Resolving episodes of deformation and hydrothermal quartz precipitation in the Amalgamated Break fault, Abitibi Subprovince, Ontario, Canada, from microstructural and SEM-CL analyses*

TAYLOR A. DUCHARME, DAVID A. SCHNEIDER, AND MARK J. COLEMAN

Department of Earth and Environmental Sciences, University of Ottawa, Ottawa, Ontario K1N 6N5, Canada <tduch009@uottawa.ca>

Scanning electron microscopy cathodoluminescence (SEM-CL) imaging of quartz can reveal microstructural relationships implicating deformation and hydrothermal growth that would not otherwise be visible using conventional optical microscopy techniques. These microstructures manifest in contrasts between strong (bright), moderate (grey) and weak (dark) CL responses. Moreover, as part of this physiochemical phenomenon, chemically distinct hydrothermal regimes may be reflected in alteration and vein mineral assemblages. Discrete episodes of hydrothermal alteration may consequently lead to variations in trace element concentrations in vein quartz and can further enhance the discrete contacts between CL-bright and CL-dark quartz in otherwise optically continuous grains. Samples from the ductile-brittle E-W-trending Amalgamated Break fault zone in the Kirkland Lake region of the Abitibi Subprovince preserve quartz vein sets emplaced during repeated episodes of deformation along the fault. These veins are hosted in subvertical, mylonitized, lowergreenschist facies chlorite-muscovite phyllite. Quartz in pyrite pressure shadows and sigmoidal aggregates of quartz or white mica preserve dominantly north-side-up and sinistral displacement along the fault. This indicates either oblique displacement during the most recent deformation or preservation of two distinct episodes of deformation. Microstructures show quartz accommodated strain by grain boundary bulging (BLG) dynamic recrystallization, suggestive of deformational temperatures between 250°C and 400°C, consistent with $\delta^{18}O$-derived data for fluid temperatures in the region. Quartz CL analysis in these veins highlights growth relationships of progressive generations of hydrothermal quartz. Quartz veins display dominantly CL-dark and CL-grey responses that reveal brecciated CL-dark quartz infilled with CL-grey quartz. Fragmented, euhedral CL-bright quartz crystals with puzzle-like geometry suggest fracturing and subsequent healing through precipitation of CL-dark quartz. Relict detrital quartz grains exhibit a predominantly CL-bright response. These grains are crosscut by bands of CL-dark quartz <1–20 μm in width. CL-bright quartz geometry in veins may represent deformed detrital grains overgrown by hydrothermal quartz. SEM-CL images integrated with polarized light photomicrographs (with the gypsum plate) reveal that intracrystalline fractures and optical grain boundaries delineate domain borders of CL-bright and CL-dark quartz, or otherwise cross-cut CL-bright domains without imposing any discontinuity in CL response. The textures observed indicate at least two episodes of coeval deformation and fluidization: (i) fracturing of CL-bright, detrital quartz followed by infilling and overgrowth by CL-dark hydrothermal quartz; (ii) brecciation of CL-dark quartz by CL-grey quartz-bearing fluids. Integration of these data can shed

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light on sequences of deformation and hydrothermal growth in regions with complex tectonic histories.

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