ESTIMATES OF RHEOLOGIC PROPERTIES FOR FLOWS ON THE MARTIAN VOLCANO OLYMPUS MONS. James R. Zimbelman (Center for Earth and Planetary Studies, National Air and Space Museum, Smithsonian Institution, Washington, D.C. 20560) and Jonathan H. Fink (Department of Geology, Arizona State University, Tempe, Arizona 85287)

Flow morphology is presently the only source of data that can provide estimates on the rheologic properties of lava flows observed on Mars. The values calculated from flow dimensions can only be considered to be 'order of magnitude' estimates of the actual rheologic parameters but even then the values can provide useful constraints on the martian flows. Here we list yield strengths and viscosities calculated for five flows on and adjacent to the southern flank of Olympus Mons, the largest of the shield volcanoes in the Tharsis province of Mars. Two flows are on the lower flank of the volcano (A and B), just above the basal scarp, and three flows are on the plains immediately adjacent to the basal scarp (C, D, and E) at varying distances from the foot of the scarp (Fig. 1). Measurements were made only of flows with well defined margins at locations where the flow thickness could be obtained from shadow lengths. Locations of measurements are referenced to the flow termination (toe) since none of the flow source areas were visible due to the extensive intermixing of flows. The complex assemblage of flows made relatively few flows suitable for measurement along a significant portion of their length. The calculated values are all comparable to results for flows on Ascraeus Mons (1), Alba Patera (2,3), and Arsia Mons (4), generally consistent with the properties associated with basaltic or basaltic andesite lavas. The calculated values do not show a consistent longitudinal trend along all of the flows, as was observed for flows on Ascraeus Mons and Kilauea (5), but this is most likely the result of the increased uncertainties in the measured flow dimensions on Olympus Mons (one pixel variation corresponds to + 30 meters for horizontal measurements and + 10 meters for heights obtained from shadow measurements).

REFERENCES: 1) J.R. Zimbelman, Proc. LPSC 16th, J. Geophys. Res. 90, D157-D162, 1985. 2) P. Cattermole, Proc. LPSC 17th, J. Geophys. Res. 92, E553-E560, 1987. 3) S.M. Baloga and D.C. Pieri, NASA TM-87563, 245-247, 1985. 4) H.J. Moore et al., Proc. LPSC 9th, 3351-3378, 1978. 5) J.H. Fink and J.R. Zimbelman, LPS XIX, 327-328, 1988.

RHEOLOGIC PROPERTIES FOR FLOWS ON OLYMPUS MONS

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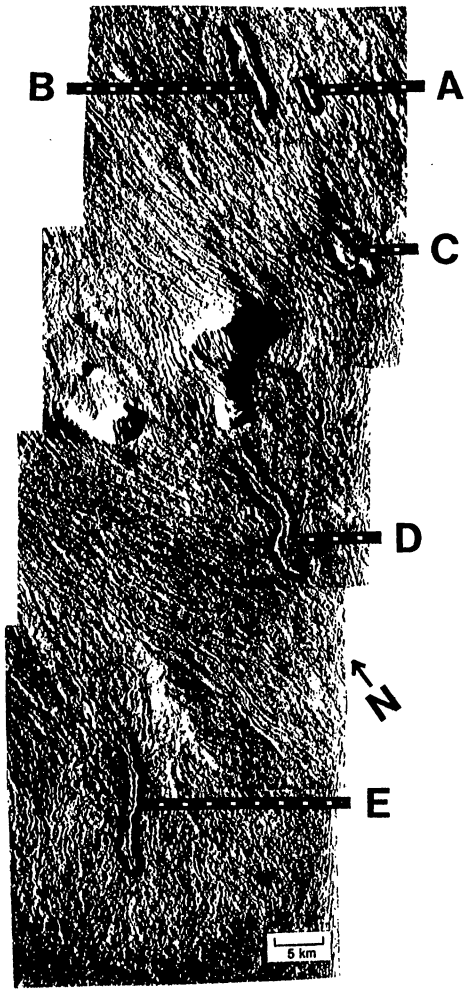

Figure 1. Five lava flows from Olympus Mons (A-E) for which rheologic properties have been calculated (Frames 468S35-41).

Loc.	Y1	Y2 (Pa)	Y3	V1	V2 (Pa-s)	V3	D (m)
A1	4.3E4	2.3E4	0	0	0	0	150
A2	4.3E4	1.8E4	8.0E4	1.7E7	7.2E6	3.2E7	800
A3	4.3E4	3.1E4	4.1E4	1.2E7	8.2E6	1.1E7	1250
A4	4.3E4	3.0E4	4.8E4	7.0E6	4.8E6	7.8E6	1950
A5	4.3E4	2.6E4	5.2E4	1.2E7	7.0E6	1.4E7	2400
A6	4.3E4	2.8E4	4.4E4	1.7E7	1.1E7	1.8E7	3300
B1	1.2E4	2.1E3	0	0	0	0	450
B2	1.2E4	1.2E3	0	0	0	0	800
B3	1.2E4	3.0E3	0	0	0	0	1300
B4	1.2E4	4.3E3	2.4E4	1.7E5	6.0E4	3.3E5	1550
B5	2.5E4	9.5E3	2.7E4	6.7E6	2.1E6	7.5E6	2250
B6	1.2E4	1.9E3	0	0	0	0	3200
B7	2.5E4	1.0E4	0	0	0	0	3950
B8	3.7E4	3.0E4	3.2E4	2.6E6	2.1E6	2.2E6	4650
B9	1.2E4	2.3E3	0	0	0	0	6000
B10	2.5E4	1.3E4	0	0	0	0	6400
B11	2.5E4	7.2E3	0	0	0	0	8050
B12	2.5E4	5.2E3	0	0	0	0	10100
B13	2.5E4	7.5E3	5.7E4	3.1E6	9.6E5	7.3E6	10900
C1	2.6E4	1.2E4	0	0	0	0	800
C2	1.7E3	4.8E3	0	0	0	0	2300
C3	8.6E3	1.1E3	0	0	0	0	3600
C4	8.6E3	9.1E2	1.4E4	8.7E6	5.2E5	1.6E7	4950
C5	8.6E3	8.8E2	3.4E4	4.6E6	2.7E5	2.9E7	6000
C6	8.6E3	6.3E2	8.8E4	2.8E6	2.1E5	2.9E7	6700
D1	3.2E3	5.2E2	0	0	0	0	1700
D2	3.2E3	6.9E2	0	0	0	0	3300
D3	3.2E3	7.7E2	0	0	0	0	4000
D4	3.2E3	1.0E3	4.8E3	9.5E4	2.3E4	1.6E5	4600
D5	3.2E3	1.2E3	4.4E3	6.8E4	2.5E4	9.5E4	5200
D6	3.2E3	1.2E3	4.1E3	7.2E4	2.1E4	1.0E5	5800
D7	3.2E3	1.5E3	0	0	0	0	9000
D8	6.3E3	4.0E3	7.0E3	1.4E5	8.9E4	1.6E5	10300
D9	6.3E3	4.7E3	4.4E3	2.7E5	2.0E5	1.9E5	11250
E1	7.0E3	1.1E3	2.9E4	4.8E5	7.7E4	2.0E6	350
E2	7.0E3	6.6E2	5.5E4	7.4E5	7.0E4	5.9E6	2450
E3	7.0E3	6.6E2	5.5E4	7.4E5	7.0E4	5.9E6	4200
E4	7.0E3	8.3E2	4.6E4	3.6E5	4.2E4	2.4E6	5050
E5	7.0E3	9.8E2	2.9E4	9.1E5	1.3E6	3.8E6	6500
E6	7.0E3	1.3E3	2.4E4	3.6E5	6.8E4	1.2E6	7150
E7	7.0E3	1.4E3	2.2E4	3.6E5	7.1E4	1.2E6	7850
E8	1.4E4	5.6E3	2.0E4	1.9E6	7.7E5	2.7E6	8650
E9	7.0E3	1.5E4	1.7E4	5.9E5	1.2E5	1.4E6	10000

Location indicates an individual set of measurements taken along the flow at a specified distance (D) upslope from the toe (termination) of the flow. Y = yield strength, V = viscosity; values are calculated according to three equations for yield strength, given in (1). If a central levee was not visible at the location, Y3 and all viscosity values could not be determined (shown as 0 above). Values are expressed in exponential form (i.e., 1E4 = 10000).