GRAIN-SIZE ANALYSIS OF MAUMEE AND VEDRA CHANNEL SEDIMENTS (MARS) USING EQUILIBRIUM SEDIMENT TRANSPORT THEORY. C. J. Thibodeaux[1], P. A. Washington[1], and R. A. De Hon[1], [1]Department of Geosciences, University of Louisiana at Monroe, Monroe, LA 71209.

Introduction: Catastrophic outflows are one agent responsible for the redistribution of martian surface material. The late Hesperian, Maja Valles outflow stretches 1200 km from Juvenate Chasma into western Chryse Planitia [1]. The initial outflow ponded on Lunae Planum before spilling across Xanthe Terra highlands to debouche into the Chryse basin. The material moved by the outflow is dependent upon the sediment transport rate and the flow rate. This paper examines the probable grain-size moved in channels across Xanthe Terra.

Method: Equilibrium Sediment Transport Theory [2-4] postulates that an equilibrium stream achieves the minimum ratio of stream power to sediment load, i.e., that the greatest possible proportion of stream energy is employed in the transport of available sediment load and that the maximum sediment transport rate is achieved for the flow rate. In achieving this equilibrium, the stream adjusts its channel geometry until the channel hydraulics achieve the ideal balance between stream power and bed mobility to maximize the transport of the available sediment. One of the most critical factors in this balance is the grain-size of the bed material. Although this theory was developed for channel design in engineered systems [4], it can be applied to the analysis of natural channels created by high paleoflows assuming that the channel hydraulics can be sufficiently constrained. The acquisition of the MOLA data has provided the needed data to constrain the channel hydraulics for the Maumee and Vedra channels.

Using equations for sediment transport [5, 6], White et al. [4] showed that sediment concentration, X, could be expressed as

$$X = \frac{D\, G_{gr}\, \rho}{Z_{avg}} \left(\frac{V}{V_*}\right)^{n} \qquad (1)$$

where D is the grain-size, the transport parameter $G_{gr} = C\,(F_{gr}/A - 1)^{m}$ with C and m being coefficients that depend on grain-size, particle density, and fluid material parameters and F_{gr} being a sediment mobility parameter with a threshold of A, ρ is normalized sediment density (i.e., density of sediment relative to density of water), Z_{avg} is the average depth of the stream, V and V_* are the average flow velocity and shear velocity, respectively, and n is a parameter depending on the grain-size and density and fluid material parameters (i.e., density and dynamic viscosity). This relation allows for the variation of a single unknown parameter until a maximum value for X is achieved. Of course, this requires that the remaining parameters are already known for the system.

For the Maumee and Vedra channels on Mars, the channel hydraulics have been constrained by application of another consequence of Equilibrium Sediment Transport Theory - the constraint on possible equilibrium channel geometries [7]. That analysis allows for the determination of the water surface during excavation of the channels using MOLA data [8]. By integrating the resulting channel hydraulics into the sediment analysis, only the grain-size is left as a variable for the analysis of sediment concentration. By solving equation (1) with a series of different grain-sizes and the hydraulic parameters of the two most equilibrated channel cross-sections for each of the channels, maximum sediment concentrations were found. According to the theory, the grain-size for this sediment concentration maximum is the equilibrium channel grain-size for these channels; it has been suggested [4, 6] that the values may be slightly large (ideal for a channel design equation), but these values nevertheless represent a first approximation.

Results: The discharge determined for the Maumee channel is approximately 1.93 x 10^6 m^3/s and for the Vedra channel is approximately 1.33 x 10^6 m^3/s. The grain-size determined for the Maumee channel range from – 7.4 to – 8.1ϕ (17 to 27 cm). The grain-size for the Vedra channel range from – 5.3 to – 7.9 ϕ (3.8 to 23 cm) [9].

Terrestrial analogs of the sedimentary load carried by catastrophic outflows include similar rapid outbursts in the form of jokulhaups in Iceland, massive discharge associated with Pleistocene ice dammed Lake Missoula [10, 11] and Lake Agazzi [12], and spillover through Red Rock Pass from the highest level of Lake Bonneville [13].

References: [1] De Hon, R. A. and E. A.Pani, 1993, *JGR, 98–Planets*, 9129-9138. [2] Lane, E. W., 1955, *Trans. Amer. Soc. Civil Eng., 120*, 1234–1260. [3]

Chang, H. H., 1980, *J. Hydraulics Div. ASCE, 105*, 1443– 1456. [4] White, W. R., R. Bettess, and E. Paris, 1982, *J. Hydraulics Div. ASCE, 108*, 1179-1193. [5] Ackers, P., and W. R. White, 1973, *J. Hydraulics Div., ASCE, 99*, 2041-2060. [6] Ackers, P., 1980, *Proc. Intern. Workshop on Alluvial River Problems*, Roorkee, India, March, 1980, 2-1 – 2-19. [7] Knighton, D., *1998, Fluvial Forms and Processes*, Arnold Publ., London, 383 p. [8] Thibodeaux, C. J., P. A. Washington. R. A. De Hon, *abs in Lunar Planet. Sci. Conf. XXXIV*. [9] Thibodeaux, C. J., 2003, *MS Thesis*, Univ. Louisiana at Monroe. [10] Baker V. R.,1973, *GSA Spec. Paper 144*, 79p. [11] Rice, J. W., Jr. and K. S. Edgett, 1997, *JGR, 102*, 4185-4200. [12] Teller, J. T, 1995, *Quaternary International, 28*, 83–92. [13] Jarrett, R. D. and H. E. Malde, 1987, *GSA Bull., 99,* 127-134.

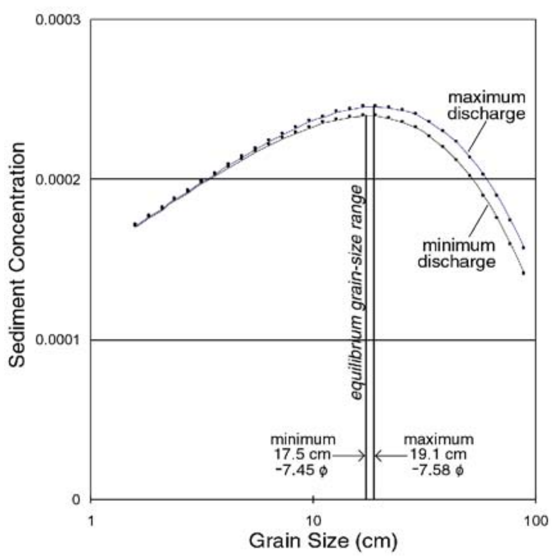

Figure 1. Grain-size determination for Maumee Vallis along orbit transect AP10900.