THE ORIGIN OF CHONDRITES: METAL-SILICATE SEPARATION EXPERIMENTS UNDER MICROGRAVITY CONDITIONS. K. Bogdon, C. White, R. Godsey, N. Kapieralski, D. Schneider, P. H. Benoit, and D. W. G. Sears, Cosmochemistry Group, Department of Chemistry, University of Arkansas, Fayetteville AR 72701, USA (dsears@comp.uark.edu).

Introduction: Arguably the property that best distinguishes the chondrite classes is their lithophile-siderophile element ratios, most particularly the ratio of silicon to iron. Urey and Craig first pointed out the compositional hiatus between H and L chondrites and suggested that it was due to the separation of silicates and metal, an interpretation that has subsequently received widespread acceptance. Most authors assume that this fractionation occurred in the primordial solar nebula prior to aggregation, although others have suggested that it occurred in a thick asteroid regolith. We have been trying to develop a quantitative understanding of the way silicates and metal might separate in the nebula or regolith. We have conducted experiments on NASA's Reduced Gravity Facility, a KC-135A that flies about 30 parabolic trajectories each allowing about 25 s of microgravity. We made two such flights in March 2000 as part of NASA's Reduced Gravity Student Flight Opportunities Program.

Experiment: Our apparatus consisted of 310 plexiglass tubes 2.5 cm in diameter in which various mixtures and grain sizes of sand and iron filings were placed (Fig. 1). Sand sieve size ranges were 149–250, 250–300, 300–425, 425–600 and iron sieve size ranges were 74–105, 105–149, 149–250. The relative proportions of iron and sand were 1:20 (by volume). Air was passed through most of the columns at a predetermined rate under microgravity conditions after which a plunger was depressed to "freeze" the columns. About 25% of the tubes were released and sealed without any air flowing through the tube so that sorting in the absence of aerodynamic processes could be explored. After the flight, ten holes were drilled in each tube and samples removed for analysis. Metal-silicate ratios were determined by magnetic separation and weighing.

Results: Some of our data are shown in Fig. 1 in which the mass ratio of sand to iron is plotted against height in the tubes for mixtures (149–250 mesh iron and 400–425 mesh sand) that are 5% Fe by volume

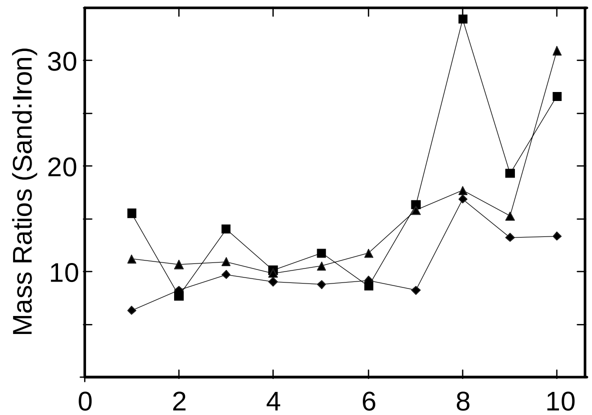

Fig. 1. Mass ratio sand and iron after being in microgravity for about 25 s as a function of height in a 10 cm deep bed. Triplicate measurements.

We were able to make three observations from a preliminary examination of the raw data. First, we never obtained a complete separation of Fe and sand in these experiments, despite large differences in size and density between the components. Throughout most of the length of the tubes the mass ratio is within or only slightly below its starting value. Second, there were no major differences in the results obtained for tubes in which a gas flowed during the low-g phase of flight and those for which there was no gas flow. Third, in most cases, a separation of sand and iron was achieved, with the upper few centimeters containing a factor of 2 to 3 times more sand by mass than the starting value.

Conclusions: The experiment design was successful and we believe that such experiments could provide new insights into the behavior of chondrite-like mixtures under microgravity. These preliminary data suggest that such processes have the potential to explain chondrite mixtures in which silicates and iron exist with small differences in fractionation. However, there is the suggestion in these data that density separation can be achieved in microgravity conditions without the need for aerodynamic sorting.