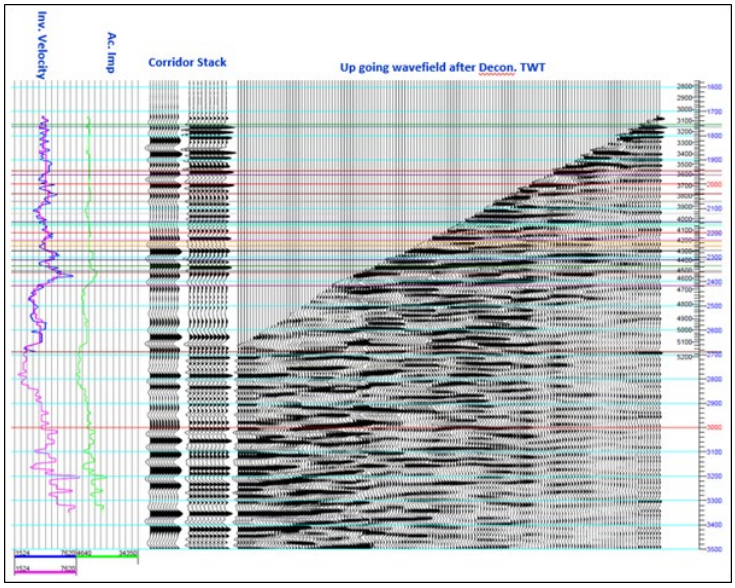
Look-Ahead VSP Survey Predicted Missed Target Ahead of Bit, Enabled Successful Casing Landing, Paved Way for Future Drilling Operations



Correlation of VSP and inverted results. VSP Inversion in frequency 5-10-72-80 Hz provide information below TD.

Objectives

- Provide seismic information ahead of total depth (TD) and identify the missing target using vertical seismic profile (VSP) data.
- Confirm the depth of the target reflector and velocity profile below the intermediate TD.
- Enable the customer to land the casing and reduce the uncertainty for further drilling.

Our Approach

- An onshore exploration well was being drilled in the fold-and-thrust belt and the customer faced uncertainty in predicting the depth of the target formation based on velocities from offset well data and the surface seismic. The estimated top of the target formation was not encountered despite drilling an additional 1,049 ft (320 m) measured depth (MD).
- In collaboration with the customer, Weatherford experts established a fit-for-purpose logging plan. Field personnel deployed a Geochain™ seismic array tool to acquire a zero-offset VSP (ZVSP) survey with three downhole component geophones and a vibroseis source. This crucial data below TD helped mitigate the overall risk of the drilling operation.
- The parametric wavefield separation technique used for the separation of the target wavefield incorporates the knowledge of the apparent slowness and separates the data in different wavefields in least-squares sense.

LOCATION
Pakistan

WELL TYPE
Development

BIT SIZE
12-1/4 in.

CASING SIZE
13-3/8 in. at 8,854 ft (2,699 m)

MEASURED DEPTH
14,763 ft (4,500 m)

PRODUCTS/SERVICES
- Wireline services
- Borehole seismic services
- Compact cement bond log (CBL) tool
- Variable density log (VDL) tool
- Monopole-dipole array (MDA)
- Geochain™ seismic array tool

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Our Approach (continued)

- The three-component processing of the VSP data and inversion of seismic trace on the well location helped to quantify the acoustic properties (acoustic impedance and velocity) ahead of the bit.

Value to Customer

- Weatherford's VSP survey provided accurate time/depth relationship and velocity profile below TD.
- Based on VSP corridor stack and inversion results, the customer knew the exact bit location and had the confidence to land the casing successfully.
- Utilizing the VSP data and survey results, the customer proceeded with additional drilling operations and reached the geological targets with accuracy.