THE DISPERSAL OF PYROCLASTS IN THE MARTIAN ATMOSPHERE. L. Kerber[1] and J. W. Head[1], Department of Geological Sciences, Brown University, Box 1846, 324 Brook St., Providence, RI 02912. Laura_Kerber@brown.edu.

Introduction: The Medusae Fossae Formation (MFF) is an enigmatic 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]. The formation is characterized by large accumulations of fine-grained, friable deposits and evidence of large amounts of erosion. There are many theories regarding the emplacement of this formation; recently the literature has focused on three possibilities: ignimbrites [2], ash fall [2,7,8] (perhaps from Tharsis Montes [7]), and aeolian dust [2,8].

If the formation is made of ash, its volume would suggest a large amount of pyroclastic activity in the past, which would have a significant effect on the atmosphere of Mars. Volcanic ash particles can effectively scatter incoming solar radiation and reduce the overall temperature of the planet. However, volcanoes which emit large amounts of greenhouse gases may warm the planet with time. Examining large deposits of possible explosive volcanic material may lead to better constraints on how volcanoes interacted with the atmosphere over time.

In order to test the hypothesis that the MFF is made of ash, we combined a Mars Global Circulation Model (GCM) [9] with a semi-analytical explosive eruption model for Mars [10]. 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.

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 [11]. 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 the deposit.

Results: The accumulation over time with an eruption flux of 1E9 kg/s is shown in **Fig 1**. A variety of parameters were tested including the height of dispersal (which is based on the strength of the eruption) **(Fig. 2)**, the size of the pyroclastic grains (which is determined by the growth of bubbles in the magma **(Fig. 3)** [11]), the density of the clasts (which is highly dependent on the circumstances of eruption and the volatile amount) **(Fig. 4)**, and the season (which changes the wind regime transporting the clasts to the surface) **(Fig. 5)**. Simulations were also run from the Tharsis volcanoes to further test the hypothesis that ash came from these sources [9] **(Fig. 6)**.

Conclusions: While seasons have some effect on the distribution, the critical parameters that govern the distance traveled by pyroclasts are the height of release, the grain size distribution, and, to a slightly lesser extent, the density of the clasts. An eruption beginning at Ls=180 (Northern Hemisphere Fall) from Apollinaris Patera seems to be the best fit for the Medusae Fossae Formation. According to the simulations, Apollinaris Patera could easily deliver tephra to the distance of the Columbia Hills.

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. Eruptions from Olympus Mons could aid in creating the great thickness of the eastern parts of the Medusae Fossae Formation, estimated to be up to 3 km thick [12]. Further tests will address the effects of changing obliquity on the ash dispersal from various sources and the effect of tephra and other volcanic emissions on the atmosphere.

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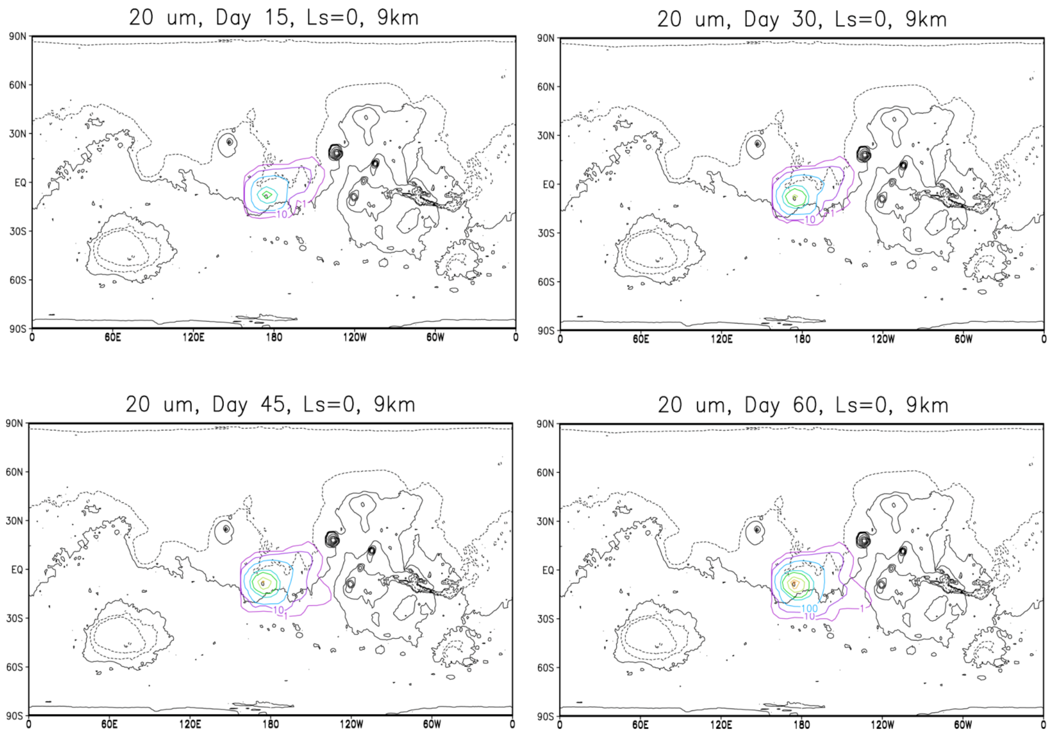

Figure 1. The dispersal of a pyroclasts over time. The flux is 1.0E9 kg/s, equivalent to a very large terrestrial eruption. In reality, the eruption would only episodically produce such a flux over a longer period. Contours are in kg/m^2 with intervals 1, 10, 100, 1000, 2000, 5000, 8000, 10000 and 20000.

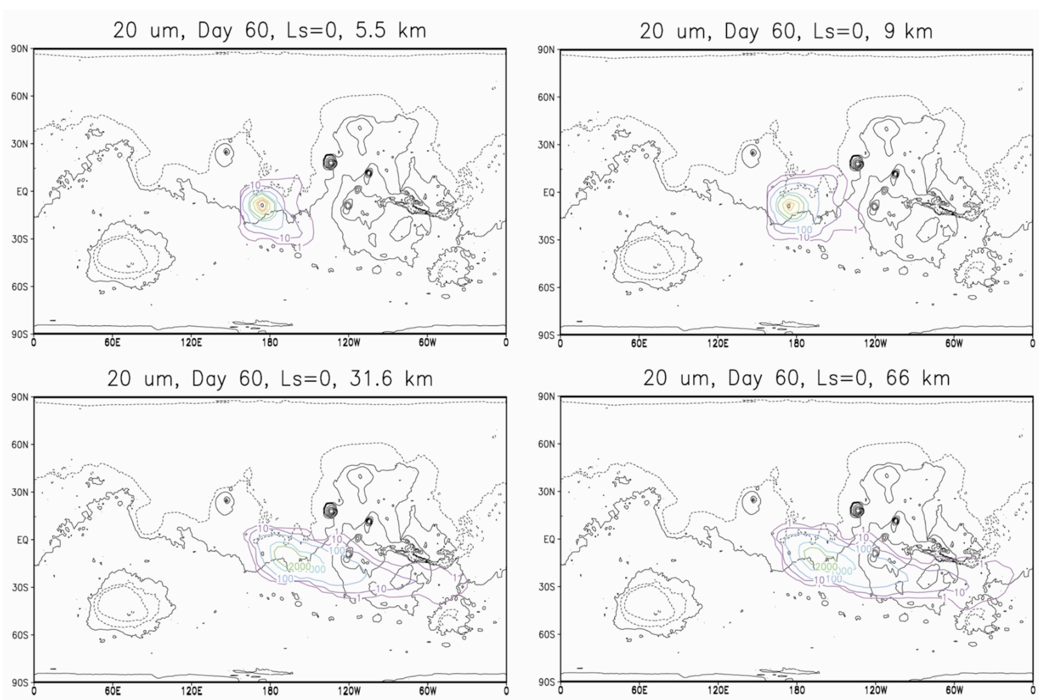

Figure 2. The dispersal of 20 μm pyroclasts based on the height of release from the plume. Contours are in kg/m^2 with intervals 1, 10, 100, 1000, 2000, 5000, 8000, 10000 and 20000.

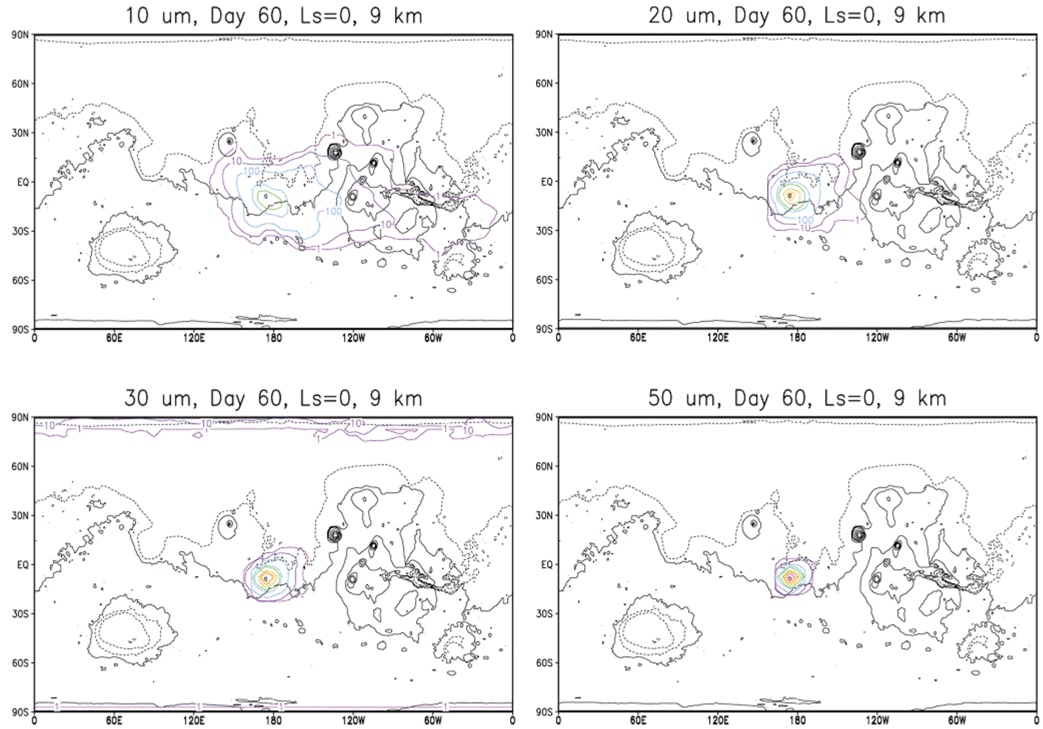

Figure 3. The dispersal of pyroclasts based on the size of the pyroclast grains. Theoretical considerations [6] suggest that clasts would normally be no smaller than 20 μm. Contours are in kg/m^2 with intervals 1, 10, 100, 1000, 2000, 5000, 8000, 10000 and 20000.

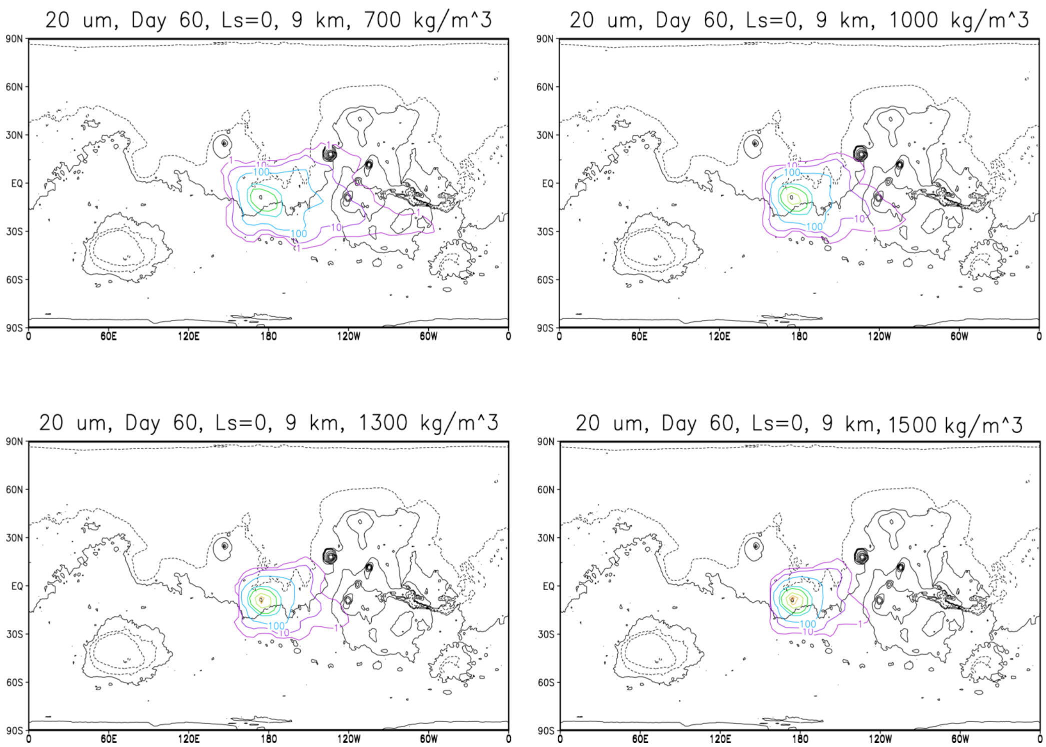

Figure 4. The dispersal of pyroclasts from Apollinaris Patera based on the density of the clasts. Less dense clasts travel considerably further. Contours are in kg/m^2 with intervals 1, 10, 100, 1000, 2000, 5000, 8000, 10000 and 20000.

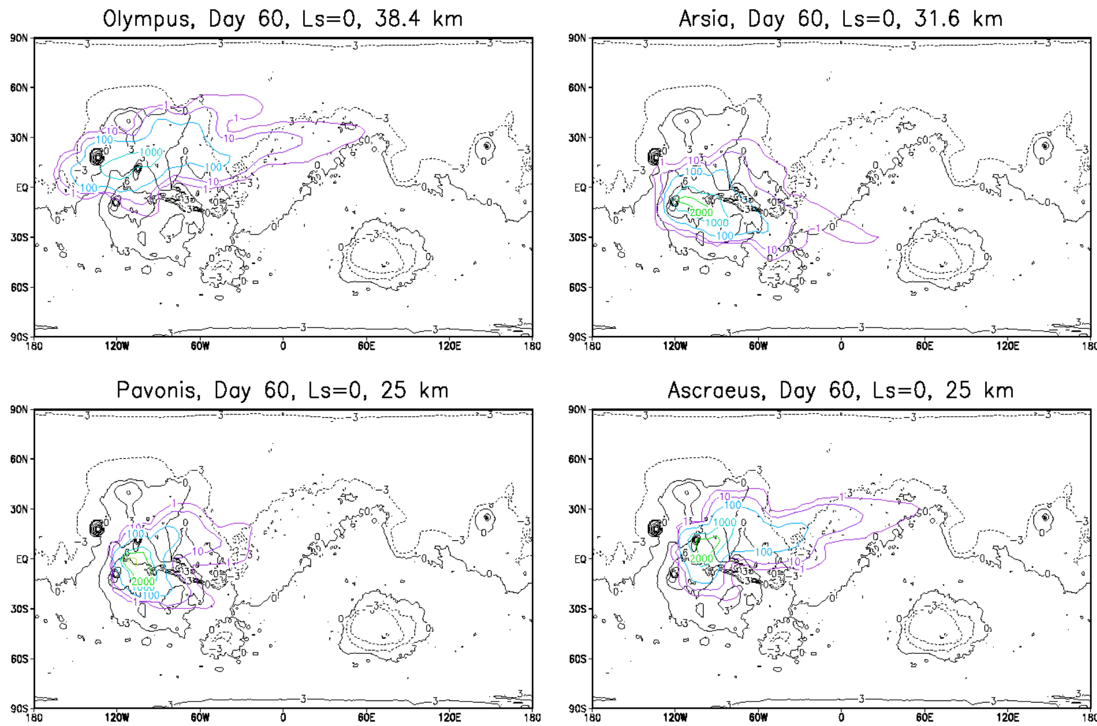

Figure 5. The dispersal of pyroclasts from the Tharsis Montes and Olympus Mons, which have also been suggested as sources for the Medusae Fossae Formation. Contours are in kg/m^2 with intervals 1, 10, 100, 1000, 2000, 5000, 8000, 10000 and 20000.

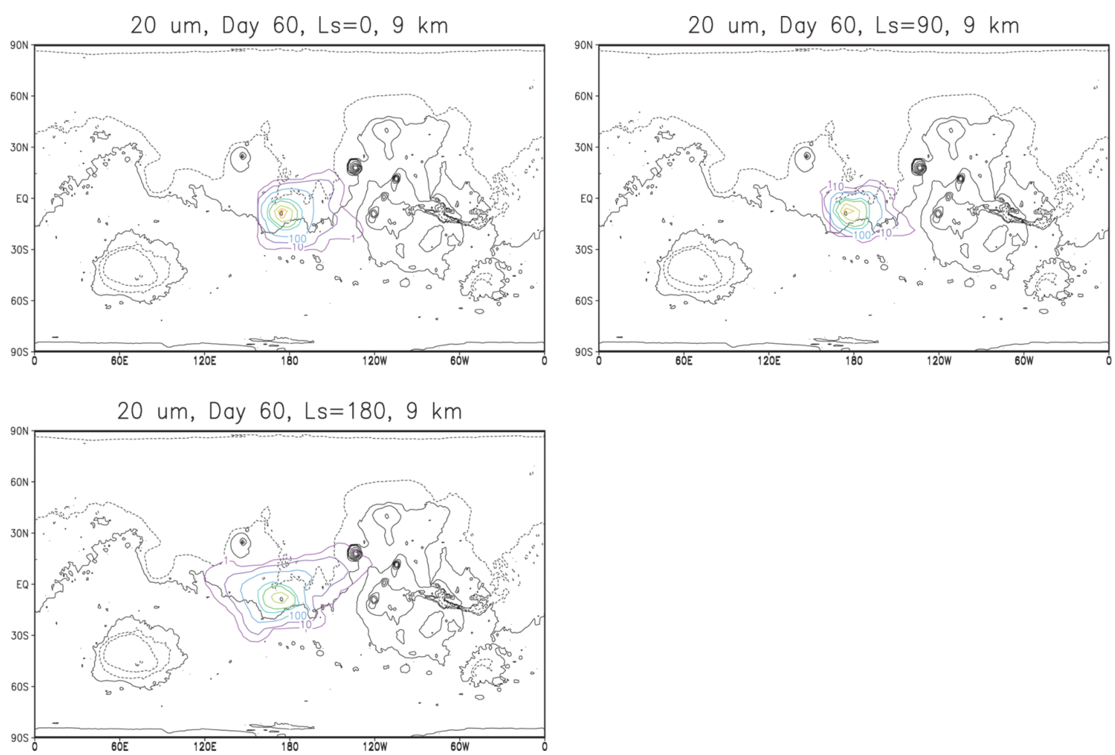

Figure 6. The dispersal of pyroclasts based on the season when the eruption begins. Northern Hemisphere Fall appears to be the best match for the shape of the Medusae Fossae Formation. Contours are in kg/m^2 with intervals 1, 10, 100, 1000, 2000, 5000, 8000, 10000 and 20000.