ESTIMATED VISCOSITIES OF ARSIA MONS LAVA FLOWS. Ernest Schonfeld. Johnson Space Center, Houston, Texas 77062.

The morphology of a lava flow is markedly affected by the viscosity of the lavas which compose the flow. Although the best viscosity data would be that obtained by a direct determination of a sample, we do not have rocks from Mars and other methods need to be used to estimate the viscosity of Martian lavas. There are two alternative methods for estimating the viscosities of natural silicates. Since the chemical composition of Martian lavas can be estimated from the chemical composition of Martian soil (1) or from geochemical modeling of Mars (2) the viscosity can be estimated from the method given by Shaw (3) who presented a correlation of chemical composition and viscosity.

Another method that can be used to estimate the viscosity of a lava flow is that proposed by Hulme (4) based on the measurment of several physical parameters such as length, total width, width of levee, and slope of the flows. It is his method of estimating the visocisity which has been applied to the data obtained by Moore et al (5) to estimate the viscosity for the Arsia Mons lava flows in this work. Hulme (4) has shown that the viscosity of a lava flow is related to several physical parameters in the following way:

$$\eta = \frac{\mathcal{F}}{F\,(g\rho)^3}\left(\frac{S_y}{\alpha}\right)^4 \qquad \text{equation 1}$$

where η is the viscosity, F is the efussion or flow rate, g is the acceleration due to gravity, ρ is the density, S_y is the yield stress, α is the slope, and $\mathcal{F}$ is a dimensionless parameter that is a function of the total flow width and the width of the stationary banks (levees). The efussion rate can be estimated from the correlation between the efussion rate and the length of a flow (6). Moore et al (5) measured the total width, the width of the levees, and the slopes for several lava flows of the volcano Arsia Mons. These flows are about 400 km from the center of the shield. Using the method of Walker (6), the calculated efussion rate is about 3.5×10^{11} cc/sec. The yield stress is a function of the density, the accelaration due to gravity, the slope and the width of the levee. The calculated efussion rate and yield stress and an assumed density of 2.7 gm/cc were used to compute the viscosity for several lava flows of Arsia Mons using equation 1. For lava flows # 3, 4, and 7 the estimated viscosities are respectively 3, 5, and 60 poises.

The estimated viscosities of Arsia Mons flows are similar to the estimated viscosities of Martian lavas derived using the method of Shaw (3) together with the estimated chemical composition of Martian samples (1,2).

The estimated viscosities of Martian lavas are lower than those for the Moon, and much lower than those for the Earth. Martian volcanoes are much larger structures than terrestial volcanoes and probably represent a special style of volcanism. This style of volcanism could be understood better if on Mars the efussion rates for some of the large volcanoes were much larger and the viscosities were much lower than for terrestial volcanoes. Also very low viscosities and large efussion rates might explain the large fluvial features on Mars (1,7,2,8).

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