

VSP versus Surface Seismic for Imaging of Salt Domes

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Abstract

Modern seismic imaging is usually the best option for developing an accurate understanding of the complex shape of salt domes. In-borehole seismic acquisition, or Vertical Seismic Profiling (VSP) is less expensive, faster and easier to permit and can be acquired where surface seismic acquisition may not be feasible due to surface constraints. However, VSP surveys provide less areal coverage and can be tricky or ambiguous to interpret. 3D surface seismic acquisition is more expensive, slower and more difficult to permit and can require more time to process but can provide full areal coverage and usually is successful in imaging the salt dome. 2D surface seismic acquisition is relatively inexpensive but provides limited subsurface information and is often plagued by out-of-plane reflections when the salt flank is structurally complex.

We present two case studies of imaging US Gulf Coast salt domes where both VSP data and 3D seismic data are available for direct comparison of results. In the first example a multi-offset VSP was recorded using reflection geometry and interferometry in an attempt to image a suspected shallow (less than 6500ft (2000m)) salt overhang. The VSP was generally unsuccessful in imaging the salt flank, because of interference from out-of-plane reflections and because the salt dome was in fact not overhanging. A 3D surface seismic survey over the dome was successful in detailing the shape of the salt dome to below 10000 ft (3000m).

In the second example a multi-offset VSP was recorded using both reflection geometry and proximity survey geometry, to image a suspected salt overhang. The interferometric solution was generally unsuccessful, but the proximity survey geometry yielded reliable results, again because the dome was in fact not overhanging. A 3D surface seismic survey was successful in imaging the entire salt dome.

We recommend that 3D surface seismic is the preferred choice for imaging salt domes if the project can support the expense and time to acquire the data. If VSPs are used to image a salt dome they should be recorded in both reflection and proximity geometries to illuminate either overhanging or non-overhanging salt flanks.

Keywords: 3D seismic, salt domes, Vertical Seismic Profile, VSP, seismic imaging, interferometry