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.

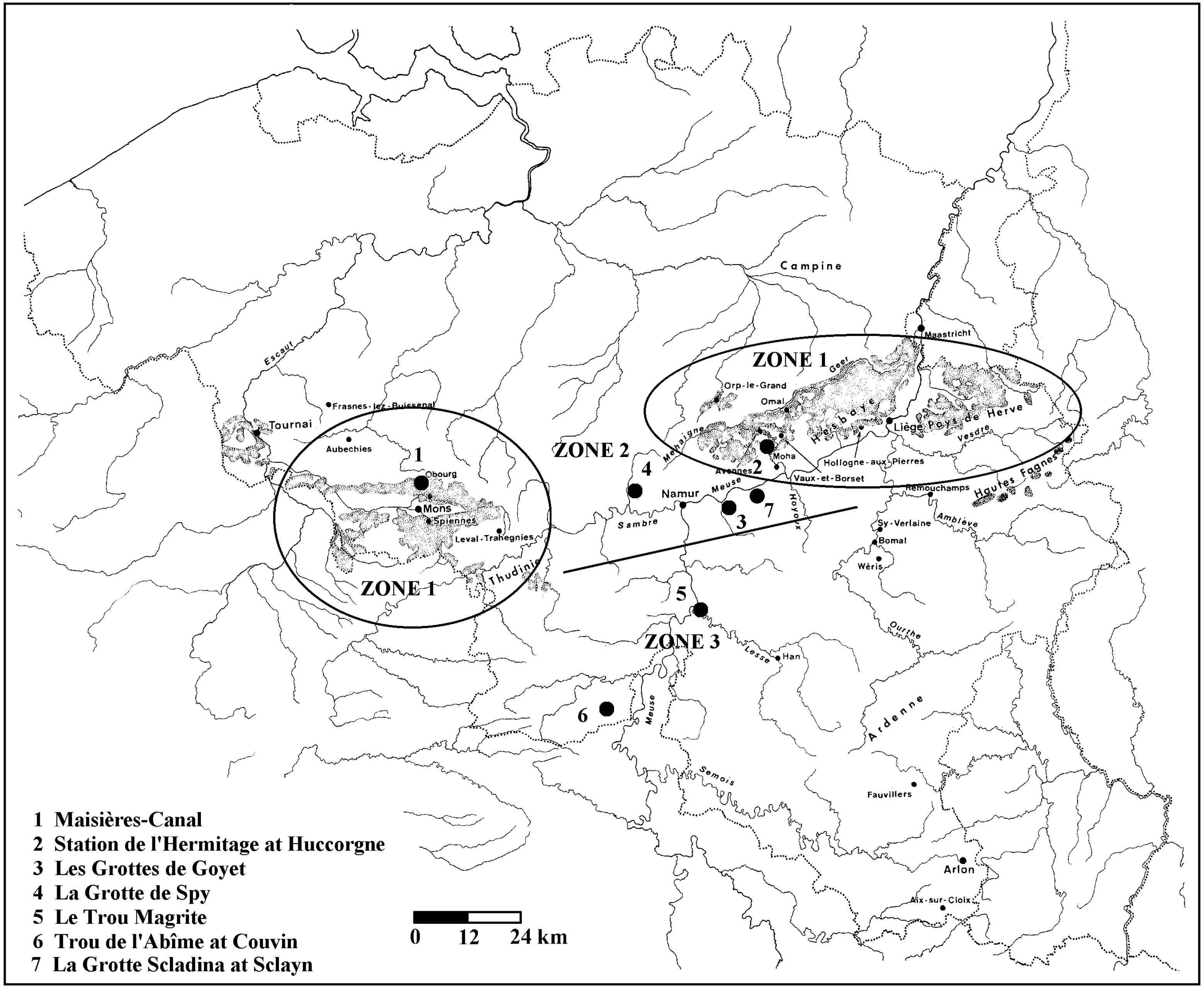

Figure 4.1. Base map showing location of study sites and raw material procurement zones.

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.