AIRCRAFT RADAR ANALYSES OF FLOW TEXTURES AND AEOLIAN MANTLING DEPOSITS, PISGAH, CA; *L. R. Gaddis and R. Greeley, Department of Geology, Arizona State University, Tempe, AZ 85287*

Analyses of radar data acquired by the NASA/JPL polarimetric Airborne Synthetic Aperture Radar (AIRSAR) for the Pisgah lava field permit mapping of lava flows and aeolian mantling deposits based on the radar response to variations in surface roughness. As part of the Mojave Field Experiment (1), the AIRSAR measured scattering matrices at 3 wavelengths (P:68 cm, L:24 cm, C:6 cm) and at multiple angles of incidence (~20° to 50° across an image). From the scattering matrices, images with a variety of polarizations may be synthesized (2,3). For this analysis, images with a resolution of ~10 m at direct (HH, VV) and cross (HV=VH) polarizations were examined. The goal is to determine the best configuration of imaging radar parameters for: (a) mapping lava flows with a variety of surface textures; (b) assessing the effects of aeolian mantling deposits on lava flow discrimination; and (c) mapping and (d) estimating the thickness of aeolian mantling deposits. The results of this study have implications for geologic mapping of terrains influenced by volcanic and aeolian processes using data such as those to be acquired for Earth by SIR-C and EOS and for Venus by Magellan.

Fig. 1 shows the distribution of Quaternary basaltic lava flows and Recent aeolian mantling deposits at Pisgah. Lava was erupted in three phases: Phase I produced thin (~1 m), flat-surfaced, "platform" pahoehoe; Phase II produced aa flows up to ~5 m thick and local patches of smooth pahoehoe; Phase III lavas mostly formed pahoehoe, with tumuli and pressure ridges up to 5 m high and smoother "platforms" (4). Parts of all flows are mantled by aeolian sediments deposited by the prevailing westerly winds. Although their thicknesses have not been mapped in detail, mantling units range from <1 cm to >1 m in thickness.

Comparison of radar responses to volcanic and aeolian units at 3 wavelengths and at HH and HV polarizations shows that unit discrimination is related to surface texture. The P- and L-band data show a greater sensitivity to larger-scale (>20 cm) roughness in the flow (tumuli, pressure ridges), whereas C-band data show a bright response due to more uniform small-scale (≤10 cm) roughness. The direct-polarized backscatter is due to single-reflection response to surface or volume scatterers of a size comparable to that of the radar wavelength, and the cross-polarized radar backscatter results from multiple surface or volume scattering at a range of roughnesses (5).

A greater variation in image brightness is observed among all units on the HV images (Fig. 2). Lava flows are generally bright at HH and HV polarizations and at all 3 wavelengths. Most of the smoother alluvial fan and playa surfaces are dark on P- and L-band HH and HV images. Only the playa surface is dark at C-band wavelength at HH and HV polarizations. On HH images, moderate variations in image brightness on the P-, and L-band data are observed but the flow surface is almost uniformly bright on the C-band image, indicating that most units are rough at 6-cm wavelength (C-band). The only generally unmantled lava flow surfaces that have moderately low returns at P- and L-band and lower-than-average returns at C-band are those of the platform pahoehoe flows of Phases I and II (near Lavic Lake playa), and III (near the flow center). These smooth surfaces may act as specular reflectors at the longer P- and L-band wavelengths, and as relatively smooth diffusely scattering surfaces at the C-band wavelength. Although in the P-band HV and HH images the brightest radar units (e.g., the aa of Phase II; tumuli of central Phase III) do correspond to the rougher parts of Phase II and III flows, it is difficult to distinguish these flow types based on their P-band radar brightness. The larger scale of roughness and texture that the P-band radar is responsive to may be comparable on these different lava flows. A similar effect is observed in the L-band HH image in which the rougher flow parts are almost uniformly bright and thus are difficult to separate. However, on the L-band HV image, we see the clearest separation of different flow surface textures [e.g., the boundary between the very rough (bright) aa of Phase II and the moderately bright pahoehoe tumuli of Phase III lavas are separable in the flow center]. The increased discrimination of lava flow units on the HV L-band image is attributed to the variation in size and spacing of multiple scatterers such as tumuli, pressure ridges, and aa clinker on the surfaces of these different flow units.

Many of the aeolian mantling deposits on the western margin of Pisgah are seen as darkened areas at all 3 wavelengths and at HH and HV polarizations (Figs. 1, 2). Detailed examination of

RADAR ANALYSES OF PISGAH: Gaddis L.R. and Greeley R.

color overlays of these data shows that penetration of the aeolian mantles may be occurring. For example, areas along the southern flow margin and west of Pisgah Crater show high backscatter at P-band wavelengths, suggesting that this longer wavelength radar is passing through the mantling material to reflect off of the underlying lava surface. Additional areas west and southwest of Pisgah Crater show moderately high backscatter at both P- and L-band, suggesting that both the 70-cm and 25-cm radar penetrates mantling material. These observations imply that mantling material is thickest (~50 to 70 cm) along the southern margin and in places on the central portion of the flow, of moderate thickness (~20 to 50 cm) west of the cone, and thinnest (~<20 cm) elsewhere along the margin of the flow.

Increased discrimination among lava flows is observed in the cross-polarized radar images due to their greater sensitivity to surface structure than to average roughness. At P-band wavelength, observed flow textures do not correspond well with mapped flow boundaries. At the L-band wavelength, the greatest discrimination among mapped flow textures is observed. At C-band wavelength the lava flow surface is ~uniformly bright, inhibiting flow discrimination. L-band cross-polarized data is best for discriminating lava flow textures at Pisgah. Aeolian mantling deposits are observable as darker areas at all three wavelengths used here. Detailed observations of radar backscatter along the flow margins permit use of the penetration capability of radar to estimate the thickness of the mantling deposits.

References: (1) Wall, S. *et al.*, 1988, *Bull.Am.Astron.Soc.*, 20 , 809; (2) Zebker, H.A. *et al.*, 1987, *JGR*, 92, 683.; (3) van Zyl, J.J. *et al.*, 1987, *Radio Sci.*, 22, 529; (4) Wise,W.S., 1966, *NASA TL 11*, 8 pp; (5) Fung, A.K. & F.T. Ulaby, 1983, *Man. Rem. Sen.*, 115.

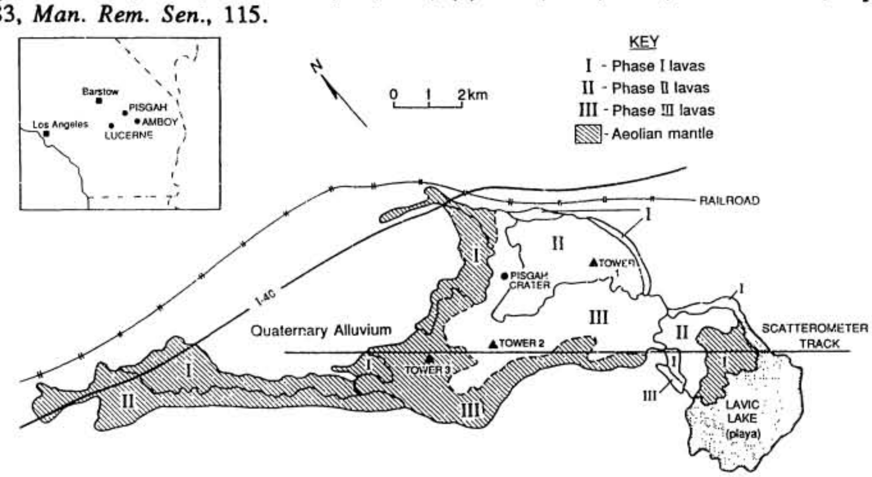

Fig. 1

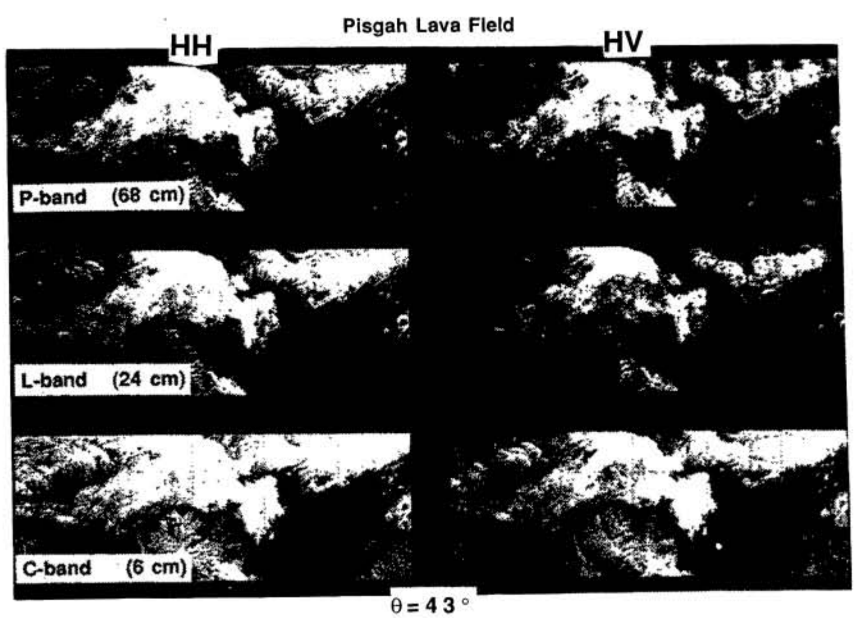

Fig. 2