Shelf Physiography and Accommodation as Controls on Permian Grainstone Bodies

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Outcrops of Permian carbonates in the Guadalupe Mts., Permian Basin, provide an ideal laboratory for examining the impact of shelf physiography and sequence-scale accommodation on carbonate grainstone bodies. Key variables effecting grainstone development are oceanographic parameters (wind and tidal current regimes, ocean water chemistry) and the physiography of the shelf, along with the accommodation setting of the platform which controls the style of preservation in the stratigraphic record. As the ~2 km thick shelf-to-basin exposure defining the western margin of the outcrops maintains a constant orientation and stable basin/climatic setting, it is possible to focus on variation in grainstone development with respect to shelf physiography and systems-tract facies partitioning across twenty-eight high-frequency sequences (HFS) and over 100 cycles. Grainstone bodies within the San Andres (G1-9HFS), Grayburg (G10-12HFS), Queen (G13-14HFS), upper Yates (G24-26HFS), and Tansill (G27-28HFS) shelf strata are available for analysis at the cycle-scale.

San Andres (G1-4) ramps display ramp-crest strike-parallel grainstone bars with low (2-10m) relief, dip-widths of 0.1-2 km, average bedform size of 0.2 m, and fine-medium-grained fusulinid-ooid composition. Grayburg transitional ramp-rim profiles, with their steeper, higher-relief/energy margins, contain both wave- and tide-dominated sand-bodies with dip dimension (0.5-5 km), bedform size up to 2 m, and are medium-coarse grained mixed intraclastic-oolitic deposits. Queen-Tansill reef-rimmed profiles have 0.1-0.5 km dip-width wave-dominated grainstone elements set up by the focused wave impact 0.5 km or less from the abrupt shelf edge. Early-lithified vadose-tepee-modified storm berms stabilize this profile and set up a dramatic grain-size distribution from back-barrier lagoonal stromatolitic mudstones through the shoal complex and seaward to outer shelf packstones in less than 1 km.

Sequence-scale accommodation variations control the vertical and lateral stacking of grainstones, impacting connectivity of facies elements. Dramatic variations in stacking are observed from ramp systems where TST tide-dominated grainstones contrast with seaward-prograding wave-dominated HST foreshore-upper shoreface sheet sands. Steep-rimmed systems where bathymetry limits progradation are dominated by vertical stacking of grainstone bodies.