Machine learning for SMART mineral mapping using coupled XRF-XRD

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A Synchrotron-based Machine learning Approach for RasTer (SMART) mineral mapping was developed to train a mineral classifier that can interpret raster-scanned millimeter-sized areas of rock thin sections with micron-sized resolution. Training is done using Artificial Neural Networks (ANN) (Figure 1) with coupled micro X-ray fluorescence (μXRF) intensities, which provide information about element abundances, and micro X-ray diffraction (μXRD) patterns, which provide information about mineral identity.

The resulting SMART mineral mapper can identify minerals using only micro X-ray Fluorescence (μXRF) data. The value of this approach comes from the fact that μXRF data are relatively fast to collect and interpret whereas the μXRD data take longer to collect and much longer to interpret.

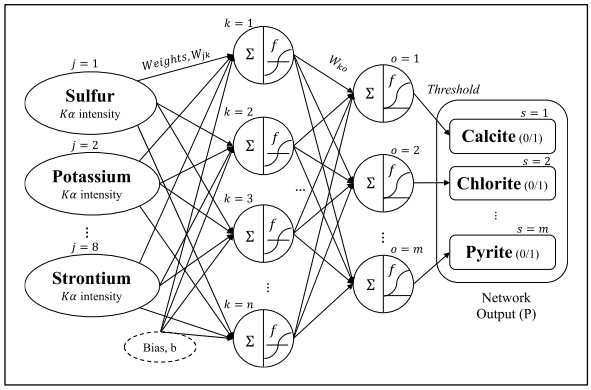

Figure 1. Artificial Neural Network (ANN) for mineral classification from XRF data.

In application to a 14 mm^2 area of a thin section of Eagle Ford shale scanned with 2 μm resolution, 26 minerals were detected using 8 elements (S, K, Ca, Ti, Mn, Fe, As, Sr). In the testing phase, all but two of 76 testing data points were correctly classified.