GLOBAL DISTRIBUTION OF ALLUVIAL FANS AND DELTAS ON MARS. A. M. Morgan[1], S. A. Wilson[1], A. D. Howard[2], R. A. Craddock[1], and J. A. Grant[1], [1]Center for Earth and Planetary Studies, National Air and Space Museum, Smithsonian Institution, 6th at Independence SW, Washington, DC, 20560 (morgana@si.edu), [2]Department of Environmental Sciences, University of Virginia, Charlottesville, VA 22904.

Introduction: Several alluvial fans [e.g. 1–6] and deltas [e.g. 7–10] on Mars have recently been dated to the Hesperian and Amazonian periods, which has major implications regarding the planet's potential late-stage habitability. Terrestrial fans have long been utilized as a record of climatic change, and thus the stratigraphy and distribution of the martian fans provide insight into the evolving post-Noachian environmental conditions. Previous workers have compiled inventories of martian fans and deltas [11–15], but these have been limited by the availability of high-resolution data. Here, we use the near-global coverage of CTX imagery to document the locations and morphometric properties of alluvial fans and deltas across Mars, and make inferences about their formative mechanisms.

Methods: Using Google Earth, we conducted a systematic global survey of fan-shaped landforms, searching within moving windows of 15° latitude and 30° longitude. We used both the CTX global mosaic and THEMIS daytime IR layers, and utilized previously constructed databases of alluvial fans [11–14], deltas [13-16], lakes [17,18], and valley networks [19] for context in identifying features. We recorded the location of all visible fans and deltas as well as all possible fans that were not covered in Google Earth's limited CTX layer based on the qualitatively assessed state of crater degradation and the proximity of other fluvial features identified in THEMIS data. Data were loaded into ArcGIS and fan and catchment properties were measured using projected CTX visual imagery and HRSC and MOLA derived topographic data.

Fan Types: We identified and mapped ~1300 landforms (Fig. 1), most of which can be categorized into three distinct types (Fig. 2):

Type 1 (814 features): These are semi-conal landforms ranging in length from hundreds of meters to tens of kilometers with average slopes of 4°. These are generally sourced from deeply eroded alcoves and do not appear to have had a sediment or flow source beyond the crater rim. These likely formed as alluvial fans, and examples include the large fans in Saheki, Harris, and Holden craters.

Type 2 (84 features): These are characterized by their terraced topographic profile, generally steep slope (>7°, but gradients vary widely), and deeply incised, low order source valleys. Features of this type have been referred to as "stepped deltas" and do not have a clear terrestrial analogue. Possible formative environments include sheetflood-dominated alluvial fan deposition [20] or deltaic deposition into a rising lake [21]. A prominent martian example is the landform in Coprates Catena [20].

Type 3 (65 features): Features of this type have a low surface gradient of ~1-2° and have been referred to in previous studies as deltas, although the depositional setting (e.g. presence of a lake) for most of the mapped features included in this survey is uncertain. There are two subclasses of this type. Branched deltas are commonly at the mouths of large valley network systems and include the famous landforms in Eberswalde and Jezero craters. Unbranched deltas have a rounded, triangular, or projecting platform, and show little evidence

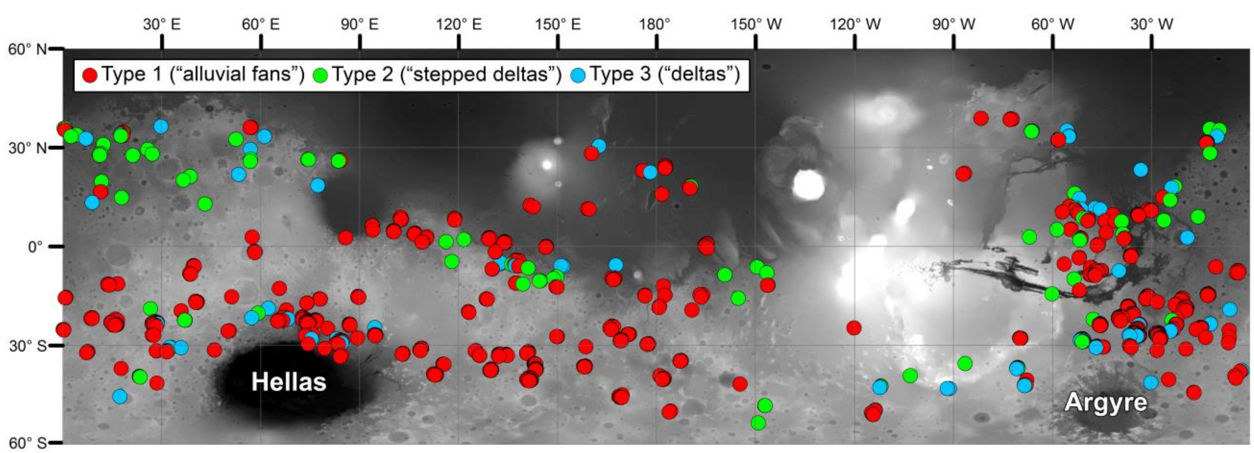

Fig. 1. Global distribution of fan landform apices on Mars plotted atop MOLA-derived topography.

for channelization, segmentation, or scarp dissection. An example is the "Pancake Delta" in Gale crater [21].

Results and Discussion: Fans are much more widespread than previously reported but are not globally distributed (Fig. 1). There are several distribution patterns, including that alluvial fans and stepped deltas are primarily within impact craters, and that stepped deltas and deltas are more concentrated along the dichotomy boundary than alluvial fans.

For the alluvial fans and stepped deltas that are within craters, we complied the locations of fan apex along the interior rim, and find that there is a prominent N-S trend (Fig. 3), a strong indicator of control by solar insolation. Combined with the lack of evidence for groundwater [1,2,4,11] we infer snowpack accumulation and melt to be the most likely source for alluvial fan-forming runoff. Assuming that the alluvial fans formed contemporaneously (which has not yet been demonstrated), crater statistics suggest an age of early Amazonian, and a vast majority of alluvial fans superpose previously mapped [22] Hesperian or Amazonian terrains.

Relative to source catchment, martian alluvial fans are larger than their terrestrial counterparts, which is likely a consequence of no tectonic subsidence. Exploratory ordinary least squares regression analyses yields no significant correlation between the response variables fan gradient, fan area, and fan concavity, and the predictor variables crater relief, crater diameter, crater depth, apex latitude, and apex elevation. We are conducting additional analyses and statistical tests to better constrain prevailing environmental conditions during the era of fan formation.

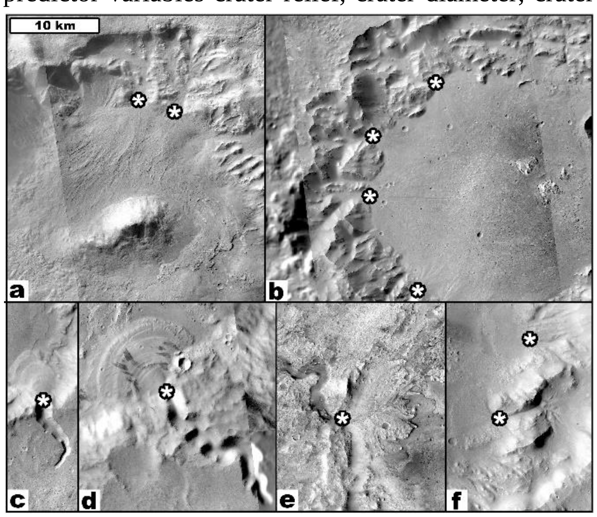

Fig. 2. CTX images revealing examples of the landforms included in this survey. All images at the same scale, north is up. Fan apices are marked with *. (a) Two coalescing alluvial fans in Majuro crater. (b) A bajada in an unnamed crater in SW Tyrhenna Terra. (c) Stepped delta in Dukhan crater. (d) Stepped delta in an unnamed crater south of Medusae Fossae. (e) The branched delta in Jezero crater. (f) Two unbranched deltas in an unnamed crater in northern Noachis Terra.

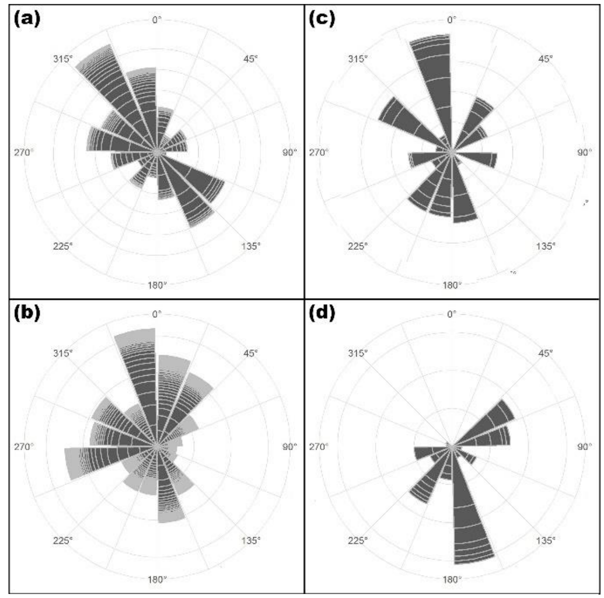

Fig. 3. Orientations of alluvial fans and stepped deltas along interior crater rims weighted by fan area. Each dark grey area indicates a different fan or delta, with larger landforms plotted as larger grey areas. (a) Northern hemisphere alluvial fans. (b) Southern hemisphere alluvial fans. (c) Northern hemisphere stepped deltas. (d) Southern hemisphere stepped deltas.

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