Integration of Sedimentology, Seismic Geomorphology, and Analogues for Improved Facies Modeling of Fluvial-Tidal Reservoirs in the West Siberian Basin

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ABSTRACT

Fluvial-tidal reservoirs with complex lateral and vertical stacking pattern, thin hydrocarbon columns, multiple contacts, and varying fluid content pose challenges to reservoir modelling and ultimately to field development. This study presents an integrated approach to facies modelling using the example of Aptian-Albian reservoirs in the Yuzhno Russkoye license (Pur-Taz area, West Siberian Basin). A gentle anticlinal structure forms the overall trapping geometry. 25 wells, including 1700 m core, limited palynology data, and log pattern of the 400 m thick succession in the 90 x 15 km large block have been studied. Attributes of a high-density 3D-seismic cube were analyzed following a careful seismic-to-well tie. Sedimentary architecture of modern depositional systems was interpreted to capture realistic facies stacking. The lower part of the succession is composed of multiple, 20 to 50 m thick packages of laterally and vertically stacked tide-influenced fluvial channel sandstones passing upwards into tide-dominated channel sandstones, bayhead delta heterolithics, estuary mudstones and flood-tidal delta heterolithics. The fluvial to increasingly marine upwards packages are interpreted as stacked incised valley fill deposits. Marginal marine mudstone covers the lower, incised valley fill-dominated part and forms the base of an overall mudstone- and coal-rich succession. Tidal-fluvial and tidal channel sandstones, oxbow lake and embayment mudstones, crevasse splay heterolithics and laterally extensive paleosol and coal layers are interpreted as delta plain deposits of a westwards prograding delta. E-W trending, 20 to 30 m thick and 5 to 10 km wide distributary channel belt sandstones form the main reservoirs in the field. Phases of repeated delta progradation and lateral switching of active and inactive delta lobes resulted in patchy reservoir geometries. Meandering channels depositing laterally stacked point bars, scroll bars, oxbow lakes etc. created internal reservoir heterogeneities. Hydrocarbon distribution along the anticline axis matches facies pattern closely. Reservoir compartmentalization can, in most cases, be explained by facies changes. Faults play a subordinate role. The depositional concept and facies maps created by integration of 1D-facies logs, seismic attributes, and modern analogues are used as input for modelling for these complex stacked reservoirs.