools, their small size makes it unlikely that they were reduced at the site to produce blanks, but rather arrived at the site in the form of tools.

What blanks were selected for retouch into tools?

To obtain a clearer picture of the lithic industry, one can examine blank form for the tools transported to the site. The following table (Table 11.7) shows the number of tools made on the different kinds of blanks. Flakes are most common, but there is a clear laminar presence.

Material	**n tools**	**flakes**	**blades**	**crested blade**	**Levallois flake**	**bifacial thinning flake**	**cores**
1 – gray flint	56	30	14	1	1	7	3
2 – brown/tan flint	2	1			1		
3 – Spiennes flint	1				1		
4 – quartzitic sandstone	1	1					
5 – limestone	1		1				

Table 11.7. Blank selection for tool production by material type.

EVALUATION OF LITHIC ECONOMY WITH RESPECT TO RAW MATERIAL CONTEXT

At other sites, the ranking of materials reflects distance in space and time. The Rank 1 materials were procured to provision the site during occupation and all stages of reduction (except primary decortication) are present. Rank 2 materials are active toolkits, diminished in volume, which are further reduced and then discarded when the Rank 1 material replaces them. Rank 3 materials are the “oldest” materials, the ones which were transported the longest and furthest and all that remains are a few curated tools and blanks which are finally discarded. At Couvin, the assemblage structure shows that *all* of the materials are equivalent to Rank 3 materials elsewhere. Only tools and blanks are present. In contrast to the other study sites, however, these materials reflect a high degree of resharpening or tool shaping at Trou de l'Abîme. This would indicate a short-term occupation, because there is no evidence of an effort to provision the site for a longer occupation. Alternatively, if Couvin had been intended to be used as a residential site, all material would have had to be imported, from a minimum of 50 km.

However, it must be stated that the lower part of the cave was never excavated, the collection from the upper part of the cave lost, and substantial portions of the terrace remain to be excavated. The inclusion of such data might completely change the interpretation of this site.

CHAPTER 12. SPATIAL VARIABILITY
VARIABILITY IN STRATEGIES ACROSS SPACE

Technological and typological analyses of lithic assemblages *in relation to* lithic raw materials utilized show patterns both at site and regional scales of analysis. These analyses help to explain assemblage variability across space and permit the formulation of hypotheses concerning the organization of prehistoric lithic economy. The six study sites were vary in terms of their raw material context: local flint sources (Zone 1), non-local flint sources < 40 km distant (Zone 2), distant flint sources (Zone 3). Thus, each zone is represented by two sites. It should be noted that other contexts are possible: in regions other than Belgium, notably in Eastern Europe, truly long-distance transport (>120 km) of flint has been observed (Schild 1987; Féblot-Augustins 1998). The raw material context is based on the location of a site in relation to the geographic distribution of flint sources and the sources actually used at the site.

This chapter presents an hypothesis for the organization of lithic economy during the Early Upper Paleolithic in Belgium, based on the results of analysis of the six study sites. It attempts to explain variability in lithic assemblages across space as the result of the selection of different strategies for procurement, transport, reduction and use from a pool of known strategies that constituted the lithic economy.

In chapter 2, a basic model adapted from economic models (Vita-Finzi and Higgs 1970; Higgs and Vita-Finzi 1972; Sheridan and Bailey 1981) and optimal foraging models (Winterhalder and Smith 1981; Smith and Winterhalder 1992; Bettinger1980, 1991) suggested that the main factors affecting choices of strategies within a lithic economy were quality of material and distances to sources, the second of which combines availability, accessibility and abundance.

Of the two factors, material quality – both for applicability of reduction techniques and effectiveness in tool use – appears to have been of primary importance during the entire European Paleolithic in general, because flint was the preferred material in the vast majority of cases. The quartz-based Mesolithic industry at such sites as Vidigal in Portugal may be an exception, although in these cases, as at Trou Magrite, local flint is lacking and the use of quartz may have been a strategic response to the raw material context (Straus and Vierra 1989). Even in cases where flint is found only as small pebbles (e.g., the Pontinian in Italy [Kuhn 1995]), flint is still used and it is reduction techniques that are modified to the material. So, one reasonable assumption of the hypothesis presented here is that, in general, relatively better-quality material (i.e., flint) was preferred. The implication is that more effort will be expended to obtain flint, even when relatively poorer-quality material is available closer to the site.

At this point, the second factor – distance to flint sources – comes into play. Depending on the degree of mobility of prehistoric groups and duration of occupation, there is a theoretical distance limit beyond which flint procurement costs become too great for its regular use, and alternative materials, closer to the site, are sought in place of flint. In Belgium, this threshold exists at the boundary between Zones 2 and 3, at approximately 50 km between site and nearest source.

For the Early Upper Paleolithic in Belgium, distance to flint sources appears to have been a limiting factor for flint procurement and alternative strategies were employed as distance to sources increased. In Table 2-1, a non-exhaustive list of potential strategies for all stages within a lithic economy (procurement, transport, reduction, use) was presented. It is appropriate now to evaluate the study sites in terms of the evidence their assemblages show to support the possible use of different strategies.

In Zone 1, at the sites of Maisières-Canal and Huccorgne, flint sources are local. At both sites, strategy 1 (procure and use local material) was employed almost exclusively, with Rank 1 materials overwhelmingly dominant: at Maisières-Canal, Obourg flint = 91.8%, at Huccorgne, Hesbaye flint = 92.2% and 99.9%, in the Otte/Straus and Haesaerts collections respectively. At both sites, rare series of other, non-local, materials were also present, transported as prepared cores and finished tools. The extremely low frequencies (< 10%) of non-local materials transported to these sites, where flint is available locally, suggests that one of the purposes of site occupation was flint procurement, with foreknowledge that flint would be available; otherwise, a more substantial active tool kit would be expected to have been transported to these sites.

Both are also open-air sites, both show evidence of hunting and butchery activity and both are strategically placed (fords, river valleys) in areas through which migrating animals would have been likely to pass. A logical interpretation would be that strategy 4 (embedded procurement) would have been employed, to take advantage of the availability of both subsistence and lithic resources. If so, one can also assume that prepared cores, blanks and tools were exported from the sites, leaving behind unsuitable blanks and tools used during occupation.

Both sites are also Gravettian, dated to 24-28,000 BP, and up to now, no similar open-air Aurignacian sites have been found (apart from surface finds near Braine-le-Comte, some 20 km from the Obourg source [Fourny and Van Assche 1992] and Lommersum in the German Rhine valley [Hahn 1977, 1987, 1989]). In Belgium, flint was clearly procured from sources in the Hainaut Basin and on the Hesbaye Plateau during the Aurignacian, evidenced at the numerous Aurignacian sites in Zone 2. The cave site of the Grotte du Docteur, located in Zone 1 at local flint sources in the Méhaigne valley on the Hesbaye Plateau, contains an Aurignacian level (Otte 1979; Miller *et al.* 1998). It is probable that similar open-air Aurignacian sites have not yet been discovered, being deeply buried on the loess-covered plateaux (Maisières-Canal and Huccorgne were only discovered as a result of modern construction activity: a canal and a railway and road, respectively). It is, however, also possible that procurement strategies were different during the Aurignacian, with ephemeral camps that left little trace.

The majority of Belgian Early Upper Paleolithic sites are found in Zone 2: the study sites Spy and Goyet, as well as cave sites along the Meuse and its tributaries: Grotte du Prince, Grotte de la Princesse, Trou Al'Wesse, and Grotte Walou. This is due in part to systematic exploration and excavation of caves during the 19th century, but may also reflect the actual settlement distribution during the Early Upper Paleolithic, when caves would have been necessary for adequate shelter, especially during the colder seasons.

For the two study sites, Spy and Goyet, the nearest flint sources are at least 25 km distant, on the Hesbaye Plateau (east of Spy and north of Goyet). Interestingly, while Spy shows a relatively higher percentage of phtanite (25 km away) than at the other study sites, the Rank 1 material comes from Obourg, around 50 km distant. This might reflect a territorial range for occupants of Spy, that concentrated on the western part of Belgium. For both Spy and Goyet, local materials included chert and quartzite cobbles, available on the terraces of the Orneau and Samson rivers respectively, but these poor materials were only very rarely exploited.

The raw material structures of the Spy and Goyet assemblages differ from those that are observed at Maisières-Canal and Huccorgne. The Rank 1 materials, while dominant, are not overwhelming: 31% for Obourg flint at Spy, 67.5% for Hesbaye flint at Goyet. Referring to Table 2-1, this suggests the regular provisioning of the site during occupation, either via strategy 3 (logistical trips) or 4 (embedded procurement). Either strategy would have been possible, since flint sources are less than 40 km distant and the time and energy expense for logistical trips would not have been too great. However, considering that the flint sources are located on the Hesbaye and Brabant Plateaus, it is probable that lithic procurement was embedded in subsistence procurement activities. For Goyet, the nearest flint source was exploited. For Spy, Obourg flint was not the nearest, and is actually at the limits of Zone 2. It should be noted that closer sources (phtanite, gray flint possibly from the Hesbaye Plateau) were also exploited and the percentage of Rank 1 material is half that at Goyet. One interpretation is that the Spy occupants obtained Obourg flint in quantity, stocking up, as it were, just prior to occupation at Spy, and a range of closer sources, rather than a single source, were subsequently used.

The Rank 2 materials are better represented at Spy and Goyet than at Maisières-Canal and Huccorgne – present in greater quantity, with evidence of reduction activity at the sites. This suggests the use of strategy 2 (transport of material from a previous site), here a number of prepared cores already in active use, with both primary and secondary reduction occurring prior to further reduction at the study sites. This is suggested by their reduced size in comparison to Rank 1 cores, although their original size is not knowable.

It is likely, too, that Rank 2 materials included blanks and tools in active use. As will be suggested below, Rank 2 materials may represent an active tool kit, for use in day-to-day activities en route to an occupation of longer duration, as well as at a new site, until a new supply of flint could be obtained.

The relatively higher quantity of Rank 2 materials, in comparison to those at Zone 1 sites, suggests that the lack of strictly local flint sources in Zone 2 was known, just as their presence *was* known in Zone 1. The transport of an active tool kit, then, apart from meeting daily needs, can be seen to reflect a degree of planning and familiarity with the landscape and raw material context.

Rank 3 materials are present at Spy and Goyet in very low percentages and are represented only by blanks and finished tools (apart from a single jasper core at Spy). No reduction activity is evidenced: these blanks and tools were prepared and shaped prior to arrival at Spy or Goyet. There are several possible interpretations for Rank 3 materials, but it is not possible, with the data currently available, to support one or another of these interpretations. First, they could reflect the use of strategy 8 (increased intensity of tool use). Second, the supply of blanks could be an anticipatory strategy, along the lines of Rank 2 materials, to have suitable blanks on hand which could be shaped into appropriate tools as needed. Third, such tools, often whole, may have been curated tools, saved for specific needs or simply seen as valuable, much as an American archaeologist guards his/her personal Marshalltown trowel. Fourth, some of these artifacts could have been kept for non-functional reasons – aesthetic, symbolic, a reminder of certain flint sources, etc. – because of characteristics of the material or because of the technical skill invested in the tool. This last could be the case for the chalcedony and jasper at Spy, these being materials not found at other sites.

Briefly then, for Zone 2 sites, the two study sites seem to show the use of multiple strategies. The nearest flint source was exploited, rejecting local poorer quality materials, to provision the site during occupation. A more substantial active took kit was transported to the site, perhaps anticipating the lack of local flint sources. Finally, certain blanks and tools were curated long after the materials on which they were made had ceased to be reduced.

In Zone 3, with Le Trou Magrite as the main example, the structure of the assemblages shows some similarities with Zone 2 sites, but there are some significant differences. For the first time, material other than flint is Rank 1. Referring to Table 2-1, strategy 1 (procure and use local flint) was used, but at Le Trou Magrite substituting poorer quality black limestone for flint. It appears that the distance threshold for flint procurement had been passed and it was no longer cost-effective to obtain flint from non-local sources, either via logistical or embedded procurement. This suggests, in addition, that the catchment territory around a site was not greater than 50 km and was probably in fact even more restricted. This limit would affect lithic procurement decisions, evaluating the costs of obtaining distant flint versus the use of local, poorer-quality materials.

The Rank 2 material is non-local flint, at Le Trou Magrite it probably came from the Hesbaye Plateau in already greatly reduced form. Most flint artifacts are very small and the material reflects the use of strategy 5 (increased intensity of reduction). The number of trimming flakes (30.6% in Stratum 2 and 38.8% in Stratum 3) suggests the use of strategy 8 (increased intensity of tool use). Ranks 3 and 4 show limited attempts to use other local materials, such as chert and quartzite, as well as the transport of rare phtanite, Spiennes and gray flints. As in Zone 2, these latter non-local materials are represented by curated blanks and tools.

Briefly stated, the case of Le Trou Magrite attests the strategic responses to a raw material context which imposes limitations on choices. Since flint sources lie beyond the distance threshold, they cannot be exploited to provision the site. The remaining supply of flint, transported as an active, but diminished tool kit, is maximized via increased intensity of reduction, producing smaller blanks which were nevertheless used, as well as by means of increased intensity of tool use, substantial resharpening of tools which were transported and shaped at the site. Local limestone was exploited to provision the site, complementing the limited supply of flint.

To emphasize the point that raw material contexts are time- and space-dependent, in this same region, there is a series of Late Upper Paleolithic sites (Chaleux, Trou Abri, Trou Da Somme, Trou des Nutons, Trou du Frontal, Trou Reuviau). These sites were adequately supplied with flint, probably from the Hesbaye Plateau, with no use of local limestone. In some cases, notably Trou Da Somme, silicified limestone coming from the Champagne region, upstream on the Meuse, was also exploited. Such a pattern serves to demonstrate that changes in mobility patterns and procurement strategies made it possible to adequately provision sites in Zone 3 with flint, overcoming the limitations which were insurmountable during the Early Upper Paleolithic. Distance thresholds could thus change: during the Late Upper Paleolithic, procurement and transport strategies were adequate to provision Magdalenian sites in the Lesse Valley, permitting occupation in regions further from flint sources (e.g., Roc-la-Tour near Charleville-Mézières, Champagne region, France [Rozoy 1987]). Long-distance migrations, perhaps seasonal, were possible, and evidence from the Belgian Magdalenian (fossil shells from the Paris Basin found in several Belgian sites) supports the idea of either long-distance exchange or migration between the Paris Basin and Belgium.

Couvin, also in Zone 3, shows a completely different pattern and it is suggested that this is due to differences in site function. The assemblage is composed almost exclusively of non-local flint, probably from the Spiennes source. In contrast to the other study sites, core reduction activity is almost absent, with only a few cores present which were reshaped into tools. Almost half of the assemblage is composed of trimming flakes, supporting the use of strategy 8 (increased intensity of tool use). In comparison with the other study sites, *all* of the material at Couvin is comparable in structure to Rank 3 elsewhere. That is, Rank 3 materials elsewhere are typically represented only by transported blanks and tools, with little or no reduction activity, while Ranks 1 and 2 materials reflect regular reduction activity. At Couvin, it appears that only blanks and tools were transported to the site, with the only reduction activity being tool shaping or resharpening.

Based on these observations, an hypothesis can be put forward to explain variability in lithic assemblages across space and the organization of lithic economy during the Early Upper Paleolithic in Belgium. Strategies of lithic economy are based on an economic model which balances quality of materials against time and energy expenses for procurement. Two factors that could affect economic decisions- quality of material and distance to sources – are considered.

According to the hypothesis, the ranking of materials at each site reflects an ongoing process of attrition and replacement of different materials as groups move across space. Following a single material through time, a material would start its history as Rank 1 at Site A. It would then be transported as an active toolkit to Site B, where it might become Rank 2 (due to attrition, reduction activity, decreasing inclusivity), depending on distance and the nature of raw materials found locally at Site B. Finally, it would then be transported as curated blanks and tools to Site C, where it becomes Rank 3. Theoretically, if one could observe the exact series of sites occupied, one would be able to see a sort of relay effect (Fig. 12-1). At Site B, a new material becomes Rank 1, which is transported to Site C as the active toolkit, etc.

Rank 1:	dominant material, nearest flint source exploited, used to provision a residential site, major reduction activity evidenced
Rank 2:	present in much lower percentages, active toolkit transported from a previous occupation Depending on raw material context, either replaced with a new Rank 1 material or more intensely exploited before being discarded
Rank 3:	rare pieces, represented by curated/transported blanks and tools, no reduction activity evidenced

The assumption is that quality of material will take precedence over distance to sources, up to a certain distance threshold. This means that non-local flint should nearly always be selected over poorer quality cherts and quartzites that are found in the proximity of the site, *within certain distance limits*. Once a critical distance threshold has been crossed, time and energy expenses to procure flint from non-local sources become too great and alternative materials will be utilized instead. This can be seen clearly at Trou Magrite, for both Mousterian and Aurignacian assemblages.

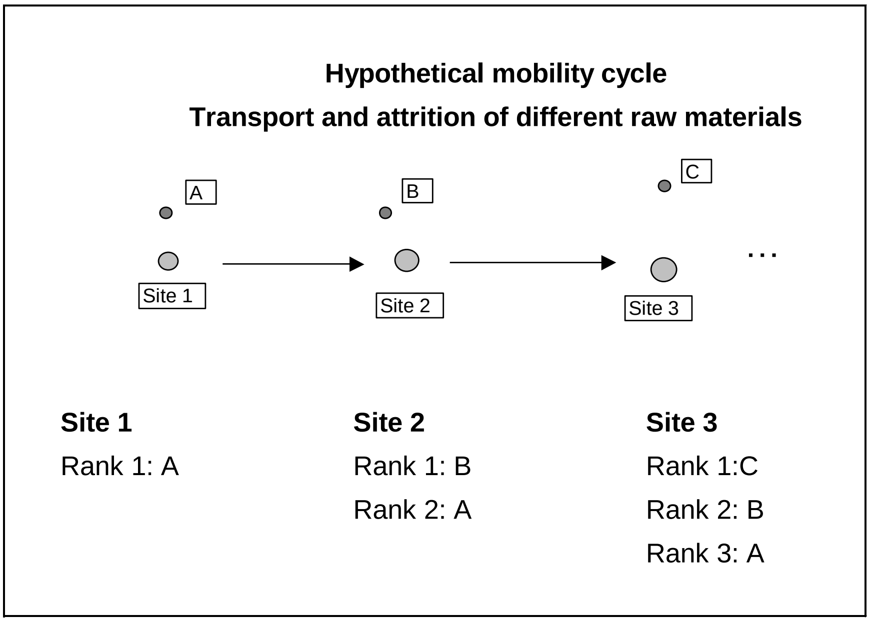


Figure 12.1. Hypothetical mobility cycle showing successive decrease in quantity and changes in reduction strategies as material is transported across space.

A corollary to the existence of a distance threshold is that it effectively corresponded to the mobility range of a group, the catchment area exploited around a site during occupation. The inverse is also true: if flint sources are beyond the distance threshold and thus out of range for procurement, Zone 3 becomes the most distant zone which can be occupied by prehistoric groups. Beyond this point, the lack of raw materials and the extreme distance from flint sources creates a second distance threshold, beyond which even a transported active tool kit would be too reduced to support an occupation. The Ardennes in southern Belgium and the Grand-Duchy of Luxembourg have yielded few Early Upper Paleolithic sites (five sites in Luxembourg, and Trou Magrite as the site the furthest south in Belgium). This southern region, in addition to lacking flint sources, also lacks caves suitable for human shelter and therefore poor preservation and/or visibility of possible open-air sites.

Interestingly, surface surveys in Luxembourg (Ziesaire 1994) have yielded numerous Mousterian finds, albeit not in stratified context. Patterns of raw material use differ radically between the Mousterian and Aurignacian in Luxembourg: Mousterian tools are commonly made on poorer quality quartzite and quartz cobbles and on Devonian quartizitic plaquettes, while from the Early Upper Paleolithic on, these materials were replaced with flint and *chaille*, a poorer quality chert (Ziesaire 1994:35-36). The implication is that the poorer-quality local material was adequate for the flake technology of the Mousterian, but better quality flint (and *chaille*) was necessary for Upper Paleolithic blade technology. Consequently, Mousterian groups were able to better exploit the region of Luxembourg, while Aurignacian groups preferred, perhaps for multiple reasons, to usually remain closer to flint sources (i.e., they were, technologically, tethered to flint sources).

The principal idea then is that prehistoric groups during the Early Upper Paleolithic in Belgium practiced a form of lithic economy that was 1) largely based on minimizing transport costs of raw material procurement and 2) in part anticipatory of a potential lack of raw material in the regions that were exploited by people. Two potential strategies can be envisioned:

> Strategy 1: Partial reduction or core preparation at flint sources with transport of prepared cores to relatively long-term (perhaps seasonal) occupation sites. Blank production and tool preparation occur at these sites. Blanks and tools may be exported to short-term sites for use in specific activities, where the only reduction activity necessary would be tool resharpening.

> Strategy 2: Specialized workshops where blank production is carried out, with export of blanks and tools to deliberately provision long-term sites. At such long-term sites, then, there would be a high percentage of blanks and tools and a lesser degree of core reduction evidenced. Workshop sites would consist of large quantities of debris, unsuitable blanks, and cores.

Considering the first point, that the main concern was to minimize transport costs of procurement, it can be seen that the dominant material at all of the study sites (in the three different raw material contexts) came from the nearest flint source, or was replaced by local non-flint materials when the distance threshold was passed. Flint was transported to the site in the form of prepared cores (Strategy 1), although when the source was close, sometimes with a fair amount of cortex remaining. It was reduced at the site to provide blanks for tool production and use during occupation. Flint appears to have been preferred over other materials, such as quartzite and limestone, that may have been locally available, but of relatively poorer quality. Such flint, however, was obtained from the *nearest* flint source, not necessarily the flint source of highest quality, and beyond certain distance limits, was replaced by local material.

There is *no* evidence for bulk transport of prepared blanks and/or tools to sites in regions lacking flint sources (Strategy 2), which would reflect reduction and/or tool production elsewhere (e.g., at specialized workshops at flint sources) with export of blanks and tools to residential sites. In contrast, the materials for which only blanks and tools exist (i.e., no reduction activity) have the lowest rank at each of the study sites; such materials are often represented by only a few pieces. If blanks and tools had been deliberately imported to provision a site, then these materials, evidencing no on-site reduction activity, should comprise a more significant percentage of the assemblage. There is, however, evidence for transport of tools to short-term logistical sites, such as temporary hunting camps. Sites such as Couvin were outfitted with the tools necessary to carry out the desired activities there and little reduction activity other than tool resharpening is observed.

However, Gravettian sites such as Maisières-Canal and Huccorgne, located at or near flint sources, appear to have served as flint workshops, with a great deal of reduction activity evidenced by numerous cores, debris, and abandonment of potential flake and blade blanks. The relatively low frequencies of tools at these sites can be attributed to short-term occupation of the sites (with tools used for domestic activities during occupation) and to probable export of prepared cores, blanks and tools elsewhere. While such flint workshops clearly existed during the Gravettian at least, they did not form a part of a *systematic* strategy to directly and regularly provision other sites. If such a strategy were in place, one would expect to see much higher frequencies of such materials in long-term sites far from the flint sources, in Ardennes cave sites. A more parsimonious interpretation of Maisières-Canal and Huccorgne is that they were perhaps seasonally occupied for flint procurement. Under this scenario, in each season, a replenished toolkit (including prepared cores) would be transported to a more long-term site. Huccorgne, based on lithic refitting of a core by Guilbaud and Martinez (1994), evidences *at least* two separate occupations over the course of a relatively short period. As at Huccorgne, the quantity of material at Maisières-Canal (approximately 30,000 lithic artifacts) supports the idea of multiple occupations over short periods. Such multiple occupations, on a scale of years or decades (even centuries) are not archaeologically identifiable either by identification of separate occupation layers or by absolute dating, because the time scale involved is too short. However, at Huccorgne, two occupations separated by around 2000 years (an occupation at 28-26,000 BP and another at around 24,000 BP) may be distinguished; these levels are apparent in Haesaerts' excavation. Each occupation may have been a series of short-term, seasonal occupations.

During the Magdalenian, a regional system encompassing flint procurement sites, residential sites and logistical sites is more clearly evidenced in the Lesse Valley and on the Hesbaye Plateau. The sites of Goyet (Stratum 2) and Chaleux appear to be residential sites, with the nearby sites of Trou des Nutons, Trou Magrite, Trou Abri, Trou du Frontal, Trou Da Somme, Bois Laiterie and Roc-la-Tour possibly serving as short-term logistical camps (see Otte and Straus (eds.) 1997, Otte (ed.) 1994, Rensink 1993, Charles 1994, 1998). Flint comes primarily from the Hesbaye Plateau and sites there, such as Orp and Kanne, may have served as specialized flint procurement sites with deliberate long-distance transport to provision the Lesse Valley. It should be noted that Trou Magrite is also found in the Lesse Valley, but the flint transported was replaced with local limestone, a strategy not employed here during the Magdalenian period.

The lithic economy appears to have been, at least in part, anticipatory of regions lacking flint sources. Rank 2 materials at a site could be interpreted as the remains of an active toolkit (cores in the process of being reduced, blanks, and tools) transported from a previous occupation. At sites such as Maisières-Canal and Huccorgne, Rank 2 materials are found in low quantities, while at Spy and Goyet, they are more substantially represented. As previously stated, such a pattern could reflect familiarity with the landscape, such that it was known that there would be flint at Zone 1 sites and none at Zone 2 sites. The transport of a larger active toolkit would have served to provision the site until new material was obtained. At a previous occupation, such Rank 2 material would have been the dominant (Rank 1) material. The active toolkit would have been transported to the current site partly in expectation of a lack of flint, but also simply because it was still "active", i.e., in daily use by the group. At the current site, depending on the raw material context, the active toolkit would either be replaced by the nearest flint source (if a flint source is found within a certain distance range) or be more intensively reduced and conserved (if flint sources are too distant to exploit).

Similarly, Rank 3 materials could represent the last vestiges of a once-active toolkit, now reduced (literally) to a few blanks and tools. These few remaining artifacts are those that have been with the group for the longest time, either as tools used until exhaustion or the last pieces of a stockpile. The material represented has successively gone through Ranks 1 and 2 at earlier occupations - dominant (Rank 1) near the source, then an active toolkit (Rank 2) at a subsequent occupation - and has arrived at Rank 3.

Such Rank 3 materials do *not* in any way reflect *direct* long-distance transport of particular objects, with the considerable time that would be invested in transporting the artifacts directly from a source to the site in which they are found. Time and energy expense has been minimized by curating blanks and tools, transporting them from one site to the next, until they are finally used. My argument is that people did not go from the site in question to a distant source specifically to bring back a few tools. A round-trip such as this would be much too costly in time and energy for the minimal numbers of tools present.

In general, then, the pattern of EUP lithic economy as represented by the study sites is one of attrition and replacement of materials as prehistoric groups moved across the landscape. When the raw material context is "favorable" (i.e., flint available within certain short distance limits, argued in Chapter 4 to be up to 50 km, Zones 1 and 2), the transported active toolkit is replaced by the new nearest flint source. When it is "unfavorable" (i.e., flint sources are greater than 50 km, Zone 3), the active toolkit is more intensely used to maximize the flint on hand. It follows from this point that there is a distance limit from flint sources beyond which groups did not travel (except for short-term camps for specific subsistence-related activities). If a group arrived in Zone 3 (as, for example, evidenced by Trou Magrite), the active toolkit is intensely used and replaced by poorer quality local materials. However, the poorer materials, while adequate for use at the site, are not adequate enough to serve as an active toolkit to transport to regions even more distant from flint sources.

CHAPTER 13
TEMPORAL VARIABILITY
CHANGE OR CONTINUITY IN STRATEGIES THROUGH TIME

During the Early Upper Paleolithic, although the number of sites studied in detail is small, it is possible to make some comments about changes in lithic economy through time. These include changes in reduction techniques, the development of new tool types, changes in procurement strategies, and possibly changes in mobility and settlement strategies. The following discussion should be taken as a provisional interpretation of change in lithic economy during the Early Upper Paleolithic, based on the sites studied. It can, however, serve as a framework for subsequent studies of lithic economy.

In the discussion of the MP-UP transition in chapter 3, I suggested that early modern humans migrating into Europe, even with new Aurignacian technology and new social behaviors, would have continually encountered unfamiliar environments. Upon arrival in each new region, there would have been a period of familiarization during which shelter, subsistence and raw material resources were located and their patterns of availability (particularly for subsistence resources) learned. This could account for the relative lack of change in hunting practices during the first part of the Early Upper Paleolithic. I suggest here that there would have been a continual process of change, from the MP-UP transition to the end of the Early Upper Paleolithic, as follows:

Mousterian	local development during the Middle Paleolithic
MP-UP transition:	following Mithen (1996) for a hypothetical cause of the changes observed during the Early Upper Paleolithic, cognitive fluidity was achieved in the minds of early modern humans
Early Aurignacian:	in a hypothesized core area, Aurignacian technology would be invented, with a period of experimentation before widespread adoption; once established in the core area (since the early Aurignacian across Europe appears to contain all of the basic components – reduction techniques, tool types, bone industry – as did the Neolithic), early modern humans began migrating across Europe, encountering unfamiliar landscapes. In each new region, there would have been a period of familiarization with the resources available.
Established Aurignacian:	Again in each region, once this familiarization process was complete, all aspects of the Aurignacian "culture" could be further developed and elaborated, with observable changes in lithic economy, settlement patterns, hunting strategies, etc.
Gravettian:	This process of development and elaboration, or continued innovation, would have led to the technological and typological changes that serve to distinguish the Aurignacian from the Gravettian.

The sites studied are here examined within this framework, to observe the process of change in the Early Upper Paleolithic of Belgium. The sites exemplify each of the above phases of change, but it should be clear that single sites cannot be used to extrapolate patterns of change for the entire region. The following discussion presents merely a possible interpretation, which can then be subject to further analysis.

Mousterian

The recently published analyses of the archaeological collections at the cave site of Sclayn (Otte *et al.* 1998) are useful for making provisional hypotheses concerning the nature of change in lithic economy at the MP-UP transition. There are two principal Mousterian archeological horizons: 1A is dated to about 40 thousand years BP (radiocarbon dates on bone collagen of >36.2 and 38.6±1.5 kya; uranium date on calcite of >36 kya; TL date on burnt flint of 44.0±5.5 kya); Stratum 5 is dated by TL to 130±20 kya. According to the latest chronostratigraphic hypothesis (Bonjean 1998), Stratum 5 was deposited during a cool episode within the Eem Interglacial (isotope stage 5c/b=Grande Pile pollen zone “St.Germain 1b”), which however would place this horizon at around 95 kya, which is in apparent contradiction with the TL date. Stratum 1A at Sclayn was formed during a major temperate episode near the end of isotope stage 3 (“Hengelo”) that was, nonetheless, colder than most of stage 5, with only modest reforestation (Haesaerts 1984).

Sclayn Level 5 – Mousterian		**% by count**	**% by weight**
Rank 1	Quartz	50.56	51.54
Rank 2	chert	27.51	13.72
	Maastrichtian flint	15.85	16.72
Rank 3	psammoquartzite	5.37	15.84
	Campanian flint	0.37	0.43
	limestone	0.30	1.42
	other flint	0.02	0.03
	Brussels sandstone	0.01	0.13
	phtanite	0.01	0.17

Table 13.1. Grotte Scladina, Stratum 5. Raw material ranking by count and weight (after Van der Sloot 1999:124)

Stratum Level 1A – Late Mousterian		**% by count**	**% by weight**
Rank 1	semi-local flint	70.18%	59.88%
Rang 2	quartz	11.59	10.97
	chert	8.87	8.19
Rang 3	sandstone	3.28	9.65
	non-local flint	2.81	3.06
	quartzite	3.21	8.17
	phtanite	0.06	0.08

Table 13.2. Grotte Scladina, Stratum 1A. Raw material ranking by count and weight (after Loodts 1999:84).

The two Mousterian assemblages at Sclayn (Loodts 1999; Van der Sloot 1999) show marked differences in their raw material structure (Tables 1 and 2) which suggest changes in quality requirement for lithic reduction from the Middle Mousterian (Level 5, 95-130,000 BP) to the Late Mousterian (Level 1A, c. 40,000 BP).

In Sclayn Level 5, non-flint materials dominate the assemblage (Table 1). The Rank 1 material is local quartz (51% by weight and count), followed by local chert (27.5% by count). Maastrichtian flint (from the Hesbaye Plateau), as Rank 2, accounts for only 16% of the assemblage. Of the range of Rank 3 materials, Campanian flint (from the western Hainaut basin) accounts for only 0.37%.

However, the majority of retouched tools – sidescrapers, denticulates, knives and others - were produced on Maastrichtian flint (112 of 163 tools; Van der Sloot 1999:124, Table 2) and only 14 tools on quartz. There are 47 cores and 1105 flakes on Maastrichtian flint, as compared to 191 cores and 338 flakes on quartz, which is represented mainly by chunks (*cassons*) (65.61%) and splinters (*esquilles*). This suggests first, that the better quality flint was maximized and used to produce formal tools and second, that quartz may have been subject to an expedient technology, producing flakes and chunks which had effective edges without retouch.

This pattern resembles that for Strata 5-3 at Le Trou Magrite, where, due to the great distance to the nearest flint sources, local limestone artifacts outnumber flint artifacts but more formal tools were made on flint. At Sclayn, where the nearest source of flint is between 20 and 40 km away, it appears that the distance threshold was much shorter. Quartz, like limestone, is extensively exploited, but the majority of formal tools are made on the existing supply of flint.

In Sclayn Level 1A, in contrast, flint becomes overwhelmingly dominant (Table 2). Semi-local flint, as Rank 1, accounts for 70.18% of the assemblage by frequency and 59.88% by weight. Non-flint raw materials, however, continue to be exploited, albeit in much lower percentages. This suggests a change in procurement strategy: instead of relying on local poorer-quality materials to supplement an existing supply of flint, flint was regularly procured from the nearest non-local flint source (on the Hesbaye Plateau) to meet the higher quality needs for tool production. In other words, the distance threshold was extended and the procurement of good quality flint outweighed procurement costs. This pattern, apart from the continued use of non-flint materials, much more closely resembles that observed at Early Upper Paleolithic sites (such as Spy and Goyet) in Zone 2.

MP-UP transition

The site of Couvin, dated to around 46,000 years, contains an industry that combines both Middle and Upper Paleolithic elements: flake and blade technology and the presence of a series of foliate points. The presence of a possible Neandertal deciduous tooth implies that this industry was made by Neandertals. The area excavated is limited, but appears to contain only blanks and finished tools, with nearly half of the assemblage consisting of trimming flakes. Thus, the only reduction activity in this area of the site was the shaping of blanks or resharpening of transported tools. This supports an interpretation of the site as a short-term, logistical camp (*sensu* Binford 1979) where blanks and/or finished tools were brought to the site for a specific purpose. The presence of a number of foliate points, probably special-purpose tools, adds to this view. Additionally, flint sources are absent in the Couvin region and the transport of tools suggests awareness of this lack. In sum, the pattern of transport form, reduction activity and tool structure shows planning in anticipation of both the lack of flint and of the intended activities.

Early Aurignacian

Le Trou Magrite, Stratum 3, if the date of 41 ± 1.7 thousand years BP is reliable, represents the earliest occurrence of the Aurignacian in Belgium. Limestone is dominant, by weight and count, over Hesbaye flint, which is present as very small artifacts. As an early Aurignacian site located in Zone 3, far from flint sources, this suggests a relative unfamiliarity with the region. Flint was transported, probably as an active toolkit en route, but was too diminished upon arrival to serve as an adequate supply for the site. Given the great distance to the nearest flint source, local limestone was thus exploited. Reduction strategies were modified to maximized flint: ordinary flake technology was used on limestone and prismatic blades and bladelets on Hesbaye flint.

Established Aurignacian

Stratum 2 at Le Trou Magrite, dated to 32/34-28,000 years BP, represents the established Aurignacian, being some 7,000 years younger than Stratum 3. During this occupation, Hesbaye flint is better represented, with more cores and chunks, blanks and tools. This suggests that a more substantial active flint toolkit was transported. Additionally, the existing flint tools were subject to increased intensity of use and re-use, evidenced by the much higher quantity of trimming flakes present. As in Stratum 3, limestone was again necessary to provision the site. However, the raw material structure suggests a greater familiarity with the region: an attempt to transport a more adequate flint supply although limestone was again needed.

The sites of Goyet and Spy, like the majority of Aurignacian sites in Belgium, are found in Zone 2. This concentration of cave (hence, shelter) sites along the Meuse river basin and its tributaries, could reflect an overall adaptation in settlement and mobility strategies, limiting “residential” occupations to the region where flint sources were within easy reach via regular, perhaps embedded, procurement trips. From such sites, short-term trips could be made for subsistence resources both on plateaus and in river valleys. The greater diversity in material types present in the Goyet and Spy collections is likely due, in part, to the palimpsest nature of the deposits, resulting from multiple occupations. However, flint from the nearest sources (Hesbaye flint for Goyet, Obourg and gray flint for Spy) dominates. The diversity of material types could indicate the suitability of Zone 2 sites for re-occupation, with the material types representing flint coming from different directions to the sites. In contrast to Le Trou Magrite, these Zone 2 Aurignacian sites suggest the establishment of a pattern of site distribution that permitted regular procurement of flint, as well as shelter and access to a range of subsistence resources on the plateaux and in valleys of Middle Belgium and the fringes of Upper Belgium.

Gravettian

The two Gravettian sites studied, Maisières-Canal (c. 28,000 years BP) and Huccorgne (28-26,000 and 24,000 years BP), are not representative of Gravettian sites in Belgium, which are mostly in caves, but represent rather the first known *in situ* open-air sites during the Early Upper Paleolithic. The Gravettian in general is less well-represented in Belgium than the Aurignacian. Apart from the two open-air sites studied, both found in Zone 1 contexts, all of the other sites (again excepting Le Trou Magrite) are found in Zone 2. This would appear to reflect a continuation of the same pattern of site distribution as during the Aurignacian, with the addition of a new strategy for flint procurement, namely open-air occupations located at or within a few kilometers of good-quality flint. Such sites would likely have had the purpose of obtaining both raw material and subsistence resources, with transport of material to “residential” sites. It should be noted that, at least in the Méhaigne Valley, cave sites (Grotte du Docteur, Abri Sandron, Grotte de l'Hermitage, etc.) were occupied during the Mousterian and Aurignacian periods but apparently not during the Gravettian, although the site of Huccorgne is adjacent.

Summary

The existence of similar ranking and similar assemblage structure corresponding both to the three raw material ranks in Sclayn Level 5 and Level 1A and to the EUP sites studied suggests continuity in patterns of procurement and transport across the MP-UP transition. In all cases, the top-ranked material comes from the nearest sources, whether it is the local quartz in Sclayn Level 5, local flint at Maisères-Canal and Huccorgne, the nearest non-local flint at Sclayn Level 1A, Spy and Goyet, or local limestone at Le Trou Magrite. Rank 2 materials were materials in active use by human groups prior to their occupation of each site and can be seen as active toolkits, containing cores, which were perhaps transported in anticipation of a lack of local flint at the sites occupied. Rank 3 materials are generally whole tools, often reflecting more elaboration, preparation and increased intensity of resharpening, and blanks, with no evidence of reduction activity at the sites studied. These are interpreted as long-curated tools, used over a period of time from site to site, much as archaeologists keep their personal Marshalltown trowels.

The principal difference lies in the range of raw materials used during the Middle and Late Mousterian and the EUP (comparing Sclayn Level 5 with Sclayn Level 1A and EUP sites). There is a clear shift from the exploitation of a range of non-flint materials (quartz, quartzite, chert, Brussels sandstone) to flint-dominance in the assemblages. In Sclayn Level 5, non-flint materials are dominant, quartz is Rank 1 and flint comprises only 15% of the assemblage, ranked third below chert and quartz. In Sclayn Level 1A, the range of lithic materials is much closer to that observed in EUP sites: flint comprises 70% of the assemblage and non-flint materials are poorly represented.

This suggests a change in quality requirements, where the quality of local non-flint materials was sufficient during the Middle Mousterian (at 100-130,000 BP) but not during the Late Mousterian and after. Beginning with the Late Mousterian and afterwards, the higher quality of non-local flint offset the increases in time and energy expenses to procure it.

The second observable change in procurement strategy in Belgium occurs with the appearance of the Gravettian. While the same sources appear to have been exploited during both the Aurignacian and Gravettian, extensive open-air sites, such as Maisières-Canal and Huccorgne, are found near flint sources, in Zone 1. At such sites, particularly Maisières-Canal, this suggests a more sustained effort to obtain greater quantities of flint for the cave sites. This may have been in response to deteriorating climate as the Last Glacial Maximum approached.

There thus appear to have been two phases of change, with a shift occurring during the Late Mousterian (c. 40,000 yrs ago) and another with the appearance of the Gravettian (c. 28-30,000 yrs ago). The first is a shift in quality requirements, where non-flint materials drop out of the range of suitable lithic materials. The second is a shift in lithic procurement, with the establishment of more extensive open-air sites at or very near sources of good quality flint.

In sum, the Belgian record suggests that some behavioral change with respect to the lithic economy occurred *during* the Middle Paleolithic while Neandertals were still the only hominids in Europe *and* that other changes occurred some 10,000 years after the so-called Middle to Upper Paleolithic transition, with no apparent relationship to a biological change among the hominids. Against the background of a fixed geography and lithology in the territory of Belgium, certain solutions to the lithic, subsistence and shelter problems of prehistoric foraging people obtained throughout the Pleistocene; selection of one or the other varied with time as the region was reoccupied, but only within narrow parameters. Proof of this is seen in the establishment of a pattern of Magdalenian sites c. 12.6 kya that was very reminiscent of the Gravettian pattern.

During the Belgian Magdalenian, more sites are found along the upstream Meuse and Lesse Valleys, in a region previously considered to be Zone 3, too distant from flint sources to be regularly provisioned with flint. In addition, there are clear open-air flint workshop sites (e.g., Orp and Kanne) on the plateaus. Such a change reflects a fundamental change in the way Magdalenian groups managed lithic resources, a fundamental change in lithic economy, probably related in large part to changes in mobility, that permitted Magdalenian groups to occupy a region largely empty (apart from Le Trou Magrite) before the Last Glacial Maximum. Other evidence suggests long-distance connections (seasonal migration, contact with other groups, exchange) with the Paris Basin and the German Rhineland, again indicating greater freedom of movement allowed by more effective management of lithic resources.

CHAPTER 14
CONCLUSIONS

Further research should focus on building a coherent picture of lithic economy across space. In this context, inter-regional comparisons should be done to identify the full range of variability in lithic economy in different raw material contexts during a temporally limited period. Focusing on the MP-UP transition and the origins and development of the Early Upper Paleolithic, it would be useful to examine regions where the Aurignacian first developed, most likely eastern Europe, and then trace the development of the Aurignacian as it expanded across continental Europe, thus both across space and through time. Clearly, reliable radiometric dates are required in order to have temporal control over the sequence of change in lithic economy.

The Aurignacian is often seen as a homogeneous industry across Europe and the Near East, based on the ubiquity of prismatic blade technology, the utilization of bone, antler and ivory as raw material for tools and decorative objects (beads, pendants, etc.), and the presence of certain "diagnostic" tool types (Mellars 1989a and b). However, while the industry seems to have spread quickly, it lasted about 10,000 years and change should be observable when examining its lithic economy through time. Several typological phases within the Aurignacian have been identified based on the appearance of different types of diagnostic tools (the early schema of Breuil, Peyrony, de Sonnevile-Bordes, and others, with more recent reinterpretation by Kozlowski 1983, Djindian 1985, among others). Such typological changes may be related to changes in human activities: the invention of new tool types to meet different needs. However, these phases also fit into a more general framework of change in lithic economy as a whole, including changes in procurement and reduction strategies. Interesting results should be obtained from comparisons between the earliest Aurignacian, representing a period of invention and experimentation with new reduction techniques and tool types and later developed or established Aurignacian in the same region (i.e., holding physical environment more or mess constant), representing a period of adoption of certain techniques and tool types. As Mithen suggests (1996), the onset of the Early Upper Paleolithic may correspond to a fundamental change in the organization of the human mind in comparison that of the Neanderthal mind, in terms of the "fluid integration" of formerly isolated modules in the mind devoted to social, technical, and natural history knowledge. This would be represented by the technical production of ornaments to convey social and/or religious information, and the specialization of tool types for specific activities as opposed to general, multi-purpose tools. If this is the case, then analysis of changes in lithic economy during the MP-UP transition and the Early Upper Paleolithic would help clarify this important development in the organization of the human mind by demonstrating how lithic economy is organized.

While technological and typological features contribute to the general impression of homogeneity during the Aurignacian, variability in raw material context contributes to variability in lithic economy at a regional scale. Hunter-gatherer groups, apart from possible long-distance migration and/or contact with groups in other regions, would have occupied the landscape at a regional scale, moving about the landscape within certain geographic limits. Thus, research designed to address human behavior should be conducted at the regional rather than at the continental scale, where variability is obscured in generalizations. Raw material context impacts questions of procurement and transport, choice of reduction techniques, degree of intensity of reduction, the kinds of tools produced on different materials, intensity of tool use, etc. The issues of 1) having sufficient quantities of material on hand and 2) having material of suitable quality for a) utilizing certain reduction techniques and b) producing effective tools were confronted by each prehistoric human group. It is the particular configuration of solutions, i.e., the particular form of lithic economy under different conditions, that is of interest.

APPENDIX 1. LITHIC RAW MATERIAL DATABASE

Appendix 1 contains a summary of data collected and described by me from lithic reference collections at Bonnefanten Museum (Maastricht) and Katholieke Universiteit (Leuven) and field survey to describe the range of potential raw materials available in the study region. This list is partial and does not include all of the raw materials encountered in archaeological assemblages.

HAINAUT REGION

Har-M *Middle Harmignies*
Craie d'Obourg (geological)

Homogeneous dark gray flint with large, irregular splotches which are lighter gray or outlined. Surface is matte and smooth to touch. Translucent on edges. Chalk cortex is thick but not banded.

Har-B *Upper Harmignies*
Silex de Spiennes (geological)

Medium to light gray, opaque, flint with many small inclusions - ovoid or round, lighter gray, spots - and fewer, but larger, irregular splotches. One sample (No. 13) has numerous tiny white flecks scattered uniformly on the surface. Chalk cortex but less thick than Har-M, with a grainier, washed/eroded aspect, possibly somewhat dissolved. Irregular surface at contact between flint and cortex, resulting in intrusive cortex.

Psp *Petit-Spiennes*
(archaeological)

Surface collection near mine.
Tan-gray flint with tiny white flecks, patinating white or bluish-white, sometimes with rust-colored veins in patina. Dark brown under chalk cortex.

Sp1 *Classical Spiennes*
(archaeological)

Material collected from extracted layer within classical (first discovered) system of mines at Spiennes. Also known as Camp-à-Cayaux.
Medium gray flint with small gray spots and splotches, becoming dark gray/black at contact with thick chalk cortex.

Sp2a *New Spiennes*
(archaeological)

Material collected from excavation dump of new system of flint mines and galleries at Spiennes, excavated in 1992 by Hubert.
Two groups distinguished in sample: 1) (nos. 14-17) banded flint, tan to brown, with wider light and narrower dark bands, banding not present throughout, 2) (nos. 18-21) brown flint patinated bluish-white or white. All pieces in sample have irregular splotches of coarser grain than the matrix.

Sp2b *Classical Spiennes*
(archaeological)

Material collected from new excavations of the classical system, but shallower (closer to surface) than classical system.
Brown flint with thick chalk cortex. One piece (no. 24) is banded similar to Sp2a, and has thin, travertine-like cortex.

Sp3 *Classical Spiennes*
(archaeological)

Surface material collected at classical mines.
Three groups distinguished: 1) (nos. 27-28) gray, matte, with large, irregular, splotches of coarser grain, 2) (nos. 29-31) dark brown to black, patinating white or gray with rust-colored veins/lines, 3) (nos. 32-33) dark brown, patinating white with rust-colored circles and veins, especially on ridges.

PLATEAU DE BRABANT

JJ *Jandrain-Jandrenouil (Orp-le-Grand)*
(archaeological)

Surface collection near mine.
Grades in color from gray to black, matte, opaque, with few large inclusions. One piece (no. 38) is banded with wide light and narrow dark bands; no. 41 is also banded, but in grays. Rust-colored veined patina present on no. 37. Irregular surface at contact between flint and chalk cortex. Three pieces are irregular nodules with thin, discolored cortex or cobble surface. Generally of poorer quality than other proveniences, but still useable.

MAASTRICHT REGION

Ba *Banholt (Mheer)*
(archaeological)

Surface collection from knapping floor.
Gray, banded brown or reddish-brown under cortex. Coarser-grained, circular inclusions. No. 111 has a large ringed oval, coarser in the middle with a light white ring.

Dom *Dommartin*
(archaeological)

Material collected from an LBK settlement site close to an extraction point.
Gray-brown or black, with many small inclusions - ovoid spots or irregular splotches. Thin chalk cortex over regular surface.

ENCI KVL 1
(geological)

From Level 1 of ENCI quarry, Lanaye chalks.
Thick chalk cortex, fossil inclusions (one long, narrow one). Very large lighter gray ovoid circles and small ovoid spots common.

ENCI KVL 2A
(geological)

From Level 2A of ENCI quarry, Lanaye chalks.
Black, opaque but translucent if thin. Thick chalk cortex. Very homogeneous. Similar to Obourg flint (Har-M) but with more inclusions and less glossy.

ENCI KVL 12A
(geological)

From Level 12A of ENCI quarry, Lanaye chalks.
Dark gray flint, banded in material but not under cortex, with thick chalk cortex.

ENCI Nekum
(geological)

From Nekum layer of ENCI quarry, Lanaye chalks.
Very homogeneous. Light gray with dark gray marbling and large ovoid spots and irregular splotches of coarser grain. Thin chalk cortex. Some pieces grade to brown.

Kee *Keerderbosch (Cadier en Keer)*
(archaeological)

Surface collection from knapping surface new mine, Margraten.
Brown-black flint, opaque, matte, banded. No. 78 has wide brown and narrow black bands. No. 84 has multi-colored bands (gray, dark gray, light gray, tan) from center to cortex. No. 83 is homogeneous light tan/yellow with tiny black flecks and cortex over irregular surface.

Kelmis B (Form U Aken)
(geological)

From Aken Formation, Aix-la-Chapelle.
Homogeneous light gray quartzite with coarse surface. Very thin chalk rind (<1 mm). No inclusions.

Lixhe (Gulpen)
(geological)

From Lixhe chalks, Gulpen.
Black, opaque, matte, with few inclusions which are medium-large irregular, coarser-grained, splotches. Thick chalk cortex over irregular surface.

MhH *Mheer Hoogbosch*
(archaeological)

Surface collection from knapping floor of extraction site near material source.
A few large, coarser-grained inclusions, small spots common, generally rough and of poorer quality but still useable.

NL2 *Valkenburg - Schaelsberg*
(archaeological?)

Numerous specks uniformly spread over surface, no inclusions.

Ru1[1] *Rullen Haut, Locality 1*
Ru1a *Rullen Haut, Locality 1a*
(archaeological)

Collected from Locality 1a in the Rullen site.
Variable. No. 91 is banded under cortex. No. 92 is reddish brown to tan with white specks and thick cortex. No. 93 is a uniform gray with small round specks and also has the dark band under the cortex. Nos. 95-96 both have dark red portions, somewhat banded.

Ru4 *Rullen Haut, Locality 4*
(archaeological)

Collected from Locality 4 in the Rullen site.
Banded dark and light gray under cortex. Light gray with small, darker gray, inclusions.

RyP *Ryckholt Plateau*
(archaeological)

Surface collections on the Ryckholt Plateau, near extraction points.
Diverse in color, grain, and kinds of inclusions. Most commonly gray to black with oval or round spots, sometimes with large, coarser-grained splotches, patinating bluish-white. Nos. 63-64 are coarser-grained clint, tan-beige, opaque, with no inclusions but densely flecked.
A large collection of cores has been collected from the fill of the Ryckholt mine, having been reduced on the surface near the mine entrance and then discarded within the mine. They are quite homogeneous, mottled dark and light gray, matte, opaque, with small round ringed spots (0.5-1 cm in diameter), and often banded under the cortex. Some are patinated bluish-white.

Schi *Schiepersberg (Valkenburg)*
(archaeological)

Surface collection from knapping floor near supposed extraction point.
Homogeneous tan with very numerous tiny black specks on surface which is otherwise uniformly tan. Coarse with rough fracture surface.

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[1] Samples come from different locations within the Rullen site. Locations 1, 1a, 2, 3, and 4 come from Rullen Haut while location 5 comes from Rullen Bas.

Si1 *Simpelveld - Baneheide*
(archaeological)

Surface collection from knapping floor near possible mine(s).
Variable sample. No. 71 is black with few inclusions and chalk cortex. No. 72 is coarser-grained, matte, with few inclusions and thin, grainy chalk cortex. No. 73 is banded with dark wide and light narrow bands. No. 74 has a reddish patina. No. 76 is tan, coarser-grained, opaque, with no inclusions.

Si2 *Simpelveld - Baneheide*
(archaeological)

Surface collection from knapping floor near possible mine(s); collected at the same time as Si1 but from a different knapping area.
Homogeneous tan-gray, faintly banded, with small ovoid spots. One piece is tabular, with cortex on two flat opposing surfaces.

APPENDIX 2. RAW MATERIAL TYPES AT EACH STUDY SITE

Appendix 2 contains descriptions of the raw material type identified at each study site, along with probable or possible source identifications, based on comparison of macroscopic characteristics with the lithic database described in Appendix 1.

Maisières-Canal: Raw material types

Ungrouped:

1 Obourg flint: fine to very fine-grained, black, glossy, rarely matte, translucent even when fairly thick, very few inclusions and if present, are tiny specks and spts, white chalk cortex; from Craie d'Obourg

2 Spiennes flint: fine-grained but coarser than Obourg, gray to dark gray, mostly matte but can have a slight gloss, slightly translucent, many inclusions, mainly large ovoid or irregular spots of medium-grained coarseness as well as round gray spots and specks, can patinate white with rust-colored lines but doesn't appear to have patinated much at Maisières-Canal, tougher/less brittle than Obourg

3 olive-green flint: fine-grained, similar to Obourg, glossy, few inclusions: bubble-like spots and some larger, coarser spots, less translucent than Obourg or Spiennes: doesn't show inclusions when translucent like Spiennes can

4 gray flint 1: very light gray without inclusions, translucent, brittle

5 brown flint: fine-grained, very translucent, brown with white flecks on surface, dark flecks within (like formica), glossy

6 gray flint 2: probably a variant of Oboug, but less translucent, more matte, homogeneous gray rather than brown or black, few inclusions but small gray spots

7 medium-grain gray flint: medium-grained, gray, opaque, matte, slightly rough fracture surface

8 brown-yellow flint: fine-grained, glossy, few inclusions, very different shade of brown from translucent Obourg, brighter and more yellow

9 phtanite: fine-grained, opaque, matte, black to dark gray

10 chert: medium-coarse-grained, irregular fracture surface

Grouped	Name	Ungrouped
1	Obourg	1
2	Spiennes	2
4	phtanite	9
8	gray flint	4, 6, 7
9	brown flint	5, 8
10	chert	10
17	olive-green flint	3

Huccorgne: Raw material types

Ungrouped material types (Straus):
MATERIAL Lithic Raw Material

Value	Label
10	fine-grain flint Obourg/Hesbaye
11	fine-grain flint N. Belgium
12	medium-grain flint
13	fine-grain flint cretaceous
15	black flint
20	chert
30	phtanite
40	medium-grain limestone
41	fine-grain limestone
42	crystalized limestone
50	medium-grain quartzite
51	fine-grain quartzite/siltstone
52	quartz crystal
53	sandstone
54	Brussels sandstone
55	psammite
90	ochre/hematite
99	other stone

Grouped types	Name	Ungrouped types
3	Hesbaye flint	10-13
4	phtanite	30
7	black flint	15
10	chert	20
11	quartzite	50-51
12	sandstone	53, 54
13	limestone	40-42
14	quartz	52

Grottes de Goyet: Raw material types

1 Obourg flint
2 Hesbaye flint: blue-gray flint, patinates blue-gray-white, white on ridges and edges.
  2a fine-grained, glossy
  2b coarser (but still fine-grained), matte
3 tan flint: lots of small (1-2 mm) beige and white speckles
4 black flint: not Obourg, white speckles, patinates gray-white, probably Maastrichtian
5 phtanite: good quality (from Ottignies source)
6 dark gray flint, not Spiennes or Obourg, glossy, few or no inclusions, homogeneous
7 cherts of unknown sources: medium to coarse-grained
8 black flint: like Obourg, but opaque (ex 2751.60), has brownish-orange irregular spots to 20 mm, but rare.
9 translucent, light brown-yellow flint, fine-grained, matte.
10 brown opaque flint
11 Spiennes flint
12 brown flint (lots of tiny inclusions within a translucent matrix)
13 medium-grained quartzite, tan, gray, or white
14 Wommersom quartzite
15 blue-gray flint (ex. 190), blue-gray under a filmy gray patina, grey and beige spots common, lots of tiny gray or blue specks. Cortex is rolled chalk. Possibly Hesbaye.
16 tan-gray flint, opaque, homogeneous in color and texture, veined, few inclusions, consistent grainy/speckled coloring but fine-grained.
17 gray flint, opaque, few inclusions (ovoid spots), rest of material is fine-grained, homogeneous in color and texture.
18 gray flint, medium to fine-grained, rough surface, opaque.
19 sandstone, black and tan (mostly tan) grains in white matrix
20 grès lustre: lustrous sandstone

Grouped	Name	Ungrouped
1	Obourg	1
2	Spiennes	11
3	Hesbaye	2, 15
4	phtanite	5
5	Wommersom	14
6	unknown tan/ brown flints	3, 9, 10, 16
7	unknown black flints, prob. Tertiary	4, 8
8	gray flints	6, 17, 18
9	brown flint	12
10	cherts	7
11	quartzites	13
12	sandstone	19, 20

Spy: Raw material types

DePuydt and Lohest, Stratum 2

Ungrouped Material Types (mactype):

1	Obourg flint: fine-grained, black, translucent, glossy, translucent brown when thin enough, rarely patinates, few inclusions, chalk cortex
2	Hesbaye flint: fine-grained, glossy or matte, patinates bluish-white, gray when unpatinated, chalk cortex
2a	Hesbaye subtype 2a: fine-grained, commonly glossy, smooth
2b	Hesbaye subtype 2b: fine-grained but coarser than 2a, commonly matte
3	phtanite: black, matte, opaque, no inclusions, no cortex
3a	typical good quality phtanite
3b	poor quality phtanite: coarser
4	Wommersom quartzite
5	gray flint: light to dark gray, matte, opaque, fine to medium-grained, smooth but can see homogeneous grains or specks which are gray, white, beige
6	Spiennes flint: light to dark gray, many inclusions (ovoid spots, irregular splotches), fine-grained
7	black flint: opaque, glossy, fine-grained, inclusions are gray spots and irregular shapes (possibilities: Lixhe/Gulpen or Lanaye KVL 2a)
8	dark gray-black flint: dark gray to black, matte, opaque, similar to Type 7 but not at all glossy, few inclusions (specks and spots)
9	gray-tan flint 1: medium-grained, opaque, gray-tan, rough fracture surface, few inclusions (see no. 236)
10	chert: dark gray, matte, opaque, few inclusions, can have smooth or rough fracture surface
11	yellow-beige flint: yellowish-beige with white flecks, fine-grained, similar to Type 5.
12	gray-tan flint 2: fine-grained, gray-tan, few inclusions, mottled with inclusions of same or similar grain size (variant of Type 9?)
13	calcedony: very fine-grained, translucent white-beige, no inclusions
14	grès lustre: fine-grained, mostly silicified, very light gray with tiny black specks and sparkling grains (=Brussels sandstone?)
15	jasper: fine-grained, dark red
16	gray flint: fine-grained, homogeneous, no inclusions, smooth, glossy, mostly opaque
17	limestone: black, surface gray, hard (like at Trou Magrite)
18	quartzite
19	light brown flint: light brown, translucent, rougher than Obourg

Spy, continued:

Grouped	Name	Ungrouped
1	Obourg	1
2	Spiennes	6
3	Hesbaye	2, 2a, 2b
4	phtanite	3
5	Wommersom	4
6	unknown tan/ brown flints	9, 19
7	unknown black flints, prob. Tertiary	7, 8
8	gray flints	5, 11, 12, 16
9	brown flint	-
10	cherts	10
11	quartzites	18
12	sandstone	14
13	limestone	17
14	quartz	-
15	calcedony	13
16	jasper	15

Trou Magrite: Raw material types

Straus material types:

- 10 fine-grain flint Obourg/Hesbaye
- 11 fine-grain flint N. Belgium
- 12 medium-grain flint
- 13 fine-grain flint cretaceous
- 15 black flint
- 20 chert
- 30 phtanite
- 40 medium-grain limestone
- 41 fine-grain limestone
- 42 crystalized limestone
- 50 medium-grain quartzite
- 51 fine-grain quartzite/siltstone
- 52 quartz crystal
- 53 sandstone
- 54 Brussels sandstone
- 55 psammite
- 90 ochre/hematite
- 99 other stone

My TM material types:

1 Obourg
2 Hesbaye
- 2a fine-grained
- 2b coarser-grained

3 phtanite
4 Wommersom quartzite
5 Spiennes flint
6 black limestone
7 gray chert: light or dark gray
8 medium- to coarse-grained quartzite
9 black flint: not Obourg, opaque, sometimes very dark gray
10 coarse-grained quartzite: white to light gray
11 light gray flint: homogeneous color, fine-grained
12 light brownish-green flint: sparkling
13 chert: dark gray with sparkling specks like mica (but are probably quartz), poor quality
14 fine to medium-grained quartzite: white to light gray, homogeneous-rough surface, homogeneous sparkle
15 sandstone: light brown, soft but gritty
16 dark gray flint: translucent, chert-like, rough
17 quartz crystal
18 light gray flint: fine-grained, homogeneous, black specks
19 dark gray flint: marbled with white veins, fine-grained, glossy

Trou Magrite grouped material types:

Grouped types	Name	My ungrouped types	Straus ungrouped types
1	Obourg flint	1	
2	Spiennes flint	5	
3	Hesbaye flints	2	10, 11, 12
4	phtanite	3	30
5	Wommersom quartzite	4	
6	unknown tan/ brown flints	12	
7	unknown black flints, prob. Tertiary	9	15
8	gray flints	11, 16, 18, 19	13
9	brown flint	not present	
10	cherts	7, 13	20
11	quartzites	8, 10, 14	50, 51
12	sandstone	15	53, 54
13	limestone	6	40, 41, 42
14	quartz	17	52

Couvin, Trou de l'Abîme: Raw material types

Ungrouped material types:

1 gray flint 1: fine to very fine-grained, patinates a glossy white-gray with slightly darker gray flecks and spots (e.g., G7.34), some pieces have an orange-rust patina which has been found on various patinated Spiennes samples from Champ-à-Cailloux.

2 gray flint 2: fine to very-fine grained flint, patinates a glossy, mottled gray-white, no visible inclusions. On G7.37, elongated white blotches are present.

3 black limestone: medium-grained, black, hard, rough fracture surface

4 brown flint 1: fine-grained flint with numerous very tiny flaws - linear gaps like tracks by grains of sand - and black specks, patinates mostly beige/tan with some white. G8.14 has chalk cortex with dark brown flint visible. Can also be from Spiennes.

5 gray flint 3: fine-grained flint, patinates a homogeneous gray composed of tiny gray specks.

6 brown flint 2: fine-grained, beige-light brown flint, chalk cortex, irregular white veins. (Possibly burned - see H6.62).

7 quartzitic sandstone: coarse-grained, rough fracture surface, light gray

8 Spiennes flint: bluish-white patina commonly associated with both Spiennes and Hesbaye flints but likely to be Spiennes based on distance.

Grouped material types:

Grouped	Name	Ungrouped
1	gray flint	1, 2, 5
2	brown flint	4, 6
3	Spiennes flint	8
4	quartzitic sandstone	7
5	limestone	3

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