Proterozoic magma activities and crustal evolution of Sør Rondane Mountains, eastern Dronning Maud Land, East Antarctica

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The Sør Rondane Mountains (SRM), eastern Dronning Maud Land, East Antarctica, are situated within the Pan-African suture zone (PASZ), between West and East Gondwana, and the timing of collision event is regarded as geological time scale from the late Neoproterozoic to early Cambrian. SRM is consist of metamorphic rocks with greenschist to granulite facies and various kinds of intrusive rocks. Geology of SRM is divided into northeast terrane (NE terrane) and southwest terrane (SW terrane) in terms of metamorphic processes and the boundary between them represents Main Boundary Thrust (Osanai et al., 2013). These two terranes were welled during the Late Proterozoic (c. 640 Ma, Shiraishi et al., 2008; Osanai et al., 2013). Lithology of SW terrane consists of Layered gneiss complex and Tonalite complex bounded by Main shear zone (MSZ). Post-kinematic igneous activity is recognized as stocks and dikes with various compositions. They intrude Layered gneiss complex and Tonalite complex in SW terrane and metamorphic rocks in NE terrane. Kamei et al. (2013) reported that Tonalite complex was Neoproterozoic oceanic arc in terms of geochemical study. In addition, Jacobs et al. (2015) obtained new geochronological date from the western part of SRM, and they proposed Tonian Oceanic Arc Super Terrane (TOAST). TOAST is covered by wide area in the southern part of PASZ. Considering the tectonic background of SRM, understanding geological evolution of the inside of PASZ is one of important subject for reconstruction of Gondwana supercontinent.

Igneous activity of SW terrane started at 1100 Ma and ceased at 550 Ma through the voluminous phase 1000 to 900 Ma and 570 to 550 Ma. Tonalite complex locally intrudes Layered gneiss complex around MSZ. Layered gneiss complex consists mainly of tonalitic gneiss, amphibolite and pelitic gneiss with small amounts of calcsilicate gneiss, charnockite, metagabbro and metadolerite. Based on field occurrence, the tonalitic gneiss, amphibolite, charnockite, metagabbro and metadolerite would be of rocks derived from igneous origin. The zircon U-Pb dating of Layered gneiss complex traces back to 1100 Ma although the intrusive age of charnockite and gneissose tonalite shows 950 Ma and 920 Ma, respectively. The bulk rock analyses for amphibolite, metagabbro and metadolerite have geochemical signature similar to volcanic arc and/or back arc basalts. The charnockite geochemically shows tholeiitic series with arc related signature whereas the tonalitic gneiss belongs to calc-alkaline series with adakitic character.

Tonalite complex consists mainly of tonalite associated with microgabbro occurring as magmatic enclaves (MME) and later dikes. The later dikes intrude the host tonalite and MME. The tonalite is geochemically subdivided into tholeiitic tonalite (TH tonalite) and calc-alkaline tonalite (CA tonalite) with adakitic features. The zircon U-Pb ages of TH tonalite are concentrated at 998 to 995 Ma whereas CA tonalite shows younger ages from 945 to 935 Ma. MME and microgabbro dike geochemically show arc tholeiite and back arc basin basalt, respectively. The zircon U-Pb ages show c. 990 Ma for MME and 950-930 Ma for the dikes and a stock. Finally, tonalite dikes intruded in Tonalite complex at 770 Ma. Petrological studies of Tonalite complex including the tonalite dike reveal that the most plausible tectonic setting is an oceanic arc (Kamei et al., 2013).

The post-kinematic intrusive suites contain granite, syenite complex, adakitic tonalite, dolerite and lamprophyre. They occur as dikes and/or stocks. The oldest post-kinematic pluton is the Dufek granite and its zircon U-Pb dating shows 620 Ma (Li et al., 2006). The zircon U-Pb dating of other plutons and dikes yield ages of 570 to 550 Ma. Chemical compositions of the post-kinematic intrusive rocks resemble those of post-collisional igneous activities.

Granitic rocks are generally produced by melting of the middle and lower crust, and hence serve as a probe for the bulk of the continental crust. Therefore, Nd isotope data of granitic rocks give important information for evolution of continental crust. Tonalite complex and Layered gneiss complex show εNd values more than zero corrected with each intrusive age. Therefore, all granitic rocks in SW terrane were produced by partial melting of a juvenile continental crust. Taking geochemical investigation into account, SW terrane as a whole represents a juvenile arc crust in PASZ, and were built during Neoproterozoic time from 1100 Ma to 700 Ma. On the other hand, the post-kinematic intrusive rocks possess almost zero or locally less than zero. It means that the old crustal materials contribute the formation of post-kinematic magmas. Considering geochemical features of igneous rocks from 1100 Ma to 550 Ma, SW terrane in SRM was grown as a juvenile crust like an oceanic arc from 1100 Ma to 640 Ma, then NE and SW terranes were welled at c. 640 Ma. The post-kinematic igneous activities occurred after amalgamation of NE and SW terranes probably caused by up-welling of mantle derived mafic magma such as syenite complex, dolerite and lamprophyre.