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Full Length Article

Bulk geochemical characteristics and carbon isotope composition of oils from the Sayhut sub-basin in the Gulf of Aden with emphasis on organic matter input, age and maturity [☆]

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ARTICLE INFO

Article history:

Received 21 February 2017

Revised 14 May 2017

Accepted 13 June 2017

Available online xxxxx

Keywords:

Crude oil

Carbon isotope

Depositional environment

Source inputs

Gulf of Aden

Yemen

ABSTRACT

The Sayhut sub-basin is undergoing hydrocarbon exploration province in the Gulf of Aden, South Yemen. In this study, geochemical analyses were performed on three oil samples from two exploration wells in the Sayhut sub-basin. The results were used to describe the source organic matter input, age and maturity and to correlate between crude oils from different pay zones.

The high saturated hydrocarbon values of more than 70% indicate that the analysed oils are normal crude oils and not degraded oils. This is supported by a complete suite of their normal alkanes and acyclic isoprenoids. The hydrocarbon distributions of normal alkane and isoprenoid with bulk carbon isotope data also suggest that the analysed oils are grouped into two genetic families and were generated from marine-source rock. The family A presents by one oil sample representing Harshiyat reservoir rock and characterized by relatively high Ph/Ph ratio > 2 and $\delta^{13}\text{C}$ values of their saturated and aromatic hydrocarbon fractions range from -26.1‰ to -24.8‰ . This oil family was derived from mixed organic matter with high contribution of a terrigenous organic matter input. The family A was deposited under suboxic conditions during the Late Cretaceous age. The family B presents by two oil samples representing Ghaydah and Habshiyah reservoir rocks and characterized by relatively low Ph/Ph ratio < 2 and carbon isotope less than -23 for their saturated and aromatic hydrocarbon fractions. These oils were generated from source rock containing high contributions of marine organic matter (e.g., algal and microbial) with minor amount of land plant source inputs that was deposited in more reducing conditions. The family B oils are consistent with those of the Paleogene Umm Er Radhuma source rock.

The hydrocarbon distribution and oil composition data also indicate that the analysed oils were generated from mature source rocks with a peak oil-window maturity.

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1. Introduction

The Gulf of Aden is hydrocarbon exploration frontier area, where minimal data are available for adequate research and hydrocarbon exploration. The area interest of this study is the Sayhut sub-basin, which occupies the coastal and shelf stretches in the eastern part of the Gulf of Aden (Fig. 1). The Sayhut sub-basin has seen increasing exploration interest and the significant hydrocarbon potential is still poorly understood. Exploration activities commenced in 1979 with 5 wells drilled along the Sayhut

sub-basin (Fig. 1B). The drilling results range from gas to heavy oils and oils in only two of the wells (Fig. 1B). The Sarar 1X and Sharmah 1X wells showed the presence of heavy oil in the upper part of the Ghaydah Formation and some oil in the Harshiyat to Habshiyah formations. The analysed oil samples in this study were collected from the Sarar 1X and Sharmah 1X wells (Table 1).

The Sayhut sub-basin has attracted the interest of several researchers and limited publications are presently available on the source rock characteristics and their relation to depositional environment conditions and hydrocarbon potential [1,2].

The Tertiary sedimentary rocks in the Sayhut sub-basin contain several potential source rocks, ranging from the Paleogene to Neogene time [2]. These source rocks include the Paleogene Umm Er Radhuma and Ghaydah and Neogene Sarar formations [2].

Peer review under responsibility of Egyptian Petroleum Research Institute.

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<http://dx.doi.org/10.1016/j.ejpe.2017.06.002>

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Please cite this article in press as: M.H. Hakimi et al., Bulk geochemical characteristics and carbon isotope composition of oils from the Sayhut sub-basin in the Gulf of Aden with emphasis on organic matter input, age and maturity, Egypt. J. Petrol. (2017), <http://dx.doi.org/10.1016/j.ejpe.2017.06.002>

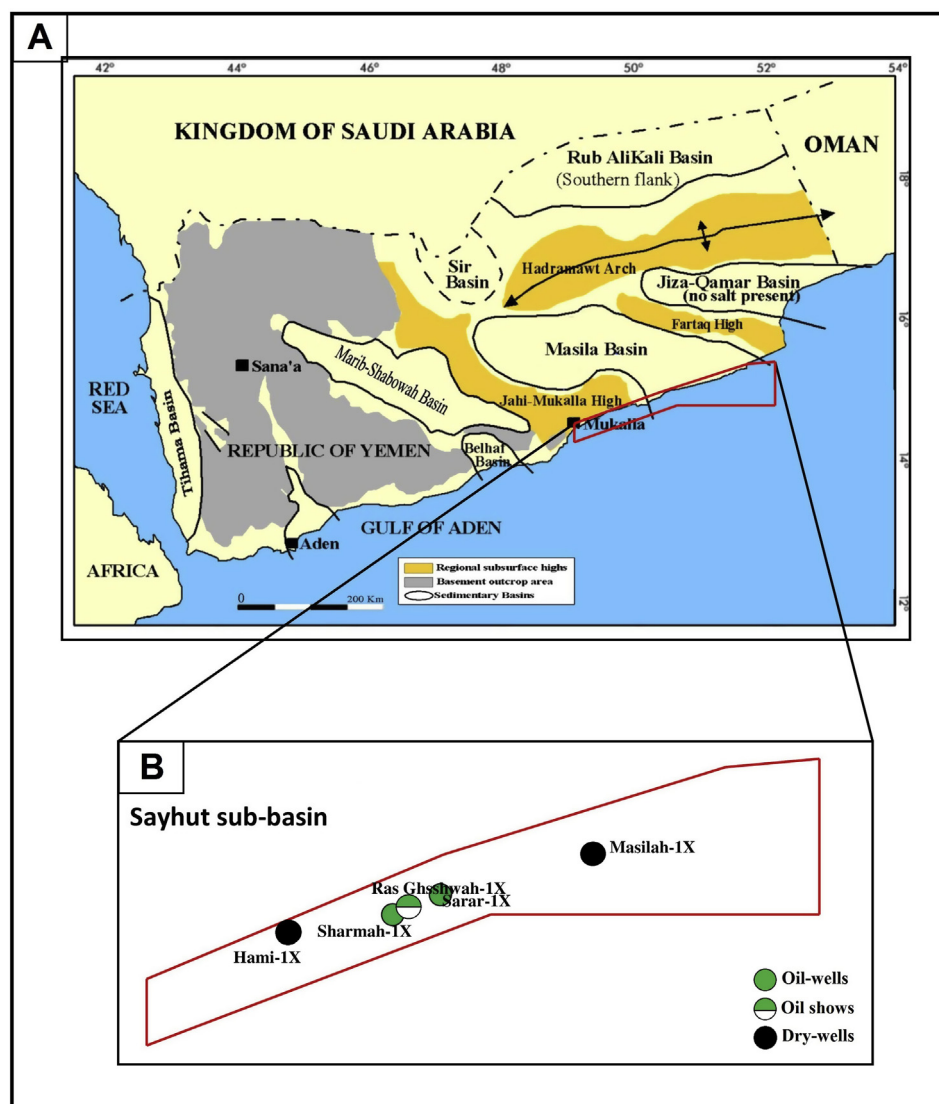


Fig. 1. (A) Location map of sedimentary basins of Yemen, showing Sayhut sub-basin in the Gulf of Aden (B) (After Hakimi and Ahmed, [2]).

Table 1
Bulk property and chemical composition results of the crude oils from two exploration wells (i.e., Sarar 1X and Sharmah 1X) in the Sayhut sub-basin, Gulf of Aden, illustrating source organic matter, depositional environment conditions and thermal maturity.

Sub-basin	Wells	Depth (m)	Reservoir/age	Fractions (wt%)			n-alkane and isoprenoids				Bulk carbon isotope compositions (‰)			Oil family
				Sat.	Aro.	NSO	Pr/Ph	Pr/C ₁₇	Ph/C ₁₈	CPI	Saturated	Aromatic	Average	
Sayhut sub-basin	Sarar 1X	2194.5–2198.5	Harshiyat/Late Cretaceous	57.7	18.5	23.8	2.27	0.45	0.21	0.94	–26.1	–23.4	–24.8	Family A
	Sharmah 1X	2152–2165	Ghaydah/Oligocene	76.5	14.2	9.2	1.66	0.32	0.23	0.99	–22.6	–21.1	–21.9	Family B
		2225–2244	Habshiyah/Eocene	66.8	10.9	22.4	1.49	0.28	0.23	0.96	–22.5	–20.7	–21.6	B

Sat.–Saturated hydrocarbons.

Aro.–Aromatic hydrocarbons.

NSO–Resin.

Pr–Pristane.

Ph–Phytane.

CPI–Carbon preference index (1): $\{2(C_{23} + C_{25} + C_{27} + C_{29}) / (C_{22} + 2[C_{24} + C_{26} + C_{28}] + C_{30})\}$.

The Paleogene Ghaydah and Umm Er Radhuma source rocks are relatively higher in genetic petroleum potential than Neogene Sarar source rock, which are the most promising oil-source rocks [2].

The present study focuses on the organic geochemical on the several oil samples from the Sayhut sub-basin in the Gulf of Aden, so as to provide an overview on the organic matter input,

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