PALEOINDIAN TECHNOLOGICAL PROVISIONING

IN THE WESTERN GREAT BASIN

by

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ABSTRACT

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North American archaeologists researching Paleoindian adaptations have suggested that Paleoindians, represented by Clovis, Folsom, and Plano traditions, were highly mobile foragers. By contrast, "Paleoarchaic" hunter-gatherers of the Great Basin are thought to have become increasingly sedentary through time, specially adapted and tethered to diverse lacustrine/marsh resources.

My research project aims to understand human adaptation during the early Holocene through characterization of the lithic assemblages from two stemmed point sites in the western Nevada, the Sadmat and Coleman sites. These sites are located in the Lahontan basin and possess data sets unique and compelling in addressing research objectives proposed in this study.

Further, this thesis examines the technological organization and provisioning strategies represented at these sites in order to address the relative degrees of mobility of early Holocene peoples in the western Great Basin.

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CHAPTER 1

INTRODUCTION

Current Paleoindian research in the Great Basin is centered on several key issues. Very few buried, open-air sites have been found and dated, leading to significant gaps in the chronologies of the Great Basin's first inhabitants. We still have little hard evidence to support a pre-11,000 B.P. Clovis occupation of the region, and it remains unclear how fluted point technologies relate temporally to stemmed point industries. A lack of solid chronological control also makes it difficult to relate archaeological sites to climatic and environmental changes across the Pleistocene-Holocene boundary, and the general absence of preserved and clearly associated faunal and floral remains severely inhibits attempts to reconstruct foraging and subsistence activities. For these reasons what we can learn about Paleoindian adaptations is limited largely to the lithic artifact record (Beck and Jones 1997; Jones and Beck 1999). Nonetheless, analyses of large lithic assemblages from Paleoindian surface sites can offer many possibilities for understanding hunter-gatherer technological organization and how it relates to human ecology and land use.

The current study reviews the lithic evidence from two major surface sites from the western Great Basin of Nevada in order to reconstruct human adaptation and behavior during the transition from the late Pleistocene to early Holocene (Figure 1.1). The Sadmat and Coleman sites have stemmed points and are thought to date to between 11,000 and 8,000 radiocarbon years before present (B.P.) (Bedwell 1973; Carlson 1983; Dansie 1981; Elston 1982, 1986; Irwin-Williams et al. 1990; Ranere 1970; Rhode et al. 2000; Tuohy 1968, 1969, 1970, 1974, 1988a, 1988b; Warren and Ranere 1968). Both sites are located in sub-basins of Pleistocene Lake Lahontan in the western Great Basin. My analysis of the lithic assemblages from these sites specifically considers variables directly related to provisioning strategies utilized by early Holocene hunter-gatherers procuring resources. Characterization of hunter-gatherer planning and technological provisioning at these stemmed point

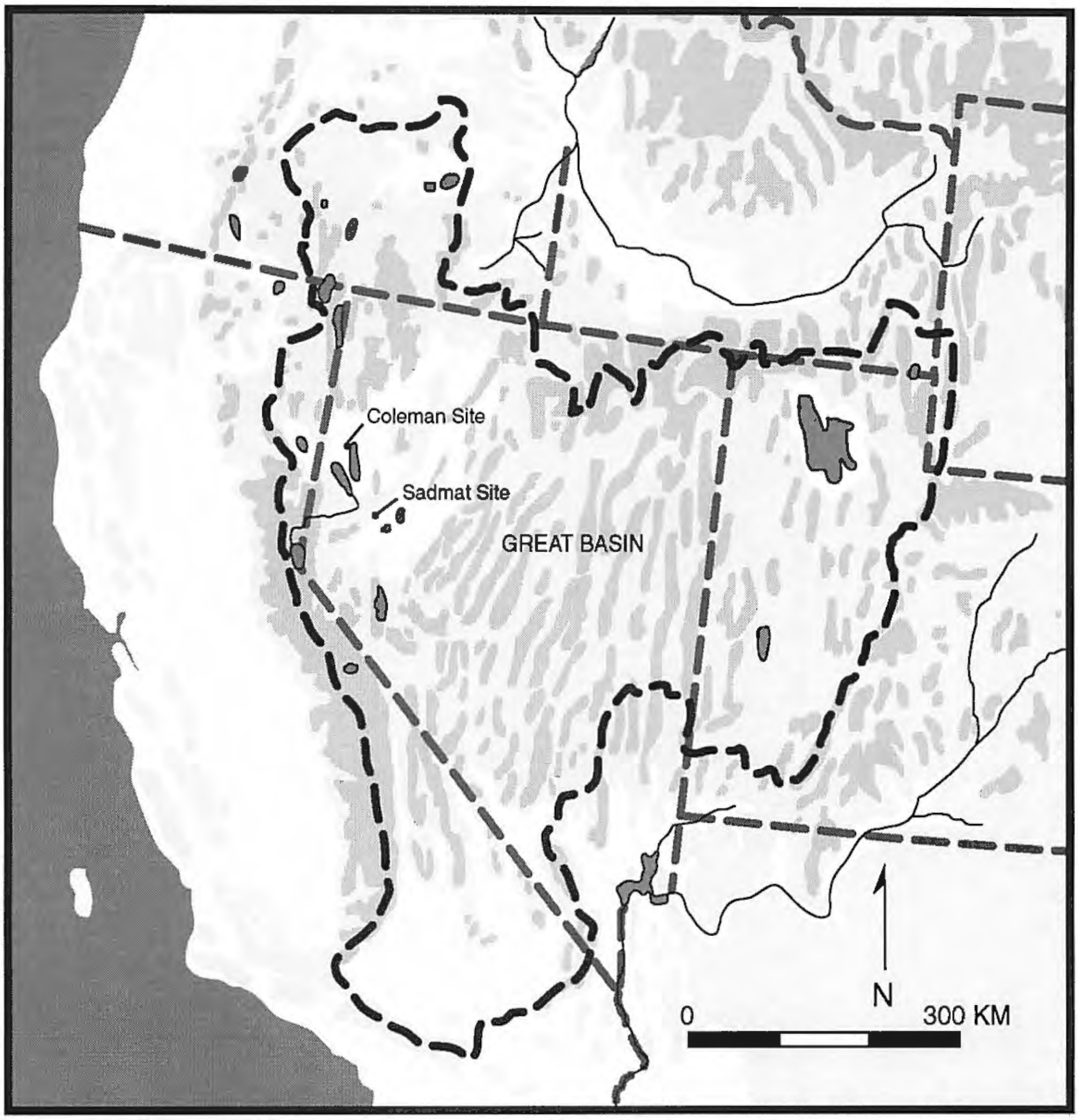


Figure 1.1. Map of the Great Basin with locations of the Sadmat and Coleman sites.

sites can provide answers to questions related to early Holocene settlement behaviors and land use patterns. Given the general lack of associated floral and faunal remains at these sites, the lithic record is virtually the only line of evidence remaining that can provide clues about prehistoric settlement.

The remainder of this chapter presents a review of previous Paleoindian archaeological research relating to current theories of Paleoindian hunter-gatherer adaptation in the Great Basin, as well as the theoretical perspective and research goals of this study. Chapter 2 provides detailed descriptions of the Sadmat and Coleman sites and associated assemblages, along with a review of past research of these sites and their significance in the development of Great Basin Paleoindian research. Chapter 3 presents the variables studied and methods used in the lithic analysis. Chapter 4 gives the results of the descriptive analyses of the assemblages, including cores, debitage, and tools. Chapter 5 presents the results of integrative statistical analyses related to specific research questions regarding provisioning strategies and mobility. Chapter 6 is a discussion of the findings and the conclusions of this study.

Background

The Great Basin Paleoindian record is riddled with chronological and contextual problems due primarily to the surficial nature of these sites. One of the major complications is separating fluted point technological and chronological contexts from those of stemmed points. Often in the surface record these sites are found together with no clear stratigraphic separation (Beck and Jones 1997; Jones and Beck 1999), leading some researchers to suggest that they are associated and linked culturally (Bedwell 1973; Bryan 1979, 1980, 1988). Others, however, have noted that when these two types of projectile points are found at the same sites, they tend to be spatially and temporally separated and thus may represent successive occupations and different time periods (Fagan 1988; Willig 1988, 1989, 1991). Thus, in order to reliably reconstruct similarities and differences between land use patterns of fluted and stemmed point complexes, sites containing only fluted or stemmed points should be analyzed. Such studies can lead to an increased knowledge of the relationships between the two point forms and their associated technologies. Great Basin stemmed point sites are recognized by the presence of large stemmed bifacial points and an associated bifacial and unifacial toolkit that is similar to Paleoindian toolkits from the Great Plains region of North America (Bryan 1980; Carlson 1983; Frison and Bradley 1980; Frison and Stanford 1982; Frison and Todd 1987; Irwin and Wormington 1970; Kelly and Todd 1988). Specifically, these toolkits are dominated by unhafted bifaces, including crescents, leaf-shaped bifaces, ovate bifaces, and discoid bifaces and unifaces, including side scrapers, end scrapers, gravers, combination tools, and retouched flakes.

Although most stemmed point sites are in surface contexts, there are a few cave and buried open-air sites in the Great Basin that appear to have been reliably dated to the late Pleistocene-early Holocene (Figure 1.2). Five of these sites are located in the Lahontan basin. Four of these, Crypt

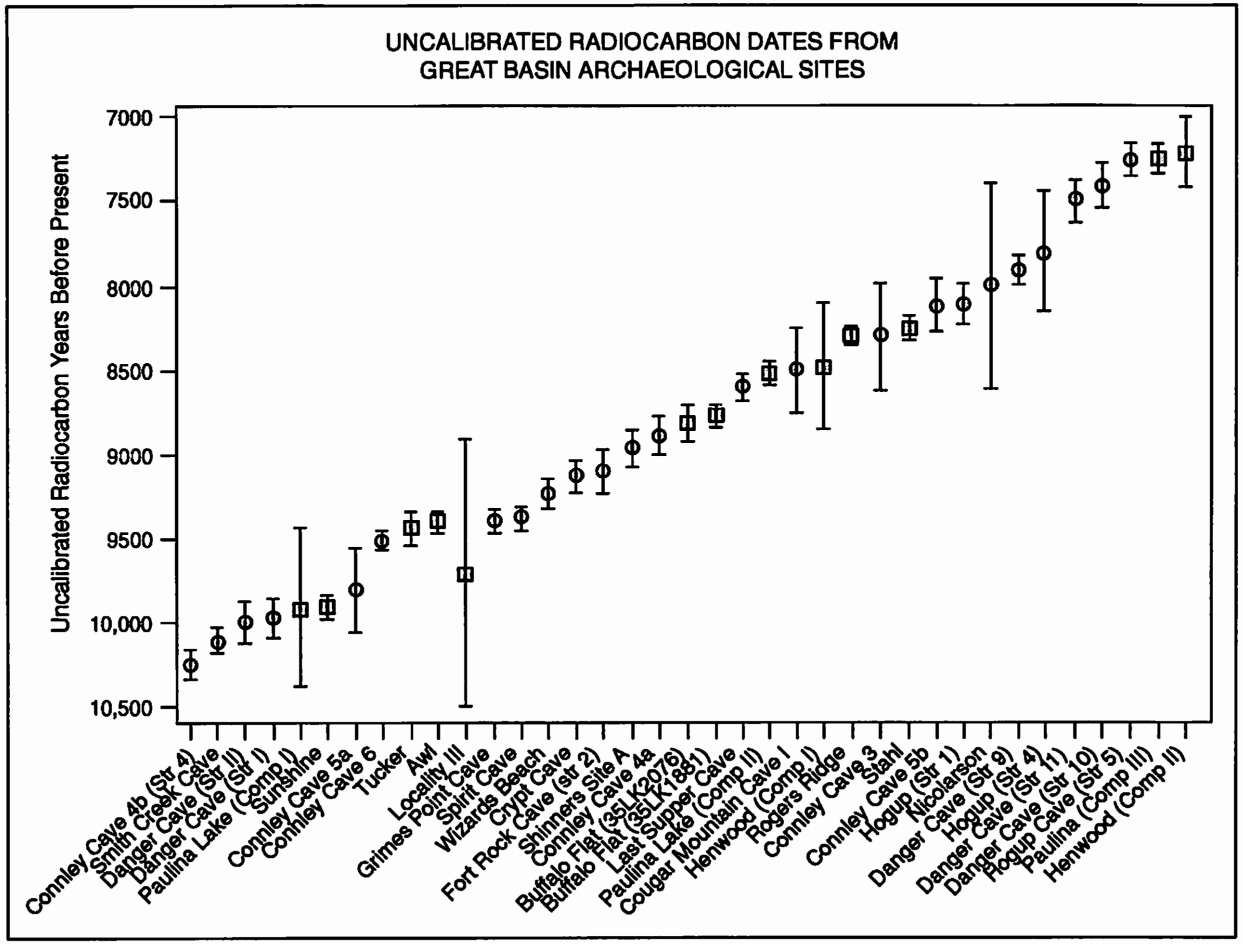


Figure 1.2. Uncalibrated radiocarbon dates (with 1 standard error) from late Pleistocene/early Holocene archaeological sites in the Great Basin. Circles represent cave sites while squares represent open-air sites (Beck and Jones 1997; Bedwell 1973; Bedwell and Cressman 1971; Bryan 1979; Connolly and Jenkins 1999; Douglas et al. 1988; Hattori 1982; Jenkins 1987; Jennings 1957; Jones et al. 1996; Layton 1979; Madsen and Rhode 1990; Mehringer and Cannon 1994; Oetting 1994; Rozaire 1969; Scroth 1994; Tuohy and Dansie 1997).

Cave, Spirit Cave, Grimes Point, and Wizards Beach (Tuohy and Dansie 1997), consist of early Holocene features; however, these do not possess stemmed points. The other site, Shinners Site A, contains a single stemmed point located stratigraphically between two textiles dating to approximately 9450 B.P. and 8380 B.P. (Hattori 1982; Rozaire 1969). Thus, most of the dated sites are primarily located in Oregon and eastern California. Further, few of these dated sites, have extensive lithic assemblages, because of the diffuse nature of artifact concentrations that characterize early Holocene sites of the Great Basin.

Recent Paleoindian research has focused increasingly on hunter-gatherer adaptations, especially in the realms of technological organization, subsistence, foraging, and settlement behavior (Amick 1994; Beck and Jones 1990; Dincauze 1993; Frison 1988, 1999; Goodyear 1989; Haynes 1982; Kelly 1996; Kelly and Todd 1988; Meltzer 1993, 1995; Stanford 1999). Great Basin researchers have also turned their attention to such research questions, going beyond descriptive cultural history to investigate and model Paleoindian adaptation (Amick 1999; Basgall 1988; Beck and Jones 1990, 1992, 1997; Elston 1994; Jones and Beck 1999; Moore 1999; Pinson 1999; Willig 1988, 1989, 1991; Willig and Aikens 1988). Much of the archaeological research concerning human activity and behavior during the late Pleistocene/early Holocene transition in the Great Basin has centered on interpretations founded on cultural ecology. Many researchers have emphasized the distribution of Paleoindian sites in proximity to hypothesized pluvial lakes and associated marshlands, suggesting that early hunter-gatherers were tethered to these wetland patches (Beck and Jones 1997; Jones and Beck 1999; Moore 1999; Pinson 1999; Price and Johnston 1988; Willig 1988, 1989, 1991; Willig and Aikens 1988). These reconstructions are largely based on associations of sites with pluvial lake landforms, while associated floral or faunal evidence and, in some cases, lithic technological evidence are not considered. Such interpretations are too deterministic (Kelly 2001), artificially reducing the range of Paleoindian behavioral choices to a select few. Minimal effort has been put into building explanations that integrate technological organization and toolstone procurement and selection to land use patterns and foraging systems. Such studies are necessary in order to know more precisely how Great Basin hunter-gatherers during the late Pleistocene and early Holocene adapted to various situations.

Typically, Paleoindians in North America, including Clovis, Folsom, and Plano complexes, have been considered to be highly mobile foragers (Dincauze 1993; Goodyear 1989; Haynes 1982; Kelly 1996; Kelly and Todd 1988). These interpretations have been based on the technological organization, levels of curation, raw material source information, and associations with large migratory fauna represented in these types of sites (Goodyear 1989; Kelly 1996; Kelly and Todd 1988). In the Great Basin, however, such evidence for mobility has not been so forthcoming. Traditionally, two competing theories explaining Paleoindian adaptations are espoused. These are referred to here as the 1) Tethered Wetland Adaptation and 2) Mobile Forager Adaptation.

Tethered Wetland Adaptation

Paleoindian research in the Great Basin has long been influenced by the notion that late Pleistocene/ early Holocene hunter-gatherers lived around pluvial lake margins and/or marshes, relying on "productive" wetland patches and exploiting a wide range of resources (Beck and Jones 1988, 1997; Bedwell 1973; Bedwell and Cressman 1971; Clewlow 1968; Grayson 1993; Hester 1973; Hutchinson 1988; Madsen 1982, 1988; Moore 1999; Pinson 1999, Price and Johnston 1988; Rozaire 1963; Simms 1988; Warren 1967; Warren and Ranere 1968; Watters 1979; Willig 1988, 1989, 1991; Willig and Aikens 1988). This notion of a wetland-exploiting, broad-spectrum hunter-gatherer was made famous by Stephen Bedwell in the early 1970's, when he referred to this phenomenon as the Western Pluvial Lakes Tradition (WPLT) (Bedwell 1973; Bedwell and Cressman 1971; Hester 1973). Bedwell's (1973) conception of a WPLT implied that pluvial lakes and marshes were ubiquitous in the Great Basin throughout the terminal Pleistocene and early Holocene until approximately 8,000 B.P. Humans inhabiting this mesic ecosystem adapted by becoming increasingly sedentary.

Recently, however, many paleoecological studies have shown that during the late Pleistocene and early Holocene climatic conditions were not so stable and pluvial lakes were not always present (Davis 1982b; Haynes 1991, 1993; Madsen 1999; Nials 1999; Rhode et al. 2000; Spaulding 1985). This has led many archaeologists to suggest that environmental changes during this time localized the distributions of wetland resources and made many food resources unpredictable in time and space (Willig 1988, 1989, 1991). If this was the case, they argue, early hunter-gatherers likely adopted a broad-spectrum adaptive strategy characterized by decreasing residential mobility (or "settling in") and focusing on mesic patches that contained a diversity of ecotones and resources close at hand (Beck and Jones 1997; Jones and Beck 1999; Moore 1999; Pinson 1999; Simms 1988; Watters 1979; Willig 1988, 1989, 1991; Willig and Aikens 1988). Willig (1991) has suggested that regular shifts in the productivity of such patches would have made the overall-hunter-gatherer adaptation very flexible and generalized. This proposed broad-spectrum livelihood led Willig (1988, 1989, 1991) to refer to these people and their signature on the landscape as "Paleo-Archaic," not quite Paleoindian, not completely Archaic, but leaning toward the latter (Willig 1988, 1989; Willig and Aikens 1988). This generalized Paleo-Archaic adaptive strategy finds continued support among archaeologists today, although sometimes in modified forms (Beck and Jones 1997; Jones and Beck 1999; Pinson 1999). Beck and Jones (1990, 1997; Jones and Beck 1999) suggest, on the basis of toolstone sourcing data, that hunter-gatherers moved great distances between these wetland patches. This hypothesis implies a highly mobile adaptation; however, one that is tethered to and reliant on wetland resources. Pinson (1999) suggests based on faunal data that early hunter-gatherers did not focus on large artiodactyls, but instead on other small mammalian resources, such as lagomorphs, found in mesic environments.

Mobile Forager

The opposing theory that finds continued support among some Great Basin archaeologists centers on a mobile forager adaptation (Ames 1988; Amick 1995, 1997; Elston 1982, 1986; Hartwell and Amick 1993; Jones and Beck 1999; Ranere 1970; Tuohy 1968, 1974; Warren and Ranere 1968). This theory characterizes humans as specialized hunter-gatherers who practiced a narrow-based resource procurement strategy, focusing on terrestrial game and occasionally on wetland resources when they were available (Basgall 1988, 1989; Butler 1973; Carlson 1983, 1988; Davis 1970; Hanes 1988; Heizer and Baumhoff 1970; Ranere 1970; Tuohy 1968, 1974; Warren and Ranere 1968; Watters 1979; Wormington 1957). The hypothesis predicts that specialized foragers would have been highly mobile, moving residences rather frequently between widely scattered patches. These patches may have been migrating herds of big game (Basgall 1988, 1989; Dansie 1987; Davis 1970; Hanes 1988) or stationary patches of wetland resources (Beck and Jones 1997; Elston 1982, 1986, 1994; Jones and Beck 1999).

Planning and Technological Provisioning Strategies

Lithics are abundant in the early record of the Great Basin and therefore are important in our understanding of early human adaptive strategies. Analyses of lithic assemblages in the Great Basin can assist in reconstructing whether late Pleistocene/early Holocene hunter-gatherers were semi-sedentary, utilizing a logistical land use pattern, or residentially mobile, moving camps frequently (Ames 1988; Basgall 1988). Central to understanding the relationship between technological organization strategies and land use patterns is availability of tool-making material, means of supply or provisioning, and design of tools (Kuhn 1989, 1991, 1992, 1993, 1994, 1995). Such technological strategies are directly tied to how humans make a living. Thus, understanding the design, resharpening, reuse, and discard trajectory of stone tools can increase our knowledge of late Pleistocene/early Holocene foraging and land use. The actual hands-on time expended to manufacture stone tools may not have been as important to hunter-gatherers as the procurement of raw material, which could potentially involve an excessive expenditure of time and energy. To some extent, hunter-gatherers would have had to have planned for future exigencies by thus provisioning or supplying themselves with essential raw materials and stone tools utilized in acquiring and processing food, thus ensuring these lithic resources were always at their disposal. Technological provisioning, as suggested by Kuhn (1991, 1992, 1993, 1994, 1995) can come in two basic forms or strategies, 1) provisioning places, and 2) provisioning individuals.

Provisioning Places

A relatively sedentary group (i.e., a group that consistently resides in one place or repeatedly revisits that place for relatively long periods of time) can afford to make sure that the place of occupation (base/home camp) is supplied or provisioned with local raw material from either directly on site or from nearby sources. These people provision or supply their home base with the necessary materials for making tools through local logistical forays. The provisioning of a place, then, is anticipated in the context of relatively sedentary, logistically organized, hunter-gatherers whose technological organization is expedient (Kuhn 1991, 1992, 1993, 1994, 1995).

Thus, the provisioning of places, as seen in the archaeological record, is expected for less mobile, logistally organized, groups. Expectations for this behavior include procurement mainly of local raw materials, a high proportion of partially reduced raw material packages, expediently produced informal tools such as utilized and retouched flakes and blades, along with an abundance of unmodified debitage. Expediency in toolstone procurement and tool manufacture is thus expected from a semi-sedentary group of hunter-gatherers, especially at base camps (Binford 1977, 1978a, 1978b, 1979, 1980; Kelly 1983, 1985, 1988a, 1988b, 1990, 1995, 1999, 2001; Kuhn 1991, 1992, 1993, 1994, 1995; Odell 1996; Parry and Kelly 1987).

Provisioning Individuals

Foraging groups practicing a residentially mobile settlement system need to make sure that individuals within the group are supplied with ready-to-use tools and light-weight cores. This kind of toolkit is essential for people on the move, not spending much time in any one place. In situations where hunter-gatherers provision individuals, an optimum use of artifacts per weight unit is ideal. The cost of carrying artifacts is of utmost concern for mobile foragers that are provisioning individuals.

Archaeologically, mobile groups are expected to show evidence of provisioning individuals. Therefore, the lithic artifact assemblage should be formalized. Raw material selection should represent the procurement of both exotic and local raw materials. Raw material choice should often reflect an anticipated need, and raw material packages should be used to the maximum extent. Little debitage should be present in sites, and formal tools (made in advance of use and intensively curated) should outnumber informal tools (expediently manufactured and not curated) (Binford 1977, 1978a, 1978b, 1979, 1980; Kelly 1983, 1985, 1988a, 1988b, 1990, 1995, 1999, 2001; Kuhn 1991, 1992, 1993, 1994, 1995; Odell 1996; Parry and Kelly 1987).

Research Goals

In order to characterize the provisioning strategies at the Sadmat and Coleman sites and relate these strategies to degrees of mobility, this study has focused on a series of research questions. These include:

- How can the lithic assemblages at Sadmat and Coleman be characterized? What are the overall technologies and what do the toolkits consist of?
- What technological activities are represented at these sites?
- How were lithic raw materials procured?
- How curated are the tool assemblages? Are toolkits formalized or expedient?
- How mobile were these hunter-gatherers?

By answering these questions, we can achieve the ultimate objective of this thesis, characterization of the settlement systems and adaptations of late Pleistocene/early Holocene hunter-gatherers in the western Great Basin.

CHAPTER 2

MATERIALS: SADMAT AND COLEMAN SITES

The data set used in this investigation includes the chipped stone assemblages from two Great Basin stemmed point localities, the Sadmat and Coleman sites, located in the Lahontan Basin (Figure 2.1) (Bedwell 1973; Carlson 1983; Dansie 1981; Elston 1982, 1986; Irwin-Williams et al. 1990; Ranere 1970; Rhode et al. 2000; Tuohy 1968, 1969, 1970, 1974, 1981, 1988a, 1988b; Tuohy and Layton 1977; Warren and Ranere 1968). Both sites are large open-air lithic scatters situated on low, presumed late Pleistocene/early Holocene lake margin features of pluvial Lake Lahontan. These sites are characterized by stemmed and lanceolate bifaces and associated biface debitage coupled with the presence of unifaces common in Paleoindian assemblages in North America (Bryan 1980; Carlson 1983; Frison 1982, 1996; Frison and Bradley 1980; Frison and Stanford 1982; Frison and Todd 1986, 1987; Goodyear 1989; Irwin and Wormington 1970; Kelly and Todd 1988). Based on their physiographic location and stone tool composition, the Sadmat and Coleman sites are associated with the late Paleoindian tradition of the Great Basin (Bedwell 1973; Carlson 1983; Elston 1982, 1986; Rhode et al. 2000; Tuohy 1968, 1969, 1970, 1974, 1981, 1988a, 1988b; Tuohy and Layton 1977; Warren and Ranere 1968), and therefore are considered to date to the latest Pleistocene or early Holocene, between 11,000 and 8,000 radiocarbon years before present (B.P.) based on other stemmed point sites that have been radiocarbon dated (Beck and Jones 1997; Bedwell 1973; Bedwell and Cressman 1971; Bryan 1979; Butler 1965, 1967; Connolly and Jenkins 1999; Douglas et al. 1988; Hattori 1982; Jenkins 1987; Jennings 1957; Jones and Beck 1999; Jones et al. 1996; Layton 1972a, 1972b, 1979; Madsen and Rhode 1990; Mehringer and Cannon 1994; Oetting 1994; Rozaire 1969; Schroth 1994; Tuohy and Dansie 1997; Willig and Aikens 1988).

The Sadmat and Coleman collections were analyzed in this study in order to implement new techniques for answering research questions using previously recorded site assemblages.

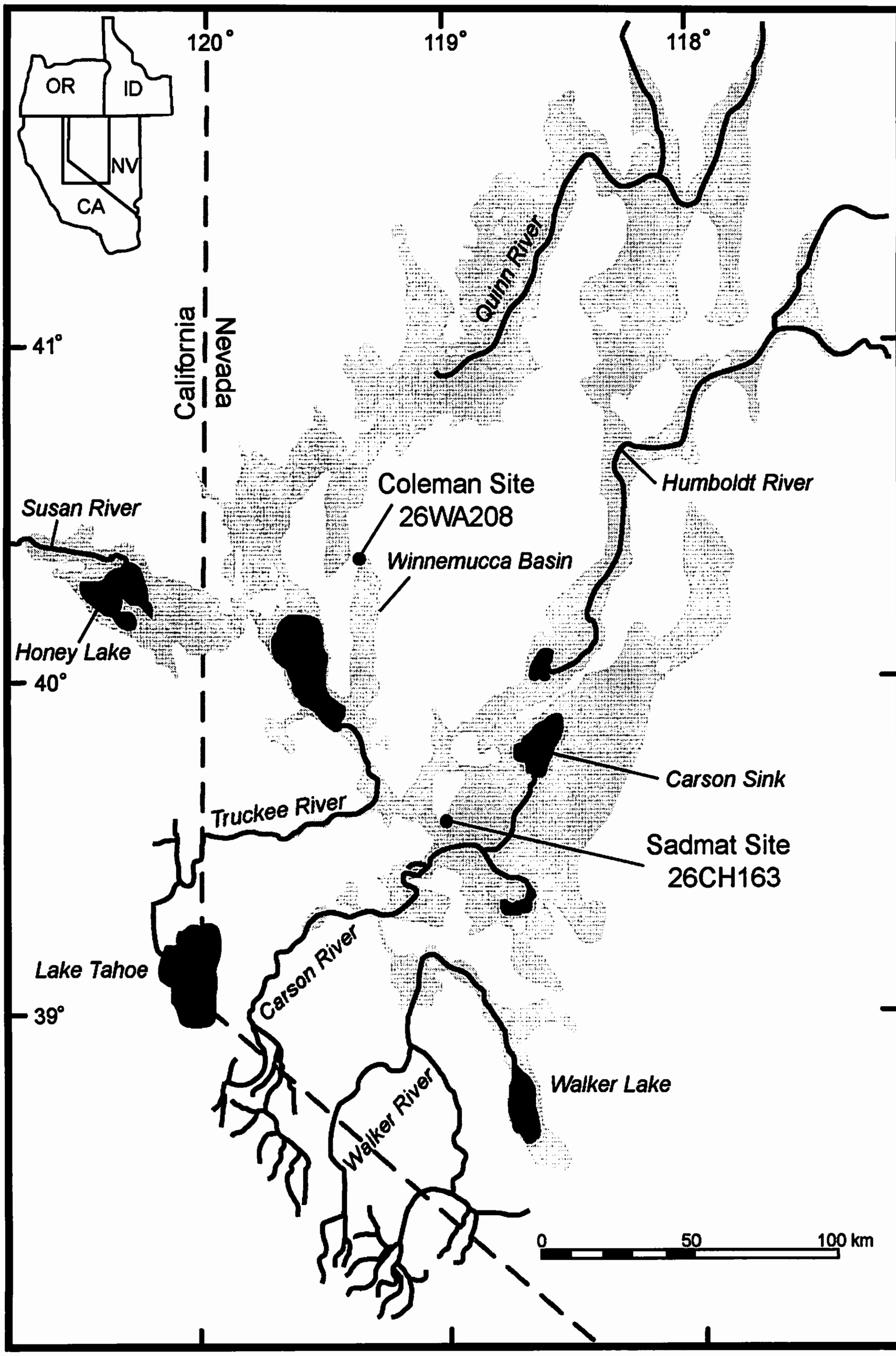


Figure 2.1. Map of pluvial maximum of Pleistocene Lake Lahonton and locations of the Sadmat and Coleman sites (after Adams and Wesnousky 1998).

Both the Sadmat and Coleman sites emerged as appropriate assemblages for studying land use patterns, provisioning, and adaptive strategies of humans at Great Basin stemmed point sites. Three qualities present in these assemblages sparked my interest when dealing with testing the Tethered Wetland (TW) and Mobile Forager (MF) adaptation hypotheses (Beck and Jones 1988, 1997; Bedwell 1973; Jones and Beck 1999; Pinson 1999, Willig 1988, 1989, 1991; Willig and Aikens 1988). First, a number of archaeologists have cited the Sadmat and Coleman sites as case studies in the long standing tethered wetland exploiter versus highly mobile forager debate when interpreting late Pleistocene to early Holocene human activity and adaptation in the Great Basin (Bedwell 1973; Carlson 1983; Elston 1982, 1986; Rhode et al. 2000; Tuohy 1968, 1969, 1970, 1974, 1981, 1988a, 1988b; Warren and Ranere 1968). Second, both sites are located on pluvial lake margins, which is what would be expected if these people were "lake" or "marsh" adapted (Bedwell 1973). Third, both sites appear to be situated close to sources of quality raw materials. These raw materials were presumably used in the manufacturing of many of the tools on the sites. Proximity to these quality raw materials alleviates interpretive problems relating some of the variables used in this study to raw material economizing behavior versus high levels of mobility (Odell 1996).

This chapter presents background information on the Sadmat and Coleman sites, including detailed descriptions of both sites and their associated artifact assemblages. Site locations, dimensions, and geomorphological contexts are described. Previous research and field investigations of both the Coleman and Sadmat sites are presented in chronological order as they were studied. Finally, this chapter discusses some of the limitations in using the data from these sites as well as the benefits from analyzing these collections in order to answer questions testing the TW and MF hypotheses.

Sadmat Site, 26CH163

The Sadmat site, 26CK163, is an open-air, surface lithic scatter composed of mainly Great Basin stemmed point series artifacts. The site is located in Churchill County in the Carson Sink approximately 3 km northeast of the town of Hazen, Nevada (Figure 2.2). Sadmat is situated approximately 10 km north of the Carson River as it flows into the Carson sub-basin and

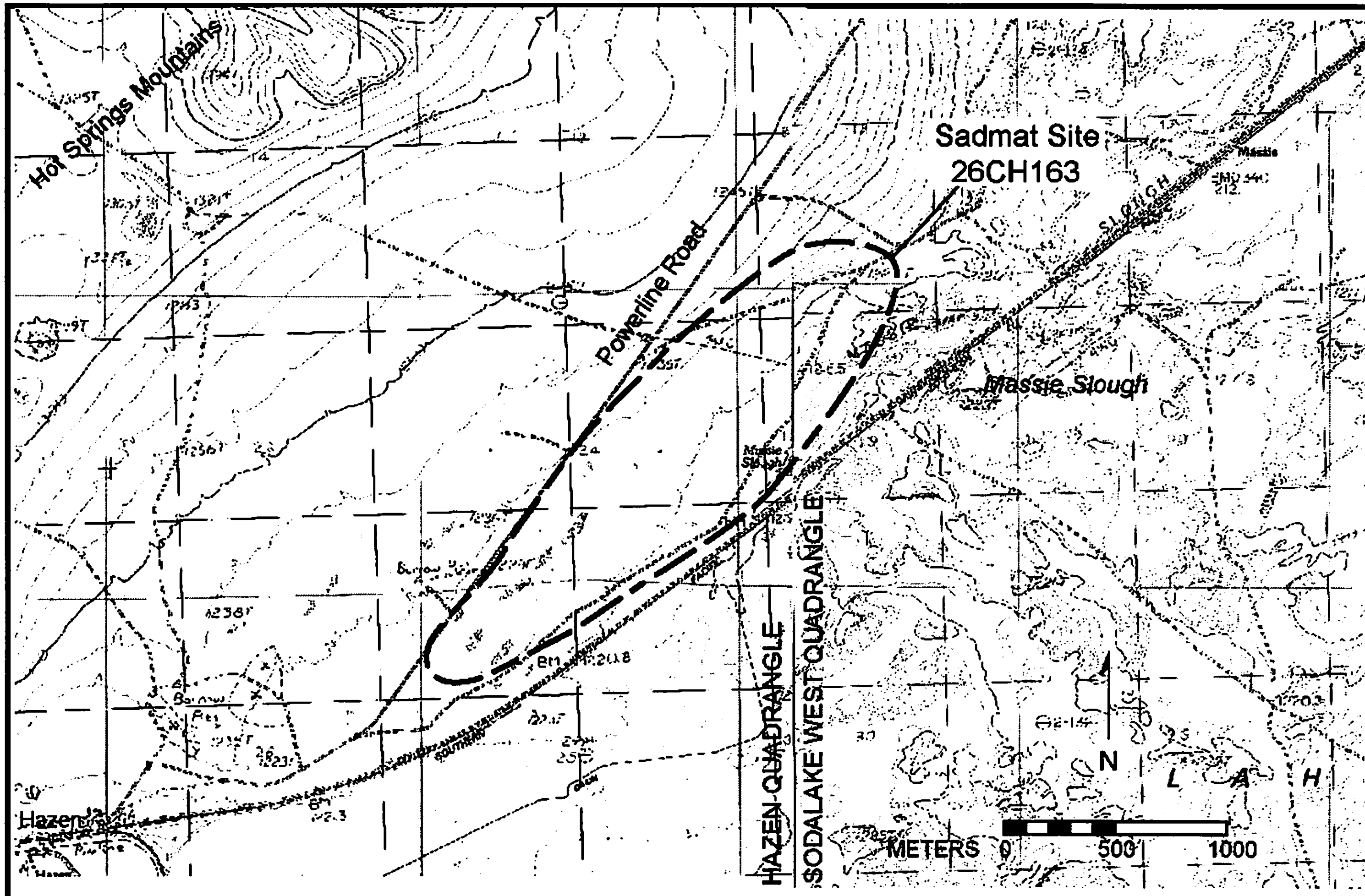


Figure 2.2. Sadmat site location. Contour interval for Hazen quadrangle is 10 meters and 2 meters for the Sodalake West quadrangle (U.S. Geological Survey, 7.5 minute maps, Hazen and Sodalake West, Nevada).

approximately 38 km west-northwest from where the Carson River drains to a terminal location in Stillwater Marsh, the sump of Carson Sink.

The first recorded visit to the Sadmat site was that of two private collectors, Etta-Mae Mateucci and Yvonne Saddler, both of Fallon, Nevada (Tuohy 1968, 1969, 1981, 1988b; Warren and Ranere 1968). The women were reported to be driving west on the power line road that runs northeast-southwest along the base of the Hot Springs Mountains in Churchill County. While taking a rest alongside the road they managed to stumble across the Sadmat site, finding lithic artifacts across the area between the power line road and railroad tracks to the south (Tuohy 1981). Both women apparently made subsequent visits to the site to collect artifacts. Tuohy (1981:7) recounts these artifact-collecting trips, "Finding the whole area, about two square miles, to be productive of artifacts they returned on successive weekends to gather additional specimens. There were so many that the ladies made canvas bags with shoulder straps to hold and to carry artifacts from the site on weekend forays." By 1974 both collectors had donated their collections to the Nevada State Museum (NSM) for curation. Yvonne Saddler's collection was accessioned into the site catalog in 1971, while Etta Mae Mateucci's collection was accessioned in August of 1973. The site was also visited by Peter Ting, Sr., who occasionally made collections and eventually donated artifacts to NSM in October of 1980 (Tuohy 1981). After initial discovery of the site, Don Tuohy and Amy Dansie of NSM and colleagues made a number of visits to Sadmat for further investigation (Dansie 1981; Irwin-Williams et al. 1990; Tuohy 1981).

Sadmat includes an area of approximately two square miles and is situated at an elevation ranging between 1,220 and 1,232 m above sea level (Rhode et al. 2000; Tuohy 1968, 1969, 1981, 1988b). Portions of the site rest on or near beach terraces that presumably formed during a latest Pleistocene/early Holocene pluvial lake sequence in the Carson Sink sub-basin (Rhode et al. 2000; Tuohy 1968, 1969, 1988b; Warren and Ranere 1968). The majority of artifacts in the collection, however, do not have detailed provenience data to directly associate specific artifacts with these features. Nonetheless, based on typology, the site assemblage has been assigned to the Great Basin Stemmed Series (Tuohy and Layton 1977) and therefore is presumed to date to the late Pleistocene/early Holocene, 11,000 to 8,000 B.P. (Bedwell 1973;

Carlson 1983; Elston 1982, 1986; Rhode et al. 2000; Tuohy 1968, 1969, 1974, 1981, 1988a, 1988b; Tuohy and Layton 1977). In fact, upon Tuohy's first examination in 1965 of Sadmat artifacts collected by Mateucci and Saddler, his opinion was that these artifacts were temporally affiliated with other early sites in the Great Basin such as the Tule Springs and the Lake Mohave localities (Tuohy 1981).

The Sadmat lithic artifact collection reportedly consists of approximately 3,050 artifacts; however, the total number of artifacts analyzed in the current study was 3,140 (several duplicate accession numbers exist). Based on my analysis, the site is characterized by the presence of an interesting tool assemblage including stemmed points including the Haskett (Butler 1965, 1967), Parman (Layton 1970, 1972a, 1972b, 1979), and Windust types (Fagan and Sage 1974; Leonhardy and Rice 1970; Rice 1972), and a host of bifaces, such as leaf-shaped, ovate, discoidal, beaked, stemmed preforms, lanceolate, and crescents, not to mention numerous other biface fragments. Other tools in the collection include a plethora of side scrapers, end scrapers, retouched flakes and blade-like flakes, gravers, burins, notches, denticulates, and various combination tools, including wedge/scrapers, graver/scrapers, graver/notches, and scraper/notches. The assemblage also includes numerous cores. These range from unprepared, multidirectional flake cores to simply-prepared unidirectional and bidirectional flake cores; some of these are exhausted cores. The dominant raw material type utilized at Sadmat is cryptocrystalline silicate (CCS), but basalt and obsidian also comprise a large percentage of the total assemblage.

It is important to note that a few Middle to Late Archaic projectile points were discovered and collected from the Sadmat site (Sadmat catalog on file at NSM). These include one Humboldt point and five Elko series points; however, these later points only make up 0.19% of the total artifact assemblage, 0.26% of the total tool assemblage, and only 3.14% of the hafted biface assemblage (i.e. projectile points). Humboldt points are chronologically undiagnostic, spanning at least 6,000 years, from 7,000 to 1,000 B.P. in the western and central regions of the Great Basin (Grayson 1993; Hattori 1982; Holmer 1986; Jennings 1986; Thomas 1981). Elko series points are early Late Archaic points, probably spanning the time period between 3,500 and 1,300 B.P. in the western Great Basin (Grayson 1993; Holmer 1986;

Thomas 1981, 1985). These isolated Archaic projectile points clearly represent a few brief and ephemeral middle to late Holocene visits to the site by later prehistoric hunters.

Coleman Site, 26WA208

The Coleman site, 26WA208, is an open-air, surface stemmed point site located in Washoe County approximately 38 km south of the town of Gerlach, Nevada, in the Winnemucca sub-basin of the Lake Lahontan pluvial system (Figure 2.3). Winnemucca sub-basin lies directly to the east of and parallel to Pyramid Lake, a remnant portion of Pleistocene Lake Lahontan. Coleman could be situated on an alluvial fan along a drainage that traverses eastward from Falcon Canyon to the Winnemucca sub-basin floor.

The Coleman site was first located in 1959 by Ruth Coleman. She discovered a concentration of surface artifacts and made collections from this locality, later referred to as Area 1 (Tuohy 1970). Subsequent investigations by Richard Shutler, Jr., and Don Tuohy, both of NSM, were conducted in later years (Tuohy 1968, 1970). According to the Coleman artifact catalog (on file at NSM) the first artifacts to be accessioned were added to the catalog in July of 1964 and the last artifacts collected were accessioned into the catalog in June of 1967. In 1983 during a highway survey the Coleman site was relocated and a brief update was added to the original site form. The boundaries of the site were expanded to include lithic scatters along Highway 34 (Coleman, 26WA208, site record). These new lithic scatters noted in this revision are as much as 3 km from the location of the stemmed point locality. In fact, the new boundary along the highway appears to contain a modern quarry and could in part represent disturbed areas. Artifacts, if collected, from the 1983 survey were not included in this study.

Originally, Coleman was composed of four localities, two of which were identified as lithic workshops, one a campsite, and one a quarry location. Area 1 and Area 2 are located along the 1,220-m contour and have been reported to represent two workshops (Tuohy 1970). Area 3 is located on a small terrace extending to the south-west of nearby Falcon Hill and sits at an elevation of 1,250 m. This locality has been reported as a campsite (Tuohy 1970); however, in Tuohy's 1968 publication it was reported to be one of the two lithic workshops, while either Area 1 or Area 2 was the campsite (Tuohy 1968). Area 4 rests at the mouth of Falcon Canyon

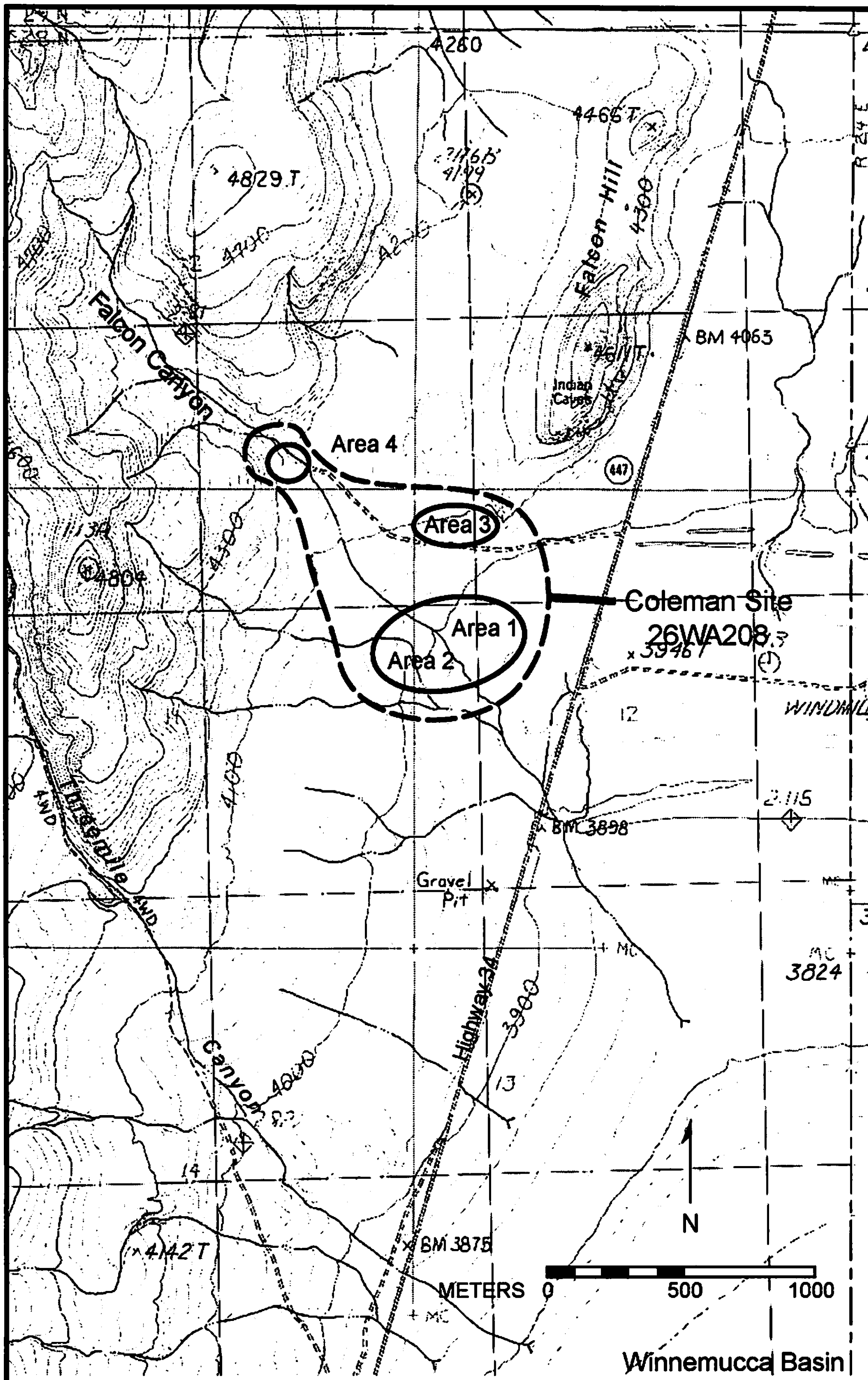


Figure 2.3. Coleman site location. Countour interval is 20 feet (U.S. Geological Survey, 7.5 minute map, Purgatory Peak, Nevada).

at an elevation of 1,296 m and is reportedly the Coleman quarry (Tuohy 1968, 1970). Tuohy (1970) reports Area 1 to measure 137 m by 46 m, comprising an area of approximately 6,302 m^2, while he reports Area 2 to measure 131 m by 70 m, covering an area of 9,170 m^2 (Tuohy 1970). The other two areas' dimensions have not been reported (Tuohy 1970) and unless denoted by another site number do not show up in the Coleman site catalog (Coleman artifact catalog, NSM). The entire collecting area was originally recorded as comprising an area that measured one-half mile by one-half mile (Coleman, 26WA208, site record).

Three other collecting areas are briefly mentioned by Tuohy (1970). These consist of Areas 5, 6, and 7. Area 5 includes materials picked up over the entire site with no provenience, Area 6 includes materials found between Falcon Hill and Area 1, and Area 7 includes debitage that was collected from a 1-m^2 collection area located within Area 1 or Area 2 (Tuohy 1970). In the Coleman catalog, however, no artifacts have been assigned to any of these areas (Coleman artifact catalog, NSM). The exact provenience of the 1-m^2 area from which Tuohy collected debitage remains unclear and was not reported by Tuohy (1970).

As with the Sadmat site the temporal association of the Coleman site is established mainly on typology. Based on the presence of stemmed points and affiliated artifacts, the site assemblage has been assigned to the Great Basin Stemmed Series (Tuohy and Layton 1977) and therefore is presumed to date to the terminal Pleistocene/early Holocene, 11,000 to 8,000 B.P. (Bedwell 1973; Carlson 1983; Elston 1982, 1986; Rhode et al. 2000; Tuohy 1968, 1969, 1974, 1981, 1988a, 1988b; Tuohy and Layton 1977).

The collection was initially reported as being composed of a total of 2,555 artifacts with 666 of this count consisting of tools and 1,889 consisting of debitage (Tuohy 1970), while the site catalog reports a total of 2,428 artifacts (Coleman site catalog, NSM). My investigations found a total of 2,427 artifacts in the collection presently curated at the NSM, with 678 tools and 1,749 pieces of debitage and/or cores analyzed. The site assemblage consists of Parman stemmed points (Layton 1979; Tuohy and Layton 1977), stemmed bifaces, beaked bifaces, ovate bifaces, leaf-shaped bifaces, other early stage bifaces, and miscellaneous biface fragments, and one crescent biface. The rest of the tool assemblage contains side scrapers, end scrapers, retouched flakes and retouched blade-like flakes, backed knives, notches, gravers, combination tools, and a few burins. Debitage is dominated by the presence of primary reduction spalls, and cores tend to be multidirectional, bidirectional, and unidirectional, all for the most part unprepared in nature.

One projectile point with a later temporal association was found at the site. This point is small, shouldered, and has a slightly expanding, indented stem suggesting it to be a Pinto point, as defined by Susia (1964) and Warren (n.d., 1980). The Pinto point was collected from Area 2 where the majority of the stemmed points were also collected (Coleman artifact catalog, NSM). It is important to note that this singular, early Archaic point represents approximately 0.04% of the total artifacts in the site assemblage, 0.14% of the total tools at the site, and approximately 12.0% of the total hafted tools in the assemblage (i.e., projectile points). Pinto points probably date to the early-middle Holocene boundary and have been assigned to the Early Archaic period (Elston 1986; Jenkins 1987; Jenkins and Warren 1984; Warren n.d.). It has been suggested that the overall population of Early Archaic people was quite low, probably due to a shift at this time in the environment to a severe hot and dry period referred to as the Altithermal (Antevs 1948; Elston 1986). Pinto points have been suggested by some researchers to represent a continuous, slow change of adaptation of humans making stemmed points in the Great Basin into the Altithermal (Susia 1964; Warren n.d., 1980).

Previous Investigations of Sadmat and Coleman Site Assemblages

In a seminal publication of the late 1960's (Irwin-Williams 1968), Warren and Ranere (1968) and Tuohy (1968) first reported the Sadmat and Coleman sites and their associated lithic assemblages, discussing the relative techno-cultural and chronological contexts of these sites compared with others in the Great Basin. This was the first time they were reported and information regarding their context was published.

Warren and Ranere (1968) suggested that based on preliminary analysis of the Sadmat artifact collection, the site assemblage is more closely associated with the artifacts found at the Haskett stemmed point site and Veriatic Rockshelter in southern Idaho (Butler 1965, 1967) and the Cougar Mountain stemmed point site in south-central Oregon (Layton 1970, 1972a, 1972b) than it is to the San Diegito complex that Warren (1967) describes for sites appearing to the south, especially in the Mojave Desert (Warren and True 1961). They indicate that Sadmat biface technology is similar to the technology represented at the Haskett sites, while the overall Sadmat assemblage including the uniface assemblage is most closely related to the Cougar Mountain assemblage. These researchers further suggest that the Sadmat assemblage should be included within a more northern cultural complex, linked to a proposed spread of big-game hunters from the Great Plains region. As a result, they coined the term "Hascomat" to refer to this complex (Ranere 1970; Warren and Ranere 1968:11).

Tuohy (1968), however, suggests that the Sadmat artifact assemblage most closely resembles the San Diegito complex and possesses an overall Lake Mohave look to it. Tuohy (1968) suggests that the San Diegito and Lake Mohave complexes are different but share overall similarities and that the two are complexes within the Lake Mohave Tradition. The discrepancy between Warren and Ranere (1968) and Tuohy (1968), related to the cultural association of the Sadmat assemblage, appears to be the result of differences in semantics, a debate over typology. Tuohy (1968) also states that the Sadmat site lacks later point types; however, my analysis shows this to be incorrect (Sadmat artifact catalog, NSM, discussion of collections above, and Chapter 4).

Warren and Ranere (1968) suggest that the Coleman artifacts most closely resemble the San Diegito Complex based on the apparent emphasis placed on percussion technology (irregular, step fracturing, and variable workmanship) and the lack of Haskett-like points. They liken these to attributes represented at the San Diegito Complex sites to the south (Warren and Ranere 1968). Tuohy's (1968) description of Coleman is very cursory, but he does suggest the relative antiquity of the Coleman site based on the site's location relative to a beach terrace, and similarities in typology with other stemmed point sites in the Great Basin (Tuohy 1968, 1970).

In 1969 Tuohy briefly describes the Sadmat site in an article in which he investigates Paleoindian point rejuvenation technology (Tuohy 1969). In this brief description Tuohy (1969) first reports the presence of rock cairns at the Sadmat site, as well as the presence of Lake Mohave-Silver Lake points resembling the Lind Coulee stemmed point type.

Tuohy (1968) suggests, based on his analysis of 147 stemmed points (less than 1/3 come from the Sadmat site), that a burin and burin facet technology was utilized in the resharpening and rejuvenation of these points, further suggesting a technological linkage among Lake Mohave-like sites based on this proposed technique. He argues that this rejuvenation technique resulted from a faulty design in stemmed points, but does not rule out impact fracturing as a possibility for the production of the burinated points. He further postulates that differences seen in stemmed point technology are due to fractures and not to the occurrence of different cultures as suggested by Warren and Ranere (1968) (Tuohy 1969).

Also observed at the Sadmat site are a series of pebble mounds that measure approximately 1 m in diameter and range from 30 cm to 60 cm in height. These mounds are reported and briefly discussed by Tuohy (1981). Tuohy (1981) suggests that the pebble mounds could be associated with the prehistoric peoples that visited the site, but most likely they represent recent use of the gravels and pebbles located in the desert pavement of the site, either by railroad workers or by collectors searching for artifacts (Tuohy 1981). This interpretation is based on Tuohy's excavation of one of the pebble mounds at Sadmat, in which he observed that some stones in the mound showed evidence of being flipped after they had acquired a coating of desert varnish. This suggests to Tuohy (1981) that the mounds were created fairly recently. Also he notes that the vegetation found in the mounds was smaller and younger than surrounding vegetation denoting a recent construction of the mounds (Tuohy 1981).

Dansie (1981) also discusses the possible functions of pebble mounds found at the Sadmat site and other sites in the Carson Desert. Based on research done on pebble mounds of similar construction in the Negev Desert in Israel, she suggests that the most parsimonious explanation of function would be that these were used by prehistoric folks to increase rainfall runoff and promote the growth of natural vegetation in the dunal features located directly downslope of pebble mound sites (Dansie 1981; Irwin-Williams et al. 1990).

In 1982 Davis tried to rule out the possibility that the mounds were constructed either in historic times or by early Holocene peoples (Davis 1982a). He demonstrates, based on observations made at the nearby Peg Wheat site of exposed surfaces versus unexposed surfaces of the pebbles, that because the vast majority of the pebbles are not sandblasted and desert varnished they most likely are recent in age or at least cannot be early Holocene in age (Davis 1982a).

When reviewing the previous investigations of the pebble mounds, clearly some researchers have interpreted these cultural phenomena as relatively recent (Davis 1982a; Tuohy 1981). Others have suggested that the mounds could be early in age based on proximity of these features to early Holocene-aged artifacts (Dansie 1981). Dansie (1981) also postulates that the mounds could be related to late Holocene irrigation of plant resources in order to placate an increase in population density and intensification of resources. Proximity of pebble mound sites to Holocene dune features suggests that these sites could have been utilized by Great Basin people during the late Holocene who intensively collected seeds (Bettinger 1999; Bettinger and Baumhoff 1982; Kelly 1985, 1999, 2001) and may have manipulated the ground surface to promote watering of seed plants. Most likely, these features post-date the stemmed-point-complex occupation of the site.

Discussion

Several problems exist when trying to analyze and interpret the Sadmat and Coleman artifact collections. Mainly these problems are directly related to the general lack of chronological control of the sites. Since the sites represent surface artifact scatters that cannot be dated by absolute means, it is hard to interpret their direct association with pluvial lake sequences. The collection techniques employed at the sites have produced data biases and a lack of good provenience. This has contributed to contextual problems discussed below.

Chronological Challenges

Both the Sadmat and the Coleman site artifacts are surface materials and, therefore, cannot be unequivocally dated. The artifacts can only be relatively dated based on typological association with similar artifacts dated elsewhere in the Great Basin. Since the majority of temporally diagnostic artifacts from these two sites is associated with other sites that have been radiocarbon dated to the late Pleistocene/early Holocene dates, 11,000 to 8,000 B.P. (Aikens 1970; Beck and Jones 1997; Bedwell 1973; Bryan 1979, 1980; Butler 1965, 1967; Connolly and Jenkins 1999; Douglas et al. 1988; Hattori 1982; Jenkins 1987; Jenkins and Warren 1984;

Jennings 1957; Jones and Beck 1999; Jones et al. 1996; Layton 1979; Mehringer and Cannon 1994; Oetting 1994; Willig and Aikens 1988), they have been also placed in this time period. Other archaeologists, when dealing with surface archaeology, have also based site chronology on typological similarities with radiocarbon dated site assemblages (Beck and Jones 1997; Elston 1986; Jones and Beck 1999; Tuohy 1968, 1969, 1974, 1981; Tuohy and Layton 1977; Warren n.d.).

Relative temporal affiliation can also be established based on the geomorphic relationship of the artifacts to late Pleistocene/early Holocene topographic features. Areas 1 and 2 of the Coleman site were originally reported by Tuohy (1970) as resting on a beach terrace at an elevation of 1,205 m, while artifacts from Areas 3 and 4 rest on other beach bar/ terrace features higher in elevation to the north and west of Areas 1 and 2. Reviewing the aerial photographs, it appears that Areas 1 and 2 are actually resting on an alluvial fan that was created by post-pluvial-lake alluvium from Falcon Canyon (Figure 2.4). Therefore Area 4 is resting on more recent alluvium and not beach deposits. The topographic environment of Area 3 is much harder to interpret. It appears from the aerial photograph that this collecting area is resting on a beach terrace; however, the only way of being sure of this would be to inspect the relative roundness of the clasts in the deposit on which the collecting area is situated. Important to note here after examining the aerial photographs is the possibility that if the Coleman site is sitting on alluvial deposits, then it could be that the artifacts are becoming exposed at the surface due to deflation and that the site itself is buried and the collections Tuohy (1970) made are only a few artifacts that have worked their way to the surface, while the rest of the site lies buried beneath the alluvium. This, however, is most likely not the case since many of the artifacts in the Coleman collection are quite large basalt bifaces, cores, and primary reduction debitage. For this many large artifacts to be found on the surface it seems that the site would have to be very shallow if it is a buried site.

The geomorphic environment of the Sadmat site is quite different. The site has been reported to rest on a series of beach terrace features at an elevation ranging between 1,220 and 1,235 m (Elston 1986; Rhode et al. 2000; Tuohy 1981). Inspection of the aerial photograph of the Sadmat site shows that the site appears to be sitting on pluvial, beach-related features

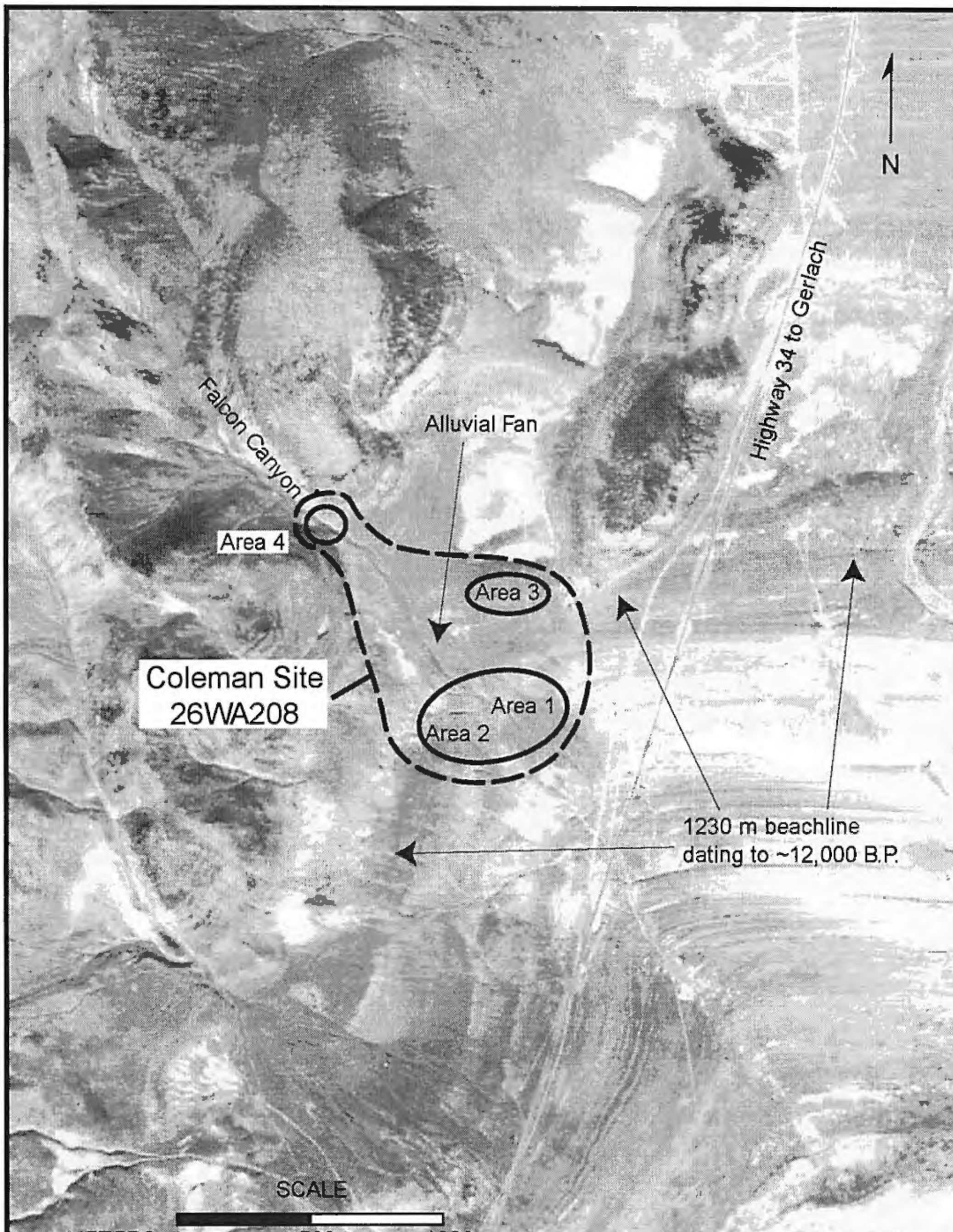


Figure 2.4. Aerial photo showing location of Coleman site areas in relation to geomorphic landforms.

(Figure 2.5). Even though the site encompasses quite an extensive area and the exact provenience of all of the artifacts is unknown, the entire site location is reported to be situated on beach terraces between the power line road and railroad (Tuohy 1981).

We assume that the Lake Lahontan highstand dates to approximately 13,000 B.P. and is located at an elevation of 1,338.5 m. This is based on radiocarbon evidence obtained by Ken Adams in the Jessup embayment area approximately 40 km northeast of the Sadmat site (Adams 1997; Adams and Wesnousky 1998, 1999; Adams et al. 1999; Rhode et al. 2000). We also know that the Carson Sink became separated from the western sub-basins of Lake Lahontan when lake levels fell below the elevation of the Fernley Sill, 1,265 m. Thus the Winnemucca and Carson Sink sub-basins would have had a somewhat different lake sequence once this event occurred. By 12,000 B.P. the lake levels of the western sub-basins receded to an elevation of 1,230 m (Thompson et al. 1986), thus separating the Carson Sink and Winnemucca basins.

Lake level data give a lower-limiting age at both the Coleman and Sadmat sites. Because the elevation of Areas 1 and 2 of the Coleman site (where the stemmed points were located) lies below the 1,230-m elevation for a proposed lake at 12,000 B.P., these people could not have inhabited the area before this date, since it would have been covered by water. There are no signs of water-related weathering on any of the artifacts. Also, because Areas 3 and 4 lie at elevations above 1,230 m, people could have inhabited these areas before 12,000 B.P., but not before 13,000 B.P., which is the date of the 1,338.5 m highstand that would have covered these areas with almost 50 m of water. In sum, the Coleman site could have been occupied sometime between 13,000 and 12,000 B.P. at the earliest, but most likely the site was visited by people possessing stemmed point technology sometime after 12,000 B.P. due to the location of Areas 1 and 2 on alluvium that must postdate pluvial lake activity at this elevation (Figure 2.4).

The relative chronology of the Sadmat site is slightly different than the Coleman site for reasons stated above. The late Pleistocene/early Holocene lake sequence has not been dated yet for the Carson Sink sub-basin and, therefore, its chronology has been interpreted differently by various geomorphologists (Adams 1997; Adams and Wesnousky 1998, 1999, Adams et al. 1999; Benson et al. 1990; Morrison 1991; Rhode et al. 2000). Rhode et al. (2000) have hypothesized a possible lake between 11,000 and 10,000 B.P. that would have reached its

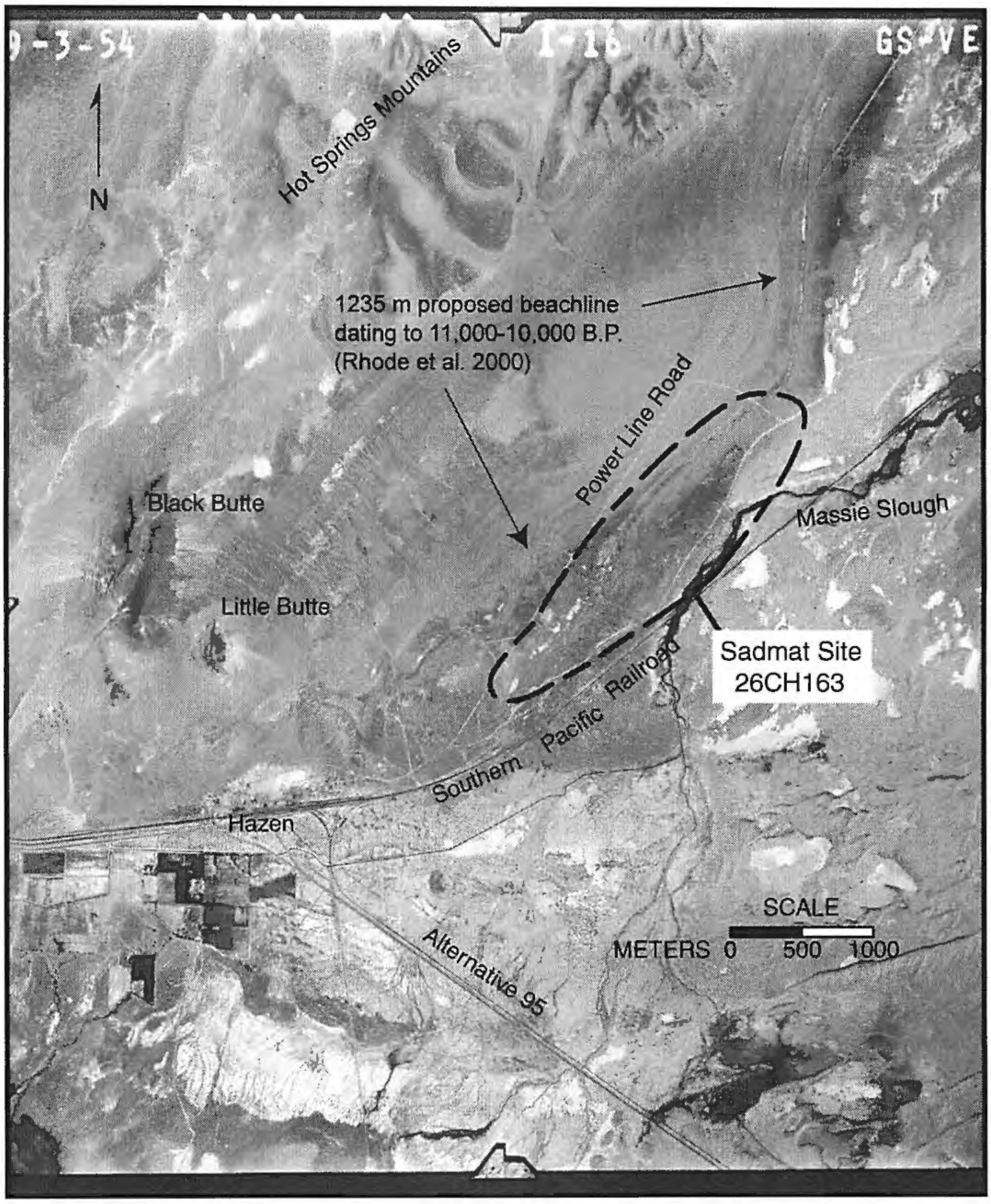


Figure 2.5. Aerial photo showing location of Sadmat site and relation to geomorphic landforms.

maximum elevation of 1,235 m. This is based on evidence from paleovegetation (Nowack et al. 1994), a hypothesized wetter period associated with the Younger Dryas, between 11,000 and 10,000 B.P. in western North America (Haynes 1991, 1993; Haynes et al. 1999), and paleoecological evidence from archaeological cave sites in the Carson Sink sub-basin (Eiselt 1997; Heizer 1956; Smith 1985).

Morrison (1991) and Davis (1982b) have both suggested that there could have been a series of small early Holocene lakes in the Carson Sink with elevations ranging between 1,200 m and 1,213 m. Since the Sadmat artifacts were located on beach features between an elevation of 1,220 m and 1,232 m we can rule out the possibility that humans were inhabiting the site before 12,000 B.P. because of a lack of clear evidence of water-worn artifacts in the collection. Then, if Rhode et al.'s (2000) hypothesized Younger Dryas lake level is shown to be correct, the Sadmat inhabitants probably visited the site after 10,000 B.P. If humans were visiting the Sadmat site before a Younger Dryas or early Holocene lake, the expectation would be to find these stemmed point artifacts with evidence of water weathering, but the only clear evidence of weathering on these artifacts is that of sand-blasting. Artifact typology and geomorphic relationships are all we really have to place these sites in a chronological context. Typologically these sites appear to date to the latest Pleistocene/early Holocene (Elston 1982, 1986; Rhode et al. 2000; Tuohy 1968, 1969, 1970, 1974, 1981, 1988a, 1988b; Tuohy and Layton 1977; Warren and Ranere 1968). The geomorphic evidence is still quite scanty, but we can assign a lower-limiting date to the artifacts of 12,000 B.P. at Coleman, and 10,000 B.P. for Sadmat, if there was a Younger Dryas lake in the Carson Sink.

Artifact Collection Challenges

Collection techniques employed at both the Sadmat and Coleman sites make interpretations about context difficult. Provenience of individual artifacts at both sites is not available. The Coleman assemblage can be separated fairly clearly into areas of collection that encompassed between 60,000 and 100,000 square m. Areas 1 and 2, which are clearly stemmed point localities, together emcompass an area of 600 m north-south by 600 m east-west. According to Tuohy (1981, 1988b) the provenience of the artifacts from the Sadmat site incorporated a collection area of nearly 5 square km. My observations have found the site to incorporate an area of approximately 3 km east-west by 500 m north-south. This observation becomes a problem when the typologically later projectile points cannot be clearly separated from the stemmed points; however, the small number of later points in the collection suggests that their incidence is not significant to the overall site assemblage.

The Sadmat site has a high incidence of tools compared to debitage. This could represent little to no on-site manufacture of artifacts, which does not seem to be the case since there is a large number of cores represented in the collection. What it could represent is a sampling bias because the site was collected mainly by private collectors and amateur archaeologists who were probably not trained in locating small debitage and probably were unaware of the importance of what can be learned from studying debitage. Some small retouch chips are present in the collection, so most likely the debitage bias is not due to a lack of primary and secondary reduction activities.

Reasons for Studying the Sadmat and Coleman Artifact Assemblages

Obviously a few problems exist with establishing the chronology and context of the artifacts at these stemmed point sites. Positive qualities of the artifact assemblages; however, do exist and these are the reasons for analyzing these assemblages to address the research questions posed in this study. The main reason for choosing these collections is that both sites seem to represent large, stemmed point assemblages located adjacent to pluvial Lake Lahontan. In order to directly test the TW hypothesis one needs to utilize data sets that are presumably associated with a pluvial lake and/or associated wetland patch, such as the Sadmat and Coleman sites (Elston 1982). The second reason for choosing these two site collections is that they contain typical stemmed points and related tools (i.e., large scrapers, gravers, and crescents) (Tuohy 1968, 1969, 1970, 1974, 1988b; Tuohy and Layton 1977; Warren and Ranere 1968). Finally, both sites contain locally available raw materials, in the cobble alluvium at Coleman and in the cobble beaches at Sadmat. While making a visit to the Coleman site in January of 2000, I collected some basalt cobbles from the alluvium and sent them to Craig Skinner of Northwest Research Obsidian Studies Laboratory for X-ray fluorescence (XRF) element characterization analysis. Indeed one of the basalt stemmed points came from the same source as the alluvial cobble I had sent for analysis (C. Skinner, personal communication February 2000). While visiting the Sadmat site in November of 2000, Dr. Ted Goebel and I collected several CCS beach cobbles from the vicinity of the site (Figure 2.6). These cobbles represent the majority of raw materials represented in the artifact assemblage. As others have shown, lithic economizing behaviors (i.e., high degrees of core reduction and/or tool reduction, manufacture and use of formal versus informal tools) potentially can be due to two factors: 1) relatively high levels of mobility and 2) raw material scarcity (Bamforth 1986; Binford 1979; Dibble 1995; Kuhn 1991, 1992, 1993, 1994, 1995; Marks 1988; Marks et al. 1991; Odell 1996). In the cases of Sadmat and Coleman, both sites are adjacent to ready supplies of high quality, fine-grained lithic material suitable for biface and tool blank manufacture. Thus, if variables analyzed suggest high degrees of economizing behaviors, these are not related to raw material scarcity, but instead to technological provisioning associated with mobility (Bamforth 1986; Binford 1979; Dibble 1995; Goodyear 1989, 1993; Kuhn 1991, 1992, 1993, 1994, 1995; Marks 1988; Marks et al. 1991; Odell 1996).

Figure 2.6. Cryptocrystalline silicate (CCS) beach cobbles from the Sadmat site.

CHAPTER 3

METHODOLOGY

This investigation describes and analyzes lithic assemblages from two late Paleoindian, stemmed point sites in the western Great Basin in order to understand early Holocene hunter-gatherer technological organization and mobility. The documentation and analysis presented in Chapters 4 and 5 are important in tackling research questions regarding stone tool procurement strategies and their relationship to land use. Research questions posed in this study can best be answered utilizing an interpretive approach, integrating analyses associating raw material selection and technological provisioning strategies with the Sadmat and Coleman lithic assemblages to try to understand the land use and settlement systems used by the hunter-gatherers that frequented these sites.

Lengths, widths, and thicknesses were measured with a set of calipers, tool edge angles were measured with a goniometer. Weights were measured using both electric scales and a triple beam balance. Data were entered, organized, and analyzed on an IBM compatible, personal computer using SPSS version 8.0 statistical software. Basic descriptive statistics (i.e., frequencies, means, and standard deviations) for each lithic variable, as well as comparative statistics, were conducted through the use of this statistical package.

This chapter presents the methods employed in this study. First, each of the variables measured and observed is described. These include the typology implemented, along with a series of non-metric and metric variables. The second portion of this chapter presents the statistical analysis used, a brief description of X-ray fluorescence (XRF) element characterization analysis and reasons for choosing this analysis. Also, integrative variables used to establish land use patterns and mobility levels represented by the lithics at the sites are described.

Descriptive Analysis

This section of the chapter presents methods for describing both the Sadmat and Coleman lithic assemblages, focusing on the methods for describing raw materials, core assemblages, debitage assemblages, and tool assemblages, including variables that were scored and measured in order to characterize technological strategies.

Raw Material

Characterization of raw materials was achieved through visual determination. Rock identification was based on the classification of artifacts into one of four categories, basalt, obsidian, cryptocrystalline silicate (CCS), or other. Other raw material types include quartz, quartzite, rhyolite, and meta-siltstone. Raw material quality was not scored during lithic analysis; however, this is discussed throughout the results of this study as a relative measure based on flaking quality, (i.e., obsidian, CCS, and basalt are high quality rock types, while quartz, quartzite, rhyolite, and meta-siltstone are low quality for flint knapping).

Core Analysis

Reconstruction of core technologies was accomplished through the use of 1) a core typology, 2) various non-metric variables and attributes, and 3) a series of metric variables.

Core Typology. Stemmed point assemblages often have numerous simply prepared and unprepared flake cores; therefore, the core typology employed in this study is relatively simple and derived from Andrefsky (1998) and to a lesser extent Kuhn (1995). It is based primarily on the direction of flake removals, but also on number and preparation of platforms (the cores' striking surfaces) and number of fronts (the cores' faces that bear flake scars). Core types include:

- Unidirectional: flake cores that possess one platform with flake removal scars originating from this platform and traversing semi-parallelly down the front (face) of the core (Figure 3.1d) (Andrefsky 1998).
- Bidirectional: flake cores that possess two platforms with flake removal scars originating from both platforms and traversing the core in two opposite directions. Also scored in this

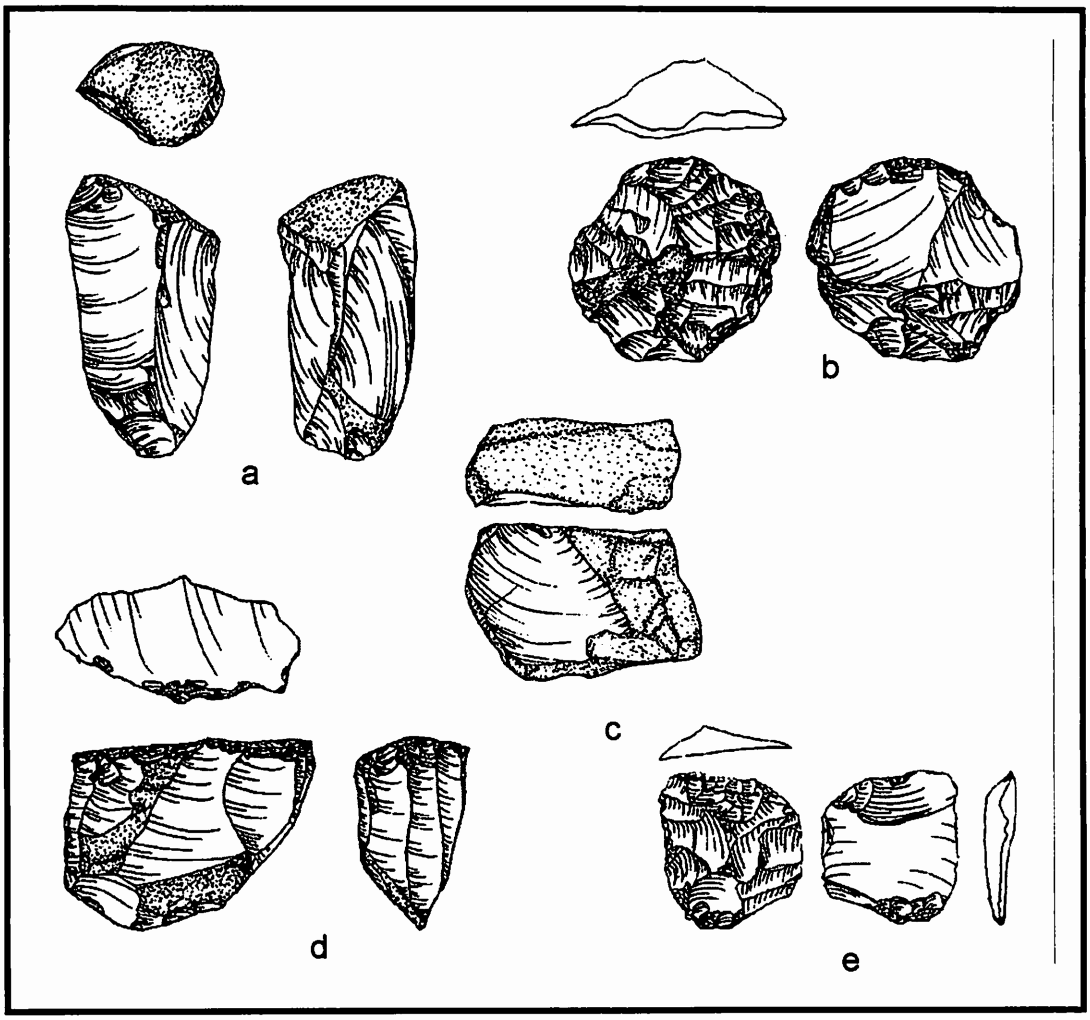


Figure 3.1. Schematic drawing of core types, a. multidirectional flake core, b. bidirectional flake core, c. tested cobble, and d. unidirectional flake core.

category are centripetally flaked discoidal cores with flake scars originating from two platform surfaces (Figure 3.1b).

- Multidirectional: flake cores that possess three or more platforms and show evidence of flake removals in at least three directions (Figure 3.1a) (Andrefsky 1998).
- Bipolar: these are cores that posses flake removals originating at opposing ends of the piece, in which the flake removals appear to be the result of compressive forces, showing distinct, concentric ripple marks, areas of crushing near points of impact, concave or even no percussion bulbs, and flake removals that travel towards each other (Figure 3.1e) (Andrefsky 1998; Kuhn 1995).

- Tested Cobbles: cobbles that have no prepared platforms, but have one or two flake removals and more than 50% cortex (Figure 3.1c).

Number of Platforms. The number of platforms on each core was counted and tallied. This variable provides an estimate of core reduction intensity.

Number of Fronts. The number of fronts (the core surfaces bearing flake scars) on each core counted and tallied. Like number of platforms, this variable provides an estimate of core reduction intensity (i.e., the more core fronts that are flaked, the more reduced the core). This number is not necessarily the same as the number of platforms represented by a core.

Surface Platform Preparation. Surface platform preparation refers to the type of striking platform observed on a core. There are four types of surface platform preparation. These include:

- Cortical: a core platform with cortex present on its surface. This type of platform represents no preparation.
- Smooth: a core platform with a smooth, flat or near flat surface. This type of platform is typically found on cores whose platforms have been simply prepared through splitting or initially flaking a cobble.
- Complex: a core platform possessing multiple surfaces resulting from more than one flake removal.
- Abraded: a core platform that shows signs of intentional abrasion to prepare the core platform for flake removals.

Cores with multiple platform types often occurred in the assemblages analyzed. In these cases, all platforms were typed.

Amount of Cortex. Cortex is the natural, weathered surface of a cobble. The relative amount of cortex visible on each core's exterior was scored utilizing the following ordinal scale: 0%, <10%, 10-50%, and >50% cortex.

Maximum Linear Dimension (MLD). Maximum linear dimension refers to the maximum length of the core, following Andrefsky (1998). MLD was measured in millimeters on each core in the assemblage.

Core Weight. All cores were weighed using either electric scales or a triple beam balance. Weights were recorded in grams.

Size Value. This measurement was used to estimate the overall sizes of cores. It was calculated by multiplying the variable, MLD, by core weight, following Andrefsky (1998). This measurement standardizes the sizes of cores so that cores of different shapes can be measured consistently.

Debitage Analysis

In this thesis, debitage refers to all waste or by-products of stone tool manufacture including unused flake blanks, cortical spalls, and retouch chips, as well as angular shatter. This all-inclusive definition follows Andrefsky (1998) and Kelly (2001) and is typical for analysis of lithic assemblages from western North America. As with core technology, debitage was characterized by the use of a typology, along with various non-metric and metric variables. These include debitage class and type, surface platform preparation, number of dorsal flake scars, amount of cortex, and size value.

Debitage Typology. The typology used for debitage classification is based on a series of morphological attributes that help characterize techniques utilized to produce specific debitage. The typology is hierarchical, in which debitage is typed both at the class and type levels. Debitage classes utilized in this typology are either flake debitage, possessing typical characteristics of flake debitage, including an obvious striking platform and/or associated attributes such as percussion bulb, eraillure scar, and ripple marks, or non-flake debitage possessing no clear evidence of such flake attributes. Classes are as follows:

- Cortical Spall: flake debitage possessing cortex on the dorsal surface.
- Flake: flake debitage possessing a platform, bulb of percussion, and/or ripple marks. These have no cortex, typically have smooth platforms, and are further defined as being larger than 1 cm^2.
- Retouch Chips: flake debitage possessing characteristic flake attributes, but are either smaller than 1 cm^2 or possess complex platforms. These are interpreted to represent secondary reduction (i.e., tool retouching and resharpening) or core platform trimming activities.

- Angular Shatter: non-flake debitage lacking recognizable dorsal and ventral surfaces and other characteristic flake attributes. They are also typically blocky and angular.
- Split Cobbles: non-flake debitage consisting of cobbles that have been either brought to the site or picked up at the site and presumably split to see if the raw material was suitable for flint knapping. These are split open, but show no signs of further manipulation.

Debitage types are subdivisions of the debitage classes discussed above. The various types are discussed and listed below.

- Cortical Spall Fragment: cortical spall possessing no striking platform that cannot be further typed into primary or secondary cortical spalls.
- Primary Cortical Spall: cortical spall with 50% of its dorsal surface covered with cortex.
- Secondary Cortical Spall: cortical spall with $<50\%$ of its dorsal surface covered with cortex.
- Flake Fragment: flake possessing typical flake attributes, but broken and missing a striking platform.
- Flake: flake typically possessing all flake attributes, including striking platform, percussion bulb, eraillure scar, and ripple marks.
- Blade-like Flake: flake typically possessing all flake attributes, but is twice as long as it is wide.
- Retouch Chip Fragment: retouch chip lacking a striking platform.
- Retouch Chip: complete retouch chip possessing all of the typical flake debitage attributes, (including a striking platform, percussion bulb, and ripple marks) and is less than 1 cm^2.
- Biface Thinning Flake: retouch chip possessing a complex platform indicating that it was detached from a bifacial edge during the retouching of a biface.

Surface Platform Preparation. As with the cores, surface platform preparation refers to the type of platform that a piece of flake debitage possesses. These are as follows:

- Cortical: debitage platform with cortex present.
- Smooth: debitage platform that is smooth, possessing no cortex or other flake facets. This type of platform typically is flat and produces a relatively obtuse outside angle with the dorsal surface.

- Complex: debitage platform showing evidence of previous flake removal. These types of platforms are typically found on bifacial thinning flakes.
- Abraded: debitage platform possessing evidence of intentional abrasion as a result of platform preparation prior to the removal of the flake.

Number of Dorsal Flake Scars. The number of dorsal flake scars is the count of negative flakes or flake scars on the dorsal side of a flake. This variable denotes the relative degree of core reduction leading up to the detachment of the measured flake. These were counted as 1 dorsal flake scar, 2 dorsal flake scars, 3 dorsal flake scars, 4 dorsal flake scars.

Amount of Cortex. Amount of cortex refers to the percentage of cortex present on the dorsal surface of the flake debitage. As with cores, these data were scored utilizing the ordinal scale of 0%, <10%, 10-50%, and >50% cortex.

Size Value. This variable refers to the size of the flake debitage and was scored utilizing the following ordinal scale:

- Very Small: flake debitage 1 cm^2.
- Small: flake debitage >1 cm^2 and <3 cm^2.
- Medium: flake debitage >3 cm^2 and <5 cm^2.
- Large: flake debitage >5 cm^2.

Tool Assemblage

The tool assemblage was characterized by the use of a tool typology including tool class and type. In addition, a series of non-metric and metric variables were measured on bifaces, including condition, maximum length, haft length, maximum width, maximum thickness, blade thickness, hafting element thickness, edge angle, and retouch invasiveness. Unifaces (tools retouched on one face) were further analyzed by scoring and measuring the following variables, tool blank, number of retouched margins, location of retouched margins, thickness, edge angle, and retouch invasiveness.

Tool Typology. Like the debitage typology, the typology used to characterize the tool assemblage is hierarchically organized with classes and types. Bifaces and unifaces are represented. Bifaces are divided at the class level by the presence or absence of hafting attributes (i.e., stems and shoulders with ground/abraded edges), while unifaces are classed by a variety of morphological attributes. The following is a description of tool classes followed by the corresponding tool types:

- Hafted Biface: biface possessing clear evidence of being hafted, including the presence of a hafting element and edge grinding and/or intentional retouching (i.e., notching) evident on the hafting element. Hafted bifaces only include those bifaces that clearly have such attributes, and do not include stemmed biface preforms that do not show evidence of actually having been completed and in a haft.
- Unhafted Biface: any biface that shows no definite signs of having been hafted.
- Side Scraper: unifacially retouched flake tool that possess retouch scars that are invasive and continuous along one or multiple margins. Side scrapers are typically made on thick flake blanks and have relatively steep working edges.
- End Scraper: unifacially retouched flake tool that displays retouch along the distal margin. As with side scrapers, end scraper retouch tends to be relatively invasive, and is combined with a thickness and edge angle that produces a steep working edge.
- Graver: a graver is a tool possessing one or more intentionally manufactured spurs. The spurs usually show signs of continuous unifacial retouch which shapes the spur into a recognizable form.
- Combination Tool: this is a tool possessing more than one type of morphological tool edge or a combination of tools, such as a scraper/graver, a combination tool that possesses a scraper edge and graver spur.
- Retouched Flake: flake debitage that is only marginally retouched. Retouch is minimal, often discontinuous, and has not directly modified the tool's shape.
- Other Tools: tools that number so few that they were placed together at the class level. These include backed knives, notches, denticulates, burins, and hammerstones.

Hafted biface types are described below. Since both Sadmat and Coleman are located in the northern half of the Great Basin, type names for stemmed points utilized in this study follow a northern Great Basin, in lieu of a Mojave Desert, classification.

- Parman Stemmed Point: stemmed point or hafted biface possessing a tongue-shaped or contracting stem, convex base, and shoulders that tend to be sloping but can be squared-off.

These points tend to possess hafting elements that are typically much longer than they are wide. My definition of a Parman point combines Layton's (1970) "Parman Type 1" and "Cougar Mountain Type" stemmed point types. These stemmed points are very similar to what many researchers refer to as "Lake Mohave" type points in the southern Great Basin (Amsden 1937; Pendleton 1979; Warren n.d., 1967, 1980; Warren and Ranere 1968; Warren and True 1961).

- Haskett Stemmed Point: stemmed point or hafted biface characterized by either a straight-sided or slightly contracting hafting element. The bases of these points tend to be straight; however, sometimes they are slightly convex. The hafting element of a Haskett point is much longer than its blade, and this point type exhibits no shouldering. This definition of a Haskett point follows Butler's (1965) description of "Haskett Types 1 and 2" and Layton's (1970) "Parman Types 2 and 3."
- Windust Stemmed Point: stemmed point or hafted biface characterized by straight-sided hafting elements and prominent squared-off shoulders (Leonhardy and Rice 1970; Rice 1972). The hafting element of a Windust point is typically shorter than that of a Parman or Haskett point, and typically is as wide as it is long. Bases are either straight, concave, or slightly convex.
- Stemmed Point Fragment: hafting element fragment missing either the base and/or shoulders, so that it is impossible to place the point into one of the three point types listed above; however, they do possess key attributes which allow for them to be placed into the stemmed point category (i.e. edge grinding).
- Humboldt Point: projectile point that is unnotched, lanceolate-shaped, and concave-based, but variably sized. These points sometimes possess parallel-oblique flaking (Green 1975; Holmer 1986; Thomas 1981).
- Elko Corner-Notched Point: projectile point that is large and corner-notched with an expanding stem and a straight base (Thomas 1981).
- Elko Eared Point: projectile point that is large and corner-notched with an expanding stem possessing a concave base (Thomas 1981).

Unhafted bifaces make up the next set of types. These are characterized in the following section.

- Biface Fragment: fragment of a biface that cannot be further typed.
- Miscellaneous Biface: untypable/unidentifiable biface that is complete or nearly complete, but cannot be further ascribed to any of the types below.
- Leaf-shaped Biface: biface that is bipointed and leaf-shaped.
- Ovate Biface: biface that is oval to ovate in shape.
- Discoid Biface: biface possessing a round shape and is disk-like.
- Crescent Biface: biface that possesses a crescentic shape with opposing convex and concave margins that converge at points on both ends.
- Stemmed Preform: biface possessing a formed stem, but is thick, chunky, and not finished, and does not display edge-margin grinding.
- Beaked Biface: biface possessing a bifacially-worked beak or spur. These are not typed as drills, because the beak is small, roughly the size of a graver spur.
- Lanceolate Biface: biface that is lanceolate-shaped, with expanding sides but no shoulders or stem.

Side scrapers are characterized below. A Bordian approach was utilized for scraper typology in order to try to fully describe scraper variation and reduction in each assemblage (Bordes 1961). The expectation is a scraper that has been retouched on more than one margin has been reworked more intensively than a scraper retouched on just one margin. Further, a convergent side scraper has been reworked to even greater an extent than a scraper retouched on two margins because the margins have been reduced to the point of converging (Dibble 1984, 1987).

- Side Scraper Fragment: broken side scraper that cannot be further typed.
- Unilateral Side Scraper: side scraper that displays invasive retouch along only one lateral margin.
- Bilateral Side Scraper: side scraper that has invasive retouch along two lateral margins.
- Convergent Side Scraper: side scraper that has invasive retouch on two lateral margins that converge at one end to form a point.

- Transverse Side Scraper: side scraper exhibiting invasive retouch along the transverse or distal edge opposite the tool blank's platform.
- Angle (Dejête) Scraper: side scraper possessing retouch along one lateral margin and the transverse margin. The point of convergence is off-angle from the long axis of the flake, unlike a convergent scraper, which has two lateral margins that converge at the long axis of the flake.
- 3-Sided Scraper: side scraper with three invasively retouched, converging margins.
- Bifacially Retouched Side Scraper: side scraper retouched on the dorsal as well as ventral face of the scraper, as to dispose of unwanted ventral surface abnormalities or bulges.
- Alternately Retouched Side Scraper: side scraper retouched on alternate surfaces of the tool, where retouch is found on a single margin of the dorsal face, and on an additional margin of the ventral face.
- Limace/Slug-Shaped Scraper: side scraper that is long and narrow, oval-shaped, thick and steeply keeled like the hull of a boat. These side scrapers have the appearance of a slug lying flat on a concrete surface.

End Scraper are further categorized into seven types. These are characterized in the next section.

- End Scraper Fragments: broken end scraper that cannot be further typed into one of the categories that follow.
- End Scraper on a Flake: end scraper manufactured on a flake.
- Round End Scraper: end scraper with a distally worked edge that forms a round scraper. The retouch traverses the distal end of the scraper from one lateral margin to the other.
- Pan-shaped End Scraper: end scraper that has a broad distal end but waisted proximal end. Some show signs of having been hafted.
- Steeply Keeled End Scraper: end scraper that is formed on a very thick flake and has very steep retouch. These are often referred to as carinated end scrapers.
- End Scraper on a Blade: end scraper that is manufactured on a blade.
- Spurred End Scraper: end scraper possessing a spur, typically at the corner of the distal margin with end-scraper retouch.

Gravers are further categorized according to number of graver spurs, as characterized in following section.

- Graver Fragment: graver that is fragmented and cannot be further typed.
- Single-Spurred Graver: graver possessing only on spur.
- Multiple-Spurred Graver: graver possessing more than one spur.

Five types of combination tools were identified and described. These are characterized in the following section.

- Wedge/Scraper: tool possessing 1) margin(s) of retouch that produces an acute edge angle and displays bifacial flaking, referred to as a wedge, and 2) margin(s) of retouch that produces steep or obtuse edge angles, resembling a scraper edge. Since these are made on flakes and display regular bifacial flaking on both tool ends, these are considered to be tools and not bipolar cores.
- Scraper/Graver: tool possessing 1) scraper margin(s) and 2) graver spur(s).
- Scraper/Notch: tool possessing 1) scraper margin(s) and 2) notch.
- Notch/Graver: tool possessing 1) margin of retouch with a notch and 2) graver spur.
- Scraper/Burin: tool possessing 1) scraper margin(s) and 2) burin.

Retouched flakes are further categorized into three types. These are characterized in the section below.

- Retouched Flake Fragment: retouched flake that occurs on a broken flake.
- Retouched Flake: flake with clear signs of marginal retouch.
- Retouched Blade: blade with clear signs of marginal retouch.

Tool types falling into the "other tools" class. These tools are characterized in the section below.

- Backed Knife: unifacial flake tool with an acute retouched margin opposite a steep unretouched margin that is formed on either a cortical surface or a break.
- Notch: tool possessing unifacial retouch forming a notch.
- Denticulate: uniface possessing a series of notches along a margin.

- Burin on Flake: uniface that has a pointed to near-pointed end produced by the removal of one or more burin spalls. Burins are the result of longitudinal removal (as opposed to facial removal) of a spall from the edge of a tool.
- Burin on Biface: biface that has a pointed to near-pointed end produced by the removal of one or more burin spalls. These may be the result of intentional resharpening, but could also be due to impact breakage.
- Hammerstone: cobble tool possessing battering on one or more ends that was presumably used as a hammer for percussion flaking.

Biface Condition. Biface condition refers to whether the biface is complete, broken, or reworked, and was scored utilizing the following set of variables:

- Complete: biface that is complete.
- Broken: biface fragment that cannot be further classified.
- Proximal Fragment: biface fragment missing everything except for the proximal end (end that contains the striking platform) or base of the biface.
- Medial Fragment: biface fragment missing the base and tip (i.e., the mid-section of the biface).
- Distal Fragment: biface fragment missing everything except for the distal end or tip of the biface.
- Lateral Fragment: biface fragment fractured longitudinally along a lateral margin.
- Reworked: biface that shows signs of being resharpened, sometimes after a previous break.

Maximum Length. The maximum length of all complete bifaces was scored. This measurement was taken in mm.

Haft Length. This measurement represents the length of the hafting element or stem of a biface. This measurement was taken in mm.

Maximum Width. This measurement represents the maximum width of all complete and reworked bifaces. This measurement was taken in mm.

Maximum Thickness. This measurement represents the maximum thickness of all bifaces that were large enough to be scored. This measurement was taken in mm.

Blade Thickness. This measurement represents the thickness of all hafted bifaces that clearly posses a blade section. This measurement was taken in mm.

Hafting Element Thickness. This measurement refers to the thickness of a biface's hafting element or stem. This measurement was taken in mm.

Edge Angle. This measurement refers to the angle produced by the retouch of the bifacial edge and was measured at the point along the edge where the most invasive flake was struck. This measurement was scored in degrees.

Invasiveness of Biface. This measurement refers to the length of the most invasive flake on the biface. This measurement was taken in mm.

Tool Blank. This variable represents the tool blanks for unifaces, and was score utilizing the following nominal scale.

- Cortical Spall: flake possessing cortex.
- Flake: flake not possessing cortex, but possessing a smooth platform.
- Biface Thinning Flake: flake possessing a bifacial/complex platform.
- Blade-like Flake: flake twice as long as it is wide.
- Blade: flake not only twice as long as it is wide, but also appears to have possessed straight, parallel lateral margins prior to retouch.
- Core: tool blank that is a recycled core.

Number of Margins Retouched. This variable represents the number of margins retouched on unifacial tools, and was scored utilizing the following ordinal scale.

- Single Margin: tool retouched on one margin.
- Multiple Margins: tool retouched on more than one margin.

Location of Retouch. This variable represents the position or location of retouch on unifaces and was scored utilizing the following nominal scale.

- Distal: retouch on the margin opposite the striking platform.
- Lateral: retouch on the margin on either side of the longitudinal axis of the uniface.
- Proximal: retouch on the margin once possessing the striking platform.
- Distal/Lateral: retouch on both the distal and lateral margins.
- Distal/Proximal: retouch on both the distal and proximal margins.

- Lateral/Proximal: retouch on both the lateral and proximal margins.
- All Margins: retouch all the way around the tool.

Maximum Thickness of Uniface. This measurement refers to the maximum thickness of the uniface and is measured in mm.

Edge Angle of Uniface. This measurement refers to the angle of the working edge of the uniface and was measured at the point along the edge of the uniface where the most invasive flake was struck. This measurement was taken in degrees.

Invasiveness. This measurement refers to the length of the most invasive flake on the uniface and is measured in mm.

Integrative Analysis

This section of the chapter deals with the methodology utilized to produce the results presented in Chapter 5. These include the methods of 1) statistical analysis, 2) XRF analysis, and 3) integrative lithic analyses.

Statistical Analysis

Comparative statistics were utilized to compare raw materials within the Sadmat and Coleman assemblages through the use of chi-square contingency table analysis and through comparison of means analysis.

To test for relationships in raw material preferences, individual nominal scale artifact variables relating to provisioning strategies were subjected to contingency table analysis, utilizing the chi-square test statistic. These variables include biface-core versus flake core use, formal versus informal tool production, including formal versus informal uniface manufacture.

Two types of comparison of means tests were utilized. First, however, before specific tests of means were chosen, a Kolmogorov-Smirnov test for normality was conducted to see if the sample analyzed possessed normal distributions. If the data were determined to have normal distributions, then a one-way analysis of variance (ANOVA) test was utilized. If, however, the data were found not to be normal, a non-parametric, Kruskal-Wallis H test was conducted. The variables analyzed in this manner include the biface reduction index, uniface reduction index, and number of margins retouched on both formal and informal tools. Where sample sizes were too small for statistical analysis, these are noted. Variables analyzed statistically are presented in more detail later in this chapter.

X-ray Fluorescence (XRF) Analysis

XRF analysis uses ratios of trace elements to characterize obsidian and basalt sources along with artifacts, allowing us to assign specific obsidian and basalt artifacts to specific sources. The methods utilized by this analysis are nondestructive and yield precise measures of trace element concentrations in these raw materials.

Obsidian sources tend to be similar in their trace element makeup; however, for many sources there is enough variability to allow source distinctions to be made (Hughes 1984; Hughes and Smith 1993). The geochemical fingerprint for basalt is typically less variable than obsidian, and therefore, source analysis of basalt is limited (Latham et al. 1992). In many instances the specific source of basalt cannot be known.

Obsidian and basalt sourcing studies are important in western United States because these toolstone types are abundant. Obsidians and basalts can be chemically traced to source areas on the landscape, therefore, offering archaeologists the opportunity to reconstruct various past behaviors of the humans that utilized these toolstones.

XRF characterization is useful in archaeological interpretation at both the site level and regional level (Hughes 1986; Hughes and Bettinger 1984; Hughes and Smith 1993). In order to answer the questions proposed in the current study, a regional approach is adopted. Therefore, artifact distributions are not reconstructed at the site, but distances to source are utilized to help reconstruct degrees of mobility and direction of travel of the inhabitants of Sadmat and Coleman. Bifaces and related debitage and bipolar cores for Sadmat were chosen for XRF analysis because these artifacts were probably heavily curated, therefore traveling far distances. For Coleman, ten artifacts were chosen, including bifaces and associated debitage and retouched flakes, because there were only 54 artifacts from the site made of obsidian and these are a representative sample of the total.

Biface-to-Core Ratio

Many researchers have suggested that bifaces are an excellent, reliable core form, especially for mobile groups wanting to reduce the risk of not being prepared while on the move, but not wanting to carry heavy flake cores (Andrefsky 1991, 1998; Kelly 1988a; Parry and Kelly 1987). As a result, mobile groups typically prefer to carry multifunctional, ready-to-use, and portable cores that can also function as tools. Figure 3.2 shows a schematic drawing of the reduction trajectory of an unhafted biface being utilized as a core. As shown in this trajectory, bifaces are the perfect mobile core. Biface thinning flakes, detached serially from a biface during its reduction and before production of the final biface form, can be used as tools themselves. Therefore, following Kelly (1988a) and Parry and Kelly (1987), I utilize the biface-to-core ratio, which refers to the frequency of unhafted bifaces to the frequency of less formal, expedient flake cores. Then, I subject this ratio at both the Sadmat and Coleman sites to chi-square analysis to test for the preference of certain raw material types for the manufacture of bifaces and cores.

Formal Versus Informal Tool Production

Formal tools are defined as those tools that have been prepared in advance of use; therefore, much effort was expended in their manufacture. Informal tools are defined as those tools that have been manufactured with little or no preparation time, in which the manufacturer spends little effort preparing these items. Various lithic researchers have suggested that formal tools are 1) flexible and easily curated (Goodyear 1989, 1993; Kelly 1988a, 2001; Kuhn 1995) and 2) transportable and ready to use whenever needed (Kelly 1988a; Kuhn 1995; Torrence 1983). For these reasons, I calculate the frequencies of formal and informal tools in the Sadmat and Coleman assemblages, and compare (with chi-square analysis) these proportions by raw materials used in their manufacture. In this study, formal tools include bifaces, scrapers, and combination tools, along with multiple-spurred gravers and burins on bifaces. Informal tools include single-spurred gravers and graver fragments (since it is unclear if these artifacts once possessed more than one spur), burins on flakes, notches, denticulates, backed knives, and retouched flakes.

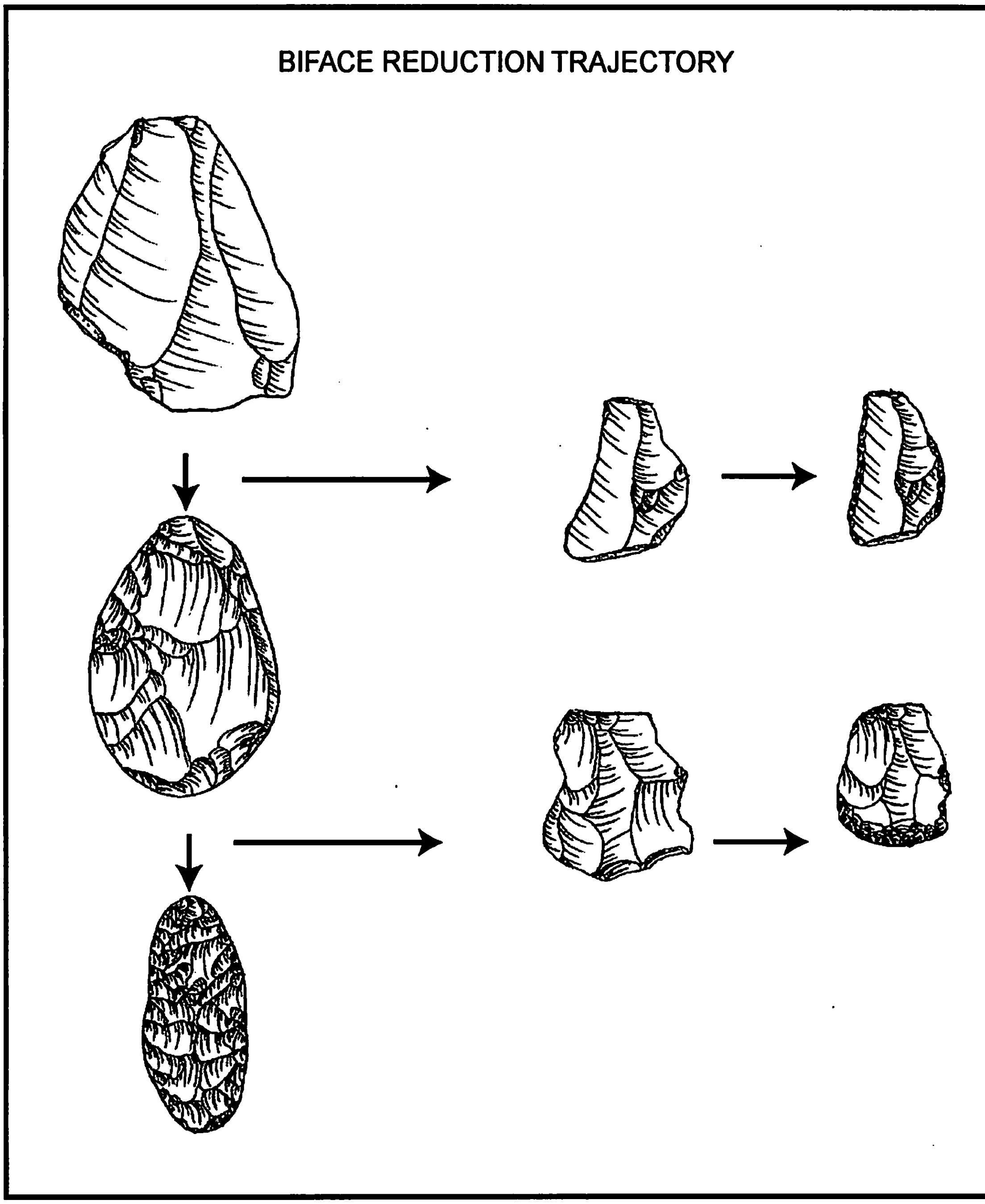


Figure 3.2. Schematic reduction trajectory for biface-cores.

Tool Use-Life Histories

Tool use-life histories help to characterize degree of tool rejuvenation or refurbishing. This is important when trying to characterize the intensification of tool use and how it relates to provisioning and mobility. Therefore, this study aims to retrace tool use-lives by 1) calculating a biface reduction index and testing its relationship to raw material selection by comparing the means of the index, 2) calculating a uniface reduction index and testing its relationship to raw material selection by comparing the means of the index, 3) calculating frequencies of formal and informal unifacial tool production and comparing these to raw material selection (with a chi-square analysis), and 4) calculating frequencies of numbers of margins retouched on formal and informal unifaces to test raw material selection by comparing the means of these data.

Explanations of Reduction Indices. The biface reduction index is measured by dividing the thickness of the biface (T) by the width of the biface (W). This measurement was taken only on the blades of hafted bifaces, because only the blades would be resharpened, while hafting element widths do not change once they have been inserted in a haft. Theoretically, the higher the ratio, the more resharpened or refurbished the biface. Inversely, the closer the ratio is to 0.0, the less refurbished the biface. Figure 3.3 is a schematic drawing of this ratio and how it works.

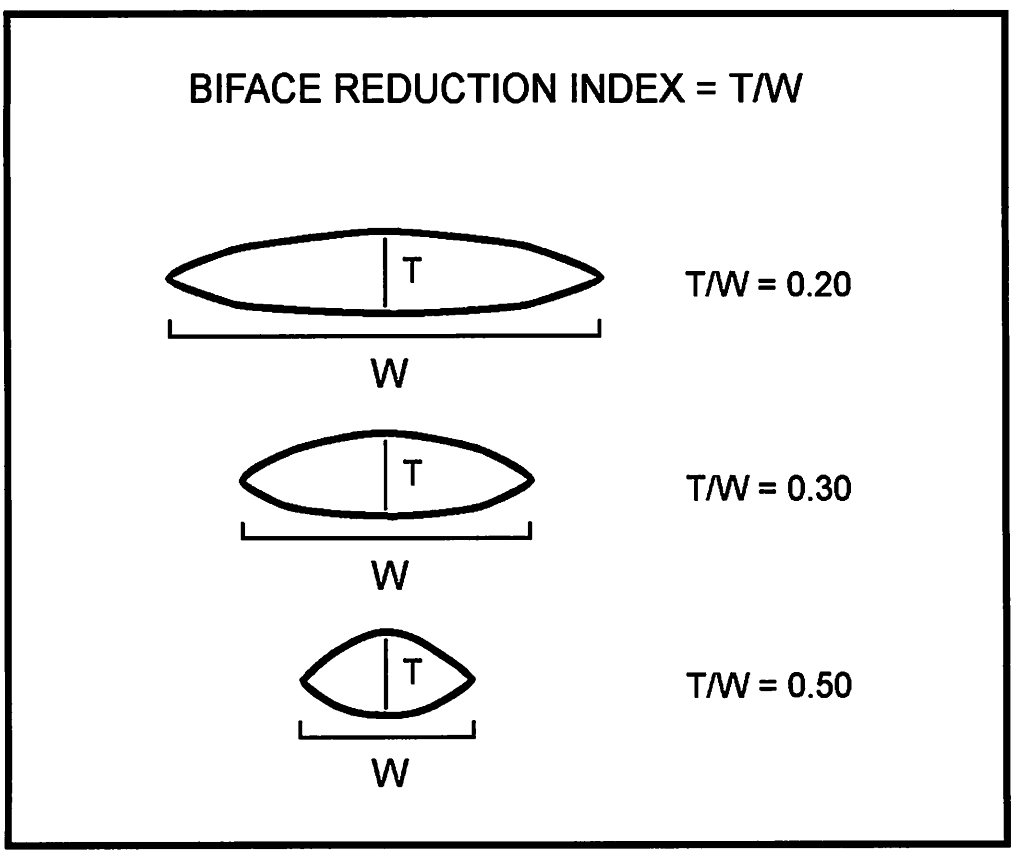


Figure 3.3. Biface reduction index used to measure the reduction intensity for hafted bifaces.

The uniface reduction index is adopted from Kuhn (1992, 1995) and is a ratio of the thickness of the reworked edge (t) divided by the total thickness of the uniface (T). As noted by Kuhn (1995), sometimes the thickness of the reworked edge is difficult to measure and therefore an adaptation of this formula was used, one in which (t) was calculated by taking the sine of the angle of the reworked edge and multiplying it by the length of the most invasive flake scar (D). Figure 3.4 is a schematic drawing of this ratio and how it works.

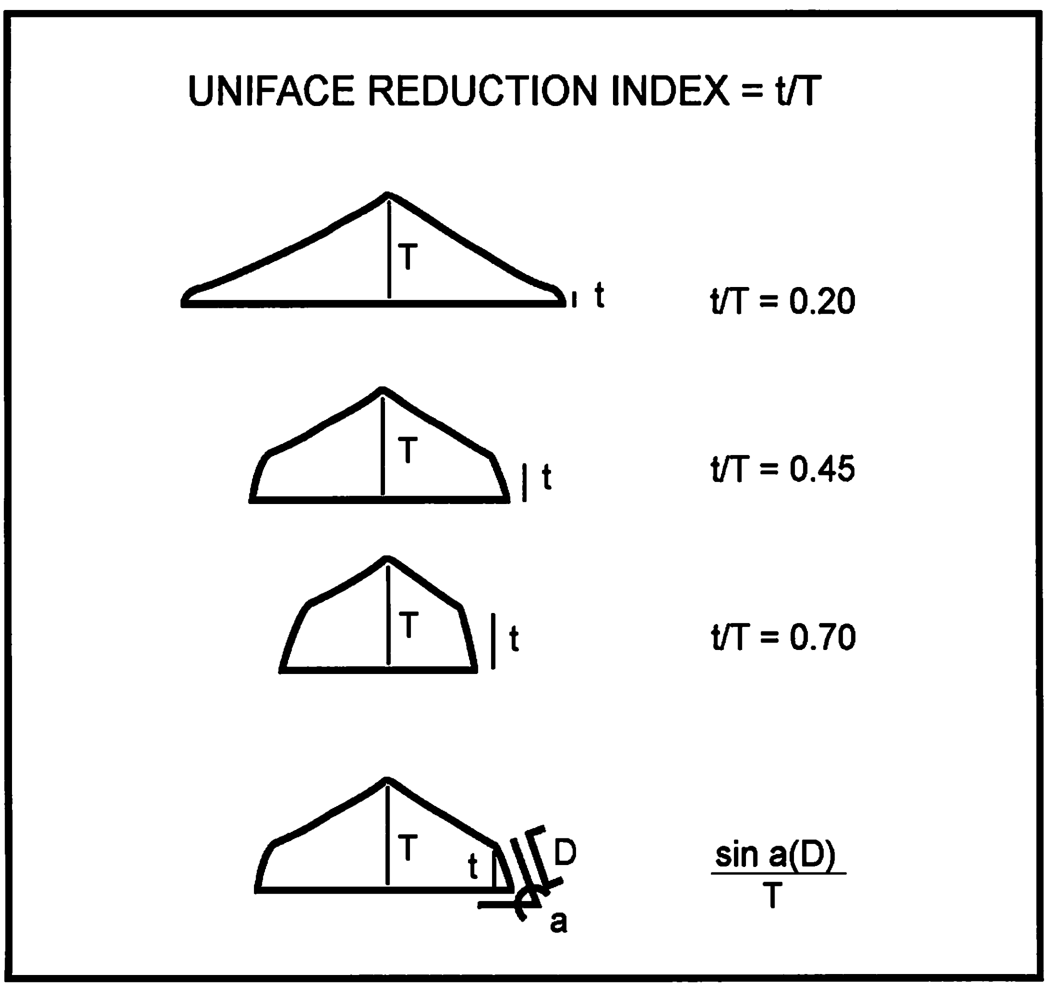


Figure 3.4. Uniface reduction index used for measuring the reduction intensity for unifaces (after Kuhn 1992, 1995).

Summary

This chapter outlined the methods employed in the current study. The typology and variables utilized in characterizing the assemblages were described. Methods used in statistical analysis of the data were described, means for choosing obsidian and basalt artifacts for XRF analysis were presented. Also, a description of variables used to measure degrees of mobility were presented. These variables, both observed and measured, can lead to a greater understanding of the raw material selection, technological organization, and settlement systems of the early inhabitants in the western Great Basin.

CHAPTER 4

THE SADMAT AND COLEMAN LITHIC ASSEMBLAGES

This chapter describes the lithic assemblages from the Sadmat and Coleman sites. As discussed in Chapter 2, both of these sites contain Great Basin stemmed points and, therefore, based on typology, are presumed to date to the late Pleistocene/early Holocene transition (Bedwell 1973; Carlson 1983; Elston 1982, 1986; Tuohy 1968, 1969, 1970, 1974, 1981, 1988b; Tuohy and Layton 1977; Warren and Ranere 1968). Each assemblage is described in the following order. First, lithic raw material types are presented. Second, cores are described according to a core typology and a series of non-metric morphological and metric variables. Third, the debitage assemblage is described according to a debitage typology and several debitage attributes. Fourth, the tool assemblage is described in detail, including a tool typology and a series of non-metric and metric attributes that in some cases are specific to single tool groups.

Results of integrative statistical analyses relating to technological activities, toolstone selection, and mobility are presented in Chapter 5. Definitions of all variables and values were presented in Chapter 3.

The Sadmat Assemblage

The Sadmat assemblage as described in this investigation consists of 3,138 lithic artifacts. These include 170 cores, 673 pieces of debitage, and 2,295 bifacial and unifacial tools.

Raw Material

The Sadmat assemblage consists of several raw material types. These include basalt, obsidian, cryptocrystalline silicate (CCS), rhyolite, quartz, quartzite, welded tuff, and meta-siltstone. Basalt, obsidian, and CCS dominate the assemblage and make up 99.1% of all of the raw materials utilized to manufacture the artifacts at the site. As shown in Figure 4.1, CCS artifacts number 1,940 (61.8%), obsidian artifacts number 812 (25.9%), and basalt artifacts number 358 (11.4%) of the assemblage. Because all other toolstone types only number 28 (0.9%), these are grouped together and labeled "Other."

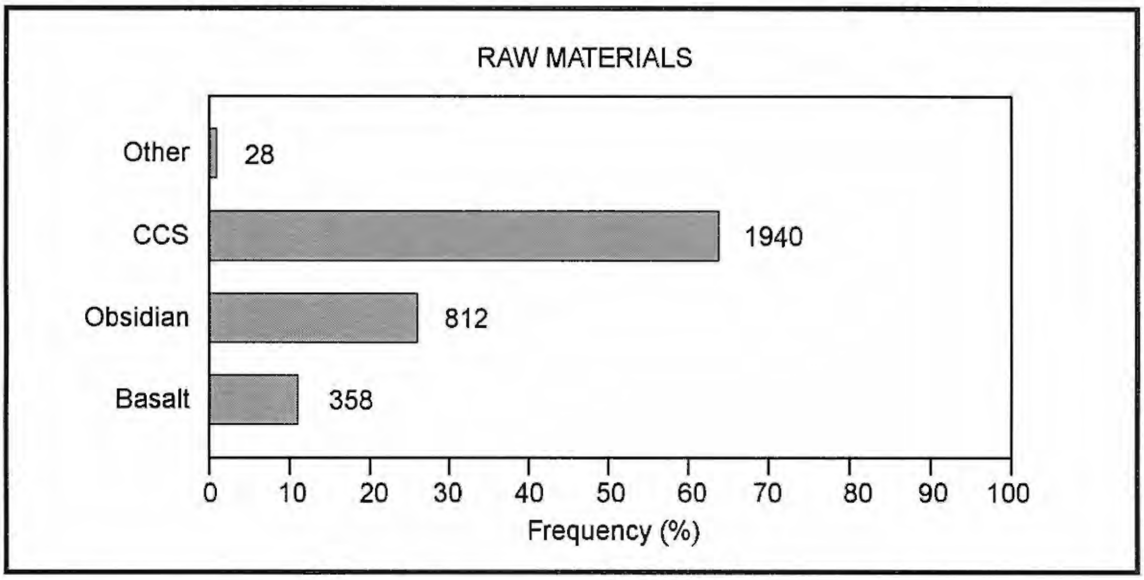


Figure 4.1. Raw materials represented in the Sadmat lithic assemblage.

Cores

The core assemblage at Sadmat is characterized by the presence of 168 flake cores and 2 possible bipolar cores. These consist of 4 (2.4%) tested cobbles, 57 (33.5%) unidirectional cores, 69 (40.5%) bidirectional cores, 38 (22.3%) multidirectional cores, and 2 (1.2%) bipolar cores (Figures 4.2 and 4.3). The two bipolar cores are on obsidian. Both appear to be tools that have been reworked bipolarly, but it is not clear whether they actually represent cores or wedges. Among the 170 cores, the vast majority (91.2%) are made on CCS (Table 4.1). Three of the tested cobbles are manufactured on CCS while the other is on quartz. Fifty-two of the unidirectional cores are manufactured on CCS, 3 on basalt, and 2 on obsidian. Sixty-five of the bidirectional cores are manufactured on CCS, 2 on basalt, and 2 on obsidian. Thirty-five of the multidirectional cores are manufactured on CCS and 3 on obsidian (Table 4.1).

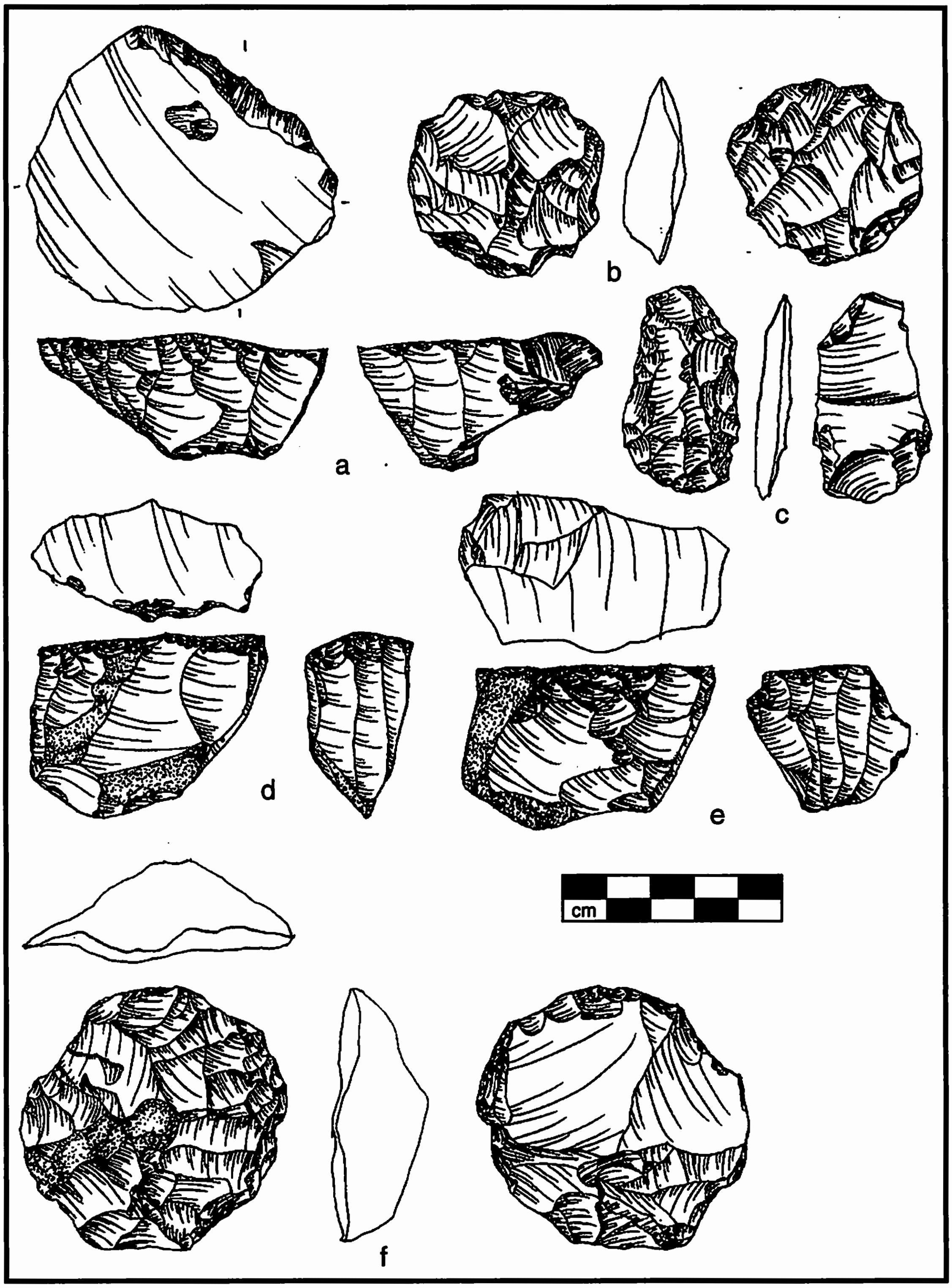


Figure 4.2. Sadmat flake cores (a, d, e: unidirectional flake cores; b, f: bidirectional flake cores; c: bipolar core).

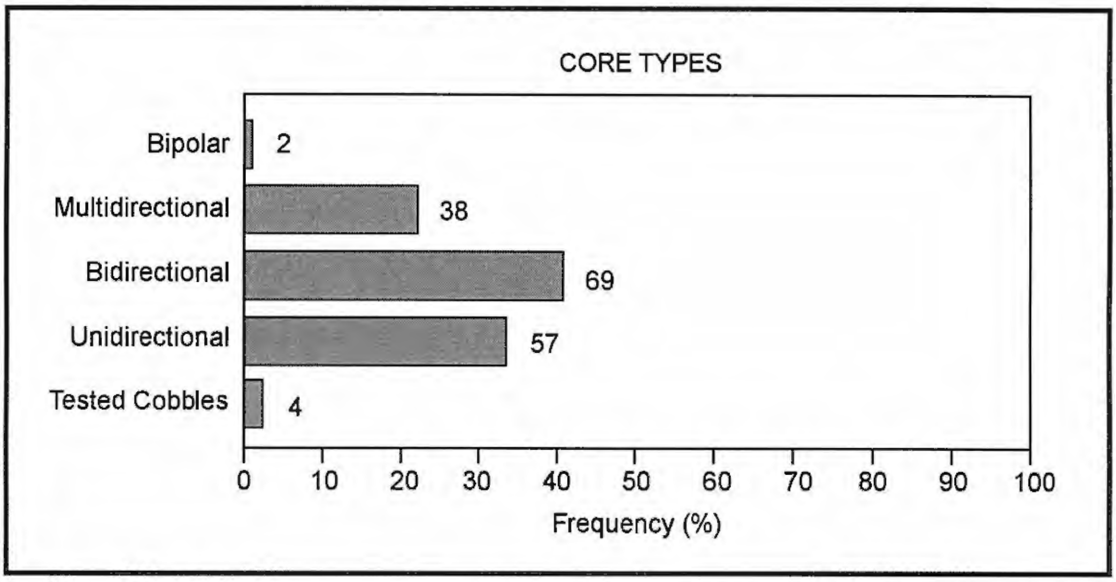


Figure 4.3. Flake core types represented in the Sadmat assemblage.

Table 4.1. Sadmat Core Types by Raw Material.

			Raw Material			
Tool Type	n	%	Basalt	Obsidian	CCS	Other
Tested Cobbles	4	2.4	0 (0.0%)	0 (0.0%)	3 (75.0%)	1 (25.0%)
Unidirectional Cores	57	33.5	3 (5.3%)	2 (3.5%)	52 (91.2%)	0 (0.0%)
Bidirectional Cores	69	40.5	2 (2.9%)	2 (2.9%)	65 (94.2%)	0 (0.0%)
Multidirectional Cores	38	22.3	0 (0.0%)	3 (7.9%)	35 (92.1%)	0 (0.0%)
Bipolar Cores	2	1.2	0 (0.0%)	2 (100.0%)	0 (0.0%)	0 (0.0%)
Total	170	100	5 (2.9%)	9 (5.3%)	155 (91.2%)	1 (0.6%)

Number of platforms serves to support analysis of the intensity of use of the core and in describing the core type (Figure 4.4). Of the 168 flake cores, for which number of platforms was scored, 58 (34.5%) possess one platform, 76 (45.2%) possess two platforms, 24 (14.3%) possess three platforms, and 10 (6.0%) possess four platforms (Figure 4.4). These numbers match the types

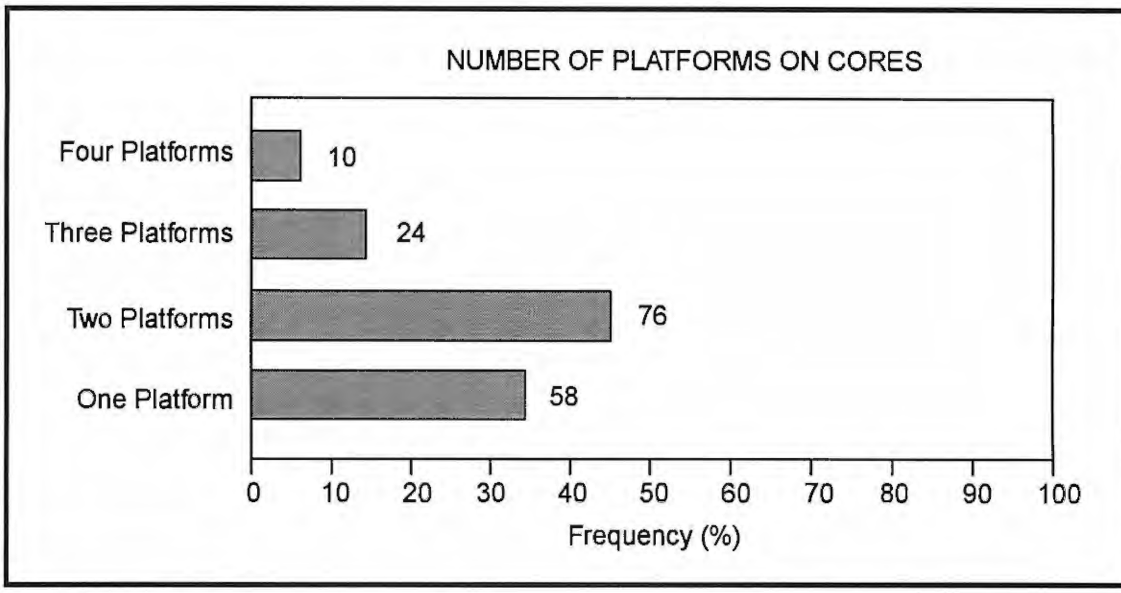


Figure 4.4. Numbers of platforms on flake cores in the Sadmat assemblage.

fairly well with only a few differences. Unidirectional cores number 57 while cores possessing only one platform number 58. The extra core possessing one platform is probably one of the four tested cobbles present in the assemblage. Likewise, the difference in the number of bidirectional cores compared to the incidence of cores with two platforms reflects the possibility that a few of the cores that have two platforms are not bidirectional in nature, but tested cobbles or multidirectional cores. Thus, nearly two-thirds of the cores have more than one platform, suggesting a high degree of core reduction.

The number of fronts for each core was scored. Five (3.0%) of the cores possess one front, 32 (18.8%) possess two fronts, 104 (61.2%) possess three fronts, and 29 (17.0%) possess four or more fronts (Figure 4.5). Therefore, 97% of the cores exhibit more than one front. Like number of platforms, this suggests a high degree of core reduction.

Surface platform preparation was tallied (Figure 4.6), with 9 (5.4%) of the cores possessing cortical platforms, 64 (38.1%) possessing smooth platforms, and 79 (47.0%) exhibiting complex platforms. Twelve (7.1%) of the cores have both smooth and complex platforms, 3 (1.8%) have both cortical and complex platforms, and 1 (0.6%) possesses both cortical and smooth platforms. As shown by these data, 95% of the cores have some form of platform surface preparation.

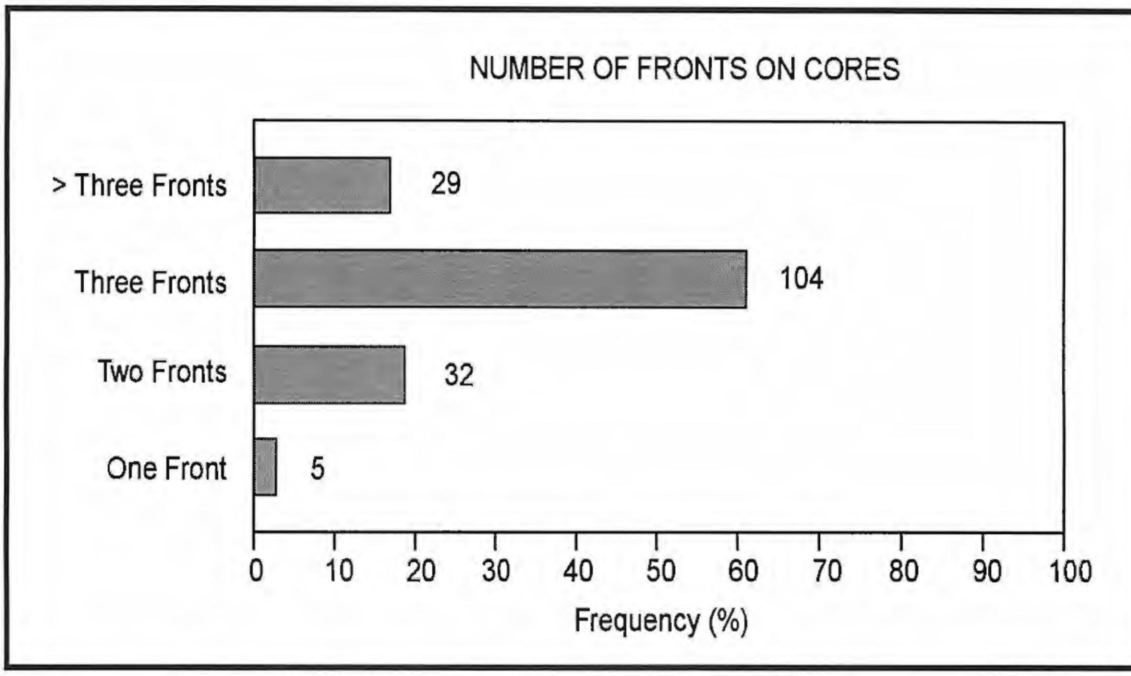


Figure 4.5. Numbers of fronts on flake cores in the Sadmat assemblage.

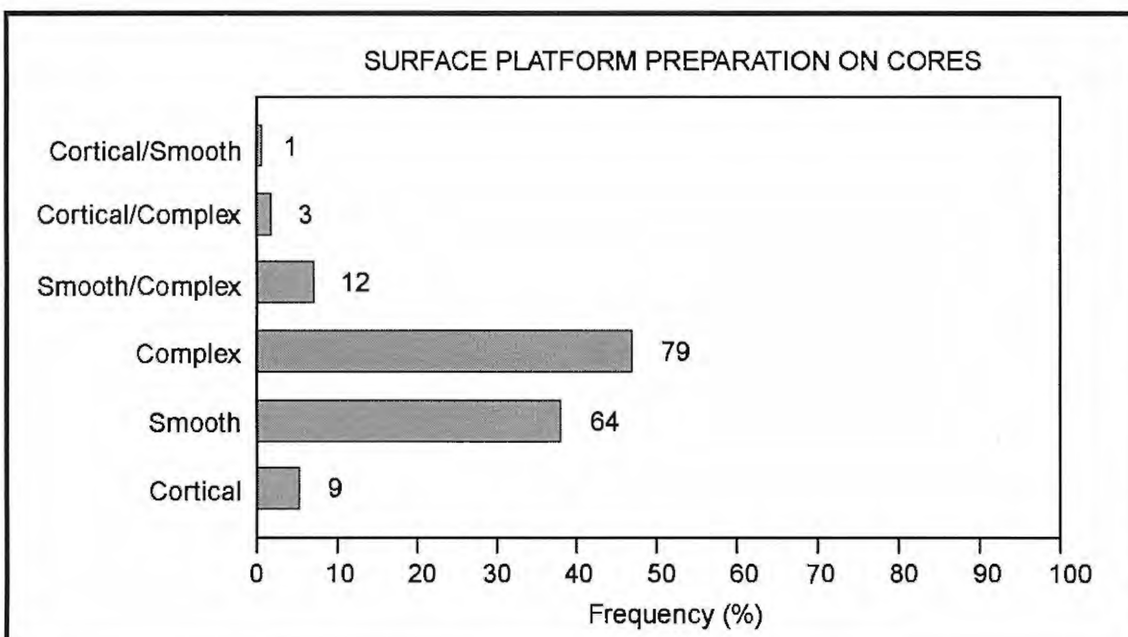


Figure 4.6. Surface platform preparation on flake cores in the Sadmat assemblage.

The amount of cortex for each core was estimated visually and scored (Figure 4.7). The majority of cores (121 [71.2%]) do not have cortex, while 16 (9%) of the cores possess less than 10% cortex, 23 (14%) bear between 10 and 50% cortex, and 10 (6%) cores contain more than 50% cortex.

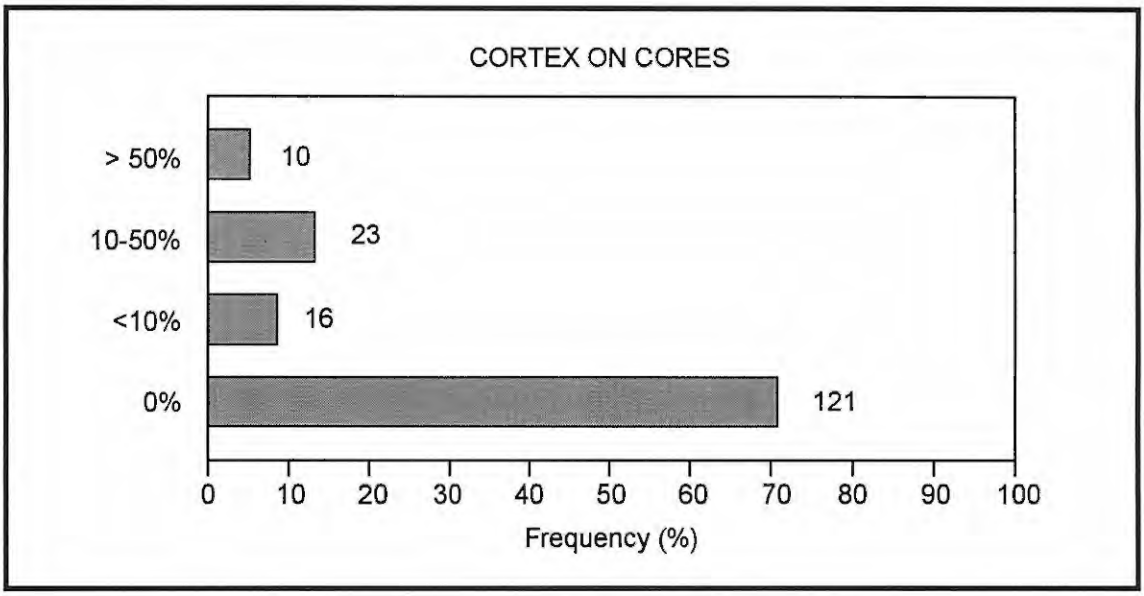


Figure 4.7. Amounts of cortex present on flake cores in the Sadmat assemblage.

The size value of each core was calculated, first by measuring the maximum linear dimension (MLD) of the core and multiplying this number by the weight of the core in grams. The MLD measurements and core weights are shown in Figures 4.8 and 4.9. The size value is shown in Figure 4.9. For MLD, 170 cores were scored. Resulting measurements range from 21 to 114 mm. The MLD mean is 55.4 mm and the standard deviation is 16.6 mm (Figure 4.8). For core weight, 170 cores were scored. Resulting measurements range from 2.8 to 346.3 g, with a mean of 55.3 g and a standard deviation of 48.4 g (Figure 4.9). The vast majority of cores have size values of less than 2,000. Size values range from 59 to 39,063, with a mean of 3,769.8 and a standard deviation of 4,931.1 (Figure 4.10). The small size of the Sadmat flake cores, combined with the high number of fronts, high number of platforms, and low amount of cortex, may suggest that the cores discarded at the site were approaching the ends of their use lives.

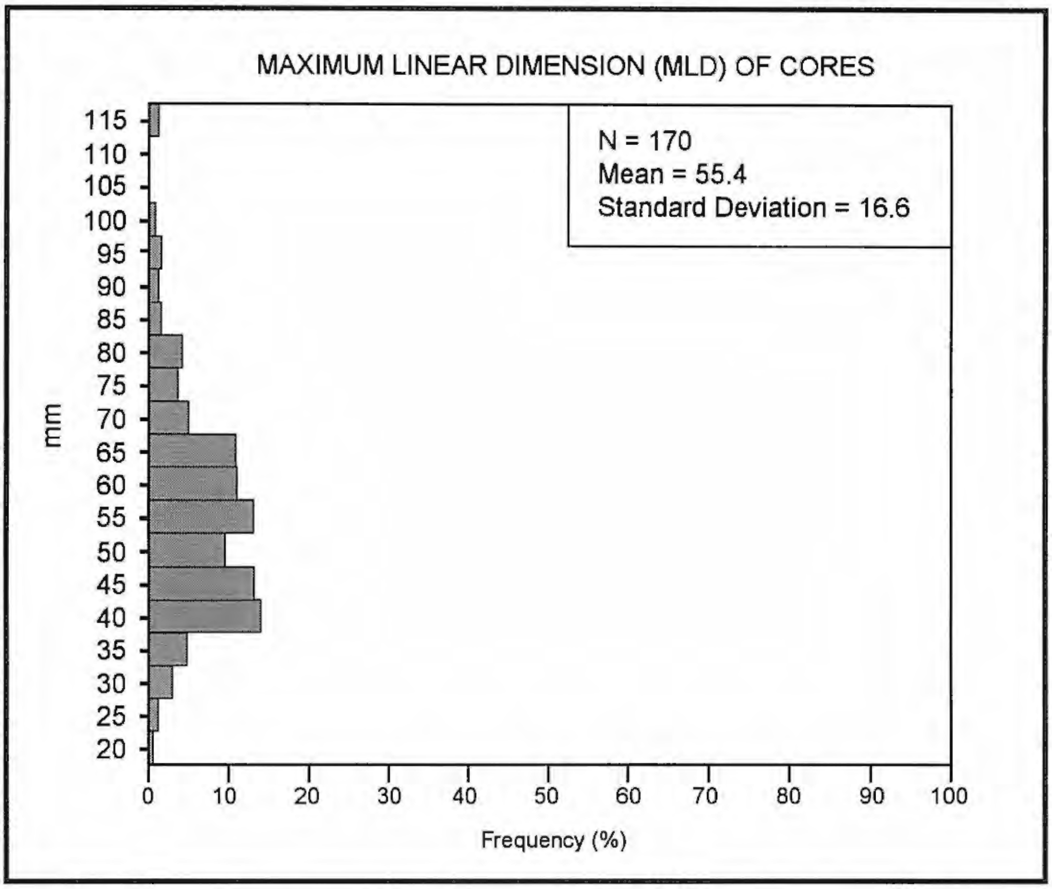


Figure 4.8. Maximum linear dimensions (MLD) of flake cores in the Sadmat assemblage.

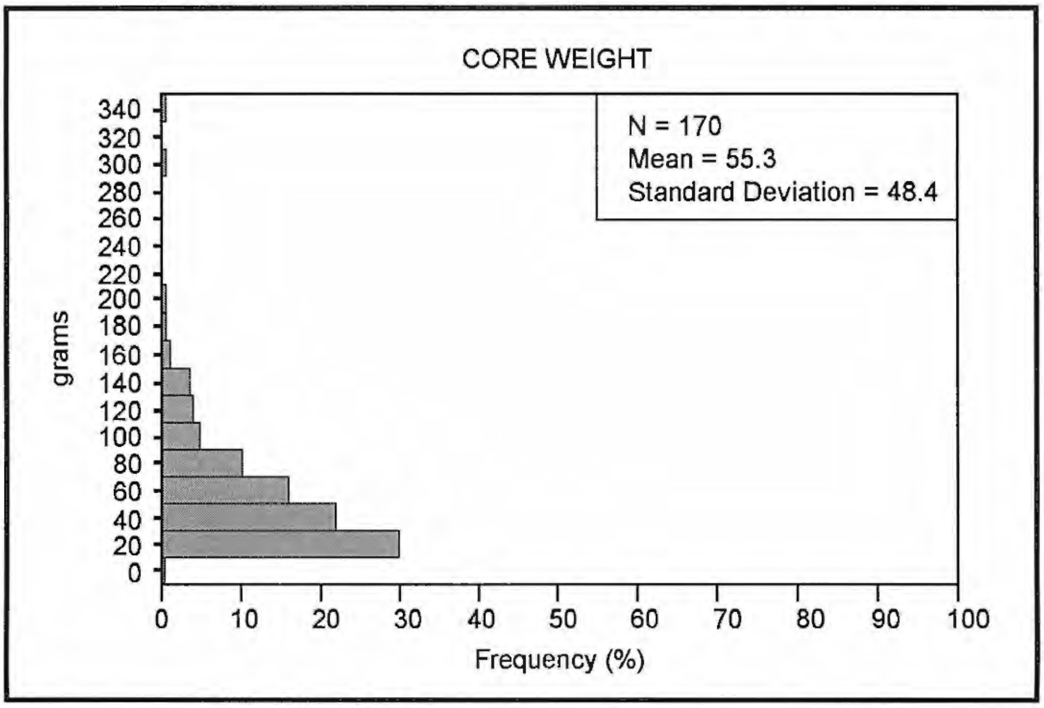


Figure 4.9. Weights of flake cores in the Sadmat assemblage.

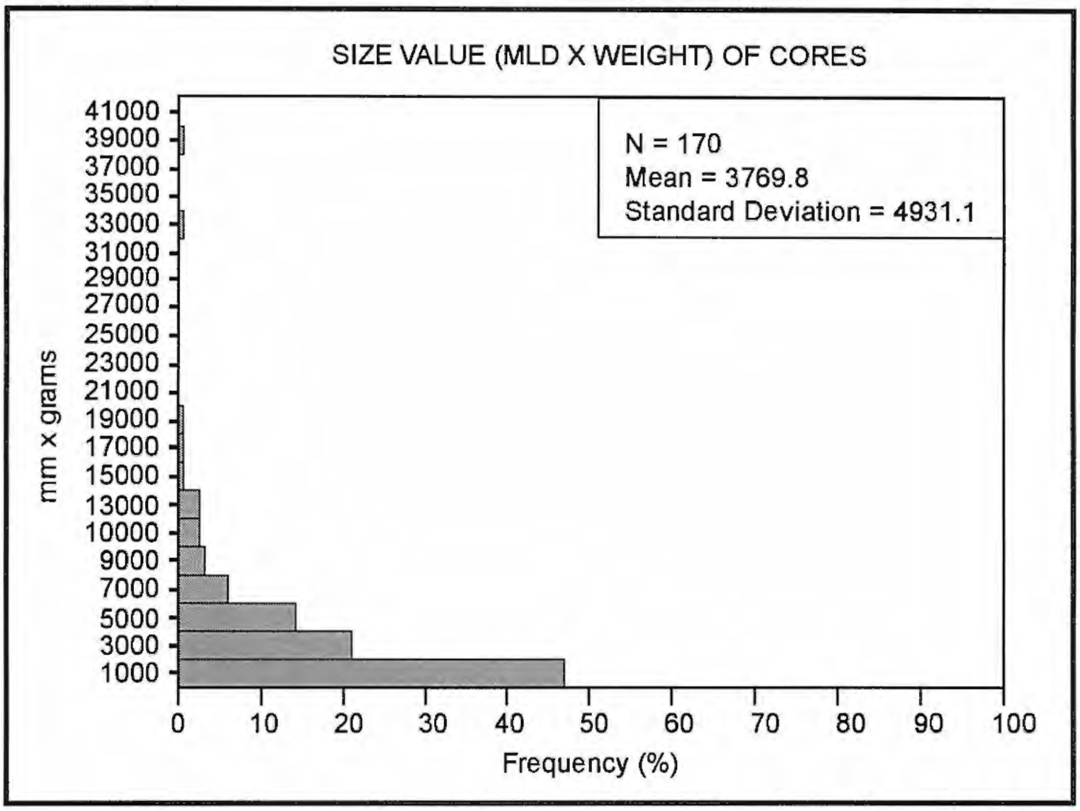


Figure 4.10. Size values of flake cores in the Sadmat assemblage.

Debitage

Only 673 pieces of debitage occur in the Sadmat assemblage. This low frequency of debitage could be a result of sampling problems and/or geomorphic disturbances, as discussed in Chapter 2. Debitage classes include 12 (1.8%) split cobbles, 24 (3.6%) pieces of angular shatter, 69 (10.3%) cortical spalls, 342 (50.8%) flakes, and 226 (33.6%) retouch chips (Figure 4.11). The debitage classes cortical spalls, flakes, and retouch chips were further broken down into types (Table 4.2). Among cortical spalls, cortical spall fragments number 16 (23.2%), primary cortical spalls number 22 (31.9%), and secondary cortical spalls number 31 (44.9%). Among flakes, flake fragments number 120 (35.1%), flakes number 205 (59.9%), and blade-like flakes number 17 (5.0%). Among retouch chips, retouch chip fragments number 16 (7.1%), retouch chips number 27 (11.9%), and biface thinning flakes (BTF) number 183 (81.0%) (Table 4.2).

When comparing these types to raw materials (Table 4.2), 9 split cobbles are manufactured on CCS and 3 split cobbles are manufactured on basalt. Eighteen pieces of angular shatter are

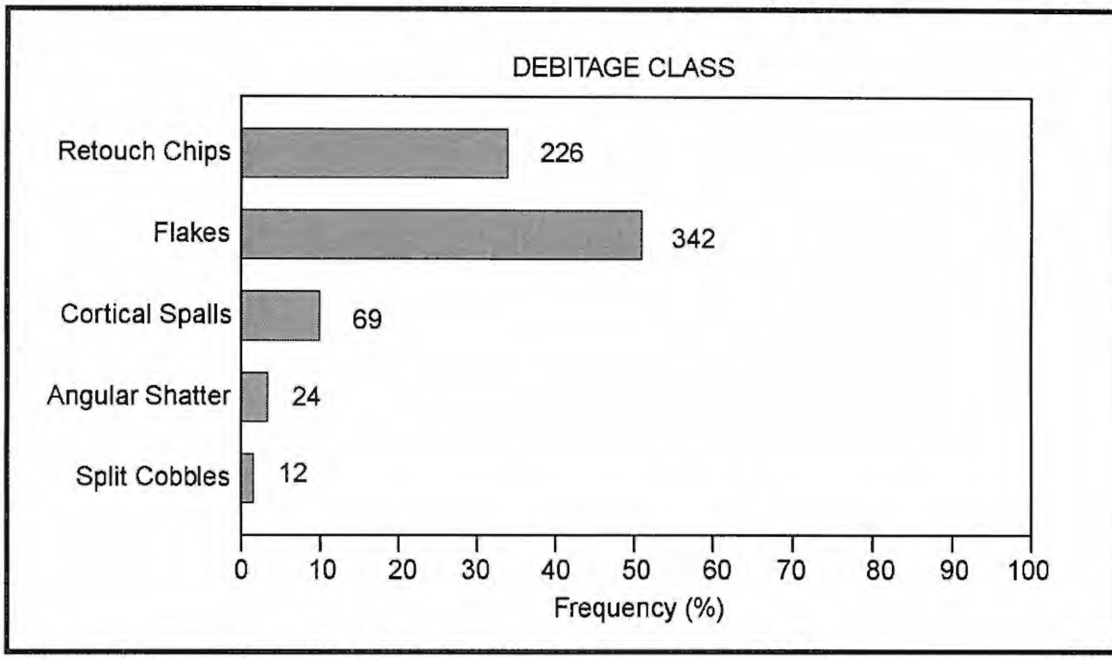


Figure 4.11. Debitage classes for the Sadmat assemblage.

manufactured on CCS, while 6 are produced on obsidian. Fourteen of the cortical spall fragments are manufactured CCS and 2 are on obsidian. Fifteen of the primary cortical spalls are manufactured from CCS, 5 on obsidian, 1 on basalt, and 1 on quartz. Twenty-six of the secondary cortical spalls are manufactured on CCS, 3 on obsidian, and 2 on basalt. Fifty-seven of the flake fragments are manufactured on CCS, 39 on obsidian, and 24 on basalt. One hundred fifty-seven flakes are manufactured on CCS, 32 on obsidian, and 16 on basalt. All seventeen blade-like flakes are manufactured on CCS. All sixteen retouch chip fragments are manufactured on obsidian. Nineteen retouch chips are manufactured on obsidian, 6 on CCS, and 2 on basalt. One hundred twenty-six biface thinning flakes are manufactured on CCS, 33 on obsidian, and 24 on basalt.

Surface platform preparation on the debitage was scored (Figure 4.12). Among the debitage, 186 pieces consist of fragments, angular shatter, and/or split cobbles that do not possess platforms that can be scored. Fifteen (3.1%) of the recognizable platforms are cortical, 256 (52.7%) are smooth, 213 (43.8%) are complex, and 2 (0.4%) are abraded. The high frequency of complex platforms is related to the presence of biface thinning flakes in the assemblage. The low frequency of cortical platforms in the debitage assemblage is not surprising given the low frequency of cores with unprepared cortical platforms.

Table 4.2. Sadmat Debitage Types by Raw Material.

Tool Type	n	%	Basalt	Obsidian	CCS	Other
			Raw Material			
Cortical Spalls						
Cortical Spall Fragments	16	23.2	0 (0.0%)	2 (12.5%)	14 (87.5%)	0 (0.0%)
Primary Cortical Spalls	22	31.9	1 (4.5%)	5 (22.7%)	15 (68.1%)	1 (4.5%)
Secondary Cortical Spalls	31	44.9	2 (6.5%)	3 (9.7%)	26 (83.9%)	0 (0.0%)
Total	69	100	3 (4.3%)	10 (14.5%)	55 (79.7%)	0 (0.0%)
Flakes						
Flake Fragments	120	35.1	24 (20.0%)	39 (32.5%)	57 (47.5%)	0 (0.0%)
Flakes	205	59.9	16 (7.8%)	32 (15.6%)	157 (76.6%)	0 (0.0%)
Blade-like Flakes	17	5.0	0 (0.0%)	0 (0.0%)	17 (100.0%)	0 (0.0%)
Total	342	100	40 (11.7%)	71 (20.8%)	231 (67.5%)	0 (0.0%)
Retouch Chips						
Retouch Chip Fragments	16	7.1	0 (0.0%)	16 (100.0%)	0 (0.0%)	0 (0.0%)
Retouch Chips	27	11.9	2 (7.4%)	19 (70.4%)	6 (22.2%)	0 (0.0%)
Biface Thinning Flakes	183	81.0	24 (13.1%)	33 (18.0%)	126 (68.9)	0 (0.0%)
Total	226	100	26 (11.5%)	68 (30.1%)	132 (58.4%)	0 (0.0%)
Split Cobbles	12	100	3 (25.0%)	0 (0.0%)	9 (75.0%)	0 (0.0%)
Angular Shatter	24	100	0 (0.0%)	6 (25.0%)	18 (75.0%)	0 (0.0%)
Total	673		72 (10.7%)	155 (23.0%)	445 (66.1%)	1 (0.01%)

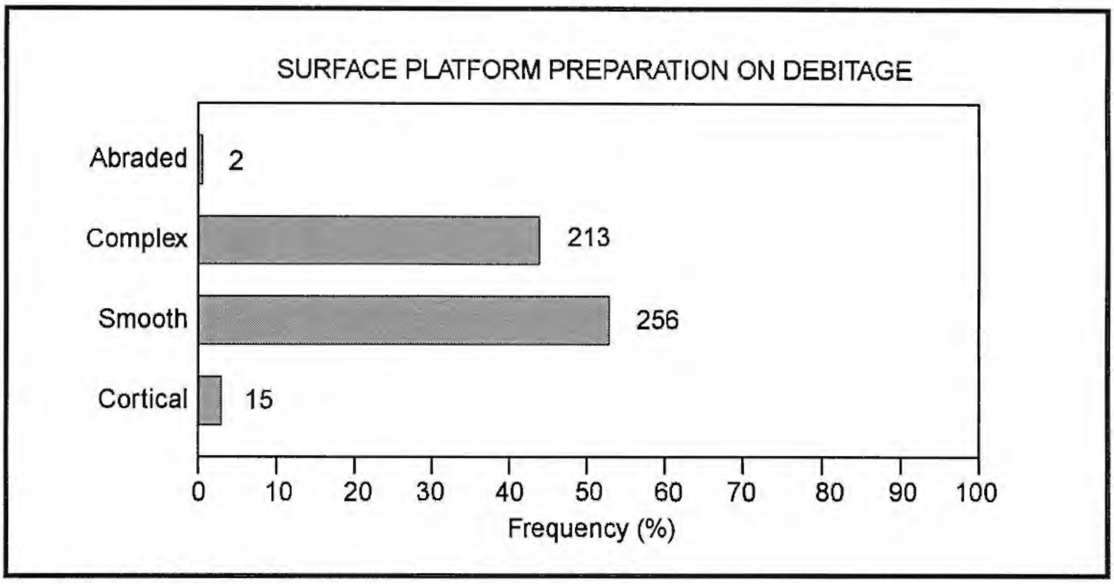


Figure 4.12. Surface platform preparation of debitage platforms in the Sadmat assemblage.

The number of dorsal flake scars on flake debitage including cortical spalls, flakes, and retouch chips was tallied (Figure 4.13). Six (0.9%) of these pieces possess only one dorsal flake scar, 64 (7.2%) possess two dorsal flake scars, 114 (17.9%) exhibit three dorsal flake scars, 225 (35.3%) of the flakes contain four dorsal flake scars, and 246 (39.6%) exhibit more than four dorsal flake scars

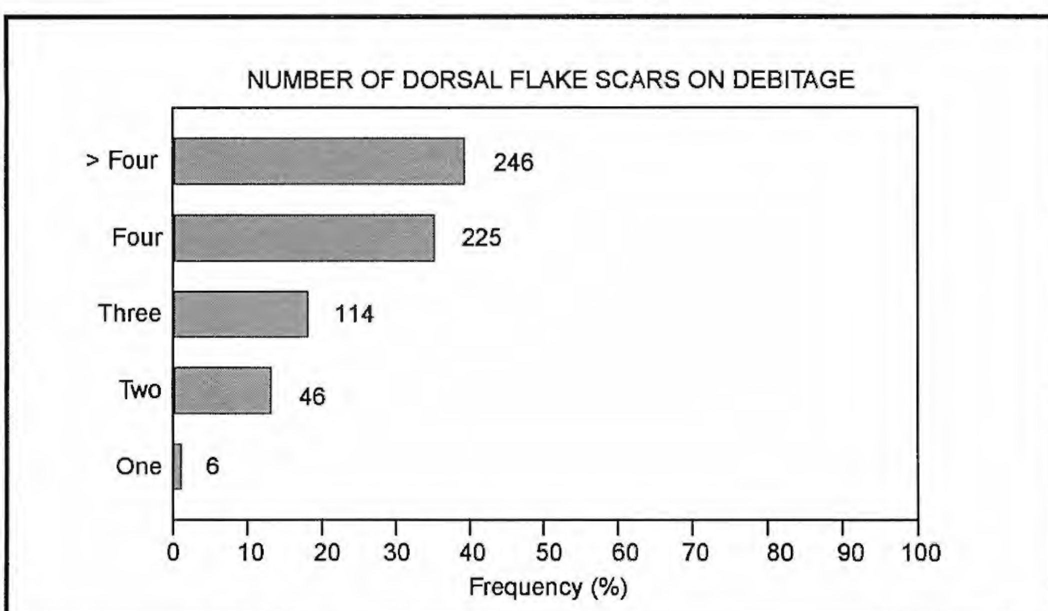


Figure 4.13. Numbers of dorsal flake scars on debitage in the Sadmat assemblage.

(Figure 4.13). This high proportion of many dorsal flake scars seems to correspond to the relatively high degree of core reduction in the assemblage.

Size value was scored for all pieces of debitage containing platforms (Figure 4.14). Four (0.6%) of the debitage pieces fall into the very small (1 cm^2) category, 381 (61.7%) are small (1 cm^2 to 3 cm^2), 199 (32.2%) are medium (3 cm^2 to 5 cm^2), and 34 (5.5%) are large (>5 cm^2). The lack of very small pieces in the debitage assemblage is probably due to field collection strategies that did not recover small-sized artifacts.

The amount of cortex on debitage was also scored (Figure 4.15). Significantly, 570 (89.2%) of the debitage pieces exhibit no cortex, only 15 (2.3%) pieces contain less than 10% cortex, 24 (3.8%) contain between 10 and 50% cortex, and only 30 (4.7%) of the debitage pieces contain more than 50% cortex. The high proportion of debitage without cortex is not surprising given the lack of cortex on the cores.

Tool Assemblage

Tool Typology. The Sadmat assemblage includes 2,295 retouched tools. Of these, 1,097 (47.8%) are bifaces and 1,198 (52.8%) are unifaces (Figure 4.16). Among the bifaces, 911 (83.0%) are unhafted and 186 (17.0%) are hafted bifaces. Side scrapers (337 [14.7%]), end scrapers (36 [1.6%]), gravers

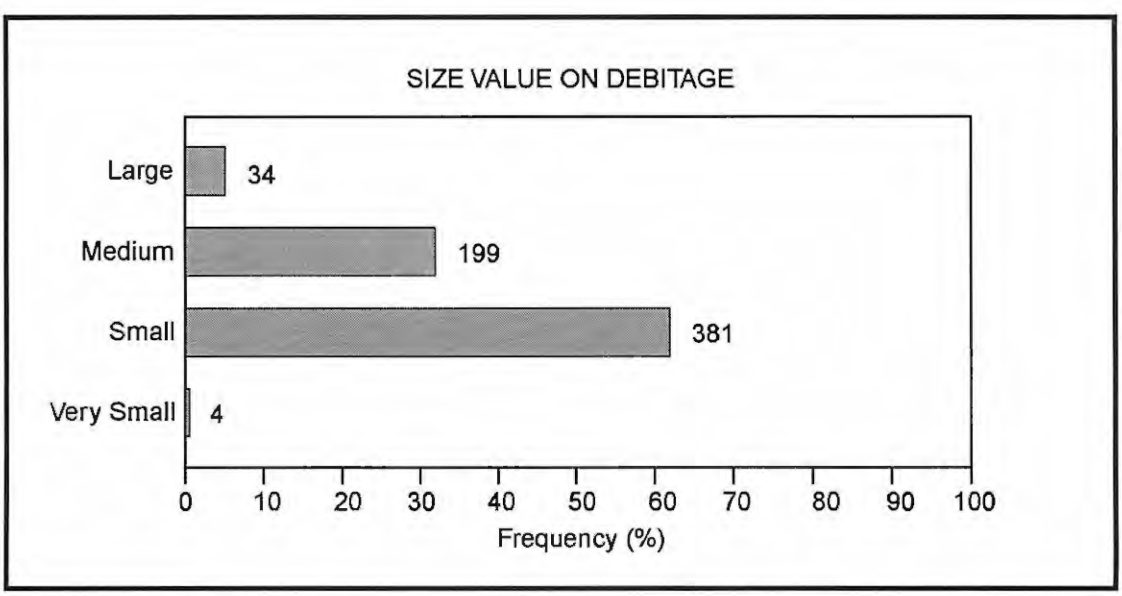


Figure 4.14. Size values for debitage in the Sadmat assemblage.

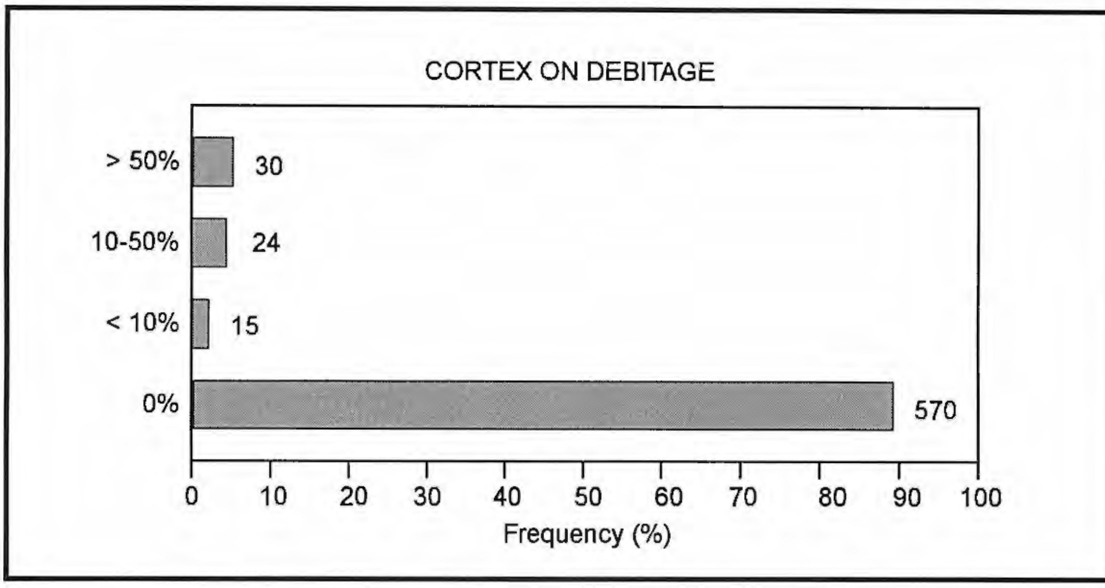


Figure 4.15. Amounts of cortex on debitage in the Sadmat assemblage.

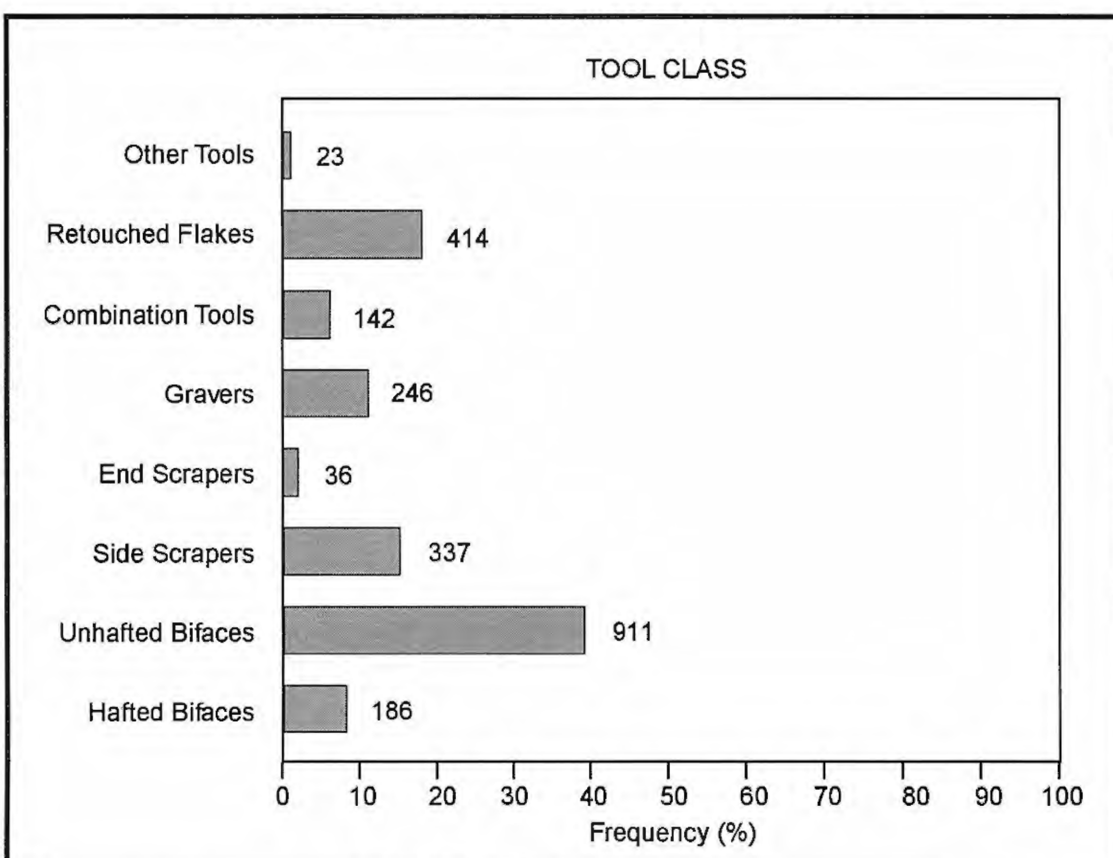


Figure 4.16. Tool classes in the Sadmat assemblage.

(246 [10.7%]), combination tools (142 [6.2%]), and retouched flakes (414 [18.0%]) are also common in the assemblage. Other less frequently occurring tools include 7 (0.3%) backed knives, 9 (0.4%) notches, 3 (0.1%) denticulates, 3 (0.1%) burins, and a single hammerstone (<0.1%). Since these only total 22 they were placed into the "Other Tools" category (Figure 4.16).

The tool assemblage can further be divided into types within the classes discussed above (Table 4.3). Hafted bifaces fall into the following types: 41 Parman stemmed points (22.1%), 40 Haskett stemmed points (21.5%), 1 Windust stemmed point (0.5%), and 98 hafted biface/stem fragments (52.7%) (Figures 4.17 and 4.18). As discussed in Chapter 2, three types of hafted bifaces representative of later periods are present in the assemblage. These make up only 3.2% of the hafted bifaces and include 3 Elko eared points (1.6%), 2 Elko corner-notched points (1.1%), and 1 Humboldt point (0.5%) of the total hafted biface assemblage. All three of the major raw material types were used to construct the 186 hafted bifaces in the assemblage. Of these, 52.6% manufactured on obsidian, 26.3% manufactured on CCS, and 19.4% are manufactured on basalt. The remaining 1.6% are manufactured on rhyolite (Table 4.3).

The 911 unhafted bifaces consist of 689 unhafted biface fragments (75.6%), 151 untypable, miscellaneous bifaces (16.6%), 41 leaf-shaped bifaces (4.5%), 11 ovate bifaces (1.2%), 7 discoid bifaces (0.8%), 7 crescent bifaces (0.8%), 3 stemmed preforms (0.3%), 1 beaked biface (0.1%), and 1 lanceolate biface (0.1%) (Figure 4.19, Table 4.3). Of these unhafted bifaces, 42.5% are manufactured on obsidian, 35.0% are constructed on CCS, 20.3% are constructed on basalt, and 2.2% are manufactured on other raw materials (quartz, rhyolite, welded tuff, and meta-siltstone). Clearly the most prevalent raw material represented in the biface assemblage is obsidian.

Side scrapers number 337 and consist of 22 fragments (6.5%), 81 unilateral side scrapers (24.0%), 75 bilateral side scrapers (22.3%), 41 convergent side scrapers (12.2%), 23 transverse side scrapers (6.8%), 35 angle or dejeté side scrapers (10.4%), 2 three-sided side scrapers (0.6%), 23 bifacially retouched side scrapers (6.8%), 24 alternately retouched side scrapers (7.1%), 3 ventrally retouched side scrapers (0.9%), and 8 limaces or slug-shaped side scrapers (2.4%) (Figures 4.20 and 4.21, Table 4.3). Seventy-eight percent of the side scrapers are manufactured on CCS, 11% on obsidian, 10% on basalt, and 0.6% on other raw materials (rhyolite and quartzite). Definitely the most sought after raw material in the manufacturing of side scrapers was CCS (Table 4.3).

Table 4.3. Sadmat Tool Types by Raw Material.

			Raw Material			
Tool Type	n	%	Basalt	Obsidian	CCS	Other
Hafted Bifaces						
Parman Stemmed Points	41	22.1	9 (22.0%)	18 (43.9%)	12 (29.3%)	2 (4.8%)
Haskett Stemmed Points	40	21.5	11 (27.5%)	12 (30.0%)	17 (42.5%)	0 (0.0%)
Windust Stemmed Points	1	0.5	0 (0.0%)	1 (100.0%)	0 (0.0%)	0 (0.0%)
Hafted Biface/Stem Fragments	98	52.7	15 (15.3%)	64 (65.3%)	18 (18.4%)	1 (1.0%)
Humboldt Points	1	0.5	0 (0.0%)	0 (0.0%)	1 (100.0%)	0 (0.0%)
Elko C-N Points	2	1.1	1 (50.0%)	1 (50.0%)	0 (0.0%)	0 (0.0%)
Elko Eared Points	3	1.6	0 (0.0%)	2 (66.7%)	1 (33.3%)	0 (0.0%)
Total	186	100	36 (19.4%)	98 (52.6%)	49 (26.3%)	3 (1.6%)
Unhafted Bifaces						
Fragments	689	75.6	161 (23.4%)	321 (46.6%)	191 (27.7%)	16 (2.3%)
Miscellaneous	151	16.6	17 (11.3%)	40 (26.5%)	92 (60.9%)	2 (1.3%)
Leaf-shaped	41	4.5	4 (9.8%)	20 (48.8%)	16 (39.0%)	1 (2.4%)
Ovate	11	1.2	2 (18.2%)	3 (27.3%)	6 (54.5%)	0 (0.0%)
Discoid	7	0.8	0 (0.0%)	1 (14.3%)	5 (71.4%)	1(14.3%)
Crescent	7	0.8	0 (0.0%)	2 (28.6%)	5 (71.4%)	0 (0.0)
Stemmed (preforms)	3	0.3	0 (0.0%)	0 (0.0%)	3 100.0%)	0 (0.0%)
Beaked	1	0.1	0 (0.0%)	0 (0.0%)	1 (100.0%)	0 (0.0%)
Lanceolate	1	0.1	1 (100.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Total	911	100	185 (20.3%)	387 (42.5%)	319 (35.0%)	20 (2.2%)
Side Scrapers						
Fragments	22	6.5	3 (13.6%)	11 (50.0%)	8 (36.4%)	0 (0.0%)
Unilateral	81	24.0	8 (9.9%)	10 (12.3%)	63 (77.8%)	0 (0.0%)
Bilateral	75	22.3	7 (9.3%)	4 (5.3%)	63 (84.1%)	1 (1.3%)

Table 4.3. Continued.

			Raw Material			
Tool Type	n	%	Basalt	Obsidian	CCS	Other
Convergent	41	12.2	5 (12.2%)	4 (9.8%)	32 (78.0%)	0 (0.0%)
Transverse	23	6.8	2 (8.7%)	1 (4.3%)	20 (87.0%)	0 (0.0%)
Angle (Dejeté)	35	10.4	5 (14.3%)	1 (2.9%)	29 (82.9%)	0 (0.0%)
3-Sided	2	0.6	1 (50.0%)	0 (0.0%)	1 (50.0%)	0 (0.0%)
Bifacially Retouched	23	6.8	2 (8.7%)	1 (4.3%)	20 (87.0%)	0 (0.0%)
Alternately Retouched	24	7.1	1 (4.2%)	2 (8.3%)	20 (83.3%)	1 (4.2%)
Ventrally Retouched	3	0.9	0 (0.0%)	0 (0.0%)	3 (100.0%)	0 (0.0%)
Limace/Slug-shaped	8	2.4	0 (0.0%)	3 (37.5%)	5 (62.5%)	0 (0.0%)
Total	337	100	34 (10.1%)	37 (11.0%)	264 (78.3%)	2 (0.6%)
End Scrapers						
Fragments	1	2.8	0 (0.0%)	1 (100.0%)	0 (0.0%)	0 (0.0%)
Flake	10	27.8	0 (0.0%)	2 (20.0%)	8 (80.0%)	0 (0.0%)
Round	8	22.2	2 (25.0 %)	0 (0.0%)	6 (75.0%)	0 (0.0%)
Pan-shaped	3	8.3	0 (0.0%)	0 (0.0%)	3 (100.0%)	0 (0.0%)
Steeply keeled	10	27.8	2 (20.0%)	0 (0.0%)	7 (70.0%)	1 (10.0%)
Blade	2	5.6	0 (0.0%)	0 (0.0%)	2 (100.0%)	0 (0.0%)
Spurred	2	5.6	0 (0.0%)	0 (0.0%)	2 (100.0%)	0 (0.0%)
Total	36	100	4 (2.8%)	3 (8.3%)	28 (77.8%)	1 (2.8%)
Gravers						
Fragments	15	6.1	1 (3.2%)	2 (9.7%)	12 (87.1%)	0 (0.0%)
Single-Spurred	104	42.3	2 (1.9%)	9 (8.7%)	93 (89.4%)	0 (0.0%)
Multiple-Spurred	127	51.6	0 (0.0%)	7 (5.5%)	120 (94.5%)	0 (0.0%)
Total	246	100	3 (1.2%)	18 (7.3%)	225 (91.5%)	0 (0.0%)
Combination Tools						
Wedge/Scraper	40	28.2	3 (7.5%)	0 (0.0%)	37 (92.5%)	0 (0.0%)

Table 4.3. Continued.

			Raw Material			
Tool Type	n	%	Basalt	Obsidian	CCS	Other
Scraper/Graver	77	54.2	3 (3.4%)	4 (5.2%)	70 (90.9%)	0 (0.0%)
Scraper/Notch	17	12.0	0 (0.0%)	1 (5.9%)	16 (94.1%)	0 (0.0%)
Notch/Graver	8	5.6	0 (0.0%)	0 (0.0%)	8 (100.0%)	0 (0.0%)
Total	142	100	6 (4.2%)	5 (3.5%)	131 (92.3%)	0 (0.0%)
Retouched Flakes						
Fragments	88	21.3	5 (5.7%)	35 (39.8%)	48 (54.5%)	0 (0.0%)
Flake	285	68.8	7 (2.5%)	56 (19.6%)	222 (77.9%)	0 (0.0%)
Blade-like Flake	41	9.9	1 (2.4%)	3 (7.3%)	37 (90.2%)	0 (0.0%)
Total	414	100	13 (3.1%)	94 (22.7%)	307 (74.2%)	0 (0.0%)
Other Tools						
Backed Knives	7	30.4	0 (0.0%)	1 (14.3%)	6 (85.7%)	0 (0.0%)
Notches	9	39.1	0 (0.0%)	0 (0.0%)	9 (100.0%)	0 (0.0%)
Denticulates	3	13.1	0 (0.0%)	0 (0.0%)	3 (100.0%)	0 (0.0%)
Burins on Bifaces	3	13.1	0 (0.0%)	3 (100.0%)	0 (0.0%)	0 (0.0%)
Hammerstone	1	4.4	1 (100.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Total	23	100	0 (0.0%)	4 (18.2%)	18 (81.8%)	0 (0.0%)
Total	2295		282 (12.3%)	646 (28.2%)	1341(58.4%)	26 (1.1%)

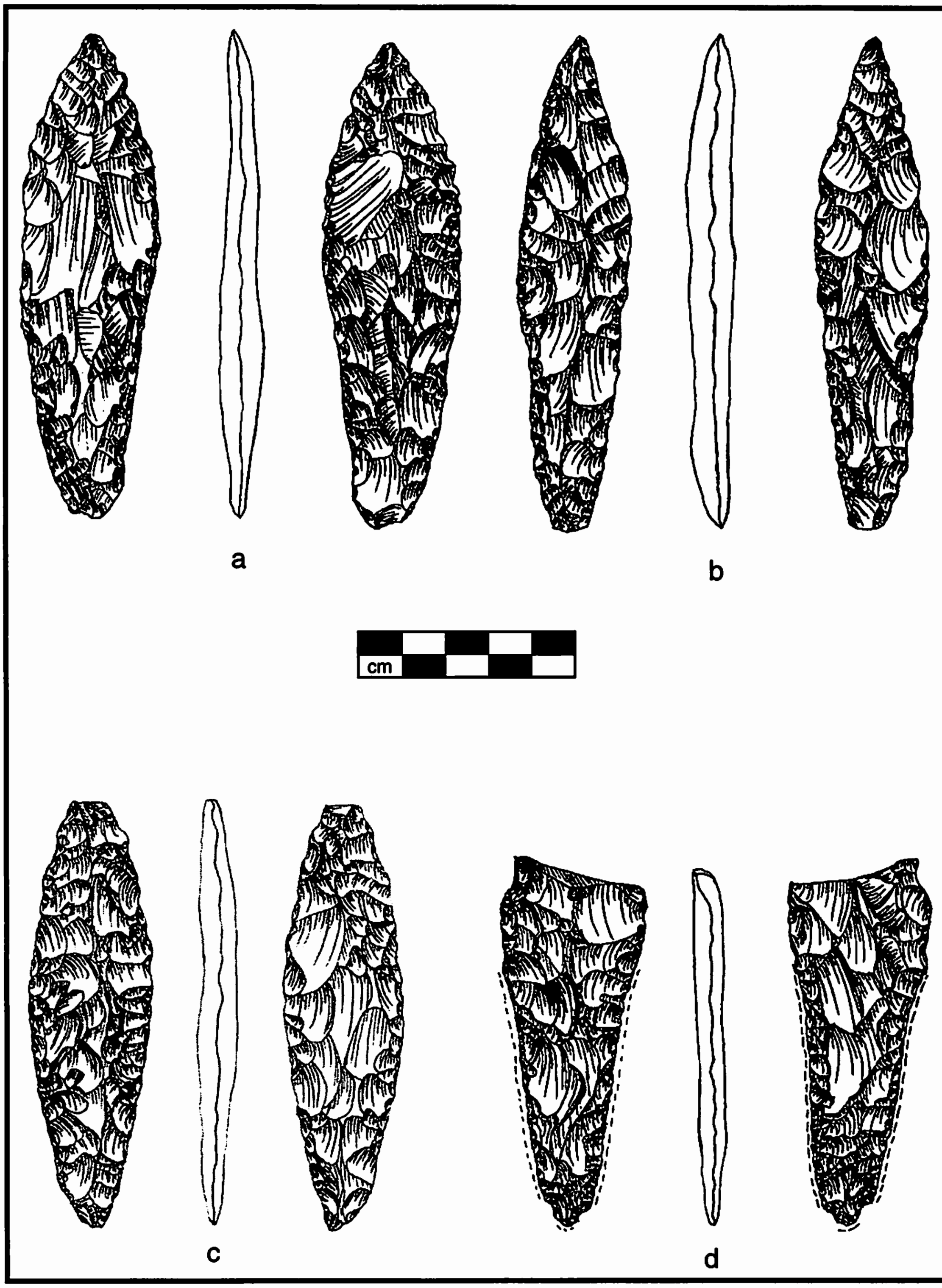


Figure 4.17. Stemmed points in the Sadmat assemblage (a-c: Haskett stemmed points; d: Parman stemmed point).

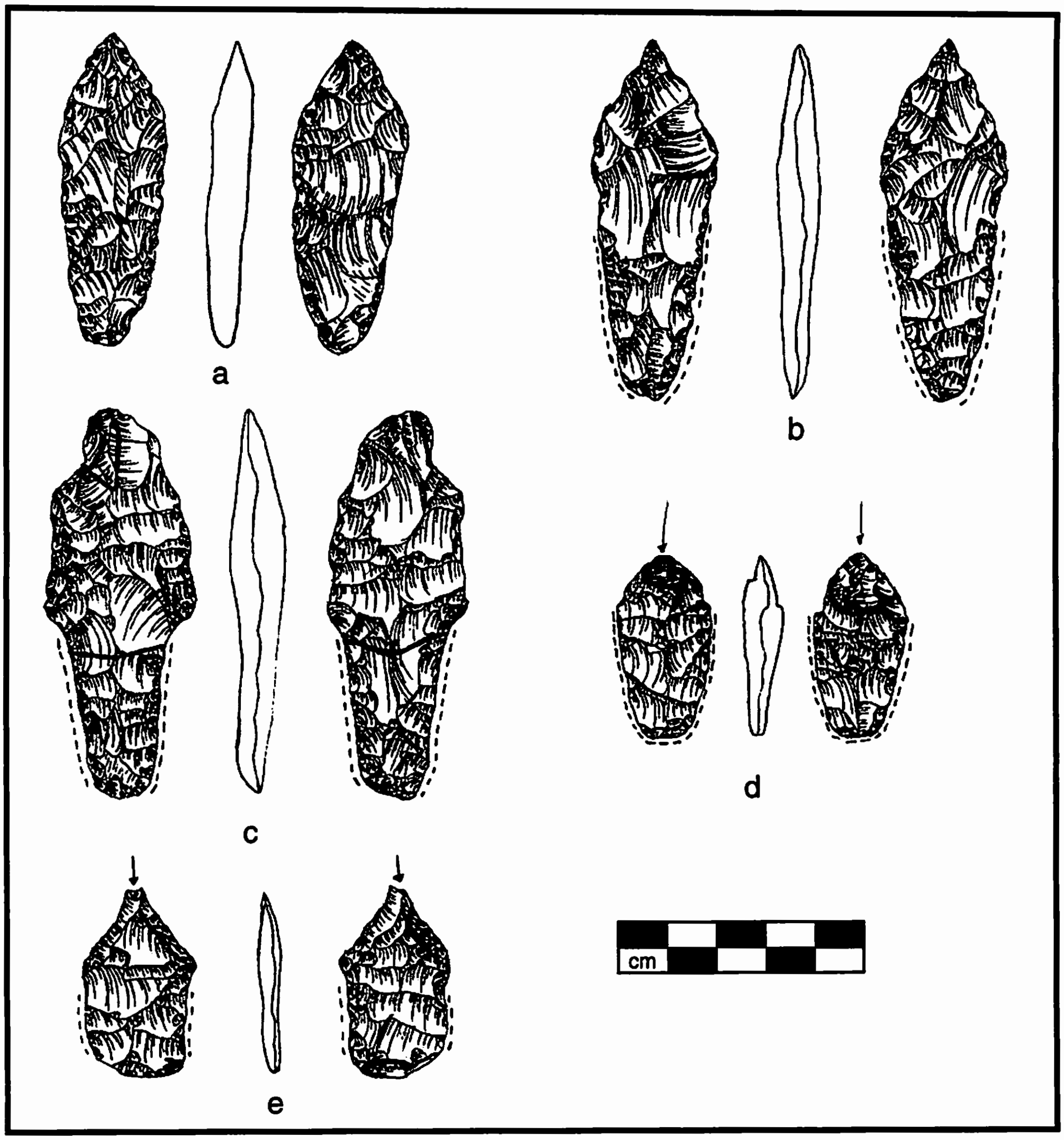


Figure 4.18. Stemmed points in the Sadmat assemblage (a, d: Haskett stemmed points; b- c: Parman stemmed points; e: Windust stemmed point).

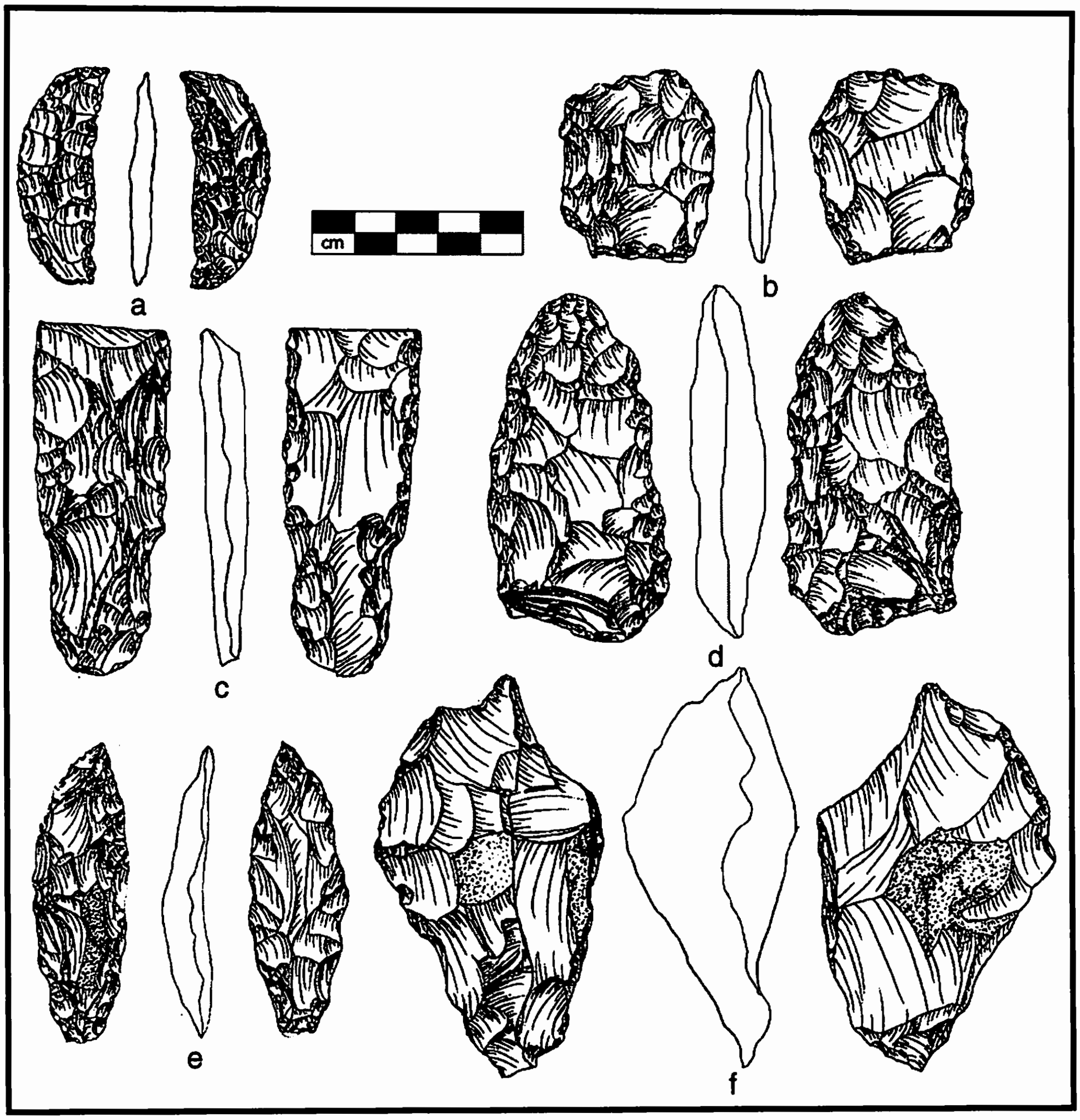


Figure 4.19. Bifaces in the Sadmat assemblage (a: crescent; b: discoid; c: stemmed preform; d: ovate; e: leaf-shaped; f: miscellaneous biface).

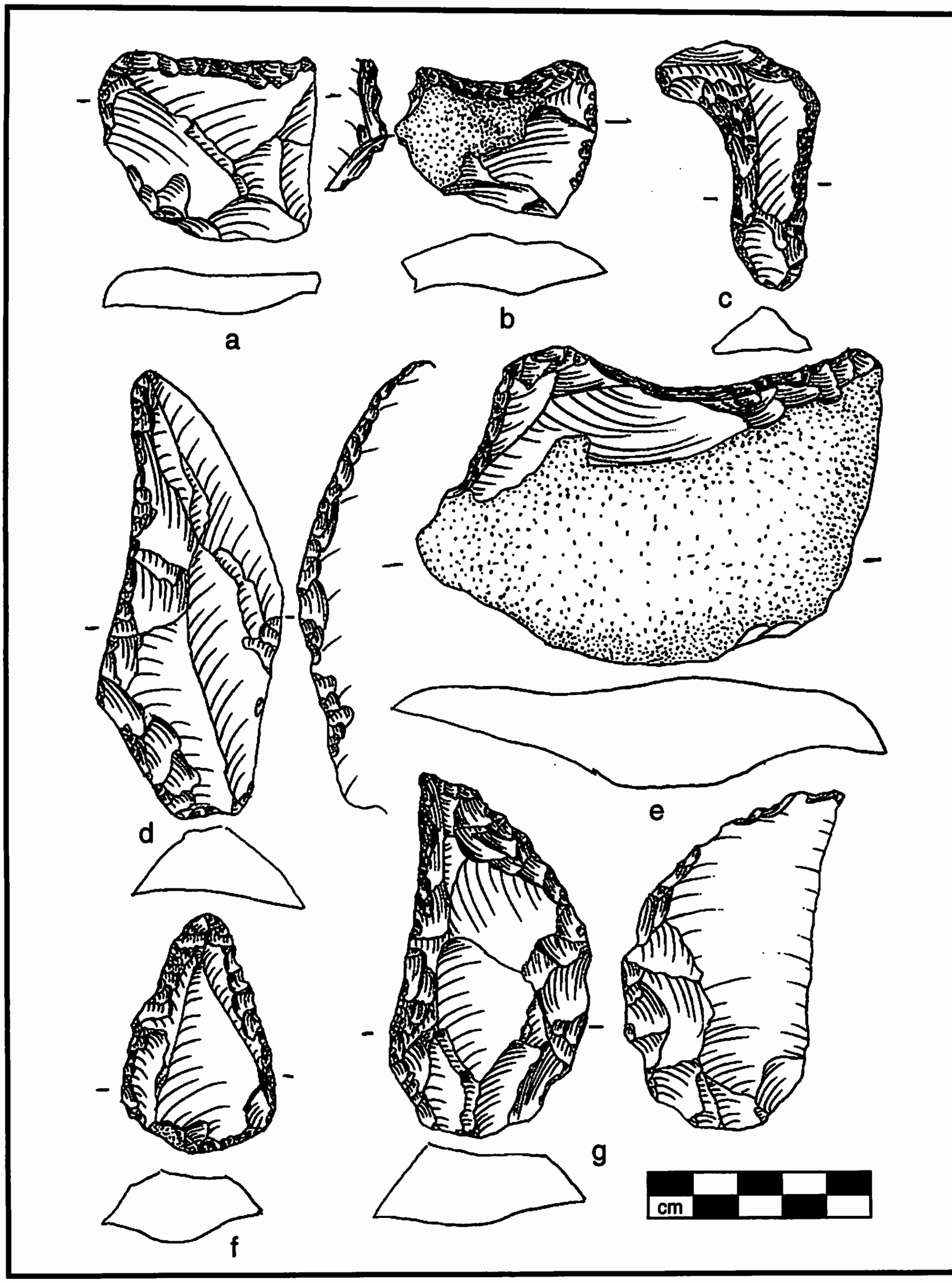


Figure 4.20. Side scrapers in the Sadmat assemblage (a-b: transverse; c: double; d: alternate; e, g: angle; f: convergent).

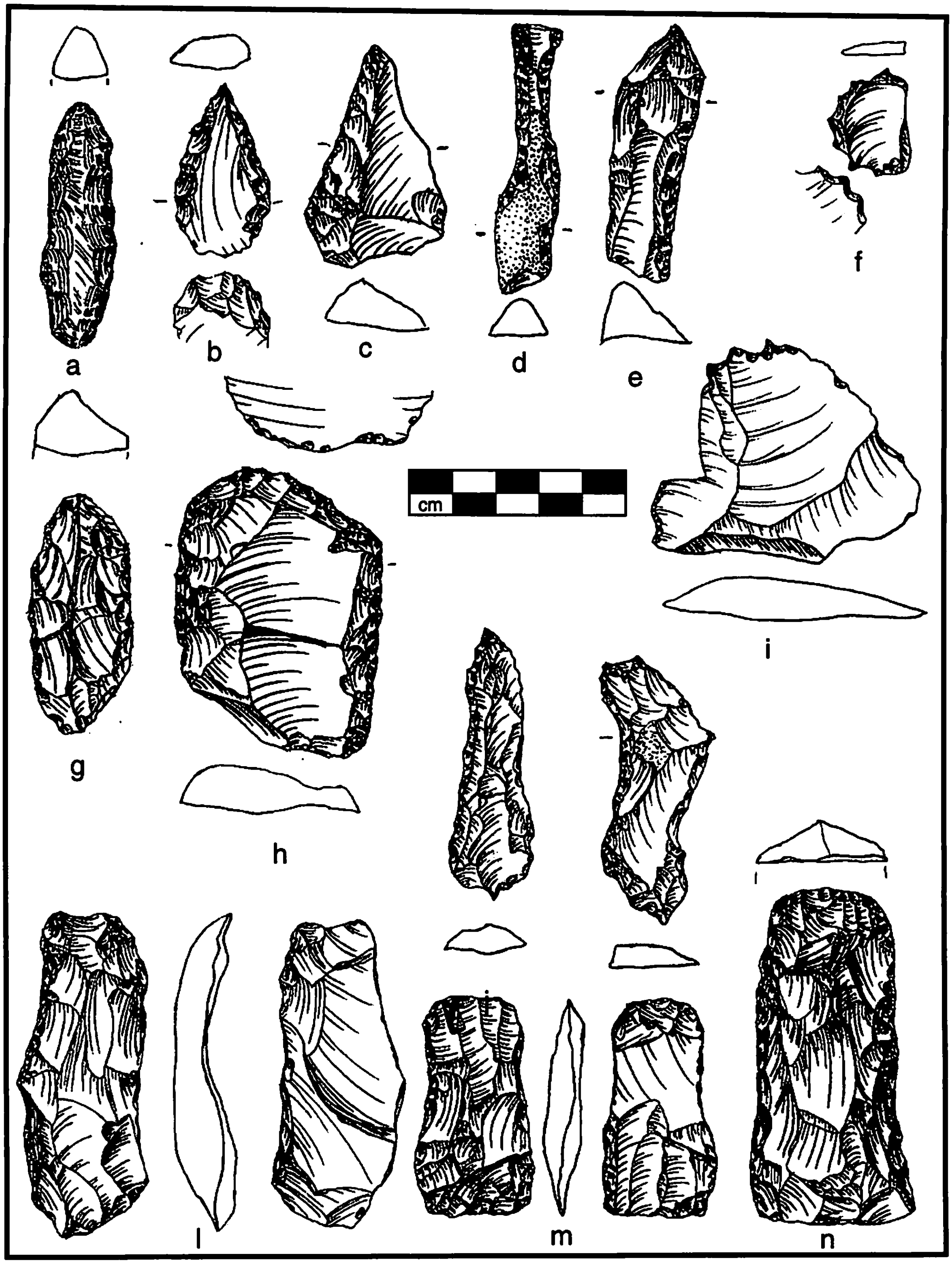


Figure 4.21. Side scrapers, gravers, and combination tools in the Sadmat assemblage (a, g: limace or slug-shaped; b: ventral; c: single; d, e: double; h: 3-sided; f, i: multiple-spurred gravers; j, k: graver/ scrapers; l-n: scraper/wedges).

There are 36 end scrapers in the assemblage. These include 1 end scraper fragment (2.8%), 10 flake end scrapers (27.8%), 8 round end scrapers (22.2%), 3 pan-shaped end scrapers (8.3%), 10 steeply keeled end scrapers (27.8%), 2 end scrapers on blades (5.6%), and 2 spurred end scrapers (5.6%) (Figure 4.22, Table 4.3). CCS was used to manufacture 77.8% of the end scrapers, obsidian was used for 8.3% of these tools, basalt was used to manufacture 2.8% of the end scrapers, and 2.8% of the end scrapers are manufactured on quartzite.

The gravers number 246 and consist of 15 graver fragments (6.1%), 104 single-spurred gravers (42.3%), and 127 multiple-spurred gravers (51.6%) (Figure 4.21, Table 4.3). The majority (91.5%) of the gravers are manufactured on CCS. The rest of the gravers are manufactured on obsidian (7.3%) and basalt (1.2%).

The combination tools number 142 and consist of 40 (28.2%) wedge/scrapers, 77 (54.2%) scraper/gravers, 17 (12.0%) scraper/notches, and 8 (5.6%) notch/gravers (Figure 4.21, Table 4.3). Of these, again CCS dominates the assemblage, with 92.3% of the combination tools being made on this raw material. Basalt and obsidian together only make up 7.7% of the combination tools.

The retouched flakes number 414 and consist of 88 retouched flake fragments (21.3%), 285 retouched flakes (68.8%), and 41 retouched blade-like flakes (9.9%) (Figure 4.23, Table 4.3). Again CCS dominates the retouched flakes, making up 74.2% of all of these tool types, while obsidian was utilized 22.7% of the time, and basalt consists of 3.1% of the flakes.

All other tools occur so infrequently (1% of all tools) that they are combined and placed into the "Other Tools" category. These consist of 7 (30.4%) backed knives, 9 (39.1%) notches, 3 (13.1%) denticulates, 3 (13.1%) burins on bifaces, and 1 (4.4%) hammerstone (Figure 4.23, Table 4.3). The backed knives are made on obsidian and CCS, while notches and denticulates are manufactured on CCS. The 3 burins are made of obsidian and the single hammerstone is basalt (Table 4.3). The burins are made on bifaces and appear to be the result of intentional manufacture, in that they have multiple, dihedral burin facets.

Biface Analysis. Bifaces in the Sadmat collection were scored based on their condition (Figure 4.24). Significantly, 804 (73.3%) of the bifaces are fragmented. Specifically, of the 1,097 bifaces in the Sadmat assemblage, 485 (44.2%) are unidentifiable/untypable biface fragments, 260

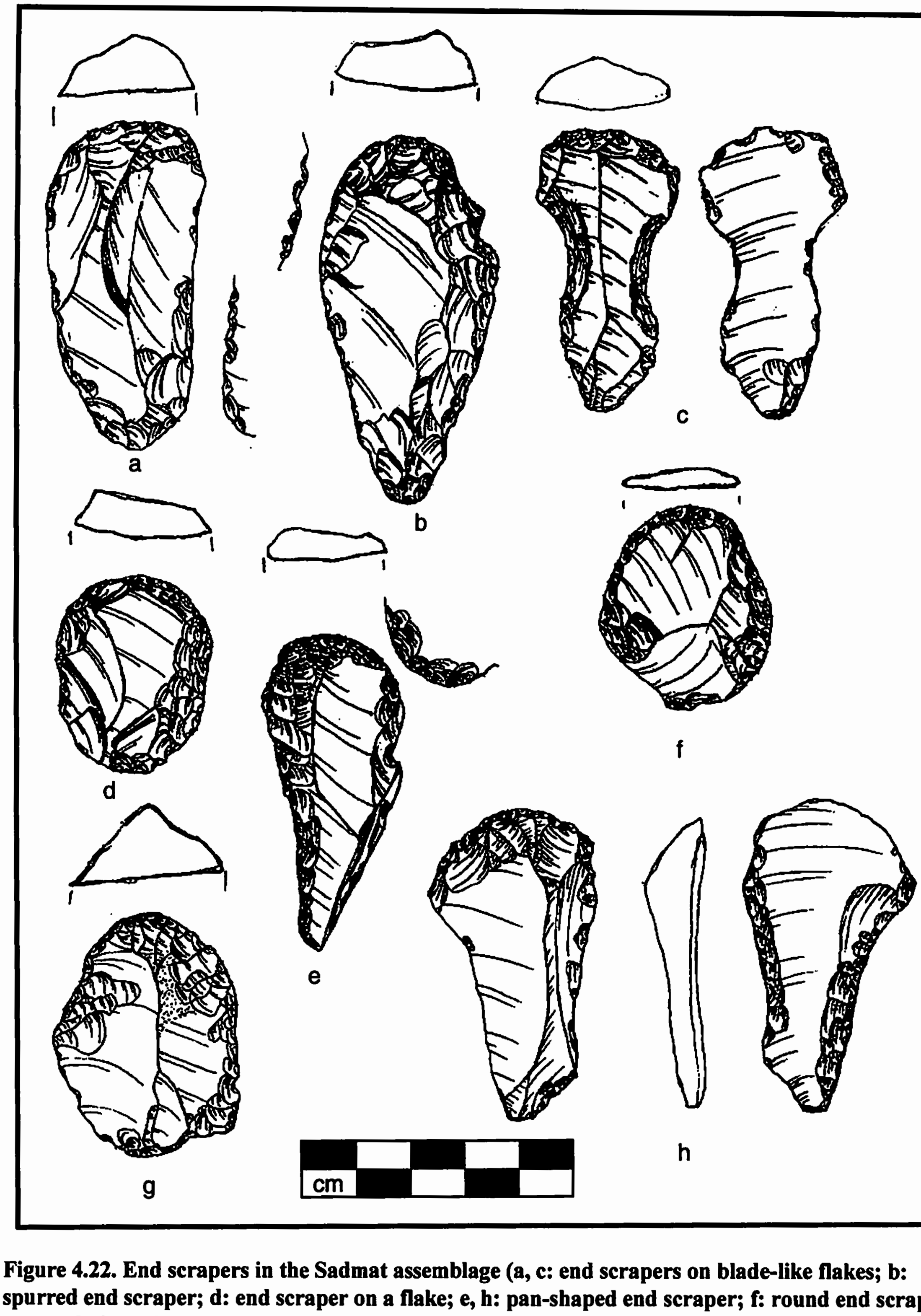


Figure 4.22. End scrapers in the Sadmat assemblage (a, c: end scrapers on blade-like flakes; b: spurred end scraper; d: end scraper on a flake; e, h: pan-shaped end scraper; f: round end scraper; g: steeply-keeled end scraper).

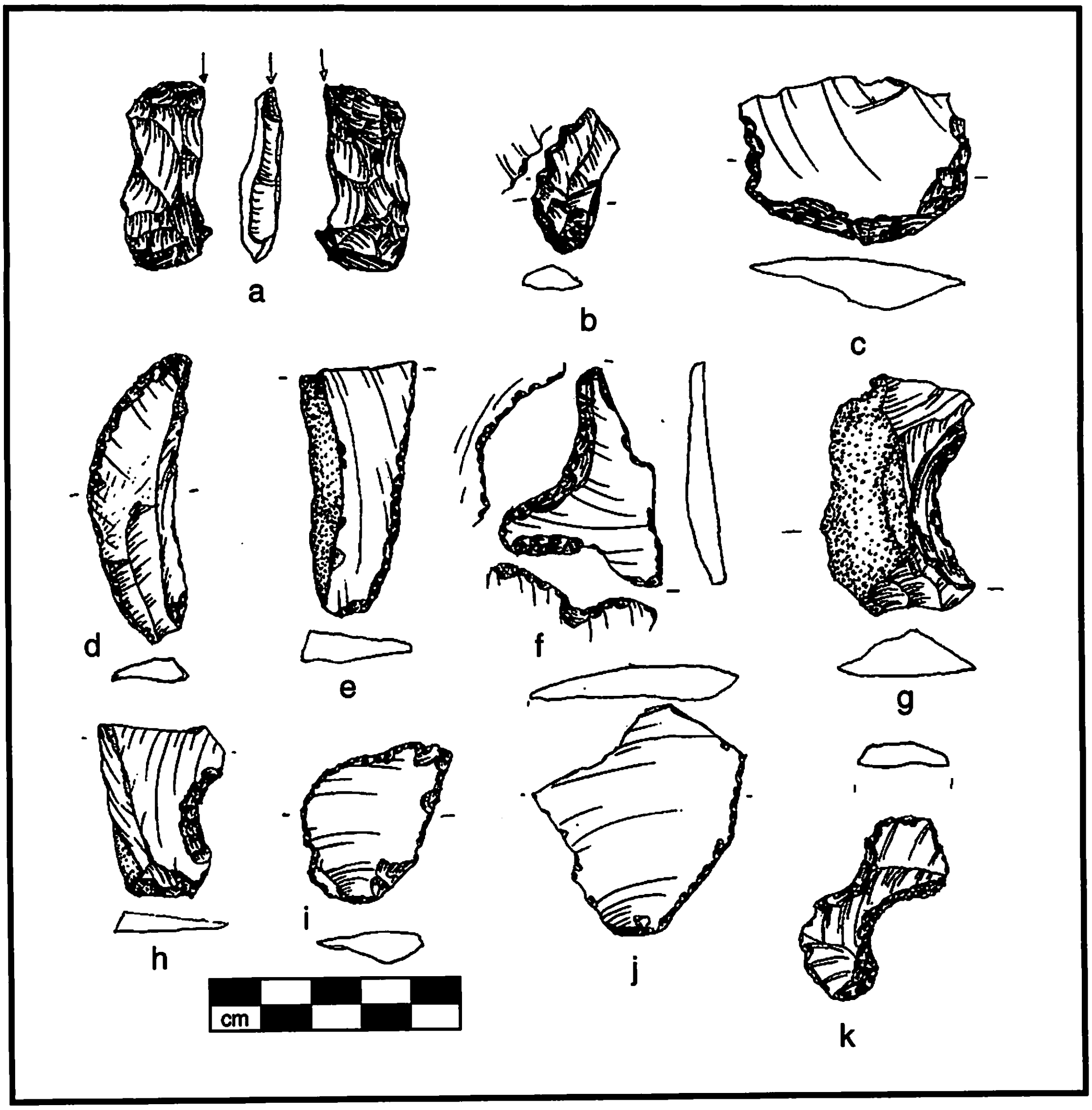


Figure 4.23. Unifacial tools in the Sadmat assemblage (a: burin on a biface; b, c: denticulates; d, e: backed knives; f, g, h, k: notches; i, j: retouched flakes).

(23.7%) are complete, 122 (11.1%) are proximal fragments, 107 (9.8%) are medial fragments, 87 (7.9%) are distal fragments, 3 (0.3%) are broken laterally, and 33 (3.0%) are reworked.

Metric variables measured on the biface assemblage include maximum length, hafting element length, maximum width, thickness, blade thickness, hafting element thickness, edge angle, and invasiveness. For an explanation of these variables, refer to Chapter 3. On 294 of the complete and reworked bifaces, maximum length was measured (Figure 4.25). These measurements range from 18.2 to 109.6 mm, with a mean of 51.5 mm and standard deviation of 16.6 mm. Eighty of the complete bifaces have a clearly defined stem or hafting element that could be measured (Figure 4.26). The hafting element lengths range from 8.3 to 64.5 mm, with a mean length of 28.1 mm and a standard deviation of 11.9 mm. Maximum widths were scored on 294 complete bifaces (Figure 4.27). Measurements range from 6.1 to 74.2 mm, with a mean measurement of 26.8 mm and standard deviation of 9.5 mm. Thickness was measured on 908 bifaces (Figure 4.28). These measurements range from 3.0 to 30.2 mm, and have a mean of 9.4 mm, and standard deviation of 4.1 mm. Ninety-three blade thicknesses were measured (Figure 4.29). These range from 3.9 to 18.6 mm, with a mean of 7.5 mm and standard deviation of 2.0 mm. Hafting element thickness was measured on 164 bifaces (Figure 4.30), and ranges from 3.1 to 16.9 mm with a mean of 7.6 and standard deviation of 1.7 mm. Edge angle was measured on 1,091 hafted and unhafted bifaces (Figure 4.31). These measurements range from 63° to 90°. The mean is 79° and the standard deviation is 5.0°. Lastly, the invasiveness of bifaces is represented by the measure of the length of the most invasive flake (Figure 4.32). This measurement was taken on 1,093 bifaces and ranges from 2.9 to 43.2 mm with a mean of 10.8 mm and standard deviation of 4.4 mm.

Uniface Analysis. Tool blank was scored for most of the unifaces in the Sadmat assemblage (Figure 4.33). Of these, 125 (13.2%) are made on cortical spalls, 400 (42.1%) are made on flakes, 350 (36.8%) are made on biface thinning flakes, 30 (3.2%) are made on blade-like flakes, 10 (1.1%) are made on blades, and 35 (3.7%) are made on cores. The number of retouched margins was scored on 641 formal unifaces (i.e., scrapers, multiple-spurred gravers, combination tools) and 556 informal unifaces (i.e., retouched flakes, single-spurred gravers, "other tools"). Of all of the unifaces, 709 (59.2%) are retouched on a single margin while 448 (40.8%) are retouched on more than one margin (Figures 4.34 and 4.35). More specifically, when broken down into formal and informal unifaces,

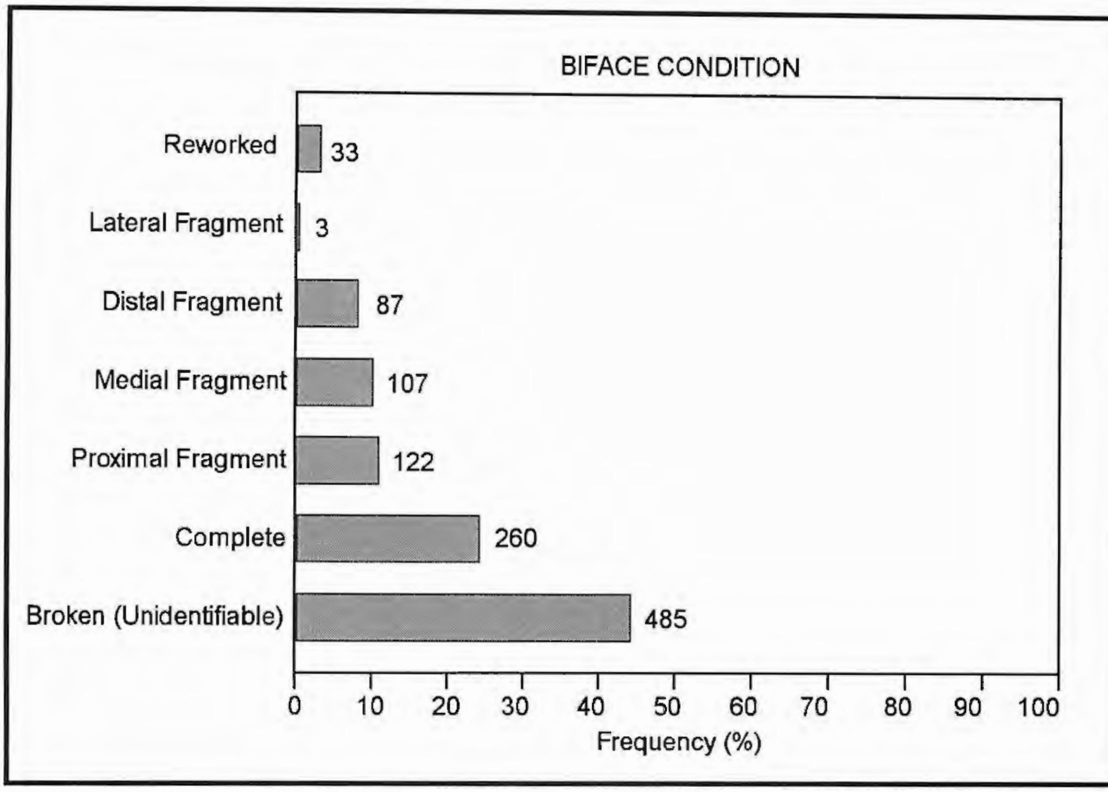


Figure 4.24. Conditions of bifaces in the Sadmat assemblage.

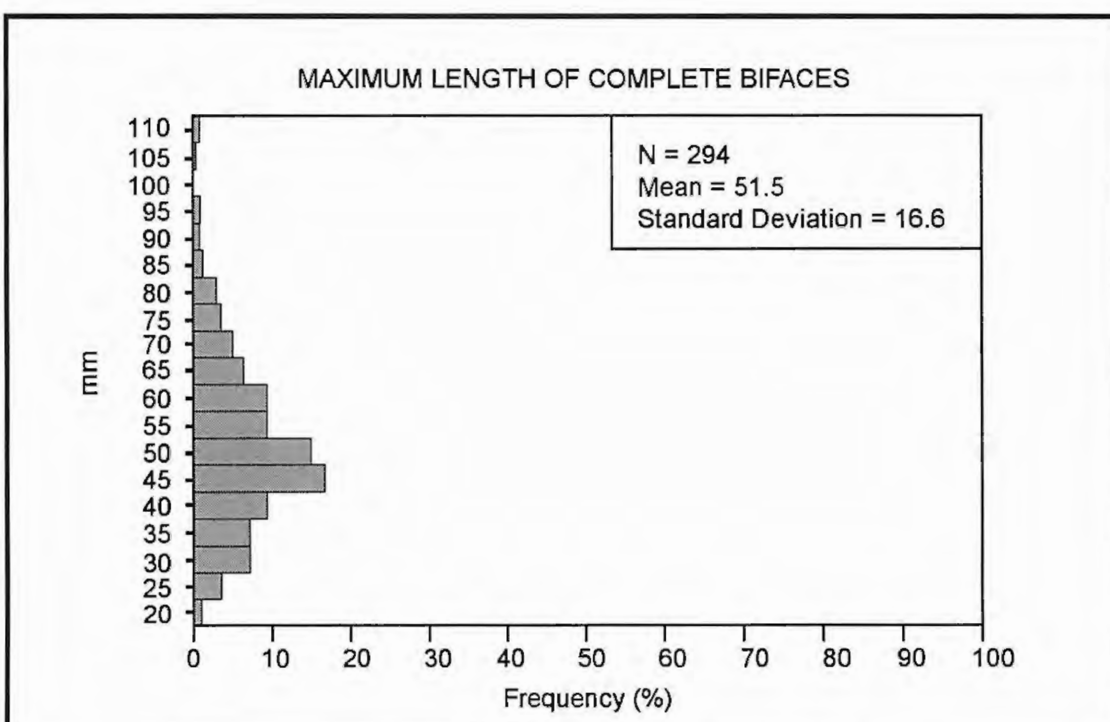


Figure 4.25. Maximum lengths of complete bifaces in the Sadmat assemblage.

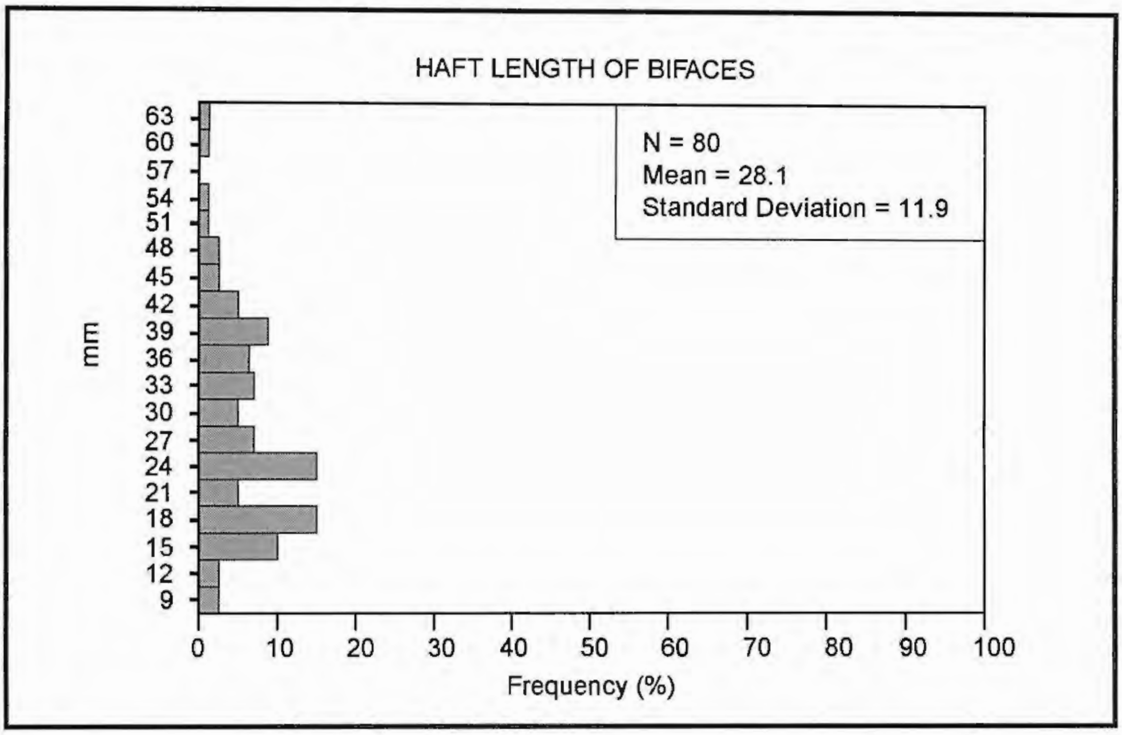


Figure 4.26. Hafting element lengths of bifaces in the Sadmat assemblage.

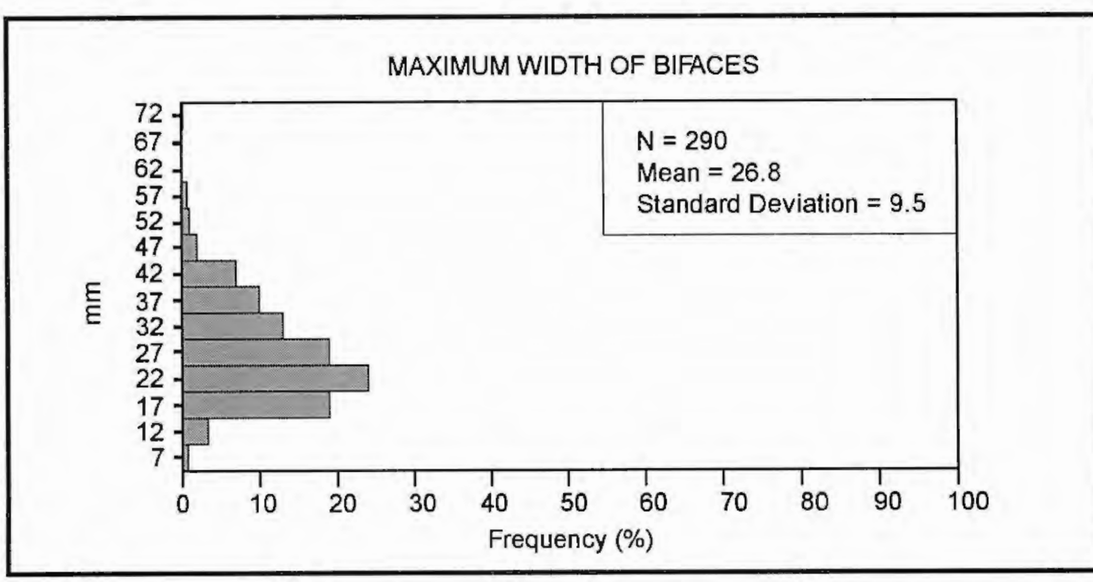


Figure 4.27. Maximum widths of bifaces in the Sadmat assemblage.

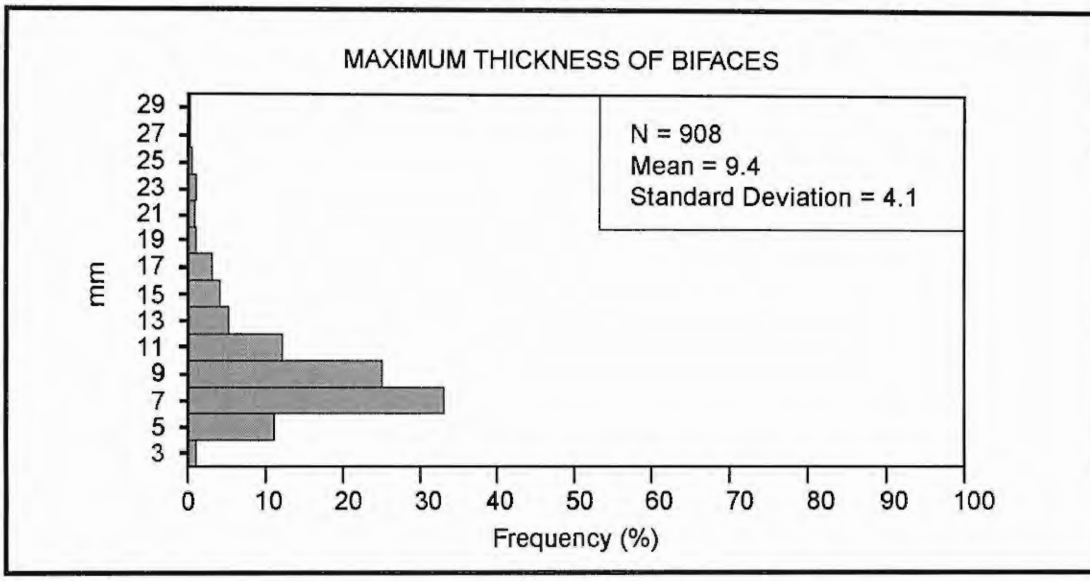


Figure 4.28. Maximum thicknesses of bifaces in the Sadmat assemblage.

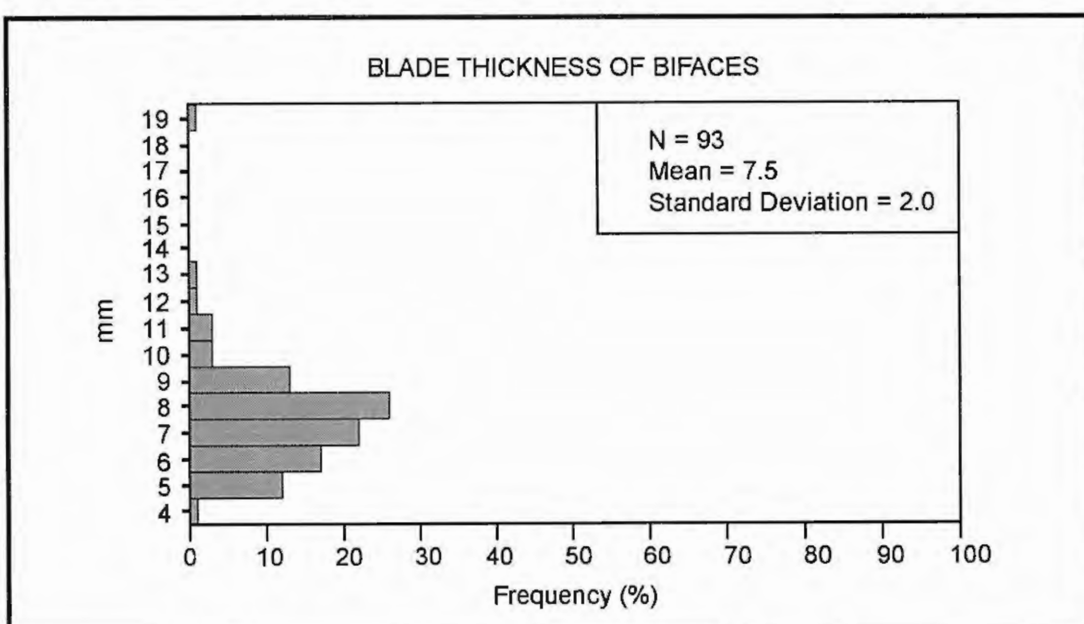


Figure 4.29. Blade thicknesses of bifaces in the Sadmat assemblage.

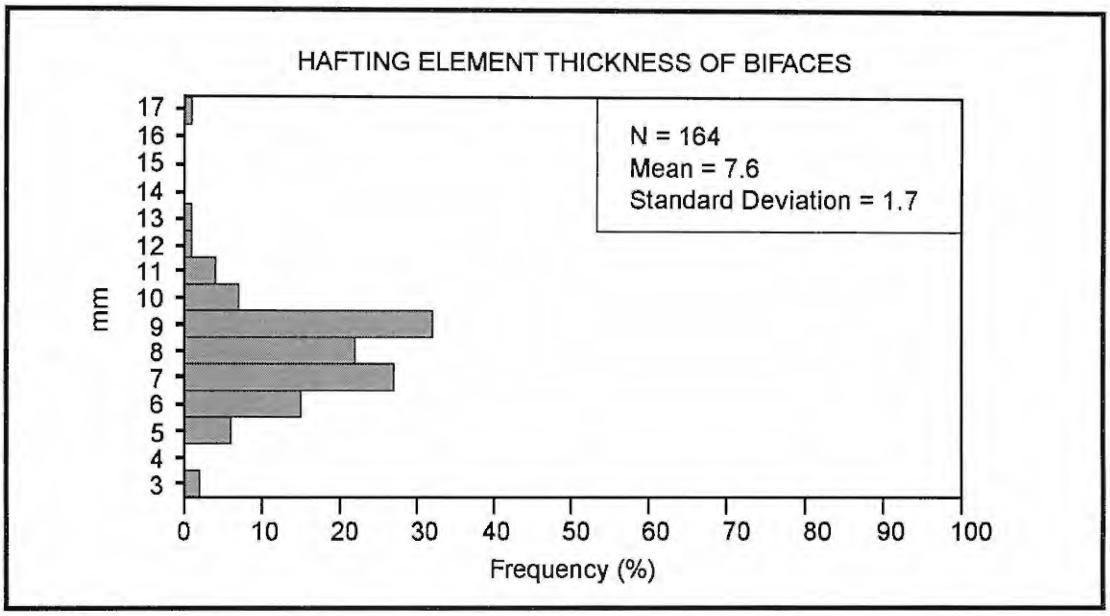


Figure 4.30. Hafting element thicknesses of biface in the Sadmat assemblage.

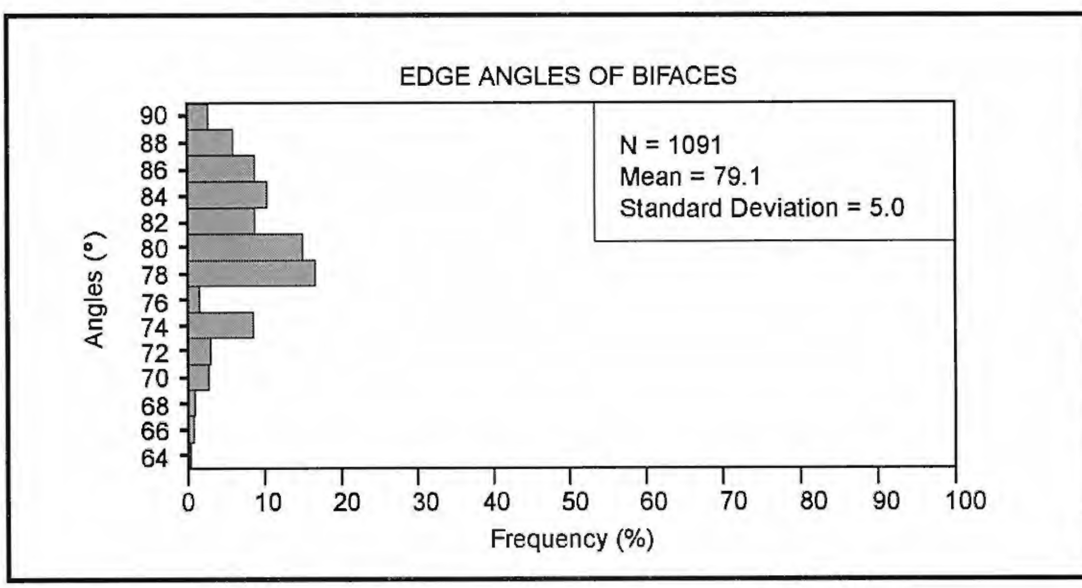


Figure 4.31. Biface edge angles in the Sadmat assemblage.

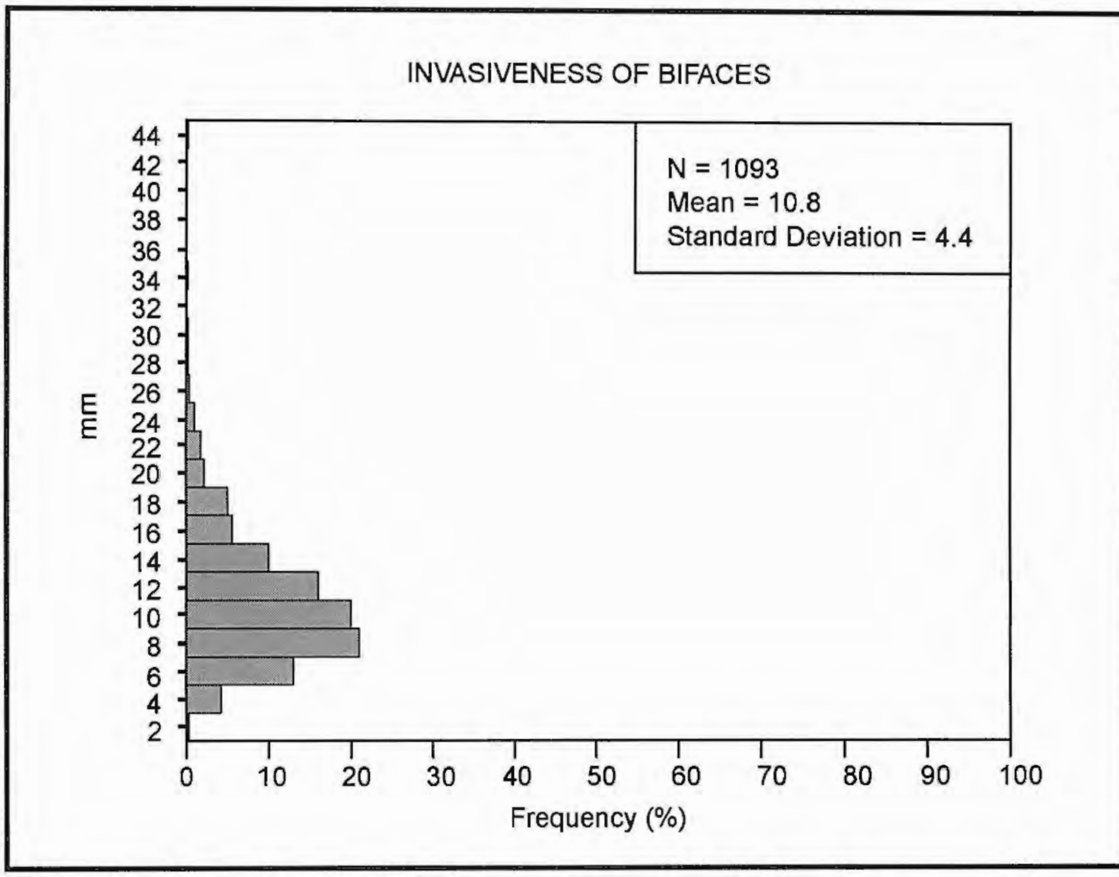


Figure 4.32. Invasiveness of bifaces in the Sadmat assemblage.

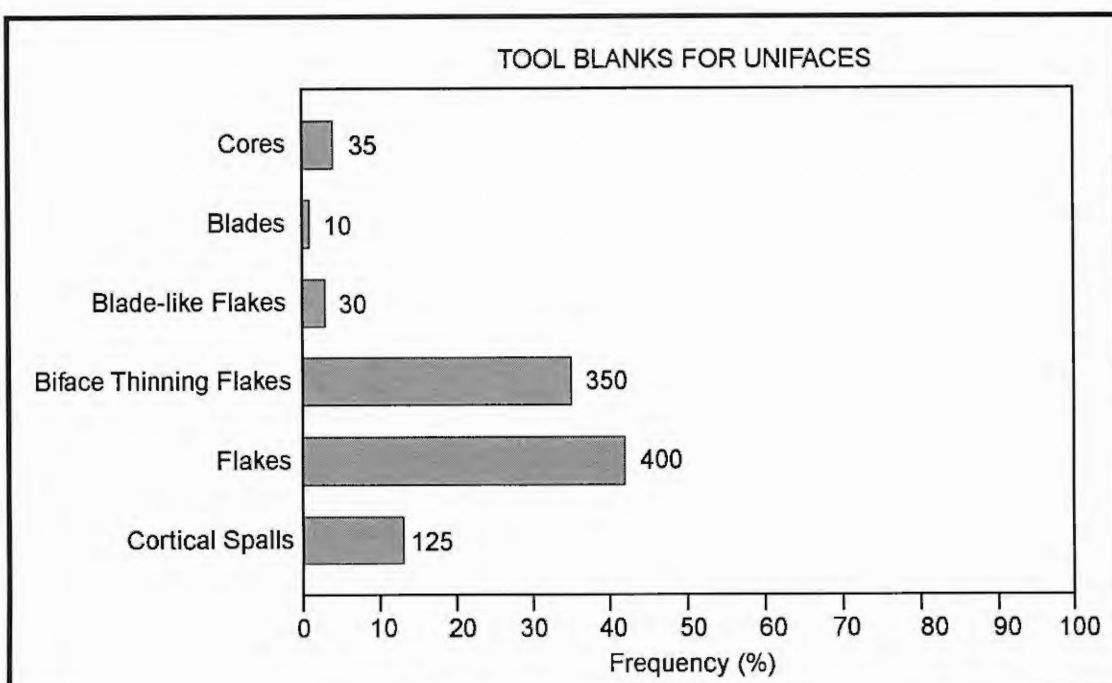


Figure 4.33. Tool blanks for unifacial tools in the Sadmat assemblage.

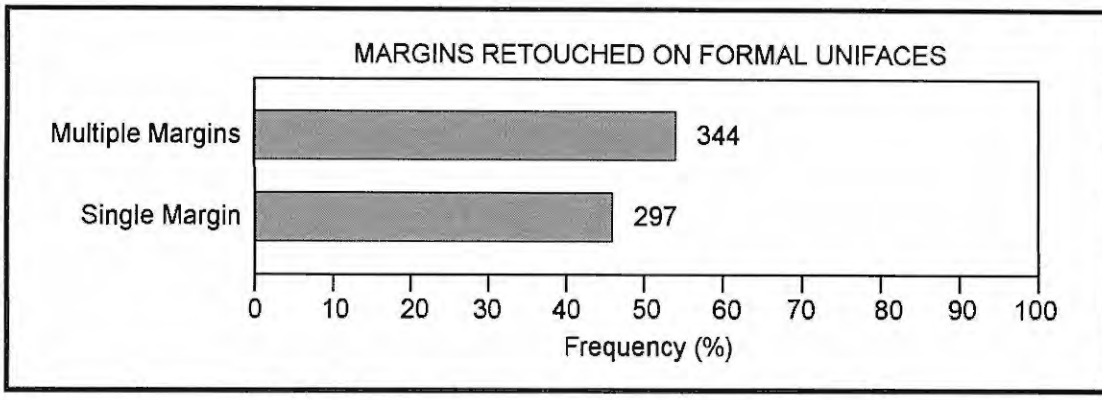


Figure 4.34. Number of margins retouched on formal unifacial tools in the Sadmat assemblage.

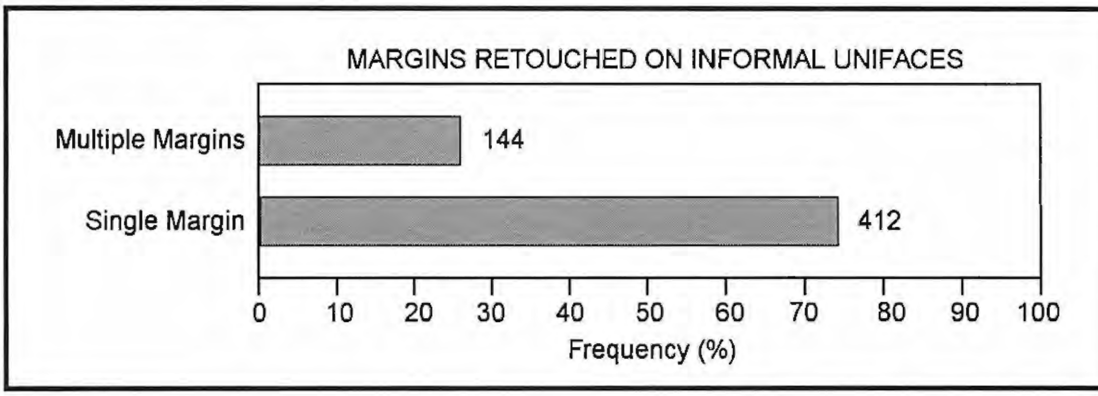
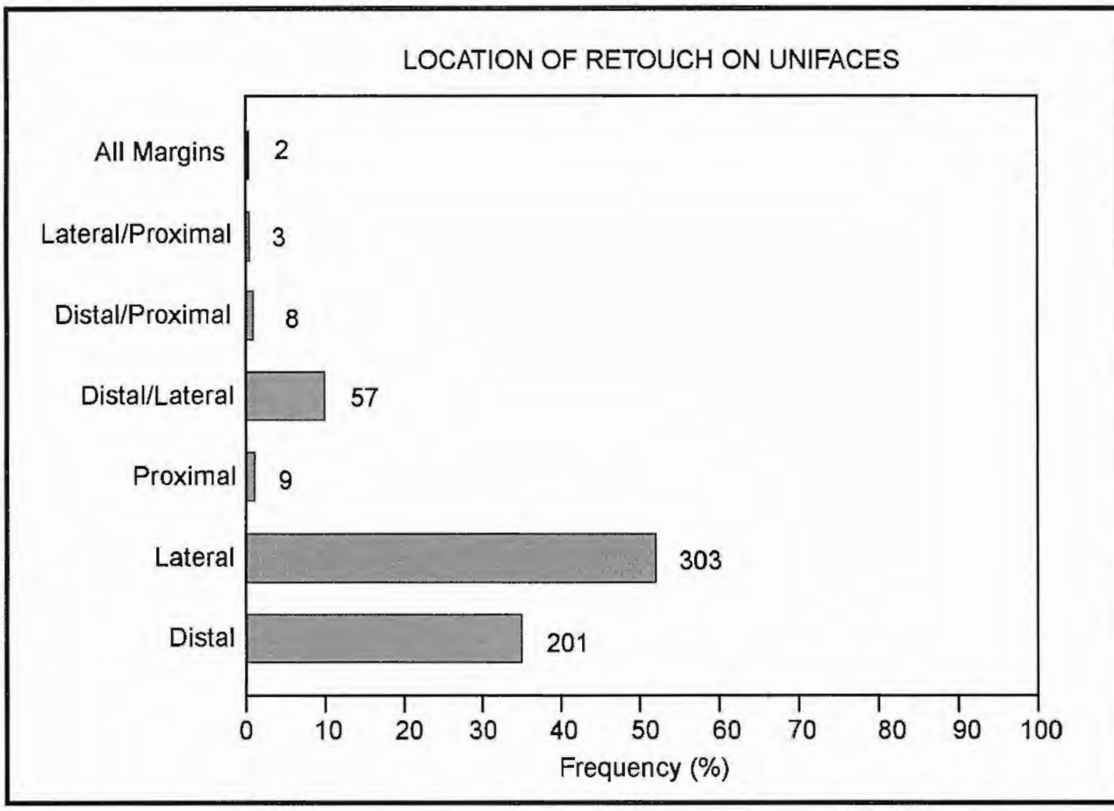


Figure 4.35. Number of margins retouched on informal unifacial tools in the Sadmat assemblage.

297 (46.3%) of the formal unifaces are retouched on a single margin and 344 (53.7%) are retouched on more than one margin (Figure 4.34). Conversely, 412 (74.1%) of the informal unifaces are retouched on a single margin only and 144 (25.9%) are retouched on multiple margins (Figure 4.35). These data support the notion that the informal unifaces were expedient tools that were minimally used prior to discard, while the formal unifaces were made in advance of use and saw prolonged use-lives.

When recognizable, the location or position of retouch was measured on unifaces (Figure 4.36). Retouch mainly occurs on the distal and lateral margins of the tools, with 201 (34.5%) being retouched distally, 303 (52.0%) being retouched laterally, and 57 (9.8%) being retouched both on the distal and lateral margins. A few of the Sadmat tools have retouch on their proximal margins. These include 9 (1.5%) with retouch just on the proximal margin, 8 (1.4%) with retouch on both distal and proximal margins, and 3 (0.5%) with retouch on both the lateral and proximal margins. Two (0.3%) unifaces were worked around the entire perimeter of the tool.



4.36. Location or position of retouch on unifacial tools in the Sadmat assemblage.

Three metric variables were measured on most of the unifacial tools. These include total tool thickness, edge angle, and invasiveness. Descriptions of the variables are presented in Chapter 3. These are presented separately for formal and informal unifaces. Thickness measurements range from 2.3 to 31.0 mm for formal tools, with a mean thickness of 13.1 mm and standard deviation of 6.0 mm (Figure 4.37). Informal tool thicknesses range from 1.2 to 24.4 mm. The mean thickness for informal tools is 13.1 mm and standard deviation is 3.6 mm (Figure 4.38). Edge angle measurements for the formal unifaces range from 63° to 95°, with a mean of 83.6° and standard deviation of 4.0° (Figure 4.39). Edge angle measurements for informal unifaces range from 57° to 90°, with a mean of 77.7° and standard deviation of 5.2° (Figure 4.40). Invasiveness was measured by recording the length of the most invasive flake on each uniface. The invasiveness measurements for formal unifaces range from 1.1 to 19.3 mm, with a mean of 8.0 mm and standard deviation of 2.9 mm (Figure 4.41). The range of invasiveness measurements for informal unifaces is 0.8 to 13.6 mm, with a mean of 3.5 mm and standard deviation is 1.9 mm (Figure 4.42). Certainly the informal unifaces are thinner, have more acute edge angles, and have smaller invasive flake scars than formal unifaces. As with the number of margins utilized, these data further prove that informal tool use was minimal while formal tools saw intensive use.

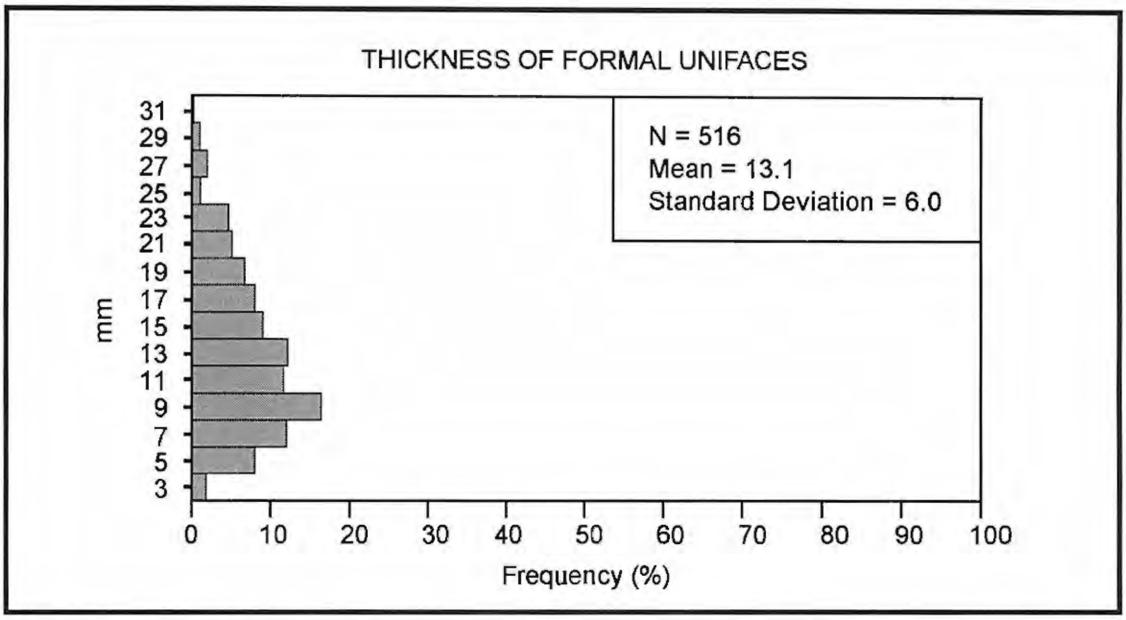


Figure 4.37. Thicknesses of formal unifacial tools in the Sadmat assemblage.

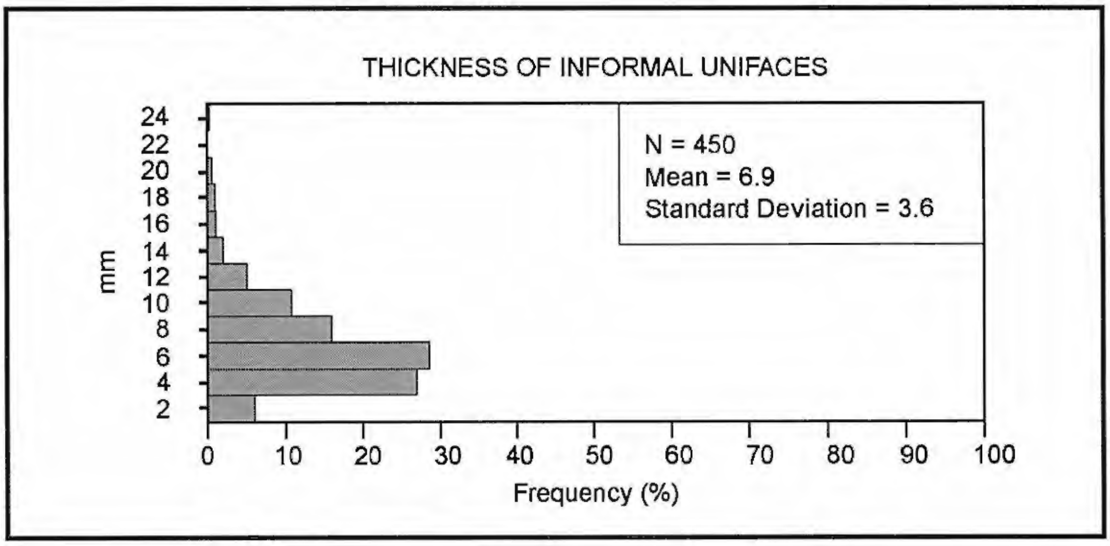


Figure 4.38. Thicknesses of informal unifacial tools in the Sadmat assemblage.

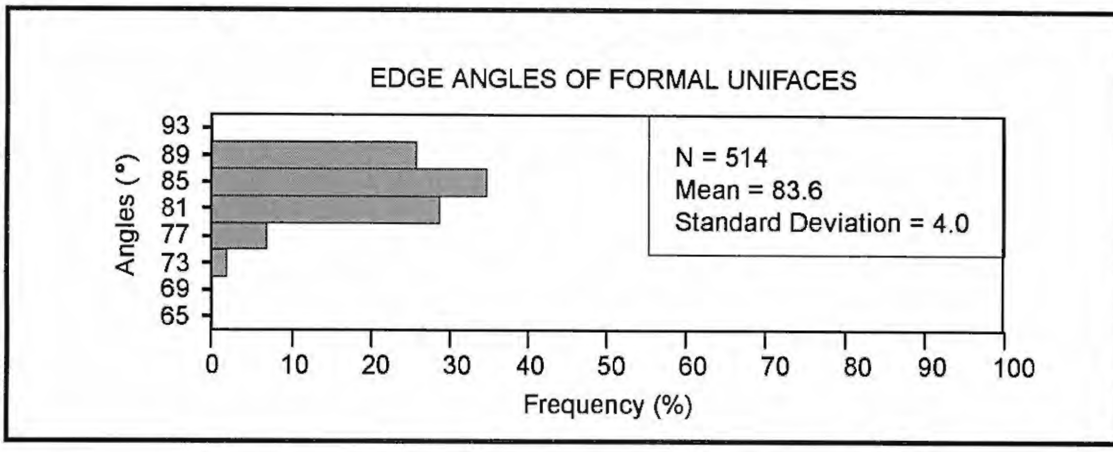


Figure 4.39. Edge angles of formal unifacial tools in the Sadmat assemblage.

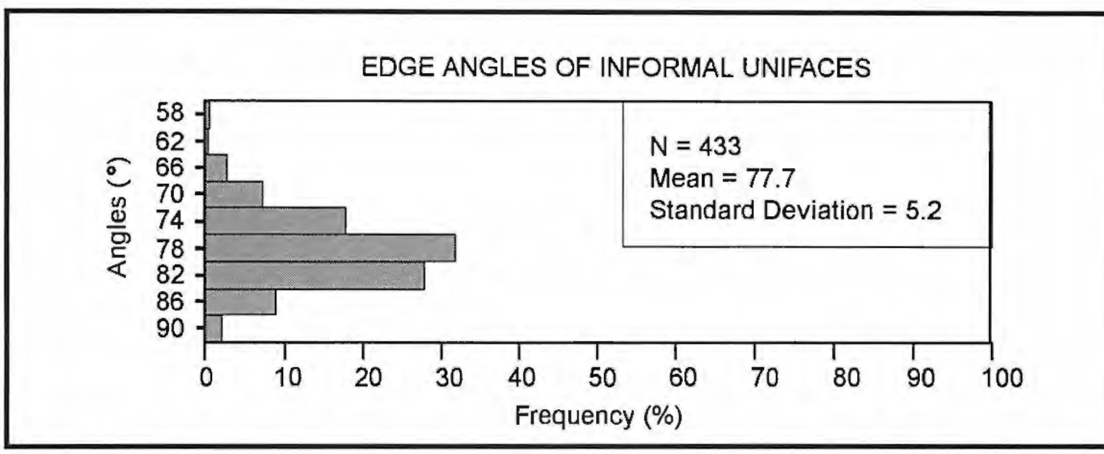


Figure 4.40. Edge angles of informal unifacial tools in the Sadmat assemblage.

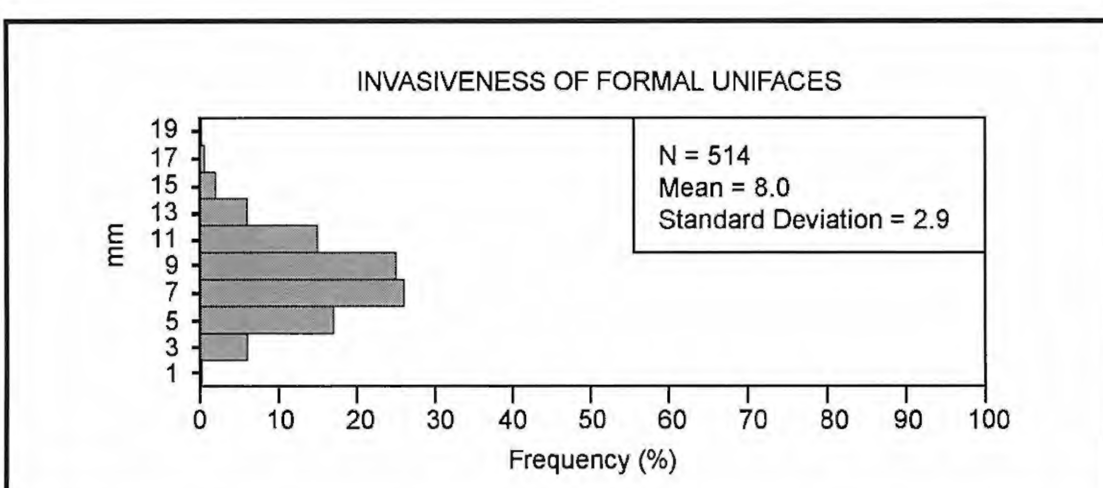


Figure 4.41. Invasiveness of formal unifacial tools in the Sadmat assemblage.

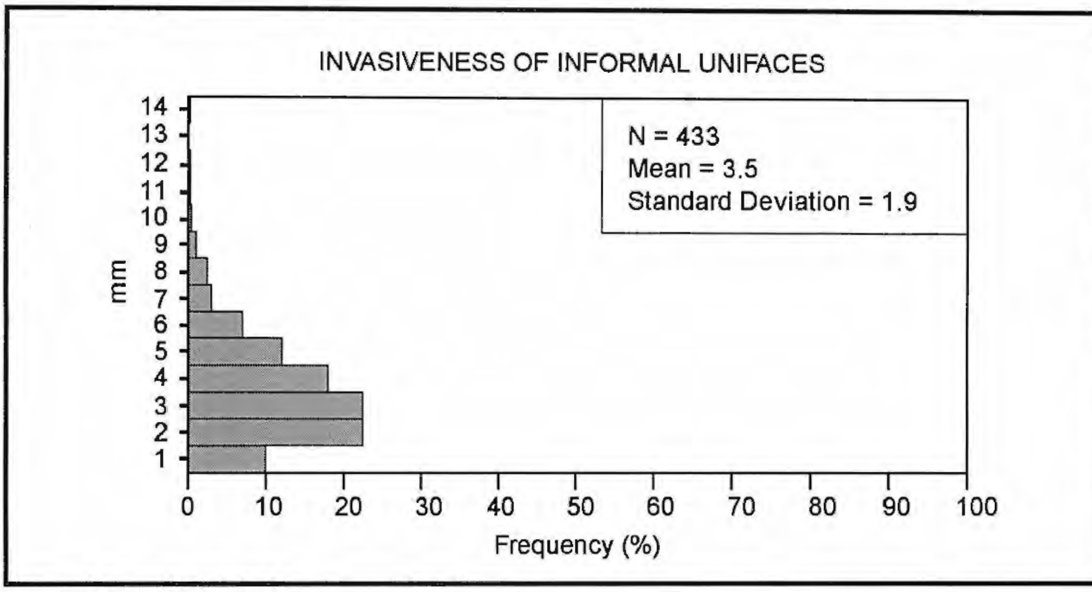


Figure 4.42. Invasiveness of informal unifacial tools in the Sadmat assemblage.

The Coleman Assemblage

The Coleman assemblage studied consists of 2,427 lithic artifacts. These include 45 cores, 1,704 pieces of debitage, and 678 bifacial and unifacial tools.

Raw Material

The Coleman assemblage consists of three raw material types. These include basalt, CCS, and obsidian (Figure 4.43). Basalt artifacts number 2,197 (90.5%), CCS artifacts number 176 (7.3%), and obsidian artifacts number 54 (2.2%) of the assemblage.

Cores

The core assemblage at Coleman has 45 flake cores. These include 5 (11.1%) tested cobbles, 11 (24.4%) unidirectional cores, 8 (17.8%) bidirectional cores, and 21 (46.7%) multidirectional cores (Figures 4.44 and 4.45).

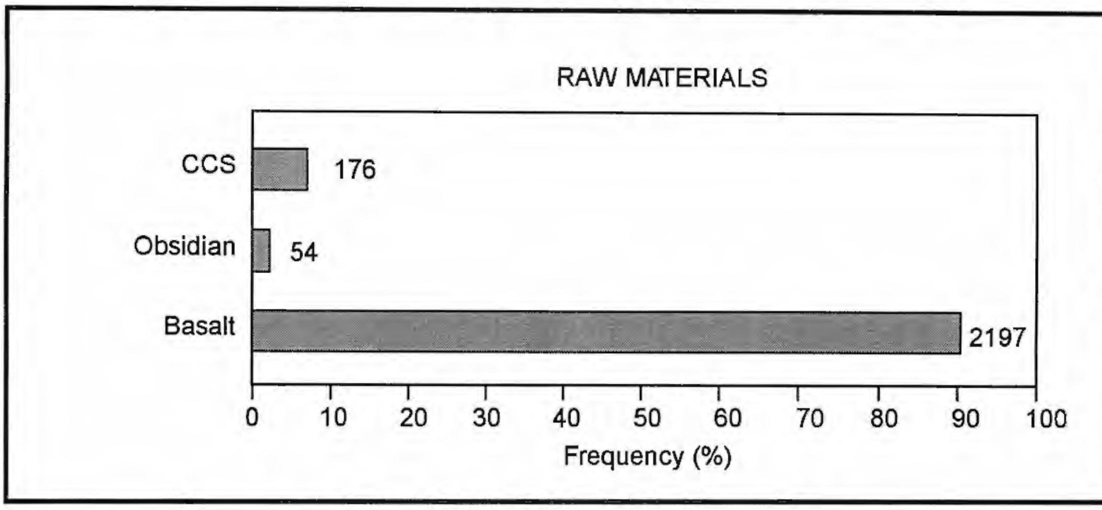


Figure 4.43. Raw materials represented in the Coleman lithic assemblage.

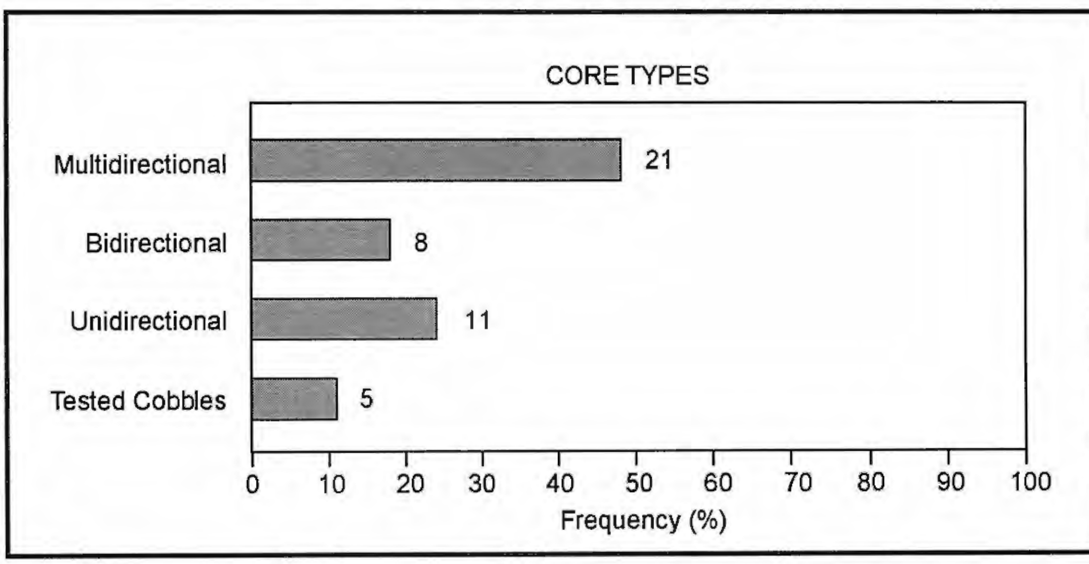


Figure 4.44. Core types represented in the Coleman assemblage.

Basalt makes up 95.6% and CCS 4.4% of the toolstones utilized to manufacture cores at Coleman. More specifically, all five of the tested cobbles and all 11 and of the unidirectional cores are manufactured on basalt (Table 4.4). Seven bidirectional cores are manufactured on basalt, and 1 is on CCS. Twenty of the multidirectional cores are manufactured on basalt and 1 is manufactured on CCS.

The number of core platforms and number of core fronts are variables that measure the reduction intensity of a core. For number of core platforms, 14 of 43 flake cores (32.6%) possess one

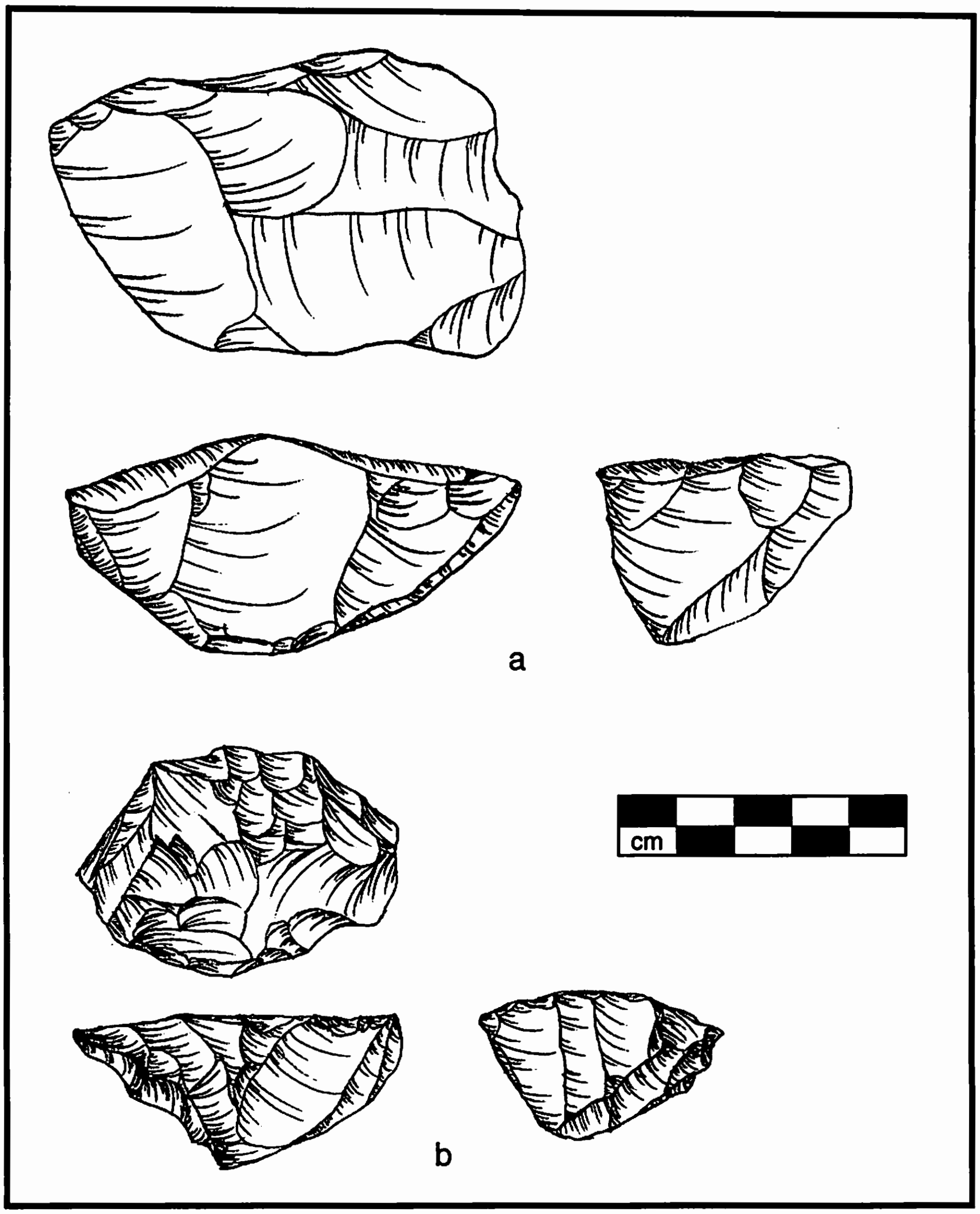


Figure 4.45. Multidirectional flake cores in the Coleman assemblage.

platform, 18 (41.9%) possess two platforms, 7 (16.3%) possess three platforms, and 4 (9.3%) possess four platforms (Figure 4.46). For number of core fronts, 3 (7.0%) of the cores possess one front, 9 (20.9%) possess two fronts, 21 (48.8%) possess three fronts, and 10 (23.3%) possess four or more fronts (Figure 4.47). The relatively high percentages of multiple platforms and fronts suggest that the cores at Coleman were being intensively reduced before discard.

Table 4.4. Coleman Core Types Site by Raw Material.

			Raw Material		
Tool Type	n	%	Basalt	Obsidian	CCS
Tested Cobbles	5	11.1	5 (100.0%)	0 (0.0%)	0 (0.0%)
Unidirectional Cores	11	24.4	11 (100.0%)	0 (0.0%)	0 (0.0%)
Bidirectional Cores	8	17.8	7 (87.5%)	0 (0.0%)	1 (12.5%)
Multidirectional Cores	21	46.7	20 (95.2%)	0 (0.0%)	1 (4.8%)
Total	45	100	43 (95.6%)	0 (0.0%)	2 (4.4%)

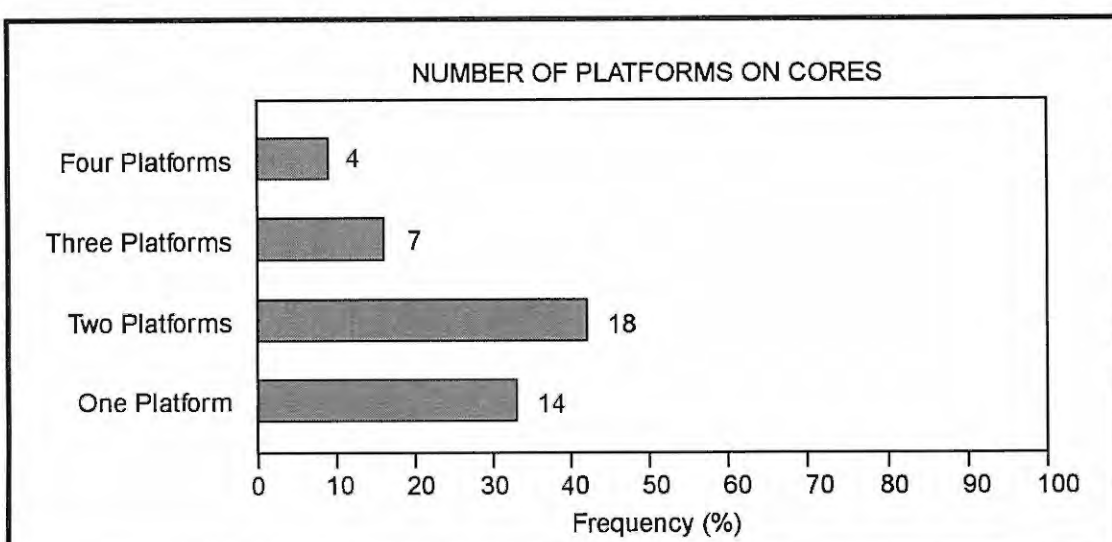
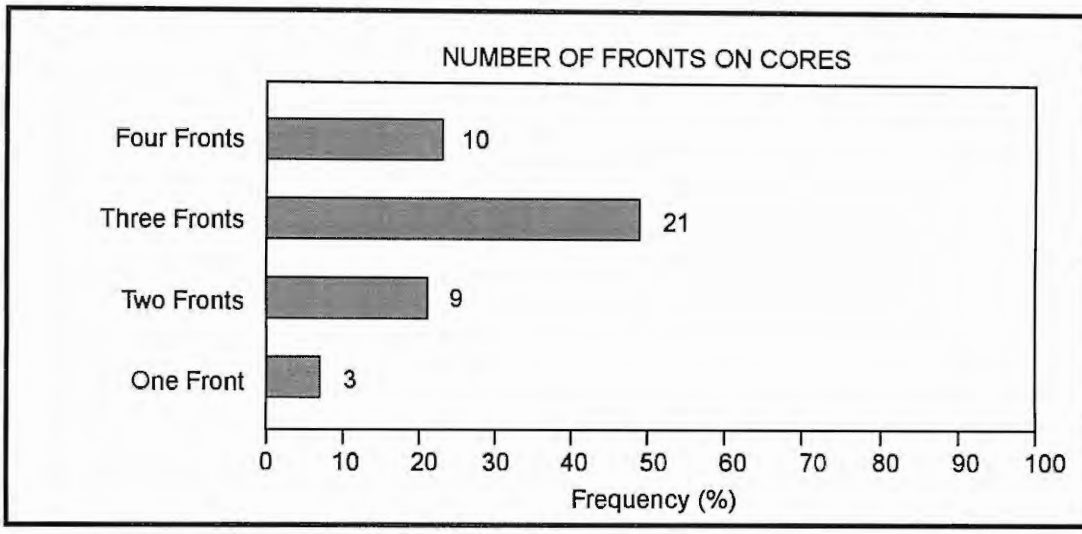


Figure 4.46. Numbers of platforms on flake cores in the Coleman assemblage.



Fignre 4.47. Numbers of fronts on flake cores in the Coleman assemblage.

Surface platform preparation was tallied, with 1 (2.6%) of the cores possessing a cortical platform, 27 (69.2%) possessing smooth platforms, and 11 (28.2%) exhibiting complex platforms (Figure 4.48).

The amount of cortex on cores was also scored. The majority of the cores, 21 (48.8%), do not have cortex, while 10 (23.3%) of the cores possess less than 10% cortex, 10 (23.3%) have between 10 and 50% cortex, and 2 (4.7%) have more than 50% cortex (Figure 4.49).

MLD measurements were taken on 38 cores. These range from 33.3 to 121.7 mm (Figure 4.50). The MLD mean is 74.5 mm and the standard deviation is 17.7 mm. Core weights were taken on 35 cores. They range from 24.1 to 500.0 g, with a mean of 125.5 g and standard deviation of 102.5 g (Figure 4.51). The vast majority of cores have size values of less than 10,000 (Figure 4.52). Size values range from 803 to 56,200, with a mean of 10,781.4 and standard deviation of 11,956.2. The Coleman cores tend to posses small size values relative to the range of measurements, suggesting they were being intensively reduced prior to discard.

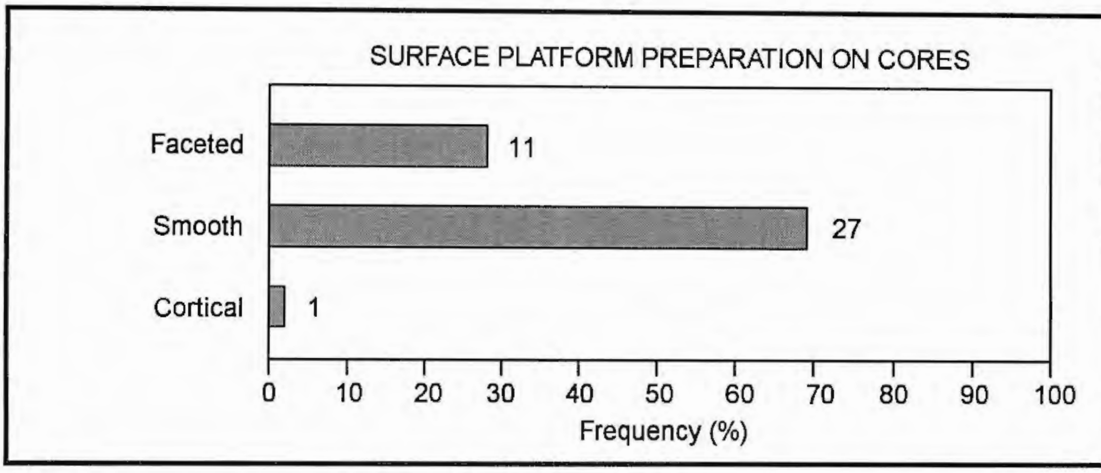


Figure 4.48. Surface platform preparation on flake cores in the Coleman assemblage.

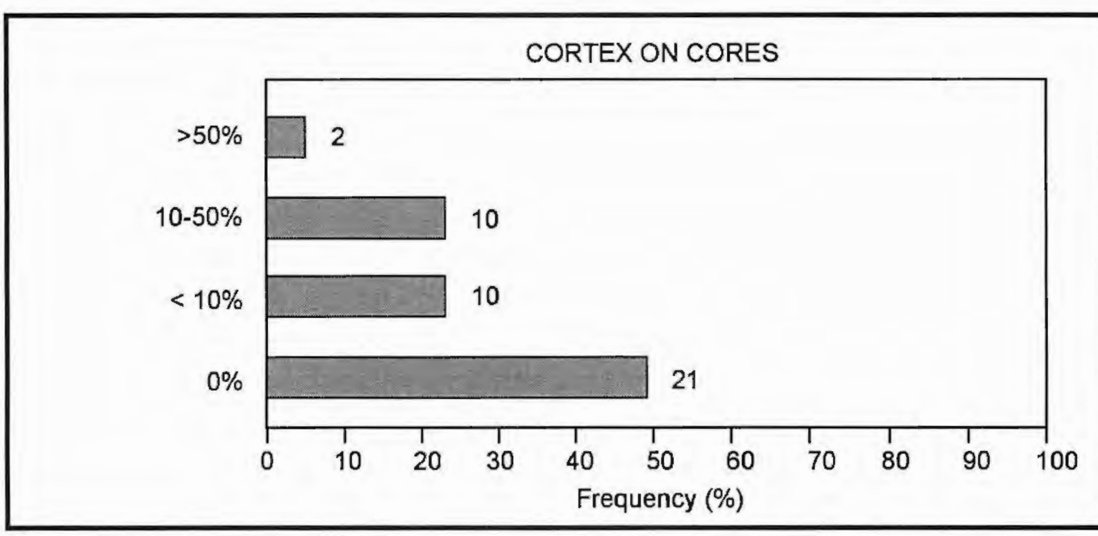


Figure 4.49. Amounts of cortex on flake cores in the Coleman assemblage.

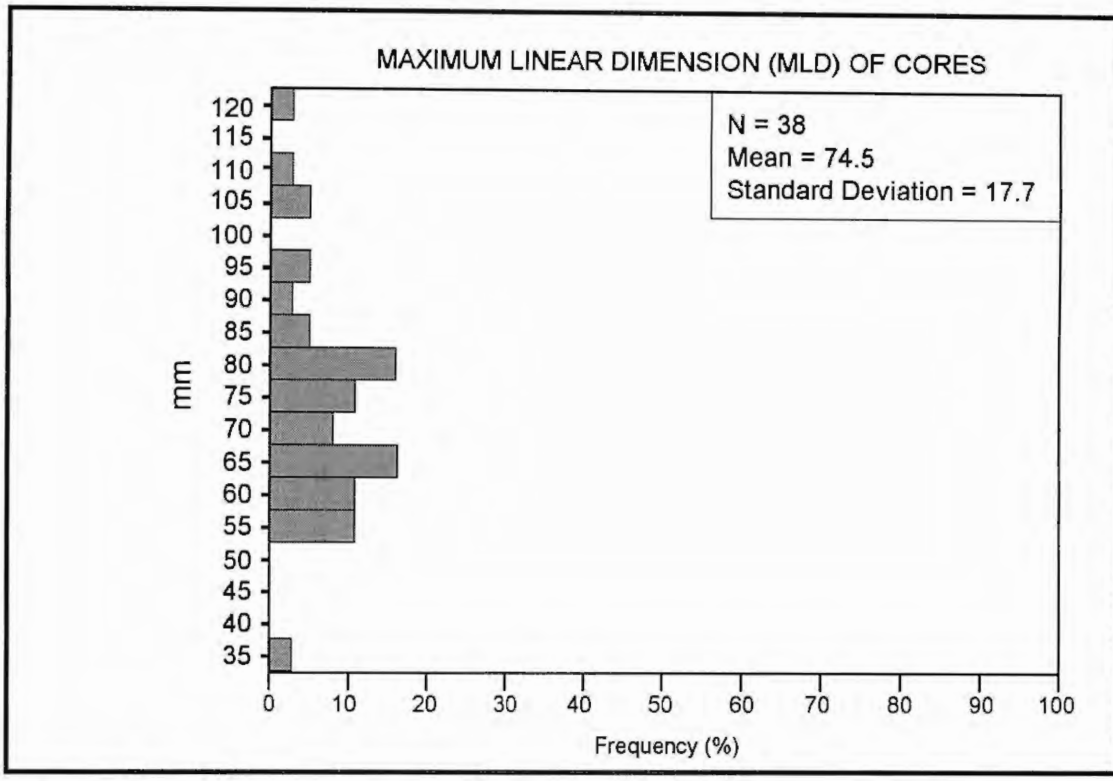


Figure 4.50. Maximum linear dimensions (MLD) of flake cores in the Coleman assemblage.

Debitage

There are 1,704 pieces of debitage in the Coleman assemblage. This is much higher than the amount of debitage from Sadmat. Each piece of debitage was assigned to a class (Figure 4.53). There are 43 (2.5%) pieces of angular shatter, 170 (10.0%) cortical spalls, 1,019 (59.8%) flakes, and 472 (27.7%) retouch chips. The debitage classes cortical spall, flake, and retouch chip were further broken down into debitage types (Table 4.5). Among the cortical spalls, there are 3 (1.8%) cortical spall fragments, 4 (2.4%) primary cortical spalls, and 163 (95.9%) secondary cortical spalls. Among the flakes, there are 364 (35.1%) flake fragments, 653 (59.9%) complete flakes, and 2 (5.0%) blade-like flakes. Among the retouch chips, there are 1 (0.2%) retouch chip fragment, 3 (0.6%) complete retouch chips, and 468 (99.2%) biface thinning flakes (Table 4.5).

When comparing these types to raw materials (Table 4.5), 36 of the angular shatter pieces are manufactured on basalt, 5 on obsidian, 2 on CCS. Among the cortical spalls, all 3 of the cortical spall fragments are manufactured on basalt, all 4 primary cortical spalls are on basalt, and 152

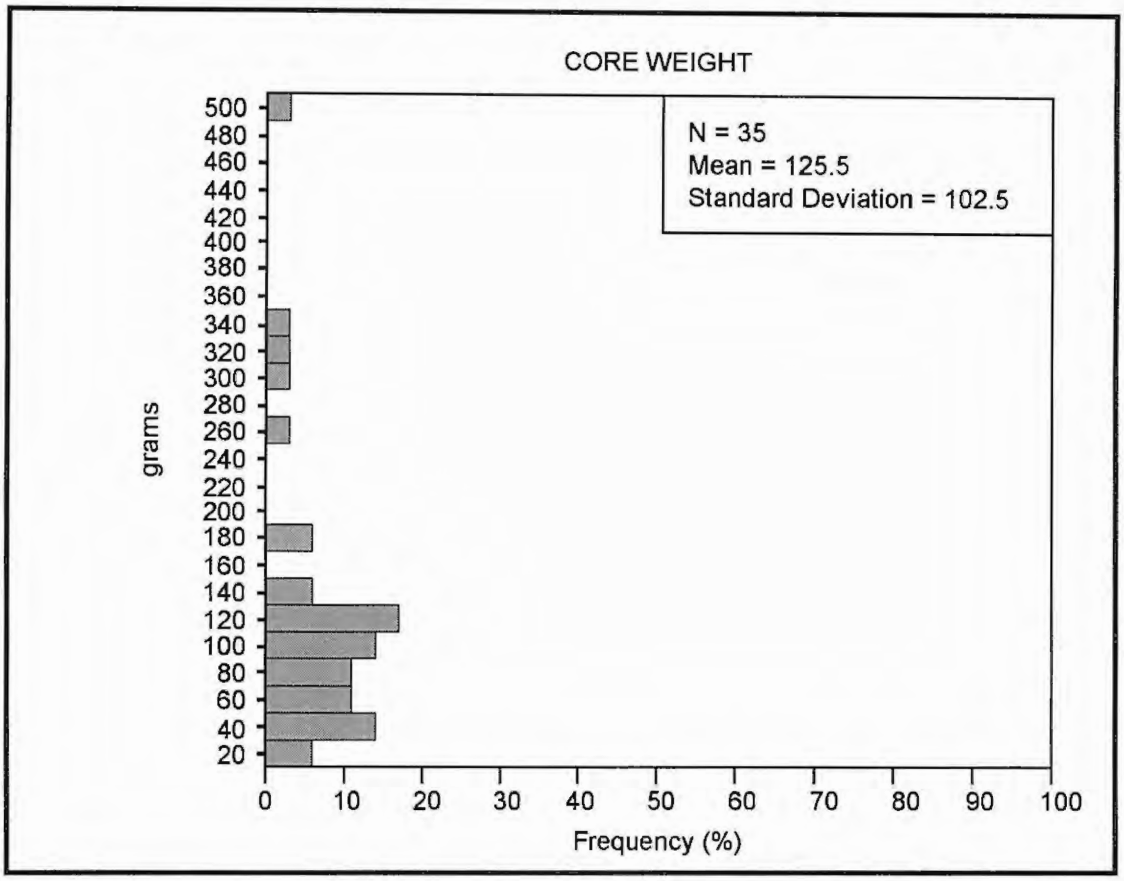


Figure 4.51. Weights of flake cores in the Coleman assemblage.

secondary cortical spalls are manufactured on basalt, 27 on CCS, and 4 on obsidian. Of the flake fragments, 327 are manufactured on basalt, 25 on CCS, and 12 on obsidian. Of complete flakes, 580 are manufactured on basalt, 60 on CCS, and 13 on obsidian. Both blade-like flakes are manufactured on basalt. The only retouch chip fragment is manufactured on basalt, and 1 complete retouch chip is made on basalt and 2 are made on CCS. For the biface thinning flakes, 488 are manufactured on basalt, 19 on CCS, and 11 on obsidian.

Surface platform preparation was scored on 1,285 debitage pieces. Besides these, 419 do not have platforms. Sixty-two (4.8%) of the recognizable platforms are cortical, 672 (52.3%) of the platforms are smooth, 513 (39.9%) of the platforms are complex, and 38 (3.0%) of the platforms are abraded (Figure 4.54).

The number of dorsal flake scars on flake debitage, including cortical spalls, flakes, and retouch chips, was tallied (Figure 4.55). Eighteen (1.4%) of these debitage pieces possess only one

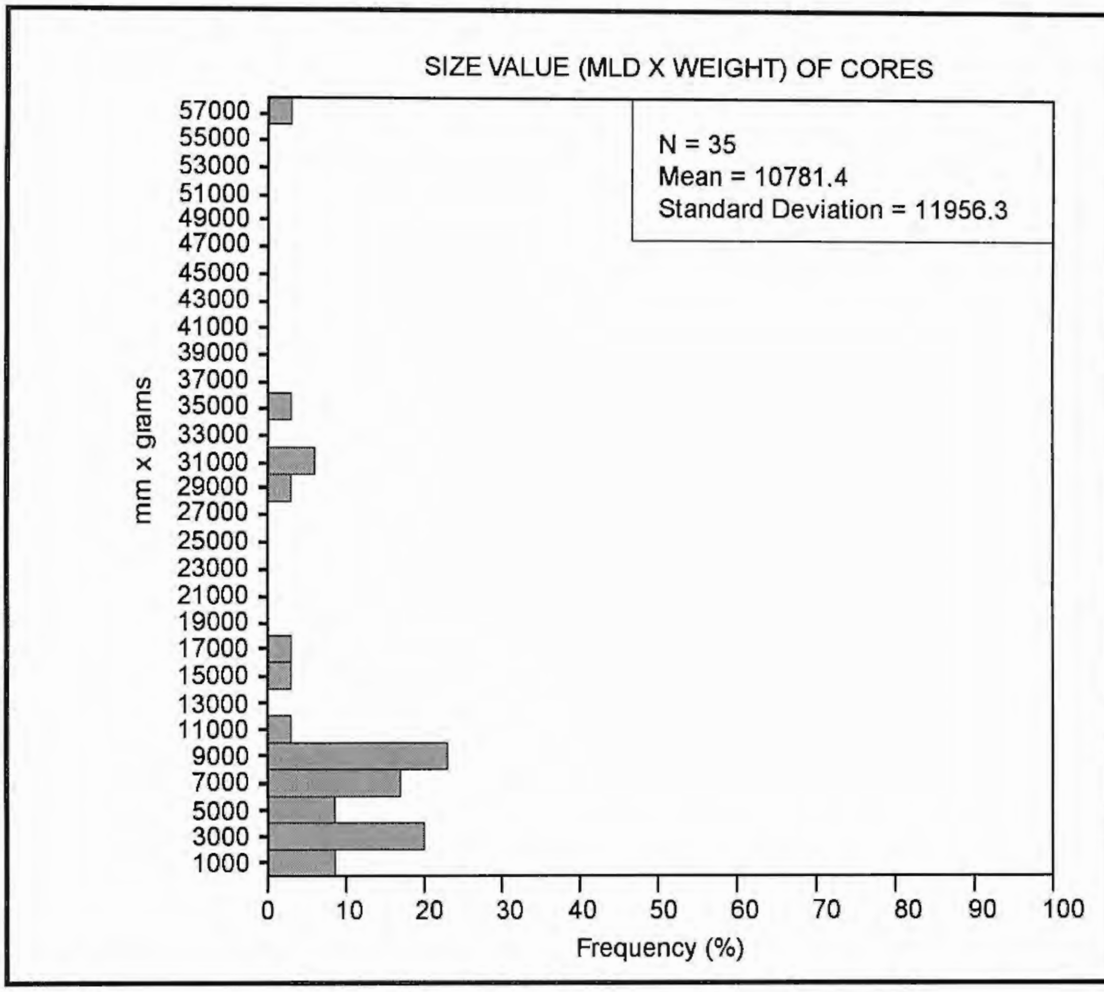


Figure 4.52. Size values of flake cores in the Coleman assemblage.

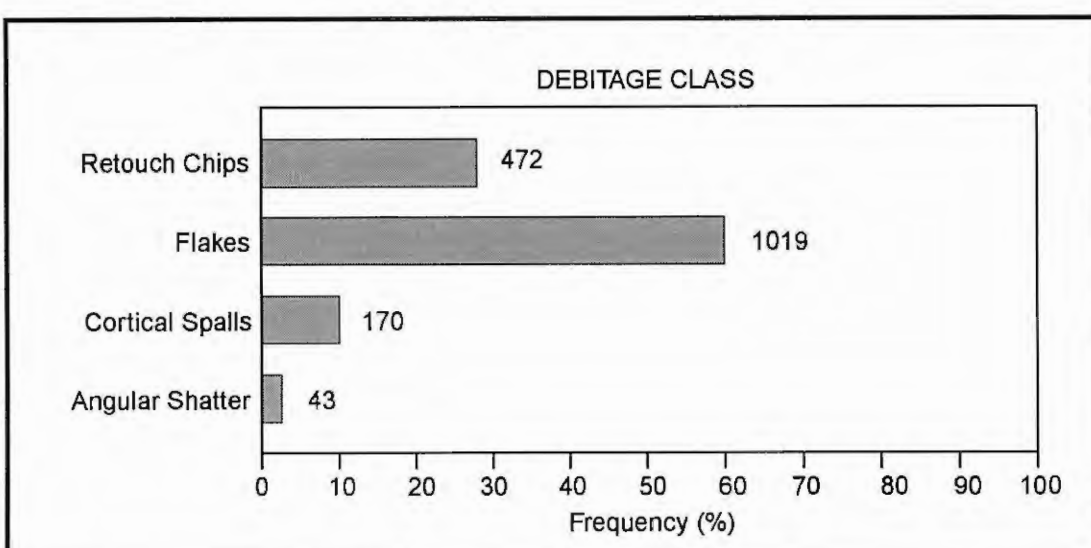


Figure 4.53. Debitage classes for the Coleman assemblage.

Table 4.5. Coleman Debitage Types by Raw Material.

			Raw Material		
Tool Type	n	%	Basalt	Obsidian	CCS
Cortical Spalls					
Cortical Spall Fragments	3	1.8	3 (100.0%)	0 (0.0%)	0 (0.0%)
Primary Cortical Spalls	4	2.4	4 (100.0%)	0 (0.0%)	0 (0.0%)
Secondary Cortical Spalls	163	95.9	152 (93.3%)	4 (2.5%)	7 (4.3%)
Total	170	100	159 (93.5%)	4 (2.4%)	7 (4.1%)
Flakes					
Flake Fragments	364	35.1	327 (89.8%)	12 (3.3%)	25 (6.9%)
Flakes	653	59.9	580 (88.8%)	13 (2.0%)	60 (9.2%)
Blade-like Flakes	2	5.0	2 (100.0%)	0 (0.0%)	0 (0.0%)
Total	1019	100	909 (89.2%)	25 (2.5%)	85 (8.3%)
Retouch Chips					
Retouch Chip Fragments	1	0.2	1 (100.0%)	0 (0.0%)	0 (0.0%)
Retouch Chips	3	0.6	1 (33.3%)	0 (0.0%)	2 (66.7%)
Biface Thinning Flakes	468	99.2	438 (93.6%)	11 (2.4%)	19 (4.1%)
Total	472	100	440 (93.2%)	11 (2.3%)	21 (4.4%)
Angular Shatter	43	100	36 (83.7%)	5 (11.6%)	2 (4.7%)
Total	1704		1544 (90.6%)	45 (2.6%)	115 (6.7%)

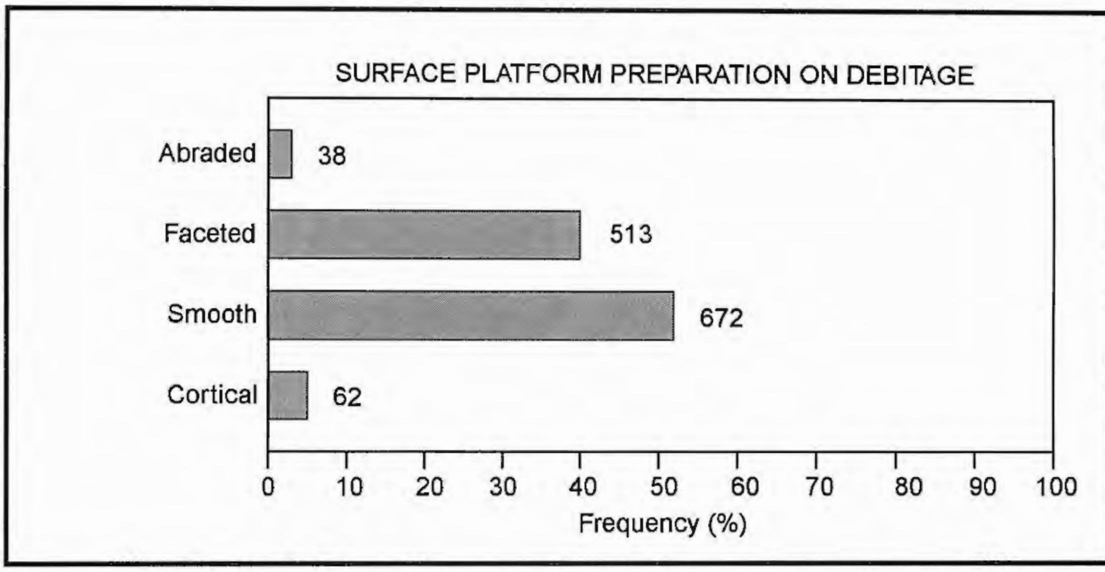


Figure 4.54. Surface platform preparation of debitage platforms in the Coleman assemblage.

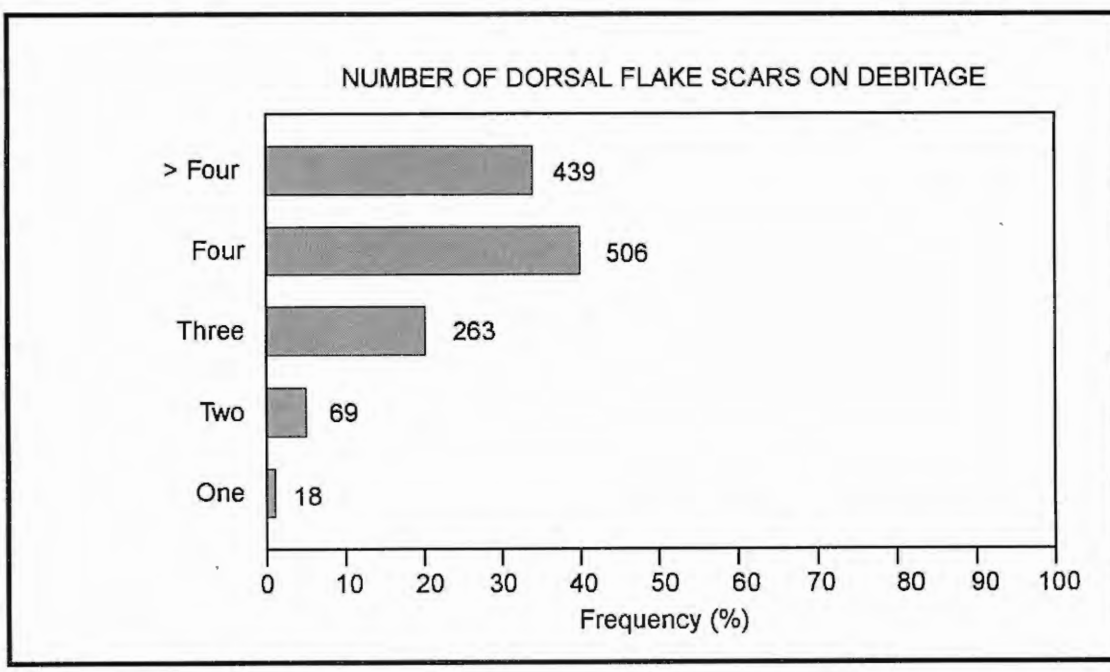


Figure 4.55. Numbers of dorsal flake scars on debitage in the Coleman assemblage.

dorsal flake scar, 69 (5.3%) possess two dorsal flake scars, 263 (20.3%) exhibit three dorsal flake scars, 506 (39.1%) contain four dorsal flake scars, and 439 (33.9%) exhibit more than four dorsal flake scars. The relatively high frequency of dorsal flake scars could suggest that the majority of debitage is related to secondary reduction.

Size value was scored on all pieces of debitage containing platforms, a total of 1,288 cases. Thirteen (1.0%) debitage pieces fall into the very small (<1 cm^2) category, 448 (34.8%) are small (1 cm^2 to 3 cm^2), 658 (51.1%) are medium (3 cm^2 to 5 cm^2), and 169 (13.1%) are large (>5 cm^2) (Figure 4.56).

Cortex was scored on 1,702 debitage pieces. Of these, 1,027 (89.6%) exhibit no cortex, while only 57 (3.3%) contain less than 10% cortex, 112 (6.6%) contain between 10 and 50% cortex,

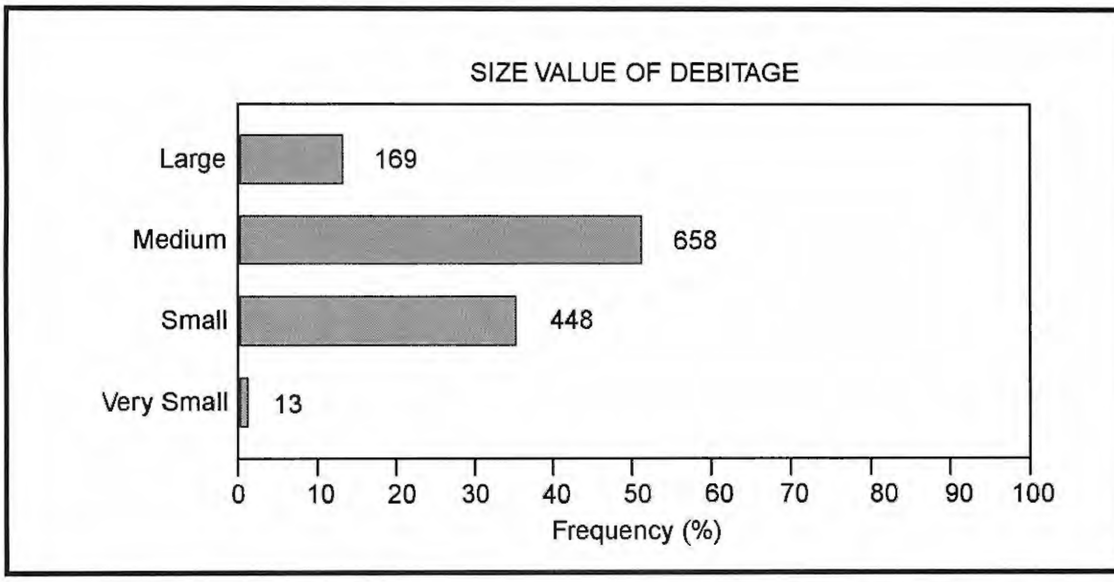


Figure 4.56. Size values for debitage in the Coleman assemblage.

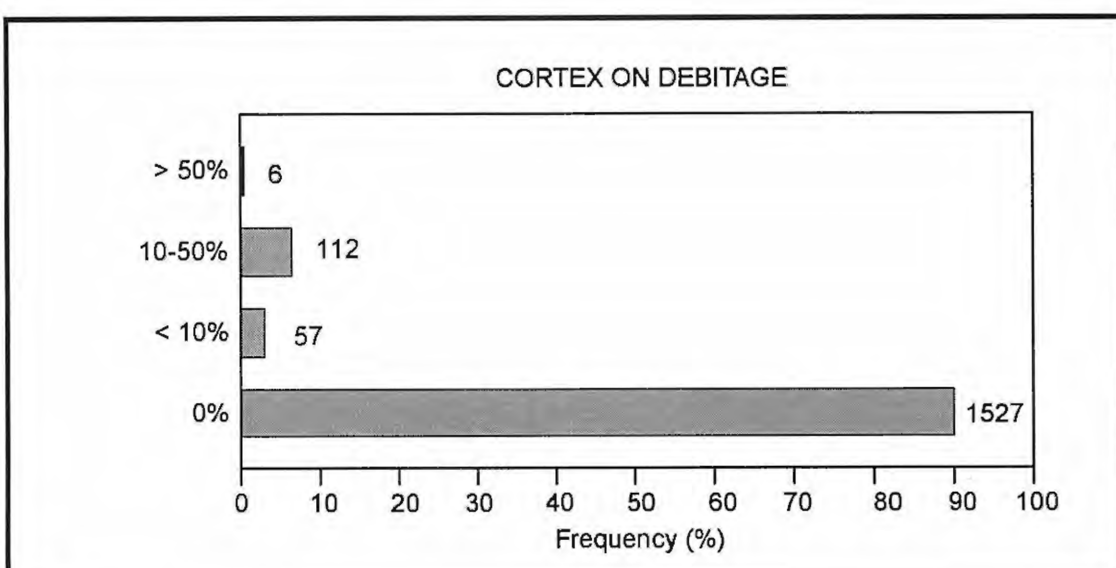


Figure 4.57. Amounts of cortex on debitage in the Coleman assemblage.

and only 6 (0.3%) pieces contain more than 50% cortex (Figure 4.57). As with the cores, a high percentage of debitage without cortex could suggest a low frequency of primary reduction; however, raw material packages from the quarry near the site are often relatively large colluvial cobbles possessing little to no cortex.

Tool Assemblage

Tool Typology. The Coleman assemblage contains 678 tools. Of these, 423 (62.4%) are bifaces and 255 (37.6%) are unifaces. Among the bifaces 415 are unhafted bifaces and 8 are hafted bifaces (Figure 4.58). Among the unifaces, there are 52 (7.7%) side scrapers, 7 (1.0%) end scrapers, 8 (1.2%) gravers , 10 (1.5%) combination tools, and 170 (25.1%) retouched flakes (Figure 4.49). There are 8 "Other Tools" in the assemblage that make up 1.2% of the tools. These include burins (0.7%), backed knives (0.3%), and a notch (0.1%).

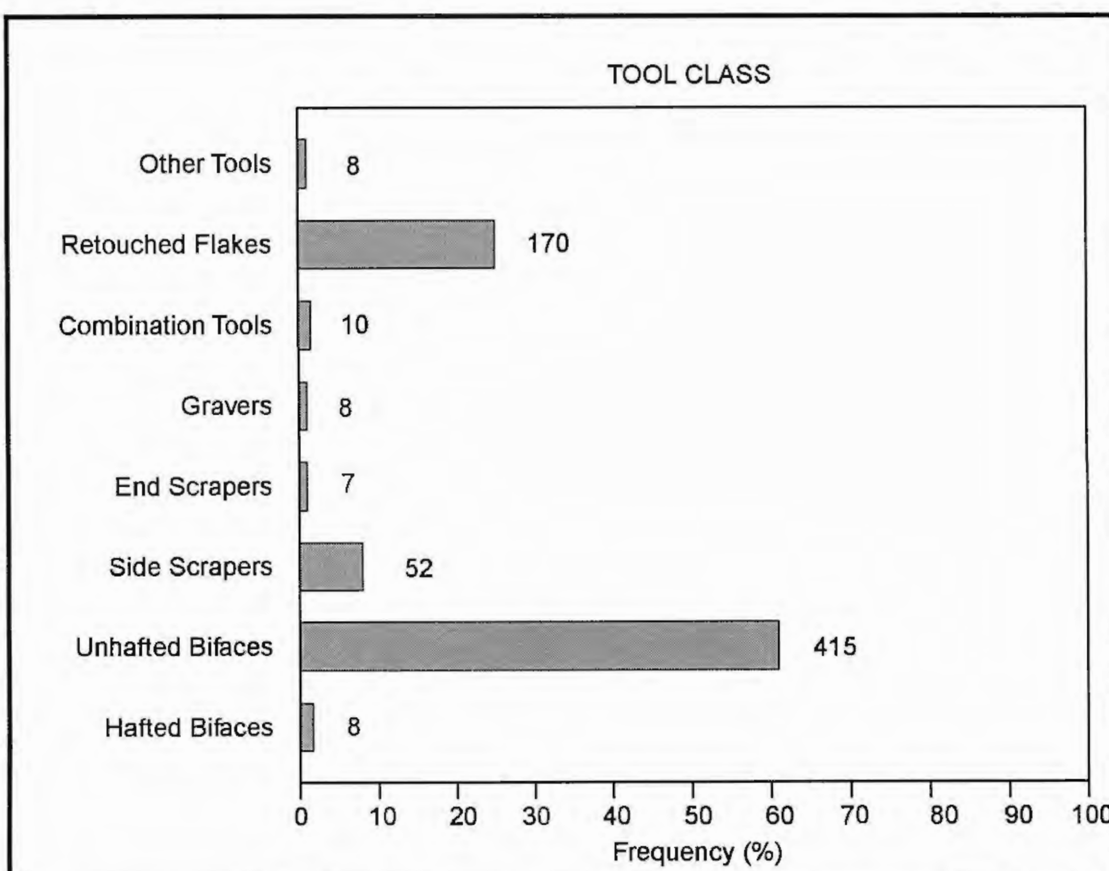


Figure 4.58. Tool classes for the Coleman assemblage.

Table 4.6. Coleman Tool Types by Raw Material.

			Raw Material		
Tool Type	n	%	Basalt	Obsidian	CCS
Hafted Bifaces					
Parman Stemmed Points	3	37.5	2 (66.7%)	1 (33.3%)	0 (0.0%)
Haskett Stemmed Points	1	12.5	0 (0.0%)	1 (100.0%)	0 (0.0%)
Windust Stemmed Points	1	12.5	1 (100.0%)	0 (0.0%)	0 (0.0%)
Hafted Biface/Stem Fragments	1	12.5	1 (100.0%)	0 (0.0%)	0 (0.0%)
Beaked	1	12.5	1 (100.0%)	0 (0.0%)	0 (0.0%)
Pinto Points	1	12.5	1 (100.0%)	0 (0.0%)	0 (0.0%)
Total	8	100	6 (75.0%)	2 (25.0%)	0 (0.0%)
Unhafted Bifaces					
Fragments	351	84.5	336 (95.7%)	0 (0.0%)	15 (4.3%)
Miscellaneous	27	6.5	26 (96.3%)	0 (0.0%)	1 (3.7%)
Leaf-shaped	10	2.4	10 (100.0%)	0 (0.0%)	0 (0.0%)
Stemmed (Preforms)	22	5.3	18 (81.8%)	1 (4.5%)	3 (13.6%)
Ovate	2	0.5	2 (100.0%)	0 (0.0%)	0 (0.0%)
Crescent	1	0.2	1 (100.0%)	0 (0.0%)	0 (0.0%)
Beaked	2	0.5	2 (100.0%)	0 (0.0%)	0 (0.0%)
Total	415	100	395 (95.2%)	1 (0.2%)	19 (4.6%)
Side Scrapers					
Fragments	10	19.2	10 (100.0%)	0 (0.0%)	0 (0.0%)
Unilateral	16	30.8	13 (81.3%)	0 (0.0%)	3 (18.8%)
Bilateral	8	15.4	6 (75.0%)	0 (0.0%)	2 (25.0%)
Convergent	4	7.7	3 (75.0%)	0 (0.0%)	1 (25.0%)
Transverse	6	11.5	6 (100.0%)	0 (0.0%)	0 (0.0%)
Bifacially Retouched	1	1.9	0 (0.0%)	0 (0.0%)	1 (100.0%)
Alternately Retouched	3	5.8	3 (100.0%)	0 (0.0%)	0 (0.0%)

Table 4.6. Continued.

Tool Type	n	%	Raw Material: Basalt	Obsidian	CCS
Ventrally Retouched	3	0.9	2 (66.7%)	0 (0.0%)	1 (33.3%)
Limace/Slug-shaped	1	1.9	1 (100.0%)	0 (0.0%)	0 (0.0%)
Total	52	100	44 (84.6%)	0 (0.0%)	8 (15.4%)
End Scrapers					
Flake	4	57.1	1 (25.0%)	0 (0.0%)	3 (75.0%)
Round	1	14.3	1 (100.0 %)	0 (0.0%)	0 (0.0%)
Steeply keeled	2	28.6	2 (100.0%)	0 (0.0%)	0 (0.0%)
Total	7	100	4 (57.1%)	0 (0.0%)	3 (42.9%)
Gravers					
Fragments	2	25.0	0 (0.0%)	0 (0.0%)	2 (100.0%)
Single-Spurred	6	75.0	4 (66.7%)	0 (0.0%)	2 (33.3%)
Total	8	100	4 (50.0%)	0 (0.0%)	4 (50.0%)
Combination Tools					
Wedge/Scrapers	2	20.0	2 (100.0%)	0 (0.0%)	0 (0.0%)
Scraper/Gravers	6	60.0	2 (33.3%)	0 (0.0%)	4 (66.7%)
Scraper/Notches	1	10.0	1 (100.0%)	0 (0.0%)	0 (0.0%)
Scraper/Burins	1	10.0	1 (100.0%)	0 (0.0%)	0 (0.0%)
Total	10	100	6 (60.0%)	0 (0.0%)	4 (40.0%)
Retouched Flakes					
Fragments	25	14.7	20 (80.0%)	0 (0.0%)	5 (20.0%)
Flake	139	81.8	122 (87.8%)	6 (4.3%)	11 (7.9%)
Blade-like Flake	6	3.5	5 (83.3%)	0 (0.0%)	1 (16.7%)
Total	170	100	147 (86.5%)	6 (3.5%)	17 (10.0%)
Other Tools					
Backed Knives	2	25.0	1 (50.0%)	0 (0.0%)	1 (50.0%)

Table 4.6. Continued.

			Raw Material		
Tool Type	n	%	Basalt	Obsidian	CCS
Notches	1	12.5	1 (100.0%)	0 (0.0%)	0 (0.0%)
Burins on Flakes	5	62.5	2 (40.0%)	0 (0.0%)	3 (60.0%)
Total	8	100	4 (50.0%)	0 (0.0%)	4 (50.0%)
Total	678		610 (90.0%)	9 (1.3%)	59 (8.7%)

The tool assemblage can be further divided into types within the classes discussed above (Table 4.6). Hafted bifaces fall into the following types. There are 3 Parman stemmed points (62.5%), 1 Haskett stemmed point (12.5%), 1 Windust stemmed point (12.5%), 1 hafted biface/stem fragment (12.5%), and 1 beaked biface (12.5%). As discussed in Chapter 2, one point, a Pinto point, is thought to represent a later occupation of the site. All three of the major raw material types were used to manufacture these hafted bifaces (Figure 4.59 and 4.60, Table 4.6). Among them, 75.0% of the hafted bifaces are made on basalt and 25.0% are on obsidian.

The unhafted bifaces consist of 351 unhafted biface fragments (84.5%), 27 untypable, miscellaneous bifaces (6.5%), 22 stemmed preforms (5.3%), 10 leaf-shaped bifaces (2.4%), 2 ovate bifaces (0.5%), 1 crescent biface (0.2%), and 2 beaked bifaces (0.5%) (Figures 4.59 and 4.60). These bifaces total 415, of which 95.2% are made on basalt, 4.6% are on CCS, 0.2% are on obsidian (Table 4.6).

Side scrapers number 52 and consist of 10 side scraper fragments (19.2%), 16 unilateral side scrapers (30.8%), 8 bilateral side scrapers (15.4%), 4 convergent side scrapers (7.7%), 6 transverse side scrapers (11.5%), 1 bifacially retouched side scraper (1.9%), 3 alternately retouched side scrapers (5.8%), 3 ventrally retouched side scrapers (5.8%), and 1 limace or slug-shaped side scraper (1.9%) (Figures 4.61 and 4.62). As for raw materials used in the manufacture of side scrapers, 84.6% are on basalt and 15.4% are on CCS (Table 4.6).

There are 7 end scrapers. These included 4 (57.1%) end scrapers on flakes, 1(14.3%) round end scraper, and 2 (28.6%) steeply keeled end scrapers (Figures 4.61 and 4.62). Basalt was used to manufacture 57.1% of the end scrapers and CCS was used for 42.9% (Table 4.6).

There are 8 gravers that are further typed into the following categories: 2 (25.0%) graver fragments and 6 (75.0%) single-spurred gravers (Figure 4.61). Half of the gravers are manufactured on basalt, while the other half are manufactured on CCS (Table 4.6).

There are 10 combination tools that consists of 02 (20.0%) wedge/scrapers, 6 (60.0%) scraper/gravers, 1 (10.0%) scraper/notch, and 1 (10.0%) scraper/burin (Figures 4.61 and 4.62). Basalt was used to make 60.0% of these combination tools, while CCS was utilized to make 40.0% (Table 4.6).

There are 170 retouched flakes. These include 25 (14.7%) retouched flake fragments, 139 (81.8%) retouched flakes, and 6 (3.5%) retouched blade-like flakes (Figure 4.62). Of the retouched

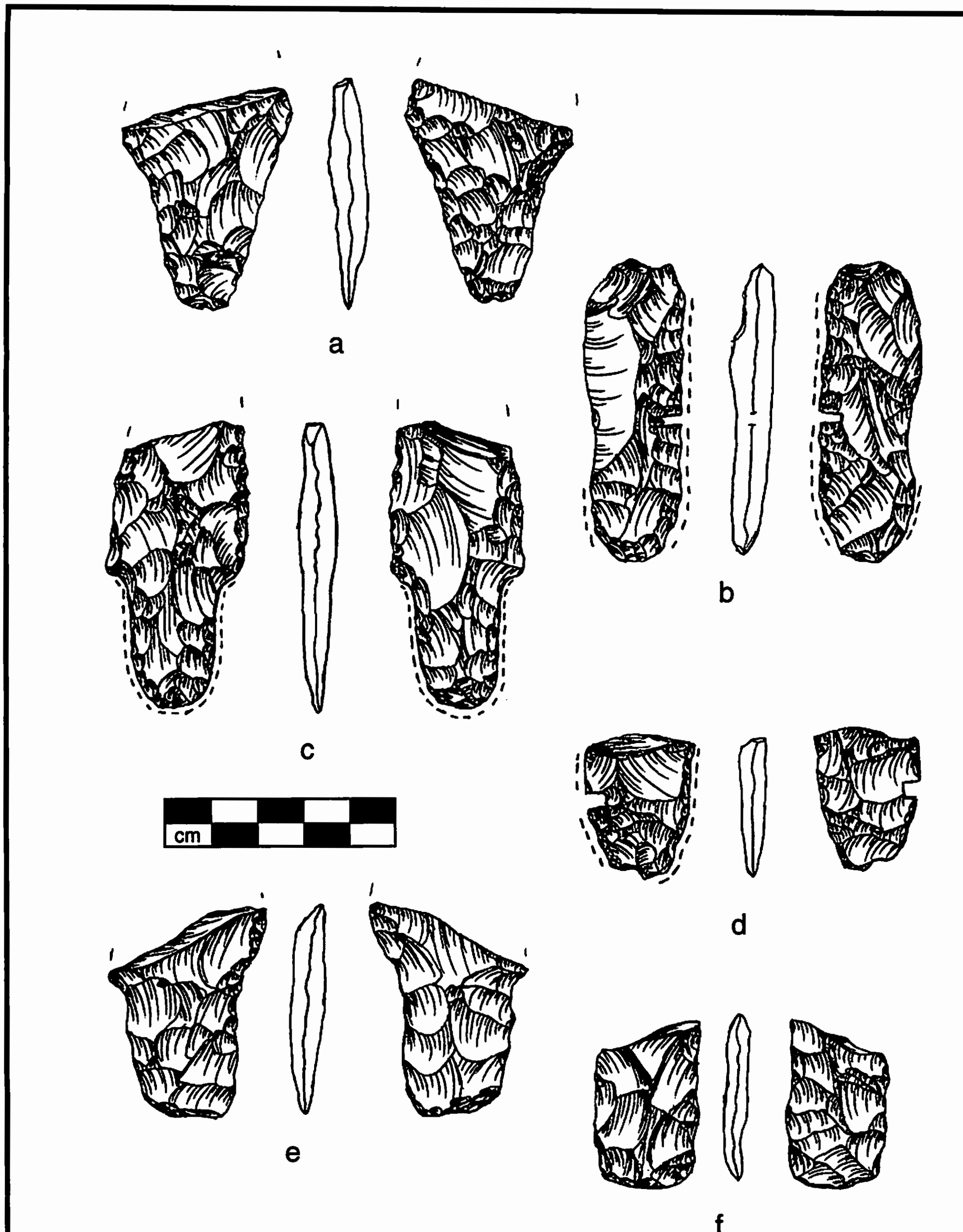


Figure 4.59. Hafted bifaces in the Coleman assemblage (a: stemmed preform; b: Haskett stemmed point; c-d: Parman stemmed points; e: Windust stemmed point; f: hafted biface/stem fragment.

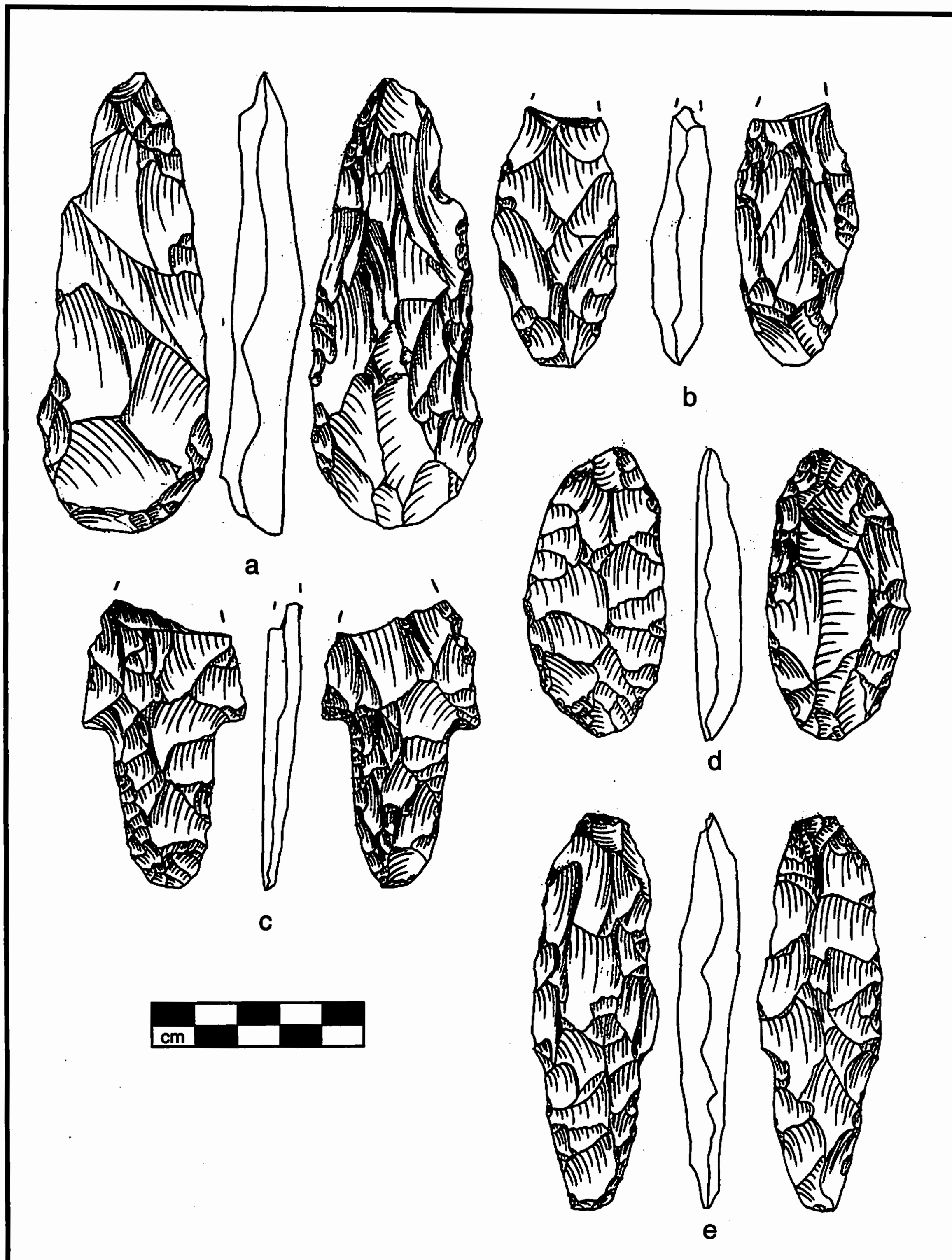


Figure 4.60. Bifaces in the Coleman assemblage (a: ovate; b, d: leaf-shaped; c: Parman stemmed point; e: stemmed preform).

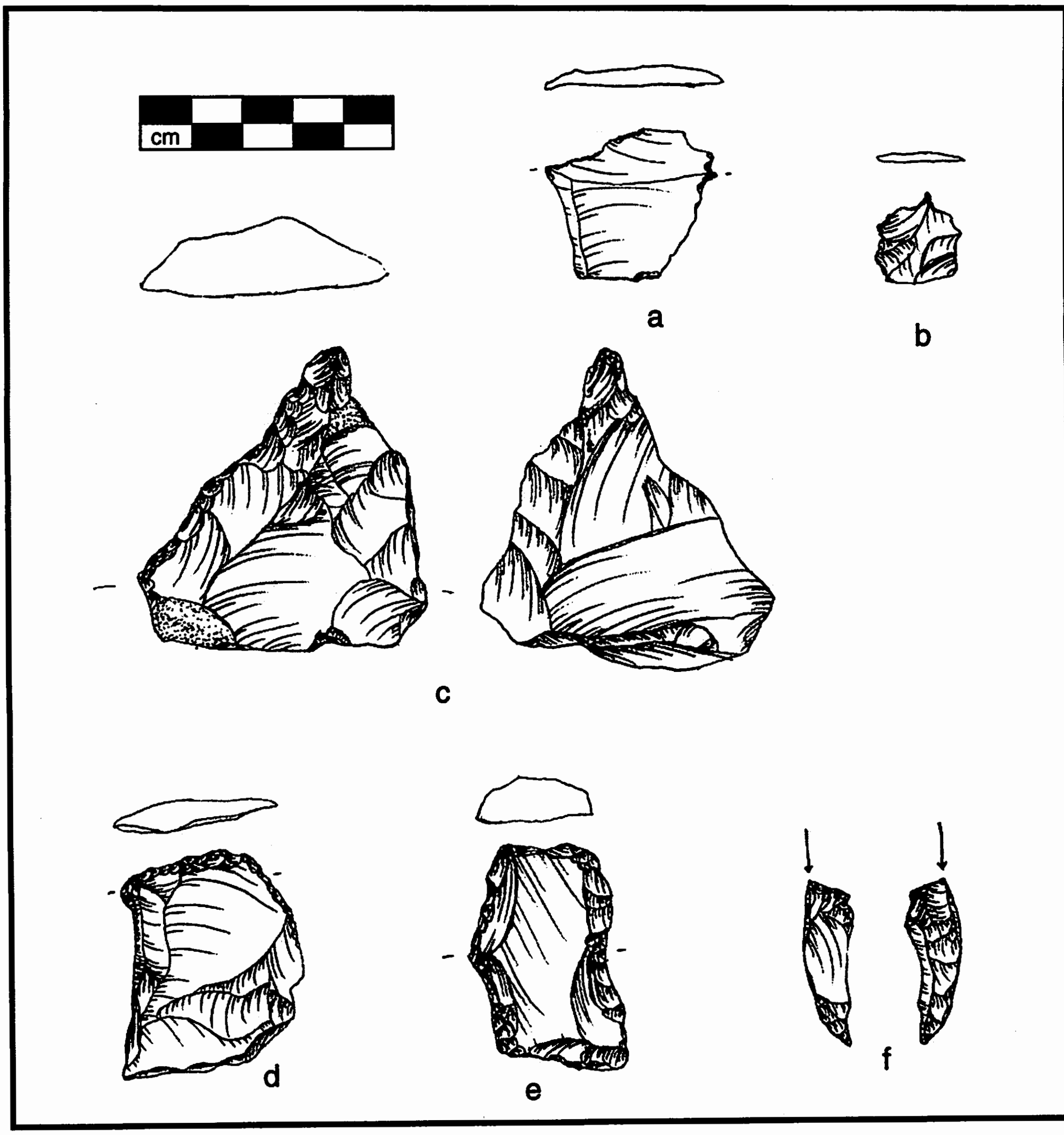


Figure 4.61. Unifacial tools in the Coleman assemblage (a-b: gravers; c: graver/scraper; d: end scraper on a flake; e: double side scraper; f: burin spall.

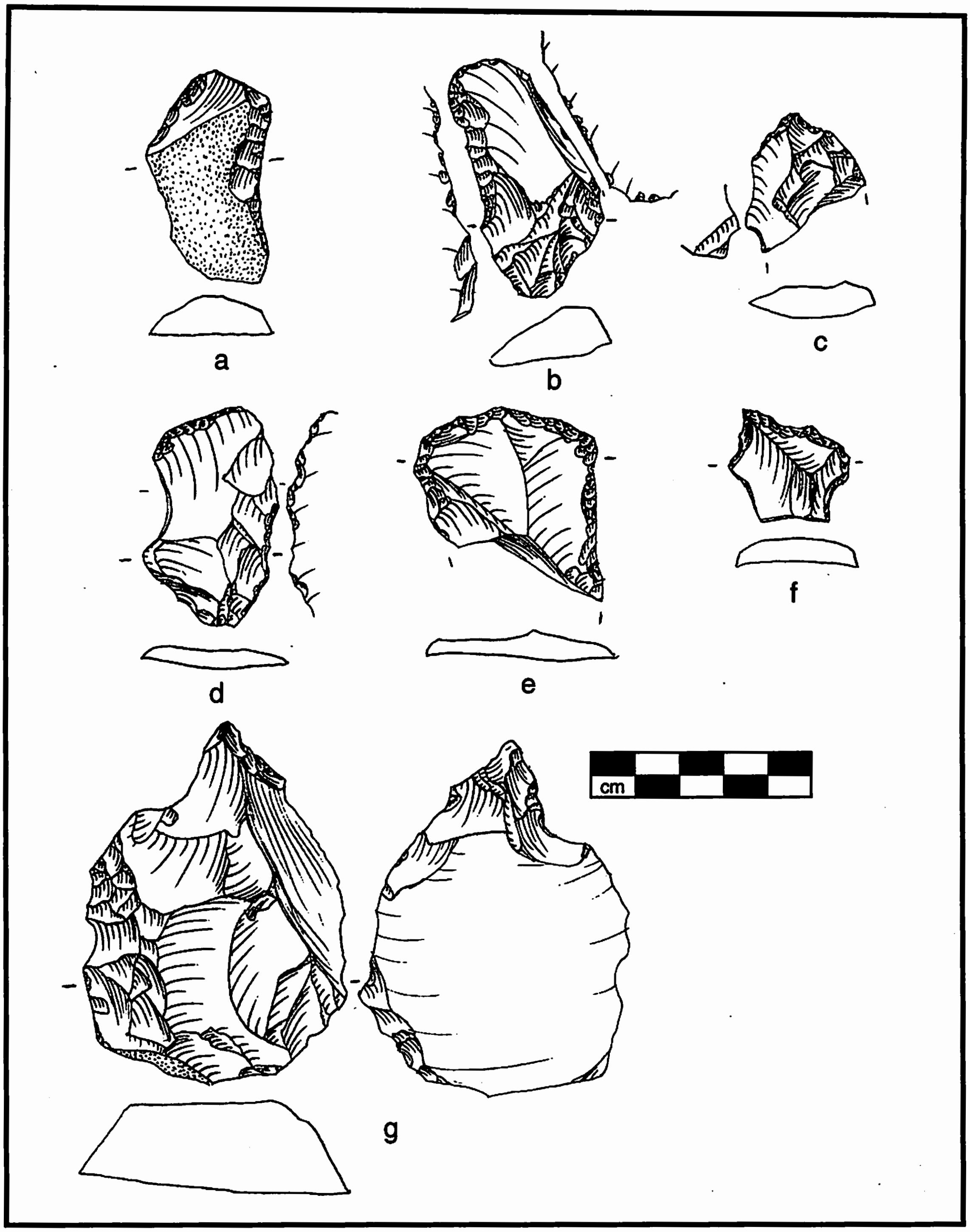


Figure 4.62. Unifacial tools in the Coleman assemblage (a: double side scraper; b: single side scraper; c-d: retouched flakes; e: end scraper on a flake; f-g: graver/scrapers).

flakes, 86.5% are made on basalt, 10.0% are made on CCS, and 3.5% are made on obsidian (Table 4.6).

Among the "Other Tools," there are 2 (22.2%) backed knives, 1 (11.1%) notch, and 5 (66.7%) burins on flakes (Figure 4.61). The backed knives are made on basalt and CCS, while the notch is manufactured on basalt. Two of the burins are made on basalt and the other 3 are on CCS (Table 4.6).

Biface Analysis. Bifaces in the collection were scored based on their condition (Figure 4.63). Of the 423 bifaces scored, 297 (70.2%) are unidentifiable/untypable biface fragments, 39 (9.2%) are complete bifaces, 21 (5.0%) are proximal fragments, 46 (10.9%) are medial fragments, 4 (0.9%) are distal fragments, 15 (3.5%) are laterally broken, and 1 (0.2%) is reworked. The high percentage of broken (91.6%) to complete or reworked bifaces (9.4%) suggests that many of the bifaces represented at the Coleman site were broken during manufacture or use, and therefore abandoned at the site.

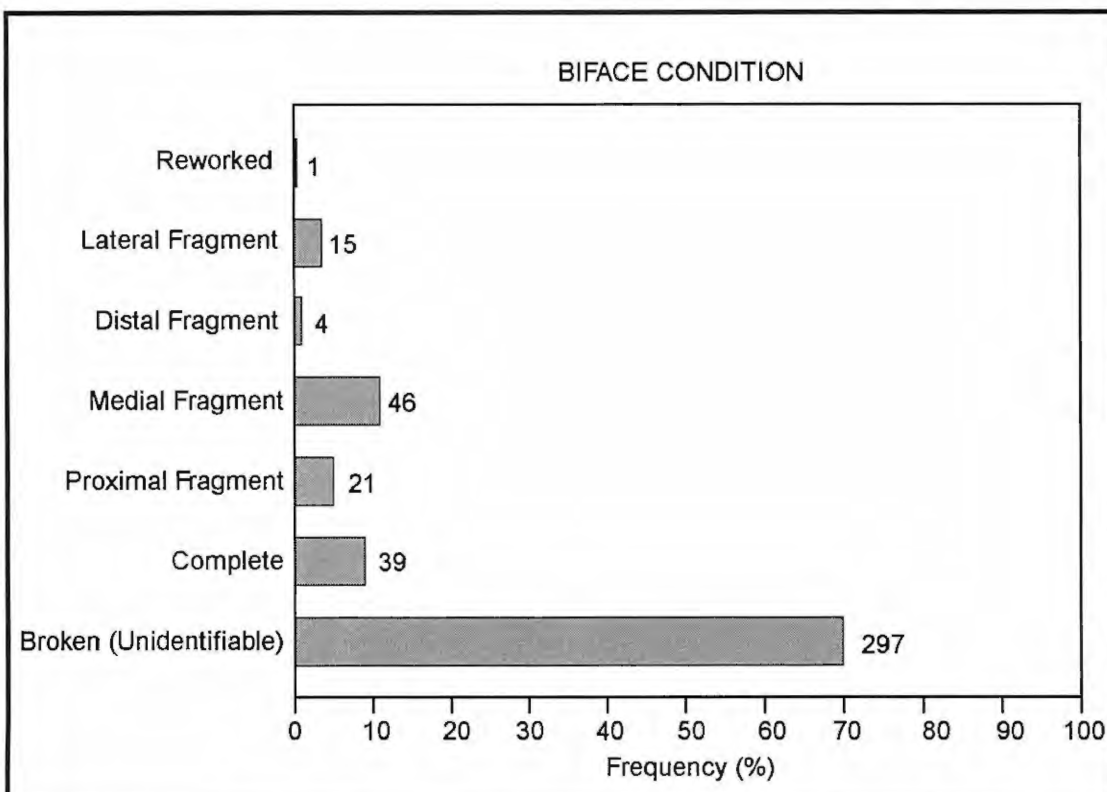


Figure 4.63. Conditions of bifaces in the Coleman assemblage.

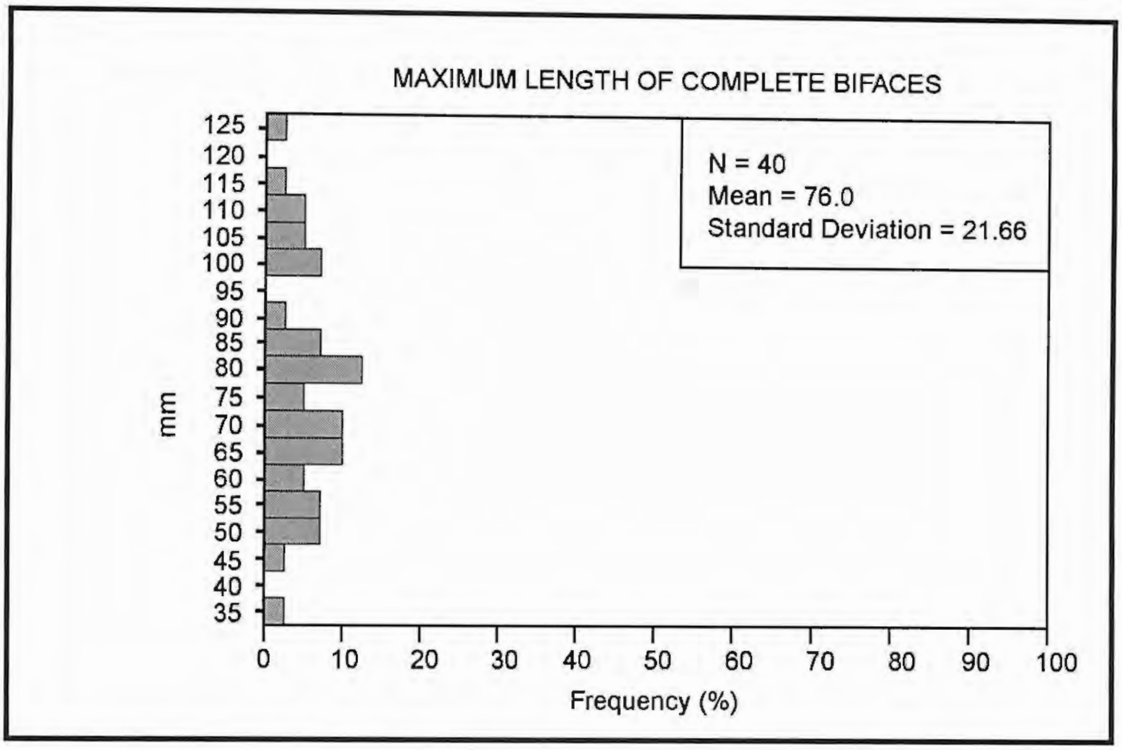


Figure 4.64. Maximum lengths of complete bifaces in the Coleman assemblage.

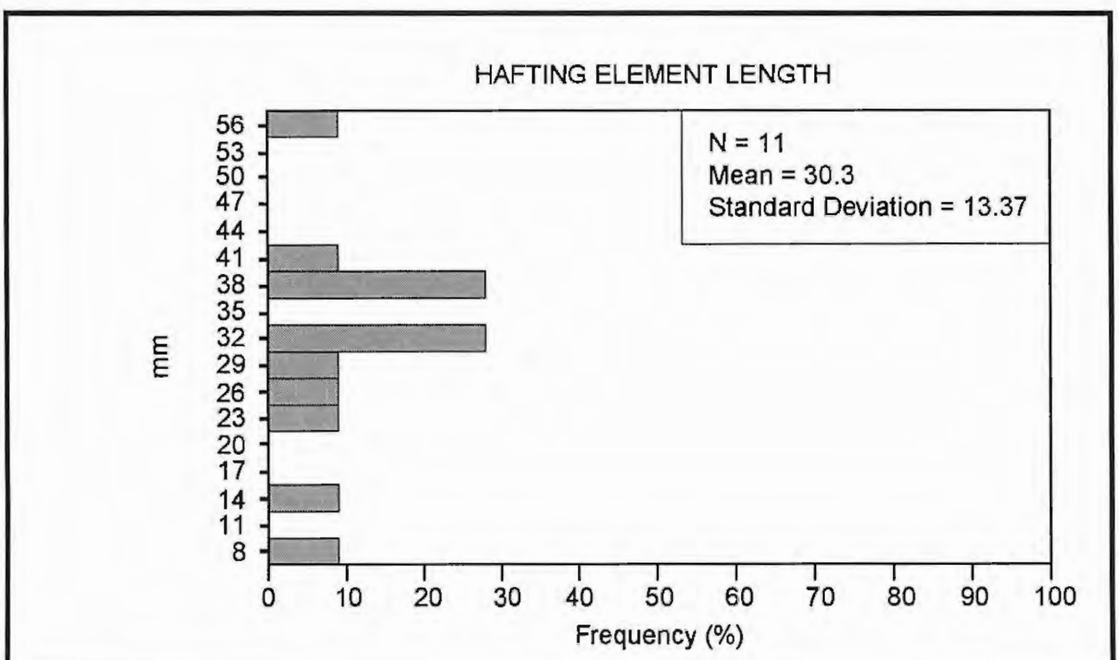


Figure 4.65. Hafting element lengths of bifaces in the Coleman assemblage.

Metric variables measured on the biface assemblage include maximum length, hafting element length, maximum width, thickness, blade thickness, hafting element thickness, edge angle, and invasiveness. Descriptions of these variables are presented in Chapter 3. Maximum length was measured on 40 complete and reworked bifaces (Figure 4.64). These measurements range from 34.4 to 123.5 mm, with a mean of 76.0 mm and standard deviation of 21.7 mm. Eleven of the bifaces with stems had a clearly defined stem or hafting element that could be measured (Figure 4.65). The hafting element lengths range from 7.3 to 56.0 mm, with a mean length of 30.3 mm and standard deviation of 13.4 mm. Maximum widths were scored on 40 complete bifaces (Figure 4.66). These measurements range from 15.8 to 59.7 mm, with a mean measurement of 39.5 mm and standard deviation of 12.6 mm. Maximum thickness was measured on 411 bifaces (Figure 4.67). These measurements range from 4.4 to 42.0 mm, with a mean measurement of 13.8 mm, and standard deviation of 5.3 mm. Ten blade thicknesses were measured (Figure 4.68). These range from 4.0 to 13.9 mm, with a mean of 8.6 mm and standard deviation of 3.2 mm. Thicknesses were measured on 10 of the bifaces possessing a stem and/or hafting element (Figure 4.69). These measurements range from 3.5 to 10.1 mm, with a mean of 7.2 mm and standard deviation of 1.8 mm. Edge angles on 422 bifaces were measured (Figure 4.70). These measurements range from 60° to 100°. The mean is 79.8° and the standard deviation is 6.5°. Invasiveness was measured on 422 bifaces (Figure 4.71). These measurements range from 1.8 to 35.4 mm, with a mean of 10.4 mm and standard deviation of 5.9 mm.

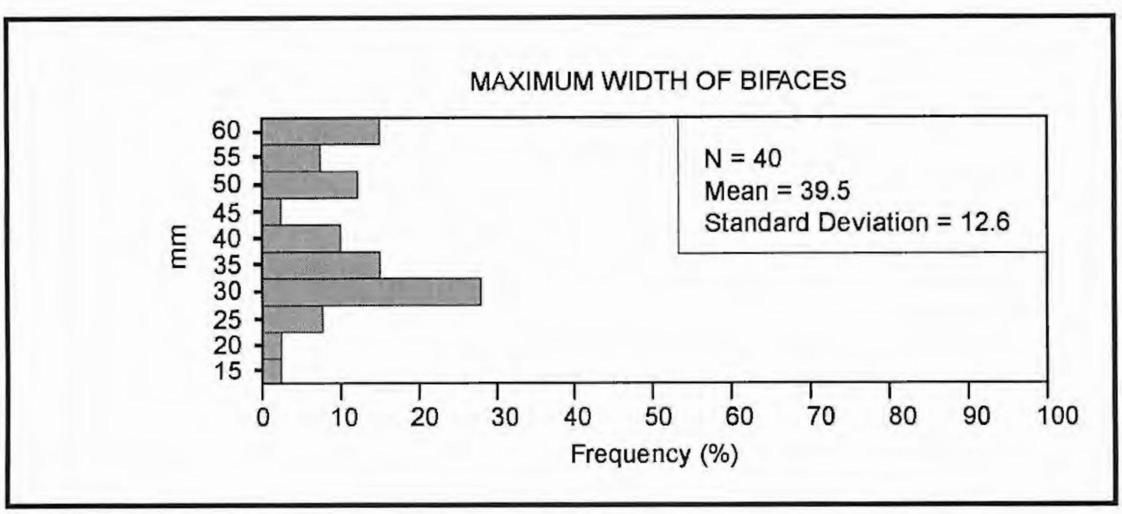


Figure 4.66. Maximum widths of bifaces in the Coleman assemblage.

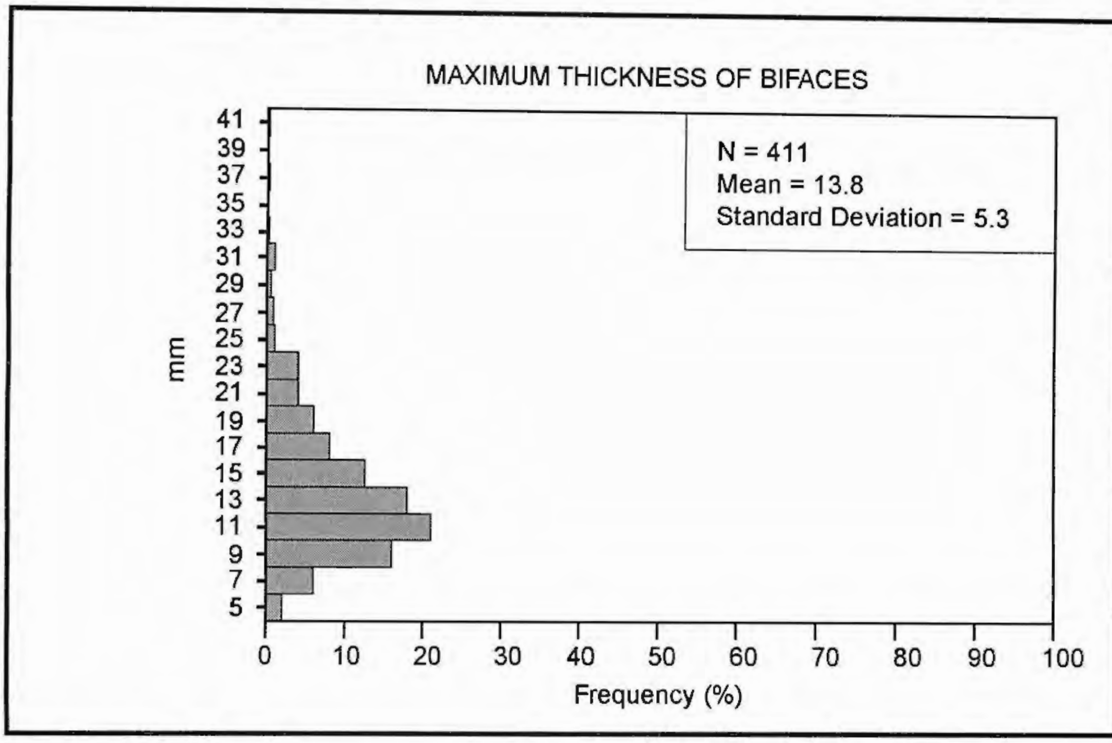


Figure 4.67. Maximum thicknesses of bifaces in the Coleman assemblage.

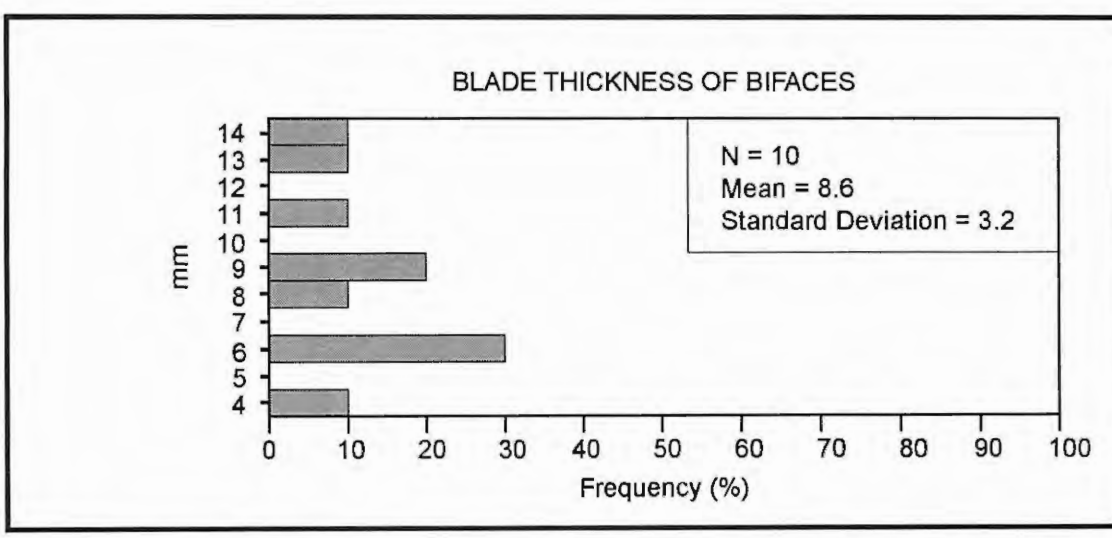


Figure 4.68. Blade thicknesses of bifaces in the Coleman assemblage.

Uniface Analysis. Tool blanks for 207 complete or near complete unifaces were tallied (Figure 4.72). Of these, 34 (16.4%) are made on cortical spalls, 132 (63.8%) are made on flakes, 37 (17.9%) are made on biface thinning flakes, 3 (1.4%) are made on blade-like flakes, and 1 (0.5%) is made on a blade. Number of margins retouched was scored on 69 formal unifaces and 186 informal unifaces (Figures 4.73 and 4.74). Of these, 168 (65.9%) are retouched on a single margin and 87

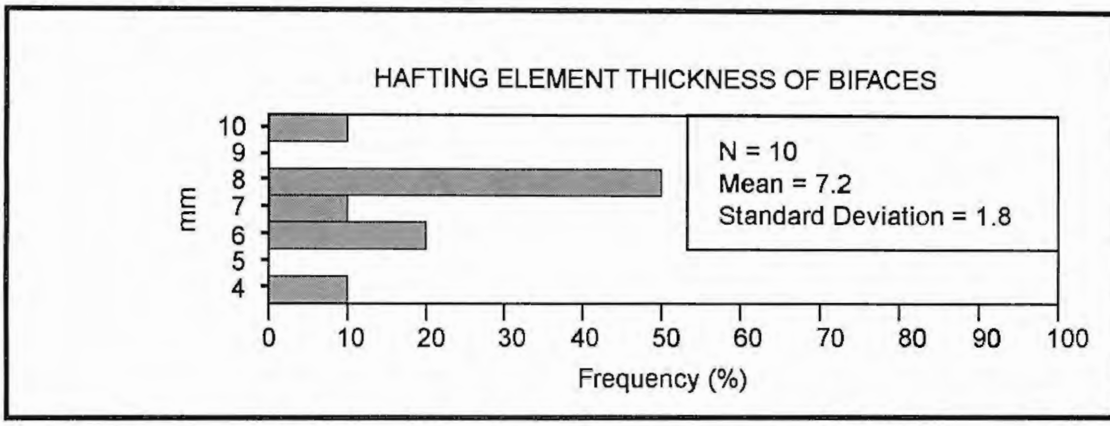


Figure 4.69. Hafting element thicknesses of bifaces in the Coleman assemblage.

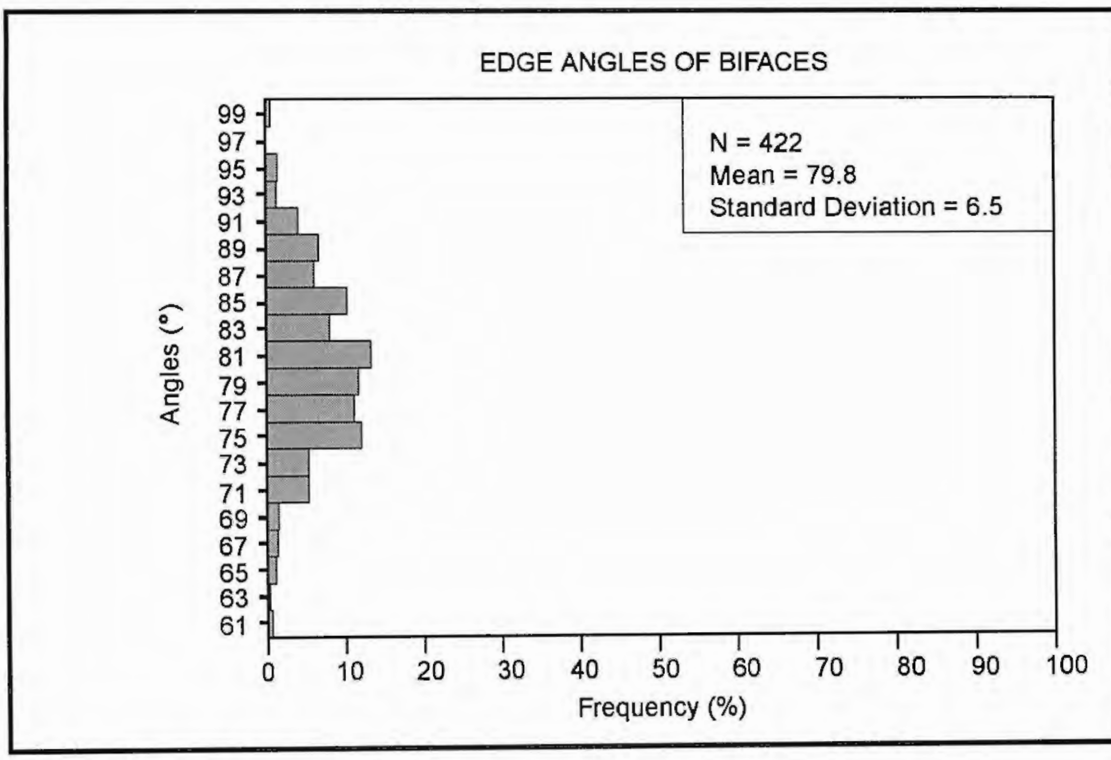


Figure 4.70. Biface edge angles in the Coleman assemblage.

(34.1%) are retouched on two or more margins. Of the formal unifaces, 30 (43.5%) are retouched on a single margin and 39 (56.5%) are retouched on two or more margins (Figure 4.73). Of the informal unifaces, 138 (74.2%) are retouched on a single margin and 48 (25.8%) are retouched on multiple margins (Figure 4.74). Retouch on unifaces is concentrated mainly on the lateral margins of the tools, with 213 (91.4%) being retouched laterally, 5 (2.1%) being retouched distally, and 15 (6.4%) being retouched both on the distal and lateral margins (Figure 4.75). The high percentage of informal unifaces compared to formal unifacial tools is not surprising, considering the site is situated adjacent

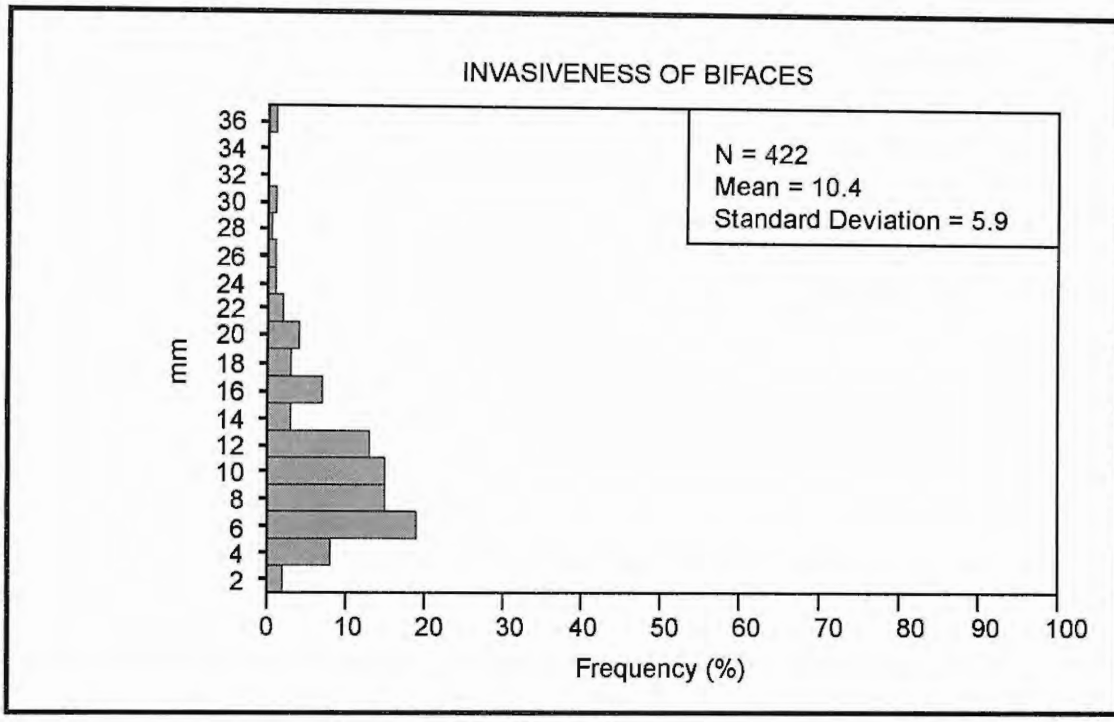


Figure 4.71. Invasiveness of bifaces in the Coleman assemblage.

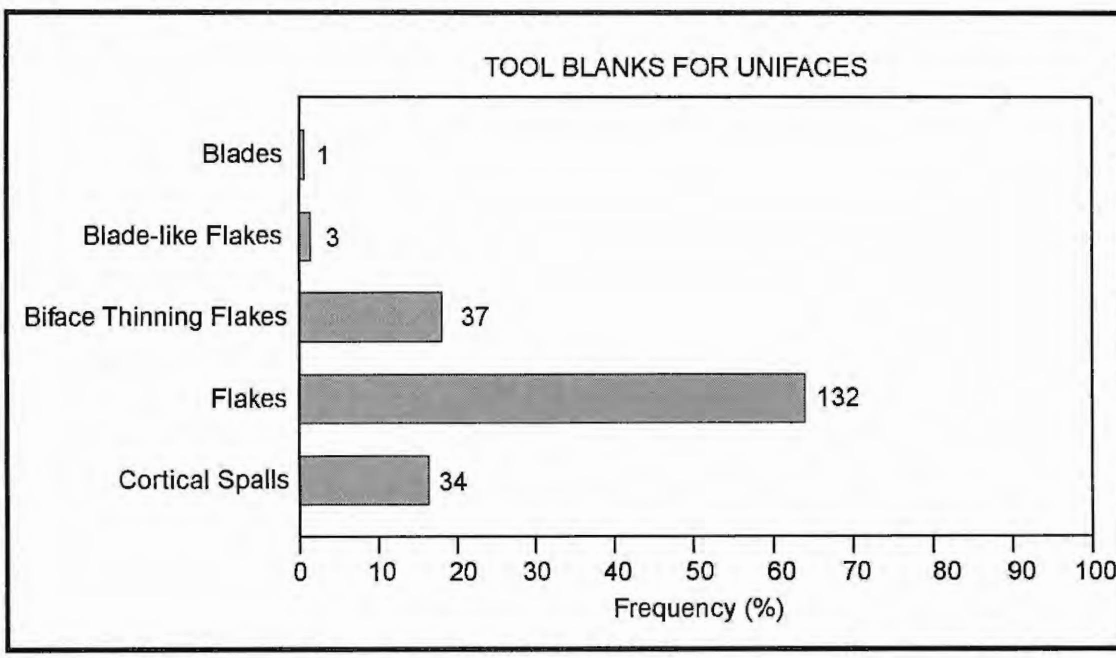


Figure 4.72. Tool blanks for unifacial tools in the Coleman assemblage.

to a quarry of high quality basalt. Nevertheless, the higher percentage of formal unifaces retouched on multiple margins suggests that the formal unifacial tools were more intensively retouched or curated than the informal unifaces.

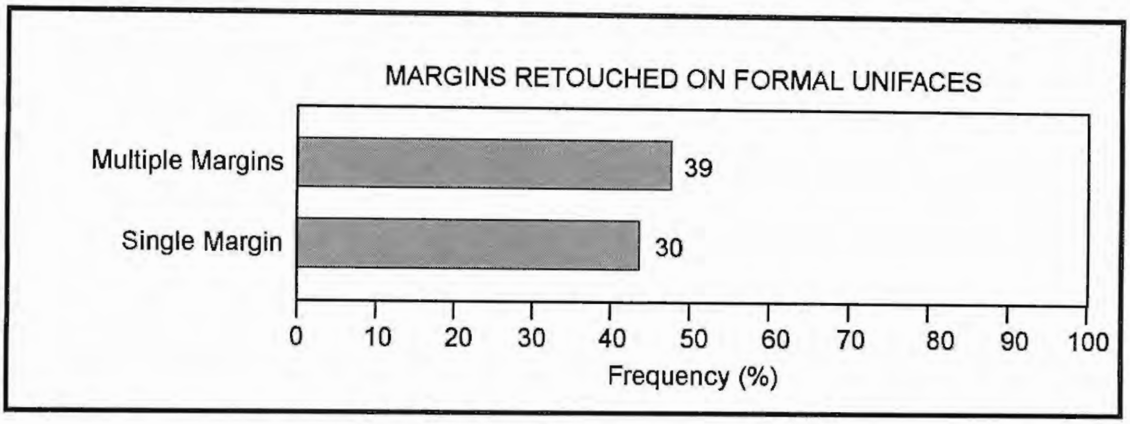


Figure 4.73. Numbers of margins retouched on formal unifacial tools in the Coleman assemblage.

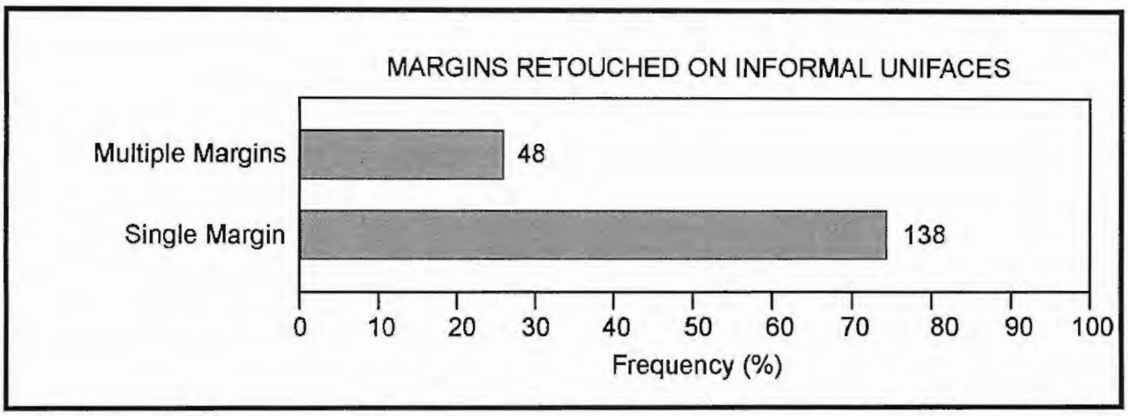


Figure 4.74. Numbers of margins retouched on informal unifacial tools in the Coleman assemblage.

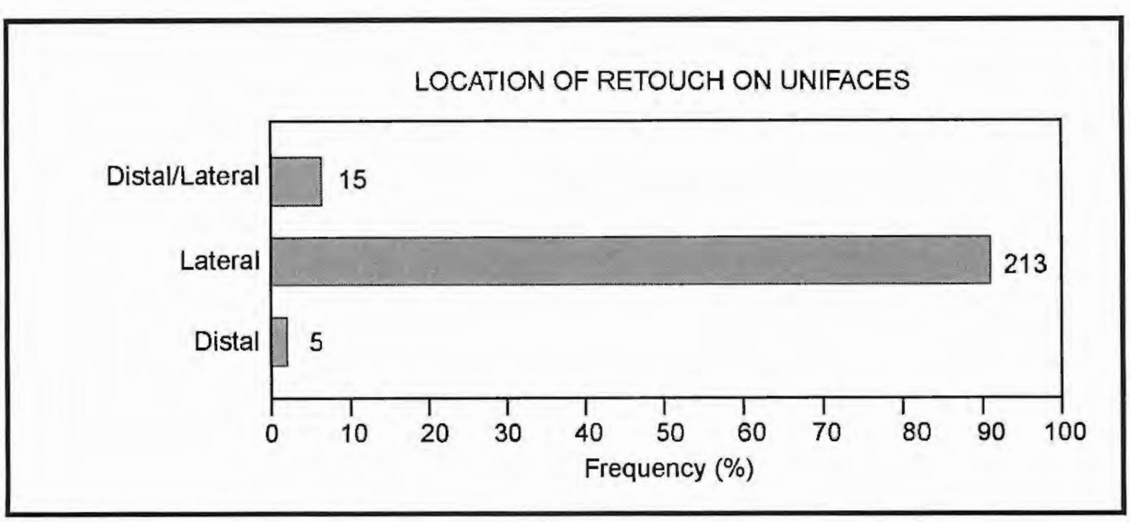


Figure 4.75. Location or position of retouch on unifacial tools in the Coleman assemblage.

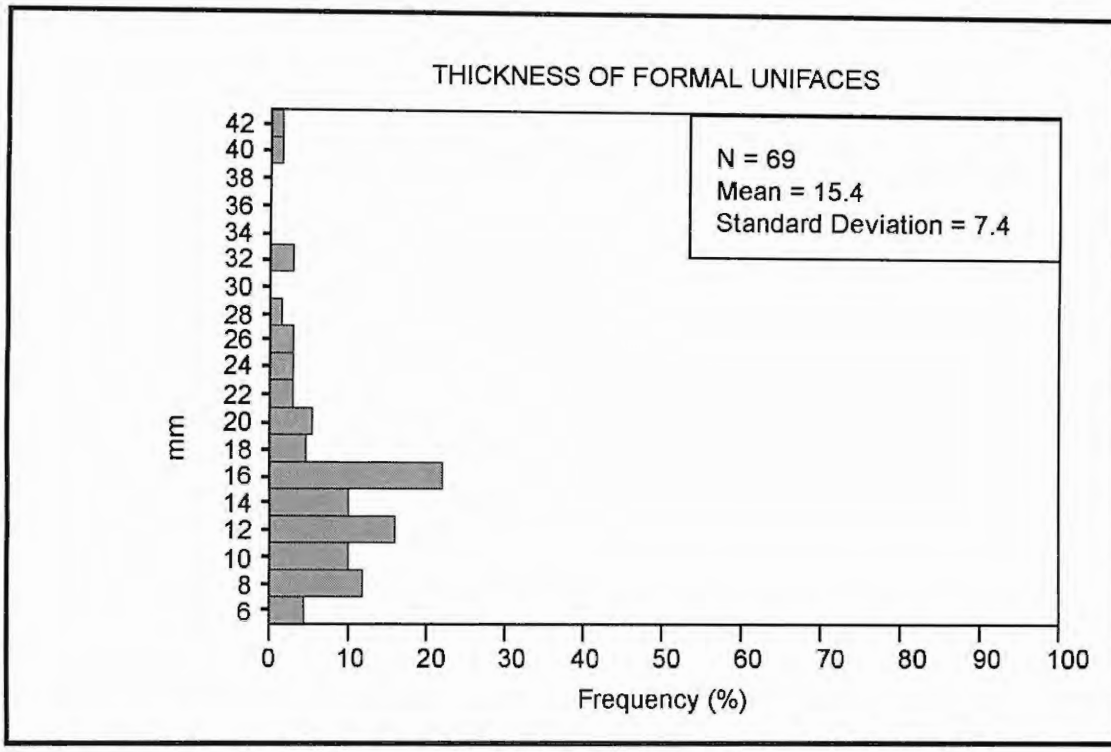


Figure 4.76. Thicknesses of formal unifacial tools in the Coleman assemblage.

Three metric variables were measured on most of the unifacial tools. Explanations of these variables are provided in Chapter 3. These include total thickness of the tool, edge angle, and invasiveness. For formal tools, thickness measurements range from 5.0 to 42.4 mm, with a mean thickness of 15.4 mm and standard deviation of 7.4 mm (Figure 4.76). Informal tool thicknesses range from 0.4 to 46.3 mm. The mean thickness for informal tools is 12.7 mm and the standard deviation is 7.2 mm (Figure 4.77). Edge angles for formal unifaces range from 71° to 94°, with a mean of 82.2° and standard deviation of 4.6° (Figure 4.78). Edge angle measurements for informal unifaces range from 55° to 94°, with a mean of 78.4° and standard deviation of 6.8° (Figure 4.79). Invasiveness was measured on 68 formal unifaces and 173 informal unifaces. Invasiveness measurements for formal unifaces range from 3.0 to 33.0 mm, with a mean of 8.1 mm and standard deviation of 4.9 mm (Figure 4.80). The range of invasiveness measurements for informal unifaces is 1.0 to 19.3 mm, with a mean of 5.1 mm and standard deviation of 3.0 mm (Figure 4.81). Like in the Sadmat assemblage, the informal unifaces in the Coleman assemblage are thinner, have acuter edge angles, and less invasive flake scars than formal unifacial tools. As with the Sadmat unifacial tool use, informal tools at Coleman were less intensively utilized than formal unifacial tools.

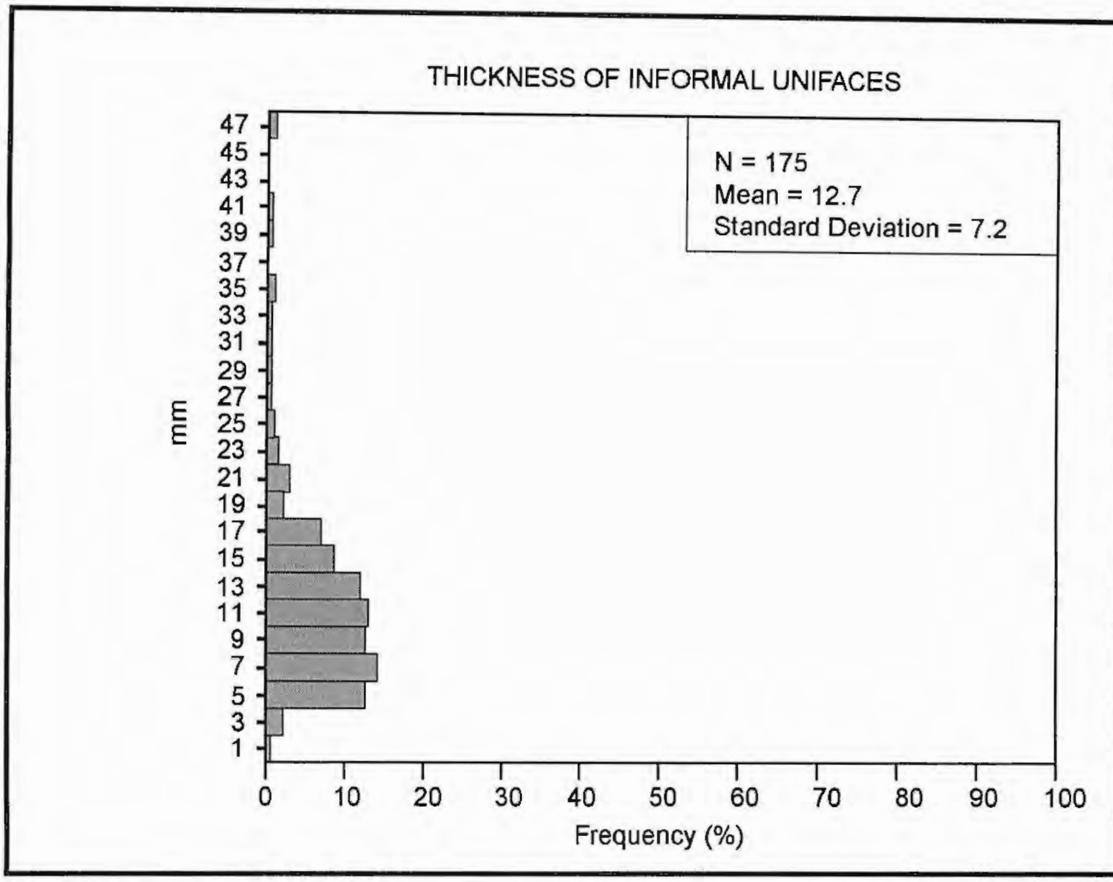


Figure 4.77. Thicknesses of informal unifacial tools in the Coleman assemblage.

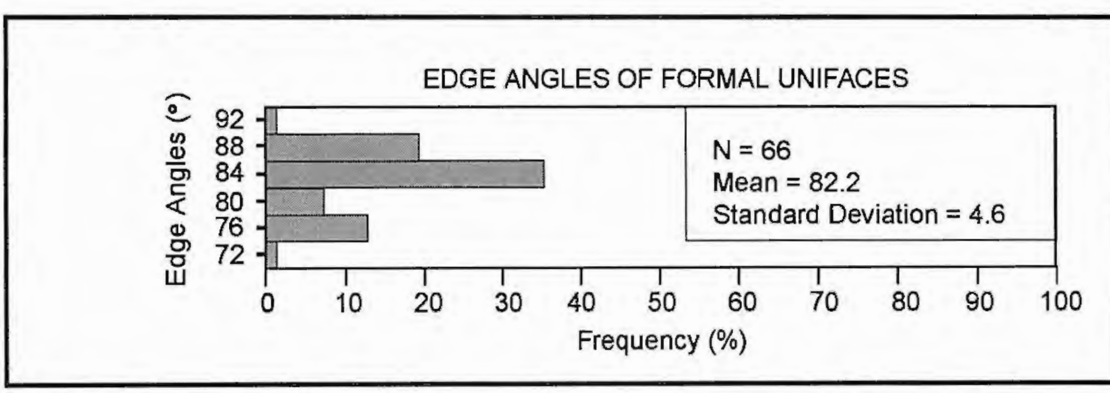


Figure 4.78. Edge angles of formal unifacial tools in the Coleman assemblage.

Summary

This chapter presents the results of the lithic analysis of both the Sadmat and Coleman assemblages. The Sadmat assemblage consists of 3,138 lithic artifacts. Of these, CCS is the dominant raw material type utilized at the site; however, obsidian and basalt, the exotic raw materials, make up nearly 38%

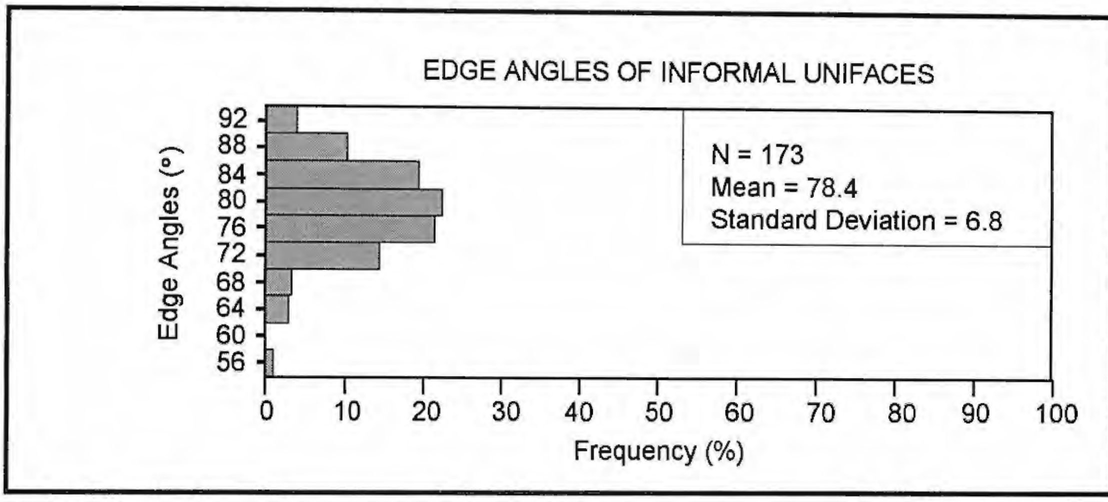


Figure 4.79. Edge angles of informal unifacial tools in the Coleman assemblage.

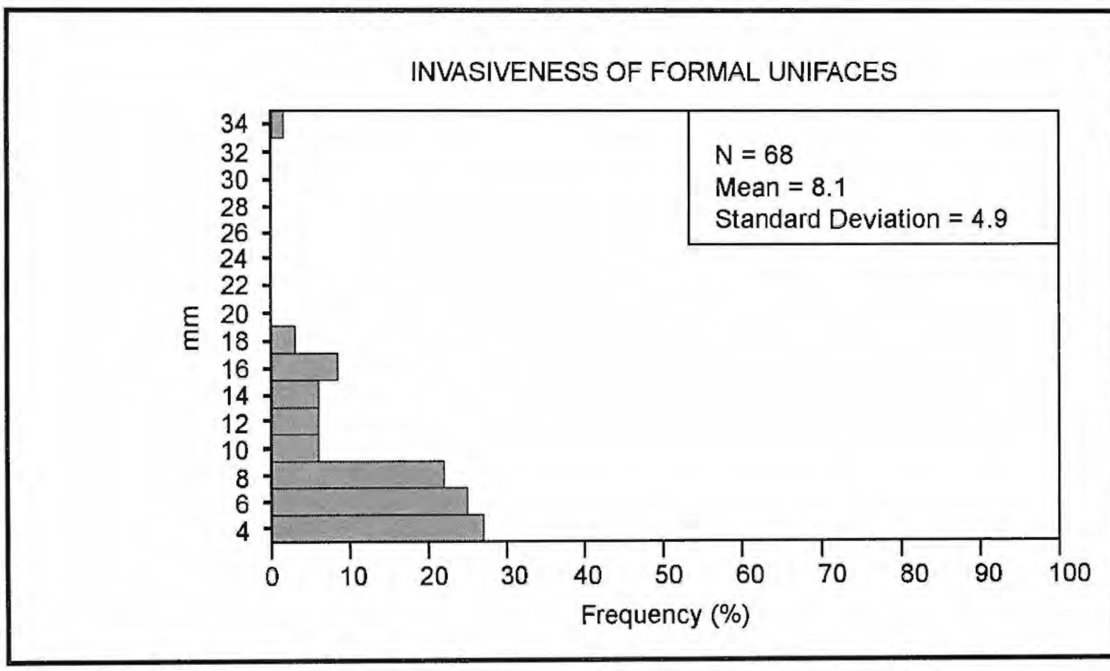


Figure 4.80. Invasiveness of formal unifacial tools in the Coleman assemblage.

of the total. This suggests that artifacts coming from distant locations were being left at the site and presumably were replaced with artifacts made on local CCS.

The majority of cores in the collection are bidirectional and multidirectional cores possessing more than one platform. As with the number of platforms, the vast majority of cores possess more than one front. These data suggest that there was a high degree of flake core reduction at the Sadmat site. Almost all of the cores have some kind of platform preparation, and most do not

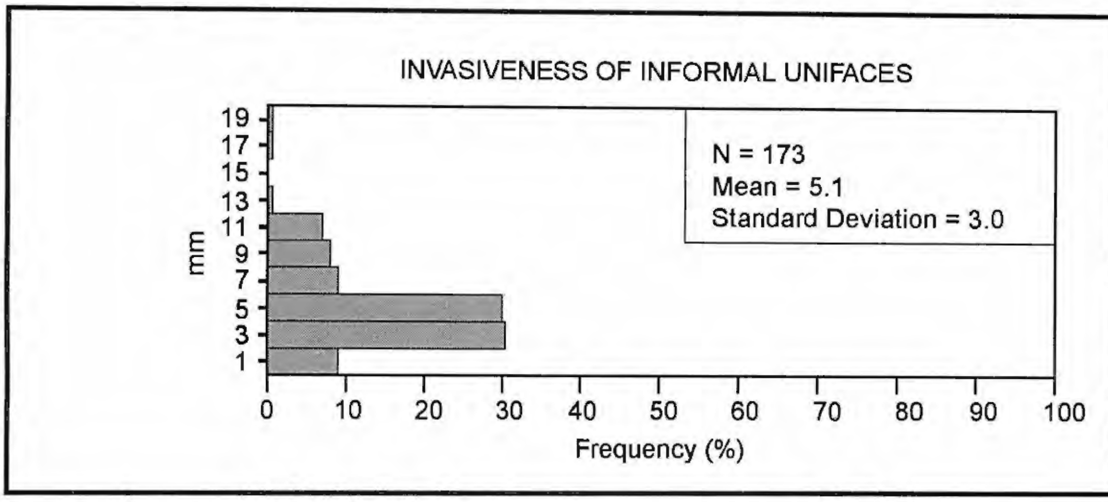


Figure 4.81. Invasiveness of informal unifacial tools in the Sadmat assemblage.

exhibit cortex. Likewise, the size values of cores at Sadmat are small. Together, these data suggest that cores represent primary reduction activities that were carried out on-site, and that these cores were intensively reduced, having approached exhaustion. Raw material, however, at Sadmat is not scarce. In fact, cobbles of CCS are found in the beach deposits at the site and many of these were transformed into cores. Given that the majority of flake cores are manufactured on CCS and are exhaustively reduced, these folks must have been retooling with CCS. Since CCS is available on-site, the expectation would be to find CCS cores minimally reduced because this toolstone is readily available and there should be no need in economizing. CCS cores, however, are being curated so that this toolstone must have served as the supply for retooling activities.

The debitage assemblage at Sadmat represents both primary and secondary reduction activities; however, the sample size is small. The presence of split cobbles, angular shatter, and cortical debitage suggests that early stage core preparation and reduction was occurring at the site. The vast majority of flakes exhibit at least four or more dorsal flake scars, the size of flake debitage tends to be small, and the frequency of cortex on debitage is very low, suggesting intensive reduction of cores and flake blanks. A high percentage of the debitage possesses complex platforms related to secondary reduction activities. Interestingly, as with the cores, CCS dominates the entire reduction sequence represented by the debitage. The only exception is with the small retouch chips. The majority of these are obsidian, suggesting that even though the major activity at the Sadmat site was retooling with CCS, the reworking of exotic obsidian artifacts was happening as well. These data support the interpretation that Sadmat represents a retooling station that potentially was repeatedly occupied by mobile hunter-gatherers.

The tool assemblage at Sadmat is characterized by the manufacture of both heavily curated, formal artifacts and informal, expedient artifacts; however, the overwhelming majority of tools are formal tools. Nearly half (47.8%) of the Sadmat tool assemblage is made up of bifaces. These bifaces are further broken down into hafted and unhafted bifaces, with hafted bifaces consisting of Parman stemmed points, Haskett stemmed points, Windust stemmed points, hafted biface/stem fragments, and few later point types such as Humboldt and Elko series points. Unhafted bifaces include fragments, miscellaneous/untypable bifaces, leaf-shaped bifaces, ovate bifaces, discoid bifaces, crescent bifaces, stemmed preforms, a beaked biface, and a lanceolate biface. Unifaces make up 52.2% of the tool assemblage and consist of side scrapers, end scrapers, gravers, combination tools, retouched flakes, and a small percentage of notches, knives, and denticulates. Three burins were made on bifaces and appear to be intentionally burinated. The large frequency of bifaces and formal unifaces suggests technological strategies related to the provisioning of individuals with durable tools.

Obsidian dominates the hafted bifaces, and shares a similar percentage with CCS for unhafted bifaces. Unifaces are overwhelmingly manufactured on CCS. These data suggest that the majority of hafted bifaces were being made elsewhere, brought to the site and discarded. Likewise, many unhafted bifaces were being brought to the site, while nearly as many were being manufactured on site. The majority of the unifaces, however, were being manufactured on site. Another interesting observation is that most broken formal tools, including bifaces and unifaces, are manufactured on obsidian. These represent durable tools that were transported to the site, broken, and replaced with fresh tools. Broken informal tools are manufactured mainly on CCS, the local toolstone, as is expected if these tools were made and used at Sadmat only. These data support the idea that the site represents a retooling location where transported tools were intensively curated and locally produced tools were only expediently used on-site.

The unifaces were manufactured on tool blanks that resulted from both primary and secondary reduction activities, including cortical spalls (13%), flakes (42%), blades and blade-like flakes (4%), cores (4%), and biface thinning flakes (37%). As mentioned above, the majority of complete unifaces are manufactured on local CCS, as opposed to the majority of bifaces being manufactured on exotic obsidian and basalt. When looking at the number of margins retouched, formal unifaces were typically retouched on more than one margin, and in some instances these unifaces were retouched along all margins of the tool blank. These results suggest extensive curation of formal unifaces.

The results of the Sadmat lithic analysis thus suggest that the site represents a retooling station. Lithic raw material is abundant on the site, but cores and debitage reflect both primary and secondary reduction, and cores appear to have been intensively reduced. Further, formal, recyclable tools (i.e., side scrapers, end scrapers, combination tools, etc.) dominate the assemblage and appear to have been heavily curated. Given the local supply of CCS toolstone it is surprising to see such extravagant core and tool reduction if the occupants of Sadmat were provisioning the place. Instead, these data better fit the expectation of provisioning of individuals, planning in anticipation of future exigencies.

The Coleman assemblage consists of 2,427 lithic artifacts. Of these, nearly 91% are manufactured on basalt, while the rest (9%) are manufactured on CCS and obsidian.

The flake core assemblage at Coleman is much smaller than at Sadmat. Like at Sadmat though, these cores are for the most part bidirectional and multidirectional, possessing more than one platform and more than one front. Nearly all of these cores are made on basalt. These data suggest that flake core reduction was relatively high at Coleman. The majority of cores possess some form of platform preparation, while half exhibit cortex. The core size at Coleman tends to be larger than at Sadmat. This is probably due to two factors: less intensive reduction of the cores and larger-sized raw material packages at Coleman. These data suggest that primary reduction activities were being extensively carried out at the site.

The debitage assemblage represents both primary and secondary reduction activities, with angular shatter, cortical spalls, flakes, and retouch chips being represented. A large part (40%) of the debitage assemblage possesses complex platforms related to bifacial reduction. The vast majority of flakes exhibit at least four or more dorsal flake scars. The size of flake debitage tends to be small to medium, and the amount of cortex on debitage is low, but still indicative of primary reduction activities. Not surprisingly, like at Sadmat, the local toolstone, in this case basalt, dominates the entire reduction sequence represented by the debitage. The secondary reduction types of debitage, however, contain more exotics, suggesting that even though the major activity at the Coleman site was retooling with basalt, the reworking of exotic obsidian and CCS artifacts was transpiring as well. These data suggest that like Sadmat, Coleman was a retooling location for early Holocene foragers.

The tool assemblage at Coleman, like at Sadmat, is characterized by the manufacture of both heavily curated, formal artifacts and informal, expedient artifacts; however, the overwhelming majority of tools are formal tools. Over half (62.4%) of all tools are bifaces with hafted bifaces consisting of Parman stemmed points, one Haskett stemmed point, one Windust stemmed point, one hafted biface/stem fragment, one beaked biface, and one Pinto point. The unhafted bifaces consist of fragments, miscellaneous/untypable bifaces, leaf-shaped bifaces, stemmed preforms, ovate biface, beaked biface, and one crescent biface. The extensive presence of bifaces in the assemblage suggests that the manufacture and resharpening of such formal tools were important technological activities carried out at the site. Basalt dominates the hafted and unhafted biface assemblage; however, obsidian bifaces that were presumably transported to the site make up 25% of the hafted biface assemblage. The production of unhafted bifaces, which are presumed to represent bifaces that were being readied to replace used hafted bifaces, are nearly all basalt. These data support the theory that the Coleman site represents a retooling locality.

Side scrapers and retouched flakes at the Coleman site are overwhelmingly manufactured on basalt, while other unifaces, such as end scrapers, gravers, combination tools, knives, burins and a notch, are commonly made on CCS. Many of these CCS unifaces were presumably transported given the lack of CCS cores and primary reduction debitage at the site, suggesting that hunter-gatherers at Coleman were retooling with the local raw material.

The frequency of broken formal tools is low, with the exception of unhafted bifaces. The majority of unhafted bifaces that were broken are manufactured on basalt, and are probably the result of breakage during manufacture. All of the stemmed points are broken in which 33% are made on non-local obsidian, suggesting that some of the hafted bifaces were being transported to Coleman from elsewhere, discarded, and replaced with fresh basalt bifaces. The other 67% of broken stemmed points manufactured on basalt could represent breakage of points during manufacture/resharpening activities or local logistical hunting forays. Broken informal tools were manufactured mainly on basalt. This is expected if the majority of these expedient types of tools were made and used only at the site. These data support the idea that the site represents a retooling location.

Interestingly, the unifaces were manufactured on tool blanks that resulted from both primary and secondary reduction activities, including cortical spalls (16%), flakes (64%), blades and blade-like flakes (2%), and biface thinning flakes (18%). The majority of the complete unifaces are manufactured on the local raw material, basalt. When looking at the number of margins retouched, the results indicate that formal unifaces were being retouched on more than one margin, and in some instances these unifaces were retouched along the lateral and distal margins of the tool blank. The relatively high proportion of unifaces made on biface thinning flakes, as well as the high frequency of margins retouched on unifaces, suggest that the Coleman unifaces were intensively curated.

Thus, the results of the lithic analysis at Coleman suggest that the site represents a retooling station. Raw material is abundant, core technology and debitage reflect both primary and secondary reduction of the local toolstone (basalt), and extensively curated, formal tools made of exotic raw materials were approaching the ends of their use lives and discarded at the site. These formal, recyclable tools dominate the bifacial as well as unifacial tool assemblages.

Both the Sadmat and Coleman sites rest on locations of high quality raw material and are interpreted to represent retooling locations. Interestingly, the Sadmat assemblage is dominated by the presence of local CCS, and the Coleman assemblage is dominated by the presence of local basalt. In both cases, the local toolstones were used for both biface and uniface tool production. Other Great Basin researchers have suggested that hunter-gatherer groups using stemmed point technology usually did not use CCS in the manufacture of their projectile points and bifaces and usually did not use basalt or other fine-grained volcanics in the manufacture of unifaces (Beck and Jones 1990; Jones and Beck 1999). Therefore, this analysis of the Sadmat and Coleman assemblages contradicts these observations. The best explanation for this contradiction is that in cases where desired toolstones were not locally available, retooling foragers had to rely on less-suitable raw materials for the manufacture of bifaces (CCS at Sadmat) or unifaces (basalt at Coleman). If this was the case at Sadmat and Coleman, then we would expect to see intensive curation of obsidian bifaces at Sadmat and CCS unifaces at Coleman. This does seem to be the case at both sites, further demonstrating that these sites represent retooling locations.

CHAPTER 5

TECHNOLOGICAL PROVISIONING, RAW MATERIAL SELECTION, AND MOBILITY

As shown in Chapter 4, both the Sadmat and Coleman sites appear to represent retooling locations, places on the landscape in the Lahontan Basin where early hunter-gatherers were replenishing their exhausted toolkits with new durable and recyclable implements. By reconstructing raw material procurement and technological organization, as outlined in Chapter 1, we can characterize prehistoric hunter-gatherer provisioning strategies, and relate these aspects of the archaeological record to land use and settlement behavior.

Binford (1979), Kuhn (1989, 1991, 1992, 1993, 1994, 1995), Kelly (1983, 1985, 1988a, 1988b, 2001), Odell (1996), and others (Andrefsky 1998; Bamforth 1986; Henry 1995; Ingbar 1992, 1994; Kelly and Todd 1988; Nelson 1991; Parry and Kelly 1987; Torrence 1983) have suggested that studies of technological organization and provisioning can lead to a better understanding of human land use patterns. Technological strategies are directly related to how humans provision themselves with the essential materials needed to acquire and process food. According to Kuhn (1991, 1992, 1993, 1994, 1995) provisioning strategies come in two basic forms, 1) provisioning places and 2) provisioning individuals. The provisioning of places is expected in the context of relatively sedentary hunter-gatherers whose technological organization is expedient. Humans living at a single place for a long time supply their residence with necessary materials to subsist. Alternatively, mobile groups provision individuals with ready-to-use, light-weight, and durable tools (Binford 1979; Kelly 1988a, 2001; Parry and Kelly 1987; Kuhn 1989, 1991, 1992, 1993, 1994, 1995).

If early hunter-gatherers of the Great Basin were part of a Tethered Wetland (TW) adaptation, we would expect to find them provisioning places within productive wetland patches. If early groups were mobile foragers the expectation would be to find them provisioning individuals.

There are several important lithic variables that help us identify provisioning behaviors: raw material procurement, biface-to-core ratio, production of formal versus informal tools, and tool use-life histories (Andrefsky 1998; Kelly 1988a, 2001; Kuhn 1989, 1991, 1992, 1993, 1994, 1995; Marks et al. 1991; Odell 1996; Parry and Kelly 1987).

For the TW hypothesis raw material sources should be chiefly local. Humans would live at one residetial base for a long period of time, and would likely provision that place and as a result exploit local raw materials except where they are scarce (Kuhn 1989, 1991, 1992, 1993, 1994, 1995; Odell 1996). Mobile foragers should exploit both local as well as exotic raw materials. They would carry some tools great distances, and retool with local raw materials, especially in places where quality raw materials are abundant, for example obsidian or basalt quarries.

The biface-to-core ratio should be low with regards to the TW. When humans provision a place on the landscape, they utilize expedient core technologies based on heavy, unprepared cores that show few signs of lithic conservation (Parry and Kelly 1987). More mobile foragers are apt to utilize light-weight, formal core technologies (Binford 1979; Kelly 1988a, 2001; Kuhn 1991, 1992, 1994, 1995; Parry and Kelly 1987). A biface is often used in this way, producing many tool blanks relative to its weight. When a biface reaches the end of its use-life as a core, it can continue to be utilized as a tool, either for weaponry or food processing (Andrefsky 1998; Kelly 1988a, 2001; Parry and Kelly 1987). Therefore, in mobile situations where humans provision individuals we would expect to find a higher biface-to-core ratio than in more sedentary situations. As a test of this expectation, we should see relatively high frequencies of tools made on biface thinning flakes.

Tool production at TW sites should focus mainly on informal tools. Hunter-gatherers who have provisioned a place and are staying there for long periods of time probably will not expend much energy in preparing formal tools that can be heavily curated. There should be no need for curation unless raw material is scarce (Kuhn 1989, 1991, 1992, 1993, 1994, 1995; Odell 1996). Mobile forager sites should have high frequencies of formal, durable tools set up for extended use (Andrefsky 1998; Binford 1979; Kelly 1988a, 2001; Kuhn 1989, 1991, 1992, 1993, 1994, 1995; Odell 1996; Parry and Kelly 1987).

Similarly, use-life histories for tools should be short at TW sites. In such sedentary situations we would expect hunter-gatherers to expend little time and energy holding on to and reworking tools, especially in situations where quality raw materials are locally available (Kuhn 1989, 1991, 1992, 1993, 1994, 1995; Odell 1996). Tool use-life histories at mobile forager sites should be relatively longer. We would expect to see more intensive reworking of tools, especially those on exotic raw materials that have been transported from some other location (Kelly 1988a, 2001; Kuhn 1990, 1991, 1992, 1993, 1994, 1995; Odell 1996; Parry and Kelly 1987).

This chapter presents the results of integrative analyses of the Sadmat and Coleman assemblages that deal with the four above-outlined expectations regarding toolstone procurement, provisioning strategies, and settlement strategy. First, raw material selection is discussed, giving the location of each known source, and its distance from each site, as well as the frequencies of artifacts manufactured on each toolstone. Second, biface-to-core ratios for both assemblages are presented. Third, frequencies of formal and informal tool production are calculated. Lastly, variables related to bifacial and unifacial tool use-life histories are presented and discussed in relation to curation and retooling behavior.

Raw Material Transport

Sadmat Site

Obsidian occurs in relatively high frequencies at the Sadmat site, with 29.0% of all tools, 21.7% of all debitage, and 5.3% of all cores being made on this toolstone (Table 4.3). In order to determine source locations of the various obsidians present in the assemblage, X-ray fluorescence (XRF) element characterization analyses were conducted by Dr. Craig Skinner of Northwest Research Obsidian Studies Laboratory, Corvallis, Oregon. The XRF analysis resulted in the identification of eight known sources and four unknown sources that suggest that the Sadmat inhabitants traveled great distances to acquire obsidian (Figure 5.1). The northernmost source is Massacre Lake/Guano Valley (Nevada/Oregon). This source covers a large area, but its southern edge is located 240 km north of Sadmat. The southernmost source, Casa Diablo (Sawmill Ridge) (California), is located just west of Lake Crowley, approximately 220 km south of the site. Bodie Hills (California) obsidian occurs most frequently among the sourced obsidian artifacts; it is located along the eastern flank of the Sierra Nevada approximately 165 km south of Sadmat. The closest identified obsidian source is

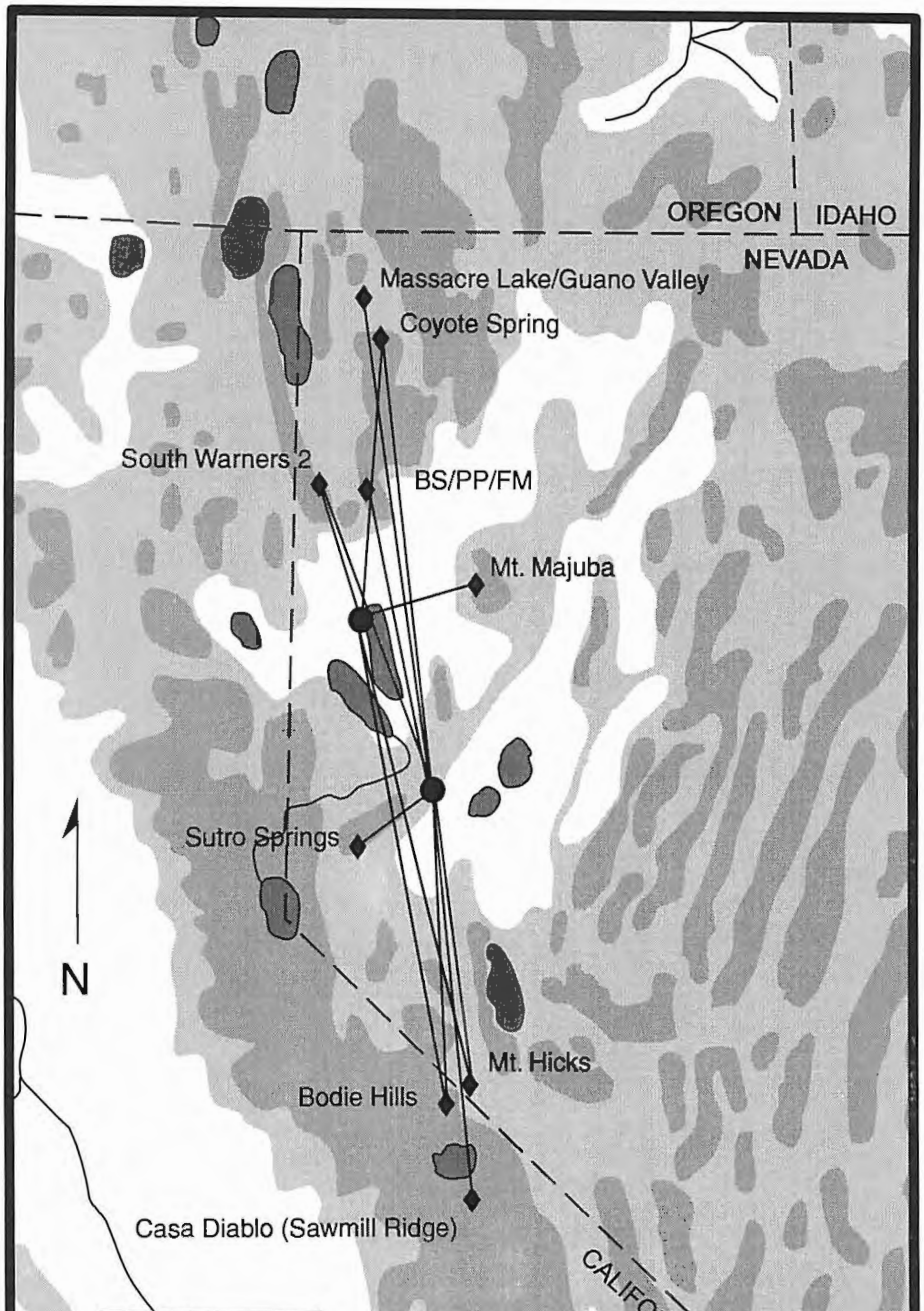


Figure 5.1. Map of the western Great Basin with locations of the Sadmat and Coleman sites and associated obsidian sources.

Sutro Springs (Nevada), located approximately 50 km southwest. Other sources include Mt. Hicks (Nevada), located 150 km south, South Warners 2/Unknown B (Nevada/California), located between 160 and 170 km northwest, Coyote Spring (Nevada), located 200 km north, and Bordwell Springs/ Pinto Peak/Fox Mountain (BS/PP/FM) (Nevada), located 160 km north of Sadmat (Figure 5.1). In addition to these, four unknown sources were also identified. These have been given the designations Unknown 2, 3, 4, and 5 (C. Skinner, personal communication 2000). All of these obsidians can be considered exotic to the Sadmat site, in that the nearest known source is at least 50 km away.

Twenty-four obsidian artifacts from Sadmat were sourced (Table 5.1). Of these, 2 (8.3%) are from the Massacre Lake/Guano Valley source, 1 (4.2%) is from Coyote Spring, 3 (12.5%) are from the BS/PP/FM source, 2 (8.3%) are from South Warners 2/Unknown B, 3 (12.5%) are from Sutro Springs, 2 (8.3%) are from Mt. Hicks, 6 (24.5%) are from Bodie Hills, 1 (4.2%) is from Casa Diablo (Sawmill Ridge), 1 (4.2%) is from Unknown 2, 1 (4.2%) is from Unknown 3, 1 (4.2%) is from Unknown 4, and 1 (4.2%) is from Unknown 5. Artifact types used in the XRF study are biface or biface debitage. Eighteen are stemmed points, of which 7 came from northern sources and 11 came from southern sources (Figure 5.1, Table 5.1). Two of the unhafted bifaces came from northern sources, and the third is tied to a southern source. Both bipolar cores, which are made on broken bifaces, came from the closest source, Sutro Springs. A biface thinning flake came from Bodie Hills, the source most represented in the sample (Table 5.1).

Ample amounts of local high-quality toolstone can be found within 15 to 20 km of the Sadmat site. Sadmat actually rests on a beach feature of Quaternary age, in which numerous 5-to-15 cm sized cobbles of cryptocrystalline silicate (CCS) and basalt can be found. Large CCS cobbles, however, occur in much higher proportions than basalt cobbles on and in the vicinity of the site. The low frequency of basalt cortical spalls (Table 4.2) in the assemblage suggests that basalt was not being procured on the site, but from other sources. Many of the CCS cobbles, though, were evidently used as toolstones. Many of these CCS and basalt cobbles ultimately originated from the bedrock formations in the mountains that surround the site. These formations include Jurassic dioritic rocks, Tertiary welded and unwelded rhyolitic tuffs, Tertiary andesitic flows, an extensive Tertiary basalt/ basaltic formation, Tertiary dacite, Tertiary sedimentary rocks containing limestones, diatomaceous and tuffaceous shale, sandstone, basalt tuffs, and other tuffs, and Tertiary-Quaternary basaltic

Table 5.1. Sadmat Obsidian Sources by Artifact.

Obsidian Source	n	%	Artifact Type							
			Parman Points	Haskett Points	Windust Point	Stem Fragments	Leaf-shaped Bifaces	Burinated Biface	Bipolar Cores	Biface Thin. Flake
Massacre Lake/Guano Valley	2	8.3				1	1			
Coyote Spring	1	4.2		1						
BS/PP/FM	3	12.5				3				
South Warners 2/Unknown B	2	8.3	1					1		
Sutro Springs	3	12.5	1						2	
Mt. Hicks	2	8.3		2						
Bodie Hills	6	24.9	2		1	1	1			1
Casa Diablo (Sawmill Ridge)	1	4.2	1							
Unknown 2	1	4.2	1							
Unknown 3	1	4.2				1				
Unknown 4	1	4.2				1				
Unknown 5	1	4.2	1							
Total	24	100	7	3	1	7	2	1	2	1

sediments (Moore 1969; Willden and Speed 1974). As a result of the high proportion of CCS available in the local beach deposits, it is not surprising that this lithic raw material makes up the largest portion of the assemblage. There are 1,940 (61.8%) CCS artifacts, including 1,341 (58.4%) tools, 445 (66.1%) debitage pieces, and 155 (91.2%) cores, and 358 (11.4%) basalt artifacts, including 282 (12.3%) tools, 72 (10.7%) debitage pieces, and 5 (2.9%) cores (Tables 4.1, 4.2, and 4.3). Three of the basalt bifaces were sent for XRF analysis. All three came from unknown basalt sources (C. Skinner, personal communication 2000).

Figure 5.2 shows the relative frequencies of raw materials observed in the Sadmat assemblage. Both hafted and unhafted bifaces were predominantly made on exotic obsidian (including 52.6% of the hafted bifaces and 42.5% of the unhafted bifaces), while local CCS was used to make 26.3% of the hafted bifaces and 35.0% of the unhafted bifaces, and basalt was used to make less than 20% of both the unhafted and hafted bifaces. Toolstone selection is different for the unifacial tools. CCS is the predominant toolstone in this part of the assemblage, making up 85.2% of the formal unifaces and 74.4% of the informal unifaces, while obsidian was used to make only 8.3% of the formal unifaces and 22.4% of the informal unifaces, and basalt was used to make only 6.2% of the formal unifaces and 3.2% of the informal unifaces (Figure 5.2). Thus at Sadmat hafted and unhafted bifaces were manufactured on exotic obsidians and basalts, as well as local CCS; however, for formal and informal unifaces there was a clear preference for the use of local raw materials.

Coleman Site

Coleman folks were also traveling great distances to acquire their obsidian (Figure 5.1). Five known sources and one unknown source have been identified. The most distant source, Bodie Hills (California), is located approximately 240 km south of the Coleman site. The furthest obsidian source to the north, Coyote Spring (Nevada), is located approximately 110 km away. The closest source is Mt. Majuba (Nevada), located approximately 50 km east of the site. The other two obsidian sources showing up in the assemblage are South Warners 2/Unknown B (Nevada/California), located approximately 65 to 75 km northwest of the site, and Mt. Hicks (Nevada), located approximately 200 km southeast of Coleman. The unknown source has been assigned the designation Unknown 1 (C. Skinner, personal communication 2000).

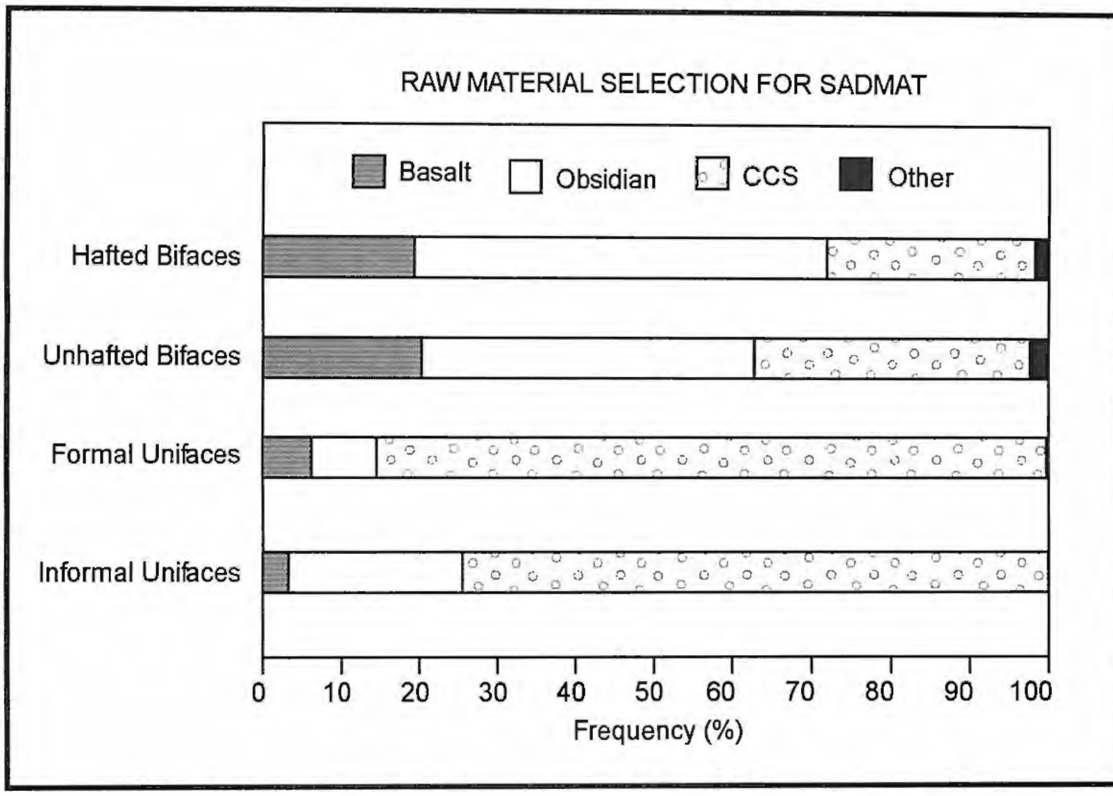


Figure 5.2. Frequencies of raw materials represented in the tool assemblage for Sadmat.

Ten obsidian artifacts from the Coleman site were sourced (Table 5.2). Two (20.0%) are from the Coyote Spring source, 1 (10.0%) is from South Warners 2/Unknown B, 4 (40.0%) are from Mt. Majuba, 1 (10.0%) is from Mt. Hicks, 1 (10.0%) is from Bodie Hills, and 1 (10.0%) is from the Unknown 1 source. The artifact types from the Coleman assemblage used in the XRF study are mixed, including stemmed points, retouched flakes, and debitage. Sourced stemmed points come from northern and southern sources. Retouched flakes come from northern sources, biface thinning flakes come from a northern and southern source, and the flakes come from a northern source as well as the unknown source (Table 5.2).

At Coleman 90% of the tools were manufactured on basalt, while CCS and obsidian together comprise only 10% of the assemblage. Further, virtually all of the basalt artifacts were made on fine-grained locally available basalt. An extensive high-quality basalt flow occurs within one-half km of the site. My sourcing studies have matched one of the Coleman hafted bifaces, a Windust stemmed point, to this source (C. Skinner, personal communication 2000). This basalt flow is part of a massive Tertiary formation that is part of the Pyramid Sequence, a set of basalt, andesite, and dacite flows

Table 5.2. Coleman Obsidian Sources by Artifact.

			Artifact Type				
Obsidian Source	n	%	Parman Points	Haskett Points	Retouched Flakes	Biface Thinning Flakes	Flakes
Coyote Spring	2	20.0		1			1
South Warners 2/Unknown B	1	10.0			1		
Mt. Majuba	4	40.0			3	1	
Mt. Hicks	1	10.0				1	
Bodie Hills	1	10.0	1				
Unknown 1	1	10.0					1
Total	10	100	1	1	4	2	2

(Bonham 1969; Johnson 1977). This rock unit makes up the majority of the northern portion of the Lake Range, which is the mountain range adjacent to and west of the site. Other rock units, located in the hills and mountains within 15 to 20 km of the site, consist of a Tertiary sedimentary rock unit, Cretaceous intrusive plutonic rock unit, Tertiary rhyolitic unit, metamorphosed sedimentary rock unit of unknown age, and Quaternary terrace, alluvial fan, and pediment gravel deposits. None of these formations are characterized by lithologies that would contain CCS. Instead, the sedimentary rocks in these formations consist of diatomite, mudstone, shale, arkose, volcanic sandstone, siltstone, breccia, conglomerates, and basaltics (Bonham 1969; Johnson 1977). In sum, the Coleman site contains local basalt, as well as exotic obsidian and possibly exotic CCS. Field checks are needed, though, to test whether CCS occurs in local gravel deposits ringing the Winnemucca Lake basin in the vicinity of the Coleman site.

Figure 5.3 shows the relative frequencies of raw materials observed in the Coleman assemblage. Both hafted (75.0%) and unhafted bifaces (95.2%) are predominantly made on local basalt. Obsidian contributes to 25.0% of the hafted bifaces and 0.2% of the unhafted bifaces, and CCS contributes to none of the hafted bifaces and only 4.6% of the unhafted bifaces. Toolstone selection is somewhat different for the unifacial tools, but is still dominated by basalt. Of these, 78.3% of the formal unifaces and 83.3% of the informal unifaces were made on basalt, none of the formal and 3.2% of the informal unifaces were made on obsidian, and 21.7% of the formal unifaces and 13.5% of the informal unifaces were made on CCS (Figure 5.3). Clearly, there was a preference for the on-site source, basalt, for making all tools represented in the assemblage. Obsidian was, for the most part, only used to manufacture hafted bifaces, and CCS was, for the most part, used to manufacture formal unifaces.

Biface-to-Core Ratio

Sadmat Site

The Sadmat site biface-to-core ratio is high, with 955 (91.0%) unhafted bifaces and bifacially worked cores to 95 (9.0%) simply-prepared flake cores. This high biface-to-core ratio implies a high degree of mobility. As seen in Table 5.3, there is a clear relationship between core type and raw material type.

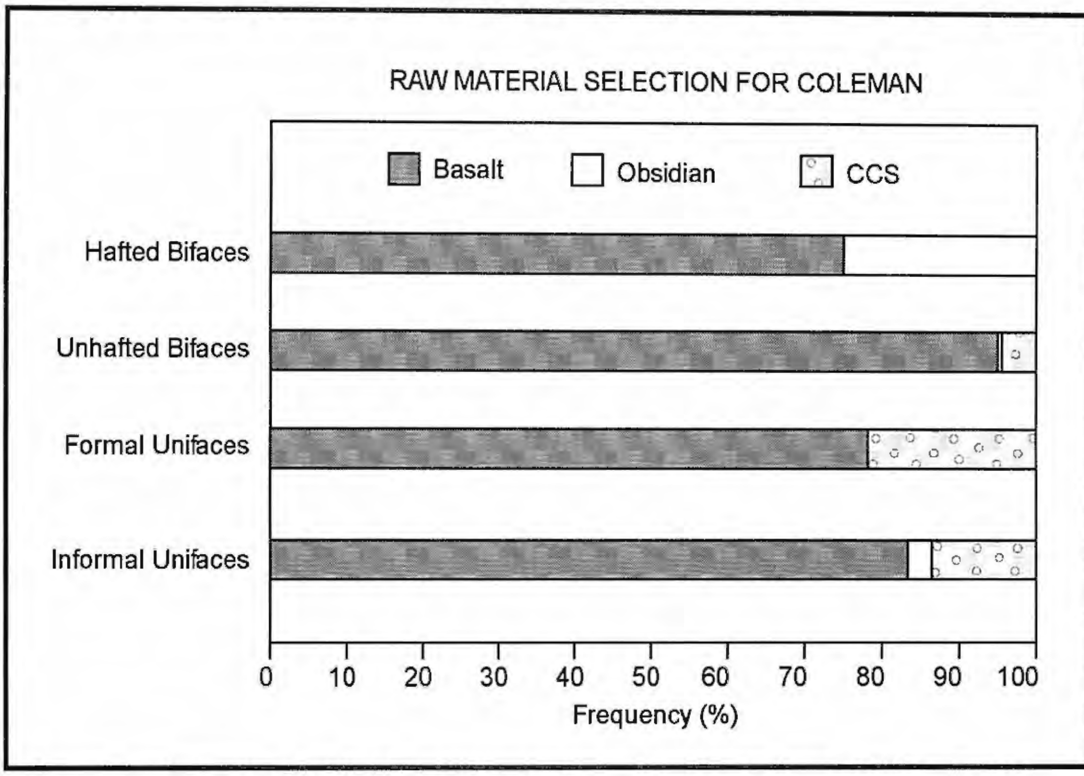


Figure 5.3. Frequencies of raw materials represented in the tool assemblage for Coleman.

A chi-square test on these data yielded a test value of 93.022, with 2 degrees of freedom and a probability value of less than 0.001, implying that the relationship is statistically significant. Thus, there is a clear preference toward the selection of exotic obsidian and basalt for the manufacture of bifaces, and an overwhelming preference for local CCS in the manufacture of flake cores. Table 5.4, further, shows that there is a statistically significant relationship between the condition of biface-cores and raw material, with a chi-square test statistic of 129.536, 2 degrees of freedom, and a probability value of less than 0.001. Complete biface-cores were mainly manufactured on CCS, while broken biface-cores tend to be obsidian or basalt bifaces brought to the site from elsewhere, discarded, and replaced by fresh, unbroken CCS bifaces. These data suggest that the Sadmat site was used as a retooling location. Although obsidian, and to a lesser degree basalt, were the preferred raw materials in the manufacture of bifaces, the occupants of Sadmat repeatedly discarded broken bifaces of these raw materials at the site and replaced them with bifaces made on locally procured CCS.

Table 5.3. Sadmat Biface to Core Ratio by Raw Material.

		Raw Material			
		Basalt	Obsidian	CCS	Total
Bifaces	Count	185	388	382	955
	Expected Count	171.0	357.4	426.6	955.0
	% of Total	17.6%	37.0%	34.6%	91.0%
Flake Cores	Count	3	5	87	95
	Expected Count	17.0	35.6	42.4	95.0
	% of Total	0.3%	0.5%	8.3%	9.0%
Total	Count	188	393	469	1050
	Expected Count	188.0	393.0	469.0	1050.0
	% of Total	17.9%	37.4%	44.7%	100.0%

Chi-Square Test: Value 93.022[a], 2 df, P<0.001.
[a] 0 cells (0.0%) have an expected count less than 5. The minimum expected count is 17.01.

Table 5.4. Sadmat Biface-core Condition by Raw Material.

		Raw Material			
		Basalt	Obsidian	CCS	Total
Complete	Count	25	67	189	281
	Expected Count	54.6	113.1	113.4	281.0
	% of Total	2.7%	7.1%	20.1%	29.8%
Fragmented	Count	158	312	191	661
	Expected Count	127.4	265.9	266.6	661.0
	% of Total	16.8%	33.1%	20.3%	70.2%
Total	Count	183	379	380	942
	Expected Count	183.0	379.0	380.0	942.0
	% of Total	19.4%	40.2%	40.3%	100.0%

Chi-Square Test: Value 129.536[a], 2 df, P<0.001.
[a] 0 cells (0.0%) have an expected count less than 5. The minimum expected count is 54.59.

Coleman Site

The Coleman site biface-to-core ratio is similar to that of Sadmat, in that 420 (92.9%) are biface-cores and only 32 (7.1%) are expediently produced flake cores (Table 5.5). The chief raw material used for biface production is local basalt, while obsidian and CCS biface cores are relatively rare. These numbers are too small to analyze statistically; however, the high ratio of formal biface-cores to informal flake cores suggests short stays at the site and a high degree of residential mobility.

Table 5.6 shows biface-core condition relative to raw material selection. As with the biface-to-core ratio, these numbers are too small to analyze statistically; however, unlike the Sadmat site, there does not seem to be a tendency for the biface-cores manufactured on exotic raw materials to be broken more than expected, nor is there a tendency for biface-cores on local raw materials (i.e., basalt) to be complete. The reason for this may be due to a high degree of breakage of basalt bifaces during manufacture.

Biface Thinning Flakes as Tool Blanks

Importantly, biface thinning flakes were utilized as tool blanks to make 46.5% of the informal unifaces at the Sadmat site, and 22.8% of the informal unifaces at Coleman (Figure 5.4). These high percentages further support the notion that bifaces were being used as cores to manufacture unifaces at both sites.

Formal Versus Informal Tool Production

Both sites have a high frequency of formal tools. At Sadmat, 75.9% of tool production is characterized by 1,742 formal tools (Figure 5.5). These include bifaces, side scrapers, end scrapers, multiple-spurred gravers, and combination tools (Figure 5.6). Combination tools are especially important in this regard, since some researchers have pointed out that mobile foragers repeatedly make tools with multiple functions (Kelly 1988a). For Sadmat, there are 142 combination tools, making up 22.0% of the formal uniface assemblage (Table 4.3). Conversely, informal tool production at Sadmat occurred much less frequently. Informal tools number only 553 (24.1%). These consist of retouched flakes, single-spurred gravers, denticulates, notches, and backed knives.

Table 5.5. Coleman Biface to Core Ratio by Raw Material.

		Raw Material			
		Basalt	Obsidian	CCS	Total
Bifaces	Count	399	2	19	420
	Expected Count	399.6	1.9	18.6	420.0
	% of Total	88.3%	0.4%	4.2%	92.9%
Flake Cores	Count	31	0	1	32
	Expected Count	30.4	0.1	1.4	32.0
	% of Total	6.9%	0.0%	0.2%	7.1%
Total	Count	430	2	20	452
	Expected Count	430.0	2.0	20.0	452.0
	% of Total	95.1%	0.4%	4.4%	100.0%

The sample cells are too small for statistical analysis.

Table 5.6. Coleman Biface-core Condition by Raw Material.

		Raw Material			
		Basalt	Obsidian	CCS	Total
Complete	Count	42	0	2	44
	Expected Count	41.9	0.1	2.0	44.0
	% of Total	10.0%	0.0%	0.5%	10.5%
Fragmented	Count	356	1	17	374
	Expected Count	356.1	0.9	17.0	374.0
	% of Total	85.2%	0.2%	4.1%	89.5%
Total	Count	398	1	19	418
	Expected Count	398.0	1.0	19.0	418.0
	% of Total	95.2%	0.2%	4.5%	100.0%

The sample cells are too small for statistical analysis.

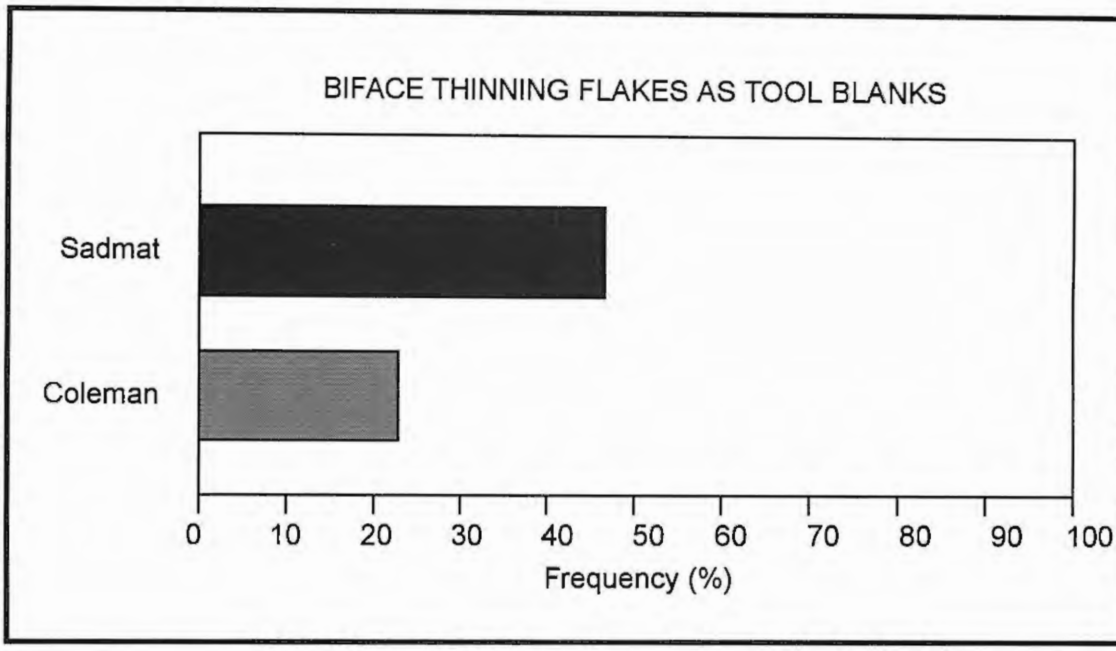


Figure 5.4. Frequencies of biface thinning flakes used as tool blanks for informal tools in both the Sadmat and Coleman assemblages.

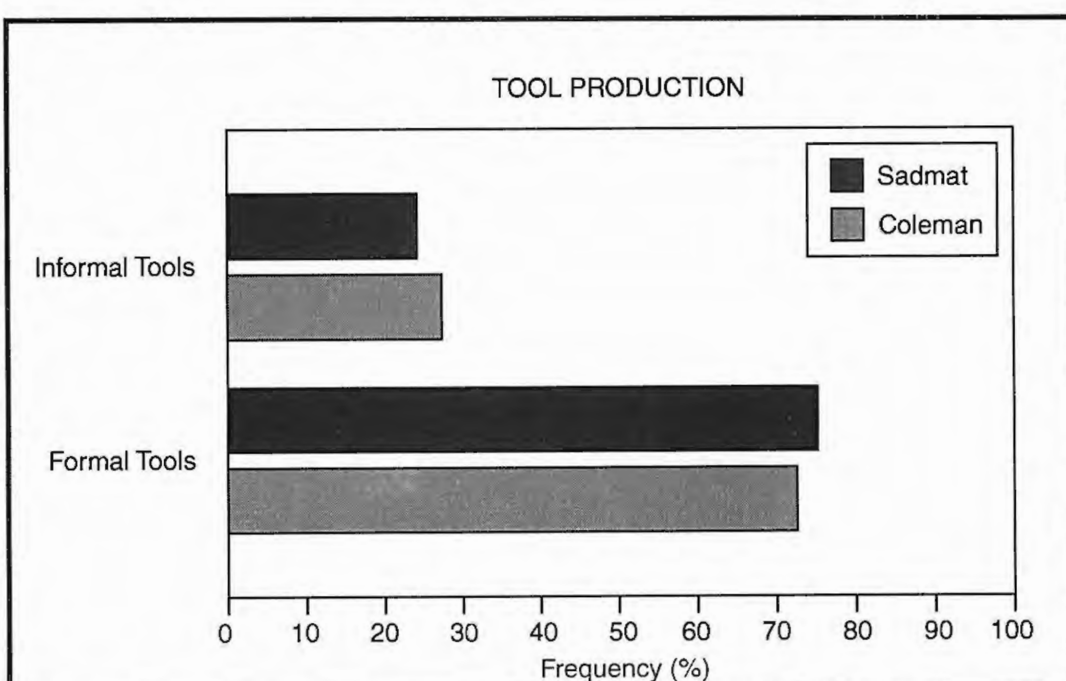


Figure 5.5. Frequencies of formal versus informal tool production represented in the Sadmat and Coleman assemblages.

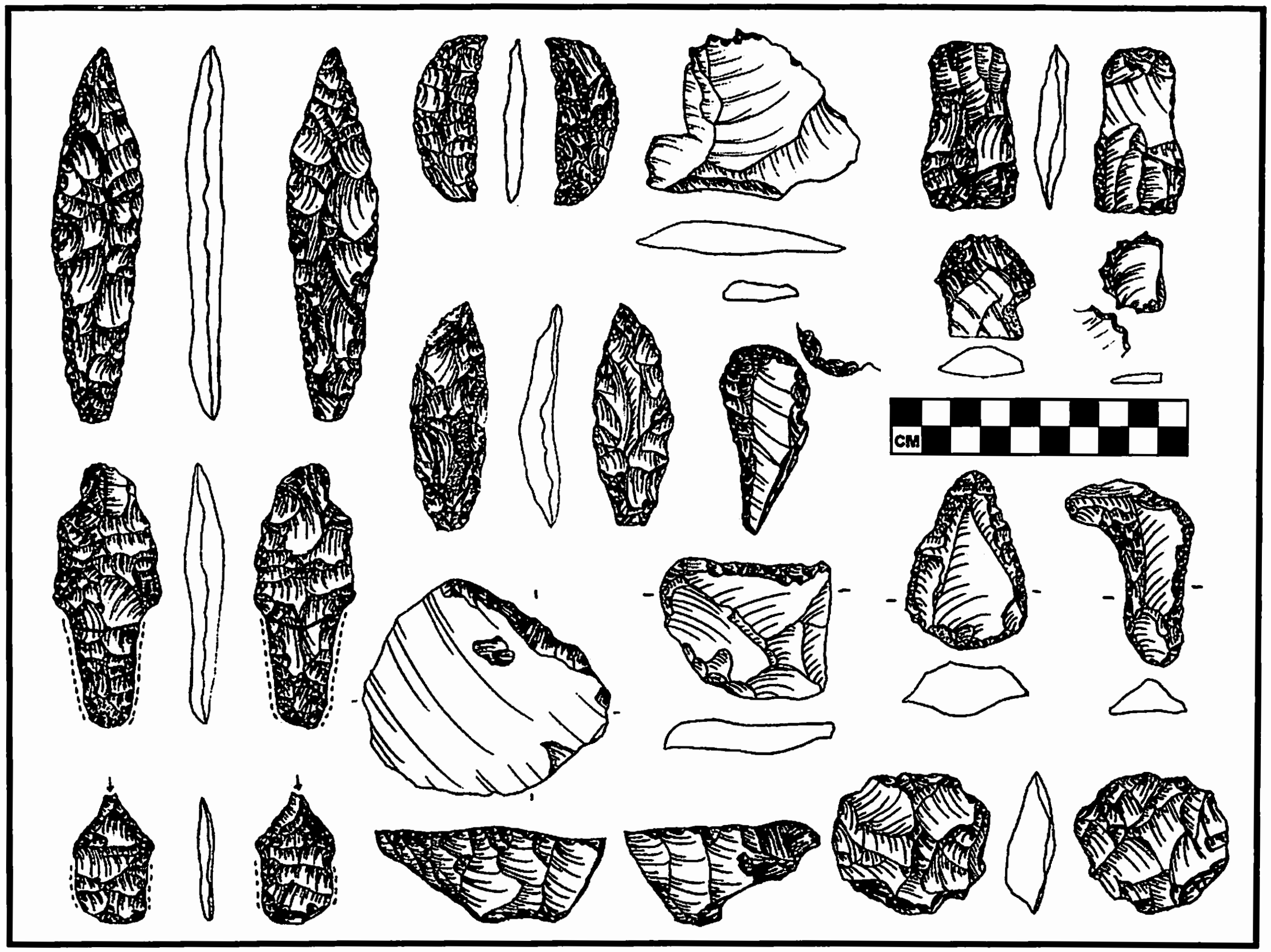


Figure 5.6. Illustration of the Sadmat tool assemblage.

At Coleman, formal tools number 492 (72.6%), making up the majority of tool production (Figure 5.5), with combination tools making up 14.5% of the formal uniface assemblage (Table 4.6). Informal tools number 186, making up only 27.4% of tool production at Coleman.

In order to further analyze formal versus informal tool production, chi-square tests were conducted for both the Sadmat and Coleman assemblages to see if relationships exist between formalized tool production and raw material selection. For Sadmat (Table 5.7), the chi-square test yielded a test value of 118.897, with 2 degrees of freedom, and a significance probability value of less than 0.001. This suggests that there is a significant relationship between these two variables. Simply put, Sadmat occupants preferred exotic obsidian and basalt in the manufacture of formal tools, and preferred local CCS in the manufacture of informal tools (Table 5.7). For Coleman (Table 5.8), the resulting chi-square test value is 14.828, with 2 degrees of freedom, and a significance probability value of less than 0.001, again suggesting a significant relationship exists between the two variables. Basalt was consistently the toolstone of choice in the manufacture of formal tools, while CCS and obsidian (exotic toolstones at Coleman) were the toolstones of choice in informal tool production. The significant preference at the Coleman site for basalt to manufacture formal tools is due to the extremely high proportion of bifaces made on this raw material. For Coleman, observed frequencies are similar to those from Sadmat for basalt and CCS, but not for obsidian. This may be due to the small obsidian sample size of the Coleman assemblage. Nonetheless, the high proportions of formal tools at these retooling sites indicates that both sites represent a series of short stays by mobile hunter-gatherers.

Tool Use-life Histories

Hafted Biface Condition

When trying to characterize bifacial tool use-life histories, stemmed point reduction can be inferred by comparing frequencies of complete, reworked, and broken hafted bifaces. Broken points at both sites greatly outnumber complete and reworked points (Figure 5.7). At Sadmat, complete hafted bifaces number 17 (23.3%), reworked hafted bifaces number 42 (9.4%), and broken bifaces number

Table 5.7. Sadmat Tool Production by Raw Material.

		Raw Material			
		Basalt	Obsidian	CCS	Total
Formal Tools	Count	265	541	909	1715
	Expected Count	212.4	489.8	1012.8	1715.0
	% of Total	11.7%	23.8%	40.1%	75.6%
Informal Tools	Count	16	107	431	554
	Expected Count	68.6	158.2	327.2	554.0
	% of Total	0.7%	4.7%	19.0%	24.4%
Total	Count	281	648	1340	2269
	Expected Count	281.0	648.0	1340.0	2269.0
	% of Total	12.4%	28.6%	59.1%	100.0%

Chi-Square Test: Value 118.897[a], 2 df, P<0.001.
[a] 0 cells (0.0%) have an expected count less than 5. The minimum expected count is 68.61.

Table 5.8. Coleman Tool Production by Raw Material.

		Raw Material			
		Basalt	Obsidian	CCS	Total
Formal Tools	Count	455	3	34	492
	Expected Count	442.7	6.5	42.8	492.0
	% of Total	67.1%	0.4%	5.0%	72.6%
Informal Tools	Count	155	6	25	186
	Expected Count	167.3	2.5	16.2	186.0
	% of Total	22.9%	0.9%	3.7%	27.4%
Total	Count	610	9	59	678
	Expected Count	610.0	9.0	59.0	678.0
	% of Total	90.0%	1.3%	8.7%	100.0%

Chi-Square Test: Value 14.828[a], 2 df, P<0.001.
[a] 1 cell (16.7%) has an expected count less than 5. The minimum expected count is 2.47.

121 (62.7%). For Coleman, there are no complete hafted bifaces, reworked hafted bifaces number 2 (28.6%), and broken bifaces number 5 (71.4%) of the hafted bifaces.

When comparing hafted biface condition to raw material selection, statistical analysis could not be undertaken because cell counts were too low for reworked points in the Sadmat assemblage and for all counts in the Coleman assemblage (Tables 5.9, 5.10). Nevertheless, Sadmat hafted bifaces are mainly manufactured on exotic obsidian (53.7%) (Table 5.9). Further, obsidian is the predominant toolstone for both the broken and reworked points left at the site, while CCS and basalt are slightly less represented than expected in these condition types. Complete bifaces occur more frequently than expected on CCS and basalt, and less frequently than expected on obsidian. This suggests that exotic obsidian hafted bifaces were typically used until exhausted, while many CCS and

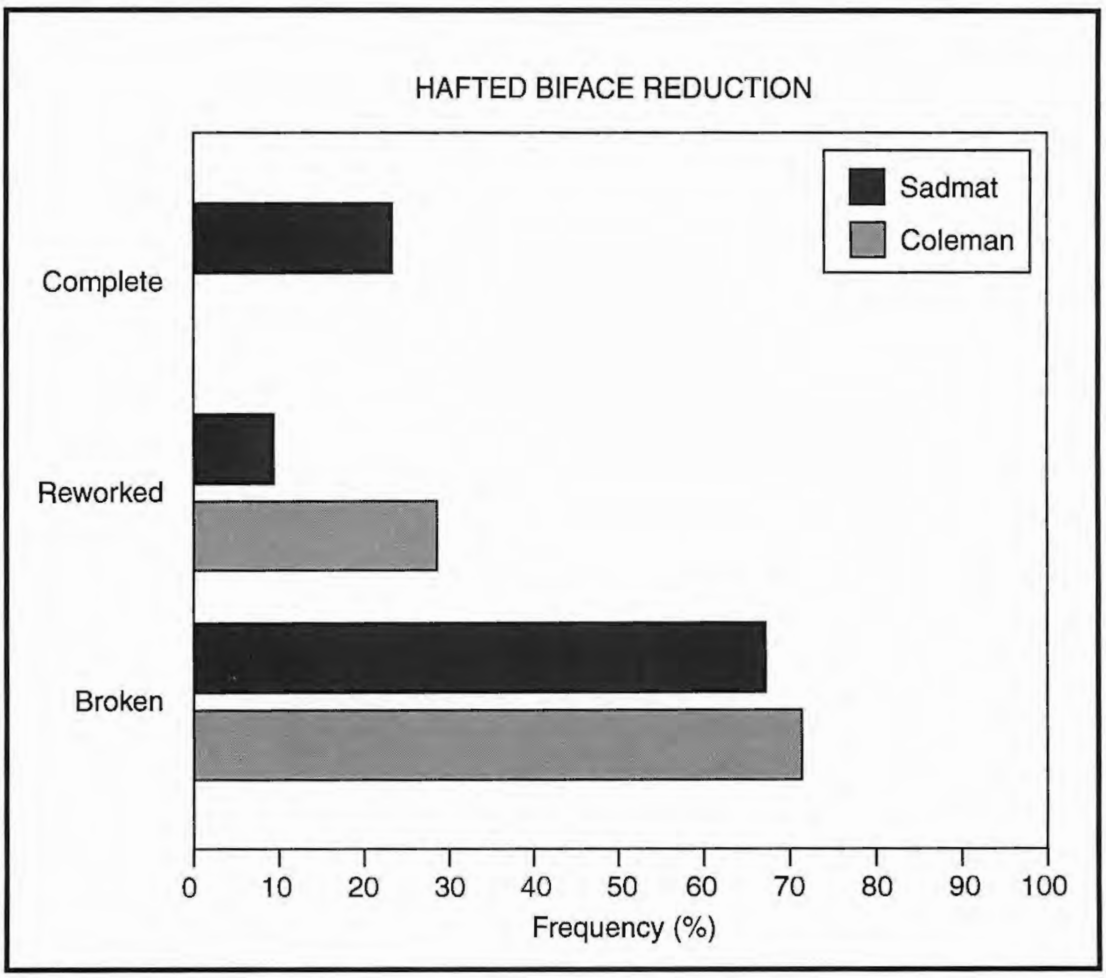


Figure 5.7. Frequencies of complete, reworked, and broken hafted bifaces in the Sadmat and Coleman assemblages.

basalt bifaces were discarded prior to being broken or exhausted. Thus broken and reworked stemmed points made of obsidian appear to be carried in from far away and replaced with locally produced CCS points, again suggesting that Sadmat functioned as a retooling site. At Coleman 71.4% of the hafted bifaces are manufactured on basalt (Table 5.10). All of the Coleman hafted bifaces, however, are reworked or broken. Therefore, it appears that all hafted bifaces at Coleman were discarded at or near the end of their use-lives. Interestingly, the broken obsidian point comes from Bodie Hills, the furthest source south of the site, while the reworked obsidian point comes from Coyote Spring, the furthest source to the north of the site. The Coleman hafted biface assemblage, however, is too small to interpret much more about biface use-life histories and retooling.

Hafted Biface Reduction Index

A biface reduction index was applied in order to further analyze the reduction and use-life of the hafted biface tools. The closer the ratio is to 1.0, the more reworked the biface, while the closer the value is to 0.0 the less reworked the biface.

At Sadmat, biface reduction index means of hafted bifaces for raw materials are 0.34 for obsidian, 0.32 for basalt, and 0.30 for CCS (Figure 5.8) The standard deviation of the mean for obsidian is 0.055, basalt 0.062, and CCS 0.058. These distributions were tested and found to be normal using a Kolmogorov-Smirnov test for normality. Therefore, a one-way analysis of variance (ANOVA) was conducted to determine whether there is a significant difference between these means. The ANOVA produced a test statistic of 5.647, with 2 degrees of freedom, and a significance probability of less than 0.001. This indicates that obsidian and (to a lesser degree) basalt hafted bifaces were significantly more intensively reworked than CCS bifaces at the Sadmat site. This statistic supports the interpretations made earlier in this chapter that biface condition and raw material are related and that retooling of the hafted bifaces transported to the site from elsewhere did occur.

This hafted biface reduction index was not calculated for the Coleman assemblage since the sample of stemmed points is too small (N = 7). Also, none of these bifaces are complete so that biface blade widths and thicknesses could not be reliably measured.

Table 5.9. Sadmat Hafted Biface Condition by Raw Material.

		Raw Material			
		Basalt	Obsidian	CCS	Total
Broken	Count	21	70	28	119
	Expected Count	23.5	63.9	31.6	119.0
	% of Total	11.9%	39.5%	15.8%	67.2%
Reworked	Count	3	10	4	17
	Expected Count	3.4	9.1	4.5	17.0
	% of Total	1.7%	5.6%	2.3%	9.6%
Complete	Count	11	15	15	41
	Expected Count	8.1	22.0	10.9	41.0
	% of Total	6.2%	8.5%	8.5%	23.2%
Total	Count	35	95	47	177
	Expected Count	35.0	95.0	47.0	177.0
	% of Total	19.8%	53.7%	26.6%	100.0%

The sample cells are too small for statistical analysis.

Table 5.10. Coleman Hafted Biface Condition by Raw Material.

		Raw Material			
		Basalt	Obsidian	CCS	Total
Broken	Count	4	1	0	5
	Expected Count	3.6	1.4	0.0	5.0
	% of Total	57.1%	14.3%	0.0%	71.4%
Reworked	Count	1	1	0	2
	Expected Count	1.4	1.4	0.0	2.0
	% of Total	14.3	14.3	0.0%	28.6%
Complete	Count	0	0	0	0
	Expected Count	0.0	0.0	0.0	0.0
	% of Total	0.0%	0.0%	0.0%	0.0%
Total	Count	5	2	0	7
	Expected Count	5.0	2.0	0.0	7.0
	% of Total	71.4%	28.6%	0.0%	100.0%

The sample cells are too small for statistical analysis.

Uniface Reduction Index

A uniface reduction index was applied in order to analyze the reduction and use-life of all uniface tools, both formal and informal. The higher the ratio, the more reworked the uniface, while the closer the value is to 0.0, the less reworked the uniface.

At the Sadmat site uniface reduction index means by raw material are 0.72 for obsidian, 0.68 for basalt, and 0.59 for CCS (Figure 5.9). The standard deviation for obsidian is 0.335, for basalt is 0.217, and for CCS is 0.267. Because the distribution of these data were determined to be not normal

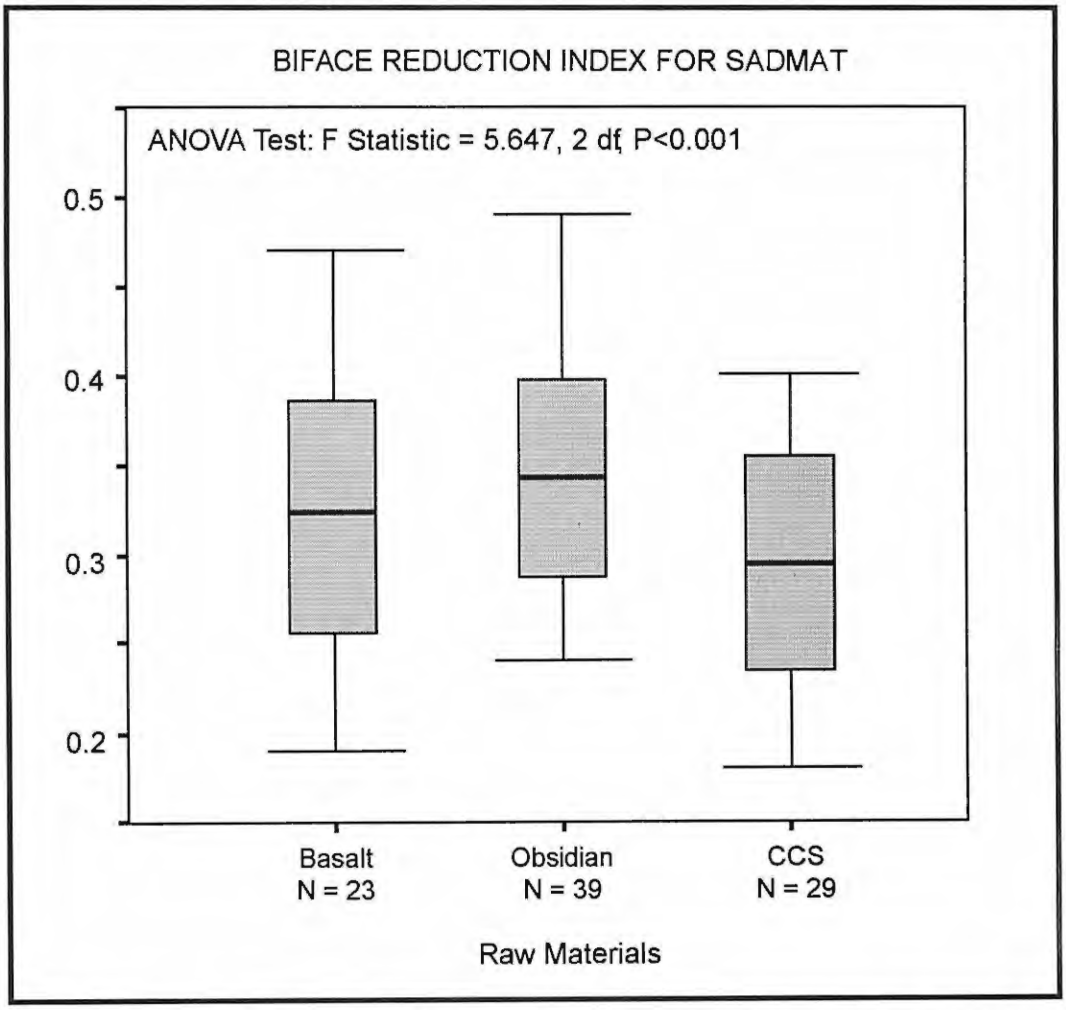


Figure 5.8. Box plot showing means of the biface reduction index for complete hafted bifaces. The boxes represent the standard deviation of the means, while the bars represent the range of mean measurements. ANOVA test results indicated that there is a significant difference in the reduction of obsidian over basalt and CCS.

by use of a Kolmogorov-Smirnov test of normality, a non-parametric Kruskal-Wallis test was conducted to determine whether there is a significant difference between these means. The resulting test statistic is 33.688, with 2 degrees of freedom, and a significance probability of less than 0.001. Thus, obsidian and basalt unifaces were more intensively reworked than CCS. Perhaps this suggests that mobile foragers were transporting obsidian and basalt from elsewhere, discarding these artifacts, and replacing them with CCS unifaces at Sadmat.

At Coleman, unifacial reduction index means are 0.63 for obsidian, 0.47 of basalt, and 0.51 for CCS (Figure 5.10). Standard deviations are 0.228 for obsidian, 0.253 for basalt, and 0.258 for CCS. Like with the Sadmat data, a Kruskal-Wallis test was conducted to see if there is a significant difference in the means of these unifacial reduction indexes by raw material. The test yielded a test statistic of 4.485, with 2 degrees of freedom, and a probability value of 0.106, suggesting that at Coleman there is not a significant difference in the reduction of unifaces by raw material. The mean for obsidian is still higher than the means for basalt and CCS (Figure 5.10). The low Kruskal-Wallis test statistic is probably due to the small sample of obsidian artifacts included in the analysis. Obsidian unifaces may have been more reworked than basalt and CCS unifaces at Coleman, but a larger sample would be needed to convincingly demonstrate this pattern.

Formal and Informal Uniface Reduction

Formal and informal uniface reduction was measured by comparing the average number of margins retouched for each raw material. Since the data collected on the number of retouched margins for formal and informal unifaces is ordinal-scale data, a Kruskal-Wallis test was used to compare the resulting means.

At Sadmat the mean number of retouched margins on formal basalt unifaces is 1.77, on formal CCS unifaces it is 1.66, and on formal obsidian unifaces it is 1.42, with standard deviations of 0.74, 0.71, and 0.57, respectively. The Kruskal-Wallis test on these data yielded a test statistic of 6.926, with 2 degrees of freedom, and a significance probability of 0.031. This indicates a significant difference in the raw material means, with basalt and CCS formal unifaces having significantly more retouched edges than obsidian formal unifaces. This is probably the case because both basalt and CCS are extremely durable, high quality raw materials, making them good choices for the manufacture of

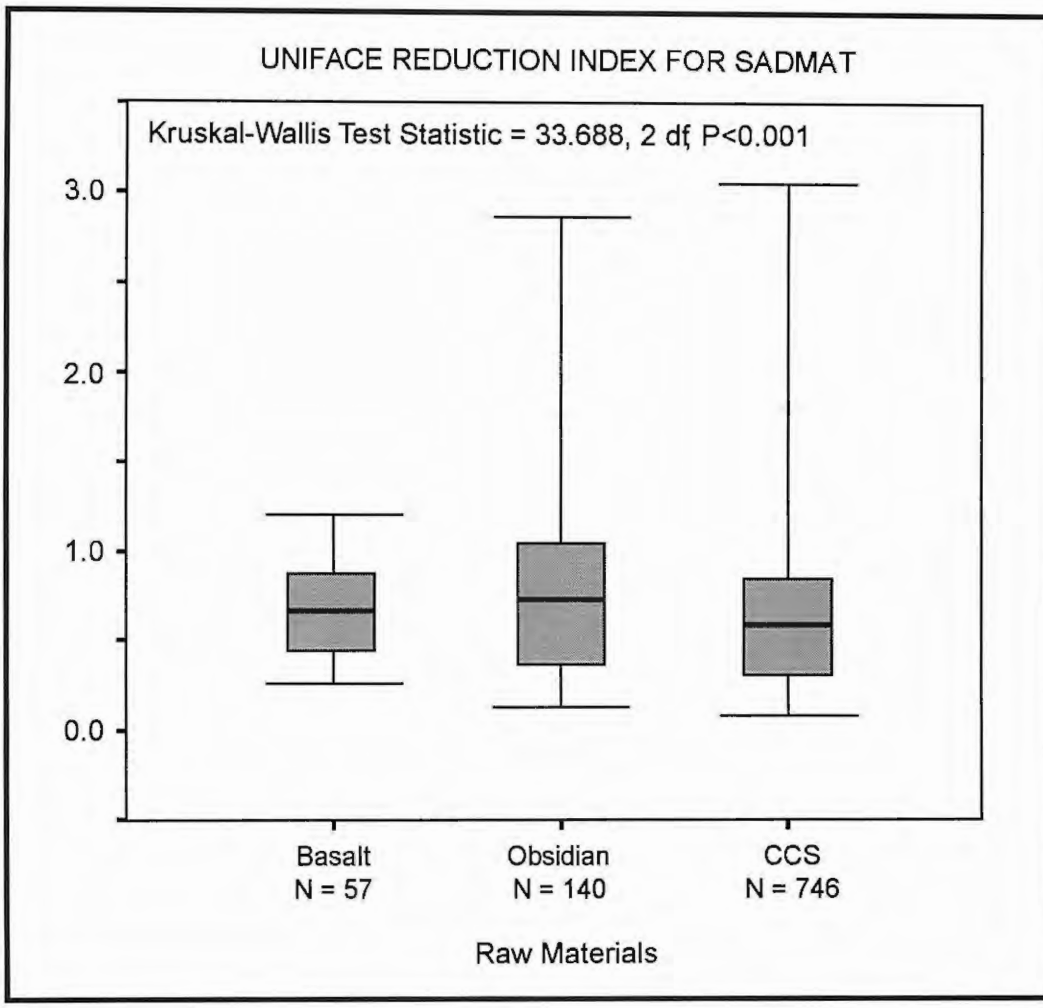


Figure 5.9. Box plot showing the means of the uniface reduction index for all unifaces. The boxes represent the standard deviation of the means, while the bars represent the range of mean measurements. Kruskal Wallis test results indicated that there is a significant difference in the reduction of obsidian over basalt and CCS.

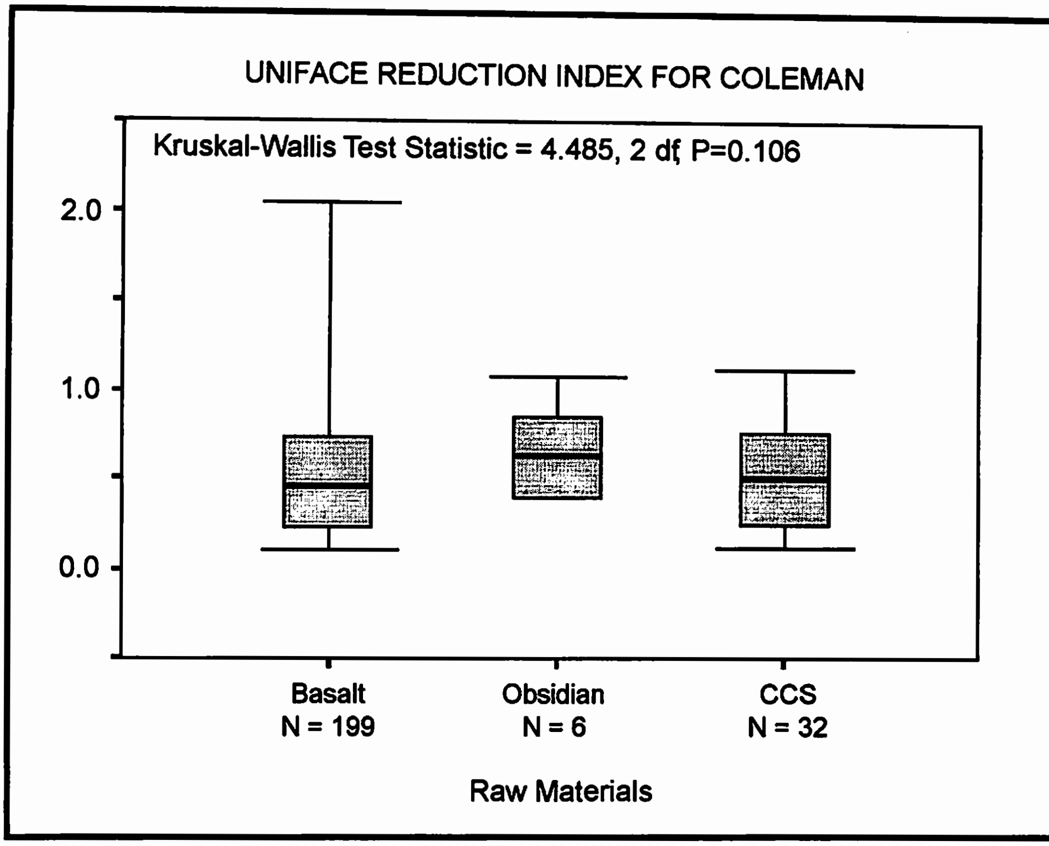


Figure 5.10. Box plot showing the means of the uniface reduction index for all unifaces at Coleman. The boxes represent the standard deviation of the means, while the bars represent the range of mean measurements. Kruskal Wallis test results indicated that there is no significant difference in the reduction of obsidian over the other raw materials.

formalized unifaces and the reduction and reuse of such formal tools. Means for the informal unifaces are 1.32 for obsidian, 1.26 for CCS, and 1.25 for basalt, with standard deviations of 0.54, 0.47, and 0.45, respectively. The Kruskal-Wallis test on these data yielded a test statistic of 0.726, with 2 degrees of freedom, and a significance probability of 0.696, suggesting that the differences between raw material means for informal unifaces is not significant. There is a trend, however, toward the intensive reduction of obsidian for informal unifaces in that the mean number of retouched margins is highest for this raw material.

To further investigate the notion that the occupants of Sadmat more intensively curated basalt and CCS formal tools, a chi-square test was conducted to examine whether a significant relationship exists between formal and informal unifaces and raw material (Table 5.11). The resulting chi-square test statistic is 40.469, with 2 degrees of freedom, and a significance probability of less

Table 5.11. Sadmat Uniface Production by Raw Material.

		Raw Material			
		Basalt	Obsidian	CCS	Total
Formal Unifaces	Count	44	52	542	638
	Expected Count	32.1	86.0	519.9	638.0
	% of Total	3.7%	4.4%	45.4%	53.4%
Informal Unifaces	Count	16	109	431	556
	Expected Count	27.9	75.0	453.1	556.0
	% of Total	1.3%	9.1%	36.1%	46.6%
Total	Count	60	161	973	1194
	Expected Count	60.0	161.0	973.0	1194.0
	% of Total	5.0%	13.5%	81.5%	100.0%

Chi-Square Test: Value 40.469[a], 2 df, P<0.001.

[a] 0 cells (0.0%) have an expected count less than 5. The minimum expected count is 27.94.

than 0.001. Thus, there is a clear preference toward the selection of CCS and basalt for the manufacture of formal unifaces, while there is a clear preference for the use of exotic obsidian for the manufacture of informal unifaces. Perhaps basalt and CCS were the materials of choice when producing formal unifaces because these toolstones are more durable and recyclable than obsidian. Further, these data support the idea above that obsidian informal unifaces were being reworked more.

For Coleman, the number of worked margins on formal unifaces for CCS is 1.73 and for basalt it is 1.59, with standard deviations of 0.59 and 0.60, respectively. The Kruskal-Wallis test on these data yielded a test statistic of 0.727, with 1 degree of freedom, and a significance probability of 0.39, suggesting that no clear difference exists in the mean number of retouched margins on CCS and basalt formal tools. This is probably the case because both basalt and CCS are extremely durable, high quality raw materials. Mean numbers of retouched margins on informal unifaces are 1.32 for basalt, 1.17 for obsidian, and 1.04 for CCS, with standard deviations of 0.51, 0.41, and 0.20, respectively. The Kruskal-Wallis test on these data yielded a test statistic of 7.667, with 2 degrees of freedom, and a significance probability of 0.02, indicating that the mean number of retouched margins on basalt and possibly obsidian is significantly higher than the mean for CCS. While, basalt and obsidian informal unifaces were more intensively reworked than CCS informal unifaces, it is not entirely clear why this may be the case; however, these results are probably related to informal tool production at Coleman. Referring back to the earlier section on formal versus informal tool production, obsidian was preferred for informal tool production. Mobile foragers visiting the Coleman site, bringing exotic obsidian, would have used this raw material intensively, economizing the obsidian. Table 5.12 presents data regarding toolstone selection in the manufacture of formal and informal unifaces. No chi-square test was conducted on the data to test for significant relationships between these variables because the sample cell numbers are too small; however, the data do suggest that CCS was utilized more often than expected in the manufacture of formal unifaces. This again is probably because CCS is the most durable toolstone.

Table 5.12. Coleman Uniface Production by Raw Material.

		Raw Material			
		Basalt	Obsidian	CCS	Total
Formal Unifaces	Count	54	0	15	69
	Expected Count	56.6	1.6	10.8	69.0
	% of Total	21.2%	0.0%	5.9%	27.1%
Informal Unifaces	Count	155	6	25	186
	Expected Count	152.4	4.4	29.2	186.0
	% of Total	60.8%	2.4%	9.8%	72.9%
Total	Count	209	6	40	255
	Expected Count	209.0	6.0	40.0	255.0
	% of Total	82.0%	2.4%	15.7%	100.0%

The sample cells are too small for statistical analysis.

Summary

Reviewing the lithic expectations of the TW (provisioning places) and mobile forager (provisioning individuals) hypotheses, we see that with every variable measured, results point to high mobility. In regards to both assemblages, there is evidence of the transport of finished tools across great distances. As for the biface-to-core ratio, both sites have very high frequencies of biface-cores, suggesting that the hunter-gatherers who produced these formal cores were residentially mobile and did not spend long periods of time at these sites. High proportions of formal tools in both the Sadmat and Coleman assemblages indicate that many tools were made in advance of use, had multiple functions, and were intensively reworked prior to discard. Finally, tool use-life histories at both sites suggest high degrees of bifacial and unifacial reduction, typically more for exotic raw materials and less for local ones, but still more than would be expected if these assemblages reflected longer stays as suggested by the TW or "Paleoarchaic" hypothesis. More specifically, these data indicate that an important technological activity at both sites was retooling of both exhausted or broken bifaces and unifaces that were transported to the site with new tools produced on locally available toolstones. Transport of curated tools and their replacement of new ones at Sadmat and Coleman fits the expectations of the mobile forager hypothesis.

Overall the variables studied support high mobility at both the Sadmat and Coleman sites. Remember that these sites are large lithic scatters and have been interpreted by some to represent long-term occupations in rich wetland patches. However, my study suggests that these sites represent repeated, short-term visits by mobile foragers who used the locations at least in part to regear individuals for yet another residential move. These people likely were moving great distances between resource patches, and did not spend much time in any one patch, even the wetland patch.

CHAPTER 6

DISCUSSION AND CONCLUSIONS

In Chapter 1, two models of adaptive strategies are presented for hunter-gatherers in the Great Basin during the early Holocene. These are the Tethered Wetland (TW) model and the Mobile Forager (MF) model. Early Holocene hunter-gatherers in the Great Basin utilizing a TW strategy would have become tethered to wetland resources or patches. The basis of this model is centered on the idea that humans would have become tied to productive patches with abundant wetland resources (Madsen 1982, 1988; Madsen and Janetski 1990). They would have settled into these patches and become residentially more sedentary. If these groups were at all mobile, they would have utilized a logistical mobility pattern. On the other hand, hunter-gatherers using a MF strategy would have concentrated their resource procurement on terrestrial game and occasionally would have exploited wetland resources when available, if this behavior fit into their land-use system. These specialized foragers would have been highly mobile, using a residential mobility pattern, thus moving residences frequently between widely scattered patches.

Due to the overall lack of buried sites in the Great Basin, surface assemblages of lithic artifacts are an important avenue for the investigation of early human adaptive strategies (Beck and Jones 1997; Jones and Beck 1999). As discussed in Chapter 1, archaeologists have become increasingly concerned with aspects of technological organization, including planning and decision-making related to acquiring raw materials, and transportation, use/reuse, and discard of tools in response to resource conditions and economic and social strategies (Andrefsky 1998; Bamforth 1986; Henry 1995; Ingbar 1992, 1994; Kelly 1983, 1985, 1988a, 1988b, 2001; Kelly and Todd 1988; Kuhn 1989, 1991, 1992, 1993, 1994, 1995; Nelson 1991; Odell 1996; Parry and Kelly 1987; Torrence 1983) . Table 6.1 presents expectations of technological organization in regards to the TW and MF models. These are described below.

Table 6.1. Expectations of the Study.

	Tethered Wetland Adaptation	Mobile Forager Adaptation
Character of the Lithic Assemblages		
Tool-to-Debitage Ratio	low	high
Groundstone	common	rare
Fire-Cracked Rock	common	rare
Within-Site Variability	low	high
Between-Site Variability	high	low
Technological Activities and Provisioning Strategies		
Raw Material Procurement	chiefly local	local and exotic
Tool Kits	expedient/informal	curated/formal
Provisioning	place	individual
Mobility Levels		
Residential Mobility	low	high
Land Use Pattern	chiefly logistical	chiefly residential

Characterization of the Sadmat and Coleman lithic assemblages is important for two reasons. First, the assemblages are described and presented (in Chapter 4) in full, and therefore, present the only comprehensive descriptions of early Holocene lithic industries from this region. Second, characterization of the assemblages permits us to investigate technological organization, provisioning strategies, and adaptation. The frequency of tools (especially formal tools) relative to debitage should be low at TW sites, while the frequency of tools relative to debitage should be high at MF sites. Frequencies of all debitage types at TW sites should be greater if these people were provisioning the place and occupying the sites for longer durations (Kelly 2001). Groundstone should be common at TW sites where humans spend longer periods of time. Inversely, groundstone should be infrequently encountered at MF sites. This is not to say that mobile groups never processed plants and/or animals in this manner, but that these tool types are not transportable and thus probably not a common tool type used by mobile foragers. Likewise, at long-term TW occupation sites, assemblages should contain high proportions of fire-cracked rock, while at short-term MF sites, assemblages should possess little fire-cracked rock (Kelly 2001).

Regarding the overall characterization of lithic assemblages, within-site assemblage variability should be low in TW situations, but high in MF situations (Binford 1980). If hunter-gatherers were logistically mobile (not residentially mobile), a limited set of technological activities associated with specific aspects of resource procurement would have been conducted at special task sites. If hunter-gatherers were residentially mobile, the expectation would be to find archaeological residues relating to all aspects of life at or near the residence (Binford 1980). This is not to say that residentially mobile hunter-gatherers would not actively utilize logistical foraying for food and raw material procurement; however, because of shorter stays at residential camps there would be a propensity for these hunter-gatherers to conduct a broader range of technological activities at that residence than at special-task camps associated with a logistically mobile system (Binford 1979; Kelly 1983, 1985, 1988a, 1988b, 1995, 1999, 2001; Nelson 1991; Torrence 1983). As Binford (1979) and others (Nelson 1991; Torrence 1983) have suggested, mobile hunter-gatherers tend to manufacture their tools and weapons at residences and bring these implements back to residences after use. Therefore, residentially mobile groups tend to combine a variety of activities at the place of residence, including raw material procurement, tool manufacture and recycling, and food procurement. Less residentially mobile groups whose land-use pattern centers on logistical use of the surrounding territory tend to procure raw materials, manufacture tools, procure and sometimes prepare food away from the residence at special-task sites and spike camps (Binford 1978a, 1978b, 1979, 1980). Thus, between-site assemblage variability tends to be high for hunter-gatherers participating in a semi-sedentary, logistically-organized way of life and low for groups participating in a highly mobile life-way. These assumptions are of course dependent on the size and character of tool assemblages and the kinds of resources important for procuring activities.

According to Binford (1979), raw material selection and procurement behavior is embedded in a group's system of land-use. Therefore, with the TW adaptive strategy, lithic raw material selection and procurement should be chiefly local (if raw material is not scarce), and raw material types should be few. On the other hand, for mobile foragers raw material procurement should be local and exotic with high frequencies of both, and raw material types should be highly variable.

The technological provisioning strategies used by hunter-gatherers are centered around and determined by subsistence and land-use behavior. These strategies are directly tied to the technological activities that can be identified in lithic assemblages. Provisioning strategies are dependent on the degrees of planning and, therefore, the responses made by hunter-gatherers to make sure they are prepared for future exigencies. Hunter-gatherers organize technology so as to supply or provision themselves with essential materials and tools needed to forage and process resources. Technological provisioning strategies come in two forms, either the provisioning of place or the provisioning of individuals within the group (Kuhn 1991, 1992, 1993, 1994, 1995).

The TW adaptive strategy, presumed here to be based on a low degree of residential mobility, would entail the provisioning of place (either a residence, spike camp, or special-purpose work station). In such a system, we would expect to find diversity of site types with expediently produced tool assemblages (minimally utilized or retouched informal tools) resulting from provisioning of places and low mobility. Archaeologically, raw materials should be locally procured and minimally reduced. Tools tend to be informal, not curated and reused. Place provisioning results when humans do not need to plan far in advance, for example in situations where residential moves come infrequently. Only when raw material is extremely scarce does relatively sedentary hunter-gatherer technological organization contradict this pattern.

Hunter-gatherers employing the MF adaptive strategy should provision individuals with formalized, curated tool kits. This type of behavior is favored by residentially mobile foragers whose major concern is making sure that essential tools are readily available, at hand when the need arises, wherever the forager is on the landscape. High mobility and its associated technological strategy, provisioning of individuals, requires humans to be supplied with ready-to-use, light-weight cores and tools. Mobile forager lithic assemblages should be formalized. Raw material choice should reflect this behavior, with durable toolstones being utilized to optimize weight per unit artifact. Also, some of the raw materials in the assemblage should be exotic and reflect a long distance of travel. Mobile foragers tend to travel great distances between residences; however, the exact distance is reliant upon the availability of lithic and food resources. As a result of these frequent and long-distance moves, raw material packages should be maximally exploited. Little unmodified debitage should be present at these types of sites. Formal tools that show signs of being curated should outnumber informal tools that show signs of minimal use and curation.

What follows is a review of the Sadmat and Coleman lithic industries analyzed in this study in relation to these assumptions and expectations. I discuss the character of the assemblages, technological activities represented at Sadmat and Coleman, and technological provisioning strategies employed at the sites, in order to relate these to mobility levels and associated adaptive strategies. Included in the discussion of technological provisioning and mobility is a comparison of the Sadmat and Coleman data to other studies of hunter-gatherer technological organization as published data permit, including data from late Holocene archaeological sites in the Long Valley Caldera, eastern California and Carson Desert/Stillwater Mountain areas of western Nevada, as well as from Paleoindian sites across western North America. The late Holocene Great Basin data sets represent logistically mobile hunter-gatherers who were probably semi-sedentary (Basgall 1989; Kelly 1999, 2001; Raven 1990), while the Paleoindian data set represents more residentially mobile hunter-gatherers of the Clovis, Folsom, and Plano complexes (Boldurian and Cotter 1999; Bradley and Frison 1996; Frison 1978, 1982; Frison and Bradley 1980; Frison and Stanford 1982; Frison and Todd 1986; Francis and Larson 1996; Goebel 1990; Goebel et al. 1991; Haynes 1980, 1982; Ingbar 1992; Kunz and Reanier 1994, 1995, 1996).

Character of the Sadmat and Coleman Lithic Assemblages

The Sadmat and Coleman site assemblages are characterized by chipped stone technology, including cores, debitage, and associated tools. The tool assemblages that characterize these sites are reminiscent of other Paleoindian assemblages across the Great Basin and western North America (Beck and Jones 1997; Bradley 1974, 1982; Bradley and Frison 1987; 1996; Bryan 1979, 1980, 1988; Butler 1965, 1967; Carlson 1983; Fagan and Sage 1974; Frison 1978, 1982, 1996; Frison and Bradley 1980; Frison and Stanford 1982; Frison and Todd 1986, 1987; Goebel et al. 1991; Ingbar 1992; Irwin and Wormington 1970; Layton 1970, 1979; Tuohy 1968, 1969, 1970, 1974, 1988a, 1988b; Warren 1967; Warren and Ranere 1968; Wormington 1957). The Sadmat and Coleman core assemblages consist of tested cobbles, unidirectional flake cores, bidirectional flake cores, and multidirectional flake cores. Sadmat, however, contains two possible bipolar cores. As Shown in Table 6.2, the core assemblages do not dominate the entire lithic assemblage; at both sites, the cores make up less than 6% of the total assemblage.

The debitage assemblages at both sites are similar in the proportions of debitage types, with both containing low frequencies of cobbles, angular shatter, and cortical spalls, a high frequency of flakes, and a moderate frequency of retouch chips (including bifacial thinning flakes). The Sadmat debitage sample, however, is nearly three times as small as the debitage assemblage represented at Coleman; nonetheless, debitage class proportions are relatively similar (Table 6.2).

The tool assemblages for each site are very similar in terms of the occurrence and proportions of tool types (Table 6.2). Both assemblages contain hafted bifaces, unhafted bifaces, side scrapers, end scrapers, gravers, combination tools, retouched flakes, notches, backed knives, and burins. The Sadmat assemblage, however, contains several denticulates and the Coleman assemblage possesses higher proportions of unhafted bifaces and retouched flakes. As presented in Chapter 4, both assemblages possess hafted bifaces or projectile points that are stemmed and typical of late Paleoindian point types elsewhere in the Great Basin and western North America (Beck and Jones 1997; Bradley 1982; Butler 1965, 1967; Fagan and Sage 1974; Frison 1978, Irwin and Wormington 1970; Layton 1970, 1979; Tuohy 1968, 1969, 1970, 1974; Tuohy and Layton 1977; Warren and Ranere 1968; Wormington 1957). Specifically, both Sadmat and Coleman are characterized by

Table 6.2. Characterization of the Sadmat and Coleman Lithic Assemblages.

	Sadmat	Coleman
Core Assemblage	●	●
Tested Cobbles	•	•
Unidirectional Flake Cores	• •	•
Bidirectional Flake Cores	• •	•
Multidirectional Flake Cores	•	• •
Bipolar Cores	•	–
Debitage Assemblage	●	● ● ●
Cobbles	•	•
Angular Shatter	•	•
Cortical Spalls	•	•
Flakes	• • •	• • •
Retouch Chips/Bifacial Thinning Flakes	• •	• •
Tool Assemblage (Tool Kit)	● ● ●	● ●
Hafted Bifaces	•	•
Unhafted Bifaces	• •	• • •
Side Scrapers	•	•
End Scrapers	•	•
Gravers	•	•
Combination Tools	•	•
Retouched Flakes	•	• •
Notches	•	•
Backed Knives	•	•
Denticulates	•	–
Burins	•	•

• low (<25%), • • moderate (25-50%), • • • high (>50%).

Parman, Haskett, and Windust stemmed points. Bifaces, side scrapers, end scrapers, and gravers found in the Sadmat and Coleman assemblages are also characteristic of other Paleoindian complexes in western North America (Beck and Jones 1997; Bradley and Frison 1987, 1996; Bryan 1980; Frison 1978, 1982, 1996; Frison and Bradley 1980; Frison and Stanford 1982; Frison and Todd 1986, 1987; Goebel et al. 1991; Ingbar 1992; Irwin and Wormington 1970; Tuohy 1968, 1969, 1970, 1974; Warren 1967; Warren and Ranere 1968; Wormington 1957).

Both the Sadmat and Coleman sites have high tool-to-debitage ratios. For Sadmat, 73% of the lithic assemblage contains tools, for Coleman, 28% are tools. The extremely high proportion of tools at Sadmat may be due to a sampling bias, but the vast quantity of tools at the site (2,295) implies that something other than sampling led to this high ratio. Coleman debitage was systematically collected, so that this ratio is not artificially inflated. Other Paleoindian assemblages typically do not have such high tool to debitage ratios. For example, the Colby, Hanson, Mill Iron, Agate Basin (Agate Basin and Hell Gap components), and Mesa sites have tool frequencies ranging from one to 23 percent (Table 6.3). Colby is a single-use, special task site (Frison and Todd 1986), while Hanson, Mill Iron, and Agate Basin, have been interpreted to represent multi-purpose, kill/camp sites (Frison and Bradley 1980; Frison 1978, 1996; Frison and Stanford 1982; Ingbar 1992), with Hanson showing evidence of being a retooling location as well (Ingbar 1992). Mesa is a repeatedly occupied hunting camp (Kunz and Reanier 1994, 1995, 1996). All of these sites' tool-to-debitage ratios are considerably lower than either Coleman or Sadmat. One would expect logistical sites (especially kill sites) to possess higher tool-to-debitage ratios, even when modification to necessary tools was conducted during the killing/butchering process. Therefore, the tool-to-debitage ratios at both the Sadmat and Coleman sites appear to support a MF adaptive strategy.

The Sadmat and Coleman assemblages lack both groundstone and fire-cracked rock. Referring back to Table 6.1, two assumptions of a TW adaptive strategy require not only the presence of both of these artifact types, but their presence to be common not rare. Groundstone most likely would be in the Sadmat collection had it been present at the site because Kelly (2001) states that private collectors in the area of the Carson Desert tend to pick up groundstone and projectile points first and foremost, recognizing these to be artifacts. Mrs. Sadler and Mrs. Mateucci surely would have noticed groundstone if it were present on the site since they had no problem finding the nearly 60

Table 6.3. Tool-to-Debitage Ratios for Paleoindian Sites in North America.

	Tool Percentage	Debitage Percentage
Paleoindian		
Colby Site (Clovis) [a]	23	77
Hanson Site (Folsom) [b]	10	90
Mill Iron Site (Goshen) [c]	6	94
Agate Basin Site (Agate Basin) [e]	6	94
Agate Basin Site (Hell Gap Component) [f]	1	99
Mesa Site (in Alaska) [d]	1	99
Great Basin Stemmed Point Sites		
Sadmat Site	77	23
Coleman Site	29	71

[a] Frison and Todd 1986.
[b] Frison 1978; Frison and Bradley 1980; Ingbar 1992.
[c] Bradley and Frison 1996; Francis and Larson 1996.
[d] Kunz and Reanier 1995, 1996.
[e] Frison and Stanford 1982.
[f] Frison 1982.

complete/reworked projectile points that littered the surface. Also, as mentioned above, R. Shutler and D. Tuohy, professional archaeologists of the Nevada State Museum, systematically collected from the Coleman site. Surely they would have recognized groundstone and added it to the collection if it was present at Coleman. This apparent lack of groundstone tends to support a MF adaptive strategy.

Fire-cracked rock is harder to recognize; even trained professionals sometimes miss these artifacts in the field. After visiting both sites, however, I recognized no such modified rock. They are absent and probably were not produced by the hunter-gatherers who occupied the two sites. Groundstone and fire-cracked rock are for the most part absent from other Paleoindian sites in the Great Basin (but see Beck and Jones 1997).

Within-site variability of lithic artifacts at both Sadmat and Coleman is relatively high. There are 20+ classes of lithics represented at the sites (including cores, debitage, and tools). Numerous activities appear to have occurred at these places, and based on the similarity of artifact types between the two sites, similar activities were occurring at each. This suggests that these are residential camps of mobile foragers. They are neither residential camps of tethered hunter-gatherers utilizing a logistical land-use pattern, nor are they logistical/special purpose sites of either residentially mobile or residentially stable hunter-gatherers.

Technological Activities and Organization

Important to the reconstruction of technological organization of the hunter-gatherers who inhabited the Sadmat and Coleman sites is the characterization of technological activities represented at both sites. Both Sadmat and Coleman appear to represent locations of lithic raw material extraction and retooling, as well as campsites. Observations leading to this conclusion are discussed in detail below.

Raw Material Selection and Procurement

Both sites, Sadmat and Coleman, are resting on or adjacent to natural locations of high quality lithic raw material. These local raw materials are present in the assemblages in relatively high frequencies, indicating that these local, on-site raw materials were desired and utilized. At Sadmat, the local toolstone is a variety of cryptocrystalline silicates (CCS), and at Coleman it is a fine-grained basalt. Both sites also contain some exotic raw materials coming from as far as 240 km away. These exotic raw materials are obsidians. Obsidians represented in these assemblages range from about 50 km to nearly 240 km from the sites. As shown in Chapter 4 and in Table 6.4, the incidence of local toolstones is high at both sites, while the incidence of exotic toolstones is moderate at Sadmat and relatively low at Coleman.

Interestingly, exotic raw materials at Coleman are mainly flakes, biface thinning flakes, broken stemmed points, and unifaces. The Coleman site is situated adjacent to a high quality basalt flow that contains numerous colluvial cobbles within 500 m of the site. These colluvial slopes contain countless large cobbles with little to no cortex and are ready for working. Minimal effort could be

Table 6.4. Technological Activities and Organization of Lithic Assemblages.

	Sadmat	Coleman
Raw Material Procurement		
Local	high	high
Exotic	moderate	low
Primary Reduction		
Core Reduction	high	moderate
Primary Debitage	low to moderate	low to moderate
Secondary Reduction		
Core Trimming	moderate	moderate
Secondary Debitage	moderate to high	moderate to high
Tool Breakage During Manufacture	moderate	moderate
Resharpening Activities	moderate	moderate
Discard of Exotic Formal Tools	high	moderate to high
Formalization of Tool Kits	high	high
Curation of Tools	high	high

expended in preparing this raw material for tool manufacture, making the Coleman location prime for manufacturing and retooling activities. Based on these data, I suggest that the high incidence of basalt tools (especially unhafted bifaces) and associated debitage, coupled with the incidence of exotic raw material represented in the rest of the tool assemblage, strongly suggests that this site was a retooling station. Because 29% of the discarded stemmed points were manufactured on exotic obsidian, 18% of the discarded unifaces were manufactured on exotic obsidian and CCS, and the majority of unhafted bifaces were manufactured on local basalt, hunter-gatherers repeatedly visited the Coleman site primarily to refurbish their tool kits from the local basalt.

The Sadmat site rests on fossil beach features that contain numerous beach cobbles of CCS, a durable and high quality raw material. Interestingly, the majority of CCS in the assemblage was utilized to manufacture unifacial tools and is evident in the cores and debitage as well. Many bifaces were also constructed of this raw material; however, the majority of hafted and unhafted bifaces were manufactured from exotic obsidian and basalt. These appear to have been discarded at the site and replaced with new bifaces made on local CCS toolstone.

Primary Reduction Activities

The entire trajectory of reduction activities, including both primary and secondary reduction activities, are represented in both the Sadmat and Coleman lithic assemblages (Table 6.4). In terms of primary reduction, both sites contain flake cores; however, the Coleman site contains a much lower percentage of these core types (2% of the entire collection, while flake cores at Sadmat represent 5% of the entire collection). This lower percentage of flake cores could be due to the relatively high proportion of biface production on the site in lieu of flake tool production. The majority of cores at both sites contain more than one platform, little to no cortex, small size values, and many fronts that have been flaked, suggesting that these cores were intensively reduced. This is especially the case at Sadmat.

Core trimming is evidenced in both the Sadmat and Coleman assemblages in that some of the unidirectional flake cores possess small core trimming negative flake scars around their platforms. These scars appear to have been the result of the preparation and rejuvenation of the striking platform for further reduction and the production of tool blanks.

Primary debitage, such as split cobbles, angular shatter, and cortical debitage, is present at both sites, but occurs in relatively low to moderate frequencies. The presence of these debitage pieces suggests that primary reduction activities occurred at both sites. Further, these debitage pieces occur for the most part on basalt and CCS at Coleman and Sadmat, respectively, further suggesting the extraction of local raw materials for the manufacture of tools.

Secondary Reduction Activities

Evidence of secondary reduction activities are present at both sites as well. Secondary reduction debitage is present in these assemblages in moderate to high amounts. These types of debitage include retouch chips, biface thinning flakes, and flakes that fit into the small size value (< 3 cm^2) and possess at least four dorsal scars. Because many of the formal and informal tools were manufactured on local raw materials, secondary reduction activities had to be occurring at both sites. Obsidian debitage related to secondary reduction also occurs, indicating that some tools transported from elsewhere to the site were retouched, refurbished, and in some cases recycled. Also related to the manufacture and resharpening of tools on-site, both assemblages contain artifacts that appear to have been broken during manufacture. Many of the formal tools that are manufactured from the local raw material also show some evidence of being resharpened, further implying secondary reduction at these sites. The presence of both primary and secondary reduction activities suggests that tools were manufactured on-site from local raw materials.

Retooling at Sadmat and Coleman is further supported by the presence of discarded, broken and heavily reworked exotic, formalized tools. These tools, evidently, were being carried to the sites and replaced with locally made tools. The formalization and heavy curation of these tool kits support the notion that the Sadmat and Coleman sites were retooling stations. Also, the tools and debitage left at the sites suggest that not only were people extracting raw materials for tool production, but that they were using these tools there, too. These sites, though occupied for short durations, were probably residences as well. This is evidenced by the host of artifacts that include butchering, hide-working, processing implements, cutting implements, combination tools, as well as weaponry, cores, and debitage. Following Binford's (1978a, 1980) characterization of hunter-gatherer site types, the Sadmat and Coleman sites, represented by their lithic assemblages, best fit the definition of the residential bases of mobile foragers.

Technological Provisioning and Adaptive Strategies

As alluded to earlier in this chapter, technological provisioning strategies are directly tied to how hunter-gatherers make a living. Important to provisioning, of course, is the availability of raw material resources. Locations with abundant local resources are important to any residentially mobile hunter-gatherer's adaptive strategy, and therefore the Sadmat and Coleman sites are near-perfect situations for characterizing provisioning strategies of the hunter-gatherers who utilized these locations. Both sites rest on or near toolstone source locations. Reviewing the lithic technological expectations of the TW and MF adaptive models as presented in Chapters 1 and 5 and Table 6.1, early

Holocene hunter-gatherers utilizing a TW adaptive strategy would show evidence of provisioning a place, while mobile foragers would have provisioned individuals. Table 6.5 shows a summary of the results presented in Chapter 5 of the provisioning strategies represented by the Sadmat and Coleman sites. For all variables used to test these models, results from both sites suggest some degree of mobility. To measure how mobile the early inhabitants of Sadmat and Coleman were, comparisons were made between these sites and other presumed mobile Paleoindian complexes of western North America and Alaska, as well as presumed semi-sedentary late Holocene complexes of the Carson Desert-Stillwater Marsh region of western Nevada and the Long Valley Caldera region of eastern California. These comparisons are made variable-by-variable (as data permit) and are presented below. The Paleoindian sites used in these comparisons include the Blackwater Draw (Clovis) assemblage, Colby (Clovis) assemblage, Hanson (Folsom) assemblage, Mill Iron (Goshen) assemblage, Agate Basin (Folsom, Agate Basin, and Hell Gap) assemblage, Mesa (Alaska) assemblage, four late Holocene Archaic sites from the Carson Sink (26CH1513, 26CH1657, 26CH1661, and 26CH1717), located approximately 60 km east of the Sadmat site, and four late Holocene Archaic sites from the Long Valley Caldera in eastern California.

The Blackwater Draw Clovis site is located in northeastern New Mexico and was excavated by the High Plains Ecology Project, Eastern New Mexico University, and the El Llano Archaeological Society in the early 1960's. The data used here include collections from these three excavations, as presented in Goebel et al. (1991). The Blackwater Draw site is the type site for the Clovis Paleoindian tradition and represents a mammoth kill site and associated campsite (Goebel et al. 1991; Warnica 1966) that appear to be *in situ*, and clearly separated stratigraphically from later cultural complexes (Haynes 1980, 1982). The Colby Clovis site is located along the Bighorn River in central Wyoming and is probably the location of a series of mammoth kills (Frison and Todd 1986). This study includes the lithic artifact collection described by Frison and Todd (1986). At these and other sites, the Clovis tradition dates from about 11,500 B.P. and 11,000 B.P. (Haynes 1980, 1982), and marks the earliest unequivocal evidence of humans in the Americas south of Alaska (Hamilton and Goebel 1999).

The Hanson site is a buried Folsom site located on the Great Plains of north-central Wyoming. This site has been interpreted to represent a quarry/retooling location, campsite, and

Table 6.5. Technological Provisioning and Adaptive Strategies Represented at the Sadmat and Coleman Sites.

	Sadmat		Coleman	
	Tethered Wetland Adaptation	Mobile Forager Adaptation	Tethered Wetland Adaptation	Mobile Forager Adaptation
Raw Material Transport		X		X
Biface to Core Ratio		X		X
Tool Production		X		X
Tool Use-Life Histories		X		X

probably a kill site (Frison 1978; Frison and Bradley 1980; Ingbar 1992). The data used here were taken from Ingbar (1992). The Folsom Paleoindian tradition dates between 11,000 B.P. and 10,000 B.P. (Haynes 1980; Haynes et al. 1992). The Mill Iron site is a Paleoindian site located in southeast Montana. The site mainly contains a cultural component ascribed to the Goshen-Plainview Complex, dating to 11,000 B.P. (Frison 1996). The data used here were taken from Frison (1996). The Agate Basin site is located in east-central Wyoming and possesses Folsom, Agate Basin, and Hell Gap components. Data on these lithic assemblages were taken from Frison and Stanford (1982). Agate Basin and Hell Gap complexes are late Paleoindian complexes that contain stemmed points. These tend to date to the early Holocene, both complexes at roughly 10,000 B.P. (Frison 1978; Frison and Stanford 1982). Paleoindians on the Great Plains are typically thought to have followed a mobile way of life, in search of large, migratory game (Frison 1978) and therefore are suitable for comparisons with the Great Basin sample and the questions posed in this study. The Mesa site is located in the Arctic Foothills of northern Alaska and is technologically similar to the Agate Basin-Hell Gap complexes of the High Plains (Kunz and Reanier 1994, 1995, 1996) and dates to roughly the same time, about 10,000 B.P. (Hamilton and Goebel 1999). It therefore is a logical choice for comparison with the Sadmat and Coleman assemblages.

The late Holocene sites in the Carson Sink reported by Raven (1990) and the sites located in the Long Valley Caldera (Basgall 1989) also provide a means for comparison with Sadmat and Coleman. They represent more sedentary groups with the presence of projectile points diagnostic of the middle (Gatecliff and Elko series) and late (Rosegate and Desert Series) Archaic of the western Great Basin. These databases provide a good control for testing the mobility levels of the Sadmat and Coleman hunter-gatherers because 1) the Carson Sink sites are located in a pluvial lake/marsh setting, and 2) the Long Valley Caldera sites are located in a high valley located near copious amounts of high quality raw material. Most of these sites potentially represent habitation sites (residences) (Basgall 1989; Raven 1990). Comparisons between these sites and Sadmat and Coleman are made below in terms of raw material transport, biface-to-core ratio, and formal versus informal tool use. Other variables that I studied (i.e., biface and uniface reduction indexes), can not be directly compared due to a lack in the other studies of such data needed to reconstruct these variables.

Raw Material Transport

Raw material selection at mobile forager sites should reflect the provisioning of individuals and therefore the choice of both local and exotic raw materials (with a preference for high quality, durable toolstone). Conversely, tethered wetland exploiters should have used mainly local resources reflecting the provisioning of place. If raw materials are relatively scarce in the direct vicinity of the site, then TW hunter-gatherers will have to provision the place by acquiring toolstone on localized, logistical forays. At any rate, local resources will be exploited most frequently and there will be little evidence of long-distance transport.

Both Sadmat and Coleman possess local and exotic raw materials. At both sites the local raw material outnumbers the exotic raw material. This would be the case if mobile foragers were camping at these sites, discarding exhausted tools made on exotic raw materials, retooling with the local, high quality source, and using both local and exotic raw material while camped at these locations. This scenario is exactly what is seen. First, exhausted exotic tools are abandoned. Second, both primary and secondary reduction activities were occurring at the sites, with tools made of the local toolstone being manufactured and tools made of both local and exotic toolstones being secondarily refurbished and/or reshaped.

The actual transport of the exotic raw materials also greatly supports the provisioning of individuals at Sadmat and Coleman, where, the farthest known source from each of the sites is more than 200 km away, almost 240 km for both sites. The sourced obsidians range from 50 km to nearly 240 km and are distributed in a north-to-south-trending pattern, possibly representing a north-to-south range for these mobile foragers (Table 6.6). Without question, these people were moving great distances to acquire their raw materials.

Raw material distances represented at six Paleoindian sites from the Great Plains region and one Paleoindian site from northern Alaska are briefly discussed in order to compare Sadmat and Coleman transport with the transport of presumed residentially mobile Paleoindian sites. The Blackwater Draw site possesses artifacts manufactured from toolstone sourced from 50 km to 150 km from the site (Boldurian and Cotter 1999). The Colby Clovis kill site possesses artifacts manufactured from raw materials sourced at 70 km to 80 km from the site (Frison and Todd 1986). Hanson, a Folsom site, contains mainly local raw materials in comparison to Sadmat and Coleman.

Table 6.6. Raw Material Transport.

	Nearest Known Source	Farthest Known Source
Paleoindian		
Blackwater Draw (Clovis) [g]	50 km	150 km
Colby Site (Clovis) [a]	?	80 km
Hanson Site (Folsom) [b]	within 1 km	40 km
Mill Iron Site (Goshen) [c]	20 km	160-400 km
Agate Basin Site (all) [e]	30 km	500 km
Mesa Site (Alaska) [d]	within 1 km	320 km
Great Basin Stemmed Point Sites		
Sadmat Site	50 km	240 km
Coleman Site	50 km	240 km
Late Holocene Sites (Long Valley Caldera, Eastern California)	10 km	65 km

[a] Frison and Todd 1986.
[b] Frison 1978; Frison and Bradley 1980; Ingbar 1992.
[c] Bradley and Frison 1996; Francis and Larson 1996.
[d] Kunz and Reanier 1995, 1996.
[e] Frison and Stanford 1982.
[g] Boldurian and Cotter 1999.
[h] Basgall 1989.

The nearest source is found adjacent to the site, within one km, while the furthest known source lies approximately 40 km from the site (Ingbar 1992). The closeness of the sources at Hanson is surprising, since Folsom technology on the Great Plains presumably represents extremely mobile foragers. Mill Iron possesses raw materials that are local, 20 km from the site, and very distant, from 160 km to 400 km from the site (Francis and Larson 1996). The Agate Basin site contains raw materials that range from 30 km to as far as 500 km from the site (Frison and Stanford 1982). Unfortunately, it is not entirely clear if all components at Agate Basin possess raw materials from all known sources; however, the range of over 500 km is telling of how far these foragers were traveling. Sadmat and Coleman foragers were not traveling 500 km to one given source; however, their range of travel encompasses nearly 500 km north to south. At the Mesa site in the Arctic Foothills of northern Alaska, the majority of raw materials are local CCS; however, some of the lithic artifacts came from an obsidian source approximately 320 km south of the site (Hamilton and Goebel 1999; Kunz and Reanier 1995), suggesting that these hunter-gatherers were traveling as far as their western North American counterparts. Evidence of Sadmat and Coleman artifact transport seems to fit within the realm of a typical mobile Paleoindian pattern.

At late Holocene sites in the Long Valley Caldera raw material artifact/transport is more localized, fitting more of a logistical pattern of land-use. According to Basgall (1989), these sites provide a good sample for considering raw material procurement activities because raw material is readily available and these sites are not situated within any of the main Sierra exchange routes. Therefore, exchange activities may not have affected raw material transport at these sites (Basgall 1989). Interestingly, 99% of the obsidian debitage sourced from these late Holocene sites came from the Casa Diablo source and 1% came from the Mono Glass Mountain source. Both of these are located within 10 km to 20 km of the sites. Sourced projectile points from these sites are not significantly different; however, some of these artifacts have a farther range, where 91% came from the Casa Diablo, Mono Glass Mountain, and Truman/Queen sources, located within 30 km of the sites, and 9% came from the Fish Springs, Mt. Hicks, and Bodie Hills sources that are located between 60 km and 65 km from the sites (Basgall 1989). The more distant obsidian used to make the latter 9% of the bifaces was probably acquired during logistical forays to the source areas. Clearly, this late Holocene pattern of toolstone procurement is remarkably different from that recognized at Sadmat and Coleman, and suggests that the early occupants of Sadmat and Coleman had a much larger range and were much more mobile than their late Holocene counterparts in the western Great Basin.

Biface-to-Core Ratio

The biface-to-core ratio should be high at mobile forager sites and low at tethered wetland sites. This relationship results because mobile foragers tend to maximize tool blank production per weight of the core used to produce blanks. The ultimate in mobile, light-weight cores is the biface (Kelly 1988a; Kelly and Todd 1988; Parry and Kelly 1987). Additionally, bifaces can be used as tools, thus increasing the flexibility and curatability of the toolkit. Once the knapper becomes familiar with the knappability of a given raw material, a biface will provide tool blanks of a predetermined shape and size, thus after initial trial and error, no added experimentation is required, producing the maximum in preparedness.

At Sadmat and Coleman (as shown in Table 6.7) the biface-to-core ratio is extremely high. For every single flake core, nine bifaces were manufactured. Clearly there was a preference for the manufacture of reliable biface-cores at both sites. These data support a mobile forager adaptation. Also, at Coleman the production of bifaces was the major technological activity transpiring at the site as evidenced by the frequency of biface thinning flakes that were the byproducts of the manufacture and reduction of bifaces. If these hunter-gatherers were not moving on a regular basis, would they have expended such effort in preparing these formalized core-tools? Probably only if toolstone was scarce and had to be conserved, which was not the case at either Sadmat or Coleman. Further support that bifaces were being used as cores is the incidence of biface thinning flakes used as tool blanks, especially for the production of expedient unifacial tools. At Sadmat and Coleman, 47% and 23% of the informal tools were made on bifacial thinning flakes, respectively. The low frequency of biface thinning flakes used as tool blanks at Coleman is probably related to the colluvial situation of the local basalt found directly adjacent to the site. Perhaps it was more efficient in this setting to produce expedient tools from simply prepared flake cores instead of from bifaces.

In comparison, the Blackwater Draw site has an 8:1 biface-to-core ratio (Goebel 1990; Goebel et al. 1991). The Folsom component of the Agate Basin site has a biface-to-core ratio of 6:1 (Frison 1982). The Mill Iron site has only bifaces and no flake cores. When examining the debitage assemblage from this Paleoindian site, it appears that debitage related to primary reduction activities only makes up 8% of the total, while the debitage related to secondary reduction activities makes up nearly 92% of the total, and the biface production-related debitage accounts for nearly 72% of the secondary reduction debitage (Francis and Larson 1996). Thus, the absence of expedient cores here is not a sampling error. Obviously, the lack of flake cores, overwhelming presence of biface debitage, and presence of only biface-cores suggests that this Goshen complex site represents a hyper-biface-to-core situation. At the Mesa site in Alaska, it appears that the biface-to-core ratio is 35:1, in which bifaces number over 70, while flake cores number only two (Kunz and Reanier 1995, 1996). Both Sadmat and Coleman biface-to-core ratios fall within the range of these measurements for mobile Paleoindian sites in North America.

Table 6.7. Biface-to-Core Ratio.

	Bifaces	Cores
Paleoindian		
Blackwater Draw (Clovis) [g]	8	1
Agate Basin Site (Folsom Component) [e]	6	1
Mill Iron Site (Goshen) [c]	9	0
Mesa Site (Alaska) [d]	35	1
Great Basin Stemmed Point Sites		
Sadmat Site	9	1
Coleman Site	9	1
Late Holocene Sites in Carson Desert [h]		
26CH1513	1	1
26CH1657	1	4
26CH1661	1	3
26CH1717	1	2

[c] Bradley and Frison 1996; Francis and Larson 1996.
[d] Kunz and Reanier 1995, 1996.
[e] Frison and Stanford 1982.
[g] Goebel et al. 1991.
[h] Raven 1990.

Comparisons can be made between Sadmat and Coleman and the late Holocene Carson Desert sites that have been interpreted by others as representing semi-sedentary groups whose land-use patterns were probably more logistically organized. Site 26CH1661 has a 1:3 biface-to-core ratio, and site 26CH1513 has a 1:1 biface-to-core ratio. Site 26CH1657 has a biface-to-core ratio of 1:4, and site 26CH1717 has a 1:2 biface-to-core ratio (Raven 1990). All four sites have biface-to-core ratios that are extremely low compared with Sadmat, Coleman, and the other Paleoindian site assemblages described in this discussion. Clearly, when compared to these sites, the Sadmat and Coleman assemblages have very high biface-to-core ratios and are therefore determined to represent a mobile forager adaptation.

Formal Versus Informal Tool Use

Tool production at mobile forager sites should be principally formal. Formal tools include all tools that were made in anticipation of use and curated, and therefore in this study include bifaces, scrapers, multiple spurred gravers, and combination tools. These tools are easily reworked and maintainable. TW sites should have high frequencies of informal tools because these types of tools are expediently produced in response to, not in anticipation of, some need. These include retouched flakes, notches, denticulates, single spurred gravers, and burins. Mobile foragers need to formalize their tool kits as much as possible, making tools that are designed for reliability, maintainability, versatility, flexibility, and transportability.

Both Sadmat and Coleman are characterized by formalized tool kits designed for these situations. The Sadmat toolkit is 76% formal and 24% informal, while the Coleman tool kit is 73% formal and 27% informal (Table 6.8). At both sites, the formal tools are dominated by bifaces. Interestingly, though, the Sadmat formal uniface assemblage consists of 142 combination tools. These are an important part of any mobile toolkit, a "Leatherman" of sorts for early Holocene foragers in the Great Basin. These tools are dependable in that they serve various uses and provide the flexibility needed in a highly mobile situation. The expressed use of formal, multipurpose, and potentially curatable tools suggests that these people were very mobile.

In comparison, the Blackwater Draw tool kit, at first glance, is not as formalized as either Sadmat or Coleman, with 46% of the tool assemblage consisting of formal tools and 54% informal tools (Goebel 1990; Goebel et al. 1991); however, this and many other Clovis assemblages are very formalized in that they contain many informal retouched blades that were part of a formalized prismatic blade technology (Collins 1999; Goebel et al. 1991; Haynes 1980, 1982), as well as informal retouched flakes that were produced on biface thinning flakes. Likewise, 49% of the Hanson tool kit is formal, while 51% is informal (Ingbar 1992). The Folsom component at the Agate Basin site possesses a more formalized tool kit with 72% of the assemblage consisting of formal tools and 28% of the assemblage consisting of informal tools (Frison 1982). The Mill Iron site is similar to Blackwater Draw and Hanson, in that 45% of the assemblage consists of formal tools and 55% is informal (Francis and Larson 1996), while the Mesa site tool kit is similar to the Sadmat, Coleman,

Table 6.8. Formal Versus Informal Tool Production.

	Formal Tool Percentage	Informal Tool Percentage
Paleoindian		
Blackwater Draw (Clovis) [g]	46	54
Hanson Site (Folsom) [b]	49	51
Agate Basin Site (Folsom Component) [e]	72	28
Mill Iron Site (Goshen) [c]	45	55
Mesa Site (Alaska) [d]	78	22
Great Basin Stemmed Point Sites		
Sadmat Site	76	24
Coleman Site	73	27
Late Holocene Sites in Carson Desert [h]		
26CH1661	37	63

[b] Frison 1978; Frison and Bradley 1980; Ingbar 1992.
[c] Bradley and Frison 1996; Francis and Larson 1996.
[d] Kunz and Reanier 1995, 1996.
[e] Frison and Stanford 1982.
[g] Goebel et al. 1991.
[h] Raven 1990.

and Folsom assemblage at Agate Basin, with 78% of the tool assemblage being formal and 22% informal (Kunz and Reanier 1995, 1996).

Site 26CH1661, one of the Carson Desert sites, is a habitation site and therefore is a good comparison to use for formal to informal tool percentage relationships. The reason for this is habitation sites of semi-sedentary hunter-gatherers should possess a low percentage of formal tools relative to informal tools because formal tools used within a logistical land-use pattern will tend to show up in special-task sites, not habitation sites (Binford 1980). Significantly, 26CH1661 contains more informal tools than formal tools, with 63% of the tool assemblage being informal and 37% formal (Raven 1990).

The high proportions of formal tools in both the Sadmat and Coleman assemblages indicate that many versatile, reliable, and transportable tools were made in advance of use. Both assemblages are dominated by a biface technology, one of the most formalized of prehistoric lithic technologies (Andrefsky 1998; Kelly 1988a; Kuhn 1995; Parry and Kelly 1987). If mobile groups were reliant on maintainable, reliable, and especially transportable tools, there is no better type of technology to use than a bifacial one.

Tool Use-Life Histories

The use lives for formal tools employed by mobile foragers should be long, while just the opposite is true for tethered wetland exploiters provisioning a place. The latter hunter-gatherers should possess unifacial and bifacial tools with short use-life histories, because these tools were typically expediently used. Residential sites of mobile foragers should have bifaces and unifaces that were reworked and many that have been discarded, especially those that were manufactured on more exotic raw materials. These should have been replaced by locally produced tools.

As mentioned above, Sadmat and Coleman both possess impressive biface industries. At both sites, many bifaces appear to be heavily curated and were discarded near the ends of their use lives, especially those manufactured on exotic raw materials. Likewise, the unifacial tool assemblages are dominated by formal production with many of these tools being intensively reduced and discarded. Like with the bifaces, there seems to be a similar pattern of discard of exhausted exotically produced unifaces, particularly at Sadmat.

Detailed comparisons of tool use life histories cannot be made with other sites, simply because little comparative data are available in the literature. Most of the Paleoindian assemblages reviewed here, however, do have tools that have been extensively recycled and reused. Agate Basin, Blackwater Draw, and Mesa have been reported to possess "reworked" bifaces and other tools (Frison and Stanford 1982; Ingbar 1992; Haynes 1980; Kunz and Reanier 1995, 1996). Further, at the later Holocene sites of the Carson Desert reworked bifaces are rare (Raven 1990), and those that are reworked may have been scavenged from earlier occupations (Kelly 2001).

Thus, as expected according to these variables, the Paleoindian assemblages reflect relatively high degrees of mobility, while the late Holocene Great Basin assemblages reflect low degrees of mobility. In every case, the Sadmat and Coleman assemblages align with the Paleoindian assemblages, further supporting the argument that these sites represent highly mobile foragers, not semi-sedentary, logistically mobile hunter-gatherers tethered to wetland patches. Thus, Sadmat and Coleman sites are excellent site assemblages for testing models related to technological provisioning. This is true because they both rest on or very near locations of high-quality raw materials, and, therefore, scarcity has not played a role in confusing economizing behaviors related to raw material availability with the potential land-use strategies of these people.

Conclusions

Great Basin archaeological research often centers on evaluating prehistoric cultural remains and how they relate to the natural environment around them, especially to water and food resources. No doubt, water and wetland resource patches would have had a huge impact on the decisions hunter-gatherers made relating to the overall strategies used to acquire needed resources. These decisions, however, were surely impacted by other factors, including established land-use patterns and the availability of raw materials for use in tool production.

This study has considered the lithic assemblages of two western Great Basin Paleoindian sites, Sadmat and Coleman, exploring the technological activities and provisioning strategies employed by the hunter-gatherers to produce these archaeological residues. Results suggest that these hunter-gatherers used formalized, transportable Paleoindian tool kits. They used the sites as raw material extraction and retooling localities. They discarded exhausted tools made of exotic toolstone and replenished them with fresh tools and mobile cores manufactured from the local raw material present at these sites. In addition they used the Sadmat and Coleman sites as temporary residences, as well as places where they performed a series of tasks related to food procurement and preparation. The sites, however, were not long-term residences of semi-sedentary, logistically organized hunter-gatherers. Instead, they were repeatedly occupied, short-term residences of mobile foragers. These people provisioned individuals with tool kits that were formalized, curatable, and transportable, as evidenced in the transport of raw materials from far distances, the extremely high biface-to-core ratios, the high formal to informal tool ratios, and long tool use-life histories. Thus, the Sadmat and Coleman lithic assemblages suggest that early Holocene hunter-gatherers in the western Great Basin were highly mobile foragers who do not appear to have been tethered to any one resource patch, even wetlands.

Perhaps, based on the data presented in this study, we need to rethink the idea that early Holocene hunter-gatherers in the Great Basin focused primarily on wetland patches. Other researchers have suggested that resource procurement was not necessarily focused on wetlands. First, sites in the Dietz Basin have long been thought to have represented a lake-side, lacustral adaptation by late Pleistocene/early Holocene humans (Willig 1988, 1989); however, Nials (n.d.) has presented a preliminary geomorphological investigation and has suggested that none of the cultural remains in this basin are associated with lacustral or littoral deposits and landforms. These interpretations are based on recent preliminary geomorphic research (Nials n.d.), and these conclusions may be unsubstantiated upon further research. Pinson (1999) has characterized the basin as dry after about 9,500 B.P. and a portion of the basin could have supported a meadow-like environment between 10,900 to 9,600 B.P.; however, the radiocarbon dates presented, 9,580 B.P. to 9,350 B.P., suggest that humans occupied the Tucker site in the Dietz Basin after 9,600 B.P., during the time when the basin was dry (Pinson 1999). These data, therefore, support Nials' (n.d.) preliminary assessment. Basgall (1988) has reported that the early Holocene site, Komodo, located in the Long Valley Caldera in east-central California, can not be associated with a lake since this valley has not contained a lake for the past 20,000 years.

Some stemmed point occupations have been discovered in areas other than around pluvial lake margins. These include Smith Creek Cave, located in a rocky canyon environment (Bryan 1979, 1988), Last Supper Cave, located in high desert country over 30 km from the nearest valley bottom (Layton 1970), and the Five Points Site, located in central Nevada at an elevation of 2,515 m (Price and Johnston 1988). Two other sites, located on the Nevada Test Site, the Alice Hill site and 26NY7920, are situated in wide canyons adjacent to dry washes that have seen little environmental change since the late Pleistocene (Buck et al. 1998; Haynes 1996). Obviously, based on these observations, the entire adaptive strategy of Paleoindians in the Great Basin did not focus on wetland resources. Geomorphic evidence from both Sadmat and Coleman does not clearly support lake or marsh-side occupation. As well, much of the evidence from sites bearing faunal remains suggests that the majority of subsistence activities at sites with stemmed point occupations centered on the exploitation of terrestrial game (Bryan 1979; Connolly and Jenkins 1999; Dansie 1987; Davis 1970; Douglas et al. 1988; Hanes 1988; Pinson 1999). Additional sites with intact faunal remains and paleoecological data would help us better characterize early Holocene sites; however, in order to address adaptive strategies used by these humans, we need to adopt more behavioral approaches looking at the technological strategies as well as subsistence behavior to come to understand the adaptations of Paleoindians in the Great Basin.

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