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Characterization of the mineralogy and microbial community present in the arsenic-contaminated sand cover and tailings at Long Lake Gold Mine, Sudbury, Ontario, Canada

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The tailings at the abandoned Long Lake Gold Mine near Sudbury, Ontario, contain high concentrations of arsenic, posing a risk to the surrounding communities and environment. These gold mine tailings contain abundant sulfide minerals, which, when oxidized, mobilize arsenic, iron and sulfur, and produce acid mine drainage (AMD). Mining operations concluded at the site in 1939, and a ~30 cm thick sand cover was applied to the surface of the tailings in the 1970s to help prevent the formation of AMD. In this study, three sampling locations on the tailings were chosen for characterization based on relative weathering and erosion of the sand cover, specifically targeting: (1) intact sand cover, (2) eroded sand cover, and (3) eroded sand cover and the presence of hardpan at the surface. Samples were collected in 5 cm increments to a depth of 50 cm. Sample mineralogy and geochemistry were characterized using X-ray diffraction, X-ray fluorescence, carbon/sulfur analysis and scanning electron microscopy to better understand the geochemical connections between primary minerals in the tailings and secondary minerals forming in the sand cover and hardpan. For each location, porewater samples were also collected from depths between 35 and 50 cm to determine aqueous concentrations of major elements, namely As, Fe, and SO_4^{2-}. All samples were acidic (pH 2-4), with As concentrations ranging from 15-357 mg L^{-1}, Fe from 382-11,199 mg L^{-1}, and SO_4^{2-} from 3,157-33,803 mg L^{-1}. This is consistent with the extensive oxidation of sulfidic minerals. The microbial communities in the depth profiles, identified using 16S rRNA amplicon sequencing, included high relative abundances of *Leptospirillum* and *Acidithiobacillus* species, which contribute to AMD formation by metabolic oxidation of sulfide minerals. The characterization of this site provides insight into the presence of microorganisms in an eroded mine site sand cover and their role in controlling As mobilization from sulfidic tailings. These findings have implications for future remediation efforts at similar historic mine sites.