A multidisciplinary approach to understanding the Geology of the Athabasca Oil Sands – 2nd largest hydrocarbon resource on Earth*

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*Abstract from 2011-2012 AAPG Foundation Distinguished Lecture presentation.

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The oil sands of northern Alberta contain 1.8 trillion barrels of bitumen, making it the second largest hydrocarbon resource on earth. Only recently has technology developed, allowing for efficient recovery of the bitumen in the subsurface. Nexen Inc. and its partner, Opti Canada Ltd, have constructed the largest SAGD (Steam Assisted Gravity Drainage) operation in the world to recover a portion of the nearly 4 billion barrels of bitumen in place on the Long Lake lease, northeastern Alberta. The sole purpose of this infrastructure is to recover and upgrade bitumen trapped within sands of the Aptian-age McMurray Formation. With the billions of dollars required to acquire land, delineate deposits, drill SAGD well pairs, build steam generation facilities and an upgrader, 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 fluvio-estuarine sediments. Fluvio-estuarine 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.

Since the inception of this project, 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. At Nexen, 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.