Mantle and crustal metasomatism of garnet-bearing peridotite in the Western Gneiss Region of the Norwegian Caledonides

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The trace element and isotope geochemistries, Re-Os model ages and Sm-Nd mineral ages of garnet-bearing orogenic peridotite bodies in the Western Gneiss Region, Norwegian Caledonides indicate an episode of mantle metasomatism and a later episode of crustal metasomatism re-fertilized dunite and harzburgite that had formed during a melting depletion event in the Archean. The early metasomatism occurred when melts passed through the sub-Baltic mantle. The oldest Sm-Nd mineral age determined (1.64 Ga) is a minimum age for recrystallization in the garnet stability field, which in turn is the minimum age for the transit of the melts. Contiguous peridotite and pyroxenite show parallel trace element patterns, enriched in LREE and some LIL elements and depleted in the HFSE, suggesting the melts metasomatized the host peridotite. Sr and Nd isotope ratios define show large variation in ^{143}Nd/^{144}Nd but very limited increase in depleted ^{87}Sr/^{86}Sr ratios as ^{143}Nd/^{144}Nd decreases. The second metasomatism occurred during the closure of Iapetus, (420-400 Ma) when the western edge of the Baltic Shield was subducted into the mantle and invaded by the peridotite bodies from the overlying mantle wedge. It was associated with the development of exsolved micro-assemblages including microdiamonds. Metasomatism was heterogeneous with depleted patterns persisting in some assemblages whereas others are enriched in LREE and some LILE, but not HFSE. The depleted assemblages display the Proterozoic isotopic patterns described above while the enriched assemblages show an increase to very high (>0.715) ^{87}Sr/^{86}Sr ratios. The patterns are consistent with metasomatism in the mantle wedge above subducting ocean crust or with metasomatism by fluids derived by dehydration reactions from the host crust.

Water content in eclogite from the ultrahigh-pressure terrane

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Water is introduced into the mantle by hydrated oceanic lithosphere at subduction zone, but most of hydrous minerals become unstable at high pressure and temperature. However, nominally anhydrous minerals can dissolve substantial amounts of hydroxyl as reported in mantle xenoliths (e.g., Bell and Rossman, 1992) and high-pressure experiments (e.g., Kohlstedt et al., 1996). In this study, we measured hydroxyl components of major constitute minerals of eclogites from the Kokchetav ultrahigh-pressure metamorphic terrane, using infrared spectroscopy and secondary ion mass spectrometry, and report how much water can be carried to the deep subduction zone.

The diamond-grade eclogite is mostly composed of omphacite and garnet with minor amounts of coesite and rutile, and yields P-T conditions of ca. 60 kbar and 1000°C. Infrared spectra reveals three hydroxyl absorption bands for the omphacite in the regions of 3440-3460 cm^{-1}, 3500-3530 cm^{-1} and 3600-3625 cm^{-1}, and ion micro-probe analysis yields 840 ppm H_2O (by weight). The garnet has a single peak at 3580-3630 cm^{-1}, and contain up to 120 ppm H_2O. The hydrogen concentrations of these minerals increase systematically with the metamorphic grade. Ca-Eskola component in the omphacite have a positive correlation with the OH content, which suggests that the M2 vacancy is most likely mechanism to incorporate hydroxyl in the omphacite. According to modal proportion of the rocks, the eclogites contain approximately 430 ppm H_2O at depths greater than 150 km. This indicates that subducting oceanic crust transports considerable amounts of water into the deep upper mantle beyond stability field of hydrous minerals. Such water may be stored in the deep mantle and have an important influence on dynamics in the Earth's interior.