ANALYSIS OF HAWAIIAN LAVA SURFACE ROUGHNESS WITH THERMAL INFRARED IMAGES; Scott R.K. Moncrief* & Scott K. Rowland. Planetary Geosciences Divn., Dept. Geology & Geophysics, SOEST, Univ. Hawaii, Honolulu, Hawaii, 96822. *Hawaii Space Grant College Undergraduate Fellow.

INTRODUCTION: We have used airborne Thermal Infrared Multispectral Scanner (TIMS) images to study the physical properties of Hawaiian lava flows. Preliminary observations indicate that there is an inverse relationship between the surface roughness of a lava flow and the contrast intensity (DN) value in a TIMS image. We compared the TIMS data to our own measurements of surface rms slope (obtained by using a field roughometer) for two lava flows. This study shows that the Thermal Emission Spectrometer (TES) planned for the Mars Observer may allow inference of surface roughness and hence the eruptive processes, of Martian volcanoes.

THERMAL IR DATA: The TIMS images (~10 m resolution) for Hawaii were collected by the NASA C-130 aircraft in November of 1985. These data cover the spectral range 8.2 - 11.7 μm in six broad channels [1]. Imaging was conducted between 11:50 a.m. and 12:10 p.m. Because of the diversity of lava flow types and their field accessibility, we selected a study site 7 km x 10 km in size on the NE rift zone of Mauna Loa at ~2000 m elevation. We observed that bright areas correspond to pahoehoe (smooth) and dark areas to a'a (rough), this contrast is most prominent at 11.4-11.7 μm (TIMS band 6).

Differences in mineralogy and surface lichen cover were also considered as causes of variable DN values of the lava flows at 11.4-11.7 μm. The olivine phyric 1952 flow has at least 3 surface types within the study area; a'a, tube-fed pahoehoe, and channel-overflow pahoehoe. The aphyric 1942 and 1984 flows are similar to each other in that they exhibit proximal and distal types of a'a surfaces [2]. In the TIMS band 6 images, both of the 1852 pahoehoe types were extremely bright, whereas the 1852 a'a was difficult to distinguish from both the 1942 and the 1984 a'a. This is despite the fact that the lichen cover (increasing with flow age from 1984 to 1942 to 1852) and mineralogies were different. It is apparent that the surface roughness affects DN to a greater extent than mineralogy or lichen thickness.

TOPOGRAPHY MEASUREMENTS: At sites representing a range of DN values, surface roughness was quantified using a field roughometer. The roughometer is similar in design to the "template" of previous surface-roughness studies [3]. At four locations, 14-meter profiles were sampled at a spacing of 2 cm. The data were filtered to remove the mean gradient across each profile, and the rms height and the correlation length were calculated using established techniques[4] from the slope-corrected data. No wavelength-dependent filtering was applied. Both of the a'a sites have a considerably higher rms slope than the pahoehoe lavas. These values were compared to the mean DN at each location (Table 1).

CONCLUSIONS: The relationship between the DN values in thermal images and surface roughness appears to be a useful method for investigating the distribution of lava flow types. This relationship may prove to be particularly helpful for the investigation of volcanic terrains on other planets. For example, the TES instrument on the Mars Observer will allow for determination of the surface characteristics of Martian lava flows. Since flow morphology is indicative of eruptive characteristics [5], this will provide important information about the eruptive histories of the volcanoes on Mars.

REFERENCES: [1] Kahle A et al. (1988) JGR 93: 15,239 - 15,251. [2] Rowland SK & Walker GPL (1987) Bull. Volcanol. 49: 631-641. [3] Gaddis LR et al. (1990) Photogram. Eng. Rem. Sen. 56: 211 - 224. [4] Campbell B et al. (1989) Rem. Sen. Environ. 30: 227 - 237. [5] Rowland SK & Walker GPL (1990) Bull. Volcanol. 52: 615-628.

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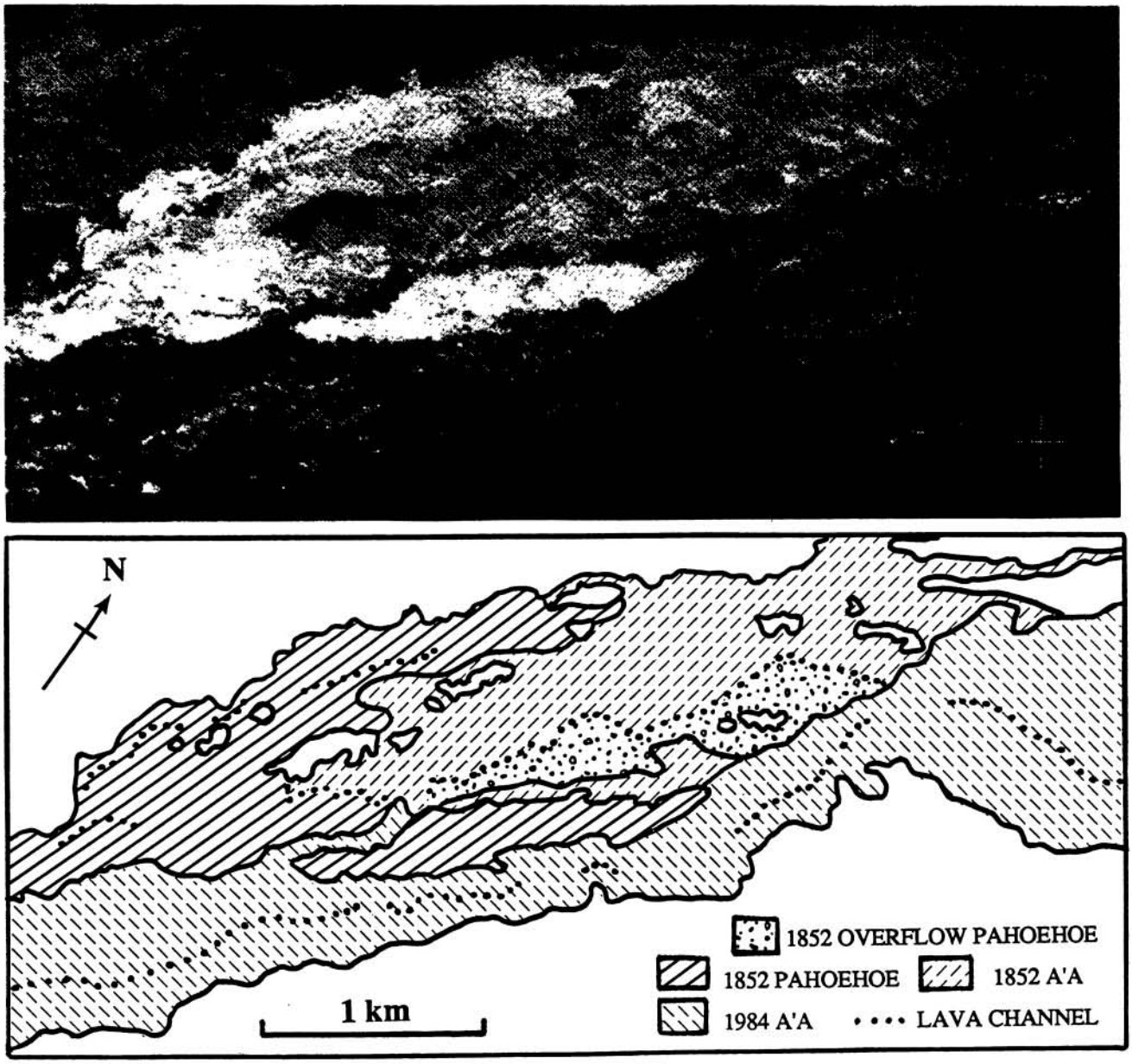

FIGURE 1: (Top) TIMS Band 6 image of Mauna Loa lava flows on NE Rift Zone studied here. (Bottom) Sketch map showing distribution of lava flow types seen in TIMS Band 6 image.

Location	rms height (cm)	corr. length (cm)	rms slope (deg.)	mean DN
1) Site 1 a'a	12.33	17.78	34.74	145 ± 9.9
2) Site 2 a'a	11.01	15.24	35.84	137 ± 2.3
3) Channel-overflow pahoehoe	06.29	116.84	03.08	167 ± 12.0
4) Tube-fed pahoehoe	12.05	86.36	07.43	175 ± 5.6

TABLE 1: TOPOGRAPHIC DATA FOR LAVA FLOWS STUDIED ON MAUNA LOA

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