DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

Prepared for the
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

ATLAS OF MERCURY
1:5,000,000 GEOLOGIC SERIES
VICTORIA QUADRANGLE
H 5M 45/45 G, 1983
I-1409 (H-2)

NOTES ON BASE

This map sheet is one of a series covering that part of the surface of Mercury that was illuminated during the Mariner 10 encounters (Davies and Batson, 1975). The source of map data was the Mariner 10 television experiment (Murray, 1975).

ADOPTED FIGURE

The map projections are based on a sphere with a radius of 2439 km.

PROJECTION

The Lambert conformal conic projection is used for this sheet, with a scale of 1:4,623,000 at lat 22.5°. Latitudes are based on the assumption that the spin axis of Mercury is perpendicular to the plane of the orbit. Longitudes are positive westward in accordance with the usage of the International Astronomical Union (IAU, 1971). Meridians are numbered so that a reference crater named Hun Kal (lat 0.6° S) is centered on long 20° (Murray and others, 1974, Davies and Batson, 1975).

CONTROL

Planimetric control is provided by photogrammetric triangulation using Mariner 10 pictures (Davies and Batson, 1975). Discrepancies between images in the base mosaic and computed control point positions appear to be less than 2 km, except for the area in the northwest corner of the quadrangle. Pictures of this area are so foreshortened that accurate map transformations were not possible. Since the base mosaic was controlled by a later iteration of the control net, large discrepancies exist between this sheet and the Kuiper (H-6) sheet to the south. These discrepancies were not adjusted, so that features in the zone of overlap on this sheet appear at different latitudes and longitudes than they do on the Kuiper quadrangle.

MAPPING TECHNIQUES

Mapping techniques are similar to those described by Batson (1973a, 1973b). A mosaic was made with pictures that had been digitally transformed to the Lambert conformal conic projection. Shaded relief was copied from the mosaics and portrayed with uniform illumination with the sun to the west. Many Mariner 10 pictures besides those in the base mosaic were examined to improve the portrayal. The shading is not generalized and may be interpreted with nearly photographic reliability (Inge, 1972, Inge and Bridges, 1976).

Shaded relief analysis and representation were made by Susan L. Davies.

NOMENCLATURE

All names on this sheet are approved by the International Astronomical Union (IAU, 1977).

H-2 — Abbreviation for Mercury (Hermes) sheet number 2.

H 5M 45/45 G: Abbreviation for Mercury (Hermes) 1:5,000,000 series; center of sheet, 45° N lat, 45° long; geologic map, G.

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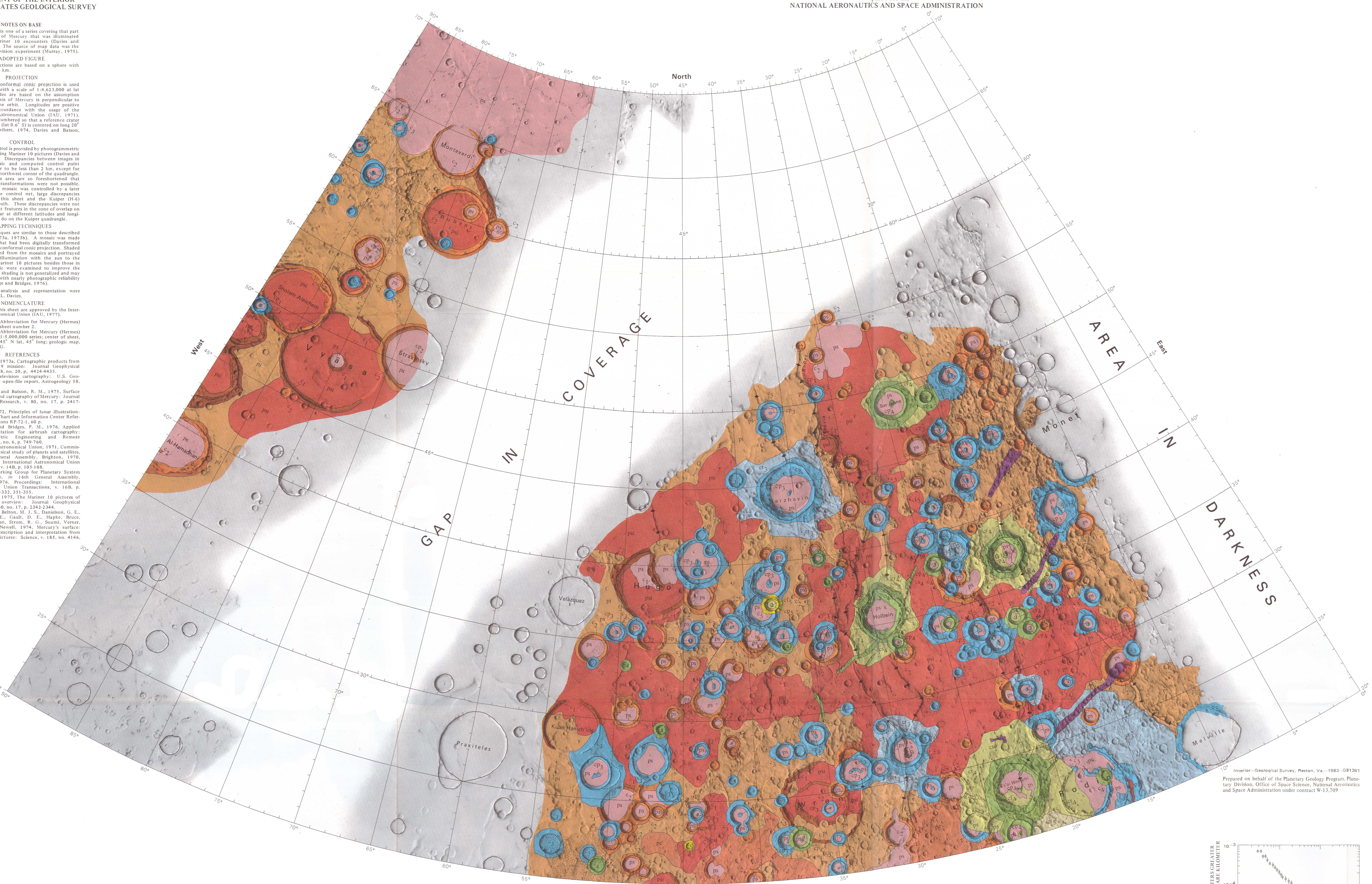

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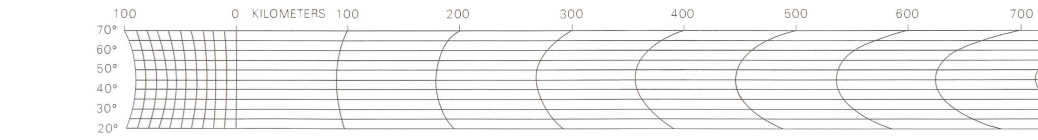
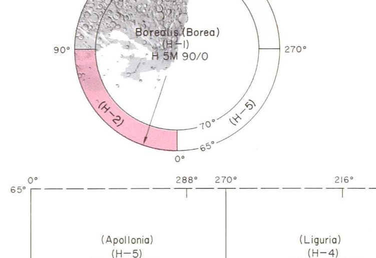
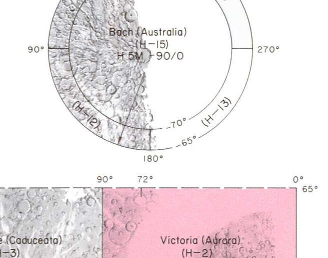
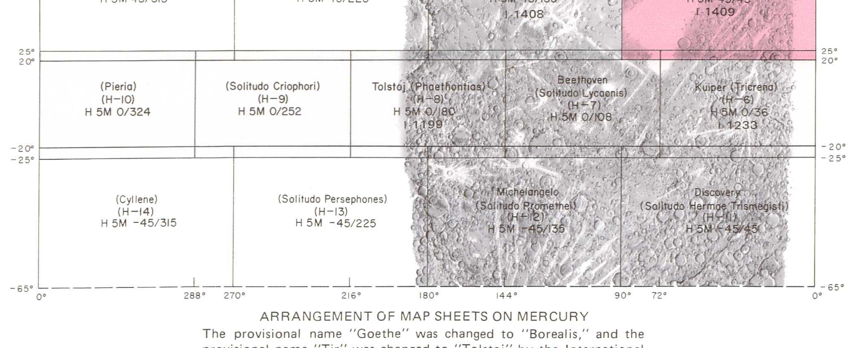
Prepared on behalf of the Planetary Geology Program, Planetary Division, Office of Space Science, National Aeronautics and Space Administration under contract W-13,709



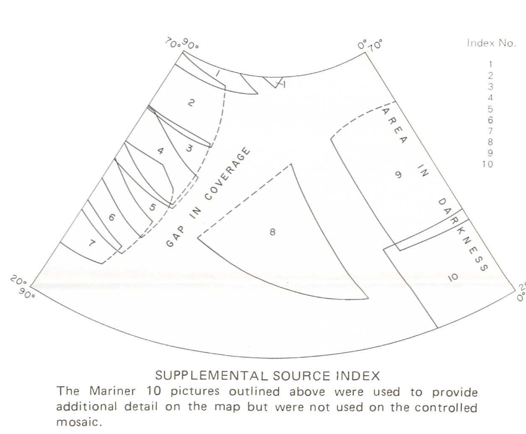






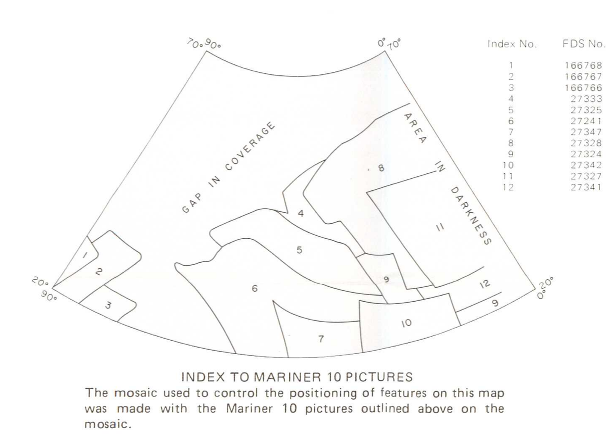
ARRANGEMENT OF MAP SHEETS ON MERCURY

The provisional name "Goethe" was changed to "Borealis," and the provisional name "Tir" was changed to "Tolstoj" by the International Astronomical Union in 1976 (IAU, 1977). These provisional names appeared on earlier editions of this index map and on the shaded relief map of the Tolstoj (H-8) quadrangle. The number preceded by I refers to published geologic map.



SUPPLEMENTAL SOURCE INDEX

The Mariner 10 pictures outlined above were used to provide additional detail on the map but were not used on the controlled mosaic.



INDEX TO MARINER 10 PICTURES

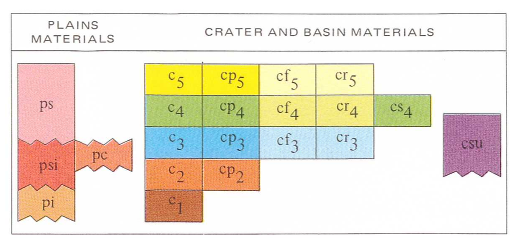
The mosaic used to control the positioning of features on this map was made with the Mariner 10 pictures outlined above on the mosaic.

GEOLOGIC MAP OF THE VICTORIA QUADRANGLE OF MERCURY

By
George E. McGill and Elbert A. King

1983

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

PLAINS MATERIALS

ps SMOOTH PLAINS MATERIAL—Forms mostly small areas of plains that appear smooth at available image resolution. Albedo similar to or higher than that of intermediate plains unit. Superposed craters all smaller than 20 km in diameter and of low density. Characteristically occupies floors of craters, including large c_4 craters. Reference area: lat 36° N., long 29°. *Interpretation:* A mixture of ejecta from small craters and material mass wasted from walls of large craters. May include some volcanic materials

psi INTERMEDIATE PLAINS MATERIAL—Forms smooth to moderately rough plains characterized by many bright patches and streaks on a background generally slightly darker than intercrater plains material. Commonly associated with elongate symmetric and asymmetric ridges and rounded scarps, all of which appear younger. Superposed craters are of moderate density, are of c_2 age or younger, and are mostly less than 50 km in diameter. Also superposed are secondary craters from several c_4 and fresh c_3 craters 100 to 150 km in diameter. Reference area: lat 30° N., long 25°. *Interpretation:* Probably basaltic lava flows, but no unequivocal supporting evidence has been found in the Victoria quadrangle

pc CRATERED PLAINS MATERIAL—Forms moderately rough to rough surfaces very similar to intercrater plains material. Unit defined to correlate with similar unit in Kuiper quadrangle (De Hon and others, 1981) to the south; elsewhere on Victoria quadrangle cratered plains material is included in intercrater plains material. Reference area: lat 22° N., long 42°. *Interpretation:* Volcanic rock, clastic blanket generated by secondary impact events, or both

pi INTERCRATER PLAINS MATERIAL—Forms moderately rough to very rough surfaces with an albedo generally slightly higher than that of the intermediate plains unit. Contacts with intermediate plains and cratered plains units locally gradational. Density of superposed craters high. Reference area: lat 27° N., long 40°. *Interpretation:* Undivided rim and ejecta materials of overlapping, very old craters and basins. Probably also includes material similar to that forming intermediate plains unit.

CRATER AND BASIN MATERIALS

Subscripts refer to degradation sequence from c_1 (most degraded) to c_5 (least degraded). Degree of degradation is inferred to represent relative age (c_1 oldest to c_5 youngest) of craters of closely similar diameters (see McCauley and others, 1981, for discussion of this age sequence). Craters less than about 20 km in diameter are not mapped. *Interpretation:* Impact craters. A very few irregular, small craters may be endogenic

c_5 CRATER MATERIAL—Undivided floor, rim, wall, and ejecta material of craters with complete and well-defined rims, central peaks, textured ejecta blankets, and high-albedo halos and rays. All are <50 km in diameter. Density of superposed craters low

cp_5 CENTRAL PEAK MATERIAL—Single or multiple rugged peaks near center of crater

cf_5 FLOOR MATERIAL—Rough material on crater floor

cr_5 RADIAL EJECTA MATERIAL—Grooved and ridged material extending outward from raised rim as lineated apron with many secondary craters

c_4 CRATER MATERIAL—Undivided rim, wall, and ejecta material of craters with complete and well-defined rims, central peaks, and textured ejecta blankets. Density of superposed craters low, but higher than on smooth plains material. Unit includes floor material for most craters less than 35 km in diameter

cp_4 CENTRAL PEAK MATERIAL—Same as cp_5 except occurs within c_4 craters

cf_4 FLOOR MATERIAL—Same as cf_5 except occurs within c_4 craters

cr_4 RADIAL EJECTA MATERIAL—Radially textured annulus around unit c_4; includes secondary craters that are sufficiently well preserved to be clearly visible around most of the periphery of larger craters

cs_4 SECONDARY CHAIN MATERIAL—Alined crater chains related to c_4 craters

c_3 CRATER MATERIAL—Undivided rim, wall, and ejecta material of craters with complete and well-defined rims. Most have central peaks. Density of superposed craters low to moderate. Unit includes floor material for most craters less than 35 km in diameter

cp_3 CENTRAL PEAK MATERIAL—Same as cp_5 except occurs within c_3 craters

cf_3 FLOOR MATERIAL—Same as cf_5 except occurs within c_3 craters

cr_3 RADIAL EJECTA MATERIAL—Around largest craters, includes moderately well preserved textured ejecta blankets and incompletely preserved fields of secondary craters

c_2 CRATER MATERIAL—Undivided floor, rim, wall, and ejecta material of craters with complete but subdued rims. Only largest craters have remnants of textured ejecta blankets. Secondary craters not recognizable. Density of superposed craters moderate

cp_2 CENTRAL PEAK MATERIAL—Same as cp_5 except seen in very few c_2 craters

c_1 CRATER MATERIAL—Undivided material of craters with subdued and incomplete rims and no recognizable central peaks, ejecta blankets, or secondary craters. Density of superposed craters moderate to high

csu CRATER CHAIN MATERIAL, UNDIVIDED—Crater chains not associated with any visible crater

Contact

Scarp—Line marks top; hachures point downslope

Crest of elongate ridge

Crater rim crest

Crater rim—Greatly subdued or buried

Area of bright crater-ray material—Interpreted as ejecta from relatively recent impacts

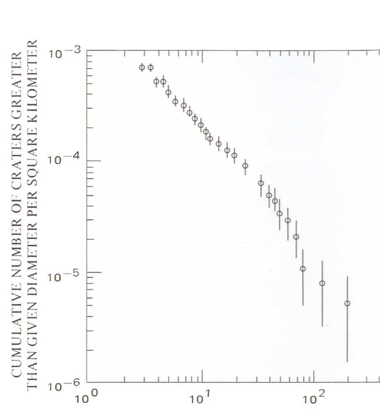


Figure 1.—*Log-log cumulative diameter versus frequency plot of craters ≥3 km in diameter superposed on intercrater plains material, Victoria quadrangle. Counting area, 377,900 km²; number of craters counted, 267.*

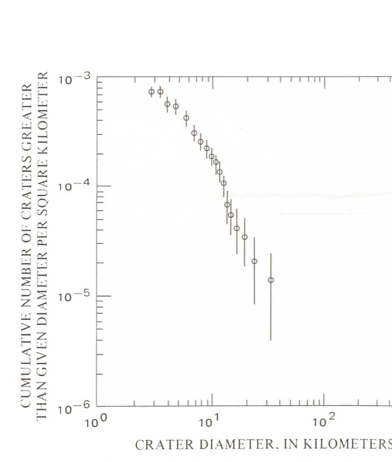


Figure 2.—*Log-log plot of cumulative diameter verses frequency of craters ≥3 km in diameter superposed on intermediate plains material, Victoria quadrangle. Areas of this unit containing clusters of large craters excluded (see text). Counting area, 151,000 km²; number of craters counted, 106.*

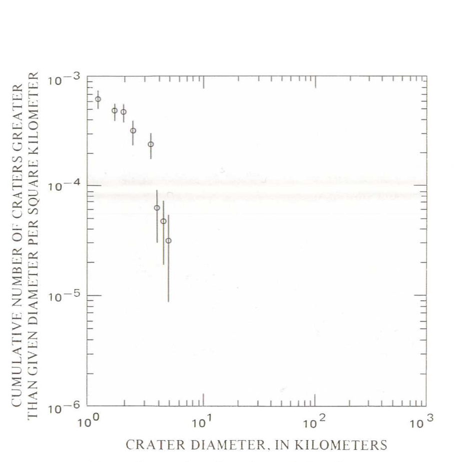


Figure 3.—*Log-log plot of cumulative diameter versus frequency of craters ≥1.2 km in diameter superposed on smooth plains material, Victoria quadrangle. Count is sum of counts from floors of six large craters. Total counting area, 68,700 km²; number of craters counted, 43.*

INTRODUCTION

Most of the Victoria quadrangle lies within an area that appears bright on telescopic images of the planet, the bright-albedo feature Aurora, which approximately coincides with the east half of the quadrangle (Davies and others, 1978, fig. 11). As is common with most of the imaged portions of Mercury, the Victoria quadrangle is dominated by basins and large craters, with plains materials occupying the areas between them.

Almost all the pictures acquired by Mariner 10 that were used for mapping were obtained during the first encounter: those covering the southeast half of the quadrangle are incoming close-encounter images, and those covering the northwest corner are outgoing close-encounter images. At the time the pictures were obtained, the terminator was at about long 7° to 8°, within the eastern part of the quadrangle. A large gap in coverage between the incoming and outgoing images appears as a northeast-trending diagonal blank strip on the base map. A small part of this gap was filled in the southwestern part of the quadrangle by very poor second-encounter images.

No images provide a vertical view; in fact, the smallest angle between the planetary surface normal and the camera axis is about 50°. The high obliquity of the images, the wide range in sun-elevation angles, and the complete transection of the quadrangle by the gap in coverage greatly hamper geologic mapping. Only in about 15 percent of the quadrangle, near the southeast corner, do data permit separation of units with the confidence possible in other quadrangles on Mercury.

STRATIGRAPHY

Three widespread units are recognized within the Victoria quadrangle. These are, from oldest to youngest, intercrater plains material, intermediate plains material, and smooth plains material. In addition, central peak, floor, rim, and ejecta materials related to the numerous craters and basins larger than about 20 km in diameter are mapped. The simplicity of the stratigraphic scheme is at least in part due to deficiencies in the data base; the history of plains formation almost certainly is more complex than our threefold division indicates, but we were not able to define consistent criteria of albedo, texture, and cratering for more than three plains units because of the highly variable quality of available pictures.

PLAINS MATERIALS

Intercrater Plains Material

About half of the intercrater area consists of material characterized by a very high density of small, mostly degraded craters, and an irregular to rough surface. Superposition relations suggest that this unit is about the same age as, or older than, all mappable craters and basins. The origin of intercrater plains material is enigmatic; some may be primitive crust, as implied by Trask and Guest (1975), but more likely it is of mixed origin, dominated by breccias formed by now-unrecognizable ancient craters. Some of the more plainslike areas included within this unit may well have an origin similar to that of intermediate plains material.

Cratered Plains Material

Within the 5° overlap area with the Kuiper quadrangle to the south, an area has been mapped that displays moderately rough to rough terrain and a high density of mostly degraded craters. This unit is very similar to intercrater plains material, and cannot be distinguished from it anywhere else in the Victoria quadrangle. Most of the cratered plains material is probably volcanic in origin, but some of it may consist of impact breccias.

Intermediate Plains Material

Smooth to moderately irregular plains occupy most of the area between large craters not underlain by intercrater plains material. These plains superficially resemble the plains of the lunar maria; they generally have a relatively low albedo (Hapke and others, 1975) and are characterized by numerous elongate ridges. Like the lunar maria, the two younger mercurian plains units have been ascribed to volcanic activity (Trask and Guest, 1975; Strom and others, 1975; Trask and Strom, 1976), although this interpretation has been questioned (Wilhelms, 1976). A volcanic origin seems most probable, but no compelling evidence exists in the Victoria quadrangle to support this opinion.

The elongate ridges, though clearly associated with intermediate plains material, are not restricted to it. Locally, ridges extend into intercrater plains material adjacent to intermediate plains material, and large young (c_4 and c_3) craters superposed on the intermediate plains material commonly are transected by these ridges.

Smooth Plains Material

Partly filling most craters is plains material that is smoother and less densely cratered than intermediate plains material. Because most areas underlain by this unit are enclosed within craters, contacts between smooth plains and older plains units are rare. Smooth plains material thus is defined almost entirely by texture and apparent crater density. Few superposition data directly support the inferred age sequence, but the relative youth of the smooth plains unit is indicated by its presence on the floors of craters that are superposed on intermediate plains material. The smooth plains unit probably includes materials of a wide range in age, but the exposed areas are too small to test this possibility quantitatively. Although a volcanic origin cannot be ruled out for all or part of the smooth plains material, it is more probably a mixture of ejecta from very small craters and colluvium mass wasted from crater walls.

STRUCTURE

The ridges associated with the intermediate plains unit are best interpreted as tectonic in origin because they extend into adjacent exposures of intercrater plains material and, more significantly, because they transect ejecta, rims, and floors of craters. The ridges range in length from about 50 km to many hundreds of kilometers, are sinuous to lobate in plan, and generally trend about north-south. Most are asymmetric, with one slope steeper than the other, and at places they can be more logically referred to as rounded scarps. Commonly, an individual ridge changes along trend from symmetric ridge to asymmetric ridge to rounded scarp. Strom and others (1975) interpreted most of these features to be surface expressions of thrust faults, and we can find no evidence within the Victoria quadrangle not already considered in their discussion.

Because of their globally systematic orientations, these ridges and scarps have been associated with stresses developed by tidal despinning of Mercury (Melosh, 1977). However, most trend approximately north-south and thus do not fit the pattern expected in the midlatitude belt, unless stresses from overall contraction were superposed on the stresses due to despinning (Melosh, 1977, figs. 3 and 5).

GEOLOGIC HISTORY

The oldest material and features in the Victoria quadrangle are the intercrater plains material and areally associated, severely degraded basins. No craters are clearly older than intercrater plains material, and the relative ages of the c_1 basins are ambiguous. Numerous large craters are superposed on intercrater plains material; by analogy with lunar and martian history (Hartmann, 1966, 1973; Neukum and others, 1975), these craters most likely date from more than about 4 b.y. ago.

The available evidence suggests a relatively long history of plains formation. Some of the material included in the intercrater plains unit appears to have been plainslike before the intense cratering characteristic of the unit. In addition, the younger plains units exhibit densities of superposed craters ranging from moderate to very sparse. The intermediate plains material is older than the freshest (c_4 and some c_3) large craters (100-150 km in diameter) but younger than all basins, and younger than all large craters that are more than moderately degraded (some c_3, and all c_2 and c_1). Thus, the material mapped as the intermediate plains unit overlaps in time of origin the tail end of the primordial bombardment.

The stresses responsible for the elongate ridges and scarps must have occurred after the end of the primordial bombardment and after emplacement of the intermediate plains unit. Where smooth plains material abuts ridges and scarps, the evidence is mostly ambiguous because we cannot tell if ridge formation involved smooth plains material or if the ridges are upwarped intermediate plains material with smooth plains material ponded against them. On the floors of some craters, such as Gluck, scarps apparently offset material mapped as smooth plains, but the exposures are so small that this interpretation could easily be challenged. Ridges appear to be both older and younger than medium-size craters (30-60 km in diameter) on the intermediate plains unit, but intersections of ridges with craters in this size range are too rare to constrain the time of ridge formation. Thus, ridge formation obviously occurred after emplacement of the intermediate plains unit, but how long after remains uncertain in this quadrangle.

Smooth plains material is apparently younger than all large craters, and hence is the youngest material in the quadrangle with the exception of the local material related to some very small craters (<20 km in diameter).

CRATER DISTRIBUTIONS

Figures 1 to 3 are plots of cumulative diameter versus frequency of craters on the three plains units. Figures 1 and 2 include craters ≥3 km in diameter on the large areas of intercrater and intermediate plains units in the southeastern portion of the quadrangle. The two counting areas together are approximately bounded by lats 20° and 32° and longs 15° and 42° and are separated by an irregular but approximately east-west-trending contact; the intercrater plains material lies to the south and the intermediate plains material to the north. Figure 3 includes craters ≥1.2 km in diameter on smooth plains material that covers the floors of six large craters.

Because of the varied and generally poor quality of the imagery, detailed cratering history cannot be inferred from these plots. However, three observations seem valid: (1) the density of large craters is distinctly higher for intercrater than for intermediate plains material; (2) for the intercrater and intermediate plains material, curves for craters with diameters between 3 and 15 km nearly coincide (the abundant, mostly degraded small craters characteristic of intercrater plains material but not characteristic of intermediate plains material are less than 3 km in diameter); and (3) craters of all sizes on the smooth plains unit are much less abundant than on the other units, although the smooth-plains plot is unreliable in detail because of the small total number of craters counted and the need to combine counts from isolated exposures.

A serious sampling problem exists for counting craters on the intermediate plains unit, because those in the diameter range of 50 to 150 km commonly occur in clusters, and it is very difficult to determine which craters of a cluster are younger than the surrounding plains unit and which are older. The area counted for figure 2 does not include any of these clusters. Immediately to the north, however, intermediate plains material surrounds three clusters of large craters, including Holbein, the c_4 crater ~ 100 km in diameter centered at lat 36° N., long 29°. This large crater clearly is younger than the surrounding intermediate plains material, and superposition relations suggest that two or three of the 50- to 60-km-diameter craters east of it also may be younger. The ages of other craters in the clusters, relative to the age of intermediate plains, are ambiguous. A second count of intermediate plains material was made that included the area of clusters of large craters, and that was based on the extreme assumption that all these large craters are younger than intermediate plains material. The resulting plot (not shown) differs from figure 2 at the large-crater end, as would be expected, but it still shows a lower density of large craters than does the plot of craters from intercrater plains material. Because not all the large craters occurring in scattered clusters are likely to be younger than intermediate plains material, the true plot of cumulative diameter versus frequency should not differ much from that shown in figure 2.

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