4932 VSP Found the Lost Reservoir

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ABSTRACT

A deviated (dev ~ 40 deg.) well was drilled to target an anticlinal carbonate reservoir in complex tectonic environment of Kohat Plateau, North-West Pakistan. The objective was to hit the apex of the structure. Due to the surface constraints, a vertical well was not possible. The deviation was planned based on 3D surface seismic; however the reservoir was not encountered as per the prognosis. It was thought that the ambiguity lied in the velocity control. For this reason, a look-ahead VSP was acquired to illuminate the target below the bit.

Because of only a very small lateral extent of the VSP image at the reservoir level, the structural interpretation was not possible with the VSP data alone. For this reason iterative numerical modeling of VSP wavefield was performed to resolve the ambiguity in the structural dip due to inherently small acquisition aperture of VSP data. Various migration techniques were used to analyze the reflections from the top of reservoir in order to reduce the uncertainty in the velocity model due to non-uniqueness of the tomographic inversion of VSP travel times and the reflector geometry. Reflection tomography of the VSP data was therefore helpful in obtaining a reliable velocity model and the subsequent VSP migration image of the top of the reservoir.

Based on the VSP migration results, it was identified that the dips were contradicting with the 3D surface seismic. A thrust fault was also identified, which suggested that the target was not below the intermediate TD, but was missed since the borehole had entered into the fault block (figure 1).

VSP thus suggested for a side track. In order to validate the interpretation, drilling was continued further for almost 100 m, but the reservoir was not encountered. This confirmed the notion of the borehole having entered into the fault block. After this validation, side track was planned and it hit the reservoir as predicted.

Figure 1: Migrated VSP overlaid on 3D surface seismic shows opposite dips compared to surface seismic and identifies a thrust fault that marks the truncation of the reservoir.