Fossil Subduction Recorded By Quartz From The Coesite Stability Field

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Investigation of mantle xenoliths can provide information on the architecture and evolution of subcontinental lithospheric mantle through time. These reconstructions rely also on correct estimates of the pressures and temperatures (P-T) experienced by these rocks over time. Unlike chemical geothermobarometers, elastic geobarometry does not rely on chemical equilibrium between minerals, so it has the potential to provide information on over-stepping of reaction boundaries and to identify other examples of non-equilibrium behaviour in rocks. Here we introduce a method that exploits the elastic anisotropy of minerals to determine the unique P and T of equilibration from a measurements of single-crystal mineral inclusions trapped in a crystalline host from an eclogite xenolith [1]. We apply it to perfectly preserved quartz inclusions in garnet from eclogite xenoliths in kimberlites. We show that the elastic strains of inclusions calculated from in-house Raman spectroscopy measurements of the inclusions are in perfect agreement with those determined from in-situ X-ray diffraction measurements performed both in-house and at the synchrotron. Calculations based on these measured strains demonstrate that quartz trapped in garnet can be preserved even when the rock passes into the stability field of coesite (high pressure and temperature polymorph of quartz). This supports a metamorphic origin for these xenoliths that provides constraints on mechanisms of craton accretion from a subducted crustal protolith. Furthermore, we show that some key inclusion minerals do not always indicate the P and T attained during subduction and metamorphism.

This project has received funding from the European Research Council under the H2020 research and innovation programme (N. 714936 TRUE DEPTHS to M. Alvaro)