Salt Shape Tomography

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ABSTRACT

In subsalt depth imaging, salt bodies are usually delineated using scenario-based migration scans. Gridded approaches can estimate spatial variations of velocity up to approximately 6 Hz but have difficulty estimating the position and amplitude of strong velocity contrasts. Using tomography to determine the shape of bodies characterized by sharp velocity contrasts at boundaries still remains a challenge.

Given that variations of velocity in salt are often small, we have developed a multi-layer nonlinear slope tomography method for estimating the shape of bodies that show sharp velocity contrasts at their boundaries with surrounding media. The data to invert mainly consists of residual moveout (RMO) information picked below the strong velocity contrasts on depth-migrated common image point gathers. In the multi-layer approach, the sharp velocity contrasts are introduced as layer boundaries. Using ray-based nonlinear slope tomography, we compute Fréchet derivatives made of traveltime derivatives with respect to the depth parameters describing the layer bounding surface to re- position. The layer (e.g., salt) shape is progressively updated after each linearized tomographic step.

We first demonstrate the method on a 2D synthetic example where a rugose base of salt boundary is updated by inverting subsalt RMO picks. We then present an application on a high fold 3D land dataset from the Sultanate of Oman where the partly invisible top-of-salt boundary at an approximate depth of 3000 m is reshaped by inverting both RMO-picked subsalt and base-of-salt. The obtained results are compared with a scenario-based approach for updating salt shape. Overall, subsalt reflectors imaged after salt shape tomography are less distorted, more continuous, and better focused. Salt shape tomography can thus help the geophysicist reduce the number of scenarios to test.