Intrinsic Controls on the Ara Sequence-Stratigraphic Framework from the Northern Rim of the South Oman Salt Basin

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Abstract

Seismic interpretation of a PSDM 3-D volume constrained by deep exploration wells, six cored wells, and ninety- three laterals from across Mukhaizna field provides valuable data for understanding intra-basin drivers on accommodation during Ediacaran-Cambrian Ara deposition across the northern South Oman Salt Basin (SOSB). Production at Mukhaizna includes oil from the uppermost dolostone underlying the pre-salt section. An extensive coring campaign that was initiated in 2021 to better define the <3rd-order stratal geometries and ultimately place the Mukhaizna pre-salt section into an evolving SOSB chronostratigraphic framework.

A 24-km long (NW–SE) seismic line-of-section including descriptions of cored wells that encompass 300 m of pre- salt stratigraphy permits detailed ~3rd-order scale sequence-stratigraphic interpretations and analysis of accommodation trends along the northern SOSB. A platform-to-basin inflection is situated above a deeper- seated fault tip. Within 10 km south of this hinge line, slope and basin strata observed in core progressively thicken by 2X. Mounded and internally shingled seismic bodies are interpreted to record lateral amalgamation of discrete mass transport deposits. The Buah Formation has been tied to this interval and its upper bounding reflector shows dimming or thinning onto the platform, which may record the regionally observed Buah-Ara unconformity. Above this horizon, stratal geometries record aggradational stacking and platformward thinning of silica-rich silty shales interpreted as the Buah silicilyte and silica-rich sub-wavebase carbonates interbedded with thin (1.0 dm-thick) illite-bearing beds. The occurrence of silica-rich dolostones and felsic tuffs represented in part by higher illite content records the onset of volcanism and initiation of Ara deposition (A0). Basin-dipping A0 strata flatten upward from 10° to <1° recording progressive infilling of the basin. Strataform breccias consisting of erosional clasts of intraclastic dolostone and thrombolites overlie the tuffaceous dolostones and pass upward into a 15-m thick succession of bedded thrombolites, carbonate-anhydrite rhythmites (mm-scale), crinkly and pustular laminites, and enterolithically folded, anhydritic and laminated peloid dolo-grainstones. The abrupt passage from deeper ramp tuffaceous dolostones into breccias and arid peritidal lithofacies records a major facies tract offset consistent with an intra A0 unconformity of unknown duration. Above the unconformity, K, U, and Si values rapidly decrease suggesting a break in volcanism. These upper A0 pre-salt peritidal reservoir strata are bracketed below the unconformity by the tuffaceous carbonates of the lower A0 and the overlying Cloudina- and Namacalathus-encrusted thrombolite mounds of the A3 stringer.

We envision a subaerial unconformity cutting into outer ramp strata perhaps as thermal doming reached a maximum or possibly due to intra-plate isostatic adjustment during the late A0 that contrast with Ara stratigraphy south of the Athel trough. Post-eruptive, thermal subsidence

combined with marine inundation of a broad and arid shelf would foster renewed carbonate sedimentation including the observed peritidal facies. Individual breccia clasts are fractured and record cm-scale dilation indicative of post-depositional compaction. Collectively, these observations are suggestive of compaction-modified evaporite karst that post-date an intra-A0 unconformity at Mukhaizna.