RADAR BACKSCATTER CHARACTERISTICS OF BASALTIC FLOW FIELDS: RESULTS FOR MAUNA ULU, KILAUEA VOLCANO, HAWAI'I. Jeffrey M. Byrnes[1] and David A. Crown[2], [1]*Department of Geology and Planetary Science, University of Pittsburgh, Pittsburgh, PA, 15260-3332, jbyrnes@ivis.eps.pitt.edu;* [2]*Planetary Science Institute, Tucson, AZ, 85719-2395, crown@psi.edu*

Introduction: This study is part of an ongoing field and remote sensing analysis of the development of basaltic flow fields on planetary surfaces. On Earth, basaltic flow fields are emplaced in a complicated sequence of interfingering and overlapping lava flows and tubes, resulting in composite surfaces of numerous flow units emplaced in different styles and at different times during flow field evolution. Previous analyses of the Mauna Ulu flow field (Kilauea Volcano, Hawai'i) have related emplacement parameters, such as flow regime and surface crust spallation, to visible- and thermal-wavelength characteristics [1-2]. The objective of the current research is to relate radar backscatter characteristics to flow field surface characteristics to allow the distribution of different emplacement and modification processes to be mapped, analyzed, and used to constrain flow field evolution.

Background: The current investigation explores relationships between radar backscatter, primary flow unit morphologies, and secondary unit modification. The primary unit morphologies considered herein include 'a'a, pahoehoe sheets, networks of pahoehoe toes, locally late-stage toe breakout lobes, remobilized pahoehoe (transitional to 'a'a), and surface-fed pahoehoe, which primarily represent differences in local supply rate, lava rheology, and driving force [e.g. 1-6]. Secondary unit modification occurs by processes such as lava flow inflation and deflation, each of which may produce cracking and/or foundering of the surface crust at a variety of scales [4,7-8]. The primary surface morphologies listed have been previously described in terms of their visible- and thermal-wavelength characteristics and found to be distributed relative to their position within the flow field (relative to the vent and the flow field margins), their local temporal sequence of emplacement, and with respect to the pre-eruption topography [1-2]. Previous considerations of post-emplacement modification that affects topography (i.e. inflation and deflation) have primarily been limited to collapse of surface-fed shelly pahoehoe [e.g. 4] and overall inflation of tube-fed pahoehoe [e.g. 9-10] without respect to specific pahoehoe morphologic varieties.

Approach: In order to understand what information radar backscatter data can provide concerning lava flow field development, we have utilized airborne radar data with complementary field measurements and observations to characterize Mauna Ulu flow field surfaces. AIRSAR (airborne Synthetic Aperture Radar [11-12]) data were acquired in TOPSAR (topographic Synthetic Aperture Radar) mode during the PacRim II (2000) mission. In order to run the AIRSAR instrument in TOPSAR mode, some of the polarimetry data is sacrificed, so full wavelength-polarization combinations are not available. Analysis of L-band (24-cm wavelength) data at HH (horizontal transmit-horizontal receive), VV (vertical transmit-vertical receive), and HV (horizontal transmit-vertical receive) polarizations and C-band (5.7-cm wavelength) data at VV polarization was conducted in order to compare different polarization combinations at a given wavelength and different wavelengths of a given polarization combination

Field investigations were made to complement the radar data analysis, including a qualitative description of study site exposure surfaces at the centimeter- to meter-scale. Quantitative topographic characterization included measurement of the maximum relief displayed over a 1-m horizontal distance within each unit and GPS/laser rangefinder profiles of selected sites to provide a measure of topographic variability. Each pahoehoe unit was also characterized in terms of the degree of fracturing and apparent inflation that had occurred at the scale of toes (small-scale), small

lobes and channels (intermediate-scale), and large lobes and tumuli (large-scale).

Results and Significance: Radar backscatter analysis for the various lava surfaces indicate that Mauna Ulu flow units display backscatter variations that can be correlated with characteristics observed in the field. The surface units display different mean radar backscatter values, and the surface units display similar overall discriminability between the two wavelengths and between the three polarizations of L-band data based on mean unit backscatter statistics. One interesting anomaly is a wavelength-dependent change in relative roughness of remobilized pahoehoe and surface-fed pahoehoe, with the remobilized pahoehoe appearing rougher at 5.7 cm and smoother at 24 cm in comparison to surface-fed pahoehoe. These two units are the roughest of the pahoehoe morphologies examined due to post-emplacement modification in the form of crust collapse (surface-fed shelly pahoehoe) and remobilization. The difference in roughness suggests that remobilized pahoehoe has a characteristically smaller fragmentation size, consistent with previous descriptions that this flow morphology is transitional to 'a'a [1-2].

Standard deviations of the radar backscatter data are highly variable between the various wavelengths and polarizations. Sampled 'a'a surfaces are notably more homogeneous than the pahoehoe surfaces, but no clear relationships exist among the pahoehoe units. The heterogeneity identified among the pahoehoe surfaces suggests that radar texture analyses may be more effective for unit classification than simply using backscatter values.

Field relationships indicate that the units display a wide range in measured decimeter- to meter-scale topography as well as in the degree and scale of surface fracturing and flow inflation, and that these parameters are correlated with each other, suggesting that they are representative of local supply conditions within the Mauna Ulu lava tube system during and after primary flow emplacement. One notable exception is the high degree of fracturing associated with shelly pahoehoe, which represents lava flow deflation rather than inflation.

Differences in mean radar backscatter between the pahoehoe units suggests that certain styles, scales, and/or extents of post-emplacement modification may be characteristically associated with each of the pahoehoe surface units. This is consistent with the field measurements, which indicate that maximum surface relief is correlated with primary unit morphology. However, the field relationships also indicate that the topographic signature of the post-emplacement modification is often greater than that associated with the primary unit morphology. This indicates that it is difficult to distinguish various pahoehoe morphologies based strictly on radar remote sensing data. However, the analyses also suggest that if independent information is available on which primary flow morphologies may be assessed (such as visible [1] or thermal [2] remote sensing data), then radar backscatter may be used to constrain secondary modification of those units.

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