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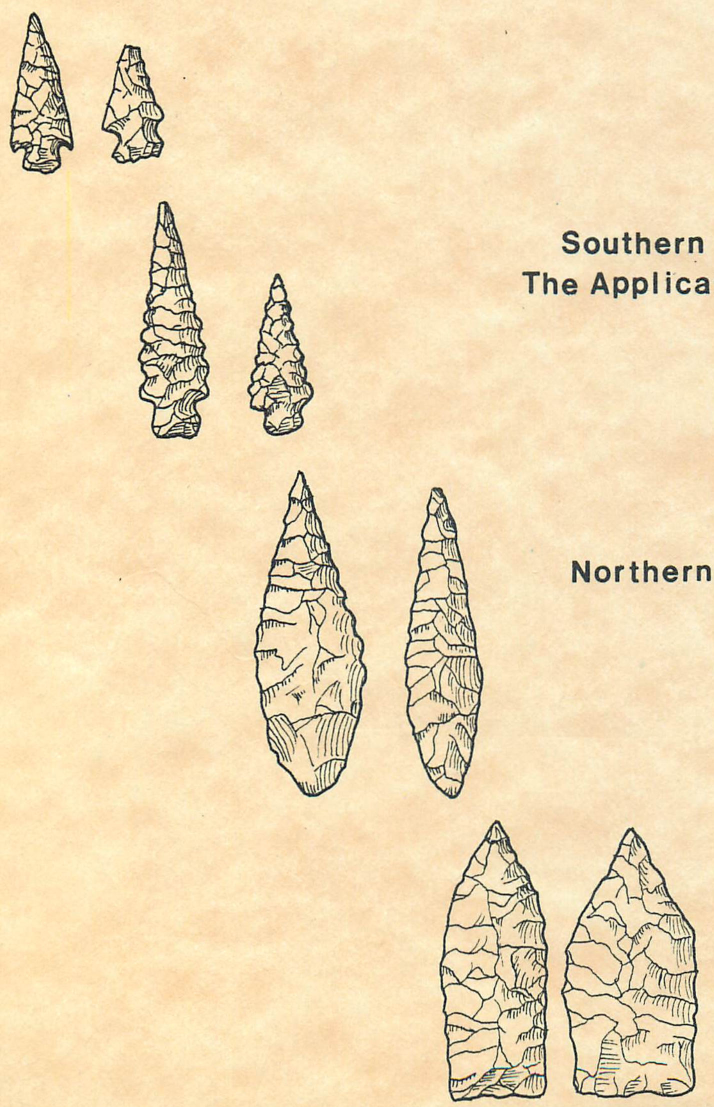

Temporal Control
in the
Southern North Coast Ranges of California :
The Application of Obsidian Hydration Analysis

by
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TEMPORAL CONTROL IN THE SOUTHERN NORTH COAST RANGES OF CALIFORNIA: THE APPLICATION OF OBSIDIAN HYDRATION ANALYSIS

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THOMAS MICHAEL ORIGER

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Archaeological sites often are marked by a paucity of temporally diagnostic artifacts and materials suitable for radiocarbon or other means of dating. Analysis of hydration bands on projectile points and obsidian flakes associated with radiocarbon dates yielded positive results. Relative dating of projectile points was accomplished based on hydration measurements. In addition, absolute hydration dating for Annadel and Napa Glass Mountain artifacts is possible. The data indicate that hydration dating is an important tool to the chronometric control of archaeological phenomena.

PREFACE

Completion of this thesis cannot be solely attributed to myself. Rather, this thesis represents the aggregate input of energy and ideas from a number of individuals.

Each of my committee members reviewed draft copies of this thesis and offered valuable criticism. Upon my review of their comments I noted that each committee member rarely expressed comment that overlapped with any other committee member. For this reason I conclude that I was fortunate in having a committee comprised of professors with distinctive interests that, in toto, cross-cut a broad theoretical and methodological perspective. I am indebted to Dr. Gary Pahl, committee chairperson, and Dr. Karen Bruhns, both of San Francisco State University. I especially express gratitude to Dr. David Fredrickson for making Sonoma State University's hydration laboratory and collections available to me and providing support and encouragement, without which this research would not have been completed. Despite my committee's input, my personality may have escaped. I accept all failings of this thesis.

Colleagues of mine at Sonoma State University contributed their ideas and encouragement. In particular I thank Paul Amaroli, Susan Davis, "Scotty" Thompson (who drafted Maps 1-4), Brian Wickstrom, and Greg White. To others not mentioned by name, thank you.

My initial involvement with obsidian hydration dating was aided by Dr. Thomas Kaufman, University of California, Los Angeles. My appreciation of obsidian's role in prehistory has been enhanced by Tom Jackson. To these individuals I express thanks.

Connie Weichel Origer expertly typed the entire manuscript. Finally, to Connie, Emilee, and Jesse, thank you for your patience.

NOTE: The above was written late in 1982. Most recently, this thesis was reevaluated for publication in this series. Reviews of this work by several collegues, especially Tom Jackson and Greg White, were very helpful in pointing out errors of omission and commission on my part. Corrections and minor revisions were made; however, the content of this thesis is nearly identical to the 1982 version.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF MAPS

LIST OF FIGURES

Chapter 1

INTRODUCTION

Understanding the prehistory of California's North Coast Ranges has been the objective of a number of archaeologists for several decades (cf. Meighan 1955; Fredrickson 1973). Indivisibly bonded to this pursuit is control of time since, human occupation of this region spans thousands of years. Without temporal control:

> Few cultural interpretations in archaeology and none that have unique interest with respect to anthropology generally can be made without reference to time (Hole and Heizer 1977:200).

Development of techniques that allow archaeologists greater control of time has accelerated since the middle of the present century. Geochemical research during the 1950s showed that obsidian, a common archaeological site constituent in the southern portion of California's North Coast Ranges, was subject to a chemical and physical form of weathering termed <u>hydration</u> (Ross and Smith 1955). Simply stated, yet poorly understood, hydration of obsidian is a process whereby an obsidian specimen absorbs water to form an outer layer of increased density which consequently raises the index of refraction, creates a mechanical strain, and is visible under proper microscopic conditions.

In 1960, Friedman and Smith published an account of their research into the phenomenon of obsidian hydration. Their pioneering work laid a foundation important to the understanding of obsidian hydration as a dating tool. Friedman and Smith found that exposed surfaces of obsidian absorbed atmospheric water to create the hydrated layer. A question regarding time arose. How long is the time interval required to create a hydrated layer? To answer this question, they solicited and received obsidian artifacts of known age from museum collections. Age of the artifacts was suggested by other dating techniques, among which was radiocarbon age determination -- itself a relatively new tool in the 1960s.

Friedman and Smith's research demonstrated that visible hydration layers formed on freshly exposed obsidian surfaces within a matter of only a few hundred years. However, the data base with which they were working required expansion to test whether increased hydration layer thickness correlated with greater artifact age. A suite of hydration measurements was obtained from obsidian specimens excavated by C. Evans and B. Meggers (1960) from the Chorrera site, in southwest Ecuador. The Chorrera site was marked by three cultural occupations and yielded obsidian from its 4-meter deep deposit. Friedman and Smith (1960:477) found that hydration measurements from the stratigraphically deepest levels exhibited thicker hydration layers than did the specimens taken from shallower depths. The data suggested to Friedman and Smith that rates of hydration might be possible to determine.

The seeming simplicity of obsidian hydration dating, however, was not to be. During the course of their research, Friedman and Smith (1960) discovered variables that affected the normal growth of hydration layers. They investigated such variables as relative humidity, temperature, composition of obsidian, burning of obsidian, and erosion of obsidian surfaces.

They (1960:482) concluded on theoretical grounds that relative humidity was not an important hydration-affecting variable. Subsequent research has not contradicted this assertion. Friedman and Smith (1960:482) and Michels and Bebrich (1971:181) found that all other factors controlled, obsidian in a dry environment will hydrate at a comparable rate to obsidian in a wet environment.

Hydration of obsidian has been described as a diffusion process, which on theoretical grounds is greatly influenced by temperature. Elevated temperatures increase the absorption of water, while in contrast, cooler temperatures inhibit absorption of water. Another aspect of temperature concerns solar radiation. Layton (1973) analyzed temporally sensitive projectile points from northern Nevada and found that specimens on the soil surface exposed to direct sunlight were marked by hydration measurements at up to twice the thickness of their subsurface counterparts. Layton (1973:131) concluded that the effect of direct sunlight was to greatly elevate the artifacts' temperature and thus encourage the hydration process.

While composition of obsidian was viewed as an important hydration-affecting variable by Friedman and Smith, their research was focused on the differences between trachytic and rhyolitic obsidian families. Later researchers suggested that chemical variations within each obsidian family can also be important and affect hydration rates (Aiello 1969; Ericson 1977; Kaufman 1980; Michels and Bebrich 1971). Fortunately, research has shown that specific geologic obsidian outcrops often are marked by diagnostic chemical attributes which allow tracing of artifacts to specific sources (Ericson 1977; Jackson 1974).

In addition to the above hydration-affecting variables, burning and erosion of obsidian can play important roles in the weathering of previously hydrated layers (Friedman and Smith 1960:485). Such weathering is generally detrimental to hydration analyses. Burning of obsidian appears to cause micro-crazing that results in hydration bands that develop a diffusion front (the location at which hydrated and non-hydrated obsidian interface) that is not a clearly demarcated line when viewed under proper petrographic conditions. Additionally, pitting of the surface of obsidian samples appears to produce hydration and measurement error since the outer portion of the hydrated zone may be partially removed.

The final hydration-affecting variable described by Friedman and Smith (1960:486) was mechanical erosion of obsidian artifacts. Artifacts subjected to sufficient water tumbling or blasting by windborne sand become smoothed and the hydration band of the specimen physically removed. Thus, measurements obtained from such specimens could very well be erroneously smaller than might be encountered under other conditions.

Other hydration-affecting factors have been observed during the two decades since Friedman and Smith (1960) initiated their studies. Artifact reuse (Clark 1961:70) can lead to misinterpretation of hydration measurements. Specimens that have been reflaked can be often detected by macroscopic visual examination; however, where visual clues are absent, the hydration measurements can attest to tool reuse, reshaping, and sharpening. In those instances where reflaking was accomplished over a portion of the artifact, it should be possible to prepare two or more hydration samples and obtain different band measurements. Unexpectedly large or small hydration measurements could cause erroneous conclusions by researchers and the possibility of artifact reflaking should be considered.

Another factor to consider is artifact breakage. Hydration analysis of artifacts subjected to breakage during site investigations should be carefully treated so that freshly exposed surfaces are identified.

Kaufman (1980:379) suggested that geothermal activity and soil pH might be important and recommended study in those areas. It is probable that research will disclose additional factors which affect hydration rates.

With the preceding discussion in mind, we turn to the research that forms the topic of this thesis. The central question is: Can obsidian hydration analysis serve as an accurate tool to date artifacts, features, and sites? It follows that if artifacts can be dated, then features can be dated under proper conditions; and if artifacts and features can be dated, chronological assignment of site occupation is possible. Determination of the time that a site was occupied is crucial in archaeological interpretation.

Chronological sequences that are relevant to the present study have been proposed for central California and the North Coast Ranges. Early researchers included Lillard, Heizer, and Fenenga (1939) who described a central California sequence of three horizons: Early, Middle, and Late; Beardsley (1954) who focused on the region north of San Francisco Bay and was able to describe more precisely Middle and Late horizon cultures; and Meighan (1955) who published descriptions of archaeological complexes for the region generally north of that covered by Beardsley. Meighan's sequence of six complexes included five that have relevance to the present study: the Borax Lake Complex, the Mendocino Complex, the Clear Lake Complex, the McClure Complex, and possibly the peripheral Wooden Valley Complex to the east.

The most recently reported chronological sequence was described by Fredrickson (1973) identifying five temporal periods: Paleo-Indian, Lower Archaic, Middle Archaic, Upper Archaic, and Emergent. Cultural units subsumed under Fredrickson's temporal concepts were termed "patterns."

> A pattern is characterized by (a) similar technological skills and devices (specific

> cultural items); (b) similar economic modes (production, distribution, consumption), including especially participation in trade networks and practices surrounding wealth (often inferential); and (c) similar mortuary and ceremonial practices (Fredrickson 1973:118).

Fredrickson's patterns that have relevance to the present study included the Borax Lake, Berkeley, and Augustine — named for the sites at which they were identified. A fourth pattern, the Houx, is now defined as an "aspect" of the Berkeley Pattern (Fredrickson 1974).

Since Fredrickson's chronological sequence constitutes the temporal framework the present study will employ, some additional explication of Fredrickson's discussion is relevant. The "phase" is the smallest cultural unit that has spacial and temporal significance in the chronological framework for the study area. A sequence of phases for a discrete geographical space combines to form an aspect (Fredrickson 1973:102).

The importance of the above concepts was well stated by Fredrickson:

> The definition of phases and their temporal and spatial relationships with one another allow the recognition of many processes, ranging from those involved in the interaction of two adjacent societies, to those accompanying alterations in the environment, to those hypothesized on the basis of general systems theory... (1973:102).

Fredrickson described artifacts that were diagnostic of specific cultural patterns. Furthermore, such items can have temporal significance. Certain projectile point forms have been ascribed to the patterns found in the present study area (cf. Appendix A). The Borax Lake Pattern, characteristic of the Lower Archaic Period, is marked by concave base, widestemmed, and narrow lanceolate projectile points (cf. Fredrickson 1973:197, Figure 14). However, a recently completed study of concave base projectile points (White, Jones, Roscoe, and Weigel in press) suggests that in Sonoma and Marin counties certain forms of concave based points could be of more recent vintage than those occurring farther to the north in Lake and Mendocino counties.

The Berkeley Pattern, characteristic of the Upper Archaic Period, is generally marked by bipointed lanceolate or shouldered lanceolate (excelsior) forms, although some large contracting stemmed forms also occur (cf. Fredrickson 1973:201 et seq., Figure 15). Available evidence suggests regional extension of Borax Lake Pattern and/or Berkeley Pattern into the Middle Archaic Period.

The Augustine Pattern, characteristic of the Emergent Period, is marked by arrow tips. In the present study area such arrow tips are of two general forms: (1) the serrated edge, stemmed, and notched varieties, and (2) the non-serrated edge, stemmed, and corner-notched varieties. These two forms are believed diagnostic of Phase I and Phase II, respectively. Limited information suggests that for both arrow tip forms, stemmed varieties precede notched varieties (Fredrickson 1968; Jackson and Fredrickson 1978; R. King 1975).

The ascription of distinctive projectile point forms to specific cultural patterns is a fundamental element of the present research. Employing hydration band analysis, the research described in this thesis seeks to explore: (1) the possibility of determining hydration measurement ranges for chronological periods and their representative cultural patterns vis-a-vis hydration measurement ranges for diagnostic projectile points; (2) the absolute dating of archaeological phenomena based on hydration measurements; and (3) the assignment of projectile points and other archaeological phenomena (e.g., obsidian flakes, features, sites) that are not temporally secure or attributed to cultural patterns.

The content of the chapters that constitute this thesis are briefly as follows. Chapter 2 describes the physical setting of the study area. Topics include geographical definition of the study area, geology, and climate. Of special importance is temperature, due to its influence on hydration.

Chapter 3 describes archaeological sites/collections that contributed obsidian specimens and radiocarbon dates pertinent to this study. Included are descriptions of site locations, visits by archaeologists, physical attributes, and materials analyzed in this study.

Chapter 4 presents the projectile points and radiocarbon dates with their associated obsidian specimens. Criteria for selection of study specimens are discussed. Descriptions of each projectile point "type" include gross morphological attributes and metrical data. The geographical distributions are cursorily presented and their chronological positions are provided. Chapter 5 focuses on discussion of the data including temporal sensitivity of projectile points, relative and absolute hydration dating, and research design considerations.

Chapter 6, the final chapter, provides a summary of the thesis.

In addition to the text of this thesis, several appendices are included that provide detailed information regarding the specimens analyzed. Appendix A illustrates the projectile points and provides metrical information. Appendix B describes procedures for hydration analysis and lists hydration measurements. Appendix C gives obsidian sourcing results. In addition, maps, figures, and tables serve to augment the research value of data contained herein.

Chapter 2

THE STUDY AREA

The study area, situated in Marin, Napa, and Sonoma counties, represents a relatively compact geographical portion of the greater San Francisco Bay Area (Map 1). The study area is subdivided into the core study area, the central point of which is considered to be Santa Rosa in south-central Sonoma County, and satellite study areas scattered throughout the larger study area.

The core study area includes all lands within a 10-mile radius of Santa Rosa. The core study area is marked by relatively gentle terrain such as the Petaluma Valley, the Santa Rosa Plain, and the Santa Rosa Creek watershed extending easterly to Oakmont. The hills surrounding the core study area range up to 832 meters (2730 feet) at Hood Mountain; however, all archaeological sites included in the core study area were situated at elevations below 415 meters (1360 feet) with all but two sites at elevations of less than 244 meters (800 feet).

Satellite study areas included in this project were located near St. Helena in Napa County; near Petaluma in extreme southern Sonoma County; near Novato, Corte Madera, Tomales, and the Point Reyes Peninsula in Marin County.

Geology

The study area is situated at the southern extremity of California's North Coast Ranges, which trend northwestward from San Francisco Bay and extend to Oregon. The North Coast Ranges, described by Alt and Hyndman (1975:13) as "a nightmare of rocks," are a chaotic mass of sedimentary and igneous rocks dominated by Franciscan sediments--"...a jumbled mass of muddy sandstones and cherts interlayered with basalt flows, the entire assemblage so thoroughly folded and sheared that some large outcrops look as though they have been stirred with a stick" (Alt and Hyndman 1975:13).

Elevations range from sea level along the Pacific coast and San Francisco Bay to a height of 2270 meters (7448 feet) at Black Butte near Mendocino Pass in western Glenn County. The North Coast Ranges, however, are not considered to be particularly high, and average between 610 and 1220 meters (2000 and 4000 feet) (Howard 1962).

Interspersed among the various upland units are lowlands of fairly level ground such as coastal marine terraces and interior valleys including Round, Ukiah, Alexander, Napa, Sonoma, and Petaluma, as well as the Santa Rosa Plain.

From a regional perspective, the geologic history has been and continues to be dynamic. Howard (1962) succinctly describes a number of occasions of marine inundation and orogeny. Concommitant with such geologic events was faulting, erosion, sedimentation, and volcanic activity. During this time of earth upheaval and subsidence, the ongoing volcanic activity eventually proved to be of paramount importance to later inhabitants of the area, although they were not to arrive on the scene for several million years.

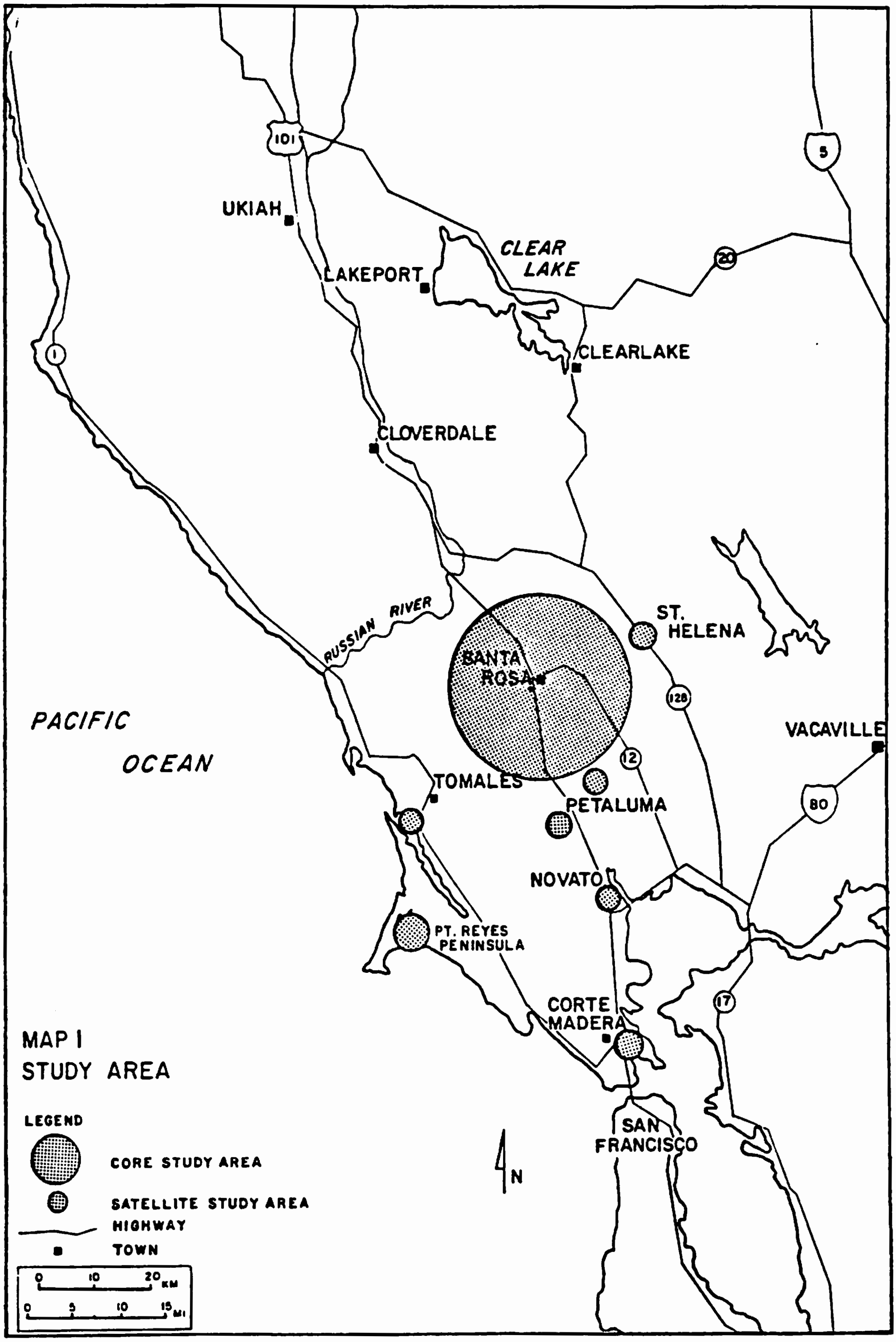
East of the Santa Rosa Plain are hills of igneous origin referred to as the Sonoma Volcanics (Koenig 1963). The importance of these hills lies in their geologic history. Large quantities of magma, released during periods of eruption, slowly cooled to form basalt, and some cooled more rapidly to form obsidian, a material of considerable utility to the inhabitants of the area.

The geologic occurrence of obsidian is widespread in the vicinity of the core study area and near St. Helena in Napa County. The greatest areal distribution is in the form of float material -- pebbles and cobbles rarely greater than 10 centimeters (cm) in their largest dimension. Of restricted occurrence but in greater concentration, are obsidian outcrops. These outcrops, the best known of which are Annadel southeast of Santa Rosa in Sonoma County and Glass Mountain near St. Helena in Napa County (Heizer and Treganza 1944), are comprised of relatively large numbers of flakes and chunks usually exposed on hillsides (Map 2).

Climate

Since it was indicated in Chapter 1 that temperature is an important factor affecting the process of hydration, the ensuing detailed description of the climate of the core study area and satellite localities is provided. In general, the core study area climate is characterized as Mediterranean; the summers lack rainfall and are warm, while the winter months receive precipitation and are cool. In coastal zones the climatic regime is characterized as maritime with abundant fog and cooler summer air.

The Santa Rosa Plain and environs are fairly typical of the greatest expanse of the overall study area. Approximately 80% of the annual precipitation falls from November through March with less than 1% during July through September. An isohyetal map prepared by the Sonoma County Water Agency dated April 1964 indicates that the county's higher elevations receive greatest precipitation, occasionally in the form of snow, while the lowlands receive much less rainfall. De Mars, Johnson, Lipshutz, Madigal, and Roberts (1977), citing the United States Department of Commerce Weather Bureau, San Francisco, indicated that over a 54-year period of records, the annual precipitation of the Santa Rosa Plain, at approximately 46 meters (150 feet) MSL, was 29.51 inches. In contrast, adjacent Sonoma Mountain at an elevation of 694 meters (2276 feet) receives 50+ inches (Sonoma County Water Agency 1964). Figures published by the National Oceanic and Atmospheric Administration (1980) indicated that satellite study areas have mean annual precipitation


UKIAH
LAKEPORT
CLEAR LAKE
CLEARLAKE
CLOVERDALE
RUSSIAN RIVER
SANTA ROSA
ST. HELENA
PACIFIC OCEAN
VACAVILLE
TOMALES
PETALUMA
NOVATO
PT. REYES PENINSULA
CORTE MADERA
SAN FRANCISCO
101
5
20
1
128
12
80
17
N
MAP I
STUDY AREA
LEGEND
CORE STUDY AREA
SATELLITE STUDY AREA
HIGHWAY
TOWN
0 10 20 KM
0 5 10 15 MI

amounts that are similar to the core study area.

Marine fog often accumulates offshore as a massive fogbank that creeps inland during afternoon hours. Gaps within the coastal hills allow easy passage of fog from the coastal to interior locations. Four such "fog gaps" identified by Gillian (1962:4) allow fog to enter the study area. They are from south to north: the Golden Gate, the Muir Woods Gap, the Nicasio Gap, and the Estero Lowland (Map 3). Due to marine influences, temperatures overall for the study area are mild with the greatest extremes experienced at interior locations; coastal temperatures are less variable. Fog is a recurrent summer phenomenon throughout a great deal of the study area.

Figures published by Elford (1964) and the National Oceanic and Atmospheric Administration (1980) indicate that greatest extremes in mean monthly temperature are experienced at such interior locations as Angwin in Napa County, and Cloverdale in Sonoma County. Summer fog, when it occurs at these locations, is much less persistent than at Cotati in Sonoma County which is situated at the interior opening of the Estero Lowland fog gap.

Based on the discussion thus far, it appears that various locations within the overall study area could experience dissimilar temperatures resulting from a variety of factors such as proximity to the coast, fog gaps, and elevations above sea level.

Table 1 compiled from data published by Elford (1964) and the National Oceanic and Atmospheric Administration (1980), provides temperature information from 24 weather stations distributed throughout the study area and surrounding environs (Map 3). Table 1 reveals that coastal locations (e.g., Fort Bragg, Fort Ross, Half Moon Bay, Pt. Arena) experience relatively cool mean annual temperatures. In contrast, interior locations situated at gaps nearly free of fog (e.g., Angwin, Clearlake Park, Cloverdale, Lakeport, St. Helena, Vacaville) experience relatively high summer temperatures. Interior locations also experience colder conditions that bring their respective mean annual temperatures down.

Those weather stations situated in close proximity to locations that yielded archaeological materials analyzed in this study include: Graton at 13.4° C (56.2° F), Hamilton AFB at 14.2° C (57.5° F), Kentfield at 14.1 C° (57.3° F), Petaluma at 14.3° C (57.7° F), Santa Rosa at 14.1° C (57.4° F), and St. Helena at 14.7° C (58.5° F). The mean annual temperatures indicate that the core study area and, at least, interior satellite study areas are similar since the temperature range is narrow.

Since no weather stations are situated on the Pacific Coast (within the study area, especially) near archaeological sites that contributed specimens analyzed in this study, temperature data are drawn from nearby coastal weather stations. These stations include: Fort Bragg at 11.6° C (52.9° F), Fort Ross at 12.4° C (54.4° F), Half Moon Bay at 12.4° C (54.4 F), and Pt. Arena at 11.7° C (53.0° F). Although coastal locations clearly experience cooler temperatures than do interior locations, the degree of effect on hydration rates has not been addressed in publication.

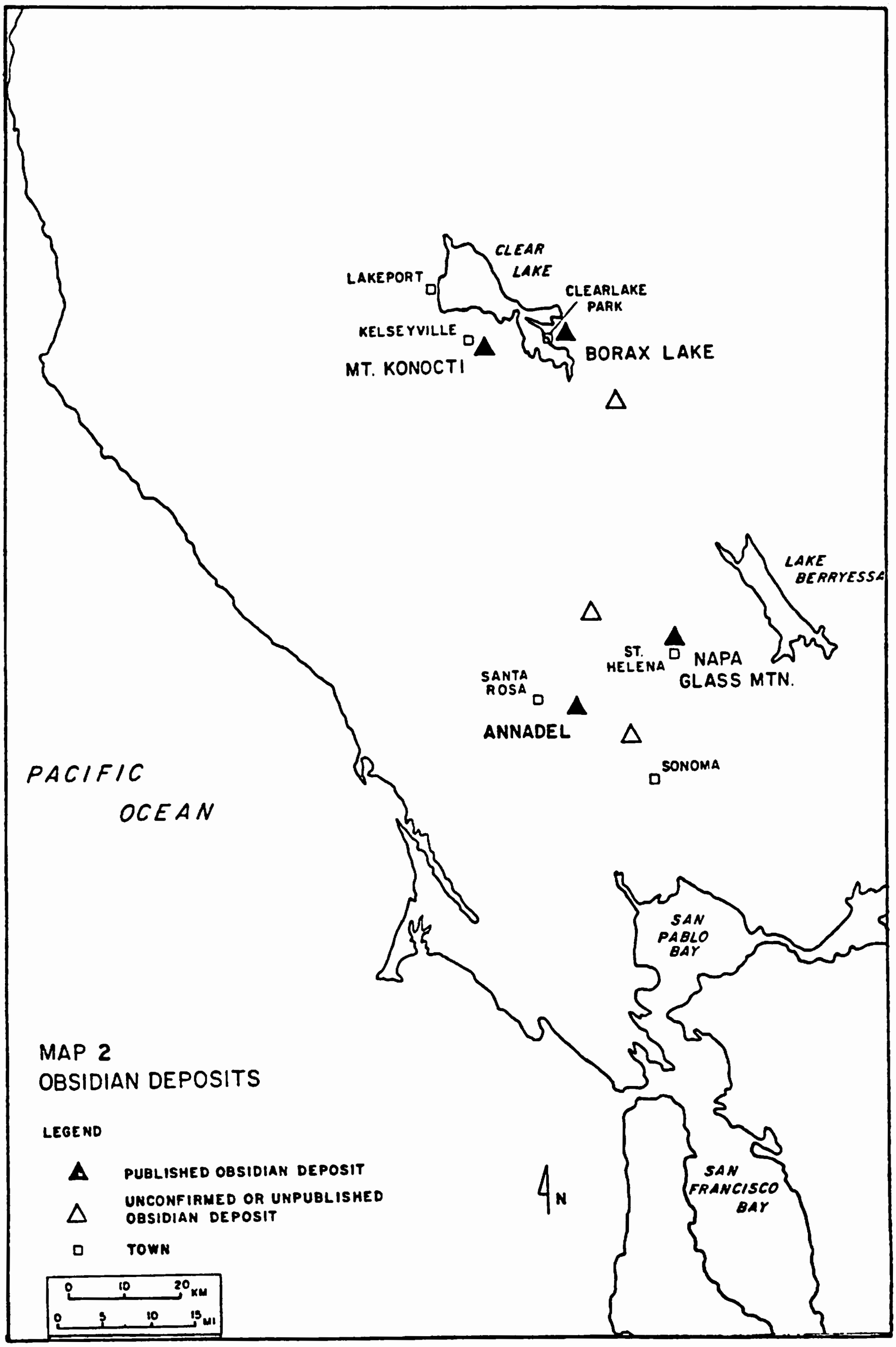
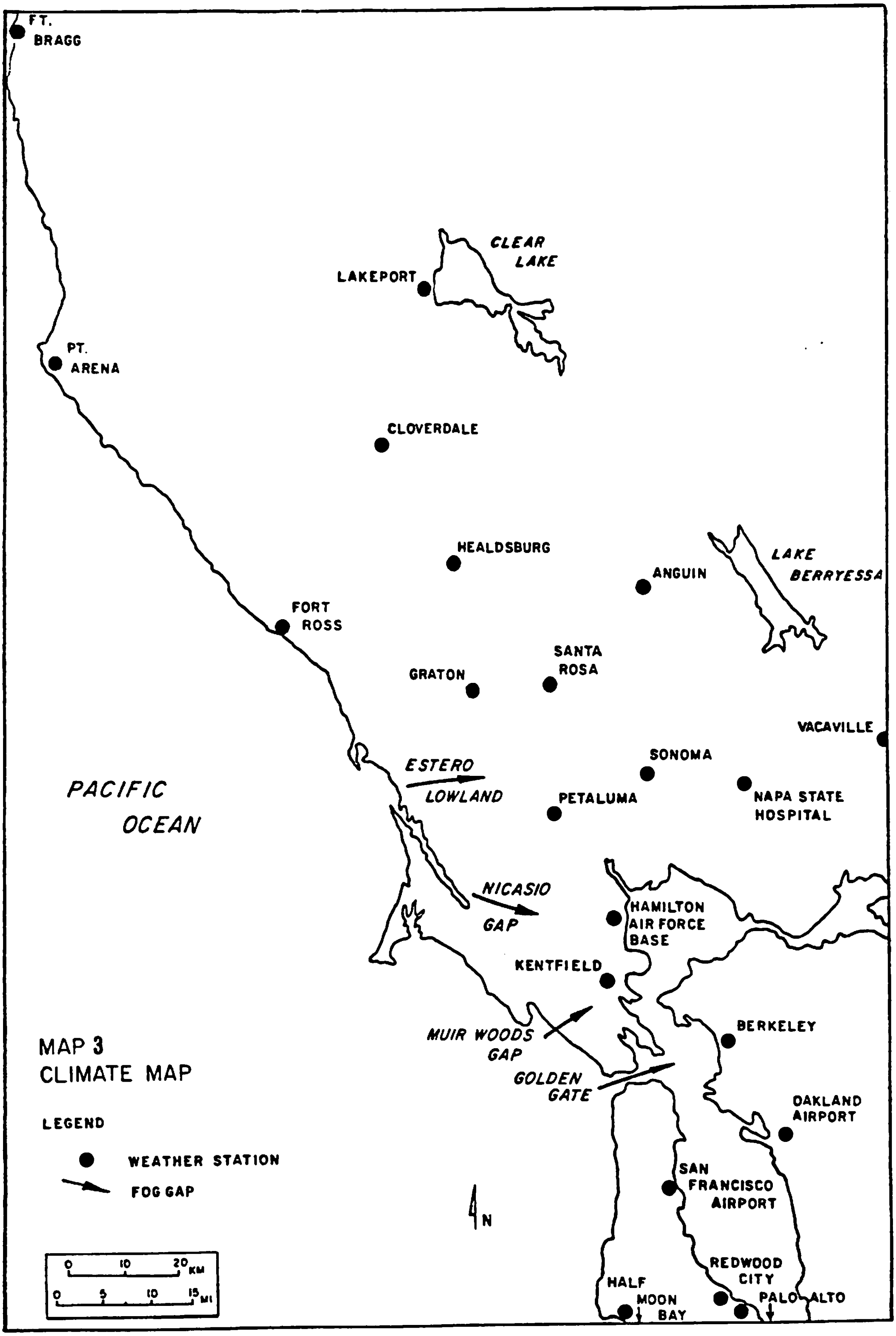

CLEAR LAKE
LAKEPORT
CLEARLAKE PARK
KELSEYVILLE
BORAX LAKE
MT. KONOCTI
LAKE BERRYESSA
ST. HELENA
NAPA GLASS MTN.
SANTA ROSA
ANNADEL
SONOMA
PACIFIC OCEAN
SAN PABLO BAY
SAN FRANCISCO BAY
N
MAP 2
OBSIDIAN DEPOSITS
LEGEND
PUBLISHED OBSIDIAN DEPOSIT
UNCONFIRMED OR UNPUBLISHED OBSIDIAN DEPOSIT
TOWN
0 10 20 KM
0 5 10 15 MI

Table 1. Temperatures for Selected Weather Stations (elevation in meters; temperature in Celsius).

Station	Ele*	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean	E.T.*
Angwin	551	6.3	8.2	8.8	11.8	14.7	18.7	22.2	20.7	19.4	16.2	11.0	8.4	13.9	16.6
Berkeley	105	9.6	11.4	12.0	13.1	14.6	16.1	16.4	16.8	17.6	16.2	13.3	10.9	13.9	15.4
Clearlake Park	435	5.8	7.7	10.0	12.6	16.2	20.2	23.9	23.1	20.0	15.1	10.0	6.6	14.3	17.8
Cloverdale	98	8.3	10.9	11.7	14.1	17.1	20.4	22.4	22.0	21.1	17.3	12.6	8.9	15.5	16.3
Fort Bragg	24	8.8	9.4	9.7	10.4	11.4	13.3	13.6	13.9	14.1	13.1	11.4	9.5	11.6	12.8
Fort Ross	35	9.8	10.4	10.6	11.4	12.6	14.3	14.3	14.6	15.1	13.9	12.0	10.4	12.4	13.6
Graton	61	7.4	9.4	10.6	12.4	14.7	17.4	18.6	18.6	18.0	15.1	11.1	7.9	13.4	15.4
Half Moon Bay	11	9.9	10.6	10.7	11.3	12.6	13.7	14.2	14.6	14.9	14.0	12.5	10.6	12.4	13.6
Hamilton AFB	2	8.2	10.1	11.7	13.6	15.6	18.1	19.1	18.7	18.7	15.9	11.8	8.9	14.2	16.1
Healdsburg	32	8.3	10.6	11.9	14.1	16.9	19.7	20.1	20.1	20.3	17.0	12.4	8.9	15.2	17.3
Kentfield	35	7.9	10.1	11.3	13.3	15.4	17.9	19.0	16.8	18.7	15.8	11.7	8.6	14.1	16.0
Lakeport	410	5.7	7.8	9.2	12.1	15.6	19.3	23.0	22.2	20.0	14.9	9.6	6.5	13.8	16.7
Napa St. Hospital	18	8.6	10.7	11.7	13.5	15.9	16.3	19.6	20.0	20.0	16.8	12.6	9.3	14.7	16.6
Oakland WSO AP	2	9.2	11.0	11.8	13.4	14.9	16.6	17.3	17.5	18.1	16.2	12.9	9.9	14.1	15.7
Palo Alto	8	8.5	10.4	11.6	13.4	15.6	17.8	18.9	18.7	18.3	15.7	12.0	9.1	14.2	16.0
Petaluma	5	8.8	10.3	11.4	12.8	15.1	17.7	18.7	19.4	19.3	16.5	12.2	8.8	14.3	16.2
Point Arena	60	9.0	9.4	9.6	10.9	12.1	13.9	13.9	14.2	14.2	12.9	10.8	9.2	11.7	12.9
Redwood City	9	9.1	10.9	12.2	14.1	16.3	18.7	20.1	19.9	19.4	16.4	12.7	9.8	14.9	16.8
San Francisco WSO AP	2	9.1	10.7	11.7	12.9	14.6	16.4	16.9	17.2	17.8	16.1	12.9	9.8	13.8	15.4
San Francisco WSO CI	40	11.1	11.8	12.4	12.9	13.7	14.8	14.7	15.2	16.8	16.3	14.1	11.1	13.7	14.9
Santa Rosa	51	7.8	10.0	11.0	13.1	15.4	18.0	19.3	19.4	18.0	16.2	11.8	8.4	14.1	16.1
Sonoma	6	7.9	9.9	10.9	13.3	15.4	18.7	20.6	19.9	19.2	15.7	11.0	8.4	14.3	16.5
St. Helena	75	7.7	9.4	11.3	13.8	16.6	20.0	21.6	20.9	19.7	16.0	11.8	8.6	14.7	17.0
Vacaville	32	7.2	9.9	11.8	14.6	18.0	21.6	22.7	23.5	21.9	17.4	11.7	7.7	15.6	18.4

sources - Climate of Sonoma County, C. Robert Elford (1964); and National Oceanic & Atmospheric Administration Climatological Data, Annual Summary, Cal. 1980, National Climatic Center, Asheville, North Carolina

* Ele = elevation; E.T. = Effective Temperature


FT. BRAGG
PT. ARENA
LAKEPORT
CLEAR LAKE
CLOVERDALE
HEALDSBURG
ANGUIN
LAKE BERRYESSA
FORT ROSS
SANTA ROSA
GRATON
VACAVILLE
SONOMA
ESTERO LOWLAND
PACIFIC OCEAN
PETALUMA
NAPA STATE HOSPITAL
NICASIO GAP
HAMILTON AIR FORCE BASE
KENTFIELD
MUIR WOODS GAP
BERKELEY
GOLDEN GATE
OAKLAND AIRPORT
SAN FRANCISCO AIRPORT
REDWOOD CITY
HALF MOON BAY
PALO ALTO
N
MAP 3
CLIMATE MAP
LEGEND
WEATHER STATION
FOG GAP
0 10 20 KM
0 5 10 15 MI

Ericson (1977:52 _et seq_.) discussed the role of temperature as a variable affecting hydration rates. Temperatures for any given locality expressed as an annual average does not consider the exponential influence of temperature increase or decrease from the mean as it affects hydration rate. A 5° C temperature increase will have a geometrically greater affect on hydration development than will a 5° C decrease. Since the process of hydration is heat sensitive monthly mean temperature fluctuations should be considered. The concept of Natural Effective Temperature (NET) was developed by Lee (1969) and NETs can be calculated according to the following equation:

$$Ta = -1.2316 + 1.0645Te - 0.1607Rt$$

where:

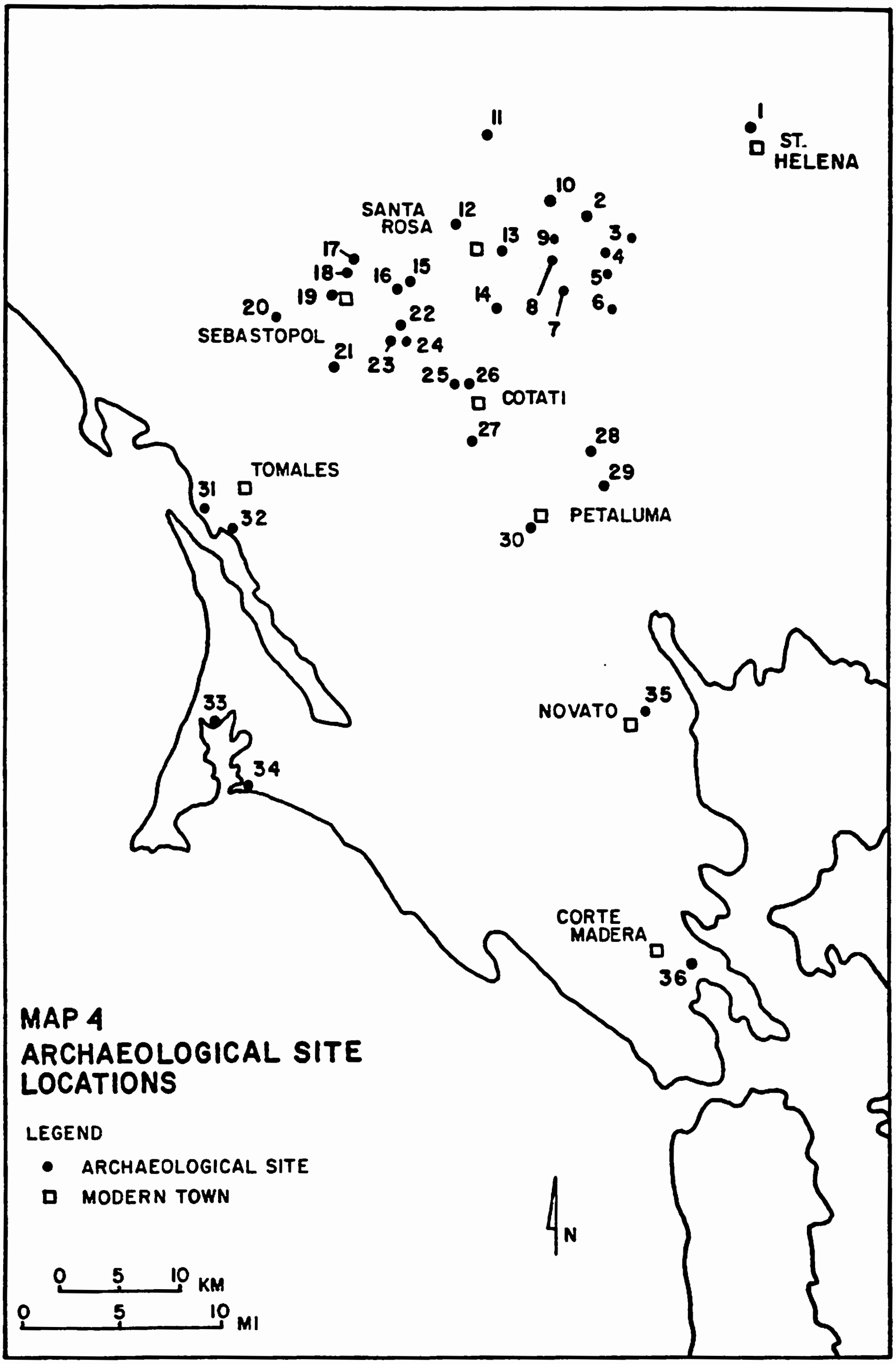
Ta = mean annual air temperature
Te = natural effective temperature
Rt = temperature range of annual monthly means.

NETs for each of the 25 weather stations were calculated and included in Table 1.

The NETs generally support conclusions drawn from mean temperatures. Coastal environments experience relatively cool annual temperatures, whereas interior locations are generally warmer in summer and marked by cooler winters.

A word of caution regarding NETs, however, is in order. Theoretically, higher NETs suggest that hydration reactions should be accelerated (with concomittant increased hydration thickness) all other factors being equal. This researcher, however, has found that increased NETs can result from _lowered_ temperatures. For example, as shown in Table 2, Station A and Station B report identical monthly temperatures, except for January which is cooler at Station B.

The annual mean for Station B is lower than for Station A and suggests that obsidian at Station B should hydrate _slower_ than obsidian at Station A, all other factors being equal. In contrast, the lower NET for Station A suggests that obsidian at Station B should hydrate at a _faster_ rate, despite a decrease in temperature. The key variable in Lee's NET formula appears to be _temperature range_, since increasing the range by decreasing the lowest temperature resulted in a larger NET. NETs should be used with



MAP 4
ARCHAEOLOGICAL SITE
LOCATIONS
LEGEND
ARCHAEOLOGICAL SITE
MODERN TOWN
0 5 10 KM
0 5 10 MI
N
ST. HELENA
SANTA ROSA
SEBASTOPOL
COTATI
TOMALES
PETALUMA
NOVATO
CORTE MADERA
1
2
3
4
5
6
7
8
9
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15
16
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Table 2. Comparison of Temperature Data for Hypothetical Weather Stations.

	Station A		Station B	
	°C	°F	°C	°F
January	7.8	46.1	4.4	40.0
February	10.0	50.0	10.0	50.0
March	11.1	51.9	11.1	51.9
April	13.1	55.5	13.1	55.5
May	15.4	59.7	15.4	59.7
June	18.0	64.4	18.0	64.4
July	19.3	66.8	19.3	66.8
August	19.4	67.0	19.4	67.0
September	19.1	66.4	19.1	66.4
October	16.2	61.1	16.2	61.1
November	11.8	53.2	11.8	53.2
December	8.4	47.2	8.4	47.2
Mean	14.1	57.4	13.8	56.9
NET	16.1	61.0	16.4	61.5

Chapter 3

THE STUDY SITES

Although a small number of specimens from the study area came from archaeological collections not assignable to recorded site locations, the greatest number of analyzed specimens derived from 36 recorded sites. These 36 sites were distributed between Marin County (6 sites), Napa County (1 site), and Sonoma County (29 sites). Map 4 depicts site locations.

A total of 24 sites was situated within the core study area surrounding Santa Rosa. Satellite localities were selected to gather data on interior and coastal locations and to increase the number of certain projectile point forms and radiocarbon dates. Such locations varied from northern Napa County, an area in excess of 30 miles from the ocean and 25 miles from San Pablo Bay, to the mouth of Tomales Bay and Drake's Estero on Point Reyes Peninsula in Marin County, which provided data on coastal environments.

Bias in selection of sites was controlled since virtually every investigated site that yielded available materials in the core study area was included. Satellite locality sites were not necessarily "selected," but rather were dictated since they represent the majority of sites with useful materials available for analysis.

In addition to the specimens which derived from specific sites, an additional 62 projectile points which lacked site provenience data were included in the study to enlarge the population of analyzed artifacts. These latter specimens included isolated specimens from the core study area as well as materials from two private collections. Isolated specimens totaled 5, the Jess Robel collection totaled 8 specimens, and the Hector Lee collection (now curated at Sonoma State University under accession number 72-2) contributed 49 specimens. The Jess Robel specimens were recovered from a locale approximately 5 kilometers south of Sebastopol, while the Hector Lee specimens were from the area west of Sebastopol in the vicinity of Occidental.

Listed below are the recorded sites that yielded projectile points and/or radiocarbon samples analyzed in this thesis.

CA-MRN-27

This site was situated on the Tiburon Peninsula approximately 1.6 kilometers east of the intersection of Highway 101 with Tiburon Blvd., Marin County (Map 4, #36). This site was recorded and described by N. C.

Nelson (1907a) as a shellheap which covered approximately 1400 square meters with an estimated depth in excess of 1.5 meters.

In 1967, residential development at CA-MRN-27 began and a salvage investigation was completed by a volunteer crew supervised by D. A. Fredrickson and reported by T. F. King (1970). CA-MRN-27 was found to be a very rich site with a wide range of artifact and feature types.

Among the artifacts recovered from the site were 13 obsidian specimens included in the present study. Four shouldered and 1 non-shouldered lanceolate projectile points were analyzed. In addition, 8 other obsidian specimens were included in this study due to association with a radiocarbon date of a multi-individual grave (Burial 3).

CA-MRN-192

This site was situated at the western base of a knoll, northeast of the point where the railroad tracks cross Olive Street in Novato, Marin County (Map 4, #35). CA-MRN-192 was recorded by N. C. Nelson (1907b) and later revisited by S. H. Bryon (1966). The site covered an estimated 1400 square meters and was marked by midden containing abundant marine shell and projectile points. Burials were said to have been uncovered during the excavation of a cellar ca. 1900 (Nelson 1907b). Urban development had substantially damaged the deposit.

CA-MRN-192 yielded one concave base projectile point analyzed in this study.

CA-MRN-202

This site was situated along the northwest shore of Tom's Point which projects from the eastern shore of Tomales Bay, Marin County (Map 4, #31). This site has had several different identification numbers assigned to it (i.e., MRN-202, Tom's Point 2, Tom's Point 7, MRN-S297, MRN-489, P.B. 202); however, it appears that all such numbers refer to the same site. CA-MRN-202 was described in a 1940 site record as a "shell-dirt" deposit which covered approximately 1300 square meters with a depth of at least 1.2 meters. CA-MRN-202 was later more fully described by A. Gerkin (1967) who collected and catalogued over 780 artifacts from the wave-washed lower portion of the site.

Twenty projectile points from CA-MRN-202, 10 corner-notched and 10 serrated specimens, were analyzed and described in this study.

CA-MRN-216

This site was situated on Limantour Spit within the Point Reyes National Seashore, Marin County (Map 4, #34). The site was described by Dillingham (1953) as a sandy midden with shell, projectile points, ceramics, bone, and possible house pits. It covered an estimated area of approximately 5200 square meters (Edwards 1967). CA-MRN-216 was investigated by

Dillingham in 1956 and Treganza in 1963. More extensive excavations were carried out between 1965 and 1967 (Moratto 1970).

One eccentric specimen, possibly a reworked wide-stemmed projectile point, was included in this study.

CA-MRN-230

This site was situated on the southeastern portion of Bull Point within the Point Reyes National Seashore, Marin County (Map 4, #33). CA-MRN-230 was recorded by Bryant ca. 1927 and later by Fenenga (1941). R. Beardsley (1954) described test excavations he undertook at the site ca. 1941. During the academic year 1978-79 the Santa Rosa Junior College conducted salvage/erosion control investigations at the site (Origer 1980). From survey and excavation information it was found that CA-MRN-230 was a midden which covered approximately 700 square meters with a depth of 0.9 meters and contained abundant shell and bone, as well as a variety of artifacts.

The site yielded 13 projectile points analyzed in this study including 12 corner-notched and 1 serrated specimens.

CA-MRN-396

This site was situated slightly north of Preston Point near the mouth of Tomales Bay, Marin County (Map 4, #32). The site was described by Upson (1966) as a shell midden which covered approximately 8400 square meters and had a depth of 60-90 cm. Human graves and possible housepits were reported from the site. Investigations were conducted there by Santa Rosa Junior College students under the supervision of Upson ca. 1966-67.

Investigations at the site yielded 17 projectile points analyzed for this study including 9 corner-notched, 6 serrated, and 2 concave base specimens.

CA-NAP-376

This site was situated on the east bank of York Creek near the intersection of State Highway 29/128 with Pratt Avenue, St. Helena, Napa County (Map 4, #1). The site was recorded and described by Y. Beard (1976) as a large midden with obsidian tools and waste flakes. The site covered approximately 2800 square meters with a depth of at least 0.45 meters. Prior to replanting with grapevines and subsequent to discing, students of the Ya-Ka-Ama Native American Cultural Heritage Training Program, supervised by students and staff of Sonoma State University, completed a surface investigation of the site. That investigation was reported by J. Dollar and A. Bramlette (1979).

These surface investigations yielded a number of projectile points analyzed for the present study including 10 corner-notched, 2 notchless, and 18 serrated forms.

CA-SON-19

This site was situated near the southeast shore of Spring Lake (Santa Rosa Creek Reservoir) between Rincon and Bennett valleys, Santa Rosa, Sonoma County (Map 4, #9). CA-SON-19 was recorded by Jesse Peter during the first decades of this century. A 1979 site visit by N. Thompson indicated that the site was a midden of some 5400 square meters marked by obsidian tools and waste flakes.

Three non-shouldered and 1 shouldered lanceolate projectile points collected at CA-SON-19 were included in the present study.

CA-SON-20

This site was situated on the south bank of Santa Rosa Creek to the southeast of Rincon Valley, Sonoma County (Map 4, #2). CA-SON-20 was recorded by Jesse Peter during the first decades of this century and later revisited by M. Baldrica and B. Wickstrom (1978), who described the site as a large scatter of abundant obsidian flakes and less common chert flakes. The site, situated in a vineyard, covered an area of approximately 31,500 square meters and had an undetermined depth.

Baldrica (1978) recommended measures designed to evaluate the research potential of CA-SON-20 due to proposed development of the parcel containing the site. A site test and evaluation was completed by J. F. Hayes and D. A. Fredrickson (1979). It was found that two loci were present that artifact types and obsidian hydration data suggested were temporally distinct.

Wickstrom and Fredrickson (1982) reported on the findings of data recovery investigations completed due to anticipated adverse impacts shown by project plans. The presence of two temporally distinct loci was further supported by a larger artifact inventory and a suite of over 100 obsidian hydration measurements. CA-SON-20's locus "A" appeared to be more recent while locus "B" appeared more ancient.

Nine projectile points from CA-SON-20 were included in this study. Among the nine were 1 corner-notched, 1 shouldered lanceolate, 3 single-shouldered lanceolate, and 4 wide-stemmed forms.

CA-SON-84

This site was situated in northeast Bennett Valley on the north bank of Spring Creek where it flows from the adjacent hills (Map 4, #8). This site was another in the series of Sonoma County sites recorded by Jesse Peter early this century. At L. L. Loud's suggestion, Peter and a group of high school students excavated at CA-SON-84 in 1921. The site was found to be approximately 1 meter in depth, to cover 1500 square meters, and to contain obsidian tools and waste flakes, marine shell, bone, ash, and charcoal in a midden matrix (Peter 1921). In 1972, R. King and S.

King visited CA-SON-84 and found it not only "heavily potted" but also in an area where the possibility of destruction was high.

T. Origer and D. Fredrickson (1977a) revisited the site while conducting an archaeological survey for a proposed housing development and made recommendations for site protection. Subsequently, J. Adams and D. A. Fredrickson (1978) completed impact mitigation investigations at specific loci where project design called for unavoidable site disturbance. Although the dominant class of artifact recovered and described by Adams and Fredrickson consisted of the ubiquitous obsidian waste flake, several projectile points were recovered.

CA-SON-84 yielded six projectile points analyzed in this study including 1 serrated arrow tip, 3 shouldered lanceolate forms, and 2 large non-shouldered lanceolate specimens.

CA-SON-159

This site was situated at the intersection of State Highway 116 and Stoney Point Road on the north bank of Gossage Creek at the southwestern edge of the Santa Rosa Plain, Sonoma County (Map 4, #25). Some documentation exists that suggests N. C. Nelson visited CA-SON-159 in 1910; however, formal site recording was not undertaken until 1948 when F. Riddell recorded the site. Riddell's (1948) site record form indicated that CA-SON-159 covered approximately 700 square meters with a "considerable cultural deposit" at least 1.2 meters deep. F. Fenenga (1949) visited the site and noted human bone on the soil surface.

During the 1970s, J. Bennyhoff directed students from Sonoma State University field method classes in the partial excavation of the site. Several house floors were encountered as were numerous obsidian and chert tools and waste flakes, marine shell, and bone.

A total of 43 projectile points including 17 corner-notched arrow tips, 2 notchless forms, 13 serrated, 4 non-shouldered and 6 shouldered lanceolates, and 1 concave base were analyzed in this study.

CA-SON-358

This site was situated on the south bank of a tributary to Santa Rosa Creek in Oakmont, Sonoma County (Map 4, #3). The earliest site description was dated 1950 when CA-SON-358 was recorded by F. Fenenga and A. Pilling. The site appeared to have midden soils with obsidian projectile points, scrapers, and waste flakes, as well as basalt core tools, scattered over an area of 7400 square meters. Later, T. King, R. King, and R. Hughes (1972) revisited the site and reported that it had sustained heavy damage during housing construction. Subsequently, R. Edwards of Cabrillo College directed investigations, the results of which were reported by T. King and R. King (1973a).

Five projectile points including 1 notchless form, 1 non-shouldered and 1 shouldered lanceolates, and 2 concave base forms were analyzed in this study.

CA-SON-445

This site was situated approximately 3.2 kilometers south of Cotati at the intersection of Jewett and Stoney Point roads, Sonoma County (Map 4, #27). The site was recorded by T. King (1965) and described as a midden that probably had graves since rumor suggested that human bone had been exposed in the railroad cut. The areal extent and depth were not reported, nor was a description of site indicators provided.

One serrated arrow point was analyzed in the present study.

CA-SON-455

This site was situated along Petaluma Hill Road approximately 4.8 kilometers south of Santa Rosa, Sonoma County (Map 4, #14). The site was discovered during the 1960s and partially excavated by D. A. Fredrickson in 1968 when road widening threatened to destroy the western edge of the deposit. The site area investigated by Fredrickson was marked by well developed midden which contained a large number of shellfish fragments, obsidian and chert tools and waste flakes, charcoal, bone, and intact features. The site's maximum depth in the area investigated was approximately 0.9 meters. An informal examination of the site by N. Bailey (1976) revealed that it contained a series of midden deposits about which were scattered approximately 2 dozen boulders with cupules and possible small bedrock mortars.

Fifty projectile points from CA-SON-455 were included in the present study. Point forms included 34 corner-notched arrow tips, 10 notchless, 4 serrated, and 1 shouldered and 1 non-shouldered lanceolates. One charred wood sample from probable structural remains was radiocarbon dated and associated obsidian flakes were analyzed. The radiocarbon date and associated hydration measurements are included in this study.

CA-SON-456

This site was situated on the Santa Rosa Plain south of Highway 12 between Santa Rosa and Sebastopol, Sonoma County, and lay on the south bank of a seasonal creek that flowed west into the Laguna de Santa Rosa (Map 4, #15). This site, first recorded by W. Upson (1969) was described as a large midden with two loci covering over 1900 square meters. A 1977 visit by Sonoma State archaeological field surveyors revealed that a third locus was present on the north bank of the seasonal creek, across from the loci recorded by Upson in 1969 (Origer and Fredrickson 1977). CA-SON-456 was marked by well developed midden containing marine shell, bone and obsidian and chert tools and waste flakes.

Archaeological investigations were carried out during the years 1969-72 by Santa Rosa Junior College students supervised by Upson. Excavations revealed a rich deposit with a wide range of materials.

CA-SON-456 contributed 109 projectile points analyzed in the present study including 26 corner-notched, 9 notchless, 41 serrated, 1 large side/corner-notched, 18 shouldered and 11 non-shouldered lanceolates, 2 convex stemmed, and 1 concave base specimens.

CA-SON-466

This site was situated on the north bank of the same seasonal creek as CA-SON-456 (Map 4, #16). When recorded in 1970 by W. Upson, the site was described as covering approximately 2800 square meters. Subsequent site testing revealed a deposit over 1.2 meters deep which contained abundant marine shellfish remains, obsidian tools and waste flakes, and some chert specimens. When revisited in 1977 by Sonoma State University archaeological field surveyors, the site appeared essentially unchanged since Upson's first recording (Origer and Fredrickson 1977).

One shouldered and 1 non-shouldered lanceolate specimens were recovered at CA-SON-466 and included in the present study.

CA-SON-518

This site was situated on the north bank of Gossage Creek near the intersection of Stoney Point Road and State Highway 116 between Sebastopol and Cotati, Sonoma County (Map 4, #26). CA-SON-518 was discovered and recorded by T. King and R. King (1973b) while surveying for archaeological resources within a Sonoma County Water Agency channel improvement right-of-way. Subsequent excavation reported by W. Upson (1973) revealed that CA-SON-518 was approximately 0.7 meters deep and marked by well developed midden with abundant marine shell, chert and obsidian tools and waste flakes, and features covering an area of approximately 900 square meters.

No projectile points recovered during investigations at CA-SON-518 were available for hydration analysis; however, obsidian flakes associated with a radiocarbon dated structure were included in this study.

CA-SON-655

This site was situated approximately 4.8 kilometers south of Sebastopol on the north bank of Blucher Creek near its headwaters, Sonoma County (Map 4, #21). First recorded by T. Origer and C. Weichel (1970), it was described as a midden covering an area of approximately 4500 square meters with an unknown depth. The deposit was marked by obsidian tools, numerous waste flakes, and rare marine shell. The adjacent Blucher Creek, following rainstorms, commonly yielded a large number of artifacts usually manufactured from obsidian, although chert tools and basalt mortar and pestle fragments were also present.

CA-SON-655 contributed 53 projectile points to the present study including 10 corner-notched, 1 notchless, 4 serrated, 2 large side/corner-notched, 21 shouldered and 8 non-shouldered lanceolates, 1 diamond shape, and 5 concave base specimens.

CA-SON-671

This site was situated in the western portion of Annadel State Park, northeast of Bennett Valley, Santa Rosa, Sonoma County (Map 4, #7). Little information was available that described the site's condition when first discovered by Sonoma State University archaeological field surveyors R. King and S. King (1972b). Reinspection of CA-SON-671 by B. Parkman and J. Hood (1981) resulted in more detailed site information. Parkman and Hood described the site as covering over 2400 square meters with an undetermined depth. The site soils appeared midden-like and surface artifacts included obsidian tools and obsidian and chert waste flakes.

Two projectile points, 1 serrated and 1 large side/corner-notched, were analyzed and included in this study.

CA-SON-674

This site was situated within the western portion of Annadel State Park at a point approximately 0.5 kilometers northeast of Lake Ilsanjo (Map 4, #4). CA-SON-674 was first recorded by R. King and S. King (1972c) and was apparently marked by a scatter of obsidian tools and waste flakes distributed over an undetermined area.

One non-shouldered lanceolate point recovered from CA-SON-674's surface was included in the present study.

CA-SON-677

This site was situated on the east side of Sonoma Mountain Road approximately 5.3 kilometers from its intersection with Old Adobe Road, Sonoma County (Map 4, #28). The site was first recorded by J. Allen and C. Stewart (1972) and described as a midden covering approximately 1200 square meters. The midden deposit was marked by a range of artifacts including projectile points, groundstone, obsidian and chert waste flakes, and occasional marine shell.

Two serrated arrow points were analyzed and included in this study.

CA-SON-678

This site was situated in south-central Annadel State Park, Sonoma County (Map 4, #6). CA-SON-678 was first recorded in 1972 by R. King and S. King and revisited in 1981 by B. Parkman. The site was described as covering 3200 square meters, with a scatter of obsidian and chalcedony, and localized midden soil.

Five projectile points including 3 corner-notched, 1 notchless, and 1 serrated forms were included in this study.

CA-SON-704

This site was situated in Annadel State Park in a low saddle slightly east of Lake Ilsanjo (Map 4, #5), and was apparently first recorded by R. King and S. King (ca. 1972e). Little descriptive information was available from the site record.

The site yielded 3 projectile points analyzed in this study including 1 corner-notched, 1 non-shouldered lanceolate, and 1 large side/corner-notched specimens.

CA-SON-744

This site was situated on the south bank of Matanzas Creek near Melbrook Way, Santa Rosa, Sonoma County (Map 4, #13). The site was recorded by T. Origer and C. Weichel (1975) and described as a possible midden deposit with occasional marine shell fragments, more abundant obsidian tools, and waste flakes. The site covered an area of approximately 450 square meters of former prune orchard and discing had disturbed the upper portion of the deposit.

Two projectile points, 1 corner-notched and 1 serrated arrow point, were included in this study.

CA-SON-966

This site was situated on the north bank of Porter Creek at the intersection of Porter Creek Road and Franz Valley Road, north-northeast of Santa Rosa, Sonoma County (Map 4, #11). When originally recorded in 1974 by G. Berg and T. King, the site covered 1600 square meters and was marked by obsidian tools and waste flakes. A. Huberland revisited the site in 1981 and noted that chert artifacts were also present.

One corner-notched projectile point was analyzed and included in this study.

CA-SON-977

This site was situated on the south bank of Colgan Creek slightly east of its confluence with the Laguna de Santa Rosa approximately 4.5 kilometers southeast of Sebastopol, Sonoma County (Map 4, #22). CA-SON-977 was discovered and recorded in 1977 by Sonoma State University archaeological field survey crews while conducting environmental work for a proposed wastewater facility (Origer and Fredrickson 1977b). This site (and 3 others) was tested, evaluated, and subjected to data recovery investigations prior to construction of the proposed wastewater facility (Origer and Fredrickson 1980).

CA-SON-977 covered approximately 3600 square meters, was marked by obsidian and chert tools and waste flakes, and reached a maximum depth of 0.6 meters of non-midden deposit.

Projectile points at the site were rare; however, one fragment of a serrated arrow tip was included in this study.

CA-SON-978

This site was situated on the east shore of the Laguna de Santa Rosa approximately 4.8 kilometers southeast of Sebastopol, Sonoma County (Map 4, #23). CA-SON-978 was discovered and recorded in 1977 by Sonoma State University archaeological field surveyors while conducting environmental work for a proposed wastewater facility (Origer and Fredrickson 1977b). Subsequent to its discovery, the site was tested, evaluated, and subjected to a data recovery program completed before the wastewater facility was constructed (Origer and Fredrickson 1980).

CA-SON-978 was marked by midden covering approximately 4500 square meters. The site's maximum depth was 1.6 meters. Archaeological materials at the site included obsidian, chert, and basalt tools and waste flakes; groundstone tools and ornaments; bone and marine shell; and baked clay/fire-cracked rock features.

One baked clay/fire-cracked rock feature with associated obsidian yielded a radiocarbon date which was included in this study.

CA-SON-979

This site was situated on the east shore of the Laguna de Santa Rosa approximately 4.8 kilometers southeast of Sebastopol, Sonoma County (Map 4, #24). CA-SON-979 was discovered and recorded in 1977 by Sonoma State University archaeological field surveyors while conducting environmental work for a proposed wastewater facility (Origer and Fredrickson 1977b). Subsequent to its discovery, the site was tested, evaluated, and subjected to a data recovery program completed before the wastewater facility was constructed (Origer and Fredrickson 1980).

CA-SON-979 was large, with midden covering well in excess of 20,000 square meters. The site deposit attained a maximum depth of 1.25 meters and contained a wide range of archaeological materials including obsidian, chert, and basalt tools and waste flakes; groundstone tools and ornaments; occasional burned bone and marine shell; and several features of baked clay/fire-cracked rock.

Projectile points included in this study consisted of 3 large side/corner-notched and 2 concave base specimens.

CA-SON-1048

This site was situated on the west bank of the Laguna de Santa Rosa where Occidental Road crosses the Laguna approximately 3.2 kilometers north of Sebastopol, Sonoma County (Map 4, #17). The site was discovered and described by R. Stradford and D. Fredrickson (1977) and subsequently tested and evaluated by R. Jackson and D. Fredrickson (1979). The site covered approximately 7800 square meters with a maximum depth of 1.0 meter. The site's midden deposit was marked by marine shell, bone, obsidian and chert tools and waste flakes, and groundstone tool fragments. One human grave was recorded.

CA-SON-1048 yielded 5 projectile points analyzed in this study. Point forms included 1 corner-notched, 1 serrated, 1 diamond shaped, and 2 concave base specimens.

CA-SON-1049

This site was situated on the west bank of the Laguna de Santa Rosa near the intersection of High School and Occidental roads approximately 3.2 kilometers north of Sebastopol, Sonoma County (Map 4, #18). CA-SON-1049 was recorded and described by R. Stradford and D. Fredrickson (1977) and subsequently tested and evaluated by R. Jackson and D. Fredrickson (1979). The investigated portion of the site covered approximately 600 square meters with a maximum depth of 0.7 meters. CA-SON-1049's midden soils contained moderate quantities of obsidian flakes and more rarely obsidian tools, marine shell, and bone.

Two projectile point fragments analyzed in the present study were recovered at CA-SON-1049. Point forms included 1 non-shouldered lanceolate, and 1 concave base fragment.

CA-SON-1082

This site was situated on the west side of "D" Street at the Petaluma city limits, Sonoma County (Map 4, #30). The site was first recorded by R. Orlins (1977) during archaeological survey for a proposed county road project. The site, covering approximately 6500 square meters, was marked by midden containing marine shell, bone, obsidian and chert tools and waste flakes, basalt tools, and fire-cracked rock. Subsequently, J. Hayes and D. Fredrickson (1981) tested areas within CA-SON-1082 where road widening was anticipated.

Two serrated projectile points from CA-SON-1082 were included in this study.

CA-SON-1195

This site was situated on the north bank of a small seasonal creek near the intersection of State Highway 116 and Covert Lane, Sebastopol, Sonoma County (Map 4, #19). This site was recorded and described by J. Quinn

(1979) as a midden with marine shell, bone, chert and obsidian waste flakes, and fire-cracked rock. The site covered approximately 1600 square meters. Proposed development of the parcel containing the archaeological site instigated data retrieval at those locations where project design would produce unavoidable site alteration.

Eight projectile points from CA-SON-1195 were analyzed for this study. Point forms included 3 corner-notched, 1 serrated, 3 shouldered lanceolates, and 1 specimen categorized as wide-stemmed.

CA-SON-1262

This site was situated slightly west of the intersection of Bodega Highway and Sexton Road, west of Sebastopol, Sonoma County (Map 4, #20). The site was discovered and described by G. White and P. Mikkelsen (1980) as a scatter of obsidian tools and obsidian and chert flakes. The site covered approximately 240 square meters of a gravel beach along a tributary to Atascadero Creek.

CA-SON-1262 yielded 1 concave base projectile point analyzed in this study.

CA-SON-1269

This site was situated on the north bank of Santa Rosa Creek in southern Rincon Valley, Santa Rosa, Sonoma County (Map 4, #10). It was first recorded and described by N. Carpenter (1980) as a moderate to dense scatter of obsidian tools and waste flakes at several discrete loci distributed over several acres of contiguous parcels. Proposed development on one such neighboring parcel (Roscoe 1980) called for unavoidable site disturbance and planned utility trenches. Data retrieval investigations were reported by J. Roscoe (1981).

CA-SON-1269 contributed 6 corner-notched, 2 notchless, 29 serrated, and 1 Gunther-like specimen and a radiocarbon date with associated obsidian specimens.

CA-SON-1281

This site was situated on the east bank of Adobe Creek within the Petaluma Adobe State Historic Monument located east of Petaluma, Sonoma County (Map 4, #29). The site was discovered and recorded by P. Amaroli (1980) at which time it was noted that it was in jeopardy due to creek bank erosion.

In the summer of 1982, Amaroli salvaged a cremation partially exposed in the creek bank. The feature included human remains, abundant charcoal, and grave goods all of which were overlain with a stone cairn.

The feature provided a radiocarbon date with associated obsidian specimens analyzed and included in this study.

CA-SON-1343

This site was situated approximately 0.6 kilometers northwest of the intersection of Airway Drive and Hopper Lane in northwest Santa Rosa, Sonoma County (Map 4, #12). The site was discovered and recorded by T. Origer (1981a) and described as marked by a hammerstone and obsidian tools and waste flakes in a midden matrix. The site covered an area of approximately 1600 square meters. Since development of the parcel containing the site was proposed, a program of site testing and evaluation was completed. Origer (1981b) described the findings of the investigation. It was found that CA-SON-1343 was 1.3 meters deep and contained, in addition to previously listed materials, fire-cracked rock, burned bone, stone cores, and occasional mortar fragments.

Four projectile points from CA-SON-1343 were analyzed for this study including 1 large side/corner-notched, 1 shouldered and 1 non-shouldered lanceolates, and 1 diamond-shaped specimens.

Chapter 4

PROJECTILE POINTS AND RADIOCARBON DATES

Classification of the projectile point assemblage analyzed in this study was based on traditional procedures in which the study specimens were examined and sorted, according to morphological attributes, into already-established categories believed to have possible temporal significance. It was beyond the scope of this project to develop a projectile point typology. Rather, the purpose of this research was to identify and segregate what have been termed "historical-index" types (Steward 1954), to measure their hydration band thicknesses, and to determine whether relationships exist between the observed hydration band development and the temporal assignment of such projectile points.

For the most part, the analyzed projectile points were easily segregated into relatively homogenous morphological groups based on a few distinctive attributes. A total of 511 artifacts, postulated to have functioned as projectile points, were sorted into 12 categories several of which were believed to be temporally significant. Others exhibit temporal ambiguity and are included to illustrate the variety of forms that occur in the study area. Since some categories have morphological characteristics that are similar to other categories, all analyzed specimens are illustrated (Appendix A). Pertinent metrical data are included in Appendix A. More formal typologies are possible and certainly other worthwhile analyses can be undertaken.

A high degree of correspondence between traditional temporal placement of time sensitive projectile points and dating generated by hydration band measurements should prove useful for temporal seriation of the entire assemblage of study specimens.

The specimens analyzed for this study represent a very large sample of available projectile points. In many instances the sample represents virtually all catalogued specimens for a given form that occurred in the core study area. Fragmented specimens that could not be confidently assigned to a category were not analyzed. Specimens from satellite areas were included based on availability and/or selection from a table of random numbers.

The study specimens were drawn from several collections including those of the Anthropological Studies Center at Sonoma State University, the Santa Rosa Junior College, the Treganza Museum at San Francisco State University, and private individuals.

Table 3 summarizes projectile point frequencies by type and site.

Projectile Points

Corner-notched. The blade element of corner-notched specimens is triangular usually with straight edges, although early forms are suspected of having some serrations. In cross-section they are lenticular and dorso-ventrally compressed. The basal portion in most instances is marked by distinctive corner-notches, an expanding stem, and, frequently, barbs. Corner-notched points served as arrow tips and were typically quite small. Illustrations and metrical data for 145 corner-notched forms included in this study are provided in Appendix A. Table 4 summarizes metrical data for complete corner-notched points.

Table 4. Summary of Metrical Data for Corner-Notched Projectile Points (n=33). Measurements in millimeters/grams.

	Length	Width	Thickness	Weight
maximum	49.3	18.4	6.1	3.1
minimum	17.5	10.7	2.2	0.6
mean	29.5	14.8	3.9	1.3
standard deviation	7.1	2.0	0.7	0.5

This projectile point form is abundant in the study area and surrounding region. White (1979:178) in Stewart and Fredrickson (1979) described morphologically similar forms as the "Rattlesnake Corner Notch," an appellation derived from Rattlesnake Island in Clear Lake where Harrington (1948) first published a description of this point type. Soule (1975) found this point form at CA-MEN-584 and called it the "Rose Spring Corner-notched." Other researchers have described this point in Marin County (Beardsley 1954), in Napa County (Heizer 1953), in Mendocino County (Meighan 1955), and in Sonoma County (Origer and Fredrickson 1980).

Corner-notched points are believed to be diagnostic of Phase II of the Augustine Pattern dated to the latter portion of the Emergent Period, ca. A.D. 1500 to the historic period.

Notchless. This point form is usually triangular in outline with a base ranging from flat to convex. In cross-section it is lenticular and quite thin. Plates included in Appendix A illustrate the specimens assigned to this class of point. Notchless specimens are small which suggest they functioned as arrow tips. It is possible that these specimens represent a stage in the manufacture of corner-notched or serrated points and are unfinished. As such, they could be preforms at a stage just prior to the addition of notches and/or serrations.

Metrical data for 28 notchless specimens included in this study are provided in Appendix A and summarized in Table 5. Note that only completed specimens contributed attribute measurements summarized in Table 5.

Table 3. Summary of Projectile Point Frequencies by Type and Site

Location	Corner-notched	Notchless	Serrated	Gunther-like	Large Side/ Corner-notched	Shouldered Lanceolate	Single-shouldered Lanceolate	Non-shouldered Lanceolate	Diamond Lanceolate	Convex Stemmed	Concave Base	Wide-Stemmed	TOTAL
Hector Lee Coll.	--	--	--	--	2	18	--	19	1	--	8	1	49
CA-SON-Isolates	--	--	--	--	--	--	--	--	--	--	3	2	5
Jess Rupel Coll.	--	--	--	--	--	4	--	--	--	--	2	2	8
CA-SON-19	--	--	--	--	--	1	--	3	--	--	--	--	4
CA-SON-20	1	--	--	--	--	1	3	--	--	--	--	4	9
CA-SON-84	--	--	1	--	--	3	--	2	--	--	--	--	6
CA-SON-159	17	2	13	--	--	6	--	4	--	--	1	--	43
CA-SON-358	--	1	--	--	--	1	--	1	--	--	2	--	5
CA-SON-445	--	--	1	--	--	--	--	--	--	--	--	--	1
CA-SON-455	34	10	4	--	--	1	--	1	--	--	--	--	50
CA-SON-456	25	9	41	--	1	18	--	11	--	2	1	--	109
CA-SON-465	--	--	--	--	--	1	--	1	--	--	--	--	2
CA-SON-655	10	1	4	--	2	21	--	8	1	--	5	--	52
CA-SON-671	--	--	1	--	1	--	--	--	--	--	--	--	2
CA-SON-674	--	--	--	--	--	--	--	1	--	--	--	--	1
CA-SON-677	--	--	2	--	--	--	--	--	--	--	--	--	2
CA-SON-678	3	1	1	--	--	--	--	--	--	--	--	--	5
CA-SON-704	1	--	--	--	1	--	--	1	--	--	--	--	3
CA-SON-744	1	--	1	--	--	--	--	--	--	--	--	--	2
CA-SON-966	1	--	--	--	--	--	--	--	--	--	--	--	1
CA-SON-977	--	--	1	--	--	--	--	--	--	--	--	--	1
CA-SON-979	--	--	--	--	3	--	--	--	--	--	2	--	5
CA-SON-1048	1	--	1	--	--	--	--	--	--	--	2	--	4
CA-SON-1049	--	--	--	--	--	--	--	1	--	--	1	--	2
CA-SON-1082	--	--	2	--	--	--	--	--	--	--	--	--	2
CA-SON-1195	3	-	1	--	--	3	--	--	--	--	--	1	8
CA-SON-1262	--	--	--	--	--	--	--	--	--	--	1	--	1
CA-SON-1269	6	2	29	1	--	--	--	--	--	--	--	--	38
CA-SON-1343	--	--	--	--	1	1	--	1	1	--	--	--	4
CA-NAP-376	10	2	18	--	--	--	--	--	--	--	--	--	30
CA-MRN-27	--	--	--	--	--	4	--	1	--	--	--	--	5
CA-MRN-192	--	--	--	--	--	--	--	--	--	--	1	--	1
CA-MRN-202	10	--	10	--	--	--	--	--	--	--	--	--	20
CA-MRN-216	--	--	--	--	--	--	--	--	--	--	--	1	1
CA-MRN-230	12	--	1	--	--	--	--	--	--	--	--	--	13
CA-MRN-396	9	--	6	--	--	--	--	--	--	--	2	--	17
TOTAL	145	28	138	1	11	83	3	55	3	2	31	11	511

Table 5. Summary of Metrical Data for Notchless Projectile Projectile Points (n=9). Measurements in millimeters/grams.

	Length	Width	Thickness	Weight
maximum	51.4	23.9	7.7	7.8
minimum	27.7	13.6	3.2	1.2
mean	36.7	19.8	5.3	3.4
standard deviation	8.0	3.0	1.4	1.8

This class of artifact, while not abundant, has been reported in Contra Costa County (Fredrickson 1968:64) and in Sonoma County (Origer and Fredrickson 1980:177; Roscoe 1981:30). The largest number of specimens included in this study were recovered at sites CA-SON-159, CA-SON-455, and CA-SON-456 situated on the Santa Rosa Plain within the Laguna de Santa Rosa watershed. Specimens of this type were first reported along the Laguna de Santa Rosa at CA-SON-980 by Origer and Fredrickson (1980: 177). During the field investigation of CA-SON-980 and three other sites, this point form was informally given the binomial "Laguna Notchless," a name favored by this researcher.

The temporal placement of notchless arrow points has been only scantily dealt with in the literature. Fredrickson (1968) found in Contra Costa County that his Type 4 points (notchless forms) stratigraphically co-occurred with Type 1 points diagnostic of Phase II of the Emergent Period's Augustine Pattern. Association of notchless and corner-notched points was reported by Origer and Fredrickson (1980) in Sonoma County. The data suggest that notchless points date between ca. A.D. 1500 to the proto-historic period.

Serrated. Specimens assigned to this class are marked by major diagnostic elements which include relatively small size and serrations along the blade element. Serrations may be square, rounded, or pointed and may occur nearest the base or along the entire blade edge. The basal portion varies, with some specimens marked by straight parallel stem edges and others by expanding stems that result in corner or side notches. In cross-section, serrated specimens are lenticular, yet overall slightly thicker than corner-notched points which results in a slightly "chunkier" feel. Plates provided in Appendix A illustrate the serrated specimens.

Serrated specimens served as arrow tips as suggested by their relatively small size. Metrical data for 140 specimens included in this study are listed in Appendix A and summarized in Table 6. Note that only complete specimens contributed attribute measurements summarized in Table 6.

Serrated points are common in the core study area and surrounding region. Their distribution about the core study area, however, is asymmetrical with few to the north and many to the south and east. Serrated points have been described and illustrated in Contra Costa County (Fredrickson

Table 6. Summary of Metrical Data for Serrated Projectile Points (n=26). Measurements in millimeters/grams.

	Length	Width	Thickness	Weight
maximum	47.3	19.5	6.0	3.4
minimum	21.4	10.8	2.4	0.8
mean	32.7	13.8	4.4	1.5
standard deviation	7.0	2.8	0.8	0.6

1968), Napa County (Heizer 1953), coastal and interior Marin County (Beardsley 1954; Slaymaker 1979), and Sonoma County (Roscoe 1981).

Serrated arrow points assigned to this class are diagnostic of Phase I of the Augustine Pattern dated to the earlier portion of the Emergent Period (Fredrickson 1973).

Gunther-like. A single asymmetrical specimen that resembled points of the Gunther series was included in this study. Gunther series points are very rare in the study area with the largest nearby assemblage found at Warm Springs in northern Sonoma County.

The Gunther-like point included in this study is slightly damaged, yet complete enough to demonstrate its rare shape (Appendix A). The asymmetrical blade is convex on one edge while the other edge is slightly concave. The hafting element contracts and the basal termination of the blade suggests the presence of poorly developed barbs. The light weight of the specimen, 0.9 grams, suggests its function as an arrow tip (Appendix A).

If this specimen is an arrow tip then temporal assignment is during the Emergent Period.

Large Side/Corner-notched. Points assigned to this category are not abundant in the study area, however, to the north they have been identified with fairly high frequency. White (1979:178 *et seq.*) described a number of corner-notched specimens from the Round Valley area, Mendocino County. Based on neck width, maximum hafting width, and haft length, White (1979:180) isolated a distinctive point form named the "Round Valley corner-notched."

Closer to the present study area, Baumhoff (1982) described the "Willits Side-notched" at Warm Springs in northern Sonoma County. Specimen 70-356-3093 (should read 70-556-3093) illustrated by Baumhoff (1982:Figure 8 "e") is very similar to specimens included in the present study.

A total of 11 specimens included in this study are classified as large side/corner-notched point forms. All but one specimen were made of Annadel obsidian. The remaining specimen was made from Napa Glass Mountain obsidian. Generally, these specimens are quite large and probably served as dart tips. Metrical data and illustrations are provided in

Although many of the specimens were fragmentary, weights ranged from 2.2 to 11.3 grams with a mean of 6.0 grams--generally too heavy for arrow points.

Temporal placement is somewhat ambiguous largely due to the scarcity of this form in the study area. Baumhoff (1982:17), however, found at Warm Springs that these point forms occurred in pre-Excelsior phases, dated earlier then 500 B.C. Baumhoff (1982:18) concluded "The dating appears early--perhaps before 1000 B.C., but how much earlier they go is not possible to say."

Shouldered Lanceolate. Shouldered lanceolates, in keeping with their name, are lanceolate projectile points with shoulders.

> The defining characteristics of the Excelsior point are a triangular, straight-edged body and a convex base, which is frequently ogival in outline; that is, it resembles a pointed arch. A frequent but necessary attribute of the Excelsior series point is the presence of a definite shoulder at the junction of the body and the base (Fredrickson 1973:199).

This artifact form is very common within the study area and surrounding region. Fredrickson (1973) completed analysis of materials recovered at site CA-LAK-261 in Lake County and recognized shouldered lanceolates as a morphologically distinct type. Fredrickson named this form the "Excelsior" after the valley in which CA-LAK-261 was situated.

Shouldered lanceolates apparently served as tips for spears and darts since they generally are far too heavy to haft on arrow shafts. Metrical data for the form is included in Appendix A and summarized in Table 7.

Table 7. Metrical Data for Shouldered Lanceolate Projectile Points (n=43). Measurements in millimeters/grams.

	Length	Width	Thickness	Weight
maximum	87.2	31.8	12.1	22.3
minimum	32.7	17.1	6.0	3.2
mean	56.9	22.3	8.8	9.2
standard deviation	12.9	3.8	1.4	4.6

Fredrickson (1973:199 et seq.) found at CA-LAK-261 that they were introduced during the later portion of the Lower Archaic Period. Large numbers of this form were present during the Upper Archaic Period. This point form continued into the proto-historic period, but was marked by lesser numbers and a reduction in size (Fredrickson 1973:200,248).

A total of 83 shouldered lanceolate points were included in this study and are illustrated in Appendix A.

Single-shouldered Lanceolate. Specimens assigned to this point category are similar to the other lanceolates except that a single shoulder is present. Few of them occur either within the study area or within the surrounding region. Kaufman (1980:Plate 3, #6375) illustrated a specimen from the Mostin Site in Lake County near Kelseyville. Hydration seriation of 18 projectile points from the Mostin Site placed the single shouldered lanceolate specimen as the earliest type (Kaufman 1980:165). Kaufman (1980:165) reported hydration measurements of 7.3 (OHL 6375) and 7.4 microns (OHL 6379). Kaufman's sample size, however, was small and secure temporal placement of this point form is lacking, especially for the present study area.

A total of 3 single-shouldered lanceolate specimens was included in this study and illustrated in Appendix A. Metrical data are given in Appendix A.

Non-Shouldered Lanceolate. Specimens assigned to this point category are included in Fredrickson's (1973) Excelsior series, however, obvious shoulders at the junction of the body and the base are absent. These lanceolate points are often bi-pointed, and in some instances, the base is rounded.

Non-shouldered lanceolate points are quite common throughout the study area and have been reported by a number of researchers (e.g., Beardsley 1954:Type N2,N4a; Chavez 1976:Plate IV,O; Heizer 1953:Figure 7,m-p; King and Upson 1970:Figure 2,d-e; King 1970:Figure 1,d; Origer and Fredrickson 1980:Figure 18,a-b; Slaymaker 1979:Figure 26, 114-509).

Non-shouldered lanceolate points apparently span a relatively long period of time. As in the case of shouldered lanceolate points, Fredrickson (1973:248) suggested that they persisted up to the proto-historic period while undergoing reduction in size. Fredrickson (1973:227, Figure 18) suggested that bipointed "willow-leaf" (non-shouldered) specimens could have origins slightly preceding the shouldered lanceolate form.

A total of 55 non-shouldered lanceolate specimens was included in this study. Specimens included here are illustrated in Appendix A. Metrical data for complete specimens are given in Appendix A and are summarized in Table 8. The summary table includes only those measurements derived from complete specimens.

Table 8. Metrical Data for Non-Shouldered Lanceolate Projectile Points (n=32). Measurements in millimeters/grams.

	Length	Width	Thickness	Weight
maximum	122.1	39.2	17.8	70.2
minimum	41.1	15.6	6.3	2.9
mean	66.0	22.7	10.0	15.8
standard deviation	20.6	5.6	3.0	15.2

Diamond Lanceolate. Specimens assigned to this category generally are rare, yet they are found over a relatively large area. Heizer's (1953: Figure 7 "s") Type 18 from Napa Valley appears to be the same form. Points of this type are diamond-shaped in outline. The blade element is short, constituting approximately one-half or less of the total length, and the edges are straight to slightly convex. The base, separated from the blade by a distinct shoulder, contracts with straight edges and is blunt.

Three specimens with respective weights of 2.7, 4.2, and 6.4 grams are included in this study. The relatively heavy weights suggest use as dart tips for at least two of these specimens. Complete metrical information is given and the specimens illustrated in Appendix A.

Temporal placement of this point form is not secure; however, it is probable that such specimens predate the arrow and could be contemporaneous with shouldered lanceolates, which they resemble slightly.

Convex Stemmed. This point form is very rare in the study area and was observed within but a single site assemblage. Specimens included in this study were marked by relatively broad, convex bases that were as long as they were wide. The blade element is obviously wider than the basal element. Specimens included in this study are illustrated in Appendix A.

Two specimens of this point form were included in this study. Measurements from these specimens are provided in Appendix A. The overall large size of this point form suggests its use as dart tips since complete specimens would exceed weight tolerances of arrow tips.

This point form has not been described in the literature of the project area, and thus, temporal assignment is not known. Its size, however, suggested a possible pre-arrow chronological placement.

Concave Base. Specimens assigned to this category were marked by a single common attribute--a concave base. Concave base points exhibit a variety of shapes that may have temporal and geographical significance (cf. White, Jones, Roscoe, and Weigel, 1982). Specimens included in this study are quite variable with respect to overall form; however, an attribute that many specimens hold in common appears to be "reworking." Specimens included in this study are illustrated in Appendix A.

Concave base points are relatively common in the study area and occur at a number of sites, but usually in small numbers. White, Jones, Roscoe, and Weigel examined and analyzed 125 concave specimens housed at the University of California, Berkeley; San Francisco State University; Sonoma State University; and the Mendocino County Museum. The frequency of this point form increased to the north. Only 3 specimens were from Marin County, while Napa and Sonoma counties contained 22 and 26, respectively. Lake and Mendocino counties yielded the highest frequencies at 38 and 36 specimens, respectively. Unfortunately for hydration studies, 47 of the 125 specimens were made from chert, however, chert specimens were infrequent within the present study area.

Heizer (1953:262) suggested that concave base points could date to the late period (cf. Figure 7,f-g). Meighan (1953:316) suggested that concave base points with flutes from CA-NAP-131 could date to quite early periods coeval with the Borax Lake site in Lake County. Fredrickson (1973:221) suggested that nonfluted concave base points date to later portions of the Lower Archaic Period.

Table 9. Summary of Metrical Data for Concave Base Projectile Points (n=18). Measurements in millimeters/grams.

	Length	Width	Thickness	Weight
maximum	64.9	33.5	10.0	15.1
minimum	31.6	16.7	6.3	4.5
mean	45.2	26.1	8.3	8.7
standard deviation	9.4	5.1	1.3	3.2

A total of 21 concave base points was included in this study. Metrical daar povided in Appendix A and are summarized in Table 9.

Wide-stemmed. This point form is rare within the study area; however, to the north it occurs with higher frequency. Two wide-stemmed point forms have been named. The first recognized was called the Borax Lake point which was recovered in appreciable numbers at the Borax Lake site and described by Harrington (1948). This point form was described by Harrington (1948:81) as follows:

> This is the type of dart-point characterized by a relatively long, broad, straight stem, medium to broad shoulders (often barbed), and a rather short blade with straight or slightly convex sides. One or both sides of the stem may show thinning flakes, and the base, usually square, may be concave. Occasionally the edges of the stem are ground smooth.

A second wide-stemmed form, the Houx Widestem, was recognized by White, Jones, Roscoe, and Weigel (1982).

The Borax Lake wide-stemmed and the Houx wide-stemmed represent relatively ancient point forms. Baumhoff (1982:a.17) summarized temporal placement of these forms as follows:

Borax Lake wide-stemmed	6000 to 4000 B.C.
Houx wide-stemmed	4000 to 1000 B.C.

A total of 11 specimens were assigned to this point category in this study. It should be noted that specimens in this study are morphologically unlike Borax Lake or Houx wide-stemmed specimens. The specimens are illustrated and metrical data are provided in Appendix A.

As can be seen, the illustrated study specimens assigned to this category have shapes that are quite variable. Rarely do these specimens fit descriptions given above for the Borax Lake or Houx wide-stemmed points. The temporal placement of this study's "wide-stemmed" projectile points is problematical. Although the literature suggests early dates, such antiquity is found only for wide-stems to the north.

Radiocarbon Dates

Radiocarbon dates and associated obsidian data sets applicable to hydration rate determination for this study were few in number. Annadel data sets totalled 6, while Napa Glass Mountain data sets totalled 5. Coastal and extreme interior radiocarbon/hydration data sets were excluded in order to control the hydration-affecting variable, temperature.

Table 10 lists relevant information concerning radiocarbon dates.

CA-MRN-27. The radiocarbon date from this site was obtained from charcoal in a mass cremation (Burial 3). Burial 3 extended over several 1 x 2 meter units at a depth of 80-100 cm and included seven individuals with males and females and adults and children represented (King 1970:15). Associated artifacts included beads, whistles, pendants, a charmstone, several projectile points, and a pestle. Hydration specimens appeared to have direct association with Burial 3.

The charcoal sample yielded a radiocarbon date of 1980 ± 95 years before present (I-3148). A second radiocarbon date of 2320 ± 190 (I-3149) from Burial 38 lacked associated items. The radiocarbon dates and artifact assemblage support temporal assignment of CA-MRN-27 to the Archaic Period.

CA-SON-455. The radiocarbon date from this site was obtained from wood charcoal that overlay a housefloor and appeared to represent structural debris. The feature extended over several 1 x 2 meter units at a depth of approximately 30-45 cm. Hydration specimens were taken from Unit F23 at a depth of 30-45 cm. and, while physically mixed with the structure remains, the association is considered stratigraphic.

Table 10. Summary of Radiocarbon Data.

Site	Feature	Depth	Material	Lab #	C14 Date	Calendar Date *
CA-MRN-27	cremation	80-100 cm	charcoal	I-3148	1980 ± 95 BP	AD 48
CA-SON-455	structure	30-45 cm	charcoal	Beta-4190	110 ± 40 BP	AD 1710
CA-SON-518	structure	20-40 cm	charcoal	UCLA-1794C	115 ± 45 BP	AD 1810
CA-SON-1269	hearth	40-60 cm	charcoal	UGA-4083	580 ± 170 BP	AD 1349
CA-SON-1281	cremation	40-120 cm	charcoal	Beta-5459	680 ± 50 BP	AD 1260
CA-SON-978	cooking area	55-65 cm	carbonaceous soil	Beta-5500	2360 ± 60 BP	490 BC

* calibrated following Ralph and Michael (1970); and Damon, Ferguson, Long, and Wallick (1974)

The charcoal sample yielded a radiocarbon date of 110 ± 40 (Beta-4190). The radiocarbon date and artifact assemblage, which was dominated by corner-notched projectile points and clam disc beads, support a Phase II date assigned to the Late Emergent Period.

CA-SON-518. The radiocarbon date from this site was obtained from wood charcoal that overlay a housefloor and appeared to represent structural debris (Upson 1973). The feature extended over several 1 x 2 meter units at a depth of 20-40 cm. Artifacts apparently associated with this feature included knives, clam disc beads and blanks, olivella beads, bird bone tubes, steatite beads, abalone discs, bead grinding slab, groundstone, corner-notched projectile points, and trade beads. Obsidian flakes subjected to hydration analysis were physically mixed with the structure remains; however, the association is considered stratigraphic.

The charcoal sample yielded a radiocarbon date of 115 ± 45 (UCLA-1794C). The radiocarbon date and artifact assemblage (i.e., clam disc beads, trade beads, and corner-notched projectile points) support a Phase II date assigned to the Late Emergent Period.

CA-SON-978. The radiocarbon date from this site was obtained from carbon-rich clods of baked clay, an element of several features found in this and other nearby sites. Feature 1 at CA-SON-978 extended over a minimum of 18 one meter square units at a depth of 45-70 cm. A single obsidian specimen was directly associated with this feature (Origer and Fredrickson 1980).

The sample yielded a radiocarbon date of 2360 ± 60 (Beta-5500). The artifact assemblage from this site suggests two major occupations; the earliest assigned to the Middle Archaic Period Berkeley Pattern which dated approximately 1000 to 2500 years ago and the latest assigned to Phase I of the Emergent Period approximately 500 to 1000 years ago. The radiocarbon date is compatible with dates for the Middle Archaic Period.

CA-SON-1269. The radiocarbon date from this site was obtained from charcoal and "fired earth" from Feature 2 that contained fire-fractured rock (Roscoe 1981). The feature was discovered in Trench 12 at a depth of 40-60 cm and appeared to be a fire hearth. Obsidian specimens subjected to hydration analysis were drawn from the Trench 12 level bags and are considered to have stratigraphic association.

The sample yielded a radiocarbon date of 580 ± 170 (UGA-4083). The abundance of serrated arrow points (n=37) suggested occupation during Phase I of the Emergent Period -- temporally compatible with the radiocarbon date. The presence of a limited number of non-serrated corner-notched arrow points and a single Type A1 clam disc bead suggested that CA-SON-1269's occupation could have been late in Phase I extending into early Phase II, ca. 280 to 680 years ago according to Scheme B1 (Bennyhoff and Hughes, 1983).

CA-SON-1281. The radiocarbon date from this site was obtained from wood charcoal in a cremation pit. The cremation pit appeared isolated and was not directly associated with other cultural materials. Since the feature was isolated and the cremation pit well defined, the recovered obsidian specimens were in direct association.

The sample yielded a radiocarbon date of 680 ± 50 (Beta-5459). The presence of serrated arrow points in the assemblage suggested a Phase I Emergent Period date. The radiocarbon date and archaeological estimate were compatible.

Chapter 5

RESULTS AND DISCUSSION

The research goals as stated in Chapter 1 are to explore, through hydration band analysis:

1) the possibility of determining hydration measurement ranges for chronological periods and their representative cultural patterns, vis-a-vis, hydration measurement ranges for diagnostic projectile points;

2) the absolute dating of archaeological phenomena based on hydration measurements;

3) the assignment of projectile points that are not temporally secure or attributed to cultural patterns.

To accomplish these goals this discussion must first answer the following questions :

a) Is the seriation of projectile points by hydration measurements in accord with the temporal series described by previous research discussed in Chapter 4?

b) In a series of radiocarbon dates with associated obsidian specimens, do the hydration measurements exhibit incremental thickness correlated to the radiocarbon age?

c) Does a coastal environment marked by generally cooler annual temperatures have a rate of hydration disimilar to that from a warmer interior location?

d) Do surface and subsurface recovered specimens have disparate hydration measurements?

e) What is the difference, if any, between the Annadel and Napa Glass Mountain rate of hydration?

These questions served to guide the design and execution of research described in this thesis.

Positive answers to the first two questions are fundamental to this research since a basic premise of obsidian hydration analysis is that the thickness of hydration on any given specimen is largely a function of time. Recently manufactured obsidian specimens should be marked by thinner hydration bands than those items originated during more ancient periods. Negative answers to questions a and b would render moot the applicability of questions c, d, and e, assuming the execution of the research design was adequate.

Studies by Origer (1982) and Origer and Wickstrom (1982) revealed that hydration measurements can be used successfully to seriate obsidian materials in the present study area. Further support of hydration based seriation of materials was found by Meighan, Foote, and Aiello (1968: 1074) in West Mexico and by Michels (1965) at the Mammoth Junction Site in California's southern Sierra Nevada mountains.

Based on information presented in Chapter 4, the archaeological evidence indicated a projectile point sequence as follows:

Corner-notched (non-serrated)	most recent
Serrated arrow points	
Shouldered Lanceolates	
Concave base	more ancient

The above sequence includes only those point types that are represented by relatively large numbers of specimens and that are fairly secure in their temporal placement.

Mean hydration measurements, taken from Table 12 which summarizes hydration data in Appendix B, suggest seriation of the 5 point types as listed on Table 11.

Table 11. Hydration Measurement Band Seriation of Selected Projectile Points.

Point Form	Annadel	Napa	
Corner-notched	1.3 microns	1.5 microns	most recent
Serrated	1.6 "	2.1 "	
Shouldered Lanceolate	2.6 "	2.8 "	
Concave Base	2.8 "	3.4 "	most ancient

The two sequences place each point type in identical chronological order. Hydration bands thicken with age for Annadel and Napa Glass Mountain obsidians. The answer to question a is <u>yes</u>. Seriation of projectile points by hydration measurements yielded a temporal sequence which duplicates that developed based on other lines of archaeological evidence.

Table 12. Summary of Obsidian Hydration Measurements for Projectile Points.

Point Form	Number*	Range	Mean	Standard Deviation
Corner-notched				
Annadel	90/80	0.9-2.2	1.3	0.26
Napa	55/50	1.0-2.2	1.5	0.30
Notchless				
Annadel	20/18	1.0-1.8	1.4	0.24
Napa	8/ 7	1.4-3.4	1.9	0.69
Serrated				
Annadel	86/79	1.2-2.2	1.6	0.24
Napa	52/48	1.5-2.7	2.1	0.29
Gunther-like				
Napa	1/ 1	-------	2.2	----
Large Side/ Corner-notched				
Annadel	10/9	1.2-2.8	2.0	0.51
Napa	1/1	-------	1.9	----
Shouldered Lanceolate				
Annadel	43/40	1.5-4.8	2.6	0.67
Napa	40/38	1.3-3.8	2.8	0.53
Single-shouldered Lanceolate				
Annadel	2/2	3.0-5.9	4.5	----
Napa	1/1	-------	3.1	----
Non-shouldered Lanceolate				
Annadel	34/30	1.4-4.2	2.6	0.71
Napa	21/19	2.3-4.5	3.5	0.62
Diamond Lanceolate				
Napa	3/3	2.7-4.8	3.8	1.06
Convex Stemmed				
Annadel	1/1	-------	4.0	----
Napa	1/1	-------	2.7	----
Concave Base				
Annadel	12/ 6	2.1-3.6	2.8	0.50
Napa	19/13	2.3-5.0	3.4	0.75
Wide-stemmed				
Annadel	8/5	1.4-3.8	2.8	0.90
Napa	3/3	6.2-6.9	6.5	0.29

* total number specimens/specimens retained following Long and Rippeteau (1974)

A second strategy designed to test the phenomenon of hydration growth with increased age is implicit in question b. Table 13, which summarizes data contained in Appendix B, shows six radiocarbon dates spanning a range of approximately 2300 years. The hydration data in each instance showed that as the radiocarbon age increased so did the thickness of hydration bands on associated obsidian specimens. Answers to questions a and b were positive and questions c, d, and e are now relevent.

The effect of temperature on the hydration process has been documented. Cooler temperatures inhibit hydration development, while warmer temperatures stimulate growth of hydration bands. Table 14 shows mean hydration values for selected point forms. In all instances the coastal specimens were marked by hydration measurements which ranged from 0.1 to 0.3 microns smaller than their interior counterparts. These differences statistically are not reflective of separate populations; however, the overall consistency of the data could support climatic information which indicates that the coastal zone is cooler than the interior. The climate of the coastal zone may be sufficiently cooler than the interior to retard the hydration process. Additional research could lead to refinement of the obsidian hydration dating method.

Table 14. Comparison of Hydration Measurement Data from Coastal and Interior Locations (number/mean in microns).

Corner-notched	Annadel	Napa
Coastal	17/1.2	12/1.4
Interior	62/1.3	39/1.6
Serrated		
Coastal	10/1.5	6/1.8
Interior	69/1.7	42/2.1

Since Layton (1973) found that differential hydration development occurred on surface finds in comparison to excavated materials, the present data were examined to determine whether such results might be obtained for this geographical area. Layton found, in an environment of extreme temperatures (especially great heat), that surface specimens had hydration bands up to twice as thick as their subsurface counterparts.

The largest body of surface and subsurface specimens is found with the corner-notched and serrated point forms. Table 15 shows mean hydration values for these point forms.

Table 13. Summary of Radiocarbon Associated Hydration Measurements.

Radiocarbon Date	Number*	Range	Mean	Standard Deviation
UCLA-1794C (A.D. 1810)				
Annadel	11/10	0.8-1.1	1.0	0.10
Napa	7/ 6	1.1-1.3	1.2	0.09
Beta-4190 (A.D. 1710)				
Annadel	11/10	1.0-1.4	1.2	0.13
Napa	10/ 9	1.1-1.5	1.4	0.13
UGA-4083 (A.D. 1350)				
Annadel	10/10	1.6-2.3	1.9	0.22
Napa	10/10	1.7-2.4	2.1	0.22
Beta-5459 (A.D. 1260)				
Annadel	7/3	1.9-2.0	2.0	0.05
Napa	6/5	2.2-2.5	2.3	0.12
I-3148 (50 B.C.)				
Annadel	1/1	-------	3.3	----
Napa	6/6	3.3-4.0	3.6	0.26
Beta-5500 (490 B.C.)				
Annadel	1/1	-------	3.4	----

* total number specimens/specimens retained following Long and Rippeteau (1974)

Table 15. Comparison of Hydration Measurement Data from Surface and Subsurface Locations (number/mean in microns).

Corner-notched	Annadel	Napa
Surface	13/1.2	15/1.5
Subsurface	45/1.4	22/1.6
Serrated		
Surface	13/1.6	19/2.1
Subsurface	51/1.7	22/2.1

Origer and Wickstrom (1982) tested a small number of corner-notched and serrated points from interior locations. They found that surface corner-notched specimens (n=4) exhibited a hydration mean of 1.3 microns identical to subsurface corner-notched specimens (n=8). Surface serrated points (n=9) had a mean of 1.6 microns compared to a subsurface serrated point (n=11) mean of 1.7 mcirons. Origer and Wickstrom concluded that:

> The environment of the Great Basin is sufficiently dissimilar to that of the Santa Rosa Plain so that our results were not identical to Layton's (1973). The arid soils of the Great Basin are generally shallow, pavemented, and support widely dispersed bushes and some grasses with bare spots between patches of vegetation. Archaeological specimens laying on the ground surface were not insulated from solar radiation and when subjected to direct sunlight were described by Layton as too hot to hold in one's hand. In contrast, the soils of our study area are deep, often churned by a variety of disturbing agents (i.e., gophers, worms, erosion, and discing), and generally support grasses, forbs, and occasional scattered trees that serve to insulate archaeological specimens from intense solar radiation. It is suggested that exposure to extreme temperatures of the Great Basin influenced the hydration rate in Layton's study (1973) while the temperatures of the Santa Rosa Plain had much less effect since archaeological specimens were usually insulated from less intensive solar radiation (1982:129-130).

Although Origer and Wickstrom analyzed a small sample of 34 specimens, the results were identical to those obtained through analysis of 206 specimens in the present research.

The data suggest that hydration analysis of obsidian materials can be successful, whether surface or subsurface specimens are available. Additional research into soil and ground cover conditions that may affect hydration rates is warranted.

Annadel obisidan is chemically (and in many instances, visually) distinct from Napa Glass Mountain materials (see Appendix C). This implies that differential hydration rates may exist, all other factors being equal.

Origer and Fredrickson (1980) examined source specific hydration data for several sites in Sonoma County and found that Napa Glass Mountain specimens were marked by thicker hydration bands than were Annadel. Two explanations were offered: Napa Glass Mountain obsidian could hydrate more rapidly than Annadel; and Napa Glass Mountain obsidians could have been preferred during earlier periods. Origer and Fredrickson (1980:94) concluded that Napa Glass Mountain was preferred during earlier periods.

Further research into the topic of differential inter-source hydration rates was reported by Origer (1981). Support was found for early period preference of Napa Glass mountain obsidians. In addition, data were generated that supported the position that Napa Glass Mountain obsidian hydrated more rapidly than Annadel (Origer 1981:49 et seq.). The data suggested that the ratio of Annadel to Napa Glass Mountain was on the order of 1:1.15.

The hydration measurements reported in this thesis constitute an excellent body of data to refine the differential rate ratio for Annadel and Napa Glass Mountain obsidians.

Table 16 presents mean source specific hydration measurements for projectile point forms and radiocarbon dates. Point forms and radiocarbon dates with small numbers of specimens were not included. The hydration measurement ratios ranged from 1:1.05 to 1:1.36 with a mean of 1:1.20. This value is quite close to the 1:1.15 ratio reported by Origer (1981: 50). The data are in agreement and indicate that Napa Glass Mountain obsidian does develop hydration at a rate exceeding that of Annadel.

The answers to questions c, d, and e serve as a foundation for guidelines in the analysis of the data toward accomplishment of the research goals stated at the onset of this chapter.

The data show that Annadel and Napa Glass Mountain obsidians do hydrate at different rates, apparently due to differing chemical composition. It is imperative that the hydration measurements be segregated according to geologic source. Segregation of surface and subsurface and interior and coastal artifacts is not warranted statistically. Positive results were obtained for questions a and b. Projectile points can be seriated with hydration measurements and hydration bands do become thicker over time.

Given the above results, the research goals of this thesis can be addressed. The first stated goal is to determine hydration measurement ranges for chronological periods and their respective cultural patterns. This is accomplished by examination of the hydration measurement frequencies and ranges for diagnostic projectile points. Table 17 provides

Table 16. Hydration Measurement Ratios for Projectile Points and Radiocarbon Dates (means in microns).

Point Type	Annadel	Napa	Ratio
Corner-notched	1.3	1.5	1:1.15
Notchless	1.4	1.9	1:1.36
Serrated	1.6	2.1	1:1.31
Shouldered Lanceolate	2.6	2.8	1:1.08
Non-shouldered Lanceolate	2.6	3.5	1:1.35
Concave Base	2.8	3.4	1:1.21
Radiocarbon Dates			
UCLA-1794C	1.0	1.2	1:1.20
Beta-4190	1.2	1.4	1:1.17
UGA-4083	1.9	2.0	1:1.05
Beta-5459	2.0	2.3	1:1.15

frequency distributions for Annadel and Napa Glass Mountain projectile points, respectively. The mean hydration measurement for each point type is indicated by a "m" in the class interval in which it falls. Mean measurements were not plotted for point forms with small sample sizes of less than 5 specimens. In those cases where considerable overlap was found (e.g., corner-notched and serrated forms) smaller class intervals were established to refine the hydration measurement parameters.

Projectile point hydration measurement data suggests approximate period/pattern ranges as shown in Table 18.

Table 18. Hydration Measurement Ranges for Periods and Patterns of the Study Area.

	Annadel	Napa
Emergent Period/Augustine Pattern	0.9 - 2.2	0.9 - 2.7
Upper/Phase II	0.9 - 1.6	0.9 - 1.8
Lower/Phase	1.7 - 2.2	1.9 - 2.7
Archaic Period	2.3 - 6.8	2.8 - 6.9
Upper/Berkeley Pattern	2.3 - 3.2	2.8 - 3.8
Middle/Late Borax Lake Pattern	3.3 - 4.6	3.9 - 4.9
Lower/Early Borax Lake Pattern	4.7 - 6.8	5.0 - 6.9
Paleo-Indian Period	6.9 - ?	7.0 - ?

Table 17. Frequency Distribution of Annadel and Napa Glass Mountain Projectile Point Hydration Measurements.

Source	Corner-notched	Notchless	Serrated	Gunther-like	Large Side/ Corner-notched	Shouldered Lanceolate	Single-shouldered Lanceolate	Non-shouldered Lanceolate	Diamond Lanceolate	Convex Stemmed	Concave Base	Wide-Stemmed
Annadel												
0.9 - 1.2 microns	34	6	4	--	1	--	--	--	--	--	--	--
1.3 - 1.6	40	9	38	--	2	1	--	2	--	--	--	1
1.7 - 2.0	4	3	31	--	2	7	--	6	--	--	--	--
2.1 - 2.4	2	--	6	--	1	11	--	5	--	--	2	1
2.5 - 2.8	--	--	--	--	3	12	--	4	--	--	2	--
2.9 - 3.2	--	--	--	--	--	6	1	6	--	--	1	--
3.3 - 3.6	--	--	--	--	--	--	--	6	--	--	1	2
3.7 - 4.0	--	--	--	--	--	1	--	--	--	1	--	1
4.1 - 4.4	--	--	--	--	--	1	--	1	--	--	--	--
4.5 - 4.8	--	--	--	--	--	1	--	--	--	--	1*	--
4.9 - 5.2	--	--	--	--	--	--	1	--	--	--	--	--
5.3 - 5.6	--	--	--	--	--	--	--	--	--	--	--	--
5.7 - 6.0	--	--	--	--	--	--	--	--	--	--	--	--
6.1 - 6.4	--	--	--	--	--	--	--	--	--	--	--	--
6.5 - 6.8	--	--	--	--	--	--	--	--	--	--	--	1*
6.9 - 7.2	--	--	--	--	--	--	--	--	--	--	--	--
Napa Glass Mountain												
0.9 - 1.2 microns	13	--	--	--	--	--	--	--	--	--	--	--
1.3 - 1.6	17	4	6	--	--	1	--	--	--	--	--	--
1.7 - 2.0	17	1	17	--	1	1	--	--	--	--	--	--
2.1 - 2.4	3	1	20	1	--	10	--	1	--	--	2	--
2.5 - 2.8	--	--	5	--	--	7	--	3	1**	1	2	--
2.9 - 3.2	--	--	--	--	--	10	1	2	--	--	2	--
3.3 - 3.6	--	1	--	--	--	6	--	3	--	--	3	--
3.7 - 4.0	--	--	--	--	--	3	--	7	1	--	1	--
4.1 - 4.4	--	--	--	--	--	--	--	2	1**	--	2	--
4.5 - 4.8	--	--	--	--	--	--	--	1	1	--	--	--
4.9 - 5.2	--	--	--	--	--	--	--	--	--	--	1	--
5.3 - 5.6	--	--	--	--	--	--	--	--	--	--	--	--
5.7 - 6.0	--	--	--	--	--	--	--	--	--	--	--	--
6.1 - 6.4	--	--	--	--	--	--	--	--	--	--	--	2
6.5 - 6.8	--	--	--	--	--	--	--	--	--	--	--	--
6.9 - 7.2	--	--	--	--	--	--	--	--	--	--	--	1

* specimen included here to increase sample size--not included in calculation of mean
** measurements from same reworked specimen

Ranges indicated for the Middle and Lower Archaic Periods are tentative due to the small number of projectile points that may be diagnostic of the appropriate patterns. It may be possible to refine these hydration ranges by including data from the following portion of this chapter which focuses on determination of hydration rates.

A large number of radiocarbon dates have been published for sites within the study area and surrounding environs. Unfortunately, obsidian associations with the majority of radiocarbon dates are dubious or some other factor reduces the utility of such associations in hydration rate determinations.

Clark (1961) calculated hydration rates for central California obsidian. Two major problems exist with Clark's research. First, radiocarbon/obsidian data sets cannot be assumed to meet current research requirements since in at least one instance, the radiocarbon sample "...was less than 20 feet..." from the obsidian specimen (Clark 1961:87), actually, an excessive distance. The second problem with Clark's research concerns the source(s) of his obsidian specimens. At the time of Clark's research, differential hydration rates for different obsidian sources were unknown. None of Clark's obsidian specimens were sourced. Since Case Diablo, Napa Glass Mountain, Annadel, Bodie Hills, and other sources (Jackson 1974) could have been in Clark's sample, his data are not suitable for current research.

Ericson (1977) completed a comprehensive obsidian study for California and amassed a large number of radiocarbon/obsidian hydration associations. Obsidian source determinations were completed.

Ericson (1977:47 et seq.) reported six radiocarbon/obsidian hydration associations for the Annadel source and 23 for the Napa Glass Mountain source. Many of Ericson's (1977:352) Annadel source radiocarbon dates have a small number of obsidian specimens that are stated to be in direct or stratigraphic association, yet the data sets appear anomalous (e.g., 2.5 microns to 570 years before present, and 2.7 microns to 3150 years before present).

Napa Glass Mountain hydration/radiocarbon data sets as reported by Ericson were confusing. Radiocarbon sample M-123 was listed at two places in his Appendix 3B with two single obsidian source hydration data sets rather thank one (cf. Ericson 1977:49, 367, and 368). Radiocarbon samples UCLA 1891 B appears to be another example of this same situation. It is not clear why Ericson subdivided his hydration measurements for three radiocarbon dates.

Further complications arise when taking Ericson's (1977) data at face value. Ericson's principle criterion of association was that the obsidian specimens be obtained from site unit-levels which yielded radiocarbon dates. However, the associations between radiocarbon samples and hydration measurements are described as either stratigraphic, direct, or "loose." Definition of his three types of association are lacking and inferred meanings are difficult. For example, radiocarbon dates (UCLA 1793 A-D) for non-feature midden soil charcoal were stated to be in direct association with same unit-level obsidian specimens (Ericson

1977:365 et seq.). At best these associations are stratigraphic.

Certainly Ericson, Clark, and others encountered problems in using the field notes, site collection information, and report data generated by previous researchers. Ericson (1977:38) recommended that each researcher seek out and compile his/her own data in order to insure self-satisfaction. However, complete rejection of another's data does not allow for expansion of our knowledge if individually we must "re-invent the wheel." Thus the data appear secure, the present study incorporates previous research.

Radiocarbon/hydration data sets included in this study were selected on the basis of several criteria. First, good association of the radiocarbon sample and obsidian specimens was required. Direct associations were preferred, but few in number. Stratigraphic associations were deemed appropriate provided the hydration measurements yielded relatively discrete clusters that suggested site integrity. Second, the number of associated obsidian specimens needed to be as large as possible. Generally, data sets with fewer than 3 obsidian measurements were rejected -- unless direct association of obsidian tools to features was demonstrated. Ubiquitous obsidian waste flakes found near features were considered to have fortuitous provenience and rejected in multicomponent sites. Radiocarbon dates from midden matrix charcoal were rejected. Finally, radiocarbon dates whose provenience suggested site matrix inversion were rejected, as were data with unknown provenience.

Although application of the above criteria reduced the number of available data sets, it is contended that the remaining data sets allowed for reliable hydration rate determinations.

Information provided in Tables 10 and 13 were used to calculate source-specific hydration rates. Hydration rate equations proposed by several researchers (Clark 1964; Findlow, Bennett, Ericson, and DeAtley 1975; Friedman and Smith 1960; Kimberlin 1976; Meighan, Foote, and Aiello 1968) were tested by the present author with data presented hereine, and by Ericson (1977:68) using information contained in his dissertation. Ericson concluded that the Friedman and Smith (1960) diffusion formula was the "...best physical model and a general mathematical description of the hydration process..." (Ericson 1977:68). Of the several equations tested by the present author, the Friedman and Smith diffusion formula provided the most consistent results.

The diffusion formula, as described by Friedman and Smith (1960) states:

$$T = kx^2$$

where:

x = hydration band thickness in microns
k = constant
t = time in years before present.

Calculation of "k" is a relatively simple procedure. The equation:

$$k = \Sigma\, x^2T / \Sigma\, x^3$$

(Thomas 1976:370) is used rather than Friedman and Smith's

$$k = T/x^3$$

because the regression line must past through the origin since freshly exposed obsidian surfaces lack hydration.

Table 19 shows the individual "k" values for each radiocarbon/hydration data set. Application of the Criterion of Chauvenet described by Long and Rippeteau (1974) reveals that the CA-SON-978 "k" value should be rejected. All data sets for Napa Glass Mountain data set resulted in "k" values that should be retained per the Criterion of Chauvenet.

The "k" value (slope of the regression line) for Annadel obsidian, excluding the rejected CA-SON-978 data set, was determined to be 184.6 and for Napa Glass Mountain obsidian 153.4 (Figure 1).

Table 19. Radiocarbon/Hydration Data Sets with "k" Solved for Each.

	t	x	"k"
Annadel Source			
CA-SON-518	170	1.0	170.0
CA-SON-455	270	1.2	187.5
CA-SON-1269	630	1.9	174.5
CA-SON-1281	720	2.0	180.0
CA-MRN-27	2030	3.3	186.4
CA-SON-978	3820	3.4	213.7
Napa Glass Mountain Source			
CA-SON-518	170	1.2	118.1
CA-SON-455	270	1.4	137.8
CA-SON-1269	630	2.0	157.5
CA-SON-1281	720	2.3	136.1
CA-MRN-27	2030	3.6	156.6

The source specific "k" values were used to calculate hydration dates that were compared to the radiocarbon dates (Table 20). Good agreement is seen between the hydration dates and their respective radiocarbon dates, as anticipiated since the correlation coefficient for the Annadel and Napa Glass Mountain hydration rate data sets were 0.983 and 0.985, respectively.

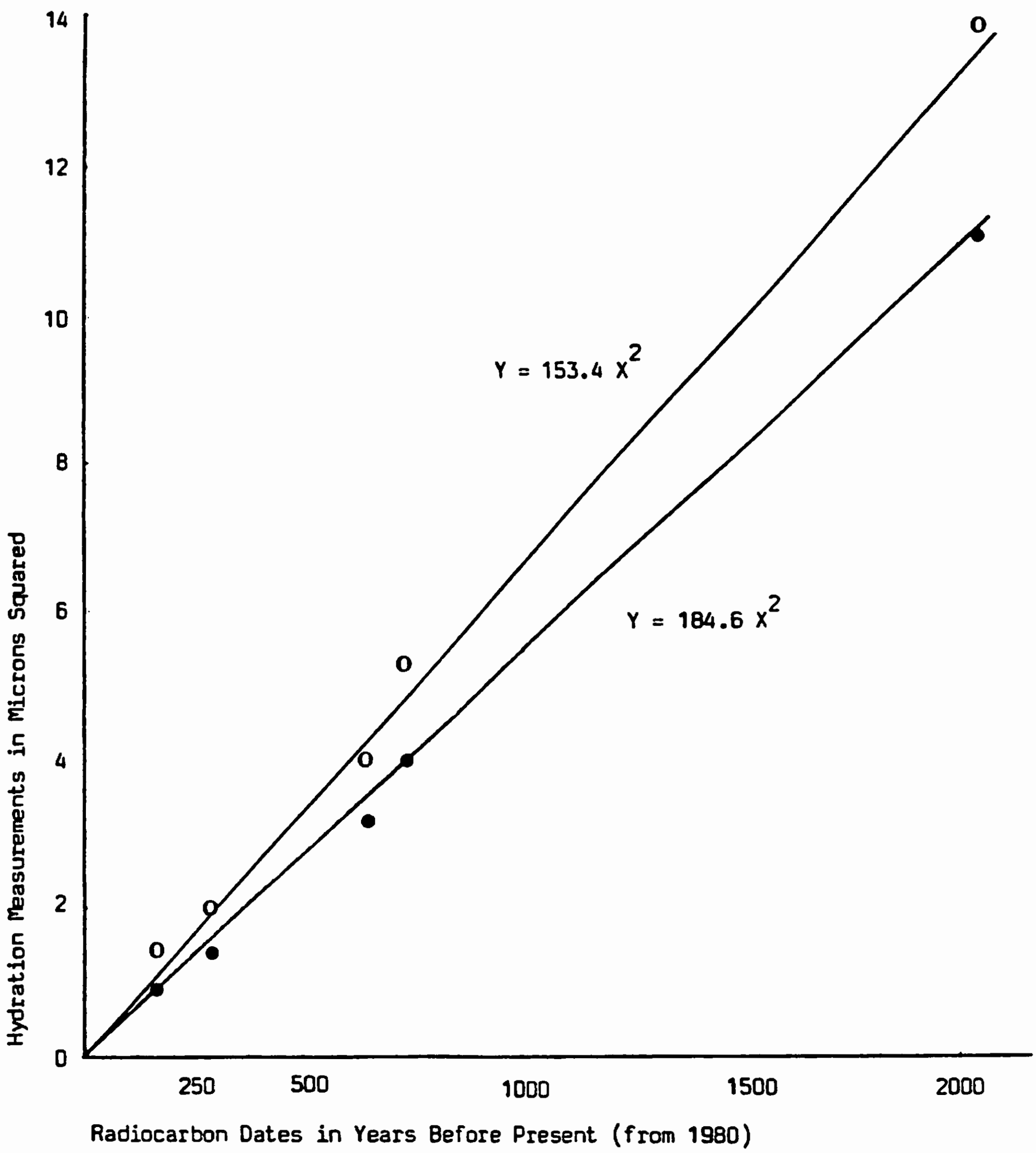

Figure 1. Scattergram of Annadel (•) and Napa Glass Mountain (o) Radiocarbon/Hydration Data Sets with Regression Lines

Table 20. Comparison of Hydration Dates to C14 Dates.

C 14 Date*	Annadel Hydration Date**	Napa Hydration Date**
170 ± 130	1.0/ 185	1.2/ 221
270 ± 130	1.2/ 266	1.4/ 301
630 ± 210	1.9/ 666	2.0/ 614
720 ± 130	2.0/ 738	2.3/ 811
2030 ± 160	3.3/2010	3.6/1988

* standard deviations according to Damon, Ferguson, Long, and Wallick (1974)

** hydration measurement/hydration date years before present using Annadel constant "k" = 184.6 and Napa Glass Mountain constant "k" = 153.4

The hydration rate constants are considered provisional and subject to refinement based on anticipated increased numbers of reliable radiocarbon/hydration data sets. Nevertheless, a test can be made of the hydration ranges proposed in preceding pages. Assuming the dates for the chronological sequence described in Chapter 1 are accurate, then calculation of hydration dates with the above constants should yield similar results -- if hydration dating works with this body of data.

Hydration measurements yield approximate dates for the chronological periods as shown in Table 21.

Table 21. Absolute Dates Calculated from Hydration Data.

Period	Annadel	Napa
Terminal Emergent	A.D. 1830	A.D. 1855
Upper-Lower interface	A.D. 1510	A.D. 1480
Terminal Archaic	A.D. 1000	A.D. 780
Upper-Middle interface	A.D. 90	235 B.C.
Middle-Lower interface	1925 B.C.	1700 B.C.
Terminal Paleo-Indian	6800 B.C.	5540 B.C.

The later period hydration dates listed in Table 21 are fairly consistent, and in good agreement with estimates recently made by Fredrickson

(1984) and as shown on Scheme B1 developed by Bennyhoff and Hughes (1983). Early period dates deviate somewhat, quite likely due to inadequate sample size and the poorly understood nature of such times since few ancient sites have been discovered and investigated.

The hydration measurement ranges proposed above for the periods of patterns, in general, appear to be appropriate. The ranges for the later periods/patterns appear most accurate, a function of greater understanding of those times. Until additional data are generated, it is proposed that the above measurement ranges stand and serve as a working model of a hydration-based chronological sequence.

Finally, the data are examined in an attempt to provide temporal placement for those projectile points (i.e., notchless, Gunther-like, large side/corner-notched, non-shouldered lanceolate, diamond lanceolate, convex stemmed, and wide-stemmed) in this study area that are temporally ambiguous. A number of factors are taken into account in this exercise. Included are: frequency, hydration range (dispersion vs. clustering), hydration mean, and their archaeological context.

Notchless forms, gennerally co-occur with later period assemblages. The hydration measurements support this contention and it appears that they should be assigned to Phase II of the Augustine Pattern dated to the Upper Emergent Period. It appears that non-serrated corner-notched and notchless projectile points marked this period.

The single Gunther-like specimen and the large side/corner-notched forms fall into the range for Phase I of the Augustine Pattern dated to the Lower Emergent Period. These specimens are coeval with the serrated corner-notched and stemmed arrow points.

The Berkeley Pattern of the Upper Archaic is dominated by shouldered lanceolate forms that persist in reduced numbers into the Emergent Period; other point forms that occur include single-shouldered lanceolates, diamond lanceolate, convex stemmed, concave base, and wide-stems, although all these forms initially appeared earlier.

The dominant Middle Archaic forms are the non-shouldered lanceolate and concave base. In addition, convex stemmed, diamond lanceolates, and several wide-stemmed variants occur.

The Lower Archaic forms are few in number and can only be tentatively assigned. The data, however, suggest that wide-stemmed forms with very broad bases and poorly developed shoulders are earliest.

Chapter 6

SUMMARY

Analysis of 591 obsidian specimens, including projectile points and items associated with 6 radiocarbon dates from an area centered on Sonoma County, California, yielded positive obsidian hydration dating results.

Statistical analysis of hydration rate data sets demonstrated a high correlation of hydration measurements with associated radiocarbon dates using the original diffusion formula described by Friedmand and Smith (1960). Seriation of projectile points based on hydration measurements was found to be in good agreement with the chronological series derived by other lines of archaeological evidence.

Since validation of hydration dating was achieved from the data, the effects of temperature and obsidian specimen exposure to surface elements (and subsurface environments) could be examined. The data suggested that, from the perspective of the hydration phenomenon, the temperature regime of the study area was relatively homogenous. Surface-collected materials also experienced development of hydration similar to that of specimens retrieved from subsurface proveniences. More research in these areas is warranted.

Provisional hydration measurement ranges were set for the temporal periods and cultural patterns recognized by previous researchers. Dominant projectile points for each period were suggested by the data.

Although generally positive results were obtained from this application of obsidian hydration analysis, it is recommended that the information be viewed critically. An increased number of good radiocarbon/hydration data sets should be sought. The sample of early period projectile points should be enlarged.

The implications of these hydration data, however, are provocative. The data suggest the capacity to refine chronological sequences, identify settlement patterns, and examine other aspects of human behavior on synchronic and diachronic levels based on hydration analysis of even the ubiquitous obsidian flake.

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TEMPORAL CONTROL IN THE SOUTHERN NORTH COAST RANGES OF CALIFORNIA: THE APPLICATION OF OBSIDIAN HYDRATION ANALYSIS

by

THOMAS MICHAEL ORIGER

October 1985

APPENDIX A

PLATES

PLATE 1

Specimen	Catalog #	Site	Hydration	Source
<u>Corner-notched</u>				
a	78-17-49	CA-SON-20a	1.0	A
b	g	CA-SON-159	nvb	A
c	h	"	2.2	N
d	i	"	1.4	N
e	72-1-8	"	2.1	N
f	72-1-21	"	1.2	N
g	72-1-107	"	1.3	A
h	72-1-130	"	1.9	N
i	72-1-135	"	1.2	A
j	72-1-136	"	1.2	A
k	72-1-168	"	1.4	A
l	74-3-15	"	1.6	N
m	74-3-120	"	1.6	N
n	74-3-133	"	2.9	N
o	74-3-227	"	1.5	A
p	75-28-174	"	1.8	A
q	75-28-198	"	1.1	A
r	75-28-244	"	1.4	A
s	F-21	CA-SON-455	1.6	A
t	-	"	1.3	A
u	1-2-5	"	1.4	A
v	1-2-8	"	1.3	A
w	1-2-13	"	1.2	A
x	1-2-14	"	1.4	A

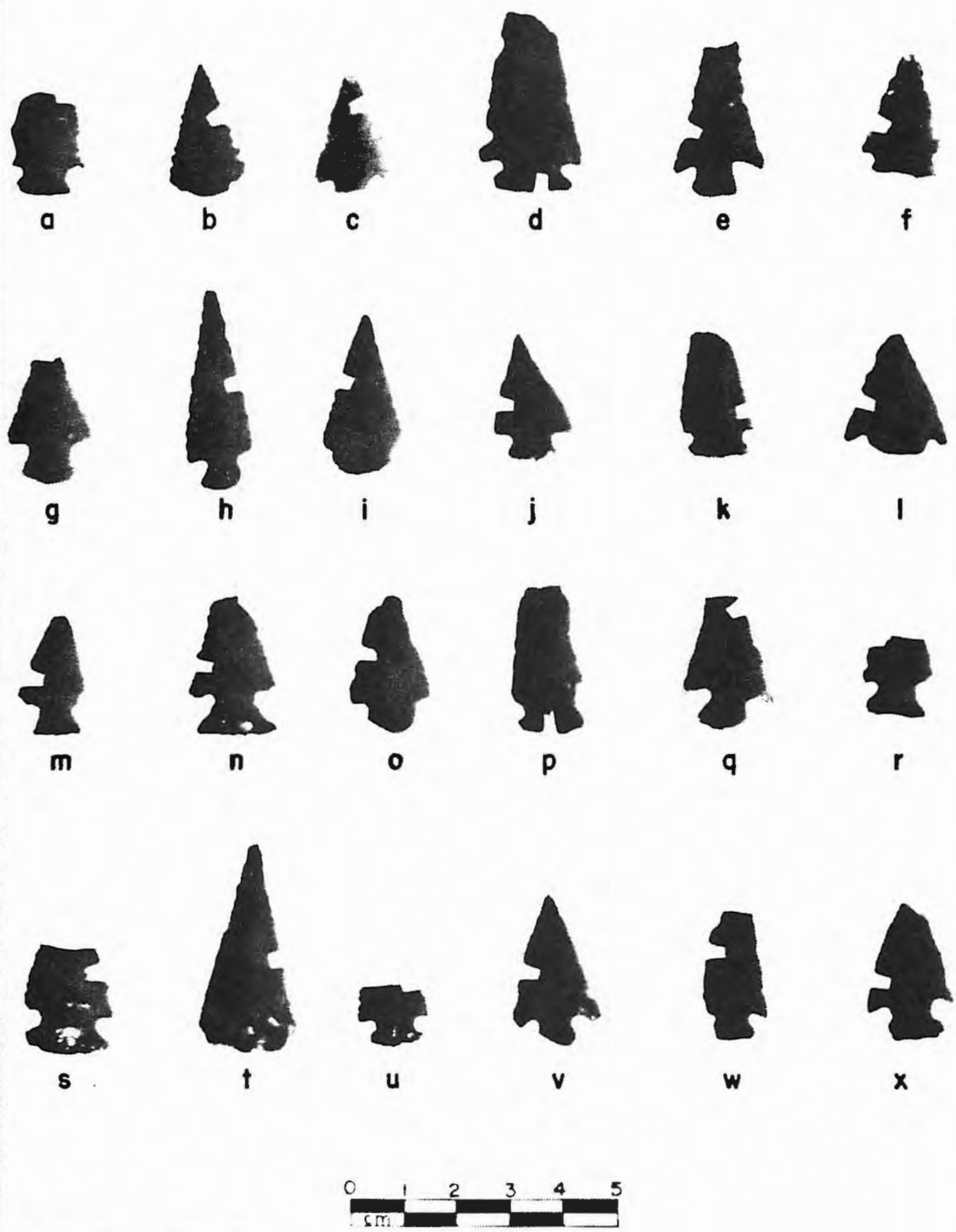

PLATE 1

PLATE 2

Specimen	Catalog #	Site	Hydration	Source
Corner-notched				
a	1-2-20	CA-SON-455	1.3	A
b	1-2-22	"	1.2	A
c	1-2-24	"	nvb	A
d	1-2-29	"	1.9	A
e	1-2-38	"	1.0	A
f	1-2-39	"	1.4	A
g	1-2-43	"	1.5	N
h	1-2-47	"	1.7	N
i	1-2-56	"	1.4	A
j	1-2-66	"	1.2	A
k	1-2-79	"	1.2	A
l	1-2-83	"	1.2	A
m	1-2-86	"	1.7	A
n	1-2-208	"	1.3	N
o	1-2-109	"	1.5	A
p	1-2-132	"	1.0	A
q	1-2-177	"	1.3	A
r	1-2-192	"	1.2	N
s	1-2-206	"	1.4	A
t	1-2-207	"	nvb	A
u	1-2-219	"	nvb	A
v	1-2-200	"	1.8	A
w	1-2-228	"	1.5	N
x	1-2-236	"	1.5	N

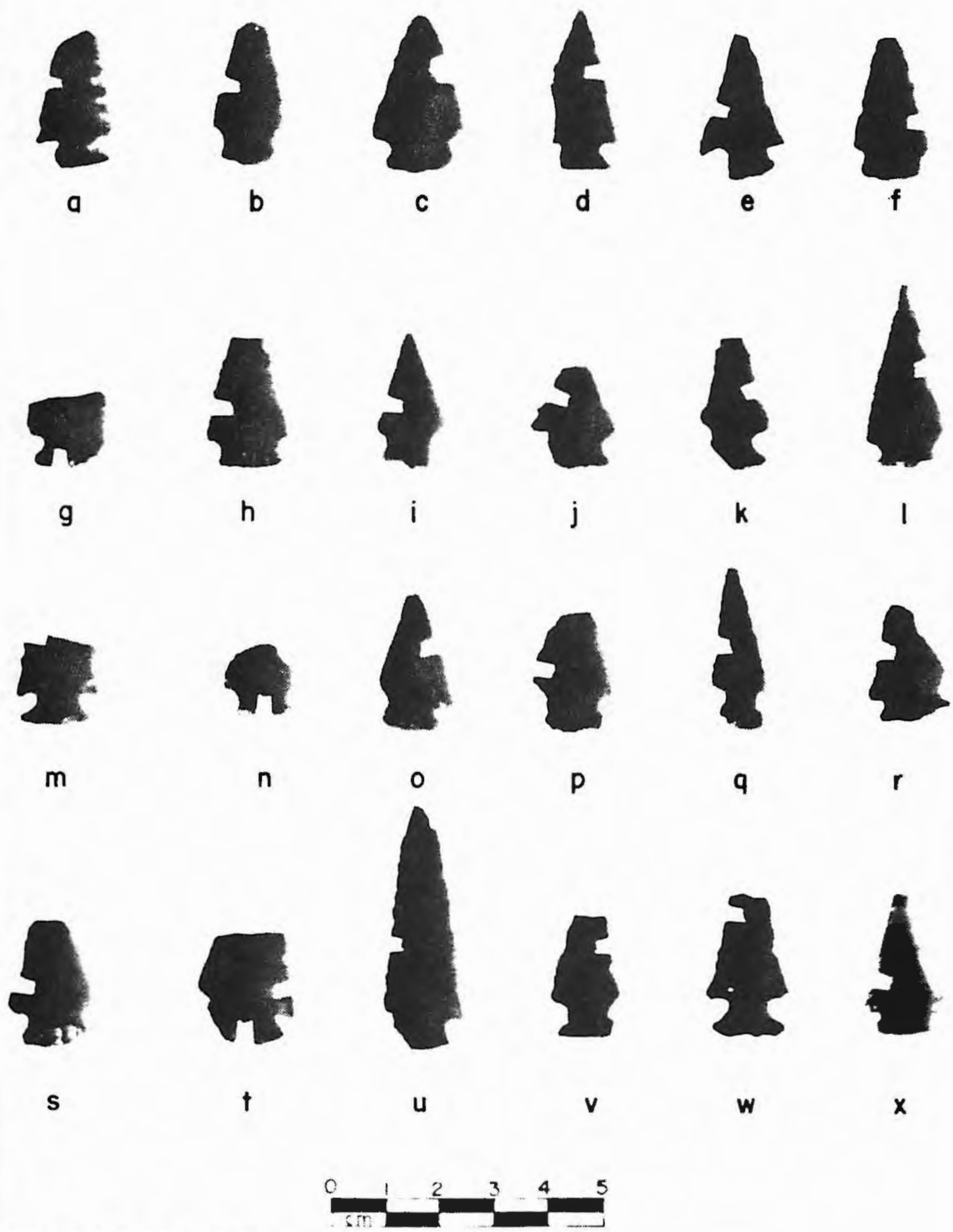

PLATE 2

PLATE 3

Specimen	Catalog #	Site	Hydration	Source
<u>Corner-notched</u>				
a	1-2-256	CA-SON-455	nvb	N
b	1-2-258	"	1.0	A
c	1-2-276	"	1.7	N
d	1-2-315	"	1.4	A
e	2056	CA-SON-456	1.5	A
f	2065	"	1.3	A
g	2142	"	1.5	N
h	2221	"	1.1	A
i	2308	"	1.4	A
j	2319	"	1.3	A
k	2358	"	1.3	A
l	2365	"	dh	A
m	2408	"	3.0	N
n	2497	"	1.2	A
o	2570	"	1.2	A
p	2617	"	1.2	A
q	2621	"	1.4	N
r	2697	"	1.3	A
s	2704	"	1.5	N
t	2728	"	nvb	N
u	2850	"	1.7	N
v	2851	"	1.0	N
w	2872	"	1.3	A
x	2956	"	1.4	N

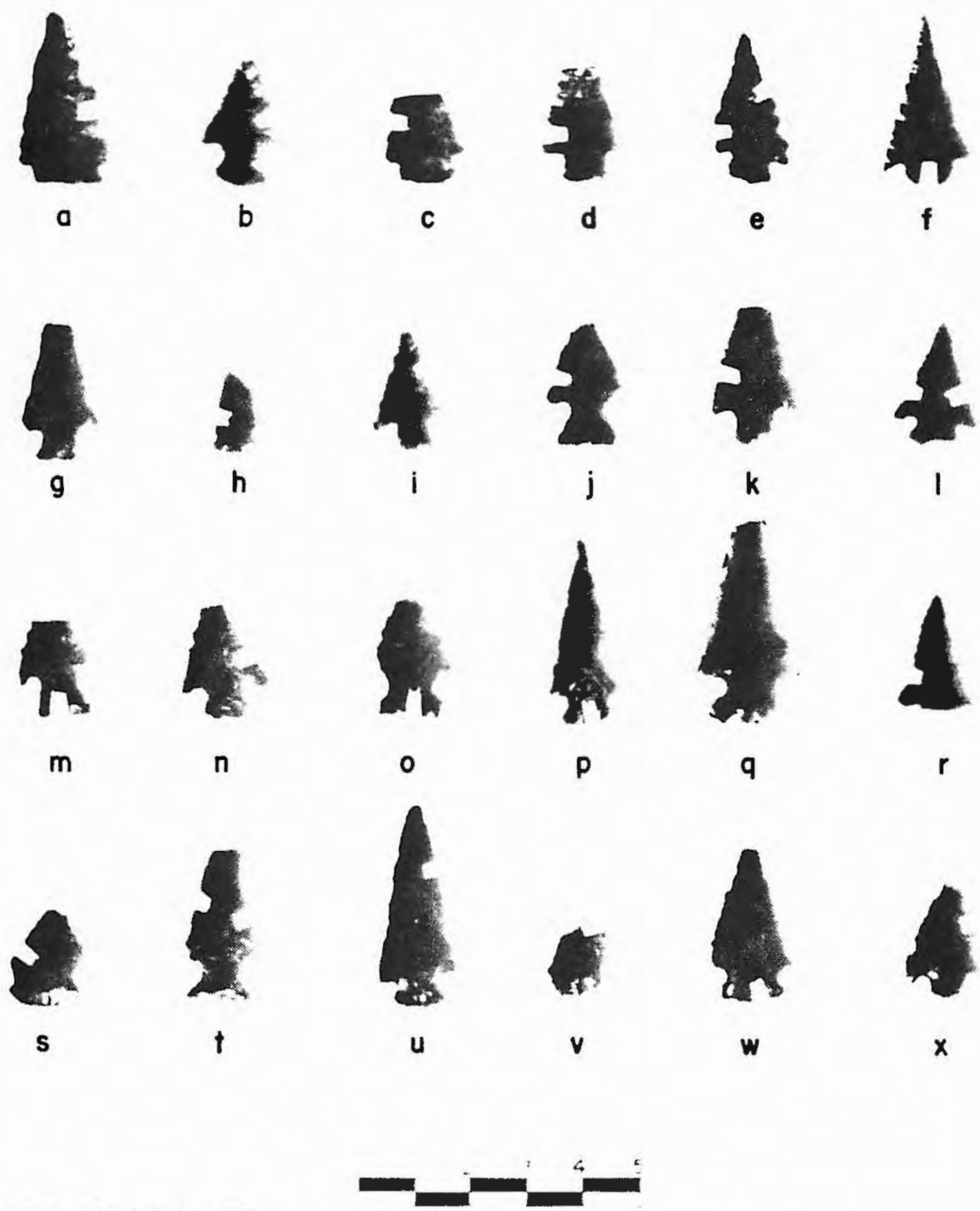

PLATE 3

PLATE 4

Specimen	Catalog #	Site	Hydration	Source
Corner-notched				
a	3000	CA-SON-456	1.4	A
b	3026	"	1.7	N
c	3058	"	1.1	A
d	3127	"	1.4	A
e	3154	"	1.3	N
f	3234	"	1.4	A
g	TO/177	CA-SON-655	1.3	A
h	TO/24	"	1.2	A
i	TO/26	"	1.0	N
j	TO/27	"	1.7	N
k	TO/29	"	1.6	A
l	TO/39	"	1.0	A
m	TO/40	"	1.8	N
n	TO/185	"	1.3	A
o	TO/212	"	1.3	A
p	TO/213	"	1.0	A
q	73-1-13	CA-SON-678	2.0	A
r	73-1-15	"	0.9	A
s	73-1-26	"	1.0	A
t	73-1-107	CA-SON-704	nvb	N
u	TO/293	CA-SON-744	1.3	A
v	79-4-158	CA-SON-1048	1.6	N
w	79-11-9	CA-SON-1195	1.6	A
x	79-11-16	"	1.6	A
y	79-11-17	"	nvb	A

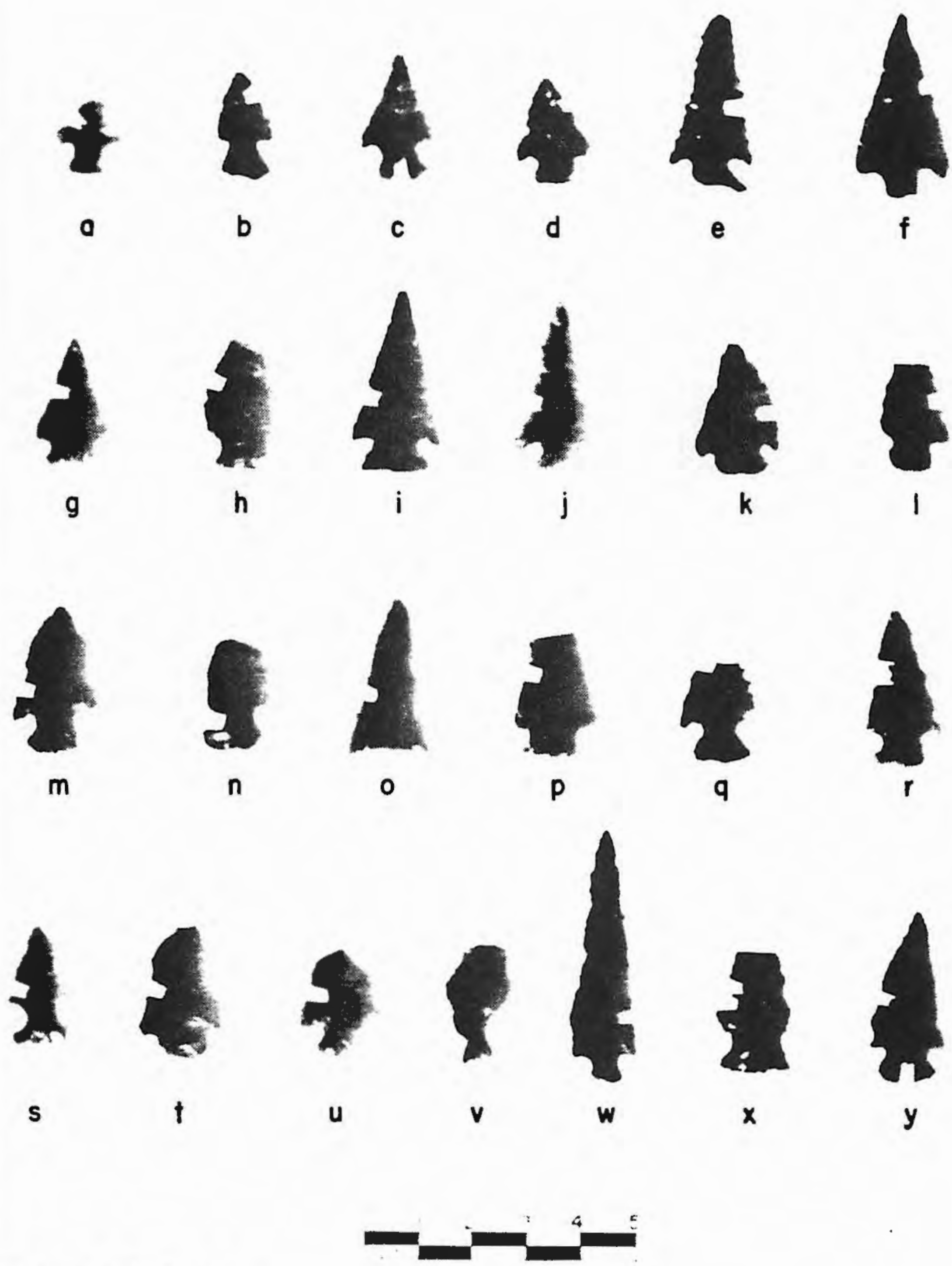

PLATE 4

PLATE 5

Specimen	Catalog #	Site	Hydration	Source
Corner-notched				
a	81-3-441	CA-SON-1269	1.2	A
b	81-3-477	"	3.2	A
c	81-3-491	"	1.9	N
d	81-3-788	"	2.2	A
e	81-3-790	"	2.2	A
f	81-3-813	"	1.4	N
g	79-3-43	CA-NAP-376	1.7	N
h	79-8-44	"	1.2	N
i	79-8-63	"	1.3	N
j	79-8-135	"	1.8/2.7	N
k	79-8-158	"	1.7	N
l	79-8-160	"	1.1	N
m	79-8-162	"	1.0	N
n	79-8-169	"	1.8	N
o	79-8-181	"	1.8	N
p	79-8-184	"	2.1	N
q	7-8	CA-MRN-202	2.8	A
r	7-17	"	1.2	A
s	7-134	"	1.0	A
t	7-142	"	1.1	A
u	7-299	"	0.9	A
v	7-449	"	1.4	A
w	7-500	"	1.0	A
x	7-534	"	1.1	A

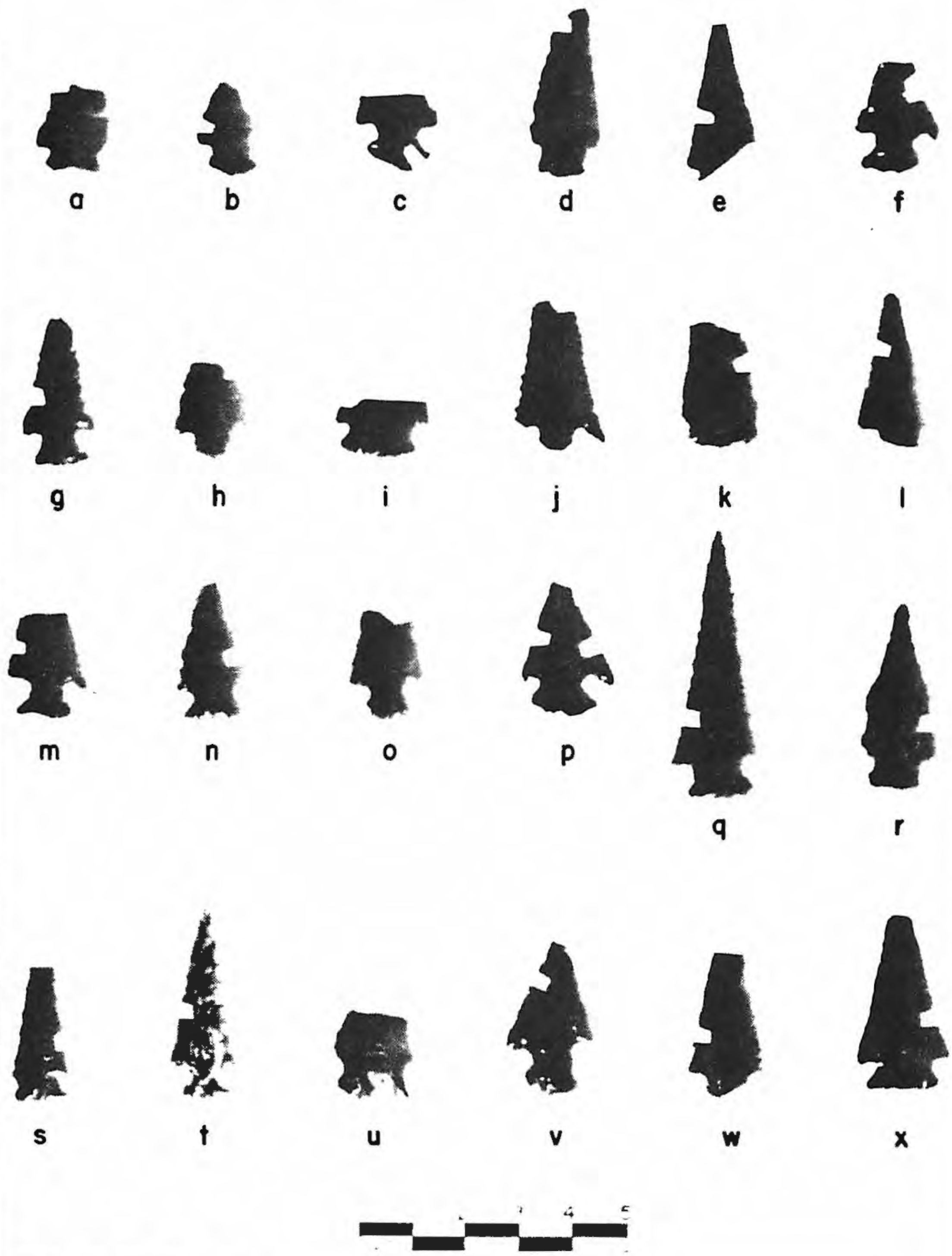

PLATE 5

PLATE 6

Specimen	Catalog #	Site	Hydration	Source
Corner-notched				
a	7-659	CA-MRN-202	1.1	A
b	7-660	"	1.0	A
c	75-6-100	CA-MRN-396	1.3/1.7	A
d	75-6-101	"	1.4/3.0	N
e	75-6-110	"	1.1	N
f	75-6-116	"	1.2	N
g	75-6-139	"	1.4	A
h	75-6-143	"	1.8	N
i	75-6-168	"	1.2/1.7	N
j	75-6-182	"	1.1	N
k	75-6-231	"	1.4	A
Serrated				
l	78-7-17	CA-SON-84	1.6	A
m	a	CA-SON-159	2.4	N
n	b	"	1.8	A
o	c	"	dh	N
p	d	"	2.4	N
q	e	"	1.9/3.6	N
r	72-1-8	"	1.2	A
s	72-1-138	"	1.3	A
t	72-1-179	"	1.8	A
u	74-3-39	"	1.8	A
v	74-3-125	"	2.3	N
w	75-28-165	"	dh	A

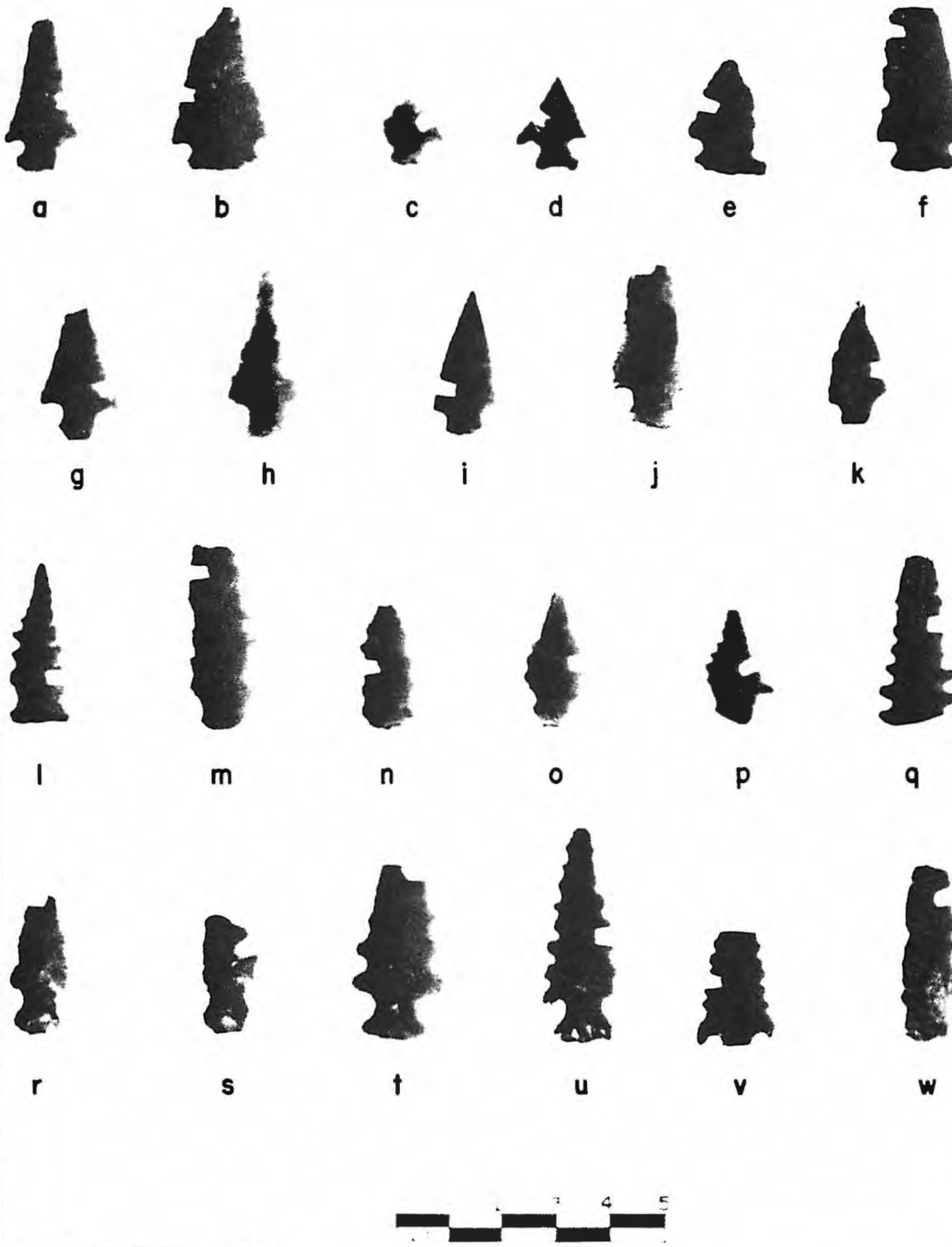

PLATE 6

PLATE 7

Specimen	Catalog #	Site	Hydration	Source
Serrated				
a	75-28-264	CA-SON-159	2.2	A
b	77-11-?	"	1.5	N
c	73-16-6	CA-SON-445	1.3	A
d	1-2-30	CA-SON-455	1.4	A
e	1-2-70	"	1.9	N
f	1-2-160	"	1.4	A
g	1-2-162	"	1.3	A
h	2000	CA-SON-456	1.5	A
i	2058	"	1.6	A
j	2199	"	1.4	A
k	2153	"	1.8	A
l	2164	"	1.6	A
m	2214	"	1.6	A
n	2227	"	2.1	N
o	2236	"	1.6	A
p	2272	"	1.8	N
q	2285	"	1.8	A
r	2294	"	1.6	A
s	2304	"	1.7	A
t	2310	"	1.6	A
u	2316	"	nvb	A
v	2398	"	1.7	A
w	2430	"	2.0	A
x	2484	"	1.7	A

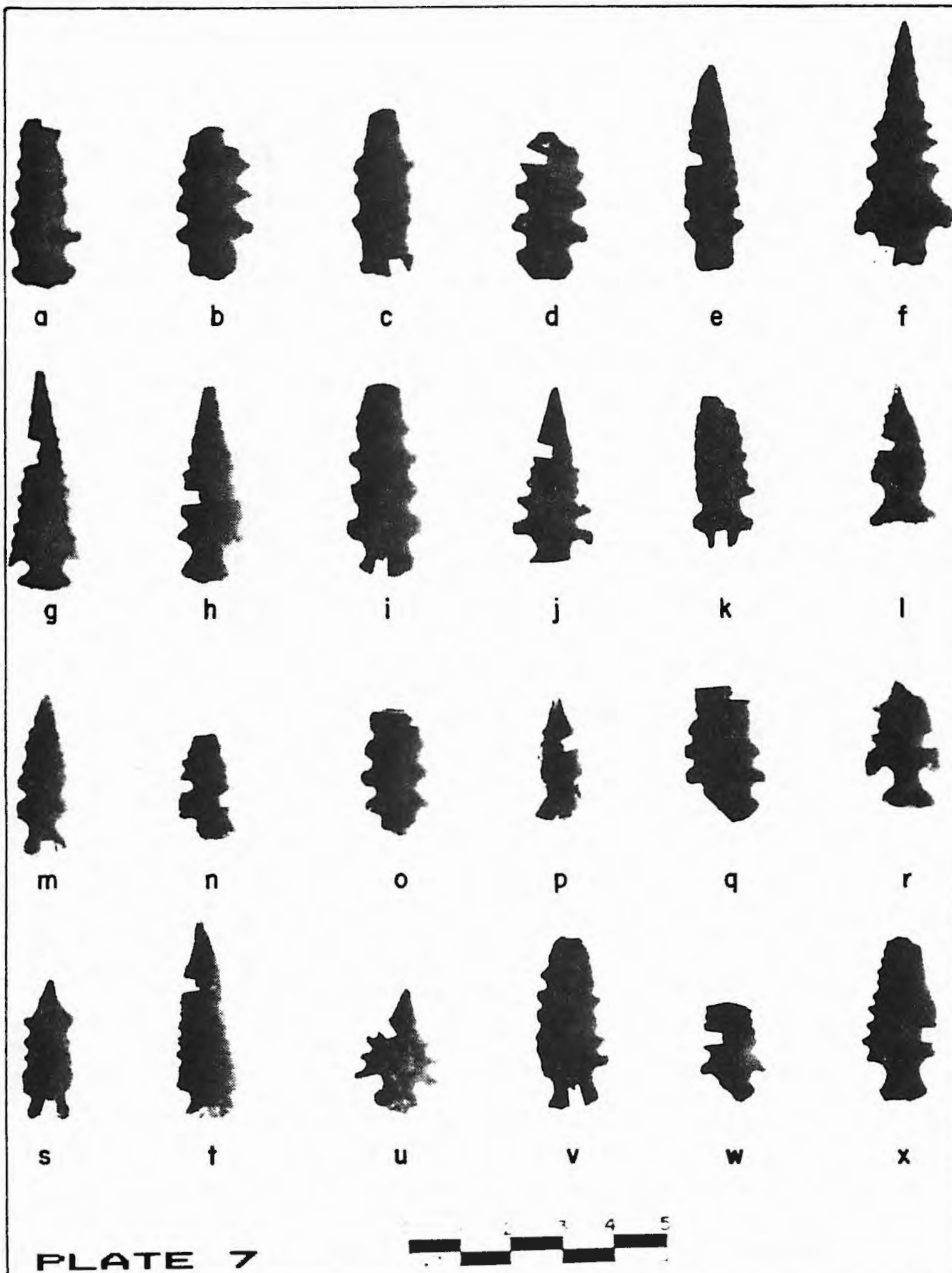

PLATE 7

PLATE 8

Specimen	Catalog #	Site	Hydration	Source
Serrated				
a	2486	CA-SON-456	1.8	A
b	2546	"	1.8	A
c	2626	"	1.9	A
d	2663	"	1.7	A
e	2668	"	1.8	A
f	2748	"	1.7	A
g	2777	"	1.6	A
g	2803	"	1.6	A
i	2812	"	5.2	N
j	2865	"	1.6	N
k	2904	"	2.1	N
l	2974	"	1.7	A
m	2980	"	1.7	A
n	3002	"	2.5	N
o	3003	"	2.1	A
p	3005	"	1.8	N
q	3034	"	nvb	N
r	3064	"	2.9	A
s	3110	"	1.8	A
t	3120	"	nvb	A
u	3134	"	2.0	A
v	3170	"	2.2	N
w	3229	"	2.1	N
x	3235	"	1.5/2.2	A

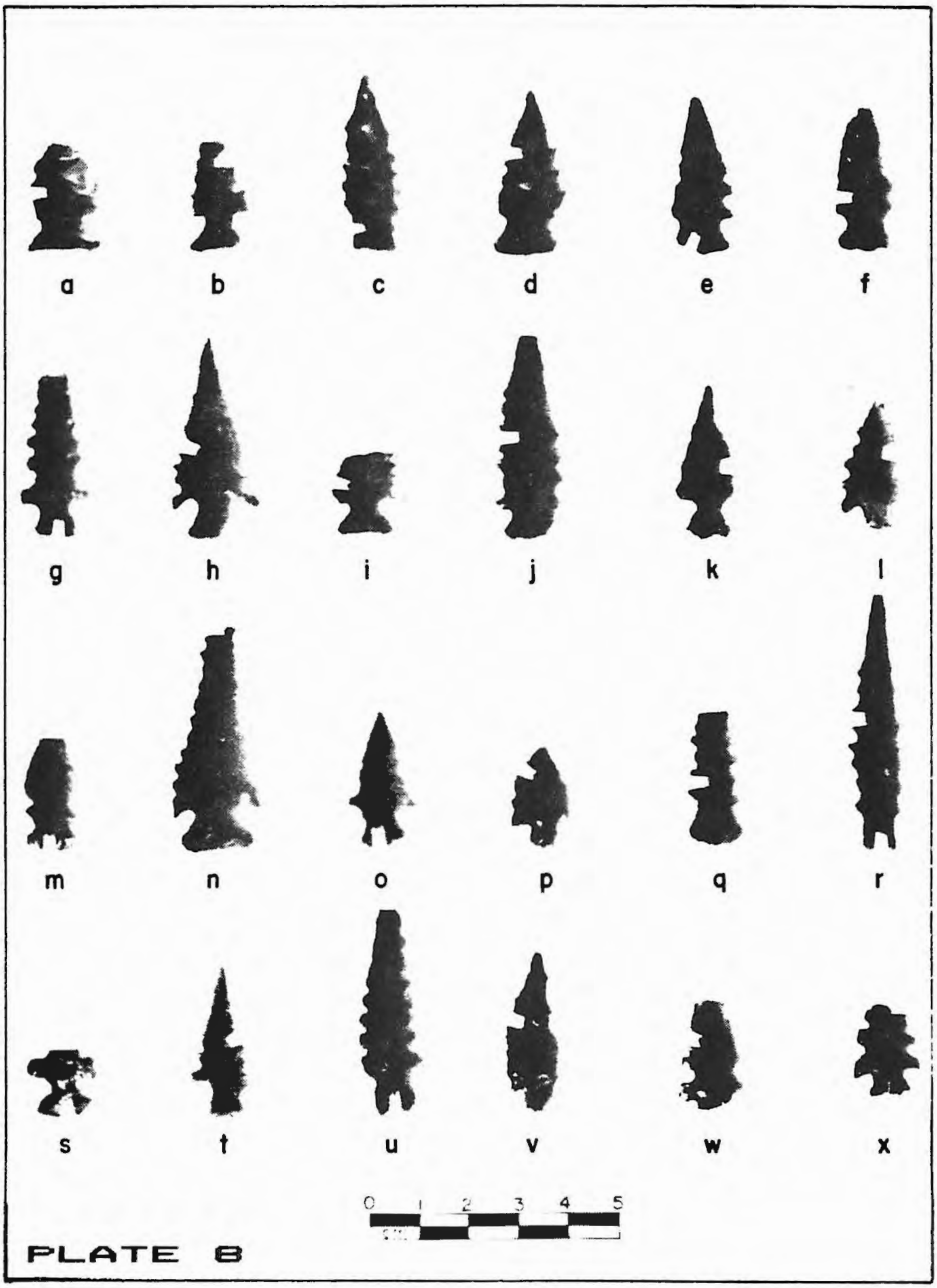
a b c d e f
g h i j k l
m n o p q r
s t u v w x
0 1 2 3 4 5
cm
PLATE 8

PLATE 9

Specimen	Catalog #	Site	Hydration	Source
<u>Serrated</u>				
a	TO/23	CA-SON-655	1.3	A
b	TO/25	"	1.7	A
c	TO/187	"	1.7	A
d	TO/211	"	1.8	N
e	73-1-33	CA-SON-671	1.9	N
f	a	CA-SON-677	2.4/3.4	A
g	b	"	1.4	A
h	73-1-14	CA-SON-678	1.6	A
i	TO/310	CA-SON-744	1.3	A
j	77-9-234	CA-SON-977	1.6	A
k	79-4-187	CA-SON-1048	2.5	N
l	80-1-17	CA-SON-1082	nvb	A
m	82-1-35	"	2.5	N
n	79-11-13	CA-SON-1195	1.4/2.2	A
o	81-3-320	CA-SON-1269	2.1	N
p	81-3-321	"	1.7	A
q	81-3-323	"	1.6	A
r	81-3-338	"	1.9	A
s	81-3-341	"	1.4	A
t	81-3-346	"	1.9	A
u	81-3-360	"	1.8	A
v	81-3-442	"	1.2/2.2	A
w	81-3-502	"	2.1	A
x	81-3-515	"	1.9	A

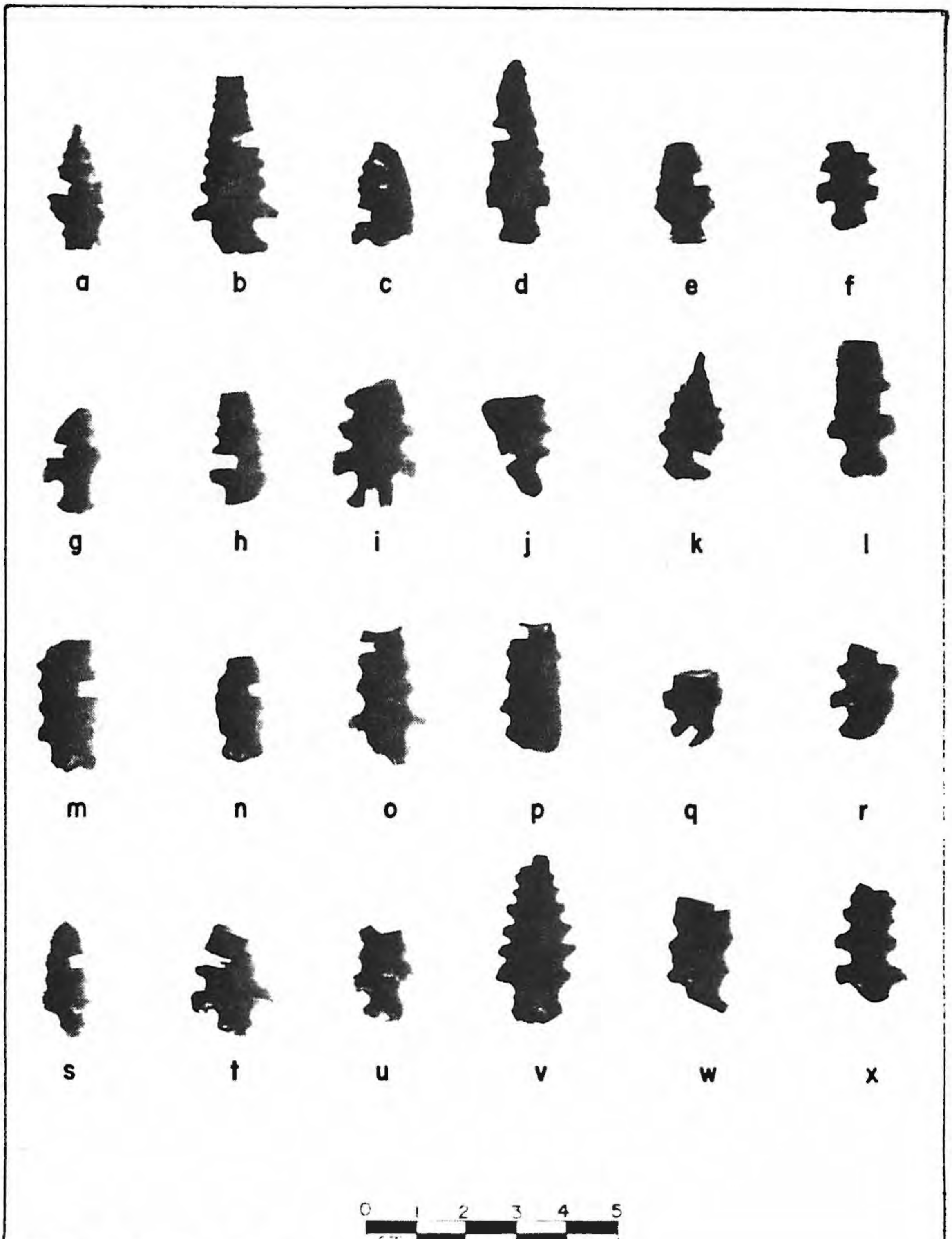

PLATE 9

PLATE 10

Specimen	Catalog #	Site	Hydration	Source
<u>Serrated</u>				
a	81-3-524	CA-SON-1269	2.2	A
b	81-3-610	"	1.8	N
c	81-3-613	"	2.3	N
d	81-3-621	"	2.0	N
e	81-3-661	"	1.7	A
f	81-3-669	"	2.5	N
g	81-3-684	"	1.4	A
h	81-3-685	"	nvb	A
i	81-3-707	"	1.2	A
j	81-3-714	"	nvb	A
k	81-3-724	"	2.3	N
l	81-3-757	"	1.6	A
m	81-3-789	"	2.2	N
n	81-3-858	"	1.6	A
o	81-3-872	"	nvb	A
p	81-3-883	"	1.4	A
q	81-3-884	"	1.3	A
r	81-3-919	"	1.6	A
s	81-3-1056	"	2.3	N
t	79-8-45	CA-NAP-376	2.1	N
u	79-8-67	"	1.8	A
v	79-8-69	"	2.0	N
w	79-8-70	"	2.2	N
x	79-8-73	"	2.2	N

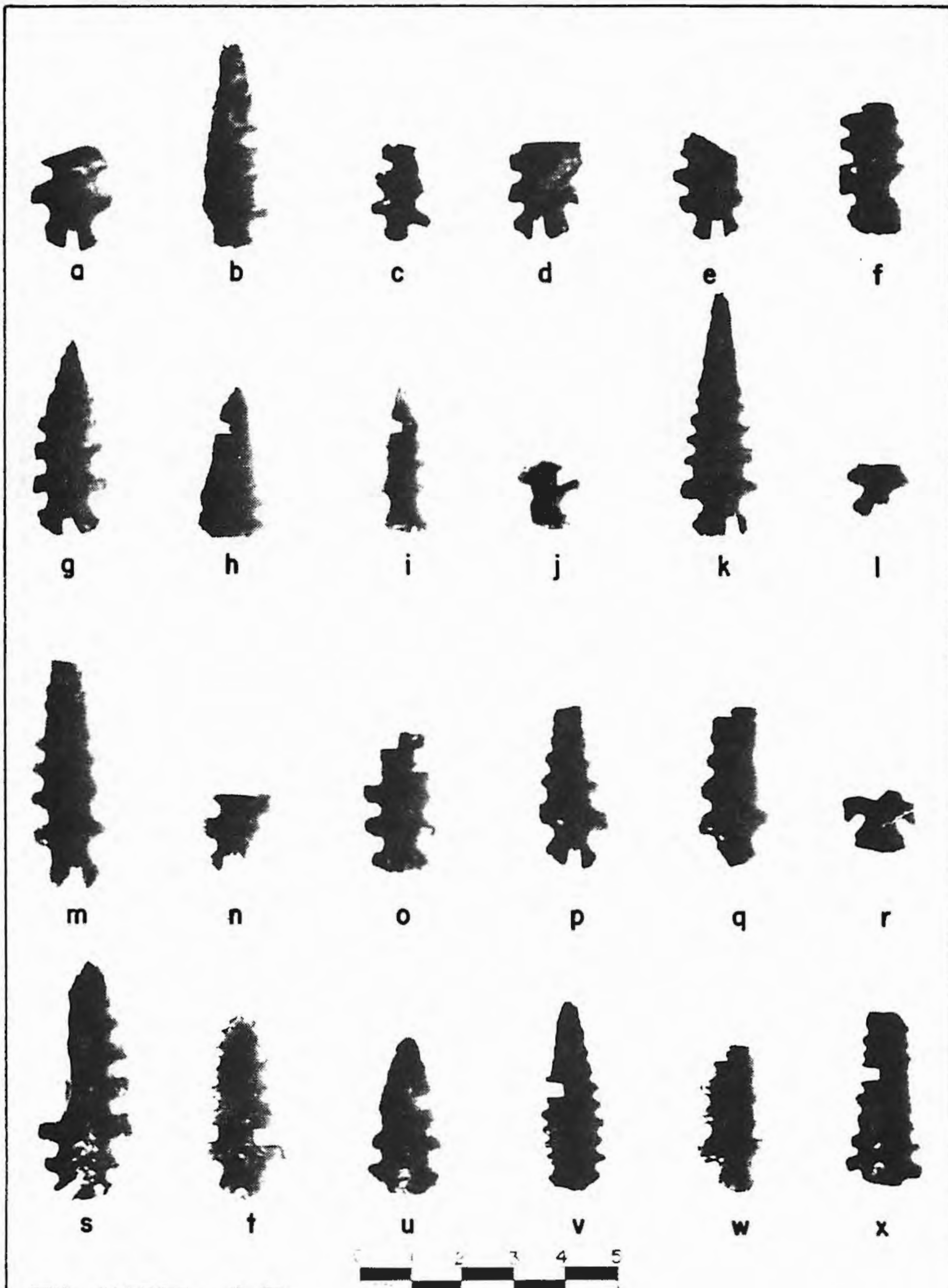

PLATE 10

PLATE 11

Specimen	Catalog #	Site	Hydration	Source
Serrated				
a	79-8-77	CA-NAP-376	1.8	N
b	79-8-78	"	2.4	N
c	79-8-81	"	dh	N
d	79-8-84	"	1.9	N
e	79-8-87	"	2.2	N
f	79-8-93	"	1.8/2.9	A
g	79-8-95	"	1.6	N
h	79-8-97	"	1.9/2.3	N
i	79-8-102	"	2.1	N
j	79-8-108	"	2.7	N
k	79-8-110	"	1.9	N
l	79-8-112	"	2.2	N
m	79-8-118	"	1.6	N
n	7-1	CA-MRN-202	1.6	A
o	7-6	"	1.5	A
p	7-132	"	2.1	A
q	7-155	"	1.2	A
r	7-282	"	1.4	A
s	7-307	"	1.6	A
t	7-308	"	1.4	A
u	7-482	"	1.7	A
v	7-725	"	1.4	A
w	7-761	"	1.4	A

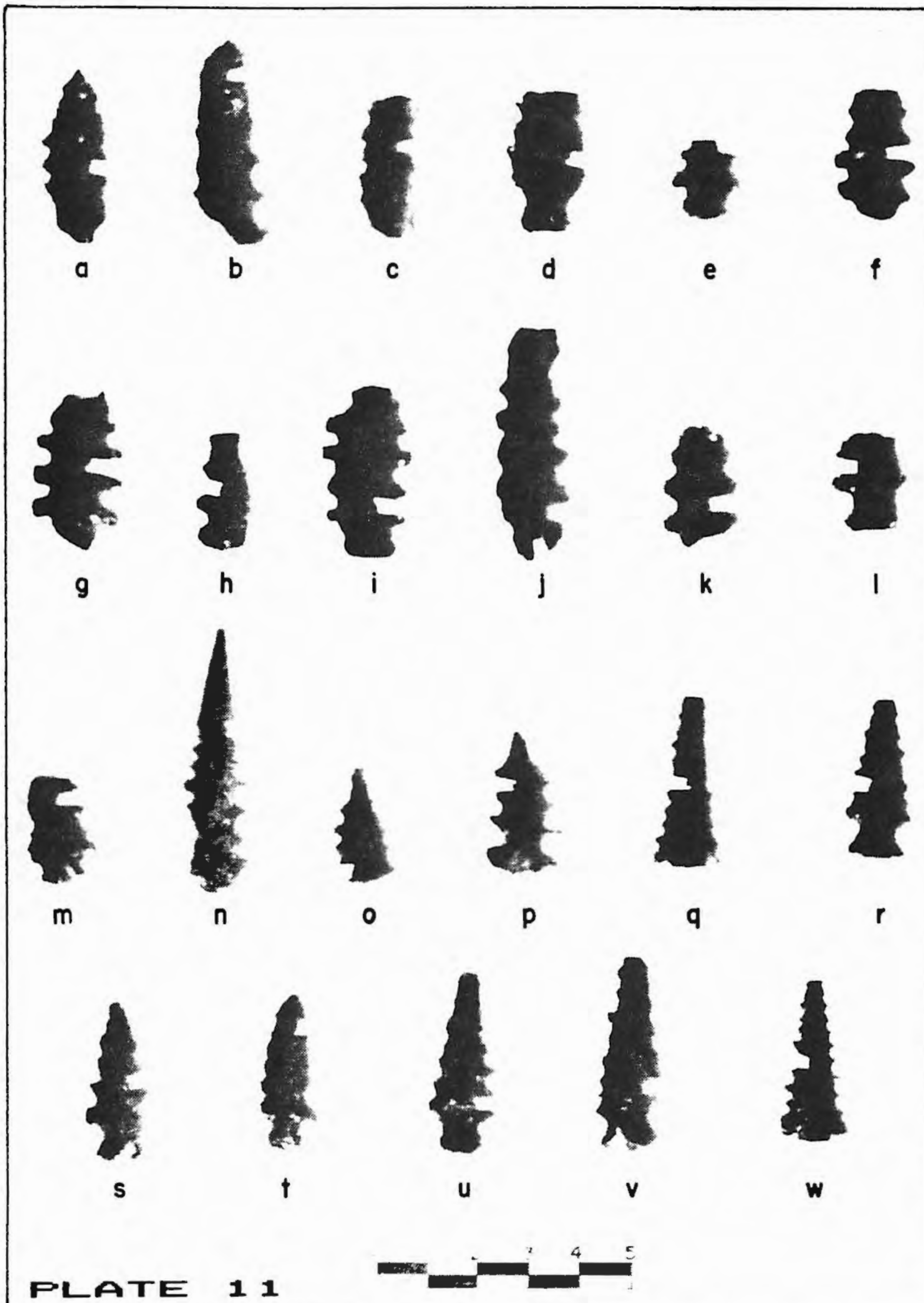

PLATE 11

PLATE 12

Specimen	Catalog #	Site	Hydration	Source
<u>Serrated</u>				
a	75-6-146	CA-MRN-396	2.0	N
b	75-6-153	"	1.8	A
c	75-6-158	"	1.6/2.0	N
d	75-6-181	"	1.8	N
e	75-6-245	"	2.0	N
f	75-6-267	"	2.1	N
<u>Gunther-like</u>				
g	81-3-493	CA-SON-1269	2.2	n
<u>Convex Stemmed</u>				
h	3208	CA-SON-456	2.7	A
i	2822	"	4.0	A
<u>Large Side/Corner-notched</u>				
j	72-2-472	Hector Lee Coll.	1.9	N
k	72-2-477	"	1.2	A
l	3012	CA-SON-456	dh	A
m	TO/159	CA-SON-655	1.6	A
n	TO/166	"	2.5	A
o	73-1-9	CA-SON-671	1.5	A
p	73-1-105	CA-SON-704	2.8	A
q	77-9-71	CA-SON-979	1.8	A
r	77-9-729	"	2.2	A
s	81-9-44	CA-SON-1343	2.5	A
t	77-9-756	CA-SON-979	1.8	A

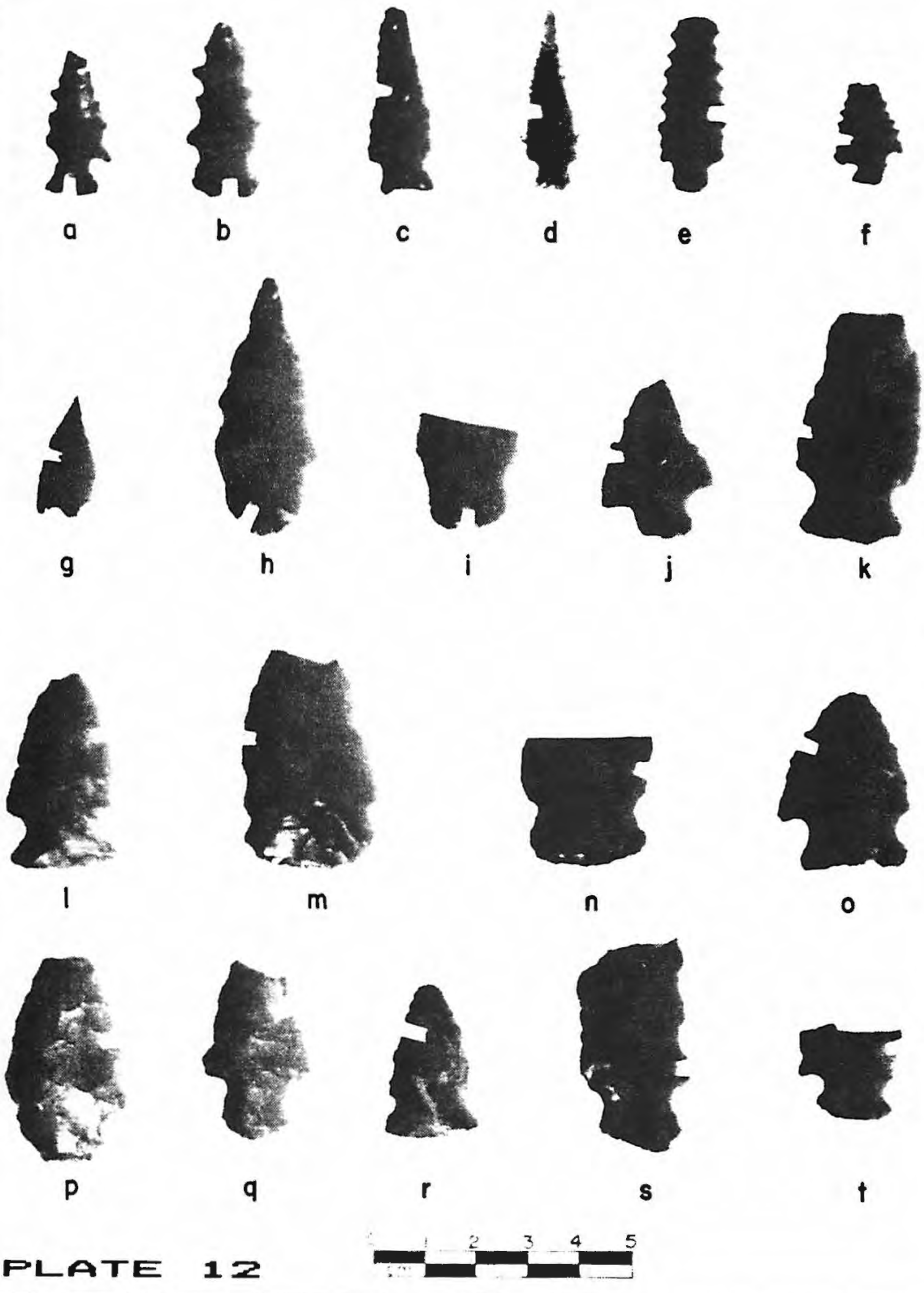

PLATE 12

PLATE 13

Specimen	Catalog #	Site	Hydration	Source
Shsouldered Lanceolate				
a	72-2-398	Hector Lee Coll.	4.4	A
b	72-2-401	"	2.8	N
c	72-2-417	"	1.5	A
d	72-2-423	"	3.0	A
e	72-2-424	"	1.8	N
f	72-2-435	"	3.7	N
g	72-2-439	"	2.4	N
h	72-2-440	"	2.4	A
i	72-2-442	"	2.0	A
j	72-2-447	"	2.0	A
k	72-2-449	"	dh	A
l	72-2-450	"	2.1	A
m	72-2-452	"	2.7	A
n	72-2-456	"	2.5	A
o	72-2-507	"	2.4	N

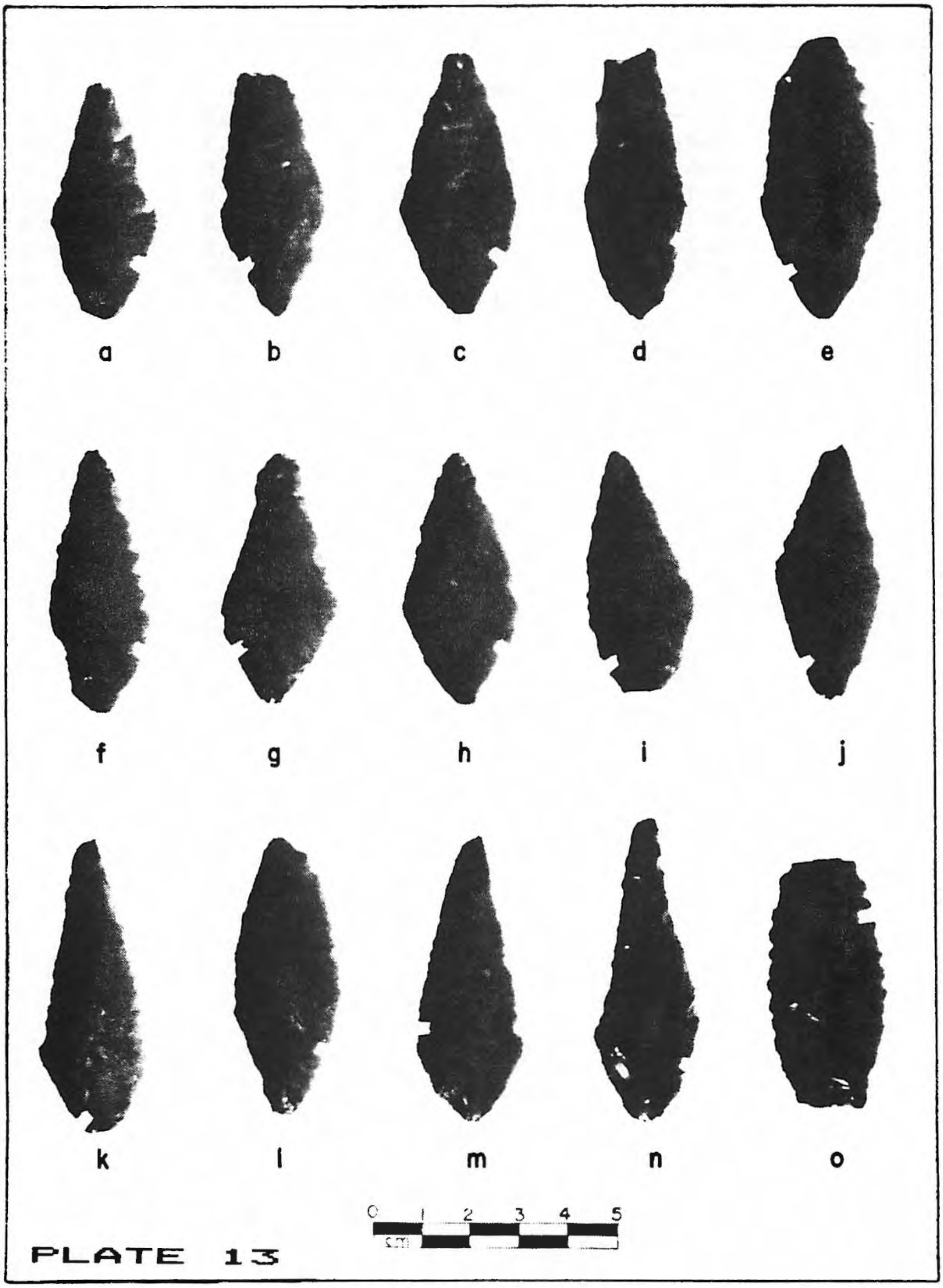

PLATE 13

PLATE 14

Specimen	Catalog #	Site	Hydration	Source
houldered Lanceolate				
a	72-2-510	Hector Lee Coll.	3.3	N
b	72-2-539	"	4.8	N
c	72-2-576	"	3.5	N
d	73-6-1	CA-SON-19	4.8	A
e	81-12-192	CA-SON-20b	3.0	A
f	78-7-19	CA-SON-84	2.5	A
g	78-7-38	"	2.8	A
h	78-7-269	"	2.1/3.2	A
i	f	CA-SON-159	3.1	A
j	72-1-176	"	5.4	N
k	74-3-152	"	2.5	N
l	75-28-41	"	1.3	N
m	75-28-125	"	2.3	N
n	75-28-170	"	3.7	N

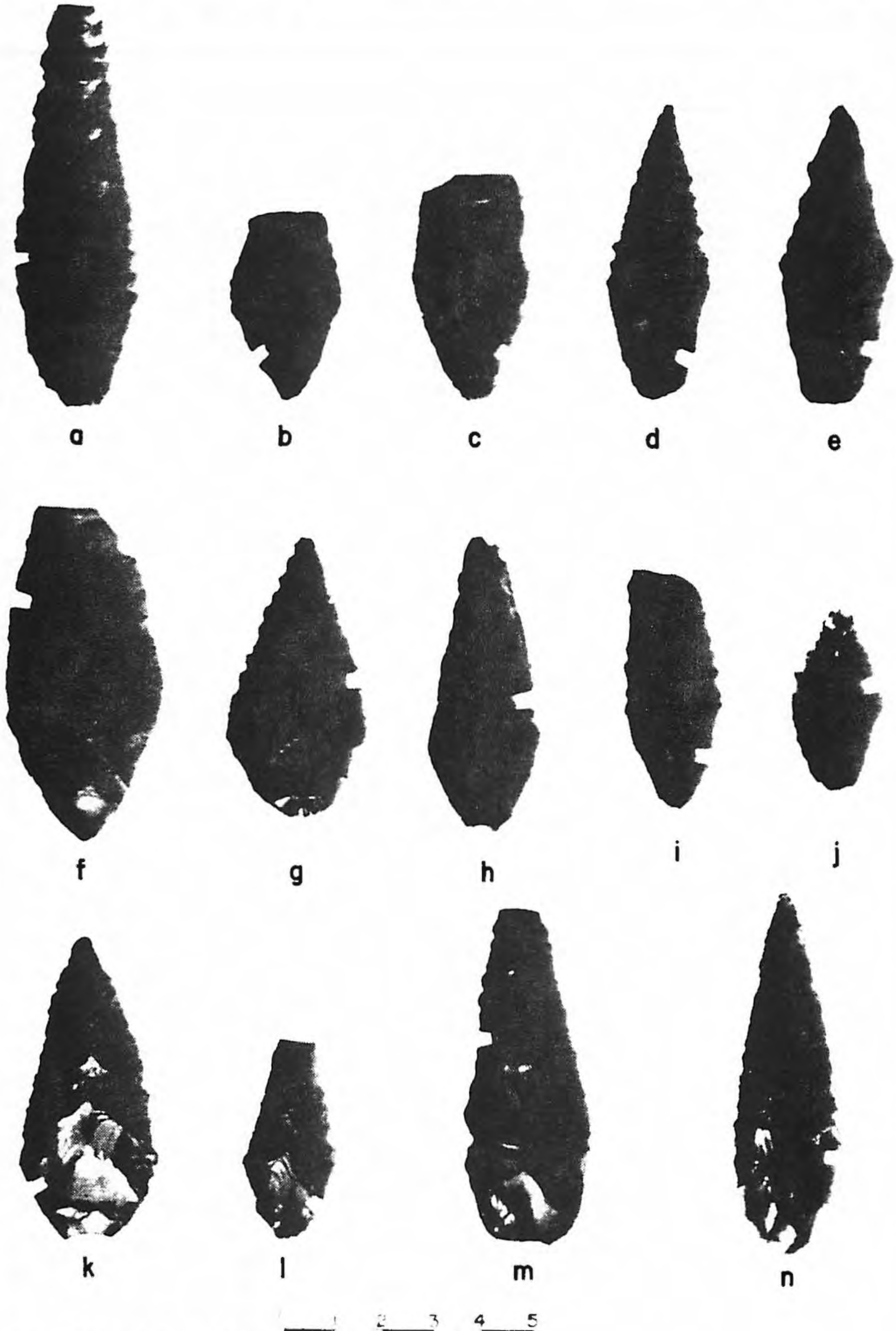

PLATE 14

PLATE 15

Specimen	Catalog #	Site	Hydration	Source
Shouldered Lanceolate				
a	73-13-13	CA-SON-358	2.2	A
b	none	CA-SON-455	3.1	N
c	2061	CA-SON-456	3.0	N
d	2117	"	3.0/3.7	N
e	2118	"	3.3	N
f	2151	"	2.3	A
g	2217	"	2.3	N
h	2321	"	2.0	A
i	2388	"	5.0	A
j	2505	"	2.1/2.3	A
k	2510	"	2.9	N
l	2566	"	3.3	N
m	2692	"	2.2	A
n	2700	"	2.1	A
o	2840	"	1.8	A

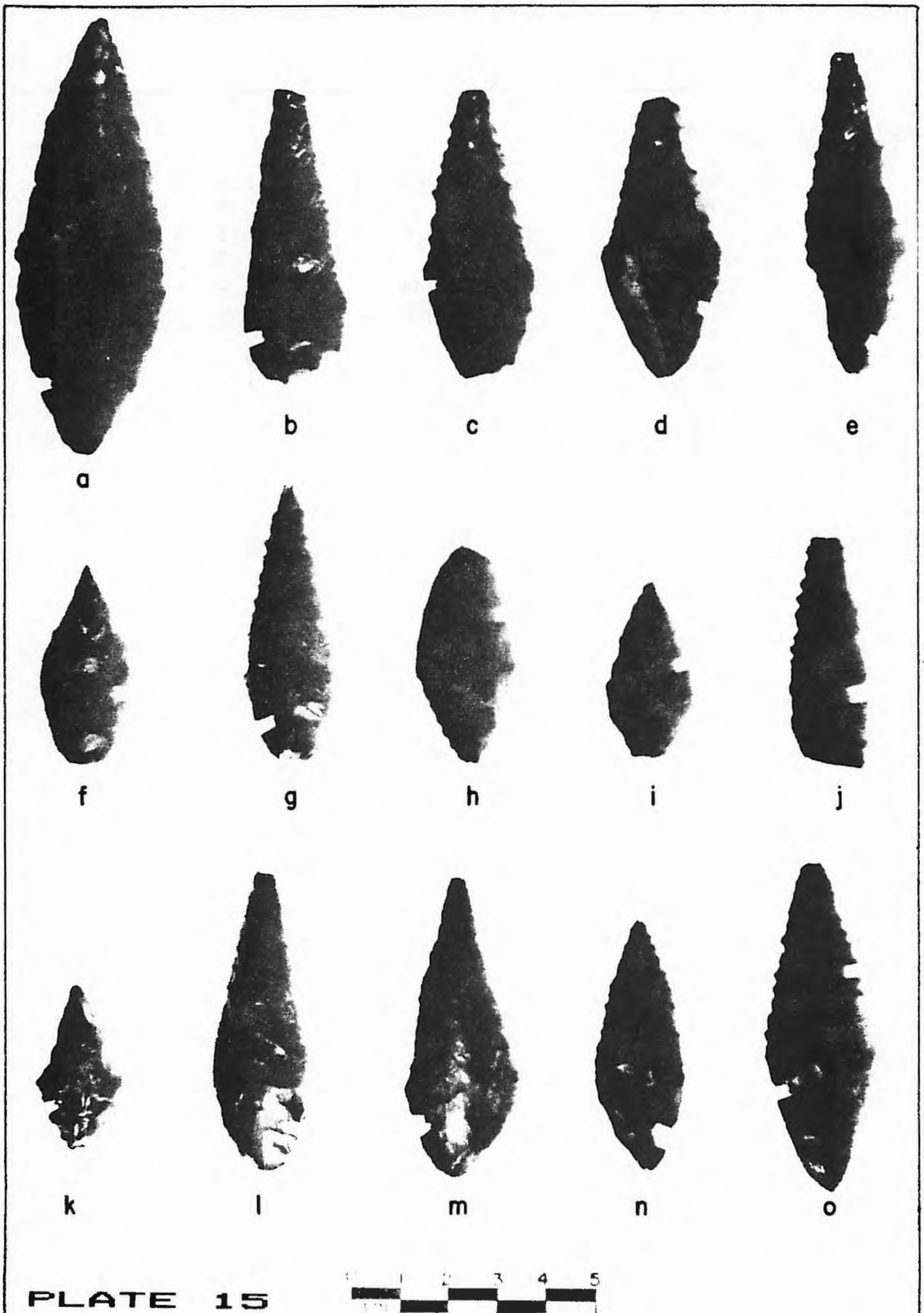

PLATE 15

PLATE 16

Specimen	Catalog #	Site	Hydration	Source
Shouldered Lanceolate				
a	2866	CA-SON-456	2.9	A
b	2996		2.9	N
c	2998	"	3.1	N
d	3152	"	1.7	A
e	2504	CA-SON-466	3.4	N
f	TO/21	CA-SON-655	5.6	A
g	TO/22	"	2.7	A
h	TO/42	"	2.6	N
i	TO/44	"	1.9	A
j	TO/54	"	2.8	A
k	TO/126	"	2.8	A
l	TO/133	"	2.4	N
m	TO/141	"	2.1	A
n	TO/153	"	2.7	A
o	TO/168	"	2.5	N

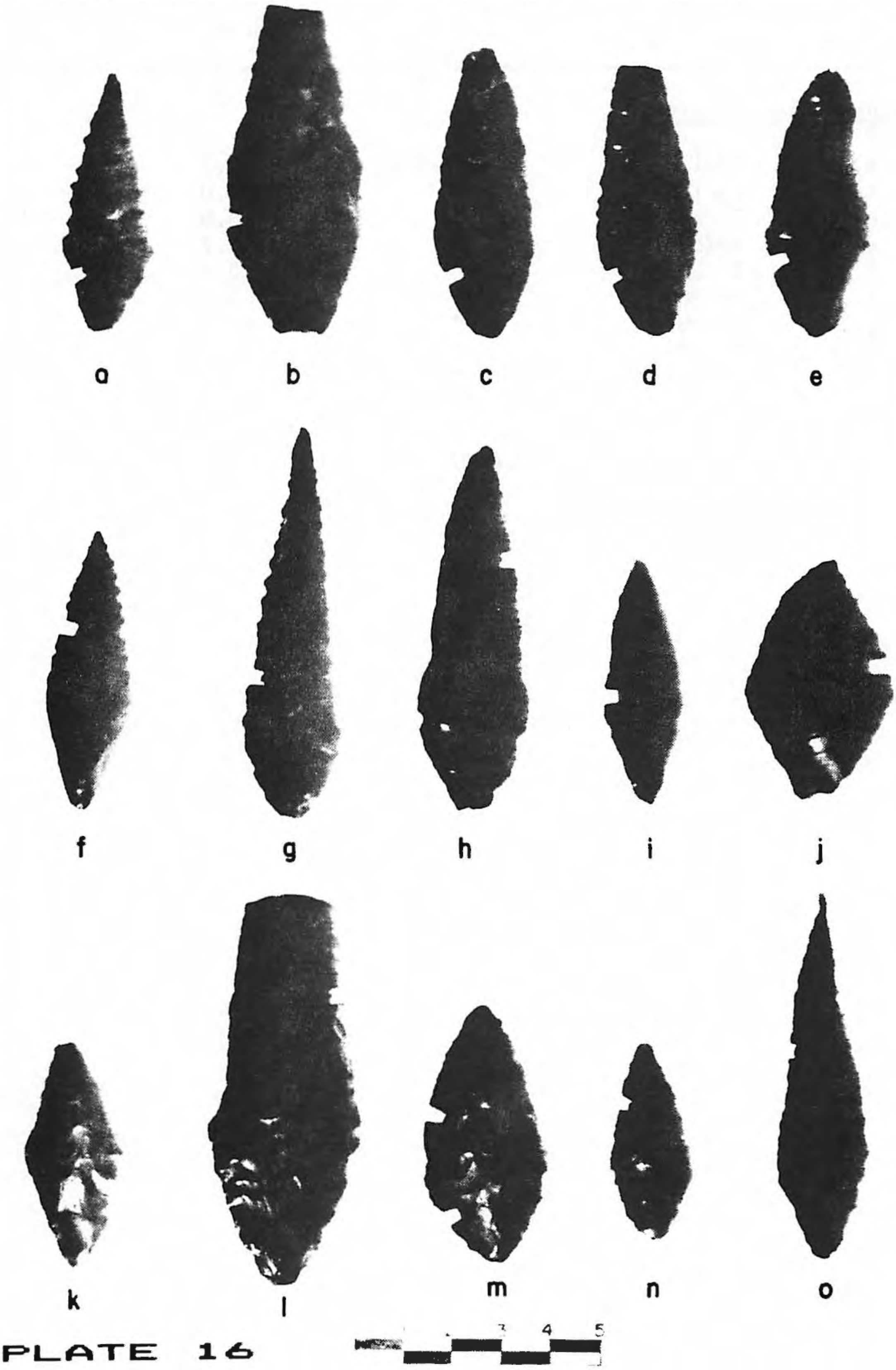

PLATE 16

PLATE 17

Specimen	Catalog #	Site	Hydration	Source
Shouldered Lanceolate				
a	TO/178	CA-SON-655	2.2	A
b	TO/180	"	3.0	N
c	TO/182	"	3.8	N
d	TO/183	"	2.7	A
e	TO/205	"	2.5	A
f	TO/206	"	2.0	A
g	TO/207	"	2.7	N
h	TO/233	"	2.9	N
i	TO/238	"	2.3	N
j	TO/239	"	2.4	N
k	TO/267	"	3.9	A
l	79-11-6	CA-SON-1195	2.5	A
m	79-11-7	"	2.2	N
n	79-11-8	"	2.2	N

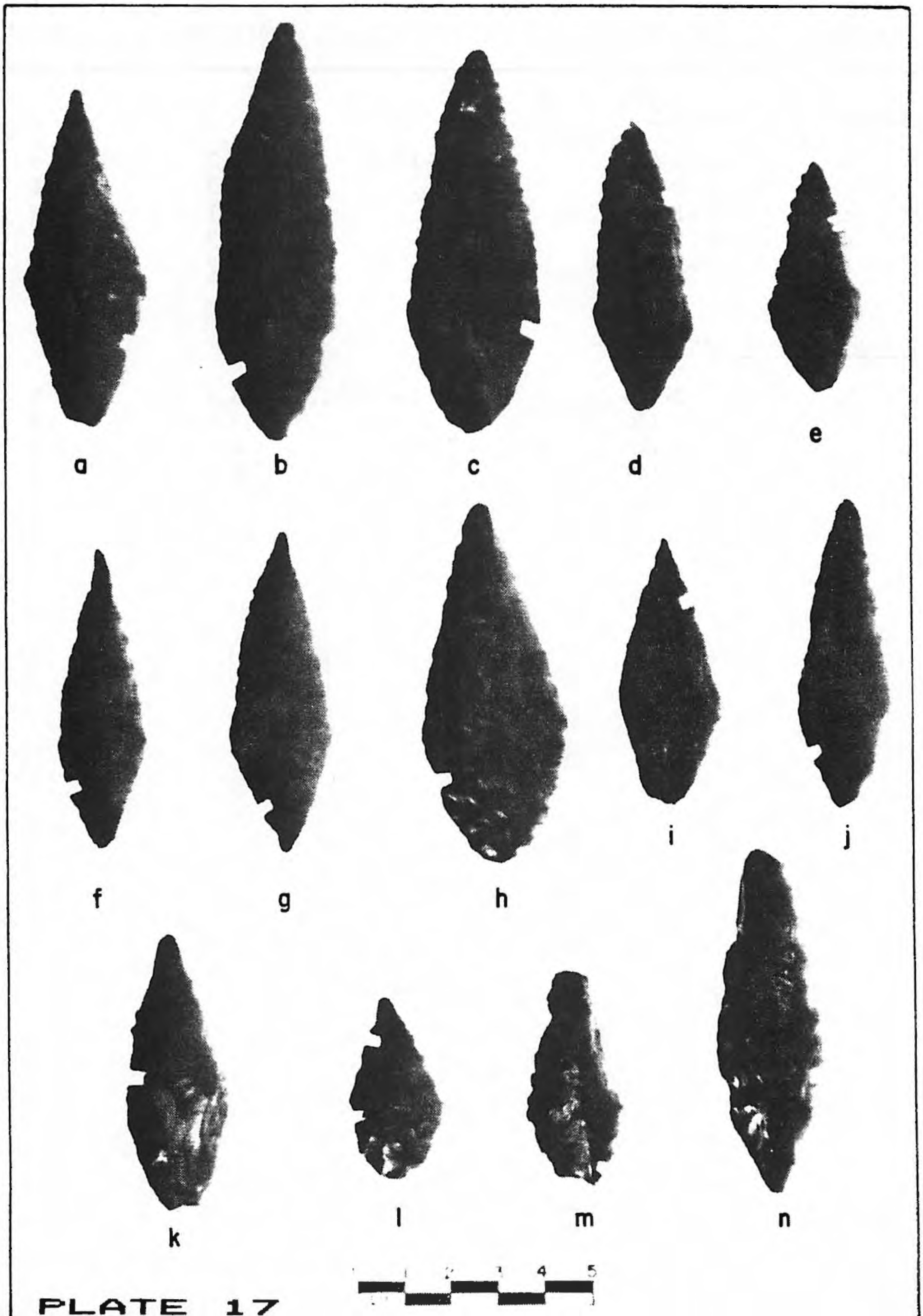

PLATE 17

PLATE 18

Specimen	Catalog #	Site	Hydration	Source
Shouldered Lanceolate				
a	81-9-42	CA-SON-1343	2.7	A
b	67-1-35	CA-MRN-27	2.3	N
c	67-1-154	"	3.1	N
d	67-1-157	"	3.3	N
e	67-1-307	"	3.2	N
Non-shouldered Lanceolate				
f	72-2-119	Hector Lee Coll.	3.8	N
g	72-2-120	"	3.9	N
h	72-2-148	"	nvb	A
i	72-2-149	"	3.6	A

PLATE 18

PLATE 19

Specimen	Catalog #	Site	Hydration	Source
Non-shouldered Lanceolate				
a	72-2-154	Hector Lee Coll.	1.9	A
b	72-2-282	"	2.6	A
c	72-2-283	"	2.9	A
d	72-2-294	"	2.1	A
e	72-2-361	"	3.1	A
f	72-2-426	"	3.7	N
g	72-2-431	"	2.3	A
h	72-2-438	"	nvb	A
i	72-2-451	"	2.6	N
j	72-2-457	"	2.0	A
k	72-2-572	"	3.0	N
l	72-2-583	"	3.5	n
m	72-2-588	"	1.7	A
n	72-2-592	"	3.5/4.2	A

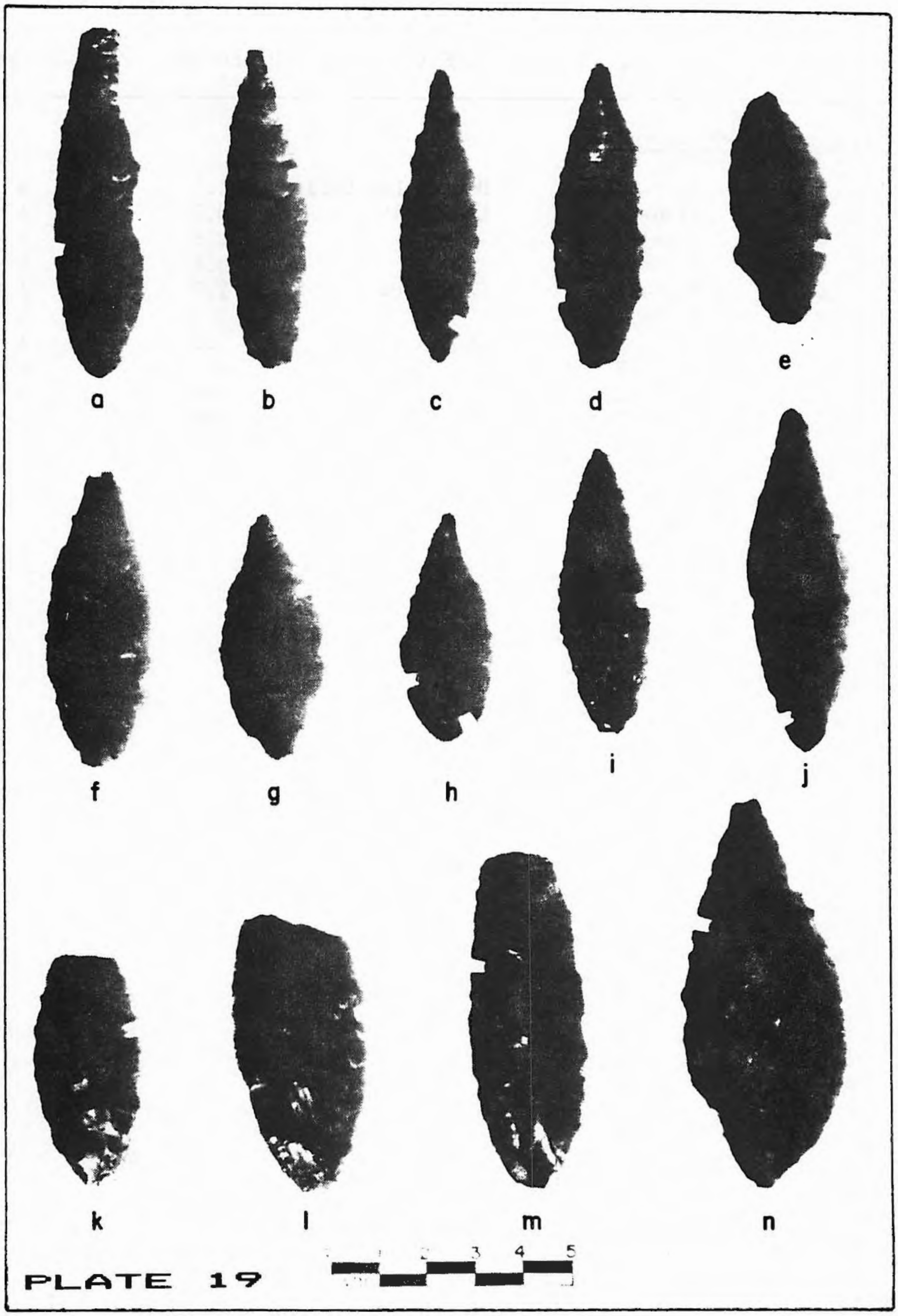

PLATE 19

PLATE 20

Specimen	Catalog #	Site	Hydration	Source
Non-shouldered Lanceolate				
a	72-2-595	Hector Lee Coll.	1.8	A
b	73-6-2	CA-SON-19	3.2	A
c	73-6-3	"	2.6	A
d	73-6-4	"	3.6	A
e	78-7-11	CA-SON-84	2.3	A
f	78-7-12	"	3.3	A
g	j	CA-SON-159	1.8	A
h	75-28-8	"	dh	N
i	75-28-221	"	3.8	N
j	75-28-263	"	nvb	A

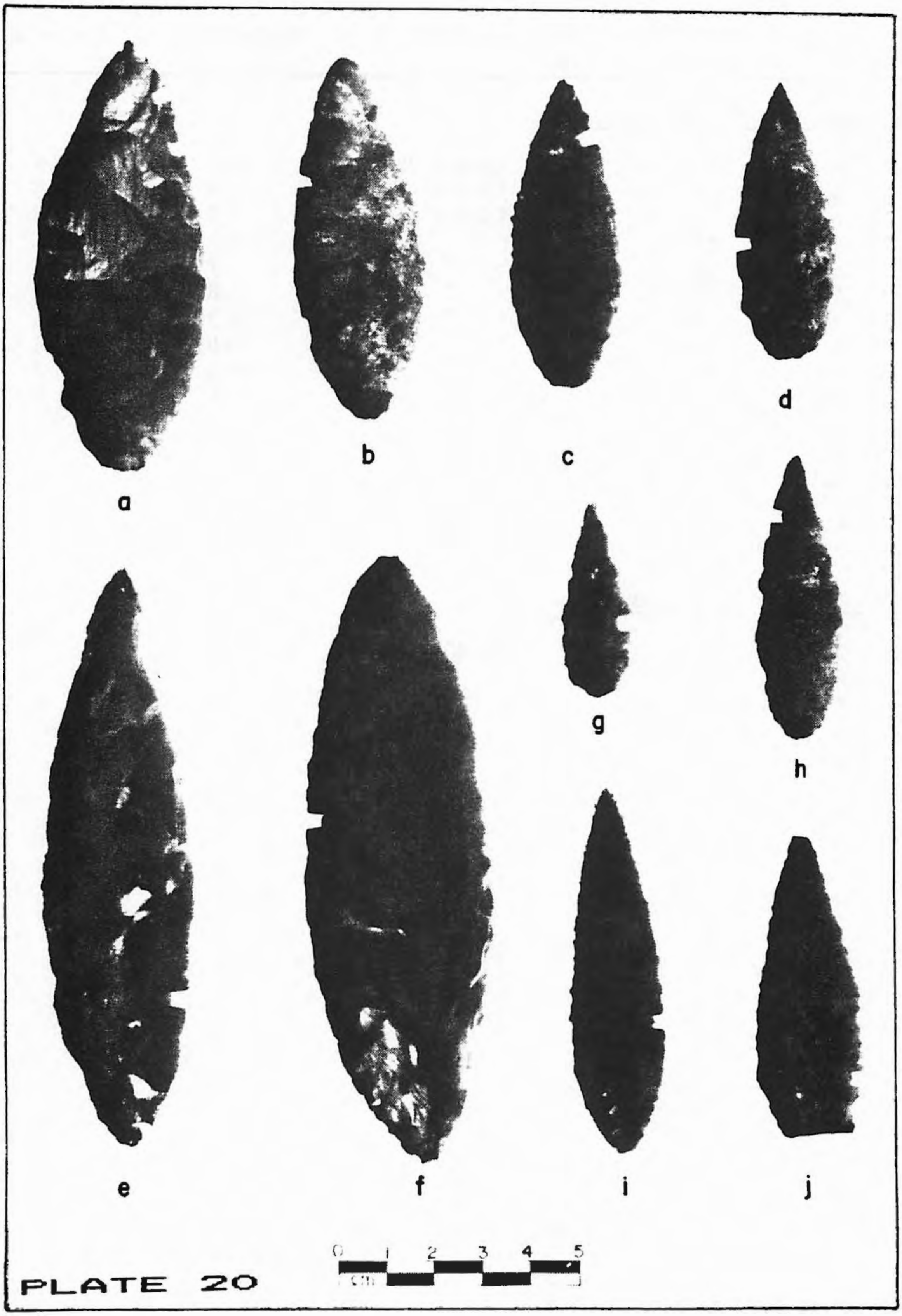

PLATE 20

PLATE 21

Specimen	Catalog #	Site	Hydration	Source
Non-shouldered Lanceolate				
a	73-13-2	CA-SON-358	2.0	A
b	none	CA-SON-455	2.7	N
c	1365	CA-SON-456	3.7	N
d	1367	"	3.0	A
e	2247	"	2.7	A
f	2746	"	3.8	N
g	2489	"	3.3	A
h	2645	"	nvb	A
i	2660	"	4.2	A
j	2774	"	1.4	A
Shouldered Lanceolate				
k	2840	CA-SON-456	1.8	A
Non-shouldered Lanceolate				
l	2922	CA-SON-456	3.5	N
m	3033	"	2.2	A
n	3236	"	4.4	N

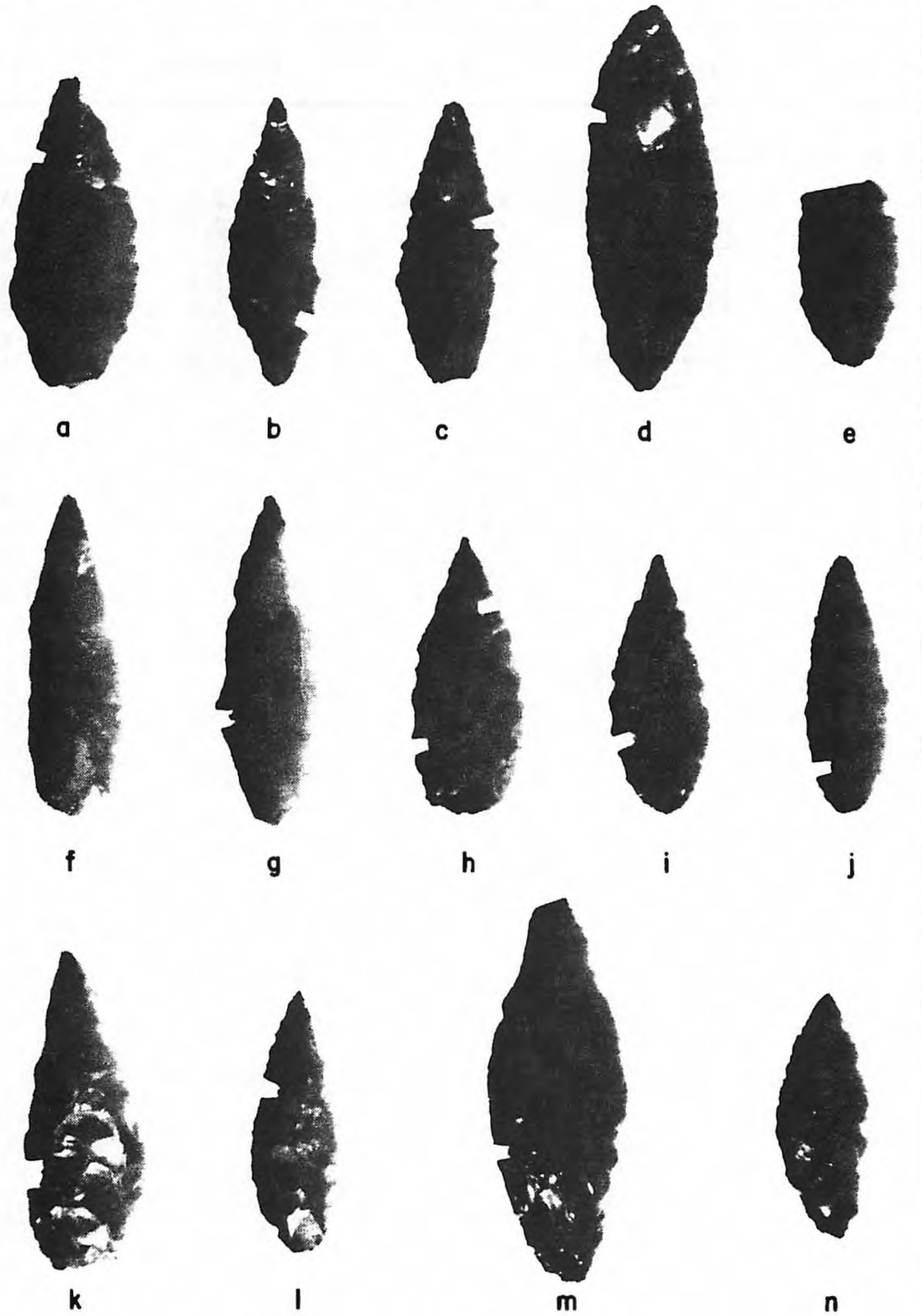

PLATE 21

PLATE 22

Specimen	Catalog #	Site	Hydration	Source
Non-shouldered Lanceolate				
a	2503	CA-SON-466	2.9	A
b	TO/32	CA-SON-655	2.2	A
c	TO/150	"	2.3	N
d	TO/196	"	1.6	N
e	TO/199	"	4.0	N
f	TO/201	"	2.8	A
g	TO/237	"	3.5	A
h	TO/258	"	4.5	N
i	TO/266	"	4.3	N
j	73-1-4	CA-SON-674	1.4	A
k	73-1-106	CA-SON-704	3.0	N
l	79-4-506	CA-SON-1049	2.9	A
m	81-9-31	CA-SON-1343	2.7	N
n	67-1-158	CA-MRN-27	3.5	N

PLATE 22

PLATE 23

Specimen	Catalog #	Site	Hydration	Source
Notchless				
a	72-1-25	CA-SON-159	1.2	A
b	77-11-?	"	1.3	A
c	73-1-104	CA-SON-358	1.8	A
d	1-2-2	CA-SON-455	1.4	N
e	1-2-3	"	1.2	A
f	1-2-138	"	1.3	A
g	1-2-15	"	1.4	A
h	1-2-71	"	nvb	A
i	1-2-99	"	1.4	N
j	1-2-135	"	1.4	N
k	1-2-210	"	1.4	N
l	1-2-262	"	1.0	A
m	1-2-336	"	1.1	A
n	2013	CA-SON-456	1.1	A
o	2379	"	1.3	A
p	2488	"	1.4	A
q	2605	"	1.4	A
r	2666	"	1.8	A
s	2702	"	nvb	A
t	2730	"	1.4	A

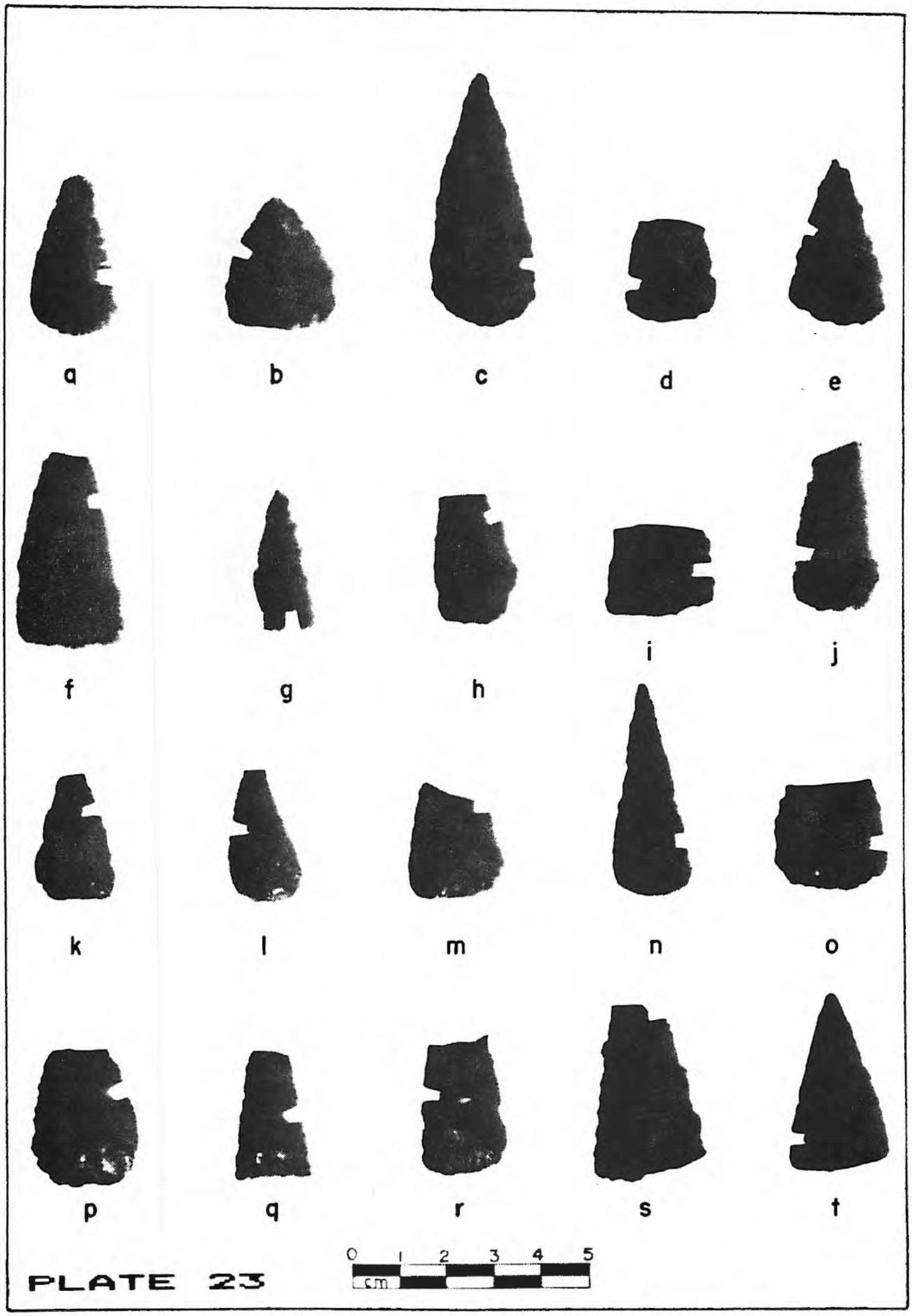

PLATE 23

PLATE 24

Specimen	Catalog #	Site	Hydration	Source
Notchless				
a	2817	CA-SON-6456	1.4	A
b	2897	"	1.8	N
c	TO/209	CA-SON-655	3.4	N
d	73-1-16	CA-SON-678	1.0	A
e	81-3-479	CA-SON-1269	1.7	A
f	81-3-628	"	1.6	A
g	79-8-116	CA-NAP-376	4.4	N
h	79-8-177	"	2.2	N
Concave Base				
i	77-3-467	CA-SON Isolates	6.4	N
j	80-3-267	"	3.2	N
k	73-31-28	"	3.9	N
l	72-2-240	Hector Lee Coll.	nvb	N
m	72-2-481	"	nvb	A
n	72-2-483	"	nvb	A
o	72-2-484	"	3.2	A
p	72-2-485	"	2.7	A
q	72-2-488	"	nvb	N

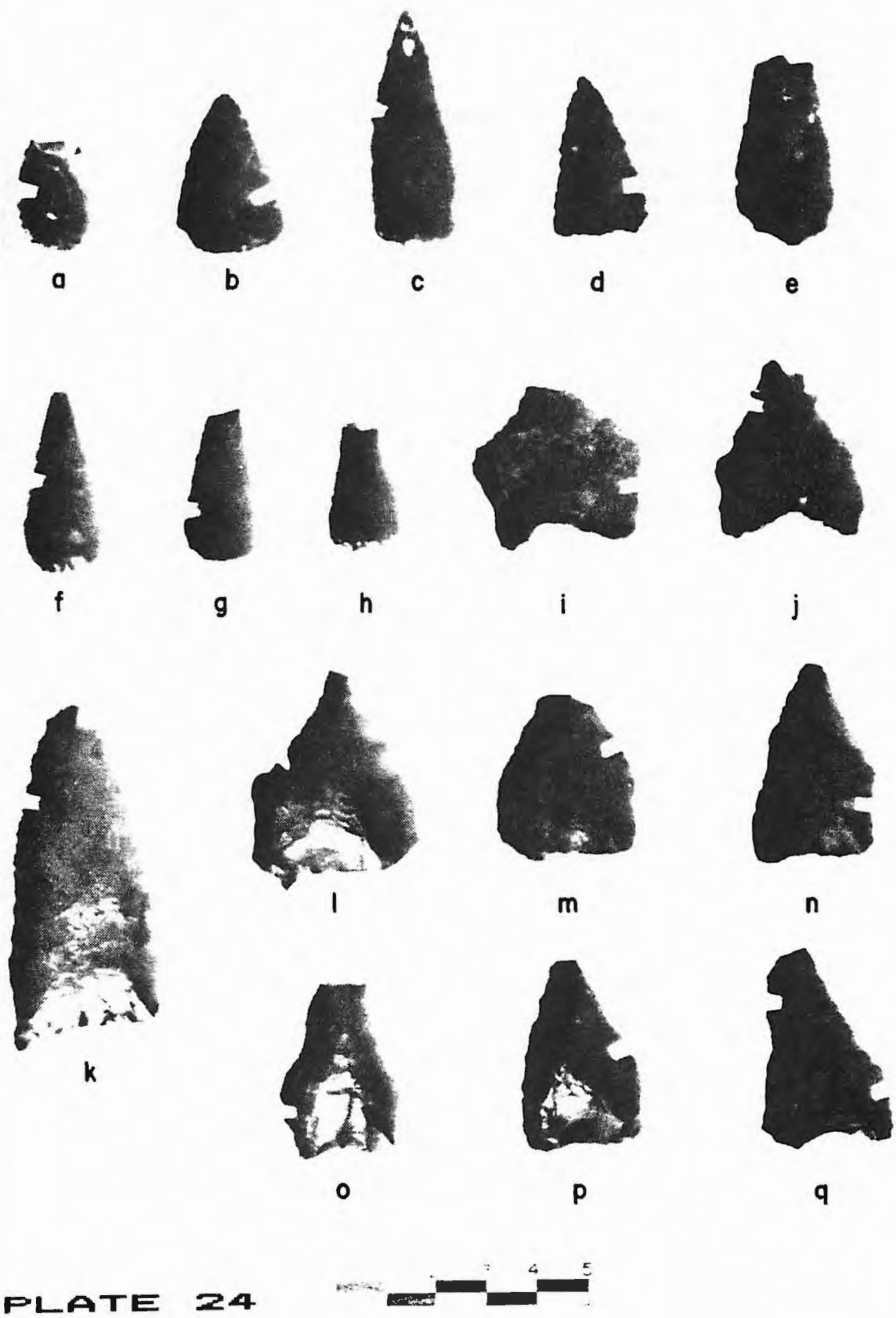

PLATE 24

PLATE 25

Specimen	Catalog #	Site	Hydration	Source
Concave Base				
a	72-2-489	Hector Lee Coll.	nvb	N
b	72-2-543	"	nvb	N
c	75-28-175	CA-SON-159	nvb	N
d	73-13-10	CA-SON-358	4.2	N
e	73-13-11	"	nvb	A
f	2038	CA-SON-456	2.4	A
g	TO/33	CA-SON-655	2.8/3.4	N
h	TO/37	"	2.1	A
i	TO/173	"	3.4	N
j	TO/210	"	2.6	N
k	TO/241	"	3.4	N
l	77-9-538	CA-SON-979	4.6	A
m	77-9-1103	"	nvb	A

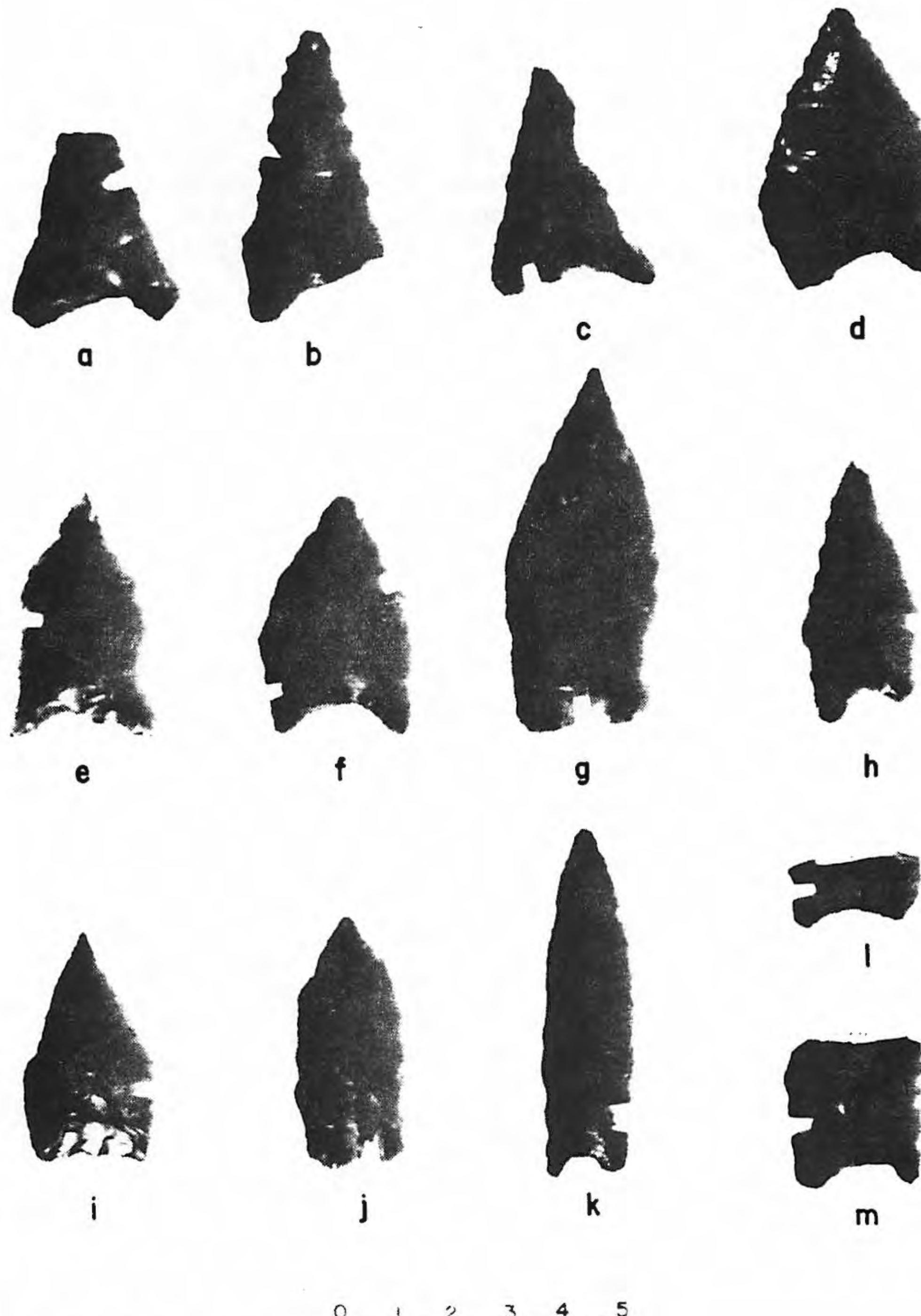

PLATE 25

PLATE 26

Specimen	Catalog #	Site	Hydration	Source
Concave Base				
a	79-4-160	CA-SON-1048	2.4/3.1	N
b	79-4-169	"	4.3	N
c	74-4-474	CA-SON-1049	nvb	A
d	80-3-5	CA-SON-1262	3.4	N
e	47-1165	CA-MRN-192	5.0	N
f	75-6-7-27	CA-MRN-396	3.1	N
g	75-6-7-436	"	2.3	N
Single-shouldered Lanceolate				
h	81-12-203	CA-SON-20b	5.9	A
i	81-12-220	CA-SON-20a	3.1	N
j	81-12-224	CA-SON-20b	3.0	A

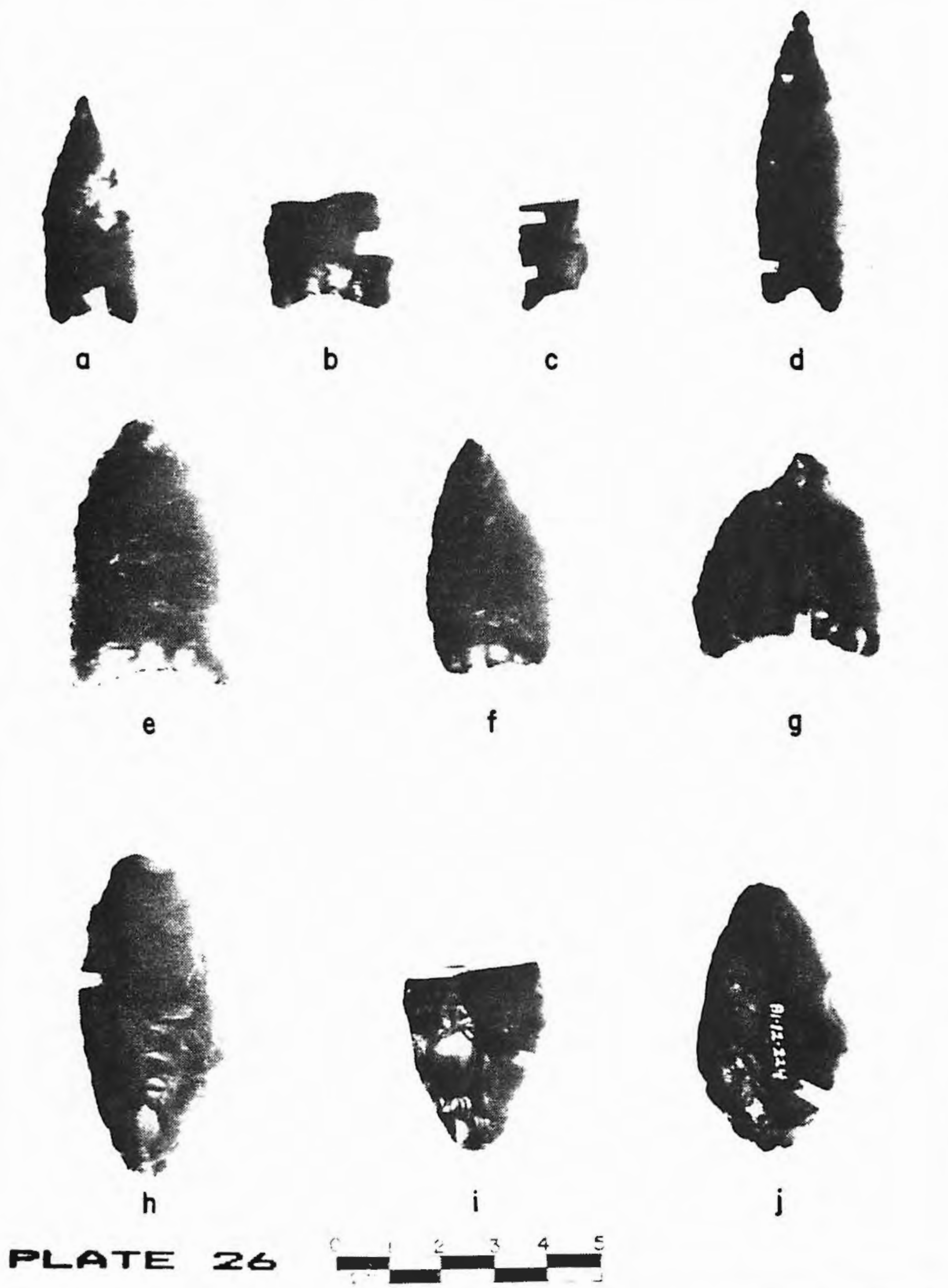

PLATE 26

PLATE 27

Specimen	Catalog #	Site	Hydration	Source
Diamond Lanceolate				
a	81-9-43	CA-SON-1343	2.7/4.4	N
b	72-2-493	Hector Lee Coll.	4.8	N
c	TO/175	CA-SON-655	4.0	N
Wide-stemmed				
d	72-2-478	Hector Lee Coll.	2.2	A
e	TO/324	CA-SON Isolates	nvb	A
f	81-12-182	CA-SON-20b	6.8	A
g	81-12-186	"	6.2	N
h	81-12-187	"	6.9	N
i	81-12-188	"	6.4	N
j	79-11-5	CA-SON-1195	3.5	A
k	75-247-C-1	CA-SON Isolates	3.3	A
l	11666	CA-MRN-216	nvb	A

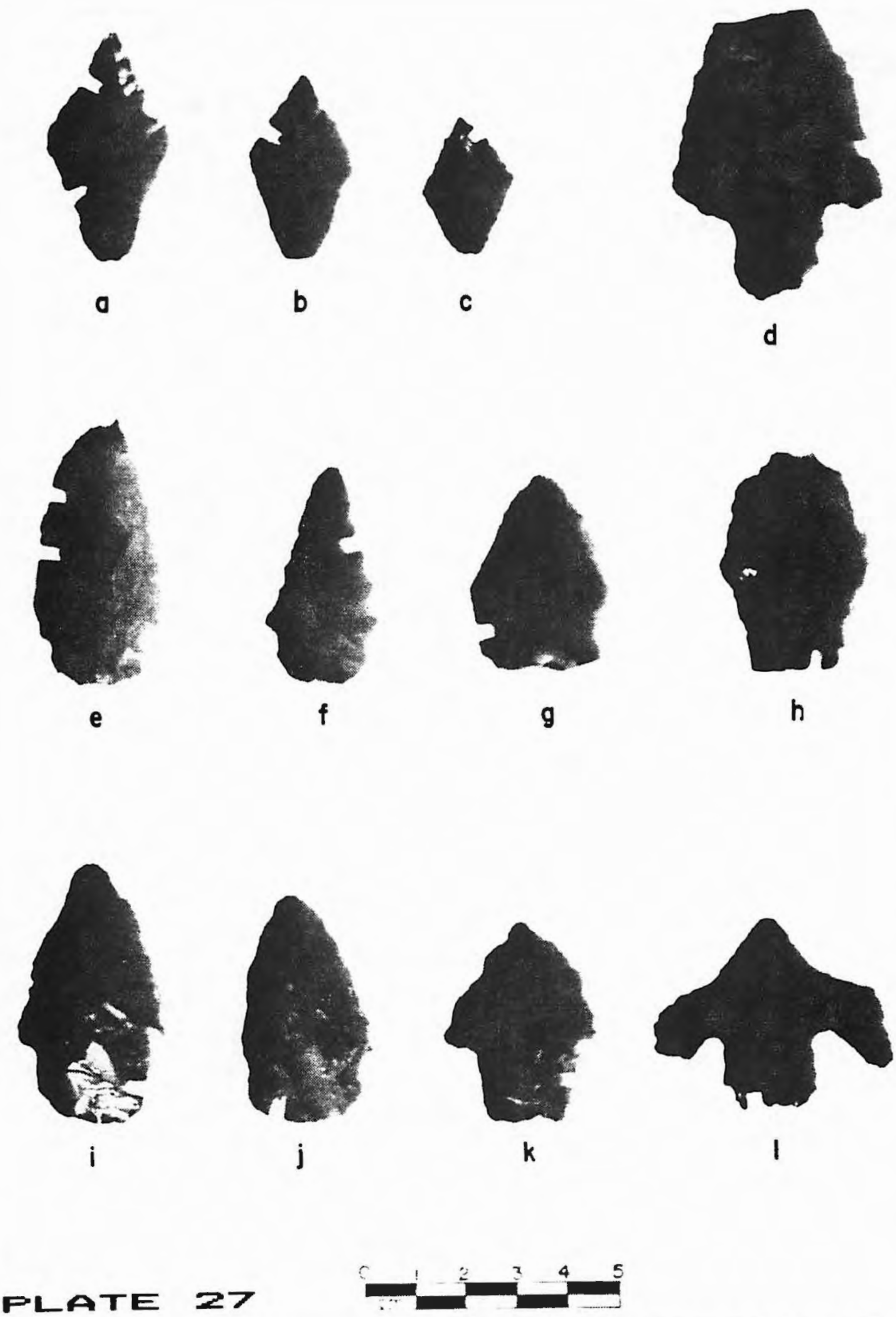

PLATE 27

PLATE 28

Specimen	Catalog #	Site	Hydration	Source
Wide-stemmed				
a	81-1-3	Jess Robel Coll.	3.8	A
b	81-1-4	"	1.4	A
Shouldered Lanceolate				
c	81-1-5	Jess Robel Coll.	2.4	N
d	81-1-6	"	2.4	N
e	81-1-7	"	2.3	N
f	81-1-8	"	2.8	N
Concave Base				
g	81-1-10	Jess Robel Coll.	nvb	A
h	81-1-11	"	2.7	A

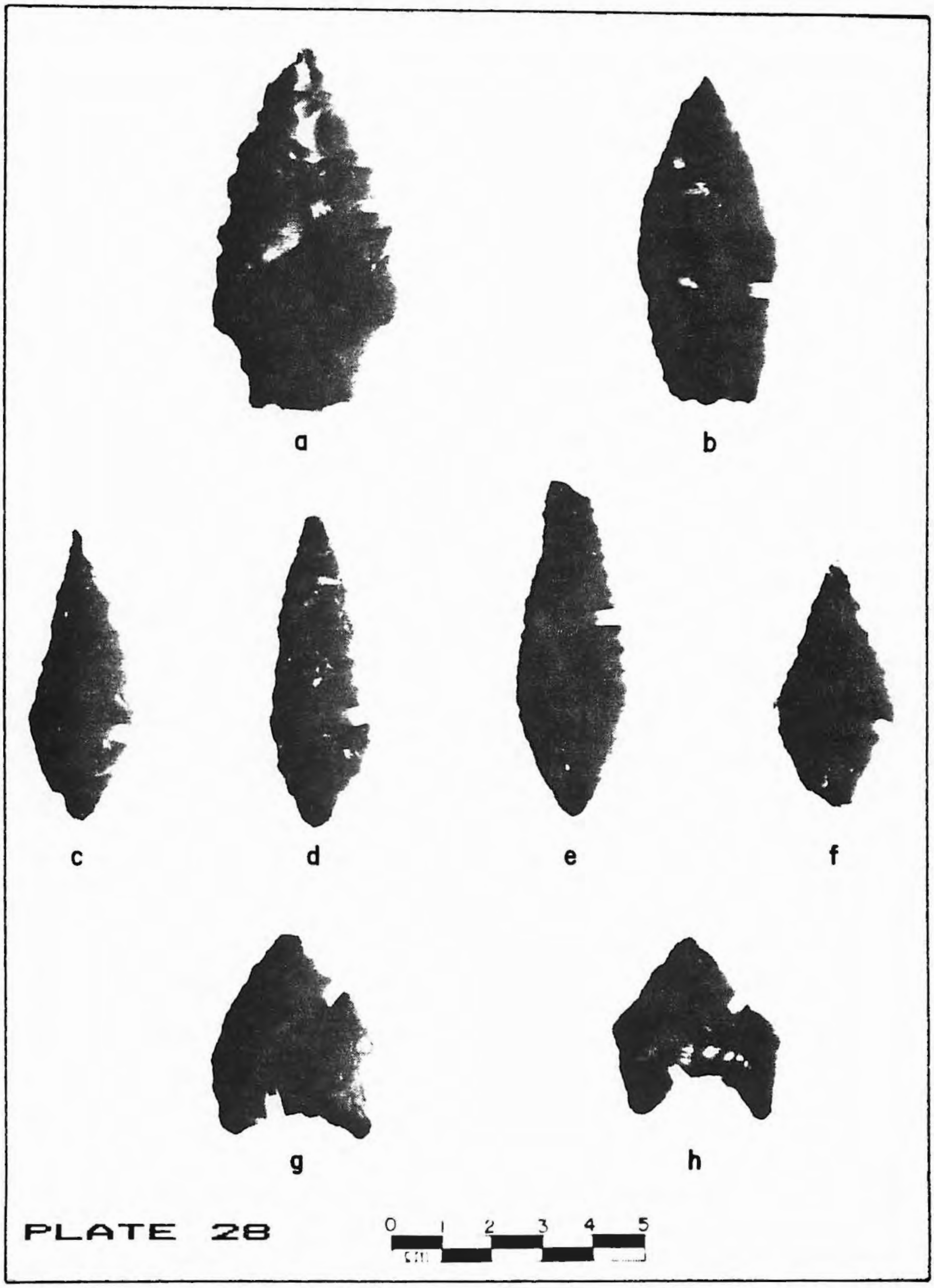

PLATE 28

APPENDIX B

SPECIMEN PREPARATION AND HYDRATION MEASUREMENTS

Appendix B

SPECIMEN PREPARATION AND HYDRATION MEASUREMENTS

Specimen Preparation

Extensive descriptions of procedures for obsidian sample preparation and hydration measurement are reported by Arnold (1967), Clark (1961), Friedman and Smith (1960), Michels (1965), and Michels and Bebrich (1971). Procedures used in this study for obsidian thin-section preparation and hydration measurement are succinctly described below.

Obsidian specimens were examined in order to locate two or more surfaces that would yield edges prependicular to the microslide to which they were adhered when preparation of the sample was completed. After location of such a locus, two parallel cuts were made with a water-cooled diamond impregnated circular saw blade. The result of the cut normally was a pie-shaped wedge with a thickness of approximately one millimeter.

The wedge was broken free of the specimen and mounted with heat-softened Lakeside cement to a pre-numbered microslide. Reduction of the thickness of the wedge was accomplished by hand-held grinding with a slurry of #600 corundum abrasive on a glass plate. Grinding motion followed a figure eight pattern to insure even wear. Initial grinding removed approximately 2/5 of the wedge thickness, eliminating microchips caused by the saw blade during the cutting process. The slide was reheated, the Lakeside cement softened, and the wedge inverted. The newly exposed surface was then ground until a thickness of 30-50 microns was attained. The final thickness was measured by the "touch" technique whereby a finger was run over the glass surface onto the wedge and the difference estimated by feel. A second technique employed for determining the proper final thin-section thickness is termed the "transparency" test whereby the slide is held against a strong light source and its transparency observed.

When the desired thickness of the thin-section was attained, the slide was again heated, which cleared the obsidian wedge perimeter of corundum abrasive and scratches in the Lakeside cement. A glass coverslip was affixed over the wedge to the microslide with piccolyte, a mounting media having properties similar to those of Canada balsam.

Examination and measurement of the hydration bands was accomplished with an American Optical petrographic microscope. Measurement of hydration band thickness was made with a Bausch and Lomb 12.5 power filar micrometer eyepeice. For most specimens, a 45 power objective was adequate, however, for very thin hydration bands approximately 1 micron) a 100 power oil emersion objective was used occasionally. Six measurements were taken at up to six loci on each specimen.

All completed microslides and their respective hydration band measurements are on file at the Obsidian Hydration Laboratory, Anthropological Studies Center, Sonoma State University.

The following tables provide hydration information. The information is organized on the tables as follows:

site trinomial
name of the submitter(s)
hydration lab technician
date(s) of preparation
OH No. (obsidian hydration lab #)
Cat. No. (submitter's catalog #)
Description (of specimen)
Provenience
Remarks (abbreviations explained at end of table)
Readings (hydration measurements in microns)
Mean (hydration mean in microns)
Source (name of obsidian deposit).

Under the Description heading, the following abbreviations were utilized:

c-n = corner-notched
g-l = Gunther-like
lg sc-n = large side/corner-notched
sl = shouldered lanceolate
s-sl = single-shouldered lanceolate
n-sl = non-shouldered lanceolate
dl = diamond lanceolate
cs = convex stemmed
cb = concave base
ws = wide stemmed.

CA-MRN-27	Thomas Origer				Thomas Origer	March 1982	
OH No.	Cat. No.	Description	Provenience	Remarks	Readings	Mean	Source
82-H135-05	67-1-35	point/sl	unknown	none	2.3 2.3 2.3 2.3 2.3 2.4	2.3	Napa
82-H135-11	67-1-154	point/sl	A51/?	none	3.0 3.1 3.1 3.1 3.2 3.3	3.1	Napa
82-H135-12	67-1-157	point/sl	A50/100-120 cm	none	3.2 3.2 3.3 3.3 3.4 3.5	3.3	Napa
82-H135-13	67-1-158	point/n-sl	A50/100-120 cm	none	3.3 3.3 3.4 3.6 3.6 3.6	3.5	Napa
82-H135-14	67-1-307	point/sl	unknown	none	3.1 3.1 3.1 3.2 3.2 3.3	3.2	Napa

Abbreviations: none

CA-MRN-192	Greg White et al.				Thomas Origer	October 1982	
OH No.	Cat. No.	Description	Provenience	Remarks	Readings	Mean	Source
80-H61-03	47-1165	point/cb	unknown	none	4.8 5.0 5.0 5.0 5.0 5.1	5.0	Napa

Abbreviations: none

CA-MRN-202	Thomas Origer				Thomas Origer	March 1982	
OH No.	Cat. No.	Description	Provenience	Remarks	Readings	Mean	Source
82-H136-01	7-299	point/c-n	surface	none	0.8 0.9 0.9 0.9 1.0 1.0	0.9	Annadel
82-H136-02	7-500	point/c-n	surface	none	0.9 1.0 1.0 1.0 1.0 1.0	1.0	Annadel
82-H136-03	7-659	point/c-n	surface	none	0.9 1.0 1.1 1.1 1.1 1.2	1.1	Annadel
82-H136-04	7-449	point/c-n	surface	none	1.3 1.3 1.4 1.4 1.4 1.4	1.4	Annadel
82-H136-05	7-142	point/c-n	surface	none	1.0 1.0 1.1 1.1 1.1 1.1	1.1	Annadel
82-H136-06	7-17	point/c-n	surface	none	1.1 1.1 1.2 1.3 1.3 1.4	1.2	Annadel
82-H136-07	7-534	point/c-n	surface	none	1.0 1.0 1.1 1.1 1.1 1.1	1.1	Annadel
82-H136-08	7-134	point/c-n	surface	none	1.0 1.0 1.0 1.0 1.1 1.1	1.0	Annadel
82-H136-09	7-282	point/serrated	surface	none	1.3 1.3 1.4 1.4 1.5 1.5	1.4	Annadel
82-H136-10	7-155	point/serrated	surface	none	1.1 1.1 1.2 1.3 1.3 1.4	1.2	Annadel
82-H136-11	7-660	point/c-n	surface	none	0.9 1.0 1.0 1.0 1.1 1.1	1.0	Annadel
82-H136-12	7-8	point/c-n	surface	none	2.6 2.7 2.7 2.9 2.9 2.9	2.8	Annadel
82-H136-13	7-761	point/serrated	surface	none	1.3 1.4 1.4 1.4 1.5 1.5	1.4	Annadel
82-H136-14	7-308	point/serrated	surface	none	1.4 1.4 1.4 1.4 1.5 1.5	1.4	Annadel
82-H136-15	7-6	point/serrated	surface	none	1.3 1.4 1.5 1.5 1.7 1.7	1.5	Annadel
82-H136-16	7-307	point/serrated	surface	none	1.4 1.4 1.5 1.7 1.7 1.8	1.6	Annadel
82-H136-17	7-132	point/serrated	surface	none	2.0 2.0 2.0 2.1 2.1 2.1	2.1	Annadel
82-H136-18	7-1	point/serrated	surface	none	1.5 1.5 1.5 1.7 1.8 1.8	1.6	Annadel
82-H136-19	7-725	point/serrated	surface	none	1.3 1.3 1.4 1.4 1.4 1.5	1.4	Annadel
82-H136-20	7-482	point/serrated	surface	none	1.5 1.5 1.7 1.7 1.7 1.8	1.7	Annadel

Abbreviations: none

CA-MRN-216

CA-MRN-216	Greg White et al.	Thomas Origer	1980

OH No.	Cat. No.	Description	Provenience	Remarks	Readings	Mean	Source
80-H62-03	11666	point/w-s	unknown	nvb			Annadel

Abbreviations: none

CA-MRN-230

CA-MRN-230	Thomas Origer	Thomas Origer	April 1982

OH No.	Cat. No.	Description	Provenience	Remarks	Readings	Mean	Source
82-H140-01	230-45	point/c-n	6/4°	none	1.1 1.1 1.2 1.2 1.2 1.2	1.2	Napa
82-H140-02	230-46	point/c-n	6/8-12°	none	1.5 1.5 1.7 1.7 1.7 1.7	1.6	Napa
82-H140-03	230-47	point/serrated	6/20°	none	1.4 1.5 1.5 1.5 1.7 1.7	1.5	Napa
82-H140-04	230-48	point/c-n	6/16-20°	none	1.1 1.1 1.2 1.3 1.3 1.3	1.2	Napa
82-H140-05	230-49	point/c-n	7/4-8°	1st b	1.1 1.2 1.3 --- --- ---	1.2	Annadel
82-H140-05	230-49	point/c-n	7/4-8°	2nd b	--- --- --- 1.8 1.8 1.9	1.8	Annadel
82-H140-06	230-51	point/c-n	12/16-20°	none	1.3 1.3 1.3 1.4 1.4 1.4	1.4	Napa
82-H140-07	230-52	point/c-n	surface	nvb			Annadel
82-H140-08	230-53	point/c-n	8/0-4°	none	1.5 1.5 1.7 1.7 1.7 1.7	1.6	Annadel
82-H140-09	230-54	point/c-n	5/20-24°	none	1.2 1.2 1.2 1.2 1.3 1.4	1.3	Napa
82-H140-10	230-55	point/c-n	8/12-16°	none	1.4 1.4 1.5 1.5 1.5 1.7	1.5	Annadel
82-H140-11	230-57	point/c-n	8/20-24°	none	1.5 1.7 1.8 1.8 1.8 1.8	1.7	Napa
82-H140-12	230-60	point/c-n	3/12°	none	1.1 1.1 1.2 1.2 1.3 1.3	1.2	Annadel
82-H140-13	230-61	point/c-n	4/4-8°	none	1.5 1.5 1.7 1.8 1.8 1.8	1.7	Napa

Abbreviations: 1st b=1st band 2nd b=2nd band nvb=no visible band

CA-MRN-396

CA-MRN-396	Thomas Origer	Thomas Origer	1980;1982

OH No.	Cat. No.	Description	Provenience	Remarks	Readings	Mean	Source
80-H61-46	75-6-7-27	point/cb	unknown	none	3.0 3.0 3.1 3.2 3.2 3.2	3.1	Napa
80-H61-47	75-6-7-436	point/cb	unknown	none	2.2 2.2 2.2 2.3 2.3 2.4	2.3	Napa
82-H125-01	75-6-100	point/c-n	616/8°	1st b	1.2 1.3 1.3 --- --- ---	1.3	Annadel
82-H125-01	75-6-100	point/c-n	616/8°	2nd b	--- --- --- 1.7 1.7 1.8	1.7	Annadel
82-H125-02	75-6-101	point/c-n	616/13°	1st b	1.4 1.4 1.4 --- --- ---	1.4	Napa
82-H125-02	75-6-101	point/c-n	618/13°	2nd b	--- --- --- 2.9 3.0 3.0	3.0	Napa
82-H125-03	75-6-110	point/c-n	618/20°	none	1.1 1.1 1.1 1.1 1.1 1.2	1.1	Napa
82-H125-04	75-6-116	point/c-n	620/12°	none	1.1 1.1 1.2 1.2 1.3 1.3	1.2	Napa
82-H125-05	75-6-139	point/c-n	623/30°	none	1.3 1.3 1.4 1.4 1.4 1.4	1.4	Annadel
82-H125-06	75-6-143	point/c-n	614/27°	none	1.7 1.8 1.8 1.8 1.9 1.9	1.8	Napa
82-H125-07	75-6-146	point/serrated	614/14°	none	1.9 1.9 2.0 2.0 2.0 2.0	2.0	Napa
82-H125-08	75-6-153	point/serrated	616/24°	none	1.8 1.8 1.8 1.8 1.8 1.9	1.8	Annadel
82-H125-09	75-6-158	point/serrated	619/16°	1st b	1.5 1.5 1.7 --- --- ---	1.6	Napa
82-H125-09	75-6-158	point/serrated	619/16°	2nd b	--- --- --- 1.9 2.0 2.0	2.0	Napa
82-H125-10	75-6-168	point/c-n	F21W;F20E/18°	1st b	1.1 1.2 1.2 --- --- ---	1.2	Napa
82-H125-10	75-6-168	point/c-n	F21W;F20E/18°	2nd b	--- --- --- 1.7 1.7 1.7	1.7	Napa
82-H125-11	75-6-181	point/serrated	H18/28°	none	1.7 1.7 1.7 1.8 1.8 1.9	1.8	Napa
82-H125-12	75-6-182	point/c-n	H18/4°	none	1.0 1.1 1.1 1.1 1.1 1.2	1.1	Napa
82-H125-13	75-6-231	point/c-n	I18/4°	none	1.3 1.3 1.4 1.4 1.4 1.4	1.4	Annadel
82-H125-14	75-6-245	point/serrated	I19/16°	none	1.9 1.9 1.9 2.0 2.0 2.0	2.0	Napa
82-H125-15	75-6-267	point/serrated	T49/4°	none	2.0 2.0 2.0 2.0 2.1 2.2	2.1	Napa

Abbreviations: 1st b=1st band 2nd b=2nd band

CA-SON-HL COLL.	Greg White et al.			Thomas Origer			1980;1982
OH No.	Cat. No.	Description	Provenience	Remarks	Readings	Mean	Source
80-H61-02a	72-2-488A	point/cb	surface	nvb dh			Napa
80-H61-02b	72-2-488A	point/cb	surface	nvb dh			Napa
80-H61-14	72-2-240	point/cb	surface	nvb			Napa
80-H61-15	72-2-481	point/cb	surface	nvb			Annadel
80-H61-16	72-2-483	point/cb	surface	nvb			Annadel
80-H61-17	72-2-484	point/cb	surface	db fb	3.1 3.1 3.1 3.2 3.3 3.3	3.2	Annadel
80-H61-18	72-2-485	point/cb	surface	none	2.6 2.6 2.7 2.7 2.7 2.7	2.7	Annadel
80-H61-20	72-2-489	point/cb	surface	nvb			Napa
80-H61-21	72-2-543	point/cb	surface	nvb db			Napa
80-H62-14	72-2-478	point/w-s	surface	none	2.1 2.1 2.2 2.2 2.3 2.3	2.2	Annadel
82-H171-01	72-2-398	point/sl	surface	none	4.2 4.3 4.4 4.4 4.4 4.5	4.4	Annadel
82-H171-02	72-2-401	point/sl	surface	none	2.6 2.6 2.7 2.9 2.9 2.9	2.8	Napa
82-H171-03	72-2-417	point/sl	surface	none	1.4 1.4 1.5 1.5 1.5 1.7	1.5	Annadel
82-H171-04	72-2-423	point/sl	surface	fb	2.9 2.9 3.0 3.0 3.2 3.2	3.0	Annadel
82-H171-05	72-2-424	point/sl	surface	none	1.7 1.8 1.8 1.9 1.9 1.9	1.8	Napa
82-H171-06	72-2-435	point/sl	surface	none	3.6 3.6 3.6 3.7 3.8 3.8	3.7	Napa
82-H171-07	72-2-439	point/sl	surface	fb	2.2 2.3 2.3 2.4 2.4 2.6	2.4	Napa
82-H171-08	72-2-440	point/sl	surface	fb	2.2 2.3 2.3 2.4 2.5 2.5	2.4	Annadel
82-H171-09	72-2-442	point/sl	surface	none	1.8 2.0 2.0 2.0 2.1 2.2	2.0	Annadel
82-H171-10	72-2-447	point/sl	surface	dh			Annadel
82-H171-11	72-2-449	point/sl	surface	none	2.0 2.0 2.1 2.1 2.1 2.2	2.1	Annadel
82-H171-12	72-2-450	point/sl	surface	none	2.5 2.6 2.7 2.7 2.7 2.7	2.7	Annadel
82-H171-13	72-2-452	point/sl	surface	none	2.4 2.4 2.5 2.5 2.6 2.6	2.5	Annadel
82-H171-14	72-2-456	point/sl	surface	none	2.2 2.3 2.3 2.4 2.4 2.5	2.4	Napa
82-H171-15	72-2-510	point/sl	surface	none	3.2 3.2 3.3 3.3 3.3 3.5	3.3	Napa
82-H171-16	72-2-539	point/sl	surface	none	4.6 4.7 4.7 4.8 4.8 5.0	4.8	Napa
82-H171-17	72-2-576	point/sl	surface	none	3.4 3.4 3.4 3.5 3.6 3.7	3.5	Napa
82-H171-18	72-2-592	point/n-sl	surface	1st b	3.4 3.5 3.5 --- --- ---	3.5	Annadel
82-H171-18	72-2-592	point/n-sl	surface	2nd b	--- --- --- 4.1 4.2 4.3	4.2	Annadel
82-H171-19	72-2-119	point/n-sl	surface	none	3.7 3.7 3.7 3.7 3.8 4.0	3.8	Napa
82-H171-20	72-2-120	point/n-sl	surface	none	3.7 3.8 3.8 3.8 4.0 4.0	3.9	Napa
82-H171-21	72-2-148	point/n-sl	surface	nvb			Annadel
82-H171-22	72-2-149	point/n-sl	surface	db fb	3.4 3.5 3.5 3.6 3.6 3.7	3.6	Annadel
82-H171-23	72-2-154	point/n-sl	surface	none	1.8 1.8 1.8 1.8 1.9 2.0	1.9	Annadel
82-H171-24	72-2-282	point/n-sl	surface	none	2.4 2.5 2.5 2.6 2.7 2.7	2.6	Annadel
82-H171-25	72-2-283	point/n-sl	surface	none	2.6 2.7 2.9 2.9 3.0 3.0	2.9	Annadel
82-H171-26	72-2-294	point/n-sl	surface	none	2.0 2.1 2.1 2.1 2.2 2.2	2.1	Annadel
82-H171-27	72-2-361	point/n-sl	surface	none	3.0 3.0 3.0 3.0 3.1 3.2	3.1	Annadel
82-H171-28	72-2-426	point/n-sl	surface	none	3.6 3.6 3.6 3.7 3.7 3.8	3.7	Napa
82-H171-29	72-2-431	point/n-sl	surface	none	2.2 2.2 2.3 2.3 2.4 2.4	2.3	Annadel
82-H171-30	72-2-438	point/n-sl	surface	nvb			Annadel
82-H171-31	72-2-451	point/n-sl	surface	none	2.5 2.6 2.6 2.6 2.6 2.6	2.6	Napa
82-H171-32	72-2-457	point/n-sl	surface	none	1.9 1.9 2.0 2.1 2.1 2.2	2.0	Annadel
82-H171-33	72-2-507	point/sl	surface	none	2.6 2.7 2.7 2.7 2.9 2.9	2.8	Napa
82-H171-34	72-2-572	point/n-sl	surface	none	2.9 2.9 3.1 3.1 3.1 3.1	3.0	Napa
82-H171-35	72-2-583	point/n-sl	surface	none	3.4 3.4 3.4 3.5 3.6 3.6	3.5	Napa
82-H171-36	72-2-588	point/n-sl	surface	none	1.7 1.7 1.7 1.7 1.8 1.8	1.7	Annadel
82-H171-37	72-2-595	point/n-sl	surface	none	1.7 1.7 1.7 1.8 1.8 1.8	1.8	Annadel
82-H171-38	72-2-472	point/lg sc-n	surface	none	1.7 1.9 1.9 1.9 1.9 2.0	1.9	Napa
82-H171-39	72-2-477	point/lg sc-n	surface	none	1.1 1.1 1.2 1.2 1.4 1.4	1.2	Annadel
82-H171-40	72-2-493	point/dl	surface	none	4.6 4.6 4.7 4.8 5.0 5.0	4.8	Napa

Abbreviations: dh=diffuse hydration nvb=no visible band db=discontinuous band
fb=faint band 1st b=1st band 2nd b=2nd band

CA-SON-ISOLATES Thomas Origer Thomas Origer 1980;1982

OH No.	Cat. No.	Description	Provenience	Remarks	Readings	Mean	Source
80-H61-32	77-3-467	point/cb	surface	none	6.3 6.3 6.4 6.5 6.5 6.5	6.4	Napa
80-H61-39	80-3-267	point/cb	surface	none	3.1 3.2 3.2 3.2 3.3 3.3	3.2	Napa
80-H61-40	73-31-28	point/cb	surface	none	3.7 3.8 3.8 4.0 4.0 4.0	3.9	Napa
82-H120-15	T0/324	point/w-s	surface	nvb			Annadel
82-H120-20	75-247-C-1	point/w-s	surface	none	3.2 3.2 3.3 3.3 3.4 3.4	3.3	Annadel

Abbreviations: nvb=no visible band

CA-SON-JR COLL. Thomas Origer Thomas Origer 1981

OH No.	Cat. No.	Description	Provenience	Remarks	Readings	Mean	Source
81-H108-01	81-1-5	point/sl	surface	none	2.3 2.3 2.3 2.4 2.4 2.5	2.4	Napa
81-H108-02	81-1-6	point/sl	surface	none	2.2 2.3 2.4 2.4 2.4 2.5	2.4	Napa
81-H108-03	81-1-7	point/sl	surface	none	2.2 2.3 2.3 2.4 2.4 2.4	2.3	Napa
81-H108-04	81-1-8	point/sl	surface	none	2.7 2.7 2.7 2.7 2.9 2.9	2.8	Napa
81-H108-05	81-1-10	point/cb	surface	nvb			Annadel
81-H108-06	81-1-11	point/cb	surface	none	2.6 2.7 2.7 2.7 2.7 2.9	2.7	Annadel
81-H108-18	81-1-3	point/w-s	surface	none	not available	3.8	Annadel
81-H108-19	81-1-4	point/w-s	surface	none	not available	1.4	Annadel

Abbreviations: nvb=no visible band

CA-SON-19 Thomas Origer Thomas Origer January 1982

OH No.	Cat. No.	Description	Provenience	Remarks	Readings	Mean	Source
82-H120-11	73-6-1	point/sl	surface	none	4.7 4.7 4.7 4.8 5.0 5.0	4.8	Annadel
82-H120-12	73-6-2	point/n-sl	surface	none	3.0 3.1 3.2 3.2 3.2 3.3	3.2	Annadel
82-H120-13	73-6-3	point/n-sl	surface	none	2.5 2.5 2.5 2.6 2.6 2.7	2.6	Annadel
82-H120-14	73-6-4	point/n-sl	surface	none	3.5 3.5 3.6 3.6 3.6 3.7	3.6	Annadel

Abbreviations: none

CA-SON-20	Brian Wickstrom				Thomas Origer		November 1981
OH No.	Cat. No.	Description	Provenience	Remarks	Readings	Mean	Source
81-H113-01	81-12-182	point/w-s	5/0-10 cm	fb	6.6 6.8 6.8 6.8 6.9 7.0	6.8	Annadel
81-H113-04	81-12-187	point/w-s	surface	none	6.8 6.8 6.9 6.9 7.0 7.1	6.9	Napa
81-H113-05	81-12-192	point/ sl	surface	ws	2.9 3.0 3.0 3.0 3.0 3.0	3.0	Annadel
81-H113-06	81-12-186	point/w-s	surface	none	6.0 6.2 6.3 6.3 6.3 6.3	6.2	Napa
81-H113-07	81-12-188	point/w-s	surface	none	6.3 6.3 6.3 6.4 6.4 6.6	6.4	Napa
81-H113-13	78-17-49	point/c-n	surface	none	0.9 0.9 1.0 1.0 1.0 1.1	1.0	Annadel
81-H113-43	81-12-203	point/ssl	S90W183/10-20 cm	none	5.7 5.8 5.8 5.9 6.0 6.0	5.9	Annadel
81-H113-45	81-12-220	point/ssl	N50W74/10-20 cm	none	3.0 3.0 3.1 3.1 3.2 3.3	3.1	Napa
81-H113-56	81-12-224	point/ssl	S90W194/30-40 cm	none	2.9 2.9 2.9 3.0 3.1 3.1	3.0	Annadel

Abbreviations: fb=faint band ws=weathered surface

CA-SON-84	Adams/Wickstrom				Thomas Origer		March 1980
OH No.	Cat. No.	Description	Provenience	Remarks	Readings	Mean	Source
80-H31-21	78-8-17	point/serrated	5/20-30 cm	none	1.4 1.4 1.5 1.7 1.7 1.7	1.6	Annadel
80-H31-22	78-7-38	point/sl	surface	none	2.7 2.7 2.9 2.9 2.9 2.9	2.8	Annadel
80-H31-23	78-7-269	point/sl	trench	1st b	2.0 2.1 2.1 --- --- ---	2.1	Annadel
80-H31-23	78-7-269	point/sl	trench	2nd b	--- --- --- 3.2 3.2 3.2	3.2	Annadel
80-H31-24	78-7-19	point/sl	2/0-10 cm	none	2.4 2.5 2.5 2.5 2.5 2.5	2.5	Annadel
80-H31-25	78-7-11	point/n-sl	1/20 cm	none	2.2 2.2 2.2 2.4 2.4 2.4	2.3	Annadel
80-H31-26	78-7-12	point/n-sl	1/20 cm	none	3.1 3.1 3.2 3.3 3.3 3.5	3.3	Annadel

Abbreviations: 1st b=1st band 2nd b=2nd band

CA-SON-159		Thomas Origer			Thomas Origer	February 1982	
OH No.	Cat. No.	Description	Provenience	Remarks	Readings	Mean	Source
80-H61-30	75-28-175	point/cb	unknown	nvb			Napa
82-H121-01	72-1-8	point/serrated	1/40-50 cm	none	1.1 1.2 1.2 1.3 1.3 1.3	1.2	Annadel
82-H121-02	72-1-18	point/c-n	2/43 cm	none	2.1 2.1 2.1 2.1 2.2 2.2	2.1	Napa
82-H121-03	72-1-21	point/c-n	surface	none	1.1 1.1 1.2 1.2 1.3 1.3	1.2	Napa
82-H121-04	72-1-25	point/notchless	1/65 cm	none	1.1 1.1 1.2 1.2 1.2 1.2	1.2	Annadel
82-H121-05	72-1-107	point/c-n	1/40-50 cm	none	1.2 1.2 1.3 1.3 1.3 1.4	1.3	Annadel
82-H121-06	72-1-130	point/c-n	1/15 cm	none	1.8 1.8 1.8 1.9 1.9 2.0	1.9	Napa
82-H121-07	72-1-135	point/c-n	1/14 cm	none	1.1 1.2 1.2 1.2 1.3 1.4	1.2	Annadel
82-H121-08	72-1-136	point/c-n	1/11.5 cm	none	1.1 1.1 1.2 1.2 1.2 1.3	1.2	Annadel
82-H121-09	72-1-138	point/serrated	1/0-10 cm	none	1.2 1.2 1.2 1.3 1.3 1.3	1.3	Annadel
82-H121-10	72-1-168	point/c-n	1/19 cm	none	1.3 1.3 1.4 1.5 1.5 1.5	1.4	Annadel
82-H121-11	72-1-176	point/sl	3/15-25 cm	none	5.3 5.4 5.4 5.5 5.5 5.5	5.4	Napa
82-H121-12	77-11-?	point/serrated	S6;W1/79 cm	none	1.4 1.4 1.5 1.5 1.7 1.7	1.5	Napa
82-H121-13	77-11-?	point/notchless	S6;W1/80-90 cm	none	1.1 1.3 1.3 1.3 1.4 1.4	1.3	Annadel
82-H121-14	74-3-15	point/c-n	N10;W12/20 cm	none	1.4 1.5 1.5 1.5 1.7 1.7	1.6	Napa
82-H121-15	74-3-39	point/serrated	N10;W12/20-30 cm	none	1.7 1.7 1.8 1.9 1.9 1.9	1.8	Annadel
82-H121-16	74-3-120	point/c-n	S2;W1/0-10 cm	dh b?			Annadel
82-H121-17	74-3-125	point/serrated	S2;W1/0-10 cm	none	2.1 2.2 2.3 2.3 2.3 2.3	2.3	Napa
82-H121-18	74-3-133	point/c-n	S2;W1/10-20 cm	none	2.7 2.7 2.9 2.9 2.9 3.0	2.9	Napa
82-H121-19	74-3-152	point/sl	N12;W4/11cm	none	2.4 2.4 2.4 2.5 2.5 2.6	2.5	Napa
82-H121-20	74-3-227	point/c-n	unknown	none	1.4 1.4 1.5 1.5 1.7 1.7	1.5	Annadel
82-H121-21	a	point/serrated	S12;W1/40-50 cm	none	2.2 2.2 2.3 2.4 2.5 2.5	2.4	Napa
82-H121-22	b	point/serrated	S10;W1/ahf	none	1.8 1.8 1.8 1.8 1.9 1.9	1.8	Annadel
82-H121-23	c	point/serrated	S10;E0/40 cm	dh			Napa
82-H121-24	d	point/serrated	S8;W1/70-80 cm	none	2.2 2.2 2.3 2.4 2.5 2.5	2.4	Napa
82-H121-25	e	point/serrated	S8;W1/70-80 cm	1st b	1.9 1.9 2.0 --- --- ---	1.9	Napa
82-H121-25	e	point/serrated	S8;W1/70-80 cm	2nd b	--- --- --- 3.5 3.6 3.6	3.6	Napa
82-H121-26	f	point/sl	S8;W1/70-80 cm	none	3.0 3.0 3.1 3.1 3.1 3.2	3.1	Annadel
82-H121-27	g	point/c-n	S12;W12/30-40 cm	nvb b?			Annadel
82-H121-28	h	point/c-n	S10;W1/ahf	none	2.0 2.1 2.2 2.2 2.2 2.2	2.2	Napa
82-H121-29	i	point/c-n	S8;W1/22 cm	none	1.4 1.4 1.4 1.4 1.5 1.5	1.4	Napa
82-H121-30	j	point/n-sl	S10;E0/50 cm	none	1.7 1.8 1.8 1.8 1.8 1.9	1.8	Annadel
82-H121-31	72-1-179	point/serrated	2/20-30 cm	none	1.7 1.8 1.8 1.8 1.9 1.9	1.8	Annadel
82-H121-32	75-28-8	point/n-sl	S12;W1/90 cm	dh			Napa
82-H121-33	75-28-41	point/sl	S14;W1/40-50 cm	none	1.2 1.2 1.3 1.3 1.3 1.3	1.3	Napa
82-H121-34	75-28-125	point/sl	surface	dh			Napa
82-H121-35	75-28-165	point/serrated	S10;E0/80-90 cm	dh			Annadel
82-H121-36	75-28-170	point/sl	S10;E0/90-100 cm	none	3.7 3.7 3.7 3.7 3.7 3.7	3.7	Napa
82-H121-37	75-28-174	point/c-n	S10;E0/?	none	1.7 1.8 1.8 1.8 1.9 1.9	1.8	Annadel
82-H121-38	75-28-198	point/c-n	S12;W1/65 cm	none	1.0 1.0 1.1 1.1 1.1 1.1	1.1	Annadel
82-H121-39	75-28-221	point/n-sl	S14;W1/29 cm	none	3.7 3.7 3.8 3.8 3.8 3.8	3.8	Napa
82-H121-40	75-28-244	point/c-n	S14;W1/0-10 cm	none	1.4 1.4 1.4 1.4 1.5 1.5	1.4	Annadel
82-H121-41	75-28-263	point/n-sl	S14;W1/50-60 cm	nvb			Annadel
82-H121-42	75-28-264	point/serrated	S14;W1/50-60 cm	none	2.2 2.2 2.2 2.2 2.3 2.3	2.2	Annadel

Abbreviations: nvb=no visible band; dh=diffuse hydration; ahf=above housefloor; b?=burned?; 1st b=1st band; 2nd b=2nd band

CA-SON-358

Brian Wickstrom | Thomas Origer | 1980-1982

OH No.	Cat. No.	Description	Provenience	Remarks	Readings	Mean	Source
80-H61-11	73-13-10	point/cb	9/0-10 cm	none	4.1 4.1 4.1 4.2 4.2 4.3	4.2	Napa
80-H61-22	73-13-11	point/cb	unknown	nvb			Annadel
81-H74-01	73-13-2	point/n-sl	surface	none	1.8 1.9 1.9 2.0 2.0 2.2	2.0	Annadel
81-H74-18	73-13-13	point/sl	auger/4cm	none	2.1 2.1 2.2 2.2 2.2 2.2	2.2	Annadel
82-H120-08	73-1-104	point/notchless	surface	none	1.7 1.8 1.8 1.9 1.9 1.9	1.8	Annadel

Abbreviations: nvb=no visible band

CA-SON-445

Origer/Wickstrom | Thomas Origer | March 1981

OH No.	Cat. No.	Description	Provenience	Remarks	Readings	Mean	Source
81-H81-05	73-16-6	point/serrated	surface	none	1.2 1.2 1.3 1.3 1.3 1.3	1.3	Annadel

Abbreviations: none

CA-SON-455		Thomas Origer			Thomas Origer		June 1981	
OH No.	Cat. No.	Description	Provenience	Remarks	Readings		Mean	Source
81-H92-01	1-2-8	point/c-n	F21/20-30 cm	none	1.2 1.2 1.2 1.3 1.4 1.4		1.3	Annadel
81-H92-02	1-2-14	point/c-n	F21/20-30 cm	none	1.4 1.4 1.4 1.4 1.4 1.5		1.4	Annadel
81-H92-03	1-2-15	point/notchless	F21/20-30 cm	none	1.3 1.3 1.4 1.4 1.4 1.4		1.4	Annadel
81-H92-04	1-2-20	point/c-n	F23/30-45 cm	none	1.2 1.3 1.3 1.3 1.4 1.4		1.3	Annadel
81-H92-05	1-2-24	point/c-n	F26/0-10 cm	nvb b?				Annadel
81-H92-06	1-2-29	point/c-n	F27/0-10 cm	none	1.8 1.8 1.8 1.8 1.9 2.0		1.9	Annadel
81-H92-07	1-2-30	point/serrated	F20/10-20 cm	none	1.3 1.3 1.4 1.4 1.4 1.4		1.4	Annadel
82-H92-08	1-2-39	point/serrated	D24/0-10 cm	none	1.3 1.3 1.3 1.4 1.4 1.4		1.4	Annadel
81-H92-09	1-2-56	point/c-n	F22/20-30 cm	none	1.3 1.4 1.4 1.4 1.5 1.5		1.4	Annadel
81-H92-10	1-2-86	point/c-n	D17/20-30 cm	none	1.5 1.7 1.7 1.7 1.8 1.8		1.7	Annadel
81-H92-11	1-2-160	point/serrated	D21/40-50 cm	none	1.3 1.4 1.4 1.4 1.4 1.4		1.4	Annadel
81-H92-12	1-2-162	point/c-n	D21/80-90 cm	fb	1.1 1.2 1.2 1.3 1.3 1.4		1.3	Annadel
81-H92-13	1-2-258	point/c-n	unknown	none	1.0 1.0 1.0 1.0 1.1 1.1		1.0	Annadel
81-H92-14	1-2-262	point/notchless	E23/10-20 cm	none	1.0 1.0 1.0 1.0 1.0 1.1		1.0	Annadel
81-H92-15	1-2-336	point/notchless	E25/0-40 cm	none	1.1 1.1 1.1 1.1 1.2 1.2		1.1	Annadel
81-H92-16	1-2-13	point/c-n	F21/60-70 cm	none	1.1 1.2 1.2 1.2 1.2 1.3		1.2	Annadel
81-H92-17	1-2-22	point/c-n	F23/30-45 cm	none	1.1 1.1 1.2 1.2 1.2 1.3		1.2	Annadel
81-H92-18	1-2-38	point/c-n	D24/0-10 cm	none	1.0 1.0 1.0 1.0 1.0 1.2		1.0	Annadel
81-H92-19	1-2-66	point/c-n	F22/0-10 cm	none	1.1 1.1 1.1 1.2 1.3 1.3		1.2	Annadel
81-H92-20	1-2-83	point/c-n	F20/0-40 cm	none	1.1 1.1 1.2 1.2 1.2 1.3		1.2	Annadel
81-H92-21	1-2-109	point/c-n	F27/10-20 cm	none	1.4 1.4 1.4 1.5 1.7 1.7		1.5	Annadel
81-H92-22	1-2-177	point/c-n	F18/0-10 cm	none	1.2 1.2 1.2 1.3 1.4 1.4		1.3	Annadel
81-H92-23	1-2-206	point/c-n	surface	none	1.3 1.3 1.3 1.4 1.4 1.4		1.4	Annadel
81-H92-24	1-2-207	point/c-n	surface	nvb				Annadel
81-H92-25	1-2-220	point/c-n	D18/0-10 cm	none	1.7 1.7 1.7 1.8 1.8 1.9		1.8	Annadel
81-H92-26	1-2-5	point/c-n	F19/10-20 cm	none	1.3 1.4 1.4 1.4 1.5 1.5		1.4	Annadel
81-H92-27	1-2-47	point/c-n	E24/30-40 cm	none	1.5 1.7 1.7 1.7 1.7 1.7		1.7	Napa
81-H92-28	1-2-79	point/c-n	D20/0-10 cm	none	1.1 1.2 1.2 1.2 1.2 1.3		1.2	Annadel
81-H92-29	1-2-108	point/c-n	E25/20-30 cm	none	1.2 1.3 1.3 1.3 1.3 1.3		1.3	Napa
81-H92-30	1-2-132	point/c-n	F21/0-10 cm	none	1.0 1.0 1.0 1.0 1.1 1.1		1.0	Annadel
81-H92-31	1-2-192	point/c-n	E25/30-40 cm	none	1.1 1.1 1.1 1.2 1.3 1.3		1.2	Napa
81-H92-32	1-2-228	point/c-n	F22/30-40 cm	none	1.5 1.5 1.5 1.5 1.5 1.5		1.5	Napa
81-H92-33	1-2-236	point/c-n	F20/10-20 cm	none	1.4 1.4 1.4 1.5 1.5 1.5		1.5	Napa
81-H92-34	1-2-256	point/c-n	unknown	nvb				Napa
81-H92-35	1-2-276	point/c-n	E23/40-50 cm	none	1.7 1.7 1.7 1.7 1.7 1.8		1.7	Napa
81-H92-36	1-2-70	point/serrated	F17/0-50 cm	none	1.8 1.9 1.9 2.0 2.0 2.0		1.9	Napa
81-H92-37	1-2-315	point/c-n	D27/10-20 cm	none	1.3 1.3 1.4 1.5 1.5 1.5		1.4	Annadel
81-H92-38	1-2-138	point/notchless	unknown	none	1.2 1.2 1.3 1.3 1.3 1.4		1.3	Annadel
81-H92-39	1-2-3	point/notchless	F18/10-20 cm	none	1.1 1.1 1.2 1.2 1.3 1.3		1.2	Annadel
81-H92-40	1-2-135	point/notchless	D20/20-30 cm	none	1.3 1.4 1.4 1.4 1.5 1.5		1.4	Napa
81-H92-41	1-2-210	point/notchless	E24/10-20 cm	none	1.2 1.3 1.3 1.4 1.4 1.5		1.4	Napa
81-H92-42	1-2-99	point/notchless	F24/20-30 cm	none	1.4 1.4 1.4 1.4 1.5 1.5		1.4	Napa
81-H92-42	1-2-2	point/notchless	F18/10-20 cm	none	1.3 1.4 1.4 1.4 1.4 1.5		1.4	Napa
81-H92-44	1-2-71	point/notchless	F22/10-20 cm	nvb				Annadel
81-H92-45	1-2-43	point/c-n	F21/60 cm	none	1.4 1.4 1.4 1.5 1.7 1.7		1.5	Napa
81-H92-46	F-21	point/c-n	F21/0-60 cm	none	1.4 1.5 1.5 1.7 1.7 1.7		1.6	Annadel
81-H92-47	none	point/c-n	unknown	none	1.2 1.2 1.3 1.3 1.3 1.4		1.3	Annadel
81-H92-48	1-2-219	point/c-n	D18/0-10 cm	nvb w				Annadel
81-H92-49	none	point/n-sl	upstream	none	2.6 2.6 2.7 2.7 2.7 2.7		2.7	Napa
81-H92-50	none	point/sl	upstream	none	3.1 3.1 3.1 3.1 3.2 3.2		3.1	Napa

Abbreviations: see next page

CA-SON-455	(Continued)	Thomas Origer	February 1982

OH No.	Cat. No.	Description	Provenience	Remarks	Readings	Mean	Source
81-H92-51	A1	flake!	F23/30-45 cm	none	1.0 1.0 1.0 1.1 1.1 1.2	1.1	Annadel
81-H92-52	A2	flake!	F23/30-45 cm	none	1.0 1.0 1.0 1.0 1.0 1.1	1.0	Annadel
81-H92-53	A3	flake!	F23/30-45 cm	none	1.2 1.2 1.3 1.3 1.3 1.3	1.3	Annadel
81-H92-54	A4	flake!	F23/30-45 cm	none	2.1 2.1 2.2 2.2 2.3 2.3	2.2	Annadel
81-H92-55	A5	flake!	F23/30-45 cm	none	1.1 1.1 1.1 1.2 1.2 1.3	1.2	Annadel
81-H92-56	A6	flake!	F23/30-45 cm	nvb			Annadel
81-H92-57	A7	flake!	F23/30-45 cm	none	1.1 1.1 1.1 1.1 1.1 1.1	1.1	Annadel
81-H92-58	A8	flake!	F23/30-45 cm	none	1.0 1.0 1.0 1.0 1.1 1.1	1.0	Annadel
81-H92-59	A9	flake!	F23/30-45 cm	none	1.1 1.2 1.2 1.2 1.2 1.3	1.2	Annadel
81-H92-60	A10	flake!	F23/30-45 cm	none	1.4 1.4 1.4 1.4 1.4 1.4	1.4	Annadel
81-H92-61	A11	flake!	F23/30-45 cm	none	0.9 1.0 1.0 1.0 1.1 1.1	1.0	Annadel
81-H92-62	A12	flake!	F23/30-45 cm	none	1.1 1.1 1.1 1.2 1.2 1.3	1.2	Annadel
81-H92-63	N1	flake!	F23/30-45 cm	none	1.1 1.2 1.3 1.3 1.5 1.5	1.3	Napa
81-H92-64	N2	flake!	F23/30-45 cm	none	1.4 1.4 1.5 1.5 1.5 1.5	1.5	Napa
81-H92-65	N3	flake!	F23/30-45 cm	nvb			Napa
81-H92-66	N4	flake!	F23/30-45 cm	none	1.3 1.4 1.4 1.5 1.5 1.7	1.5	Napa
81-H92-67	N5	flake!	F23/30-45 cm	nvb			Napa
81-H92-68	N6	flake!	F23/30-45 cm	none	1.1 1.2 1.2 1.2 1.3 1.4	1.2	Napa
81-H92-69	N7	flake!	F23/30-45 cm	none	1.5 1.7 1.7 1.7 1.8 1.8	1.7	Napa
81-H92-70	N8	flake!	F23/30-45 cm	none	1.2 1.2 1.3 1.4 1.5 1.5	1.4	Napa
81-H92-71	N9	flake!	F23/30-45 cm	none	1.3 1.4 1.4 1.5 1.5 1.5	1.4	Napa
81-H92-72	N10	flake!	F23/30-45 cm	none	1.0 1.1 1.1 1.1 1.1 1.1	1.1	Napa
81-H92-73	N11	flake!	F23/30-45 cm	none	1.2 1.2 1.3 1.4 1.4 1.4	1.3	Napa
81-H92-74	N12	flake!	F23/30-45 cm	none	1.5 1.5 1.5 1.5 1.5 1.5	1.5	Napa

Abbreviations: nvb=no visible band   fb=faint band   b?=burned?   w=weathered
!=associated with C14 materials

CA-SON-456		Thomas Origer			Thomas Origer	August 1980	
OH No.	Cat. No.	Description	Provenience	Remarks	Readings	Mean	Source
80-H50-01	2038	point/cb	5S;60E/0'9"	none	2.3 2.3 2.3 2.3 2.4 2.5	2.4	Annadel
80-H50-02	2061	point/sl	10N;10W/?	none	3.0 3.0 3.0 3.0 3.1 3.1	3.0	Napa
80-H50-03	2117	point/sl	20S;40W/1'7"	1st b	3.0 3.0 3.1 --- --- ---	3.0	Napa
80-H50-03	2117	point/sl	20S;40W/1'7"	2nd b	--- --- --- 3.7 3.7 3.8	3.7	Napa
80-H50-04	2118	point/sl	20S;40W/36"	none	3.2 3.2 3.3 3.3 3.3 3.3	3.3	Napa
80-H50-05	2217	point/sl	10N;20E/6"	none	2.2 2.2 2.3 2.3 2.3 2.3	2.3	Napa
80-H50-06	2692	point/sl	10S;25E/1'9"	none	2.1 2.1 2.1 2.2 2.3 2.4	2.2	Annadel
80-H50-07	2700	point/sl	10S;25E/1'10"	none	2.0 2.0 2.0 2.1 2.1 2.2	2.1	Annadel
80-H50-08	2804	point/sl	35S;15E/3'4"	none	3.0 3.0 3.0 3.1 3.1 3.1	3.1	Annadel
80-H50-09	2866	point/sl	20N;15WII/12"	none	2.7 2.9 2.9 2.9 3.0 3.0	2.9	Annadel
80-H50-10	2998	point/sl	20N;30W/15"	none	2.9 3.0 3.0 3.1 3.1 3.2	3.1	Napa
80-H50-11	3152	point/sl	35N;70E/1'11"	none	1.7 1.7 1.7 1.7 1.7 1.7	1.7	Annadel
80-H50-12	2058	point/serrated	10N;10W/24"	none	1.4 1.5 1.5 1.7 1.7 1.7	1.6	Annadel
80-H50-13	2214	point/serrated	10N;20E/5"	none	1.5 1.5 1.5 1.7 1.7 1.7	1.6	Annadel
80-H50-14	2304	point/serrated	15S;0E/5"	none	1.5 1.7 1.7 1.7 1.7 1.7	1.7	Annadel
80-H50-15	2398	point/serrated	25N;0E/18-24"	none	1.7 1.7 1.7 1.7 1.8 1.8	1.7	Annadel
80-H50-16	2626	point/serrated	10S;25E/8"	none	1.8 1.8 1.9 1.9 1.9 1.9	1.9	Annadel
80-H50-17	2668	point/serrated	0N;50W/1'5"	none	1.8 1.8 1.8 1.8 1.9 1.9	1.8	Annadel
80-H50-18	2777	point/serrated	30N;50E/?	none	1.5 1.5 1.7 1.7 1.7 1.7	1.6	Annadel
80-H50-19	2980	point/serrated	35N;5E/1'5"	none	1.7 1.7 1.7 1.7 1.7 1.7	1.7	Annadel
80-H50-20	3134	point/serrated	35S;5E/1'11"	none	2.0 2.0 2.0 2.0 2.1 2.1	2.0	Annadel
80-H50-21	3064	point/serrated	35N;5E/2'6"	none	2.7 2.9 2.9 2.9 3.0 3.0	2.9	Annadel
80-H50-22	2056	point/c-n	10N;10W/6"	none	1.4 1.5 1.5 1.5 1.5 1.5	1.5	Annadel
80-H50-23	2065	point/c-n	15S;20W/18"	none	1.2 1.2 1.3 1.3 1.3 1.3	1.3	Annadel
80-H50-24	2358	point/c-n	15S;0E/13"	none	1.2 1.2 1.3 1.3 1.3 1.3	1.3	Annadel
80-H50-25	2365	point/c-n	5N;5E/1'7"	dh			Annadel
80-H50-26	2408	point/c-n	10S;5E/6"	none	3.0 3.0 3.0 3.0 3.0 3.1	3.0	Napa
80-H50-27	2570	point/c-n	10N;5W/6"	none	1.1 1.1 1.2 1.2 1.3 1.3	1.2	Annadel
80-H50-28	2617	point/c-n	10S;25E/10"	none	1.1 1.1 1.2 1.3 1.3 1.3	1.2	Annadel
80-H50-29	2728	point/c-n	0N;50W/1'3"	nvb			Napa
80-H50-30	2872	point/c-n	25S;75W/4"	none	1.2 1.3 1.3 1.4 1.4 1.4	1.3	Annadel
80-H50-31	3058	point/c-n	20N;30W/3'9"	none	0.9 1.0 1.1 1.1 1.1 1.2	1.1	Annadel
80-H50-32	2000	point/serrated	0N;70W/12"	none	1.4 1.4 1.5 1.5 1.5 1.7	1.5	Annadel
80-H50-33	2294	point/serrated	0N;15W/9"	none	1.5 1.5 1.5 1.7 1.7 1.8	1.6	Annadel
80-H50-34	2310	point/serrated	5N;5E/6"	none	1.4 1.5 1.5 1.7 1.7 1.7	1.6	Annadel
80-H50-35	2430	point/serrated	5S;20W/1.5"	none	1.9 1.9 1.9 1.9 2.1 2.1	2.0	Annadel
80-H50-36	2484	point/serrated	10S;20E/18"	none	1.7 1.7 1.7 1.7 1.7 1.8	1.7	Annadel
80-H50-37	2486	point/serrated	10S;20E/8"	none	1.7 1.8 1.8 1.8 1.8 1.9	1.8	Annadel
80-H50-38	2497	point/c-n	55S;20E/6-12"	none	1.1 1.1 1.1 1.1 1.2 1.3	1.2	Annadel
80-H50-39	2546	point/serrated	55N;15S/6"	none	1.7 1.7 1.7 1.7 1.8 1.9	1.8	Annadel
80-H50-40	2812	point/serrated	35S;15E/34"	none	5.0 5.0 5.1 5.3 5.3 5.4	5.2	Napa
80-H50-41	3003	point/serrated	20N;20W/22"	none	2.0 2.0 2.1 2.1 2.2 2.2	2.1	Annadel
80-H50-42	3110	point/serrated	25S;75W/?	none	1.7 1.7 1.7 1.8 1.8 1.9	1.8	Annadel
80-H50-43	3120	point/serrated	10S;40E/36"	nvb b?			Annadel
80-H50-44	2379	point/notchless	0N;15W/3"	none	1.3 1.3 1.3 1.3 1.4 1.4	1.3	Annadel
80-H50-45	2488	point/notchless	55S;20E/12"	none	1.3 1.4 1.4 1.4 1.5 1.5	1.4	Annadel
80-H50-46	2605	point/notchless	40N;25W/12"	none	1.3 1.4 1.4 1.4 1.4 1.4	1.4	Annadel
80-H50-47	2666	point/notchless	0N;50W/11"	none	1.7 1.7 1.8 1.8 1.8 1.8	1.8	Annadel
80-H50-48	2702	point/notchless	20N;50E/6-12"	nvb			Annadel
80-H50-49	2817	point/notchless	75S;15E/39"	none	1.3 1.3 1.4 1.4 1.4 1.5	1.4	Annadel
80-H50-50	2897	point/notchless	15N;40WII/10"	none	1.7 1.7 1.7 1.8 1.9 1.9	1.8	Napa
80-H50-51	2119	point/serrated	20S;40W/9"	none	1.3 1.4 1.4 1.4 1.4 1.4	1.4	Annadel
80-H50-52	2227	point/serrated	40N;15E/5"	none	2.0 2.0 2.1 2.1 2.1 2.2	2.1	Napa
80-H50-53	2272	point/serrated	5S;5E/12-18"	none	1.7 1.7 1.8 1.8 1.9 2.0	1.8	Napa
80-H50-54	2748	point/serrated	35S;15E/7"	none	1.5 1.7 1.7 1.8 1.8 1.8	1.7	Annadel
80-H50-55	3002	point/serrated	20N;30W/16"	none	2.3 2.3 2.4 2.5 2.6 2.6	2.5	Napa
80-H50-56	3005	point/serrated	20N;30W/22"	none	1.7 1.7 1.7 1.8 1.8 1.9	1.8	Napa
80-H50-57	2822	point/cs	surface	none	3.8 3.8 4.0 4.0 4.0 4.1	4.0	Annadel

OH No.	Cat. No.	Description	Provenience	Remarks	Readings	Mean	Source
80-H50-58	3208	point/cs	35N;70W/6"	none	2.6 2.6 2.7 2.7 2.7 2.9	2.7	Annadel
80-H50-59	1365	point/n-sl	unknown	none	3.6 3.6 3.7 3.7 3.8 3.8	3.7	Napa
80-H50-60	2489	point/n-sl	55S;20E/6-12"	none	3.2 3.3 3.3 3.3 3.3 3.4	3.3	Annadel
80-H50-63	2566	point/sl	surface	none	3.2 3.2 3.3 3.3 3.4 3.5	3.3	Napa
80-H50-64	2645	point/n-sl	15S;30W/6"	nvb			Annadel
80-H50-65	2660	point/n-sl	25S;15W/4"	none	not available	4.2	Annadel
80-H50-66	2746	point/n-sl	40N;25W/36"	none	3.8 3.8 3.8 4.0 4.1 4.1	3.9	Napa
80-H50-67	2774	point/n-sl	30N;50E/30-36"	b?	1.4 1.4 1.4 1.4 1.5 1.5	1.4	Annadel
80-H50-68	2840	point/sl	35N;5E/6"	none	1.7 1.7 1.8 1.8 1.8 1.8	1.8	Annadel
80-H50-69	2922	point/n-sl	20N;30W/7.5"	none	3.4 3.4 3.5 3.6 3.6 3.6	3.5	Napa
80-H50-70	2142	point/c-n	30N;20E/30"	none	1.4 1.4 1.5 1.5 1.7 1.7	1.5	Napa
80-H50-71	2319	point/c-n	0N;15W/7"	none	1.0 1.0 1.1 1.1 1.2 1.3	1.1	Napa
80-H50-72	2704	point/c-n	30N;50E/10.5"	none	1.4 1.4 1.5 1.5 1.5 1.7	1.5	Napa
80-H50-73	2851	point/c-n	5S;40W/6"	none	0.9 0.9 0.9 1.0 1.0 1.0	1.0	Napa
80-H50-74	3154	point/c-n	5S;40W/?	none	1.1 1.3 1.3 1.3 1.4 1.4	1.3	Napa
80-H50-75	2151	point/sl	15S;20W/32"	none	2.2 2.2 2.3 2.4 2.4 2.5	2.3	Annadel
80-H50-76	2236	point/serrated	40N;15E/11"	none	1.4 1.4 1.5 1.5 1.7 1.9	1.6	Annadel
80-H50-77	2321	point/sl	0N;15W/9.5"	none	1.9 1.9 2.0 2.1 2.1 2.2	2.0	Annadel
80-H50-78	2388	point/sl	4N;5E11/30"	none	4.8 5.0 5.0 5.1 5.1 5.2	5.0	Annadel
80-H50-79	2510	point/sl	5S;20W/24"	none	2.7 2.9 2.9 2.9 3.0 3.0	2.9	Napa
80-H50-80	2697	point/c-n	10S;25E/24"	none	1.2 1.2 1.3 1.4 1.4 1.4	1.3	Annadel
80-H50-81	2996	point/sl	20N;30W/15"	none	2.7 2.7 2.7 2.9 3.0 3.1	2.9	Napa
80-H50-82	3229	point/serrated	30S;35E/18-24"	none	2.0 2.0 2.1 2.1 2.1 2.1	2.1	Napa
80-H50-83	3234	point/c-n	30S;35E/12-18"	none	1.3 1.3 1.3 1.4 1.5 1.7	1.4	Annadel
80-H50-84	3235	point/serrated	30S;35E/12-18"	1st b	1.5 1.5 1.5 --- --- ---	1.5	Annadel
80-H50-84	3235	point/serrated	30S;35E/12-18"	2nd b	--- --- --- 2.2 2.2 2.3	2.2	Annadel
80-H50-85	3236	point/n-sl	30S;35E/12-18"	none	4.2 4.3 4.4 4.4 4.4 4.4	4.4	Napa
80-H50-86	2013	point/notchless	30N;20E/11"	none	1.1 1.1 1.1 1.1 1.1 1.2	1.1	Annadel
80-H50-87	2730	point/notchless	0N;50W/15"	none	1.3 1.3 1.4 1.4 1.4 1.4	1.4	Annadel
80-H50-88	3012	point/lg sc-n	25S;75W/30"	dh			Annadel
80-H50-89	1367	point/n-sl	unknown	none	2.9 2.9 3.0 3.0 3.0 3.0	3.0	Annadel
80-H50-90	2247	point/n-sl	5S;5E/12"	none	2.6 2.6 2.6 2.7 2.7 2.9	2.7	Annadel
80-H50-91A	2505	point/sl	10S;5E/16"	ns	2.0 2.1 2.1 2.1 2.2	2.1	Annadel
80-H50-91B	2505	point/sl	10S/5E/16"	os	2.2 2.2 2.4 2.4 2.5	2.3	Annadel
80-H50-92	3033	point/n-sl	5S;40W/20"	none	2.0 2.1 2.2 2.2 2.4 2.4	2.2	Annadel
80-H50-93	2221	point/c-n	10N;20E/9"	none	1.0 1.0 1.1 1.1 1.2 1.2	1.1	Annadel
80-H50-94	3000	point/c-n	20N;30W/15"	none	1.3 1.3 1.4 1.4 1.4 1.5	1.4	Annadel
80-H50-95	3026	point/c-n	10S;40E/42"	none	1.5 1.7 1.7 1.8 1.8 1.8	1.7	Napa
80-H50-96	2308	point/c-n	25S;0E/4"	none	1.3 1.4 1.4 1.4 1.5 1.5	1.4	Annadel
80-H50-97	2621	point/c-n	10S;25E/6"	none	1.2 1.2 1.4 1.4 1.5 1.5	1.4	Napa
80-H50-98	2850	point/c-n	5S;40W/6"	none	1.5 1.5 1.7 1.7 1.7 1.8	1.7	Napa
80-H50-99	2956	point/c-n	10S;40E/30"	none	1.3 1.3 1.4 1.4 1.4 1.5	1.4	Napa
80-H50-100	3127	point/c-n	35S;5E/15"	none	1.4 1.4 1.4 1.4 1.5 1.5	1.4	Annadel
80-H50-101	2153	point/serrated	15S;20W/31"	none	1.7 1.7 1.7 1.8 1.8 1.9	1.8	Annadel
80-H50-102	2164	point/serrated	20S;55E/17"	none	1.4 1.5 1.5 1.7 1.7 1.8	1.6	Annadel
80-H50-103	2285	point/serrated	5N;5E11/4"	none	1.7 1.7 1.8 1.8 1.8 1.9	1.8	Annadel
80-H50-104	2316	point/serrated	15S;0E/3"	nvb			Annadel
80-H50-105	2663	point/serrated	0N/50W/11.5"	none	1.5 1.7 1.7 1.7 1.8 1.8	1.7	Annadel
80-H50-106	2803	point/serrated	35S;15E/29"	none	1.5 1.5 1.5 1.7 1.7 1.8	1.6	Annadel
80-H50-107	2865	point/serrated	20N;15W11/5"	none	1.4 1.5 1.5 1.7 1.7 1.7	1.6	Napa
80-H50-108	2904	point/serrated	10S;40E/12"	none	2.0 2.0 2.1 2.1 2.1 2.2	2.1	Napa
80-H50-109	2974	point/serrated	35N;5E/11"	none	1.5 1.5 1.7 1.7 1.7 1.8	1.7	Annadel
80-H50-110	3034	point/serrated	5S;40W/31"	nvb			Napa
80-H50-111	3170	point/serrated	35S;5E/9"	none	2.0 2.1 2.2 2.2 2.2 2.2	2.2	Napa

Abbreviations: nvb=no visible band; ns=newer surface; 1st b=1st band; os=older surface; 2nd b=2nd band; b?=burned?; dh=diffuse hydration

CA-SON-466		Thomas Origer			Thomas Origer	October 1981	
OH No.	Cat. No.	Description	Provenience	Remarks	Readings	Mean	Source
80-H50-61	2503	point/n-sl	2/30"	none	2.7 2.7 2.9 2.9 3.0 3.0	2.9	Annadel
80-H50-62	2504	point/sl	2/30"	none	3.3 3.3 3.3 3.4 3.5 3.5	3.4	Napa

Abbreviations: none

CA-SON-518		Thomas Origer			Thomas Origer	March 1982	
OH No.	Cat. No.	Description	Provenience	Remarks	Readings	Mean	Source
82-H128-01	F1-A	flake#	1N;8W/40+ cm	nvb b			Annadel
82-H128-02	F1-B	flake#	1N;8W/40+ cm	none	1.0 1.0 1.0 1.1 1.1 1.1	1.1	Annadel
82-H128-03	F1-C	flake#	1N;8W/40+ cm	none	0.9 0.9 0.9 1.0 1.0 1.0	1.0	Annadel
82-H128-04	F1-D	flake#	1N;8W/40+ cm	none	0.8 0.8 0.8 0.8 0.9 0.9	0.8	Annadel
82-H128-05	F1-E	flake#	1N;8W/40+ cm	none	1.1 1.1 1.1 1.1 1.1 1.1	1.1	Annadel
82-H128-06	F1-F	flake#	1N;8W/40+ cm	none	1.0 1.0 1.1 1.1 1.1 1.2	1.1	Napa
82-H128-07	F1-G	flake#	1N;8W/40+ cm	none	1.2 1.2 1.3 1.4 1.4 1.4	1.3	Napa
82-H128-08	F1-H	flake#	1N;8W/40+ cm	none	1.2 1.2 1.3 1.3 1.4 1.4	1.3	Napa
82-H128-09	F1-I	flake#	1N;8W/40+ cm	dh			Napa
82-H128-10	F1-J	flake#	1N;8W/40+ cm	none	1.2 1.2 1.2 1.3 1.3 1.4	1.3	Napa
82-H128-11	F1-K	flake#	0S;9W/35-45 cm	none	0.9 0.9 1.1 1.1 1.1 1.1	1.0	Annadel
82-H128-12	F1-L	flake#	0S;9W/35-45 cm	none	0.9 0.9 1.0 1.1 1.1 1.1	1.0	Annadel
82-H128-13	F1-M	flake#	0S;9W/35-45 cm	none	1.0 1.0 1.0 1.0 1.0 1.1	1.0	Annadel
82-H128-14	F1-N	flake#	0S;9W/35-45 cm	none	1.1 1.1 1.2 1.3 1.3 1.4	1.2	Napa
82-H128-15	F1-O	flake#	0S/9W/35-45 cm	none	1.1 1.1 1.1 1.1 1.1 1.1	1.1	Napa
82-H128-16	F1-P	flake#	1N;6W/40+ cm	none	1.3 1.3 1.4 1.4 1.4 1.4	1.4	Annadel
82-H128-17	F1-Q	flake#	1N;6W/40+ cm	none	0.9 0.9 1.0 1.1 1.1 1.1	1.0	Annadel
82-H128-18	F1-R	flake#	1N;6W/40+ cm	none	0.8 0.8 0.8 0.8 0.9 0.9	0.8	Annadel
82-H128-19	F1-S	flake#	1N;6W/40+ cm	nvb			Annadel
82-H128-20	F1-T	flake#	1N;6W/40+ cm	none	0.9 1.0 1.0 1.1 1.1 1.2	1.0	Annadel
82-H128-21	F1-U	flake#	1N;6W/40+ cm	none	1.4 1.4 1.5 1.5 1.7 1.7	1.5	Napa

Abbreviations: b=burned dh=diffuse hydration nvb=no visible band
#=associated with C14 materials

CA-SON-655	Origer/Wickstrom				Thomas Origer	Mar;Oct 1981	
OH No.	Cat. No.	Description	Provenience	Remarks	Readings	Mean	Source
81-H81-06	23	point/serrated	surface	none	1.2 1.2 1.3 1.3 1.3 1.4	1.3	Annadel
81-H81-07	177	point/c-n	surface	none	1.2 1.3 1.3 1.3 1.3 1.3	1.3	Annadel
81-H110-01	33	point/cb	surface	1st b	2.7 2.9 2.9 --- --- ---	2.8	Napa
81-H110-01	33	point/cb	surface	2nd b	--- --- --- 3.4 3.4 3.5	3.4	Napa
81-H110-02	159	point/lg sc-n	surface	none	1.5 1.5 1.5 1.7 1.7 1.7	1.6	Annadel
81-H110-03	173	point/cb	surface	none	3.3 3.3 3.3 3.4 3.4 3.4	3.4	Napa
81-H110-05	210	point/cb	surface	none	2.4 2.5 2.5 2.6 2.7 2.7	2.6	Napa
81-H110-07	24	point/c-n	surface	none	1.1 1.1 1.2 1.3 1.3 1.4	1.2	Annadel
81-H110-08	25	point/serrated	surface	none	1.5 1.7 1.7 1.8 1.8 1.8	1.7	Annadel
81-H110-09	26	point/c-n	surface	none	0.9 0.9 1.0 1.0 1.0 1.1	1.0	Napa
81-H110-10	27	point/c-n	surface	none	1.5 1.5 1.7 1.7 1.8 1.9	1.7	Napa
81-H110-11	29	point/c-n	surface	none	1.5 1.5 1.5 1.5 1.7 1.7	1.6	Annadel
81-H110-12	39	point/c-n	surface	none	0.9 1.0 1.0 1.1 1.1 1.1	1.0	Annadel
81-H110-13	40	point/c-n	surface	none	1.7 1.7 1.8 1.8 1.8 1.8	1.8	Napa
81-H110-14	185	point/c-n	surface	none	1.2 1.2 1.4 1.4 1.4 1.4	1.3	Annadel
81-H110-15	187	point/serrated	surface	none	1.7 1.7 1.7 1.7 1.7 1.7	1.7	Annadel
81-H110-16	211	point/serrated	surface	none	1.7 1.8 1.8 1.8 1.8 1.9	1.8	Napa
81-H110-17	212	point/c-n	surface	none	1.2 1.3 1.3 1.4 1.4 1.4	1.3	Annadel
81-H110-18	213	point/c-n	surface	none	0.9 0.9 1.0 1.0 1.1 1.1	1.0	Annadel
81-H110-19	37	point/cb	surface	none	2.0 2.0 2.0 2.1 2.2 2.2	2.1	Annadel
81-H110-20	166	point/lg sc-n	surface	none	2.4 2.5 2.5 2.5 2.5 2.7	2.5	Annadel
81-H110-21	175	point/dl	surface	none	3.8 3.8 4.0 4.0 4.0 4.1	4.0	Napa
81-H110-22	209	point/notchless	surface	none	3.3 3.3 3.4 3.4 3.5 3.6	3.4	Napa
81-H110-23	241	point/cb	surface	none	3.3 3.3 3.4 3.4 3.4 3.4	3.4	Napa
81-H110-24	21	point/sl	surface	none	5.5 5.5 5.5 5.5 5.7 5.8	5.6	Annadel
81-H110-25	22	point/sl	surface	ww	2.6 2.6 2.7 2.7 2.7 2.8	2.7	Annadel
81-H110-26	54	point/sl	surface	none	2.6 2.6 2.7 2.8 2.8 3.0	2.8	Annadel
81-H110-27	133	point/sl	surface	none	2.2 2.3 2.4 2.4 2.4 2.5	2.4	Napa
81-H110-28	153	point/sl	surface	none	2.6 2.6 2.7 2.7 2.7 2.7	2.7	Annadel
81-H110-29	168	point/sl	surface	none	2.4 2.5 2.5 2.5 2.6 2.6	2.5	Napa
81-H110-30	178	point/sl	surface	none	3.0 3.0 3.1 3.2 3.3 3.3	3.2	Annadel
81-H110-31	182	point/sl	surface	none	3.7 3.8 3.8 3.8 3.8 3.8	3.8	Napa
81-H110-32	205	point/sl	surface	none	2.3 2.4 2.5 2.5 2.6 2.6	2.5	Annadel
81-H110-33	206	point/sl	surface	none	1.9 1.9 2.0 2.0 2.0 2.2	2.0	Annadel
81-H110-34	207	point/sl	surface	none	2.6 2.6 2.7 2.7 2.7 2.9	2.7	Napa
81-H110-35	233	point/sl	surface	none	2.9 2.9 2.9 2.9 3.0 3.0	2.9	Napa
81-H110-36	238	point/sl	surface	none	2.2 2.2 2.2 2.3 2.3 2.4	2.3	Napa
81-H110-37	239	point/sl	surface	none	2.3 2.4 2.4 2.4 2.5 2.5	2.4	Napa
81-H110-38	32	point/n-sl	surface	none	2.1 2.1 2.2 2.2 2.2 2.2	2.2	Annadel
81-H110-39	42	point/sl	surface	none	2.5 2.5 2.6 2.6 2.6 2.6	2.6	Napa
81-H110-40	44	point/sl	surface	none	1.7 1.7 1.9 1.9 1.9 2.0	1.9	Annadel
81-H110-41	126	point/sl	surface	none	2.7 2.7 2.7 2.7 2.9 2.9	2.8	Annadel
81-H110-42	141	point/sl	surface	none	not available	2.1	Annadel
81-H110-43	150	point/n-sl	surface	none	2.2 2.2 2.2 2.3 2.3 2.4	2.3	Napa
81-H110-44	180	point/sl	surface	none	2.9 2.9 2.9 3.0 3.1 3.1	3.0	Napa
81-H110-45	183	point/sl	surface	none	2.6 2.6 2.7 2.7 2.7 2.9	2.7	Annadel
81-H110-46	196	point/n-sl	surface	none	1.4 1.5 1.7 1.7 1.7 1.8	1.6	Napa
81-H110-47	199	point/n-sl	surface	none	3.8 3.8 4.0 4.0 4.0 4.1	4.0	Napa
81-H110-48	201	point/n-sl	surface	none	2.7 2.7 2.7 2.7 2.9 3.0	2.8	Annadel
81-H110-49	237	point/n-sl	surface	none	3.3 3.4 3.4 3.5 3.6 3.6	3.5	Annadel
81-H110-50	258	point/n-sl	surface	none	4.4 4.4 4.4 4.5 4.5 4.6	4.5	Napa
81-H110-51	266	point/n-sl	surface	none	4.2 4.2 4.3 4.3 4.4 4.5	4.3	Napa
81-H110-52	267	point/sl	surface	none	3.7 3.8 3.8 3.8 4.0 4.0	3.9	Annadel

Abbreviations: ww=water worn 1st b=1st band 2nd b=2nd band

CA-SON-671

Thomas Origer | Thomas Origer | January 1982

OH No.	Cat. No.	Description	Provenience	Remarks	Readings	Mean	Source
82-H120-03	73-1-9	point/lg sc-n	surface	none	1.3 1.4 1.5 1.5 1.7 1.7	1.5	Annadel
82-H120-04	73-1-33	point/serrated	surface	none	1.9 1.9 1.9 1.9 2.0 2.0	1.9	Napa

Abbreviations: none

CA-SON-674

Thomas Origer | Thomas Origer | January 1982

OH No.	Cat. No.	Description	Provenience	Remarks	Readings	Mean	Source
82-H120-09	73-1-4	point/n-sl	surface	none	1.4 1.4 1.4 1.4 1.4 1.5	1.4	Annadel

Abbreviations: none

CA-SON-677

Thomas Origer | Thomas Origer | January 1982

OH No.	Cat. No.	Description	Provenience	Remarks	Readings	Mean	Source
82-H120-01	A	point/serrated	surface	1st b	2.4 2.4 2.5 --- --- ---	2.4	Annadel
82-H120-01	A	point/serrated	surface	2nd b	--- --- --- 3.4 3.4 3.5	3.4	Annadel
82-H120-02	B	point/serrated	surface	none	1.3 1.4 1.4 1.4 1.5 1.5	1.4	Annadel

Abbreviations: 1st b=1st band 2nd b=2nd band

CA-SON-678

Origer/Wickstrom | Thomas Origer | 1981;1982

OH No.	Cat. No.	Description	Provenience	Remarks	Readings	Mean	Source
81-H81-01	73-1-13	point/c-n	surface	none	1.9 1.9 2.0 2.0 2.0 2.0	2.0	Annadel
81-H81-02	73-1-14	point/serrated	surface	none	1.4 1.4 1.4 1.7 1.7 1.8	1.6	Annadel
81-H81-03	73-1-15	point/c-n	surface	none	0.8 0.8 0.9 0.9 0.9 1.0	0.9	Annadel
81-H81-04	73-1-26	point/c-n	surface	none	1.0 1.0 1.0 1.0 1.0 1.1	1.0	Annadel
82-H120-10	73-1-16	point/notchless	surface	none	0.9 1.0 1.0 1.0 1.0 1.1	1.0	Annadel

Abbreviations: none

CA-SON-704

Thomas Origer | Thomas Origer | January 1982

OH No.	Cat. No.	Description	Provenience	Remarks	Readings	Mean	Source
82-H120-05	73-1-105	point/lg sc-n	surface	none	2.7 2.7 2.7 2.9 2.9 2.9	2.8	Annadel
82-H120-06	73-1-106	point/n-sl	surface	none	2.7 2.9 2.9 3.1 3.1 3.1	3.0	Napa
82-H120-07	73-1-107	point/c-n	surface	nvb			Napa

Abbreviations: nvb=no visible band

CA-SON-744

Origer/Wickstrom	Thomas Origer	March 1981

OH No.	Cat. No.	Description	Provenience	Remarks	Readings	Mean	Source
81-H81-08	TO/293	point/c-n	surface	none	1.2 1.3 1.3 1.4 1.4 1.4	1.3	Annadel
81-H81-09	TO/310	point/serrated	surface	none	1.2 1.2 1.3 1.3 1.3 1.4	1.3	Annadel

Abbreviations: none

CA-SON-966

Barry Price	Thomas Origer	February 1981

OH No.	Cat. No.	Description	Provenience	Remarks	Readings	Mean	Source
81-H72-45	none	point/c-n	surface	none	1.5 1.5 1.5 1.5 1.7 1.7	1.6	Napa

Abbreviations: none

CA-SON-977

Thomas Origer	Thomas Origer	1977

OH No.	Cat. No.	Description	Provenience	Remarks	Readings	Mean	Source
77-H(none)	77-9-234	point/serrated	N3;W73/25-50 cm	none	not available	1.6	Annadel

Abbreviations: none

CA-SON-978

Thomas Origer	Thomas Origer	1977

OH No.	Cat. No.	Description	Provenience	Remarks	Readings	Mean	Source
77-H(none)	77-9-412	point/sl#	N32;W16/55cm	none	3.3 3.3 3.3 3.4 3.5 3.6	3.4	Annadel

Abbreviations: #=associated with C14 materials

CA-SON-979

Thomas Origer	Thomas Origer	1977

OH No.	Cat. No.	Description	Provenience	Remarks	Readings	Mean	Source
77-H(none)	77-9-538	point/cb	N36;W81/0-25 cm	none	not available	4.6	Annadel
77-H(none)	77-9-1103	point/cb	surface	nvb			Annadel
77-H(none)	77-9-71	point/lg sc-n	N39;W60 surface	none	not available	1.8	Annadel
77-H(none)	77-9-729	point/lg sc-n	N39;W102/0-25 cm	none	not available	2.2	Annadel
77-H(none)	77-9-756	point/lg sc-n	N27;W108/0-25 cm	none	not available	1.8	Annadel

Abbreviation.: nvb=no visible band

CA-SON-1048 Rob Jackson 1979

OH No.	Cat. No.	Description	Provenience	Remarks	Readings	Mean	Source
79-H?-29	79-4-158	point/c-n	10N;30E/0-10 cm	none	not available	1.6	Napa
79-H?-31	79-4-169	point/cb	10N;30E/70 cm	none	not available	4.3	Napa
79-H?-33	79-4-160	point/cb	10N;30E/10-20 cm	1st b	not available	2.4	Napa
79-H?-33	79-4-160	point/cb	10N;30E/10-20 cm	2nd b	not available	3.1	Napa
79-H?-34	79-4-187	point/serrated	10N;30E/10-20 cm	none	not available	2.5	Napa

Abbreviations: 1st b=1st band 2nd b=2nd band

CA-SON-1049 Rob Jackson 1979

OH No.	Cat. No.	Description	Provenience	Remarks	Readings	Mean	Source
79-H?-21	79-4-474	point/cb	10N;30E/60-70 cm	nvb			Annadel
79-H?-28	79-4-506	point/n-sl	B/40-50 cm	none	not available	2.9	Annadel

Abbreviations: nvb=no visible band

CA-SON-1082 Mick Hayes Thomas Origer February 1980

OH No.	Cat. No.	Description	Provenience	Remarks	Readings	Mean	Source
80-H30-03	80-1-17	point/serrated	1/10-20 cm	nvb			Annadel
80-H30-11	82-1-35	point/serrated	surface	none	2.4 2.4 2.5 2.5 2.5 2.5	2.5	Napa

Abbreviations: nvb=no visible band

CA-SON-1195 Allan Bramlette Thomas Origer July 1979

OH No.	Cat. No.	Description	Provenience	Remarks	Readings	Mean	Source
79-H9-14	79-11-17	point/c-n	ET;3S/6-7 cm	nvb w?			Annadel
79-H9-15	79-11-13	point/serrated	ST;3E/20-30 cm	1st b	1.4 1.4 1.5 --- --- ---	1.4	Annadel
79-H9-15	79-11-13	point/serrated	ST;3E/20-30 cm	2nd b	--- --- --- 2.0 2.1 2.4	2.2	Annadel
79-H9-16	79-11-9	point/c-n	ET;16S/24-30 cm	none	1.4 1.4 1.5 1.6 1.6 1.8	1.6	Annadel
79-H9-17	79-11-7	point/sl	WT;2S/14 cm	none	2.1 2.2 2.2 2.2 2.3 2.3	2.2	Napa
79-H9-18	79-11-16	point/c-n	ST;0E/20-30 cm	w	1.5 1.5 1.5 1.7 1.7 1.7	1.6	Annadel
79-H9-19	79-11-6	point/sl	ET;10S/22 cm	none	2.4 2.4 2.4 2.6 2.6 2.6	2.5	Annadel
79-H9-20	79-11-8	point/sl	WT;3S/43 cm	none	2.0 2.2 2.2 2.3 2.3 2.3	2.2	Napa
79-H9-21	79-11-5	point/w-s	ET;5S/34 cm	none	3.4 3.5 3.5 3.5 3.5 3.6	3.5	Annadel

Abbreviations: nvb=no visible band w(?)=weathered(?) 1st b=1st band 2nd b=2nd band

CA-SON-1262	Thomas Origer	Thomas Origer	1980;1981

OH No.	Cat. No.	Description	Provenience	Remarks	Readings	Mean	Source
80-H61-38	80-3-5	point/cb	unknown	none	not available	3.4	Napa

Abbreviations: none

CA-SON-1269	Jamie Roscoe	Thomas Origer	June 1981

OH No.	Cat. No.	Description	Provenience	Remarks	Readings	Mean	Source
81-H90-01	81-3-320	point/serrated	80S;25E/surface	db fb	1.9 2.0 2.0 2.1 2.1 2.2	2.1	Napa
81-H90-02	81-3-321	point/serrated	75S;38E/surface	none	1.7 1.7 1.7 1.7 1.7 1.7	1.7	Annadel
81-H90-15	81-3-323	point/serrated	75S;20E/surface	none	1.4 1.5 1.5 1.5 1.7 1.7	1.6	Annadel
81-H90-16	81-3-338	point/serrated	70S;0E/surface	none	1.8 1.8 1.8 1.9 1.9 1.9	1.9	Annadel
81-H90-17	81-3-346	point/serrated	70S;8E/surface	none	1.8 1.8 1.9 1.9 1.9 1.9	1.9	Annadel
81-H90-18	81-3-360	point/serrated	60S;36E/surface	none	1.8 1.8 1.8 1.8 1.9 1.9	1.8	Annadel
81-H93-01	81-3-491	point/c-n	T12/40-60 cm	none	1.8 1.8 1.8 1.9 1.9 1.9	1.9	Napa
81-H93-02	81-3-502	point/serrated	T10/20-40 cm	none	1.9 1.9 2.0 2.1 2.2 2.2	2.1	Annadel
81-H93-03	81-3-515	point/serrated	T1/0-10 cm	none	1.9 1.9 1.9 1.9 1.9 2.0	1.9	Annadel
81-H93-04	81-3-524	point/serrated	T1/40-50 cm	fb	2.2 2.2 2.2 2.2 2.3 2.3	2.2	Annadel
81-H93-05	81-3-613	point/serrated	T3/20-30 cm	none	2.2 2.2 2.3 2.3 2.4 2.5	2.3	Napa
81-H93-06	81-3-621	point/serrated	T3/30-40 cm	db fb	1.9 1.9 1.9 2.0 2.0 2.0	2.0	Napa
81-H93-07	81-3-628	point/notchless	T3/40-50 cm	none	1.5 1.5 1.5 1.5 1.7 1.7	1.6	Annadel
81-H93-08	81-3-661	point/serrated	T13/0-20 cm	none	1.5 1.7 1.7 1.7 1.7 1.8	1.7	Annadel
81-H93-09	81-3-669	point/serrated	T13/20-40 cm	none	2.4 2.5 2.5 2.5 2.5 2.6	2.5	Napa
81-H93-10	81-3-684	point/serrated	T13/40-60 cm	none	1.3 1.4 1.4 1.5 1.5 1.5	1.4	Annadel
81-H93-11	81-3-685	point/serrated	T13/40-60 cm	nvb			Annadel
81-H93-12	81-3-707	point/serrated	T20/0-10 cm	none	1.2 1.2 1.2 1.2 1.2 1.2	1.2	Annadel
81-H93-13	81-3-714	point/serrated	T19/40-60 cm	nvb			Annadel
81-H93-14	81-3-724	point/serrated	T20/60-90 cm	none	2.2 2.2 2.2 2.2 2.3 2.5	2.3	Napa
81-H93-15	81-3-757	point/serrated	T15/0-20 cm	none	1.5 1.5 1.7 1.7 1.7 1.7	1.6	Annadel
81-H93-16	81-3-788	point/c-n	T15/60-90 cm	db fb	2.1 2.1 2.2 2.2 2.2 2.2	2.2	Annadel
81-H93-17	81-3-789	point/serrated	T15/60-90 cm	none	2.2 2.2 2.2 2.2 2.3 2.3	2.2	Napa
81-H93-18	81-3-790	point/c-n	T15/60-90 cm	none	2.1 2.1 2.2 2.3 2.3 2.4	2.2	Annadel
81-H93-19	81-3-813	point/c-n	T15/20-40 cm	none	1.3 1.3 1.4 1.4 1.4 1.5	1.4	Napa
81-H93-20	81-3-858	point/serrated	T11/20-40 cm	db	1.4 1.5 1.5 1.7 1.7 1.7	1.6	Annadel
81-H93-21	81-3-872	point/serrated	T11/40-60 cm	nvb			Annadel
81-H93-22	81-3-883	point/serrated	T11/60-70 cm	none	1.3 1.4 1.4 1.5 1.5 1.5	1.4	Annadel
81-H93-23	81-3-884	point/serrated	T11/60-70 cm	none	1.2 1.2 1.3 1.3 1.3 1.4	1.3	Annadel
81-H93-24	81-3-919	point/serrated	T21/60-80 cm	none	1.5 1.5 1.7 1.7 1.7 1.7	1.6	Annadel
81-H93-25	81-3-1056	point/serrated	T4/50-60 cm	none	2.2 2.2 2.2 2.3 2.4 2.4	2.3	Napa
81-H93-26	81-3-477	point/c-n	T12/20-40 cm	fb	3.1 3.2 3.2 3.2 3.3 3.4	3.2	Annadel
81-H93-27	81-3-442	point/serrated	T17/60-80 cm	1st b	1.1 1.2 1.2 --- --- ---	1.2	Annadel
81-H93-27	81-3-442	point/serrated	T17/60-80 cm	2nd b	--- --- --- 2.2 2.2 2.3	2.2	Annadel
81-H93-28	81-3-610	point/serrated	T3/10-20 cm	none	1.7 1.7 1.8 1.8 1.8 1.8	1.8	Napa
81-H93-29	81-3-441	point/c-n	T17/60-70 cm	fb	1.1 1.2 1.2 1.2 1.3 1.3	1.2	Annadel
81-H93-30	81-3-341	point/serrated	70S;2E/?	none	1.3 1.3 1.4 1.4 1.4 1.4	1.4	Annadel

Abbreviations: see next page

CA-SON-1269 (Continued) Thomas Origer June 1981

OH No.	Cat. No.	Description	Provenience	Remarks	Readings	Mean	Source
81-H93-31	81-3-493	point/g-1	T12/60-90 cm	none	2.1 2.2 2.2 2.2 2.3 2.3	2.2	Napa
81-H93-37	81-3-479	point/notchless	T12/40-60 cm	none	1.5 1.5 1.7 1.8 1.8 1.8	1.7	Annadel
81-H93-44	81-3-483	flake/utilized*	T12/40-60 cm	none	2.1 2.2 2.2 2.3 2.4 2.4	2.3	Annadel
81-H93-45	81-3-484	flake/utilized*	T12/40-60 cm	none	1.7 1.7 1.7 1.7 1.7 1.8	1.7	Annadel
81-H93-46	81-3-487	flake/utilized*	T12/40-60 cm	none	1.9 1.9 1.9 2.0 2.0 2.1	2.0	Annadel
81-H93-47	81-3-488	flake/utilized*	T12/40-60 cm	none	1.5 1.7 1.7 1.7 1.7 1.7	1.7	Annadel
81-H93-48	81-3-489	flake/utilized*	T12/40-60 cm	none	1.8 1.8 1.9 1.9 1.9 1.9	1.9	Annadel
81-H93-49	81-3-485	flake/utilized*	T12/40-60 cm	none	2.1 2.1 2.2 2.2 2.2 2.2	2.2	Napa
81-H93-50	81-3-490	flake/utilized*	T12/40-60 cm	none	2.4 2.4 2.4 2.5 2.5 2.5	2.4	Napa
81-H93-51	81-3-546a	flake*	T12/40-60 cm	none	1.7 1.7 1.8 1.9 1.9 2.0	1.8	Napa
81-H93-52	81-3-546b	flake*	T12/40-60 cm	none	1.9 1.9 1.9 1.9 2.0 2.0	1.9	Napa
81-H93-53	81-3-546c	flake*	T12/40-60 cm	none	1.9 1.9 2.0 2.1 2.2 2.2	2.1	Napa
81-H93-54	81-3-546d	flake*	T12/40-60 cm	none	1.7 1.7 1.7 1.7 1.8 1.8	1.7	Napa
81-H93-55	81-3-546e	flake*	T12/40-60 cm	none	2.1 2.1 2.1 2.2 2.2 2.2	2.2	Napa
81-H93-56	81-3-546f	flake*	T12/40-60 cm	none	1.9 1.9 1.9 1.9 2.0 2.1	2.0	Napa
81-H93-57	81-3-546g	flake*	T12/40-60 cm	none	1.9 2.0 2.1 2.1 2.2 2.2	2.1	Napa
81-H93-58	81-3-546h	flake*	T12/40-60 cm	fb	2.0 2.0 2.0 2.1 2.1 2.2	2.1	Napa
81-H93-59	81-3-546i	flake*	T12/40-60 cm	none	1.9 2.1 2.1 2.1 2.1 2.2	2.1	Annadel
81-H93-60	81-3-546j	flake*	T12/40-60 cm	1st b	2.1 2.1 2.2 --- --- ---	2.1	Annadel
81-H93-60	81-3-546j	flake*	T12/40-60 cm	2nd b	--- --- --- 2.6 2.6 2.6	2.6	Annadel
81-H93-61	81-3-546k	flake*	T12/40-60 cm	none	1.4 1.5 1.5 1.7 1.7 1.7	1.6	Annadel
81-H93-62	81-3-546l	flake*	T12/40-60 cm	none	1.7 1.7 1.7 1.7 1.8 1.8	1.7	Annadel
81-H93-63	81-3-486	chunk*	T12/40-60 cm	none	1.9 1.9 2.0 2.0 2.0 2.2	2.0	Annadel

Abbreviations: 1st b=1st band; 2nd b=2nd band; db=discontinuous band; fb=faint band; nvb=no visible band; *=associated with C14 materials

CA-SON-1281 Amaroli/Origer Thomas Origer September 1982

OH No.	Cat. No.	Description	Provenience	Remarks	Readings	Mean	Source
82-H182-01	82-1-134	point/serrated*	cremation	none	2.5 2.5 2.5 2.5 2.5 2.5	2.5	Napa
82-H182-02	82-1-135	biface*	cremation	none	2.0 2.1 2.3 2.3 2.3 2.3	2.2	Annadel
82-H182-03	82-1-137	point/n-sl*	cremation	none	2.2 2.2 2.2 2.3 2.3 2.3	2.3	Napa
82-H182-04	82-1-138	biface*	cremation	none	1.9 1.9 2.0 2.0 2.0 2.0	2.0	Annadel
82-H182-05	82-1-139	unifacial tool*	cremation	none	3.5 3.6 3.6 3.6 3.6 3.6	3.6	Annadel
82-H182-06	82-1-140	point/serrated*	cremation	none	1.3 1.3 1.3 1.3 1.4 1.4	1.3	Napa
82-H182-07	82-1-141	unifacial tool*	cremation	none	1.9 1.9 2.0 2.0 2.0 2.1	2.0	Annadel
82-H182-08	82-1-142	point/serrated*	cremation	none	1.5 1.5 1.5 1.5 1.7 1.7	1.6	Annadel
82-H182-09	82-1-143	unifacial tool*	cremation	vw		3.0+	Annadel
82-H182-10	82-1-144	point/n-sl*	cremation	1st b	1.5 1.5 1.7 --- --- ---	1.6	Napa
82-H182-10	82-1-144	point/n-sl*	cremation	2nd b	--- --- --- 2.2 2.2 2.2	2.2	Napa
82-H182-11	82-1-145	point/n-sl*	cremation	none	2.4 2.4 2.4 2.4 2.5 2.5	2.4	Napa
82-H182-12	82-1-146	biface*	cremation	none	2.1 2.1 2.2 2.3 2.3 2.3	2.2	Napa
82-H182-13	82-1-147	biface*	cremation	none	1.8 1.8 1.9 1.9 1.9 1.9	1.9	Annadel
82-H182-14	82-1-148	unifacial tool*	cremation	nvb			Annadel

Abbreviations: 1st b=1st band; 2nd b=2nd band; *=associated with C14 materials; nvb=no visible band; vw=varying width

CA-SON-1343	Thomas Origer				Thomas Origer	August 1981	
OH No.	Cat. No.	Description	Provenience	Remarks	Readings	Mean	Source
81-H96-01	81-9-44	point/lg sc-n	S8;W12/surface	none	2.3 2.4 2.4 2.5 2.6 2.6	2.5	Annadel
81-H96-02	81-9-31	point/n-sl	S24;W20/surface	none	2.6 2.7 2.7 2.7 2.7 2.9	2.7	Napa
81-H96-03	81-9-43	point/dl	S26;W8/surface	ns	2.6 2.7 2.7 2.7 2.7 2.7	2.7	Napa
81-H96-04	81-9-43	point/dl	S26;W8/surface	os	4.3 4.3 4.4 4.4 4.4 4.4	4.4	Napa
81-H96-11	81-9-42	point/sl	S24;W6/80-90 cm	none	2.6 2.6 2.7 2.7 2.7 2.9	2.7	Annadel

Abbreviations: ns=newer surface os=older surface

CA-NAP-376	Thomas Origer				Thomas Origer	February 1982	
OH No.	Cat. No.	Description	Provenience	Remarks	Readings	Mean	Source
82-H123-01	79-8-45	point/serrated	5N;35E/surface	none	2.0 2.0 2.1 2.1 2.1 2.2	2.1	Napa
82-H123-02	79-8-69	point/serrated	25N;10E/surface	none	1.9 1.9 1.9 2.0 2.1 2.1	2.0	Napa
82-H123-03	79-8-70	point/serrated	30N;60E/surface	none	2.1 2.1 2.1 2.1 2.2 2.4	2.2	Napa
82-H123-04	79-8-73	point/serrated	30N;30E/surface	none	2.2 2.2 2.2 2.2 2.2 2.2	2.2	Napa
82-H123-05	79-8-77	point/serrated	50N;5E/surface	none	1.7 1.8 1.8 1.8 1.9 1.9	1.8	Napa
82-H123-06	79-8-84	point/serrated	70N;40E/surface	none	1.7 1.8 1.9 1.9 1.9 1.9	1.9	Napa
82-H123-07	79-8-95	point/serrated	70N;15E/surface	none	1.4 1.4 1.7 1.7 1.7 1.7	1.6	Napa
82-H123-08	79-8-102	point/serrated	35N;20E/surface	none	2.1 2.1 2.1 2.1 2.2 2.2	2.1	Napa
82-H123-09	79-8-110	point/serrated	15N;40E/surface	none	1.8 1.8 1.9 1.9 1.9 2.0	1.9	Napa
82-H123-10	79-8-118	point/serrated	10N;10E/surface	none	1.5 1.5 1.5 1.5 1.7 1.8	1.6	Napa
82-H123-11	79-8-116	point/notchless	40N;20E/surface	none	4.3 4.3 4.3 4.4 4.4 4.5	4.4	Napa
82-H123-12	79-8-177	point/notchless	45N;50E/surface	none	2.1 2.2 2.2 2.2 2.2 2.3	2.2	Napa
82-H123-13	79-8-43	point/c-n	5N;50E?/surface	none	1.5 1.5 1.7 1.7 1.7 1.8	1.7	Napa
82-H123-14	79-8-63	point/c-n	15N;5E/surface	none	1.2 1.3 1.3 1.3 1.3 1.5	1.3	Napa
82-H123-15	79-8-135	point/c-n	80N;0E/surface	1st b	1.8 1.8 1.8 --- --- ---	1.8	Napa
82-H123-15	79-8-135	point/c-n	80N;0E/surface	2nd b	--- --- --- 2.5 2.6 2.9	2.7	Napa
82-H123-16	79-8-158	point/c-n	55N;45E/surface	none	1.5 1.5 1.7 1.7 1.7 1.8	1.7	Napa
82-H123-17	79-8-162	point/c-n	45N;65E/surface	none	0.9 0.9 1.0 1.1 1.1 1.1	1.0	Napa
82-H123-18	79-8-169	point/c-n	15N;20E/surface	none	1.7 1.7 1.8 1.8 1.8 1.9	1.8	Napa
82-H123-19	79-8-181	point/c-n	40N;65E/surface	none	1.7 1.7 1.7 1.8 1.8 1.9	1.8	Napa
82-H123-20	79-8-184	point/c-n	40N;5E/surface	none	2.0 2.0 2.0 2.1 2.1 2.2	2.1	Napa
82-H123-21	79-8-81	point/serrated	65N;30E/surface	dh			Napa
82-H123-22	79-8-87	point/serrated	40N;65E/surface	none	2.0 2.0 2.1 2.2 2.4 2.4	2.2	Napa
82-H123-23	79-8-112	point/serrated	40N;50E/surface	none	2.1 2.1 2.2 2.2 2.2 2.3	2.2	Napa
82-H123-24	79-8-44	point/c-n	5N;50E?/surface	none	1.1 1.1 1.1 1.2 1.3 1.3	1.2	Napa
82-H123-25	79-8-160	point/c-n	10N;20E/surface	none	1.1 1.1 1.1 1.1 1.2 1.2	1.1	Napa
82-H123-26	79-8-97	point/serrated	45N;75E/surface	1st b	1.9 1.9 1.9 --- --- ---	1.9	Napa
82-H123-26	79-8-97	point/serrated	45N;75E/surface	2nd b	--- --- --- 2.2 2.3 2.3	2.3	Napa
82-H123-27	79-8-108	point/serrated	15N;40E/surface	none	2.6 2.6 2.7 2.7 2.7 2.9	2.7	Napa
82-H123-28	79-8-67	point/serrated	10N;15E/surface	none	1.7 1.7 1.7 1.8 1.8 1.9	1.8	Annadel
82-H123-29	79-8-93	point/serrated	30N;40E/surface	1st b	1.8 1.8 1.8 --- --- ---	1.8	Annadel
82-H123-29	79-8-93	point/serrated	30N;40E/surface	2nd b	--- --- --- 2.7 2.9 3.0	2.9	Annadel
82-H123-30	79-8-78	point/serrated	40N;40E/surface	none	2.3 2.3 2.4 2.4 2.4 2.5	2.4	Napa

Abbreviations: 1st b=1st band 2nd b=2nd band dh=diffuse hydration

APPENDIX C

OBSIDIAN SOURCE DETERMINATION

Appendix C

OBSIDIAN SOURCE DETERMINATION

Techniques of obsidian source determination used to identify specimens analyzed in this study included macroscopic visual examination and x-ray fluorescence spectrography. The merits of macroscopic visual examination, x-ray fluorescence spectrography, and other methods of obsidian source determination have been reviewed by a number of researchers (e.g., Ericson 1977; Griffin, Gordus, and Wright 1969, Jackson 1974; Jack and Carmichael 1969; Kaufman 1980; Stevenson, Stross, and Heizer 1971).

Macroscopic visual examination can yield good results provided the researcher is thoroughly familiar with the numerous characteristics of obsidian occurring in the study area. Additionally, macroscopic visual examination can result in a large number of sourced specimens in a short time and at little cost. X-ray fluorescence spectrography yields extremely accurate results when undertaken by a qualified analyst. The cost of x-ray fluorescence spectrography, although quite reasonable (in the $10 - $25 per specimen range), does limit the number of specimens that can be sourced. These two techniques of sourcing obsidian, when used in tandom, can provide the careful researcher with high quality, abundant data.

Macroscopic Visual Examination

Since the present research was restricted to obsidian specimens derived from two geological sources, it was necessary to identify those visual attributes that were diagnostic of the two sources.

Annadel source obsidian from near Oakmont in Sonoma County was collected as nodules from the source and specimens previously subjected to x-ray fluorescence served as a control sample to discern distinctive characteristics. Annadel obsidian is marked by several color phases including black, grey, green, and rarely, brownish (when held to a strong light source). Many specimens exhibit banding. The luster of Annadel obsidian is less variable than color. Generally, the luster is poor with freshly exposed surfaces being dull. Such freshly exposed surfaces are grainy. When held to a strong light source, Annadel obsidian varies in its transparency. The majority of specimens allow little transmittal of light; however, some specimens are somewhat clear and others allow no light to pass through. The specimens that are somewhat clear to partially opaque are marked by a "dirty" color when held to strong light. Commonly this "dirty" color takes on a grey-brownish hue. The opaque specimens are very dark, almost black, and are grainy with poor luster.

Napa Glass Mountain source obsidian was also examined from the source near St. Helena in Napa County and from x-ray fluorescence spectrography sourced specimens. Napa Glass Mountain source obsidian dominantly occurs as black, although Jackson (1974:7) reports red and brown phases. Banding is rare. Napa Glass Mountain obsidian is characteristically marked by high luster, especially on freshly broken surfaces. The freshly exposed surfaces are smooth and glossy. When held to a strong light source, Napa Glass Mountain obsidian is most transparent near the edges and the color is usually a uniform grey. Interior portions of chipped artifacts rarely transmit light. A number of very translucent specimens, identified via x-ray fluorescence spectrography as from the Napa Glass Mountain source, may have originated from a deposit near Calistoga. A sample of specimens from the deposits near Calistoga was analyzed by the author and found to be very clear and chemically very similar to Napa Glass Mountain obsidian. Since this source near Calistoga (called the Blossom Creek source) is chemically very similar to Napa Glass Mountain source obsidian, they have not been segregated in this study.

Macroscopic visual examination of the attributes described for Annadel and Napa Glass Mountain has been used successfully to discriminate obsidian sources. Wickstrom and Fredrickson (1982) reported the results of visual obsidian sourcing combined with x-ray fluorescence. Four observers visually sourced 99 specimens, 50 of which were subjected to x-ray fluorescence analysis. It was found that 100% accuracy was achieved for those specimens all observers identified as from the same source. Accuracy of source identification for specimens the observers did not agree upon ranged from 78% to 88%. The data indicated an overall accuracy rate of approximately 92%. (The author had an accuracy rate of 93%.)

Comparable accuracy rates have been achieved a number of times. For example, obsidian specimens analyzed in this study from CA-SON-1281 were subjected to visual sourcing. Eleven of 13 specimens were identified as from particular sources by the author and one colleague. The remaining 2 specimens' sources were not agreed upon, yet educated "guesses" were made. The specimens were then subjected to x-ray fluorescence analaysis. For the 11 agreed upon specimens, 100% accuracy was achieved. The overall accuracy rate for the 13 specimens was slightly better than 92%.

The specimens included in this study were all visually sourced by the author and for a large number of the specimens, three colleagues completed examinations. All specimens with uncertain source determinations were subjected to x-ray fluorescence spectrography. Additionally, a large sample of specimens was subjeced to x-ray fluorescence that visual sourcing results were considered confident.

A total of 134 (26%) projectile points and 35 (44%) radiocarbon associated specimens was analyzed by x-ray fluorescence spectrography. The x-ray fluorescence data is included on the following tables.

X-Ray Fluorescence Source Data for Corner-notched Projectile Points (n=42).

Catalog #	Site	Rubidium %	Strontium %	Zirconium %	Source
F-21	CA-SON-455	20	10	70	Annadel
1-2-8	"	21	10	69	Annadel
1-2-13	"	21	9	70	Annadel
1-2-14	"	19	9	72	Annadel
1-2-20	"	23	10	67	Annadel
1-2-22	"	20	9	70	Annadel
1-2-24	"	20	8	72	Annadel
1-2-29	"	30	0	70	Napa
1-2-38	"	20	9	71	Annadel
1-2-39	"	22	9	70	Annadel
1-2-56	"	20	9	71	Annadel
1-2-66	"	21	9	70	Annadel
1-2-83	"	20	9	71	Annadel
1-2-86	"	21	9	70	Annadel
1-2-109	"	20	9	71	Annadel
1-2-177	"	20	9	70	Annadel
1-2-206	"	20	10	71	Annadel
1-2-207	"	21	10	69	Annadel
1-2-220	"	20	9	71	Annadel
1-2-258	"	22	9	70	Annadel
2056	CA-SON-456	21	10	69	Annadel
2065	"	24	9	67	Annadel
2358	"	19	9	73	Annadel
2365	"	19	9	72	Annadel
2408	"	31	2	67	Napa
2570	"	19	9	72	Annadel
2617	"	19	10	72	Annadel
2728	"	32	3	65	Napa
2872	"	18	9	74	Annadel
3058	"	20	10	70	Annadel
TO/177	CA-SON-655	19	9	72	Annadel
73-1-13	CA-SON-678	19	8	73	Annadel
73-1-15	"	19	9	72	Annadel
73-1-26	"	20	10	70	Annadel
TO/293	CA-SON-744	19	9	72	Annadel
79-4-158	CA-SON-1048	30	9	61	Annadel
81-3-441	CA-SON-1269	22	10	69	Annadel
81-3-477	"	25	10	65	Annadel
81-3-491	"	30	0	70	Napa
81-3-788	"	20	13	67	Annadel
81-3-790	"	23	9	68	Annadel
81-3-813	"	34	0	66	Napa

X-Ray Fluorescence Source Data for Notchless Projectile Points (n=4).

Catalog #	Site	Rubidium %	Strontium %	Zirconium %	Source
1-2-15	CA-SON-455	22	9	69	Annadel
1-2-262	"	22	9	68	Annadel
1-2-336	"	20	8	72	Annadel
2379	CA-SON-456	21	9	70	Annadel

X-Ray Fluorescence Source Data for Serrated Projectile Points (n=47).

Catalog #	Site	Rubidium %	Strontium %	Zirconium %	Source
73-16-6	CA-SON-445	20	10	71	Annadel
1-2-30	CA-SON-455	21	8	71	Annadel
1-2-160	"	21	8	71	Annadel
1-2-162	"	21	9	70	Annadel
2058	CA-SON-456	19	10	72	Annadel
2119	"	22	9	69	Annadel
2214	"	20	9	71	Annadel
2304	"	20	9	71	Annadel
2398	"	20	10	69	Annadel
2626	"	19	9	73	Annadel
2668	"	18	9	72	Annadel
2777	"	18	9	73	Annadel
2980	"	20	10	70	Annadel
3064	"	20	11	69	Annadel
3134	"	20	9	71	Annadel
3235	"	22	8	70	Annadel
TO/23	CA-SON-655	20	8	72	Annadel
A	CA-SON-677	33	3	64	Napa
73-1-14	CA-SON-678	20	10	70	Annadel
TO/310	CA-SON-744	18	10	72	Annadel
77-9-234	CA-SON-977	27	9	63	Annadel
79-4-187	CA-SON-1048	45	2	53	Napa ?
80-1-17	CA-SON-1082	28	13	59	Annadel
81-3-320	CA-SON-1269	29	0	71	Napa
81-3-321	"	19	10	71	Annadel
81-3-341	"	21	8	71	Annadel
81-3-442	"	21	9	70	Annadel
81-3-502	"	19	11	70	Annadel
81-3-514	"	22	10	68	Annadel
81-3-524	"	22	14	64	Annadel
81-3-610	"	35	0	65	Napa
81-3-621	"	33	0	67	Napa
81-3-661	"	23	9	68	Annadel
81-3-669	"	35	0	65	Napa
81-3-684	"	22	10	68	Annadel
81-3-685	"	24	11	64	Annadel
81-3-707	"	23	8	70	Annadel
81-3-714	"	24	11	66	Annadel
81-3-724	"	34	0	66	Napa
81-3-757	"	21	11	68	Annadel
81-3-789	"	33	0	67	Napa
81-3-858	"	22	11	67	Annadel
81-3-872	"	24	10	65	Annadel

(continued on next page)

X-Ray Fluorescence Source Data for Serrated Points (n=47) (continued)

Catalog #	Site	Rubidium %	Strontium %	Zirconium %	Source
81-3-883	"	24	12	64	Annadel
81-3-884	"	22	9	69	Annadel
81-3-919	"	21	11	69	Annadel
81-3-1056	"	36	0	64	Napa

X-Ray Fluorescence Source Data for Gunther-like Projectile Points (n=1).

Catalog #	Site	Rubidium %	Strontium %	Zirconium %	Source
81-3-493	CA-SON-1269	35	0	65	Napa

X-Ray Fluorescence Source Data for Large Side/Corner-notched Projectile Points (n=4).

Catalog #	Site	Rubidium %	Strontium %	Zirconium %	Source
77-9-71	CA-SON-979	nd	nd	nd	Annadel
77-9-729	"	nd	nd	nd	Annadel
77-9-756	"	nd	nd	nd	Annadel
81-9-44	CA-SON-1343	21	9	71	Annadel

nd = no data available

X-Ray Fluorescence Source Data for Shouldered Lanceolate Projectile Points (n=11).

Catalog #	Site	Rubidium %	Strontium %	Zirconium %	Source
2061	CA-SON-456	25	2	73	Napa
2117	"	29	2	69	Napa
2118	"	28	2	69	Napa
2217	"	30	2	68	Napa
2692	"	19	11	69	Annadel
2700	"	17	8	75	Annadel
2804	"	20	9	71	Annadel
2866	"	19	8	73	Annadel
2998	"	29	3	68	Napa
3152	"	20	9	72	Annadel
81-9-42	CA-SON-1343	20	9	71	Annadel

X-Ray Fluorescence Source Data for Single-shouldered Lanceolate Projectile Points (n=1).

Catalog #	Site	Rubidium %	Strontium %	Zirconium %	Source
81-12-220	CA-SON-20a	32	1	67	Napa

X-Ray Fluorescence Source Data for Non-shouldered Lanceolate Projectile Points (n=2).

Catalog #	Site	Rubidium %	Strontium %	Zirconium %	Source
79-4-506	CA-SON-1049	31	9	60	Annadel
81-9-31	CA-SON-1343	34	1	65	Napa

X-Ray Fluorescence Source Data for Diamond Lanceolate Projectile Points (n=1).

Catalog #	Site	Rubidium %	Strontium %	Zirconium %	Source
81-9-43	CA-SON-1343	32	2	66	Napa

X-Ray Flourescence Source Data for Concave Projectile Points (n=18).

Catalog #	Site	Rubidium %	Strontium %	Zirconium %	Source
77-3-467	CA-SON Isolates	30	0	70	Napa
80-3-267	"	30	0	70	Napa
72-2-240	Hector Lee Coll.	33	0	67	Napa
72-2-481	"	19	8	72	Annadel
72-2-484	"	19	8	73	Annadel
72-2-485	"	19	10	71	Annadel
72-2-488	"	33	0	67	Napa
72-2-489	"	29	0	71	Napa
72-2-543	"	31	0	69	Napa
73-31-28	CA-SON-Isolates	36	0	64	Napa
75-28-175	CA-SON-159	30	0	70	Napa
73-13-11	CA-SON-358	25	9	66	Annadel
2038	CA-SON-456	20	9	72	Annadel
77-9-538	CA-SON-978	nd	nd	nd	Annadel
77-9-1103	"	nd	nd	nd	Annadel
79-4-160	CA-SON-1048	50	1	49	Napa ?
80-3-5	CA-SON-1262	31	0	69	Napa
47-1165	CA-MRN-192	30	0	70	Napa

nd = no data available

X-Ray Fluorescence Source Data for Wide-stemmed Projectile Points (n=3).

Catalog #	Site	Rubidium %	Strontium %	Zirconium %	Source
81-12-186	CA-SON-20b	30	2	68	Napa
81-12-188	"	34	1	65	Napa
11666	CA-MRN-216	24	7	69	Annadel

X-Ray Fluorescence Source Data for Obsidian Specimens Associated with Radiocarbon Dates (n=35).

Catalog #	Site	Rubidium %	Strontium %	Zirconium %	Source
77-9-412	CA-SON-978	nd	nd	nd	Annadel
81-3-483	CA-SON-1269	20	7	73	Annadel
81-3-484	"	22	9	69	Annadel
81-3-487	"	20	10	70	Annadel
81-3-488	"	21	9	70	Annadel
81-3-489	"	22	8	70	Annadel
81-3-485	"	34	1	65	Napa
81-3-490	"	36	1	63	Napa
81-3-546a	"	33	2	65	Napa
81-3-546b	"	33	1	66	Napa
81-3-546c	"	33	1	66	Napa
81-3-546d	"	36	1	63	Napa
81-3-546e	"	33	1	66	Napa
81-3-546f	"	33	1	66	Napa
81-3-546g	"	33	0	67	Napa
81-3-546h	"	34	0	66	Napa
81-3-546i	"	22	8	70	Annadel
81-3-546j	"	22	9	69	Annadel
81-3-546k	"	20	9	71	Annadel
81-3-546l	"	21	9	70	Annadel
81-3-486	"	24	14	62	Annadel
82-1-134	CA-SON-1281	34	1	65	Napa
82-1-135	"	23	9	68	Annadel
82-1-137	"	35	2	63	Napa
82-1-138	"	22	8	70	Annadel
82-1-139	"	21	9	70	Annadel
82-1-140	"	36	1	63	Napa
82-1-141	"	21	9	70	Annadel
82-1-142	"	20	9	71	Annadel
82-1-144	"	34	2	64	Napa
82-1-145	"	33	1	66	Napa
82-1-146	"	33	2	65	Napa
82-1-147	"	21	9	70	Annadel
82-1-148	"	21	8	71	Annadel
67-1-153	CA-MRN-27	45	0	55	Napa ?

nd = no data available