Fe isotope signatures of eclogites from the Münchberg Massif, Germany

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Fe isotopes provide a promising tool to trace fluid-rock interactions and mass transfer in subducting oceanic lithosphere due to redox-sensitive isotope fractionation (phases rich in Fe3+ preferentially incorporate the heavier isotopes). Our study aims at understanding to which extent the Fe isotope signatures of eclogites reflect (1) igneous protolith formation, (2) subsequent seafloor alteration, or (3) fluid-rock interactions during the subduction-exhumation cycle.

The Münchberg Massif represents a nappe pile within the Variscan orogen. MORB-type eclogites and gneisses of the uppermost nappe (Hangendserie) show variable degrees of amphibolite facies retrogression. A dark, kyanite-free eclogite (Mg# <65, Al2O3 <15.5 wt.%) can be distinguished from a light, Ky-bearing eclogite (Mg# >65, Al2O3 >15.5 wt.%; usually higher Cr and lower HFSE contents). Despite their different major and trace element contents, δ56Fe values of dark (–0.068 ± 0.018 to –0.007 ± 0.003‰) and light eclogites (–0.053 ± 0.002 to +0.014 ± 0.024‰) overlap. δ56Fe tends to increase with Mg# and to decrease with FeOtot, Sc, Ni, V and Zn. Fluid-mobile elements are decoupled from δ56Fe. Fe3+/ΣFe tends to decrease with higher δ56Fe, but also to increase with higher δ18O values (up to 10‰). δ56Fe values of the Münchberg eclogites are generally lower than values for MORB, but overlap with those of arc basalts.

It appears that δ56Fe values are still largely controlled by protolith signatures. Light and dark eclogites may have a cumulate-differentiate relationship or are derived from different parental magmas. Low temperature seafloor alteration probably caused secondary oxidation of some samples. Fe isotope fractionation at this stage or during HP metamorphism cannot be precluded. Retrogression does not prove to be influential for eclogite Fe isotope signatures.