Intimate link between the deep Earth's nitrogen and hydrogen cycle

YAN YANG[1*], VINCENT BUSIGNY [2], WENDI LIU[1], QUN-KE XIA [1]

[1] Zhejiang University, Hangzhou, 310027, China, (*correspondence: yanyang2005@zju.edu.cn)

[2] University Paris Diderot, UMR 7154 CNRS, F-75005 Paris, France

The deep Earth is the largest reservoir of nitrogen and hydrogen. Subduction is the important mechanism for carrying both nitrogen and hydrogen into deep reservoirs. However, the deep Earth's nitrogen and hydrogen cycles are generally considered independently. Phengite, stable to depths of about 300 km in subduction environment, may be a good candidate for transferring both, nitrogen and hydrogen to the deep Earth. We investigated mechanism and kinetics of ammonium loss from phengite, and effect of ammonium on dehydration. We found that mechanism of ammonium loss involves the transfer of a hydrogen atom in ammonium to oxygen of the silicate network, thus forming ammonia (NH_3) and hydroxyl. Ammonium release is not only easier than dehydration but also can promote dehydration in phengite. The ammonium effect on dehydration can be expected from ammonium loss mechanism which produces an additional proton source for dehydration.

The transport of nitrogen and hydrogen in phengite during subducting is thus intimately linked. Although the flux of phengite alone might be small compared to the total water flux in the subducting slab, it is possible that other ammonium-bearing hydrous minerals undergo similar ammonium-related dehydration. Therefore, our study opens a nitrogen perspective for the study of the deep hydrogen cycle and reminds us the potential mutual effects of cycling of different volatile elements.