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The petroleum geochemistry of the Termit Basin, Eastern Niger

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ABSTRACT

Sixty crude oils from the Termit Basin (Eastern Niger) were analysed using biomarker distributions and bulk stable carbon isotopic compositions. Comprehensive oil-to-oil correlation indicates that there are two distinct families in the Termit Basin. The majority of the oils are geochemically similar and characterized by low Pr/Ph (pristane to phytane ratios) and high gammacerane/C_{30} hopane ratios, small amounts of C_{24} tetracyclic terpanes but abundant C_{23} tricyclic terpane, and lower $\delta^{13}C$ values for saturated and aromatic hydrocarbon fractions. All of these geochemical characteristics indicate possible marine sources with saline and reducing depositional environments. In contrast, oils from well DD-1 have different geochemical features. They are characterized by relatively higher Pr/Ph and lower gammacerane/C_{30} hopane ratios, higher amounts of C_{24} tetracyclic terpane but a low content of C_{23} tricyclic terpane, and relatively higher $\delta^{13}C$ values for saturated and aromatic hydrocarbon fractions. These geochemical signatures indicate possible lacustrine sources deposited under freshwater, suboxic-oxic conditions. This oil family also has a unique biomarker signature in that there are large amounts of C_{30} 4α-methylsteranes indicating a freshwater lacustrine depositional environment.

The maturity of the Termit oils is assessed using a number of maturity indicators based on biomarkers, alkyl naphthalenes, alkyl phenanthrenes and alkyl dibenzothiophenes. All parameters indicate that all of the oils are generated by source rocks within the main phase of the oil generation stage with equivalent vitrinite reflectance of 0.58%–0.87%.

1. Introduction

The Termit Basin is one of the largest Cretaceous–Tertiary rift basins in the West and Central Africa rift system (WCARS). It connects with Tefidet Basin and Tenere Basin to the north and adjoins Bornu Basin at the northern end of Benoue fault zone in the south (Fig. 1). The Termit Basin is an extensional asymmetric rift, 300 km long and 60–110 km wide (Liu et al., 2012). It contains estimated maximum sediment thickness of around 12,000 m (Fig. 2) (Liu et al., 2012). These sediments comprises of 300–2500 m of Lower Cretaceous terrigenous clastics, 800–4200 m of Upper Cretaceous shallow marine shales, sandstones, siltstones interbedded with minor carbonates and up to 350–2500 m Cenozoic continental sands, and shaly sediments (Fig. 2).

The exploration for rift-basin petroleum in this region was pioneered by Conoco in Chad in 1969. Conoco discovered the first oil in the Chad part of the Termit basin near Lake Chad in 1974 (Genik, 1993). Eocene and Upper Cretaceous sandstones are the main reservoir intervals in the Termit Basin. The oil discoveries from the Termit Basin mainly occur in the Eocene reservoirs. The hydrocarbons are mainly sourced from and sealed by Upper Cretaceous and Eocene marine and lacustrine shales (e.g. Genik, 1993; Harouna and Philp, 2012). The most common structural styles and hydrocarbon traps are typically associated with normal fault blocks.

Genik (1993) classified two main oil families in WCARS: one type is derived from marine-paralic source, and the second from lacustrine sources. The differences in geochemical signatures were also preliminarily discussed, as for example, the biomarker *m/z* 191 triterpanes in lacustrine shale extracts from the Termit basin indicates absence of tricyclics and low amounts of homohopanes, whereas Termit basin marine shale extracts have a homologues series of tricyclics/tetracyclics, gammacerane, and higher concentrations of homohopanes (Genik, 1993). The overall geochemical characteristics of potential source rocks in the Termit Basin have been reported by Harouna and Philp (2012). However, the detailed molecular geochemical characteristics for Termit oils have not yet been systematically studied.

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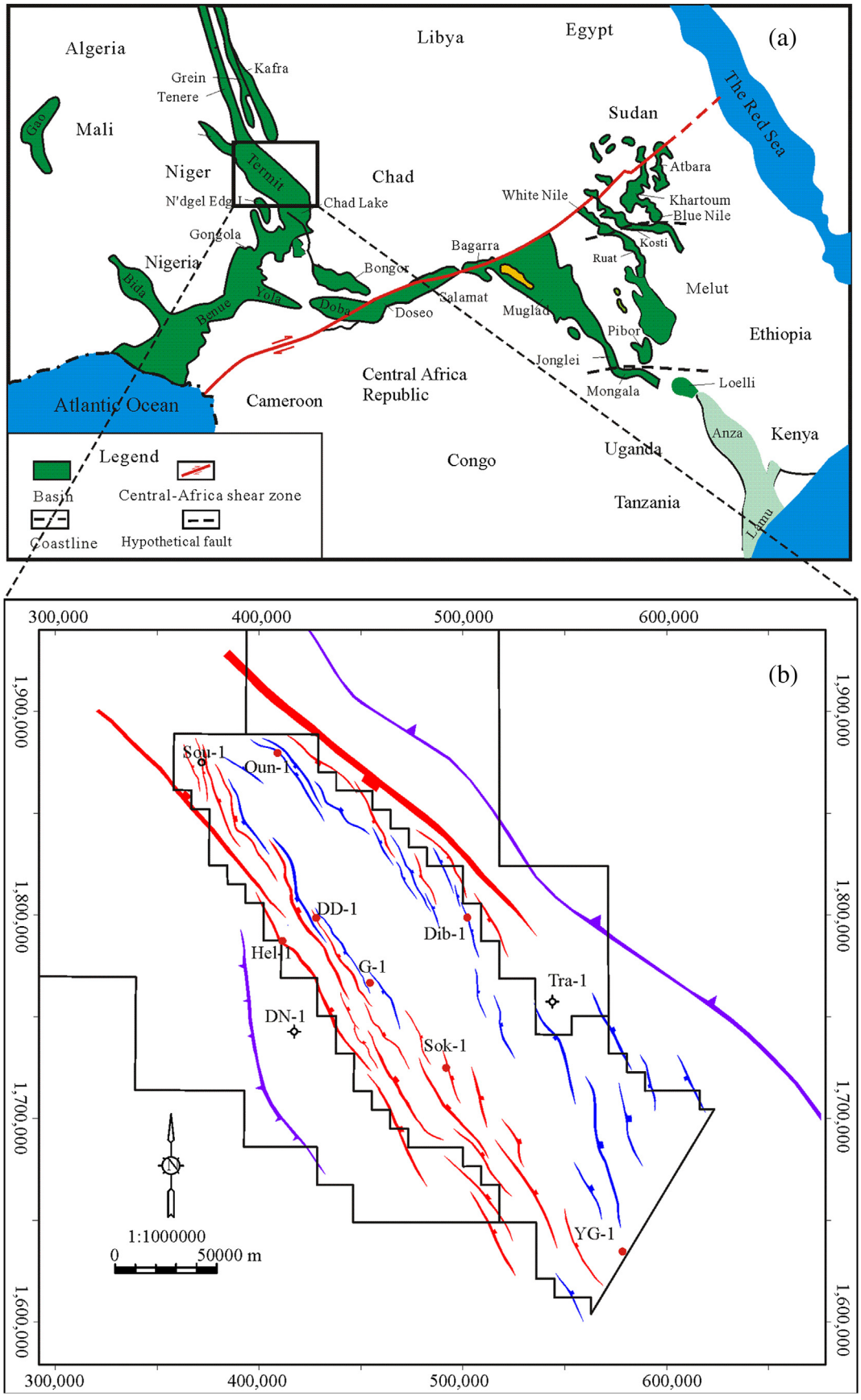

Figure 1. Generalized geological map showing (a) the location, and (b) outline sedimentary basin architecture schematic structures of the Termit Basin, Niger (After Genik, 1993).