EROSION AND TRANSPORT IN MARTIAN OUTFLOW CHANNELS, Blasius, K. R. and Cutts, J. A., Planetary Science Institute 283 S. Lake Suite 218, Pasadena, California 91101

There are two separable aspects to carving a channel with an erosive fluid such as water or air. The first is a means of breaking up the material in the floor of the channel to form debris in a size range that can be efficiently transported by the fluid. The second is effecting the transport of the debris as a bedload or as a suspension in the flow.

In a companion paper (1) we have examined transport of particulate materials in martian outflow channels in the context of models of channel formation by atmospheric and water flows. We showed that simple catastrophic flooding models require unreasonably large transport ratios (ratio of sediment transport to discharge) when judged against theoretical predictions of bedload and suspension transport in catastrophic water flows on Mars. We also demonstrated that if transport capacity is the only limiting factor, large outflow channels could have been carved by bedload eolian transport alone in less than a million years or in a few hundred thousand years if eolian suspension is taken into account. Although an adequate transport capacity is a necessary ingredient of any successful model for the formation of martian outflow channels it is not the only element in a successful model. Here we examine the problem of breaking up the material in the floor of the of the channel to form debris in a size range that can be efficiently transported by the fluid.

The size of particles that can be moved by the transporting fluid is an important consideration in this problem of channel formation. The sizes of particles that can participate as bedload and as suspended sediment loads in a water flow have been estimated by Komar (2,3). In general, because of the lower gravity for a given flood velocity larger particles can be moved in the bedload on Mars than in similar terrestrial floods. The maximum possible size of the suspended particles will also be larger on Mars than on Earth. Particles much larger than 1m can certainly be moved as bedload in a catastrophic flood on Mars and particles up to .01 m may be transported in suspension (3).

The sizes of particles that participate as bedload and as suspended loads in a martian atmospheric flow can be derived from theoretical considerations, laboratory simulations and actual observations of the planet. Pollack et al. (4) have argued that the particle size demarcating saltation and suspension transport is approximately 100 μm, close to the particle size for which the threshold wind velocity for initiating particle motion is a minimum. Particles between about 100 μm and 1mm are expected to saltate on Mars and particles smaller than 100 μm are expected to enter suspension. Dust storm observations suggest that typical suspended particle size is much smaller (less than 5 um).

In a catastrophic flood, a portion of the flow energy that is overcoming bedload resistance is expended detaching blocks of debris from the flow bed and comminuting those blocks as they participate in the bedload. Consequently, the production of particles suitable for transport is intimately coupled to the bedload transport process. It is conceivable that a flood cascading over a bedrock surface devoid of a ready made supply of debris may generate first a bedload and subsequently, by comminution, suspended debris' sufficient to saturate its transport capacity.

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With eolian transport it is much less likely that debris in the appropriate size range can be created at a rate which matches the transport capacity of a high velocity atmospheric flow. According to McCauley (5), an atmospheric flow will pluck material in an analogous manner to a water flow. However, the sizes of the particles affected and the hardness of the rock that will permit this process to take place are orders of magnitude lower than for water flow. Once particles of a size range for participation in saltation have been released, comminution can take place. However, an eolian flow does not provide a direct mechanism for creating particles in the size range for saltation.

If eolian flow is to be a viable mechanism for carving outflow channels there must be a means of providing these particles. Possible modes of origin include: 1) the channeled geological units are weakly bound as assemblages of solid grains, 2) direct saltation impact creates small particles - a suggestion due to Sagan (6) , 3) weathering processes have broken down crystalline rocks into friable grain assemblages. The issue is: can saltating grains be derived directly by plucking from the channel beds or from the apparent source regions (chaotic terrain)? The first alternative is not supported by photogeological analysis; the second alternative is allowed.

REFERENCES: (1) Cutts and Blasius (these conference abstracts 1979), (2) Komar, P.D.(1978) Icarus (in press). (3) Komar, P.D. (1979 priv. commun.) (4) Pollack, et al, (1976) Icarus 29, 395-417, (5) McCauley, J.R., et al. (1978) NASA Tech. Mem. 79729, 219-221, (6) Sagan, C. (1973) J. Geophys. Res. 78, 4155-4162.