

Melting phase relations in binary and ternary iron alloys and possible compositional range for the outer core

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A variety of liquid properties such as sound velocity, electrical conductivity, density, and liquidus phase relations have been recently measured/determined under high pressure in a diamond-anvil cell. We have been extensively working, in particular on the liquidus phase relations in iron alloy systems containing one or two light elements, in order to constrain the liquid core composition. It is crucially important to prepare a chemically homogeneous starting material for a DAC experiment, even for melting experiments. We employed such starting materials synthesized by ultra-rapid quenching from liquid or by sputtering. Liquidus phase relations in a ternary iron alloy system are sometimes very different from those in relevant binary systems; for example, SiO_2 exhibits a large liquidus field in Fe-Si-O, suggesting that SiO_2 oxide should have crystallized before inner core crystallization if core formation occurred at moderately high temperature and consequently the core originally included large amounts of silicon and oxygen (Hirose et al., 2017 Nature). We have examined the location of a ternary eutectic point in Fe-Si-S (Tateno et al., 2018 AmMin) and Fe-S-O (Yokoo et al., this meeting), with respect to those of binary eutectic points in Fe-Si (Ozawa et al., 2016 EPSL), Fe-S (Mori et al., 2017 EPSL), and Fe-O at equivalent pressure. Combining the results of these melting experiments with theoretical calculations of the densities and velocities of liquid iron alloys, we argue possible compositional ranges for the present-day liquid outer core.

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