Predicting Fluid Phase in a Complex Setting, Yenisei Khatanga Basin, West Siberia, Russia: Is There a Big Oil Prize in This Under-Explored Basin?

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ABSTRACT

Recent oil and condensate discoveries in the Yenisei Khatanga Basin (YKB) such as the Baikalovskoye and Paiyakhskoye fields have drawn attention to this underexplored part of the West Siberian Basin (WSB). Significant discoveries in YKB to-date are mainly in Neocomian clinoforms, in stratified toe-set and top-set reservoirs of the Sukhodudin and Nizhnekhet Formations. However, previous discoveries are mainly gas. The main source rocks are at the boundary between the Upper Jurassic Golchikhin and Lower Cretaceous Nizhnekhet formations, equivalent to the prolific Bazhenov source in the WSB which in the YKB is probably expressed in more diluted and oxidized facies. Multi-1D basin modelling indicates that this source rock reached the main to late-oil generation window in the central YKB. Other potential source rocks include the gas-prone Middle Jurassic Malyshev Formation, and the probably mixed oil/gas-prone Lower Jurassic Kiterbyut Formation, both of which are mostly in the gas window at present day. Coals are present within the Cretaceous strata, and whilst generally immature they may have contributed biogenic gas. The analysis of fluids from Baikalovskoye and nearby fields suggests a complex charge history. A mixture of thermogenic and primary and secondary biogenic gas is present in sandstones of Cenomanian to Barremian age, associated with oils and condensates of highly variable densities (20° - 55° API). These fluids are a mixture of severely biodegraded marine oils with a later contribution of less biodegraded and more mature fluids. Oils and highly mature gases from terrigenous sources rocks are also found in Jurassic and Cretaceous reservoirs probably generated by Middle Jurassic and older sources. 2D basin models also support mixing within the Neocomian reservoirs of oils sourced from the Upper Jurassic with lighter hydrocarbons from deeper source rocks. The limited seal capacity of silts and muds dividing stacked Neocomian reservoirs allows vertical leakage and remigration. Together with variable mixing proportions of fluids from different sources and intensities of biodegradation due to an interplay between charge and biodegradation rates, this leads to a highly variable and difficult to predict distribution of fluid properties in top-sets. However, we propose a model in which deeper toe-set reservoirs closely coupled to the Upper Jurassic source rock may have preferentially retained oil leading to exciting exploration opportunities in the YKB.