

Evaluating the chemical reactivity of dusts from mining and upgrading of the Athabasca Bituminous Sands (ABS) in Alberta, Canada using trace elements in moss and snow

FIGORELLA BARRAZA¹, NA CHEN¹, MUHAMMAD B. JAVED^{1,2}, TOMMY NOERNBERG¹ AND WILLIAM SHOTYK¹

¹University of Alberta

²Hatfield Consultants

Presenting Author: barrazac@ualberta.ca

Open pit mining of the Athabasca Bituminous Sands (ABS) in northern Alberta generates large volumes of dust. Fine aerosols arise from combustion processes (e.g. fossil fuels for hydrocarbon upgrading) and coarse aerosols from mechanical processes (e.g. rock crushing). In regard to potentially toxic trace elements (TEs), these two size fractions should exhibit very different properties. Here, the chemical reactivity of summer and winter aerial deposition was evaluated using HNO₃ to leach the ash fraction of *Sphagnum* moss and bulk samples of snow, respectively. *Sphagnum* moss was collected from 30 bogs within the ABS region, and snow at 30 sites along the Athabasca River. Leachates were filtered (0.45 μm PTFE membrane), then analyzed using ICP-MS in the metal-free, ultra-clean SWAMP laboratory (<https://swamp.ualberta.ca/>).

In snow from the ABS region, conservative lithophile elements such as Al, Y, La and Th, increased in concentration toward industry, with the smallest and greatest values differing by approximately 100 times. Elements enriched in bitumen (V, Ni and Mo) showed similar increases. The range in concentration of chalcophile TEs (As, Cd, Pb, Sb, Tl), however, was only a factor of approximately 10x. When the concentrations of TEs in this fraction of snow from the industrial region were compared to the control site, the lithophile elements showed the greatest enrichments (up to 2300x) followed by elements such as V (380x), Pb (150x) and Cd (12x). In the moss samples, most of the Al was found in the acid-soluble ash (ASA) fraction; this was true also of V and Ni. In contrast, only a small proportion of the Pb, Sb and Tl were found in the acid-soluble fraction.

Taking lithophile elements such as Al as indicators of the extent of dust dissolution, it is clear that potentially toxic TEs such as Cd, Pb, Sb, and Tl, are under-represented in the leachates. Given the very low pH of the solutions used, even less dissolution of these dusts is expected when they come into contact with natural waters.