NATIVE AMERICAN USE OF NON-QUARRY OBSIDIAN IN NORTHERN SONOMA COUNTY: A PRELIMINARY ASSESSMENT

SUNSHINE PSOTA

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Native American Use of Non-Quarry Obsidian in Northern Sonoma County: A Preliminary Assessment

by

Sunshine Psota

A thesis submitted to

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for the degree of

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in

Cultural Resources Management

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ABSTRACT

Purpose of Study:

During a recent archaeological investigation in Alexander Valley, results from obsidian sourcing and flaked stone analyses suggested a greater use of culturally modified non-quarry obsidian than previously identified in Sonoma County. Spurred by these conclusions, this project focuses on identifying the geographic and cultural distribution of obsidian obtained from non-quarry areas. Research is complicated by the lack of geochemically distinct obsidian from these collecting areas, which geochemically sources to Napa Valley and Franz Valley. With the use of social distance and technological organization models, this study proposes to determine the effects that the cultural use of non-quarry obsidian had on the distribution and use of the major regional sources of Napa Valley, Annadel, Mt. Konocti, and Borax Lake.

Procedure:

Of the 142 Native American archaeological sites in the research area, collections from 25 sites were classified and analyzed. Based on obsidian hydration values, arbitrary analytical periods were established and temporally diagnostic projectile points described. Two contemporaneous sites, CA-SON-1810 and -1811, were chosen for a more detailed flaked stone analysis. This analysis was designed to generate data applicable for interpretations of various behavioral strategies.

Findings:

The combination of social distance and technological organization models provide a greater understanding of the various levels of behaviors by peoples in the research area. These models applied to flaked stone data from CA-SON-1810 and -1811 suggest two contemporaneous populations: at CA-SON-1811 there was a more sedentary group with a flaked stone toolkit of predominately locally obtained obsidian; and at CA-SON-1810 there was a more mobile group with a flexible flaked stone toolkit containing a variety of local and exotic obsidian and chert. Non-quarry obsidian was extensively used by Native Americans during all temporal periods in the Central and

South Regions and at selected site in the North Region. It is proposed that in the research area the use of obsidian from non-quarry areas restricted the utilization of obsidian from the major regional sources.

Chair: David A. Fredrickson

Date: 4-18-94

M.A. Program: Cultural Resource Management
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Sunshine Psota
4 May 1994

"Science, in the very act of solving problems, creates more of them."
Abraham Flexner 1930

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-CHAPTER ONE-

INTRODUCTION

Many archaeological investigations in the southern North Coast Ranges have focused on culturally modified obsidian presumably obtained from the four major obsidian flows of Annadel, Napa Valley, Borax Lake, and Mt. Konocti. Based on hydration information from these geochemically distinct glasses, regional syntheses have centered on refining temporal periods and temporally diagnostic artifacts (Wickstrom 1986; Origer 1987), establishing comparison rates (Tremaine 1989), and inferring social distance from exchange patterns (Jackson 1986; Fredrickson 1989). Visual sourcing using obsidian's macroscopic characteristics has concentrated on these major sources; often yielding a greater than 90% success rate for experienced researchers (Wickstrom and Fredrickson 1982).

Within this volcanic region, some obsidian geochemically sourced to these major flows may be obtained from both quarrying areas and non-quarrying areas (Jackson 1986). To differentiate these areas, the following definitions are provided. A quarrying area refers to a discrete deposit of obsidian that can be excavated, and in geological terminology, an obsidian quarry is a primary deposit (Bates & Jackson 1984:414; McKechnie 1983:1475. Recent research has determined that obsidian is not limited to discrete sites or quarries (Jackson 1986). For instance, with "Napa" obsidian, a generalized attribution of "Napa Valley" is considered more appropriate (Jackson 1986), since this obsidian can be obtained at both a quarry in northern Napa County and at a number of non-quarry locations in both Napa and Sonoma counties (Jackson 1978, 1986).

In addition to these major sources, other minor regional obsidian sources, such as Franz Valley and Trinity, have recently been identified (Jackson 1974, 1986). Prior to their distinct geochemical characterization, these minor sources, also known as "float," may have been assigned to a major source based on macroscopic characteristics. Float is a "general term for isolated, displaced fragments of rock" (Bates and Jackson 1984:187); in the study area, these naturally occurring, unmodified obsidian cobbles are usually found near creeks or eroding from hillsides (Fox et al. 1985). (Using the Wentworth [1922:377] scale, pebbles were defined as ranging from 0.2 to 6.4 centimeters and rocks varying from 6.4 to 25.6 centimeters were considered cobbles.) This material is geologically classified as a secondary deposit (Fox 1983). In northern Sonoma County, obsidian float cannot be attributed to one particular geochemical obsidian source (Jackson 1986). Geochemical and macroscopic attributes of float sources, including culturally modified specimens found in archaeological deposits, allow Franz Valley glass, for example, to be distinguished from Napa Valley and Annadel glasses (geochemically: Jackson 1986; Jackson and Davis 1993a, 1993b; Hughes 1991; macroscopically: Psota n.d., cited by Gmoser 1992). When the cultural use of secondary obsidian deposits was identified in archaeological sites, previous researchers (e.g., Greenway 1986; Jackson 1978) have considered it an insignificant portion of the recovered archaeological sample and not associated with formal tools.

When preliminary results from investigations at CA-SON-1810 and -1811 suggested that locally occurring obsidian from non-quarry areas was used at a much higher rate than previously suspected for this area, the extent of its use needed to be determined (Psota n.d., cited by Gmoser 1992). The present research has two main objectives: to evaluate and characterize the extent of non-quarry obsidian use in the northern portion of Sonoma County; and to examine the implications that use of this obsidian had on the distribution and utilization of the four major obsidian sources of Napa Valley, Annadel, Mt. Konocti, and Borax Lake. Social distance and technological organization are two related models that are used to elucidate the utilization and cultural distribution of obsidian within and surrounding the research area.

Social Distance

Social distance is a model frequently used in sociology, animal behavior studies and geography's central place theory. Archaeologists in the United States have been inspired from such works as Kummer's (1969) observations that the more spatially close two animals live, the more they must adapt to the context and meaning of the other animal. When exchange is added to this biological model, the degree of social distance between groups of people can be discerned by shared similarities in their material culture. Adapted to archaeology by Wilmsen (1973) and utilized by Kay (1975), this model was created for regional studies of contemporaneous band organized societies.

> As interactions take place between bands and as obligations, vows, spouses, and objects flow across boundaries, information about environmental conditions, group identification, current deployment of individuals (e.g., hunters, mates, curers) goes with them. Implicit in the model is the notion that the structure of the flow is discernible in the distribution of the items passed between groups. Most important for archaeology, however, is the fact that spatial organizations, and their correlative social organizations, may be deduced from formally constructed models when only visible parts of their systems are known (Wilmsen 1973:27).

Exchange can be ad hoc, referring to an occasional or casual trade system, or regularized, referring to a frequent and more formalized trade system. While often the type of trade system can be inferred from archaeological materials, some researchers believed that the information exchanged and not the material cultural was the most valuable part of interactions for both groups (Moore 1981; Root 1983). Information exchange can not be interpreted from archaeological data.

Ericson (1984:6) proposed that the degree of social distance can be inferred from the type of item traded. Direct contact between trade partners allowed the supplier to produce an item that could be immediately used. Whereas, items traded over great distances or between multiple groups were intentionally kept simpler, e.g., biface blanks and preforms, so that consumers would have had more stylistic options.

More locally in the Geysers region, Fredrickson (1989) used this model to distinguish different groups and their degree of interaction based on obsidian sourcing and hydration values. While all four groups were located approximately equal distance from the Napa Valley and Annadel quarries, generally light use of Napa Valley glass occurred in the southern localities, and only rare use of Annadel glass was identified. He concluded that some groups had a high degree of interaction (Kelsey and Squaw localities, and Big Sulphur and Putah localities), while others had little interaction (Big Sulphur and Squaw localities) (Fredrickson 1989).

On a larger scale, Jackson (1986) created a social distance model to ascertain village and regional interaction during the Upper Emergent Period in Central California. This model was developed using the direct historical approach. Social boundaries were defined by the frequencies and types of obsidian used to produce corner-notched projectile points. From sites within the Warm Springs area, the Makahmo Pomo and the Dry Creek (or Amalako) Pomo used different obsidian sources for these points. Jackson proposed that some ethnographic boundaries were fluid and others rigid as illustrated by his interpretation that the northern and western distribution of Annadel glass was impeded by various Pomo groups, that the Makahmo Pomo interacted more with the Native Americans near Mt. Konocti, and that the Amalako Pomo were somehow linked to the controllers or traders of Napa Valley glass. He concluded that for Central California groups "the 'socially relevant source' of obsidian was the tribelet center of the primary group, not the quarry" during the Late Period (Jackson 1986:114).

Technological Organization

For the present study, additional interpretations of flaked stone items include technological organization models. Designed for hunter-gatherer groups, technological organization includes the "strategies for making, using, transporting, and discarding tools and the materials needed for their manufacture and maintenance," using economic and social variables (Nelson 1991:57). The combination of these two concepts allows for a broader interpretation of the types of social distances between regional groups and their use of non-quarry obsidian. Archaeological interpretations of forager and collector societies have rarely appreciated the wide range of mobile and sedentary strategies illustrated by some research in ethnoarchaeology, such as the Basarwa (Kent 1992), and in archaeology (Chatters 1987; Nelson 1990). To acknowledge the range of possibilities, terms such as "more mobile" or "more sedentary" are used to describe the Native American peoples who lived in the research area. These different strategies can be reflected in the flaked stone debris left by these peoples (Binford 1973, 1978, 1979, 1982; Shott 1986; Parry and Kelly 1987).

Although an area may include an array of natural resources, it is the social, economic, and technological strategies of peoples that determine what, how, and to what extent natural resources are used. Models of technological organization include interrelated variables ranging from raw material availability (Bamforth 1986; Kelly 1988; Andrefsky 1994) to social aggregation requirements (Jochim 1976). These technological factors can reflect the degree of human mobility and provide a framework to interpret regional and temporal changes in economic systems (Nelson 1990:150). To understand sites within a regional context, analysis of the area's artifact assemblages is used to contribute information concerning both mobile and sedentary peoples.

Since tools were manufactured, used, and transported from location to location, the type and amount of tools discarded at a location can help archaeologists understand how, where, and when a group of people interacted with their neighbors, as opposed to interpreting site function (Binford 1979a; White 1984; Nelson 1991; Bieling 1992). These general behavioral inferences are possible because few locations included all of the different activities that people accomplished in their lifetime. Generally, flaked stone materials were transported from quarries and non-quarry areas to other locations in various forms. These forms may have been further modified as some of these items were used or transported to other locations. Some specimens may have been transported to a number of locations, possibly the results of years of use.

Different kinds of tools were subject to different curation practices, with curation referring "to the practice of maximizing the utility of tools by carrying them between successive settlements" (Shott 1989:24). The extent to which Native Americans curated materials is assumed to depend on the abundance or scarcity of available resources, as well as the time and effort invested in their production, with formal tools presumably requiring a greater time investment than informal tools (Ericson 1984; Bamforth 1986; Andrefsky 1994). Flaked stone tools that could be recycled or resharpened, are presumed to have had longer use lives and were more likely to have been curated than tools such as edge modified flakes (EMFs), which are presumably associated with a specific, short term activity. EMFs were probably discarded after an activity was completed or the tool broke, while points and bifaces were probably curated after each use, or maintained, or recycled (Murray 1980; Kelly 1988; Barton 1990). This is further complicated by Kelly's (1988) suggestion that personal preference may have biased tool curation, a factor that could account for ambiguities in the archaeological record. Additionally, kinds of social interaction and seasonality could affect access to flaked stone material, which in turn would influence curation practices (Kelly 1983; Bieling 1992). The combination of curated and expedient tools in an assemblage reflects not two opposite poles, but the consequences of complex organizational strategies chosen by a group (Nelson 1991).

For example, Parry and Kelly (1987:288) believed there was a direct correlation throughout North America between an increase in sedentism and the use of amorphous cores. They suggested that there was a shift away from the ubiquitous bifaces characterizing the mobile populations of the Archaic Period to unmodified expedient flaked tools produced from amorphous cores in residential settings. For more mobile groups, Parry and Kelly (1987) proposed that investment of time and energy in personal formal tool production allowed for continued reuse of an item (e.g., biface and core), easy tool maintenance, and transportation to areas to meet anticipated and opportunistic needs. In contrast, in more sedentary groups, unmodified and minimally modified flaked stone materials were stored at residences and used to produce flakes for a variety of expedient and anticipated uses. In this context, Parry and Kelly (1987) contended these flakes were used once and then discarded.

While planning for and acquiring anticipated resources can generate curated and expedient tools, similar tools may be the results of opportunistic behavior (Nelson 1991). When unscheduled resources were encountered, groups needed the appropriate tools to obtain and possibly to transport, store, and use these resources. Groups could not take advantage of this situation without appropriate toolkits. The latter would have contained the tools or materials to produce a tool to process or to hunt the unplanned resource. These toolkits can be characterized by certain design elements: flexible, referring to the potential that an object has to be changed into other forms (e.g., Parry and Kelly 1987; Kelly 1988); versatile, reflecting the multi-purpose objects (Bleed 1986); and portable, referring to how transportable an object or toolkit is (Nelson 1990). For instance, some stages in biface reduction may be the results of use from flexibly designed toolkits as opposed to sequences designed exclusively for projectile point manufacture (Callahan 1979).

Generally, more mobile people required a portable toolkit that was flexible and versatile to allow for both planned and opportunistic behavior (Binford 1978;

Goodyear 1979; Bleed 1986; Parry and Kelley 1987). This strategy may have resulted in more extensive tool maintenance and recycling, various degrees of biface staging, shaped standardized cores, and curated tools from a variety of tool stone materials. Frequent camping, often at approximately the same locations as previous years, tended to yield sparse cultural deposits (Binford 1982). In contrast, toolkits of more residential people have less emphasis on flexible design. Unmodified and minimally modified items from selected local tool stone materials were probably stored in residential areas for expedient special task use (Murray 1980). Depending on the availability of tool stone materials, curation and tool staging could have been less important (Andrefsky 1994). Many of these curated tools could have been produced from more exotic tool stone materials that were traded into the area. Long-term annual use of one or two residential areas contributed to a greater accumulation of cultural items discarded at a single location, resulting in dense discrete deposits (Binford 1982).

The types and condition of flaked stone can aid in interpreting general behavior that occurred at a site, especially if the site had more than one use (Binford 1979a, 1982; Nelson 1991; Bieling 1992). Attributes used for this tool and debitage analysis were chosen for their value in arriving at such inferences. These attributes included obsidian source assignments and hydration readings, which provide data needed not only to determine relative ages of cultural deposits, but also to infer social distance by using relative frequencies of different sources per period. Typically, at most sites, formal tools were produced from a greater variety of stone types than informal tools and debitage (Binford 1973, 1978). Size, percentage of cortex, dorsal surface complexity, and width-thickness (W:T) ratios provide details for determining tool subcategories, possible use lives, and curation. Resharpening and edge preparation of bifacial tools, which can decrease the tools' W:T ratio, and alter the shape of margins from excurvate to incurvate, are examples of attributes used to identify maintenance and reworking of tools.

It is assumed that formal tools were discarded not only when broken, but also when worn items could be easily replaced or could no longer be effectively repaired. By identifying the type of tool fracture, specific kinds of activities can be inferred. For instance, medial biface fragments with two bending breaks and other fragments with multiple fractures, such as bending breaks, lateral sectioning, or facial channeling, suggest impact fractures derived from use as projectiles, implying hunting behavior. Non-projectile point, biface fragments with single bending breaks can be attributed to manufacturing and maintenance discards while thinning, shaping, or resharpening a tool (Bieling 1992). Proportions of proximal to distal projectile point ends can be used to imply behavior carried out at find locations, e.g., behaviors that imply a hunting area, characterized by more distal ends, contrasted with a base camp or residential area, characterized by more proximal ends (Binford 1977, 1979b; White 1984; Flenniken 1991).

Since most debitage was not curated, the types and quantities of debitage may contain information not extractable from formal tools (Binford 1978, 1979; Shott 1989). The presence of flakes and shatter with cortex covering one entire surface indicates that primary reduction was occurring at a site, whereas the presence of very small interior flakes indicates tool finishing or maintenance. A range in the size, materials, and shapes of flakes suggests a variety of reduction, manufacturing, and maintenance activities occurred at a location. It is the combination of these sets of flake attributes that allow for interpretation of on-site activities (Jackson et al. 1983; Scott 1991; Nelson 1991; Bieling 1992).

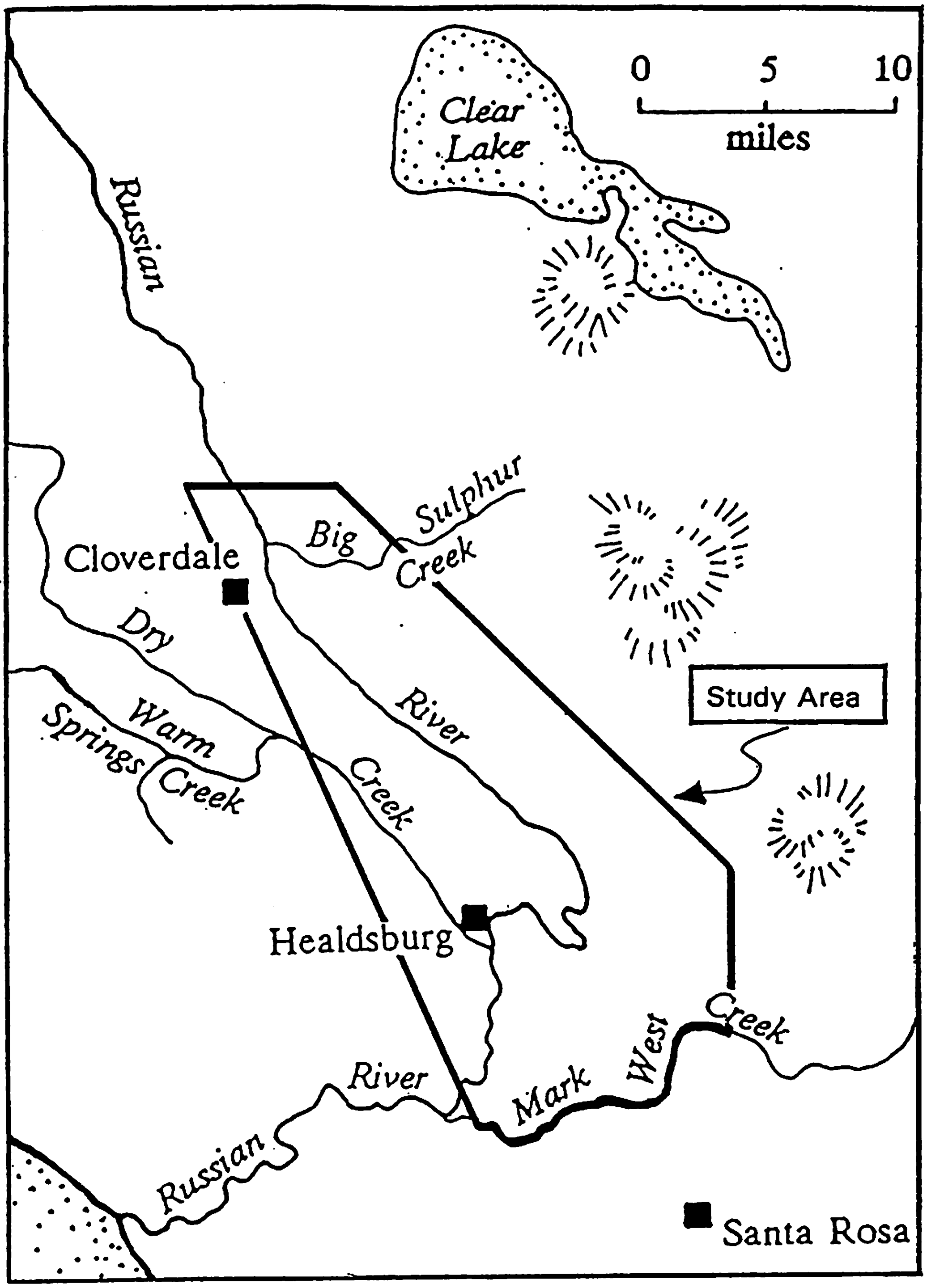
Related Obsidian Studies

Few archaeological investigations have focused on the cultural use of non-quarry obsidian: Timber Butte and Owyhee obsidians in Idaho (Sappington 1984); Red Hill obsidian in New Mexico (Sappington and Cameron 1981); and Anahim obsidian in British Columbia (Apland 1979; Nelson et.al., 1975). The presence of primary and secondary decortication flakes and geochemical results from sites near collecting areas aided in documenting the geochemically distinct non-quarry obsidian used. The lack of culturally modified items at these obsidian areas was interpreted as a deliberate procurement strategy as opposed to non-use of these sources (Sappington 1984:25). Apland (1979:34-35) suggested that the residual cortex on unworked pebbles and flaked pieces may have made the materials easier to transport. This also may indicate that the quality of the obsidian pieces from this area was relatively homogenous, thereby reducing the need to test the quality of the material obtained.

Recent studies have focused on the distribution of geochemically distinct obsidian sources (Hughes and Bettinger 1984; Van de Hoek 1990), and the geographic distribution and cultural boundaries of many geochemically distinct obsidian sources across a large area per temporal period (Findlow and Bolognese 1984; Jackson 1986; Hughes 1986; Fredrickson 1989). At cultural boundaries, obsidian source variability was frequently greater within a region, than between regions, suggesting the use of more than one exchange system (Findlow and Bolognese 1984). In these studies, source fall-off rates were determined to be a product of social boundaries and geographical features.

Research

The present research will review obsidian materials from archaeological sites in and adjacent to a non-quarry obsidian area in northern Sonoma County to interpret general site activities and to address the use of obsidian at these sites (Map 1). This research focuses on the effect that the use of non-quarry obsidian had on the exchange networks of quarried obsidian sources. By identifying temporal and group boundary uses, and if possible the geographic extent of a non-quarry obsidian area, unexpected fall-off rates for the major obsidians within this region may be explained. If distance-decay models of exchange were consistent geographically for each major obsidian source, then use of Annadel glass would have been dominant in the research area because Annadel is the nearest major obsidian deposit. Also, there would have been generally light use of Napa Valley glass that decreased westward, and relatively light use of Mt. Konocti glass in the northern portion of the research area as Annadel glass decreased. The more formal the tool form, the higher the likelihood it was manufactured from more exotic obsidians, whereas, debitage and expediently-used tools, some with cortex remaining, would reflect how local material was used at a site. This study differs from previous research because two geochemically distinct obsidians, Napa Valley and Franz Valley, have been identified in the non-quarry area, and the cobbles of Napa Valley obsidian obtained from a non-quarry area are not geochemically different from obsidian obtained at the Napa Valley quarry. By using technological organization models to understand the extent of non-quarry obsidian use, a better understanding of the social distance between groups within and adjacent to the research area can be provided.



Map 1. Study Area.

Thesis Organization

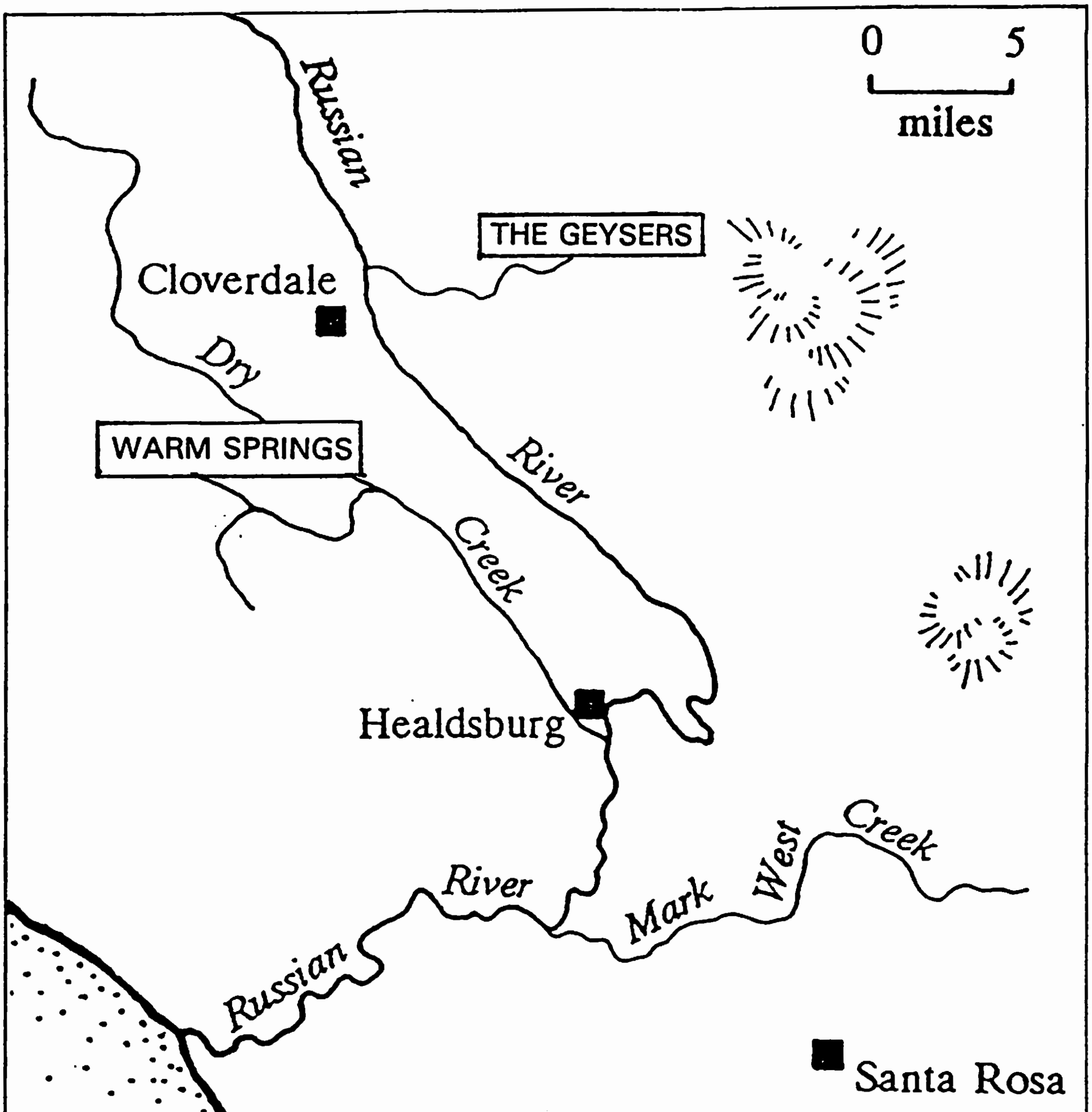
This first chapter explains the research objectives and the theoretical models used to interpret flaked stone materials. Chapter two focuses on previous archaeological research within and adjacent to the study area, describes area chronologies, provides interpretations of boundaries and multiple used areas, and discusses the local ethnography. Chapter three discusses the methods used by previous researchers and the reliability of these methods, and the methods and terminology used for this study. The fourth chapter describes the study area, and details use of flaked stone materials from Native American archaeological sites. Chapter five describes the types of flaked stone residues at two of the sites in the study area, CA-SON-1810 and -1811. The sixth chapter summarizes the research presented, interprets flaked stone use throughout the research area and more specifically from CA-SON-1810 and -1811, and discusses the effects that use of non-quarry obsidian had on the exchange systems involving the four major quarry obsidian sources in this area.

-CHAPTER TWO-

AREA RESEARCH AND CHRONOLOGY

This chapter discusses the previous relevant archaeological and ethnographic research conducted within and adjacent to the study area. Prior to the 1970s little archaeological work had been conducted in the interior of Sonoma County and so Native American use of this area was minimally understood by archaeologists (Stewart 1982). When investigations increased in the North Coast Ranges, some researchers realized that the Central California taxonomic system had significant limitations when applied to this area. In answer to this problem, Fredrickson (1973) built upon this system revising its structure so that the terminology was similar to Willey and Phillips (1958); he used temporally diagnostic artifacts from the southern North Coast Ranges to illustrate his ideas. Although the archaeological sites discussed by Fredrickson are situated outside this study area, his framework has become the foundation for culture chronology in the North Coast Ranges. This chronology and its more recent modifications are discussed below.

In the southern North Coast Ranges, most archaeological investigations over the past thirty years have been conducted in compliance with state and federal legislation. Except for the large, federally-funded Warm Springs Dam/Lake Sonoma Project and California Department of Transportation Projects, most of the archaeological investigations were generated by the California Environmental Quality Act. This has produced a large arbitrary sample of surveyed lands and archaeological sites in a variety of environmental settings. Analysis from the application of obsidian hydration and sourcing data has allowed research to include



Map 2. Areas Surrounding the Research Area.

a variety of site types within the region's chronology, thereby enabling interpretation to encompass a wider perspective of Native American lifeways. Current regional research focuses on refining chronology within different localities (Wickstrom 1986; Origer 1987; Jones and Hayes 1989; Basgall and Bouey 1991; Stewart 1993).

Unlike the surrounding areas, the present study area is a minimally studied section of northern Sonoma County. To the east, the Geysers geothermal region, developed to generate electricity, has had over 100 archaeological field investigations (Map 2; Fredrickson 1989). North of the Cloverdale region, several investigations were conducted to mitigate impacts for various proposed California Department of Transportation road improvements (Rondeau 1985, 1990). In the intermontane region west of the research area, numerous large-scale investigations have been conducted relating to the creation of Lake Sonoma/Warm Springs Dam (e.g., Basgall and Bouey 1984, 1991; Stewart 1989, 1993). But it is the Santa Rosa region to the southeast of this study area that has most influenced regional archaeological investigations. Based on temporally diagnostic artifacts, obsidian hydration values, visual and geochemical sourcing assignments, and radiocarbon results, a cultural chronology has been established for the Santa Rosa region (Origer 1987; Wickstrom 1986). It was subsequently borrowed by archaeologists for interpretations of nearby regions, including many studies within the present research area. A summary of this chronology is presented below with examples of sites characteristic of each period (see Fredrickson 1973, 1974, 1984; Stewart 1982; Wickstrom 1986; Origer 1987; and Jones and Hayes 1989). Source specific hydration values for each period are provided in Table 1.

Table 1. Temporal Periods in Hydration Values for the Major Obsidian Sources in the North Coast Ranges.

Period	Napa Valley	Mt. Konocti	Annadel	Borax Lake
Emergent:				
Upper	1.0 - 1.5	1.0 - 1.5	0.8 - 1.2	1.3 - 1.9
Lower	1.6 - 2.2	1.6 - 2.2	1.3 - 1.7	2.0 - 2.8
Archaic:				
Upper	2.3 - 3.1	2.3 - 3.1	1.8 - 2.5	2.9 - 3.9
Middle	3.2 - 4.9	3.2 - 4.9	2.5 - 3.9	4.0 - 6.2
Lower	5.0 - 6.9	5.0 - 6.9	4.0 - 5.4	6.3 - 8.8
Paleoindian	>6.9	>6.9	>5.4	>8.8

Measurements in microns (μ).
Table adapted from Wickstrom (1982).
Established conversion rates after Tremaine (1989):
K=NV, A X 1.30=NV, BL X 0.79=NV.

Paleoindian Period, approximately 12,000 - 8,000 B.P.

Very limited evidence of the Paleoindian Period has been identified in Sonoma County. From CA-SON-977 by the Laguna de Santa Rosa, two chalcedony effigy crescent fragments are attributed to this period (Origer and Fredrickson 1980). In nearby Lake County, fluted points were part of the flaked stone tool kit (Fredrickson 1984). The few Paleoindian tools identified in the southern North Coast Ranges suggest a hunting emphasis using darts and atlatls. With no identifiable milling equipment, there was probably limited use of hard seeds, especially those that needed to be processed by grinding. Archaeological sites from elsewhere in California have been interpreted as residue from small groups of mobile peoples who lived along the edge of lakes and wetlands during the late Pleistocene (Moratto 1984).

Lower Archaic Period, approximately 8,000 - 5,000 B.P.

While several Sonoma County sites have outlying hydration readings corresponding to the range defining the Lower Archaic Period, two contained enough cultural materials to contribute to describing a temporal assemblage: CA-SON-20B, from which the Spring Lake Phase was named; and CA-SON-348/H. Situated near the Annadel obsidian quarry in southeastern Santa Rosa, CA-SON-20B yielded wide-stem projectile points produced from Borax Lake obsidian, unifacial basalt cobble tools, and handstones and milling slabs (Wickstrom and Fredrickson 1982). Recent testing at CA-SON-348/H, a multilayered, heavily mixed shell midden on the Sonoma County Coast, contained items assigned to this period by hydration values (Schwaderer 1992). The various flaked stone specimens included bifaces, a uniface, cores, and edge modified flakes (EMFs). They were produced primarily from Napa Valley and Annadel glasses, but with a trace of Borax Lake glass. A "Lake Mohave" style point was attributed to this period (3.5 μ Annadel, 4.6 μ Napa Valley value [NVV]), but reorienting the artifact 180 degrees would yield a shouldered lanceolate, an artifact common to this region and compatible with the hydration value (Origer 1987). Associated with the Altithermal, the Lower Archaic Period's social grouping is assumed to be similar to the Paleoindian Period but with less emphasis on aquatic resources (Jones and Hayes 1989). Flaked stone artifacts were produced from local materials, with occasional curated tools from Borax Lake obsidian.

Middle Archaic Period, approximately 5,000 - 3,000 B.P.

Frequently, this period is subdivided into two parts: 3.2 - 4.0 μ and 4.1 - 4.9 μ, both NVV. Again, the early portion is poorly represented in Sonoma County with the exception of occasional hydration values. Temporally diagnostic artifacts associated with the early portion of this period derive from CA-SON-20B and -456, and consisted of shouldered lanceolate points and an occasional concave base point. The latter form increased with frequency during the later portion of this period and there may be stylistic changes associated with age and region (White et al. 1982). Also indicative of the later portion were large side-notched points and biface blanks; Napa Valley glass was the most frequently used tool stone material. Referred to as the Black Hill Phase, it is unknown if this phase represents more than one mobile group.

Upper Archaic Period, approximately 3,000 - 1,500 B.P.

The Upper Archaic Period is well represented in Sonoma County. A greater number of components and a wider variety of site types have been interpreted as an increase in population and land use. Temporally diagnostic artifacts for this period included concave base points, shouldered and non-shouldered lanceolates, and biface blanks; milling equipment included the initial use of bowl mortars with pestles. Although used to process other food and non-food items, use of bowl mortars was often attributed to an increased use of acorns, improved acorn leaching, and food storage. It is not known if only the improved technology, or if people with this knowledge reached this area. Research suggests that the Laguna people lived more sedentary lives than their contemporaneous Black Hill neighbors, an interpretation reflected by their use of local obsidians as opposed to their neighbor's preference for chert (Fredrickson 1984).

Lower Emergent Period, approximately 1500 - 500 B.P.

Serrated corner-notched points, large corner-notched knives or spear points, and

Olivella M1 sequin type shell beads were new additions to this region, along with the continued use of shouldered lanceolate points, and the mortar and pestle. The use of Annadel glass increased and spread geographically. Small serrated points were attributed to the introduction of the bow and arrow, and mark the beginning of this period. Researchers (Jackson 1974; Fredrickson 1984) proposed that populations expanded significantly, continuing or increasing their use of obsidian, that _ad hoc_ exchange was becoming regularized, and that social stratification was beginning. There are fewer indications of multi-group area use, perhaps because of acculturation through intermarriage and exchange (possibly a by-product of more regularized social interaction), displacement, or improved hunting technology acquired by all groups (Armaroli 1982).

Upper Emergent Period, approximately 500 B.P. - Euroamerican Contact

Named the Gable Phase after the common name for CA-SON-455, artifacts included non-serrated corner-notched points, notchless points (possibily preforms), hopper mortars, chert drills, and clam shell disk beads. A gradual shift away from serrated points separated this period from the previous one. Jackson (1986) has posited that there was regularized exchange, increased social stratification, intermarriage between the elites of each neighboring major village, and craft specialization. A decrease in the number of sites assigned to this period may represent the consolidation of smaller communities into larger villages, a response to increased social stratification, or possibly a result of introduced diseases from early 16th century sailors (Armaroli 1982).

After Euroamerican Contact

Diseases and mission practices drastically reduced the numbers of local Native

Americans (Cook 1956; Castillo 1978). Those who survived, experienced significant changes in their lives with the introduction of metal, glass, and other traded or discarded items. Access to hunting and collecting areas, including obsidian sources, was disrupted. This paper will not address Native American life and exchange during this period, due to the lack of information from associated Native American sites and the introduction of resources that were competitive with flaked stone resources.

From a Warm Springs Perspective

Avoiding the generally accepted culture chronology for the southern North Coast Ranges, Baumhoff and Orlins (1979) and Basgall and Bouey (1984, 1991) developed a local sequence for the Warm Springs area based on temporally diagnostic artifacts, and obsidian hydration and radiocarbon results. Divided into three phases, Skaggs, Dry Creek, and Smith, these phases appear to be local expressions of Fredrickson's "patterns." Of the 64 archaeological sites recorded in the lower elevations of this rugged montane area, extensive excavations were limited to the 17 midden sites or villages. A summary of the locality's culture history is extracted from Basgall and Bouey (1991) and Basgall (1993). The range in hydration values per source underscores the multidirectional exchange system for Warm Springs area during the Dry Creek and Smith Phases (Table 2).

Original indications of Paleoindian use of the Warm Springs area (Baumhoff 1980, Baumhoff and Orlins 1979) were not substantiated with additional testing. Limited use of this area began approximately 5000 years ago and is referred to as the Skaggs Phase (5000-2500 B.P.; $>3.5\ \mu$ NVV). Temporally diagnostic artifacts included large concave base and large (Willits) side-notched projectile points, both overwhelmingly manufactured from chert, and groundstone items consisted of milling slabs and handstones. Also noted were a high amount of cores, bifacial preforms, and unifaces. The small percentage of obsidian in the flaked stone assemblage consisted of Mt. Konocti and Napa Valley glasses. It was inferred that projectile points with atlatls were used for hunting.

During the Dry Creek Phase circa 2500-700 B.P. (or 2.5 - 3.5 μ NVV), the number of components dramatically increased. Stylistic projectile points consisted of lanceolates and a continuation of large side-notched. While the latter were produced mainly from chert, the lanceolates and numerous bifaces were manufactured from obsidian. Mt. Konocti was the most frequently used glass, followed by Napa Valley. Bowl mortars and pestles have been interpreted to indicate intensification of an acorn economy (Basgall 1987 and Bouey 1987). While the beginning of this phase has been characterized as an abrupt shift, inferred as an intrusion of a new group of peoples, Stewart (1993) believed that this shift was not empirically supported and that the movement of a new group into this area did not necessarily displace the Skaggs people. She posited that the two groups lived near each other with the new group favoring lowland settlements over upland localities.

The Smith Phase (700 B.P. - Historic or 0.9 - 2.4 μ NVV), was characterized by small corner-notched arrow points, chert drills associated with shell bead manufacture, and bowl mortars and pestles. There was a decrease in the use of obsidian and an increase in the use of chert, although obsidian was still dominant. Obsidian use shifted to Napa Valley glass, predominately, including the use of small obsidian cobbles sourced to Napa Valley. Serrated points, when found, are associated with this phase.

Table 2. Flaked Stone Recovered From Adjacent Areas

sites	% of ob	hyd	ob to chert	
WARM SPRINGS				
64 sites	50% K	0.9 - 5.2 µ (n=157)	75%	25%
	38% NV	0.9 - 5.5 µ (n=193)		
	9% A	0.9 - 2.7/ 1.2 - 3.5 µ NVV (n=31)		
	3% BL	1.0 - 4.1/ 0.8 - 3.2 µ NVV (n=71)		
NORTH OF CLOVERDALE				
CA-MEN-1802	99% K	2.6 - 5.7 µ (NVV), mean 3.7 (n=18)	76%	24%
	<1% NV	2.7 - 5.8 µ, mean 4.1 (n=17)		
	<1% BL	3.2 - 5.5/2.5 - 4.3 µ NVV, mean 3.4 (n=14)		
	<1% A	4.6/6.0 µ NVV (n=1)		
CA-MEN-2220	99% K	1.0 - 5.8 µ (NVV), mean 2.7 (n=92)	77%	23%
	<1% NV	1.6 - 5.4µ, mean 3.5 (n=19)		
	<1% BL	1.2 - 4.9/0.9 - 3.9 µ NVV, mean 2.7 (n=75)		
	<1% A	1.8/2.3 µ NVV (n=1)		
THE GEYSERS				
Squaw Creek				
CA-SON-833	99% K	1.5 - 1.9 µ (NVV) (n=5);2.7 - 5.9 µ (NVV), mean 3.4 (n=32)	83%	17%
	<1% BL	3.8 - 7.2/3.0 - 5.7 µ NVV (n=5)		
	<1% NV	2.5 µ (n=1)		
	<1% A	1.8/2.3 µ NVV (n=1)		
CA-SON-841	99%K	1.2 - 5.4 µ (NVV), mean 3.2 (n=34)	53%	47%
	<1% BL	1.5 - 6.8/1.2 - 5.4 µ NVV (n=8)		
	<1% NV	1.2 - 1.9 µ (n=3)		
	<1% A	1.3/1.7 µ NVV (n=1)		
Big Sulfur Creek				
CA-SON-783	56% K	2.1 - 3.2 µ (NVV), mean 2.5 (n=6)	94%	6%
	24% BL	3.8 - 4.4/3.0 -3.5 µ NVV, mean 3.2 (n=4); 5.4 - 6.8/4.3 - 5.4 µ NVV, mean 5.0 (n=5)		
	20% NV	3.3 - 3.7 µ, mean 3.5 (n=7)		

Compiled from Basgall (1993); Rondeau (1985, 1990); Farber et al. (1987); Origer and Fredrickson (1984). Obsidian conversion rate established by Tremaine (1989).

North of Cloverdale

Just north of the study area, CA-MEN-1802, a temporary campsite, and -2220, a village, were two contemporaneous sites in the hilly region beyond Alexander Valley (Table 2). Occupants of both sites overwhelmingly preferred Mt. Konocti glass with other glasses frequently used for formal tools (Rondeau 1985, 1990). CA-MEN-2220 was more intensively used for a longer time and contained a greater variety of artifacts. Unique to CA-MEN-1802 was the high amount of minimally modified handstones. Rondeau (1985, 1990) suggested that the chert was locally obtained, then transported to, and reduced at these sites.

The Geysers

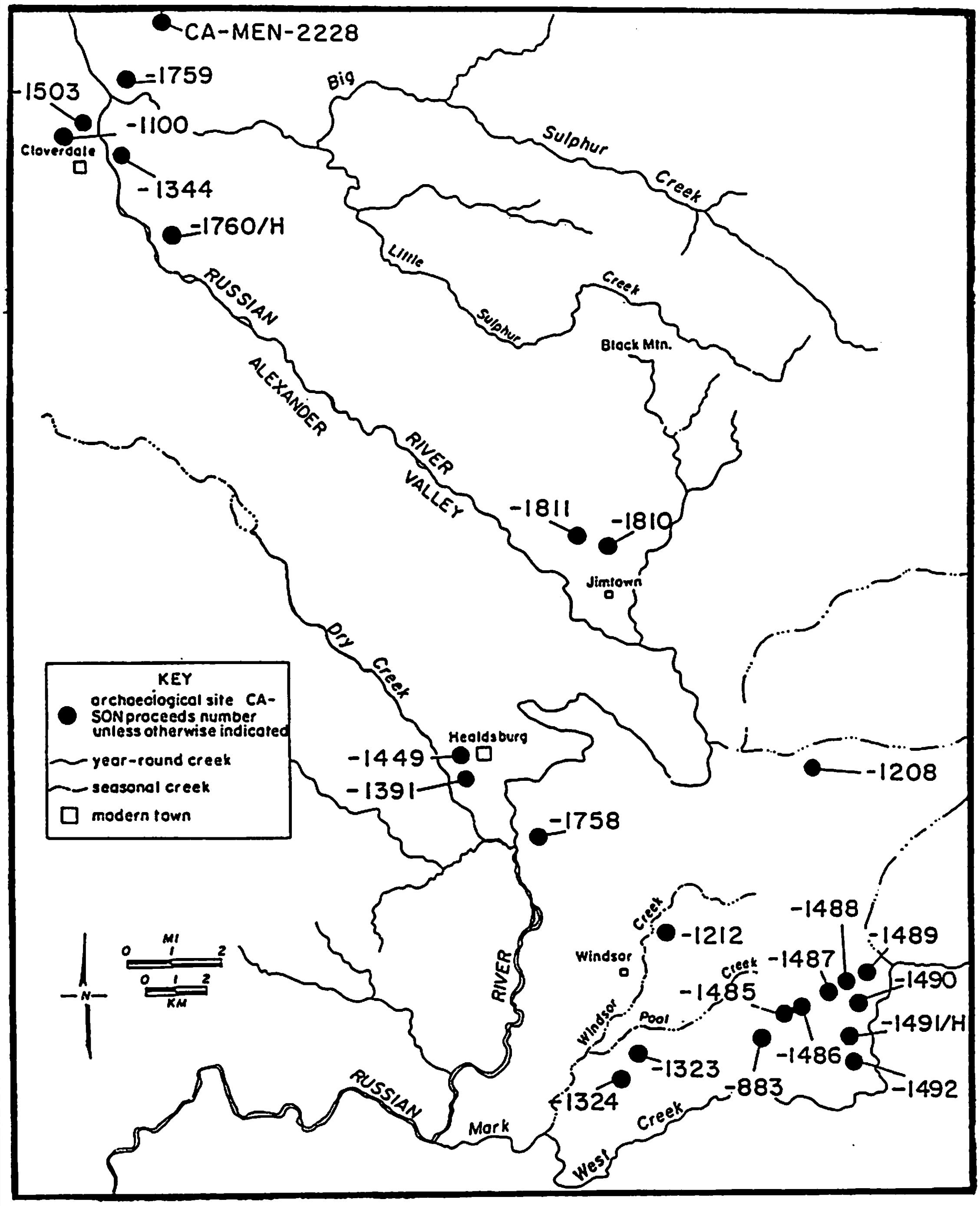
This large montane area east of the project area is comprised of northwest/southeast trending ridgelines. Research of spatial and temporal patterning within the Geysers (Fredrickson 1989) suggested a different, contemporaneous group was living in each of the four major stream drainages: Kelsey Creek; Putah Creek; Squaw Creek; and Big Sulphur Creek. The latter two are most relevant to this research. Based on results from Peak and Associates (1985), Farber (1987), and Origer and Fredrickson (1984), the following summary is provided for both drainages.

Proportions of flaked obsidian recovered from sites in the Squaw Creek drainage (CA-SON-833, -841, -1406, and -1407) approximated percentages of obsidians recovered from CA-MEN-1802 and -2220 (Table 2). The amount of flaked chert varied with time and between sites, ranging from a high of 26% at CA-SON-833 to a "statistically insignificant" sample at CA-SON-1407. Its use appeared limited to debitage and informal tools although occasional bifaces and projectile points were produced from this material. Obsidian flake sizes were overwhelmingly 1X1cm or smaller, suggesting residue from tool maintenance (Peak and Associates 1985; Farber 1987). In contrast, contemporaneous sites in the Big Sulphur Creek drainage contained different percentages of obsidian (Table 2; Origer and Fredrickson 1984). Based on frequencies of these major obsidians and social distance models, Fredrickson (1989) posited that the people of Squaw Creek and Big Sulphur Creek localities interacted less with each other than with their other Geysers' neighbors.

Study Area

Although archaeological research within the study area has often been limited to site recording, there were 23 sites that have been intensively investigated, usually by some form of subsurface testing (Map 3). A brief description for each site is provided. Further description is given in Chapter 4 with associated obsidian hydration readings provided in Appendix B. Six sites in the northern portion of the research area around the town of Cloverdale are discussed initially.

Excavated to mitigate proposed California Department of Transportation impacts (Garfinkel and Bingham 1984), CA-SON-1344 yielded materials from two components. The early archaic component, a seasonal campsite, was widely diffused over most of the site, but was dominate in the southern portions (White 1984b). Napa Valley obsidian predominated and included the following tools: dart-size, stemmed and lanceolate points, bifaces and cores. Also recovered were chert bifaces and cores, pestles, and cobbles from an unknown obsidian source. Following a hiatus, the site was occupied again. The northern portion of the site



Map 3. Selected Sites in the Research Area.

contained an Emergent Period component comprised of a discrete midden. Artifacts from this area included small corner-notched points mainly of Napa Valley glass, Mt. Konocti obsidian bifaces and cores, hammerstones, and heat-altered rock (White 1984b).

Situated approximately 1.5 miles northwest of CA-SON-1344, CA-SON-1503, a seasonal base camp, contained Upper Archaic and Lower Emergent Period components. The Archaic Period component contained chert, Mendocino-style stemmed points and the Emergent Period component included a chert corner-notched projectile point. The two components were not spatially discrete, but most materials were attributed to the earlier period. In contrast to CA-SON-1344, all obsidian recovered from this site was visually sourced to Mt. Konocti glass (Dowdall et al. 1989).

Located near the confluence of Big Sulphur Creek and the Russian River, CA-SON-1759 was probably the large ethnographic village of Makahmo (Peri et al. 1985:38; Waechter 1989a). Hydration values documented the long use of the site from Archaic to Emergent Periods. While Mt. Konocti obsidian was extensively used, Napa Valley obsidian was limited to early use of the site. Late period corner-notched and serrated points were produced from Mt. Konocti glass. Obsidian represented 71% of the debitage sample and was dominated by Mt. Konocti obsidian (Waechter 1989a).

Situated approximately four miles southeast of the town of Cloverdale, the Native American component at CA-SON-1760/H consisted of a rich midden with a variety of cultural materials (Waechter 1989a). Temporally diagnostic flaked stone tools consisted of a large corner-notched projectile point associated with the Upper

Archaic Period, and serrated and small corner-notched projectile points associated with the Lower Emergent Period. Waechter (1989a) noted a dominance of Mt. Konocti obsidian used during early occupation of this village with a gradual shift to Napa Valley obsidian. She attributed this shift to a change in exchange systems emphasizing southern trade and increased interactions in later periods.

The only uplands site for this northern region was CA-MEN-2228, a shallow, sparse lithic scatter, situated approximately four miles northeast of the town of Cloverdale. No projectile points were recovered. Most debitage was Mt. Konocti glass, but sixty percent of the tools were manufactured from Napa Valley glass. Mt. Konocti and Napa Valley obsidian hydration values reflected a bimodal use of this site during the Upper and Lower Emergent Periods (Waechter 1989a).

Within the present town of Cloverdale, CA-SON-1100 was a sparse scatter of lithics. Auger borings were used to define the site's limits and to determine if there were any subsurface materials (Offermann and Fredrickson 1978). Since the cultural materials were not counted, described, or curated, no comparative site information can be extracted.

In general, two patterns of obsidian use has emerged from the Cloverdale region. One group relied on Mt. Konocti obsidian and chert for most of their flaked stone material and other imported obsidian for their formal tools. In contrast, another group used a much higher frequency of Napa Valley obsidian for a greater variety of artifacts and relied less on Mt. Konocti obsidian. Two interpretations have been offered to explain the dissimilar use of obsidians (Fredrickson 1989, cited by Waechter 1989a). First, CA-SON-1760/H and -1344 were geographically "closer to the sources of Napa Valley obsidian and float" (Fredrickson 1989, cited by Waechter 1989a:43-44). Or second, there was less social distance between some Cloverdale region people and the suppliers of Napa Valley obsidian (Fredrickson 1989, cited by Waechter 1989a:44). Either way, the Cloverdale locality was a boundary area for two groups of people during the Upper Archaic and Emergent Periods.

Situated approximately 15 miles southeast of Cloverdale and approximately four miles north of Healdsburg were CA-SON-1810 and -1811. CA-SON-1810, a seasonal camp site, was a low density deposit of limited diversity with no morphologically diagnostic artifacts. In contrast, the village of CA-SON-1811 was a more intensively used locality with midden and a variety of lithic and faunal remains. Flaked stone items were dominated by obsidian. Lanceolate (Upper Archaic Period) and small corner-notched (Emergent Period) projectile points were the morphologically distinctive flaked stone artifacts. Gmoser (1992) suggested that Napa Valley and Franz Valley obsidians were obtained from nearby float areas. Preliminary test results from these sites were interpreted as contemporaneous occupation by two different groups (Gmoser 1992).

Two sites, CA-SON-1391 and -1449, were located within the city of Healdsburg. Limited testing of CA-SON-1391, probably the ethnographic village of Ka'le, recovered the following materials from its midden: shell, bone, groundstone, and flaked stone artifacts including serrated and non-serrated corner-notched projectile points associated with the Emergent Period. No obsidian hydration, radiocarbon, or visual and geochemical source analyses were conducted for this project, limiting comparisons to other local sites. Occupation during the Upper Emergent Period was inferred because of projectile point styles, but it was unknown if the site was used during other periods (Busby et al. 1984).

Test excavations were limited to a small peripheral portion of the village of CA-SON-1449, and archaeologists recovered a "sparse, homogenous scatter of chert and obsidian lithics" (Waechter 1989b:23). No temporally diagnostic flaked stone tools were identified, but hydration values place use from the Middle Archaic Period to the Lower Emergent Period. Almost 89% of the obsidian was Napa Valley with some probably obtained from nearby float areas (Waechter 1989b:17).

Approximately six miles east of Healdsburg, CA-SON-1208 was situated in a hilly terrain surrounded by small unmodified obsidian pebbles. Temporally diagnostic Archaic Period artifacts consisted of a large corner-notched point, pestles, and a bowl mortar fragment. Hughes (1980, cited by Eisenmann and Fredrickson 1980) could not confidently assign a source to one obsidian flake, but thought it was probably Annadel glass. Recent geochemical research had assigned naturally occurring obsidian from Knight's Valley to Napa Valley glass (Hughes 1980, cited by Eisenmann and Fredrickson 1980) and had suggested Napa Valley glass was present in primary, secondary, and tertiary forms from the Upper Napa Valley to as far west as Santa Rosa (Jackson 1978:5.11). Eisenmann and Fredrickson (1980) suggested limited use of the local obsidian pebbles, because of the small sizes of this material surrounding this seasonal campsite, and the presence of residual cortex on some obsidian debitage and tools.

Approximately five miles southeast of Healdsburg, a large sparse site, CA-SON-1212 was first recorded by Soule (1979). He described it as a 40-acre locality where naturally occurring obsidian had occasionally been modified and discarded by Native Americans with more recent modifications attributed to plowing. When extensive development had encroached over most of this float area, research was conducted that established CA-SON-1212 was not only an intensively plowed area of somewhat dense unmodified and recently-modified obsidian cobbles, but also a Native American campsite and a non-quarry collecting area (Bieling and Bramlette 1989). Bieling and Bramlette (1989) proposed that during the Lower Archaic Period the people at this site preferred Napa Valley obsidians that may have been imported or obtained from local cobbles. After a long hiatus, the site was used during the Emergent Period by people who used mainly Napa Valley obsidian (both probably imported and locally obtained) and some Annadel obsidian (Bieling and Bramlette 1989).

Situated approximately eight miles south of Healdsburg were CA-SON-1323 and -1324 (Greenway 1986a, 1986b). CA-SON-1323 was described as a leached midden containing a diversity of materials, including lanceolate, shouldered lanceolate, concave base, and large stemmed projectile point. Also, bifaces, EMFs, and cores were recovered as well as a milling slab fragment, possible pendant fragments, and charmstones. Sustained use of this base camp was correlated to the Lower Archaic Period and continued through the Lower Emergent Period (Greenway 1986a). Investigations at CA-SON-1324 (Greenway 1986b), a seasonal campsite, included the recovery of a large corner-notched projectile point and a mortar fragment. Greenway (1986b:50) believed that Napa Valley glass was used almost exclusively during the Middle and Upper Archaic Periods with an abrupt shift to the almost exclusive use of Annadel obsidian during the late Upper Archaic and continuing through the Emergent.

A cluster of non-midden sites, situated above the valley floor in hills approximately seven miles southeast of Healdsburg, was studied (Greenway n.d., cited by Waechter 1989b). For two of the sites, CA-SON-1485 and -1486, limited subsurface testing was conducted, and an additional eight sites, CA-SON-883, -1487, -1488, -1489, -1490, -1491/H, -1492, and -1493, were surface collected. Combined obsidian sourcing and hydration results yielded flaked stone obsidian from all periods (Greenway n.d., cited by Waechter 1989b:6).

Other Related Studies

The suggestion that Native Americans used non-quarry obsidian has been presented in various studies from both Napa and Sonoma counties (Stewart 1984). Jackson (1978) documented cultural use of Napa Valley obsidian float at CA-NAP-261. Based on the presence of waterworn cortex on debitage, he suggested that obsidian pebbles and cobbles obtained from the Napa River were used to produce flake tools, and that obsidian for formal tools was obtained either through exchange or made from material extracted from the Napa Glass quarry. Additionally, he believed that Napa Valley glass obtained through trade may have derived from more areas than its primary source (Jackson 1978:5.11). From biface blanks identified as float derived, Flynn (1978) posited that a large area of the Napa Valley near Glass Mountain contained secondary obsidian deposits. In Sonoma County, investigations near the Laguna de Santa Rosa identified large amounts of various size float, the largest cobble weighing 470 grams (Origer and Fredrickson 1980). In the same area, CA-SON-906 yielded naturally occurring obsidian pebbles that could have been used for flake tools (Praetzellis and Praetzellis 1976). It was proposed (Praetzellis and Praetzellis 1976) that the site occupants would have had to travel or trade for obsidian large enough to produce more formal tools.

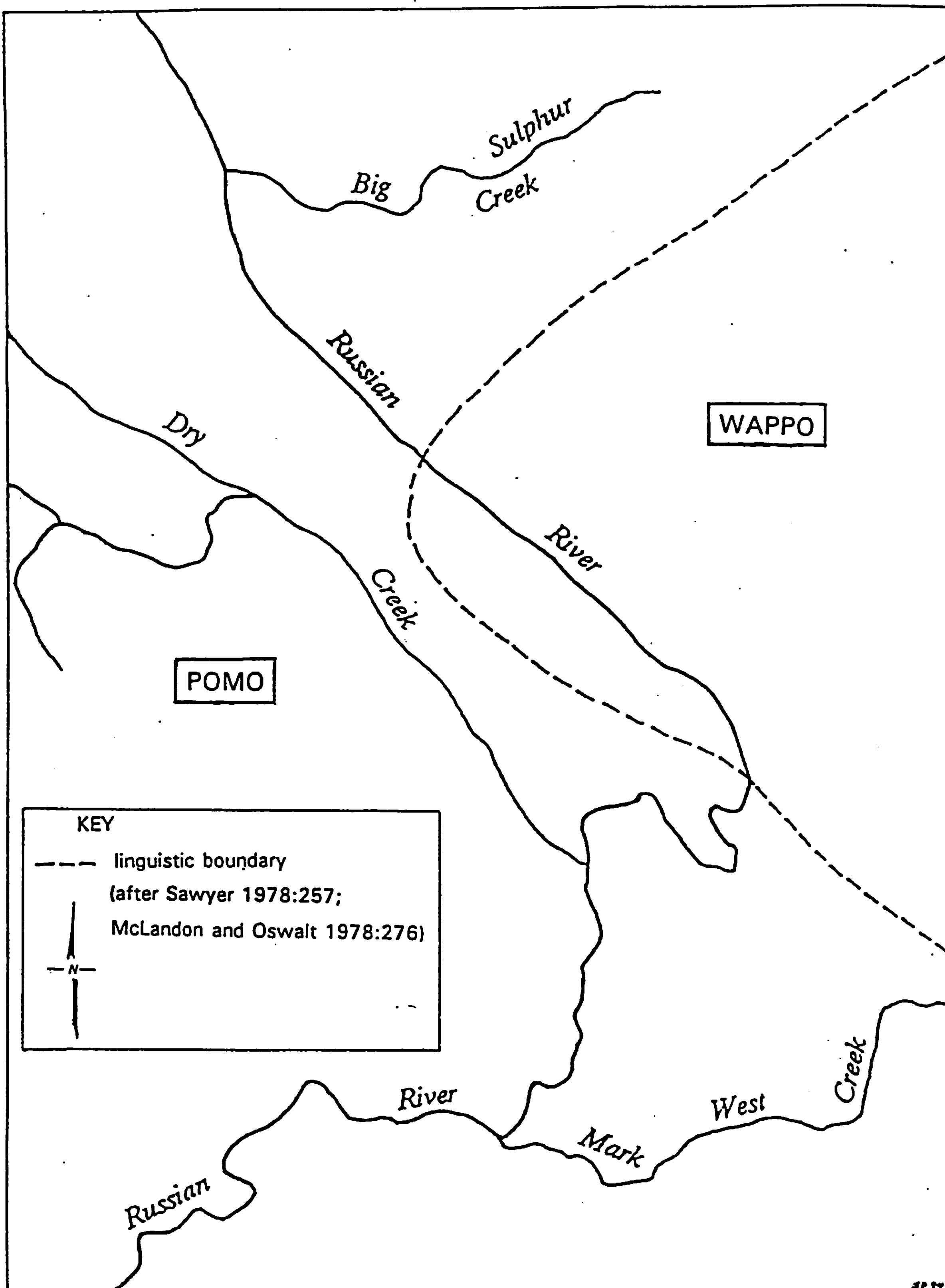
The prevailing suggestion that more formal tools were not manufactured from local secondary deposits was probably influenced by three factors. First, previous studies have concentrated on exchange of formal tools, especially those emphasizing major sources (Bennyhoff 1977; Hughes 1978; Jackson 1986). Second, a byproduct of formal tool production would be the drastic reduction or elimination of float characteristics, thereby reducing the identification of this raw material. Lastly, secondary deposits of obsidian in the Glen Ellen Formation frequently contain only small pebbles. The latter may be biased by impacts from recent activities, such as extensive plowing and other vehicle use. Occasionally, obsidian with recent breaks have been identified as "artifacts" within "sites" (such as CA-SON-1107 just south of the research area), and others were identified as resulting from recent breakage combined with Native American modified obsidian (Werner and Fredrickson 1980; Bieling and Bramlette 1989). Probably larger pieces were collected and used prehistorically, or later, were extensive plowed and driven over, resulting in pseudo-artifacts and few remaining cobbles.

Typical of small surveys and site recording in and near the research area were statements such as Bramlette's (1985:3) description of CA-SON-1480 as a very sparse lithic scatter comprised of primary and secondary reduction flakes. Descriptions of primary reduction are usually associated with locations within or near a quarry (Jackson et al. 1983; Patterson et al. 1987). Also, Mikkelsen et al.'s (1984) investigation of CA-SON-963 and -964 three miles south of the research area noted Napa Valley obsidian float. In summation, many investigations have implied or inferred limited use of obsidian from non-quarry areas in Sonoma and Napa counties.

Ethnographic Background

Comparative linguistic and ethnographic data place two major linguistic groups within the study area: the Wappo, associated with the Yukian Linguistic Stock of languages; and the Pomo, associated with the Hokan Linguistic Stock of languages (Map 4; Barrett 1908; Kroeber 1925; Driver 1936; Sawyer 1978; McLendon and Oswalt 1978). While terms such as "Pomo" and "Wappo" are useful to linguists, there is general agreement among ethnographers that these groupings were linguistic descriptions and did not denote cultural groupings (Barrett 1908; Kroeber 1925). Though these terms are still used, ethnographers believed the independent village-community, or tribelet, was politically autonomous and socially distinct, although there were close cultural similarities between village-communities (Kroeber 1925; Gifford and Kroeber 1939). These tribelets consisted of one main village and frequently several smaller satellite villages. Barrett (1908) identified seven ethnographic Wappo villages and approximately 45 Pomo villages within the study area. The best documented village-community was that of the Makahmo Pomo who lived within and adjacent to the present town of Cloverdale. CA-SON-1759 was believed to be this village (Peri et al. 1985; Waetcher 1989a).

The following is a partial summation of Makahmo culture with information borrowed heavily from Peri et al. (1985). The territory was based on the community's dietary, spiritual, intellectual, and aesthetic needs. All parts of the territory were used, though some portions were more intensively utilized than others. The valley surrounding the Russian River contained three or four politically autonomous winter villages named Makahmo, Amako, Mayumo, and possibly Koloko, and seven summer villages and campsites. Additionally, other valley



Map 4. Linguistic Boundaries within the Research Area.

localities were used for sacred and dietary purposes, other plant collecting, and mineral extraction (Peri et al. 1985:Map 3a). For example, approximately one mile from the village of Amako was a quarry from which chert was obtained as an alternative to imported obsidian (Peri et al. 1985:Map 2a).

The village-community of Mahakmo was centrally located with many major trails intersecting the village (Peri et al. 1985:Map 9a). Native Americans following these trails could have traveled west to the coast or east to the Mt. Konocti area. The village location was a definite economic, social, and political advantage. Trade was so important a part of the residents' lives that one leadership position was Trading Captain, a multi-lingual person who planned and arranged exchange of materials between communities. There is limited documentation of the kinds of exchange items traded between tribelets. While Davis (1961) provided a list for linguistically-based groups in California, his smallest groupings for the southern North Coast Ranges were Pomo and Wappo, which is not specifically useful with respect to individual communities.

Reportedly the relationships between the Makahmo people and their neighbors varied considerably, ranging from amicable to war-like. Beside trading and friendly socializing with most of their immediate neighbors, important yearly travel to both Clear Lake and the coast occurred. During trips to Clear Lake, access to the Mt. Konocti obsidian quarry was requested and given by the people who occupied these lands (Stewart 1943; Heizer and Treganza 1971). Additionally, shaped Mt. Konocti obsidian bifaces and projectile points were exchanged during these visits. While some ethnographers reported limited and war-like interactions with the Wappo-speaking people to their southeast (e.g., Kroeber 1925), more recent research comparing the many similarities in both group's basketry designs suggested a friendlier degree of interaction (Pryor 1987). Since inter-tribelet exchange allowed non-local items into a larger region, Peri et. al. (1985:208) believed that regularized exchange systems were a major factor in allowing Native Californian populations to live in dense residential settlements.

Along different lines, Pomoan-speakers' stories have been well documented (Barrett 1933). Most pertinent to the present study was the supernatural being Katca-tca or Obsidian-man. Created by Coyote from an obsidian arrow point, obsidian-man was believed to reside on Mt. Kanaktai (Konocti). Barrett documented the story from people attributed to the Yokaia, Central Pomo, and Eastern Pomo. An uncited variation of this story has obsidian-man living "in a big sulphur spring near Calistoga" (Barrett 1933:31). In light of the present study, this has been interpreted to mean that the Calistoga Creek area was a known non-quarry area. This is consistent with Driver's (1936:195) statement that Wappo speaking peoples obtained nodules at St. Helena, transported them home whole, and reduced them at their villages.

-CHAPTER THREE-

METHODS

Research Methods

Methods and classifications used for the present research are provided in this chapter along with some generally accepted methods employed in northern California. Research for this study is structured into three phases, beginning with a records search at the Northwest Information Center, California Archaeological Inventory at Sonoma State University. This consisted of examining all records for Native American sites within the study area and plotting site locations. Research focused on studies documenting unmodified and culturally modified obsidian, especially when investigations included surface collection or any subsurface testing. Results of geochemical and visual sourcing analyses were also noted. Additionally, primary obsidian hydration data were collected from site records, studies, and files of the Anthropological Studies Center's Obsidian Laboratory at Sonoma State University.

The second phase of research consisted of examining a sample of cultural materials from each site in the research area that had a curated collection at Sonoma State University's Collections Facility, as well as one collection from the Academy of Natural Sciences in San Francisco and one collection from the City of Healdsburg. All obsidian tools and a sample of the flakes from each were visually sourced by the author. For collections with less than 100 flakes, the entire collection was visually sourced and descriptive information recorded. For larger collections, all tools and an arbitrary sample of at least 100 flakes were examined.

Presence or absence of cortex was noted along with other diagnostic attributes, such as bifacial platforms. Pebbles of obsidian, recent "artifacts" apparently created by automobiles, plows, etc., and other non-culturally modified items are not included in these counts; consequently, the latter may vary from counts presented in original reports. The term "chert" is used to describe stone that ranges from predominately chert to chalcedony, in the few instances where more than chert was modified. All of this information was obtained to address the area's chronology, and spatial and temporal similarities and differences.

The final phase of research was a flaked stone analysis of all tools and a sample of debitage from two sites, CA-SON-1810, and CA-SON-1811. These sites were selected based on interpretations from visual and geochemical sourcing results that suggest obsidian from non-quarry areas was frequently used to produce various formal and informal tools (Psota 1991, cited by Gmoser 1992). To understand how and for what items obsidian float was used, specimens were measured, weighed, described, and visually sourced. Since neither of the two sites contained a spatially discrete temporal component, the flaked stone analysis combined all materials recovered by site, except those items defined as temporally specific through either hydration analysis or typological studies.

Obsidian Sourcing in the Southern North Coast Ranges

Although obsidian studies have proven indispensable to researchers in northern California, it is not without some minor problems or adjustments. Most archaeological investigations in Sonoma County have relied solely on visual sourcing to ascertain the kinds of obsidian utilized. Few of the researchers conducting these studies are known to have tested their visual sourcing results with an experienced visual sourcing researcher and/or with geochemical assignments (Table 3). This can result in visual sourcing inconsistencies when compared to both experienced researchers and geochemical results. In the past, one problem area has been obsidian containing atypical macroscopic attributes. When geochemical sourcing has not been used to confirm visual sourcing groupings or identify obsidian with unusual characteristics, this material was frequently either lumped with the closest macroscopic group, or referred to as "float" or "?".

Additionally, visual sourcing assignments can reflect trends in interpretations of macroscopic attributes and geochemical sourcing developments. For example, when Jackson (1974) believed he could geochemically distinguish some Blossom Creek obsidian, the specimens assigned to this category were used to establish visual sourcing attributes. While others still cite this thesis for its geochemical assignment, Jackson presently believes "Blossom Creek" is a location,

Table 3. Use and Limitation of Visual Sourcing and X-Ray Fluorscence Analyses.

Visual Sourcing	X-Ray Fluorescence
-for trained personnel, efficient and economical with accuracy rates of 90% or better in specific regions*	-all culturally used sources in a region must be identified for accurate assignments
-patination obscures some macroscopic attributes	-patination and cortex can distort measurements***
-items < 1x1cm are less accurately sourced **	-specimens should be a minimum of 1x1x0.3cm****

* (Ammerman 1979; Wickstrom and Fredrickson 1982; Clark and Lee 1984)
** (Wickstrom and Fredrickson 1982; Psota 1990)
*** (Hughes 1980)
**** (Jackson and Hampel 1992)

CA-NAP-509, where unmodified and modified obsidian occurs rather than an obsidian flow area. He believes this is not a distinct or discrete geochemical source, but probably a combination of some geologically redeposited obsidian sources. Additionally, he suggests that prior to his thesis "Blossom Creek" would have been assigned to Napa Valley glass during geochemical analysis (T. Jackson personal communication, 1992).

Another instance of sourcing problems is the small sample of inconclusive geochemical results generated by this research, e.g., CA-SON-1585, 87-1-451A and CA-SON-1811, 91-36-60N, both small, thin items of the size known to yield ambiguous results (Jackson and Hampel 1992). The testing of one thin flake from CA-SON-1585 generated element values that "are more or less mid-way between Franz Valley and Annadel, maybe a bit closer to Annadel" (Jackson and Davis 1993b, Appendix A). Likewise, a small thin flake from CA-SON-1811 yielded element values that are "somewhat closer to the Franz Valley chemical group," it could either be Franz Valley or Annadel glass (Jackson and Davis 1993a, Appendix A). Presently not all researchers have geochemically distinguished Franz Valley glass (Bouey personal communication, 1993; Hughes personal communication, 1991; Jackson personal communication, 1992).

Franz Valley obsidian was first geochemically characterized by Jackson in 1986. Hughes (1991, [Appendix A]; 1991, cited by Schwaderer 1992) and Jackson (1986; Jackson and Davis 1993a, [Appendix A], 1993b [Appendix A]) have been the only two researchers to assign a specimen to Franz Valley glass, consequently, all other post-1986 researchers' geochemical assignments to Annadel glass are questioned. Apparently, the difficulty of geochemically sourcing Franz Valley glass arises when geochemical testing relies on three trace-elements (rubidium [Rb], strontium [Sr], zirconium [Zr]) for obsidian assignments. In this case, Franz Valley obsidian probably falls within the range of Napa Valley glass assignments (Jackson personal communication 1992). Use of the present seven trace-element analysis (zinc [Zn], lead [Pb], rubidium [Rb], strontium [Sr], yttrium [Y], zirconium [Zr], niobium [Nb]) can still result in misassignments of Franz Valley glass to Annadel glass (such as CA-SON-1760/H, 89-2-243, Jackson and Davis 1993b, Appendix A; Holson 1989, cited by Waechter 1989a; Jackson personal communication 1992). When using the latter analysis, some researchers have distinguished Franz Valley glass from Annadel glass based on the former's higher strontium readings (after Jackson 1986).

Adjustments of obsidian hydration data are sometimes warranted. All obsidians do not hydrate at the same rate, so direct comparisons are not necessarily meaningful. Tremaine's (1989) research concluded that: the two glasses most frequently used in this research area, Napa Valley and Mt. Konocti, hydrated similarly; Annadel glass hydrated at a slower rate than Napa Valley (Annadel x 1.30 = Napa Valley and Mt. Konocti); and Borax Lake glass hydrated faster than any of these glasses (Borax Lake x 0.79 = Napa Valley and Mt. Konocti). (Please note, no comparison rate was established for Franz Valley obsidian.) To compare hydration readings, all obsidians with known comparison rates are converted to Napa Valley values (NVV) for this research. All hydration readings present in this study are provided in their original, unmodified form in Appendix B.

Also, comparison between regions may necessitate modifications. For example, Healdsburg's average annual temperature is one degree Celsius warmer than Santa

Rosa and Cloverdale's average temperature. Research has suggested a 4-6% correction factor per degree Celsius for hydration values when regional comparisons are made to sites within the Santa Rosa area (Origer 1989). Since there is only one degree Celsius variation in the research area and no distinct temperate boundaries, no adjustments are made when comparing regional similarities and variations in the study area. Other factors to consider when using obsidian hydration data include possible reader and instrument error of plus or minus 0.3 μ per reading (Freund and Origer 1990), and variation in humidity and other possible affecting factors (Jackson 1986; Mundy 1993).

Obsidian Sourcing for the Research Area

During field work at CA-SON-1810 and CA-SON-1811, it became evident that the macroscopic attributes of some obsidian recovered from both sites were not consistent with the attributes usually associated with the four major obsidian sources of the southern North Coast Ranges. Not only did some characteristics differ, but many cultural materials retained high proportions of cortex. This cortex is not battered or water-worn, attributes that are often associated with stream-tumbled cobbles, and did not always exhibit characteristics similar to obsidian from traditional quarrying areas. For instance, few Napa Valley obsidian specimens contained the rust colored, well defined, ridged cortex associated with Napa Valley quarry obsidian. Instead the cortex had a smooth surface with an off-white to grey fine layer of dust or ash.

After visually sourcing materials from one unit level from both CA-SON-1810 and -1811, Origer and Psota sorted the materials into six groups, based solely on macroscopic characteristics. Two samples of each group were subjected to trace element analysis and assigned to known obsidian sources by Hughes (1991, Appendix A) with the following results: Group 1 = Mt. Konocti; Group 2 = Napa Valley; Group 3 = Franz Valley, Group 4 = Napa Valley, and Group 5 = Franz Valley. Group 6 could not be assigned to a source from this sample. For this analysis, Groups 3 and 5 are combined as Franz Valley and Groups 2 and 4 are combined as Napa Valley.

Based on information gained from all geochemical sourcing conducted in association with this study, together with the established macroscopic attributes (Jackson 1986), the following is a description of each glass's macroscopic attributes.

1) Mt. Konocti's characteristics are clear to blackish in color, high amount of inclusions, and semi-glossy to sugary in texture (Hughes 1991, Appendix A, 91-36-15A and B).

2) Napa Valley glass ranges from: A) a transparent to translucent, clear to black in color, very glossy with no inclusions, and occasional grey banding (Hughes 1991, Appendix A, 91-36-15C and D); B) an opaque black or "root beer" brown in color and texture ranges from very glossy with no inclusions to almost a fine-grained basalt (Hughes 1991, Appendix A, 91-36-15G and H).

3) Borax Lake material ranges from translucent to opaque grey, very "sugary" or "dirty" in appearance with inclusions (Origer 1987).

4) Annadel obsidian is described as opaque and: A) grey-black in color with a "matte" or "greasy" surface, frequently with distinct banding (Jackson 1986:51); B) occasionally reddish-brown at edges (Jackson 1986:51); C) greenish with a "dirty" color (Origer 1987:194).

5) Exhibiting the most macroscopic diversity, Franz Valley glass varies from: A) glossy to semi-glossy, often with a yellow or greenish hue, translucent black in color with occasional grey banding, and when compared to Napa Valley, contains areas of fine-grained inclusions (Hughes 1991, Appendix A, 91-36-15E and F); B) glossy, translucent often with a yellow tinge, and when compared to translucent Mt. Konocti glass, air bubbles instead of inclusions; C) grey to black in color, opaque, often banded, glossy to semi-glossy with occasional fine-grained inclusions and when compared to Annadel, glossier with curved or marblized banding (Hughes 1991, Appendix A, 91-36-15I and 29A); and D) a matte, opaque battleship grey almost fine-grained basalt, similar to grey chalcedony (Jackson 1986).

Terms such as Franz Valley and Napa Valley are used to refer to a distinct geochemical obsidian assignment, and may not be limited to a particular flow or geographic area. A question mark reflects uncertainty about the possible source.

Visual sourcing assignments are made by either Origer and Psota, or Psota. An established visual sourcer, Origer uses the small freshly cut samples extracted from specimens for hydration analysis to make his sourcing assignments. Psota relies on the specimen's freshly cut notches made during obsidian hydration analysis, other recent breaks, and macroscopic attributes developed in conjunction with geochemical analysis performed for this research. Consequently, not all assignments are compatible. From a sample of 391 items, however, Origer and Psota's assignments are consistent 347 times or approximately 89%. Remarkably, this approximates expected success rates for non-float areas in the southern North Coast Ranges (Wickstrom 1982).

Since Franz Valley has only recently been geochemically described (Jackson 1986), determining if this material can be accurately visually assigned is one by-product of this research. To accomplish this, Origer visually sourced an arbitrary sample without access to XRF results or Psota's assignments. His results provide a better understanding of how some researchers may have assigned Franz Valley glass and illustrates the range of macroscopic attributes for this glass. Psota's visual sourcing assignments include comparison to geochemical and Origer's assignments. For the present study, most specimens selected for geochemical analysis are large enough for reliable readings (Jackson and Hampel 1992) and have inconclusive visual sourcing assignments. Visual sourcing accuracy improved with each XRF sample, though Origer and Psota did not discuss different assignments (Table 4). (Although comparisons and discussions are a proven method to enhance previous researchers' averages [Wickstrom and Fredrickson 1982].)

Classification of Tools

Whenever possible, descriptive flaked stone categories were chosen to generate behavioral inferences ranging from access to resources based on the quantity of material identified and the amount and extent of residual cortex, to general site activities inferred from the variety and quantity of debitage and tools present.

Flaked stone tools are divided into two main categories: formal tools, which include the subcategories of projectile points, bifaces, drills, and unifaces; and informal tools consisting of EMFs and cores.

Formal Tools

The term "biface" is applied to any bifacially worked tool with intentional shaping. Bifaces are subdivided into two groups, Forms 1 and 2, which presumably reflect different amounts of time invested to create a tool. Form 1 bifaces, whose minimal working implies less time investment, have the potential to be employed as cores to provide usable flakes as needed, or to become points or knives manufactured in a variety of shapes for an assortment of uses. Form 2 bifaces, assumed to have required more time to produce, have been shaped and thinned, limiting the number of possible future uses and shapes.

Form 1 bifaces have most of the following characteristics: 1) minimal modification, often with marginal dorsal and ventral scar coverage; 2) small flake scars, often non-invasive, interpreted as signs of edge abrasion or pressure flaking; 3) high amounts of residual cortex; 4) easily identifiable flake attributes such as remnants of original dorsal and ventral surfaces, and residual striking platforms; 5) straight to moderately sinuous margin profiles; and 6) high W:T ratios for interior flakes and low ratios for secondary decortication flakes. Form 2 bifaces have several of these additional attributes: 1) margin profiles that are moderately sinuous to sinuous; 2) large angle of blade constriction (here >43 degrees); 3) fewer items, excluding proximal ends, with a small amount of residual cortex; 4) incomplete dorsal scar coverage; and 5) identifiable ventral and dorsal surfaces.

Form 2 bifaces with many of the following characteristics are classified as projectile points: 1) basal hafting elements; 2) incomplete to complete ventral and

Table 4. Comparisons of XRF and Visual Sourcing Assignments.

researcher	v.s. assign.	xrf								sample size
Origer		NV	K	BL	A	FV	FV/A	FV?	Unknown A	89
	NV	20				1				21
	K									0
	BL			2						2
	A		1		12	8				21
	FV									0
	A?	4				3		1		8
	NV?					1				1
	?					5				5
	sample size	24	2	2	12	18	0	1	0	59
Psota										
	NV	21								21
	K	1	1					1		3
	BL			2						2
	A									0
	FV	6			8	31	1		1	47
	NV/FV	2								2
	NV?	2				1				3
	FV?				1	1				2
	FV/A		1		7	1				9
	sample size	32	2	2	16	34	1	1	1	89

dorsal scar coverage, often obscuring original flake characteristics; 3) high W:T ratio; 4) small angle of blade constriction (here varying from 18 to 40 degrees); 5) non-sinuous margin profiles; 6) biconvex cross sections; and 7) patterned flake removal. Biface fragments that are classified as projectile points have some of these attributes and frequently possess multiple fractures associated with impacts.

Fragments with only one of these attributes are listed under the multi-functional category of biface (after Dahlstrom and Bieling 1990; Fredrickson 1991:61-62; Bieling 1992:47, 59-61).

The remaining formal tools consist of drills and unifaces. Small artifacts trifacially worked to a point are considered drills. Unifaces are tools with significant dorsal surface scar coverage and no ventral surface scar coverage.

Informal Tools

The informal EMF flaked tool category contains flakes with patterned, minimal use damage, or intentional reworking along one or more margins of their dorsal surfaces. Trampling and other incidental effects may create some items categorized as EMFs (cf. Tringham et al. 1974; Gifford-Gonzalez et al. 1985). Some examples of activities associated with the deliberate manufacture of EMFs are: 1) flakes used to skin animals, to work bone or wood, and to cut plants; 2) intentional shaping, sharpening, or reworking of a flake for a tool; 3) the results of platform preparation when prepare a flake to be further modified; or 4) reducing the sharpness of edges prior to transport. EMFs are then divided into two subgroups: those with low edge angles; and those with steep-sided edge angles. Low edge angles are assumed to represent limited use and reflect a short use life. In contrast, high edge angles describe items probably characterized by moderate to intensive use. These specimens with longer use lives might imply a level of tool curation.

Cores, other than those represented by Form 1 bifaces, are characterized by unifacial, bifacial or multi-directional flake scars (Crabtree 1972). Many cores retain sufficient mass for production of additional flakes. Many are thick (low W:T ratio) with high percentages of cortex. Cores are divided into three groups: 1) assay cobbles, the breaking or minimal testing of a cobble to assess the interior's quality (Bates and Jackson 1984); 2) cores that retain enough mass to continue to be used as a core (Crabtree 1972); and 3) spent cores that were so fully utilized that there is not enough remaining mass to continue efficient use as a core. Some cores and spent cores were also used as tools as evidenced by wear patterns.

Debitage

Debitage, here the "residual lithic material resulting from tool manufacture" (Crabtree 1972:58) combines the debris from intentionally removing or shaping of an item and unintentional debris created during tool use or maintenance. For the flaked stone analysis, the debitage is separated into four groups: complete flakes that are >90% intact and have complete lengths and widths; incomplete flakes that have a complete length or width; fragments that retain some identifiable flake characteristics such as dorsal and ventral surfaces, or striking platforms; and miscellaneous debitage that retain no flake characteristics, including "shatter," generally associated with waste from primary reduction. If flakes are complete, then analysis includes recording size, percentage of cortex, weight, type (e.g., bifacially edged, overshot), obsidian source, and dorsal surface complexity. The latter consists of two categories: simple with two or fewer major arrises; and complex with more than two major arrises. For debitage categories other than complete flakes, the analysis consists of recording source, presence or absence of cortex, and weight.

Conclusion

While the methods used for this study are typical of those utilized in northern

California, their use in conjunction with non-quarry obsidian yields some unusual approaches. Little has been published on the geochemical characterization, geographic extent, and cultural use of Franz Valley glass. To obtain such information frequently required personal communications with geochemical researchers. Also, visual sourcing was similar to expected success rates in the southern North Coast Ranges, although neither Psota nor Origer have the usually acceptable success rate when categorizing Franz Valley and Annadel glasses because of the great range in macroscopic attributes for Franz Valley. So, while Origer's visual sourcing assignments are the standard for this area, his assignments of Annadel and Franz Valley obsidians were not always used. The chapter concludes with descriptions of all flaked stone tool categories to avoid any misinterpretations.

-CHAPTER FOUR-

THE RESEARCH AREA

Introduction

After briefly describing the geography and geology of the research area, this chapter focuses on 25 of the 142 Native American archaeological sites in the study area. These sites, many of which were discussed briefly in Chapter 2, and the geographic limits of the research area were selected to provide a sample of the material culture from sites situated in or near a geochemically analyzed non-quarry area, and from sites situated at a greater distance from such areas, which would function the control for this research. Given the range of available information obtained from these sites by a variety of researchers using a range of methods and analyses, data biases are provided. Obsidian hydration and sourcing results allow for temporal periods to be established and described, and for comparisons of obsidian use between sites, regions, and temporal periods to be made. To explain many of these ideas, figures, tables, and maps are enclosed.

Of 142 Native American prehistoric archaeological sites recorded by 1 January 1994 in the study area, all but 11 contain the following flaked stone material categories:

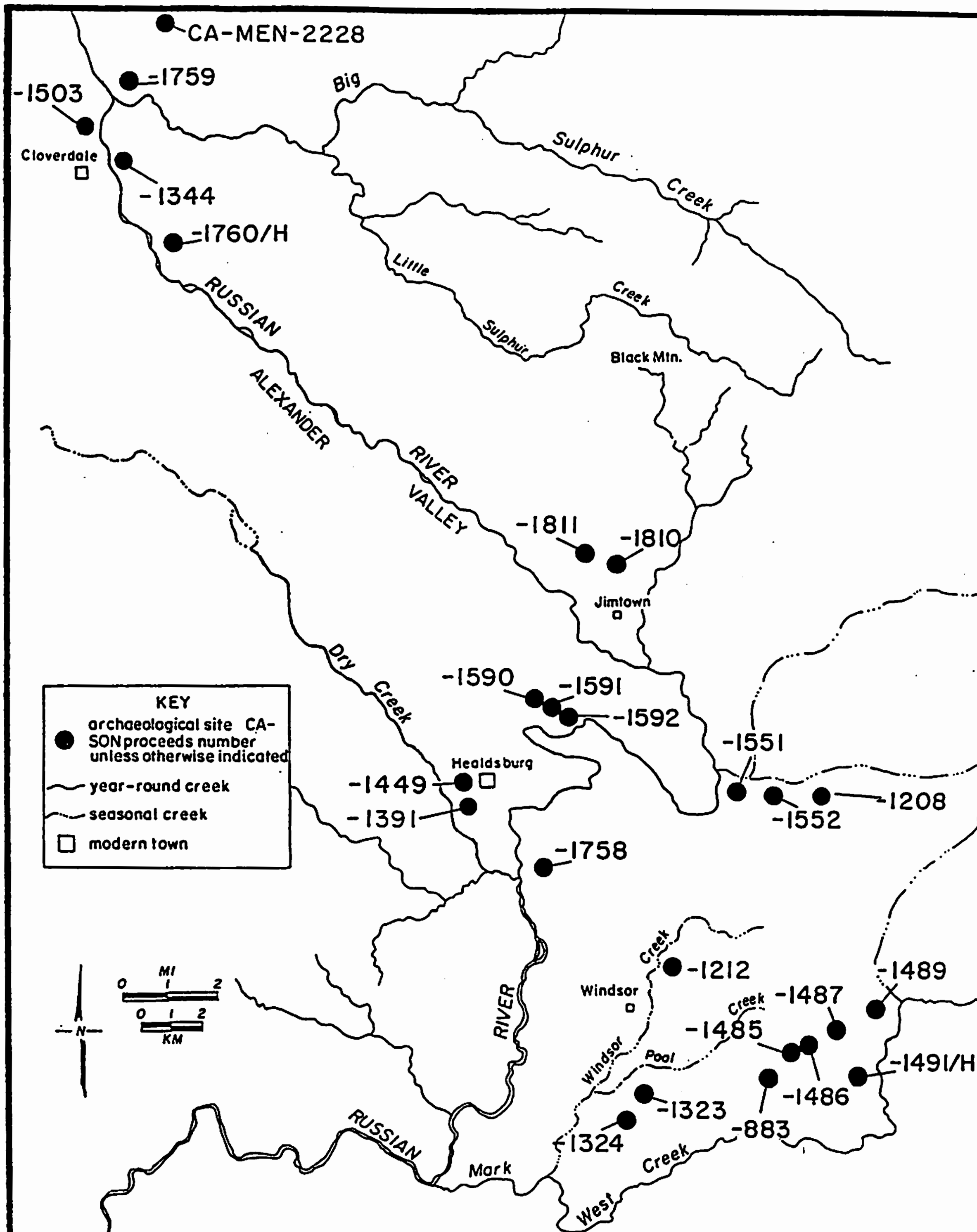
lithic scatters--	
obsidian and chert	50
obsidian	23
unspecified	6
chert	4
obsidian, chert, and basalt	2
obsidian and basalt	1
sparse lithic scatters--	
obsidian and chert	26
obsidian	19
total	131

The present research ignores other cultural characteristics, such as midden development and milling equipment. Twenty-five sites were selected from the study's sample when a sufficient quantity of curated materials and a useable number of obsidian hydration data were available (Map 5). Many of these sites are in the valleys adjacent to the Russian River. Only a few sites, CA-MEN-2228, CA-SON-1208, -1486, -1487, -1489, and -1491/H, are situated above the valley floor in hilly terrain. Most are in or near potential non-quarry areas (Map 6). The proximity of these collecting areas to Native American sites within the research area contrasts with the distance from these sites to the quarry locations of the four major obsidians in the southern North Coast Ranges (Map 7). These potential non-quarry areas are in the geologic formation called the Glen Ellen Formation (Fox et al. 1985).

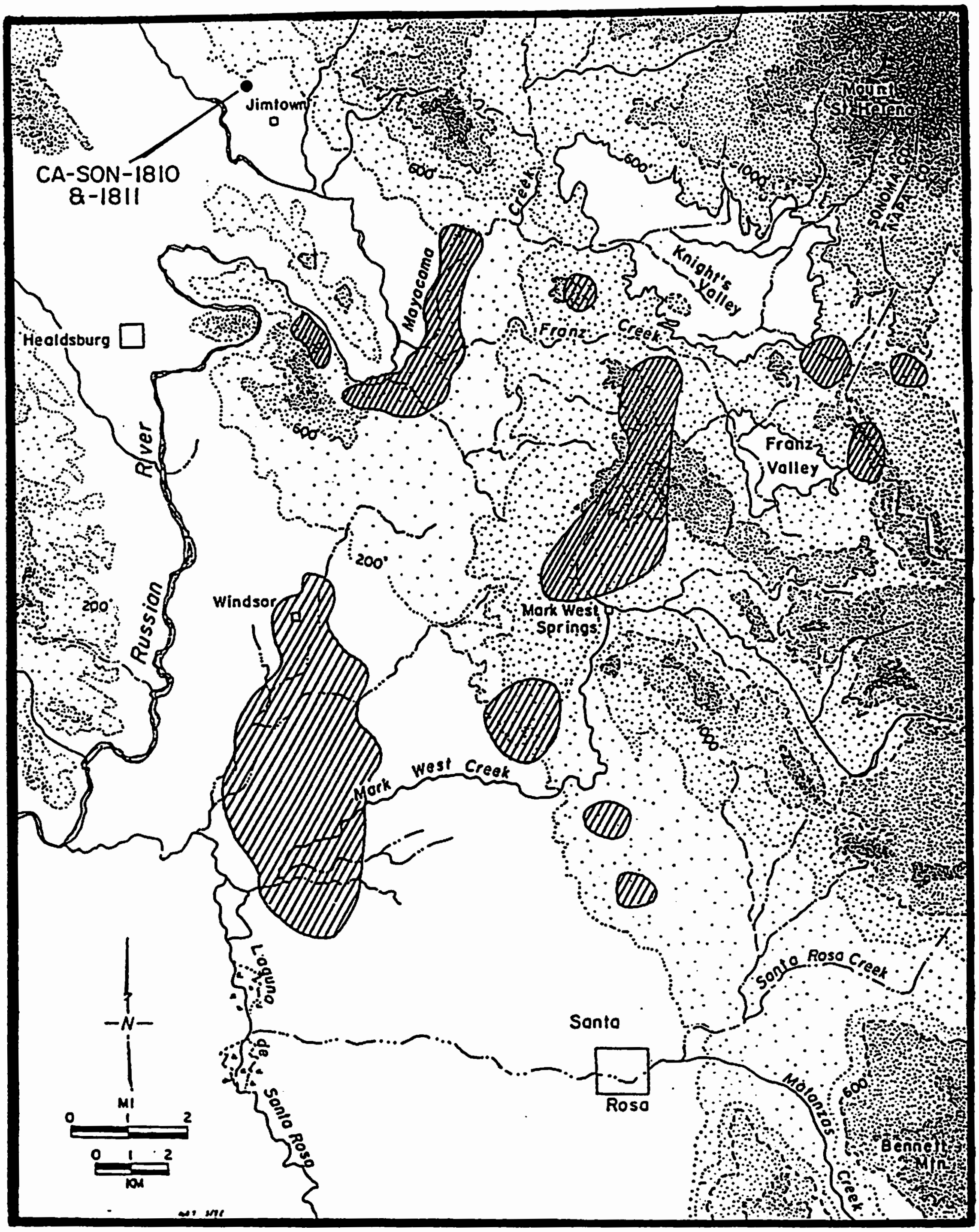
Glen Ellen Formation and Related Geology

Of the known obsidian quarries in the southern North Coast Ranges, Napa Valley and Annadel obsidians are included in the geological group referred to as "Sonoma volcanics." Fox et al. (1985:1) described this group as "consisting of complexly interleaved and much deformed lava flows, ash-flow tuffs, and pyroclastic deposits." Over millions of years the Sonoma volcanics have eroded from volcanic flows, extending "about 90 kilometers in a northwest direction, and span about 40 kilometers in the transverse direction" (Fox et al. 1985:1). Redeposited Sonoma volcanics were identified predominately within the Glen Ellen formation.

In Sonoma and Napa counties, this formation was deposited in alluvial fans and terraces in valleys, at the base of hills, and on midslope terraces possibly during the



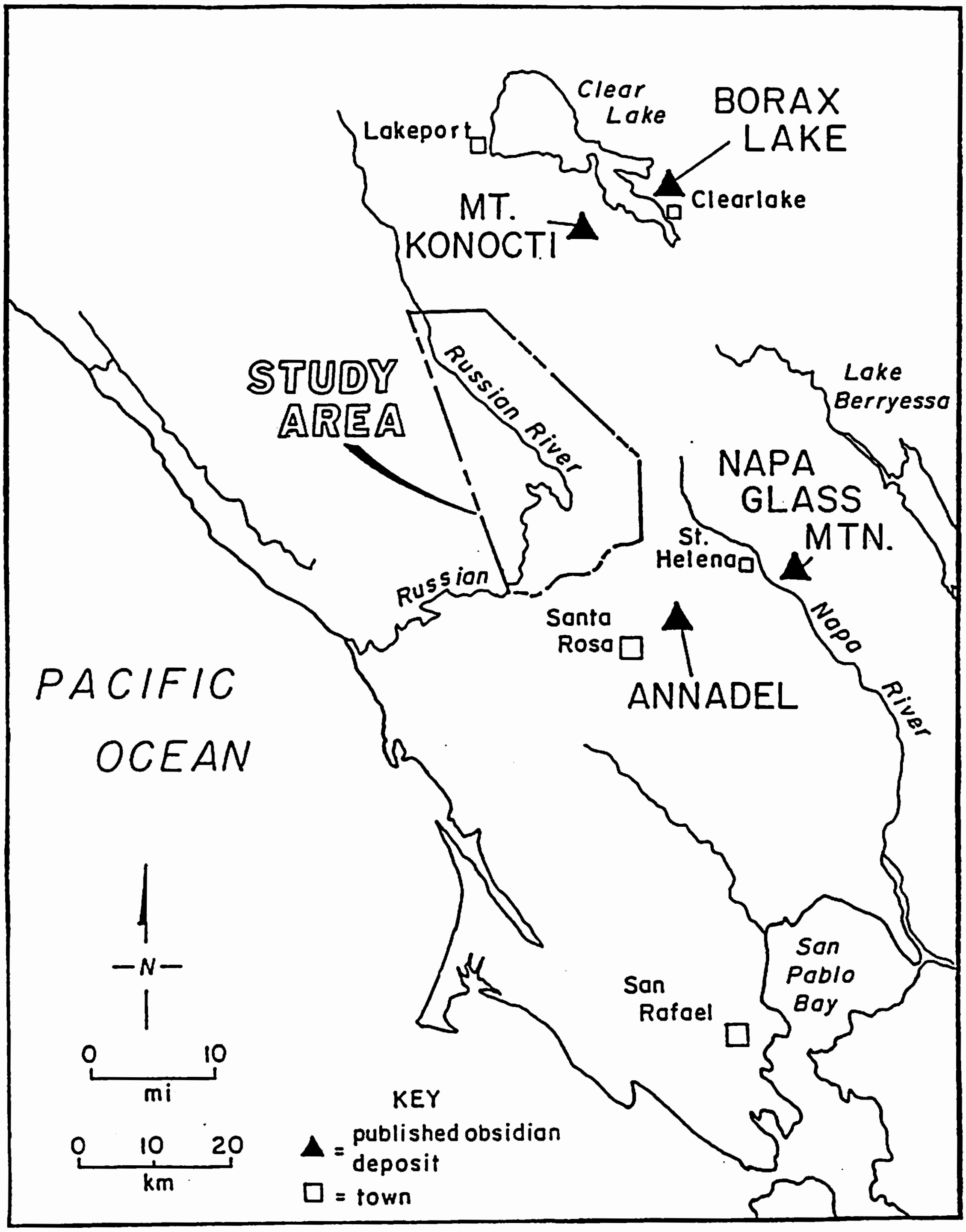
Map 5. The 25 Study Area Sites.



= collecting areas

= generalized topography (dense stipple=higher elevation)

Map 6. Potential Non-Quarry Areas in and near the Research Area.



Map 7. Major Obsidian Quarries in the Southern North Coast Ranges.

late Pliocene and principally the early Pleistocene. First identified in 1949 (Weaver 1949), it was described as an extremely heterogeneous mixture of clay, silt, gravel, and sand alternating with thick layers and lenses of coarse conglomerate of mainly andesitic cobbles, and also included obsidian pebbles and cobbles (Cardwell 1958:47; California Department of Water Resources 1975:157-158). Travis (1952) believed 3% of the typical composition of Pleistocene gravels from Santa Rosa Valley were obsidian. The distribution and size of the obsidian rocks vary. All gravel deposits do not contain obsidian, and many that do, contain pebbles too small to have been useful to Native Peoples.

The presence of obsidian pebbles and cobbles aids geologists in distinguishing the Glen Ellen Formation from other nearby formations. Boundaries of this formation are not discreet, but "discontinuously overlie and locally interfinger with the Sonoma volcanics and that interfingers with the Merced formation" (Cardwell 1958:47-48). Mapped locations of these formations differ from geologist to geologist. Their maps are biased by the field locations checked, the specific information they needed to convey, and the map's scale that often eliminated smaller and interfingering areas. Comparisons of mapped locations for the Glen Ellen Formation show the main areas to be similar, but boundaries and smaller locations can vary greatly (e.g., Weaver 1949; Cardwell 1958; Department of Water Resources 1975; Fox et al. 1985).

Based on gravel density and geographic distribution, the Glen Ellen Formation has been divided into two areas, the Windsor and Kenwood-Sonoma synclines (Cardwell 1958). This thesis focuses on cultural use of obsidian from a portion of the former, although the more general term, Glen Ellen Formation, is used throughout this research. Map 6 depicts areas documented to contain small to medium size cobbles of obsidian using the Wentworth scale (1922).

Use of Non-Quarry Obsidian

If these potential non-quarry areas were used by Native Americans, then evidence of this use should be manifested at locations within such areas and also at nearby archaeological sites within the research area. The following would be indications of Native American use of float: low proportions of primary decortication flakes; more secondary decortication flakes; and a majority of interior flakes; well-defined platforms; patination; and informal and formal tools (Patterson et al. 1987). Locations with predominately primary decortication flakes, and unmodified pebbles and cobbles are probably the result of plowing and other vehicular impacts as discussed in Chapter 2. Also, obsidian hydration analysis can assist in age determination.

Presently only one site specific investigation has been conducted at a non-quarry area, CA-SON-1212 (Bieling and Bramlette 1989). Results from this investigation suggest the obsidian cobbles at CA-SON-1212 were reduced there. Most of the other sites selected for study also exhibited evidence of culturally modified obsidian from collecting areas. This is manifested by:

1) primary and secondary decortication flakes of Napa Valley and Franz Valley glasses; 2) a large range of macroscopic attributes for Napa Valley and Franz Valley obsidians; 3) assay cores, where a cobble or large pebble has had one or two flakes removed to test the quality of the glass; and 4) cobble cores retaining much of their original shape and cortex.

Biases of Data

The 25 sites chosen for this research were investigated over the last 15 years with few conducted by the same researcher. Based on proposed impacts, the scope of work varied greatly. Some research included radio-carbon dating or obsidian hydration and sourcing analyses, whereas, other projects did not. While combining these data has resulted in a greater understanding of the study area, it is not without a few adjustments and acknowledged problems. The one uniting factor in all these studies was the presence of obsidian. To understand the range in obsidian methods, the following discussion of obsidian hydration analysis is provided.

Sites containing hydration values that are exclusively from one obsidian source may be either the result of the sample selected for hydration analysis, or reflect exclusive use of the obsidian source. For example, typically, surface collections or small subsurface testing investigations may have submitted only selected formal tools and a sample of flakes from the dominant obsidian source (i.e., CA-SON-1208, Eisenman and Fredrickson 1980; CA-SON-1323, Greenway 1986a; CA-SON-1324, Greenway 1986b; CA-MEN-2228, CA-SON-1759, and -1760/H, Waechter 1989a; CA-SON-1449, Waechter 1989b; CA-SON-1212, Bieling and Bramlette 1989; CA-SON-1503, Dowdall et al. 1989; CA-SON-1485 through 1491/H, Greenway n.d., cited by Waechter 1989b). While collections from some sites in the research area actually do contain predominately or exclusive use of a major obsidian source (i.e., CA-SON-1503, Dowdall et al. 1989; -1449, Waechter 1989b; -1590, Hayes and Jordan 1987; -1212, Bieling and Bramlette 1989; and -883, Greenway n.d., cited by Waechter 1989b), hydration results from other sites were used to establish temporal use and did not reflect the assortment of the major obsidians utilized (i.e., CA-MEN-2228, Waechter 1989a; CA-SON-1758, Waechter 1989a; -1391, Busby et al. 1984; and -1208, Eisenmann and Fredrickson 1980).

In contrast, usually larger or federally-funded projects have had more elaborate research designs and budgets allowing for submission of multiple hydration samples; each designed to address specific areas of research (i.e., Garfinkel and Bingham 1984 [CA-SON-1344]; Gmoser 1992 [CA-SON-1810 and -1811]). Frequently, the first hydration sample submitted establishes a site's temporal span. This is usually accomplished by submitting a hydration sample using only the dominant obsidian source at a site. If a second sample is submitted, the intent may be to elaborate on aspects of the site's temporal use, supplement the analysis of various formal tools, or examine the use of other obsidian sources. Frequently, the latter two are combined because often formal tools were produced from a wider variety of obsidian sources than might be represented by the obsidian debitage as discussed in Chapter One. Thus, the testing of tools frequently generates hydration values characterizing a greater variety of obsidian sources.

The few hydration samples analyzed for part of this research were limited to addressing the temporal use of the study's sites (i.e., CA-SON-1758 and -1391). It was beyond the scope of this preliminary study to generate hydration readings for non-Napa Valley glass use through time, because to be meaningful it would require establishing a comparison constant for Franz Valley glass. Visual sourcing frequencies of the major obsidians and Franz Valley glass per site are included in Table 5.

Temporal Periods and Regions within Research Area

The research area is divided into three regions:

North	Central	South
CA-MEN-2228	CA-SON-1811	CA-SON-1324
CA-SON-1503	CA-SON-1810	CA-SON-1323
CA-SON-1344	CA-SON-1758	CA-SON-1212
CA-SON-1759	CA-SON-1449	CA-SON-1485
CA-SON-1760/H	CA-SON-1391	CA-SON-1486
	CA-SON-1590	CA-SON-1487
	CA-SON-1591	CA-SON-1489
	CA-SON-1592	CA-SON-1491/H
	CA-SON-1551	CA-SON-883
	CA-SON-1552	
	CA-SON-1208	

Further information concerning the use of non-quarry obsidian cannot be provided without describing a general history of the research area and identifying pertinent trends through time. These regions are delineated to identify the geographic distribution of the various obsidian sources, and to recognize inter- and intra-regional similarities and differences. In the following figures, tables, and maps, sites are organized from north to south. CA-MEN-2228 is the only site not in Sonoma County; all other site numbers have a CA-SON- prefix.

Table 5 presents data employing the visual sourcing categories described in Chapter 3. Because few sites were single component, or had discreet single component areas, obsidian frequencies per source may reflect general site use over time. Percentages of obsidian to chert are provided to illustrate the variety and frequency of flaked stone material used. Debitage specimens from some sites, such as CA-SON-1811, were overwhelmingly less than one square centimeter. Research has indicated visual sourcing results were less reliable with smaller pieces because fewer diagnostic macroscopic attributes were present (Wickstrom and

Figure 1. Converted Hydration Values for Annadel, Borax Lake, Konocti, and Napa Valley Obsidians.

	NORTH					CENTRAL											SOUTH									
Hyd	2228	1503	1344	1759	1760	1811	1810	1758	1449	1391	1590	1591	1592	1551	1552	1208	1324	1323	1212	1485	1486	1487	1489	1491	883	All
1.0														1			1							2	1	5
1.1	2													1			1				1			2	3	10
1.2	3				1	3	1							1	1						1					11
1.3	2					3				1										1	1					8
1.4			1	1	1							2					2		1			1		1		10
1.5			1			4		1					1													7
1.6				1	1										1								1	1		5
1.7			3		2	1																1		1		8
1.8		1	3		1																					5
1.9										1							1					1				3
2.0			3														2					1				6
2.1			2	1									1		1		1	1					1			8
2.2	1	1			1	1		2				1		1				1		1						10
2.3			1							3		1	1				1	1		1	1		2			12
2.4		2	4		1	3											2						1			13
2.5	1		2	2		2							2				1			3	2					15
2.6		1	1	1		5		2	2	2	1		2													17
2.7	1				1	2						1	2				1	2								10
2.8			3	1	1	2	2		1					1			1									12
2.9		1			1	5				1				1				1		2			1		1	14
3.0			2		2	9	2			2			1							1						19
3.1					2	2	3		1	2							1	1								12
3.2			1	1	2	1	3																			8
3.3			2			1	1		1	1	1						1	1			1					10
3.4		1		1		6				1							1	4		1					1	16
3.5		1	5			2	2		1								2	2					1			16
3.6		1	4	2	1	4	4		3						1		1	2		1	1				1	26
3.7		2	5	1	2	9									1			3	1							24
3.8		2	3	3	1	1	4										1	1			1					17
3.9		3	2			3	2			2	1							1							1	15
4.0		3	5	1		1	1		3								2			1						17
4.1		1	2	2		1						1						3								10
4.2		3			1							1				1	4	1		2						13
4.3		1	2	1		5	4			1						1	1	2			2					20
4.4			1	1		2	4									1	1	1		1	4					16
4.5			4	1					1						1			1		1						9
4.6			4	2			1		1						1			1		1						11
4.7			4			1					1			1		1		1			1					10
4.8			1	1			2					1		1			1	1								8
4.9						1	1		1	1				1				1							1	7
5.0			2		1	1	1		1					1			1	1								9
5.1			3				1											2								6
5.2						1			1					1	1											4
5.3			1				1		1								1									4
5.4			2				1												1							4
5.5						1																				1
5.6																	1	1								2
5.7			1				1				1								1	1						5
5.8						1																				1
5.9							1											1								2
6.0																			1							1
6.1																			1							1
6.2			1																							1
6.3			1																1							2
6.4									1																	1
6.5																										
6.6			1								1									1						3
6.7																			1							1
6.8			1						1																	2
6.9																			1							1
7.0																										
7.1																										
7.2				1																						1
7.3										1	1								1							3
7.4																										
	10	24	84	25	23	84	43	5	20	19	7	8	10	11	8	4	33	36	10	19	16	4	7	7	9	528

Figure 2. Napa Valley Obsidian, Actual Values.

	NORTH				CENTRAL											SOUTH									
Hyd	2228	1344	1759	1760	1811	1810	1758	1449	1391	1590	1591	1592	1551	1552	1208	1324	1323	1212	1485	1486	1487	1489	1491	883	All
1.0													1			1							2	1	5
1.1	1															1				1			2	3	8
1.2	1				3								1	1						1					7
1.3					3				1										1						5
1.4		1		1							2					2		1			1		1		9
1.5		1			4		1					1													7
1.6				1										1								1			3
1.7		3		1	1																				5
1.8		3		1																					4
1.9									1							1					1				3
2.0		3														2					1				6
2.1		2										1		1		1	1					1			7
2.2				1	1		2						1						1						6
2.3		1							3		1	1							1	1		2			10
2.4		4		1	3											2						1			11
2.5		2			2							2							3	2					11
2.6					5		2	2	2	1		2													14
2.7	1				1												1								3
2.8		2		1	2			1					1			1									8
2.9					4				1				1											1	7
3.0		2			7				2			1													12
3.1					1	2		1	2							1									7
3.2		1			1	2																			4
3.3		2			1			1	1	1						1	1			1					9
3.4					4				1							1	4		1					1	12
3.5		3			2			1								2	2					1			11
3.6		2	1	1	4	3		3						1		1	2		1	1				1	21
3.7		2			8												3	1							14
3.8		3	1		1	4										1	1			1					12
3.9		1			3	2			2	1														1	10
4.0		3			1	1		3								2									10
4.1		1	1								1						3								6
4.2				1							1				1	2	1		1						7
4.3		2	1		5	3			1						1	1	2			2					18
4.4		1	1		1	2									1	1	1		1	4					13
4.5		4						1						1			1		1						8
4.6		3	2			1		1						1			1		1						10
4.7		2			1					1			1		1		1			1					8
4.8						2					1		1			1	1								6
4.9					1	1		1	1				1											1	6
5.0		1		1	1			1					1			1	1								7
5.1		1				1											2								4
5.2					1			1					1	1											4
5.3						1		1								1									3
5.4		1				1												1							3
5.5					1																				1
5.6																1	1								2
5.7		1				1				1								1	1						5
5.8																									
5.9																									
6.0																		1							1
6.1																		1							1
6.2																									
6.3		1																1							2
6.4								1																	1
6.5																									
6.6										1									1						2
6.7																		1							1
6.8		1						1																	2
6.9																		1							1
7.0																									
7.1																									
7.2			1																						1
7.3									1	1								1							3
7.4																									
	3	60	6	10	73	27	5	20	19	7	6	8	10	7	4	28	30	10	14	15	3	6	5	9	367

Figure 3. Konocti Obsidian, Actual Values.

Hyd	NORTH 2228	1503	1344	1759	1760	CENTRAL 1811	1810	1591	1551	1552	SOUTH 1485	All
1.0												
1.1	1								1			2
1.2	2				1		1					4
1.3	2											2
1.4				1								1
1.5												
1.6				1								1
1.7					1							1
1.8		1										1
1.9												
2.0												
2.1				1								1
2.2	1	1						1				3
2.3												
2.4		2										2
2.5	1			2								3
2.6		1	1	1								3
2.7					1							1
2.8			1	1			1					3
2.9		1			1	1						3
3.0					2	2	2				1	7
3.1					1	1	1					3
3.2				1	2							3
3.3							1					1
3.4		1		1		2						4
3.5		1	2									3
3.6		1	2	1			1					5
3.7		2	2	1	2	1				1		9
3.8		2		2	1							5
3.9		3	1									4
4.0		3	2	1								6
4.1		1	1	1		1						4
4.2		3										3
4.3		1										1
4.4												
4.5				1								1
4.6												
4.7			1									1
4.8			1	1								2
4.9												
5.0												
5.1			1									1
5.2												
5.3												
5.4												
5.5												
5.6												
5.7												
5.8												
5.9												
6.0												
6.1												
6.2			1									1
6.3												
6.4												
6.5												
6.6			1									1
6.7												
6.8												
6.9												
7.0												
7.1												
7.2												
7.3												
7.4												
	7	24	17	17	12	8	7	1	1	1	1	96

Figure 4. Borax Lake Obsidian, Actual Values.

Hyd	NORTH 1344	CENTRAL 1811	CENTRAL 1810	SOUTH 1323	SOUTH 1485	All
1.0						
1.1						
1.2						
1.3						
1.4						
1.5						
1.6						
1.7						
1.8						
1.9						
2.0						
2.1						
2.2						
2.3						
2.4						
2.5						
2.6						
2.7						
2.8			1			1
2.9					1	1
3.0						
3.1						
3.2			1			1
3.3						
3.4						
3.5			2			2
3.6						
3.7	1					1
3.8						
3.9						
4.0					1	1
4.1						
4.2					1	1
4.3			1			1
4.4			2			2
4.5						
4.6	1					1
4.7	1					1
4.8						
4.9				1		1
5.0	1		1			2
5.1	1					1
5.2						
5.3	1					1
5.4	1					1
5.5						
5.6						
5.7						
5.8		1				1
5.9			1			1
6.0						
6.1						
6.2						
6.3						
6.4						
6.5						
6.6						
6.7						
6.8						
6.9						
7.0						
7.1						
7.2						
7.3						
7.4						
	7	1	9	1	3	21

Figure 5. Annadel Obsidian, Actual Values.

	NORTH	CENTRAL				SOUTH							
Hyd	1760	1811	1591	1592	1324	1323	1485	1486	1487	1489	1491	1917	All
1.0													
1.1													
1.2													
1.3								1					1
1.4													
1.5													
1.6											1		1
1.7									1		1		2
1.8													
1.9													
2.0													
2.1													
2.2						1							1
2.3					1	1							2
2.4													
2.5					1								1
2.6													
2.7		1	1	2	1	1							6
2.8													
2.9						1	1			1			3
3.0													
3.1	1					1							2
3.2													
3.3												1	1
3.4													
3.5													
3.6													
3.7													
3.8													
3.9						1							1
4.0													
4.1													
4.2					2								2
4.3													
4.4		1											1
4.5													
4.6													
4.7													
4.8													
4.9													
5.0													
5.1													
5.2													
5.3													
5.4													
5.5													
5.6													
5.7													
5.8													
5.9						1							1
6.0													
6.1													
6.2													
6.3													
6.4													
6.5													
6.6													
6.7													
6.8													
6.9													
7.0													
7.1													
7.2													
7.3													
7.4													
	1	2	1	2	5	7	1	1	1	1	2	1	25

Figure 6. Franz Valley Obsidian, Actual Values.

	NORTH		CENTRAL								SOUTH							
Hyd	1344	1760	1811	1810	1758	1591	1592	1551	1552	1208	1324	1323	1212	1485	1489	1491	883	All
1.0																		
1.1						1					1							2
1.2		1											1					2
1.3													1				1	2
1.4													1			1		2
1.5																		
1.6	1				1													2
1.7											1	1						2
1.8		1			1													2
1.9											1							1
2.0												1		1				2
2.1			1				1					1	1	1				5
2.2												1		1				2
2.3	1		2									2					1	6
2.4		1	1					1					1	1				5
2.5			1	1							1	1	1					5
2.6			1	1						1		1		1				5
2.7			2											1				3
2.8												1	1					2
2.9			1									1						2
3.0		1	2									1						4
3.1									1			1						2
3.2		1	2									1						4
3.3			2						1			1		1				5
3.4				1								1						2
3.5														1	1			2
3.6																		
3.7													1					1
3.8			1									1	1					3
3.9																		
4.0	1																	1
4.1																		
4.2				2														2
4.3																		
4.4	1																	1
4.5	1																	1
4.6												1						1
4.7																		
4.8												1						1
4.9																		
5.0																		
5.1																		
5.2																		
5.3																		
5.4																		
5.5																		
5.6																		
5.7											1							1
5.8																		
5.9																		
6.0																		
6.1				1														1
6.2				1														1
6.3																		
6.4	1																	1
6.5																		
6.6																		
6.7																		
6.8																		
6.9																		
7.0																		
7.1														1				1
7.2												1						1
7.3																		
7.4				1														1
	6	5	16	8	2	1	1	1	2	1	5	19	9	9	1	1	2	89

Table 5: Flaked Stone Recovered from the 25 Study Sites

site		NV	FV	A	FV/A	BL	K	?	total	Percentage of Ob	to Chert
		Visual Sourcing (qty/# with cortex)									
CA-MEN-2228	tools	3/1		1/0			2/0				
	deb	4/1	1/0			1/0	20/0				
	total	7/2	1/0	1/0		1/0	22/0		32/2	93	7
1503	tools										
	deb	6/3			1/0		480/**				
	total	6/3			1/0		480/**		487/**	73	27
1344 Hyd Sample	tools	26/6	7/1			2/0	10/1				
	deb	41/16	3/2			4/1	7/2	1/0			
	total	67/22	10/3			6/1	17/3	1/0	101/29	**	
1344 early	tools										
	deb	38/1				1/0	11/1	1/0			
	total	38/1				1/0	11/1	1/0	51/2	40	60
1344 late	tools										
	deb	39/3	4/1			2/0	17/1	1/0			
	total	39/3	4/1			2/0	17/1	1/0	63/5	79	21
1759	tools						3/0				
	deb	8/0					13/2				
	total	8/0					16/2		24/2	71	29

site		NV	FV	A	FV/A	BL	K	?	total	Percentage of Ob	to Chert
		Visual Sourcing (qty/# with cortex)									
1760/H	tools	16/3	2/2	1/0			17/2	2/0			
	deb	127/26	18/3			12/6	202/20	2/0			
	total	143/29	20/5	1/0		12/6	219/22	4/0	399/62	77	23
1810	tools	5/1	2/0			3/1	3/0				
	deb	70/22	60/10			7/1	15/3				
	total	75/23	62/10			10/2	18/3		165/38	40	60
1811	tools	73/42	21/9	2/0		2/1	3/1				
	deb	195/32	103/8	1/0			21/0				
	total	268/74	124/19	3/0		2/1	24/1		421/95	89	11
1758	tools	5/4									
	deb	10/7	3/3								
	total	15/11	3/3						18/14	**	
1449	tools	2/1									
	deb	31/8					5/1				
	total	33/9					5/1		38/10	34	66
1391	tools	28/15	9/6				2/0				
	deb	560/69	59/18				4/0	2/0			
	total	588/84	68/24				6/0	2/0	664/108	76	20

		Visual Sourcing (qty/# with cortex)								Percentage of	
site		NV	FV	A	FV/A	BL	K	?	total	Ob to	Chert
1590	tools	2/1									
	deb	6/4									
	total	8/5							8/5	**	
1591	tools	4/3						1/0			
	deb	7/4	1/1	1/1							
	total	11/7	1/1	1/1				1/0	14/9	**	
1592	tools	10/4		1/1							
	deb	6/4	4/2	1/1			3/0				
	total	16/8	4/2	2/2			3/0		25/12	**	
1551	tools	7/3	1/1				1/0				
	deb	30/13	1/0	1/0							
	total	37/16	2/1	1/0			1/0		41/17	84	16
1552	tools	7/2					1/0				
	deb	11/5	3/1								
	total	18/7	3/1				1/0		22/8	92	8
1208	tools	6/4	6/3								
	deb	128/33	54/17								
	total	134/37	60/20						194/57	74	26

		Visual Sourcing (qty/# with cortex)								Percentage of	
site		NV	FV	A	FV/A	BL	K	?	total	Ob	to Chert
1324	tools	6/3	1/1	1/1							
	deb	193/64	29/7	10/1	1/0						
	total	199/67	30/8	11/2	1/0				241/77	71	28
1323	tools	22/10	23/7	5/0	1/0	1/0					
	deb	162/67	52/32	19/2			3/0	1/0			
	total	184/67	75/39	24/2	1/0	1/0	3/0	1/0	289/108	74	26
1212	tools	2/1	4/3		2/0						
	deb	25/11	13/7		3/1			3/2			
	total	27/13	17/10		5/1			3/2	52/25	••	
1485	tools	9/1	4/2		2/0	2/0	1/0	2/0			
	deb	95/28	34/14	5/1							
	total	104/29	38/16	5/1	2/0	2/0	1/0	2/0	154/46	86	14
1486	tools	8/1	2/2	2/0							
	deb	64/25	11/6			1/0					
	total	72/26	13/8	2/0		1/0			88/34	••	
1487	tools	1/0		1/1							
	deb	5/4	1/0								
	total	6/4	1/0	1/1					8/5	••	

site		NV	FV	A	FV/A	BL	K	?	total	Percentage of Ob to Chert
1489	tools									
	deb	8/3	1/1	1/0		1/0		1/1		
	total	8/3	1/1	1/0		1/0		1/1	12/5	**
1491/H	tools	3/2	1/1	2/0						
	deb	4/2		2/0						
	total	7/4	1/1	4/0					12/5	**
883	tools	9/3	5/2							
	deb	16/1	7/4	1/1						
	total	25/4	12/6	1/1					38/10	**

Visual Sourcing (qty/# with cortex)

sites: all prefixed by CA-SON-, unless specified
** not noted or quantifiable

Fredrickson 1982; Psota 1990). Also, small specimens produced fewer reliable geochemical readings (Jackson and Hampel 1992). (In general, smaller flakes tend to be a byproduct of tool maintenance and recycling, or initial manufacture [Stahle and Dunn 1982]; in this portion of northern California, small flakes may indicate Late Period use, a result of all of these activities [Tremaine et al. 1986].)

Figures 1-6 focus solely on obsidian hydration values with no temporal adjustments for comparison with other areas. Cumulative hydration readings adjusted to Napa Valley values (NVV) are presented in Figure 1 (Tremaine 1989). Figures 2-5 provide NVV hydration readings for each individual source used to produce Figure 1 with all primary, non-converted hydration readings provided in Appendix B. Since Franz Valley glass does not have an established comparison constant rate, all obsidian hydration values assigned to this glass have been separated from obsidians with known comparison constant rates (Figure 6). Hydration values for temporally diagnostic projectile point types (Table 6) exhibit similar ranges and means to those established by Origer (1987).

Temporal Periods

Each of the three study regions contains a variety of site types ranging from middens to sparse lithic scatters with some sites represented by less than ten obsidian hydration readings. Because well marked temporal trends could not be established from hydration readings and temporally diagnostic artifacts, arbitrary analytic periods were used to establish a temporal framework (adapted after Bramlette 1988). Although temporally diagnostic artifacts have been recovered from some study area sites and certain assemblages have been proposed (e.g., Garfinkel and Bingham 1984; Greenway 1986a; Waechter 1989a), the enlarged

Table 6. Temporally Diagnostic Projectile Points.

Points	Research Area Site	Research Area Acc#	Hyd	Source	Southern North Coast Ranges Established Hyd Range for Points + Qty	Range NVV	Mean
corner-notched	CA-SON-1344	82-19-603	1.4	NV	130	1.0 - 2.9	1.6
	CA-SON-1344	82-19-769	1.5	NV			
	CA-SON-1344	82-19-44	1.7	NV			
	CA-SON-1344	82-19-480	2.3	NV			
	CA-SON-1344	82-19-494	2.3	FV			
	CA-SON-1759	89-2-41	2.5	K			
	CA-SON-1759	89-2-40	2.6	K			
	CA-SON-1760/H	89-2-241	1.7	K			
	CA-SON-1760/H	89-2-242	1.8	NV			
	CA-SON-1811	91-36-290	1.5	NV			
	CA-SON-1811	91-36-289	2.4	NV			
	CA-SON-1491/H	85-5-913	NVB	A			
serrated corner-notched	CA-SON-1759	89-2-42	2.5	K	127	1.5 - 2.9	2.1
	CA-SON-1760	89-2-243	1.2	FV			
contracting stem	CA-SON-1323	85-7-15	3.4	FV			
	CA-SON-1323	85-7-15	4.8	FV			
	CA-SON-1323	85-7-16	4.6	FV			
lanceolate	CA-SON-1344	82-19-500	2.6	K	127	1.3 - 6.2	3.2
	CA-SON-1344	82-19-503	2.8	K			
	CA-SON-1811	91-36-273	2.7	NV			
	CA-SON-1811	91-36-40	3.3	NV			
	CA-SON-1811	91-36-63	3.4	NV			
	CA-SON-1811	91-36-47	3.7	NV			
	CA-SON-1811	91-36-82	3.7	NV			
	CA-SON-1811	91-36-64	4.4	NV			
	CA-SON-1323	85-7-53	4.3	NV			
	CA-SON-883	85-5-900	3.6	NV			
large corner-notched	CA-SON-1760	89-2-257	3.1*	A	10	1.6 - 3.6	2.5
	CA-SON-1208	549-42	4.4	NV			
	CA-SON-1324	86-6-113	2.5*	A			
	CA-SON-1490	85-5-908	5.0	NV			
concave base	CA-SON-1323	85-7-6b	4.7	NV			
	CA-SON-1323	85-7-6a	4.8	NV			
	CA-SON-1323	85-7-14	4.5	A?**			
	CA-SON-1323	85-7-73	8.9++	FV			
stem	CA-SON-1323	85-7-10	4.9*	BL			
	CA-SON-1917	90-3-500	3.3*	A			
wide stem	CA-SON-1344	82-19-269	4.0	FV	8	1.8 - 6.9	4.7
	CA-SON-1344	82-19-96	4.5	FV			

\+ adapted from Origer 1987:47, using Tremaine 1989.
* NVV
** very patinated, hydration reading not adjusted to NVV
\+ + weathered edges, reading from a crack

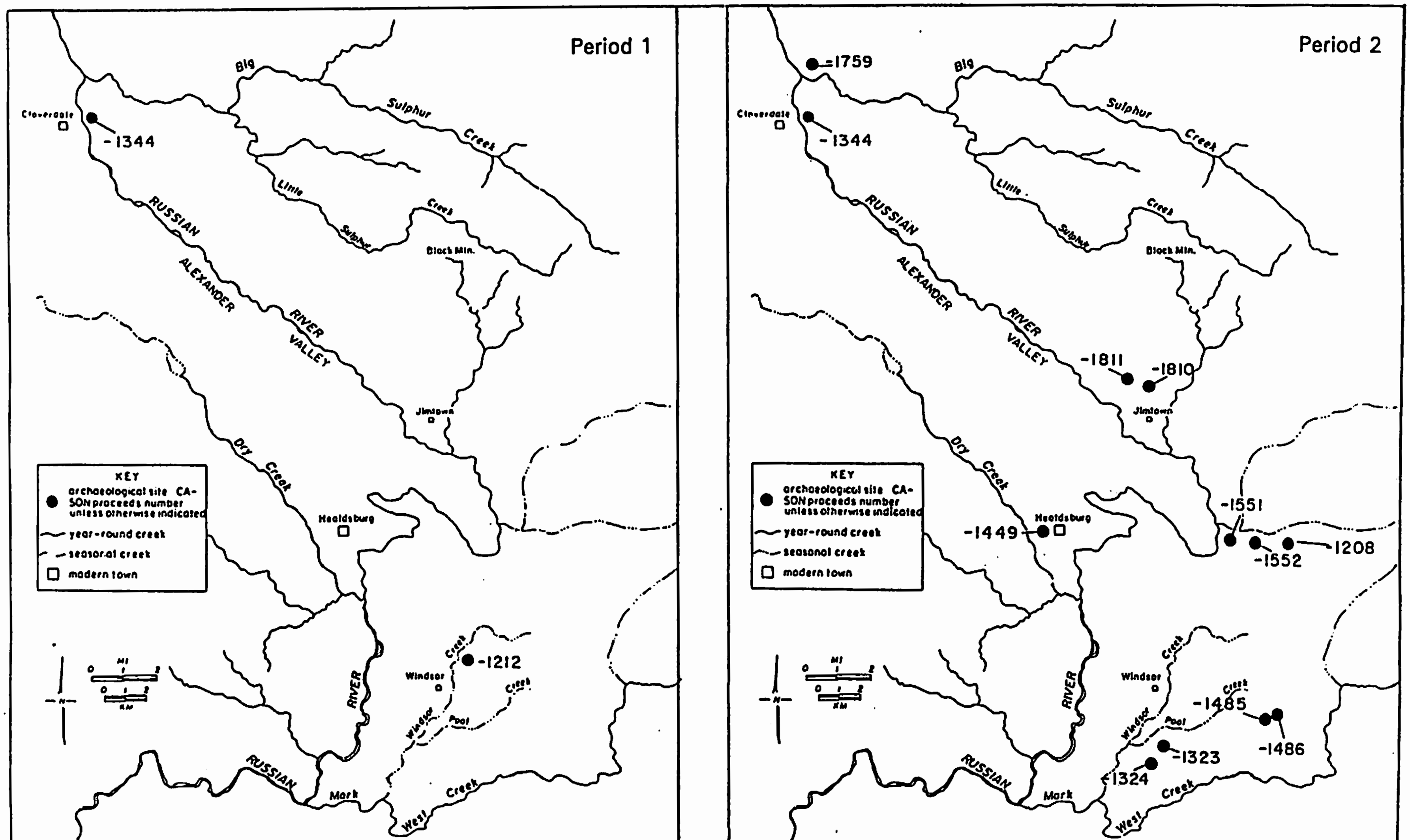
sample produced no clear assemblages and periods. Except for a few outliers, hydrations readings clustered between 1.0 and 7.4 μ NVV. Four analytic periods were established each with a span of 1.6 μ, except the latest period that absorbed the extra 0.1 μ reading. These are:

Period 1	5.9 - 7.4 μ
Period 2	4.3 - 5.8 μ
Period 3	2.7 - 4.2 μ
Period 4	1.0 - 2.6 μ.

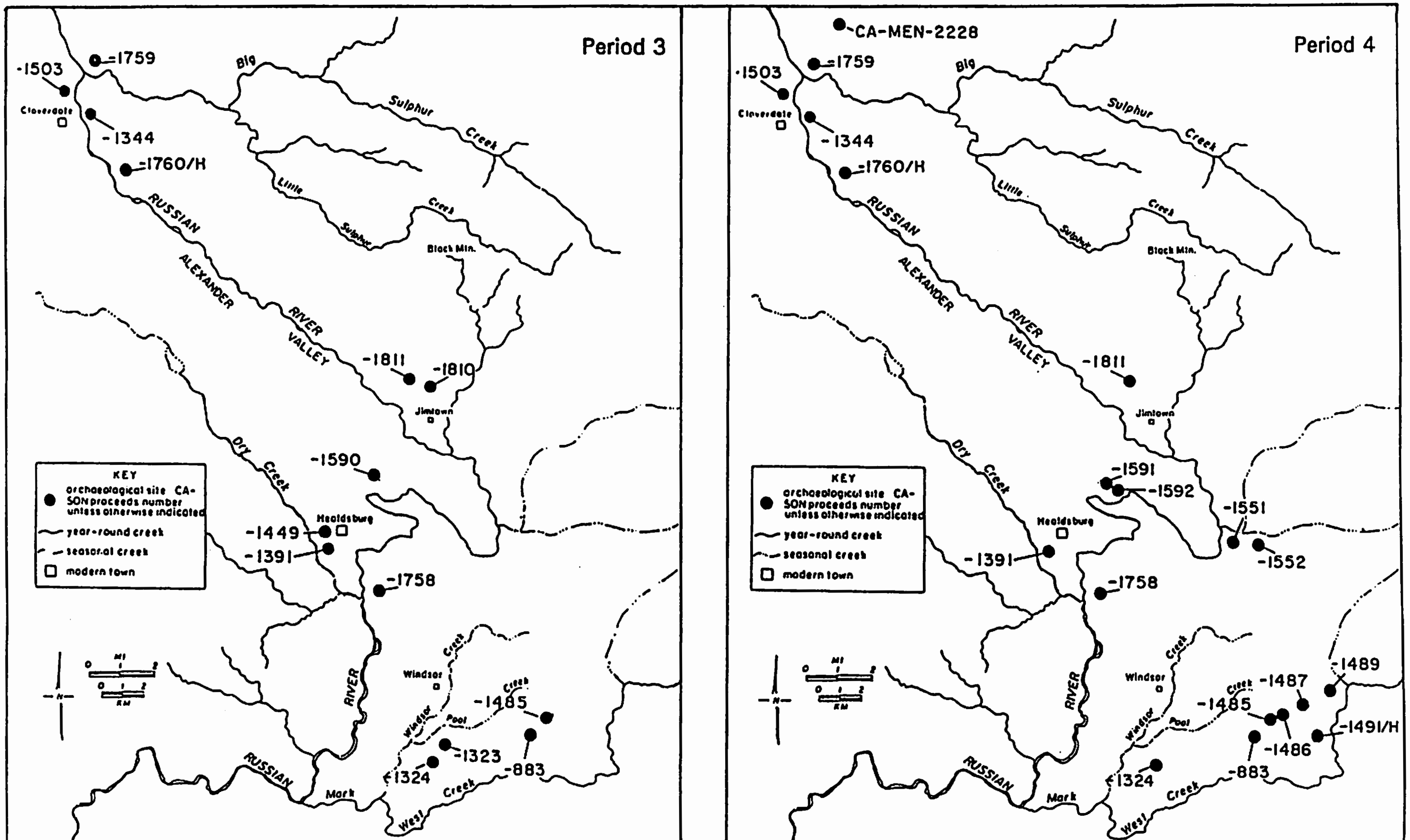
Figures 1-6 document the temporal standing of each of the 25 sites per obsidian source (Map 5). Maps 8 and 9 depict site use and distribution per period. Again, with an unknown comparison hydration rate, Franz Valley glass hydration readings are not included. Sites are plotted on these maps if they contain at least five hydration readings per period, or if three or four hydration readings in a period comprise 36% or greater of the total hydration readings from a site. This enables a variety of site types, including sparse lithic scatters, to describe temporal trends in site use, but not cultures. A description of each period is provided below, centering on the use of material from the four major obsidian sources.

Period 1

Very light use of this area begins in Period 1 as depicted in Map 8. No temporally diagnostic formal artifacts have been identified to this period. In the North Region, Napa Valley and Mt. Konocti glasses were used equally. Exclusive use of Napa Valley obsidian occurred in the South Region. Although both sites contained flaked chert (Table 5), available data do not allow relative frequencies of chert and obsidian cannot be determined for this or any other period. To date, no sites within the Central Region have been documented to this period.



Map 8. Sites Used During Temporal Periods 1 and 2.



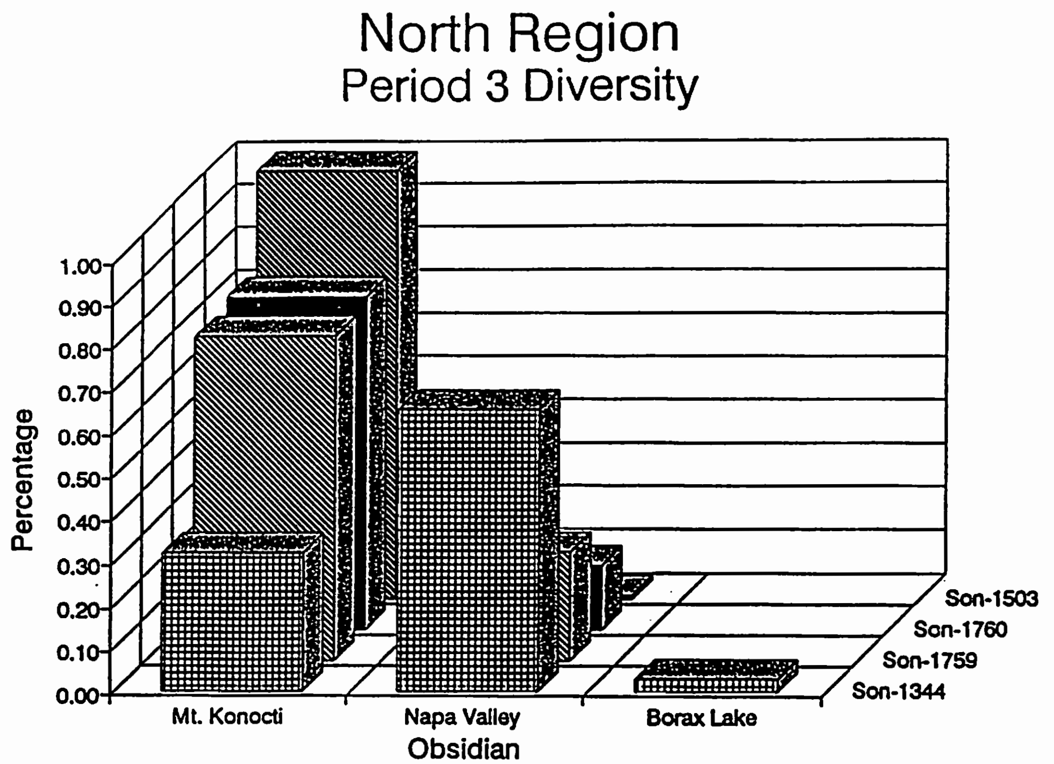
Map 9. Sites Used During Temporal Periods 3 and 4.

Period 2

There is an increase in the number of sites used during Period 2 (Map 8). Temporally diagnostic points consist of stem and concave bases with lanceolates and large corner-notched initially used near the end of this period. The North Region was characterized by a dominance of Napa Valley glass (approximately 65%) with generally light use of Mt. Konocti glass (ranging from 9 to 34%). Annadel glass was not used. Initial use of the Central Region is documented by hydration values from six sites. There was a predominance of Napa Valley obsidian at all sites; CA-SON-1810 contained exclusive use of this major obsidian. Use of the South Region was similar to the Central Region in the dominance of Napa Valley glass with only a few pieces of Annadel glass identified at CA-SON-1324. One site from each region, CA-SON-1344, -1810, and -1323, contained relatively light use of Borax Lake obsidian, ranging from 20-26% of the hydration sample defining this period.

Period 3

Sites used during Period 3 are depicted on Map 9. Hydration values demonstrate that both lanceolates and large corner-notched points continued to be used during this period. Frequencies of Annadel glass were greatest in the South region and decreased progressively northward. Period 3 began with an increase in use of the North Region that decreased after 3.2 μ. During this time, sites in this region exhibit contrasting ratios of obsidian use (Figure 7). For example, CA-SON-1759 and -1760 contained predominately Mt. Konocti glass with Napa Valley the next most frequently used glass; at CA-SON-1760 one piece of Annadel was identified to this period. CA-SON-1503 included almost exclusive use of Mt.



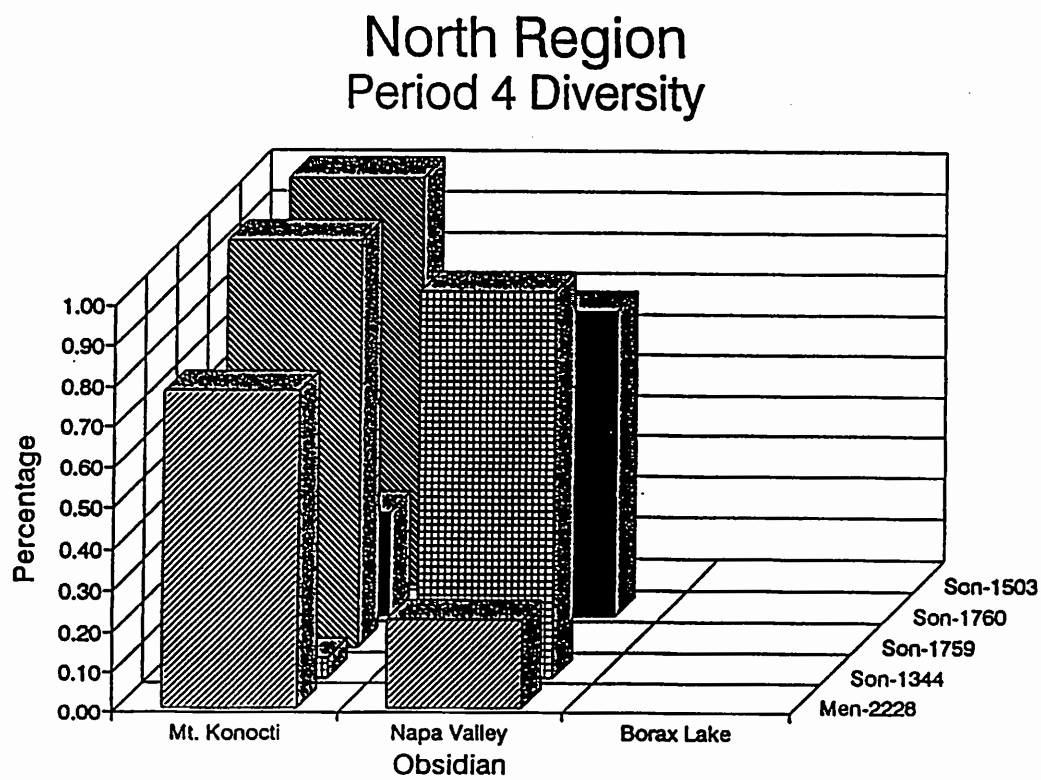


Figure 7.

Variablilty of Obsidian Use for the North Region During Periods 3 and 4.

Konocti glass. In contrast, CA-SON-1344 was comprised of predominately Napa Valley glass with relatively moderate amounts of Mt. Konocti glass and rare use of Borax Lake glass.

In the Central Region, no hydration data are represented for the southeast portion of the region. Napa Valley obsidian was exclusively represented at CA-SON-1449 and -1391. At CA-SON-1811, Napa Valley glass dominated (80%) with lesser amounts of Mt. Konocti glass (18%) and rare use of Borax Lake glass (<1%). At CA-SON-1810, there was a dominance of Napa Valley glass (57%) with lesser quantities of Mt. Konocti (26%) and Borax Lake (17%).

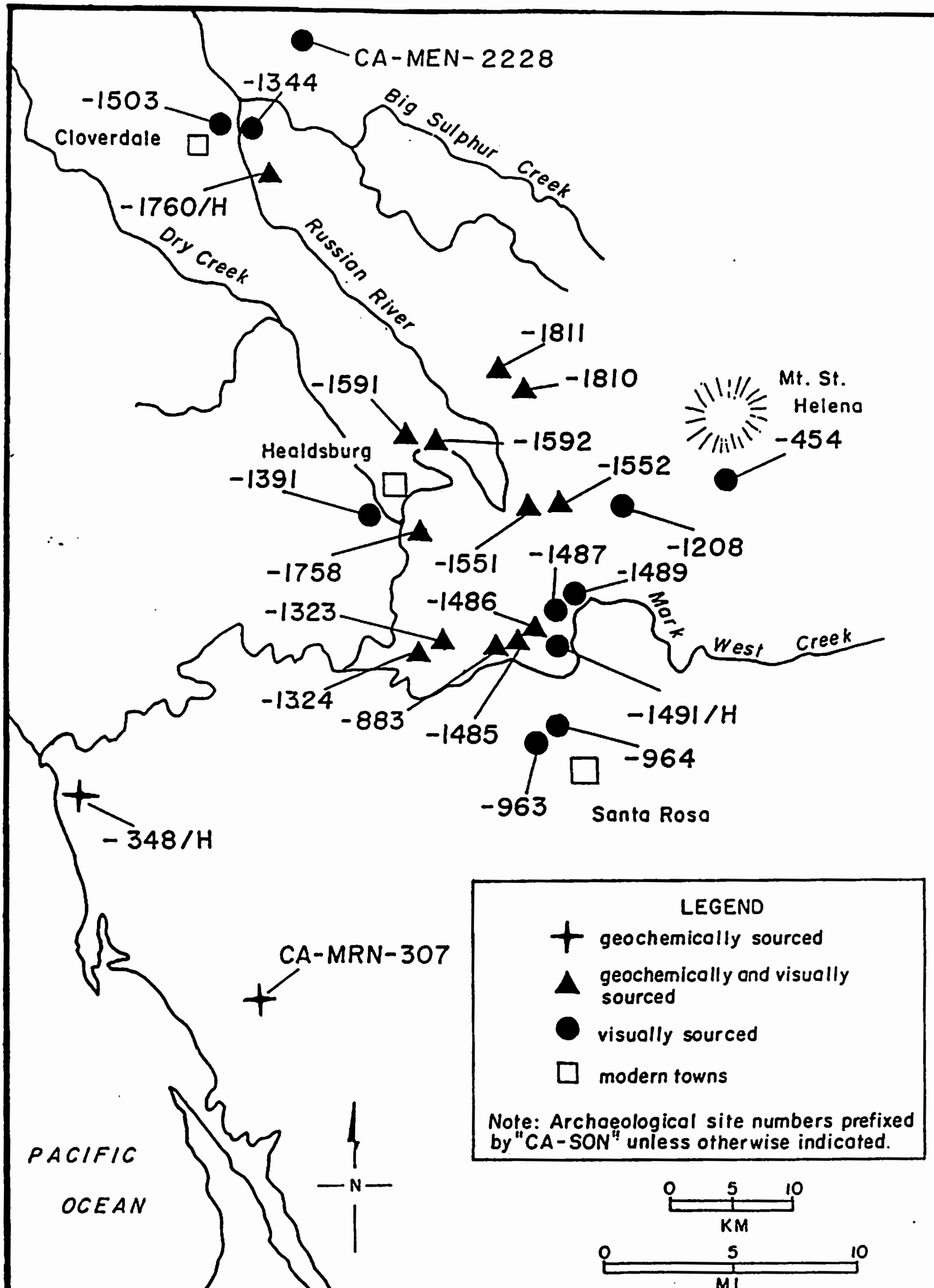
In the South Region, there was an increase in use along an unnamed drainage that flows into Pool Creek. Again, this region continued to yield a predominance of Napa Valley obsidian. At CA-SON-883, there was exclusive use of this obsidian and at the remaining sites it was used approximately 80% of the time. Moderate use of Annadel glass occurred at the latter sites.

Period 4

The last period, Period 4, documented an increase in the number of site use with a decrease in hydration readings at 1.9 μ (Map 9). No Borax Lake obsidian use can be attributed to this time in any of the three regions. Small corner-notched points and occasional serrated points were recovered from the Central and North Regions. The oldest small corner-notched points, made from Mt. Konocti obsidian, were from the North Region; with time they were replaced by Napa Valley obsidian. The North Region continued to exhibit a diversity of glass sources (Figure 7). CA-SON-1503 and -1759 contained exclusive use of Mt. Konocti obsidian. At CA-MEN-2228, Mt. Konocti was employed most of the time with the remainder consisting of Napa Valley obsidian. In contrast, Napa Valley obsidian dominated use at CA-SON-1760/H and 1344 with smaller quantities of Mt. Konocti obsidian used. There was almost exclusive use of Napa Valley obsidian in the Central Region. As with all other periods, Napa Valley glass continued to dominate use in the South Region. At CA-SON-883, -1485, and -1489 only this obsidian was used. At CA-SON-1324, -1486, -1487, and -1491/H Napa Valley obsidian use ranged from 71 to 83% with remaining percentages attributed to Annadel obsidian.

Franz Valley Glass

Having summarized the periods and trends by region, a discussion concerning the use of Franz Valley glass is warranted. The cultural use of this obsidian was greater than the geographic extent of the research area (Map 10). The northern boundary was at Cloverdale with probably only a rare piece exchanged or transported further north. Additional boundaries of relatively moderate to light cultural use of Franz Valley glass were not discernible from this research. South of the research area, results from various archaeological investigations have shown little or no use of obsidian float (e.g., Wickstrom and Fredrickson 1982; Mikkelsen et al. 1985; Wickstrom 1986). Southwest of the study area along the Sonoma - Marin coast, there was rare evidence of transported or exchanged Franz Valley obsidian use. At CA-SON-348/H, the Duncan's Landing site, there was one piece of this obsidian, probably representing early use (4.8 μ). The three small corner-notched points identified at CA-MRN-307 near Tomales are associated with Period 4. Apart from these two western occurrences, there has been no other identification of Franz Valley's use until a few miles south of Mark West Creek. In part, this distribution is probably biased by this research sample.



Map 10.

The Geographical Distribution of Culturally Modified Franz Valley Obsidian.

When all Franz Valley hydration readings for sites (n=15) within the study area are combined, they yield a mean of 2.6 μ (n=84, Figure 6). While outlying values reached as high as 9.3 μ, relatively light continued use of this obsidian began at 4.8 μ and continued through 3.9 μ. Generally consistent use of this glass was documented from 1.1 - 3.8 μ. Comparisons of Franz Valley glass to the area's major obsidian sources can only be made on a limited basis without an established comparison constant or a substantially larger hydration sample. Hydration readings attributed to this material from the study sites have fallen within the range of other southern North Coast Ranges obsidians, except hydration rims from CA-SON-1212. Most of the temporally diagnostic artifacts produced from Franz Valley glass were styles associated with later periods (Table 6 and Figure 8). Rim values for these points appear to be within established ranges for Napa Valley and Annadel glasses (Origer 1987).

Interpretations

For all sites in the Central and South Regions and for some sites in the North Region, Napa Valley was the most frequently used obsidian during all periods. General distributions of non-Napa Valley glasses suggest both similarities and differences within and between some analytic periods and regions. Annadel glass was used sporadically during Periods 2 and 3 in the Central Region, and rarely used in the North Region (Period 3); this material was most frequently used in the South Region during the last three periods. Conversely, Mt. Konocti obsidian was most prevalent in the North Region and rarely was used beyond the northern portion of the Central Region (CA-SON-1810 and -1811). Only once were Annadel and Mt. Konocti obsidians utilized at the same site during the same period (CA-SON-1811 in

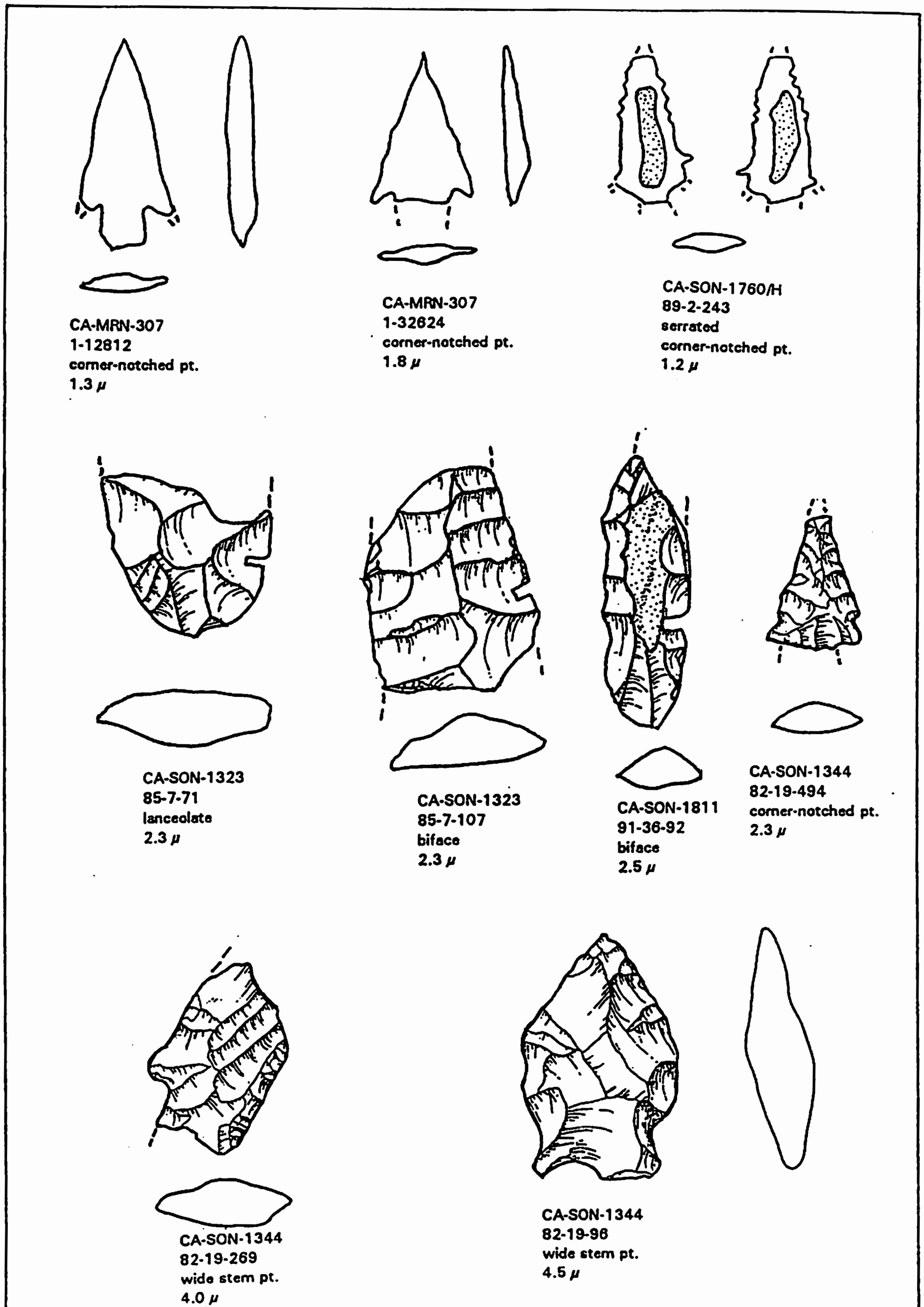


Figure 8. Formal Tools Produced from Franz Valley Glass.

Period 2). Borax Lake glass was used only at certain eastern sites. This glass frequently appeared contemporaneously with Mt. Konocti glass, but never co-occurred with Annadel glass.

Comparisons of Franz Valley glass to the four major obsidian sources in this area can only be made on a limited basis. Most of the temporally diagnostic projectile points produced from Franz Valley glass are styles, such as small corner-notched points, associated with later periods. Rim values for these points are within established ranges for Napa Valley and Annadel glasses (Table 6; Origer 1987). However, since there are few earlier temporally diagnostic points manufactured from Franz Valley, it is unknown if a larger sample of hydration readings from all point styles would be consistent with the hydration range of Napa Valley and Annadel glasses.

To summarize, analytic periods and regions are established and described to provide a framework for understanding obsidian trends within the research area. The arbitrary sample of various obsidians from 25 sites reveals the highest amount of cortex remained on Napa Valley and Franz Valley obsidians (Table 5). The highest proportions of residual cortex were from sites situated in the South and Central Regions; while sites in the North Region included some items with cortex, it was identified on fewer items. Even the next most frequently used obsidian, Mt. Konocti, contained few pieces with residual cortex. Both Napa Valley and Franz Valley obsidians occur in the Glen Ellen Formation and are available at non-quarry areas in and near the research area. Indications of float obsidian use are manifested by the presence of Franz Valley glass, by the greater range of macroscopic characteristics for Napa Valley glass, and by greater percentages of cortex remaining on tools and debitage produced from Napa Valley and Franz Valley glasses. To develop a greater understand of how obsidian obtained from non-quarry areas was used, Chapter 5 will consist of a flaked stone analysis of materials recovered from test excavations at CA-SON-1810 and -1811.

-CHAPTER 5-

THE FLAKED STONE RECOVERED FROM CA-SON-1810 and -1811

Given the absence of single component study area sites subjected to subsurface investigations, two contemporaneous Central Region sites, CA-SON-1810 and -1811, are selected for flaked stone analysis. In the summer of 1991, archaeological study of these sites included surface collecting and subsurface testing to determine eligibility for inclusion on the National Register of Historic Places and to address potential impacts from proposed California Department of Transportation road improvements (Gmoser 1992). A total of 5.5 cubic meters of deposits was examined at CA-SON-1810 and 5.8 cubic meters were studied at CA-SON-1811. Unit locations were selected to examine both horizontal and vertical variability of the material culture items discarded at these sites. CA-SON-1810 contained a sparse scatter of chert and obsidian debitage and tools. In contrast, items recovered predominantly from the midden area of CA-SON-1811 included a rich deposit of obsidian and chert tools and debitage, dietary debris, and milling equipment.

CA-SON-1810's Flaked Stone

A total of 848 Native American flaked stone items were recovered from CA-SON-1810. These items include 816 pieces of debitage, 11 bifaces, 16 EMFs, four cores, and one uniface (Table 7). The flaked stone sample contains approximately 41% obsidian and 59% chert with a trace of basalt. Overall, there is little variation in percentages of materials used for tools as compared with debitage.

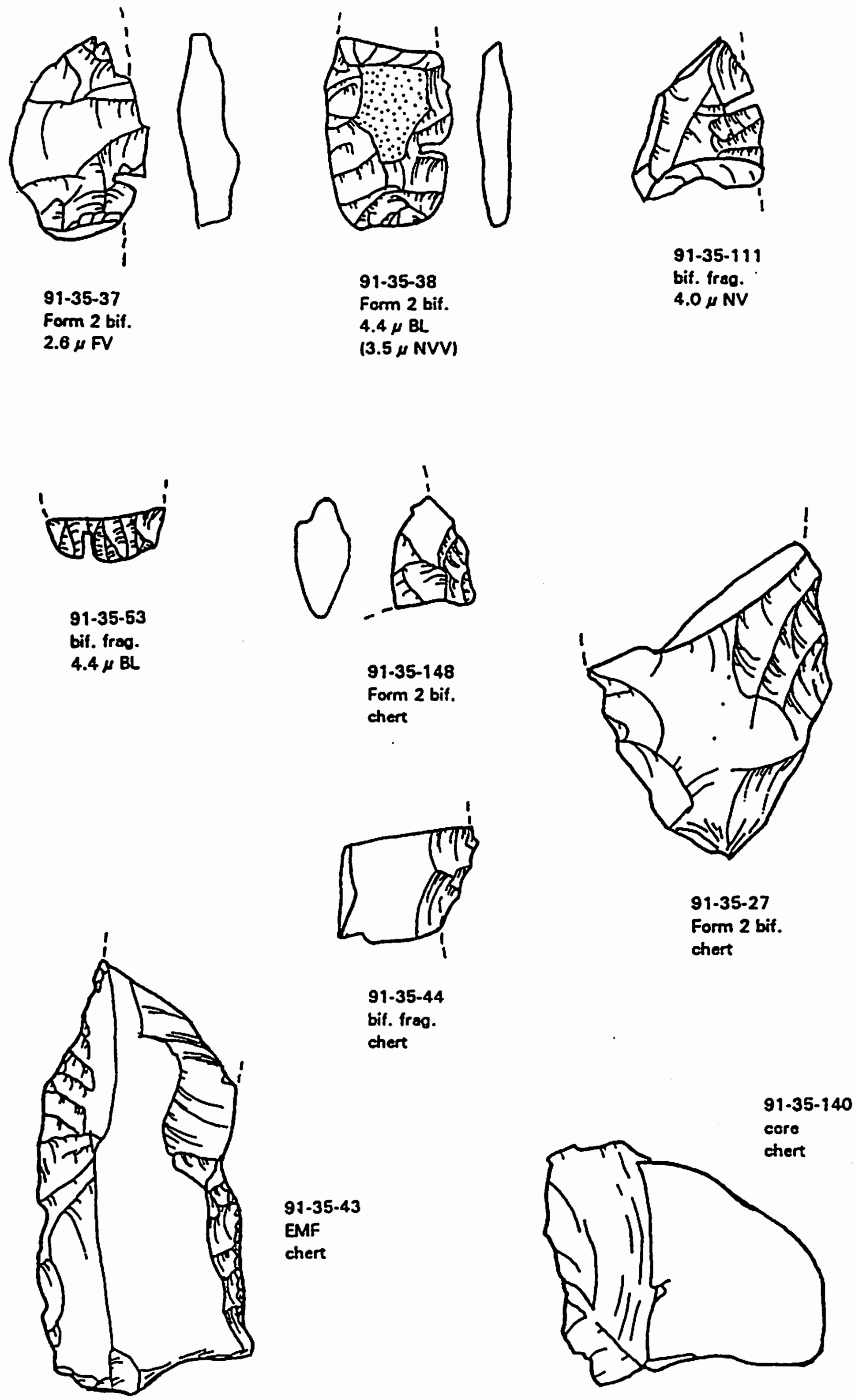


Figure 9. A Sample of Tools from CA-SON-1810.

Obsidian hydration results are provided (Table 15) and a sample of tools is illustrated (Figure 9).

Bifaces

Of the 11 incomplete bifaces, four are classified as Form 2, two as Form 1, and five as unclassifiable fragments (Table 7). Three Form 2 bifaces are leaf-shaped and the remaining Form 2 biface may be the proximal end of a concave base point (91-35-148). Two Form 1 bifaces are end fragments. Form 2 bifaces consist of two chert, one Franz Valley obsidian, and one Borax Lake obsidian; Form 1 bifaces include one of chert and one of Napa Valley glass. Unclassifiable biface fragments consist of one chert, two Napa Valley obsidian, one Mt. Konocti obsidian, and one Borax Lake obsidian. Whether Form 1 or 2, obsidian bifaces averaged a lower W:T ratio (mean = 2.20 range 1.29 - 3.13) than chert bifaces (mean = 2.64 range 2.31 - 2.89).

Uniface

One Mt. Konocti obsidian uniface was recovered. This item may be a piece of an impact-shattered biface. A more detailed description cannot be provided given its fragmentary condition.

Cores

All four cores are chert. Two are minimally modified and multi-directionally flaked. The other two, also multidirectionally flaked, have more substantial modification. All contain residual cortex.

EMFs

Fourteen EMFs, nine chert and five obsidian, were recovered. Chert items are two to three times larger than obsidian specimens. Based on its size and shape, one low edge angle chert EMF (91-35-19) may be a minimally modified biface blank. Sources for obsidian EMFs include two Napa Valley, one Mt. Konocti, one Borax Lake, and one Franz Valley (Table 8).

Debitage

All 392 pieces of debitage recovered from Unit TE1 30-32N, a 1 X 2m unit, are analyzed. The sample consists of 240 chert items, 152 obsidian items, and one basalt item. The following obsidian sources are represented: 70 Napa Valley, 60 Franz Valley, 15 Mt. Konocti, and seven Borax Lake (Table 9). A variety of debitage sizes was recovered with seventy-one percent of all complete obsidian flakes weighing 0.4 grams or less. Debitage produced from Napa Valley and Franz Valley obsidians exhibits the greatest size range; Mt. Konocti obsidian debitage has a more limited size range and Borax Lake debitage tends to be small (Table 9). Chert debitage is consistent with the size range of Napa Valley and Franz Valley debitage. Some non-complete obsidian flakes (19%) contain cortex. Additional debitage information is provided in Tables 9-16.

Summary

Except for one biface margin (91-35-16), biface obsidian hydration readings are tightly clustered, ranging from 3.8-4.3 μ NVV (mean=4.0 μ, n=4; Table 17). Based on W:T ratios and cross sections, all chert and approximately half the obsidian bifaces appear to have had longer use lives than the remainder (Table 7); no items contain characteristics associated with reworking or recycling. Given the frequency of simple bend breaks, it is assumed that most of the fractures resulted from manufacture or maintenance; only two bifaces contain multiple breaks, suggestive of possible use as projectiles. Bifaces were manufactured predominantly from local materials of chert, and Napa Valley and Franz Valley obsidians, with a small sample of non-local Mt. Konocti obsidian.

Most EMFs had low edge angles (Table 7). This may be biased by the high amount of chert EMFs, which would not exhibit modification as easily discernible as obsidian. The four usable hydration readings obtained from EMFs have a mean of 3.9 μ NVV (Table 15). Produced from local materials of chert, and Napa Valley and Franz Valley obsidians, obsidian hydration results suggest that EMFs were used throughout the site's history. Given the lack of significant modification, these items were probably not subjected to extended curation.

When outlying hydration readings are eliminated, the remaining debitage hydration rims (n=31) cluster between 2.8 and 5.4 μ NVV (mean=4.0 μ; Table 15). The variety of debitage size and diversity of materials used implies manufacturing and maintenance-related activities. A high percentage of cortex remained on chert debitage from all categories (Table 10). Many attributes associated with the cultural use of local obsidian float, such as those noted in Chapter 1, were identified from the debitage analysis. These characteristics associated with Napa Valley and Franz Valley glass include the relatively high percentage of residual cortex on the debitage (Table 14), and the greatest range in the size, dorsal surface complexity, and condition of the flakes (Table 9, 12, and 13). Also, flake fragments and miscellaneous debitage were most frequently from these local obsidian.

The mean obsidian hydration readings for the assemblage falls within Period 3, with the range associated with both Periods 2 and 3 (Table 15). The quantity of primary Napa Valley and Franz Valley obsidians and chert flakes suggest limited primary reduction of these materials occurred at CA-SON-1810. In addition, tools and smaller obsidian flakes were probably resharpened at this site. The flaked stone toolkit, used during Periods 2 and 3, was dominated by chert; utilization of locally available obsidian may have been restricted by the size and abundance of cobbles collected from the Glen Ellen Formation. Lake County obsidian was represented by small amounts of tools and tools fragments, and flakes. The toolkit included leaf-shaped bifaces, a possible concave base, chert cores, and predominantly low edge angle EMFs. This type of toolkit is versatile, easily adaptable to various anticipated and opportunistic activities, and transportable; toolkits with these characteristics are associated with more mobile peoples (as discussed in Chapter 1; Binford 1973, 1978, 1982; Goodyear 1979; Kelly 1983, 1988; Bleed 1986).

Legend for All Tool Measurement Figures:

Port. - portion:
- prx - proximal
- dst - distal
- mrg - margin
- mdl - medial

Cond. - condition:
- ITL - incomplete total length
- IBW - incomplete basal width
- CC - conditionally complete
- C - complete

Fracture:
- bb bending break
- fc facial channeling
- ls lateral sectioning
- p perverse
- s shatter
- ts tip snap

W:T - width thickness ratio

Scar Coverage D - dorsal scar coverage:
- <30% - marginal
- 30-90% - incomplete
- >90% - complete

Cross Sct - cross section:
- bcx - biconvex
- c-t - convexo-triangular
- bpl - biplano
- btr - bitriangular
- pc - plano convex

PSA - proximal shoulder angle

DSA - distal shoulder angle

BT - Basal Thickness

BW - Basal Width

Angle - Angle of Constriction

SCR - obsidian source:
- A - Annadel
- BL - Borax Lake
- FV - Franz Valley
- K - Mt. Konocti
- NV - Napa Valley
- v - visually sourced
- x - geochemically sourced

EA - edge angle
- LEA - low edge angle
- HEA - high edge angle

Table 7. Formal and Informal Tools from CA-SON-1810

Cat#	Unit/Coord.	Depth	Mat.	Port.	Fract.	Length /	Width /	Thick	Wt.	W:T	% Cort./	Loc.	DSC	C-S	PSA	DSA	BT	BW	Angle	SRC
Tool Type: Form 2 Bifaces																				
27	TE1/30-32N	30-40 cm	ccr	END	bb	44.80	35.15	12.43	16.10	2.83	0.00		30-90%	c-t						
37	TE1/30-32W	50-60 cm	obs	PRX	bb	26.52	19.32	7.29	3.80	2.65	0.00		>90%	c-t						FV x
38	TE1/30-32W	50-60 cm	obs	END	bb	27.33	18.62	5.94	3.50	3.13	0.00		30-90%	pc				15		BL x
148	TE1/30-32N	10-20 cm	ccr	PRX	bb	15.18	16.95	7.34	1.40	2.31	0.00		>90%							
Tool Type: Form 1 Bifaces																				
44	TE1/30-32N	60-70 cm	ccr	MRG	ls	16.28	18.71	7.46	3.10	2.51	0.00		30-90%							
147	TW1 62N 175' 1m	surface	obs	DST	bb	18.90	12.30	4.40	2.30	2.80	0.00		<30%	c-t						NV v
Tool Type: Biface Fragments																				
16	TE1/30-32N	10-20 cm	obs	MRG	bb	24.15	19.20	13.74	4.90	1.40	0.00		<30%							K v
53	TE1/30-32N	30-40 cm	obs	MRG/END	bb	18.02	6.92	3.63	0.40	1.91	0.00		>90%							BL x
88	TE1/0-2N	00-10 cm	obs	MRG	bb	20.25	8.02	6.22	0.80	1.29	0.00		30-90%							NV x
111	TE5/20-22E	00-10 cm	obs	MRG	bb,ls	21.81	19.59	8.96	3.70	2.19	0.00		>90%	c-t						NV x
133	TW2/10-12N	00-10 cm	ccr	END	bb	13.62	16.86	5.83	1.30	2.89	0.00		>90%							
Tool Type: Uniface																				
143	TE1/30-32N	30-40 cm	obs	MRG	bb	22.34	8.80	6.74	1.20	1.31	0.00		<30%							K v
Tool Type: Cores																				
29	TE1/30-32N	30-40 cm	ccr			33.54	32.10	28.90	39.30	1.11	0.10	one side	30-90%							
30	TE1/30-32N	30-40 cm	ccr			46.63	28.99	25.82	35.20	1.12	0.10	both sides	30-90%							
140	TE1 32N/250'/3.9m	surface	ccr			39.80	29.97	29.99	61.40	1.00	0.50	one side	30-90%							
142	TE1/37N	surface	ccr			78.38	51.73	38.54	189.40	1.34	0.75	one side	30-90%							

Table 7 (cont.). Formal and Informal Tools from CA-SON-1810.

Cat#	Unit/Coord.	Depth	Mat.	Length/Width/Thick			Wt.	W:T	% Cortex/Location	EA	SRC
Tool Type: EMF											
56	TE1/30-32N	40-50 cm	obs	20.39	17.86	5.84	2.50	3.06	0.00	HEA	NV v
19	TE1/30-32N	20-30 cm	ccr	59.45	49.31	7.85	27.80	6.28	0.95 one side	LEA	
20	TE1/30-32N	20-30 cm	ccr	36.73	27.89	14.96	17.20	1.86	0.00	LEA	
21	TE1/30-32N	20-30 cm	ccr	24.12	19.37	5.05	2.50	3.84	0.00	LEA	
34	TE1/30-32N	40-50 cm	ccr	40.35	14.24	11.62	8.40	1.23	0.00	LEA	
39	TE1/30-32N	50-60 cm	obs	25.71	19.88	2.14	1.00	9.29	0.00	LEA	FV x
40	TE1/30-32N	30-40 cm	ccr	31.32	21.65	16.41	9.50	1.32	0.95 one side	LEA	
43	TE1/30-32N	60-70 cm	ccr	62.18	30.30	7.20	15.60	4.21	0.00	LEA	
55	TE1/30-32N	10-20 cm	obs	26.79	23.28	4.41	2.00	5.28	0.25	LEA	BL v
115	TE7/20-22E	00-10 cm	obs	17.62	12.06	4.09	0.80	2.95	0.95 one side	LEA	NV v
121	TW1/60-62N	00-10 cm	obs	20.96	17.74	3.16	1.40	5.61	0.00	LEA	K v
123	TW1/60-62N	00-10 cm	ccr	31.46	30.84	12.17	14.70	2.53	0.50 one side	LEA	
139	TE1 32N/260'/5.6m	surface	ccr	37.88	31.24	10.27	11.90	3.04	0.10 one side	LEA	
141	TW1 62N/145'/3M	surface	ccr	53.25	33.73	9.49	22.10	3.55	0.00	LEA	

Table 8. EMFs.

Description	Qty	Mean W:T Ratio
ob. low edge angle w/o cortex	2	7.4
ob. low edge angle w/cortex	2	4.1
chert low edge angle	9	3.1
obs. high edge angle w/o cortex	1	3.1
Total	14	

Table 9. Debitage Sample.

Material/Source	Qty	Widths*	Mean W	L:W Ratio	Mean L:W
Napa Valley	70	0.5-3.9	1.6	0.4-1.7	0.8
Franz Valley	60	0.7-3.8	1.7	0.5-1.7	0.9
Mt. Konocti	15	1.0-2.2	1.6	**	
Borax Lake	7	0.7	0.7	1.1	1.1
Chert	240	0.6-3.7	1.7	0.4-2.5	1.0
Basalt	1	2.9	2.9	1.3	1.3

*only complete widths (in centimeters) were used.
**no complete lengths and widths for this source.

Table 10. Chert Debitage.

	Condition				
Cortex	Complete	Incomplete	Frag.	Misc.	Total/%
absent	30	94	33	7	164/68
present	13	36	20	7	76/32
Total	43	130	53	14	240/100

Table 11. Percentage of Cortex on Complete Chert Flakes.

	Complexity		
	Complex	Simple	Qty/%
0.00	10	20	30/70
0.10		6	6/14
0.25	1	2	3/7
0.50		1	1/2
0.75			
0.90		1	1/2
1.00		2	2/5
Total	11	32	43/100

Table 12. Obsidian Debitage.

		Source			
Condition	K	NV	FV	BL	Qty/%
complete		24	15	1	40/26
fragment	11	29	24	3	67/44
incomplete	4	14	20	3	41/26
miscellaneous	3	1			4/4
Total	15	70	60	7	152/100
mean weight	1.0	0.5	0.6	0.6	1.7

Table 13. Complete Obsidian Flakes.

	Source				
Complexity	K	NV	FV	BL	Qty/%
complex		6	4		10/25
simple		18	11	1	30/75
Total	0	24	15	1	40/100
mean weight		0.9	0.4	0.1	0.6

Table 14. Complete Obsidian Flakes with Cortex.

		Source			
Cortex	K	NV	FV	BL	Qty/%
0.00		11	8	1	20/50
0.10		8	4		12/30
0.25		2	2		4/10
0.50		2			2/5
0.75		1			1/<3
0.90					
1.00			1		1/<3
Total	0	24	15	1	40/100

Table 15. CA-SON-1810 Hydration, Actual Results.

Cat #	Item	Provenience	Mean	Source*	Comments
91-35-16	biface	TE1 30-32N 10-20cm	1.2	K/K	
91-35-37	biface	TE1 30-32N 50-60cm	2.6	FV	
91-35-38	biface	TE1 30-32N 50-60cm	4.4	BL	
91-35-53	biface	TE1 30-32N 30-40cm	4.4	BL	
91-35-88	biface	TE1 0-2N 0-10cm	4.3	NV	
91-35-111	biface	TE5 20-22E 0-10cm	4.0	NV	1st band
91-35-111	biface	TE5 20-22E 0-10cm	5.7	NV	2nd band
91-35-147	biface	TW1 62N 175 deg 1m	DH	NV/NV	weathered
91-35-39	emf	TE1 30-32N 50-60cm	2.5	FV	
91-35-55	emf	TE1 30-32N 10-20cm	6.3	BL/BL	1st band
91-35-55	emf	TE1 30-32N 10-20cm	7.5	BL/BL	2nd band
91-35-56	emf	TE1 30-32N 40-50cm	3.5	NV/NV	
91-35-115	emf	TE7 20-22E 0-10cm	3.6	NV/NV	
91-35-121	emf	TW1 60-62N 0-10cm	3.3	K/K	
91-35-143	uniface	TE1 30-32N 30-40cm	3.0	K/K	
91-35-31AA	flake	TE1 30-32N 30-40cm	2.8	K?/K	
91-35-31CC	flake	TE1 30-32N 30-40cm	3.0	K?/K	
91-35-31BB	flake	TE1 30-32N 30-40cm	3.1	K?/K	
91-35-35A	flake	TE1 30-32N 40-50cm	3.6	K?/K	
91-35-35B	flake	TE1 30-32N 40-50cm	4.0	BL/BL	
91-35-31EE	flake	TE1 30-32N 30-40cm	5.4	BL/BL	
91-35-35C	flake	TE1 30-32N 40-50cm	5.6	BL/BL	
91-35-31DD	flake	TE1 30-32N 30-40cm	5.6	BL/BL	
91-35-15B	flake	TE1 30-32N 0-10cm	3.1	/NV	
91-35-31F	flake	TE1 30-32N 30-40cm	3.1	/NV	
91-35-61H	flake	TE6 20-22E 0-10cm	3.2	NV?/NV	
91-35-31A	flake	TE1 30-32N 30-40cm	3.2	/NV	
91-35-31GG	flake	TE1 30-32N 30-40cm	3.6	NV/NV	
91-35-46D	flake	TE1 30-32N 60-70cm	3.6	/NV	
91-35-61F	flake	TE6 20-22E 0-10cm	3.8	NV/NV	
91-35-17A	flake	TE1 30-32N 10-20cm	3.8	/NV	
91-35-46B	flake	TE1 30-32N 60-70cm	3.8	/NV	
91-35-46C	flake	TE1 30-32N 60-70cm	3.8	/NV	
91-35-31HH	flake	TE1 30-32N 30-40cm	3.9	NV	
91-35-31II	flake	TE1 30-32N 30-40cm	3.9	NV	
91-35-61B	flake	TE6 20-22E 0-10cm	4.3	NV?/NV	
91-35-61G	flake	TE6 20-22E 0-10cm	4.4	NV?/NV	
91-35-48A	flake	TE1 30-32N 70-80cm	4.4	/NV	
91-35-17B	flake	TE1 30-32N 10-20cm	4.6	/NV	
91-35-61C	flake	TE6 20-22E 0-10cm	4.8	NV/NV	
91-35-31B	flake	TE1 30-32N 30-40cm	4.8	/NV	
91-35-31E	flake	TE1 30-32N 30-40cm	4.9	/NV	
91-35-48B	flake	TE1 30-32N 70-80cm	5.1	/NV	
91-35-61A	flake	TE6 20-22E 0-10cm	5.3	NV/NV	
91-35-61D	flake	TE6 20-22E 0-10cm	5.4	NV/NV	
91-35-31FF	flake	TE1 30-32N 30-40cm	6.1	NV/NV	
91-35-61E	flake	TE6 20-22E 0-10cm		/NV	thin
91-35-15A	flake	TE1 30-32N 0-10cm	NVB	/NV	
91-35-17C	flake	TE1 30-32N 10-20cm	3.4	FV	
91-35-31D	flake	TE1 30-32N 30-40cm	4.2	/FV	
91-35-48C	flake	TE1 30-32N 70-80cm	4.2	/FV	
91-35-46A	flake	TE1 30-32N 60-70cm	6.2	/FV	
91-35-17D	flake	TE1 30-32N 10-20cm	7.4	/FV	
91-35-31C	flake	TE1 30-32N 30-40cm	9.3	/FV	

NVB - no visible band DH - diffuse hydration

* source: visual sourcing results - NV (Origer)/NV (Psota); NV = XRF results

thin - ground too thin

Table 16. Hydration Range for CA-SON-1810

Temporally Equivalent Readings

				Totals				Primary Data	
NV	K	BL	A	Qty	NV	K	BL	microns	FV*
1.2	1.2	1.5	0.9	1		1			
2.5	2.5	3.2	1.9					2.5	1
2.6	2.6	3.3	2.0					2.6	1
2.7	2.7	3.4	2.1					2.7	
2.8	2.8	3.6	2.2	2		1	1	2.8	
2.9	2.9	3.7	2.2					2.9	
3.0	3.0	3.8	2.3	2		2		3.0	
3.1	3.1	3.9	2.4	3	2	1		3.1	
3.2	3.2	4.1	2.5	2	2		1	3.2	
3.3	3.3	4.2	2.5	1		1		3.3	
3.4	3.4	4.3	2.6					3.4	1
3.5	3.5	4.4	2.7	2			2	3.5	
3.6	3.6	4.6	2.8	4	3	1		3.6	
3.7	3.7	4.7	2.8					3.7	
3.8	3.8	4.8	2.9	4	4			3.8	
3.9	3.9	5.0	3.0	2	2			3.9	
4.0	4.0	5.1	3.1	1	1			4.0	
4.1	4.1	5.2	3.2					4.1	
4.2	4.2	5.3	3.2					4.2	2
4.3	4.3	5.5	3.3	4	3		1	4.3	
4.4	4.4	5.6	3.4	2			2	4.4	
4.5	4.5	5.7	5.5					4.5	
4.6	4.6	5.8	3.5	1	1			4.6	
4.7	4.7	6.0	3.6					4.7	
4.8	4.8	6.1	3.7	2	2			4.8	
4.9	4.9	6.2	3.8	1	1			4.9	
5.0	5.0	6.4	3.9	1		1		5.0	
5.1	5.1	6.5	3.9	1	1			5.1	
5.2	5.2	6.6	4.0					5.2	
5.3	5.3	6.7	4.1	1	1			5.3	
5.4	5.4	6.9	4.2	1	1			5.4	
6.1	6.1	7.7	4.7					6.1	1
6.2	6.2	7.9	4.8					6.2	1
6.3	6.3	8.0	4.9					6.3	1
7.4	7.4	9.4	5.7					7.4	1
9.3	9.3	11.8	7.2					9.3	1
Totals				41	26	7	8		9

* There is no conversion rate for Franz Valley Glass.

CA-SON-1811's Flaked Stone

A considerably larger flaked stone assemblage, 5499 items, was recovered from CA-SON-1811. These items consist of 5378 pieces of debitage, 13 projectile points, 23 bifaces, 68 EMFs, 16 cores, and one uniface (Table 17). This sample is dominated by obsidian (88%) with lesser amounts of chert (12%) and basalt (>1%). Results of obsidian hydration analysis are furnished (Table 25) and selected formal and informal flaked tools are depicted (Figure 10).

Projectile Points

All 13 projectile points recovered are obsidian. Eight of these are lanceolate shaped, manufactured mainly of Napa Valley glass with the exceptions being one each of Annadel and Mt. Konocti glasses (Table 17). Only one of these Napa Valley points (91-36-63) was reworked as indicated by irregular blade margins. Half the points produced from Napa Valley obsidian retain cortex. Lanceolates averaged a 2.10 W:T ratio. The other temporally diagnostic projectile points are small corner-notched points. They consist of two incomplete arrow points with expanding stem bases. Both were produced from Napa Valley obsidian and have no remaining cortex. Three biface fragments of Napa Valley obsidian were classified as non-diagnostic projectile points. None of these points contain residual cortex.

Bifaces

Six Form 1, nine Form 2, and eight small incomplete, unclassifiable bifaces were recovered. Form 2 bifaces were manufactured from Napa Valley, Franz Valley, and Mt. Konocti obsidians; Form 1 bifaces and biface fragments were produced from Napa Valley and Franz Valley obsidians, and chert (Table 17). Six Form 2 fragments were leaf-shaped, with an average W:T ratio of 2.19. W:T ratio

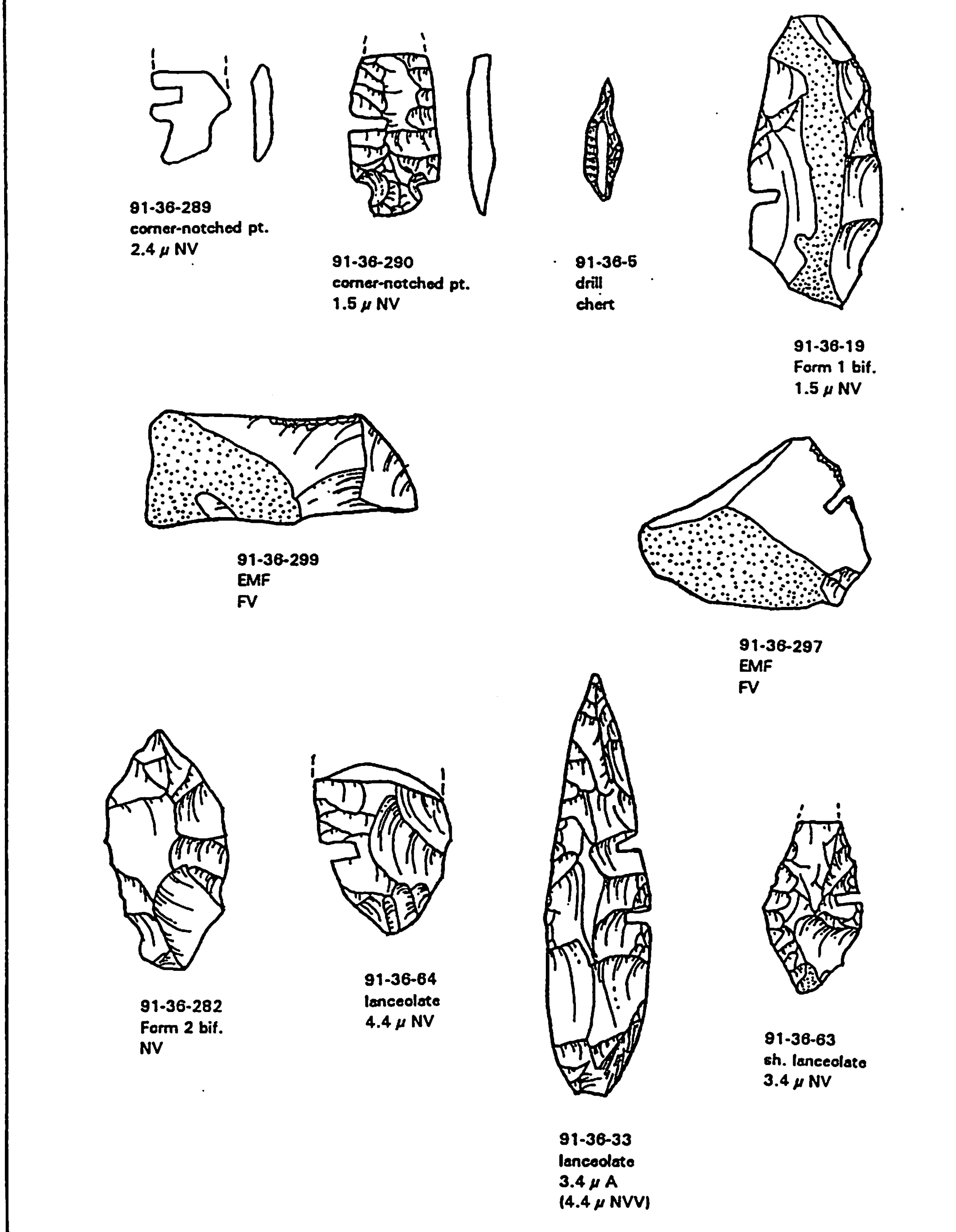


Figure 10. A Sample of Tools from CA-SON-1811.

of Form 1 bifaces averaged 2.35. Although several bifaces have fractures usually associated with impact from use as projectiles, they lack additional necessary attributes (e.g., dorsal surface complexity, hafting elements) to be classified as projectile points. These might represent minimally modified bifaces that were used as projectile points, or they might have been broken during thinning from the tips of the bifaces.

Uniface

One Napa Valley obsidian uniface fragment was recovered. This small item appears to be part of an impact-shattered biface, as opposed to a broken uniface tool, but its size and remaining attributes limit further discussion.

Drills

Two chert drills were recovered; both were complete. These tools were moderately shaped (Figure 10).

Cores

Sixteen cores, ten obsidian and six chert, comprise this category. The obsidian cores were made from mainly Napa Valley (n=9), and Franz Valley (n=1). The majority of flake scars are multi-directional; only a few have unidirectional scars. The average W:T ratio is 1.55 for obsidian and 1.27 for chert; most retain much of their original cobble shape (Table 17).

EMFs

Eleven chert and 57 obsidian EMFs were recovered (Table 18). Low edge angle obsidian EMFs (n=48) consist of 27 Napa Valley, 12 Franz Valley, and two Borax Lake (Table 17). High edge angle obsidian EMFs are represented by 13 Napa Valley, two Franz Valley, and one Annadel. One chert EMF is classified as a small ovoid scraper.

Debitage

Since hydration readings from this site suggest an absence of horizontal and vertical stratigraphy, two contiguous levels from Unit TA 10N/50-51W (3mm) are used for analysis. Due to the large quantity of material, one quarter of the obsidian debitage volume per level is analyzed. Each level of obsidian flakes was spread out on a surface and divided into four groups of approximately equal weights, sizes, and volume. One group from each level was arbitrarily selected for analysis. All chert debitage recovered from these levels are analyzed. The total number of debitage analyzed is 119 chert items and 319 obsidian items (Table 19).

Napa Valley and Franz Valley obsidians and chert were most frequently recovered with lesser amounts of Mt. Konocti obsidian. For all obsidian debitage, 89% of complete flakes weigh 0.4 grams or less; 76% weigh 0.1 gram or less. Debitage size for all flaked stone materials is similar with Napa Valley and Franz Valley obsidian debitage tending to be somewhat smaller in size and lighter in weight (Table 19). Most obsidian flakes have simple dorsal surface complexity (Table 23). Of the non-complete debitage, 88% contain no residual cortex. Approximately one quarter of the chert flakes retain cortex (Table 20). Additional debitage information is provided (Tables 19-24).

Summary

Based on the combination of obsidian hydration values and artifact types, use of this site occurred during Periods 2, 3, and 4. Lanceolates have a mean hydration of 3.7 μ NVV (range 2.7-4.4 μ, n=7; Table 25). The two corner-notched points have a mean of 2.0 μ NVV and the three point fragments have a mean hydration of 2.1 μ NVV. Projectile point fractures are represented by nearly equal portions of bending and more complex breaks, indicating at least half were the result of projectile impacts (Table 17). The leaf-shaped Form 2 biface fragments have a mean hydration value of 3.4 μ NVV, whereas, Form 1 bifaces have a mean hydration value of 2.2 μ NVV. Breakage patterns suggest that most incomplete bifaces were damaged and discarded during manufacture or maintenance.

The hydration values obtained from the small sample of obsidian cores yield a bimodal distribution: 1.2-1.3 μ NVV (n=3); and 2.8-4.7 μ NVV (mean 3.9 μ, n=4). A variety of modified cores from CA-SON-1811 suggests either extended use at this site or curation. Given the presence of residual cortex on many of the cores (Table 17), most of these items were produced probably from obsidian and chert cobbles obtained locally. These cores may have been the resource from which expedient EMFs were produced.

Obsidian hydration analysis yielded five readings for low edge angle EMFs ranging from 1.3-5.0 μ NVV (mean 3.4 μ) and six readings for high edge angle EMFs ranging from 1.3-5.5 μ NVV (mean 3.6 μ). This data indicates EMFs were utilized throughout the use of CA-SON-1811. Approximately 70% of the EMFs had presumably short use lives as indicated by low edge angles, with the remainder containing high edge angles associated with moderate use lives (Table 18). Given the amount of modification, these were not heavily curated items, but they might have been used more than once, repaired between or during uses, or utilized intensively. In comparing the short use life to the moderate use life obsidian EMFs, both groups without cortex average a higher W:T ratio (Table 18). In general, both chert and obsidian high edge angle EMFs average a lower W:T ratio. This suggests, when more energy was expended in creating and maintaining an EMF, durability (as defined by thickness and possibly size) played an important role in flake selection (e.g., Kuhn 1992; Rolland and Dibble 1990).

Hydration rim readings of debitage indicate use at this site from 2.2 to 4.3 μ NVV, with an average of 2.9 μ (n=53). Approximately half the chert debitage retained cortex, implying that local materials were occasionally being used to produce EMFs, usually for expedient items. Local obsidian (Napa Valley and Franz Valley) contained the next highest percentages of cortex, though somewhat less than associated with regional obsidian quarrying areas (Bieling, personal communication 1992). In combination with the latter, other indications of non-quarry obsidian use were suggested by the range and amounts of incomplete flakes and flake fragments (Table 22), the identification of Franz Valley obsidian used to produce informal and formal tools (Table 17), and the range in macroscopic attributes for Napa Valley and Franz Valley obsidian. Unlike CA-SON-1810, few flakes with dorsal surface complexity were identified at CA-SON-1811.

Small non-cortical flakes with simple dorsal complexity dominate the CA-SON-1811 sample, suggesting secondary reduction (Jackson et al. 1983). If tools were being resharpened, they were being transported away from this location, as indicated by the lack of reworked tools. The intensity of secondary reduction, however, probably overshadows other flaked stone activities at this site. Given the unmodified obsidian cobble, obsidian cobble cores, and a moderate amount of cortical small obsidian flakes, primary reduction of local cobbles, also, probably occurred at this site. The relatively low volume of these items implies that this was not a heavily used workshop area, but probably an area for personal tool production. Since unmodified obsidian cobbles presumably occurred in or near this site, and considering the lack of reworked tools, it appears that tool replacement, as oppose to extensive tool maintenance, was selected by these people. Also, the proportion of EMFs to bifaces and projectile points might infer that EMFs were used for certain tasks (Parry and Kelly 1987).

As previously mentioned, obsidian hydration readings suggest use at this site during Periods 2, 3, and 4 (Table 25). During the later portion of Period 2 and during Period 3, the Native Americans at CA-SON-1811 had a flaked stone tool kit that included lanceolate-shaped projectile points and Form 2 bifaces, obsidian cores, and predominantly low edge angle EMFs. During Period 4, a flaked stone tool kit included small corner-notched points, minimally modified bifaces, cores and predominantly low edge angle EMFs. Both toolkits relied heavily on locally-obtained obsidian for tool stone material. The type and quantities of tools, and the use of selected local materials are indications of technological organization models associated with more sedentary peoples (Binford 1973, 1979; Parry and Kelly 1987).

Legend for All Tool Measurement Figures:

Port. - portion:
- prx - proximal
- dst - distal
- mrg - margin
- mdl - medial

Cond. - condition:
- ITL - incomplete total length
- IBW - incomplete basal width
- CC - conditionally complete
- C - complete

Fracture:
- bb bending break
- fc facial channeling
- ls lateral sectioning
- p perverse
- s shatter
- ts tip snap

W:T - width thickness ratio

Scar Coverage D - dorsal scar coverage:
- <30% - marginal
- 30-90% - incomplete
- >90% - complete

Cross Sct - cross section:
- bcx - biconvex
- c-t - convexo-triangular
- bpl - biplano
- btr - bitriangular
- pc - plano convex

PSA - proximal shoulder angle
DSA - distal shoulder angle
BT - Basal Thickness
BW - Basal Width
Angle - Angle of Constriction
SCR - obsidian source:
- A - Annadel
- BL - Borax Lake
- FV - Franz Valley
- K - Mt. Konocti
- NV - Napa Valley
  - v - visually sourced
- x - geochemically sourced

EA - edge angle
- LEA - low edge angle
- HEA - high edge angle

Table 17. Formal and Informal Tools from CA-SON-1811

Tool Type: Lanceolate Points

Cat#	Unit/Coord.	Depth	Mat.	Port.	Fract.	Length	Width	Thick	Wt.	W:T	% Cort./Loc.	DSC	C-S	PSA	DSA	BT	BW	Angle	SRC
33	TA10N/50-52W	20-30cm	obs			63.86	17.17	7.81	7.50	2.20	0.00	>90%	bcx			5.6	9.2	33	A x
40	TA10N/50-52W	20-30cm	obs	PRX	bb	19.24	17.32	5.36	1.60	3.23	0.00	>90%	bcx			4.5	6.1		NV x
47	TA10N/50-52W	30-40 cm	obs			41.98	14.75	7.39	4.50	2.00	0.10 one side	>90%	btr			3.6	8.8	40	NV v
63	TA10N/50-52/W	40-50cm	obs	PRX	ts	27.08	15.54	6.98	2.20	2.23	1.00 end	>90%	bcx					40	NV v
64	TA10N/50-52/W	40-50 cm	obs	PRX	bb	25.15	20.96	5.54	3.00	3.78	1.00 end	>90%	bcx						NV v
82	TA10N/50-52/W	50-60 cm	obs	DST	bb,fc	45.83	17.77	7.23	5.70	2.46	0.00	>90%	bcx					40	NV x
273	R5W/40MW	surface	obs	PRX	fc	25.02	18.36	5.42	2.00	3.39	0.00	30-90%	bcx						NV x
276	R12S/20MW	surface	obs	PRX	bb	52.33	23.28	10.26	13.90	2.27	0.00	>90%	bcx						K v

Tool Type: Corner-notched Points

Cat#	Unit/Coord.	Depth	Mat.	Port.	Fract.	Length	Width	Thick	Wt.	W:T	% Cort./Loc.	DSC	C-S	PSA	DSA	BT	BW	Angle	SRC
289	TD41W	surface	obs	PRX	bb,ls	14.70	12.24	3.28	0.50	3.73	0.00	>90%	bcx	120	102	2.5	8.6		NV v
290	R7S/TF 60-62W	surface	obs	PRX	bb	24.54	14.00	3.49	1.40	4.01	0.00	>90%	bpl	126	130	2.6	8.7		NV v

Tool Type: Projectile Point Fragments

Cat#	Unit/Coord.	Depth	Mat.	Port.	Fract.	Length	Width	Thick	Wt.	W:T	% Cort./Loc.	DSC	C-S	PSA	DSA	BT	BW	Angle	SRC
1	TA10N/50-52/W	00-10 cm	obs	DST	bb	19.47	6.82	2.40	0.20	2.84	0.00	>90%	bcx					18	NV v
48	TA10N/50-52/W	30-40 cm	obs	MDL	bb	15.76	19.78	8.29	2.10	2.39	0.00	>90%	pc						NV v
274	R9S/19MW	surface	obs	DST	bb	20.68	13.57	5.35	1.10	2.54	0.00	>90%	bcx					38	NV v

Tool Type: Form 2 Bifaces

Cat#	Unit/Coord.	Depth	Mat.	Port.	Fract.	Length	Width	Thick	Wt.	W:T	% Cort./Loc.	DSC	C-S	PSA	DSA	BT	BW	Angle	SRC
18	TA10N/50-52W	10-20 cm	obs	END	p	35.70	32.95	12.18	11.70	2.71	0.25 both sides	30-90%							K v
28	TA10N/50-52W	10-20 cm	obs	DST	bb,fc	23.76	11.29	5.67	1.20	1.99	0.00	>90%	c-t					58	FV v
41	TA10N/50-52W	20-30 cm	obs	END	bb	32.77	24.31	7.38	5.70	3.29	0.00	>90%	pc						NV v
65	TA10N/50-52/W	40-50 cm	obs	END	bb,ls	17.31	17.68	7.05	2.00	2.51	0.00	>90%	bcx						K v
119	TA0-2N	00-10 cm	obs	PRX	bb,fc	12.73	13.48	7.24	1.50	1.86	0.00	>90%	bcx				12		FV v
275	R11S/38MW	surface	obs	END	bb,ls	24.37	16.05	5.79	2.50	2.77	0.00	>90%	c-t						FV v
277	R10S/3ME	surface	obs	END	bb	28.28	17.20	6.95	3.50	2.47	0.50 end, one side	30-90%	bcx						NV v
282	R1S/28MW	surface	obs		bb	37.75	18.87	8.08	5.20	2.34	0.10 one side	30-90%	c-t						NV v
284	R3N/6ME	surface	obs	PRX	bb	37.03	18.82	10.29	7.00	1.83	0.00	30-90%	c-t						NV v

Cat#	Unit/Coord.	Depth	Mat.	Port.	Fract.	Length /	Width /	Thick	Wt.	W:T	% Cort./Loc.	DSC	C-S	PSA	DSA	BT	BW	Angle	SRC
Tool Type: Form 1 Bifaces																			
19	TA10N/50-52W	10-20 cm	obs		bb	45.79	21.33	6.55	8.20	3.26	0.25 one side	30-90%	c-t						NV v
27	TA10N/50-52W	10-20 cm	obs		bb	33.89	30.67	13.80	10.20	2.22	0.50 one side	<30%							NV v
51	TA10N/50-52/W	30-40 cm	ccr		bb	54.88	27.48	11.26	20.80	2.44	0.00	30-90%	c-t			5.7	17		
92	TA10N/50-52/W	60-70 cm	obs			44.67	13.82	8.53	5.20	1.62	0.50 one side	30-90%	c-t						FV x
271	R3S/37MW	surface	obs	END	bb	27.71	15.71	8.62	3.10	1.82	0.50 margin	30-90%							NV v
287	R6N/9ME	surface	obs			49.73	22.90	8.14	8.50	2.81	0.50 one side	30-90%	c-t						FV v
Tool Type: Biface Fragments																			
2	TA10N/50-52W	00-10 cm	obs	END	bb	11.42	17.23	4.44	0.80	3.88	0.00	>90%	bcx						FV v
12	TA10N/50-52W	00-10 cm	obs	MRG	bb,s	14.74	12.19	5.13	0.70	2.38	0.00	>90%							NV v
49	TA10N/50-52/W	30-40 cm	obs	DST	bb	20.33	12.06	3.72	0.60	3.24	0.10 one side	30-90%	bpl					44	NV v
50	TA10N/50-52/W	30-40 cm	obs	MDL	bb,fc	15.80	17.03	6.48	1.50	2.63	0.00	>90%	bcx						FV v
83	TA10N/50-52/W	50-60 cm	obs	PRX	bb	21.08	16.83	6.69	2.30	2.52	1.00 end	30-90%	bcx						NV v
167	TA10N/70-72W	00-10 cm	obs	MRG	ls	12.93	5.18	3.42	0.10	1.51	0.00	>90%							NV v
250	TI50-52W	00-10 cm	ccr	END	bb	21.88	11.09	9.14	2.70	1.21	0.00	30-90%							
279	R2N/21MW	surface	obs	END	bb,ls	13.12	18.94	4.76	1.10	3.98	0.00	>90%	bcx						NV v
Tool Type: Drills																			
4	TA10N/50-52W	00-10 cm	ccr			17.80	6.43	4.39	0.50	1.46	0.00	>90%							
5	TA10N/50-52/W	00-10 cm	ccr			19.38	5.62	4.96	0.60	1.13	0.00	30-90%							
Tool Type: Uniface																			
288	R10N/7ME	surface	obs	MDL	bb	20.29	15.35	5.73	1.70	2.68	0.00	30-90%							NV v
Tool Type: Cores																			
3	TA10N/50-52W	00-10 cm	obs			25.58	22.00	9.48	5.10	2.32	0.50 one side	30-90%							NV v
42	TA10N/50-52W	20-30 cm	obs			22.95	23.98	9.13	5.50	2.63	0.25 margin	30-90%							NV x
43	TA10N/50-52W	20-30 cm	obs			35.18	17.74	14.11	10.50	1.26	0.25 both sides	30-90%							NV x
93	TA10N/50-52/W	60-70 cm	obs			40.34	22.97	14.41	14.70	1.59	0.50 both sides	30-90%							NV x
164	TA10N/70-72W	00-10 cm	obs			26.53	11.66	9.70	3.20	1.20	0.00	30-90%							FV x

Cat#	Unit/Coord.	Depth	Mat.	Port.	Fract.	Length	Width	Thick	Wt.	W:T	% Cort./Loc.	DSC	C-S	PSA	DSA	BT	BW	Angle	SRC
Tool Type: Cores																			
3	TA10N/50-52W	00-10 cm	obs			25.58	22.00	9.48	5.10	2.32	0.50 one side	30-90%							NV v
42	TA10N/50-52W	20-30 cm	obs			22.95	23.98	9.13	5.50	2.63	0.25 margin	30-90%							NV x
43	TA10N/50-52W	20-30 cm	obs			35.18	17.74	14.11	10.50	1.26	0.25 both sides	30-90%							NV x
93	TA10N/50-52/W	60-70 cm	obs			40.34	22.97	14.41	14.70	1.59	0.50 both sides	30-90%							NV x
164	TA10N/70-72W	00-10 cm	obs			26.53	11.66	9.70	3.20	1.20	0.00	30-90%							FV x
166	TA10N/70-72W	00-10 cm	ccr			48.34	26.09	22.55	38.70	1.16	0.25 one side	30-90%							
197	TF20-22W	00-10 cm	obs			34.77	24.02	15.58	12.10	1.54	0.50 both sides	30-90%							NV v
207	TF40-42W	00-10 cm	ccr			26.15	23.25	17.70	12.10	1.31	0.00	30-90%							
218	TF80-82W	00-10 cm	obs			40.01	19.85	13.70	8.70	1.45	0.10 one side	30-90%							NV x
251	TI50-52W	00-10 cm	ccr			40.45	27.34	24.03	27.10	1.14	0.00	30-90%							
268	R1S/41MW	surface	obs			30.23	22.16	21.89	15.80	1.01	0.25 both sides	30-90%							NV x
291	R2S/26MW	surface	obs			34.09	27.61	22.92	25.80	1.20	0.75 one side	30-90%							NV x
292	TA18N/4MW	surface	ccr			43.66	32.98	20.53	42.60	1.61	0.00	>90%							
293	TA8.5N/5MW	surface	ccr			46.75	30.59	27.19	54.20	1.13	0.10 end	30-90%							
294	R11S/35MW	surface	obs			43.52	22.34	17.56	19.50	1.27	0.25 one side	30-90%							NV x

Table 17 (cont.). Formal and Informal Tools from CA-SON-1811.

Cat#	Unit/Coord.	Depth	Mat.	Length/Width/Thick			Wt.	W:T	% Cortex/Location	EA	SRC
Tool Type: EMF											
14	TA10N/50-52W	00-10 cm	obs	25.58	31.86	12.93	8.90	2.46	0.95 one side	HEA	NV x
34	TA10N/50-52W	20-30 cm	obs	27.25	21.19	8.97	4.90	2.36	0.10 one side	HEA	NV v
120	TA0-2N	00-10 cm	obs	18.42	14.76	6.24	1.40	2.37	0.00	HEA	NV x
121	TA0-2N	00-10 cm	obs	13.59	18.44	4.00	1.50	4.61	0.00	HEA	NV v
146	TA10N/30-32W	00-10 cm	obs	19.87	16.31	2.63	0.90	6.20	0.00	HEA	NV v
147	TA10N/30-32W	00-10 cm	obs	32.12	26.07	8.62	6.60	3.02	0.00	HEA	NV v
165	TA10N/70-72W	00-10 cm	obs	23.75	21.87	5.71	2.90	3.83	0.50 one side	HEA	NV v
171	TA10N/80-82W	00-10 cm	obs	36.28	22.38	9.64	7.40	2.32	1.00 one side	HEA	NV v
200	TF20-22W	00-10 cm	ccr	31.23	25.98	10.03	8.50	2.59	0.00	HEA	
212	TF60-62W	00-10 cm	obs	10.23	11.35	6.74	0.70	1.68	0.75 one side	HEA	NV v
213	TF60-62W	00-10 cm	ccr	24.14	25.01	9.03	5.40	2.77	0.10 one side	HEA	
230	TH18S/10-12W	00-10 cm	obs	22.19	13.31	5.28	1.10	2.52	0.00	HEA	FV v
232	TH18S/10-12W	00-10 cm	ccr	25.50	28.12	6.71	5.30	4.19	0.95 one side	HEA	
243	TI30-32W	00-10 cm	obs	15.41	11.46	4.78	0.80	2.40	0.50 one side	HEA	NV v
272	R3S/69mW	surface	obs	32.50	29.96	7.64	9.70	3.92	0.00	HEA	A x
280	R2N/36 MW	surface	ccr	30.42	35.28	12.49	16.50	2.82	1.00 end	HEA	
286	R5N/9ME	surface	obs	36.20	40.70	13.01	18.40	3.13	0.50 one side	HEA	NV v
325	TA10N/50-52W	50-60 cm	obs	16.88	9.01	2.92	0.40	3.09	0.10 one side	HEA	FV v
332	TA10-12N/2W	00-10 cm	obs	14.90	10.34	3.88	0.60	2.66	0.00	HEA	NV v
336	TA10N/50-52W	40-50 cm	obs	16.40	14.60	5.30	1.90	2.75	0.00	HEA	NV v
13	TA10N/50-52W	00-10 cm	obs	19.83	17.54	9.74	4.00	1.80	0.50 one side	LEA	NV v
129	TA10-12N	00-10 cm	obs	11.52	8.18	1.96	0.20	4.17	0.00	LEA	NV v
136	TA10N/2022W	00-10 cm	obs	16.34	14.97	2.24	0.40	6.68	0.00	LEA	NV v
141	TA20-22N	00-10 cm	ccr	22.87	14.61	4.99	1.50	2.93	0.00	LEA	
145	TA10N/30-32W	00-10 cm	obs	24.70	18.96	5.32	2.50	3.56	0.50 one side	LEA	FV v
172	TA10N/80-82W	00-10 cm	obs	12.17	7.96	2.25	0.20	3.54	0.00	LEA	NV v
180	TC20-22N	00-10 cm	obs	15.64	17.23	2.55	0.70	6.76	0.00	LEA	NV v
182	TD20-22N	00-10 cm	obs	12.40	10.35	3.63	0.50	2.85	0.10 one side	LEA	FV v
190	TD60-62W	00-10 cm	obs	23.62	15.56	8.42	2.40	1.85	0.10 one side	LEA	NV v
198	TF20-22W	00-10 cm	obs	19.11	14.10	4.94	1.60	2.85	0.00	LEA	FV v
199	TF20-22W	00-10 cm	obs	20.24	13.23	7.10	1.40	1.86	0.50 one side	LEA	FV v
210	TF60-62W	00-10 cm	obs	19.47	19.07	8.32	2.40	2.29	1.00 end	LEA	NV v
229	TH18S/10-12W	00-10 cm	obs	29.50	23.55	7.68	4.80	3.07	0.50 one side	LEA	BL v
236	TH18-20S	00-10 cm	obs	15.91	18.39	10.37	2.70	1.77	0.25 one side	LEA	NV v
240	TI10-12W	00-10 cm	obs	25.87	22.27	10.07	4.90	2.21	0.50 one side	LEA	FV v
247	TI50-52W	00-10 cm	obs	25.35	18.39	5.97	2.20	3.08	0.50 end	LEA	NV v
248	TI50-52W	00-10 cm	ccr	17.05	10.91	2.76	0.50	3.95	0.00	LEA	
254	TI70-72W	00-10 cm	ccr	32.49	24.77	6.60	8.50	3.75	0.00	LEA	
255	TI70-72W	00-10 cm	ccr	12.35	10.56	3.18	0.60	3.32	0.00	LEA	
260	TJ10-12W	00-10 cm	obs	18.90	15.86	7.48	2.70	2.12	0.00	LEA	FV v
263	TJ30-32W	00-10 cm	obs	22.86	17.04	3.93	1.70	4.34	0.25 margin, one side	LEA	NV v
297	TA10N/50-52W	00-10 cm	obs	33.90	25.70	8.03	6.20	3.20	0.50 one side	LEA	FV x
299	TA10N/50-52W	00-10 cm	obs	31.45	19.28	5.01	3.10	3.85	0.50 one side	LEA	FV v
301	TA10N/50-52W	00-10 cm	obs	21.29	13.62	4.07	1.40	3.35	0.00	LEA	NV v
302	TA10N/50-52W	10-20 cm	obs	38.86	9.21	3.26	1.20	2.83	0.00	LEA	FV v
303	TA10N/50-52W	10-20 cm	obs	30.04	14.70	4.83	2.00	3.04	0.25 one side	LEA	NV v
304	TA10N/50-52W	20-30 cm	obs	27.49	12.69	3.28	1.20	3.87	0.00	LEA	FV x
305	TA10N/50-52W	30-40 cm	obs	27.99	18.95	5.62	2.30	3.37	0.25 one side	LEA	NV v

Cat#	Unit/Coord.	Depth	Mat.	Length/Width/Thick			Wt.	W:T	% Cortex/Location	EA	SRC
Tool Type: EMF											
306	TA10N/50-52W	30-40 cm	obs	15.83	9.43	2.66	0.40	3.55	0.00	LEA	NV v
307	TA10N/50-52W	50-60 cm	obs	26.80	22.20	2.63	1.30	8.44	1.00 end	LEA	NV v
308	TA10N/50-52W	00-10 cm	obs	28.12	22.20	3.91	1.90	5.68	0.10 one side	LEA	NV v
309	TA10N/50-52W	00-10 cm	ccr	20.14	14.27	6.78	2.00	2.10	0.00	LEA	
310	TA10N/50-52W	20-30 cm	obs	22.27	24.41	5.13	2.90	4.76	0.25 one side	LEA	NV v
312	TA10N/50-52W	20-30 cm	obs	19.34	20.16	3.60	1.40	5.60	0.00	LEA	BL v
314	TA10N/50-52W	20-30 cm	obs	10.20	9.41	3.12	0.10	3.02	0.25 one side	LEA	NV v
316	TA10N/50-52W	30-40cm	ccr	26.47	14.22	4.99	2.00	2.85	0.00	LEA	
317	TA10N/50-52W	30-40 cm	obs	34.55	26.01	6.31	4.30	4.12	0.00	LEA	NV v
318	TA10N/50-52W	30-40 cm	obs	18.66	12.92	1.42	0.50	9.10	0.00	LEA	NV v
319	TA10N/50-52W	30-40 cm	obs	15.68	9.65	1.91	0.20	5.05	0.00	LEA	NV v
323	TA10N/50-52W	40-50 cm	obs	15.94	12.54	2.11	0.30	5.94	0.00	LEA	FV v
324	TA10N/50-52W	50-60 cm	obs	21.77	13.25	3.02	0.70	4.39	0.50 end	LEA	NV v
326	TA10N/50-52W	50-60 cm	obs	10.46	9.16	1.43	0.10	6.41	0.00	LEA	FV v
328	TA10N/50-52W	60-70 cm	obs	34.63	31.36	3.19	2.70	9.83	0.00	LEA	NV v
329	TA10N/50-52W	70-80 cm	ccr	18.26	17.22	2.77	1.30	6.22	0.00	LEA	
331	TA10-12N/2W	00-10 cm	obs	15.35	13.21	3.89	1.00	3.40	0.50 end	LEA	NV v
335	TA10N/50-52W	40-50 cm	obs	35.80	14.50	4.60	2.30	3.15	1.00 end	LEA	NV v
337	TA10N/50-52W	10-20 cm	obs	25.60	21.20	9.20	3.60	2.30	0.25 one side	LEA	NV v
338	TA10N/50-52W	40-50 cm	obs	13.19	13.17	2.16	0.30	6.10	0.00	LEA	NV v

Table 18. EMFs.

Description	Qty	Mean W:T Ratio
obs. low edge angle w/o cortex	41	5.0
obs. low edge angle w/cortex	23	3.6
chert low edge angle	7	3.7
obs. high edge angle w/o cortex	8	3.5
obs. high edge angle w/ cortex	8	2.7
chert high edge angle	4	3.1
Total	91	

Table 19. Debitage.

Material/Source	Qty	Widths*	Mean W	L:W Ratio	Mean L:W
Napa Valley	195	0.4-2.2	0.9	0.4-2.0	0.9
Franz Valley	103	0.5-2.6	0.9	0.6-1.6	1.0
Mt. Konocti	21	0.6-2.4	1.2	0.8-1.2	1.0
Chert	119	0.4-2.7	1.5	0.6-1.9	1.1
Total		438			

*only complete widths (in centimeters) were used.

Table 20. Chert Debitage.

	Condition				
Cortex	Complete	Incomplete	Frag.	Misc.	Total/%
absent	12	10	66		88/74
present	4	4	14	9	31/26
Total	16	14	80	9	119/100

Table 21. Percentage of Cortex on Complete Chert Flakes.

	Complexity		
	complex	simple	Qty/%
0.00	3	9	12/74%
0.10		2	2/13%
0.25			
0.50			
0.75			
0.90			
1.00		2	2/13%
Total	3	13	16/100%

Table 22. Obsidian Debitage.

Condition	K	Source NV	FV	BL	Qty/%
complete	3	46	27		76/24
fragment	6	106	66		178/56
incomplete		43	10		53/16
miscellaneous	12				12/4
Total	21	195	103	0	319/100
mean weight	0.7	0.4	0.3		

Table 23. Complete Obsidian Flakes.

	K	Source NV	FV	BL	Qty/%
complex	1	7	1		9/12
simple	2	39	26		67/88
Total	3	46	27	0	76/100
mean weight	0.5	0.3	0.3		

Table 24. Complete Obsidian Flakes with Cortex.

Cortex	K	Source NV	FV	BL	Qty/%
0.00	21	163	95		279/87
0.10	21	5			26/8
0.25		5	1		6/2
0.50		1	2		3/1
0.90		4			4/1
1.00		1			1/1
Total	21	195	103	0	319/100

Table 25. CA-SON-1811 Hydration, Actual Values.

Cat #	Item	Provenience	Mean	Source*	Comments
91-36-276	proj pt	Row 12S 29mW surface	VW	K/K	weathered, burned
91-36-33	proj pt	TA10N/50-52W 20-30cm	3.4	A	
91-36-290	proj pt	Row 7S 60mW	1.5	NV/NV	
91-36-1	proj pt	TA10N/50-52W 0-10cm	1.7	NV	
91-36-289	proj pt	TD41W surface	2.4	NV/NV	
91-36-274	proj pt	Row 9S 19mW surface	2.5	NV/NV	
91-36-273	proj pt	Row 5S 40mW surface	2.7	NV	
91-36-40	proj pt	TA10N/50-52W 20-30cm	3.3	NV	
91-36-63	proj pt	TA10N/50-52W 30-40cm	3.4	NV/NV	
91-36-47	proj pt	TA10N/50-52W 30-40cm	3.7	NV/NV	
91-36-82	proj pt	TA10N/50-52W 50-60cm	3.7	NV	
91-36-64	proj pt	TA10N/50-52W 40-50cm	4.4	NV/NV	
91-36-18	biface	TA10N/50-52W 10-20cm	3.1	K/K	
91-36-65	biface	TA10N/50-52W 40-50cm	4.1	K/K	
91-36-19	biface	TA10N/50-52W 10-20cm		NV/NV	aprox 1.5
91-36-92	biface	TA10N/50-52W 60-70cm	2.5	FV	
91-36-27	biface	TA10N/50-52W 10-20cm	2.8	NV/NV	
91-36-277	biface	Row 10S 3mE surface	3.0	NV/NV	
91-36-284	biface	Row 3N 6mE surface		NV/NV	weathered
91-36-287	biface	Row 6N 9mE surface	NVB	FV	
91-36-294	core	Row 11S 25mW surface	1.2	NV	
91-36-268	core	Row 1S 41mW surface	1.2	NV	
91-36-291	core	Row 2S 26mW surface	1.3	NV	
91-36-218	core	TF80-82W 0-10cm	2.8	NV	
91-36-93	core	TA10N/50-52W 60-70cm	3.7	NV	
91-36-43	core	TA10N/50-52W 20-30cm	4.3	NV	
91-36-42	core	TA10N/50-52W 20-30cm	4.7	NV	
91-36-164	core	TA10N/70-72W 0-10cm	2.1	FV	
91-36-272	emf	Row 3S 69mW surface	2.1	A	
91-36-286	emf	Row 5N 9mE surface	1.3	NV/NV	
91-36-263	emf	TJ30-32W 0-10cm	1.3	NV/NV	
91-36-337	emf	TA10N/50-52W 10-20cm	2.9	NV/NV	
91-36-328	emf	TA10N/50-52W 60-70cm	3.4	NV/NV	
91-36-121	emf	TA 0-2N 0-10cm	3.6	NV/NV	
91-36-120	emf	TA 0-2N 0-10cm	3.9	NV	
91-36-34	emf	TA10N/50-52W 20-30cn	4.3	NV/NV	
91-36-308	emf	TA10N/50-52W 60-70cm	4.3	NV/NV	
91-36-307	emf	TA10N/50-52W 50-60cm	5.0	NV/NV	
91-36-14	emf	TA10N/50-52W 0-10cm	5.5	NV	
91-36-304	emf	TA10N/50-52W 20-30cm	2.3	FV	
91-36-297	emf	TA10N/50-52W 0-10cm	2.4	FV	
91-36-60II	flake	TA10N/50-52W 30-40cm	2.9	K	
91-36-60HH	flake	TA10N/50-52W 30-40cm	3.0	K/K	
91-36-60JJ	flake	TA10N/50-52W 30-40cm	3.0	?/K	
91-36-60KK	flake	TA10N/50-52W 30-40cm	3.4	K/K	
91-36-60LL	flake	TA10N/50-52W 30-40cm	3.4	K/K	
91-36-60GG	flake	TA10N/50-52W 30-40cm	3.7	K?/K	
91-36-29	flake	TA10N/50-52W 10-20cm	7.3	BL/BL	
91-36-52A	flake	TA10N/50-52W 30-40cm	2.3	A	
91-36-52N	flake	TA10N/50-52W 30-40cm	2.6	A	
91-36-52C	flake	TA10N/50-52W 30-40cm	3.0	A	
91-36-60FF	flake	TA10N/50-52W 30-40cm	NVB	A/A	
91-36-252C	flake	TI50-52W 0-10cm	1.2	NV/NV	
91-36-252A	flake	TI50-52W 0-10cm	1.5	NV/NV	
91-36-60F	flake	TA10N/50-52W 30-40cm	1.5	/NV	

Cat #	Item	Provenience	Mean	Source*	Comments
91-36-108D	flake	TA10-12N/2W 0-10cm	2.2	NV/NV	
91-36-168A	flake	TA10N/70-72W 0-10cm	2.4	NV/NV	
91-36-168B	flake	TA10N/70-72W 0-10cm	2.4	NV/NV	
91-36-237A	flake	TH18-20S 0-10cm	2.5	NV/NV	
91-36-15F	flake	TA10N/50-52W 0-10cm	2.6	/NV	
91-36-108B	flake	TA10-12N/2W 0-10cm	2.6	NV/NV	
91-36-252B	flake	TI50-52W 0-10cm	2.6	NV/NV	
91-36-52E	flake	TA10N/50-52W 30-40cm	2.6	NV/NV	
91-36-60A	flake	TA10N/50-52W 30-40cm	2.6	NV	
91-36-52O	flake	TA10N/50-52W 30-40cm	2.7	NV	
91-36-52G	flake	TA10N/50-52W 30-40cm	2.9	NV/NV	
91-36-52H	flake	TA10N/50-52W 30-40cm	2.9	NV/NV	
91-36-52K	flake	TA10N/50-52W 30-40cm	2.9	NV?/NV	
91-36-237D	flake	TH18-20S 0-10cm	3.0	NV/NV	
91-36-60B	flake	TA10N/50-52W 30-40cm	3.0	/NV	
91-36-60MM	flake	TA10N/50-52W 30-40cm	3.0	NV	
91-36-98A	flake	TA10N/50-52W 70-80cm	3.0	/NV	
91-36-98B	flake	TA10N/50-52W 70-80cm	3.0	/NV	
91-36-60DD	flake	TA10N/50-52W 30-40cm	3.1	NV	
91-36-52M	flake	TA10N/50-52W 30-40cm	3.2	NV?/NV	
91-36-52L	flake	TA10N/50-52W 30-40cm	3.4	NV/NV	
91-36-60AA	flake	TA10N/50-52W 30-40cm	3.4	NV	
91-36-108A	flake	TA10-12N/2W 0-10cm	3.5	NV/NV	
91-36-60E	flake	TA10N/50-52W 30-40cm	3.5	NV	
91-36-237C	flake	TH18-20S 0-10cm	3.6	NV/NV	
91-36-168D	flake	TA10N/70-72W 0-10cm	3.6	NV/NV	
91-36-98E	flake	TA10N/50-52W 70-80cm	3.6	/NV	
91-36-15G	flake	TA10N/50-52W 0-10cm	3.7	/NV	
91-36-15B	flake	TA10N/50-52W 0-10cm	3.7	NV	
91-36-252D	flake	TI50-52W 0-10cm	3.7	NV/NV	
91-36-52F	flake	TA10N/50-52W 30-40cm	3.7	NV/NV	
91-36-98F	flake	TA10N/50-52W 70-80cm	3.7	/NV	
91-36-52J	flake	TA10N/50-52W 30-40cm	3.8	NV/NV	
91-36-15A	flake	TA10N/50-52W 0-10cm	3.9	/NV	
91-36-168C	flake	TA10N/70-72W 0-10cm	3.9	NV/NV	
91-36-15E	flake	TA10N/50-52W 0-10cm	4.0	/NV	
91-36-237B	flake	TH18-20S 0-10cm	4.3	NV/NV	
91-36-98G	flake	TA10N/50-52W 70-80cm	4.3	/NV	
91-36-108C	flake	TA10-12N/2W 0-10cm	4.9	NV/NV	
91-36-52I	flake	TA10N/50-52W 30-40cm	5.2	NV/NV	
91-36-52D	flake	TA10N/50-52W 30-40cm	NVB	NV/NV	weathered
91-36-15D	flake	TA10N/50-52W 0-10cm	2.7	/FV	
91-36-98D	flake	TA10N/50-52W 70-80cm	2.9	/FV	
91-36-60EE	flake	TA10N/50-52W 30-40cm	3.0	NV/FV	
91-36-60NN	flake	TA10N/50-52W 30-40cm	3.0	FV?	
91-36-60D	flake	TA10N/50-52W 30-40cm	3.2	/FV	
91-36-98C	flake	TA10N/50-52W 70-80cm	3.2	/FV	
91-36-15C	flake	TA10N/50-52W 0-10cm	3.3	FV	
91-36-52B	flake	TA10N/50-52W 30-40cm	3.3	NV/FV	
91-36-60C	flake	TA10N/50-52W 30-40cm	3.8	/FV	
91-36-60BB	flake	TA10N/50-52W 30-40cm	NVB	NV/FV	
91-36-60CC	flake	TA10N/50-52W 30-40cm	DH	FV	

NVB - no visible band
DH - diffuse hydration
VW - variable width
* source: visual sourcing results - NV (Origer)/NV (Psota); NV: XRF results

Table 26. Hydration Range for CA-SON-1811.

Temporally Equivalent Readings				Totals					Primary Data	
NV	K	BL	A	Qty	NV	K	BL	A	microns	FV*
1.2	1.2	1.5	0.9	3	3					
1.3	1.3	1.7	1.0	3	3					
1.4	1.4	1.8	1.1							
1.5	1.5	1.9	1.2	3	3					
1.6	1.6	2.0	1.2							
1.7	1.7	2.2	1.3	1	1					
2.1	2.1	2.7	1.6						2.1	1
2.2	2.2	2.7	1.7	1	1				2.2	
2.3	2.3	2.9	1.8						2.3	2
2.4	2.4	3.0	1.8	3	3				2.4	1
2.5	2.5	3.2	1.9	2	2				2.5	1
2.6	2.6	3.3	2.0	5	5				2.6	1
2.7	2.7	3.4	2.1	2	1			1	2.7	2
2.8	2.8	3.6	2.2	2	2				2.8	
2.9	2.9	3.7	2.2	5	4	1			2.9	1
3.0	3.0	3.8	2.3	9	7	2			3.0	2
3.1	3.1	3.9	2.4	2	1	1			3.1	
3.2	3.2	4.1	2.5	1	1				3.2	2
3.3	3.3	4.2	2.5	1	1				3.3	2
3.4	3.4	4.3	2.6	6	4	2			3.4	
3.5	3.5	4.4	2.7	2	2				3.5	
3.6	3.6	4.6	2.8	4	4				3.6	
3.7	3.7	4.7	2.8	9	8	1			3.7	
3.8	3.8	4.8	2.9	1	1				3.8	1
3.9	3.9	5.0	3.0	3	3					
4.0	4.0	5.1	3.1	1	1					
4.1	4.1	5.2	3.2	1		1				
4.2	4.2	5.3	3.2							
4.3	4.3	5.5	3.3	5	5					
4.4	4.4	5.6	3.4	2	1			1		
4.5	4.5	5.7	5.5							
4.6	4.6	5.8	3.5							
4.7	4.7	6.0	3.6	1	1					
4.8	4.8	6.1	3.7							
4.9	4.9	6.2	3.8	1	1					
5.0	5.0	6.4	3.9	1	1					
5.1	5.1	6.5	3.9							
5.2	5.2	6.6	4.0	1	1					
5.3	5.3	6.7	4.1							
5.4	5.4	6.9	4.2							
5.5	5.5	7.0	4.2	1	1					
5.6	5.6	7.1	4.3							
5.7	5.7	7.2	4.4							
5.8	5.8	7.4	4.5	1			1			
Total				83	72	8	1	2		16

+ There is no conversion rate for Franz Valley glass.

Interpretations of CA-SON-1810 and 1811

Interestingly, analyses demonstrated that the occupation of CA-SON-1810 and -1811 was partially contemporaneous, although the flaked stone assemblages were dissimilar (Table 27). The different technological organization of tool stone resources recovered from both sites probably reflect site use by two dissimilar populations during Periods 2 and 3. Using the criteria described in Chapter 1, the people at CA-SON-1810 were more mobile, using a variety of local flaked stone materials while at the site during their seasonal round (Figure 11). In contrast, CA-SON-1811's inhabitants were more residential and relied on selected, local tool stone resources to a greater degree. These sites are not interpreted as representing different activities by the same population because of the presence of functionally equivalent but stylistically different flaked stone tools, of the different frequencies of flaked stone materials, and of dissimilar organizational strategies as indicated by dissimilar forms and proportions of curated and expedient tools. Contemporaneous components from CA-SON-1810 and -1811 reflect different strategies (forager versus collector), behaviors, social distances, discard rates, occupation spans, and probably population size. These findings are consistent with other recent interpretations of multi-contemporaneous populations for a northern California locality or region (Jones and Hayes 1989; Wickstrom 1986 [southeastern Santa Rosa]; Stewart 1993 [Warm Springs]; White and Fredrickson 1992 [Clearlake area]; Wiberg 1993; Bieling 1993 [Green Valley of Solano County]).

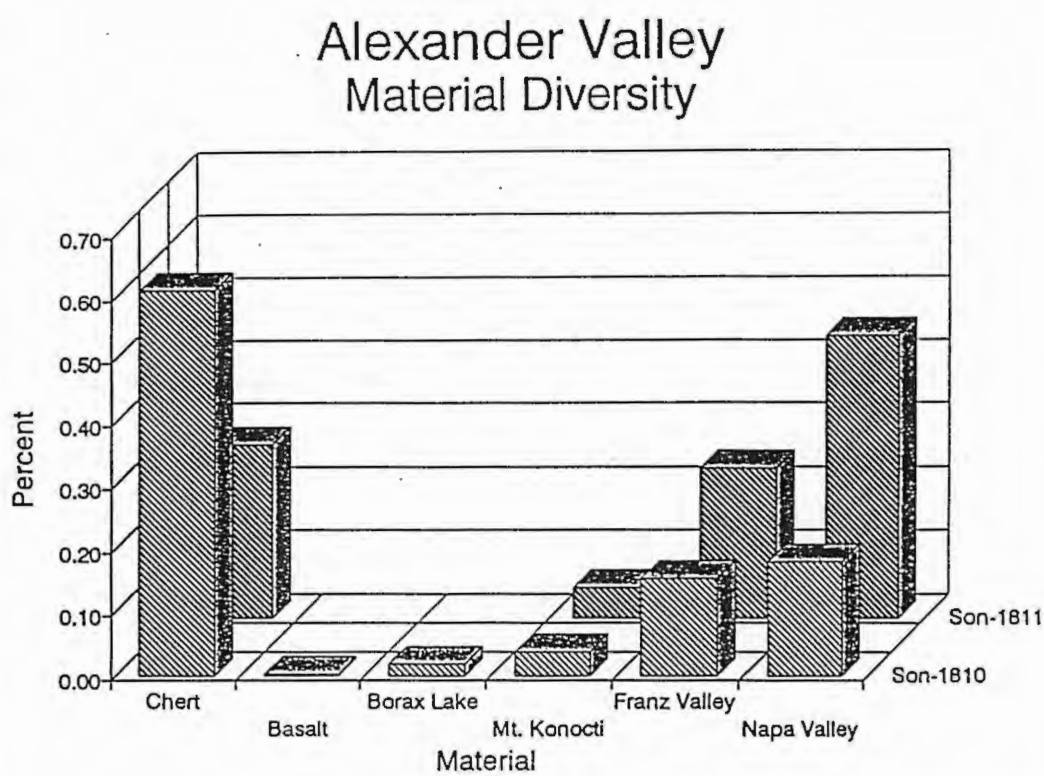


Figure 11.

Variability of Flaked Stone Material at CA-SON-1810 and CA-SON-1811.

Table 27. The Diversity of Flaked Stone Recovered From Similar Soil Volumes at CA-SON-1810 and -1811.

Sites:	CA-SON-1810	CA-SON-1811
Temporal Periods:	Periods 2 and 3	Periods 2, 3, and 4
Flaked Stone Material:	41% obsidian - 59% chert	88% obsidian - 12% chert
Flaked Stone Items:	possible chert concave base fragment	13 projectile points: lanceolates and small corner-notched, all obsidian
	11 bifaces	23 bifaces
	16 EMFs	68 EMFs
	4 chert cores	16 cores
	1 uniface	1 uniface
	816 flakes	5378 flakes
		1 unmodified obsidian cobble

CA-SON-1810's Flaked Stone

At CA-SON-1810 the low diversity of flaked stone tools, and the flexibility and versatility of the assemblage as a whole suggests use for a range of activities, attributed by obsidian hydration values to Periods 2 and 3. The data imply frequent visits by a small mobile group that relied on local materials to replenish a carried-along toolkit composed of more diverse materials. The abundance of Napa Valley and Franz Valley obsidian debitage, both with high amounts of cortex, indicates direct access to non-quarry obsidian areas, when available. Based on the limited diversity of obsidian tools, it is concluded that this material was probably not available on a regular annual basis, either locally or through trade, at most or all the localities annually frequented by this group. Although minimally used, Lake County obsidians occurred at this site with Borax Lake obsidian being used initially, followed by a gradual shift to Mt. Konocti obsidian. The variety of chert tools suggests this material was available locally in most or all the area over which the population ranged.

The chert assemblage, indicated by debitage types and tool variety, suggests a wide range of reduction activities occurred at or near the site. In contrast, Napa Valley and Franz Valley obsidians are present in more moderate quantities and exhibit less diversity of forms than chert, with many containing some cortex. The sample of chert, Napa Valley, and Franz Valley obsidian debitage contains the largest flakes recovered from both sites.

Obsidian hydration readings range from 2.8 to 5.6 μ NVV with limited use of nonlocal obsidians. No Annadel glass was identified. Hydration results of Borax Lake obsidian suggest use between 3.2 - 5.0 μ NVV (n=6, mean 4.0 μ) and the use of Mt. Konocti obsidian occurred only later in the occupation of the site (3.6 to 2.8 μ NVV, n=6, mean 3.1 μ) when Napa Valley glass use decreased.

CA-SON-1811's Flaked Stone

The density and variety of flaked stone items recovered from the midden soil of CA-SON-1811 suggest a more intensive site use than at CA-SON-1810, during Periods 2 and 3. Unlike CA-SON-1810, use of this site continued into Period 4. When comparing the richest levels from both sites, CA-SON-1811 contained 3.5 times more flaked stone material per cubic meter. There was a clear preference for obsidian and little evidence of tool maintenance at CA-SON-1811. Width thickness ratios and minimal reworking suggest that formal tools were neither heavily curated nor manufactured in great quantities. Most points and bifaces were manufactured from local obsidian materials, with few produced from local chert and nonlocal obsidians.

The presence of minimally modified cores, one unmodified obsidian cobble, and the high proportion of small flakes with simple dorsal surface complexity suggest CA-SON-1811 was both a primary and secondary reduction area. The high amount of local obsidian, the low proportion of flakes with dorsal surface complexity, and the moderate amount of cortex, suggest direct access to tool stone resources. Probably, cobbles were tested at a non-quarry area to determine the quality of the material, with only suitable specimens carried elsewhere.

Obsidian hydration values from CA-SON-1811 imply site use ranging from 2.2 to 4.3 μ NVV with infrequent use between 1.2 to 1.5 μ NVV. Mt. Konocti was sporadically used between 2.9 to 4.1 μ NVV (n=8, mean 3.3 μ). Rare use of Annadel (2.7 and 4.0 μ NVV, n=2) and Borax Lake glasses (5.8 μ NVV, n=1) was documented.

-CHAPTER SIX-

SUMMARY AND INTERPRETATIONS

Social Distance and Technological Organization Models

The use of social distance models in combination with models of technological organization has allowed for a greater understanding of how various obsidians were transported and used. Proportions of flaked stone materials can provide some social distance information concerning the similarities between sites or localities, but it is the addition of models based on technological organization that permits researchers to have a greater understanding of how and where people lived, and how their objects moved across the landscape (e.g., Binford 1979, 1982; Kelly 1983, 1988; White 1984a; Shott 1986, 1989; Chatters 1987; Bieling 1992; Andrefsky 1994). Instead of solely providing jargonized descriptions of flaked lithic specimens, models of technological organization enable researchers to make interpretations concerning various levels of behaviors, though all are not archaeologically testable (e.g., Goodyear 1979; Nelson 1991). For example, planning options and types of settlement patterns extrapolated from discard and curation practices enable different strategies to be interpreted.

Diversity of use is part of technological organization models. On a large geographic scale, this can define an area's culture history, but variability of landscape patterns may apply for smaller areas, too. The interpretation that coexisting populations used the land and its natural resources differently, allows for a greater understanding of the peoples at CA-SON-1810 and -1811, their interactions, and their behaviors. Previous models that were unilinear and diffusion-based, did not allow for more than one group of people per time. By using a combination of variables, technological organization models have provided this research with explanations for the use and distribution of culturally modified obsidian and other materials, site use, and mobility/residential living strategies. The archaeological testability of the following interpretations based on social distance and techonological organization models is noted.

Summary of Research

This research has focused on identifying and evaluating the cultural use of obsidian from non-quarry areas in northern Sonoma County, and determining what effect use of this obsidian had on the cultural distribution of obsidian from the major regional sources of Annadel, Napa Valley, Mt. Konocti, and Borax Lake. To accomplish this, flaked stone items contained in collections from 25 Sonoma County archaeological sites were counted, described, and analyzed. Most of the obsidian from these sites was visually sourced for this study, while fewer specimens have been subjected to hydration and geochemical analyses. The combination of hydration and sourcing results yielded no clear temporal trends, so four arbitrary analytic periods, based on hydration values, were chosen to divide the study area. To identify spatial variability, the research area was partitioned into three regions: North, Central, and South. Except for some site components in the North Region, most obsidian flaked stone assemblages were characterized by a dominance of Napa Valley glass. Franz Valley obsidian, rarely documented at archaeological sites before this research, was identified at many sites. Although only limited incorporation of Franz Valley obsidian into models of prehistoric cultural systems can be made, the presence of culturally modified specimens at an archaeological site is important because it documents the use of obsidian from areas other than quarries.

Few studies from the southern North Coast Ranges have identified culturally modified obsidian other than the four major regional sources. The limited use of Franz Valley glass in combination with Napa Valley glass identified by this research is consistent with Jackson's (1986) geochemical results, where he assigned both of these sources to obsidian float collected from the Glen Ellen Formation near the present town of Windsor. Previously, non-quarry areas were thought to have been minimally used and, therefore, they would have contributed little to local exchange practices. From flaked stone analyses conducted on the 25 study sites, the present research has determined that the following characteristics are attributed to cultural use of obsidian collected from non-quarry areas: primary and secondary decortication flakes of Napa Valley and Franz Valley glasses; cobble cores and assay cores of these materials; and Napa Valley and Franz Valley obsidians with a greater range of macroscopic attributes than previously described by Jackson (1986) or Origer (1987). To distinguish archaeological sites from intensively plowed areas in the Glen Ellen Formation, certain attributes, such as obsidian flakes and tools with various stages of patination and dorsal surface complexities, would be indications of Native American use.

The degree to which non-quarry Napa Valley and Franz Valley obsidian can be macroscopically distinguished from each other, and other major regional obsidians was tested. Macroscopic attributes not previously associated with Napa Valley glass were confirmed by geochemical analysis. These include faint banding and inclusions, but this material's greatest range of attributes was with rootbeercolored specimens. Jackson (1986, personal communications 1992) did not believe Franz Valley obsidian could be accurately macroscopically assigned because of its range of attributes and visual similarities with other major regional obsidian. By originally sorting obsidian items according to visual attributes and not by assigning them to a particular source, the author was initially able to group items that were assigned to Franz Valley glass by geochemical analysis. This glass was the most difficult to assign, either visually or geochemically, when its characteristics were similar to Annadel glass. Typically in the southern North Coast Ranges, research not generated by federal requirements has relied solely, for funding reasons, on visual sourcing to determine which obsidian sources were used. Results of visual and geochemical source assignments utilized for the present study indicates that the inclusion of geochemical testing was an important factor in identifying and confirming the extensive cultural use of Franz Valley glass, and in determining the sources of obsidian with atypical macroscopic attributes. For future investigations in, adjacent to, and away from non-quarry areas, the inclusion of geochemical analysis to confirm or refute visual sourcing assignments is encouraged.

Research Objectives

Native American use of non-quarry areas would be consistent with general ethnographic (e.g., Heizer and Treganza 1971) and ethnoarchaeological (e.g., Binford 1979) interpretations. While there is limited ethnographic information concerning procurement of local obsidian for the southern North Coast Ranges, general statements have been made regarding the accessibility and use of various flaked stone materials by Native Californians. For example, Heizer and Treganza

(1971:352) wrote:

> ...each local Indian group knew every rock outcrop within its territory, and if any stone was of a variety which lent itself to making implements, they used it. Actual prospecting, where the Indian would set out blindly on a search to locate a specific stone material, probably was unknown.

This concept is consistent with observations from ethnoarchaeological research of mobile populations (Binford 1979, 1982; Gould and Saggers 1985). Probably Heizer and Treganza's comment is applicable to Native American use of obsidian from non-quarry collecting areas, as well as quarry areas.

For all temporal periods, much of the culturally modified Napa Valley obsidian identified at various archaeological sites in the study area was probably collected locally rather than at the known Napa Valley quarry, situated in northern Napa County. The present research suggests that use of obsidian obtained from non-quarry areas was not limited to expedient tools as other researchers have proposed (Praetzellis and Praetzellis 1976; Jackson 1978, 1986). Both formal and informal tools were made from Napa Valley and Franz Valley obsidian, including some Form 1 and 2 bifaces retaining cortical surfaces as documented in Chapters Four and Five. Since various stages of biface production from local obsidian are represented in the study sites, this suggests projectile points were also manufactured from this material. It is not known how many of the research area's 27 temporally diagnostic obsidian projectile points produced from Napa Valley and Franz Valley were produced from obsidian obtained locally at non-quarry areas and how many were transported or traded into the research area.

Obsidian hydration values from archaeological sites in the research area provide little evidence for obsidian scavenging or reuse from older archaeological deposits. In this portion of the southern North Coast Ranges, these activities may not have been necessary because of the accessibility of various local tool stone materials. With the presence of local chert and obsidian, site occupants might have used these materials for most or all of their flaked stone needs, as opposed to transporting or trading from elsewhere. Although difficult to test given the scale of most archaeological investigations in the southern North Coast Ranges, it seems likely that the people at CA-SON-1810 discarded their curated tools, produced from chert and Lake County obsidian, near the locations where they would have accessed or modified local materials of Napa Valley and Franz Valley obsidian into new tools. This discard and replacement pattern is similar to technological organization models for more mobile people (Binford 1979, 1982; Murray 1980; Kelly 1983; Shott 1986, 1989; Flenniken 1991).

The geographical distribution of culturally modified obsidian float indicates a rapid distance-decay model, probably because of the accessibility to or established trade patterns of nearby major obsidian sources and locally occurring chert. Apparently, Native American use of non-quarry areas in Sonoma County was not limited to the present study area. The Windsor syncline of the Glen Ellen Formation extends south and east of the present research area as described in Chapter Four (Cardwell 1958; Fox et al. 1985). Residual cortex and visual sourcing results from flaked stone specimens recovered south of the research area also suggest local use of obsidian float (e.g., Bieling 1987 [at CA-SON-1585]; Praetzellis and Praetzellis 1976 [at CA-SON-710 and -906]; Mikkelsen et.al., 1984 [at CA-SON-963 and -964]; Bieling 1987 [along eastern edge of and within the Laguna de Santa Rosa]; Kuhn 1979; Psota 1992 [at CA-SON-1238]). Since no geochemical testing has been conducted on unmodified obsidian float from south of the study area, its geochemical source assignments are unknown. This may mean that other obsidian sources present in the Sonoma Volcanics, such as Annadel, are represented in the southern portions of the Glen Ellen Formation. Current research of geochemical sourcing indicates that the cultural distribution of Franz Valley glass was probably more limited than that of Napa Valley. Results from the author's visually sourcing a small, arbitrarily selected obsidian sample from archaeological sites south of the research area suggest that the occurrence of Franz Valley obsidian rapidly diminishes south of Mark West Creek in proportion to increases in Annadel glass.

Since the present research has established the extensive use of non-quarry obsidian from the Glen Ellen Formation, an appropriate name is needed to distinguish these collecting areas from quarry areas. While the term "casual-collecting area" has been proposed to describe non-quarry areas such as the Windsor locality (Jackson 1986), the term "casual" and its implied connotations are inappropriate. This research suggests Native American use of Napa Valley and Franz Valley glass from these areas was not casual. At many study sites, these obsidian sources were dominant or exclusively used during all periods, even if presumably the product of opportunistic behavior. The reliance on these non-quarry areas, in contrast to dependence on either exchange of or direct access to the more distant quarry areas for Annadel, Napa Valley, Borax Lake, or Mt. Konocti obsidian, is evident. The terms "non-quarry areas" and "collecting areas" are preferred; the former is most consistently used throughout western North America (Nelson et al. 1975 [British Columbia]; Apland 1979 [British Columbia]; Sappington and Cameron 1981 [New Mexico]; Sappington 1984 [Idaho]).

The Role of Non-Quarry Obsidian Use at CA-SON-1810 and -1811

Specific interpretations of how the various flaked stone materials arrived at CA-SON-1810 and -1811 are discussed here. Mt. Konocti obsidian probably arrived at the study sites in the form of finished bifacial tools, as indicated by the patterning of projectile points, bifaces and debitage, and the absence of cores and EMFs from this material. The more mobile occupants of CA-SON-1810 may have had direct access to or ad hoc exchange of Mt. Konocti glass during part of their cycle, modifying the material while traveling to Alexander Valley. This hypothesis could be strengthened by the presence of Napa Valley and Franz Valley obsidian at the Mt. Konocti quarry. This obsidian probably arrived at CA-SON-1811 by one of the following scenarios: the people from CA-SON-1811 may have obtained this glass from the people who lived at CA-SON-1810, or from people who lived near Cloverdale or in the southwestern portion of the Geysers; or the material was discarded by the mobile people from CA-SON-1810 while temporarily living at CA-SON-1811 when its more residential occupants lived elsewhere. These alternatives are not as easily tested archaeologically.

Borax Lake glass was represented by two medium size flake blanks at CA-SON-1811, presumably a product of trade to this location. At CA-SON-1810 use of this glass, though limited, included a variety of tools and debitage representing a higher proportion of the obsidian assemblage than at CA-SON-1811. Similar to their later use of Mt. Konocti glass, the people at CA-SON-1810 may have obtained Borax Lake glass either through limited direct access or through exchange during their annual mobile cycle. Its rare use at CA-SON-1811 may be interpreted as exchanged items from their more mobile neighbors or as discarded items from the more mobile people of CA-SON-1810 while staying at CA-SON-1811. These interpretations would be difficult to test archaeologically.

The use of Annadel obsidian was extremely limited in this area. It was not represented at CA-SON-1810 and appeared in very limited amounts of curated tools at CA-SON-1811. This meager amount illustrates the rare ad hoc exchange of Annadel obsidian into this region.

Napa Valley was the most frequently used material at CA-SON-1811 and the most frequently used obsidian at CA-SON-1810. Both sites had similar percentages of flaked stone items produced from this material containing residual cortex, indicating reduction of local cobbles obtained from the Glen Ellen Formation. Based on the frequency of residual cortex, debitage, cores, and an unmodified cobble, it can be inferred that the peoples from both sites had direct access to this and Franz Valley obsidian. Presumably, suitable cobbles, sometimes in the form of cobble cores, were transported away from non-quarry areas for future use. CA-SON-1810 contained no obsidian cores of either Franz Valley or Napa Valley glass. If they were used at this location, then these cores were probably transported to other sites for continued use. Since cobble cores would ideally be further reduced at other sites, this action would reduce its cobble attributes and the mass of obsidian as suggested by other researchers (e.g., Goodyear 1979; Murray 1980; Parry and Kelly 1987; Andrefsky 1994). Documenting and tracing this reduced material in debitage and tool form, including discarded cores, across the landscape could test this interpretation. Also, both peoples may have accessed these collecting areas at other locations, or traded for Napa Valley obsidian in biface or projectile point form. Site specific investigations at other archaeological sites where the reduction of non-quarry obsidian is investigated would reinforce the latter interpretation. Presently, the extent of Napa Valley glass exchanged from resource locations more distant cannot be determined.

Franz Valley obsidian was used for a variety of flaked stone tools. CA-SON-1811 contained the greatest number and assortment of tools ranging from EMFs to Form 2 bifaces made from this glass, while only one Form 2 biface was recovered at CA-SON-1810. At the latter site, one fifth of the obsidian items assigned to Franz Valley glass included residual cortex, whereas CA-SON-1811 materials contained a somewhat smaller sample. The recovery of one such tool and debitage with residual cortex at CA-SON-1810 is consistent with models for more mobile people, who replaced their worn and broken items with locally available materials and then the replenished toolkit was transported elsewhere (Kelly 1983, 1988; Nelson 1991). Cultural use of Franz Valley obsidian presumably reflects similar utilization of the proportion of Napa Valley glass obtained from non-quarry areas.

Chert was the only other tool stone material recovered that contained a sufficient sample for analysis. It was the most frequently used flaked stone material at CA-SON-1810 and although it was not the dominant material at CA-SON-1811, the latter contained more flaked chert items than were recovered at the former. The cores and cortical debitage from both sites imply that there was direct access to this local material. At CA-SON-1810, debitage and all stages of tools manufacture were recovered. In contrast, chert was represented at CA-SON-1811 by only an occasional biface, core, or drill; the remainder were flakes. The presence of this material at CA-SON-1811 may be the result of opportunistic behavior, trade from the occupants of CA-SON-1810, or limited use of CA-SON-1811 by the people from CA-SON-1810, when their neighbors lived elsewhere. The preference for chert at CA-SON-1810 may be attributable to more than its availability throughout most of the North Coast Ranges. For although chert is more difficult to flake than obsidian, it is less brittle and the tool's edge stays sharper longer and is resistant to breakage (Lawn and Marshall 1979). Mobile people, who had limited access to obsidian, probably found that chert was a more durable flaked stone material, which may have been preferred for certain activities. This suggestion may be testable from use wear, or blood residue analyses, or by association with other artifacts, such as the co-occurrence of chert drills and clam shell beads.

General Interpretations of Non-Quarry Obsidian Use in the Research Area

Interpretations of tool stone material from CA-SON-1810 and -1811 may apply to other nearby sites. Within the research area, the only single component sites are associated with Period 4, CA-SON-1487, -1491, and -1758; they contained no Lake County obsidians, CA-SON-1487 and -1491 had higher amounts of Annadel glass than surrounding sites. Since there are so few single component sites, only general patterns can be discussed. Again, the high percentage of Napa Valley glass, combined with attributes usually associated with direct access to resources, suggests that both Napa Valley and Franz Valley obsidians were obtained from nearby non-quarry areas. Northwest of Santa Rosa only occasional pieces of Annadel glass associated with Period 2 have been identified, this suggests very limited ad hoc exchange. During Periods 3 and 4, some sporadic use of Annadel is present at an increasing number of southern study sites with only an occasional piece identified beyond Cloverdale (e.g., CA-MEN-2228). These findings are consistent with localities northeast and northwest of the project area, where Annadel obsidian is rare (Fredrickson 1989; Rondeau 1985, 1990). In the South Region, the abrupt shift from Napa Valley glass to Annadel glass during the end of Period 3 and continuing into Period 4 as suggested by Greenway (1986b), appears more gradual and less extensive.

Regularized exchange of, or direct access to Mt. Konocti glass is only apparent near the present town of Cloverdale during Periods 2, 3, and 4 as indicated by the quantity of material and their hydration values. Ad hoc exchange of both Lake County obsidian sources is proposed for most of the remaining sites associated with Periods 2 and 3, with the southern most sites containing little or no Lake County glass. It is proposed that the utilization of non-quarry obsidian restricted the use of Mt. Konocti glass to northern portions, confined the use of Borax Lake glass to western portions, and limited the use of Annadel glass mainly to the southern region.

North Region

While general interpretations of the study area address non-quarry obsidian utilization, the Cloverdale region was unique for its diverse obsidian use and as the sample's control area. What may appear as a garbled mixture of obsidian utilization at the North Region's sites during Periods 2 through 4, may be explained by any of the following interpretations: sample bias; social status; and multiple contemporaneous populations. While any sample is probably biased, the sites from this region were all arbitrarily selected because of various, independently proposed development projects. The sample consists of sites with components containing midden (CA-SON-1760, -1759, and -1344), and components with non-midden (CA-SON-1503, -1344, and CA-MEN-2228). The small sample size may account for some sample bias, which with further large-scale investigations might be alleviated. Although differential living situations attributed to social status can yield some dissimilar items, the lack of such items (e.g., beads, steatite ornaments and bowls, charmstones) at any of these sites, weakens this interpretation.

The suggestion that multiple contemporaneous populations lived in the Cloverdale region is supported by the proportions of obsidian items recovered from surrounding regions (Table 2). The nearly exclusive obsidian use of Mt. Konocti was typical of sites to the north and northwest of Cloverdale (Rondeau 1985, 1990; Jackson 1986; Fredrickson 1989), whereas, sites to the east of Cloverdale tended to have a dominance of Mt. Konocti with smaller amounts of Napa Valley and Borax Lake (Fredrickson 1989). Some components in the North Region appear most similar to the Central Region, where Napa Valley glass was dominant (Psota n.d., cited by Gmoser 1992). The Cloverdale region might have been a boundary area for as many as three contemporaneous populations. If so, then exchange between the groups from the north and south of this area was infrequent or there was a great social distance between these groups. The people to the east had more interactions with both of their neighbors.

Franz Valley Obsidian

In the entire research area, the presence of culturally modified Franz Valley glass suggests use of nearby non-quarry areas. Franz Valley hydration rims cannot be incorporated into the previously described analytical periods because its hydration rate relative to other obsidian sources is not known. Presently, there are few temporally diagnostic artifacts produced from Franz Valley glass and most of these are stylistically associated with the latest period. While the current sample of hydration values for these points is consistent with the range of Annadel and Napa Valley glass, it is unknown if a larger sample of hydration readings derived from all point styles would be consistent with established rates for these other glasses (after Origer 1987). Since there are so few identified single component sites within the research area and they are all attributed to late use, hydrations readings from these sites probably would provide limited information for comparisons to other glass hydration rates. Thus, archaeologists should use caution in interpreting Franz Valley hydration data.

Conclusion

This research documents the extensive Native American use of obsidian obtained from non-quarry areas, even though there is little documented archaeological evidence of such use in collecting areas. Characteristics typical of obsidian obtained at these areas have been provided and included a greater range of macroscopic attributes for Napa Valley and Franz Valley glass than previously described. These visual sourcing characteristics are furnished in Chapter Three to illustrate some of the macroscopic differences in obsidian within the research area, and they should not be used to visually source items without additional confirmation by geochemical analysis from researchers capable of assigning obsidians to minor sources. Future research should recognize that geochemical obsidian assignments do not necessarily reflect the geographic location where the obsidian was obtained; these assignments only identify established geochemically-distinct obsidian. For archaeological investigations in and near the present study area, researchers should incorporate the use of non-geochemically distinct, non-quarry obsidians into their social distance models.

Minor obsidian flows and non-quarry areas should have a limited area of cultural use with a dramatic distance-decay rate. Native American utilization of collecting areas will obviously vary according to a site's location within this region and the different strategies used by more mobile and residential peoples. Undoubtedly, some non-quarry locations were more desirable for collecting material than others because of the size of cobbles comprising the obsidian float, ease of access, and capacity for coordination with other activities. While only the northern distribution of culturally modified obsidian from non-quarry areas in the Glen Ellen Formation could be determined, the predominance of this obsidian in archaeological sites throughout the research area suggests when it was culturally modified, non-quarry obsidian was heavily used and perhaps this limited the distribution and utilization of other obsidian into this area. The consequences of non-quarry obsidian use are manifested in the area's social and exchange systems, and may provide insights into the cultural and temporal use of certain regions. When archaeological investigations are near non-quarry areas, future research questions should identify and consider the effects of such obsidian sources. The combined use of technological organization models with social distance models will elaborate on many research objectives unobtainable by the sole use of social distance models or the ad hoc use of technological organization and social distance models. Identification and analysis may provide a better understanding of the local temporal sequence, material procurement, exchange systems, and differences in social distance.

- Appendix A -

November 20, 1991

Ms. Sunshine Psota
Anthropological Studies Center
Sonoma State University
Rohnert Park, CA 94928

Dear Sunshine:

Enclosed with this letter you will find a copy of a table presenting x-ray fluorescence data generated from the analysis of 17 obsidian artifacts from CA-Son-1212 (n=4) and CA-Son-1811 (n=13) Sonoma County, California. The research reported here was completed pursuant to your letter request of August 25, 1991 and Sonoma State University Academic Foundation, Inc. account no. 31520, job 36/91.

Laboratory investigations were performed on a Spectrace™ 5000 (Tracor X-ray) energy dispersive x-ray fluorescence spectrometer equipped with a rhodium (Rh) x-ray tube, a 50 kV x-ray generator, with microprocessor controlled pulse processor (amplifier) and bias/protection module, a 100 mHz analog to digital converter (ADC) with automated energy calibration, and a Si(Li) solid state detector with 150 eV resolution (FWHM) at 5.9 keV in a 30 mm^2 area. The x-ray tube was operated at 35.0 kV, .28 mA, using a .127 mm Rh primary beam filter in an air path at 200 seconds livetime to generate x-ray intensity data for the trace elements zinc (Zn $K\alpha$), gallium (Ga $K\alpha$), rubidium (Rb $K\alpha$), strontium (Sr $K\alpha$), yttrium (Y $K\alpha$), zirconium (Zr $K\alpha$) and niobium (Nb $K\alpha$). X-ray intensities were converted to concentration estimates employing a least-squares calibration line established for each element from analysis of up to 26 international rock standards certified by the U.S. Geological Survey, the U.S. National Institute of Standards and Technology (formerly National Bureau of Standards), the Geological Survey of Japan, and the Centre de Recherches Petrographiques et Geochimiques (France). Data processing for all analytical subroutines is executed by a Hewlett Packard Vectra™ microcomputer, with operating software and analytical results stored on a Hewlett Packard 20 megabyte fixed disk. Further details pertaining to x-ray tube operating conditions and calibration appear in Hughes (1988).

All trace element values in the table are expressed in quantitative units (i.e. parts per million [ppm] by weight), and these were compared directly to values for known obsidian sources that appear in Bowman et al. (1973), Hughes (1986, 1989), Jack (1976), and Jackson (1986, 1989). Artifacts were assigned to a parent obsidian type if diagnostic trace element values (i.e., ppm values for Rb, Sr, Y, and Zr) corresponded at the 2-sigma level. Stated differently, artifact-to-obsidian source (geochemical type) matches were considered reliable if diagnostic mean measurements for artifacts fell within 2 standard deviations of mean values for source standards. The term "diagnostic" is used here to specify those trace elements that are well-measured by x-ray fluorescence, and whose concentrations show low intra-source variability and marked variability across sources. Diagnostic elements, then, are those whose concentration values allow one to draw the clearest geochemical distinctions between sources (see Hughes 1990; Hughes and Lees 1991). Although Zn and Ga ppm concentrations also were measured and reported for each specimen, they are not considered "diagnostic" because they don't usually vary significantly across obsidian sources (see Hughes 1982, 1984). This is particularly true of Ga, which occurs in concentrations between 10-30 ppm in nearly all sources in the study area. Zn ppm values are always high in Zr-rich, Sr-poor peralkaline volcanic glasses (like those in northwestern Nevada, where concentrations are >150 ppm), but otherwise they do not vary dramatically between sources.

The trace elemental composition measurements presented herein are reported to the nearest ppm to relect the resolution capabilities of non-destructive energy dispersive x-ray fluorescence spectrometry. The resolution limits of the present x-ray fluorescence instrument for the determination of Zn is about 3 ppm; Ga about 2 ppm; for Rb about 4 ppm; for Sr about 3 ppm; Y about 2 ppm; Zr about 5 ppm; and for Nb about 3 ppm. When counting and fitting error uncertainty estimates (the "±" value in the table) for a sample are greater than calibration-imposed limits of resolution, the larger number is preferred as a more conservative, robust reflection of elemental composition and measurement error due to variations in sample size, surface and x-ray reflection geometry (see Hughes 1988).

The obsidian source attribution for each specimen appears in the data table. As you can see, x-ray fluorescence analyses indicate that six samples conform to the Napa Valley (*sensu* Jackson 1989) obsidian trace element "signature", three match the geochemical profile of Mt. Konocti obsidian, while the remaining eight specimens have Rb, Sr, Y, and Zr concentrations within the range reported by Jackson (1986: 57; Tables A1.8 and A1.9) for Franz Valley obsidian. Obsidian of the Franz Valley geochemical type also occurs in redeposited contexts in the Glen Ellen Formation in the Santa Rosa area (see Jackson 1986: 57-58).

I hope this information will help in your analysis and interpretation of these site materials. Please contact me at my laboratory (phone: [916] 364-1074) if I can provide further assistance or information.

Sincerely,

Richard Hughes

Richard E. Hughes, Ph.D.

encl.

REFERENCES

Bowman, H.R., F. Asaro, and I. Perlman

1973 On the Uniformity of Composition in Obsidians and Evidence for Magmatic Mixing. **Journal of Geology** 81: 312-327.

Hughes, Richard E.

1982 Age and Exploitation of Obsidian from the Medicine Lake Highland, California. **Journal of Archaeological Science** 9 (2): 173-185.

1984 Obsidian Sourcing Studies in the Great Basin: Problems and Prospects. *In* Richard E. Hughes (ed.) Obsidian Studies in the Great Basin. **Contributions of the University of California Archaeological Research Facility,** No. 45, pp. 1-19.

1986 Diachronic Variability in Obsidian Procurement Patterns in Northeastern California and Southcentral Oregon. **University of California Publications in Anthropology,** Vol. 17.

1988 The Coso Volcanic Field Reexamined: Implications for Obsidian Sourcing and Hydration Dating Research. **Geoarchaeology: An International Journal** 3 (4): 253-265.

1989 A New Look at Mono Basin Obsidians. *In* Richard E. Hughes (ed.), Current Directions in California Obsidian Studies. **Contributions of the University of California Archaeological Research Facility** No. 48, pp. 1-12.

1990 Obsidian Sources at James Creek Shelter, and Trace Element Geochemistry of Some Northeastern Nevada Volcanic Glasses. *In* Robert G. Elston and Elizabeth Budy (eds.), The Archaeology of James Creek Shelter, Nevada. **University of Utah Anthropological Papers** No. 115, pp. 297-305.

Hughes, Richard E. and William B. Lees

1991 Provenance Analysis of Obsidian from Two Late Prehistoric Archaeological Sites in Kansas. **Transactions of the Kansas Academy of Science** 94 (1&2): 38-45.

Jack, Robert N.

1976 Prehistoric Obsidian in California I: Geochemical Aspects. *In* R.E. Taylor (ed.), **Advances in Obsidian Glass Studies: Archaeological and Geochemical Perspectives,** pp. 183-217. Noyes Press, Park Ridge, New Jersey.

Jackson, Thomas L.

1986 Late Prehistoric Obsidian Exchange in Central California. Unpublished Ph.D. Dissertation, Department of Anthropology, Stanford University.

1989 Late Prehistoric Obsidian Production and Exchange in the North Coast Ranges, California. *In* Richard E. Hughes (ed.), Current Directions in California Obsidian Studies. **Contributions of the University of California Archaeological Research Facility** No. 48, pp. 79-94.

Trace Element Concentrations

Specimen Number	Zn*	Ga*	Rb*	Sr*	Y*	Zr*	Nb*	Obsidian Source (Chemical Type)
91-36-15a	51 ±6	17 ±3	209 ±5	69 ±3	39 ±2	190 ±5	10 ±3	Mt. Konocti
91-36-15b	44 ±6	20 ±3	207 ±5	64 ±3	37 ±2	188 ±5	10 ±3	Mt. Konocti
91-36-15c	72 ±6	17 ±3	188 ±5	6 ±3	47 ±2	229 ±5	11 ±3	Napa Valley
91-36-15d	77 ±6	17 ±4	210 ±3	7 ±2	49 ±5	249 ±3	6 ±3	Napa Valley
91-36-15e	78 ±6	22 ±3	186 ±5	50 ±3	44 ±2	254 ±5	12 ±3	Franz Valley
91-36-15f	70 ±6	17 ±3	181 ±5	45 ±3	45 ±2	250 ±5	7 ±3	Franz Valley
91-36-15g	67 ±6	22 ±3	197 ±5	7 ±3	48 ±2	234 ±5	6 ±3	Napa Valley
91-36-15h	69 ±6	18 ±3	204 ±5	6 ±3	49 ±2	246 ±5	10 ±3	Napa Valley
91-36-15i	66 ±6	18 ±3	189 ±5	49 ±3	44 ±2	257 ±5	8 ±3	Franz Valley
91-36-29a	65 ±5	18 ±3	173 ±4	45 ±3	41 ±2	244 ±5	9 ±3	Franz Valley
91-36-29b	49 ±6	18 ±3	247 ±5	69 ±3	38 ±2	204 ±5	10 ±3	Mt. Konocti
91-36-29c	96 ±7	18 ±4	214 ±5	54 ±3	46 ±3	269 ±5	10 ±3	Franz Valley
91-36-278	61 ±6	17 ±3	192 ±5	5 ±3	46 ±2	224 ±5	9 ±3	Napa Valley
89-7-136	59 ±5	14 ±3	170 ±4	7 ±3	45 ±2	221 ±5	10 ±3	Napa Valley
89-7-202	51 ±6	21 ±3	175 ±5	41 ±3	40 ±2	238 ±5	11 ±3	Franz Valley
89-7-271	53 ±6	17 ±3	163 ±4	42 ±3	37 ±2	233 ±5	8 ±3	Franz Valley
89-7-274	64 ±5	16 ±3	175 ±4	43 ±3	42 ±2	246 ±5	7 ±3	Franz Valley

* = trace element values in parts per million (ppm); ± = pooled estimate (in ppm) of x-ray counting uncertainty and regression fitting error at 200 seconds livetime.

REPORT OF X-RAY FLUORESCENCE ANALYSIS OF ARTIFACT OBSIDIAN FROM CA-SON-1810 AND CA-SON-1811

Thomas L. Jackson and
M. Kathleen Davis

January 8, 1993

Fourty-two pieces of artifact obsidian from sites CA-SON-1810 and CA-SON-1811, in Sonoma County, were submitted for determination of the geological source of the raw material using energy dispersive X-ray fluorescence trace-element analysis.

X-RAY FLUORESCENCE METHODS

Analyses were completed using a Spectrace 5000 energy dispersive X-ray fluorescence system. The system is equipped with a Si(Li) detector with a resolution of 155 eV FHWM for 5.9keV X-rays (at 1000 counts per second) in an area $30mm^2$. Signals from the spectrometer are amplified and filtered by a time variant pulse processor, and sent to a 100 MHz Wilkinson type analog-to-digital converter. The X-ray tube employed is a Bremsstrahlung type, with a Rh target, and 5 mil Be window. The tube is driven by a 50 kV 1 mA high voltage power supply, providing a voltage range of 6 to 50 kV.

For analysis of the elements zinc (Zn), gallium (Ga), lead (Pb), thorium (Th), rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr), and niobium (Nb), the Rh X-ray tube is operated at 30 kV, .30 mA (pulsed), with a .127 mm Pd filter. Analytical lines used are: Zn (K-alpha), Ga (K-alpha), Pb (L-alpha), Th (L-alpha), Rb (K-alpha), Sr (K-alpha), Y (K-alpha), Zr (K-alpha) and Nb (K-alpha). Scanning period is 200 seconds live-time in an air path. Trace-element intensities for the Zn-Nb series elements are converted to parts-per-million (ppm) by weight using a least squares polynomial fit routine. Ppm values may vary according to specimen mass and nature of the surface of the sample. All samples are scanned as unmodified rock specimens (not powder).

X-RAY FLUORESCENCE RESULTS

Analytical results are given in the following table. Of fourty-two specimens submitted, twenty-five are characteristic of the Napa Valley chemical group. Also represented in the sample are the sources Franz Valley (ten specimens), Annadel (three specimens), Borax Lake (two specimens), and Mt. Konocti (one specimen). The remaining specimen, 36-60N, is designated "Franz Valley?." This specimen is a thin flake with a hydration cut through the middle, and probably because of its small mass, the resulting numbers are inconclusive. Though somewhat closer to the Franz Valley chemical group, this piece could be from either Franz Valley or Annadel.

Trace-Element Concentration Values: CA-SON-1810 and CA-SON-1811

Sample #	ZN	GA	PB	TH	RB	SR	Y	ZR	NB	Location
<u>CA-SON-1810</u>										
35-17C	78.8	26.5	28.6	15.9	149.9	39.3	37.9	221.5	4.9	FV
+/-	7.6	4.5	4.2	4.7	2.7	6.0	2.0	8.4	2.6	
35-3II	60.7	22.0	30.2	18.1	190.1	8.8	45.3	238.6	11.4	NAP
+/-	4.8	2.4	2.5	2.9	1.9	5.9	1.4	8.2	1.6	
35-31.008	60.0	20.5	33.4	16.7	182.7	19.5	40.9	234.5	10.6	NAP
+/-	4.9	2.4	2.6	2.9	2.0	5.9	1.5	8.2	1.7	
-31.023A	146.3	14.2	33.0	22.7	168.1	7.7	39.6	217.8	6.2	NAP
+/-	7.9	4.7	4.3	5.0	3.0	6.1	2.1	8.4	2.5	
-31.023B	61.4	15.0	30.7	24.0	159.3	8.6	36.3	192.8	10.4	NAP
+/-	6.7	3.9	4.0	4.9	2.6	6.0	1.9	8.4	2.2	
35-31.024	62.5	19.5	35.8	17.4	200.9	8.3	49.1	251.1	14.0	NAP
+/-	4.7	2.4	2.5	2.9	2.1	5.9	1.5	8.2	1.6	
35-37	64.1	23.5	32.2	17.6	171.3	47.2	42.0	254.5	11.5	FV
+/-	4.4	2.1	2.2	2.5	1.8	5.9	1.4	8.2	1.5	
35-38	50.6	20.9	32.6	22.1	221.7	15.8	41.4	105.5	12.1	BL
+/-	4.4	2.1	2.2	2.5	1.9	5.9	1.4	8.1	1.5	
35-39	105.1	17.3	32.1	19.7	170.1	47.0	41.3	257.0	9.6	FV
+/-	5.0	2.2	2.3	2.6	1.8	5.9	1.4	8.2	1.6	
35-53	68.0	25.4	34.2	19.0	220.8	13.2	43.5	105.3	11.0	BL
+/-	5.8	3.3	3.3	3.9	3.0	5.9	2.0	8.3	2.1	
35-88	60.4	19.2	29.0	17.2	175.7	10.2	42.4	225.5	9.9	NAP
+/-	5.0	2.5	2.7	3.1	2.2	5.9	1.6	8.2	1.8	
35-111	83.5	22.3	34.9	19.9	189.5	10.5	45.4	242.4	10.3	NAP
+/-	4.7	2.3	2.4	2.7	1.9	5.9	1.4	8.2	1.6	
<u>CA-SON-1811</u>										
36-14	66.5	24.8	36.4	26.3	194.5	6.0	43.9	245.5	9.6	NAP
+/-	4.6	2.2	2.3	2.7	1.8	5.9	1.4	8.1	1.5	
36-15B	77.5	15.0	38.1	23.1	198.6	9.3	46.7	247.8	12.7	NAP
+/-	4.6	2.3	2.5	2.8	2.0	5.9	1.4	8.2	1.6	

Trace-Element Concentration Values

Sample #	ZN	GA	PB	TH	RB	SR	Y	ZR	NB	Location
36-15C	58.7	16.5	34.3	20.9	172.5	48.0	36.3	244.2	12.9	FV
+/-	5.1	2.8	2.7	3.3	2.2	5.9	1.6	8.3	1.8	
36-33	78.4	19.4	31.8	14.8	137.6	52.3	48.9	288.4	11.1	ANN
+/-	4.7	2.3	2.4	2.5	1.7	5.9	1.4	8.2	1.6	
36-40	66.5	13.0	35.5	18.7	185.9	8.5	47.5	239.9	12.9	NAP
+/-	4.8	2.5	2.5	2.9	2.0	5.9	1.5	8.2	1.6	
36-42	69.3	22.0	38.4	18.6	197.7	21.7	44.5	247.9	10.1	NAP
+/-	4.6	2.3	2.3	2.7	1.9	5.9	1.4	8.2	1.6	
36-43	68.4	20.4	34.3	19.8	196.1	8.3	48.5	251.1	14.3	NAP
+/-	5.0	2.6	2.7	3.1	2.2	5.9	1.6	8.2	1.7	
36-82	68.1	25.0	34.2	19.0	197.0	8.0	45.7	254.8	8.4	NAP
+/-	4.7	2.4	2.5	3.0	2.1	5.9	1.5	8.2	1.7	
36-92	53.4	24.6	33.4	17.7	174.9	49.0	39.0	261.8	10.2	FV
+/-	4.5	2.2	2.3	2.5	1.8	5.9	1.4	8.2	1.6	
36-93	88.6	16.6	34.0	16.9	184.8	8.5	45.4	238.3	7.1	NAP
+/-	4.5	2.1	2.2	2.5	1.8	5.9	1.3	8.1	1.6	
36-120	74.2	20.8	34.2	20.4	195.6	8.3	45.8	246.9	11.7	NAP
+/-	4.8	2.3	2.4	2.9	2.0	5.9	1.5	8.2	1.6	
36-164	61.6	15.5	34.7	20.0	172.9	50.1	41.9	256.5	12.8	FV
+/-	4.8	2.4	2.5	2.9	2.0	5.9	1.5	8.2	1.7	
36-218	66.9	21.8	35.1	18.9	194.5	8.4	46.0	253.3	13.3	NAP
+/-	4.5	2.1	2.3	2.6	1.8	5.9	1.4	8.2	1.5	
36-268	66.1	22.7	37.0	17.2	192.9	8.5	45.2	250.4	11.6	NAP
+/-	4.4	2.0	2.2	2.5	1.8	5.9	1.3	8.1	1.5	
36-272	78.4	15.7	28.6	9.8	136.6	49.5	50.7	288.4	15.1	ANN
+/-	4.4	2.1	2.3	2.2	1.5	5.9	1.3	8.2	1.5	
36-273	57.9	15.2	33.3	19.8	179.8	7.6	44.2	235.6	12.3	NAP
+/-	4.4	2.1	2.2	2.5	1.7	5.9	1.3	8.1	1.5	
36-291	74.3	19.6	35.0	21.3	196.9	8.2	45.2	251.5	12.0	NAP
+/-	4.6	2.2	2.3	2.7	1.8	5.9	1.4	8.2	1.5	

Trace-Element Concentration Values

Sample #	ZN	GA	PB	TH	RB	SR	Y	ZR	NB	Location
36-294	67.4	20.2	34.3	15.6	193.9	10.2	43.1	242.2	10.3	NAP
+/-	4.7	2.2	2.5	2.7	1.9	5.9	1.4	8.2	1.6	
36-297	55.0	9.6	30.5	19.1	173.8	46.9	40.2	252.1	9.6	FV
+/-	4.4	2.3	2.2	2.5	1.7	5.9	1.3	8.2	1.5	
36-304	78.0	21.6	35.5	21.0	177.1	47.3	43.1	255.1	10.7	FV
+/-	5.0	2.5	2.5	3.0	2.1	5.9	1.5	8.2	1.7	
36-60A	70.6	24.7	38.4	18.2	203.8	9.5	48.6	252.9	10.5	NAP
+/-	4.5	2.0	2.3	2.6	1.9	5.9	1.4	8.2	1.6	
36-60C	74.8	24.5	36.2	11.8	177.6	46.7	38.0	242.6	8.9	FV
+/-	5.9	3.3	3.3	3.7	2.5	6.0	1.8	8.4	2.1	
36-60D	65.1	16.7	32.3	16.4	182.2	7.4	42.5	233.5	10.5	NAP
+/-	5.0	2.5	2.7	3.0	2.1	5.9	1.5	8.2	1.7	
36-60F	110.5	24.1	34.8	15.7	155.3	57.1	52.1	302.2	13.6	ANN
+/-	5.1	2.3	2.4	2.5	1.7	5.9	1.4	8.2	1.6	
36-60I	51.0	11.7	33.0	24.3	219.8	68.1	39.2	198.2	11.1	KON
+/-	5.1	2.9	2.8	3.6	2.4	6.0	1.6	8.2	1.8	
36-60CL	60.5	19.2	37.3	20.9	206.3	8.6	47.0	249.5	12.4	NAP
+/-	5.0	2.5	2.6	3.1	2.2	5.9	1.5	8.2	1.7	
36-60M	72.7	23.5	35.5	22.1	199.6	9.5	49.1	252.5	14.0	NAP
+/-	4.7	2.3	2.4	2.9	2.0	5.9	1.5	8.2	1.6	
36-60N	80.6	22.6	37.2	18.4	191.1	55.2	44.4	265.8	10.4	FV?
+/-	5.1	2.6	2.7	3.2	2.2	5.9	1.6	8.3	1.8	
-52.067	65.8	20.5	34.7	20.5	187.5	10.4	43.4	248.9	10.6	NAP
+/-	4.4	2.1	2.2	2.5	1.7	5.9	1.3	8.1	1.5	
-52.080	69.8	17.4	33.0	18.8	175.2	47.4	40.5	256.2	12.5	FV
+/-	4.6	2.3	2.4	2.7	1.9	5.9	1.4	8.2	1.6	
W-2	79.0	19.2	7.9	-0.3	23.3	196.8	19.4	103.2	5.9	reference
+/-	4.9	2.4	2.8	1.2	1.1	6.1	1.3	8.2	1.7	standard

Abbreviations: NAP = Napa Valley; FV = Franz Valley; BL = Borax Lake; ANN = Annadel; KON = Mt. Konocti; FV? = this piece is an awkward shape and the numbers are inconclusive. It could be either Franz Valley or Annadel (see text).

BIOSYSTEMS ANALYSIS INC.

March 22, 1993

Sunshine Psota
Anthropological Studies Center
Foundation Center, Bldg. 300
1801 East Cotati Avenue
Rohnert Park, CA 94928

Dear Sunshine:

Enclosed please find the XRF report and artifacts (n=47) for Alexander Valley. The source results came out with 24 pieces from Franz Valley, 14 Annadel, 6 Napa, one Konocti, one unknown, and one specimen which we've designated Franz Valley/Annadel. The numbers for this specimen (SON-1585, 451a) are more or less mid-way between Franz Valley and Annadel, maybe a bit closer to Annadel. It is a fairly thin piece, which is probably the reason for the screwy numbers.

If you have any questions about the report please give us a call.

Sincerely,

Kathy Davis

M. Kathleen Davis

303 Potrero Street, Suite 29-203, Santa Cruz, CA 95060 • (408) 425-8755 (Office) • (408) 425-0928 (Fax)

REPORT OF X-RAY FLUORESCENCE ANALYSIS OF ARTIFACT OBSIDIAN FROM ALEXANDER VALLEY

Thomas L. Jackson and
M. Kathleen Davis

March 22, 1993

Fourty-seven pieces of artifact obsidian from various sites in Alexander Valley, located in northwestern California, were submitted for determination of the geological source of the raw material using energy dispersive X-ray fluorescence trace-element analysis.

X-RAY FLUORESCENCE METHODS

Analyses were completed using a Spectrace 5000 energy dispersive X-ray fluorescence system. The system is equipped with a Si(Li) detector with a resolution of 155 eV FHWM for 5.9keV X-rays (at 1000 counts per second) in an area $30mm^2$. Signals from the spectrometer are amplified and filtered by a time variant pulse processor, and sent to a 100 MHz Wilkinson type analog-to-digital converter. The X-ray tube employed is a Bremsstrahlung type, with a Rh target, and 5 mil Be window. The tube is driven by a 50 kV 1 mA high voltage power supply, providing a voltage range of 6 to 50 kV.

For analysis of the elements zinc (Zn), gallium (Ga), lead (Pb), thorium (Th), rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr), and niobium (Nb), the Rh X-ray tube is operated at 30 kV, .30 mA (pulsed), with a .127 mm Pd filter. Analytical lines used are: Zn (K-alpha), Ga (K-alpha), Pb (L-alpha), Th (L-alpha), Rb (K-alpha), Sr (K-alpha), Y (K-alpha), Zr (K-alpha) and Nb (K-alpha). Scanning period is 200 seconds live-time in an air path. Trace-element intensities for the Zn-Nb series elements are converted to parts-per-million (ppm) by weight using a least squares polynomial fit routine. Ppm values may vary according to specimen mass and nature of the surface of the sample. All samples are scanned as unmodified rock specimens (not powder).

X-RAY FLUORESCENCE RESULTS

Analytical results are given in the following table.

303 Potrero Street, Suite 29-203, Santa Cruz, CA 95060 • (408) 425-8755 (Office) • (408) 425-0928 (Fax)

BioSystems Analysis, Inc.
XRF LABORATORY CATALOGUE

PROJECT NAME: Alexander Valley

ACCESSION DATA lab#	catalog#		Zn	Pb	Rb	Sr	Y	Zr	Nb	Ba	Fe/Mn ratio	SOURCE
9001			34.5	22.4	144.9	99.5	24.7	219.1	9.5			RGM-1 Reference Standard
		+/-	4.4	1.9	1.7	7.1	1.3	5.6	1.3			
CA-MEN-2228												
4	89-2-5f		87.2	32.0	155.9	54.5	53.4	297.3	11.1			Annadel
		+/-	5.5	2.8	2.2	7.1	1.7	5.8	1.8			
CA-SON-1212												
39	89-7-77a		66.0	36.8	200.3	8.3	49.1	262.6	14.1			Napa Valley
		+/-	4.8	2.3	2.1	7.0	1.5	5.6	1.5			
40	89-7-104b		59.3	28.1	164.2	42.8	36.5	244.2	11.0			Franz Valley
		+/-	4.5	2.2	1.9	7.1	1.4	5.6	1.4			
41	89-7-278		63.9	32.3	183.4	44.9	42.2	262.6	9.5			Franz Valley
		+/-	4.6	2.4	2.0	7.1	1.5	5.6	1.5			
CA-SON-1323												
42	85-7-68		64.5	28.7	178.4	48.0	41.6	253.5	11.9			Franz Valley
		+/-	4.5	2.1	1.9	7.1	1.4	5.6	1.4			
43	85-7-71		72.1	35.9	182.8	46.7	41.2	263.5	11.0			Franz Valley
		+/-	4.6	2.2	2.0	7.1	1.4	5.6	1.4			
44	85-7-107		59.2	33.2	173.2	48.0	40.9	257.0	9.9			Franz Valley
		+/-	4.5	2.2	1.9	7.1	1.4	5.6	1.5			
45	85-7-109		62.2	31.9	179.9	47.2	44.1	259.2	12.2			Franz Valley
		+/-	4.6	2.3	2.0	7.1	1.5	5.6	1.5			
46	85-7-261		64.6	30.5	172.1	45.4	40.1	254.7	10.7			Franz Valley
		+/-	4.5	2.2	1.9	7.1	1.4	5.6	1.4			
47	85-1-568		80.0	31.5	144.2	52.5	47.7	295.1	14.2			Annadel
		+/-	4.7	2.2	1.8	7.1	1.4	5.6	1.4			

Cont.

ACCESSION DATA lab#	catalog#		Zn	Pb	Rb	Sr	Y	Zr	Nb	Ba	Fe/Mn ratio	SOURCE
CA-SON-1324												
35	86-6-53b		100.8	33.0	194.7	47.4	46.7	267.7	10.4			Franz Valley
		+/-	6.4	3.2	2.8	7.2	1.9	5.9	2.0			
36	86-6-64		72.8	30.5	135.0	48.2	48.9	285.3	11.1			Annadel
		+/-	4.8	2.3	1.9	7.1	1.5	5.7	1.5			
37	86-6-112		68.5	32.2	182.5	45.6	42.6	256.6	11.8			Franz Valley
		+/-	4.6	2.3	2.0	7.1	1.5	5.6	1.5			
38	86-6-113		94.4	34.4	152.7	51.6	50.0	300.0	15.8			Annadel
		+/-	4.8	2.3	1.9	7.1	1.5	5.7	1.4			
CA-SON-1449												
1	89-2-612a		59.6	32.8	176.2	14.0	43.9	229.2	11.0			Napa Valley
		+/-	5.8	2.9	2.3	7.1	1.6	5.7	1.7			
2	89-2-616c		63.9	29.3	172.9	2.5	36.9	206.4	8.7			Napa Valley
		+/-	6.0	3.4	2.5	7.1	1.8	5.8	1.9			
3	89-2-621b		90.0	46.4	204.9	6.6	44.6	239.4	8.9			Napa Valley
		+/-	7.3	4.1	3.5	7.1	2.4	6.2	2.6			
CA-SON-1485												
31	85-5-5c		67.4	29.3	163.2	41.5	39.6	240.6	10.7			Franz Valley
		+/-	5.0	2.5	2.1	7.1	1.5	5.7	1.6			
32	85-5-5d		53.5	31.1	160.9	40.1	31.0	229.3	10.7			Franz Valley
		+/-	7.4	3.8	3.0	7.2	2.2	6.0	2.3			
33	85-5-204		57.0	25.7	167.0	63.8	27.6	161.4	12.4			Mt. Konocti
		+/-	6.3	3.7	3.0	7.2	2.1	5.9	2.2			
34	85-5-230		80.3	33.3	187.8	50.6	42.5	267.3	9.6			Franz Valley
		+/-	4.9	2.3	2.0	7.1	1.5	5.6	1.5			
CA-SON-1486												
29	85-5-45e		57.4	35.9	174.1	44.4	40.8	255.2	11.1			Franz Valley
		+/-	4.6	2.3	1.9	7.1	1.4	5.6	1.4			
30	85-5-229g		68.6	31.2	143.0	50.8	48.9	291.7	12.3			Annadel
		+/-	4.8	2.3	1.9	7.1	1.5	5.7	1.5			

TRACE-ELEMENT CONCENTRATION VALUES (ppm)

Cont.

ACCESSION DATA lab#	catalog#		Zn	Pb	Rb	Sr	Y	Zr	Nb	Ba	Fe/Mn ratio	SOURCE
CA-SON-1487												
26	85-5-904		71.3	32.9	135.4	49.3	49.7	284.2	10.4			Annadel
		+/-	4.7	2.2	1.8	7.1	1.5	5.7	1.5			
CA-SON-1491												
27	85-5-913		71.3	32.1	147.5	49.8	54.0	300.2	15.0			Annadel
		+/-	5.0	2.5	2.0	7.1	1.6	5.7	1.6			
28	85-5-916		68.1	32.2	144.5	52.8	53.5	298.7	13.4			Annadel
		+/-	4.7	2.2	1.8	7.1	1.4	5.6	1.4			
CA-SON-1551												
21	86-1-224a		64.7	32.8	179.3	47.0	40.6	253.3	14.5			Franz Valley
		+/-	5.4	2.8	2.4	7.1	1.7	5.8	1.7			
CA-SON-1552												
22	86-1-228a		64.9	34.4	186.6	49.2	43.9	265.9	10.9			Franz Valley
		+/-	4.9	2.5	2.0	7.1	1.5	5.6	1.4			
23	86-1-228b		67.3	31.5	171.4	43.5	38.1	244.6	12.0			Franz Valley
		+/-	5.0	2.5	2.1	7.1	1.6	5.7	1.5			
CA-SON-1585												
17	87-1-451a		105.6	41.0	171.2	62.0	54.7	308.1	12.6			Franz Valley/Annadel
		+/-	6.2	3.2	2.7	7.2	2.0	6.0	2.0			
18	87-1-453a		89.9	31.0	152.1	51.9	49.3	291.3	12.8			Annadel
		+/-	5.7	3.0	2.3	7.1	1.8	5.9	1.8			
19	87-1-453b		71.3	30.3	137.4	47.3	45.5	278.0	10.7			Annadel
		+/-	5.6	2.8	2.2	7.1	1.7	5.8	1.8			
CA-SON-1591												
12	87-1-506h		63.9	29.0	172.5	47.2	41.3	254.3	11.4			Franz Valley
		+/-	4.8	2.5	2.1	7.1	1.5	5.7	1.6			
13	89-1-506i		69.3	30.5	138.0	48.8	46.6	286.0	13.7			Annadel
		+/-	4.5	2.1	1.7	7.1	1.4	5.6	1.4			
CA-SON-1592												
14	87-1-507r		73.7	33.2	143.7	50.8	52.5	295.1	13.6			Annadel
		+/-	4.7	2.3	1.8	7.1	1.5	5.7	1.5			

Header note: TRACE-ELEMENT CONCENTRATION VALUES (ppm)

Cont.

ACCESSION DATA lab#	catalog#		Zn	Pb	Rb	Sr	Y	Zr	Nb	Ba	Fe/Mn ratio	SOURCE
CA-SON-1592												
15	87-1-507s		67.8	27.1	137.1	48.2	50.3	277.9	13.2			Annadel
		+/-	5.0	2.4	1.9	7.1	1.5	5.7	1.5			
16	87-1-507zz		62.9	34.4	185.2	46.9	41.3	255.3	10.3			Franz Valley
		+/-	5.3	2.7	2.3	7.1	1.6	5.7	1.7			
CA-SON-1758												
9	89-2-31a		63.4	32.0	173.9	46.1	42.5	255.5	9.7			Franz Valley
		+/-	4.4	2.1	1.9	7.1	1.4	5.6	1.4			
10	89-2-31b		71.5	33.7	175.0	47.6	42.6	264.4	13.1			Franz Valley
		+/-	4.7	2.4	2.0	7.1	1.5	5.7	1.5			
11	89-2-31c		69.6	37.2	205.6	3.9	46.2	225.8	10.7			Napa Valley
		+/-	4.6	2.3	2.0	7.0	1.5	5.6	1.5			
CA-SON-1760/H												
5	89-2-243		65.8	29.5	179.7	49.6	41.5	249.9	14.4			Franz Valley
		+/-	5.4	2.8	2.4	7.1	1.8	5.8	1.7			
6	89-2-251		60.5	35.5	179.0	48.0	40.7	258.9	12.4			Franz Valley
		+/-	4.7	2.2	2.0	7.1	1.5	5.6	1.4			
7	89-2-261		73.6	38.4	203.5	6.4	44.0	251.0	9.6			Napa Valley
		+/-	4.8	2.4	2.2	7.0	1.6	5.6	1.5			
8	89-2-265		53.5	30.7	159.3	96.9	33.0	126.1	10.2			Unknown A
		+/-	4.5	2.1	1.8	7.1	1.4	5.5	1.4			
CA-SON-1917												
20	90-3-500		71.7	30.2	149.4	53.5	50.8	302.1	13.2			Annadel
		+/-	4.9	2.4	1.9	7.1	1.5	5.7	1.5			
CA-SON-883												
24	85-5 903h		67.9	32.9	179.0	44.6	40.5	258.3	11.6			Franz Valley
		+/-	4.7	2.3	2.0	7.1	1.5	5.6	1.5			
25	85-5 903i		64.8	32.9	173.4	45.7	39.6	257.8	12.4			Franz Valley
		+/-	5.1	2.4	2.3	7.1	1.6	5.7	1.6			

Trace-element concentration values (ppm)

- Appendix B -

Legend:

Cv Hyd - converted hydration using "Source" assignment and
Tremaine's (1989) established rates

SRC - visual sourcing Origer|Psota or Hughes or Jackson's
geochemical results

Hyd - readings for CA-SON-1344 were by Matthew Hall, all other
readings were by Thomas M. Origer

Type - c-n pt (corner-notched point)
- deb (debitage)
- lg c-n pt (large corner-notched point)

Remarks - VW (variable width)
- DH (diffuse hydration)
- NVB (no visible band)

Appendix B: Actual Hydration Values from Various Specimens Obtained within the Research Area

<table>
<tr><th>Acc#</th><th>Cat#</th><th>Type</th><th>Hyd</th><th>Cv Hyd</th><th>SRC</th><th>Source</th><th>Remarks</th></tr>
<tr><td colspan="8">Site: CA-MRN-307</td></tr>
<tr><td>1-</td><td>128712</td><td>c-n pt</td><td>1.3</td><td></td><td>FV</td><td>FV</td><td></td></tr>
<tr><td>1-</td><td>132624</td><td>c-n pt</td><td>1.8</td><td></td><td>FV</td><td>FV</td><td></td></tr>
<tr><td colspan="8">Site: CA-SON-883</td></tr>
<tr><td>85-5</td><td>903 i</td><td>deb</td><td></td><td></td><td>A|FV</td><td>FV</td><td>no hyd</td></tr>
<tr><td>85-5</td><td>903 h</td><td>deb</td><td>1.3</td><td></td><td>A|FV</td><td>FV</td><td></td></tr>
<tr><td>85-5</td><td>903 g</td><td>deb</td><td>2.3</td><td></td><td>A|FV</td><td>FV</td><td></td></tr>
<tr><td>85-5</td><td>903 d</td><td>biface</td><td></td><td></td><td>NV|NV</td><td>NV</td><td>no hyd</td></tr>
<tr><td>85-5</td><td>903 j</td><td>deb</td><td>1.0</td><td>1.0</td><td>A|NV</td><td>NV</td><td></td></tr>
<tr><td>85-5</td><td>903 c</td><td>deb</td><td>1.1</td><td>1.1</td><td>NV|NV</td><td>NV</td><td></td></tr>
<tr><td>85-5</td><td>903 f</td><td>deb</td><td>1.1</td><td>1.1</td><td>A|NV</td><td>NV</td><td></td></tr>
<tr><td>85-5</td><td>902</td><td>biface</td><td>1.1</td><td>1.1</td><td>NV|NV</td><td>NV</td><td></td></tr>
<tr><td>85-5</td><td>903 e</td><td>deb</td><td>2.9</td><td>2.9</td><td>NV|NV</td><td>NV</td><td></td></tr>
<tr><td>85-5</td><td>903 b</td><td>biface</td><td>3.4</td><td>3.4</td><td>NV|NV</td><td>NV</td><td></td></tr>
<tr><td>85-5</td><td>900</td><td>biface</td><td>3.6</td><td>3.6</td><td>NV|NV</td><td>NV</td><td></td></tr>
<tr><td>85-5</td><td>901</td><td>biface</td><td>3.9</td><td>3.9</td><td>NV?|NV</td><td>NV</td><td>H2O worn</td></tr>
<tr><td>85-5</td><td>903 a</td><td>emf</td><td>4.9</td><td>4.9</td><td>NV|NV</td><td>NV</td><td></td></tr>
<tr><td colspan="8">Site: CA-SON-1208</td></tr>
<tr><td></td><td></td><td>deb</td><td>2.6</td><td></td><td>A?|FV</td><td>FV</td><td></td></tr>
<tr><td></td><td></td><td>deb</td><td>4.2</td><td>4.2</td><td>NV|NV</td><td>NV</td><td></td></tr>
<tr><td></td><td></td><td>proj pt</td><td>4.3</td><td>4.3</td><td>NV|NV</td><td>NV</td><td></td></tr>
<tr><td></td><td></td><td>lg c-n pt</td><td>4.4</td><td>4.4</td><td>NV|NV</td><td>NV</td><td></td></tr>
<tr><td></td><td></td><td>emf</td><td>4.7</td><td>4.7</td><td>NV|NV</td><td>NV</td><td></td></tr>
<tr><td colspan="8">Site: CA-SON-1212</td></tr>
<tr><td>89-7</td><td>76 j</td><td>deb</td><td></td><td></td><td></td><td></td><td>VW, approx. 20.0</td></tr>
<tr><td>89-7</td><td>77 a</td><td>deb</td><td></td><td></td><td></td><td></td><td>DH, weathered</td></tr>
<tr><td>89-7</td><td>78 d</td><td>deb</td><td></td><td></td><td></td><td></td><td>NVB</td></tr>
<tr><td>89-7</td><td>81</td><td>deb</td><td></td><td></td><td></td><td></td><td>DH, weathered</td></tr>
<tr><td>89-7</td><td>85</td><td>deb</td><td></td><td></td><td></td><td></td><td>DH, weathered</td></tr>
<tr><td>89-7</td><td>93</td><td>deb</td><td></td><td></td><td></td><td></td><td>VW, weathered</td></tr>
<tr><td>89-7</td><td>96 e</td><td>deb</td><td></td><td></td><td></td><td></td><td>VW, weathered</td></tr>
<tr><td>89-7</td><td>97 a</td><td>deb</td><td></td><td></td><td></td><td></td><td>NVB</td></tr>
<tr><td>89-7</td><td>97 b</td><td>deb</td><td></td><td></td><td></td><td></td><td>NVB</td></tr>
<tr><td>89-7</td><td>102 b</td><td>deb</td><td></td><td></td><td></td><td></td><td>NVB</td></tr>
<tr><td>89-7</td><td>104 b</td><td>deb</td><td></td><td></td><td></td><td></td><td>NVB</td></tr>
<tr><td>89-7</td><td>58</td><td>deb</td><td></td><td></td><td></td><td></td><td>NVB, ugly</td></tr>
<tr><td>89-7</td><td>55 b</td><td>deb</td><td></td><td></td><td>|?</td><td>?</td><td>DH</td></tr>
<tr><td>89-7</td><td>63 b</td><td>deb</td><td></td><td></td><td>|?</td><td>?</td><td>NVB, ugly</td></tr>
<tr><td>89-7</td><td>52 f</td><td>deb</td><td></td><td></td><td>|FV</td><td>FV</td><td>DH</td></tr>
<tr><td>89-7</td><td>75 a</td><td>deb</td><td></td><td></td><td>|FV</td><td>FV</td><td>NVB, weathered</td></tr>
<tr><td>89-7</td><td>55 c</td><td>deb</td><td>1.2</td><td></td><td>|FV</td><td>FV</td><td></td></tr>
<tr><td>89-7</td><td>56 b</td><td>deb</td><td>1.3</td><td></td><td>|FV</td><td>FV</td><td></td></tr>
<tr><td>89-7</td><td>78 e</td><td>deb</td><td>1.4</td><td></td><td>|FV</td><td>FV</td><td></td></tr>
<tr><td>89-7</td><td>98 a</td><td>deb</td><td>2.1</td><td></td><td>|FV</td><td>FV</td><td></td></tr>
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Acc#	Cat#	Type	Hyd	Cv Hyd	SRC	Source	Remarks
89-7	61 d	deb	2.4		|FV	FV	
89-7	76 b	deb	2.5		|FV	FV	
89-7	248	biface	2.8		FV	FV	
89-7	70	deb	3.7		|FV	FV	
89-7	57 a	deb	3.8		|FV	FV	
89-7	52 e	deb			|FV/A?	FV/A	DH
89-7	46 b	deb			|NV	NV	DH
89-7	57 b	deb			|NV	NV	VW, weathered
89-7	61 c	deb			|NV	NV	DH, weathered
89-7	76 c	deb			|NV	NV	VW, weathered
89-7	76 a	deb	1.4	1.4	|NV	NV	
89-7	94 b	deb	3.7	3.7	|NV	NV	
89-7	71 b	deb	5.4	5.4	|NV	NV	
89-7	61 a	deb	5.7	5.7	|NV	NV	
89-7	87 e	deb	6.0	6.0	|NV	NV	weathered
89-7	95	deb	6.1	6.1	|NV	NV	
89-7	52 g	deb	6.3	6.3	|NV	NV	
89-7	45 b	deb	6.7	6.7	|NV	NV	
89-7	45 a	deb	6.9	6.9	|NV	NV	
89-7	98 b	deb	7.3	7.3	|NV	NV	weathered
89-7	52 a	deb	11.0	11.0	|NV/FV	NV	VW

Site: CA-SON-1323

Acc#	Cat#	Type	Hyd	Cv Hyd	SRC	Source	Remarks
85-7	511	core	3.2		A|-	?	
85-7	51	proj pt	1.7	2.2	A|A	A	
85-7	9	proj pt	1.8	2.3	A|A	A	1st band
85-7	568	emf	2.1	2.7	A	A	
85-7	11	proj pt	2.2	2.9	A|A	A	
85-7	106	deb	2.4	3.1	A|A/FV	A	
85-7	9	proj pt	3.0	3.9	A|A	A	2nd band
85-7	14	concave base pt	4.5	5.9	A|A/FV	A	
85-7	10	stem pt	6.2	4.9	BL|BL	BL	
85-7	65	proj pt	1.7		A|FV	FV	
85-7	72	biface	2.0		NV|FV	FV	
85-7	61	biface	2.1		A|FV	FV	
85-7	57	biface	2.2		A|FV	FV	
85-7	71	biface	2.3		FV	FV	
85-7	107	emf	2.3		FV	FV	
85-7	103	biface	2.5		A|FV	FV	
85-7	102	emf	2.6		NV|FV	FV	
85-7	68	deb	2.8		FV	FV	
85-7	261	core	2.9		FV	FV	
85-7	109	biface	3.0		A?|FV	FV	
85-7	59	biface	3.1		A|FV	FV	
85-7	55	biface	3.2		A|FV	FV	
85-7	7	biface	3.3		A|FV	FV	weathered
85-7	15	contracting stem	3.4		NV?|FV	FV	1st band
85-7	108	uniface	3.8		A|FV	FV	
85-7	16	contracting stem	4.6		A|FV	FV	faint band
85-7	15	contracting stem	4.8		NV?|FV	FV	2nd band

Acc#	Cat#	Type	Hyd	Cv Hyd	SRC	Source	Remarks
85-7	73	concave base	7.2		NV|FV	FV	2nd band
85-7	311 j	deb			NV|NV	NV	DH
85-7	56	emf	2.1	2.1	A|NV	NV	
85-7	111	uniface	2.7	2.7	NV?|NV	NV	
85-7	305 a	deb	3.3	3.3	NV|NV	NV	
85-7	305 b	deb	3.4	3.4	NV|NV	NV	
85-7	311 f	deb	3.4	3.4	NV|NV	NV	
85-7	52	biface	3.4	3.4	BC|NV	NV	
85-7	501	core	3.4	3.4	NV|-	NV	
85-7	311 g	deb	3.5	3.5	NV|NV	NV	
85-7	70	biface	3.5	3.5	NV|NV	NV	1st band
85-7	13	biface	3.6	3.6	NV|NV	NV	
85-7	p	deb	3.6	3.6	NV|NV	NV	
85-7	305 e	deb	3.7	3.7	NV|NV	NV	
85-7	311 h	deb	3.7	3.7	NV|NV	NV	
85-7	104	deb	3.7	3.7	BC|NV	NV	
85-7	305 d	deb	3.8	3.8	NV|NV	NV	
85-7	311 i	deb	4.1	4.1	NV|NV	NV	
85-7	100	uniface	4.1	4.1	BC|NV	NV	
85-7	521	core	4.1	4.1	NV|NV	NV	
85-7	101	emf	4.2	4.2	NV|NV	NV	
85-7	53	lanceolate	4.3	4.3	A?NV?|NV	NV	
85-7	q	deb	4.3	4.3	NV|NV	NV	
85-7	3	biface	4.4	4.4	NV|NV	NV	
85-7	513	core	4.5	4.5	NV|NV	NV	
85-7	4	biface	4.6	4.6	NV|NV	NV	
85-7	6 b	concave base	4.7	4.7	NV|NV	NV	reworked port.
85-7	6 a	concave base	4.8	4.8	NV|NV	NV	
85-7	69	biface	5.0	5.0	NV|NV	NV	
85-7	305 c	deb	5.1	5.1	NV|NV	NV	
85-7	70	biface	5.1	5.1	NV|NV	NV	2nd band
85-7	50	emf	5.6	5.6	BC|NV	NV	

Site: CA-SON-1324

86-6	34 b	deb	1.0		A|NV/FV	?	
86-6	30 b	deb			A|A	A	DH, pitted
86-6	57 b	deb	1.8	2.3	A|A	A	
86-6	64	deb	1.9	2.5	A	A	
86-6	33 c	deb	2.1	2.7	A|A	A	
86-6	3 e	deb	3.2	4.2	A|A	A	
86-6	113	lg c-n	3.2	4.2	A	A	
86-6	7 j	deb	1.1		A|FV	FV	
86-6	60 b	deb	1.7		A|FV	FV	DH, weathered
86-6	112	core	1.9		FV	FV	
86-6	7 k	deb	2.5		A?|FV	FV	
86-6	53 b	deb	5.7		FV	FV	pitted surface
86-6	3 c	deb			BC|NV	NV	DH
86-6	30 c	deb			A?|NV	NV	DH
86-6	34 a	deb			NV|NV	NV	DH
86-6	2	deb	1.0	1.0	NV|NV	NV	1st band

Acc#	Cat#	Type	Hyd	Cv Hyd	SRC	Source	Remarks
86-6	32 a	deb	1.1	1.1	NV|NV	NV	1st band
86-6	31 b	deb	1.4	1.4	A?|NV	NV	
86-6	32 c	deb	1.4	1.4	A|NV	NV	
86-6	53 c	deb	1.9	1.9	?|NV	NV	
86-6	4 h	deb	2.0	2.0	A|NV	NV	
86-6	111	biface	2.0	2.0	NV|NV	NV	
86-6	4 g	deb	2.1	2.1	A|NV	NV	
86-6	8 m	deb	2.4	2.4	A?|NV	NV	
86-6	32 b	deb	2.4	2.4	A|NV	NV	
86-6	1	deb	2.8	2.8	BC|NV	NV	
86-6	30 a	deb	3.1	3.1	NV|NV	NV	
86-6	60 a	deb	3.3	3.3	NV|NV	NV	
86-6	60 c	deb	3.4	3.4	A|NV	NV	
86-6	33 b	deb	3.5	3.5	NV|NV	NV	
86-6	53 a	deb	3.5	3.5	NV|NV	NV	faint band
86-6	32 a	deb	3.6	3.6	NV|NV	NV	2nd band
86-6	57 a	deb	3.8	3.8	NV|NV	NV	
86-6	4 f	deb	4.0	4.0	NV|NV	NV	
86-6	8 l	deb	4.0	4.0	NV|NV	NV	
86-6	2	deb	4.2	4.2	NV|NV	NV	2nd band
86-6	29 b	deb	4.2	4.2	NV|NV	NV	
86-6	56 a	deb	4.3	4.3	NV|NV	NV	
86-6	56 b	deb	4.4	4.4	NV|NV	NV	
86-6	31 a	deb	4.8	4.8	NV|NV	NV	
86-6	3 d	deb	5.0	5.0	BC|NV	NV	
86-6	5	deb	5.3	5.3	BC|NV	NV	
86-6	29 a	deb	5.6	5.6	NV|NV	NV	
86-6	33 a	deb	7.6	7.6	NV|NV	NV	

Site: CA-SON-1344

82-19	29	deb	2.6		|?	?	
82-19	654	core	4.8		|NV/FV	?	
82-19	124	emf	4.7	3.7	|BL	BL	
82-19	139 b	deb	5.8	4.6	|BL	BL	
82-19	470	deb	6.0	4.7	|BL	BL	
82-19	682	emf	6.3	5.0	|BL	BL	
82-19	145	emf	6.5	5.1	|BL	BL	
82-19	753 b	deb	6.7	5.3	|BL	BL	
82-19	141	emf	6.8	5.4	|BL	BL	
82-19	816	deb	1.6		|FV	FV	
82-19	494	c-n pt	2.3		|FV	FV	
82-19	269	widestem pt	4.0		|FV	FV	
82-19	340	biface	4.4		|FV	FV	
82-19	96	widestem pt	4.5		|FV	FV	
82-19	309	deb	6.4		|FV	FV	
82-19	500	lanceolate	2.6	2.6	K	K	
82-19	503	lanceolate	2.8	2.8	K	K	
82-19	203	deb	3.5	3.5	|K	K	
82-19	431	deb	3.5	3.5	|K	K	
82-19	163	biface	3.6	3.6	|K	K	

Acc#	Cat#	Type	Hyd	Cv Hyd	SRC	Source	Remarks
82-19	368	biface	3.6	3.6	K	K	
82-19	308	deb	3.7	3.7	K	K	
82-19	753	deb	3.7	4.7	K	K	
82-19	367	emf	3.7	3.7	NV	K	
82-19	373	emf	3.9	3.9	NV	K	
82-19	224	emf	4.0	4.0	K	K	
82-19	741	emf	4.0	4.0	K	K	
82-19	212	emf	4.1	4.1	K	K	
82-19	736	biface	4.8	4.8	NV	K	
82-19	561 b	deb	5.1	5.1	K	K	
82-19	163	biface	6.2	6.2	K	K	
82-19	134	deb	6.6	6.6	K	K	
82-19	603	c-n pt	1.4	1.4	NV	NV	
82-19	769	c-n pt	1.5	1.5	NV	NV	
82-19	44	c-n pt	1.7	1.7	NV	NV	
82-19	591	emf	1.7	1.7	NV	NV	
82-19	599	deb	1.7	1.7	NV	NV	1st band
82-19	595	emf	1.8	1.8	NV	NV	
82-19	632	deb	1.8	1.8	NV	NV	
82-19	95	deb	1.8	1.8	NV	NV	
82-19	52	emf	2.0	2.0	NV	NV	
82-19	59	deb	2.0	2.0	NV	NV	
82-19	318	deb	2.0	2.0	NV	NV	
82-19	22	deb	2.1	2.1	NV	NV	
82-19	240	deb	2.1	2.1	NV	NV	
82-19	480	c-n pt	2.3	2.3	NV	NV	
82-19	476	deb	2.4	2.4	NV	NV	
82-19	60	emf	2.4	2.4	NV	NV	
82-19	609	deb	2.4	2.4	NV	NV	
82-19	251	emf	2.4	2.4	NV	NV	
82-19	385	deb	2.5	2.5	NV	NV	
82-19	588	deb	2.5	2.5	NV	NV	1st band
82-19	448	emf	2.8	2.8	NV	NV	
82-19	109	core	2.8	2.8	NV	NV	
82-19	514	deb	3.0	3.0	NV	NV	
82-19	455	deb	3.0	3.0	NV	NV	
82-19	78	deb	3.2	3.2	NV	NV	
82-19	256	deb	3.3	3.3	NV	NV	
82-19	356	deb	3.3	3.3	NV	NV	
82-19	604	proj pt	3.5	3.5	NV	NV	
82-19	102	biface	3.5	3.5	NV	NV	
82-19	343	emf	3.5	3.5	NV	NV	
82-19	520	emf	3.6	3.6	NV	NV	
82-19	653	emf	3.6	3.6	NV	NV	
82-19	562 a	deb	3.7	3.7	NV	NV	
82-19	114	emf	3.7	3.7	NV	NV	
82-19	41	deb	3.8	3.8	NV	NV	
82-19	572	deb	3.8	3.8	NV	NV	
82-19	588	deb	3.8	3.8	NV	NV	2nd band
82-19	139 a	deb	3.9	3.9	NV	NV	

<table>
<tr><th>Acc#</th><th>Cat#</th><th>Type</th><th>Hyd</th><th>Cv Hyd</th><th>SRC</th><th>Source</th><th>Remarks</th></tr>
<tr><td>82-19</td><td>599</td><td>deb</td><td>4.0</td><td>4.0</td><td>|NV</td><td>NV</td><td>2nd band</td></tr>
<tr><td>82-19</td><td>719</td><td>emf</td><td>4.0</td><td>4.0</td><td>|NV</td><td>NV</td><td></td></tr>
<tr><td>82-19</td><td>167</td><td>deb</td><td>4.0</td><td>4.0</td><td>|NV</td><td>NV</td><td></td></tr>
<tr><td>82-19</td><td>292</td><td>deb</td><td>4.1</td><td>4.1</td><td>|NV</td><td>NV</td><td></td></tr>
<tr><td>82-19</td><td>462</td><td>deb</td><td>4.3</td><td>4.3</td><td>|NV</td><td>NV</td><td></td></tr>
<tr><td>82-19</td><td>160</td><td>deb</td><td>4.3</td><td>4.3</td><td>|NV</td><td>NV</td><td></td></tr>
<tr><td>82-19</td><td>560</td><td>emf</td><td>4.4</td><td>4.4</td><td>|NV</td><td>NV</td><td></td></tr>
<tr><td>82-19</td><td>446</td><td>deb</td><td>4.5</td><td>4.5</td><td>|NV</td><td>NV</td><td></td></tr>
<tr><td>82-19</td><td>539</td><td>deb</td><td>4.5</td><td>4.5</td><td>|NV</td><td>NV</td><td></td></tr>
<tr><td>82-19</td><td>14</td><td>deb</td><td>4.5</td><td>4.5</td><td>|NV</td><td>NV</td><td></td></tr>
<tr><td>82-19</td><td>147</td><td>deb</td><td>4.5</td><td>4.5</td><td>|NV</td><td>NV</td><td></td></tr>
<tr><td>82-19</td><td>491</td><td>deb</td><td>4.6</td><td>4.6</td><td>|NV</td><td>NV</td><td></td></tr>
<tr><td>82-19</td><td>705</td><td>deb</td><td>4.6</td><td>4.6</td><td>|NV</td><td>NV</td><td></td></tr>
<tr><td>82-19</td><td>326</td><td>deb</td><td>4.6</td><td>4.6</td><td>|NV</td><td>NV</td><td></td></tr>
<tr><td>82-19</td><td>79</td><td>emf</td><td>4.7</td><td>4.7</td><td>|NV</td><td>NV</td><td></td></tr>
<tr><td>82-19</td><td>244</td><td>biface</td><td>4.7</td><td>4.7</td><td>|NV</td><td>NV</td><td></td></tr>
<tr><td>82-19</td><td>795</td><td>deb</td><td>5.0</td><td>5.0</td><td>|NV</td><td>NV</td><td></td></tr>
<tr><td>82-19</td><td>617</td><td>emf</td><td>5.1</td><td>5.1</td><td>|NV</td><td>NV</td><td></td></tr>
<tr><td>82-19</td><td>633</td><td>emf</td><td>5.4</td><td>5.4</td><td>|NV</td><td>NV</td><td></td></tr>
<tr><td>82-19</td><td>106</td><td>deb</td><td>5.7</td><td>5.7</td><td>|NV</td><td>NV</td><td></td></tr>
<tr><td>82-19</td><td>342</td><td>deb</td><td>6.3</td><td>6.3</td><td>|NV</td><td>NV</td><td></td></tr>
<tr><td>82-19</td><td>131</td><td>emf</td><td>6.8</td><td>6.8</td><td>|NV</td><td>NV</td><td></td></tr>
<tr><td colspan="8">Site: CA-SON-1391</td></tr>
<tr><td>FC#</td><td>106 ma</td><td>core</td><td></td><td>0.0</td><td>A|NV</td><td>NV</td><td>NVB</td></tr>
<tr><td>FC#</td><td>342 a</td><td>deb</td><td>1.3</td><td>1.3</td><td>NV|NV</td><td>NV</td><td></td></tr>
<tr><td>FC#</td><td>342 c</td><td>deb</td><td>1.9</td><td>1.9</td><td>NV|NV</td><td>NV</td><td></td></tr>
<tr><td>FC#</td><td>13 a</td><td>core</td><td>2.3</td><td>2.3</td><td>NV|NV</td><td>NV</td><td></td></tr>
<tr><td>FC#</td><td>320 e</td><td>core</td><td>2.3</td><td>2.3</td><td>NV|NV</td><td>NV</td><td></td></tr>
<tr><td>FC#</td><td>12</td><td>biface</td><td>2.3</td><td>2.3</td><td>NV|NV</td><td>NV</td><td></td></tr>
<tr><td>FC#</td><td>308 a</td><td>deb</td><td>2.6</td><td>2.6</td><td>NV|NV</td><td>NV</td><td></td></tr>
<tr><td>FC#</td><td>308 d</td><td>deb</td><td>2.6</td><td>2.6</td><td>NV|NV</td><td>NV</td><td></td></tr>
<tr><td>FC#</td><td>308 c</td><td>deb</td><td>2.9</td><td>2.9</td><td>NV|NV</td><td>NV</td><td></td></tr>
<tr><td>FC#</td><td>301 b</td><td>deb</td><td>3.0</td><td>3.0</td><td>A|NV?</td><td>NV</td><td></td></tr>
<tr><td>FC#</td><td>335 a</td><td>deb</td><td>3.0</td><td>3.0</td><td>NV|NV</td><td>NV</td><td></td></tr>
<tr><td>FC#</td><td>302</td><td>biface</td><td>3.1</td><td>3.1</td><td>NV|NV</td><td>NV</td><td></td></tr>
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<tr><td>FC#</td><td>308 b</td><td>deb</td><td>3.3</td><td>3.3</td><td>NV|NV</td><td>NV</td><td></td></tr>
<tr><td>FC#</td><td>308 e</td><td>deb</td><td>3.4</td><td>3.4</td><td>NV|NV</td><td>NV</td><td></td></tr>
<tr><td>FC#</td><td>342 b</td><td>deb</td><td>3.9</td><td>3.9</td><td>NV|NV</td><td>NV</td><td></td></tr>
<tr><td>FC#</td><td>342 d</td><td>deb</td><td>3.9</td><td>3.9</td><td>NV|NV</td><td>NV</td><td></td></tr>
<tr><td>FC#</td><td>301 a</td><td>deb</td><td>4.3</td><td>4.3</td><td>NV|NV</td><td>NV</td><td></td></tr>
<tr><td>FC#</td><td>439 a</td><td>core</td><td>4.9</td><td>4.9</td><td>NV|NV</td><td>NV</td><td></td></tr>
<tr><td>FC#</td><td>335 b</td><td>deb</td><td>7.3</td><td>7.3</td><td>NV|NV</td><td>NV</td><td></td></tr>
<tr><td colspan="8">Site: CA-SON-1449</td></tr>
<tr><td>89-2</td><td>607 b</td><td>deb</td><td>2.6</td><td>2.6</td><td>NV|NV</td><td>NV</td><td></td></tr>
<tr><td>89-2</td><td>610</td><td>deb</td><td>2.6</td><td>2.6</td><td>NV|NV</td><td>NV</td><td></td></tr>
<tr><td>89-2</td><td>612 a</td><td>deb</td><td>2.8</td><td>2.8</td><td>NV</td><td>NV</td><td></td></tr>
<tr><td>89-2</td><td>605</td><td>deb</td><td>3.1</td><td>3.1</td><td>NV|NV</td><td>NV</td><td></td></tr>
</table>

Acc#	Cat#	Type	Hyd	Cv Hyd	SRC	Source	Remarks
89-2	607 a	deb	3.3	3.3	NV|NV	NV	
89-2	613	deb	3.5	3.5	NV|NV	NV	
89-2	606 a	deb	3.6	3.6	NV|NV	NV	
89-2	615 b	deb	3.6	3.6	NV|NV	NV	
89-2	622 b	deb	3.6	3.6	NV|NV	NV	
89-2	615 a	deb	4.0	4.0	NV|NV	NV	
89-2	616 a	deb	4.0	4.0	NV|NV	NV	
89-2	616 b	deb	4.0	4.0	NV|NV	NV	
89-2	621 a	deb	4.5	4.5	NV|NV	NV	
89-2	622 a	deb	4.6	4.6	NV|NV	NV	
89-2	606 b	deb	4.9	4.9	NV|NV	NV	
89-2	621 b	deb	5.0	5.0	NV	NV	
89-2	611	deb	5.2	5.2	NV|NV	NV	
89-2	616 c	deb	5.3	5.3	NV	NV	
89-2	623	deb	6.4	6.4	NV|NV	NV	
89-2	612 b	deb	6.8	6.8	NV|NV	NV	

Site: CA-SON-1485

Acc#	Cat#	Type	Hyd	Cv Hyd	SRC	Source	Remarks
85-5	30 b	deb					no hyd
85-5	31 a	deb					no hyd
85-5	227	biface					faint, DH
85-5	228	biface					NVB
85-5	16 b	deb	2.2	2.9	A|FV?	A	
85-5	5 a	deb	3.7	2.9	BL|BL	BL	
85-5	4 a	deb	5.0	4.0	BL|BL	BL	
85-5	5 b	deb	5.3	4.2	BL|BL	BL	
85-5	230	deb	2.0		FV	FV	
85-5	31 b	emf	2.1		A|FV	FV	
85-5	29 b	deb	2.2		A|FV	FV	
85-5	5 c	deb	2.4		FV	FV	
85-5	8 a	deb	2.6		NV|FV	FV	
85-5	33 b	deb	2.7		A|FV	FV	
85-5	10 b	deb	3.3		A|FV	FV	
85-5	5 d	deb	3.5		FV	FV	
85-5	34 a	deb	7.1		NV|FV	FV	
85-5	204	biface	3.0	3.0	K	K	
85-5	6 b	deb			A|NV	NV	DH
85-5	40 b	deb	1.3	1.3	A|NV	NV	
85-5	8 b	deb	2.2	2.2	A|NV	NV	
85-5	226	biface	2.3	2.3	A|NV	NV	
85-5	34 b	deb	2.5	2.5	NV|NV	NV	
85-5	40 a	deb	2.5	2.5	NV|NV	NV	
85-5	301	biface	2.5	2.5	NV|NV	NV	
85-5	6 a	deb	3.4	3.4	NV|NV	NV	
85-5	27 a	deb	3.6	3.6	NV|NV	NV	
85-5	27 b	deb	4.2	4.2	A|NV	NV	
85-5	10 a	deb	4.4	4.4	NV|NV	NV	
85-5	30 a	deb	4.5	4.5	NV|NV	NV	
85-5	33 a	deb	4.6	4.6	NV|NV	NV	
85-5	16 a	deb	5.7	5.7	NV|NV	NV	

Acc#	Cat#	Type	Hyd	Cv Hyd	SRC	Source	Remarks
85-5	201	biface	6.6	6.6	NV|NV	NV	
85-5	29 a	deb	7.5	7.5	NV|NV	NV	

Site: CA-SON-1486

Acc#	Cat#	Type	Hyd	Cv Hyd	SRC	Source	Remarks
85-5	45 g	deb					no hyd
85-5	203	concave base					W, patinated
85-5	229	biface			A|A	A	NVB
85-5	302	deb	1.0	1.3	A|A	A	
85-5	45 d	deb	1.1	1.1	NV|NV	NV	
85-5	44 b	deb	1.2	1.2	A|NV	NV	
85-5	45 k	deb	2.3	2.3	NV|NV	NV	
85-5	45 m	deb	2.5	2.5	NV|NV	NV	
85-5	45 f	deb	2.5	2.5	A|NV	NV	
85-5	45 h	deb	3.3	3.3	A|NV	NV	
85-5	44 a	deb	3.6	3.6	NV|NV	NV	
85-5	45 l	deb	3.8	3.8	NV|NV	NV	
85-5	45 j	deb	4.3	4.3	NV|NV	NV	
85-5	45 c	deb	4.3	4.3	NV|NV	NV	
85-5	45 i	deb	4.4	4.4	NV|NV	NV	
85-5	45 o	deb	4.4	4.4	NV|NV	NV	
85-5	45 a	emf	4.4	4.4	NV|NV	NV	
85-5	45 b	deb	4.4	4.4	NV|NV	NV	
85-5	45 n	deb	4.7	4.7	NV|NV	NV	

Site: CA-SON-1487

Acc#	Cat#	Type	Hyd	Cv Hyd	SRC	Source	Remarks
85-5	905 d	deb					no hyd
85-5	904	biface	1.3	1.7	A|A	A	
85-5	905 c	deb	1.4	1.4	NV|NV	NV	
85-5	905 b	deb	1.9	1.9	NV|NV	NV	
85-5	905 a	deb	2.0	2.0	NV|NV	NV	

Site: CA-SON-1488

Acc#	Cat#	Type	Hyd	Cv Hyd	SRC	Source	Remarks
85-5	906 a	deb	2.8	2.8	NV|NV	NV	
85-5	906 b	deb	4.3	4.3	NV|NV	NV	

Site: CA-SON-1489

Acc#	Cat#	Type	Hyd	Cv Hyd	SRC	Source	Remarks
85-5	907 d	deb	2.2	2.9	A|?	A	
85-5	907 e	deb	3.5		A|FV	FV	
85-5	907 a	deb			NV|NV	NV	DH
85-5	907 f	deb	1.6	1.6	NV|NV	NV	
85-5	907 b	deb	2.1	2.1	NV|NV	NV	
85-5	907 i	deb	2.3	2.3	NV|NV	NV	
85-5	907 c	deb	2.3	2.3	NV|NV	NV	
85-5	907 h	deb	2.4	2.4	NV|NV	NV	
85-5	907 g	deb	3.5	3.5	NV|NV	NV	

Site: CA-SON-1490

Acc#	Cat#	Type	Hyd	Cv Hyd	SRC	Source	Remarks
85-5	909 b	deb			A|A	A	DH
85-5	909 d	deb	1.4	1.1	A|A	A	
85-5	909 c	deb	2.2	1.7	A|A	A	

Acc#	Cat#	Type	Hyd	Cv Hyd	SRC	Source	Remarks
85-5	909 e	deb			A|K	A/K	DH
85-5	908	proj pt	5.0	5.0	N?|NV	NV	
85-5	909 a	emf	6.8	6.8	NV|NV	NV	
Site: CA-SON-1491							
85-5	913	c-n					NVB
85-5	917 d	deb	1.2	1.6	A|A	A	
85-5	916	biface	1.3	1.7	A|A	A	
85-5	917 e	deb	1.4		A|FV	FV	
85-5	914	biface	1.0	1.0	NV|NV	NV	
85-5	915	emf	1.0	1.0	A|NV	NV	
85-5	917 a	deb	1.1	1.1	NV|NV	NV	
85-5	917 c	deb	1.1	1.1	A|NV	NV	
85-5	917 b	deb	1.4	1.4	NV|NV	NV	
Site: CA-SON-1492							
85-5	918 a	deb			NV	NV	DH
85-5	918 b	deb	2.1	2.1	NV|NV	NV	
85-5	918 c	deb	2.8	2.8	NV|NV	NV	
Site: CA-SON-1493							
85-5	920	emf	5.3	5.3	NV|NV	NV	
Site: CA-SON-1503							
88-11		deb			K|K	K	NVB
88-11		deb			K|K	K	NVB
88-11	4	biface	1.8	1.8	K|K	K	
88-11		deb	2.2	2.2	K|K	K	
88-11	9	biface	2.4	2.4	K|K	K	
88-11		deb	2.4	2.4	K|K	K	
88-11		deb	2.6	2.6	K|K	K	
88-11	1	biface	2.9	2.9	K|K	K	
88-11	3	biface	3.4	3.4	K|K	K	
88-11		deb	3.5	3.5	K|K	K	
88-11	2	biface	3.6	3.6	K|K	K	
88-11	6	biface	3.7	3.7	K|K	K	
88-11		deb	3.7	3.7	K|K	K	
88-11		deb	3.8	3.8	K|K	K	
88-11		deb	3.8	3.8	K|K	K	
88-11	5	biface	3.9	3.9	K|K	K	
88-11		deb	3.9	3.9	K|K	K	
88-11		deb	3.9	3.9	K|K	K	
88-11	10	biface	4.0	4.0	K|K	K	
88-11		deb	4.0	4.0	K|K	K	
88-11		deb	4.0	4.0	K|K	K	
88-11	7	biface	4.1	4.1	K|K	K	weathered
88-11	8	biface	4.2	4.2	K|K	K	
88-11		deb	4.2	4.2	K|K	K	
88-11		deb	4.2	4.2	K|K	K	
88-11		deb	4.3	4.3	K|K	K	

Acc#	Cat#		Type	Hyd	Cv Hyd	SRC	Source	Remarks
Site: CA-SON-1551								
86-1	224	a	emf	2.4		FV	FV	
86-1	223	k	deb	1.1	1.1	K|K	K	
86-1	223	c	deb	1.0	1.0	NV|NV	NV	
86-1	223	e	deb	1.2	1.2	NV|NV	NV	
86-1	223	f	deb	2.2	2.2	NV|NV	NV	
86-1	223	h	emf	2.8	2.8	NV|NV	NV	
86-1	223	j	emf	2.9	2.9	NV|NV	NV	
86-1	223	b	emf	4.7	4.7	NV|NV	NV	
86-1	223	g	biface	4.8	4.8	NV|NV	NV	
86-1	223	d	emf	4.9	4.9	NV|NV	NV	
86-1	223	i	emf	5.0	5.0	NV|NV	NV	
86-1	223	a	deb	5.2	5.2	NV|NV	NV	
Site: CA-SON-1552								
86-1	228	b	deb	3.1		FV	FV	
86-1	228	a	deb	3.3		FV	FV	
86-1	227	j	biface	3.7	3.7	K|K	K	
86-1	227	d	deb			NV|NV	NV	weathered
86-1	227	f	emf			NV|NV	NV	weathered
86-1	227	i	emf	1.2	1.2	NV|NV	NV	
86-1	227	h	emf	1.6	1.6	NV|NV	NV	
86-1	227	g	emf	2.1	2.1	NV|NV	NV	
86-1	227	c	emf	3.6	3.6	NV|NV	NV	
86-1	227	e	deb	4.5	4.5	NV|NV	NV	
86-1	227	a	deb	4.6	4.6	NV|NV	NV	
86-1	227	b	deb	5.2	5.2	NV|NV	NV	
Site: CA-SON-1585								
87-1	453	b	deb			A	A	DH
87-1	453	a	deb	3.0	3.9	A	A	
Site: CA-SON-1590								
87-1		c	deb	2.6	2.6	NV|NV	NV	
87-1		a	deb	3.3	3.3	NV|NV	NV	
87-1		b	deb	3.9	3.9	NV|NV	NV	
87-1		g	biface	4.7	4.7	NV|NV	NV	
87-1		f	emf	5.7	5.7	NV|NV	NV	
87-1		e	emf	6.6	6.6	NV|NV	NV	
87-1		d	deb	7.3	7.3	NV|NV	NV	
Site: CA-SON-1591								
87-1		i	deb	2.1	2.7	A	A	
87-1		h	deb	1.1		FV	FV	
87-1		q	biface	2.2	2.2	K|K	K	
87-1		l	deb			NV|NV	NV	DH
87-1		m	deb	1.4	1.4	NV|NV	NV	
87-1		n	deb	1.4	1.4	NV|NV	NV	
87-1		p	emf	2.3	2.3	NV|NV	NV	

Acc#	Cat#	Type	Hyd	Cv Hyd	SRC	Source	Remarks
87-1	j	deb	4.1	4.1	NV|NV	NV	
87-1	k	deb	4.2	4.2	NV|NV	NV	
87-1	o	emf	4.8	4.8	NV|NV	NV	

Site: CA-SON-1592

Acc#	Cat#	Type	Hyd	Cv Hyd	SRC	Source	Remarks
87-1	r	deb	2.1	2.7	A	A	
87-1	s	deb	2.1	2.7	A	A	
87-1	507 zz	deb	2.1		FV	FV	
87-1	z	biface	1.5	1.5	A?|NV	NV	
87-1	y	deb	2.1	2.1	NV|NV	NV	
87-1	x	deb	2.3	2.3	A?|NV	NV	
87-1	v	deb	2.5	2.5	NV|NV	NV	
87-1	w	deb	2.5	2.5	NV|NV	NV	
87-1	t	deb	2.6	2.6	NV|NV	NV	
87-1	u	deb	2.6	2.6	NV|NV	NV	
87-1	aa	biface	3.0	3.0	NV|NV	NV	

Site: CA-SON-1758

Acc#	Cat#	Type	Hyd	Cv Hyd	SRC	Source	Remarks
89-2	31 a	deb	1.6		FV	FV	
89-2	31 b	deb	1.8		FV	FV	
89-2	31 e	deb	1.5	1.5	NV|NV	NV	
89-2	31 c	deb	2.2	2.2	NV	NV	
89-2	31 d	deb	2.2	2.2	NV|NV	NV	
89-2	31 f	deb	2.6	2.6	NV|NV	NV	
89-2	31 g	deb	2.6	2.6	NV|NV	NV	

Site: CA-SON-1759

Acc#	Cat#	Type	Hyd	Cv Hyd	SRC	Source	Remarks
89-2	77 b	deb	1.4	1.4	K|K	K	
89-2	71 a	deb	1.6	1.6	K|K	K	
89-2	72	deb	2.1	2.1	K|K	K	
89-2	41	c-n pt	2.5	2.5	K	K	
89-2	42	s pt	2.5	2.5	K	K	
89-2	40	c-n pt	2.6	2.6	K	K	
89-2	107 a	deb	2.8	2.8	K|K	K	
89-2	107 c	deb	3.2	3.2	K|K	K	
89-2	106 b	deb	3.4	3.4	K|K	K	
89-2	76 b	deb	3.6	3.6	K|K	K	
89-2	107 b	deb	3.7	3.7	K|K	K	
89-2	77 a	deb	3.8	3.8	K|K	K	
89-2	106 a	deb	3.8	3.8	K|K	K	
89-2	78	deb	4.0	4.0	K|K	K	
89-2	71 d	deb	4.1	4.1	K|K	K	
89-2	71 c	deb	4.5	4.5	K|K	K	
89-2	71 b	deb	4.8	4.8	K|K	K	
89-2	76 a	deb	3.6	3.6	NV|NV	NV	
89-2	103 b	deb	3.8	3.8	NV|NV	NV	
89-2	103 a	deb	4.1	4.1	NV|NV	NV	
89-2	114 b	deb	4.3	4.3	NV|NV	NV	
89-2	103 d	deb	4.4	4.4	NV|NV	NV	
89-2	102	deb	4.6	4.6	NV|NV	NV	

Acc#	Cat#	Type	Hyd	Cv Hyd	SRC	Source	Remarks
89-2	114 a	deb	4.6	4.6	NV|NV	NV	
89-2	103 c	deb	7.2	7.2	NV|NV	NV	

Site: CA-SON-1760/H

Acc#	Cat#	Type	Hyd	Cv Hyd	SRC	Source	Remarks
89-2	257	lg c-n pt	2.4	3.1	A|A	A	
89-2	243	serrate pt	1.2		FV	FV	
89-2	311 h	deb	1.8		NV|FV	FV	
89-2	251	biface	2.4		FV	FV	
89-2	311 f	deb	3.0		NV|FV	FV	
89-2	265	biface	3.2		Unknown	FV	
89-2	249	biface	1.2	1.2	K	K	
89-2	241	c-n pt	1.7	1.7	K	K	
89-2	296 a	deb	2.7	2.7	K|K	K	
89-2	296 b	deb	2.9	2.9	K|K	K	
89-2	311 a	deb	3.0	3.0	K|K	K	
89-2	311 e	deb	3.0	3.0	K|K	K	
89-2	311 d	deb	3.1	3.1	K|K	K	
89-2	247	biface	3.2	3.2	K|K	K	
89-2	259	emf	3.2	3.2	K|K	K	
89-2	311 b	deb	3.7	3.7	K|K	K	
89-2	311 c	deb	3.7	3.7	K|K	K	
89-2	297 b	biface	3.8	3.8	K|K	K	
89-2	311 i	deb	1.4	1.4	NV|NV	NV	
89-2	296 d	deb	1.6	1.6	NV|NV	NV	
89-2	296 f	deb	1.7	1.7	NV|NV	NV	
89-2	242	c-n pt	1.8	1.8	NV	NV	
89-2	296 g	deb	2.2	2.2	NV|NV	NV	1st band
89-2	311 g	deb	2.4	2.4	NV|NV	NV	
89-2	296 c	deb	2.8	2.8	NV|NV	NV	
89-2	296 e	deb	3.6	3.6	NV|NV	NV	
89-2	296 g	deb	4.2	4.2	NV|NV	NV	2nd band
89-2	311 j	deb	5.0	5.0	NV|NV	NV	

Site: CA-SON-1810

Acc#	Cat#	Type	Hyd	Cv Hyd	SRC	Source	Remarks
91-35	56	emf	3.5	2.8	BL|BL	BL	
91-35	35 b	deb	4.0	3.2	BL|BL	BL	
91-35	38	biface	4.4	3.5	BL	BL	
91-35	53	biface	4.4	3.5	BL	BL	
91-35	31 ee	deb	5.4	4.3	BL|BL	BL	
91-35	31 dd	deb	5.6	4.4	BL|BL	BL	
91-35	35 c	deb	5.6	4.4	BL|BL	BL	
91-35	55	emf	6.3	5.0	BL|BL	BL	1st band
91-35	55	emf	7.5	5.9	BL|BL	BL	2nd band
91-35	39	emf	2.5		FV	FV	
91-35	37	biface	2.6		FV	FV	
91-35	17 c	deb	3.4		FV	FV	
91-35	31 d	deb	4.2		|FV	FV	
91-35	48 c	deb	4.2		|FV	FV	
91-35	31 ff	deb	6.1		NV|FV	FV	
91-35	46 a	deb	6.2		|FV	FV	

Acc#	Cat#	Type	Hyd	Cv Hyd	SRC	Source	Remarks
91-35	17 d	deb	7.4		|FV	FV	
91-35	31 c	deb	9.3		|FV	FV	
91-35	16	bif	1.2	1.2	K|K	K	
91-35	31 aa	deb	2.8	2.8	K?|K	K	1st band
91-35	31 cc	deb	3.0	3.0	K?|K	K	
91-35	143	uniface	3.0	3.0	K|K	K	
91-35	31 bb	deb	3.1	3.1	K?|K	K	
91-35	121	emf	3.3	3.3	K|K	K	
91-35	35 a	deb	3.6	3.6	K?|K	K	
91-35	31 aa	deb	10.0	10.0	K?|K	K	2nd band, approx
91-35	147	biface			NV|NV	NV	DH, weathered
91-35	15 b	deb			|NV	NV	NVB
91-35	15 a	deb	3.1	3.1	|NV	NV	
91-35	31 f	deb	3.1	3.1	|NV	NV	
91-35	31 a	deb	3.2	3.2	|NV	NV	
91-35	61 h	deb	3.2	3.2	NV?|NV	NV	weathered
91-35	31 gg	deb	3.6	3.6	NV|NV	NV	
91-35	46 d	deb	3.6	3.6	|NV	NV	
91-35	115	emf	3.6	3.6	NV|NV	NV	
91-35	17 a	deb	3.8	3.8	NV	NV	
91-35	46 b	deb	3.8	3.8	|NV	NV	
91-35	46 c	deb	3.8	3.8	|NV	NV	
91-35	61 f	deb	3.8	3.8	NV|NV	NV	
91-35	31 hh	deb	3.9	3.9	NV	NV	
91-35	31 ii	deb	3.9	3.9	NV	NV	
91-35	111	biface	4.0	4.0	NV	NV	1st band
91-35	88	biface	4.3	4.3	NV	NV	
91-35	17 e	deb	4.3	4.3	|NV	NV	
91-35	61 b	deb	4.3	4.3	NV?|NV	NV	
91-35	48 a	deb	4.4	4.4	|NV	NV	
91-35	61 g	deb	4.4	4.4	NV?|NV	NV	
91-35	17 b	deb	4.6	4.6	|NV	NV	
91-35	31 b	deb	4.8	4.8	|NV	NV	
91-35	61 c	deb	4.8	4.8	NV|NV	NV	
91-35	31 e	deb	4.9	4.9	|NV	NV	
91-35	48 b	deb	5.1	5.1	|NV	NV	
91-35	61 a	deb	5.3	5.3	NV|NV	NV	
91-35	61 d	deb	5.4	5.4	NV|NV	NV	
91-35	111	biface	5.7	5.7	NV	NV	2nd band

Site: CA-SON-1811

91-36	60 ff	deb			A	A	NVB
91-36	272	emf	2.1	2.7	A	A	
91-36	33	biface	3.4	4.4	A	A	
91-36	29	deb	7.3	5.8	BL|BL	BL	
91-36	60 bb	deb			NV|FV	FV	
91-36	60 cc	deb			FV	FV	NVB
91-36	287	biface			NV|FV	FV	NVB
91-36	164	core	2.1		FV	FV	
91-36	52 a	deb	2.3		FV	FV	

Acc#	Cat#	Type	Hyd	Cv Hyd	SRC	Source	Remarks
91-36	304	emf	2.3		FV	FV	
91-36	297	emf	2.4		FV	FV	
91-36	92	biface	2.5		FV	FV	
91-36	52 n	deb	2.6		A?|FV	FV	
91-36	15 d	deb	2.7		|FV	FV	
91-36	52 o	deb	2.7		A?|FV	FV	
91-36	98 d	deb	2.9		|FV	FV	
91-36	60 ee	deb	3.0		NV|FV	FV	
91-36	60 nn	deb	3.0		FV?	FV	
91-36	60 d	deb	3.2		|FV	FV	
91-36	98 c	deb	3.2		|FV	FV	
91-36	15 c	deb	3.3		FV	FV	
91-36	52 b	deb	3.3		NV|FV	FV	
91-36	60 c	deb	3.8		|FV	FV	
91-36	276	proj pt			K|K	K	VW, burnt
91-36	60 ii	deb	2.9	2.9	K	K	
91-36	60 hh	deb	3.0	3.0	K|K	K	
91-36	60 jj	deb	3.0	3.0	?|K	K	
91-36	18	biface	3.1	3.1	K|K	K	
91-36	60 kk	deb	3.4	3.4	K|K	K	
91-36	60 ll	deb	3.4	3.4	K|K	K	
91-36	60 gg	deb	3.7	3.7	K?|K	K	
91-36	65	biface	4.1	4.1	K|K	K	
91-36	284	biface			NV|NV	NV	weathered
91-36	52 d	deb			NV|NV	NV	NVB
91-36	252 c	deb	1.2	1.2	NV|NV	NV	
91-36	268	core	1.2	1.2	NV	NV	
91-36	294	core	1.2	1.2	NV	NV	
91-36	263	emf	1.3	1.3	NV|NV	NV	
91-36	286	emf	1.3	1.3	NV|NV	NV	
91-36	291	core	1.3	1.3	NV	NV	
91-36	19	biface	1.5	1.5	NV|NV	NV	
91-36	60 f	deb	1.5	1.5	|NV	NV	
91-36	252 a	deb	1.5	1.5	NV|NV	NV	
91-36	290	c-n pt	1.5	1.5	NV|NV	NV	
91-36	1	proj pt	1.7	1.7	K?|NV	NV	
91-36	108 d	deb	2.2	2.2	NV|NV	NV	
91-36	168 a	deb	2.4	2.4	NV|NV	NV	
91-36	168 b	deb	2.4	2.4	NV|NV	NV	
91-36	289	c-n pt	2.4	2.4	NV|NV	NV	
91-36	237 a	deb	2.5	2.5	NV|NV	NV	
91-36	274	proj pt	2.5	2.5	NV|NV	NV	
91-36	15 f	deb	2.6	2.6	|NV	NV	
91-36	52 e	deb	2.6	2.6	NV|NV	NV	
91-36	60 a	deb	2.6	2.6	|NV	NV	
91-36	108 b	deb	2.6	2.6	NV|NV	NV	
91-36	252 b	deb	2.6	2.6	NV|NV	NV	
91-36	273	lanceolate	2.7	2.7	NV	NV	
91-36	27	biface	2.8	2.8	NV|NV	NV	
91-36	218	core	2.8	2.8	NV	NV	

Acc#	Cat#	Type	Hyd	Cv Hyd	SRC	Source	Remarks
91-36	52 g	deb	2.9	2.9	NV|NV	NV	
91-36	52 h	deb	2.9	2.9	NV|NV	NV	
91-36	52 k	deb	2.9	2.9	NV?|NV	NV	
91-36	337	emf	2.9	2.9	NV|NV	NV	
91-36	52 c	deb	3.0	3.0	NV	NV	
91-36	60 b	deb	3.0	3.0	|NV	NV	
91-36	60 mm	deb	3.0	3.0	NV	NV	
91-36	98 a	deb	3.0	3.0	|NV	NV	
91-36	98 b	deb	3.0	3.0	|NV	NV	
91-36	237 d	deb	3.0	3.0	NV|NV	NV	
91-36	277	biface	3.0	3.0	NV|NV	NV	
91-36	60 dd	deb	3.1	3.1	NV	NV	DH
91-36	52 m	deb	3.2	3.2	NV?|NV	NV	
91-36	40	lanceolate	3.3	3.3	NV	NV	
91-36	52 l	deb	3.4	3.4	NV|NV	NV	
91-36	60 aa	deb	3.4	3.4	NV	NV	
91-36	63	lanceolate	3.4	3.4	NV|NV	NV	
91-36	328	emf	3.4	3.4	NV|NV	NV	
91-36	60 e	deb	3.5	3.5	|NV	NV	
91-36	108 a	deb	3.5	3.5	NV|NV	NV	
91-36	98 e	deb	3.6	3.6	|NV	NV	
91-36	121	emf	3.6	3.6	NV|NV	NV	
91-36	168 d	deb	3.6	3.6	NV|NV	NV	
91-36	237 c	deb	3.6	3.6	NV|NV	NV	
91-36	15 b	deb	3.7	3.7	NV	NV	
91-36	15 g	deb	3.7	3.7	|NV	NV	
91-36	47	lanceolate	3.7	3.7	NV|NV	NV	
91-36	52 f	deb	3.7	3.7	NV|NV	NV	
91-36	82	lanceolate	3.7	3.7	NV	NV	
91-36	93	core	3.7	3.7	NV	NV	
91-36	98 f	deb	3.7	3.7	|NV	NV	
91-36	252 d	deb	3.7	3.7	NV|NV	NV	
91-36	52 j	deb	3.8	3.8	NV|NV	NV	
91-36	15 a	deb	3.9	3.9	|NV	NV	
91-36	120	emf	3.9	3.9	NV	NV	
91-36	168 c	deb	3.9	3.9	NV|NV	NV	
91-36	15 e	deb	4.0	4.0	|NV	NV	
91-36	34	emf	4.3	4.3	NV|NV	NV	
91-36	43	core	4.3	4.3	NV	NV	
91-36	98 g	deb	4.3	4.3	|NV	NV	
91-36	237 b	deb	4.3	4.3	NV|NV	NV	
91-36	308	emf	4.3	4.3	NV|NV	NV	
91-36	64	lanceolate	4.4	4.4	NV|NV	NV	
91-36	42	core	4.7	4.7	NV	NV	
91-36	108 c	deb	4.9	4.9	NV|NV	NV	
91-36	307	emf	5.0	5.0	NV|NV	NV	
91-36	52 i	deb	5.2	5.2	NV|NV	NV	
91-36	14	emf	5.5	5.5	NV	NV	

Appendix B: Actual Hydration Values from Various Specimens Obtained within the Research Area

Acc#	Cat#	Type	Hyd	Cv Hyd	SRC	Source	Remarks
Site: CA-SON-1917							
90-3	500	exp stem pt	2.5	3.3	A	A	
Site: CA-MEN-2228							
89-2	5 f	deb			A	A	DH, weathered
89-2	5 b	deb	1.1	1.1	K|K	K	
89-2	5 c	deb	1.2	1.2	K|K	K	
89-2	5 d	deb	1.2	1.2	K|K	K	
89-2	5 e	deb	1.3	1.3	K	K	
89-2	3	biface	1.3	1.3	K	K	
89-2	6	deb	2.2	2.2	K|K	K	
89-2	5 aa	deb	2.5	2.5	K|K	K	
89-2	5 a	deb	1.1	1.1	NV|NV	NV	
89-2	4	emf	1.2	1.2	NV|NV	NV	
89-2	1	biface	2.7	2.7	NV|NV	NV	

REFERENCES

Andrefsky, William, Jr.
1994 Raw-Material Availablilty and the Organization of Techonology. American Antiquity 59(1):21-34.

Ammerman, Albert J.
1979 A Study of Obsidian Exchange Networks in Calabria. World Archaeology 11(1):95-110.

Apland, B.
1979 Reconnaissance Survey in the Rainbow Mountains Region of West-Central British Columbia. In The Annual Report for the Year 1976: Activities of the Provincial Archaeologist Office of British Columbia and Selected Research Reports, ed. by B.O. Simonsen, Victoria, British Columbia.

Armaroli, Paul
1982 Spatial and Temporal Analysis of the Obsidian Hydration Measurements from the Santa Rosa Valley, Sonoma County, California: A Pilot Study. Paper presented at the Annual Meeting of the Society of California Archaeology, Sacramento.

Bamforth, D.
1986 Technological Efficiency and Tool Curation. American Antiquity 51(1):38-50.

Barton, C.M.
1990 Beyond Style and Function: A View From the Middle Paleolithic. American Anthropologist 92:57-72.

Barrett, S.A.
1908 The Ethno-geography of the Pomo and Neighboring Indians. University of California Publications in American Archaeology and Ethnology 6(1):1-322. University of California Press, Berkeley.

1933 Pomo Myths. Bulletin of the Public Museum of the City of Milwaukee 15:1-608.

Basgall, Mark E.
1987 Resource Intensification Among Hunter-Gathers: Acorn Economies in Prehistoric California. Research in Economic Anthropology 9:21-52.

1993 Chronological Sequences in the Southern North Coast Ranges, California. In There Grows a Green Tree: Papers in Honor of David A. Fredrickson, edited by G. White, P. Mikkelsen, W. Hildebrandt, and M. Basgall, pp. 167-195. Center for Archaeological Research at Davis, Volume 11, Davis.

Basgall, Mark E., and Paul D. Bouey
1984 Prehistory of Northern Sonoma County: The Archaeology of the Warm Springs Dam Project. Prepared for United States Corp of Engineers, San Francisco District.

1991 The Prehistory of North-Central Sonoma County: Archaeology of the Warm Springs Dam-Lake Sonoma Locality. On file at the Northwest Information Center, file #S-12511.

Bates, Robert L. and Julia A. Jackson
1984 Dictionary of Geological Terms. Anchor Press, Garden City, New York.

Baumhoff, Martin A.
1980 The Evolution of Pomo Society. Journal of California and Great Basin Anthropology 2:175-186.

Baumhoff, Martin A., and Robert I. Orlins
1979 An Archaeological Assay on Dry Creek, Sonoma County, California. Contributions of the University of California Archaeological Research Facility, No. 40, Berkeley.

Bennyhoff, James A.
1977 Ethnogeography of the Plains Miwok. Center for Archaeological Research at Davis, Publication 5.

Bieling, David G.
1987 An Archaeological Investigation of 43.23 Acres in Fulton, Sonoma County, California. On file at the Northwest Information Center, file #S-9380.

1992 Perspectives on Behavior Gained from Lithic Analysis and Archaeological Investigations near Bridgeport, Mono County, California. M.A. thesis in Cultural Resources Management, Sonoma State University, Rohnert Park, California.

1992 Personal communication concerning a traditional quarrying area for Annadel, CA-SON-29.

1993 Analysis of Obsidian from CA-SOL-355/H, Green Valley, Fairfield, Solano County, California. In Final Report: Archaeological Data Recovery at Prehistoric Site CA-SOL-355/H, Green Valley, Solano County, California, ed. Randy S. Wiberg, pp. 114-138. On file at the Northwest Information Center, file #S-12758.

Bieling, David A. and Allan G. Bramlette
1989 Archaeological Investigations at Prehistoric Site CA-SON-1212, within A.P. Nos. 65-151-41, -42, -43, & -44, Sonoma County, California. On file at the Northwest Information Center, file #S-11157.

Binford, Lewis R.

1973 Interassemblage Variablility - the Mousterian and the "Functional" Argument. In The Explanation of Culture Change, ed. by C. Renfew, pp. 227-52. Duckworth Press, London.

1977 Forty-Seven Trips. In Stone Tools as Cultural Markers, R.V.S. Wright ed., pp. 24-36. Australian Institute of Aboriginal Studies, Canberra.

1978 Nunamiut Ethnoarchaeology. New York, Academic Press.

1979 Organization and Formation Processes: Looking at Curated Technologies. Journal of Anthropological Research 35(3):255-273.

1982 The Archaeology of Place. Journal of Anthropological Archaeology 1:5-31.

Bleed, P.

1986 The Optimal Design of Hunting Weapons: Maintainability or Reliability. American Antiquity 51(4):737-747.

Bouey, Paul

1987 The Intensification of Hunter-Gather Economies in the Southern North Coast Ranges of California. Research in Economic Anthropology 9:53-101.

1993 Personal communication concerning XRF assignments of Franz Valley glass.

Bramlette, Allan G.

1985 An Archaeological Study for the Jensen Property Annexation in Santa Rosa, Sonoma County, California (85-0041). On file at the Northwest Information Center, file #S-7358.

Busby, Colin I., James C. Bard, Michael A. Siskin, Donna M. Garaventa, Larry S. Kobori, Rebecca Loveland Antastasio, Melissa C. Kennard, and Meoldy E. Tannam

1984 A Limited Cultural Resources Testing of CA-SON-1391, City of Healdsburg, Sonoma County, California. On file at the Northwest Information Center, file #S-6820.

California Department of Water Resources

1975 Evaluation of Ground Water Resources: Sonoma County. Volume 1: Geologic and Hydrolic Data. Bulletin No. 118-4. Prepared in cooperation with County of Sonoma. Department of Water Resources, Sacramento.

Callahan, E.

1979 The Basics of Biface Knapping in the Eastern Fluted Point Tradition: A Manual for Flint Knappers and Lithic Analysts. Archaeology of Eastern North America 7(1):1-179.

Cardwell, G.T.
1958 Geology and Ground Water in the Santa Rosa and Petaluma Valley Areas, Sonoma County, California. Geological Survey Water-Supply Paper 1427. Prepared in cooperation with California Department of Water Resources. United States Government Printing Office, Washington, D.C.

Castillo, Edward D.
1978 The Impact of Euro-American Exploration and Settlement. In Handbook of North American Indians, Volume 8, edited by R.F. Heizer, pp. 99-127. Smithsonian Institution, Washington D.C.

Chatters, James C.
1987 Hunter-Gatherer Adaptations and Assemblage Structure. Journal of Anthropological Archaeology 6:336-375.

Clark, John E. and Thomas A. Lee, Jr.
1984 Formative Obsidian Exchange and the Emergence of Public Economies in Chiapas, Mexico. In Trade and Exchange in Early Meso-America, edited by K.G. Hirth, pp. 235-275. University of New Mexico Press, Albuquerque.

Cook, S.F.
1956 The Aboriginal Population of the North Coast of California. University of California Anthropological Records 16(3):81-130.

Crabtree, Donald
1972 An Introduction to Flintworking. Occasional Papers of the Idaho State University Museum, No. 28, Pocatello.

Dahlstrom, Bruce, and David G. Bieling
1991 A Morpho-Functional Classification System for Bifaces. Paper presented at the Annual meeting of the Sociaty for California Archaeology, Sacramento.

Davis, James T.
1961 Trade Routes and Economic Exchange Among the Indians of California. Reports of the University of California Archaeological Survey No. 54. Berkeley.

Dowdall, Katherine M., Allan G. Bramlette, and David A. Fredrickson
1989 An Archaeological Investigation of CA-SON-1503: A Limited Activity Site in Cloverdale, Sonoma County, California. On file at the Northwest Information Center, file #S-10503.

Driver, Harold E.
1936 Wappo Ethnography. University of California Publications in American Archaeology and Ethnology 36(3):179-220. Berkeley.

Eisenmann, Lynn, and David A. Fredrickson

1980 Archaeological Investigations at CA-SON-1208 Located in the Franz Valley Area of Sonoma County, California. On file at the Northwest Information Center, file #S-2188.

Ericson, J.E.

1984 Toward the Analysis of Lithic Production Systems. In Prehistoric Quarries and Lithic Production, J.E. Erickson and B.A. Purdy, eds., pp. 1-9. Cambridge University Press, Cambridge.

Farber, Alfred (with contributions by H.L. Crew and A.S. Peak)

1987 Archaeological Investigations in the Mayacamas Mountains: Volume II. CA-SON-833 and CA-SON-841. On file at the Northwest Information Center, file # S-9136.

Findlow, Frank J., and Marisa Bolognese

1984 Boundary Effects and the Analysis of Prehistoric Exchange Systems. In Exploring the Limits: Frontiers and Boundaries in Prehistory, ed. by S. P. De Atley and F. J. Findlow, pp. 173-187. BAR International Series 223, London.

Flenniken, J. Jeffrey

1991 The Diamond Lil Site: Projectile Point Fragments as Indicators of Site Function. Journal of California and Great Basin Anthropology 13(2):180-193.

Flynn, Katherine S.

1978 Archaeological Reconnaissance of the City of St. Helena Proposed Water Treatment Plant on Crystal Springs Road, Dago Valley, Napa California. On file at the Northwest Information Center, file #S-1122.

Fox, Kenneth F.

1983 Tectonic Setting of Late Miocene, Pliocene, and Pleistocene Rocks in Part of the Coast Ranges North of San Francisco, California. U.S. Geological Survey Professional Paper 1239.

Fox, K.F., Jr., R.J. Fleck, G.H. Curtis, and C.E. Meyer

1985 Potassium-Argon and Fission-Track Ages of the Sonoma Volcanics in an Area North of San Pablo Bay, California. U.S. Geological Survey Map MF-1753, Miscellaneous Field Studies Map. Department of the Interior, Washington D.C.

Fredrickson, David A.

1973 Early Cultures in the North Coast Ranges, California. Ph.D. dissertation, Department of Anthropology, University of California, Davis.

Fredrickson, David A. (cont.)
1974 Cultural Diversity in Early Central California: A View from the North Coast Ranges. Journal of California Anthropology 1:41-53.

1984 The North Coastal Region. In California Archaeology, edited by M.J. Moratto, pp. 471-527. Academic Press, Inc., New York.

1989 Spatial and Temporal Patterning of Obsidian Materials in the Geysers Region. In Current Directions in California Obsidian Studies, ed. Richard E. Hughes, Contributions of the University of California Archaeological Research Facility, No. 48, pp. 95-109. University of California, Berkeley.

1991 Archaeological Evaluation of CA-MNO-2456, -2488, and -564, near Bridgeport, Mono County, California. Project 09-MNO-395 P.M. 79.7/81.2, 09140-212800. On file at the Anthropological Study Center, Sonoma State University Academic Foundation, Inc., Rohnert Park, California.

Freund, Joanna, and Thomas M. Origer
1990 Intra-Operator Hydration Measurement Results: An Experiment Designed To Test Hydration Measurement Repilcability. Paper presented at Society of California Annual Meeting, Foster City.

Garfinkel, Alan P., and Jeffrey C. Bingham
1984 Archaeological Investigations at CA-SON-1344, a Makahmo Pomo Site, near Cloverdale, California. On file at the Northwest Information Center, file # S-8081.

Gifford, Edward W., and Alfred L. Kroeber
1939 Culture Element Distributions, IV: Pomo. University of California Publications in American Archaeology and Ethnology 37(4):117-254.

Gifford-Gonzalez, D.P., D.B. Damrosch, D.R. Damrosch, J. Pryor, and R.L. Thunen
1985 The Third Dimension in Site Structure: An Experiment in Trampling and Vertical Dispersal. American Antiquity 50:803-818.

Gmoser, Glenn J.
1992 Preliminary Results of Archaeological Testing at Sites CA-SON-1810 and CA-SON-1811. On file at the Northwest Information Center, file #S-11606.

Goodyear, A.C.
1979 A Hypothesis for the Use of Cryptocrystalline Raw Material Among Paleo-Indian Groups of North America. Research Manuscript Series, No. 156. Institute of Archaeology and Anthropology, University of South Carolina, Columbia.

Gould, R.A., and S. Saggers
1985 Lithic Procurement in Central Australia: A Closer Look at Binford's Idea of Embeddedness in Archaeology. American Antiquity 50(1):117-136.

Greenway, Marlene
1986a Archaeological Investigations at CA-SON-1323 within the Sonoma County Airport Sewer Project Area, Sonoma County, California. On file at the Northwest Information Center, file #S-7802.

1986b Archaeological Investigation at CA-SON-1324 within the Sonoma County Airport Sewer Project Area, Sonoma County, California. On file at the Northwest Information Center, file #S-9229.

Hayes, John F., and Leigh Jordan
1987 An Archaeological Survey of the Passalacqua Property of Passalacqua Road, Healdsburg, Sonoma County, California, MNS 87-5710 (APN No. 88-01-1 and 88-01-3). On file at the Northwest Information Center, file #S-9431.

Heizer, R.F., and A.E. Treganza
1971 Mines and Quarries of the Indians of California. In The California Indians: A Source Book, edited by R.F. Heizer and M.A. Whipple, pp. 346-359. University of California Press, Berkeley.

Hughes, Richard E.
1978 Aspects of Prehistoric Wiyot Exchange and Social Ranking. Journal of California Anthropology 5(1):53-66.

1980 X-Ray Fuorescence Analysis of 12 Obsidian Artifacts from CA-SON-1107. Appendix 2 in Letter Report: Archaeological Evaluation at CA-SON-1107, the Hopper Lane Site, Santa Rosa, Sonoma County, California, by Roger H. Werner and David A. Fredrickson. On file at the Northwest Information Center, File #S-2215.

1986 Diachronic Variability in Obsidian Procurement Patterns in Northeastern California and Southcentral Oregon. University of California Publications in Anthropology, Vol. 17. University of California Press, Berkeley.

1991 Report of X-Ray Fluorescence Data Generated from 17 Items from CA-SON-1212 and CA-SON-1811. Included in Appendix A of this report.

1992 Personal communication concerning Franz Valley obsidian.

Hughes, Richard E., and Robert L. Bettinger
1984 Obsidian and Prehistoric Sociocultural Systems in California. In Exploring the Limits: Frontiers and Boundaries in Prehistory, ed. by S. P. De Atley and F. J. Findlow, pp. 153-172. BAR International Series 223, London.

Jackson, Robert J., Mark E. Basgall, and Tina Biorn
1983 Technological Flaked-Stone Analysis. In Archaeology of the Forest Service Forty Site (CA-MNO-529), Mono County, California, By M.E. Basgall. Prepared for Inyo National Forest, Bishop.

Jackson, Thomas L.
1974 The Economics of Obsidian in Central California Prehistory: Application of X-Ray Fluorescence Spectrography in Archaeology. M.A. thesis, Department of Anthropology, California State University, San Francisco.

1978 Final Report of Archaeological Investigations at The River Glen Site (CA-NAP-261). On file at the Northwest Information Center, California Archaeological Inventory, Rohnert Park, California, file #S-1227.

1986 Late Prehistoric Obsidian Exchange in Central California. Ph.D. dissertation, Department of Anthropology, Stanford University, Stanford.

1992 Personal communication concerning CA-MRN-307 and Franz Valley and Blossom Creek obsidians, and X-Ray Fuorescence.

Jackson, Thomas L. and M. Kathleen Davis
1993a Report of X-Ray Fuorescence Analysis of Artifact Obsidian From CA-SON-1810 and CA-SON-1811. Included in Appendix A of this report.

1993b Report of X-Ray Fluorescence Analysis of Artifact Obsidian From Various Sites Near Alexander Valley. Included in Appendix A of this report.

Jackson, Thomas L., and Joachim Hampel
1992 Size Effect in the Energy-Dispersive X-Ray Fluorescence (EDXRF) Analysis of Archaeological Obsidian Artifacts. Paper present at International Symposium on Archaeometry, Los Angeles.

Jochim, M. A.
1976 Hunter-Gatherer Subsitstance and Settlement: A Predictive Model. Academic Press, New York.

Jones, Terry and John Hayes
1989 Archaeological Data Recovery at CA-SON-120, Sonoma County, California 04-Son-12 P.M. 29.1 04334-112241. Prepared by California Department of Transportation, San Francisco. On file at the Northwest Information Center, file #S-11398.

Kay, Marvin
1975 Social Distance Among Central Missouri Hopewell Settlements: A First Approximation. American Antiquity 40(1):64-71.

Kelly, Robert L.
1983 Hunter-Gatherer Mobility Strategies. Journal of Anthropological Research 39(3):277-306.

1988 Three Sides of a Biface. American Antiquity 53(4):717-734.

Kent, Susan
1992 The Current Forager Controversy: Real Versus Ideal Views of Hunter-Gatherers. Man 27:45-70.

Kroeber, A.L.
1925 Handbook of the Indians of California. Bureau of American Ethnology, Bulletin 78, Smithsonian Institute, Washington, D.C. (Reprinted by Dover Publications, Inc., New York, 1976).

Kuhn, Steven L.
1979 An Archaeological Survey of the Proposed Downward Lot Split (MN 6991), Sonoma County, California. On file at the Northwest Information Center, file #S-1840.

1992 Blank Form and Reduction as Determinants of Mousterian Scraper Morphology. American Antiquity 57(1):115-128.

Kummer, Hans
1969 Spacing Mechanisms in Social Behavior. In Man and Beast, edited by J.F. Eisenberg and W.S. Dillon. Smithsonian Institute Press, Washington, D.C.

Lawn, B.R. and D.B. Marshall
1979 Mechanics of Micro-Contact Fracture in Brittle Solids. In Lithic Use-Wear Analysis, B. Hayden ed, pp.63-82. Academic Press, New York.

McLendon, Sally, and Robert L. Oswalt
1978 Pomo: Introduction. In California, ed. by Robert F. Heizer, pp.274-288. Handbook of North American Indians, vol. 8, William C. Sturtevant, general editor. Smithsonian Institution, Washington, D.C.

McKechnie, Jean L., general editor
1983 Webster's Universal Unabridged Dictionary. Simon and Schuster, New York.

Mikkelsen, Pat, David A. Fredrickson, and Thomas M. Origer
1984 An Archaeological Investigation of Two Prehistoric Sites, CA-SON-963 and CA-SON-964, at 3040 Marlow Road, Santa Rosa, California. On file at the Northwest Information Center, file #S-6438.

1985 An Archaeological Investigation of Prehistoric Site CA-SON-860/H, Santa Rosa, Sonoma County, California. On file at the Northwest Information Center, file #S-7073.

Moratto, Michael J., with contibutions by D.A. Fredrickson, C. Raven, and C.N. Warren
1984 California Archaeology. Academic Press, New York.

Mundy, Joseph W.
1993 Elevation-related Variables and Obsidian Hydration: A Diffusion Cell Study in Yosemite. Paper presented at Society of California Archaeology Annual Meeting, Asilomar.

Murray, P.
1980 Discard Location: The Ethnographic Data. American Antiquity 45(3):490-502.

Nelson, D.E., J.M. D'Auria, and R.B. Bennett
1975 Characterization of Pacific Northwest Coast Obsidian by X-Ray Fluorescence Analysis. Archaeometry 17(1):85-97.

Nelson, Margaret C.
1990 Sedentism, Mobility, and Regional Assemblages: Problems Posed in the Analysis of Southwest Prehistory. In Perspectives on Southwestern Prehistory, ed. by P.E. Minnis and C.L. Redman, pp. 150-156. Westview Press, Boulder.

1991 The Study of Technological Organization. In Archaeological Method and Theory, vol. 3, M. B. Schiffer, ed., pp. 57-100. The University of Arizona Press, Tucson.

Offermann, Janis and David A. Fredrickson
1978 Exploratory Auger Borings at CA-SON-1100, the "Rancho Musalacon" Site. On file at the Northwest Information Center, file #S-935.

Origer, Thomas M.
1987 Temporal Control in the Southern North Coast Ranges of California: The Application of Obsidian Hydration Analysis. Papers in Northern California Anthropology No. 1. Northern California Anthropological Group, Berkeley.

1989 Hydration Analysis of Obsidian Flakes Produced by Ishi During the Historic Period. In Current Directions in California Obsidian Studies, ed. by Richard E. Hughes, Contributions of the University of California Archaeological Research Facility, No. 48, pp. 69-77. University of California, Berkeley.

Origer, Thomas, and David A. Fredrickson
1980 The Laguna Archaeological Research Project, Sonoma County, California. On file at the Northwest Information Center, file #S-2043.

1984 An Archaeological Investigation and Evaluation of CA-SON-783 Located near the Geysers, Sonoma County, California. On file at the Northwest Information Center, file #S-6361.

Parry, William J. and Robert L. Kelly
1987 Expedient Core Technology and Sedentism. In The Organization of Core Technology, ed. by J.K. Johnson and C.A. Morrow, pp. 285-304. Westview Press, Boulder.

Patterson, L.W., L.V. Hoffman, R.M. Higginbotham, and R.D. Simpson
1987 Analysis of Lithic Flakes at the Calico Site, California. Journal of Field Archaeology 14:91-106.

Peak and Associates, Inc.
1985 Archaeological Investigations in the Mayacamas Mountains: Vol. I. CA-SON-1406 and CA-SON-1407, Sonoma County, California. On file at the Northwest Information Center, file #S-7992.

Peri, David W., Scott M. Patterson, and Susan L. McMurray
1985 The Makahmo Pomo: An Ethnographic Survey of the Cloverdale (Mahakmo) Pomo. Prepared by the Warm Springs Cultural Resources Study, Sonoma State Academic Foundation, for U.S. Army Corps of Engineers, San Francisco District.

Praetzellis, Adrian, and Mary Praetzellis
1976 Archaeological Excavations at CA-SON-710 and CA-SON-906. On file at the Northwest Information Center, file #S-322.

Pryor, John
1987 Temporal and Spatial Stylistic Patterns of Northern California Indian Baskets. Ph.D. dissertation, Department of Anthropology, State University of New York, Binghamton.

Psota, Sunshine
1990 Reexamining the Potential to Visually Source Western Great Basin Obsidians. Paper presented at Society of California Archaeology Annual Meeting, Sacramento.

1992 Results of Archaeological Monitoring for a Portion of CA-SON-1238 Located Within APN 78-200-02, 6251 Trenton Healsdburg Road, Forestville, Sonoma County, California. On file at the Northwest Information Center, file #S-14410.

Rolland, N., and H.L. Dibble
1990 A New Sythesis of Middle Paleolithic Variability. American Antiquity 55(3)480-499.

Rondeau, Michael
1985 The Meagan Site:Excavations at CA-MEN-1802, Mendocino County, California. On file at the Northwest Information Center, file #S-8944.

Rondeau, Michael (cont.)
1990 Excavations at the Kindra Site, CA-MEN-2220, Mendocino County, California. On file at the Northwest Information Center, file #S-10766.

Sappington, R.L.
1984 Procurement Without Quarry Production: Examples from Southwest Idaho. In Prehistoric Quarries and Lithic Production, ed. by J.E. Ericson and B.A. Purdy, pp. 23-34. Cambridge University Press, Cambridge.

Sappington, R.L., and C.M. Cameron
1981 Obsidian Procurment at Chaco Canyon, Northwestern New Mexico, A.D. 500-1200. Paper presented at the 46th Annual Meeting of the Society for American Archaeology, San Diego.

Sawyer, Jessie O.
1978 Wappo. In California, ed. by Robert F. Heizer, pp.256-263. Handbook of North American Indians, vol. 8, William C. Sturtevant, general editor. Smithsonian Institute, Washington, D.C.

Schwaderer, Rae
1992 Archaeological Test Excavation at the Duncans Point Rockshelter, CA-SON-348/H. In Essays on the Prehistory of Maritime California, ed. by T.L. Jones, pp 55-71. Center for Archaeological Research at Davis, Volume 10, Davis.

Scott, Sara A.
1991 Problems with the Use of Flake Size in Inferring Stages of Lithic Reduction. Journal of California and Great Basin Anthropology 13(2):172-179.

Shott, Michael
1986 Technological Organization and Settlement Mobility: An Ethnographic Examination. Journal of Anthropological Research 42(1):15-51.

1989 On Tool-Class Use Lives and the Formation of Archaeological Assemblages. American Antiquity 54(1):9-30.

Soule, William E.
1979 Cultural Resource Survey Report for Napa Valley Vineyard Company for a Proposed Pit Reservoir near Windsor. On file at the Northwest Information Center, file #S-1673.

Stahle, David W. and James E. Dunn
1982 An Analysis and Application of the Size Distribution of Waste Flakes from the Manufacture of Bifacial Stone Tools. World Archaeology 14(1):84-97.

Stewart, Omer C.
1943 Notes on Pomo Ethnography. University of California Publications in American Archaeology and Ethnology 40(2):29-62. Berkeley.

Stewart, Suzanne
1982 Prehistoric Overview Northwest Region: California Archaeological Inventory. Volume 3: Napa and Sonoma Counties. On file at the Northwest Information Center.

1989 Warm Springs Project, Rockpile Road Upgrade: Data Recovery Investigations at CA-SON-1471. On file at the Northwest Information Center, file # S-1131.

1993 Upper Archaic Diversity in the Warm Springs Locality Sonoma County, California. M.A. thesis in Cultural Resources Management, Sonoma State University, Rohnert Park, California.

Travis, Russell B.
1952 Geology of the Sebastopol Quadrangle, California. California Division of Mines and Geology Bulletin # 162.

Tremaine, Kimberly J.
1989 Obsidian as a Time Keeper: An Investigation in Absolute and Relative Dating. M.A. thesis in Cultural Resources Management, Sonoma State University, Rohnert Park, California

Tringham, R., G. Cooper, G. Odell, B. Voytek, and A. Whitman
1974 Experimentation in the Formation of Edge Damage: A New Approach to Lithic Analysis. Journal of Field Archaeology 1:171-196.

Van de Hoek, Enid J.
1990 A Spatial and Temporal Study of Blue Mountain Obsidian: Territorial Implications on the Devil's Garden in Northeastern California. M.A. thesis in Cultural Resources Management, Sonoma State University, Rohnert Park, California

Waechter, Sharon A.
1989a Archaeological Test Excavations at CA-MEN-2228, CA-SON-1759, and CA-SON-1760/H for the AT&T Buried Fiber Optics Cable from East Windsor to Cloverdale Peak, Sonoma and Mendocino Counties, California. On file at the Northwest Information Center, file #S-10733.

1989b Report on the Limited Test Excavations at CA-SON-1449 for the Proposed Grove Street Extension Project, City of Healdsburg, Sonoma County, California. On file at the Northwest Information Center, S-10820

Weaver, C.E.
1949 Geology and Minimal Deposits of an Area North of San Francisco Bay. California Divisions of Mines, Bulletin No. 149.

Wentworth, Chester K.
1922 A Scale of Grade and Class Terms for Clastic Sediments. The Journal of Geology 22:377-392.

Werner, Roger H., and David A. Fredrickson
1980 Letter Report: Archaeological Evaluation of CA-SON-1107, the Hopper Lane Site, Santa Rosa, Sonoma County, California 04-Son-101 P.M. 22-7/23.2 04219. On file at the Northwest Information Center, file #S-2215.

White, Greg
1984a The Archaeology of LAK-510, Near Lower Lake, Lake County, California. Final report submitted to the California Department of Transportation in Sacramento. On file at the Northwest Information Center, file #S-6899.

1984b A Critique of the Final Draft Report: Archaeological Investigations at CA-SON-1344 (The Cloverdale Site) 04-SON-101 R49.8/R54.2 04225-121451-3 Cult by A. Garfinkel and J. Binghamm. Manuscript in possession of author.

White, Greg and David A. Fredrickson
1992 A Research Design For: The Anderson Flat Project, Archaeological Data Recovery Investigations at Sites CA-LAK-72, 509, 510, 536, 538, 542, and 1375, Lake County, California. Prepared by the Cultural Resources Facility, Sonoma State University for California Department of Transportation, Eureka.

White, Greg, Terry Jones, James Roscoe, and Lawrence Weigel
1982 Temporal and Spatial Distributions of Concave Base Projectile Points from the North Coast Ranges, California. The Journal of California and Great Basin Anthropology 4:67-79.

Wiberg, Randy S. (Contributions by D.G. Bieling, E. Luby, R. Milliken, J.P. Quinn, P.N. Williamson, and E. Wohlgemuth)
1993 Final Report: Archaeological Data Recovery at Prehistoric Site CA-SOL-355/H, Green Valley, Solano County, California. On file at the Northwest Information Center, file #S-12758.

Wickstrom, Brian P.
1986 An Archaeological Investigation of Prehistoric Sites CA-SON-1250 and CA-SON-1251, Southern Sonoma County, California. M.A. thesis in Cultural Resources Management, Sonoma State University, Rohnert Park, California.

Wickstrom, Brian and David A. Fredrickson

1982 Archaeological Investigations at CA-SON-20, Santa Rosa, Sonoma County, California. On file at the Northwest Information Center, file #S-4514.

Willey, Gordon R. and Philip Phillips

1958 Method and Theory in American Archaeology. University of Chicago Press, Chicago.

Wilmsen, Edwin E.

1973 Interaction, Spacing Behavior, and the Organization of Hunting Bands. Journal of Anthropological Research 29(1):1-31.