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Title: Late Pleistocene Lithic Technological Organization on the Southern Oregon Coast: Investigations at Indian Sands (35-CU-67C)

Abstract approved:

Loren G. Davis

Excavations conducted at Indian Sands (35-CU-67C), located along Oregon's southern coast, during 2002 and 2003 identified two discreet, artifact-bearing stratigraphic units. The uppermost unit is a deflated surface containing burnt shell and lithic artifacts associated with early Holocene ^{14}C dates, while the underlying unit contained only lithic tools and debitage, some of which were associated with a ^{14}C date of 10,430 ± 150 RCYBP. The late Pleistocene lithic assemblage at 35-CU-67C provides the earliest evidence for human presence on the Oregon coast to date. Analysis performed on the late Pleistocene assemblage addresses the validity of existing hypotheses regarding the nature of early Oregon coastal hunter-gatherer technological and subsistence strategies. These hypotheses are focused on whether early populations on the Oregon coast practiced a generalist-forager or collector subsistence strategy.

Using theoretical approaches that deal with the organization of hunter-gatherer technology, analyses were conducted on the lithic tool and debitage assemblages at 35-CU-67C in order to infer past hunter-gatherer behavior. Through the implementation of multiple tool and debitage analysis methodologies, issues of hunter-gatherer mobility, raw material procurement, stages of lithic reduction, tool production, and site function are presented. The data generated by the late Pleistocene lithic assemblage at 35-CU-67C are compared with the overlying surficial assemblage, additional early sites along the North American Pacific coast, and to contemporaneous sites located further inland within the Pacific Northwest region.

Results of the lithic analyses at 35-CU-67C show distinct similarities in debitage trends between the assemblages of each stratigraphic unit. However, when tool assemblages from these units are compared, discrepancies in the types and amount of tools are found. Reasons for intra-site variability and similarity are explained through raw material studies and site function at 35-CU-67C. Additionally, similarities between the early tool assemblage at 35-CU-67C and those found in early tool assemblages on the extended Pacific coast and interior Pacific Northwest regions are discussed.

This thesis demonstrates that early southern Oregon coastal populations had a tendency towards high mobility and used a generalized toolkit organization. Early lithic technology used at 35-CU-67C emphasized multidirectional core technology and biface manufacture in the form of preforms and leaf-shaped projectile-points. This type of technological organization is to be expected from hunter-gatherers practicing a generalist-forager subsistence strategy. Based on the 10,430 ± 150 RCYBP date and technological organization at 35-CU-67C, early Oregon coastal occupation is seen as encompassing a generalist-forager subsistence strategy most likely adapted to both coastal and terrestrial environments.

Late Pleistocene Lithic Technological Organization on the Southern Oregon Coast: Investigations at Indian Sands (35-CU-67C)

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Chair, the Department of Anthropology

Dean of the Graduate School

I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

Samuel C. Willis, Author

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Late Pleistocene Lithic Technological Organization on the Southern Oregon Coast: Investigations at Indian Sands (35-CU-67C)

Chapter 1: Introduction

This thesis concerns the analysis of the lithic tools and debitage (i.e., chipped stone debris or waste) recovered from the Indian Sands site (35-CU-67C) located in Curry County on the southern Oregon coast (Figure 1.1). Under the auspices of the *Southern Oregon Coast Early Sites Project* (Hall 2000) at Oregon State University, archaeological excavations conducted during the 2002 and the 2003 field seasons at Indian Sands locating a paleosol producing a ^{14}C date (Beta-173811, charcoal) of 10,430±150 Radiocarbon Years Before Present (RCYBP). The ^{14}C date, based on wood charcoal from the base of the paleosol, was associated with cultural material in the form of lithic tools and debitage (Davis et al. 2003). The radiocarbon date establishes Indian Sands as one of the earliest sites on the Pacific coast of the New World. This study is the result of a larger body of research interested in early coastal occupation by attempting to locate late Pleistocene-age sites on the southern Oregon coast through the use of a geoarchaeological model (Hall 2003; Davis et al. 2003).

The discovery of the early component at Indian Sands represents an important step forward in the interdisciplinary investigation of early site research on the Pacific coast. Due to the distinct possibility that the majority of the late Pleistocene coastal sites have been inundated by the Pacific ocean due to maritime transgression (i.e., sea level rise) since the Last Glacial Maximum (LGM) the only feasible and promising areas to locate late Pleistocene sites on the Pacific coast are either on uplifted headlands or in select river valleys within close proximity to the coast (Bryan 1991; Punke and Davis 2003).

Evidence for initial occupation of the North American Pacific coast, as well as initial coastal migration routes into the New World proposed by Fladmark (1979) and Gruhn (1994), is expected to predate12,500 RCYBP based on the age of a late Pleistocene occupation at the Monte Verde site located in southern Chile (Dillehay 1997; Meltzer 2003). Although the late Pleistocene date at Indian Sands is too young to represent an initial migration along a coastal route, it is important for inferring the possible technology and subsistence strategies that might be indicative of early coastal adapted peoples as well as the location of additional early sites along the Pacific coast.

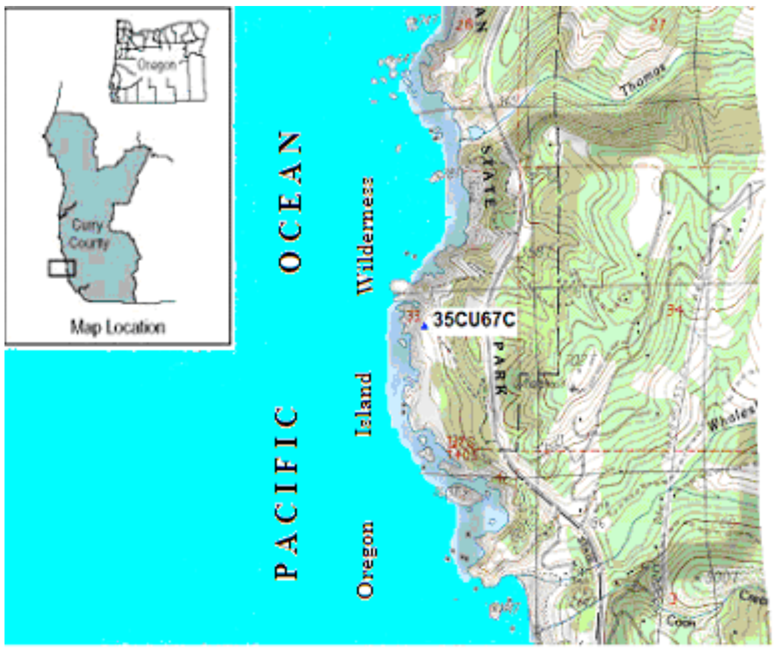

Figure 1.1: Map showing location of Indian Sands (35CU67C).

Because of the dearth of late Pleistocene sites along the Pacific coast, our understanding of early hunter-gatherer technology is equally limited. This thesis will allow for improvement in our understanding of how early hunter-gatherers on the Pacific coast organized themselves through the study of their subsistence technology.

Paleoenvironmental Records of the Oregon Coast and Pacific Northwest Region

Although a detailed paleoenvironmental history is lacking for the southern Oregon coast, general patterns of late Pleistocene environmental and climatic conditions are available from pollen records collected near the Oregon coast (Grigg and Whitlock 1998) and in the greater Pacific Northwest region (Heaton et al. 1996).

Late Pleistocene paleoenvironmental reconstructions based on western Oregon pollen records allow for some inferences on what environmental and climatic conditions the occupants of Indian Sands most likely faced at ca. 10,430 RCYBP. From two research areas in western Oregon, Little Lake and Gordon Lake, respectively, pollen records show a shift to fir (*Pseudotsuga sp.*) forest at approximately 14,250 BP with an increase of western and white pines (*Haploxylon Pinus*) seen from ca. 12,400 to 11,000 BP (Grigg and Whitlock 1998). The increase in *Pinus* dominance reflects increased seasonality at approximately 13,000 to 11,000 BP (Grigg and Whitlock 1998). Human populations present at Indian Sands at ca. 10,430 RCYBP would have likely experienced cooler winters and arid summers under this increased seasonality.

On a regional scale, research off the coast of British Columbia has shown that an extensive and productive terrestrial environment was available from 14,000 to 12,000 BP (Mandryk et al. 2001). Bathymetric data reveals that large river systems, paleo-deltas, and lakes were present. This coastal environment had a productive littoral zone as well as a forested environment vegetated with grasses, sedges, and dwarf willows by 13,000 BP (Mandryk et al. 2001).

In addition to the bathymetric research, studies on late Pleistocene black and brown bear species allow for the possibility of a coastal entry into the New World. Paleoenvironmental research conducted on the Alexander Archipelago in Alaska provides evidence that a hospitable refugia did indeed exist during the LGM (Heaton et al. 1996). Due to the fact that both bear species and humans each have similar environmental requirements in order to survive, the recovery of bear remains in key localities along the Pacific coast supports the idea that early coastal popuations would have been able to subsist on the Northwest Coast during the late Pleistocene. Recent investigations in karstic landscapes on the Queen Charlotte Islands in British Columbia support this idea as well (Ramsey et al. 2004). Remains of five bears recovered in a limestone solution cave (K1 Cave) on the west coast of the Queen Charlotte Islands provided a series of dates from 14,400 to 9375 RCYBP (Ramsey et al. 2004).

The Geologic Setting at Indian Sands

The geologic setting at Indian Sands is one of the more important aspects of the site and may have a great deal to do with site function. Indian Sands is situated on an uplifted marine terrace on the southern Oregon coast approximately 30 meters above sea level and about 100 meters east of the Pacific Ocean. The site is surrounded by Jurassic sedimentary and igneous rocks classified to the Otter Point Formation (Jop) whose origin is believed to be indirectly related to submarine volcanism (Beaulieu and Hughes 1976). This formation includes thin beds or nodules of chert deposits which are of a variety of colors and textures. Raw material surveys conducted by the author revealed that chert deposits embedded within the Jop formations literally surround Indian Sands indicating a very attractive locality for raw material procurement activities (Figure 1.2). The Jop chert breccias, in terms of quality and color, are similar to a source of chert nodules located approximately 1.6 kilometers southeast in alluvial gravels along Whaleshead Creek. Raw material surveys undertaken at Indian Sands also identified areas along the deflated surface of the site which exhibited concentrations of water-worn pebble tools, which probably originated from Whaleshead Creek.

Figure 1.2: Picture showing moderate sized chert nodule embedded in bedrock.

There is an additional aspect of the geology at Indian Sands that potentially influenced site function and should be discussed. Geoarchaeological research at the site reveals the possibility of a large dunal ramp connecting the headland on which Indian Sands is situated to the coastal plain at ca. 10,430 RCYBP (Davis et al. 2003). This inference is due to the presence of extensive dune deposits at Indian Sands that are thought to have originated as coastal shelf deposits blown landward (Davis et al. 2003). These dunal deposits are located on the top of the uplifted bedrock. This height above sea level suggests that there must have been a ramp connecting Indian Sands to the exposed coastal plain (Davis et al. 2003). Because the present-day coastline would have appeared as vertical cliffs behind a coastal plain during the late Pleistocene, the availability of easy access between the coast and uplands in the form of a dunal ramp would have made Indian Sands a very attractive locality to late Pleistocene populations (Davis et al. 2003). At ca. 10,430 RCYBP, Indian Sands was located approximately 1.5 to 2.0 kilometers east of the Pacific coastline. Terminal Pleistocene occupants situated on this headland, would have been able to look out over a coastal plain (Davis et. al 2003).

The Excavation and Site Stratigraphy

During the summer field seasons of 2002 and 2003, excavations at 35-CU-67C randomly sampled three 1 x 2 meter and five 2 x 2 meter test units allowing for an adequate sub-surface coverage of Indian Sands (Figure 1.3). Three 50 x 50 centimeter test units were excavated as well to assist in the placement of the larger test units mentioned above. Excavation levels followed the surface contour in arbitrary and parallel 5 cm levels. All cultural material was recovered either *in situ* or through the use of 1/8 inch screens.

Geoarchaeological field research revealed a profile of site stratigraphy (Figure 1.4) locating three pedostratigraphic units (PU) designated S1, S2, and S3 (Davis et. al 2003). Test Unit A contained the radiocarbon date of 10,430±150 RCYBP within the lower reaches of the S3 soil corresponding to the 3Ab horizon. The 3Ab horizon overlies a deflated surface (4Bsb) that dates

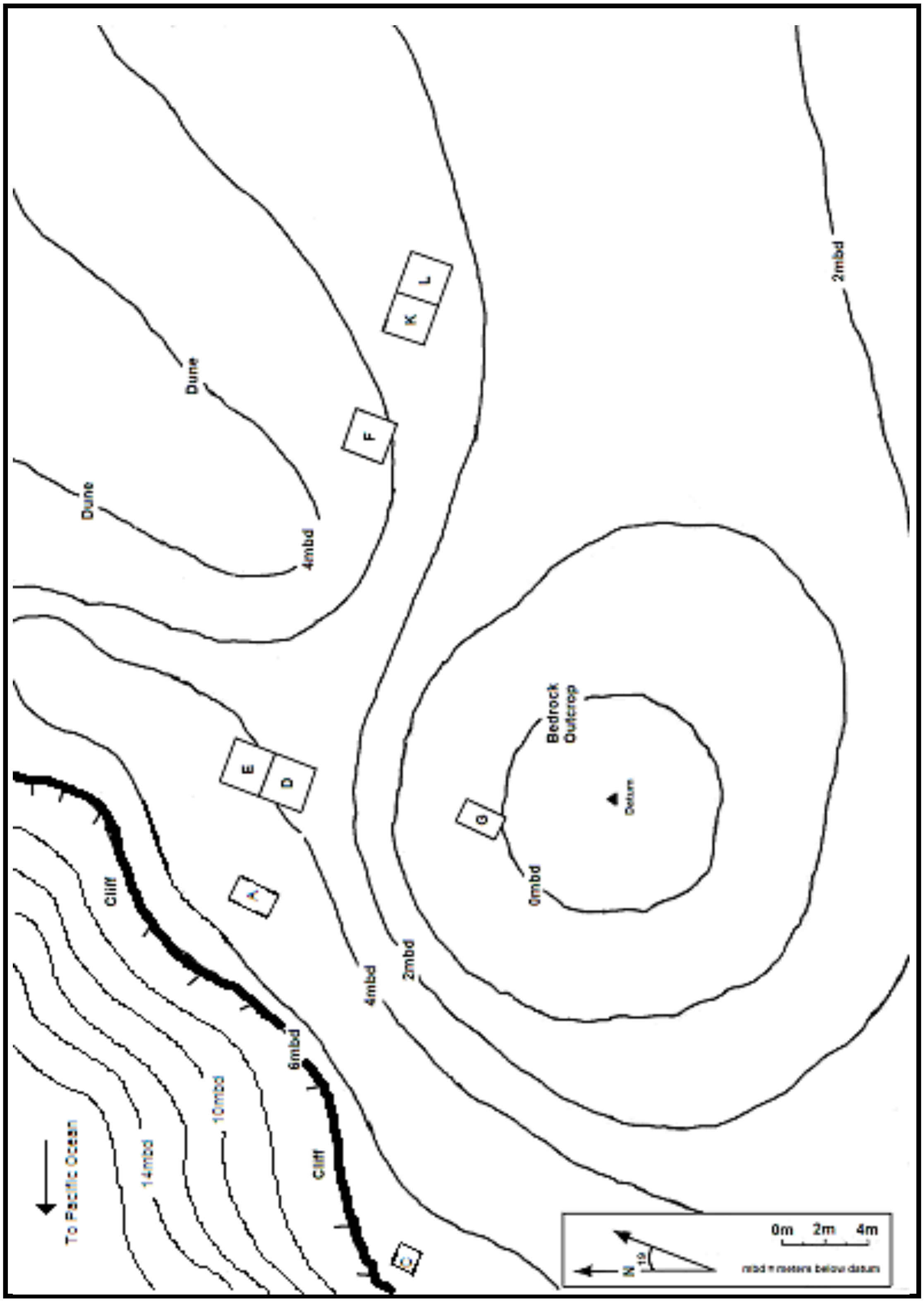

Figure 1.3: Site Map of Indian Sands showing location of test units.

to 15,600 BP. A discontinuous deposit of loamy sand (2C) is situated directly above the 3Ab horizon (Davis et al. 2003). Test Units A, D, E, F, K, and L all contained the complete transition from 2C to 3Ab to 4Bsb. Test Units C and G on the western edge of the site exhibit a direct transition from the 2C to the 4Bsb horizon and did not contain the 3Ab paleosol. Both the 3Ab and 2C horizons were laden with cultural material with the 4Bsb being a possible earlier candidate. However, it should be noted that artifacts drop off sharply at the 3Ab and 4Bsb boundary. Furthermore, the 4Bsb horizon is a deflated surface and would not likely produce the amount of artifacts recovered in the above mentioned horizons. Excavations did not investigate the 4Bsb horizon due to time constraints. The deflated 2C deposit contained both lithic material and organic remains, in the form of shell and a few specimens of unidentified bone, and is most likely indicative of a

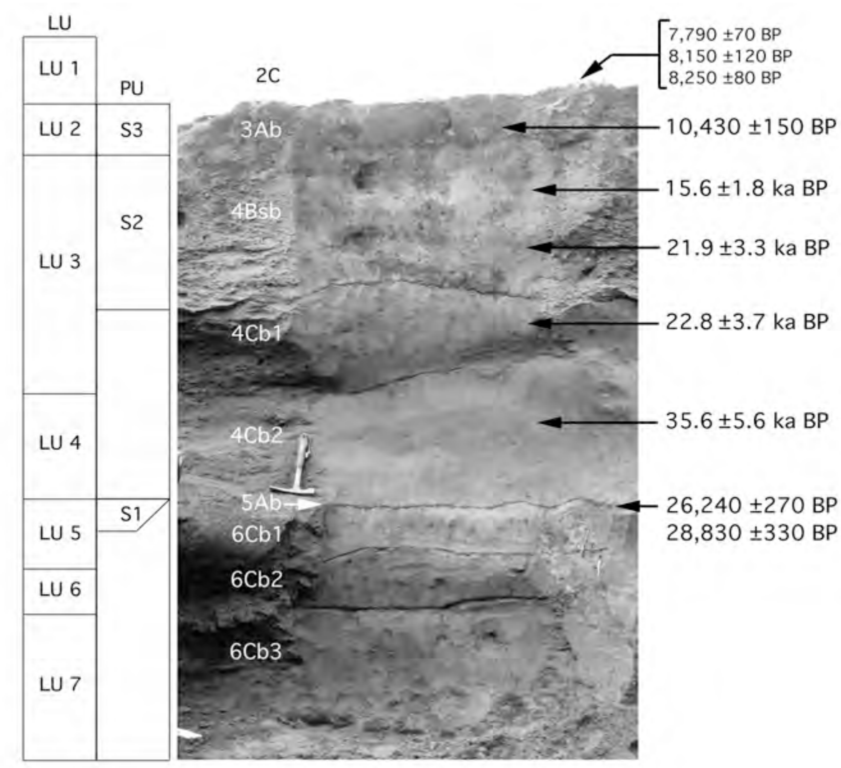

Figure 1.4: The profile and description of stratigraphy at Indian Sands (35-CU-67-C). The image is taken from Davis et. al (2003).

mixing of multiple cultural occupations. Erlandson and Moss (1995) report multiple ^{14}C dates on marine shell collected from the surface of the 2C deposit ranging from 7790±70 RCYBP to 8250±80 RCYBP.

Lithic artifacts alone were recovered from the 3Ab horizon associated with the 10,430 RCYBP date. All test units that exhibited the 3Ab horizon (Test Units A, D, E, F, K, and L) included lithic cultural material. Although faunal materials and organic artifacts were absent in the 3Ab horizon, there is no reason to believe that organic materials, either marine or terrestrial, were not utilized or consumed at Indian Sands during the early occupation.

There are two possible explanations for the lack of organic remains in the 3Ab paleosol. Firstly, the paleocoastline was located 1.5 to 2.0 km from Indian Sands during the terminal Pleistocene and only 0.5-0.25 km away during the early Holocene (Davis et al. 2003). This may be a reason for the absence of marine resources in the 3Ab horizon and their presence in the 2C deposit. An alternative possibility is that the absence of both marine and terrestrial faunal resources may be due to the highly acidic soil which characterizes much of the Northwest Coast resulting in poor organic preservation (Willis 2003).

Goals of the Research:

In order to elucidate the form of late Pleistocene technological organization at 35-CU-67C, results of a lithic analysis conducted on the 2C and 3Ab assemblages will be used in an attempt to explain four aspects, which include:

1) What is the structure of a late Pleistocene Pacific coastal lithic toolkit? Or, how did late Pleistocene Pacific coastal hunter-gatherers organize their lithic technology? Technological organization will be considered from aspects of core technology, reduction trajectories, transportability, and tool production relying on the work of various authors, including Andrefsky (1998), Amick (1999), Bamforth (1986), Binford (1980), Bleed (1986), Connolly et

al. (1995), Kelly (1988), Torrence (1989), and Yesner and Adovasio (2003). To do this, I will describe all lithic debitage and tools recovered from the 3Ab and 2C soil horizons.

2) Are there marked differences or similarities between the lithic assemblages in the 3Ab paleosol and the 2C horizon? As part of this aspect I will address the issue of whether the 3Ab assemblage reflects the use of adaptive hunter-gatherer strategies different than those seen among early Holocene populations, or whether a similar technological tradition existed throughout the early prehistoric period on the southern Oregon coast? This aspect will be addressed by comparing similarities or dissimilarities between the 2C and 3Ab horizon assemblages. Furthermore, results of the 3Ab assemblage will be compared with the findings from early Holocene and late Pleistocene lithic assemblages recovered from the surrounding Northwest coast, the northern California coast, and contemporaneous interior Pacific Northwest sites.

3) Is coastal hunter-gatherer mobility contingent upon raw material choice, acquisition, restriction, and importation/possible trade?

4) What function did site 35-CU-67C at Indian Sands play in the past? An interpretation of site function will be attempted by using the results of the lithic analysis, focusing specifically upon the stages of the reduction trajectory and type of tool production, coupled with the geological setting of the site. Based on the interpretation of technological organization, does Indian Sands represent past and current theories of early Oregon coastal populations? Were populations utilizing a generalist-forager/residential strategy, a collector/logistical strategy, or a mixture of both?

Chapter 2: Theoretical and Cultural Background

Middle-Range Theory and Hunter-Gatherer Studies

In order to interpret late Pleistocene site function and technological organization at Indian Sands quantitative data from lithic analyses must be linked to larger concepts of human behavior. This can be accomplished by utilizing what is commonly known as *middle-range theory* (Binford 1980; Bettinger 1991). The goal of middle-range theory is concerned with the interpretation of the archaeological record by narrowing the gap between the static physical manifestations of material culture (i.e., artifacts and features) with the dynamic human behavior that produced the archaeological record (Thomas 1986). Put another way, middle-range theory explains past human behavioral patterns by linking low range explanations and generalizations with higher order theories (Raab and Goodyear 1984), as well as allowing for inferences of hunter-gatherer social systems from the direct interpretation of the material record. The use of middle-range theory in prehistoric hunter-gatherer studies can be used to elucidate broad aspects of dynamic behavior from the archaeological record, including mobility, site function, intra-site activities, and regional scale land use patterns (Amick 1999).

By linking low and high range theories through middle-range theoretically based methodologies, the analysis performed on the Indian Sands assemblage will allow for an understanding of what late Pleistocene coastal lithic technology incorporated and possible insights on how the populations were exploiting their surrounding upland and coastal environments. In addition, this thesis will attempt to demonstrate the usefulness of middle-range theory used in conjunction with contemporary lithic analytical techniques and their ability to explain past hunter-gatherer behavior and organization.

Middle-range theory can explain that lithic technological organization and raw material procurement utilized by late Pleistocene hunter-gather peoples fit into the optimal use, or organization, of time and energy in a much similar manner as with other equally important subsistence practices such as food allocation and mobility (Binford 1980; Torrence 1989).

Amick (1999) suggests that contemporary lithic analysis should move beyond basic descriptive methods and integrate larger research questions that address the reconstruction of past behavior.

> Because chipped stone technology is a subtractive process, we can often reconstruct past behavior in exceptional detail. Moving from reconstruction to explanation of past behavior is the key to epistemological archaeology (Amick 1999:164).

Middle-range and microeconomic theories geared towards the understanding of the level of mobility, site function, regional-scale land use patterns, raw material studies, reduction trajectories, and toolkit organization may allow for a more reliable explanation of past human behavior.

One of the most commonly utilized products of middle-range research is a classification system of hunter-gatherer organization constructed by Binford (1980). He describes two modes of logistical and technological organization hunter-gatherer societies used to interact with their environments. This classification is composed of forager systems and collector systems (Binford 1980). Past human behavior, including environmental interaction and landscape use, reflected in the static archaeological record, are largely determined by these different sets of social organizations. Collectors and foragers practice different adaptive and technological strategies that produce different material records (Binford 1980; Bettinger 1991). Identifying whether a population practiced a collector or forager way of life is a research question often confronted in New World late Pleistocene archaeology. Studies dealing with the peopling of the Americas are often geared towards an understanding of this dichotomy in order to determine how these past groups organized themselves as well as how they interacted with their environments. In order to discuss the differences between forager and collector strategies, it is best to compare how each reacts in situations in which all hunter-gatherer groups must participate. Some of these situations include, but are not limited to, mobility, both logistical and residential, hunting strategies, raw material procurement, technological organization, diet breadth, and the presence or absence of food and material storage or caching. In short, both collector/logistical and forager strategies are methods of utilizing the landscape that are dictated by *principles of organization* (Nelson 1991).

A foraging system is generally defined by a set of cyclical strategies used within a landscape whose climate is relatively "aseasonal" and whose resources are evenly spread out (Bettinger 1991). When an area is exhausted of its resources, groups move to another location within the landscape and continue the same cycle (Binford 1980; Bettinger 1991). Foraging systems incorporate high residential mobility using one to two kinds of site types (Binford 1980; Bettinger 1991). These include either residential base camps and/or location sites. Residential base camps are the locations where the entire group resides and carries out the majority of processing and consumption activities. Location sites can be seen as areas traveled to if a specific extraction task is needed (Bettinger 1991). Foraging systems are typically practiced in environments that offer many resources in one centralized location. In some literature, this method of food and material allocation is termed "embedded" meaning that the environment offers these materials in a relatively even distribution throughout the landscape (Binford 1980). The term "embedded" can also imply that various resource activities are not seen so much as specific tasks, but are opportunistic undertakings carried out during the course of other activities (Binford 1980; Bettinger 1991)). Hence, residences are moved when that "patch", or area of occupation and material extraction, has been exhausted (Bettinger 1991). Hunting and gathering tactics will generally be focused on an encounter basis that can yield various types of nutritional intake within an environment that offers a broad set of dietary resources. A variety of plants and animals that occupy the "patch" area will be consumed in a continuous and low yield (Bettinger 1991). Because food and raw material consumption is interested in immediate yield, are in close proximity, and residential mobility is high, storage of food and materials are not necessary.

Technology used by a foraging population will typically be *generalized* and incorporate a "stream-lined" design (Nelson 1991). Here, the term generalized will be used to describe both formal and non-formal tools that are geared towards interaction with multiple tasks and situations. This word usage is in opposition to the commonly used term “expedient” which typically connotes crude, ill-designed, and unsophisticated technology made and used for any purpose at hand (Binford 1980). It will be made apparent that many late Pleistocene populations, some very likely practicing a forager subsistence, manufactured highly skilled and well designed lithic toolkits. Problems with semantics in lithic research are a common hazard and will be discussed below.

In contrast to the foraging system, collector strategies include high logistical mobility with low residential mobility. Hunting and gathering tasks are fixated on certain species or locations in which resource extraction is planned for in advance and is based on the interception of the resource as opposed to an encounter method. Small task groups will leave the residence, or base camp, in order to move to certain locals chosen specifically for certain economic yields (Binford 1980). This collector mode of resource acquisition is typically practiced in environments exhibiting narrow diet breadth and lower spatial productivity. Because resources are widely spaced, their procurement costs, in the form of time, energy, planning, and distance traveled, often favor the use of storage and caching facilities. Collector groups will tend to utilize a technology that is *specialized*, including a toolkit that is specifically manufactured for certain tasks. Two main site types are produced under collector/logistical strategies. The base camp tends to have evidence of either seasonal or year-long occupation accruing a relatively rich and diverse material record from intensive site use (Binford 1980). Small camp/task-oriented sites are formed away from the base camp where a group of collectors exploit certain resources. The sites are generally occupied for short periods and may only retain material records that reflect specific tasks or actions such as hunting and processing. This leads to an important question: aside from the large and archaeologically visible base camp, how can a collector/logistical task site be differentiated from a residential/foraging site? As will be shown, making such a determination from lithic assemblages alone can prove difficult.

It appears that knowledge of technological organization coupled with a diachronic understanding of large-scale regional land use is the only viable method for understanding the subtleties of hunter-gatherer residential and mobility patterns (Amick 1999). Because human groups utilize regional landscapes, an understanding of the strategies practiced (i.e., procurement and residential/mobility strategies, types of sites) within the region during a distinct period in prehistory and how technology is organized in order to be used within this region will allow for a more complete idea of prehistoric hunter-gatherer behavior (Amick 1999).

Contemporary Lithic Analysis and the Dichotomy of Generalized and Specialized Toolkit Organization

Recent trends in contemporary lithic studies offer strong inferences in explaining past hunter-gatherer technological organization. Technological organization relates to behavioral systems, or strategies, which help hunter-gatherers decide how and what type of chipped stone tools are manufactured, the activities associated with the use of certain designs, the acquisition of raw material, the portability or non-portability of the toolkit, the levels of maintenance, and when tools are ultimately discarded (Nelson 1991). Kelly (1988:717) states that organization of technology is:

> the spatial and temporal juxtaposition of the manufacture of different tools within a cultural system, their use, reuse, and discard, and their relation not only to tool function and raw-material type and distribution, but also to behavioral variables that mediate the spatial and temporal relations among activity, manufacturing, and raw material loci.

In addition to behavioral or social factors, toolkit organization is affected by various environmental and economic influences, and/or restrictions, including the relative productivity of resources within an environment, the amount of mobility in lieu of this relative productivity, and the size of the region or area utilized (Nelson 1991).

In terms of North American lithic analysis, the study of the organization of technology has traditionally used the Binfordian concept of collector/forager dichotomy. Therefore, technological organization is typically classified as having either *expedient* characteristics (i.e, indicative of a foraging system) or *curated* characteristics (i.e., indicative of a collector system).

Many researchers have come to realize the inadequacies of these two broad categorizations whose meanings are difficult to apply to lithic studies (Bleed 1986; Bamforth 1986; Nelson 1991; Andrefsky 1998; Magne 2001) and, according to some researchers, whose usage should be suspended (Odell et al. 1996). It should be noted that the Binfordian concept of forager and collector was never meant to be diametrically opposed. Instead, each adaptive strategy is seen as occupying the ends of a continuum suggesting that most lithic technological organization will fall in between these two strategies (Bettinger 1991; Odell 1996).

In place of expedient and curated descriptions for the explanation of technological organization, as well as the types of social systems they relate to (i.e. forager or collector), this thesis will instead describe the basics of hunter-gatherer technology, both forager and collector, as modes of mobile technological organization (Rasic and Andrefsky 2001). By using the idea of mobile technology to describe collector and forager strategies, more intricacies may be extracted from the lithic analysis of the Indian Sands assemblage. The term *generalized* will be used to describe the technological organization of forager systems, which are typically associated with a utilitarian, broadly applied technology. The term *specialized* will be applied to collector systems, which are typically associated with a task-specific and highly diverse technology, but keeping in mind that, as with site types, many lithic technologies may exhibit characteristics of both states (Rasic and Andrefsky 2001).

Generalized toolkit organization is considered here as a technological design scheme that allows for transportability and multi-purpose usage in a variety of economic situations, but does not necessarily lack formal tool manufacture. This type of toolkit organization is typically attributed to hunter-gatherer groups utilizing a foraging system whose tools would need to perform in environments exhibiting a wide diet breadth (Shott 1986; Bettinger 1991). It is apparent that the traditional use of the term *expedient* does not fully describe this foraging strategy very well and furthermore, lends a sense of oversimplification and limitation to the performance and construction of toolkit organization. As mentioned above, a generalized toolkit can be composed of both formal and informal tools. Formal tools are considered those which have been modified by explicit retouch in order to transform the original flake or blank into a desired form. Non-formal tools are those which exhibit no retouch and are only modified through use (Tomka 2001). Generalized toolkit design incorporates three major factors into its design, including: 1) maintainability, in the form of flexibility and versatility; 2) transportability; and 3) multi-functionality which allows a minimal diversity of tool types to perform a wide variety of tasks in a diversified environment (Bleed 1986; Shott 1986; Nelson 1991).

Maintainability in toolkit organization is achieved by design concepts that allow for performance and productivity in a variety of activities or economic settings (Bleed 1986). Theoretically, because environments used by hunter-gatherers practicing a forager subsistence strategy have an evenly distributed range of resources, the technology must be designed to have the ability to anticipate future procurement tasks. Additionally, the design of the toolkit should be functional in those future tasks no matter what order they occur considering a foraging system emphasizes an encounter-based hunting and gathering strategy (Binford 1980; Bettinger 1991). Lithic tool and debitage analyses performed on the early Indian Sands components will be tested for evidence of maintainability in design implementation and results will be discussed in Chapter Five. Maintainability can be reduced into ideas of *versatility* and/or *flexibility* incorporated into the toolkit design. A versatile tool is one that cannot easily change form but can be used in a number of different situations and may include a variety of functional edges (Bleed 1986; Shott 1986). Additionally, toolkit versatility can be expressed in the high percentage of generalized edge forms (Nelson 1991). Toolkit organization may also include a certain degree of flexibility. The difference between versatile tools and flexible tools is that flexibility is found in those tools that can change form in order to meet a range of situations (Nelson 1991). Each of these aspects of versatility and flexibility illustrate the maintainable nature of a generalized toolkit.

As noted above, transportability is a design factor that is an indicator of a generalized toolkit. According to Nelson (1991), transportability in toolkit organization is a design scheme that allows a technology to be taken to the activity or task area. Transportability will be designed into a toolkit so as to not interfere with the movement of people or economic surplus to and from residential sites and activity or task areas. It is noted that transportability, as well as overall toolkit organization, is greatly affected by the differential distribution and qualities of local and non-local toolstone sources (Nelson 1991; Andrefsky 1994, 1998). This aspect of lithic studies specifically addresses mobility in lieu of, and acquisition to, lithic raw material. It is a subject deserving of its own section and will be discussed in more detail in Chapter Three. Toolkit organization that has transportability as part of its design scheme will include obvious tendencies toward low weight and simplification (i.e. streamlined). Simplicity and low weight will affect the number of tools included in a toolkit (Torrence 1983; Shott 1986; Nelson 1991). The use of transportability in the design of a lithic toolkit mirrors earlier noted qualities inherent in a generalized morphology. If transportable, the toolkit organization must be either flexible or versatile (i.e. maintainable) because it will incur a minimal diversity in the amount of tool types it incorporates. Kuhn (1994) suggests that an example of an optimal mobile toolkit would be one that is comprised of a number of smaller tools rather than a few multifunctional (i.e. heavier) objects.

Generalized toolkit organization is further demonstrated by the amount of tool diversity that a lithic assemblage retains. Whereas specialized technological organization will tend to include a relatively high amount of tool types specifically manufactured for explicit tasks, the streamlined quality of a generalized technological organization is reflected in fewer types of tools within the site assemblage (Nelson 1991; Collins 1999). This is seen as a technological solution to an environment favoring high residential mobility where continual movement cannot support the possession of a large and complex toolkit.

Transportability, flexibility, and versatility relate not only to a technology's ability to perform in a multitude of situations, but there must also be a way of applying these design strategies to allow for conservation of raw material. A generalized toolkit design will leave a distinct pattern in a site's archaeological record. Specifically, debitage patterns and tool morphology should indicate a relatively high frequency of bifacial thinning flakes, a low frequency of angular debris, and a trend towards high angle retouch (i.e. $\geq$45˚) on modified tool edges (Mitchell and Pokotylo 1996; Andrefsky 1998).

One of the better examples of a generalized technological organization is the biface (Kelly 1988; Nelson 1991; Andrefsky 1998). Bifaces are highly formalized tool which can be used as a core, cutting tool, and as part of a weapon system (Kelly 1988). Bifaces meet the generalized criteria by exhibiting a variety of functional edges (Shott 1986), generalized edge forms (Nelson 1991), and are transportable. As a core, a biface can support a mobile toolkit through the production of useable flakes for additional flake tools while continuing to retain its original form as well as a functional tool edge (Kelly 1988). Nelson (1991) adds that other benefits of the bifacial core, and its role in a generalized toolkit, is that it promotes conservation when toolstone is scarce by allowing for a minimum amount of waste. The low proportion of waste flakes contrasts with the high proportion of usable flakes that can be produced while maintaining the working design of the biface. Kuhn (1994) states that if bifaces are used as cores, and as these cores are reduced for the manufacture of useable flake tools, the three-dimensional reduction in bifacial size will allow for an optimal weight/utility ratio and, hence, bifacial technology is seen as the most cost-effective solution for mobility in toolkit design.

On the other end of the spectrum, specialized toolkit organization used by hunter-gatherer groups must be highly transportable for logistical rather than residential purposes (Nelson 1991). A major difference between specialized and generalized mobile toolkit organization is that specialized toolkits will place more emphasis on reliability rather than on multi-functionality (Bleed 1985; Nelson 1991; Rasic and Andrefsky 2001). Because the environments used by collectors are typically characterized by a narrow diet breadth, anticipation and scheduling of future tasks are of high importance (Binford 1980; Nelson 1991). This is reflected in a standardization, or serial nature (Bleed 1985; Nelson 1991), designed into the technological organization.

Specialized toolkit organization is best exemplified by a blade and core technology. There are two examples of early populations utilizing this method of technological organization. One is the microblade and microcore tradition used in the northern Northwest Coast region of North America during the early Holocene (Ackerman 1992; Carlson 1996). The other is the prismatic macroblade and macrocore technology implemented by certain late Pleistocene-age fluted point traditions in the south-central and eastern regions of North America (Collins 1999). In their study of specialized and generalized core technologies, Rasic and Andrefsky (2001) state that the blade core has a single function which is to produce symmetrical, standardized, and consistent products (i.e. serial). These products are blades that are produced for a small range of functions and are typically not seen as being very flexible. Both macrocore and microcore and blade production is not necessarily versatile but is reliable. Both core strategies produce uniform blades with predictable sizes and amounts of cutting edge. However, Rasic and Andrefsky (2001) note that macrocore and macroblade production can be considered more generalized than microcores and microblades because larger blades allow for more versatility in form retaining more area of cutting edge capability. Once again, this is an important quality in toolkit organization particularly when one knows what resources are to be taken when occupying an environment with a narrow diet breadth.

Rasic and Andrefsky (2001) present an idea that should concern all hunter-gatherer lithic research. Replication experiments producing blade cores and bifaces based on lithic trends found throughout northwestern Alaska showed that there is no reason that both blade and core (i.e., specialized core technology) and bifacial core (i.e., generalized core technology) technologies cannot be used in the same toolkit organization (Rasic and Andrefsky 2001). With this in mind, will lithic assemblages from foragers practicing a highly mobile residential strategy be that different than an assemblage from a collector group practicing specialized procurement strategies outside of their base camp? Both toolkits share similarities in that they are both portable. Two North American late Pleistocene technologies support this idea as well. Both late Pleistocene fluted technologies found throughout North America as well as the Western Stemmed Point Tradition incorporated macroblade cores and bifacial cores into their technological organization (Rice 1972; Collins 1999).

Initial Occupation of the Americas and the Northwest Coast

The feasibility of an initial colonization of the New World by way of a coastal route has been strengthened in the last decade through the use of archaeological and geoscientific research (Fedje and Christensen 1999; Mandryk et. al. 2001). It is postulated that the late Pleistoncene coastal populations were generalized foragers focused on the rich biodiversity of marine and terrestrial resources (Fladmark 1979; Dixon 1999; Mandryk et al. 2001; Ames 2003).

Recent investigations into the late Pleistocene and early Holocene prehistory of the Northwest region has brought into question traditionally-held assumptions about who the first peoples of the region were and when they arrived. Identification of these populations has generally been based on radiocarbon dated sites associated with distinctive lithic technologies. There are generally agreed to be three technological traditions that are believed to have been a part of the initial peopling of the Pacific Northwest. Here, technological traditions are made up of "diagnostically similar artifacts or items shared by multiple cultural groups whose use may extend for a prolonged period of time (Bryan 1980)." These technological traditions include the Western Fluted Point Tradition (WFPT) (Bryan 1991:18), considered a component of the Clovis tradition, the Western Stemmed Point Tradition (WSPT) (Bryan 1980, 1988), alternatively termed the Protowestern or Western Pluvial Lakes Tradition (Borden 1969; Bedwell 1973), and the Pebble Tool Tradition (PTT), which has also been considered a component in the Old Cordilleran culture (Butler 1961; Carlson 1991, 1996; Matson and Coupland 1995). Both the WFPT and the WSPT are unquestioningly associated with late Pleistocene populations (Bryan 1980, 1988; Carlson 1996; Meltzer 2003). The PTT is typically associated with early Holocene dates although theories of a much earlier existence during the late Pleistocene have been considered with good reason (Borden 1975; Bryan 1991; Carlson 1996). The manner in which these three Pacific Northwest technological traditions are related is poorly understood (Bryan 1980, 1988; Carlson 1991, 1996; Davis 2001).

The Pacific Northwest is a unique area in the larger context of the late Pleistocene peopling of the Americas and their accompanying technological traditions. The vast majority of archaeological literature has continuously, despite recent research by Bryan (1988) and Davis (2001), placed the WFPT as representing the earliest human presence in the Pacific Northwest (Carlson 1991, 1996; Matson and Coupland 1995; Erlandson and Moss 1996). This idea is based on a virtual dearth of fluted points, comprised of isolated surface finds and a minimal amount of questionably dated sites. Most notable of these sites in the Pacific Northwest region are the East Wenatchee and Dietz sites, which have not been securely dated by radiometric means (Willig 1988; Mehringer and Foit 1990; Meltzer 2003). Dates for the WFPT, as well as the entire Clovis tradition, are varied. Meltzer (2003) contends that the age range for traditional Clovis occupation is from approximately 11,570 RCYBP to 10,900 RCYBP across the entire North American continent while Haynes (1992) and Collins (1999) consider the age range to be 11,200 RCYBP to 10,900 RCYBP. Later fluted variant styles date to as late as 10,200 RCYBP in some regions (Frison 1992; Meltzer 2003).

A recurring problem in first American studies is that these Clovis date ranges have been liberally applied to the Pacific Northwest region as well (Carlson 1996; Matson and Coupland 1995). Recent studies by Anderson and Faught (2002) show that dated fluted point sites follow a younger to older pattern running along a west-to-east continuum. Their research further reveals that the distribution pattern of Clovis points, including the later-evolved and regionally specific variant styles of fluted forms, tend to quantitatively increase in an exponential manner east of the Rocky Mountains. The largest and most diverse population of these fluted forms is concentrated in the southeastern region of North America (Anderson and Faught 2002). Following Bryan (1988), the high density of fluted projectile points located east of the Rocky Mountains, coupled with a comparatively minimal amount in the Far Western region, especially in the Pacific Northwest, is best exemplified by the age-area hypothesis (Bryan 1988). This hypothesis states that an area exhibiting the largest amount of an artifact type is indicative of its center of origin while minimal amounts of that artifact type located away from the center of origin are indicative of a late marginal persistence. Bryan’s (1988) hypothesis coupled with Anderson and Faughts’ (2002) data suggests that the Clovis tradition might be a North American invention having its origins in the southeastern United States rather than a technology brought from northeast Asia, down through the ice free corridor, and subsequently radiating outward from the Rocky Mountain region (Bryan 1991).

Recent research dealing with WSPT sites (Bryan 1988; Davis 2001), as well as Anderson and Faughts' (2002) distribution patterning, suggests that the WFPT may not be associated with the earliest sites in the Pacific Northwest and, more importantly, may have been only one of many technological traditions practiced by early peoples of the region (Bryan 1988, 1991). Bryan (1991) and Ames (2003) have postulated that earlier traditions other than the WFPT existed in the Pacific Northwest and on the Pacific Coast during the late Pleistocene. Bryan (1991) postulates that these populations more than likely utilized a generalist-forager economy and exhibited a generalized technology most likely using a leaf-shaped finished biface design with socketed hafting. Ames (2003) suggests that if a coastal entry into the New World was used early coastal peoples would be adapted to high-latitude environments requiring a sophisticated marine technology. Although each idea differs, both offer no credence to the idea of fluted point-bearing peoples initially occupying the Pacific coast from an interior route.

Late Pleistocene Lithic Technological Traditions in the Far Western Region of North America

The Western Fluted Point Tradition

Although the WFPT toolkit organization is considered by some to be highly specialized in nature and implemented by highly mobile groups (Meltzer 2003), a different, and perhaps, more accurate analysis of Far Western fluted technology is that it is mainly generalized with only a small portion of the technology dedicated to specialized roles (Collins 1999). Given the richness and diversity of environments with which the fluted technology interacted (i.e., most of the North American continent and into portions of South America), it is proposed here and by others (Bryan 1991; Collins 1999) that fluted point technology is more indicative of a generalized toolkit organization used by numerous generalist-foraging cultures (i.e., fluted point technology is a specialized add-on to an otherwise generalized toolkit). Rather than viewing the fluted point-using cultures as using a collector adaptive strategy based on the specialized hunting of large mammals, it is more plausible to consider the environmental and ecological context in which the majority of fluted point-bearing sites exist (Grayson and Meltzer 2002). Coupled with the moderate richness and diversity of WFPT and Clovis lithic toolkits, use of a specialized technology and a collector adaptive strategy is unlikely (Bryan 1991). The only evidence for this specialized collector economy is evident in the Rocky Mountain region where large kill sites show an association of extinct megafauna with fluted points. So, it is no coincidence that these rather impressive kill sites lead to ideas of livelihood that have been applied far from the region where it actually occurred. Taking the paleoenvironment into consideration, this idea of specialized subsistence has been inaccurately applied to other regions based on the recovery of fluted bifacial technology. Bryan (1991) further believes that Rocky Mountain fluted point-using cultures are more accurately described as generalist-forager peoples adapting to a collector/logistical economy due to the mountainous region's narrow diet breadth.

The WFPT technology seems to be both maintainable and transportable. It also exhibits evidence of being multi-functional. The structure of WFPT technology appears to follow Rasic and Andrefsky's (2001) proposal that both generalized and specialized designs may be implemented into the organization of a single toolkit. Because fluted projectile points cannot easily change form, versatility is represented in a high degree of generalized tool edges based on a bifacial margin. Additionally, the versatile nature and moderate diversity of transportable tool types allow WFPT toolkits to operate in a forager or collector adaptive strategy. This is plausible when one thinks of fluting as a representation of a technological idea or influence and not the product of a unique culture or migration (Bryan 1980). Some of the varieties of lithic tools associated with a fluted toolkit include fluted projectile points, large bifaces (both in the form of cores and performs), conical and wedge-shaped macrocores, macroblades, unifacial side scrapers, concave scrapers, endscrapers, gravers, choppers, and multiple non-formal modified flake tools (Collins 1999; Justice 2002).

There are two acknowledged design strategies for WFPT lithic toolkits including a biface reduction strategy and a core and prismatic blade strategy (Collins 1999). The bifacial reduction technology is the most widespread strategy associated with fluted assemblages. The prepared conical and wedge-shaped core and prismatic blade strategy is found in the south-central and eastern regions of North America with a complete absence of this strategy west of the Rocky Mountains (Collins 1999). Once again, it is possible to consider this facet of technological organization as being part of a generalized nature if one acknowledges Rasic and Andrefsky's (2001) theory, which states that macrocore and macroblade technology, although reliable (i.e., specialized), offers a measure of multi-functionality and versatility in design due to the large amount of generalized edge form.

Techno- complex	Date Range (BP)	Lithic Technology
WSPT	>11,410 –10,000	Blade and core, flake and core, stemmed and foliate projectile points, formal and non-formal tools made on flakes and blades, cobble tools
PTT	?	Flake and core, foliate projectile points, formal and non-formal flake tools, cobble tools
WFPT	?11,200 - 10,200	Blade and core, bifacial core, fluted projectile points, formal and non- formal tools made on flakes
35CU67C	? - 10,430	Flake and core, possible bifacial core, foliate projectile points, bifacial preforms, formal and non-formal tools made on flakes

Table 2.1: Summary of late Pleistocene technocomplexes in the Pacific Northwest.

In many instances, fluted bifaces were manufactured from the reduction of either large cobbles or large flake blanks produced from prepared conical or wedge-shaped cores. Subsequent tools were manufactured on the waste flakes from either core and blade reduction or bifacial reduction including many modified flake tools manufactured on bifacial thinning flakes (Fagan 1988; Collins 1999). There is little evidence for a separate core and flake reduction strategy (Collins 1999). Adding to this evidence, research at the Dietz site concluded that the debitage from the manufacture of large bifaces, which ultimately resulted in fluted preforms or finished points, was subsequently used for a variety of modified flake tools (Fagan 1988; Frison 1992; Collins 1999; Meltzer 2003). Although not mentioned by any of these researchers, this scenario seems to reflect a bifacial core strategy and a generalized toolkit organization. Table 2.1 compares the WFPT with other early lithic technological traditions in the Pacific Northwest.

Western Stemmed Point Tradition

The WSPT is found west of the Rocky Mountains in North America and runs in a roughly north to south continuum from British Columbia to the southern boundaries of the Great Basin region (Carlson 1996; Justice 2002). This technological tradition is suggested to date from 10,700 to 9,000 BP (Bedwell 1973 ; Leohnardy and Rice 1970; Rice 1972; Bryan 1988). However, excavations at Smith Creek Cave by Bryan (1988) produced dates over 11,000 BP while recent excavations at the Cooper's Ferry site on the Lower Salmon River in Idaho by Davis (2001) recovered a feature including a cache of stemmed points which was subsequently dated between 11,370±40 RCYBP to 11,410±70 (Davis and Schweger 2004). This places the WSPT well before any chronometrically-dated fluted sites within the Pacific Northwest region as well as showing a contemporaneous existence with many of the earlier manifestations of traditional Clovis sites in North America (Meltzer 2003). These findings suggest, as Bryan has noted (1988), that the WSPT and the WFPT were probably contemporaneous and co-evolutionary lithic technologies. Furthermore, it seems plausible that this chronology represents separate technologies utilized by different populations. Considering the implications of the age-area effect on Clovis point distributions in North America, fluted point technology probably arrived in the Pacific Northwest as a migration of ideas and/or populations originating from regions east of the Rocky Mountains. If so, this fluted technological migration would have arrived into a region with an established population bearing a well adapted technological organization that included a stemmed and foliate shaped biface technology (Bryan 1980, 1988, 1991; Davis 2001).

In terms of lithic technology, this thesis will address the WSPT as it is understood in the Pacific Northwest region. The area, distribution, and environments in which stemmed point technology encompasses are expansive and include small subtleties in lithic toolkit organization unique to each sub-complex (Justice 2002). In the Pacific Northwest, the WSPT is represented by the Lind Coulee, Windust, and Cooper's Ferry I phase type-sites (Daugherty 1956; Leohnardy and Rice 1970; Davis 2001).

The WSPT lithic toolkit includes both stemmed projectile points as well as foliate/leaf-shaped forms. The appearance of foliate shaped forms and their relation with the stemmed point technologies is not completely understood. The foliate shaped bifaces tend to occur later rather than earlier in these components which have also given validity that the early phase of the Pebble Tool Tradition is more indicative of an early Holocene technological adaptation and is likely evolved from the stemmed biface form (Butler 1961; Leohnardy and Rice 1970; Rice 1972; Carlson 1996; Connolly 1999). However, there is a hypothesis that states that stemmed point technology is evolved from an earlier technology using simple leaf-shaped/foliate-shaped projectile points (Bryan 1988, 1991). This idea is based on the hypothesis of an early coastal peoples who possessed a generalized flake and foliate-shaped bifacial industry which they brought down the Pacific coast from northeastern Asia (Bryan 1991; Carlson 1996). The earliest component at Marmes Rockshelter (Rockshelter Stratum Unit I), located in the rockshelter proper, contained ^{14}C dates on mussel shell of 10,810 ±300, 10,750 ±300, and 10,475 ±300 RCYBP (Ozbun et al. 2004) associated with leaf-shaped/foliate and stemmed projectile points. Stemmed and foliate projectile points are known to co-occur at other sites in the Pacific Northwest. At Newberry Crater in central Oregon, the earliest component (component I) at the Paulina Lake Site (35-DS-34) date between 11,000 and 10,000 BP and contains both stemmed and foliate biface varieties (Connolly 1999).

As with the WFPT, technological organization of the WSPT is well developed, transportable, is of a generalized design, and includes both macrocore and macroblade and bifacial reduction technologies (Leonhardy and Rice 1970; Rice 1972; Fedje 1996). WSPT toolkit organization produced tools and bifaces from large prismatic blades originating from prepared polyhedral and from flakes struck from bifacial cores (Leonhardy and Rice 1970; Fedje 1996; Ozbun et al. 2004). Unlike the WFPT, WSPT lithic reduction is also centered on a less formal core and large tabular flake technology. Aside from the projectile points, WSPT lithic assemblages exhibit a moderate amount of tool types. Some of these include formal and non-formal modified flake tools including perforators, side scrapers, poorly-formed end scrapers, utilized spalls, cobble tools, and burins (Leohnardy and Rice 1970).

Pebble Tool Tradition

The Pebble Tool Tradition (PTT) is commonly considered an early Holocene technological tradition (Carlson 1991, 1996) and was previously referred to as the Old Cordilleran culture where it occurs in the interior Pacific Northwest (Butler 1961; Warren 1968; Brauner and Nesbitt 1983; Matson and Coupland 1995). Early sites associated with this component are much more common on the Northwest Coast and share commonalities with early Pacific coastal sites found further south in California, Baja California, and South America (Bryan 1991). The PTT is believed to date from approximately 10,000 to 9000 RCYBP (Carlson 1996). It should be noted that similar assemblages are also known throughout the Pacific Northwest exemplified by the Cascade Phase (Leonhardy and Rice 1970). However, Brauner and Nesbit (1983) argue that the Old Cordilleran Culture is found only in south-central and eastern Washington, northeastern Oregon, and in portions of Idaho. Alternatively, the PTT is seen as being a coastal manifestation with little understanding of its relation, if one exists, to contemporaneous interior groups (Carlson 1996). The most plausible connection that the PTT and Old Cordilleran Culture might share is that each occurs during the early Holocene, both use pebble tools, and aside from the side-notched technology such as that seen in later manifestations of the Cascade Phase, each uses a foliate/leaf-shaped projectile point (Butler 1961; Leonhardy and Rice 1970; Carlson 1996).

The hallmark artifact of the PTT is not necessarily the utilized pebble tool, which is not present at every PTT site, but the foliate/leaf-shaped projectile point (Carlson 1996). For this reason, Carlson (1996) has noted that the PTT might be more accurately named the Foliate Biface Tradition. Because the use of pebble tools are not indicated at every PTT site, and because pebble tools are seen at some WSPT sites, the boundaries that separate the PTT and the WSPT are not clearly definitive. An important aspect to keep in mind when discussing these two technological traditions is that, which ever is the earliest, each may be related by their manner of hafting (Bryan 1991). Musil (1988) and Bryan (1991) have argued that both stemmed and foliate-shaped projectile point technologies share a technological link in their hypothesized use of socketed hafts. Considering this link, the idea that the WSPT is evolved from the WFPT (Willig 1988) makes little sense. Fluting is believed to have used a split-stem method of hafting (Musil 1988; Bryan 1991; Collins 1999), which is demonstrably different than socketing.

One of the better discussions of PTT technology and environmental use is provided by Matson and Coupland (1995) who state that the Bear Cove and Glenrose Cannery sites as well as other PTT sites on the Northwest coast reveal a large expanse of early peoples adapted to coastal environments. This adaptation is viewed as a continuation of the interior Old Cordilleran culture. A large variety of both terrestrial and marine products were recovered from both PTT sites with a lithic technology offering little variety (Matson and Coupland 1995). Each believes that this is most likely due to high residential mobility and/or the lithic technology was used in order to create more specialized organic technology (Matson and Coupland 1995).

The lithic toolkit organization of the PTT seems to be transportable (i.e., apart from pebble tools) and generalized in nature. Although large pebble tools are not necessarily portable, the raw materials for pebble tool manufacture were available in high abundance along much of the Northwest Coast. This abundance allows for immediate use and discard at virtually any area negating the need to transport these tools. PTT toolkit organization is best exemplified by the large lithic assemblage recovered from the early component (Component 1) at Namu dating from approximately 9700 ±140 to 6310 ±80 RCYBP in British Columbia (Carlson 1996). At Namu, macrocore and blade technology is absent from the PTT, which instead shows a focus on a multidirectional core and flake technology (Carlson 1996). Other lithic tools include various forms of bifacial tools including foliate/leaf-shaped projectile points and preforms and drills, cobble tools including multidirectional cobble cores (some of which were also used as scrapers), unifacial choppers, formal modified flake tools such as denticulate scrapers, spurs/gravers, end scrapers, and non-formal modified flakes tools.

Carlson (1996) makes a very interesting point regarding the early assemblage at Namu and PTT technological organization in general. He states that a lithic component in a typical PTT technological organization may be a part of a more complex organic tool technology for use on the coast, an idea echoed earlier by Matson and Coupland (1995). Although terrestrial products could also be exploited with a typical PTT lithic toolkit, the PTT technology seems to be directed to an archaic subsistence pattern (i.e., generalist-forager) wherein many environmental resources were targeted including the development of a marine economy (Carlson 1996; Ames 2003). Lithic assemblages, especially those with a large number of bifaces, are generally attributed to terrestrial based economies. This is a hallmark assumption that has been used in North American archaeology from the beginning of the discipline (Steffen et al. 1999) and is formally known as “biface bias” (Cassidy et al. 2004).

Local Trends in Early Lithic Technologies: a southern Oregon coast Perspective

Archaeological research dealing with early hunter-gatherer behavior and subsistence on the Oregon coast has been limited to a small sample of sites dating between the early and middle Holocene (Lyman 1991). Although the discovery of a late Pleistocene component at Indian Sands provides a rare source of archaeological information, it is clear that the lithic analysis of one site cannot provide an unbiased or complete view of late Pleistocene human adaptation along the southern Oregon coast. It is now appropriate to briefly discuss concepts that have been put forward regarding early Oregon coast occupation. These ideas can then be compared with the results of the lithic analysis conducted on the assemblage from 35-CU-67C.

Meighan (1965) provides the first attempt to understand the initial occupation of the Oregon coast. He suggests that the initial colonization of the coast originated from the interior reaches of the Pacific Northwest with a minimal use of coastal resources until approximately 7500 BP (Meighan 1965). Ross (1984) echoes this sentiment, proposing that the initial occupation of the coast was comprised of interior-adapted populations who did not exploit coastal or marine resources until ca. 8000 to 9000 BP. Later, Ross (1990) stated that this coastal resource adaptation did not begin until ca. 3000 to 2500 BP. It is obvious that theories on the timing of initial coastal occupation of the southern Oregon coast and their subsistence strategies are not well understood. This is most likely due to a very small sample of archaeological sites dating earlier than the middle Holocene (Lyman 1991). Based on the above hypotheses, pre-littoral adaptation on the Oregon coast existed anywhere from approximately 3000 to 8300 BP (Lyman 1991).

Other researchers suggest that the nature of early Oregon coastal occupation is not well understood due to a scarcity of evidence and that broad claims of either littoral or pre-littoral adaptive strategies should be discouraged (Erlandson and Moss 1998). Erlandson and Moss (1998) argue that because their discovery of burned mussel shells, which returned ^{14}C dates between 8250 ± 80 and 8150 ± 120 RCYBP, shows that the idea of early coastal peoples practicing a pre-littoral subsistence strategy is incorrect. Instead, sites without shell or other marine resources are indicative of an archaic based strategy (i.e., general-forager) that included the use of both terrestrial and littoral zones. This appears to be an improved way to view early Oregon coastal prehistory considering lack of early sites. The idea of a pre-littoral adaptation seems to be based on the fact that 1) early sites contain little or no shell and 2) the idea that the initial peopling of the Pacific coast originated from the interior by populations possessing a terrestrial oriented adaptive strategy.

Until recently, Pleistocene age sites were unknown along the Oregon coast (Moss and Erlandson 1997; Davis et. al. 2002; Willis 2003). To date, only a handful of coastal sites include early Holocene components, while Indian Sands contains the only known late Pleistocene site on the Oregon coast. Attempting to interpret late Pleistocene human behavior through lithic toolkit organization is difficult at the local scale given the absence of other contemporaneous site assemblages in the local study area with which to compare. It is then justified to compare the early paleosol assemblage at Indian Sands to other younger coastal sites as well as with those located further inland. Because the lithic toolkit at Indian Sands is the product of a people living in a coastal environment, it may retain broad similarities with early Holocene technological organization in the area. Conversely, the late Pleistocene lithic assemblage at Indian Sands may reflect early hunter-gatherers living in non-analogous environments that were present during lower sea levels and, thus, show little similarity to Holocene assemblages.

Comparisons of interior site assemblages with the Indian Sands lithic assemblage should be considered due to the fact that there seems to have been significant coastal-inland interaction at 35-CU-67C during the late Pleistocene. Obsidian debitage and tools recovered from Indian Sands originate from interior volcanic sources. This procurement signifies either established trade networks or direct acquisition (Willis 2003). Both scenarios allow for reasonable assumptions that the peoples inhabiting Indian Sands at ca. 10,430 ±150 RCYBP either had extensive trade contacts with interior groups, or that direct procurement took place. Interior contacts through established trade networks allow for the possibility that some degree of cultural interaction would have transpired, possibly influencing toolkit organization and style. Acquiring the obsidian through direct procurement would be indicative of a very mobile population being equally well-adapted to interior environments as well as to coastal habitats further demonstrating similarities with other interior sites in toolkit organization and design.

There are four early Holocene sites known from the Oregon coast. These include Tahkenitich Landing, Blacklock Point, The Neptune Site, and Devil's Kitchen. Tahkenitich Landing (35-DO-130) is an early Holocene site located on the central coast with the earliest occupation dating to ca. 8000 BP. The site is located on the shore of a dune-bound freshwater lake behind the largest dune field on the Oregon coast (Minor and Toepel 1986). Paleoenvironmental records indicate that during the initial occupation at Tahkenitch Landing, the site was located along an estuary with the Pacific Ocean around one kilometer to the west. Minor and Toepel (1986) describe the earliest artifact bearing deposit (Stratum 4A) as the Pre-Shell Component, which dates between 8000 to 5200 BP. The hypothesis of early populations being mainly terrestrial hunter-gatherers and not utilizing marine resources (i.e. pre-littoral) is evident in Oregon coast archaeology (Meighan 1965; Ross 1984, 1990; Lyman and Ross 1988; Lyman 1991).

The lithic technology of the Pre-Shell component is extremely minimal. Seven tools were recovered, including a scraper, graver, three hammerstones, a chopper, and one abrader (Minor and Toepel, 1986). Although a descriptive analysis on the debitage recovered was not published, the occurrence of large modified flake tools with large utilized pebble tools is reminiscent of the PTT. Moreover, the functional traits attributed to the tools by Minor and Toepel (1986) are similar to elements of PTT technological organization. All tools, except for the one sandstone abrader, were made of cryptocrystalline silicate or basalt, which were available from outcrops in the surrounding Coast Range streams (Minor and Toepel 1986).

An interesting situation exists at Tahkenitch Landing that is absent at other early sites on the Oregon coast. A small amount of organic remains were recovered in Stratum 4A. Although very little molluscan use was recovered, evidence for mammal, bird, and fish exploitation is evident during the early Holocene (Minor and Toepel 1986). The array of fauna being utilized at this early date further supports the idea that early coastal populations practiced a generalist-forager way of life (Ames 2003).

The Blacklock Point site (35-CU-75) has garnered attention as a possible early site (Minor 1986). Located on a bluff overlooking the modern Pacific coastline, the site was investigated by Ross (1975) and Minor (1986, 1993). Two ^{14}C dates of 2750 ±55 RCYBP and 7560 ±80 RCYBP were recovered on charcoal associated with a moderate amount of lithic tools and debitage (Ross 1975; Minor 1986; Erlandson and Moss 1998). Minor (1986) suggests possibilities of an earlier occupation as well but this has not been demonstrated. Local collectors have reported foliate/leaf-shaped and stemmed projectile points, large bifaces, various modified and un-modified flakes, and one mortar from the site (Minor 1986). Based on the earlier ^{14}C date and the collected artifacts, the assemblage seems to fit fairly comfortably into a PTT categorization. Brauner and Nesbit (1983) conclude that the Blacklock Point site is quite different from the majority of coastal sites at least as far as the lithic technology is concerned, and may have functioned as a lithic workshop. Cobbles of chert and agate were available in bedrock and stream gravels adjacent to the site (Brauner and Nesbit 1993).

The Neptune site (35-LA-3) is located in Lane County on the central Oregon coast. Excavations conducted by Ross in the early 1970s provided a ^{14}C date on charcoal of 8310±110 RCYBP associated with a stratum below a shell midden (Lyman 1991). Although a report on this work has not been published, a small quantity of lithic debitage was recovered in association with the charcoal. However, subsequent research at a later time determined that the early date could possibly be problematic in its association with the lithic debitage (Lyman 1991). Moss and Erlandson (1998) revisited the site as part of a coastal survey for Oregon State Parks and were not able to relocate the early site component.

The Devil's Kitchen site (35-CS-9) was excavated by Loren Davis in 2000, and has provided evidence of early Holocene occupation. A stratified series of three ^{14}C samples returned ages of 2970 ±70 RCYBP (Beta-170404), 5820 ±40 RCYBP (Beta-170405), and 11,000 ±140 RCYBP (Beta-189636) (Davis, personal communication 2004). The late Pleistocene date is associated with a sterile horizon; however, lithic tools and debitage were recovered in the levels between the the 5900 ±80 and 11,000 ±140 RCYBP ^{14}C dates. Although future research may clarify the age of the lowest artifact-bearing level, it is believed that 35-CS-9 contains early cultural components.

The lithic assemblage from the Devil's Kitchen site was studied by the author in the same manner that has been used with the Indian Sands assemblage (see Chapter Four). The lithic assemblage found below the 5820 ±40 RCYBP date included 74 pieces of lithic debitage, a biface fragment, and a core all manufactured from locally-available chert. The biface fragment is an early stage preform I with non-patterned flake removal, unstraitened margins, and is manufactured on a large flake. The core is multi-directional with irregular and non-patterned flake removal. Notwithstanding a small sample size, the lithic debitage analysis, showing a trend towards late stage tool production/maintenance, whereas the presence of a core suggest that core reduction and tool production took place at the site.

Excavations at site 35-JA-53, situated along the Applegate River in Jackson County, produced evidence of a potentially early cultural component (Brauner and Nesbit 1983). Although the site's contents were not directly dated, the landform on which the site is situated has been relatively dated to the late Pleistocene. The lithic assemblage recovered from the site does not fit into any local patterns but is instead similar to technological attributes seen in the Windust Phase (i.e. WSPT) in the Plateau region (Brauner and Nesbit 1983). The bifacial technology of 35-JA-53 is evident from a suite of stemmed projectile points, the majority of which exhibit unusually short blades due to extensive re-sharpening episodes (Brauner and Nesbit 1983). Brauner and Nesbit (1983) suggest that the projectile points may be indicative of a pioneering population moving into southwestern Oregon. Aside from the unique stemmed projectile points, the lithic assemblage is composed of an abundant amount of scrapers, which mainly appear as steep-edged end scrapers, side scrapers, and spall scrapers. Interestingly, there is a very small amount of non-formal modified flake tools. Core technology consists of two types, the most common being an unprepared and tested cobble form. The other type is represented by a very moderate amount of formally prepared discoidal cores. Brauner and Nesbit (1983) note that 35-JA-53 appears to show a large amount of experimentation with local raw material. A groundstone component is also present in the form of manos and metates. Small circular schist discs were also recovered but their original function is unknown.

Excavations at the Duncans Point Cave site (CA-SON-34H) in northern California produced large quantities of lithic tools and debitage, and a shell midden with good organic preservation.

Lithic and organic remains associated with ^{14}C dates of 8620 ±420 RCYBP and 8210 ±110 RCYBP were obtained from the lower levels (component 2) of the midden (Schwaderer 1992). Debitage trends emphasize the maintenance of bifacial implements as well as the manufacture of formal and non-formal modified flake tools primarily originating from cobble core production, which, in some instances, were also utilized as tools. A small number of platform cores and bipolar cores were also recovered. The majority of the site's raw material originates from local chert sources with only a minimal amount from imported obsidian. Although obsidian hydration analysis conducted on one stemmed projectile point recovered from component 2 revealed a relatively low hydration rind, it is typologically similar to Lake Mojave types and seems to be indicative of a late Pleistocene/early Holocene occupation. The reason for the low hydration reading is unclear and could be caused by a number of past environmental events such as fire or largely unknown rates of precipitation within the coastal area.

Early Sites on the North American Pacific Coast: A Regional Perspective

To date, only three late Pleistocene-age sites exist on the Pacific coast of the New World. These consist of K1 Cave, located on the west coast of Haida Gwaii in coastal British Columbia, Daisy Cave from southern California, and Indian Sands on the southern Oregon coast.

Recent explorations and excavations at K1 Cave in the karstic region of Haida Gwaii recovered the bases of two stemmed bifaces stratigraphically situated between the bones of a late Pleistocene-age black bear. The black bear bones from the upper level were dated to 10,510 RCYBP while the lower bones dated to 10,960 RCYBP (Fedje et. al 2004). No other lithic or bone artifacts were recovered from the site, which suggests that a wounded bear might have animal brought the bifaces into the cave (Fedje et. al 2004).

Investigations at Daisy Cave (CA-SMI-261) on San Miguel Island, located along the southern California coast, recovered a small lithic assemblage associated with various types of marine shell including red abalone, mussel, turban snail, chiton, and crab in a thin stratigraphic layer (Erlandson and Moss 1996). Samples of shell and wood charcoal from this layer produced dates of 10,700 ± 90 RCYBP and 10,390 ±130 RCYBP. The associated lithic assemblage is limited to a small amount of chert and siliceous shale debitage (Erlandson 2000). In the stratigraphic layer immediately overlying the late Pleistocene layer, a larger assemblage of bone and lithic artifacts were found associated with early Holocene dates ranging from ca. 9700 to 8000 RCYBP. This later bone and lithic assemblage includes bone bi-points, which are considered by Erlandson (2002) to be fish gorges and indicative of a maritime economy.

Each of these sites gives evidence to late Pleistocene occupation on the Pacific coast. However, the minimal amount of sites, including a diminutive amount of cultural material recovered from these sites, do not present a coherent picture of what initial occupation on the North American Pacific coast entailed or what technological and subsistence strategies were used by these early coastal hunter-gatherers. Ideas on the nature of the initial occupation of the coast have been proposed by some researchers.

Ames (2003) suggests that initial New World occupation via a coastal route would have only been possible by populations adapted to a high-latitude marine environment, which included the use of boats. Populations were most likely on the Northwest coast by approximately 13,000 BP and practicing a generalist-forager strategy with low populations and high mobility. The southern and central portions of the Northwest coast are seen as dominated by a lithic technology using a leaf-shaped projectile point. Ames (2003) suggests that this bifacial technology has similarities to "Archaic-like" complexes in the interior Pacific Northwest.

Bryan (1991) states that the first coastal occupants were generalist-foragers with an adaptation to a highly unpredictable late Pleistocene environment. Furthermore, the occupation of coastal environments would not necessarily demand a specialized lithic technology considering that the coast would be extremely productive. According to Bryan (1991), the earliest sites would be located on the Pacific coast of North America and occupied by peoples adapted to coastal environments who expanded down the unglaciated Pacific coast from northeast Asia at approximately 14000 BP. These early sites would yield evidence of an unspecialized (i.e., generalized) flake and core lithic technology with an emphasis on willow or leaf-shaped projectile points and unifacial flake tools with high edge angles designed for use with wood.

Carlson (1991) explains that the oldest biface assemblages are located on the northern Pacific coast. Similar lithic assemblages appear later in the southern areas of the coast and upriver into the interior of the Pacific Northwest. This suggests that the initial occupation of the Pacific coast originated from a maritime economic strategy rather than a terrestrial strategy spreading from the interior to the coast (Carlson 1991).

Dixon (2001) regards the pioneering coastal populations as implementing a generalist-forager subsistence strategy that was adapted to a temperate and productive Pacific coast. This coastal environment allowed for an unspecialized technological organization that incorporated naturally occurring material requiring little modification such as organic products, drift wood, and beach cobbles. Dixon (2001) bases his ideas of what the initial coastal-adapted technological organization would have consisted of on the recovered lithic and organic artifact assemblage at Monte Verde. Although biface technology existed, there was more emphasis placed on simple flake tools and organic material. Initial coastal occupation was based on a maritime economy that allowed multiple adaptive strategies to evolve when populations expanded into the interior (Dixon 2001). Furthermore, a generalist-forager subsistence strategy is regarded as the most optimal and effective way to colonize unknown environments (Dixon 2001).

Erlandson (1999, 2002) sees the initial Pacific coast occupants as being adapted to a marine economy, having the ability to construct and use watercraft, and making use of many environments within the Pacific coastal region. These late Pleistocene coastal environments would have offered an array of resources including both marine and terrestrial products leading to an optimal, efficient, and varied subsistence strategy due to the high productivity of these coastal habitats.

Mandryk et al. (2001) state that the peopling of the New World occured via a migration route down an unglaciated Pacific coast at approximately 14,000 to 12,000 BP. These populations expanded out of the maritime regions of Japan and/or northern China and used a generalized technological organization based on a late-Paleolithic bifacial strategy (Mandryk et al. 2001). This postulation is based on the lithic assemblage recovered from the pre-9000 BP levels at Haida Gwaii that contain multiple bifaces and large stone tools (Mandryk et al. 2001).

Chapter 3: Methodology and Analysis

Methodology

The lithic assemblage recovered from the late Pleistocene-early Holocene component at site 35CU67C will be subjected to several analyses in order to define various technological aspects. The assemblage will be segregated into two main categories: lithic debitage and formed stone tools. The lithic debitage will be subjected to individual attribute analysis methods and aggregate/mass oriented methods. Both types of analyses will be used in order to strengthen the results of the other as well as keep the resulting inferences as objective and replicable as possible. It is believed by the author and others (Andrefsky 1998; Kelly 2001; Magne 2001) that by using multiple lines of evidence generated from independent analytical methods, a general pattern will emerge from the lithic population which will allow for a better understanding of past technological organization and reduction trajectories (Pecora 2001; Odell 2004). Furthermore, patterned debitage and formed tool characteristics noted within the Indian Sands lithic assemblage can be compared to other late Pleistocene toolkits recovered from areas further inland from the southern Oregon coast, as well as other early coastal assemblages in the Northwest Coast region, in order to see if demonstrable similarities exist.

Applying both aggregate and individual attribute-based analyses to the Indian Sands lithic assemblage is important because it allows for the consideration of technological variability at different scales. Comparing individual flake characteristics with broader patterns seen at the assemblage level can lead to an integrated understanding of the stages of the reduction trajectory, the type of reduction, toolkit organization, and ultimately site function (Connolly 1999). All lithic analyses used here are based on macroscopic observations, in which all attributes and measurements were made by visually inspecting each lithic artifact under 10x magnification or less. Microscopic studies (i.e. usewear analysis) were not performed here and should be considered for future studies. Specific methods of macroscopic inspection will be discussed in more detail below.

The literature dedicated to lithic analysis is full of technical terminology that has limited the unification of perspectives on lithic technology. The use of varying nomenclature for a single lithic phenomenon or attribute has plagued lithic research for some time and, only in recent years has there been a major push by researchers to use more uniformity in categorical and definition terminology (Andrefsky 1998, 2001; Magne 2001; Odell 2004). In order to avoid confusion, it is important for analysts to use agreed upon nomenclature for varieties of lithic types which can commonly be found in contemporary scholarly journals and archaeological reports. A simple and obvious method for addressing inconsistencies is to initiate a list of all types of lithic specimens and attributes included in a study and specifying a definite meaning for them. In the sections that follow, the introduction of a technical term will be accompanied by its definition.

Raw Material Studies

The selection and use of raw lithic materials by hunter-gatherers reveals aspects of site function, economic activities, and cultural behaviors relating to toolkit organization and mobility. Andrefsky (1994a, 1994b) has noted that the level of lithic raw material abundance, availability, and quality is one of the more important factors that can influence toolkit organization. The level of toolstone quantity (i.e. availability and abundance) and quality in certain regions may be indicated by formal to non-formal tool ratios within lithic assemblages. Interestingly, Andrefsky (1994a) argues that lithic technological organization is not necessarily indicative of hunter-gatherer settlement patterns (i.e. forager versus collector or sedentary versus mobile). Toolstone quantity and quality, he believes, played a larger role in the organization of a toolkit than in determining a group's subsistence system. Conversely, Perry and Kelly (1985) demonstrate that subsistence and residential systems do play a major role in determining formal and non-formal tool ratios. Perry and Kelly (1985) see the level of mobility as an initiating factor in the utilization of a formal bifacially-oriented technology. They do not necessarily demarcate forager and collector systems in reference to technologies (i.e. generalized versus specialized), but are more interested in a comparison between mobile populations and sedentary populations. In reality, what effects technological organization is likely a mixture of both of these theoretical views (Kuhn 1995; Odell 2004), and may include critical factors not understood by contemporary researchers (Andrefsky 1994a). In light of the role of potentially unique conditions, Brantingham (2003) has postulated that raw material variability within lithic assemblages may have nothing to do with either functional or adaptive strategies. Understanding past lithic technological organization by observing raw material variability at a site might be skewed by archaeological site formation processes. According to Brantingham (2003), raw material procurement episodes most likely occurred on small time scales (i.e. a day, a month, etc.). Because sedimentation is a much slower process and "geochronological controls rarely offer such fine-scale resolution", minute episodes in raw material selection that can lead to the understanding of toolkit organization may go undetected by contemporary archaeological methods (Brantingham 2003:257).

Kuhn (1995) attempts to demonstrate that it is possible to arrive at an understanding of whether tool organization is affected by the relative availability, or cost, of toolstone procurement. He used a set of statistical tests comparing known locations of toolstone sources and five Mousterian sites in addition to recovered faunal data and core and tool reduction strategies (Kuhn 1995). Kuhn's (1995) studies showed that technological organization is indeed affected by the abundance of toolstone sources. Although he does not necessarily discuss quality, this may be due to the fact that the majority of the chert sources were relatively equal in quality throughout the Mousterian landscape of France. According to Kuhn (1995), technological organization results from the combined set of decisions based on the evaluation of immediate and future situations, including abundance of toolstone, distance to sources, transport of toolkit, hunting strategies, and residential systems. At sites located in areas having a scarcity of toolstone sources, cores and tools exhibited a high degree of use and exhaustion, and cores were more formalized, and efficient in design. In contrast, areas with a high amount of toolstone exhibited a wider diversity of core reduction techniques along with a high amount of tested cores and cobbles (Kuhn 1995).

Andrefsky (1994a, 1994b) has developed four possible scenarios that may have certain observable effects upon technological organization related to lithic raw material quantity and quality. 1.) In areas containing abundant high quality toolstone, the manufacture of both formal and non-formal tools will be evident. 2.) In areas that contain high quality lithic raw material in relatively low abundance, a lithic assemblage will exhibit a concentrated effort towards the manufacture of formal tools with little evidence for the manufacture of non-formal tools. 3.) In areas containing abundant low quality toolstone assemblages will mainly consist of non-formal tools with moderate to no evidence of formal tool manufacture. 4.) Areas exhibiting low quality toolstone in low abundance will tend towards the exclusive manufacture of non-formal tools.

Using Andrefsky's (1994a, 1994b) and Kuhn's (1995) ideas regarding lithic raw material quality and abundance, my analysis of the Indian Sands lithic assemblage will test these generalizations by attempting to understand raw material quality and abundance based on hand specimen and geochemical techniques (Odell 2004), results from raw material surveys in the area of the site, as well as a formal to non-formal tool ratio.

The hand specimen technique involves the macroscopic observation of color and texture (Odell 2004). Being able to visualize and identify different raw materials based on color and texture has been quite accurate in many lithic studies. In areas where raw material sources are well-known, an accuracy of over ninety percent can be expected (Odell 2004).

One of the more useful contemporary geochemical techniques used in lithic sources is *x-ray fluorescence spectroscopy* (XRF). XRF has the ability to source raw materials based on the measured wavelength readings which are fluoresced back from the specimen when it is subjected to X-rays. The fluorescence signature is related to elements contained in the specimen (Odell 2004). XRF studies can be used with many types of artifacts including lithic material and clays (e.g., ceramic artifacts, bricks). Because debitage and tools made from obsidian were recovered from the early Indian Sands assemblage, XRF analysis was conducted by the author in conjunction with Craig Skinner and Jennifer "Pipps" Thatcher at the Northwest Research Obsidian Studies Laboratory in 2003.

Attribute Analyses Methods

The attribute analysis of debitage allows for an inference of site function, reduction trajectories, and toolkit organization by examining the "distribution of an attribute(s) over an entire population or assemblage" (Andrefsky 2001:9). There are a multitude of possible attributes to consider when analyzing debitage and care must be taken in selecting appropriate characteristics that have been shown to accurately describe assemblage variability. Replicability of analytical results have proven to be a major concern with attribute methods (Andrefsky 1998; Odell 2004). With this in mind, the Indian Sands assemblage will record those attributes which are most replicable as well as those that have been proven useful in deriving ideas of site function, reduction trajectory stages, and toolkit organization.

The entire debitage population was initially segregated into platform and non-platform-bearing flakes based on the free-standing typology (see below). All platform-bearing flakes were then investigated for certain attributes. The platform facet count assists in understanding the stage of reduction as well as the type of production at the site. When related to all other analyses methods, the number of facets on a platform can help to discern between unifacial or bifacial, or uni-directional and multi-directional, core technology (Andrefsky 1998). Multiple facet counts are an indicator of bifacial/multi-directional core reduction as well as early or late stage reduction junctures when compared to weight and size classes. The Indian Sands platform-bearing flakes were grouped into two classes based on either a 0-1 facet count or a 2+ facet count.

Platform-bearing flakes were further segregated by assessing the amount of dorsal scars for each platform-bearing flake. When this attribute is compared with the results of the platform facet count we can infer stages of reduction as well as general ideas of core technology, whether uni-directional or multi-directional. The platform-bearing flakes were placed into two classes based on the count of dorsal scars. One class has a dorsal scar count of 0-1 while the other consists of those with 2+ dorsal scars. A final attribute was recorded for the platform-bearing flakes. This includes platform lipping and is used in conjunction with the 2+ facet count class and 2+ dorsal scar class to determine the presence of bifacial reduction. Complete and broken flakes that possess all three attributes are checked for consideration as a *bifacial thinning flake*. The presence of bifacial thinning flakes allow for immediate inference in assessing whether bifacial production took place at a site and will be discussed in depth below.

Typological Analyses Methods

Typological analyses are useful for assessing the location, or stage, of a debitage specimen or group of debitage within the general reduction trajectory that is associated with all manners of lithic tool manufacture. These analyses also allow for the recognition of specific types of lithic tool manufacture. The typological analyses methods used with the Indian Sands lithic assemblage are discussed below. Used together with results from the aggregate analyses, typological analysis methods have the potential to make powerful inferences about prehistoric behavior (Andrefsky 1998; Jochim 1989).

Free Standing Typology

This analysis is also known as an “interpretation free analysis” (Sullivan and Rosen 1985) and finds its strength in the fact that it is both objective and replicable. Each piece of lithic debitage in the entire assemblage will be inspected and placed into one of four categories based on the presence or absence of platforms, a ventral surface, and intact margins. The categories consist of complete flake, broken flake, flake fragment, or debris (Figure 3.1).

The inferred results of this process are important in determining the range of reduction strategies implemented within a lithic assemblage. Because it rests upon easily utilized categories that are replicable and objective, simple statements of behavior can be obtained by the analyst. It is generally agreed that assemblages with a high degree of debris and complete flake percentages are representative of an early stage in the lithic reduction trajectory while high percentages of broken flakes and flake fragments represent a late stage lithic reduction strategy

(Sullivan and Rosen 1985). Noting the different stages of a lithic reduction trajectory can allow for insights into site usage, mobility, tool production strategies, and organization.

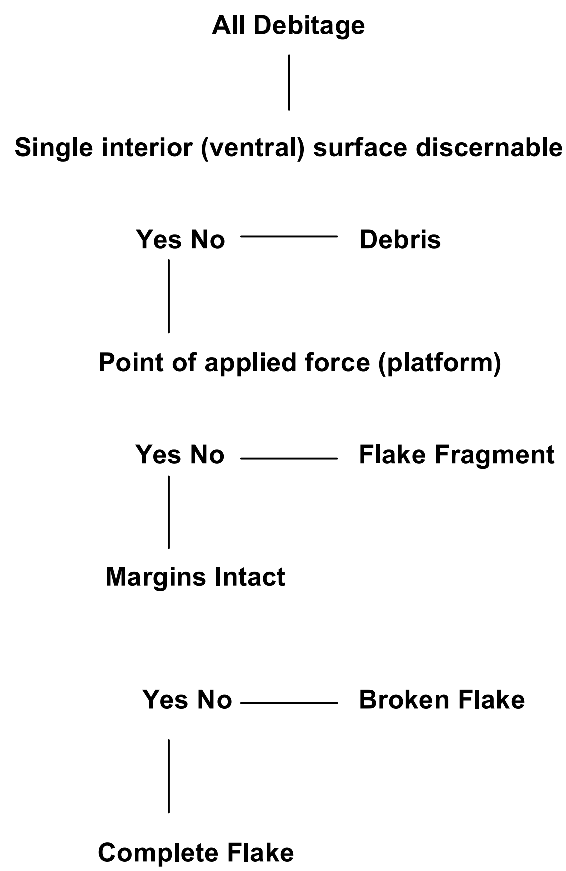

Figure 3.1: Diagram of the Free-Standing Typology (Sullivan and Rosen 1985).

Triple Cortex Typology

This method of analysis is also designed to understand the stages of lithic reduction. The triple cortex approach provides a replicable and objective means of observing patterns in the lithic debitage population based on the presence or absence of cortex (i.e. cortical rind or the weathered outer surface of the parent material) and the percentage of cortex that is present on each piece of debitage (Andrefsky 1998). The rationale for this approach is based on the assumption that tools and debitage are the result of a lithic reduction process. Because of this, not only will the objective piece become smaller, as will the detached debitage, but the amount of cortex will become less as the objective piece is further reduced. In order to measure stages of lithic reduction through cortex amounts, debitage specimens are ranked as primary, secondary, or interior pieces. Primary debitage are those specimens with 50-100% cortex covering their dorsal surfaces. Secondary refers to those specimens with 25-50% observable cortex remaining. Interior debitage are those with less than 25% cortex remaining. As with the free-standing typology, the triple cortex approach is a very efficient and reliable way to achieve general assumptions about site usage and human behavior through the understanding of lithic reduction stages.

However, reliability is not always a constant. Accuracy in interpreting the stages of the reduction trajectory through the measuring of cortex depends upon an understanding of the raw material which is utilized for tool and core production. Connolly's (1999) research in the Newberry Crater region of Oregon demonstrated that the triple cortex typological method is indeed capable of being inaccurate. Analysis conducted on lithic assemblages associated with obsidian quarries exhibited a very small percentage of cortex (Connolly 1999). In theory, raw material quarry locales should encompass a sizeable amount of cortex-bearing debitage considering that nodules are initially decorticated and reduced for further manipulation at the site or prepared for transport. Connolly (1999) found that because the majority of obsidian at the quarry source was naturally decorticated, evidence for early stage reduction based on cortex percentage was neither accurate nor applicable for discerning stages of reduction. As stated above, multiple lines of evidence should be implemented in lithic studies that can allow for the understanding of the accuracy of this and other methodologies. Because the majority of *Jop* chert-bearing breccias at 35-CU-67C lack cortical weathering rinds as in Connolly's obsidian quarries, the Indian Sands lithic assemblage is in a position, in conjunction with all other analytical methods being utilized, to test the accuracy of the triple cortex typology (Willis 2003).

Technological Typology

A technological typology is based on identifying attributes on individual pieces of lithic debitage. It is imperative for the analyst to only use those attributes that have been acknowledged by other researchers to be indicative of certain types of technology based on the use of experimental studies. As previously discussed, this can be accomplished by using agreed upon and standardized terminology as well as strictly defined attributes including the utilization of an intensive reference system and literature review of other published lithic analyses.

In regards to the technological typology, this analysis has the potential to infer human behavior and technological organization based upon certain attributes found within the lithic assemblage (Andrefsky 1998; Shott 1993). One of the main reasons that this method will be employed is that it allows for immediate behavioral and technological strategies to be recognized with as little as one piece of debitage. An example of this is can be found in what many researchers commonly regard as a *bifacial thinning flake*. This is generally agreed to be a flake that has been detached from a bifacial edge in order to shape or thin the objective piece. The detached flake will typically have a remnant of the bifacial edge from the original bifacial tool. Hence, if a bifacial thinning flake is found within an assemblage, the researcher will be able to immediately infer that bifacial tools were being made and/or maintained at the site even if actual bifaces are not recovered from the archaeological record.

Coupled with the larger population trends found with the free-standing typology, triple cortex approach, and aggregate analysis (see below), individual technological types can lend assistance to the understanding of tool production and behavioral strategies. In my analysis of the debitage assemblage at Indian Sands, I will be interested in locating the presence of bifacial thinning flakes, macroblades, microblades, and core rejuvenation/reduction flakes.

Aggregate Analyses Methods

Aggregate analysis, also termed "mass analysis", is conducted by stratifying the entire lithic assemblage of debitage by some uniform criterion and then comparing the relative frequencies of debitage in each stratum" (Andrefsky 1998:126). A uniform criterion typically consists of either the size and/or weight of the lithic debitage with the stratum being composed of different size or weight classes that can be compared to one another. Coupled with the aforementioned analyses, this method can produce useful data that can be used to provide more accurate results in regards to the stage of reduction that the site occupants used. Aggregate analysis can assist in discerning whether the tools were being produced from early, initial raw material reduction stages or to late stage, finished products. Understanding the level or stage of the reduction process assists in assessing the occupants' behavior in the terms of how the site was utilized. By using multiple lines of evidence, the aggregate analyses used with the Indian Sands assemblage should provide useful results. Aggregate analyses also provide quick and efficient ways to collect large amounts of data in a replicable and objective manner. These methods will be used with the Indian Sands debitage assemblage and will be focused upon two different attributes, or criterion, which include debitage size and debitage weight. Weight has been shown to be one of the most reliable measures of debitage attributes (Odell 2004). Because of the reductive aspect of the lithic manufacturing process, it is assumed that both size and weight will decrease as the stages of lithic reduction increase (Ahler 1989). Thus, an early stage lithic reduction sequence will have a high percentage of larger sized and heavier debitage specimens than those of a late stage reduction juncture (Ahler 1989; Andrefsky 1998).

With the present analysis, each individual specimen of debitage was measured for both size and weight. For size classes, each piece of debitage was placed on an incremental circular grid containing seven 1 cm size classes (1-6 cm). Additionally, each individual specimen was placed upon a digital scale and its weight was measured to the closest 0.1 g. The results were grouped into eleven weight classes between 0.1-0.2 g, through 2.1+ g. Results of size and weight classes can be expressed as a cumulative frequency in order to project reduction stages of the entire population. Concentration curves for both variables can be shown as well. Patterns for both size and weight classes should coincide with one another allowing for inference on the stage of reduction and tool manufacturing process taking place at the site.

Dorsal Scar Count/Weight Ratio:

A final analysis will be used with the platform-bearing flakes that incorporates aspects of individual attribute and aggregate methodologies. A dorsal scar count and weight ratio will be calculated for each platform-bearing flake. This simply entails dividing the number of dorsal scars on a flake by its weight. Bradbury and Carr (2001) demonstrate that this is useful for two reasons. One is that the results suggest inferences on the level of tool production versus core production/reduction within an assemblage. High dorsal scar count/weight ratios are believed to relate to core production/reduction whereas low dorsal scar count/weight ratios tend to represent tool production/maintenance activities (Bradbury and Carr 2001).

Summary of Debitage Analysis Methods

By using multiple lines of evidence, it is possible to understand aspects of early lithic technological organization used at Indian Sands. Multiple lines of evidence used for the lithic debitage assemblage in this thesis include typological and aggregate oriented methods. Typological analyses, including the free-standing typology, triple cortex typology, and technological typology consider certain attributes of each piece of debitage on an individual basis (Table 3.1). Typological analyses are useful for determining stages of reduction, whether an assemblage emphasizes core reduction or tool production, and can identify whether specific types of lithic technology were being manufactured at a site (Andrefsky 1998; Odell 2004).

Aggregate analyses are useful for understanding the stages of reduction in a lithic assemblage. These analyses use either size or weight categories to determine whether an assemblage represents an early, middle, or late stage reduction trajectory and can also be used to determine whether core reduction or tool production took place at an archaeological site (Table 3.1). Aggregate analysis methods consider lithic debitage at the assemblage rather than the individual level (Andrefsky 1998; Odell 2004).

The manufacture of tools versus core reduction can also be determined by a non-typological attribute analysis method and a debitage analysis method combining both aggregate and attribute levels of analysis (Table 3.1). One analysis includes a debitage weight versus dorsal scar count ratio (Bradbury and Carr 2001). The other analysis is based on the number of dorsal scars and platform facets that are observable on platform-bearing flakes (Andrefsky 1998; Odell 2004).

Analysis Method	Level of Analysis	Objective of Analysis Method
Free-Standing	Attribute/Individual	Identifies emphasis of core reduction and/or tool production
Triple Cortex	Attribute/Individual	May indicate between early, middle, and late stage reduction trajectories
Technological	Attribute/Individual	Can identify specific types of lithic techonogies including types of core and tool produciton
Size Class	Aggregate/Mass	May indicate between early, middle, and late stage reduction trajectories in an efficient manner
Weight Class	Aggregate/Mass	May indicate between early, middle, and late stage reduction trajectories in an efficient manner
*pfc/dsc count	Attribute/Individual	Identifies emphasis of core reduction and/or tool production
*wgt/dsc ratio	Aggregate/ Attribute	Identifies emphasis of core reduction and/or tool production combining two types of analysis methods

Table 3.1: Summary of the types of debitage analysis methods and their benefits (pfc/dsc = platform facet/dorsal scar and wgt/dsc = weight/dorsal scar).

Statistical Methodology

In order to observe significant differences or similarities between the 2C and 3Ab horizon debitage and tool assemblages, the results of the lithic analyses will be subjected to statistical tests. The statistical tests chosen for this study are well suited for making comparisons of lithic assemblage attributes between the 2C and 3Ab horizons at the test unit level. The statistical tests will include the t-test, the Kolmogorov-Smirnov test, and a simple linear regression.

The t-test will be used to compare the 2C and 3Ab horizon assemblages of each test unit in regards to the free-standing typology analysis results. A t-test is a comparison of means and can be used to test two samples. Confidence intervals are constructed for each mean and the differences between the means at the 95% confidence level. In this study, the t-test will be used to determine whether the differences of the two means equals zero (i.e., the null hypothesis), suggesting that the two populations are not significantly different, or that the means do not equal zero (i.e., the alternative hypothesis), which states there is a significant difference between the two populations (Loether and McTavish 1988).

The Kolmogorov-Smirnov test can be used to compare the distributions of two samples. The K-S statistic tests a null hypothesis that suggests the two samples are not significantly different. This is accomplished by computing the maximum distance between the cumulative distributions of the two samples (Thomas 1988). A p-value greater than or equal to 0.05 signifies that there is not a statistically significant difference between the two distributions at the 95% confidence level. In this study, the K-S statistic will be used to determine whether there are significant differences between the entire 2C and 3Ab horizon assemblages in regards to the dorsal scar to weight ratio analysis results.

Finally, a simple linear regression will be applied to the tool assemblages from the 2C and 3Ab soil horizons. Specifically, assemblage size (i.e., the independent variable) and assemblage diversity (i.e., the dependent variable) will be compared for each assemblage in addition to other early Pacific Northwest lithic assemblages. The idea is that assemblages produced by groups practicing less mobility and more intense residential occupation will produce regression curves with steep slopes while more mobile populations will produce assemblages with regression curves with lower slopes (Kelly 2001).

Formed Lithic Tool Analyses Methods

This method of analysis excludes all debitage. The focus is centered upon identifying, quantifying, and describing formal and non-formal tools found within the lithic assemblage. Formed tool analysis is important in that it can shed light upon behavior and tool organization as it relates to larger theoretical issues. Some of these include the use of a generalized versus specialized toolkit, sedentary versus mobile lifeways, and forager versus collector strategies

(Andrefsky 1998; Binford 1980; Bleed 1986; Pecora 2001; Torrence 1989; Winterhalder and Smith 2000). Analysis will group formed tools into one of three categories: 1.) cores, 2.) bifaces, and 3.) formal and non-formal unifacially or bifacially modified flake tools.

Core Analysis Method

Cores are considered objective pieces that show evidence for flake removal in the form of negative scars (Crabtree 1999). They can take many shapes including conical, amorphous, multidirectional, unidirectional, discoidal, and bifacial. Although some researchers believe that cores should be treated as debitage, cores and core fragments/core reduction flakes will here be considered to be a formed and systematic use of raw material that produces usable flakes for the manufacture of tools (Andrefsky 1998; Crabtree 1999) as well as having the ability to be utilized as functional tools themselves (e.g., core hammers, core scrapers). Cores found within the assemblage will be recorded metrically using a ratio of maximum linear dimension multiplied by the weight (*core size = MLD x core weight)* so that all measurements will be objective and not depend on the rather anomalous shapes that cores can generally take (Andrefsky 1998).

An addition to core analysis is the presence and identification of core rejuvenation/reduction flakes (Crabtree 1999; Stafford 1999). Although retaining attributes of debitage, these specimens originate from a core and may be large enough to have continued use as a core in themselves (cf. Brantingham 2003). A core reduction flake is typically produced in order to allow for a new striking platform on the original core. Core reduction flakes are generally large and thick exhibiting multiple negative flake scars on the dorsal surface of the flake. These flakes allow for inferences on original core technology when actual cores are absent through transportation away from the site or the core is exhausted.

Biface Analysis and Reduction Trajectory Methods

Bifaces are objective pieces that have been reduced on two faces that allow for the presence of a formed edge bearing this bi-directional reduction (Andrefsky 1998; Crabtree 1999). The bifacial edge will circumscribe the entire tool. The biface is one of the most common multi-purpose tools utilized by mobile hunter-gatherers whether they are collectors or general-foragers in orientation (Johnson 1989). This thesis will employ a biface reduction trajectory model in order to understand the progress of bifacial production at Indian Sands from an unmodified piece of raw material to a finished product. Setting up differing stages of bifacial forms to construct a model or sequence of bifacial production has been used by many researchers (Muto 1971; Callahan 1979; Johnson 1989; Andrefsky 1998; Connolly 1999). Bifaces will be categorized here depending on whether they exhibit early, middle, or late stages of manufacture. Each stage is defined by the amount of reduction that has occurred on the biface as it progresses towards a final form (Andrefsky 1998). This analysis will use a bifacial trajectory sequence based on aspects of Johnson's (1989) and Connolly's (1999) methods (Figure 3.2).

It should be noted that the majority of biface trajectory models, including Connolly's (1999), are based on the pioneering work of Callahan's (1979) model for eastern fluted biface manufacture. Callahan's model includes: 1.) blank, 2.) preform I, 3.) preform II, and 4.) finished biface. The main differences between each stage are based on treatment of the lateral margins and the amount of negative flake scars removed from both surfaces. Although this bifacial sequence is somewhat subjective, a set of metric measurements were taken so that, in addition to the morphological characteristics, the bifaces can be graphically represented in one of these four categories.

A blank is a stage I biface and is the initial sequence of biface manufacture, represented by flake removal on both surfaces and an incompletely but initiated lateral margin. The sizes of bifacial blanks are typically large but this is not necessarily a good indicator, considering that the size of the original flake from which the blank is manufactured might be of moderate dimensions. The edge angle will be approximately 50˚ to 80˚.

A preform I is a stage II biface. The biface will have a complete lateral margin but will retain some cortex. It will show some thinning with the majority of flake scars meeting to at least the implement midline. The cross-section will be lenticular in form but not necessarily flattened. The edge angle will be approximately 40˚ to 50˚.

A preform II is a stage III biface. The biface will lack all cortex but will not exhibit complete lateral edge straightening. The flake removal will cross the implement midline and the cross-section will be lenticular and flattened. The edge angle will be approximately 25˚ to 45˚.

A finished biface is a stage IV biface and commonly considered a projectile point or knife. It will have all surfaces exhibiting negative flake scars, the complete straightening of the lateral margin, possible edge trimming, and will more than likely show evidence of hafting. In short, this will be the final shaping, aside from any future resharpening or recycling of the biface form for use as a tool. As with the stage III cross-section, the finished biface will be lenticular and flattened. The edge angles will be approximately 25˚ to 45˚.

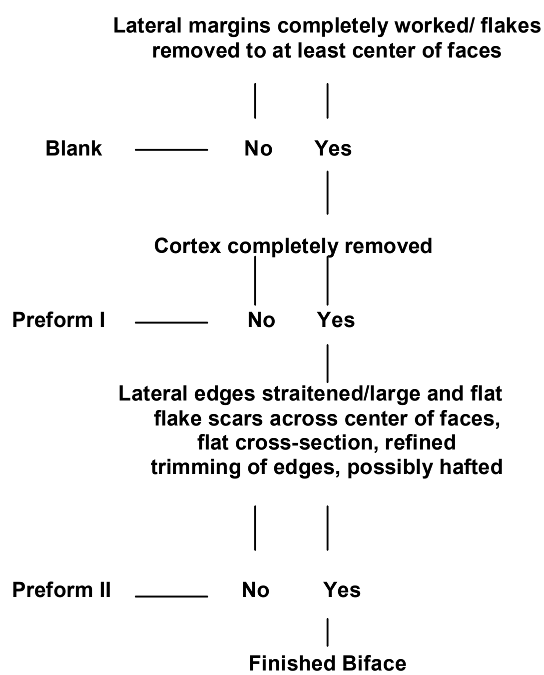

Figure 3.2: Biface key used in the 35-CU-67C assemblage based on Johnson (1989) and Connolly (1999).

It is of interest to note that Connolly's (1999) research in the Newberry Crater region of central Oregon located two types of lithic reduction trajectories. One involved an initial large flake blank, reduced to preform I and preform II bifaces, which were transported out of the area and possibly used as cores. The second type of trajectory initiates with either unifacial or bifacial core production used for the manufacture of moderate sized flake blanks. These blanks were either further reduced to finished bifaces or taken out of the area as preforms. It should be noted that the second type of trajectory was the most common in the pre-Mazama assemblages (components I and II) at site 35-DS-34 in Newberry Crater (Connolly 1999).

Modified Flake Tools

Flakes that have been modified through utilization or formal retouch for use as tools are considered to be modified flakes. Modified flake tools will be divided into two classes including formal and non-formal. Formal modified flake tools are those that have enough significant and extensive retouch to alter the original flake or blade form (Tomka 1998). Non-formal modified flake tools are those which have not been manually retouched, whose modified edge form has not altered the original flake characteristics, and whose modified edge is caused by utilization only (Tomka 1998). A host of metric measurements as well as observations of morphological attributes were taken for both formal and non-formal modified flake tools and are as follows: 1.) maximum length, maximum width, and maximum thickness (all in millimeters); 2.) the weight of the object (in grams); 3.) the category of lithic reduction in reference to the free-standing typology; 4.) the remaining amount of cortex the object retains; 5.) the number of tool edges; 6.) the location of the modified edge (i.e. proximal, distal, right or left lateral margin); 7.) the tool edge characteristic (i.e. convex, straight, or concave); 8.) the angle of the modified edge will be recorded to attempt a functional interpretation of the tool (e.g., flakes exhibiting a steep edge will most likely be due to use as a scraping implement as opposed to a cutting or slicing implement (Anderfsky 1998); 9.) the retouch attribute, which includes uni-marginal, one lateral edge modified, bi-marginal, two lateral edges modified, or combination flake tools exhibiting multiple modified edges in different locations, and; 10.) the retouch distribution (i.e. continuous or clustered). In order to make all observations reliable, modified flake tools were observed with the platform area pointing down towards the author and the dorsal surface facing up (Andrefsky 1999). It should be stated that this is the opposite of how debitage is recorded (i.e. debitage is recorded with the distal portion pointing down towards the author with the dorsal surface facing up).

Chapter 4: Lithic Analysis

Raw Material Results

Based on the hand specimen technique, the vast majority of raw material utilized in toolkit manufacture at Indian Sands seems to be a variety of locally-available chert toolstone (Figure 4.1). As stated in the introduction, because the Indian Sands locality includes an extensive *Jop* formation, numerous chert outcrops surround the site (Figure 4.2). Additionally, water-borne chert nodules are also located only 1.6 km southeast (~151˚ SSE) of the site at the mouth of Whaleshead Creek. Local chert comprises over ninety percent of the material used for stone tool manufacture at Indian Sands. Of the 4162 lithic tools and debitage in the 2C and 3Ab horizons examined, 4122 lithic artifacts are comprised of debitage with the remaining 40 being tools. Chert toolstone comprises 94.8% (n=3946) of the lithic assemblage at Indian Sands. Obsidian debitage and tools (n=173) accounts for 4.1% of the assemblage. The remaining raw material type is made up of igneous and quartzite debitage (n=43) comprising 1.0% of the assemblage.

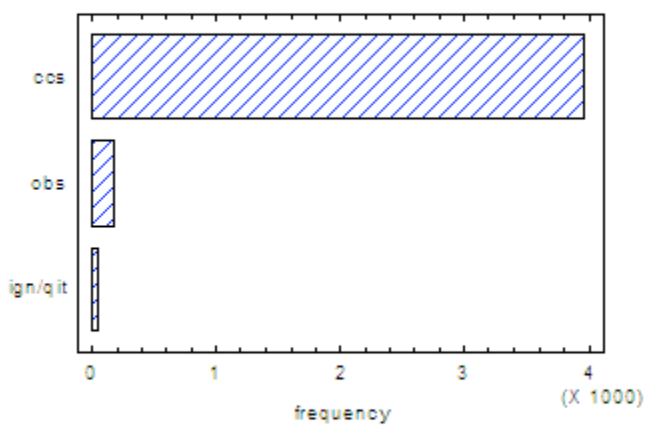

Figure 4.1 Composition of raw material at Indian Sands (ccs=chert, obs=obsidian, ign=igneous, qit=quartzite).

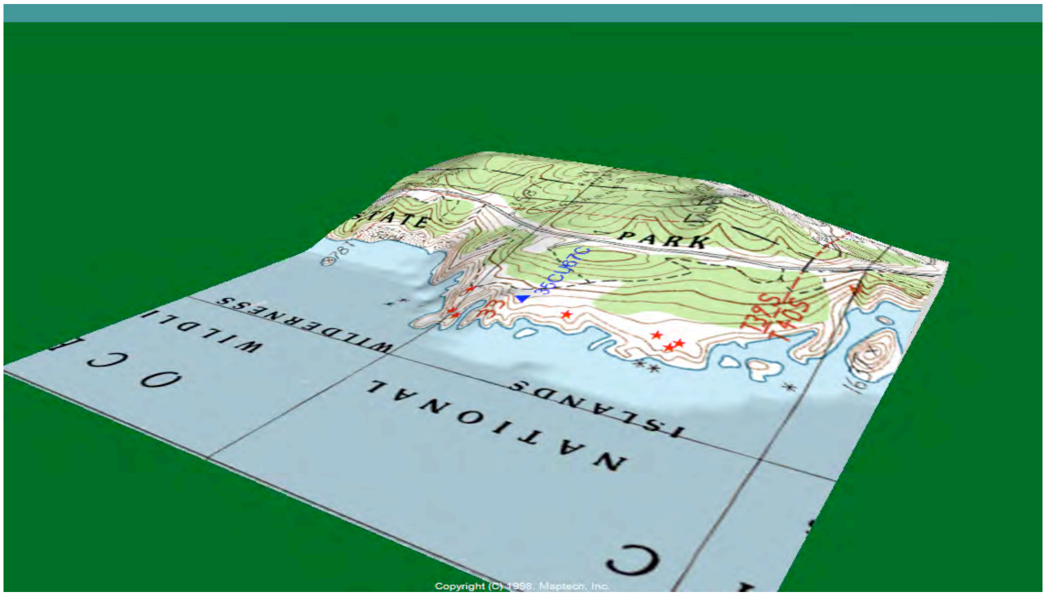

Figure 4.2: Three-Dimensional 7.5 minute topographic map showing location of JOP chert outcrops (stars) in relation to 35CU67C site datum (triangle).

Figure 4.3: Map showing location of Indian Sands in relation to known obsidian procurement locals.

One of the inferred site functions of Indian Sands is that of a quarry where the procurement of chert toolstone supported lithic production on site or at a distant locale (Davis et al. 2002; Willis

2003). This is a very important aspect of site interpretation and may have a strong affect on the morphology of the lithic debitage assemblage in both the 2C and 3Ab soil horizons. XRF analysis indicates that obsidian was imported to Indian Sands from four known sources (Figures 4.3 and 3.4). The distance between these obsidian sources and Indian Sands help explain the relative dearth of obsidian artifacts and plentiful amount of local chert toolstone at Indian Sands. The importance of the obsidian artifacts are also revealed by the absence of cores, debitage patterns exhibiting only a small amount of interior flakes mainly comprised of flake fragments and broken flakes, as well as three broken finished bifaces. These results provide a means to assess issues of mobility and raw material procurement strategies employed at Indian Sands. The results of the XRF analysis show obsidian was imported to Indian Sands, which suggests the existence of a coastal-inland trade network or high mobility among coastal peoples during the late Pleistocene.

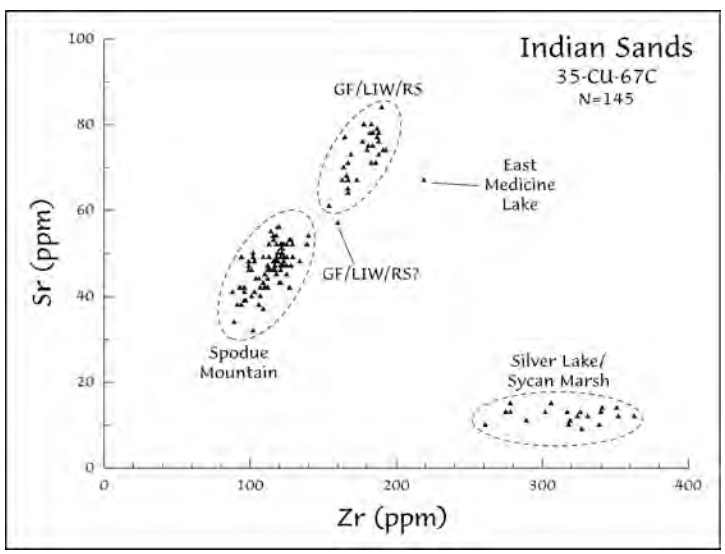

Figure 4.4: Scatterplot comparing Sr and Zr concentrations based on XRF results of obsidian debitage and tools.

Obsidian hydration analysis was conducted on a sample (n=46) of the obsidian debitage including populations from both 2C and 3Ab soil horizons in an attempt to obtain a relative age for site stratigraphy. Results of the obsidian hydration analysis are shown in Table 4.1. As can be seen, there is little variation in mean hydration rim micrometer (μ) measurements among obsidian in the 2C and 3Ab horizons. Deeply buried samples from levels 10 and 13 in test unit F have the highest hydration readings, which should be expected; however, medium and low thickness hydration rims are also present. Because there is no way to retrieve an exact date for the rim thickness readings, it is only safe to assume that both the 2C and 3Ab horizons at Indian Sands are indeed the products of prehistoric activity (Craig Skinner, personal communication 2004).

A linear regression analysis was conducted on all obsidian hydration results to assess the relationship between rim thickness and depth. The rationale for this analysis lies in the hypothesis that if the rim thickness readings are accurate, the specimens associated with the 3Ab horizon will have thicker measurements than those specimens from the 2C horizon. Although a positive relationship is observed with the regression line in Figure 4.5, the correlation coefficient shows a weak (r = 0.06) relationship of rim thickness with depth. This small increase in rim

Unit	**Level**	**Source**	**RimThk.**	**Unit**	**Level**	**Source**	**RimThk.**
A	3	GLR	4.6	A	7	SM	3.9
B	1	GLR	4.6	A	7	SM	4
B	1	GLR	4.9	C	5	SM	4.2
F	1	GLR	4.4	F	1	SM	4.1
F	1	GLR	4.4	F	1	SM	4.1
F	7	GLR	3.9	F	1	SM	4.1
F	9	GLR	5.6	F	1	SM	3.6
F	11	GLR	3.8	F	3	SM	3.4
F	13	GLR	4.4	F	4	SM	3.8
F	13	GLR	5	F	4	SM	4
F	13	GLR	5.5	F	5	SM	4.2
F	13	GLR	3.6	F	6	SM	3.8
A	3	GG	4.5	F	6	SM	4
A	6	GG	4.1	F	8	SM	4.4
F	2	GG	3.5	F	10	SM	4.1
F	4	SL	4.6	F	10	SM	4.5
F	6	SL	3.5	F	11	SM	2.8
F	7	SL	4.1	F	11	SM	4.6
F	10	SL	3.3	F	11	SM	4.2
F	13	SL	4.2	F	12	SM	4.9
F	15	SM	4.4	F	13	SM	2
F	15	SM	4.5	F	13	SM	4.4
F	17	SM	4.3	F	14	SM	4.6

Table 4.1: Table showing obsidian hydration specimens and rim thickness measurements. Sources: GLR = Grasshopper Flats, Lost Iron Well, Red Switchback; GG = Grasshopper Group; SL = Silver Lake/Sycan Marsh; SM = Spodue Mountain)

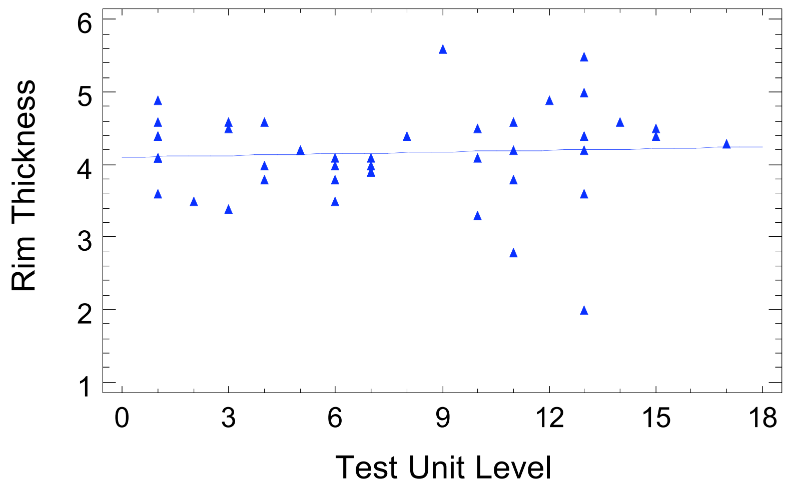

Figure 4.5: Linear regression comparing obsidian debitage rim thickness with depth.

thickness with depth is confirmed by a low, although increasing, regression slope of 0.0078. Therefore, the obsidian hydration measurements explain that either there was some type of physical shifting of the obsidian from the upper levels into the 3Ab deposits, or that the hydration readings are not accurate. The latter hypothesis seems more realistic considering that late Quaternary precipitation rates are largely unknown in this area.

Individual Test Unit Debitage and Tool Analysis Results

Unit A

Debitage Analysis

The lithic debitage assemblage in unit A, and in other units to follow, was segregated stratigraphically by soil horizon following Davis et al. (2004). In unit A, the 2C horizon contained 1 tool and 229 pieces of lithic debitage. The 3Ab horizon had a total of 2 tools with 135 pieces of lithic debitage. Figure 4.6 and Table A1 (Appendix A) present the results of analysis using the free-standing typology. The 2C assemblage mainly contains flake fragments (63.3%) followed by broken flakes (28.4%). Complete flakes and angular debris make up the remaining 8.3% of the debitage. Similarly, the debitage in the 3Ab population is comprised of 64.4% flake fragments and 31.8% broken flakes. The remaining debitage is represented by complete flakes making up the remnant 3.7% of the population. Under the free-standing typology, unit A debitage suggests a focus on tool production rather than initial core reduction occurred through time. The t-test fails to show a significant difference between the 2C and 3Ab assemblages (t = 0.62 , p-value = 0.558, the confidence interval for the difference between the means extends from -69.2 to 116.2).

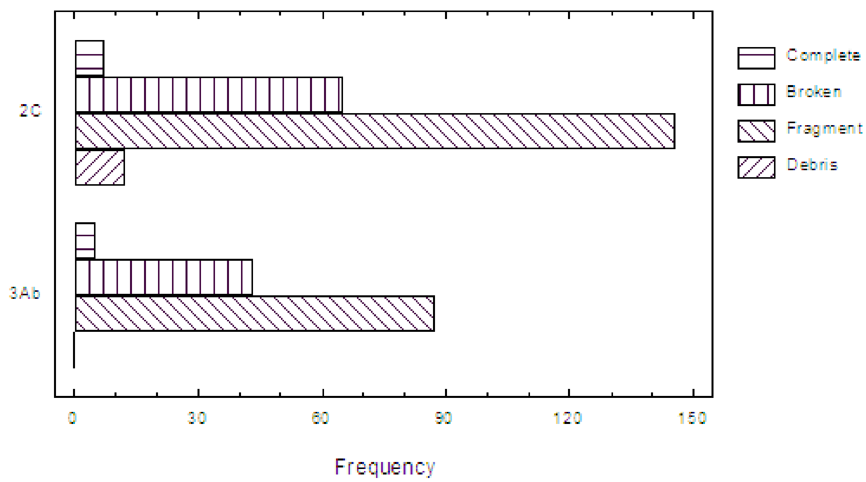

Figure 4.6: Barchart showing the Free-Standing Typology results for the 2C and 3Ab soil horizons for Unit A.

Results of the attribute and technological typology analyses are summarized in Figure 4.7 and Table A2 (Appendix A). Bifacial thinning flakes make up 24% of the of the 2C platform-bearing flakes. Platform facet counts show a relatively even representation of both single and multiple faceted platforms. Single facet flakes account for 54% of flakes whereas multiple faceted flakes comprise 46% of the platform-bearing flake population. The dorsal scar counts for the 2C platform-bearing flakes show 61% exhibiting multiple dorsal scars and 39% having single dorsal scars. The 3Ab platform-bearing flakes show similar results among bifacial thinning flakes which comprise 23% of the population. The platform facet count differs however, as 23% of the assemblage retains multiple faceted platforms, whereas single platform facet counts comprise

77% of the assemblage. Regarding the 3Ab dorsal scar count, flakes with single dorsal scars account for 77% of the population while multiple dorsal scars account for 33% of the assemblage. Tool production/maintenance is evident in both 2C and 3Ab platform-bearing flake populations through the presence of platform lipping representing 31% in each horizon.

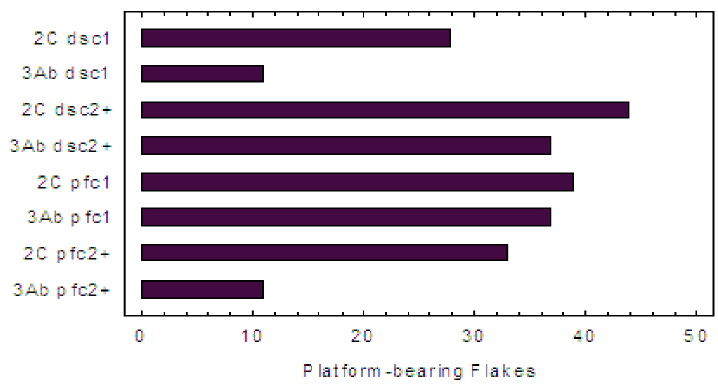

Figure 4.7: Frequency distribution showing platform-bearing flake results of 2C and 3Ab assemblages for Unit A.

Table A3 (Appendix A) shows the summary of the triple cortex typology analysis, which produced results similar to those produced by the free-standing typology. The majority of both 2C and 3Ab debitage falls within the interior flake category, suggesting a trend towards late stage reduction (e.g., tool production/maintenance). Interior flakes for the 2C population comprise 90.4% of the population with 8.3 % being secondary flakes and 1.3% being primary flakes. Similarly, the 3Ab debitage population contained 85.9% interior flakes, 12.6% secondary flakes, and 1.5% primary flakes.

Size and weight aggregate analyses for unit A point to a trend in late stage reduction (Figure 4.8). Within the 2C horizon size analysis, 97% of the debitage falls within the first two size classes with the remaining 3% contained in the 3 cm size class. The weight analysis for the 2C horizon in unit A mirrors these results with 97% of the debitage comprising the first two weight classes. Size analysis for the 3Ab horizon is similar shows 86% of the assemblage falling within the first two size classes. Mid-size classes (3 cm through 5 cm) are represented by the remaining 14%. Weight analysis for the 3Ab horizon shows 83% of the assemblage falling within the two lowest weight classes. It is interesting to note that 7% of the remaining assemblage is included in the heaviest weight class. The remaining 10% of the debitage is evenly distributed throughout the middle weight classes.

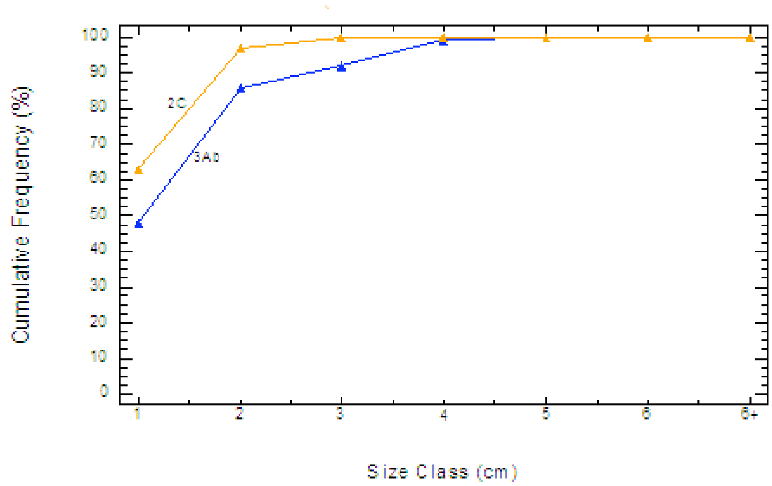

Figure 4.8: Cumulative frequency graph showing size class results of 2C and 3Ab assemblages for Unit A.

Tool Analysis

Core Reduction Flake/Core Fragment (n=1)

Specimen 34, level 7, 3Ab horizon (Figure 4.4C): The specimen is considered a core reduction flake based on its linear and weight measurements as well as the retention of a multi-faceted, lipped, and high angle platform. The flake removal characteristics of the dorsal surface suggest a multidirectional core technology. The intact platform further suggests that the multidirectional core was probably bifacial or discoidal in nature. The core reduction flake is made of a local dark red ccs with vein-like inclusions.

*(mm/g) MxL	MxWDT	MxTHK	WGT	FST	TCT
46.8	32.68	13.6	15.4	broken	interior

*(*MxL=maximum length, MxWDT-maximum width, MxTHK=maximum thickness, WGT=weight, FST=free-standing typology, TCT-triple cortex typology)*

Non-formal modified flake tool (n=2)

Specimen 3, level 1, 2C horizon (Figure 4.4A): This unifacial flake tool appears to be a type of scraper due to continuous retouch made on the distal end of an interior flake fragment. The retouched edge is convex and greater than 60˚, which also gives the impression that the tool was utilized as a scraper. The flake tool is broken both crosswise and lengthwise and does not lend itself to maximum length or maximum width measurements. Raw material is is gray-green in color with vein-like inclusions and is consistent with local cryptocrystalline chert (ccs) found at the site. Micro-fractures are present on the utilized margin but polish cannot be discerned.

*(mm/g) MxL	MxWDT	MxTHK	WGT	EDGE˚	FST	TCT	Edge#	RT Loc	TEC
9.44	13.39	4.22	0.6	60	flake frag.	interior	1	distal	convex

RTA	RTD
uni-marginal	continuous

*(*EDGE˚=modified edge angle, Edge#=number of modified edges, RT Loc=modified edge location, TEC=tool edge characteristic, RTA=retouch attribute, RTD=retouch distribution)*

Specimen 93, level 7, 3Ab horizon, Figure 4.4B: The retouched edge of the modified flake exhibits unifacial retouch located on the proximal end of a broken secondary flake. The modified edge has a straight edge characteristic and shows evidence of use wear in the form of micro-fracture and polish. Because of the condition of the modified flake being broken both crosswise and lengthwise, maximum length and maximum width cannot be assessed. The raw material is of a locally available gray-green ccs chert with vein-like inclusions. The area of the platform that exhibits cortex appears to be weathered.

(mm/g) MxL	MxWDT	MxTHK	WGT	EDGE˚	FST	TCT	Edge#	RT Loc	TEC
21.4	29.5	10.2	9.6	63	broken	secondary	1	proximal	straight

RTA	RTD
uni-marginal	continuous

Unit C

Debitage Analysis

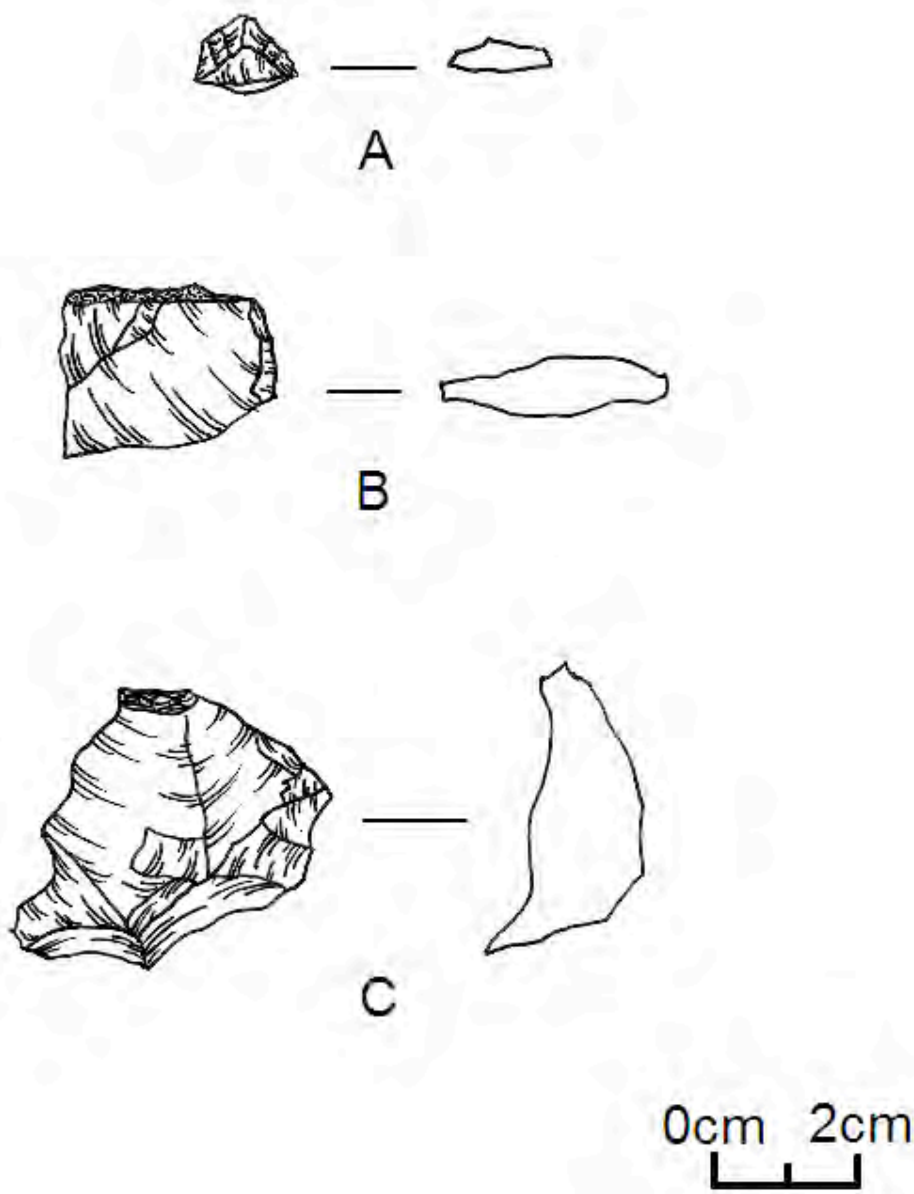

Figure 4.9: Lithic artifacts from Unit A; specimen 3, A; specimen 93, B; and specimen 34, C.

Test unit C is composed entirely of 2C component material. The unit produced 10 tools and 309 pieces of lithic debitage. Tables A4, A5, and A6 (Appendix A) summarize the results for the free-standing typology, the platform-bearing flake attribute analysis, and the triple cortex typology. As with unit A, the free-standing typology (Figure 4.10) grouped most debitage in the flake fragment category, comprising 64%, followed by the broken flake category, comprising 26%. Complete flakes are few, representing 2.6% of the population with angular debris comprising 7.4%.

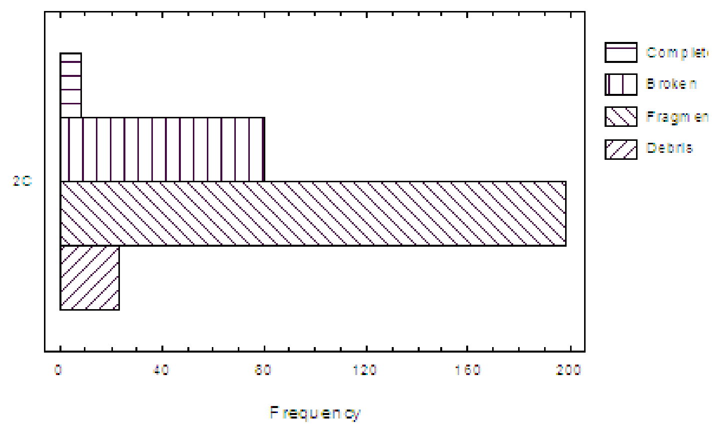

Figure 4.10: Barchart showing the Free-Standing Typology results for the 2C soil horizon for Unit C.

The platform-bearing flakes (Figure 4.11) show a marked similarity between the single and multiple facet count categories. Single platform facet and multiple platform facet flakes each account for 50% of the population. The dorsal scar count results in single dorsal scar flakes comprising 44.3% of the population and multiple dorsal scar flakes representing 55.7%. Bifacial production/ maintenance is suggested, since 22% of the platform-bearing flakes retain characteristics of bifacial thinning and 24% of the flakes exhibit evidence of platform lipping. The triple cortex typology shows interior flakes as representing 87% of the population. Secondary flakes comprise 10.7% and the remaining 2.3% are primary flakes.

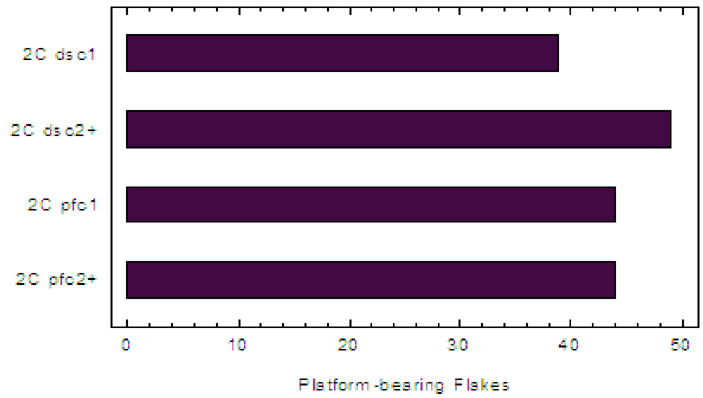

Figure 4.11: Frequency distribution showing platform-bearing flake results of 2C assemblage for Unit C.

The results of the size and weight aggregate analyses (Figure 4.12) show a relatively even distribution of late and middle stage size and weight classes. Only 16% of the debitage falls in the lowest size class and 82% lies in size classes 2 cm through 4 cm. The remaining 2% of the debitage falls within the 5 cm and 6 cm size classes. The weight analysis shows a similar distribution with 36% of the debitage contained in the lowest weight class and the remaining population represented in all but the 1.9-2.0 g class. It is of interest to note that early stage reduction classes (i.e. the 1.7-1.8 g and 2.1 g+ classes) only account for 11% of the assemblage.

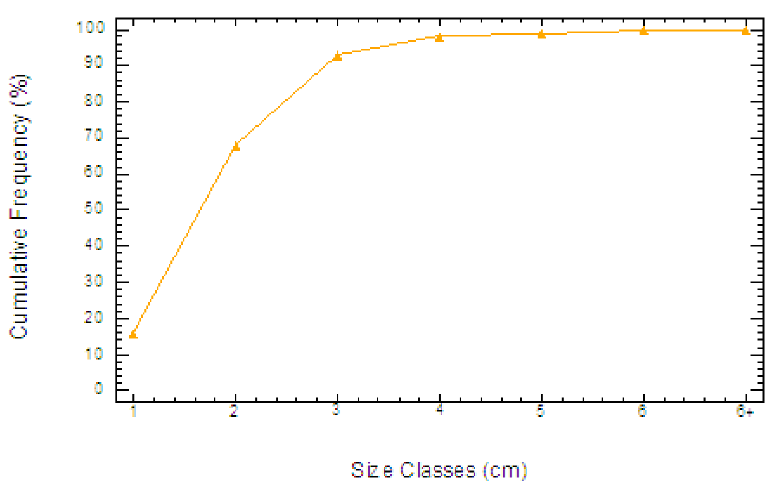

Figure 4.12: Cumulative frequency graph showing size class results of 2C assemblage for Unit C.

Tool Analysis

Core Reduction Flake/Core Fragment (n=2)

Specimen 70, level 1, 2C horizon (Figure 4.14D): This core fragment is broken either crosswise or lengthwise and it is not possible to orient. The specimen is a fragment from a multi-directional and/or bifacial/discoidal core. It is possible that the specimen could be a very early stage preform, possible stage 2, due to a minute amount of edge trimming (Andrefsky, 1998). The raw material is of a local gray and light-green ccs.

(mm/g)	MxL	MxWDT	MxTHK	WGT	FST	TCT
	15.7	33.1	16.0	9.9	flake frag.	interior

Specimen 94, level 1, 2C horizon: The specimen appears to be a core reduction flake. This broken interior flake most likely originated from a multi-directional core due to the numerous negative flake scars on the dorsal side. The proximal end exhibits a platform that is complex and multi-faceted with evidence of crushing/abrasion. Similar to specimen 34, the large size and thickness of the platform does not seem applicable to a bifacial edge. Raw material is a locally available reddish-dark-brown ccs with vein-like inclusions. Maximum length cannot be obtained due to a crosswise break on the flake.

(mm/g)	MxL	MxWDT	MxTHK	WGT	FST	TCT
	20.2	26.9	14.8	6.8	broken	interior

Pebble Tool/Hammerstone (n=1)

Specimen 51, level 1, 2C horizon: The specimen appears to be a hammerstone based on evidence of heavy abrasion and crushing on one end most likely due to impact. The mid-section of one surface of the specimen also shows signs of impact possibly due to another type of activity rather than stone tool reduction. The specimen is complete. The raw material is igneous.

(mm/g)	MxL	MxWDT	MxTHK	WGT	EDGE°
	96.88	76.56	39.68	341.3	70

Non-formal Modified Flake Tool (n=4):

Specimen 96, level 1, 2C horizon (Figure 4.14B): This modified flake is manufactured on interior flake fragment. The working edge seems to be more from expedient utilization than formal manufacture. This is compounded by the fact that the edge angle is between 30˚ and 60˚. The working edge is on the left lateral margin. Hafting cannot be discerned due to the flake being broken both crosswise and lengthwise. The utilized area is positive for micro-fracture and polish. Because of breakage, maximum width and maximum length cannot be obtained. Raw material is a local ccs of an opaque-light-brown color.

(mm/g)	MxL	MxWDT	MxTHK	WGT	EDGE˚	FST	TCT	Edge#	RT Loc	TEC
	19.6	10.58	3.08	0.7	45	flake frag.	interior	1	lateral (L)	straight

RTA	RTD
uni-marginal	continuous

Specimen 97, level 1, 2C horizon (Figure 4.14C): This flake tool appears to be a type of scraper made on an interior flake fragment. The unifacially retouched edge suggests formal modification, due to a patterned flake removal. The edge angle is greater than 60˚. The area of utilization is located on the distal end and is convex in shape. Because the flake tool is broken crosswise, the maximum length cannot be obtained, and does not allow for the verification of a potential haft element. The raw material is a light-gray-opaque ccs of local origin.

(mm/g)	MxL	MxWDT	MxTHK	WGT	EDGE˚	FST	TCT	Edge#	RT Loc	TEC
	8.58	18.04	5.36	0.8	70	flake frag.	interior	1	distal	convex

RTA	RTD
uni-marginal	continuous

Specimen 79, level 1, 2C horizon: This modified flake is an interior flake fragment. Because of the fragmentary nature of the flake, it is not possible to orient proximal, distal, or lateral margins. Retouch is most likely on the distal end. Also, it is not possible to definitively describe the retouched edge characteristic. It is more than likely convex in shape. Micro-fracture is present, but it is impossible to determine whether the polish is due to weathering or use-wear.

(mm/g)	MxL	MxWDT	MxTHK	WGT	EDGE˚	FST	TCT	Edge#	RT Loc	TEC
	n/a	n/a	2.76	0.1	42	flake frag.	interior	1	n/a	convex

RTA	RTD
uni-marginal	continuous

Specimen 52, level 1, 2C horizon (Figure 4.13C): The flake tool exhibits formal retouch on the distal end of complete interior flake. The angle of the modified edge is greater than 60˚, which suggests that the tool was possibly used as some type of scraping implement (Andrefsky 1998). The proximal end of the modified flake shows evidence of a complex platform and is multi-faceted. This could be a possible remnant of a bifacial edge. The retouched edge is positive for both micro-fracture and a small amount of polish. The raw material is a locally available ccs, which is a mottled light and dark gray.

(mm/g) MxL	MxWDT	MxTHK	WGT	EDGE˚	FST	TCT	Edge#	RT Loc	TEC
45.98	28.06	7.32	8.9	75	complete	interior	1	distal	convex

RTA	RTD
uni-marginal	continuous

Uniface (n=1):

Specimen 53, level 1, 2C horizon (Figure 4.14A): The flake tool appears to be a fragment of a formal hafted scraper manufactured of an interior flake fragment. Because the flake tool is broken lengthwise, the maximum width cannot be obtained. However, the right lateral margin, extending for 13.5 mm from the proximal end of the flake to the distal end, is associated with a continuous pattern of micro-fracture and polish indicating a possible haft element. Retouch on the distal, or working, end is convex and has an angle greater than 60˚. The flake tool is made of a local gray-green ccs.

(mm/g) MxL	MxWDT	MxTHK	WGT	EDGE˚	FST	TCT	Edge#	RT Loc	TEC
20.06	15.6	5.04	1.3	70	flake frag.	interior	2	distal	convex

RTA	RTD
uni-marginal	continuous

Biface (n=2):

Specimen 54, level 1, 2C horizon (Figure 4.13B): This biface fragment appears to be the mid-section and basal portion of a finished biface. This is based on the presence of final thinning and shaping along the edge margins. The distal portion of the remaining base is 16.5 mm wide and seems to be characteristic of a stemmed point technology. The flaking pattern is random on one face while it exhibits a collateral pattern on the opposite surface. The biface fragment is broken crosswise in two separate areas, which include both the distal portion and the proximal portion. The raw material is a local ccs with a gray and green color and exhibits vein-like inclusions.

*(mm/g)	MxL	MxWDT	MxTHK	MxWGT	EDGE˚	BW	BM˚	B˚
	n/a	18.06	n/a	1.3	n/a	16.38	n/a	n/a

*(EDGE˚=bifacial margin angle, BW=base width, BM˚=basal margin angle, B˚=basal angle)

Specimen 55, level 1, 2C horizon (Figure 4.13A): The specimen is a finished biface fragment that is mainly comprised of a base along with a small portion of the mid-section. One side of the biface fragment is fractured from a possible impact, which will be discussed in depth below. The intact bifacial edge exhibits a flaking pattern that shows flake scars extending across its surface in a flat and even procession for approximately 3.2 mm from the opposite edge. The termination of the crosswise flake scars is due to a small fracture that runs lengthwise on the surface. The bifacial margins show evidence of serration while the basal portion exhibits a possible tapering stem. The distal basal width is 15.5 mm. Because the proximal end of the base is gradually rounded, the proximal basal width is not measurable. The presence of micro-fracture and polish on the right lateral margin may indicate a haft element. One surface of the biface fragment retains a "flute-like" negative scar with bipolar ripple marks suggesting the action of a compressive force. These features are consistent with impact fractures studied on finished bifaces by Bergman and Newcomer (1983). The negative flake scar exhibits an *outré passé* termination coinciding with Bergman and Newcomer's (1983) experiment. The raw material is a local gray-light brown ccs.

(mm/g)	MxL	MxWDT	MxTHK	MxWGT	EDGE˚	BW	BM˚	B˚
	n/a	n/a	n/a	1.7	n/a	15.48	n/a	n/a

Unit D

Debitage Analysis

Within test unit D, the 2C horizon assemblage contains no tools and 96 pieces of lithic debitage while the 3Ab horizon assemblage is comprised of 5 tools and 263 pieces of lithic

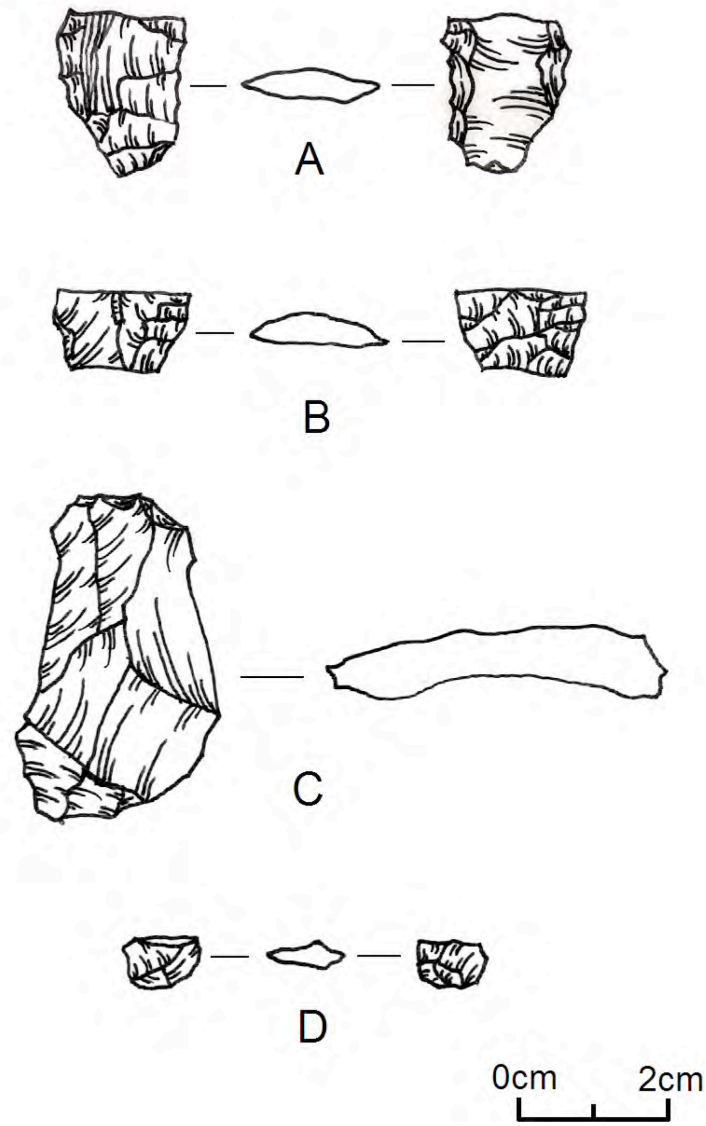

Figure 4.13: Lithic artifacts from Unit C; specimen 55, A; specimen 54, B; and specimen 52, C.

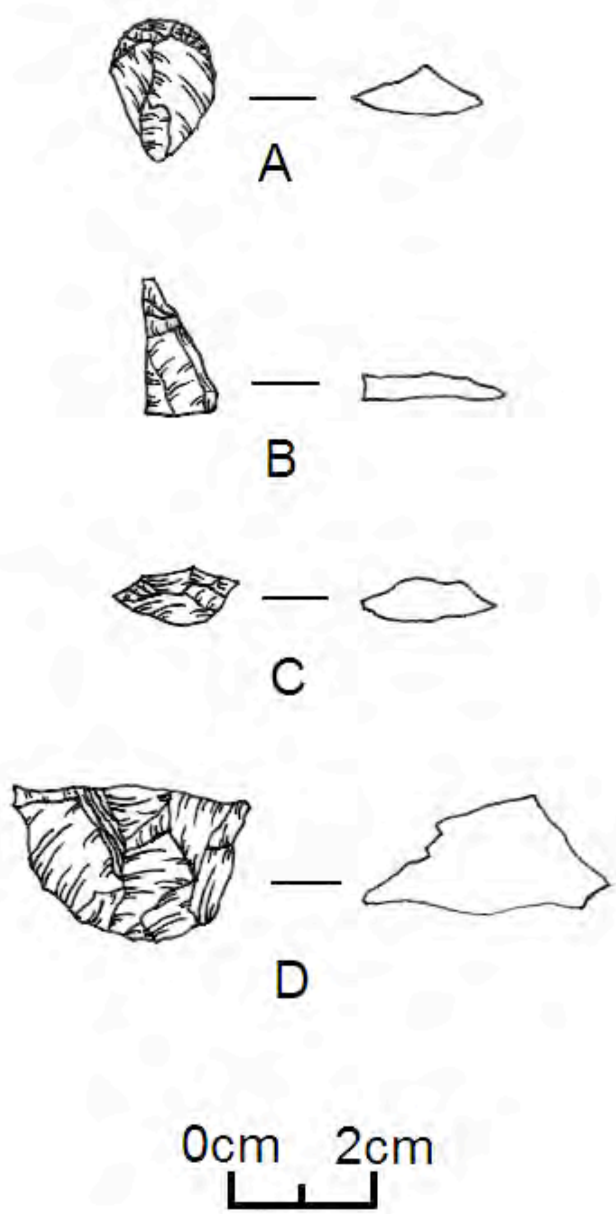

Figure 4.14: Lithic artifacts from Unit C; specimen 53, A; specimen 96, B; specimen 97, C; and specimen 70

debitage. The results of the free-standing typology analysis are shown in Figure 4.15 and Table A7 (Appendix A). The majority of 2C component debitage falls within the flake fragment category, consisting of 65.6% of the population, and the broken flake category containing 24% of the debitage. The remaining debitage is equally divided between complete flakes and angular debris with each making up 5.2% of the population. The 3Ab component shows comparable results with58.1% of the debitage contained in the flake fragment category and 31.2% within the broken flake category. Angular debris comprises 5.7% of the debitage with the remaining 5% belonging to the complete flake category. The results of the t-test support the raw percentage results for the free-standing typology (t = -1.16, p-value = 0.289, the confidence interval for the difference between the means extends from -129.6 to 46.1).

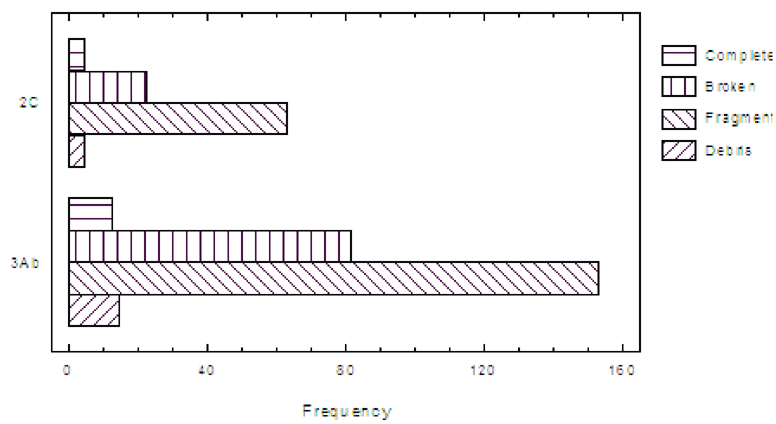

Figure 4.15: Barchart showing the Free-Standing Typology results for the 2C and 3Ab soil horizons for Unit D.

Figure 4.16 and Table A8 (Appendix A) show the results of attribute and technological typology analyses. The dorsal scar count for the 2C component shows 57.1% of the platform-bearing flakes exhibiting multiple dorsal scars with 42.9% of the population exhibiting single dorsal scar counts. The opposite is true for the platform facet counts. The platform facet counts show that single facets account for 57.1% of the population with 42.9% consisting of multiple platform facets. Bifacial production/maintenance is represented by bifacial thinning flakes making up 21% of the population and 18% of the population exhibiting platform lipping. The platform-bearing flakes in the 3Ab component show similar results. Single dorsal scar counts account for 39.4% of the population whereas 60.6% of the population retains multiple dorsal scar counts. Those flakes with single platform facet counts are represented by 43.6% of the population while 56.4% of the flakes have multiple platform facet counts. Bifacial thinning flakes consist of 34% of the platform population with 27.7% having evidence of platform lipping.

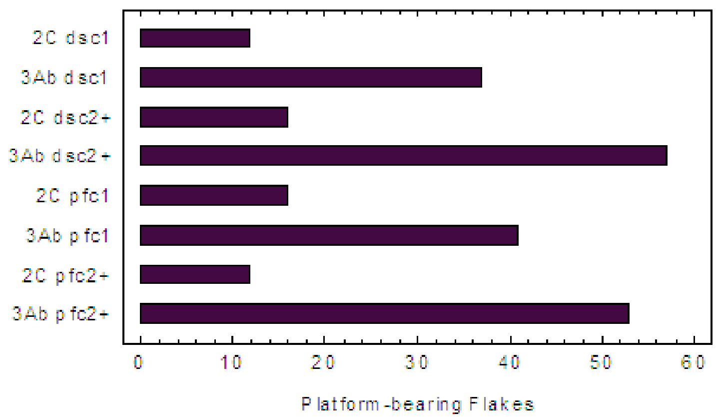

Figure 4.16: Frequency distribution showing platform-bearing flake results of 2C and 3Ab assemblages for Unit D.

The triple cortex typology results are shown in Table A9 (Appendix A). The 2C component is comprised entirely of interior and secondary flakes. On this basis, 80.2% of the population is grouped in the interior flake category and 19.8% of the debitage falls in the secondary flake category. As with the free-standing typology, the results of the 3Ab component show similar trends with 89.7% of the population comprising the interior flake category and 10.3% making up the secondary flake category. There is a complete lack of corticated primary flakes within either horizon.

Trends in the aggregate analyses for unit D show evidence for late stage reduction in both 2C and 3Ab horizon assemblages. The size analysis results (Figure 4.17) for the 2C assemblage show 95% of the debitage comprising the first two lightest size classes. The remaining 5% falls within the size 3 cm and 4 cm classes. Size results for the 3Ab assemblage show a trend toward late stage reduction as well with 97% of the population consisting of the 1 cm through 3 cm size classes. Weight results for the 2C assemblage point towards a trend in late stage reduction with 97% of the assemblage falling in the four lowest weight classes. Two percent of the debitage are in the 1.3-1.4 g and 1.5-1.6 g classes with only 1 percent contained in the 2.1 g+ weight class. The 3Ab assemblage is similar in that 90% of the population is contained in the lightest three weight classes. The remaining 10% is evenly distributed among the middle and early stage weight classes.

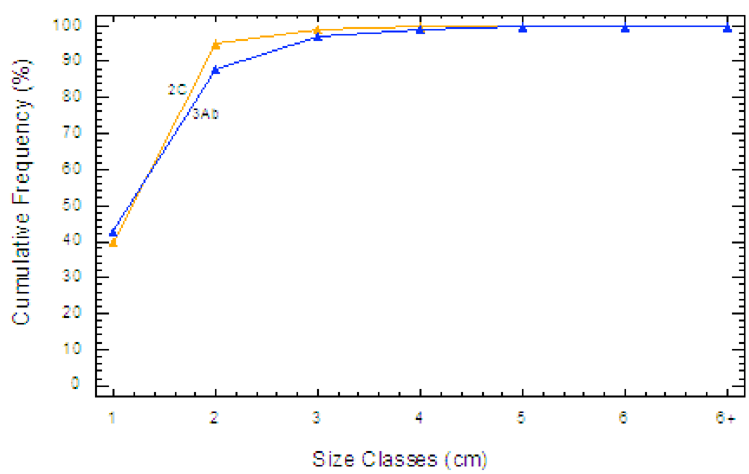

Figure 4.17: Cumulative frequency graph showing size class results of 2C and 3Ab assemblages for Unit D.

Tool Analysis

Non-formal modified flake tool (n=1):

Specimen 315, level 6, 3Ab horizon: The specimen exhibits modification at the proximal end and is manufactured on a broken flake. The flake removal orientation is unidirectional and originates from the dorsal surface to the ventral surface. The flake removal characteristics include a small area of continuous retouch represented by a mixture of step and feather-terminating flake scars. A low to moderate edge angle, approximately 40˚, suggests possible cutting and slicing rather than scraping activities. A technological typological characteristic of the broken flake suggests that it was originally a bifacial thinning flake. The modified flake exhibits both micro-fracture and polish and is made of a local dark red ccs.

(mm/g)	MxL	MxWDT	MxTHK	WGT	EDGE˚	FST	TCT	Edge#	RT Loc	TEC
	25.48	22.92	2.22	1.4	40	broken	interior	1	proximal	straight

RTA	RTD
uni-marginal	continuous

Uniface (n=1)

Specimen 117, level 7, 3Ab horizon (Figure 4.18D): This uniface is considered a formal scraper due to a high edge angle and the amount of retouch that created it (Tomka 2001). The specimen is manufactured on a flake due to intact dorsal and ventral surfaces and a platform. The modified flake is radial and tabular in shape. The specimen exhibits steep feather-terminating flake removal along the entire margin except for the platform area. Flake removal is from the ventral surface to the dorsal surface. There is no evidence of a haft element. Examination under 10x magnification revealed polish as well as micro-fracture along the entire retouched margin. The modified flake is made of a local dark gray/green ccs.

(mm/g)	MxL	MxWDT	MxTHK	WGT	EDGE˚	FST	TCT	Edge#	RT Loc	TEC
	25.76	27.28	4.9	4.6	70	complete	interior	1	all	convex

RTA	RTD
uni-marginal	continuous

Biface (n=3)

Specimen 311, level 2,3Ab horizon, Preform - Stage II (Figure 4.18B): This specimen is considered to be a preform II based upon a limited observable morphology. The biface is a medial portion and is broken cross-wise in two areas. The nature of the breakage makes it difficult to discern whether it is possibly a finished biface because of the narrow width and low edge angle (33˚). The biface exhibits a relatively thick rhomboid-like cross-section and shows edge trimming with a weakly-developed collateral flake removal pattern. The biface appears to be made on a flake based on the remnant of a dorsal ridge running lengthwise along one surface of the specimen. The biface is made of a local gray and green ccs.

(mm/g) MxL / MxWDT / MxTHK / MxWGT / EDGE˚

MxL	MxWDT	MxTHK	MxWGT	EDGE˚
13.42	17.26	7.58	1.7	33

Specimen 312, level 2, 3Ab horizon, Preform – Stage II (Figure 4.18C): This specimen appears to be a preform II based on linear and weight dimensions, and edge angle. All cortex is removed from the biface and the cross-section is thinned exhibiting a mostly biconvex characteristic. Large, flat, and long flake removals terminate at the middle of the biface comprising a collateral shaping pattern. The bifacial preform is manufactured on a flake which can be discerned by a remnant dorsal ridge as well as one face exhibiting a remnant ventral surface. The specimen is broken at one end in a crosswise manner and partially along a lengthwise direction. The biface is made from a local light gray/brown ccs.

(mm/g) MxL / MxWDT / MxTHK / MxWGT / EDGE˚

MxL	MxWDT	MxTHK	MxWGT	EDGE˚
42.12	22.48	9.16	8.8	43

Specimen 125, level 9, 3Ab horizon, Finished Biface (Figure 4.18A): The specimen is a finished basal portion of a finished biface. The biface is broken crosswise at the distal base termination. Based on basal angle, basal margin angle, and basal width, the biface was probably a foliate shaped form. Flake removal is collateral. One large flake scar on the basal margin is a possible impact fracture. There is the presence of a step fracture on the area of the crosswise break. All cortex is removed but there is a heavy and well developed patina over the entire surface. The cross section of the biface is biconvex. The biface appears to have been manufactured on a flake due to a remnant dorsal ridge on one face. Evidence of edge grinding can be observed on the one bifacial margin as well as the extreme proximal end of the basal margin. The finished biface is made of a local dark green/gray ccs.

(mm/g) MxL / MxWDT / MxTHK / MxWGT / EDGE˚ / BW / BM˚ / B˚

MxL	MxWDT	MxTHK	MxWGT	EDGE˚	BW	BM˚	B˚
13.12	22.38	6.08	1.2	23	4.88	58	162

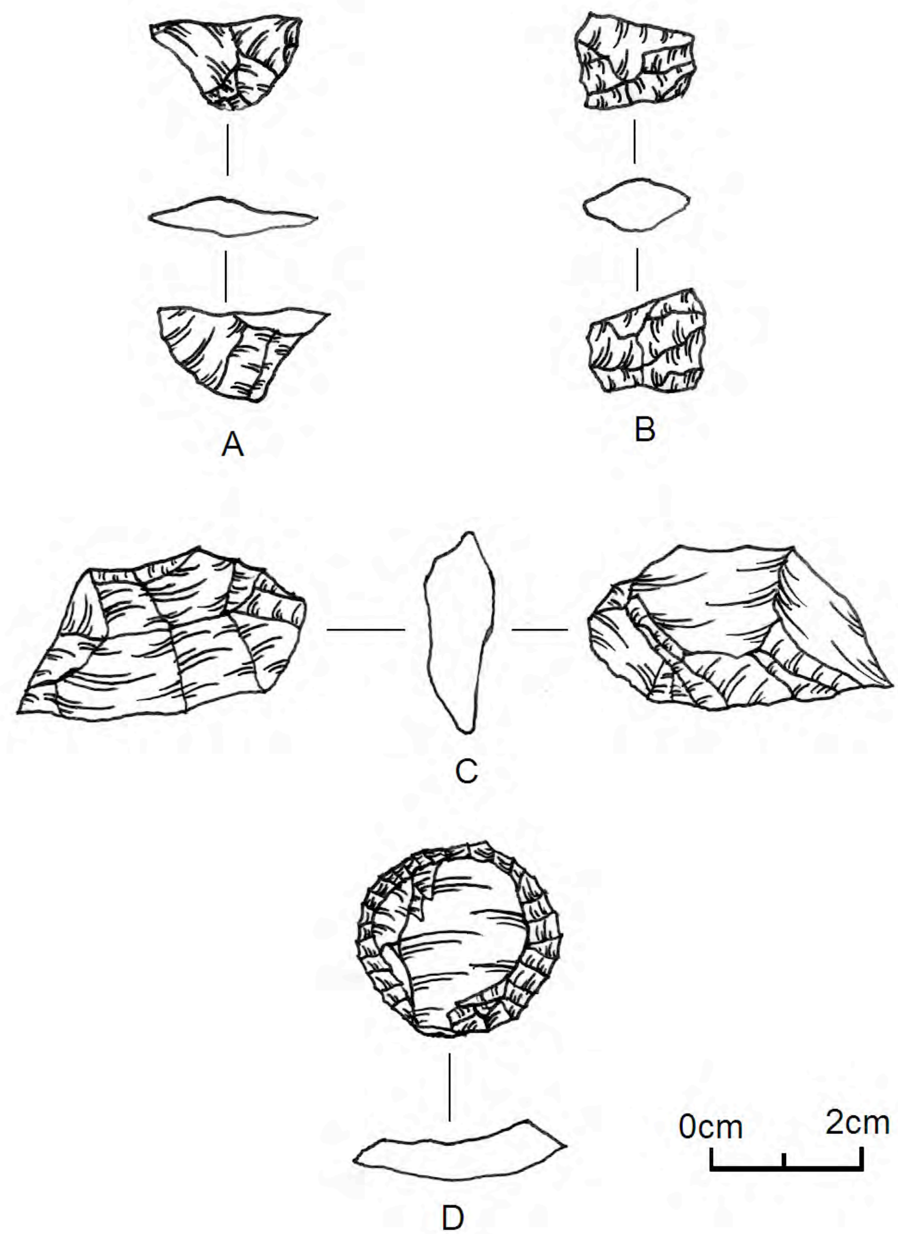

Figure 4.18: Lithic artifacts from Unit D: specimen 125, A; specimen 311, B; specimen 312, C; and specimen 117, D.

Unit E

Debitage Analysis

The 2C horizon assemblage for test unit E contains 1 tool and 85 pieces of lithic debitage. The 3Ab horizon contains 4 tools and 307 pieces of lithic debitage. The results for the free-standing typology are listed in Figure 4.19 and Table A10 (Appendix A). The 2C component shows the majority of its population falling within the flake fragment category comprising 62.4%, and broken flake category accounting for 27.1%. The remaining debitage population consists of complete flakes, accounting for 2.3%, and angular debris making up 8.2% of the debitage. The 3Ab component is comparable with the flake fragments category comprising 67.4% of the assemblage, broken flakes making up 25.4%, complete flakes accounting for 3.6%, and angular debris containing 7.6% of the debitage. As with the raw percentage results, the t-test statistic shows that there is very little difference between the horizons at the 95% confidence level ($t = -1.17$, p-value = 0.288, the confidence interval for the difference between the means extends from -171.9 to 60.9).

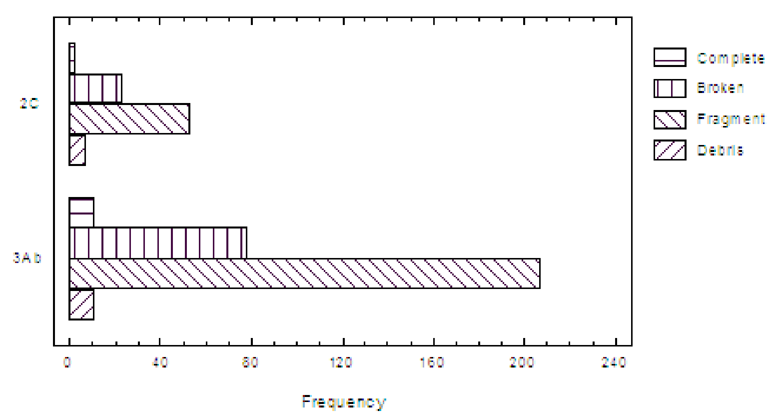

Figure 4.19: Barchart showing the Free-Standing Typology results for the 2C and 3Ab soil horizons for Unit E.

The results of the attribute and technological typology analyses are located in Figure 4.20 and Table A11 (Appendix A). The dorsal scar counts for the 2C component vary from the results of

the 3Ab slightly. The 2C component shows 64% of the platform flakes exhibiting single dorsal scar counts with multiple dorsal scar flakes accounting for 36%. Platform facet counts for the 2C component show 48% having single facet counts and 52% possessing multiple facet counts. Bifacial thinning flakes account for 24% of the assemblage with evidence of platform lipping located on 36% of the 2C assemblage. The 3Ab platform-bearing flakes
show little variance in the dorsal scar counts as those with single counts consist of 42% of the assemblage and multiple dorsal scar counts account for 58%. The 3Ab platform facet counts show more similarity with the 2C results with the single facet counts comprising 42% of the population and multiple facet counts making up 58% of the assemblage. Bifacial

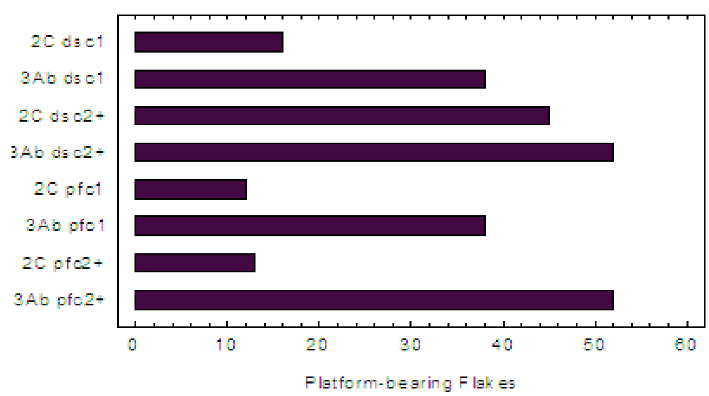

Figure 4.20: Frequency distribution showing platform-bearing flake results of 2C and 3Ab assemblages for Unit E.

production/maintenance is suggested by 30% of the platform-bearing flakes revealing evidence of bifacial thinning flake characteristics including platform lipping, that is found in 20% of the assemblage.

The triple cortex typology exhibits a bit of variation between the 2C and 3Ab components that can be seen in Table A12 (Appendix A). The 2C component is comprised of 80% interior flakes and 20% secondary flakes with no evidence of primary flakes. The 3Ab shows the majority of its flakes as being interior with 90.2% of the population and 9.5% contained in the secondary flake category. Primary flakes account for only 0.3% of the 3Ab assemblage.

Results for the aggregate analyses for unit E show a trend towards late stage reduction in both size and weight classes for the 2C and 3Ab horizon assemblages that can be viewed in Figure 4.21. Within the 2C assemblage, size classes 1 cm through 3 cm account for the entire population. The 3Ab assemblage is similar in regards to the size analysis with 98% of the population falling within size 1 cm through 3 cm classes. The remaining 2% is distributed throughout the 4 cm through 6 cm size classes. The results of the weight analysis are similar to the size results. The 2C assemblage shows that 94.5% of the population falls within the lightest three classes with the remaining 5.5% of the debitage distributed in the heavier 0.7-0.8 g through

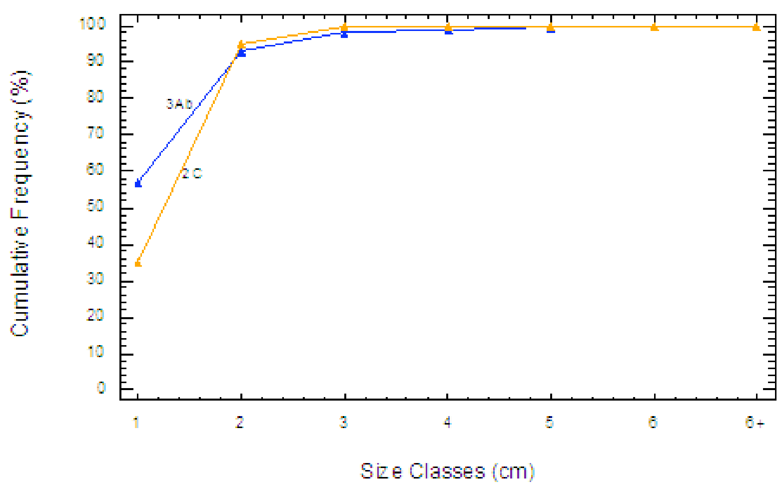

Figure 4.21: Cumulative frequency graph showing size class results of 2C and 3Ab assemblages for Unit E

1.3-1.4 g classes. A trend in late stage reduction is also evidenced in the 3Ab assemblage weight analysis as well. Ninety-four percent of the 3Ab assemblage falls within the lightest three weight classes. The remaining 6% of the population is evenly distributed throughout the middle and early stage weight classes.

Tool Analysis

Non-formal modified flake (n=3)

Specimen 162, level 9, 3Ab horizon: The specimen exhibits one modified edge possibly due to utilization. The modified flake was manufactured on a broken flake. It is possible that the modified edge could have extended along the entire lateral margin if not for a break that obscures the area of modification. It is not known whether this break occurred prior to or after modification. The retouched margin is located on the lateral margin nearer the proximal end of the flake. Micro-fracture exists but there is the absence of polish. The flake removal orientation is from the ventral surface to the dorsal surface and is of a uniform and feather-terminating character. The modified flake is made of a local gray/green ccs. There is no evidence of hafting.

(mm/g)	MxL	MxWDT	MxTHK	WGT	EDGE°	FST	TCT	Edge#	RT Loc	TEC
	n/a	25.1	6.48	4.7	65	broken	interior	1	lateral	straight

RTA	RTD
uni-marginal	continuous

Specimen 318, level 4, 3Ab horizon (Figure 4.22A): The specimen exhibits modification at one of the lateral margins and is manufactured on a flake fragment. The flake removal orientation is from the ventral surface to the dorsal surface. Flake removal characteristics include a moderate sized concaved area of continuous feather-terminating flake scars suggestive of a spokeshave. A low edge angle suggests cutting and slicing activities rather than scraping activities. Evidence for polish is present but there is the absence of micro-fracture. It is probable that the modified edge could have been produced by utilization rather than formal retouch. The modified flake is made of a local gray/green ccs. There is no evidence of hafting.

(mm/g)	MxL	MxWDT	MxTHK	WGT	EDGE°	FST	TCT	Edge#	RT Loc	TEC
	22.5	26.06	4.32	2.7	27	fragment	interior	1	lateral	concave

RTA	RTD
uni-marginal	continuous

Specimen 319, level 9, 3Ab horizon (Figure 4.22C): The specimen exhibits modification on one of the lateral margins located near the proximal end and is manufactured on a broken flake. The flake removal orientation is from the dorsal surface to the ventral surface. The flake removal characteristics include a small area of modification with continuous, shallow, and feather-terminating flake scars. A low to moderate edge angle suggests cutting or slicing activities rather than scraping episodes. As with specimen 318 the nature of the flake removal characteristics suggests that the modification is possibly due to utilization rather than formal retouch. There is evidence of both micro-fracture and polish. The modified flake is made of a local dark gray/green ccs. There is no evidence of hafting.

(mm/g)	MxL	MxWDT	MxTHK	WGT	EDGE°	FST	TCT	Edge#	RT Loc	TEC
	n/a	23.54	6.7	2.7	36	broken	secondary	1	lateral	straight

RTA	RTD
uni-marginal	continuous

Uniface (n=1)

Specimen 132, level 1(surface/2C horizon), (Figure 4.22D): The specimen is considered a formal unifacial scraper due to its high edge angle and amount of formal retouch. It is very similar both morphologically and dimensionally to specimen 117. The uniface is manufactured on a complete flake due to the remnant ventral and dorsal surfaces. There is no evidence of a haft element. As with specimen 117, the specimen is radial in shape and is tabular in cross-section. Retouch is steep, continuous, even, and feather-terminated along the entire margin of the modified flake except for the platform area. Only a very small amount of cortex remains on the dorsal surface of the flake tool. Flake removal is from the ventral surface to the dorsal surface and micro-fracture and polish is present along entire retouched margin. The unifacial scraper is made from a local light brown/dark red ccs.

(mm/g)	MxL	MxWDT	MxTHK	WGT	EDGE°	FST	TCT	Edge#	RT Loc	TEC
	22.2	23.6	9.22	5.8	83	complete	secondary	1	all	convex

RTA	RTD
uni-marginal	continuous

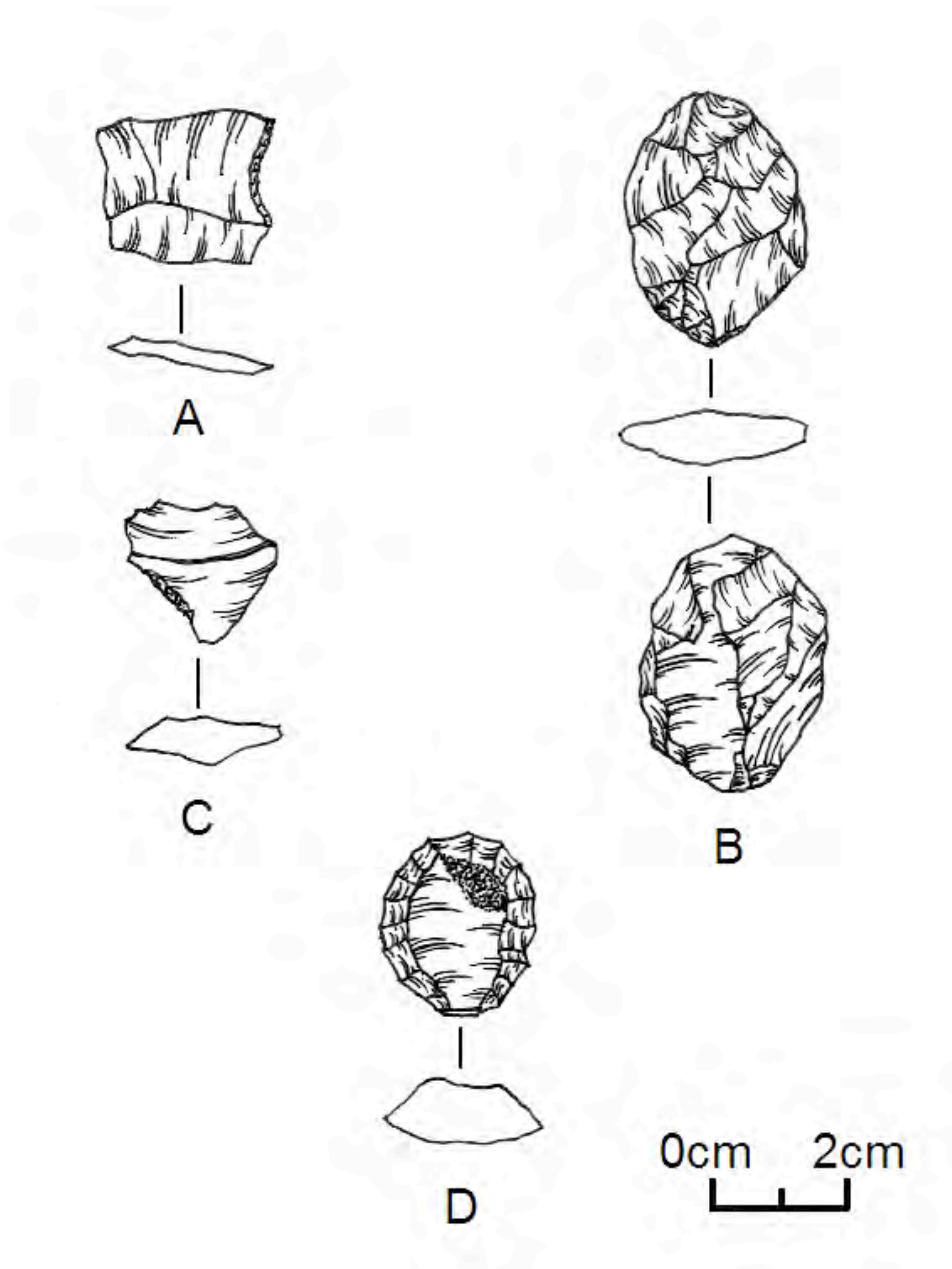

Figure 4.22: Lithic artifacts from Unit E; specimen 318, A; specimen 156, B; specimen 319, C; and specimen 132, D.

Biface (n=1)

Specimen 156, level 8, 3Ab horizon, Preform-Stage II (Figure 4.22B): The specimen appears to be a preform II based on linear and weight measurements. It exhibits a relatively thinned cross section and flake removal extends to the center of both faces with all cortex completely absent. The preform is manufactured on a large flake and retains a multifaceted platform. Flake removal patterning is random, partially collateral, and multidirectional in nature. The specimen is complete and is made of a dark red/burgundy ccs.

(mm/g)	MxL	MxWDT	MxTHK	MxWGT	EDGE°
	30.8	27.58	8.42	9.0	27

Unit F

Debitage Analysis

The 2C horizon assemblage in test unit F is composed of 1 tool and 241 pieces of lithic debitage. The 3Ab horizon assemblage is comprised of 7 tools and 838 pieces of lithic debitage. Figure 4.23 and Table A13 (Appendix A) give the results of the free-standing typology for unit F. As with all previously mentioned test units, the 2C component of unit F shows the majority of

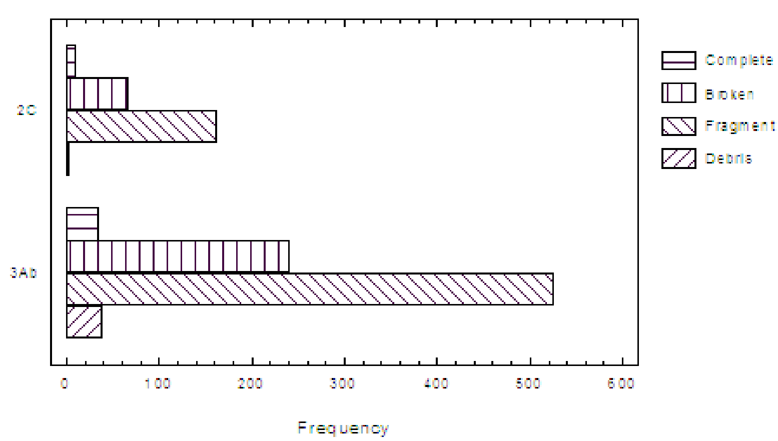

Figure 4.23: Barchart showing the Free-Standing Typology results for the 2C and 3Ab soil horizons for Unit F.

flakes falling in the flake fragment category, comprising 67.2% of the population, and broken flakes making up 27.4% of the assemblage. There is a noticeable lack of angular debris, accounting for only 0.8% of the assemblage, with 4.6% of the population represented by complete flakes. The 3Ab component of unit F shows a similar trend with flake fragments accounting for 62.8% of the assemblage and broken flakes making up 28.8%. Angular debris represents 4.5% of the population and complete flakes accounting for the remaining 3.9%. As with the raw percentages, the t-test statistic explains that that there is little difference between the horizons at the 95% confidence level (t = -1.23, p-value = 0.266, the confidence interval for the difference between the means extends from -447.2 to 148.7).

Platform-bearing flakes in test unit F have comparable results as the previously discussed test units. Figure 4.24 and Table A14 (Appendix A) give the results of the attribute and technological typology for both soil horizons. The 2C population shows platform-bearing flakes with single dorsal scar counts as accounting for 33.8% of the population with the remaining 66.2% comprised of multiple dorsal scar flakes. The platform facet counts show single platform facet flakes representing 48% of the assemblage with multiple facet counts consisting of 52%. Bifacial production/maintenance within the 2C component is suggested by 17% of the assemblage consisting of bifacial thinning flakes and those with platform lipping accounting for 22% of the

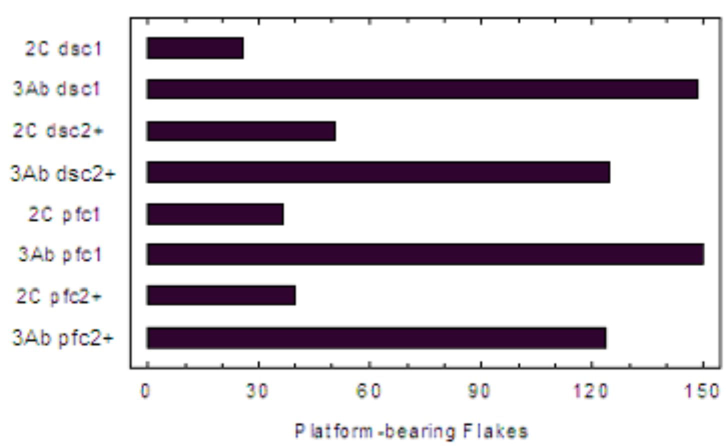

Figure 4.24: Frequency distribution showing platform-bearing flake results of 2C and 3Ab assemblages for Unit F.

assemblage. Regarding the 3Ab component, platform-bearing flakes with single dorsal scars represent 54% of the assemblage and multiple dorsal scar flakes account for the remaining 46%. Platform flakes with single facet counts comprise 55% of the 3Ab population with 45% of the flakes having evidence for multiple facet counts. Bifacial thinning flakes account for 23% of the population with those having platform lipping comprising 22%.

The triple cortex typology for both 2C and 3Ab soil horizons are summarized in Table A15 (Appendix A). The results of this analysis are very similar for both 2C and 3Ab components. With the 2C component, interior flakes account for 91.3% of the population and secondary flakes make up 8.7% with no evidence of primary flakes. The 3Ab component comprised of 92.6% of the debitage falling into the interior flake category, 7% consisting of secondary flakes, and only 0.4% making up the primary flake category.

The size and weight aggregate analyses for unit F exhibit a marked trend towards late stage reduction in both 2C and 3Ab horizon assemblages (Figure 4.25). The size analysis for the 2C assemblage results in 98% of the population falling within the 1 cm through 3 cm size classes. The size 4 cm class comprises the remaining debitage. Although all size classes are represented in the 3Ab debitage assemblage, 96% of the population falls within the 1 cm through 3 cm size classes. The remaining 4% is evenly distributed throughout the larger size classes. Weight analysis results show similar trends towards late stage reduction. The 2C debitage assemblage shows 92.9 % of the population consisting of the 0.1-0.2 g through 0.7-0.8 g weight classes. All other debitage is distributed evenly throughout the other classes with each weight class consisting of at least 0.4% of the population. The weight analysis of the 3Ab assemblage is similar to the 2C population. The 3Ab debitage population shows that 90.3% fall within the 0.1-0.2 g through 0.7-0.8 g weight classes. As with the 2C population, the remaining 3Ab assemblage accounts for a small part of each weight class including 4.2% comprising the heaviest 2.1 g+ class.

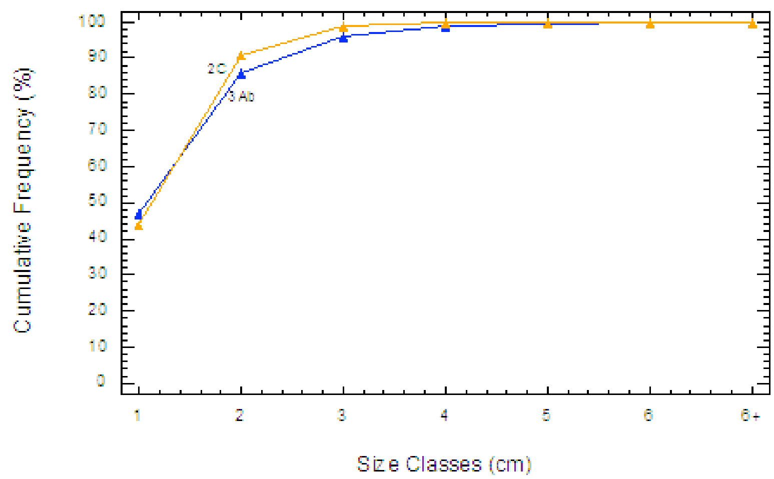

Figure 4.25: Cumulative frequency graph showing size class results of 2C and 3Ab assemblages for Unit F.

Tool Analysis

Non-formal modified flake (n=2)

Specimen 165, level 1, 2C horizon (Figure 4.28B): The specimen exhibits modification on a small portion of the lateral area and is manufactured on a flake fragment. Flake removal orientation is from the ventral surface to the dorsal surface and terminates at an area incurring a natural break. Flake removal characteristics include continuous and feather-terminated flake scars with a moderately high edge angle, approximately 60˚, suggesting scraping activities rather than cutting or slicing. The modified area is located at a point where the lateral margin meets a natural break in the flake. This location of modification lends itself to consideration of a burin-like implement. The modified flake shows signs of thermal alteration and is made of a light gray/green ccs. There is no evidence of hafting and modification seems to be through utilization rather than formal retouch.

(mm/g) MxL	MxWDT	MxTHK	WGT	EDGE˚	FST	TCT	Edge#	RT Loc	TEC
n/a	49.42	11.88	7.9	60	fragment	secondary	1	lateral	straight

RTA	RTD
uni-marginal	continuous

Specimen 213, level 16, 3Ab horizon (Figure 4.27C): The specimen exhibits modification at the distal area and is manufactured on a flake fragment. The flake removal orientation is from the ventral surface to the dorsal surface. The flake removal characteristics include a small area of continuous and feather-terminating flake scars and exhibits a moderately steep edge angle, approximately 62˚, suggesting scraping activities rather than cutting or slicing. There is the presence of both micro-fracture and polish. The modified flake is made of a local ccs. There is no evidence of hafting and modification seems to be through utilization rather than formal retouch.

(mm/g)	MxL	MxWDT	MxTHK	WGT	EDGE˚	FST	TCT	Edge#	RT Loc	TEC
	n/a	12.14	17.14	1.7	62	fragment	interior	1	distal	straight

RTA	RTD
uni-marginal	continuous

Biface (n=6)

Specimen 202, level 13, 3Ab horizon, Preform-Stage II (Figure 4.27B): The specimen appears to be a preform II based on linear and weight measurements. It exhibits a relatively thinned cross section and flake removal extends to the center of both bifacial surfaces with all cortex absent except on one of the remnant platforms. The preform is manufactured on a large flake and exhibits two separate platforms. Platform A is a flat single-faceted platform and is likely due to the bifacial margin/thinning. Platform B is a multi-faceted platform and appears to be the result of the large flakes origin of which the preform is manufactured on. It is prominent and exhibits a small amount of cortex. Although it does retain a minute amount of cortex, the biface is considered a preform II because the cortex is contained on the remnant platform only. Flake removal is random, partially collateral, and multidirectional in nature. The specimen is complete and is made of a local light green/gray ccs.

(mm/g)	MxL	MxWDT	MxTHK	MxWGT	EDGE˚
	46.46	32.48	10.18	15.4	48

Specimen 183, level 7, 3Ab horizon, Preform-Stage I (Figure 4.27A): The specimen appears to be a preform I based upon linear and weight measurements. The preform exhibits a partially thinned, biconvex cross section with flake removal being largely collateral and multidirectional including the appearance of large and broad flake scars. There is a small amount (20%) of cortex on one face/surface. There are numerous platforms along the circumference of the bifacial margin and the preform appears to be made on a large flake. Specimen is broken crosswise at one end (distal or proximal is not discernable) and is made from a dark gray ccs.

(mm/g)	MxL	MxWDT	MxTHK	MxWGT	EDGE°
	43.5	32.12	10.96	16.6	40

Specimen 184, level 7, 3Ab horizon, Preform-Stage I (Figure 4.28A): The specimen appears to be a preform I based upon linear and weight measurements. The preform exhibits a rather thick cross section, including a thickness/width ratio of 2.6, and is mainly biconvex in shape. The specimen is possibly a bifacial core fragment based upon the cross section as well as the thickness/width ratio. Flake removals are random and multidirectional with a complete absence of cortex. The specimen is broken crosswise in the medial area and is manufactured from a light gray/green ccs. It is difficult to discern whether the preform was made on a flake or from cobble core reduction.

(mm/g)	MxL	MxWDT	MxTHK	MxWGT	EDGE°
	26.08	33.76	13.18	7.0	47

Specimen 191, level 9, 3Ab horizon, Finished Biface (Figure 4.26A): The specimen is a finished biface basal fragment. The biface is broken crosswise at the haft element. It is the basal fragment of either a foliate/leaf-shaped biface or a stemmed biface. Based on basal angle, basal margin angle, and basal width, the biface suggests a foliate shaped form. Flake removal is partially collateral with a biconvex cross section. The finished biface is manufactured on a flake with all cortex being removed. Lateral basal margins show heavy grinding indicative of a possible haft element. The specimen is made of imported obsidian.

(mm/g)	MxL	MxWDT	MxTHK	MxWGT	EDGE°	BW	BM°	B°
	10.98	15.06	6.08	0.9	36	2.78	56	164.5

Specimen 190, level 9, 3Ab horizon, Finished Biface (Figure 4.26C): The specimen is a finished biface basal fragment. The biface is broken crosswise at the haft element. It is the basal fragment of either a foliate/leaf-shaped biface or a stemmed biface. Based on basal angle, basal margin angle, and basal width, the biface is a probable foliate shaped form. Flake removal is random and non-patterned. The specimen has a biconvex cross section and appears to have been manufactured on a flake due to a remnant platform on the proximal end as well as a remaining dorsal ridge. The biface does exhibit a small amount of cortex on one surface. Although it is noted that this should place it in the preform stage, the morphological characteristics coupled with the size of the biface places it in the finished stage.

The simplest explanation is that the cortex seems to be deeply embedded in raw material which does not allow for full removal through the process of reduction. One surface exhibits a large flake scar which is indicative of Bergman and Newcomers' (1983) work on impact fractures. It is postulated that the crosswise break, in addition to the large flake scar, is due to use. Grinding is absent along the basal margin, but there is the presence of polish. This polish could have possibly been caused by hafting. The finished biface is made of a light green/gray ccs.

(mm/g)	MxL	MxWDT	MxTHK	MxWGT	EDGE˚	BW	BM˚	B˚
	11.14	15.14	5.28	0.7	23	3.98	55	164

Specimen 194, level 10, 3Ab horizon, Finished Biface (Figure 4.26B): The specimen is a finished biface basal fragment. The biface is broken cross-wise at the haft element. It is the basal fragment of either a foliate/leaf-shaped biface or stemmed biface. Based on basal angle, basal margin angle, and basal width, the biface is a probable foliate shaped form. Flake removal is random and non-patterned. The cross-section is plano-convex suggesting that the biface was most likely manufactured on a flake. All cortex is removed. Additional evidence for the possibility that the finished biface was produced on a flake is that there is the presence of a remnant dorsal ridge on one surface. Both basal margins of the biface appear to exhibit grinding. This grinding is most likely due to hafting. The finished biface is made of imported obsidian.

(mm/g)	MxL	MxWDT	MxTHK	MxWGT	EDGE˚	BW	BM˚	B˚
	20.02	23.0	4.82	1.9	28	5.06	58	151

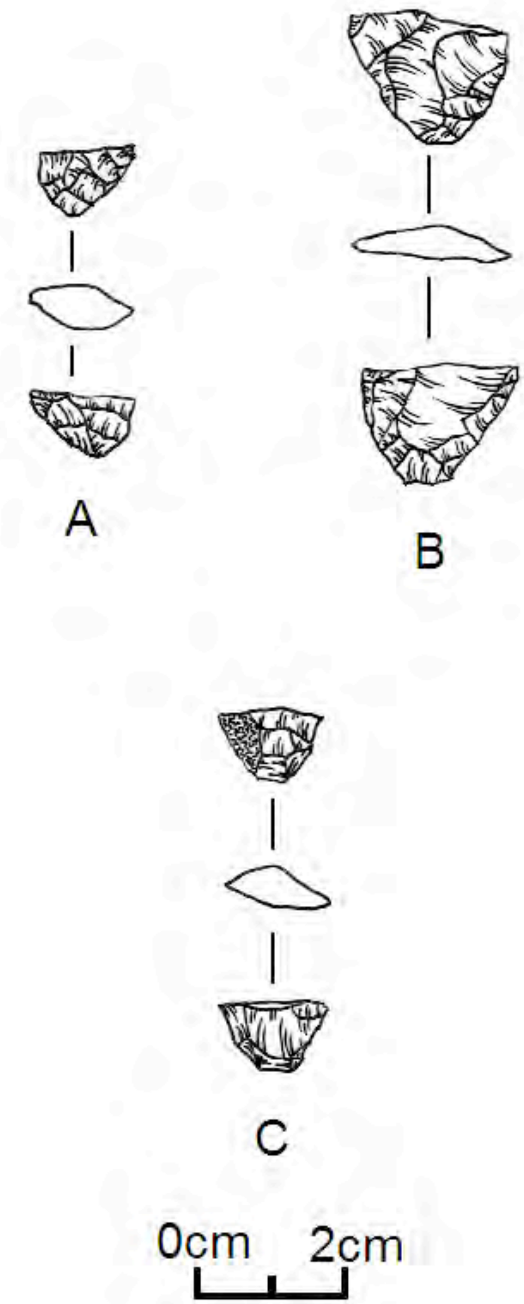

Figure 4.26: Lithic artifacts from Unit F; specimen 191, A; specimen 194, B; and specimen 190, C.

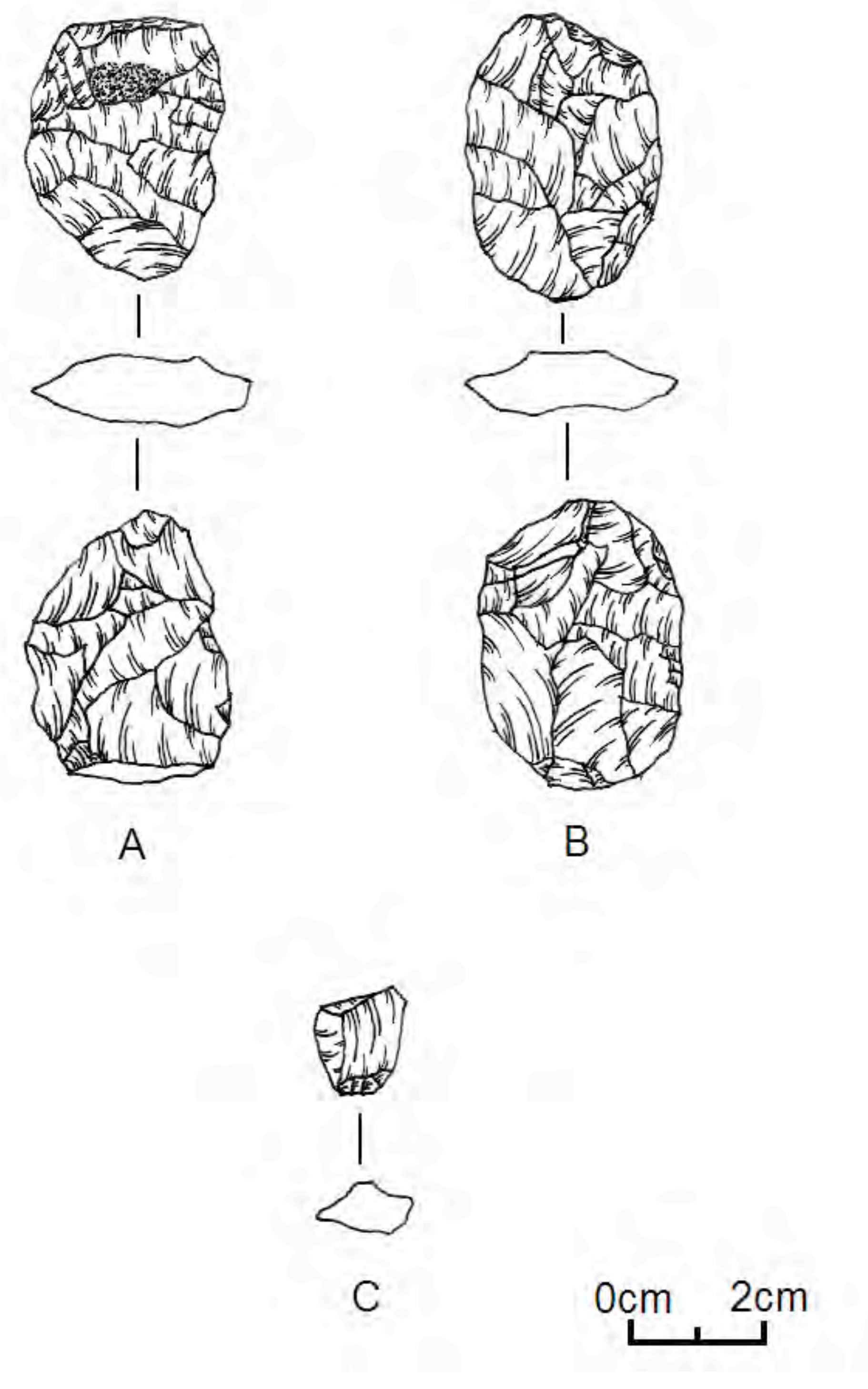

Figure 4.27: Lithic artifacts from Unit F; specimen 183, A; specimen 202, B; and specimen 213, C.

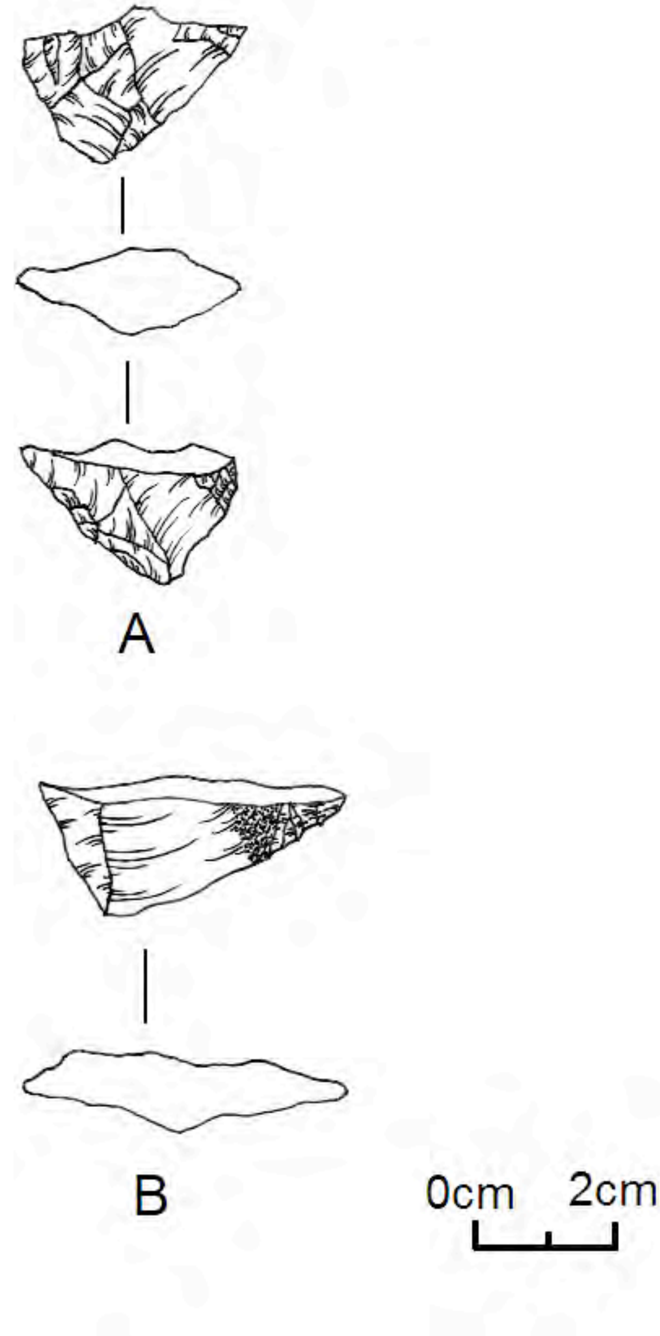

Figure 4.28: Lithic artifacts from Unit F; specimen 184, A; and specimen 165, B.

Unit G

Debitage Analysis

Test unit G exhibited a 2C horizon with no evidence of the 3Ab horizon. The unit contained no tools but included 267 pieces of lithic debitage. Figure 4.29 and Table A16 (Appendix A) provide a summary of the results of the 2C debitage population under the free-standing typology. The majority of the assemblage is composed of flake fragments (64.8%), and broken flakes (28.8%), suggesting probable tool production and/or maintenance. Complete flakes account for 3.7% of the population with angular debris comprising the remaining 2.6%.

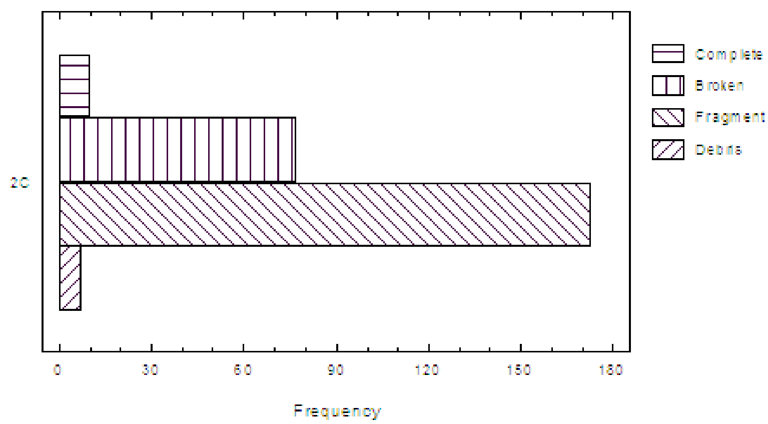

Figure 4.29: Barchart showing the Free-Standing Typology results for the 2C soil horizon for Unit G.

The platform-bearing flake data are summarized in Figure 4.30 and Table A17 (Appendix A). Flakes having single dorsal scar counts account for 62% of the population with the remaining 38% retaining multiple dorsal scar counts. Platform facet counts are more evenly represented with 50.6% of the flakes exhibiting single facet counts and 49.4% having multiple facet counts. Bifacial production and/or maintenance is represented by 22% of the platform bearing flakes having characteristics of bifacial thinning flakes and a similar 22% showing evidence of platform lipping.

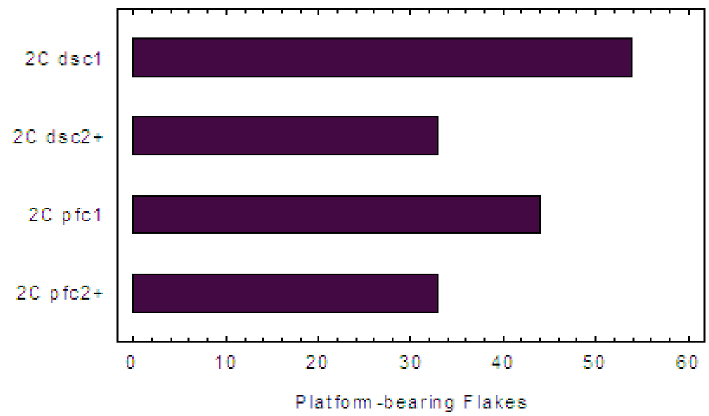

Figure 4.30: Frequency distribution showing platform-bearing flake results of 2C assemblage for Unit G.

The triple cortex typology analysis show similar results as the other test units. Interior flakes account for 93.3% of the population. The remaining debitage is composed of secondary flakes with no evidence for primary flakes (Table A18, Appendix A).

The size and weight aggregate analyses for unit G both show a trend towards late stage reduction (Figure 4.31). The size analysis shows that 98% of the debitage comprise the 1 cm

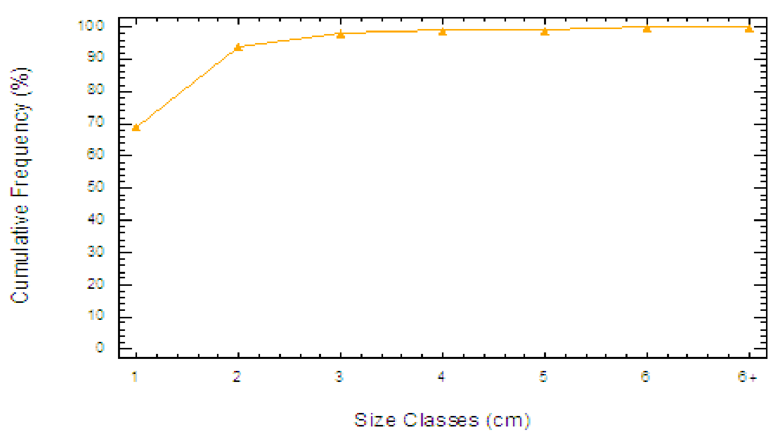

Figure 4.31: Cumulative frequency graph showing size class results of 2C assemblage for Unit G.

through 3 cm size classes with the remaining 2% falling into the 4 cm and 6 cm classes. The weight analysis shows that 94.9% of the population is concentrated in the 0.1-0.2 g through 0.5-0.6 g weight classes. The remaining 5.1% is evenly distributed throughout the other middle and early stage weight classes with 2.2% comprising the 2.1 g+ class.

Unit K

Debitage Analysis

Test unit K exhibited both 2C and 3Ab horizons. The 2C horizon assemblage includes no tools and 91 pieces of lithic debitage while the 3Ab horizon assemblage contains 4 tools and 581 pieces of lithic debitage. The results of analysis on the 2C and 3Ab debitage assemblages utilizing the free-standing typology is presented in Figure 4.31 and Table A19 (Appendix A). The 2C assemblage is composed of 57% flake fragments, 32% broken flakes, 8% angular debris, and 3% complete flakes. The 3Ab assemblage shows a slightly higher percentage represented by flake fragments, accounting for 69% of the total, and slightly lower amount of broken flakes comprising 25% of the assemblage. Both angular debris and complete flakes are evenly represented each accounting for 3% of the assemblage. The t-test supports the null hypotheses suggesting that there is not a significant difference between the populations ($t = -1.35$, p-value = 0.226, the confidence interval for the difference between the means extends from -344.8 to 99.8).

The 2C and 3Ab platform-bearing flake results are presented in Figure 4.32 and Table A20 (Appendix A). The dorsal scar counts for the 2C assemblage show that single and multiple dorsal scars are evenly represented at 50%. The platform facet count for the 2C assemblage shows that 53% of the population is composed of single platform facets and 47% of the platform-bearing flakes have multiple facet counts. Bifacial thinning flakes account for 16% of the platform-bearing flakes while 34% showing evidence of platform lipping. The 3Ab results for dorsal scar counts show 64.4% having single dorsal scars and the remaining 35.6% as having multiple dorsal scars. The platform facet counts are similar with 59.5% of the assemblage retaining single facets and

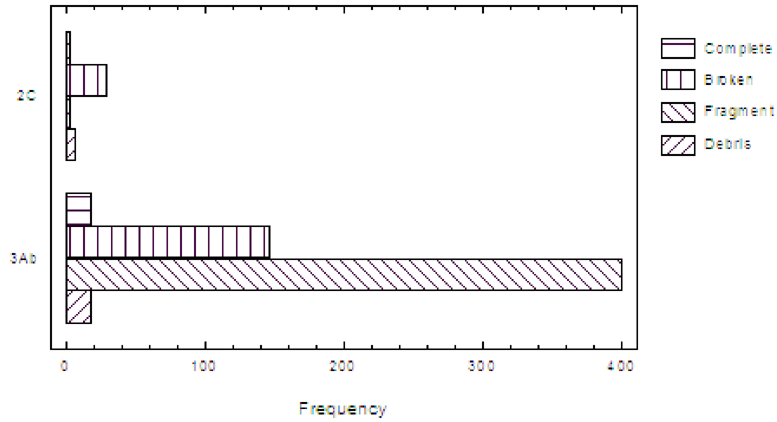

Figure 4.32: Barchart showing the Free-Standing Typology results for the 2C and 3Ab soil horizons for Unit K.

40.5% having multiple facets. Bifacial production and/or maintenance is represented by 22% of the population that is composed of bifacial thinning flakes while 26% show evidence of platform lipping.

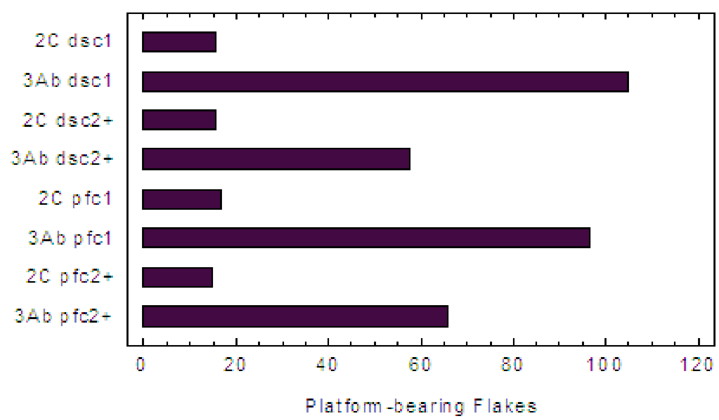

Figure 4.33: Frequency distribution showing platform-bearing flake results of 2C and 3Ab assemblages for Unit K.

The results of analysis using the triple cortex typology on the 2C and 3Ab assemblages for unit K can be seen in Table A21 (Appendix A). As with the other units, a high percentage of the flakes fall within the interior category in both horizons. The 2C assemblage is represented by

85% interior flakes, 14% secondary flakes, and 1% primary flakes. The 3Ab assemblage is similar with 92.3% interior flakes, 7.6% secondary flakes, and 0.1% primary flakes.

The results of the size and weight aggregate analyses for unit K show the vast majority of debitage for both 2C and 3Ab debitage assemblages exhibit evidence for late stage reduction (Figure 4.34). The size analysis for the 2C assemblage shows the entire population falling within the 1 cm and 2 cm size classes. Ninety-seven percent of the 3Ab assemblage population falls into the 1 cm through 3 cm size classes with the remaining 3% accounting for the 4 cm and 5 cm classes. The weight analysis for the 2C assemblage is similar in that 97.9% of the population comprises the 0.1-0.2 g through 0.7-0.8 g weight classes. The remaining 2.1% fall within the 0.9-1.0 g and 1.9-2.0 g weight classes. The 3Ab assemblage shows that 92.1% of the population comprises the 0.1-0.2 g through 0.7-0.8 g weight classes. The remaining 7.9% is evenly distributed throughout all other weight classes with 3.9% falling in the heaviest 2.1+ g class.

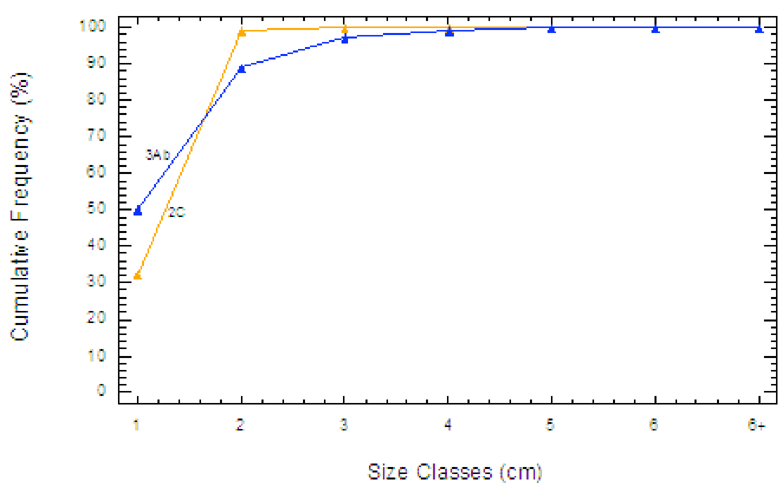

Figure 4.34: Cumulative frequency graph showing size class results of 2C and 3Ab assemblages for Unit K.

Tool Analysis

Core Reduction Flakes/Core Fragment (n=2)

Specimen 259, level 4, 3Ab horizon (Figure 4.36B): The specimen is considered a core reduction flake based upon its large size and weight as well as the retention of a large, lipped, and high angle platform. The platform is characteristic of one that can be associated with the margin of an initially shaped, early stage, multidirectional (and probable bifacial/discoidal) core. The flake removal pattern on the dorsal surface is characterized by multidirectional long, flat flake scars. A large step fracture just below the platform could be the reason for the detachment of the specimen in question. The core reduction flake is made of a local light gray/green ccs.

(mm/g)	MxL	MxWDT	MxTHK	WGT	FST	TCT
	57.26	34.54	21.82	27.6	complete	interior

Specimen 271, level 8, 3Ab horizon (Figure 4.36A): The specimen is considered a core reduction flake based on its large size and weight measurements as well the presence of a remnant bifacial margin which constitutes one of the lateral edges. Flake removal is characterized by large, flat, and multidirectional flake scars predominantly along one surface with a small amount on the other surface. At the very least the core reduction flake can be said to have originated from a multidirectional core although the probable bifacial margin suggests a reduction from a bifacial/discoidal core. Evidence of a small, non-faceted, corticated platform remains. The core reduction flake is made of a local ccs.

(mm/g)	MxL	MxWDT	MxTHK	WGT	FST	TCT
	41.5	12.38	11.16	5.7	complete	secondary

Biface (n=2)

Specimen 258, level 4, Multidirectional/Bifacial Core/Preform-Stage I (Figure 4.35B): The specimen appears to be a bifacial core based on weight, maximum linear dimension (MLD; see below), a large thickness and width ratio of 2.5, and a high edge angle (63˚). The specimen is very large in comparison to all other bifaces in the assemblage and exhibits multiple platforms along the bifacial margin. The core is manufactured on what is a probable large flake blank due to a massive platform on one end. The bifacial core is broken crosswise at the distal end. The biface exhibits multidirectional flake removal in a random and non-patterned order. The biface is capable of producing large usable flakes. There is a small amount of cortex on both faces of the bifacial core (~ 10-15% on each face). The specimen is manufactured from a dark green/gray ccs.

(mm/g)	MxL	MxWDT	MxTHK	MxWGT	EDGE°	Core Size Value:	MLD	MxWGT	Unit Size
	56.98	47.94	19.0	49.8	63		56.98	49.8	2837.6

Specimen 270, level 8, 3Ab horizon, Finished Biface (Figure 4.35A): The specimen is a finished biface basal fragment. The biface is broken cross-wise at the haft element. As with specimen 190, there is a “flute-like” flake scar most likely due to an impact fracture through use (Bergman and Newcomer 1983). It appears to be the basal fragment of either a foliate/leaf-shaped biface or stemmed biface. Based on basal angle, basal margin angle, and basal width, the biface is a probable foliate shaped form. Flake removal is collateral and all cortex is removed. The biface exhibits a bi-convex cross-section and appears to be manufactured on a flake due to a remnant dorsal ridge. The presence of grinding can be observed on the basal margin and is indicative of hafting. The finished biface is manufactured from imported obsidian.

(mm/g)	MxL	MxWDT	MxTHK	MxWGT	EDGE°	BW	BM°	B°
	11.82	16.48	5.72	0.9	27	7.26	67	NA

Unit L

Debitage Analysis:

Test unit L contains the 2C horizon, which included one tool and 96 pieces of lithic debitage, and the 3Ab horizon, which produced 2 tools and 584 pieces of lithic debitage. Analytical results for the 2C and 3Ab debitage assemblages in unit L under the free-standing typology are presented in Figure 4.37 and Table A22 (Appendix A). The 2C assemblage is mainly composed of flake fragments (59.4%) and broken flakes (30.2%). The remaining debitage is represented by angular debris (4.2%) and complete flakes (6.2%) of the 2C. The 3Ab assemblage shows similar results with a slightly higher percentage of flake fragments at 68% and broken flakes at 25%. As with the 2C component, the remaining assemblage is composed of angular debris at 4% and complete flakes comprising 3% of the population. The t-test shows that there is not a statistically

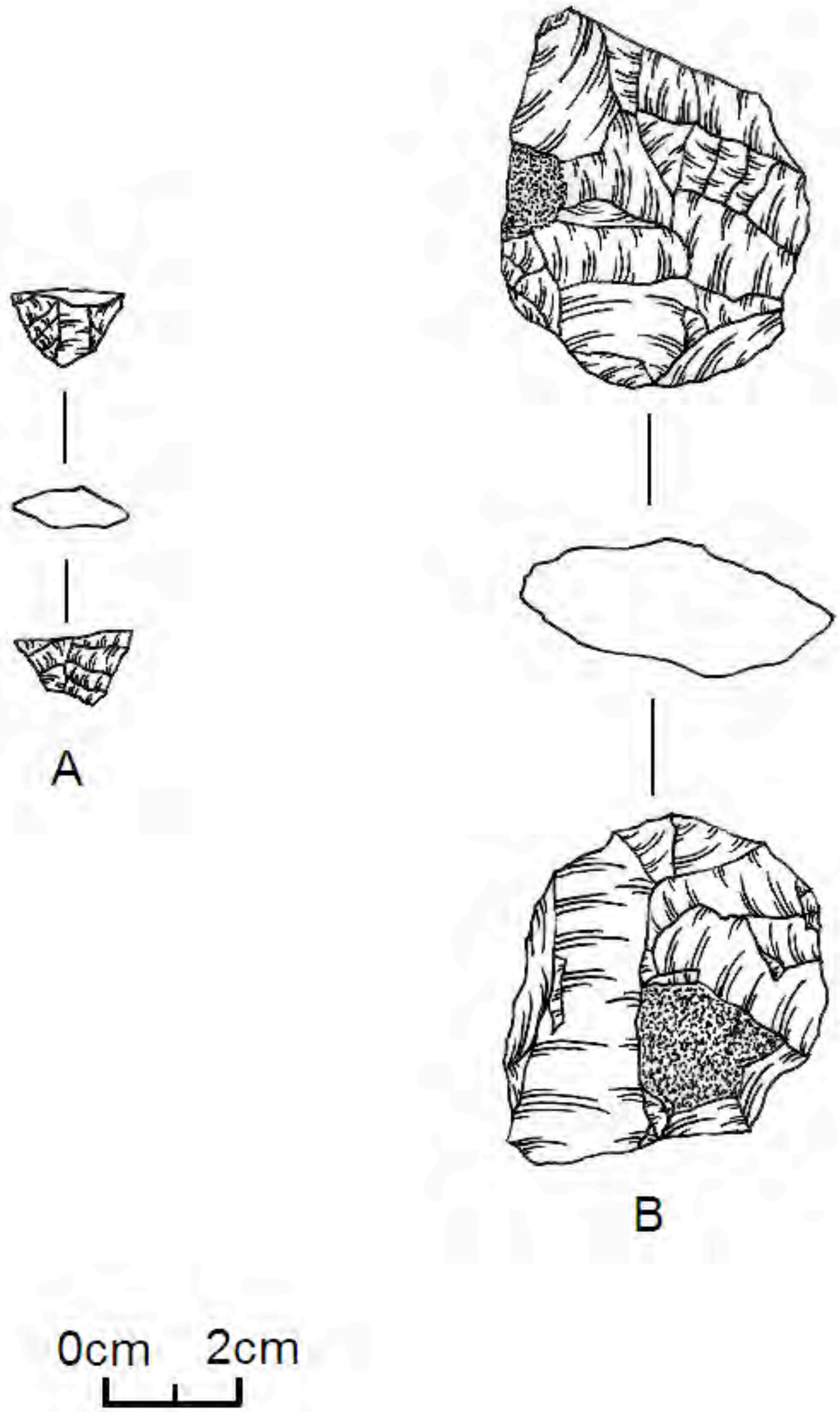

Figure 4.35: Lithic artifacts from unit K; specimen 270, A; and specimen 258, B.

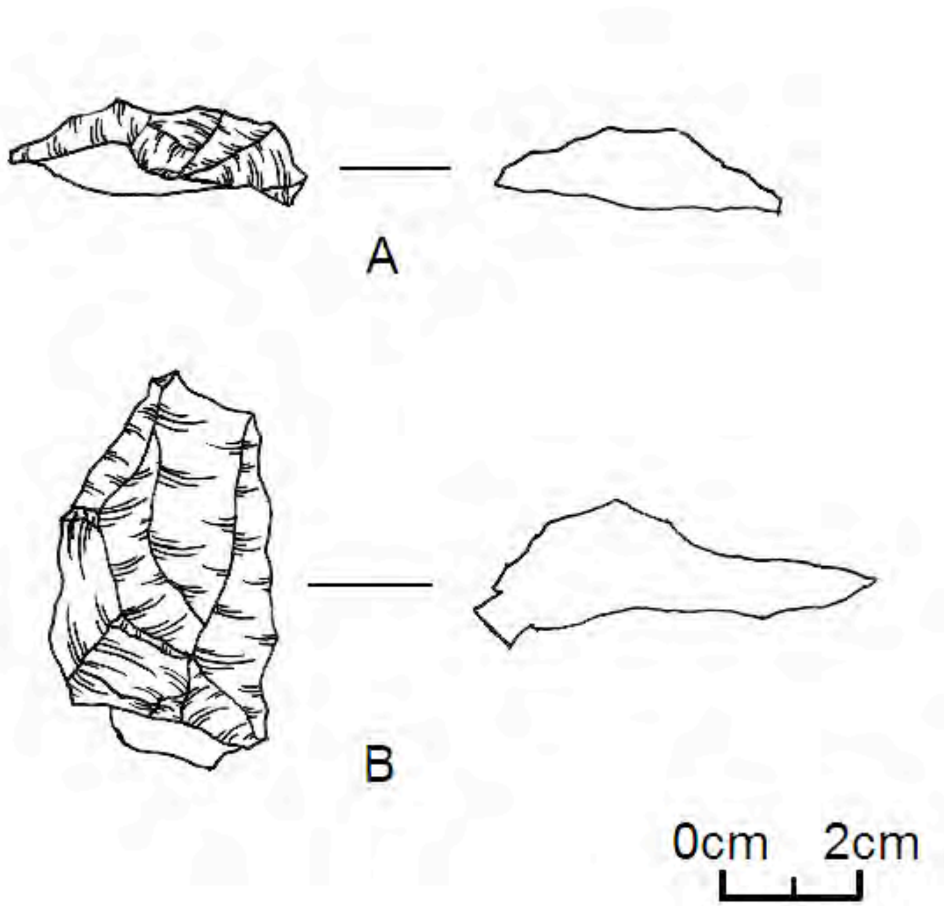

Figure 4.36: Lithic artifacts from unit K; specimen 271, A; and specimen 259, B.

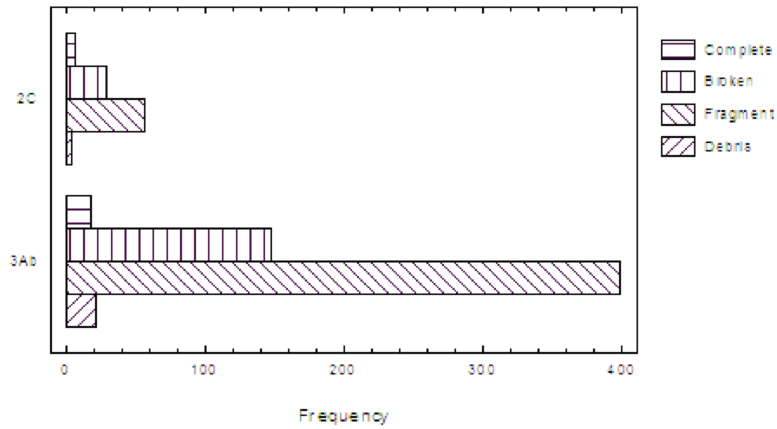

Figure 4.37: Barchart showing the Free-Standing Typology results for the 2C and 3Ab soil horizons for Unit L.

significant difference between the means of the two horizons at the 95% confidence level (t = -1.35, p-value = 0.225, the confidence interval for the difference between the means extends from -342.7 to 98.7).

Results for the attribute and technological typology analysis of the 2C and 3Ab horizons in unit L are shown in Figure 4.38 and Table A23 (Appendix A). The dorsal scar counts for the 2C assemblage are represented by single dorsal scar counts accounting for 48.6% of the population and 51.4% being of the multiple dorsal scar category. The platform facet counts for the 2C assemblage show a similar trend with 54.3% having one facet count and 45.7% having evidence of multiple facet counts. Bifacial production and/or maintenance is evidenced by 18% of the 2C population being composed of bifacial thinning flakes and 26% of the assemblage exhibiting platform lipping. The 3Ab assemblage has comparable results with the 2C assemblage. Dorsal scar counts for the 3Ab platform-bearing flake population show that 49% have one dorsal scar with 51% incurring multiple dorsal scars. The platform facet counts for the 3Ab assemblage show that 58.2% have single facet counts with the remaining 41.8% having multiple facet counts. Bifacial thinning flakes account for 18% of the 3Ab population with 22% of the assemblage showing evidence for platform lipping.

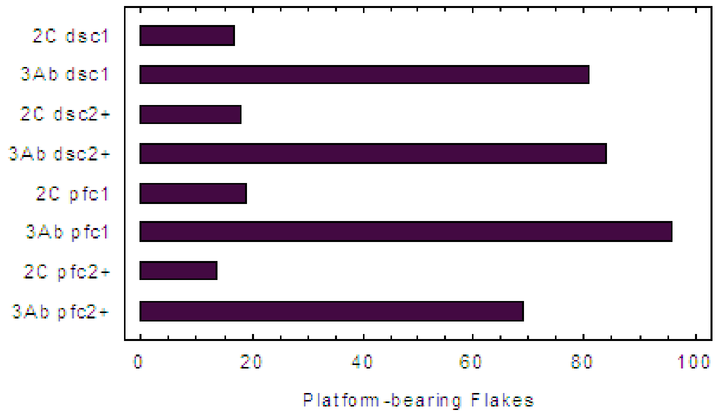

Figure 4.38: Frequency distribution showing platform-bearing flake results of 2C and 3Ab assemblages for Unit L.

The triple cortex typology analysis shows similar results for both the 2C and 3Ab horizons that can be viewed in Table A24 (Appendix A). Interior flakes account for 91.7% of the assemblage and secondary flakes comprise 7.3%. Primary flakes account for 1% of the 2C population in unit L. In the 3Ab horizon, interior flakes make up 93% of the assemblage, secondary flakes comprise 7%, and there are no primary flakes represented.

As with the majority of other units, the size and weight aggregate analyses for Unit L suggest late stage reduction in both 2C and 3Ab assemblages (Figure 4.39). The size analysis for the 2C assemblage shows that 99% of the population is composed of the 1 cm through 3 cm size classes. The remaining 1% comprises the 4 cm size class. The 3Ab debitage assemblage shows that 96% of the population falls within the 1 cm through 3 cm size classes while the remaining 4% is distributed in the 4 cm and 5 cm size classes. The weight analysis for the 2C assemblage reveals that 98% of the population falls in weight classes 0.1-0.2 g through 0.7-0.8 g. The 1.5-1.6 g and 2.1 g+ size classes account for the remaining 2% of the population. The weight analysis for the 3Ab assemblage shows that 88.3% of the debitage are included in the 0.1-0.2 g through 0.7-0.8 g weight classes. The remaining 11.7% is evenly distributed throughout the other weight classes with the 2.1 g+ class accounting for 4.5% of the 3Ab debitage.

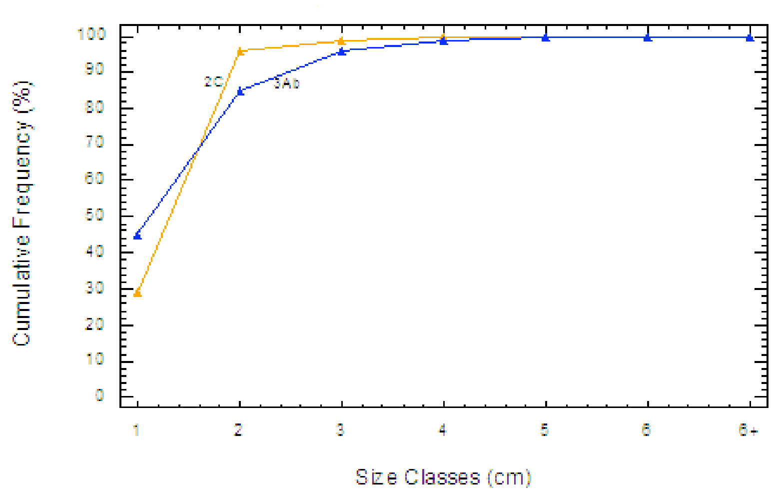

Figure 4.39: Cumulative frequency graph showing size class results of 2C and 3Ab assemblages for Unit L.

Tool Analysis

Biface (n=3)

Specimen 278, level 1, 2C horizon, Preform-Stage II (Figure 4.40C): The specimen exhibits a relatively thick and flat cross section with flake removal being multidirectional. There is a relatively high thickness to width ratio. It cannot be discerned whether the biface was made on a flake due to the fact that the specimen does not retain a remnant platform or dorsal ridge. The specimen has a weathered patina and appears to be thermally altered based on the presence of multiple heat spalls. The preform is broken crosswise in the medial area and is made from a local medium gray ccs with dark gray inclusions.

(mm/g)	MxL	MxWDT	MxTHK	MxWGT	EDGE°
	18.3	21.56	8.16	3.2	40

Specimen 291, level 6, 3Ab horizon, Preform-Stage I (Figure 4.40B): The specimen appears to be a stage I preform based on linear and weight measurements as well as edge angle. Flake removal reaches to the center of the specimen and is multidirectional and collateral in nature. A small amount of cortex remains on one face (15%). The cross section is between biconvex and plano-convex and is thick. A very small cross-wise break occurs at on end of the specimen.

Whether the preform was made on a flake is difficult to discern. The preform is manufactured from a light gray/green ccs.

(mm/g) MxL	MxWDT	MxTHK	MxWGT	EDGE°
42.2	32.06	14.58	16.5	46

Specimen 281, level 2, 3Ab horizon, Preform-Stage II (Figure 4.40A): The specimen appears to be a stage II preform based on linear and weight dimensions, and edge angle. All cortex is removed and the cross section shows evidence of thinning and is mainly biconvex. Flake removal is collateral with large and flat negative scars running to the center of both faces. There is evidence of retouch on both lateral margins. The cross section gives evidence of the biface being manufactured on a flake due to a remnant dorsal ridge. The specimen is made from a local dark gray/brown ccs.

(mm/g) MxL	MxWDT	MxTHK	MxWGT	EDGE°
28.38	36.88	9.56	14.4	43

A Summary and Comparison of 2C Horizon and 3Ab Horizon Lithic Assemblages

As stated in Chapter One, one of the goals of this study is to verify whether there are significant differences between the 2C and 3Ab horizon lithic assemblages. The debitage attribute and aggregate analyses show that the 2C and 3Ab horizon debitage assemblages are very similar in composition based on raw percentage scores as well as the t-test statistics, and cumulative frequency projections.

According to all debitage analyses, there appears to be a general trend towards late stage reduction (e.g., tool production/maintenance) rather than core reduction in both the 2C and 3Ab soil horizons. There is most certainly evidence for core reduction within both horizons given the moderate number of core reduction flakes recovered and the amount of platform-bearing flakes having single faceted platforms and single dorsal scar counts. However, the evidence for core reduction does not lend itself to the idea that this is one of the main reduction trajectories practiced at the site. Because horizons in each test unit have only been individually compared

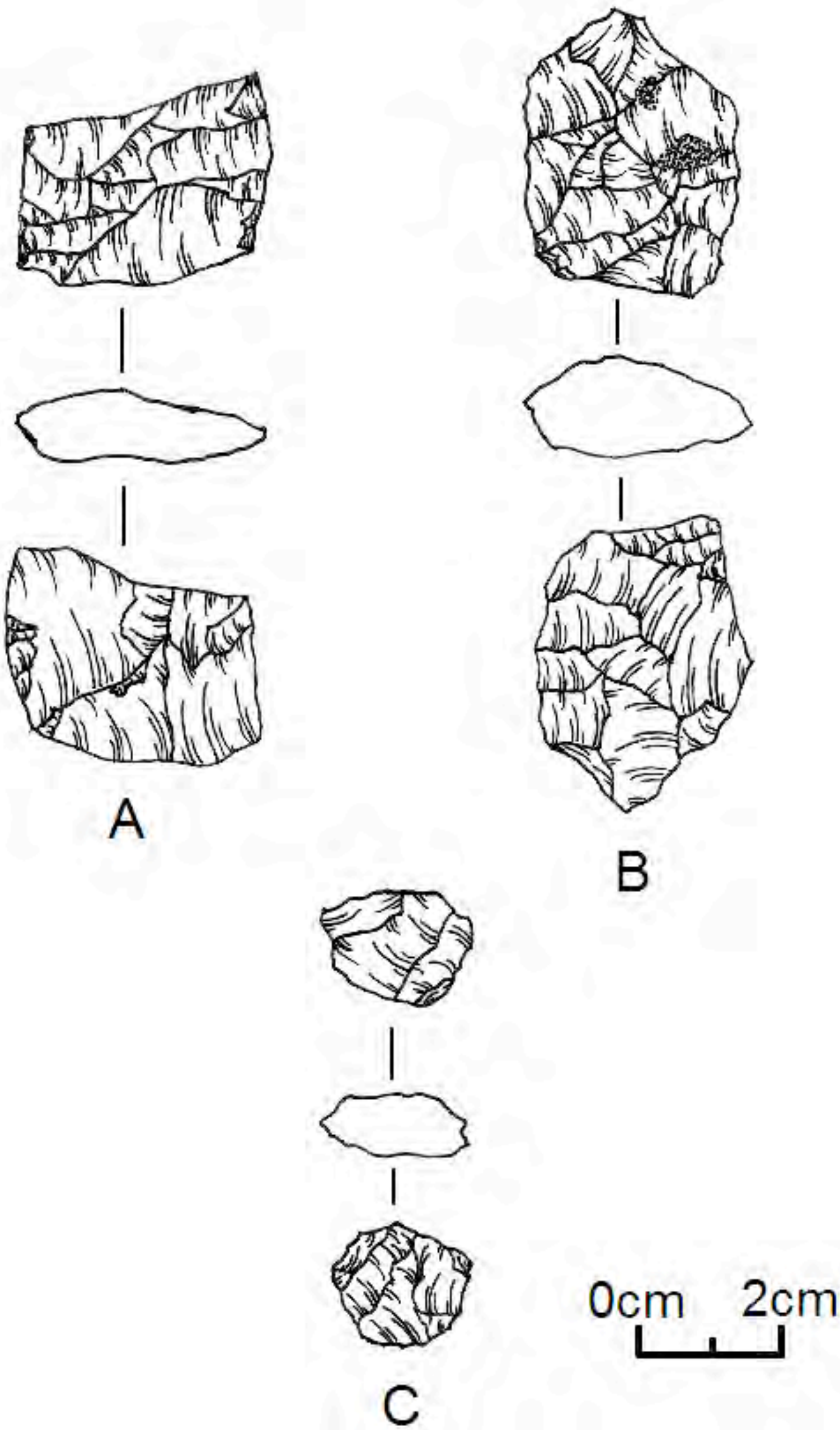

Figure 4.40: Lithic artifacts from Unit L; specimen 281, A; specimen 291, B; and specimen 278, C.

thusfar in this study, it is now appropriate to compare the 2C and 3Ab horizon assemblages at the site level.

The results of the aggregate analysis include some of the most telling similarities between the horizons, and forms the basis for inferring a focus upon late stage reduction/tool production. Figures 4.41 and 4.42 show size class and weight class trends within each of the horizons across the site. Both graphs show a very strong signature of late stage lithic reduction. Reasons for this similarity may be due to site function and the availability of raw material at the site. Evidence for tool production from each soil horizon is inferred from the analysis of platform-bearing flakes exhibiting bifacial thinning flake characteristics, multiple dorsal scars and platform facet counts, and platform lipping. The results of these analyses are projected in a cumulative frequency diagram, which shows the variability in bifacial thinning flakes recovered in all unit excavations (Figure 4.43).

As mentioned in Chapter Three, the analysis of the ratio of dorsal scar counts to individual flake weight allows for inferences upon either core production or tool production/maintenance. A high ratio suggests a focus upon core production/reduction while a low ratio indicates a focus on tool production/maintenance.

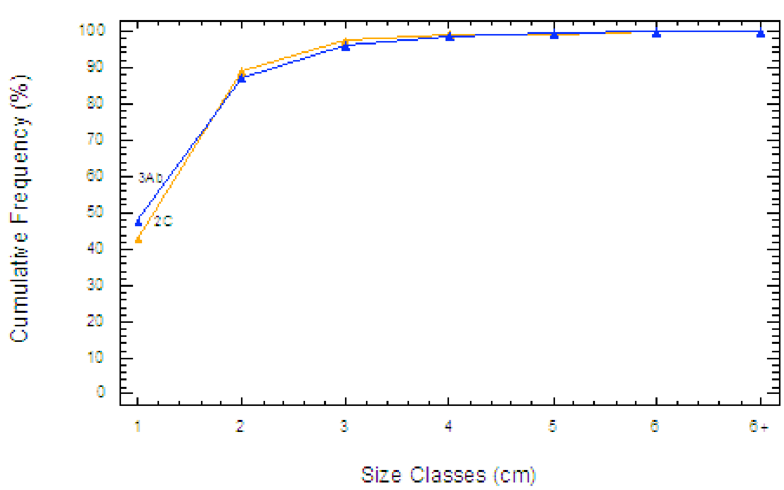

Figure 4.41: Cumulative frequency showing the results of the size classes of both the 2C and 3Ab horizons across the entire site.

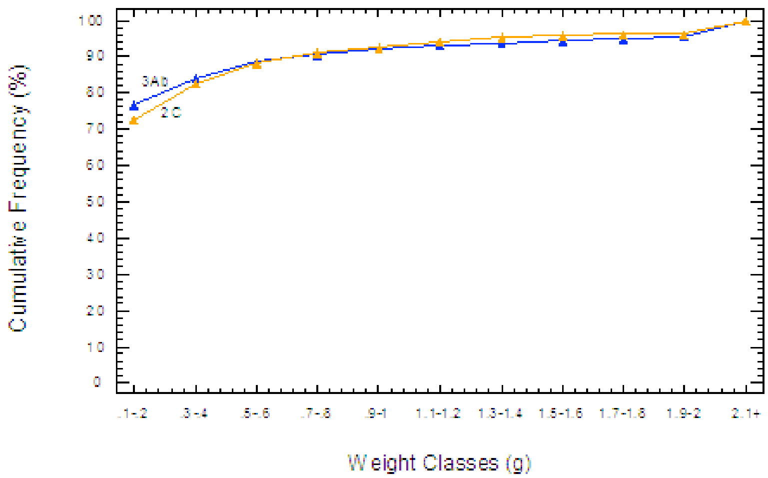

Figure 4.42: Cumulative frequency showing the results of the weight classes of both the 2C and 3Abhorizons across the entire site.

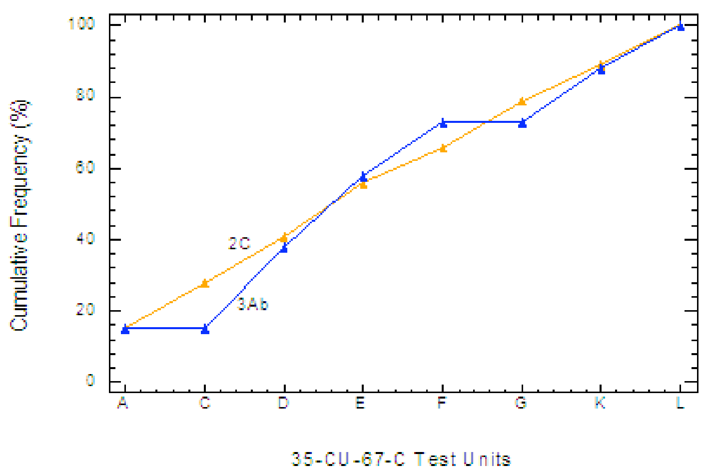

Figure 4.43: Cumulative frequency showing the amount of bifacial thinning flakes recovered in each of the horizons across the entire site.

A Kolmogorov-Smirnov (K-S test) statistic was conducted on the calculated ratios from each horizon and compared between all test units. In the case of the dorsal scar count/weight ratio method, significant differences between the two horizons were observed at the 95% confidence level (DN = 0.397; K-S statistic = 6.78; p-value = 0.0; df = 1, Figure 4.39). In addition to the

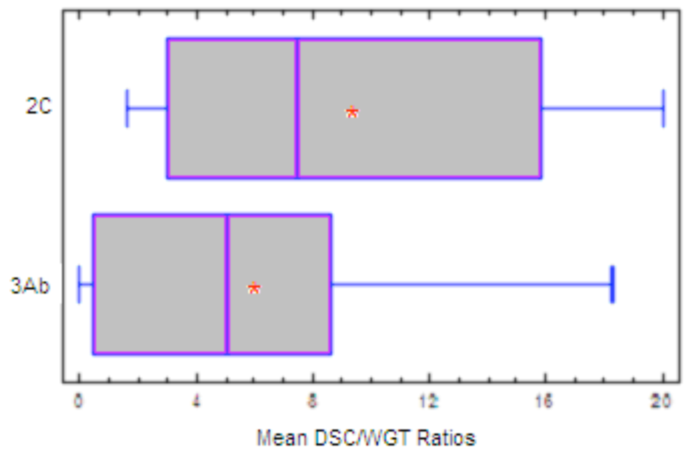

Figure 4.44: Box-plot of dorsal scar counts and weight ratios for 2C and 3Ab horizons.

K-S statistic, a comparison of means was conducted with the dorsal scar count/weight ratio method as well. Results of the t-test show that there is a significant difference at the 95 % confidence level (t = -2.39; p-value = 0.017). On this basis, it appears that the dorsal scar count and weight ratios show a higher incidence of core reduction in the 2C assemblage than in the 3Ab assemblage.

Additional differences between the 2C and 3Ab horizon assemblages are demonstrably evident in the frequency and types of tools. Figure 4.45 shows these differences as a cumulative

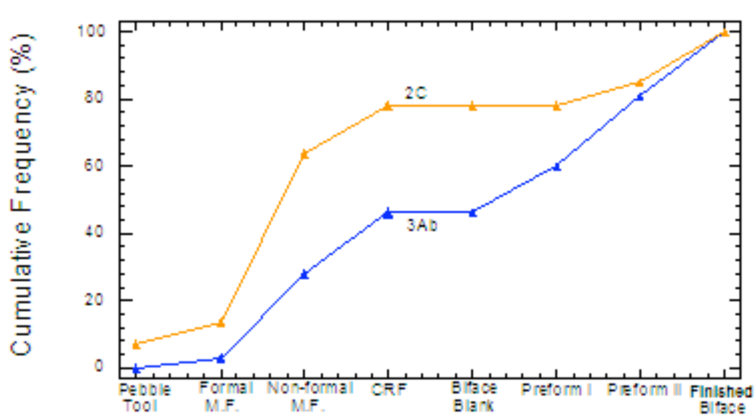

Figure 4.45: Cumulative frequency of tool types and tool amounts for both 2C and 3Ab horizons.

frequency of tool types. Although each horizon has a similar amount of formal modified flakes (e.g., unifaces), the 2C horizon shows greater quantities of core reduction flakes (CRF) and some pebble tool use. The 3Ab horizon shows lithic production activities that appear to be focused on bifacial tool manufacture/maintenance with higher amounts of preform I, II, and finished bifaces.

Although each horizon is being treated as its own variable throughout this study, it should be noted that each of the horizons probably contain many components representing multiple episodes of cultural occupation over time. It is less likely that this is the case for the 3Ab horizon considering it is contained within a “protected” paleosol. The 3Ab may retain evidence of multiple occupations, but there is more reason to believe that this occurred within a more limited time-frame before subsequently being buried by sediment. Conversely, the 2C assemblage is contained in the 2C horizon on its surface as a deflated component where it has been susceptible to natural and human forces. Because of this, the 2C assemblage most likely represents a palimpsest of multiple occupations potentially spanning thousands of years. Therefore, we should exercise caution when making comparisons between the 3Ab and 2C assemblages. Although the surface of the 2C horizon has provided early Holocene ^{14}C ages, it is inaccurate to think that the 2C assemblage solely represents an early Holocene component. Instead, a late Pleistocene component is being compared to a surficial lithic scatter most likely representing multiple arrays of distinct chronological and technological traditions. Regardless of this issue, technological similarities seen between the two horizons are due to site function, which appears relatively consistent over the last 10,500 RCYBP or so.

Chapter 5: Discussion and Conclusions

Discussion

The recovery of a late Pleistocene-age lithic assemblage at Indian Sands allows for insights into the early occupation of the southern Oregon coast. It is also demonstrates that there is still much more research that needs to be conducted in order to understand the initial peopling of the Pacific coast. Ideas gained through the Indian Sands lithic data will benefit greatly with more intensive paleoenvironmental reconstruction of the now-inundated late Pleistocene coastal plain (Davis et al. 2003).

As discussed in Chapter Two, most researchers interested in initial coastal populations regard the initial occupants of the North American Pacific coast as possessing a generalist-forager subsistence strategy. This idea is most prevalent in research conducted by Bryan (1991), Dixon (2001), Erlandson (1999, 2002), and Ames (2003). This generalist-forager strategy would have allowed productivity and adaptability in multiple and diverse environmental situations like those expected in the coastal and upland regions of a newly colonized landscape. Carlson (1991) and Mandryk et al. (2000) view early Holocene assemblages from the Northwest coast as evidence in support of the idea that earlier occupants of the Pacific coast followed a generalist-forager subsistence strategy. Furthermore, they perceive these existing early coastal hunter-gatherer technologies as evidence that initial occupation occurred along a coastal migration route originating from northeastern Asia whose populations were already adapted to coastal environments.

It is now pertinent in this study to discuss how the analysis results of the 3Ab lithic assemblage at Indian Sands compare with past and present ideas of early occupation on the Oregon and greater North American Pacific coast regions. Technological organization, mobility, and site function will be addressed.

Technological Organization and Reduction Trajectories for the 3Ab Horizon Assemblage

As stated in the Chapter One, a goal of this study is to attempt an interpretation of technological organization based on the lithic artifacts recovered from the 3Ab soil horizon. Analysis of the 3Ab horizon's lithic tool assemblage reveals that the reduction trajectory seems geared toward the production of varying sizes of flake blanks used in the manufacture of formal and non-formal tools. The vast majority of bifaces retain original flake blank characteristics including platforms on proximal ends and original dorsal ridges. That most bifacial preforms (i.e., stage I and II) and finished bifaces retain an original platform suggests that large linear flakes were preferred for the manufacture of bifacial implements. This technological pattern is similar to other early Pacific Northwest bifacial manufacturing strategies (Ozbun et al. 2004). Aside from specimen 258 (e.g., Figure 4.35B, Chapter Four), which may be evidence for bifacial/discoidal core production, no other cores were recovered within the horizon. However, the recovery of core reduction flakes suggests that multidirectional core technology existed during the late Pleistocene occupation of Indian Sands, and is consistent with specimen 258. Core reduction at Indian Sands is also represented in the debitage assemblage resulting in a moderate amount of single faceted platforms including many platform-bearing flakes exhibiting only one to zero dorsal scar counts.

The entire 3Ab horizon biface population is manufactured from flake blanks. In addition to morphological features of the 3Ab horizon biface assemblage, segregation between preforms and finished bifaces can be established on the basis of metric attributes (Figure 5.1). As mentioned in Chapter Four, the production of flake blanks is further supported by the analysis conducted on the platform-bearing flakes. In addition to bifacial tool production/maintenance, modified flakes were manufactured and used at Indian Sands during the late Pleistocene. Over 90% of the modified flake tools are comprised of non-formal specimens with only one being from formal manufacture. The variation in edge angles, micro-fracture, and polish seen on a majority of the modified flake tool assemblage suggests that other activities, including possible food and clothing processing and/or organic tool production, might have taken place

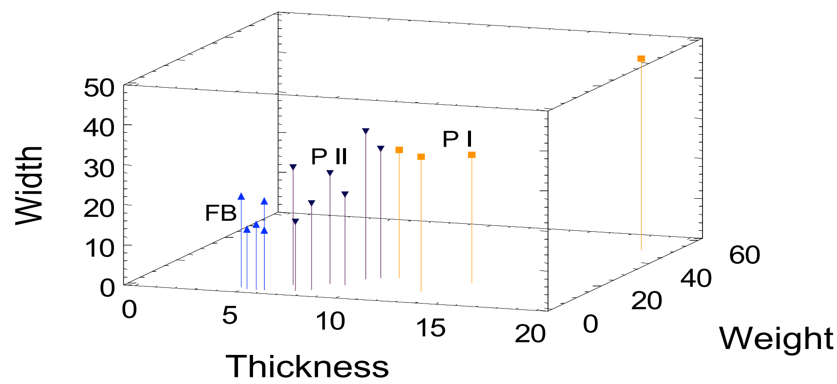

Figure 5.1: Scatterplot of the entire 3Ab horizon biface assemblage comparing width, thickness, and weight measurements (P I = preform I, P II = preform II, FB = finished biface).

at Indian Sands. Because organic preservation is poor, there is no way of independently confirming this aspect. A concise use-wear analysis should be conducted on the 3Ab horizon tool assemblage at Indian Sands to asses this possibility.

Based on the lithic analysis presented here, technological organization in the 3Ab horizon assemblage at Indian Sands is geared towards a generalized toolkit design, which is typical of generalist-foraging societies (Bryan 1991; Kelly 1999; Ames 2003). This interpretation is supported by the consideration of three main aspects that comprise a generalized technological design: maintainability, multi-functionality, and transportability.

Toolkit organization in the 3Ab horizon assemblage exhibits qualities of maintainability. This is manifested in both versatile and flexible characteristics that allow for the future performance of many procurement activities in relatively any order that they may occur (Bleed 1986; Nelson 1991). Evidence for toolkit maintainability is found in the high degree of generalized tool edges in the 3Ab assemblage (Shott 1986). Although bifaces cannot easily change form, large bifaces (i.e., preforms) are able to produce useable flakes that can be employed in a variety of situations. As mentioned in Chapter Two, generalized toolkit design typically leaves a distinct pattern in the archaeological record. Debitage patterns and tool morphology may indicate a relatively high frequency of bifacial thinning flakes, a low frequency of angular debris, and a tendency towards high angle retouch (i.e. $\geq$45˚) on modified tool edges (Mitchell and Pokotylo 1996; Andrefsky 1998). The 3Ab horizon lithic assemblage contains all of these characteristics. Figure 5.2 shows retouch angles on all formal and non-formal modified flake tools.

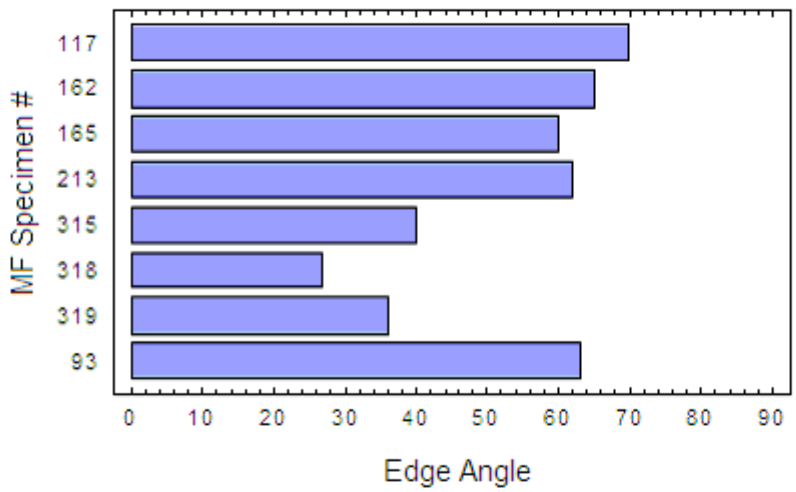

Figure 5.2: Scatterplot of both formal and non-formal modified flake tool edge angles for the 3Ab horizon.

Multi-functionality can also be identified in the 3Ab horizon assemblage. A simplification, or decrease, in the number of tool types in an assemblage is present in regards to the 3Ab horizon lithic assemblage (Nelson 1991). There are less tools to perform multiple tasks. An additional aspect of multi-functionality lies in the idea that highly mobile foraging groups should produce toolkits incurring a high biface/flake tool ratio within site assemblages (Kelly 1999). This is evident in the Indian Sands 2C and 3Ab assemblages, which have a biface to flake tool ratio of 2.14.

Mobility of late Pleistocene hunter-gatherers can be viewed in two ways from the 3Ab horizon assemblage. First, the procurement of obsidian from interior volcanic sources is very evident at Indian Sands. Interior sources of obsidian are located long distances from Indian Sands (e.g., ~300 km) and would account for the rather modest numbers of obsidian tools and debitage recovered from the site. Figure 5.3 shows the relationship between debitage and the distances for sources of obsidian and ccs raw materials. It is of interest to consider a few points with the obsidian acquisition.

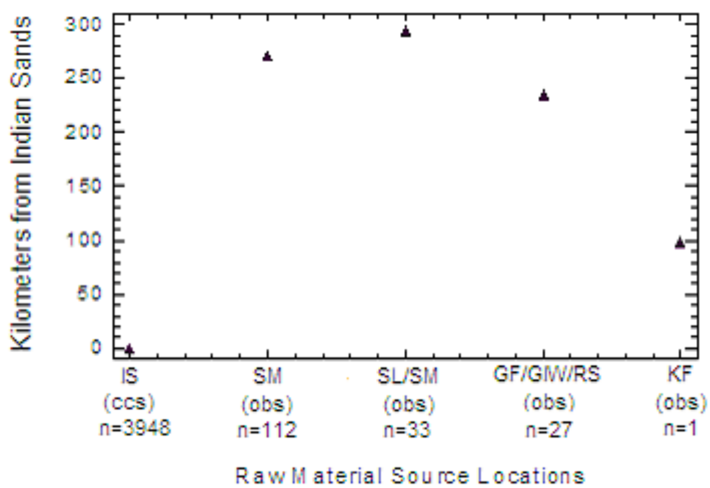

Figure 5.3: Plot of geographical distance of Indian Sands (35-CU-67C) from various raw material sources. Compare the distances with amount of artifacts (IS=Indian Sands, SM=Spodue Mountain, SL/SM=Silver Lake/Sycan Marsh, GF/GIW/RS=Grasshopper Group, KM=Klamath Falls).

In addition to the structural characteristics of toolkit design, the idea of direct procurement of obsidian implies that late Pleistocene hunter-gatherers who occupied Indian Sands during the late Pleistocene were highly mobile. These groups would have had knowledge of at least four regional obsidian sources, in addition to possessing knowledge of coastal toolstone locations. If true, such an early familiarity with widespread lithic resources may suggest humans were present on the Oregon coast much before 10,430 BP. It is also possible that groups possessed knowledge of the obsidian sources before coming to the coast.

The early presence of obsidian at Indian Sands may also reflect importation through trade networks with interior groups. Importation through trade allows for the possibility of a deeper prehistory for coastal occupation as well. If trade and/or contact did exist at approximately 10,430 RCYBP, it can be postulated that some type of demarcated land use between different groups existed at this time. If this is indeed the case, it can be proposed that the amount of time to establish a trade network based on a specific group's ability to have knowledge of and acquire certain materials from distinct locales should take an appreciable amount of time. It is known that the interior of the Pacific Northwest was inhabited prior to 10,430 RCYBP (Bedwell 1973; Bryan 1988; Davis 2001). If trade was occurring with coastal inhabitants at this time, the possibility that a trade network existed between interior and coastal groups well before 10,430 RCYBP also exists.

Whether through direct procurement or importation from trade, it can be argued that peoples of the coast and interior regions shared technological ideas. Three finished obsidian bifaces, most likely leaf-shaped/foliate projectile points, were recovered from the 3Ab horizon. Although direct links to diagnostic interior toolkits cannot be proven, similarities should at least be mentioned in light of this information. As stated previously, a recent re-analysis on the lithic assemblage from Marmes Rockshelter was conducted by Ozbun et al. (2004). Leaf-shaped projectile points were recovered in the rockshelter's earliest deposit (Rockshelter Stratum Unit I) associated with a range of samples that returned radiocarbon ages between 10,810 ± 300 BP and 10,475 ± 300 BP (Ozbun et al. 2004). The finished obsidian bifaces at Indian Sands show strong similarities in projectile point style, and in their manner of reduction. Comparatively, the Ozbun et al. (2004) analysis of the Marmes Rockshelter assemblage and my analysis of the Indian Sands assemblage show that leaf-shaped finished bifaces were produced from flakes that commonly retain their original platform at the base. Also, the technology at each site incorporated a multi-directional core and flake industry mainly focused on the production of large linear flake blanks for production of tools. It is noted that this does not prove the presence of a cultural continuum nor clarify any ancestral relationship between interior and coastal populations. This comparison simply shows that similar modes of technological organization were used in the Pacific Northwest during the late Pleistocene among contemporary interior and coastal populations.

Toolkit organization reveals aspects of mobility as well. There are a number of telling characteristics in both the debitage and tool assemblages from the 3Ab horizon that allude to high mobility probably due to generalist-forager strategies. Kelly (1999) presents a suite of concepts that relate aspects of toolkit organization to high and low mobility strategies practiced by hunter-gatherers. These concepts are compared to the results of the lithic analyses on the 3Ab horizon assemblage to eliminate whether high or

	High Residential Mobility	Low Mobility/ Sedentism	Indian Sands
Lithic Raw Material	high quality	low quality	high quality
Evidence of bifaces as cores	common	rare	present
Bifaces as by-products	rare	common	rare
Bipolar knapping/ scavenging	rare	occasional to common	rare
Flake (non-biface reduction) tools	rare to occasional	common	occasional
Fire-cracked rock	rare	common	rare
Site size/density	small/low	large/high	small/low
Tool/debitage ratio	high	low	high
Biface/flake tool ratio	high	low	high
Complete flakes	rare	common	rare
Broken flakes	common	rare	common
Flake fragments	common	rare	common
Angular debris	rare	common	rare
Assemblage size/diversity	low slope	high slope	low slope

Table 5.1: A list of mobility concepts borrowed from Kelly (1999) and compared with the 3Ab horizon lithic assemblage at Indian Sands.

low mobility strategies were practiced at the site. As Table 5.1 shows, it is obvious that the 3Ab horizon toolkit was geared towards high residential mobility, which is consistent with Bryan's (1991) and Ames' (2003) hypotheses on early coastal peoples.

Other indications of toolkit transportability are found in particular elements of the tool assemblage. Although it is very likely that specimen 258 represents a bifacial/discoidal core, the 3Ab horizon toolkit appears to be predominantly focused on the production of preform I and preform II bifaces. An emphasis on the production of smaller preforms is reminiscent of Kuhn's (1994) idea of a highly cost-effective transportable toolkit. A toolkit containing a number of smaller bifaces will be multi-functional and will incur an optimal weight to utility ratio while maintaining the ability to produce useable flakes for tools through further bifacial reduction. It seems that in the 3Ab component at Indian Sands, multi-directional cores were produced in order to make flake blanks for the production of preforms, which could then be transported elsewhere and utilized as the basis for a generalized toolkit. Once again, this has distinct similarities with the pre-Mazama component (component I) at the Paulina Lake Site in central Oregon (Connolly 1999).

Another method used to test for high mobility involves an evaluation of the statistical correlation between assemblage size and diversity. This evaluation can be accomplished through a simple regression analysis with attention paid to the y-intercept and slope (Kelly 1999). In this regression analysis, the assemblage size is the independent variable and the assemblage diversity is the dependent variable. Assemblage size is the total number of artifacts (i.e., debitage and tools) recovered from a site or component while the assemblage diversity is the total number of tool categories divided by the total number of tools recovered (Kelly 1999). Assemblages that are indicative of high residential mobility or logistical task sites will typically show assemblage diversity as a low to moderate increase in light of the assemblage size due to the moderate amount of tool types indicative of a generalized toolkit. The smaller variety of tool types will tend to produce a low slope (Kelly 1999). Larger, more sedentary settlement sites such as collector base camps will tend to show evidence for a wider range of activities, reflected in a broad assortment of specialized tools designed for those activities. This larger toolkit will show a fairly abrupt increase in assemblage diversity in relation to assemblage size resulting in a steep slope (Kelly 1999). In order to evaluate the level of early hunter-gatherer mobility, a regression analysis was used to compare both horizons at Indian Sands in addition to the four earliest components at Marmes Rockshelter (Ozbun et al. 2004) (Figure 5.4). As can be seen in Figure 5.4, the correlation between

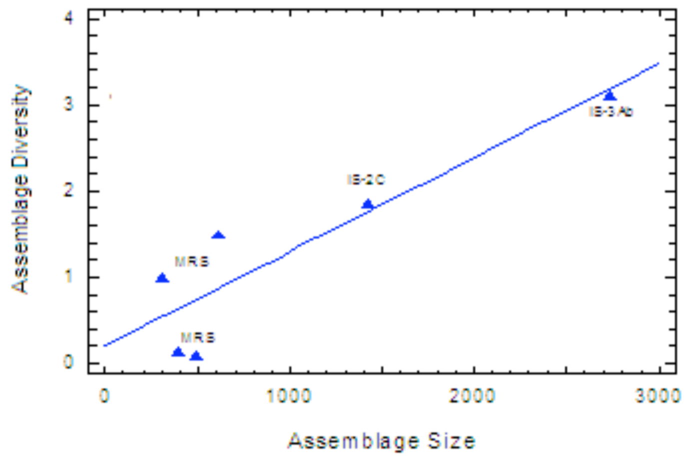

Figure 5.4: Linear regression of earliest components from Marmes Rockshelter (MRS) and the 2C and 3Ab horizons from Indian Sands (IS-2C and IS-3Ab).

the assemblage size and diversity for the 3Ab and 2C components and the four earliest components at Marmes Rockshelter produce a very low slope indicative of high residential mobility (Y-intercept = 0.215 ; r^2 = 0.89 ; slope = 0.00108 ; df = 5).

Site Function at Indian Sands

One purpose of this study is to attempt an interpretation of site function by using the results of the lithic analysis, focusing specifically upon the stages of the reduction trajectory and type of tool production, coupled with the geological setting of the site. As mentioned previously, Indian Sands is undoubtedly a source for ccs raw material. The presence of raw material is understood to have been an important site feature and probably attracted prehistoric peoples throughout the late Pleistocene period into later periods (Davis et al. 2003; Willis 2003). If Indian Sands was a site used for raw material procurement, why does the lithic assemblage from 35-CU-67C show a focus upon late stage reduction and tool production/maintenance when much of the archaeological literature predicts that early stage reduction should dominate quarry locales? The physical nature of the raw material at the site may hold the answer to this discrepancy.

The ccs deposits at Indian Sands naturally lack cortex as a rule and are moderate in size. Because of these factors, it is very possible that the typical signs of initial stage reduction may be masked. As use of the triple cortex typology shows, there is almost a complete absence of primary flakes in either horizon and very few secondary flakes were recovered. Connolly (1999) realized the same problem with his lithic analysis of sites in Newberry Crater. The raw material at several obsidian quarry sites, namely the Game Hut Obsidian Quarry (35-DS-485) and the Paulina Lake site (35-DS-34), showed very few signs of cortication due to the nature of the lava flows. Therefore, in order to utilize the triple cortex approach, one must understand the source and nature of the raw material. Because the toolstone source can be observed within the bedrock at Indian Sands, and most of the debitage recovered at 35-CU-67C was locally-derived, it is believed that the triple cortex typology is not a reliable methodology for this site.

Another point should be made in considering raw material sources in light of Indian Sands. The quantity and size of ccs material at Indian Sands may have impacted lithic reduction strategies throughout prehistory regardless of the technological designs practiced by different cultural groups. The nature of the raw material at Indian Sands may have influenced, or limited, the type of lithic tool/core production that occurred at the site. The debitage analysis results support this.

As mentioned in the Chapter Four, the debitage assemblages from both the 2C and 3Ab horizons showed strong similarities. There is overwhelming evidence in the 2C and 3Ab horizon assemblages for late stage lithic reduction and tool production/maintenance. The debitage assemblages share similar characteristics based on size, weight, cortex, and individual flake attributes. However, the 2C and 3Ab horizon tool assemblages were quite different. The 3Ab horizon tool assemblage indicates a preference for bifacial preform production. This discrepancy seems reasonable at Indian Sands. Based on field work, 35-CU-67C is a site that offers a moderate amount of toolstone that would not have supported a large amount of cortex-laden waste flakes or evidence for primary reduction. As stated by

Andrefsky (1994), in areas that exhibit moderate amounts of good quality toolstone, we should expect to see a focus on later stage reduction and tool production/maintenance of both formal and informal tools. Because of these site characteristics, prehistoric groups may have made the choice to exploit Indian Sands as one of many quarry sites on the southern Oregon coast as part of a larger system of settlement and subsistence strategies (Binford 1980).

Future Research at Indian Sands

In order to achieve a better understanding of late Pleistocene occupation of the Oregon coast, a variety of research avenues should be addressed in the future. These include experimental archaeology, lithic microwear analysis, obsidian studies, and archaeological surveys and testing.

Experimental archaeology in the form of reproducing bifacial and modified flake tools should be undertaken. These studies should use similar ccs material that may be recovered near the vicinity of the Indian Sands site. Flintknapping and usewear experimental studies can possibly elucidate ideas of terrestrial versus marine resource exploitation. Replicated lithic tools can be used in documented tests on a variety of organic products from both terrestrial and marine environments located in the southern Oregon coast area. Macroscopic analysis methods such as used in this study should be conducted on the replicated lithic tools before and after the experimental tests are performed.

In addition to experimental archeology, microwear analysis should be completed on both the recovered tools from the Indian Sands 3Ab horizon assemblage as well as with the replicated tools. The results of the microwear analysis from the experimental data set could then be compared with the analysis from the 3Ab tool assemblage. It is possible that similar usewear patterns may be located between tools in each assemblage. With the knowledge of the type of organic materials that were processed with certain replicated tools, specific ideas of what processing tasks the 3Ab assemblage tools were associated with may be ascertained.

Obsidian studies, namely obsidian hydration, need to be carried out in both coastal and interior regions of Oregon. A better understanding of past and present precipitation rates should be initiated for areas of the Oregon coast, such as Indian Sands, and known interior volcanic sources. A record of precipitation in association with hydration rim measurements in these areas may allow for a reliable dating method in the future.

Future excavations should be conducted at 35-CU-67C to investigate the 4Bsb soil horizon which is overlain by the 3Ab horizon. Because it has been dated to 15,600 BP, efforts should be made to recover cultural material from within this paleosol or on its deflated surface. Artifacts recovered from the 4Bsb horizon would have strong implications for the initial peopling of the New World.

Systematic archaeological surveys on the coast of Oregon can assist in locating additional early sites. More specifically, certain locations possessing two characteristics should be investigated. These two characteristics consist of uplifted terraces and ccs deposits. Documenting existing uplifted terraces with toolstone sources along the Oregon coast may assist in locating additional late Pleistocene sites. With a record of these sites completed, systematic testing can be conducted at these sites in order to recover buried late Pleistocene deposits.

Conclusion

This thesis has used multiple lines of evidence in order to describe and interpret the lithic debitage and tools recovered at Indian Sands. The 3Ab horizon assemblage at 35-CU-67C is indicative of early Oregon coastal peoples using an unspecialized technological organization (i.e., generalized), most likely practicing a generalist-forager subsistence strategy with a highly mobile residential pattern. This hypothesis is supported by a technological organization that is based on a transportable flake and core industry and bifacial strategy focusing on the production of preforms and foliate/leaf-shaped projectile points.

Although the results of the lithic analysis performed on the 3Ab horizon assemblage do not necessarily clarify the issue of when was the Oregon coast initially occupied, or by whom, it does suggest initial coastal settlement predates 10,430 ± 140 RCYBP. Specifically, the importation of obsidian from multiple distal interior sources indicates that trade or mobility patterns for aquiring obsidian were in place by 10,430 ± 140 RCYBP. The knowledge and procurement of wide ranging raw material sources during the late Pleistocene would most likely have taken an appreciable amount of time to organize. Therefore, the early presence of obsidian debitage and tools at Indian Sands provides indirect proof for even greater antiquity of coastal occupation.

The technological organization at Indian Sands agrees with many of the previously mentioned hypotheses regarding early coastal peoples, most specifically the ideas of Bryan (1991) and Mandryk et al. (2001). The 3Ab horizon lithic assemblage at 35-CU-67C could have been implemented in a variety of environmental situations including terrestrial and coastal habitats. Although the 3Ab horizon toolkit is entirely composed of lithic products, there is no reason to suggest that it is only limited to terrestrial activities. It is also noted that there are broad similarities in lithic technologies recovered at Indian Sands and interior Pacific Northwest sites of relatively similar ages, namely WSPT sites. These similarities include core technology, biface strategies and designs, and a high level of mobility.

In conclusion, it is probable that, given the close proximity of both the uplands and coastal environments, late Pleistocene occupants at Indian Sands were extracting resources from both areas in a way reminiscent of Erlandson's (1999) idea of optimal and varied adaptive strategies. Contrasting theories suggesting that some type of maritime economy did not exist on the Oregon coast before approximately 8000 BP is highly unlikely given the site's proximity to the coast. Indian Sands was very likely used as a lithic procurement site that could have been accessed during movements between the coastal lowland and terrestrial upland areas. A generalized toolkit organization is one which is designed for multi-functionality, cost-efficient use in multiple environments, and transportability. Such a toolkit was recovered in the 3Ab horizon at Indian Sands in just such an environmental situation.

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APPENDICES

Appendix A

Lithic Debitage Data and Results of the Analyses

Note on abbreviations:
Material: ccs=chert, obs=obsidian, ign=igneous, qit=quartzite
Free-standing Typology: CF=complete flake, BF=broken flake, FF=flake fragment, D=debris
Platform-bearing flakes: BTF=bifacial thinning flake, Lipped=presence of lipping on platform,
0-1 DS=0-1 dorsal scars, 2+ DS= 2 or more dorsal scars
0-1 Plat.=0-1 platform facets, 2+ Plat.=2 or more platform facets
Aggregate analysis: Size; 1=1cm, 2=2cm, 3=3cm, 4=4cm, 5=5cm, 6=6cm, 6+=more than 6cm
Weight; 1=0.0-0.1g, 2=0.2-0.3g, 3=0.4-0.5g, 4=0.6-0.7g, 5=0.8-0.9g, 6=1.0-1.1g, 7=1.2-1.3g;
8=1.4-1.5g, 9=1.6-1.7g, 10=1.8-1.9g, 11=2.0g+

	Material	**CF**	**BF**	**FF**	**D**	**Total**
2C	ccs	7	62	135	11	215
	obs	0	3	3	0	6
	ign	0	0	5	1	6
	qit	0	0	2	0	2
	Total	7	65	145	12	229
3AB	ccs	4	40	81	0	125
	obs	0	3	5	0	8
	ign	1	0	1	0	2
	qit	0	0	0	0	0
	Total	5	43	87	0	135

Table A1. Summary of debitage analyis for unit A using the free-standing typology**.**

	Material	**BTF**	**Lipped**	**0-1 DS**	**2+ DS**	**0-1 Plat.**	**2+ Plat**
2C	ccs	15	20	28	41	39	30
	obs	2	2	0	3	0	3
	ign	0	0	0	0	0	0
	qit	0	0	0	0	0	0
	Total	17	22	28	44	39	33
3AB	ccs	11	15	9	35	33	11
	obs	11	0	1	2	3	0
	ign	0	0	1	0	1	0
	qit	0	0	0	0	0	0
	Total	11	15	11	37	37	11

Table A2. Attribute analysis and technological typology results of platform-bearing flakes for unit A.

	Material	Primary	Secondary	Tertiary	Total
2C	ccs	3	18	194	215
	obs	0	0	6	6
	ign	0	1	5	6
	qit	0	0	2	2
	Total	3	19	204	227
3AB	ccs	1	16	108	125
	obs	0	0	8	8
	ign	1	1	0	2
	qit	0	0	0	0
	Total	2	17	116	135

Table A3. Summary of the triple cortex typology analysis for unit A.

	Material	CF	BF	FF	D	Total
2C	ccs	8	73	192	23	296
	obs	0	2	1	0	3
	ign	0	4	4	0	8
	qit	0	1	1	0	2
	Total	8	80	198	23	309

Table A4. Summary of debitage analysis for unit C using the free-standing typology

	Material	BTF	Lipped	0-1 DS	2+ DS	0-1 Plat.	2+ Plat
2C	ccs	19	21	33	48	39	42
	obs	0	0	1	1	1	1
	ign	0	0	4	0	3	1
	qit	0	0	1	0	1	0
	Total	19	21	39	49	44	44

Table A5. Attribute analysis and technological typology results of platform-bearing flakes for unit C.

	Material	Primary	Secondary	Tertiary	Total
2C	ccs	7	31	258	296
	obs	0	0	3	3
	ign	0	2	6	8
	qit	0	0	2	2
	Total	7	31	269	309

Table A6. Summary of the triple cortex typology analysis for unit C.

	Material	CF	BF	FF	D	Total
2C	ccs	4	21	60	5	90
	obs	0	2	1	0	3
	ign	1	0	2	0	3
	qit	0	0	0	0	0
	Total	5	23	63	5	96
3AB	ccs	12	74	144	14	244
	obs	0	7	9	0	16
	ign	1	1	0	1	3
	qit	0	0	0	0	0
	Total	13	82	153	15	263

Table A7. Summary of debitage analysis for unit D using the free-standing typology.

	Material	BTF	Lipped	0-1 DS	2+ DS	0-1 Plat.	2+ Plat
2C	ccs	5	4	11	14	13	12
	obs	1	1	1	1	2	0
	ign	0	0	0	1	1	0
	qit	0	0	0	0	0	0
	Total	6	5	12	16	16	12
3AB	ccs	30	25	32	53	37	48
	obs	2	1	3	4	2	5
	ign	0	0	2	0	2	0
	qit	0	0	0	0	0	0
	Total	32	26	37	57	41	53

Table A8. Attribute analysis and technological typology results of platform-bearing flakes for unit D.

	Material	Primary	Secondary	Tertiary	Total
2C	ccs	0	17	73	90
	obs	0	0	3	3
	ign	0	2	1	3
	qit	0	0	0	0
	Total	0	19	77	96
3AB	ccs	0	25	219	244
	obs	0	0	16	16
	ign	0	2	1	3
	qit	0	0	0	0
	Total	0	27	236	263

Table A9. Summary of the triple cortex typology analysis for unit D

	Material	CF	BF	FF	D	Total
2C	ccs	2	21	50	7	80
	obs	0	2	0	0	2
	ign	0	0	3	0	3
	qit	0	0	0	0	0
	Total	2	23	53	7	85
3Ab	ccs	7	71	197	11	286
	obs	4	5	9	0	18
	ign	0	2	1	0	3
	qit	0	0	0	0	0
	Total	11	78	207	11	307

Table A10. Summary of debitage analysis for unit E using the free-standing typology

	Material	BTF	Lipped	0-1 DS	2+ DS	0-1 Plat.	2+ Plat
2C	ccs	5	8	16	7	11	12
	obs	1	1	0	2	1	1
	ign	0	0	0	0	0	0
	qit	0	0	0	0	0	0
	Total	6	9	16	9	12	13
3AB	ccs	25	18	34	45	33	45
	obs	2	0	2	7	3	6
	ign	0	0	2	0	2	1
	qit	0	0	0	0	0	0
	Total	27	18	38	52	38	52

Table A11. Attribute analysis and technological typology results of platform-bearing flakes for unit E.

	Material	Primary	Secondary	Tertiary	Total
2C	ccs	0	16	64	80
	obs	0	0	2	2
	ign	0	1	2	3
	qit	0	0	0	0
	Total	0	17	68	85
3AB	ccs	1	29	256	286
	obs	0	0	18	18
	ign	0	0	3	3
	qit	0	0	0	0
	Total	1	29	277	307

Table A12. Summary of the triple cortex typology analysis for unit E.

	Material	CF	BF	FF	D	Total
2C	ccs	11	63	155	2	231
	obs	0	3	4	0	7
	ign	0	0	3	0	3
	qit	0	0	0	0	0
	Total	11	66	162	2	241
3AB	ccs	26	226	501	37	790
	obs	7	14	24	0	45
	ign	0	1	1	1	3
	qit	0	0	0	0	0
	Total	33	241	526	38	838

Table A13. Summary of debitage analysis for unit F using the free-standing typology

	Material	BTF	Lipped	0-1 DS	2+ DS	0-1 Plat.	2+ Plat
2C	ccs	12	16	25	49	35	39
	obs	1	1	1	2	2	1
	ign	0	0	0	0	0	0
	qit	0	0	0	0	0	0
	Total	13	17	26	51	37	40
3AB	ccs	56	53	143	109	138	114
	obs	8	7	5	16	11	10
	ign	0	0	1	0	1	0
	qit	0	0	0	0	0	0
	Total	64	60	149	125	150	124

Table A14. Attribute analysis and technological typology results of platform-bearing flakes for unit F.

	Material	Primary	Secondary	Tertiary	Total
2C	ccs	0	19	212	231
	obs	0	2	7	7
	ign	0	0	1	3
	qit	0	0	0	0
	Total	0	21	220	241
3AB	ccs	2	56	732	790
	obs	0	1	44	45
	ign	2	1	0	3
	qit	0	0	0	0
	Total	4	58	776	838

Table A15. Summary of the triple cortex typology analysis for unit F.

	Material	CF	BF	FF	D	Total
2C	ccs	10	69	171	7	257
	obs	0	8	2	0	10
	ign	0	0	0	0	0
	qit	0	0	0	0	0
	Total	10	77	173	7	267

Table A16. Summary of debitage analysis for unit G using the free-standing typology

	Material	BTF	Lipped	0-1 DS	2+ DS	0-1 Plat.	2+ Plat
2C	ccs	16	16	54	25	41	38
	obs	3	3	0	8	3	5
	ign	0	0	0	0	0	0
	qit	0	0	0	0	0	0
	Total	19	19	54	33	44	43

Table A17. Attribute analysis and technological typology results of platform-bearing flakes for unit G.

	Material	Primary	Secondary	Tertiary	Total
2C	ccs	0	18	239	257
	obs	0	0	10	10
	ign	0	0	0	0
	qit	0	0	0	0
	Total	0	18	249	267

Table A18. Summary of the triple cortex typology analysis for unit G.

	Material	CF	BF	FF	D	Total
2C	ccs	3	28	52	7	90
	obs	0	1	0	0	1
	ign	0	0	0	0	0
	qit	0		0	0	0
	Total	3	29	52	7	91
3AB	ccs	17	139	391	18	565
	obs	0	7	9	0	16
	ign	0	0	0	0	0
	qit	0	0	0	0	0
	Total	17	146	400	18	581

Table A19. Summary of debitage analysis for unit K using the free-standing typology

	Material	BTF	Lipped	0-1 DS	2+ DS	0-1 Plat.	2+ Plat
2C	ccs	5	11	15	16	17	14
	obs	0	0	1	0	0	1
	ign	0	0	0	0	0	0
	qit	0	0	0	0	0	0
	Total	5	11	16	16	17	15
3AB	ccs	33	42	104	52	95	61
	obs	2	1	1	6	2	5
	ign	0	0	0	0	0	0
	qit	0	0	0	0	0	0
	Total	35	43	105	58	97	66

Table A20. Attribute analysis and technological typology results of platform-bearing flakes for unit K.

	Material	Primary	Secondary	Tertiary	Total
2C	ccs	1	13	76	90
	obs	0	0	1	1
	ign	0	0	0	0
	qit	0	0	0	0
	Total	1	13	77	91
3AB	ccs	1	44	520	565
	obs	0	0	16	16
	ign	0	0	0	0
	qit	0	0	0	0
	Total	1	44	536	581

Table A21. Summary of the triple cortex typology analysis for unit K.

	Material	CF	BF	FF	D	Total
2C	ccs	5	27	55	3	90
	obs	0	2	1	0	3
	ign	1	0	1	1	3
	qit	0	0	0	0	0
	Total	6	29	57	4	96
3AB	ccs	15	137	377	21	550
	obs	2	11	19	0	32
	ign	0	0	2	0	2
	qit	0	0	0	0	0
	Total	17	148	398	21	584

Table A22. Summary of debitage analysis for unit L using the free-standing typology

	Material	BTF	Lipped	0-1 DS	2+ DS	0-1 Plat.	2+ Plat
2C	ccs	5	8	15	17	18	13
	obs	1	1	1	1	0	2
	ign	0	0	1	0	1	0
	qit	0	0	0	0	0	0
	Total	6	9	17	18	19	14
3AB	ccs	25	32	78	74	91	62
	obs	5	4	3	10	5	8
	ign	0	0	0	0	0	0
	qit	0	0	0	0	0	0
	Total	30	36	81	84	96	69

Table A23. Attribute analysis and technological typology results of platform-bearing flakes for unit L.

	Material	Primary	Secondary	Tertiary	Total
2C	ccs	0	7	83	90
	obs	0	0	3	3
	ign	1	0	2	3
	qit	0	0	0	0
	Total	1	7	88	96
3AB	ccs	0	41	509	550
	obs	0	0	32	32
	ign	0	0	2	2
	qit	0	0	0	0
	Total	0	41	543	584

Table A24. Summary of the triple cortex typology analysis for unit L.

		Size Classes							
	Material	1	2	3	4	5	6	6+	Total
2C	ccs	136	72	7	0	0	0	0	215
	obs	2	4	0	0	0	0	0	6
	ign	4	2	0	0	0	0	0	6
	qit	2	0	0	0	0	0	0	2
	Total	144	78	7	0	0	0	0	229
3AB	ccs	60	47	8	8	2	0	0	125
	obs	5	3	0	0	0	0	0	8
	ign	0	1	0	1	0	0	0	2
	qit	0	0	0	0	0	0	0	0
	Total	65	51	8	9	2	0	0	135

Table A25: Summary of size analysis for unit A

	Weight Classes												
	Material	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**Total**
2C	ccs	197	12	2	0	2	1	0	0	0	0	1	215
	obs	5	1	0	0	0	0	0	0	0	0	0	6
	ign	6	0	0	0	0	0	0	0	0	0	0	6
	qit	2	0	0	0	0	0	0	0	0	0	0	2
	Total	210	13	2	0	2	1	0	0	0	0	1	229
3AB	ccs	97	5	8	1	1	1	1	1	1	0	9	125
	obs	8	0	0	0	0	0	0	0	0	0	0	8
	ign	1	1	0	0	0	0	0	0	0	0	0	2
	qit	0	0	0	0	0	0	0	0	0	0	0	0
	Total	106	6	8	1	1	1	1	1	1	0	9	135

Table A26: Summary of weight analysis for unit A

	Size Classes								
	Material	**1**	**2**	**3**	**4**	**5**	**6**	**6+**	**Total**
2C	ccs	46	153	75	17	3	2	0	296
	obs	2	1	0	0	0	0	0	3
	ign	0	5	1	1	0	1	0	8
	qit	0	2	0	0	0	0	0	2
	Total	48	161	76	18	3	3	0	309

Table A27: Summary of size analysis for unit C

	Weight Classes											
	Mat.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
2C	ccs	109	53	34	18	22	13	6	6	3	0	32
	obs	2	0	1	0	0	0	0	0	0	0	0
	ign	0	1	4	0	0	0	1	0	0	0	2
	qit	1	0	1	0	0	0	0	0	0	0	0
	Total	112	54	40	18	22	13	7	6	3	0	34

Table A28: Summary of weight analysis for unit C

	Size Classes								
	Material	**1**	**2**	**3**	**4**	**5**	**6**	**6+**	**Total**
2C	ccs	37	48	4	1	0	0	0	90
	obs	1	2	0	0	0	0	0	3
	ign	0	3	0	0	0	0	0	3
	qit	0	0	0	0	0	0	0	0
	Total	38	53	4	1	0	0	0	96
3AB	ccs	101	112	22	5	4	0	0	244
	obs	11	5	0	0	0	0	0	16
	ign	2	1	1	0	0	0	0	4
	qit	0	0	0	0	0	0	0	0
	Total	114	118	23	5	4	0	0	264

Table A29: Summary of size analysis for unit D

	Weight Classes											
	Mat.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
2 C	ccs	63	13	7	4	0	0	1	1	0	0	1
	obs	3	0	0	0	0	0	0	0	0	0	0
	ign	1	1	0	1	0	0	0	0	0	0	0
	qit	0	0	0	0	0	0	0	0	0	0	0
	Total	67	14	7	5	0	0	1	1	0	0	1
3AB	ccs	182	23	13	6	4	5	2	0	1	1	7
	obs	16	0	0	0	0	0	0	0	0	0	0
	ign	2	0	0	0	0	0	0	0	0	0	1
	qit	0	0	0	0	0	0	0	0	0	0	0
	Total	200	23	13	6	4	5	2	0	1	1	8

Table A30: Summary of weight analysis for unit D

	Material	1	2	3	4	5	6	6+	Total
				Size Classes					
2C	ccs	28	48	4	0	0	0	0	80
	obs	1	1	0	0	0	0	0	2
	ign	1	2	0	0	0	0	0	3
	qit	0	0	0	0	0	0	0	0
	Total	30	51	4	0	0	0	0	85
3AB	ccs	159	104	14	5	2	1	0	285
	obs	13	4	1	0	0	0	0	18
	ign	1	1	0	0	0	0	0	2
	qit	0	1	0	0	0	0	0	1
	Total	173	110	15	5	2	1	0	306

Table A31: Summary of size analysis for unit E

	Mat.	1	2	3	4	5	6	7	8	9	10	11
						Weight Classes						
2C	ccs	61	11	3	3	0	1	1	0	0	0	0
	obs	2	0	0	0	0	0	0	0	0	0	0
	ign	3	0	0	0	0	0	0	0	0	0	0
	qit	0	0	0	0	0	0	0	0	0	0	0
	Total	66	11	3	3	0	1	1	0	0	0	0
3AB	ccs	241	23	4	3	3	0	2	2	0	1	7
	obs	17	0	0	1	0	0	0	0	0	0	0
	ign	2	1	0	0	0	0	0	0	0	0	0
	qit	0	0	0	0	0	0	0	0	0	0	0
	Total	260	24	4	4	3	0	2	2	0	1	7

Table A32: Summary of weight analysis for unit E

	Size Classes								
	Material	**1**	**2**	**3**	**4**	**5**	**6**	**6+**	**Total**
2C	ccs	100	110	19	2	0	0	0	231
	obs	5	2	0	0	0	0	0	7
	ign	1	1	1	0	0	0	0	3
	qit	0	0	0	0	0	0	0	0
	Total	106	113	20	2	0	0	0	241
3Ab	ccs	364	312	84	23	5	2	0	790
	obs	30	13	1	1	0	0	0	45
	ign	0	1	1	0	0	0	1	3
	qit	0	0	0	0	0	0	0	0
	Total	394	326	86	24	5	2	1	838

Table A33: Summary of size analysis for unit F

	Weight Classes											
	Mat.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
2C	ccs	190	14	9	4	1	2	4	1	1	1	4
	obs	7	0	0	0	0	0	0	0	0	0	0
	ign	1	1	0	0	0	0	1	0	0	0	0
	qit	0	0	0	0	0	0	0	0	0	0	0
	Total	198	15	9	4	1	2	5	1	1	1	4
3AB	ccs	602	62	29	20	17	5	10	4	4	4	33
	obs	41	2	0	0	0	0	0	0	1	0	1
	ign	0	0	0	0	0	0	0	0	1	0	2
	qit	0	0	0	0	0	0	0	0	0	0	0
	Total	643	64	29	20	17	5	10	4	6	4	36

Table A34: Summary of weight analysis for unit F

	Size Classes								
	Material	**1**	**2**	**3**	**4**	**5**	**6**	**6+**	**Total**
2C	ccs	176	66	9	3	0	3	0	257
	obs	9	1	0	0	0	0	0	10
	ign	0	0	0	0	0	0	0	0
	qit	0	0	0	0	0	0	0	0
	Total	185	67	9	3	0	3	0	267

Table A35: Summary of size analysis for unit G

	Weight Classes											
	Mat.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
2C	ccs	227	9	7	1	0	3	2	1	0	1	6
	obs	10	0	0	0	0	0	0	0	0	0	0
	ign	0	0	0	0	0	0	0	0	0	0	0
	qit	0	0	0	0	0	0	0	0	0	0	0
	Total	237	9	7	1	0	3	2	1	0	1	6

Table A36: Summary of weight analysis for unit G

	Size Classes								
	Material	**1**	**2**	**3**	**4**	**5**	**6**	**6+**	**Total**
2C	ccs	29	60	1	0	0	0	0	90
	obs	0	1	0	0	0	0	0	1
	ign	0	0	0	0	0	0	0	0
	qit	0	0	0	0	0	0	0	0
	Total	29	61	1	0	0	0	0	91
3AB	ccs	279	227	43	12	4	0	0	565
	obs	13	2	1	0	0	0	0	16
	ign	0	0	0	0	0	0	0	0
	qit	0	0	0	0	0	0	0	0
	Total	292	229	44	12	4	0	0	581

Table A37: Summary of size analysis for unit K

	Weight Classes											
	Mat.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
2C	ccs	67	13	4	4	1	0	0	0	0	1	0
	obs	1	0	0	0	0	0	0	0	0	0	0
	ign	0	0	0	0	0	0	0	0	0	0	0
	qit	0	0	0	0	0	0	0	0	0	0	0
	Total	68	13	4	4	1	0	0	0	0	1	0
3AB	ccs	444	39	29	9	3	3	6	2	2	5	23
	obs	15	0	0	0	0	0	0	1	0	0	0
	ign	0	0	0	0	0	0	0	0	0	0	0
	qit	0	0	0	0	0	0	0	0	0	0	0
	Total	459	39	29	9	3	3	6	3	2	5	23

Table A38: Summary of weight analysis for unit K

	Size Classes								
	Material	**1**	**2**	**3**	**4**	**5**	**6**	**6+**	Total
2C	ccs	26	61	2	1	0	0	0	90
	obs	2	1	0	0	0	0	0	3
	ign	0	2	1	0	0	0	0	3
	qit	0	0	0	0	0	0	0	0
	Total	28	64	3	1	0	0	0	96
3AB	ccs	240	228	58	16	8	0	0	550
	obs	24	6	2	0	0	0	0	32
	ign	0	1	1	0	0	0	0	2
	qit	0	0	0	0	0	0	0	0
	Total	264	235	61	16	8	0	0	584

Table A39: Summary of size analysis for unit L

	Weight Classes											
	Mat.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
2C	ccs	65	14	6	4	0	0	0	1	0	0	1
	obs	3	0	0	0	0	0	0	0	0	0	0
	ign	0	0	2	0	0	0	0	1	0	0	0
	qit	0	0	0	0	0	0	0	0	0	0	0
	Total	68	14	8	4	0	0	0	1	0	0	1
3AB	ccs	400	45	28	14	13	8	4	3	5	4	26
	obs	29	2	1	0	0	0	0	0	0	0	0
	ign	0	1	0	0	0	0	0	1	0	0	0
	qit	0	0	0	0	0	0	0	0	0	0	0
	Total	429	48	29	14	13	8	4	4	5	4	26

Table A40: Summary of weight analysis for unit L

Appendix B

Obsidian XRF Analysis Results

This appendix lists the X-ray fluorescence results for all pieces of obsidian debitage and tools for the 2002 and 2003 field seasons at 35-CU-67C. The following pages contain a table listing each specimen denoted by its catalogue number and corresponding obsidian source. The definitions for the headings of the table are listed below:

CAT_NUMBER: The specimen's catalogue number.

INSTRUCTIONS: The analysis conducted on the specimen (XRF or obsidian hydration).

UNIT: The test unit that the specimen was recovered from at 35-CU-67C.

DEPTH: The depth (centimeters below datum) that the specimen was recovered.

CHEM_SOURCE: The volcanic source that the specimen originates from.

ZN_PPM: Zinc measured in parts per million.

RB_PPM: Rubidium measured in parts per million.

SR_PPM: Strontium measured in parts per million.

Y_PPM: Yttrium measured in parts per million.

ZR_PPM: Zirconium measured in parts per million.

NB_PPM: Niobium measured in parts per million.

PB_PPM: Lead measured in parts per million.

CAT_NUMBER	INSTRUCTIONS	UNIT	DEPTH	CHEM_SOURCE	ZN_PPM	RB_PPM	SR_PPM	Y_PPM	ZR_PPM	NB_PPM	PB_PPM
35CU67C-99-A	XRF only	D	25	Spodue Mountain *	39	118	51	25	122	16	9
35CU67C-99-B	XRF only	D	25	Silver Lake/Sycan Marsh *	83	109	10	49	318	18	19
35CU67C-99-C	XRF only	D	25	Spodue Mountain *	47	113	47	23	128	14	17
35CU67C-102	XRF only	D	25-30	GF/LIW/RS *	36	151	75	30	184	9	30
35CU67C-106-A	XRF only	D	30-35	GF/LIW/RS *	61	152	78	31	184	8	22
35CU67C-106-B	XRF only	D	30-35	Grasshopper Group *	31	162	74	32	191	9	26
35CU67C-106-C	XRF only	D	30-35	Spodue Mountain *	76	123	54	29	118	17	24
35CU67C-106-D	XRF only	D	30-35	Spodue Mountain *	71	98	40	20	107	17	42
35CU67C-110-A	XRF only	D	35-39	GF/LIW/RS *	37	148	76	32	188	12	26
35CU67C-110-B	XRF only	D	35-39	Silver Lake/Sycan Marsh *	105	146	12	58	363	20	34
35CU67C-110-C	XRF only	D	35-39	Silver Lake/Sycan Marsh *	95	145	14	54	341	20	34
35CU67C-114	XRF only	D	39-44	Silver Lake/Sycan Marsh? *	145	119	13	46	275	6	41
35CU67C-118-A	XRF only	D	49-54	Spodue Mountain *	64	108	46	20	101	16	37
35CU67C-122-A	XRF only	D	54-59	Spodue Mountain *	82	106	41	16	96	10	27
35CU67C-122-B	XRF only	D	54-59	Spodue Mountain *	71	120	48	26	119	13	25
35CU67C-122-C	XRF only	D	54-59	Spodue Mountain *	77	136	49	28	129	12	6
35CU67C-314	XRF only	D	44-49	Spodue Mountain? *	43	97	49	17	94	10	33
35CU67C-128	XRF only	D	69-74	Spodue Mountain *	65	133	47	21	125	17	38
35CU67C-133-A	XRF only	E	30.0	Grasshopper Group *	34	163	84	30	190	12	26
35CU67C-133-B	XRF only	E	30.0	Spodue Mountain *	75	118	46	22	114	14	26
35CU67C-140-A	XRF only	E	36-41	Silver Lake/Sycan Marsh *	75	123	13	49	317	17	18
35CU67C-140-B	XRF only	E	36-41	Spodue Mountain *	57	114	48	20	118	11	15
35CU67C-140-C	XRF only	E	36-41	Silver Lake/Sycan Marsh *	86	135	12	50	331	19	29
35CU67C-140-E	XRF only	E	36-41	Spodue Mountain *	54	110	43	21	109	16	28
35CU67C-140-F	XRF only	E	36-41	Silver Lake/Sycan Marsh *	128	128	15	44	306	13	33
35CU67C-140-G	XRF only	E	36-41	GF/LIW/RS *	61	152	67	26	167	7	28
35CU67C-140-H	XRF only	E	36-41	Spodue Mountain *	47	104	46	19	99	6	19
35CU67C-140-J	XRF only	E	36-41	Spodue Mountain? *	45	95	39	22	96	13	6
35CU67C-144-A	XRF only	E	41-46	Spodue Mountain *	67	130	52	23	121	13	26
35CU67C-144-B	XRF only	E	41-46	Spodue Mountain *	58	121	52	18	113	15	20
35CU67C-147-A	XRF only	E	46-51	GF/LIW/RS *	40	167	71	29	183	9	24
35CU67C-147-B	XRF only	E	46-51	Spodue Mountain *	50	102	37	19	109	16	18

CAT_NUMBER	INSTRUCTIONS	UNIT	DEPTH	CHEM_SOURCE	ZN_PPM	RB_PPM	SR_PPM	Y_PPM	ZR_PPM	NB_PPM	PB_PPM
35CU67C-147-C	XRF only	E	46-51	Spodue Mountain *	67	111	50	14	102	15	31
35CU67C-150	XRF only	E	51-56	Spodue Mountain *	47	119	42	20	107	9	16
35CU67C-159	XRF only	E	66-71	Spodue Mountain? *	52	83	38	24	106	11	27
35CU67C-167-A	XRF+ OH	F	6.0	GF/LIW/RS *	30	166	78	28	188	10	29
35CU67C-167-B	XRF+ OH	F	6.0	Spodue Mountain *	70	129	52	20	139	5	22
35CU67C-167-C	XRF+ OH	F	6.0	GF/LIW/RS *	29	147	65	27	167	14	17
35CU67C-167-D	XRF+ OH	F	6.0	Spodue Mountain *	67	127	52	21	118	14	29
35CU67C-167-E	XRF only	F	6.0	Spodue Mountain? *	63	91	38	11	91	8	37
35CU67C-167-F	XRF+ OH	F	6.0	Spodue Mountain *	61	112	44	21	112	16	18
35CU67C-167-G	XRF+ OH	F	6.0	Spodue Mountain *	78	135	56	23	119	16	17
35CU67C-170-C	XRF+ OH	F	6-11	Grasshopper Group *	28	147	74	22	193	11	25
35CU67C-170-D	XRF only	F	6-11	Spodue Mountain? *	19	85	41	16	88	12	24
35CU67C-171	XRF+ OH	F	11-16	Spodue Mountain *	45	107	47	23	117	12	22
35CU67C-174-A	XRF+ OH	F	16-21	Spodue Mountain *	22	115	47	22	121	14	22
35CU67C-174-B	XRF+ OH	F	16-21	Silver Lake/Sycan Marsh *	137	135	11	48	319	11	21
35CU67C-174-C	XRF+ OH	F	16-21	Spodue Mountain *	60	131	56	22	120	14	24
35CU67C-177-A	XRF+ OH	F	21-27	Spodue Mountain *	11	101	41	20	103	10	18
35CU67C-177-C	XRF only	F	21-27	Spodue Mountain? *	60	98	38	16	94	5	19
35CU67C-177-D	XRF only	F	21-27	Silver Lake/Sycan Marsh? *	111	122	15	41	278	20	24
35CU67C-180-A	XRF+ OH	F	27-31	Silver Lake/Sycan Marsh *	85	123	10	54	339	17	27
35CU67C-180-B	XRF+ OH	F	27-31	Spodue Mountain *	48	129	52	25	123	18	24
35CU67C-180-C	XRF+ OH	F	27-31	Spodue Mountain *	101	114	42	16	110	12	25
35CU67C-180-D	XRF only	F	27-31	Silver Lake/Sycan Marsh *	137	135	13	50	302	15	35
35CU67C-185-A	XRF+ OH	F	31-36	GF/LIW/RS *	18	135	67	26	173	7	16
35CU67C-185-B	XRF+ OH	F	31-36	Silver Lake/Sycan Marsh *	102	142	12	55	352	17	24
35CU67C-187	XRF+ OH	F	36-42	Spodue Mountain *	50	115	48	21	123	10	24
35CU67C-192-A	XRF+ OH	F	42-47	GF/LIW/RS *	60	163	79	29	187	9	25
35CU67C-195-A	XRF+ OH	F	47-52	Spodue Mountain *	57	121	52	25	129	15	24
35CU67C-195-B	XRF+ OH	F	47-52	Silver Lake/Sycan Marsh *	91	136	13	49	340	15	21
35CU67C-195-C	XRF+ OH	F	47-52	Spodue Mountain *	51	120	49	24	121	17	23
35CU67C-198-A	XRF+ OH	F	52-57	GF/LIW/RS *	52	157	77	29	165	13	30
35CU67C-198-B	XRF+ OH	F	52-57	Spodue Mountain *	56	107	48	20	103	9	24

CAT_NUMBER	INSTRUCTIONS	UNIT	DEPTH	CHEM_SOURCE	ZN_PPM	RB_PPM	SR_PPM	Y_PPM	ZR_PPM	NB_PPM	PB_PPM
35CU67C-198-C	XRF+ OH	F	52-57	Spodue Mountain *	59	112	48	21	118	6	17
35CU67C-198-D	XRF+ OH	F	52-57	Spodue Mountain *	52	119	47	26	117	13	22
35CU67C-200	XRF+ OH	F	57-62	Spodue Mountain *	50	97	46	23	121	13	16
35CU67C-206-A	XRF+ OH	F	62-67	GF/LIW/RS *	64	176	80	27	183	10	23
35CU67C-206-B	XRF+ OH	F	62-67	Spodue Mountain *	56	131	53	23	127	16	17
35CU67C-206-C	XRF+ OH	F	62-67	GF/LIW/RS *	42	172	75	27	181	15	24
35CU67C-206-D	XRF+ OH	F	62-67	GF/LIW/RS *	47	158	73	29	169	4	35
35CU67C-206-F	XRF+ OH	F	62-67	Spodue Mountain *	64	123	53	24	116	13	26
35CU67C-206-G	XRF+ OH	F	62-67	Silver Lake/Sycan Marsh *	109	151	13	51	326	17	29
35CU67C-206-H	XRF+ OH	F	62-67	GF/LIW/RS *	40	147	68	25	166	6	31
35CU67C-209-A	XRF+ OH	F	67-73	Spodue Mountain *	57	111	47	22	122	17	20
35CU67C-209-B	XRF only	F	67-73	Spodue Mountain? *	36	119	52	14	125	8	27
35CU67C-211-A	XRF+ OH	F	73-78	Spodue Mountain *	68	134	54	24	140	16	25
35CU67C-211-B	XRF+ OH	F	73-78	Spodue Mountain *	54	119	47	23	112	16	8
35CU67C-211-C	XRF only	F	73-78	Silver Lake/Sycan Marsh? *	62	103	10	41	261	14	13
35CU67C-320	XRF+ OH	F	83-88	Spodue Mountain *	45	110	46	22	112	15	20
35CU67C-221-A	XRF only	G	38	GF/LIW/RS *	50	155	77	27	187	13	27
35CU67C-221-B	XRF only	G	38	GF/LIW/RS *	43	172	78	30	182	10	26
35CU67C-221-C	XRF only	G	38	GF/LIW/RS *	50	156	64	29	167	11	24
35CU67C-221-D	XRF only	G	38	GF/LIW/RS *	58	148	70	29	164	11	18
35CU67C-221-E	XRF only	G	38	Spodue Mountain *	40	97	41	23	103	14	12
35CU67C-228-A	XRF only	G	38-58	Spodue Mountain *	66	135	53	23	128	15	19
35CU67C-228-B	XRF only	G	38-58	Spodue Mountain *	ND	137	54	23	116	18	19
35CU67C-228-C	XRF only	G	38-58	GF/LIW/RS *	48	161	71	21	167	10	27
35CU67C-228-D	XRF only	G	38-58	Spodue Mountain *	62	109	46	21	116	19	25
35CU67C-228-E	XRF only	G	38-58	Silver Lake/Sycan Marsh *	95	133	9	50	327	15	28
35CU67C-235	XRF only	H	20-30	Spodue Mountain *	45	107	43	24	120	17	17
35CU67C-238	XRF only	H	40-50	Spodue Mountain *	45	116	49	22	121	13	15
35CU67C-250	XRF only	K	7	Spodue Mountain *	39	119	47	21	123	17	22
35CU67C-252-A	XRF only	K	7-12	Spodue Mountain *	54	118	45	22	118	18	16
35CU67C-252-B	XRF only	K	7-12	Spodue Mountain? *	56	84	34	14	89	10	9
35CU67C-252-C	XRF only	K	7-12	Spodue Mountain *	59	113	42	23	112	14	18

CAT_NUMBER	INSTRUCTIONS	UNIT	DEPTH	CHEM_SOURCE	ZN_PPM	RB_PPM	SR_PPM	Y_PPM	ZR_PPM	NB_PPM	PB_PPM
35CU67C-252-D	XRF only	K	7-12	GF/LIW/RS *	83	173	80	30	178	8	33
35CU67C-260-A	XRF only	K	17-22	Spodue Mountain *	35	105	45	24	125	16	15
35CU67C-260-B	XRF only	K	17-22	GF/LIW/RS *	46	158	71	27	183	13	32
35CU67C-260-C	XRF only	K	17-22	Spodue Mountain *	51	115	55	23	114	12	16
35CU67C-260-D	XRF only	K	17-22	Spodue Mountain *	74	115	49	19	113	15	23
35CU67C-260-E	XRF only	K	17-22	Spodue Mountain *	42	115	45	23	110	14	18
35CU67C-260-F	XRF only	K	17-22	Spodue Mountain *	76	122	50	19	102	12	20
35CU67C-264-A	XRF only	K	22-27	Spodue Mountain? *	38	111	51	16	121	5	26
35CU67C-264-B	XRF only	K	22-27	Spodue Mountain *	49	130	52	20	118	14	27
35CU67C-323	XRF only	K	27-32	Silver Lake/Sycan Marsh *	117	128	12	55	324	17	37
35CU67C-272-A	XRF only	K	37-43	GF/LIW/RS *	46	138	74	25	180	5	27
35CU67C-272-B	XRF only	K	37-43	Spodue Mountain? *	28	116	48	23	134	ND	9
35CU67C-272-C	XRF only	K	37-43	GF/LIW/RS *	39	132	57	26	160	11	19
35CU67C-276-A	XRF only	L	8	Spodue Mountain *	22	97	42	22	127	15	13
35CU67C-276-B	XRF only	L	8	East Medicine Lake *	12	143	67	31	219	9	32
35CU67C-276-C	XRF only	L	8	Silver Lake/Sycan Marsh? *	70	113	11	33	289	13	26
35CU67C-280-A	XRF only	L	8-13	Spodue Mountain *	50	111	50	23	122	16	18
35CU67C-280-B	XRF only	L	8-13	Spodue Mountain *	50	102	47	15	99	11	10
35CU67C-282-B	XRF only	L	13-18	Spodue Mountain *	46	122	52	24	122	16	21
35CU67C-282-C	XRF only	L	13-18	Spodue Mountain *	43	105	39	17	97	10	25
35CU67C-282-D	XRF only	L	13-18	GF/LIW/RS *	43	161	73	28	188	11	26
35CU67C-282-E	XRF only	L	13-18	Spodue Mountain? *	70	83	32	20	102	8	13
35CU67C-282-F	XRF only	L	13-18	GF/LIW/RS? *	100	130	61	24	154	7	24
35CU67C-284-A	XRF only	L	18-23	Spodue Mountain *	64	124	49	25	125	14	18
35CU67C-284-B	XRF only	L	18-23	Spodue Mountain *	37	121	50	24	122	15	20
35CU67C-284-C	XRF only	L	18-23	Spodue Mountain *	40	118	47	25	125	13	19
35CU67C-284-D	XRF only	L	18-23	Spodue Mountain *	64	107	49	20	102	10	24
35CU67C-284-E	XRF only	L	18-23	Spodue Mountain *	82	107	48	18	99	12	21
35CU67C-287-A	XRF only	L	23-28	Spodue Mountain? *	44	95	42	19	93	13	20
35CU67C-287-B	XRF only	L	23-28	Spodue Mountain *	59	102	40	18	101	11	20
35CU67C-287-C	XRF only	L	23-28	GF/LIW/RS *	33	140	67	22	163	8	27
35CU67C-292	XRF only	L	28-33	Spodue Mountain *	67	111	44	19	104	15	16

CAT_NUMBER	INSTRUCTIONS	UNIT	DEPTH	CHEM_SOURCE	ZN_PPM	RB_PPM	SR_PPM	Y_PPM	ZR_PPM	NB_PPM	PB_PPM
35CU67C-295-A	XRF only	L	33-38	Silver Lake/Sycan Marsh *	109	139	14	55	351	20	23
35CU67C-295-B	XRF only	L	33-38	Spodue Mountain *	44	111	48	22	116	15	24
35CU67C-295-C	XRF only	L	33-38	Spodue Mountain *	69	124	49	22	118	15	25
35CU67C-295-D	XRF only	L	33-38	GF/LIW/RS *	34	162	76	24	177	11	29
35CU67C-295-E	XRF only	L	33-38	Silver Lake/Sycan Marsh? *	111	124	13	43	278	13	31
35CU67C-295-F	XRF only	L	33-38	Spodue Mountain? *	14	89	42	19	96	12	13
35CU67C-299-A	XRF only	L	38-43	Spodue Mountain *	66	114	50	23	119	17	19
35CU67C-299-B	XRF only	L	38-43	Spodue Mountain *	43	109	49	24	109	13	11
35CU67C-299-C	XRF only	L	38-43	Spodue Mountain *	52	123	46	23	113	13	29
35CU67C-302-A	XRF only	L	43-48	Spodue Mountain *	40	117	43	20	121	17	26
35CU67C-302-B	XRF only	L	43-48	Spodue Mountain *	43	135	52	22	123	11	24
35CU67C-302-C	XRF only	L	43-48	Spodue Mountain *	75	115	46	23	117	14	15
35CU67C-305-A	XRF only	L	48-53	Spodue Mountain *	44	114	48	25	117	15	20
35CU67C-305-B	XRF only	L	48-53	Spodue Mountain *	79	99	44	19	106	13	12
35CU67C-191	XRF only	F	42-47	GF/LIW/RS *	36	146	71	29	186	10	25
35CU67C-270	XRF only	K	37-43	GF/LIW/RS *	36	146	71	30	186	9	28
35CU67C-194	XRF only	F	47-52	Spodue Mountain *	46	119	49	26	123	15	24
RGM-1	RGM-1	--	--	RGM1 ReferenceStandard	46	152	106	26	220	8	20