THESIS

DEVELOPING A FRAMEWORK FOR LATE QUATERNARY HUMAN PALEOECOLOGY IN CENTRAL ASIA: 2003-2004 INVESTIGATIONS AT ANGHILAK CAVE, UZBEKISTAN

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WE HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER OUR SUPERVISION BY JEFFREY A. ADAMS ENTITLED: DEVELOPING A FRAMEWORK FOR LATE QUATERNARY HUMAN PALEOECOLOGY IN CENTRAL ASIA: 2003-2004 INVESTIGATIONS AT ANGHILAK CAVE, UZBEKISTAN, BE ACCEPTED AS FULFILLING IN PART REQUIREMENTS FOR THE DEGREE OF MASTER OF ARTS.

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ABSTRACT OF THESIS

DEVELOPING A FRAMEWORK FOR LATE QUATERNARY HUMAN PALEOECOLOGY IN CENTRAL ASIA: 2003-2004 INVESTIGATIONS AT ANGILAK CAVE, UZBEKISTAN

Interdisciplinary archaeological investigations were conducted at Anghilak Cave in 2003 and 2004. The proximate goal of this research was to develop a reliable, chronometrically dated stratigraphic framework for the site by integrating concepts and methods from archaeology, geomorphology, and taphonomy into a single methodological and analytical framework. The ultimate goal was to use the stratigraphic framework to address a series of research questions concerning human paleoecology during the Late Quaternary. Two primary depositional units (Units 1 and 2) comprising five stratigraphic layers (Strata I-V) were excavated, identified, described, sampled and analyzed. A total of five AMS radiocarbon dates were obtained from charcoal samples ranging from 2,798 to 43,900 BP. Stratum IV produced three dates ranging from 27,310 to 43,900, and contained Mousterian artifacts, hominid skeletal remains, and a faunal assemblage dominated by medium ungulates, small animals, and tortoise. The results of this research indicate that Anghilak Cave was occupied during the Last Full Glacial (OIS 3) by hominids producing Mousterian stone tool assemblages. Subsistence ecology is characterized by intensive processing of medium ungulates, followed by small-game resources.

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CHAPTER 1. INTRODUCTION

The Uzbek-American Stone Age Project (UASAP) discovered Paleolithic artifacts in Anghilak Cave during archaeological test excavations in the summer of 2002 (Glantz et al. 2003). The site is a small east-facing limestone cave (Figure 1.1) located in the Kashkadariya Province of southeastern Uzbekistan (Figure 1.2). It is situated in the Karatube Hills, foothills of the Zerafshan Mountains, an extension of the western Tien Shan Range. The site represents the first new Paleolithic discovery in Central Asia in the last 30 years. The cave contains deposits that can contribute important information to our understanding of human evolution during the Late Quaternary period. The research comprising this thesis was carried out in conjunction with ongoing excavations at the cave. The goal of the UASAP is to provide further documentation of the Paleolithic settlement of Central Asia by conducting interdisciplinary archaeological investigations at Anghilak Cave and other localities in eastern Uzbekistan.

Figure 1.1. Overview of Anghilak Cave looking west. The depressions on the ridge in the mid-foreground are the remains of a Medieval Period village site. Photo by M. Glantz, July 2003.
Figure 1.2. Political and Physical Relief Map of Central Asia showing the location of Anghilak Cave (Map source: http://www.stantours.com/pics/ca_mn_map_top_xl.gif).

PURPOSE AND GOALS

The primary purpose of this research was to provide further support for the original interpretation of Paleolithic occupation and use of Anghilak Cave (Glantz et al. 2003). This interpretation was based on preliminary studies of lithic and faunal materials recovered during test excavations conducted in 2002 by the UASAP. These investigations were limited to test pits, but yielded a large lithic assemblage (n=485) with Middle Paleolithic affinities, including typical non-Levallois Mousterian points and denticulates, as well as a large but fragmentary faunal assemblage (n=>2,200), similar to those recovered from other Middle and Early Upper Paleolithic cave sites (e.g., Klein and Cruz-Uribe 2000; Speth and Tchernov 2002; Stiner 1994, 2005; Vishnyatsky 1999). At least five natural stratigraphic levels were noted and the potential for datable, stratified archaeological deposits appeared to be high.
The materials recovered during the 2002 test excavations provided ample evidence that the
cave contained substantial cultural deposits and warranted additional research and development
of a formal archaeological research design (Glantz et al. 2003). Several attributes of the deposit
were observed in the field that warranted further analysis to explain and to aid in the
interpretation of hominid use of the cave. Two critical aspects of future research included
controlled archaeological excavations and baseline geoarchaeological investigations.
Accordingly, the goals of this research were specifically developed to address aspects of the
proposed research at Anghilak Cave.

The proximate goal of this research was to develop a reliable, chronometrically dated
stratigraphic framework by integrating concepts and methods from archaeology, geomorphology,
and taphonomy, into a single methodological and analytical framework. These investigations
were guided by a set of five primary research questions:

- How did the cave form?
- How old are the cave’s deposits?
- What is the depositional history within the cave?
- How have the cave’s deposits weathered?
- What is the taphonomic history of the cave’s deposits?

Field investigations were conducted during two short seasons of fieldwork in the summers of
2003 and 2004, and approximately nine months of laboratory analysis guided by two preliminary
research projects regarding geoarchaeology (Adams et al. 2004) and taphonomy (Ritzman et al.
2004). Field investigations consisted of controlled archaeological excavations, artifact collection
and curation, grid excavation sampling, profile mapping, sediment descriptions, sediment
sampling, and photography. Laboratory investigations included AMS radiocarbon dating,
sediment analyses, taphonomic analysis of the faunal assemblage, archaeological data analysis,
preliminary faunal analysis, and a limited amount of lithic analysis. A discussion of the field and
laboratory results as they pertain to these research questions is presented in Chapter 6: Discussion and Synthesis with each bulleted question presented as a heading.

In addition to contributing to the UASAP research program in general, the ultimate goal of this research was to draw conclusions about human paleoecology at Anghilak Cave and in the Kashkadariya valley during the Late Quaternary. A series of research questions guided the investigation, including:

- When did Late Quaternary hominids use the cave?
- What activities appear to be represented?
- What inferences can be made about hominid subsistence ecology?
- How Does Anghilak compare to other Central Asian Paleolithic sites?

The deposits in Anghilak Cave contain the material and organic residues of past human activity that have been transformed by both biotic and abiotic factors operating within the cave (Binford 1983). Archaeologists study aspects of past human ecosystems by attempting to identify the cultural, physical, and biological processes that form these deposits (Butzer 1982). Studying the human ecosystem in the geologic past requires an interdisciplinary approach that links multiple datasets into an evolutionary framework aimed at reconstructing prehistoric lifeways (Binford 1964).

**CONCEPTUAL FRAMEWORK: ARCHAEOLOGY AS HUMAN PALEOECOLOGY**

Archaeologists are concerned with identifying and documenting the archaeological record to understand the myriad dynamic processes that created it (Binford 1968, 1983, 1989). The archaeologist’s goal is to theoretically bridge our knowledge and perceptions of the present to models and explanations of past human behavior and evolution. This has proven difficult both because contemporary archaeology has become a discipline of often compartmentalized specialist fields and because our knowledge of the archaeological record is limited by sampling bias at a
variety of scales. It has long been recognized that an integrated, interdisciplinary research design is essential for providing the links needed to bridge the gap between our knowledge of the present and our perceptions of the past (Binford 1964; Butzer 1966, 1971, 1975, 1982).

An interdisciplinary ecological approach to prehistoric archaeology was first developed in Scandinavia during the early part of the 19th century (Trigger 1989). Scandinavian archaeologists developed relative dating techniques, interdisciplinary research methodologies, and research questions concerned with the evolution of prehistoric lifeways. They believed that a vast amount of interdisciplinary data could be obtained from controlled archaeological excavations and that interdisciplinary investigations were necessary to fully interpret archaeological data and prehistoric lifeways. Early Scandinavian archaeologists, particularly Sven Nilsson and Jens Worsaae, brought more than just a scientific approach to archaeology; they can also be acknowledged for the pioneering development of a human paleoecological approach to archaeology. Their studies were interdisciplinary in nature and were concerned with understanding how prehistoric human populations technologically adapted to and interacted with their environments. These are the basic goals of ecology: the study of how organisms interact with one another and their environment (Begon et al. 1996). By the time of publication of Darwin’s Origin of Species in 1859, these pioneering interdisciplinary approaches to studying the past had also been formalized in Scotland and Switzerland, with relative dating techniques ultimately being adopted throughout the world. However, this ecologically oriented perspective was overshadowed by unilinear imperialistic and culture historical approaches through the latter portion of the 19th century and first half of the 20th century (Trigger 1989).

Ecological perspectives in archaeology began to form again in the middle of the 20th century through paradigmatic movements in cultural anthropology, such as functionalism and neo-evolutionism (Childe 1932; Clark 1952; Sahlins and Service 1960; Steward 1955; White 1959). These early unilinear approaches were concerned with the evolution of cultural systems and were strongly deterministic. Concurrently, paradigms in archaeology also shifted in the 1950’s, once
again toward the study of prehistoric lifeways and cultural processes (Caldwell 1959). This began the development of a new scientific approach for studying cultures as adaptive systems (Binford and Binford 1968). At the forefront of this new perspective, Lewis Binford (1964, 1968a, 1983) argued that the archaeological record was the direct result of cultural behavior and, therefore, it was possible to study whole cultural systems in the past given an appropriate theoretical framework and research design.

**Archaeology as Human Paleoecology**

“Paleoecology is the study of interactions of organisms with one another and with their environment in the geologic past” (Dodd and Stanton 1990).

Following this simple definition of paleoecology, human paleoecology can be defined as the study of interactions of hominid populations with other organisms and with their environment in the geologic past. This is typically accomplished by integrating a variety of interdisciplinary concepts, methods, and techniques into an archaeological research design (Butzer 1982). Stratified archaeological deposits contain both biotic and abiotic fossils that can provide information about past ecological community structure, food web interactions, and paleoclimatic change (Behrensmeyer et al. 1992; Butzer 1982). Biotic data derive from a variety of fossil materials, including faunal remains, insects, invertebrates, pollen, phytoliths, and plant macrofossils, while abiotic data typically derive from the sedimentary deposits that contain the fossils.

Paleoecologists study the fossils of the targeted species directly and then provide context for interpreting behavior and evolution by reconstructing paleoenvironments from interdisciplinary datasets (Behrensmeyer et al. 1992; Dodd and Stanton 1990). Human paleoecologists do the same thing, but they also have the advantage of studying the material remains of past human behaviors, such as artifacts, butchered faunal remains, intact activity areas, processed plant remains, or architecture. Linking the archaeological and fossil records with other proxy datasets
deriving from stratified archaeological deposits provides the necessary framework for interpreting, modeling, and testing hypotheses that explain both behavioral and biological evolution.

Karl Butzer’s *Archaeology as Human Ecology: Method and Theory for a Contextual Approach* (1982) provided one of the first comprehensive and cohesive outlines for an interdisciplinary human paleoecological perspective in archaeology. His contextual approach focuses on:

“… The study of archaeological sites or site networks as part of a human ecosystem. … Less concerned with artifacts than with sites, contextual archaeology focuses on the multidimensional expression of human decision making within the environment. And, without attempting to deal directly with ecological phenomena such as energy flows and food chains, it aims to stimulate holistic research by calling attention to the complex systemic interactions among cultural, biological, and physical factors and processes” (1982:7; emphasis added).

Following these three systems (cultural, biological, and physical), he defines the foundations of the ecological approach in three primary sub-fields that contribute primary data to a human ecological approach: including a) *geo-archaeology*, the study and interpretation of sediments and physical landscapes; b) *archaeometry*, the use of physical and chemical methods of measurement, including raw-material provenance, dating, and site prospecting; and c) *bioarchaeology*, the study of plant (archaeobotany) and animal remains (zooarchaeology) that reflect subsistence activities as well as biotic environments (Butzer 1982: xi).

In the last 25 years, archaeology has enjoyed the development and advancement of an evolutionary and ecological body of theory based on more than 100 years of ethnographic and ethnoarchaeological research among hunter-gatherer populations around the world (Bettinger 1991; Binford 1978, 2001; Gould 1978; Kelly 1995). This is accomplished by recognizing patterns of behavior as they correlate to a specified set of environmental variables, such as climate and productivity (Binford 2001; Kelly 1995). From this, archaeologists have been able to develop empirical models and hypotheses of human behavioral and biological evolution in the geologic past.
Defining Scales within a Human Paleoecological Framework

Paleoecologists study populations, communities, and ecosystems in the geologic past by integrating interdisciplinary methodologies into an evolutionary framework (Behrensmeyer et al. 1992). Archaeologists as human paleoecologists study human populations, their communities, and ecosystems in the geologic past by integrating interdisciplinary methodologies into an evolutionary framework aimed at identifying the cultural, physical, and biological processes that form the archaeological record (Bettinger 1991; Binford 1964; Butzer 1982). Exactly which combination of interdisciplinary concepts and methods are selected and integrated into the research design depends on the scale and nature of the questions being addressed.

The Paleolithic archaeological record is the direct result of human behavior during the Late Quaternary (Binford 1983). More specifically, the archaeological record consists of artifacts and food residues that have transitioned from the biosphere to the lithosphere (Lyman 1994; Rapp and Hill 1998). Therefore, studying the human ecosystem in the geological past requires an interdisciplinary research design that integrates concepts and methods from disciplines that are concerned with this dynamic process. In this thesis I have chosen to integrate archaeology, geomorphology, and taphonomy into a single analytical and methodological framework that allows the analysis of the human ecosystem at the biosphere level (archaeological and fossil records), lithosphere (cave geomorphology), as well as the “transitional” zone between the two (taphonomic history). Figure 1.3 illustrates a human paleoecological framework where the human ecosystem in the geologic past resides in this zone. Archaeologists as human paleoecologists study the human ecosystem in the geologic past at a variety of scales ranging from isotopes to landscapes (Binford 1964; Butzer 1982; Clarke 1977). The scale of any research design will be determined by the researcher, but the range of scales commonly employed by archaeologists can be summarized under three basic headings: including particulate, deposit, and landscape scales.
Figure 1.3. A human paleoecological framework and the scales of archaeological investigations. The three disciplines (archaeology, geomorphology, taphonomy) represent an interdisciplinary research design focused at the deposit scale.

For example, the landscape scale of investigations could consist of a regional analysis of settlement patterns and landscape ecology; the deposit scale may include pedology, geomorphology, and taphonomy; and the particulate scale may include bone surface modification, lithic analysis, and soil micromorphology. This study is focused primarily at the deposit scale of investigation. The deposit is the unit of analysis for geoarchaeologists working in caves and rockshelters (Farrand 2001; Stein 1987, 2001), and with the proximate goal of developing a stratigraphic framework this scale appeared to be the most appropriate.
Geoarchaeology: archaeology and the geosciences

"Geoarchaeology implies archaeological research using the methods and concepts of the earth sciences" (Butzer 1982:35).

Archaeology was born from, shares many methods with, and has long been integrated with the geosciences (Wheeler 1954). It is strongly empirical and adheres strictly to the principle of uniformitarianism. Since the archaeological record is a component of the earth’s surface and immediate sub-surface, all archaeological problems are inherently geoarchaeological problems (Goldberg et al. 2001; Rapp and Hill 1998). “Geoarchaeology,” as it were, hardly seems like a sub-discipline, rather than a necessary step toward interpreting the archaeological record. Regardless, geoarchaeology as a specified sub-set of archaeological science has been formally conceptualized, beginning in the 1960’s (Butzer 1966, 1975) and 1970’s (Davidson and Shackley 1976). There are several recent introductory textbooks that review the definition, history and purpose of geoarchaeology (e.g., Rapp and Hill 1998; Waters 1992). Today, geoarchaeologists do many different things, ranging from microscopic analysis of sediment micromorphology to the GIS analysis of landscapes. In this thesis, two main segments of geoarchaeology are employed, including sedimentology and pedology.

For the geoarchaeologist working with buried archaeological materials in caves and rockshelters, the unit of analysis is the deposit (Farrand 2001; Stein 1987, 2001). Stein states, “[A deposit] is defined as a three-dimensional unit distinguishable in the field on the basis of observable changes in some physical properties” (2001:4). In general, deposits are comprised of sediments or particulate matter that was transported from one location to another, including not only sands, silts, and gravels, but also lithic artifacts, bones, seeds, etc. Taken as a whole, the composition, context, and distribution of these elements provide indirect proxy data for identifying the cultural, biological and physical processes that formed the deposit (Butzer 1982). Analysis of the deposit and the associations of particles comprising it is the job of the
The study of soils by archaeologists has been a common practice for at least 50 years (Cornwall 1958). This interdisciplinary integration came shortly after pedology was formally conceptualized (Jenny 1941). The archaeological record is often contained within soils – both at the surface and within ancient buried soils. Therefore, the archaeological record forms as a result of the same factors that influence the state of a soil. These factors include a complex interaction of physical, biological, and chemical processes, as well as cultural activities. Soils in a stratigraphic sequence contain information about the history and formation of deposits and thus, provide a very useful avenue of research for archaeologists. First, soils provide important contextual information for interpreting the archaeological record and, second, are useful as paleoenvironmental indicators (Holliday 1992). According to Birkeland: “A soil is a natural body consisting of layers (horizons) of mineral and/or inorganic constituents of variable thickness, which differ from the parent materials [i.e., sediments] in their morphological, physical, chemical, and mineralogical properties and their biological characteristics” (1999:2).

In this thesis, I will include many field and lab techniques and terminology borrowed from soil science under the single heading of geomorphology (Birkeland 1999). Determining the type and degree of post-depositional weathering processes is critical for interpreting the formation of the archaeological record.

**Taphonomy**

Taphonomy has become an integral component of most contemporary archaeological research design. The concepts and techniques of taphonomy have been applied to many different
problems and scales in archaeology, including the formation of ancient collapsed caves (Brain 1981), bison bonebeds (Todd 1987), and even landscapes (Burger 2002). Like geoarchaeology, or any other type of archaeological inquiry, taphonomy is concerned with the cultural, biological, and physical factors (or agents) and processes that contribute to the formation of the archaeological record or, the vertebrate fossil attributes of the record, in this case (Lyman 1994).

Taphonomy is defined as the study of the transition of organic materials from the biosphere to the lithosphere. The overall chronology of this “transition” is called the *taphonomic history*, which is the result of *taphonomic agents* and *processes* (Lyman 1994:3). Taphonomic agents are the source of the force that causes the modification of bone surfaces (e.g., a hominid or hyena), while taphonomic processes are the physical and dynamic actions created by the agents. Vertebrate skeletal remains are the primary materials considered in this thesis. Taphonomic analysis of faunal remains and identification of taphonomic processes provides information needed to identify the primary agents of bone accumulation at a given site (Lyman 1994). The macroscopic analysis of bone surface modifications can also provide indirect information regarding ecosystem structure and food web interactions (e.g., cut marks, carnivore tooth marks, and rodent gnawing). Finally, taphonomic analyses also provide information for reconstructing depositional history and identifying post-depositional weathering processes.

The goals of taphonomic analysis of faunal assemblages recovered from archaeological deposits differ from the goals of standard zooarchaeological analysis. Lyman (1994) lists two primary goals for each avenue of research. First, taphonomic research is aimed at “1) “stripping away” the taphonomic overprint from the fossil record to obtain accurate resolution of the prehistoric biotic community, and 2) determining the nature of the taphonomic overprint in order to be able to list the precise taphonomic mechanisms responsible for a given fossil assemblage, enabling the writing of taphonomic histories” (Lyman 1994:5). On the other hand, zooarchaeologists generally aim to 1) reconstruct hominid subsistence patterns and 2) reconstruct
paleoecological conditions (1994:2). These goals are beyond the scope of this study and will be addressed by collaborating specialists in the future.

CAVES AND ROCKSHELTERS

“These localities are extraordinary data sources for two fundamental reasons: they repeatedly provided permanent shelter for human groups, and they serve as fairly permanent post-depositional containers for the material residues of those human occupations” (Straus 1979:333).

Cave and rockshelter deposits have long been considered an important source of information for reconstructing the character and evolution of human ecosystems during the Late Pleistocene (Straus 1979, 1990). Around the world, caves have played a pivotal role in the development of archaeological method and theory (e.g., Brain 1981; Butzer 1981; Laville et al. 1980), particularly in karstic and arid regions. Caves and rockshelters provide a unique microhabitat and attract many different animals depending on time of day, season, or longer-term climatic episodes. Considering Straus’s (1979) reference to these geomorphological features as “sediment containers,” cave and rockshelter deposits often afford a more accurate reflection of these ecosystem interactions than do open air sites.

Caves and rockshelters also provide information important to paleoenvironmental reconstructions at both the local level and sometimes as regional markers. Woodward and Goldberg (2001) discuss the usefulness of cave and rockshelter sediments as archives of environmental change. They describe two characteristics of caves and rockshelters that determine their usefulness in this capacity: temporal resolution and environmental sensitivity (Woodward and Goldberg 2001:329). Sites that are limited in these characteristics are not likely to play an important role in developing regional stratigraphic networks. However, a detailed and rigorous analysis of a cave’s deposits is likely to yield important information about local conditions.
Bulk sediment analysis of cave and rockshelter deposits provides necessary information for reconstructing depositional history (Farrand 2001; Stein 2001) and identifying post-depositional weathering processes (Holliday 1992). French archaeologists pioneered the applications of particle size analysis (or granulometric analysis) to reconstructing depositional history in calcareous caves and rockshelters beginning in the 1950’s (Laville 1976). Since then, particle size or textural analysis is included in any basic geoarchaeological research design around the world, in both sheltered and open air sites. The differential frequency and distribution of coarse fragments and gravels are indicative of varying rates and modes of deposition, and alone can shed light on changes in depositional regime (Stein and Farrand 2001). Coupled with other physical and chemical attributes, changes in particle size distributions can reflect changes in climate, vegetation, and terrestrial ecology. Considering artifacts and bone fragments as particles within the deposit also lends to analysis of their physical attributes and spatial distributions.

Although caves and rockshelters have long been attractive landscape features and generally provide a protected environment for the long-term preservation of archaeological materials, they can also be very difficult to study. Unlike most open-air sites, cave and rockshelters present physical constraints (e.g., the mouth, cave walls, boulders) that can spatially limit the patterns of human behavior (Straus 1979). This is sometimes good because behavioral patterns are rarely predictable; however, in sites with slow rates of deposition and repeated occupations, palimpsest deposits and time averaging pose a difficult problem for interpreting specific behaviors and chronologies, particularly in small, shallow caves like Anghilak.

**THESIS STRUCTURE**

Chapter 1 provides an introduction to the thesis research and consists of an outline of the purpose and goals, and an overview of the conceptual framework that guides the investigations. The conceptual framework is subdivided into three main sections, archaeology as human paleoecology, geoarchaeology, and taphonomy (i.e., archaeology, geomorphology, and
taphonomy), following the three disciplines that were integrated into the research design. The structure of Chapter 1 is reflected in Chapters 4, 5, 6, and 7 of the thesis.

Chapters 2 and 3 provide the background and contextual information for the research. Chapter 2 provides a general literature review and regional overview of Central Asia, the Paleolithic archaeological record, and the Late Quaternary period. Chapter 3 provides a physical description of the cave and a more detailed overview of the immediate environmental setting surrounding Anghilak Cave, as well as a brief summary of previous investigations at the site.

Chapters 4 and 5 are both organized according to the three integrated disciplines: archaeology, geomorphology, and taphonomy. Chapter 4 summarizes the materials and methods selected, and Chapter 5 summarizes the results.

A discussion and synthesis of the results as they pertain to the bulleted points outlining the proximate goal of the research are presented in Chapter 6. The proximate goal was to develop a reliable stratigraphic framework for the site. The structure of the chapter follows the bulleted points presented in Chapter 1, with each bullet presented as a heading. It is structured as to provide the framework for the conclusions presented in the last chapter.

Finally, Chapter 7 is summary of the conclusions drawn from the bulleted questions outlining the ultimate goal of the research: to address basic questions about human paleoecology at Anghilak Cave and in Central Asia in general. Like the previous chapter, the structure of the Chapter 7 follows the bulleted points presented in Chapter 1, with each bullet presented as a heading. Chapter 7 also includes a brief summary of future research directions at Anghilak Cave and in the Kashkadariya Valley. Chapter 7 is followed by References Cited. Appendix A includes a Field Specimen Data Form, a Level Forms, and a list of level numbers and corresponding grid elevations. Appendix B includes other maps and profiles.
CHAPTER 2. CENTRAL ASIA, THE LATE PLEISTOCENE, AND THE PALEOLITHIC RECORD

“To what extent should Soviet Central Asia be regarded as marginal or peripheral to the Paleolithic world?” (Davis 1987:123)

Today, most political definitions of Central Asia include five nations: Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan. However, geographic definitions often include portions of northern Iran, northern Afghanistan, western China, Mongolia, southern Russia, and the Transcaucasian countries (Azerbaijan, Armenia, and Georgia). The region, particularly Kazakhstan, was under Russian influence as early as the 1820’s, and the entire region was under Soviet control between the 1920’s and the collapse of the U.S.S.R. in 1991 (Rashid 1994). In the Post-Soviet Era, they are now independent Republics. The history of this region includes some of the earliest literate agricultural civilizations and early trade routes between the East and West (e.g., The Silk Road). Today’s population is over 50 million, with nearly half concentrated in Uzbekistan. The archaeological record suggests that the genus *Homo* has been present in the region for at least 800,000 years (Ranov et al. 1995; Vishnyatsky 1999).

PHYSIOGRAPHY AND BIOGEOGRAPHY

Central Asia extends from the Caspian Sea in the west to the Tien Shan Mountains in the east and from the foothills of the Ural Mountains in the north to the high peaks of the Pamir and Kopetdag Mountains in the south (Figure 2.1)(Merzlyakova 2002; Vishnyatsky 1999). This area comprises extreme elevation gradients: from 28 meters below sea level on the surface of the Caspian Sea to almost 8,000 meters in the Pamir and Tien Shan mountains. There are three primary biomes that characterize the region: 1) low deserts in the central and southwest, 2) vast
semi-arid steppes in the north, and 3) high mountains in the east and southeast. Paleolithic archaeological materials have been reported from all three biomes (Vishnyatsky 1999:Figure 1).

The region comprises vast areas of internal drainage. Major rivers originate in the mountainous southeast and flow northwest, some emptying into the Aral Sea and Lake Balkash. Many of the river systems never reach these internal basins, disappearing into the vast arid plains. The biggest rivers and their tributaries, including the Amudariya, Zerafshan, Syrdariya, Ili, and Chu, traverse hundreds of kilometers of steppes and deserts. These critical water sources have long supported human populations in the region. The extensively irrigated, deep alluvial plains that extend onto the high steppes along the foothills are the mainstay of the economy and support the densest populations.

Figure 2.1. Physical and Political Map of Central Asia showing the location of Anghliak Cave.
Hot lowland deserts dominate the southwestern portions of the region, including southern Kazakhstan, central Turkmenistan, and western Uzbekistan. These include the Karakum, Kyzylkum, and Khorezm Deserts. The Taklamakan Desert of western China is sometimes considered the eastern margin. The region is flanked by high peaks and deep structural basins along its south and east margins.

The mountains of Central Asia formed as the result of continental collision between Eurasia and India – a process that began in the Late Cretaceous period, about 65 to 100 ma (Merzlyakova 2002:379). This includes three seismically active mountain complexes: the Kopetdagh in the south, the Pamir and Hindu Kush in the southeast, and the Tien Shan in the east.

The Kopetdagh, Pamir, and Hindu Kush formed contemporaneously with the Great Himalayas during the most intensive period of collision, the Alpine Orogeny beginning in the Miocene (26 – 12 ma)(Merzlyakova 2002:379). The Kopetdagh ranges formed as the Iranian Block moved northeast, relative to the Eurasian continent. They trend from northwest to southeast and, when aligned with the Caucasus, form a massive ridge from the Black Sea to the Hindu Kush. This ridge also forms the southern margin of the Caspian Depression. Several lesser ranges to the northeast follow this northwest-southeast pattern. These heavily eroded ranges extend southeast from the Aral Depression and converge with the Pamir and Tien Shan complexes in the southeast portion of the region. It is possible that these lesser ranges are considerably older than the Kopetdagh, formed as the result of earlier collision or movement between the Iranian Block and the Eurasian continent.

The Tien Shan and the Pamir are actively converging along their western flanks, but formed during different tectonic episodes (Merzlyakova 2002). This convergence zone is expansive and is characterized by high peaks, deep structural basins (e.g., Ferghana Valley, Tajik Depression, Taklamakan) and extensive foothill and piedmont complexes. The Tien Shan form an arc from southwest to northeast between Uzbekistan and western China, while the Pamir form a massive block at the western end of the Great Himalayan Arc. The formation of the Tien Shan is much
older than the Pamir; Merzlyakova (2002:379) states: “By contrast, the Tien Shan and mountains
of Kazakhstan are of an older age: they were formed by the convergence and collision of the
Siberian continent with the ancient massifs located south of the continent; eroded, being
transformed into a peneplain of the Kazakh Knolls type, and rejuvenated in the Cenozoic.” These
mountains have also continued to rise and are probably higher in elevation now than they were
during the Cenozoic.

Biogeographically, Central Asia exhibits marked contrasts between different physiographic
zones. The distribution and abundance of biota varies according to aspect, elevation, and
microclimatic conditions. Precipitation on the low desert plains is less than 10 cm annually,
while specific portions of the high mountains can receive over 150 cm annually (Merzlyakova
2002). As stated above, there are three primary biomes in Central Asia: including deserts,
steppes, and mountains. Vast steppes occupy the north, as well as foothill and plateau regions
adjacent to the mountains in the south and east. The arid desert plains occur in the southwest and
central portions and in structural basins in the east. The mountains support various forest
communities depending on elevation and aspect.

**THE LATE QUATERNARY PERIOD**

For about the last one million geologic years, the Quaternary Period is marked by long-term
climatic oscillations resulting in numerous glacial/interglacial cycles (Dansgaard 1985;
Dansgaard et al. 1993; Holliday 2001; Stringer and Gamble 1993). This period is called the
Pleistocene and the Central Asian Paleolithic archaeological record spans nearly the entire period
(Vishnyatsky 1999). However, most sites in the region date to the Late Pleistocene, particularly
the last 250,000 years. The few dated and well-documented sites from the region date to between
125 ka and 25 ka (Vishnyatsky 1999). The Late Pleistocene comprises Oxygen Isotope Stages
(OIS) 1 through 5, which span the period between from the Last Interglacial (LIG) to the Last
Glacial Maximum (LGM), or the Late Pleistocene.


**Oxygen Isotope Stages (OIS)**

The Late Quaternary consists of seven Oxygen Isotope Stages (OIS) that have been identified in the stratified layers of glacial ice (Dansgaard 1985; Dansgaard et al. 1993; Grootes et al. 2001) and deep-sea ocean floor cores (Shackleton and Opdyke 1973) from around the world. OIS 7 is the oldest and OIS 1 is the most recent. Even numbers represent cool and dry periods with low sea levels and advancing ice sheets and glaciers, while odd numbers represent warm and moist periods with elevated sea levels and receding ice sheets and glaciers. The isotope curves derived from ice and ocean cores are based on the change in the ratio between $^{16}$O and $^{18}$O (or, $\delta^{16/18}$O).

Figure 2.2 compares curves from OIS 1-5 (adapted from van Andel 2002). The following discussion follows the marine isotope stages described in deep-sea core V28-238 from the equatorial Pacific (Holliday 2001:Figure 1.2; Shackleton and Opdyke 1973; Stringer and Gamble 1993:Chapter 2). The more generalized curve is derived from deep-sea cores, while the higher frequency OIS 3 curve is derived from GISP2. OIS 7 (~250 – 186 ka) is described as having mainly temperate or cool conditions, occasional short glacial intervals, large oceans, and small ice caps. OIS 6 (186 – 128 ka) is a full glacial cycle with short, milder intervals. Stage OIS 5e (128 – 115 ka) is the last interglacial and is characterized by warm conditions comparable to today’s climate (see Figure 4). OIS 5a-d (115 – 71 ka) are characterized by moderately cool and temperate, but broadly fluctuating conditions. OIS 4 (71 – 59 ka) is a relatively short phase of slightly cooler and dry conditions that is consistent with the long term cooling trend exhibited by OIS 5 and 3. OIS 3 (71 – 24 ka) is characteristic of cool glacial conditions and expanding ice caps. Conditions were stable through OIS 3, but alternated between warm and cold phases on a centennial to millennial time scale (Grootes et al. 1993; van Andel 2002) Finally, OIS 2 (24 – 13 ka) marks the last glacial maximum, and is characterized by cold glacial conditions and depressed sea levels. The current interglacial, or OIS 1 (13 ka – present), has been arbitrarily divided from...
the Pleistocene and termed the Holocene, but is not unique relative to any other interglacial stage (Holliday 2001:9).

Figure 2.2. Comparison of ice core and deep-sea core isotope records of climate change during the Late Quaternary period (Adapted from van Andel 2002:Figure 4).

Central Asian Glaciations

Late Pleistocene glacial events in Central Asia have been correlated with events throughout Europe and Asia (Velichko and Spasskaya 2002). During the last glacial maximum, Central Asia would have fallen south of any major ice sheet, with glaciation limited to alpine zones in the east and southeast (Figure 2.3). Continuous permafrost covered the northern steppes of Kazakhstan, decreasing in depth toward the south. Moving south, there is a transitional zone, grading through discontinuous permafrost as far south as the margins of the Caspian Depression: then, through seasonal deep-freezing as far south as the southern margins of the Aral Sea. The southern regions, low desert plains and semi-arid steppe foothills, would have been only marginally
affected by freezing. However, the dynamics of the big river systems that drain through these areas would have been affected by advancing glaciers in the alpine regions where they originate to the south and east. Deposition and soil formation in the region were likely affected by changing climatic conditions, such that periods of soil development correspond to warm and moist interglacial periods, while cool and dry glacial periods are characterized by limited soil development and massive loess accumulations south of the ice sheets (Stringer and Gamble 1993:48). Massive loess accumulations were periodically deposited in the Tajik Depression throughout the Pleistocene, and several Lower Paleolithic assemblages have been discovered in the paleosol sequences spanning the Pleistocene (Ranov et al. 1995; Vishnyatsky 1999).

Figure 2.3. Map showing the extent of ground freezing during the Last Glacial Maximum (18 - 24 ka)(OIS 2). Earlier, more intense advances may have had more effect on the southern portions of the region (adapted from Merzlyakova 2002).
It is unlikely that seasonal freezing or permafrost affected the area surrounding Anghilak. Undoubtedly, the region experienced changes in climate and environment during these periods. Some Paleolithic researchers have argued that the lack of Upper Paleolithic assemblages in Central Asia was due to extremely cold and arid conditions during the Last Full Glacial and Last Glacial Maximum (OIS 2-3) leaving the region all but uninhabitable (Ranov and Davis 1979).

**THE CENTRAL ASIAN PALEOLITHIC**

The Paleolithic archaeological record of Central Asia and Uzbekistan spans the entire Paleolithic period (Ranov and Davis 1979). Few chronometric dates have been produced from previous investigations, and most Paleolithic sites have been identified and described on the basis of lithic technology and fauna (Vishnyatsky 1999). The Lower and Middle Paleolithic periods are relatively well represented throughout the region, while Upper Paleolithic period sites are few in number (Ranov and Davis 1979; Vishnyatsky 1999).

Several important sites have been investigated and described, particularly in Uzbekistan and Tajikistan. Russian and Uzbek researchers such as Boriskovsky, Derevianko, Islamov, Okladnikov, Ranov, and Suleymanov have contributed the primary data comprising the Central Asian Paleolithic archaeological record (Vishnyatsky 1999). Movius (1953) provided two of the earliest Russian to English translations of Paleolithic literature regarding Central Asia. A majority of the literature for the region is still published in Russian, but a few key English publications provide more recent syntheses (Davis 1987; Ranov and Davis 1979; Vishnyatsky 1999).

Most investigations in the past employed coarse-grained excavation methods, with analyses limited to culture historical reconstructions based on stratigraphic descriptions, lithic typology, and bone counts. Aside from recent and ongoing collaborative Uzbek, American, and Russian efforts (Adams et al. 2004; Burger et al. 2002; Derevianko et al. 2003; Glantz et al. 2002, 2003,
little interdisciplinary archaeological research has been conducted in Uzbekistan. Davis states:

“[T]he ecological systems approach, so common in Western archaeology, is not given much attention by the vast majority of Soviet archaeologists. Central Asia remains virtually free of any Soviet attempt to analyze its prehistory from a thoroughgoing ecological point of view.” (1987:130-131).

In the post-Soviet era however, this has begun to change. For example, Derevianko states about recent research in the Altai:

“Investigations of Paleolithic sites are interdisciplinary in character. Experts from many branches of knowledge, including geology, geomorphology, paleobotany, paleontology, paleopedology, anthropology, geophysics, geochronology, etc. from various academic and education institutions in Novosibirsk, Moscow, St. Petersburg, and other scientific centers have participated in the research. Such a complex and interdisciplinary approach assures collecting the fullest possible information concerning human cultural evolution and environment during the past 300,000 year.” (2001:70).

In the last few years, American researchers from the University of Arizona and Harvard have begun to collaborate with Russian teams at Obi-Rakhmat Grotto in Uzbekistan (Derevianko et al. 2003). Although these recent efforts have become methodologically interdisciplinary, they have changed little theoretically, still relying on multi-linear culture historical reconstructions based on variations in lithic technology and speaking little to the ecological systems approach. However, recent analysis of the faunal remains and a more integrated methodology will allow more detailed paleoecological reconstructions (Wrinn 2003).

These continued investigations, along with the discovery of typical Mousterian points, a hominid foot bone, and probable Paleolithic fauna in Anghilak Cave in 2002 has renewed interest in archaeological exploration in Uzbekistan. The Anghilak Cave site marks the first new Paleolithic discovery in the region in the last 30 years (Glantz et al. 2003). New discoveries and research are critical for our understanding of Paleolithic settlement patterns in Central Asia.
Lower Paleolithic

The Paleolithic archaeological record in Central Asia indicates hominid settlement and occupation of the region beginning at least 800 ka (Ranov et al. 1995). The Lower Paleolithic is represented by 21 sites, including numerous surface sites found throughout the region and a few firmly dated sites in the eastern portion of the region (Vishnyatsky 1999). The 21 Lower Paleolithic assemblages are characterized by two different lithic industries, including nine assemblages containing bifacial tools (hand axes) and 12 assemblages containing cores, flakes, and pebbles (Ranov and Davis 1979; Vishnyatsky 1999). These two industries have long been recognized among Paleolithic researchers and were originally described by Movius (1949, 1953) as being separated geographically (i.e., the Movius Line) with the hand axe tradition occupying the northwestern portions of Asia, and the core-and-flake tradition occupying the southeastern portions. Today, researchers still recognize the presence of two industries in Central Asia, and in general, bifacial industries occupy the northwest and pebble/flake industries occupy the southeast with some overlapping convergence (Vishnyatsky 1999:Figure 12). All of the stratified, well-dated Lower Paleolithic assemblages are from the southeastern portion of Central Asia and contain pebble or core-and-flake industries.

There are at least three important Lower Paleolithic sites that occur in the loess deposits of the Tajikistan Depression (Tajik Loess). Kuldara is the oldest known site in Central Asia and it is firmly dated at 800 to 900 ka within the Lower Pleistocene paleosols of the Tajik Loess (Ranov et al. 1995). It consists of only 40 pebble and flake tools that compare to other pebble industries associated with *Homo erectus* across Africa and Asia. The sites of Karatau I and Lakhuti are also localities within the paleosols of the Tajik Loess, but the absolute age of these deposits is not firmly dated. The paleosols containing the materials produced thermo-luminescence dates of 200 and 130 ka, but more recent investigations have correlated the paleosols with OIS 15 (600 ka) and 13 (500 ka)(Vishnyatsky 1999:89). These sites also yielded a pebble industry similar to Kuldara,
but far more abundant. Further north in the Ferghana Valley of Uzbekistan, Sel’ungur is a large cave that has produced Lower Paleolithic stone tool and faunal assemblages associated with possibly five stratified artifact-bearing layers. The deposits are dated to the Middle Pleistocene and have yielded a uranium-thorium date of 126 ka (Vishnyatsky 1999:94). This is the only Lower Paleolithic site that has yielded substantial faunal remains, including a variety of ungulates, carnivores, and rodents. Possible human remains were also recovered from Sel’ungur Cave, and have been described as belonging to a specialized variant of *Homo erectus* (Vishnyatsky 1999:94). Given a date from OIS 5, this interpretation may need to be reexamined (Michelle Glantz, Personal Communication).

**Middle Paleolithic: The Central Asian Mousterian**

Although the Middle Paleolithic archaeological record is seemingly rich and many key sites have been investigated, Central Asia continues to be considered marginal, peripheral, or intermediate to other regions, particularly the Levant and the Altai (Bar-Yosef and Pilbeam 2000; Chard 1974; Derevienko et al. 2001; Okladnikov 1988). A reference to the region, specifically to the juvenile hominid remains found in Teshik-Tash Cave in Uzbekistan, can be found in nearly any Middle to Upper Paleolithic literature found in introductory textbooks, articles, and popular books (e.g., Stringer and Gamble 1993:preface)(Ranov and Davis 1979). However, the limited amount of archaeological exploration in remote areas of Central Asia has marginalized the region to the point that researchers perceive it as a “transitional bridge” connecting other better explored regions, such as the Levant and the Altai (e.g., Derevianko et al. 2001:42). Until these obvious biases are realized among Paleolithic researchers, models of hominid behavioral and biological evolution in Central Asia during the Late Quaternary will remain limited by these interpretations.

The record of Middle Paleolithic hominid settlement and subsistence in Central Asia is characterized by typical Mousterian stone tool assemblages and faunal assemblages dominated by ungulates (Vishnyatsky 1999). Dozens of Mousterian sites have been documented across Central
Asia, and approximately half of them occur in the southeastern portions of the region, including portions of Uzbekistan and Tajikistan (see Vishnyatsky 1999:Figure 1). A few key sites in southeastern Uzbekistan include the cave sites of Obi-Rakhmat, Aman-Kutan and Teshik-Tesh, and the open air sites of Kuturbulak and Kulbulak.

Until recently (Vishnyatsky 1999), most Paleolithic researchers have believed that Central Asian Mousterian lithic industries exhibit a high degree of variability (Bar-Yosef and Pilbeam 2000; Derevianko 2001; Gamble 1999; Ranov and Davis 1979; Suleymanov 1972). In an attempt to explain the variability, Ranov and Davis (1979:256) proposed four subdivisions or variants of the Central Asian Mousterian: including Levallois, Levallois-Mousterian, Typical (Mountain) Mousterian, and Mousterian of Soan Tradition. However, Vishnyatsky (1999) argues that there is no reason to divide the Mousterian into culture historical units representing different cultural groups, but instead to consider the region as a single technological entity, appropriate for interregional comparison. Further, he states “… the differences between the Mousterian assemblages of Central Asia appear (when considered against the background of common features) so insignificant and casual that there is no incentive to try to divide them into “variants,” “types,” or “facies”” (Vishnyatsky 1999:108-109). Rather than dwell on poorly inventoried intra-regional variability, he points out important similarities between the Central Asian Mousterian with surrounding regions, such as the Zagros-Taurus, the Levant, and the Altai.

Faunal assemblages associated with Mousterian stone tool assemblages are typically dominated by ungulates, such as wild goat and sheep (*Capra sibirica* and *Ovis orientalis*), followed by red deer (*Cervus elaphus*), roe deer (*Capreolus* sp.), and also by tortoise (*Testudo horsfieldi*) and horse (*Equus caballus*)(Ranov and Davis 1979; Vishnyatsky 1999). Common carnivore bones found in cave sites include specimens from brown bear (*Ursus arctos*), leopard (*Felis pardus*), cave hayaena (*Hyaena crocuta spelaea*), wolf (*Canis lupis*), and golden jackal (*Canis cf. aureus*). Occasional remains of hare (*Lepus tolai*), porcupine (*Histrix* sp.), and wild
Equus hemionus) are also encountered. In addition, a variety of rodents and other small mammals have been reported.

Two key Mousterian sites in southeastern Uzbekistan include Teshik-Tash and Obi-Rakhmat Grotto. In 1938-39, the deposits at Teshik-Tash were completely excavated in two field seasons (Movius 1953). The lithic assemblage consisted of very few resharpened tools made from poor quality raw material. The most important discovery at Teshik-Tash Cave was the juvenile hominid remains popularly interpreted as a Neanderthal burial (Movius 1953; Stringer and Gamble 1993). This discovery expanded the geographic range of Neanderthal remains and further confirmed the association of Mousterian industries and Neanderthal populations (Gamble and Roebroeks 1999; Stringer and Gamble 1993). The faunal assemblage was typical, with a predominance of medium ungulates followed by small-game and tortoise. These early investigations in the region yielded no chronometric dates. The deeply stratified deposits at Obi-Rakhmat contain possibly the longest sequence and largest Mousterian assemblage in the region (Derevianko et al. 2001, 2003; Suleymanov 1972). Recent investigations have yielded a series of AMS dates ranging from about 41,000 to 48,000 BP from the upper half of the deposits (Derevianko et al. 2003). Fauna at the site are typical of cave assemblages with a strong dominance of ungulates (Wrinn 2003).

Two important Mousterian sites in the Tajik Depression include the open air site of Khudji and the cave site of Ogzi-Kichik (Vishnyatsky 1999:90-91). At Khudji, cultural materials were contained within the loess loams of the Dushanbe Complex and consisted of a typical Mousterian lithic industry and a typical faunal assemblage. This site yielded a radiocarbon date of 38,900 BP from a charcoal sample recovered from the cultural level. The cave of Ogzi-Kichik contained a large Mousterian lithic assemblage and a faunal assemblage dominated by tortoise (Testudo horsfieldi) and then wild goat and sheep (Capra and Ovis). Other interesting fauna at the cave included Pleistocene ass (Equus hydruntinus?) and woolly rhinoceros (Coelodonta
antiquitas?) (Vishnyatsky 1999:91). Ogzi-Kichik also yielded two radiocarbon dates of 15,700 and 30,000 BP, possibly suggesting that the deposits were mixed.

Following his discussion of the Central Asian Mousterian variability and comparison with surrounding regions, Vishnyatsky makes four important observations or assumptions:

“… (1) the probability of a relatively late age for the Central Asian Mousterian sites, (2) their association with Neanderthals (at Shanidar and Teshik-Tash), (3) the total absence in Central Asia of any clear predecessor from which this industry could have evolved, and (4) the similarity of the Zagros-Taurus, Trans-Caspian, and Altai stone assemblages ...” (1999:111-112).

From these observations, he then proposes two hypotheses to explain the relatively high frequency of Mousterian sites and the movement of Neanderthals into Central Asia from the west: 1) Central Asian sites occupied by Neanderthals moving east, and 2) a result of either successful adaptation or a forced retreat under pressure from another expanding population (i.e., modern humans) (Vishnyatsky 1999:112). Of course, this model assumes that 1) Neanderthals were coming from the west and not evolving from dispersed in situ populations; and 2) these populations were not anatomically modern humans.

**OIS 3: The Middle to Upper Paleolithic “Transition”**

Everywhere in the Paleolithic and Stone Age archaeological world – from the Iberian Peninsula to the Altai and from Russia to South Africa – there are clear and significant changes in human behavior and biology following the Last Interglacial period (OIS 5) (Bar-Yosef 1998, 2002; Binford 1989b; Klein 1989, 1995, 2000; McBrearty and Brooks 2000). This change manifests in the archaeological record of the Mediterranean Basin (Europe and western Asia) around 40,000 BP, in the form of techno-typological changes (Bar-Yosef and Kuhn 1999), diversification of subsistence strategies (Klein and Cruz-Uribe 2000; Speth and Tchernov 2002; Stiner et al. 1999, 2000), and cognitive developments allowing increased social complexity, as well as the manufacture of sophisticated art objects (e.g., Venus figurines) and expressions (e.g., cave paintings) (Bar-Yosef 1998, 2002; Binford 1989b; Gamble 1986; Klein 1989, 1995, 2000).
These evolutionary changes correspond to the cool conditions of the Last Full Glacial (OIS 3), when conditions were locally unstable and exhibited strong centennial and millennial scale warm and cool fluctuations (Dansgaard 1985; Dansgaard et al. 1993; van Andel 2002). A discussion of observed behavioral and biological changes in the Paleolithic archaeological record during OIS 3 is important to Central Asian research because many of the radiometric dates associated with Mousterian industries from the region correspond to marked changes observed in the record of the Mediterranean Basin.

This pattern is often referred to as the “human revolution” (see Mellars and Stringer 1989), and this explanatory model proposes that these changes in behavior occurred rapidly and simultaneously throughout the entire Old World over a relatively short period of time. However, McBrearty and Brooks (2000) argue that the observed changes in human behavior that comprise the “human revolution” are actually observable in various forms and locations throughout Africa for tens-of-thousands of years prior to the appearance of this pattern in the Mediterranean archaeological record; and therefore, that “modern human behavior” evolved in Africa and was then exported to populations in Europe and western Asia during the population expansion characteristic of this period (Bar-Yosef and Pilbeam 2000). McBrearty and Brooks (2000:534) further argue that the “human revolution” model is limited by Western ethnocentrism because it ignores the patterns observable in the African record and places emphasis on European and Levantine Mediterranean origins (e.g., Bar-Yosef 1998, 2002).

Our perceptions of this period are strongly rooted in a culture historical paradigm; the observed variability has been accounted for by categorizing assemblages (often arbitrarily) into homogeneous types, variants, and facies that are used to earmark different prehistoric human populations, such as Neanderthals and anatomically modern *Homo sapiens*. The presence of a significant change in both technology and subsistence during OIS 3 is generally accepted, but the character, timing, and origin of these evolutionary changes are variable and remain in debate.
Technology

The observed changes in the character of lithic industries during OIS 3 is popularly perceived as the “transition” from the Middle to the Upper Paleolithic, and is characterized by the increasing ubiquity of laminar or blade-based reduction strategies (Bar-Yosef and Pilbeam 2000; Derevianko et al. 2001; Gamble 1999; Hoffecker 2002; Svoboda 2001). However, laminar reduction techniques have been observed throughout the Middle Paleolithic, possibly as old as 300 ka, in assemblages from far distant regions, such as the Levant, Europe, and the Altai (Bar-Yosef and Kuhn 1999; Derevianko 2001). In Central Asia, Vishnyatsky (1999:112) argues that Upper Paleolithic assemblages exhibited “a marked retention of Middle Paleolithic elements … in typology and technology” as opposed to the more traditional view that many Middle Paleolithic assemblages exhibit laminar industries indicative of the Upper Paleolithic.

The presence and frequency of these assemblages are highly varied through time and space; they seem to emerge and subside locally, until about 35-40,000 BP, when they come to dominate the archaeological records of western Eurasia and Africa (Bar-Yosef and Kuhn 1999:322). In Central Asia, Derevianko et al. (2001) reports this change occurring between 40-50,000 BP, with the “transitional” period beginning as early as 100 ka. More importantly, Bar-Yosef and Kuhn (1999) argue that laminar or blade-based reduction strategies alone are not indicative of the transition from Middle to Upper Paleolithic. Instead, they argue that the frequency and abundance of composite tools and the increased use of soft hammer and pressure flaking techniques in the production of blades is more important for identifying the transition than just the presence of blades.

This shift also roughly coincides with important changes in the fossil and faunal records. However, Bar-Yosef and Kuhn state, “there is no justification in maintaining that the development of laminar lithic technologies per se is linked to the appearance of either modern anatomy or ‘modern’ behavior” (1999:323). The debate in archaeology concerning the transition from Middle to Upper Paleolithic is as heated and sometimes as disparate as the debate among
paleoanthropologists about “modern” human origins. This is certainly because both debates are faced with the same basic problem – the inability to directly observe human behavioral or biological interactions in the past. We are limited to making inferences from the information that we glean from the archaeological and fossil records and, therefore, must be cautious when considering models that explain behavioral and biological evolution during the Late Pleistocene.

The lithic assemblage recovered from Obi-Rakhmat is the longest sequence and most thoroughly studied in the region (Derevianko et al. 2001, 2003; Suleymanov 1972). It has been described as a “transitional” assemblage dating to the earliest Upper Paleolithic, with AMS dates recently acquired from the upper half of the deposits ranging from about 41 and 48 ka (Derevianko et al. 2001). Derevianko et al. (2001:59) suggest that human occupation of the cave may have started during the final Riss-Wurm interglacial, at the end of OIS 5, and that the stone tool sequence from Obi-Rakhmat “indicate[s] the gradual replacement of the Levallois stone reduction strategy by a blade stone knapping technology, and Mousterian tool types tend to be replaced by Upper Paleolithic forms.”

Suleymanov (1972) proposed a similar linear evolutionary model of technological change based on a thorough statistical analysis of the Obi-Rakhmat technological sequence. He described an in situ evolution of technology grading through five progressive stages, but occurring within a single homogeneous cultural tradition (Derevianko 2001:53). Most Russian scholars also use the culture historical approach to define the stratified assemblage from Obi-Rakhmat as representative of the “Obi-Rakhmat Transitional Culture” (Derevianko et al. 2001). Based on a culture historical comparison of several “transitional” assemblages from Southwest Asia (Levant), Central Asia (Obi-Rakhmat), and the Altai, Derevianko et al. argue that the evidence support “hypotheses based on the gradual development of Upper Paleolithic industries out of local Middle Paleolithic parallel reduction strategies” (2001:61-62). It seems little has changed with Russian culture historical interpretations since Davis (1987) criticized them for
employing a Marxist multi-linear, progressive evolution. This pertains to perceptions of the Lower, Middle and Upper Paleolithic of Central Asia.

As this discussion indicates, changes and variability in the character of Paleolithic stone tool assemblages during OIS 3 are well documented across the Paleolithic Old World. However, changes observed in western Asia, Europe, and Africa, do not occur in Central Asia at the same time, or perhaps at all (Ranov and Davis 1979). Very little research has been conducted east of the Caspian that attempts to explain the cause and mechanisms of the observed changes.

**Subsistence strategies**

Changes observed in lithic industries and cognition during OIS 3 are also paralleled by changes observed in the faunal or fossil record at deeply stratified archaeological sites in the Mediterranean Basin (Stiner 1994, 2005). According to Stiner et al. (1999, 2000), the transition from Middle to Upper Paleolithic lithic industries occurs at 44,000 BP in the Levant and at 36,000 in Italy. They analyze small-game faunal assemblages from stratified Paleolithic deposits in Italy and the Levant and demonstrate that changes observed in material culture are also accompanied by a shift in diet, subsistence strategies, and food web interactions. The results of these analyses demonstrated that with the expansion of hominid populations during OIS 3, also came an expansion of their foraging niche. During the late Middle Paleolithic, faunal assemblages are dominated by ungulates and then small, slow moving small-game species such as tortoise (*Testudo horsfieldi*) and a great variety of shellfish. At the beginning of the Mediterranean Upper Paleolithic, small-game assemblages come to be dominated by fast moving small-game species such as hares (*Lepus capensis*), partridges (e.g., *Alectoris chukar, Perdix perdit*, *Coturnix coturnix*), and rabbits (*Oryctolagus cuniculus*) (Stiner et al. 1999:191). It is then argued that this niche expansion corresponds to a population expansion and dispersal. They conclude:

“… 1) early Middle Paleolithic populations were exceptionally small and highly dispersed, 2) the first major population growth pulse in the eastern Mediterranean probably occurred before the end of the Middle Paleolithic, and (3) subsequent
demographic pulses in the Upper and Epi-Paleolithic greatly reshaped the conditions of selection that operated on human subsistence ecology, technology, and society.” (Stiner et al. 2000:39).

In Central Asia, faunal assemblages appear to be very similar across the region (Bibikova 1958; Ranov and Davis 1979; Ritzman et al. 2004; Vishnyatsky 1999; Wrinn 2003); however, only limited zooarchaeological analyses have been conducted to date, and many artifact recovery methods did not accommodate small animal bones or fragments. True Upper Paleolithic stone tool assemblages are few in number and faunal assemblages associated with them are rare. The long faunal series at Obi-Rakhmat is ideal for studying the evolution of diet, subsistence strategies, and food web interactions during OIS 3-5 in Central Asia (Wrinn 2003).

**The Human Fossil Record**

Although no Lower Pleistocene hominid fossils have yet been discovered, the antiquity of early stone tool industries, perhaps 800 ka (Vishnyatsky 1999), suggests that hominid populations had dispersed into Central Asia shortly after 1.0 million years ago (ma). This corresponds to the dispersal of *Homo erectus* out of Africa and across the lower latitudes of Asia. The archaeological evidence for hominid populations residing in Central Asia during the Lower and Middle Pleistocene is sparse, but does indicate a sporadic and continuous use. Based on the frequency of Mousterian assemblages dating to the Late Pleistocene (OIS 3-4), there appears to have been a substantial expansion and dispersal of hominid populations throughout Central Asia during this period. In radiometric terms, a Mousterian population expansion in Central Asia during OIS 3 would correspond to the transition from Middle to Upper Paleolithic stone tool industries, diets, subsistence strategies, and cognitive behavior observed in the Europe and the Mediterranean Basin (Bar-Yosef 1999; Stiner et al. 1999). Hominid expansions in Central Asia during OIS 3 also coincide with the gradual disappearance of the “classic” Neanderthal morphological pattern, and with the emergence of modern human skeletal morphology in the fossil records of Europe and the Levant (Bar-Yosef and Pilbeam 2000; Stringer and Gamble 1993).
Many researchers (e.g., Davis 1987, Derevianko 2001), including Darwin himself, have argued that the origins of modern human anatomy and behavior would be discovered in Asia. However, most Western researchers embrace the model of African or Levantine origins supported by a vague conception of the replacement model (Bar-Yosef and Pilbeam 2000; Gamble and Roebroeks 1999; Hoffecker 2002). Again, this model appears to be a reflection of the geography of fossil and archaeological discoveries, and perhaps of Western ethnocentrism (see McBrearty and Brooks 2000), more than a biological model explaining microevolution. If there is only one region of origin and, if we can actually identify what ‘becoming modern” looks like in the fossil and material records, its discovery or realization is not likely to happen with major geographic regions remaining largely unexplored or underrepresented in the archaeological literature.

Since the 1938 discovery of the juvenile hominid skeleton at Teshik-Tash (Movius 1953), Central Asia has played an important role in the debate regarding interactions between hominid populations during the Late Pleistocene. This discovery has led to both a popular belief and an archaeological model, demarking Central Asia, particularly Uzbekistan, as the eastern-most periphery of known Neanderthal range (Schwartz and Tattersall 2001; Stringer and Gamble 1993). Weidenreich (1945) and others (e.g., Glantz et al. 2004) have argued that the specimen exhibits mixed morphological features (i.e., Neanderthal and anatomically modern *Homo sapiens*). If these observations are correct, the region has even greater importance for the debate surrounding taxonomic classification and the ecology of hominid populations during the Late Pleistocene.

In addition to the juvenile hominid fossil remains from Teshik-Tash, hominid remains have been recovered from four sites (Teshik-Tash, Shanidar, Anghilak, Obi-Rakhmat) across Central Asia that also contained Mousterian stone tool assemblages (Derevianko et al. 2004; Glantz et al. 2004; Movius 1953; Solecki 1963; Trinkaus 1983). The Shanidar specimens are irrefutably Neanderthal in their skeletal morphology (Trinkaus 1983), and many other specimens also exhibit Neanderthal morphological patterns (Movius 1953, but see Weidenreich 1945 and Glantz et al.
Whether the Mousterian stone tool industries of Central Asia were carried by Neanderthals, modern humans, or some combination thereof, it will continue to be a central theme in studies of prehistoric Central Asia. Recently acquired radiometric dates (Adams et al. 2004; Derevianko et al. 2004; Glantz et al. 2006) indicate that there were hominid populations inhabiting the area during the Late Pleistocene, particularly during OIS 3 or the Last Full Glacial.

As more research is conducted in Central Asia, the region will play an increasingly important role in the debate between researchers arguing in favor of multi-regional evolution vs. population replacement models. It seems that the region’s perceived “transitional” or “peripheral” status is simply a reflection of the limited field exploration, discovery, and documentation when compared to other regions such as the Levant and Altai. With new fossil discoveries at Obi-Rakhmat Grotto (Derevianko et al. 2004) and Anghilak Cave (Glantz et al. 2004) current perceptions of Central Asia’s role in the debate is likely to change considerably in the near future.

**Upper Paleolithic**

From a Western techno-typological perspective, the Upper Paleolithic is very poorly represented in Central Asia (Vishnyatsky 1999), and may not be present at all during the extremely cold, arid conditions of the Last Glacial Maximum (OIS 2)(Ranov and Davis 1979). Although changing through time, stone tool assemblages dated to the early Upper Paleolithic period (OIS 3) retain a dominance of Middle Paleolithic (i.e., Mousterian) affinities (Derevianko et al. 2001; Glantz et al. 2006). This indicates a late age for the Mousterian in Central Asia (Vishnyatsky 1999) and a possible decline in population densities during the Last Glacial Maximum (OIS 2: 18-24 ka)(Ranov and Davis 1979).

Several Upper Paleolithic sites have been identified in the Zerafshan Basin, including the intensively investigated open-air site of Samarkandskaya that is located within the limits of the city of Samarkand. Approximately 1,000 m² have been excavated at the site since 1939 and large lithic and faunal assemblages have been recovered (Vishnyatsky 1999). In contrast to Middle
Paleolithic sites dominated by ungulates and small animals, the faunal assemblage from Samakandskaya was dominated by large mammals such as horse (*Equus* cf. *przewalskii*), the Pleistocene ass (*Equus hydruntius*), and aurochs (*Bos primigenius*), as well as lesser frequencies of camel (*Camelus koblochi*), red deer, (*Cervus elaphus*), steppe sheep (*Ovis arcal*), gazelle (*Gazella subgutturosa*), wild boar (*Sus scrofa*), wolf (*Canis lupis*), and wild ass (*Equus hemionus*). There are anatomically modern Homo sapiens fossil specimens from the site, but their context is unclear and may be intrusive. The site has not yielded a radiometric date and the lithic assemblage has not been thoroughly analyzed or reported. Vishnyatsky (1999:87) describes the deposits as “a palimpsest of occupational episodes widely spaced in time (from the middle to the final Late Pleistocene) and associated with different cultural traditions.” Further exploration and excavations supported by radiometric dates are necessary to develop a reliable chronology for the Upper Paleolithic in Central Asia.

Although a few sites are dated to the early Upper Paleolithic, there is a general lack of later Upper Paleolithic assemblages when compared to the overall increased frequency of these assemblages during OIS 3 in the Mediterranean Basin. It is likely that hominids were present during the part of OIS 3, but the questions still remains: Did hominin populations disperse or disappear during the cold and arid conditions of the Last Glacial Maximum (OIS 2)? Or, is the lack of truly Upper Paleolithic stone tool assemblages dated to this period the result of limited archaeological exploration and a bias toward caves. One possible scenario that has not been considered is that hominin populations relied less on rockshelter and cave sites, and more intensively exploited open air sites, such as floodplains and stream terraces.

**SUMMARY AND CONCLUSION**

Central Asia is a vast region comprising hot lowland deserts in the southwest, dry steppes in the north, and foothills and mountains in the southeast. The Paleolithic archaeological record spans at least 800,000 years (Ranov et al. 1995) and is present in all three primary biomes, with
more than half of the total number of sites located in the more mountainous southeastern portion of the region (i.e., Uzbekistan and Tajikistan) (Vishnyatsky 1999:Figure 1). Although the region has not been subject to thorough systematic archaeological surveys, there are at least 21 known Lower Paleolithic sites, and more than 40 cave and open-air sites containing Middle Paleolithic assemblages (Vishnyatsky 1999). Hominid fossil remains have been recovered from four sites (i.e., Teshik-Tash, Shanidar, Anghilak, Obi-Rakhmat) across Central Asia that also contained Mousterian stone tool assemblages (Derevianko et al. 2004; Glantz et al. 2004; Movius 1953; Solecki 1983; Trinkaus 1983). The Shanidar specimens are irrefutably Neanderthal in their skeletal morphology (Trinkaus 1983), and many other specimens also exhibit Neanderthal morphological patterns (Movius 1953, but see Weidereich 1945 and Glantz et al. 2004). Recently acquired radiometric dates associated with Mousterian assemblages (Adams et al. 2004; Derevianko et al. 2003; Glantz et al. 2006) indicate that there was a substantial hominid population inhabiting the area during the Late Pleistocene, particularly during OIS 3 or the Last Full Glacial.

The Last Full Glacial (OIS 3) period also comprises the emergence of modern human behavior and skeletal morphology (Bar-Yosef 1998, 2002; Klein 1989, 1995; McBrearty and Brooks 2000), when Upper Paleolithic stone tool industries come to dominate the record in western Asia, Europe, and Africa. Unlike these regions to the west, there is a lack of Upper Paleolithic stone tool industries in Central Asia from the Last Glacial Maximum (OIS 2) to the Terminal Pleistocene and early Holocene (OIS 2/1), and Middle Paleolithic stone tool attributes are retained in assemblages dating to the early Upper Paleolithic period (Vishnyatsky 1999). This indicates a late age for the Mousterian in Central Asia and a possible decline in population densities during the Last Glacial Maximum (OIS 2: 18-24 ka). Future investigations, such as Uzbek-American Stone Age Project and the research presented in this thesis, are likely to contribute significant information to our knowledge and perceptions of the Middle Paleolithic settlement of Central Asia.
CHAPTER 3. THE SETTING

Artifacts were discovered in Anghilak Cave (Figure 3.1) in May of 2002 by archaeologists with the Uzbek-American Stone Age Project (UASAP) while conducting a survey of caves in the Kashkadariya valley (Glantz et al. 2003). The cave is set at 796 m above mean sea level among rugged limestone mountains that extend northwest from the Zerafshan Range. It is located in the Kashkadariya region of southeastern Uzbekistan, about 50 km (30 mi.) northwest of the towns of Kitab and Shahrisabz. Artifacts were observed on the surface and the potential for buried deposits appeared good. The site is relatively easy to access by car, with only a short hike up the steep talus slope to reach the cave.

Figure 3.1. View of Anghilak Cave looking northwest. Photo by J. Adams (July 2003).
In June and July of 2002, the UASAP team, co-directed by Dr. Michelle Glantz, Colorado State University, and Dr. Suleymanov, National University of Uzbekistan, excavated two test units in the back portions of the cave. These units included a 1 x 2 m test pit excavated to about 145 centimeters below the ground surface (cmbs) and a 1 x 1 m test pit excavated to about 50 cmbs. Each 1 x 1 m square was trowel-excavated in 50 x 50 cm quadrants and in 10 cm arbitrary levels measured below the modern ground surface. The upper 20 to 30 cm was removed prior to screening. All other sediments were screened through ¼” mesh hardware cloth and then picked for artifacts in the field. All items greater than 5 cm in maximum length that were found in situ were mapped and recorded. All materials observed were collected and are stored at the Institute for Archaeology in Samarkand.

The test units produced a total of 485 lithic artifacts and more than 2,200 bone fragments (Glantz et al. 2003). Lithic materials consisted of hundreds of debitage and several tools, including typical Mousterian artifact types (e.g., points and denticulates)(Figure 3.2). Bone accumulations were dense and consisted of highly fragmented remains from many vertebrate taxa: including tortoise (Testudo horsfieldi), a variety of small mammals, carnivores (e.g., Canids and Ursids), small ungulates such as roe deer (Capreolus capreolus), medium ungulates such as mountain sheep/goat (Capra sibirica), large ungulates such as red deer (Cervus elaphus), and possibly larger (possibly Equus sp., Camelus sp., or Bos sp.). A cursory examination of the faunal assemblage indicated that some of the fragments exhibited evidence of fresh breakage patterns indicative of human butchery.

A fifth right human metatarsal (Figure 3.2) was recovered from a dry screen sample and identified in the laboratory (Glantz et al. 2004). The bone was found in two pieces and refitted in the laboratory. The bone was recovered from the test unit corresponding to N93/E93 within the grid excavation. It was bagged in the general dry screen sample from 40 to 50 cmbs. This depth corresponds to Stratum IV, which is now chronometrically dated and described in this thesis. It also contained the typical Mousterian point illustrated and at lower left in Figure 3.2.
Figure 3.2. Artifacts and AH-1, a hominid right 5th metatarsal from the 2002 test excavations (From Glantz et al. 2003; Glantz et al. 2006).
CAVE GEOMORPHOLOGY

Anghilak is a relatively small east-facing cave, measuring about 8 m wide at the drip line, by about 8 m deep from the cave mouth to the back wall (Figures 3.3 and 3.4). It is more similar to a rockshelter in size and shape. However, the cave can be defined as a passive karst cave formed as the result of bicarbonate solution in joints and fissures of Lower Devonian Limestone (Woodward and Goldberg 2001; Gillieson 1996). Following Courty and Vallverdu (2001:Figure 7), the current conditions at Anghilak can be classified as a Type 1 system characterized by long-term drying, external soil deflation, and strong winds. Today, net-loss of sediment predominates, but minor accumulations from allogetic eolian inputs are present.

Figure 3.3. Anghilak Cave facing southwest (Photo J. Adams, July 2003).

It is likely that the cave formed after the original uplift of the Karatube Hills, but before the bedrock was exhumed. The cave appears to have formed while the karst was still active (i.e., saturated for part of the year), as indicated by several solution cavities that are present in the back
walls along the northwestern portion of the cave. The cavities occur along linear structural joints and cracks in the walls and ceiling of the cave. These linear joints and cracks criss-cross roughly north to south through the back portions of the cave, forming a small natural chimney in the roof (Figure 3.4a). The original karst likely formed in solution along these joints and cracks, following mountain uplift. The lack of secondary biocarbonate deposits (e.g., travertine, speleothems, stalagmites) within the cave may be the result of typically dry conditions during the Pleistocene and/or intense surface erosion of the cave surfaces after exhumation of the bedrock.

The current ground surface and the underlying limestone bedrock within the cave slope downward from the cave mouth to the back (Figure 3.4b). This is a bit atypical, as most caves slope downward from the back to the mouth as sediments and clasts accumulate inside. As observed within the excavation area, the subsurface bedrock is eroded and drops off to an unknown depth about 3 to 4 meters from the back wall of the cave. In planview, the edge of the bedrock appears to mark the original karst opening that occurs along one of the major joints and below the natural chimney. There is a large block of isolated, weathered bedrock between the bedrock edge and the back wall of the cave. This block could be the product of detachment within the original karst as it formed; subsequently, the upper portions were weathered as the cave mouth opened and then buried by allogenic sedimentation.
Figure 3.4. Planview map (a) and cross-section (b) of Anghilak Cave.
PHYSIOGRAPHY AND DRAINAGE

Anghilak Cave is located at about 750 meters above sea level in the transitional semiarid steppe and foothill region between the low desert plains that extend northwest to the Aral and Caspian Seas and the high peaks of the Tien Shan and Pamir to the east and southeast. It is situated in rugged foothills of the extreme southwestern Tien-Shan Mountains, where the Zerafshan and Gissar Ranges diverge and form the Kashkadariya depression (Figure 3.5)(Merzlykova 2002). These foothills are located at the western margins of the Zerafshan Range along the north margins of the depression.

Figure 3.5. A 30 m Digital Elevation Model of the western Tien-Shan Mountains and surrounding major geographic landforms. Also depicted are the locations of Anghilak Cave, Teshik-Tash, Samarkandskaya, and Aman-Kutan (adapted from Glantz et al. 2003).
This is also an area where the western-most foothills of the Tien Shan converge with a lesser northwest-southeast trending range that extends onto the plains toward the Aral Sea. It appears that this northwest-southeast trending range formed prior to the Tien Shan as a result of early tectonic movement of the Iranian Block relative to the Eurasian continent, perhaps during the late Cretaceous (terminal Mesozoic). Later tectonic activity in this area during the Alpine orogeny of the Miocene (late Cenozoic) formed the Kopetdagh to the southwest. The range is relatively low in elevation and appears highly eroded. As the Tien Shan formed, the existing eroded hills in the convergence zone at the southeast end of the range were uplifted again. Thus, the southeast end of the older eroded range slopes upward as it converges with later formation of the Tien Shan foothills (i.e., Zerafshan). The Pre-Cambrian granite core of the range can be observed along the highway between Samarkand and Kitab.

The cave is located on the south slope of the Zerafshan foothills within this convergence zone. These foothills are called the Karatube (Black) Hills, which are comprised of a highly eroded northwest-southeast trending faulted ridge of marbleized Lower Devonian Limestone (Figure 3.6). The ridge is deeply bisected by the Rio Ayakchi-Say, which flows from east to west, forming a deep, steep-sided canyon though the Karatube formation. Anghilak is situated within this canyon at the terminus of a long ridge that forms a divide between the main valley and an intermittent primary tributary. The cave is about 150 m above the current position of the stream and faces upstream toward the east. It sits just above the steep talus of unsorted colluvium that flanks the exposed limestone ridge. Several remnant Quaternary terraces were observed in the general vicinity of the site. It is likely that the stream has down cut since the Late Pleistocene occupation of the cave.
The Kashkadariya River originates on the north slopes of the Gissar Range and the south slopes of the Zerafshan Range. It flows generally west through the Kashkadariya Depression, terminating before it reaches the Amudariya River to the south. The historic towns of Shahrisabz and Kitab are located along the alluvial plains of the Kashkadariya River, in the piedmont zone at the foot of the mountains. Several tributaries of the Kashkadariya originate in the uplifted foothills where Anghilak is located (e.g., the Rio Ayakchi-Say).

**Lithic Resources**

Lithic raw materials comprising the Anghilak Cave assemblage are predominantly derived from local sources (Glantz et al. 2006). Raw materials include silicified sediment, chert, quartz, quartzite, and possibly basalt. Cobbles of all these materials were observed in the stream channel of the Rio Ayakchi-Say, just below the site. All of these materials, except the basalt, likely derive from the Lower Devonian Limestone. It is not clear if raw materials were procured from the
secondary stream deposits or from primary deposits elsewhere. However, rounded cobble cortex was observed on many lithics during the excavation, suggesting that at least some portion of the raw materials represented in the assemblage were procured from the stream bed or terraces of the Rio Ayakchi-Say. A possible unit of flint was indicated on geologic maps, about 1 km down valley (see Figure 3.6). In 2003, two members of the UASAP team surveyed the general location indicated on the maps, but could not identify any usable raw materials. The geologic maps were reviewed at a local Institute for Geology in the city of Sharhisabz, but were not available for reproduction.

MODERN TERRESTRIAL ECOSYSTEMS

The climate in southeastern Uzbekistan is strongly continental, with a wide range of daily and seasonal temperatures. In general, the region is dry with relatively low humidity, especially in summer. The coldest winter month is January, when temperatures can drop below freezing, while the hottest summer month is July, when the temperature averages 25 to 30°C (77 to 86°F), but can reach 47°C (>115°F) in foothills and plains regions. In the lowland deserts, the temperature can reach 70°C (158°F) in the summer!

Vegetation and Soils

Vegetation in the region varies according to elevation, aspect, and proximity to water. Irrigated crops cover the alluvial plains and lowlands along the lower mountain slopes and piedmont, while short grass and semi-arid steppe dominate the upland areas. Merzlyakova (2002:Figure 16.8b) reports vegetation communities by elevation gradient for the Western Tien Shan and Pamir regions. Although no models are available for the Kashkadariya Depression, a model from Turkestan Ridge can be used as a general regional model because it describes an elevation range that includes Anghilak and its surroundings. Turkestan Ridge parallels the Zerashshan Range to northeast, several hundred kilometers northeast of Anghilak Cave. The
model presented by Merzlyakova (2002:Figure 16.8b) indicates ephemeral semi-deserts below 500 m, dry steppes from 500 to 1,000 m, meadow steppes from 1,000 to 1,500 m, sparse arid woodlands from 1,500 to 1,750 m, and sparse juniper woodlands up to about 3,000 m. Montane steppes and cryophytes occur at elevations above 3,000 on Turkestan Ridge. The two ridges are similar as they both extend from the mountains through the foothills convergence zone and include elevations below 500 meters. At about 750 meters above sea level, Anghilak falls within the semi-arid steppe characteristic of the foothills and plateau regions between 500 and 1,000 meters.

More specifically, short grasses and weeds (e.g., thistle) dominate the general area around and within the cave. Vegetation within the cave is very sparse. A few isolated trees and shrubs were observed on the mountain slopes, but the Karatube Hills do not host montane forests and meadow steppes like many of the ranges to the east. Meadow steppes generally occur above 1,000 meters, while montane forests generally occur above 1,500 meters. The Karatube Hills may have hosted these communities at varying times in the past. Taller grasses and trees occur along the stream channel of the Rio Ayakchi-Say and irrigation ditches cut into its terraces. Nearly all of the irrigable floodplain areas are under cultivation and major irrigation systems were noted along stream terraces throughout the general area. Vegetation within the cave is limited to a few sparse unidentified grasses and weeds. Roots were very rare within the excavation, but some were noted up to about 30 cmbs.

Soils in Uzbekistan are typically aridisols with high salinity, but this varies according to elevation, relief, aspect, vegetation, and precipitation. Mountain slopes and upland hills are comprised of generally deep, well-drained sediments. Deep Quaternary alluvium occurs along the stream terraces.
**Fauna and modern land-use**

Humans are certainly the most prevalent faunal species in the area, followed by domesticated livestock, including a variety of sheep and goat. There is a small village named Qanjagali located along the Rio Ayakchi-Say about 1 km to the southwest of Anghilak Cave. There are numerous villages of this type along the Ayakchi-Say and larger villages along the Kashkadariya River, including Kitab and Shahrisabz.

Although no wild mammalian species were observed in the general area surrounding the cave, they are known to include wild sheep (*Ovis ammon*), Siberian mountain goat (*Capra sibirica*), red deer (*Cervus Elaphus*), roe deer (*Ovis* sp.), wolf (*Canis lupis*), and coyote (*Canis latrans*). Numerous scavenging birds are present, namely vultures, and they were observed to use small caves in the general vicinity of Anghilak Cave. The Central Asian, or Four-Toed Tortoise Tortoise (*Testudo horsfieldi*) (Bergmann 2001) comprises an important portion of the faunal assemblage from the cave and from Aman-Kutan, another small, low elevation cave on the north slope of the Zerafshan Mountains (Glantz et al. 2002). No tortoises were observed in the general vicinity of the cave, but individuals were observed at higher elevations along the road between Samarkand and Kitab. Although ecologically dissimilar to sites in the Mediterranean and Levant that contain tortoise remains (see Speth and Tchernov 2002; Stiner 1999), the presence of buried tortoise remains in Anghilak Cave may be a useful indicator of fluctuating conditions at the site.

**SUMMARY AND CONCLUSION**

Anghilak Cave is a small cave set among rugged limestone foothills, the Karatube hills, at the extreme western reach of the Zerafshan Mountains. It is a passive karst cave formed in Lower Devonian Limestone and presently exhumed at the end of a steep, craggy ridge and overlooking the Rio Ayakchi-Say Canyon to the southeast. It contains Paleolithic artifacts, abundant faunal remains, and stratified sedimentary deposits that have the potential to yield significant
information about human behavioral and biological evolution during the Late Quaternary period. The cave was likely an attractive shelter for hominid groups exploiting fauna, vegetal, and lithic raw material resources along the Rio Ayakchi-Say drainage. Today, the area is sparsely populated with small agricultural villages along perennial streams in the piedmont areas.
CHAPTER 4. MATERIALS AND METHODS

The purpose of the analysis of the cave’s deposit was to provide empirical evidence for interpretations regarding Late Quaternary hominid use of the cave. The methods and techniques used in this analysis were selected to address questions about the deposit that were developed from the UASAP test excavations (Glantz et al. 2003). These proposed research questions were focused on cave geomorphology, the absolute age of the sediments, reconstructing depositional history, identifying post-depositional weathering processes, and determining the primary agents of bone accumulations. Many methods were used to address peripheral questions developed during the 2003 field season, and also to become more familiar with the laboratory techniques.

Methods are divided into three major categories: Archaeology, Geomorphology, and Taphonomy. All three avenues of research include both a field and laboratory segment. The following description of methods and selection criteria is also divided under these three headings. The Archaeology section includes a brief overview of excavation methods, data collection procedures, and excavation grid sampling. The Geomorphology section is divided into Field and Laboratory sections. Field methods include mapping, profiling, and sampling, while laboratory methods include sediment and soil sample analyses. The Taphonomy section includes methods describing general faunal assemblage characteristics, artifact context, and bone surface modification. Ritzman et al. (2004) conducted the taphonomic analysis and portions of the original study are used with the permission of the senior author.
ARCHAEOLOGY: EXCAVATION METHODS

In 2003-2004, the Uzbek-American Stone Age Project (UASAP) team continued excavations at Anghilak Cave. In the spring of 2003, I was invited by Dr. Michelle Glantz (Principal Investigator) to contribute to the project by developing and implementing an excavation methodology and research design that could provide detailed spatial documentation of artifact and bone distributions, and accommodate interdisciplinary investigations such as archaeometry, geoarchaeology, paleobotany, taphonomy, and zooarchaeology. The excavation methodology was developed over a 3-month period prior to fieldwork. The methods integrated into the research for this thesis were developed simultaneously and implemented in conjunction with the continued investigations at the site.

A metric three-dimensional grid system was established in the cave by setting a baseline and meridian using a Sokkia electronic Theodolite (Figure 4.1). A ‘permanent datum’ (large steel bolt) was set in concrete at the north side of the mouth of the cave and assigned coordinates North 100.000, East 100.000, Elevation 10.000 (N100/E100/Z10). The baseline was aligned to the 2002 test excavation units so that grid north was situated to best accommodate excavation of the cave sediments. Grid north is about 43 degrees east of magnetic north. Several grid corners were marked with 14 in. spikes to delineate excavation units and as temporary mapping stations. Unfortunately, the ‘permanent datum’ was removed by an unknown party during the winter of 2003-2004 and was not recovered. However, the grid was easily re-established from the previous excavation block corners and walls, and from mapping station nails left at other grid corners and covered by gravel or backfill. Absolute elevation within the grid was also easily re-established by taking numerous measurements at locations that were recorded in 2003.
Figure 4.1. Anghilak Cave 2003-2004 excavation grid.
Excavations proceeded in 1 m$^2$ grid units divided into 50 cm quadrants and 5 cm levels (Figure 4.2). Grid units were named according to their southwest grid corner (e.g., N93/E95). Quadrants were labeled according to compass direction: i.e., southwest (SW), northwest (NW), northeast (NE), and southeast (SE). Each arbitrary 5 cm level was given a level number corresponding to an even grid elevation at its base (e.g., the base of Level 25 is Z8.800, or 1.200 m below the datum). A complete list of level numbers and their corresponding grid elevations is presented in Appendix A. The excavated sediments from each quad within a specified level were dry sieved through $\frac{1}{16}$” mesh hardware cloth. All artifacts were picked by hand, bagged, and labeled by unit, level, quad, date and initials.

![Figure 4.2. Illustration of grid excavation methods.](image)

Horizontal grid measurements were recorded to the nearest 0.5 cm and vertical grid measurements were recorded to the nearest millimeter. Mapping was done with tape measures from the west and south walls of the excavation units, or other walls where appropriate. Grid elevations were measured with an auto level (theodolite) and homemade stadia rod. The auto
level was set-up daily over a nail with known elevation and the instrument height was measured from the top of the nail. The instrument was then added to the nail elevation to calculate the absolute height of the auto level. The stadia rod consisted of a metric tape measure nailed to the edge of a 2 x 5 cm board. The board was then held vertically and leveled with torpedo levels on two sides. The measurement was read from the tape measure through the optical lens of the auto level. The stadia measurement was recorded and then subtracted from the elevation of the instrument to calculate the absolute elevation within the excavation grid. Measurements were recorded to the nearest millimeter.

Data Collection

Three-dimensional coordinates were recorded for chipped stone artifacts >2 cm and bone fragments >3 cm that were recovered in situ and thus, some artifacts meeting size cut-offs were sorted with general bone for the quad and level. All data were recorded on Field Specimen Data forms and Excavation Level forms. The Field Specimen Data form consists of 20 attribute columns for each item, group of items, or sample removed from the excavation area. Systems of codes were used for some attribute categories (Todd 1987; see www.humanpaleo.org for further details). Features were recorded on a Feature Excavation form. Field forms are presented in Appendix A.

Field Specimen Forms are divided into five major categories: including Field Specimen Number, Provenience, Context, Description, and Other. Various attributes are recorded within each category. Field Specimen Number consists of the North and East grid coordinate of the southwest corner of the unit, followed by a number in a consecutive series per unit (e.g., N94/E93-276). Provenience includes three-dimensional and arbitrary spatial data divided into five sub-categories: grid North, grid East, and grid Elevation (measured to the nearest centimeter or less), Strata, and arbitrary Level (LVL). Context consists of provenience-point of a specific item (PRO), Brunton compass orientation (ORT), Brunton compass inclination (INC), and side
up (UP). Description includes nine attribute categories. These are specimen Class (CLAS), type of Element (EL), Portion of element (POR), Segment of portion (SG), Side for faunal remains (SD), Maximum Length in millimeters (Mlen), discernable Breakage (BR), and evidence of Burning (BN). Other includes the excavator’s Initials (IN), and comments (Comments).

Excavation grid sampling

To accommodate multiple avenues of research and integrate multiple datasets, a series of samples were recovered during the excavation of each level in select units. Most samples have not been analyzed due to lack of budget and transportation limitations. Samples were removed from the SW Quad of each 5 cm level in two excavation units: N94/E93 and N94/E94. The samples include:

- Pollen and Phytolith (PP): 0.5 liter
- Macrobotanical (MB): 1.0 liter
- Fine Fraction (FF): 2.0 liters
- Feature fill (F): no limit, all fill was recovered

Macrobotanic samples were floated and picked in the field lab by Lydia Pyne, University of Texas at Austin. Light and heavy fractions were separated and collected, including bone and chipped stone, then recorded on Field Specimen Data forms. The storage location of the samples collected in 2003 is in Khazakstan. Pollen and phytolith samples were submitted for analysis, but no information has yet been revealed about their location or status. The 2004 samples are stored in the basement of the Institute for Archaeology in Samarkand.

**GEOMORPHOLOGY: FIELD METHODS**

A standard set of geoarchaeological field methods was employed to support the geomorphology portion of this research, including site mapping, sampling, and descriptions. The methods were selected to provide spatial, textural, and chemical context for the development of a stratigraphic
framework that can support reconstructions of depositional history and identify post-depositional weathering processes, and ultimately to support human paleoecological interpretations.

Maps and Profiles

In addition to basic piece-plot maps for each level and unit, four types of maps were produced in the field, some versions of which have already been presented. These include cave planview maps, excavation planview maps, a cave cross-section map, and excavation wall profile maps. Mapping was completed with a digital theodolite, a homemade stadia rod in millimeters, and tape measures. Most mapping took place after the main grid was set and marked inside of the cave. Maps were drawn to scale on metric grid paper in the field, then later scanned and drafted digitally.

A total of six excavation wall profiles were taken over the two years of work in the cave. Only two are presented in the body of this thesis. The selected profiles provide two perpendicular sections through the excavation area. The remaining maps are included in Appendix B. Profile maps were drawn by setting-up a level string line running the length of the prepared section. The elevation of the string line was measured with the auto level to align the map with the excavation grid. Maps were prepared by taking depth measurements below or above the string line at either set increments (20 cm) or at point locations. All chipped stone and bone specimens in the profile walls were mapped and left in situ. Profiles were drawn to scale on metric grid paper in the field, then later scanned and drafted electronically. Other maps of interest include an excavation ending base map and a one day record of shade within the cave mapped hourly (Appendix B). No composite excavation level or stratigraphic unit maps have yet been prepared.

Sampling

In 2003, sediment samples were collected for physical and chemical analyses from two locations (Columns A and B) within the excavation area (Figure 4.3). Column A was located on
Figure 4.3. Anghilak Cave Planview Map Showing Excavation Units, Profiles A & B, and Sampling Locations. Sample locations include Sample Column A and B, Micromorphology Column, and OSL Core Column. Charcoal and other grid samples were recovered from the block area.
the west wall of the excavation area and is in the deepest part of the deposit. Column B was located about 3 m to the east where the deposit is shallow. These locations were selected to allow for comparisons between different areas of the cave deposit. A total of 48 sediment samples were collected in 2003 and 26 were used in the analysis. Bulk sediment samples (200 grams) were collected in continuous vertical columns at 5 cm intervals (samples Ab 1-12 and Bb 1-7) and 3 cm intervals (samples Aa 1-20 and Ba 1-12) from both locations. The latter were not used because of limited funding. The samples are stored at the Lab for Human Origins, Colorado State University. As reported here, Sediment Column A includes samples Ab 1-12 and is 60 cm deep, while Sediment Column B includes samples Bb 1-7 and is 35 cm deep. In addition, a vertical column of bulk soil samples (0.5 L each) was collected from Column A, with each sample corresponding to an observed stratigraphic horizon. This includes samples sp-1 through sp-7. Three samples (Bb-1, Bb-4, and Bb-7) from Column B were used in many of the laboratory analyses.

Additional samples were collected in 2004, including a micromorphology column and Optical Stimulation Luminescence (OSL) dating cores. The micromorphology column includes four intact sediment blocks removed from the south wall of N92/E93. This location was chosen because it is in the back of the cave and the deposits here are deep and well stratified. The blocks were roughly 15 cm tall x 10 cm wide x 10 cm deep. The upper three blocks came from a single vertical column, but the deepest block collapsed and a new sample was removed just to the east of the main column. Sediments are highly friable and were difficult to sample intact. The sample blocks are currently stored at the Lab for Human Origins at Colorado State University.

The cores collected for OSL dating were removed with 1.5 in. steel tubes because the analysis requires intact sediments that have not been exposed to light. A plastic cap was placed on one end of the steel tube and then the open end was hammered into the excavation wall with a rubber mallet. The tubes containing the intact cores were then removed carefully and the open end is
also capped. The cores were labeled and sealed with Duck tape for transport back to the US. They were stored at the Lab for Human Origins at CSU.

**In-field Sediment and Soil Descriptions**

In-field soil descriptions followed USDA Soil Survey Staff (1996) terminology and guidelines. Seven attributes were described in the field: including depth, Munsell color (moist and dry), structure, percent gravel, consistence (wet, moist, and dry), texture by ribbon test, and notes. Descriptions were prepared at the two sampling columns, and samples were taken from horizons identified during the investigation. The form used for in-field soil descriptions is presented in Appendix A.

**GEOMORPHOLOGY: LABORATORY METHODS**

“In deciding on laboratory procedures the research questions involved are to be considered. … The methods used in any analytical study should be explicitly identified and referenced or described” (Holliday and Stein 1989:356).

A wide variety of laboratory techniques and analytical methods were employed during the analysis of sediment samples. In addition to supporting a stratigraphic framework, these methods were selected for two reasons: 1) to provide as much baseline information as possible for the site, and 2) to develop a laboratory skill set by becoming familiar with basic laboratory techniques, analytical methods, and various analytical instruments. I considered the opportunity to work in the Soil-Plant-Water Testing Laboratory at CSU a privilege and selected many analyses to gain the experience in performing them. Therefore, several methods may provide redundant information and were selected only for their peripheral contribution to the ultimate goals of the research.
AMS Radiocarbon Dating

One of the primary goals of the UASAP research program in 2003-2004 was to obtain chronometric dates from the cave’s deposits (Glantz et al. 2003). There are very few chronometrically dated sites in Central Asia (Vishnyatsky 1999) and the dating program was vital for developing a stratigraphic framework and interpreting hominid paleoecology at the cave. A total of five $^{14}$C AMS radiocarbon assays were obtained from piece-plotted charcoal recovered during excavation of grid unit N94/E93. In the field, the samples were removed from intact sediments using the corner of a clean trowel. The entire piece and some surrounding sediments were then placed in a hand-folded foil pouch, labeled and then placed inside a plastic baggie and labeled again. Four of the samples came from the southwest quad of the grid unit and one was from the western portion of the southeast quad, so that all of the samples came from 50 cm diameter horizontal area. Samples were selected in the laboratory based first on their elevation and position within the deposits, and secondly, based on the size and quality of the sample. Samples were processed and analyzed at the University of Arizona AMS Laboratory: two in 2003 and three in 2004. Charcoal samples for $^{14}$C AMS dating were processed with the assistance of Patrick Wrinn.

General Sediment Sample Preparation

All analyses were completed at the Soil-Plant-Water Testing Laboratory, Natural and Environmental Sciences Building, Colorado State University, under the supervision and consultation of Dr. James Self, Laboratory Manager. The total Carbon analysis was conducted in the Wet Chemistry Laboratory of the Natural Resources Ecology Laboratory. To ensure quality control, all sediment analyses were run in batches with a blank, a check, and two duplicate samples.
The 0.5 L bulk samples removed from Column A (SP 1-7) were mechanically ground. All other samples were hand sieved. All laboratory determinations, except Particle Size Analysis, were performed on bulk sediments from the fine fraction (<2 mm). The following basic preparatory procedures were necessary for more than one determination and are briefly described here.

- **A Saturation Paste** is prepared with 50-100 grams of bulk sediment from the fine fraction placed in a plastic cup and mixed with De-Ionized Water (DI-H$_2$O) until saturated or, the consistency of cake batter. Rather than using the same amount of liquid each time, the same consistency is achieved for each sample. The samples are left overnight and then more DI-H$_2$O is added, if needed. The paste is either used directly (e.g., pH) or the liquid is extracted for analysis (e.g., ICP-OES).

- **A Saturation Paste Extract** is prepared by removing the liquid from the soil saturation paste with a vacuum extractor and filter paper. The extracted liquid is captured in glass extraction vials, and is either used directly (e.g., EC) or is diluted for analysis (e.g., ICP-OES).

- **A High Moisture Extract** is prepared by placing 2.0 grams of bulk sediment from the fine fraction in plastic centrifuge tubes and then adding 40 ml of DI-H$_2$O. The tubes are capped, shaken by hand, then shaken mechanically for 30 minutes, and again by hand. Samples are left overnight to settle and then the liquid is poured-off into a syringe. It is then pushed through a 0.45 µm filter and placed in ICP test tubes.

**Particle Size Analysis (PSA)**

The purpose of the analysis was to determine the variation in texture and particle size throughout the profile with the goal of interpreting depositional history and post-depositional weathering processes (Holliday 1992; Stein and Farrand 2001). Particle Size Analysis (PSA) was
performed on a total of 26 samples. This includes the two continuous Sediment Columns (A and B) from both sample locations and the seven 0.5 L bulk soil samples from Soil Column A.

Particle size was determined by using a sieve set and hydrometer. All measurements follow the U.S.D.A. texture classification (Soil Survey Staff 1996). Samples were dry sieved by hand into three fractions: including very coarse sand and gravels (>2 mm; VCS), coarse sand (1-2 mm; CS), and fines (sand, silt, and clay; <1 mm; Fines). The volume of each fraction was measured in ml in a graduated cylinder. Volumes were then summed and percentages were calculated by dividing fraction volume by total sample volume. All bone, lithics, and gravels in the coarse fractions were saved.

Sand, silt, and clay volumes were determined on the fine fraction using an hydrometer. Samples were prepared by placing 50 g of dry fine fraction sediment in “milk jars” and, then adding 100 ml of sodium hexametaphosphate (Calgon). Shaking mechanically overnight disperses particles. Samples are then poured into graduated cylinders and DI-H₂O is added until full at 1000 ml.

The hydrometer measures the density of the liquid with particles in suspension. Two hydrometer readings are taken for each sample, separated by exactly two hours of settling time. First, the sample in the cylinder is agitated with a stirring rod for exactly 20 seconds. The hydrometer is immediately placed in the cylinder and a reading is taken exactly 40 seconds after. This reading measures the density of the liquid with silts and clays in suspension. The sediments are allowed to settle for 2 hours and then a second reading is taken by carefully placing the hydrometer in the cylinders. This reading measures the density of the liquid with only clays in suspension. The raw data are then entered into a calculating spreadsheet to determine percent sand, silt and clay, as well as texture classification.
Calcium Carbonate Content (% CaCO₃)

A total of 10 samples were analyzed for Calcium Carbonate content (CaCO₃) following Loeppert and Suarez (1996), including the seven bulk soil samples from Column A (SP 1-7) and three samples from Column B (Bb 1, 4, 7). The analysis was performed on 2.0 grams of ground sediment from the fine-fraction (<2 mm) of each sample. Analysis of CaCO₃ is a fundamental technique practiced in all cave and rockshelter settings. The illuviation of carbonates through the cave’s profile was identified in the field by the presence of filaments, blebs, and nodules observed in varying frequency through the excavation area and profiles. Because the cave is calcareous (i.e., limestone), CaCO₃ content was expected to be consistently high, but varying amounts and stages of CaCO₃ suggested that post-depositional weathering (diagenesis) could be quantified to determine the degree of weathering. Moreover, the deepest deposits within the cave (Unit 2; Stratum V) appeared to be non-calcareous, suggesting an allogenic origin. Determination of CaCO₃ was intended to confirm this field observation.

Calcium Carbonate content was determined using the acid-neutralization method. Two grams of dry fine-fraction sample are placed in a 125 ml flask. Six ml of Ferrous Chloride (FeCl₂) and 4N HCl are placed in a small vile, which is then placed inside the flask with the sample still dry. A plastic funnel is placed in the flask to regulate the dispersal of CO₂. Once assembled, all items are weighed to the nearest ten-thousandth of a milligram. The acid is then spilled inside the flask and swirled to contact the entire sample. The assembly is weighed again 2.5 hours later. Raw data are entered into a calculating spreadsheet and weight loss is used to calculate %CaCO₃.

Total Carbon (total C)

A total of 10 samples were analyzed for total Carbon (total C) content: including the seven bulk soil samples from Column A (SP 1-7) and three samples from Column B (Bb 1, 4, 7). The
total C analysis was performed on 0.18 to 0.24 grams of sediment from the fine-fraction of each sample. The purpose of this analysis was to determine the variation of Total C throughout the profile to identify buried soil horizons and to become familiar with the methods and instruments.

Total C was determined using the High-Temperature Induction Furnace Method as described by Nelson and Sommers (1996) and was performed on a LECO 1000 CHN elemental analyzer (Figure 4.4) in the Wet Chemistry Laboratory of the Natural Resources Ecology Laboratory, Colorado State University. About 0.2 g of dry fine-fraction sample is placed in a pure Aluminum foil cone, weighed and entered into the instrument. Each sample is then closed tightly within the foil cone making a compact tear drop shape. All samples are then placed in the sample holder and automatically handled. The instrument analyzes one sample at a time by dropping the foil container into a combustion chamber where the temperature of the furnace (1000°C) and the flow of pure oxygen cause the sample to combust, converting any elemental carbon, hydrogen, or nitrogen into CO$_2$, H$_2$O, N$_2$, and NO$_x$. Carbon is determined by passing the liberated CO$_2$ through an infrared cell, where the rate of CO$_2$ absorption of infrared light is detected.

**Organic (OC) and Inorganic Carbon**

A total of 10 samples were analyzed for organic carbon (OC) and inorganic carbon content following Nelson and Sommers (1996), including the seven bulk soil samples from Column A (SP 1-7) and three samples from Column B (Bb 1, 4, 7). The purpose of this analysis was to determine the variation of OC throughout the profile to identify buried soil horizons and to
become familiar with the methods and instruments. OC is determined by calculation. Because 12\% of a CaCO_3 molecule is carbon, inorganic carbon is calculated as follows:

\text{Equation 1.} \quad \text{Inorganic carbon} = (\%\text{CaCO}_3)(.12)

Therefore, OC is the dividend of total carbon minus inorganic carbon:

\text{Equation 2.} \quad \text{Organic Carbon} = [\%\text{total C} - (\%\text{CaCO}_3)(.12)]

\textbf{Organic Matter (OM)}

A total of 10 samples were analyzed for Organic Matter (OM) following Nelson and Sommers (1996), including the seven bulk soil samples from Column A (SP 1-7) and three samples from Column B (Bb 1, 4, 7). The analysis was performed on 0.5 g of sediment from the fine-fraction (<1 mm) of each sample. The purpose of this analysis was to determine the variation of OM throughout the profile to identify buried soil horizons and to become familiar with the methods and instruments. Soil Organic Matter (OM) was determined using the overnight Modified Walkley-Black method (Jim Self, Personal Communication). This method uses an acid digest and Spectronic 20 light spectrometer (Figure 4.5). The sample is prepared by placing 0.5 gram of dry fine-fraction sample in a 50 mL flask. Then, 4 ml of Sulfuric Acid (H_2SO_4) and 4 ml of Potassium Dichromate (K_2Cr_2O_7) were added to the flask and swirled. The acid was left to cool for 10 minutes after the last sample was reacted, and then 20 ml of DI-H_2O was added to each flask. The samples were then left overnight (~24 hours) to settle. About 12 mL of the particle-free liquid is then carefully poured into spectrometer vials, which are then analyzed for transmission of spectral light in Figure 4.5. The Spectronic 20 light spectrometer used for determination of Organic Matter using the overnight method.
nanometers using the Spectronic 20. Percent transmission calibrated to the blank sample was then calculated from a master chart.

**Soil pH**

A total of seven samples were analyzed for Soil pH. The samples are all from Column A (SP 1-7). Soil pH was determined by using an Orion Research 211 digital pH meter placed in a saturated soil paste. This analysis was performed because it is a standard determination and provides baseline information about the deposits for future reference.

**Electrical Conductivity (EC)**

A total of seven samples were analyzed for Electrical Conductivity (EC). The samples are all from Column A (SP 1-7). This analysis was performed because it is a standard determination and provides baseline information about the deposits for future reference. The analysis was performed on Saturated Paste Extracts. EC was determined by using an YSI-35 digital conductance meter and calculating with a factorial, where:

\[
\text{Factor} / 0.01 \text{N KCl reading} = \text{factorial (reading)} = \text{EC}
\]

(i.e., \(1.4118/1.33 = 1.06\) (reading) = EC)

**Percent Saturation (% SAT)**

A total of seven samples were analyzed for Percent Saturation (% SAT). The samples are all from Column A (SP 1-7). This analysis was performed because it is a standard determination and provides baseline information about the deposits for future reference. The analysis was performed on about 50 grams of dry fine fraction sample.

% SAT is determined by placing about 50 grams of sample into a disposable plastic cup and then adding DI-H\(_2\)O until saturated. The cup and 50 grams of sample is weighed and recorded to the nearest tenth of a gram. The DI-H\(_2\)O is added and the weight of the saturation paste and cup
is also recorded. The difference between the two weights is then multiplied by two to estimate % SAT.

ICP-OES Geochemistry

A total of seven samples were analyzed to determine Ca, Mg, and Na content, and to ultimately calculate gypsum content and the Sodium Absorption Rate (SAR) with the goal of identifying a Salic or Gypsic horizon (Soil Survey Staff 1996). Small crystals would regularly form on the surface of soil profiles within the excavation area. The analysis aimed to determine whether these were gypsum or sodium, and if they had been translocated through the profile. An ancillary goal was to become familiar with the methods and instruments used in the analysis. All samples are from Column A (SP 1-7). Elemental analysis was determined on 18 total sample solutions using a Jarrell Ash-Iris Advantage high resolution Inductively Coupled (Argon) Plasma – Optical (Argon) Emission Spectrometer (ICP-OES or ICP-AES)(Figure 4.6). This included seven samples of filtered high moisture extract (SP 1-7), three samples of saturation paste extract in 1:10 dilution with DI-H$_2$O (0.5 ml extract: 4.5 ml DI-H$_2$O)(SP 5-7), four samples of saturation paste extract in1:100 dilution with DI-H$_2$O (0.5 ml of 1:10 extract solution: 4.5 ml DI-H$_2$O)(SP 1-4), and four samples of saturation paste extract in 1:1,000 dilution in DI-H$_2$O (0.5 ml of 1:100 extract solution: 4.5 ml DI-H$_2$O)(SP 1-4). Volumes were measured with a pipet and placed in ICP test tubes.

The test tubes were then placed in the automatic sample handler. The instrument was set for Automated Analysis using the SAR 2 method, using a 3 calibration standard for assured quality control; these include a blank of DI-H$_2$O run against a standardized solution of Ca, Mg, Na (100
(20 ppm), and B (2 ppm). The calibration was then repeated. Once the instrument was calibrated and passed the quality control check, the samples were automatically analyzed. Data were reported in parts-per-million (ppm) and then calculated to milliequivalents per volume (meq) as the standard unit for reporting (Jim Self, personal communication).

**Gypsum (% Gypsum)**

A total of seven samples were analyzed for Gypsum (% Gypsum) content following Loeppert and Suarez (1996). The samples were all from Column A (SP 1-7). The analysis was performed on high moisture and saturated paste extracts in varying dilution, as described above. The purpose of this determination was to identify the presence/absence of a Gypsic horizon (Soil Survey Staff 1996). At Anghilak, small crystals would regularly form on the surface of soil profiles within the excavation area. The analysis aimed to determine whether these were gypsum or soluble salts, and if they had been translocated through the sediments. An ancillary goal was to become familiar with the methods and instruments used in the analysis.

Milliequivalents (meq) Gypsum per 100 grams of soil is determined by calculating from Ca and Mg values obtained from the ICP-OES. % Gypsum is calculated from meq. The calculation is as follows:

**Equation 3.** \[ \text{meq Gypsum} = \left( \frac{(\text{Ca-Mg})_{\text{meq}} \times 2000}{1000} \right) - \left( \frac{(\text{Ca-Mg})_{\text{meq}} \times \%\text{SAT}_{1000}}{1000} \right) \]

**Sodium Absorption Rate Index (SAR)**

The SAR Index was calculated for a total of seven samples from Column A (SP 1-7). The SAR was calculated with meq Na, Ca, and Mg per 100 grams of soil. These values were determined during the ICP analysis and the SAR is calculated as follows:

**Equation 4.** \[ \text{SAR} = \frac{\text{meq Na}}{\sqrt{\text{meq Ca} + \text{meq Mg}}} / 2 \]
The SAR is used in soil classification to determine the presence of a Salic horizon, a subsurface diagnostic soil horizon that is formed by the accumulation of illuviated salts greater than 13.0% per volume (Soil Survey Staff 1996).

**TAPHONOMY: LABORATORY METHODS**

The entire 2003 faunal assemblage was transported back to CSU for a preliminary faunal analysis and more rigorous taphonomic analysis. The 2003 faunal remains were returned to Uzbekistan in 2004 and are stored at the Institute for Archaeology in Samarkand. The 2004 assemblage was not transported to CSU, but remains in storage with the 2003 materials. Ritzman et al. (2004) conducted the investigations and the methods presented in this section were integrated during that study. The inclusion of these methods in this thesis was with permission from the senior author. The original study conducted by Ritzman et al. (2004) included a variety of analyses and only selected aspects of the whole study are used in this thesis. Many of the attributes were originally recorded in the field and were confirmed or corrected during the laboratory analysis.

There were two main objectives to including the taphonomy segment of this study: 1) to conduct a preliminary faunal analysis, and 2) to reconstruct the taphonomic and depositional history within the cave. The preliminary faunal analysis consisted of classifying bone fragments according to Genus or body size class, and skeletal element and portion. The taphonomic analysis was designed to address two primary goals: 1) to reconstruct depositional history and 2) to identify the primary agents of bone accumulation. Two primary aspects of the taphonomic analysis (Ritzman et al. 2004) included a size-grade analysis of the entire 2003 assemblage and an macroscopic analysis of bone surface attributes.
Preliminary Faunal Analysis

The goal of zooarchaeological analysis generally aims to reconstruct hominid subsistence patterns and paleoecological conditions (Lyman 1994; Stiner 1994). These goals were in mind when the preliminary faunal analysis was conducted; however, the scope of the study was aimed more at identifying macroscopic bone attributes and surface modifications for reconstructing the taphonomic and depositional history within the cave (Ritzman et al. 2004). The general characteristics comprising the preliminary faunal analysis were described to support the goal of the taphonomic study. A thorough zooarchaeological analysis has not yet been undertaken. However, the general characteristics described by Ritzman et al. (2004) provide critical information for interpreting hominid paleoecology at the cave.

A total of 595 specimens from the 2003 sample were included in the preliminary faunal analysis (Ritzman et al. 2004). The purpose of this study was to determine the frequency and distribution of faunal remains according to animal body size class and skeletal element. The animal body size class analysis described five classes following Brain (1981), including:

- Large mammal
- Medium mammal
- Small mammal
- Small reptile
- Unidentifiable

Individual specimens were classified using comparative collections at the Center for Human Paleoecology at CSU. Non-diagnostic bone fragments were classified based on thickness and density, when possible.

Each of the 595 individual specimens was also classified according to skeletal element, portion, and segment. This analysis provides critical information for reconstructing
paleoecological conditions and hominid subsistence at Anghilak Cave. Skeletal element categories used in the analysis included:

- Identified long bone shaft fragments
- Unidentified long bone shaft fragments
- Unidentified long bone epiphyseal ends
- Tarsals, carpals, and phalanges
- Cranial fragments and teeth
- Vertebral and rib fragments
- Tortoise carapice fragments
- Unidentified

Summaries of the results are presented in the next chapter (Chapter 5), and synthesized into the discussion (Chapter 6) and conclusions (Chapter 7).

**Size-grade Analysis**

The entire 2003 faunal assemblage was graded into size classes corresponding to 1 cm increments (Anderson et al. 1994). These data was collected by manually dividing the assemblage into 1 cm grades up to 11 cm. A laminated size-grade chart was developed for dividing and tallying all bone fragments that are less than 6 cm in maximum length. All specimens over 3 cm in length that were piece-plotted and bagged separated in the field were also tallied and measured to the nearest 0.1 mm using digital calipers. Size-grade data were recorded on a simple data form and then entered into an excel spreadsheet. The analysis was primarily conducted by Terry Ritzman in the Human Origins Laboratory at CSU in the winter of 2003-2004.
Relative spatial density was calculated by dividing the total number of specimens per unit by the volume of that unit that was excavated in 2003. Data from the eight units in the contiguous excavation block were used.

**Bone Surface Attribute Analysis**

A total of 639 fragmentary faunal specimens were included in the macroscopic bone surface attribute analysis (Ritzman et al. 2004). This sample consisted of all specimens >3 cm maximum length that were recovered in 2003. Nine attributes were described and recorded: including four abiotic categories (weathering, rounding/abrasion, CaCO3 accumulations, and Manganese specking) and five biotic categories (green breakage, cutmarks, impact fractures, carnivore modification, and root etching). Data were recorded on a simple attribute data recording form. Most specimens were piece-plotted in the field and packaged individually; however, many pieces over 3 cm in length were not encountered in situ and were thus bagged with general screen bone. These larger pieces were removed from the general screen bone bags when encountered in the lab; then, bagged separately and included in the attribute analysis. The macroscopic analysis of bone surface attributes was primarily conducted by Terry Ritzman in the Laboratory for Human Origins in the winter of 2003-2004.

- **Maximum weathering** was recorded following Behrensmeyer’s (1978) 6-Stage system. The purpose of this analysis was to determine the range and degree of bone surface weathering on the larger (>3 cm) specimens, and also to determine the variability of bone surface weathering within the deposit. The frequency and distribution of bone weathering characteristics within an assemblage are important for reconstructing taphonomic histories and paleoecological conditions (Behrensmeyer 1978; Lyman 1989).
- **Rounding/Abrasion** was recorded following Fiorillo’s (1988) 4-Stage system. Like Maximum weathering, the purpose of this analysis was to determine the range and degree
of bone surface weathering on the larger (>3 cm) specimens, and also to determine the variability of bone surface weathering within the deposit.

- **CaCO$_3$ accumulations** were observed on faunal specimens during the excavations, occurring at varying frequencies throughout the deposit. This analysis was intended to determine the spatial distribution of CaCO$_3$ accumulations on larger (>3 cm) bone fragments. The pattern of CaCO$_3$ accumulations can lend insight into the intensity of post-depositional weathering, as well as changing climatic conditions (Stein 1984, 2001). This attribute was quantified by a simple presence/absence inventory.

- **Green breakage** was apparent on numerous bone fragments from the 2002 test excavations and the 2003 grid excavations. This analysis was intended to determine the frequency and spatial distribution of green breakage patterns on larger (>3 cm) bone fragments. The pattern of green breakage within an assemblage can lend insight into agents of bone accumulations and potentially support interpretations of hominid subsistence ecology (Lyman 1994; Todd and Rapson 1988). This attribute was quantified by a simple presence/absence inventory.

- **Cut marks and impact fractures** were rarely observed during the excavations, but several specimens were observed during a cursory laboratory examination. This analysis was intended to determine the frequency and spatial distribution of cut marks on larger (>3 cm) bone fragments. Cut marks can provide direct evidence of hominid diet and subsistence ecology (Lyman 1994). This attribute was quantified by a simple presence/absence inventory.

- **Carnivore modification** in the form of tooth marks were observed on a few specimens during the excavations, but were also observed during a cursory laboratory examination. This analysis was intended to determine the frequency and spatial distribution of carnivore modification on larger (>3 cm) bone fragments. The type, frequency, and
spatial distribution of carnivore tooth marks within an assemblage are critical for reconstructing taphonomic histories and determining the agents of bone accumulation (Bartram and Marean 1999; Brain 1981), particularly in caves where carnivores frequently den. The juxtaposition of carnivore modification with archaeological materials can provide direct evidence of hominid paleoecology, including food web structure and interactions (Behrensmeyer et al. 1992; Lyman 1994). This attribute was quantified by a simple presence/absence inventory.

SUMMARY AND CONCLUSIONS

The methods and techniques integrated into this research methodology were selected to support the proximate goal: to develop a reliable, chronometrically dated stratigraphic framework for the site. The methods and techniques chosen here were borrowed from archaeology, geomorphology, and taphonomy, and integrated into a single methodological and analytical framework. A series of research questions were used to guide the investigations, as well as the selection of the materials and methods used in this thesis. In general, these research questions were aimed at reconstructing depositional history and identifying post-depositional weathering processes. The ultimate goal of the research was to use the stratigraphic framework to draw conclusions from basic research questions about human paleoecology at Anghilak Cave and in the Kashkadariya valley during the Late Quaternary.
CHAPTER 5. RESULTS

The 2003-2004 investigations at Anghilak Cave produced a wealth of archaeological, geomorphological, and taphonomic data. Preliminary field and laboratory results were first presented at the 69th Annual Meeting of the Society for American Archaeology in Montreal, Canada (Adams et al. 2004; Ritzman et al. 2004). The results derived from two primary studies conducted during the winter of 2003-2004, the goals of which were quite similar – to reconstruct depositional history and identify post-depositional weathering. Adams et al. (2004) focused on the geoarchaeology of the cave deposits, while Ritzman et al. (2004) focused on the taphonomy of the faunal assemblage. All of the results from Adams et al. (2004) are presented here and only select portions of the results from Ritzman et al. (2004) are included. Archaeological data from the 2003-2004 excavations is not presented in this thesis. Many avenues of analysis are still ongoing or remain unexplored (e.g., faunal analysis, pollen/phytoliths). More adequate funding has expanded the team’s effort considerably. Results are presented under the same three headings as the previous chapter: Archaeology, Geomorphology, and Taphonomy.

ARCHAEOLOGY

In total, approximately 8.5 m$^3$ of cave sediments have been excavated in Anghilak Cave, including 3.5 m$^3$ in 2002, 2.83 m$^3$ in 2003, and 2.17 m$^3$ in 2004. Results from 2003-2004 include 1,903 lines of field data from 14 different grid excavation units (1 x 1 m) and 24 vertical 5 cm levels, totaling about 400 individual 50 x 50 x 5 cm quads. In addition to reopening the test pits from 2002, the 2003-2004 investigations included excavation in 11 new grid units (Figure 5.1).
All grid units were excavated to bedrock or sterile deposits (Strata V). A summary of the 2003-2004 excavations by grid unit are presented in Table 5.1: including excavation levels sampled, number of quads excavated, volume in m³ (calculated from number of quads), number of piece-plotted lithics, number of piece-plotted bone, associated features, and base of excavation.

Figure 5.1. Planview of 2002-2004 excavations.

<table>
<thead>
<tr>
<th>Grid Unit</th>
<th>Levels</th>
<th># Quads</th>
<th>m³</th>
<th>Piece-plot Lithics</th>
<th>Piece-plot Bone</th>
<th>Feature</th>
<th>Max Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>N92/E93</td>
<td>12-23</td>
<td>44</td>
<td>0.55</td>
<td>37</td>
<td>90</td>
<td>F1, F6</td>
<td>Stratum V</td>
</tr>
<tr>
<td>N92/E94</td>
<td>11-23</td>
<td>44</td>
<td>0.55</td>
<td>23</td>
<td>83</td>
<td>F1, F4</td>
<td>Stratum V</td>
</tr>
<tr>
<td>N93/E92</td>
<td>11-23</td>
<td>26</td>
<td>0.325</td>
<td>48</td>
<td>36</td>
<td>--</td>
<td>Stratum V</td>
</tr>
<tr>
<td>N93/E95</td>
<td>11-24</td>
<td>50</td>
<td>0.625</td>
<td>42</td>
<td>74</td>
<td>--</td>
<td>Bedrock</td>
</tr>
<tr>
<td>N93/E96</td>
<td>10-16</td>
<td>24</td>
<td>0.30</td>
<td>6</td>
<td>29</td>
<td>--</td>
<td>Bedrock</td>
</tr>
<tr>
<td>N93/E97</td>
<td>6-11</td>
<td>12</td>
<td>0.15</td>
<td>0</td>
<td>3</td>
<td>F3</td>
<td>Bedrock</td>
</tr>
<tr>
<td>N94/E93</td>
<td>10-27</td>
<td>68</td>
<td>0.85</td>
<td>93</td>
<td>174</td>
<td>--</td>
<td>Stratum V</td>
</tr>
<tr>
<td>N94/E94</td>
<td>10-25</td>
<td>46</td>
<td>0.575</td>
<td>43</td>
<td>98</td>
<td>F5</td>
<td>Stratum V &amp; Roof fall</td>
</tr>
<tr>
<td>N95/E93</td>
<td>21-25</td>
<td>13</td>
<td>0.1625</td>
<td>4</td>
<td>1</td>
<td>--</td>
<td>Stratum V</td>
</tr>
<tr>
<td>N95/E94</td>
<td>11-25</td>
<td>60</td>
<td>0.75</td>
<td>29</td>
<td>26</td>
<td>F2</td>
<td>Stratum V</td>
</tr>
<tr>
<td>N98/E100</td>
<td>4-6</td>
<td>8</td>
<td>0.10</td>
<td>0</td>
<td>0</td>
<td>--</td>
<td>Bedrock</td>
</tr>
<tr>
<td>N98/E101</td>
<td>4-5</td>
<td>4</td>
<td>0.05</td>
<td>0</td>
<td>0</td>
<td>--</td>
<td>Bedrock</td>
</tr>
<tr>
<td>TOTALS</td>
<td>24</td>
<td>399</td>
<td>4.99</td>
<td>325</td>
<td>614</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

Most of the excavation was focused within the drip line of the cave. Only two units were excavated outside of the drip line and they encountered regolith and bedrock within 10 cm of the surface. All of the units were excavated to bedrock or into sterile Stratum V.

Artifacts: Chipped Stone and Faunal Remains

Tens-of-thousands of chipped stone and bone specimens were recovered from the cave during the three years of investigations. These materials are relatively dense and comprise a considerable portion of the coarse fraction of the deposit. A total of 939 specimens were piece-
plot mapped and recorded in 2003-2004: including 325 chipped stone specimens (>2 cm) and 614 bone fragments (>3 cm). Chipped stone materials recovered from dry screening number in the thousands and bone fragments number in the tens-of-thousands. The lithic assemblage could not be removed from Uzbekistan and a total count is not currently available. Dr. Gilbert Tosteven of the University of Minnesota is analyzing the lithic assemblage and preliminary results were recently presented (Glantz et al. 2006).

The entire 2003 faunal assemblage was transported back to CSU between the two field seasons, and was returned to the Institute for Archaeology in Samarkand in 2004. To date, there are easily over 25,000 bone fragments that have been recovered from the deposit, with 18,785 fragments recovered in 2003 alone (Ritzman et al. 2004). However, highly fragmentary and unidentifiable remains characterize the assemblage, with 55% under 1 cm and 95% less than 3 cm in maximum length. A more thorough and rigorous zooarchaeological analysis has not been conducted. Ritzman et al. (2004) conducted a preliminary faunal and taphonomic analysis of the 2003 faunal assemblage, providing essential baseline data. Selected results from this study are presented in the taphonomy section of this chapter.

The Ritzman et al. (2004) study also included a size-grade analysis of all collected bone specimens, including 367 piece-plotted items and all items recovered from dry screening. This aspect of the Ritzman et al. (2004) study allowed an evaluation of the excavation team’s recovery rate of bone fragments greater than 3 cm in maximum length. As described in the excavation methodology, the goal was to piece-plot map bone fragments larger than 3 cm that were found in situ. The size-grade analysis of the entire faunal assemblage identified 762 bone fragments greater than 3 cm maximum length. Of the 762 items, 367 were piece-plot mapped in situ, reflecting a recovery rate of only 48% for the artifact class. This indicates that the actual length of most mapped bone fragments is probably greater than 3.5 cm.
Recent Cultural Features

A total of six features were discovered and documented in 2003 (see Table 5.1). All features appear to be small circular hearths with small basins, or the remains of such hearths. All feature fill was removed, placed in a labeled bag, and stored at the Institute for Archaeology in Samarkand for future analysis (e.g., AMS dating of charcoal, flotation, pollen/phytoliths analysis); however, the location of these samples was unknown in 2004 and it is unlikely that they will be recovered. All of these features appear to be relatively recent in age and intrusive to the underlying Paleolithic deposits. The tops of the features occur just below the surface gravel lens, with the basins extending into underlying Strata II and III.

**Feature 1 (F1)** was discovered in 2002 and the north half was excavated in the 1 m x 2 m test unit (J10-11). It is located in the rear portions of the cave about two meters from the back wall. In 2003, it was plan and cross-section mapped, excavated, and recorded (Figure 5.2). It consist of three sub-features (F1a, F1b, and F1c) representing reuse episodes. These reuse episodes indicate a sequence of initial excavation and use, then two episodes of in-fill and re-excavation. The fill from each sub-feature was excavated and bagged separately. The feature appears to be relatively recent as indicated by its proximity to the surface. However, no dates have been obtained from the hearth fill and no diagnostic artifacts were observed in direct association. The hearth fill contains numerous charcoal pieces adequate for AMS dating. It is important that the fill from this feature is further analyzed, as it will provide important information for dating the cave deposits and interpreting site formation processes.

![Figure 5.2. Feature 1 sub-features during excavation.](image-url)
**Feature 2 (F2)** consists of a small, shallow circular charcoal and ash stain. It was encountered immediately below the dense gravel lens just below the cave floor surface. It is located in the rear portions of the cave about 2 m from the back wall. It appears to be only a remnant of larger shallow basin hearth that was subsequently eroded and deflated before being stabilized by the overlying gravel layer. A small volume of fill was recovered and few pieces of charcoal were observed.

**Feature 3 (F3)** consists of a small, shallow circular stain with a basin shaped profile. The south half of the feature was excavated in N93/E97, while the north half remains exposed in the north wall of the unit (see below [Figure 5.5: Profile B]). The west edge of the feature is only a few centimeters from the surface. A small volume of fill was recovered and few pieces of charcoal were observed. Further analysis of this feature will be limited.

**Feature 4 (F4)** consists of a small, shallow circular stain located near F1. It was encountered immediately below the dense gravel lens just below the cave floor surface. It is located in the rear portions of the cave about two meters from the back wall. It appears to be only a remnant of larger shallow basin hearth that was subsequently eroded and deflated before being stabilized by the overlying gravel layer. A small volume of fill was recovered and few pieces of charcoal were observed.

**Feature 5 (F5)** consists of a relatively deep, semi-circular basin containing abundant charcoal and stained sediments. The margins of the feature were difficult to define, suggesting that the upper portions were disturbed and eroded prior to burial. A large amount of fill was collected from the feature. Portions remain exposed in the east wall of excavation unit N94/E94. No dates have been obtained from the hearth fill and no diagnostic artifacts were observed in direct association. The hearth fill contains numerous charcoal pieces adequate for AMS dating. It is important that the fill from this feature is further analyzed, as it will provide important information for dating the cave deposits and interpreting site formation processes.
Feature 6 (F6) consists of a well-defined circular, shallow basin hearth occurring in the back portions of the cave, less than a meter from the back wall and directly underneath the cave’s natural chimney. The east half of the hearth was excavated and collected, while the west half remains exposed in the west wall of N92/E93. There is a near continuous charcoal lens that extends north from the edge of the hearth to four meters or more to the north.

**GEOMORPHOLOGY: FIELD RESULTS**

Field investigations included preparation of profile maps, sediment descriptions, and collection of 29 sediment samples. All original maps and profiles are in possession of the author and are also stored in hardcopy form at CSU. All maps have been scanned and are stored in electronic format. All sediment samples used in this study were collected in 2003, transported from Uzbekistan to the U.S., and are stored at CSU’s Lab for Human Origins. A variety of other samples were collected for ancillary studies, including OSL dating (3 cores), micromorphology analysis (4 samples from one column), pollen/phytolith analysis, and macrobotanical analysis. The OSL and micromorphology samples were stored at CSU, while the pollen/phytolith and macrobotanical samples were stored at the Institute for Archaeology in Samarkand, Uzbekistan. A selection of macrobotanical samples collected in 2003 were processed by flotation in the field by Lydia Pyne, and a selection of pollen/phytolith samples were submitted for analysis in Uzbekistan, but no results have yet been reported.

**Maps and Profiles**

Dozens of maps were prepared in the field, including excavation unit level maps, excavation plan maps, cave plan maps, cave cross-section maps, and stratigraphic profile maps. Many of the maps that were drawn in the field have been presented in various composite forms throughout the previous sections. Grid unit excavation level maps are not included here. Additional profile maps are presented in Appendix B.
Profiles A and B are composite maps that were drafted from several profile maps drawn during the 2003-2004 field seasons (Figure 5.3). Other profile maps of individual excavation unit walls were also prepared, but are not presented here. Profile A is a 4 m long section along the E93 grid line between N92 and N96 (Figure 5.4). This profile parallels the back wall of the cave about 1 to 2 m away from it. Profile A provides a cross-section of the deepest deposits within the cave. Profile B is a 5 m long section along the N94 grid line between E93 and E98 (Figure 5.5). This profile is perpendicular to Profile A and runs from 1 m inside the drip line to 1.7 m from the base of the back wall. A soil description and sampling column were taken from each profile.

Figure 5.3. Location of Profiles A and B. Note proximity of Profile A to the back wall. Photo by J. Adams, July 2003.
Figure 5.4. Composite Profile A taken along the E93 grid line.
Figure 5.5. Composite Profile B taken along the N94 grid line.
Stratigraphic Descriptions

Field descriptions identified five primary stratigraphic horizons (Strata I to V) comprising two primary depositional units (Units 1 and 2) (Figure 5.6; Table 5.2). Stratigraphic designations were used primarily to describe changes in texture and color within Unit 1, and also to describe the distribution of the cultural materials. Samples from Soil Columns A and B correspond to the five stratigraphic horizons and laboratory results confirm the field designations. Unit 1 comprises Strata I through IV and consists of poorly-sorted silts, fine sands, gravels, bone fragments, and artifacts, while Unit 2 comprises Stratum V alone and consists of deep, well-sorted laminated clays. The two depositional units are separated by an abrupt, wavy disconformity occurring at 50 to 80 cm below the surface of the cave floor (cmbs). Unit 1 becomes increasingly thinner toward the mouth of the cave where it mantles bedrock by only about 5 cm, and the underlying Unit 2 occurs only in the back portions of the cave. Stratigraphic descriptions and corresponding samples were prepared at two columns within the excavation area. Column A is located along Profile A and Column B along Profile B. Because Column B was only 35 cm deep, the following information primarily reflects the results of work at Column A.
Table 5.2. Soil description from Column A (see Soil Description key in Appendix A for codes)

SOIL DESCRIPTION: COLUMN A

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>SP 1</td>
<td>9.500 O/A1 SCL</td>
<td>7.5YR4/1</td>
<td>7.5YR5/2</td>
<td>a, w</td>
<td>Limestone</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>SP 2</td>
<td>9.450 A2 SiL</td>
<td>10YR4/3</td>
<td>10YR6/3</td>
<td>c, s</td>
<td>Few Blebs</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>SP 3</td>
<td>9.350 Bw SiL</td>
<td>7.5YR4/3</td>
<td>10YR6/3</td>
<td>c, s</td>
<td>Few filaments</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>SP 4</td>
<td>9.250 Bk1 L</td>
<td>10YR5/3</td>
<td>10YR6/3</td>
<td>g, i</td>
<td>Filaments, nodules</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>SP 5</td>
<td>9.050 Bk2 L</td>
<td>10YR4/3</td>
<td>10YR6/3</td>
<td>a, b</td>
<td>Nodules</td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>SP 6</td>
<td>8.850 2Bk3 CL</td>
<td>7.5YR5/4</td>
<td>7.5YR7/3</td>
<td>d, ?</td>
<td>Few Nodules</td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>SP 7</td>
<td>8.500 2Bw(t) C</td>
<td>7.5YR6/6</td>
<td>7.5YR7/4</td>
<td>pr, vc, 2</td>
<td>None</td>
<td></td>
</tr>
</tbody>
</table>

Unit 1: Strata I through IV

In general, Unit 1 (Strata I-IV) consists of poorly sorted fine loam with abundant gravels, rock fragments, lithic artifacts, bone fragments, and sparse roots. It is the primary artifact-bearing deposit. This unit ranges from about 5 to 80 cm in thickness, thinning toward the mouth of the cave. It is disconformably overlaying Unit 2 in the back of the cave and thinly mantling bedrock at and beyond the drip line (see Figure 5.5: Profile B). As observed during excavation and during profile preparation, coarse fragments are most prevalent at two depths: just below the ground surface and at the bottom of Unit I in Stratum IV. These dense gravel lenses likely accumulated over a long period of time corresponding to significant changes in the cave’s morphology or climatic change, or both. Unit I is fairly homogenous in color when moist, but weak horizons are discernable by subtle color changes when dry. Texture also varies according to horizon. Sediments range from light yellow-gray to medium brownish gray. The surface of Profile A would typically be covered with salt crystals that would accumulate over three or four days.
**Stratum I** (A1 and A2) extends from the current cave floor surface to a maximum depth of 14 cm and extends across the entire surface of the cave floor. It is thickest in the back portion of the cave, where it is composed of thin, inter-bedded layers of gravel, livestock manure, compact silt loam sediments, and charcoal and ash lenses. Toward the dripline of the cave, the horizon consists of a 2 to 5 cm thick lens of gravels and compact silty clay. Overall gravel and rock fragment content ranges from about 25 to 50%. Color ranges from dark gray to pale brown. Structure varies from single grain fine sands to hard subangular blocky. Visible amounts of salts were noted within this horizon, possibly leaching from the manures. The horizon appears to be mixed by continued historic and modern use of the cave. There at least four thermal features in Stratum I and there is a continuous cultural level discernable across the back portion of the cave (see Figure 5.4: Profile A). Artifacts recovered from this layer include chipped stone, bone fragments, modern debris such as bottle glass and bottle caps. Stratum I overlies Stratum II in the back half of the cave, and overlays Stratum III in the front half.

**Stratum II** (Bw) is composed of pale brown silt loam with approximately 15% gravel and rock fragment content. It has a slightly more reddish-brown appearance than the underlying horizon when dry. The horizon is present only in the back portions of the cave and has a maximum thickness of 15 cm. It has weak, medium granular structure. Few fine CaCO$_3$ filaments were observed. The layer thins toward the mouth of the cave, eventually pinching-out about 4 m from the back wall and about half way to the drip line. The boundary with underlying Stratum III is clear and smooth.

**Stratum III** (Bk1) is composed of pale brown loam with approximately 15% gravel and rock fragment content. It has weak, medium granular structure. It has a maximum thickness of about 30 cm and extends across the entire cave interior. This layer is essentially parent material with accumulations of CaCO$_3$ in the form filaments and occasional nodules. Carbonate accumulations also appear in bone beginning in this horizon. The boundary with Stratum IV is gradual and irregular.
**Stratum IV** (Bk2) is composed of pale brown to brown loam with approximately 25% gravel and rock fragment content. It has weak, medium granular structure. It has a maximum thickness of about 20 cm and, like Stratum II only occurs in the back portions of the cave interior. Carbonate accumulations are most substantial in this horizon, forming large nodules and concretions surrounding gravels. Heavy accumulations are also present on the bottom surface of larger bone fragments. The boundary with underlying Stratum V is abrupt and highly irregular.

**Unit 2: Stratum V**

**Stratum V** (2Bk3 and Bw) is composed of laminated clays and fine silts that occur within a 10 to 12 square meter area in the back portions of the cave. In contrast to the overlaying strata of Unit 1, these sediments are non-calcareous and have very sparse gravel and rock fragment content, representing only 3% of the total fraction. The overall depth of these deposits is unknown, but they extend to at least 150 cmbs. The contact with Unit 1, where definable, is between 50 and 80 cmbs. The laminated clay lenses are essentially level in the northern half of the excavation area, but then dip to toward the southwest, or the rear of the cave, just below the natural chimney. The upper-most beds dip at about 15°, while the lower beds dip at about 22°. Upper beds are thinner, easier to discern, and break apart in angular nodules when dry. The lower beds appear form a massive structure breaking into medium blocky to prismatic peds when dry. Artifacts occur at the upper contact and appear to be slightly mixed in along the uppermost portions of the stratum. This deposit is non-calcareous. Color when dry is pink, with moist colors ranging from reddish-yellow to light brown. The upper boundary of Stratum V is abrupt and irregular, probably resulting from truncation and bioturbation when the cave mouth formed or opened. Sediments in the upper portion of the layer are discolored and appear yellow and orange.
GEOMORPHOLOGY: LABORATORY RESULTS

The purpose of the laboratory analysis of materials contained in the cave’s deposit was to provide empirical evidence for reconstructing depositional history and post-depositional weathering. The methods and techniques used in this analysis were selected to address questions about the deposit that were developed from the UASAP test excavations (Glantz et al. 2003), and were then refined during the 2003 field season. Many methods were used to address peripheral questions and to become more familiar with the laboratory techniques. The selection criteria for each method are presented in the previous chapter.

AMS Radiocarbon Dating

A total of 26 charcoal samples were collected during the 2003-2004 excavations. Sixteen of the 26 samples were recovered from varying depths in one excavation unit (N94/E93). Five of the 16 charcoal samples from the south half of N94/E93 were selected for analysis: two specimens collected in 2003 and three specimens collected in 2004. All five charcoal samples were submitted to the University of Arizona AMS Laboratory and all yielded radiocarbon ages. Table 5.3 lists the AMS radiocarbon results from charcoal samples.

Table 5.3. Summary of AMS Radiocarbon Sample Results.

<table>
<thead>
<tr>
<th>Cat. #: N94/E93</th>
<th>AA#</th>
<th>East</th>
<th>Elev.</th>
<th>Level</th>
<th>Quad</th>
<th>Strata</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>88</td>
<td>AA57042</td>
<td>94.085</td>
<td>93.035</td>
<td>9.310</td>
<td>SW</td>
<td>II/III</td>
<td>2,978±34</td>
</tr>
<tr>
<td>162</td>
<td>AA57043</td>
<td>94.495</td>
<td>93.030</td>
<td>9.152</td>
<td>SW</td>
<td>III/IV</td>
<td>27,310±270</td>
</tr>
<tr>
<td>338</td>
<td>AA61241</td>
<td>94.085</td>
<td>93.885</td>
<td>8.988</td>
<td>SE</td>
<td>IV</td>
<td>43,900±2,000</td>
</tr>
<tr>
<td>443</td>
<td>AA61243</td>
<td>94.210</td>
<td>93.440</td>
<td>8.805</td>
<td>SW</td>
<td>IV</td>
<td>38,100±2,100</td>
</tr>
<tr>
<td>462</td>
<td>AA61242</td>
<td>94.220</td>
<td>93.490</td>
<td>8.713</td>
<td>SW</td>
<td>V</td>
<td>&gt;26,300</td>
</tr>
</tbody>
</table>

AA#: University of Arizona AMS Labs Sample Number
The selected charcoal samples were all at least 10 mm in maximum length and were reported to have low humic content during the lab preparation process (Patrick Wrinn, Personal Communication). These dates have been previously reported in two conference presentations about the site (Adams et al. 2004; Glantz et al. 2006).

The dates range from about 3,000 to 45,000 BP. All samples came from within a 50 cm diameter area of the deposit and were from depths spanning Strata II through V. Unfortunately, there are two dates out of sequences, likely the result of mixing within Stratum IV. The deepest sample (N94/E93-462) was recovered from the upper few centimeters of Stratum V and yielded an uncorrected radiocarbon age of >26,300, possibly indicating that it exceeded the upper limit of radiocarbon half-life (i.e., >50,000 BP). The dates demonstrate that Unit 1 (Strata I-IV) was deposited during the last 50,000 years and that the oldest hominid occupations correspond to the early Upper Paleolithic.

**Particle Size Analysis (PSA)**

Particle size was determined for a total of 26 samples deriving from three sample sets. The results from 21 of the 26 samples are presented here. This includes 14 samples from Column A and seven samples from Column B. At Column A, 12 of the 14 samples were collected from a continuous column in 5 cm increments through Unit 1 (Strata I-IV) and into the upper portions of Unit 2 (Stratum V). The two remaining samples were collected from lower portions of Unit 2 (Stratum V) providing a total depth of 1.0 m at Column A. The seven samples from Column B were collected from a continuous column in 5 cm increments through Unit 1 (Strata III-IV) to bedrock. Particle size classes followed Soil Survey Staff (1996). The coarse fraction consists of very coarse sand and gravels greater than 2 mm (VCS) and coarse sand between 1-2 mm (CS), and the fine fraction consists of sand, silt, and clay. The total volume in mL is presented for each sample as well as VCS, CS, and fines. Percent volume for all of the size classes equals 100% for the total sample. The Clay-free Index is calculated as % volume of Sand + Silt / Sand. Table 5.4
and Figure 5.7 charts the percent of total volume by grid elevation for each sample from Columns A and B.

Table 5.4. Results of Particle Size Analysis from Columns A and B.

<table>
<thead>
<tr>
<th>COLUMN A</th>
<th>&gt;2mm (VCS*)</th>
<th>1-2mm (CS*)</th>
<th>&lt;1mm total</th>
<th>&lt;1mm (fines)</th>
<th>sand</th>
<th>silt</th>
<th>clay</th>
<th>clay-free index</th>
</tr>
</thead>
<tbody>
<tr>
<td>sp #</td>
<td>mL</td>
<td>%</td>
<td>mL</td>
<td>%</td>
<td>mL</td>
<td>%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ab-1</td>
<td>9.500</td>
<td>I</td>
<td>212</td>
<td></td>
<td>80</td>
<td>38</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Ab-2</td>
<td>9.450</td>
<td>I</td>
<td>215</td>
<td></td>
<td>45</td>
<td>21</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Ab-3</td>
<td>9.400</td>
<td>II</td>
<td>159</td>
<td></td>
<td>26</td>
<td>16</td>
<td>15</td>
<td>9</td>
</tr>
<tr>
<td>Ab-4</td>
<td>9.350</td>
<td>II</td>
<td>163</td>
<td></td>
<td>16</td>
<td>10</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>Ab-5</td>
<td>9.300</td>
<td>II/III</td>
<td>178</td>
<td></td>
<td>22</td>
<td>12</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>Ab-6</td>
<td>9.250</td>
<td>III</td>
<td>168</td>
<td></td>
<td>20</td>
<td>12</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>Ab-7</td>
<td>9.200</td>
<td>III</td>
<td>161</td>
<td></td>
<td>25</td>
<td>16</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>Ab-8</td>
<td>9.150</td>
<td>III</td>
<td>182</td>
<td></td>
<td>28</td>
<td>15</td>
<td>14</td>
<td>8</td>
</tr>
<tr>
<td>Ab-9</td>
<td>9.100</td>
<td>IV</td>
<td>157</td>
<td></td>
<td>26</td>
<td>17</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>Ab-10</td>
<td>9.050</td>
<td>IV</td>
<td>171</td>
<td></td>
<td>36</td>
<td>21</td>
<td>17</td>
<td>10</td>
</tr>
<tr>
<td>Ab-11</td>
<td>9.000</td>
<td>IV</td>
<td>168</td>
<td></td>
<td>40</td>
<td>24</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>Ab-12</td>
<td>8.950</td>
<td>V</td>
<td>162</td>
<td></td>
<td>5</td>
<td>3</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>SP-6</td>
<td>8.850</td>
<td>V</td>
<td>450</td>
<td></td>
<td>15</td>
<td>3</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>SP-7</td>
<td>8.500</td>
<td>V</td>
<td>475</td>
<td></td>
<td>15</td>
<td>3</td>
<td>***</td>
<td>***</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>COLUMN B</th>
<th>&gt;2mm (VCS)</th>
<th>1-2mm (CS)</th>
<th>&lt;1mm total</th>
<th>&lt;1mm (fines)</th>
<th>sand</th>
<th>silt</th>
<th>clay</th>
<th>clay-free index</th>
</tr>
</thead>
<tbody>
<tr>
<td>sp #</td>
<td>mL</td>
<td>%</td>
<td>mL</td>
<td>%</td>
<td>mL</td>
<td>%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bb-1</td>
<td>9.450</td>
<td>I</td>
<td>188</td>
<td></td>
<td>50</td>
<td>27</td>
<td>14</td>
<td>7</td>
</tr>
<tr>
<td>Bb-2</td>
<td>9.400</td>
<td>I/III</td>
<td>164</td>
<td></td>
<td>50</td>
<td>30</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>Bb-3</td>
<td>9.350</td>
<td>III</td>
<td>170</td>
<td></td>
<td>40</td>
<td>24</td>
<td>16</td>
<td>9</td>
</tr>
<tr>
<td>Bb-4</td>
<td>9.300</td>
<td>III</td>
<td>173</td>
<td></td>
<td>60</td>
<td>35</td>
<td>17</td>
<td>10</td>
</tr>
<tr>
<td>Bb-5</td>
<td>9.250</td>
<td>III</td>
<td>172</td>
<td></td>
<td>36</td>
<td>21</td>
<td>20</td>
<td>12</td>
</tr>
<tr>
<td>Bb-6</td>
<td>9.200</td>
<td>IV</td>
<td>166</td>
<td></td>
<td>36</td>
<td>22</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>Bb-7</td>
<td>9.150</td>
<td>IV</td>
<td>134</td>
<td></td>
<td>22</td>
<td>16</td>
<td>12</td>
<td>9</td>
</tr>
</tbody>
</table>

*VCS=very coarse sand and gravels; **CS=coarse sand; ***CS included with % sand in the fine fraction after mechanical grinding.

The results for the coarse fraction (VCS and CS) are presented in the chart to the left, while the fine fraction (fine sands, silts, and clays) are in the chart to the right. The sum of volumes for all grades equals 100%. The results of the PSA confirm the stratigraphic delineations made in the field. Changes in particle size vertically through the profile appear to correspond to the five identified Strata (I-V).
Figure 5.7. Results of Particle Size Analysis (PSA) for 21 samples from two sample columns.
CaCO₃, total C, OC, IC, OM

Percent volume of calcium carbonate (CaCO₃), total carbon (total C), organic carbon (OC), inorganic carbon (IC), and organic matter (OM) were determined for a total of 10 samples deriving from two sample sets. These include the seven 0.5 L bulk samples from Column A (SP 1-7) and three samples from continuous sediment Column B. Results are presented in percent volume per sample and their sum does not necessarily equal 100%. Table 5.5 lists the results of the laboratory determinations.

Table 5.5. Results of CaCO₃, total C, OC, IC, OM determinations for 10 samples from Sample Columns A and B.

<table>
<thead>
<tr>
<th>COLUMN A</th>
<th>Soil horizon</th>
<th>elev</th>
<th>texture</th>
<th>% CaCO₃</th>
<th>% inorg C</th>
<th>% total C</th>
<th>% OC</th>
<th>% OM</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP-1</td>
<td>O/A1</td>
<td>9.500</td>
<td>SCL</td>
<td>27.63</td>
<td>3.32</td>
<td>7.828</td>
<td>4.51</td>
<td>8.0</td>
</tr>
<tr>
<td>SP-2</td>
<td>A2</td>
<td>9.450</td>
<td>SiL</td>
<td>19.15</td>
<td>2.30</td>
<td>3.016</td>
<td>0.72</td>
<td>1.3</td>
</tr>
<tr>
<td>SP-3</td>
<td>Bw</td>
<td>9.350</td>
<td>SiL</td>
<td>15.10</td>
<td>1.81</td>
<td>2.21</td>
<td>0.40</td>
<td>1.1</td>
</tr>
<tr>
<td>SP-4</td>
<td>Bk1</td>
<td>9.250</td>
<td>L</td>
<td>19.82</td>
<td>2.38</td>
<td>2.94</td>
<td>0.56</td>
<td>1.2</td>
</tr>
<tr>
<td>SP-5</td>
<td>Bk2</td>
<td>9.050</td>
<td>L</td>
<td>14.01</td>
<td>1.68</td>
<td>2.261</td>
<td>0.58</td>
<td>1.0</td>
</tr>
<tr>
<td>SP-6</td>
<td>2Bk3</td>
<td>8.850</td>
<td>CL</td>
<td>7.15</td>
<td>0.86</td>
<td>0.897</td>
<td>0.04</td>
<td>0.2</td>
</tr>
<tr>
<td>SP-7</td>
<td>2Bt</td>
<td>8.500</td>
<td>C</td>
<td>0.74</td>
<td>0.09</td>
<td>0.259</td>
<td>0.17</td>
<td>0.1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>COLUMN B</th>
<th>Soil horizon</th>
<th>elev</th>
<th>texture</th>
<th>% CaCO₃</th>
<th>% inorg C</th>
<th>% total C</th>
<th>% OC</th>
<th>% OM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bb-1</td>
<td>A</td>
<td>9.450</td>
<td>SL</td>
<td>17.50</td>
<td>2.10</td>
<td>7.319</td>
<td>5.22</td>
<td>8.0</td>
</tr>
<tr>
<td>Bb-4</td>
<td>C1</td>
<td>9.300</td>
<td>L</td>
<td>16.91</td>
<td>2.03</td>
<td>2.775</td>
<td>0.75</td>
<td>1.7</td>
</tr>
<tr>
<td>Bb-7</td>
<td>C2 (Bt)</td>
<td>9.150</td>
<td>CL</td>
<td>1.13</td>
<td>0.14</td>
<td>0.73</td>
<td>0.59</td>
<td>0.9</td>
</tr>
</tbody>
</table>

Figure 5.8 illustrates percent volume for each sample by grid elevation. The charts are shown next to generalized stratigraphic column from Profiles A and B. Highest values in the profile for all determinations occur in Strata I and III, while the lowest values occur in the lower portions of
Stratum V (Unit 2). A comparison of the curves demonstrates redundant results; the highest values occur at the surface and the lowest at the base of the profile.

**Figure 5.8.** Laboratory determinations for Sample Columns A and B, including percent volume of Calcium Carbonate (CaCO₃), total carbon (total C), organic carbon (OC), inorganic carbon (IC), and organic matter (OM).

Calcium carbonate content was expected to be high for all of the samples given the limestone bedrock and calcareous environment. However, Stratum V appeared to be non-calcareous and lab determinations were used to confirm this observation. The lower portions of Stratum V (SP 7) demonstrated that the sediments comprising Unit 2 are non-calcareous (<3%) and thus were
deposited under different conditions than are present today. Carbonates were detected in the upper portions of Stratum V, probably as a result of secondary accumulations resulting from illuviation from the overlying calcareous sediments.

**Soil pH, EC, %SAT, Gypsum, and SAR**

Soil pH, Electrical Conductivity (EC), Percent Saturation (%SAT), Gypsum, and Sodium Absorption Rate Index (SAR) were determined for a total of seven samples all deriving from Soil Column A (Table 5.6).

<table>
<thead>
<tr>
<th>COLUMN A</th>
<th>Sample</th>
<th>Strata</th>
<th>elev</th>
<th>texture</th>
<th>pH</th>
<th>EC</th>
<th>% SAT</th>
<th>% gypsum</th>
<th>Meq/L gypsum</th>
<th>SAR Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP 1 I (A1)</td>
<td>9.500</td>
<td>SCL</td>
<td>7.34</td>
<td>118.2</td>
<td>39</td>
<td>1.18</td>
<td>13.70</td>
<td>9.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SP 2 I (A2)</td>
<td>9.450</td>
<td>SiL</td>
<td>7.53</td>
<td>37.1</td>
<td>43</td>
<td>3.63</td>
<td>42.20</td>
<td>5.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SP 3 II (Bw)</td>
<td>9.350</td>
<td>SiL</td>
<td>7.40</td>
<td>55.7</td>
<td>45</td>
<td>2.29</td>
<td>26.70</td>
<td>6.10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SP 4 III (Bk1)</td>
<td>9.250</td>
<td>L</td>
<td>7.67</td>
<td>28.7</td>
<td>44</td>
<td>0.71</td>
<td>8.26</td>
<td>4.60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SP 5 IV (Bk2)</td>
<td>9.050</td>
<td>L</td>
<td>7.67</td>
<td>13.3</td>
<td>42</td>
<td>0.00</td>
<td>0.00</td>
<td>3.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SP 6 V (2Bk3)</td>
<td>8.850</td>
<td>CL</td>
<td>7.59</td>
<td>9.0</td>
<td>64</td>
<td>0.00</td>
<td>0.00</td>
<td>1.90</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SP 7 V (2Bt)</td>
<td>8.500</td>
<td>C</td>
<td>7.46</td>
<td>7.0</td>
<td>82</td>
<td>0.00</td>
<td>0.00</td>
<td>1.60</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

These results exhibit a similar pattern as observed in the carbon determinations. The highest values occur at the surface (Stratum I) and then in Stratum III, while the lowest values occur in Stratum V. The results of the Gypsum determinations do not confirm the presence of a Gypsic horizon (<5.0% Gypsum), and the results of the SAR index calculations do not confirm the presence of a Salic horizon (<13.0 SAR).

**ICP-OES Geochemistry**

A total of seven soil samples from Column A (SP 1-7) were analyzed with the ICP-OES. Eighteen total samples were prepared in different solutions as described in the previous chapter.
(Chapter 4). This included seven samples of high moisture extract (SP 1-7), three samples of saturation paste extract in 1:10 dilution (SP 5-7), four samples of saturation paste extract in 1:100 dilution with DI-H$_2$O (SP 1-4), and four samples of saturation paste extract in 1:1,000 dilution in DI-H$_2$O (SP 1-4). Table 5.7 lists the results for Ca, Mg, and Na determinations in milliequivalents per Liter (meq).

Table 5.7. Results for ICP-OES determination of Ca, Mg, Na.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Strata</th>
<th>Soil horizon</th>
<th>Texture</th>
<th>Ca meq/L</th>
<th>Mg meq/L</th>
<th>Na meq/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP 1</td>
<td>I</td>
<td>O/A1</td>
<td>9.500</td>
<td>903.00</td>
<td>294.50</td>
<td>231.96</td>
</tr>
<tr>
<td>SP 2</td>
<td>I</td>
<td>A2</td>
<td>9.450</td>
<td>228.35</td>
<td>82.15</td>
<td>62.44</td>
</tr>
<tr>
<td>SP 3</td>
<td>II</td>
<td>Bw</td>
<td>9.350</td>
<td>440.80</td>
<td>151.67</td>
<td>104.13</td>
</tr>
<tr>
<td>SP 4</td>
<td>III</td>
<td>Bk1</td>
<td>9.250</td>
<td>127.10</td>
<td>49.29</td>
<td>43.57</td>
</tr>
<tr>
<td>SP 5</td>
<td>VI</td>
<td>Bk2</td>
<td>9.050</td>
<td>72.90</td>
<td>26.28</td>
<td>21.12</td>
</tr>
<tr>
<td>SP 6</td>
<td>V</td>
<td>2Bk3</td>
<td>8.850</td>
<td>62.20</td>
<td>21.74</td>
<td>12.48</td>
</tr>
<tr>
<td>SP 7</td>
<td>V</td>
<td>2Bt</td>
<td>8.500</td>
<td>50.40</td>
<td>17.12</td>
<td>9.14</td>
</tr>
</tbody>
</table>

The results of the ICP elemental analysis were used to calculate gypsum content and the SAR index for the seven samples.

**TAPHONOMY**

There were two main objectives for including the taphonomy segment in this study: 1) to include a preliminary faunal analysis, and 2) to aid in reconstructions of the taphonomic and depositional history within the cave. The results presented here were derived from a study of the 2003 faunal assemblage conducted by Ritzman et al. (2004). The preliminary faunal analysis consisted of classifying bone fragments according to Genus or body size class, and skeletal element and portion. The taphonomic analysis was designed to address two primary goals: 1) to reconstruct depositional history and 2) to identify the primary agents of bone accumulation. Two
primary aspects of the taphonomic analysis (Ritzman et al. 2004) included a size-grade analysis of the entire 2003 assemblage and a macroscopic analysis of bone surface attributes.

**Preliminary Faunal Analysis**

A total of 595 specimens from the 2003 sample were included in the preliminary faunal analysis by Ritzman et al. (2004). The purpose of this study was to determine the frequency and distribution of faunal remains according to animal body size class and skeletal element. This analysis provides critical information for reconstructing paleoecological conditions and hominid subsistence at Anghilak Cave. The animal body size class analysis described five classes following Brain (1981). Figure 5.9 summarizes the results of the body size class analysis.

![Figure 5.9. Results of animal body size class analysis for a sample of the 2003 faunal assemblage (Adapted from Ritzman et al. 2004:Figure 14).](image)

The results of the body size class analysis indicate that more than half (52.8%) of the assemblage was classified as medium mammal, followed by small mammal (32.1%), small reptile or tortoise (6.4%), unidentified (5.7%), and finally large mammal (3.0%). In general, the faunal assemblage is dominated by medium to small mammals (83.9%), with Tortoise (*Testudo horsfieldi*) comprising 6.6% of the sample. Figure 5.10 lists species corresponding to these body
size classes reported from other Paleolithic cave sites in Central Asia (Bibikova 1958; Glantz et al. 2002; Movius 1953; Vishnyatsky 1999; Wrinn 2003). These results provide important information regarding community structure and food web interactions.

![Species in Body Size Class Reported at Sites in the Region](image_url)

**Figure 5.10.** lists species corresponding to these body size classes reported from other Paleolithic cave sites in Central Asia (from Ritzman et al. 2004:Figure 10).
A total of 594 individual specimens were also classified according to skeletal element, portion, and segment (Ritzman et al. 2004:Figure 15). The results of this analysis demonstrate that the assemblage is dominated by unidentified long bone shaft fragments (68.2%), followed by unidentifiable fragments (17.0%), and then tortoise (6.4%). The remaining 8.4% of the sample consists of vertebral and rib fragments (2.3%), identified long bone epiphyseal ends (2.4%), cranial fragments and teeth (1.9%), identified long bone shaft fragments (1.3%), and finally, tarsals, carpals, and phalanges (0.5%), in descending order of frequency.

**Size-grade Analysis**

The faunal assemblage was highly fragmentary and all recovered bone fragments (n=18,785 pieces) from the 2003 excavation were manually size-graded (Ritzman et al. 2004). The proximate goal of the size-grade analysis was to quantify the degree of overall fragmentation and to identify variation in the spatial distribution of the fragments. The ultimate goal was to reconstruct taphonomic and depositional history. Results demonstrate a predominance of small pieces, with a vast majority (95%) of the faunal remains measuring less than 3 cm maximum length. Figure 5.11 summarizes the results of the size-grade analysis.

The results of the size-grade analysis were also used to calculate the relative spatial density of bone fragments recovered during the 2003 excavations (Figure 5.12). The results demonstrate that higher densities of faunal remains occur in the western portions of the block excavation or, toward the back of the cave (Ritzman et al. 2004:Figure 11). This could be the result of either differential accumulation or differential preservation. Excavation in the eastern-most unit (N93/E97) exhibits only 5.6% relative spatial density, while the western-most unit (N94/E93) exhibits a 117.2% relative spatial density of faunal remains, more than twenty times as many.
Figure 5.11. Results of size-grade analysis for the entire 2003 sample (n=18,785)(adapted from Ritzman et al. 2004:Figure 13).

Figure 5.12. Relative spatial density and distribution of faunal remains from the 2003 sample (from Ritzman et al. 2004:Figure 11).
This indicates that higher densities of bone have accumulated in the back portion of the cave. Ritzman et al. (2004:Figure 12) also report higher relative spatial densities by level from the 2003 sample. The results demonstrate the highest relative densities occur at grid elevation 9.350 and 9.100, and the lowest densities at 8.900. The higher density accumulations correspond to Stratum II/III and Stratum IV, with the lowest density in Stratum V.

**Bone Surface Attribute Analysis**

A total of 639 fragmentary faunal specimens were included in the macroscopic bone surface attribute analysis (Ritzman et al. 2004). This sample consisted of all specimens >3 cm maximum length that were recovered in 2003. Six attributes were described and recorded: including four abiotic categories (weathering, rounding/abrasion, CaCO3 accumulations) and three biotic categories (green breakage, cutmarks and impact fractures, carnivore modification).

- **Stage 1 weathering** characterized 81.3% of the sample (Ritzman et al. 2004). This indicates that conditions in the cave have remained generally dry and that larger fragments were buried relatively quickly.
- **Stage 1 rounding and abrasion** characterized 88% of the sample (Ritzman et al. 2004). This indicates that fragments were subject to a limited amount of trampling or movement prior to burial.
- **CaCO3 accumulations (NWSM 1)** were observed on up 100% of fragments from some portions of the deposit. The highest frequencies were from Strata I and IV. Stratum is the 10 cm of limestone gravel and compacted silts comprising the cave floor surface and stratum IV is the deepest horizon in deposition Unit 1. This horizon discomformably overlays Stratum V (Unit 2) and contains high gravel content, suggesting that it was the cave floor surface for a long period of time prior to the accumulation of overlaying Stratum III. The lowest values were from the silty Stratum II.
Green breakage patterns were observed on a relatively high percentage (42.9%) of fragments in the 2003 sample.

Cut marks were observed on only five specimens (0.9%) and impact fractures were observed on seven specimens (1.2%). Therefore, direct evidence of human butchery is extremely sparse.

Carnivore modification in the form of tooth marks was observed on 29 specimens (5.1%) from the 2003 sample. This indicates relatively low carnivore consumption or scavenging within the cave.

Although few in number, the presence of carnivore toothmarks (5.1%), stone tool cut marks (0.9%), and impact fractures (1.2%) suggests that some of the bones were accumulated in the cave by hominids and carnivores either by predation or scavenging. The highly fragmentary nature of the assemblage may suggest that animal units were transported to the cave and then intensively processed by both hominids and carnivores. In sum, the results of the bone surface attribute analysis from the 2003 sample is characterized by limited amount of surface weathering, rounding, and abrasion, but exhibits a high frequency of green breakage patterns. Accumulations of CaCO$_3$ indicate post-depositional weathering within the cave deposits.

**SUMMARY AND CONCLUSIONS**

The 2003-2004 investigations included two seasons of fieldwork (eight weeks) and six months of laboratory analysis. The UASAP investigations have yielded a wealth of data in all three disciplines (archaeology, geomorphology, and taphonomy) integrated into this research methodology. The results of the investigations have produced the necessary information to develop a reliable, chronometrically dated stratigraphic framework for the site. In the next chapter (Chapter 6), I will synthesize the results into a discussion following the five research questions outlined under the proximate goal of developing a stratigraphic framework. In the final
chapter (Chapter 7), I will use the stratigraphic framework to draw conclusions to questions outlined under the ultimate goal of interpreting human paleoecology at the cave.
CHAPTER 6. DISCUSSION AND SYNTHESIS

The proximate goal of this research was to develop a reliable, chronometrically dated stratigraphic framework to support preliminary interpretations of Middle Paleolithic occupation (Glantz et al. 2003) and to support interpretations of human paleoecology at Anghilak Cave during the Late Quaternary. This was accomplished by developing an interdisciplinary methodology that integrated concepts and methods from archaeology, geomorphology, and taphonomy, into a single analytical framework aimed at reconstructing depositional history and post-depositional weathering processes within the cave. These investigations were guided by five primary research questions pertaining to cave geomorphology, absolute age, depositional history, post-depositional weathering, and taphonomy. This section provides a discussion and synthesis of the results as they pertain to each of the five questions, with each question presented as a heading.

- **HOW DID THE CAVE FORM?**

  Anghilak Cave is a small east-facing cave, measuring about 8 x 8 m within the drip line. It is more similar to a rockshelter in size and shape; however, the cave can be defined as a passive karst cave formed as the result of bicarbonate solution in joints and fissures of Lower Devonian Limestone (Gillieson 1996; Woodward and Goldberg 2001). Following Courty and Vallverdu (2001:Figure 7), the current conditions at Anghilak can be classified as a Type 1 system.
characterized by long-term drying, external soil deflation, and strong winds. Today, net-loss of sediment predominates, but minor accumulations from allogenic eolian and alluvial sheetwash inputs are present.

It is likely that the cave formed in the subsurface after the original uplift of the Karatube Hills, perhaps during the Cenozoic Era. The karst cave appears to have formed under active conditions (i.e., saturated for part of the year). This is indicated by the presence of solution cavities in the back walls of the cave and by the presence of well-sorted, non-calcareous sediments of allogenic origin (Unit 2) buried beneath poorly-sorted, calcareous sediments of mixed origin. The old solution cavities are weathered and occur along linear structural joints and cracks in the walls and ceiling of the cave. These linear joints and cracks criss-cross roughly north to south through the back portions of the cave, forming a small natural chimney in the roof.

The original karst likely formed in solution along the joints and cracks, following mountain uplift, but prior to exhumation of the bedrock and formation of the cave. The lack of secondary bicarbonate deposits (e.g., travertine, speleothems, stalagmites) within the cave is likely the result of intense erosion of the cave surfaces after exhumation of the bedrock. The exhumation of the bedrock likely occurred during the colder and drier conditions typical of the Pleistocene. As the overlying soil mass was deflated and eroded away, the surface of the limestone bedrock was exposed (Courty and Vallverdu 2001). Subsequent weathering and erosion deteriorated the bedrock along cracks and fissures, allowing the long-buried karst to become exposed and open.

The bedrock that forms the mouth of the cave slopes below the surface at both sides of the cave mouth just outside of the drip line. Two grid excavations were placed at the mouth of the cave outside of the drip line and bedrock was encountered within 10 to 15 cm of the surface. However, the back portion of the cave contained deep sediments in an area where the subsurface bedrock is eroded and drops off to an unknown depth, about 3 to 4 meters from the back wall of the cave. This may be the original karst that has been exhumed, eroded, and filled with sediments.
There is a large block of weathered bedrock that underlies both depositional Units 1 and 2 and is located between the back wall of the cave and the edge of the bedrock. The upper portion of the boulder protrudes into both overlying sedimentary Units and was only about 25 cm below the present ground surface at its highest point (see Figure 5.5: Profile B). The upper surface is weathered smooth and was likely exposed during the Paleolithic occupation of the cave. This large block may have detached from and collapsed into the karst opening, forming a partial plug and allowing sediments to accumulate within the karst opening. This block may have been deposited in the karst prior to exhumation of the bedrock. After exposure, the bedrock then continued to deteriorate and erode, eventually completely opening the cave and leaving the top of the boulder protruding above the surrounding sediments.

The current ground surface and the underlying limestone bedrock within the cave slope downward toward the back of the cave (see Figure 3.4b: Anghilak Cross-Section). This is a bit atypical, as most caves slope downward from the back to the mouth as sediments, clasts, and roof fall accumulate inside. Roof fall was observed both on the surface of the cave’s floor and contained within the subsurface deposits. One large block of roof fall occurred within the northern portion of the excavation area (see Appendix B: Profile D). It was completely contained within Unit 1 (Strata I-III) and appears to have been deposited sometime during the Late Pleistocene or early Holocene, as the bottom of the boulder rests on top of Stratum IV. This may indicate that it detached from the ceiling during the Last Glacial Maximum (OIS 2). The block was broken-up with picks and removed from the excavation area to allow excavations to continue below the rock. Artifacts and bone were recovered from the sediments below the boulder, particularly a large number of Tortoise (*Testudo horsfieldi*) bone fragments.

- **HOW OLD ARE THE DEPOSITS WITHIN THE CAVE?**

There are two primary depositional units (Units 1 and 2) within the cave that are separated by an abrupt, irregular disconformity (Figure 6.1). The two depositional units comprise five
stratigraphic layers (Strata I to IV). A total of five AMS radiocarbon dates were obtained from charcoal samples mapped and collected in grid excavation unit N94/E93. All five dates came from within 50 cm of one another horizontally in the southern half of the unit. They were selected for submission to the University of Arizona AMS Laboratory based on depth within the deposit and then size of the charcoal specimen. All dates referred to in this discussion are uncalibrated radiocarbon ages.

Figure 6.1. Generalized stratigraphic column of sediments within Anghilak Cave.
Unit 1 (Strata I to IV)

Strata I through IV comprise Unit 1, and overlay the older Unit 2 (Stratum V). Four AMS radiocarbon dates were obtained from charcoal samples recovered from Unit 1. They range from about 3,000 to 44,000 BP and span only 60 cm of the deposit. The most recent date of 2,978±34 was obtained from charcoal at the boundary between Strata II and III. This indicates that the shallow cultural horizons observed in Strata I and II represent very recent occupations of the cave. The next youngest date of 27,310±270 BP was obtained from charcoal at the boundary between Strata III and IV. This date indicates that Stratum III spans the Last Glacial Maximum, the Late Pleistocene, and the Early Holocene. This layer is only about 10 to 20 cm thick and the dates recovered from the upper and lower boundaries span almost 25,000 years. Artifacts were encountered throughout Stratum III across the entire excavation area. In addition to the upper contact of Stratum IV dating to 27,310 BP, two dates were obtained from charcoal samples within Stratum IV. The oldest date from Stratum IV was 43,900±2,000 BP and the third sample yielded a date of 38,100±2,100 BP. Unfortunately, the oldest date came from the middle portion of Stratum IV and the more recent date was from a deeper sample recovered near the lower boundary. Stratum IV is between 15 and 30 cm thick and the radiocarbon ages span at least 20,000 years. This layer also exhibits some mixing from krotovina and other unidentified intrusions (see Profiles A and B in Figures 5.4 and 5.5). The lower boundary of Stratum IV is abrupt and irregular, and disconformably overlays the underlying non-calcareous Stratum V.

Unit 2 (Stratum V)

The age of Stratum V remains unknown, but was likely formed while the cave was still buried. A single charcoal sample recovered from the upper few centimeters of the deposit yielded an uncorrected radiocarbon date of >26,300 BP. It is likely that this sample exceeded the upper limit of radiocarbon range, given the age of overlying Stratum IV. The upper portions and
boundary of Stratum V are highly irregular and appear to have been exposed for a long period of time while the cave was opening, and prior to the accumulation of overlaying Stratum IV. The sediments comprising Stratum V (Unit 2) are non-calcareous and are therefore, allogenic in origin. These sediments may have been deposited during the Late Tertiary, perhaps during the Pliocene.

Summary

Unit 1 (Strata I through IV) was deposited during the Late Pleistocene. Dates obtained from charcoal samples recovered from grid excavation unit N94/E93 yielded uncorrected AMS radiocarbon ages ranging from 2,978 to 43,900 BP. Strata I and II are the most recent and were likely deposited during the last 3,000 years of the Holocene. Strata III is up to 20 cm thick and spans about 25,000 years, including the Last Glacial Maximum, the Late Pleistocene and Early Holocene. This is based on dates of 2,978±34 to 27,310±270 BP obtained from the upper and lower boundaries, respectively. Stratum IV was deposited during the Last Full Glacial as indicated by two dates of 43,900±2,000 and 38,100±2,100 BP. Stratum V (Unit 2) is the oldest deposit and yielded a date of >26,300 from its upper boundary. This boundary forms a disconformity with overlying Unit I and may have been exposed for a long period of time prior to burial by overlying Unit 1 sediments. These deposits may have formed during the Early Quaternary or Late Tertiary.

• WHAT IS THE DEPOSITIONAL HISTORY WITHIN THE CAVE?

Particle size analysis (granulometry) of cave and rockshelter sediments has long been recognized as an effective method for reconstructing depositional history (Colcutt 1979; Laville 1976; Shackley 1972) and is based primarily on the identification and interpretation of non-uniform patterns of distribution of coarse fragments and other particulates such as artifacts and
bone (Stein and Farrand 2001). The sediments contained within Anghilak Cave are composed of two primary depositional Units (1 and 2) separated by an abrupt, highly irregular disconformity dating to at least 50,000 ka. The older underlying Unit 2 consists of non-calcareous, well-sorted clays of allogenic origin, while the overlying Unit 1 consists of calcareous, poorly-sorted silty loam, gravels, and rock fragments, as well as artifacts and bone fragments. This indicates that the two depositional units were formed under very different conditions. In this section, I will discuss the older Unit 2 (Stratum V) first, then the disconformity, and finally Unit 1 (Strata I-IV). Refer to Figures 5.4, 5.5, and 5.6 in the previous chapter (Chapter 5) for detailed illustrations and descriptions of the deposits.

**Unit 2 (Strata V)**

Unit 2 (Stratum V) consists of non-calcareous (0.74 to 7.0% CaCO$_3$) sediments containing very sparse limestone rock fragments (<3%), indicating that the sediments were derived from an allogenic source. The deposit is composed of well-sorted, laminated clays that were likely deposited by occasional flooding and pooling within the karst prior to opening. Silts and clays are frequently transported by infiltration through cracks and conduits in the bedrock of active caves in karstic regions of the Mediterranean (Woodward and Goldberg 2001). The clays comprising Unit 2 in Anghilak Cave were likely deposited in this manner. They are well-sorted (>90% fines) and occur in layers and nodules that are indicative of highly saturated clays flowing, dripping, and pooling. The bedrock chimney in the roof of the cave could have been where sediments were able to infiltrate into the karst and then flow or drip down the walls and accumulate around the large bedrock plug or block that was previously deposited. Only about 25 cm of the large weathered limestone block protrudes above the upper contact of the of Unit 2 (Stratum V).

The clays are predominantly red and pink, with some orange and greenish layers in the upper portions. The color suggests that they formed in an oxidizing environment, such as a subsurface
cave that was dry for part of the year (Courty and Vallverdu 2001). The discoloration of the upper portions of the deposit is likely the result of CaCO$_3$ accumulations from the overlying calcareous sediments, and possibly from weak reduction and oxidation concentrations along the contact (Soil Survey Staff 1996). The results of the CaCO$_3$ determinations on two samples from Stratum V demonstrate that carbonates decrease from 7.15 to 0.74 percent from the upper to lower portions, supporting the first scenario of illuviation of carbonates.

The Unit 2 sediments are deformed in the southwest corner of the cave. South of the N94 grid line and the weathered limestone roof fall, the laminated clay deposits dip to the southwest at angles up to 15 degrees. North of the N94 grid line, the laminated clays are level and parallel to the cave floor surface. This may be the result of subsurface cavities below Stratum V that have collapsed as a result of tectonic activity. Earthquakes are common in Uzbekistan and a major event could have dislodged debris that had plugged the cavity, causing the Stratum V sediments to collapse and deform. The upper contact of Unit 2 (Stratum V) has also been disturbed by bioturbation as indicated by several large krotovina (up to 30 cm max diameter) along the boundary. These large krotovina may be explained by the presence of abundant tortoise carapace fragments and skeletal remains in the deposits. The Central Asian tortoise (*Testudo horsfieldi*) is common to the region and lives in burrows up to 2 m below the ground surface (Bergmann 2001). The larger krotovina appear to be the appropriate size to accommodate a tortoise.

**The Disconformity**

The abrupt and highly irregular boundary that separates depositional Units 1 and 2 is a major disconformity indicating significant change in the caves geomorphology and depositional environment. The predominant mode of deposition shifted from allogenic infiltration from the overlying soil mantle to mixed autogenic and allogenic accumulations from a variety of sources, such as exfoliation, spalling, in wash, sheet wash, and eolian. Following Courty and Vallverdu (2001:Figure 7), the disconformity represents a shift from a Type 5 system characterized by
accumulations from massive in-wash, soil erosion, runoff, and infiltration, to a Type 1 system characterized by accumulation from eolian inputs and external soil deflation.

The disconformity appears to be at least 50,000 years old as indicated by a date of 43,900 BP from about 10 cm above. As suggested earlier, the exhumation of the bedrock and formation of the cave likely occurred during the drier conditions typical of the Pleistocene. As the radiocarbon dates from the contact and the sediments immediately overlying it suggest, the cave was likely open and habitable by as early as the Last Interglacial (OIS 5). The upper surface of Unit 2 (Stratum V) was exposed for an unknown length of time prior to the accumulation of the overlying Unit 1 sediments (Strata I-IV). The highly undulating and irregular nature of the contact suggests that considerable mixing has occurred both during the process of burial (e.g., sheet wash, trampling) and more recently in the form of animal burrowing (krotovina). The oldest hominid occupations are associated with this contact, but have likely been displaced or have accumulated as a palimpsest with limited potential for temporal or spatial resolution.

**Unit 1 (Strata I – IV)**

Unit 1 ranges from 50 to 80 cm in thickness and is stratified by minor changes in texture, color, and chemistry. It can be divided into at least four stratigraphic horizons (Strata I-IV). Artifacts and bone were recovered from all four horizons, but in varying densities. Unit 1 is a mix of allogetic and autogenic materials. Autogenic limestone gravels comprise about 20 to 25 percent of the deposit and were derived from roof fall, surface exfoliation, spalling, and subsequent decomposition (see Table 5.4, Figure 5.7). Allogenic particulate contributions derive from carnivores, scavengers, prehistoric hominids, and recent human activities. The following discussion of horizon formation will be presented from oldest, or deepest (Stratum IV), to the present cave floor surface (Stratum I). A discussion of the distribution of coarse fragments, artifacts, and bone fragments is presented under a separate heading: Distribution of Coarse Fragments.
Stratum IV dates to the Last Full Glacial period (OIS 3) and contains Mousterian artifacts (Glantz et al. 2003) and hominid skeletal remains (Glantz et al. 2004, 2006). AMS radiocarbon dates range from 27,310 to 43,900 BP. Stratum IV disconformably overlays Stratum V (see Figure 5.4) and ranges from 15 to 30 cm in thickness. The lower boundary is abrupt and highly irregular. Gravel densities increase with depth, comprising 28% of the sediments at the upper contact and 40% in the lower portions. The density of gravels at the lower boundary is indicative of slow aggradations of fine sediments and long-term exposure.

The sediments comprising Stratum IV appear to have been deposited over a 15,000 to 20,000 year period. The lower portions contain high gravel content and likely accumulated slowly as the bedrock was fully exhumed and the cave opened and formed. The abrupt and irregular lower boundary indicates that the cave floor was leveled during the formation of Stratum IV. This was probably the result of a variety of agents, such as in-filling from colluvium, eolian, and sheet wash alluvium, as well as trampling from hominid and other faunal use of the cave. During the 2004 excavations, dense gravel lenses and pockets were observed in low-lying areas along the lower boundary of Stratum IV (see Figure 5.4: Profile A). These accumulations are indicative of in-washing episodes after the cave had opened. Artifacts and bone occur in higher densities in Stratum IV than in both underlying (Stratum V) and overlying (Stratum III) horizons (Ritzman et al. 2004).

There is evidence of bioturbation in the form of krotovina ranging from 5 to 30 cm in diameter, probably formed from burrowing animals such as rodents and Tortoise (Testudo horsfieldi). However, portions of Stratum IV appear to be well preserved, particularly areas underlying roof fall blocks (Figure 6.2). These areas contained high frequencies of charcoal in the form of chunks up to 15 mm max length. Artifacts and bone were also recovered from these portions of the horizon, including an abundance of tortoise carapace fragments.
There appears to be limited potential for the archaeological data derived from this horizon to provide time sensitive resolution regarding hominid occupations. In other words, the deposit represents a palimpsest of occupational episodes accumulated over a long period of time, and discerning individual occupation episodes would be extremely difficult and would require an extremely detailed excavation methodology. However, a thorough spatial analysis based on the 2003-2004 excavation data would likely yield important information about the distribution of artifacts associated with Stratum IV, perhaps on the order of 3,000 to 5,000 years.

**Stratum III** spans a vast amount of time and is only 10 to 25 cm thick. According to AMS radiocarbon dates from the upper (2,798 BP) and lower contacts (27,310), the sediments span the Last Glacial Maximum (OIS 2), the Terminal Pleistocene (OIS 2/1), and first half of the Holocene (OIS 1). This horizon contains slightly increasing densities of gravel with depth. The
lowest observed densities of artifacts and bone are associated with this horizon, suggesting a decreased use of the cave by hominids.

**Stratum II** dates to the Late Holocene and ranges from 2 to 15 cm in thickness. This horizon contains a relatively low density of gravels (13%) and the highest content of silt (46%) within depositional Unit 1 (Strata I-IV). This horizon is not continuous throughout and only occurs in the back portions of the cave. It contained a high frequency of chipped stone artifacts and bone fragments. Modern thermal features and cultural horizons (i.e., Late Holocene) occur at the upper contact or are intrusive into Stratum II.

**Stratum I** extends from the cave floor surface to about 15 cm maximum thickness. Radiocarbon dates from 10 cm below the lower boundary indicate that the sediments were very recently deposited (<2,000 BP). The upper 5 cm of Stratum I (A1) consists primarily of coarse sand and gravels (48%) forming a thin pavement over the cave floor surface. Fine sediments such as silt (13%) are likely being stripped away by wind deflation, leaving the gravels to accumulate at the surface. The lower 5 to 10 cm of Stratum I (A2) consist of a compact layer of dense gravels and silts.

Stratum I sediments are highly compact. This is likely the result of recent trampling by humans and livestock that frequently use the cave. There are several recent thermal features and a continuous charcoal and ash stain associated with this horizon (see Figure 5.4: Profile A). Most of the features are small circular basins filled with charcoal stained sediments. The basins of these small hearths were often excavated into underlying Stratum II. Modern trash such as glass, bottle caps, ceramic roof tile fragments, and bone, occurred within this horizon.

**Distribution of Coarse Fragments**

A comparison of coarse fragment classes by grid elevation demonstrates a non-uniform vertical distribution through the profile in the back portions of the cave (Figure 6.3). This suggests that different processes and agents are responsible for the varying distribution and
Figure 6.3. A comparison of coarse fragment classes by grid elevation demonstrating a non-uniform vertical distribution. The chart on the left illustrates the distribution of gravels (>2 mm) and coarse sand (1-2 mm) from the Particle Size Analysis, while the chart on the right illustrates the vertical distribution of mapped chipped stone (CS) artifacts from and mapped bone fragments from grid excavation unit N94/E93, as well as chipped stone artifacts recovered from dry screen samples from grid excavation unit N93/E92.
density of particulate classes. In this comparison, coarse fragments consist of gravels (>2mm), coarse sand (1-2 mm), mapped chipped stone artifacts (>2 cm) and bone fragments (>3 cm) from grid excavation unit N94/E93, as well as chipped stone recovered from the dry screen samples for each 5 cm level through the east half of grid excavation unit N93/E92. Mapped chipped stone and bone from N94/E93 were selected because the unit was excavated through the entire deposit and contained no large roof fall blocks. In addition, sediment descriptions and samples were located in the southwest corner of the unit, and all five AMS radiocarbon dates were obtained from charcoal recovered from the grid unit. The chipped stone dry screen sample from N93/E92 was selected because it was also excavated through the entire deposit, contained no large roof fall blocks, and because chipped stone for each level was counted in the field and entered onto data forms. Dry screen sample artifacts were inconsistently counted in the field and have not yet been counted in the lab.

Chipped stone artifacts were undoubtedly deposited by hominids, and thus provide a rough yardstick for measuring the intensity of human occupation when compared to the provenience of acquired AMS radiocarbon dates. Hominids, carnivores, scavengers, birds, and injured or sick animals seeking refuge in the cave were likely the primary agents of bone accumulations. Gravels and coarse sand accumulations were likely the result of physical processes such as cave wall erosion and colluvium, or low energy sheet wash or surface rill alluvium. A shallow rill was observed on the surface flowing from the dripline to the back in the southern portion of the cave.

Several interesting trends are illustrated in the comparison of coarse fragment classes presented in Figure 6.3.

1) There is a sharp decrease of all coarse fragment classes between grid elevation 8.950 and 9.050. This corresponds to the highly irregular upper disconformity between Stratum IV and V, depositional Units 1 and 2. Gravels drop from 24% to less than 3%, and coarse sand drops from 10% to zero. The number of chipped stone artifacts recovered from dry screen samples from the east half of grid unit N93/E92 drops from 40 to zero.
within 10 cm (9.05 to 8.95), with excavations ending entirely within Stratum V. Mapped chipped stone and bone fragments from grid unit N94/E93 both exhibit a noted decrease at this depth; however, mapped chipped stone and bone fragments continue in varying densities to a depth of 8.70. This can be explained by the highly undulating boundary between Stratum IV and V, which forms a small shallow depression extending 20 to 30 cm below the surround depth of the contact. This is illustrated in Figure 5.4: Profile A. An abundance of artifacts were mapped and recorded within Stratum IV sediments where the contact dipped. All grid units were excavated into the upper portions of Stratum V (Unit 2) and the density of artifacts and bone decreased sharply across the excavated areas in the back of the cave. This indicates that Stratum V (Unit 2) sediments were deposited prior to exhumation of the bedrock and formation of the cave – before the earliest hominid occupations. Artifacts, bone fragments, and gravels were observed in direct association with the upper contact of Stratum V, suggesting that the sediments were present when the cave opened and hominids and other fauna began to use the cave.

- 2) The highest density of mapped chipped stone and the second highest density of dry screened artifacts occur at 9.05, within the upper half of Stratum IV. Two charcoal samples from 5 cm above and below this level yielded AMS radiocarbon dates of 27,310 and 43,900, respectively. Gravel content increased with depth through Stratum IV, with the highest density of gravels in the subsurface occurring at grid elevation 9.00, and at the contact between Strata IV and V. However, an unexpected trend in artifact density occurs at this elevation. According to the results presented in the comparison chart, the overall number of chipped stone artifacts decreases in the lowest portions of Stratum IV. This is contrary to what was observed in the field during excavations. Typically, abundant artifacts and bone were observed along the lower boundary of Stratum IV and the upper few centimeters of Stratum V. This may be the result of a highly undulating
lower boundary within N94/E93. However, this level was excavated on the last day of the 2003 field season and excavations may have been hurried. Despite the low frequency of mapped chipped stone (n=4), more than 75 specimens were recovered from the dry screen samples corresponding to this level.

- 3) The highest overall densities of artifacts and bone correspond to the lowest density of gravels throughout Unit 1 (Strata I-IV). This occurs at 9.350, within Stratum II, and about 15 cm below the cave floor surface. This indicates that there was relatively frequent use of the cave during the Late Holocene and that artifacts and bone comprise a substantial proportion of the coarse fraction.

- 4) The lowest frequencies of chipped stone and bone fragments are associated with Stratum III (9.150 to 9.250). There is also a noted decrease in gravel content compared to the underlying Stratum IV. This overall decrease in coarse fragments may indicate a more rapid accumulation of fine sediments, such as the loess deposits that correspond the glacial episodes throughout the Pleistocene. Dates from this horizon span the Last Glacial Maximum (OIS 2) and early Holocene (OIS 1). This horizon may also correspond to the lack of Upper Paleolithic assemblages that Ranov and Davis (1979) attribute to the extreme glacial conditions.

The comparison of different coarse fragment classes illustrates a non-uniform vertical distribution through the profile. A few interesting trends were observed. Artifacts were observed throughout depositional Unit 1 (Strata I-IV), but appear to occur in higher frequencies at two different depths within the deposit, including the upper portions of Stratum IV and the lower portions of Stratum II. Stratum IV dates to the Last Full Glacial and Stratum II dates to the Late Holocene, suggesting that the most frequent exploitation of the cave occurred during these periods.
• **HOW HAVE THE CAVES DEPOSITS WEATHERED?**

Post-depositional weathering processes are evident in the back portions of the cave. These processes include oxidation (discoloration) and illuviation and accumulation of CaCO$_3$. The sediments inside the cave were moist throughout most of the profile, even during July, the hottest, driest month of the year in Uzbekistan. The back portion of the cave is flat and lower in elevation than the mouth and drip line. During the excavations, rainwater was observed flowing into the cave from the drip line as sheet wash and small rills. This suggests that water occasionally pools in the cave allowing the moist subsurface conditions to be maintained, and saturation to occur periodically.

The cave is only 8 m deep from the drip line to the back wall and most of the cave floor receives direct sunlight until about noon (see July shade map in Appendix B). Organic contributions to the cave were likely sparse in the past. However, sparse plants occur within the cave, and rotted roots were observed in the excavation area, suggesting that plants may have been more common during moister periods in the past. Other organic contributions in the past could have included manure deposited by animals seeking shelter and from decomposing animal carcasses, as were observed during field excursions to other small caves surrounding Anghilak. Today, there are substantial contributions of manure from grazing livestock. Children tending flocks would commonly bring livestock to the cave.

Oxidized sediments were observed at varying locations throughout the deposit. Three observed trends were noted. First, Stratum II (Bw) is slightly more reddish in color than the overlying and underlying horizons. This is possibly the result of oxidized organics at or near the surface, suggesting weak soil development at the surface. Second, the lower portions of Stratum III (Bk1) are lightly oxidized in the back portions of the cave. The origin of this discoloration is unknown, but may be explained by subsurface water periodically saturating the lower portions of Unit 1 (Strata III-IV) as a result of accumulation above the more impermeable clays comprising
Unit 2 (Stratum V). As the subsurface water transpires upward through the sediments, oxidation may have occurred at the upper limits of the saturation. This is also apparent at the upper contact of Unit 2 (Stratum V), where subsurface water was likely to accumulate because it is composed of impermeable clays. Finally, oxidized sediments were observed in the few centimeters overlying the larger weathered block of limestone in grid unit N94/E94. Again, this is likely the result of periodic saturation from subsurface water percolating through the profile, then accumulating in the few centimeters overlying the impermeable limestone, and then evaporating.

The most prominent evidence of post-depositional weathering is in the form of illuviated CaCO$_3$. Carbonates were observed in Unit 1 and the upper portion of Unit 2 during excavations and at the sediment description column (Column A). They ranged from fine filaments in Strata II and III to cemented nodules containing gravels and bone fragments at the bottom of Stratum IV. Laboratory results indicate a general decrease of CaCO$_3$ below Stratum III and an unexpectedly low percentage in Stratum IV; however, the highest densities and largest nodules observed during the excavations were within Stratum IV, particularly the lower portions overlying the more impermeable clays of Stratum V. This is also confirmed by the bone surface attribute analysis (Ritzman et al. 2004). Bone fragments exhibiting accumulations of CaCO$_3$ were most abundant in Strata I and IV where nearly 100% of the analyzed specimens from these levels exhibited carbonate accumulations (Ritzman et al. 2004:Figure 20). A possible explanation for the unexpectedly low percentage of CaCO$_3$ in Stratum IV is that the analysis was performed on the fine fraction from sediment samples, rather than on mechanically ground samples. In other words, the carbonates in Stratum IV predominantly occur in the form of cemented nodules and bone accumulations, and these were not accounted for in the laboratory determinations. In contrast, the percentage of CaCO$_3$ is highest in Stratum III where carbonates occur in the form of filaments and small nodules that were incorporated into the fine fraction used in the analysis.

The post-depositional weathering processes identified in the field and confirmed in the laboratory are indicative of weak pedogenesis or soil formation within the back portions of the
cave. Based on the horizon descriptions and lab determinations, the surface soil within the back portions of the cave can be classified as a Typic Haplocalcid with slightly moister conditions (Ustic?)(Soil Survey Staff 1996). A Calcic horizon (Bk2; Stratum IV) was identified based on the presence of abundant cemented carbonate nodules and accumulations on bone. Another notable trend in the upper portions of the deposit is the considerable amount of total Carbon and Organic Matter in Stratum I (A1 and A2), combined with the highest levels of soluble salts (SAR Index 9.5) and Gypsum (3.63%)(see Table 5.6 and Figure 5.8 in the previous chapter). These trends may be explained by recent grazing livestock contributions. However, this may also correspond to the increased erosion of salts from the basin of the receding Aral Sea that has been observed in the last 50 years (Merzlyakova 2002). Silty Stratum II (Bw) is slightly reddish in color and may be an oxidized A horizon that has been truncated at the surface by recent cave use. A date of about 3,000 years was obtained from the bottom of this horizon, which may indicate Holocene soil development. The underlying Bk horizon (Stratum III) is about 15 – 20 cm thick and contains dense filaments of CaCO₃.

Stratum IV (Bk2) is the most important in this discussion because it has yielded three radiocarbon dates ranging from 27,310 to 43,900 BP. This horizon is slightly darker in color and contains dense gravels, oxidized sediments, and cemented carbonate nodules. Because the lower boundary of this horizon is the disconformity with Stratum V (Unit 2), it likely contains the remains of the earliest occupations of the cave. Excavations also revealed a higher density of chipped stone and bone associated with this depth. The slightly darker color coupled with the oxidation and secondary carbonate accumulation in the upper portions of the underlying Stratum V suggests relatively long-term cave floor stability during the deposition of this layer. According to the radiocarbon dates, the deposition and formation this horizon occurred during the Last Full Glacial period (OIS 3). Stratum IV exhibits similar properties as the modern surface soil (oxidation, CaCO₃), and may represent weak soil development corresponding to periodic warmer periods of OIS 3 and 4.
**WHAT IS THE TAPHONOMIC HISTORY OF THE CAVE DEPOSITS?**

The taphonomic analysis of the 2003 faunal assemblage consisted of a preliminary faunal analysis (n=595), a size-grade analysis of the entire assemblage (n=18,785), and an analysis of bone surface attributes (n=639). The goals of the investigation were to identify the primary agents of bone accumulation and to aid in reconstruction of depositional history.

The results of the preliminary faunal analysis demonstrate that the 2003 assemblage is dominated by medium mammals (52.8%), such as wild goat and sheep (*Carpra* and *Ovis*), followed by small animals (32.1%) and tortoise (*Testudo horsfieldi*)(6.4%). This is typical of Middle Paleolithic faunal assemblages from across the Old World, where medium ungulates dominate and small animals comprise a smaller proportion of the assemblage but have important implications regarding diet and subsistence ecology (Klein and Cruz-Uribe 2000; Speth and Tchernov 2002; Stiner 1994, 2005; Stiner et al. 2000; Vishnyatsky 1999). Many sites in Central Asia contain tortoise remains (e.g., Aman-Kutan, Khudji, Obi-Rakhmat, Ogzi-Kichik, and Teshik-Tash)(Vishnyatsky 1999), but no thorough zooarchaeological analyses of small game assemblages have yet been conducted for Central Asian assemblages. Moreover, excavation methods were typically coarse-grained (see Movius 1953) and many small faunal remains were not likely recovered or recorded from many sites (see also Glantz et al. 2002).

The faunal assemblage is dominated by long bone shaft fragments (69.5%), followed by unidentified fragments (17.0%), and then tortoise carapace and skeletal fragments (6.4%). In addition to the predominance of long bone shaft fragments, nearly half (42.9%) of the assemblage exhibited green bone breakage patterns. This pattern is indicative of long bone processing for marrow extraction (Todd and Rapson 1988). In comparison, the relatively low frequency of carnivore tooth marks (5.1%) suggests that the green breakage patterns and preponderance of long bone shaft fragments is likely the result of hominid subsistence activities, rather than carnivores. Further, there is a very low frequency of long bone epiphyseal ends (2.36%).
Bartram and Marean (1999) provide ethnoarchaeological evidence that the type of assemblage recovered from Anghilak Cave (i.e., abundant long bone shaft fragments and a paucity of epiphyseal ends) can be explained by indirect interactions of hominids and carnivores, where hominids procure and transport long bones to the site and then process them for marrow extraction, leaving highly fragmentary shaft fragments and epiphyseal ends. Subsequently, scavenging carnivores (e.g., cave hyena, bear) would then consume and/or remove the remaining epiphyseal ends, and thus leave a faunal assemblage dominated by long bone shaft fragments (Marean and Spencer 1991). Figure 6.4 provides a simplified taphonomic model illustrating this hominid-carnivore interaction and the resulting faunal assemblage pattern.

Figure 6.4. Ritzman et al. (2004:Figure 29) simplified taphonomic model explaining the preponderance of long bone shaft fragments and green breakage patterns, and lack of epiphyseal ends at Anghilak Cave (adapted from Bartram and Marean 1999).
Other agents may be responsible for the differential frequency of skeletal element portions, such as geologic destruction (Stiner et al. 2001). However, epiphyseal ends typically exhibited the highest bone density for long bones, and these portions are expected to survive in higher frequencies than less dense shaft fragments (Lyman 1994).

Tortoise (*Testudo horsfieldi*) carapace shell fragments comprise 6.4% of the 2003 faunal assemblage (Ritzman et al. 2004), and also occurred in high frequencies in the 2002 test excavation assemblage (Glantz et al. 2003). The presence of tortoise is interesting for two reasons: 1) tortoise are known to occur in many Middle Paleolithic faunal assemblages throughout the Old World, and are commonly believed to represent an important component of hominid diet (Speth and Tchernov 2002; Stiner et al. 1999, 2000); and 2) the Central Asian tortoise burrow up to 2 m into subsurface sediments (Bergmann 2001), suggesting that tortoise may have inhabited the cave and were not necessarily transported by hominids and carnivores. No stone tool cut marks or other evidence of hominid processing was observed on tortoise faunal remains; however, carnivore tooth punctures were noted on several fragments in the assemblage (Ritzman et al. 2004:Figure 26). Sampson (2000) conducted a taphonomic analysis of tortoise assemblages accumulated by African Bushmen and raptors in caves in South Africa. This study demonstrates that the assemblages deposited by these two different agents are distinguishable based on differential skeletal element frequencies and overall condition of the fragments. A more rigorous analysis of the tortoise remains from Anghilak Cave, particularly those from Stratum IV, would likely yield important information regarding the primary agents of tortoise bone accumulations and hominid subsistence ecology.

The size-grade analysis of the 2003 faunal assemblage demonstrated that small fragments (<3 cm max length) predominated (95%) the 18,785 fragments included in the analysis. This would suggest that skeletal remains remained on the surface of the cave for a long period of time and were subject to a variety of taphonomic forces (e.g., trampling) prior to burial. Conversely, the results of the maximum weathering (81.3% Stage 1) and rounding/abrasion (88.0% Stage 1)
analyses on 639 larger fragments (>3 cm) suggest that skeletal remains were buried quickly and were not subject to intense taphonomic forces. These attributes also suggest a relatively constant rate of deposition throughout the deposit; however, evidence of varying rates of deposition is provided by non-uniform vertical distributions of coarse fragments.

**SUMMARY AND CONCLUSIONS**

The proximate goal of these investigations was to develop a reliable, chronometrically dated stratigraphic framework by integrating concepts and methods from archaeology, geomorphology, and taphonomy into a single methodological and analytical framework. The investigations were guided by five primary research questions concerning the cave’s geomorphology, absolute age, depositional history, post-depositional weathering, and taphonomy.

Anghilak Cave is a small, passive limestone karst cave. There are two primary depositional units (Units 1 and 2) comprising at least five stratigraphic horizons (Strata I-V) in the back portions of the cave. Unit 1 (Stratum I-IV) is the most recent and produced four AMS radiocarbon dates ranging from 2,798 to 43,900 BP. Three of the four dates were recovered from Stratum IV, the deepest horizon within depositional Unit 1, and produced dates between 27,310 and 43,900. This suggests that Stratum IV was deposited during the Last Full Glacial (OIS 3). This stratum has also yielded typical Mousterian stone tools (Glantz et al. 2003), a single hominid foot bone (Glantz et al. 2004), and a faunal assemblage similar to other Middle Paleolithic sites found throughout the Old World (Ritzman et al. 2004). Depositional Unit 2 (Stratum V) consists of allogenic non-calcareous laminated clays that were likely deposited in the karst cave while it was still active within the subsurface (Woodward and Goldberg 2001). The deepest charcoal sample was recovered from the upper boundary of Stratum V and produced an AMS radiocarbon date of >26,300. This date may suggest that the age of the charcoal sample exceeded the upper limit of radiocarbon range.
Unit 1 (Strata I-IV) accumulated over the last 50,000 years. The sediments comprising this depositional unit are only 50 to 80 cm deep, and only well stratified in the back portions of the cave. This indicates a very slow rate of deposition over a long period of time. However, non-uniform vertical distributions of coarse fragment classes, including artifacts and bone, may suggest that the rates of deposition have changed through time. Coarse fragments occur in highest frequencies at the surface (Stratum I) and at the base of depositional Unit 1 (Stratum IV). Although large amounts of time are averaged within shallow horizons, a thorough spatial analysis of the 2003-2004 archaeological data may reveal important trends within the deposit.

Sediments within the cave have been subject to minor post-depositional weathering processes evident from oxidization and illuviation of CaCO$_3$. There is weak soil development at the surface, probably resulting from the warm, moist conditions typical of the Late Holocene. Similar to coarse fragment distributions, carbonates occur in highest frequencies at the surface (Stratum I) and at the base of depositional Unit 1 (Stratum IV). This may be explained by the increased density of limestone fragments. In Stratum IV, CaCO$_3$ occur as cemented nodules and bone accumulations.

The faunal assemblage from Anghilak Cave is dominated (95%) by small fragments (<3 cm). The skeletal element analysis of 595 fragments demonstrated that there is a preponderance of long bone shaft fragments (68.2%) and a high frequency of green breakage patterns (42.9%). In contrast, there is a paucity of long bone epiphyseal end (2.36%), and a low frequency of carnivore tooth marks (5.9%). This type of assemblage has been observed in ethnoarchaeological assemblages where human groups process long bones for marrow, leaving abundant shaft fragments with green breakage patterns, and then scavenging carnivores remove and/or consume the long bone epiphyseal ends (Bartram and Marean 1999). According to the results of the taphonomic analysis, hominids were likely the primary agent of bone accumulations. However, a more thorough and rigorous analysis of faunal remains and their spatial distribution is needed to confirm this preliminary interpretation.
CHAPTER 7. CONCLUSIONS AND FUTURE RESEARCH DIRECTIONS

The 2003-2004 investigations at Anghilak Cave yielded a wealth of information regarding depositional history, post-depositional weathering processes, and the spatial distribution of artifacts and bone fragments. In total, the excavations produced more than 3,000 chipped stone artifacts and 20,000 bone fragments within a 4.99 m$^3$ area. A total of 325 chipped stone artifacts and 614 bone fragments were piece plot mapped and described in the field. Five AMS radiocarbon dates were acquired from selected charcoal samples in the excavation area. Anghilak is the first new Paleolithic discovery in Central Asia in the last 30 years and one of very few sites that have been radiocarbon dated. The excavation methods implemented at Anghilak Cave may include the most detailed data collection procedures yet employed in Central Asia.

The primary purpose of this research was to provide further support for the original interpretation of Paleolithic occupation and use of Anghilak Cave (Glantz et al. 2003). The research comprising this thesis was carried out in conjunction with ongoing investigations conducted by the Uzbek-American Stone Age Project (UASAP). The proximate goal was to develop a reliable, chronometrically dated stratigraphic framework by integrating concepts and methods from archaeology, geomorphology, and taphonomy, into a single methodological and analytical framework. These investigations were guided by a set of five primary research questions regarding cave geomorphology, the absolute age of sediments, depositional history, post-depositional weathering processes, and taphonomy. The ultimate goal was to use this
stratigraphic framework to address a series of questions regarding hominid paleoecology at the cave and in Central Asia in general.

- **WHEN DID LATE QUATERNARY HOMINIDS USE THE CAVE?**

The results of this research demonstrate that Anghilak Cave has been periodically inhabited for the last 50,000 years. The primary artifact-bearing deposit (Unit 1: Strata I-IV) is relatively shallow (<80 cm) and moderately mixed by bioturbation. However, Stratum IV and the upper portions of Stratum V (Unit 2) have yielded four AMS radiocarbon dates ranging from >26,300 to 43,900BP, as well as typical Mousterian artifacts (Glantz et al. 2003, 2006), a single hominid foot bone (Glantz et al. 2004), and a faunal assemblage similar to other Middle and early Upper Paleolithic sites in Central Asia (Ranov and Davis 1979; Ritzman et al. 2004; Vishnyatsky 1999). Localized areas of Stratum IV were intact and relatively undisturbed.

Stratum IV is 15 to 30 cm thick and represents roughly 20-25,000 years spanning OIS 3. Using the entire stratum as the unit of analysis for lithic and faunal materials would be inappropriate and would lack any temporal or spatial resolution, and would not be very meaningful. Instead, the unit of analysis should be focused on the spatial distributions of coarse fragment classes, including artifacts and bone. A detailed spatial analysis of archaeological data from Stratum IV could potentially identify palimpsest clusters that accumulated over shorter periods of time, perhaps on the order of 3-5,000 years. At this resolution, it would be possible to observe patterns in the evolution of the human ecosystem during OIS 3.

The age of these deposits corresponds to the Middle to Upper Paleolithic transition observed at stratified sites in surrounding regions, particularly the Mediterranean Basin (Bar-Yosef 2002; Derevianko 2001; McBrearty and Brooks 2001). The results of excavations in Stratum IV indicate that hominids inhabited the cave during the latter half of OIS 3, or the Last Full Glacial, and possibly into the earliest part of the Last Glacial Maximum (OIS 2). Lithic assemblages from Anghilak Cave and other sites in Central Asia that date to OIS 3 retain Mousterian characteristics.
(Derevianko et al. 2001, 2003; Vishnyatsky 1999). The results from the 2003-2004 excavations at Anghilak Cave provide definitive evidence that Central Asia was occupied by hominids bearing Middle Paleolithic stone tool assemblages during OIS 3.

- **WHAT ACTIVITIES APPEAR TO BE REPRESENTED?**

  “If a particular cave were repeatedly used at the same season and/or for a specific purpose or set of purposes during a given climatic phase, a long sequence of highly redundant occupational residues might well result as a factor of physical constraints” (Straus 1979:335).

  The results of the investigations suggest ephemeral hominid use of the cave for shelter and various foraging activities, such as stone tool maintenance and resharpening (Glantz et al. 2006), butchering and processing of locally captured game (Ritzman et al. 2004), and possibly for capturing tortoises burrowing into the cave’s deposits. Deposits within the cave are shallow and indicative of very slow aggradation of sediments resulting in a palimpsest of hominid occupation events over long periods of time. This problem is compounded by the small size of the cave, which would have constrained the spatial limits of hominid activities and resulted in accumulations of artifacts and activity residues in localized areas (Straus 1979). This pattern was apparent in the upper portions of depositional Unit 1 (Stratum I-II), where recent (Late Holocene) human use of the cave resulted in overlapping thermal features (see Figure 5.2: Feature F1). Therefore, individual occupational events and specific activities will be difficult to discern from the level of detail provided by the 2003-2004 excavations.

  The abundance of highly fragmentary faunal remains suggests that hominids and/or carnivores used the cave for processing and consumption of locally acquired game. This interpretation is confirmed by the presence of stone tool cut marks, green breakage patterns, impact fractures, and carnivore tooth marks (Ritzman et al. 2004).
WHAT INFERENCES CAN BE MADE ABOUT HOMINID SUBSISTENCE ECOLOGY?

Similar to many Middle and early Upper Paleolithic faunal assemblages found throughout the Old World (Bar-Yosef and Pilbeam 2000; Gamble 1986; Hoffecker 2002; Klein and Cruz-Uribe 2000; Speth and Techernov 2002; Stiner et al. 1999, 2000; Stringer and Gamble 1993; Vishnyatsky 1999), the assemblage from Anghilak Cave is dominated by medium-sized mammals (52.8%), such as wild goat (Capra siberica), wild sheep (Ovis orientalis), and Red Deer (Cervus elaphus), followed by small game (32.1%) and tortoise (Testudo horsfieldii)(6.4%).

The preponderance of long bone shaft fragments (68.2%) and green breakage patterns (49.2%), coupled with the low frequency of carnivore tooth marks (5.1%) and a paucity of long bone epiphyseal ends (2.36%), suggests that hominids were the primary agent of bone accumulations in the cave, rather than carnivores or raptors (Bartram and Marean 1999; Marean and Spencer 1991; Ritzman et al. 2004). According to these results, the human ecosystem in the Kashkadariya valley during OIS 3 encompassed a great variety of species. Hominid populations appear to have had direct interactions with a variety of game populations at and around the cave, as well as indirect interactions with carnivore and scavenger populations.

If this preliminary interpretation is reliable, hominids were procuring medium ungulates, small-game, and occasional large game, and then transporting them to the cave for intensive processing. However, it is also possible that the cave was used for capturing small-game that were inhabiting the cave in burrows or in nests. The Central Asian Tortoise (Testudo horsfieldii) lives in burrows up to 2 m below the surface (Bergmann 2001), and may have resided in the cave. The Mousterian occupation at Anghilak appears to correspond with OIS 3, or the Middle to Upper Paleolithic transition, which is characterized by a significant shift in the character of small-game assemblages found in the Mediterranean Basin (Stiner et al. 1999, 2000). No small-game assemblages from Central Asian Mousterian sites have yet been analyzed; however, Patrick
Wrinn (2002) is currently analyzing the deeply stratified faunal series from Obi-Rakhmat and the results of these investigations are likely to produce significant information about hominid diet and subsistence ecology during OIS 3-4.

- **HOW DOES ANGHILAK COMPARE TO OTHER CENTRAL ASIAN PALEOLITHIC SITES?**

  The stone tool assemblage and faunal remains recovered from Anghilak Cave are similar to many Middle and early Upper Paleolithic sites that have been investigated in Central Asia, including Aman-Kutan, Kuturbulak, Khudji, Obi-Rakhmat, Ogzi-Kichik, and Teshik-Tash (Ranov and Davis 1979; Vishnyatsky 1999). Few of these sites have been chronometrically dated and the regional Paleolithic chronology is based primarily on techno-typological classification. However, recent dates acquired from Anghilak Cave (Adams et al. 2004; Glantz et al. 2006) and the upper levels at Obi-Rakhmat Grotto (Derevianko et al. 2001, 2003) suggests that hominid populations producing Mousterian stone tool assemblages were present in Central Asia, or at least eastern Uzbekistan, well into the early Upper Paleolithic or OIS 3. Vishnyatsky (1999: 111) has also suggested the probability of a relatively late age for Central Asian Mousterian sites, based on the presence of bladey assemblages and late radiocarbon dates from Khudkji and Ogzi-Kichik.

  Interestingly, Ranov and Davis (1979) suggest that the lack of Upper Paleolithic technotypological assemblages in Central Asia is due to deteriorating climatic conditions during OIS 3 (Last Full Glacial) and into OIS 2 (Last Glacial Maximum). They argue that conditions may have become too arid and cold to sustain substantial hominid populations. The results from the 2003-2004 investigations at Anghilak Cave indicate that the Kashkadariya valley was occupied during OIS 3 (26-45,000 BP) by hominids bearing Mousterian stone tool assemblages. However, the recently acquired dates from Anghilak and Obi-Rakhmat do not provide evidence for occupation during OIS 2 (Last Glacial Maximum), which would have been the coldest and most arid period.
of the Last Glacial Cycle of the Pleistocene. At Anghilak, the overall artifact densities are lower in Stratum III than in underlying and overlying strata (see Figure 6.3). Although a few sites are dated to the early Upper Paleolithic, there is a general lack of later Upper Paleolithic assemblages when compared to the overall increased frequency of these assemblages during OIS 3 in the Mediterranean Basin. It is likely that hominids were present during the part of OIS 3, but the questions still remains: Did hominid populations disperse or disappear during the cold and arid conditions of the Last Glacial Maximum (OIS 2)? Or, is the lack of truly Upper Paleolithic stone tool assemblages dated to this period the result of limited archaeological exploration and a bias toward caves. One possible scenario that has not been considered is that hominid populations relied less on rockshelter and cave sites, and more intensively exploited open air sites, such as floodplains and stream terraces.

There is very little Paleolithic archaeological research being conducted in Central Asia today. Many sites have been investigated and reported, but few have been excavated with detailed methodologies, and even fewer have been radiometrically dated. Moreover, very little intensive surveys have been conducted. Further investigations in the region are necessary.

**FUTURE RESEARCH DIRECTIONS**

Future research in Anghilak Cave promises exciting discoveries that will contribute further significant information to the archaeological record of Central Asia. Probably the single most important area of future research at Anghilak Cave is a thorough analysis of the spatial distribution of artifacts and bone fragments recovered during the 2002 to 2004 excavations. Three-dimensional sub-centimeter provenience measurements were recorded for 325 chipped stone artifacts and for 614 bone fragments. In addition, at least 3,000 chipped stone artifacts and 20,000 bone fragments were recovered from dry screen samples corresponding to each arbitrary 5 cm level. A Geographic Information Systems (GIS) analysis of the spatial distribution of artifacts and bone from the excavation area may reveal patterned clusters of artifacts accumulated over
shorter time periods, perhaps on the order 5,000 years. This would be particularly interesting within Stratum IV, where radiocarbon dates range from roughly 26,000 to 44,000 BP. This horizon is only 15 to 30 cm thick and vertical stratification of specific or episodic occupation events are not likely to be discerned. However, spatial analysis could reveal horizontally stratified palimpsest deposits. Furthermore, spatial data could potentially allow lithic and faunal analyses to be more meaningful by delineating more specific units of analysis.

The excavations in Anghilak Cave were focused in the southern half of the cave’s interior, and approximately 75% of the deposits within the drip line remain intact. Continued excavations employing a more detailed excavation methodology focused on Stratum IV and the upper portions of Stratum V would likely produce a substantial amount of additional information about the Late Quaternary hominid occupation of Anghilak Cave. No excavations were conducted in the north half of the cave and there is potential for the deeper, stratified deposits observed in the south half to continue across the entire back portion of the cave. In addition to investigating the distribution of artifacts and bone throughout the cave, these excavations could help to delineate the edge of the bedrock between the drip line and the back wall of the cave, and to identify the size and shape of the original karst.

The second most important area of future research at Anghilak Cave is a thorough zooarchaeological and taphonomic analysis of the faunal assemblage recovered between 2002 and 2004. In particular, the 2003 faunal assemblage included 32.1% small-game and 6.4% tortoise (Ritzman et al. 2004). Stiner et al. (1999, 2000) have demonstrated the potential of small-game assemblages for reconstructing changing hominid diet, demography, and subsistence ecology in stratified sites in the Mediterranean Basin. Tortoises are represented in Middle Paleolithic and Stone Age cave sites across Asia, the Mediterranean, and throughout Africa (Klein and Cruz-UrIBE 2001; Speth and Terchnov 2002; Stiner et al. 2000). Sampson (2000) provides ethnoarchaeological (South African Bushmen) and actualistic (raptor nests) evidence for the formation of tortoise assemblages based on skeletal element frequencies. A similar analysis
of the Anghilak tortoise assemblage would be appropriate. A thorough zooarchaeological analysis of the entire faunal assemblage will likely yield important results for interpreting human paleoecology during the Late Quaternary. In addition, a survey and collection of faunal remains from the surface of small caves in the area would provide a taphonomic assemblage to compare to the excavated faunal remains from Anghilak. This could shed light on the non-human formation of faunal assemblages typical of the region, and allow for more informed reconstructions of the taphonomic history within the cave.

Other important avenues of research at Anghilak Cave include an analysis of pollen, phytolith, and macrobotanical remains to support paleoecological reconstructions. Dozens of samples were collected from the grid excavations specifically for this purpose and are stored at the Institute for Archaeology in Samarkand, Uzbekistan. This could provide important information about ecosystem evolution in and around the cave.

In general, very little systematic archaeological exploration has been undertaken in Central Asia, particularly in more remote and less developed regions such as the Kashkadariya Province of Uzbekistan. Anghilak cave was discovered by the UASAP team during a recent reconnaissance survey of caves along the north and south slope of the Zerafshan Mountains (Burger et al. 2002; Glantz et al. 2003). More studies like this are likely to identify additional sites. Moreover, there is absolutely no known information regarding open-air Paleolithic sites in the Kashkadariya River valley. There are Quaternary terrace complexes along all of the larger drainages in the Kashkadariya valley (e.g., Rio Ayakchi-say) and a systematic survey of these landscapes on a drainage-wide scale would likely contribute a significant amount of information to our understanding of Paleolithic hominin settlement patterns and landscape use.

**Getting over the Pompeii Premise in Central Asian Paleolithic studies**

“You can’t always get what you want, but if you try sometimes, you just might find … you get what you need.” (Rolling Stones 1972).
There is a tendency among archaeologists to search for and focus on a few key stratified and well-preserved sites within a given region (e.g., Derevianko et al. 2001). This biased approach to regional studies has been described as the “Pompeii Premise” (Ascher 1961; Binford 1981). There is a bias toward these unique sites because they can offer detailed temporal and spatial resolution, as well as easily definable analytical units or layers. This is backed by a belief that these analytical units represent snapshots of the past frozen in time with very little distortion (Ascher 1961; Binford 1981). Furthermore, these sites represent a very small proportion of the archaeological record and will produce little information regarding human paleoecology and the organization of past cultural systems (Binford 1981:206).

“Disturbed deposits … are the most common remains we encounter; if we hold out for the very few sites where we may “recognize” undistorted “analytical units,” then we will have very few remains from the past with which to work. The challenge is how to use the “distorted” stuff, not how to discover the rare and unusual Pompeiiis.” (Binford 1983:240)

Deeply stratified cave sites have and will continue to play a critical role in the development of detailed regional chronologies of human behavioral and biological evolution, as well as to the development of archaeological method and theory (Brain 1981; Butzer 1981; Laville et al. 1980; Straus 1979, 1990). However, shallow sites containing palimpsest deposits are more common and can also contribute critical information to regional studies, given the appropriate level of detail in the survey or excavation methodology used to study them. In general, deeply stratified sites are going to be the exception, and therefore, large portions of the archaeological record equating to hundreds or thousands of sites are regularly overlooked. In Uzbekistan, many of the key sites have been intensively excavated for decades, and in some cases, are completely excavated (Derevianko et al. 2001; Movius 1953; Vishnyatsky 1999). To develop spatially and temporally detailed Paleolithic chronologies in Central Asia, this obvious bias will need to be overcome. Until systematic surveys are conducted and more sites are investigated, reconstructions of hominin paleoecology will remain premature and based on biased datasets and methods of analysis.
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APPENDIX A
Field forms, Excavation forms, level grid elevations
APPENDIX B
Other maps and profiles
PROFILE C: SOUTH WALL ALONG N92 GRID LINE

Legend:
- Modern ground surface
- Gravely overburden
- Stratum I
- Stratum II
- Stratum III
- Stratum IV
- Stratum V
- Feature 4 Fill
- Limestone Fill
- Krotovina
- Bone Fragments
- Chipped Stone
- Micromorphology Column

Profile C
ANGHILAK CAVE:
SURFACE ELEVATION MAP (2003)

Excavated in 2002, surface disturbed
Lower Devonian limestone bedrock
Roof fall block within Unit 1
Roof fall block underlying Unit 2
Stratum V sediments
Chimney opening in ceiling

Current position of drip line
Joints/Fissures
Edge of subsurface bedrock