The Ranikot Formation as the Potential Unconventional Petroleum System in the Kirthar Foldbelt, Pakistan

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Abstract

Geochemical and geological studies were performed in the Ranikot Formation drilled within the Kirthar Block (Kirthar Foldbelt). The Ranikot Formation within the study area is untested to date and requires detailed investigation to evaluate its hydrocarbon potential. The Ranikot section is dominated by clay (up to 70%) and thus the unit of interest can be called the Ranikot shale. It was deposited in the shoreface system exhibiting intercalations of sandstones and mudstones formed as thin beds. Organic richness of the formation varies from 0.36% to as high as 2.57% TOC. Assuming 1.5% TOC as a cutoff for effectively producing source rock, the inferred source intervals reach the thickness between 120 and 200 m in the study area. TOC increases uniformly with depth in this prospective zone and corresponds to elevated mud gas readings (11-46%). The interval is over-pressured (up to 4200 psi) with a measured pore pressure gradient of 0.59 psi/ft. S_2 and HI values vary from 0.4 to 4.8 mg HC/g rock and 20 to 250 mg HC/gTOC, respectively. Visual kerogen assessment indicates diverse composition of organic matter throughout the basin. The northern section is enriched in humic type-III kerogen (up to 86%, avg. 80%) with a small proportion of inertinite (1-6%). The southern section contains much more sapropelic type-II kerogen up to 74% (avg. 51%), however, the contribution of inertinite can be as high as 77% (avg. 44%). Thermal maturity of the source interval indicates a W-E increasing trend between 0.85 to 1.4%R_o. Carbon isotope record indicates mudgas thermal maturity between 1.1 and 1.4%R_o. The transformation ratio of organic matter varies between 50 and 90% through the interval. The calculated original

TOC and hydrocarbon potential could have been 1.7-3.2% and 2.8-10 mgHC/gRock, respectively. The Ranikot gas is of thermogenic origin, generated by the mixed type-II/III organic matter. The associated character of gas suggests a relatively low content of oil cracking, reflecting high accumulation efficiency of the closed system. The prospective section of the Ranikot shale is considered to be a hybrid unconventional system with moderate geochemical risk for commercial shale gas production.

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