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Refining chemistry-based thermobarometric models using X-ray microdiffraction on experimentally synthesized clinopyroxenes

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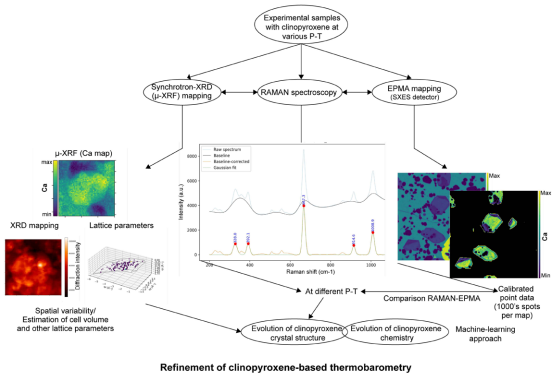

Refinement of clinopyroxene-based thermobarometry

Clinopyroxene is a mineral commonly found in igneous rocks, and its chemistry records a large diversity of physicochemical changes during magmatic processes. The dependence of clinopyroxene chemistry on pressure and temperature is exploited to build thermobarometers, however, the composition of clinopyroxene is also strongly dependent on the composition of the melt it crystalizes from, which may limit the accuracy of thermobarometry models.

Here we present synchrotron-based X-ray microdiffraction (micro-XRD) data collected on clinopyroxenes experimentally synthesized at pressures up to 40 kbar and temperatures between 1000 and 1380 °C. MicroXRD mapping offers high spatial resolution (few mm) quantification of lattice parameter variations within thin sections, though its application to complex geological samples remains computationally and analytically challenging. The experimental charges contain clinopyroxene co-existing with other mineral phases such as amphibole, orthopyroxene, and olivine. The structural and chemical evolution of these samples was assessed through a combination of synchrotron-micro XRD and XRF mapping, Raman spectroscopy, and electron probe micro-analysis (EPMA), providing a multidimensional understanding of the relationships between intensive parameters such as pressure and temperature, chemical composition of the melt and the chemistry of clinopyroxene crystals (Fig. 1). Quantifying these coupled variabilities is a critical step toward refining the accuracy of clinopyroxene-based thermobarometry models.