Igneous activity of Middle Proterozoic meta-tonalite in Cape Hinode, Prince Olav Coast, East Antarctica

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Middle Proterozoic meta-tonalite is widely distributed in Cape Hinode, Prince Olav Coast, East Antarctica. Sun et al. (2014) suggested that this meta-tonalite was strongly metamorphosed at granulite-facies. However, this condition is not common in the Prince Olav Coast because the metamorphic grade in this area has generally reached up to amphibolite-facies (Hiroi et al., 1987). Additionally, the intrusive age of the meta-tonalite is interpreted to 1017 Ma by SHRIMP U-Pb zircon method (Shiraishi et al. 2003). It is also incorrespondence with the timing of main igneous and metamorphic activities of the Prince Olav Coast at 550 - 500 Ma. Therefore, the meta-tonalite of Cape Hinode is considered to have unique lithology in this region.

JARE-58 surveyed the meta-tonalite in 2016–2017 and recognized that its lithofacies mostly unity throughout the whole area in Cape Hinode. It would be suggesting that the meta-tonalite is derived from a single plutonic magma. On the other hand, small mafic rocks are scattered in the meta-tonalite. The mafic rocks show some different occurrences in fields such as lense, block, and dike. They would have different ages and petrogeneses. In this study, we consider the igneous activity of the meta-tonalite and its geological back ground based on the geochemical investigations of the meta-tonalite and its related rocks.

The meta-tonalite in Cape Hinode is characterized geochemically by higher Al_2O_3, Na_2O, and Sr contents, and lower K_2O and Y contents. Ikeda et al. (1997) suggested that such the geochemical characters are conformable to typical TTGs produced by oceanic crust melting. It is supported by the lower K_2O/Na_2O ratios of the meta-tonalite (about less than 0.5). This reflects the basaltic source composition, that is, the continental basaltic lower crust generally has higher K_2O/Na_2O ratios than the oceanic basalt (i.e MORB). Consequently, slab derived adakites (or TTGs) have lower K_2O/Na_2O ratios (<1.0) than those of continental adakites (>1.0) (Kamei et al., 2009).

The mafic rocks in Cape Hinode are largely divided into two types such as volcanic arc basalt (VAB) and within plate basalt (WPB) from the geochemical point of view. Mafic lenses and meta-Gb intrusion show VAB features on ternary plots of Ti-Zr-Y and Ti-Mn-P, and on binary plots of Cr vs Y, V vs Ti, Ti vs Zr, and Zr/Y vs Zr. Furthermore, they have negative Nb and Zr anomalies and enriched LILEs contents on their MORB normalized spider diagrams. The chondrite normalized REEs patterns are mostly flat. In the fields, the mafic lenses are usually arranged parallel to the foliation of the meta-tonalite. Hence, the rocks originated as mafic micro granular enclaves (MMEs) injected into the protolith magma of the meta-tonalite. The meta-Gb intrusion intrudes into the meta-tonalite. The intrusive boundary shows wave-like outline, not sharp. Therefore, the timing of igneous activities of the mafic lenses and meta-Gb intrusion would be closely same to the meta-tonalite. There is no contradiction in considering that these were active in a volcanic arc setting together with the meta-tonalite.

On the other hand, gabbroic xeno-blocks in the meta-tonalite indicate WPB signature on the ternary and binary plots above. Especially, the blocks are categorized to ocean island alkaline (OIA) basalt on the Ti-Mn-P diagram. The xeno-blocks is geologically interpreted as a forerunner intrusion (i.e wall rock) for the meta-tonalite. Therefore, there is a higher possibility that the setting before the activity of the meta-tonalite was oceanic area. These evidences suggest that the meta-tonalite of Cape Hinode was produced as a portion of a juvenile oceanic arc formed at about one billion years ago.

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