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Isotopes and Geochemistry: enhancing the understanding of Alberta's groundwater resources through Canada's Oil Sands Innovation Alliance (COSIA)

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Introduction

Knowledge of the hydrogeological conditions within Alberta's oil sands has often been constrained by fragmented datasets generated by various environmental monitoring agencies and industry proponents. This has resulted in 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 in east-central Alberta has experienced an increase in the number and size of thermal in situ development projects over the last decade. Groundwater extraction to support steam generation, and injection of related wastes, are two activities with potential to impact the subsurface environment.

Method and Results

To gain a better understanding of the risks and opportunities related to groundwater resources in that region, COSIA commissioned a project to combine disparate geochemical and isotopic datasets of regional groundwaters. The data was acquired from participating team members and public domain sources (e.g., AGS open file reports). The key objective of the Regional Geochemistry and Isotope Study (RGIS) was to identify important areas of potential connectivity across key bedrock aquifers and provide a more refined understanding of system interactions to enhance the ability of thermal in-situ operators to responsibly manage groundwater resources.

InnoTech Alberta and Integrated Sustainability Consultants Ltd. were commissioned to consolidate the geochemical and isotope datasets obtained for the study area. This unified database of water quality parameters 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 associated 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 quality 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

Conclusions

This presentation will showcase an example of how COSIA is working to enhanced knowledge of hydrogeological conditions in an important area of Alberta, with the goal of better managing groundwater resources through focussed monitoring efforts, consistent data collection and interpretation, and a consolidated understanding of interactions within, and between, distinct hydrostratigraphic intervals. The benefits of a consolidated and holistic approach to resolving complex hydrogeological settings are obvious from this example, and will hopefully pave the way to further knowledge and data sharing to enhance responsible development of Alberta's natural resources.

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