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Qualitative Mineralogical Analysis of Deep-Sea Sediments Based on the Lithology in the Offshore Mannar Basin by using FTIR and XRD Techniques

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Abstract

The Mannar Basin, with a total area of 45,000 km^2, is a key sedimentary basin for petroleum prospecting in Sri Lanka. It stretches from southeast India to southwest Sri Lanka and the basin is made primarily of Precambrian high-grade metamorphic rocks. In 2011, Cairn Lanka Private Limited (Cairn) drilled three exploration wells (Dorado, Dorado North, and Barracuda) and one exploration well (Wallago) in the recent petroleum exploration in Mannar basin. Source rock quality and maturity are important factors to consider when evaluating oil and gas potential. As a result, mineralogy plays an important role in the geochemical characterization of source rocks. In this study sediment samples of Barracuda exploration well in Mannar basin were collected from Petroleum Resources Development Secretariat in Sri Lanka (PRDS) at depth ranging from 2,260 to 4,740 m, and the samples were cleaned before analysis to eliminate drilling mud. The powdered material was made by crushing the cleansed sediment samples with a motor and petal, then screening them through a 53 µm standard sieve. After that sediment samples were analyzed through Fourier Transformation Infrared Spectroscopy (FTIR) and X-Ray Diffractometer (XRD) to obtained the available mineralogy qualitatively. The observed data were interpreted based on sample age, depth, and lithology, as well as their impact on the Mannar basin. According to previous research, the detected FTIR band wavelengths were used to determine the accessible mineralogy of the samples. The XRD peaks were determined using Crystal Impact Match 3.0 software and literature. The presence of quartz, feldspar, kaolinite montmorillonite, and calcite in the entire marlstone and mudstone samples is confirmed by FTIR analysis. The XRD analysis revealed that calcite, and quartz are dominant in marlstone with black carbon sediment samples and marlstone sediment samples. Quartz, illite, and calcite dominate in argillaceous marlstone sediment samples. Illite, montmorillonite, kaolinite, and calcite are dominant in slightly calcareous mudstone sediment samples. Quartz overgrowth and cementation were caused by the presence of quartz. In the Mannar Basin, quartz cementation can reduce reservoir rock porosity and have an effect on permeability by increasing rock brittleness and occupying pore space. Overgrowths of quartz reduce reservoir porosity and permeability. Feldspar alteration changes porosity and permeability, whereas dissolution increases secondary porosity and permeability of source rock in the basin. Clay minerals have an impact on hydrocarbon formation, accumulation, migration, and reservoir quality in the basin. Also, tectonics and sedimentation modify the abundance and crystal structure of clay minerals. Furthermore, the presence of carbonate minerals and hematite is responsible for the cement's creation. Calcite cement has an effect on the basin's reservoir quality, while hematite cement is uncommon.

Keywords: Mannar basin, Sediment, Mineralogy, FTIR, XRD