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Seismic Sequence Stratigraphy and Structural Trends of Late Cretaceous Carbonate Tidal Channel Fairways from Onshore Giant Oil Field in Middle East

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Interpretation of high-resolution onshore 3D seismic and integration with well logs, and core data from giant onshore oil field in Middle East revealed Late Cretaceous deposits comprising several seismic units, interpreted as transgressive and high stand systems tracts formed from lower Cenomanian to early - middle Turonian. One late highstand unit was identified by logs and core data as multi-cycle grainstone dominated tidal deposits in mainly lagoonal mud-dominated facies, suggesting it formed during sea-level changes over areas of low-angle ramp, which were entirely exposed, resulting in sub aerial erosion associated with paleo-channel incisions by Tethys sea paleo-tidal waves. As low-angle ramp was flooded, the incised tidal channel fairways were backfilled with carbonate grainstone dominated coastal sediments, forming incised channel-fill deposits. Lagoonal mud-dominated sediments were later deposited due to sea-level rise periodically during the late highstand period.

Late Cretaceous tidal channel fairway geometries were identified using combination of seismic attribute volumes and acoustic impedance relationship observed from several well penetrations of the late highstand unit with log and core measurements within the 3D seismic area. Once major tidal channel fairways were defined by the combined seismic attribute volumes cut-off process, geobodies of all major fairways were calculated and used to further enhance geologic model 3D representation of tidal channel fairways, which played key role in explaining recent, and historical production and injection measurement anomalies. Variable channel fairways loading patterns and configuration were detected at several well penetrations by log, and core, and placed additional demand for detailed geologic model 3D representation of channel fairway geometries.

Modeling channel seismic derived geometries by scaling well logs to channel geometries seismic response, initial process incorporated seismic attributes cut-off derived channel fairway geometries, where finer well-scale channel bodies were populated manually in a later step. Simulation model of tidal channel reservoirs was developed and after initial runs, it was determined that more lateral extensive geologic reservoir connections were required to better explain fluid flow and pressure measurement anomalies during history match and prediction trials. A seismic volume neural network-based method was used to capture additional channel fairways at every well penetration by correlating porosity log measurements to seismic acoustic impedance attribute volume. Carbonate tidal channel interval 3D porosity seismic volume was calculated and compared with seismic spectrally decomposed frequency volumes of the same tidal channel fairway interval, demonstrated the potential of further enhancing channel fairway geometries representation by providing internal depositional details, significant to core and surveillance data derived high permeability layers placement.

Analogue modern carbonate tidal channel fairways geometries along the coastlines of Abu Dhabi and Florida although comparable to 3D seismic observed Late Cretaceous tidal channel fairways, but not of the same geologic age, clear evidence of tidal dominated carbonate complex was observed from high resolution onshore 3D seismic data.

The project illustrates various methods of how seismic volume interpretation is incorporated in seismic conditioning of a geological model outlining various challenges and limitations of integrating geophysical and geological description of complex carbonate tidal channel reservoirs from a giant onshore oil field in the Middle East.