

Well Seismic Profiling

WSP uses geophones in a borehole and generating seismic waves at the surface or at depth. The main uses of WSP are:

1. High-Resolution Imaging Near the Borehole
 - Provides detailed seismic images of the subsurface near the wellbore.
 - Improves resolution compared to surface seismic due to closer proximity between receivers and target zones.
2. Time-Depth Conversion
 - Accurately ties surface seismic data to well logs.
 - Converts two-way travel time (TWT) from surface seismic into depth using direct velocity measurements.
3. Identification of Multiple Reflections
 - Helps distinguish between primary reflections and multiples in seismic data.
 - Enhances data quality by allowing for better multiple suppression in surface seismic processing.
4. Lithology and Fluid Prediction
 - Through amplitude versus offset (AVO) and seismic inversion techniques, WSP helps in identifying fluid content and lithological variations.
5. Detection of Fractures and Faults
 - Helps identify natural fractures and faults around the wellbore using advanced processing like walkaway or 3D VSP.
6. Detection of Overpressure Zones Below the Borehole
 1. Accurate Velocity Measurements
 - Over-pressured formations often show abnormally low seismic velocities (especially compressional or P-wave velocities) due to under-compaction or fluid over-pressure. These velocity anomalies can be strong indicators of overpressure.
 2. Refinement of Pore Pressure Prediction
 - Comparing measured interval velocities from WSP with normal compaction trends, pore-pressure prediction models (e.g., Eaton's method) can be calibrated or refined.
 - Helps identify the onset and depth of over-pressuring below the current drilling depth.
 3. Look-Ahead VSP Techniques
 - Reverse VSP or look-ahead VSP uses downhole receivers and a source at the bit or in the borehole to "see" ahead of the drill bit.
 - Can potentially detect overpressure zones before they are drilled, improving safety and planning.

Note the Limitations:

- Overpressure detection is indirect — based on seismic velocity and rock properties.
- It must be combined with well logs, mud weight data, and geological models for reliable interpretation.

- Below borehole resolution depends on the source-receiver geometry and data processing quality.

Summary:

WSP helps detect overpressures below the borehole primarily through accurate velocity profiling and time-depth calibration, enabling better pore pressure prediction and early identification of risky zones.