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16. Abstract

Description of topographic features is given for the North polar region of the planet Venus. Principal geomorphic types of terrain are characterized as well as their geologic relations. Relative ages of geologic units in Venus North polar region are discussed.

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O. N. Rzhiga, A. I. Sidorenko, Yu. N. Aleksandrov,
I. M. Bokshteyn, M. A. Kronrod
Verndaskiy Institute of Geochemistry and Analytical
Chemistry of the USSR Academy of Sciences
Moscow Power Engineering Institute
Institute of Radiotechnology and Electronics
of the USSR Academy of Sciences
Institute of Information Transmission Problems
of the USSR Academy of Sciences

Introduction

The northern polar region of Venus, like the southern, /177* is inaccessible to radar observations from earth. The most general ideas as to the global relief of Venus were obtained only in 1979 through the altimeter data from the Pioneer-Venera-Orbiter spacecraft with a resolution of 100 km [8]. However, this information about the relief of the planet is confined to the latitude zone of ±75°. Therefore, prior to the survey of the planet Venus by the side-looking radar from the automatic interplanetary stations Venera 15 and 16, the northern polar region had continued to be a "blank." The radar survey of the surface of the northern hemisphere of Venus from the Venera 15 and 16 stations permitted the most felicitous combination of geological information with hypsometric data of the planet. This unique experiment provided the first opportunity not only of glimpsing the surface of the polar region of the planet, but

*Numbers in the margin indicate pagination in the foreign text.

also of constructing a hypsometric chart of this region on the basis of altitude data gathered by profilographs (Fig. 1). The chart with an altitude interval of 500 m was compiled from surface height readings, adjusted to a sphere of radius 6051 km. The height measurement accuracy of the profilographs was around ±50 m for a focal width of 40-50 km on the planetary surface. The vast majority of designations of relief features in the northern polar region of Venus have been assigned on the basis of the radar survey from the Venera 15 and 16 stations and approved by the International Astronomic Society in 1985 (Fig. 2). We used two kinds of radar image to study the surface of the northern polar region of Venus: one type obtained by direct onboard processing of the signal (on-line operation) [5], the other processing the obtained signal by ground computer complexes [7]. The resolution of the radar images produced by the /178 two methods was 3-4 km and 1-2 km, respectively. The general relief features of the northern polar region were studied by montages of radar images obtained in the on-line condition (Fig. 3). A more detailed geological-morphological cartography of this region of the planet and analysis of the relationships among the various terrain types were done for the radar images in strips with a resolution of 1-2 km (Fig. 4).

Hypsometric Characteristics of the Region

According to the hypsometric data obtained by Venera 15 /179 and 16, the northern polar region of Venus in the bounds of 70° N.L. represents one of the most extensive lowlands in the northern hemisphere (Fig. 1). Much of the surface of this lowland is below the average hypsometric level of the planet, corresponding to a radius of 6051 km. This polar depression shows up well on the hypsometric profiles of various bearings passing through the pole (Fig. 5). The diameter of the polar depression is in excess of 3000 km and is comparable in size

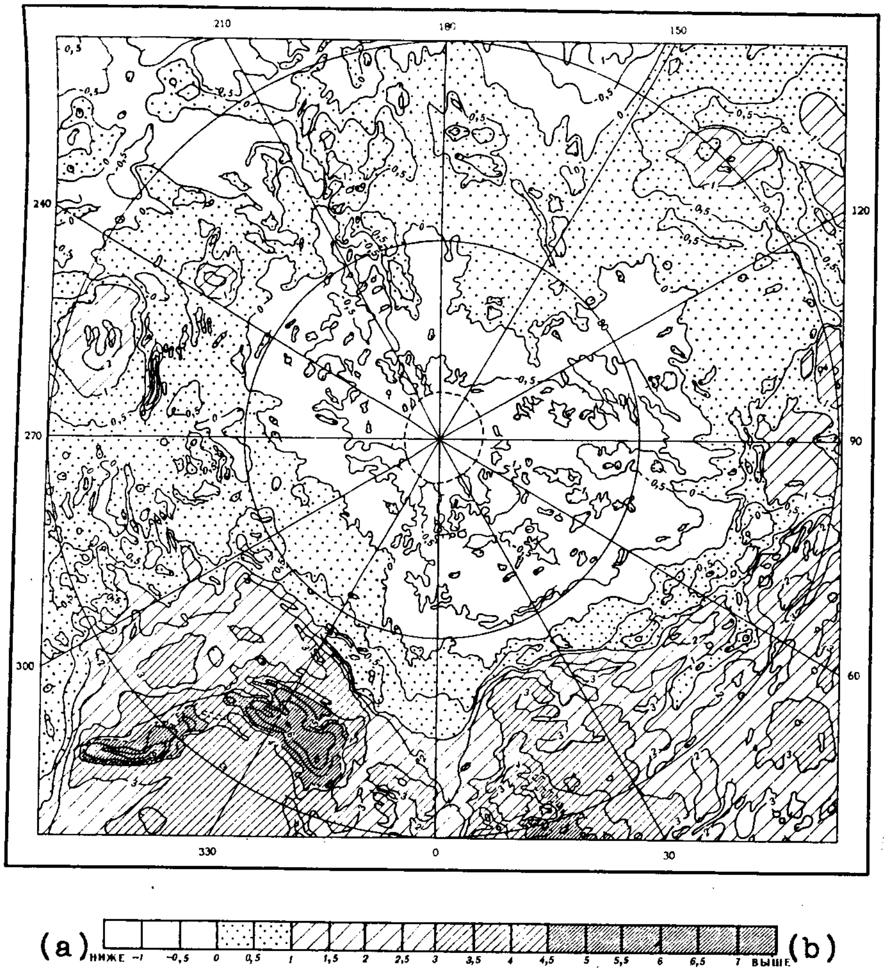

Fig. 1. Hypsometric chart of the northern polar region of Venus compiled from results of processing of profilograph data of the Venera 15 and 16 automatic stations. Height readings from a sphere of radius 6051 km. For height below 1 km, isolines shown every 0.5 km; at higher levels, every 1 km. Key: a - below; b - above.

with the deepest depression on Venus - the Plain of Atalanta, with which it actually communicates in the longitude range of 150-180° W.L. The northern polar region of Venus has a circumpolar structure in terms of hypsometric features. Thus, in the range of 80° N.L., roughly 80% is occupied by surfaces below the average conditional height of the planet, while the area of the

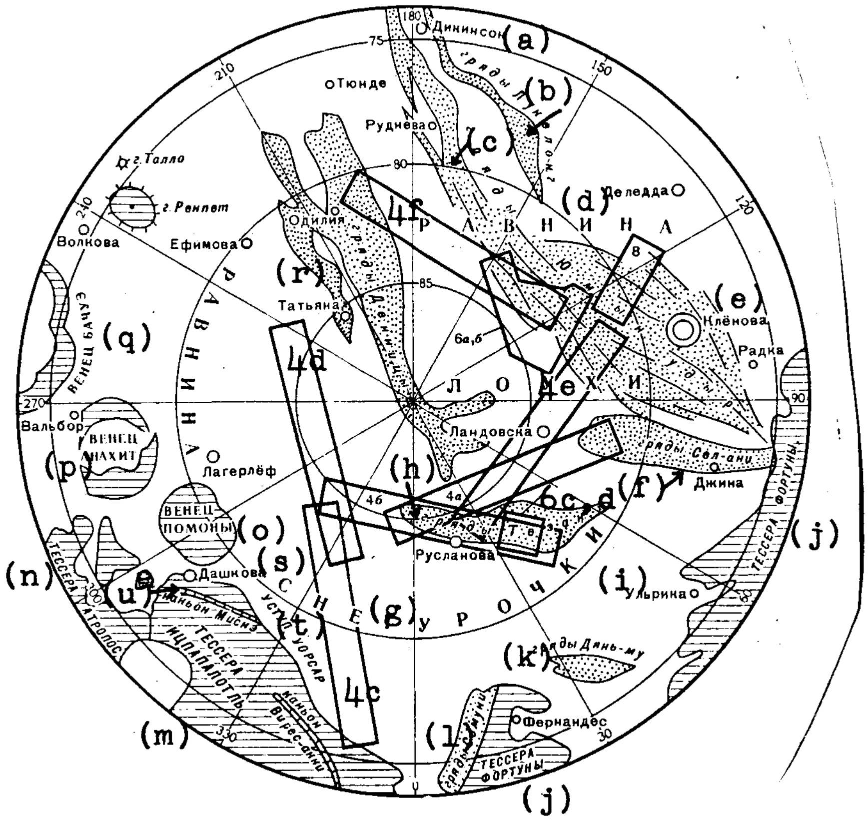

Fig. 2. Map of designated relief features of the polar region of Venus. Contours of Fig. 4,6,8 shown. Key: a - Dickinson; b - Lukelong ridges; c - Yumyn-udyr ridges; d - Plain of Loukhi; e - Klenova; f - Sel-ani ridges; g - Plain of Snegurochka; h - Tezan ridges; i - Ulrika; j - Tessera Fortuna; k - Dyan'-mu ridges; l - Semuni ridges; m - Tessera Itzpapalotl; n - Tessera Atropos; o - Pomona crown; p - Anakhit crown; q - Bachue crown; r - Dennitsa ridges; s - Dashkova; t - Uorsar escarpment; u - Misné canyon.

lowest sectors (1 km below the conditional level) is around 5%. The maximum height gradient here is 1.5 km.

Relief Decipherability at Various Radar Survey Bearings

The radar survey of the polar region is characterized by /184
certain peculiarities, unlike the survey of the planetary sur-

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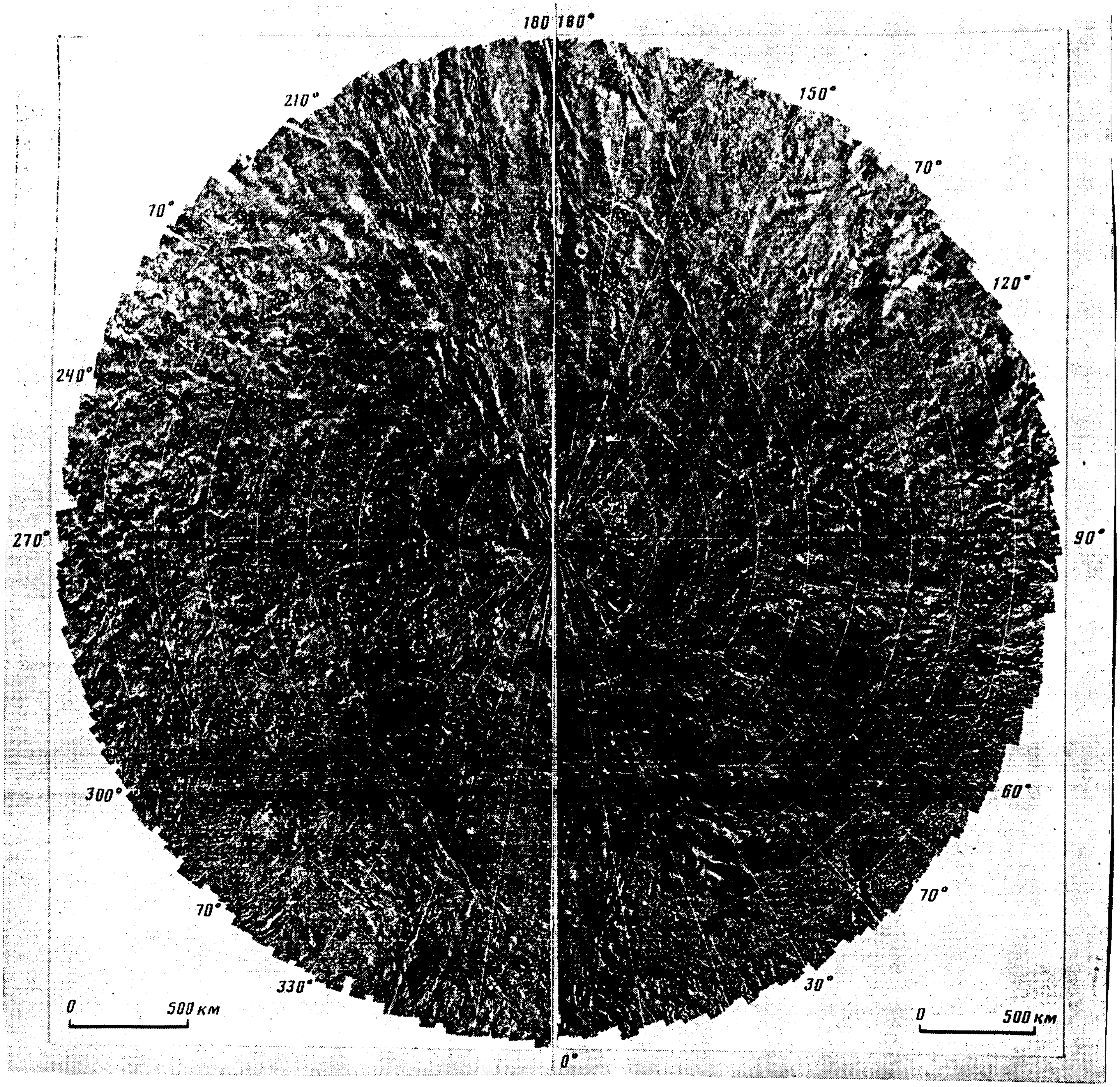

Fig. 3. Photographic map of the northern polar region of Venus above 70° N.L.

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face at lower latitudes. Because of the repeated crossing of orbital path projections, a situation was created where the same sections of the surface were surveyed on more than one occasion and at different bearings. It therefore became possible to obtain more detailed information as to the structure of surface formations in the polar region and to perceive how the decipherability of individual elements of major relief forms is affected lengthwise or transverse to the direction of the radar beam. Figure 6 shows images of several sections of the surface, surveyed at bearings differing by more than 60°. /185

The very same segment of the Plain of Loukhi, cluttered with a segment of a mountain zone and a system of linear mountain ranges and escarpments, appears quite differently in these pictures (Fig. 6a,b). The same may be said concerning the relief features of the Tezan ranges, a portion of which is shown in Fig. 6c,d. As is evident from these pictures, the observed lessening of the morphological contrast of the mountainous forms is accompanied by a general smoothing of the surface features of the plain and the appearance of a hilly-hummocky relief zone in place of the belt, oriented transverse to this belt. The identified hilly-hummocky relief zone is confined to the central portion of the mountain belt (Fig. 6a,b). It is a characteristic fact that the same pictures revealing the transverse structure of the mountain belt once again reveal a lengthwise mountainous relief in places where the belt is bowed (where it is oriented transverse to the radar beam). Moreover, it is readily seen how short and winding ranges (3-5 km wide and 15-40 km long), grouped into a chain, become nearly invisible when the survey bearing is changed by 45° from the original bearing. In other cases, groups of albedo surface details in the form of dark spots and bands are resolved into distinct linear depressions, hollows, escarpments, ranges and isolated hills when the survey bearing is different (Fig. 6a,b). From

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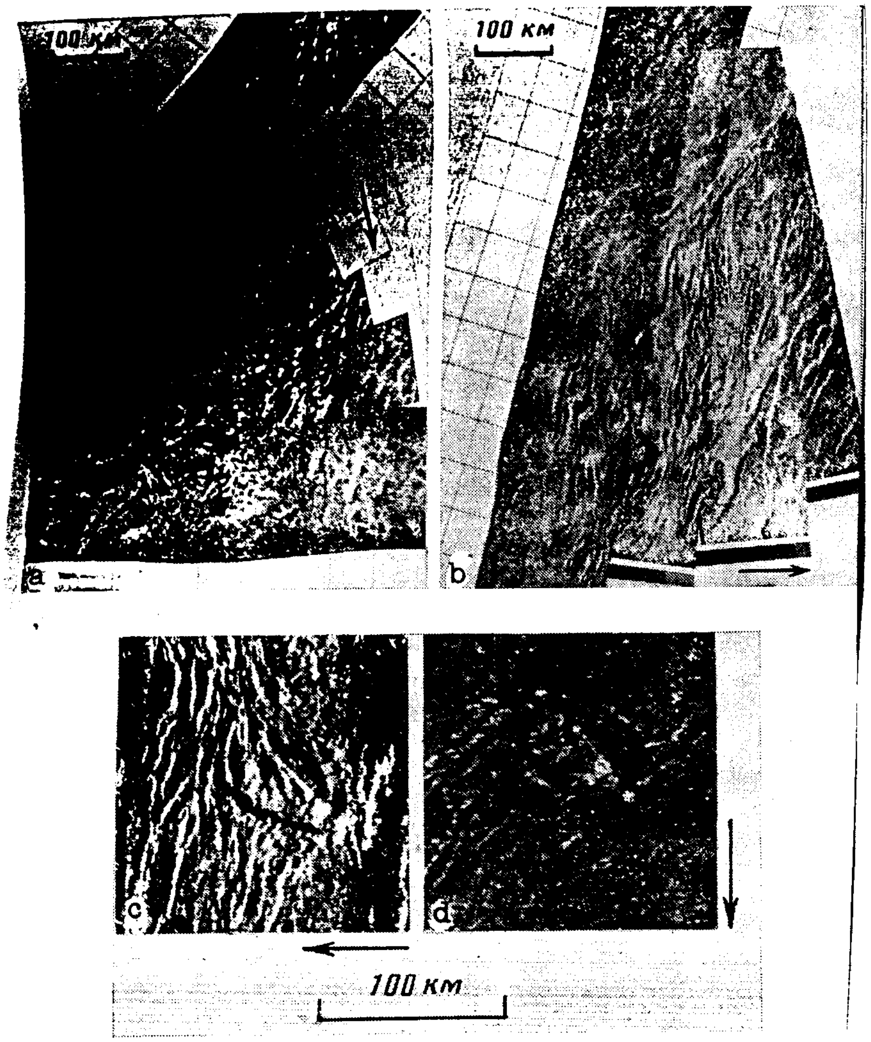

Fig. 6. Radar images of sections of the Yumyn-udyr range (a,b) and Tezan range (c,d) obtained at different survey bearings (shown by arrows).

these examples it is perfectly obvious that the distinct mountain chain relief of the belts observed with an orientation transverse to the line of sight of the radar vanishes almost entirely or changes shape when the direction of the belt coincides with the direction of the radar beam. The discovered relationship between visibility of the morphological pattern of the identical relief and the radar survey bearing must be taken into account both in the compilation of photographic montages with computer and in the geological charting of the planetary surface.

Basic Terrain Types and Individual Structures

As follows from the results of geological-morphological analysis of the radar images of the surface of Venus, level terrain types prevail within the northern polar region. Only a slight area is occupied by the northern fringe of the highlands of Land of Ishtar. The major geological structures delineated against the background of the level terrain include linear mountain belts and large ring-shaped formations, known as "crowns." The more fine structures are represented by numerous lineaments (in the form of rectilinear or curving ranges, hollows and escarpments), isolated domes, slopes of hills and impact craters. Furthermore, rather large (above /186 50 km) ring-shaped formations are occasionally met, recognizable in the radar photographs by virtue of the albedo contrast.

The photogeological analysis of the radar images and charting of surface relief elements of the northern polar region resulted in the geological-morphological map shown in Fig. 7. This map depicts the principal types of geological terrain prevalent in the polar region of the planet in their relative sequence of formation.

Among the plains of the northern polar region of Venus we /187 identified several terrain types differing from each other in morphological surface features: terrain with predominantly smooth nonstructured surface (smooth plane); terrain with rolling surface, cluttered by hill, dome and ridge formations (rolling plain); terrain with knoll-and-ridge relief (knoll-ridge plain); terrain with extensively developed systems of linear ridges and radio-bright bands (striated-ridge plain).

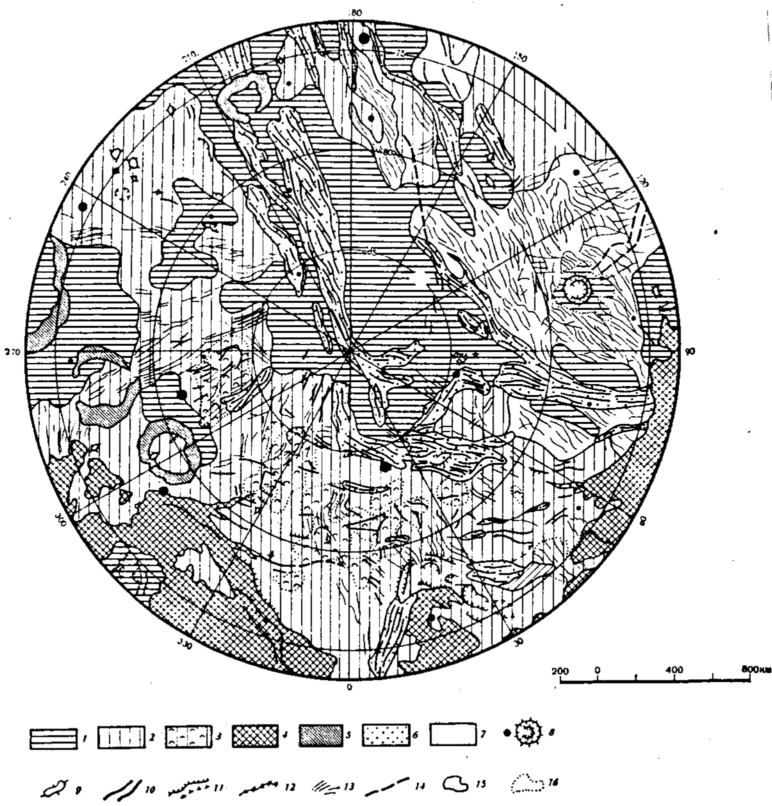

Fig. 7. Geological-morphological map of the northern polar region of Venus: 1 - smooth plains; 2 - winding plains; 3 - hilly-hummocky plain; 4 - parquet terrain; 5 - crowns; 6 - mountain belts; 7 - ridge-striated plain; 8 - simple and complex impact craters; 9 - hills and domes; 10 - ridges; 11 - distinct and indistinct escarpments; 12 - valleys; 13 - radio-bright bands; 14 - lineaments of unclear origin; 15 - boundaries of terrain types; 16 - indistinct boundaries.

The striated-ridge plain shows up sharply against the background of the other lowlands by the fact that its relatively dark surface is cluttered by numerous light lineaments, imparting a striated appearance to this type of terrain (Fig. 8). This type of terrain occupies the center of the Plain of Loukhi and extends in a latitude direction from the Sel-ani ridges to longitude 180° W.L. The northern bound of the striated-ridge plain is formed by the Yumyn-udyr ridges, while the southern

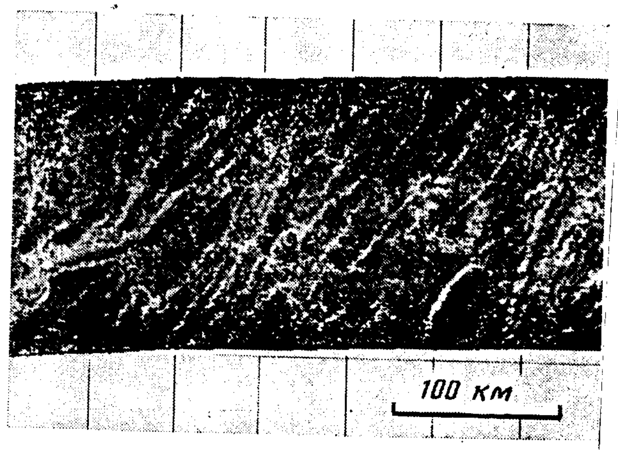

Fig. 8. Segment of the striated-ridge plain in the central Plain of Loukhi.

borders on the eastern fringes of Land of Ishtar and roughly corresponds to the parallel of 74° N.L. Isolated portions of this terrain type are encountered in the form of "windows" amidst the rolling plain. Depending on the orientation of the linear structures with respect to the radar beam (alongside or transverse), they appear as either distinct ridges (less often as escarpments and furrows) or as light bands of variable width. In different regions of the plain the ridges and the light bands combine into systems with varying orientation, so that a streaked, reticulated, or polygonal-reticulate surface pattern is formed. The width of the ridges and the radio-bright zones varies from the limit of resolution of the images to 10-15 km, while the length is between several dozen kilometers and 100-200 km.

With the evident diversity of orientations of the ridges and radio-bright zones, a general arclike orientation is conspicuous, extending from the Sel-ani ridges to a junction with the zone of Lukelong ridges. A large double-ring impact structure (∿136 km across) - the Crater of Klënova - shows up against the background of the striated-ridge terrain. The fact that the surface of the plain and the network of lineaments are covered beneath the ejected matter of this impact structure testifies that the crater was formed much later than this type of terrain.

The rolling plain type is very widespread within the charted polar region and, territorially speaking, almost entirely coincides with the Plain of Snegurochka (Fig. 2 and 7), with the exception of isolated portions of smooth plain and isolated "windows" of striated-ridge terrain. The most clearcut and natural bounds of the rolling terrain are the northern fringe of the Land of Ishtar (from the Pomona Crown in the west to the eastern edge of Tessera Fortuna) and a linear system of ridge zones - the ridges of Dennitsa and Sel-ani. In terms of relief, this terrain type is the most complicated of the charted plain types. Hence, the title of this terrain came from the rolling nature of its surface. /188

The rolling surface of this terrain type is unevenly cluttered with numerous ridges and light lineaments of various orientations, furrows, domelike formations and hills, impact craters, and ringlike structures of distinct albedo. Furthermore, sections of knoll-and-ridge relief (Fig. 4c) are encountered, showing up distinctly against the background of the other relief by the variegated albedo. We classified such surface segments as a subtype of the rolling plain, specifically, as the knoll-and-ridge plain. The surface albedo of the rolling terrain is not uniform, being cluttered by numerous diffuse spots of light and darker tone, and, moreover, darker-tone "windows" of striated-ridge terrain and lighter segments of smooth terrain are encountered. The hills cluttering the rolling plain occasionally form clusters (Fig. 4a). The transverse dimensions of such hills range from the limit of resolution to 5 km. The domelike formations are characterized by larger dimensions (up to 40 km) and gentle slopes (Fig. 4e). Judging from the hypsometric data, these formations have low height (200-300 m) for a diameter of 10-15 km. Occasionally, they are complicated by craters at the top. On the whole, these formations in external appearance have a certain resemblance to the volcanic domes which are widespread on the northern plains of Mars (e.g., the Plain of Arcadia and the Acidali plain), which have been formed with substantial involvement of basaltic surface vulcanism [9]. One of the characteristic features of the described terrain is the fact that the relief forms cluttering it are for the most part fragments and features of a more ancient relief, protruding or showing through the younger plain-forming material. The majority of the lineaments cluttering the rolling terrain show up on the radar pictures as light albedo bands, while other lineaments of similar orientation constitute rather distinct ridges, escarpments, and (less often) furrows (Fig. 4d). According to the hypsometric profiles obtained by Venera 15 and 16, /189 the gradient of the rolling plain does not exceed 0.5 km in height.

The smooth plain. The terrain type known as the smooth plain occupies the northern portion of the Plain of Loukhi (the space between the zone of the Dennitsa ridges and the Yumyn-udyr ridges). Isolated portions of this terrain are found in the northwestern part of the Plain of Snegurochka and on the southern fringe of the Plain of Loukhi. Of all the terrain types occurring in the northern polar region, the smooth plain is characterized by the most level (in the scale of the picture) and virtually nonstructured surface with quite uniform radio albedo (Fig. 4f). Only seldom is its surface cluttered by barely noticeable light lineaments and isolated positive relief forms such as hills and domes, which are found most frequently on the rolling plain. In regard to the large positive relief forms, the material of the smooth plains acts as a cover, as indicated by ingress of this material into the broken relief of the belts, its covering of the systems of ridges and portions of the belts, as well as its covering of ejected matter from impact craters (cf. Fig. 4a). The aforementioned level terrains of Venus display a morphological affinity with vulcanogenic plains of the mare type on the moon, Mercury and Mars. This affinity is strengthened by the fact that flowlike formations and volcanolike relief forms have been discovered on the plains of Venus [2,3]. It may therefore be confidently presumed that the plain-forming material of the charted terrain of Venus is represented by basalt lava and pyroclastics (as on the other planets). However, we cannot rule out the possibility that aeolian deposits have also played a certain part in the formation of the plain-forming cover (perhaps in the regions with lower albedo), although estimation of the actual contribution of aeolian accumulation is not yet possible, given the resolution of the radar images.

The ridge belts and ring structures ("crowns"). Major formations such as belts of ridges and ring structures are conspicuous against the background of the level terrain in the polar region of Venus. The ridge belts and their fragments observed in this territory constitute a portion of the planetary system of such formations [4], widely distributed in the territory covered by the radar survey, especially in the longitude range of 150-240°. Thus, e.g., along the meridian 200° W.L. extending to the pole is a wide (100-380 km) belt of the Dennitsa ridges, whose extent within the polar region (from 70° to the pole) is around 2000 km. After crossing the pole, this belt divides into two arms (the Tezan ridges and the Sel-ani ridges), whose direction changes by 60° to the east. The width of these belts is considerably less (up to 100 km), while their length is around 1000 km. The Sel-ani ridges at 75° N.L. are interrupted by more recent highlands, the surface of which is characterized by highly irregular relief known as parquet terrain [2]. The Tezan ridges are first oriented along /190
the 0° meridian from north to south, then make an elbow bend at latitude 85° N.L. to the southeast and abruptly stop in the neighborhood of the rolling plain at 81° N.L. Such large frag-

ments of the ridge belts as the Dyan'-mu and Semuni ridges pinch off the heavily intersected relief of the northern fringe of the Land of Ishtar (parquet terrain of the Tessera Fortuna) from the less complex surface of the Plain of Snegurochka. It is entirely possible that the ridge belts at one time formed a single elbow shaped system, bordering the western portion of Tessera Fortuna. At present, they are separated by an overlying half-ring structure (around 150 km across), complicated about the perimeter by a system of indistinct ridges oriented in the northerly and northwesterly direction. Furthermore, the observed gap between the belts is highlighted by the plain-forming material which covers them in this place.

The width of the described belts reaches 100 km for a length of around 400 km. An unnamed fragment of ridge belt, morphologically similar to the above, borders the eastern half of Tessera Fortuna on the north. At a latitude of around 80° N.L. a ridge belt of northeasterly trend joins the Sel-ani ridges (or branches off from them) in the east. This belt is less conspicuous in relief, and its width varies from 50 to 100 km for a length up to 1000 km. The belt forms a part of the system of Yumyn-udyr ridges and serves as a natural northern boundary between the striated-ridge and the smooth terrain within the confines of the Plain of Loukhi (Fig. 2 and 7). The relief of all the discussed ridge belts consists of ridges and equal-sized valleys (Fig. 4a,f), parallel and subparallel to the general trend of the belt. The width of the ridges and valleys ranges from the limit of resolution of the pictures to 10-15 km, while the length varies from several dozen to several hundreds of kilometers. The structure of the belts clearly reveals a cord-like system of ridges separated by valleys on a scale of several dozen to several hundred kilometers. Similar to the situation commonly encountered at the lower latitudes, the ridge belts of the polar region have a less pronounced relief in certain sections. This occurs when they are covered by more recent plains (Fig. 4b,f). In such cases, a system of narrow (1-3 km) furrows is frequently visible instead of the ridge relief, preserving the same orientation as the ridges.

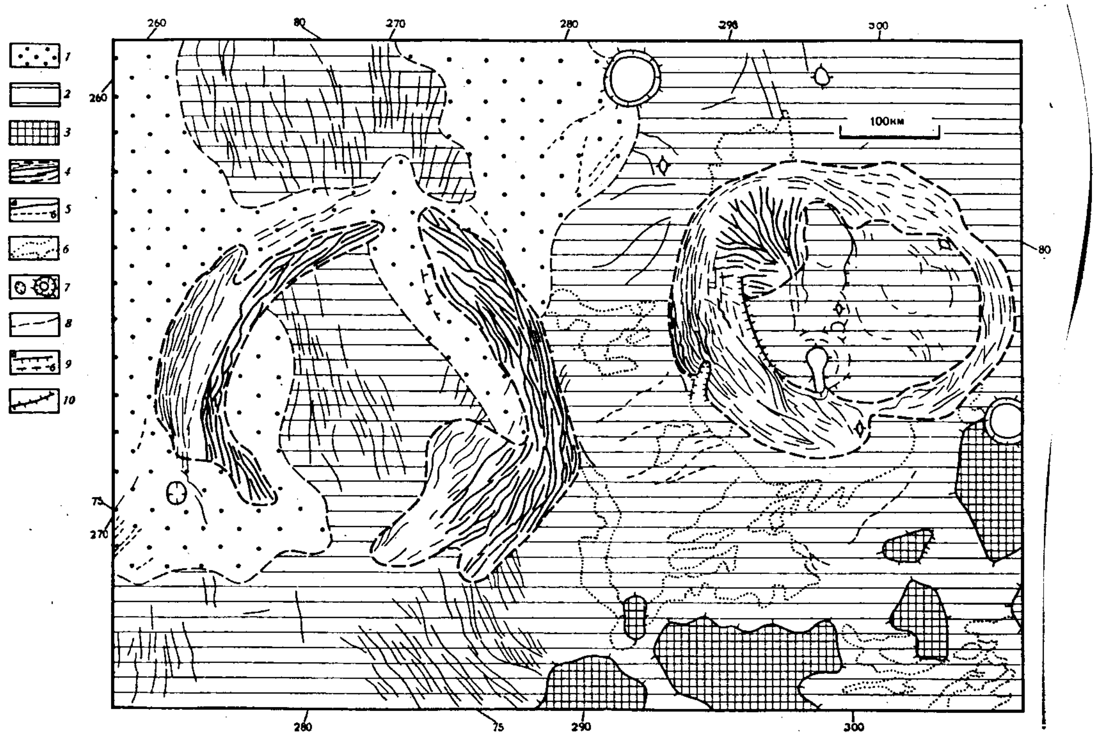

Fig. 9. Interpretation of the Anakhit and Pomona Crowns: 1 - smooth plain; 2 - rolling plain; 3 - parquet terrain; 4 - ridge structure of crowns; 5 - distinct (a) and indistinct (b) ridge structures; 6 - outlines of radio-bright spots; 7 - impact craters; 8 - boundaries of the terrain types; 9 - distinct (a) and indistinct (b) escarpments; 10 - crests.

Two major (around 400 km) ring structures (Fig. 9) have been mapped within the northern polar region, known as "crowns" on account of their morphological peculiarities [2]. These structures, both in shape and in size, have no immediate resemblances to anything on earth or the other planets. There is only a remote suggestion of the Precambrian ovoid massifs on earth [6]. These ring structures, known as the Anakhit crown (77° N.L., 280° W.L.) and the Pomona Crown (79° N.L., 300° W.L.), are examples of both a crown of the most conspicuous shape and relief and of a crown which has been significantly altered by volcanic processes. As the investigation of similar formations over the entire territory of the radar survey revealed [2], a /192 whole series of transitional forms in the size interval between 200 and 500 km exists between these extreme manifestations of ring structure. The greater number of such formations are characterized by a concentric system of ridges on their periphery, outlining the structure as a whole in the form of a ring (or fragments thereof) of roughly oval shape (Fig. 9).

The surface of the center of the crowns, which generally rises above the surrounding locality, is not homogeneous - there are isolated depressions and elevations with relatively even surface, as well as sections with relief similar to the relief of the parquet terrain of the Tessera Itzpapalotl and the Tessera Fortuna. Morphological indications of tectonic disturbances of the rocks, observed in the ring-shaped ridges of the Anakhit crown, as well as volcanic structures and traces of lava flows, which complicate the Pomona Crown, suggest a volcanic-tectonic origin of these formations.

Meteorite craters. In the explored region (within limits of 75° N.L.) there were 17 crater structures mapped, belonging to the meteorite craters in characteristic morphological features. Depending on the degree of preservation of their shape, these formations are represented by craters of the first to the third morphological class, while their size varies from 14 to 136 km. Most of these craters belong to the second morphological class (64%). The craters of the first class comprise 24%, those of the third 13%. Worthy of note is the fact that the density of distribution of craters in the northern polar region proved to be much higher than that over the entire remaining territory of the northern hemisphere of Venus subject to the radar survey. Thus, the region charted by us, which constitutes 5% of the entire territory of the planet surveyed by Venera 15 and 16, contained 15% of all craters detected in the radar pictures. Such an elevated number of craters (unless a natural fluctuation) implies that the surface of Venus within the confines of the northern polar region is apparently more ancient than the other surfaces in the zone of the radar survey. While according to the available crater statistics the average age of the surveyed territory of the northern hemisphere of Venus is 0.5-1 billion years [1], the age of the surface of the northern polar region may prove somewhat more ancient.

Geological relationships. The above described terrain types and individual formations are not confined to the polar region studied. They are widespread over the entire planetary surface within the radar survey [2,4]. The charted terrain types constitute the observable vestiges of planetary activity left by the geological processes during the various stages of its evolution. For now, it is not possible to estimate the absolute ages of the different sections of the surface of Venus, although the relative sequence of the major stages in the formation of its surface may be reconstructed from the observable relationships among the principal types of terrain and the individual geological structures. /193

The following relationships have been discovered by geological morphological analysis of the radar pictures. The striated-ridge plain is usually superposed on the other terrain types. The surface of this plain is covered either wholly or in part by plain-forming materials, laying down rolling and smooth plains. Less clearcut relationships are found between the striated-ridge plain and the ridge belts. Judging from the gradual transition of ridge structures and radio-bright bands into the structures of the ridge belts (e.g., in the vicinity of the Yumyn-udyr ridges and the Lukelong ridges, Fig. 2 and 3), it can be assumed that the formation of these terrain types took place in a recent period of time. However, the fact that a similar orientation of the lineaments of the striated-ridge plain is preserved at either side of the belt of the Sel-ani ridges indicates that the belt structure intersects the surface of this plain. This provides a reason for assuming that the surface of this type of plain is somewhat more ancient than the ridge belts. The ridge belts themselves are covered (or outlined) in the investigated region by the plain-forming material of the rolling and smooth plains, and are also intersected by the parquet terrain. The former is confirmed by the example of the Dennitsa, Tezan, Sel-ani ridges and the Yumyn-udyr ridges. The same is proved by the presence of buried fragments of ridge belts within the rolling plain (Fig. 3,7). The hypsometric data indicate that the relief height gradient within the ridge belts does not exceed a few hundred meters. Since the ridgelike relief of the belts vanishes in areas where covered by the plain forming material, it may be conjectured that the thickness of this material within the confines of the polar region is several hundred meters. The most convincing instance of intersection of the ridge belt by a parquet terrain is observed in the region with coordinates 75° N.L. and 80° W.L. Here, the intersection of the belt of Sel-ani ridges by the parquet terrain of Tessera Fortuna is most evident. In this same region, the covering of the surface of individual segments of Tessera Fortuna by the material composing the rolling and smooth plains is very conspicuous. This is further proved, both by the ingressions of plain-forming material in the relief of the parquet terrain (e.g., in the regions of craters Ulrika and Dashkov) and by outliers of this terrain within the rolling plain (e.g., in the region of the Dyan'-mu ridges).

The northern fringe of the mountainous terrain of the Tessera Itzpapalotl clearly reveals how its outermost linear structures are gradually buried beneath the cover of the rolling plain, becoming lineaments of indistinct origin.

The "crown" ring formations charted in the explored region, like the similar structures in other regions of the survey [2], gravitate toward the level terrains. This type of structure is covered in different degrees by the material of the rolling and smooth plains. Occasionally it is associated with interrupted systems of ridges, which appear to be cut in relation to the crowns (e.g., in the case of the Anakhit crown). In certain /194 cases the crown directly intersects a ridge belt, as for example the unnamed ring structure which complicates the Dennitsa ridges (76° N.L., 205° W.L.).

According to the previously published results of geological morphological analysis [2], crowns are almost totally absent from the parquet terrains, but are preferentially situated about their periphery or in regions of development of ridge belts. This may serve as an indirect indication that the crowns were formed prior to (or at the inception of) the development of the parquet terrains.

Such formations as the clusters of hills gravitate toward the surfaces of both the rolling and the smooth plains, while the domelike structures more often occur on the rolling plain. More than half the meteorite craters in the polar region have been found within the striated-ridge plain and the ridge belts. Many of the charted craters are characterized by excellent morphological preservation of the crater depression itself, with little or no indication of the zone of ejected matter; this may be the result of partial covering of the zone of ejected matter by the plain-forming material. An alternative mechanism of liquidation of the zone of ejected matter may be the wind action on the surface of the planet.

Conclusion

According to the results of the analysis of altimeter information from Venera 15 and 16, the northern polar region is a vast lowland, the surface of which is primarily constituted of level terrain in combination with a system of ridge belts and isolated ring structures - "crowns." The heightened density of impact craters indicates that the surface of the explored region is apparently the most ancient of the entire territory of the survey conducted by Venera 15 and 16.

The following conclusion may be drawn from the geological relationships discovered among the various types of plains, ridge belts, crowns and parquet terrain. The most ancient type of terrain in the polar region of the planet is the striated-ridge plain, which has been complicated by the ridge belts somewhat afterwards. Apparently, the formation of this plain was originally due to the development of basaltic vulcanism of the lunar mare type, which later culminated in the development of intrusive activity and the action of tectonic deformations. These processes (with probable involvement of aeolian processes) resulted in formation of the numerous ridge forms and light lineaments observable at present. Subsequently, the deformational stresses became localized into linear zones, resulting in formation of the peculiar type of ridge belt terrain. The /195 ring structures of the "crowns" were formed predominantly after the ridge belts and preceded the development of the parquet terrain. The stage of surface lava extrusions, which came next, variously affected the "crowns" as well, resulting in the observed morphological diversity of this type of structure. The parquet terrain of the Tessera Itzpapalotl and Tessera Fortuna was primarily formed after the ridge belts, but is more ancient than the surface of the rolling and smooth plains. The plain forming material of the smooth plain is superposed over all the discovered types of terrain and geological structure. Evidently, this is one of the most recent terrains of the planet.

The investigated region is characterized by a relatively recent observed population of impact craters (64% of the craters belong to the second morphological class) and absence of heavily degraded craters, so characteristic of the primordial continental crust of the moon, Mercury and Mars. This implies that, prior to formation of the most ancient of the observed terrains of Venus, the planet was subjected to a period of intense endogenic (and, possibly, exogenic) reworking of the surface, eliminating the traces of the earlier intense meteorite bombardment. The relatively young population of craters observed at present may testify to a considerable quieting of the processes of surface reworking of the planet during the last billion years.

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