Growth of zircon in metacarbonate rocks from Sør Rondane Mountains, East Antarctica

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Zircons in metasedimentary rocks are extensively studied to understand the provenance and tectonic evolution of orogenic belts, because it is believed that zircon can preserve the isotopic composition of different stages of orogenesis. In this study we report SHRIMP ages and geochemical characteristics of zircons in silicate-bearing metacarbonate rocks from the Sør Rondane Mountains (SRMs), East Antarctica. The SRMs, located in the Neoproterozoic to Early Cambrian East African-Antarctic collisional orogen, are composed of medium- to high-grade metasedimentary, metaigneous and intrusive rocks of diverse composition. Multidisciplinary geological studies have revealed that this region can be separated into two distinct terranes, a metasedimentary and metaigneous dominated Northeastern (NE) and a meta-tonalitic and meta-sedimentary dominated Southwestern terrane (SW), that collided at around 650-660 Ma along the Main Tectonic Boundary (Osanai et al., 2013; Hokada et al., 2013). Strontium isotope chemostratigraphy of pure metacarbonate rocks in the SRMs suggested late-Tonian (880-850 Ma) apparent depositional ages in the SW terrane, whereas those in the NE terrane recorded slightly older early Cryogenian ages (820-790 Ma) (Otsuji et al., 2013). Furthermore, a detailed study of Nd isotopes in the metacarbonates identified the existence of an extinct East Antarctic Ocean and its peripheral oceanic island arc system that preceded the formation of the East Antarctic continent in the Neoproterozoic before the final assembly of Gondwana (Otsuji et al., 2016, Kitano et al., 2016). These results corroborate with the emerging idea on the possible presence of a Tonian Ocanic super Arc Terrane (TOAST) in the western Dronning Maud Land (Jacobs et al., 2015).

Pure metacarbonates in the SRMs are characterized by typical marine O and C isotopic composition, low concentrations for mobile trace elements and flat REE patterns, whereas the impure metacarbonates have heterogeneous O and C isotopic compositions, high concentrations of mobile elements and LREE enriched patterns. These together with the presence of hydrous silicate minerals in impure metacarbonates suggest that these rocks have been affected extensively by fluid infiltration events, possibly during the retrograde metamorphism. Petrographic observations revealed that zircons are abundant in impure metacarbonate rocks, superficially the grains appear detrital, but CL imaging revealed textures consistent with metamorphic growth. SHRIMP analyses of zircons in three impure metacarbonate rocks gave well defined tight concordia U-Pb zircon ages of 545 +/- 1 Ma, 546+/- 2 Ma and 549 +/- 2 Ma, younger than the peak metamorphism in the SRMs.

Oxygen isotope analyses of zircon in these rocks yielded interesting results, extremely high $\delta^{18}O_{(V\text{-}SMOW)}$ for zircon of about 23.4‰, and 21.5‰ in two samples, which are found to be in equilibrium with associated carbonate minerals. These high values are comparable with the previous reports on high oxygen isotope ratios for zircons in metacarbonate rocks from Sri Lanka and Myanmar (Cavosie et al., 2011) as well as those from marble hosted UHP eclogites from the Sulu orogen (Chen et al., 2016). The zircons in the Sør Rondane impure metacarbonate rocks have not only re-equilibrated with the U-Pb system at c.550 Ma, but also for the oxygen isotopes with the surrounding carbonate minerals. The titanium-in zircon thermometry in the zircon suggested temperature conditions of around 800 °C, consistent with zircon-calcite oxygen isotope thermometry estimate of 820 to 850 °C and carbon isotope thermometry between calcite and graphite of 780 to 848 °C. Based on all these evidences, we suggest that zircon growth at around 550 Ma has resulted in the oxygen isotope equilibration between zircon and carbonate. A total dissolution-reprecipitation of zircons in metacarbonate rocks has resulted during the widespread granitic activity at this age. We also discuss the possible role of alkaline Ca-bearing fluids that might have been instrumental for the recrystallization process of zircon in metacarbonate rocks.

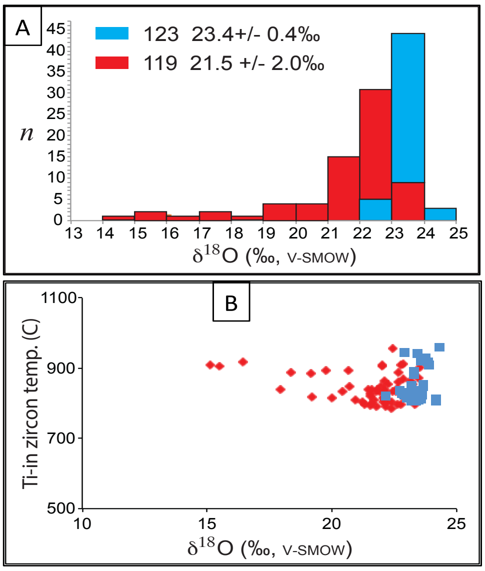

Figure 1 A*. Distribution of oxygen isotopic composition of zircons.* ***B****. Ti-in zircon thermometry for zircons in relation with oxygen isotopic composition suggesting no direct relation between the lowering of oxygen isotopes and temperature of formation of zircon*

References

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