APOLLINARIS MONS, MARS: A NEW NAME AND A NEW PAST. Tracy K.P. Gregg and Daniel J. Krysak, Dept. of Geology, 411 Cooke Hall, University at Buffalo, Buffalo, NY 14260 (tgregg@buffalo.edu).

Introduction: Apollinars Mons* (174°E, 8.5°S), Mars, is a low-relief, central-vent volcano located just north of the dichotomy boundary and ~200 km north of Gusev crater (Fig. 1). Apollinaris Mons (AM) is characterized by low (<3°) flank slopes, a basal scarp, and a fan-shaped deposit containing valleys that appears to emanate from the summit caldera complex and drape the southeastern flank (Fig. 1). Researchers have reported that the main volcano edifice is composed of pyroclastic deposits and that lava flows comprise the fan[1]; and that the fan is composed of pyroclastic materials [2]. Here, we present results of our geologic mapping of AM in an attempt to resolve the origin of the summit caldera, its relation to the fan deposit, and the formation of the fan deposit.

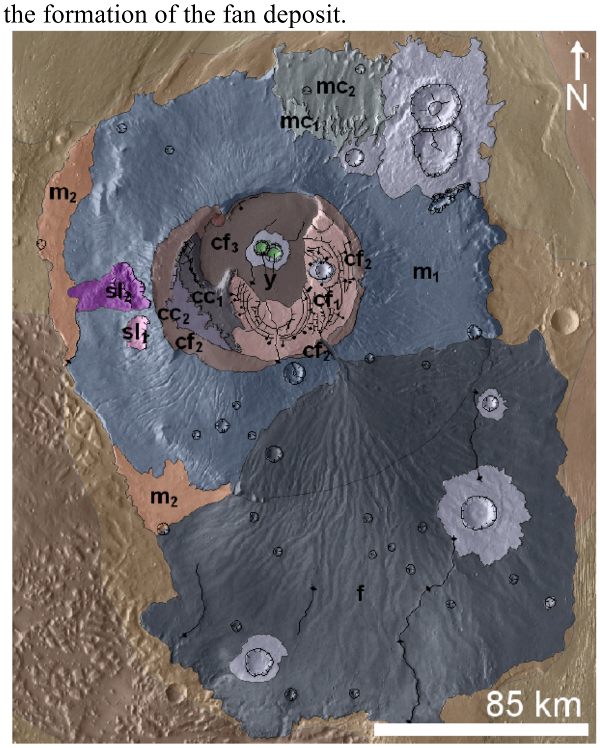

Figure 1. Geologic map of Apollinaris Mons, superposed on THEMIS daytime infrared and Scott and others' [3] map comprises the background. Upper left corner is 172.5°E, 7.3°S; lower right corner is 176.5°E, 11.6°S. See Table 1 for unit names.

Background: Based on Viking Orbiter data, Greeley and Spudis [4] identified Apollinaris Patera* as the sole member belonging to "Class I" martian paterae. Gulick and Baker [5] stated that the channels observed within the AM fan deposit have a "simple or rille-like morphology," consistent with immature fluvial valleys or valleys formed by pyroclastic density currents (such as pyrolcastic flows or surges). Earlier investigators [6,7] interpreted the morphology of the fan deposit to be most similar to lava flows emanating from a volcanic rift zone. Robinson and others [1] generated a Viking Orbiter based geologic map of AM and identified 4 units comprising the volcano: 2 caldera units, a "main edifice" unit, and the fan deposit. They mapped the fan deposit as emanting from the summit caldera complex, and concluded that it was most likely composed of pahoehoe-like lavas. Scott and others [3] also created a geologic map using Viking Orbiter images as a basemap. They concluded that the fan deposits are most likely pyroclastic materials, and were emplaced during the Hesperian Epoch. More recently, Farrell and Lang [2] assessed THEMIS infrared and visible images, and agreed that the fan materials are probably pyroclastic deposits.

Table 1. Geologic unit abbreviations for Apollinaris Mons. Subscripts in Fig. 1 indicate relative age (1 = oldest) and are not listed here; impact crater materials are not included.

Unit Abbreviation	Unit Name
cc	Crenulated caldera-filling material
cf	Caldera-filling material
cs	Caldera slumped material
f	Fan-shaped deposit
m	Main edifice material
mc	Main edifice crenulated material
sl	Slumped material
y	Yardang-like material

Methods: We mapped a roughly 4° x 4° region encompassing the main edifice and fan deposits of Apollinaris Mons (Fig. 1). THEMIS daytime infrared (obtained via JMARS at jmars.asu.edu) was imported into ArcGIS 9.3 for the basemap; higher resolution image data (e.g., HiRISE and CTX) were imported into ArcGIS as needed. All available image data sets were examined (including HRSC, MOC-NA, THEMIS VIS and TES) although they were not necessarily co-registered in GIS. Gridded MOLA data (128 px/°) were also imported into ArcGIS.

In addition to mapping geologic contacts, we mapped channels within the fan deposit and measured angles where channel tributaries were found (no distributary systems were found). Combining MOLA data with geologic mapping allowed us to estimate volumes of units and the summit caldera complex. Impact craters >1 km in diamter were counted to determine crater size-frequency distributions (Table 2).

Results and Discussion: *Summit Caldera Complex:* We have identified 5 separate units within the caldera complex. We interpret the youngest (cf_3) to be ponded lava, as evidenced by embayment relations with adjacent units. The oldest caldera units appear to be erosional remenants of a previously more extensive deposit: their margins in planform are similar to those observed in the Medusae Fossae Formation (MFF) [8, 9] and to terrestrial ignimbrites [9]. Although it is clear that a channel connected to the fan deposit cross-cuts the outer caldera wall, the channel disappears within the caldera floor. Arcuate scarps and fractures are abundant within the caldera complex. We interpret these structures to reflect injection and withdrawal of magma beneath the caldera complex. The volume that the caldera complex could hold is ~10^3 km^3.

Fan deposit and fan channels: The fan deposit is thin [1], and comprises a volume of ~10^3 km^3—similar to the caldera volume, consistent with a genetic relationship. Although the fan is younger than the main edifice of AM, the channel feeding the fan deposit only touches unit cf_1 in the summit caldera complex, so the precise stratigraphic relation between the fan and the youngest caldera-filling unit cannot be determined. Impact crater statistics suggest that the fan deposit is older than the youngest caldera-filling unit.

Channels within the fan locally display first-order tributaries (Fig. 2); no distributaries are observed. Locally, layering is observed in channel walls [cf. 10]. Channels tend to be V-shaped in cross-section, although locally they contain more U-shaped or rectangular incised channels. We interpret this morphology to be consistent with initial formation by pyroclastic flow, lahar, or fluvial processes, with subsequent modification by fluivial or groundwater sapping processes [5]. Thus, we interpret the fan to be formed of either pyroclastic deposits or lahar deposits.

Modification: Two impact craters in the summit of AM contain deposits that are morphologically similar to the MFF. Similar deposits are visible over most of the Apollinaris Mons' flanks in CTX images. This may mean that MFF once covered AM [11].

Conclusions: The units mapped here are small, requiring that impact crater statistics be interpreted with caution. However, we propose the following history for Apollinaris Mons. Geologic mapping and crater statistcs suggest that main edifice of AM is constructed of fluid lavas that were emplaced in the Late Noachian. The oldest deposits found within the summit caldera complex are interpreted to be remenants of pyroclastic deposits, possibly associated with a transition from early effusive to later explosive activity; they are older than the Late Noachian edifice but younger than the Early Amazonian caldera-filling materials. Thus, AM experienced a change in eruptive style during the Hesperian Epoch, and the fan deposit (most likely composed of pyroclasts or volcaniclastic materials) was emplaced during the Late Hesperian.

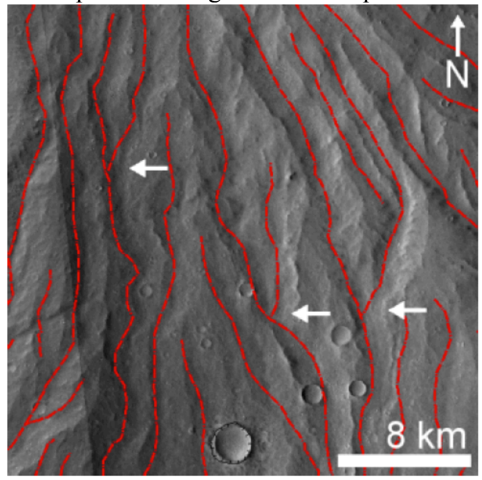

Figure 2. Channels (in red) within the fan deposit of AM, shown on THEMIS daytime infrared image mosaic (jmars.asu.edu). Arrows point to tributary junctions.

Table 2. Impact crater statistics for units in Figure 1.

Unit label	Total no. craters	Area (km^2)	N(2)	N(5)	N(16)	Age range (epoch)	Estimated Age
y*	0	42	0	0	0		EA**
cs	0	24	0	0	0		EA**
cf_3	2	1602	1248±883	1248±883	0	EA - MN	EA
mc_2	2	1314	1522±1076	0	0	LH - LN	LH
mc_1	0	275	0	0	0		LH**
sl_2	0	395	0	0	0		LH**
f	19	21138	899±206	189±95	0	LH - LN	LH
cc_2	0	300	0	0	0		LH**
cc_1	0	494	0	0	0		MH**
cf_2	0	1100	0	0	0		MH**
cf_1	1	1663	601±601	601±601	0	LA - MN	EH
sl_1	0	104	0	0	0		LN**
m_2	2	1726	1159±819	0	0	EA - LN	LN
m_1	13	13574	815±266	251±147	125±104	LH - EN	LN

Listed from youngest to oldest.***
* The yardang-like unit (y) surface areas were included in unit cf_3 since there were no discernible impact craters of relevant sizes located within them.
** Relative ages. Based on ages of surrounding units due to lack of impact craters within the unit.
*** Impact crater ejecta units (c) were not included in this table since no impact craters of relevant sizes were seen within them. Ejecta blanket surface areas were included within the surface area of their respective units.

References: [1] Robinson, M.S. et al. (1993) *Icarus 104*:301-323. [2] Farrell, A.K. and N.P. Lang (2010) *LPS XLI*, Abstract #2072. [3] Scott, D.H. et al. (1993) *USGS Misc. Inv. Series I-2351*, 1:500,000. [4] Greeley, R. and P.D. Spudis (1978) *Geophys. Res. Lett. 5(6)*:453-455. [5] Gulick, V.C. and V.R. Baker (1990) *J. Geophys. Res. 95(B9):*14,325-14,344. [4] Robinson, M.S. et al. (1993). [6] Carr, M.C. (1981) *The Surface of Mars*, Yale University Press. [7] Baker, V.R. (1982) *The Channels of Mars*, University of Texas Press. [8] Mandt, K.E. et al. (2008) J. Geophys. Res. 113(E12011), doi:10.1029/2008JE003076. [9] Mandt, K.E. et al. (2009) *Icarus 204(2):*471-477. [10] Lang, N.P. et al. (2008) *LPS XXXIX,* Abstract #1914. [11] Kerber, L. and J.W. Head (2010) *Icarus 206(2)*:669-684.

**Note that the name "Apollinaris Patera" now refers only to the summit caldera complex; the volcano is correctly referred to as "Apollinaris Mons."*