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Partial melting in deep subduction zone detected from zircon preserved in the Sanbagawa eclogite

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Subducting oceanic plate is dehydrated due to metamorphic reaction in higher pressure and temperature conditions. The dehydrated fluid is considered to cause deep focused earthquake and Island Arc volcanism. Recently we have discovered an eclogite outcrop exhibiting partial melting texture from the Sanbagawa high P/T metamorphic belt, characterized as subducted oceanic material (Okamoto & Arakawa, 2011). The discovery is significantly important because the melt may play an important role in deep-focused earthquake and the melt itself directly may contribute to the origin of Island Arc magma. Due to an extensive retrograde hydration and deformation, melting process is only preserved in garnet on thin section. Zircon is the best tool to reconstruct melting process at eclogite facies condition because it preserves 1) high P minerals, 2) melt and fluid as inclusion and 3) the zircon growth history can be traced from its zonal texture.

Analytical method

We carefully collected the eclogite (SHT15) and the melted portion (SHT16) characterized as quartz-plagioclase rich domain from the outcrop exhibiting melting texture. Zircon separation was based on Tsutsumi et al. (2009). One another sample (SHT17) showing the eclogite with minor melted texture was also collected. Separated zircons from the above three specimens were carefully observed under SEM, CL, and the zircon inclusions were identified using EDS and laser Raman.

Result

The zircons from the eclogite portion (SHT15) are elongated and have relatively large diameters in 100 to 250 microns. The zircons from the melted portion (SHT16) are rounded and 100 to 200 microns. The specimens SHT17 have elongated and rounded zircons. Zonal textures in the zircon from the SHT15 are classified as core, mantle and rims. Zircons from the melted portion (SHT16) have homogeneous core with thin mantle and rims. Zircon inclusions from the core (SHT15 and SHT17) are characterized as igneous and altered phase (apatite and gypsum). Rutile and amphibole are recognized from the mantle.

Discussion and conclusion

The zircon features from the melted portion (SHT16) are identical with the zircons (GO4) from the quartz bearing eclogite described by Okamoto et al. (2004). The GO4 zircons are considered as grown at prograde stage (120 to 110 Ma). The zircons from the SHT15 and SHT17 are comparable with zircons from the metasedimentary rock (QM) associated with the quartz bearing eclogite (Okamoto et al. 2004). The QM zircons have detrital core with metamorphic mantle grown at 120-110 Ma and thin rims. These lines of evidence suggest that the Sanbagawa eclogite suffered partial melting in deep subduction zone. Under the micron scope, mylonite texture is obvious in thin sections from the specimen SHT16. It may suggest that semi-brittle deformation was caused by partial melting and the melt accumulation was also governed by the deformation.

Keywords: deep subduction zone, partial melting, eclogite, zircon