GEOCHEMICAL AND PORE STRUCTURE CHARACTERIZATION OF DELTAIC SHALE AND COAL FROM MAMU FORMATION, ANAMBRA BASIN, NIGERIA

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Abstract

Marine shale has received considerable attention as the primary target for unconventional hydrocarbon exploration. In contrast, fundamental data on the reservoir quality of deltaic shale within the context of organic geochemical and pore structure characterization remain scarce. In the present study, organic geochemical and pore characteristics of shale and sub-bituminous coal from shallow wells of 51 m deep in the Lower Maastrichtian Mamu Formation, Anambra Basin, Nigeria, were assessed using Rock-Eval analysis, mineralogy, N_2 and CO_2 adsorption and scanning electron microscopy (SEM) analyses.

The results from the Rock-Eval analysis, elemental composition and carbon isotope of the kerogen, classify the organic matter as mixed Type II/III and III. The TOC contents show a considerable variation ranging from 1.30 - 58.28% with an average value of 18.24%. The hydrogen index values range from 174 - 235 mg HC/ g TOC. Within the interval studied, the samples are thermally immature with Tmax values in the range of 417 – 422 ^{o}C (average of 419 ^{o}C). The bulk mineralogy of the samples is dominated by kaolinite and quartz, constituting 52.1% and 41.6%, respectively. Quartz contents positively correlated with the organic-rich samples (Fig. 1a), indicating at least a partial biogenic origin. The nanopores observed from the FE-SEM indicate the presence of primary organic matter pores and mineral matrix pores including intraparticle and interparticle pores (Figs. 1b-d). Several small primary organic matter pores are noted in the sub-bituminous coal samples (Fig. 1c). The mean total pore volume and specific surface area in the samples are 0.042 cm^3/g and 22.43 m^2/g, respectively. The specific surface area is dominated by micropore with coal having the most significant percentage (94.7%). The pore volume is dominated by mesopore. Shale mesopore and macropore volumes are the largest. Pore-related variances among the shales are strongly controlled by the mineral composition (Figs. 1e-h).

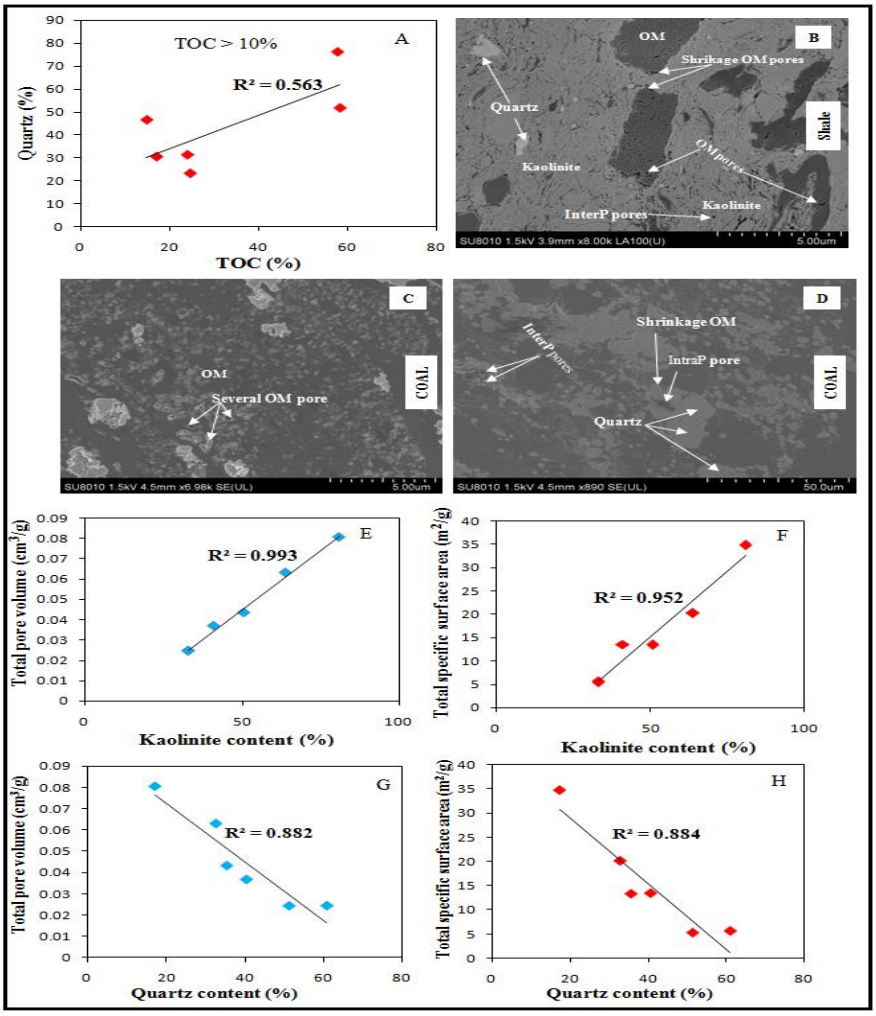

Figure 1: *Plot between quartz content and TOC (a); SEM images of different pore types in the Mamu Formation (b-d); Relationship between kaolinite content and total pore volume (e);and total specific surface area (f); Relationship between Quartz content and Total pore volume (g); and total specific surface area (h).*

This study shows that at appropriate thermal maturity, the shale and sub-bituminous coal samples would generate both oil and gas. Pore network in the shale samples is typically associated with micropore and mesopore emanating from primary organic matter and mineral pores. The balanced amounts of the clay and quartz minerals are of a great benefit for shale gas exploration and development in the Formation. More studies are required from more matured sections to better understand the pore structural evolution of the shale with more possible controlling factors.

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