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Geochemical studies of the Silurian oil reservoir in the Well Shun-9 prospect area, Tarim Basin, NW China

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Abstract: Commercial oil flow has been obtained from the sandstone reservoir of the Lower Silurian Kelpintag Formation in the Well Shun-9 prospect area. In the present studies, 10 Silurian oil and oil sand samples from six wells in the area were analyzed for their molecular and carbon isotopic compositions, oil alteration (biodegradation), oil−source rock correlation and oil reservoir filling direction. All the Silurian oils and oil sands are characterized by low Pr/Ph and C_{21}/C_{23} tricyclic terpane (<1.0) ratios, "V"-pattern C_{27}-C_{29} steranes distribution, low C_{28}-sterane and triaromatic dinosterane abundances and light $\delta^{13}C$ values, which can be correlated well with the carbonate source rock of the O_3l Lianglitage Formation. Different oil biodegradation levels have also been confirmed for the different oils/oil sands intervals. With the S_1k^2 seal, oils and oil sands from the S_1k^1 interval of the Kelpintag Formation have only suffered light biodegradation as confirmed by the presence of "UCM" and absence of 25-norhopanes, whereas the $S_1k^{3\text{-}1}$ oil sands were heavily biodegraded (proved by the presence of 25-norhopanes) due to the lack of the S_1k^2 seal, which suggests a significant role of the S_1k^2 seal in the protection of the Silurian oil reservoir. Based on the Ts/(Ts+Tm) and 4-/1-MDBT ratios as reservoir filling tracers, a general oil filling direction from NW to SE has been also estimated for the Silurian oil reservoir in the Well Shun-9 prospect area.

Key words: Silurian oil reservoir, Well Shun-9 prospect area, geochemistry, oil−source rock correlation, alteration, oil reservoir filing direction

1 Introduction

The Well Shun-9 prospect area is located at the south of the Shuntuoguole Low Uplift, Tarim Basin. After undergoing several years exploration and after sand fracturing operations, commercial oil flows have been obtained from the sandstone reservoirs of the Lower Silurian Kelpintag Formation at Wells Shun-9, -901, -902H in the area in the last two years.

Silurian sandstones are widely distributed in the Shuntuoguole Low Uplift and its adjacent regions. As early as 1994, Silurian commercial oil was discovered in Well TZ-11, in the Tazhong Uplift on the south of the Shuntuoguole Low Uplift (Zhai and Wang, 1999). Since then, the Silurian interval became one of the most important exploration targets (Zhang et al, 2004; Jia et al, 2006). As the first discovered Silurian oil reservoir in Shuntuoguole Low Uplift, studies on it are significant for oil exploration in the area.

In the present study, three oil and seven oil sand samples from the Silurian oil reservoir were collected from six exploration wells (sampling well location see Fig. 1) and analyzed in the laboratory for oil molecular and isotopic compositions. Alteration (biodegradation), oil−source rock correlation and oil filling orientation were deduced from the results.

2 Geological setting

The Shuntuoguole Low Uplift is in fact still a negative structure, being a relative uplift within a huge depression zone. The depression zone is composed of the Manjiaer and Awati Depressions as well as the Shuntuoguole Low Uplift in between. The Shuntuoguole Low Uplift is also located between the Tabei Uplift on the north and the Tazhong Uplift on the south (Fig. 1).

The Shuntuoguole Low Uplift occurred during early Paleozoic time and subsequently underwent multi-stage tectonic transformation. Compared with surrounding uplifts and depressions, however, the geological setting of the Shuntuoguole Low Uplift is more stable tectonically and more favorable for crude oil preservation (Xiong et al, 2013).

Regionally, the Lower-Middle Silurian strata are widespread and comprised of the S_1k Kelpintag, S_1t Tataertag and S_1y Yimugantawu Formations in the Shuntuoguole Low Uplift (Zhu et al, 2005; Jia et al, 2006; Fig. 2). As a principal reservoir interval, the S_1k Kelpintag Formation can be divided

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