INTERPRETATION OF MARTIAN DELTA MORPHOLOGY AND PROCESSES BASED ON EXPERIMENTAL WORK. G. de Villiers, G. Postma and M.G. Kleinhans. Faculty of Geosciences, Utrecht University, Utrecht, The Netherlands (g.devilliers(at)geo.uu.nl).

Introduction: Deltas have been identified on Mars and clearly indicate that water flowed on the surface during the planet's history. These sedimentary deposits and their feeder channels record flow event duration and magnitude. Volumes of deltas can be used to calculate flow and sediment dynamics as well as a minimum time of formation, with the use of flow and sediment transport predictors, a simple morpho-logical model and measured channel and delta dimen-sions. Pilot experimental results have shown that Mar-tian deltas show architectural elements similar to those of terrestrial analogues, e.g. lobes, terraces, and incised fronts and the interpretation of these elements can be used to infer the processes that were active on the fan surface during formation (see [1]) . Delta morphology is related to flow discharge and duration (upstream conditions), sediment properties, and basin size (downstream conditions). However, it remains challenging to relate surface morphology to processes and climatic conditions at the time of formation.

Our objective is to compare DTM data of Mars and of controlled laboratory experiments quantitatively with a morphological model to infer sediment transport mode and formative duration. We use a quantitative morphological model for fan and delta formation that assumes as little as possible. The model calculates the growth of a sedimentary body in a crater lake, represented by a low-gradient (subaerial) cone on top of a high-gradient (subaqueous) cone. The water and sediment fluxes were calculated with physics-based predictors based on the feeder channel. The parameters that determine which morphology emerges are the supply of sediment and water to the basin, the size of the basin and the duration of the flow.

Experiments: Laboratory experiments were conducted in the Eurotank facility at Utrecht University. We investigated the morphologic development of fans as well as the influence of different external factors which control delta morphology, such as water level, water discharge, and sediment type. We also investigated the effect of horizontal scale and vertical exaggeration in the experimental set-up, as well as the effects of feeder valley size and that of the ratio of feeder valley width to basin width. We constructed two circular basins similar in shape to a typical impact crater, with the average depth/diameter relationship as that of large complex Martian craters (see Figure 1). Some experiments were performed in 2 m diameter crater with twice vertical exaggeration, others in a 4 m diameter crater with no vertical exaggeration.

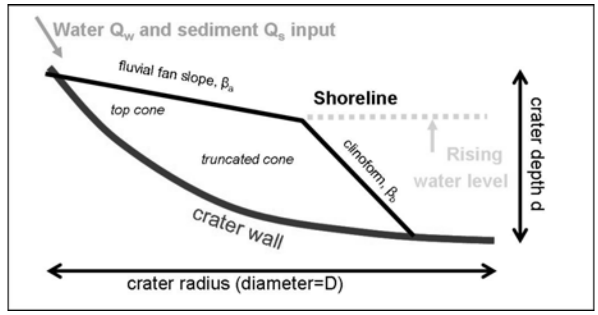

Figure 1: Experimental set-up for both the laboratory and the numerical model.

Each experiment had two phases: During the first phase of the experiment, the crater filled with water, resulting in a retrograding, back-stepping (some deposits had a smoother gradient with fewer distinct steps than the classic back-stepping cases, probably related to lower discharge) similar to the stepped or terraced deltas on Mars [2]. In the second phase of the experiment, a breach in the crater rim was initiated, resulting in a prograding, branched delta similar to the branched deltas on Mars [3], or in some cases, a smooth-topped, Gilbert-type delta, also seen on Mars [4].

Results: Two different types of deltaic deposits can be formed by varying only the relative motion of the water level (see Figure 2). Sub-types are formed by varying water and sediment input between experiments. We see that significant amounts of sediment transport still takes place even without the aid of vertical exaggeration. Additionally, we see that most morphologies are independent of scale, but that it is easier to construct certain morphologies with larger craters when the lowering of the water level is more constant and less sudden. The model does not predict the shape of the deposit very well, but the differences are attributed to sediment pulsing, which is not incorporated in the model; to groundwater outflow, which effectively reduces the ratio of discharge and sediment flux; and to change in sediment availability – a tremendously high sediment transport rate is observed in the beginning of the experiments because of the unconsolidated sediment. However, the model does seem to agree very well with the Martian cases (as shown in [5]).

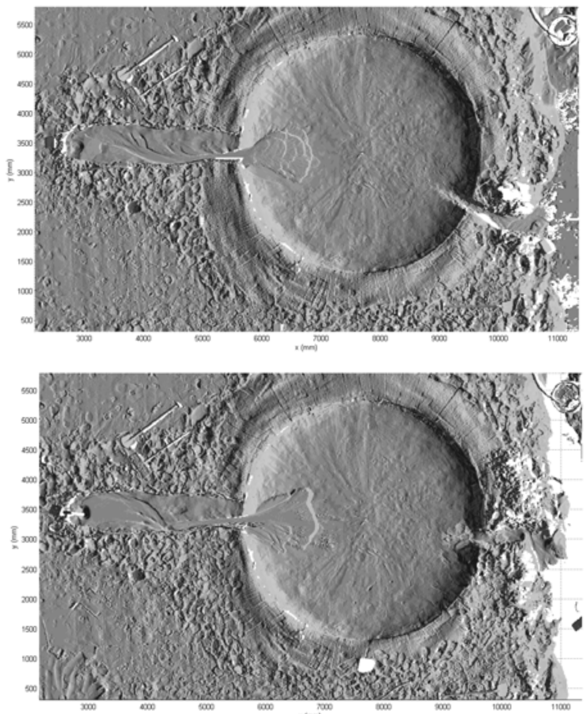

Figure 2: DTMs of laboratory analogues from the Eurotank, showing first the formation of a retrograding back-stepping delta (top) and then a prograding scarp-fronted delta (bottom).

Summary: The results from these experiments are in the first place evidence of the fact that we are able to recreate the morphologies of all different delta-types on Mars by merely varying basic parameters such as water level, discharge and sediment type; and in the second place an independent test of the assumptions that are used in the numerical morphological model. Furthermore, these results are important for trying to understand the processes that are responsible for the formation of fan-shaped sedimentary deposits on Mars and in doing so, understanding the climatic conditions during which these deposits were formed.

References: [1] De Villiers et al. (2011) *LPSC* abstract submitted [2] Kraal E. R. et. al. (2008) *Nature 451*, 973-977. [3] Fassett C. I. and Head J. W. (2005) *Geo. Res. Let. 32*, L14201. [4] Cabrol N. A. and Grin E. A. (2001) *Icarus 149*, 291-328. [5] Kleinhans et al. (2009) *EPSL 294*, 378-392

Acknowledgments: We acknowledge the assistance of the Eurotank technical team, in particular with the experimental set-up. The authors are grateful for financial support from the Dutch Research Foundation (NWO) and the Netherlands Institute for Space Research (SRON).