Petrogenesis of Tonalite Middle Crust of the Northern IBM Arc: Constraints from Geochemical and Geophysical Studies of the Miocene Tanzawa Plutonic Complex

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Collision of the Izu-Bonin (Ogasawara)-Mariana (IBM) arc with the Honshu arc has been occurring since the mid-Miocene (~15 Ma). It led to uplift and exposure of the middle-upper crust of northern IBM arc in the Izu-collision zone (ICZ). The Miocene (~7 Ma; K-Ar ages) Tanzawa plutonic complex (TPC) in ICZ has been interpreted as exposed deep crust of the northern IBM arc. TPC consists mainly of tonalite intrusions with subordinate gabbro and is thought to represent the middle crust of the ~22-km-thick, intra-oceanic IBM arc (Kawate and Arima, 1998; *Island Arc*). TPC was intruded into the Miocene (17-11 Ma) Tanzawa Group which consists of submarine volcanic rocks with volcaniclastic and hemipelagic sediments metamorphosed up to pumpellyite-actinolite facies (about 6 km depth). TPC belongs to the calc-alkaline series and exhibits a wide range of chemical variation (SiO_2 43 to 75 wt. %).

TPC plutonic rocks are characterized by relatively high Ba/Rb and Ce/Nb, and low abundance of K_2O, LIL and REE elements and strongly depleted LREE. Sr-, Nd- and Pb-isotope compositions of TPC rocks show remarkable isotopic homogeneity ($^{87/86}Sr$ = 0.7034~0.7036, ε_{Nd} = +5.8 to +9.2, $^{206/204}Pb$ = 18.18~18.28, $^{207/204}Pb$ = 15.53~15.55; $^{208/204}Pb$ = 38.2~38.3) indicating that these are broadly cogenetic. Compared to modern lavas of the Izu arc, TPC rocks have similar Sr and Nd isotopic compositions but have slightly less radiogenic Pb than lavas erupted along the volcanic front but are comparable to those erupted towards the rear of the arc. The geochemical and isotopic data, combining melting experimental studies of basaltic compositions (Nakajima and Arima, 1998; *Island Arc*), collectively indicate that these were derived from a common intermediate parental magma.

Comparison of the measured Vp of TPC rocks with the seismic structure of northern Izu arc (Suyehiro et al., 1996; *Science*) provides an excellent opportunity to examine the architecture of IBM arc crust. Ultrasonic compressional wave velocities (Vp) were measured up to 1.0 GPa in a temperature range 25 to 400°C for TPC rocks (Kitamura et al., 2003; *Tectonophysics*). The data illustrate that tonalitic crust extending up to 6 km thickness exists at mid-crustal depth (6.1-6.3 km/sec Vp) and overlies 2-km-thick hornblende gabbroic crust (6.8 km/sec Vp). High impedance contrast between TPC tonalite and hornblende gabbro coincides with the 12-km-depth strong reflector observed by Takahashi et al. (1998; *Island Arc*). TPC rocks rarely reach such high Vp as 7.1-7.3 km/sec in the lower crust at 15 to 22 km depth, suggesting that the lower crust is composed mainly of pyroxene-abundant mafic rocks instead of hornblende gabbro. The present data suggest andesitic bulk composition of the northern part of IBM arc.