

Revised Oil-Source Correlation Models in the Chao-Chang Region and Implications for Lower Cretaceous Petroleum Play Concepts in the Songliao Basin, NE China

Xue Wang¹, Maowen Li², Zihui Feng¹, Wei Fang¹, Zhenguang Li¹, Qiuli Huo¹, Sneha Achal², Marina Milovic², Rachel Robinson², Chunyuan Huang¹, and Guixia Song¹

¹Research Institute of Petroleum Exploration and Development, PetroChina Daqing Oilfield Company, Daqing, China.

²Geological Survey of Canada, Calgary, AB, Canada.

Biomarkers in 60 oil samples from the Chao-Chang region, Songliao Basin, NE China reveal three genetic oil groups and suggest characteristics of their probable source rocks. Group 1 (57 Lower and Upper Cretaceous-reservoired oils over the entire region) was sourced from the Upper Cretaceous Qingshankou Formation (K2Qn1), the main petroleum source rocks in the basin. Group 2 (two Lower Cretaceous-reservoired oils in the Changchunling anticline zone) and group 3 (one Lower Cretaceous-reservoired oil in the Sanzhao sag) derive from two high quality sources with more localized occurrence, corresponding to carbonate-evaporate and freshwater lacustrine facies, respectively. The relative abundance of gammacerane in the group 1 oils suggests the deposition of their type I, algal rich, lacustrine source rocks under conditions of enhanced salinity-stratified water columns, consistent with those in the K2Qn1 member. The large variation in the molecular maturity parameters of the group 1 oils (such as sterane isomerization ratios) was not substantiated by the gross oil compositions and n-alkane concentration. Although we did not intend to address source rock volumes in this molecular study, there is clear evidence against the previously proposed model of downward oil migration from a local source. Instead, lateral migration of the oils derived from the younger K2Qn1 sources in the deeper parts of the Sanzhao and Wangfu sags appears responsible for the occurrence of the group 1 oils in the older Lower Cretaceous reservoirs in the Chaoyanggou terrace and Changchunling anticline zones. The large variation in the biomarker concentrations in source rocks with different maturity levels illustrates how the addition of small amounts of soluble organic matter from a local source (e.g. caprock and intra-reservoir shale) to a mature oil could potentially compromise its biomarker maturity parameters. Although most oils in the study area derive from the Upper Cretaceous K2Qn1 source, the presence of other oil genetic groups suggests that future exploration in this region should also carefully consider the potential of the not yet penetrated, probably more localized, Lower Cretaceous source rocks in the deeper parts of the basin.