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Pore Size Distribution of shale using Advanced Analytical Techniques

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Shale gas is becoming one of the important targets as a future energy source. In addition, they can be utilized as potential sequestration sites for carbon storage to mitigate the global greenhouse effect. However, the pore size distribution of Indian shale gas systems is poorly understood. Knowledge on pore size distribution is one of the fundamental requirements for characterization of shale gas reservoirs and for accurate estimation of gas storage potential. The work presented here is probably the first effort on the characterization of different Indian shale reservoir basins based on the pore size distribution. Mercury Injection Porosimetry (MIP) and low-pressure gas adsorption (CO_2) techniques were used to study the nano-scale pore size of the shales. For the qualitative assessment of porosity Four Dimensional X-Ray Microscopy (FDXM) is used. The type and quantity of clay minerals present were assessed by X-Ray Diffraction analysis.
Shale samples were taken from the Krishna-Godavari basin in India. Geographically, KG basin is located on the southeast coast in the Indian state of Andhra Pradesh. It is a peri-cratonic passive margin basin covering an area of 28,000 square km. The known hydrocarbon-bearing areas are divided into five petroleum systems, the major source rocks being early Permian, cretaceous, paleocene and Eocene. The thermal maturity of the shales ranges from 0.7% to 2% Ro. The cores collected from the site were relatively hard and compact. The stiffness of the sample makes it a good candidate for hydraulic fracturing.
The samples exhibited higher thermal maturity with increasing organic content. The chemical composition of the shale samples was inferred from XRD data, which depicted high enrichment of kaolinite among other clay minerals. The experimental result suggested that the samples exhibited diversified pore size characteristics. The micropores were efficiently accessed using CO_2 adsorption which showed a type I isotherm curve indicative of micro-pore infilling. MIP analysis was used to infer the pore throat area. The average pore diameter of the samples was 3.94 nm. The KG shales exhibited a BET surface area of 2.24 m2/g while the total pore volume amounted to 0.002 cc/g. The MIP results indicate that the KG shales have a broader range of pore diameters towards the larger pore size (9 nm).
The study shows that KG shales have a broad range of pore diameters. Although the adsorption quantity is not high as compared to that of other shales, it exhibits enough adsorption to be regarded as a reservoir. With further in-depth study and the application of high-pressure gas adsorption, the storage potential of the shale can be assessed.