ELECTROSTATIC AGGREGATION OF FINELY-COMMINUTED GEOLOGICAL MATERIALS

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Electrostatic forces are known to have a significant effect on the behavior of finely-comminuted particulate material: perhaps the most prevalent expression of this being electrostatic aggregation of particles into relatively coherent clumps. However, the precise role of electrostatic attraction and repulsion in determining the behavior of geological materials (such as volcanic ash and aeolian dust) is poorly understood. It may be an important factor in volcanic activity where the size of particles affects the behavior of eruption clouds during ash-fall or pyroclastic-surge, and it may also be important in affecting the threshold, transport, and deposition of aeolian particles. The effect of electrostatics on both pyroclastic and aeolian material could be important on Mars and Venus, as well as on Earth.

Electrostatic aggregation of fine particles is difficult to study on Earth either in the geological or laboratory environment principally because the material in an aggregated state remains airborne for such a short period of time. Also, aerodynamic forces acting on the clusters of particles during precipitation probably affect the aggregation process so that it is impossible to be certain about the respective roles of interparticle forces and aerodynamic forces in any experiment.

Previous studies with finely-comminuted (crushed) geological materials have shown that aggregation occurs very quickly after aerodynamic entrainment, that materials form a variety of aggregation products (one, two, and three-dimensional structures --filaments, flakes, and spheroids, respectively) and that aerodynamic forces during settling apparently modify the rate and nature of aggregation. The experiments also showed that the finest (clay-size) materials of the particulate mass were the primary contributors to aggregates.

Experiments conducted in the NASA/JSC - KC135 aircraft would shed some light on the aggregation process. Zero gravity would allow 1) a brief, but significant, time period for aggregation processes to be studied without settling of material, and 2) an environment in which electrostatic and aerodynamic forces could be separated.

The experimental variables for consideration would be the type of geological material, the method of comminution (aeolian attrition, glacial crushing, volcanic fragmentation, etc.), particle size and shape, and the atmospheric pressure (density) and temperature. The role of time cannot be studied in the KC 135 (except within a ~20 second period) and aircraft experiments are therefore seen as precursors to more elaborate and scientifically more comprehensive Shuttle or Space Station activities. For the KC 135, initial experiments would involve a simple glass case into which a particle cloud could be injected immediately prior to the zero-gravity maneuver. Photography would be the principal experimental record, but a framing rate of ~16 photos per second would be adequate for preliminary assessment of aggregation. In order to prevent contamination of the environment with the particles, the glass experimental chamber would be equipped as a standard glove box that would allow the total confinement of sample loading and chamber cleaning between experiments.

Although the proposed experiments are primarily aimed at aeolian and volcanic processes, the information obtained would be directly relevant to some of the more recent major issues of "nuclear winter" and the extinction of species in the geological record speculated to be caused by meteorite impact. Both hypotheses rely upon the role of atmospherically-suspended, finely-comminuted material.