

The Influences of Cenozoic Palaeodrainage on Southern Indian Petroleum Systems

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The drainage of southern India has changed remarkably since the beginning of the Cenozoic. Using drainage and landscape analysis, climate studies, structural interpretation and palaeogeographic maps, the evolution and influences of the river systems on the offshore petroleum systems can be determined.

In the process of landscape and drainage analysis, a topography grid is generated; findings are then incorporated with the other disciplines to obtain an integrated evolution of the drainage basins. This aids in petroleum exploration in better understanding of the location of palaeo-river outlets, the sizes of palaeodrainage basins, the nature of the material being transported (and deposited) and the tectonic processes affecting the region. For instance, the relative quality of offshore clastic reservoirs may be predicted as well as the location of past deltaic and fluvial deposits in areas/depths not yet surveyed seismically.

In India, the unequal amounts of Cenozoic sediments found along the western and eastern margins are a direct result of the landscape evolution and hence development of drainage basins on the subcontinent. Since the Tertiary, several tectonic events (i.e. rift flank uplift of the Western Ghats and uplift of the Mangalore-Chennai Arch) have disrupted the stream network which directly caused changes in the deposition of sediment in the offshore basins. This is observed by changes in lithology, the distribution and the amount of sediment being deposited. Three examples are shown where drainage and landscape evolution has influenced the petroleum systems in offshore southern India.

In the Konkan-Kerala Basin on the west coast, deep weathering occurred during the Paleocene via short-headed coastal rivers from the newly uplifted Western Ghats escarpment face. Recent drainage piracy, in conjunction with the onset of intense monsoons caused rapid erosion and a heavy influx of terrigenous shales and clays onto the shelf and shelf margin (Cochin and Kasargod Formations). As a result, carbonate sedimentation ceased and potential reservoir quality clastics (and intercalated seals) were deposited, simulating the material of the eroded hinterland; wackes composed of basaltic fragments from the flood basalts and potentially quartz-rich sands from the breakdown of crystalline Precambrian basement.

The Cauvery River draining east represents a scenario where two palaeo-rivers coalesced during the Quaternary to form one major river. This occurred due to fault activity and uplift causing increased erosion and sediment flux offshore, consequently changing the basin from a carbonate to clastic regime with the deposition of the highly porous sandstone of the Tittacheri Formation.

During the Paleogene, the uplift of the Mangalore-Chennai Arch affected drainage patterns of the Cauvery, Krishna, Pennar, Palar and Ponnaiyar Rivers, diverting them north and south from the coast-to-coast drainage divide whilst the rift flank uplift of the Western Ghats created the north-south drainage divide.