Comparing microscale XRF analysis to bulk results in geological samples

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X-ray fluorescence (XRF) is a reliable, non-destructive method for measuring elemental abundances in geological samples. Micro-XRF mapping measurements are becoming more common, and they can reveal valuable information about a rock, including the spatial relationships between elements and how they are distributed in a sample. However, the bulk-rock properties remain important both inherently for understanding the sample as well as for comparing to other bulk measurements that may previously exist. Here, a pair of igneous samples (a granite and a diabase) collected from the same sites as USGS geochemical reference samples G-1 and W-1 are mapped. Measurements were taken over an 18 mm by 18 mm grid with 1 mm spacing and a 100-micron spot-size. Spectra were analyzed using PIQUANT, x-ray fluorescence analysis software for developed for the Planetary Instrument for X-ray Lithochemistry (PIXL).

We have three main findings. First, there are different ways to combine data from a micro-XRF maps to generate bulk results for elemental abundance. Summing spectra versus averaging quantification results from individual measurements makes negligible difference for major elements but can lead to very different results for trace elements. Second, in both samples, a consistent, representative sampling of the bulk rock is achieved in 20 spectra, after which increased sampling yields diminishing returns (Figure 1). Third, information on the mineral components of the rock may be obtained, but it is likely limited by the grain-size to beam-size ratio.

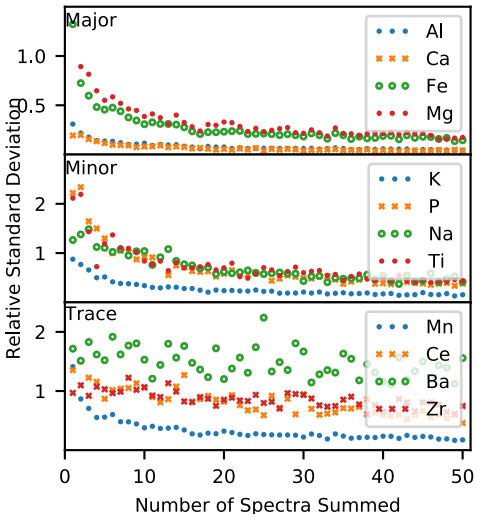

Figure 1: Standard deviation of summed microscale measurements of a granite sample. Plotted here is the standard deviation within sets of 50 summed microscale analysis against the number of spectra included in each sum.