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# Elkhorn Slough Revisited: Reassessing the Chronology of CA-MNT-229

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**I**N 1985 the California Department of Transportation (Caltrans) contracted a major data recovery excavation at CA-MNT-229, situated at the mouth of Elkhorn Slough in Monterey County (Fig. 1). A large volume (101.9 m.<sup>3</sup>) of midden was extracted and processed at this location, and the resulting faunal and artifact assemblages were pivotal in a new assessment of the relative mobility and ecology of prehistoric central coast hunter-gatherers (Dietz et al. 1986, 1988). Of crucial importance to this effort was the interpretation of CA-MNT-229 as essentially a single-component Middle Period site. Since extant models of Monterey Bay area prehistory (Breschini and Haversat 1980; Dietz and Jackson 1981; Moratto 1984) did not recognize the existence of a Middle Period, the excavation served to define this important period (dated ca. 600 B.C.-A.D. 1000) in this district.

Absolute dating of CA-MNT-229 was accomplished with a large, complex battery of chronometric analyses, including 28 radiocarbon assays, 192 obsidian source and hydration readings, and typological analysis of 3,535 time-sensitive shell beads. Bead and hydration data were largely congruent, indicating occupation during the above-delineated time span, with some evidence for minor earlier (ca. 2,600 B.C.), and later (historic) site use. Radiocarbon results, however, were only partially in agreement with this dating; 19 radiocarbon samples yielded Middle Period dates, however, seven dates, mostly derived from estuarine shell samples, produced calendric readings between 4,000 and 6,200 B.C. Because these dates did

not conform with the other chronometric data, and because of potentially exacerbated problems with the "reservoir effect" in estuarine contexts (Berger et al. 1966), they were dismissed. Based upon a re-evaluation of site stratigraphy and new research on the accuracy of marine-shell-derived radiocarbon dates (Stuiver et al. 1986), it has become apparent that these assays were not in error, and that in addition to a substantial Middle Period component, CA-MNT-229 also harbors evidence of a relatively ethereal occupation dating ca. 6,200-4,000 B.C.

Recognition of this earlier occupational component has significant implications for regional settlement histories and cultural chronology. Subsequent treatments of central coast culture history (Jones and Hylkema 1988; Jones et al. 1989) have relied heavily upon data from this location to define the Middle Period. Recent discussion of early Holocene settlement along the central California coast has been forced, following the original conclusions on the dating of CA-MNT-229, to interpret an apparent absence of early coastal sites in the Monterey Bay area (Breschini and Haversat 1991a:125-132). Breschini and Haversat suggested that this absence may be attributed either to sea-level rise (1991a:127) or to the ruggedness of the Monterey Bay shoreline relative to more habitable inland terrain (1991a:131). The early component now recognized at CA-MNT-229 supports recent findings from CA-SON-348/H (Schwaderer et al. 1990; Schwaderer 1992) and other sites, where the antiquity of human

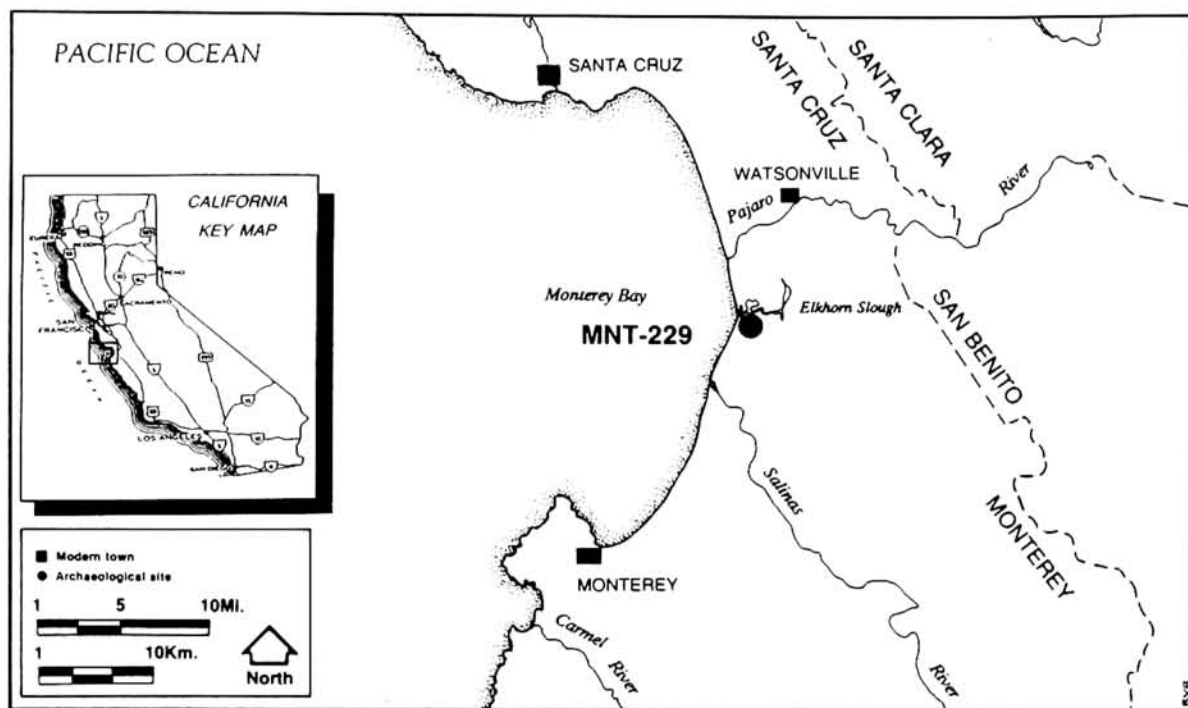


Fig. 1. Location of CA-MNT-229.

presence in the coastal zone of central California has been found to be substantially older than suggested by the corpus of previously available data. Since the original interpretation of the chronology of CA-MNT-229 has been questioned elsewhere (Jones and Hildebrandt 1990:73; Bouey and Basgall 1991:52), this paper is simply intended to set the record straight and present a revised assessment of the dating of this important site. The following discussion emphasizes those aspects of the excavation that bear on the dating of the site—radiocarbon, obsidian hydration, shell and glass beads, and flaked and ground stone artifacts. Descriptions of the rest of the material inventory recovered from this location are included in the original site reports (Dondero 1984; Dietz et al. 1986, 1988).

#### SITE DESCRIPTION

CA-MNT-229 is an extensive shell midden, situated on the south bank of Elkhorn Slough,

near its present, artificial outlet to the sea (Fig. 1). First noted by Golomshtok in 1922, the site was more formally described by Wood (MS) who remarked on the occurrence of human interments. Pilling assigned a trinomial to the midden in 1948, and Greengo completed the first site form in 1950. Subsequently, Greengo (1948) analyzed a shell column from this location as part of his treatise on shellfish use in aboriginal California.

The site was severely impacted by the construction of the Pajaro Valley Consolidated Railroad line through its center in the 1890s (Dondero 1984:9), and later by the completion of California Highway 1 in 1929 along the same route. Not long afterward, in the 1950s, Pacific Gas and Electric Company erected a power plant, affecting the integrity of the southern flank of the deposit. Despite these not inconsequential disturbances, large, intact portions of midden were discovered when Caltrans conducted an archaeological testing program at the site

in anticipation of replacement of the Elkhorn Slough Bridge (Dondero 1984). Based on the testing results, CA-MNT-229 was determined eligible for the National Register of Historic Places, and data recovery was undertaken in 1985 to mitigate the impact of the bridge construction. The bridge was built later that same year, and the report documenting the data recovery was completed soon thereafter (Dietz et al. 1986), and was subsequently published (Dietz et al. 1988).

### STRATIGRAPHY AND SITE STRUCTURE

Testing and data recovery revealed CA-MNT-229 to harbor faunal and artifactual constituents typical of central coast estuarine shell middens: an abundance of mussel (*Mytilus edulis*), clam (*Protothaca staminea*, *Tresus nuttallii*), and oyster shell (*Ostrea lurida*) fragments, fire-altered rock, vertebrate remains, ash, and organically enriched soil.

Ranging from 0 to 230 cm. in depth, the cultural materials were present in a sandy loam matrix derived from a stabilized sand dune. During data recovery, the portion of the site targeted for excavation was divided arbitrarily into three loci: the Northern, Middle, and Southern site areas; and a large block of 1 x 2-m. units was excavated in each area (Fig. 2). While a certain uniformity was apparent throughout the deposit, excavation also produced modest evidence of horizontal and vertical variation in the midden profile. The northern portions of the site manifested one primary cultural layer: Stratum B, a friable, very dark, grayish brown shell midden extending from 20 to 150 cm. below the surface. Overlying this stratum was an organic zone, Stratum A, and beneath it, a mixing zone between cultural and sterile soils, Stratum C. Excavations in the southern site area revealed the presence of an additional cultural substratum (C<sup>1</sup>) slightly lighter in color and more compact than the deposits above it. The depth and thickness of this deposit varied,

but commonly extended between 110 and 160 cm. below surface (Fig. 3). Dondero (1984:41) detected this stratum (his Stratum C) only in one of his six test pits (Unit 6) between 140 and 160 cm. below surface. As with all sites on the central California coast, evidence of rodent disturbance was prolific, and recognition of the full impact of this activity on stratigraphic integrity is critical to interpretation of excavation results. Stratum B was interpreted as representing the majority of occupation at this locale. Since no cultural stratigraphy was evident among the recovered artifacts, constituent distribution essentially corresponded with physical stratigraphy, in that frequencies were highest in those levels associated with that stratum, and little typological variation was evident vertically. In essence, CA-MNT-229 was interpreted as a single cultural component, represented by Stratum B.

A series of 28 features provided an additional dimension to site structure. These included 10 human interments, four mussel shell concentrations, three clam shell concentrations, five thermally-altered rock concentrations, one ash concentration, five sub-midden pits, and one twentieth-century trash pit. The circumstances leading to the creation of the various shell and rock concentrations were not wholly understood, nor were their functions. The features nonetheless were presumed (in the original reports) to be of cultural origin, and radiocarbon dates obtained from these contexts have been critical in interpreting site chronology.

### SITE CHRONOMETRICS

#### Radiocarbon

**The Sample.** The 28 radiocarbon dates obtained from CA-MNT-229 represent an interesting interpretive challenge. Analyses were run by Beta Analytic and Washington State University on samples from four species of marine (estuarine) shell (*Mytilus edulis*, *Protothaca*

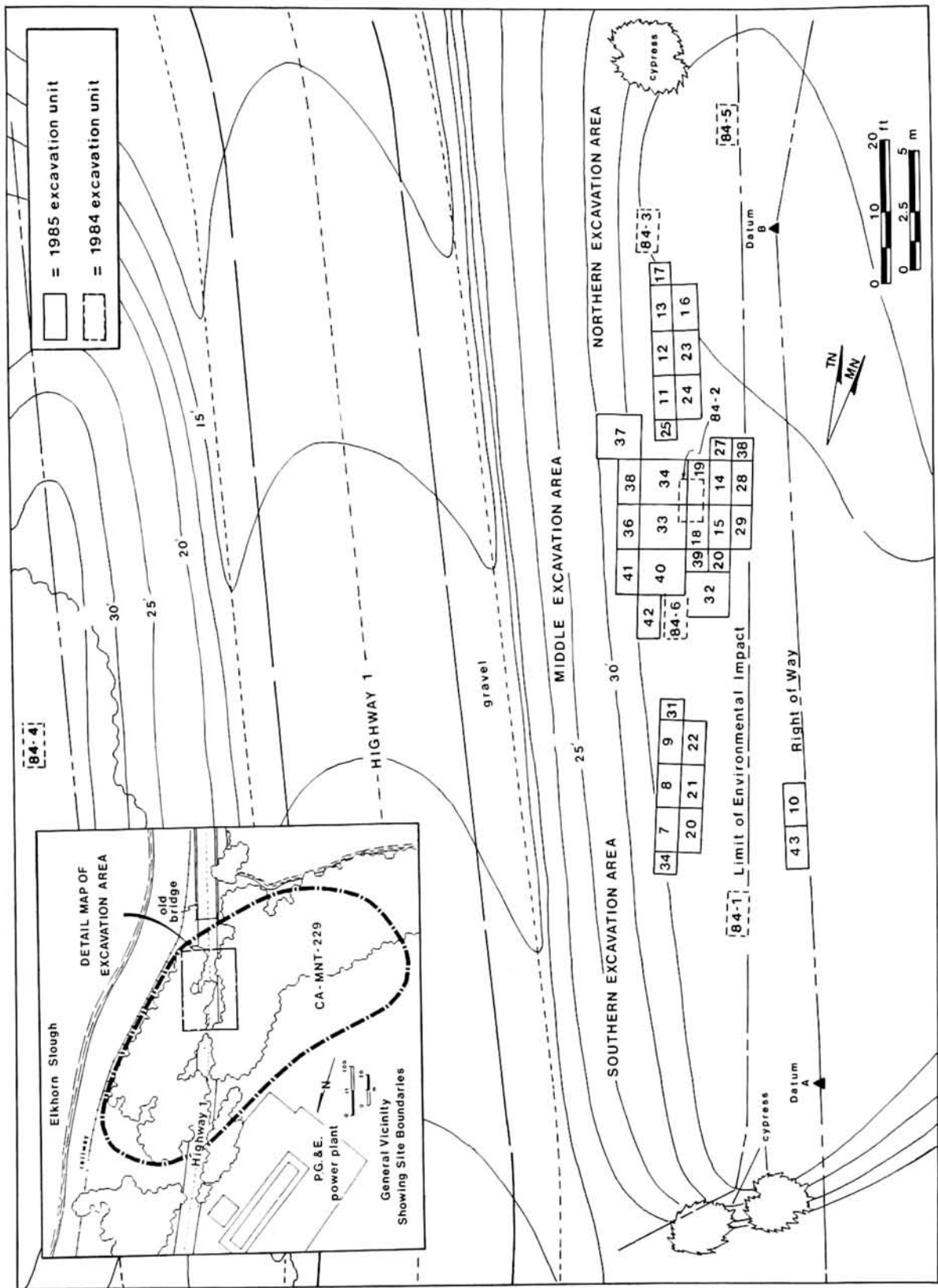


Fig. 2. Map of the CA-MNT-229 site.

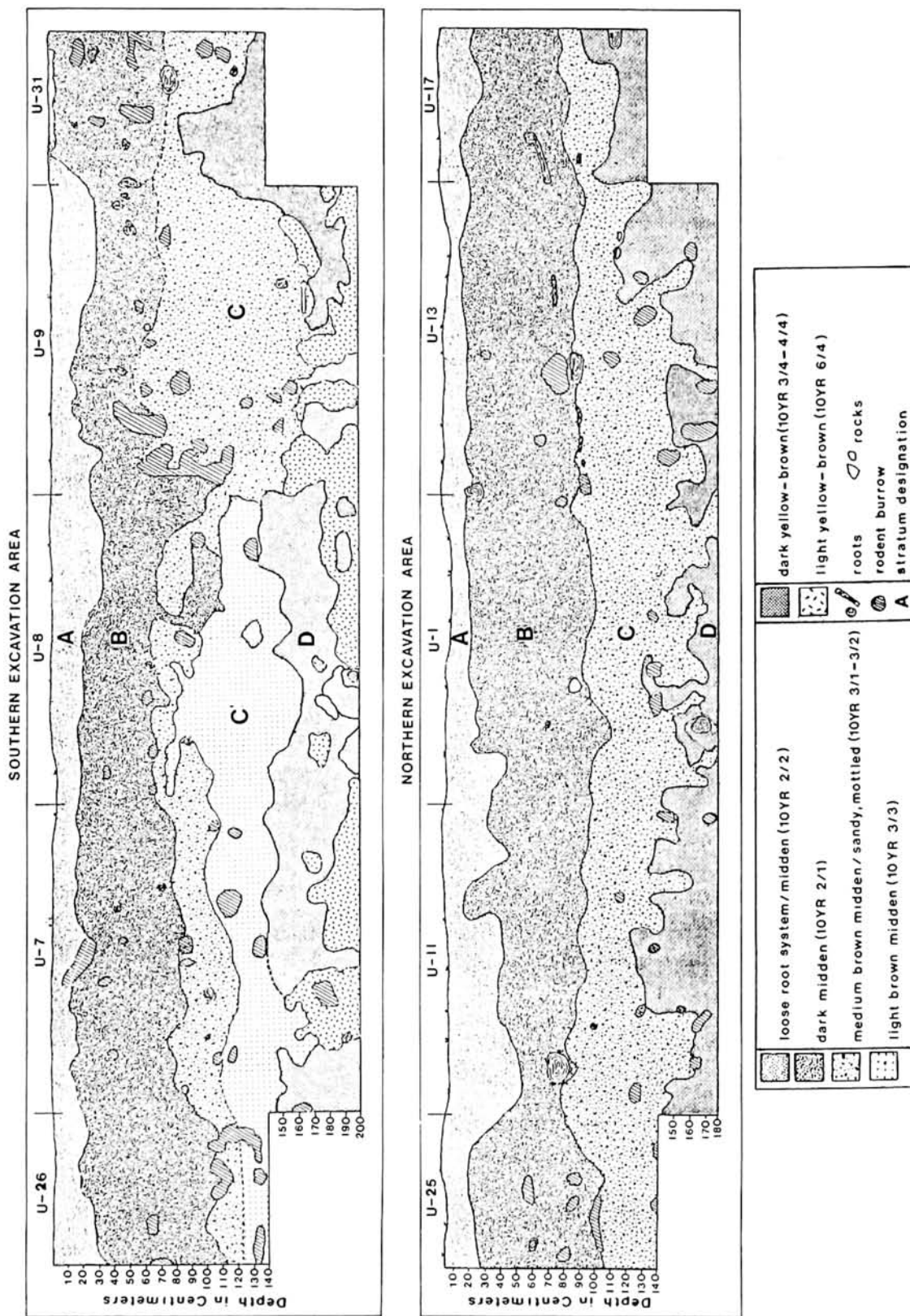


Fig. 3. Sidewall Profile, CA-MNT-229, Southern Excavation Area, West Wall.

*staminea*, *Tresus nuttallii*, and *Olivella biplicata*), charcoal, and collagen from two mammalian taxa (*Cervus elaphus* and *Odocoileus hemionus*). The majority of assays were from samples of midden shell selected at random from as wide and complete a spectrum of excavation proveniences as possible (Table 1). All three vertical excavation areas were sampled, as were nearly all excavation levels between 0 and 230 cm. below surface. Eight of the samples were derived from three features: samples of *Mytilus* and *Protothaca* from a shell concentration (Unit 13, Feature 2), samples of charcoal, *Mytilus*, and *Protothaca* from a similar concentration (Unit 21, Feature 1), and three lots of *Olivella* shell beads (Type G6; cf. Bennyhoff and Hughes 1987) associated with a human interment (Burial 5). None of the samples were corrected for isotopic fractionation. Twelve of the shell dates were obtained from samples composed of multiple shell fragments, while the remainder were from single pieces.

The array of samples produced a wide variety of dates: seven dates between 6,000 and 8,100 radiocarbon years B.P. (RCYBP), one of ca. 4,200 RCYBP, and 20 between 3,200 and 800 RCYBP (Table 1). Distinctive patterning evident in this large, complex sample led to the conclusion that only dates post 4,200 RCYBP were accurate (Dietz et al. 1988). First, of seven dates in excess of 6,000 RCYBP, six were derived from samples of estuarine clam, both *Protothaca staminea* and *Tresus nuttallii*. Only a single sample of another material, elk bone collagen (WSU-3314), yielded a comparable date. In contrast, samples derived from shells of *Mytilus edulis*, without exception, yielded dates more recent than 3,200 RCYBP. This marked discrepancy suggested that variation in the preferred habitats of these invertebrate species—subsurface mudflats for the clams and intertidal rocks for mussels—affected, perhaps drastically, the radiocarbon content of shells.

Two sets of dates obtained from features contributed heavily to suspicions regarding the reliability of dates derived from estuarine clam shells. From Unit 13, Feature 2, multiple fragments of *Mytilus edulis* yielded a date of 2,570  $\pm$  60 B.P. (WSU-3309), while a single shell of *Protothaca staminea* yielded a date of 6,580  $\pm$  80 years B.P. (WSU-3310). Unit 21, Feature 1, produced charcoal (2,070  $\pm$  90; WSU-3304), multiple mussel shell fragments (2,475  $\pm$  110; WSU-3305), and multiple fragments of *P. staminea* (4,120  $\pm$  90; WSU-3006). These results were viewed as a reaffirmation of the unreliability of clam-derived dates in this setting (Dietz et al. 1988:122-125). In addition to the rejection of the older dates resulting from these pairings, an attempt to compensate for the reservoir effect in the remaining radiocarbon assays was also undertaken. Based on the results from Unit 21, Feature 1, a correction factor of 400 years was subtracted from all mussel and olive shell-derived dates. All samples derived from clam shells were rejected. Sixteen of 18 dates in the resulting sample spanned between 800 B.C. and A.D. 1000. A single date of ca. A.D. 1500 was attributed to sporadic use of the site location during the Late Prehistoric/Historic era and a single date obtained from elk bone in excess of 7,000 RCYBP remained unexplained (Dietz et al. 1988:126).

A set of three dates obtained from G6 type beads associated with Burial 5 are also of some import in discussion of chronometric variability at this specific location, and coastal contexts in general. Despite the presumed contemporaneity in deposition, these beads yielded dates that deviate from one another by 600 radiocarbon years (Table 1). This discrepancy clearly and simply reflects the lack of precision inherent in contemporary chronometric techniques. Such variability cannot, at present, be brought under control, and chronological assessments based on radiocarbon must realistically acknowledge this imprecision.

Table 1

## CORRECTED AND RECALIBRATED RADIOCARBON DATES FROM CA-MNT-229

Unit	Depth (cm.)	Associations	Sample Number	RCYBP <sup>a</sup>	Material	Fractionation Correction <sup>b</sup>	Reservoir Effect and Secular Variation <sup>b</sup>	1 Sigma	2 Sigma
6	30-40	—	Beta-11021	1,380±70	<i>Mytilus</i> <sup>c</sup>	1,790±99	A.D. 965-985 B.P.	A.D. 840-1040	A.D. 720-1170
6	70-80	—	Beta-11022	2,000±60	<i>Mytilus</i> <sup>c</sup>	2,410±92	A.D. 286-1,664 B.P.	A.D. 178-418	A.D. 80-530
6	150-160	—	Beta-11023	2,780±80	<i>Mytilus</i> <sup>c</sup>	3,190±106	736 B.C.-2,685 B.P.	790-500 B.C.	890-370 B.C.
6	180-200	—	Beta-11024	3,180±80	<i>Mytilus</i> <sup>c</sup>	3,590±106	1,140 B.C.-3,089 B.P.	1,290-980 B.C.	1,410-840 B.C.
4	80-90	—	Beta-11025	860±60	<i>Mytilus</i> <sup>c</sup>	1,270±92	A.D. 1422-528 B.P.	A.D. 1327-1473	A.D. 1280-1550
4	150-160	—	Beta-11026	2,090±80	<i>Mytilus</i> <sup>c</sup>	2,500±106	A.D. 188-1,762 B.P.	A.D. 70-330	70 B.C.-A.D. 440
4	220-230	—	Beta-11027	2,310±360	<i>Mytilus</i> <sup>c</sup>	2,720±366	71 B.C.-2,020 B.P.	510 B.C.-A.D. 380	940 B.C.-A.D. 730
5	140-150	—	Beta-11028	6,080±170	<i>Tresus</i> <sup>c</sup>	6,490±183	4,773 B.C.-6,722 B.P.	4,980-4,560 B.C.	5,210-4,350 B.C.
31	0-20	—	WSU-3297	1,920±130	<i>Protothaca</i>	2,330±147	A.D. 405-1,545 B.P.	A.D. 220-570	A.D. 50-690
32	40-60	—	WSU-3298	7,700±90	<i>Protothaca</i>	8,110±114	6,222 B.C.-8,171 B.P.	6,400-6,090 B.C.	6,480-6,010 B.C.
32	60-80	—	WSU-3299	1,700±70	<i>Protothaca</i>	2,110±99	A.D. 643-1,307 B.P.	A.D. 540-710	A.D. 420-820
32	100-120	—	WSU-3300	6,510±80	<i>Protothaca</i>	6,920±106	5,185 B.C.-7,134 B.P.	5,240-5,040 B.C.	5,340-4,900 B.C.
32	120-140	—	WSU-3301	6,820±100	<i>Protothaca</i>	7,230±122	5,428 B.C.-7,371 B.P.	5,520-5,310 B.C.	5,630-5,210 B.C.
11	160-170	—	WSU-3302	6,240±145	<i>Protothaca</i>	6,650±161	4,836 B.C.-6,785 B.P.	5,040-4,670 B.C.	5,210-4,460 B.C.
14	160-180	—	WSU-3303	1,760±80	<i>Protothaca</i>	2,170±106	A.D. 585-1,365 B.P.	A.D. 450-670	A.D. 340-770
21	100-120	Feature 1	WSU-3304	2,070±90	charcoal	2,070±114	101 B.C.-2,050 B.P.	210 B.C.-A.D. 60	390 B.C.-A.D. 130
21	100-120	Feature 1	WSU-3305	2,475±110	<i>Mytilus</i> <sup>c</sup>	2,885±130	313 B.C.-2,262 B.P.	400-100 B.C.	650 B.C.-A.D. 60
21	100-120	Feature 1	WSU-3306	4,120±90	<i>Protothaca</i> <sup>d</sup>	4,530±114	2,352 B.C.-4,301 B.P.	2,480-2,180 B.C.	2,640-2,010 B.C.
—	185	—	WSU-3307	2,470±50	<i>Mytilus</i> <sup>c</sup>	2,880±86	300 B.C.-2,249 B.P.	373-156 B.C.	460-40 B.C.
13	120-125	Feature 2	WSU-3309	2,570±60	<i>Mytilus</i> <sup>c</sup>	2,980±92	378 B.C.-2,327 B.P.	491-313 B.C.	720-160 B.C.
13	120-140	Feature 2	WSU-3310	6,580±80	<i>Protothaca</i>	6,990±106	5,219 B.C.-7,168 B.P.	5,310-5,130 B.C.	5,410-4,980 B.C.
40	20-40	—	WSU-3311	1,380±100	deer metatarsal	1,460±135	A.D. 600-1,350 B.P.	A.D. 430-670	A.D. 259-865
15	60-80	—	WSU-3312	1,980±75	elk radius	2,060±102	96 B.C.-2,045 B.P.	200 B.C.-A.D. 60	370 B.C.-A.D. 120
20	60-80	—	WSU-3313	1,980±70	elk vertebrae	2,060±99	96 B.C.-2,045 B.P.	197 B.C.-A.D. 53	368-272 B.C.
12	100-120	—	WSU-3314	7,020±170	elk tibia	7,100±183	5,975 B.C.-7,924 B.P.	6,100-5,750 B.C.	6,384-6,314 B.C.
—	136	Burial 5	WSU-3308	2,780±200	<i>Olivella</i>	3,190±211	736 B.C.-2,685 B.P.	890-380 B.C.	1,190-120 B.C.
—	136	Burial 5	WSU-3320	2,720±140	<i>Olivella</i>	3,130±156 <sup>d</sup>	581 B.C.-2,530 B.P. <sup>d</sup>	790-370 B.C. <sup>d</sup>	930-180 B.C. <sup>d</sup>
—	136	Burial 5	WSU-3321	2,270±135	<i>Olivella</i>	2,680±152	17 B.C.-1,966 B.P.	200 B.C.-A.D. 150	380 B.C.-A.D. 150

<sup>a</sup> radiocarbon years before present.<sup>b</sup> 325 ± 35 years for regional upwelling.<sup>c</sup> Multiple fragment sample.<sup>d</sup> Average readings from sample numbers WSU-3308, WSU-3320, and WSU-3321.



**Reinterpretation.** Several aspects of the radiocarbon analysis must now be questioned. First, attempts made to correct and calibrate marine-shell-derived dates in the original site report are inadequate. As pointed out by Bouey and Basgall (1991), a correction of  $\pm 410$  years must be made on marine shell specimens to offset the effect of  $^{13}\text{C}/^{12}\text{C}$  fractionation (Stuiver and Polach 1977). Of even more importance in evaluating dates derived from marine shell is consideration of the difference between  $^{14}\text{C}$  in the atmosphere and in the ocean. Correction for this problem in data from coastal contexts has been troublesome due to conflicting opinions on the magnitude of the necessary correction and divergent approaches to calibration.

The approach employed at CA-MNT-229—dating charcoal and shell samples from the same provenience—is a common one that has been employed elsewhere along the California coast with mixed results. There is reason to suspect the validity of the charcoal/shell date pairings reported from CA-MNT-229. Given the severity of mixing evident in the deposit, the possibility exists that some of the shell concentration features were not cultural in origin, but rather were related to rodent activity. At the very least, their cultural integrity is suspect. Comparable suspicions must be expressed regarding findings from similar contexts elsewhere. Breschini et al. (1985) and Breschini and Haversat (1988:viii) have suggested, based on nearly identical shell- and charcoal-derived dates obtained from an apparent feature context at CA-SCR-79 (Table 2), that a correction factor might not be necessary in some areas. Dietz and Jackson (1981:341) reported a set of dates from mussel shell (*Mytilus californianus*), abalone shell (*Haliotis rufescens*), and charcoal, that suggested a discrepancy of 300 to 400 years (Table 2). On the northern California coast, Ferneau (1989) reported a discrepancy of 620 radiocarbon years between dates from chiton shell (*Cryptochiton stelleri*) and a charcoal

sample, and 340 years between mussel shell (*Mytilus californianus*) and the charcoal (Table 2), with all dating samples retrieved from the same feature. None of the latter include consideration of isotopic fractionation.

Following Dietz et al. (1988:124) and Patch and Jones (1984:30), Ferneau (1989) interpreted the interspecies difference in dates as a reflection of the difference in the preferred habitat. Mussels occur high in the intertidal zone, where she suggests that a mixing of surface and atmospheric carbons would cause a lowered content of old upwelled carbon in the mussel; chitons, on the other hand, are rarely exposed to the air and thus would retain a higher proportion of marine carbon. While this explanation is reasonable, it is contradicted by the radiocarbon dates reported by Dietz and Jackson (1981:341) from CA-MNT-113, where a mussel sample produced an older date than that from a sample of red abalone (*Haliotis rufescens*). Red abalone generally reside in the low intertidal and sublittoral zone, whereas mussels occur in the mid-intertidal.

On the south coast, Berger et al. (1966) and Schroth (1983) have advocated a correction of  $160 \pm 80$  years, but more recently Taylor et al. (1986:44) have used a reservoir correction factor of  $700 \pm 200$  years (corrected for isotopic fractionation) for marine shell samples from CA-LAN-43. Those authors advocate the development of regionally specific correction figures to compensate for local variation in upwelling. An additional study by Robinson and Thompson (1981) suggests a correction of  $680 \pm 15$  years for samples from the central California coast. More recently, Bouey and Basgall (1991:43-45) have reported modern (collected between A.D. 1932 and 1949) samples of mussel (*Mytilus californianus*), abalone (*Haliotis rufescens*), and turban shell (*Tegula funebris*) that produced dates between  $300 \pm 70$  and  $750 \pm 70$  RCYBP. When the effects of isotopic fractionation are figured into those

Table 2

**MATCHED SHELL, CARBON, AND BONE RADIOCARBON DATES,  
AND HISTORIC RADIOCARBON DATES FROM THE CALIFORNIA COAST**

Site	Lab. No.	RCYBP <sup>a</sup>	Material	Isotopic Fractionation Corrected Age	Calibrated Date	1 Sigma	2 Sigma	
<b>SHELL/CHARCOAL/BONE SETS</b>								
CA-MNT-63	WSU-4053	440±80	<i>Haliotis</i>	850±106	A.D. 1824	A.D. 1680-1950	A.D. 1560-1950	
CA-MNT-63	WSU-4054	105.6±0.7	charcoal	105.6±70	A.D. 1709 A.D. 1718 A.D. 1882 A.D. 1915 A.D. 1955	A.D. 1685-1731 A.D. 1808-1932 A.D. 1666-1784	A.D. 1666-1784 A.D. 1794-1949 A.D. 1794-1949	
CA-MEN-2139	--	170±70	charcoal	170±99	A.D. 1674 A.D. 1743 A.D. 1801 A.D. 1941 A.D. 1955	A.D. 1655-1707 A.D. 1718-1815 A.D. 1827-1880 A.D. 1916-1955	A.D. 1518-1596 A.D. 1620-1955	
CA-MEN-2139	--	110±70	bone	190±99	A.D. 1668 A.D. 1751 A.D. 1758 A.D. 1777 A.D. 1796 A.D. 1947 A.D. 1953	A.D. 1644-1707 A.D. 1718-1815 A.D. 1826-1880 A.D. 1916-1955	A.D. 1510-1602 A.D. 1610-1955	
CA-MEN-2139	--	730±70	<i>Cryptochiton</i>	1,140±99	A.D. 1496	A.D. 1440-1630	A.D. 1350-1690	
CA-MEN-2139	--	450±70	<i>Mytilus</i>	860±99	A.D. 1816	A.D. 1680-1950	A.D. 1570-1950	
CA-MNT-113	RL-838	550±100	<i>Haliotis</i>	960±122	A.D. 1677	A.D. 1540-1840	A.D. 1570-1950	
CA-MNT-113	RL-840	660±100	<i>Mytilus</i>	1,070±122	A.D. 1557	A.D. 1460-1680	A.D. 1340-1870	
CA-MNT-113	RL-839	260±100	charcoal	260±122	A.D. 1648	A.D. 1480-1680 A.D. 1731-1807 A.D. 1934-1955	A.D. 1440-1890 A.D. 1912-1955	
CA-SCR-79	WSU-3054	2,300±75	wood	2,300±102	393 B.C.	745-724 B.C. 706-697 B.C. 519-464 B.C. 450-340 B.C. 330-200 B.C.	765-677 B.C. 660-607 B.C. 600-607 B.C. 144-118 B.C.	
CA-SCR-79	WSU-3100	2,340±60	<i>Protothaca</i>	2,750±92	101 B.C.	209 B.C.-A.D. 16	360 B.C.-A.D. 120	
CA-SCR-79	WSU-3099	2,130±40	bone	2,210±53	354 B.C. 292 B.C. 257 B.C. 253 B.C. 232 B.C. 217 B.C. 214 B.C.	377-370 B.C. 365-346 B.C.	394-169 B.C.	
<b>HISTORIC SHELLS</b>								
Collection Site	Lab. No.	Collection Date	RCYBP <sup>a</sup>	Material	Isotopic Fractionation Corrected Age	Age Corrected for Historic Atmospheric <sup>14</sup> C Content <sup>b</sup>	Reservoir Effect Corrected Date	1 Sigma
Mendocino County <sup>a</sup>	Beta-38058	A.D. 1949	750±70	<i>Haliotis</i>	1,160±70	870±100	A.D. 1807	A.D. 1670-1950
San Luis Obispo County <sup>a</sup>	Beta-36175	A.D. 1932	580±60	<i>Tegula</i>	1,030±60	810±130	A.D. 1887	A.D. 1690-1950
Ventura County <sup>a</sup>	Beta-36172	A.D. 1946	530±90	<i>Mytilus</i>	970±90	710±120	A.D. 1955	A.D. 1680-1950
Elkhorn Slough <sup>c</sup>	Beta-52859	A.D. 1930	250±70	<i>Mytilus</i>	630±70	480±70	A.D. 1955	A.D. 1955
Vandenberg AFB	UCI-183	A.D. 1920-1930	630±75	<i>Haliotis</i>	1,055±75	905±75	A.D. 1706	A.D. 1663-1869
Vandenberg AFB	Beta-33261	A.D. 1920-1930	680±75	<i>Mytilus</i>	1,080±60	930±60	A.D. 1692	A.D. 1657-1815

<sup>a</sup> radiocarbon years before present

<sup>b</sup> Dates reported by Bouey and Basgall (1991), corrections for historic <sup>14</sup>C content from Tom Braziunas (personal communication 1992).

<sup>c</sup> Date reported by William Hildebrandt (personal communication 1992).

<sup>d</sup> Dates reported by Ericson (1989)

samples, the dates are even older— $740 \pm 70$ ,  $1,160 \pm 70$  years B.P. Based on the mean values of these age discrepancies Bouey and Basgall (1991:44) developed three taxon-specific reservoir effect corrections:  $1,000 \pm 30$  for *Haliotis rufescens*,  $925 \pm 120$  for *Mytilus californianus*, and  $1,010 \pm 100$  for *Tegula funebris*. These correction factors are significantly larger than any others yet developed for the California coast, however, the authors neglected to consider variation in atmospheric  $^{14}\text{C}$  related to 20th century industrial activity. Atmospheric  $^{14}\text{C}$  is known to have been ca. 100 radiocarbon years by A.D. 1910, 150 radiocarbon years by 1930, and 200 radiocarbon years by 1950; recalculation of the original shell dates, taking this variation into account, produces figures of  $810 \pm 130$ ,  $710 \pm 120$ , and  $870 \pm 100$  radiocarbon years (Tom Braziunas, personal communication 1992).

A recent study (Stuiver et al. 1986) clearly demonstrated that the excessively old dates derived from marine shell may be due to properties of the physical chemistry of ocean environments which are far more complex than generally appreciated by the archaeological community. A solution developed by Stuiver et al. (1986) on the basis of a world-wide study of ocean water  $^{14}\text{C}$  content, involves recognition of two factors that contribute to excessively old marine-shell dates: (1) global discrepancies between atmospheric and oceanic  $^{14}\text{C}$  content and (2) increased variance on a regional basis as a result of regionally specific upwelling. An important aspect of global variation in marine and atmospheric  $^{14}\text{C}$  levels is that those levels change through time (Stuiver et al. 1986:982). Regional variation, on the other hand, is considered relatively constant, as recently confirmed<sup>1</sup> by Southon et al. (1990). After the effects of isotopic fractionation are accounted for, corrections for a given shell-derived radiocarbon date must take both factors into consideration. The regional upwelling correc-

tion factor developed for the central California coast is  $225 \pm 35$  years, although this increases latitudinally to  $390 \pm 25$  years off the coast of Washington. Determination of the appropriate correction for global marine/atmospheric  $^{14}\text{C}$  variance is accomplished through reference to a series of time-dependent age-correction factors that are accessed through the Stuiver and Reimer (1986) computer program.

Recently acquired data from another Monterey County shell midden suggest that a slight modification to the Stuiver et al. (1986) regional upwelling factor is appropriate. CA-MNT-63, situated on the Big Sur coast, yielded a black abalone (*Haliotis cracherodii*) containing charcoal (Table 2) within the context of a Mission Period rock and shell feature. The shell yielded an uncorrected date of  $440 \pm 80$  years B.P. (WSU-4053), and the charcoal,  $105.6 \pm 0.7$  years B.P. (WSU-4054) (Table 2). The feature can be definitively dated to A.D. 1800-1816 on the basis of abundant and clearly associated glass beads (Jones MS). Taking into account the effect of isotopic fractionation, the Stuiver et al. (1986) correction factor does not bring the shellfish-derived date into line with the known age of the feature, but a derived figure of  $325 \pm 35$  does. When the effects of  $^{12}\text{C}^{13}\text{C}$  are taken into account, this figure also brings the *Haliotis*-derived date (Dietz and Jackson 1981: 341) from CA-MNT-113 into agreement with the charcoal date with which it was directly associated. This figure falls short of correcting the shell date reported by Breschini et al. (1985) by several hundred years, but it is relatively effective in correcting the shell-derived dates from CA-MEN-2139 reported by Ferneau (1989). It should be noted that the association between the shell and other materials from these latter two locations is perhaps less certain than it is for the samples from CA-MNT-63 and CA-MNT-113, where charcoal was embedded within each shell. Of these two, absolute dating is most secure for the specimen from CA-MNT-

63, based on temporal anchoring afforded by the associated glass beads. Relatively inconsequential variation in the range of 100 to 200 years remains unaccounted for through this procedure, and may relate to minor seasonal, temporal, or spatial variability in the reservoir effect. The Stuiver and Reimer (1986) program, used with a local upwelling correction factor of  $300 \pm 35$  years, is equally effective in calibrating the dates derived from historic shells reported by Bouey and Basgall (1991), when these are corrected for historic variation in  $^{14}\text{C}$  content (Table 2).<sup>2</sup> This equation also correctly calibrates an historic shell date recently obtained on a sample from the Elkhorn Slough area (William Hildebrandt, personal communication 1992). Collected in 1930, this specimen of bay mussel (*Mytilus edulis*) yielded a fractionation-corrected age of  $630 \pm 70$  years, which reduces to ca.  $480 \pm 70$  when corrected for historic atmospheric  $^{14}\text{C}$  content. Its correct calibration to the historic era via the Stuiver and Reimer (1986) program and an upwelling correction factor of  $300 \pm 35$  (Table 2) indicates that variability related to different shellfish habitats is apparently inconsequential on the central California coast.

When all appropriate corrections and calibrations are made, significant, albeit previously unrecognized, vertical patterning becomes evident in the radiocarbon samples from CA-MNT-229. Of the seven dates in excess of 4,000 years B.C., only one was recovered from a depth shallower than 100 cm., and the majority were recovered below 110 cm. (Table 1), conforming quite closely with the location of Stratum C<sup>1</sup> (Fig. 2). Most (8 of 13) of the nonfeature Middle Period dates were recovered from 80 cm. or above. Further confusing the issue of the accuracy of shell-derived dates at CA-MNT-229 was the use of samples containing multiple shell fragments. In a multi-component, bioturbated site like CA-MNT-229, such a pro-

cedure is hazardous. Twelve dates composed of multiple shell fragments were included among the assays, and these must be regarded with some suspicion. One date of  $4,120 \pm 90$  years B.P. (WSU-3306), falling midway between the other date clusters, is particularly questionable, and apparently reflects a mixture of older and younger shell fragments (Fig. 4). Eliminating this sample, correcting the remaining dates for isotopic fractionation, applying a local upwelling correction factor of  $-300 \pm 35$ , years, and including one sigma probability spans for the dates, the calendric age of the primary occupation at CA-MNT-229 is seen as occurring between 1,000 B.C. and A.D. 1000 (Fig. 4). This dating differs only slightly from that offered in the original site report, where the beginning of the primary occupation was thought to date ca. 700 B.C. (Dietz et al. 1988:135). However, seven dates, mostly from the bottom of the deposit, indicate an additional earlier occupational component dating ca. 6,200 to 4,000 B.C. (Fig. 4). Interestingly, the hiatus evident here between the Middle and Millingstone/Early Archaic periods is also manifested at nearby CA-MNT-228 (Jones et al. 1992) and CA-MNT-234 (Breschini and Haversat 1991b), when multiple-sample derived dates are excluded from consideration. This hiatus seems to be related to a major infusion of fresh water into Elkhorn Slough ca. 1,500 B.C. Of unknown duration, this freshwater event is clearly represented in the local pollen profile (West 1988:30), and apparently represents either a meander of the Salinas River, silting-in of the mouth of Elkhorn Slough, or discharge from inland lakes formerly present in southern Santa Clara Valley (Jenkins 1973:158). The hydrographic landscape on the central Monterey Bay area indicates that such events occurred more than once in the past, and that they effected major changes in the composition of the aboriginal resource base (Patch and Jones 1984).

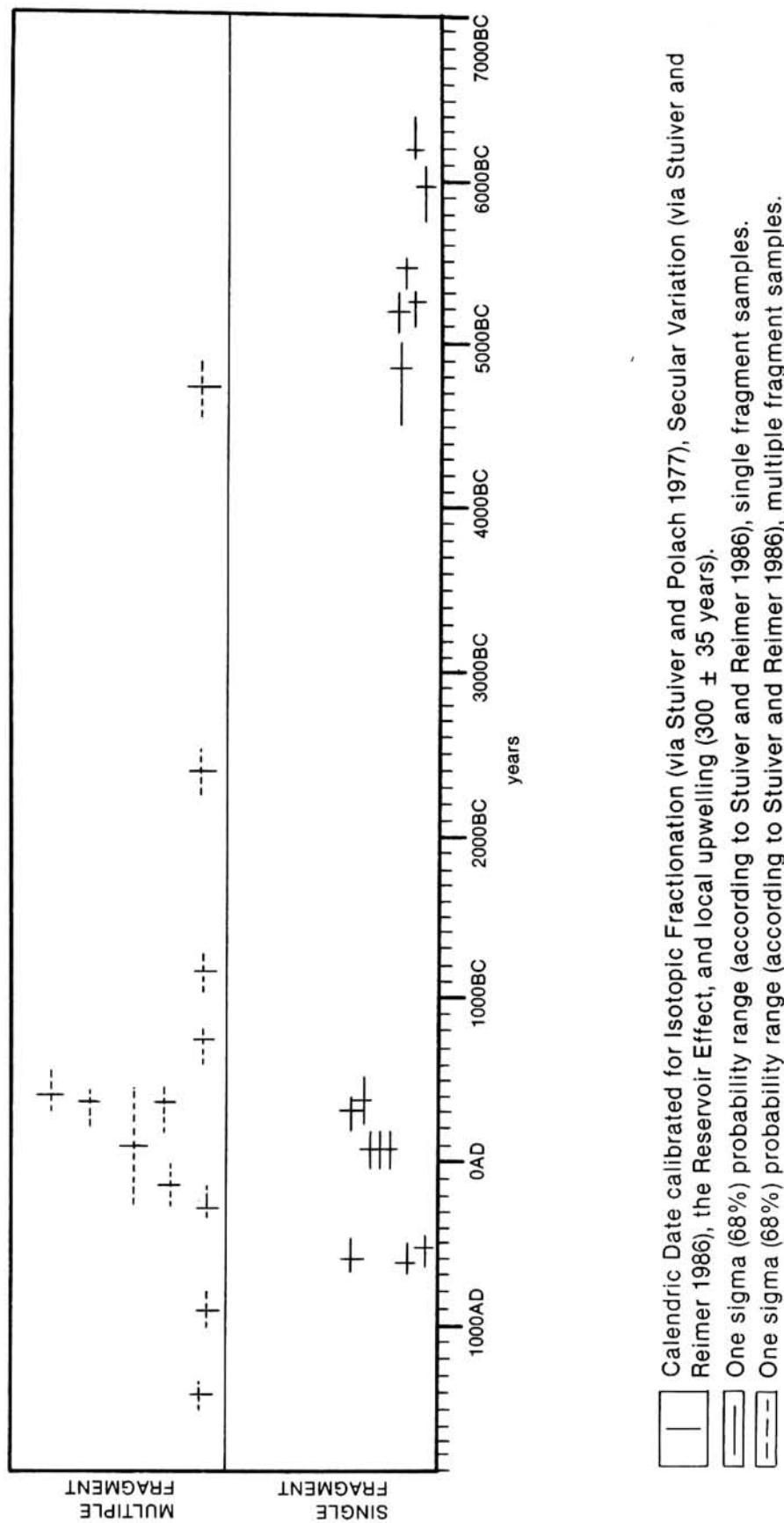


Fig. 4. Summary of Radiocarbon Results from CA-MNT-229.

### Obsidian Sourcing and Hydration

Hydration and sourcing results from 152 specimens of Casa Diablo and Napa obsidian also played a primary role in dismissing the possibility of early occupation at CA-MNT-229. Patterning evident in this sample was exceptionally clear, and almost wholly consistent with the chronology suggested by shell beads and the nonclam radiocarbon assays: 102 of 112 Casa Diablo readings fell between 2.0 and 4.5 microns and 31 of 40 Napa readings were within 2.3 and 4.1 microns (Fig. 5). A scattering of readings on both obsidians fell before and after these primary clusters (Fig. 5) corroborating the other chronometric evidence for a modicum of earlier and later site use. To correlate these readings with calendric dates, the authors of the original site report employed the absolute hydration rates developed by Hall (1984) for Casa Diablo and Origer (1982) for Napa, adjusted for EHT via the Michels (1982) formula. The use of absolute hydration rates is a highly questionable procedure, given the many uncontrollable variables involved in hydration band development, nonetheless, these rates suggested that the Napa cluster dated ca. 600 B.C.-A.D. 1200, and the Casa Diablo cluster dated 100 B.C.-A.D. 1475. The oldest time depth suggested by the thickest Napa reading of 5.4 microns was 2,500 B.C. and on Casa Diablo glass (6.1 microns) was only 1,638 B.C. Alternative hydration rates reported by Bouey and Basgall (1991:51-54), employing the Lee (1969) EHT formula, date the Napa hydration ca. 1,000 B.C.-A.D. 1100, and Casa Diablo (employing the Hall and Jackson [1989] formula); 100 B.C. to A.D. 1500. Regardless of which rates are used, none of the hydration readings are remotely congruent with a time depth of ca. 6,000 B.C. In the original site report this absence was taken as solid confirmation that CA-MNT-229 was primarily a single-component Middle Period site. However, the lack of hydration readings correlating

occupation ca. 4,000-6,000 B.C. must simply reflect the absence of exchange networks linking this region to obsidian sources at this time depth. The Monterey Bay area is situated at great distance from the nearest sources (Napa and Annadel are 200 km. across San Francisco Bay and Casa Diablo is 270 km. over the Sierra Nevada), and there is no reason to suspect that regularized exchange would have extended to such distances at this early stage in California prehistory. In point of fact, only one site in the Monterey Bay area, CA-SCR-177 at Scotts Valley, has produced hydration readings that equate to a comparable time depth, and these amount to no more than nine readings (Cartier 1989) from a location where the excavation volume was in excess of 200 m<sup>3</sup>. The only unresolved issue related to the hydration data is the lack of correlation between the absolute dates calculated from Napa and Casa Diablo glass, and the Middle Period radiocarbon assays. However, there is little justification for considering obsidian hydration on the same level of reliability and precision as radiocarbon. Rather than evaluating the radiocarbon results relative to the hydration dating, we suggest that the CA-MNT-229 data are indicative of the relative dating of Napa and Casa Diablo obsidians in this locality. The 2.3 to 4.5 micron span on Casa Diablo obsidian and the 2.3 to 4.1 micron span on Napa glass are both most likely representative of the Middle Period dating indicated by the radiocarbon of ca. 1,000 B.C.-A.D. 1000. This application also provides a parsimonious explanation for the strong similarity in patterning of the hydration clusters among the two obsidians (Fig. 5).

### CULTURAL ASSEMBLAGE

#### Beads

Although artifact typologies available for the Monterey Bay area are still in a nascent stage of development, shell beads, because of their demonstrated utility as time markers across wide

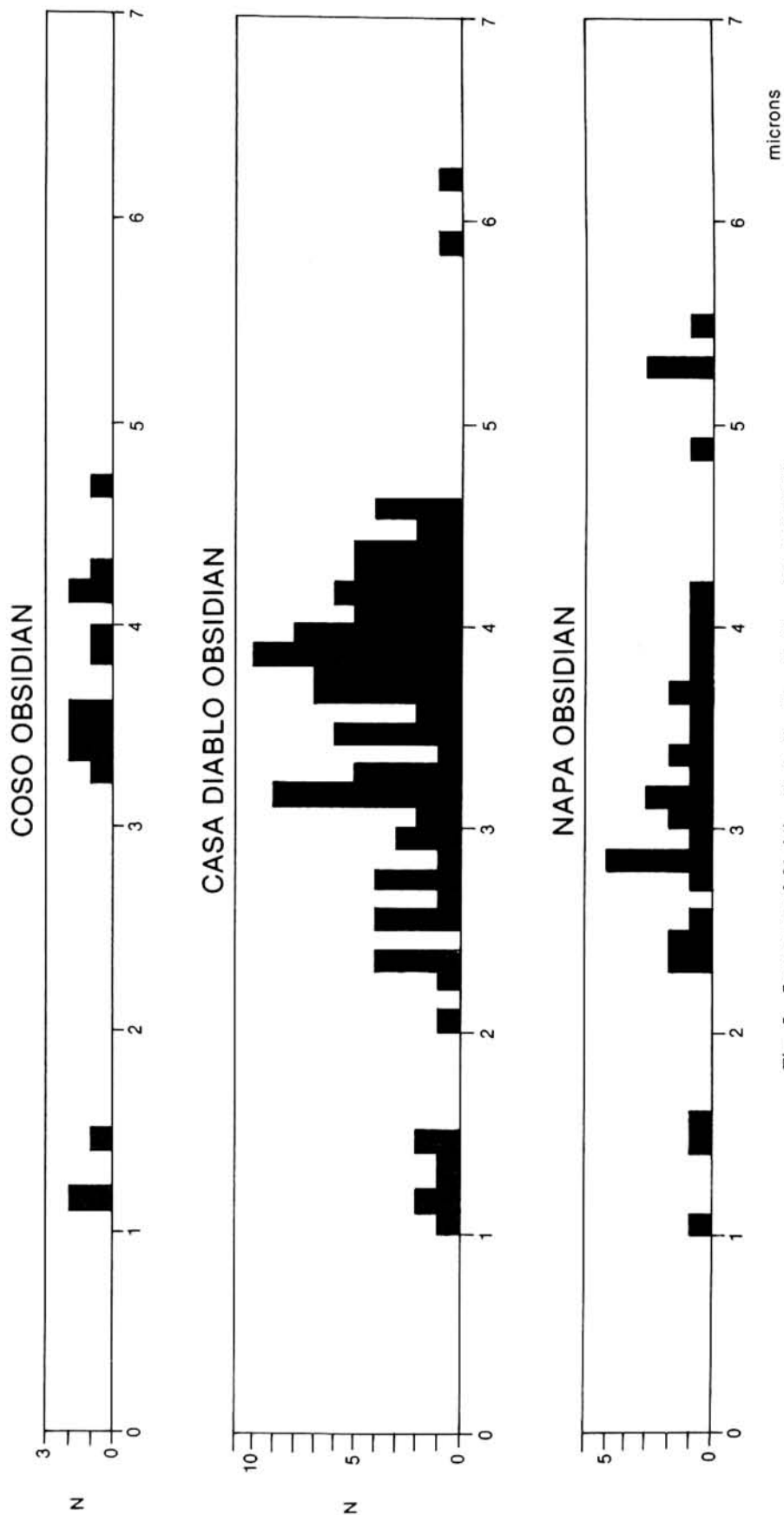


Fig. 5. Summary of Obsidian Hydration Results from CA-MNT-229.

geographic spans (Bennyhoff and Hughes 1987), were heavily relied upon in initial evaluations of site chronology. The 3,638 shell beads were found to represent 11 types from six distinct classes. Of these, 103 are Spire-topped *Olivella*, which are of little utility as time markers. Of the remaining 3,535 beads, 3,516 represent Class G, the *Olivella* saucer (Bennyhoff and Hughes 1987:134), with 53 Normal Saucers (G2), one Ground Saucer (G4), and 3,462 Irregular Saucers (G6), which were established as a new type on the basis of this collection. A total of 3,251 of the latter type was found in association with Burial 5.

Other types represented, all in significantly lower frequencies, are two Barrels (B3), one Cap (B4), five Small Thick Rectangles (L2), nine Ovoid Thick Rectangles (L3), one Limpet Ring, and one *Haliotis* Square (H1). Clearly, the bead assemblage is dominated by *Olivella* Saucers, which are reliable markers of the Middle Period in central interior California (Bennyhoff and Hughes 1987:134). Radiocarbon dating of 118 of the G6 beads associated with Burial 5 yielded dates consistent with this time period (Table 1). Saucer beads were recovered from all excavation areas, at depths ranging from 0 to 180-cm. below the surface. With the exception of the limpet ring, the temporal significance of which is uncertain, all of the non-Saucer beads represent the Early Period in central and southern California (King 1981; Bennyhoff and Hughes 1987). Because of the preponderance and spatial ubiquity of *Olivella* saucers throughout Stratum B, the primary cultural component was ascribed to the Middle Period. Earlier bead types were thought to represent brief intermittent use of this location ca. 2,500-1,500 B.C. A single glass bead, recovered during site testing (Dondero 1984:49), indicates at least some post-contact site use. The lack of bead support for occupation dating ca. 6,000 B.C. should not be unexpected; bead use at such a time depth has not

been documented in most of California. Even in the Santa Barbara Channel, where bead industries were prolific, only a few types (e.g., the *Olivella* barrel with chipped bases and spires, *Olivella* rectangle, and clam disk), occur this early (King 1981:360-362), and the spatial distribution of some of these may be limited. The vertical distribution of Middle Period beads at CA-MNT-229 can be readily attributed to mixing from rodent activity.

### Projectile Points

Despite the large excavation volume, only 15 projectile points were recovered from the combined testing and data recovery excavations. Because regional typologies were poorly developed, the point assemblage was not of major import in evaluating site chronology, but rather the collection was used as a baseline with which to establish Middle Period point types for the central coast, under the assumption that CA-MNT-229 was essentially a single-component site. The site yielded a single arrow point, thought to correlate with historic site use, and 14 larger points. Of the latter, four are side-notched, nine are contracting-stemmed, and one (33-016) originally classified as corner-notched, was subsequently re-classified as a Rossi Square-stemmed (Jones and Hylkema 1988:181).

Sixty additional bifaces were recovered, one (40-046) of which is a medial fragment of a crescent-shaped implement, thought to have functioned as a scraping or cutting tool (Dietz et al. 1988:152). Two of the contracting-stemmed points (8-021 and M-062), exhibited extremely long stems (Fig. 6), and subsequently contributed to the definition of the Año Nuevo Long-stemmed type (Jones and Hylkema 1988:174). All of the points are considered to be morphologically consistent with those from contemporaneous Monterey Bay area site components, notably CA-MNT-101 (Dietz 1987) and CA-SCR-9 (Hylkema 1991:151), with some limited



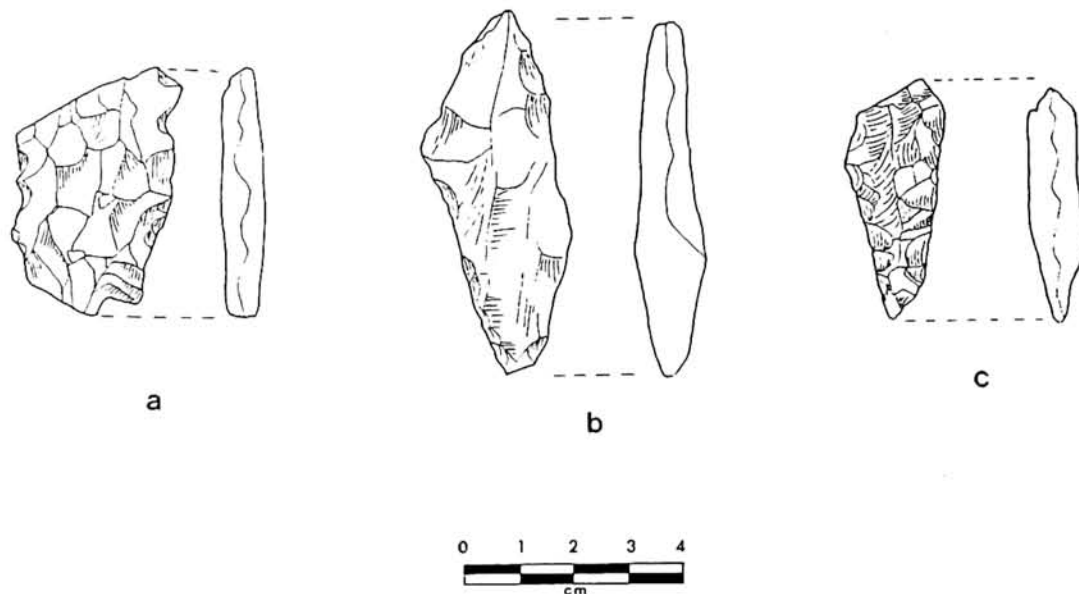


Fig. 6. Bifacial flaked stone tools associated with the early occupation at CA-MNT-229: a) crescent Fragment (40-046); b) Long-stemmed projectile point (8-021); c) Long-stemmed projectile point (M-062).

similarity also noted with the Willow Creek Site (CA-MNT-282) on the Big Sur coast (Pohordecky 1976).

Also of note among the flaked stone inventory are 12 cobble/core tools, manufactured from jasper, quartzite, and a variety of metavolcanics (Fig. 7). Largely recovered from depths in excess of 100 cm. at CA-MNT-229, these tools have been noted frequently in components pre-dating 2,000 B.C. in the Monterey Bay Area (Jones and Hylkema 1988:167).

Revised dating provides a decidedly different perspective on the flaked stone tool inventory. Although fragmentary, the crescentic shaped biface can be readily classified as an eccentric (Fig. 6), similar to those reported from early Holocene contexts throughout California (Fenenga 1984). Together with the long-stemmed points, and cobble tools, the crescent is part of an assemblage that exhibits remarkable similarity with the San Dieguito and Lake Mojave complexes in the south, as well as

the Browne Site, where crescents and cobble/core tools were also recovered (Greenwood 1969). The recent report of a long-stemmed point (classified as Lake Mojave) from a ca. 6,000 B.C. context on the Sonoma coast (Schwaderer 1992:62) provides additional support for the antiquity of this type. The Año Nuevo Long-stemmed type is probably a local variant of a widespread tradition that began earlier than the 2,000 B.C. date offered by Jones and Hylkema (1988:183) in the original type definition. Its occurrence in more recent contexts represents either the persistence of an archaic type, or morphological overlap with later stemmed types common to the central coast (e.g., the provisional Central Coast Stemmed series defined by Jones and Waugh [1992]).

#### SUMMARY

CA-MNT-229 previously was interpreted as essentially a single-component Middle Period site. Primary occupation was dated ca. 700

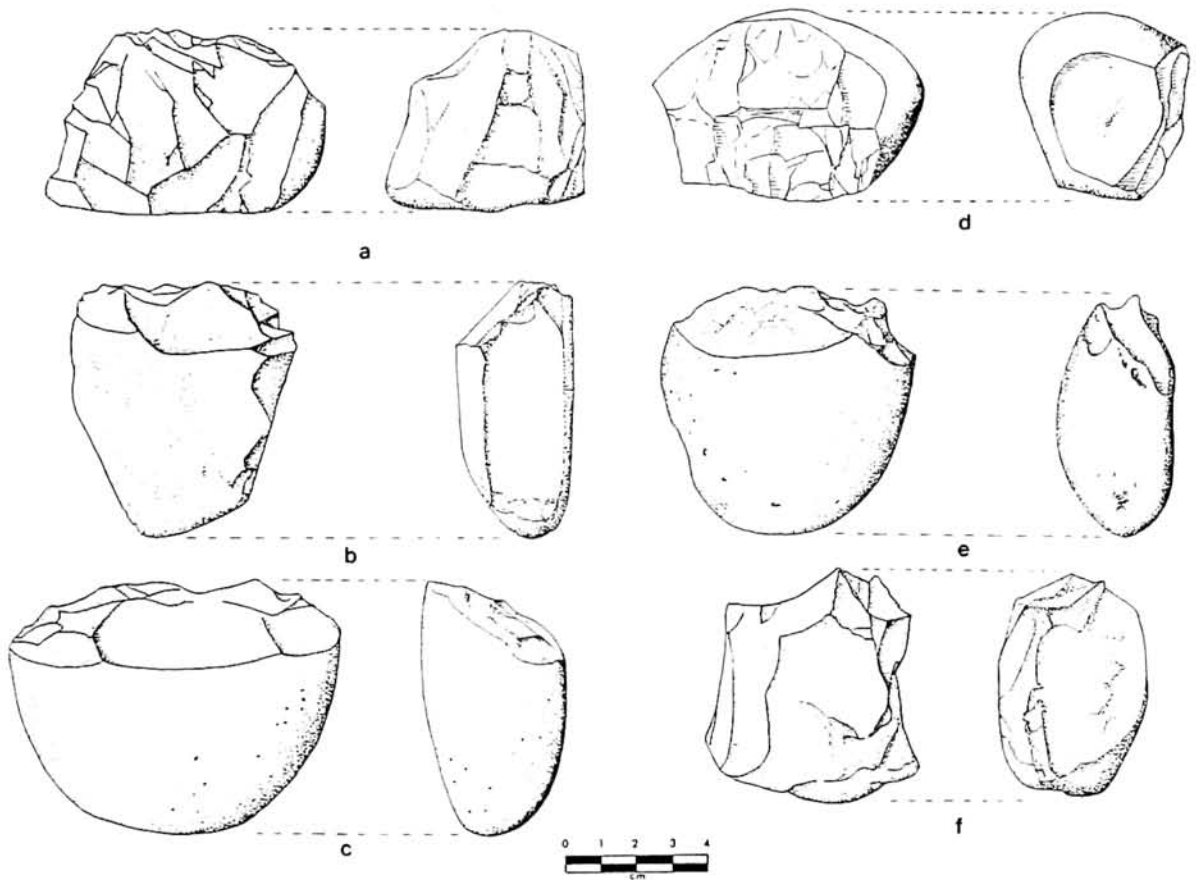


Fig. 7. Cobble tools from CA-MNT-229: a) M-093; b) 229-2095; c) 229-5079; d) 14-014; e) 15-099; f) 16-011.

B.C.-A.D. 1100, with evidence for minor earlier (ca. 2,600 B.C.) and later (ca. A.D. 1550-1820) site use. Re-interpretation of site stratigraphy, obsidian hydration and sourcing results, temporally diagnostic shell beads, flaked stone, and particularly radiocarbon reveals substantial evidence for the presence of an earlier occupational component dating ca. 6,200-4,000 B.C. The component is associated with a discrete stratigraphic unit (Stratum C<sup>1</sup>), underlying that portion of the deposit ascribed to the Middle Period (primarily Stratum B). Bioturbation has seriously affected the integrity of these components, but the older occupation is generally evident below a depth of 110 cm. The items that appear to correlate with the early

occupation include shellfish remains, a fragmentary eccentric crescent, long-stemmed projectile points, and cobble tools, all of which are common in contemporaneous contexts to the south. Crescents and points have also been found in the Bodega Bay locality to the north (Fredrickson 1985:516; Schwaderer et al. 1990), also in estuarine context<sup>3</sup>. Shell beads and obsidian hydration readings correlate almost exclusively with the Middle Period occupation, and their absence from the earlier assemblage reflects the low intensity of inter-regional exchange at that time depth along the central California coast. An occupational hiatus between 4,000 and 1,000 B.C. is associated with a stratigraphic unconformity between the

Early and Middle period components, and appears to correlate with a freshwater event within Elkhorn Slough. Most of the assemblage originally attributed to the Middle Period, including side-notched and stemmed projectile points, mortars and pestles, bone implements, and *Olivella* saucer beads, has been correctly ascribed.

Several attributes of the early component have methodological and theoretical implications beyond the limits of the Monterey Bay area. First, this component has been recognized only through extensive radiocarbon dating in conjunction with the recovery of a sizeable excavation sample. Even then, appropriate conservatism concerning the reliability of radiocarbon assays prevented identification of the early occupation until now. Certainly this raises questions about the possibility of unrecognized and similarly ethereal components in shell middens where sample sizes have been smaller and dating less comprehensive. The apparent lack of early shell middens along the fringes of San Francisco Bay, for example, could be partially related to the completion of many excavations there prior to the advent of radiocarbon technology. Second, CA-MNT-229 supports a pattern of early human preference for estuarine and lacustrine settings in California. With the exception of CA-SON-20 (Wickstrom and Fredrickson 1982), all sites demonstrating antiquity of 8,000 years or more in central California have been found in one or the other of these settings. The findings from CA-MNT-229 also demonstrate uniformity in early assemblages between these two highly similar environments.

### NOTES

1. In their radiocarbon analysis of a series of wood and shell samples extracted from sediments off the coast of British Columbia, Southon et al. (1990) generally found good evidence for a constancy in upwelling patterns between the late Pleistocene and the present. However, one brief interval ca. 6,400 years ago demonstrated a discrepancy between ocean and atmospheric  $^{14}\text{C}$  content of a magnitude that is

indicative of at least one Holocene interlude during which ocean circulation patterns were different than today.

2. No single upwelling correction factor accounts for all of the historic shell dates and archaeological shell/charcoal pairs. The figure of  $325 \pm 35$  corrects the greatest number of dates within a one sigma probability; however, a figure of  $375 \pm 35$  would be needed to correct two historic dates reported by Ericson (1989) from Vandenberg Air Force Base within one sigma probability.

3. The Duncan's Landing Cave (CA-SON-348/H) is presently situated on an open, rocky shoreline, and molluscan remains present in the upper site levels clearly reflect this setting, exhibiting a high frequency of the exposed coast mussel (*Mytilus californianus*). Schwaderer (1992) documented a radical transition in the invertebrate assemblage with depth, as the lowermost levels, dating ca. 6,000 B.C., show a preponderance of estuarine taxa (a high frequency of oyster [*Ostrea lurida*]). Schwaderer correctly interpreted this transition as evidence for the former presence of an estuary/lagoon in the vicinity of the cave. Unrecognized was the likelihood that the estuarine assemblage represents a former connection between the Russian River and the Bodega Bay Lagoon that has been obliterated by sea level rise.

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