2-Myr metamorphic history of the Sanbagawa terrane deduced from the multimineral petrochronology

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Metamorphic ages are ideally determined from metamorphic minerals that are also used for P-T estimation, although minerals that are suitable for dating and do not always coincide with those suitable for P-T estimation. However, recent progresses in both petrology and geochemistry have increased the opportunity for single mineral P-T-t estimation. In this presentation, we introduce our recent studies deducing P-T-t information of multiple metamorphic stages by the abovementioned strategy.
The Sanbagawa metamorphic terrane is exposed mainly in the southwest Japan. The main constituent component is the late Jurassic sediments that underwent intermediate high-pressure/low-temperature type metamorphism at <85 Ma, whose metamorphic ages have been determined from white-mica K-Ar method (Aoya et al., 2013 and references therein). The highest-grade part of the country rocks reached c. 600 oC/1 GPa (Enami et al., 1994), whereas the eclogite unit exhibiting distinctly higher pressures (c. 2 GPa) exist at central & eastern Shikoku (e.g., Kouketsu et al., 2014).
A marble sample collected from the Eastern Iratsu body, one of the coarse-grained eclogitic bodies, records a unique and long-lived history of the relevant area (Yoshida et al., 2021a, b; Niki et al., under review). The studied marble is weakly foliated and is mainly composed of grossular-garnet, diopside, calcite, and quartz, with minor amount of Fe-sulfide, titanite, and apatite. The grossular-garnet in the matrix contains omphacite and high-Si phengite (Si~3.5 at O=11 basis), indicating its origin of the eclogite-facies metamorphism. Different from the matrix mineral paragenesis, quartz-rich domain (Qz-pod) exists subparallel to the main foliation of the matrix, consisting mainly of quartz, diopside, grossular-garnet, and minor amount of Fe-sulfide and titanite. The grossular-garnet in the Qz-pod shows patchy texture with grossular-core containing aragonite and andradite-rich-rim containing calcite.
The eclogite-facies stage and subsequent fluid infiltration were recovered from the Qz-pod. Carbonate minerals in the grossular-core and andradite-rich-rim indicated exhumation from the eclogite-facies conditions, while datolite [CaBSiO4(OH)] inclusion in the rim inferred the B-rich fluid infiltration was involved in rim formation (Yoshida et al., 2021a). Newly developed LA-ICP-MS in-situ dating of grossular-garnet revealed 97 ±10 and 106 ±16 Ma for core and rim, respectively (Niki et al., under review). Similar ages for both core and rim formation could be originated from either (1) the rim inherited isotopic signature of the core during fluid-mediated dissolution and reprecipitation process, or (2) the obtained ages failed to distinguish two events due to the large errors. The core age of 97 ±10 Ma is comparable with the age of Grt-Cpx Lu-Hf age of the Seba and Kotsu eclogitic mass (Wallis et al., 2009).
In contrast, matrix mineral assemblages recorded earlier histories (Yoshida et al., 2021b). LA-ICP-MS U-Pb dating of titanite and zircon in the matrix provided an older age of approximately 200 Ma where corresponding P-T conditions were estimated to be >1000 oC and 2.5 GPa using Zr-in-titanite thermometer and elastic mineral barometry applied for the quartz-in-titanite pair. Titanite rims gave an age of 126 Ma which is equivalent to the early Sanbagawa metamorphism (e.g. Endo et al., 2009), where no P-T information for 126 Ma age was available in our sample.
The newly discovered “pre-Sanbagawa metamorphism” was older and higher-P and T compared to those previously recognized in the relevant area. The remnant of such old event could have been preserved due to the dry environment of the studied marble. Growth (or replacement) of the datable

minerals had limitedly occurred when fluid infiltration took place in a short period. Our results indicated the importance of the dating using the mineral species used for P-T estimation if possible.

Keywords: Sanbagawa metamorphic terrane, pre-Sanbagawa metamorphism, LA-ICP-MS

