CONSTRAINING TIME SCALES OF THE DECOMPRESSION OF MANTLE ROCKS FROM SECONDARY CHEMICAL ZONING OF GARNET FROM THE GFÖHL-UNIT, MOLDANUBIAN ZONE

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Up to 100 m sized mafic-ultramafic lenses, considered as mantle fragments, are embedded in felsic granulites of the Gföhl unit, Moldanubian zone, which were incorporated into mid-crustal rocks during the Variscan orogeny. We investigated a garnet-pyroxenite occurrence pertaining to these lenses. The primary mineral assemblage comprises Ca-rich garnet (XGrs = 0.4), kyanite, and Al-rich clinopyroxene (XCaTs = 0.23), indicating pressures of about 1.9 GPa and temperatures of 1100 °C. Towards the margins of the mafic lens, destabilization of these primary mineral assemblages during overprint at lower pressure conditions of about 1.0 GPa is evident. A first decompression phase is represented by sapphirine-spinel-plagioclase symplectites, which presumably replace kyanite and clinopyroxene. A second phase is evident from the partial resorption of garnet by plagioclase and clinopyroxene in the form of "corrosion tubes" that penetrate the garnet in a worm-like fashion. At pressures of about 0.8 GPa and temperatures of about 800 °C, the garnet was partially replaced by plagioclase-orthopyroxene-spinel symplectites at the rim. Along with this, garnet shows a pronounced secondary compositional zoning towards the decompression products. For the sapphirine-spinel-plagioclase symplectites and the plagioclase-clinopyroxene corrosion tubes, the secondary zoning is characterized by a decrease in the Ca content and a simultaneous increase in the Mg and Fe content. Secondary zoning toward the plagioclase-orthopyroxene spinel symplectites shows an increase in the Fe content and a simultaneous decrease in the Mg content with constant Ca content. By fitting a multicomponent diffusion model to the secondary zoning patterns, time scales for the duration of decompression were estimated. These vary, depending on the choice of experimental calibrations of the diffusion coefficients, from a few 1000 to several 100,000 years. Here, the early decompression reactions show the longest time scales of several 100,000 years and are up to five times longer than those obtained from the corrosion tubes and about ten times longer than the late plagioclase-orthopyroxene spinel symplectites. These time scales reflect the duration of the process from the beginning of the decompression reaction until the rocks have cooled below about 700 °C, when the compositional patterns of the garnet were effectively frozen due to increasingly sluggish diffusion towards lower temperatures. In the context of the evolution of the Moldanubian Zone, these time scales are short and indicate rapid transport of mafic-ultramafic lithologies from mantle to intermediate crustal levels and simultaneous integration into a predominantly felsic environment, accompanied by immediate cooling.