GEOGRAPHIC DISTRIBUTION AND MORPHOLOGICAL CHARACTERISTICS OF FAN-SHAPED SEDIMENTARY LANDFORMS ON MARS. A. M. Morgan[1,2*], S. A. Wilson[2], A. D. Howard[1], [1]Planetary Science Institute, 1700 East Fort Lowell, Tucson, AZ, [2]Center for Earth and Planetary Studies, National Air and Space Museum, Smithsonian Institution, Washington, DC; *amorgan@psi.edu.

Introduction: Mars today is a cold, dry and hypobaric global desert, but its fluvially-formed landscapes are a testament to an early history with a climate that was capable of sustaining liquid water on or near the surface. Fluvially deposited sedimentary landforms, such as alluvial fans and deltas, are particularly intriguing targets of exploration. as their stratigraphy records the environmental conditions present during the transport and deposition of material. Alluvial fans form at the base of mountain fronts as a channel debouches onto adjacent, lower-lying terrain, and the reduction in carrying capacity due to slope reduction and lateral expansion of flow forces the deposition of sediment. Deltas form subaqueously as a river deposits material into standing water, and exhibit distinctive sedimentology, including topset, foreset, and bottomset beds.

Methods: Using globally available CTX imagery, we extended the [1] database to include all fan-shaped sedimentary landforms on Mars rather than just those within impact craters. We mapped the outlines of fans and their catchments and compiled a number of metrics including fan apex location, fan area, fan length, fan relief, fan gradient, fan concavity, catchment area, catchment length, and catchment relief. For fans within impact craters, we used craters superposed on ejecta to estimate maximum formation ages. In addition, we dated the surfaces of a number of individual alluvial fans in Ganges Chasma and Tyrrhena Terra.

Results and Discussion: We identified ~1500 fan-shaped sedimentary landforms (Fig. 1), which we classified as alluvial fans, branched scarp fronted deposits, unbranched scarp fronted deposits, and terraced scarp fronted deposits (Fig. 2). We use the term scarp fronted deposit (SFD) instead of delta because stratigraphic indicators for deltas are not generally available on Mars due to limitations by data coverage and subsequent erosion.

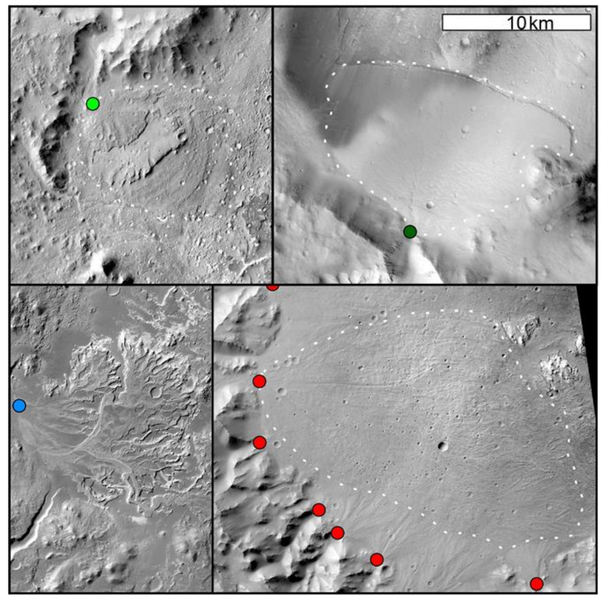

Fig. 2. The four classifications of fan-shaped sedimentary deposits in the catalog. See Fig. 1 for legend.

Alluvial fans (n=1237) are semi-conical features that range in length from hundreds of meters to tens of kilometers with average slopes of ~4° and no terminal slope break. Scarp fronted deposits are fan-shaped landforms with prominent frontal scarps, potentially indicative of deposition in standing water. These are

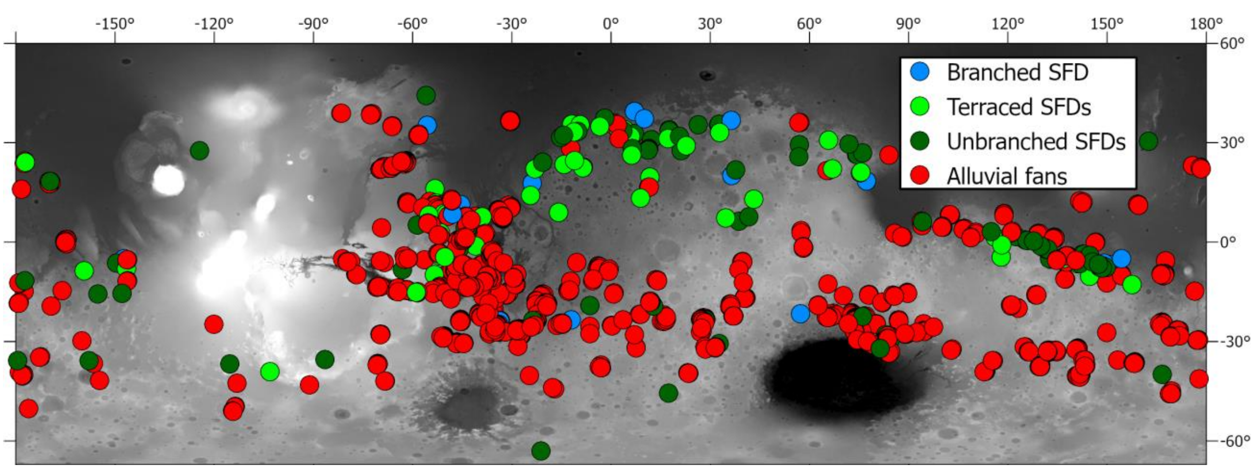

Fig 1. The global distribution of fan-shaped sedimentary landforms on Mars.

divided into three subclasses. Branched SFDs (n=16) are those features which have channels on their surface and include the prominent landforms in Eberswalde and Jezero craters. These are generally found at the lower end of larger valley network systems, in stark contrast to the short drainages that feed the other fan types. Unbranched SFDs (n=103) typically have a sharply defined frontal scarp but otherwise smooth, featureless surfaces. These have a rounded, triangular, or projecting platform, and show little evidence for channelization, segmentation, or scarp dissection. Terraced SFDs (n=55) are characterized by their terraced topographic profile with numerous exposed layers, typically steep slope (>7°, but gradients vary widely), and deeply incised, low order source valleys. Terraced SFD catchments are longer and of lower order from alluvial fan catchments.

Alluvial fans: Alluvial fans within craters exhibit a deficiency in E-W orientation relative to crater center, but when weighted by fan area this trend is not as prevalent as found by [1]. Alluvial fans cluster near the areas of highest crater relief, which we interpret as a signal of orographic control in providing precipitation for runoff. Most fan-hosting craters formed between the Middle Noachian to Late Hesperian during the era of valley network formation [2], but some fan-hosting craters did not form until the Amazonian. The surfaces of individual fans are considerably younger, dating to the Hesperian or Amazonian Periods (Fig. 3). Alluvial fans are at lower elevations and at higher latitudes (in the southern hemisphere) [1] than the older valley networks (Fig. 4), perhaps reflecting a drying climate that restricted snowmelt to lower elevations [3].

SFDs (putative deltas): Terraced SFDs also exhibit a defiency in E-W orientation but unlike the alluvial fans show no relationship to crater topography. All three classes of SFD are found at across a wider range of latitudes than alluvial fans (with terraced SFDs being predominately in the northern hemisphere), but are found at similar low elevations. Although stratigraphic evidence for deltaic formation is generally lacking [4], the local setting sof the various classes of SFD is consistent with deposition into standing water. For example, experimental results indicate that terraced SFDs are a result of deposition into a lake of rising water level [5,6]. All but 3 of the 54 terraced SFDs in our catalog are within closed basins.

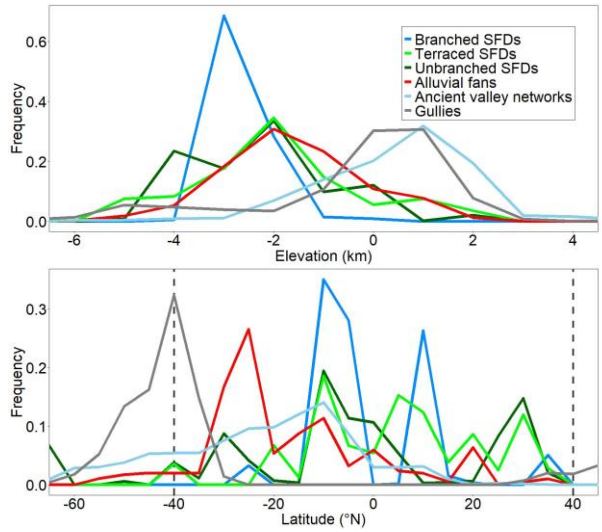

Fig. 4. Elevation (top) and latitude (bottom) distribution of the fan landforms in the database compared to Late Noachian/Early Hesperian valley networks and Amazonian gullies. SFD and alluvial fan frequencies are weighted by area while valley networks are weighted by valley segment length.

References: [1] Wilson et al. (2021) *GRL* 48. [2] Fassett and Head (2008) *Icarus* 195. [3] Kite et al. (2021) *LPSC* 52. [4] Tebolt and Goudge (2022) *Icarus* 372. [5] Kraal et al. (2008) *Nature* 451. [6] de Villiers et al. (2013) *JGR:Planets* 118.

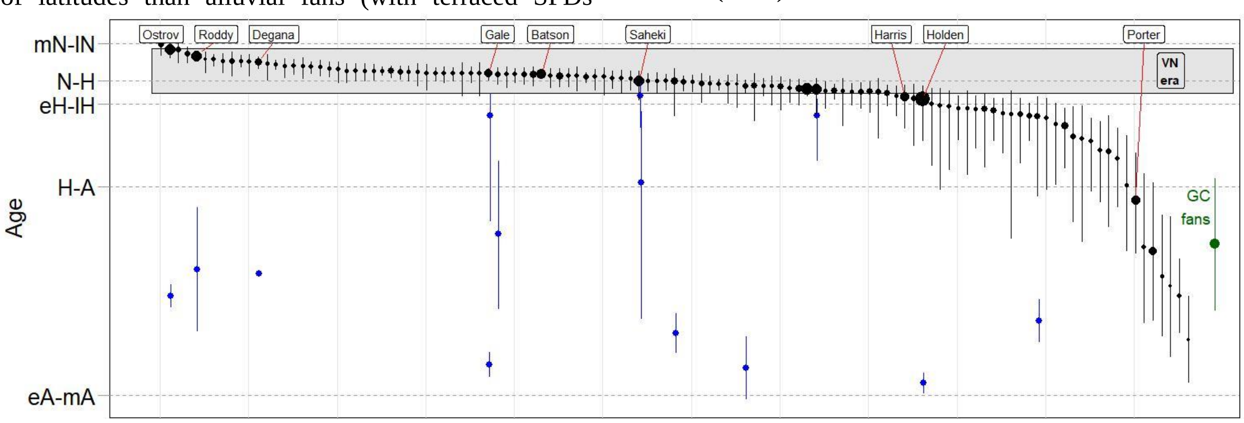

Fig. 3. Timing of martian alluvial fan-bearing craters. Notable craters are labelled. Ages are using the Hartmann system. The gray shaded area indicates the era of valley network formation. Black dots indicate host crater age, where the dot size reflects the cumulative fan area within that crater. Blue dots are the ages of fans within craters. The green dot/line at right is cumulative fans in Ganges Chasm.