Goldschmidt 2024 Abstract
https://doi.org/10.46247/gold2024.23719

Microbial redox processes can biodegrade petroleum hydrocarbons suppressing CH_4 production from oil sands tailings ponds and end-pit lakes

IRAM AFZAL, NAVREET SURI, ALSU KUZNETSOVA, ANIA ULRICH AND TARIQ SIDDIQUE

University of Alberta

Presenting Author: iafzal@ualberta.ca

Surface mining of shallow oil sands deposits (~500 km^2 of total deposits) in Alberta, Canada produces waste, fluid fine tailings (FFT), that is a slurry consisting of water, fine solids, unrecovered bitumen, and residual diluent (used to improve bitumen recovery). FFT are temporarily stored in oil sands tailings ponds that cover ~270 km^2. Establishing end-pit lakes (EPLs) by depositing FFT in mined-out pits and covering it with water is considered a suitable reclamation strategy. However, methane (CH_4) production from the biodegradation of ~40% of diluent hydrocarbons in FFT may affect the sustainability of EPLs. Therefore, we investigated the response of indigenous microbial communities in FFT retrieved from Base Mine Lake (a commercial-scale demonstration EPL in the Athabasca region of Alberta) to alternative redox conditions by adding amendments (nitrate, sulfate, and iron) for anaerobic hydrocarbon biodegradation. Our long-term laboratory studies indicate that ~33%, and ~38% of naphtha hydrocarbons (including *n*-alkanes, *iso*-alkanes, and monoaromatics), which are considered labile for microbial metabolism, can be biodegraded under nitrate- and sulfate-reducing conditions, respectively, without CH_4 production. Sulfate-reducing FFT cultures that became enriched with microorganisms belonging to family; Desulfocapsaceae, Desulfosarcinaceae, and Syntrophobacteraceae, indicated relatively faster biodegradation of hydrocarbons (~400 days) than nitrate-reducing cultures (~600 days) that indicated enrichment of facultative anaerobes during hydrocarbon biodegradation. In FFT cultures containing iron mineral (ferrihydrite) amendment, CH_4 was suppressed; however, only toluene is biodegraded (~75-120 days) during 500 days of incubation. These findings suggest that nitrate and sulfate may be suitable amendments because a broad range of petroleum hydrocarbons can be biodegraded under these alternative redox conditions without CH_4 production. Geochemical and metagenomic analyses are in progress to understand the fate of nitrate and sulfate and to link hydrocarbon biodegradation with the transformation of nitrogen and sulfur so that the effectiveness of these redox processes can be assessed. Combined results and modeling of these redox processes will help in strategizing *in-situ/ ex-situ* redox amendments to suppress CH_4 production from oil sands tailings ponds and EPLs. These findings have applications for bioremediation of other hydrocarbon-contaminated anaerobic environments such as wetlands, groundwater, and estuaries.