

The varying contribution of the subducted slab on the heterogeneous mantle source for boninite, evidence from iron isotope variations

YUANYUAN XIAO¹, YONGXIANG YAO¹, ZIHUANG HUANG¹ AND YIBING LI²

¹Institute of Oceanology, Chinese Academy of Sciences

²Institute of Geology, Chinese Academy of Geological Sciences

Presenting Author: yuanyuan.xiao@qdio.ac.cn

Boninite is thought to be the melting product of highly refractory mantle with the addition of slab-derived fluids. Previous studies have found that boninite like other subduction-related magmas has chondrite-like iron isotope composition (c. 0.03‰), lighter than those of ocean basalts on average. However, it still remains arguable whether the lighter iron isotope composition of subduction-related magmas is inherited from the depleted mantle source or caused by the addition of slab-derived oxidized fluids. Moreover, highly varied element patterns of boninite (e.g., Yb, Zr) reflect varied degrees of mantle depletion and different contributions of slab-derived fluids. Thus, it is important to systematically study iron isotope composition of boninite with different compositions.

Here we report iron isotope compositions of boninite from two classic suites on Earth, i.e., Bonin islands and submarine forearc (low-Ca boninite; CaO/Al₂O₃ mainly < 0.75) and Troodos ophiolite complex, Cyprus (high-Ca boninite: CaO/Al₂O₃ = c. 0.85). The analyzed $\delta^{56}\text{Fe}$ values of the Bonin boninite are varied from $-0.046 \pm 0.003\text{‰}$ to $0.078 \pm 0.031\text{‰}$ (2SD, SD = standard deviation of 4 times repeated analysis; with an average of $0.03 \pm 0.03\text{‰}$, n = 14), which has been affected by the fractional crystallization. The $\delta^{56}\text{Fe}$ value of the Troodos boninite is relatively constant, i.e., from $0.046 \pm 0.010\text{‰}$ to $0.091 \pm 0.016\text{‰}$ with an average of $0.06 \pm 0.01\text{‰}$ (n = 7). Bonin forearc basalt (FAB) were also analyzed for comparison and the $\delta^{56}\text{Fe}$ is $\sim 0.10\text{‰}$, except those samples with higher Th/U ratio and Cu contents. Together with previously reported $\delta^{56}\text{Fe}$ data for boninite from New Caledonia (low-Ca boninite with CaO/Al₂O₃ = ~ 0.4 , $\delta^{56}\text{Fe} = \sim +0.03\text{‰}$), the lower $\delta^{56}\text{Fe}$ of the Bonin boninite than Bonin FAB and Troodos boninite reflects the lighter iron isotope composition of the more depleted mantle source. Based on relationships between different indicators for various fluids (e.g., Ba/La, Zr/Sm) and modelling, Bonin boninite is likely produced by partial melting of the refractory mantle with an addition of sediment melts, while the formation of Troodos boninite can be ascribed to the melting of less refractory mantle, which had been metasomatized by sediment-derived fluids previously.