Generating Reservoir Models from High Resolution Outcrop Studies: a case study from the Lower Cretaceous McMurray Formation, northeastern Alberta

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ABSTRACT

It is estimated that the Athabasca Oil Sands contain 950 bbls of bitumen in place and subsurface extraction is an increasingly important means of exploiting these resources in the McMurray Formation, northeast Alberta. Unfortunately, in situ production efforts are hampered by complexities of the geological media present in the McMurray strata, characterized by channel deposits partially infilled with inclined heterolithic stratification (IHS). Variability in bed thickness, lateral continuity, presence or absence of bioturbation, and the possibility of mud-bed fracturing, all contribute to complex flow within these potential reservoirs.

Delineation of facies architecture was accomplished by combining high resolution sedimentologic and ichnological mapping with outcrop photo mosaics. Two and three-dimensional numerical modeling was completed to assess the factors governing fluid flow at outcrop scale. These models integrated changes in permeability fields, attributed to bioturbation and mud-bed fracturing, and populated based on statistical assessment of the data, into a base model representing the distribution of lithologies. Simulations were run on the models to gage the relative effects of these parameters on horizontal and vertical fluid flow. Lithology was shown to be the predominant control on both vertical and horizontal bulk permeability. Mud-lined burrows found locally within the sand member of IHS decrease horizontal bulk permeability but have little effect on vertical permeability. Mud-bed fracturing increases vertical permeability but little change on horizontal bulk permeability was observed.

From this methodology, a list was compiled of the most influential parameters on fluid flow- a valuable asset for geologists and engineers responsible for outcrop data collection and subsurface reservoir modeling.