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Implications for Upscaling in Reservoir Geomechanical Simulations of the McMurray Formation Oil Sands – How Does Core Heterogeneity Inform Geomechanical Behavior at Multiple Scales?

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Abstract

During thermal recovery operations in oil sands reservoirs, pore pressure and temperature are raised which result in alteration of in situ stresses and deformation of the reservoir and associated loading of the caprock. Sequentially-coupled reservoir geomechanical simulations are generally conducted to assess the impacts of these processes. Detailed geocellular models populated with appropriate petrophysical properties such as porosity, permeability and fluid saturations and rock mechanical properties, including elastic and plastic properties are typically the foundation for these reservoir geomechanical simulations. While geostatistical techniques are used widely to provide multiple equi-probable geological realizations for petrophysical properties, upscaling of rock mechanical properties has not received the same attention. Heterogeneity within the McMurray Formation can significantly impact on the deformation response and failure modes of oil sands mixed with shale bedding planes (IHS) and hence selection of the "scale" of "upscaling" becomes a very important factor. This talk will use core from a typical well in the Athabasca oil sands region to discuss issues related to geomechanical upscaling, the challenges of honoring upscaled properties for failure modes and effective plastic (failure or yield) properties and how core-based decisions related to shale volume fraction, spatial range and inclinations of shale (i.e. IHS) can impact the constitutive behaviour of (geomechanically) upscaled zones. Understanding these issues is important since ultimately, these decisions can impact monitoring/surveillance plans, anticipated reservoir behaviour and caprock integrity.