SPLISH, SPLASH, AND CRASH: GEOLOGICAL IMPLICATIONS ON THE COASTAL ARCHAEOLOGICAL RECORD OF NORTHWEST CALIFORNIA

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ABSTRACT

The north coast is notable for its lack of archaeological sites dating in excess of 2,200 years B.P. In contrast, central and southern California coastal sites indicate prehistoric occupation as early as 9,000 years B.P. The paucity of early to mid Holocene archaeological sites along the north coast has been attributed to a pair of competing causes. The first and most widely held view is that the archaeological record along the coast has been destroyed by coastal erosion and flooding, caused by sea level rise. The second, more recent, view espouses the notion that exploitation of the littoral zone by indigenous peoples occurred relatively late, due to the abundance of terrestrial game and anadromous fish found in the interior river valleys. This paper explores recent geological evidence on the causal relationship between the dynamic and complex geologic setting of north coastal California and the archaeological record.

INTRODUCTION

In keeping with the theme of the meetings at which it was delivered, the approach of this paper is multi-disciplinary, with the goal of offering possible directions for future archaeological research. Recent advances in knowledge of the complex and dynamic geology of the northwest coast have provided the opportunity to shed new light on an old archaeological problem. This paper will examine new geological evidence and its probable effects on the archaeological record and indigenous people of northwest California.

SETTING AND BACKGROUND

Although some of the discussion of this paper has implications for the California coastline as a whole, the portion of coast this paper concentrates on is the area from Cape Mendocino to the Oregon border, with particu-lar emphasis on the Humboldt Bay to Big Lagoon region.

Beginning with Lewellyn Loud's (1918) seminal work around Humboldt Bay and the lower reaches of the Mad and Eel Rivers in 1913, northwest California has been a major focus of archaeological research (Moratto 1984). Loud, and those who followed him, documented an intensive prehistoric maritime/riverine adaptation referred to as the Gunther Pattern (Fredrickson 1974; Moratto 1973). The dominance of these late period settlements has contributed to the conclusion that 'regular' occupation of this portion of the California coast did not occur until approximately 1,500 B.P. (Heizer and Elsasser 1964; Elsasser and Heizer 1966; Milburn and Fredrickson 1979; Hildebrandt and Jones 1992). In contrast, recent research in the interior of northwest California, stimulated by cultural resources management programs, has revealed a terrestrially

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oriented settlement pattern in place by ca. 6,000 B.P. (Baker 1990; Fredrickson 1984; Hildebrandt and Hayes 1983, 1984; Hayes and Hildebrandt 1985; Sundahl 1988).

In the past two decades, archaeological examination of coastal sites in southern and central California has found an even greater contrast between the settlement of those portions of the coast and that of northwest California. No less than 21 sites in southern California contain evidence of coastal occupation and marine-resource use dating between 11,000 and 8,500 years B.P. (Jones 1991). Along the central California coast, a smaller but yet undeniably early group of sites which span the early to mid Holocene circa 8,500-5,500 B.P. has been investigated (Breschini and Haversat 1991; Dietz et al. 1988; Greenwood 1972; Jones 1991; Jones and Hildebrandt 1990).

The absence of early to mid Holocene coastal sites in northwest California has given rise to a pair of competing models which endeavor to explain why the northwest coast is devoid of early sites.

The first model espouses the opinion that California marine environments offered such a rich array of easily exploitable resources to colonizing hunter-gathering populations, that evidence of early human activity should be found all along the California shoreline (Jones 1992). Yet in northwest California there are only three coastal sites with components dating in excess of 2,000 years B.P. (Gould 1972; Levulett 1982). According to this model, the lack of diachronic homogeneity in the initial use of California's coastal resources is due in part to eustatic sea level rise and coastal erosion (Bickel 1978a, 1978b), which has effectively "masked" significant portions of the coast and therefore the archaeological record.

The second model, devalues coastal resources as secondary foods that were exploited only when adjacent terrestrial habitats were poor, or were in decline due to a climatic shift. Consequently, the lack of early to mid Holocene deposits along the littoral zone of northwest California can be attributed to the abundance of fish, terrestrial game, and vegetal foods found in the interior valleys and upland habitats (Hildebrandt and Jones 1992). According to this model, this settlement pattern was terminated when a climatic shift reduced upland terrestrial resources, forcing a concomitant migration towards lowland riverine habitats that in turn led to semi-permanent settlements.

EUSTATIC SEA LEVEL CHANGE AND COASTAL EROSION

It has been recognized for many years that one of the principal agents of change along the California coastline in the last 15,000 years has been eustatic sea level rise. This well-documented global pattern of the gradual rise of the oceans, due to the release of glacially locked water at the end of the last Wisconsin stadial, is the principal cause for the absence of early coastal sites worldwide (Bickel 1978a; Jones 1991). Bickel (1978a) was the first to correlate the implications of global sea level rise to the archaeological record of coastal California. From approximately 18,000 to 7,000 B.P., sea levels rose roughly 115 meters (Flint 1971). After 7,000 B.P. sea level rise decelerated sharply and modern coastal landscapes began to assume their present morphology (Bickel 1978a; Bloom 1983; Vick 1988). The amount of reshaping of the coast during the period of rapid sea level rise is correlated with the width and depth of the continental shelf; areas with broad continental shelf undergo more dramatic changes than areas where the shelf is narrow and steep. The continental shelf north of Cape Mendocino is broad and flat; as a result, changes in sea level rise could cause greater shifts in the shape and location of the coastline.

A concomitant factor of marine transgression is coastal erosion. Rates of coastal erosion are influenced by bedrock resistance and protection from wave attack and therefore may be very localized. According to Rust (1984), north coast erosion studies indicate that, in general, 1 to 2 feet per year is lost at sites with weak bedrock.

Greater rates have been found at soft sand sites like Big Lagoon, where between 1875 and 1931 the cliffs retreated 300 feet, or approximately 5 feet per year (Rust 1984).

Most coastal erosion in northern California occurs during winter months when ocean storms generate heavy seas and high rainfall. Johnson (1973) noted that because of the alignment of the coastline in this region it experiences the most powerful wave conditions in California. For example, winter storms have generated huge waves, some as high as 44 feet. Events such as these can cause episodic erosion which can have devastating affects on coastal archaeological deposits. A resurvey of Loud's recorded sites, conducted by the State of California Department of Parks and Recreation about 10 years ago, failed to find many sites because they had simply been washed away (Terry Jones, personal communication, 1993). In Redwood National Park, at least two coastal archaeological sites have been destroyed and a third is threatened.

Coastal cliff retreat was undoubtedly at its peak during the period of rapid sea rise 18,000 to 7,000 years ago. There is, however, geological and historical evidence that the present shoreline is approaching a relatively stable equilibrium position as uplift rates and sea level rise approximately balance each other (Rust 1984).

NEW GEOLOGICAL DATA

In conjunction with sea level rise and coastal erosion, a new body of geological evidence that has consequences for the archaeological record of northwest California has come to light in the past 10 years. The north coast region of California is one of the most seismically active areas in the continental United States (Clarke 1992). The region is located in a geologically dynamic area surrounding the Mendocino Triple junction, the point where three tectonic plates meet: the Pacific, North American, and Gorda. These crustal plates in turn are bounded by three large fault systems: the Cascadia Subduction Zone, the San Andreas Fault System, and the Mendocino Fault.

The area is characterized by two distinct tectonic regimes. To the south of Cape Mendocino, the Pacific Plate is moving northward relative to the North American Plate along the San Andreas Fault. To the north of Cape Mendocino, the Gorda Plate is colliding with and is subducted below the North American Plate. This plate boundary is known as the Cascadia Subduction Zone and extends from near Cape Mendocino to north of Vancouver Island, British Columbia (Carver and Burke 1992). Most of this new knowledge about the subduction zone off northern California has been generated in the last 10 years through the pioneering work of Dr. Gary Carver of Humboldt State University.

More than 60 earthquakes have caused damage in the North Coast region since the mid-1800s (Dengler 1992). Although none of these recent earthquakes have been attributed to the subduction zone, paleoseismic evidence indicates that the subduction zone has generated 10 large earthquakes within the last 4,500 years, some of a magnitude between 8.4 and 9 on the Richter scale (Valentine et al. 1992).

The Cascadia Subduction Zone is also responsible for a number of other associated geological features and phenomenon in the region. It has created a fold and thrust belt system which includes numerous reverse faults, fault generated anticlines, and broad-trending synclines that extend across the western margin of the North American Plate. For the most part these geological features are located several miles offshore; however, they occur on land from approximately Big Lagoon south to Cape Mendocino (Clarke 1992). Recorded in these features is evidence of a number of seismic events that may have had an effect upon the archaeological sites of the region. Evidence of these events includes: (1) displacement of thrust faults, (2) coastal uplift, and (3) subsidence.

First, major surface displacement within the last 25,000 years has been revealed along several faults in the area. The most extreme example is the Little Salmon fault which records 4.5 to 7 meters of displacement within the last 1,600 years (Carver and Burke 1992).

Second, localized Holocene uplift events generated by the Cascadia Subduction Zone earthquakes have also been recorded along the coast. Two uplift events have been documented at 1,100 and 300 B.P. (Carver and Burke 1992). The most recent example of an uplift event now exists near Cape Mendocino where the April 25, 1992, a 7.1 magnitude earthquake elevated a 25 km stretch of coast as much as 1.5 meters (Jayko et al. 1992). Uplift events such as these along the coastline cause significant changes in the intertidal and marsh environments through massive die-offs of organisms. Species of plants and animals in the intertidal zone which provided food for prehistoric peoples may have taken as many as three to five years to recolonize (Gravelle 1992a).

Third, localized down-drops or subsidence events, which may or may not occur simultaneously with uplifts, are also known to occur. Late Holocene estuarine deposits containing buried marsh surfaces that represent episodic rapid subsidence events have been documented in Humboldt Bay and in the lower Eel River valley (Clark and Carver 1992; Vick 1988; Valentine et al. 1992). These sudden events are thought to be associated with the growth of synclines during large magnitude Cascadia Subduction earthquakes. Repeat sequences of peats composed of fossil salt marsh plants entombed by overlying muds indicate sudden submergence. Carver and Burke (1992) have reported more spectacular evidence of sudden submergence found beneath the muds of the Mad River Slough and in the lower Eel River Valley, where buried fossil spruce trees have been found in the growth position. Analysis of annual tree ring patterns of the fossil trees at both locations indicate normal growth to the last year of the tree life followed by sudden death. Similar ring patterns have been found in spruce trees killed by subsidence and submergence following the 1964 Alaskan earthquake. The combination of the buried fossil marsh plants and spruce trees has been interpreted to reflect seven late Holocene events of coseismic subsidence and corresponding uplift events during large subduction zone earthquakes.

Direct evidence of paleoseismic subsidence events affecting prehistoric peoples has been found along the northern Oregon coast (Grant 1991). Four hearths, evidence of prehistoric fishing camps, found beneath buried soils are interpreted to be a late Holocene sudden submergence event dated to 300 years B.P. While this event was fairly recent, it exemplifies the effects of the Cascadia Subduction Zone on local indigenous people.

Lastly, in addition to the above phenomena, earthquakes can trigger landslides and generate tsunamis. Several hundred landslides and rockfalls along coastal cliffs and mountainous areas have been documented for a 50 km stretch of coastline south of the Eel River (Prentice and Keefer 1992). Landslides of this scale, at a minimum, certainly would have disrupted prehistoric trail systems and perhaps buried entire settlements. Tsunamis generated by large subduction events also would have had dire consequences for prehistoric inhabitants of low-lying areas as exemplified by the devastation of Crescent City following the 1964 Alaskan earthquake. Local earthquakes could have caused similar or greater tsunamis in prehistoric times.

NATIVE AMERICAN MYTH AND GEOLOGICAL PHENOMENON

Undoubtedly, earthquakes and related phenomena were a hazard for the earliest inhabitants of the region, and this fact is reflected in the ethnohistoric record of the Native American peoples who inhabited the northwest coast. Kroeber (1976), working with Yurok at the turn of the century, recorded two myths which have the clearest examples of geological phenomena. In one of these myths, "How Prairie Became Ocean", Earthquake, and Thunder are concerned about humans' needs for subsistence and so they run north and south making the "earth quake and quake again and again...(until the water) was flowing all over...causing the ground to sink and water to fill in the depressions, leaving the tops of the trees and brush sticking out of the water..." (Kroeber 1976:463). Similar stories are recorded in the myths of the Wiyot, Karuk, and Tolowa peoples (Kroeber and Gifford 1980; Loud 1918). These orally transmitted stories, although highly allegorical and difficult to interpret, probably represent actual geological events that have been woven into the oral traditions of northwest California (Eidsness 1993; Gravelle 1992b).

DISCUSSION: AGE AND DISTRIBUTION OF SITES

In the past decade, the pace of archaeological research of coastal California has accelerated (Dietz et al. 1988; Erlandson 1985, 1988a, 1988b; Erlandson and Colten 1991; Glassow et al. 1988; Hildebrandt and Jones 1992; Jones 1991, 1992). Until recently there were no known archaeological deposits dating to the early Holocene from San Francisco to the Oregon border (Erlandson and Colten 1991:3). However, a recent test excavation at Duncans Point Cave (SON-348/H) on the Sonoma County coast has revealed a rich stratified shell midden deposit, representing over 8,000 years of human use (Schwaderer 1992:55). An analysis of the shellfish remains by component from this site indicates that the oldest component contained a relative abundance of taxa found only in protected bay or estuarine habitats. This suggests that an estuary existed "in the immediate vicinity during the Holocene" (Schwaderer 1992:65). However, no protected bay or estuary presently exists at this site. The data from this site provide some possible evidence of the effects of marine transgression on coastal paleogeography, which include the inundation of major river valleys, resulting in the rapid formation and obliteration of embayments (Carbone 1991:13).

Further north, a recently excavated site on the north-central coastline of Oregon, located at Yaquina Head, has produced reliable dates of circa 4,100 radiocarbon years B.P. for the initial occupation of the site (Minor 1991). More locally, Eidsness (1993) reported on a site located on the former margins of Humboldt Bay. Obsidian hydration data from HUM-351/H suggests an "approximate 3,000 year span of site use" (Eidsness 1993:117). These two sites indicate that exploitation of littoral and terrestrial resources can be extended an additional 1,500 to 500 years beyond the earliest known dates of circa 2,500 B.P. for the northwest coast (Gould 1966; Levulett 1982). Despite these data, evidence of an early to mid Holocene coastal occupation from north of Sonoma County is still lacking.

CONCLUSIONS

Although marine transgression and coastal erosion have been recognized as the primary agents that shaped the California coastline throughout the Holocene, current tectonic research of the Cascadia Subduction Zone and its related phenomenon is providing important clues to geological factors that may also have affected the formation of the northwest coast and the archaeological record of this area. Although the data presented in this paper do not resolve the differences in the two models concerning the timing of prehistoric coastal occupation of northwest California, they do offer plausible explanations for the lack of early coastal archaeological deposits in specific areas of this region. We suggest that future research be directed towards reconstruction of early Holocene coastal configurations, such as locating former estuarine environments, through a combination of refined local sea level curves, offshore exploration, and increased onshore geological and archaeological surveys.

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