Santa Barbara Basin, California Borderland: Holocene Model for Mudrock Deposition in an Organically-rich, Silled Hemipelagic Basin during Greenhouse Earth: Analog for Unconventional Reservoirs

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ABSTRACT

Marine-deposited mudrocks and Quaternary muddy marine sediments continue to be an area of very active research in organic facies, paleoclimatology and shelf-basin floor sedimentary systems. The successes of unconventional reservoir oil and gas exploration have focused attention on Holocene analogs for mudrock objectives. However, actual analogs for these rock reservoirs are inadequately applied or understood. Santa Barbara Basin (hereafter SBB), the northernmost basin in the California Continental Borderland, is a slope-centered mudrock depositional system with a small, much studied anoxic, or dysaerobic basin floor. The slope comprises 96% of the basin and exhibits large areas of sediment creep, debris flows, rotational slides, silty turbidite transport and syntectonic deformation. The basin floor, only 4% of the basin area, has been the focus of significant sedimentologic, geobiologic, paleooceanographic and anthropogenic nitrate studies during the uppermost slice of a greenhouse earth hemipelagic deposition. Basin sediments on the shelf, slope and basin floor reflect a diverse group of sedimentary processes including mass movement, fine-grained turbidite deposition, flood-borne deposition from surface, hyperpycnal and hypopycnal plumes and vigorous current winnowing of sandstone by the Anacapa Current. The dominant point source of terrigenous clastic input, the Santa Clara River-Ventura River Influx (SDRVRI), injects sand and clayey silt sized sediment in surface suspensate plumes during flood years driven by El Nino events, as well as hypopyncal and hyperpycnal plumes out to the shelf break and deep basin. In addition to sediment, these plumes are likely the major input for flux of anthropogenic influx to the basin such as nitrogen and phosphorous derived from fertilizers. The transport time of the fine-grained sediment from the SDRVRI to the deep slope and basin floor in the water column has been estimated to take 1.5-4 years. The SDRVRI produces gray flood layers during particularly rainy periods. During greenhouse earth in the SDVRI drainage basin, predominant textural input is silt and clay, rather than sand in icehouse earth periods when silt and sand dominate. However, on the eastern limit of the basin, the Hueneme Sill, the vigorous Anacapa Current generates a silty sand dune field, with sand waves averaging 20 m in height and 300 m in wavelength. In the western central basin floor, a "hemipelagic core" is evidenced by grain counts, texture, calcium carbonate content and organic carbon contents of 2.6-3.4 %. High sedimentation rates vary from 66-120 mg/cm2/yr, with a maximum measured as 173 cm/1000 yr in one piston core from varve counting, result from the sediment pathways from the NW, NE and East. These high sedimentation rates result in high water contents in surficial sediments, resulting in massive areas of mass movement. The Goleta Slide consists of both mass movement, as well as syntectonic deformation in the zone between the Pitas Point and Santa Inez faults, which extend offshore from the onshore Ventura Basin. These two drivers result contorted and faulted sedimentary layers, and possible generation of turbidity currents and massive slumps. Gray layer turbidites occur at a frequency of 1/120 years and all gray layers (flood and turbidite) occur at a frequency of 1159 years. The gray layer turbidites are likely associated with particularly strong flooding events triggered by El Nino events. The SBB exhibits nearly all possible stratigraphic sequences and sedimentary environments in a tectonically-active, slope-dominated mudrock depositional environment applicable for exploration in unconventional mudrock exploration in analogous tectonic environments, as well as more passive basin settings.