Near Surface and Anisotropy Modeling Strategies for Fast-Track Land Depth Imaging

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ABSTRACT

Compared to marine seismic data, pre-stack depth migration of land data faces specific challenges mostly related to the near-surface velocity variations where these complexities can cause poor imaging, generate distortions and ultimately mask the true structure of the reservoir. Particularly in areas of low relief geology, accurate handling of long wavelength velocity anomalies is the most important aspect for obtaining reliable depth images. Since sub-horizontal fine scale layering can cause velocities to vary depending on the angle of the wave propagation with respect to vertical, such anisotropy needs to be taken into account to produce good quality images matching the depth of formation tops from well data. A robust and efficient workflow to produce depth images of land seismic data in layered geology is presented where we approach near-surface modelling by generating velocities in depth, together with long-, medium- and short-wavelength static corrections, reflection velocity analysis and anisotropic parameter scanning for the deep structure. The long wavelength part of the near surface velocity variations is solved by dynamic velocity analysis, while the medium- and short-wavelength terms are resolved by surface-consistent analysis of refracted and reflected data. The continuity of the deeper section of our study area allows it to be described by laterally smooth velocity fields. We apply the workflow to a wadi structure in central Saudi Arabia, which is known to have complex near-surface conditions and imaging problems. Geologically-consistent velocity model updates generated through interaction with seismic interpreters reduce the possibility of introducing errors in areas far from well control. High-resolution helicopter-borne transient electromagnetic data was utilized to constrain seismic traveltime tomography through cross-gradient structural regularization for the near-surface model. Combined with geologically consistent anisotropic parameter scanning (V0, delta and epsilon), combining the shallow and deep models can accurately image formations with minimal depth errors, as validated by well control. The applied workflow provided an effective solution for pre-stack depth imaging of land data in low relief geology.