ABSTRACT

FUSED SHALE AS TIME MARKER IN SOUTHERN CALIFORNIA:

REVIEW AND HYPOTHESIS

By

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December 1981

Fused shale in southern California is a product of combustion metamorphism occurring perhaps as early as the Pleistocene. It is a vesicular, natural glass which fractures conchoidally and was used by prehistoric native Californians as raw material for projectile points and other chipped-stone tools.

Fused shale exposures occur locally in Ventura County and may have been present at other localities in the past. Fused shale artifacts occur as trade items in the southern zone of the southern California region as far east as Palm Springs and as far south as Laguna Niguel.

Fused shale artifacts occur infrequently in the southern zone. Projectile point styles, obsidian hydration measurements, and radiocarbon dates suggest a greater frequency of distribution in Late contexts. However, such artifacts also occur in Milling Stone and Intermediate

Horizon contexts. Fused shale, therefore, cannot be considered a time marker for the Late Horizon based upon present evidence.

FUSED SHALE AS TIME MARKER IN SOUTHERN CALIFORNIA:

REVIEW AND HYPOTHESIS

A THESIS

Presented to the Department of Anthropology

California State University, Long Beach

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

By Carol Ramona Demcak

December 1981

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Research Design

This thesis presents a body of archaeological research into the geographic and temporal distribution of fused shale artifacts in the southern California cultural region. The study area includes the coastal zone from the Palos Verdes Peninsula south to San Diego County (figure 1).

The general outline of the cultural sequences for the study area are commonly inferred from region-wide syntheses formulated by Wallace (1955) and Warren (1968). Based on these syntheses, cultural development can be divided into three horizons: Milling Stone (Encinitas), Intermediate (Campbell), and Late. A fourth horizon, Early Man (San Dieguito), is poorly defined and unknown in the study area; therefore, it is excluded from discussion here.

According to Wallace and Warren, aboriginal populations in southern California were culturally conservative and remained basically collectors throughout the prehistoric period. During the earliest occupation which can be documented for the area, the Milling Stone (Encinitas), a

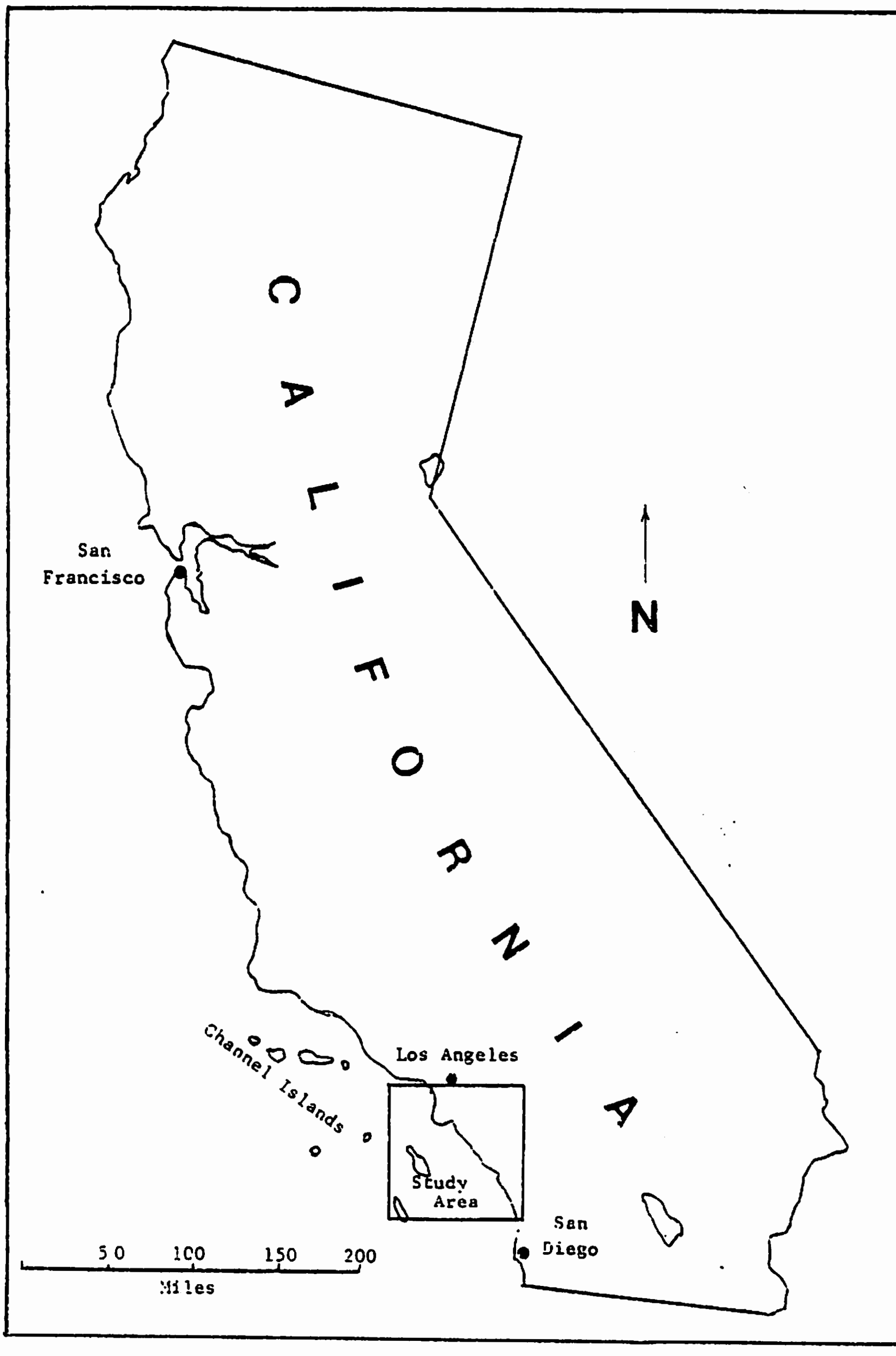


Fig. 1. Study area

littoral adaptation can be seen. Small native populations subsisted primarily on plant foods, collected shellfish, and hunted small game. They made wide use of the milling stone and muller. Projectile points were few in number, large and heavy, and presumably served as spear points based on their weights (Fenenga 1953). Basketry was utilized by some groups. Cog stones, enigmatic ground discs, serve as time markers for this early cultural period.

In the ensuing period, the Intermediate Horizon (Campbell), local populations experienced an expanded economic base. Hunting and fishing became important supplements to the plant-food based economy. Mortar and pestle, implying acorn and other fleshy-food processing, largely replaced earlier grinding equipment throughout much of the area. Populations in the southern portion of the area, however, continued the use of older forms. Projectile points remained relatively large and heavy compared to later forms. Basketry gained in use as attested to by the increase in the number of bone awls found in deposits belonging to this cultural period.

In the final prehistoric period, the Late Horizon, there is evidence of marked expansion of the economic base and consequent increase in cultural elaboration and proliferation of nonutilitarian items in the culture inventory. The introduction of the sea-going plank canoe (tomolo) ushered in a marine adaptive pattern throughout much of southern California in vivid contrast to the littoral or land-locked adaptation of the previous cultural periods. Fishing and the hunting of sea mammals assumed greater significance in the subsistence strategies of populations in the northern portion of southern California, while central and southern contingents continued to rely upon plants, shellfish, and large and small game which they hunted with small, lightweight projectile points and the bow as inferred from the weights of these points. The trading of steatite and other lithic materials, the widespread use of asphaltum, and the introduction of pottery in the San Diego area were characteristic of the Late Horizon. Portable mortars, and in particular the basket-hopper mortar, and pestles were the dominant grinding equipment in the north; bedrock mortars and metates were more widely used by southern groups, while the central zone shows overlapping of the two types of equipment. Personal ornaments of shell, bone, and stone abounded in all zones. Throughout the southern California coastal area, the Late Horizon was a time of population expansion and cultural flowering of locally-adapted populations within the overriding influence of the maritime patterns of the northern populations.

Within the study area, the settlement and subsistence patterns of aboriginal populations are becoming more and more well understood by researchers. The temporal framework of these patterns is not well understood, however. Archaeological sites, though numerous, are often unstratified shell middens with few time markers present and only small amounts of obsidian for hydration measurements. Shell is readily available for radiocarbon measurements, but bone and charcoal, though more reliable for dating, are generally available in insufficient quantities for dating. The absence of good chronological controls severely limits research into local cultural developments. This research project was undertaken in order to test the feasibility of the use of fused shale as a time marker in the study area.

Methods

In an effort to gain additional chronological controls within the study area, a testable hypothesis was set up involving fused shale, a lithic raw material. Based upon remarks by Rosen (1978, 1979a, b) as to the temporal distribution of fused shale artifacts, the following hypothesis was formulated: Fused shale is a time marker for the Late Horizon in the study area, i.e., Palos Verdes Peninsula, southern Channel Islands, southern Los Angeles County, and Orange County. By way of explanation, the study area was chosen both for the unity of its research problems and for the relative ease in conducting research.

Data were drawn primarily from sites in Orange County where housing demands have necessitated large numbers of salvage excavations and surface collections and have thus created a large data base.

The following assumptions were made regarding fused shale: (1) fused shale has a limited geologic occurrence in the local area; (2) due to its limited geologic occurrence, fused shale occurs most frequently in archaeological sites in the immediate vicinity of the geological deposits; (3) fused shale occurring in archaeological sites at considerable distance from the geologic deposits are trade items; (4) fused shale occurs most frequently in the northern area of the southern California region; and (5) widespread trade was limited to the Late Horizon in southern California.

Test implications developed from the hypothesis were that fused shale would occur exclusively or nearly exclusively in sites dating to the Late Horizon in the study area, and that little or no fused shale would occur in Intermediate and Milling Stone Horizon sites in the study area. The following predictions were formulated for the research project: (1) fused shale would be an infrequent find in the study area; (2) the highest frequency of fused shale would occur in Late Horizon sites by analogy with the northern area, supposed point of origin of the fused shale; (3) fused shale would occur rarely in

Intermediate or Milling Stone Horizon sites in the study area; and (4) no local quarrying of fused shale would be found to occur in the study area.

Data gathering techniques for this research project included a thorough search of site reports and other archaeological literature relating to the study area and to the areas in the immediate vicinity of the fused shale deposits. Interviews of individuals involved in fused shale research and in the archaeology of the areas under study were also conducted. Numerous visits to museums, laboratories, and other storage facilities were undertaken. The geological literature was carefully scanned for references to fused shale. Consultations with a geologist familiar with fused shale were also carried out.

Although other techniques contributed to the body of research, the most valuable technique employed was the quarrying and visual inspection of a variety of combustion metamorphic rocks from the Grimes Canyon and Happy Camp Canyon deposits in Ventura County, some 50 miles northwest of Los Angeles. Through the use of a hand lens and a binocular microscope, a thorough examination of surface and internal structures of fused shale and other rock types was completed. Proper identification of fused shale in artifact form would have been nearly impossible without such a study.

Other preliminary work involved a careful study of the physical characteristics of fused shale as a lithic raw material. A series of tests was carried out on samples of fused shale from Ventura County. These tests provided data for a detailed description of fused shale which is presented in chapter II, Geology.

As an additional aid to understanding of the fused shale, some limited experiments in chipping the raw material were undertaken by the author. Observations as to fracturing properties, homogeneity, hardness, and other aspects of the stone as potential raw material for flintknapping, were added to those generated from an earlier experience of participation in a flintknapping class conducted at California State University, Long Beach, by Dr. E. Jane Rosenthal, of the school faculty. At that time, some 200 pounds of the fused shale was quarried at Grimes Canyon for the use of the students in that class. This was the author's first exposure to fused shale as raw material and served as an early impetus to research.

CHAPTER II

GEOLOGY

Combustion Metamorphism

Fused shale is a natural glass which was used by aboriginal Californians as a raw material for stone-tool manufacture. It is one of several rock types produced by combustion metamorphism. Combustion metamorphism is a rare geological phenomenon which is reported to have occurred in such scattered areas as Australia, India, USSR, Jordan, Israel, Canada, and in the United States in Montana and California (Bentor and Kastner 1976:486). As the name implies, combustion metamorphism is a type of alteration of existing rocks by the burning of organic materials within a deposit.

In southern California combustion metamorphism has been confined to the shales of the Monterey Formation in the counties of Santa Barbara, Ventura, and Los Angeles (figure 2, combustion metamorphism localities). The term Monterey Formation refers to a series of exposures at the type site southeast of Monterey and has been expanded to include exposures of similar composition elsewhere in central and southern California (Brown 1959:39; Arnold and

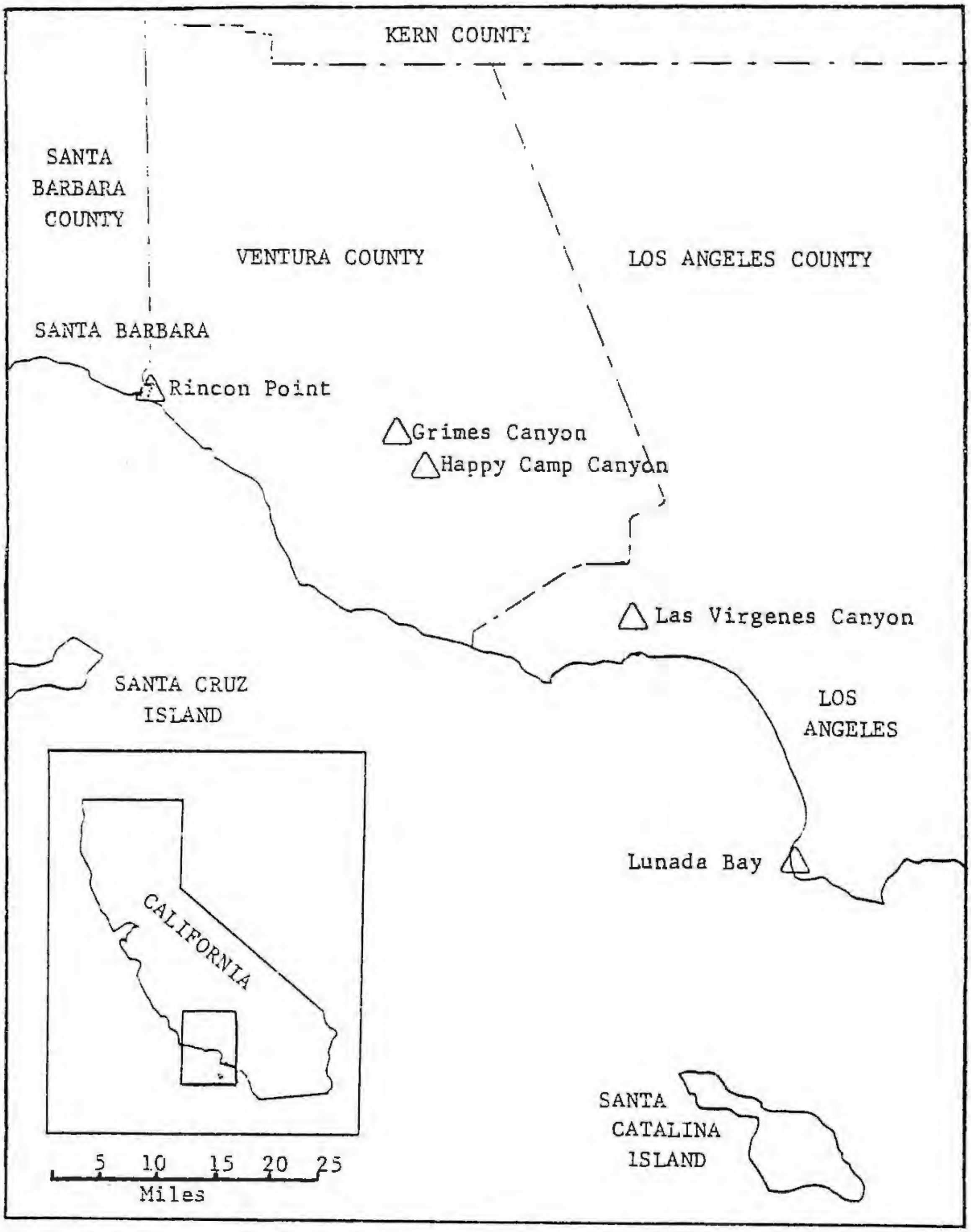


Fig. 2. Combustion metamorphism localities

Anderson 1907:33). Although the term Modelo Formation has been used to designate deposits of equivalent age in the Santa Monica Mountains and Ventura Basin (Soper 1938:69; Lung 1958:30), the Monterey designation is more widely used by geologists and will be used here.

Monterey shales are of Miocene age and contain large amounts of organic matter, consisting largely of the remains of small marine organisms, such as diatoms. In addition the shales are the reservoir and probable source of a large portion of the petroleum occurring in California (Arnold and Anderson 1907:51).

Combustion of the shales may have taken place spontaneously through underground heating of the hydrocarbons present in the deposit (Bentor and Kastner 1976:486; Lung 1958:35; Soper 1938:180; Arnold and Anderson 1907:51). Alternatively the shales may have been ignited externally by chaparral fires induced by lightning or purposely set by man upon his arrival in the area (Arnold and Anderson 1907:51-52; Bentor and Kastner 1976:487). Burning seems to have been restricted to the organic shales, a rich source of fuel. Historic accounts of subterranean fires in areas of petroleum and/or asphalt deposits bear out the association between combustion metamorphism and organic-rich deposits (Antisell 1857:71; Arnold and Anderson 1907:48).

The timing of the combustion of the Monterey shales is a subject of great interest to geologists and archaeologists alike. Geologists naturally seek to know the timing of all geologic events, while archaeologists wish to know at what time in the past the combustion metamorphic rocks were produced and became available for aboriginal use. Several lines of evidence may be offered in this regard. Combustion may have taken place very recently. Fire, smoke, and sulfurous gases were reportedly issuing from rock fissures near the city of Santa Barbara at the time of the Pacific Railroad surveys (Antisell 1857:67). Fires in progress in the shales were observed as recently as the turn of the century in the same area (Arnold and Anderson 1907:51).

In contrast to the preceding evidence of recency for the burning, Arnold and Anderson (1907:52) point out as evidence of the antiquity of the altered shale the presence of burnt shale in horizontal beds of Pleistocene age and lying some 10 feet below ground level. For the Santa Barbara County deposits, one may infer that combustion may have occurred as early as the Pleistocene and may have been a continuing phenomenon up to the Recent period.

In the Ventura County localities of combustion metamorphism, evidence of recent burning has been reported (Lung 1958:36). Bentor and Kastner (1976:486) assert that burning probably took place as recently as the late nineteenth century. Stratigraphic evidence, however, suggests that burning may have occurred prior to local faulting in the South Mountain area and before the Pico Formation of late Pliocene age was laid down (Lung 1958:36), or that burning took place selectively at any time following the laying down of the Saugus Formation which occurred in late Pliocene and early Pleistocene times (Brown 1959:52). Although the issue is somewhat confused, it can be logically inferred that the Ventura County deposits of combustion metamorphic rocks may also be of considerable age.

The Los Angeles County deposits at Las Virgenes in the Santa Monica Mountains and Lunada Bay on the Palos Verdes Peninsula have been only minimally described in the geological literature (Soper 1938:180; Woodring et al. 1946:29). No statements as to the timing of combustion can be made other than the observation that burning must have taken place after the middle Miocene deposition of the Monterey shales.

Combustion of the Monterey shales, whenever it occurred, may have followed this sequence of developments in the production of fused shale, according to geologist, S. Williams (personal communication): (1) a fire in the chaparral community, or one created by internal oxidation of hydrocarbons, initiated combustion in the Monterey beds and induced very high temperatures; (2) the shales began heating up causing organic materials to begin to burn; (3) superheated gases flowed along bedding planes, burning and melting materials upon contact; (4) a pseudomagma developed and flowed through the shale beds, breaking them up and oxidizing their contents; (5) gases became trapped in the flow; and (6) rapid cooling of the flow produced glasses with no crystal structure, i.e., fused shale, but with "bubbles" of trapped gases suspended within them. The presence of these "bubbles" and the even distribution of them within fused shale is called "uniform vesiculation" by this author and is the distinguishing characteristic of fused shale as a lithic type.

Combustion Metamorphic Rocks

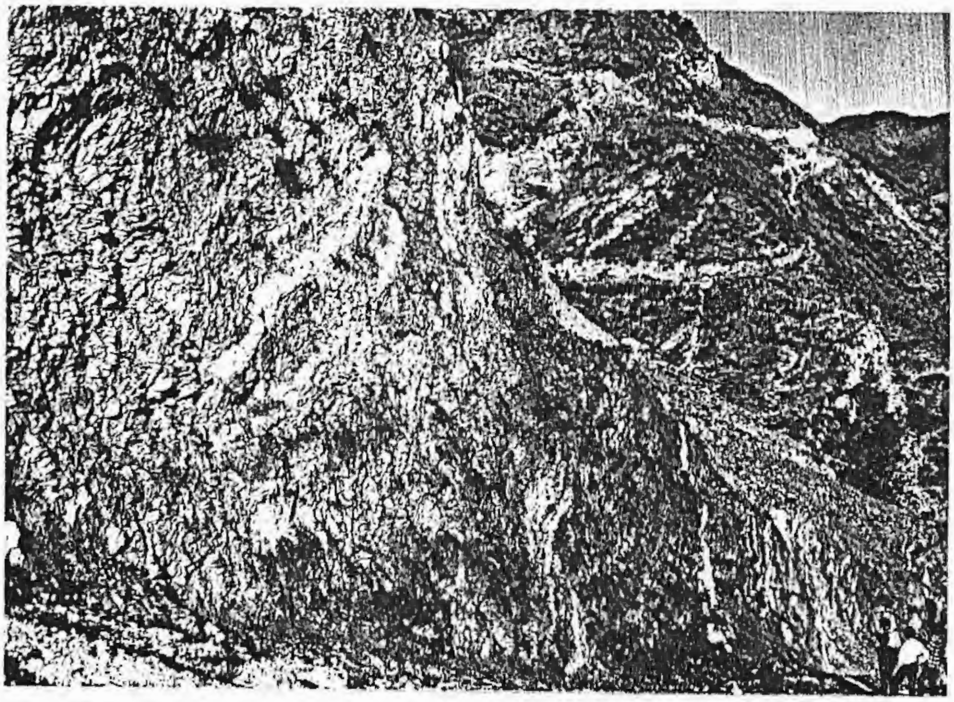
Grimes Canyon in Ventura County is the only local occurrence of combustion metamorphism which has been studied in any detail. Thirty percent of the rocks there are described as glasses, either slaglike or obsidianlike in appearance. The glasses resulted from the rapid cooling of the pseudomagma flowing through the Monterey layers. The remainder of the rocks are said to be stony types, resulting from recrystallization of the shales in place, or a combination of stony and glassy as laminae or in brecciated form (Bentor and Kastner 1976:487). The alternating glassy (dark-colored) and stony (light-colored) layers can be seen in a series of photographs from Grimes Canyon (figure 3).

Combustion metamorphic rocks are highly variable in color, hardness, texture, and other physical characteristics. Bentor and Kastner (1976:487) divide these rocks into three categories: (1) glassy, (2) stony, and (3) a combination of stony and glassy. This author makes two divisions of the combustion metamorphic rocks based upon physical characteristics and archaeological distinctions. The two named types are burnt shale and fused shale.

Burnt Shale

Burnt shale includes both the stony rocks and the combination of stony and glassy rocks described by Bentor and Kastner (1976:487). Such metamorphic rock types underwent lesser alteration in the combustion process and thus retained more of the characteristics of the original shales. Burnt shale shows little variety in color, ranging from a white, yellow, yellowish white, dull gray, to a light brick red. The texture of the burnt shale is rough and granular. Burnt shale is softer than fused shale and friable, crumbling easily to powder. This stone fractures irregularly along preserved bedding planes or around grains.

Burnt shale was used as a raw material for pigments by prehistoric southern Californians. Large quantities of it were found at the Aerophysics Site (SBa-53) and in the a



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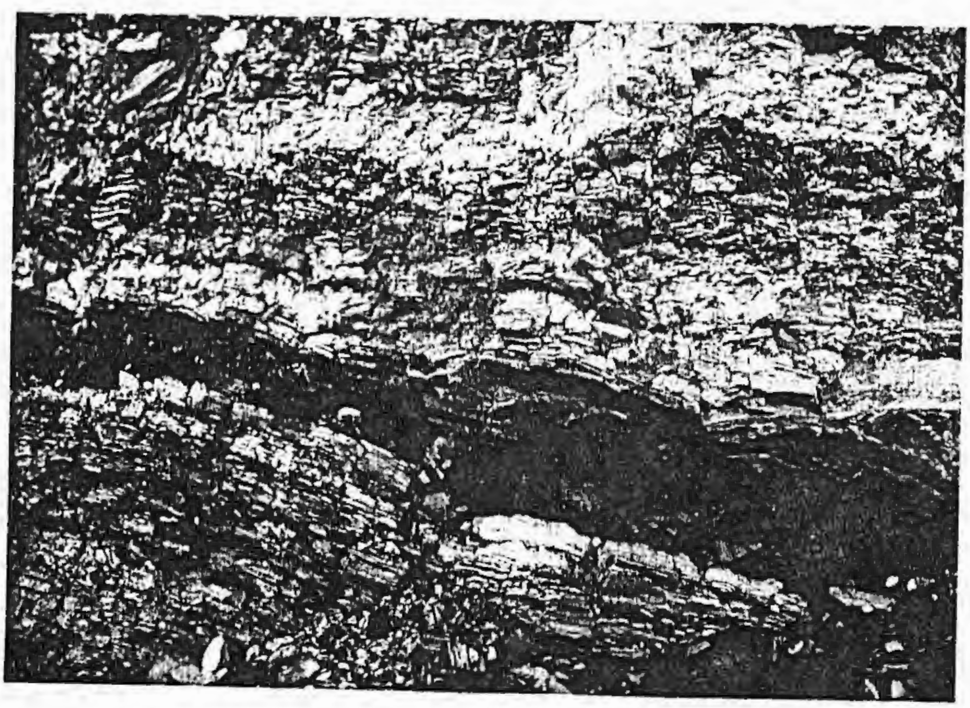


Fig. 3. Combustion metamorphic exposures, Grimes Canyon, Ventura County: (a) long view, and (b) close-up

Corona del Mar Site (SBa-54) and were presumed to be pigment materials. Traces of a red pigment were found on an anvil stone, pestle, and asphalt plug from SBa-53 (Harrison and Harrison 1966:52). Burnt shale is present in all the combustion metamorphism localities (figure 1, page 2). Chunks of this material occur as stream deposits in the vicinity of Grimes Canyon and Happy Camp Canyon and would have presumably have been similarly accessible in the past. Figure 4 shows a red specimen of stream-deposited burnt shale. Powdered and mixed with a suitable fatty material, this specimen makes a vivid brick-red smear.

C. King (personal communication) has established that burnt shale served as raw material for bead making in the Middle and Late cultural periods, circa 1200 B.C. to the historic period, on the northern Channel Islands. On Santa Rosa Island one artifact cluster lay two feet from a burial and included several tubular beads made of red burnt shale while another grouping consisted of more than 30 tubular, disc, and globular beads of red burnt shale as well as a double-perforated pendant, and a perforated plummet-shaped piece of the same material, referred to as "red stone" in Jones' report (1956:219). A long, grooved tubular bead made of red burnt shale formed part of a necklace of more than 26 stone and shell beads on burial B-1, site SCrI-100, found on Santa Cruz Island. This and the remaining specimens described above are housed

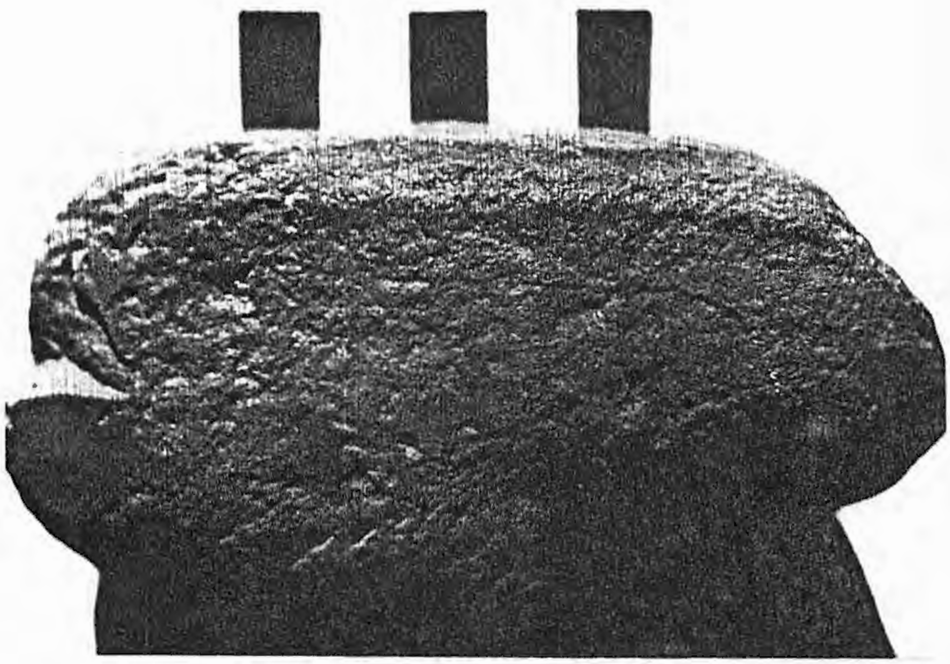


Fig. 4. Burnt shale specimen

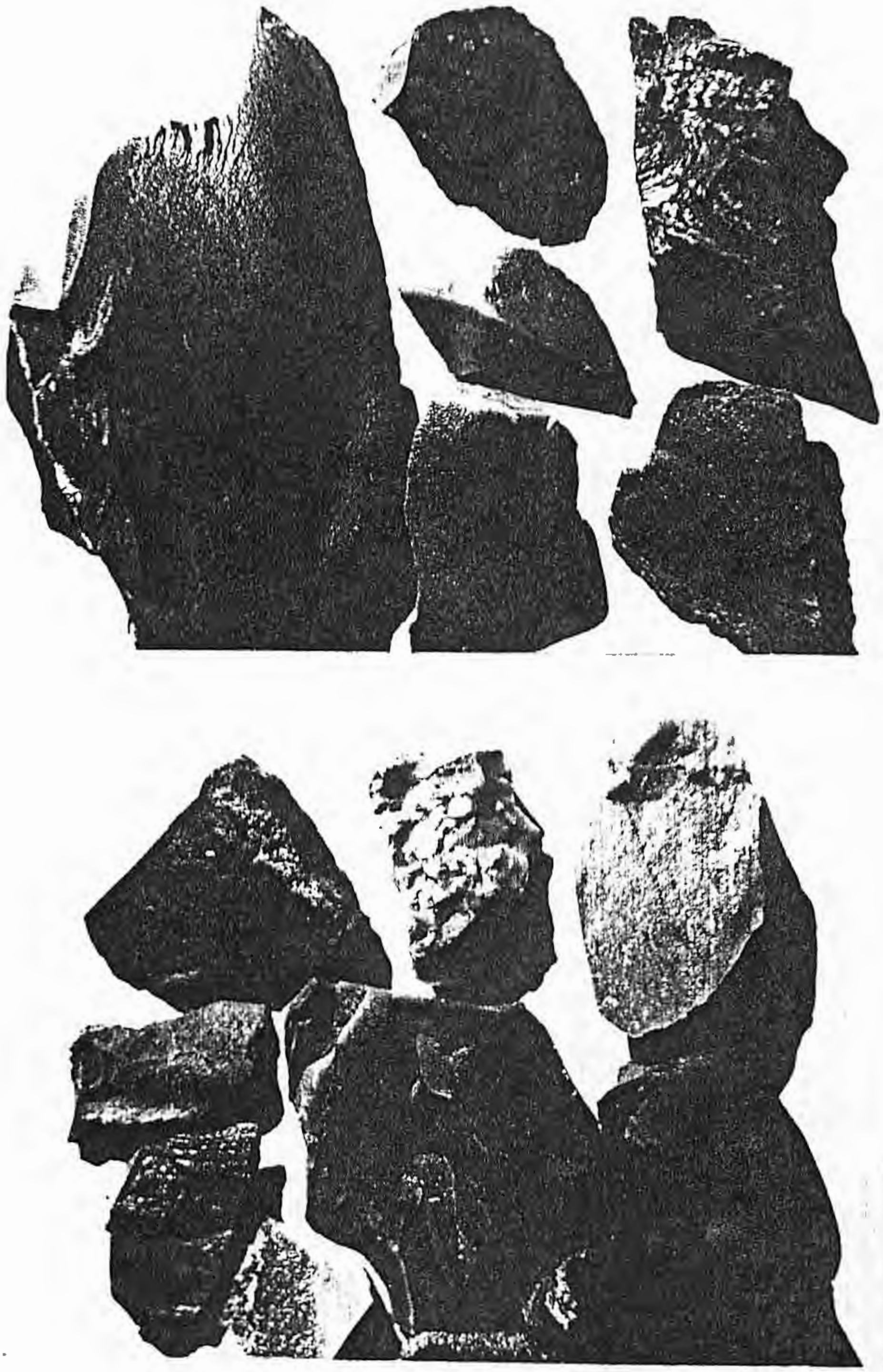
at the Lowie Museum, University of California, Berkeley. C. King examined the artifacts and identified them as burnt shale.

Fused Shale

In contrast to burnt shale, fused shale refers to the glasses resulting from the rapid cooling of the pseudo-magma in the combustion process. These glasses were the most highly altered of the metamorphic rocks resulting from combustion. The color range of fused shale is considerable and includes clear to milky, orange red, brick red, brown, light gray, medium gray, charcoal gray, greenish gray or brown, and a near black. Figure 5 shows some of the colors of fused shale.

Fused shale is a hard rock type. Hardness tests carried out on samples of fused shale using a standard rock test kit and Mohs scale suggest that fused shale has a hardness value of between 6 and 7, similar to that of chalcedony or quartz crystal. By comparison with the fused shale, obsidians appeared to be less hard, less resistant to scratching, and are reportedly rated at hardness 5 to 5.5 on the Mohs scale (Liddicoat 1975:421).

Fused shale has a variable texture. Generally specimens are fine-grained, smooth and glassy in appearance. Weathered specimens exhibit a dull luster. Fused shale which has acquired hydration layers, in the same way



a

b

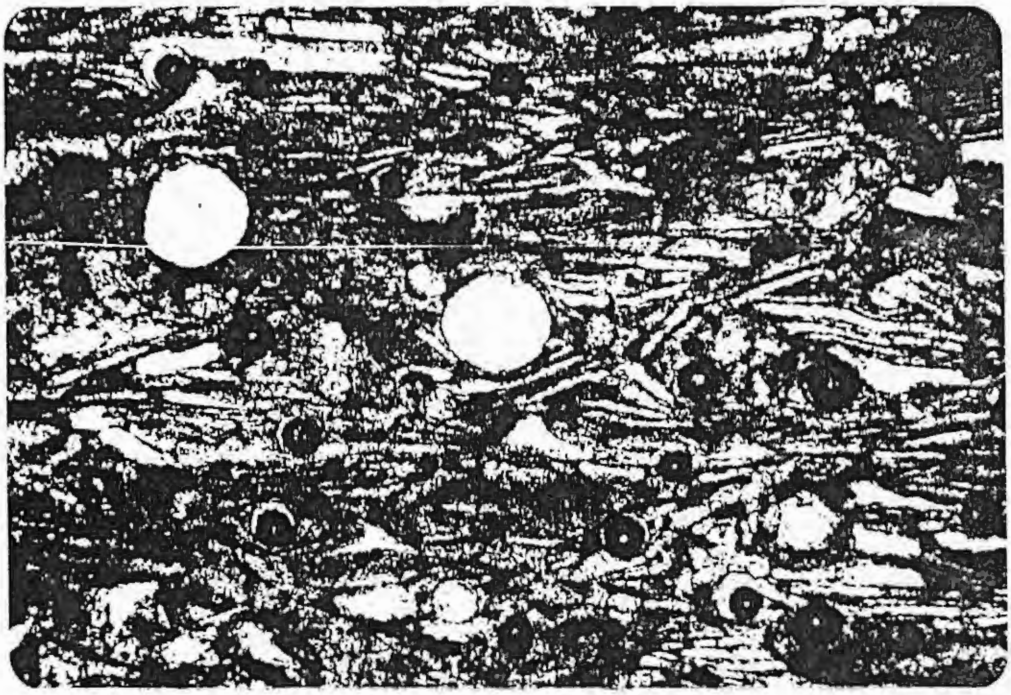
Fig. 5. Colors of fused shale: (a) reds, and (b) grays

as obsidian does, will also appear dull.

All varieties of fused shale display vesiculation ("bubbles") in their structure. These vesicles, or collapsed gas and water pockets, in the fused shale are remnants of the combustion process. When the vesicles are interrupted, they reveal themselves to be smooth round cavities in the stone. Freshly quarried samples of fused shale very often display vesicles on the surfaces which were severed from the deposit. Vesicles tend to become worn down and smoothed out as the fused shale fragments tumble about with other rocks in a rock fall or in a stream flow.

The vesicles which occur in the fused shale are variable in size. Some are small but visible with the naked eye; others are microscopic in size. Still others are relatively large and resemble the vesicles found in scoriaceous lava, a similarity which led Antisell (1857:71) to mistake fused shale deposits for scoriaceous lava.

Vesicles are present throughout fused shale. As fused shale is nearly transparent on thin edge, it is possible to view the vesicles by holding a piece of fused shale up to strong light. Magnification of a specimen of fused shale enables one to see the large number of vesicles which are evenly distributed in the stone. In figure 6, microphotographs reveal the contrast in internal structure of the highly vesicular fused shale (a) and the a



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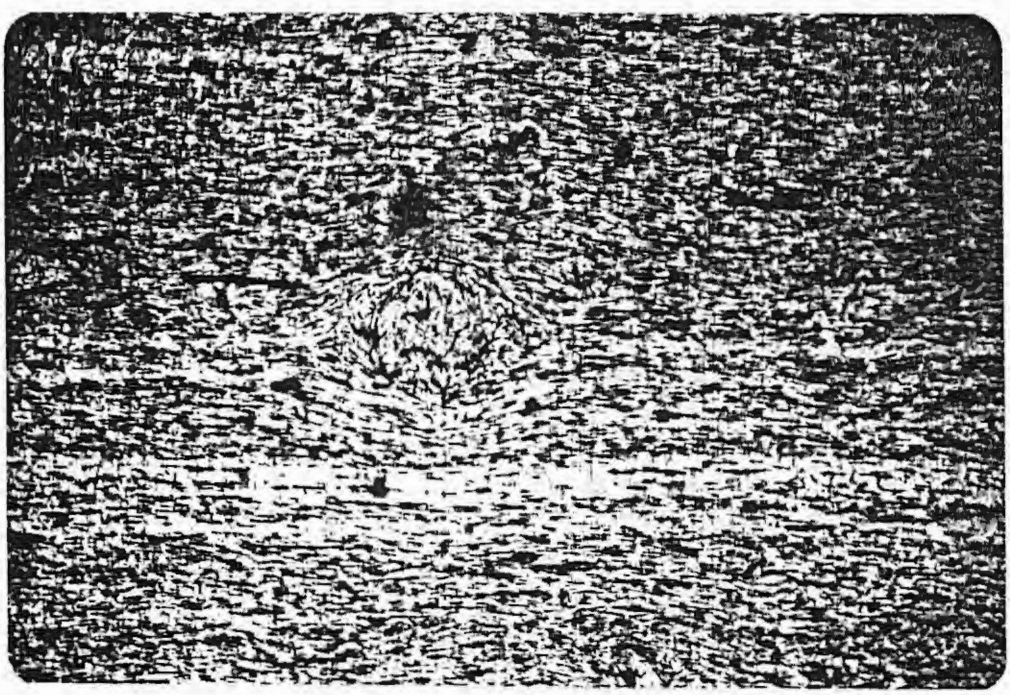


Fig. 6. Microphotographs (125X) of (a) fused shale, and (b) obsidian

nonvesicular obsidian (b).

Uniform vesiculation appears to be the distinguishing characteristic of fused shale so far as this writer has been able to determine from minute examination of fused shale itself and by comparison with other lithic types. Characteristics such as luster, hardness, color, and texture assist one in making a proper identification of fused shale. Fused shale has proved difficult to identify nonetheless. Walker (1936:15) described the quarry at Grimes Canyon as an obsidian deposit. Johnson (1966:5) refers to his material type as grainy obsidian, although he correctly notes that this material is sometimes called fused shale. The confusion of obsidian for fused shale is understandable in view of the large number of physical characteristics the two have in common.

Obsidian and fused shale are both natural glasses which display a high luster except for weathered or hydrated specimens. Color ranges overlap to some degree, although fused shale has a wider range than do California obsidians which are usually a true black, gray, mahogany red brown, or greenish hues of the other colors. Fused shales are commonly colored red, brown, grays, white, clear, greenish hues, and a near black. Some specimens contain several colors on the same piece. In addition to a wider color range, fused shale also has a greater hardness than does obsidian.

Fused shale and obsidian both fracture conchoidally. They are generally homogeneous in composition. Fused shale has a vesicular microstructure, while obsidian often contains spherical growths of quartz. When either the vesicles or the quartz growths are interrupted in the process of reduction of the stone, irregular fracturing of the stone occurs. Because of the high degree of vesiculation of the fused shale, this difficulty in control of flaking occurs more often in that stone than in obsidian. Thus in ease of reduction, obsidian offers advantages over fused shale as a lithic raw material.

Although similar to obsidian in many characteristics, fused shale can be distinguished from obsidian by the presence of vesicles generally evenly dispersed throughout the stone. This vesiculation can be seen with the naked eye, a hand lens, or a microscope. Once this vesiculation is observed, identification of a specimen as fused shale is nearly assured so far as this writer can tell. As an aid to archaeologists and other interested persons, a guide to the identification of fused shale is included in appendix A (page 58).

Thus far fused shale has been described as a product of local combustion metamorphism which may have occurred as early as the Pleistocene. Fused shale contrasts with burnt shale in hardness, color range, fracturing properties, and in archaeological use. It is distinguished from all other lithic types, including obsidian, on the basis of uniform vesiculation.

CHAPTER III

ARCHAEOLOGY OF FUSED SHALE

Quarrying

Fused shale has a single known source in southern California, namely, the combustion metamorphic deposits at Grimes Canyon and Happy Camp Canyon in Ventura County. Another deposit is said to be found at Rincon Point near Ventura (Anthropology 196 Class 1956:13), but this cannot be confirmed at this time. Neither of the Los Angeles County localities of combustion metamorphism, Las Virgenes (B. Edberg, personal communication), nor Lunada Bay (author's personal observation) contain fused shale. Sources other than those in Ventura County may well have been available in the past. Given the number of exposures of the Monterey shales, the great number of organic deposits, and the frequency of chaparral fires, it seems quite likely that other as yet unknown localities of combustion metamorphism do exist and that fused shale may be present there.

Of the exposures in Ventura County, the Grimes Canyon quarry is by far the more extensive. The quarry there has been operated as a commercial decorative rock outlet for the past 50 years according to one of its operators. Numerous blasting and other earth-moving activities have exposed a vast quantity of metamorphic rocks. The steeply sloping hills contain a series of exposures estimated to total 20 kilometers long by 3 kilometers wide (12 by 1.8 miles) with a vertical extension of 400 meters (.24 miles) along canyon walls (Bentor and Kastner 1976:486). Fused shale occurs there in wide bands of various colors (reds, browns, grays) and alternates with the lesser-altered burnt shale deposits. Walker (1936:15) reported an aboriginal "obsidian" quarry there but included no details as to quarrying techniques. Modern use of the quarry has apparently destroyed all evidence of aboriginal use.

The Grimes Canyon quarry is privately owned, and the owners and operators seem keenly interested in the archaeological and geological research which has taken place there over the last few years. They are cooperative and generous in allowing interested and qualified persons access to the combustion metamorphic rocks. There seems little chance that the small amounts of materials being removed for lithic research will in any way destroy or damage the deposit. Considerable amounts of fused shale and burnt shale occur as stream deposits and constitute yet another source for sampling the deposits.

Happy Camp Canyon lies to the southeast of the Grimes Canyon quarry and is a much smaller deposit. Discontinuous exposures, none larger than perhaps 12 by 30 feet, line the banks of a stream. Fused shale occurs there in narrow bands along with burnt shale. Colors and other physical characteristics of the fused shale appear to be identical with those of the fused shale at Grimes Canyon.

Several archaeological sites are located along Happy Camp Canyon, e.g., Ven-301, Ven-302. A small chipping station with waste flakes and utilized flakes of fused shale can be observed on a knoll near the head of the canyon. Aboriginal quarries are also present along the canyon. These quarries consist of rounded cavities, perhaps 4 by 3 by 3 feet, which had been roughed out perhaps with the aid of a hammer or picklike stone implement like the one which appears in the author's hand in the photograph, figure 7. Heizer and Treganza (1972:345) note that rough handpicks and hammers were among the mining, or quarrying, tools which were used in aboriginal California. The stone implement shows battering on one end and was found lying just downslope of the two side-by-side quarries. Both quarries contained bands of fused shale and larger quantities of burnt shale. Access to the quarries up the steep slope would have been difficult, but the ease of removal of the quarried materials by rolling them down

Fig. 7. Aboriginal quarries, Happy Camp Canyon, Ventura County

into the streambed would have been some compensation for their efforts.

Flintknapping

Fused shale is a hard, fine-grained, glassy rock which can be reduced by the percussion method, but this involves some difficulty. Once reduction has been initiated, perhaps with a hard hammer, then care must be taken to avoid hitting large vesicles which may be present in the stone. When large vesicles are contacted, the stone generally fractures unpredictably. Smaller vesicles usually pose no such problem. The difficulty in controlling primary reduction may account in part for the apparent absence of large core tools made of fused shale. A single large (19.2 centimeters in length) leaf-shaped blade of fused shale is reported from Santa Cruz Island (Curtis 1960:62). An artifact of that size is a rarity in fused shale.

Direct free-hand percussion flaking of fused shale with hard hammer technique results in the production of well-defined bulbs of force and prominent rings of compression, both negative and positive, very similar to those which appear on obsidian. Note the multiple flake scars and distinct compression rings on the specimen in figure 8. These were produced by direct percussion with a hard hammer. This fused shale specimen also exhibits many of

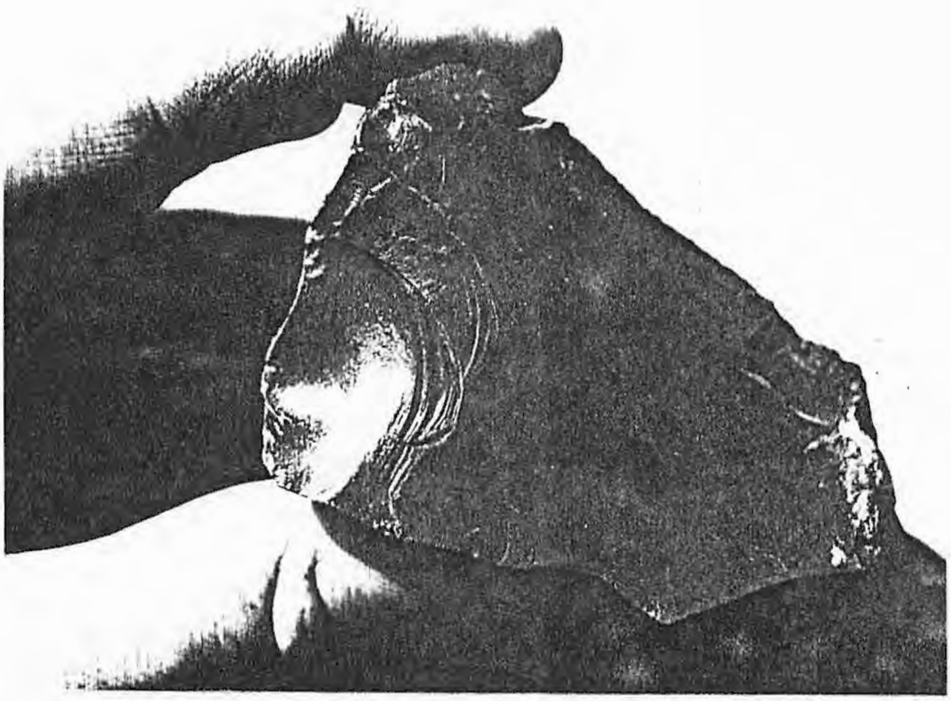


Fig. 8. Fused shale specimen

the distinctive physical characteristics of its rock type, including glassy, or vitreous, luster; smooth, fine-grained surface; and multiple coloration on a single piece.

Observation of a number of fused shale artifacts suggests that primary reduction was carried out on freshly quarried specimens, not on weathered ones. Cortex is not present on any of the fused shale artifacts which this author has analyzed. Hydration layers are common on fused shale artifacts of some age giving their surfaces a dulled appearance. Seen under a binocular microscope, the hydration layers exhibit a granularity which is greater than that of the unhydrated fused shale specimens. The surface alteration which hydration produces in the fused shale appears identical to that which appears on obsidian which has undergone hydration.

Once primary reduction of a fused shale core has taken place, flakes which have been struck off lend themselves easily to further reduction by the pressure method. Many different materials have been used for pressure flakers, including bone, hardwood, and horn (Crabtree 1972:14). Aboriginal northern and central Californians most frequently employed an antler or bone flaker, either unhafted or hafted for additional control (Squier 1953:24). One bone and two antler flakers were recovered from site Sba-53, Aerophysics Site, in Santa Barbara County. Fused shale artifacts in this site and others in the area were probably pressure flaked with such tools.

Among flintknapping techniques observed on the fused shale artifacts in this study, the following may be noted: (1) platform preparation does not appear to have been carried out as there is no evidence of grinding, polishing, or the like on the specimens; (2) hinge and step fractures are commonly observed suggesting that control of flaking was a major problem in reduction due either to a lack of homogeneity in certain pieces or a lack of skill on the part of the flintknapper; (3) final reduction by lever flaking, producing wide rounded flake scars as in notching technique, occurs more frequently than standard pressure flaking technique which produces long, thin flake scars; this suggests lack of control of the pressure flaker for whatever reason; and (4) random flaking is usual on the fused shale projectile points perhaps due to stylistic preferences or to difficulty in control of flaking.

Artifact Types

Due to a certain unpredictability in primary reduction of fused shale, large core tools have apparently not been manufactured from this raw material, at least none is reported in the archaeological literature with which this author is acquainted. Furthermore fused shale, as a glass, does not constitute an ideal raw material for large core tools, such as scraper planes. Its acquisition and retention of a sharp edge renders it more suitable for cutting than for heavy scraping.

Artifacts which are manufactured from fused shale include projectile points, biface-knives, drills, and scrapers. Nearly all are created from flakes, not cores. Secondary and/or final reduction is achieved through pressure-flaking techniques, with few exceptions.

Within the study area, the breakdown of fused shale artifact types was as follows:

Projectile points, fragments	24
Biface-knives	4
Drills	3
Core-scrapers	2
Utilized flakes	1

Two core fragments round out the inventory of fused shale specimens. Projectile points are by far the most numerous. They occurred throughout the study area.

Spatial Distribution

Fused shale artifacts occur in archaeological sites throughout most of the southern California coastal area from Santa Barbara County south into Los Angeles and Orange County but not extending into San Diego County. Fused shale is found in archaeological sites as far east as the Palm Springs area (Bowles and Salpas 1980:27) and as far south as Laguna Niguel in Orange County.

Archaeological sites containing fused shale artifacts are also found on the Channel Islands, lying offshore to the west and southwest of southern California. A single projectile point is reported from Santa Catalina (Reinman and Eberhart 1980:76). No fused shale is reportedly found on San Nicolas (J. Clevenger, personal communication) nor on San Clemente. The northern Channel Islands lie offshore just to the west of the Ventura area, source area for fused shale. Beads of burnt shale are reported from Santa Cruz (C. King, personal communication) and Santa Rosa (Jones 1956:219). An unusually large specimen of fused shale, a blade measuring 19.2 centimeters in length, was found on Santa Cruz Island (Curtis 1960:62). Santa Barbara and the Anacapa group apparently do not have sites with fused shale in them; none is reported in the literature so far as this author is aware.

Within the study area fused shale artifacts occur most frequently in archaeological sites in the Newport Bay area (see figure 9). Sites Ora-58, -119, -120, and -508 lie along the present bay or the old upper bay area. In the San Joaquin Hills and coastline south of Newport Bay lie sites Ora-109, -198, and -232. Elsewhere in Orange County lies Ora-244, a large site which is located in the foothills of the Santa Ana Mountains to the northeast of the El Toro Marine Air Station. Ora-244 is the greatest distance inland of the Orange County sites containing fused

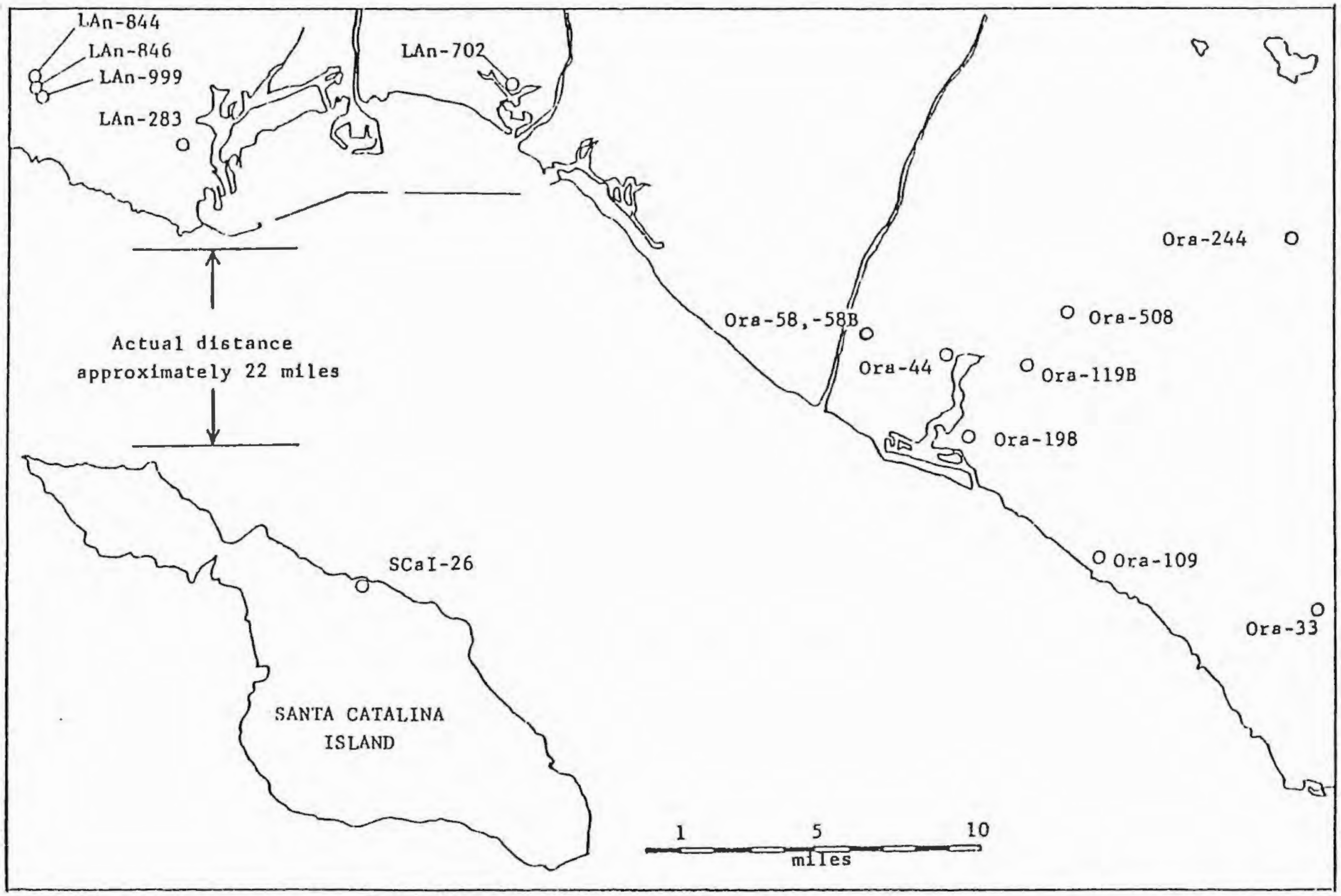


Fig. 9. Study area sites containing fused shale

shale artifacts. Southernmost of the sites is Ora-33 which is located a short distance inland near Laguna Niguel. Fused shale artifacts, as presumed trade items, appear to have penetrated no further inland than 19.2 kilometers (12 miles), a good day's hike from the coast.

In the Los Angeles County portion of the study area, fused shale artifacts are clustered in the Palos Verdes Peninsula-San Pedro areas. A single core fragment was found at LAn-702 in Long Beach.

The degree to which the present artifact clusters resemble the actual prehistoric occurrence of fused shale artifacts would be very difficult to assess. The collections which were made available for this study do not constitute a random sample of archaeological sites in the area by any means. Sites were chosen and collections sought on the basis of reported or suspected occurrences of fused shale artifacts. Owing to the confusion of fused shale with obsidian and possibly with other rock types, there exists the possibility that a much larger number of fused shale artifacts did in fact occur in the study area but have either not been located in surveys and excavations or have gone unrecognized as fused shale when located. It should be pointed out here that in the course of this research much reliance was placed upon personal contact with persons familiar with fused shale and the archaeology of a particular area.

Temporal Distribution of Fused Shale

Although the timing of the combustion metamorphism which produced fused shale is difficult to establish, the timing of the occurrence of fused shale in archaeological sites is easier to determine. Rosen (1979b:26) comments that ". . . fused shale was probably not accessible prior to A.D. 500." Elsewhere he remarks that ". . . the mere presence of fused shale in an archaeological deposit provides a relative date (post A.D. 500) for the site" (1978:81). The archaeological evidence suggests otherwise.

Northern Zone (Santa Barbara County, Ventura County, northern Los Angeles County, and northern Channel Islands

In the northern zone fused shale occurs in archaeological sites which date to a very early period in local prehistory, the Milling Stone Horizon. Among the Milling Stone sites which contain fused shale artifacts are the following (see table 1 for summary of the early sites): (1) Glen Annie Canyon (SBa-142), 5320 ± 120 B.C. to 4430 ± 120 B.C. (Curtis 1965:5); (2) Zuma Creek (LAn-174), 3000 ± 200 B.C. (Bright 1965:370); and (3) Topanga Canyon (LAn-2), 750 ± 150 to 490 ± 200 B.C. (Johnson 1966:15), a very late manifestation of the Milling Stone Horizon and perhaps transitional to the Intermediate Horizon.

TABLE 1.--Summary of Early sites containing fused shale in the northern zone

Site name, number	Radiocarbon dates	Artifact types	Sources
Glen Annie Canyon SBa-142	5320 ± 120 to 4430 ± 120 B.C.	1 small disk scraper	Owen et al. (1964) Curtis (1965)
Zuma Creek LAn-174	3000 ± 200 B.C.	2 leaf-shaped projectile points in burial; 1 small, contracting stem projectile point	Peck (1955) Bright (1965)
Aerophysics Site SBa-53	2940 ± 80 B.C. 2670 ± 80 B.C. 3030 ± 80 B.C. (Average = 2880 B.C.)	1 flake scraper 3 retouched flakes 5 utilized flakes 2 side-notched projectile points 1 blank	Harrison and Harrison (1966)
Topanga Canyon LAn-2	750 ± 150 to 490 ± 200 B.C.	1 thumbnail scraper 2 small projectile points (1 lozenge, 1 leaf-shaped) 4 large projectile points (1 each, contracting stem, small stem, basal notched, and leaf shape)	Johnson (1966)

An archaeological site which can be assigned to the Intermediate Horizon and which contains fused shale artifacts is the Aerophysics Site (SBa-53), an early "Hunting Culture" site radiocarbon dated at 3030 ± 80 B.C. to 2670 ± 80 B.C. (Harrison and Harrison 1966:34).

As to the presence of fused shale artifacts in Late Horizon sites, it is well documented. Some Late Horizon sites and brief descriptions of the fused shale artifacts found in these sites are as follows: (1) Conejo Rock Shelter (Ven-69), fused shale as predominant material in small scrapers, three Desert Side-notched projectile points of fused shale recovered (Glassow 1965); (2) Soule Park Site (Ven-61), fused shale platform cores, blades, projectile points, flake knives, and scrapers; (3) "Simomo" (Ven-24), historic Chumash village, excavated and reported as VE-26 by the Anthropology 196 class at the University of California, Los Angeles; 91% of the projectile points and 25% of the blades were of fused shale; and (4) Arroyo Sequit (LAn-52), fused shale artifacts included projectile points, blades, drills, gravers, and scrapers; 24% of the total debitage was fused shale (Owen, Curtis, and Miller 1964).

Southern Zone (Palos Verdes Peninsula, southern Los Angeles County, Orange County, southern Channel Islands

Of the sites in the southern zone which contain fused shale, several may be said to represent a Milling Stone occupation. LAn-283 (San Pedro Harbor Site) is described by Butler (1974) as having Milling Stone, Intermediate, and Late components. F. Fenenga (personal communication) points out, however, that an unpublished review of Butler (1974) by William J. Wallace would place the whole occupation in the Intermediate Horizon. There are no absolute dates available from the site. One may conclude, then, that occupation of the site probably occurred prior to the Late Horizon. Ora-58 (Banning-Norris, Fairview Hospital Site) contained cog stones, a time marker for the Milling Stone Horizon, in stratigraphic context (Dixon 1968). Radiocarbon dates and obsidian hydration measurements also suggest a late Milling Stone occupation, circa 1700 B.C. (Dixon 1970).

Sites which contain Intermediate Horizon occupations and have fused shale artifacts include the following (Orange County sites, table 2; Los Angeles County sites, table 3): (1) Ora-244 (Tomato Springs), part of a village complex; artifacts, radiocarbon dates, and obsidian hydration readings suggest a long occupation extending from the

TABLE 2.--Summary of Orange County sites containing fused shale

Site	Radiocarbon dates	Obsidian hydration	Artifact types	Notes
Ora-244 (Tomato Springs)	A.D. 795 ± 110 to A.D. 1343 ± 110 Cottrell and Del Chario (1981)	4.4 to 12.7 microns Cottrell and Del Chario (1981)	2 projectile points 1 biface-knife	Artifacts and dates suggest occupation from ca. 2500 B.C. to historic times.
Ora-508	380 ± 130 B.C. Westec (1979)		2 projectile point fragments 1 biface-knife	Intermediate Horizon occupation
Ora-119B	A.D. 490 ± 140 to A.D. 1120 ± 140 Allen (1981)	5.0 to 11.6 microns Allen (1981)	1 biface-knife	Late Horizon occupation
Ora-44	A.D. 50 ± 80 Cottrell (1978)		1 projectile point fragment	Intermediate to Late Horizon
Ora-33		1.5 to 11.1 microns Bright (1965)	1 projectile point fragment	Manos, metates, choppers, stone pendant, scrapers, recorded on site suggest Milling Stone Horizon.
Ora-109 (Moro Canyon #2)				Pottery, pestles, asphaltum, projectile points, metates, manos observed on surface
Ora-58	1575 ± 100 B.C. to A.D. 990 ± 110 Dixon (1970)	1.8 to 12.4 microns Dixon (1970)	9 projectile points 1 drill 1 biface-knife	Artifacts and dates suggest Milling Stone and Late Horizon occupations.

TABLE 2--Continued

Site	Radiocarbon dates	Obsidian hydration	Artifact types	Notes
Ora-58B		1.7 to 7.6 microns Bleitz-Sanburg (1981)	1 projectile point 1 drill	Late Horizon artifacts present; obsidian hydration suggests earlier occupation.

TABLE 3.--Summary of Los Angeles County sites containing fused shale

Site	Radiocarbon dates	Obsidian hydration	Artifact types	Notes
LAn-702 (Sims Pond Site)	1130 ± 190 B.C. to A.D. 1320 ± 140 Allen (1980)	5.0 to 6.1 microns Allen (1980)	1 small core fragment	Artifacts and dates suggest Intermediate to Late Horizon occupation; fused shale in Interval I, earliest occupation.
LAn-283 (San Pedro Harbor Site)			3 projectile points 1 core-scraper	Butler (1974) indicates long occupation from Milling Stone through Late Horizon.
LAn-844	2680 ± 70 B.C. to 590 ± 70 B.C. T. Cooley (pers. comm.)	5.8 to 7.3 microns C. Meighan (pers. comm.)	1 projectile point	Artifacts and dates suggest Intermediate Horizon.
LAn-846			1 utilized flake 1 small core fragment	Surface finds only; not indicative of a particular horizon
LAn-999			2 projectile points 1 drill	Rosen (1979) suggests Late Horizon occupation.

third millenium B.C. up into historic times; (2) Ora-44, radiocarbon dated to A.D. 50 ± 80 on shell which lay in same level as small projectile point fragment of fused shale; evidence of trade network at site involving obsidian, quartz crystals, and steatite; (3) Ora-508, site located on the Tustin Plain near old upper Newport Bay; radiocarbon dated to 380 ± 130 B.C., and LAn-844, Palos Verdes Peninsula, where artifact assemblage, radiocarbon dates, and obsidian hydration measurements all indicate an Intermediate Horizon occupation (T. Cooley, personal communication).

Late Horizon sites in the southern area which contain fused shale include the following: (1) Ora-119B, Newport Bay, considered a late site from artifacts, features, and radiocarbon dates; obsidian hydration measurements suggest slighter earlier occupation; (2) Ora-109, coastal site; site recording team observed pottery, asphaltum, mortars and pestles, knives, scrapers, projectile points, and drills on the surface; suggestive of Late Horizon; (3) Ora-198 (Buck Gully #5), is believed to be a late site based upon assemblage; Chace (1974:101) dates initial occupation to A.D. 200 to 400 and terminal occupation to perhaps A.D. 1600 to 1700; and (4) LAn-999, Palos Verdes Peninsula, said to be Late Horizon site based upon assemblage, and in particular, the presence of small fused shale projectile points; no radiocarbon dates or obsidian hydration readings available from the site.

It can be observed from the foregoing discussion that fused shale artifacts occur in Milling Stone, Intermediate, and Late Horizon contexts in the southern zone. Only one site, Ora-44, contains a fused shale artifact in a level which is radiocarbon dated. The resultant absolute date for the fused shale projectile point fragment is 2060 ± 80 B.P. (UCLA-OHL 2145F), or a corrected date of 80 B.C. to A.D. 140 (Cottrell 1978).

A single date is insufficient evidence for the introduction of fused shale into the southern zone. Coupled with radiocarbon dates and obsidian hydration readings from other sites containing fused shale which occur in the southern zone, such a date takes on greater significance. An analysis of the fused shale artifacts themselves can provide additional evidence.

Artifact Analysis

Artifact categories include projectile points, biface-knives, drills, core-scrapers, and utilized flakes. All categories are described in detail in appendix B (page 61). Biface-knives, drills, and core-scrapers are illustrated in appendix C (page 66), and appendix D (page 69) contains a list of the artifact collections and the storage facilities where they are found.

The projectile points number 24, including fragments. They are classified into the following types: I, small, stemless, 15 total (figure 10); II, small, stemmed, 3 total (figure 11a); III, small or medium, side notched, 2 total (figure 11b, 722); IV, medium size, leaf shaped, approaching plano-convex in cross section, 1 total (figure 11b, 1574); and V, large, stemmed, 3 total (figure 11c).

The small, stemless points (type I) each weigh less than 3.5 grams and would therefore be considered arrowpoints (Fenenga 1953) and would suggest a Late Horizon occupation (Wallace 1955; Warren 1968). Small, stemmed points (type II) are present in early sites with a Milling Stone occupation. Examples include Little Sycamore (Wallace et al. 1956), Zuma Creek (Peck 1955), LAn-2 (Johnson 1966), and the Sayles Site (Kowta 1969). Type II points appear to persist for a long time and occur in the Late Horizon, Level 4, at Malaga Cove (Walker 1952) and at Arroyo Sequit (Curtis 1959). Side-notched projectile points provide dubious time indications as well. They occur early in Pinto Basin sites (Harrington 1957), and in Santa Barbara County, they occur in early Intermediate contexts (Harrison and Harrison 1966). Small, "Desert side-notched" projectile points, however, do serve as time markers for the Late Horizon, but none of these occur in the study collections.

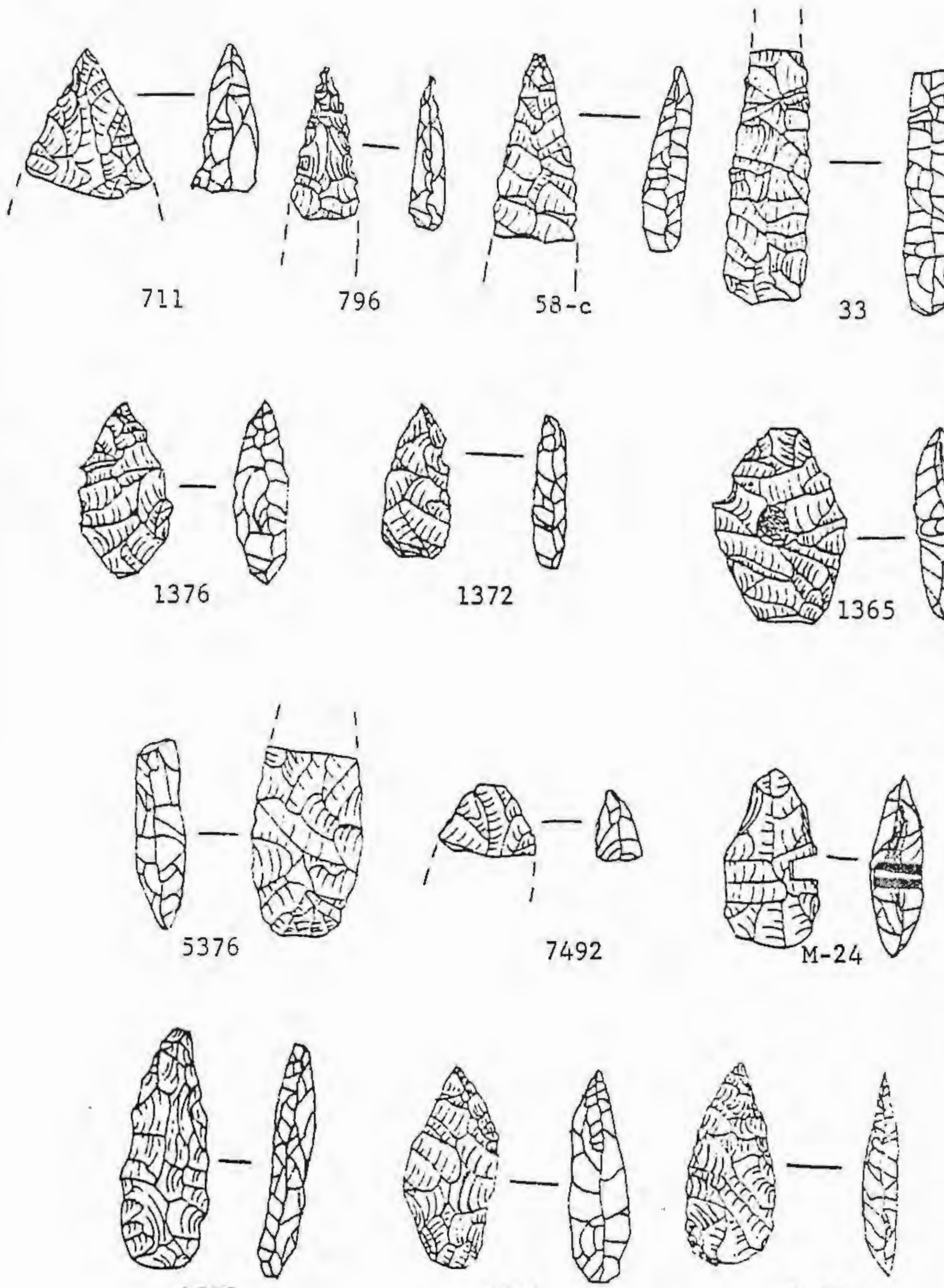


Fig. 10. Small, stemless projectile points of fused shale from the study area

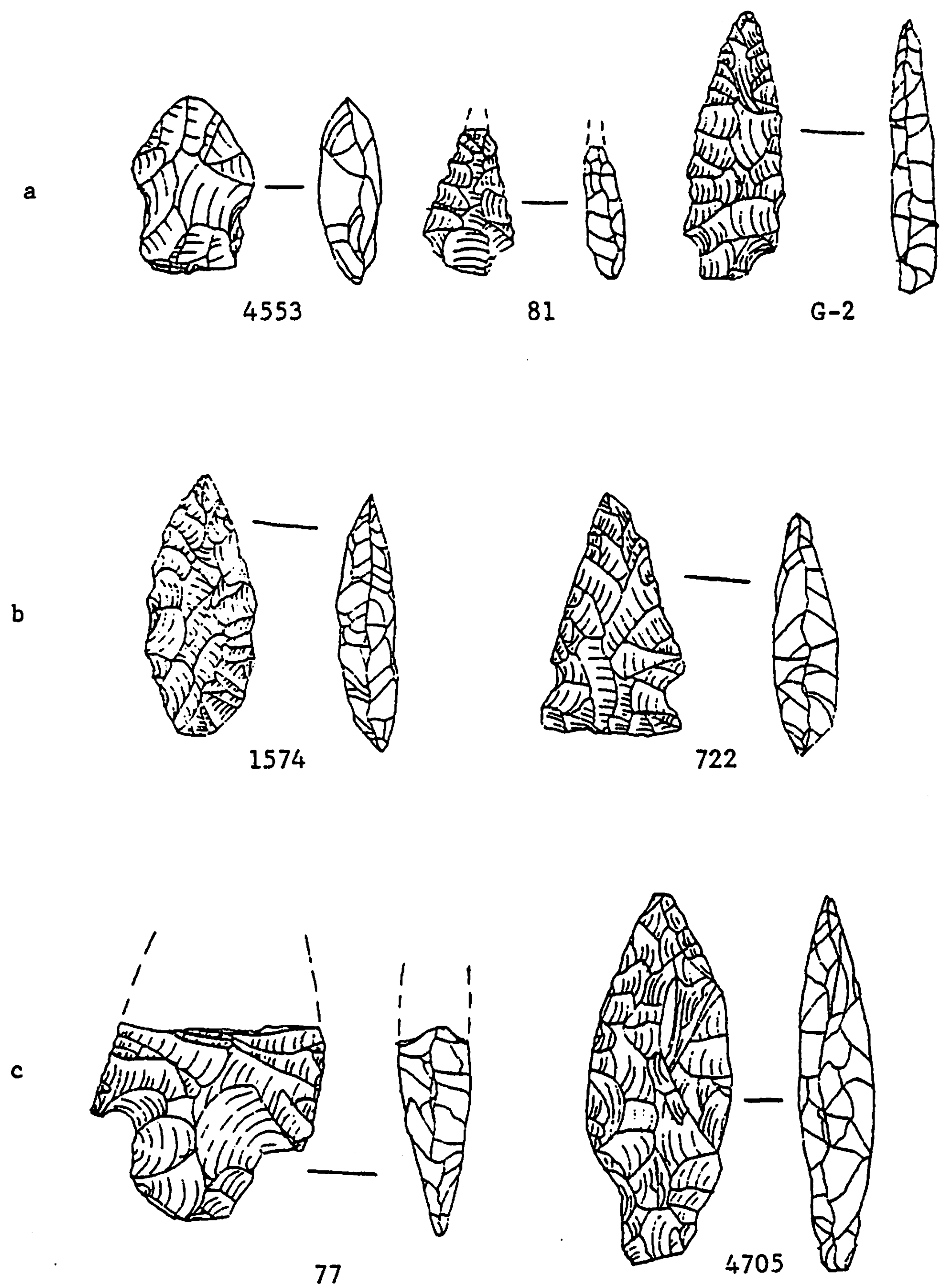


Fig. 11. Projectile points: (a) small, stemmed; (b) medium: leaf shaped, side notched; and (c) large: contracting stem, one-shoulder

Leaf-shaped points (type IV) are common to all time periods. The type which approaches plano-convex in cross section (1574, figure 11b) is found in the Sayles Site (Kowta 1969:17, type 7), a Milling Stone Horizon site, and in Ven-61 (Susia 1962), a Late Horizon occupation, where two examples occur in fused shale (1962:167). A fused shale projectile point of this type also occurred on Santa Catalina Island (Reinman and Eberhart 1980:fig. 15m) in a Late Horizon occupation. T. Cooley (personal communication) remarks that the Santa Catalina point is identical to the specimen from LAn-844 except that it is slightly larger.

Of the large projectile points (figure 11c), a single-shouldered type may provide a link with early sites in the Pinto Basin. Cottrell and Del Chario (1981:61) describe the specimen as a one-shoulder and sub-type of a Pinto Basin point (Harrington 1957:49). Such a type, however, persists for thousands of years in the desert and offers little help in dating. The remaining large point type, represented by two specimens, does not seem to provide much information as to time. Similar points with a long, contracting stem occur in Milling Stone sites (Treganza and Bierman 1958:83-85) and in Intermediate sites (Harrison 1965:112; Johnson 1966:35). They are not characteristic of Late Horizon sites, but they do occur late, as in the Big Tujunga Site (Ruby 1966:101).

As to the stratigraphic contexts of the fused shale projectile points, fully 54% of them (13) are of unknown depth; 9 occur as surface finds; one occurs in a rodent disturbance; another was recovered from a grading operation. Of the remaining points, the depths of occurrence are as follows:

0- 30 centimeters	7 (64%)
30- 50	2 (18%)
50- 60	1 (9%)
80-100	1 (9%)

Of the projectile points occurring in the upper 30 centimeters, all but one are typologically linked to the Late Horizon. The exception is a large, stemmed point fragment (77) which was recovered in the Upper Zone of Ora-58 although the type suggests an Intermediate (Johnson 1966) or Milling Stone (Treganza and Bierman 1958) occupation. By contrast, specimen G-2 occurred at 80-100 centimeters at the same site, although it may well represent a Late Horizon type based on its slight weight. These may be indicative of stratigraphic mixing in the site. To generalize from the depth readings, fused shale artifacts in the study area tend to occur in the upper levels of the sites and would suggest a Late context for the specimens.

In summarizing the time associations of the projectile point types, they indicate a tendency toward occurrence in the Late Horizon. Of the projectile points, 62.5%

(15/24) are linked typologically to Late Horizon contexts. Stratigraphic associations likewise indicate a tendency toward Late Horizon occurrence of the fused shale projectile points. It would appear that trading of fused shale reached a maximum in the Late Horizon in the study area.

As to the remaining 8 projectile points which suggest earlier cultural contexts, it would be difficult to explain their appearance in southern zone sites earlier than perhaps 2000 B.C., although fused shale artifacts do occur some two to three thousand years earlier in the northern zone. The earliest occurrence which can be suggested for the southern zone would be in the late Milling Stone or early Intermediate occupations at perhaps Ora-58 and Ora-244 in Orange County, or LAn-283 and LAn-844 in Los Angeles County. One might imagine a scenario of trade relations between the inhabitants of the southern mainland, Santa Catalina Island, and the maritime-oriented villagers of SBa-53 in Santa Barbara County. Fused shale would be traded to island and mainland peoples in exchange for steatite and other minerals from Santa Catalina. Food or ceremonial items, such as quartz crystals or cog stones, might have served as exchange items from mainland peoples.

CHAPTER IV

CONCLUSIONS

As to the hypothesis that fused shale is a time marker for the Late Horizon in the study area, it cannot be demonstrated from the archaeological evidence presented here. While a majority of the projectile points analyzed in this study indicate a Late Horizon occupation, others point toward Intermediate or Milling Stone Horizon occupations. Furthermore, archaeological sites in the study area containing fused shale artifacts date to all time periods. The difficulty in attempting a temporal framework for fused shale is that no one so far has been able to date the material directly as is done with obsidian currently. The single absolute date which was available for fused shale in this study came fortuitously from a radiocarbon dating of shell in the same level. One such date is hardly sufficient.

Fused shale has the potential, however, for use as an absolute time indicator. It hydrates and therefore develops hydration rims which can be measured just as those of obsidian are. An experiment with hydration measurement on fused shale specimens was undertaken by Aiello (1969). He observed that different colors of the fused shale underwent hydration at different rates on the same specimen. Thus no single rate of hydration could be generated for use. He reasoned that the different hydration rates were related to gross differences in the chemical composition of the two colored segments, but chemical analyses revealed no such differences. Aiello then proposed that differences in the relative amounts of other minerals, such as, iron, sodium, or aluminum, would account for the observed differences in hydration rates. No resolution of this question has apparently been achieved. The matter of differing hydration rates remains an object of research.

As an observation in regard to this question of differing rates, nearly all fused shale artifacts and flakes are of a single color, not multiple. It would seem feasible to isolate single-color groups, such as grays, reds, etc., and to measure them and cross compare them. Individual color-group hydration measurements could then be correlated with radiocarbon dates to establish hydration rates for the various color groups which could be subjected then to further testing and reformulation if necessary. The successful carrying out of such a study would lead to the development of a direct dating technique for fused shale and ultimately to a clearer understanding of the timing and intensity of trade relations among prehistoric populations in the northern and southern zones in southern California.

Despite the inherent difficulties in establishing a temporal framework for a material which (a) was largely unknown to archaeologists in southern California until the 1960s, (b) is still mistaken for obsidian, chert, and other rock types, and (c) is not directly datable at present, the following conclusions regarding fused shale are tentatively offered, based upon this body of research.

First, fused shale as raw material was limited in southern California to combustion metamorphism deposits in Ventura County so far as is presently known. Fused shale outside the northern zone occurs as trade items.

Second, fused shale was traded into the study area in finished artifact form. This conclusion is based upon an analysis of the fused shale specimens which occur in the study area. Evidence of quarrying and/or manufacturing of fused shale would consist of the presence of cores and waste flakes in archaeological sites containing fused shale artifacts. A single flake and a small core fragment were found at site LAn-846 on Palos Verdes. Another small core fragment was recovered from site LAn-702 in Long Beach. A small core-scraper was found at LAn-283, San Pedro Harbor Site, and another at Ora-198, near Newport Bay in Orange County. Other than these specimens, no evidence of quarrying or manufacturing has been discovered in the study area.

Third, fused shale artifacts occur early in the northern zone, circa 5000 B.C., while southern examples appear at a later point in time, circa 2000 B.C. As would be expected, fused shale artifacts are generally similar in the two zones, although red-colored fused shale does not occur in the south, nor do ceremonial blades made of fused shale. In neither area does one find large core tools made of fused shale. The most frequently occurring types of artifacts of fused shale in both areas are projectile points, biface-knives, and small scrapers.

Fourth, projectile point types of fused shale in the southern zone suggest a tendency toward occurrence in Late Horizon occupations. One may view this as indicating that trading of fused shale artifacts was occurring with greater frequency in the Late Horizon than in earlier cultural periods.

APPENDICES

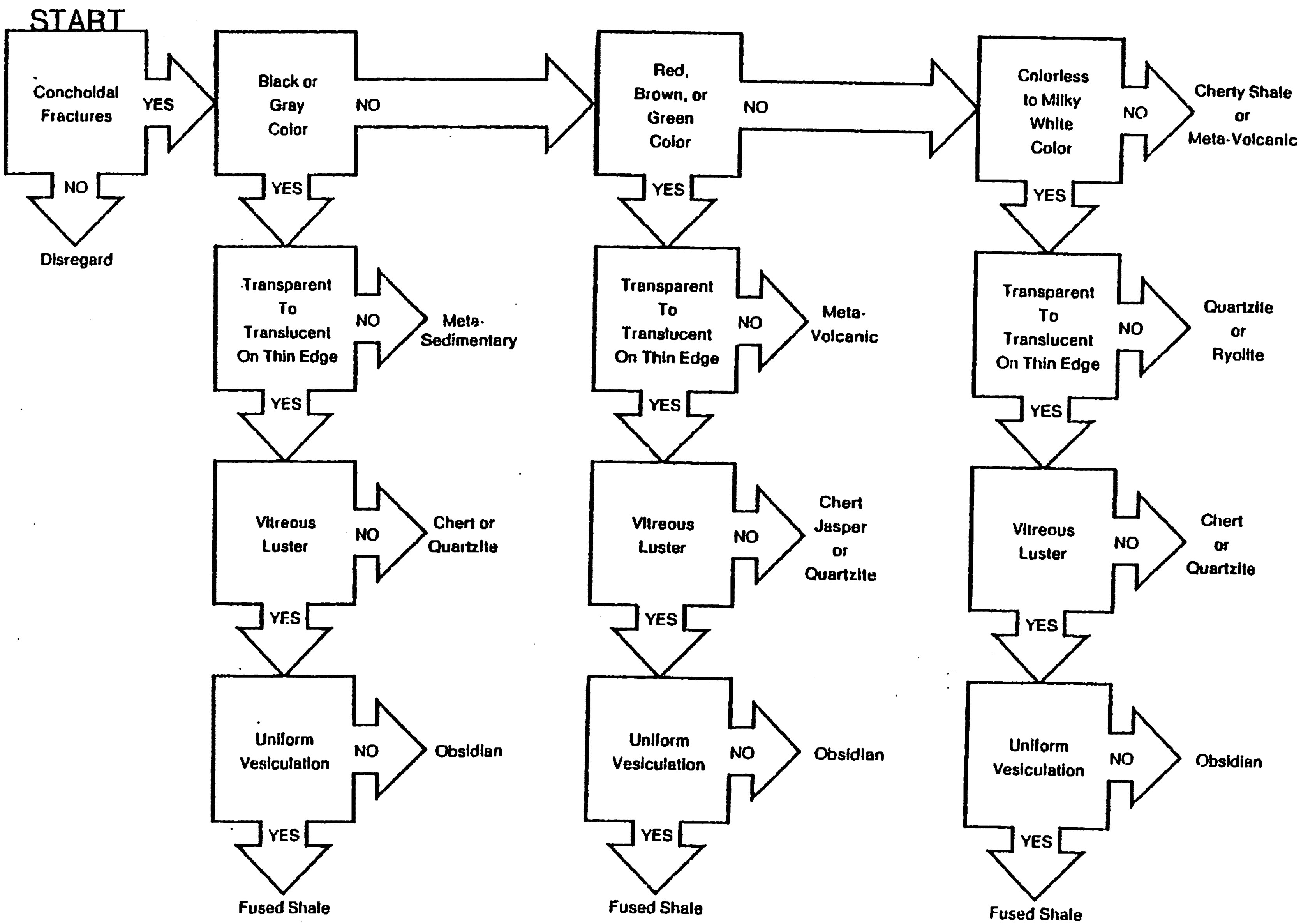
APPENDIX A

GUIDE TO THE IDENTIFICATION OF FUSED SHALE

Figure 12. Guide to the identification of fused shale

Instructions

This flow chart is intended to aid in the identification of fused shale in contrast to some other rock types commonly found in southern California. Enter by rock color, and continue down the chart as long as the answer remains "yes." If "no," choose from the possibilities to the right.


START
Concholdal Fractures
YES
NO
Disregard
Black or Gray Color
NO
YES
Transparent To Translucent On Thin Edge
NO
Meta-Sedimentary
YES
Vitreous Luster
NO
Chert or Quartzite
YES
Uniform Vesiculation
NO
Obsidian
YES
Fused Shale
Red, Brown, or Green Color
NO
YES
Transparent To Translucent On Thin Edge
NO
Meta-Volcanic
YES
Vitreous Luster
NO
Chert Jasper or Quartzite
YES
Uniform Vesiculation
NO
Obsidian
YES
Fused Shale
Colorless to Milky White Color
NO
Cherty Shale or Meta-Volcanic
YES
Transparent To Translucent On Thin Edge
NO
Quartzite or Ryolite
YES
Vitreous Luster
NO
Chert or Quartzite
YES
Uniform Vesiculation
NO
Obsidian
YES
Fused Shale

APPENDIX B

ARTIFACT DESCRIPTIONS

ARTIFACT DESCRIPTIONS

The fused shale projectile points in this research project were classified according to weight, shape of body, shape of base, thickness, and presence or absence of stem or notch.

Type I points are small, stemless, and weigh less than 3.5 grams. They are generally thin and lenticular in cross section. Sub-types include I-a, triangular with flat base (4 specimens), and I-b, leaf shaped with convex base (11 specimens).

Type II points are small and stemmed. They weigh less than 3.5 grams and are generally thin and lenticular in cross section. Sub-type II-a has well-defined shoulders and serrated margins (2 specimens), while II-b points have sloping shoulders and no serration (1 specimen).

Side-notched projectile points comprise type III. These are either small or medium sized, generally thick and lenticular in cross section, with weights which fall into the small category or between the small and large categories (Fenenga 1953). Type III-a points are small with a single side notch present (1 specimen). Type III-b points are of medium size and have double notches (1 specimen).

Type IV points are leaf shaped with convex base. They are of medium size and weigh between the small and large categories (Fenenga 1953). These are rather thick and approach plano-convex in cross section (1 specimen).

Type V points are large, weighing more than 4.5 grams, and generally thick and lenticular in cross section. Sub-type V-a are points with a long, contracting stem, either pointed or straight (2 specimens). Type V-b points are leaf shaped with one shoulder and a flat base (1 specimen).

The biface-knives in the collection are all large and bifacially flaked with edge wear and retouch along one or both margins. They are generally thick and lenticular to flat in cross section (4 specimens).

The drills are small and generally leaf shaped with a medium-sized base. They have short bits which approach a diamond shape in cross section (4 specimens).

Core-scrapers are small core fragments with bifacial flaking and edge wear present on one or more margins (2 specimens).

Utilized flakes are small flake tools with use wear present but without retouch (1 specimen).

Table 4 presents additional artifact descriptions in the form of raw data on size, weight, and depths of occurrence of the fused shale artifacts from the study collections.

TABLE 4.--Artifact descriptions: raw data

Type	Weight (g)	Length (cm)	Width (cm)	Thickness (cm)	Artifact number	Depth (cm)
Projectile points						
I-a	0.6	1.8*	0.8	0.2	796	0- 20
	1.1	2.2*	1.1	0.5	58-c	Surface
	1.7	1.9*	1.6	0.8	711	Surface
	2.3	3.2*	0.9	0.3	33	Surface
I-b	0.5	0.7*	1.0	0.3	7492	Surface
	0.8	1.8	0.8	0.2	1372	Surface
	1.1	2.5	1.1	0.2	379	0- 10
	1.4	2.5	1.1	0.3	2-90	0- 20
	1.6	2.2	1.2	0.4	1376	Surface
	1.6	2.3	1.3	0.4	479	40- 50
	1.7	2.2	1.1	0.5	M-24	Unknown
	1.9	3.2	2.1	0.4	4722	Rodents
	2.1	2.3*	1.3	0.4	5376	20- 30
	2.6	2.7	1.2	0.6	1364	Surface
	3.1	2.5	1.6	0.5	1365	Surface
II-a	2.5	3.5	1.1	0.4	G-2	80-100
	1.1	1.8	1.1	0.3	81	0- 15
II-b	2.5	2.1	1.1	0.5	4553	Unknown
III-a	3.2	2.3	1.8	0.6	4515	15- 30
III-b	3.9	3.1	1.7	0.6	722	Surface
IV	3.8	3.6	1.6	0.7	1574	50- 60
V-a	6.3	2.5	2.9	0.6	77	15- 30
	5.0	3.1	2.4	0.7	4510	30- 45
V-b	7.7	5.1	2.1	0.8	4705	Trench
Biface-knives						
Untyped	5.3	4.5	1.7	0.6	32	60- 70
	5.4	3.5	1.9	0.5	506	50- 60
	9.7	4.6	2.2	0.6	58-b	Surface
	11.8	4.7	2.9	0.7	7060	Surface

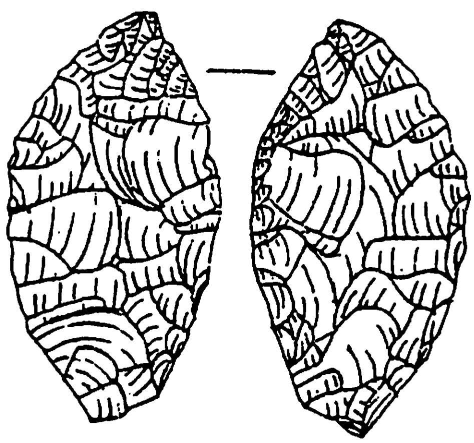
TABLE 4--Continued

Type	Weight (g)	Length (cm)	Width (cm)	Thickness (cm)	Artifact number	Depth (cm)
			Drills			
Untyped	1.7	3.0	1.1	0.4	614	0- 10
	2.9	3.4	1.3	0.4	2-101	0- 20
	3.9	3.3	1.5	0.5	58-a	Surface
			Core-scrapers			
Untyped	3.1	1.9	1.7	0.6	929	Unknown
	3.4	1.8	1.3	0.9	2368A	Unknown
			Utilized flakes			
Untyped	1.8	2.3	1.9	0.5	423-89	Surface

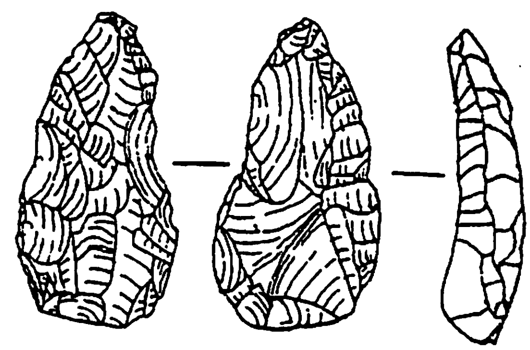
*Fragment.

APPENDIX C

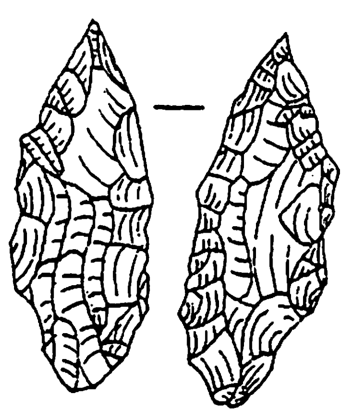
ARTIFACT ILLUSTRATIONS



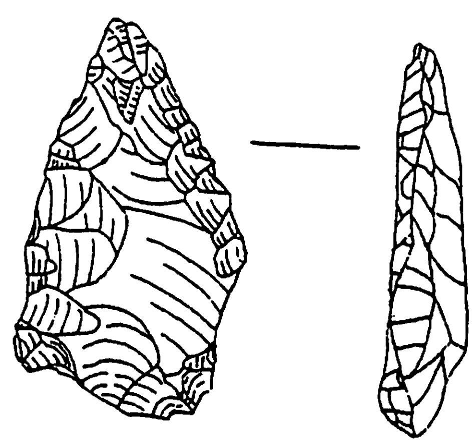
7060



506

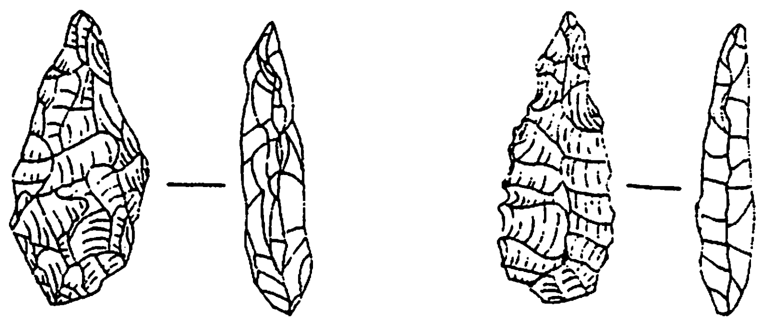


32



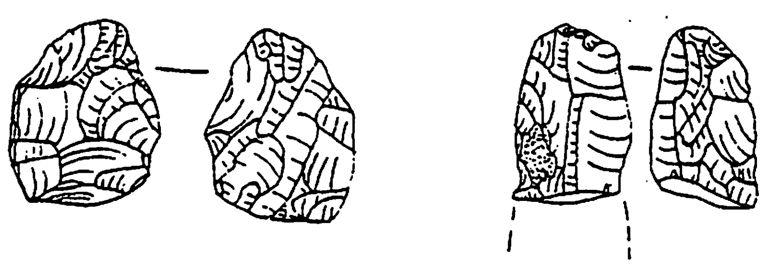
58-c

Fig. 13. Biface-knives



58-a 2-101

Fig. 14. Drills



929 2368A

Fig. 15. Core-scrapers

APPENDIX D

LIST OF COLLECTIONS AND STORAGE FACILITIES

TABLE 5.--List of collections and storage facilities

Site number	Artifact number	Source person	Facility
		Orange County	
Ora-33	40ra33	Jane Gothold	P.C.A.S.
Ora-44	5376	Marie Cottrell	A.R.M.C.
Ora-58	77 81 1364 1365 1372 1376 722 G-2	Keith Dixon	Dept. of Anthropology, C.S.U.L.B.
Ora-58	58-a 58-b 58-c	Jane Gothold	P.C.A.S.
Ora-58B	2-101 2-90	Dana Bleitz-Sanburg	Dept. of Anthropology, C.S.U.L.A.
Ora-109	G-24	Jane Gothold	P.C.A.S.
Ora-119B	506	Lawrence Allen	A.R.M.C.
Ora-198	796 929	Adella Schroth	Dept. of Anthropology, C.S.U.F.
Ora-244	32 4705 4722	Marie Cottrell	A.R.M.C.
Ora-508	7060 711 7492	Lawrence Allen Westec Services	A.R.M.C. A.R.M.C.

TABLE 5--Continued

Site number	Artifact number	Source person	Facility
		Los Angeles County	
Lan-283	4510 4515	Andrew Christenson	Dept. of Anthropology, U.C.L.A.
Lan-283	4553 2368A	Franklin Fenenga	Dept. of Anthropology, C.S.U.L.B.
Lan-702	2577	Lawrence Allen	A.R.M.C.
Lan-844	1574	Theodore Cooley	Dept. of Anthropology, C.S.U.L.A.
Lan-846	423-89 423-89	Andrew Christenson	Dept. of Anthropology, U.C.L.A.
Lan-999	379 479 614	Andrew Christenson	Dept. of Anthropology, U.C.L.A.

Key to abbreviations:

A.R.M.C. Archaeological Resource Management Corporation

C.S.U.F. California State University, Fullerton

C.S.U.L.A. California State University, Los Angeles

C.S.U.L.B. California State University, Long Beach

P.C.A.S. Pacific Coast Archeaological Society

U.C.L.A. University of California, Los Angeles

REFERENCES CITED

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Aiello, Paul V.
1969 The Chemical Composition of Rhyolitic Obsidian and Its Effect on Hydration: Some Archaeological Evidence. M.A. thesis, Department of Anthropology, University of California, Los Angeles.

Allen, Lawrence P.
1979 Archaeological Test at CA-Ora-508, Village 14, City of Irvine, California. Report submitted to the Irvine Company, Newport Beach, Ca.

1980 The Sims Pond Site, CA-LAn-702, Alamitos Bay, Los Angeles County, California. Report submitted to Pacific Marine Investments, Torrance, Ca.

1981 The Archaeology of Locus B of CA-Ora-119, City of Irvine, California. Report submitted to the Irvine Company, Newport Beach, Ca.

Antisell, Thomas
1857 Geological Report on the Coast Range of California. In Explorations and Surveys for the Pacific Railroad, vol. 7, pp. 65-72. U.S. War Department.

Anthropology 196 Class
1956 Excavations of Site VE-26, Ventura County, California. MS on file at Archaeological Survey, University of California, Los Angeles.

Arnold, Ralph, and Robert Anderson
1907 Geology and Oil Resources of the Santa Maria Oil District, Santa Barbara County, California. U.S. Geological Survey Bulletin 322.

Bentor, Y. K., and M. Kastner
1976 Combustion Metamorphism in Southern California. Science 193:486-88.

Bleitz-Sanburg, Dana
1981 Excavations at Ora-58B. MS on file at Department of Anthropology, California State University, Los Angeles.

Bowles, Larry L., and Jean A. Salpas
1980 Mitigation of the ATO Sites--Phase I. Report submitted to A. T. O. Development, Riverside, Ca.

Bright, Marcia
1965 California Radiocarbon Dates. In Archaeological Survey Annual Report 1965, pp. 363-76. Los Angeles: University of California.

Brown, Richard Shaw
1959 The Geology of the Grimes Canyon Area, Moorpark and Fillmore Quadrangles, Ventura County, California. M.A. thesis, Department of Geology, University of California, Los Angeles.

Butler, William B.
1974 The San Pedro Harbor Site: A Primary Subsistence Village on the Southern California Coast. Pacific Coast Archaeological Society Quarterly 10(3,4):1-80.

Chace, Paul G.
1974 Redating the Buck Gully Site, with Implications for Settlement Patterns. Pacific Coast Archaeological Society Quarterly 10(3,4):99-113.

Clevenger, Joyce M.
1981 Personal communication. M.A. thesis in progress, Department of Anthropology, California State University, Long Beach.

Cooley, Theodore G.
1981 Personal communication. M.A. thesis in progress, Department of Anthropology, California State University, Los Angeles.

Cottrell, Marie G.
1978 Westbay: Archaeological Resources Investigation. Report submitted to Larry Seaman Associates, Newport Beach, Ca.

Cottrell, Marie G., and Kathleen Del Chario
1981 Archaeological Investigations of the Tomato Springs Sites. Report submitted to Boyle Engineering, Newport Beach, Ca.

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

Curtis, Freddie
1960 Some Santa Cruz Island Artifacts. Masterkey 34:62-65. Los Angeles: Southwest Museum.

1965 The Glen Annie Canyon Site (SBa-142): a Case for Sedentary Village Life. In Archaeological Survey Annual Report 1965, pp. 1-18. Los Angeles: University of California.

Dixon, Keith A.
1968 Cogged Stones and Other Ceremonial Cache Artifacts in Stratigraphic Context at Ora-58, a Site in the Lower Santa Ana River Drainage, Orange County. Pacific Coast Archaeological Society Quarterly 4(3):57-65.

1970 A Brief Report on Radiocarbon and Obsidian Hydration Measurements from Ora-58 (the Banning-Norris or Fairview Hospital Site) Orange County. Pacific Coast Archaeological Society Quarterly 6(4):61-68.

Edberg, Robert
1981 Personal communication. Northridge Archaeological Research Center, California State University, Northridge.

Fenenga, Franklin
1953 The Weights of Chipped Stone Points: a Clue to their Functions. Southwestern Journal of Anthropology 9(3):309-23.

1981 Personal communication. Department of Anthropology, California State University, Long Beach.

Glassow, M. A.
1965 The Conejo Rock Shelter: An Inland Chumash Site in Ventura County, California. In Archaeological Survey Annual Report 1965, pp. 19-80. Los Angeles: University of California.

Harrington, M. R.
1957 A Pinto Site at Little Lake, California. Southwest Museum Papers No. 17. Los Angeles.

Harrison, William M.
1965 Mikiw: A Coastal Chumash Village. Archaeological Survey Annual Report 1965, pp. 91-178. Los Angeles: University of California.

Harrison, William M., and Edith S. Harrison
1966 An Archaeological Sequence for the Hunting People of Santa Barbara, California. In Archaeological Survey Annual Report 1966, pp. 1-89. Los Angeles: University of California.

Heizer, Robert F., and Adan E. Treganza
1972 Mines and Quarries of the Indians of California. Ramona, Ca.: Ballena Press.

Jones, Phillip M.
1956 Archaeological Investigations on Santa Rosa Island in 1901. In Anthropological Records, vol. 17(2), pp. 201-80. Berkeley: University of California.

Johnson, Keith L.
1966 Site LAn-2; a Late Manifestation of the Topanga Complex in Southern California Prehistory. In Anthropological Records, vol. 23, pp. 1-36. Berkeley: University of California.

King, Chester D.
1981 Personal communication. Ph.D. dissertation in progress, Department of Anthropology, University of California, Davis.

Kowta, M.
1969 The Sayles Complex: A Late Milling Stone Assemblage from Cajon Pass and the Ecological Implications of Its Scraper Planes. University of California Publications in Anthropology, vol. 6. Berkeley.

Liddicoat, Richard T., Jr.
1975 Handbook of Gem Identification. 10th ed. Los Angeles: Gemological Institute of America.

Lung, Richard
1958 Geology of the South Mountain Area, Ventura County, California. M.A. thesis, Department of Geology, University of California, Los Angeles.

Meighan, Clement W.
1981 Personal communication. Department of Anthropology, University of California, Los Angeles.

Owen, R. C., Freddie Curtis, and Donald S. Miller
1964 The Glen Annie Canyon Site, SBa-142: An Early Horizon Coastal Site of Santa Barbara County. In Archaeological Survey Annual Report 1963-1964, pp. 431-503. Los Angeles: University of California.

Peck, Stuart L.
1955 An Archaeological Report on the Excavation of a Prehistoric Site at Zuma Creek, Los Angeles County, California. Archaeological Survey Association of Southern California Paper No. 2. Los Angeles.

Reinman, Fred, and Hal Eberhart
1980 Test Excavations at Ripper's Cove Site (SCaI-26). Pacific Coast Archaeological Society Quarterly 16(1,2):61-105.

Rosen, Martin D.
1978 Archaeological Investigations at Ven-294, an Inland Chumash Village Site. In The Archaeology of Oak Park, Ventura County, California, vol. 2, C. W. Clewlow, H. F. Wells, and A. G. Plastron, eds., pp. 9-113. Monograph 5, Institute of Archaeology, University of California, Los Angeles.

1979a Archaeological Excavations at the Burrell Site, CA-LAn-999, City of Rancho Palos Verdes, California. Report submitted to Burrell, Ltd., Palos Verdes Peninsula, Ca.

1979b Resource Acquisition at CA-Ven-294. Journal of New World Archaeology 3(2):11-31.

Ruby, Jay
1966 Archaeological Investigations of the Big Tujunga Site (LAn-167). In Archaeological Survey Annual Report 1966, pp. 92-122. Los Angeles: University of California.

Soper, E. K.
1938 Geology of the Central Santa Monica Mountains, Los Angeles County. California Journal of Mines and Geology 34(2):131-80.

Squier, Robert J.
1953 The Manufacture of Flint Implements by the Indians of Northern and Central California. In University of California Archaeological Survey Reports, vol. 19, pp. 15-44. Berkeley.

Susia, Margaret
1962 The Soule Park Site (Ven-61). In Archaeological Survey Annual Report 1961-1962, pp. 157-234. Los Angeles: University of California.

Treganza, A. E., and A. Bierman
1958 The Topanga Culture: Final Report on Excavations, 1948. In Anthropological Records, vol. 20(2), pp. 45-86. Berkeley: University of California.

Walker, Edwin F.
1936 Obsidian Used by Prehistoric Californians. Masterkey 10:15. Los Angeles: Southwest Museum.

1952 A Stratified Site at Malaga Cove. In Five Prehistoric Sites in Los Angeles County, California. Frederick Webb Hodge Anniversay Fund, vol. 6, pp. 27-69. Los Angeles: Southwest Museum.

Wallace, William J.
1955 A Suggested Chronology for Southern California Coastal Archaeology. Southwestern Journal of Anthropology 11:214-30.

Wallace, William J., et al.
1956 The Little Sycamore Shellmound, Ventura County, California. Archaeological Research Associates Contributions to California Archaeology No. 2. Los Angeles.

Warren, Claude N.
1968 Cultural Tradition and Ecological Adaptation of the Southern California Coast. In Archaic Prehistory of the Western United States. C. Irwin-Williams, ed. Eastern New Mexico University Contributions in Anthropology, vol. 1(3), pp. 1-14.

Westec Services, Inc.
1979 Archaeological Salvage Program at CA-Ora-508, Irvine, California. Report submitted to the Irvine Company, Newport Beach, Ca.

Williams, Steven L.
1981 Personal communication. Texaco Corporation, Los Angeles, Ca.

Woodring, W. P., M. N. Bramlette, and W. S. W. Kew
1946 Geology and Paleontology of Palos Verdes Hills, California. U.S. Geological Survey Professional Paper 207.