Composition and Evolution of the IBM Arc Crust

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The IBM oceanic arc is characterized by the occurrence of the middle crust with P-wave velocity of 6.0-6.5 km/s and probably having andesitic compositions. It may be thus suggested that this arc could represent the initial stage of formation of the andesitic continental crust. Knowledge of arc crust composition and its temporal variation is crucial to understanding the evolution from the arc to the continental crust. We herein estimate the composition of the IBM arc crust based on the seismic structure of the arc and compositions of IBM arc magmas including the Tanzawa tonalite that would represent the obducted portion of the IBM middle crust.

Two different processes of andesitic crust formation are assumed: (1) 30% melting of the pre-existing basaltic crust that was created by 20% fractionation of olivine from an inferred IBM primary basalt magma; (2) mixing of the differentiated basalt magma and the felsic magma produced by 15% melting of the basaltic crust, Both processes can reasonably explain compositions of the Tanzawa tonalite.

Seismologically determined volume of the IBM middle crust and the inferred andesite formation processes provide estimates for volume of dunitic cumulate and gabbroic restites. The calculated volume of the restite layer is greater than that determined by seismic observation, suggesting that the cumulate and the part of restite may not form a part of the arc crust. These components would be transformed to the mantle and contribute to form the uppermost subarc mantle having unusually low-velocity.

Delamination of the mafic crust component, which is required for andesitic continental crust formation from parental basaltic magma, may not be operated through gravitational instability, but through transformation of crustal components to the mantle.