.**THE FORMATION OF RADIAL LINEAMENTS ON FLUIDIZED EJECTA.** A. Suzuki[1], I. Kumagai[1], Y. Nagata[2], K. Kurita[1] and O. S. Barnouin-Jha[3,4], [1]Earthquake Research Institute, U. Tokyo, Japan, [2]Fac. of Engineering, Tokyo University of Agriculture and Technology, [3]Dept. of Engineering and Complexity Science, U. Tokyo, Japan, [4]JHUAPL, Laurel, MD.

Introduction: Many Martian craters possess peculiar ejecta whose fluidized morphologies differ from other ballistic ejecta seen in dry, airless environment. An important subclass of such fluidized ejecta is found at pedestal craters [e.g.1,2]. These ejecta typically possess concave inner lobe consisted of near rim moat, outward rise and distal cliff, and faint outer lobe without distinct distal rampart (Figure 1). These ejecta are also sometimes classified as double layered ejecta (DLE) [3,4]. Depositional features of the inner and the outer lobe are so distinct that there would be at least two different processes of ejecta sedimentation in a single impact [5].

New imaging dataset (MOC and THEMIS) revealed that the pedestal craters have numerous radial lineations on their ejecta [6,7]. These lineations continue from the surface of the inner lobe to that of the outer lobe, indicating that the flow after sedimentation of the inner lobe generates these lineations [7]. Mouginis-Mark proposed that these lineations are only visible on pedestal craters [6].

Two factors are typically invoked to describe the flow of ejecta at Martian craters: (1) subsurface volatiles that are incorporated into the ejecta [1,4,5,6,8]; and (2) the dynamic response of the atmosphere subsequent to an impact [9,10,11,12]. In this study, we have conducted water tank experiments examining the interaction between a vortex ring and a particle layer to see how the atmosphere displaces the ejecta material and modifies the surface morphology during the generation of surface lineations on the ejecta of pedestal craters. We will discuss the late stage interaction between a vortex ring and the ejecta particles, suggesting that even present Martian conditions are sufficient to form lineations seen on fluidized ejecta.

Experimental Approach: Numerous laboratory investigations elucidate the role of the atmosphere [9,10,11,12]. As opposed to the previous impact experiments where entire ejecta entrainment, transport and emplacement process was observed, we will focus on the late stages where the vortex ring interacts with a erodible surface of particles.

Figure 2 illustrates our experimental setup. The experiments were carried out in a transparent rectangular tank filled with a mixing of water and sugar or salt, at the bottom of which we placed a layer of glass beads uniform in size. A vortex generator, which is composed of a piston and a cylinder, was placed at the top of the tank. The water is pushed through the cylinder by dropping the piston leading to flow separation at the edge of walls of the cylinder and subsequent generation of a vortex ring [e.g.13]. The displacement length and velocity of the piston controls the flow velocity in the vortex ring. We achieve conditions in the laboratory between the vortex ring and the particles of our erodible surface that are analogous to those expected at Martian craters for current atmospheric condition by varying the densities of the water mixing sugar or salt, the size of the glass beads and the translational velocity of the piston. Fluid motion is analyzed by PIV method using fine tracer and a light sheet.

Results: We find three modes (Figure 3) of interactions between the vortex ring and our glass beads surface: (Mode 1) the vortex ring does not only sweep away the glass beads but also lift up them as it expands radially outwards, forming radial lineaments and petal-like features; (Mode 2) the vortex ring can not lift the beads in displacing them so that it generates only a circular erosion zone with few radial lineaments; and (Mode 3) the vortex ring is too weak and nothing happens. The data indicates that the interaction between the vortex ring and the surface depends on two dimensionless numbers, θ and *Re* [e.g.14]. The variable θ is parameterized inertial resistance of the surrounding fluid to gravitational forces corrected for buoyancy acting on the particles encountered by the vortex ring. The Reynolds number *Re* parameterized the ratio of inertial to viscous forces acting on these same particles. A relationship between θ and *Re* exists that delineates Mode 1 from Mode 3, occurring approximately at the transition Mode 2.

Discussion: The range of θ and *Re* obtained in the laboratory is equivalent to those that can be achieved on Mars for winds ranging from 10-100m/s under current atmospheric conditions. Thus all three modes of vortex ring-surface interactions are possible, maybe explaining why some large craters possess surface lineaments while others do not.

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Figure 1: An example of Martian pedestal craters located at 35.2N, 102.5E. We can see that this crater possesses two different type of lobe and numerous radial lineaments on its ejecta. This is the THEMIS VIS image.

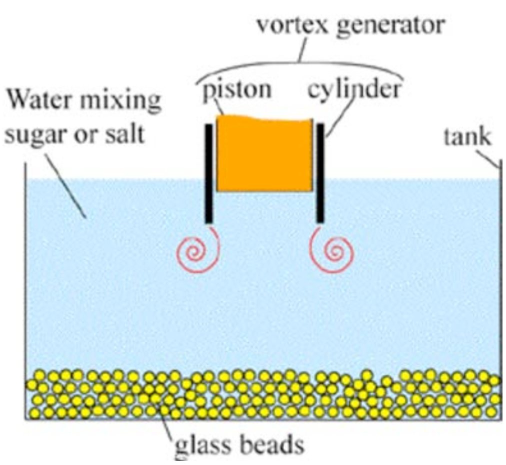

Figure 2: A cross-sectional schematic view of the experimental setup. When we displace the piston like the black arrow in this figure, the flow separates at the edge of the cylinder and develops into a vortex ring just like red curves.

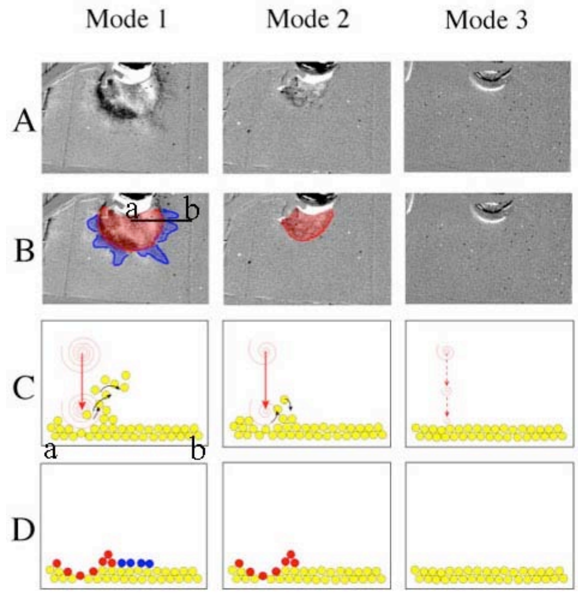

Figure 3: Example of the three modes of the vortex ring-surface interactions. Each column represents one mode. A) B) Oblique plan view of particle layer that is illuminated from the upper right. Bright or dark area indicates regions of particle displacement. C) Cross-sectional schematic view on the line a-b in B) of the interaction between a vortex ring and a particle layer and D) subsequent particle sedimentation. Red and blue circles correspond to red and blue area of B), respectively.

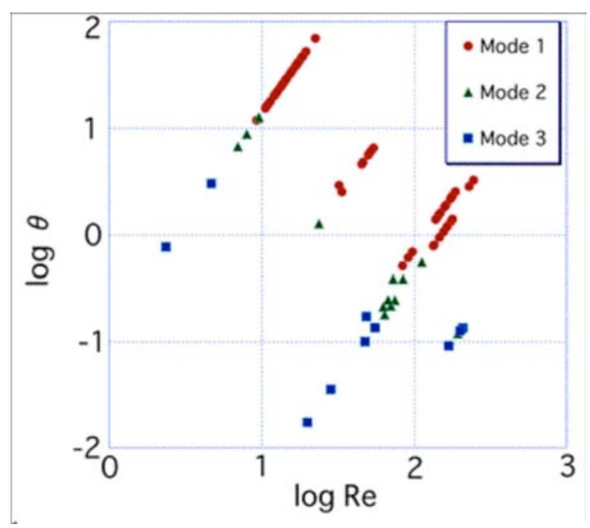

Figure 4: Regime diagram of the experimental results between θ and *Re*. The descriptions of these parameters are written in text. This figure indicates that the interaction between the vortex ring and the surface depends on these two dimensionless numbers.