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Geochemical characteristics and origin of the crude oils and condensates from Yakela Faulted-Uplift, Tarim Basin

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ABSTRACT

Yakela Fault-Uplift is one of the most petroliferous belts of Tarim Basin in China. In this regard, the geochemistry and origin of the representative oils from different fields on the belt were investigated and compared with hydrocarbons from adjacent Kuqa Foreland Depression and Tahe Oilfield using GC, GC–MS and stable carbon isotope techniques. Three oil groups can be distinguished in terms of their molecular and stable carbon isotope composition. The oils from Yakela and Donghetang fields (group A) share similar molecular compositions and $\delta^{13}C$ values with Tahe oils. They are characterized by high concentrations of nC_7 and branched alkanes, resulting in elevated heptane values and nC_7/MCC_6 ratios. Mango's light hydrocarbon parameter K_2 values are low, as are Pr/Ph, $(C_{19}+C_{20}+C_{21})/(C_{23}+C_{24})$ tricyclic terpanes and C_{24} tetracyclic/C_{23} tricyclic terpane ratios. High abundances of tricyclic terpanes, fluorine and methylated dibenzothiophenes are present, also relatively negative $\delta^{13}C$ values. The geochemical characteristics indicate that they originated from marine source rocks in cratonic area. The condensates from Dalaoba (group B_1) and Luntai fields (group B_2) show most similarity with Kuqa oils in molecular compositions, distinctly different from group A. However, difference also apparently presents between Dalaoba and Luntai oils, the latter with more abundant C_{19}–C_{20} tricyclic terpanes and positive $\delta^{13}C$ values. The $\delta^{13}C$ composition indicates that Dalaoba oils originated from Mesozoic lacustrine shale source rocks in the Kuqa Depression, while Luntai oils are generated from Mesozoic coal. The results show that Yakela Faulted-Uplift separates the cratonic marine oil province from non-marine oil province in north.

1. Introduction

The Tarim Basin, NW China, is a Paleozoic cratonic basin, overlain in the south and north by Mesozoic–Cenozoic foreland depressions (i.e., Southwest and Kuqa Foreland Depression, Li et al., 1996). It is one of the most petroliferous basins of China, with economic accumulations of hydrocarbons derived from marine and non-marine source rocks (Li et al., 2005). Marine oil and gas pools are discovered mainly in the cratonic areas of the basin, with their source rocks thought to be Cambrian–Lower Ordovician marine shale or Middle–Upper Ordovician carbonate rocks (Xiao et al., 1996; Hanson et al., 2000; Zhang et al., 2000a). As the largest marine oil field of the basin, Tahe Oilfield is situated at the southern slope of the Ackule Uplift (Kang and Kang, 1996; Zhang, 1999, 2003; Zhou et al., 2001b) and lies adjacent to Yakela Faulted-Uplift on the south side. Most of the oil and gas accumulations derived from non-marine sources have been discovered in the Kuqa Foreland Depression in the northern Tarim Basin (Li et al., 2005). The source rocks for non-marine oil and gas are Mesozoic dark lacustrine shales and coals (Zhao et al., 1999; Zhao and Zhang, 2001; Qin et al., 2002).

Yakela Faulted-Uplift is a faulted block bounded by two thrust faults (Luntai and Yanan) in northern Tarim Basin, extending in a nearly E–W direction with and an area of 4400 km^2 (Fig. 1, Hu and Shen, 1990). It is the intermediate zone between the cratonic areas and Kuqa Foreland Depression, separated from Kuqa Depression by Yanan fault in the north and from Halahatang sag, Akekule uplift and Caohu sag by the Luntai fault in the south (Guo, 2005; Dai et al., 2009; Luo et al., 2012). There are no effective source rocks deposited on the Yakela Faulted-Uplift; however, the bidirectional injection of hydrocarbons from cratonic area and Kuqa Depression allows the accumulation of both marine and non-marine-sourced hydrocarbons (Geng et al., 2008; Lü et al., 2008; Luo et al., 2013). After the exploration breakthrough in well SC2 in 1984, a number of small and medium sized oil and gas fields have been discovered (Yu, 2008; An et al., 2009; Guo, 2005; Luo et al., 2012) and the majority of them are along main faults, i.e., Yanan,

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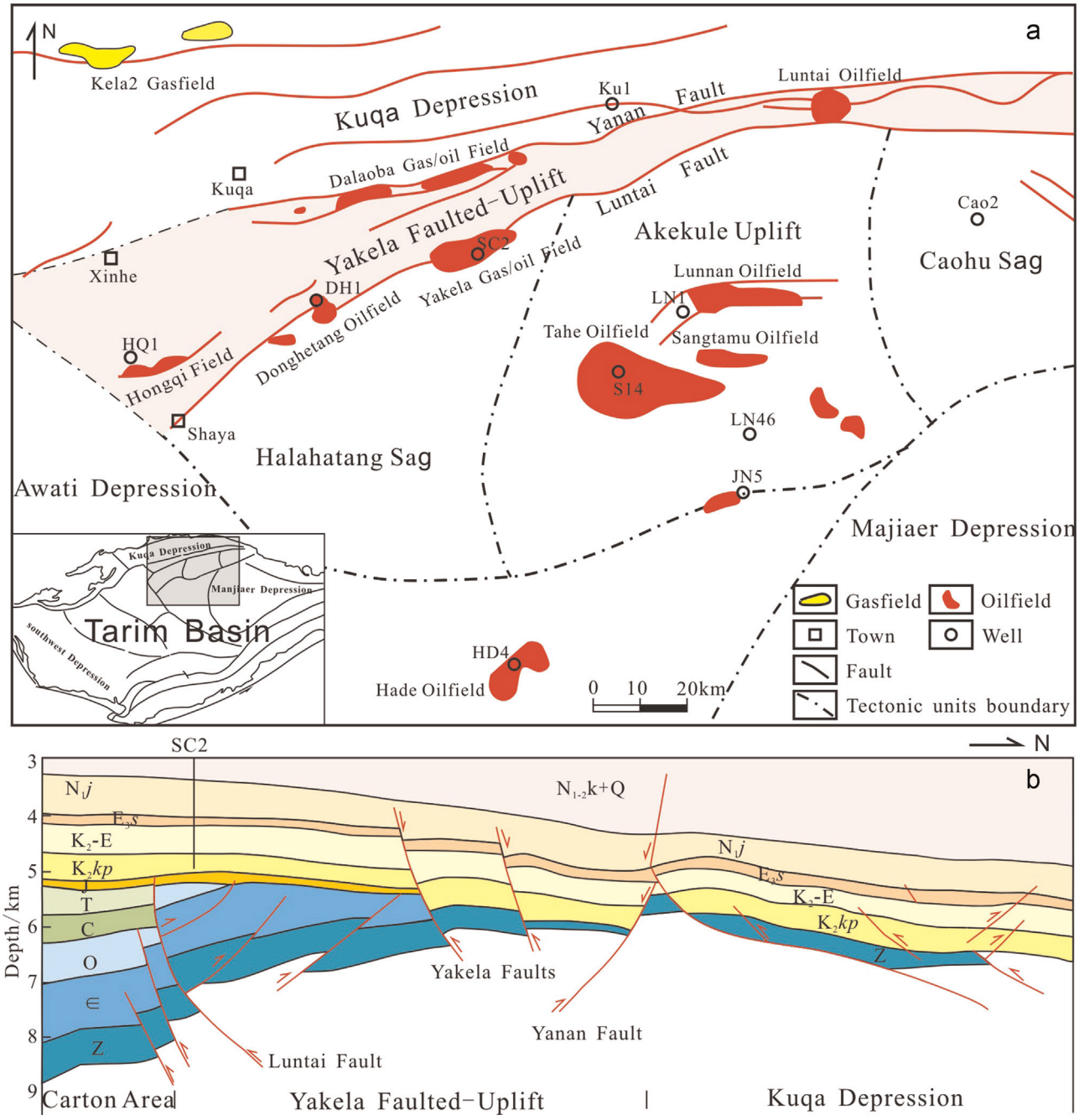

Fig. 1. (a) Tectonic units of the Tarim Basin and location of the Yakela Fauted-Uplift. (b) Schematic structural cross section of Yakela Fauted-Uplift.

Luntai and Yakela faults (Yang et al., 2000; Wei et al., 2001; Zhou et al., 2001a).

In this paper, the geochemical compositions and origin of the crude oils/condensates from the Yakela Faulted-Uplift were investigated by correlation with crude oils from adjacent Kuqa Foreland Depression and Tahe Oilfield.

2. Samples and methods

2.1. Samples

A total of 24 crude oils and condensates were collected from 4 fields in the Yakela Faulted-Uplift (9 condensates from Dalaoba gas/oil Field, 10 condensates and normal oils from Yakela gas/oil Field, 3 condensates from Luntai oilfield and 2 samples from Donghetang oilfield). In order to compare their geochemistry with that of typical marine and non-marine oils, 11 marine sourced oils from the Tahe oilfield and 5 non-marine oils from the Kuqa Foreland Depression were chosen for oil–oil correlation. The field/location and wells, where the samples were taken, are shown in Fig. 1a and Table 1.

2.2. Methods

The oils were deasphalted using *n*-hexane and then fractionated using column chromatography into saturate, aromatic and NSO fractions by sequential elution with *n*-hexane, toluene and chloroform.

Gas chromatography (GC) of the oils was performed using an