The isotopic imprints of effluents from an oil sand tailing pond in Alberta, Canada

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The rapid growth of the oil sand industry in Alberta, Canada has triggered an intensive environmental debate on the source and fate of contaminants associated with the oil (tar) sand operations. As part of the oil sand operations, a large volume (~840x10^6 m^3) of oil sand process-affected water (OSPW) is generated and stored in oil sand tailing ponds. [1] The seepage and migration of OSPW into the underlying aquifer is a potential long-term risk for oil sand operations. The objective of this study is to establish distinctive geochemical monitoring tools for tracing the migration of OSPW to aquifers near oil sand tailing ponds. The geochemical and isotopic variations of dissolved boron, strontium and lithium were measured in groundwater underlying the South Tailing Pond site in Alberta, Canada. The shallow groundwater is characterized by statistically higher salinity (TDS ~2250 mg/L), boron (3508 ppb), and lithium (232 ppb) relative to the underlying deep groundwater (mean values of 491 mg/L, 170 mg/L, and 36mg/L, respectively). d11B and d7Li of the boron- and lithium-rich groundwater (+25± 1‰ and +18.7±2‰, respectively) were both significantly distinct from those of the deep groundwater (+9.5‰±5‰, and +11‰±0.9‰,). These results are consistent with independent OSPW measurements (d11B=24±2‰; d7Li=15.6±0.5‰). The distinctive boron and lithium isotopic ratios of the OSPW imply a new sensitive tool to monitor and quantify OSPW migration and contamination of regional groundwater.

[1] Holden, Donahue & Ulrich (2011), *J. Contaminant Hydrology* **119**, 55-68.