3D Seismic Data and Geomechanics Integration for Tight Sand Appraisal Program Optimization – A Case Study in Saudi Arabia

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ABSTRACT

Advanced seismic techniques such as AVO pre & post stack inversion and rock physics modeling were integrated with geomechanics to optimize the appraisal program in a complex heterogeneous tight sand reservoir; Sarah Formation in northern Saudi Arabia. The reservoir is characterized by intense heterogeneity, rapid facies variations and complex erosional events. It represents unconfined, glaciomarine fans and elongate ribbon channels, sourced by the erosion of tunnel valleys in ice proximal areas. A multidisciplinary approach combining rock physics, geo-modeling and geomechanics was followed to build a 3D Mechanical Earth Model (M.E.M). Initially a 1D MEM was built using information in the area such as geophysical logs, mechanical core test, breakouts and induced fractures from image- logs, Leak off test results and drilling events. Extensive dataset of conventional cores, image logs, sidewall cores and wireline logs from many wells augmented by 3D seismic amplitude time-slice maps, and palynology data supported the framework interpretation. To ensure the quality and reduce the uncertainty in the mechanical earth model, seismic inversion and rock physics techniques were applied to extract mechanical properties from the seismic attributes. Mechanical properties, locally calibrated from mechanical cores, were spatially improved using seismic inversion and rock physics analysis. The seismic and geomechanics integration helped in selecting and ranking the future drilling locations. This was achieved by mapping the pay zone with less risk of borehole damage which used to limit formation evaluation of the reservoir, evaluate the risk of sanding production for open hole/cased hole well testing, assess and qualify the location as future candidate for vertical hydraulic fracture or horizontal lateral drilling. The workflow and case study presented in this contribution highlights the value of adopting a multidisciplinary approach to the exploration of complex reservoirs, when detection, distribution and prediction of pay zones properties are beyond any single technique.