What is the age of peak metamorphism in the Sanbagawa belt? The formation age of the highest-grade most deeply formed rocks in metamorphic belts is important to constrain exhumation rates and orogenic time scales. Nearly all the radiometric dating in the Sanbagawa belt is related to the cooling history, and the peak of metamorphism is much less well constrained. Zircon U-Pb SHRIMP dating suggests the peak age may be around 110–120 Ma[1]. However, the dated zircon is not clearly linked to eclogite facies metamorphism.

Omphacite-garnet Lu-Hf dating of eclogite in the Kotsu and Seba regions of the Sanbagawa belt suggests the peak formation age of eclogite is 88–89 Ma; much younger than previously thought. These two areas were selected for dating because of their well characterized metamorphic and deformation history. The two analysed samples gave isochron ages of 88.2 Ma and 88.8 Ma with an implied initial Hf isotopic ratio of 0.283063, the samples being identical within error. Laser ablation profiling of garnets shows that Lu is concentrated in the cores of garnet. In addition, micro Raman and EPMA studies show that Seba sample has omphacite present from core to rim of the garnet. The Kotsu sample lacks omphacite inclusions in the core region where Lu is most highly concentrated. However, an isochron defined by two fractions of garnet shows no significant difference from a three-point isochron including omphacite supporting the ages as robust and geologically meaningful.

Appropriate closure temperatures for the Lu Hf system in garnet and omphacite are not well established, but almost certainly greater than that for the Sm – Nd system (>600°C) for orogenic time scales and mm-sized omphacite and garnet grains. This is shown by the following considerations.

1) In samples for which there are both Sm-Nd and Lu-Hf dates available, the Lu Hf ages are invariably older suggesting a higher closure temperature.

2) Diffusion in garnet is broadly similar for all 3+ REE ions whereas the Hf exists as 4+ and is expected to have a slower diffusion rate[2].

The peak temperature of the Kotsu and Seba eclogites is around 600°C and hence the Lu-Hf ages represent the formation age of omphacite and garnet and also the peak of metamorphism.

A combination of the Lu-Hf ages with other cooling ages shows Sanbagawa eclogite exhumation up to lower crustal levels took place at cm per year. The Kotsu and Seba eclogite units structurally overlie units with younger deformation fabrics implying these are all younger than 89 Ma. The Sanbagawa orogen was largely complete within a few million years and represents a snap shot in the history of the subduction zone rather than a prolonged development.

References