ALLUVIAL FANS IN RODDY CRATER ON MARS. S. A. Wilson[1], A. D. Howard[2], 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 (wilsons@si.edu), [2]Department of Environmental Sciences, University of Virginia, Charlottesville, VA, 22904.

Introduction: Alluvial fans are broad, gently sloping, semi-conical features that form when sediment is fluvially transported from mountainous terrain onto adjacent, lower-gradient surfaces. Fan lobes build up over time during high magnitude, short duration releases of water and sediment. The stratigraphy of the fan, which records grain-size and the extent of deposit, can inform discharge rates that often reflect changes in environmental conditions.

The growing inventory of post-Noachian alluvial fans on Mars [1-8] has played a significant role in challenging the paradigm that the Hesperian and Amazonian epochs were sub-optimal for widespread precipitation-led fluvial erosion. Detailed mapping and characterization of Martian craters that host alluvial fans–including defining their age, sedimentology, sequence of fan development, and relation to other landforms–is essential to our understanding of climate history and potential habitability during this relatively late period on Mars.

Motivation and Methods: This work aims to constrain the source(s) of water for fan formation and characterize the hydrologic and climatic environment that permitted the formation of alluvial fans. Our investigation focuses on Roddy, an ~86 km-diameter, fan-bearing [8] crater in northwestern Noachis Terra (~21.6°S, 320.6°E). Roddy is ideal for detailed mapping and analysis due to the stratigraphic relationships between its large, well-exposed alluvial fans and other landforms that provide insight into the timing and processes affecting fan development.

We map and characterize geomorphic units, channels, ridges, and light-toned layers in Roddy in ArcGIS using standard mapping techniques [9]. We utilize CTX (~6 m/pixel) [10] and HiRISE (~25 cm/pixel) [11] images from the Mars Reconnaissance Orbiter, Mars Odyssey THEMIS IR data [12], and MOLA [13] topography from Mars Global Surveyor.

Observations and Preliminary Results:

The age of Roddy crater: The size-frequency crater distribution on Roddy's ejecta (~19,000 km^2) suggest the crater is early Hesperian in age, consistent with its observed state of degradation and presence of secondary craters on the floor of Vinogradov and Roddy's northeastern rim from the mid-to Late Hesperian [14] Holden crater (Fig. 1).

Roddy's interior landforms: Depth-to-diameter relationships suggest the crater has been infilled with hundreds up to ~1800 meters of material [15]. The interior of Roddy contains fans, fluidized ejecta, knobs, rugged terrain, benches, and aeolian material (Fig. 1). The greatest fan development in Roddy originates from the north/northeastern rim (Fig. 1), likely due to the inventory of fine-grained material from the adjacent Vinogradov basin exposed in Roddy's interior walls, which could be readily eroded and transported. Smaller fans coalesce to form a bajada along the western and southern crater floor, and all fans terminate in a low-lying (-1700 m elevation) depression on the southwestern crater floor (generally associated with the "rugged" unit, Fig. 1).

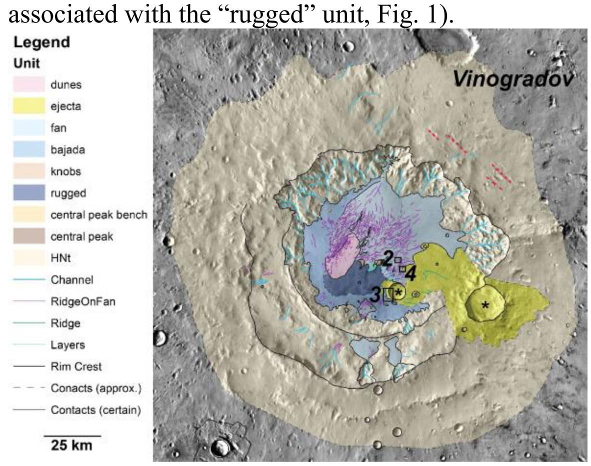

Fig. 1. Preliminary geomorphic map of Roddy crater and its associated interior units. Roddy is located between Holden crater and Valles Marineris, and is contiguous with the ancient Vinogradov basin. "*" marks the D~7.6 km crater on floor (Fig. 3) and D~15 km crater on Roddy's rim (Fig. 4). Red dashed lines are Holden secondaries; boxes show location of Figs. 2-4. Base map is THEMIS daytime IR.

Fan stratigraphy: Fan surfaces are deflated, leaving distributary channels, presumably consisting of coarser, more resistant material, standing in positive relief (Fig. 2 and purple lines mapped as ridges in Fig.1). This inversion of fan topography is consistent with a mostly fine-grained component for the bulk of the fans [1]. There are larger, meter-scale boulders incorporated into some inverted fan ridges (Fig. 2b), but more work is required to determine the nature, spatial distribution, and origin of the blocks. In other locations, the layers within the fans appear to be more massive and relatively light-toned, and erode along fractures to form blocks in contrast to layers that incorporate meter-scale boulders (Fig. 3).

The timing of alluvial fan formation: The unnamed ~7.6 km- and ~15 km-diameter craters on Roddy's floor and eastern rim, respectively (Fig. 1), provide insight into the relative timing of fan formation. The fluidized ejecta from the ~15 km-diameter crater mantles the fluvial fan deposits and the floor of the ~7.6 km-diameter crater (Fig. 1). The fluidized ejecta that overlies some fan surfaces has preserved at least ~60 m of layered fans relative to adjacent, unarmored fan surfaces (Fig. 4). The relationship between the fans in Roddy and the ejecta from the ~15 km-diameter crater suggests the deposition of fans in Roddy occurred before the ~15 km-diameter crater formed. We estimate a mid-Hesperian to Early Amazonian age for the ~15 km-diameter crater based on the crater statistics from its continuous ejecta. The lack of Holden secondaries on the fluidized ejecta is consistent with this age, but the small (~1500 km^2) area under consideration make this result tentative.

Thus, the age of Roddy and the ~15 km-diameter crater provide a lower and upper limit on fan formation, respectively. The development of these alluvial fans, likely in the Hesperian to early Amazonian, is consistent with fan development elsewhere in Margaritifer Terra [2-3] and on Mars [e.g., 1], and suggests there were at least episodes of widespread climate favorable for such aqueous activity relatively late in Mars' history.

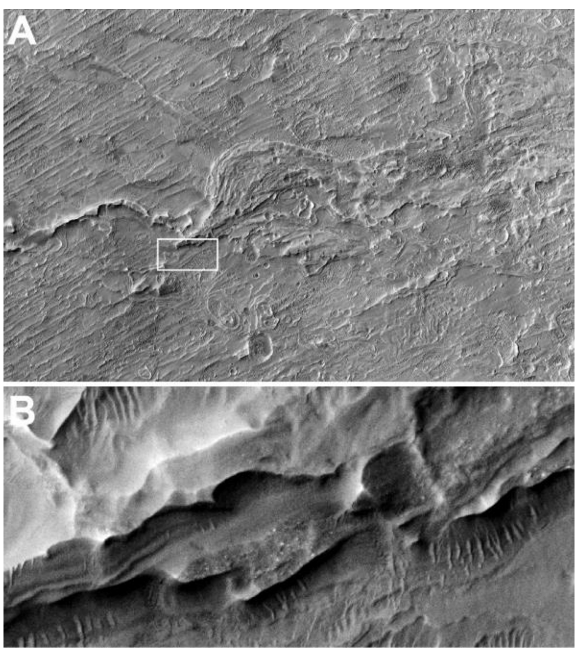

Fig. 2. Distributary morphology. A) Deflated fan surfaces suggest they are primarily fine-grained, but fan distributaries consisting of coarser material are left in positive relief. Box shows (B). Subframe of ESP_033471_1580 (see Fig. 1). Image is ~3.8 km across, north to top. (B) Relatively light-toned, meter-scale blocks are incorporated into some layers (see (A) for context). Image is ~300 m across.

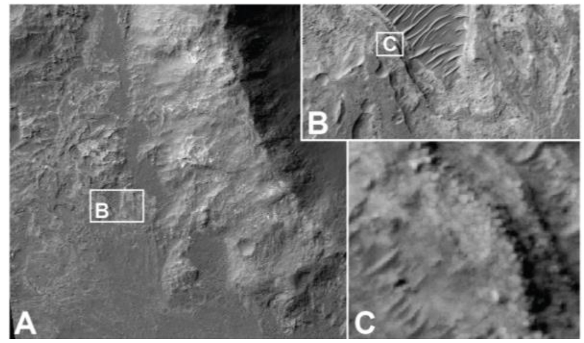

Fig. 3. A) Fans embay the exterior rim of a relatively older ~7.6 km-diameter crater on Roddy's floor (see Fig. 1). Subframe of ESP_043216_1575, image is ~6 km across. B) Detail of fan morphology, image is ~750 m across. C) Layers appear to be weathering into meter-scale blocks suggesting a fine-grained component. North is to the top in all images.

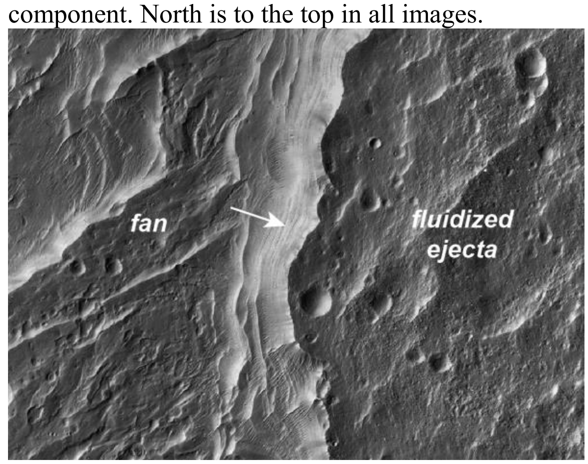

Fig. 4. Thin, distal, fluidized ejecta surface (right) from the ~15 km-diameter crater on Roddy's eastern rim protects underlying fans (left) from erosion (see Fig. 1 for context). The ~60 m scarp exposing layered fan sediment (arrow) suggests substantial erosion since the emplacement of the fluidized ejecta. HiRISE ESP_033471_1580, image is ~1 km across.

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