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SPEAKERS CLUB

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Hyperpycnal currents with reversing buoyancy: examples from Quaternary deposits, flume experiments, and the ancient rock record

Elisabeth Steel

Department of Earth Science

UC Santa Barbara

Turbidity currents are subaqueous sediment gravity flows that carve enormous canyons in the seafloor and deposit large submarine fans in deep ocean basins. Although many turbidity currents are initiated through re-suspension of sediment on the continental shelf or upper slope, extreme river floods can result in such high concentrations of suspended sediment that the river effluent plunges at the fluvial-marine interface and continues along the seafloor in the form of a turbidity current. These river-derived currents, known as hyperpycnal currents, provide a mechanism for cross-shelf transport of suspended sand beyond the coastline. This delivery of sediment to the continental shelf is in contrast to traditional models, which suggest that continental shelves are largely sediment-starved during sea-level highstand and most sediment is trapped at the high-energy shoreline. If hyperpycnal currents are capable of depositing sediment on the continental shelves or deep ocean basins they may serve as archives of extreme river floods. Additionally, understanding hyperpycnal current deposition may aid in the understanding of sandstones that are interpreted as turbidity currents but lack typical Bouma-type features. However, hyperpycnal deposits have not yet been directly sampled and facies models remain largely theoretical.

Rivers draining the Transverse Ranges of Southern California are capable of producing hyperpycnal currents, and Quaternary deposits directly offshore from these rivers provide an opportunity to directly sample hyperpycnal deposits for the first time. We describe these deposits using bathymetry, sediment cores, radiocarbon chronology, and grain-size analysis. In order to further understand the evolution of hyperpycnal currents and the effects of fresh interstitial water on flow dynamics, we conducted a series of physical flume experiments. These experiments shed light on a process known as buoyancy reversal, or lofting, in which a turbidity current becomes less dense than the surrounding fluid and lifts off from the basin floor. Buoyancy reversal results in narrow, well-sorted sand bodies and may help to explain previously describe enigmatic sandstones in the rock record. This work provides the first steps towards creating a robust facies model of a previously overlooked type of sand body: shelf hyperpycnites.