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3D seismic Data Helps To Lift The Fog - Structural and Stratigraphic Architectural Observations From A Recent 3D Seismic Survey, Block 4, Qatar

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Abstract

A recent 1,860 square kilometre high quality marine 3D seismic survey over Block 4, Qatar was acquired in 2006 and processed in 2007. The 3D data set provides outstanding images of Mid-Upper Cretaceous (Wasia and Aruma Groups) stratigraphic intervals. The quality of the 3D allows excellent fault resolution and insight into the details of both the structural history and the stratigraphic architecture of this part of the Qatar Arch and possibly the greater Region.

The top of the Cretaceous Shuaiba Formation carbonate has been well documented as a surface of regional significance separating the Aptian and Neocomian (Thamama Group) below from the Albian above. The Shuaiba interval in Qatar can be divided into an upper and lower unit. The Upper Shuaiba consists of prograding high frequency carbonate cycles (J.C.Hohman, Sequence Stratigraphic Analysis of The Shuaiba Formation: Implications for Exploration in Qatar. IPTC 11027). At least 8 high frequency cycles have been identified and it is possible to demonstrate that a number of the cycles have been removed by erosion, particularly towards northwest offshore Qatar including Block 4. Seismic analysis supports the identification of significant erosion of the top Shuaiba surface, as demonstrated by seismically derived isopachs and changing acoustic properties of the top Shuaiba boundary. In addition, seismic data indicates that the top Shuaiba surface has been incised, often deeply, by a significant through going channel system which displays incised valley morphology. From detailed horizon interpretation, seismic attribute analysis (amplitude extraction, semblance), and especially from flattened seismic volumes (flattened on the Top Nahr Umr horizon), the stratigraphic architecture of the channel system can be interpreted. Seismic time slice images from the flattened seismic volume (**Figure: 1**) clearly illustrate that the channels are multi-scale, high sinuosity, nested systems which can be traced for at least 40 km. Channel orientations are multidirectional but SW-NE and WSW-ENE trends are predominant. Numerous channel systems are seen to be cross-cutting suggesting multiple phases of channelling. Individual channel widths vary from tens of metres to 250m, although amalgamated channel belts can be up to 2km wide. Where imaging allows, analysis of meander loop migration would suggest flow towards the northeast. Analysis from vertical seismic profiles indicate thicknesses of channels/channel belts to vary from a few metres to tens of metres. Several channels demonstrate concave-convex channel morphology, indicating differential compaction suggesting sand-prone fill. Given that the channels are deeply incised into the top Shuaiba carbonate surface, and that the Shuaiba is overlain by the clastic dominated Nahr Umr Formation, the most likely origin of the incised valleys is fluvial, the incision being associated with late Aptian lowstand. However, the subsequent fill of the valleys could be either coeval late Aptian fluvial deposits or younger transgressive backfilling mid Aptian tidal/marine sediments.

The channel fill is sufficiently different from that outside of the channels to generate a marked low velocity anomaly within the channels, generating a velocity push down beneath the channels. Consequently, the time structure maps of preceding intervals, including potential reservoir layers such as the Kharaib and Arab, display a footprint of the overlying channels. The channelling is as clearly imaged at the Kharaib level as it is at the Shuaiba.

Structural analysis suggests deposition may have been influenced by paleotopography, with the main channel system following structural lows. Channels are observed to cross SE-NW trending faults without changing course, indicating faulting occurred later.

The faulting in Block 4 which affects the Shuaiba surface is best imaged on the overlying top Nahr Umr and Mauddud surfaces. Faulting is dominated by a through going 30km long SE-NW trending fault system. In detail the fault system is composed of multiple right stepping en echelon faults, separated by relay ramps, and characterised by rapidly varying throws.