AIRCRAFT IMAGING RADAR DATA OF HAWAII: A POTENTIAL MAGELLAN ANALOG;
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The Magellan radar has already returned spectacular images of geological features on Venus. From these images it is clear that volcanism has played a significant role in modifying the surface, with numerous types of lava flows and volcanic constructs identified. Our understanding of volcanism and other geologic processes on Venus will undoubtedly be improved via quantitative studies of the Magellan radar and altimetric data. The Magellan SAR produces images at 12.6-cm wavelength, 18 - 50^{o} incidence angle (dependent upon the latitude of the target), and HH-polarization [1]. As a result, the complete radar scattering behavior of the surface cannot be determined for any one area of the planet, either in terms of the polarimetric response of the surface or the variation of radar backscatter as a function of incidence angle. One way of investigating the possible surface morphologies that are responsible for the radar characteristics seen by Magellan is to compare these venusian data with terrestrial analogs. As part of an up-coming Space Shuttle Imaging Radar (SIR-C) experiment that is due to fly in 1993, we have been analyzing quad-polarization, multi-wavelength, multi-incidence angle, multi-look direction imaging radar data for the Big Island of Hawaii. Although we are still at an early stage of our data reduction, it is clear that many of the radar images of Kilauea and Mauna Loa volcanoes will be relevant to the interpretation of volcanic terrains on Venus.

THE HAWAII DATA SET:

The Hawaii data were collected between August 2 - 8, 1990, using the JPL radar system flown onboard the NASA DC-8 aircraft. This radar collects data at three wavelengths (5.7, 24.0, and 68.0 cm) and preserves the entire radar polarization matrix (so that any combination of transmitted and received polarizations can be synthesized). Range resolution is about 3.3 m/pixel, and azimuth resolution is about 12.0 m/pixel. The range of incidence angles within a single scene is typically ~20 - 60 degrees, depending upon the specific geometry assigned for that data take. Swath width is about 10 km.

Approximately 30 flight lines of 70 km length and 10 flight lines of 35 km length were obtained over the volcanoes on the Big Island of Hawaii. Multiple flight lines were flown over Kilauea Volcano and the NE Rift Zone of Mauna Loa, wherein two pairs of three parallel flight lines (each off-set from its neighbor by ~2 km so that different incidence angles were obtained for the same target) were flown with at least two different look-directions. At least two data sets were also obtained for the summit of Mauna Loa, the 1984 Mauna Loa lava flows, the SW Rift Zone of Mauna Loa, the rift zones of Hualalai Volcano, the southern flanks of Mauna Kea (including many of the Quaternary cinder cones), the 1969 - 1974 Mauna Ulu flows (at three different look-directions), and the palagonite ash deposits at South Point. Data were also obtained in interferometric mode (P-band only) over the moving lava flows at the Kalapana coast in order to investigate the velocity flow-field of the surface flows.

PRELIMINARY INTERPRETATIONS:

To date, only data for the caldera of Kilauea Volcano and the Ka'u Desert have been processed at full resolution. Radar data for both of these areas show significant improvements over the earlier SIR-B Shuttle radar data collected in 1984 [2]. In the first of eight scenes collected for the Ka'u Desert, total power images show that the transition between pahoehoe and a'a on the December 1974 lava flow [3] can be seen to occur over a distance of ~2 km, with C-band data (5.7 cm) required to detect the smooth pahoehoe close to the vent at 42 - 57^{o} incidence angles. Flows from the northern rift of Mauna Iki volcano are also visible (at 50^{o} incidence angle) at L-band (24 cm), and then with increasing distance from vent become progressively rough at P-band (68-cm).

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At the summit of Kilauea Caldera, the September 1982 lava flow is only visible at C-band, while the 1924 boulder field around Halemaumau Crater can be seen at all three wavelengths (37^o incidence angle). Several of the 1974 pahoehoe flow units within the caldera are dark even at C-band and 43^o incidence angle. No returns from the 1790 or 1924 ash deposits within the Kau'u Desert can be observed at incidence angles of 35 - 45^o, although there is a very marked gradation (at 45^o incidence angle) in the returns from the ash deposits associated with the Devastation Trail area, which was created during the 1959 fire fountaining eruption of Kilauea Iki. In both the Kilauea Caldera and Ka'u Desert scenes, radar-facing scarps that are only 5 - 10 m high are clearly visible.

In conclusion, it is clear that the radar characteristics of many Hawaiian volcanic landforms can be investigated with the new DC-8 aircraft radar data set, particularly because the polarimetric properties of these landforms can be analysed. Furthermore, if Magellan is able to obtain multi-incidence angle data for individual targets during an extended mission, our Hawaii coverage may prove to be especially useful for interpreting the radar-scattering properties of diverse volcanic surfaces on Venus. Because of the range of radar roughnesses seen by the Pioneer Venus Orbiter for Eistla Regio, Beta Regio, Ishtar Terra and the rolling plains [4], a large number of terrestrial analog surfaces will have to be considered. By studying the "radar detectability" of subtly different volcanic features in Hawaii that were viewed at various incidence angles and viewing geometries, we therefore hope that we will be able to help constrain the nature of inter-unit differences observed in the Magellan data.

REFERENCES: [1] Saunders R.S. et al. (1990). JGR **95**, 8339 - 8356. [2] Gaddis L.R. et al. (1989) Geol. Soc. Amer. Bull **101**, 317 - 332. [3] Gaddis L.R. et al. (1990) Photogram. Eng. Rem. Sen. **56**, 211 - 224. [4] Pettengill G.H. et al. (1988) JGR **93**, 14,881 - 14,892.