

3-D Basin Modeling of the Changling Depression: A New Method of Exploring Petroleum Generation and Migration in Deep Tight Sandstone Reservoirs

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ABSTRACT

Tight sandstone reservoir has become to be a research hotspot among unconventional reservoirs. However, there is little research on the tight sandstone hydrocarbon reservoir forming characteristics and petroleum system. The 3D basin modelling is an effective method to address the masses and characteristics of petroleum generated, accumulated and lost during the evolution of the basin. The Changling depression is the largest reservoir with abundant resources in the South Songliao Basin, China. The 3D structure model of the Changling depression was constructed from the basement to the ground surface based on the 3D seismic data along with well penetrations. The heat flow history was calibrated by present formation temperatures and observed maturity (vitrinite reflectance). Three main erosion episodes during the burial history (one in Early Cretaceous and two in Later Cretaceous) were also taken into consideration. The maturity levels of the Early Cretaceous source rocks (Shahezi Formation and, Yingcheng Formation) were reconstructed and source rock evaluation studies show good gas generating potential. The reservoirs strata include Denglouku Formation and Quantou Formation in early Cretaceous. As we all know, tight sandstone reservoir has poor physical property and strong heterogeneity. Furthermore, Changling depression has complex fault system and multiple tectonic movements. In order to reach higher modelling accuracy, the Denglouku Formation is additionally subdivided into several subunits with different porosity, permeability, lithology and sedimentary micro-facies distribution, based on the core analysis and Petrel simulation. Our research based on the source rock evaluation, reservoir fine modelling and basin modeling, in order to study the abundance, types and maturity of source rocks, thermal history and hydrocarbon generation history of single wells and cross sections, speculated the process of hydrocarbon accumulation in Changling depression. We've got the following recognitions: A) We found out that the hydrocarbon generation period is between the end of Early Cretaceous and the middle of Late Cretaceous. B) According to the inclusions homogenization temperature analysis, the Early Cretaceous reservoir should be formed at the end of Late Cretaceous. C) The petroleum system model of Changling depression shows new favorable gas exploration targets and deepen the understanding of deep tight sandstone reservoirs.