Paleoenvironments, source rock potential and thermal maturity of the Upper Benue rift basins, Nigeria: implications for hydrocarbon exploration

SAMUEL O. AKANDE[1]*, OLUSOLA J. OJO[1], BERND D. ERDTMANN[2] and MAGDOLNA HETENYI[3]

[1]Department of Geology, University of Ilorin, P.M.B. 1515, Ilorin, Nigeria, [2]Institut für Geologie und Paläontologie, Technische Universität, Berlin, Germany and [3]Institute of Mineralogy, Geochemistry and Petrography, Attila Jozsef University, 6701 Szeged, Hungary

Abstract—The Upper Benue rift comprising the Gongola and Yola Basins in Nigeria consist of the Aptian–Albian Bima Formation, the Yolde Formation (Cenomanian–Turonian), Gongila/Pindiga/Dukul Formation (Turonian–Coniacian) and Gombe Formation (Campanian–Maastrichtian). To evaluate the maturity and source rocks potential, vitrinite reflectance, Rock-Eval pyrolysis and infrared spectroscopy were carried out on 52 shale samples collected from boreholes, mine quarries and outcrop sections. In the Gongola Basin, mean random vitrinite reflectance (R_{om}) values range from 0.45% in the Gombe Formation to 0.69% in the Pindiga Formation and to 0.82% in the Bima Formation. Reflectance values in the Yola Basin also increase with stratigraphic age ranging from 0.73% in the Dukul Formation to 0.94% in the Yolde Formation and up to 1.37% in the Bima Formation. Total organic carbon (TOC) values in the Pindiga and Gongila Shales are between 0.4 to 2.4% averaging 0.75%. TOC contents from 0.10 to 12.9 averaging 1.2% are contained in the Yolde Formation of the Yola Basin. T_{max} values from the pyrolysis of shales in the Gongola Basin range from 419 to 435°C whereas for shales in the Yola Basin they range from 431 to 442°C. Plots of HI vs T_{max} for kerogen classification indicate the prevalence of Type III kerogens in the Gongila and Pindiga Shales although there are some indications of Type II–III kerogens in the Yolde Shales of the Yola Basin. Our preliminary data suggest that Cretaceous successions in the Gongola Basin are thermally immature to marginally mature whereas source rocks in the Yola Basin are thermally mature with respect to hydrocarbon generation. The predominance of Type III kerogens in the Gongola Basin suggest their potential to generate gas in the deeply buried sections. The Dukul and Yolde formations with Type II–III kerogens may have generated some quantities of oil and gas in the deeper non-emergent sections.