GASEOUS DEBRIS FLOW MODELING OF MARTIAN FLUIDIZED EJECTA BLANKETS. Glen Akridge and Derek W.G. Sears. Cosmochemistry Group, Department of Chemistry and Biochemistry, University of Arkansas, Fayetteville, Arkansas 72701, USA. E-mail: cosmo@uafsysb.uark.edu

Previous workers have modeled Martian fluidized ejecta blankets (FEBs) as mud flows originating from impact vaporization of subsurface ice and recondensation during the expansion of the ejecta. The flows appear to be thin, ground-hugging and often are diverted by low-rising surface features. We believe that mud flows do not adequately describe FEBs due to the large amounts of entrained water required to sustain a debris-rich mud flow and the improbability of recondensing water vapor in the ejecta flow from the impact event. Gaseous debris flows similar to terrestrial pyroclastic flows may better explain the rampart features of Martian FEBs. Pyroclastic flows from Mt. St. Helens and Mt. Pinatubo were ground-hugging and strongly slope dependent. Barriers often diverted the flow path, but when barriers were overcome little or no deposits were left on ridge crests. Martian FEB characteristics seem to favor a gas driven ejecta flow.

The FEBs discovered on Mars by the Mariner and Viking spacecraft have provided critical evidence for subsurface stores of ice. Impact ejecta does not appear to have been ballistically emplaced, but rather forms a circular rampart with a distal ridge or escarpment (figure 1). Ejecta ranges are up to three times greater than expected[1] and are indicative of the increased mobility of the flow. The ejecta flow is often diverted by small preexisting surface protrusions, which suggests that the flow is thin and ground hugging[2]. The lobate morphology of most flows has lead many researchers to conclude a mud flow arising from the entrained water within the ejecta is responsible for rampart features[2,3].

We believe that mud flows do not adequately describe FEBs and mud flow characteristics on Mars would be significantly different than the surface features we now observe. Gaseous debris flows similar to terrestrial pyroclastic flows may better represent FEB morphology. Pyroclastic flows originating from the Mt. St. Helens and Mt. Pinatubo eruptions were gas driven debris surges that were strongly slope dependent[4]. Flow deposits at Mt. Pinatubo ranged from 30-50 m in depth[5] and are comparable to the estimated 30-60 m thickness of Martian FEBs[1]. Volcanic pyroclastic flows are primarily constrained to valleys and low lying regions, but may also surmount barriers. Deposit depths of high-density flows are proportional to the downward slope and inversely proportional to the distance from the source. At Mt. St. Helens, when gas-driven debris-flows overrode small barriers, virtually no buildup of debris occurred[7]. The flows terminated in distinct lobate deposits (figure 2) with lobes radiating outward from the main flow. The lobate edges were typically steep sided and resemble the rampart characteristics of Martian FEBs.

Arguments against gaseous debris flows have centered around the density of the outward moving material. Carr *et al.*[2] reasoned that a low-density solid-gas mixture would have been able to overcome small obstacles rather than being deflected. Gas flows were expected to have been low-density flows that would deflate considerably upon deposition causing striking elevation contrasts between the flow and obstacle. Modeling of volcanic flows[8] reveal similar densities between gas-driven flows (1450 kg/m^3) and mud flows (2008 kg/m^3). Gaseous debris

GASEOUS FLOW MODELING OF MARTIAN FEBs: Akridge G. and Sears D.W.G.

flow thicknesses are probably no more than twice their post-emplacement deposit depths[6]. The gas-solid flows may overcome barriers but do not typically leave deposits on ridge crests. In figure 1, a pre-Yuty crater is partially buried but still visible through the thin ejecta blanket. The crater rim is distinctly visible, which is not expected for a mud flow morphology. Mud flows would smear out rim edges, whereas gas-driven flows may leave deposits within the crater but are unlikely to alter rim crests.

The mechanism proposed for FEB mud flows on Mars is an impact into a dry surface layer and excavation of an ice-rich subsurface layer[9]. Mud flows typically require 20 wt. % of the flow to be liquid water[10] in order to support the sediment load. Using the FEB volume estimates of Mouginis-Mark[1], the Martian regolith would require a soil-water content of at least 600 kg/m^3 to sustain a mud flow. This value is only a minimum soil-water content estimate since it assumes that all of the vaporized water ice recondenses into a mud flow. Since FEBs are distributed globally, this seems to require regolith water contents similar to terrestrial aquifers. We conclude that FEBs on Mars were produced by gas-driven fluidization.

Figure 1. The 18 km diameter Yuty crater with several complexly lobed ejecta layers. A small pre-Yuty crater is still visible indicating a thin ejecta flow.

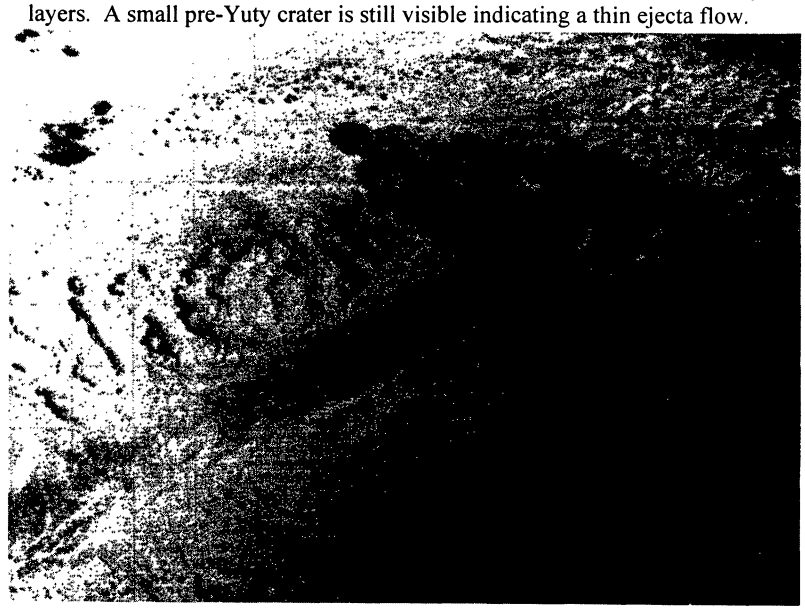

Figure 2. A 1 km pyroclastic flow deposit showing a tongue and radiating lobes from the May 18, 1980 eruption of Mt. St. Helens.

1, Mouginis-Mark P.J. (1978) *Nature* 272,691-694. 2, Carr M.H. *et al.* (1977) *Journal of Geophysical Research* 82, 4055-4065. 3, Gault D.E. and Greeley R. (1978) *Icarus* 34, 486-495. 4, Waitt R.B. (1981) *Geological Survey Professional Paper* 1250, 439-458. 5, Solidum R.U. Jr. (1994) *Bulletin of Volcanology* 56(31), 56-58. 6, Wilson L. and Head J.W. (1981*) Geological Survey Professional Paper* 1250, 513-524. 7, Hoblitt *et al.* (1981) *Geological Survey Professional Paper* 1250, 401-419. 8, McEwen A.S. and Malin M.C. (1989) *Journal of Volcanology and Geothermal Research* 37, 205-231. 9, Squyres *et al.* (1992) *Mars* 523-554. 10, Smith G.A. and Lowe D.R. (1991) SEPM *Special Publication No. 45*, 59-70.