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Barium isotope fractionation during slab dehydration as revealed by studies on UHP eclogite-HP vein systems

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Exhumed ultrahigh-pressure (UHP) eclogites in orogenic belts represent fragments of previously subducted slab, while high-pressure (HP) metamorphic veins within the eclogites are direct records of slab-derived fluids. Hence the UHP eclogite-HP vein systems could provide important constraints on the behaviors of element migration and isotope fractionation in subduction zones. To explore the behavior of Ba isotope fractionation during slab dehydration, we studied the Ba isotopic compositions of three well-characterized UHP eclogite-HP vein systems (Ganghe, Hualiangting, and Bixiling) from the Dabie orogen, central China.

The results show that the HP veins have remarkably heavier Ba isotopic compositions than the host UHP eclogites, indicating significant Ba isotope fractionation during metamorphic dehydration of eclogites, with the vein-forming fluids enriched in heavy Ba isotopes. Petrological observations and mineral isotopic data reveal that the specific fractionation mechanism is the retrograde breakdown of lawsonite or breakdown of phengite during different stages of slab exhumation. The estimated $\Delta^{138/134}Ba_{fluid\text{-}eclogite}$ (= $\delta^{138/134}Ba_{fluid}$ - $\delta^{138/134}Ba_{eclogite}$) of these two cases is about 0.2‰ and 0.4‰, respectively. This, together with the different Ba/Th between the fluid derived from lawsonite breakdown and the fluid derived from phengite breakdown, suggests that metasomatism by fluids derived from different dehydration reactions of the slab may lead to the Ba/Th and Ba isotopic heterogeneity in the mantle wedge. Therefore, Ba isotopes could be used to trace the origin of metasomatic fluids at subduction zones.