

Distribution and preservation of hydrogen in the lithospheric mantle:

The message from the peridotite xenolith

SYLVIE DEMOUCHEY^{1,*}

¹ Géosciences Montpellier, UMR 5243, Université Montpellier & CNRS, Montpellier, France;
*demouchy@um2.fr

The minerals constituting the Earth's upper mantle contain hydrogen as a trace element, decorating point defects in their crystalline structure. They are the so-called nominally anhydrous minerals (NAMs). Experimental petrology and mineralogy have quantified the maximum concentration under several compositional and thermodynamic conditions, but systematic studies on the hydrogen concentration in minerals from mantle-derived rocks have only recently been carried out. Here, a compilation of the distribution of hydrogen in upper mantle peridotite xenoliths is presented. NAMs from peridotite xenoliths contain a few ppm wt H₂O in their structure. From the current database, the maximum hydrogen concentrations in olivine regularly increase with increasing depth. The amount of hydrogen in NAMs from peridotite xenoliths from subduction contexts does not seem higher than in other geological contexts for similar temperature and pressure conditions. The highest hydrogen concentrations are found in peridotitic olivines from cratonic mantle (Siberia), and are likely due to the deeper depth of origin. The increasing hydrogen concentration in olivine with increasing depth is likely controlled by the increase of H partitioning into olivine at the expense of orthopyroxene as imposed by a decrease in Al content in opx with depth. However, the sparse data could also indicate that the bulk hydrogen concentration slightly increases with depth higher than 150 km. In this case, it would suggest, locally (Udachnaya, Siberia for example), a possible increase in water fugacity due to fluid saturation.

Even if the most abundant mineral in mantle rocks is olivine, the bulk hydrogen concentration in peridotites is controlled by the amount of hydrogen stored in pyroxenes. However, hydrogen concentration in olivine remains crucial for consequences on physical properties such as rheology and electrical conductivity.

At last, the questions of the preservation of hydrogen concentration in NAMs due to rapid ionic diffusion will be discussed in the light of recent results from peridotite xenoliths and diffusion models.