

# Oil charging pathways of the Ordovician deep carbonate reservoirs in the Tuofutai area, Tarim Basin, NW China

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## Introduction

The Tuofutai area is situated on the southwest slope of the Akekule High in the Tabei Uplift of the Tarim Basin, NW China. Oil and gas are mainly enriched in carbonate reservoirs of Yijianfang Formation in Ordovician to form typical deep reservoirs with buried depth over 6000m(19685.03ft), which experienced multi-stage hydrocarbon accumulation and secondary transformation under three main tectonic movements.

The study of deep hydrocarbon is more complex than that of shallow. At present, the tracing of deep hydrocarbon migration direction is mainly based on oil maturity (England et al., 1987). However, many geochemical parameters, such as C<sub>29</sub> sterane, lose indicative significance at the high maturity stage of crude oil. Combined with previous studies, it is found that 4-/1-MDBT, Ts/(Ts+Tm) and C<sub>29</sub>Ts/(C<sub>29</sub>Ts+C<sub>29</sub>H) are not only resistant to biodegradation but also not influenced by the maturity which have been successfully applied to the tracing of hydrocarbon migration direction of deep carbonate reservoirs in Tahe and Halahatang oilfields (Wang et al., 2004; Li et al., 2014). Therefore, this study is to trace the migration orientation and to predict the location of potential kitchens of deep hydrocarbon in Tuofutai area by using 4-/1-MDBT, Ts/(Ts+Tm) and C<sub>29</sub>Ts/(C<sub>29</sub>Ts+C<sub>29</sub>H) and the oil group component combined with geological background.

## Results

In this study, 31 oil samples were analyzed by group component separation. Saturated and aromatic fractions were further geochemically analyzed by gas chromatography spectrometry (GC) and gas chromatography-mass spectrometry (GC-MS) to trace migration direction of deep hydrocarbon.

Similar characteristics of saturated hydrocarbon chromatography, steroid terpenoid biomarkers and stable carbon isotopic composition show that oil of Tuofutai area belong to the same oil family. The oil component shows that there is a great difference between oil from the south and the north of Tuofutai area. The characteristics of low saturated hydrocarbons(40%~60%), high aromatics(20%~30%) and non-hydrocarbon and asphaltene(10%~30%) in northern reservoirs indicate that they have experienced strong oxidative degradation. The southern and central reservoirs have the characteristics of high saturated hydrocarbons(>60%), medium aromatics(10%~20%) and low non-hydrocarbon and asphaltene(<15%), which reflect that the maturity of oil increases gradually from south to north.

4-/1-MDBT, Ts/(Ts+Tm) and C<sub>29</sub>Ts/(C<sub>29</sub>Ts+C<sub>29</sub>H) also show that the maturity of crude oil in the south of Tuofutai area is obviously higher than that of the north (Fig. 1a). In addition, these values at the major fault are significantly lower than those on both sides(Fig. 1b). And 4-/1-MDBT, Ts/(Ts+Tm) and C<sub>29</sub>Ts/(C<sub>29</sub>Ts+C<sub>29</sub>H) decrease gradually along the NE trending major fault but some wells, such as well 1 and 2, are abnormally high (Fig. 1b). Therefore, the NE trending major fault is the main channel of late hydrocarbon charging but is characterized with segmentation combined with the geological background. Oil and gas migrate northward

along the NE trending major fault and then adjust laterally along the NW trending faults. It is further inferred that the source kitchen of Tuofutai area is located in the west Manjiaer region in the south of Tuofutai area.

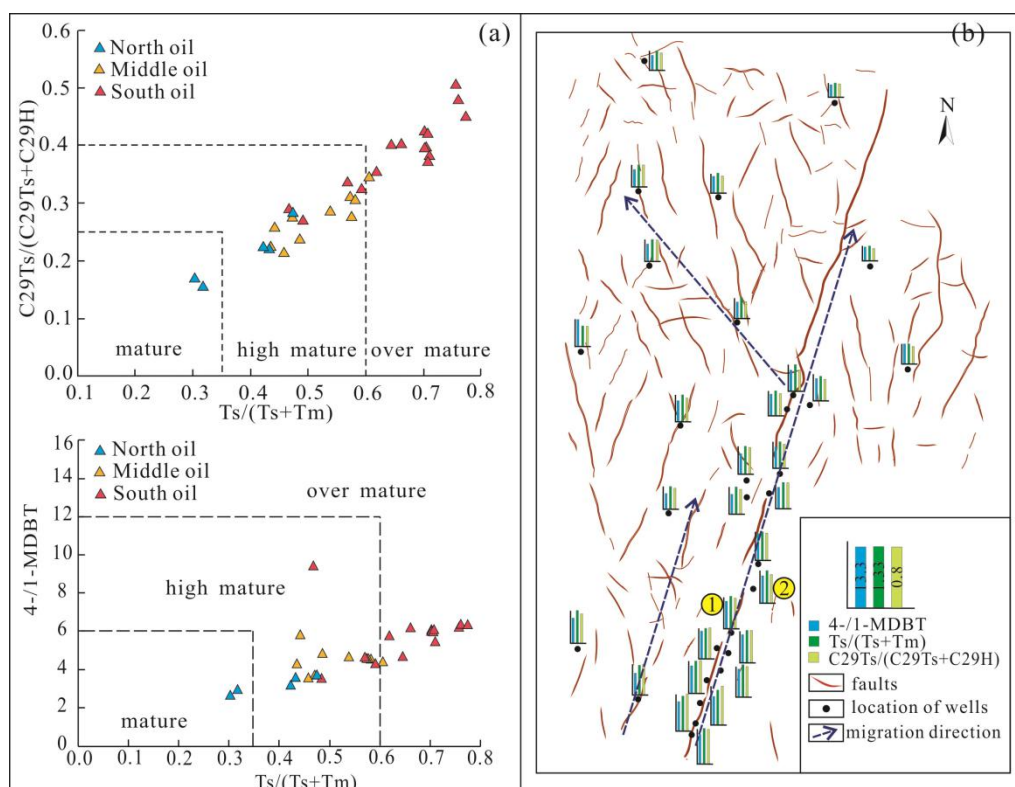


Figure 1: (a)  $4-/1-MDBT$ ,  $Ts/(Ts+Tm)$  and  $C_{29}Ts/(C_{29}Ts+C_{29}H)$  cross-plots in the Tuofutai area. (b) The horizontal distribution of  $4-/1-MDBT$ ,  $Ts/(Ts+Tm)$  and  $C_{29}Ts/(C_{29}Ts+C_{29}H)$  in the Tuofutai area.

## Conclusions

Oil from Tuofutai area belong to the same oil family. The maturity of crude oil in Tuofutai area is gradually reduced from the south to the north. The NE trending major fault is the main channel of late hydrocarbon charging but is characterized with segmentation. Oil and gas migrate from south to north along the NE trending major fault firstly and then adjust laterally along NW trending faults. According to the hydrocarbon migration orientation, it is inferred that the source kitchen is located in the west Manjiaer region in the south of Tuofutai area.

## REFERENCES

- England, W, Mackenzie, A.S, Mann, D.M, et al. The movement and entrapment of petroleum fluids in the subsurface[J]. Geological Society, 1987, 144(2):327-347.
- Wang TG, He FQ, Li MJ, et al. Alkyldibenzothiophenes: molecular tracers for filling pathway in oil reservoirs[J]. Chinese Science Bulletin, 2004, 49(22):2399-2404.
- Li MJ, Wang TG, Shi SB, et al. Benzo[b]naphthothiophenes and alkyldibenzothiophenes: molecular tracers for oil migration distances[J]. Marine and Petroleum Geology, 2014, 57:403-417.