HETEROGENEITY AND ITS CONTROLLING FACTORS OF LACUSTRINE ORGANIC-RICH SHALE IN THE OLIGOCENE BIYANG DEPRESSION, EAST CHINA

Y. Song 1, S. Li 1, S. Hu 1, X. Ruan 1

1 Key Laboratory of Tectonics and Petroleum Resources (China University of Geosciences), China

Lacustrine organic-rich shales are widely developed in the Paleogene continental basins of east China. Many of these organic-rich shales have been proven as potential hydrocarbon source rocks of crude oil, as well as reservoirs of shale oil. However, compared with the relatively homogenous marine shales, the lacustrine shales in east China generally show strong heterogeneity. Based on petrological, mineralogical and geochemical methods, the heterogeneity and its controlling factors of organic-rich shales in the Oligocene Biyang Depression are investigated.

Six organic-rich shale layers have been recognized in the Oligocene Hetaoyuan Formation of the Biyang Depression, among them shale layers 5 and 3 hold the best shale oil potential. Mineralogical data indicate that the organic-rich shales are mainly composed of quartz, plagioclase, clay minerals, calcite and dolomite, traces of pyrite and gypsum. The organic-rich shales can subdivide into six lithotypes, including (muddy) siltstone, silty shale, clay shale, calcareous shale (sparry/micritic), dolomitic shale and massive mudstone. Based on the lithotype associations, shale layer 5 can be further divided in to lower, middle and upper units. The lower and upper units consist of (muddy) siltstone, silty shale and calcareous shale (micritic), whereas the middle unit comprises mainly calcareous shale (sparry) and clay shale. Shale layer 3 develops dolomitic shale, clay shale and massive mudstone.

The organic matter (OM) within these shales mainly originate from lamalginite (type I-II1) and within the oil window maturity. Total organic carbon (TOC) contents of lower and upper units are 2.6 wt% (0.5-5.6 wt%), lower than that of middle unit (3.6 wt%, 1.1-7.6 wt%). Shale layer 3 shows higher TOC contents, ranging from 1.9 to 8.6 wt%, with an average of 4.9 wt%. Shale layer 5 was deposited in a semi-deep lacustrine environment under a moderately warm-humid paleoclimate, relatively high TOC contents in the middle unit is probably caused by high bioproductivity together with anoxic and brackish water conditions. In contrast, warm-humid paleoclimate resulted in a deep lacustrine environment during the deposition of shale layer 3. High TOC contents in shale layer 3 probably related to the excellent preservation conditions (anoxic, saline water and photic zone euxinia), together with moderate bioproductivity.

Core scanning analysis have been conducted on clay shale and calcareous shale (sparry). The result indicates that the light laminae in clay shale is mainly composed of quartz and clay minerals, probably related to the increased terrestrial detrital influx (TDI) under a warm-humid paleoclimate. In constrast, the light laminae in calcareous shale comprises mainly calcite, and mostly formed with decreased TDI under a moderately warm-humid paleoclimate.

Based on the above results, in can be concluded that under the stable subsidence tectonism, paleoclimatic fluctuation is probably the primary controlling factor of heterogeneity in lacustrine organic-rich shales. Furthermore, other factors such as detrital influx, algal bloom, as well as diagenesis cannot be ignored for their influence on heterogeneity of lacustrine organic-rich shales.