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Zoned quartz phenocrysts from the rhyolitic Bishop Tuff

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ABSTRACT

Cathodoluminescence (CL) reveals growth zones in quartz phenocrysts from the rhyolitic Bishop Tuff. Melt inclusions occur in various zones and record the evolving melt composition during zonal growth. The zones form an oscillatory pattern between bright and dark CL quartz. There are three recognizable patterns of CL zoning in these crystals: (1) weakly zoned cores and bright CL rims; (2) weakly zoned cores and dark CL rims; and (3) no CL intensity difference from core to rim. Dark CL quartz generally occurs at crystal edges, contains most of the melt inclusions and is interpreted as fast-growing. Zones that occur along recognizable crystal edges (edge zones) are thicker than the same zone on adjacent faces, consistent with relatively fast growth of these zones. In each successive zone, these edge zones decrease in size toward the rim, while the zones along the crystal faces increase. Some of the melt inclusions have bright CL quartz locally associated with them. This is interpreted as the postentrapment crystallization of slow-growing quartz in the melt inclusions. Many crystals display zone discordance from the weakly zoned interiors to the rims. Most of the discordant surfaces are rational and probably are primary growth features. Pumice clasts from the southern vents are largely compositionally and texturally distinct from those from the northern vents, and this distinction is also evident in the quartz CL. The crystals that have bright CL rims are all associated with the late-erupted northern part of the Bishop Tuff. Melt inclusion compositions and CL zoning patterns suggest a common origin for early and middle-erupted quartz and the interior zones of late-erupted quartz; however, the bright CL rim on the late-erupted quartz indicates an additional stage of crystallization in late-erupted magma. Melt inclusions in individual early erupted crystals have small variations in Ba whereas inclusions in late-erupted crystals markedly increase in Ba toward the rim, which is opposite to the normal zoning of sequentially trapped melts expected during closed system crystallization differentiation. The quartz zoning features are consistent with the hypothesis of crystal settling in evolving magma that erupted late from northern vents.