From isotopic exchange kinetics to geodynamics of continental subduction: A case study of ultrahigh pressure eclogites from the Dabie-Sulu orogen in China

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The occurrence of coesite and micro-diamond in eclogites from the Dabie-Sulu terranes in East China provides compelling evidence for the subduction of continental crust to mantle depths of greater than 100km. The oxygen and hydrogen isotope analyses of mineral separates from UHP eclogites in the Dabie-Sulu terranes show a large variation in $\delta^{18}O$ values of -10 to $+9$ ‰ for garnet and omphacite but a small range in δD value of -73 to -104 ‰ for phengite. Oxygen isotope equilibrium has been preserved between the eclogite minerals (exclusive of zoisite and rutile) and yields concordant isotopic temperatures of 550 to 750 ℃. These not only demonstrate that the UHP rocks acquired the unusual $\delta^{18}O$ values prior to eclogite-facies metamorphism by interaction with ^{18}O-depleted fluids, but also precludes the infiltration of external fluids during exhumation as the cause for the ^{18}O-depletion in the eclogites.

Heterogeneous $\delta^{18}O$ distribution of the eclogites suggests a channelized fluid flow during prograde metamorphism and thus corresponds to a rapid subduction. Preservation of the $\delta^{18}O$ values as low as -10 to -8 ‰ indicates a short residence of less than 20 Ma at mantle depths during the UHP metamorphism, otherwise the extremely ^{18}O-depleted eclogites would be reequilibrated isotopically with the mantle due to diffusion and recrystallization. This suggests restricted fluid mobility and limited crust-mantle interaction during the UHP metamorphism. The consistency of oxygen isotope temperatures between different mineral pairs points to relatively rapid cooling and ascent for the UHP eclogites in the early stage of their exhumation, otherwise the oxygen isotope fractionations between the major coexisting phases would be reset due to diffusion-controlled isotopic exchange.