Oxygen Isotope Systematics of Magmatic Epidote

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Although magmatic epidote in granitic rocks can potentially provide important constraints on depths of crystallization and rates of ascent, existing textural criteria for distinguishing magmatic from subsolidus epidote can be equivocal. Oxygen isotope compositions may provide additional constraints on the magmatic versus subsolidus origins of epidote. A biotite rhyolite of the Pleistocene Sutter Buttes volcano contains phenocrysts of magmatic epidote (Ep), quartz (Qt), plagioclase (Pl) and biotite (Bt). Discrete but spatially related Ep, Qt, Pl and Bt from 6 samples yield an average □Qt-Ep of 3.10±0.12‰ (n=5), □Pl-Ep = 1.75‰, and □Ep-Bt = -0.44‰. Values in Late Cretaceous rhyodacite dikes from Boulder County include □Qt-Ep = 3.12±0.06‰ and □Ep-Bt = 1.47±0.34‰. The 3 Late Cretaceous tonalitic plutons in which Zen and Hammarstrom (1984) originally documented magmatic epidote, plus the Ordovician Ellicott City granodiorite, yield remarkably consistent values: □Qt-Ep = 4.19±0.17‰, □Pl-Ep = 1.64±0.19‰, □Ep-Amph = 0.54±0.25, and □Ep-Bt = 0.85±0.24‰. Values of $\delta^{18}O$ for mafic diorites and gabbronorites from Milford Sound (New Zealand) are more variable:

Ep $\delta^{18}O$ = 3.65 to 4.25‰, Pl $\delta^{18}O$ = 4.93 to 6.37‰, and Amph $\delta^{18}O$ = 3.06 to 4.16‰. The data are interpreted to indicate that 1) published fractionations involving epidote may be in error, 2) natural samples preserve a combination of magmatic fractionations, post-crystallization diffusion, and evidence of interaction with high temperature fluids.