Quartz inclusions from eclogite xenoliths record past subduction

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The mechanisms attending the downward transport of crustal material, and its return back to the Earth's surface, are still a matter of debate. Chemical information only allows the interpretation of mineral assemblages in terms of lithostatic pressure and chemical equilibrium which might be biased by the presence of deviatoric stresses. A mineral trapped as an inclusion within another host mineral is not free to expand or contract as would a free crystal and develops a deviatoric stress field during the exhumation, that differs from the external stress or pressure applied to the host. We developed a new elastic geobarometric approach that exploits the elastic anisotropy of minerals to quantify the stresses at entrapment if no plastic or brittle deformation occurred upon exhumation. We combine micro-Raman spectroscopy and X-ray diffraction to determine the residual strain state in the inclusion while still trapped in its host [1]. The anisotropic elastic relaxation is evaluated with Finite Element analyses carried out on the realistic 3D reconstruction of the sample obtained from synchrotron X-ray tomographic microscopy. Finally, a thermodynamic calculation that combines the axial equations of state of the host and of the inclusion is adopted to recalculate one unique P and T of entrapment.

The application of this method on quartz inclusions entrapped in a garnet from an eclogite xenolith from the Mir pipe (Yakutiya, [2]) point to an elastic re-equilibration occurred under external hydrostatic conditions at P of ~ 3 GPa and temperatures between 925°C and 1000°C. This suggests a metamorphic origin of this eclogite xenolith, providing constraints on the mechanisms of craton accretion from a subducted crustal protolith.

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[1] Murri et al. (2018) *Am Min*, **103**, 1869–1872. [2] Korsakov et al. (2009) *EJM* , **21**, 1313–1323.