Age and metamorphic conditions of highly metamorphosed Cretaceous accretionary complex in the Kerama Islands, the Ryukyu Arc

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The Kerama formation, a member of the Shimanto accretionary complex in the Kerama Islands, the Ryukyu Arc, consists of greenstone, sandstone, and pelitic phyllite. The boundary between the greenstone and the overlying sedimentary rocks records intrusion of basaltic lava, the protolith of the greenstone. Previous study shows the greenstone in Kerama formation has geochemical features of N-MORB (Chinen et al., 2004), suggesting that ridge igneous activity occurred near the trench axis where terrigenous sediment was deposited. The bottom of the greenstone is characterized by conglomeratic sandstone mylonite originated from gravel sandstone, which records evidence of ductile top-to-SE shear deformation.

The metamorphic facies of the greenstones are confirmed to be epidote–amphibolite facies by optical microscopy and mineral chemistry of metamorphic minerals. The peak temperature of the pelitic phyllite and conglomeratic sandstone mylonite estimated by Raman spectra of carbonaceous materials thermometer (Beyssac et al., 2002; Aoya et al., 2010) is 470-530˚C. The result of Ti-Amphibole thermometer (Liao et al., 2021) for greenstone is 514˚C. The pressure condition estimated by the Phengite barometer (Massonne and Schreyer, 1987) is 0.6-1.0 GPa. The estimated metamorphic temperature conditions are higher than that of the Shimanto belt, but consistent with the pressure and temperature conditions of epidote–amphibolite facies in greenstone (Peacock, 1993). Comparison with numerical modeling (Iwamori, 2000) suggests that this pressure-temperature condition is achieved at the plate boundary up to several million years after the ridge subduction.

The U-Pb dating of detrital zircon shows that the sandstone shows the youngest single grain age of 112-104 Ma. Phengite K-Ar ages of 91-90 Ma were obtained for the pelitic phyllite. These results suggest that the sedimentation age is approx. 100 Ma and that by 90 Ma the temperature had decreased to 350˚C, the closure temperature of the K-Ar system in phengite, after peak metamorphism of ~500˚C.

The metamorphic conditions inferred from the application of geothermometer and geobarometer could be achieved within a few million years after ridge subduction. Ridge subduction is also supported by the existence of N-MORB intruded into trench-filled terrigenous sediment. This result contradicts the reconstruction of Müller et al. (2019) and is dated differently from that of Isozaki et al. (2010). It will be necessary to construct a new plate reconstructions model by re-examining the geological records of Taiwan, other parts of the Ryukyu Arc, southwest Japan, and northeast Japan, taking geographical distribution into account.

