Migration and evolution of oil sands tailings pond seepage through glacial till sediments: combined field and laboratory investigations

A. HOLDEN[1*], M. KONE[1], K. U. MAYER[2], A. ULRICH[1]

[1] University of Alberta, Civil and Environmental Engineering, Edmonton, Canada, aholden@ualberta.ca (*presenting author), macoura@ualberta.ca, aulrich@ualberta.ca
[2] University of British Columbia, Earth and Ocean Sciences, Vancouver, Canada, umayer@eos.ubc.ca

In Northern Alberta, at least three major oil sands tailings impoundments have been constructed atop aquifers, mantled by a layer of glacial till. Despite these favourable conditions, absolute containment within these enormous, man-made structures is not achievable, and oil sands process water (OSPW) from the ponds is expected to infiltrate through the aquitard, impacting groundwater quality on site and potentially beyond [1]. However, to date, there has been no research investigating the evolution and migration of OSPW in glacial till sediments, and thus the nature of contaminants entering the groundwater-bearing formations remains unclear.

The present study seeks to a) characterize the potential for glacial till sediments to attenuate, or to modify the composition of, ingressing major ions contributing to salinization; and b) to clarify the key geochemical processes governing system behaviour. Of novelty, groundwater was monitored for 6 years, from its pristine state through to first ingress of OSPW, and results are interpreted in conjunction with radial diffusion cell experiments [2] using the same sediments.

Field observations show that OSPW intrusion resulted in high concentrations of Na, Cl and alkalinity (likely HCO_3), at approximately 900, 370 and 1350 (as $CaCO_3$) mg L^{-1} respectively. In agreement with findings from radial diffusion experiments, initial ingress of sodium-rich OSPW exchanged with sediment-bound Ca, while NO_2, NO_3 and high concentrations of SO_4 were mitigated, due to reduction reactions. However, displacement of exchangeable Mg was observed in the laboratory but not on site, though perhaps the change too subtle or localized to be detected by annual sampling.

Field monitoring enables the detailed assessment afforded under the well-controlled conditions of the diffusion cells, to be expanded to include field-scale heterogeneity in mineralogy and hydrology, and variable climate. Together, the unified results are expected to aid future remediation and environmental management strategies.

[1] MacKinnon *et al.* (2004). *IAHS Publ.* **297**, 71-80.
[2] van der Kamp *et al.* (1996) *Water Resour. Res.* **32**, 1815-1822.

Bacterial Diversity in Athabasca Oil Sands Composite Tailings Components

STEVEN P. HOLLAND[1]*, TARA COLENBRANDER NELSON[1], KATE STEPHENSON[1], KATIE KENDRA[1], TARA PENNER[2], LESLEY A. WARREN[1]

[1]School of Geography and Earth Sciences, McMaster Universiy, Hamilton, ON, Canada, hollansp@mcmaster.ca (*presenting author), tnelson@mcmaster.ca, steph2k@mcmaster.ca, kendrake@mcmaster.ca, warrenl@mcmaster.ca
[2]Syncrude Canada Ltd., Edmonton, AB, Canada, Penner.Tara@syncrude.com

Sustainable reclamation of tailings, process water, and disturbed land represents the largest environmental challenge facing the Alberta Oil Sands industry. Bitumen extraction generates immense quantites of composite tailings (CT), a material that remains, to date, uncharacerized with regards to bacterial genetic diversity. Syncrude Canada Ltd. is currently building the first large-scale reclamation freshwater fen overlying sand-capped CT. Unexpected hydrogen sulfide (H_2S) gas emissions coinciding with dewatering of the CT associated with fen construction has highlighted the need to more thoroughly constrain S biogeochemistry in these materials. Recently initiated work is now investigating microbial linkages between S cycling and the generation of H_2S gas in untreated CT as well as CT undergoing reclamation fen development. CT consists of process water, gypsum, sand, and fluid fine tailings (FFT), a process waste that is rich in microbial life as well as Fe-bearing clay content. Understanding the putative microbial links to H_2S generation thus requires a thorough characterization of the microbial players that may be present in the starting materials, as well as those in the composite tailings *in situ*, and their potential impact for S cycling. The objectives of this work are to characterize the bacterial diversity of FFT, CT, and overlying sand cap materials, as well as process water, via molecular, cultivation-independent 16S approaches. Results of this genetic charactierzation, as well as Fe and S metabolic enrichment from these materials, and the potential linkages to H_2S gas generation will be presented.