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Mineralogy of Athabasca Oil Sands Fine Tailings

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Beamline(s): X3B1

Introduction: Understanding the mineralogy of the phyllosilicates in oil sands fine tailings is essential for modeling the release water chemistry in addition to understanding the rheological and geotechnical behaviour during transport and deposition. Synchrotron x-ray diffraction provided a means for studying small amounts of interstratified smectite in the kaolinitic and illitic fractions. The interstratification is largely responsible for the large surface area of the phyllosilicates and controls the fine tailings properties.

Methods and Materials: Oriented and randomly oriented aggregates saturated with interlayer water and ethylene glycol were investigated using x-ray diffraction.

Results: Figure 1 shows the diffraction patterns of oriented minus 0.2-μm and minus 2-μm fractions of the fine tailings. With two molecules of ethylene glycol in the interlayer, discrete smectite (17 Å) was not observed in the samples. The peak at 12.7 Å is typical of ordered illite-smectite mixed layers (~ 75% illite in the mixed layer). K - saturation and dehydration caused the swelling layers in the illite-smectite fraction to collapse to 10 Å of discrete illite. Dehydration also increased the low-angle asymmetry of the 7.2 Å peak (basal reflection of kaolin). Smectite was determined to be randomly interstratified in kaolin (~ 90% kaolin in the mixed layer). Higher-order reflections show the mixed layering effects of kaolin and illite with smectite [1]. Quartz and chlorite are present in minor quantities in the minus 2-μm fraction. Figure 2 shows a three-dimensional diffraction pattern of the fine tailings. The (hk0) peaks of all the phyllosilicates are nearly coincident and very broad indicating the large surface areas of these minerals. The nature of the scattering domains in the (hk0) planes is still being investigated. Aside from the phyllosilicates, there are minor concentrations of quartz, rutile and anatase, especially in the minus 2-μm fraction.

Conclusions: The phyllosilicates in oil sands fine tails are primarily illite, illite-smectite, kaolin, kaolin-smectite and minor quantities of chlorite. The smectitic interstratification in kaolin and illite is responsible for the large surface area of the fine tailings.

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References:

[1]. O. E. Omotoso, R.J. Mikula and P. W. Stephens, “Surface Area of Interstratified Phyllosilicates in Athabasca Oil Sands from Synchrotron XRD,”submitted: *Adv. X-Ray Anal.,* (2001).

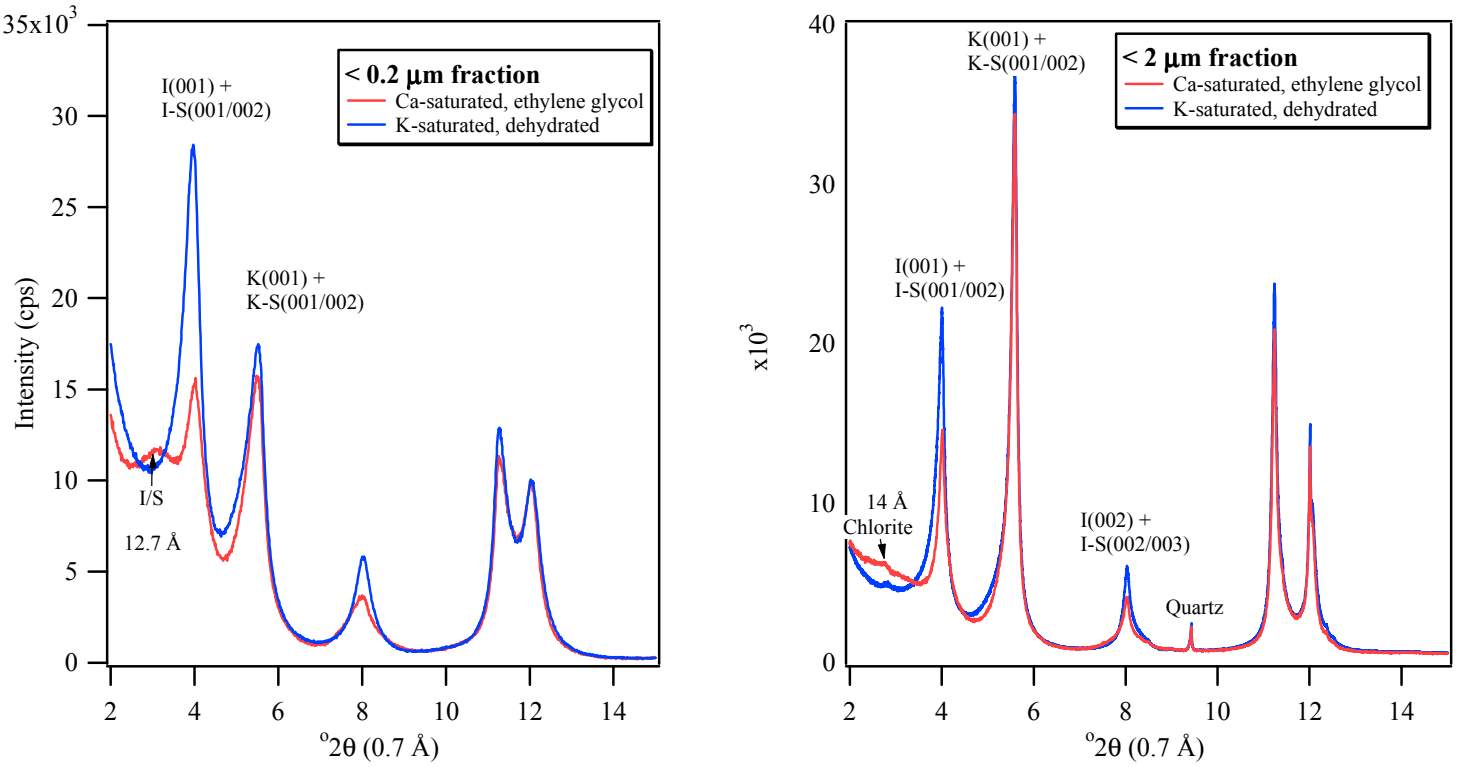

Fig. 1: XRD patterns of oriented slides of fine tailings.

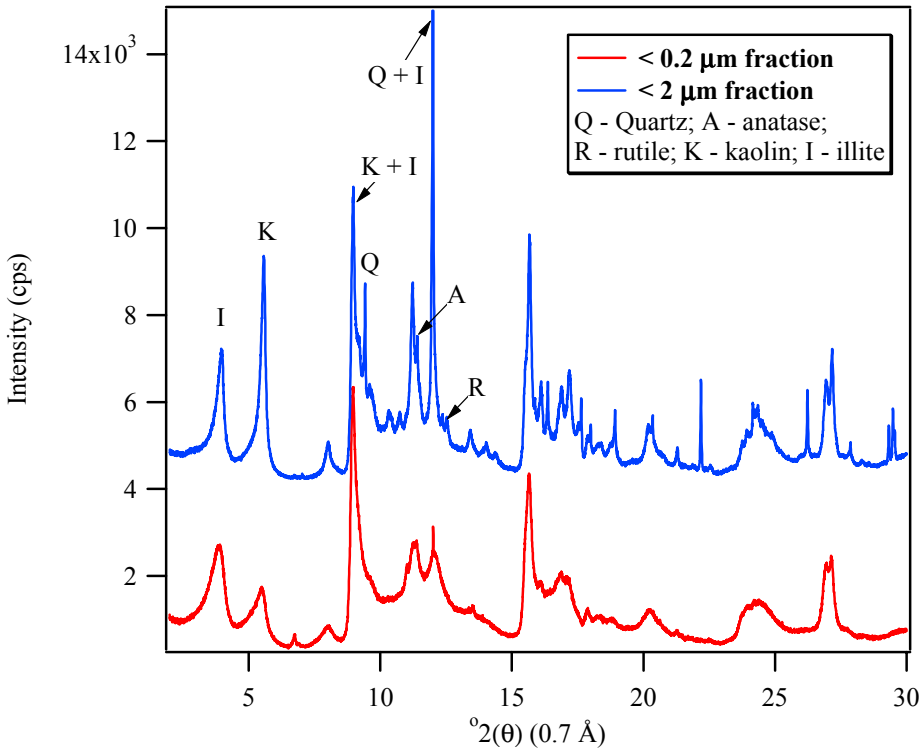

Fig. 2: Randomly oriented XRD patterns of fine tailings.