Remelting of andesite in oceanic island arc crust: an example from the Izu-Bonin

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The origin of rhyolite in the oceanic arc crust is a matter of considerable interest. The Izu-Bonin volcanic arc is an excellent example of an intra-oceanic convergent margin. Basalt and basic andesite (SiO_2< 57 wt. %) are the predominant eruptive products of the Izu-Bonin arc, and rhyolite (SiO_2>70 wt. %) forms another peak in volume. We suggest that rhyolite is a partial melt of hidden calc-alkaline andesite in an oceanic island arc crust. Given that an original calc-alkaline andesite magma is water-saturated, it freezes in the crust and changes into a solidified andesite source region, which is reheated and remobilised by influxes of basalt.

The Izu-Bonin volcanic arc is an excellent example of an intra-oceanic convergent margin. Seventeen Quaternary volcanoes of the arc, including 6 island volcanoes and 9 submarine silicic calderas on the volcanic front and 1011 chemical analyses of these volcanoes, were reviewed in order to estimate relative proportions of magmas erupted. The number-of-analyses vs. SiO_2 histogram is converted into volume-weighted histogram. Basalt and basic andesite (SiO_2< 57 wt. %) are the predominant eruptive products of the Izu-Bonin arc, and rhyolite (SiO_2>70 wt. %) forms another peak in volume. Such rhyolites possess compositions identical to those of partial melts produced by dehydration-melting of calc-alkaline andesites at low pressure (< 7kb). Further, groundmasses of calc-alkaline andesites of the Shirahama Group, Izu Peninsula, have compositions similar to those of Izu-Bonin rhyolites. These lines of evidence may suggest that the rhyolite magmas were produced by dehydration-melting of calc-alkaline andesite in the upper to middle crust. If so, then the presence of large amounts of calc-alkaline andesites (3~5 times as large as rhyolites) within the oceanic arc crust would be expected, which is consistent with a proposed structural model across the Izu-Bonin arc. Calc-alkaline andesite magmas may be water-saturated, and would crystallize extensively to freeze within the crust. Rhyolite eruptions could be triggered by influx of hot basalt magmas, which reheats and softens the frozen calc-alkaline andesite magma bodies.