Oil Generation as the Dominant Overpressure Mechanism in the Dongying Depression, Bohai Bay Basin, China

Guo, Xiaowen [1]; He, Sheng [1]; Liu, Keyu [2] (1) Key Laboratory of Tectonics and Petroleum Resources, Chinese Ministry of Education, China University of Geosciences, Wuhan, China. (2) CSIRO Petroleum, Kensington, WA, Australia.

The Dongying Depression in the Bohai Bay Basin is a young, prolific petroleum producing basin in China. The mudstones and oil shales of the Eocene Shahejie Formation (Es3 and Es4) are the major source rocks dominated by Type I kerogens with TOC of up to 18.6%. The Es3 member is characterized by a relatively high sedimentation rate of up to 500 m/Ma. Widespread overpressures are present in Es3 and Es4 with pressure coefficients up to 1.99. Among the sonic, resistivity and density logs, only the sonic log displays an obvious response to the overpressure. Acoustic travel time vs effective vertical stress analysis of more than 300 wells suggests that they are affected by the effective vertical stress with the travel-time reducing with increasing vertical effective stress.

Disequilibrium compaction has been previously proposed as the sole cause for the high magnitude overpressures in the Eocene strata of the Dongying Depression citing the rapid deposition of the fine-grained sediments. However, we believe that the overpressures are caused by oil generation from the source rocks in the Es3 and Es4 intervals. The overpressured sediments display a normal compaction as evidenced from the overpressured mudstones exhibiting no anomalous low density, the apparent none-correlation between the mudstone densities and the effective vertical stress, and the overpressured reservoir sandstones showing no anomalous high matrix porosities or anomalous geothermal gradient. The depths to the top of the overpressure intervals range from 2000m to 3000m following closely with the depths of the associated source rocks. All the overpressured reservoirs and source rocks have a minimum temperature of approximately 87 °C. The overpressured source rocks generally have vitrinite reflectance (Ro) values of 0.6% or higher. Overpressures are not found in the strata within which the Ro values are < 0.5%. The overpressured Es3 and Es4 reservoirs are predominantly filled with oil or oil-bearing. Organic-rich source rocks with overpressures are capable of generating hydrocarbons and thus can maintain an abnormal high pressure. The precipitation of calcite in the calcareous mudstones observed in the source rocks may have caused significant reduction in porosity and permeability to form an effective pressure seal. The origin of overpressures in the reservoir rocks may have been generated by the overpressured fluid transmission from the source rocks through active faulting and fracturing.