Pseudosection modeling and zircon geochronology of barroisite eclogites from the Antarctic Ross orogen

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I investigated pristine barroisite eclogites from the Ross orogen, Antarctica. Mineral assemblages are represented by garnet + omphacite + calcic/sodic-calcic amphibole + epidote + phengite + paragonite + rutile + quartz. These eclogites revealed three stages of prograde metamorphism, defining two distinctive *P-T* trajectories, $M_{1–2}$ and M_3. The *P-T* pseudosections were calculated in the (Mn)NCKFMASHO model system. The *P-T*-M_{H2O} relationship suggests that higher amounts of H_2O are required for the M_1 assemblages, in which hydrous phases are stable, than those for the M_2. The Fe^{3+} content of bulk composition was estimated on the basis of *P*-X_{Fe3+} and *T*-X_{Fe3+} diagrams. I adopted the X_{Fe3+} values for original and fractionated bulk compositions which are similar to reported values from medium-*T* eclogites and unaltered mid-ocean ridge basalts, respectively. A decrease of the X_{Fe3+} values from M_1 to M_2 suggests f_{O2} decrease during prograde metamorphism. The eclogites have initially evolved from ~15 to 20 kbar and 520–570 °C (M_1) to ~22–25 kbar and 630–650 °C (M_2). The second segment ($M_{3A–B}$) of prograde *P-T* path was constrained at ~26 ± 3 kbar and 720 ± 80 °C, using the garnet-clinopyroxene-phengite thermobarometer. Further details are available in Kim et al. (2019, J. Metam. Geol.).

Two distinctive *P-T* trajectories of prograde metamorphism were correlated to episodic growth and/or recrystallization of the zircon mantle and rim domains during two stages of subduction burial at 515.2 ± 3.9 Ma ($t\sigma$) and 498.1 ± 10.8 Ma ($t\sigma$), respectively. Average burial rates (<2 mm/year) are too low for cold subduction regime (~5–10 °C/km), suggesting that an exhumation stage intervened between two prograde segments of *P-T* path. Inherited zircon cores are characterized by the presence of subtle oscillatory zonation and acicular apatite inclusion. The zircon cores are relatively high in Th/U ratios (0.33–0.99), and yielded the $^{206}Pb/^{238}U$ ages of 590.9 ± 5.1 Ma ($t\sigma$) and 604.8 ± 4.8 Ma ($t\sigma$). Hf isotopic compositions of the same analytical pits of U-Pb analyses resulted in the initial $\varepsilon_{Hf}(t)$ values of zircon core ranging from +9.2 to +18.8. Combined with mildly alkalic, within-plate to continental basalt-like geochemistry, these late Neoproterozoic gabbroic protoliths of the Cambrian eclogites are spatial-temporal equivalent to *c.* 600–580 Ma rift to passive margin magmatic rocks in eastern Australia.