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Formational History of Kaolinitic Clay Deposits in Lower Benue Trough, Nigeria with Reference to Rare Earth Elements and Stable Isotope Geochemistry

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Abstract : The Cretaceous kaolinitic clay deposits of Ajali/Mamu and Enugu/Nkporo Formations from the Lower Benue Trough (LBT) of Nigeria were analyzed for their rare-earth elements and hydrogen and oxygen isotopic compositions to determine the formational history such as alteration type, origin, temperature of formation, fractionation factor as well as the precursor for the LBT clay deposits. The investigated samples are characterized by a negative Eu-anomalies, the chondrite-normalized La/Yb and Gd/Yb ratios varied in the Mamu/Ajali and Enugu Formations from 9.51 to 30.10 and 1.20 to 2.18 and 9.05 to 20.99 and 1.38 to 2.18 respectively, and LREE enriched with an almost flat HREE patterns. The δD value ranged from -66.1 to -50.80‰ for the clay samples of Mamu/Ajali Formation but -66.4 to -57.8‰ was obtained for the Enugu/Nkporo Formation The δO18 values varied between 15.8 and 21.2‰ in the clay samples of Mamu/Ajali Formation as against 15.4 to 16.7‰ in the Enugu/Nkporo samples with temperature of formation between 54 – 91°C for the two formations, suggesting that the clay samples are residual materials derived from chemical weathering (supergene origin) of felsic rock and have been deposited in a sedimentary basin (δO18 =+19 to +21.2‰), where the sediments have longer interaction with meteoric water enriched in δD and δ18O. The data also support equilibration of kaolinite with meteoric waters at surficial temperatures, evident from the values of ~1 obtained for all samples.The geochemical parameter (R~0.2) that approaches zero which proved an intensive weathering associated with the breakdown of feldspar and deposition to form kaolinite and the relationship between the concentration of LREE and Y in the clay samples revealed that they were significantly enriched during the weathering and kaolinization processes. Based on the rare earth elements and δD and δ18O values, the kaolinitic clay deposits of LBT are residual material of supergene origin derivative of felsic rock and were deposited in a sedimentary basin at a temperature < 100°C.

Keywords : LBT, kaolinitic clay, supergene, fractionation factors, origin
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