Study of the liquid Fe-S-Si immiscible system: core segregation with two metallic liquid phases ?

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The segregation of the metallic core from the silicate mantle is a process that controls the chemical composition of these two reservoirs. Understanding the mechanisms of this differentiation will give discriminating information on the amount of the different light elements in the core, and vice versa. There is a large consensus about the nature of these light elements: S, Si, C, O, H (Poirier, 1995). Taking into account the presence of light elements is crucial since the behaviour of the liquid phase may drastically change upon which element is present. Moreover, metallurgical studies of such alloys have shown the presence of miscibility gaps in a lot of systems (Fe-S-Si and Fe-C-S, Rhaghavan, 1988; Fe-FeO, Kato and Ringwood, 1989; Ohtani and Ringwood, 1984).

A strange behaviour at ambient pressure of the Fe-S-Si miscibility gap is the decrease of the miscible field with the increase of temperature (Rhaghavan, 1988). By analysing samples quenched from experiments done in multi-anvil apparatus and in a Paris Edinburgh press up to 15 GPa and 2300 K (i.e. the closure of the miscibility gap; Sanloup et al, 2004), we follow the shape of the miscibility gap with pressure and temperature. From the demixing paths, the thermodynamic parameters are deduced from a model based on the minimization of the energy of the system. This gives the possibility to extrapolate the shape of the gap at higher temperatures. A small miscible field at high temperature allows, even with low light element content, the existence of a two fluids system during planetary differentiation.

In the case of a differentiation with two metallic phases, the geometrical relationships between both liquids are important because they control the geochemical equilibrium with the silicate matrix as well as percolation processes. The wetting properties of each liquid depend on their light elements contents. A precise quantification of the interfacial tension (liquid Fe-S/liquid Fe-Si and wetting liquid/capsule) at different pressures and temperatures are under process at the ID19 beamline of ESRF, with a 3D X-ray *in situ* tomography experiment using the Paris Edinburgh press.

Yoshino et al. (2003) have shown, with high-pressure electrical conductivity experiments, that Fe-S liquid alloys do percolate through a solid silicate sample (olivines), even for low temperatures (~1200 K; Fei et al., 2000) and below the percolation threshold, for a metal content in the sample as small as 6%. The effect of Si on Fe-S percolation through a silicate matrix has to be evaluated.