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Improved clinopyroxene barometry sheds light on translithospheric magma storage underneath a continental distributed volcanic field (Chaîne des Puys, France).

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Large uncertainties on existing calibrations have precluded the use of clinopyroxene-based barometers to accurately image the magma storage systems of mafic volcanoes. There is however more and more evidence that these magmatic systems are complex and can extend down to the mantle lithosphere, particularly in distributed volcanic fields.

In this study, large homogeneous clinopyroxene crystals were experimentally grown at 0.2 to 3.0 GPa from a series of samples that span the range of the mildly alkalic series (primitive basanite, trachybasalt, trachy-andesite). The reliability of a variety of clinopyroxene-based barometers was then investigated using these experimentally-grown crystals. Special care was taken to investigate potential sources of uncertainty and mitigate them when possible. Pressure uncertainty in our piston-cylinder setup varies between 25 and 70 MPa (2σ), depending on pressure. Analytical uncertainty can be improved to a value equivalent to 25 MPa (2σ) on most existing barometers by increasing counting times and optimizing diffracting crystals on the electron microprobe. Under those conditions, the accuracy of clinopyroxene barometers (i.e. the absolute crystallization depth) can possibly be improved to a standard error of estimate of about 120 MPa, equivalent to 4.5 km in the continental crust, and the precision (i.e. the relative crystallization depth) to a value of 25 MPa (1 km).

An improved barometric formulation was tested on a selection of basaltic to trachy-andesitic lava flows from the Chaîne des Puys distributed volcanic field (France). This volcanic chain shows a typical example of mildly alkaline magmatic series, from basanite to rhyolite, with the latest eruption well into the Holocene (4700 BC). The least differentiated basalts and trachybasalts were stored near the MOHO (25 km) but underwent a complex story, including mixing with more evolved lavas as shown by ubiquitous reversely-zoned cpx phenocrysts, and incorporated crystals cores that grew deeper within the mantle lithosphere, down to 45 km. There is no evidence of mid-crustal storage for the basalts, but more differentiated lavas probably ponded in intracrustal reservoirs. These results highlight a complex translithospheric magma system that runs from the upper mantle lithosphere to the upper crust.