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Emissions of reduced sulfur compounds generated during hydrocarbon metabolism intreated tailings

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Northern Alberta's shallow oil sands deposits are surface-mined to recover bitumen using a hot-water process that produces large volumes of fine tailings (FT). FT is a slurry of fine solids, unrecovered bitumen, and residual diluent (naphtha or paraffinic solvent), which is temporarily stored in tailings facilities for subsequent reclamation. Some mine operators treat FT with sulfate-based amendments to achieve rapid dewatering before incorporating it into other landforms for reclamation. However, elevated sulfate concentrations are known to stimulate the growth of indigenous sulfate-reducing bacteria (SRB) that biodegrade residual hydrocarbons in FT under anaerobic conditions. Sulfate reduction during microbial metabolism has the potential to produce biogenic H_2S and other reduced sulfur compounds (RSCs), thereby potentially affecting air and water quality for surrounding Indigenous communities. In this context, we investigated the effect of different sulfate amendments (ferric sulfate, gypsum, and alum) on anaerobic microbial metabolism of hydrocarbons (naphtha) and the production of various RSCs (e.g., hydrogen sulfide, carbon disulfide, *iso*-butane thiol, dimethyl disulfide, carbonyl sulfide, thiofuran, diethyl sulfide, methyl disulfide, isopropyl mercaptan, and multiple thiophene species) in laboratory microcosms. Our long-term incubation (~500 days) demonstrated varying extents of naphtha hydrocarbon biodegradation (*n*-alkanes, monoaromatics, and *iso*-alkanes) in treated FT, in the following order: ferric sulfate > gypsum > alum. Although quantification of RSCs is complex due to their high chemical reactivity, our findings suggested that different RSCs were detected in FT cultures amended with different sulfate sources. However, H_2S was the most commonly detected RSC, followed by thiophene species, in all treated FT. Additionally, we are investigating RSC partitioning in different tailings phases (gas, liquid, solids) to improve our estimation about the extent of RSC emissions from sulfate-treated tailings and tailings reclamation landforms. Our findings may inform strategies for RSC monitoring for air and water quality, and potential RSC emissions management.