

A New Type of Tight Oil Formed by the Participation of Mantle-Magmatic Hydrothermal Fluid

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Abstract

Objectives: Discuss the relationship between the tight oil and the hydrothermal fluid in Middle Permian Lucaogou Formation, eastern and southern Junggar Basin and Santanghu Basin, NW China. **Procedures:** Mineralogical, lithological, isotopics and organic geochemistry. **Results:** Middle Permian Lucaogou Formation is characterized as the oil-bearing black rocks with over 200 meters thick, and is confirmed to be tight oil-bearing rocks in recent years. These rocks are composed of multiple magmatic clasts, hydrothermal minerals and organic matter. They are laminated magmatic-hydrothermal sedimentary rocks, named as "Exhalative Sedimentary Rocks". The magmatic clasts are usually coarse to fine grained, ranged from 0.1 to 1.0 mm. Their parent rocks are from peralkaline-alkaline carbonic lavas, iolites, pyroxenites, analcitic phonolite, alkali basalts, and andesites. The magmatic clasts were aggregated by impulse eruptions, and were intercalated as 0.5 to 3.0 mm thick laminae into the tuffites and tuffaceous micritic dolostones. The hydrothermal minerals are mainly composed of buddingtonite, Sr-rich calcite, As-rich pyrite, batisite, and serpentine. The $^{87}\text{Sr}/^{86}\text{Sr}$ ratio of 10 micritic dolostone samples ranges from 0.70457 to 0.706194, and 0.705360 on average, which indicate the hydrothermal fluids may source from mantle. Oil-bearing rocks in Lucaogou Formation are lenticular in vertical sequence, while are dotted and extremely heterogeneous in plane distribution. These rocks are featured by TOC content 1% to 21%, type I or type II kerogen, C17-C20 main peak of n-alkane, rich isoprenoid, more gonane than terpane, over 1000ppm chloroform bitumen 'A', and over 300 HI. Some layers have high oil productivity, S1+S2 mostly 4 kg/t, some over 9 kg/t, and the ratio of chloroform bitumen 'A/TOC' over 10%. The black oil-bearing rocks in Lucaogou Formation is a new type of tight oil which was formed in the high salinity (rich in halite, $Z > 120$), and high temperature (80-100°C and 200-260°C temperature zones of fluid inclusions) lacustrine environments. **Conclusions:** Hydrothermal fluids from deep earth and mantle provided favorable temperatures and nutrients for algae and microbes in the lake, enhanced the heat sensitivities of the organic matters, and accelerated the organic matters transforming into hydrocarbon. Therefore, the tight oil of Lucaogou Formation has been formed very early.