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Application of Automated SEM-EDS Based Mineral Identification Systems to Problems in Metamorphic Petrology

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Automated scanning electron microscopy-energy dispersive x-ray spectrometer (SEM-EDS) based mineral identification systems such as QEMSCAN have been in development for over 20 years, primarily as a tool to understand mineral liberation and element distribution in metal mining industry. This powerful technique is now being used in non mining applications such as metamorphic petrology where accurate mineral identification and metamorphic fabrics are key to deciphering the metamorphic history of samples.

The QEMSCAN was developed by CSIRO for application in the mining industry where it is used to understand mineralogy, texture, mineral associations, the presence of gangue minerals and deleterious elements that may potentially interfere with mineral processing and planning, and the overall impact of mineralogy on grinding and flotation processes. It is capable of identifying most rock-forming minerals in milliseconds from their characteristic x-ray spectra. The collected x-ray spectra are compared to entries in a database containing the species identification profiles (SIPs) and are assigned a label accordingly. QEMSCAN is capable of searching large sample areas at high resolution resulting in the accurate and precise determination of all minerals present. Reports that were originally developed for the mining geologist can be equally useful to the petrologist, e.g. phase/mineral maps, modal mineral abundances and mineral association reports.

Identification of key minerals is of great importance to determining the petrologic history of a sample. These key minerals may be few in number and present as small microinclusions (less than 100 μm) making them difficult to identify, if at all, with the petrographic microscope. Therefore, imaging by electron-microprobe or scanning electron microscope are the methods traditionally used. However, because of the small field of view available on these instruments at a magnification necessary to resolve micron sized relicts and textures, the search for a few microinclusions may be extremely time consuming, tedious and costly. QEMSCAN with its ability to provide large quantitative data sets and search large sample areas at high resolution means that whole thin sections can have their mineralogy accurately and precisely determined in hours. For instance in metamorphic petrology once relict minerals of earlier metamorphic assemblages are located; thermobarometry and geochronology can then be applied; resulting in a wealth of information on previous segments of the pressure-temperature-time-deformation path. The relict mineral textures and their relationship to the fabric of the entire thin section can be easily seen in the phase/mineral map yielding important textural information.

We have developed a SIP database to be used to study metamorphic samples from the Central Metamorphic terrane (CMt) of the eastern Klamath Mountains, northern California. The CMt was chosen because recent work has resulted in the discovery of relict rutile grains and ilmenite-plagioclase-amphibole symplectites textures interpreted as the decomposition of either garnet or omphacite during exhumation from eclogite facies conditions. The QEMSCAN is being used primarily to search for these relict garnet and omphacite grains. Although only a few samples have been run, no garnet or omphacite have been located thus far. However, in a very short period of time the modal mineral abundances and overall fabric have been determined to a degree never previously achieved.