Incorporation of XRF Data in Rock Analysis Workflow: Applications to Oil Sands

Tom Weedmark, MSc, P. Geol.
XRF Solutions Ltd., tweedmark@xrfsolutions.ca

Summary

XRF Solutions have developed a novel approach to determine reservoir properties of oil sands and heavy oil reservoirs through direct XRF measurements on core and cuttings. There are several benefits to using this approach: including non-destructive data collection, high resolution data, determination of multiple reservoir properties from a single analysis, rapid turnaround, and lower cost compared to conventional laboratory analyses. Several reservoir properties can all be derived from modelling XRF elemental data; including spectral gamma, mineralogy (including clays), grain size, porosity, permeability, oil content, water content, and oil quality. Results produced are comparable to those obtained from conventional laboratory techniques such as XRD, Dean Stark and others. These conventional laboratory analyses are destructive, costly and require significant time (weeks to months). XRF data are obtained and processed rapidly (within a few days) at a fraction of the cost and at higher resolution (10 cm spacing resulting in 100's of analyses per core). An example of XRF derived reservoir properties from two oil sand cores are displayed in Figure 1 and compared against data from conventional lab techniques.

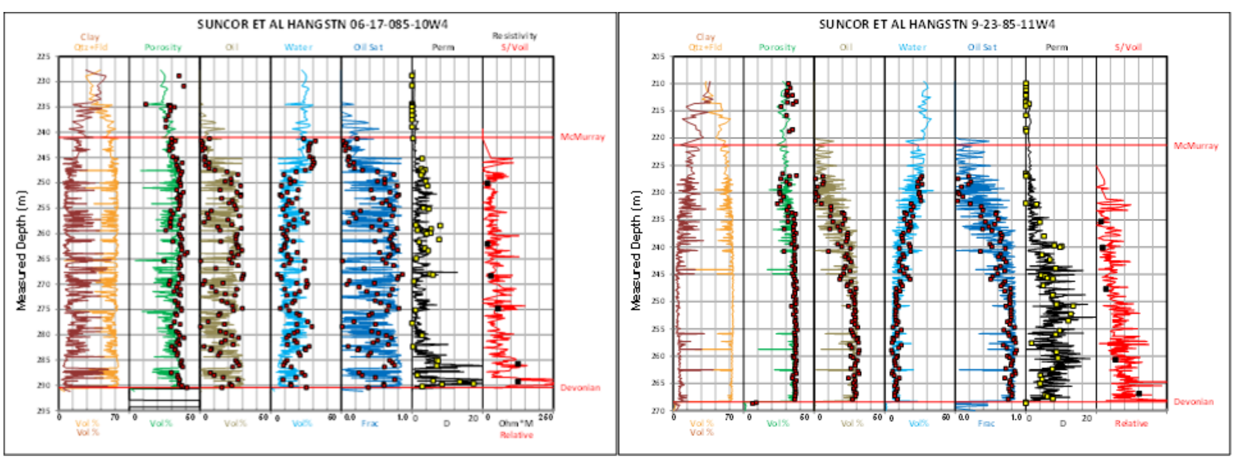

Figure 1. XRF Reservoir Properties. Reservoir properties from two oil sands cores are displayed with depth. Continuous colored curves are XRF modelled reservoir properties for mineralogy, porosity, oil content, water content, oil saturation, permeability, and S/Voil. Lab data are overlain as colored boxes from Dean Starks (red), permeability (yellow), and viscosity (black) analysis.

In order to develop reservoir properties from XRF elemental data, a model must be developed on 2-3 cores in the area. This model building process generally requires a few weeks. XRF analyses can be employed as a screening tool after photographing the core in order to attain high resolution initial estimates of reservoir properties. Initial results can be used to select areas of interest for conventional lab testing, thereby high grading those sample points. When lab results are available, the two data sets can be compared for quality control and to determine if final calibrations are required on the XRF results. By incorporating XRF into the core analysis process, high resolution data are available for all modelled reservoir properties much faster and with less conventional sampling.

The XRF models developed on core can also be applied to data collected on drill cuttings from SAGD or heavy oil horizontal wells. All the same reservoir properties (except oil and water estimates) modelled on core can be determined along the horizontal well path. This data is useful for customizing completions, mapping the reservoir, planning well stimulation, and locating problematic intervals. An example of XRF determined mineralogy and particle size distribution along a heavy oil horizontal well are displayed in Figure 2.

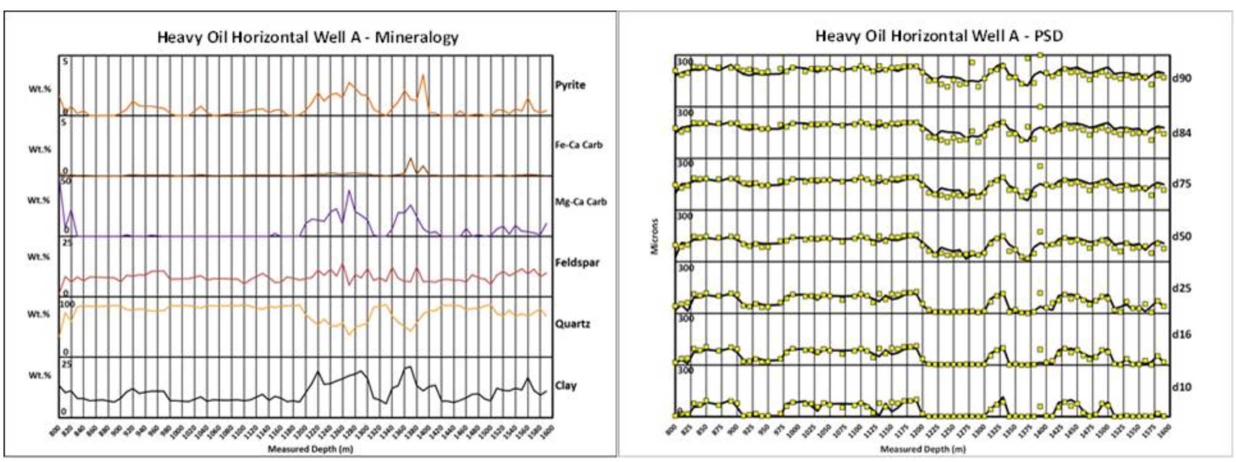

Figure 2. XRF Mineralogy and Particle Size Distribution in Horizontal Well. Mineralogy and particle size distributions (PSD) determined on cuttings from XRF elemental data are displayed with depth along a horizontal well. Continuous curves are XRF modelled vales for Mineralogy and PSD. PSD determined from lab measured laser diffraction particle size distribution analysis are overlain as yellow squares.