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Organic-inorganic composition of Indian shale and their effect on micro-pore characteristics and gas storage potential: A comparative analysis of Gondwana and Tertiary shale

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Shales are able to hold massive amount of commercially recoverable gas and 40 % -50 % of the total gas content of shale is stored in adsorbed state. Since adsorption acts as a key parameter in the storage of methane gas in shale, it is of utmost importance to understand the adsorption behavior of shale-gas reservoirs that is taking place in the micropores (<2nm diameter) of organic matter and clays. In this study, an effort has been made to understand the effect of shale composition on the micropore characteristics and methane gas storage capacity of very less explored Indian shales.

Samples were collected from Gondwana Damodar-valley and Tertiary Assam basin, which are two of the six target basins for shale gas exploration and exploitation in India. Rock-Eval and XRD studies determined the organic-inorganic composition of shale. Micropore characteristics and methane sorption capacity were investigated by Low-pressure CO_2 isotherms and high-pressure methane adsorption isotherm studies respectively.

The XRD analysis reflects clay rich nature of the studied shale samples with low quartzo-feldspathic content. All the samples have excellent Total Organic Carbon (TOC) content ranging from 4.8% - 37.36%; HI values between 142 to 338 mg HC/g TOC indicate in?ux of type II and type II+III kerogen. Organic petrography reveals Vitrinite rich nature of the samples with minor presence of Liptinite in Assam shales. The T_{max} value varying between 422˚C-465˚C suggests an early to late phase of thermal maturity. In a nutshell, source rock study reveals very good to excellent hydrocarbon generation potential of the shale samples. Low-pressure CO_2-adsorption isotherms are observed to be Type I, indicating microporous nature of the samples. The CO_2-micropore volume varies from 4.23cc/g - 18.8cc/g. Assam shale samples show higher value of methane Langmuir-volume (V_L) indicating higher methane sorption capacity than that of Damodar-valley samples. The positive linear relationship between CO_2-micropore volume with TOC and methane-V_L suggests that organic matter contributes to the micropore volume which further controls the methane sorption potential. The positive correlation between TOC and V_L ascertain a strong influence of organic matter on methane sorption capacity of the studied samples. Lack of correlation between clay content with CO_2-micropore volume and methane-V_L plot suggests that clay minerals of the studied shale samples lack microporosity compared to organic matter and these clay minerals do not affect the methane sorption capacity. Damodar-valley samples exhibit an increasing trend of V_L and CO_2-micropore volume with increasing thermal maturity. This phenomenon indicates generation of more micropores leading to higher sorption capacity with increasing thermal maturity. Assam samples exhibit no such behavior. Also, different kerogen types show no effect on microporosity and methane sorption capacity of the studied shales.

This study depicts that organic matter, unlike clay minerals contribute to the microporosity in case of the studied samples. Microporosity leads to large internal surface areas and higher adsorption energies ultimately causing higher gas storage capacity in the organic matter rich Indian shale.