Partitioning of the $FeSiO_3$, $FeAlO_3$ and Al_2O_3 components between bridgmanite and post-bridgmanite

C.E. MOHN[1], R.G. TRØNNES[1,2]

[1]Centre for Earth Evolution and Dynamics, Univ. Oslo
[2]Natural History Museum, Univ. Oslo

The phase relations of coexisting bridgmanite (bm) and post-bridgmanite (pbm) in the systems $MgSiO_3$-$FeSiO_3$ (MS-FS), $MgSiO_3$-$FeAlO_3$ (-FA) and $MgSiO_3$-Al_2O_3 (-AA) were studied by multi-configurational Monte Carlo methods with density functional theory. The Clapeyron slope for the bm-pbm transition in pure MS is 10-13 MPa/K, and we assume a transition pressure of 128 GPa at 3000 K. The FS and FA components partition into pbm, but the MS-FA phase loop in pressure-composition space is narrow and flat compared to the MS-FS loop. The stability limits of single-phase bm at 3000 K are about 112 and 102 GPa for 10 and 20 mol% FS, and about 125 and 120 GPa for 10 and 20 mol% FA, respectively. The partitioning range is nearly identical for the two systems. Low-pressure bm with 10 and 20 mol% FS or FA exsolve pbm with about 20 and 37 mol% FS or FA.

In the MS-AA system bm and pbm coexist with $MgAl_2O_4$ (Ca-ferrite structure) + SiO_2 above 70 GPa [e.g. 1]. Although the solubility of AA in bm increases considerably in the 27-45 GPa range [2], it seems to drop below 10 mol% in the 70-130 GPa range. Although AA partitions into bm, the bm-pbm phase loop is narrow and flat.

The slow crystallisation of a thermally insulated basal magma ocean (BMO), possibly extending through the Hadean, would be accompanied by supply of silica from the core and transfer of Fe-oxides to the core [3]. The stagnant E'-layer of the outermost core provides a trace of the core-BMO exhange [4,5]. The exchange would maintain high Si/Mg and Mg/Fe ratios in the shrinking BMO, suppress ferropericlase crystallisation, extend the crystallisation of $MgSiO_3$-dominated bm and enrich the BMO in alumina. The low AA solubility in bm will favour late-stage bm cumulates with a high FA/FS ratio from the most Fe-enriched BMO, leading to basal LLSVP-layers (large low S-wave velocity provinces) with about 16 mol% FA+FS [3]. The large positive dp/dT slope of the bm-pbm transition and an estimated temperature excess of 750 K in the LLSVPs relative to the cooler parts of the D"-zone, may exclude pbm from the LLSVPs. This agrees with seismic evidence that D" discontinuities are found mostly outside the LLSVPs.

[1] Stixrude & Lithgow-Bertelloni (2011) *GJI* **44**, 8303. [2] Liu et al. (2017) *JGR* **122**, 7775. [3] Trønnes et al. (2018) *Tectonophys.*, accept. [4] Brodholt & Badro (2017) *GRL* **44**, 8303. [5] Hernlund & McNamara (2015) *Tr.Geophys*. **7**-11.