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Iron isotope fractionation and geochemical cycling in eclogites from the Münchberg Massif, Germany

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Iron isotopes are of interest as a potential redox proxy for subduction zone research, but a better understanding of the Fe isotope systematics of subducted lithosphere is required. It needed to be tested whether the whole rock Fe isotope compositions of subducted metabasites are dominated by the magmatic protolith composition, low-temperature hydrothermal alteration, or fluid-rock interactions during subduction. Likewise, a better understanding of Fe isotope fractionation between minerals during high-pressure metamorphism was seeked. This thesis presents a large geochemical dataset for eclogites and associated rocks from the Variscan Münchberg Massif, comprising Fe and O isotopes, major and trace elements, and Fe oxidation states.
Major and trace element compositions reveal the Münchberg eclogites to be derived from a single parental magma that underwent fractional crystallization and sediment contamination. Despite a mid-ocean ridge basalt signature and evidence for seawater alteration, the Münchberg eclogites were not derived from typical oceanic crust, but probably from a transitional setting between continental rifting and seafloor spreading. Metamorphic veins are uncommon and mostly in mineralogical, textural, mineral chemical, and oxygen isotope equilibrium with their host eclogites. This indicates limited fluid flow and thus a largely conservative behavior of most elements during high-pressure metamorphism. The eclogite mineral assemblages appear to have attained equilibrium for most trace elements during high-pressure metamorphism. Subsequently, the minerals seem to have preserved the oxygen isotope equilibrium they attained at peak metamorphic temperatures around 700°C, except for rutile.
The Fe isotope compositions of the Münchberg eclogites appear to be inherited from the magmatic protoliths, whereas fluid-rock interactions had little if any influence. This may be usual for continental eclogites, for which Fe isotopes could provide information about mantle source properties. The Fe isotope compositions of eclogite minerals seem to reflect differences in both Fe oxidation state and Fe coordination. Garnet is often zoned in Fe isotopes, reflecting Rayleigh fractionation, diffusion, or a combination of both.

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