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Age, Composition and Origin of In-Situ Leucosome Pockets in Partially Melted UHP Eclogite from the Sulu Orogen, China

Peng Feng (1), Lu Wang (1), Michael Brown (1,2), and Songjie Wang ()

(1) State Key Laboratory of Geological Processes and Mineral Resources, and Center for Global Tectonics, School of Earth Sciences, China University of Geosciences, Wuhan 430074, China (pengfeng1991.cug@foxmail.com), (2) Laboratory for Crustal Petrology, Department of Geology, University of Maryland, College Park, MD 20742, USA, (3) College of Earth Science and Engineering, Shandong University of Science and Technology, Qingdao 266590, China

Recent studies of fluids and melts in UHP eclogites have addressed issues such as generation, evolution and crystallization. However, it remains challenging to determine the composition of initial melts in nature due to overprinting processes including melt migration, partial crystallization and melt drainage, and melt infiltration. To avoid these problems we have studied small-scale in-situ leucosomes in eclogite from Taohang, in the central Sulu Belt. We have used a combination of field structural mapping, estimates of leucosome composition and thermobarometry to constrain the mechanism(s) of partial melting.

Partially melted eclogites from Taohang are composed of garnet (39–43%) + omphacite (25–29%) + zoisite (9–11%) + quartz (8–12%) + phengite (4–6%) + plagioclase (3–4%) + kyanite (1%) + Amp (1%). Various lines of evidence suggest partial melting. 1) The occurrence of plagioclase as veinlets along grain boundaries surrounding phengite, quartz and zoisite, and has low dihedral angles at triple junctions. 2) The presence of in-situ leucosome pockets composed of plagioclase, euhedral amphibole and minor K–feldspar, surrounded by coarse garnet, omphacite and zoisite. Fine-grained omphacite relicts scattered throughout the leucosome pockets have significantly lower jadeite content (Jd32–37) compared with the coarse omphacite grains in the host eclogite (Jd46–54). Plagioclase in the veinlets and pockets has similarly compositions (Ab86–89). 3) The presence of multi-phase solid inclusions of Pl + Kfs and Ph + Ky + Kfs in zoisite, and of Kfs + Qz ± Pl ± Amp in garnet.

Major oxide compositions of 19 leucosome pockets were determined based on modes and mineral compositions. The leucosomes have moderate SiO_2 (61.16–65.19 wt%), high Na2O (6.19–10.17 wt%) and $Al2O_3$ (19.65–23.02 wt%), and relatively low $Fe2O_3$T (0.04–2.37 wt%), MgO (0–2.98 wt%), CaO (0.10–1.01 wt%) and K2O (0.13–1.88 wt%). Garnet–omphacite thermometry combined with Si-in-phengite barometry using mineral compositions from the host eclogite yields T of 840–930 °C at P of 2.9–3.3 GPa, inferred to record the peak metamorphism. Jadeite geobarometry on omphacite relics in the recrystallized melt pockets yields P of 1.4–1.6 GPa at 800 °C, and the amphibole–plagioclase thermometry gives 800–850°C at 1.5 GPa. Overall, the compositions and P–T condition of the leucosome pockets are similar to glass (melt) compositions produced in partial melting experiment on zoisite- and phengite-bearing eclogite at P = 1.5 GPa and T = 850°C.

SS-LASS analysis of thin metamorphic rims on zircon from eclogite and two leucosomes yields weighted mean ages of 220 ± 2.5 Ma (n = 12), 215 ± 4 Ma (n = 15) and 214 ± 4 Ma (n = 5), respectively. Ti-in-zircon thermometry on these rims yields 746–594°C (mean = 633°C).

Overall, we interpret low-volume partial melting of UHP eclogite at Taohang to have been induced by breakdown of zoisite rather than phengite, with crystallization of the melt occurring around 215 Ma at the wet solidus. This represents the first detailed micro-scale study of in-situ melting of UHP eclogite from the Sulu Belt.