

TOPOGRAPHIC VARIABILITY OF THE LOWLANDS OF VENUS

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INTRODUCTION: Recent Earth-based radar images¹⁻³ have shown a diversity of terrain types on Venus at scales varying from <5 km - 1,000's km. Several types of features are visible in these high resolution images, including volcanoes, flows, lineaments and impact craters. However, due to data acquisition methods¹, only a restricted area of the surface of Venus will be available in the foreseeable future for analysis from Earth. We are therefore attempting to determine whether this diversity of features and terrain types extends to other areas of Venus (specifically the lowland regions, since they cover over 90% of the mapped surface; ref.4). Using the Pioneer Venus (PV) altimeter data sets, we are studying deviations from randomness in the relief of topographic features (described here as "topographic variability"), and the distribution of meter-scale roughness. Included within our analysis are Atalanta, Sedna, Lavinia, Helen, Guinevere and Niobe Planitiae, together with, for comparison, parts of Ishtar and Aphrodite Terrae.

ANALYTICAL TECHNIQUES: PV topographic data (including all data collected up until 12/82) are used to investigate the diversity of 30 study areas that are 3.78×10^6 to 8.14×10^6 km² in size (Fig.1). Four new data sets were created by resampling these data at grid spacings of $1^\circ \times 1^\circ$, $1.5^\circ \times 1.5^\circ$, $2^\circ \times 2^\circ$ and $3^\circ \times 3^\circ$. The resampled data were then used to produce for each area a set of cumulative variability curves for both topography and RMS slope. These curves incorporate the standard deviations (S.D.) of the data at the given grid size, rather than absolute elevation or surface roughness values. Data are given in the form of the cumulative percent of grid points having S.D. within the given interval and represent the variability of the terrain, either in terms of altitude or RMS slope. We have performed this analysis at each grid size and have found that as the grid size is increased, the larger areas averaged into each grid point result in a shift in the cumulative curves toward greater variability; at 1° and 1.5° interval, the areas are less variable than for 2° or 3° grid sizes. However, the 2° and 3° curves are virtually coincident, implying that an increase in grid size beyond 2° does not result in the sampling of more morphologically diverse landforms (which in turn indicates that most landforms in the venusian lowlands have a scale of about 200 km or less).

RESULTS AND DISCUSSION: From the resultant cumulative curves (Fig.2), the slope and mid-point of each curve were calculated, permitting scatter diagrams (based on average value, average curve slope, and cumulative % curve mid-point) for both elevation and RMS slope to be derived⁵. In comparison to the average characteristics of the lowlands, these results suggest that two distinct groups of anomalous sample areas can be identified. For example, from the cumulative % curves for RMS slope (Fig.3) one group of five areas ("rough") has a pairing of a large (0.7 - 0.9 deg.) mid-point with a shallow (0.5 - 1.0 deg.) curve slope. A second group of three sample areas ("smooth") has a small mid-point (0.5 deg.) and a steep (1.3-1.7 deg.) curve slope. Significantly, we have found⁵ that for any combination of the above six attributes the same areas are always classified as either "rough" or "smooth". In plotting the geographic distribution of the two groups (Fig. 1), there is a tendency for each group to cluster in moderately well-defined regions of Venus, and for sample areas with the same topographic characteristics to be adjacent to each other. Interestingly, however, the geographically isolated Leda Planitia (45°N , 60°W) has the same topographic variability as Guinevere Planitia. Based on the above roughness/smoothness criteria, it would therefore appear that these two planitiae have comparable relief distributions and, hence, possibly comparable landforms or degree of erosion. From the distribution of the clustered sample areas, it is evident (Fig. 1) that there is no uniform distribution of clusters as a function of latitude or longitude, nor does the height above Venus datum appear to be a controlling factor in the distribution of topographic variability (at least for the elevation range investigated here). It is also apparent⁵ that even for well matched groups of areas, there is quite a range in surface roughness at the meter scale. If one assumes that the derived RMS slope measurements do indeed describe some physical property of the surface (either in the form of surface facets or the size and frequency of surface rocks; Ref.4), then it is evident from this study that a diversity in absolute RMS slope values does not reflect variations in the topography on a 100 - 200 km scale.

TOPOGRAPHY OF VENUS LOWLANDS

Blake P.L. and Mouginis-Mark P.J.

This analysis therefore suggests that the lowland plains within Guinevere and Sedna Planitia may be typical of many lowland areas of Venus (Fig.1). However, the plains to the west of Beta Regio are typically more variable in their topography than other lowland regions of the planet studied so far by Earth-based radar, while the southern planitiae (Helen and Aino Planitiae) are smoother than areas so far investigated from Earth. Unfortunately, until high resolution radar images are available from an orbiting spacecraft, it is not possible to uniquely associate these topographic characteristics with specific geological features or processes.

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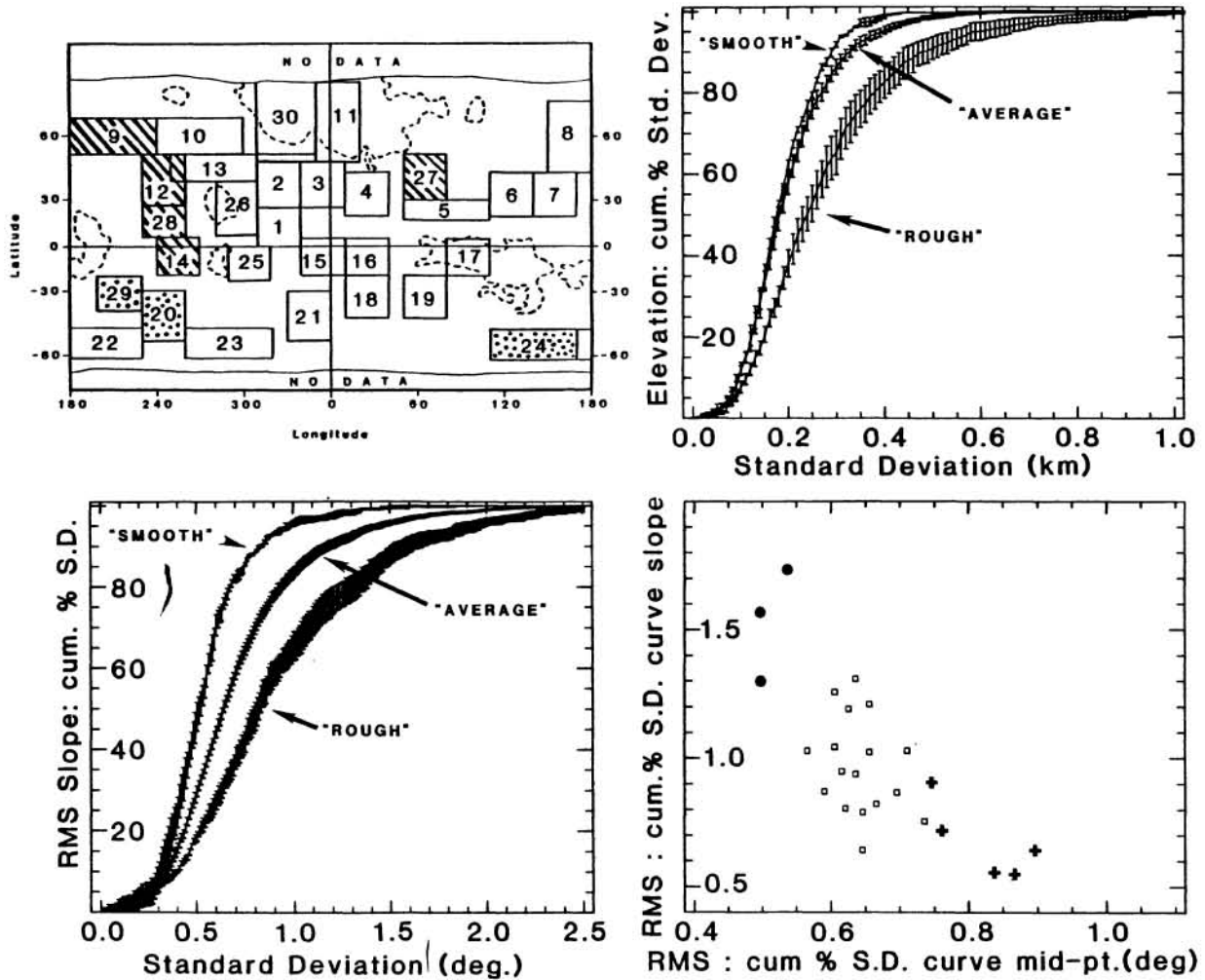


Fig.1 (top left): Location of sample areas studied here. For reference, outlines of highland areas are shown by dashed lines. Lowland areas classed as "rough" are marked by cross-hatch, "smooth" areas by dotted texture. Fig.2A (top right): Cumulative curves of topographic variability at $2^\circ \times 2^\circ$ grid spacing for the "rough", "smooth" and "average" areas identified in Fig.1. Error bars are 1 S.D. Fig.2B (bottom left): Equivalent curves to Fig.2A, except for RMS slope. Fig.3 (bottom right): Example of scatter plot used to distinguish "rough" (crosses) and "smooth" (solid circles) sample areas from "average" values (open squares); in this case the cumulative RMS curve is plotted against the mid-point value for the RMS curve (i.e., data derived from Fig.2B).