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Cathodoluminescence dependence on feldspar mineral structure and implications for forensic geology

Sarah A. Brokus[1,2,*], Danielle K. Silletti[1,2,†], J. Mark Lunderberg[2,‡], Paul A. DeYoung[3], Graham F. Peaslee[1,2], Dyanne E. Carpenter[1,§] and JoAnn Buscaglia[4,‖]

[1]Visiting Scientist Program, Counterterrorism, and Forensic Science Research Unit, FBI Laboratory, Quantico, Virginia 22135, U.S.A.
[2]Chemistry Department, Hope College, Holland, Michigan 49423, U.S.A.
[3]Physics Department, Hope College, Holland, Michigan 49423, U.S.A.
[4]Counterterrorism and Forensic Science Research Unit, FBI Laboratory, Quantico, Virginia 22135, U.S.A.

Abstract

A collection of 42 feldspar mineral samples from a wide geographical range of North America was examined by cold-cathode cathodoluminescence (CL) spectroscopy. Characteristic wavelength peaks, which were determined to be independent of geographic origin, were associated with each feldspar phase. Most of these peaks were attributed to previously assigned Mn^{2+} and Fe^{3+} luminescent centers and structural defects. An unattributed set of infrared (IR) peaks was observed in many samples; one uncommon ultraviolet (UV) peak was observed in samples from two locations. The peak centroids associated with the Mn^{2+} and Fe^{3+} luminescent centers vary with stoichiometric changes in the K-Na-Ca composition of the feldspars. For both alkali and plagioclase feldspars, shifts in CL peak centroids correlate well with lattice size, as measured by X-ray diffraction (XRD). Additional analyses of the feldspar samples by electron microprobe analysis (EMP), particle-induced X-ray emission spectroscopy (PIXE), energy-dispersive micro-X-ray fluorescence spectroscopy (μXRF), and/or laser-ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) were conducted for confirmation of elemental composition. These results demonstrate the potential of CL spectroscopy, a relatively nondestructive analytical technique, to facilitate rapid discrimination between feldspar samples. The addition of CL spectroscopy of feldspars to existing forensic analytical protocols for geologic materials has the potential to provide support for casework, both to discriminate sources in a forensic comparison, as well as to constrain the provenance of an unknown sample.

Keywords: Luminescence, feldspar, forensic geology, spectroscopy