Oxygen isotope evidence for 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, since 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 impure 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 [1] [2]. 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) [3]. Furthermore, a detailed study of Nd isotopes in the metacarbonates has helped to identify 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.

In contrast to the typical sedimentary O and C isotopic composition, low concentrations for mobile trace elements and flat REE patterns for pure metacarbonates, 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 minerals in impure metacarbonates suggest that they have been affected extensively by fluid infiltration events. Petrographic observations revealed that zircon is abundant. 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 (n=55), 546+/- 2 Ma (n=33) and 549 +/- 2 Ma (n=58), younger than the peak metamorphism of the SRMs.

Oxygen analyses of dolomite/calcite and zircon in these rocks yielded interesting results—high $d^{18}O_{(SMOW)}$ for zircon of about 23.4‰, and 24‰ in the surrounding dolomite. Similar to the previous reports on high oxygen isotope ratios for zircons in metacarbonate rocks from Sri Lanka and Myanmar [5], 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. Based on the evidence from oxygen isotopes, we suggest the possibility of oxygen isotope equilibration between zircon and carbonate and total dissolution-reprecipitation of zircons in metacarbonate rocks during the last stage of fluid infiltration coeval with the granitic activity. 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.

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