TYPES OF MARTIAN FAN-SHAPED SEDIMENTARY DEPOSITS. G. de Villiers[1], M. Kleinhans[1], G. Postma[1], E. Hauber[2], S. de Jong[1] and P.L. de Boer[1]. [1]Faculty of Geosciences, Utrecht University, Utrecht, The Netherlands. g.devilliers(at)geo.uu.nl, [2]Institute of Planetary Exploration, German Aerospace Centre (DLR), Berlin, Germany.

Introduction: Deltas, fans and channels on Mars clearly indicate surface water in the past. These landforms contain valuable information about the duration and magnitude of surface-water flow, with obvious implications for potential life on Mars. Martian fan-shaped deposits such as deltas and alluvial fans show architectural elements similar to those of terrestrial analogs, e.g. lobes, terraces, and incised delta fronts. Pilot experiments demonstrate that delta morphology is related to flow discharge and duration, sediment properties, and crater size [1]. However, the important relationships between surface morphology and climate remain unquantified and it is difficult to unambiguously relate the architecture of sediment bodies to certain boundary conditions. The objectives of this study are to qualify and quantify the morphological elements of Martian fan-shaped deposits with the use of the unique remote sensing data by Mars Express-HRSC.

Discussion: The population of fan-shaped deposits on Mars varies greatly in terms of size, shape and morphology. In order to understand the processes involved in their formation, and hence the climate conditions under which they were formed, one must first establish whether it is possible to distinguish between different types of these deposits. Some authors have done this based on the setting in which the deposits were formed (e.g. in ponding water, in impact crater basins, within 30° of the equator, etc.). We attempt to distinguish different types by analysing morphometric properties and key architectural elements.

Key Architectural Elements: Terrestrial alluvial systems are classified on basis of characteristic features such as size, gradient and shape, as well as external factors such as the up- and downstream conditions that allude to their depositional history [2]. Processes that range from episodic land sliding and debris flows to continuous stream flow result in various types of alluvial and fluvial fans, so providing insight into the type of climate that controlled their deposition [3]. We quantify key architectural elements of the Martian deposits using images and Digital Elevation Maps (DEMs). Quantification of shapes, dimensions, volumes and DEM derivatives focuses on the feeder valleys, the fan terraces and the fan lobes. We ascertain the lengths and gradients of channels (if present), bars, terraces, and lobes. In addition, we determine the diameter, depth, volume, and maximum water levels of the crater basins within which most of these deposits are located. Preliminary analyses affirm that the gradients or slopes decrease with increase in fan size (both area and length, see Figure 1). However, there is apparently very little relationship between fan gradient and basin size. Based on the geomorphic shapes alone, different types of fan-shaped deposits can be distinguished and combined with differences in sizes and gradients, four types of fan-shaped deposits have been identified (Figure 2).

Types of Fan-shaped Deposits:

Type 1: Classic, cone-shaped alluvial fan deposits with an average gradient of roughly 3 degrees and lengths of 10-30 kilometers. Examples include those in Craters A, D, F, and S (Ostrov), as referred to by Moore and Howard [4] (Figure 2).

Type 2: Typical, flat-topped, semi-circular delta-like deposits with clear fronts. The average gradient is about 1 degree and lengths are approximately 10 kilometers. Typical examples of this type include the Aeolis Mensae [5] fans (Figure 2).

Type 3: Branched, flat-topped, delta-like deposits with an average gradient of about 1 degree and lengths of approximately 5 kilometers. Examples of this type include the famous Eberswalde [6], Nanedi Vallis [7], and Nili Fossae [8] deposits (Figure 2).

Type 4: Typical stepped or terraced fan deposits with clear fronts. The gradients of the individual events in each of these deposits are in some cases difficult to determine due to limitations in the detail of the topographical data. In the four terraced deposits that have been identified, the gradients range from as high as 10 degrees to as low as 2 degrees. More work is being done to calculate slopes of individual events. A famous example of this type is the Coprates Catena terraced deposit [9, 10] (Figure 2).

Remarks: The relatively high gradients of the Type 1 alluvial fans could indicate debris-flow dominated processes whereas the low gradients of delta-like fans from Types 2 and 3 indicate sheet-flow dominated processes. All gradients of fans on Mars are expected to be slightly lower than for similar terrestrial deposits. Also, it is unclear how large the role is that post-depositional aeolian processes may have played in the modification of these deposits.

Further work: More in-depth analysis of the morphologies observed and the processes that formed them is being done. The population size of the experimental pilot study is 21 deposits, which is only a third or less of the known fan-shaped deposits on Mars. More deposits are currently being studied. Experimental work, aiming to understand morphologic development of fans by water and by later wind erosion, is underway.

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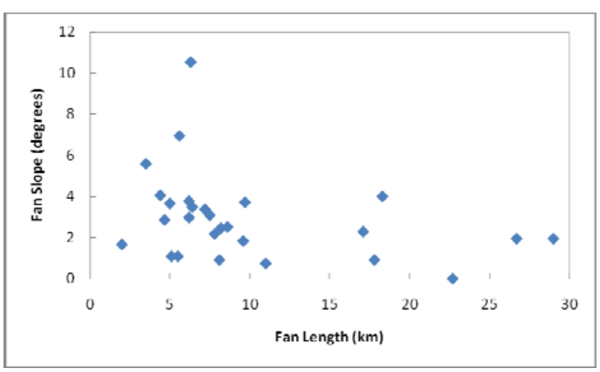

Figure 1: Fan slopes plotted against fan lengths.

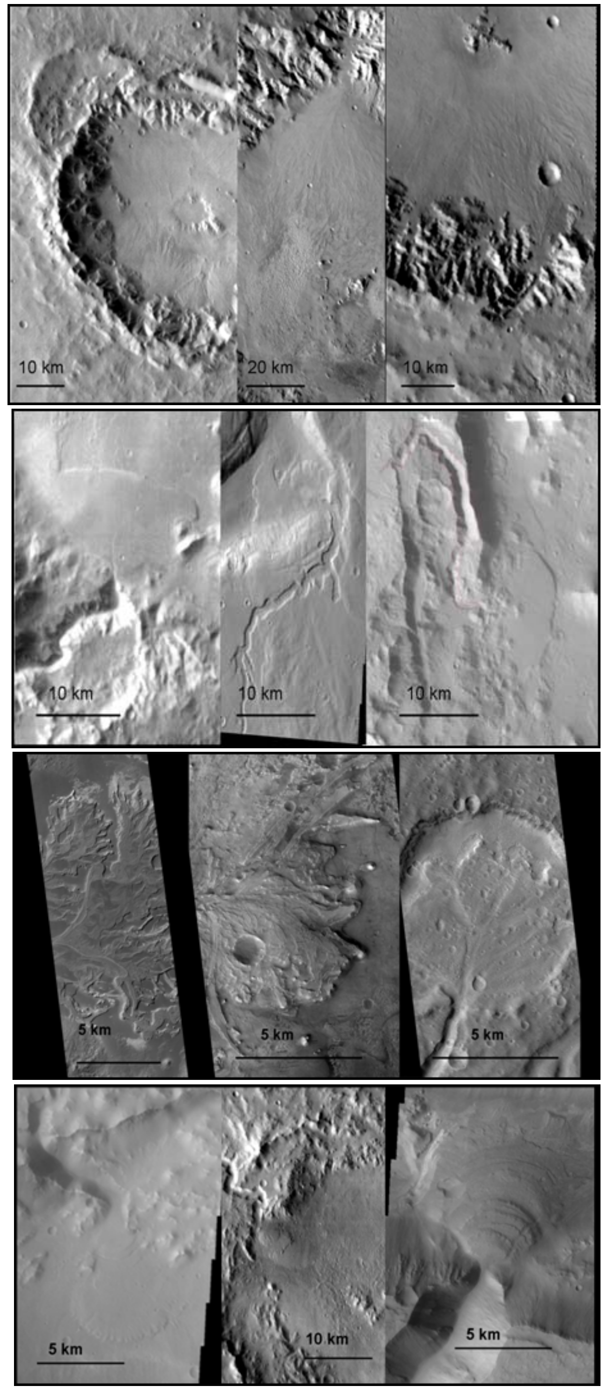

Figure 2: Four types of fan-shaped deposits, from top to bottom: Classic cone-shaped alluvial fans (Type 1); Flat-topped, semi-circular, delta-like deposits (Type 2); Fans with branching channel networks (Type 3); Stepped fan-deltas (Type 4).