Study reveals heterogeneous mantle source compositions for boninite from Bonin and Troodos

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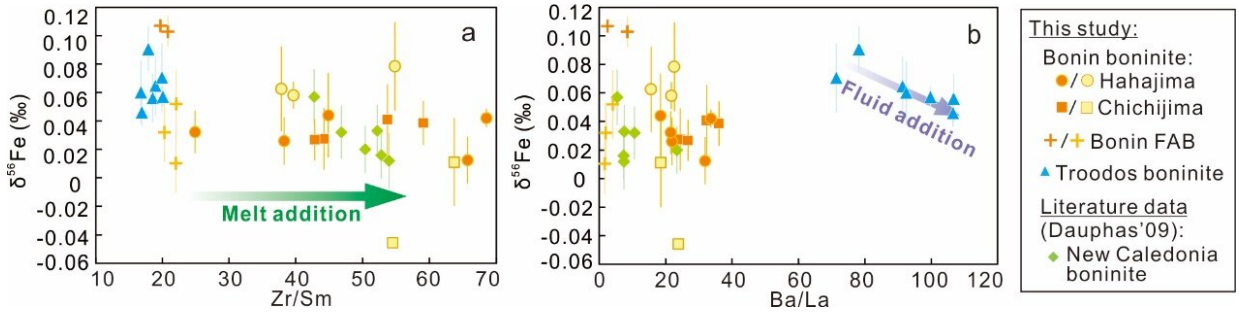

The δ^{56}Fe isotope variation among different boninite sampling suites. Credit: IOCAS

Subduction-zone magmas are characterized by high fluid contents and $Fe^{3+}/\Sigma Fe$ ratios, which are closely associated with slab-derived fluids during subduction. However, instead of a heavier iron isotope composition preferred under an oxidized state, arc magmas have lighter iron isotope compositions than seafloor basalts, including mid-ocean ridge basalts (MORB) and oceanic island basalts (OIB).

It remains unclear 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.

Recently, a research team led by Prof. Xiao Yuanyuan from the Institute of Oceanology of the Chinese Academy of Sciences (IOCAS) has reported new Fe isotope data for low-Ca boninite from the Bonin islands and submarine forearc off Japan and high-Ca boninite from the Troodos ophiolite complex in Cyprus, which is thought to result from melting of highly depleted refractory mantle with varying effects of slab-derived fluids. Their study was published in *Lithos*.

The researchers found that δ^{56}Fe values of the Bonin boninite were highly variable, which were affected by mineral cumulates, while the δ^{56}Fe values of the Troodos boninite were relatively uniform. Together with the literature data on boninite from New Caledonia, the average δ^{56}Fe value of the Troodos high-Ca boninite was higher than those of low-Ca boninite from Bonin and New Caledonia, the latter of which was originated from a more refractory mantle source. Thus, the iron isotope variation of boninite among different sample suites reflected the heterogeneous mantle composition caused by different prior depletion histories.

In addition, the researchers found an inverse correlation of decreasing δ^{56}Fe with increasing Ba/La in the Troodos boninite, reflecting the addition of aqueous fluids in the mantle source for metasomatism during the long evolution history before melting. On the other hand, the Bonin boninite magma was best understood as resulting from melting of highly refractory mantle mixed with slab-derived melts.

This study shows that the effects of subduction component on iron isotope composition of boninite may be limited (e.g., Troodos boninite) or have been hidden (e.g., Bonin boninite), while the influence of highly refractory mantle sources is more significant, which may also be responsible for a relatively lighter iron isotope composition of subduction-related magmas than seafloor basalts.

"Given the limited data for iron isotope composition of boninite so far available, it is thus required to systematically study iron isotope composition of boninite with different compositions to further understand the petrogenesis of boninite and the iron isotope variation of subduction-related magmas," said Prof. Xiao.

More information: Yuanyuan Xiao et al, Heterogeneous mantle source compositions for boninite from Bonin and Troodos, evidence from iron isotope variations, *Lithos* (2023). DOI: 10.1016/j.lithos.2023.107214

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