Strain-induced Quartz Recrystallization in Butte Porphyry Cu Deposit Produces Mottled Cathodoluminescent Textures and Preserves Minimum Ti Concentrations of Dark Euhedral Bands

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We report the first observations of recrystallization textures in vein quartz from the Butte, MT Porphyry Cu deposit. These observations explain the distinct origins of euhedral cathodoluminescent (CL) and mottled CL.

Within single thin sections, grain boundary shapes reveal all three modes of quartz recrystallization, from low-T to high: bulging recrystallization, subgrain rotation, and grain boundary migration. The latter two are most common in Pre-Main Stage quartz. Some quartz grains exhibit euhedral forms in scanning electron microscope (SEM) – CL images, but recrystallized grains exhibit mottled CL texture. Ti in quartz is a CL activator, so CL intensity corresponds with higher Ti concentration. Mottled texture is caused by recrystallization-induced Ti redistribution facilitated by water over a temperature range of 250 – 550° C. Among mixed euhedral and mottled quartz crystals in a single section, the c-axes of the two are roughly perpendicular. Even in the presence of abundant water and high T, quartz did not recrystallize if the dominant slip mechanism for a given deformation regime is restricted by crystal orientation in a stress field. For example, recrystallization by grain boundary migration, which occurs by basal sliding perpendicular to the c-axis, is inhibited if the applied stress lacks a shear component perpendicular to the c-axis. Thus, we conclude that contiguous CL-euhedral crystals did not recrystallize because they weren't favourably oriented. CL textures are intermediate between mottled and euhedral in crystals that have undergone subgrain rotation, a lower temperature and slower recrystallization process than grain boundary migration.

Microprobe analyses of CL-bright -dark oscillations in single CL-euhedral crystals show Ti average concentrations of 100 ppm in the bright zones and 30 in dark. Mottled edges of the same crystals yield an average of 30 ppm. Ti in neighbouring CL-mottled crystals also average 30 ppm, as does Ti in intermediate CL textures. These data show that Ti homogenization of euhedral CL quartz preserves the Ti concentration of the dark CL bands, which affects interpretation of TitaniQ temperatures in CL-mottled quartz.