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Rheologic Properties of Young Lava Flows on the Tharsis Montes, Mars

Harald Hiesinger1; Dennis Reiss1; Sabine Dude1; Christopher Ohm1; James W. Head III2; Gerhard Neukum3

1Westfälische Wilhelms-University, Inst. für Planetologie, Münster, Germany; 2Brown University, Dept. of Geological Sciences, Providence, RI, USA; 3Freie Universität Berlin, Germany; Hiesinger@uni-muenster.de

We performed a study of the rheologic characteristics of young lava flows on the large Tharsis Montes volcanoes Arsia Mons, Pavonis Mons, and Ascraeus Mons, which are located on the extensive Tharsis bulge. There are several studies that demonstrated that, in principle, flow dimensions could be used to derive rheologic properties such as yield strength, effusion rates and viscosity. In order to investigate possible similarities and differences among the late-stage lava flows of the Tharsis Montes, we expand on our previous study of the rheologic properties of lava flows on Ascraeus Mons. For our study we utilized images obtained by the High Resolution Stereo Camera (HRSC) on board ESA's Mars Express spacecraft in combination with Mars Orbiter Laser Altimeter (MOLA) data. These data allow one to measure the dimensions and slopes of the investigated young lava flows with high precision in order to constrain their rheologic properties. Several HRSC orbits with spatial resolutions of about 10-20 m/pixel cover the study area and can be used to precisely measure the length and width of the studied lava flows. The flow heights were derived from individual MOLA profiles and gridded MOLA topography was used to measure the slope on which these flows occur.

Results for Ascraeus Mons: Our calculations of the yield strengths for lava flows on Ascraeus Mons range from $\sim$2.0 x 10^2 Pa to $\sim$1.3 x 10^5 Pa, with an average of $\sim$2.1 x 10^4 Pa. These values are generally in good agreement with estimates for terrestrial basaltic lava flows. The effusion rates are on average $\sim$185 m^3s^{-1}, ranging from $\sim$23

m^3s^{-1} to ~404 m^3s^{-1}. While these results are higher than earlier findings that indicate average effusion rates of 35 m^3s^{-1} (18-60 m^3s^{-1}), they are similar to terrestrial effusion rates of Kilauea and Mauna Loa and other Martian volcanoes. Viscosities were calculated to be on average ~4.1 x 10^6 Pa-s, ranging from ~1.8 x 10^4 Pa-s to ~4.2 x 10^7 Pa-s. On the basis of our effusion rates and the flow dimensions, we calculated that the time necessary to emplace the young flows on Ascraeus Mons is on average ~26 days.

Results for Pavonis Mons: The flows of Pavonis Mons are characterized by an average yield strength of ~3.4 x 10^3 Pa, ranging from ~4.3 x 10^2 to ~1.3 x 10^4 Pa. The average effusion rate is ~242 m^3s^{-1}, ranging from ~168 $m^3s^{-1}$to ~449 m^3s^{-1}. Viscosities are on average ~1.6 x 10^6 Pa-s, ranging from ~1.7 x 10^5 Pa-s to ~5.7 x 10^6 Pa-s.

Results for Arsia Mons: For the flows on Arsia Mons we find that the average yield strength is ~2.2 x 10^3 Pa, ranging from ~2.7 x 10^2 to ~9.3 x 10^3 Pa. The effusion rate varies from ~76 to ~1455 m^3s^{-1}, with an average of ~567 m^3s^{-1}. The average viscosity of the Arsia flows is ~2.5 x 10^6 Pa-s, ranging from ~1.7 x 10^4 Pa-s to ~9.3 x 10^6 Pa-s.