

RADAR PROPERTIES IN THE EQUATORIAL PLAINS OF VENUS - INFLUENCE OF IMPACT, VOLCANIC AND TECTONIC FEATURES; J.J. Plaut, R.E. Arvidson, McDonnell Center for the Space Sciences, Department of Earth and Planetary Sciences, Washington University, St. Louis, MO 63130, E.R. Stofan, Jet Propulsion Laboratory, 4800 Oak Grove Drive, Pasadena, CA 91109, P.C. Fisher, Department of Geological Sciences, Brown University, Providence, RI 02912.

Early results from the Magellan mission have confirmed that approximately 80% of the surface of Venus can be characterized as plains (1). Many keys to understanding the geological evolution of the planet are expected to be recorded in the plains surfaces. Among the issues to be addressed are: can impact crater abundances and preservation states be used for relative and absolute age determinations?; can the superposition and degradation of volcanic deposits be used as a tool for reconstructing the geologic history of the plains?; how does the morphology of tectonic structures on the plains reflect the geologic history? In this study, preliminary Magellan data for a region in the equatorial plains are used to explore the influence of surficial processes and deposits on the full ensemble of measurements obtained by the Magellan radar system. Results indicate that impact ejecta can dominate the microwave signatures of broad areas and provide stratigraphic markers. Signatures of lava flows are highly variable, and are not necessarily correlated with ages. Tectonic structures in the plains have distinct signatures related to fracturing and mass wasting processes.

The data sets obtained by Magellan are the high resolution SAR image data, altimetry, and microwave radiometry of the surface (2). The radiometry data provide 20 km resolution emissivity estimates and the reduced altimetry data include estimates of the Fresnel reflectivity and rms slopes (at \geq meter scales), at approximately 10 km resolution. The SAR, emissivity and rms slope data are used here because they record three essentially independent physical properties of the surface. The SAR signature is dominated by roughness near the scale of the wavelength (12 cm); the emissivity is controlled primarily by the dielectric constant of the surface material, with a minor secondary roughness control; and the rms slope records the roughness at scales much larger than the wavelength. Figure 1 shows the SAR, emissivity and rms slope data for a region in the equatorial plains (-20° to 20° lat.) near the prime meridian. Parts of this region have been observed previously by the Goldstone ground-based radar (3), for which calibrated radar backscatter values have been derived (4). The area includes parts of Guinevere and Tinatin Planitiae, and lies between Eistla and Alpha Regiones. The 1000 km diameter corona Heng-O (3,4) lies near the center of the area. Other features include: about a dozen impact craters, several with dark margins, and two with prominent low emissivity parabola features (upper left and right; see 5,6); lava flows on the southern flanks of Sif and Gula Montes (upper part of frame); the northwestern edge of Alpha Regio tessera (lower right); and a region of quasi-circular "arachnoid" structures (lower left).

Impact craters with dark (SAR) margins in this area have a corresponding smooth signature in rms slope. On the other hand, an impact-related emissivity signature is seen only in the large low-emissivity features that extend west of small craters in the upper left and right of the frame. The crater NE of Heng-O is about 20 km in diameter, yet the parabolic feature extends over 900 km to the W, NW and SW. This signature dominates the emissivity of the northern 1/3 of the area, and a corresponding high reflectivity signature dominates the reduced altimetry reflectivity data (not pictured). The low emissivity deposit appears to overlie, and thus post-date, the deformed northern rim of Heng-O. The thinning north arm of the NW parabola may be related to later volcanic activity along the south margin of Sif Mons. Such observations may be used to place constraints on the timing of volcanic and tectonic events, relative to the impact events.

Lava flows in the region have variable radar signatures. Sif Mons flows in the upper part of the frame have generally bright signatures in the SAR. However, the emissivity and rms slope signatures are extremely variable. The low emissivities (high dielectric constants) on some flows may be due to mineralogical and/or porosity differences. The E-W trending low emissivity feature in the lower left of the frame corresponds to a SAR-bright fresh-looking volcanic field. The areas directly S and SW of Heng-O have fairly homogeneous signatures in SAR and emissivity, and low rms slopes. This combination of properties is consistent with an older plains surface, in which weathering, mass wasting and aeolian processes have smoothed the surface, and reduced its variability.

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Tectonic structures in the area display several types of signatures. In general, areas that are bright in SAR also show high rms slopes. However, the converse is commonly not true. For example, the portions of the Heng-O rim showing the highest rms slopes (N and NW parts) are relatively dark in the SAR. This suggests that the "fractal" behavior of roughness between wavelength and multiple-wavelength scales does not always hold. Several of the structures in the arachnoid area have high rms slopes, yet the bright SAR signature is more areally extensive. This may be caused by debris aprons surrounding uplifted structures that show a decreasing scale of roughness with distance away from the structure.

Future work on the radar signatures of the plains will include: the integration of calibrated Goldstone data with Magellan data; development of a coherent stratigraphy of plains deposits using impact and volcanic deposits; and development of models of the evolution of radar signatures as a function of surface exposure age.

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Figure 1. Magellan radar data for an area of equatorial plains (lat. -20° to 20° ; lon. 343° to 1° ; 4200 km top-to-bottom). Left to right: SAR, emissivity, rms slope. Emissivity values pictured range from 0.77 to 0.89; rms slope values from 0.2° to 4.8° . Heng-O corona is the large circular structure near center of frame.