Present understanding of Cl-rich fluid/melt infiltration events recorded in a granulitic lower crustal section of the Sør Rondane Mountains, East Antarctica

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Chlorine-rich fluid/melt infiltration events during amphibolite to granulite facies metamorphism in the Sør Rondane Mountains (SRM), East Antarctica are recorded as Cl-rich biotite, amphibole and apatite found as inclusions in garnet, matrix minerals and post tectonic crack-filling/vein-forming minerals [1-3]. The field distribution of the Cl-rich minerals is thought to be subparallel to the Main Tectonic Boundary (MTB) of [4] and [5], and consistent with the location of the Balchen Detachment Fault and the large scale dextral shear zone in Balchenfjella [6]. One locality from southern Balchenfjella is due to post-tectonic granite intrusion [7].

The MTB is defined based on the *P-T* path of metamorphic rocks and detrital zircon ages, and divides the NE terrane (clockwise *P-T* path with detrital zircon > 1200 Ma) from the SW terrane (counter-clockwise *P-T* path with detrital zircon < 1200 Ma) [4]. Recent results [3,8] suggest that detailed location of the MTB should be revised, and the Cl-rich mineral distribution is in good agreement with the location of the revised MTB especially in the central SRM (Fig. 1). These observation indicate that records of Cl-rich fluid/melt are localized at the large scale shear zones or the tectonic boundary [1]. In spite of the localization of the Cl-rich fluid/melt infiltration, its timing determined by LA-ICPMS U-Pb zircon dating and REE pattern analyses of zircon and garnet, vary from prograde metamorphic stage at ca. 580 Ma at Perlebandet [3,9], near-peak metamorphic stage at ca. 560 Ma and 605 Ma at Balchenfjella [1, 9] and ca. 619 Ma at Brattnipene [9] to post tectonic retrograde stage at < 617 Ma at Brattnipene [2,9]. These variation in metamorphic ages clearly show presence of several metamorphic events during ca. 640–520 Ma period [10,11], and Cl-rich fluid/melt were common in these garnet- and zircon-forming high-*T* metamorphic events both in the NE and SW terranes [9]. The Cl-rich fluid/melt in Balchenfjella is considered to have had a low $\delta^{18}O$ composition (< 20 ‰), based on the oxygen isotope analysis of garnet rim including Cl-rich biotite [12]. In Balchenfjella, low-$\delta^{18}O$ marbles [13] are distributed near the pelitic gneiss that is recording low-$\delta^{18}O$ and Cl-rich fluid/melt infiltration. Therefore, the low-$\delta^{18}O$ and Cl-rich fluid/melt may have regionally affected marbles of this area as well. Origin of such a low-$\delta^{18}O$ fluid is considered to be the mafic and ultramafic lithology that commonly show low $\delta^{18}O$ [12].

In order to generalize the geologic importance of the fluid/melt events summarized above, tectonic setting of the SRM should be understood in detail. The tonalite complex to the south of the Main Shear Zone (MSZ) is considered as a ca. 1 Ga juvenile oceanic arc [14,15]. Sedimentation of the protoliths of surrounding metasediments in the SW terrane including marbles presumably occurred at ca. 880–850 Ma and 820–790 Ma [13] followed by accretion to the arc, and metamorphosed mainly at ca. 600–560 Ma [4,10,11]. Prograde records in the SW terrane metamorphic rocks [3,11,16] points to subduction during this metamorphism. The NE terrane rocks were sourced from different provenance with older components possibly located to the NE [4,13]. They deposited during the similar period as the SW terrane [13] and metamorphosed mainly at ca. 650–600 Ma and older [1,4,10], with several stages of younger overprints recorded in zircon [17]. Absence of prograde metamorphic records in the SW terrane rocks [1,17] would imply that granulites were already located at the lower crustal level (~1 GPa) at ca. 650–600 Ma, and reworked and started exhumation at this timing. As regional ductile deformation was still ongoing at ca. 575 Ma in the SW terrane [18], thrusting over of the NE terrane onto the SW terrane [4] might have occurred at ca. 580 Ma as supported by the counterclockwise ca. 580 Ma metamorphism in Perlebandet [3]. The deformation event halted by ca. 564 Ma as evidenced by undeformed minette dykes [18,19]. The oldest phase of the Pan African granitoid is in Dufekfjellet (ca. 640–620 Ma) and other massive ones in the SW terrane are mostly ca. 575–505 Ma [10,11,18]. Involvement of mantle melts is proposed for magmatic activities during ca. 575–550 Ma period, such as the Lunkeryggen syenite complex (ca. 560 Ma) [18]. In contrast to the tectonic model proposed by Osanai et al. [4], Elburg et al. [18] favored a collage-style accretion of fragments with contrasting geological histories (Indonesian area as a

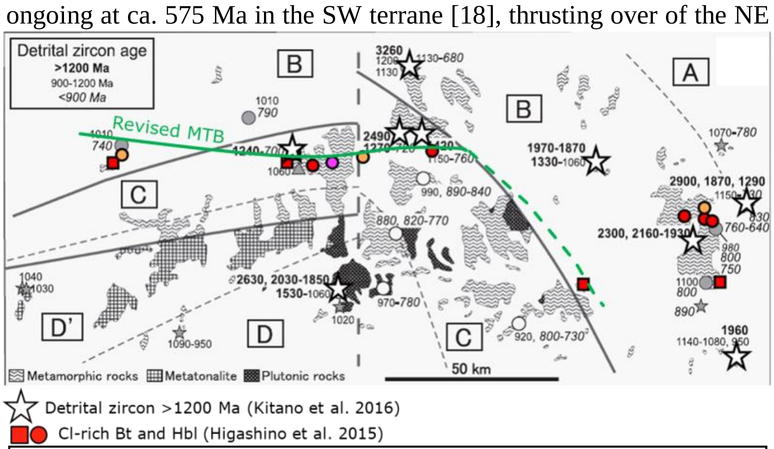

Fig. 1 Field distribution of Cl-rich minerals and age distribution of detrital zircon modified after [8]. Location of revised MTB is shown in green.

modern analogue) based on the variations in inherited zircon ages and differences in zircon Hf isotopic composition between different sectors of the SW terrane, and supported by the semicontinuous magmatism for 150 Myr in the SRM [18]. Therefore, the site of Cl-rich fluid/melt related phenomenon cannot be determined in detail yet. The unsolved problems regarding the Cl-rich fluid/melt infiltration in the SRM are: (1) Source of Cl-rich fluid/melt in each metamorphic stage, especially on the validity of generalization of low-δ^{18}O nature of the fluid/melt, and presence or absence of specific fluid source. (2) Spatial distribution of the traces of Cl-rich fluid/melt movement in the field and relationship with the large scale shear zones and tectonic boundaries. (3) Tectonic location and timing of the Cl-rich fluid infiltration, and whether it can be an analogue of lower crustal processes beneath island arc. These problems should be solved in future JARE projects.

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