

Seismic Stratigraphy of a Prograding Carbonate Platform: Faridah Reservoir North of Ghawar Field

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ABSTRACT

Platform margins and clinoforms are clearly visible on seismic and these have been mapped and tied to the stratigraphy of the Faridah reservoir in North Ghawar area using 3D seismic and well data. The height of the clinoforms are an indicator of paleo-water depth which is interpreted to have been about 150 meters. The Gotnia Basin was located to the north and the carbonate platform extended to the south. The platform to basin transition occurs over a distance of approximately 50 kilometers and is marked by a belt of clinoforms prograding from south to north as they progressively filled the available accommodation space between the carbonate platform margin and the basin slope/floor.

As successive carbonate clinoforms were deposited, and shifted from one area to another, there are substantial time gaps between adjacent clinoforms. These time gaps are represented by muddy lagoonal material or occasional storm deposits comprised of distal muds. These muddy carbonate intervals created intra-formational seals between individual clinoform reservoirs. These are typically only a few feet thick but they form competent seals that have a capillary entry capacity that is able to hold giant oil and gas accumulations.

Well data and seismic amplitude analyses indicate that the steeper clinoforms are composed of coarser, grainier reservoirs. The clinoform reservoirs consist of coarsening upward debris toward the clinoform toes, and fairly blocky, grainy, in-situ carbonate deposits toward the top of the clinoform. Reservoir quality is generally better in the grainy facies and poorer in the carbonate muds near the toe. This spatial variation in reservoir quality is repeated for each clinoform. The lateral stacking of different clinoform reservoirs means that multiple wells are required to adequately test the hydrocarbon play. Faridah reservoir intervals near the crests of the clinoforms have porosities around 15 %, net to gross of 70%-90% and permeabilities up to 50 md with fairly good lateral continuity along strike. Reservoir quality is significantly poorer near the clinoform toe with porosities around 12%, permeabilities of only a few millidarcy, net to gross less than 50% and they exhibit poor lateral reservoir continuity.

The major source kitchens in the vicinity of the Faridah clinoforms — the Gotnia and Central Arabian basins — are well-documented and oil originating from these sources has been proven. High TOC source rock has been sampled within the late Faridah equivalent basinal setting. This is a marine shale source rock currently mature for generating oil. Oil generation began in the early Tertiary, about 65 Ma, however, subsequent structural tilting to the north, which provided the 3-way dip component of the traps, only occurred at about 35 Ma. Since this time the traps have captured relatively mature, 22-31° API oil. The source rock signature has been mapped on 3D seismic and is associated with a strong amplitude, low-impedance signature.

This study demonstrates the potential for stratigraphic plays located within a relatively well-understood, petroleum system in a mature basin.