Chemical composition of Earth’s core

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Introduction: Solar chemical condensation calculation shows that iron and sulfur are the most likely element to condense and form the cores of planets and meteorites [1]. Calculations along adiabatic paths starting at pressures of 10⁻¹² and 10⁻⁵ bars show that condensates would contain 25% by weight FeS at 600 K.

Thermodynamics and phase relations: There are several new experimental data for pure iron and we have calculated a new phase diagram of iron. Similarly in the binary Fe-S system, we have assessed the thermodynamic data with experimental constraints. Our calculated phase diagram extending to core pressures shows that the two new sulfide phases

Fig. 1. Thermodynamically assessed iron phase diagram (FeS and FeS₂) discovered by Fei et al [2] are stable down to 300 GPa. The iron-hcp phase melts at a little above 5000 K at 365 GPa (if the bcc is the phase the melting temperature is higher). Equations of state for hcp iron and Fe₃S₂ phases show that the density difference between the two phases is not high enough and would require an addition of large amount of S to model the inner and outer core densities. The Fe-S binary eutectic would cause a significant drop in temperature of melting of the alloy with very

Fig. 2. Phase diagrams of Fe and Fe-S system.

important geophysical consequences. The figure at 21 GPa is similar to the experimental data by Fei et al [2]. The unmixing of the liquid phase at 300 GPa is speculative due to large extrapolation.