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Rheology and Ages of Lava Flows on Arsia and Pavonis Mons, Mars

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We performed a new study of young lava flows on Arsia and Pavonis Mons. Compared to our previous study of Arsia and Pavonis flows [1], we not only expanded on the number of flows (13 additional new flows at Arsia; six new flows at Pavonis), but we also derived absolute model ages (AMAs) based on crater size-frequency distribution (CSFD) measurements.

On the basis of the current study, we find that the yield strengths of the studied lava flows on Arsia Mons vary between ∼2.54 x 102 Pa and ∼9.63 x 103 Pa. The effusion rates are on average ∼563 m3s-1. The calculated eruption durations range from three days to ∼142 days with an average of ∼32 days. The viscosities of the lava flows on Arsia Mons are on average ∼2.54 x 106 Pa-s and vary between ∼1.32 x 104 and ∼2.88 x 107 Pa-s.

The study also revealed an average yield strength of the Pavonis flows of ∼3.56 x 103 Pa, ranging from ∼2.5 x 102 to ∼8.6 x 103 Pa. The effusion rates range from ∼ 60 m3s-1 to ∼309 m3s-1, with an average value of ∼197 m3s-1. The investigated flows are characterized by an eruption duration in the range of ∼3 to ∼41 days, averaging about 15 days. The viscosities vary between ∼2.8 x 104 Pa-s and ∼7.6 x 106 Pa-s, with an average value of ∼1.77 x 106 Pa-s.

The new CSFD measurements for the Arsia flows yielded AMAs between ∼36 and ∼857 Ma. One unit shows an underlying older age of ∼2.50 Ga and evidence for a resurfacing event at ∼857 Ma. These ages are similar to those presented by [2-4] for the caldera of Arsia Mons, i.e. ∼100-200 Ma. In addition, [4] argued that their ages represent the latest stages of summit and flank eruptions and that earlier episodes stopped at about 500 Ma, 800 Ma, and 2 Ga ago.

Previously, we performed the first study that correlated rheologic properties and AMAs of lava flows on Elysium Mons [5]. We reported that the yield strengths of 32 investigated Elysium flows are on the order of ∼3.0 x 103 Pa, ranging from ∼3.8 x 102 to ∼1.5 x 104 Pa. The effusion rates of the flows range from ∼99 to ∼4450 m3s-1, averaging at ∼747 m3s-1. The lava flows were emplaced in less than a week (very small flows) to up to half a year (∼6-183 days). Viscosities were calculated to be on average ∼4.1 x 102 Pa-s, with a range of ∼1.2 x 105 to ∼3.1 x 107 Pa-s. The AMAs of the Elysium flows range from ∼632 to ∼3460 Ma [5].

Lava flows on both Arsia and Elysium Mons do not show any systematic correlations between the rheologic properties and model ages. In particular, neither yield strength and effusion rate, nor viscosity seems to be correlated with the AMA. Thus, the rheology of the studied flows did not change over several hundreds of million years. Preliminary results for Pavonis flows also do not show systematic changes of the rheology with time.

[1] Hiesinger et al. (2008) LPSC 39, 1277. [2] Neukum et al. (2004) Nature 432, 971-979. [3] Robbins et al. (2011) Icarus 211, 1179-1203. [4] Werner (2009) Icarus 201, 44-68. [5] Pasckert et al. (2012) Icarus 219, 443-457.