THE DISPERSAL OF PYROCLASTS FROM APOLLINARIS PATERA, MARS. L. Kerber[1] and J. W. Head[1], J.B. Madeleine[2], F. Forget[2], and L. Wilson[3]. Department of Geological Sciences, Brown University, Box 1846, Providence, RI 02912 (laura_kerber@brown.edu), [2]Laboratoire de Météorologie Dynamique du CNRS, Université Paris 6, Paris, [3]Environmental Science Division, Lancaster University Lancaster LA1 4YQ, UK.

Introduction: The Medusae Fossae Formation (MFF) is a complicated and discontinuous formation located in the southern parts of Elysium Planitia and Amazonis Planitia (130°-230°E and 12°S-12°N), covering an area of approximately 2.1 x 10^6 km^2 and having an estimated volume of 1.4 x 10^6 km^3 [1]. It is thought to have been deposited during the Amazonian period [2,3]; however, much of the cratering record may have been erased as friable units were eroded and long-buried terrains exhumed [4-6], and many stratigraphic relationships are ambiguous [7]. The formation is characterized by fine-grained, friable deposits and evidence of large amounts of erosion. There are many theories regarding the emplacement of the formation; recently the literature has focused on three possibilities: ignimbrites, ash fall, and aeolian dust [see 8].

The medium-sized Hesperian-aged volcano Apollinaris Patera (-8ºS, 174ºE) is located in a unique position close to the global dichotomy boundary, as well as near the Mars Exploration Rover (MER) Spirit landing site in Gusev Crater, where tephra deposits may be exposed in the Columbia Hills [9]. Given its proximity to the Medusae Fossae Formation, and the unique opportunity to compare data taken from orbit with information from the surface, we decided to test the likelihood that this volcano was the source for at least some of the deposit.

In order to test this hypothesis, we combined a Mars Global Circulation Model (GCM) [10] with a semi-analytical explosive eruption model for Mars [11]. The explosive model determines the rise-height of the eruption column and the release heights for volcanic clasts of various sizes while the GCM provides time-dependent wind profiles for calculating the range of each particle.

Results: Various parameters were tested, including the height of release (which is based on the strength of the eruption), the size of the pyroclastic grains (which is determined by the growth of bubbles in the magma), the density of the clasts (which depends on the composition of the magma and the amount of trapped volatiles), and the season (which changes the wind regime transporting the clasts to the surface). Since the Medusae Fossae Formation has also been hypothesized to come from the Tharsis Montes volcanoes [12], simulations were run from these volcanoes as well.

Discussion: The critical parameters that govern the distribution of pyroclasts appear to be the height of release **(Fig. 1)**, and the grain size **(Fig. 2)**. The density of the clasts has a lesser effect within the range of terrestrial pyroclast densities tested (~700-1500 kg/m^3). Seasons have some effect on the shape of the resulting surface ash distribution; an eruption beginning at Ls=180 (Northern Hemisphere Fall) seems to be the best fit for the Medusae Fossae Formation **(Fig. 3)**.

Dispersal from the Tharsis volcanoes is wide because of the high altitude of their vents but, because of the global wind patterns, the bulk of the clasts are emplaced to the east of the edifices themselves in most cases. Of the Tharsis volcanoes, Olympus Mons seems the most likely to have aided in creating the great thickness of the eastern parts of the Medusae Fossae Formation, estimated in places to be up to 3 km thick [13] **(Fig. 4)**. Wide dispersal from low altitude (possibly buried) vents is hampered by low wind speeds and decreased flight time. The height of Apollinaris (4 km) and its position in the center of the deposit would make it possible for the volcano to disperse voluminous amounts of ash over the widespread areas covered by the MFF. Simulations were run over 60 days with an eruption flux of 10^9 kg/s. A total of ~3500 km^3 of material would result from such an eruption, and ~400 such eruptions would be required to create the volume suggested by [1] for the MFF, assuming a density of 1500 kg/m^3. The Yellowstone Volcanic complex experiences comparable (~2000 km^3) caldera-forming eruptions with a ~700,000 year recurrence interval [14]. At this rate of recurrence (not counting hundreds of more frequent, smaller eruptions), the MFF could have been emplaced over ~280 million years.

Based on these results, we conclude that Apollinaris Patera could have been responsible for a significant portion of the Medusae Fossae Formation, with additional material provided by other nearby volcanoes. We are currently examining the stratigraphy and age of the MFF in order to assess what components might be contemporaneous with eruptions from Apollinaris [15].

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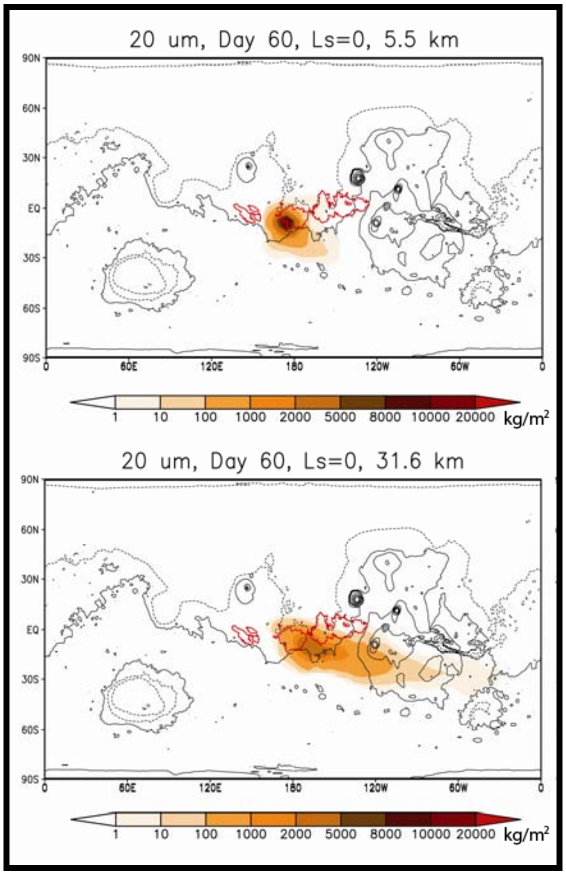

Figure 1. The dispersal of pyroclasts from Apollinaris Patera based on the height of dispersal, which for 20 μm clasts corresponds with the top of the plume. Contours are surface accumulation in units of kg/m^2 for a high eruption rate of 10^9 kg/s. Eruptions begin in Northern Hemisphere Spring. The MFF is outlined in red.

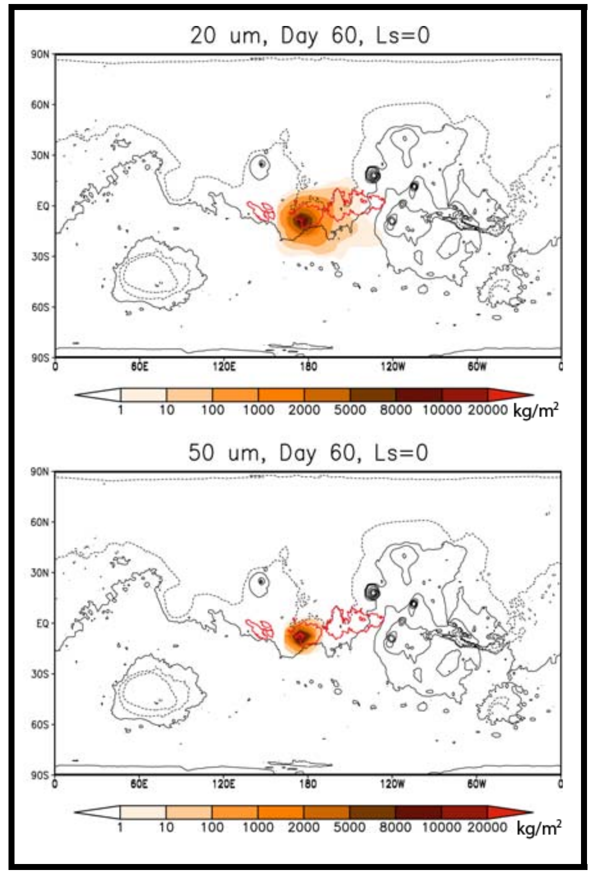

Figure 2. The dispersal of pyroclasts from Apollinaris based on the size of the pyroclast grains. Theoretical considerations [11] suggest that clasts would normally be no smaller than 20 μm. Eruptions begin in Northern Hemisphere Spring.

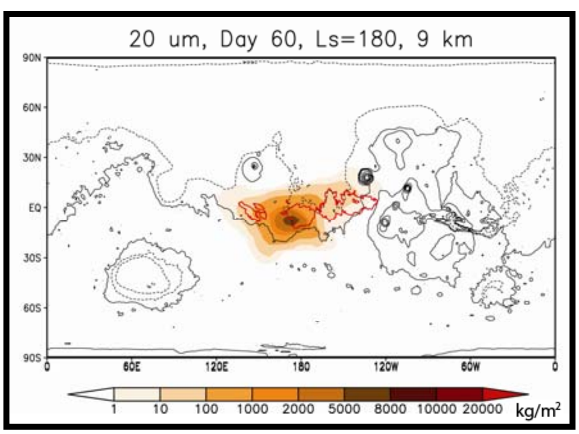

Figure 3. Eruptions taking place in different seasons produce slightly different dispersal patterns. Northern Hemisphere Fall appears to be the best match for the shape of the Medusae Fossae Formation, though the formation would most likely be composed of the sum of many eruptions over several different seasons.

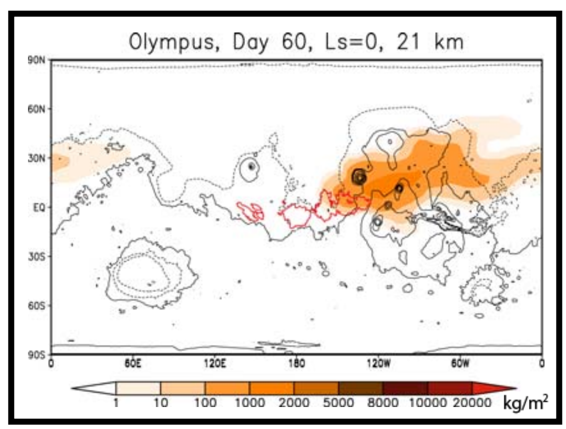

Figure 4. Olympus Mons and the Tharsis Montes have also been suggested as possible sources for the Medusae Fossae Formation [12]. Model results indicate that most of the ash from these volcanoes would be emplaced east of these edifices in the present atmosphere. Olympus Mons could have contributed some material to the eastern parts of the Medusae Fossae Formation.