Recent Successes in FWI Deployment on Land-Data

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Abstract

Over the past years PDO has put massive efforts to improve subsurface imaging which has been proved to be beneficial. However, few obstacles, such as shallow sinkhole disruption, have still to be properly addressed. In this paper we present the challenges of seismic imaging below a major sinkhole in a producing field in north of Oman that are present in the shallow section. Many trials of different technologies have been carried out to address this challenge including joint inversion of seismic and non-seismic data, as well as various velocity model building trails. The major roadblock on the way of field development plans has always been the quality of the legacy seismic image. 3D-WAZ survey was recently acquired over the field with a main objective of enhancing the reservoir and the deeper image especially around the sinkholes. The data went through a thorough model building exercise including building near surface velocity model using Multi-Wave Inversion (MWI), acoustic FWI and concluded with a tomographic velocity model building. The above has resulted in a major data enhancement, however, it didn't succeed in revealing details beneath the sinkhole disturbance. In this paper we will be presenting the results of a pilot study in which different FWI techniques were tested, including time shifts minimization approach (Kinematic FWI) utilizing the diving wavefield. This approach has been proved to be robust in overcoming the fundamental cycle skipping issue that is faced when a sub-optimal starting model is used. The kinematic FWI inversion was run using diving waves with acoustic propagator for a maximum acquisition offset of 10km and a maximum frequency of 4Hz. The vendor's FWI model was used as a starting model. The kinematic FWI inversion results succeeded to determine the velocities around the sinkholes and properly capture the shallow velocity inversion, leading to enhanced imaging with less distortion and improved resolution of target reflectors. Additional enhancement was achieved with a phase-only reflection based FWI up to 6Hz which provided another improvement to inverted model. A tomographic velocity model update was also performed to rectify residual velocities errors. The implementation of the kinematic FWI and phase-only reflection based FWI workflows contributed to resolving imaging complexities around the sinkholes, hence positively impacted the seismic imaging of field area. The learnings from this project are being implemented in an ongoing project from north of Oman where different challenges are being addressed like capturing the velocities of shallow channel deposits, and imaging low relief clinoforms.

Acknowledgement: We would like to thank the Ministry of Energy and Minerals & Petroleum Development Oman for the permission to share these results and Shell Global Solutions International for their support and cooperation.