# Lithic Variability and Middle Paleolithic Behavior

## new evidence from the Iberian Peninsula

C. Michael Barton

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## PREFACE

This monograph is based on research that took place between January of 1984 and May of 1987. A study of this scope cannot be completed without the support and assistance of many people. I can not properly thank the many who offered helpful suggestions, contributed stimulating ideas, or gave needed moral support without adding an additional chapter. Nevertheless, I would like to extend my thanks to some of those who made this work possible.

I feel fortunate to have had advice and guidance of Drs. Arthur J. Jelinek, C. Vance Haynes, and Geoffrey A. Clark in this work. Arthur Jelinek was a major influence throughout my graduate career at the The University of Arizona. His expertise in the study of lithic variability and the Middle Paleolithic in general made a valuable contribution to this project and is greatly appreciated. I am also grateful for the opportunity I have had to benefit from Vance Haynes' extensive knowledge of Quaternary geology and geomorphology. His help with arranging radiocarbon dating has also been especially appreciated. Geoffrey Clark offered considerable support and provided invaluable assistance in the establishment of contacts with the Spanish archaeological community without which this research would not have been possible.

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As is the case with any research, this work has built on that of others. Although they are cited in the text, I would like to extend my thanks to several people who kindly provided the otherwise unavailable results of their personal research. Dr. Catherine Flataker Mueller-Wille, Texas A&M University, permitted me to use a penultimate copy of her dissertation on the Middle Paleolithic of eastern Spain. Dr. Harold Dibble, University of Pennsylvania, provided me with several pre-publication versions of his papers dealing with Mousterian lithic variability. Dr. Valentín Villaverde Bonillo, University of Valencia, sent me a copy of his dissertation on the Middle Paleolithic of Valencia. Dr. Josette Renault-Miskovsky, Institute de Paléontologie Humaine (Paris), has provided me with a variety of papers on the palynology of early Upper Pleistocene sediments. All these works were of critical importance to my own research.

I would also like to mention and thank a group of friends and colleagues from whose shared discussions over beers and cards I learned more of the Paleolithic than from any formal class. These are the former (and perhaps secretly still) members of the Friends Of the Paleolithic--including Mark Baumler, Mary Bernard-Shaw, Philip Chase, Harold Dibble, Katherine Kamp, Deborah Olszewski, and John Whittaker.

Financial support and access to research facilities are basic requirements of most scientific endeavors. This work was supported in part by grants from the Graduate College and the Department of Anthropology, University of Arizona. The Department of Anthropology also provided the microcomputer facilities and funding for mainframe computer time needed for analysis. The NSF-Arizona Accelerator Facility for Radioisotope Analysis at the University of Arizona funded the radiocarbon dating of the samples from Cova Beneito. The Department of Anthropology, Arizona State University, provided provided facilities for the production of the final version of this manuscript.

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C. Michael Barton
February 1988

# CHAPTER 1

# INTRODUCTION

Since their fossil remains were first recognized in the Neander Valley in 1857, neandertals have been the subject of a great deal of study and considerable controversy. Numerous sites with evidence of their presence have been excavated or collected and hundreds more located. Their fossil remains have been recovered in far greater numbers than any hominid other than ourselves. Thousands of their artifacts are housed in museums. Their bones, their discarded artifacts, and their food remains have been the focus of over a century of research, resulting in a tremendous body of material and scientific literature. It is surprising, then, that so little is known about these closest of our prehistoric relatives.

Their phylogenetic status remains a subject of debate, especially with regard to their evolutionary relationship to modern Homo sapiens.. There remains uncertainty over how many of the faunal remains found at Middle Paleolithic sites are there as a result of neandertal activities and how many are were brought there by non-human carnivores. For the bones that are associated with neandertals, there are questions concerning whether they are from animals that were hunted or scavenged. We can be sure that neandertals ate foods other than meat, but there is no direct evidence to support this. We have elaborately classified their artifacts, arranged them in space and time, and have identified patterns of similarity and dissimilarity among groups of artifacts. Yet we still do not know what these patterns signify in terms of behavior or which, if any, of these differences and similarities are functional or stylistic in origin. For the most part, we are not sure what the artifacts were used for or, in many cases, which artifacts were or were not used.

On the other hand we do have a considerable amount of information about neandertal biology. We do know that evolutionarily they were closely related to ourselves. We have developed a rather detailed picture of when and where they lived, and under what conditions. And we are gaining an increasingly good appreciation of the distribution of variability in their cultural remains through space and time.

Many of the questions that remain about these hominids concern their behavior--their subsistence practices, their settlement systems, their social organizations. Because they are so close to ourselves, both genetically and temporally, it is important to be able to reconstruct and explain their behavioral systems in order to understand the origins of modern human biology and and behavior.

For the reconstruction and explanation of past behaviors, archaeology relies on interpretations of the the significance of variability in material residues of behavior. For the Middle Paleolithic those residues that remain preserved are primarily restricted to chipped stone artifacts and animal bones. This means that the data base upon which we base our interpretations about neandertal behavior is narrowly restricted. On the other hand, chipped stone artifacts were undoubtedly an important component of Middle Paleolithic technological systems and should, therefore, contain considerable information about past activities. For this reason, these lithic artifacts have been the objects of considerable interest since the beginnings of paleolithic archaeology.

The investigation of variability in Middle Paleolithic chipped stone artifacts and its significance for the reconstruction and explanation of past behavior is the subject of the research reported here. Because so little is known about neandertal behavior, this work is primarily concerned with fundamental questions about the dimensions and distribution of variability in these artifacts. It is hoped, though, that an attempt to answer some of these questions might provide useful insights into relationships between lithic variability and neandertal behavior. In order for such relationships to be of value for the reconstruction and explanation of broader behavioral patterns than those specifically related to manufacture and use of chipped stone artifacts, however, it is necessary that they be examined within the framework of the temporal, spatial, and environmental contexts of which they were originally a part. For this reason, the remainder of this chapter and the next chapter are primarily concerned with establishing this framework for the discussion of lithic variability that follows.

## Overview of Upper Pleistocene Chronology and Environment In the Northwestern Mediterranean Region

During the last two decades, our understanding of Pleistocene chronology and environment has been revolutionized by the analysis of deep sea cores that contain, continuous, almost complete records of this period. Additionally, the discovery of long, relatively complete sedimentary and pollen sequences from terrestrial contexts have not only complemented the marine record, but have provided finer chronological and climatic resolution than the sea cores. Finally, the development of means to absolutely date these sequences has at last begun to make it possible to calibrate Pleistocene environmental fluctuations as well as the various evidence for human activities during this important time span.

Although, in many respects, the effects of this revolution have yet to be fully realized, there are several notable ways in which it has directly affected paleolithic archaeology. It has shown that the four glacial model, based on the alpine studies of Penck and Bruckner (Lamb, 1977:323-325), was a great oversimplification of the climatic changes of the Pleistocene. It is now recognized that there may have been at least eight major cold/warm oscillations since the beginning of the Middle Pleistocene alone (Shackleton, 1975; Butzer,1975b). This presents an environmental backdrop of considerably greater environmental complexity against which human physical and cultural development took place.

Associated with this picture of numerous environmental fluctuations, many of the correlations between regional sequences--based on the four glacial model--are now known to be doubtful or incorrect (see Gamble, 1986:76-95). This has meant that the relative chronology of the Paleolithic is in a state of flux and older interpretations of patterns of cultural and biological variability are on much less stable ground. This is especially true in Europe and the Near East where considerably more data are available than elsewhere (see Dennell, 1983:41).

Finally, of particular importance for the present study, the Upper Pleistocene sequence and its various substages now appear to be considerably longer than was previously thought (e.g., Butzer, 1981; Kukla, 1975; 1980; Dennell, 1983:62). This give the Middle Paleolithic a much longer time span and requires some rethinking of the meaning of the presence and absence of diachronic variability.

### SOURCES OF INFORMATION

Deep sea cores. The importance of sediment cores from the ocean basins for reconstructing Pleistocene chronology and paleoenvironments was first recognized by Emiliani (1955). Since then, the analysis and correlation of numerous cores from throughout the world have provided the primary record of world-wide environmental change throughout the Pleistocene (see Shackleton, 1975; Lowe and Walker, 1984:291-294).

Changes in the morphology and relative abundance of different taxa of Foraminifera, whose shells are found in these sediments, have been used to reconstruct marine environmental parameters such as surface temperature and salinity (Shackleton, 1975; Imbrie and Kipp, 1971; Wollin, et.al., 1971). More important, however, have been the numerous studies of fluctuations in the ratio of oxygen isotopes (18O/16O) incorporated into the carbonate of Foraminifera shells.

These fluctuations are now felt to reflect the amount of water in the oceans and, consequently, the amount of glacial ice on land (Lowe and Walker, 1984:144-150; Shackleton, 1975). The quality and reliability of the results obtained depend on such factors as the rate of sedimentation where the core was taken, the amount of sediment mixing by currents or burrowing organisms, the taxa of Foraminifera analyzed, and the depth at which the core was taken (Lowe and Walker, 1984:148-150). However, the close similarity among 18O/16O profiles of numerous cores indicates the high resolution and reliability of these data for the Upper Pleistocene. An additional advantage of deep sea cores is that the carbonates and other organic materials that make up much of their composition lend themselves well to dating by 14C and Uranium series methods (Shackleton, 1975; Wollin, et.al., 1971). This permits calibration of the observed fluctuations over long time spans with an accuracy not possible for most terrestrial data.

As indicated above, the study of the marine core data has revealed a much more complete and complex picture of Pleistocene paleoenvironmental change than was indicated by terrestrial evidence. In fact a primary difficulty in using this information has been the correlation of the much more varied and closely studied terrestrial record with the more complete marine data (see Butzer, 1981; Kukla, 1975). This is being accomplished by a variety of means discussed below.

Terrestrial oxygen isotope data. Since the demonstration of the value of examining oxygen isotope ratios in marine sediments, additional terrestrial sources for analogous data have been discovered. Long ice cores from existing continental glaciers (Dansgaard, et.al., 1971; Lamb, 1977:332) have provided a record for the Upper Pleistocene comparable to that of the marine cores.

Of perhaps greater relevance to paleolithic archaeology, however, are studies of 18O/16O ratios in cave speleothems. Not only are these stalagmitic formations located in caves, such as Orgnac III, that might have also housed prehistoric humans, but their carbonates are also datable like those of marine cores (Duplessy, et. al., 1970; Harmon, 1979).

Beyond the general information from marine cores and terrestrial oxygen isotope data, terrestrial sediments, floral remains, and faunal remains remain the primary sources of data for reconstructing terrestrial chronology and environments for the Upper Pleistocene. Additionally, various "absolute" dating techniques are of great importance where applicable, although much of the earlier Upper Pleistocene--especially that part associated with the Middle Paleolithic--lies beyond the range of the most reliable and widely used technique, 14C analysis.

Sediments. All archaeological remains, including surface finds, are found in a sedimentary context. Often, these contexts can provide information about the environments associated with the deposition of the artifacts. In many cases, this will closely correspond to environments associated with the manufacture and use of the artifacts. Examples of the chronological and environmental information provided by the sedimentary contexts of paleolithic sites can be found in Miskovsky's (1976) summary of deposits at sites in the French Midi, Laville's (Laville, et.al., 1980) review of similar information for the Perigord, and Butzer's (1981) study of the deposits in Cantabrian paleolithic sites.

Even beyond the context of archaeological deposits, sediments play a vital role in the reconstruction of Upper Pleistocene environments, if only because of their ubiquitous presence. While other sources of paleoenvironmental data tend to be only rarely available because of the special conditions required for their formation and preservation, sedimentary data are almost always available. The variety of conditions under which sediments occur, on the other hand, sometimes makes their interpretation with respect to past environments a complex and difficult task. Butzer's (1975a) work on Mallorca and Kukla's (1975; 1980) study of central European loess profiles provide examples of the information that can be obtained when these difficulties are overcome.

Floral remains. With few exceptions (e.g., see Beaulieu, 1972; Renault-Miskovsky, 1972) most environmental chronologies derived from floral remains are based on analyses of pollen. Where pollen is preserved in sufficient quantities it can be used to reconstruct the composition of past floral communities, although differences among various plant taxa with respect to quantity and transportability of pollen produced and effects of topography must be taken into account (Anderson, 1970; Faegri and Iversen, 1975:144-184; Janssen, 1970). Additionally, archaeological sites can present special problems due to the effects of human activities (Jelinek, 1966; Renault-Miskovsky, 1972). Nevertheless, in stratigraphic contexts, pollen can provide detailed information about the biological environment and its fluctuations through time. Climatic information can, in turn, be derived from reconstructed floral assemblages, which makes the construction of environmental chronologies possible for wide areas.

The few long sequences that span the entire range of the Upper Pleistocene or even longer are especially valuable in this respect. Among the best known of these are those from Grand Pile in northeastern France (Wolliard, 1978; Wolliard and Mook, 1982), Padul in southeastern Spain (Florschütz, et. al., 1971), and Tenaghi-Phillipon in Macedonia, Greece (Van der Hammen, et. al., 1971). These provide evidence for the effects on the terrestrial biologic environment of the worldwide environmental changes seen in the marine cores. On a somewhat different scale, but equally important for assessing Upper Pleistocene environments, are the data from more numerous temporally restricted sites, such as rock shelters in the French Midi, that provide valuable information about environmental variability in space as well as time (Renault-Miskovsky, 1986).

Faunal remains. The analysis of faunal remains, primarily remains of large mammalian fauna, has played an important role in the development of chronology and reconstruction of past environments since the birth of paleolithic archaeology (Daniel, 1975:57-62, 99-109). On a large scale, evolutionary changes in fauna have provided chronological markers for the entire Pleistocene (Maglio, 1975). However, for the Upper Pleistocene, such changes are considerably less apparent and are primarily in the form of extinctions, local or general. Of greater significance for this time range are fluctuations in the relative abundance or regional presence/absence of taxa as a result of changes in environmental parameters.

There are several problems related to the use of faunal remains in this way however. The large mammals whose remains are more likely to survive and be recovered during excavation, and are thus more likely to be analyzed and reported, tend to have relatively wide ranges of environmental tolerances. And while there are modern analogs of most Upper Pleistocene taxa, the natural environmental preferences and tolerances of modern taxa are often not well known and may not be identical to those of their Upper Pleistocene counterparts (Gamble, 1986:103; Davidson, 1980:244-246).

Additionally, it is difficult to assess the degree to which faunal assemblages from archaeological sites are representative of the living faunal communities from which they were derived. Given that there is evidence for preferential hunting of certain taxa during the Middle Paleolithic (Chase, 1983:221-231; Bouchud, 1976), assemblages that were produced by carnivores rather than humans might be preferable for developing chronology and reconstructing environment. However, most reported assemblages are from archaeological sites. While it is very likely that such assemblages result from the activities of both humans and non-human carnivores, distinguishing between these sources is frequently difficult (Brain, 1976; Chase, 1983:85-92).

In spite of these cautions, there seem to be similarities between relative frequencies of different faunal taxa and other forms of paleoenvironmental evidence for assemblages from Middle Paleolithic archaeological sites (Klein and Cruz-Uribe, 1984:76-77; Chase, 1983:23). This would suggest that temporal variations in faunal assemblages remain useful for the development of environmental chronologies, at least at a general level.

Absolute dating. Besides 14C, several other techniques, seem to hold considerable promise for improving Upper Pleistocene chronologies, but their usage has so far been limited. Uranium-series dating is the most widely applied of these at present. The relationships between various isotopes of Uranium, Thorium, and Protactinium (primarily 235U, 234U, 232Th, 230Th, and 231Pa) have proven useful for dating certain types of marine deposits (e.g., Sterns and Thurber, 1967), and especially so for calibrating deep sea cores (Shackleton, 1975). With refinement, this method is becoming increasingly useful in terrestrial contexts. However, difficulties in controlling for sources of accumulation and attrition of these isotopes in terrestrial systems have thus far restricted its reliable applicability to speleothems, travertines, and similar carbonate deposits (Szabo, 1969; Duplessy, et. al., 1970; Lowe and Walker, 1984:226-227).

Thermoluminescence (TL) dating, seems promising for directly dating chipped stone artifacts that have been heated. Additionally, it may prove useful for dating marine sediments and loess (Wintle and Huntley, 1979; Wintle, 1981). However, this technique has seen only limited use to date and the results it has generated suggest that its reliability and calibration still require improvement (Davidson, 1980:5.20-5.24).

Like TL dating, analysis of the electron spin resonance (ESR) of atoms may also provide a means to date lithics as well as speleothems by measuring the length of time they have been exposed to naturally occurring radioactivity (Garrison, et.al., 1981). While potentially of great value, the technique is still in the early stages of development.

These various sources of evidence permit the development of a chronological framework and the reconstruction of environmental contexts within which human activities took place during the early Upper Pleistocene. Although such contextual data from the sites which are the focus of this study are discussed in the following chapter, an overview of early Upper Pleistocene chronology and environments, for the northwestern Mediterranean region as a whole, is presented below. In order to provide a set of reference points for paleoenvironmental reconstruction, modern environmental parameters of the northwestern Mediterranean are also briefly reviewed.

## CHRONOLOGICAL FRAMEWORKS

Since Penck and Bruckner devised their four glacial scheme, an increasing variety of environmental chronologies have been devised, each with its own set of named subdivisions of regional significance (see Gamble, 1986:75, 78, 93; de Lumley, 1976a). The complexities involved in correlating these multiple chronological schemes have been worsened by various workers using the same terms for different subdivisions (Ibid.). Out of this somewhat tangled web, the numbered stages of 18O/16O fluctuations in marine cores, first proposed by Emiliani (1955) and subsequently expanded by other workers (eg., Shackleton, 1975), appear to be the most widely applicable, most consistently used, and best calibrated of existing chronological frameworks for the Pleistocene. Hence, they will be used as the chronological framework for the present study.

The Upper Pleistocene comprises stages 5-2. These stages and their subdivisions, dated with increasing precision by 14C and 230Th/234U methods, are shown in Figure 1.1. Correlation of these stages with the version of the Alpine sequence most widely used in the northwestern Mediterranean is shown for reference and follows the work of Butzer (1981),

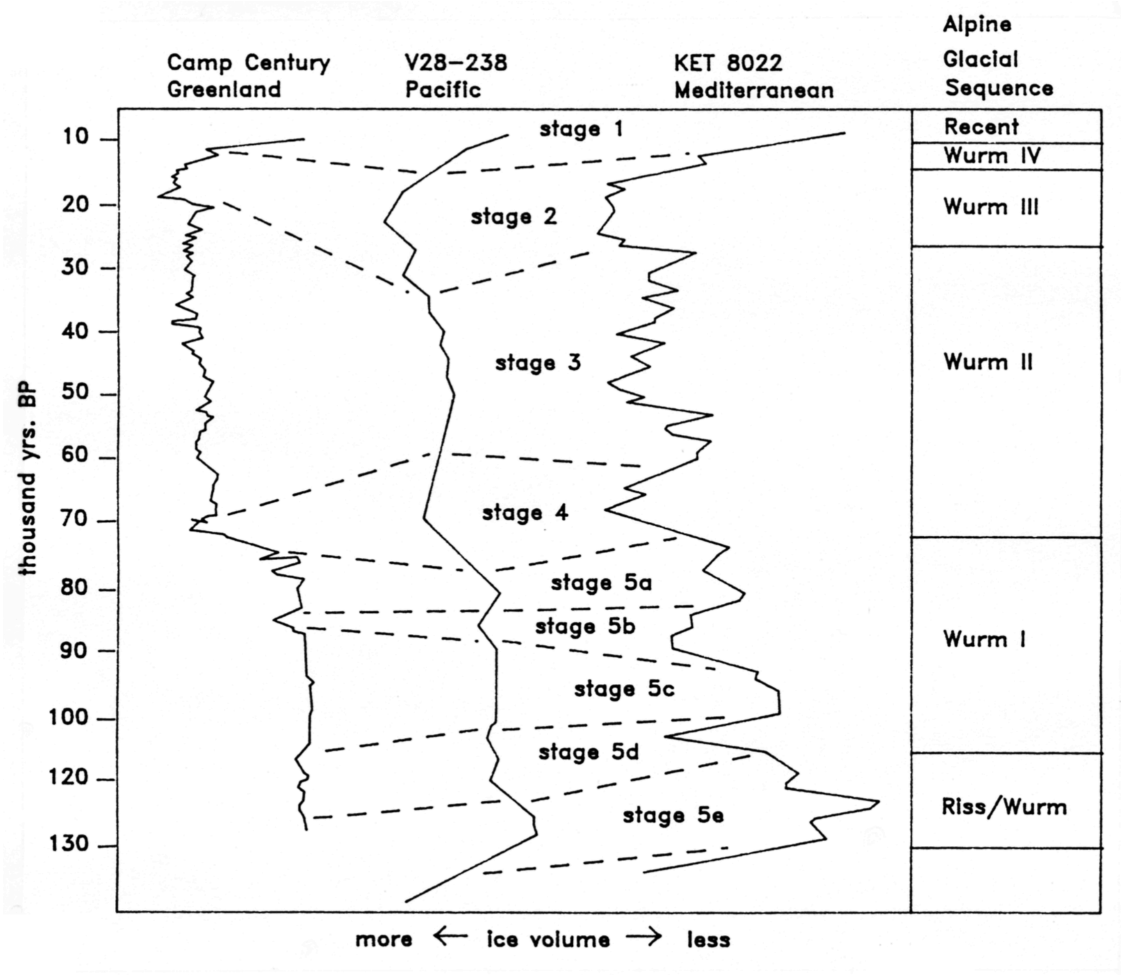



Figure 1.1. Oxygen isotope chronology for the Upper Pleistocene.

18O/16O curve for marine sediments from the Pacific and Mediterranean, and for glacial ice from Greenland. Alpine sequence also shown for reference (after Dansgaard, et.al., 1971; Shackleton and Opdyke, 1973; Renault-Miskovsky, 1986).

Duplessy, et.al., (1976), and Wolliard and Mook (1982). Several large-scale divisions of the Upper Pleistocene are notable.

Substage 5e, at 128,000-118,000 BP represents the last interglacial. The 18O/16O profile indicates that ocean volume was the greater in this substage than at any other time during the Upper Pleistocene. This also means that land ice was at its lowest ebb and that temperatures were probably their highest. With a duration of only 10,000 years, this substage represents only a small fraction of the Upper Pleistocene.

The remainder of stage 5 (substages 5d-5a) encompasses the early glacial. Two marked intervals of land ice accumulation at c. 115,000 and 95,000 BP alternate with periods of lesser extent of continental glaciation. The end of stage 5 is marked by a rather dramatic change at c. 75,000 BP.

The stages 4 and 3 represent the beginning of true glacial conditions in the lower and middle pleniglacial. Stage 4, c. 75,000 to 65,000-60,000 BP, appears to represent the most extensive continental glaciation of this time range while the longer stage 3, 65,000-60,000 to 40,000-35,000 BP, appears climatically more variable, with some retreat of continental glaciation.

The Middle Paleolithic is generally considered to encompass stages 5-3, although it may extend farther back in time, giving it a duration of over 90,000 years (128,000 to 35,000 BP.). The remainder of the Upper Pleistocene, the upper pleniglacial or full glacial of stage 2 at c. 35,000-10,000 BP, is associated with the Upper Paleolithic and fully modern humans.

## PRESENT NORTHWESTERN MEDITERRANEAN ENVIRONMENTS

Climate. Present climate of this region follows a Mediterranean pattern of warm to hot, dry summers with milder temperatures and more precipitation during the rest of the year. Throughout most of this area, the greatest amount of precipitation falls during Spring and Fall. Within this general pattern, climatic parameters vary both latitudinally and topographically.

Both summer and winter temperatures tend to be higher and precipitation considerably less, with a more pronounced summer dry season, in the southern part of the region compared to the northern reaches. In the Mediterranean France, mean July temperatures range from 22o to 24o C and mean January temperatures are 7o-9o. Mean annual precipitation is 600-800 mm with as much as 20% falling in summer. (Arléry, 1970). Along the coast of southeastern Spain, on the other hand, mean July temperature ranges are 24o-26o and mean January temperatures are generally above 10o. Mean annual precipitation declines to less than 300 mm. in some areas, only 5% of which falls during the summer months (Linés Escardó, 1970).

Topography affects climate in two general ways in this region. Inland from the coast, climate becomes more continental in Spain and more oceanic in France. Additionally, the effects of altitude are notable, with higher elevations experiencing lower temperatures and greater precipitation. Compared to the southeastern coast of Spain mean July and January temperatures in the Sierra Nevada, only a short distance inland, are 20o and 0o respectively, while annual precipitation can be as high as 800 mm (Ibid.).

Flora. Due to the long duration of human settlement in the region and associated environmental disturbance, natural climax vegetation of the northwestern Mediterranean must be reconstructed from relict stands and Holocene pollen records (for example, see Birot and Gabert, 1964:66-94; Houston, 1967:79-104; Lopez, 1978; Davidson, 1980:2.6-2.9). Generalized reconstructed vegetation zones are shown in Figure 1.2.

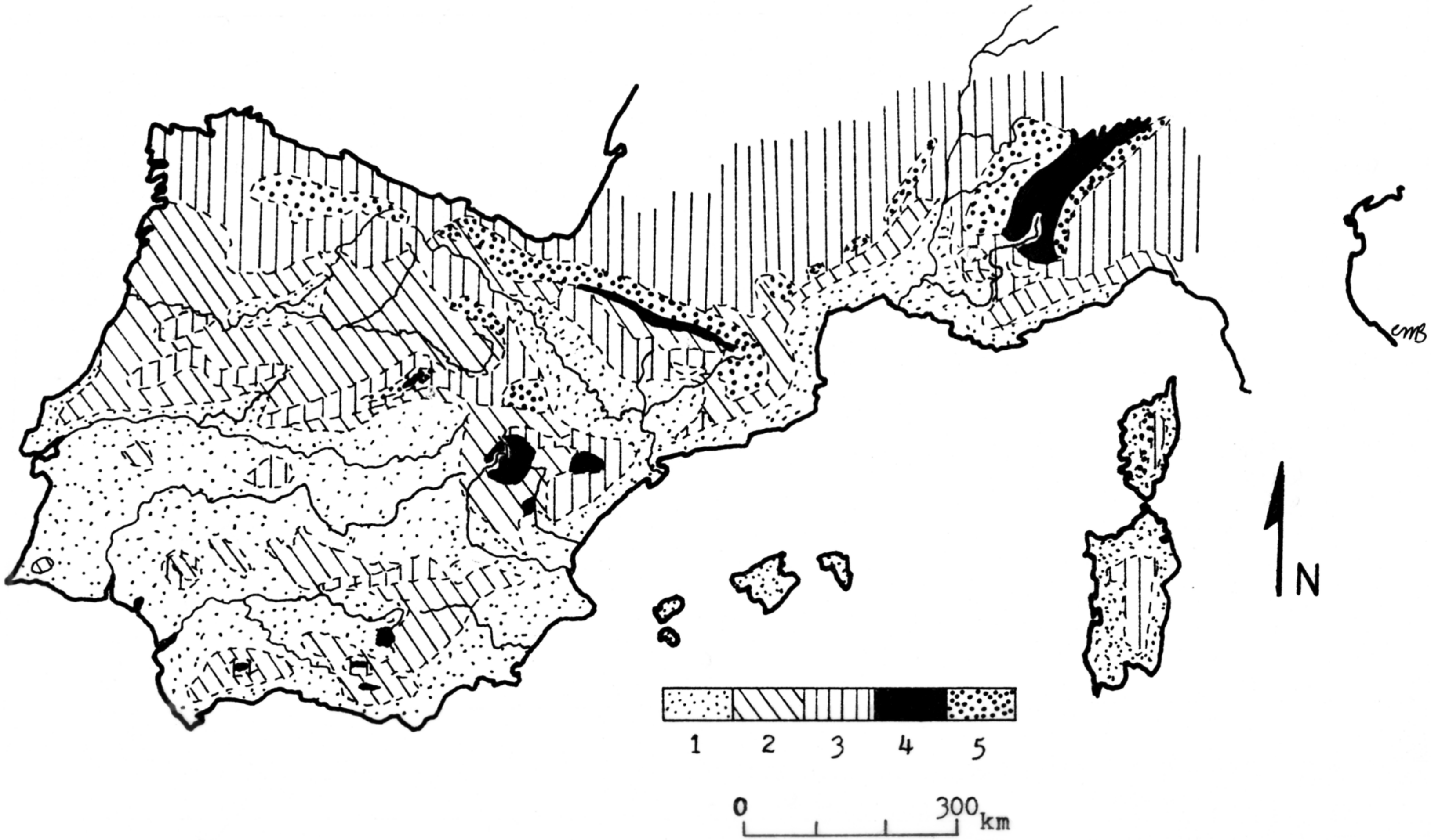



Figure 1.2. Reconstructed vegetation zones in the northwestern Mediterranean.

1) Mediterranean woodland; 2) mixed deciduous/coniferous forest; temperate, mixed-oak deciduous forest; 3) montane coniferous forest; 5) beech, pine, fir dominated forest (after Birot and Gabert, 1964:76-77).

Nearly all of the region would probably be covered with some form of forest or woodland. At lower elevations, Mediterranean woodland would occur, dominated by evergreen oaks and xerophitic pines (e.g., Quercus ilex, Q. suber, and Pinus halepensis). Probably ranging up to altitudes of 500 m. in the French Midi and 1,300 m. in southeastern Spain, this woodland would also include olive (Olea spp.) and pistachio (Pistacia spp.).

At slightly higher elevations, the greater precipitation would permit a mixed deciduous forest. Dominated by pubescent oak and scots pine (Q. pubescens and P. sylvestris), the forest would also include beech, fir, and chestnut (Fagus silvatica, Abies spp., and Castenea sativa). At high elevations, the latter three taxa would become dominant up to the tree line at c. 2,000 m., above which open alpine vegetation would predominate.

Fauna. The natural fauna of the region are even less known than the flora. Many larger taxa have become locally or regionally extinct, and those remaining may be artificially restricted to unrepresentative portions of their former ranges (Davidson, 1980:209-215). Probably, the natural fauna would be more or less the same community found throughout much of Holocene Europe. Large herbivores in this community include red deer (Cervus elephus), row deer (Capreolus capreolus), fallow deer (Dama dama), aurochs (Bos primigenius), bison/wisent (Bison spp.), wild boar (Sus scrofa), horse (Equus spp.), chamois (Rupicapra rupicapra), and ibex (Capra ibex and C. pyrenaica). Larger carnivores include brown bear (Ursus arctos), wolf (Canis lupus), red fox (Vulpes vulpes), wolverine (Gulo gulo), wild cat (Felis sylvestris), and possibly the leopard (Felis pardus) and lion (Felis leo) (Ibid.; Maglio, 1975).

## UPPER PLEISTOCENE ENVIRONMENTS

Published information about Upper Pleistocene environments is abundant for the French Midi, but rather sparse for Spain. Nevertheless, the data that are available provide a relatively coherent picture of environments and their changes within the northwestern Mediterranean region as a whole. Especially helpful in this respect are two long pollen cores, from opposite ends of the the Mediterranean, that provide a continuous environmental record for the entire Upper Pleistocene (Figure 1.3). These are the cores from Padul in southeastern Spain (Florschütz, et.al., 1971) and Tenaghi Phillipon in eastern Macedonia (Van der Hammen, et.al., 1971). Although not in the Mediterranean region, the long, well dated pollen sequence from Grand Pile in the Vosges Mountains of northeastern France also provides a complete Upper Pleistocene record that is useful for comparative purposes (Wolliard, 1978; Wolliard and Mook, 1982).

Stage 5e --last interglacial. In many respects environments in the northwestern Mediterranean during stage 5e seem to have been very Figure 1.3. similar to current ones. Sea level was at or above its present level, temperatures were warm, and most of the region was covered by forest or woodland. There are indications that this last interglacial may have been even slightly warmer and more humid than the present one.

Sea level may also have been slightly higher than at present (Harmon, et.al., 1981) indicating less glacial ice in arctic regions. In the Phillipon pollen profile (elevation 50 m.), while elements of Mediterranean woodland are present, pollen of a deciduous oak dominated forest community dominate the assemblage (Van der Hammen, et.al., 1971). Likewise, at Padul (elevation 740 m. [Butzer, 1975a]) a deciduous oak dominated forest grew in a region that currently supports evergreen oak dominated Mediterranean woodland (Florschütz, et.al., 1971). The importance of deciduous forest is also reflected in pollen spectra from several sites in the French Midi (Beaulieu, 1972; Renault-Miskovsky, 1976a; 1976b; 1986)

Stages 5d-5a -- early glacial. Environments varied considerably during this period. Marine data indicate a gradual build-up of land ice. However, a variety of evidence

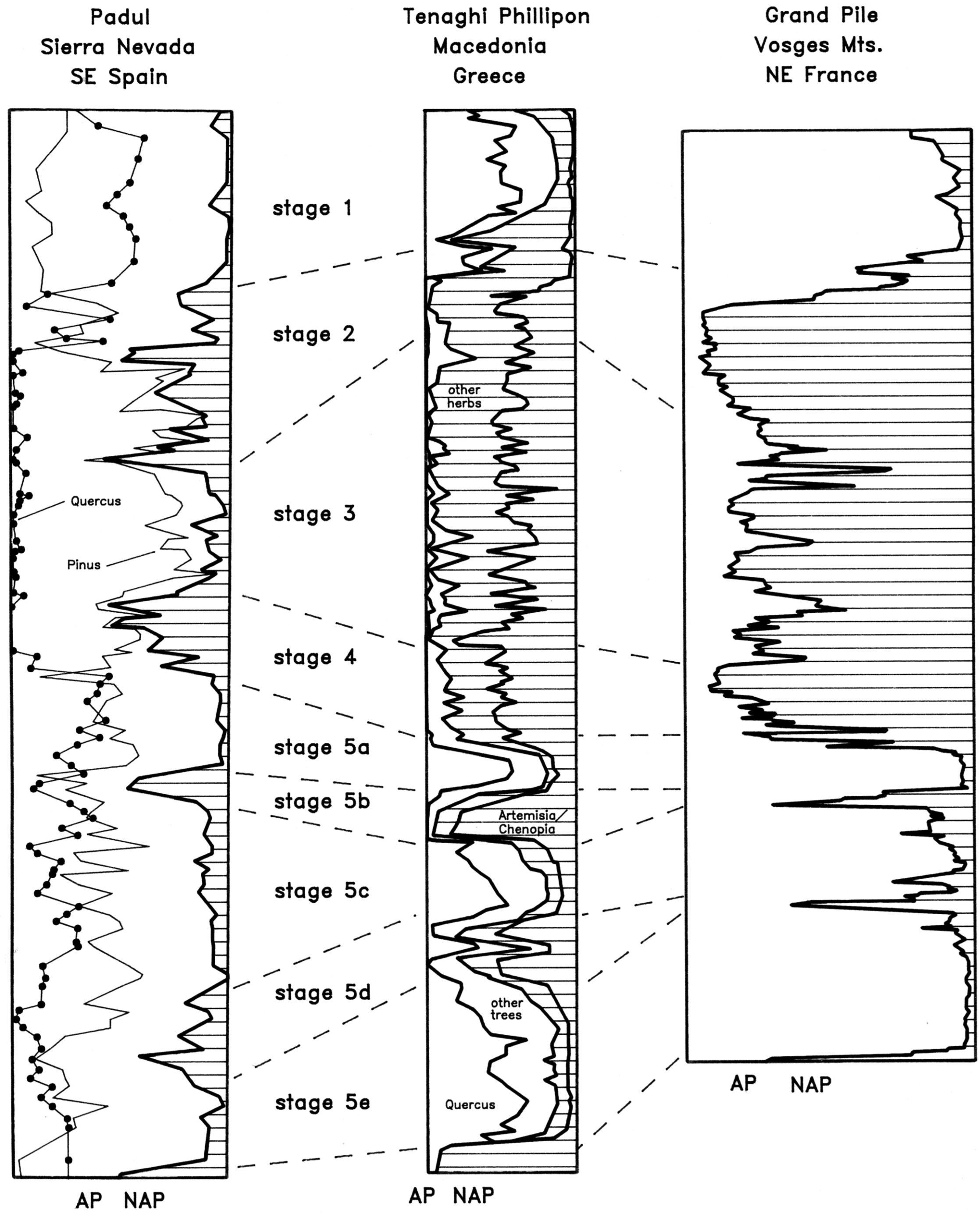



Figure 1.3. Upper Pleistocene pollen sequences

From Padul and Tenaghi Phillipon in the Mediterranean region and Grand Pile in northeastern France (from Florsch`tz, et.al, 1971; Van der Hammen, et.al., 1971; Wolliard and Mook, 1982). AP: arboreal pollen; NAP: non-arboreal pollen.

suggests that at least two short, but intense cold episodes alternated with periods of much more temperate conditions not much different than those of stage 5e during the early glacial in this region. At Padul, the first cold phase is accompanied by the spread of pine forest. This is followed by a return to an oak dominated open forest with pines. The second cold phase appears more severe and drier with the spread of Artemesia dominated step or parkland, with stands of pine and evergreen oak. This is again followed by the re-establishment of woodland, but of the evergreen oak dominated Mediterranean community (Florschütz, et.al., 1971).

Analogous patterns are observable elsewhere in the Mediterranean though the effects seem more pronounced north of Padul. Beach deposits in Mallorca that correspond to the early glacial include terra rossa paleosols that, when correlated with inland soils and colluvial sediments, suggest brief cooler (and possibly moister) episodes during overall temperate conditions (Butzer, 1975a). In Macedonia, the first cold phase is associated with the spread of steppe/parkland and the second is dominated by primarily treeless steppe. Intervening warm episodes see the re-establishment of oak dominated forest/woodland, though to successively lesser extents compared with stage 5e (Van der Hammen, et.al., 1971).

In Mediterranean France, shorter sequences at various archaeological and non-archaeological sites (including Borie-Verte, Ramandils, Grotte du Prince, Pié-Lombard, and La Calmette) indicate alternations between open, steppic vegetation and temperate (though often pine dominated) forest during this period (Renault-Miskovsky, 1976a; 1976b; 1986). Sedimentary data from this region agree with the pollen data in indicating a generally cool/temperate and humid character of this period, interrupted by two colder and drier episodes (Miskovsky, 1976).

The base of the pollen sequence at Lake Vico in western Italy seems associated with the last warmer episode, stage 5a. It suggests that a mixed, but pine dominated forest occurred in this area at that time (Frank, 1969). Finally, although its chronological position within the early Upper Pleistocene is the subject of some debate (see Butzer and Freeman, 1968; Butzer, 1975a), the pollen profile from Cueva del Tol in northeastern Spain indicates fluctuations between open steppe and pine dominated forest during the early glacial (Menéndez-Amor and Florschütz, 1962).

Stages 4 and 3 -- lower and middle pleniglacial. Overall, this period was characterized by significantly different environments than those of stage 5. A variety of data suggest that climate was significantly colder and often drier than during the preceding early glacial. Open steppic communities seem to have been prevalent throughout much of the Mediterranean at both low and high elevations. For most of this period, forest seems to have been restricted to a relatively narrow belt between the intense cold of high elevations and the aridity of low elevations. Within this general pattern, stage 4 seems to reflect the most rigorous conditions, while stage 3 appears to have been more variable with occasionally warmer temperatures and less aridity.

The site of Padul seems to have been near or in the forest belt throughout this period. While the pollen profile indicates open Artemesia steppe at the site during stage 4, arboreal pollen, particularly pine, continues in significant frequencies. During stage 3, arboreal pollen--primarily pine--dominates the spectra indicating a pine forest grew at the site (Florschütz, et.al., 1971). At the lower elevation of the Phillipon core, on the other hand, open steppe is indicated for the entire period, though there are small, but significant increases in the frequencies of arboreal taxa during stage 3 that indicate fluctuations in the position and extent of the forest belt.

In the Mediterranean France, pollen from the sites of Ramandils, Pié-Lombard, La Calmette, Tournal, Ioton, and l'Hortus indicates the extent of open steppe during much of this period, while spectra from l'Hortus and Saltpetre de Pompignan also show the establishment of pine forest during the milder parts of stage 3 (Renault-Miskovsky, 1976a; 1976b; 1986). Sediments from paleolithic sites, particularly cryoclastic debris in rock shelters, also indicate the much colder and generally drier character of this period (Miskovsky, 1976).

Pollen from Lake Vico, Italy indicates dry and cold conditions with open Artemesia steppe during stage 4 and somewhat moister conditions with open parkland during stage 3 (Frank, 1969). Additionally, sediments on Mallorca associated with this period suggest cool, dry conditions (Butzer, 1975a).

Fauna. Information about Upper Pleistocene fauna is not available in the amount of detail represented by floral and climatic data. However, there seems an overall correspondence between changes in large mammal communities and the general environmental parameters discussed above. Taxa throughout stage 5 seem predominantly dominated by forest associated forms reflecting the extent of woodlands during this period. In stages 4 and 3, while woodland forms are still important, especially in Spain, open country taxa such as horse and bison, and montane forms such as chamois and ibex become more prominent in faunal assemblages. Additionally, cold climate taxa such as woolly rhinoceros, woolly mammoth, and reindeer occasionally occur in faunal assemblages, though more in France than in Spain (de Lumley, 1969b; 1971; Waechter, 1964; Butzer and Freeman, 1968; Villaverde, 1984)

## The Middle Paleolithic in the Northwestern Mediterranean

### GENERAL CONSIDERATIONS

The northwestern Mediterranean region shares with the rest of western Europe a long history of study of Middle Paleolithic sites and artifacts. On the one hand this has meant that a substantial body of literature has accumulated that treats the cultural materials and their variability as well as their distribution in time and space. On the other hand, this long history of research means that many collections derive from excavations that took place many years ago, in which techniques and recovery strategies were used that would be unacceptable by modern standards. Also, in many cases, neither the cultural materials nor their contexts were described in detail and original records of the excavations (if indeed there were any) have been lost. The end result of this situation is that there exists a large amount of information of extremely variable quality for the Middle Paleolithic of this region.

For the French Midi, this situation has been improved considerably by the recent reanalysis and description of much of the older material and by new excavations at a number of sites, primarily by de Lumley and his co-workers (de Lumley, 1969b; 1971; 1976b; 1976c). Although de Lumley's work included the study of collections from a few sites in northeastern Spain, the great bulk of the Middle Paleolithic material from the Iberian Peninsula has never been systematically described.

Very recently, the quality of the Spanish data, too, has been improved as a result of a variety of studies. These include the reexcavation of important sites such as Cova Negra (Villaverde, 1984) and Abri Agut (in Mueller-Wille, 1983:115-124) and the systematic study and description of older collections (Mueller-Wille, 1983; Villaverde, 1984; Vega, 1980).

### APPROACHES TO THE MIDDLE PALEOLITHIC

In the above cited descriptive works, Bordes' (1961) Lower and Middle Paleolithic typology has been used, and provides a substantial typological base for the comparison of collections. This has permitted the assessment of the extent of variability in Middle Paleolithic assemblages and the spatial and temporal distribution of this variability within the northwestern Mediterranean region.

In fact, the primary goal of most of this work has been the comparison of assemblages on the basis of overall typological similarities and differences; the classification of assemblages within the recognized Mousterian industries and their variants; and the arrangement of classified assemblages in space and time (e.g., Villaverde, 1984). This general strategy has been widely used in the study of the Middle Paleolithic throughout western Europe (see Bordes, 1973). Explanations based on this strategy tend to see contemporaneous assemblage variability as arising out of cultural differences between distinct human groups, sometimes compared to tribes, and change through time as a result of evolutionary development (de Lumley, 1971:356-365).

A somewhat different approach to the Middle Paleolithic of this region is seen in the work of Mueller-Wille (1983). With a methodology based on the work of Freeman (1964; 1978), she has used multivariate statistical techniques to not only delineate similarities and dissimilarities among assemblages, but also to identify patterns of covariation between artifact types. Rather than classifying assemblages according to industrial variant, she suggests that "it might be more realistic and useful to envision a continuum or continua of variability, with many levels or assemblages falling into groups along such axes of variability , others falling between groups ..." (1983:305). She identifies two such axes, variability in the relative frequencies of denticulates and sidescrapers and in the relative frequencies of single and multiple edged sidescrapers, but stops short of offering an explanation for these patterns.

## TYPOLOGICAL VARIABILITY

It is not the purpose of the present study to undertake a comprehensive review of the assemblages and industries from the northwestern Mediterranean. However, several observations derived from the works cited above can serve to provide a context for collections studied here, within the general framework of Middle Paleolithic research in western Europe.

Those involved in systematically describing northwestern Mediterranean assemblages have noted that, while the collections can be described with Bordes' typology, they cannot be easily classified into any of the Mousterian industries identified in southwest France. The general response to this situation has been the creation of regional variants of the original five Mousterian industries as well as the definition of completely new industries. De Lumley, for example, identifies Para-Charentien, atypical Charentien, Quina Charentien, Ferrassie Charentien, denticulate-rich eastern Ferrassie, sidescraper-rich Typical Mousterian (with and without levallois debitage), sidescraper- and pseudo levallois point-rich Typical Mousterian, sidescraper- and blade-rich Typical Mousterian, and Typical Mousterian of denticulate facies (with and without levallois debitage) for assemblages he attributes to the Würm II alone (1971:362-363).

This points out another aspect of the Middle Paleolithic of the northwestern Mediterranean. Typologically at least, it appears quite varied. One result of this is that variants sometimes seem to bear little resemblance to the original Mousterian industry after which they are named. Thus, in the Typical Mousterian of denticulate facies of c. 17-26 of Hortus, the frequency of denticulates (Group IV ess) reach 48% while that of scrapers (IR ess) are only 14% (de Lumley, 1971:153-155). Another result of this is that there is often considerable variability within defined industries. Scraper frequencies, for example, vary from 28% in the Typical Mousterian of Macassargues to 82% in the Typical Mousterian of Bézal-de-Souvignargues (de Lumley, 1976c). Expansion of the criteria of defined industries so as to accommodate this variability can be taken to the point that the industries no longer have descriptive value. Villaverde (1984:212) notes this as a potential problem with sidescraper-rich Typical Mousterian and Para-Charentian industries.

It is apparent that the Middle Paleolithic of the northwestern Mediterranean can not be easily characterized within the scheme developed for the Perigord. This is not to say that these assemblages are radically different from others in France or elsewhere in western Europe, only that patterns of variability differ from those of southwestern France. In fact, this should be expected as the northwestern Mediterranean region covers a considerable geographic expanse and is relatively distant from the Perigord, both spatially and environmentally. Indeed, the present difficulties with traditional archaeological systematics in the northwestern Mediterranean region make it an interesting place for the study of the significance of variability in Middle Paleolithic artifacts.

## Introduction to the Present Study

During the past several years I have had an opportunity to undertake a study of variability in the Middle Paleolithic chipped stone tools from sites within the northwestern Mediterranean region. Specifically, these artifacts are from four sites in the Iberian Penninsula. While these sites, their deposits, and their assemblages are discussed in detail in the following chapters, a brief overview is presented here by way of introduction.

Two of the sites, Gorham's Cave and Devil's Tower rock shelter, are located along the western coast of Gibraltar (see Figure 1.4). Climatically, Gibraltar has hot, dry summers, and mild humid winters. The mean July daily maximum temperature is 28o C, and the minimum is 20o. Mean daily extremes for January are 16o and 10o. Mean annual precipitation is about 750 mm. Its seasonal distribution follows a typical Mediterranean pattern, with 80% falling from November through March (Pearce and Smith, 1984:372). Modern natural vegetation has been severely disturbed by the dense human settlement of the peninsula, but would probably be reconstructed as a mixed Mediterranean woodland.

The retouched tools from the Gorham's Cave and Devil's Tower assemblages were studied, comprising 95 and 45 pieces respectively. As is detailed in the next chapter, these artifacts derive from deposits that probably span much of the early Upper Pleistocene, from stage 5e through stage 4 and possibly stage 3. The Gorham's Cave collections are curated in the Institute of Archaeology, University of London, London and the Gibraltar Museum, Gibraltar. The collections from Devil's Tower are curated in The British Museum, London.

The other two sites, Cova del Salt and Cova del Pastor, are located near the town of Alcoy, in the coastal mountains of eastern Spain, midway between Valencia and Alicante (see Figure 1.4). At a higher elevation than Gibraltar and further inland (see Chapter 2), the Alcoy basin experiences slightly cooler winter temperatures. The mean for January is 9o C. Summers are hot, however, with a mean July temperature of 24o. The basin is somewhat drier than Gibraltar with a mean annual rainfall of 600 mm, with nearly 90% falling in Fall, Winter, and Spring (Linés Escardó, 1970). Natural vegetation is also severely disturbed in this region. Currently, most of the land not under cultivation supports mattorral shrub communities or olive groves, or is in the process of reforestation by fast growing pines. However, the natural vegetation is probably Mediterranean woodland grading into mixed deciduous forest in the mountains surrounding the basin.

The retouched tools studied from the Cova del Salt and Cova del Pastor assemblages comprised 908 and 45 pieces respectively. The Salt assemblages are from deposits that may be associated with the early glacial of stages 5d-5a, while those from Pastor are possibly associated with the more rigorous conditions of stage 4 or 3. The assemblages from these sites that I was able to study include the main part of the collections from Cova del Salt and a portion of the collections from Cova del Pastor, curated in the Museo Arqueológico Municipal, Camilo Visedo Molto, Alcoy, Alicante. The remainder of the Salt collections are curated by the Servicio de Investigación Prehistórica of Valencia and the University of Barcelona. A collection of pieces from the initial excavation of Pastor is in private hands.

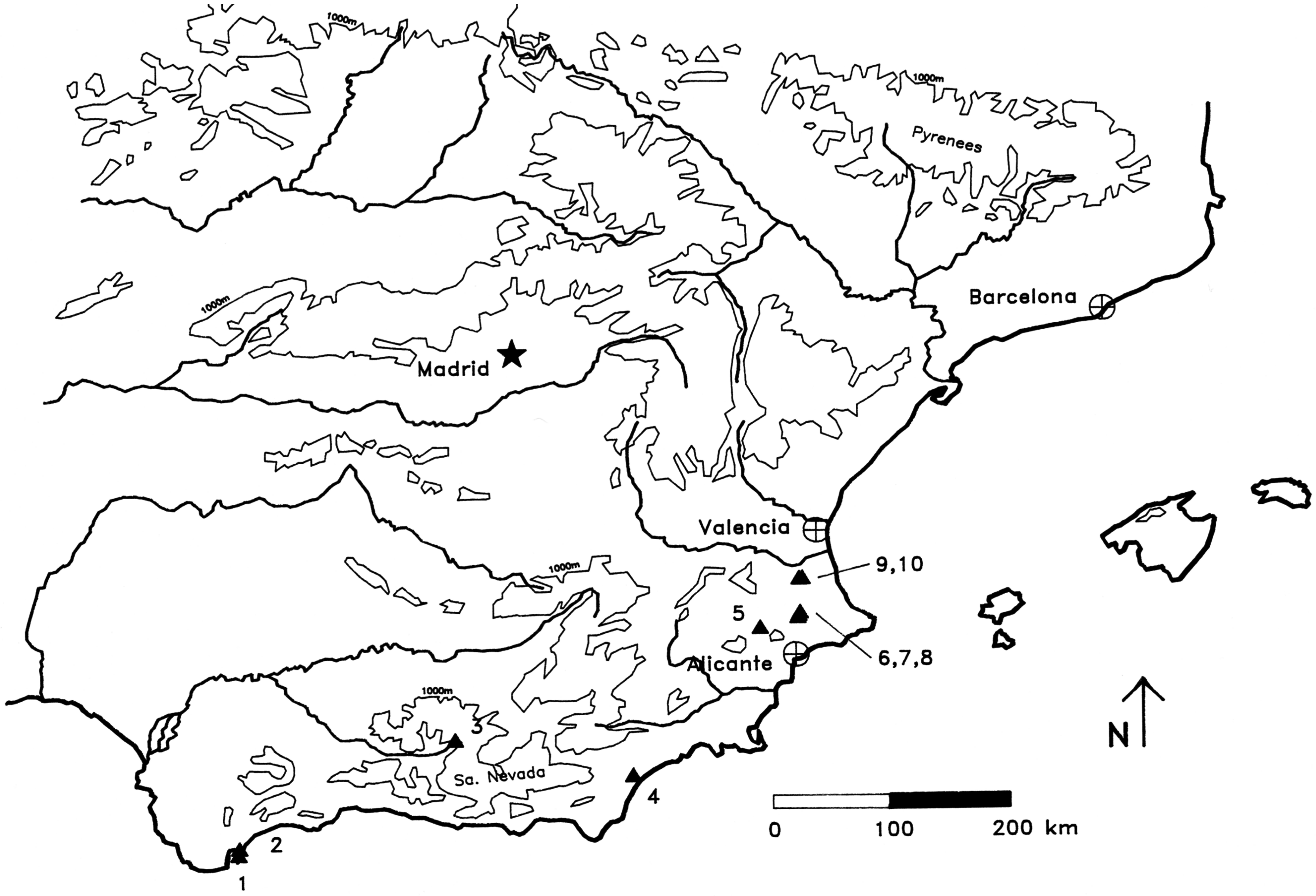



Figure 1.4. Locations of Iberian peninsula sites discussed in the text.

1) Gorham's Cave; 2) Devil's Tower; 3) Cueva de Cariguèla; 4) Zajara I; 5) Cova Cochino; 6) Cova del Salt; 7) Cova del Pastor; 8) Cova Beneito; 9 Cova Negra; 10) Cova Petxina. 1.000 m contour outlined.

The research described in the following chapters represents a departure from the types of analyses of Middle Paleolithic artifacts represented in the studies cited above. The present study is not restricted to a quantitative analysis based in the classification of artifacts according to Bordes' typology, but also emphasizes an investigation of both continuous and discrete morphological variability at the level of tool edges. This investigation resulted in neither a validation of the existing typological system nor the construction of a new "statistical" typology. Rather, it has led to the delineation of patterns of variability at the edge, piece, and assemblage level, and an attempt to explain these patterns in terms of human behavior.

# CHAPTER 2

# BACKGROUND AND DEPOSITIONAL CONTEXTS

The primary aim of this study is the description and interpretation of variability in Middle Paleolithic chipped stone assemblages. The contexts from which these assemblages derive, however, are important for establishing a spatial, chronological, and environmental framework within which they can be studied. Additionally, information about the way in which the assemblages were recovered and the degree to which they are representative of cultural materials originally left at the sites is a necessary background to the examination of lithic variablility.

The assemblages which provide the focus of this study are from four sites in the Iberian Penninsula--Gorham's Cave and Devil's Tower rock shelter in Gibraltar, and Cova del Pastor and Cova del Salt in the Alcoy Basin of the eastern coastal mountains of Spain. Gibraltar and the Alcoy Basin represent rather different environmental settings. Such differences could well have affected the range of Middle Paleolithic activities and related lithic variability. All four sites are rock shelter or cave sites containing relatively thick, stratified deposits from which the assemblages derive. These deposits provide valuable information about the chronological and paleoenvironmental context of the lithic assemblages studied. The depositional contexts of the assemblages can provide a framework for examining variability through time as well as with respect to environmental variability.

In this section, the general setting of the two areas and the history of research at the four sites are briefly summarized, and an overview of the cultural materials recovered is presented. Additionally, the depositional contexts of the assemblages studied are examined in detail in order to provide a framework for the analysis of lithic variability in the chapters that follow.

## Gibraltar

### SETTING

Gibraltar is a narrow peninsula that extends southward more than 4 km. from near the southern tip of the Iberian Peninsula. Composed primarily of Jurassic limestone, the Rock of Gibraltar rises to a height of over 400 m. at its northern end and continues in a ridge to the south, where it drops to the shelf of Europa Point. The northern and western faces of the Rock are very steep, with cliffs reaching over 300 m. in height. The eastern side slopes more gently from the crest to the sea. The Rock is connected to the mainland by a low sandy isthmus that rises to only about 3 m. above current mean sea level (MSL). The peninsula is almost 1.5 km. wide at this point, and narrows to only 0.5 km. at its southern tip (Garrod, et. al., 1928).

*Gorham's Cave*. Gorham's Cave is one of seven caves located on the eastern side of the Gibraltar peninsula, at the base of the cliffs which form this side of the Rock. The rock floor of the cave, not reached during excavation, lies at less than 9 m. above current MSL. The mouth of the cave opens to the east, about 40 m. from the water line. The modern beach, however, is an artifact of recent tunneling above the site and the cave may well have opened directly onto the sea in recent times.

The cave is about 10 m. wide at the mouth, and extends more than 50 m. into the Rock (Figure 2.1; Waechter 1951). Although the height of the opening is not reported by Waechter, based on my visit to the site I would estimate it to be nearly 10 m. The cave was originally filled with deposits, primarily sand, reaching a maximum height of 17 m. above

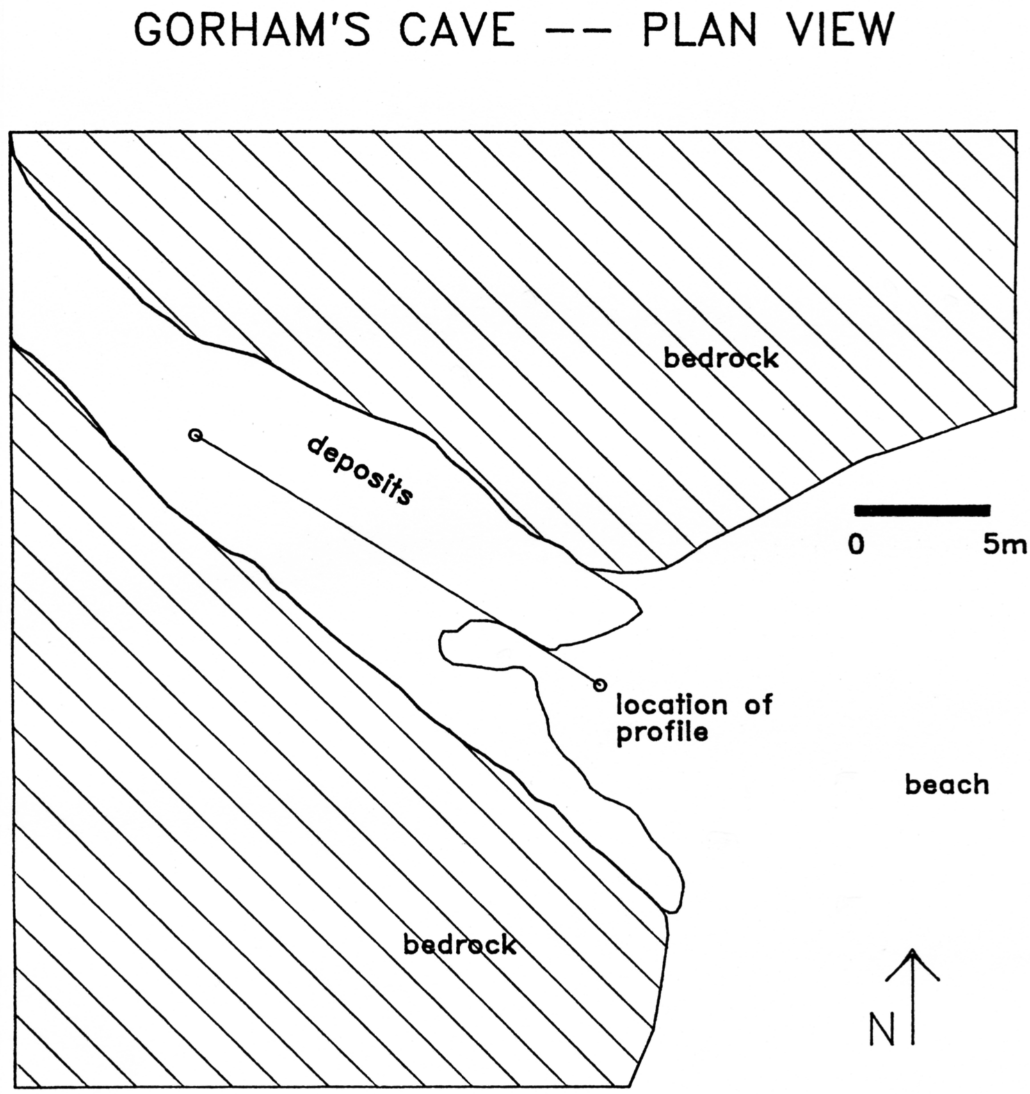



Figure 2.1. Plan view of Gorham's Cave.

sea level. The front edge of these deposits presented a steep scarp, where it had been notched by action of waves that reach the cave during storms. Below the scarp, the sandy deposits sloped downward to the sea.

*Devil's Tower Rock Shelter*. Devil's Tower Rock Shelter is a narrow fissure in the northeastern face of the Rock of Gibraltar (Figure 2.2). Its floor is 9 m. above the level of the Mediterranean, which lies less than 300 m. to the east. The fissure has a maximum height of 12 m, a maximum width of 1.2 m, and extends obliquely into the Rock for about 4 m. before narrowing to a crack (Garrod, et. al., 1928). When first discovered, it was filled to the roof with fine sand, and sandy talus sloped steeply downward from the shelter to the level of the narrow isthmus that connects Gibraltar with the Spanish mainland.

## HISTORY OF RESEARCH

*Gorham's Cave*. The cave is named after Major A. Gorham, who explored the cave in 1907. The archaeological deposits were noted some time after this by Captain G.B. Alexander and Lieutenent Monke who excavated in the upper layers of the site. Formal excavation of the site was directed by J. d'A. Waechter, beginning in 1948 and ending in 1954 (Waechter 1951; 1964).

An initial sounding in 1948, revealed 5 m. of stratified deposits. Subsequent excavation, in the form of a series of steps extending back from the scarp described above, exposed nearly 8 m. of stratified deposits without reaching the rock floor of the cave. The deposits were divided into 26 discretely lettered and numbered layers, from A to U, that are described below and in Table 2.1. As can be noted in Figure 2.3, while the upper layers were excavated over a large part of the site, only a relatively small portion of the lowest layers was excavated.

*Devil's Tower*. Although only 350 m. east of Forbes Quarry, the site of the earliest known discovery of Neanderthal remains in 1848, Devil's Tower Rock Shelter was not recognized as a possible paleolithic site until 1917 when the Abbé Breuil noticed fossil bones eroding from the talus below the site. In 1919, Breuil and Col. Willoughby Verner excavated a test trench in the talus, recovering faunal remains and chipped stone implements they identified as Mousterian.

At Breuil's suggestion, Dorothy A.E. Garrod excavated the shelter and its talus in several field seasons, totaling seven months, between November 1925 and January 1927 and recovered the lithic assemblages studied here. The excavation is described in a fashion rather typical of the era. "The work carried out consisted of emptying the cave down to the rock floor and removing the talus or terrace deposits over an area extending from the rock wall which bounded them on the west to a line 4.5 m. to the east of the cave mouth. Seven layers of deposit were revealed in this way..." (Garrod, et. al., 1928). Fortunately, the deposits excavated and materials recovered were described in considerably more detail and are discussed below.

Garrod divided the more than 10 m. of deposits at Devil's Tower into seven geologic layers that filled the shelter and extended onto the talus in front of it. Additionally, she defined a layer of sand that she called the "wash", primarily derived from erosion of the deposits and covering them outside the shelter. Beneath the uppermost layer of sand and the "wash", the deposits extend horizontally from the shelter, forming a sort of terrace in front of it (see Figure 2.2). The deposits are shown in Figure 2.4 and briefly described in Table 2.2.

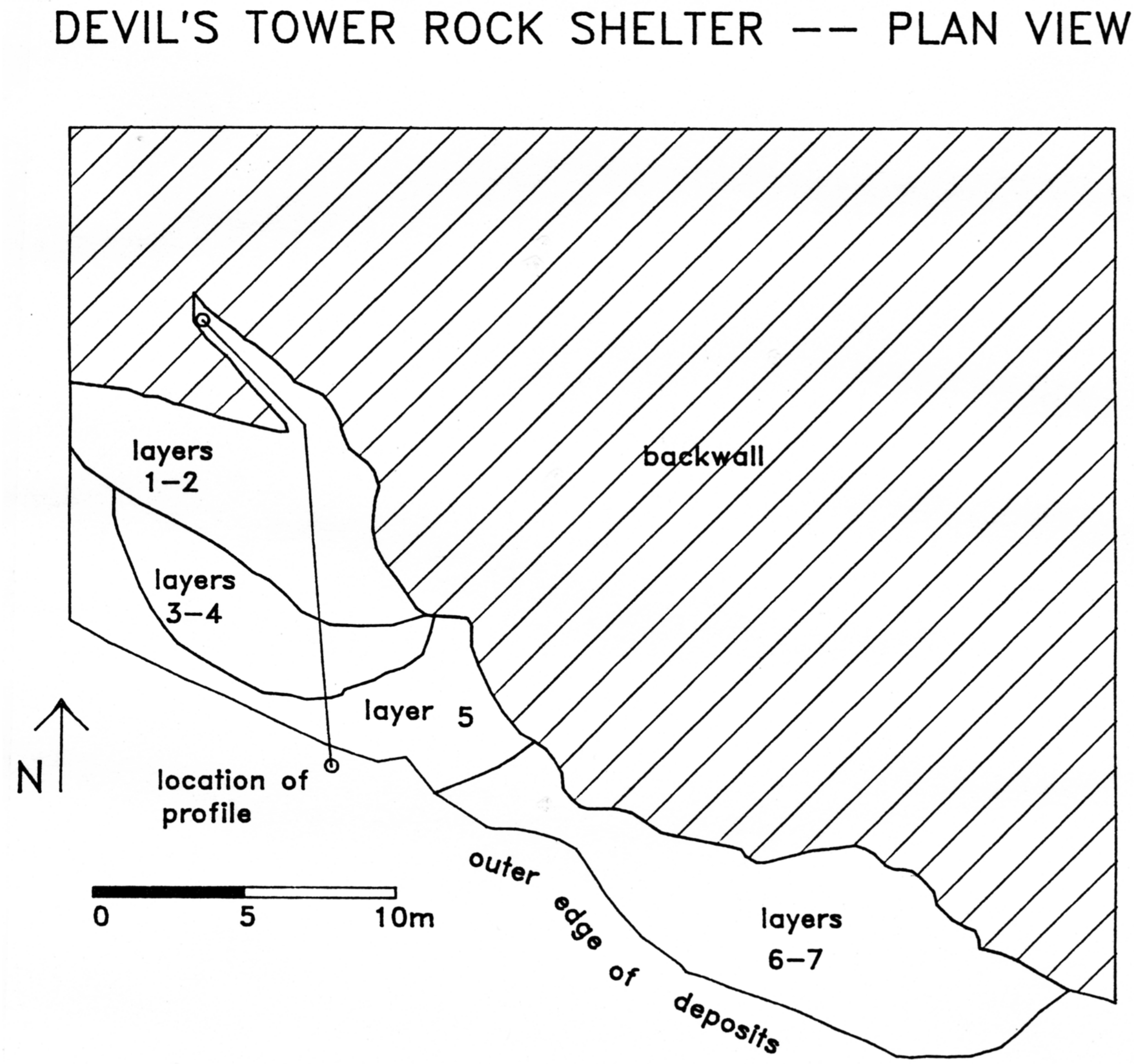



Figure 2.2. Plan view of Devil's Tower rock shelter.

Table 2.1. Stratigraphy of Gorham's Cave.

Based on Zeuner (1953) and Waechter (1951; 1964)
(Elevation in meters above Mean Sea Level)

| | |
|---|---|
| Layer A | 17.40-17.30 m. Surface stratum with much organic matter. Primarily consists of sand and bat guano. |
| 4th stalagmite | Included in thickness of A. Solid sheet of $CaCO_3$ stalagmite that sealed the layers beneath. |
| Layer B | 17.30-17.10 m. Clean yellow sand with pieces of angular limestone. Slightly compact at top and very hard at base. Scattered charcoal. |
| Layer D1-D2 | 17.10-16.80 m. D1: slightly clayey sand darkened with abundant charcoal. D2: subdivision in which sand contains charcoal occurring in compact lenses or hearths. Contains water worn pebbles interpreted as used to line hearths. |
| Layer E | 16.80-16.70 m. Sand with flecks of charcoal, strongly cemented in parts. Contains discontinuous lenses of small pebbles. |
| 3rd stalagmite | 16.70-16.60 m. |
| Layer F1-F3 | 16.60-16.20 m. F1: sand darkened with abundant charcoal, occasionally in lenses or hearths. F2: lighter sand with flecks of charcoal. F3: dark sand. |
| Layer G | 16.20-15.45 m. Streaky, slighty sticky sand with scattered charcoal. |
| Layer H | 15.45-15.00 m. Deep yellow sand with angular fragments of rock at base. |
| 2nd stalagmite | 15.00-14.90 m. |
| Layer J1-J2 | 14.90-14.70 m. J1: brown, clayey silty sand. "Tougher" and more clayey. May be an organic or weathering horizon. J2: slightly orange clayey silty sand. Softer and sandier. Incipient B horizon? |
| 1st stalagmite | 14.70-14.65 m. Sandy stalagmitic layer. |
| Layer K | 14.65-14.15 m. Dark, "tough" (ie., clayey) sand. |
| Layer L | 14.15-13.75 m. Clean yellow sand with gravel or pebbles. |
| Layer M | 13.75-13.10 m. Dark, "tough" sand. |
| Layer N/O | 13.10-12.40 m. Sand with some gravel; more near top of layer. |
| Layer P | 12.40-12.30 m. Dark sand with scattered charcoal. |
| Layer Q | 12.30-12.00 m. Clean yellow sand. |
| Layer R | 12.00-11.00 m. Yellow sand with dark, sticky lenses, pebbles, and patches of stalagmite. |
| Layer S1-S3 | 11.00-10.60 m. S1: dark clayey sand. S2: light and dark sands interstratified. S3: sticky sandy clay. |
| Layer T | 9.90- 9.70 m. Cemented upper part of beach deposit containing shell and bone. |
| Layer U | 9.70- ? m. Fine beach sand. |

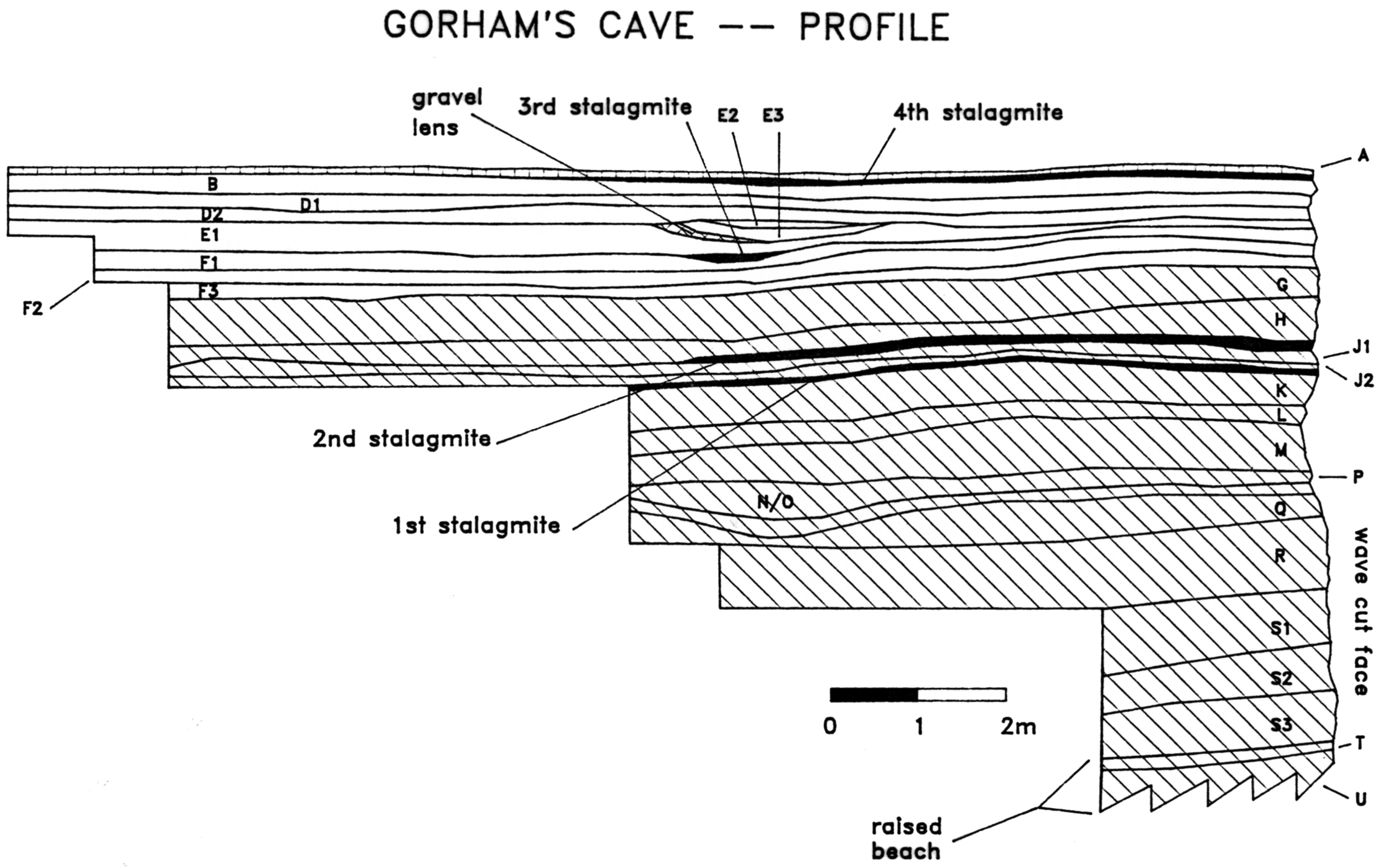



Figure 2.3. Profile Gorham's Cave deposits.

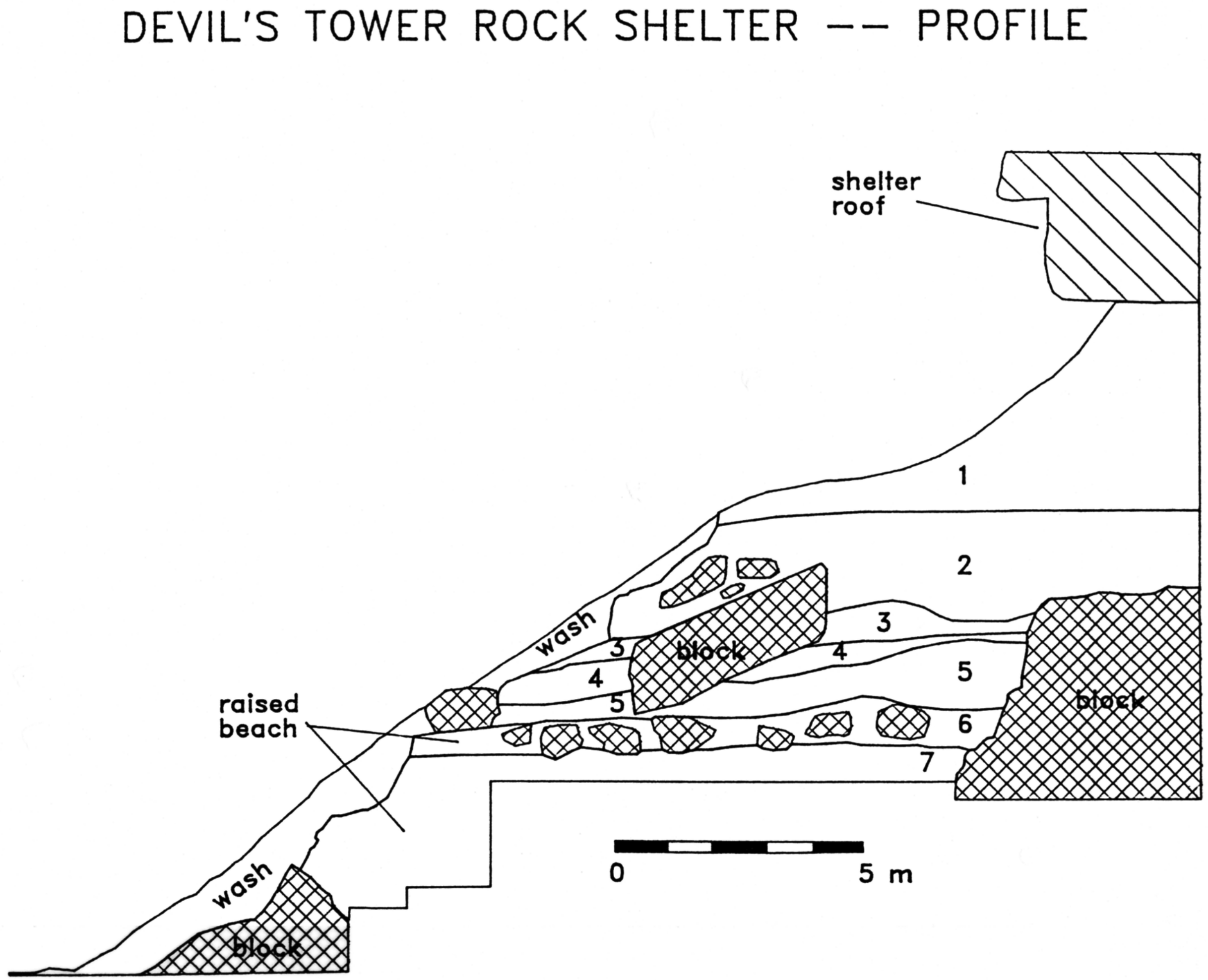



Figure 2.4. Profile Devil's Tower deposits.

Table 2.2. Stratigraphy of Devil's Tower Rock Shelter.

Based on Garrod, et. al. (1928)

| | |
|---|---|
| Layer 1 | Light yellow, fine sand 1.5-4.5 m. thick, extending a maximum of 4 m from the mouth of the shelter. Color darkens toward base of layer. Strongly cemented inside the shelter, but soft and friable at the mouth and outside the shelter. Originally filled the shelter to the roof and merged with the "wash" outside the shelter. |
| Layer 2 | Calcareous tufa of varying consistency, 1-4 m. thick, extending an average of 4 m from the shelter. Contains numerous angular cobbles and blocks of limestone. Divided into three sub-layers, 2a-2c. |
| 2a | Dark, tufaceous clay, 1.5 m thick, becoming more sandy away from the shelter. Truncated in front of the shelter by a cut channel. |
| 2b | Porous tufa, 1.5 m thick, with a consistency varying from "moderately hard travertine" to "tough sticky clay", and containing occasional pockets of fine sand. Merges into massive sand deposits 4 m east of the shelter. |
| 2c | "Whitish crumbling tufa", 0.4-1.0 m thick, merging with sand to the east. |
| Layer 3 | Fine yellowish sand, 0.2-1.0 m thick, extending an average of 6 m from the shelter mouth. A "well marked hearth" present over nearly the entire layer, sand especially blackened near its outer edge east of the shelter. Merges with "reddish cave-earth" inside the shelter, and abuts a group of rocks that block the fissure in the rear of the shelter. Garrod notes that, "A curious feature of this level was a collection of small objects brought from the beach--quantities of ittle pebbles, a few rolled fragments of shell..., and a shark's tooth." $^{14}C$ date of >30,000 BP (Almagro Gorbea, 1970) |
| Layer 4 | Brownish-grey travertine or tufa, 0.1-0.8 m thick, extending an average of 6 m from the shelter. Very strongly cemented on the terrace in front of the shelter, more so to the west than to the east, where it eventually merges with a loose massive sand. Within the shelter, it is a less cemented, porous, crumbly tufa. Abuts the group of rocks mentioned above. Garrod notes a "confused mass of bone", shell, and artifacts adjacent to the western edge of the shelter that she interprets as the result of pooling water. |
| Layer 5 | Fine yellowish sand, 0.4-1.4 m thick, extending an average of 8 m from the shelter. Well cemented in the basal 30 cm. Inside the shelter, the deposit becomes dark brown and clayey. |
| Layer 6 | Pink travertine, 0.5-0.75 m thick, extending about 8 m from the mouth of the shelter. Contains weathered beach cobbles and very strongly cemented outside the shelter. Inside, it merges with a "crumbling dark-coloured tufa". |
| Layer 7 | Raised beach with a surface 8-9 m above current mean sea level. Composed of sea worn pebbles and cobbles, and sand with abundant marine shells. Extends around 8 m from the face of the rock, its outer edge forming a steep scarp 4.5 m high. Appears to extend both east and west of the shelter, and merges with marine sands underlying the isthmus that connects Gibraltar with the mainland. Bottom of deposit was not reached in a 3.5 m deep trench opposite the shelter. |

STRATIGRAPHY AND CHRONOLOGY

*Gorham's Cave*. The Stratigraphy and chronology of Gorham's Cave is discussed in Waechter (1951; 1964) and Zeuner (1953). The information presented here and in Table 2.1 represents a summary of Waechter's and Zeuner's descriptions and a reinterpretation of some of the conclusions in the light of recent knowledge of Upper Pleistocene chronology. The deposit consists primarily of sand, the lowermost member of which is a beach deposit. The sands are interstratified with occasional clayey and/or stalagmitic layers. These latter, provide important markers for environmental changes at the site and, hence, a basis for developing a chronology.

Based on the size and morphology of the sand grains, and structure of the beds, Zeuner (1953) suggested that the sands in the deposits are primarily the result of aeolian transport and deposition of sand from an extensive foreshore and beach fronting the cave. The existance of such a foreshore would require a lower sea level than that of the present. Hence, he correlated the sands with the eustatically lowered sea levels resulting from the growth of land ice. Conversely, the clayey and stalagmitic levels, also tending to show relatively high levels of organic residues, are very similar to the surface layer currently forming in the cave. These levels he associated with conditions approximating the warm temperatures and humidity (accompanied by water trickling through the cave) of the present day.

In addition to the environmental fluctuations represented in the sediments of the site, several other lines of evidence are useful for establishing a chronology for the site. The Mediterranean reached the cave at least twice before the present, once when it formed (or at least scoured out) the cave leaving the beach sands of layers T and U, and a second time when waves cut into consolidated cave sediments on the north side of the entrance (Zeuner, 1953). The cultural material (discussed below and in Chapters 4 and 5) also provides chronologically relevant information. Most of the artifacts from layer A have Punic associations, confirming the recent age of this layer. Layers B through F contain bone and lithic artifacts that are almost certainly Upper Paleolithic. Layers G through U produced a series of assemblages that would be typologically associated with the Middle and Lower Paleolithic (Waechter, 1951; 1964). Finally, a series of radiocarbon dates from the site provides an absolute age for two of the layers. Two samples from layer D have been dated to 27,860 ± 300 BP and 28,700 ± 200 BP. Two samples from layer G have been dated to 47,700 ± 1,500 BP and 49,200 ± 3,200 BP (Oakley in Waechter, 1964).

On the basis of these data, a chronology for the deposits at Gorham's Cave can be proposed. This is summarized in Table 2.3. In this scheme, layers U through R would represent the last interglacial, or oxygen isotope stage 5e. Layers U and T are composed of beach sand and represent the highest sea level at the site, 8-9 m. above current mean sea level. Raised beaches and wave cut platforms are found at about the same elevation at a variety of localities in Gibraltar as well as much of the rest of the western Mediterranean littoral (Butzer, 1975; Freeman, 1981; Zeuner, 1953). Although there are several beach and platform horizons at this elevation but of different ages, the one associated with the last interglacial would correlate with stage 5e and has been dated on Mallorca by Uranium series methods to 125,000 ± 10,000 BP (Butzer, 1975). However, the difficulties of correlating raised beach deposits leaves the assignment of layers U and T to stage 5e open to some question (Ibid.).

Layers S3-S1 are predominantly clayey sand. This thick series seem to represent a period of low sea level that exposed a sandy foreshore to the wind, but accompanied by relatively humid conditions. Layers Q through K represent another period of low sea level, but with greater local aridity, as evidenced by the lack of carbonate deposits, organic residues, and fine sediments.

Conversely, the carbonates of layer R and especially the first and second stalagmite with intervening layer J represent conditions much more similar to those of the present,

Table 2.3. Suggested chronology for Gorham's Cave and Devil's Tower.

| GORHAM'S CAVE STRATIGRAPHY | DEVIL'S TOWER STRATIGRAPHY | ISOTOPE STAGES | $^{14}C$ DATES |
|---|---|---|---|
| A surface stratum with organics | no deposits ? | 1 | |
| 4th stalagmite | | | |
| B sand | | 2 | |
| D sand | | | 27,860; 28,700 Gorham's Cave layer D |
| E sand | | | |
| 3rd stalagmite | | | |
| F sand | | 3 | |
| G sand | 1 fine sand | | 47,700; 49,200 Gorham's Cave layer G |
| H sand | | 4 | |
| 2nd stalagmite | 2 various tufas, travertines, and some sand | 5a | |
| J clayey, silty sand | | | |
| 1st stalagmite | | | |
| K sand | 3 sand | 5b | >30,000 Devil's Tower, layer 3 |
| L sand | | | |
| M sand | | | |
| N sand and some gravel | | | |
| O sand | | | |
| P sand | | | |
| Q sand | | | |
| R light and dark sand with stalagmite | 4 tufa | 5c | |
| S1 dark clayey sand | 5 sand, lower part cemented | 5d | |
| S2 light and dark sand | | | |
| S3 sticky sandy clay | | | |
| T cemented beach sand | 6 travertine | 5e? | |
| U beach sand | 7 beach deposit | | |

accompanied by a reduction in sand deposition. Zeuner (1953) also correlated storm wave erosion at the mouth of the cave with layer J, suggesting a sea level close to that of the cave but not as high as in the lower beach deposits.

As a group, layers S3 through the 2nd stalagmite seem best correlated with the early glacial of isotope stages 5d-5a. In such a correlation, the carbonate horizons would be most likely represent the relatively mesic environmental conditions associated with stages 5c and 5a, while the sand layers represent the episodes of more glacial climate of stages 5d and 5b. The the more humid conditions of the first sand series (layers S3-S1) and the greater aridity of the second series (lQ-K) agrees with pollen data for the Mediterranean region for environments of stages 5d and 5b respectively. Likewise, marine core data suggest that the last moderately high sea level was during stage 5a, but that it was below the level of stage 5e. The wave erosion associated with layer J is the last evidence for a moderately high sea level at the site, but not as high as the lower beach deposits.

These layers are followed by a series of sand deposits (H-F) and the third stalagmite. The sands indicate that a sand source was once again active and that local conditions were drier. This is followed by a brief return to more humid conditions (the third stalagmite). This series of deposits could correlate with lower and middle pleniglacial conditions of stages 4 and 3. The sand layer H would correlate with the climatic deterioration and low sea level of the onset of full glacial conditions. Sand layers G and F seem to represent similar conditions, though they have higher organic contents than H (Zeuner, 1953). The radiocarbon dates for G suggests that it may be associated with stage 3, while the Upper Paleolithic industry of F indicates that it is probably no older than this stage. The third stalgmite suggests increased humidity such as associated with part of stage 3 in pollen data from the region.

Another series of sands follows (layers E-B), indicating a drop in available moisture. The radiocarbon dates for layer D make the correlation between these sands and the glacial maximum of stage 2 quite reasonable. This is followed by a stalagmitic layer and the much less sandy layer A, marking a return to interglacial conditions (ie., stage 1).

*Devil's Tower*. Although the chronology of Devil's Tower was discussed by Garrod (1928), the stratigraphy has never been restudied with respect to current knowledge about Upper Pleistocene chronology and climatic variation. A possible chronology can be suggested, however, based on Garrod's descriptions of the deposits and Zeuner (1953) analysis of the sediments at Gorham's Cave discussed above.

The base of the Devil's Tower sequence is a raised beach (layer 7) 8-9 m. above mean sea level. Garrod equates this beach with the last interglacial. It is the same height as the one that Zeuner describes at Gorham's Cave (layer U) and represents the last time the sea was high enough to reach the site. This would suggest that like layer U at Gorham's Cave, this deposit would most likely date to the last interglacial, stage 5e (see above). Layer 6, merely the cemented upper part of this beach and equivalent to layer T at Gorham's Cave, would then also date stage 5e.

At the upper end of the sequence, Garrod ascribes the "six rough flakes of quartzite, and a few fragments" from layer 1 to the Middle Paleolithic. There are too few pieces to be sure, but the lack of blades does not conflict with this suggestion. On the other hand, the retouched pieces of layer 2 are almost certainly Middle Paleolithic (see Chapters 4 and 5). This would indicate a date of no later than late stage 3 (c. 35,000 BP) for at least layer 2, and possibly layer 1. A $^{14}C$ date from layer 3 is inconclusive, giving an age of > 30,000 BP (Almagro Gorbea, 1970).

If a rather straightforward correlation between the deposits of Gorham's Cave and Devil's Tower Rock Shelter is postulated, a somewhat more detailed chronology can be established. Such a correlation, although without direct stratigraphically evidence, is not unreasonable. Both sites are in similar topographic settings; they are both cavities, opening to the sea in the eastern face of the Rock, at about the same elevation. Also, the sites are only a few kilometers apart. It seems reasonable to assume, then, that the sediments at both sites might be the result of geomorphic processes, controlled at least in part by fluctuations in local environmental conditions affecting both sites in a similar fashion.

At Gorham's Cave, the alternating layers of sands and carbonates/fine sediments/organics are interpreted as the combined result of eustatic fluctuations in sea-level and the (possibly related) amount of water available in the Rock for seepage and spring activity (see above). Similarly, alternating layers of sand and tufa/travertine are found at Devil's Tower. Beginning with the beach deposits, a possible correlation of aeolian sand and carbonate deposits between the two sites is proposed in Table 2.3. In this scheme, nearly all of the sequence would be associated with stage 5. Layers 2 through 5, representing the early glacial of stages 5d-5a would be ≥ 75,000 years in age; if the raised beach represents stage 5e it would be upwards of 120,000 years in age. Layer 1, then, is most likely correlated with the climatic deterioration that began in stage 4. Unlike the sequence at Gorham's Cave, there is no clear cultural evidence for deposits more recent than stage 3. On the other hand, layer 1 is very thick (over 4 m in places) and could well represent a considerable length of time. It is possible that this layer, along with the secondary deposit, the "wash" could encompass all of the full glacial and Holocene (stages 4-1).

## UPPER PLEISTOCENE ENVIRONMENTS AT GIBRALTAR

*Sediments*. Sedimentary evidence at both Gorham's Cave and Devil's Tower points to at least a slightly drier and possibly cooler climate at the site for most of the period of Paleolithic occupation. The many aeolian sand layers at Gorham's Cave--without evidence of weathering, a substantial fine sediment component, or stalagmitic carbonates--suggest that the cave was relatively dry during the time of their deposition. Additionally, these sands suggest that during times of lowered sea level, there was insufficient vegetation to stabilize the exposed foreshore sands and prevent significant wind erosion. In fact, Zeuner (1953) identified only a single soil horizon in in the massive sand beds that accumulated against the eastern side of the Rock, above Catalan Bay, since the formation of a wave cut platform 17-18 m. above sea level (presumably dating to the Middle Pleistocene, and certainly predating the sediments in Gorham's Cave). Such evidence also suggests relative aridity.

Similar conditions seem to be represented in the unweathered, aeolian sand deposits at Devil's Tower. These also suggest that low sea level exposed a greater expanse of minimally stabilized sandy foreshore from which the wind could blow sand against the Rock and into the fissure. Additionally, the lack of carbonates in these beds suggests that the periodically active springs at the site were inoperative at such times.

The apparent aridity at both sites could be a result of either a relative drop in effective precipitation or the lowered sea level, or a combination of the two phenomena. A decrease in effective precipitation would reduce the amount of water available in the Rock for springs; lower sea level could cause a drop in the local water table and also decrease spring activity at the base of the Rock.

Sedimentary evidence for cooler temperatures associated with the sand layers is considerably more equivocal at Gorham's Cave and lacking at Devil's Tower. Subangular limestone debris in layer N/O of Gorham's Cave could be partly cryogenic in origin (Zeuner, 1953). However, Butzer (1964) suggests that true cryogenic deposits may be rare to nonexistent at low elevations in the western Mediterranean, although the data from his extensive study of Mallorcan sediments do suggest January mean temperatures $5^{o}$-$10^{o}$ below those of today during the last glacial (Butzer, 1964; 1975).

The layers of more calcareous and clayey/silty/organic sediment at Gorham's Cave are more easily interpreted as they are very similar to those forming today (Zeuner, 1953). They suggest temperate and humid conditions in the cave, like those of the present.

At Devil's Tower, the calcium carbonate beds are very probably a result of local spring activity, especially as these deposits tend to merge in a facies relationship with massive sands a relatively short distance from the shelter. On the other hand, I observed a similar sequence of sands and tufa/travertine layers a few hundred meters southwest of the site. While not suggesting that these deposits would directly correlate with those of the shelter, their presence indicates that the carbonates may be a result of phenomena that affected more than just the immediate vicinity of the site.

These tufa/travertine layers suggest locally moister and possibly warmer conditions than during the formation of the sand beds (see Bresson, et. al., 1973; Butzer, 1963; 1975). Additionally, if the darker color of the carbonates is due to a higher organic content as is the case at Gorham's Cave, it would suggest that more vegetation was growing at the time of their deposition than during the deposition of the sand layers

Finally, the cemented portion of the beach deposits at both sites (layer T at Gorham's Cave and layer 6 at Devil's Tower) appears characteristic of processes currently operating in the western Mediterranean littoral (Alexandersson, 1972:203-223).

In summary, sedimentary evidence suggests that the immediate environments of both sites, and possibly that of Gibraltar as a whole, was somewhat drier and possibly slightly cooler during the episodes of sand deposition. These are correlated with the periods of glacial maxima during the early Upper Pleistocene. The periods of carbonate deposition are correlated with interglacial and interstadial conditions. Environments similar to those of the present are suggested for such times.

*Fauna*. The marine molluscs from the sites might provide some evidence for variations in sea temperatures during part of the sequence, assuming they were transported from the beach to the cave while alive or relatively shortly after death. Prior to layer G at Gorham's Cave, all species found in the deposits are those currently found in the Mediterranean or in the Atlantic, ranging from Gibraltar, south (Baden-Powell, in Waechter, 1964). Beginning in layer G and continuing through layer B, a number of Atlantic species that range from Gibraltar, north join the assemblage. Additionally, in layers D and B are found representatives of two north Atlantic species (*Modiolus modiolus* and *Nucilla lapillus*) that are not currently found in the coastal waters of Gibraltar (Ibid.). This would suggest that water temperatures were cooler than present in the time period dating from layer G through layer B. However, the sample size in these upper layers is much greater than that of the lower layers and may be the primary reason for this apparent difference.

At Devil's Tower, the overwhelming majority of the taxa from the beach level are found in the Mediterranean today. The range of the few found only in the Atlantic is not specified. In the other levels, the majority of the specimens is also of an Atlantic species of unspecified range, *Patella vulgata* (Fischer in Garrod, et. al., 1928).

The remains of mammalian fauna, while abundant, are even less informative from an environmental standpoint than are the molluscs. The fauna from Gorham's Cave are listed according to numbers of elements present for each taxon in each level (Baden-Powell, in Waechter, 1964). Although there is some disagreement as to the value of using number of elements (verses minimum number of individuals) to assess relative abundance of different species (see Chase, 1983:11-16, 18; Perkins and Daly, 1968; Klein and Cruz-Uribe, 1984:24-38), the relative number of elements can provide this information, at least to a limited degree (its major problem being overrepresentation of more abundant taxa).

The faunal counts from Gorham's Cave have been converted to percent of total elements by level in Table 2.4. Additionally, these percents are summed for several groups of taxa with similar environmental associations. The groups include: a steppic, a Mediterranean/temperate forest, and a montane group for large herbivores; a rabbit group (as they are the most numerous of the fauna and possibly the most local to the rocky cliffs and sandy foreshore in the immediate vicinity of the site); and a carnivore group (to assess the potential for non-human carnivores being responsible for the assemblage).

Most of the terrestrial fauna represented at both sites would be native to the region today (Corbett, 1978:216) with horse, rhinoceros, elephant, and some of the large carnivores being the primary exceptions (and all but rhinoceros and elephant probably lived in the area during the early Holocene). With the exception of layers H and I, which have very small samples, members of the steppe group are consistently rare throughout the sequence. Grassland environments are currently very rare in the vicinity of the site and also appear to have been so in the past. Mediterranean forest and montane rocky slopes are currently found in the immediate vicinity of the cave. These environments are those best represented by the large ungulate remains.

Additionally, relative fluctuations among the different ungulate groups do not appear to coincide with sedimentary data. Members of the forest group tend to be more frequent in layers U-G, and less frequent in layers F-A. Members of the montane group are relatively frequent in layers P-M, K, and B, which may be cooler and more arid based on sedimentary and stratigraphic data. But they are also frequent in layers U and A, which represent interglacial conditions, and rare in F-D which are correlated with the glacial maximum.

While variability in relative abundance of taxa do not seem to provide a consistent environmental picture, they may provide information about human hunting strategies and their change through time. The most readily apparent pattern in faunal variability is that in the Middle Paleolithic layers (U-G), large ungulates are more frequent and rabbits less so than in the Upper Paleolithic and modern layers (F-A). The relative frequency of carnivore remains is very low throughout the entire sequence, suggesting that the majority of the faunal remains result from human hunting (see Klein and Cruz-Uribe, 1984:84). This would suggest that there was a greater emphasis on the hunting of large ungulates during the Middle Paleolithic than during later occupations of the site. Nevertheless, fauna from all three environmental zones remained accessible to the occupants of the site, but those from the forest and montane zones were most readily available--the conditions which exist today.

For Devil's Tower, the fauna are only listed according to taxa present, with a few notes on relative abundance, for all layers combined (Bate in Garrod, et. al., 1928). These are shown in Table 2.5. The same groups are represented at Devil's Tower as are found at Gorham's Cave. Rabbits (*Oryctolagus cuniculus*) are, as at Gorham's Cave, the most numerous of the mammalian taxa, and probably represent local inhabitants of the rocky talus and sandy foreshore. Remains of members of the forest and montane groups, including pig , red deer, and ibex are described as relatively abundant, while those of the steppic group (ie., horse) are comparatively rare. This closely parallels the overall distribution of taxa at Gorham's Cave.

*Flora*. Direct information about the vegetation is almost entirely lacking for both sites. Analyzed macrobotanical remains are only reported from Gorham's Cave, and are confined to possible seed fragments of *Pinus pinea* from layer B; charcoal from pine (*P. pinea*) and boxwood (*Buxus sp.*) from layer D; and charcoal and cone fragments of pine (*P. pinea*) from layer G (Metcalf in Waechter, 1964). All of these trees could grow in the area naturally today.

In summary, environmental fluctuations recorded at the Gibraltar sites during the Upper Pleistocene include variations in the amount of land area, primarily sandy foreshore, depending on sea level; fluctuations in available water, possibly linked to variability in the

Table 2.4 Faunal Remains from Gorham's Cave

(Percent of total elements by level)

| SPECIES | A | B | C | D | E | F | G | H | I | J |
|---|---|---|---|---|---|---|---|---|---|---|
| *Homo sapiens* | 0.0 | 1.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| *Dicerorhinus sp.* | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 16.6 | 0.0 | 16.6 |
| *Equus caballus* | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 1.1 | 0.0 | 0.0 | 0.0 |
| Steppe Group Sum | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 1.1 | 16.6 | 0.0 | 16.6 |
| *Sus scrofa* | 0.0 | 0.8 | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| *Cervus elaphus* | 1.3 | 2.8 | 0.0 | 4.5 | 5.3 | 0.0 | 29.3 | 0.0 | 0.0 | 0.0 |
| *Bos cf. primigenius* | 0.0 | 1.2 | 0.0 | 0.1 | 0.0 | 0.0 | 2.8 | 0.0 | 0.0 | 0.0 |
| Forest Group Sum | 1.3 | 4.8 | 0.0 | 4.9 | 5.3 | 0.0 | 32.1 | 0.0 | 0.0 | 0.0 |
| *Capra cf. ibex* | 25.9 | 20.0 | 11.7 | 9.5 | 5.3 | 7.2 | 6.2 | 0.0 | 0.0 | 0.0 |
| Mountain Group Sum | 25.9 | 20.0 | 11.7 | 9.5 | 5.3 | 7.2 | 6.2 | 0.0 | 0.0 | 0.0 |
| *Oryctolagus cuniculus* | 71.4 | 69.8 | 88.2 | 78.9 | 87.5 | 90.9 | 53.1 | 83.3 | 0.0 | 83.3 |
| *Lepus sp.* | 0.0 | 0.4 | 0.0 | 1.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Rabbit Sum | 71.4 | 70.2 | 88.2 | 80.8 | 87.5 | 90.9 | 53.1 | 83.3 | 0.0 | 83.3 |
| *Canis lupus* | 0.0 | 0.8 | 0.0 | 0.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| *Ursus arctos* | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| *Crocuta crocuta* | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.8 | 0.0 | 0.0 | 0.0 |
| (coprolites) | - | - | - | - | - | + | + | - | + | - |
| *Felis silvestris* | 0.0 | 0.0 | 0.0 | 0.3 | 1.7 | 0.0 | 0.5 | 0.0 | 0.0 | 0.0 |
| *Felis lynx* | 1.3 | 0.0 | 0.0 | 0.8 | 0.0 | 1.8 | 2.8 | 0.0 | 0.0 | 0.0 |
| *Panthera pardus* | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 | 0.0 | 0.0 | 0.0 |
| *Panthera cf. leo* ? | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Carnivore Sum | 1.3 | 0.8 | 0.0 | 1.6 | 1.7 | 1.8 | 6.6 | 0.0 | 0.0 | 0.0 |
| *Halichoerus grypus* | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| *Monachus monachus* | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| *Cetacea* | 0.0 | 2.4 | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Marine Group Sum | 0.0 | 2.4 | 0.0 | 2.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Rodentia | 0.0 | 0.4 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| *Erinaceus sp* | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 | 0.0 | 0.0 | 0.0 |
| *Talpa sp.* | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total n | 77 | 245 | 17 | 566 | 56 | 55 | 177 | 6 | 0 | 6 |

Table 2.4. (Continued)

(No faunal remains from layer S)

| SPECIES | K | L | M | N/O | P | Q | R | T | U |
|---|---|---|---|---|---|---|---|---|---|
| *Homo sapiens* | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| *Dicerorhinus sp.* | 0.5 | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| *Equus caballus* | 0.0 | 0.0 | 2.0 | 0.0 | 0.0 | 0.0 | 0.7 | 0.0 | 0.0 |
| Steppe Group Sum | 0.5 | 0.0 | 2.2 | 0.0 | 0.0 | 0.0 | 0.7 | 0.0 | 0.0 |
| *Sus scrofa* | 0.0 | 8.0 | 0.0 | 8.8 | 0.0 | 0.0 | 0.7 | 5.5 | 0.0 |
| *Cervus elaphus* | 7.2 | 4.0 | 13.4 | 8.8 | 10.4 | 2.0 | 6.3 | 16.6 | 14.2 |
| *Bos cf. primigenius* | 1.2 | 0.0 | 2.7 | 0.0 | 1.0 | 2.0 | 0.0 | 0.0 | 0.0 |
| Forest Group Sum | 8.4 | 12.0 | 16.1 | 17.6 | 11.4 | 4.0 | 7.0 | 22.1 | 14.2 |
| *Capra cf. ibex* | 40.2 | 0.0 | 33.5 | 13.3 | 31.2 | 4.0 | 0.7 | 5.5 | 14.2 |
| Mountain Group Sum | 40.2 | 0.0 | 33.5 | 13.3 | 31.2 | 4.0 | 0.7 | 5.5 | 14.2 |
| *Oryctolagus cuniculus* | 46.4 | 84.0 | 45.1 | 66.6 | 54.1 | 34.0 | 39.7 | 16.6 | 14.2 |
| *Lepus sp.* | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Rabbit Sum | 46.4 | 84.0 | 45.1 | 66.6 | 54.1 | 34.0 | 39.7 | 16.6 | 14.2 |
| *Canis lupus* | 0.5 | 0.0 | 0.2 | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| *Ursus arctos* | 0.7 | 4.0 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| *Crocuta crocuta* | 1.2 | 0.0 | 1.0 | 0.0 | 1.0 | 2.0 | 0.0 | 5.5 | 0.0 |
| (coprolites) | + | + | + | + | + | - | + | - | - |
| *Felis silvestris* | 0.0 | 0.0 | 0.2 | 2.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| *Felis lynx* | 0.5 | 0.0 | 0.5 | 0.0 | 1.0 | 2.0 | 0.7 | 0.0 | 0.0 |
| *Panthera pardus* | 1.4 | 0.0 | 0.5 | 0.0 | 0.0 | 4.0 | 0.0 | 0.0 | 0.0 |
| *Panthera cf. leo ?* | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Carnivore Sum | 4.3 | 4.0 | 2.6 | 2.2 | 3.0 | 8.0 | 0.7 | 5.5 | 0.0 |
| *Halichoerus grypus* | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| *Monachus monachus* | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| *Cetacea* | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Marine Group Sum | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Rodentia | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| *Erinaceus sp* | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| *Talpa sp.* | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 14.2 |
| Total n | 403 | 25 | 394 | 45 | 96 | 50 | 141 | 18 | 7 |

Table 2.5. Vertebrate Fauna from Devil's Tower rock shelter.

From Garrod, et. al. (1928)

MAMMALS

Order Insectivora
- *Talpa europea*
- *Crocidura russula*

Order Chiroptera
- *Myotis, cf. myotis*
- *Nyctinomus teniotis*

Order Carnivora
- *Canis lupus*
- *Ursus arctos*
- *Meles meles*
- *Hyena crocuta*
- *Felis pardus*
- *Felis, cf. sylvestris*
- *Lynx pardellus*
- *Monachus albiventer*

Order Lagomorpha
- *Oryctolagus cuniculus*

Order Rodentia
- *Eliomys quercinus*
- *Apodemus sylvaticus*
- *Arvicola sp.*
- *Pitymys sp.*
- *Microtus brecciensis*
- *Hystrix cristata*

Order Artiodactyla
- *Sus scrofa*
- *Cervus elaphus*
- *Bos, cf. primigenius*
- *Capra pyrenaica*

Order Perissodactyla
- *Equus sp.*

Order Proboscidia
- *Elephas sp.*

BIRDS

Order Passeriformes
- *Pyrrhocorax graculus*
- *Pyrrhocorax alpinus*
- *Fringilla, cf. coelebs*
- *Passer sp.*
- *Turdus viscivorus*
- *Turdus, cf. merula*
- *Turdus sp.*
- *Hirundo rustica*
- *Cypselus melba*
- *Picus viridis*

Order Falconiformes
- *Falco peregrinus*
- *Falco eleonorae*
- *Falco subbuteo*
- *Falco tinnunculus*
- *Falco (?) cenchris*
- *Haliaetus albicilla*
- *Hieraetus fasciatus*
- *Hieraetus pennatus*
- *Gyps fulvus*

Order Anseriformes
- *Oidemia (?) fusca*
- *Mergus, cf. serrator*

Order Pelecaniformes
- *Phalacrocorax (?) carbo*
- *Phalacrocorax graculus*

Order Procellariiformes
- *Puffinus kuhli*
- *Puffinus anglorum*

Order Columbiformes
- *Columba livia*
- *Columba oenas*
- *Columba palumbus*

Order Charadriiformes
- *Sterna (?) sandvicensis*
- *Larus fuscus*
- *Alca impennis*
- *Uria troille*

*Order Galliformes*
- *Alectornis (?) petrosa*

REPTILES

- *Testudo ibera*

FISH

- *Percoid, cf. lates*
- misc. interminable fragments

amount and distribution of precipitation. While some fluctuation in temperature undoubtedly occurred, the evidence for this is minimal. These environmental fluctuations do not, however, seem to have been extreme or to have affected the availability of terrestrial fauna for the occupants of the site.

EVIDENCE FOR HUMAN ACTIVITIES

The primary record of human activities at both Gorham's Cave and Devil's Tower is found in the chipped stone artifacts recovered from the sites. These are discussed below and in more detail in Chapters 4 and 5. However, other evidence for human presence and activity in Gibraltar also exists and should be at least briefly noted.

*Human fossils*. Fragmentary human physical remains were discovered in layer 4 of Devil's Tower. These include most of a calotte, facial/maxillary fragments, a right temporal, and a nearly complete mandible (Buxton in Garrod, et.al., 1928). All are from a very young individual, about age five. Although it has been suggested that the temporal, which cannot be articulated with the calotte, may be from a second, younger individual, this has not been firmly established (Stringer, Hublin, and Vandermeersch, 1984). A combination of primitive and modern characteristics have been noted in this specimen. However, given the incomplete understanding of Neanderthal development, the evolutionary significance (if any) of this suite of features is uncertain (Ibid.).

*Subsistence activities*. Evidence for subsistence activities are reported from both Gorham's Cave and Devil's Tower. This is primarily in the form of the bones and shells of animals thought to have been used for food, described as burned and broken in most of the Devil's Tower deposits, and charcoal from fires that would have been used for cooking and warmth. Charcoal was reported from many of the Gorham's Cave strata and from all but the beach deposit at Devil's Tower. In some of these deposits, it formed dense lenses that have been interpreted as hearths (Table 2.1, 2.3; Waechter, 1951; 1964; Garrod, et. al., 1928). At least some of this is certainly charcoal, probably from human caused fires (Metcalf in Waechter, 1964). The faunal remains from the sites have been discussed above. The low frequency of carnivore remains at Gorham's Cave at least, suggests that humans may well be responsible for much of the fauna there.

It should be remembered, however, that a considerable proportion of the deposit at the Devil's Tower consists of tufa. Vegetal material and mineral deposits, such as Manganese, are often incorporated in such carbonate deposits during their formation, producing dark staining that can be mistaken for charcoal. Bones incorporated into such deposits can be similarly darkened, appearing burned and are often fractured, both by the mechanical action of the spring and from being trampled by animals drinking at the spring (Shutler, 1967). Additionally, some of the layers at Gorham's Cave have a high organic content, resulting from bat guano, algal mats, and other non-human sources (Zeuner, 1953). This organic material can also resemble charcoal in sediments and should at least be considered as a potential source for some of the material reported as such. This is not to say that none of the "charcoal" or faunal remains are the result of human activities, especially considering the undisputed presence of human produced chipped stone implements, only that the possibility of a non-human source for at least some of this material should be seriously considered.

In addition to mammalian fauna, marine mollusc shells are also present at both sites, at times in abundance. As the sea has not reached either site since the formation of their basal layers, the molluscs may well have been brought here as food--especially considering that many of them are edible (Freeman, 1981; Waechter, 1964; Garrod, et. al., 1928).

*Lithics*. Lithic artifacts are by far the most abundant record of human activities at both sites. The collection recovered from Gorham's Cave is the larger of the two. In the seven years of excavation at the site, more than 9,895 pieces of chipped stone were recovered, including 9,074 pieces from the Middle Paleolithic layers alone. A summary inventory of the lithics, based on Waechter's (1951; 1964) reports, is given in Table 2.6. The declining quantities of artifacts with depth for the Middle Paleolithic is somewhat misleading. Layers K-R were excavated over an area only about half the extent of the excavation of layers A-J. Similarly, only a very small area of layers S1-U were excavated (see Figures 2.1 and 2.3).

Table 2.6 shows that, while Waechter recovered and described a very large number of lithics from Gorham's Cave, it has been possible to locate and study only a small fraction of these--in collections that are curated at the Institute of Archaeology, University of London, and the Gibraltar Museum in Gibraltar. Careful examination of Waechter's reports and accompanying illustrations suggests, however, that these collections probably represent most (if not all) of the retouched Middle Paleolithic tools from the site. As shown in the table, the tools measured for this study make up in numbers about 80% of Waechter's reported tool counts for the three main Middle Paleolithic layers (G, K, and M). At least part of the remaining 20% can be accounted for by pieces Waechter considered as tools, but that either were not retouched (eg., unretouched, pointed flakes and levallois points he classed as "points") or whose "retouch" consisted of minimal edge damage of questionable origin. It might be reasonably surmised that the collections left for study and display in Gibraltar and London comprised all (or nearly all) of the pieces he classed as tools, and a selection of the better examples of utilized flakes, debitage, and cores. (This was certainly the case with the cores.) The location of the missing debitage and cores remains a mystery. As the study described here focuses on variability in the retouched pieces, however, the measured sample of such artifacts from Gorham's Cave can probably be considered a very nearly complete one.

Nearly 500 lithics were excavated from Devil's Tower, with all layers except 7 containing chipped stone (Garrod, et. al., 1928). Unfortunately, most of these were unretouched debitage and cores and, in keeping with the usual procedures of the day, were considered of very minimal significance and discarded. No description or exact count of this material is recorded.

101 chipped stone artifacts, 2 hammerstones, and two pieces of bone (thought by Garrod to be pressure flakers) were kept from the excavations, and are presently curated at The British Museum in London. Of these, 45 are retouched tools and were measured for this study. Judging from Garrod's report and illustrations, this appears to represent all or very nearly all of the retouched pieces from the site. The remainder in London include 17 cores (one of the measured tools is also a core that had been reused as a scraper) and 39 unretouched flakes.

## The Alcoy Basin

### SETTING

The Alcoy basin is located midway between the cities of Valencia and Alicante, at the northeastern edge of the Baetic system of mountain ranges that occupy much of the southeastern Iberian Peninsula. The ranges of this part of the Baetic system are primarily composed of folded Cretaceous limestone in a southwest to northeast orientation. Those that form the boundaries of the Alcoy basin include the Benicadell to the north, the Mariola to the west, and the Almudaina, Serella, Alfaro, and Aforada ranges to the east. These mountains rise to heights of over 1,500 m., while the elevation of the basin ranges from 562 m. at Alcoy in the southwest to about 300 m. around Beniarres Reservoir in the northeast.

The basin itself is of tectonic origin and filled with a thick sequence of Tertiary erosional debris and lacustrine sediments. The Quaternary drainage system, consisting of the Rio Serpis and its tributaries, has cut deeply into these sediments and formed a series of ter-

Table 2.6. Lithic inventory from Gorham's Cave

| LAYER | REPORTED BY WAECHTER (1951; 1964) | | | | | IN LONDON AND GIBRALTAR (1984) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Tools | Utilized | Unretouched | Cores | Total Pieces | Measured Tools | Cores | Debitage | Total Pieces |
| A | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| B | 10 | ? | ? | ? | 161 | 10 | 0 | 10 | 20 |
| D1-D2 | 12 | >1? | ? | ? | 568 | 0 | 5 | 0 | 5 |
| E1-E3 | 3? | ? | ? | >3 | >38 | 0 | 0 | 0 | 0 |
| F1-F2 | 10 | 0 | 38 | 6 | 54 | 3 | 2 | 0 | 5 |
| G | 48 | 67 | 4968 | 150 | 5233 | 41 | 6 | 7 | 54 |
| H | 0 | 0 | 19 | 2 | 21 | 0 | 0 | 0 | 0 |
| K | 32 | 29 | 1362 | 75 | 1498 | 26 | 16 | 14 | 56 |
| L | 1? | 1 | 116 | 8 | 126 | 0 | 0 | 0 | 0 |
| M | 20 | 40 | 1329 | 78 | 1467 | 18 | 26 | 31 | 75 |
| N/O | 1 | 7 | 141 | 10 | 159 | 0 | 0 | 0 | 0 |
| P | 2 | 20 | 420 | 22 | 464 | 6 | 8 | 37 | 51 |
| Q | 0 | 5 | 30 | 3 | 38 | 2 | 2 | 12 | 16 |
| R | 1 | 0? | 5 | 38 | 44 | 2 | 0 | 2 | 4 |
| S1 | 0 | 0 | 15 | 0 | 15 | 0 | 0 | 0 | 0 |
| T | 0 | 0 | 5? | 0 | 5 | 0 | 0 | 0 | 0 |
| U | 0 | 0 | 2 | 2 | 4 | 0 | 1 | 2 | 3 |
| M. Paleo. Total | 104 | 169 | 8407 | 388 | 9074 | 95 | 59 | 105 | 259 |

races, the highest of which is about 70 m. above the current floodplain. The Serpis forms in the city of Alcoy from the junction of several rivers and streams, including the Polop, Barchell, Molinar, and Sinc, and flows northeastward a little more than 40 km. to reach the Mediterranean at Gandía (Villaverde, 1984:280; Houston, 1967:182-184, 194-196).

*Cova del Salt*. Cova del Salt is a very large rock shelter (actually more of an overhung cliff) located some 2 km. southwest of Alcoy. At an elevation of about 650 m. and facing east-northeast, it is located on the southern side of a large embayment opening to the east in high tufa/travertine cliffs (see Figure 2.5). Near the southern end of the Sierra de Mariola, the cliffs form the Falls of the Barchell River, which crosses the cliffs about 0.5 km. south of the site. The site itself is an abandoned falls of the river, the embayment and overhang forming as the falls retreated. Villaverde (1984:280) suggests the tufa/travertines are of uncertain Quaternary age, and Butzer feels they may be Middle Pleistocene (Mueller-Wille, 1983:177). In any case they predate the Middle Paleolithic occupation of the site.

The shelter or overhang is 35 m. wide, 10-15 m. deep, and at least 30 m. high. An "upper cave", c. 4 m. high and 3 m. wide at the mouth, is located at the northwest edge of the shelter, 8-10 m. above the top of the excavated deposits. A substantial part of these deposit underneath the overhang (and also perhaps in the rest of the embayment) has been leveled for construction and as a source of "garden soil", producing a sort of terrace (Martín, n.d.). The excavations at the site took place along the outer (ie., northeast facing) edge of this terrace. In the area excavated, over 4.5 m. of sediments were exposed before reaching a rock floor, and the original thickness of deposits was probably much greater.

*Cova del Pastor*. Pastor is considerably smaller than Salt and is a true rock shelter or shallow cave. It is located 2.5 km. northwest of Alcoy where the Barranc del Sinc has incised a deep, narrow gorge through the southern quarter of the Sierra de Mariola. The site is at the base of the southwestern side of the gorge and at the top of what is probably a high alluvial terrace (or possibly colluvial deposits).

The shelter opens to the northeast at an elevation of 800 m. It is 16.5 m. wide and 7 m. high at the mouth, and extends 6 m. into the rock of the gorge wall (Figure 2.6). Soundings made in the back of the shelter reached a depth of 1.2 m. without reaching a rock floor (Seguí, n.d.; Cortell and Segura, n.d.).

## HISTORY OF RESEARCH

*Cova del Salt*. El Salt was first visited by the Abbé Breuil, who considered the deposits to be of minimal archaeological significance (Villaverde, 1984:280). The potential of the site was not recognized until 1958, when a group of "aficionados" led by Dr. Vincente Pascual (then director of the *Museo Arqueológico Municipal de Alcoy*) found flint tools in the soil of a garden that was being leveled with sediments from the shelter. A surface collection at the shelter produced Middle Paleolithic artifacts, prompting the museum to apply for permission to excavate the site and to ask the owner to stop using the site as a source for garden soil. While the museum was awaiting permission to proceed, a man by the name of Fernando Ponsell managed to excavate a trench in the site. He reported three distinct layers of lighter sediment separated by charcoal layers. Most of the artifacts he recovered are thought to have been lost (Martín, n.d.; Villaverde, 1984:280).

When permission was granted to the museum, the work undertaken was directed by Pascual and Ricardo Martín Tobías of the *Servicio de Investigaciones Arqueológicas of Barcelona*. Most of the work at the site took place during two field seasons, totaling about 30 working days. Martín returned to the site for two more brief excavations of a week each in August of 1964 and 1965 to study the stratigraphy in more detail and take samples for paly-

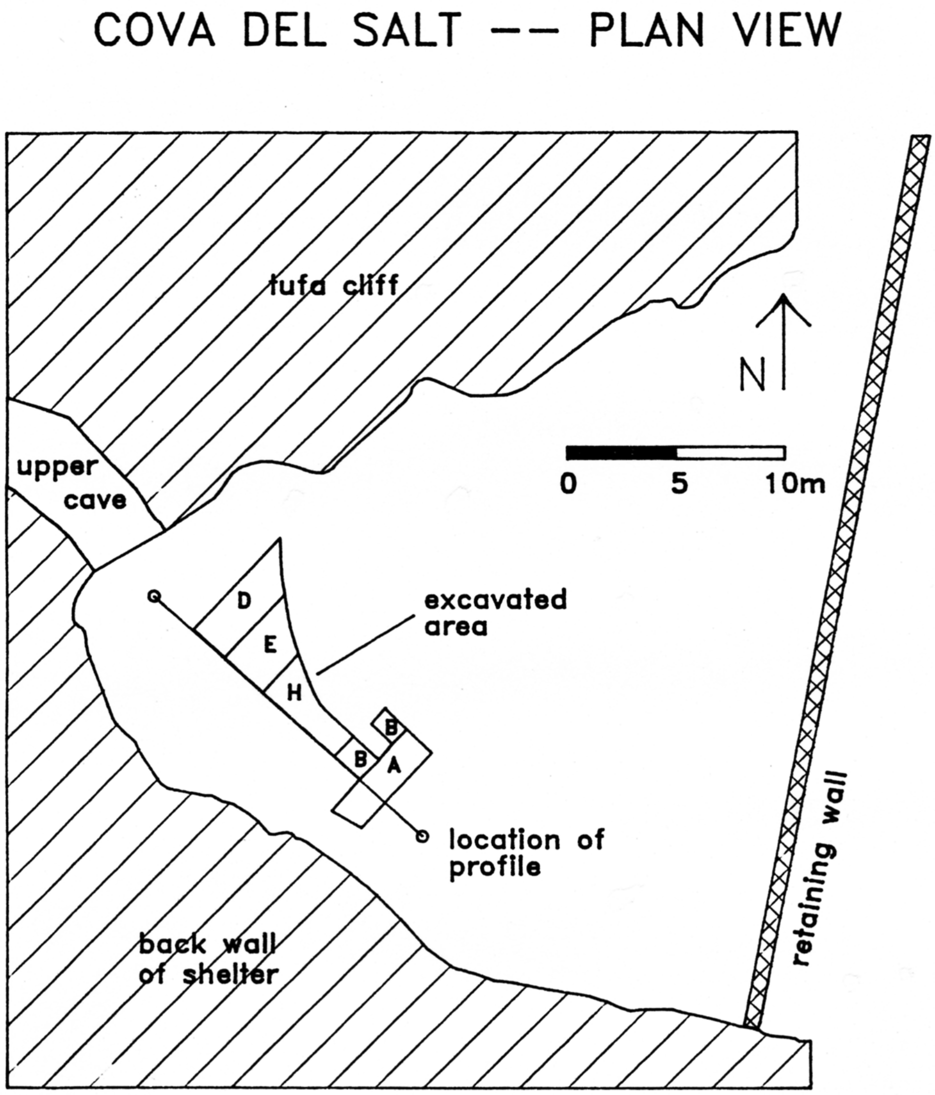



Figure 2.5 Plan view of Cova del Salt.

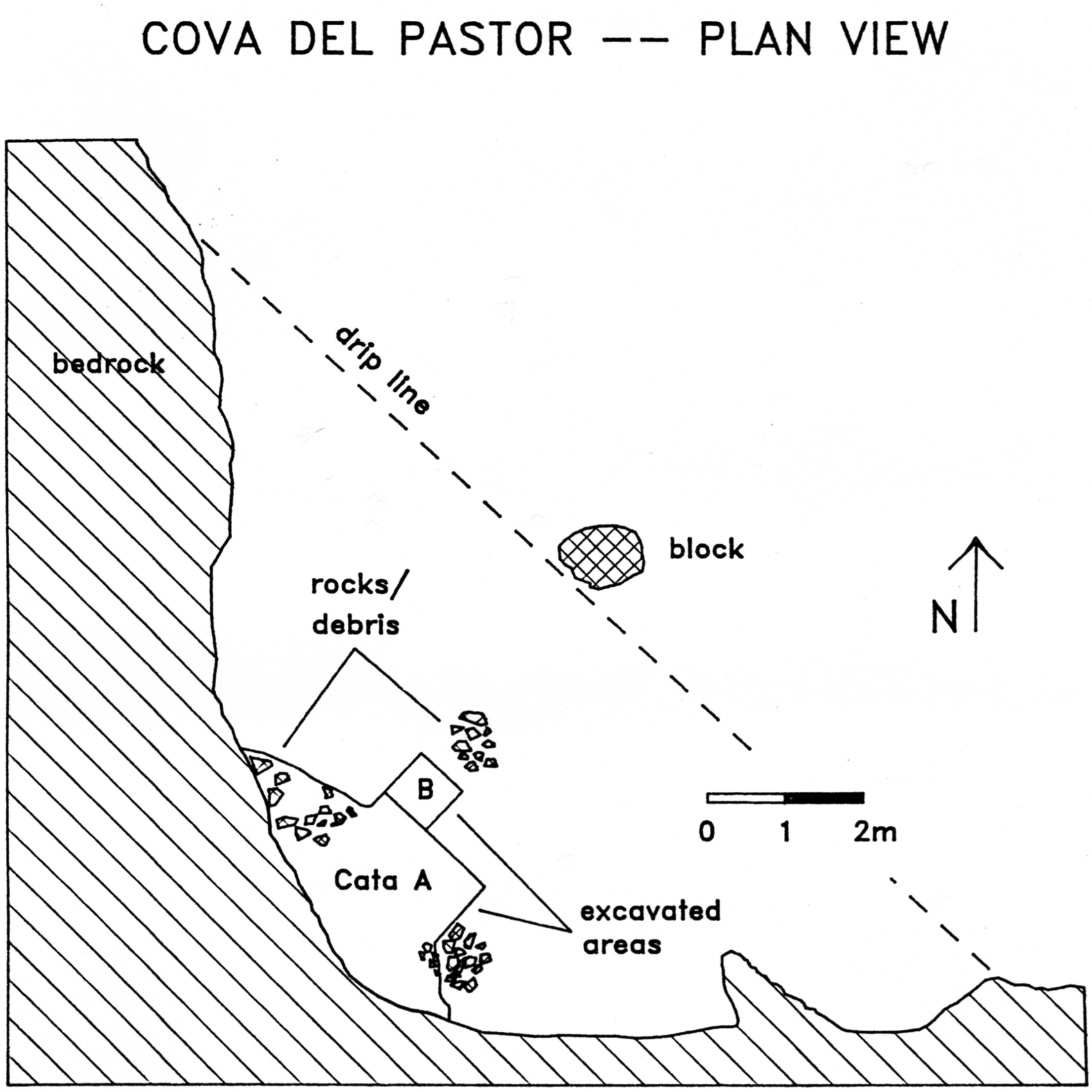



Figure 2.6 Plan view of Cova del Pastor.

nological, sedimentological, and radiocarbon analyses (Martín, n.d.). Unfortunately any results from these analyses have never been published.

The site was excavated in five horizontal units, Sectors A, B, D, E, and H (see Figure 2.5) totaling about 36 $m^2$ (Villaverde, 1984:280). Martín identified five upper sterile strata and six lower archaeological strata. He also identified transitional strata that separated the archaeological layers. The deposits were excavated to a depth of 4.5 m. below the surface of the terrace, in Sector A at least, before reaching a rock floor. According to the personnel at the museum in Alcoy, and documented in a photo of excavations at the site, excavated sediments were dry screened.

*Cova del Pastor*. The archaeological significance of Pastor was first recognized by another group of "*aficionados*", M. Brotóns, J. Pastor, and H. García, in 1951. They excavated a small, irregular trench against the back wall of the shelter to a depth of a little more than 50 cm. recovering abundant lithics and bones.

In the Fall of 1976, A. Seguí, from the *Sección de Arqueología del Centro Excursionista de Alcoy*, excavated a slightly larger (0.9 X 1.65 m.), more regular test trench along the front edge of the Brotóns excavation. This trench, called Cata A, was excavated to a maximum depth of 1.20 m.

Finally, Emilio Cortell and José Mª Segura, from the *Museo Arqueológico Municipal* of Alcoy, worked at the site briefly in 1972. In June of that year they cleaned and profiled the walls of Seguí's trench. They returned in September to map the site. At that time, they also excavated a small (0.75 X 0.75 m.) sounding to the depth of 0.7 m. All three excavations identified three layers, described below (Figure 2.6; Villaverde, 1984:294; Cortell and Segura, n.d.; Seguí, n.d.).

## STRATIGRAPHY AND CHRONOLOGY

Stratigraphy of Cova del Salt. Martín (n.d.) described the deposits of Cova del Salt in variable detail. Additionally, Butzer visited the site in 1979, and examined the sediments in Sector A and in the vicinity of the site (Mueller-Wille, 1983:176-180). Finally, in March of 1984, I was given the opportunity to briefly examine the sediments in the part of the old excavation trench that remained exposed. The results of these various studies are summarized in Table 2.7. Figure 2.7 shows the sediments at the site as they appeared in 1984. This profile has been matched with a pencil sketch by one of the excavators (probably Martín) that shows the 5 sterile strata and 6 archaeological strata (along with transitional strata) as recognized during the original excavation in Sector A. Martín describes these archaeological strata as consisting of alternating layers of ash, ashy soil, non-ashy soil, and lines of hearths. As indicated in Figure 2.7, it likely that I had the opportunity to examine a significant part of these deposits in the section that remained exposed in 1984. While no hearths were observed, lamina of dark organically stained sediments, containing charcoal or carbonized plant remains, and "ashy" sediments were noted.

As a whole, the deposits at Cova del Salt form a roughly fan-like deposit filling, and spilling out of, a notch in the face of the tufa cliffs. Judging from the slope of the deposits in the exposed section, they probably originally reached at least the mouth of the upper cave in the back of the embayment. It is apparent in Table 2.7 that the deposits at El Salt can be separated into two gross divisions, an upper series of coarse gravels and large blocks, and a lower series of fine silty sands. These two divisions mark a major change in the geomorphology of the site. The distribution of archeological materials closely corresponds to this major division, with the upper gravels essentially archaeologically sterile (except for subrecent-recent ceramics in the top of the uppermost layer) and the lower sands containing Middle Paleolithic assemblages.

Table 2.7. Stratigraphy of Cova del Salt.

| | |
|---|---|
| Layer A | Coarse gravel and sand. (Martín's sterile 1-3; Butzer's level C.)<br><br>Pinkish grey or lighter, coarsely bedded, poorly sorted, silty sand and calcareous tufa gravel that forms indistinct lenses. Gravel density is 20-40% with sizes ranging from small pebbles to large blocks. The small pebbles include both rounded and angular pieces, while the larger material is almost all angular. Ranges in thickness from 1.2 m. at Sector A in the southeast to 0.2 m. in the center of the section where it thins to a minimal surface layer==has probably been artifically leveled. Contains ceramics or tiles (modern or subrecent). Contact with B, is clear. |
| Layer B | Coarse gravel and sand. (Martín's sterile 4; Butzer's level B.)<br><br>Similar to layer A. Pinkish grey or lighter, massive to very weakly bedded, poorly sorted, silty sand and calcareous tufa gravel. Gravel density is 20-40% with sizes ranging from small pebbles to large blocks, though fewer larger pieces than layer A. All pieces appear more rounded than those in layer A. Also slopes upward to the northwest, with thickness ranging from from 1.2 m. at Sector A to 0.2 m. at the northwest edge of Sector D. No cultural material was observed. Contact with layer C is clear to gradual. Contact with layer D is clear. |
| Layer C | Partly cemented layer of large blocks. (Included in Martín's sterile 4? Not in Butzer's profile.)<br><br>Pinkish grey or lighter, massive layer of tufa cobbles and large blocks in well sorted silty, fine sand. Very calcareous and stongly cemented to indurated, with occacional flow stone. The cobbles and blocks vary in size up to > 1.5 m in diameter. The layer has a maximum thickness of 1.5 m. in Sector B, sloping upward and thinning to end in the center of the section. No cultural material was observed. Contact with D is gradual. |
| Layer D | Silty fine sand. (Martín's sterile 5; Butzer's level A.)<br><br>Pinkish grey (7.5YR 7/2 moist), massive, well sorted, moderately compact, silty fine sand or silt loam, containing a few lenticles of brown (7.5YR 5/4) sandy silt or loam. Reaction to HCl indicates significant carbonate component, visible as small vesicles, scattered small flecks, and tiny nodules of $CaCO_3$. More $CaCO_3$ is visible and reaction to HCl stronger in portion underlying layer C==probably from leaching of tufa. Contains < 5% gravel of small to moderate pebble size, decreasing in density toward the bottom of the unit. Unit varies in thickness with a maximum visible of 1.5 m. in the center of the section. Slopes upward toward the northwest. Thins considerably under layer C. No cultural material was observed. However, Martín reports a few "atypical" lithics in poor condition. Contact with layer E is gradual (ie., transitional over ~10 cm.). |

Table 2.7. (Continued).

| | |
|---|---|
| Layer E | Silty fine sand. (Upper part of Martín's archaeological levels.)<br><br>Dark brown (7.5YR 4/4 moist), massive, very well sorted, silty fine sand or sandy loam with discontinuous pinkish grey lenticles or lamina. More lenticles/lamina apparent towards the northwestern part of section. Contains a large block at base of profile 3. Although it has a stronger reaction to HCl than layer D (except where D underlies layer C), no $CaCO_3$ was visible as particles or coatings. Unit slopes upward and thins to the northwest, with a thickness ranging from > 1.0 m. in the southwestern part of the section to 0.5 m. at the northwestern edge of Sector D. Cultural material observed includes abundant lithics and scattered tiny flecks of charcoal. Animal bones were also noted. A bone (Sample # 3) from this layer was submitted to the University of Arizona Tandem Accelerator, Mass Spectromenter Laboratory for $^{14}C$ dating. Contact with F is abrupt and straight. |
| Layer F | Fine, slightly silty sand. (Upper to middle (?) part of Martín's archaeological levels.)<br><br>Dark reddish brown (5YR 3/4 moist), massive, very well sorted, fine sand or sandy loam with < 5% scattered gravel (including a roof fall plaque c. 10 cm dia. and 1-1.5 cm thick). Persistant reaction to HCl but no carbonate particles visible. The upper 5 cm of this layer is a darker brown (7.5YR 5/4 moist) zone that may represent a weak weathering horizon, though no soil structure was apparent. Slopes upward to northwest and may grade into layer E; 0.25 m. thick. Contains moderately abundant lithics, scattered small bones, and a few scattered charcoal flecks. Contact with G is abrupt and irregular. |
| Layer G | Fine, slightly silty sand. (Middle to lower (?) part of Martín's archaeological levels.)<br><br>Brown (10 YR 5/3 moist), laminated, very well sorted, fine slightly silty sand or sandy loam. Stronger reaction to HCl than layer F, though no carbonate particles or coatings noted. Laminae are vary in color and texture, including lenses of very pale brown (10YR 7/3), greyish, ashy looking sediment with fleck of charcoal and flecks of red; dark reddish brown (5YR 2/2) sediment that appears to contain substantial organic material or charcoal; and dark grey brown (10YR 4/2) sediment that also appear to contain organic material. > 0.9 m. thick, extending below present ground surface. Contains scattered, moderately abundant lithics and a few bones. |

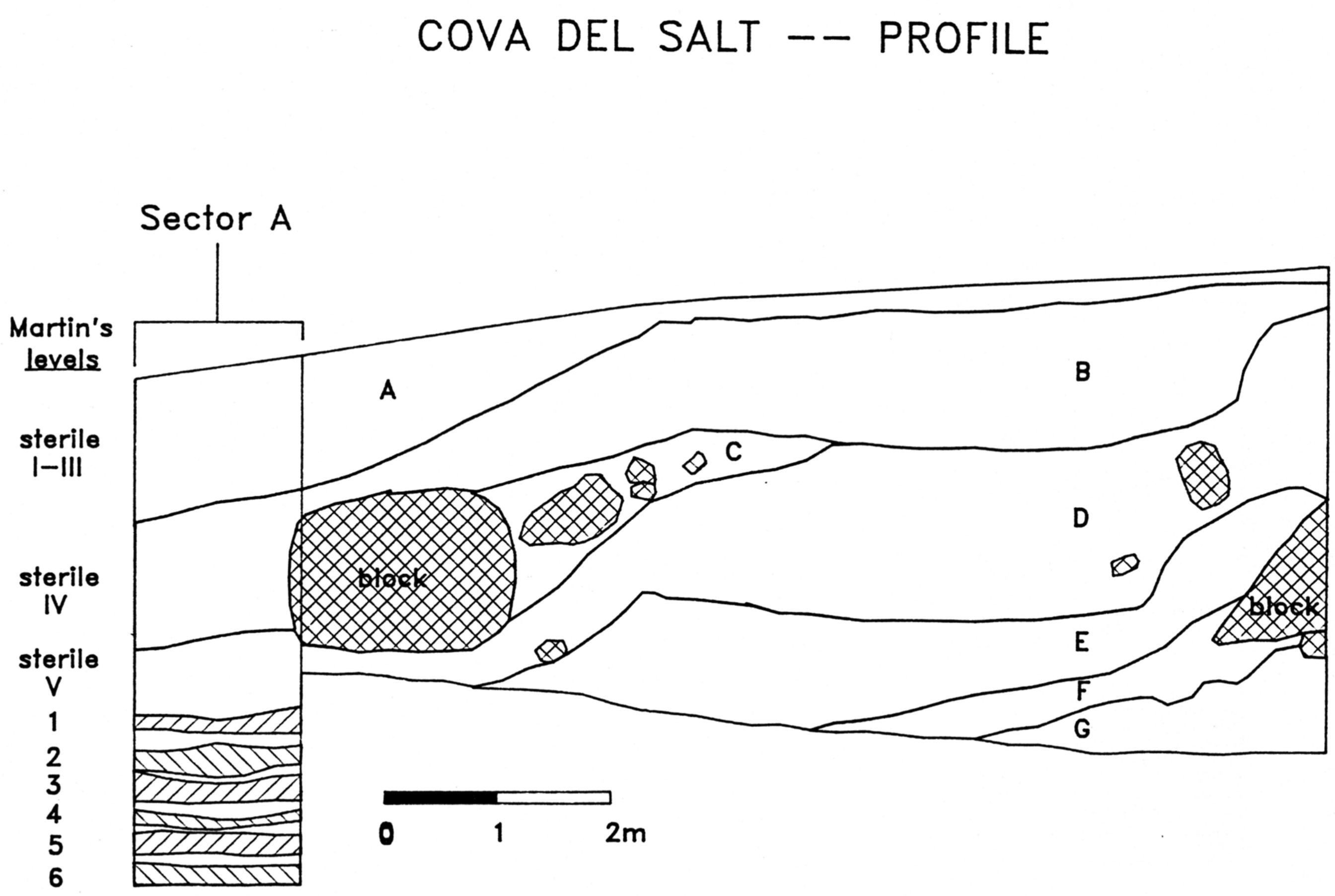



Figure 2.7. Profile of Cova del Salt deposits (exposure visible in 1984).

The lower group of sands that contain the Middle Paleolithic assemblages are fine and well sorted, suggesting transport over some considerable distance. They were probably brought to the site by water intermittently flowing over the cliff, possibly above the upper cave. The minimal amount of clastic debris in these deposits also indicates the relative stability of the overhang and cliff. The dark zone at the top of layer F, possibly a weak weathering horizon, also suggests the relative stability of the sands, although no true soil horizons were noted.

The size and angularity of clasts, and the lack of sorting in the upper gravels suggest transport over much shorter distances. This is especially true of layer B which appears to represent a rubble accumulation. The probable source of the angular gravel, and certainly the very large blocks, is the roof and walls of the shelter itself and may well be due to frost weathering. Similar coarse rubble occurs elsewhere along the base of the cliffs that form the Falls of the Barchell. The gravel lenses of layer A, while equally as local in origin as the gravel of layer B, may have been at least reworked by debris flows if not brief torrential flows of water over the cliff. The abrupt transition from the lower sands to the upper gravels suggests an intervening period of erosion.

Layer C may represent sediments that were trapped behind a very large block during this erosional episode (see Figure 2.7). Its well sorted, fine, sandy matrix is similar to layer D and could represent continued influx of alluvial sediments and/or the erosion of existing sediments. However, the layer also contains very coarse rubble derived from the overhang, indicating the beginning of the processes that formed layer B. The flowstone and partial cementation of this layer is not seen in layer D where C is not present, suggesting that this is a result of the deposit being saturated with carbonate rich water during or shortly after deposition, rather than from illuvial carbonates leached from the above layers at a much later time. Springs are not uncommon in the tufa cliff and one is currently located near the upper cave. Such a spring could well have been responsible for the cementation of layer C.

*Cova del Pastor*. The deposits exposed in the limited excavation at Cova del Pastor are briefly described by Cortell and Segura (n.d.) as follows:

Layer I: 0-0.20 m. below surface. Dark, very fine "powdery" sediment without rocks.

Layer II: 0.20-0.45 m. below surface. Yellowish breccia, strongly cemented with generally small rocks. Contains bones and Middle Paleolithic lithics.

Layer III: 0.45 m. to bottom of excavation (0.70 m. in Cortell and Segura's sounding). Uncemented rocks and sand, slightly more yellowish than layer II.

Lacking more information, the Pastor deposits are more difficult to interpret geomorphologically. It is likely that the rubbly deposits of layers II and III are predominantly of local origin, deriving from the roof of the shelter, and represent different geomorphic conditions from the fine layer I sediment. It is not possible to tell from the description whether or not the lower layers are cryoclastic, although this is not unlikely. The breccia in layer II is interesting. From the brief description, layer I does not sound like a likely source of carbonates for the cementation of layer II. This would suggest that II is more of a stalagmitic layer, cemented during or shortly after deposition, and before the the deposition of layer I.

*Chronology of Salt and Pastor*. Based on artifactual data, it is possible to say that both sites have beds that probably date to the early Upper Pleistocene, and that Salt at least also has deposits that extend into the subrecent. A bone sample from layer E at Salt has been submitted to the University of Arizona radiocarbon laboratory for dating on the Tandem Accelerator/Mass Spectrometer but the results of the analysis are not yet available. In order to propose a more detailed chronology for the deposits and the cultural materials they contain, it is necessary to compare information derived from the geomorphology of these sites with that from other contemporaneous, but better studied sites in the region.

Cova Beneito is a rock shelter site currently under excavation about 14 km. north of Salt and 10 km. north of Pastor. It is located at an elevation of c. 700 m. in a ravine on the slopes of the southern end of the Sierra Benicadell, and overlooking the Rio Agres whose valley separates the Benicadell and Mariola ranges. It has at least 3.75 m. of deposits containing Middle Paleolithic, Upper Paleolithic, and Bronze Age cultural material. The deposits are briefly described from bottom to top as follows: 50 cm. of cemented coarse gravels; 60 cm. of blocks and coarse gravels, with traces of corrosion and partially dissolved concretions; 45 cm. fine calcareous sand with less gravel; 30 cm. of medium gravels that coarsen upward; 184 cm. of coarse gravels in a darker (slightly more organic), silty matrix (Iturbe and Cortell, 1982). The lower 75 cm. of deposits contain Middle Paleolithic artifacts (see Table 2.8).

Iturbe and Cortell indicate that the cementation in the lowermost unit represents a region-wide phenomenon associated with cementation in other shelters and correlated with the upper member of Terrace B of the Serpis, Segura, and Vinalopó valleys. This terrace has been dated to 39,500 ± 500 B.P. (SUA 1175). This correlation has recently been confirmed by a $^{14}C$ date from the University of Arizona T.A./M.S. of 38,800 ± 1,900 (AA-1387) for charcoal from the top of the cementation layer at Beneito. Iturbe and Cortell correlate the calcareous sands with the Arcy interstade, dated to c. 28,000 B.P. This date also seems reasonable in the light of a second T.A./M.S. date of 33,900 ± 1,100 B.P (AA-1388) for charcoal from the top of the uncemented gravels immediately below these sands.

In addition to Beneito, recent work at Cova Negra de Xàtiva provides information useful for understanding the chronology of Salt and Pastor. This cave site, located 17 m. above the Rio Albaida (and 100 m. above MSL.), near the town of Xàtiva some 31 km. north of Salt, contains over 5 m. of deposits with Middle Paleolithic artifacts, human remains, and animal bones. A detailed study of the old excavation units, accompanied by limited testing, was undertaken in 1981 and 1982 by a team directed by D. Fletcher and V. Villaverde of the *Servicio de Investigación Prehistórica* of Valencia. Although the data are still being analyzed, preliminary results describe a series 36 beds that are interpreted as extending from the last interglacial through the middle of the last glacial.

The deposits can be briefly summarized as follows: c. 1.7 m. of brownish and grayish marls with a negligible coarse component (layers 36, 34-32), and stalagmitic layers (layers 35, 31) that have been assigned to the last interglacial; 1.8 m. of silty or clayey brown sands with discontinuous lamina of darker sediment, and containing large blocks from the cave roof in the upper part of the unit (layers 30 and 29), followed by 30 cm of sand and coarse cryoclastic gravel (layer 28) assigned to the Würm I; 10 cm. of silty sand with a weak soil and some leaching of carbonates (layer 27) assigned to the Würm I/II interstade; over 2.0 m. of a series of layers predominantly of silty sand/sandy silt with a variable but usually significant coarse cryoclastic component (layers 27-1) assigned to the Würm II (see Table 2.8a). The upper part of the Würm II series includes a layer (3) with appreciable carbonate deposits (Villaverde, 1984:168-175).

The pattern of deposition of the glacial sequence at Cova Negra is similar in general outline to that of Cova del Salt. The sand of layers 30 and 29 at Cova Negra appear structurally analogous to those of layers G-D at Salt. The top of the sand layers at both sites contain large blocks (i.e., the upper part of layer 29 at Cova Negra and layer C at Salt). Conditions analogous to those that cemented layer C may have produced the weak soil of layer 27 at the lower elevation of Cova Negra. Coarse gravels overlay the layer of large blocks at both sites. However, the gravels of layers 26-1 at Cova Negra contain Middle Paleolithic artifacts while gravel layers B and A at Salt postdate the Middle Paleolithic oc-

Table 2.8. Suggested chronology and paleoenvironments for sites in eastern Spain.

| ISOTOPE STAGES | COVA DEL SALT Deposits | | COVA DEL SALT Environment | COVA NEGRA Deposits | | COVA NEGRA Environment |
|---|---|---|---|---|---|---|
| Stage 1 | | Deposits removed or disturbed | | | | |
| | A | Coarsely bedded, coarse gravel and sand | Cold but more humid | | ? | |
| Full Glacial | B | Massive, coarse gravel and sand | Colder and drier | 1-2 | Sandy aeolian silt | Cold and dry |
| Stages 4-2 | | Erosion ? | | 3 | Gravels with carbonate deposits | More humid? |
| | | | | 4-26 | Silty sands and sandy silts with variable amount of coarse cryoclastic gravels | Cold with variable humidity |
| - - - - - | C | Carbonate cemented, large blocks and cobbles in fine sand. | Milder and humid | 27 | Silty sand with weak soil and carbonate leaching | Mild and humid |
| | | | Colder and more humid | 28 | sand and cryoclastic gravel | Cold and humid |
| Early Glacial | | | | 29 | Large blocks. | |
| Stages 5d-5a | D | Massive, silty fine sand | | | Laminated sands with lenses of organic material | Mild with moderate humidity |
| | E | Silty fine sand with weak bedding | | | | |
| | F | Silty fine sand with possible weathering horizon | Cool/temperate with moderate humidity | 30 | Laminated clayey sands | |
| | G | Laminated fine sand | | | | |
| Interglacial Stage 5e | | | | 31-36 | Marls and travertines | Warm and humid |

Table 2.8. (Continued).

| ISOTOPE STAGES | COVA DEL PASTOR | | | COVA BENEITO | | |
|---|---|---|---|---|---|---|
| | | Deposits | Environment | Deposits | Environment | $^{14}C$ Dates |
| Stage 1 | I | Very fine, dark sediment | | Medium to fine gravel in fine matrix | | [Bronze Age] |
| Full Glacial Stage 2 | | ? | | Coarse gravel in darker, more organic matrix | Milder | 16,480 ± 480 |
| | | | | Medium gravel, coarsening upward | Cold and dry | |
| | | | | Fine calcareous sand with less gravel | Milder | |
| | | | | Uncemented blocks and coarse gravels | Cold and dry | 33,900 ± 1100 |
| Full Glacial Stage 3 | II | Medium gravel. Carbonate cemented | Cool with more humidity | Cemented gravels | Cold and humid | 38,800 ± 1900 |
| | III | Coarse gravel and sand | Cold and dry? | ? | | |
| | | ? | | | | |

cupation there. On the other hand, a considerable amount of sediment has probably been removed from Salt, possibly by erosion during and/or after the deposition of layer C and recently by human activities. Remnants of the recently removed beds still remain at the site. Their potential for containing additional cultural materials is indicated by a large flake, like those of the Middle Paleolithic layers, found on such remnant deposits near the elevation of the upper cave during my visit to the site.

While the currently available evidence does not permit correlation of the deposits at the sites discussed above with any certainty, it does suggest a preliminary chronology that is at least not unreasonable (see Table 2.8). The similar patterns of fine sands, large blocks, and coarse clastic deposits at both Cova Negra and Cova del Salt may be the result of environmental changes that affected the nature of geomorphic processes at a regional level. If so, this would suggest a general temporal correspondence between the lower sands at Cova Negra (layers 30-29) and the artifact bearing sands at Salt. Butzer (1975a; in Mueller-Wille, 1983:176-180) associates fine alluvial deposits such as those accumulated at Salt with denudation accompanying early glacial conditions and Villaverde proposes an early glacial (i.e., Würm I) age for the lower sands at Cova Negra. Based on these data, an early glacial age (stages 5d-5a) would seem most likely for the artifact bearing deposits at Cova del Salt.

Likewise, the layers of large blocks at Salt and Cova Negra seem most likely associated with either a late and severe early glacial cold episode (as suggested by Villverde for the Cova Negra sequence), stage 5b for example, or mark the onset of full glacial conditions at the stage 5/4 boundary.

The coarse gravels at both sites seem most likely associated with the more rigorous conditions of full glacial stages 4-2. At Cova Negra, the presence of Middle Paleolithic artifacts in these gravels indicates that they probably represent stages 4 and/or 3. At Salt, the lack of artifacts (other than sub-recent ones) in these gravels, in addition to the obvious disturbance of the upper deposits prevents a suggested temporal assignment more specific than sometime during the full glacial.

At Pastor, the only known artifact bearing sediments are a cemented clastic deposit. Coarse clastic deposits seem reasonably associated with full glacial conditions at Salt, Cova Negra, and Cova Beneito while fine sediments seem associated with the early glacial at both Salt and Cova Negra. The possible region-wide episode of increased moisture and spring activity at c. 39,000 BP that is associated with carbonate deposition at Beneito cannot be identified at Salt, but may appear late in Würm II deposits (layer 3) at Cova Negra. This makes a stage 4 or 3, possibly relatively late stage 3, age within reason for the excavated Middle Paleolithic deposits at Pastor. Without a better understanding of the deposits, however, suggestions of age must remain very questionable for this site.

## UPPER PLEISTOCENE ENVIRONMENTS

*Sediments*. The deposits at Salt and Pastor provide the primary direct evidence for reconstructing paleoenvironments in the Alcoy Basin during the early Upper Pleistocene (see Table 2.8a). The lower sands of Salt suggest a very different environment from the upper gravels. The well sorted, fine, laminated sediments of these layers suggest a regular source of water bringing sediments to the site--possibly a relatively gentle stream of runoff from the surrounding mountains. Additionally, the gray and dark lamina are indicative of organic material, vegetation growing at the site and/or refuse from human activities. However, the top of layer F shows the only evidence for even weak pedogenesis, testifying to the lack of sufficient vegetation and/or lack of sufficient stability of the deposits for such processes. This is in contrast to the dense vegetation and accumulation of organic debris on the surface of the site today, in spite of very recent disturbance. Although there is no direct evidence of temperatures, the lack of coarse, cryoclastic debris argues against extremely cold conditions.

These conditions seem to continue throughout most of the lower sands that contain the Middle Paleolithic assemblages with only a few changes. One of these is the increasingly lighter color of the sediments from layers G through D (see Table 2.7) that may indicate a decrease in the amount of organic material and possibly in the degree of biological weathering of the sediments. The increase in gravel in the top of layer D also suggests the beginning of a change to stronger but less regular flows of water reaching the site,. Butzer interprets the sediments of layer D as indicating a cool denudation regime (Mueller-Wille, 1983:176-180) in which devegetation of upland areas, due to lower temperatures and precipitation, resulted in increased erosion and the accumulation of alluvial sediments at lower elevations (see also, Butzer, 1975a).

Layer C presents a considerably different environmental picture from the lower sands. The evidence for erosion in this layer suggest considerably stronger flows of water across the site that, among other things, would make the site much less desirable for human habitation. Additionally, the carbonates of layer C suggest the presence of a spring in the tufa/travertine cliff like the one which currently flows at the site and possibly an increase in humidity. Finally, the large blocks that have fallen from the overhang could indicate either a reactivation of the falls and occasional torrential flows of water over the overhang or from frost weathering associated with seasonally cold temperatures and increased humidity. The latter is somewhat more likely due to the lack of fluvial channel features that should accompany the amount of water necessary to erode and move the large size debris of the layer. In summary, layer C suggests a period of increased humidity reflected in erosion and increased spring activity, and either a reactivation of the falls or cooler temperatures, with the latter more likely.

The poorly sorted, massive, coarse gravel and sand of layer B indicate somewhat different conditions. This material seems to have been produced by frost weathering, possibly in conjunction with strong but brief runoff from the cliffs, and may indicate colder and drier conditions than the layers below. Layer A presents a similar picture, though with more angular clasts, stronger frost weathering is suggested. Additionally, the structure of the gravels may indicate stronger and less ephemeral flow of water during deposition or the later reworking of the deposit by fluvial action or debris flows. The latter explanation could explain the incorporation of subrecent-recent ceramics into deposits that seem to represent pre-Holocene environmental conditions.

The small amount of information available from Cova del Pastor makes it more difficult to environmentally interpret its deposits (see Table 2.8b). If the coarse debris of layers III and II is cryoclastic, it would represent cooler temperatures. The cementation of layer II, however, would mark a change to greater humidity and possibly milder temperatures. The predominantly fine sediments of layer I (possibly with a higher organic content indicated by the darker color) may represent Holocene or Holocene-like conditions with a lack of cryogenesis and an increase in vegetation at the site.

Environmental information for the region is also provided by the preliminary analyses of the sediments of Cova Beneito and Cova Negra (see Table 2.8a, b). At Beneito, Iturbe and Cortell (1982) interpret the coarse gravels that contain the Middle Paleolithic assemblages as representative of a rather cold climate, while the carbonate deposits may also suggest greater humidity. The less gravelly, calcareous sands that follow are thought to represent some degree of climatic amelioration.

At Cova Negra, the lower sands assigned to the Würm I seem to represent mild, humid conditions. The layer of large blocks near the top of the sands is interpreted as indicating cold, humid conditions, as are the coarse gravels of layer 28 that follow the sands (Villaverde, 1984:172-175). The weakly developed soil of layer 27 indicates a return to milder temperatures. The upper 2 m. of deposits is felt to represent generally colder temperatures than at present, and increasing aridity.

*Fauna*. Although there has been no published study of faunal remains from either Salt or Pastor, the few brief comments made by Martín (n.d.) about the fauna from Cova del Salt are interesting (Refer to Table 2.7 and Figure 2.7 for relationships between the layers described by Martín and the stratigraphy observed in 1984). He mentions Caprids and Equids as conspicuous among the large fauna throughout the sequence. He notes that in the upper archaeological strata, ibex is considerably more numerous than horse, in contrast to the lower layers. In archaeological stratum 3, he mentions abundant horse and ibex. In stratum 5 he mentions abundant Equids, Caprids, and Bovids, though, in his description of stratum 6, he suggests that ibex occurs in lower frequency than the other two taxa in both 5 and 6.

If Martín's brief, preliminary account does indeed reflect the relative abundance of remains of Equids, Caprids, and Bovids, it suggests a steady, consistent environmental shift throughout the period of occupation. The lowest layers (5 and 6) contain representatives of forest, steppic, and montane environments--Bovids, Equids, and Caprids respectively--and those from forest and steppic environments predominate. In stratum 3 taxa from steppic and montane environments are described as abundant, while forest taxa are not mentioned. In strata 2 and 1, the montane taxon is more numerous than the steppic taxon. If generally representative of the fauna at the site, these data would suggest a retreat of the forest and increasingly alpine conditions in the vicinity of El Salt during the Middle Paleolithic occupation of the site.

The rich faunal assemblage from Cova Negra also provides environmental information for the general region. They have been studied in detail by Pérez Ripoll (1977), and are currently being reanalyzed in the light of the recent restudy of the site's stratigraphy. Villaverde (1984:175-176) presents a summary of the preliminary results of this new work. As at the Gibraltar sites, the taxon with the most numerous elements is rabbit (*Oryctolagus cuniculus* cf. cuniculus) which Pérez Ripoll feels provides little environmental information (1977:85-93). The large herbivores can be grouped in to a steppic group consisting of rhinoceros and horse, a montane group that includes ibex and chamois, and a forest group composed of elephant, aurochs, red deer, roe deer, and pig. The fauna are listed by total elements for each taxon and grouped according to archaeological levels, which have been roughly correlated with the sedimentary layers and their associated chronological phases by Villaverde (1984:178).

Figure 2.8 shows the relative frequency of these groups. The lower Würm I sands show high percentages of forest taxa and steppic taxa, with very low percentages of montane taxa (4% of all large herbivore remains). The upper Würm I deposits show a marked increase in montane taxa (to 32%) at the expense of the steppic group. Then the steppic group shows a marked increase at the expense of the forest group. In the layers attributed to the Würm I/II, there is a sharp decrease in the relative frequency of both steppic and montane taxa relative to forest taxa, with forest taxa making up a maximum of over 58% of the large herbivores. Montane taxa do not drop to as low a frequency as at the base of the sands, however.

The pattern then repeats in the gravels assigned to the Würm II, with montane taxa expanding in relative frequency, first at the expense of steppic taxa, then also at the expense of forest taxa. They reach a peak of 50% of large herbivore remains, after which their frequencies decline with an expansion of the steppic group. In the uppermost gravels, this pattern seems to start to repeat again.

These patterns may indicate that initially during cold phases, a depression in temperature and possible increase in effective if not absolute precipitation resulted in the expansion of forest environments into open areas as well as a depression in upland life zones. As the cold phase progressed, additional drop in temperature and/or effective precipitation caused the eventual retreat or opening up of the forest. Additionally, the patterns seen in

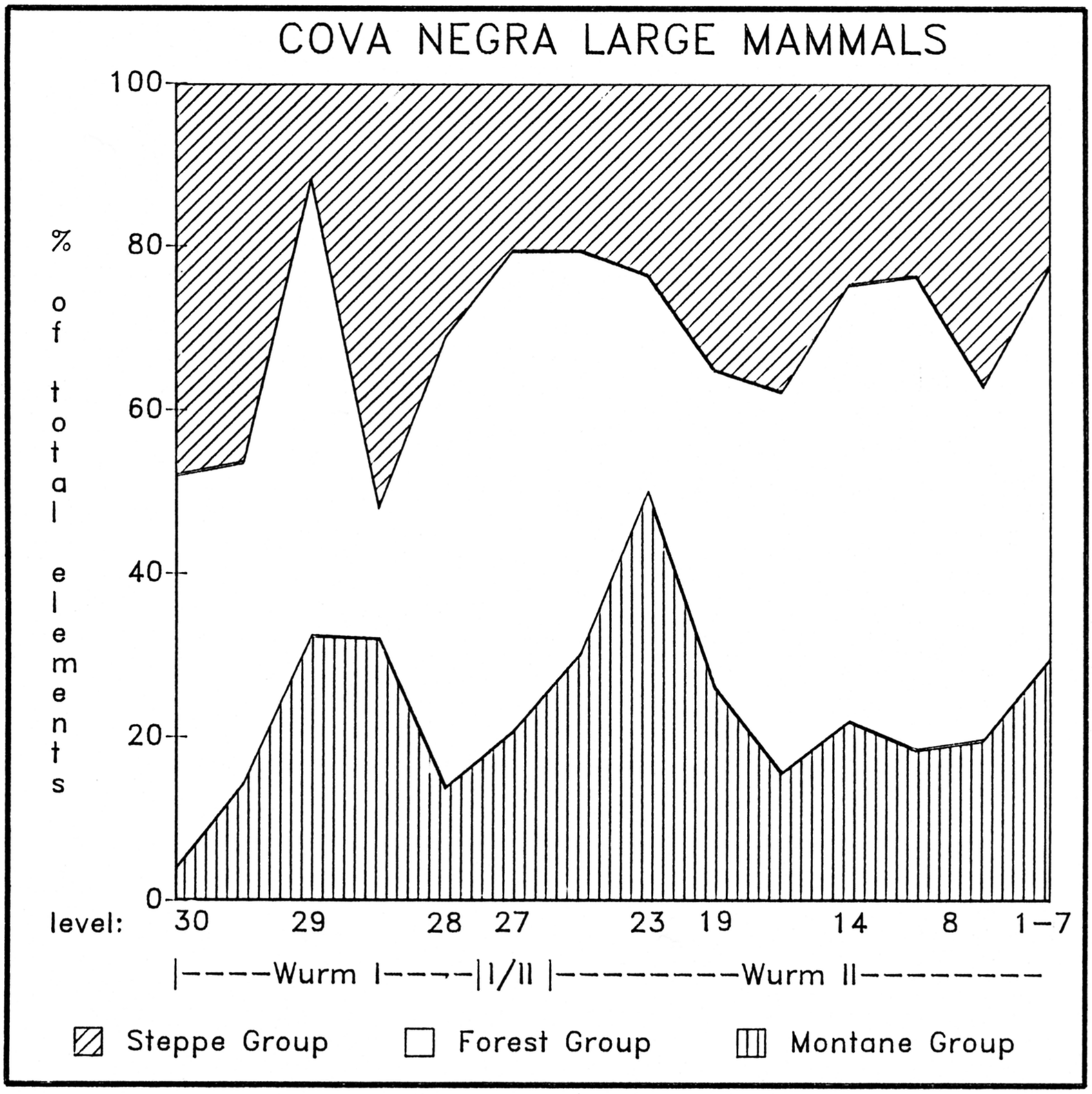



Figure 2.8. Cova Negra faunal groups.

the Cova Negra fauna seem to indicate that the upper gravels at the site do indeed represent a harsher environment than do the lower sands with higher overall frequencies of montane taxa among large herbivores. These data appear to agree with with the sparse information from Salt. Additionally, the faunal data seem to present an environmental picture similar to that indicated by the sediments.

In summary, available data suggest that the environment of the Middle Paleolithic occupation in the Alcoy basin can be characterized as relatively mesic initially, becoming increasingly colder toward the end of the occupation. Unlike the Gibraltar sites, evidence suggests that significant changes in climate, fauna, and (by inference) flora took place in the Alcoy Basin during the Middle Paleolithic.

## EVIDENCE FOR HUMAN ACTIVITIES

Lithics represent the primary evidence of human activities at Cova del Salt and Cova del Pastor to an even greater extent than at the Gibraltar sites. While faunal remains that could provide information about subsistence activities were found at both sites, any analyses of these materials that may have been done remain unreported. Martín mentions numerous "hearths" at Salt. However, as mentioned above, no *in situ* features of this nature were observed in 1984--although small pieces of redeposited charcoal were in evidence. This leaves the assemblages of chipped stone artifacts left by the Middle Paleolithic inhabitants of the sites as virtually the only currently available record their activities.

*Cova del Salt Lithics*. Table 2.9 lists the known lithics recovered from Cova del Salt. Of the more than 6,500 pieces, those from Sectors A, B, D, and H are in the *Museo Arqueológico Municipal Camilo Visedo Molto* in Alcoy. I was able to examine these pieces, and measured the 908 for this study. Those from Sector E are curated by the *Servicio de Investigación Prehistórica* of Valencia, where they have been studied by Dr. Valentín Villaverde Bonillo (1984:280-294).

Several points should be noted about the assemblages from Salt. The vertical provenience refers to archaeological layers 1-6 identified during the original excavation and described by Martín (n.d.) for Sector A. The relationship between these archaeological layers and the strata observed in 1984 is indicated in Table 2.7 and Figure 2.7.

Adjacent archaeological layers were separated by intervening transitional layers, 1-2 between layers 1 and 2 for example, that do not seem to have been continuous or continuously recognized throughout the excavated area. Layer 0-1 did not extend to Sector A, nor, apparently, to Sector B. It seems to begin somewhere in the center of the excavated sector and continue to the northwest, appearing in Sectors E, H, and D. Layer 6-inferior was not noted by Martín in Sector A, and appears to either be sterile or non-existent in all other Sectors but D. Finally, Villaverde makes no comment about the apparent lack of artifacts from layers 5-6 and 6 in Sector E, but they could be those that he lists as having indeterminate provenience from the sector (he suggests that they may be from a surface layer).

There is good reason to assume that the samples from Sector D, all but layer 2 of Sector A, and (apparently) Sector E are complete samples of all lithics excavated. In all three sectors, the relative proportions of retouched tools, cores, and debitage appear to support this assumption. Additionally, the debitage from Sectors A and D, which I was able to personally examine, includes large numbers of small flakes, broken fragments, and heat shattered debris--not the type of material normal kept in a highly selected sample. Given this information, it appears that the assemblage from layer 2, Sector A is missing most of its debitage. It also appears that the debitage from Sectors B and H is missing. Although the lithics from Sectors A and D have apparently been kept at Alcoy since the excavation of the site, those from Sectors B and H were taken to Barcelona for study, where they remained un-

Table 2.9. Lithic Inventory from Cova del Salt

| LAYER | SECTOR A | | | SECTOR B | | | SECTOR D | | |
|---|---|---|---|---|---|---|---|---|---|
| | Measured Tools | Cores | Debitage | Measured Tools | Cores | Debitage | Measured Tools | Cores | Debitage |
| 0-1 | --- | --- | --- | --- | --- | --- | 15 | 2 | 61 |
| 1 | 40 | 29 | 210 | 7 | 0 | 0 | 20 | 15 | 148 |
| 1-2 | 0 | 0 | 0 | 2 | 0 | 1 | 11 | 21 | 62 |
| 2 | 37 | 2 | 12 | 8 | 1 | 0 | 11 | 10 | 69 |
| 2-3 | 0 | 0 | 0 | 19 | 0 | 3 | 15 | 7 | 84 |
| 3 | 199 | 83 | 936 | 8 | 0 | 1 | 25 | 7 | 77 |
| 3-4 | 58 | 1 | 338 | 8 | 0 | 0 | 19 | 7 | 90 |
| 4 | 12 | 7 | 178 | 8 | 1 | 9 | 8 | 1 | 18 |
| 4-5 | 58 | 33 | 305 | 2 | 0 | 1 | 9 | 3 | 31 |
| 5 | 71 | 8 | 568 | 3 | 1 | 5 | 9 | 3 | 37 |
| 5-6 | 21 | 8 | 186 | 4 | 1 | 3 | 13 | 3 | 42 |
| 6 | 28 | 12 | 195 | 7 | 0 | 1 | 16 | 8 | 45 |
| 6 inf. | --- | --- | --- | --- | --- | --- | 13 | 9 | 69 |
| Total | 524 | 203 | 2928 | 76 | 4 | 24 | 184 | 96 | 833 |
| Sector Total | 3655 | | | 104 | | | 1113 | | |

Table 2.9. (Continued).

| LAYER | SECTOR H | | | SECTOR E (from Villaverde, 1984) | | | TOTAL FOR ALL SECTORS |
|---|---|---|---|---|---|---|---|
| | Measured Tools | Cores | Debitage | Tools | Levallois Flakes | Other Debitage | |
| 0-1 | 7 | 0 | 1 | 16 | 26 | 109 | 237 |
| 1 | 11 | 0 | 1 | 20 | 17 | 245 | 763 |
| 1-2 | 17 | 1 | 3 | 12 | 11 | 141 | 282 |
| 2 | 10 | 1 | 0 | 10 | 2 | 98 | 271 |
| 2-3 | 5 | 0 | 1 | 5 | 7 | 45 | 191 |
| 3 | 18 | 2 | 1 | 12 | 7 | 66 | 1442 |
| 3-4 | 13 | 0 | 0 | 1 | 1 | 33 | 589 |
| 4 | 10 | 0 | 4 | 4 | 1 | 22 | 283 |
| 4-5 | 0 | 0 | 0 | 5 | 0 | 19 | 466 |
| 5 | 13 | 0 | 2 | 3 | 2 | 11 | 736 |
| 5-6 | 9 | 4 | 0 | --- | --- | --- | 294 |
| 6 | 11 | 0 | 0 | --- | --- | --- | 323 |
| 6 inf. | --- | --- | --- | --- | --- | --- | 91 |
| unknown | --- | --- | --- | 15 | 18 | 256 | 289 |
| Total | 124 | 8 | 13 | 103 | 92 | 1045 | 6257 |
| Sector Total | 145 | | | 1240 | | | |

(Pieces of unknown provenience: tools = 50, cores = 28, debitage = 301)

**Total pieces recovered from site = 6646 Total pieces measured = 908**

til shortly before my visit in 1984. It is quite possible that the debitage from these sectors has remained in Barcelona. Excavation notes that contain initial inventories for these sectors tend to confirm that all the retouched pieces have been returned to Alcoy and were available to the present study.

*Cova del Pastor Lithics*. Of the three excavations at Pastor, the initial one by Brotóns, Pastor, and García produced the largest collection. However, this collection is in private hands (Brotón's family) and not currently available for study. A series of drawings of what appear to be primarily retouched pieces give some idea of the extent of this collection. The pieces are divided into three "levels"--A, B, and X. There are 31 pieces from A, 104 from B, and 98 from X. It can be assumed that a considerable amount of debitage augmented the 233 pieces drawn. The relationship of the three levels to the stratigraphy described above is uncertain, as only a single layer (2) contained artifacts in the later soundings.

From Seguí's sounding (Cata A), 54 pieces are curated in the museum in Alcoy. Of these, 45 are retouched tools and were measured. This suggests that the debitage from this sounding has been lost or was never kept. Based on Seguí's notes and reports from the personnel at the museum, the 45 measured pieces seem to represent a complete or nearly complete sample of the retouched pieces from this unit.

From Cortell and Segura's sounding (Cata B), 30 pieces were recovered, three of them retouched. Unfortunately, these three have been misplaced and were not available for study. This ratio of three retouched to 27 unretouched pieces gives some idea of the relative amounts of debitage that originally accompanied the pieces in the two earlier soundings (an estimate of over 2,000 pieces of debitage for the Brotóns excavation and over 400 for Seguí).

## Summary

The depositional contexts of the assemblages that form the focus of this study have been examined. The Gibraltar sites represent chronological contexts that span at least the last interglacial and the first part of the last glacial episodes, and, at least in the case of Gorham's Cave, contain deposits that represent the rest of the last glaciation through the recent. In the Alcoy Basin, on the other hand, cultural material at Cova del Salt seems restricted to the early last glacial (stage 5d-5a) and, while of considerably more questionable chronological context, the assemblage from Cova del Pastor may be of stage 3 age.

Environmentally, the coastal setting of Gibraltar seems to have experienced considerably less extreme fluctuation than the upland setting of the Alcoy Basin during the Upper Pleistocene. At Gibraltar, eustatic fluctuations in sea level altered the land area available to Middle Paleolithic hunter/gatherers. Additionally, fluctuations in effective or absolute precipitation seem to have occurred. However, changes in temperature and in the composition of the fauna seem to have been minimal.

In the Alcoy Basin, environments of the early glacial seem to have been relatively mesic, though not identical to those of today. With time, however, there is increasing evidence for colder temperatures, possible changes in the amount or distribution of precipitation, and suggestions of significant changes in faunal distributions.

From the depositional contexts of the assemblages, it has been possible to construct a chronological and environmental framework within which patterns of lithic variability can be studied. In the chapters which follow such variability and its potential for reconstructing Middle Paleolithic activities in these regions of the Iberian Peninsula will be examined in detail.

# CHAPTER 3

# METHODOLOGY

In order to understand past human behavior, it is necessary to identify and explain the significance of variability (or lack of it) in the cultural materials resulting from this behavior. In the case of the Middle Paleolithic, due to factors of preservation, these cultural materials are almost entirely restricted to chipped stone artifacts, the bones of animals hunted for food, and a few features such as hearths. Lithics are the most ubiquitous of this evidence and were probably directly associated with a wide variety of activities. Lithic artifacts represent primary implements for procuring and processing food and other raw materials, and were also used to make other items of material culture that permitted Middle Paleolithic hominids to function successfully in their world. Hence, lithic artifacts should contain a considerable amount of information about the a wide range of Middle Paleolithic behaviors.

However, the interpretation of lithic variability with respect to the activities in which they were used has been difficult. This is especially true for societies of hominids predating modern *Homo sapiens*, such as those of the Middle Paleolithic, where uncertainty with regard to the extent of biocultural differences from modern humans leaves analogies with recent hunters and gathers open to question.

## Background to the Study of Lithic Variability

Although temporal and spatial variability among Middle Paleolithic assemblages has long been recognized, an interpretation of this variability with respect to human behavior has only recently begun to be achieved. Because of links between paleolithic archaeology, the natural sciences, and evolutionary theory, early workers were initially interested in using lithics to demonstrate the antiquity of man. Later, lithic variability was used by workers such as Lartet and De Mortillet to chronologically order assemblages and to document human cultural and physical evolution (Daniel, 1975:99-108, 122-130). Such a chronological/evolutionary focus has remained a significant feature of the study of Middle Paleolithic lithic variability up to the present (see, for example, Bordes, 1973; de Lumley, 1971:356-365).

This focus on chronology has been accompanied by an emphasis on the classification of lithics, which has resulted in the development of increasingly refined systematics and detailed typologies for paleolithic chipped stone (see Bordes, 1972:48-54; Brézillon, 1968:11-67). For the Middle Paleolithic of Western Europe and the Near East (as well as in many other areas of the world) the most widely used typology is that of Bordes (1961). Bordes' types are defined on the basis of associations of morphological attributes of artifacts, and assemblages are characterized by the the relative frequencies of these types. In regional syntheses, lithic industries are defined on the basis recurring distributions of relative frequencies of types within assemblages. These patterns of type distribution have been used to assess relationships among industries in time and space--approaching, in the extreme, phylogenetic relationships (see, for example, de Lumley, 1971:350, Figure. 300).

In order to explain such phylogenetic relationships, many workers have ascribed much observable lithic variability to differences in cultural traditions of the makers (for example, Bordes, 1973; 1981). But while cultural traditions may indeed contribute to lithic variability, other factors can be equally or more important. Binford and Binford (1966) used a multivariate statistical technique in an attempt to redefine Middle Paleolithic industries in terms of 'tool kits' and inferred associated activity sets, and thus started what has come to be termed the 'mousterian debate' (Binford, 1973; Binford and Binford, 1966; 1969; Bordes 1973; 1981; Bordes and de Sonneville-Bordes, 1970). Mellars (1969) suggested that some observed variability may be a result of diachronic change, although the causes of such changes remain unclear (see Chapter 5).

In all probability, lithic variability for the Middle Paleolithic has more than a single primary cause. Jelinek (1975; 1976) has suggested that factors affecting lithic variability include the raw material used and its properties, techniques of manufacture, the functions which the artifact served, and culturally determined preferences from a set of functionally or technically equivalent forms (ie., style). Recent studies have begun to move away from the more traditional typological approach in order to examine the sources of variability in Middle Paleolithic assemblages. Most successful to date have been studies of variability in unretouched debitage. These have included replicative experiments (Dibble, 1981:56-78), the reassembling of cores from debitage (Marks and Volkman, 1983), and the quantitative statistical analysis of debitage attributes (Baumler, 1987; Dibble, 1983; Fish, 1979; Jelinek, 1982).

Retouched tools, because they have been intentionally modified, would seem more likely to contain information about a wider variety of activities than unmodified debitage. As a consequence, however, extraction of this more complex information is a difficult process. Although more rigorous systematics have been applied to Middle Paleolithic retouched tools than to debitage, this has not led to a better understanding of the activities associated with these artifacts. The 'mousterian debate' has never been adequately settled (see Gamble, 1986:13-15). Like studies of debitage, the potentially most informative approaches to these artifacts have been ones that have diverged from the traditional approach to examine possible sources of variability. Jelinek's (1982) study of Middle Paleolithic retouched tools from Tabun and reviews of analogous published data from Europe (Barton, 1981; Baumler, 1982) have suggested patterns of covariance between relative frequencies of certain types and regional paleoenvironmental conditions that crosscut traditionally defined industries. Rolland's (1981) examination of the relative frequencies of retouched tools as a whole and broad artifact classes (i.e., sidescrapers, notches, and denticulates) resulted in suggestions that variability might be a result of the intensity of raw material use and the frequency with which a few very broad classes of activities (e.g., general purpose cutting and scraping versus manufacturing of wood items) took place. In a study focusing on Middle Paleolithic scrapers, Dibble (1984; 1987) has suggested that differences between some of these types may simply represent degrees of modification and use, as opposed to either distinct activities or styles. Such work leads to the question of whether industries and the types on which they are based are the most relevant units of analysis for interpreting variability with respect to activities or even social relationships.

Middle Paleolithic tool types are defined on the basis of the location, extent, shape, and number of retouched edges. Implicit in this classification is the assumption that a single piece represents a single tool. This is the usual case in our own society where most tools are associated with a single purpose (or restricted set of purposes). Whether Middle Paleolithic tools were so specialized has not been demonstrated, however. Additionally, the existence of tool types as discrete, recurring groups of edges has never been examined. Tools with retouched edges represent lithic artifacts that were intentionally modified in association with their use. However, variability relevant to activities may be masked by focusing on types and industries rather than the edges that were actually used. A quantitative study of the edges of these retouched artifacts can help to clarify the sources of variability in Middle Paleolithic retouched tools and, in turn, provide a firmer basis for examining relationships between Middle Paleolithic activities and lithic variability. Such a study is the focus of the research described here.

## Methods and Techniques

### ATTRIBUTES MEASURED ON PIECES

In order to provide data for this study, information was recorded for 1,093 tools from the four sites described in the last chapter. Each piece was classified according to Bordes' typology so that the quantitative results of this study could be compared with typological variability, and to provide a basis for comparison with assemblages from other sites where tool classification has been the only form of analysis done. Additionally, a suite of attributes related to the technology of flake manufacture was measured (Figure 3.1). These included:

1. size and shape of the piece, as indicated by length, width, and thickness;
2. the raw material used;
3. the shape and type of modification of the striking platform and the exterior flake surface at the platform;
4. the pattern of previous flake scars on the exterior surface of the piece;
5. the amount of cortex on the exterior surface;
6. the extent (if any) of heat alteration.

These features permit an assessment of tool variability primarily related to techniques of flake manufacture rather than use.

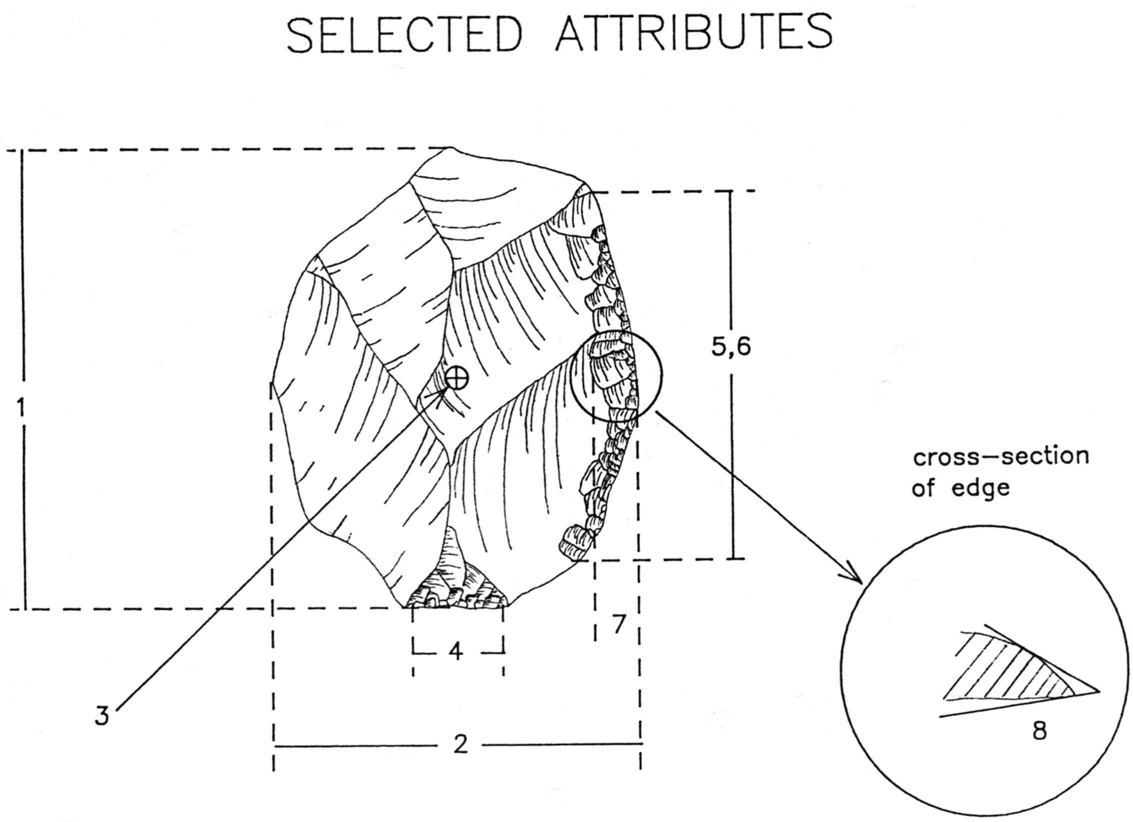
### ATTRIBUTES MEASURED ON EDGES

The primary focus of the study, however, is on tool edges. Information was recorded for all edges of the tools, both modified and unmodified (see Figure 3.1). The attributes chosen were felt to be those that, taken together, could well represent the morphological variability in edges. While any of the attributes could potentially vary with respect to associated activities, it was felt that a suite that included invasiveness, edge length, and amount of step flaking could also give some measure of the degree to which edges were used and modified. Attributes measured for both modified and unmodified edges included:

1. the length of each edge, and whether or not it was terminated by a break;
2. its position on the piece;
3. the edge angle. For retouched edges measurements also included:
4. the shape of the edge (in radius of curvature);
5. the invasiveness and type of modification;
6. the number, location, and type of any sub-edges (eg., a notch on a scraper edge).

Retouched edges were additionally classified as to 'type', analogous to Bordes' tool types in that they represent clusters of attributes on edges (convex scraper edges, for example). This was done to provide summary information about edge configuration and, once again, to provide a more detailed basis for examining relationships between typological variability and variability displayed in the quantitative attributes.

In addition to the measurements they shared with retouched edges, unretouched edges were classed as broken or unbroken. Unbroken edges were further identified as cortical or non-cortical and sharp, rounded, or 'backed' (as in 'naturally backed knives'--these being cortical and 'backed'). In all, 3,028 edges were measured. A detailed description of measurement techniques and a key to the categories used for non-continuous attributes are provided in Appendices I and II.




KEY TO ATTRIBUTES

1. length
2. width
3. point of thickness measurement
4. platform (flat surface with exterior facetting
5. extent of modified edge (for measurement of edge length, edge shape, etc.)
6. edge in positions 7, 8, and 9
7. invasiveness
8. edge angle

Figure 3.1. Attributes measured on tools.

TYPES OF ANALYSES PERFORMED

The information recorded for these artifacts permitted detailed quantitative analyses of the distribution of variability in a substantial sample of Middle Paleolithic tools. Because of the nature of this information, it was possible to examine variability at several different levels: that of the edge; the piece, representing the primary technological unit and comprising a group of edges, as well as being the basic typological unit in traditional systematics; and the assemblage, representing, in the ideal, a group of tools used by a single group of hominids performing a set of activities limited in time and space.

Additionally, variability was examined in various dimensions. As this is primarily exploratory data analysis, unidimensional or univariate analyses provided a primary means for examining the distribution of variability in the attributes that contribute to the morphology of edges (Hartwig and Dearing, 1979:9-13, 70-79). Bivariate relationships between attributes also were examined. These included both relationships between attributes at the same level of analysis (eg., step-flaking and invasiveness) and units from different levels (eg., edge angle and the total amount of edge modification on a piece). In both univariate and bivariate analyses, graphical representation of attribute data and relationships between attributes played a significant role in the identification of patterns of variability, although summary statistics (eg., mean, median, mode) and those describing the strength of relationships (eg., correlation coefficient) were used where appropriate.

A variety of multidimensional analyses were also performed to assess complex interrelationships between attributes. Due to the lack of *a priori* information about the patterns, distribution, or potential sources of variability for these artifacts, however, these were limited in number and restricted in scope. Analyses of variance were performed to examine the significance of differences between the widely used types in terms of the quantitative attributes measured. Additionally, factor analysis was performed in an attempt to reduce the dimensions of complex variability in edges to a more manageable set of factors.

Finally, observed patterns of lithic variability were examined with respect to chronological, spatial, and environmental variability of the early Upper Pleistocene as represented at the sites from which the studied assemblages derive. In addition to data derived from the analysis of lithic variability itself, this can provide further information about the potential relationships between lithic variability and human behaviors. The results obtained from these forms of analysis, and their implications for the interpretation of variability in Middle Paleolithic retouched tools are presented in the following chapters.

Attribute data were input, organized, and initially manipulated using dBase II and III database management programs on Cromemco and IBM PCXT micro-computers. Statistical analyses were performed on IBM PCXT and IBM PCAT personal computers using SPSS-PC, and on a CDC CYBER 175 mainframe computer using SPSSX, version 2.0.

# CHAPTER 4

# QUANTITATIVE VARIABILITY IN MIDDLE PALEOLITHIC TOOLS

The types of data generated in the course of this study permit a view of lithic variability that is considerably different than that provided by traditional typology. Although typological information is included for reference and for comparison with assemblages other than those analyzed in this study, the primary focus here is on aspects of discrete and continuous morphological variability, regardless of assigned type. These data do, however, permit investigation of the degree to which Middle Paleolithic typology accurately reflects lithic variability.

Typological analysis begins with the classification of pieces in an assemblage and then goes directly to an assessment of variability in assemblages, measured by relative frequencies of different types. The approach presented here begins on a much more basic level, with an assessment of the quantitative variability in morphological features of the individual edges that probably represent the most basic functional element of chipped stone artifacts. These data are then aggregated to the level of the piece that forms the basal unit of typological analyses. The distribution of both edge and piece level variability among assemblages is then examined. It is at this assemblage level that typological variability, as it is currently studied, can be compared with the results of this study. It is also at the level of the assemblage, that the data obtained here can be compared with information from other sites in the region.

## Variability in Edges

### DISTRIBUTION OF VARIABILITY IN EDGE ATTRIBUTES

*Edge angle*. Figure 4.1a shows the distribution of edge angle for all retouched edges. It has been suggested that the angle of an edge should be an important determinant of its efficiency of use for different tasks such as cutting meat, scraping hides, or scraping wood (Wilmsen, 1970:68-73). If the edges of Middle Paleolithic tools were specifically selected or prepared for tasks that required different edge angles, one might expect multimodality in the distribution of edge angles, with each mode representing a more or less optimum angle for a certain group of tasks. This distribution is continuous and normal, however, with $\overline{x} = 55^{o}$, $\sigma = 14^{o}$, and $\overline{x}$ = median = mode.

Sharp, unretouched edges were grouped with retouched edges and their combined distribution was also examined for multimodality. This combined distribution is also shown in Figure 4.1a. Like the distribution of retouched edges alone, the combined distribution appears continuous and quite normal, though slightly skewed to the left (i.e., more acute edge angles) with $\overline{x} = 51^{o}$, $\sigma = 15^{o}$, median=$50^{o}$, mode=$43^{o}$.

The lack of multimodality in these distributions suggests that, while there is variability in edge angle, it is not the discrete variability that might be expected if there was consistent association between edge angles and specific tasks. Furthermore, the distribution of retouched edges seems to differ only slightly from that of unretouched edges, rather than representing specifically modified edges as distinct from unmodified edges.

*Edge shape.* Figures 4.2a and 4.2b show the distribution of the log of Shape Index (SI) for all retouched edges, as well as several recognized edge types. SI was created from the reciprocal of the radius of curvature of edges in millimeters. The reciprocal was used in order to represent shape as the amount of positive (for convex) or negative (for concave) deviation from a straight edge (see Appendix I for detailed description and formula for SI).

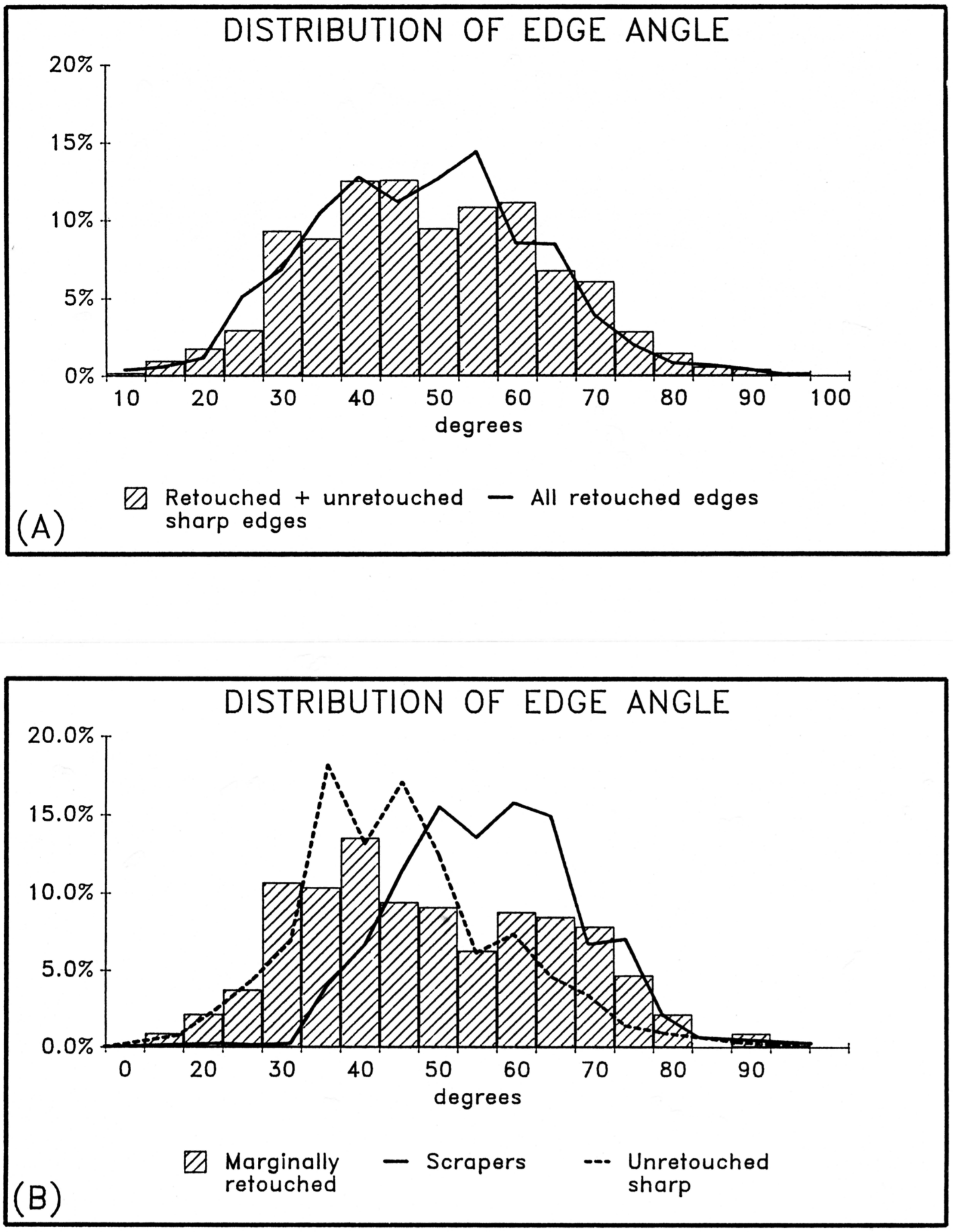
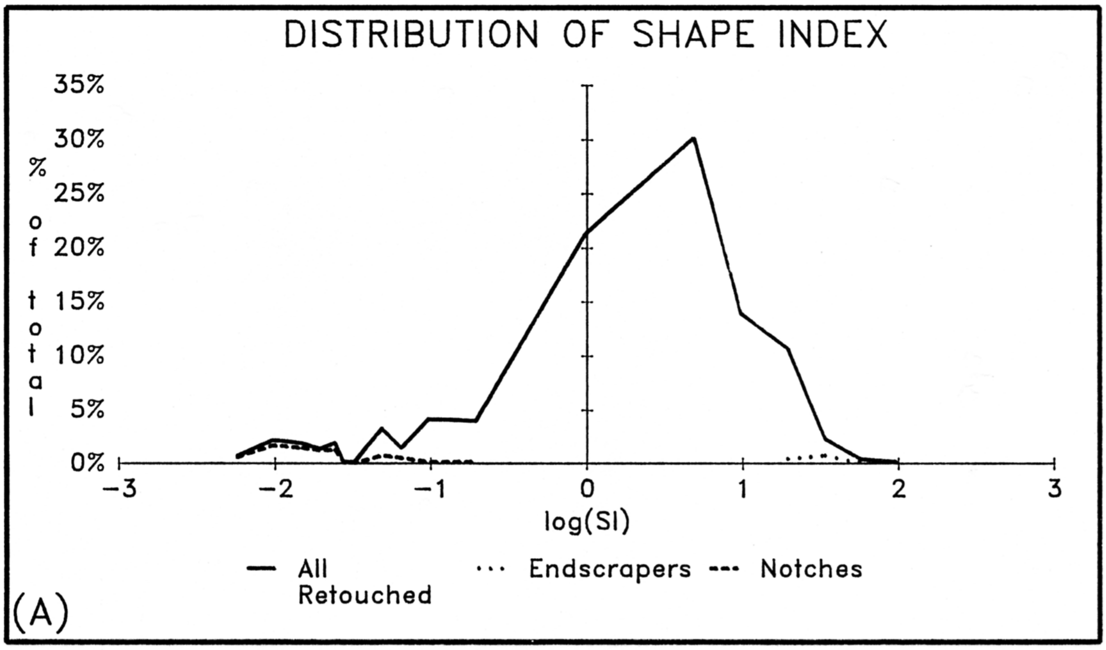



Figure 4.1. Distribution of variability in edge angles.

a) Frequency distribution for all retouched edges, and combined group of retouched and unretouched sharp edges. b) Frequency distribution for sidescraper edges, marginally retouched edges, and unretouched edges



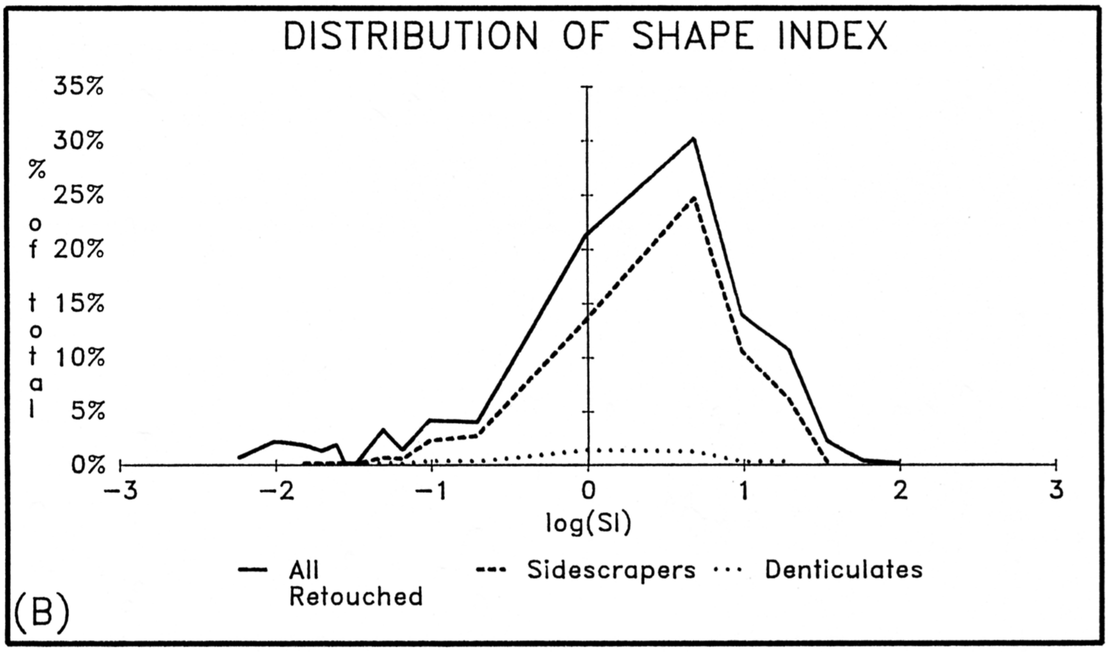




Figure 4.2. Distribution of variability in edge shape.

a) Log (Shape Index) for all retouched, notched, and endscraper edges. b) Log (Shape Index) for all retouched, sidescraper, and denticulate edges.

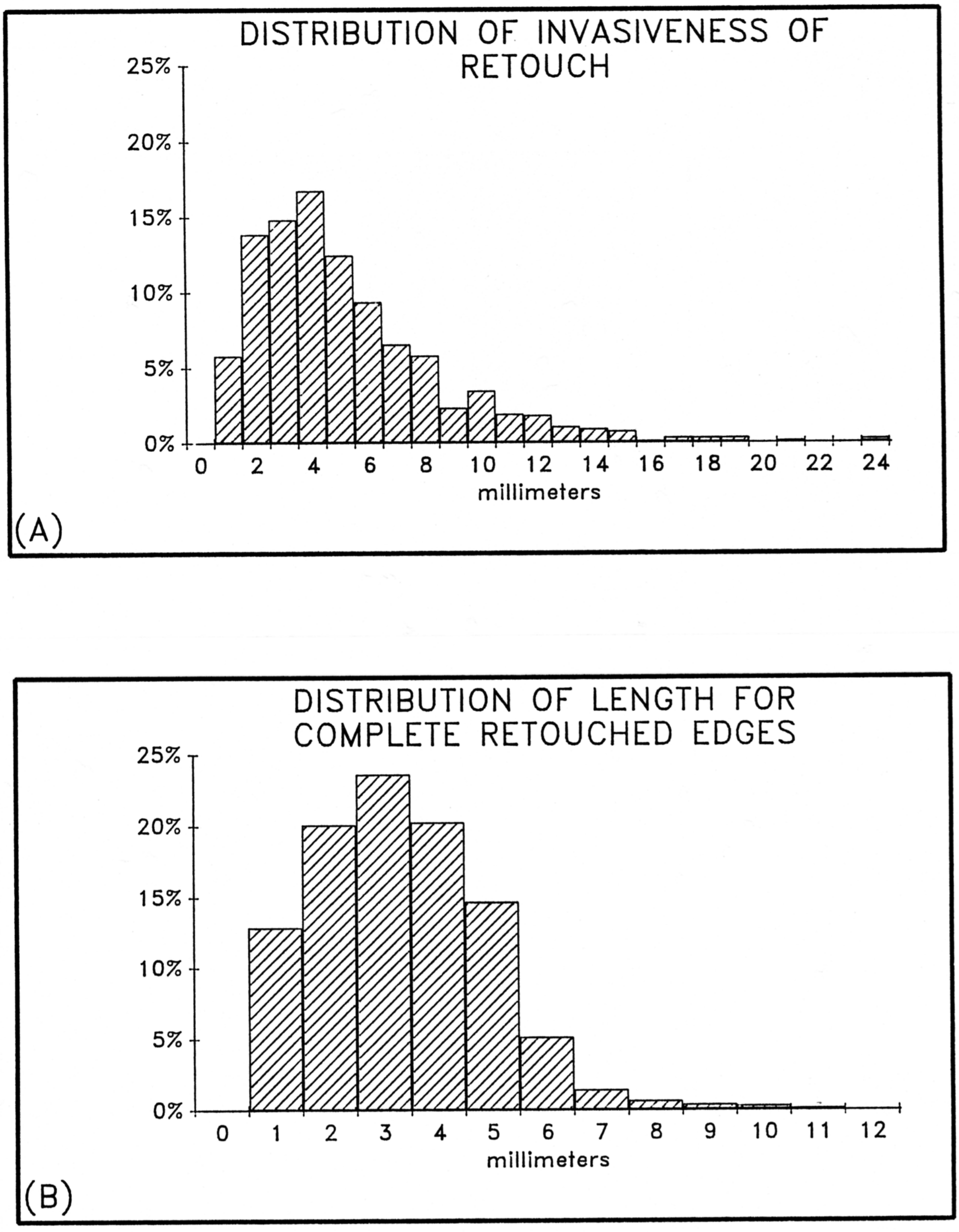



Figure 4.3. Distribution of variability in (a) retouch invasiveness and (b) edge length for complete retouched edges.

Because the area under a curve varies with the square of the radius of curvature (and, hence the square of the recipocal of SI), the log of SI was felt to more accurately represent shape than SI alone. On the graph, a value of 0 for log(SI) represents a straight edge.

Shape is a major determinant of tool type. For example, scrapers are classified according to the shape of their edges as convex, concave, straight, or some combination of these shapes. If different shapes were associated with different tasks, discontinuities in the distribution of edge shape might be expected to reflect this.

For the majority of retouched edges, the distribution of shape is continuous and slightly skewed to the right, with the overwhelmingly greatest proportion of edges slightly convex. For log(SI), $\overline{x} = 0.424$, $\sigma = 0.966$, median = 0.818, mode = 1.119 (converted to radius of curvature, $\overline{x} = 385$ mm., median = 76 mm., and mode = 38 mm.). Although unretouched flakes were not measured in this study, most have slightly convex edges due to the nature of flake production techniques. If retouched edges are part of a continuum that includes unretouched edges with respect to edge angle, an analogous pattern might be expected with edge shape. This indeed appears to be the case.

At some variance to this pattern are the outliers to the far left, or concave, side of the distribution. As can be seen in Figure 4.2a, these outliers are notches. Possibly representing a separate mode of shape, notches may be associated with a set of activities distinct from those associated with other edges. It should also be noted that burins and piercers cannot be adequately represented on this scale because their shapes are not simple curves, and hence, may also represent edges indicative of distinct activity sets

*Edge length and invasiveness.* The invasiveness of retouch and the length of complete, retouched edges and are shown in Figures 4.3a and 4.3b. As with edge angle and shape, the distribution of both these attributes is continuous, again suggesting the lack of distinct ranges of invasiveness or length that might be associated with specific activities.

The distribution of invasiveness is skewed to the left. This indicates that, while edges could be extensively modified, most were not; retouch extended less than 10 mm. inward from the margin of the greatest number of edges.

Edge length has a somewhat leptokurtic distribution that is truncated on the left side. The peaked distribution is due to the fact that edge length is limited by piece size which is fairly constant in addition to always being greater than zero (see below). The truncation on the left is primarily a result of the fact that the smallest unit of measurement for edge length was 1 cm. (see Appendix I).

*Sub-edges.* A possible reason for the lack of distinct modes in the variability of edges is that they were reused for various tasks and each time they were reused, their morphology changed accordingly. This has been termed the "Frison Effect" (Jelinek, 1975; 1976; Frison, 1968). Although not alwayse readily observable, evidence for such reuse of edges was noted as sub-edges on 98 out of 1,321 retouched edges. These are sections of edges with a recognizably different morphology from the rest of the edge (eg., a notch on a scraper edge). The majority of the sub-edges noted were notches (81%) and most of the remainder were piercers (14%). As indicated above, both edges may represent different, more distinct patterns of variability than seen in most edges.

If edges with subedges represent reuse, they might be expected to show more evidence of use than those without sub-edges. This could include more invasivene modification, steeper edge angle, a greater linear extent of retouch, and more step flaking. Although T-Tests did not indicate differences significant at the 0.05 level, edges with sub-edges consistently had slightly higher means for all these attributes compared with edges without sub-edges, as is shown below.

| | | Edge Angle (degrees) | Invasiveness (mm.) | Length (mm.) | % With Stepping |
|---|---|---|---|---|---|
| With | $\bar{X}$ | 56.1 | 5.6 | 36.9 | 27.6 |
| Sub-edges | σ | 12.7 | 3.3 | 13.9 | |
| | n | 98 | 98 | 98 | 27 |
| Without | $\bar{X}$ | 54.6 | 5.3 | 33.3 | 21.3 |
| Sub-edges | σ | 14.1 | 3.8 | 16.2 | |
| | n | 1219 | 1221 | 1223 | 261 |

RELATIONSHIPS BETWEEN EDGE ATTRIBUTES

An examination of bivariate relationships between attributes provides one means for finding possible explanations for some of the univariate patterns. Covariance between edge attributes (either positive or negative) would suggest that variability in one attribute is either causally related to the other or that variability in both features is attributable to the same underlying cause.

The attributes examined do not display linear or curvilinear relationships. Correlation coefficients, while at times statistically significant, are consistently very low (i.e., always below ± 0.50). Nevertheless, meaningful patterning does appear to exist in some of these relationships. Most notable are relationships in which one attribute limits the distribution of the other. Examples of this type of patterning are seen in bivariate scatter plots shown in Figures 4.4, 4.5, and 4.7 .

Figure 4.4 shows a scatter plot of edge angle and invasiveness for retouched edges. While the relationship depicted is not linear, virtually all edges would lie above a line drawn from the lower left corner to the upper right corner of the plot. This suggests that there was a limit to the minimum edge angle that could be achieved with a given invasiveness. Edges with invasive retouch almost always have relatively high edge angles, while extremely acute edge angles are only found on minimally invasive pieces. This pattern does not appear to be a function of the raw material used, as it encompasses a variety ranging from chalcedony to quartzite. On the other hand, this relationship could be reflecting limitations of the technical skills of the neandertals that made these artifacts.

However, another explanation is suggested by examining the way in which these attributes also vary with the dimensions of the pieces on which the edges are located. Figure 4.5 is a scatter plot of width/thickness and invasiveness. It is apparent that invasive retouch is restricted to relatively narrower/thicker pieces, while wider/thinner pieces have only minimally invasive retouch. The relationship between flake area (the product of length and width) and invasiveness displays a very similar pattern. Larger flakes tend to be minimally retouched while the most invasive retouch occurs on the smaller flakes.

Figure 4.6 is a scatter plot of width/thickness and edge angle. While not as clear as the relationship with invasiveness, the relationship between width/thickness and edge angle is obviously an inverse one. More acute edge angles tend to occur on wider/thinner flakes and steeper edge angles on narrower/thicker flakes.

The interrelationship between these three attributes suggests that these aspects of modified edges were the result of piece reduction during the course of use and resharpening rather than purposeful shaping for specific tasks. Due to the increasing thickness of the flake margin as it was reduced toward center of piece, more invasive retouch would be required to resharpen it and the edge angle would tend to increase. The extent to which this

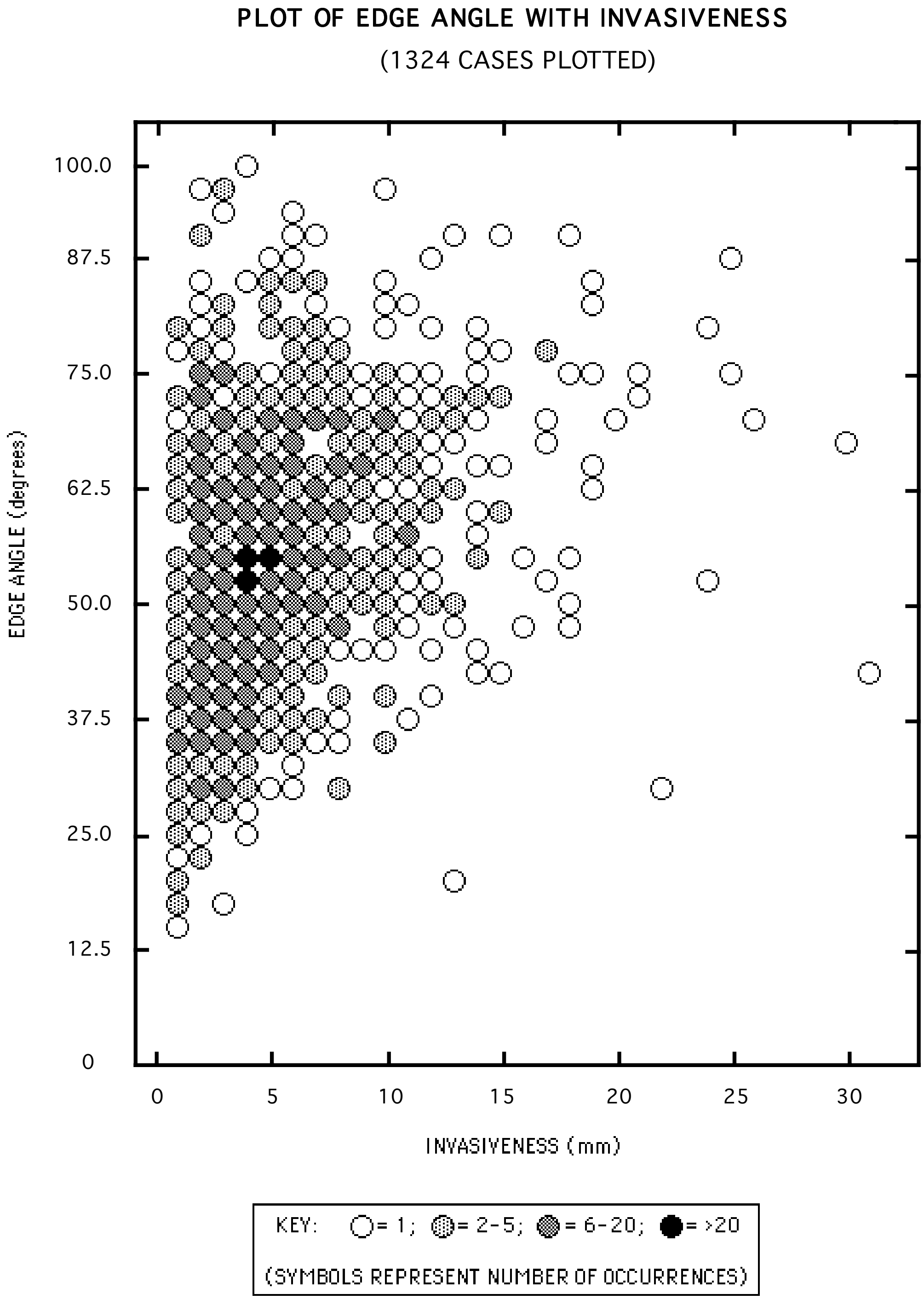



Figure 4.4. Scatter plot of edge angle vs. invasiveness for all retouched edges.

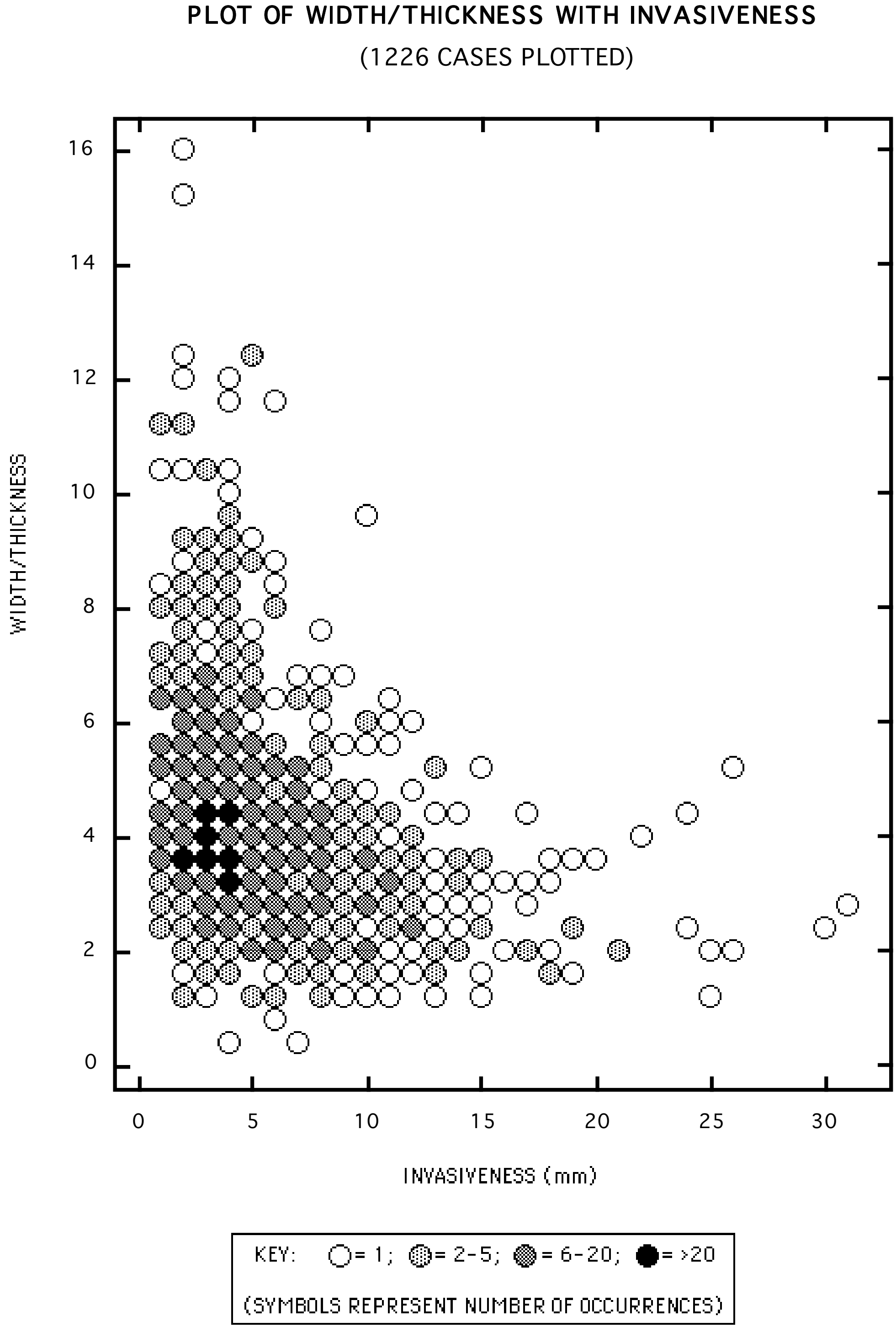



Figure 4.5. Scatter plot of piece width/thickness vs. retouch invasiveness for all retouched edges.

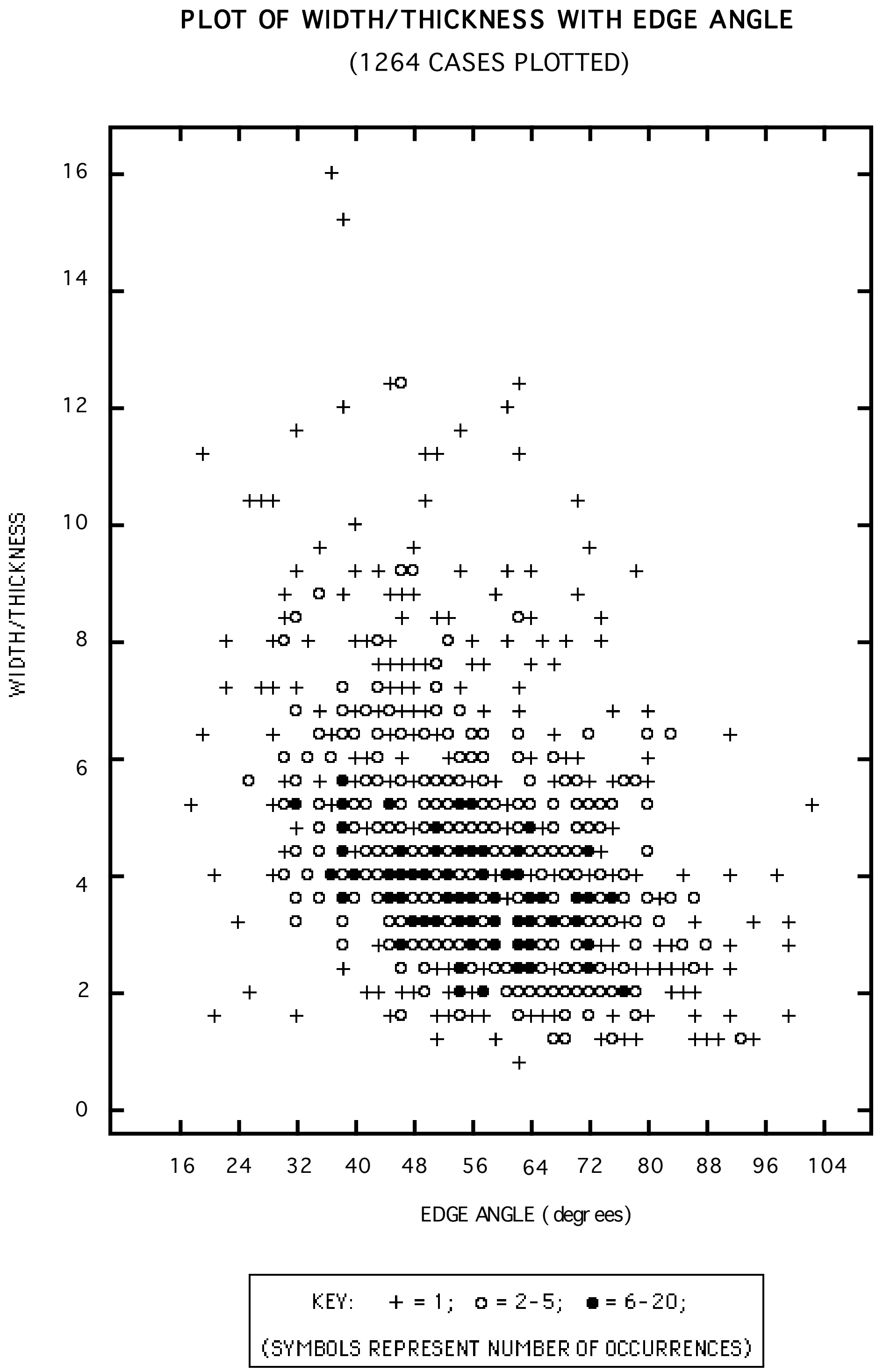



Figure 4.6. Scatter plot of piece width/thickness vs. edge angle for all retouched edges.

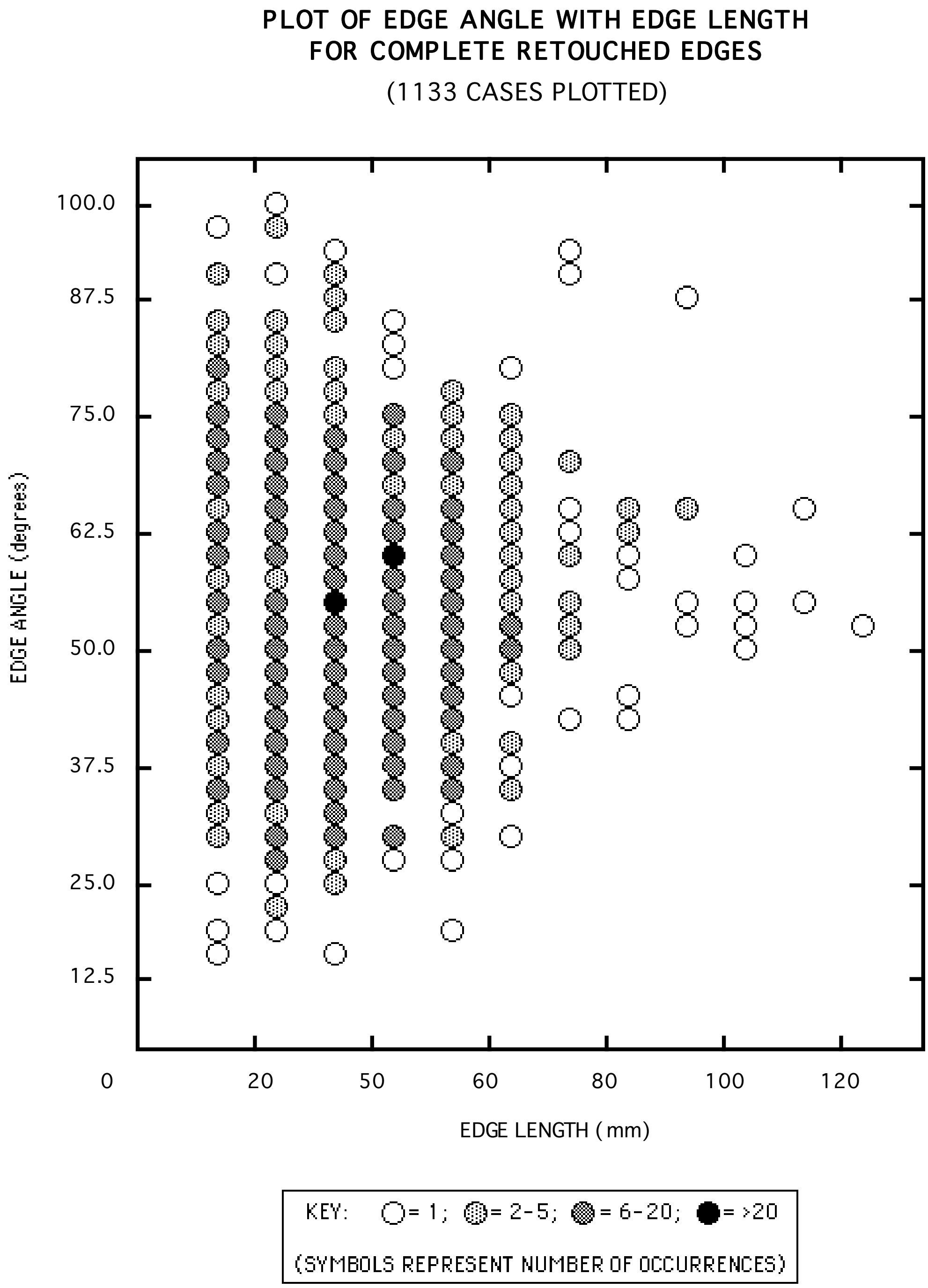



Figure 4.7. Scatter plot of edge angle vs. edge length for all complete retouched edges.

process could continue would primarily depend on the original steepness of the edge and the dimensions of the flake--more reduction being possible on wider and thinner flakes, with more acute original edges. If this was the case, the lower margin of the distribution in Figure 4.4 would represent the limits for edge angle and invasiveness during the use life of the most acute edged blanks.

A somewhat different pattern is seen in the relationship between the angle and length of retouched edges, displayed in Figure 4.7. The bivariate distribution suggests that an increase in edge length is associated with an increase in minimum edge angle up to the maximum retouched edge length. Given the relationships described above, this suggests that, for many edges, the linear extent of retouch is positively associated with the amount the edge was used, resharpened, and reduced.

However, above about 60$^{o}$, steeper edge angles are associated with increasingly shorter edges. This seems to represent edges on which use/modification was concentrated in small areas, notches for example, rather than spread over the entire edge. This increasingly concentrated use is accompanied by greater edge reduction and steeper edge angles. The total distribution suggests a dichotomy in the pattern of edge use--edges where use is concentrated in small areas, showing an inverse relationship between maximum edge and angle and edge length, and edges where use is linearly extensive showing the opposite relationship between these attributes.

In summary, then, patterning in the bivariate distribution of edge attributes suggests primarily mechanical relationships between attributes in which one attribute limits the range of variability in another. The degree to which edges were reduced seems to account for a significant amount of variability in edge angle and the invasiveness of retouch. In general, these data would suggest that, for many edges, the amount that an edge was used and resharpened may be a more important cause of variability in its final morphology than the specific activities for which it was used.

However, while edge length also seems associated with the intensity of reduction, it is a positive association for some edges and a negative one for others. This may be reflecting an activity related dichotomy in the way edges were used.

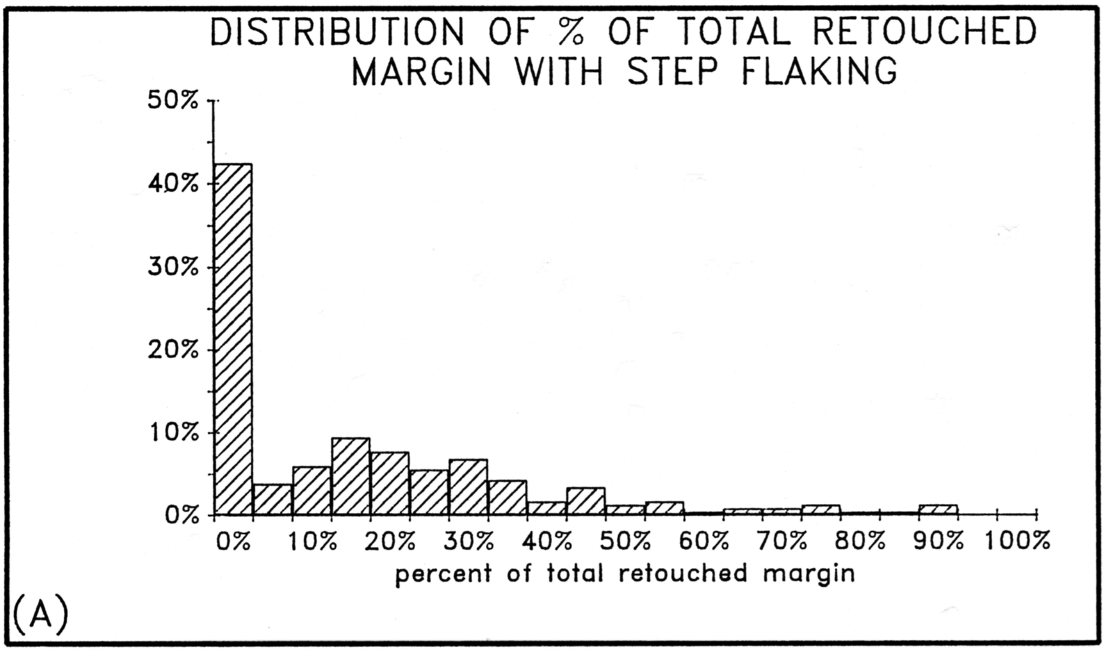
## Variability in Pieces

### AGGREGATE EDGE VARIABILITY

Although variability in edge morphology appears continuous and is often normally distributed, it is possible that edges with similar morphologies cluster on pieces to produce distinct types as is assumed in typological analysis. That at least some of these types represent activity specific tools is the implicit assumption in most functional studies of retouched tools. This possibility was explored by the examination of aggregate edge variability on pieces. Examples of aggregate edge variability include mean edge angle of the retouched edges on each piece, the total extent of modified edge, and the percent of the total amount of retouched edge showing step flaking.

The distribution of most aggregate edge variables is continuous and often normal, much like the variability in edge attributes. Aggregate variables that behave in this manner include mean, maximum, and minimum retouched edge angle on pieces, mean, maximum, and minimum invasiveness, and the total length of modification on pieces. The amount of step flaking on retouched edges and possibly the amount of edge retouched on pieces show somewhat different distributions, however.

As can be seen in Figure 4.8a, pieces can be divided into two groups on the basis of the extent of whether or not step flaking occurs on more or less than 5% of the retouched



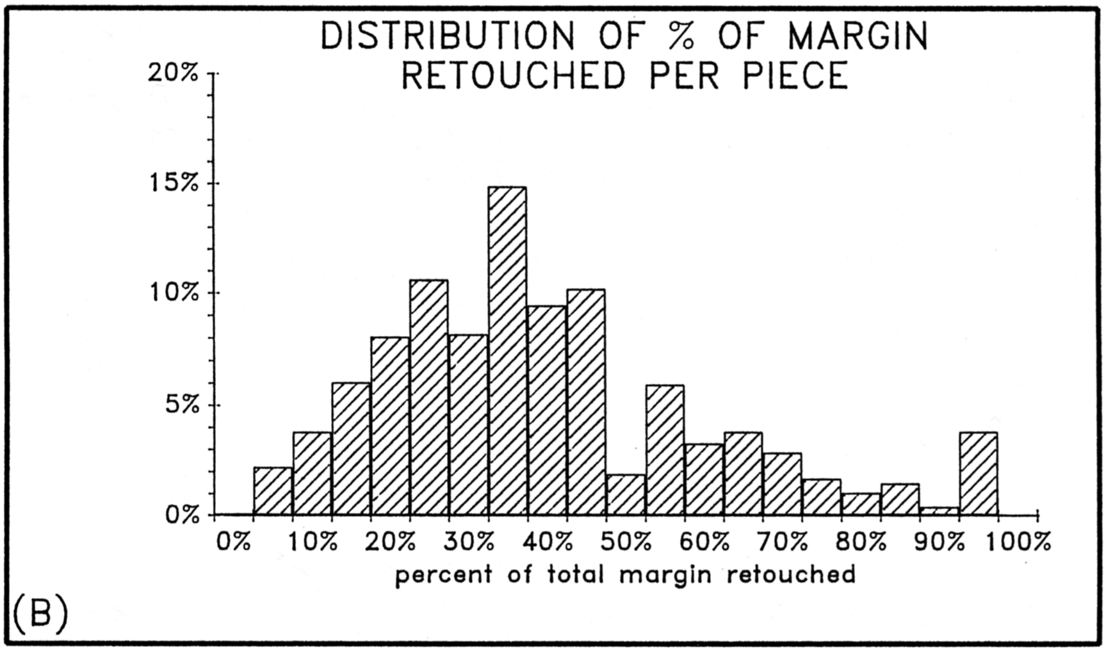




Figure 4.8. Distribution of variability in (a) percent of total retouched margin with step flaking per piece and (b) percent of total margin retouched per piece.

margin. For the group with step flaking however, the percent of the retouched margin with step flaking displays a continuous, though slightly left skewed distribution with $\overline{x}$ = 31.1%, σ = 19.6, median = 26%, and mode = 20% (n = 153). It should be noted here that, for the most part, the step flaking observed and measured in this study is relatively fine and does not consists of the heavy step flaking that would be termed Quina retouch.

Figure 4.8b shows the distribution of the percent of the total piece margin which is modified. It appears that that there may be two or three modes to this distribution, and that it can be divided into those with ≤ 50% , those with 50-99%, and those with 100% of their margins modified. This may be reflecting the differences between extensive and concentrated edge use mentioned above. However, none of the groups show an internal distribution as uniform as the one that characterizes the divisions based on step flaking. Additionally, they cross-cut the divisions based on step flaking.

In order to assess the significance of the divisions based on step flaking and extent of retouch, they were examined with respect to variability in other features. Table 4.1 compares pieces with and without step flaking with respect to other aggregate variables. Table 4.2 compares pieces with less than 50% and greater than 50% of the margin modified (because there are only 36 pieces with 100% of the margin modified, they have been grouped with the > 50% group--n = 261 for the combined group).

It is apparent from table 4.1 that pieces with > 5% of their retouched margin displaying step flaking are markedly different from pieces with little or no step flaking. Pieces with step flaking have steeper edge angles and more invasive retouch. Additionally, they are on larger, relatively thicker pieces with a longer total margin than pieces with little or no step flaking. Finally, more of the margin of pieces with step flaking shows evidence of modification and use, and the modified edges are longer. T-tests to determine the significance of these differences showed the two groups defined on the basis of step flaking differed significantly with respect to all these features.

Table 4.2 shows that while the groups defined on the basis of the percent of the margin showing modification differed, they did not differ as profoundly as those defined by step flaking. Pieces with more than 50% of the margin modified have significantly steeper and more invasively retouched edges than pieces with less than 50% modification. Surprisingly, pieces with more of the margin retouched also have less step flaking. Not so surprisingly, they have longer retouched edges. Pieces with more retouch do not differ significantly from pieces with less than 50% of the margin retouched with respect to any of the piece dimensions examined.

Both with respect to the distribution of variability in the defining attribute and with respect to variability in other features, the groups defined on the basis of the amount of step flaking may represent distinct divisions in the aggregate variability of chipped stone artifacts. On the other hand, the groups defined on the basis of the total extent of edge modification seem more questionable.

The step flaked pieces may represent some sort of heavy duty tool. Their mean area at discard is almost a third larger than other pieces, in spite of the fact that their mean width/thickness ratio, retouched edge angle, invasiveness, and measures of linear extent of retouch, as well as the amount of step flaking all indicate that they experienced considerably more use and modification, with associated reduction in piece size. This would suggest that pieces with more than 5% of their retouched margin displaying step flaking represented originally larger and subsequently more heavily used artifacts than other pieces.

Table 4.1. Comparison of pieces with step flaking on > 5% of the retouchedmargin vs. pieces with < 5% step flaking.

| Aggregate Variable | $\bar{X}$ of >5% Step Flaking | $\bar{X}$ of < 5% Step Flaking | 2-Tailed T | α | n |
|---|---|---|---|---|---|
| Mean angle of retouched edges (degrees): | 59 | 53 | 5.45 | 0.0 | 985 |
| Mean invasivess (mm.): | 8 | 5 | 9.47 | 0.0 | 985 |
| Total margin length (mm.): | 122 | 104 | 6.73 | 0.0 | 986 |
| % of margin modified: | 54.6 | 41.1 | 7.45 | 0.0 | 986 |
| Mean length of retouched edges (mm.): | 43 | 32 | 8.91 | 0.0 | 986 |
| Width/thickness: | 3.39 | 4.49 | -6.49 | 0.0 | 935 |
| Area (mm2): | 1469 | 1120 | 6.27 | 0.0 | 973 |

Table 4.2. Comparison of pieces with modification on > 50% of the margin, vs.those with < 50% modification.

| Aggregate Variable | $\bar{X}$ of >50% Modified | $\bar{X}$ of <50% Modified | 2-Tailed T | α | n |
|---|---|---|---|---|---|
| Mean angle of retouched edges (degrees): | 65 | 54 | -2.51 | 0.01 | 932 |
| Mean invasivess (mm.): | 6 | 5 | -4.36 | 0.0 | 932 |
| Total margin length (mm.): | 106 | 109 | 1.13 | 0.26 | 933 |
| Mean length of retouched edges (mm.): | 39 | 32 | -7.22 | 0.0 | 933 |
| % of retouched margin with step flaking: | 16.1 | 22.1 | 2.53 | 0.01 | 242 |
| Width/thickness: | 4.25 | 4.34 | .62 | 0.54 | 884 |
| Area (mm2): | 1235 | 1166 | -1.45 | 0.15 | 921 |

## RELATIONSHIPS BETWEEN AGGREGATE AND PIECE ATTRIBUTES

As was the case with edges, relationships between aggregate variables and between aggregate variables and piece dimensions were examined in an attempt to clarify observed univariate patterns. Patterning is not apparent in many of the bivariate relationships examined.

In most cases, the relationships that do show apparent patterning are very similar to those described above for individual edges. The relationship between mean retouched edge angle and mean invasiveness for entire pieces is almost identical to that of the corresponding edge attributes, reinforcing the interpretations suggested above for these attributes. This is also the case for the relationships between width/thickness, mean invasiveness, and mean edge angle. Finally, the bivariate distribution of mean edge angle and the total length of retouch on pieces mirrors that of edge angle and retouched edge length for individual edges.

Bivariate distributions that could be assessed for pieces but not individual edges included those between total length of modification along the margin and piece dimensions. While the extent of modification does not appear to exhibit patterned relationships with either width or thickness, its relationship with piece length displays the strongest correlation of all bivariate distributions examined, although it is still rather weak with $R = 0.47$. Like the other previously described distributions, however, this is primarily a limiting relationship, in which the maximum total length of modification is limited by piece length. This is not overly surprising.

## MULTIVARIATE ANALYSES

In order to examine more complex interactions between attributes and reduce the relatively complex variability seen in retouched tools, factor analysis was performed. Attributes used in the analysis included the total margin length of pieces, the total length of modified margin, the total length of step flaking, mean edge angle, mean invasiveness of retouch, piece length, piece width, piece thickness, and piece breadth (defined as width for pieces with lateral retouched edges and length for pieces with retouch on their proximal or distal ends).

A principle components analysis was performed on these attributes. The derived factors were then rotated, using the varimax method, to obtain orthagonal relationships between the factors. The results of the analysis are shown below.

ROTATED FACTOR MATRIX

| Variable | Factor 1 | Factor 2 | Factor 3 |
|---|---|---|---|
| Piece length | .86783 | .23721 | -.03310 |
| Total retouch length | .82161 | .06700 | .07891 |
| Total margin length | .71945 | .52471 | .08704 |
| Total step flaking | .57739 | -.22374 | .34262 |
| Piece width | -.01062 | .87363 | .08837 |
| Piece breadth | .23660 | .80137 | .11818 |
| $\bar{X}$ Invasiveness | .07540 | .11514 | .74324 |
| $\bar{X}$ Edge angle | -.01584 | -.04247 | .69772 |
| Piece thickness | .18642 | .21315 | .68860 |

| Factor | Eigenvalue | % of Variability Explained | Cumulative % Explained |
|---|---|---|---|
| 1 | 3.14374 | 34.9 | 34.9 |
| 2 | 1.42204 | 15.8 | 50.7 |
| 3 | 1.32967 | 14.8 | 65.5 |

Three factors were derived before the associated eigenvalues dropped below 1.00, accounting for 65.5% of the variability observed in the retouched tools as measured by the attributes included in the analysis. The composition of the factors derived generally support the interpretations of variability suggested by univariate and bivariate analyses.

The primary attributes contributing to factor one are length, total margin length, the linear extent of modification, and amount of step flaking. As indicated above, piece length not surprisingly affects the total extent of modification possible. Also, it was observed that pieces with step flaking are significantly larger than pieces without step flaking. The second factor is composed primarily of width and breadth, closely related measurements. The primary attributes contributing to the third factor are mean edge angle, mean invasiveness, and thickness. The relationships between these attributes have already been discussed in considerable detail. This probably reflects the degree an artifact has been used, modified, and reduced.

In summary, much of the variability in pieces is simply a reflection of the variability in their edges. This suggests that the retouched tools examined here are generally the simple sum of their component edges rather than the distinct functional or stylistic clusters of edges that is implied in many analyses based on the existing typological system. Furthermore, factor analysis as well as the univariate and bivariate analyses suggest that the dimensions of the flake on which a tool is made and the intensity with which it has been used may be the most important factors affecting variability in Middle Paleolithic retouched tools.

## Assemblage Level Variability

The first part of this chapter has been devoted to the detailed examination of patterns of overall variability in the entire sample of Middle Paleolithic from this study. However, these tools derive from a series of assemblages that differ from each other with respect to time, space, and a variety of associated environmental parameters. In order to better understand the relationships between variability in retouched chipped stone artifacts and Middle Paleolithic behavior, it is necessary to also examine lithic variability at the assemblage level, arranged as best as possible in time and space.

### EDGE VARIABILITY

Temporal and spatial variability in edge attributes is shown in Figures 4.9-4.11. These figures display the means of edge angle, invasiveness, edge length, shape index, and percent of the edge with step flaking for assemblages from each of the sites studied. The assemblages have been broadly arranged according to the correlations proposed in Chapter 2. All assemblages from Cova del Salt and Devil's Tower and all but layer G from Gorham's Cave seem most likely associated with the early glacial. Gorham's Cave layer G and the single assemblage from Cova del Pastor seem most reasonably correlated with the lower or middle pleniglacial. The assemblages from the layers M-R of Gorham's Cave and 4-5 of Devil's Tower have been combined due to the low sample sizes from these proveniences.

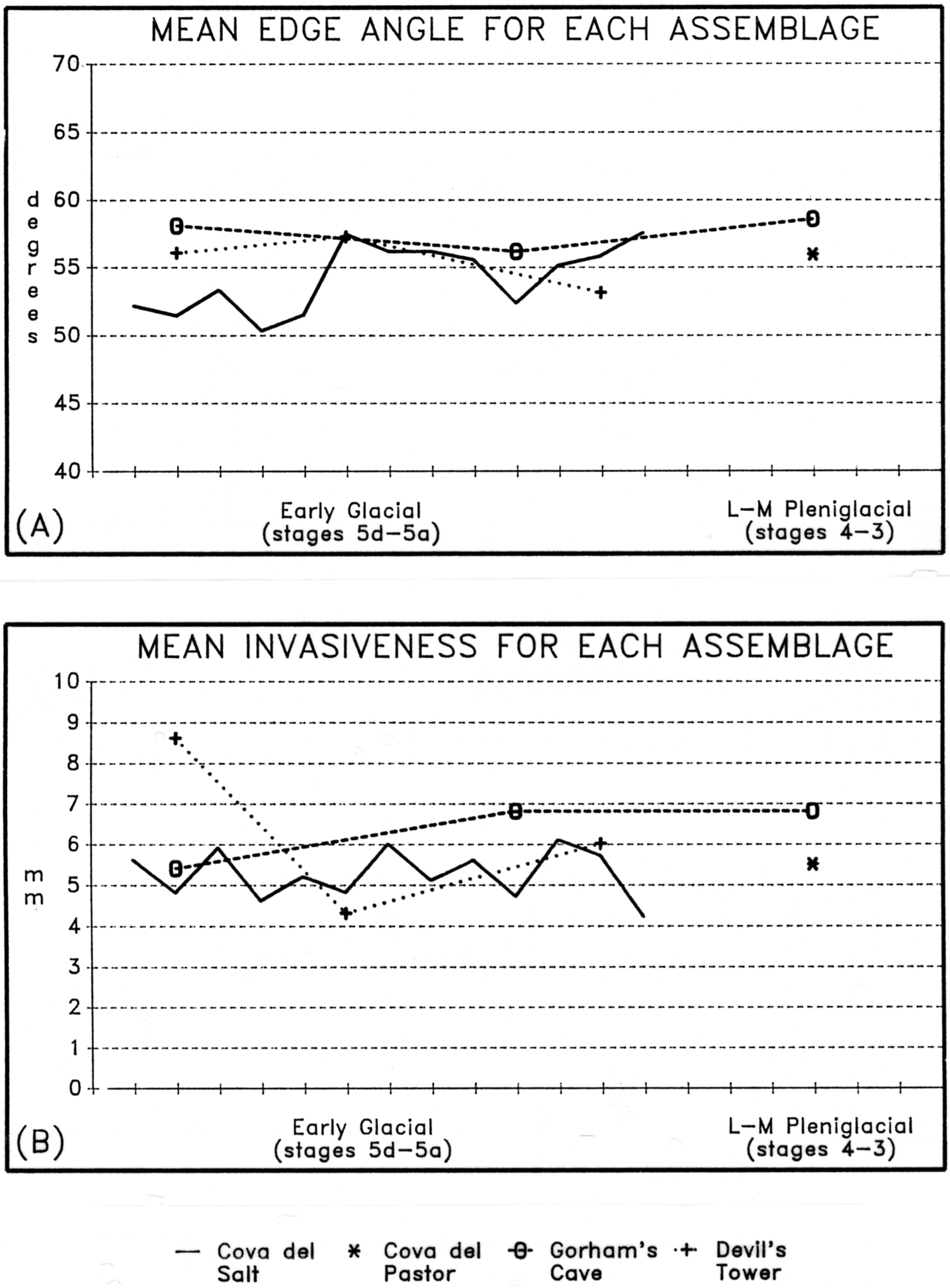



Figure 4.9. Variability in means of (a) retouched edge angle and (b) retouch invasiveness for retouched edges in assemblages from the sites studied.

Assemblages arranged (left to right) according to chronologies proposed in Chapter 2, and include archaeological layers 6-inferior through 0-1 from Cova del Salt; the single assemblage from Cova del Pastor; layers M-R, K, and G from Gorham's Cave; and layers 4-5, 3, and 2 from Devil' Tower.

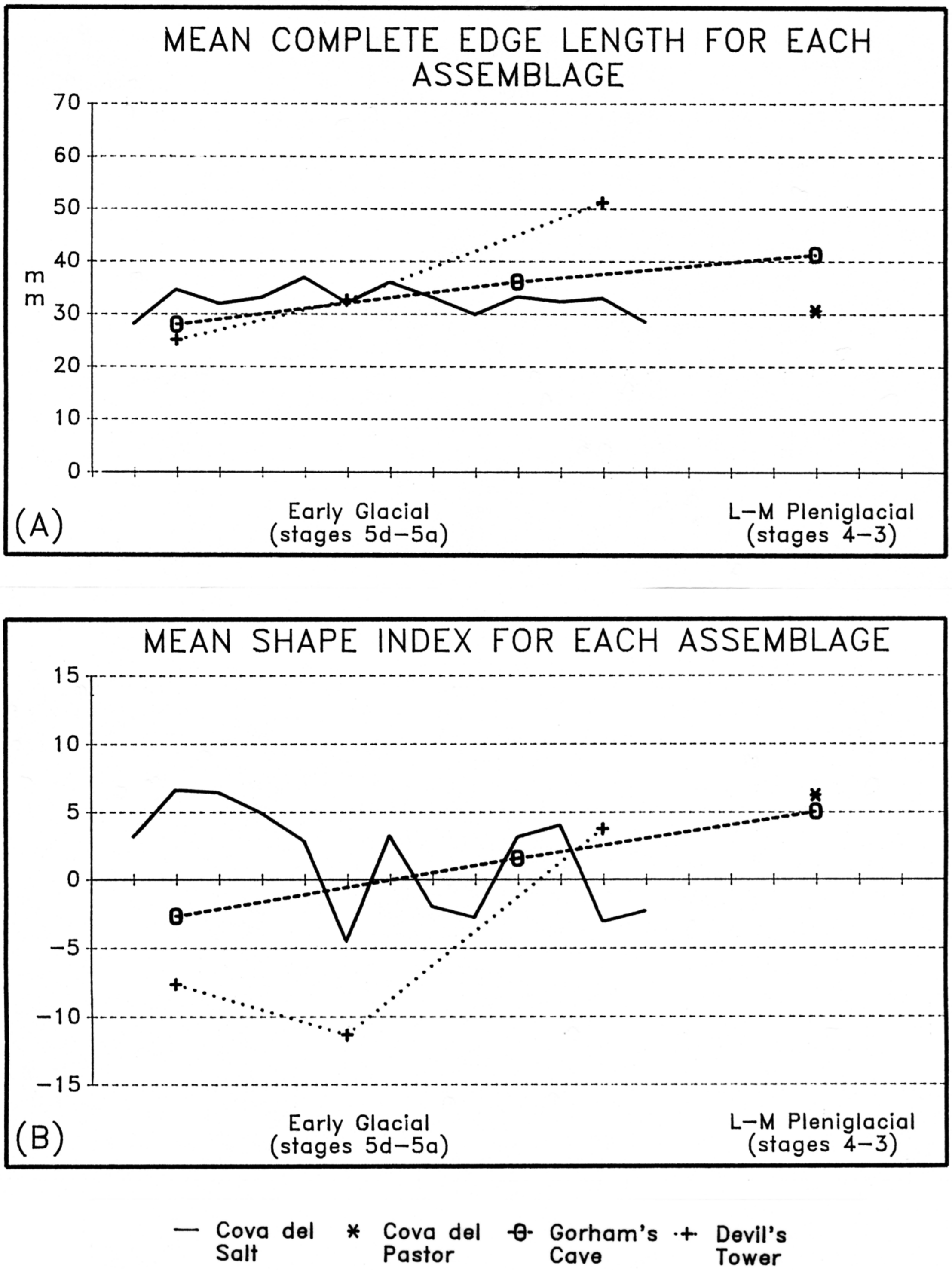



Figure 4.10. Variability in means of (a) edge length and (b) Shape Index for retouched edges in assemblage from the sites studied.

Assemblages arranged (left to right) according to chronologies proposed in Chapter 2, and include archaeological layers 6-inferior through 0-1 from Cova del Salt; the single assemblage from Cova del Pastor; layers M-R, K, and G from Gorham's Cave; and layers 4-5, 3, and 2 from Devil' Tower.

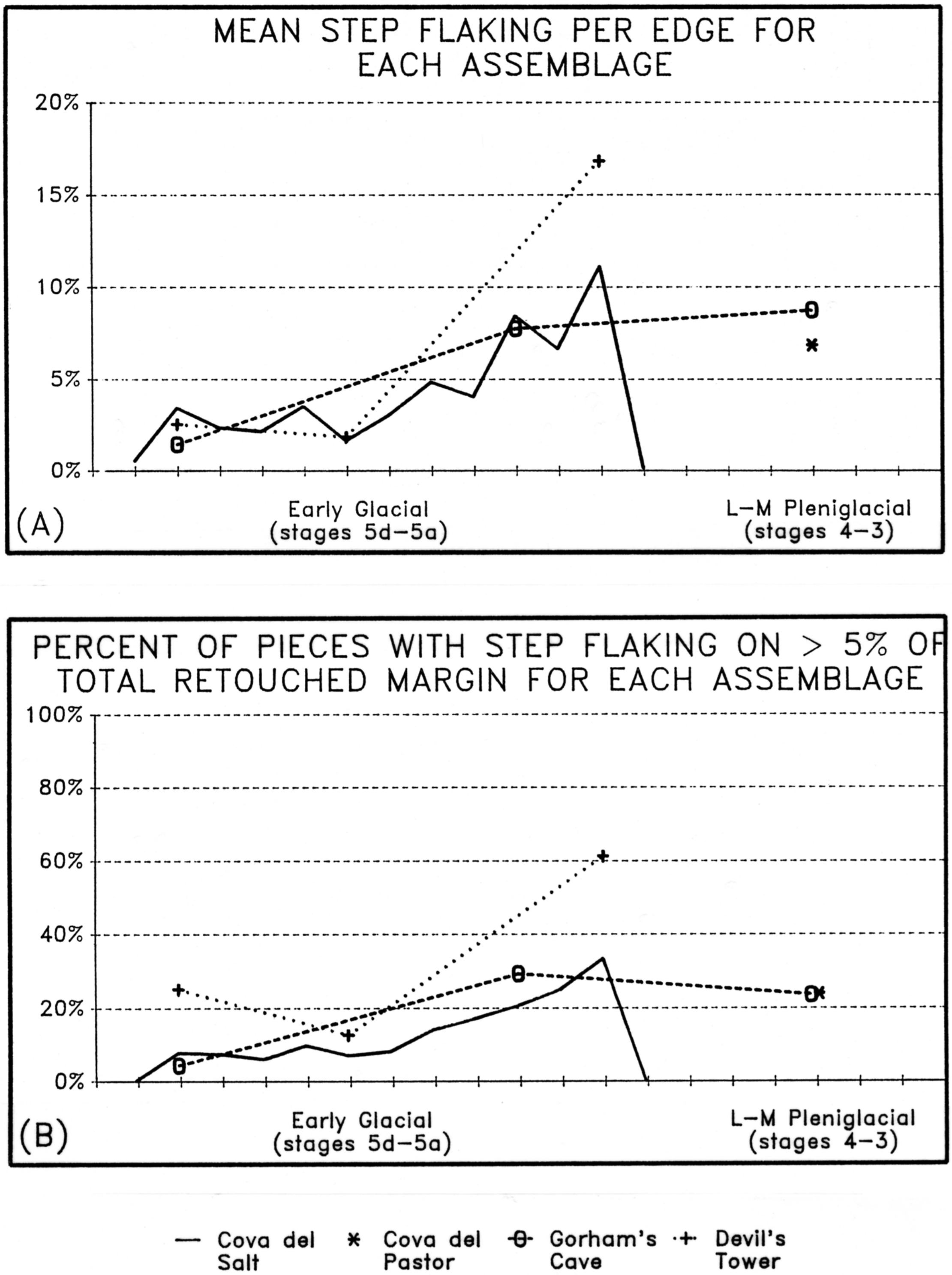



Figure 4.11. Variability in (a) means of percent step flaking per edge and (b) percent of pieces with step flaking on > 5% of the total retouched margin in assemblages from the sites studied.

Assemblages arranged (left to right) according to chronologies proposed in Chapter 2, and include archaeological layers 6-inferior through 0-1 from Cova del Salt; the single assemblage from Cova del Pastor; layers M-R, K, and G from Gorham's Cave; and layers 4-5, 3, and 2 from Devil' Tower.

As can be seen, variability through time in the edge attributes does exist, though not for all attributes and not equally at all sites. The most stable edge feature in both time and space is mean retouched edge angle. It fluctuates between 50º and 60º at all four sites (Figure 4.9a).

The mean of invasiveness of retouch (Figure 4.9b) also varies little, ranging between 4 and 7 mm. in all assemblages except for the lowest layers of Devil's Tower (4-5) where it reaches a value of nearly 9 mm. Mean retouched edge length (Figure 4.10a) fluctuates within a relatively narrow range (28-37 mm.) through time at the Alcoy Basin sites. It increases through a slightly wider range at Gorham's Cave (28-41 mm.), and a considerably wider range at Devil's Tower (27-52 mm.). Mean values of edge length in assemblages from the upper layers of both Gibraltar sites are above those from the Alcoy Basin sites.

The shape of retouched edges (Figure 4.10b) varies through time at all sites. At Cova del Salt it is convex for the lower layers of the site (archaeological layers 6-inferior through 4-5) and repeatedly fluctuates in the remaining layers from positive to negative (i.e., from convex to concave) within a range of +6 to -4 for SI (reflecting radii of curvature varying from +83 mm. to -125 mm.). At Gorham's Cave, edge shape becomes increasingly convex, from SI=-3 to SI=+5. At Devil's Tower, mean edge shape is strongly concave in the lower layers (4-5 and 3, with SI values of -8 and -11 respectively--corresponding to radii of curvature of -62 mm. and -45 mm. respectively), but becomes convex in the layer 2 (SI=+4).

The mean percent of step flaking (Figure 10a) on retouched edges shows a consistent increase at all sites. At Cova del Salt, it climbs from less than 5% in the lower layers to more than 10% in the upper layers (except for the uppermost layer, 0-1, where it is 0). At Gorham's Cave the ammount of step flaking seems to increase within about this same range, while at Devil's Tower the mean percent of step flaking per edge increases to 17% in layer 2.

In general, with the possible exceptions of edge shape and step flaking, edge attributes seem to show considerable stability through time at all sites. For all attributes, Cova del Pastor appears very similar to Cova del Salt. Larger differences exist between mean attribute values for assemblages from Gorham's Cave and Devil's Tower, and between these Gibraltar sites and the Alcoy Basin sites. This may be due as much to the smaller sizes of the Gibraltar assemblages and the probably greater time spans represented by these sites as to any activity related variability.

## PIECE DIMENSIONS

Dimensional features for entire pieces from each site were also examined. Mean piece length varies little through time at all sites, and is higher at the Gibraltar sites (53-64 mm.) than the Alcoy Basin sites (36-42 mm.). Mean piece width also shows minimal temporal variability and is greater at the Gibraltar sites (29-34 mm. for Gorham's Cave and 36-46 mm. for Devil's Tower) than the Alcoy Basin sites (25-30 mm.). Mean thickness fluctuates between 6 and 8 mm. at Salt and Pastor, 7-10 mm. at Gorham's Cave, and 10-14 mm. at Devil's Tower. While variability is greater in a relative sense than that displayed by length and width, it is still minimal. As with the other dimensions, means for the Gibraltar sites are higher than those for the Alcoy Basin sites. As might be expected, mean width/thickness does not vary much through time at any site. Interestingly, at all sites values of this ratio fluctuate within the same range of 3.9-4.8.

## AGGREGATE EDGE VARIABILITY

It was suggested above that retouched tools can be divided into two groups on the basis of whether step flaking occurred on more or less than 5% of the total retouched margin of pieces. Figure 4.11b shows the frequency of pieces with more than 5% step flaking relative to all retouched pieces in each assemblage. The general trend closely matches that of the amount of step flaking per edge seen in Figure 4.11a. This indicates that the increase in the the amount of step flaking per edge is associated with an increase in the number of pieces with step flaking.

Mean total retouch per piece in each assemblage was also examined. Like step flaking, this value tends to increase through time at the three sites with multiple assemblages. At Gorham's Cave, a mean of 49 mm. of the margin per piece was retouched in layers M-R. This increases to 60 mm. in layer K and 56 mm. in layer G. At Devil' Tower, mean total retouch per piece increases from 32 mm. in layers 4-5 to 83 mm. in layer 2. At Cova del Salt the values increase from 38 mm. to 52 mm. in archaeological layers 6-inferior through 1-2, but decrease to 36 mm. in layers 1 and 0-1. As piece size is relatively constant at all sites, observed variability seems to be indicating net increase in the amount of modification to each piece through time.

## INTERPRETING ASSEMBLAGE LEVEL VARIABILITY

The lack of variability through time in most attributes at Cova del Salt seems to argue for minimal changes in the way in which chipped stone artifacts were used at the site. Although only one assemblage was available from Pastor, it closely matches the upper levels of Salt for almost every attribute examined. It should be remembered that all values for attributes represent the value at which the artifact was discarded, so the consistencies noted mark extreme stability in the points at which tools were discarded.

Most variability that does occur, takes place in the only two attributes that that might reflect distinct activity sets--edge shape and step flaking. Variations in mean edge shape are generally matched by the percentage of notched edges relative to all retouched edges in each assemblage ($R = 0.66$) even though they make up a relatively small fraction ($\leq 10\%$) of the retouched edges. This suggests variability in activities associated with concave edges that include, but are not limited to, notches. As notches also are edges on which use/modification was concentrated in a small area, this variability may also reflect fluctuations in activities requiring extensive verses concentrated edge use.

For step flaking, there is both an increase in the amount of step flaking per edge and in the number of pieces with more than minimal step flaking. Both measures of step flaking suggest an increase over time in activities that might cause this type of edge feature.

Similar patterns of variability among assemblages occur for the Gibraltar sites as have been described for the Alcoy basin sites. However, at Gibraltar, there is also an increase in mean invasiveness and retouched edge length, suggesting an overall increase in intensity of use of chipped stone artifacts at these sites through time.

One way in which the intensity with which lithics were used in assemblages can be estimated is simply the percent of the assemblage that has been retouched. Table 4.3 shows this information for assemblages where debitage counts are present and probably reliable. At Salt, percentages of retouched pieces tend to be moderate in the lower half of the sequence, and lower in the upper half. A similar pattern is seen at Gorham's Cave, where the highest relative frequencies of retouched pieces is seen in the assemblages of the lower layers Q and R. Although they show similar trends in changing intensity of stone tool use, Cova del Salt shows a much greater overall intensity of lithic utilization than Gorham's Cave.

In summary, there is considerable uniformity in many aspects of variability from assemblage to assemblage in all sites studied. There is greater uniformity in the Alcoy basin assemblages, possibly because they represent a shorter spans of time than the Gibraltar assemblages. Some of the variability that does exist may reflect Middle Paleolithic behav-

Table 4.3. Frequency of retouched pieces in assemblages from Cova del Salt and Gorham's Cave.

| | COVA DEL SALT | | | | | | GORHAM'S CAVE | | |
|---|---|---|---|---|---|---|---|---|---|
| Layer | Sector A | | Sector D | | Sector E ("Tools") | | Layer | All | |
| | % | n | % | n | % | n | | % | n |
| 0-1 | | | 16.7 | 13 | 10.6 | 16 | G | 0.8 | 41 |
| 1 | 12.9 | 36 | 10.9 | 20 | 7.1 | 20 | H | 0.0 | 0 |
| 1-2 | | | 9.6 | 9 | 7.3 | 12 | K | 1.7 | 26 |
| 2 | | | 12.2 | 11 | 9.1 | 10 | L | 0.0 | 0 |
| 2-3 | | | 12.1 | 13 | 8.8 | 5 | M | 1.2 | 17 |
| 3 | 15.3 | 186 | 20.2 | 22 | 14.1 | 12 | N/O | 0.0 | 0 |
| 3-4 | 12.9 | 54 | 12.1 | 14 | 2.9 | 1 | P | 1.3 | 6 |
| 4 | 6.1 | 12 | 25.9 | 7 | 14.8 | 4 | Q | 5.3 | 2 |
| 4-5 | 13.6 | 54 | 18.6 | 8 | 20.8 | 5 | R | 4.5 | 2 |
| 5 | 9.9 | 64 | 16.3 | 8 | 18.8 | 3 | S1 | 0.0 | 0 |
| 5-6 | 8.8 | 19 | 15.5 | 9 | | | T | 0.0 | 0 |
| 6 | 10.6 | 25 | 21.7 | 15 | | | U | 25.0 | 1 |
| 6 inf. | | | 12.1 | 11 | | | | | |
| Total | 13.3 | 450 | 14.4 | 160 | 9.3 | 88 | Total | 1.0 | 95 |

ior, both in the nature of activities performed and in the intensity of lithic utilization. The significance of this variability with respect to behavior is discussed more fully in the next chapter.

## Types and Quantitative Variability

### TYPES AND EDGE VARIABILITY

It has been suggested above that most of the variability in retouched edges is continuous and relatively normally distributed, without the multimodality that might be expected if edges represented discrete functional or stylistic types. It was also noted that retouched edges appear to vary continuously with unretouched edges with respect to edge angle, suggesting that modified edges are more likely the result of continued use and resharpening of unmodified edges than of intentional design. In order to examine the distribution of quantitative edge variability among the types in the widely used typology of Bordes, edges were classified in a modified version of this system. Although no multiple edged types such as convergent scrapers could be used, all single edged types were used where appropriate (convex scraper edge, notch, and denticulate edge for example).

*Edge Angle.* Figure 4.1b shows the relative frequency of edge angles for unretouched sharp, marginally retouched (i.e., those with invasiveness < 2 mm.), and scraper edges. Both unretouched and scraper edges show relatively normal distributions that overlap considerably, with scraper edges being steeper (unretouched: $\bar{x} = 42^{o}$, $\sigma = 13^{o}$, median = $41^{o}$, mode = $43^{o}$; scrapers: $\bar{x} = 54^{o}$, $\bar{x} = 12^{o}$, median = $53^{o}$, mode = $55^{o}$). Marginally retouched edges, have a flatter distribution that encompasses that of the other two groups ($\bar{x} = 51^{o}$, $\sigma = 16^{o}$, median = $49^{o}$, mode = $43^{o}$). Other edge types have similar distributions, and all lie within the range shown here.

These distributions appear to lend added support to the interpretations of edge variability suggested above. Scraper edges, marginally retouched edges, and unretouched edges appear to represent arbitrary divisions of a continuous distribution of variability in edge angle. Unretouched edges, representing minimally used edges, are at one end of this distribution. Scrapers, representing more heavily used, resharpened, and reduced edges, are at the other end of the distribution. Marginally retouched edges, with intermediate amounts of use, are more variable, but their mean and median lie between those of unretouched and scraper edges.

*Shape.* It was noted above that the values for the shapes of most edges lie within a continuous distribution, although those with extremely concave edges, such as notches may represent a distinct group. The distribution of variability in shape can be examined with respect to edge types at a more detailed level.

Scrapers represent more than one third of all Middle Paleolithic tool types, and are defined to a large extent on the basis of edge shape. The distribution of shape for scrapers is shown in Figure 4.2. Variation here appears continous and varies from normal primarily in that the distribution is slightly skewed to the right ($\bar{x} = 0.576$, $\sigma = 0.792$, median = 0.893, mode = 1.119--converted to radii of curvature, $\bar{x} = 69$ mm., median = 64 mm., mode = 38 mm.).

Other types are also shown in Figures 4.2a and 4.2b. Endscrapers are, by definition, more convex than sidescrapers. Indeed, their distribution is to the convex side of the distributions of shape for both sidescrapers and all retouched edges. However, as can be seen in Figure 4.2a, they appear more to represent an extreme of a continuous distribution than a separate group. The distribution of denticulates (Figure 4.2b) closely overlaps that of scrapers indicating no difference between the ranges of shape for the two types. Finally, Figure 4.2a shows that the outliers to the concave side of shape are indeed almost entirely notches.

## MULTIVARIATE ANALYSES

Middle Paleolithic types are defined on the basis of a variety of morphological features, not just on variability in a single attribute. In order to examine relationships between various quantitative attributes and typological variability, analyses of variance with post facto range Scheffe tests were performed for both edge types and associated edge attributes, and the traditional types for entire pieces with the associated aggregate variables. The range tests indicate which types differ significantly from which other types with respect to each attribute examined (Nie, et.al., 1975:427-428).

All ANOVA's performed indicated significant levels of variability among types. However, as might be expected from the results described above, the range tests indicated almost no significant differences between any pairs of types with respect to any of the attributes. Both for edge types and the traditional tools types, the only significant differences among types tend to be restricted to expected ones--that is, the primary attributes which define the types that differed. Marginally retouched edges and pieces differ from most others types with respect to invasiveness; notches differ significantly in shape from other types; notches and denticulates differ from marginally retouched edges and pieces with respect to edge angle; for pieces, convergent and double scrapers differ significantly from most other pieces with respect to the linear extent of retouch. Such variability is merely reflecting the criteria of the classification system.

The reason for the lack of significant differences between types is probably twofold. First, quantitative variability appears to be continuous in almost all attributes measured, rather than occurring in the discrete packages that types imply. Secondly, the range of variability within each type, with respect to the attributes measured, is relatively large. Hence, while quantitative measures of morphological variability is differentially distributed across traditional types, differences in frequencies of types tend to reflect this variability at only a very gross level if at all. Additionally, typological analysis has the tendency to misrepresent variability as discrete when in most cases it is continuous. Nevertheless, typological analyses, primarily based on Bordes' system, are the only measures of variability in virtually all published studies of Middle Paleolithic assemblages. For this reason, it is valuable to identify ways in which the results of such analyses can be compared with quantitative variability.

## RELATING TYPOLOGICAL AND QUANTITATIVE VARIABILITY

Piece dimensions appear to represent an important factor affecting variability in Middle Paleolithic chipped stone assemblages. While measurements of length, width, and thickness have not traditionally been a part of typological analysis, these measurements are increasingly a part of more recent studies (see below). Though dimensions are more often reported for debitage than retouched tools, if any measurements for tools are reported, these three are the most likely, permitting comparisons with dimensional variability observed in the present study.

It has also been suggested that the intensity with which lithics were utilized strongly contributes to observed morphological variability. Although measures of edge angle, invasiveness, or extent of modification are not available in most studies, intensity of utilization can be estimated in a variety of ways from many published analyses. Initially, this can be estimated by the ratio of retouched to unretouched artifacts. The commonly computed scraper index (IR), representing the percent of essential types 5-44 and 51-63 that are scrapers (types 9-29), provides a relative measure of pieces that tend to be extensively and invasively retouched. Finally, counts of retouch types, increasingly reported in more recent studies, provide analogous information--both in terms frequencies of pieces with invasive verses marginal retouch and pieces with abrupt versus non-abrupt retouch.

With respect to variability that might represent different activities, changes in the mean of shape is closely matched by relative frequencies of notched edges. An index composed of the combined relative frequencies of types 42, 52, and 54 (notches, notched triangles, and end-notched pieces respectively) among tools closely approximate this. Burins and piercers were also suggested as possibly representing different activities from the bulk of retouched tools. These make up an important part of the Upper Paleolithic Group, or Group III, whose relative frequency is often computed in standard analyses. Additionally, an index of these specific types (32-35) can be computed like that for notches.

For step flaking, several measures exist. The most common is the Quina Index, although this only counts the amount of extreme step flaking represented by Quina retouch among single convex sidescrapers and convex transverse scrapers. Sometimes the amount of less extreme step flaking is reported in counts of pieces with demi-Quina retouch. Finally, some studies of retouch report the the frequency of pieces with step flaking, even if it does not qualify as Quina or demi-Quina.

Using these methods, typological variability can be utilized to indicate quantitative morphological variability in pieces. This permits comparisons at a gross scale, at least, between the sites of this study and a selection of other Middle Paleolithic sites in the northwestern Mediterranean.

## Comparison of Results with Other Sites

Tables 4.4 and 4.5 show standard type counts, essential percents, and typological indices for Cova del Salt, Cova del Pastor, Gorham's Cave, and Devil's Tower. Some assemblages have been combined to increase the sample sizes for typological analysis. For Salt, each transitional layer has been combined with the layer below, 2-3 with 3 for example. This produced adequate sample sizes for six combined levels. The samples for the other sites, in spite of combining proveniences, are lower than is generally desirable for this form of analysis and any conclusions based on these sites must be drawn with some reservations. All assemblages from the lower (i.e., stage 5) layers at Gorham's Cave were combined. In spite of the sample size, it was felt to be of value to differentiate between the early glacial and pleniglacial assemblages. This was not possible for Devil's Tower due to the considerably lower total number of tools from that site.

In addition to the standard indices, several additional indices have been computed in order to convert the data of the present study to a form more comparable to information found in other analyses. The percents of notches and burins/piercers among essential tool types represent variability in extremes of shape and are pieces exhibiting concentrated rather than extensive retouch. Additionally, quantitative measures of invasiveness have been converted to the percentage of edges with invasiveness > 2 mm. (i.e., invasive edges) and those with invasiveness < 2 mm. (i.e., marginal edges) among all retouched edges.

These typological data, in conjunction with previously discussed quantitative attributes, will be used to compare lithic variability at the sites studied with several other sites of the northwestern Mediterranean primarily along two axes of variability suggested by the quantitative data discussed in the preceding parts of this chapter. One axis is the intensity with which chipped stone was utilized. At the level of assemblages, this is represented by the frequency of retouched to unretouched pieces. At a piece level, this is reflected in measures of invasiveness and edge angle. The other axis is the extent of the margin that is modified. This variability seems to be reflected in IR and the relative frequency of certain types such as notches. This variability in extent of utilization seems at least associated (if not partly causally related) to variability in piece length. In addition to

Table 4.4. Type counts and essential percents for sites studied.

| TYPE | COVA DEL SALT COMBINED LAYERS 1 n (%) | 2 n (%) | 3 n (%) | 4 n (%) | 5 n (%) | 6 n (%) | COVA DEL PASTOR All Layers n (%) | GORHAM'S CAVE G n (%) | K-R n (%) | DEVIL'S TOWER All Layers n (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| 3 | 1 (---) | | 2 (---) | 1 (---) | 1 (---) | 1 (---) | | 5 (---) | 5 (---) | |
| 4 | | | | 1 (0.4) | | | | 1 ( 3.2) | 1 ( 2.1) | |
| 5 | | | | | | 1 ( 0.9) | | | | |
| 6 | 1 ( 1.1) | 1 ( 1.3) | 1 ( 0.4) | 1 ( 0.9) | | | | | 1 ( 2.1) | |
| 7 | | | | | | | | | | |
| 8 | | | | | | | | | 1 ( 2.1) | |
| 9 | 16 (18.4) | 9 (11.7) | 21 ( 9.1) | 11 (10.2) | 14 (10.8) | 8 ( 7.5) | | | 1 ( 2.1) | 4 (10.3) |
| 10 | 25 (28.7) | 29 (37.7) | 81 (34.9) | 32 (29.6) | 42 (32.3) | 36 (33.6) | 13 (35.1) | 5 (16.1) | 18 (17.0) | 7 (17.9) |
| 11 | 2 ( 2.3) | 2 ( 2.6) | 4 ( 1.7) | 4 ( 3.7) | 3 ( 2.3) | 3 ( 2.8) | 2 ( 5.4) | 2 ( 6.5) | 3 ( 6.4) | 4 (10.3) |
| 12 | 1 ( 1.1) | | | | | | | 1 ( 3.2) | 1 ( 2.1) | 2 ( 5.1) |
| 13 | | 2 ( 2.6) | 3 ( 1.3) | 2 ( 1.9) | | 2 ( 1.9) | | 1 ( 3.2) | | 1 ( 2.6) |
| 14 | | | 1 ( 0.4) | | | | | | | |
| 15 | | 4 ( 5.2) | 4 ( 1.7) | 2 ( 1.9) | 2 ( 1.5) | 1 ( 0.9) | 1 ( 2.7) | | 1 ( 2.1) | 2 ( 5.1) |
| 16 | | | | | | | | | | |
| 17 | | | 2 ( 0.9) | 1 ( 0.9) | | | 3 ( 8.1) | | | 1 ( 2.6) |
| 18 | | 1 ( 1.3) | | | | | | | | |
| 19 | | 2 ( 2.6) | 5 ( 2.2) | 3 ( 2.8) | 2 ( 1.5) | 2 ( 1.9) | | 2 ( 6.5) | 1 ( 2.1) | 3 ( 7.7) |
| 20 | | | | | | | | | | 1 ( 2.6) |
| 21 | 5 ( 5.7) | 3 ( 3.9) | 4 ( 1.7) | 4 ( 3.7) | 4 ( 3.1) | 3 ( 2.8) | 5 (13.5) | | | 1 ( 2.6) |
| 22 | 2 ( 2.3) | | 11 ( 4.7) | 3 ( 2.8) | 8 ( 6.2) | 7 ( 6.5) | 1 ( 2.7) | 1 ( 3.2) | | 1 ( 2.6) |
| 23 | 5 ( 5.7) | 5 ( 6.5) | 17 ( 7.3) | 6 ( 5.6) | 10 ( 7.7) | 11 (10.3) | 3 ( 8.1) | | 1 ( 2.1) | 1 ( 2.6) |
| 24 | 2 ( 2.3) | | 1 ( 0.4) | 2 ( 1.9) | 2 ( 1.5) | 1 ( 0.9) | | | | |
| 25 | 1 ( 1.1) | | 4 ( 1.7) | | 3 ( 2.3) | | | 1 ( 3.2) | 5 (10.6) | 1 ( 2.6) |
| 26 | | | | | 2 ( 1.5) | 1 ( 0.9) | 1 ( 2.7) | | | |
| 27 | 2 ( 2.3) | 1 ( 1.3) | 4 ( 1.7) | 2 ( 1.9) | 1 ( 0.8) | | 1 ( 2.7) | | | |
| 28 | 2 ( 2.3) | 1 ( 1.3) | 6 ( 2.6) | 2 ( 1.9) | 1 ( 0.8) | | | | 1 ( 2.1) | |
| 29 | 1 ( 1.1) | 2 ( 2.6) | 1 ( 0.4) | 1 ( 0.9) | 1 ( 0.8) | | | | 1 ( 2.1) | |
| 30 | | | 3 ( 1.3) | 1 ( 0.9) | 2 ( 1.5) | 2 ( 1.9) | | 1 ( 3.2) | | |
| 31 | | 1 ( 1.3) | | | 3 ( 2.3) | 1 ( 0.9) | | | 1 ( 2.1) | |
| 32 | | | 1 ( 0.4) | 1 ( 0.9) | | | | | 5 (10.6) | 1 ( 2.6) |
| 33 | | | 1 ( 0.4) | 1 ( 0.9) | 1 ( 0.8) | | | 1 ( 3.2) | | |
| 34 | | 1 ( 1.3) | | | | | 1 ( 2.7) | | | |
| 35 | 2 ( 2.3) | | | | | 1 ( 0.9) | | 1 ( 3.2) | | 1 ( 2.6) |
| 36 | 1 ( 1.1) | | 1 ( 0.4) | 1 ( 0.9) | 1 ( 0.8) | | | | 1 ( 2.1) | |
| 37 | | | 1 ( 0.4) | | 1 ( 0.8) | 2 ( 1.9) | | | | 1 ( 2.6) |

Table 4.4. (Continued).

| TYPE | COVA DEL SALT COMBINED LAYERS | | | | | | COVA DEL PASTOR | GORHAM'S CAVE | | DEVIL'S TOWER |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | All Layers | G | K-R | All Layers |
| | n (%) | n (%) | n (%) | n (%) | n (%) | n (%) | n (%) | n (%) | n (%) | n (%) |
| 38 | 6 ( 6.9) | 3 ( 3.9) | 20 ( 8.6) | 12 (11.1) | 13 (10.0) | 12 (11.2) | 1 ( 2.7) | | 1 ( 2.1) | |
| 39 | | 2 ( 2.6) | 1 ( 0.4) | 2 ( 1.9) | 1 ( 0.8) | | | | | |
| 40 | 1 ( 1.1) | | 3 ( 1.3) | 3 ( 2.8) | 4 ( 3.1) | 2 ( 1.9) | | | 3 ( 6.4) | 1 ( 2.6) |
| 41 | | | | | | | | | | |
| 42 | 5 ( 5.7) | 2 ( 2.6) | 19 ( 8.2) | 3 ( 2.8) | 5 ( 3.8) | 3 ( 2.8) | 2 ( 5.4) | | 5 (10.6) | 5 (12.8) |
| 43 | 5 ( 5.7) | 4 ( 5.2) | 5 ( 2.2) | 6 ( 5.6) | 2 ( 1.5) | 6 ( 5.6) | 3 ( 8.1) | 12 (38.7) | 3 ( 6.4) | 1 ( 2.6) |
| 44 | | | | | | | | | | |
| 45 | | 1 ( 1.3) | 4 ( 1.7) | 1 ( 0.9) | 1 ( 0.8) | 2 ( 1.9) | | | 1 ( 2.1) | |
| 46 | | | 1 (---) | | | 1 (---) | | | | |
| 47 | | 1 (---) | | | | | | | | |
| 48 | 6 (---) | 13 (---) | 34 (---) | 17 (---) | 22 (---) | 10 (---) | 5 (---) | 3 (---) | 2 (---) | 5 (---) |
| 49 | 1 (---) | 1 (---) | | | | | | | 2 (---) | 1 (---) |
| 50 | | 1 (---) | 2 (---) | 1 (---) | 1 (---) | | 2 (---) | | | |
| 51 | | | | | | | 1 ( 3.2) | 1 ( 2.1) | | |
| 52 | 1 ( 1.1) | | | | | | | | | |
| 53 | | | | | | | | | | |
| 54 | | 1 ( 1.3) | 2 (0.9) | | 1 ( 0.8) | | | 1 ( 3.2) | | |
| 55 | | | | | | | | | | |
| 56 | | | | 1 ( 0.9) | | | | | | |
| 57 | | | | | | | | | | |
| 58 | | | | | | | | | | |
| 59 | | | | | | | | | | |
| 60 | | | | | | | | | | |
| 61 | 1 ( 1.1) | | | | | | | | | |
| 62 | | | | | | | | | | |
| 63 | | | | | | | | | | |
| Total | 95 | 93 | 271 | 127 | 154 | 119 | 42 | 41 | 56 | 45 |
| ess. Total | 87 | 77 | 232 | 08 | 30 | 106 | 37 | 31 | 47 | 39 |
| Tool Fragments | 5 | 2 | 8 | 10 | 10 | 4 | 3 | 1 | | |

Table 4.5. Computed indices for sites studied.

| ESSENTIAL INDICES | COVA DEL SALT COMBINED LAYERS | | | | | | COVA DEL PASTOR | GORHAM'S CAVE | | DEVIL'S TOWER |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | All Layers | G | K-R | All Layers |
| IR | 73.6 | 79.2 | 72.8 | 69.4 | 73.1 | 70.8 | 81.1 | 41.9 | 48.9 | 74.4 |
| IC | 32.3 | 22.1 | 22.8 | 22.2 | 27.7 | 27.4 | 24.3 | 3.2 | 4.3 | 17.9 |
| IAU | 2.3 | 1.3 | 0.0 | 0.0 | 0.0 | 0.9 | 2.7 | 3.2 | 0.0 | 2.6 |
| Group II | 74.7 | 80.5 | 73.3 | 70.4 | 73.1 | 70.8 | 81.1 | 41.9 | 53.2 | 74.4 |
| Group III | 4.6 | 2.6 | 4.3 | 6.5 | 9.2 | 7.5 | 2.7 | 9.7 | 21.3 | 10.3 |
| Group IV | 5.7 | 5.2 | 2.2 | 5.6 | 1.5 | 5.7 | 8.1 | 38.7 | 6.4 | 2.6 |
| Notches | 6.9 | 3.9 | 9.1 | 2.8 | 4.6 | 2.8 | 5.4 | 3.2 | 10.6 | 12.8 |
| Burins/Piercers | 2.3 | 1.3 | 0.9 | 1.9 | 0.8 | 0.9 | 2.7 | 6.5 | 10.6 | 5.1 |
| % Invasive | 85.0 | 73.6 | 74.1 | 74.2 | 74.3 | 77.2 | 68.2 | 79.2 | 81.8 | 83.9 |
| % Marginal | 15.0 | 26.4 | 25.9 | 25.8 | 25.7 | 22.6 | 31.8 | 20. | 18.2 | 16.1 |

these axes, possible variability in the types of tasks that may be represented by step flaking or the frequencies of a few types with extremes of shape are noted.

EASTERN SPAIN

Of the relatively numerous sites in the Valencian region of eastern Spain, three have sufficiently large and well described collections for comparison with the results of the present study. Cova Negra, has already been discussed in Chapter 2. The other two are Cova de la Petxina and Cueva del Cochino. These comparative data are summarized in Table 4.6.

*Cova Negra.* Villaverde (1984:109-165) describes the lithic assemblages from 14 archaeological levels in considerable detail. Typologically, he has assigned the assemblages variously to the Archaic Quina, Para-Charentian, Quina, and sidescraper-rich Typical. The provenience of the assemblages is a little confusing as the archaeological levels, primarily defined in the course of earlier excavations, do not correspond to the stratigraphic layers identified in the 1981-82 work and described in Chapter 2. In general, however, archaeological levels 14-10 correlate with the lower stratigraphic layers 30-28, assigned by Villaverde to Würm I. Archaeological level 9 correlates with stratigraphic layer 27, assigned to the Würm II/III. The remaining archaeological levels 8-1 are associated with the upper stratigraphic layers 26-1, assigned to the Würm II.

A total of 3149 pieces were recovered from the site. Of these, almost half are retouched. The percentage of retouched pieces in the lower levels (9-14, assigned to the Würm I and I/II) ranges from 50-74%. It steadily declines upward through the sequence to 44% in the uppermost level. All levels have a much higher frequency of retouched pieces than any of the sites in the present study. As there is no indication in Villaverde's (1984) monograph that debitage was discarded by the excavators, this suggests a much more intensive, though declining, degree of utilization of chipped stone at Cova Negra than at the sites of the present study.

While chipped stone was used and modified more often, the amount that each piece was utilized seems less than at the sites of the current study based on the frequency of pieces with invasive retouch. Also, frequencies of invasive retouch at Cova Negra seem to reflect the gradual decline through time of the relative frequency of retouched pieces. In the lower levels 50-65% of the retouched pieces are classed as having invasive retouch, while only 1-2% have 'very marginal' retouch. In the upper four levels invasively retouched pieces make up 41-49% of the retouched pieces, and very marginally retouched pieces make up 2-7%. Finally, although edge angle was not directly measured at Cova Negra, abrupt edges occur on less than 10% of all retouched pieces in all but the lowest level of the site.

Values of IR show a pattern opposite that of measures of intensity of utilization. In the lower levels, IR is 58-62%, considerably lower than all sites in the present study except for Gorham's Cave. It increase through the time reaching values of 70-74%, (closer to the values of Salt, Pastor, and Devil's Tower) in the upper four layers. The same is true of piece length. The majority of pieces in levels 8, 9, and 11-14 are 2-3 cm. in length, while most pieces in levels 1-7 are 3-4 cm. long (much closer to the Alcoy basin means of 3.6-4.2 cm.). IR tends to reflect the extent of margin retouched, which is associated with piece length. This suggests that, at Cova Negra, lithic use tended to be concentrated in smaller areas of smaller pieces rather than being extensive--especially in the lower layers.

The frequency of selected types with concentrated edge use fits this pattern. The frequency of pieces with notches (types 42, 52, and 54) in the lower layers at Cova Negra range from 4% to 14%, while in the upper four layers they make up 2-4% of essential tools. On the whole, the frequencies of notches at Cova Negra tend to be higher than in the Alcoy basin sites. The same is true of burins and piercers, which occur in frequencies of more than

Table 4.6. Comparative data from sites in southeastern Spain.

| | COVA NEGRA -- ARCHELOLOGICAL LEVELS | | | | | | | | | | | | COVA DE LA PETXINA | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11-12 | 13-14 | 2-3 | 4-9 |
| DIMENSIONS (modes for retouched pieces by level) | | | | | | | | | | | | | | |
| length (cm) | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 2.5 | 2.5 | 3.5 | 2.5 | 2.5 | 2.5 | 2.5 |
| width (cm) | 2.5 | 3.5 | 2.5 | 2.5 | 2.5 | 3.5 | 2.5 | 2.5 | 3.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 |
| RETOUCH (% of all retouched pieces by level) | | | | | | | | | | | | | | |
| abrupt | 3.4 | 2.2 | 4.0 | 7.1 | 4.6 | 7.6 | 9.2 | 3.5 | 7.5 | 8.8 | 3.3 | 11.1 | 9.6 | 14.0 |
| invasive | 49.3 | 41.6 | 41.4 | 46.4 | 50.9 | 53.6 | 60.8 | 45.9 | 56.3 | 64.7 | 51.6 | 50.0 | 62.1 | 53.0 |
| marginal | 46.8 | 53.9 | 51.7 | 52.4 | 48.2 | 43.9 | 39.2 | 52.9 | 42.5 | 35.3 | 47.2 | 47.8 | 35.2 | 41.0 |
| very marginal | 3.9 | 4.5 | 6.9 | 1.2 | 0.9 | 2.5 | 0.0 | 1.2 | 1.2 | 0.0 | 1.1 | 2.2 | 2.8 | 6.0 |
| ESSENTIAL INDICES | | | | | | | | | | | | | | |
| IR | 72.4 | 74.4 | 69.5 | 71.4 | 62.0 | 65.8 | 64.8 | 59.7 | 59.5 | 57.6 | 57.8 | 61.7 | 61.3 | 66.7 |
| Quina/demi-Quina | 20.8 | 13.7 | 15.5 | 16.1 | 23.4 | 30.4 | 28.6 | 24.0 | 22.9 | 46.3 | 24.2 | 21.0 | 33.7 | 11.6 |
| notches | 3.8 | 3.3 | 3.7 | 4.8 | 9.8 | 7.9 | 6.9 | 4.8 | 12.3 | 13.6 | 4.5 | 4.6 | 12.4 | 2.9 |
| burins/piercers | 3.0 | 2.2 | 5.0 | 1.2 | 3.9 | 5.3 | 2.3 | 11.9 | 4.9 | 4.5 | 2.2 | 5.7 | 3.6 | 4.4 |
| % retouched | 44.4 | 48.1 | 45.2 | 44.9 | 50.2 | 51.8 | 55.6 | 53.4 | 54.8 | 49.3 | 59.5 | 74.4 | 25.3 | 30.8 |
| Total pieces | 923 | 185 | 385 | 187 | 215 | 303 | 234 | 159 | 146 | 138 | 153 | 12 | 1572 | 325 |

Table 4.6. (Continued).

| | CUEVA DEL COCHINO | CUEVA DE LA ZAJARA | | | | CUEVA DE LA CARIGÜELA | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ALL | 1 | 2 | 3 | V | 2-3 | 4-5 | 6 | 7 | 8 | 9-10 | Site Total |
| DIMENSIONS (modes for retouched pieces) | | (means for unretouched flakes by level) | | | | | | | | | | |
| length (cm) | 3.5 | 4.2 | 4.2 | 4.1 | 4.1 | --- | --- | --- | --- | --- | --- | |
| width (cm) | 2.5 | 3.2 | 3.5 | 3.1 | 3.2 | --- | --- | --- | --- | --- | --- | |
| thickness (cm) | --- | 1.1 | 1.1 | 1.2 | 1.0 | --- | --- | --- | --- | --- | --- | |
| RETOUCH (% of all retouched pieces) | | (% of all retouched edges by level) | | | | (% of all retouched pieces) | | | | | | |
| abrupt | 8.6 | 14.3 | 13.9 | 18.8 | 27.6 | (values for individual levels estimated from graphs in de Lumley, 1969:Fig. 3) | | | | | | 1.1 |
| invasive | 47.5 | 68.0 | 74.4 | 74.8 | 61.2 | | | | | | | 36.1 |
| marginal | 42.6 | 32.0 | 25.6 | 25.2 | 38.8 | | | | | | | 12.6 |
| very marginal | 9.9 | --- | --- | --- | --- | | | | | | | |
| Quina/demi-Quina | --- | 4.3 | 11.1 | 4.1 | 1.1 | | | | | | | 4.5 |
| ESSENTIAL INDICES | | | | | | | | | | | | |
| IR | 72.7 | 57.0 | 74.1 | 61.3 | 58.8 | 73.5 | 63.3 | 75.3 | 61.3 | 66.3 | 60.7 | |
| Quina/demi-Quina | 19.8 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |
| Notches | 5.3 | 17.9 | 4.5 | 8.1 | 9.4 | 6.0 | .9 | 4.7 | 5.6 | 5.4 | .5 | |
| Burins/Piercers | 1.3 | 5.4 | 2.2 | 0.0 | 2.4 | 1.7 | 0.7 | 2.3 | 0.8 | 1.1 | 0.9 | |
| % retouched | 13.5 | 10.4 | 13.6 | 13.9 | 6.9 | --- | --- | --- | --- | --- | --- | |
| Retouched edges | --- | 440 | 655 | 234 | 188 | --- | --- | --- | --- | --- | --- | |
| Total Pieces | 1160 | 2767 | 2829 | 920 | 1501 | --- | --- | --- | --- | --- | --- | |
| Essential Total | --- | --- | --- | --- | --- | 234 | 139 | 215 | 248 | 92 | 107 | |

2% in all but one level of Cova Negra. The pattern of use at Cova Negra, although not the intensity, is similar to that seen at Gorham's Cave, with low values of IR and relatively higher frequencies of notches, burins, and piercers.

Step flaking also seems much more common at Cova Negra than in the sites of the current study. Quina and demi-Quina retouch occurs on 14% to 46% of all scrapers there, but is almost non-existent in the assemblages of the present study. This may be a reflection of the intensity of lithic use at the site, or possibly an indication of a greater frequency of a set of activities resulting in step-flaked artifacts.

In summary, the assemblages at Cova Negra suggest a higher intensity of lithic utilization than seen in any of the sites in the current study in terms of amount of all chipped stone used and modified. However, this degree of intensity seems to decline with time and does not seem to be mirrored in the degree to which each piece was used as indicated by frequencies of invasive retouch. Additionally, there appears to be a greater emphasis on the concentration of use in relatively small sections of flake margins compared with the Alcoy basin sites, resembling to the pattern of use at Gorham's Cave. Finally, the higher frequency of Quina and demi-Quina retouch may reflect a correspondingly higher degree of lithic utilization and/or frequency of a set of activities that result in step-flaked tools.

*Cova del Petxina.* Petxina is a small shelter in the valley of the Rio Albaida, some 2 km. downstream from Cova Negra. The site was excavated in 1931 by Vines (Villaverde, 1984:214) but the lithics were not described in any detail until recent studies by Mueller-Wille (1983) and Villaverde (1984). The lithic assemblages come from the surface of the site and eight archaeological levels (2-9). Unfortunately, there remains no description of the stratigraphy and, as far as is known, all *in situ* archaeological sediments have been removed from the shelter.

The eight levels at Petxina produced 897 artifacts. In order to provide sufficiently large samples of retouched tools for comparison, though, the assemblages from levels 2 and 3 have been combined into an upper group, and levels 4-9 have been combined into a lower group. Villaverde (1984:214-253) has classed the assemblages as Para-Charentian and Ferrasie. He also describes the them in sufficient detail to permit comparisons with the present study.

Petxina presents a pattern of intensive lithic utilization, with a tendency toward concentrated, rather than extensive, use of piece margins that is very similar to that seen at Cova Negra. The frequency of retouched pieces, while not as high as at Cova Negra, is nonetheless higher than any site in the current study. Likewise, 53% of the retouched pieces in the lower levels and 62% of the pieces in the upper levels are classed as having invasive retouch, while only 6% and 3% are characterized by very marginal retouch in each group of levels respectively. Abrupt retouch is still rare, but more common than at Cova Negra.

In a several other features, lithic variability seems very close to the that for Cova Negra. These include the moderate frequency of extensively retouched pieces as measured by IR, and the significant number of pieces exhibiting a pattern of concentrated use of flake margins such as notches, burins, and piercers. The modal length of retouched pieces is 2-3 cm. This is equivalent to the pattern seen at Cova Negra, as is the relative frequency of Quina and demi-Quina retouch--ocurring on between 20% and 35% of all scrapers.

In summary, lithic variability at Cova del Petxina seems very similar to that expressed at Cova Negra. It differs from the Alcoy basin sites both in the intensity of utilization of chipped stone and in the way in which piece margins were used. Like Cova Negra, the focus on concentrated, rather than extensive, use of pieces resembles the pattern seen at Gorham's Cave.

*Cuevo del Cochino.* Cueva del Cochino is small shelter located in northwestern Alicante, along the southern slopes of the Sierra de Morron, about 35 km. west of Cova del Salt. It was excavated by J.M. Soler García, of the *Museo Arqueológico Municipal* of Villena, in 1955. Most of the 36 $m^2$ of the excavation took place outside the mouth of the shelter. Soler published a summary of the work at the site (1956), but again, the collections were first described in detail by Mueller-Wille and Villaverde.

Soler described three archaeological levels, totaling about 70 cm in depth. This stratigraphy has been recently reevaluated by Cuenca and Walker (Mueller-Wille, 1983:162-164). They identified an upper layer, (40 cm thick) that encompasses Soler's levels 1 and 2, a middle layer (averaging 30 cm thick) that is equivalent to Soler's level 3, and a third layer, consisting of remnants of stalagmitic breccia on the cave walls, not mentioned by Soler.

The upper layer consists of an organic clayey silt containing altered cryoclastic debris. The upper 15 cm. of this layer is archaeologically sterile. The lower part contains Neolithic and Bronze Age artifacts, with Middle Paleolithic artifacts at the base.

Cuenca and Walker's second layer, the source of most of the Middle Paleolithic materials from the site, is composed fine limestone gravel in a matrix of carbonates, rock particles, and clay. They suggest that this represents a paleosol cemented by carbonate-rich water (Mueller-Wille, 1983:164). The paleosol and carbonate cementation, with an absence of cryoclastic debris, suggest relatively mild climatic conditions, although it is not possible to suggest an age for the deposit from the information available.

Villaverde (1984:266-280) has included the assemblages at Cuevo del Cochino within the Ferrasie Mousterian industry, while Mueller-Wille (1984:166) has classed them as sidescraper-rich Typical Mousterian. Nevertheless, the pattern of lithic variability seen at Cuevo del Cochino is somewhat different than that of Cova Negra and Petxina. Although 1160 lithic artifacts were recovered from the site, the count of retouched tools is relatively low at 14% (Mueller-Wille, 1983:168-169). Hence, the assemblages from Soler's levels 2 and 3 (equivalent to Cuenca and Walker's basal upper and middle layers) have been combined to provide adequate sample sizes of retouched pieces.

The lower fraction of the total assemblage showing modification is similar to that of the Alcoy basin sites. The percentage of pieces with invasive retouch, at 48%, is within the lower part of the range of Cova Negra and is lower than the Petxina range. The frequency of very marginally retouched pieces, 10%, is considerably higher than the frequency at either Cova Negra or Petxina. Likewise the frequency of abrupt retouch, at 4%, is at the low end of the Cova Negra range, and far below the values at Petxina (Villaverde, 1984:266-273).

IR also also closely matches the values for the Alcoy Basin sites and differs from those at Cova Negra and Petxina (Mueller-Wille, 1983:168-169). Seemingly associated with this higher value, the modal length of retouched pieces is 3-4 cm. (Villaverde, 1984:271). Additionally, the pieces with extremes of shape and which exhibit modification concentrated in small areas are infrequent, much as they are at the Alcoy basin sites. Notches make up 5% of the retouched tools and burins and piercers make up 1% (Mueller-Wille:169-169). Finally, although the frequency of Quina and demi-Quina retouch is high compared to the Alcoy basin sites, it is below the frequencies at Petxina and toward the bottom of the range at Cova Negra (Villaverde, 1984:273-278).

Although, not identical, the variability seen in the lithic assemblage from Cochino is quite similar to that of Salt and Pastor, at least with respect to type frequencies, retouch classes, and length. This suggests similarities with respect to the intensity of utilization of chipped stone and the ways in which edges were used. Compared to Cova Negra and

Petxina, however, Cochino seems to represent less intensity of utilization and more extensive, rather than concentrated, use of piece margins.

SOUTHEASTERN SPAIN

Two sites in southeastern Spain that have sufficiently large, well described collections for comparison with the sites of the present study are Cueva de la Zájara I and Cueva de Carigüela. Comparative data from these sites are also summarized in Table 4.6

*Cueva de la Zájara I.* Cueva de la Zájara I was a collapsed shelter in south-central Almería, about 7 km. inland, along the Rio Almanzora. At an elevation of 111 m., it was one of numerous eroded cavities in Pliocene sandy conglomerates that border the river. The site was excavated in 1904 by M.L. Siret. Unfortunately, it was destroyed in course of road construction prior to 1930. Siret's field notes describe the fill of the shelter as undifferentiated fine sediment, with a maximum depth of 4 m., and containing horizontal lenses of burned earth with charcoal and bone fragments. The interior of the shelter was excavated in four arbitrary levels of 70 to 100 cm. thick. Additionally, surface materials were recovered and a "level V" was excavated. Level V is of uncertain provenience, but probably represents associated deposits in front of the shelter proper (Vega, 1980; Mueller-Wille, 1983:207-209).

Siret recovered more than 8300 artifacts from the site. Vega (1980) describes those from levels 1-3 and V in detail. He only briefly describes the materials from the surface and level 4 because of their small samples sizes (82 pieces with 8 retouched for the surface assemblage and 58 pieces with 4 retouched from level 4). Due to this and the questionable provenience of level V, the following discussion will be restricted to levels 1-3.

The relative frequency of retouched pieces in these three assemblages is equivalent to values at the Alcoy basin sites at 14-10%. The percentages of invasive retouched edges among all retouched edges are as high as values for the Alcoy basin sites, and parallel the frequencies of retouched pieces. The frequencies of abrupt edges also roughly parallel those of invasive edges and of retouched pieces in the total assemblage

Measures of the extent of use and modification vary among the levels. IR is lower in levels 3 and 1 and higher in level 2. As at other sites, the frequencies of notches vary inversely with IR. The frequencies burins and piercers do not follow those of notches, however, increasing from 0 to 5% across the three levels. Interesting, and unlike the previously described sites, values for Quina and demi-Quina retouch parallel IR suggesting that the variations in the frequency of more extensively utilized artifacts (i.e., scrapers) is primarily composed of artifacts with step flaking. Although the lengths of retouched pieces were not noted by Vega, Mueller-Wille (1983:156) reports the mean lengths of unretouched pieces. These, at least, do not vary with IR at Zájara, but are very consistent, with values of 4.1-4.2 cm. In summary, Zájara seems very similar to the Alcoy basin sites and (except for invasiveness) to Cochino with respect to measures of the intensity of lithic utilization. Level 2 is also similar to the Alcoy basin sites and Cochino in the way in which pieces and edges were used. However, levels 1 and 3 seem to represent less extensive use of piece margins, more like the pattern seen at Gorham's Cave, Cova Negra, and Petxina.

*Cueva de Carigüela.* Carigüela is a solution cavern located about 35 km. northeast of Granada. It is in a limestone escarpment of the Sierra Harana, at an elevation of 850 m. Its several entrances and entrance galleries in which excavation has taken place are numbered I-V. It is from Carigüela III that the collection of Middle Paleolithic artifacts discussed below were recovered.

The most significant excavations at the site were carried out by J.-C. Spani in 1955 and 1956. Only brief summaries of this work were published by Spani (1955) and García (1960) who examined the human remains from the site. De Lumley (1969) published the first detailed descriptions of the Middle Paleolithic assemblages from the site. These artifacts were re-examined by Mueller-Wille (1983:225-254). Almagro, Irwin, and Fryxell began new work at the site in 1969, but spent most of the season re-establishing the boundaries of Spani's excavations. The work was not continued and only a preliminary report (Almagro, et. al., 1970) was published. While Mueller-Wille (1983:225-229) reported that D. Gerardo Vega has recently worked at the site, no published accounts of these investigations are available.

Spani divided the nearly 6 m. of deposits he excavated in Carigüela III into 11 layers, all but layers 1 and 4 containing Middle Paleolithic artifacts. In their re-examination of the site, Almagro, Irwin, and Fryxell identified 42 cultural horizons and 12 geologic layers within Spani's layers 5-11. Unfortunately, except for a drawing and a few brief notes in the 1970 report, no descriptions of these stratigraphic units have been published. Spani's stratigraphic descriptions, described in all the works cited in the preceding paragraph, are not very detailed. Of note are the presence of angular, possibly cryoclastic, debris in layers 2 and 6-11; a cemented layer (5) that Spani describes as stalagmitic, but that Fryxell feels was brecciated post-depositionally by illuvial carbonates; and two layers (6 and 9) with reddish sediments that Fryxell suggests may be redeposited paleosols from outside the cave.

Some 1500 pieces of chipped stone were kept from Spani's excavations. In order to have adequate sample sizes of retouched tools for comparisons, the assemblages from levels 2 and 3, 4 and 5, and 9 and 10 have been combined.

Unfortunately, Spani discarded most of the debitage from Carigüela (Almagro, et. al., 1970). The only clue to the actual quantity of lithics and the ratio of modified to unmodified pieces is a statement in Almagro, et. al. that a cubic meter from the paleolithic deposits contains 400-500 tools and 50,000 unmodified pieces. If this figure is accurate for all of the deposits excavated by Spani, an estimated 150,000 pieces were excavated from the site and only about 1% of them were retouched. This ratio of retouched to unretouched is equivalent to the low values from at Gorham's Cave.

With respect to other measures of intensity of utilization, invasive retouch occurs on about 30-40% of all retouched pieces, abrupt retouch is present on less than 5% of the retouched pieces in all levels (de Lumley, 1969). Taken together these data suggest a very low intensity of utilization of chipped stone at the site, in spite of the absolutely large numbers of pieces, especially if the estimate of 1% retouched is close to correct.

Measures of the extent of retouch on pieces are very similar to values at Alcoy basin sites, Cochino, and Zájara level 2. The only difference is that IR is slightly lower, varying between 61% and 75%, in contrast to the Alcoy basin sites where it varies from 69% to 81%. Measurements of length are not available, but frequencies of notches are between 5% and 8% of essential types while burins and piercers have frequencies of 1-2%, again very close to the Alcoy basin data. Also similar is the frequency of step flaking, with Quina + demi-Quina retouch below 10% in all single and combined levels (de Lumley, 1969).

In summary, Carigüela seems to have a much lower degree of lithic utilization than any of the sites discussed so far except Gorham's Cave, especially if the estimate of the frequency of retouched pieces in the assemblages is correct. However, the pattern of utilization of the pieces that were modified is very similar to the Alcoy basin sites with respect to the extent of retouch and range of variability in possibly task related step flaked pieces and those of extreme shapes.

## OTHER SITES IN THE NORTHWESTERN MEDITERRANEAN

For much of the rest of the northwestern Mediterranean region, northeastern Spain and the French Midi, there is a considerably larger amount of published information about

Middle Paleolithic sites and their assemblages (for example, see de Lumley, 1969b; 1971) than there is for the eastern and southeastern parts of Spain already discussed. While it is not the purpose of the present study to present a full survey of the Middle Paleolithic throughout the northwestern Mediterranean, a few observations about this body of data are in order here.

On the one hand, there are much better descriptions and more detailed studies of the stratigraphic and paleoenvironmental contexts of the assemblages for these regions than is the case for most of the other Spanish sites. On the other hand, most of the lithic collections are not described in the amount of detail that is found in the studies already discussed. Indices and relative type frequencies are published for a great many sites, but actual artifact counts, dimensional measurements, and information about unretouched debitage tends to be lacking. Also, information about invasiveness and types of retouch tend to be only minimally reported. Hence, while the amount of available information is considerable, its usefulness for comparisons with the present study is often limited. With these considerations in mind, some generalizations about this information are possible based on information in de Lumley (1969b; 1971) and Mueller-Wille (1983).

There is considerable variability in IR, ranging from a value of 3% at Abri Agut in northeastern Spain to 80% at Balauziere in Provence. As was the case with the eastern and southeastern Spanish data, this seems to reflect variability in extent of margin retouched overall and tends to be inversely related to the frequencies of notches. However, this inverse relationship may actually be something of a dichotomous distribution. For a group of 29 assemblages from 16 of the larger sites in the region, those with values of IR above 52% (12 assemblages) have frequencies of notches below 5% in all but one case (Baume des Peyrards c. 9-5, in which they still make up only 6-7% of essential types). However, the frequencies of notches do not seem in any way related to frequencies of scrapers within this group of assemblages. For the 17 assemblages with values of IR ≤ 52%, frequencies of notches range from 12% to 24% in all but two cases where they are < 10% (Bau de l'Aubesier and Baume des Peyrards c. 12-10). Again, there is no apparent relationships between scraper frequencies and notch frequencies within this group.

Step flaking, represented by frequencies of pieces with Quina and demi-Quina retouch (among all pieces as opposed to IQ which is measured only among scrapers) also seems to vary in a similar fashion. In all but 2 of 12 assemblages for which frequencies of this type of retouch is reported and which have values of IR ≥ 50%, the combined frequency of Quina and demi-Quina retouch is > 15% in all but two cases (Baume Bonne "Riss/Würm" and c. A17-A8). On the other hand, in the 14 assemblages with values of IR < 50% and where frequencies of Quina and demi-Quina retouch are reported, this form of retouch is described as rare or absent.

Based on this information, it might be possible to divide the assemblages into two groups. One group would consist of assemblages with IR ≥ 50%, step flaking common, and notches rare. The other group would consist of assemblages with IR < 50%, step flaking rare, and notches common. The significance, or even reality of such groupings is difficult to assess at present, however.

The difficulty of identifying adequate criteria, based on typological data alone, for defining such groups is apparent when one looks at the sites of the current study. Salt and Pastor have high values of IR and low frequencies of notches, but also have almost no Quina/demi-Quina retouch. Both Gibraltar sites have relatively high frequencies of notches and virtually no Quina/demi-Quina retouch. On the other hand, while Gorham's Cave has an IR of < 50%, the IR for Devil's Tower is 74%. Thus, while variability, and possibly discontinuous variability, does exist with respect to extent of retouch, frequencies of artifacts with very differently shaped edges, and frequencies of step flaking, it remains difficult to characterize assemblages in terms of this variability solely on the basis of typological data.

## Summary

In summary, edge variability in the assemblages studied seems predominantly continuous and tends to normally distributed. Edges with very different shapes such as notches, burins, and piercers represent the only apparent exceptions to this continuous variability. Those bivariate distributions of edge attributes that seem to be significantly patterned take form of relationships in which one attribute limits, rather than determines, the range of variability in the other. These suggest more or less mechanical relationships between attributes, based in the degree to which use, resharpening, and consequent edge reduction has taken place. Additionally, a dichotomy in patterns of edge use is suggested--edges in which use and modification was linearly extensive and those in which it was concentrated in small areas.

Most variability in pieces simply mirrors that of individual edges, suggesting that retouched artifacts are more the result of the extent and nature of the use of their various edges than planned tools for which the maker had some form of "mental template". Variability seems primarily distributed along axes that consist of piece dimensions, whether edge use was extensive or concentrated, and the intensity of utilization of edges. Secondarily there may be some discrete variability, possibly representing artifacts used for different tasks. This discrete variability is reflected in artifacts with edges that have extremes of shape and those with or without step flaking.

At the level of assemblages, temporal differences seem primarily restricted to variations in features of discrete variability--step flaking and shape. Piece dimensions, extensiveness of edge use, and intensity of utilization seem consistent through time at the sites studied. Spatially patterned variability is a little more apparent, however. The two sites of the Alcoy Basin are very similar with respect to all attributes examined, while the two Gibraltar sites display more differences, both with the Alcoy Basin sites and with each other.

The many aspects of the continuous morphological variability that is the focus of this study are not well reflected in the commonly used Middle Paleolithic typology. Because of the continuous nature of most variability in retouched tools, and because of the great range of variability within most of Bordes' tool classes, there are only minimal, if any, significant differences between the majority of these types with respect to the attributes examined here. Thus, types may tend to misrepresent variability in Middle Paleolithic tools as discrete, whereas, in most cases, it is probably continuous.

However, since the results of typological analyses are so widely available and studies like the present one are rare, it is valuable to identify ways in which the two forms of analysis can be related. In this respect, extent of retouch is indicated by frequencies of extensively retouched artifacts, such as scrapers, and artifacts in which retouch is concentrated, such as notches, burins, and piercers. In addition, the frequency of notches seems to mirror continuous variability in edge shape. Intensity of utilization of chipped stone can be assessed by the relative frequencies of retouched to unretouched pieces and by frequencies of different classes of retouch where this information is reported. Dimensional measurements, where available, can be directly compared with the results of the current study.

Using this information, the sites of the present study have been examined in the context of a larger population of Middle Paleolithic sites in Spain and the northwestern Mediterranean as a whole. For eastern and southern Spain, a series of upland sites that include Salt, Pastor, Cochino, and Carigüela seem very similar with respect to the intensity and pattern of use of chipped stone. Use and associated modification of piece margins tends to be extensive rather than concentrated, intensity of utilization seems to be low--both with respect to the frequency of retouch in the entire assemblage and the intensity of retouch on individual pieces--and pieces with extreme shapes seem to be rare.

Lower elevation sites seem more variable. Cova Negra, Petxina, Gorham's Cave, and Zájara levels 1 and 3 seem similar with respect to greater use of pieces with concentrated retouch. Devil's Tower and Zájara level 2 are more like the upland sites in this respect. On the other hand, all Zájara levels and Gorham's Cave have low frequencies of retouched pieces in their assemblages while nearly half of all pieces were retouched at Cova Negra. Intensity of retouch per piece also varies among these sites.

With respect to sites of northeastern Spain and the French Midi, the less detailed data suggest yet another pattern with a dichotomous division of assemblages based on IR, frequencies of notches, and amount of step flaking. Hence, sites tend to group differently along different axes of variability. Also the inherent discreteness of typological variability may result in groupings of sites that are more apparent than real.

Variability in Middle Paleolithic chipped stone tools is considerable. However, it does not seem to be distributed in the manner implied by many of the studies that have attempted to interpret this variability. This suggests a need to a re-examine the possible causes of lithic variability with respect to the results of this study. Such a discussion is the focus of the next chapter.

# CHAPTER 5

# DISCUSSION

The last chapter presented an in depth analysis of patterns of lithic variability, focusing on assemblages from four Middle Paleolithic sites in the Iberian Peninsula. Variability was examined at levels of analysis ranging from edges to assemblages. Additionally, the results of this study were compared with published data from other sites within the northwestern Mediterranean region. A few very basic use patterns were proposed as contributing to a significant amount of observed variability.

In this concluding chapter, the interpretation of these patterns of variability and use is explored in relation to Middle Paleolithic behavior. Initially, the results of this study are examined in the light of the three major classes of explanations most often proposed as accounting for variability in Middle Paleolithic assemblages--stylistic differences related to social organization, the functions for which the artifacts were used, and diachronic change. Subsequently, a variety of aspects of Middle Paleolithic behavior--ranging from raw material usage to settlement patterns--are examined as potential sources for the patterns of lithic variability in the assemblages studied.

## Lithic Variability and Middle Paleolithic Behavior

### STYLE, FUNCTION, AND TIME

*Style.* Style is a concept that has been expressed in many ways (Gamble, 1986:322-324; Dunnell, 1978; Sackett, 1973; 1982; Jelinek, 1976). However, for Middle Paleolithic archaeology, the primary interest in style is whether lithic variability reflects behaviors conditioned more by the social environment than the natural environment. If so, it could then provide information about social relationships and organization. Methodologically, the identification of patterns in variability has been accomplished by comparing assemblages, usually graphically, with respect to variations in the relative frequencies of different types of retouched tools among assemblages (see Bordes, 1972:48-54, for an example of this technique).

For the Middle Paleolithic, the primary justification for attributing all or even part of lithic variability to style is that observed patterns appear to cross-cut synchronic and diachronic patterns of environmental variability (Bordes, 1973; Ashton, 1985). While this is certainly characteristic of some stylistic variability, it is not always the case. The basic unit of analysis for Middle Paleolithic assemblabes is the retouched tool type. In order to attribute typological variability to cultural tradition it is necessary that these types adequately represent morphological variability and that this variability includes relevant stylistic elements. Tool types are defined by a variety of criteria that include the position, extent, and nature of retouch on pieces and certain technological features such as the form of the platform and pattern of previous removal scars on the exterior surface of the piece.

It is, of course, possible that variability in technological features may be conditioned by cultural choices with respect to equivalent reduction techniques (e.g., Ashton, 1985). However, a considerable amount of evidence suggests that such variability is more likely a due to the character of the raw material (Fish, 1979:128-130; Jelinek, 1976; 1977), the physical capabilities of the makers (Jelinek, 1982), or even the stage(s) of core reduction represented in the assemblage (Baumler, 1987; Marks and Volkman, 1983).

With respect to the nature of retouch, the data presented in the last chapter suggest that the pattern of modification on tools is more likely the result of artifact use, especially the amount of use, than the production of a preconceived morphology. While there may well have been culturally determined differences among Middle Paleolithic social units with respect to such behaviors as how much a given piece would be used and resharpened prior to discard this information is not readily apparent in the frequency of tool types. Additionally, this type of behavior may be better explained by such factors as the availability of raw materials, the length of occupation of a site, and the activities performed than by the pattern of social relationships (Rolland, 1981). Hence, while information about social organization may be contained in lithics (Gamble, 1986:330-331) it may not be easily addressed in the study of fluctuating frequencies of currently used types.

*Function.* Like style, the concept of function in archaeology has often been the subject of considerable discussion. For the Middle Paleolithic, however, interest in function has tended to center on the same question mentioned above with respect to style. That is, is observed lithic variability reflecting behaviors primarily associated with adaptation to the natural environment, as opposed to behaviors associated with social relationships? Again, relevant methodology has generally involved attempts to identify recurring patterns in the relative frequencies of types among assemblages and relate these patterns to environmental variability. Following the pioneering works of Freeman (1964) and Binford and Binford (1966), multivariate statistical techniques, primarily factor analysis, have been used with some frequency to assess variability. Patterns revealed by such techniques have been attributed to activities and associated artifacts classes to "tool kits".

Even if methodological criticisms of these studies are disregarded, several assumptions that are integral to functional interpretations of these patterns require re-examination. It is assumed that the typological system adequately represents morphological variability (Freeman 1964:1-2). It is further assumed, often a priori, that typological variability is primarily functional variability (Binford, 1973). Finally, it is assumed that types or groups of types can be associated with distinct activity sets (e.g., Freeman, 1964:187-190; Binford and Binford, 1966; Binford, 1973), that is, there is a consistent relation between form and function.

It might seem that Bordes' typology includes almost anything that can be done to manufacture a chipped stone artifact because nearly all Middle Paleolithic retouched tools can be classified using this system. It would not be an adequate, general typology if this were not the case. How well it actually represents morphological variability, especially variability relevant to the use of tools, is another matter. The results of the present study suggest that the system does not reflect many aspects of variability in artifact edges or aggregate variability on complete pieces.

The second assumption seems reasonably supported by the results of this study. Primary axes of variability do seem associated with use. However, the amount and intensity of use, rather than only the type of the activities involved, seems to significantly contribute to this variability.

As mentioned in Chapter 3, the assumption of reasonably direct (even if unknown) relationships between form and function is a result of viewing stone tool use from the perspective of modern society. Both studies of modern stone tool users (Gould, et. al., 1971) and of prehistoric assemblages (Frison, 1968; Keeley, 1980:109-116) suggest that this perspective is misleading. While it is not intended here to digress to a discussion of the relevance of emic versus etic types (see Dunnell, 1986), it should be pointed out that the relationships between form and function and the consistency of this relationship were very different for Neanderthal users of chipped stone than they are for modern users of socket wrenches and power saws. The results of this difference are apparent in the continuous, often normal distribution of variability for the lithics examined in the course of this study--even though these artifacts represent a variety of well-defined "types".

Considering these problems with the basic assumptions about the distribution and meaning of variability in the units of analysis, it is not surprising that the function/style debate was never adequately resolved for the Middle Paleolithic. This is not to say that attempts to identify and interpret stylistically or functionally significant patterns in lithic variability are trivial or pointless. In fact, the ultimate goal of much archaeological research is to reconstruct and explain prehistoric social relationships and adaptive systems. However, it is difficult to to attain these goals for the Middle Paleolithic by simply identifying patterns in the frequencies of tools types, without understanding the underlying causes of variability in these types.

*Time.* Temporal change has variously been used to explain differences among Middle Paleolithic assemblages (Mellars, 1969). However, change though time does not constitute in and of itself an explanation of variability. It is, rather, merely an observation about the distribution of variability. For the Middle Paleolithic, possible explanations of temporal variability can be divided into three general groups.

One group of possible causes of variability through time is essentially stylistic in nature and can, in analogy with evolutionary biology, be best termed cultural drift. This is represented by stochastic processes with neutral adaptive significance (Dunnell, 1978). Cultural drift can be expected to produce non-repetitive changes that are essentially small, random fluctuations from a previous condition at any point in time. Biological variability produced by genetic drift provides reliable chronological markers and characteristics that are useful for identifying descent lines. In archaeology, such variability is likewise very useful for developing seriations for chronologies and for identifying cultural groups.

As indicated above, there is no compelling reason for assuming that variability among types is largely stylistic. Additionally, the variability identified in the present study seems primarily related to use. Finally, the temporal recurrence of identified assemblage groupings (Bordes, 1973; Laville, et. al., 1980:208-215; Butzer, 1981) does not seem consistent with the pattern of change described above.

A second group of possible explanations involves processes associated with adaptation to environmental changes. The lack direct association between Middle Paleolithic industries, defined on the basis of overall similarities among assemblages in the relative frequencies of types, and environmental fluctuations observed in rock shelter deposits have led some feel that such processes do not fit Middle Paleolithic data (Ibid.). However, part of this lack of association may be caused by the inability of overall type frequencies to adequately characterize relevant assemblage variability or the lack of sufficient resolution in paleoenvironmental data (see Rolland, 1981).

When, as was exemplified in the last chapter, analyses are limited to specific types that may more accurately reflect axes of variability, a closer correspondence between lithic and environmental variability can be seen. Jelinek (1982), for example, notes parallels between relative frequencies of handaxes and scrapers through time at Tabun and associated environmental fluctuations.

The third group of explanations for temporal variability involves changes resulting from associated biological evolution in the hominids making the artifacts. Physical and mental differences in hominids over time could be expected to affect both social organization and the range of activities performed. Such differences are certainly notable in overall differences between Oldowan, Acheulean, Mousterian, and Aurignacian assemblages for example. Within the Middle Paleolithic, however, changes in flake dimensions that might be related to biological changes permitting improved control over flake production techniques, represent one of the few cases where such processes may be seen (Jelinek, 1982; Dibble, 1983).

In the present study, the lack of variability through time is notable for many attributes examined. However, some temporal changes do occur. Considering the nature of observed variability, as described in the last chapter, these changes most likely relate to fluctuations in adaptive responses to the environment rather than the other two groups of explanations. They are discussed more fully below.

## POTENTIAL BEHAVIORAL SOURCES OF VARIABILITY

*Raw material usage.* While the raw material used for the manufacture of lithic artifacts is regularly listed as a part of modern analyses, it does not tend to be used in explanations of variability, although exceptions to this do occur (see Jelinek, 1976; Gamble, 1986:282-284, 331-338; Fish, 1979:128-130). With respect to the current study, differences in raw material that occur among the sites whose assemblages were examined may be responsible for some of the observed variability.

Nearly 100% of all pieces from Salt and Pastor were made on flint, which is reported to be easily obtained in the vicinity. While flint was also used at Gorham's Cave and Devil's Tower, quartzite--primarily obtained from beach pebbles--is the most common raw material in the entire assemblages of both sites (Waechter, et. al., 1964; Garrod, et. al., 1928). Nevertheless, 78% of the retouched tools from Gorham's Cave and 44% of the retouched tools from Devil's Tower are made on flint.

The initial impression is that flint was the preferred raw material for tool manufacture, at least at Gorham's Cave. But if flint were the material of choice for use, why were so many quartzite flakes produced? Closer examination of the data suggest an explanation that differs from simple preference.

If retouched tools are primarily only pieces that have been more intensively used and resharpened than unretouched flakes (as opposed to purposefully modified artifacts), then the higher percentage of flint "tools" indicates that flint flakes were used and resharpened more than quartzite flakes. Given that quartzite is more immediately available, especially at Gorham's Cave, it was little more trouble to strike a fresh flake than resharpen an old one. Flint, while available in Gibraltar, required more effort to obtain than quartzite. Hence, flint would have had a greater tendency to be resharpened prior to discard. Additionally, quartzite is a more durable material than flint. Being less subject to fracturing and microchipping, there would be less need to resharpen quartzite flakes as compared to flint flakes.

This pattern of differential utilization of raw material is also noticeable in the cores from Gorham's Cave. Waechter (1964) notes that quartzite cores tend to be larger than flint cores. He suggests that flint from the Gibraltar deposits may have been highly fractured and produced only small pieces. This size difference was apparent for the cores that I was able to examine from the site, as can be seen below.

GORHAM'S CAVE CORES

| | | Flint | Quartzite |
|---|---|---|---|
| Length | $\bar{X}$ | 39.4 | 53.5 |
| | Range | 24-55 | 31-84 |
| Width | $\bar{X}$ | 39.0 | 50.1 |
| | Range | 19-54 | 28-83 |
| Thickness | $\bar{X}$ | 15.9 | 24.1 |
| | Range | 5-33 | 12-50 |
| | n | 37 | 17 |

However, a number of the flint cores had remnant cortex on the bottom that suggested they had originally been considerably larger. Additionally, large flint tools exist, attesting to the original existance of large flint cores. The most reasonable explanation for this pattern is that the flint cores were more heavily worked than the quartzite cores. This also fits the pattern of utilization seen in the retouched pieces.

These processes might be not represented in the Devil's Tower assemblages where flint was used for only 44% of the retouched tools. However, the smaller collection size and the lack of information about debitage makes this difficult to demonstrate. Garrod (1928) stated that the total number of pieces recovered from the site was less than 500. This means that retouched pieces make up > 9% of the total assemblage. Additionally, the dimensions of flint and quartzite cores are very similar in the 12 cores available for study (e.g., $\overline{x}$ length = 55.2 and 54.1 mm. for flint and quartzite cores respectively). This suggests a somewhat more equitable utilization of the different raw materials.

*Intensity of utilization.* It was suggested in the last chapter that the degree to which edges were utilized, resharpened, and reused constitutes a major axis of variability in the Middle Paleolithic retouched tools examined in this study. Rolland (1981) suggested that the amount of resharpening, associated with economizing raw material, may a primary cause of variability in frequencies of scrapers (and of retouched pieces in general). In two recent articles, Dibble (1984; 1987), has similarly suggested that the amount of reduction may be a major cause of variability among Middle Paleolithic sidescrapers. Specifically, he presents a model in which the final discarded scraper "type" is primarily a function of the original flake width and the amount of subsequent reduction.

In summary, the model begins with a flake on which initial retouch has produced a single edged scraper. If the piece is wide enough, reduction can either continue with a single edge, producing a transverse scraper if the process continues sufficiently, or a second edge can be started, resulting in a double scraper. If a second edge is started and the piece is still wide enough to allow continued reduction, eventually a convergent scraper can be produced. The amount that reduction continues in either trajectory is controlled by the width of the piece--that is, reduction ceases when a certain minimum width is reached.

Considering the types of data generated in the present study and the interpretations suggested by the results, it seemed valuable to test Dibble's model on these Iberian collections. If the model is correct, there are several implications: 1) the degree retouch/reduction should increase from single, to double, to transverse or convergent scrapers; 2) while length might vary--with single and double scrapers being longest, followed by convergent and, finally, transverse scrapers--width of all scrapers should be equivalent; 3) the original width of the most reduced scrapers (i.e, convergent and transverse scrapers) should be greater than the least reduced scrapers. Dibble estimated original width from platform dimensions. As these were not measured in the present study, this aspect of the model cannot be tested. However, the two other implications can be examined in detail.

Table 5.1 shows the means of various aggregate and dimensional measurements for the different types of scrapers. With respect to piece dimensions, the values fit the model rather well for the most part, but there are some discrepancies. Convergent and single scrapers are about the same length, and both are considerably shorter than double scrapers. Single, double, and convergent scrapers are approximately the same width, fitting the model quite well. While transverse scrapers are considerably wider, their lengths closely match the widths of other types of scrapers. This also fits Dibble's model as, due to differences in techniques of measuring length and width of transverse scrapers (see Appendix I), his width is roughly equivalent to length in the present study (Dibble, pers. comm.).

With respect to measures of the intensity of use and resharpening, all variables show increases from single to double to convergent scrapers. However, transverse scrapers have values that reflect an intensity of utilization more similar to single scrapers than to double or convergent scrapers.

Table 5.1. Variability among scraper types.

| VARIABLE | | SCRAPER TYPE | | | |
|---|---|---|---|---|---|
| | | Single | Double | Convergent | Transverse |
| Length (mm.) | $\bar{X}$ | 44.3 | 49.6 | 44.8 | 28.9 |
| | σ | 12.5 | 16.7 | 17.1 | 6.9 |
| | n | 329 | 35 | 54 | 91 |
| Width (mm.) | $\bar{X}$ | 27.3 | 29.6 | 28.7 | 36.4 |
| | σ | 7.2 | 7.7 | 7.6 | 8.9 |
| | n | 394 | 53 | 58 | 96 |
| Thickness (mm.) | $\bar{X}$ | 7.6 | 7.9 | 7.6 | 7.8 |
| | σ | 3.6 | 2.9 | 2.6 | 2.9 |
| | n | 401 | 53 | 59 | 98 |
| % of margin retouched | $\bar{X}$ | 41.7 | 64.0 | 78.7 | 44.4 |
| | σ | 14.8 | 17.5 | 18.2 | 17.0 |
| | n | 403 | 53 | 59 | 100 |
| Mean edge angle | $\bar{X}$ | 52.5° | 54.7° | 55.6° | 50.6° |
| | σ | 11.0° | 10.6° | 10.6° | 10.6° |
| | n | 403 | 52 | 59 | 100 |
| Mean invasiveness (mm.) | $\bar{X}$ | 5.3 | 6.1 | 6.1 | 5.6 |
| | σ | 2.6 | 3.1 | 2.4 | 2.9 |
| | n | 403 | 53 | 59 | 100 |
| Total length of step flaking (mm.) | $\bar{X}$ | 10.4 | 16.2 | 19.2 | 7.6 |
| | σ | 11.6 | 16.9 | 17.3 | 7.2 |
| | n | 112 | 26 | 29 | 28 |
| % of pieces with step flaking | | 27.8 | 49.1 | 49.2 | 28.0 |

In general, the data from the present study indicate that variability among single, double, and convergent scrapers fit Dibble's model quite well. Transverse scrapers appear more like single scrapers than the other types with respect to all variables. This suggests that, unlike those studied by Dibble, transverse scrapers in the Iberian collections studied here probably represent single scrapers on short, wide flakes rather than heavily reduced scrapers. However, the point at which they were discarded still seems a function of width as is generally suggested by Dibble's model.

These data represent a specific, but significant subset of the general relationships described in the last chapter. The distribution of variability in attributes such as edge angle, invasiveness of retouch, width/thickness, and the length of retouched edges indicate a positive relationship between the linear extent of margin retouched and intensity of utilization for extensively modified artifacts such as scrapers. While an inverse relationship between extent of modification and intensity of utilization has been postulated for artifacts with retouch concentrated in small areas, it cannot be supported typologically in the way that scraper frequencies support the alternate pattern of use.

*Variability in activities performed.* It has been suggested here that the amount of use and reduction of pieces may have contributed more significantly to the morphological variability in the Middle Paleolithic retouched tools examined in the course of this study than did the activities for which they were used. The distribution of variability also suggests that the morphology of most artifacts does not appear to be task specific. Micro-refitting of fragments and resharpening flakes suggests that such non-specificity in form/function relationships is not limited to the Middle Paleolithic, but may be characteristic of chipped stone use in general (Frison, 1968). Microwear studies confirm the existence of this pattern as early as the Middle Pleistocene (Keeley, 1980:109-116). They also indicate that a considerable portion of the minimally and un- retouched debitage was utilized--artifacts that were not examined in the course of the present study and tend to be minimally reported elsewhere.

In spite of this general tendency toward non-specific relationships between form and function, possible activity related variability was noted in a few cases. Rolland (1981) has suggested that most Middle Paleolithic tools may fall into two broad functional classes. One is a set of multi-purpose processing implements that include most types of scrapers. The second represents implements for manufacturing items from hard substances, such as wood and bone, and includes notches, denticulates, and abrupt scrapers. The results of the present study suggest an analogous, though not identical, dichotomy defined on the basis of extent of modifcation. The group of extensively modified artifacts is primarily composed of sidescrapers. While artifacts with concentrated retouch are more varied, notches comprise an important component of this group.

Similarly, a few edge shapes, at the extremes of the overall distribution, may represent a more limited ranges of activities than the bulk of the artifacts. In fact, limited microwear studies indicate that burins and piercers may have been used primarily for graving and boring bone and wood (Keeley, 1980:87-112). The same studies suggest that notches may be primarily associated with wood working. This does not mean that other artifacts were not used for the same activities, only that these morphologies seem more closely associated with limited ranges of activities.

In this respect, the shape of notches may at least provide a clue to associated activities. The shape 45% of all 89 notches with shape measurements fit curves with a radii of 5-8 mm. and an additional 35% fit curves with radii of 10-14 mm. If notch radius reflects that of the objects being worked, this would suggest that the diameters of these objects was rather small. Only the upper end of the range of radii would seem adequate for spear shafts, although any of these notches could have been used to work spear tips. These notches, then, may well reflect the production of non-lithic artifacts for which there is apparently no known record from the Middle Paleolithic. Hence, these chipped stone artifacts, though limited in number, indeed seem likely to be associated with production, possibly of other tools as was suggested by Rolland. In a very restricted way, they may provide some information about the relative importance of such activities at sites.

Lithic artifacts with step flaking on > 5% of the retouched margin also seemed to be somewhat different from the bulk of the tools. If they do represent some discrete set of tasks, the nature of these activities is far from clear. They are associated with a variety of edge shapes and occur as almost half of the retouched tool types (the distribution of types among these step flaked pieces is more or less the same as the distribution of these types among all tools). Only the amount of step flaking, size, and intensity of utilization sets these artifacts apart from others, leaving their possible uses uncertain.

*Intensity of occupation.* So far, the discussion of the causes of lithic variability has been limited to factors directly related to the manufacture and use of chipped stone artifacts. However, other, larger scale, patterns of human activity also may affect variability in these implements. While various aspects of lithic assemblages as a whole have been discussed, including assemblage size and the ratio of retouched to unretouched pieces, it should be remembered that these assemblages primarily represent waste discarded by humans while they were living at sites. As such, the quantity of such debris at a site is affected by the the frequency with which it was visited, size of the group that occupied the it, and the length of time that they stayed there. Additionally, these factors also affect the pressure put on available resources, including lithic resources. This, in turn, may influence the manner and intensity of lithic use.

Gamble (1986:343-367) has discussed in detail the problems and potential for assessing intensity of occupation from artifact assemblages. Among other observations, he stresses the importance of assessing artifact assemblage size in relation to the volume of sediment excavated as a way to begin to appreciate variability in paleolithic settlement patterns. Even while realizing the possibilities for variability due to depositional processes alone, he has noted striking regional variation in artifact densities.

Table 5.2 shows variability in total quantity of lithics and in retouched pieces per total volume of sediment excavated at four sites for which this information is available. The area excavated at Gorham's Cave was estimated from information presented in Waechter's two reports (1951; 1964) and Zeuner's (1953) study of the site's stratigraphy. For Cova del Salt, dimensions of Sector A and level thicknesses were derived from Martín's (n.d.) notes and drawings. The data from Cova del Pastor represents Cortell and Segura's sounding (Cortell and Segura, n.d.). Lithic counts are from personal counts for Salt and Pastor, and from personal counts and Waechter's reports for Gorham's Cave. All information about Cova Negra is derived from Villaverde (1984). Due to difficulties in determining area excavated in the lower layers K-T of Gorham's Cave, the total volume excavated for these layers may be underestimated and, hence, the count of pieces/$m.^3$ overestimated. Additionally, there is a good chance that most of the debitage is missing from the layer 2 assemblage of Cova del Salt, Sector A (see Chapter 2).

Considerable variability in artifact densities is apparent among the sites. First, in overall artifact density, the two higher altitude sites (Salt and Pastor) have more artifacts per cubic meter of sediment than do the lower altitude sites. However, Salt differs from Pastor by almost an order of magnitude, as Gorham's Cave does from Cova Negra.

Additionally, artifact density tends to increase at all four sites throughout most of their sequences. Reversals of this pattern are seen in the upper layers of Gorham's Cave and Cova del Salt, although the low density in Salt layer 2 may be a result of uncounted debitage. However, the frequency of retouched pieces per cubic meter closely parallels the frequency of total pieces. Given this relationship and the drop in retouched tool density in Salt layer 2, less debitage may be missing than has been previously indicated.

Table 5.2. Lithic densities at selected sites.

| Site | Layer/ Level | Volume ($m^3$) | Total Pieces | Pieces/$m^3$ | Retouched Pieces | Retouched Pieces/$m^3$ |
|---|---|---|---|---|---|---|
| Gorham's Cave | G-H | 117.0 | 5233 | 44.7 | 41 | 0.4 |
| | K | 8.0 | 1519 | 189.9 | 26 | 3.3 |
| | L-M | 16.8 | 1593 | 94.8 | 17 | 1.0 |
| | N-Q | 17.6 | 661 | 37.6 | 8 | 0.5 |
| | R-T | 20.5 | 68 | 3.3 | 3 | 0.1 |
| | Total | 179.9 | 9074 | 50.4 | 95 | .5 |
| Cova del Salt, Sector A | 1 | 0.76 | 279 | 367.1 | 36 | 47.4 |
| | 2 | 1.51 | 51 | 33.8 | 36 | 23.8 |
| | 3 | 1.89 | 1218 | 644.4 | 186 | 98.4 |
| | 3-4, 4 | 1.44 | 614 | 426.4 | 54 | 37.5 |
| | 4-5, 5 | 2.27 | 1043 | 459.5 | 54 | 23.8 |
| | 5-6, 6 | 1.89 | 450 | 238.1 | 19 | 10.1 |
| | Total | 9.76 | 3655 | 374.5 | 385 | 39.4 |
| Cova del Pastor | Cata B | 0.39 | 30 | 76.9 | 3 | 7.7 |
| Cova Negra, all sectors | 1 | 64.5 | 923 | 14.3 | 410 | 6.4 |
| | 2 | 16.1 | 185 | 11.5 | 89 | 5.5 |
| | 3 | 36.9 | 385 | 10.4 | 174 | 4.7 |
| | 4 | 31.6 | 187 | 5.9 | 84 | 2.7 |
| | 5 | 32.3 | 215 | 6.7 | 108 | 3.3 |
| | 6 | 42.4 | 303 | 7.1 | 157 | 3.7 |
| | 7 | 37.6 | 234 | 6.2 | 130 | 3.5 |
| | 8 | 26.7 | 159 | 6.0 | 85 | 3.2 |
| | 9 | 29.6 | 146 | 4.9 | 80 | 2.7 |
| | 10 | 28.5 | 138 | 4.8 | 68 | 2.4 |
| | 11 | 18.0 | 69 | 3.8 | 41 | 2.3 |
| | 12 | 28.1 | 84 | 3.0 | 50 | 1.8 |
| | 13 | 24.2 | 71 | 2.9 | 55 | 2.3 |
| | 14 | 22.2 | 50 | 2.3 | 35 | 1.6 |
| | Total | 438.7 | 3149 | 7.2 | 1566 | 3.6 |

The differences between sites could be primarily a result of differences in sedimentation rate. If so, Salt should represent the slowest rate of sedimentation and Cova Negra the highest. However, geomorphological and other data presented in Chapter 2 also suggest that Salt may represent a shorter time span than either Cova Negra or Gorham's Cave. Given this, there does not seem to be enough difference between the thicknesses of the deposits at Salt (3-4 m.), Cova Negra (4-5 m.) and Gorham's Cave (6.5 m.) to account for the magnitude of differences in density between these sites on the basis of sedimentation rates alone. This may, however, in part be responsible for the apparent differences in density between Cova Negra and Cova del Pastor, which has identified artifact bearing deposits only 0.7 m. thick.

Other possible explanations for variability in artifact densities relate to differences in intensity of prehistoric occupation of the sites and the activities performed there. Activities associated with production and use of lithics have been discussed above. Intensity of occupation is meant to include frequency of visits to a site, length of stay, and group size because it is not possible to differentiate between the relative significance of these factors based on available information for the sites. Any of these three factors affect the average number humans per unit time at a site and, hence, could have also affected the rate of accumulation of lithic debris.

If intensity of occupation contributed positively to variability in the density of lithics at the sites, it could be argued that the higher altitude sites, especially Salt experienced more intense occupation than the lower altitude sites, and that all sites show an increase in occupation intensity over time.

Gamble (1986:115) argues that conditions of the early glacial--with open vegetation and abundant large herbivores--may have been the optimum Pleistocene environment for Paleolithic adaptive strategies. With the onset of the last glaciation, such conditions could be expected to be first and most strongly manifested in upland regions. Subsequently, with the drop in altitudinal life zones as the glacial stage progressed, these conditions would be more apparent at lower elevations. Environmental data presented in Chapters 1 and 2 suggest that was the case. If Gamble is correct, the highest density of human population, would occur at higher elevations--especially in the initial stages of glaciation. Later, lower elevation sites would become increasingly attractive. It is possible that, with increasingly rigorous climate, higher altitude sites eventually became less attractive. If so, this might explain the drop in artifact density in the upper layers of Cova del Salt, after which the site was abandoned.

Even without postulating relatively optimum conditions for human settlement, these environmental differences could have caused apparent differences in human demography. All four sites are rock shelters or caves. Such sites would tend to be more attractive for settlement under colder climatic conditions. Conversely, they may not be as attractive locales for settlement during more mesic periods. Evidence from both Gorham's Cave and Cova Negra suggest that they were rather wet caves during periods of milder climate, and drier during colder episodes. The abandonment of Cova del Salt was followed, if not accompanied, by disintegration of the shelter (possibly the result of increasing cold) which certainly made it a less suitable place to live. Such processes would make shelters in the uplands more attractive than those in the lowlands during the onset of glacial conditions. As the stage progressed, however, increasingly rigorous conditions would make lowland shelters increasingly attractive and might also result in partial or complete abandonment of some upland locales.

Finally, differences in geographic setting of the sites could be responsible some of the differences between sites. Salt is a large, well sheltered, south facing locale with a probably very regular water source. Additionally it overlooks the Barchell and the broad Polop valley. It has easy access to mountain and valley habitats. All these factors make the site a very desirable one--especially for hunters. Pastor, while smaller, is in a major pass through the Sierra de Mariola. This also makes it a desirable locality. Gorham's Cave, on the other hand, is in very high, steep cliffs, and fronts directly onto the Mediterranean. During recent times it has at times been accessible only by boat. Even during times of low sea level, its shorefront setting would not make it especially attractive for hunters and gathers. The setting of Cova Negra is more difficult to assess in detail as I have not visited the site. It is along a major river. However, it is only 17 m. above the current river bed, and its lower layers are fluvial deposits. This suggests it was at river level for a considerable time during the Upper Pleistocene. As such, it may not have been as attractive to hunters and gatherers as a site farther from the river.

*Adaptation to different environments.* Although environmental change did occur during the early Upper Pleistocene, it is difficult to assess the impact of such change on human populations from variability in the lithics examined in the present study. The apparent lack of task specific variability alone poses considerable difficulties in this respect. Also, the variability that is apparent among assemblages seems primarily attributable to factors other than the types of activities for which the lithic artifacts were used

Additionally, environmental information for the sites studied is available at only a gross level at best. At this level, little environmental variability is indicated among the strata bearing sufficiently large assemblages to provide information about lithic variability at each of the sites.

A similar lack of resolution affects the lithic assemblages themselves. Although stratigraphically ordered, it is extremely doubtful that any of the assemblages represent the debris of single, chronologically limited occupations of the sites. Rather all are probably the accumulated debris from numerous occupations over an indeterminate period of time. Given these various cautions, a few general suggestions can still be made regarding relationships between lithic and environmental variability.

For the three sites with more than one assemblage, several general trends can be seen. There is a general increase in the amount of step flaking and the total amount of retouch per piece at all sites. Additionally, the Gibraltar sites show slight increases in mean invasiveness and edge length. This may indicate an increase through time in the amount of extensive utilization of piece margins, and possibly the intensity of utilization per retouched piece. On the other hand, the percentage of retouched pieces in each total assemblage seems to decline slightly at Gorham's Cave and Cova del Salt, suggesting a decrease through time in the overall intensity of use of chipped stone at these sites. Finally, the overall density of lithics at the sites seems to increase over time, suggesting an increase in intensity of occupation accompanied the changes in patterns of lithic variability through time.

In the comparison of the sites of the present study with others in the northwestern Mediterranean, it was noted that the lithic assemblages of those at relatively high elevations seem to share a set of characteristics that include a relatively low percentage of retouched tools in the total assemblage, relatively high frequencies of scrapers, and low frequencies of pieces with extreme shapes and concentrated retouch. Overall, these sites seem to be characterized by a relatively low degree of utilization of chipped stone and a low degree of variability in morphology. On the other hand, the higher altitude sites with available information have higher concentrations of artifacts.

Conversely, lower elevation sites seem to be considerably more diverse--both in relation to each other and in the greater amount of lithic variability. Pieces with concentrated retouch and extreme shapes are more common at at least some of these sites (e.g., Cova Negra and Petxina). The intensity of utilization also seems considerably higher in most cases. In at least one case where this intensity appears low (Gorham's Cave) it seems explainable by variability in raw material availability. Nevertheless, even at these sites, there is a general trend toward lower frequencies of retouched pieces and less overall intensity of utilization through time, with increases in extensively retouched pieces at the expense of other forms. Additionally, while artifact density is below that of higher altitude sites, it tends to increase through time.

A model can be presented that accounts for at least some of these patterns. Upland sites, such as Cova del Salt, Cova del Pastor, Cova de Cochino, and Cueva de la Carigüela, suggest a pattern of rather casual use of chipped stone. Based on the low frequency of retouched pieces and the relatively high frequency of the extensively retouched pieces among the tools, the higher elevation sites may represent relatively short-term occupations where multipurpose, extensively retouched tools were used for a limited variety of activities.

Additionally, Salt and Pastor have high artifact densities (as does Carigüela if the estimated density reported in the last chapter is correct). This, along with the relatively low frequency of retouched pieces, suggests little need to economize raw material through resharpening. This would be the case if the sites were visited in association with wide ranging movement on the part of the occupants and stays were short (see Roland, 1981). The settings of these sites seem to have made them ideal bases for hunting, an activity which might have been associated with this pattern of occupation. With such a settlement pattern, the supply of raw material at the sites could be frequently replenished. This could lead to relatively high artifact densities, but relatively low retouched tool frequencies. Additionally, as naturally sheltered locales, valuable for the protection they afforded in the at least seasonally cold upland environment, repeated reoccupation of these cave and shelter sites would be encouraged. This would also tend to have increased artifact density.

The lower elevation sites would, conversely, represent a wider range of activities. Additionally, the greater intensity of utilization of lithic resources at some of these sites suggests more intensive occupations. The lower total artifact densities at Gorham's Cave and especially Cova Negra would seem to support such an occupation pattern for these sites. Longer stays at the sites would mean that the occupants would have less opportunity to collect lithic raw material other than that available in the immediate vicinity. The differential use of quartzite and flint at Gorham's Cave, discussed above, is interesting in this respect. Additionally, these lower altitude sites may have been visited less often than the higher altitude sites. Potential reasons for less frequent reoccupation of the sites include lower overall population densities (possibly associated with the amount and/or distribution of food resources), less need for naturally sheltered locales in the milder low-altitude climate, and the rather unattractive living conditions in caves during milder climatic episodes.

Interestingly, these lower elevation sites show a tendency toward the higher elevation pattern over time. This may be indicating a shift in activities and settlement patterns in response to the decline altitudinal life zones that accompanied deteriorating climatic conditions as the last glacial period progressed. While founded on something more than pure speculation, the very tentative nature of the data relegates this model to a hypothesis that needs to be much more extensively tested.

## Conclusions

In many ways, this research represents a significant departure from most traditional studies of Middle Paleolithic tools--both in the concepts that form the basis of the research as well as in the methods used. However, this study is also an example of a fundamental shift in the way in which archaeologists have begun to view lithics, especially those of the Paleolithic.

For a variety of reasons, some historical some methodological, most of the studies of the chipped stone artifacts that make up the bulk of Middle Paleolithic material culture have focused on the classification of these artifacts within a culture-historical paradigm. Additionally, lithics have tended to be viewed from the same perspective that we, as members of an industrial society, view tools in our own lives. That such a perspective is applicable to Stone Age societies of humans like ourselves is questionable; that it is applicable to lithic use in societies of humans different from ourselves is doubtful.

While typology and culture history brought a semblance of order to the Paleolithic and allowed us to arrange assemblages in time and space, they have done relatively little to help us understand what Middle Paleolithic people were actually doing. However, attempts at processual studies of these artifacts while using the same typology, and maintaining a perspective that views chipped stone as merely a primitive version of the contents of a modern toolbox have been equally uninformative.

In response to these problems, it has begun to be realized that, in order to reconstruct and explain Middle Paleolithic behavior from discarded chipped stone artifacts, it is necessary to re-examine the bases for interpreting lithic variability. Rather than asking whether existing types represent functional or stylistic variability, it would appear more valuable to first ask a set of more fundamental questions: what is the nature of lithic variability; at the most basic level, what processes of manufacture, use, and discard contribute to this variability; how do these processes relate to past human behavior? Only after these questions have been answered can the significance of typological variability or other forms of variability be adequately assessed.

It is hoped that the study that has been presented here represents a step in this direction. The results of this work provide a very different perspective on lithic variability than would the more traditional forms of analysis. Additionally, although the current work is limited in scope to data from four sites in the Iberian Penninsula, the brief comparisons with other Middle Paleolithic sites presented in the last chapter suggest that similar analyses could be fruitfully applied elsewhere.

If we are to explain past human behavior, we must first reconstruct behavior. Reconstruction of behavior is usually the result of explaining the causes of variability in the material culture produced by that behavior. For much of the human past this primarily means explaining the causes of variability in chipped stone artifacts. It is essential that we understand the underlying patterns of variability and the processes that produce it if we are to accomplish this.

The goal of the research described here has been to carry out such fundamental investigations into the patterns and processes of variability in Middle Paleolithic chipped stone tools. Certainly other aspects of variability than those treated here remain to be examined and it is necessary to study other assemblages in order to assess the extent to which the patterns observed here are applicable to the Middle Paleolithic as a whole. However, it is hoped that this study will provide a foundation for additional research in this area and a basis for a better understanding of Middle Paleolithic behavior.

# APPENDIX I

# MEASUREMENT TECHNIQUES AND INSTRUMENTS

### Pieces

All pieces with evidence of modification were measured. These included all pieces that would be included in the essential tool count of Bordes typology. Because they are typologically considered tools, naturally backed knives were also measured, although they usually show no evidence of modification. Broken pieces were noted as such and the position of breaks was identified (see below). They were excluded from analyses where appropriate.

LENGTH

Medial length was measured. As defined by Jelinek, this is measured from the point of percussion to the farthest distal point on the piece. If the piece ended in a break or a transverse hinge fracture, the measurement was taken from the point of percussion to the center of the distal end. For pieces missing the platform, length was measured from the center of the proximal end to the appropriate distal point as described above.

WIDTH

Width was measured as the distance perpendicular to length, at the mid-point of the medial axis as defined above.

THICKNESS

Thickness was measured at the intersection of the medial length and width as defined above.

### Edges

All edges of a piece were measured. As mentioned in the text, however, retouched edges received somewhat different treatment than unretouched edges. Retouch was generally defined as intentional modification. However, without microscopic analysis, which was not feasible in this study, it is not always easy to differentiate between retouched pieces, pieces with modification that derives solely from use rather than retouch, and pieces with naturally damaged edges that resemble modified edges. For this reason, edges having modification with an invasiveness of < 2 mm. were termed 'marginally retouched' indicating that the modification could have come from intentional modification or regular use without intentional modification. They were measured like retouched edges but were treated separately in many analyses. Those with edge modification that was intermittent, irregular, and generally very marginal were considered to have been naturally damaged and treated as unretouched edges.

It was necessary of distinguish separate edges along the continuous margin of a piece so that they could be measured individually. Edges were identified in the following manner:

1. Continuous zones of modification distinct from other such zones along the margin of a piece. Two modified edges were considered to be distinct when a) they were separated by a significant amount of un-

retouched margin; b) when separated by a significant, abrupt change in edge direction (eg., at the intersection of the retouched lateral and distal margins of a déjeté scraper); or c) in a few cases when separated by a significant, abrupt change in retouch, including the style, invasiveness, angle, and side of piece.

2. For unretouched edges, separate edges were originally defined in a similar manner to retouched edges. However, for analysis, the total extent of margin of a given morphology was treated as a single edge, regardless of whether or not it was continuous. For this purpose, unretouched edges were classified as follows: sharp non-cortical, sharp cortical, rounded non-cortical, rounded cortical, backed (ie., steep to abrupt but not broken) non-cortical, backed cortical, broken.

SHAPE

Edge shape was measured in radius of curvature, positive for convex shapes and negative for concave shapes. For irregularly shaped edges, the radius of the curve most closely approximating the shape of the entire edge was used. A radius of about ± 300 mm. was the greatest that could be reliably differentiated from a straight edge for the lengths of edges measured. In order to represent edge shape variability, the reciprocal of radius of curvature was used to compute an index of shape (SI). This is because convex and concave edges approach each other in shape as they approach straight, but radius of curvature approaches infinity as it approaches straight. Because of the limit of 300 mm. mentioned above, a radius of 500 mm. was defined as straight and given a value of 1 for the index of shape. Edges shapes were then converted to shape index using the formula $SI = 500/r$ (where $r$ = radius of curvature for the edge).

LENGTH

Edge length was measured as the extent along the margin of an edge, as opposed to a straight line chord from one terminus of an edge to the other. Due to the precision of the instrument used (a planmeter, see below), edge length was measured in centimeters.

POSITION

The position of an edge on a piece was determined with reference to 10 numbered regions around the circumference of the piece margin. For a piece in standard orientation (platform down and exterior face outward; see Figure 3.1), beginning with the platform and moving clockwise, 0 is the platform or proximal end where the platform is not present, 1-3 are located on the left lateral margin, 4-6 on the distal end, and 7-9 on the right lateral margin. The position of an edge was delineated by which of these regions it occupied. There were a few exceptions to this. On pieces which converged in a point (eg., a convergent scraper), regions 4-6 were deemed missing. On a few pieces, called diagonally convergent, positions 1-3 or 7-9 were deemed missing.

INVASIVENESS

The invasiveness of modification was measured as the chord extending from the margin of the edge to the modification scar extending farthest toward the center of the piece at the point of measurement. For edges ≤ 50 mm. in length, a single measurement of invasiveness was taken at the midpoint of the edge (unless this was obviously an atypical point, in which case the measurement was taken at the closest representative point to the midpoint. For edges > 50 mm. in length, evenly spaced measurements were taken for every 50 mm of length (eg., two measurements for edges 50-100 mm. long). The average of these measurements was used for analysis.

EDGE ANGLE

For most edges, edge angle was measured with a specially modified set of calipers (described below) that measured the thickness of the edge at a constant distance from the margin. This thickness measurement could then be trigonometrically converted to degrees (by a formula described below). In some cases the morphology of the edge made it impossible to use the calipers. In these cases a goniometer was used. Edge angle was measured at the same locations as invasiveness, described above.

STEP-FLAKING

Step-flaking was measured as the total linear extent along the margin of an edge that exhibited step-flaking. Step-flaking included, but was not limited to the coarse, heavy version termed Quina-type retouch.

**Instruments**

All straight line measurements were made with vernier calipers to the nearest millimeter. These measurements included length, width, and thickness of each piece; the invasiveness of each edge; and the extent of step-flaking.

Edge shape was measured with a transparent template, on which curves having various radii were drawn. The radius of the curve that most closely matched the edge was the one used.

Edge angle was measured with a set of specially modified calipers first described by Dibble and Bernard (1980). A stationary bar is affixed a small distance behind the tips of needle point calipers. This allows the thickness of the edge to be measured at a constant distance from the margin. The measured thickness is converted to degrees through the formula: $A = 2(\arctan(T/2D))$ where $A$ is the edge angle in degrees, $T$ is the measured thickness, and $D$ is the constant distance from the bar to the points of the calipers (3.58 mm. for the calipers used in this study). Although not as flexible as a goniometer for measuring the angle of marginally retouched edges, the caliper method is consistent, reliable, and considerably faster than using a goniometer.

Edge length was measured using a planmeter. All pieces were traced, and the boundaries of all edges were noted on the tracings. A planmeter could then be rolled along the margin of each edge to measure the length. I was unable to find a planmeter that measured in units finer than a centimeter. Hence, edge length was measured in this unit.

## APPENDIX II

## KEY TO ATTRIBUTES

I. GENERAL DATA

**ID:** piece ID number

**Site:** site code
p = Cova del Pastor; gc = Gorhams' Cave; s = Cova del Salt; dt = Devil's Tower

**Provenience:** vertical and horizontal where appropriate.

**Type:** Bordes' type numbers

**Material:** (incl. a. rock type, b. color and, c. heat alteration)

a. f = flint; b = basalt; q = quartzite; r = rhyolite
letter followed with number for each variety (eg., f1 or q3)

b. colors indicated by various abbreviations (eg., lTn = light tan)

c. heat alteration codes:
00 = none

| | | |
|---|---|---|
| 11 = discolored | 21 = very discolored | 31 = extremely discolored |
| 12 = damaged | 22 = very damaged | 32 = extremely damaged |
| 13 = both | 23 = very both | 33 = extremely both |

II. PIECE MORPHOLOGY

**Length:** in mm.

**Width:** in mm.

**Thickness:** in mm.

(piece also noted as complete or incomplete in direction of each dimension measurment)

**Exterior scarring:**

| | |
|---|---|
| 1 = radial | 6 = unknown |
| 2 = mixed radial/parallel | 7 = cortex |
| 3 = subparallel | 8 = other (often used for naturally backed knives) |
| 4 = parallel | |
| 5 = irregular | 9 = opposing |

**Cortex:**

| | |
|---|---|
| 1= <10% | 3= 51=90% |
| 2= 10-50% | 4= >90% |

**Technological catagory of piece** (no designated location for recording)

| | |
|---|---|
| 0 = other | 4 = core |
| 1 = flake | 5 = core tablet |
| 2 = flake fragment | 6 = pebble |
| 3 = debris/chunk | 7 = edge flake/spall |

III. PLATFORM

**Surface preparation:**

0 = N/A (no platorm)
1 = missing (platform removed or broken)
2 = cortex
3 = plain
4 = 2 facets
5 = >2 facets
6 = other/irregular
7 = unknown

**Surface shape:**

0 = N/A
1 = missing
2 = flat
3 = triangular
4 = convex
5 = concave
6 = chapeau de gendarme
7 = other/irregular
8 = unknown

**Exterior preparation:**

0 = N/A
1 = missing
2 = none
3 = facetting
4 = grinding
5 = facetting and grinding
6 = other/irregular
7 = unknown

**Exterior shape:**

0 = N/A
1 = missing
2 = flat
3 = triangular
4 = convex
5 = concave
6 = chapeau de gendarme
7 = other/irregular
8 = unknown

IV. EDGES (information recorded for each edge of piece)

**Type:**

For retouched edges: equivalent of Borde's types for single edged tools (eg., #10 = convex scraper edge)

For unretouched edges: letter originally recorded; converted to number for analysis

S (1000) = noncortical sharp
SC (1100) = cortical sharp
B (2000) = noncortical backed
BC (2100) = cortical backd
R (3000) = noncortical rounded
RC (3100) = cortical rounded
BK (4000) = break

**Shape** (recorded next to type)**:** positive/negative radius of curvature. Originally measured in inches, converted to mm.

**Subedges** (recorded next to shape)**:**

Count of sub-edges
Sub-edge type: equivalent to edge type.
Sub-edge position: lateral edges: 100 = proximal; 010 = medial; 001 = distal
transverse edges: 100 = left; 010 = center; 001 = right

**Length:** in mm. (whether edge complete or broken also noted)

**Position:** noted which of positions 0-9 (below) occupied by edge

```
          4  5  6
       _  |  |  |  _
    3  _           _  7
    2  _           _  8
    1  _           _  9
          |  0  |
```

**Side:** (face of piece with modification)

| | |
|---|---|
| 1 = exterior | 4 = alternate |
| 2 = interior | 5 = edge (eg., burins and breaks) |
| 3 = bifacial | |

**Invasiveness:** in mm.

**Edge angle/bit angle:** not differentiated here. Edge angle location used for goniometer measurement. Bit angle location used for caliper measurement (see Appendix I).

**Step flaking:** in mm.

**Retouch type:**

| | | |
|---|---|---|
| 0 = none | 4 = nibbling | 8 = break |
| 1 = scalar | 5 = large irregular | 9 = other |
| 2 = parallel | 6 = small irregular | 10 = burin spall |
| 3 = subparallel | 7 = backing | 11 = clactonian notch |

V. OUTLINE TRACING (back of form)

Includes: outline of piece; location of platform and point of percussion; location of each edge; points on margins where measurements taken.

**LITHIC RECORD FORM**
C. Michael Barton

**I. GENERAL DATA**
ID:_______________
Site:_____________
Provenience:______
__________________
Type:_____________
Material:_________
__________________

**II. PIECE MORPHOLOGY**
Length: |_|_|_|
Width: |_|_|_|
Thickness: |_|_|_|
Exterior scarring: |_|
Cortex: |_|

**III. PLATFORM**
Surface preparation: |_|
Surface shape: |_|
Exterior preparation: |_|
Exterior shape: |_|

**IV. EDGES**

**Edge 1**
Type: __________
Length: |_|_|_|
Position: |_|_|_|_|_|_|_|_|_|_|
1 2 3 4 5 6 7 8 9 0
Side: |_|
Invasiveness:
|_|_|_| |_|_|_| |_|_|_|
Edge angle:
|_|_|_| |_|_|_| |_|_|_|
Bit angle:
|_|_|_| |_|_|_| |_|_|_|
Step flaking: |_|_|_|
Retouch type: |_|
Other modification:____________
_______________________________
_______________________________

**Edge 2**
Type: __________
Length: |_|_|_|
Position: |_|_|_|_|_|_|_|_|_|_|
1 2 3 4 5 6 7 8 9 0
Side: |_|
Invasiveness:
|_|_|_| |_|_|_| |_|_|_|
Edge angle:
|_|_|_| |_|_|_| |_|_|_|
Bit angle:
|_|_|_| |_|_|_| |_|_|_|
Step flaking: |_|_|_|
Retouch type: |_|
Other modification:____________
_______________________________
_______________________________

**Edge 3**
Type: __________
Length: |_|_|_|
Position: |_|_|_|_|_|_|_|_|_|_|
1 2 3 4 5 6 7 8 9 0
Side: |_|
Invasiveness:
|_|_|_| |_|_|_| |_|_|_|
Edge angle:
|_|_|_| |_|_|_| |_|_|_|
Bit angle:
|_|_|_| |_|_|_| |_|_|_|
Step flaking: |_|_|_|
Retouch type: |_|
Other modification:____________
_______________________________
_______________________________

**Edge 4**
Type: __________
Length: |_|_|_|
Position: |_|_|_|_|_|_|_|_|_|_|
1 2 3 4 5 6 7 8 9 0
Side: |_|
Invasiveness:
|_|_|_| |_|_|_| |_|_|_|
Edge angle:
|_|_|_| |_|_|_| |_|_|_|
Bit angle:
|_|_|_| |_|_|_| |_|_|_|
Step flaking: |_|_|_|
Retouch type: |_|
Other modification:____________
_______________________________
_______________________________

V. OUTLINE TRACING (on back of page)

Example of form used to record attributes.

## APPENDIX III

## AVAILABILITY OF RAW DATA

Original data from this study are available for research purposes, at cost, upon request. Artifact measurements will be furnished on 5.25 inch floppy disks. Data are in IBM/MS-DOS 3.11, ASCII text fixed format. Other disk and data formats might also be available upon request.

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