Tracing metasomatic reactions using inert zircon coronas around ilmenite

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Thin (typically ≤ 10 µm wide) coronas of zircons are commonly found around Fe-Ti oxides in mafic granulites and gabbroic rocks (Bingen *et al*. 2001; Søderlund *et al*. 2004). The zircons may remain inert during subsequent metamorphic and metasomatic alteration and outline former grain boundaries allowing to quantify mass transfer and to constrain the mechanism of replacement reactions. We use microtextures and zircon coronas to obtain information on the metasomatic alteration related to scapolitization and albitization of two gabbros (Ødegården and Langøya gabbros) from Kragerø, Southern Norway. During scapolitization ilmenite is completely replaced by silicates and rutile. The scapolitized Ødegården gabbro contains trails of tiny zircons in talc (after enstatite) documenting a complete replacement of the Fe-Ti phase with a Mg-silicate (mg# = 0.95). In addition to Cl-rich scapolite and apatite, Mg-rich minerals phlogopite (mg# = 0.95) amphibole (mg# = 0.85) and sapphirine (mg# = 0.98) are formed during this alteration. The ilmenite in the scapolitized Langøya olivine gabbro is replaced by phlogopite and amphibole. Additional phases are prehnite and tourmaline. While Fe in both cases leaves the system, Ti remains as rutile in the scapolitized Ødegarden gabbro. However the rutile is located outside the zircon coronas suggesting local scale mobilization of Ti. The nearby Langøya magnetite mines are the likely sink for the leached Fe and indicate transport on the scale of km.

Trails of ca 10 µm sized zircons are also present in the albitite-rock of the Ødegården area. Here the zircons trails are located in albite spatially associated with rutile suggesting the albitite formed from an ilmenite bearning gabbro possibly via a stage of scapolitization.

References

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Iron partitioning and the self-oxidation of the lower mantle

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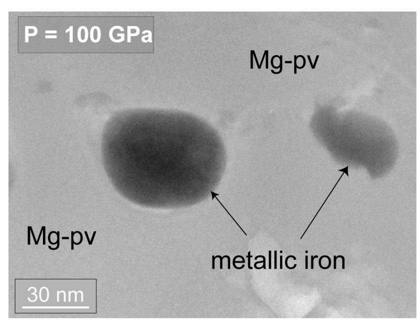
Magnesium silicate perovskite (Mg,Fe)SiO_3 (Mg-*pv*) and ferropericlase (Mg,Fe)O (*fp*) are the dominant phases in the lower-mantle. Their physical and chemical properties determine the dynamics of the deep Earth. It is thus of prime importance to constrain element partitioning at high pressure for improving the geochemical models of the Earth. We investigated iron partitioning between Mg-*pv* and *fp* synthetised under lower-mantle conditions (up to 115 GPa and 2200 K) in a laser heated diamond anvil cell (LH-DAC). Recovered samples were thinned to electron transparency by focussed ion beam (FIB) and characterized by analytical transmission electron microscopy (ATEM) and nanometer scale ion probe (nanoSIMS). Iron concentrations in both phases were obtained from EDX measurements and nanoSIMS. Our results are the first to show that recently reported transitions in the lower-mantle (Badro *et al*, 2003; Murakami *et al*., 2004) directly affect the evolution of Fe-Mg partitioning between both phases. Mg-*pv* is increasingly iron-depleted above 70-80 GPa possibly due to the high spin-low spin transition of iron in *fp*. Conversely, the perovskite to post-perovskite transition is accompanied by a strong iron enrichment of the silicate phase. Iron concentrations determined by ATEM and nanoSIMS are in excellent agreement. Nanoparticles of metallic iron were observed in the Mg-*pv* bearing runs (figure), suggesting the disproportionation of ferrous iron and the self-oxidation of the mantle, but were not observed when the post-perovskite (*ppv*) phase was present. Implications on the oxidation state of the Earth and core segregation will be discussed.



TEM imaging of the small particles (< 50 nm) of iron-rich metal which are systematically observed in Mg-*pv* + *fp*.

References

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