Surface Properties, Mineralogical Properties and Chemical Composition of Petrologic End Members of Alberta Oil Sands

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The Alberta oil sands ores are a combination of four petrologically different "end members", that were deposited in marine and estuarine sedimentary environments. These are the Marine Sands, Marine Clay, Estuarine Sands and Estuarine Clay. Certain minerals (mainly clay minerals) in the oil sands may affect processability of the ore during non-aqueous extraction. The aim of the present study was to perform mineral and chemical characterization of the four end members, as well as to examine the surface properties in order to better understand the mineralogical and geochemical factors affecting non-aqueous bitumen extraction and solvent recovery from the extraction tailings. The as-received end members and their different size fractions were examined using XRD, QXRD, FTIR, ICP-MS, elemental (CHNS) analysis, Mössbauer spectroscopy, cation exchange capacity, layer charge density and specific surface area analysis. The results revealed variable amounts of toluene insoluble organic carbon in the samples after bitumen removal. The amount was higher in the finer size fractions, indicating its association mainly with the clay minerals. Bitumen removal was most effective in the coarse-grained quartz-rich samples containing a minimal amount of the clay minerals. The four end members were composed of quartz, clay minerals (kaolinite, illite, mixed layer illite-smectite and chlorite), carbonates, K-feldspar and TiO_2 minerals. The highest relative amount of mixed layer illite-smectite was found in the finest fractions (<0.2 μm). The expandability (S_{XRD}) of illite-smectite was about 9%. The quantitative mineralogical analysis correlated well with chemical composition analysis and surface properties of the petrologic end members.