Brief Description:

The work that is to be performed will contribute towards an understanding of how the bitumen extraction process and the aging of tailings in tailings ponds affects the concentration and oxidation states of cadmium, chromium, and arsenic. In order to reach this understanding, a series of scans will be performed on raw ore and mature fine tailings. As to further confirm the oxidation states of the elements being tested, scans will be performed on standards and compared to the raw ore and mature fine tailings. Successful execution of these experiments will result in a better understanding and more in depth knowledge of the dangers of oil sands tailings and raw ore, with regard to the heavy metals being tested. Knowledge of the productivity of the bitumen extraction process and aging of tailings in limiting harmful effects of these heavy metals will also be strengthened.

Societal and Economic:

Along with increasing the scientific aptitude and developing the future of Canadian science this project may yield impact that is relevant in the short term as well. Through examining the changes in the speciation of arsenic, chromium and cadmium from raw ore to mature fine tailings/polymer amended mature fine tailings we can determine whether the bitumen extraction process increases or decreases potential environmental effects. This will equate to a positive societal and economic impact. Through examining the environmental implications that the bitumen extraction process poses, we will be able to evaluate its sustainability.

Industrial Relevance:

There are many critics with our new government and the future of our oil, gas and coal industry. Much clarity is needed right now for the future of the Energy Industry. The government of Alberta has granted the Alberta Energy Regulator (AER) to oversee all aspects of energy activities in accordance with government policies, to regularly inspect energy activities to insure that all applicable requirements are met and to penalize companies that fail to comply with AER requirements. The AER can enforce industry compliance with regulations using tools that include more frequent and detailed inspections and therefore shutting down operations leading to a financial strain to our economy. Our experiment may provide more clarity regarding the presence of heavy metals. This could help guide the refinement of the bitumen extraction process, making it more efficient, clean and productive and to open questions regarding the prevention of accumulation of harmful concentrations of heavy metals.

Scientific Merit:

Specific oxidation states of arsenic and chromium are considered to be some of the most toxic naturally occurring elements. Both are highly toxic in small doses, and arsenic is extremely soluble in water. The Bishop Carroll SotB team is studying the concentrations and the oxidation states of arsenic, cadmium, and chromium. Prior to attending the CLS, our team plans to collect samples and further research any relevant information or previous accounts of arsenic, chromium or cadmium found in refineries of bitumen. We intend to carry out XRF and XANES scans with the high energy crystal on IDEAS beamline on raw ore and mature fine tailings, as well as some standards: Arsenic(III), Arsenic(V), Chromium(III), Chromium(VI). And Cadmium(II). Standards will be used for linear combination fitting. From XRF scans we ran during previous beam time we can hypothesize that the concentrations of chromium and arsenic will be greater in the mature fine tailings than in the raw ore.

Past Productivity:

Three returning students had one shift at the CLS in February of 2016, where they tracked the concentration and oxidation states of sulfur throughout the bitumen extraction process. It was found that the concentration decreased and the ratio of oxidation states 5 and 6 to oxidation state 0 increased throughout the bitumen extraction process.

Experimental Procedure:

XRF and XANES scans with a high energy crystal will be performed on 3 samples and 4 standards (refer to Chemical Materials). Each sample will be enclosed in kapton tape. The estimated time for an XRF scan is 5-10 minutes, and for a XANES scan is approximately 20-30 minutes. The XANES data will be analyzed using linear combination fitting.

Samples:

Raw Ore(s)
Mature Fine Tailings(l)
Polymer Amended Mature Fine Tailings(l)
Arsenic III
Arsenic V
Chromium VI
Chromium III

Slide 1:
-MFT XRF
-MFT XANES (Arsenic)
-MFT XANES (Chromium)
-RO XRF
-RO XANES (Arsenic)
-RO XANES (Chromium)
-Arsenic V XANES
-Arsenic III XANES

Slide 2:
-Chromium VI XANES
-Chromium III XANES
-PAMFT XRF
-PAMFT XANES (Arsenic)
-PAMFT XANES (Chromium)