Common Reflection Angle Pre-Stack Depth Migration as Data Enhancement Method for 3D Sparse Land Seismic Data, Case Study from Saudi Arabia

Asaad E. Alzawwad[1], Krzysztof K. Sliz [1], and Luke LaFreniere[1]

[1]ETSD, Saudi Aramco, Saihat, Eastern Province, Saudi Arabia.

ABSTRACT

The majority of vintage seismic datasets acquired for new exploration frontiers are sparse surveys, which lack the resolution of a full and dense 3D seismic survey, and therefore creating imaging artifacts. This study shows that it can greatly improve images from old sparse 3D surveys limiting acquisition impact and improving signal quality by using Common Reflection Angle Pre-Stack Depth Migration (CRAM) on a sparse 3D land seismic dataset from northern Saudi Arabia. The seismic data was acquired over a fractured subsurface formation using vibroseis sources, with maximum in-line and cross-line offsets of 7780 m and 4200 m, respectively. The subsurface Common-Midpoint (CMP) bins grid size is 30 m by 30 m. The sparse geometry resulted in a spatially varying fold from 60 in the majority of the area up to a maximum of 460 on some in-lines. The subsurface geology is complex with a large anticlinal structure in the center of the study area. Due to extensive faulting over the top of the structure propagating up to the surface, a wadi (valley) with elevation changes up to 170 m was created. The near-surface Rus Formation exhibits intensive karsting adding extra challenges to our imaging workflow. The conventional Kirchhoff Pre-Stack Time Migration (PSTM) and Depth Migration (PSDM) results, suffered from migration artifacts due to the abrupt changes in the fold resulting in signal/noise ratio disparities. These migration artifacts were reduced by application of Veronei weights but they are still clearly visible on the depth slices. Even with the presence of these undesired artifacts, PSDM results were superior to PSTM results. The CRAM results showed additional enhancements in terms of the image quality and the migration artifact reduction, thanks to the additional internal interpolation and the specular scaling. CRAM results were also used in the iterative velocity model building workflow including angle domain tomography. Note that the angle domain reduces further the impact of irregular discontinuous in the acquisition geometry, thereby improving both residual moveout picking process and quality of the tomographic updates.