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Partially Melted UHP Eclogite in the Sulu Orogenic Belt, China and its rheological significance to deep continental subduction: Micro- to Macro-scale Evidence

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Numerous studies have described partial melting processes in low-high pressure meta-sedimentary rocks, some of which may generate melts that coalesce to form plutons. However, migmatized ultrahigh pressure (UHP) eclogite has never been clearly described from the microscale to macroscale, though experimental studies prove dehydration partial melting of eclogite at high pressure condition[1] and low degrees of partially melted eclogite have been reported from the Qaidam UHP orogenic belt in NW China[2,3] or inferred from multiphase solid (MS) inclusions within eclogite[4] in the Sulu UHP belt.

We present field-based documentation of decompression partial melting of UHP eclogite from Yangkou and General's Hill, Sulu Orogen. Migmatized eclogite shows successive stages of anatexis, initially starting from intragranular and grain boundary melt droplets, which grow into a 3D interconnected intergranular network, then segregate and accumulate in pressure shadow areas, and finally merge to form melt channels and dikes that transport melts to upper lithospheric levels. In-situ phengite breakdown-induced partial melting is directly identified by MS inclusions of Kfs+ barium-bearing Kfs + Pl in garnet, connected by 4-10 μm wide veinlets consisting of Bt + Kfs + Pl next to the phengite. Intergranular veinlets of plagioclase + K-feldspar first form isolated beads of melt along grain boundaries and triple junctions of quartz, and with higher degrees of melting, eventually form interconnected 3D networks along grain boundaries in the leucosome, allowing melt to escape from the intergranular realm and collect in low-stress areas.

U-Pb (zircon) dating and petrological analyses on residue and leucocratic rocks shows that partial melting occurred at 228-219 Ma, shortly after peak UHP metamorphism ($\sim$230 Ma), and at depths of 30-90 km. Whole-rock trace element analyses show that the leucocratic rocks, residue and peak metamorphic stage eclogite (no decompression partial melting) show well matched mass balance relationships. Melts derived from eclogite partial melting lubricated the subducted eclogite slices and facilitated their buoyant rise from mantle depths to crustal levels.

Partial melting of deeply subducted eclogite is an important process in determining the rheological structure and mechanical behavior of subducted lithosphere and its rapid exhumation, controlling flow of deep lithospheric material, and for generation of melts from the upper mantle, potentially contributing to arc magmatism and growth of continental crust. Deeply subducted, partially melted eclogite from General's Hill show that eclogites can develop regularly spaced melt channels, a meter or two thick, that would act as significant seismic anomalies[5]. This may provide direct evidence for the nature of enigmatic "bright zones" presented in some deep-crustal seismic reflection profiles which have been interpreted to represent areas of melt, high fluid content or unusual rock compositions[6].

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