Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.33801

Experimental insights into phase relations and liquid lines of descent of low- and high-Si boninitic magmas from the Izu-Bonin-Mariana fore-arc

LENNART KOCH, RENAT R. ALMEEV, FELIX MARXER AND FRANÇOIS HOLTZ

Leibniz University Hannover

Expedition 352 of the International Ocean Discovery Program (IODP) aimed to investigate magmatic processes related to the initiation of intra-oceanic subduction. For that purpose, four drill cores were recovered from the Izu-Bonin-Mariana (IBM) fore-arc. The sampled rocks comprise fore-arc basalts and boninites which are characteristic for early magmatic processes during the beginning of subduction.

In order to constrain the evolution of magma storage conditions and differentiation during early stages of intra-oceanic subduction, we performed hydrous equilibrium crystallization experiments on two boninitic melt compositions from the IBM fore-arc, namely a low-Si boninite (LSB) and a high-Si boninite (HSB). Using an internally heated pressure vessel (IHPV), experiments were conducted at temperatures between 1020 and 1220 °C and at pressures of 200 and 400 MPa.

The experimental results demonstrate that boninitic magmas crystallize orthopyroxene and/or olivine (±Cr-spinel) along the liquidus followed by clinopyroxene and finally plagioclase. Dissolved water suppresses the formation of plagioclase and also stabilizes olivine and clinopyroxene relative to orthopyroxene. Residual melts evolve to high-Mg andesitic and (high-Mg) dacitic compositions. The results further indicate that natural IBM boninitic magmas were strongly hydrous. Based on our experimentally determined phase diagrams and liquid lines of descent, we estimate H_2O contents in the range of 1-3 wt% for natural LSB magmas and 3-5 wt% for natural HSB magmas. These different H_2O contents demonstrate the increasing importance of water fluxes during the evolution of boninitic magmas, from LSB in early stages to HSB in later stages of subduction initiation. In contrast, systematic differences in magma storage conditions of LSB and HSB magmas could not be detected. LSBs and HSBs both differentiated at temperatures between 1220 and 1040 °C and were stored at pressures between 100 and 300 MPa prior to eruption. Our study further demonstrates that residual boninite melt evolution was likely controlled by (near-)equilibrium crystallization processes. However, additional magmatic processes including magma mixing and reworking of harzburgitic/dunitic cumulates contribute to the large compositional variety observed for IBM fore-arc eruptive products.