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Late Pleistocene to Holocene sedimentation and hydrocarbon seeps on the continental shelf of a steep, tectonically active margin, southern California, USA

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Abstract Small, steep, uplifting coastal watersheds are prolific sediment producers that contribute significantly to the global marine sediment budget. This study illustrates how sedimentation evolves in one such system where the continental shelf is largely sediment-starved, with most terrestrial sediment bypassing the shelf in favor of deposition in deeper basins. The Santa Barbara–Ventura coast of southern California, USA, is considered a classic area for the study of active tectonics and of Tertiary and Quaternary climatic evolution, interpretations of which depend upon an understanding of sedimentation patterns. High-resolution seismic-reflection data over >570 km^2 of this shelf show that sediment production is concentrated in a few drainage basins, with the Ventura and Santa Clara River deltas containing most of the upper Pleistocene to Holocene sediment on the shelf. Away from those deltas, the major factor controlling shelf sedimentation is the interaction of wave energy with coastline geometry. Depocenters containing sediment 5–20 m thick exist opposite broad coastal embayments, whereas relict material (bedrock below a regional unconformity) is exposed at the sea floor in areas of the shelf opposite coastal headlands. Locally, natural hydrocarbon seeps interact with sediment deposition either to produce elevated tar-and-sediment mounds or as gas plumes that hinder sediment settling. As much as 80% of fluvial sediment delivered by the Ventura and Santa Clara Rivers is transported off the shelf (some into the Santa Barbara Basin and some into the Santa Monica Basin via Hueneme Canyon), leaving a shelf with relatively little recent sediment accumulation. Understanding factors that control large-scale sediment dispersal along a rapidly uplifting coast that produces substantial quantities of sediment has implications for interpreting the ancient stratigraphic record of active and transform continental margins, and for inferring the distribution of hydrocarbon resources in relict shelf deposits.

Keywords Continental shelf · Fluvial sediment · Hydrocarbon seeps · Southern California

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Introduction

Styles of sedimentation on continental shelves influence the economic potential, geohazard risk, and vulnerability to anthropogenic environmental contamination of many coastal regions worldwide. Understanding patterns of sediment dispersal and deposition from small, steep, mountainous watersheds is particularly important in regional and global sedimentology because 10^1–10^4 km^2 watersheds along mountainous coasts collectively have a proportionately greater importance for global sediment production than do larger rivers (Milliman and Syvitski 1992). In this paper, we examine a new, high-resolution seismic record of continental-shelf sedimentation along ~120 km of mountainous, tectonically active coastline in southern California, USA. These data, collected as part of the U.S. Geological Survey (USGS) California seafloor mapping program and a collaborative study of hydrocarbon seeps by the USGS and U.S. Minerals Management Service, elucidate 10s-km-scale sedimentation patterns that have proceeded since late