3

Of Marine Terraces and Sand Dunes: The Landscape of San Clemente Island

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Introduction

B. K. Roberts (1987:79) has written that landscapes "…give character and diversity to the earth's surface and form the physical framework within which human societies exist." Characteristics of the landscape are closely linked to all aspects of human life from the economic to the more ethereal by powerful social, religious, and psychological bonds. Because of this, the description of a landscape is important for the study of context and distribution in archaeological systems. On San Clemente Island, recent research infers important relationships between the island's landscape and the distribution of its archaeology. The study of these relationships has required the differentiation of terrains on the island as a framework for sampling the archaeological data. The description of these terrains, which follows, provides the reader with not only the rationale for current avenues of archaeological inquiry at San Clemente Island, but also frames the geographical context of the research reported in this volume.

The 1981 Merriam-Webster Dictionary defines a *landscape* as "…the terrains of a region in aggregate." The landscape of San Clemente Island can be seen as an aggregate of six different *terrains,* where *terrain* is defined as a discrete geographical tract comprised of associated *terrains* (e.g. cliffs, terraces, etc.) of similar topographic or geomorphic character. The descriptions of these terrains provide an insight into physical variables which may have conditioned the use of the island by prehistoric populations. This kind of geographic categorization is particularly applicable to San Clemente Island, where geologic and geomorphic processes have created a diversity of sharply defined topographic features that can be readily differentiated or combined as terrains within the landscape.

Geology and Geomorphology

The diversity of terrains in the landscape of San Clemente Island is the topographic evidence of tectonic and climatic dynamics during the Quaternary. The geology into which the features of these terrains are incised is composed mainly of Miocene andesite with lesser amounts of dacite, rhyolite and marine sedimentary rocks (Olmsted 1958). Potassium-argon dating of these volcanic materials has yielded dates of around 15.5 million YBP (Merrifield et al 1971). Quaternary deposits overlie bedrock on much of the island, and include dune sand, eolianite, alluvial fan deposits, and marine terrace deposits (Crittenden and Muhs 1986:293).

Beginning with the earliest geological studies, San Clemente Island has been recognized to be an uplifted structural block with a steep eastern fault escarpment associated with the submerged San Clemente fault

(Lawson 1893; Smith 1898; Muhs 1980:8). This right-lateral transverse fault is one of many within the Southern California Continental Borderland related to regional deformation associated with the San Andreas fault system. This may also connect structurally with the Agua Blanca fault in northern Baja California (Muhs 1980:11; Orme 1980:158). The uplift of the island block likely represents the release of primary compressional forces along the fault. This has resulted in doming and tilting of the block, the creation of perpendicular lateral faulting, with *horsts* and *grabens*. (A *horst* is an upstanding mass between two fault troughs. A *graben* is a sunken tract due to downfaulting or the uplift of adjacent areas [Ridlon 1969:45-46]). Exposure of the island block above sea level occurred probably no earlier than the late Pliocene and, most likely, the early Pleistocene. Uplift since that time has probably continued at a rate of 20-40 cm per thousand years (Muhs 1980:31-36). The island presently has a maximum elevation of 599 meters (m) (1965 ft.) on Mt. Thirst.

That San Clemente Island has been so tectonically active through the Quaternary period is fundamental to the evolution of its terrains. Globally, as a product of the growth and decay of continental glaciers, sea level fluctuated many times during this period. At the last glacial maximum (ca. 18,000 BP), it was as much as 125 m lower than at present. During the previous warm interglacial (ca. 125,000 BP), the oceans rose 5-7 m above modern levels. On tectonically rising coasts such as San Clemente Island (as well as places like New Guinea, Barbados, and the Palos Verdes Hills on the California mainland, north of San Clemente Island), evidences of high sea level stands during the Quaternary exist as emergent marine terrace sequences, consisting of both erosional and depositional elements (Muhs 1980:31). This relationship was first recognized in the 19th century from observations made of the Palos Verdes Hills and San Clemente Island (Whitney 1865; Schumacher 1878a). During sea-level maximums, sea cliffs and wave-cut terraces were eroded and marine terrace deposits laid down. The new seabeds were then exposed by the sea's lowering. Where uplift was rapid enough, as at San Clemente, these features were raised above subsequent terrace maximums and preserved (Fig. 3.1).

Lowered sea levels can also leave evidences, if indirect ones. By exposing submerged off-shore shelves and their unconsolidated calcareous sands to prevailing onshore winds, lowered sea levels create conditions conducive to the deflation and transport of these sediments to form eolian deposits onto adjacent uplands. Resulting dune fields can modify or mask the upland terrains. The significance of these and related geomorphic processes to the creation of San Clemente's landscape is discussed below.

On the related matter of lowered sea levels and their effect on the colonization of islands by biological and cultural systems, recent bathymetric studies in the Southern California Bight have produced no evidence that any dry land link ever existed between San Clemente Island and the mainland or between San Clemente and any other Channel Island (Vedder and Howell 1980:23-25). Even during times of maximum sea-level lowering, the island was not significantly closer to any other land mass than it is now (Vedder and Howell 1980:22).

Terrains in the Landscape

For the investigation of the distribution of archaeological site locations on San Clemente Island, the landscape has been divided into six terrains—the *Coastal Terrace,* the *Upland Marine Terraces,* the *Plateau,* the *Eastern Escarpment,* the *Major Canyons,* and the *Sand Dunes* (Yatsko 1989; 1991b). They are differentiated from one another by the character of erosional or depositional modification to these geomorphic elements. Differentiation is also based in part on these terrains' proximities to the littoral ecotone.

Fig. 3.1. Emergent Pleistocene marine terrace on the west side of the island, between Norton and Box Canyons (used by permission, John S. Shelton, all rights reserved).

Coastal Terrace

Geomorphically, the Coastal Terrace terrain consists of two marine terraces: first, the one being currently abraded and second, the youngest and lowest emergent terrace. The second terrace was cut during the last interglacial, about 120,000 to 125,000 BP. Topographically, it is a generally flat, gradually sloping (less than five per cent) coastal plain, rising from sea level to its intersection with the basal sea cliff of the Upland Marine Terraces terrain (see below) at about 30 m elevation. It is usually featureless except for scattered bedrock seastacks. The Coastal Terrace averages 300 m to 400 m in width, but some stretches can pinch down to only a few score meters. The terrace platforms are generally overlain with thin soils, with colluvium wedges at the bases of bordering sea cliffs; however, where the Major Canyons (see below) emerge from their dissections of the Upland Marine Terraces, they have deposited substantial alluvial fan deposits (*fanglomerates*) on the terrace surface (Muhs 1980). The predominant vegetation overall is a low-lying, lycium-phase Maritime Desert Scrub.

This terrain is continuous along the northern, western, and southern coastlines, except where interrupted by the Sand Dunes (see below) or sea cliffs which rise directly from the coastline into the Upland Marine Terraces. It also occurs in isolated segments along the northeastern coast at Dolphin Bay and Wilson Cove. In total, the Coastal Terrace covers approximately 12 square kilometers (km), or about 8 per cent of the island's total land area.

Upland Marine Terraces

The Upland Marine Terraces terrain incorporates the well-expressed emergent marine terraces that ascend the island from the Coastal Terrace to the uppermost fossil sea cliff defining the margin of the Plateau terrain (see below). These terraces date from around 215,000 YBP to, perhaps, 1,500,000 YBP, or older (Muhs 1980:37). In elevation, this terrain extends above the 30 m contour to 450 m at mid-island (vicinity of upper Horse Canyon). Soil conditions are similar to those on the Coastal Terrace. Vegetation is transitional between Maritime Desert Scrub and the Island Grassland of the Plateau, with abundant cactus.

Found along the northern, western or southern exposures of the island, the Upland Marine Terraces are laterally continuous in the northwest. South of mid-island, however, the lateral continuity is increasingly and significantly dissected by the Major Canyons (see below). This terrain covers the second largest portion of San Clemente Island (after the Plateau), with a total area of just over 50 square km or 34 per cent of the land surface.

Plateau

The Plateau is a moderately-rolling, peripherally-dissected upland terrain. This oldest terrain on the island (over 1,500,000 YBP), is also composed of emergent marine terraces, but erosional and other processes have altered typical terrace features to such a degree that they are often difficult to perceive. Erosion and colluvial deposition on the Plateau have significantly degraded the steepness of its sea cliffs, and stabilized dune deposits have buried both sea cliffs and terrace platform features. As a result, this Island Grassland-covered terrain rolls continuously all along the central spine of the island, without significant interruption in slope. It rises from about 120 m in the north to 599 m mid-island and grades gradually downslope to 275 m at the Southern end above Pyramid Cove. Its margins are defined as the top of the bordering fossil sea cliffs at the upper limit of the Upland Marine Terrace terrain and the upper edge of the Eastern Escarpment (see below). These lateral boundaries are increasingly segmented toward the south due to dissection by the upper ends of the Major Canyons. Covering 58 square km or 40 per cent of island area, the Plateau is the largest terrain on the island.

Eastern Escarpment

The Eastern Escarpment is a precipitous, dissected fault scarp terrain directly associated with the San Clemente Fault. With slopes of 75 per cent to over 100 per cent, it is continuous along the entire eastern side of the island (Fig. 3.2). The terrain covers elevations from 150 m in the north to 550 m at Mt. Thirst and around 230 m toward the south near Pyramid Head. Actually oriented somewhat to the northeast, the Eastern Escarpment is the most cool and moist terrain on the island. Because of this, it harbors most of San Clemente Island's trees and woody shrubs within a Canyon Shrubland/Woodland flora. Included are island oak, Catalina ironwood, toyon, and island cherry. Its area is slightly more than 16 square km or 11 per cent of the island's surface.

Major Canyons

Fifteen precipitous drainages along the southwestern slope of the island comprise the Major Canyon terrain. The product of rapid tectonic uplift and an arid climate with an episodic, flash-flood hydrology, these canyons severely dissect the other terrains they traverse, especially the southern portion of the Upland Marine Terraces. In doing so, they create some of the more dramatic topography on San Clemente Island, while comprising

Fig. 3.2. Precipitous slope on east side of San Clemente Island.

only 4 per cent of the island's area (about 6 square km).

From the bordering terrace platforms, the canyon walls drop off sharply, descending nearly vertically, at times, to depths of as much as 150 m. This provides relatively cool and moist shelters on the canyon floors which support a Canyon Shrubland/Woodland flora. Plunge pools and other natural bedrock catchments in these canyons also hold significant amounts of runoff water through the driest periods of the year. This is of critical concern in a location that receives only 5-7 inches of precipitation annually and whose geology does not generally provide for the development of springs.

Typical dramatic features in a landscape, these canyons have all been named. Some names are descriptive (Red, Cave, Wall Rock); others reflect historic use (Middle Ranch, Horse, China), or persons (Norton, Chenetti); and two recognize aboriginal ties with the island (Kinkipar, Chukit).

Sand Dunes

The Sand Dunes terrain at San Clemente Island is (or was) comprised of a number of active or recently-active calcareous (as much as 97 per cent marine shell and other organic carbonates) dune fields overlying portions of the Coastal Terrace and Upland Marine Terraces at the northern extremes of the island. Originally distributed as three separate but proximate fields covering over 3.5 square km, two of these fields were destroyed during the construction of the island airfield in the late 1950s. The surviving Sand Dunes now encompass approximately one-half square km of the west coast opposite Wilson Cove. Visually, the Sand Dunes present a typical, brilliantly white, rounded dune terrain, with gradual windward slopes and steep leeward slip faces laid out along the axis of the prevailing wind. The most active portions are bare of vegetation, while elsewhere dune vegetation has begun to stabilize the surface.

As described earlier, sand dunes on San Clemente Island record periods of sea level minima. Muhs (1980:38-48) has mapped four separate dune units reflecting different episodes of dune building dating back more than 20,000 years. Because their development depends on an exposed off-shore sand source, the current sea level maximum has cut off new eolian material from the currently active dunes and is, in fact, rapidly removing the Sand Dunes' seaward face. They are the most transient of the island's terrains.

Archaeological Implications

Transient or otherwise, the terrains of San Clemente Island exist much as they were before the first maritime-adapted Indian groups came to the island nearly 10,000 years ago. Their access to, residence on, and movement across the island were conditioned and constrained by these terrains. Because of this, and because the island's relatively limited use in historic times has allowed for the preservation of perhaps 80 per cent of its archaeological loci in substantially pristine condition, the potential exists for important archaeological inquiry into prehistoric settlement and use.

The first three island terrains (i.e. Coastal Terrace, Upland Marine Terraces, and Plateau) provide excellent geographic parameters for stratified regional sampling. Each of these terraced landscapes contain abundant level ground suitable for habitation. The context of these level areas varies between terrains with the flat uniformity of the Coastal Terrace and the ascending, rolling continuity of the Plateau, contrasting with the dissected character of the Upland Marine Terraces, where sharply defined cliffs and deep canyons segregate the terrace surfaces as discrete elements. Difficulty in accessibility within a terrain (especially where lateral continuity is interrupted in

the southern Upland Marine Terraces by the Major Canyons) may influence the densities and distributions of sites. Concurrently, the Upland Marine Terraces' cliffs and canyon walls themselves provide opportunities as well as constraints for occupation. These precipitous features not only interrupt movement across and between the terrains, but they also often contain rock shelters suitable for occupation.

A number of intensive archaeological site surveys have been conducted on San Clemente Island in recent years, among them resurveys I have conducted on portions of earlier coverage (Yatsko, 1989 and in this report). The sampling strategy for these and a recently completed island-wide probabilistic site survey were applied stratigraphically, with the strata defined by the three primary terrain categories. Resurvey results have demonstrated significant variability in site densities between the terrain samples, ranging from over 300 sites per square km on the Coastal Terrace to under 100 per square km in the Upland Marine Terraces and fewer than 25 per square km in areas of the Plateau. The just-finished probabilistic sampling has revealed further variability in density within individual terrains. For example, site densities for discrete sampled areas on the Coastal Terrace range from 50 per square km at its northern extreme to 360 per square km at mid-island around Seal Cove.

This internal variability suggests additional characteristics of terrain morphology may require investigation, with the possibility that the existing categories require refinement. One possibility is differentiation of soil morphology, which is highly variable across the island because of the differential ages of the various terrains and different parent materials. For instance, better drained soils (e.g. porous dune soils) might condition surface habitability in wet weather, as opposed to clayey bedrock-derived profiles. A correlation here may be suggested by the occurrence of the highest concentrations of cultural materials (represented as very large, multiple-hectare-size sites) in association with the well-drained Sand Dune, and other localized dune deposits. Importantly, the island's terrains are also ecologically differentiated, each probably presenting different terrestrial resource opportunities to the island's prehistoric occupants. The occurrence of numerous shell middens high on the island's Plateau suggests their location for other than marine resource acquisition, pointing to the need for closer attention to sites' paleobotanical evidences, and attempting a better reconstruction of the island's prehistoric ecosystem.

Terrain variables will continue to be the focus of many aspects of archaeological investigation on San Clemente Island (if only because they create difficulties in research access to many areas of the island). Wherever particular research issues lead, they can be expected to be interwoven in contextual themes of space, scale, complexity, interaction, and equilibrium, framed in the island's geography. As Butzer (1982:6) suggests for this direction of research, it will continue to be "less concerned with artifacts than with sites" and more focussed on the "multi-dimensional expression of human decision making within the environment."