NATURE OF THE LOW EMISSIVITY HIGHLANDS ON VENUS INFERRED FROM THE ANALYSIS OF MAGELLAN DATA: SAPAS, MAAT, AND OZZA MONTES;

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Magellan radar backscatter, emissivity, and altimetry data were examined for Sapas, Maat, and Ozza Montes, located in Atla Regio, Venus. These three volcanoes are well-suited for testing hypotheses concerning the nature and origin of the low emissivity highlands of Venus because they occupy 75% of the observed range of elevations on Venus (from 6051 to 6063 km) and contain volcanic flows with a range of ages (based on stratigraphic relationships). Analyses of these volcanoes suggest that a time-dependent process is responsible for microwave signatures. The general emissivity-elevation trends, including the presence of radar-dark summits, are consistent with a ferroelectric phase being present.

Background. A dominant characteristic of Venus is the transition from lowland areas with microwave emissivities and radar specific cross sections typical of bedrock or tightly packed debris, to highland regions with unusually low emissivities (as low as 0.3) and high radar backscatter [1]. This characteristic was explored by [2] through altitude vs. emissivity (*a/e*) scatter plots of several highland areas. These areas displayed a gradual decrease in emissivity with increasing elevation and have an inflection in the *a/e* plot occuring between 6053.5 and 6055.8 km (termed the "critical elevation"). All highland areas, with the exception of Maat Mons, show roughly similiar *a/e* trends. Additionally, a return to rock-like values of emissivity and backscatter is observed at the highest elevations [3]. For Ovda Regio, the return occurs within a <0.5 kilometer range in elevation at 6056 km [3].

Arvidson *et al.* [3] inverted microwave properties of Ovda Regio using polarized emissivity and radar backscatter to separate dielectric constant and geologic controls on microwave signatures and found that dielectric constants are directly related to elevation whereas roughness values depend on geology. The results support a model which accounts for the gradual increase in dielectric constant with increasing elevation and the abrupt return to rock-like values at the highest elevations due to the existence of a ferroelectric mineral phase with a Curie temperature equal to the temperature at the transition (*e.g.*, 6056 km for Ovda Regio) [4]. The ferroelectric phase is either intrinsic to the surfaces or plated as the result of vapor transport. Another mechanism to account for this return to rock-like signatures include the presence of a thermodynamic equilibrium boundary between perovskite and a rutile-fluorite assemblage [5]. Additionally, extremely large variations in local composition and/or surface texture may be responsible. We test these hypotheses through similar analyses of the volcanoes Sapas, Maat, and Ozza Montes.

Sapas Mons. Emissivity values in the radar-dark surrounding plains (6053.2 km) are rock-like (0.85) and decrease as the volcano is approached (at an elevation of 6053.6 km) and radar-brightness increases. Lava flows that cut across this change in radar backscatter are seen. A radar-bright ridge running north-south borders the two radar-dark peaks in the west. Some dark flows originating at the northern peak lie on top of the otherwise bright flows that surround the peaks. Return to a near-normal emissivity value of 0.7 occurs at the summits (6056 km), but the emissivity footprint is an average of both bright and dark units found there.

Ozza Mons. On the eastern flank of the volcano, the terrain slopes downward to the east and the *a/e* scatter plot of this area shows a typical decrease in emissivity with increasing elevation. A large, 200 km by 100 km radar-dark plateau lies west of the summit at an elevation of 6056 km. Lava flows and bright rifts cut across the area. To the north of the summit lies a dome field in which dozens of small kilometer-scale domes reside on an apron of radar-bright flows. The radar-dark summit rises as high as 6058 km and is tectonized primarily in the south and embayed by bright flows associated with the dome field. The emissivity of the summit has rock-like values.

Maat Mons. Unlike Sapas and Ozza Montes, this volcano is surrounded primarily by radar-dark, normal emissivity flows, with the notable exception of a stratigraphically older radar-bright flow exposed on the southern flank. This area, occupying elevations between 6054 and 6061 km, shows less than normal emissivity values (ranging from 0.5 to 0.7). The radar-dark summit of this volcano sits at 6061 km elevation and rock-like emissivity values are displayed. Distinctive normal emissivity flows on the southern flank cut across and embay a highly tectonized region containing local areas of high elevation and low radar backscatter. A very high radar-dark tectonized plateau lies about 300 km due south of the summit of Maat Mons. Conservative estimates place the elevation at 6057.7 km, although it may be as high as 6063 km, the second highest elevation seen on Venus (exceeded only on Maxwell Montes). Emissivities in this region have normal values.

Interpretation. The general *a/e* trends observed in Sapas, Ozza, and Maat Montes are comparable to that of Ovda Regio, including the return to rock-like values at the summit regions. As elevation-controlled dielectric constant was shown to dominate the Ovda Regio microwave signature [3], it is likely that the same holds true for these volcanoes. The return to rock-like microwave properties at the summit regions is consistent with the presence of a ferroelectric phase, either an *in situ* phase or a transported phase. The lack of low emissivity flows on Maat Mons, except for stratigraphically older portions, argues that the production of low emissivity surfaces takes time (either by coating or weathering) or that volcanic flows from Maat Mons have a wide range of composition. The fact that both tectonic and volcanic units superimpose and embay the high, fractured, dark plateau on the southern flank of Maat Mons (and in cases occur topographically higher) also is consistent with a time-dependent process being responsible for their origin. The variation in elevation at which dark summits occur argues against an origin due to a global thermodynamic equilibrium boundary, unless orographic control of temperature occurs [2]. Whether a plating or weathering mechanism is ultimately at work in these areas cannot presently be determined from the data at hand. Results are consistent with the plating model of [6], with transport of ferroelectric metal halides or chalcogenides to the cool highlands. The gradual decrease of emissivity with increasing elevation and the abrupt return to normal values at highest elevations on Sapas and Ozza Montes are consistent with the ferroelectric model proposed by [4].

References. [1] Pettengill *et al.* (1988) JGR 93, 14881, [2] Klose *et al.* (1992) JGR 97, 16353, [3] Arvidson *et al.* (1994) Icarus in press, [4] Shepard *et al.* (1994) GRL 21, 469,[5] Fegley *et al.* (1992) Proc. LPSC 22, 3, [6] Brackett *et al.* (1994) JGR in press.