TRACING THE PROTOLITHS OF RUTILE ECLOGITES FROM THE SULU UHPM TERRANE, EASTERN CHINA: IMPLICATIONS ON RUTILE FORMATION

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The rutile eclogites in the Sulu ultrahigh pressure metamorphic (UHPM) terrane have negative εNd values consistent with continental origin. They are characterized by enrichment in Ti accompanied by depletions in Nb, Ta, Zr and Hf. Because these high field strength elements (HFSE) are immobile, fractionations between HFSE are uncommon and provide critical constraints on the protoliths of these economically valuable rutile eclogites.

Comparing trace element variations of rutile eclogites to those of common geochemical reservoirs shows that only the high-Ti gabbros are possible protoliths for rutile eclogites. However, most gabbros are of oceanic origin without significant fractionation between Ti and other HFSE. To constrain the trace element characteristics of continental gabbro, we used the MELTS algorithm to model major element compositions and mineral proportions of gabbros derived from Emeishan high-Ti tholeiitic basalts by fractional crystallization. Despite of the variations in the proportions of constituting minerals, all gabbros crystallized from such tholeiites at 10 - 20 kbar have major oxide contents comparable to those of rutile eclogites. However, only the cumulates containing 63 % clinopyroxene, 32 % plagioclase and 5 % ilmenite have trace element abundances comparable to rutile eclogites. The fractionation of Ti from other HFSE reflects the combined effects of plagioclase/melt and ilmenite/melt partitioning. Based on major and trace element compositions as well as Nd isotopic ratio, we suggest that the protolith of Sulu rutile eclogite is gabbro crystallized from continental high-Ti tholeiitic basalts at 10 ~ 12 kbar and 1140 ~ 1160 °C.

During UHP eclogitization, ilmenite and clinopyroxene are the sources of Ti for forming rutile. Ilmenite might break down releasing Fe to form large grain rutile. In contrast, clinopyroxene transfer to omphacite liberating excess Fe and Ti, which might enter garnet enriching the Fe and Ti contents in garnet up to 26 wt% and 0.34 wt%, respectively. Retrograde eclogites with higher FeO and TiO_2 and lower SiO_2 and CaO contents are mainly composed of garnet and ilmenite without omphacite. These characteristics reflect the effects of interacting with fluid after peak metamorphism. As indicated by experimental results, Ti could become mobile at pressures > 1 GPa. Interacting with high pressure high-Ti fluids, the eclogites might be enriched in Ti abundance. Meanwhile, these fluids might trigger omphacite breakdown and remove SiO_2 and CaO from eclogites. Consequently, Ti was concentrated in two stages; breakdown of ilmenite during prograde metamorphism and interacting with fluids during retrograde metamorphism.