Reservoir Surveillance Case Study for a Steam Flood Project in Kuwait

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ABSTRACT

Kuwait Oil Company conducted a 3DVSP steam flood monitoring program in a heavy oil field in 2016 to help optimize development options. The key objectives for this reservoir surveillance project include acquiring a repeatable baseline survey; image two vertically stacked thin reservoir units, perform characterization to understand reservoir complexity and lateral barriers, and estimate the steam chamber size after 30 days of steam injection. This 3DVSP survey took less than a week with rigless acquisition only during daylight hours. The survey area was fairly congested with infrastructure making it difficult to manoeuvre between source positions easily. To tackle this, two groups of vibrators were used with a source driven acquisition technique. This meant much of the acquisition process was automated providing better efficiency and removing human error. Resulting data was processed and imaged with proprietary 3DVSP Kirchhoff depth migration algorithms. Due to an innovative acquisition design, output frequencies were 30% higher than achieved in previous VSPs or seismic data in the area. Velocity models were derived using the zero offset VSP data and a geomodel was derived from well data. The migration was sampled at dX/dY/dZ values of one meter each to help create a high resolution image. Synthetic seismograms from well logs and corridor stacks from the zero offset VSP were used to accurately tie the well data to the 3DVSP volume. This data volume was mapped using seismic workstations and amplitude anomalies were obvious around the steam injected well making possible the mapping of the steam chamber. Deterministic inversions from this data help identify facies changes and channels explaining the direction and pathways of the steam flow. In summary, each of the goals for this project was achieved. The two thin reservoir units and the top sealing shale were resolved while inversions were very beneficial for reservoir characterization and understanding facies changes. The steam chamber was easily discernable and its volume was calculated. These results justified the first ever 4DVSP in Kuwait which was acquired in January 2017. Ultimately, knowing where the steam fronts travel, where lateral barriers divert the steam, and how quickly it moves will help to optimize the development plans for the best possible EOR effectiveness and recovery rate improvement.