Th SP2 04

Molecular Composition of Abu Gabra Organic-rich Sediments in the Fula Sub-basin, Muglad Basin (Sudan)

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SUMMARY

The Abu Gabra sediments possess a very good oil-generative potential as suggested by high amounts of organic matter with high TOC values in the range of 1.3 to 8.3 % that is dominated by Type I and Type II oil-prone kerogens. This is indicated by a significant presence of alginite and amorphous organic matter and supported by HI values in the range of 287-865 mg HC/ g TOC. Vitrinite reflectance (0.60-0.72%Ro) and Tmax values (430–438oC), and biomarker thermal maturity parameters indicate that the Abu Gabra sediments have entered an early mature of oil window. The predominance of even-over-odd (n-C14 to n-C20) with significant presence of waxy n-alkanes (+n-C23) and with isoprenoids Pr/Ph ratios in the range of 1.17-2.51, indicating that these sediments were deposited in a suboxic, lacustrine environment that received both algal/bacterial and terrigenous organic matter input.

Introduction

The Muglad Basin located within southern Sudan and the Republic South Sudan, and it covers an area of about 120,000 km² across the two countries (Lirong et al. 2013). The basin is an important hydrocarbon province, but the origin of the hydrocarbons has not yet been fully understood. The Muglad Basin contains sediments of Cretaceous and Tertiary age (Fig. 1). The Lower Cretaceous (Albian-Aptian) Abu Gabra Formation is well exposed in the Muglad Basin (Schull, 1988). It consists of claystone and shale with rich sandstones. The organic-rich claystone and shale sediments of Lower Cretaceous Abu Gabra Formation are considered an important regional source rock in the Muglad Basin, Sudan. A total of 20 cutting samples from these organic-rich sediments were collected from wells drilled at oilfields in the Fula sub-basin, Muglad Basin in order to geochemically assess the type of organic matter, thermal maturity and palaeoenvironmental conditions.

Figure 2 Regional stratigraphy of the Muglad Basin, southern Sudan (after Schull, 1988; McHargue et al., 1992; Lirong et al., 2013).

Methodology

A total of 20 cutting samples from three wells in the Great Moga oilfield, Muglad Basin were selected for different petrological and geochemical studies. The samples were collected from shale and claystone intervals within the Abu Gabra Formation (Fig. 1). The petrological analyses that is carried

out in this study include, vitrinite reflectance measurements and kerogen microscopy, whilst geochemical analyses includes Source Rock Analyzer (equivalent to Rock-Eval equipment), TOC (Total Organic Carbon), (total sulphur) TS contents, bitumen extraction, gas chromatography–mass spectrometry (GC–MS), and Spectrometry (GC-MS/MS).

Results and Discussion

Results reveal that Abu Gabra sediments contain high organic matter content of more than 2.0 wt% TOC and have a very good to excellent hydrocarbon potential. This is supported by high bitumen extractions and hydrocarbon (HCs) yields with values exceeding 5,000 and 3,000 ppm, respectively.

The investigated biomarkers of the Lower Cretaceous Abu Gabra extracts are characterized by a dominance of low to medium molecular weight *n*-alkane compounds with the presence of abundant waxy alkanes ($n\text{-C}_{25}\text{--}n\text{-C}_{34}$), moderately high Pr/Ph ratio (1.17–2.51), high abundance of C_{27} regular sterane, high $\text{C}_{27}/\text{C}_{29}$ regular steranes, and the presence of tricyclic terpanes as well as relatively low biomarker sterane/hopane ratios. These data indicate that the Abu Gabra sediments contain a mixture of fresh water (algal and bacterial) and terrigenous organic matter that were deposited in a lacustrine environment and preserved under suboxic conditions. The high tetracyclic polyphenols (TPP) ratio (i.e. TPP ratio >0.40) is also consistent with a lacustrine setting.

With regard to maturity, the samples under current investigation are thermally mature for hydrocarbon generation as indicated by biomarker distribution. Biomarker thermal maturity indicators such as $22\text{S}/22\text{S}+22\text{R}$ C_{32} homohopane and $\beta\beta/(\beta\beta+\alpha\alpha)$ C_{29} sterane have reached equilibrium, with values range from 0.47 to 0.63 and 0.53–0.73, respectively, suggesting that the Abu Gabra organic-rich sediments are thermally mature and the oil window has been reached. This conclusion is supported by vitrinite reflectance values that range from 0.60 % to 0.72%Ro.

Conclusion

The Abu Gabra sediments possess a very good oil-generative potential as suggested by high amounts of organic matter with high TOC values in the range of 1.3 to 8.3 % that is dominated by Type I and Type II oil-prone kerogens. This is indicated by a significant presence of alginite and amorphous organic matter and supported by HI values in the range of 287–865 mg HC/ g TOC. Vitrinite reflectance (0.60–0.72%Ro) and Tmax values (430–438°C), and biomarker thermal maturity parameters indicate that the Abu Gabra sediments have entered an early mature of oil window. The predominance of even-over-odd ($n\text{-C}_{14}$ to $n\text{-C}_{20}$) with significant presence of waxy *n*-alkanes ($+n\text{-C}_{23}$) and with isoprenoids Pr/Ph ratios in the range of 1.17–2.51, indicating that these sediments were deposited in a suboxic, lacustrine environment that received both algal/bacterial and terrigenous organic matter input.

Acknowledgements

The authors thank the Ministry of Petroleum, Sudan for supplying the samples for this study. The authors are most grateful to the Department of Geology for providing facilities to complete this study and to University Malaya for providing IPPP research grants (numbers PG140-2012B and RG145/11AFR).

References

- Lirong, D., Dingsheng, C., Zhi, L., Zhiwei, Z. and Jingchun, W. [2013] Petroleum geology of the Fula-Sub Basin, Muglad Basin, Sudan. *Journal of Petroleum Geology*, **36**, 43–60.
- McHargue, T.R., Heidrick, J.L. and Livingstone, J.E. [1992] Tectonostratigraphic development of the interior Sudan rifts, Central Africa. *Tectonophysics*, **213**, 187–202.
- Schull, T.J. [1988] Rift basins of interior Sudan: Petroleum exploration and discovery. *American Association of Petroleum Geologists Bulletin*, **72**, 1128–1142.