data set into three parts: (1) <0.1, to be less than any measured terrestrial solid rock, low dielectric constant ($\varepsilon < 4$), almost certainly incorporating a significant fraction of porous material, (2) 0.1–0.2, moderate dielectric constant, probably comprising a large fraction of consolidated material if of terrestrial or lunar mineralogy [*Olhoeft and Strangway*, 1975], and (3) >0.2, at or beyond the upper end of the range of terrestrial rocks, high dielectric constant ($\varepsilon > 9$), indicating mainly consolidated material with perhaps some anomalously high-dielectric material representing mineralogies probably enriched in FeS_2, Fe, and/or Ti oxides (Plate 4). The moderate range, which comprises 67% of the observed surface area of the planet, is likely to include a significant proportion of rocks or bedrock with only a minor contribution from porous ("soil") fractions. Even soil derived from high-dielectric minerals should make only a minor contribution, since *Campbell and Ulrichs* [1969] determined that the dielectric constants of powdered rock samples are universally low (e.g., $\varepsilon < 4$), independent of the properties of the original rock. As has been noted elsewhere, this surface type, the largest fraction of the Venusian surface, is unlike the unconsolidated soil typical of the moon and much of Mars.

The map distribution of correspondences between roughness and elevation subdivisions is shown in Plate 5, between reflectivity and elevation subdivisions in Plate 6, and between roughness and reflectivity subdivisions in Plate 7. Note that the three parameters (roughness, reflectivity, and elevation) are continuous over the entire data range. Therefore, although the resulting surface units are defined within a specific range of values (for example, regions of low roughness and intermediate reflectivity have values of 1°–2.5° rms slope and 0.1–0.2 reflectivity, indicating that the terrain is likely to be smooth and composed of a large fraction of rock material), they are in fact gradational with each other because roughness, reflectivity, and elevation represent a spectrum of values. Thus, as is common with terrestrial geologic unit definition, the units are transitional at their boundaries.

RESULTS

Elevation Versus Roughness

Spatial correspondences of three divisions in roughness and four divisions in elevation are shown in Plate 5. Using hue to distinguish divisions in elevation and intensity to distinguish divisions in roughness, a pattern of increasing roughness with elevation is apparent (also compare Plates 2 and 3). As noted in previous studies [*Pettengill et al.*, 1980*b*; *Masursky et al.*, 1980; *McGill et al.*, 1983; *Garvin et al.*, 1983*a*], highest regions are generally roughest, and lowest regions are relatively smooth, although not necessarily the smoothest regions found on Venus. In detail, however, noteworthy deviations from this trend are observed.

Most lowlands (<0.0 km elevation) are smooth or transitional from smooth to rough. Within the lowlands the regions of low and moderate roughness (darker hues) are spatially well defined (i.e., occur as clusters of 1° × 1° cells). In contrast, high-roughness units in the lowlands occur in isolated patches (i.e., single 1° × 1° cells of high roughness surrounded by smoother surfaces). Small topographic depressions ($<10^6$ km^2) tend to have moderate roughness values, while broader lowlands are both smooth and transitional. The pattern of roughness in the broader lowlands shows regional clustering. In Sedna and Guinevere planitiae, for example, areas toward Beta Regio show intermediate roughness values, while those toward Ishtar Terra show low roughness values. Atalanta Planitia, in contrast, is dominated by widespread regions of low roughness.

The rolling plains (0.0–2.0 km) display broad regions of both smooth and transitional roughness. Transitional roughness areas often flank highland regions, most notably around Beta–Phoebe Regio, but also in narrower, less continuous zones around Ishtar and Aphrodite Terra. Broad circular features, such as the Nightingale-Earhart region of eastern Tethus Regio, show intermediate roughness values. Many of the small elevated plateaus (e.g., Tellus, Alpha Regio) contained within this topographic province have transitional to high roughness values. Rough units occur as either small regional clusters or isolated features. Chasmata contained within Aphrodite Terra, while poorly resolved at this spatial resolution, appear to be relatively smooth.

Most highlands (2.0–4.5 km) appear transitional in roughness. Smooth regions can be observed in Lakshmi Planum, northwest and west of Maxwell Montes, west of Akna Montes, and in isolated sections of Aphrodite. Rough regions occur adjacent to the mountainous terrain within the highlands, as seen, for example, in the western and central highlands of Aphrodite and eastern Ishtar Terra. Mountainous regions (>4.5 km) are mostly transitional or rough, with only isolated occurrences of smoother surfaces.

Elevation Versus Reflectivity

Spatial correspondences of radar reflectivity and elevation are shown in Plate 6 (also compare Plates 2 and 4). Elevations are represented by hues and reflectivity subdivisions by intensity variations. A less distinct relationship exists betwen elevation and reflectivity than that observed between elevation and roughness from a statistical standpoint [*Garvin et al.*, 1984*a*] as well as from general map unit trends. While a general trend of increasing reflectivity with elevation is apparent, for a given elevation range a wide range of reflectivity map units are observed (Plate 6).

The majority of lowlands are moderate in reflectivity, suggesting a predominantly rock surface. Lower-reflectivity units dominate Lavinia Planitia and occur as distinctive patches in the otherwise intermediate-reflectivity Guinevere and Sedna planitiae. The most distinctive occurrences of high-reflectivity patches are in Atalanta Planitia. On the basis of these observations it is clear that there is a diversity of reflectivity units both within and between planitia (e.g., within Sedna and between Sedna and Atalanta planitiae).

Rolling plains are also mostly moderate in reflectivity, implying a predominance of surface materials with dielectric properties similar to terrestrial rocks. Low-reflectivity units tend to be adjacent to highland regions, such as Beta and Aphrodite Terra, but are not evenly distributed around the entire highland perimeters. Several regiones are also dominated by low reflectivity (Alpha, Tellus) as is Lada Terra, the rolling plains area at high southern latitudes. Chasmata, in general, appear to contain material with low reflectivity. High-reflectivity units are widely distributed but occur mostly in isolated small areas. A notable exception to this is the region west of Atalanta Planitia (the Nightingale-Earhart region of eastern Tethus Regio).

Highland regions generally show a pattern of highest reflectivity adjacent to mountainous terrain, with decreasing reflectivity away from these peaks. This pattern is well illustrated in the western and central highlands of Aphrodite and in northern Beta Regio. In eastern Ishtar Terra the pattern of reflec-