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Clay mineralogy and their textural attributes from different hydrocarbon reservoir rocks of Cambay basin for crude oil recovery

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The micro- and the fine mesopore network formed in the clay-laden reservoir rocks are primarily controlled by different clay species, their mode of origin as well as their textural attributes. In hydrocarbon reservoir, clay minerals interact with crude oil over geological time and adsorb the polar components of crude oil due to their large surface area and cation exchange capacity (CEC) which vary with the varying clay species and their occurrence in the textural network. This adsorption phenomenon affects the primary as well as secondary oil recovery from the reservoir rocks. Thus clay mineralogy, their distribution pattern, and the mode of occurrence in different types of hydrocarbon reservoirs have a significant effect in hydrocarbon exploitation, explicitly in crude oil recovery and the present work is an attempt towards that.

Four representative samples namely Fractured basalt, Himmarnagar sandstone, Kalol sandy shale, and Cambay shale are considered and characterized in this work for their textural and mineralogical details. Petrographic observation under the polarizing microscope and scanning electron microscope were used for detail textural analysis of the rock samples whereas the mineralogical characterization of the rock samples was done with election probe micro analysis (EPMA), X-ray diffraction (XRD), and Fourier transform infrared (FTIR) spectroscopy data.

The analysis manifested that Fe-Mg rich smectite is the dominant clay mineral present in Fractured basalt which occurred as the vesicle fill materials replacing the primary minerals and in lath like manner within the magmatic pyroxene. The smectites formed replacing pyroxene minerals in an alumina lacking microsystem with the addition of hydrous fluids. In Himmatnagar sandstone sample, the hair like illite and books of kaolinite are present as pore-filling materials due to diagenetic alteration of orthoclase feldspar. The illites are commonly observed parallel to the non-clay mineral surface in the pore spaces. In few places, illites grew on the diagenetic kaolinites. Fe-Al rich smectite is present as major clay phase in both the shale (Kalol sandy shale, and Cambay shale) samples as pore-filling material possibly, indicating weathered basaltic provenance. Detail characterization of the clay species and their mode of occurrence in studied reservoir rock samples of Cambay basin will help to understand the oil production mechanism through the capillary channels of the pore network during primary and enhance oil recovery stages.