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Tectonically - Driven Evaporite-Carbonate Transitions in a Precambrian/Cambrian Saline Giant: Ara Salt Basin of South Oman

An intra-salt petroleum system known as the Ara carbonate “Stringer” play occurs in the South Oman salt basin, a 'saline giant' of latest Neoproterozoic to earliest Cambrian age. The Ara Stringer play source, reservoir and seal rocks represent a single tectono-stratigraphic unit (Ara Group). Recent chronostratigraphic constraints based on carbon-isotopic, biostratigraphic, and U-Pb zircon geochronologic data indicate that the Ara Group straddles the Precambrian/ Cambrian boundary.

The Ara Group represents at least six 3rd -order cycles of carbonate to evaporite sedimentation in a tectonically active basin. Carbonates occupy positions within the basin center (in addition to flanks) and vary in thickness from 50- 200 m. They formed during relative highstands in sea level characterized by mostly unrestricted conditions, exemplified by biohermal facies containing Cloudina and Namacalathus body fossils. Deposition of overlying thick and laterally extensive basin-center evaporites occurred during drawdown and low stands in sea level. Ara evaporites include 10-20 m thick anhydrites, and 100's of meter thick halite and potash salts. Toward the eastern flank of the Ara salt basin, the basin-center evaporites pinch out.

Explanation of the observed evaporite-carbonate transitions requires resolution of the 'Ara paradox': carbonates form isolated, basin-centered platforms that are directly overlain by thick shallow-water evaporites - “lowstand” evaporites occur stratigraphically on topographic highs. These platforms have a complex internal architecture of deep to shallow-water facies, and are completely sealed by thick sequences of mostly shallow-water evaporites. Hence, the Ara evaporites do not occur as basin-filling wedges onlapping basin margin carbonates, but blanket the isolated carbonate platforms, providing top and base seals for the hydrocarbons contained within the carbonates. Resolution of this paradox requires that evaporite deposition occurred during strong tectonic subsidence, creating enough accommodation space so that lowstand evaporites could overlap earlier highstand carbonates.