TWO GLOBAL CONCENTRATIONS OF SMALL DOME-LIKE HILLS ON VENUS; *Jayne*
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Introduction. Small dome-like hills are among the smallest resolvable features with distinguishing characteristics in Venera 15/16 images of Venus[1]. More than 22,000 small dome-like hills have been mapped in the 20% of the surface imaged by Venera and they are the most numerous identified single morphologic feature on Venus. Domes are defined and identified on the basis of their positive topographic form, generally circular planimetric outlines, diameters in the range 1-2km to 20km, and slopes of ≤10° (and probably ≤5°) [2]. Associated characteristics include summit pits, radar bright slopes and aprons, and basal topographic platforms [3].

On the basis of an assessment of their individual and cluster characteristics, their overall surface distribution and associations[3], and theoretical analyses of the eruption conditions for magmas on Venus[4], domes have been shown to be analogous to the characteristics of small shield volcanoes constructed from multiple centralized effusive eruptions consiting of discrete volumes of material erupted over short time intervals. On the basis of their overall abundance, regional distribution, individual characteristics, and associated geologic terrain units, they are interpreted to be similar to seamounts on Earth [3].

In this study, we show that domes on Venus predominantly occur in their greatest concentration in two regions that are near Beta Regio and Thetis Regio. These well-known global topographic rises have been previously interpreted, on the basis of a variety of characteristics, to represent potential hot spots and regions of anomalous heat flow, associated rifting, and dynamic topography. The concentration of domes in these two areas may represent increased volcanic productivity associated with enhanced regional thermal budgets, perhaps in association with large scale regions of mantle convective upwelling.

Global Distribution. Dome density contour maps produced by Slyuta *et al.* [2] show local and regional clustering of domes in specific areas, particularly in the Akkruva Colles area. For the present study, detailed maps of dome location, number and distribution for every Venera quadrangle have been prepared in which all domes larger than 5 km are identified and digitized. Only bright features showing a paired dark side were interpreted to be domes and included in the data set. The resultant dome point map shows two significant areas of major dome concentrations approximately 180° longitude apart: (i) the largest concentration occurs in the Akkruva Colles area of Niobe Planitia centered at approximately 45°N/120°E and including Ananke, Kutue and Shimti Tesserae and Uni Dorsa (east of Tellus Regio, and just north of the flanks of the Thetis Regio rise), and (ii) another significant concentration occurs in northwestern Guinevere Planitia centered at approximately 35°N/300°E and including Lachesis Tessera (north flank of Beta Regio rise). Because these areas lie adjacent to the limits of Venera image coverage, the extent of these regional clusters is known only for their north, east, and west margins. In addition to these major areas of concentrations, domes occur in smaller concentrations throughout the imaged area of Venus, generally in association with known local scale volcanic edifices, calderas [5], and certain features (corona) interpreted to be volcanic in origin [6].

Global Association. The Akkruva and Beta dome concentration areas are also anomalous in other respects. Both areas predominantly consist of intermediate elevations (6051-6053) and show relatively prominent regional orthogonal tectonic patterns analogous to those associated with tessera. These characteristics stand in contrast to surrounding regions of relatively smooth low-lying plains and to the complexly disturbed and elevated surfaces of adjacent areas of true tessera and imply that the surfaces on which the two significant dome concentrations occur have a more complex origin than do the simple smooth low elevation plains.

Both areas generally coincide with the unit designated Rolling Plains [7] and with the Plains-Corona-Tessera, Plains, and Plains-Corona Assemblages [7]. These assemblages can be characterized in a tectonic sense as having formed predominantly from vertically directed deformational forces [7] as opposed to significant lateral deformation known to occur elsewhere [8]. The Beta concentration has been imaged by Arecibo high-resolution radar and, on this basis, large volcanic edifices[Campbell et al. 1989] are known to occur in association with domes in this area. Analysis of Pioneer-Venus radar properties [9] also distinguishes these areas as smooth to transitional in roughness and low to intermediate in reflectivity, which has been interpereted [9] as implying a predominant surface material ranging from porous material such as soil to a material comparable to terrestrial rock. These characteristics are consistent with surface exposure of rough to smooth plains-forming lava flows with variable degrees of surficial weathering products overlying smooth surfaces and infilling small-scale surface roughness elements.

Discussion. Both of the regional dome concentrations occur on the slopes, or in proximity to, significant regional topography that correlates with positive anomalies in the gravity potential field [10]. Both the Beta Regio and Thetis Regio-Eastern Aphrodite areas have been shown previously to be characterized by topography/gravity correlations [10] and correspondingly deep apparent depths of compensation commonly interpereted to represent deep convective upwelling, dynamically supported topography, and associated dynamic tectonic deformation. These characteristics are large enough to show considerable expresssion even at low harmonic degrees [11] (long wavelengths), implying that their origin is significant at global scales, and that the effects of the perturbing underlying mantle may be expressed over areas larger than the topographic influences alone.

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Predicted influences of significant dynamic mantle upwelling include enhanced regional heat flow associated with the correspondingly warm upwelling mantle, and local lithospheric thinning, associated rifting, a significant increase in shallow mantle melting, corresponding increases in magma production, and increase in surface volcanic production rates and crustal thickness. The presence of numerous small effusive volcanoes in these areas on Venus is interpreted to represent enhanced regional and global scale distribution of advective heat flow in association with two areas of large scale dynamic mantle upwelling.

Global scale clustering of volcanic edifices on this scale is known to occur on Earth and may represent similar large scale mantle convective processes. On Earth a degree 2 pattern of hot spot concentrations (Pacific and Africa-North Atlantic hot spots centered 180° apart) is known to correlate with degree 2 variations in upper mantle temperature, and, once corrected for shallow density variations in the lithosphere, corresponding geoid highs can be shown as well [12]. These observations have been interpreted to reflect large scale patterns of mantle convective upwelling on Earth [13], associated increased upper mantle temperatures and hemispheric regions of enhanced volcanism (antipodal hot spot concentrations).

Conclusions. Two global scale regions of dome concentration occur on Venus, one near Beta Regio and another north of Thetis Regio, and are interpreted to be exceptionally large concentrations of numerous small effusive shield volcanoes. Corresponding associated anomalous geologic unit characteristics, intermediate (neither "lowland nor highland") regional elevation of the surface, proximity to large regional highlands, and correlated long wavelength positive gravity anomalies are all associated characteristics of both of these areas. On the basis of the regional positive gravity and topography correlations and associated geologic characteristics indicative of rifting and tectonic extension, the nearby highland areas of Beta and Thetis Regio have been commonly interpreted as potential regions of dynamic mantle support of overlying topography, buoyant mantle upwelling and increased mantle heat flow. If so, the concentration of effusive volcanic activity near these areas is suggested to reflect two areas of regionally enhanced thermal budgets, increased shallow melting, and relatively enhanced higher volcanic production and eruption.

Questions that remain include the following: (i) is the apparent longitudinally antipodal concentration of regional volcanic activity an artifact of the limited area and limited resolution currently available for Venus?; (ii) are other areas interpreted to be characterized by the geological and geophysical characteristics of dynamic mantle upwelling also areas of enhanced volcanic effusive activity?; and (iii) what is the dome global distribution, abundance, size-frequency distribution, and changes in these characteristics with latitude? Increased resolution of small domes less than 2 km in diameter and increased areal identification from Magellan data will enable a more thorough assessment of these questions.

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