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Title: ARC EVOLUTION, CONTINENTAL CRUST FORMATION, AND CRUST-MANTLE TRANSFORMATION

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Abstract: Evolution of arc crust and subarc mantle in the Izu-Bonin-Mariana (IBM) intra-oceanic arc-trench system is examined by petrological modeling of arc magma generation and differentiation. Characteristic seismic structural features of the IBM arc highlighted in this modeling include the presence of (1) a middle crust with a P-wave velocity (Vp) of 6.0-6.5 km/s, (2) a 6.5-6.8 km/s Vp layer at the top of the lower crust, (3) a high-velocity (Vp=6.8-7.2 km/s) lower crust, and (4) an uppermost mantle exhibiting rather low velocities (Vp=7.2-7.6 km/s). The middle crust, considered to have an intermediate composition similar to the average continental crust, is assumed to be produced by either anatexis of the initial mafic lower crust or mixing of mantle-melting-derived basaltic magma with crust-melting-derived felsic magma. The Vp calculated on the basis of the inferred compositions for each layer of the IBM crust are consistent with the observed values, suggesting that the present model could reasonably represent the process of IBM arc crust creation. The results further suggest that the volume of mafic restite and cumulates that are “crustal residues” after middle and upper arc crust creation is three to nine times greater than that of the seismically defined IBM lower crust. One possible explanation to overcome this apparent dilemma is that the mafic to ultramafic crustal components are transformed to subarc mantle. The transformed crustal residues would be more enriched in Fe and Al than mantle peridotites, providing a reasonable explanation for the rather low velocity observed in the uppermost subarc mantle. This crust-mantle transformation could play the major role in the creation of mature arc crust with compositions similar to continental crust. The transformed crustal residues may separate from the arc lithosphere and founder towards the deep mantle, contributing to the geochemical evolution of the deep mantle.