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Spectroscopic approaches to probing metamorphic episodicity and its drivers

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Raman and Fourier transform infrared (FTIR) spectroscopy have seen recent popularization [e.g. 1] following occasional petrological application since the 1990s. These methods are useful in that they are independent but complementary to established geochemical techniques for probing pressure–temperature (*P–T*) conditions during metamorphism. The utility of spectroscopic techniques in petrology, combined with the fine spatial resolution they offer, makes them particularly useful for investigating the nature and drivers of small-scale metamorphic episodicity [e.g. 2].

Major-element zoning in high *P*/low *T* garnets from Ring Mountain, California and Puerto Cabello, Venezuela record multiple growth–resorption cycles (Figure 1). Such features must mark episodes of garnet stability then instability, presumably driven by changing *P–T* conditions and/or chemical availability. Quartz-in-garnet barometry by Raman spectroscopy was performed to investigate a potential association between fluctuating *P* and these garnet growth–resorption cycles.

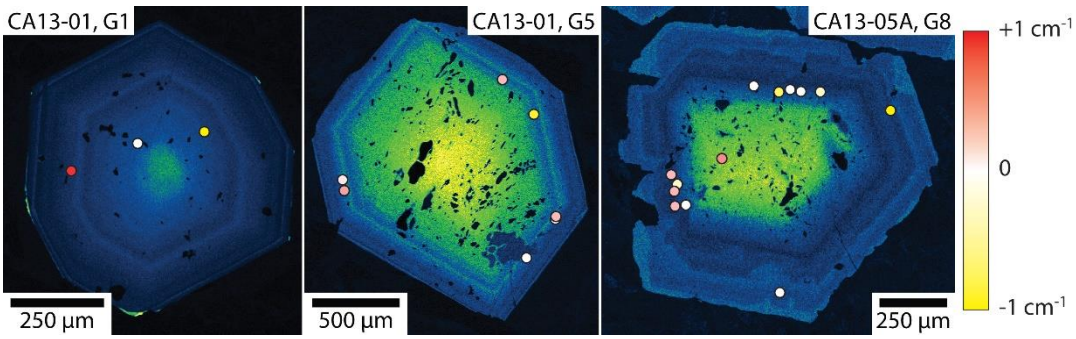

Figure 1: Mn raw x-ray count maps showing growth–resorption zoning in garnets from Ring Mountain, California. Locations of quartz-in-garnet Raman analyses are shown. Analysis spot color gives relative shift of 464 cm^{-1} (A1g) Raman peak in quartz inclusions.

The quartz-in-garnet work demonstrates that growth–resorption zoning is associated with 0.5–1 cm^{-1} variation in position of the A1g Raman peak, over distances < 50 µm (Figure 1). This result indicates multiple, rapid *P* fluctuations of 100–300 MPa—values similar to the expected strength of the rock—during subduction. The growth–resorption features may mark multiple cycles of overpressure development then release; i.e. seismic cycles within the subduction environment. The question of the role of fluids—as a metamorphic catalyst and/or agent of overpressure development—remains. Structural OH and molecular H_2O can be probed by FTIR spectroscopy in the 3200–3800 cm^{-1} range. Interestingly, incorporation of OH in garnet displays *P* dependence [3]. FTIR spectroscopy is planned to confirm the small-scale *P* fluctuations and investigate the potential role of fluids in driving them.

Quartz-in-garnet barometry by Raman spectroscopy was also used to investigate the role of km-scale convection in homogenizing metamorphic *T* gradients in migmatitic rocks of the El Oro Complex, Ecuador [4]. Continuous garnet growth during convection would result in *P* variation during garnet growth. Preliminary results suggest that, from core to rim, quartz inclusions in garnet record small-scale *P* fluctuations. These results await confirmation from the larger sample set.

References:

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