The Onshore Blue Nile Basin, Ethiopia: De-Risking Exploration in Volcanically-Affected Basins

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ABSTRACT

The impact of flood basalt volcanism on hydrocarbon systems in prospective basins has come to the fore with the realisation of important intra-volcanic discoveries (e.g. Kudu, Rosebank). Exploration is hampered however, by the absorption and scattering of acoustic signals by the lava flows. Even if the sub- and intra-volcanic sequences are imaged the interpretations are hindered by the seismic-scale resolution (tens of metres) of the data. These problems make it difficult to delineate and characterise petroleum system components, such as, reservoir architectures within volcanic sequences. There is a need to mitigate interpretations through well-exposed analogues and the onshore Blue Nile Basin, Ethiopia, with its working petroleum system, is a suitable candidate. The Blue Nile Basin has been uplifted and the subsequent incision by the Blue Nile River has exposed a >1.5 km thick Mesozoic sedimentary succession mantled by the Ethiopian Flood Basalt Province. Lithostratigraphic logs collected across the basin detail the unconformable transition from marine limestones and fluvial sandstones to the subaerial lava flows. Clean siliciclastic sandstones are interbedded with the basal lava flows suggesting volcanism did not shut down pre-existing clastic systems. In the middle of the lava flow succession there is locally a several hundred metre thick interlava sequence that has been mapped over distances of at least 50 km. The base of the interlava sequence consists of mass flow and fluvial volcaniclastic conglomerates and sandstones that are dominated by felsic material (e.g. quartz, rhyolites) in the north and mafic material (e.g. pyroxene, basalts) in the south. The variability in composition has implications for drainage development within lava fields as well as reservoir/sealing properties due to their differing susceptibilities to alteration. The upper part of the interlava sequence consists of diatomaceous units and felsic tuffs suggesting the development of large-scale lakes during volcanism. Thickness mapping of key intervals is also helping to delineate basin structure and facies distributions with the aim of unlocking the petroleum potential of volcanically-affected basins.