DO LAVA FLOWS ERODE? PRELIMINARY ASSESSMENT; R. Greeley, R.S. Harris, S.D. Kadel, D.A. Williams, *Dept. of Geology, Arizona State University, Tempe, AZ 85287-1404*, J.E. Guest, *University of London Observatory, London NW7 4SD, England*

Summary. In the last decade or more, numerous studies have invoked erosion by flowing lava to explain various geological features on Earth and other planets. For example, economic deposits of NiS ore found in komatiite lavas were attributed to erosion of pre-flow, sulfur-rich sediment and assimilation into the high temperature, turbulently flowing lavas during emplacement [1]. In the planetary context, calculations were made to suggest that thermal melting of lunar crust by mare lavas could account for sinuous rilles [2, 3]; similarly, thermal erosion was used to explain the large sizes of lunar rilles by considering possible rates of effusion and vent geometry [4, 5, 6]. More recently, the discovery of long (>5000 km) channels on Venus that are inferred to be of volcanic origin has prompted consideration of thermal erosion by a variety of eruptive materials [7, 8, 9]. However, despite the frequent reference to erosion by lava flows in these models, little evidence is cited that flows actually do erode. Our analysis of "sheet flows" (komatiites and flood lavas) and lava tubes on Earth shows some local erosion, but thus far in the study, such erosion appears to be relatively limited.

Our goal is to collect field evidence for erosion by lava and where evidence is found: [1] determine the extent of the erosion, [2] assess the conditions favorable for erosion, and [3] use the results to constrain analytical models of lava erosion. Moreover, we hope to be able to distinguish thermal from mechanical erosion and to assess their relative importance. Two general environments are considered, erosion along the bases of sheet flows and erosion associated with channelized and tube-fed flows.

Sheet flows

The most likely candidates for erosion by sheet flows are lavas that were erupted at high temperatures and high rates of effusion, such as flood basalts and komatiite flows. In order to assess possible erosion, several kilometers of the lower contacts of flood basalt flows in the Columbia River Plateau were examined for evidence of downcutting into the underlying rocks and incorporation of pre-flow materials into the lavas. Except for an exposure near Soap Lake, Washington, where minor amounts (a few tens of cm) of pre-flow material were incorporated into the flow, little evidence of erosion could be found.

Komatiite lavas are ultramafic flows erupted primarily during the Archean and are considered to have produced very high temperature, perhaps turbulently flowing masses [10]. Although most komatiite flows are severely altered, localities in Canada and Australia include flow contacts that were examined for erosion. Evidence of possible erosion includes: truncation of horizontal rock units by channelized komatiite flows in the Abitibi belt, Ontario [11], and small amounts of entrained substrate fragments and geochemical anomalies suggestive of assimilation of substrate by flowing komatiite lava in the Yilgarn Craton, Western Australia [12, 13].

Tube-fed flows

In contrast to sheet flows, more definitive evidence for erosion by lava is found in association with basaltic lava tube flows. Several segments of the Ape Cave lava tube system on the southern flank of Mount St. Helens show undercutting of the pre-flow terrain by the lava tube [14]. Evidence is found for both mechanical erosion (evidenced by inclusions of pre-flow country rock incorporated into the flow) and a single occurrence of thermal erosion (a partly melted block of dacite). In general, sites of erosion occur in segments of the lava tube that have steeper flow gradients than elsewhere. Other localities of erosion by lava tube flows include northern California and possibilities in Hawaii, Idaho, and Iceland. In addition, at least two active flows in Hawaii suggest erosion through tubes, the Mauna Ulu flows in the early 1970s [15] and the current activity in Kalapana on the East Rift zone of Kilauea [16].

Preliminary conclusions suggest that erosion by sheet flows is very limited. Erosion by tube-fed flows appears to occur under some circumstances, but at this time the extent of erosion is not known. Ongoing work involves correlation of sites of erosion with local geological setting. Results from this study will be combined with the development of analytical models [17] and physical models [18].

REFERENCES:

[1] Naldrett, A.J. (1981), *Econ. Geol. 75th Anniversary Volume*, 628-685. [2] Hulme (1973), *Modern Geology, 4*, 107-117. [3] Carr, M.H. (1974), *Icarus, 22*, 1-23. [4] Head, J.W. and L. Wilson (1980), *LPSC 11*, 426, 428. [5] Wilson, L. and J.W. Head (1980), *LPSC 11*, 1260-1262. [6] Head, J.W. and L. Wilson (1981), *LPSC 12*, 427-429. [7] Baker et al. (1993), *J. Geophys. Res., 97*, 13,621-13,644. [8] Komatsu et al. (1993), *Icarus, 102*, 1-25. [9] Gregg and R. Greeley (1993), *J. Geophys. Res., 98*, 10,873-10,882. [10] Arndt, N.T. and E.G. Nisbet (1982), *Komatiites*, Allen and Unwin: London. [11] Davis et al. (1993), *GSA Abstracts with Programs, A-600.* [12] Barnes, S.J. et al. (1988), *J. Pet., 29*, 305-331. [13] Perring, C.S. et al. (1993), *IAVCEI* (abstract), 86. [14] Greeley, R. (1987), *U.S. Geol. Sur. Prof. Pap. 1350*, 1589-1602. [15] Tilling, R. et al. (1987), *U.S. Geol. Sur. Prof. Pap. 1350*, 405-469. [16] Jackson, D.B. et al (1987), *EOS, 68*, 1543. [17] Williams and Greeley (this issue). [18] Challis et al. (this issue).