Water content and hydrogen isotope composition of phenocrysts from Cenozoic continental basalt in North China: Implications to the hydrous properties of subcontinental lithospheric mantle

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Phenocrysts from Cenozoic continental basalt in North China were analyzed by FTIR for structural hydroxyl content and by TC/EA-MS for total water content and hydrogen isotope composition. The results provide insights into the hydrous properties of subcontinental lithospheric mantle. Structure hydroxyl is not dectected in olivine while clinopyroxene phenocrysts contain 62 to 913 ppm structure hydroxyl. There are substantial amounts of total water in both olivine and clinopyroxene phenocrysts, indicating the presence of molecular water as nanoscale inclusions. Total water contents of clinopyroxene phenocrysts are generally less than those of olivine phenocrysts, while δD values of clinopyroxene phenocrysts are higher than those of olivine phenocrysts. The phenocryst minerals exhibit δD values of -145 to -94‰ that are roughly negatively correlated with their total water contents. Acoording to the clinopyroxene with the highest Mg#, total structural hydroxyl of the initial basaltic melt is estimated to 0.6 wt%. Then it increases to 3.5-6.7 wt% due to fractional crystallization, rendering the melt water-saturated in the late stage of magma evolution. Fractional crystallization would also lead to the partial conversion of structural hydroxyl into molecular water, resulting in the depletion of in the phenocrysts and the systematic variation of structural hydroxyl content with the Mg number of clinopyroxene. The structural hydroxyl content of mantle source for the continental basalt is estimated to 290 ppm. This is slightly higher than that of MORB-type mantle but similar to that of OIB-type mantle. Thus, subcontinental lithospheric mantle in North China is rather hydrous and D-depleted, which may be attributed to the entrainment of recycling subduction-modified oceanic crust in the mantle source. Reaction of the mantel wedge peridotite with hydrous melts derived from partial melting of the subducted oceanic crust is suggested as a physicochemical mechanism for the crust-mantle interaction in subcontinental subduction channel.