

Evaluation and application of the quartz-inclusions-in-epidote mineral barometer

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ABSTRACT

We have examined the suitability of a quartz-inclusions-in-epidote (qtz-in-ep) mineral barometer to better constrain P - T histories of epidote-bearing lithologies. Theoretical calculations applying an isotropic elastic model suggest that the qtz-in-ep barometer exhibits minimal temperature dependence, and thus, offers the potential to constrain growth conditions of epidote in various geologic environments, including skarn deposits, epidote-bearing granitoids, and metamorphic rocks.

To test if the applied equations of state and isotropic elastic model reasonably simulate the elastic evolution of two anisotropic minerals, we measured Raman shifts of the 464 cm^{-1} band of quartz inclusions relative to that of an unencapsulated quartz standard. We calculated a quartz inclusion pressure (P_{incl}^{464}) at various temperatures and compared these values with temperature-dependent P_{incl} predicted by elastic modeling ($P_{\text{incl}}^{\text{mod}}$) at elevated temperatures. Three epidote-bearing samples with reasonably well-constrained P - T histories were also examined: (1) sample HF14C from the Upper Schieferhuelle in the Western Tauern Window, Italy ($P_{\text{incl}}^{464} = 0.01$ GPa); (2) sample LdC-31C from Lago di Cignana, Italy ($P_{\text{incl}}^{464} \approx 0.16$ GPa); and (3) sample FT1E from the Frosnitz Tal in the Western Tauern region, Austria ($P_{\text{incl}}^{464} = 0.57$ GPa).

Entrapment pressures (P_{ent}^{464}) calculated from P_{incl}^{464} determined at various temperatures show nominal differences from P_{ent} calculated from $P_{\text{incl}}^{\text{mod}}$, suggesting that for qtz-in-ep pairs, the calculated P_{ent} does not significantly vary with the temperature of measurement. Furthermore, our calculated P_{ent}^{464} for a sample from the Upper Schieferhuelle is in agreement with petrographic context and previously established P conditions, and the P_{ent}^{464} determined for the Frosnitz Tal sample closely approximate previously reported pressures. The Lago di Cignana sample is derived from an epidote vein that is encased in a high- P foliation, and the calculated P_{ent}^{464} is consistent with early, low- P epidote vein formation that pre-dates high- P metamorphism, or alternatively, late vein formation during exhumation, and confirms that the epidote did not form at or near peak conditions (~ 2.0 GPa). The results of this study indicate that the qtz-in-ep barometer potentially provides another tool that geoscientists can employ to better constrain P - T conditions in some epidote-bearing environments, where conventional thermobarometric techniques cannot be applied.

Keywords: Elastic thermobarometry, epidote, Raman spectroscopy, quartz inclusions, thermobarometry; Applications of Fluid, Mineral, and Melt Inclusions