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Marangoni effect in metal-silicate self separation

Stephane Labrosse (1), Hidenori Terasaki (2), and Yanick Ricard (1)

(1) Laboratoire des sciences de la Terre, Universite de Lyon, Universite Lyon-1, Ecole Normale Superieure de Lyon, Lyon, France (stephane.labrosse@ens-lyon.fr), (2) Dept. Earth & Planetary Materials Science, Tohoku Univ. Aoba, Aramaki, Aoba-ku, Sendai, 980-8578, JAPAN.

High pressure experiments of metal silicate mixture display a tendency for the molten metal phase to percolate through the solid silicate matrix toward the coolest regions of the sample. This simple observation carries important implications for processes leading to formation of planetary cores and present day core-mantle interactions. For the percolation to work, two ingredients are necessary, the classical wetting condition and a driving force to compact the silicate matrix. In laboratory scale experiments, gravity is negligible and the only available driving force is the interfacial tension, and in particular its temperature dependence, the Marangoni effect. We developed a physical model to treat numerically this problem within the framework of the compaction two-phase theory proposed by Bercovici, Ricard et al. Experimental results can be used to tune several of the unknown parameters in the numerical model and to test the theory. Both models and experiments show that interfacial tension can trigger metal silicate differentiation at the local scale, even in small planetesimals before gravity can act, and help global scale core formation. In addition, at the bottom of the mantle, the large temperature gradient can help core material to percolate upward. This process is much faster than the time scale for changes in the mantle and a steady state calculation gives the height in the mantle reached by the metal. The implications in terms of core-mantle electromagnetic interactions will be considered.