Petrological studies of the tonalitic intrusion during the early arc volcanism at the Komahashi-Daini Seamount, Kyushu-Palau Ridge

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Tonalitic plutonic rocks in the Komahashi-Daini Seamout, northern Kyushu-Palau Ridge, is considered to form during early arc volcanism stage. Recent seismic refraction and reflection data suggest that the continents are underlain by mafic lower crust and felsic middle crust. Petrogenesis of granitic middle crust layers is important for understanding the formation and evolution of continental crust. In modern tectonic regimes, tonalitic rocks and chemically equivalent volcanic rocks occur in island arcs and active continental margins. Thus, the petrogenesis of tonalite and related rocks in intra-oceanic arc settings is of great importance in understanding the processes of both recent island arc and continental crust formation.

Tonalitic rocks in the Komahashi-Daini Seamount was investigated by the Japanese Geodynamics Project (GDP) cruises in the 1970's, and by the R/V Tansei-maru (Ocean Research Institute, University of Tokyo) in the 1990's (KT94-10, 1994 and KT98-19, 1998). Plutonic rocks were dredged from the seamount and are classified as biotite-hornblende tonalite and hornblende tonalite, and have wide range of SiO2 concentrations from 55 to 75 wt.%, and many samples have from 70 to 75 wt.% of SiO2. These tonalites show 38Ma of K-Ar ages (Shibata et al. 1977), and these data indicate that acidic plutonic activity occurred during the early stages of Izu-Ogasawara (Bonin)-Mariana (IBM) arc volcanism. The petrographical and geochemical characteristics of the Komahashi-Daini Seamount tonalite are summarized as follows: (1) Phenocrysts, especially plagioclase, show common lamellar twins and oscillatory zoning patterns; (2) This tonalite show low content of bulk LILE, and classified into low-K series (Gill, 1981); (3) This tonalite shows roughly parallel and increasing total REE content with increasing SiO2 content, except for increasingly strong negative Eu anomaly at higher SiO2 levels. Differences between Komahashi-Daini Seamount and Tanzawa tonalite, considered to expose middle island-arc crust, are; (4) Cumulate textures are not observed in the tonalite from the Komahashi-Daini Seamount; (5) Komahashi-Daini Seamount tonalite has lower LILE content than the other island-arc tonalite; (6) Komahashi-Daini Seamount tonalite shows linear variation of Zr and REE vs. SiO2.

These data and observations support the interpretation that tonalite in the Komahashi-Daini Seamount was produced by fractional crystallization processes, and the parent magma have lower than 55% of SiO2. Experimental study by Nakajima and Arima (1998) show that the parent magma of the Tanzawa plutonic complex is andesitic magma (SiO2=62%) from partial melting of balsaltic lower crust. And Kawate and Arima considered the characteristics of the Tanzawa complex was explained by fractionation and accumulation process. If the parent magma of Komahashi-Daini Seamount tonalite was derived from melting of basaltic lower crust, the degree of partial melting required is unreasonably high (more than 80% when calculated using melting experiments on basalt or amphibolite; Nakajima and Arima, 1998). Therefore, we concluded that this parent magma was basaltic magma from mantle peridotite.

The origin of Tanzawa plutonic complex which is melting of lower arc crust indicate that thick island-arc crust had already existed during the activity of the Tanzawa Complex (10~5 Ma). On the other hand, arc crust during the activity of the Komahashi-Daini Seamount tonalite (38 Ma) was thin because of basaltic magma origin. We suggest that fractional crystallization operated during the early stage of oceanic island arc formation to produce mantle-origin tonalite classified into primary granitoid (clark, 1992).