INVENTORY OF EQUATORIAL ALLUVIAL FANS AND DELTAS ON MARS. S. A. Wilson[1,2], J. A. Grant[1] and A. D. Howard[2], [1]Center for Earth and Planetary Studies, National Air and Space Museum, Smithsonian Institution, 6th at Independence SW, Washington, DC, 20560 (purdys@si.edu, grantj@si.edu), [2]Department of Environmental Sciences, University of Virginia, Charlottesville, VA 22904 (ah6p@virginia.edu).

Introduction: The distribution of alluvial deposits on Mars records evidence for the nature and origin of past fluvial activity [1-11] that likely occurred during a period(s) of enhanced precipitation (snow) and runoff [e.g. 1, 4]. Previous studies of fan deposits in craters on Mars identified 26 alluvial fans (2 and 24 in the north and south, respectively) [1-8] and 34 deltas (17 in both hemispheres [9] and references therein). This study refines and expands recent work to locate fans using CTX data in the southern highlands [10] to provide an equatorial inventory of intracrater fans and deltas from 0º to 360ºE between 40ºS and 40ºN. Fans in this study are distinguished from deltas as they are sourced from the interior crater walls; deltas are steep-fronted landforms that were deposited in water at the terminus of a valley that breached the crater rim.

Inventory and Distribution of Alluvial Deposits: Between 40ºS-40ºN, we identified alluvial fans in 100 additional craters (41 and 59 in the north and south, respectively) and deltaic deposits in 30 additional craters (24 and 6 in the north and south, respectively) (Fig. 1, next page). This study quintuples the number of craters with fans and doubles the deltas on Mars.

Most craters with fans (67%) are located in the southern hemisphere with an average latitude of ~10ºS (SD ~20º). Within the southern population of craters with fans, nearly 65% occur between 10°S-30°S from northern Argyre to Noachis Terra (~310°E-40°E, connecting the geographic regions I and II [1]), and on the north/northeast rim of Hellas (~65°E-95°E, region III [1]). Additional clusters of craters with fans occur in Xanthe and Arabia Terra, Terra Cimmeria, and along the highland-lowland boundary east of Isidis Planitia.

The majority of craters with deltas (64%) are in the northern hemisphere in Arabia Terra, Xanthe Terra and along the highland-lowland boundary (e.g., Aeolis Mensae). Craters hosting fans and deltas are generally not found in regions underlain by Hesperian and Amazonian volcanic plains [10] and do not generally cluster together except in the Xanthe Terra region.

Characteristics of Craters Hosting Fans: The average diameter of craters hosting alluvial fans is 49 km (SD 29km, range 6.5km-167km). The average floor of fan-bearing craters is -1675m in elevation (SD 1600m; range -5700m to 1700m) and the average crater depth from floor to rim is ~2000m (SD 630m, range 440m to 4460m). For craters hosting deltas, the average diameter is 46 km (SD 31km, range 6km-166km), average floor is -2035m in elevation (SD 1525m; range -5160m to 2150m) and average floor-to-rim crater depth is ~1235m (SD 855m, range 80m-4860m).

Over half of the craters with alluvial fans impacted into a crater(s) or topographic depression, with many of the fans originating from the shared rim of these "nested" craters (e.g., craters Harris, Saheki, and Ritchey). Fans may preferentially develop along shared rims due to a pre-existing inventory of fine grained material that is readily erodible.

Number and Orientation of Intracrater Alluvial Fans: There are at least 443 individual fans in 120 craters in addition to 6 craters (5 north, 1 south) with either bajadas or indiscrete fans that were not counted. Fans may have multiple flow lobes but individual fans are defined by distinct apices and well-defined drainage basins incised into crater rim. Overall, >70% of the craters have 1-4 fans and only 3 craters have >10 fans (e.g., Holden, ~18 fans). Craters host an average of 3 and 4 fans in the north and south, respectively.

Most fans in both hemispheres occur on the northern and southern rims of their host crater (Fig. 2), suggesting a strong obliquity or insolation control on the generation of discharge responsible for fan formation. Of the 115 fans in the 37 northern craters included in the analysis, there is a clear directional bias as most fans originate from the N/NE/NW rim (46%) compared to western (23%), S/SE/SE (21%), and eastern (10%) rims. The 328 fans in the 83 southern craters included in the analysis are predominantly oriented on the N/NW/NE (38%) and S/SW/SE (34%) rather than the western (12%) and eastern (16%) rims.

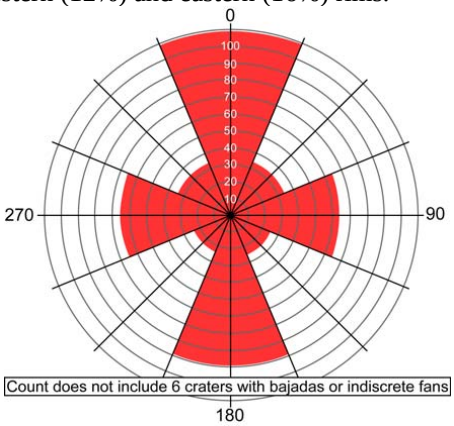

Figure 2. Azimuthal distribution of 443 alluvial fans in 120 craters (40°S-40°N) shows directional bias of fans originating from the northern and southern rims.

Morphology and Size of Alluvial Fans: The morphology of fans varies (Fig. 3), but most are characterized by a conical fan shape with inverted channels either on the fan surface or at the distal end of the fan (n=61, 48.5%). These "inverted" channels are likely formed as finer material is preferentially removed by aeolian erosion leaving the coarser and/or cemented channel sediment in positive relief. Other fans with a typical conical fan shape have both inverted and incised channels (n=17, 13.5%), and some fans only have incised channels on their fan surface (n=9, 7%). Occasionally fans are identified only by a fan shape (often faint or mantled, sometimes discerned by varying albedo) and lack channels on the fan surface (n=34, 27%). Five craters (4%) host numerous inverted channels originating from the crater walls and extending to the crater floor that may be deflated fan surfaces. Nearly all fans poleward of 30°S are covered to some extent by Amazonian mantling material [e.g., 12], so it is possible that additional fans at higher southern latitudes are buried beneath thicker deposits.

The fans in the southern highlands identified by [1-4] are generally well-exposed, large (average 18+ km in length [1]) and are late Hesperian to early Amazonian in age [4, 13], dating to a late period of widespread fluvial activity [e.g., 4, 21]. Preliminary data of fans identified in this study are significantly smaller (generally <10 km in length). Further study will determine the age of the fans and the timing of the associated fluvial activity responsible for fan formation.

References: [**1**] Moore, J.M., A.D. Howard (2005) *JGR*, 110, doi:10.1029/2005JE002352 [**2**] Kraal, E.R. et al. (2008) *Icarus*, 194, 101, doi:10. 1016/j.icarus.2007.09.028 [**3**] Williams, R.M.E. et al. (2011) *Icarus*, 211, 222-237 [**4**] Grant, J.A. Wilson, S.A., 2011, GRL, *38*, L08201, doi:10.1029/2011 GL046844 [**5**] Milliken et al. (2008*) LPS XXXVIIII* Abstract 4036. [**6**] Wilson et al. (2007), JGR, 112, E08009, doi:10.1029/2006 JE002830 [**7**] Erkeling, G. et al. (2012) *Icarus*, 218, 393-413 [**8**] Williams, R.M.E., M.C. Malin (2008) *Icarus*, 198, 365-383 [**9**] DiAchille, G., B.M. Hynek (2010) *Nat. Geosci. 3*, 459-463 [**10**] Wilson et al. (2012) *LPS XXXX*VII, Abst. 2462. [**11**] Howard, A.D., Moore, J. M. (2011), *JGR*, 116, doi:10.1029/2010 JE003782. [**12**] Soderblom et al. (1973) *JGR*, 78 (20), 4117-4122. [**13**] Morgan et al. (2013), *JGR*, in prep.

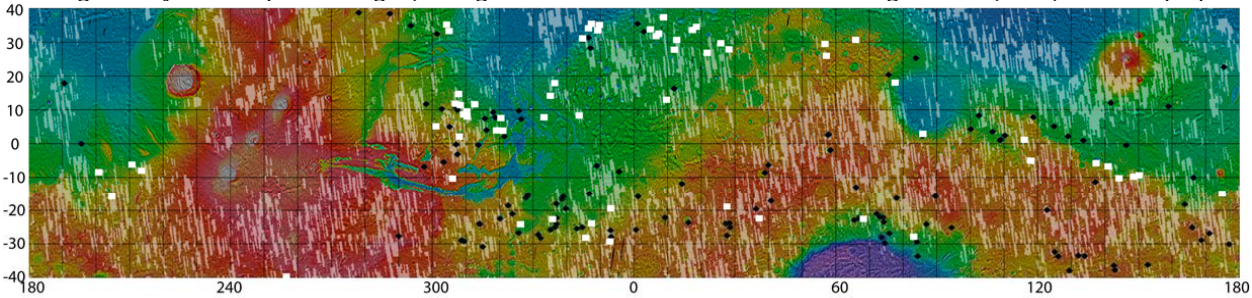

Figure 1 (above). Distribution of craters hosting alluvial fans (black diamonds) and deltas (white squares) on Mars from 0 to 360E between 40S and 40N. MOLA topography. Shaded white areas indicate gaps in CTX coverage.

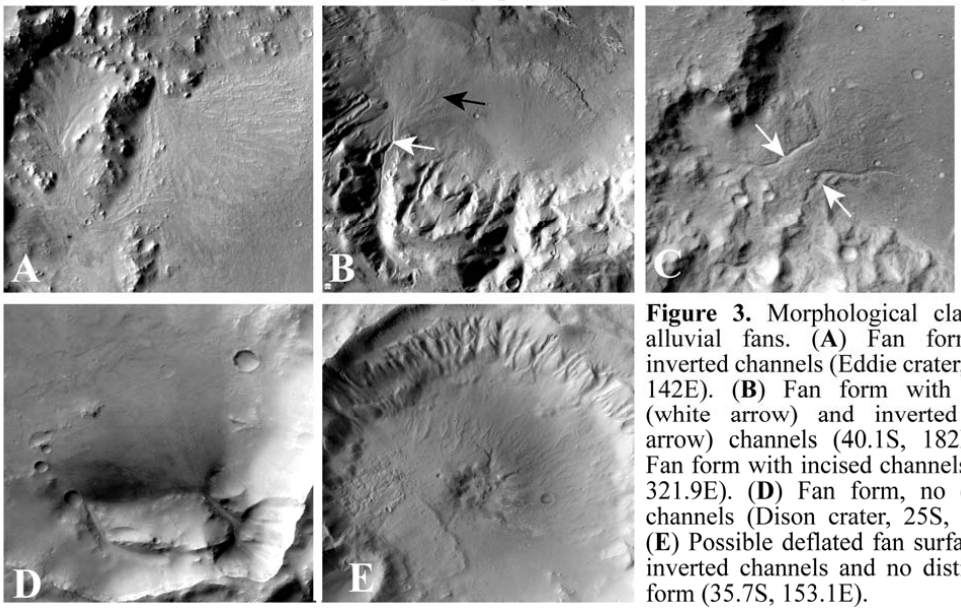

Figure 3. Morphological classes of alluvial fans. (**A**) Fan form with inverted channels (Eddie crater, 12.3N, 142E). (**B**) Fan form with incised (white arrow) and inverted (black arrow) channels (40.1S, 182E). (**C**) Fan form with incised channels (2.4N, 321.9E). (**D**) Fan form, no obvious channels (Dison crater, 25S, 343.5E. (**E**) Possible deflated fan surface with inverted channels and no distinct fan form (35.7S, 153.1E).