Apparent age of deposition of meta-carbonate rocks from Sør Rondane Mountains, East Antarctica

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In recent studies for determining depositional age of sedimentary rocks, geochemistry of carbon, oxygen and strontium isotopes, trace and rare earth elements in meta-carbonate rocks have been widely used, since they preserve the record of depositional history and post-depositional alterations (e.g., Melezhik et al., 2005, Satish-Kumar et al., 2008).

The Sør Rondane Mountains (71.5°-72.5°S, 22°-28°E), East Antarctica is a Latest Proterozoic to Early Cambrian collision zone in the so-called East African-Antarctic Orogen, and consist of medium- to high-grade metamorphic rocks, together with various igneous rocks. This area is separated into Northeastern (NE) and the Southwestern (SW) terranes based on lithology and metamorphic grade (Osanai et al., 1992). The NE terrane, dominated by metamorphic rocks, is estimated to have attained 800 °C and 7–8 kbar during peak metamorphism, and 530–580 °C and 5.5 kbar during subsequent amphibolite-facies retrograde metamorphism and regional rehydration. The SW terrane exposes tonalitic igneous rocks and greenschist- to amphibolite-facies metamorphic rocks. Meta-carbonate rocks are composed of pure dolomite/calcite layers interspersed with layers containing calc-silicate minerals such as olivine, spinel, clinohumite, phlogopite and diopside.

Pure meta-carbonate samples collected during the 51st Japanese Antarctica Research Expedition from different regions throughout the Sør Rondane Mountains were selected for detailed Sr isotope study by careful screening based on carbon and oxygen isotope and trace and rare earth element (REE) data. Oxygen isotopes and some trace elements such as Mn, light-REE, Fe, Y and Sr in carbonate minerals can be easily disturbed by post-depositional alteration and metamorphic fluid processes. High $\delta^{18}O$ values and low concentrations for mobile trace elements and rare earth element patterns typical for sedimentary carbonates indicate that the samples were least affected by post-depositional alterations.

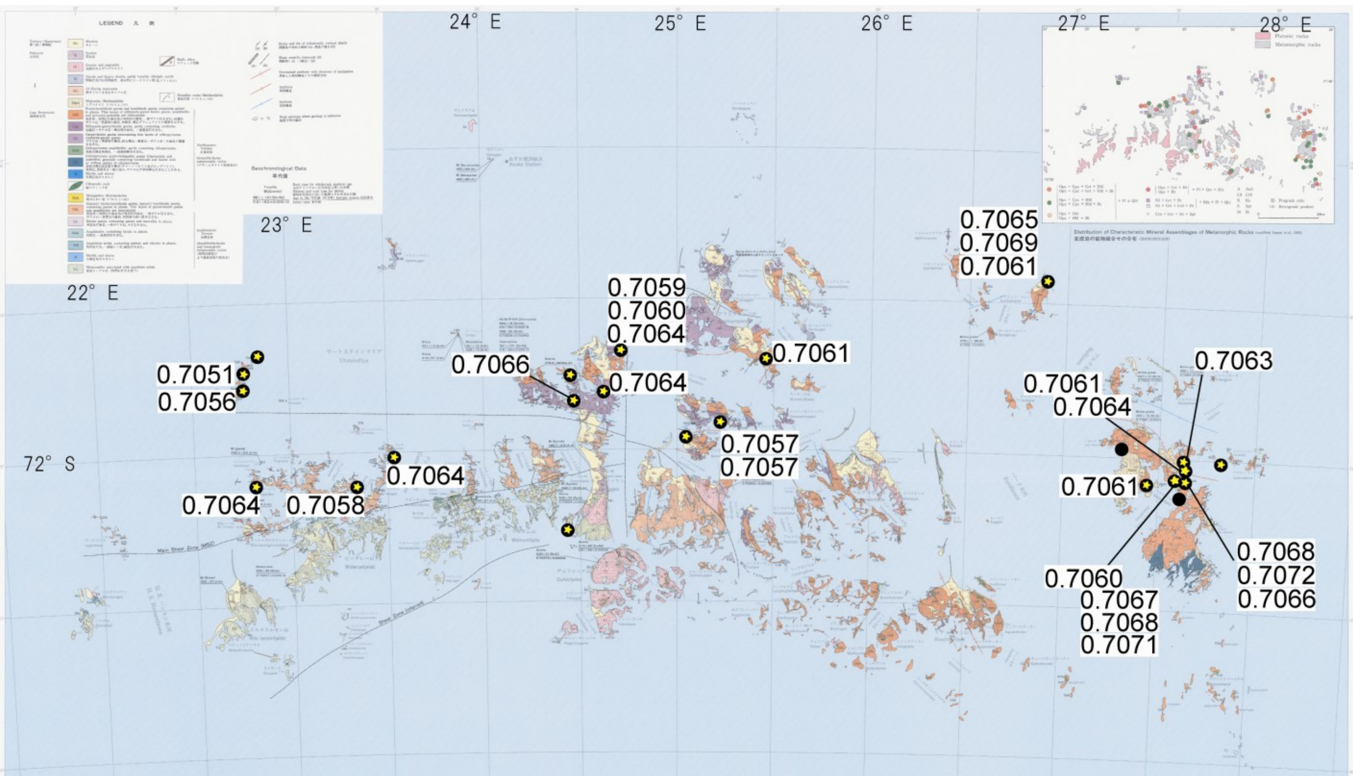

Figure1 Geological map of Sør Rondane Mountains showing the sampling site of meta-carbonate rocks and $^{87}Sr/^{86}Sr$ ratio

After strict screening and selection in terms of presence of calc-silicate minerals, field occurrence, $\delta^{18}O$ values, trace and rare earth element concentrations, 38 samples were selected for further detailed studies, including Sr isotope measurement for understanding the depositional condition. $^{87}Sr/^{86}Sr$ ratio distributed between 0.7051 and 0.7071.

Trace and rare earth elements show various behaviors, and can be used for estimating the initial $^{87}Sr/^{86}Sr$ ratios. For example, fluid tends to be depleted in Sr and enriched in Mn. In case meta-carbonate rocks were affected by fluid (more alteration), both Sr/Mn and $^{87}Sr/^{86}Sr$ ratio increases. Based on several parameters, we were able to recognize the difference between SW and NE terrane, and initial $^{87}Sr/^{86}Sr$ ratios were estimated for both terrains. These ratios reveal the possible Sr isotope value of ocean from which carbonate was deposited.

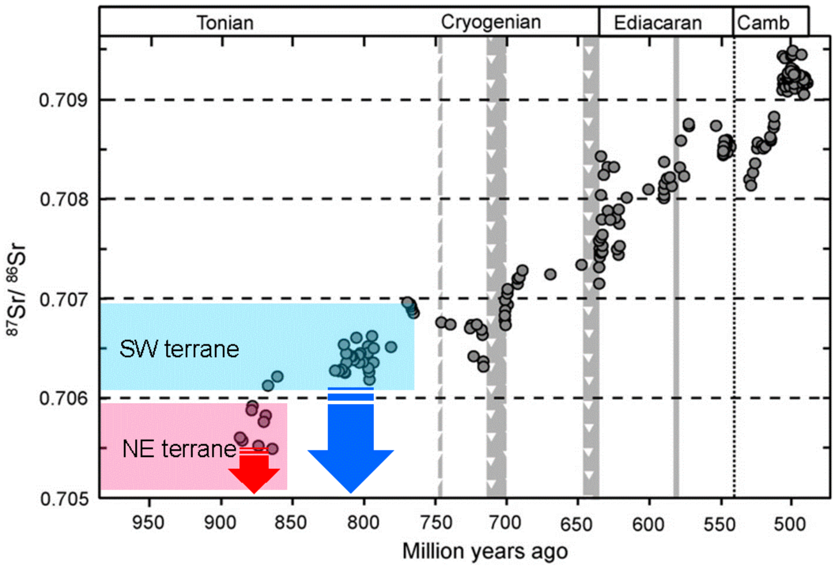

Figure2. Based on Halverson et al., 2010, the depositional age of carbonate rocks can be estimated from initial Sr isotope ratio. Carbonate rocks from the NE terrane were most likely to have deposited around 770-850Ma and those from SW terrane were deposited around 890-850Ma.

The Sr isotope initial ratios for carbonate rocks from NE and SW terrane were around 0.7060 to 0.7070 and 0.7050 to 0.7060, which suggest an apparent age of deposition around 770-850 and 890-850 Ma, respectively. We discuss the implications of the depositional ages of Sør Rondane meta-carbonate rocks in a context of collision tectonics between East and West Gondwana.

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