EXCAVATION TIME FOR THE VEDRA AND MAUMEE CHANNELS (MARS) BY APPLICATION OF EQUILIBRIUM SEDIMENT TRANSPORT THEORY. R. A. De Hon[1], P. A. Washington[1], and C. J. Thibodeaux[1], [1]Department of Geosciences, University of Louisiana at Monroe, Monroe, LA 71209.

Introduction: The question of survival times of water on the surface of Mars has implications for the composition, thickness, and surface temperature of the martian atmosphere. Whether water was present for extremely brief periods or for geologically significant time spans may be determined in part by examination of the times necessary for sustained flow to empty reservoirs or to excavate channels. Previous estimates of the duration of the Maja Valles [1] outflow system were poorly constrained by lack of accurate channel geometry. The acquisition of the MOLA data has provided the needed data to constrain the channel geometries sufficiently to determine the channel slope and cross-sectional geometry for several transects across the Maumee and Vedra trunk channels.

Method: Equilibrium Sediment Transport Theory [2, 3, 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. Achievement of equilibrium conditions is indicated by the development of a parabolic channel cross-section [5].

The theory [4, 6] indicates that there are three independent variables that control the equilibrium conditions (i.e., sediment discharge vs. stream power) for any natural channel: discharge, grain-size, and channel slope. If any two of these can be constrained, the sediment transport rate can be determined by analysis of the balance between sediment discharge and the unknown variable to maximize the mobile sediment concentration within the stream.

Because the limits on the parabolic cross-sectional geometry define the upper limits of the equilibrium channel, the equilibrium discharge was able to be determined by synthesis of the limiting discharges determined for the various transects [7]; the equilibrium discharge for the Maumee channel is approximately 1.93×10^6 m^3/s and for the Vedra channel is approximately 1.33×10^6 m^3/s [8]. Very little evidence of late stage channel modification was observed in this study, suggesting that the equilibrium bed surface established during the high stage flow was sufficiently armored that later lower flow stages did not have sufficient energy to modify the bed. The lack of later channel modification is consistent with the equilibrium grain-size (between 3.8 and 27 cm; i.e., pebbles and cobbles) determined for these channels [9].

Results: Applying these discharges and the local slopes to the best constrained channel transects, we find that the equilibrium sediment concentration for the Maumee channel was between 2.41×10^{-4} and 3.43×10^{-4} and for the Vedra channel was between 1.40×10^{-4} and 4.40×10^{-4}. Thus, the sediment transport rate during equilibrium flow for Maumee was between 900 and 1280 m^3/s and for Vedra was between 480 and 900 m^3/s. Considering that the primary sediment contribution from any portion of a stream channel is derived from the area of the initial excavation of the channel, and that sediment concentrations are relatively constant for the existing portions of a channel downstream of the primary incision areas (i.e. the downstream channel segments are primarily carrying sediment in transit from the upstream areas of incision), the equilibrium sediment transport rate for all downstream portions of a channel should be essentially the same. The headward growth of the channel, as opposed to simultaneous down cutting or debris-flow collapse of the excavated regolith, is indicated by slightly greater depth of the top of the equilibrium channel (i.e., apparent water surface) at the downstream end (the channel morphology indicates full-bank at the upstream ends only), by the low (fluvial) channel slopes, and by the equilibrium channel morphology that is only achieved after some period of continuous flow.

Given the internal consistency of the equilibrium discharge estimates for the entire length of each channel, the equilibrium discharges and sediment concentrations can be assumed to provide a reasonable basis for the calculation of the duration of the flow that excavated the channels. Based on the synthesis of multiple transects across the channels, the volume of the hydraulically excavated portion of the Maumee channel is approximately 58.2 km^3 and the volume of the hydraulically excavated portion of the Vedra channel is approximately 46.2 km^3 (these estimates assume that the uppermost bound of the channel formed the axis of a broad shallow depression that channeled the flow and focused the channel excavation). Thus, the apparent flow duration required to excavate the Maumee channel is between 980 and 1400 sols, and to excavate the Vedra channel is between 915 and 2790 sols.

These times represent the time required to excavate the channels while maintaining equilibrium flow. They do not take in to account earliest discharge through the anastomosing channel system, nor the prolonged waning discharge associated with greatly reduced head as the source basin is drained. These durations are two to three times longer than the previous estimates [10]. Although these remain geologically short time spans, they are significant. Catastrophic outflows are not instantaneous events. Ambient surface conditions were such as to allow sustained flow for considerably more than a martian year.

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