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Natural "laboratories" of southern California: Integrated methodologies to predict coarse-grained sediment flux to the deep sea

Members of the Chevron Clastic Stratigraphy R&D team are conducting research in modern, that is, earth surface and shallow subsurface, natural "laboratories" of southern California to test and develop predictive models of the timing and processes of sediment transport from source to sink. Such research provides predictive guidelines for basinal sediment composition, caliber, distribution, and supply. Southern California sediment-routing systems were chosen as pilots because of their data availability and small sizes, which allow for manageable analyses of different routing segments and their interactions. Here we focus on results from two studies of a sediment-routing system comprising the terrestrial Peninsular Ranges, shelfal Oceanside littoral cell, and La Jolla Canyon and deep-sea fan.

1) Our initial study was an integrated radiocarbon and seismic-stratigraphic analysis of the timing and volume of sediment supplied to the deep sea during thousands of years of sea-level fluctuations. We show that the amount of sediment transported to deep-sea basins is approximately constant regardless of sea level, but the pathways of transport are different. These results highlight caveats to generally successful sequence-stratigraphic predictive models.

2) Our subsequent study was a sediment budget for on- to offshore sediment transfer using cosmogenic radionuclide-derived Peninsular Ranges erosion rates and La Jolla deep-sea fan deposition rates measured during the latest Pleistocene to Holocene marine transgression. We found that there is remarkable similarity between rates of terrestrial erosion and deep-sea deposition, indicating that the redistribution of sediment from land to sea is approximately steady over thousand-year time scales. This insight has direct implications for basinal sediment characteristics in spatially restricted systems-sediment is predicted to be texturally immature and deposition is focused at the terminus of the routing system, with little sediment sequestered en route.

As a preliminary test of insights from this small southern California sediment-routing system, we employed a global database of highly temporally resolved (i.e., k.y.'s) continental-margin deep-sea deposition rates, activities of canyon-channel systems, and episodes of fan growth since 35 ka to assess the timing of terrigenous sediment delivery to the deep sea. Results show that deposition rates are relatively large during periods of marine transgression and lowstand of sea level; however, deposition of coarse-grained sediment in the deep sea can occur at any sea-level state as a result of the tectono-morphologic character of the margin (e.g., narrow shelves) and climatic extremes (e.g., sporadic subglacial meltwater and monsoonal pulses). Therefore, rather than a one-size-fits-all approach to sedimentologic and stratigraphic models, a more holistic understanding of the tectonic and climatic forcings inherent to a continental margin is essential to accurately predict timing, magnitude, and character of deep-sea deposition and place it in the context of sequence stratigraphy.

Biography

Dr. Jacob Covault attended Stanford University for his undergraduate degree on a football scholarship, during which he was on 2000 Rose Bowl and 2001 Seattle Bowl teams and received Pac-10 Athletic Conference honors (2003 preseason All-Pac10, second team middle linebacker). Jake stuck around Stanford for his PhD working with Steve Graham and Bill Normark (USGS). Jake has authored >20 peer-reviewed journal articles (three of which currently in review) and nearly 40 conference abstracts. Jake received the 2005 and 2009 AAPG Pacific Section A.I. Levorsen awards (first author and co-author, respectively) and was a co-author on the 2009 AAPG Pacific Section H. Victor Church Memorial Award for best poster at the annual convention. Jake also received the 2008-2009 Stanford-USGS Fellowship. Jake currently is a research scientist at Chevron Energy Technology Company in San Ramon, CA