RE-EXAMINING THE RELATIONSHIP BETWEEN APOLLINARIS PATERA AND GUSEV BASALTS.

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Introduction: Basaltic rocks analyzed on the floor of Gusev Crater by the Spirit rover represent the most complete compositionally and texturally characterized suite of erupted materials on Mars [1]. However, the source of these rocks remains ambiguous. Identifying the source of this volcanic suite is critical for further understanding the petrogenesis of these rocks as well as for constraining the geologic and magmatic history of this region.

The presence of Apollinaris Patera north of Gusev Crater has led some workers to propose that it sourced the Gusev basalts, although a source within the crater may also be viable [2-3]. The possibility of an Apollinaris-Gusev connection is bolstered by the relatively similar ages of Apollinaris flank deposits (~3.76 Ga) and Gusev floor materials (~3.65 Ga) [3]. However, if the basalts on the floor of Gusev did flow from Apollinaris, then not only should the ages of the materials be similar, but there should have existed an unimpeded flow path from Apollinaris to the Gusev floor.

Here we further test the hypothesis that the basaltic lavas within Gusev Crater originated from Apollinaris Patera. Specifically, we use use Mars Orbiter Laser Altiemter (MOLA) gridded data to perform a topographic analysis on the possible flow path(s) from Apollinaris Patera into Gusev Crater. Based on constructed topographic profiles and their comparison with published geologic mapping [4], we conclude that no viable flow path exists between the two locales. Therefore, it seems unlikely that the Gusev basalts originated directly from the Apollinaris construct. Instead, the Gusev basalts may have been sourced from within the crater during a period of magmatism that may have also sourced Apollinaris Patera as suggested by [3].

Geologic Framework: Apollinaris Patera is located ~200 km north of Gusev Crater (Figure 1). From north to south, the terrain between Apollinaris and Gusev consists of an east-west canyon system and two distinct plateaus (P1 and P2 on Figure 1). The canyon system hosts chaotic terrain and cuts the southern edge of the Apollinaris construct and P1 and must have therefore post-dated volcanism on Apollinaris' southern flank. The second plateau (P2) sits topographically higher than P1 and parallels the outside of Gusev's northern rim. Near the northwest corner of Gusev Crater, Gusev's rim and P2 have been dissected, or breached, resulting in one or more apparent pathways that connect the floor of Gusev with P1. At least part of this breach has been destroyed and blocked by an unnamed impact crater (Figure 2). Although the impact has modified the breach, possible flow paths between Gusev and P1 are still visible and are marked by the dashed red lines in Figure 2. If lavas did flow from Apollinaris into Gusev, they would have likely flowed across P1 and through the breach via a pathway marked in Figure 2 and prior to the formation of the unnamed crater [2]. Therefore, a test of the hypothesis that Apollinaris lavas flowed into Gusev through this breach is the construction of a topographic profile along the flow paths (Figure 3). If lavas did flow through the breach, then the flow path from P1 into Gusev should either maintain a constant elevation or slope south into the crater. Any increase in elevation along this path would need to be attributable to either post-volcanic tectonism (including volcanic loading) and/or to the subsequent emplacement of a material unit (i.e., ejecta).

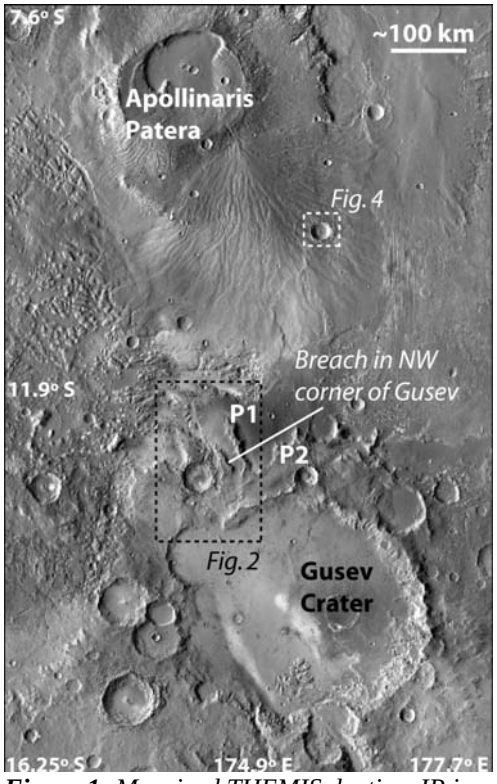

Figure 1: *Mosaiced THEMIS daytime IR image of the Apollinaris-Gusev region. From jmars.*

Discussion: Comparison of the topographic profile in Figure 3 with the distribution of impact ejecta from the unnamed crater shown in Figure 2 shows that the topography steadily rises ~70 m in elevation from the start of P1 south to the first occurrence of the unnamed crater's ejecta blanket (as currently mapped; *see* [4]). Further, the apparent absence of obvious faulting and/or folding [4] along this path on P1 suggests that this rise in topography is primary and not the result of tectonic deformation. This indicates that if lavas did flow from Apollinaris into Gusev, they would have traversed uphill. Therefore, it seems unlikely that the Gusev basalts originated directly from the Apollinaris construct as suggested by [2; *see also* 3]. Instead, based on the constraints of current published mapping [e.g., 4], it seems more likely that the Gusev basalts were locally erupted within the crater via preexisting fractures and/or volcanic constructs that have been subsequently modified, destroyed, or buried [3].

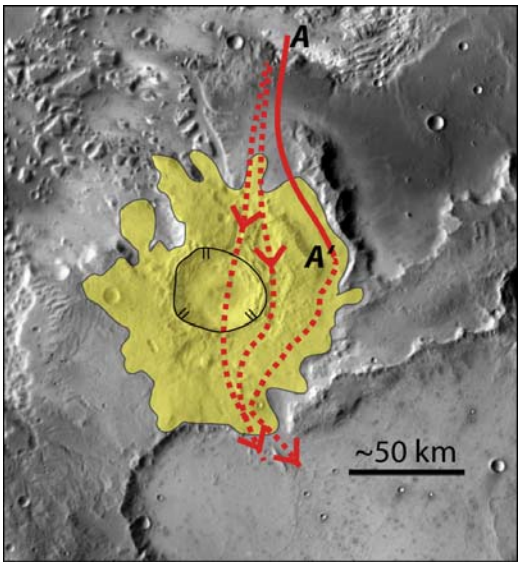

Figure 2: *THEMIS daytime IR image with the distribution of the unnamed impact crater's ejecta blanket at the NW Gusev breach. Ejecta distribution is taken from [4]. Dashed red lines show the locations of possible flow paths through the breach prior to the impact. Solid red line marked A-A' is the location of the topographic profile in Figure 3. Due to space constraints,we show the profile only partway through the breach.*

If the Gusev basalts are not sourced from the Apollinaris construct, then the relatively similar ages of Apollinaris flank deposits and Gusev materials [3] is intriguing and raises the possibility that the two are related to the same magmatic event [3]. Perhaps this event was a plume and Apollinaris and Gusev reflect different melt regions across the plume. Such a scenario may be testable through continued geologic mapping and spectroscopic studies across the region. Specifically, the identification of (likely buried?) regional fracture systems connecting Apollinaris and Gusev may be attributable to the interaction of a plume head on the base of the lithosphere. Although the Apollinaris construct is too dusty [e.g., 5] for spectroscopic analysis using most instruments, observation of layerd deposits on the volcano's southern flank (Figure 4) raises the possibility that future spectroscopic instruments may be able to analyze Apollinaris volcanics. Compositional analysis of these deposits would yield more insight into their petrogenesis and allow for continued comparison with the Gusev basalts.

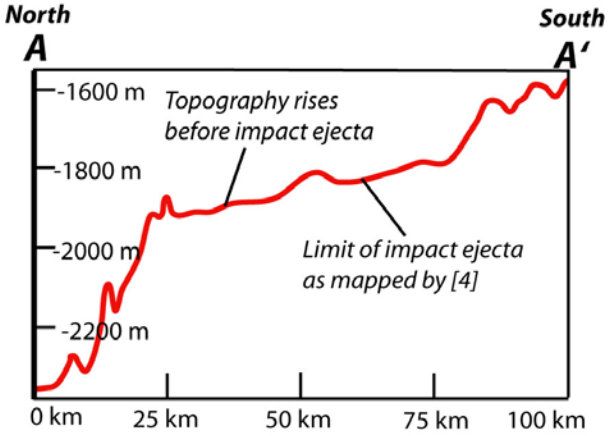

Figure 3: *Topographic profile from P1 to the breach.*

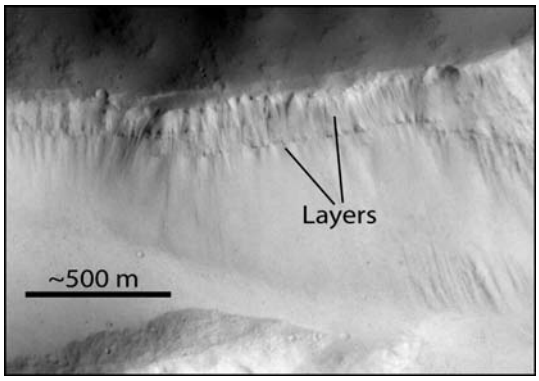

Figure 4: *Layers within Apollinaris' south flank. Portion of MOC image S0602038.*

References: [1] McSween, H.Y. et al. (2006) *JGR*, 111, E09S91, doi:10.1029/2006JE002698. [2] Martinez-Alonso, S. et al. (2005) *JGR*, 110, doi:10.1029/2004JE002327. [3] Greeley, R. et al. (2005) *JGR*, 110, doi:10.1029/2005JE0024001. [4] Kuzmin, R.O. et al. (2000) *USGS Misc. Inv. Ser. Map I-2666*. [5] Ruff, S.W. and Christensen, P.R. (2002) *JGR*, 107, 10.1029/2001JE001580.