Evolution of Tide-Dominated Oolite Shoals on an Intrashelf Basin Margin: Case Study from the Lower Arab Formation, Onshore UAE

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Abstract

The Late Jurassic Arab Formation is being developed in a major gas accumulation located onshore southern UAE. The lower Arab Formation consists of wackestones to mudstones of mid ramp to basinal setting overlain by foreshoal and oolitic grainstone shoal deposits. Despite the number of well penetrations, several published models have been proposed for the palaeogeographic evolution of the shoal complex which is broadly situated on the SE margin of an intra-shelf basin.

The grainstone-dominated interval comprises skeletal and ooid-rich wackestones and packstones grading upwards into oolitic grainstones interpreted as the result of north-easterly progradation of foreshoal to ooid shoal environments. A key element to understanding reservoir architecture has been the integration of core descriptions with borehole image logs, permitting recognition and re-orientation of the main bounding surfaces, cross-bedding sets. Existing depositional models for grainstone shoals are highly schematic and not useful for defining reservoir architecture.

Two key surfaces constrain correlation and reservoir architecture: a basal dolomitic hardground and an upper erosion surface which terminates grainstone deposition. Shoal initiation started in the SW of the study area with progradation of bioturbated foreshoal deposits with isolated planar cross-sets. Tidal reversals become more frequent upwards, with deposition mainly in offshore flood-oriented ooid sand ridges.

The main part of the grainstone interval is dominated by stacked parabolic sand shoal complexes comprising cross-bedded oolitic and skeletal grainstones. Macroporosity in this facies association is pervasively cemented. Behind the shoal complex (south-eastwards), planar laminated oolitic grainstones accumulated in flood-tidal deltas in a broad lagoon. Due to the extensive nature of the shoal and lagoonal complex, location of the basin margin is uncertain and sediment dispersal took place on both margins of the shoal complex. However, more protected lagoonal deposits are inferred in the southeastern part of the study area.

Progressive infilling of the lagoon by sediment supplied from the shoal resulted in basinward (NE) shifting of the shoreline and development of linear beach ridges which are clearly imaged on seismic. Bioturbated to massive grainstones capping shoal complexes are clean and only patchily cemented retaining a well connected primary macropore network.

Geometries, scales of cyclicity and facies distributions indicate analogs to modern tidally-influenced ooid ridges, parabolic bars and tidal channels. Comparison of the facies successions and inferred architectural elements are made with the modern Bahamas ooid shoal complexes.