Intuition and Experience: Asteroid Surfaces, Meteorites and Planetary Geosciences in microgravity

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Abstract

Planetary scientists considering geological processes that occur in microgravity, such as on the surface of asteroids, face an intrinsic difficulty in that humans have experienced a lifetime of observing Nature under the fairly substantial gravity field of the Earth. In order to accumulate some experience of how geological materials behave under microgravity, we have conducted three sets of experiments on the NASA KC-135 microgravity facility (the "vomit comet"). We examined the behavior of a variety of possible regolith simulants being disturbed under microgravity conditions: sand, iron filings, gravel, and even concrete. Each set of experiments was for a different purpose and the experimental details differed considerably, but some common results were: Particle size sorting of the surface material occurred readily Segregations that occurred early in the process are retained during considerable amounts of subsequent activity There are several implications of these results for planetary science. For instance, since the surface will be so easily disturbed and mineral and phase separations will occur so readily, it can be predicted that the surface of asteroids will reflect these processes and not the internal composition of the asteroid. Thus deductions made by spectroscopic observations of the surface will not simply yield meaningful information about their bulk composition. Similarly, chondrule and metal size sorting appears to be a common feature of meteorites could have occurred on the surfaces of their parent bodies, presumably asteroids, and not necessarily in the protosolar nebular. Furthermore, the nature of the segregations is not always intuitively obvious. In our sand and metal mixtures, iron frequently rose to the surface. Thus care should be taken in applying terrestrial experiences to microgravity situations like the surface of asteroids.