Importance of local-scale geological features in regional-scale groundwater modelling

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ABSTRACT
Groundwater flow models in the South Athabasca Oil Sands (SAOS) region inform the groundwater decision-making process. They aim at reasonably predicting regional changes in hydraulic heads and groundwater flux to assess potential cumulative environmental impacts. While the objective of such models is to reproduce regional-scale groundwater flow in major aquifers, local-scale geological features can have a significant impact on the behaviour of the regional groundwater flow system. Therefore, local features need to be adequately represented in numerical models in order to make reasonable, fit-for-purpose predictions.
Focusing on the thick Quaternary stratigraphic sequence in the SAOS region, local features identified through geologic characterization over the last decade include Quaternary glacial meltwater channel incisions cross-cutting multiple bedrock aquifers, aquifer outcrop areas and intersections with surface water bodies, and 'windows' of hydraulic connectivity through regionally-continuous till sheets. This presentation describes workflows and tools to take advantage of large regional datasets available from sources like the Alberta Geological Survey (AGS) that are combined with locally refined datasets of markers from geophysical well logs, seismic and airborne resistivity maps, to generate regional 3D geomodels. These geomodels will ultimately be used in the construction of numerical models of groundwater flow. The geomodels can have spatially variable meshes that are refined based on an understanding of the local features to capture. Datasets can be integrated using simple cokriging approaches to locally deform regional maps and honour all the available data. From the 3D geomodels, automated scripts are run to construct groundwater models in FEFLOW that honour the integrated geological interpretation, by assigning material properties to hydrostratigraphic units. These material property assignments can accurately represent aquifer pinch-outs and hydraulic connectivity between units even when continuous model layers are required. This expedites groundwater numerical model construction and ultimately results in more useful predictive tools.