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A Multi-Technique Approach to Geological Sample Analysis: X-Ray and Raman Spectroscopies

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Detailed studies of mineral assemblages in geological samples often require information on both the elemental and molecular levels. X-ray microanalytical techniques such as energy-dispersive and wavelength-dispersive spectroscopies (EDS and WDS) provide the analyst with tools to rapidly determine elemental and mineral distributions across samples. However, knowledge of the elemental chemistry alone may not enough to fully characterize a mineral phase, and information on the molecular chemistry is desired. The vibrational information from Raman microscopy allows the analyst to generate chemical images on the molecular level. These images can be correlated with the elemental images from EDS to provide a complete picture of the sample chemistry

The Raman microscope provides viewing options such as transmitted, reflected and polarized light as found in a standard petrographic microscope. This allows the geologist to easily identify and target the areas of interest for analysis. The high (sub-micron) spatial resolution of Raman microscopy allows correlation of sample features observed and analyzed by EDS/WDS in the scanning electron microscope (SEM).
EDS and WDS are x-ray techniques that utilize the SEM. The spatial resolution of the analyses are limited only by the type of electron microscope and the beam-sample interaction constraints. The depth of x-ray generation in the sample is a function of electron beam accelerating voltage and sample chemistry. In optically transparent samples Raman microscopy can extend the analysis to isolate and characterize sub-surface features such as inclusions (e.g melt inclusions and fluid inclusions).

Samples prepared for petrographic microscopy (thin sections, ore mounts) need no further preparation for analysis with the Raman microscope and only a thin conductive coating may be necessary for EDS/WDS analysis in the SEM.

We present case studies of geological materials in which the use of the complementary x-ray microanalysis and Raman spectroscopy techniques are necessary to fully characterize the chemistry of the samples.