EVIDENCES ON EFFECTIVE CARBONATE SOURCE ROCKS OF LOW ORGANIC MATTER ABUNDANCE IN THE PLATFORM OF TARIM BASIN, CHINA

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Introduction

Tarim Basin, located in Xinjiang, China, is the largest oil-bearing sedimentary basin of the country covering platform of about $40\times10^4 km^2$. The oil and gas are mainly distributed in the Lianglitage Formation and Yingshan Formation of Ordovician system. They are mainly from carbonatite source rocks of Cambrian and Ordovician. The burial depth of hydrocarbon source rocks within the area is 4,500-7,000m, the thermal evolution degree is higher (the average value of vitrinite reflectance Ro is 1.32%), and the organic matter abundance is low (the average value of TOC is 0.14%).

In the platform of Tarim Basin, only high-abundance hydrocarbon source rocks with TOC > 0.5% are considered in the resource evaluation, which are mainly carbonatite. However, the distribution range and scale of high-abundance hydrocarbon source rocks with TOC> 0.5% in the area are not enough to explain the scale of oil and gas discovered at present. The oil and gas resources evaluated by high abundance hydrocarbon source rocks with TOC> 0.5% are even less than the reserves discovered at present. By the end of 2011, the evaluation results in northern area of Tarim Basin show that the amount of oil and gas resources is $18.16\times10^8 t$, but now the reserves of the third grade are over $30\times10^8 t$. The great difference between the resource evaluation and the actual exploration reserves shows that the resource evaluation conducted with TOC > 0.5% as an effective hydrocarbon source rocks in the platform of Tarim Basin is facing great challenges, which indicates that the low organic matter abundance (TOC < 0.5%) source rocks may contribute to hydrocarbon accumulation.

Results

The characteristics of TOC change show that low organic matter abundance carbonatite source rocks have made hydrocarbon expulsion. Natural evolution profile, experimental thermal simulation (Qin et al, 2005) and numerical simulation computing (Zhong et al, 2004) all show that the TOC of carbonatite hydrocarbon source rocks decreases with thermal evolution or hydrocarbon generation and expulsion, and so it is with low-abundance hydrocarbon source rocks. Since the Tarim Basin is generally among carbonatite hydrocarbon source rocks with high-over matured and low-abundance organic matter, the TOC reduction means that hydrocarbon generation and expulsion has occurred and can be considered as effective hydrocarbon source rocks.

The characteristics of H/C and O/C changes indicate low organic matter abundance carbonatite source rocks are effective hydrocarbon source rocks. A significant reduction of the H/C and O/C atomic ratios of the kerogen also means that the hydrocarbon source rock has generated and expelled a certain amount of oil and gas and can be effective hydrocarbon source rock. We can find the relationship between H/C and O/C atomic ratios in low-abundance hydrocarbon source rocks in Tarim Basin. It can be seen that with the increase of maturity, H/C and O/C

atomic ratios go down, R_o=0.5%~2.5%, H/C decreases from 1.5 to 0.45, O/C from 0.22 to about 0.05, and the magnitude of the decrease is generally larger, more than 70%. According to the above analysis, this shows that the low-abundance hydrocarbon source rocks, which can be effective hydrocarbon source rocks, can generate a large amount of oil and gas, and can expel a certain amount of it.

The changing characteristics of hydrocarbon generation potential indicate that low organic matter abundance carbonatite source rocks are effective hydrocarbon source rocks. (S_1 + S_2)/TOC is the hydrocarbon generation potential index, reflecting the hydrocarbon generation potential per unit mass of organic carbon (Pang et al., 2004). The depth or R_o corresponding to the turning point of (S_1 + S_2)/TOC from big to small is the hydrocarbon expulsion threshold. The reduction of hydrocarbon generation potential after hydrocarbon expulsion threshold indicates the large high generation and discharge of oil and gas, meaning that early hydrocarbon generation rocks have been transformed into effective hydrocarbon source rocks.

The changing characteristics of residual hydrocarbon content indicate that low organic matter abundance carbonatite source rocks are effective hydrocarbon source rocks. The content of residual hydrocarbon increases with hydrocarbon generation content going bigger;after meeting the residual hydrocarbon critical saturation, most of the hydrocarbons produced are expelled, and the residual hydrocarbon critical saturation decreases with the increase of depth((Pang, 1995).Based on the changing of residual hydrocarbons of S_1/TOC and "A"/TOC in low-abundance carbonatite hydrocarbon source rocks in the Tarim Basin. The residual hydrocarbons of the 12 wells of the Tarim Basin and the Tarim Basin area also increase first and then decrease. Therefore, they have begun hydrocarbon generation of expulsion in large quantity, which are regarded as effective hydrocarbon source rocks.

Conclusions

The studying results show that the geochemical indicators of low organic matter abundance carbonatite source rocks in the platform deep area of the Tarim Basin increase with the increase of depth or R_o or present a regular change, which reflects a phenomenon that TOC, H/C and O/C reduce gradually, and the potential of hydrocarbon generation and residual hydrocarbons increase first and then decrease. It indicates that the low organic matter abundance carbonatite source rocks with high evolution degree in the platform deep area of Tarim Basin take place much expulsion of oil and gas, which contributes a lot to oil and gas accumulation and making it effective hydrocarbon source rocks.

References

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