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Effect of gravity on terminal particle settling velocity on Moon, Mars and Earth

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Gravity has a non-linear effect on the settling velocity of sediment particles in liquids and gases due to the interdependence of settling velocity, drag and friction. However, Stokes′Law, the common way of estimating the terminal velocity of a particle moving in a gas of liquid assumes a linear relationship between terminal velocity and gravity. For terrestrial applications, this "error" is not relevant, but it may strongly influence the terminal velocity achieved by settling particles on Mars. False estimates of these settling velocities will, in turn, affect the interpretation of particle sizes observed in sedimentary rocks on Mars. Wrong interpretations may occur, for example, when the texture of sedimentary rocks is linked to the amount and hydraulics of runoff and thus ultimately the environmental conditions on Mars at the time of their formation.
A good understanding of particle behaviour in liquids on Mars is therefore essential. In principle, the effect of lower gravity on settling velocity can also be achieved by reducing the difference in density between particle and gas or liquid. However, the use of such analogues simulating the lower gravity on Mars on Earth is creates other problems because the properties (i.e. viscosity) and interaction of the liquids and sediment (i.e. flow around the boundary layer between liquid and particle) differ from those of water and mineral particles. An alternative for measuring the actual settling velocities of particles under Martian gravity, on Earth, is offered by placing a settling tube on a reduced gravity flight and conduct settling tests within the 20 to 25 seconds of Martian gravity that can be simulated during such a flight. In this presentation we report the results of such a test conducted during a reduced gravity flight in November 2012. The results explore the strength of the non-linearity in the gravity-settling velocity relationship for terrestrial, lunar and Martian gravity.