MAUNA LOA 1950 SULFUR FLOW AS AN ANALOG FOR FUMAROLIC FLOWS ON IO

Ronald Greeley, Eilene Theilig, and Philip Christensen, Department of Geology, Arizona State University, Tempe, AZ 85287.

The composition of flows on Io is subject to speculation. Lava flows on Io exhibit features typical of silicate flows on Earth and estimates of the material properties of ionian features also suggest silicate compositions (1). On the other hand, spectral measurements indicate the presence of sulfur and/or sulfur-rich compounds, although the spectral data apply only to the upper few millimeters and the sulfur may be only a "sprinkling" of material over silicate flows. One approach to address the question is through flow morphology; because of the unusual rheological properties of sulfur (it becomes less viscous as it cools through the range of 200° to 160°C), distinctive landforms may develop in sulfur flows. Natural sulfur flows are rare on Earth (2,3); however, the 1950 sulfur flow of Mauna Loa, Hawaii, is well-preserved and relatively accessible (4). The flow occurs on the western side of Sulphur Cone, a cinder-and-spatter cone at the 11,200' level on the southwest rift of Mauna Loa. The flow is about 27 m long, 14 m wide, ranges in thickness from 10 to 45 cm, and was derived from secondary (fumarolic) sulfur deposits which were presumably mobilized by heating related to the 1950 Mauna Loa eruption. Fumarolic sulfur deposits are common throughout this part of the rift zone, and the loose talus on the flank of Sulphur Cone is ideal for fumarolic accumulation. Sulfur becomes relatively fluid at its melting point (~115°C) and given typical basalt flow temperatures of >1000°C, it is reasonable to expect mobilization of the sulfur, even if it is not in direct contact with the lava. Moreover, several segments of the rift pass directly through the cone and it is reasonable to expect heating above the sulfur liquidus. The Mauna Loa sulfur flow is fan-shaped with the apex pointing toward the apparent source in the talus. Flow surface features include sheet flows, a leveed channel, and numerous flow lobes 1 to 10 cm wide, a few cm to 50 cm long, and up to 2 cm thick. The flow lobes are overlapping and anastomosing in a pattern suggesting repeated outflow from the source area. Most of the flow lobes occur in the upper (near-source) 1/3 of the flow; in the lower part of the flow, the lobes give way to a knobby texture. A small lava tube ~30 cm in diameter is exposed along this margin; unfortunately, a talus block has broken the roof and the full extent of the tube cannot be determined. The tube appears to have fed a small flow lobe measuring 4 m long by 2.5 m wide.

Several areas on Io display zones that are markedly lemon-yellow, here designated LYA (lemon yellow areas). Even though the colors seen on Voyager images are dependent upon image processing, the color of these areas is generally not as "white" as inferred SO_2 frost deposits, nor as orange, red, or brown as the flows which make up the volcanoes. LYA typically occur around the margins of flow lobes in areas of presumed lower topography, as "pockets" within rough-textured flows, and on the floors of some calderas. None of the LYA show topographic relief, although relief of many meters would not be resolvable on Voyager images. Unlike the inferred SO_2 frost deposits which have diffuse outer boundaries, LYA form sharp contacts with the surrounding terrain. In some cases, the areas occur as discontinuous patches on the surfaces of irregular, darker flows, suggesting derivation from local sources.

MAUNA LOA 1950 SULFUR FLOW AS AN ANALOG FOR FUMAROLIC FLOWS ON IO

R. Greeley et al.

Despite the fact that the entire Mauna Loa sulfur flow is smaller than a single Voyager image resolution element (pixel) on Io, some of the geological relationships observed in the flow may apply in considering volcanic processes on Io:

1. Given the presence of sulfur/sulfur compounds indicated by spectral data, it is likely that extensive secondary deposits of sulfur exist, some of which may be fumarolic and analogous to the Mauna Loa flow.
2. Given the likelihood of silicate volcanism of Io based on the inferred material properties of some flows and the attendant high temperatures for silicate volcanism, it is likely that the secondary sulfur deposits would be melted and mobilized.
3. Mobilized sulfur flows on Io may flow long distances as a result of: a) low viscosities in the low-temperature melting range, b) sustained effusion resulting from continued heating of the source area, c) relatively low heat-loss in the ionian environment (5).
4. Sulfur flows may form a relatively thin veneer over silicate flows and other surface units, given their fluidity and low melting temperature. Such flows would pond in low areas and form sharp contacts. Furthermore, the flows would be expected around the margins of other flows where secondary sulfur might have accumulated.

REFERENCES

1. Clow, G.D. and M.H. Carr, 1980, Icarus, 44, 268-279.
2. Theilig, E., 1982, NASA CR 3594, 34 pp.
3. Watanabe, T., 1940, Japanese Jour. of Geology and Geography, 17, 289-310.
4. Skinner, B.J., 1970, Pacific Science, 24, 144-145.
5. Fink, J.H., S.O. Park, R. Greeley, 1983, Icarus, 56, 38-50.