

New experimental data on Fe and Fe-S melting and the temperature at the core-mantle boundary

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Using a new method of rapid data acquisition in a double-sided laser-heating system at ESRF we measured X-ray diffraction patterns of laser heated iron to above its melting temperature in an argon pressure medium to 114 GPa, and in Al₂O₃ to 150 GPa. Only the fcc and hcp phases were observed. Fcc iron is stable to at least 68 GPa and at higher pressures only hcp was observed making this phase again the most likely candidate for the solid-inner core. The room-temperature equation of state of these fully annealed iron samples is identical to that previously measured in a helium pressure medium (Dewaele *et al.*, 2006). The highest P-T conditions at which melting was documented were 150 GPa and 3400 K, in excellent agreement with previous optical measurements (Boehler, 1993).

In the Fe-S system we reinvestigated the melt depression of iron using recovery experiments and electron microscopy. In contrast to our previous visual measurements there exists still a substantial melt depression of 1000 K at 50 GPa (Chudinovskikh and Boehler, 2007).

Both studies strongly suggest low core temperatures. The temperature at the core-side of the core-mantle boundary (at 135 GPa) would be substantially below 4000 K and thus, significantly decreasing the previously predicted large temperature jump across this boundary.

References

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Calcium isotope budget of the Phanerozoic ocean

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We present a new Early Ordovician to Late Triassic Ca isotope record measured on brachiopods. In combination with published and new Mesozoic-Cenozoic data (Late Jurassic-Early Cretaceous belemnites and brachiopods, Late Cretaceous brachiopods, Neogene foraminifera) our $\delta^{44/40}\text{Ca}$ record covers most of the Phanerozoic history. The data show significant variability on several timescales: An overall 0.5 ‰ increase in $\delta^{44/40}\text{Ca}$ from the Ordovician to the Pleistocene is mainly due to rising values during the Mississippian followed by a drop to intermediate values in the Permian-Triassic and a second increase during the Jurassic to a Cretaceous maximum. Neogene $\delta^{44/40}\text{Ca}$ values are in the same range as the Cretaceous values. Superimposed on these long-term (ca. 100 Ma) trends are several higher order oscillations (ca. 5-30 Ma) with magnitudes of up to 0.4 ‰. Well documented examples of the latter occurred during the Neogene [1] and the Jurassic-Cretaceous [2].

There is currently no simple explanation for the reconstructed isotope variability of seawater calcium. Variable continental weathering fluxes and carbonate deposition in the oceans cannot explain the isotope variations. These mechanisms only influence the ocean carbon cycle, which operates on a much shorter timescale than the Ca cycle. Variable Ca isotope fractionation on the continents also is unlikely to cause significant variability in ocean $\delta^{44/40}\text{Ca}$, due to the huge size of the ocean calcium reservoir compared to terrestrial Ca sediments (e.g. in soils or travertine). The most likely mechanism to explain ocean $\delta^{44/40}\text{Ca}$ variations is variable input of hydrothermal Ca and of Ca from dolomite formation. In addition, we observe a correlation of $\delta^{44/40}\text{Ca}$ and seawater Mg/Ca ratios during the Paleozoic, which can be best explained by a shift from calcite dominated sedimentation during the Early Paleozoic to aragonite dominance in the Late Paleozoic and Triassic. Aragonite is stronger fractionated than calcite, so sedimentation dominated by aragonite leads to an enrichment of seawater in ^{44}Ca . However, this correlation breaks down after the Carboniferous, possibly due to the evolutionary shift to mineralogy-independent fractionation of modern carbonate producers [3].

References

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