Geochronological evidence of rapid progression of regional metamorphism in Hida Metamorphic Complex, southwest Japan

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Geochronological constraints from metamorphic rocks provide important information for understanding crustal evolution as well as metamorphic processes. The Hida Belt, situated at the northern part of southwestern Japan, consists of low P/T metamorphic rocks (Hida Metamorphic Complex) and Permo-Triassic granitoids, and is an important geological unit for discussion about crustal evolution at continental margin. In this study, zircon U–Pb geochronology was applied to the Hida gneisses and the Unazuki metamorphic rocks situated at the northeastern part of the Hida Belt to discuss the timing and the duration of regional metamorphism.

Zircon grains collected from the Hida gneisses have a dark CL response mantle and a bright CL response rim around igneous zoning core. The youngest age population of the igneous zoning core is 253 ± 5 Ma. The mantle and the rim yielded same age of 247 ± 4 Ma, suggesting a rapid progression from igneous activity to regional metamorphism. REE patterns of the rim suggest overgrowth of zircon under hydrothermal fluids.

Protoliths of the Unazuki metamorphic rocks are sedimentary and felsic volcanic rocks of late Carboniferous to early Permian age, based on the fossil evidence. U–Pb data of quartzo-feldspathic schist derived from felsic volcanics yield an eruption age of 258 ± 2 Ma, indicating that regional metamorphism occurred after 258 Ma. On the other hand, U–Pb age of a granite intruding the schist is 253 ± 1 Ma. The granite contains some xenoliths of the Unazuki schist, in which staurolite is replaced by andalusite and cordierite due to thermal flux from granitic magma. Therefore, the regional kyanite-sillimanite type metamorphism occurred between 258 and 253 Ma, suggesting a rapid metamorphic progression. Further work is needed to confirm this rapidity of crustal-thickening process.

Helium isotope map of Japan

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A helium isotope ratio(^{3}He/^{4}He ratio) could be a good tracer for estimating the extent of upwelling deep fluids. This is because the helium has two origins, ^{3}He in terresial sample is considered to be a primordial isotope derived from the mantle, while ^{4}He is mainly from the crust. The spatial distribution of helium isotope ratios is characterized by high values of 4 to 8Ra (where Ra is the atmospheric ^{3}He/^{4}He ratio of 1.40×10^{-6}) along the volcanic front and in the back-arc region at northeastern Japan. In contrast forearc region shows low values less than 1Ra. This trend has simply been interpreted that helium in the back-arc region originates from the mantle and that in the fore-arc region is from the crust [e.g. 1, 2]. On the other hand, ^{3}He/^{4}He ratio of the southwestern Japan shows no clear and complex distribution. The complexity cause a lot of discussion for many years [e.g. 1, 3, 4, 5, 6]. However, no end to this discussion is currently in sight.

In recent 20 years, an increasing number of hot spring wells have been constructed in Japan. We collected gas and water samples from hot springs, deep wells, and mineral springs whole of Japan, and carried out the analysis of helium isotope ratio. At the same time, the helium data of previous studies are compiled.

The total number of data points is over 2000 including 1091samples obtained in our study and 1121 samples from previous studies. We show helium isotope map of Japan.

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