Understanding and Modeling the Tidally influenced Fluvial Reservoirs of a Supergiant Oil Field

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Abstract

The subsurface reservoir geology of tidally influenced fluvial reservoirs is extremely complex and difficult to model. Mudstone is a pervasive component, occurring in many forms, but particularly in IHS (inclined heterolithic stratification) of meandering point bar deposits. A realistic geological interpretation and reservoir model requires the full use and integration of all geological data incorporating geophysics and engineering. Closely tied to this is a comprehensive understanding of modern depositional systems to ensure realistic rather than surrealistic modeling.

The oil sands of northern Alberta contain 1.8 trillion barrels of bitumen, making it one of the largest hydrocarbon resources on earth. Only recently has technology developed allowing for efficient recovery of the bitumen in the subsurface. Several companies have constructed SAGD (Steam Assisted Gravity Drainage) infrastructures to recover the bitumen. The sole purpose of this infrastructure is to carry out in situ recovery of bitumen trapped within sands of the Aptian-age McMurray Formation. With the tens of billions of dollars required to acquire land, delineate deposits, drill SAGD well pairs, build steam generation facilities and some upgraders, it is critical that the geological and geochemical complexity of the reservoir be fully understood.

Early regional stratigraphic studies across the Athabasca basin showed the McMurray Formation to be comprised of three or more episodes of incision, valley creation and subsequent infill with tidally influenced fluvial sediments. These deposits are, by their nature, heterogeneous. This, combined with the multiple incision and fill events, resulted in a complex amalgam of reservoir and non-reservoir facies locally creating stratigraphic compartments across the basin.

The industry has been committed to developing a thorough understanding the deposits of the McMurray Formation through the integration of detailed geological, geophysical and geochemical data sets. Subsequent to routine delineation of McMurray oil sand deposits through core hole drilling, core analysis, petrophysical logging, and acquiring 2-D and 3-D seismic surveys, major efforts have been put into a broad range of geoscience studies. These include sedimentology, stratigraphy, sequence stratigraphy, palynostratigraphy, ichnology, chemostratigraphy, geochemistry, seismic attribute analysis, and modern analogs. The integration of these data sets has allowed the mapping of individual valley fills on regional and lease scales. On a more detailed reservoir development scale, mapping of depositional elements and fluid characterization allows planning and production optimization of existing and future SAGD well pairs. The resulting 3-D object-based models and baseline bitumen characterization studies (physical properties and molecular composition) reduce reservoir uncertainty, improve reservoir visualization, and are used for reservoir simulation, history matching and monitoring steam chamber growth.