Zircons in metacarbonate rocks from Sør Rondane Mountains, East Antarctica

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Zircons in metasedimentary rocks are believed to preserve age information of different stages of orogenesis and helps to understand the provenance and tectonic evolution of orogenic belts. However, it is also vulnerable to dissolution re-precipitation and isotopic resetting by various events during retrogression, such as thermal perturbations, fluid infiltration and so on. Most of the previous studies have focused on the zircons in metapelitic rocks, quartzites and igneous rocks in orogenic belts in order to characterize the major events in the tectonothermal history. However such studies are seldom carried out in metacarbonate rocks, which comprises of completely different chemical system than the pelitic rocks. In this study, we report morphological characteristics, geochemical features and SHRIMP U-Th-Pb ages of zircons in the impure metacarbonate rocks from the Sør Rondane Mountains, East Antarctica.

The Sør Rondane Mountains (SRMs), East Antarctica, situated in the junction of the N-S East African Antarctic Orogen and E-W Kuunga orogeny, is a key area to understand the tectonics of the final stages of amalgamation of Gondwana Supercontinent (Satish-Kumar et al., 2013). This region exposes a suite of highly deformed medium- to high-grade metamorphic rocks in association with various types of igneous rocks. Metasedimentary rocks in this terrain were supposed to have formed in the paleo-ocean between East and West Gondwana, called as "Mozambique Ocean". Based on recent geological and geophysical studies, SRMs are divided into two terranes, the SW and NE terranes, by the Main Tectonic Boundary (MTB) (Osanai et al., 2013). In the SW terrane, metaigneous rock of ca. 1000 Ma intrusive ages occur along with metasedimentary rocks, which underwent metamorphic evolution along a clockwise P-T path. The NE terrane is dominated by metasedimentary rocks, which is characterized by a anticlockwise P-T path. Additionally, metapelitic rocks in the SW terrane have similar detrital age population with the nearby metaigneous rocks, in contrast to those in the NE terrane show older detrital ages (~ca. 3300Ma) (Osanai et al., 2013). Both these terranes were subjected to regional metamorphism and terrane collision at around 650-660 Ma along the Main Tectonic Boundary during the amalgamation of Gondwana (Osanai et al., 2013; Hokada et al., 2013).

Metacarbonate rock samples were collected from 24 different marble layers from seven regions within the Sør Rondane Mountains during the 51st Japanese Antarctica Research Expedition. Most of metacarbonate layers occur as conformable units associated with gneisses of both sedimentary and igneous origins. Thickness of the layers varies from several decimeters to over ten meters, within which thin layers of pure and impure marbles crops out as alternate bands parallel to the regional trend of the major deformation. Skarn layers are developed between marble and gneiss in some units. In the impure marble layers, calc-silicate minerals such as olivine, spinel, clinohumite, phlogopite, diopside and tremolite are observed, in addition to accessory amounts of zircon and graphite. Strontium isotope chemostratigraphy of pure metacarbonate rocks suggested late-Tonian (880-850 Ma) apparent depositional ages in the SW terrane, whereas those in the NE terrane recorded early Cryogenian ages (820-790 Ma) (Otsuji et al., 2013).

Three impure carbonate rocks were selected for zircon geochronology. Morphology and CL

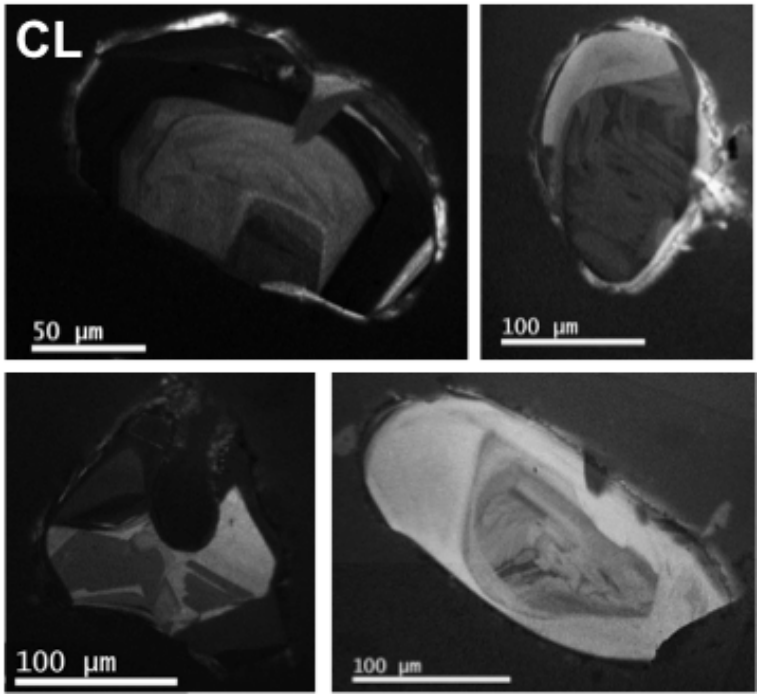

Fig. 1 Morphological features of zircons in the metacarbonate sample 20100119-01-D from Balchen. Irrespective of the contrasts seen in the CL images all zircons yielded similar the ages.

images suggest that zircon grains from impure carbonate rocks are big and round, and significant difference between core and rim is absent. Some zircon grains have a texture like the 'convoluted zoning' that are usually observed in those formed in a hydrothermal environment. The ages obtained from the zircons show a well-defined concordia at around 545-550 Ma, indicating complete resetting at the latest stage of metamorphism. Surprisingly, no protolith ages were obtained. This age represent the youngest event of retrograde metamorphic ages in the Sør Rondane Mountains.

The impure metacarbonates show lower oxygen and carbon isotopic compositions than the pure carbonate-rich metacarbonate rocks, high concentrations of mobile elements and LREE enriched patterns. In contrast, the pure metacarbonate rocks preserve typical sedimentary oxygen and carbon isotopic composition, low concentrations of mobile trace elements and flat REE patterns. These together with the presence of hydrous minerals in impure metacarbonates suggest that they have been affected extensively by fluid infiltration events.

Petrographic observations revealed that zircon is abundant and textural features resemble those of detrital origin. However, SHRIMP ages of zircons in three impure metacarbonate rocks gave well-defined tight concordia U-Pb zircon ages of 544.9 +/- 2.4 Ma (n=77), 545+/- 1 Ma (n=55) and 549.2 +/- 2.6 Ma (n=27). These ages are neither detrital, nor they represent peak metamorphism of the SRMs. We present evidence from textural and geochemical data that the ages recorded in the zircons are related to the latest phase of fluid infiltration coeval to the granitic activity. We also discuss the possible role of alkaline Ca-bearing fluids might have been instrumental recrystallization processes.

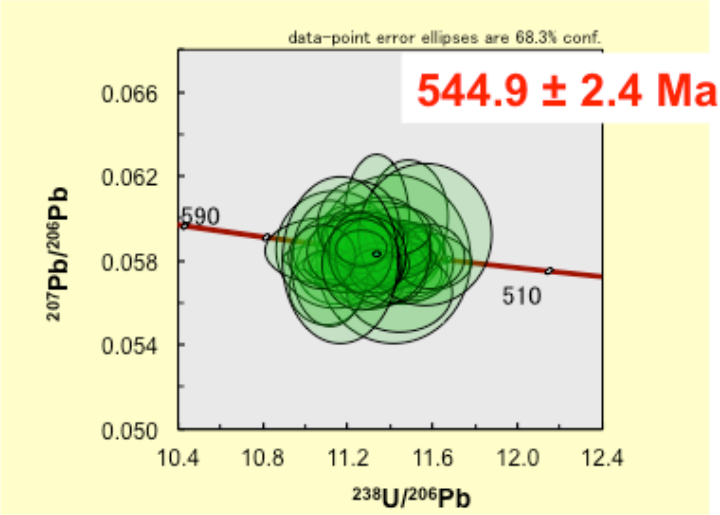

Fig. 2 Concordia plot for all analyzed zircons in the metacarbonate sample 20100119-01-D from Balchen.

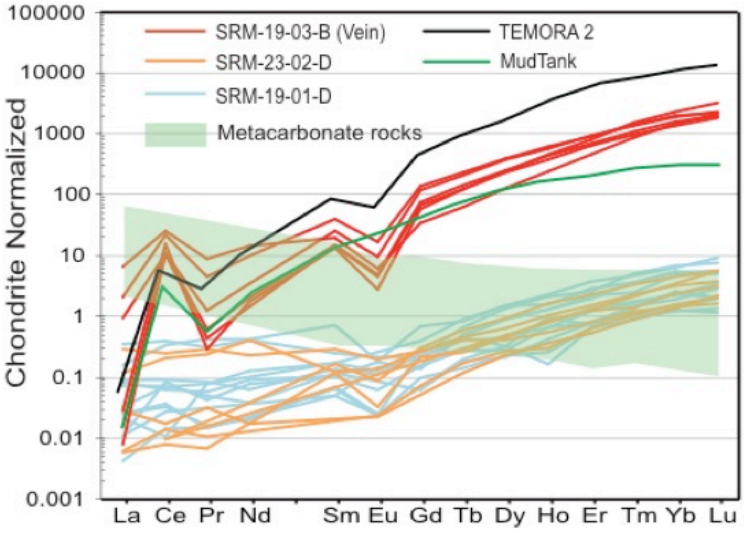

Fig. 2 Rare Earth Element patterns of zircons in the metacarbonate sample 20100119-01-D in comparison with the bulk rock REE patterns and standard zircons

References

Hokada, T., Horie, K., Adachi, T., Osanai, Y., Nakano, N., Baba, S. and Toyoshima, T., (2013) Unraveling the metamorphic history at the crossing of Neoproterozoic orogens, Sør Rondane Mountains, East Antarctica: Constraints from U–Th–Pb geochronology, petrography, and REE geochemistry. Precambrian Research, 234, 183-209, 2013.

Osanai, Y., Nogi, Y., Baba, S., Nakano, N., Adachi, T., Hokada, T., Toyoshima, T., Owada, M., Satish-Kumar, M., Kamei, A., & Kitano, I. (2013) Geologic evolution of the Sør Rondane Mountains, East Antarctica: Collision tectonics proposed based on metamorphic processes and magnetic anomalies. Precambrian Research, 234, 8-29, 2013.

Otsuji, N., Satish-Kumar, M., Kamei, A., Tsuchiya, N., Kawakami, T., Ishikawa, M. & Grantham, G.H. (2013) Late-Tonian to early-Cryogenian apparent depositional ages for metacarbonate rocks from the Sør Rondane Mountains, East Antarctica., Precambrian Research, 234, 257-278, 2013.

Satish-Kumar, M. Hokada, T., Owada, M., Osanai, Y., Shiraishi, K., 2013. Neoproterozoic orogens amalgamating East Gondwana: Did they cross each other? Precambrian Research, 234, 1-7.