Improved PSDM Imaging Workflow by Integrating Near Surface and Well Velocities

Duryodhan Epili[1], Hani Alzharani[1], Adam J. Fox[1], and Luke LaFreniere[1]

[1]Aramco, Dhahran, Eastern Province, Saudi Arabia.

ABSTRACT

Prestack depth migration (PSDM) reduces inherent distortions in the presence of complex geology with rapid vertical and lateral velocity changes. This results in improved imaging of faults and deeper horizons, and may enable the depth section to be tied correctly to well data using check shots, Vertical Seismic Profiles (VSPs) and well tops. In summary, it handles properly the positioning and the focusing of seismic amplitudes, implying a major impact on exploration and production projects. If the velocity model is not good enough, and, for example, if the complexities from the shallow unconsolidated sediment velocities are not incorporated, PSDM produces deteriorated images. We propose an improved methodology (i.e., workflow), where the sub-optimal near surface velocity model as derived from the refraction tomography and the borehole information are integrated within the velocity model to provide a better subsurface image. Approximately 1000 km2 of wide azimuth land seismic data recorded in Saudi Arabia are imaged. There is no significant anisotropy observed in the data, so we limited our imaging to the isotropic case. The proposed workflow includes the following steps: (1) The Near Surface Model (NSM) is used for residual time statics correction on input prestack time gathers. The NSM is derived by joint inversion of both seismic refraction and controlled electromagnetic data; (2) the initial velocity model is built by seaming the near surface model, non-check shot calibrated model, followed by a one pass of velocity picks on the PSDM image stretched to time; (3) the initial model is updated with two more passes of shallow grid tomography (above 1500 m). As the offset gathers are not adequate for building the shallow part of the velocity model, we use continuous azimuth-angle gathers instead. The resulting velocity model is seamed with the deeper section of the VSP horizon-based geo-statistical velocity model; (4) the entire model is enhanced with three iterations of reflection tomography; (5) the seismic image is calibrated with the picked well tops/markers. In conclusion, imaging improvements were achieved by processing the data with the proposed isotropic depth imaging workflow. The final result is the enhanced subsurface image with geologically meaningful results that ties to the seismic well marker depths.