Pathways and Connections: enhancing knowledge of Alberta's groundwater resources through Canada's Oil Sands Innovation Alliance (COSIA)

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ABSTRACT
Knowledge of hydrogeological conditions within Alberta's oil sands has often been constrained by fragmented datasets. The result has been conflicting interpretations regarding real or perceived interactions between distinct hydrostratigraphic intervals and the potential consequences for development. Compared to other oil sands development areas, the Southern Athabasca Oil Sands (SAOS) region has experienced the highest rate of thermal in situ development over the last decade. Groundwater extraction to support steam generation, and injection of related wastes, has raised some concerns regarding risk to the subsurface environment.
To gain a better understanding of these risks (and potential opportunities), COSIA commissioned a project to combine disparate geochemical datasets of regional groundwaters into one unified database. The input for this database was acquired from participating operators and public domain sources, with the objective to identify areas of potential connectivity across key bedrock aquifers and provide a more refined understanding of flow system interactions to enhance the ability of thermal in-situ operators to responsibly manage groundwater resources.
InnoTech Alberta and Integrated Sustainability were commissioned to conduct this work. The resulting database was used to evaluate conceptual models of groundwater flow by identifying the origin, age, and mixing between various major hydrostratigraphic intervals through a forensic evaluation. The existing conceptual model of topographically-influenced groundwater flow systems was refined to include areas of suspected cross-formational flow and pore water mixing, as well as zones of flow stagnation linked to the presence of buried pre-glacial channels. Salinity patterns, along with hydrochemical facies mapping, geochemical fingerprinting, and isotopic tracer analysis substantiated the general down-dip pattern of increasing mineralization towards the southwest in all formations. However, areas displaying substantially different pore water conditions were also identified, implying influence from deeper formations in some locations, extended water/rock interaction in others, and discrete areas of interactions with the near-surface environment.