A82 Cathodoluminescent Signatures of Neutron Irradiation

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After attending this presentation, attendees will understand the principles of cathodoluminescence spectroscopy and the effects of neutron irradiation damage to minerals commonly encountered in soils and building materials.

This presentation will impact the forensic science community by illustrating the practical application of cathodoluminescence spectroscopy of commonly encountered minerals to the detection of proximate nuclear materials.

Nuclear proliferation and the potential threat to national security from unsecured special nuclear materials have renewed our national interest in not only detecting the presence of these materials, but also in detection of materials' pathways into this country. Currently, the only method to identify where special nuclear materials have been stored involves measuring induced radiation in adjacent materials, which is usually short-lived (n, gamma) radiation. Identified in this research is a permanent change to the luminescent properties of certain common minerals that is due to neutron irradiation that could potentially be developed into a nuclear forensics tool.

Feldspars and carbonates are ubiquitous minerals that are known to luminesce under electron bombardment. The UV-Visible spectra of hundreds of individual potassium feldspar and calcite grains were measured with cathodoluminescence (CL) spectroscopy before and after neutron irradiation. CL excitation uses an electron beam to induce fluorescence in certain minerals due to their chemical composition and defects in their crystal lattice structure; the resultant emission spectrum is acquired with a UV-Visible spectrometer.

The presence of ionizing radiation causes additional crystal lattice defects that leave a permanent CL signature. A spectroscopic signature is described that increases proportionately to neutron dose in both calcites and feldspars. Preliminary dose-response results from a neutron source study and a reactor study will be presented. There is also an orientation dependence in the luminescence measurement technique that complicates the analysis, but when fully understood could allow not only the total dose to be estimated, but also the direction of origin of the neutrons to be determined.

Cathodoluminescence, Nuclear Forensics, Minerals