Zone *WD* shows an increase in pine and a decrease in spruce pollen grains. The few birch and willow pollen grains in this upper zone suggest more open conditions.

The relative percentages of nonarboreal pollen grains do not show any significant fluctuations throughout the section exposed in the Court of Claims excavation. Pollen grains from aquatic plants are in general more abundant in the lower horizons and decrease in number upward. Those from sedge and alder reach their highest percentages in the peat. These grains undoubtedly came from plants living along the banks of the river, as indicated by the associated megafossils, and they reflect the gradual decrease in the water level and the establishment of marsh plants which led to the formation of the peat.

The peat accumulation was suddenly terminated by the deposition of overlying silt which destroyed the peat-forming plants. This silt layer, which forms the foundation of the Dolly Madison House, rests conformably on the peat and is here about 1 m thick. Because of its distinctive characteristics and distribution, I suggest that the silt is most likely a loess deposit resulting from wind action on the newly exposed flood plain of the Potomac River when the water level fell during the middle or later part of this glacial period.

The presence of sediments of probable glacial age above interglacial beds and 15 m above the present Potomac River estuary is surprising since it is generally believed that, because of glacial control, sea level was high during interglaciations and much lower during glaciations.

Cooke, who studied the Pleistocene terraces of the Atlantic Coastal Plain, correlated the terrace on which Lafayette Park and the White House are located with his 21-m Penholoway Terrace (*4*). He believed that this terrace was formed by marine or estuarian erosion as a result of falling sea level during the latter part of an interglacial period. In 1935 (*5*) he assigned this terrace, as well as the 43-m, 30-m, and the 13-m terraces also found in Washington, to the Sangamon Interglaciation; but in 1952 he reassigned these terraces tentatively to the Yarmouth Interglaciation.

Cooke placed the Pleistocene sediments, including the Walker Swamp deposit, which underlies these terraces, in the so-called Wicomico Formation. He assumed that the deposition of the Wicomico began during late Kansan Glaciation and continued during the Yarmouth Interglaciation when sea level rose and reached a maximum height of 43 m above its present stand.

Cooke based his correlations largely on geomorphological criteria and on the assumption that there had been little or no land movement along the southeastern seaboard during the Pleistocene. In recent years, however, several authors (*6*) have questioned the Pleistocene stability of the Chesapeake Bay area and the origin and correlation of the terraces. My palynological and geological investigations (*7*) of the terraces and terrace deposits in the District of Columbia and Maryland seem to support these doubts.

My studies indicate that the Lafayette Park terrace and the topmost part of the underlying fossiliferous sediments, such as those exposed in the U.S. Court of Claims excavation, are the result of continued aggrading by the Potomac River, probably during the early part of the Wisconsin Glaciation, and that the maximum height of relative sea level in late Pleistocene time occurred in this area during the early part of this glacial period and not during an interglacial period, as previously believed. I find no evidence that tidewater level in the vicinity of Washington ever reached a height greater than 20 m above the present level during the middle or late Pleistocene.

The Walker Interglacial Cypress Swamp north of Lafayette Park is of probable Sangamon age (*7*). It rests in a broad valley cut through the Pleistocene silts and basal gravels, which underlie Cooke's 30-m and 43-m terraces, and through Cretaceous sediments into bedrock to a depth of 4 m above sea level. This suggests a long period of erosion after the upper terraces had been formed and before the deposition of the sediments below the Walker Swamp, presumably during the Illinoian Glaciation (*8*). It thus appears that Cooke's upper terraces and the underlying Pleistocene sediments, which contain pollen grains indicating a cold climate up to a height of 26 m above sea level, probably date from the early Pleistocene and are certainly much older than the Walker Swamp deposits and the Lafayette Park terrace to the south.

The lower 13-m and 8-m terraces just south of the White House, which Cooke believed to be the result of estuarian erosion during the Yarmouth and Sangamon interglaciations, respectively, were most probably formed by nonestuarian stream erosion as a result of the lowering of sea level and some isostatic uplift (*9*) during the middle or upper Wisconsin Glaciation.

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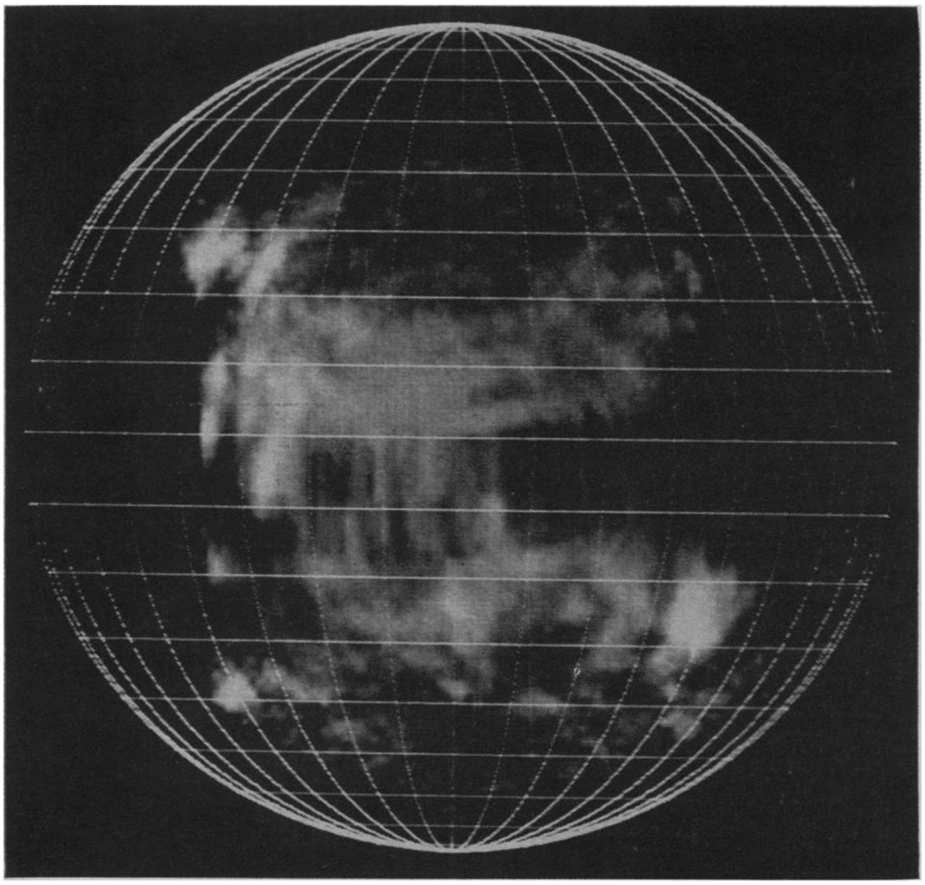
Venus: Mapping the Surface Reflectivity by Radar Interferometry

Abstract. *The surface reflectivity of Venus obtained by radar interferometry at a wavelength of 3.8 centimeters has been mapped for a region extending approximately from −80° to 0° in longitude (Carpenter's definition) and from −50° to +40° in latitude. The map is free from the twofold range-Doppler ambiguity because the interferometer fringe pattern makes possible the separation of two points of equal range and Doppler shift. The map presents many new features and clearly delineates features already observed. Most notably, the map shows large circular regions of significantly lower reflectivity than their surroundings.*

Radar reflections from the planet Venus have provided important evidence on the nature of its surface. The rotation rate (*1*) of the planet has been determined by measuring the frequency spread of the echo from a continuous wave transmission. Furthermore, precise delay measurements (*1*) have been used to determine the orbit and radius of the planet. Analysis of the frequency and delay spectra at various wavelengths indicates that the surface is somewhat smoother on the average than the lunar surface. However, cer-



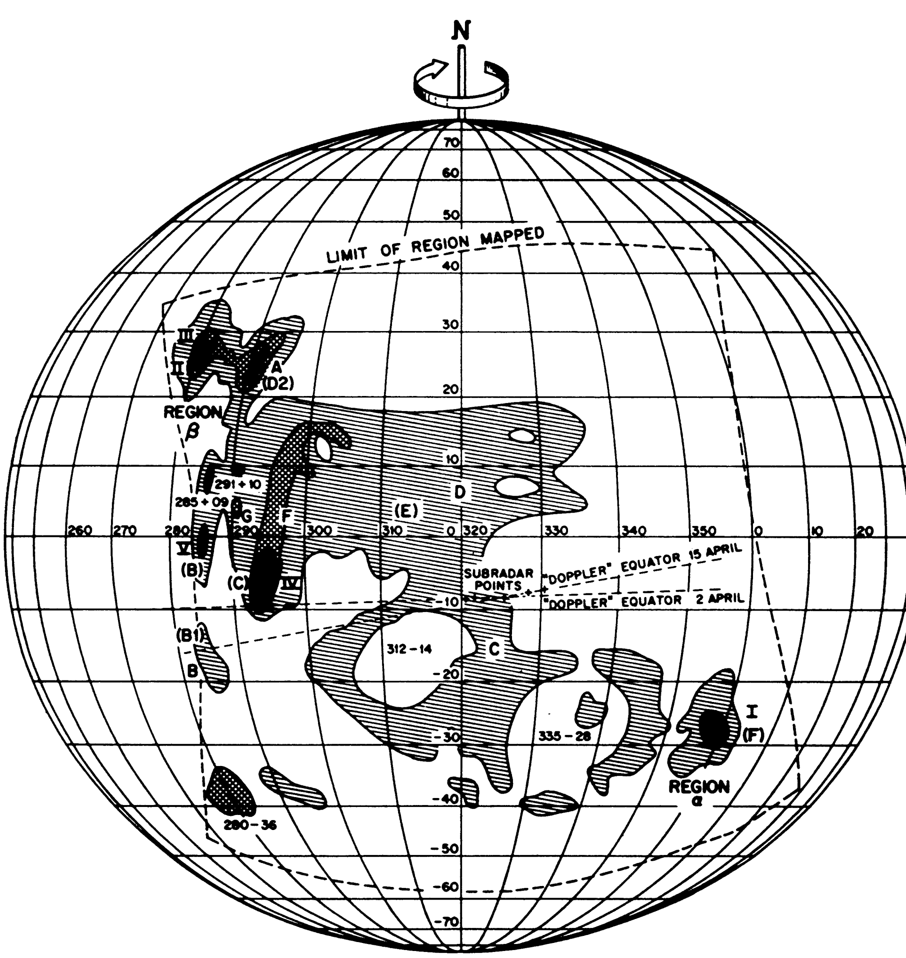


Fig. 1 (top left). Intensity map of the radar backscatter from the planet Venus. Coordinates are Carpenter's planetocentric positions (*2*) with −40° (320°) longitude and 0° latitude at the center. The planet is assumed to have rotated in a retrograde fashion with the earth synchronous period of 243.16 days. The axis direction (Venusian north) was assumed to be 270.3° in right ascension and 66.7° in declination. Data is the average of observations made on 2, 3, 7, 11, and 15 April 1969.

tain regions on the planet show a marked departure from the mean reflectivity most probably due to changes in local roughness. Carpenter and others (*2, 3*) have observed these regions as repeatable features in the frequency spectrum of the echo and have attributed them to surface features mainly because their Doppler shift is in agreement with that expected for a region fixed with respect to the planetary surface. Carpenter has used measurements of the Doppler shift over a period during which a large rotation of the planet has taken place to derive the planetocentric positions of these features. Simultaneous measurements of range and Doppler shift enable one to locate features directly within a twofold hemispheric ambiguity. By range-Doppler mapping we have confirmed the positions of most of the features observed by Carpenter (*2*) and have added some features (*3*). In the measurements reported here we used two antennas as an interferometer during echo reception to resolve this twofold ambiguity.

The Haystack 120-foot (36.5-m) antenna and the Westford 60-foot (18.3-m) antenna (both of the M.I.T. Lincoln Laboratory) located in Tyngsboro and Westford, Massachusetts, respectively, were operated as a radar interferometer at a wavelength of 3.8 cm. The antennas are approximately 1200 m apart along a line 22° east of north. A right-circularly polarized signal of 350 kw was transmitted from the Haystack site,

Fig. 2 (bottom left). Key to map (Fig. 1). Three levels of shading have been used to indicate standard deviation values of approximately 20 (blackened regions), 10 (cross-hatched regions), and 5 (hatched regions). Where features can be identified with the positions measured by Carpenter, the feature letter used by Carpenter is shown in parentheses. Features observed previously by Haystack-Westford radar interferometry (*3*) are indicated by letters and numbers. Newly observed features are labeled by their central coordinates.

and the left-circularly polarized echo was received by both sites. The signal was phase reversal–modulated by means of a 31-element 500-μsec code (*1*). The received signals were decoded, and their frequencies were analyzed with 1-hz resolution. This separates the planetary surface into "range rings" and "Doppler strips." The resolution varies with the size of the "range-Doppler cell," which is at best about 150 km square on the planet's surface and becomes elongated toward the "Doppler equator" (a line perpendicular to the apparent rotation axis going through the subradar point). The signals from the two sites are then cross-multiplied to obtain the complex cross power or "fringe amplitude and phase" for each range-Doppler cell. The fringe pattern is rotated so that lines of constant phase are normal to the axis of apparent rotation of the planet. Thus two cells with the same range and Doppler shift contribute to the complex cross power with phases that are equal in magnitude and opposite in sign. The fringe spacing along the apparent rotation axis is due to the projection of the base line onto the axis. Typically, this amounted to about six fringes across the planet's disk.

If the fringe phase of the upper cell of an ambiguous pair is ϕ, the sum of the powers from the two cells is

$$P_u + P_l = \text{(real part of cross power)}/\cos\phi \quad (1)$$

and the difference of powers is

$$P_u - P_l = \text{(imaginary part of cross power)}/\sin\phi \quad (2)$$

These equations are solved for P_u and P_l by least-squares analysis for a set of observations over which ϕ varies considerably because of variation in the projected base line.

To correct for the drifting of the fringe pattern owing to irregularities of refraction in the earth's atmosphere, the echo from the subradar region was used as a "phase calibrator" every 15 seconds; that is, the fringe phase of the subradar region was measured and all other phases were referred to it. The effects of the Venus atmosphere on the location of the range-Doppler cells should be negligible on the scale of resolution observed for a model based on a CO_2 atmosphere with a pressure of 200 atm at the surface. Effects become serious near the limb but the map does extend far enough back to require correction.

Figure 1 maps the radar reflectivity on a system of planetary coordinates defined by Carpenter (*2*). The intensities have been scaled to take into account the "mean planetary scattering law" so that the intensity represents the fraction of the mean planetary scattering appropriate for that distance from the subradar region. Thus a uniformly rough planet (made of a homogeneous material) would appear uniformly bright if we assume that backscatter results from roughness. A perfectly smooth planet produces only a specular reflection at the subradar point.

The map was produced by averaging periods of observation, each about 7 hours long, made over 5 days at the time of inferior conjunction this year. The data were processed and displayed by a digital computer. Coordinate transformation was performed on the assumption that the planet rotated in a retrograde fashion with the earth synchronous period of 243.16 days. The axis direction (*4*) was assumed to have a right ascension of 270.3° and a declination of 66.7°.

The map's extent is limited by code length and a bandwidth of 64.5 hz (which is less than the Doppler spread across the planet). Fine structure toward the edges of the map is mainly noise. The strong feature at −26° latitude and 0° longitude has a signal-to-noise ratio of about 20 standard deviations. The signal-to-noise ratio of the map improves closer to the subradar region. Generally, noise can be recognized by its lack of correlation from cell to cell.

Figure 2 shows a diagram of the features taken from the intensity map and identifies them with features located by Carpenter (*2*) and those observed by means of the Haystack-Westford antennas (*4*) at the last conjunction. New features are labeled by their central coordinates—longitude in degrees followed by latitude in degrees. The map shows dark circular features (two of the most prominent are labeled 312-14 and 335-28) not seen in previous data probably because of the poor signal-to-noise ratios obtained in previous maps. These circular features have the size and appearance of lunar maria although any physical similarity is mere speculation at this stage.

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Carbonado: Natural Polycrystalline Diamond

Abstract. *Carbonados are porous aggregates of mostly xenomorphic diamond crystallites ranging in diameter from a fraction of a micron to over 20 microns. Crystalline inclusions (up to 3 percent) occur in the pores of the crystallites and consist mainly of orthoclase and small amounts of other igneous, metamorphic, and secondary minerals.*

The term "carbonado" (black diamond) was originally coined by Brazilian miners to designate the opaque, black or gray, polycrystalline diamond found mainly in the highlands of Bahia, Brazil, and in smaller amounts in Venezuela and British Guiana. Carbonado makes up only 0.1 percent of the world's production of industrial diamonds, but, because of its extraordinary toughness, it is often used in combination with bort diamonds as studding on drill bits designed to pierce hard rocks.

Carbonado has been known as a distinct form of diamond since at least 1843. Roth *et al.* (*1*) and Gerlach (*2*) postulated the presence of amorphous carbon or graphite as a coloring and binding agent between diamond crystallites. Brandenberger (*3*) found no such evidence in x-ray diffraction diagrams and assumed that carbonados are masses of crystallites resembling the aggregates of crystals found in metals. Fettke and Sturgis (*4*) and Kerr *et al.* (*5*) examined carbonados by light microscopy and observed the existence of