Integrating Geophysics and Geology for Improved Seismic Imaging to Extract the Best From Legacy Acquisition – A Case Study From Ultra-Deep-Water Lower Congo Basin, Angola

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ABSTRACT

The success of the Tertiary discoveries in the deep-water part of the Lower Congo basin, offshore Angola, has encouraged explorers to evaluate similar plays in the frontier ultra-deep-water province. Successful exploration in the deep-water blocks is focussed on turbidite sands deposited by the paleo-Congo delta. These turbidites continue to extend under the salt diapirs, which form potential traps with an effective seal in unexplored realms. Subsalt imaging, however, is highly compromised in legacy seismic data. To address this, we reprocessed 7922 km2 of 3D seismic data (acquired in 1999) over Blocks 46, 47, and 48. The latest reprocessing and model building techniques enhanced the image beneath salt and significantly reduced structural uncertainty of potential traps. If successfully explored, this subsalt play could add significant quantities of hydrocarbon reserves in this region. In our study, we demonstrate what may be achieved from legacy acquisition by using up-to-date processing techniques, such as better signal-to-noise ratio processes, source and receiver deghosting for a broadband product, and improved regularisation. Following this, dense global tomographic updates of the velocity model and complex salt modelling, using both Kirchhoff and reverse time migrations for the most appropriate images, produced greatly superior results compared to ten years ago. Within the model building, combining the expertise of geologists and geophysicists was key to accurate event positioning, better interpretation, and a geologically plausible velocity model that reduces structural uncertainty. The reprocessed data show enhanced signal-to-noise ratio and improved event continuity. Deghosting techniques applied at the pre-processing stage remove the effects of the source and receiver ghosts and enhance the amplitude spectra for low and high frequencies. In the new reprocessed data, there is greater confidence in interpretation, which must be based on the seismic reflection pattern in the absence of well data. Overall, significant uplift is observed in legacy data that were reprocessed with this advanced imaging workflow.