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Determination of Reservoir Properties in Bitumen Saturated Core from XRF Analyses

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Oil sand reservoirs pose significant obstacles in the determination of even fundamental rock properties such as mineralogy. The bitumen in these reservoirs coat and fill among grains making direct visual observation impractical. Conventional techniques for determination of mineralogy such as examination using binocular microscopes, thin section analyses or X-Ray Diffraction (XRD) require the heavy oil or bitumen to be removed from the sample. Solids, including clay minerals, are lost during this procedure. Determination of the types and amounts of clay minerals present is important in these reservoirs as they impact both production and upgrading processes.

Surfaces of slabbed oil sands cores can be analysed directly using portable XRF instruments, eliminating the need to extract the bitumen from the sample prior to analysis. These analyses are rapid, non-destructive, require minimal sample preparation and allow for the collection of a large amount of data at low cost. XRF analyses provide highly precise, and if calibrated properly, accurate data on the bulk chemistry of a sample.

Elemental data obtained from XRF analyses are useful in determination of a chemical stratigraphy. However, geoscientists and engineers are more familiar with and work with mineralogy and reservoir properties rather than elemental composition. We have developed normative mineral and reservoir property algorithms to convert the elemental data into these more familiar forms. Normative mineral algorithms applied to sedimentary rocks are often unsuccesesful in determining mineralogy because mineral compositions are underconstrained. Our normative mineral algorithms employ both major and trace element composition. The addition of trace element distribution factors allow much better constraints to be placed on the segregation of major rock forming elements. By incorporating the distribution of both major and trace elements into specific minerals, mineralogy determinations and mass balance equations for each element can be optimized.

Mineralogy and elemental data are also used to define reservoir properties through a set of semi-emperical equations. Porosity, bitumen content, and sulphur in bitumen values obtained using XRF data compare well with wireline logs and lab measured results.