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.