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Correlations between cathodoluminescence intensity and aluminum concentration in low-temperature hydrothermal quartz

Mao-Wen Yuan[1,2], Lin Li[1,3,*], Masroor Alam[4], M. Santosh[2,5], Sheng-Rong Li[1,2], and Zeng-Qian Hou[6]

[1]State Key Laboratory of Geological Processes and Mineral Resources, China University of Geosciences, Beijing 100083, China
[2]School of Earth Science and Resources, China University of Geosciences, Beijing 100083, China
[3]Institute of Earth Sciences, China University of Geosciences, Beijing 100083, China
[4]Department of Earth Sciences, Karakoram International University, Gilgit 15100, Pakistan
[5]Department of Earth Sciences, University of Adelaide, South Australia 5005, Australia
[6]Institute of Geology, Chinese Academy of Geological Sciences, Beijing 100037, China

Abstract

Quartz cathodoluminescence (CL) images are commonly combined with trace element concentrations to decipher complex histories of hydrothermal systems. However, the correlations between aluminum content and CL zoning of low-temperature hydrothermal quartz and their genesis remain controversial. In this contribution, a multiparametric study was carried out on CL-aluminum zoning of low-temperature hydrothermal quartz (<350 °C) from the Shihu and Rushan quartz-vein type Au deposits in the North China Craton. The results show that aluminum concentration correlates negatively with CL intensity in quartz from the Shihu Au deposit. CL-dark quartz zoning has significant Al concentrations as well as detectable Al-H bonds. However, in the Rushan Au deposit, the correlation is positive, and aluminum is enriched in the CL-bright quartz zoning. The Al content is positively correlated with K content with $r^2 = 0.769$. Combined with the electron backscatter diffraction (EBSD), X-ray single crystal diffraction (XRD), and transmission electron microscope (TEM) data, we infer that the genesis of CL zoning in the low-temperature hydrothermal quartz is closely related to Al^{3+}-H^+ and Al^{3+}-K^+ concentrations. The Al^{3+}-K^+ may act as the CL-activator, while the Al^{3+}-H^+ may act as the CL-dampener. Where Al^{3+}-Si^{4+} substitution is charge balanced by hydrogen, the intensity of CL response decreases; where Al^{3+}-Si^{4+} substitution is charge balanced by potassium, the intensity of CL response increases. The correlations between CL intensity and aluminum concentration in the low-temperature hydrothermal quartz reflect pH fluctuations of hydrothermal system.

Keywords: Shihu and Rushan Au deposits, low-temperature hydrothermal quartz, cathodoluminescence, Al^{3+}-H^+ and Al^{3+}-K^+ concentrations, pH