CORE CRYSTALLIZATION AND CHEMICAL EVOLUTION OF IRON METEORITES PARENT BODIES.

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The large range in trace elements concentration measured within iron meteorite groups is usually thought to reflect fractional crystallization approaching ideal conditions, and has lead to favor an Earth-like outward crystallization mode. The recognition that core crystallization in asteroid-sized bodies would in fact start at the core-mantle boundary (CMB) [1] makes the explanation of the observed chemical differentiation somewhat more problematic. We investigate here possible solidification regimes with numerical solidification models and analog experiments, and discuss the implications of our physical models in terms of the resulting chemical fractionation.

Assuming first that the iron crystals stay fixed at the CMB, a dendritic layer will grow inward, releasing S-rich liquid in between the growing dendrites. In this configuration, the interdendritic melt is stably stratified (e.g. [2]), and no large scale convection occurs in the dendritic layer. The direct consequence is that there is no chemical flux from the dendritic layer to the inner liquid domain, which therefore does not evolve chemically: no global chemical differentiation would occur. We found however that the temperature within the liquid domain eventually falls below the solidification temperature before the solidification front reaches the center of the core, allowing secondary crystallization in the deep core. While this may drive convection in the liquid domain and allow its chemical evolution, the degree of differentiation by this process is actually found to be very small.

Laboratory experiments suggest that the dendritic layer would grow until a critical thickness is reached, after which crystals will continuously fall from it. Relaxing the assumption of no crystal fall will help chemical fractionation, by removing iron rich crystals from the solidifying region, leaving behind a progressively more and more evolved liquid, and allowing further crystallization within the core. Fallen crystals will sediment and accumulate to form a partially solid inner core. The core chemical evolution would be in fact close to fractional, with deviations coming mostly from the presence of partially solidified zones: some liquid is expected to be trapped in both the loosely packed inner core and the dendritic zone below the CMB. Further crystallization of this melt will induce a secondary chemical differentiation, leveled by solid state diffusion, which may account for the scatter in element *vs.* element diagrams and for the distinct compositional trend measured in the Cape York meteorites shower [3].

References: [1] Haack H. and Scott E.R.D.. 1992. *Journal of Geophysical Research* 97:14727–14734. [2] Huppert H.E. and Worster M.G.. *Nature* 314:703-707. [3] Esbensen K.H. et al., 1982. *Geochimica et Cosmochimica Acta* 46:1913-1920.