

AN EXAMINATION OF THE CONTACT BETWEEN APOLLINARIS PATERA AND THE MEDUSA FOSSAE FORMATION, MARS: IMPLICATIONS FOR APOLLINARIS' VOLCANIC EVOLUTION. N.P. Lang¹, R. Kelley¹, and A.K. Farrell¹ ¹Geology Department, Mercyhurst College, 501 E. 38th St., Erie, PA 16546; nlang@mercyhurst.edu.

Introduction: Critical for understanding the geologic history and significance of Apollinaris Patera and the Medusa Fossae Formation (MFF) is an understanding of the nature of the contact between these two units. Crater counting places Apollinaris at ~3.75 Ga [1] and the MFF is mapped as Amazonian in age [2-4], meaning that Apollinaris is typically interpreted as older than the MFF [5].

Here we examine the contact between these two units with the goals better understanding 1) the timing between Apollinaris and the MFF and 2) the volcanic evolution of Apollinaris Patera. Our analysis: 1) questions the notion that Apollinaris is necessarily older than the MFF, 2) provides further insight into the volcanic evolution of Apollinaris, and 3) raises new questions regarding the origin of the MFF.

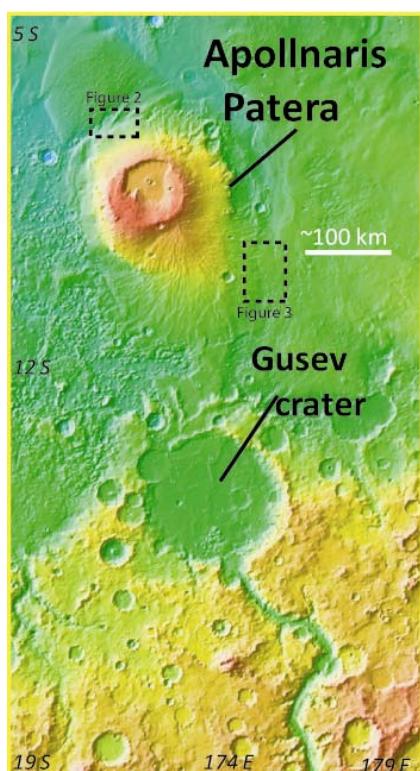


Figure 1: MOLA color shaded relief image of the regional context of this study. Apollinaris Patera (8.5° S, 174° E) is in depositional contact with the MFF to the north and east. Dashed black boxes show the locations of figures 2 and 3.

Geologic Context and Overview: Figure 1 shows the geologic context of our study area. Apollinaris is a singular, isolated volcano located near 8.5° S, 174° E along the crustal dichotomy. It is ~200 km north of Gusev crater and is in contact with the MFF to its north and east.

Apollinaris Patera: Apollinaris Patera is a ~150 km diameter Hesperian volcano [6] that is ~6 km in height and broadly divisible into [6]: 1) a summit caldera, 2) easily erodible flanks, and 3) a south-trending fan. The easily erodible nature of the flanks indicates that the volcano formed through pyroclastic activity [6]. A ~500 m tall basal scarp exists along much of the volcano that is locally overlain by the south-trending fan deposit, which suggests that a possibly extensive hiatus in volcanism occurred at this volcano [see 6].

MFF: The MFF outcrops as an extensive series of low, broad, flattopped topographic mounds in the equatorial region of Mars between Elysium Planitia and the Tharsis Province [4]; the surfaces of each of the outcrops may take on numerous textural appearances [4]. The origin of the MFF is enigmatic, but may (at least partly) reflect prolonged accumulation of pyroclastic deposits sourced from the Elysium, Apollinaris, and Tharsis regions [4, 8]; the MFF is typically mapped as Amazonian in age, but accumulation of the formation may have initiated in the Hesperian [2-3]. The MFF is broadly divided into the 1) lower, 2) middle, and 3) upper members [4]; the lower and upper members are in contact with Apollinaris.

Examination of the Apollinaris-Medusa Fossae Contact: Figures 2 and 3 are HiRISE images that highlight the Apollinaris-MFF contact along Apollinaris' northern and eastern margins, respectively. In figure 2, the contact is between Apollinaris' basal scarp and the MFF's lower member. The age of the two units in relation to one another is not obvious here due to the fact that erosion of Apollinaris' weak flank materials has obscured the contact; the contact at this location could represent a buttress unconformity where the MFF has been deposited up to the basal scarp or Apollinaris deposits could be deposited on top of the MFF here. Figure 3, however, shows a much more obvious contact relation between the two where materials from the south-trending fan overlie and locally embay yardangs of the MFF's middle member; this indicates that, at least at this location, Apollinaris' south fan is younger than MFF's middle member.

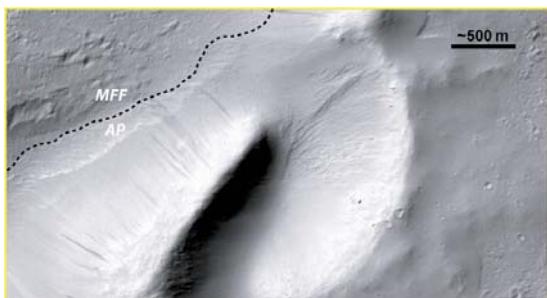


Figure 2: HiRISE image

P18_007882_1703_XN_09S185W showing the contact (dashed black line) between Apollinaris and the lower member of the MFF north of Apollinaris. The contact here is denoted by the basal scarp along Apollinaris, but the timing of the two units here is unclear, though Apollinaris flank materials are eroding onto the MFF.

Discussion: Though the timing between Apollinaris and the MFF is only resolvable in figure 3, there are two points worth noting at both contact locations. First, the nature of the contact at both locales is likely depositional. Second, and possibly more importantly, the physical properties of the Apollinaris deposits at each locale are strikingly different. To elaborate, Apollinaris deposits at both locales likely represent pyroclastic deposits [7], but the deposits along the basal scarp (figure 2) are much weaker than those comprising the south-trending fan (figure 3). In fact, as one works up through Apollinaris' stratigraphic section, the pyroclastic deposits exhibit an overall decrease in relative erodibility such that the south-trending fan materials appear to be the physically strongest deposits comprising the edifice's flanks. Assuming that 1) Apollinaris' flank deposits are indeed pyroclastic and 2) that relative erodibility can be used as a qualitative proxy to the degree of welding (i.e., eruption temperature) within pyroclastic deposits, these observations imply that the materials in the south-trending fan are more welded than the deposits reflected in the basal scarp and that the eruption temperature of the pyroclastic deposits increased over the volcano's lifetime. If true, an increase in eruption temperature here may reflect a decrease in the water:magma interaction ratio, which may reflect a drop in the amount of water present in this part of Mars. Although purely speculative, such a scenario for Apollinaris is consistent with morphologic evidence that past water may have existed within this region; in fact, the location of Apollinaris coincides with the Arabia shoreline of [8] – perhaps the decreasing water:magma ratio at Apollinaris is linked to the recession of this postulated northern ocean.

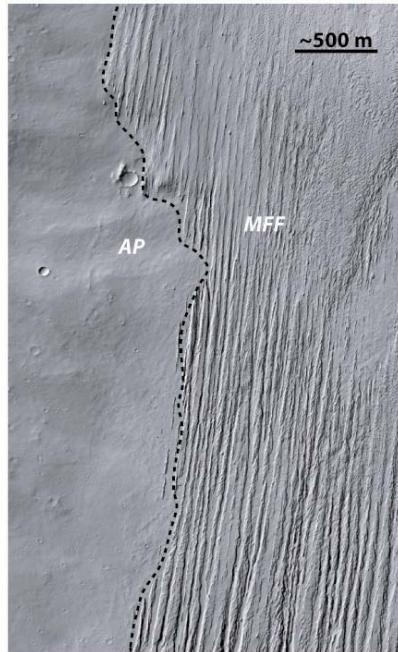


Figure 3: HiRISE image P22-009464_1693_XN_10S183W showing the contact between Apollinaris' south-trending fan and the MFF along Apollinaris' south-eastern margin. The fan materials embay and locally cover MFF yardangs.

Implications: The contact relations between Apollinaris and the MFF highlighted here have two implications. First, outcroppings of the MFF along Apollinaris' eastern boundary are not entirely younger than the Apollinaris construct, which challenges previous interpretations that Apollinaris is indeed older than the MFF; a younger Apollinaris than originally mapped would be consistent with modeling work demonstrating that the MFF likely contains Apollinaris deposits [9]. Second, if Apollinaris did form in a water-rich environment, then the older MFF deposits may represent sub-aqueous deposits that have been subsequently modified by aeolian processes.

References: [1] Greeley, R. et al. (2005) *JGR*, 110, E05008, doi:10.1029/2005JE002401. [2] Scott, D.H. and Tanaka, K.L. (1986), *USGS Map I-1802-A*. [3] Greeley, R. and Guest, J.E. (1987), *USGS Map I-1802-B*. [4] Mandt, K.E. et al. (2008), *JGR*, 113, E12011, doi : 10.1029/2008JE003076. [5] Scott, D.H. et al. (1993) *USGS Map I-2351*. [6] Robinson, M.S. et al. (1993), *Icarus*, 104, 301-323. [7] Farrell, A.K. and Lang, N.P. (2010), *41st LPSC Abstract #2072*. [8] Clifford, S.M. and Parker, T.J. (2001), *Icarus*, 154, 40-79. [9] Kerber, L. et al. (2010), *41st LPSC Abstract #1006*.