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HOW CAN ANALOG EXPERIMENTS HELP UNDERSTAND CORE SEGREGATION IN SMALL PLANETARY BODIES?

SOBOLEWSKA, Sara, Lamont-Doherty Earth Observatory, Columbia University, Palisades, NY 10964; Department of Chemistry, Hunter College, New York, NY 10065, OPPENHEIMER, Julie C., Lamont-Doherty Earth Observatory, Columbia University, Palisades, NY 10964 and LINDOO, Amanda, Geophysical Laboratory, Carnegie Institution For Science, Washington DC, 20005

Core formation in small planetary bodies likely involves percolation of immiscible liquids (e.g. S- and C- rich iron alloys) through pore spaces in a silicate medium. The manner in which this phenomenon occurs is not fully understood. Furthermore, it is unknown whether the metallic melts can physically segregate during percolation. To improve our understanding of core formation in small planetesimals, we performed analog experiments. We used an emulsion of oil and water to simulate an emulsion of S-rich and C-rich iron alloys, respectively. The experiments were performed in a Hele-Shaw cell, a thin “channel” made of two acrylic plates (51 cm x 15 cmx 1.3 cm) kept apart with a thin aluminum plate (0.27 mm). A U-shaped cut out of the aluminum plate formed the channel. We used a syringe pump to inject the emulsion into the channel through a hole in the top plate. We investigated the effect of injection rate and droplet size on the percolation behavior of the emulsion. We observed that droplet velocity was size dependent. The smallest droplet size detected was 0.0133 mm2 with a velocity of 0.67 mm/s. Medium size droplets ranged from 0.03mm2 – ~10 mm2 with average velocity of ~0.43 mm/s. Larger droplets moved faster: the largest droplet, with an area of 91.4 mm2, had a velocity of 7.95 mm/s. We suggest that (1) suspended droplets slow down when they begin to touch the Hele-Shaw plates (medium size droplets), and (2) droplets flow faster when they become large enough to deform with the flow. We also tested percolation through a channel filled with polydisperse acrylic particles of diameter < 50 µm. When injected into the granular matrix, the oil formed a wetting front while the water advanced in “pulses”. These pulses may represent the faster flow of larger water droplets. In conclusion, the size of the droplets affects their velocity and possibly their ability to migrate through pore networks. The results suggest that immiscible liquids could potentially segregate due to different percolation efficiencies of the non-wetting/wetting phases. Consequently, this would affect the distribution of the metallic components within differentiated planetesimals.

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