



Hydrogen isotopic signatures of the upper mantle recorded from xenoliths: What diffusion experiments tell us.

Studies have reported depleted values for the hydrogen isotope signatures of mantle xenoliths. The deep origin of these depleted values has been questioned. Some arguing that they represent a primary distinct reservoir, other an influence of magma degassing. We performed original hydrogen-deuterium diffusion experiments in cubic pieces of natural xenolith aggregates of 1 cm³, between 600 and 900 °C, at room pressure in deuterium enriched gas. The objective was to explore the role of grain boundary diffusion in the control of isotopic exchanges during xenolith transport up to the surface.

We compared intra-crystalline diffusion profiles measured in orthopyroxenes (opx) single crystals and opx located at the edge of the cubes with diffusion profiles within opx inside the cubes. The diffusion profiles in crystals inside the cubes are only slightly shorter than the ones in crystals directly in contact with the gas. In the experiments, apparent diffusion coefficients in opx inside the cubes are lower by a maximum of 0.6 log units. It suggests that the grain boundaries diffusion of hydrogen in xenoliths is at least 2.5 log units faster than intra-crystalline diffusion in opx. The results confirm that the isotopic exchange is fast enough to constantly rebalance the δD values between the xenolith and the surrounding magma. Consequently, we conclude that the depletion of δD in pyroxenes from mantle xenoliths may have been influenced by late degassing prior to and during eruptions.

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1. Diffusion experiments
2. Pyroxenes
3. Hydrogen isotopes