P07

Geochemical Studies of Black Shales for Shale Gas Prospects of the Semri Group, Vindhyan Basin, Exposed around Maihar Area

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SUMMARY

The Proterozoic basins from different parts of the world viz. Lena Tunguska, Siberia; Amadeus and McArthur basins, Australia; Sichuan and Tarim basins, China and Huqf basin, Oman etc. have reported commercial production of oil and gas. The Vindhyan basin of India has all the favorable geological conditions which were conducive for generation and accumulation of Hydrocarbon within the basin. It is one of the several “Purana” (ancient) sedimentary basins of the Indian. It is a sickle-shaped basin, outcropping between the Archaean Aravalli-Bundelkhand province to the north and east and the Cretaceous Deccan Traps to the south and by the Great Boundary Fault to the west.

The TOC is varies from 0.1% to 4% in the study area. The black shales unit of the Rohtasgarh Limestone has higher TOC. The HI values are ranging, 0 to 51 mg HC/g TOC. A Tmax higher than 470° C represents the wet-gas zone to over maturation of organic matter. The HI vs. Tmax values show Type I and Type II (gas prone) kerogen field. Also, Oxygen Index (OI) vs. Hydrogen Index (HI) diagram indicates type II kerogen. The light gaseous hydrocarbon compositions are showing higher concentration of C1, C2 and C3 gases in the shales.

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The lithological successions in the basin are un-metamorphosed, tectonically less disturbed. It is one of the best-preserved sedimentary succession which spreads over a large area extending in central Indian states of Bihar, Uttar Pradesh, Madhya Pradesh and Rajasthan, occupying an area of 2, 00,000 sq. km. Out of this 80,000 sq. km. is covered by the Decan Trap and possibly 10,000 sq. km. lies hidden under the Gangetic alluvium. It is drained by the two major rivers, the Son and the Chambal. After these two rivers, the entire succession of the Vindhyan Supergroup is divided into the Son Valley and the Chambal Valley successions. The sedimentary succession is collectively known as the Vindhyan Supergroup (VSG).

In present paper we report results obtained on the black shale samples collected from the different localities and geological formations of the Semri Group. The objective of work is to analyze the samples for gas prospects and Hydrocarbon maturation level of these shales. These samples are analyzed for total organic carbon content (TOC), rock eval pyrolysis and gases contents within the shale.

The TOC varies from 0.1% to 4% in the study area. The black shales unit of the Rohtasgarh Limestone has higher TOC comparatively. The hydrogen index values are generally low ranging, 0 to 51 mg HC/g TOC. A Tmax higher than 470° C represents the wet-gas zone to over maturation of organic matter. The HI vs. T_{max} values show Type I and Type II (gas prone) kerogen field. Also, Oxygen Index (OI) vs. Hydrogen Index (HI) diagram indicates type II kerogen. The light gaseous hydrocarbon compositions are showing higher concentration of C1, C2 and C3 gases in the shales.

The associated light gaseous hydrocarbon in black shale have C1/C2+C3 ratios <100, $\delta^{13}\text{C}_1$ heavier than -60 ‰, and decreasing trend in concentration from methane to pentane i.e. C1>C2>C3>C4>C5 showing characteristic of thermogenic origin of hydrocarbons. Almost 95% of samples are showing C3/C1×1000 ratio between 2 and 20, which are lying in the dry gas zone. The combination of Wetness (Wh) ratio, Balance ratio (Bh) and Character ratio (Ch) are suggesting the gaseous hydrocarbons are light density (dry gas) hydrocarbons, associated with oil.