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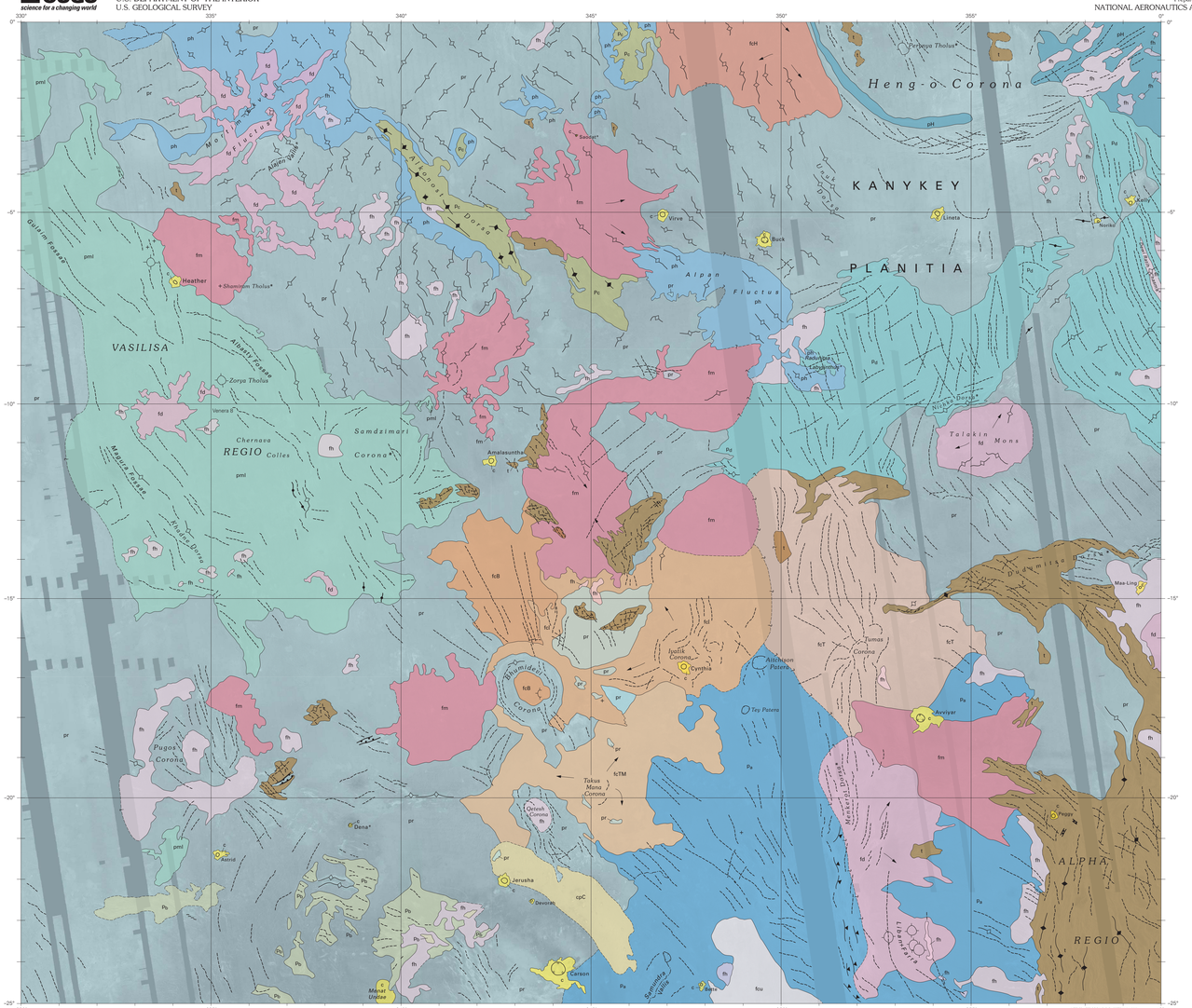
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

GEOLOGIC INVESTIGATIONS SERIES I-2620
ATLAS OF VENUS: CARSON QUADRANGLE (V–43)



* Indicates name is provisional; it has not been approved by the International Astronomical Union.

SCALE 1:5 198 981 (1 mm = 5.198 km) AT 0° LATITUDE
1:4 711 886 AT 20° LATITUDE
MERCATOR PROJECTION

Prepared on behalf of the Planetary Geology Program, Solar System Exploration Division, Office of Space Science, National Aeronautics and Space Administration

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DESCRIPTION OF MAP UNITS

[A listing of the physical properties associated with each unit can be found in table 1. Backscatter coefficient (σ_0) values for each unit are shown in figure 3]

FLOW UNITS

[Typically of limited extent; unit source construct/area often identifiable; flows may have lobate margins; related flows are grouped according to morphology and relative stratigraphic position into units fm, fcM and fh; all occurrences of a single unit did not necessarily form from identical materials simultaneously throughout each period of time]

Corona flows—Material, often in digitate form, of various backscatter—bright to dark; individual lobes up to 100 km long and 5 to 10 km wide; material originates at or near the base of steep-sided structure or large show within structure; contacts with adjacent units typically sharp. *Interpretation*: Volcanic flows related to corona formation/evolution, or post corona flows utilizing corona structures/weaknesses

Corona flows, Heng-o—Associated with Heng-o Corona (at 0°, long 355° E.); occurs on west side of corona

Corona flows, Tumas—Associated with Tumas Corona (at 16° S., long 352° E.)

Corona flows, Iyatik—Associated with Iyatik Corona (at 16.5° S., long 349.5° E.)

Corona flows, Takus Mana—Associated with Takus Mana Corona (at 19.6° S., long 345.3° E.)

Corona flows, Bhumidevi—Associated with Bhumidevi Corona (at 17.2° S., long 343.6° E.)

Corona flows, unnamed—Associated with unnamed corona at lat 27° S., long 348° E. (south of map area)

fd **Digitate flows**—Dark, intermediate, and bright radar backscatter materials forming digitate patterns; some areas primarily of dark flow units; lengths of individual flows vary (10 to 50 km); typically material may have radial pattern around source area; source areas typically composed of numerous small edifices or single larger construct; contacts with adjacent units are sharp. Type locality: lat 8.5° S., long 350° E. *Interpretation*: Unit comprises multiple volcanic flows

fh **Homogeneous flow**—Areas of uniform backscatter—dark, intermediate, or bright; typically associated with single small edifice; some have fracture as apparent source area; contacts with adjacent units are sharp. Type locality: lat 14° S., long 336° E. (dark). *Interpretation*: Unit comprises single volcanic flow or multiple related flows

fmM **Mottled flow**—Material with mottled appearance—circular to elongate patches of bright, intermediate, and dark radar backscatter; mottling on scale of 10 to 20 km; numerous small edifices typically present; margins of areas have portions almost digitate in form; contacts with adjacent units are sharp. Type locality: lat 8.5° S., long 342° E. *Interpretation*: Unit comprises numerous small volcanic flows originating from small edifice sources

PLAINS UNITS

[Typically covers extensive areas with no identifiable source area and no indication of flow direction]

pr **Regional plains material**—Material having dark to intermediate radar backscatter; some parts broadly mottled, others uniform in backscatter; modified to form coronae; prominent wrinkle ridges in northern portion, less prominent in southern portion; lineaments locally present; contacts with adjacent units generally sharp. Type locality: lat 8° S., long 339° E. *Interpretation*: Volcanic plains modified at some time by fractures

ph **Plains material, unit a**—Material having intermediate radar backscatter; some areas broadly mottled, others more uniform; fractures, lineaments, small edifices, and channels abundant in western section; limited lineaments and small wrinkle ridges present in eastern section; contacts sharp to gradational. Type locality: lat 22° S., long 355° E. *Interpretation*: Volcanic plains modified at some time by structures

Homogeneous plains material—Material having bright radar backscatter; limited amounts of wrinkle ridges present; some channels present; contacts with adjacent units sharp, often lobate. Type locality: lat 0.5° S., long 338° E. *Interpretation*: Volcanic plains

pH1 **Plains material, Heng-o**—Material having intermediate radar backscatter; abundant wrinkle ridges on very fine scale; modified to form ridge of Heng-o Corona. Type locality: lat 0.1° S., long 359.9° E. *Interpretation*: Volcanic plains modified at some time by structures

p_b **Plains material, unit b**—Isolated areas of material containing closely spaced parallel lineaments or fractures; radar backscatter is low to intermediate; parabolic ejecta deposit from Carson crater; lineament spacing 1 to 5 km, lineament trend west-northwest to east-southeast; contacts with exterior margin units sharp, lineaments terminate at contact. Type locality: lat 23° S., long 340° E. (west of Carson crater). *Interpretation*: Older volcanic plains (fowM) modified at some time by lineament formation

pml **Mottled, lineated plains material**—Material having intermediate to bright radar backscatter; mottled; lineaments are locally present (spacing of 2 to 5 km); in areas lineaments trend northwest-southeast; in other areas lineaments are arcuate in a circular pattern; numerous small edifices present; unit slightly elevated in relation to surrounding plains, gently rolling topography; contacts with adjacent units generally sharp. Type locality: lat 13° S., long 336° E. (units in western part of map area). *Interpretation*: Older volcanic plains (fowM) modified at some time by structures (lineaments, coronae)

p_L **Plains material, unit c**—Material having dark to bright radar backscatter; ridges locally present (spacing tens of kilometers); rolling (with 10 to 30 km), ridges trend northwest-southeast; lineaments, fractures, and some small grabens present; contacts with adjacent units sharp. Type locality: lat 30° S., long 342.5° E. *Interpretation*: Material (volcanic flows?) which has been modified by ridge (possibly fold) formation

p_d **Plains material, unit d**—Material having intermediate to bright radar backscatter; lineaments are abundant, in some places forming a gridded pattern; lineament spacing 5 to 10 km; lineaments trend generally toward the north, secondary trend toward east-northeast; contacts sharp at northern boundaries, more gradational at southern margin. Type locality: lat 9° S., long 353° E. *Interpretation*: Volcanic (?) plains, modified at some time by lineament formation

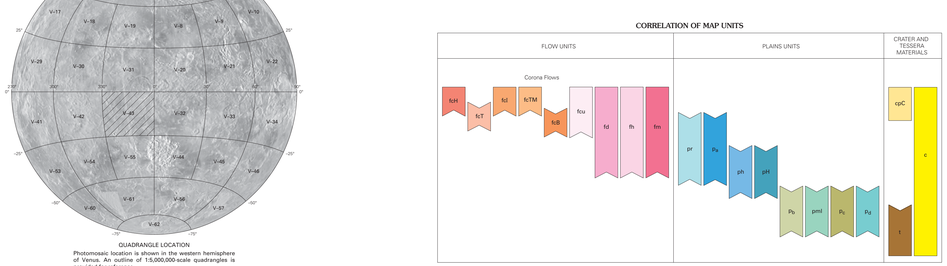
CRATER AND TESSERA MATERIALS

cpC **Crater parabolic ejecta material, Carson**—Intermediate radar backscatter; mantles underlying material and structures; gradational margins; north of and associated with Carson crater. Type locality: lat 23° S., long 345° E. *Interpretation*: Air-deposited material related to Carson cratering event and parabolic ejecta halo deposition

c **Crater materials**—Consists of (1) crater floor material—radar bright or dark, (2) crater rim and ejecta material—radar bright, and (3) crater outflow material—radar bright to dark flows originating at crater or within crater boundaries typically sharp. Type locality: Carson crater, lat 24.2° S., long 344.1° E. *Interpretation*: Originated from exogenic impacts event and response of impacted materials to shock and thermal alteration

t **Tessera material**—Bright radar backscatter due to structural (wrinkling) material affected by ridges and fractures, having single or multiple deformation trends, lineament spacing typically 2 to 5 km, lengths tens to hundreds of kilometers; locally elevated; contacts with adjacent units typically distinct. Type locality: Alpha Regio. *Interpretation*: Old material, possibly of volcanic origin, that has been subjected to one or more period of deformation. In map area base unit is covered and embayed by subsequent volcanic activity and other processes

CORRELATION OF MAP UNITS



QUADRANGLE LOCATION

Photomosaic location is shown in the western hemisphere of Venus. An outline of 1:5,000,000-scale quadrangles is provided for reference.

GEOLOGIC MAP OF THE CARSON QUADRANGLE (V–43), VENUS

By
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2000

STRATIGRAPHY

Because the number of impact craters on Venus is small, standard crater counting techniques do not supply sufficient information to establish the relative stratigraphy between map units. Rather, relative ages, determined from unit superposition, crosscutting, and embayment relations, provide a clearer approach to assess the geologic history of the Carson region.

Tessera (unit t), the largest occurrence of which is found at Alpha Regio, is stratigraphically the oldest unit exposed in the map area. The relative ages among the various widely spaced exposures of this tectonically complex unit are unknown; however, in all occurrences, the unit is embayed by younger volcanic units. The appearance of tessera is dominated by tectonic lineaments, making the determination of a possible material unit variations impossible. From a material standpoint, tessera is therefore mapped as a single unit. However, variations in tectonic structures can distinguish tectonic units to be identified and mapped (Bender and others, 1996) (see fig. 2). Within Alpha Regio tessera, two distract zones of lineations are identified: (1) a complex narrow zone composed of ridges and troughs trending in multiple, cross-cutting directions—reflecting three distinct stress regimes, and (2) —125-kilometer-wide belt of ridges and troughs along Alpha's western margin that generally trends north-south—parallel to the contact with younger lava flow materials to the west. The range in type and trend of deformation within Alpha Regio indicates that this area of tessera was formed by multiple tectonic events and that care should be exercised in mapping it and other disparate outcrops of tessera as a single stratigraphic map unit.

The vast majority (>90%) of the surface in the Carson quadrangle is made up of plains units. The oldest plains units fills p_b, p_d, and pml were tectonically modified prior to embayment by more recent units. Insufficient data exist to determine the relative age of the contact between the different units. Because most units are not in direct contact with each other, age relations cannot always be clearly determined. Plains unit b (unit p_b) is characterized by densely packed, parallel lineations trending generally west-northwest to east-southeast, whereas mottled, lineated plains material (unit pml) exhibits some northeast–southeast trending lineations as well as areas of arcuate features, perhaps indicating the presence of very old, degraded coronae. Plains unit c (unit p_L) has been modified by the formation of ridges and fractures, and its two major occurrences (at 5° S., long 350° E., and lat 7° S., long 345° E.) have been deformed and uplifted, producing elevated ridge belts. Plains unit d (unit p_d) is characterized by a pattern of lineations forming a grid that trends approximately north-south, east-northeast to west-southwest, and northwest to southeast. This unit is superposed in its northeastern section by younger flows.

Intermediate-age plains include two units: plains unit a (unit ph) is associated with Heng-o Corona (unit pH) near, and possibly associated with, the formation of the corona (in the northeast corner of the map area), and homogeneous plains material (unit pH). Unit pH is characterized over most of its extent by fine-scale, closely spaced wrinkle ridges having an average length of 10 kilometers and spacing between 2 and 5 kilometers. The longest wrinkle ridges are up to 40 kilometers long. The south rim of Heng-o Corona is a large ridge bounded by troughs. The ridge appears to be formed of unit pH. Unit ph is found in the northern part of the map area and is characteristically higher in backscatter than the surrounding plains. The age relation between unit ph and the surrounding regional plains material (unit pr) is typically difficult to determine. Homogeneous plains material appears to be embayed by regional plains material in most places; however, the exposure at lat 7° S., long 347° E. suggests that unit ph has embayed unit pr.

The younger plains materials in the map area are units pr and pa, with the regional plains material (unit pr) being the most extensive plains unit in the map area. Regional plains (unit pr) are most likely composed of multiple flow units emplaced over an unknown time period. In the southern part of the map area, plains unit p_d is interpreted to have been emplaced contemporaneous with unit pr. The contact between unit pr and unit p_d is masked by the parabolic ejecta halo of Carson crater in the southern portion of the map area. These units are distinguished mainly by unit pr having a radar darker appearance. Unit p_d may represent part of unit pr with a slightly different surface texture rather than a separate episode of emplacement.

Digitate, homogeneous, and mottled flows (units fd, fh, fm) account for the remainder of the volcanic units within the Carson quadrangle. Whether originating at fractures or volcanic edifices, these are localized units with identifiable sources. Though relative age varies by location, these flows are always superposed on the surrounding units. Evidence of multiple episodes of lava emplacement exists in several locations. An example is at Liban Farra, a group of steep-sided domes at lat 23.5° S., long 353° E. The domes appear to have been formed after the initial flow of the unit they occur within, but prior to the final flow of the unit at this location. Units fd, fh, and fm are mapped based on flow morphology. It is not suggested that all these units formed at the same time in the widely distributed locations throughout the quadrangle, nor that they are all of the same material, only that there is a common morphologic character to the units which, with their stratigraphic relations, separates them from other volcanic units in the map area. Slight variations do exist among different outcrops of the same unit; an example is the occurrence of unit fm at lat 10° S., long 345° E. In SAR appearance this unit is no different from other locations where unit fm is found; however, examination of the emissivity data set shows that unit fm at lat 10° S., long 345° E. has a lower emissivity value than other occurrences of the unit within the map area.

In the south-central portion of the map area and at Heng-o, the plains have been modified by the formation of more recent coronae with elevated rims, annulus of fractures, and so on. Associated with most of these coronae are lava flows, which, in some cases, nearly bury the corona. The relative timing of corona-related tectonic deformation and associated volcanism is not well determined. At two locations, Takus Mana Corona (lat 19.5° S., long 345° E., unit fcTM) and Iyatik Corona at lat 16° S., long 347° E. (unit fcB), lava flows appear to be the youngest units in the area. Examination of altimetry data show that lava flows from Tumas (lat 16° S., long 351° E., unit fcT), and Takus Mana coronae (unit fcTM) and the corona at lat 27° S., long 348° E. (outside map area) (unit fcu) all derive from elevated source regions within the corona. In contrast, flows from Heng-o (unit fcH) and Bhumidevi coronae (at 17° S., long 343.5° E., unit fcB) appear to originate from arcuate fractures along the periphery of the coronae.

Crater material (unit c) and crater related deposits are found throughout the map area and superpose surfaces of all types. The crater parabolic ejecta material (unit cpC) is part of the parabolic material associated with Carson crater, which, in this location, is thick enough to completely mantle the underlying surface. In the remainder of the parabola, the underlying surface is visible through the thin, radar-dark deposit.

STRUCTURES

TECTONIC FEATURES

As previously discussed, the map area contains a variety of tectonic features, including ridges, troughs, fractures, grabens, lineaments, and coronae. The densest concentration of tectonic structures in the Carson quadrangle is found within outcrops of tessera, the largest of which is the Alpha Regio highlands (topographically a plateau) in the southeast corner of the map area. The complexity of this area of tessera led to detailed structural examination and preparation of a tectonic area map. Examination of tessera for structural trends rather than material differences led to the identification of five structural units within Alpha Regio tessera (see fig. 2); portions of four of these units (units A, B, C, and D) are found within the Carson map area. All four tectonic units contain both contractional (ridges, troughs) and extensional (fractures, grabens) features, with extension appearing to post-date contraction. Most agree that ridges record an early phase of contraction followed coeval by extension to form the grabens (Bindschadler and others, 1992). This sequence of deformation could occur by a change from contraction to extension, due to either progressive deformation or two separate unrelated events (Hansen and Willis, 1996).

Differences in feature trends within the four tectonic units of Alpha Regio tessera in the Carson map area indicate variation in the regional stress regimes during formation. Area A consists of extensional terrain (sheet paired linear fractures) and arcuate ridges bordered by troughs. The average trend for extensional terrain is N. 51° W. As previously mentioned, extensional terrain post-dates the ridge and trough system indicative of area A. The arcuate ridges have a dominant northeast trend. Outside the Carson map area extensional ridges give a radial appearance. The change in trend direction, or the change in the orientation of the strain regimes from northeast to northwest, requires that polyphase deformation took place (Hansen and Willis, 1996). Spacing of individual ridges varies from 20 to 30 km. Average ridge length is 40 km.

Area B, which is approximately 1 km lower than the rest of Alpha Regio tessera, consists of extensional terrain, anastomosing fine- and broad-scale ridges and troughs, fractures, and grabens. Extensional features have a general trend of N. 26° W. Fine- and broad-scale ridge and trough systems trend approximately N. 26° E. and generally parallel to highland border. Most ridge and trough structures are approximately 2 kilometers wide and up to 60 km. Fractures occur mainly along the eastern border of area B and tend to follow the same trend as adjacent ridges. Spacing of fractures ranges from less than 3 km to 24 km. Grabens occur in the northern part of the area and vary in trend from N. 55° W. to N. 9° E. with widths averaging 3 km. Crosscutting relations between grabens are quite prevalent, with many of the northwest-trending grabens parallel to the broad-scale ridge features of area D, indicating convergence of two different stress regimes.

The western termination of area C occurs within the map area. Area C is a broad zone composed of linear disruptions, fine-scale linear ridges, broad-scale linear and arcuate ridges, and grabens. According to Bindschadler and others (1992), the disruption zone can consist of narrow troughs filled by radar-dark plains, wider zones characterized by radar-bright lineaments (scarps), and linear zones along which most cross-structures are truncated. The disruption zone, which has lineation trends of west-northwest or east-northeast, causes a deflection in adjacent structural trends so as to align the structures with the zone as they approach it. The interactions that occur between the disruption zone and other structures suggest that the zone is probably a complex shear zone representing an area of accommodation during compressional and extensional deformation rather than a manifestation of strike-slip offset (Bindschadler and others, 1992a; Senske and others, 1991).

Area D consists of extensional terrain, broad-scale linear ridges, and grabens. Due to extensive deformation within the highland the visible occurrence of extensional terrain within area D is localized with trends ranging from N. 23° W. to N. 37.5° W. As in area A, extensional terrain appears to post-date ridge and graben structures. Broad-scale ridges have lengths varying from 30 to 60 km, with 40 km being the most prevalent, and average spacings of 15 to 20 km. A possible lack of a strain gradient is indicated by there being no obvious change in ridge spacing throughout the area. Average ridge trend within the Carson map area is N. 23.1° W. Ridges are cut by localized bands of grabens. Graben trend, in most cases, is perpendicular to the ridge axis the graben cuts.

Within the various other units of the map area exist numerous tectonic structures, including scarps, fractures, and ridges. The ridges of unit p_b are contractional and trend northwest. Fractures in unit p_b trend west-northwest to almost east-west. Fractures in unit p_d have a dominant trend to the northwest (N. 20° W. to N. 26° W.) and secondary trends north-northeast and east-northeast. Scarps within unit p_b parallel the boundary of the nearby Alpha Regio tessera (N. 10° W.), whereas associated fractures to the west of the scarps trend generally N. 26° W. All the fractures and scarps mentioned above are interpreted to have formed due to extension. The similarities in trend and feature type between the structures found within plains units and the structures of Alpha Regio tessera may indicate that tectonic activity responsible for the formation of the tessera lasted long enough to affect materially younger units. Wrinkle ridges found within the regional plains (unit pr) and young flow materials of the northwestern part of the map are apparently the youngest structural features in the map area. Wrinkle ridges are interpreted to represent compression. No dominant trend of the wrinkle ridges exists in the map area; they range from northeast to north to northwest. The almost orthogonal pattern appears to represent local accommodation (bending of the ridge for intersections with no offsets) rather than different episodes of compression.

One of the most interesting, and unique, structures on Venus is the corona. As interpreted in this study, Carson quadrangle contains five major coronae, part of the large Heng-o Corona, and these features interpreted to be old, degraded coronae that are characterized by arcuate fractures. Heng-o Corona (800 kilometers in diameter) is centered at lat 2.0° N., long 355.0° E. The southern rim of Heng-o Corona lies within the map area. In comparison to its elevated northern rim, the structure of the southern rim of Heng-o is characterized as a narrow ridge bounded on both sides by a trough. The plains to the south of the corona and at nearly the same level as the top of the ridge are complexly fractured and deeoted into a series of smaller ridges and troughs. The three lineaments interpreted to be old, degraded coronae are centered at lat 8.5° S., long 334° E., lat 10° S., long 336.5° E., and lat 11° S., long 339.5° E. (Sandimari Corona). The so-called Pugos Corona (lat 19° S., long 335° E.) is not interpreted by the mappers to have formed by classical corona evolution processes.

With the exception of Heng-o Corona, the coronae within the Carson quadrangle are all clustered in the south-central portion of the map area. The five major coronae are all similar in size (measured to the edge of the major annulus of concentric fractures).

Qetesh Corona 20.5° S., 343.5° E.—80 kilometers in diameter
Bhumidevi Corona 17.2° S., 343.6° E.—175 kilometers in diameter
Takus Mana Corona 19.6° S., 345.3° E.—125 kilometers in diameter
Iyatik Corona 16.0° S., 347.5° E.—125 kilometers in diameter
Tumas Corona 16.3° S., 352.2° E. 100 kilometers in diameter

These coronae are surrounded by younger plains-forming volcanic flows. With the exception of Qetesh Corona, all the coronae have associated volcanic flows. Because there are no clear overlapping relations, it is not possible to determine age relations among the various corona. However, some of the flows that originate from the coronae, either from a source central to the structure or from the fractures, exhibit in some areas superposition relations (discussed above). The age relations among the corona-related flows may be indicative of the relative timing of the tectonic deformation that formed the structure of the individual corona.

VOLCANIC FEATURES

Volcanic constructs in the Carson quadrangle include large edifices, small shields, and steep-sided domes. Three major volcanic edifices are present in the map area. Sandali Mons is superposed on regional plains material and consists of digitate flows radial to the summit. Another relatively large volcanic edifice is on the southwest portion of the elliptical Tumas Corona, and a smaller edifice is in the center of Takus Mana Corona.

Small shield volcanoes occur throughout the map area, but they do not appear to be related to any single unit or type of unit. Small shields range in size from the limit of resolution to ~5 km. Ten steep-sided domes occur within Carson quadrangle and range in size from 10 to 24 kilometers in diameter. Geologic associations show the steep-sided domes occur on younger plains-forming lava flows and with coronae. A cluster of steep-sided domes, Liban Farra, is west of Alpha Regio at lat 23.5° S., long 353° E., and a single dome lies within the Venera 8 landing circle.

GEOLOGIC HISTORY

A major part of the geologic history of Venus is recorded in extensive regions of plains that make up over 70% of the surface of the planet. Assessment of the stratigraphy of these units provides a basis through which the processes by which the planet has been resurfaced can be evaluated. The diversity of units and the establishment of distinct stratigraphic assemblages within Carson quadrangle allow a detailed history of the region to be determined. In this section, we evaluate age relations between units, identify and constrain different episodes of tectonic activity, and examine the relation between the styles of volcanism and different episodes of plains emplacement.

On the basis of crosscutting and superposition relations, the stratigraphically oldest unit in the Carson quadrangle, tessera (unit t), is typically found as high-standing isolated occurrences. The largest tessera outcrop, at Alpha Regio, is characterized by distinct truncation of tectonic fabric, ridges and troughs, at its boundary with adjacent plains units. The contact between tessera and plains indicates a history characterized by (1) the initial emplacement of pre-tessera surface material, (2) subsequent series of deformation events forming the tessera surface and the elevated topography, with extensional processes found to post-date contraction in most cases, (3) initial volcanism that embayed the margins of the tessera, and (4) later small-scale volcanic flows. Since it generally is not possible to identify flows lobes associated with the lava flows of stage 3 above, these deposits are interpreted to have been emplaced by flood volcanism. The span of time over which tessera-forming tectonic deformation occurred cannot be well established. That is, it may have been intense and short lived or it may have occurred at a modest rate over a long period of time.

Although tessera is distinguished by its multiple episodes of deformation, as demonstrated by the various orientations of its tectonic fabric, additional, relatively intense tectonic activity is recorded within plains units. This activity may be a record of the final stages of tessera-forming tectonism or may indicate that regional tectonic activity continued for some time after the formation of tessera. West of Carson crater, outcrops of relatively high standing plains, unit p_b, primarily record deformation forming closely spaced linear faults and fractures. This unit, interpreted to be deformed lava deposits, is found as isolated occurrences and is embayed by surrounding, younger lava plains (unit pr). Unit p_b records an episode of deformation that formed fractures, lineaments, some grabens, and ridges.

In addition to plains unit p_b, an assemblage of units (units pml, p_d, and p_d) appear to be at a stratigraphic level comparable to that of unit p_b. The most laterally extensive of these units, unit pml, is along the western margin of the quadrangle, is part of an elevated region that rises several hundred meters above its surroundings, and contains the Venera 8 lander site. This unit is also found in quadrangles to the west and northwest. The material making up unit pml is interpreted to have been formed during an early episode of lava flooding, on the basis of its large areal extent and the lack of flow lobes. Along its southern boundary, a sharp and distinct contact with more recent regional plains (pr) is present. Regional plains are the most extensive unit in the quadrangle. On the basis of the presence of channel segments and the lack of identifiable flow margins, unit pr is interpreted to have been emplaced by lava flooding. Occurrences of unit pr in the northern part of the quadrangle appears abundant, low, widely spaced, sinuous ridges that are interpreted to have been formed by compression resulting in modest crustal shortening. In several locations these ridges cut across units of different ages, providing evidence that the ridges were formed relatively recently.

There is a transition between the style of volcanism that formed early plains units and more recent deposits. The stratigraphically younger surfaces correspond to an assemblage of flow units where it is possible to identify source regions (small to large shields, domes, calderas) and individual sets of lobes. The most distinct group of units corresponds to those that are associated with coronae (units fcH, fcT, fcI, fcTM, fcB, and fcu). Overlapping deposits indicate that multiple episodes of lava emplacement have occurred. In other locations, deposits of relatively limited extent, tens to hundreds of kilometers, are superposed on older plains. These small deposits (units fd, fh, and fm) are typically associated with clusters of small shields or domes and possess a range of radar textures.

The results from geologic mapping of Carson quadrangle show that plains-forming events for this part of the planet were characterized by two distinct styles of volcanism. During the early history of the region, multiple episodes of lava flooding produced laterally extensive units of homogeneous plains. More recently, volcanism has been relatively localized, forming deposits associated with individual shields, shield clusters, large calderas, and coronae. The Carson area also has undergone a series of tectonic events. Three different tectonic episodes have been identified. The first corresponds to tessera formation and records both extensional and compressional deformation. The second tectonic episode is characterized by fracturing and faulting within plains unit p_b and others and may be associated with the trailing end of tessera formation. Finally, the most recent deformation corresponds to widespread, moderate compression that has produced long, narrow sinuous ridges.

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GEOLOGIC INVESTIGATIONS SERIES I-2620 ATLAS OF VENUS: CARSON QUADRANGLE (V–43)

Table 1. *Physical properties values for units in the Carson quadrangle (V–43).*

[Values in parentheses are the minimum and maximum, number of significant digits is a guide to the accuracy of each value. Sigma 0 values were derived using the program MacSigma0 II on C1-MDR data, the remainder of the values were derived using B. Campbell's arc_data program.]

Unit	Latitude, Longitude	Number of Pixels	Incidence angle (deg)	Elevation (km)	Product used
fcM	0.2- 1.0 S, 348.5-349.3 E	134640	45	6051.218 (6050.991, 6051.423)	C1-00N352 frames 27
	1.2- 1.9 S, 349.9-350.8 E	123823	44.8	6051.263 (6051.246, 6051.335)	C1-00N352 frames 36
fcT	15.7-16.2 S, 352.1-352.9 E	108560	45.1	6051.440 (6051.337, 6051.586)	C1-155352 frames 27
	16.7-17.5 S, 352.7-353.8 E	134352	39.7	6051.229 (6051.118, 6051.280)	C1-155352 frames 37
fd	8.0-14.8 S, 348.0-349.0 E	101235	40.5	6051.455 (6051.406, 6051.515)	C1-155352 frames 34
	14.0-14.8 S, 348.0-348.6 E	118755	40.7	6051.455 (6051.406, 6051.515)	C1-155352 frames 35
fcTM	19.3-19.9 S, 344.0-344.7 E	77517	38.7	6051.341 (6051.233, 6051.423)	C1-155352 frames 41
	19.3-19.8 S, 346.1-347.0 E	82212	38.8		C1-155352 frames 42
fcB	14.3-15.1 S, 342.8-343.5 E	130368	40.6	6051.447 (6051.352, 6051.510)	C1-155352 frames 25
	15.0-15.7 S, 343.1-343.5 E	49266	39.5	6051.370 (6050.684, 6051.423)	C1-155352 frames 31
fcu	23.7-24.3 S, 349.2-349.7 E	71065	35.9	6051.389 (6051.278, 6051.487)	C1-305351 frames 4
	24.5-25.0 S, 349.3-349.8 E	56840	35.7	6051.335 (6051.211, 6051.393)	C1-305351 frames 12
fh	10.0-10.5 S, 333.5-334.0 E	54635	42.3	6052.163 (6052.117, 6052.221)	C1-155335 frames 12
	16.4-11.1 S, 334.8-335.9 E	228521	42.1	6052.208 (6051.077, 6053.360)	C1-155335 frames 13
fmM	20.6-21.9 S, 352.6-353.4 E	210105	37.5	6051.279 (6050.983, 6051.492)	C1-155352 frames 53
	22.5-23.0 S, 356.3-356.4 E	29344	36.7	6051.113 (6051.041, 6051.197)	C1-305351 frames 7
fm	9.0- 9.5 S, 349.6-350.1 E	40582	42.7	6051.263 (6051.300, 6051.429)	C1-155352 frames 4
	7.9- 8.6 S, 339.9-340.6 E	83811	43.0	6051.201 (6051.067, 6051.275)	C1-155335 frames 7
	5.7- 6.9 S, 334.7-335.6 E	219219	43.7	6051.312 (6051.192, 6051.629)	C1-00N335 frames 53
	9.5-10.1 S, 346.3-347.2 E	114325	42.5	6051.453 (6051.385, 6051.562)	C1-155352 frames 37
	17.2-18.2 S, 340.1-341.1 E	185277	39.3	6051.297 (6051.134, 6051.487)	C1-155335 frames 39
	17.3-17.9 S, 358.5-359.3 E	92120	39.3	6051.044 (6050.951, 6051.113)	C1-155352 frames 60
	4.4- 5.0 S, 353.0-353.8 E	114228	44.0	6051.503 (6051.415, 6051.579)	C1-00N352 frames 45
	2.0- 2.3 S, 341.9-342.7 E	147798	44.8	6050.823 (6050.644, 6051.000)	C1-00N352 frames 60
	16.5-17.5 S, 337.2-338.4 E	257223	39.6	6051.434 (6051.311, 6051.575)	C1-155335 frames 38
p_a	17.4-17.9 S, 355.2-355.7 E	60258	39.2	6051.033 (6050.996, 6051.070)	C1-155352 frames 58
	21.8-22.4 S, 355.4-356.1 E	39936	37.1	6051.046 (6051.003, 6051.112)	C1-155352 frames 54
	20.9-21.8 S, 347.8-348.4 E	111826	37.5	6051.526 (6051.271, 6051.818)	C1-155352 frames 47
ph	6.9- 7.5 S, 349.5-349.9 E	65041	43.7	6051.148 (