Garnet records of pressure and fluid pulses during subduction

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Synchrotron Fourier transform infrared (FTIR) microspectroscopy was performed on rhythmically (compositionally) zoned, high pressure/low temperature (H*P*/L*T*) garnets from the Franciscan Complex, California and Puerto Cabello, Venezuela. Results reveal a decrease in OH rim-side of garnet dissolution–precipitation surfaces ('petrologic unconformities') marked by sharp breaks in garnet major-element composition. OH in pyrope is correlated with crystallization pressure, and the association between zoning and OH is taken to suggest garnet growth–dissolution cycles were driven by pressure fluctuations during subduction.

Rhythmic major-element zoning in the H*P*/L*T* garnets can be accounted for by periodic pore-fluid overpressure development then dissipation, linked to passing porosity waves and/or seismic cycles within the subduction environment. These models each predict clear association between (over)pressure pulses and fluids. In order to test the origin of the (over)pressure pulses and rhythmic garnet zoning, oxygen isotope analyses were performed by secondary ion mass spectrometry on multiple H*P*/L*T* garnets from California and Venezuela.

Analyses demonstrate no systematic grain-scale oxygen isotope zoning. However, subtle variation in oxygen isotope composition is observed across the domains that define the rhythmic compositional zoning, and a subtle but resolvable break in oxygen isotope composition is associated with garnet growth unconformities. These results are taken to suggest that fluid histories involved distinct open-system events that can be linked to (over)pressure fluctuations and development of the garnet rhythmic major-element zoning.