Fe-rich Ferropericlase in super deep diamonds and the stability of high FeO Wadsleyite. Implications on the composition and temperature of the Earth´s transition zone

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The high amount of Fe-rich ferropericlase inclusions found in diamonds of a potential super-deep origin questions the bulk chemical model of the Earth [e.g., 1]. Although this might be due to a biased sampling of the lower mantle, it is worth to further address this discrepancy.

A limiting factor of the Fe-content of the Earth´s deep mantle (TZ and lower mantle) is a correlation of the depths of the observed main mantle discontinuities with the (Fe,Mg)SiO_4 phase diagram. In particular, the 520 km-discontinuity is related to the phase transformation of wadsleyite (assuming Fa_{10}) to ringwoodite. The existing phase diagrams suggest a stability limit of wadsleyite $\leq Fa_{40}$ [e.g., 2,3], which limits the Fe-content of the Earth´s transition zone. Here we report on a discovery of Fe-rich wadsleyite grains (up to Fa_{56}) in the high-pressure silicate melt droplets within Fe,Ni-metal in shock veins of the CB (Bencubbin-like) metal-rich carbonaceous chondrite QC 001 [4], which were identified using HR-EDX, nano-EBSD and TEM. Although the existence of such Fe-rich wadsleyite in shock veins may be due to the kinetic reasons, new theoretical and experimental studies of the stability of (Fe,Mg)SiO_4 at high temperature (> 1800 K) are clearly needed. This may have significant impact on the temperature and chemical estimates of the Earth´s transition zone.

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