Integrated Interpretive Processing - Pre Stack Depth Migration in Bahrah Area, Kuwait

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Abstract

Bahrah, in north Kuwait, is a geologically complex area with heavily faulted shear zones and associated fracture corridors. The structures being subtle, moderate to low relief and fault bounded, requires good seismic image and accurate depth predictions, which in turn need an accurate velocity model to convert time structure to depth. But very sharp lateral velocity variations coupled with strong vertical velocity variations extending over very short intervals make depth conversions highly challenging in Bahrah. After an extensive analysis of the predicted depths based on the vintage PSTM seismic data and the actual drilled depths in the area (differing by 200-350 ft), it is observed that seismic imaging is complicated by the presence of anisotropy and sharp velocity gradients in the subsurface geology overlying the prospective zones. On the other hand recent drilling successes/failures in Bahrah area shows that extremely accurate depth structure predictions of less than 50ft is required to exploit the full potential of numerous smaller structures where subtle changes can mean the difference between achieving production or not. A critical analysis of the acquisition parameters of the full azimuth single sensor seismic data and the vintage PSTM data clearly indicates that there is definite room for improvement, which was not exploited in the initial processing efforts. A new PSTM reprocessing effort including advanced refraction statics,5D interpolation and regularization, SRME, inter-bed multiple elimination, anisotropic PSTM, radon and post-stack time processing was implemented. This time processing shows great structural improvement relative to the existing well picks, but it is felt there are some still unresolved structural anomalies where there was a need to continue the processing into the depth domain using TTI depth imaging. The depth migration algorithm allows a more complex velocity field to be used in the imaging process than time migration. Using data from a newly acquired multi azimuth walk-away walk-around VSP, multiple zero-offset VSPs, sonic data, well ties and velocity and anisotropy data from the seismic data to form the initial TTI model, tomography was used to update the velocity model for the PSDM workflow. The resulting outputs from this PSDM are highly successful with significant enhancement in the seismic imaging quality with sharp fault definitions, high resolution within the shear zones and by accurately mapping subsurface positioning which is proved by successful drilling of new wells. This new PSDM depth image, resulting from integration of interpreters with the processing team by continuous interaction in quality control, anisotropy estimations and critical inputs for successive velocity model iterations is providing an exploration and development road map to exploit the full hydrocarbon potential of thin reservoirs in Bahrah area.