UNIVERSITY OF CALIFORNIA

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THE DYNAMICS, KINEMATICS, AND GEOMORPHIC EVOLUTION OF THE SAN DIEGO, CALIFORNIA COASTLINE

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DISSERTATION ABSTRACT

Seacliff erosion in San Diego County, California, USA, is a complex phenomenon that involves both marine and subaerial or terrestrial forcing and is dependent on a variety of primary, intrinsically-related and secondary, extrinsically-related variables. Primary or intrinsic factors directly or internally influence seacliff stability and include physical properties such as material strength and the geometry of structural discontinuities. Secondary or extrinsic factors externally influence seacliff stability and include variables such as wave energy, beach width and height, and amount of groundwater seepage or precipitation. Although many comprehensive seacliff erosion studies have been conducted in San Diego County over the past few decades, the long-term cliff recession rates, controlling mechanisms and variables, and the evolutionary processes of coastal cliff erosion are not well known. I examine this integrated process of seacliff erosion in San Diego County, California, by: (1) determination of high-resolution, historical seacliff retreat rates, (2) in-situ measurement of seacliff rock strength, (3) geologic mapping of seacliff structure, (4) quantification and classification of important material/physical properties, (5) quantification and modeling of nearshore hydrodynamic forcing conditions, and (6) conceptual modeling of seacliff evolution over varying time-scales.

Long term mean seacliff erosion rates, generated at the University of California, Santa Cruz (UCSC) Coastal Geology and Imaging Laboratory (CGIL) as part of an erosion hazards study funded by the Federal Emergency Management Agency (FEMA), range from 3.0 cm/yr in well-lithified Cretaceous sandstone to 43.0 cm/yr in unlithified Pleistocene sands. Results from field studies conducted in San Diego County over the course of the 1997-1998 El Niño winter suggest that lithology and material strength exert

a first-order control on the rate of seacliff erosion over historical time. Statistically significant at the 1% level, the relationship between seacliff erosion rates and intact rock strength explains the majority of variability in rate of seacliff erosion over much of this century. While the rate of seacliff erosion is highly dependent on material strength, structural weaknesses such as joints, fractures, and faults exert a secondary control on the morphology, manner, and rate of seacliff erosion. By accounting for the orientation, width, spacing, and continuity of structural weaknesses in a seacliff stability classification system, the stability analysis is significant at the 0.1% level. Investigation of the relationship between seacliff erosion rates and nearshore wave power (energy flux) in 10 m of water and at the breaker-position also supports cliff-forming materials as a first-order control as seacliff retreat rates are inversely proportional to wave energy in San Diego County. Seacliffs have eroded at a rate that is proportional to rock strength, which has in turn influenced the distribution of wave energy in the nearshore. Over longer time-scales (>1000 years), sea level position relative to onshore topography, and therefore both eustasy and tectonics, exerts the primary control on the evolution of seacliffs.