Integration of High Resolution Gravity and Seismic Data Interpretation Techniques for Onshore Frontier Hydrocarbon Exploration: Examples From the East African Rift

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ABSTRACT

The value of potential field data as an integral tool in hydrocarbon exploration has long been recognized by geoscientists; however the practical application of this method has often been restricted to the regional scale due to limited resolution. Advances driven by mineral exploration in acquisition, imaging and interpretation techniques (particularly in area of gravity gradiometry) over the last decade have brought the comparatively low cost potential field method into the spatial domain of seismic data. This has improved the application of the method to hydrocarbon exploration at both the basin and prospect scales. A suite of these techniques based on the uncommonly large and contiguous high resolution potential field dataset over the Broadly Rifted Zone of the East African Rift System were combined with seismic interpretation methods to produce an integrated regional hydrocarbon prospectivity review of the region. Outputs of the multi-scale edge detection structural imaging technique performed on gravity gradiometry data were combined with surface structural lineaments interpreted from digital elevation data and satellite imagery to produce a structural framework of the Rift Valley and Northern Turkana basins to guide seismic interpretation. Edge detection mapping products were further used at the seismic scale to constrain fault correlation over sparse and poor quality 2D seismic grids, reducing the probability of structural aliasing. ‘Depth to basement’ approximations were calculated using 2D inversion of gravity gradiometry and high resolution gravimetry data after Murthy & Rao (1986). Although sensitive to the presence of shallow volcanics, the high resolution of the input gravity data allowed the output pseudo-depth grids to be visually calibrated to seismic data to provide a qualitative assessment of the reliability of the method away from seismic control. 2D Murthy & Rao ‘depth to basement’ approximations were used to constrain seismic interpretation in areas with little or no well control and to identify potential sedimentary basins in areas with no seismic coverage. The 2D depth approximations were also used in conjunction with 2D seismic, surface geology and hand sample data in the construction of robust geological forward models for 3D ‘depth to basement’ inversion. Depth approximations from 2D and 3D inversion were input into source rock maturity modelling providing a useful basin screening tool in areas of limited seismic coverage.