Growth of metamorphic and peritectic garnets in UHP metagranite during continental subduction and exhumation in the Dabie orogen

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Two generations of garnet are recognized in ultrahigh-pressure (UHP) metagranite from the Dabie orogen by a combined study of petrography, major and trace element profiles in garnet, and phase equilibrium modeling for metagranite. The results enable distinction between metamorphic and peritectic garnet on the basis of BSE images, and major and trace element compositions. Our research provides new insights into the growth of anatectic garnet due to dehydration melting of UHP metamorphic rocks during exhumation frommantle depths. The first generation of garnet (Grt-I) occurs as a broad domain in the center, which is related to metamorphic growth during prograde subduction. This garnet is dark in BSE images, rich in grossular and poor in almandine and pyrope. The chondrite-normalized rare earth element (REE) patterns show LREE depletion and flat MREE-HREE patterns. The second generation of garnet (Grt-II) occurs as a rim of euhedral garnet, or as patches in Grt-I domains, recrystallized after dissolution of pre-existing metamorphic garnet in the presence of anatectic melts during exhumation. It is bright in BSE images, poor in grossular, and rich in almandine and pyrope contents. Trace element analyses on Grt-II domains yield high contents of Sc, Cr, Y and HREE and low contents of Ti and MREE. The chondrite-normalized REE patterns exhibit LREE depletion, and steep MREE-HREE patterns. Based on REE partitioning between garnet and zircon/titanite, the last growth times for metamorphic and anatectic garnets are constrained by zircon and titanite U–Pb ages to be ~240 Ma and ~220 Ma, respectively. Based on anatectic microstructures and a modeled P-T pseudosection, it is suggested that dehydration melting occurred at 2.0-2.5 GPa during exhumation. Melting occurred through the breakdown of phengite via the peritectic reaction: garnet (I) + phengite + plagioclase + quartz → garnet (II) + biotite + K-feldspar + melt.