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Origin and significance of the yellow cathodoluminescence (CL) of quartz

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Abstract

The origin of yellow cathodoluminescence (CL) in quartz has been investigated by a combination of CL microscopy and spectroscopy, electron paramagnetic resonance (EPR) spectroscopy, and spatially resolved trace-element analysis by laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS). The study shows that the appearance of a ~570 nm (2.17 eV) emission band can be attributed to high oxygen deficiency and local structural disorder in quartz. A proposed luminescence center model implies self-trapped exciton (STE) emission from localized amorphized regions in quartz. Although the high-intensity emission at 570 nm is in general consistent with high concentrations of E_1' defects detected by EPR spectroscopy, CL studies with different electron beam parameters and annealing experiments up to 600 °C show a temperature and irradiation dependence of the luminescence related defects excluding the role of E_1' centers as direct luminescence activators for the 570 nm emission. The evaluation of geochemical data shows that quartz with yellow CL occurs in low-temperature hydrothermal environment (mostly <250 °C) and is related to fast crystallization in an environment with oxygen deficiency.

Keywords: Cathodoluminescence (CL), yellow CL, quartz, electron paramagnetic resonance (EPR), trace elements