An overview of the Setouchi volcanic belt, SW Japan: High-Mg andesite, sanukitoid, and continental crust

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The occurrence of unusual high-Mg andesite (HMA) characterizes the Setouchi volcanic belt in SW Japan, which was activated at 13.7 ± 1.0 Ma by subduction of the young and hot Shikoku Basin lithosphere into the high-temperature upper mantle. This tectonic setting may be analogous to the thermal regime during Archean times, which suggests more ubiquitous production of HMA. A plausible process that can comprehensively account for the petrological and geochemical characteristics of Setouchi HMAs involves partial melting of subducting lithosphere, subsequent melt-mantle interactions, and final equilibration with the upper-most mantle. HMAs and more differentiated andesites, which are coined ‘sanukitoids’, are distinct in that they are phenocryst-poor (<10%), compact, and nearly anhydrous, despite HMA magmas originally containing ~7 wt% H$_2$O, and commonly form composite lava flows. One mechanism for explaining these features is formation of a mostly solidified HMA pluton, remelting of the HMA pluton by intrusion of a high-temperature basaltic magma, consequent production of a nearly dry HMA magma, mixing of this HMA magma with overlying residual felsic melts during ascent to form a zoned magma reservoir.

The average continental crust possesses intermediate compositions that typify arc magmatism and as a result it is believed to have been created at ancient convergent plate boundaries. One possible mechanism for creation of intermediate continental crust with an average $V_p$ of ~6.5 km/s is the direct production of hydrous andesitic (HMA) melts in the upper mantle and formation of andesitic plutons within the crust. The calculated $V_p$ of HMA plutons is broadly close to the average $V_p$ of the continental crust, supporting the above mechanism. On the other hand, geochemical modeling suggests that the isotopic characteristics of slab residues do not fit with those of any known geochemical reservoir in the deep mantle, such as EMI, EMII, or HIMU that have been proposed for explaining the compositional diversity of ocean island basalts.

References: