Microanalysis across the Curriculum – Integrating Electron Microprobe and Micro-XRF Instruments into Undergraduate Teaching and Research

Abstract

In 2010, Concord University, a 2800-student, predominantly undergraduate institution in southern West Virginia, installed an ARL SEMQ electron microprobe and a Bruker AXS XRF microprobe. These instruments provide a unique opportunity for undergraduate students to gain hands-on experience with microanalysis techniques. The instrumentation is housed in the Microanalytical Laboratory, which is a part of the Department of Physical Sciences at Concord University.

The SEMQ is equipped with energy-dispersive x-ray spectroscopy (EDS) and wavelength-dispersive spectroscopy (WDS) for elemental analysis. The EDS detector is capable of detecting elements as light as sodium (Na) and as heavy as uranium (U). The WDS detector is used for higher-resolution analysis of specific elements.

The XRF microprobe is equipped with a high-sensitivity energy-dispersive x-ray detector and a sample stage capable of point analysis and X-ray mapping/imaging (including spectral imaging/hyper-mapping). X-ray fluorescence (XRF) analysis is used for qualitative elemental mapping of areas as large as 100 cm² with a resolution of 0.1-1 mm. This equipment offers outstanding opportunities for our students who have taken the upper-level undergraduate courses in mineralogy. We have begun to integrate microanalysis into the curriculum at all levels from introductory general education to advanced major courses in multiple disciplines, including the earth sciences, chemistry, and physics/material science. Initial enrollment in our microanalytical courses in fall and spring 2012 reached 100 students.

We have found that students who have completed primary coursework in mineralogy are more engaged and interested in the microanalytical aspects of geology, and we have observed an increase in the number of students pursuing majors in geology.

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The West Virginia Research Trust Fund supported the installation and initial operation of the electron microprobe.

A West Virginia EPSCoR Innovation Grant funded 3/4 of the EDS upgrade.

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Microanalysis in Geology 101

[Diagram of mineral analysis process]

Mineral Specimens - Spot Analyses. Chemistry as a tool in mineral identification; and Thinking of minerals as compounds.

Rocks - Spot Analyses, X-ray Maps, & Area Analyses - continued

Composite EDS spectra and semi-quantitative analyses extracted from selected regions of the X-ray maps. Together these show that elements contribute to form minerals which in turn form rocks.

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Microanalysis in Student Research

Example: chemical fingerprinting of volcanic ash for lahar monitoring.

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