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Density and magnetic properties Fe_7C_3 to 1.7 Mbar with implications for carbon in the Earth's inner core

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The global carbon cycle may involve iron carbide Fe_7C_3 as a major component of the Earth's inner core. Testing the hypothesis of a carbon-rich inner core requires knowledge on the phase stability, density, and sound velocities of Fe_7C_3 under the corresponding pressure and temperature conditions. Here we report new x-ray diffraction spectra of Fe_7C_3 compressed to 1.7 Mbar, well into the pressure range of the Earth's core. In combination with parallel measurements on ^{57}Fe-enriched Fe_7C_3 using the synchrotron Mossbauer spectroscopy. Our data reveal two discontinuities in the compression curve, which we attribute to magneto-elastic coupling associated with pressure-induced second-order transitions. On the basis of the equation of state fitted to the XRD data above 60 GPa, we found that Fe_7C_3 provides a good match for the inner core density, supporting the notion that carbon is by far the largest reservoir of carbon inside the Earth.

Keywords: Fe7C3, inner core, carbon, magnetic transition, x-ray diffraction, synchrotron Mossbauer spectroscopy