

Mecanisms and kinetics of hydrogen exchange in olivine: A review from experimental and computational studies

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Mobility of hydrogen in mantle minerals and especially olivine has raised interest for its impact on mantle properties for many years. Nevertheless, the mechanisms and kinetics of hydrogen exchange in olivine remain largely misunderstood. We present here a review on the current knowledge of hydrogen kinetics in olivine, highlighted by recent results from experiments [1], [2] and numerical modelling [3]. In forsterite, laboratory's experiments, suggest that incorporation of hydrogen is controlled by the mobility of magnesium vacancies with a diffusion of hydrogen faster than exchange rate along direction [100] and slower in the two other directions. A common kinetics is generally observed for all OH bands, in apparent contradiction with their different origin as highlighted by numerical modelling. In olivine, diffusion of small-polarons is faster than diffusion of hydrogen. These results suggest that diffusion of polarons is anisotropic, with diffusion along [100] probably faster. Theoretical interpretations in connexion with electrical conductivity properties of olivine are discussed.

[1] Du Frane and Tyburczy (2012) *Geochem Geophys Geosyst* DOI:10.1029/2011GC003895. [2] Ingrin *et al.* (2013) *Phys Chem Mineral* DOI: 10.1007/s00269-013-0587-3. [3] Balan *et al.* (2011) *Eur J Mineral* DOI: 10.1127/0935-1221/2011/0023-2090.

The nitrogen isotope composition of volcanic fluids

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The main potential sources of nitrogen in volcanic and hydrothermal fluids are (i) the atmosphere; (ii) the upper mantle, including contribution from the subducting plates at the arc settings; (iii) the lower mantle at the hot spot settings; and (iv) the continental crust. The meaningful differences in $\delta^{15}\text{N}$ among the four main potential sources of nitrogen make it a useful tracer providing relevant information on the geodynamic environments in which volcanic fluids are generated.

Here we present a large and new data set of nitrogen isotope, $\text{N}_2/^{36}\text{Ar}$ and $^3\text{He}/^4\text{He}$ in fluids from more of 20 volcanic systems of different geodynamic setting including subduction zones (Mediterranean volcanoes, Mexico, Central and South America, Kamchatka); spreading zones (Socorro Island) and hotspots (Iceland, Azores, Galapagos). The goals of this work are i) to identify the relationships between the geodynamic setting and the isotopic composition of nitrogen in volcanic fluids; ii) to characterize the lower mantle (fluids with $^3\text{He}/^4\text{He}$ much higher than MORB values) in terms of $\delta^{15}\text{N}$ and iii) to understand the inhomogeneity of $\delta^{15}\text{N}$ with respect to the upper mantle.

The preliminary obtained results showed a wide range of $\delta^{15}\text{N}$ values, for estimated deep component (ASW corrected), from +7 to -16‰. The fluids related to subduction zones are characterized by values from -5‰ to +7‰, while the very light $\delta^{15}\text{N}$ (up to -16‰), were found in some gases of Iceland evidencing an important contribution from the lower mantle. We also discuss some problems related to possible effects of the nitrogen isotope fractionation ($\text{N}_2\text{-NH}_3$ system) and to the air correction procedure.