Basement Architecture within Coastal Area of the Red Sea, Saudi Arabia

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Abstract

Depth to basement and its faulting pattern, associated with differentiating crustal types are critical in understanding the process of continental rifting, breakup and evolution of petroleum systems within passive continental margins. An integrated analysis of gravity, magnetic and seismic data is conducted to define the regional structural framework and to estimate the local depth to basement within the coastal area of a continental margin context. We apply specific edge detector filters on gravity and magnetic gridded data to delineate the regional structural framework and to differentiate continental and oceanic crusts. Initial depth to basement constraints are obtained directly from magnetic data by Werner method. These constraints are then used in initiation of integrated quantitative analysis of multi‐physics datasets comprising of gravity and magnetic data, seismic images and available well data. Quantitative modelling is then performed, including the inversion of both gravity and magnetic data along several profiles, to sequentially obtain depth to Moho and depth to basement. In this process, shallower sedimentary formations are also considered, constraining their geometry by seismic interpretation for the depth ranges in which seismic data is well imaged. Sedimentary rocks are characterized by very low magnetization in comparison to basement, volcanics and metamorphic rocks, and thus their magnetic response is considered negligible in the current context. Magnetic minerals lose magnetic properties at a higher temperature than Curie point, and consequently basement rocks below the Curie isotherm level do not contribute to measured magnetic response. Thus, by comparing gravity and magnetic anomalies, regional sedimentary structures associated with salt and carbonates sequences are inferred, and long wavelength gravity anomalies are tied more directly to depth to Moho and mantle density variation. The presented workflow shows the impact of including magnetic data along with regional gravity data and its application to similar geological petroleum exploration systems. This study demonstrates a successful integration of multiple geophysical data sets to map crustal thickness and delineate continental/oceanic crust boundary, and provides an insight into possible scenarios acting locally within regional context of the continental margin.