ALLUVIAL FANS ON MARS. E. R. Kraal[1], J.M. Moore[2], A. D. Howard[3], E. A. Asphaug[1] [1](Department of Earth Sciences, University of California Santa Cruz, 1156 High Street, Santa Cruz, California, 95064, ekraal@es.ucsc.edu, asphaug@es.ucsc.edu), [2](NASA Ames Research Center, MS 245-3, Moffet Field, CA 94035-1000, jeff.moore@nasa.gov), [3](Department of Environmental Sciences, University of Virginia, 291 McCormick Rd., PO Box 400123, Charlottesville, VA 22904-4123, alanh@virginia.edu).

Overview: Moore and Howard [1] reported the discovery of large alluvial fans in craters on Mars. Their initial survey from 0-30° S found that these fans clustered in three distinct regions and occurred at around the +1 km MOLA defined Mars datum. However, due to incomplete image coverage, Moore and Howard [1]could not conduct a comprehensive survey. They also recognized, though did not quantitatively address, gravity scaling issues.

Here, we briefly discuss the identification of alluvial fans on Mars, then consider the general equations governing the deposition of alluvial fans and hypothesize a method for learning about grain size in alluvial fans on Mars.

Alluvial Fans: Fan deposits are formed by the deposition of sediment from a shifting source (such as a stream migrating over the deposit) and are recognized by their cone-shape morphology. Fans are well studied on Earth and form in many conditions from large underwater deposits at the mouths of rivers to sub-aerial gravity driven flows. This continuum of formation processes produces slight variations in morphology (such as slope, area, and basin size) that can be used to distinguish the formation process as well as information about the sedimentary system (for review see [2]).

Features in some craters on Mars, discovered in THEMIS daytime IR images and MOLA topography, have the same cone shape as terrestrial alluvial fan deposits. Comparison of fan statistics such as fan gradient, fan area, and basin area to statistics of terrestrials fans indicates that Martian fans follow the same approximate trends and compare well to very large terrestrial alluvial fans with possibly finer sediment size and lower sediment concentrations [1] (Figure 1).

Gravity Scaling: The deposition of sediment in alluvial fans occurs when the fluid transitions from the steep alcove area to the lower slope basin. As a result of this transition, the sediment load, eroded and transported through the alcove, is deposited in the adjacent basin. The repetitive deposition of sediment creates the distinct cone shaped deposit. Stream power is one equation that governs the transport and deposition of sediment ([3, 4]) in alluvial fans. The stream power (Ω) is:

$$\Omega = \rho g Q S$$

ρ is the density of water, g is planetary gravity, Q is water discharge, and S is the slope of the water surface. The ability of the fluid to entrain particles is, in part, based on empirical coefficients that have been developed for Earth and their direct application to a planet with different gravity is complex (e. g. see [5, 6]).

An additional challenge is that we do not have direct measurements of the clast sizes contained within Martian fans. The grain size is below current resolution and the top layer exposed to thermal inertia measurements is not necessarily representative of the entire fan but rather represents the modification processes that have occurred post formation. One approach we will explore is fan volume. Figure 2 illustrates that it is possible to calculate the volume of a fan by assuming crater shape was symmetric prior to deposition and extrapolating the crater wall. This volume can be compared to the estimated eroded volume of the alcove. We know of no such fan volume data sets on Earth (likely because the software to make such modifications and estimations as well as DEM topography is only recently available). Therefore, we will also need to compare measurements of fan volume to alcove volume for terrestrial examples where clast size is known from field studies. Ultimately, these calculations may give some estimate of fan porosity, which can offer some otherwise unavailable insight into sediment size.

Results: At the conference we will present the results of the comprehensive survey of alluvial fans from 0-30° S. The comprehensive survey, combined with the calculation of fan volumes in Martian and terrestrial settings, will permit us to begin to address the issues of gravity scaling in a quantitative manner.

References: [1.] Moore, J.M. and A.D. Howard, *Large alluvial fans on Mars.* JGR - Planets, in press. [2.] Harvey, A.M.,, in *Arid Zone Geomorphology: Process, Form, and Change in Drylands.* 1997. [3.] Harvey, A.M.,. Israel Journal of Earth Sciences, 1992. [4.] Bull, W.B., . GSA-Bull, 1979. 5. Wilson, L., et al.,. JGR-Planets, 2004. [6.] Komar, P.D., Icarus, 1979.

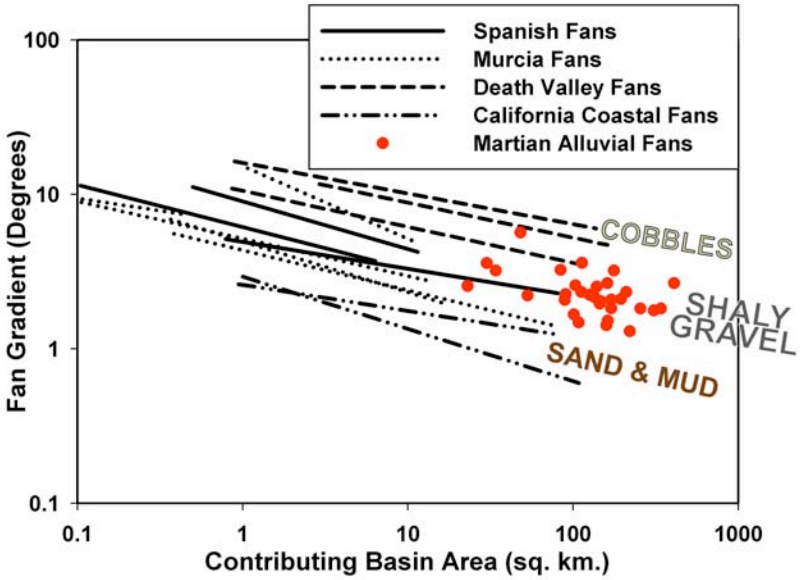

Figure 1: Comparison of fan gradient and contributing basin area of Martian alluvial fans to terrestrial ones (where grain size is known). Martian fans have lower slopes and larger drainage areas plotting in the shaley gravel portion of the graph. From Moore and Howard (in press, JGR)

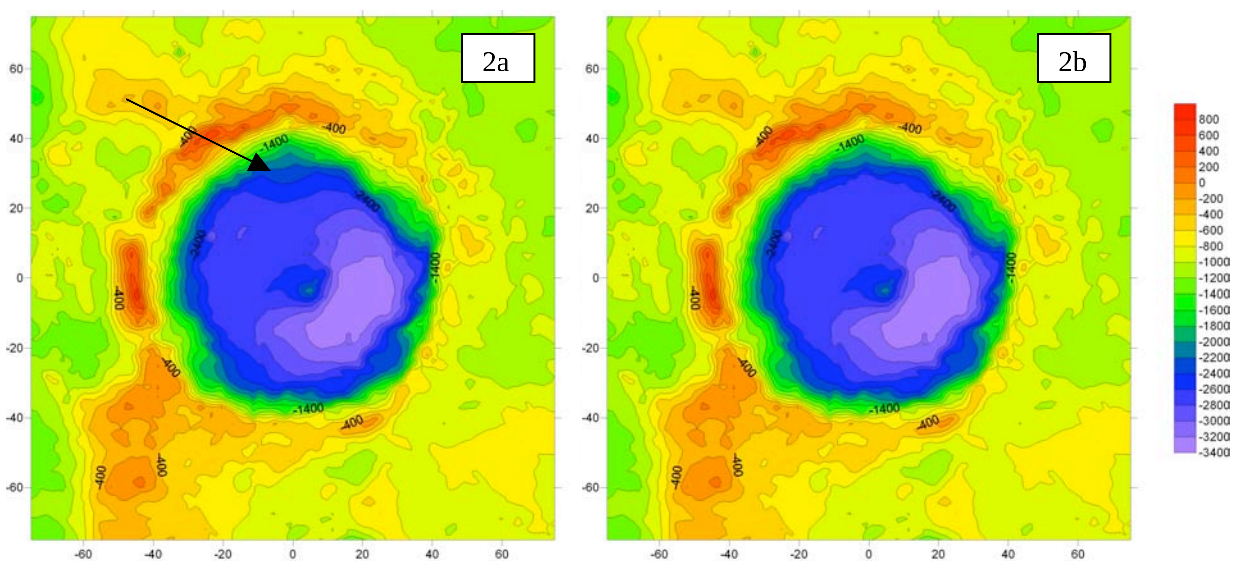

Figure 2: Jones Crater (-18.32 S, 324.85E). Axis in km, color bar scale in meters from MOLA datum. Volume of the fan is estimated to be 26 km^3, corresponding to an average thickness of ~80 m. Fan volume was estimated by generating a DEM from MOLA topography of the crater containing an identified fan (2a, arrow indicating fan). The crater was assumed to be circular and the contours of the crater were extended 'under' the fan (to within limits of the grid resolution). The two DEM's were differenced to estimate volume. Future volume calculations in combination with other fan statistics may offer insights into grain size and fan processes.