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Interactions of ammonium and lattice of feldspar at high temperatures

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Nitrogen cycling between the Earth's surface and interior influences atmosphere evolution, climate and habitability of our planet. Nitrogen transport process in the Earth's interior is a key part of the cycling, which remains enigmatic. Silicate minerals are the main carriers of nitrogen mainly in the form of ammonium. Thus, untangling interactions of ammonium and lattice of the host minerals at the deep Earth's conditions, is essential for understanding nitrogen transport process.

Feldspar, the most abundant mineral in the Earth's crust, is a carrier of nitrogen to the deep Earth. Nitrogen is incorporated as ammonium in the M site of feldspar framework. To investigate interactions of ammonium and lattice at high temperatures, we conducted FTIR, Raman and XRD spectra measurements at high temperatures to 1000 ^{o}C on an ammonium-bearing feldspar, and revealed ammonium diffusivities and impacts on the lattice. The results show that diffusivities of ammonium at 800, 900 and 1000 ^{o}C are comparable to those of hydroxyl in feldspar, but much slower than structural molecular water. Importantly, ammonium in the M site of feldspar seems more stable than that in the layered site of phengite previously reported. Moreover, ammonium-bearing feldspar has smaller temperature-induced Raman mode wavenumber shifts and thermal expansion coefficients, as compared with ammonium-free feldspar.

The above results suggest interactions of ammonium and lattice of the silicate minerals at high temperatures. Thermal stabilities of ammonium depend on structure of the host silicates, and thermal stabilities of the host silicates are in turn affected by ammonium incorporated.