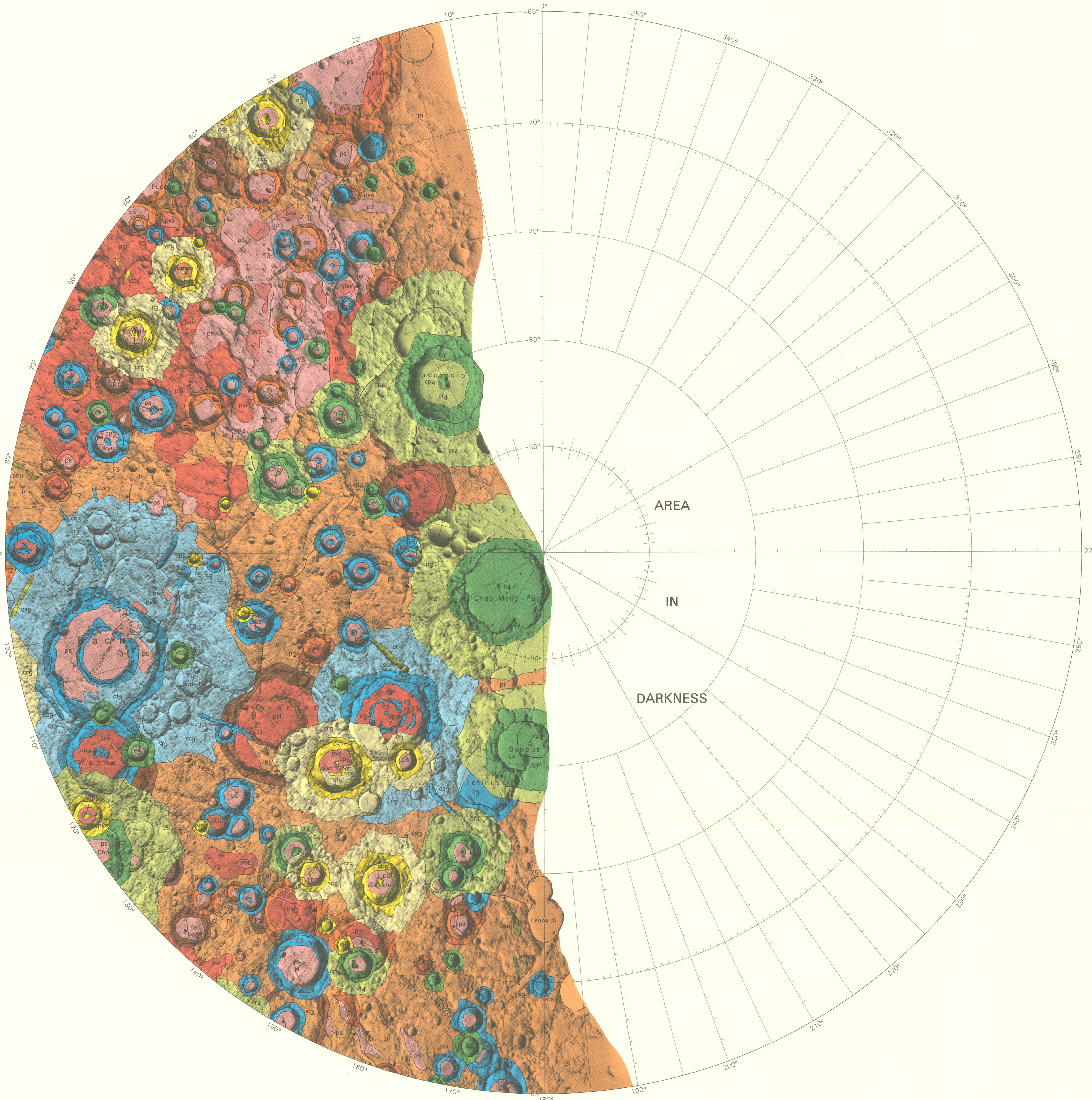
DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Prepared for the
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

ATLAS OF MERCURY
1:5,000,000 GEOLOGIC SERIES
BACH REGION
H5M -90/0 G, 1990
I-2015 (H-15)



Base from U.S. Geological Survey, 1976, Shaded relief map of the Bach area of Mercury: U.S. Geological Survey Miscellaneous Investigations Series Map I-959

SCALE 1:4 290 000 AT -65° LATITUDE
POLAR STEREOGRAPHIC PROJECTION

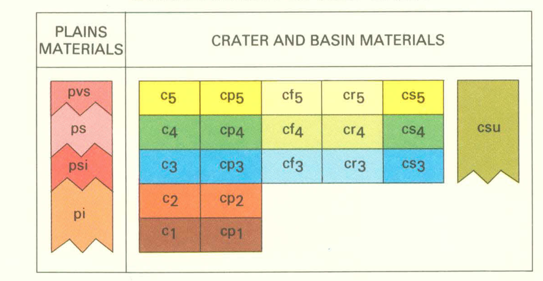
KILOMETERS

INTERIOR—GEOLOGICAL SURVEY, RESTON, VA—1990

Prepared on behalf of the Planetary Geology Program, Solar System Exploration Division, Office of Space Science, National Aeronautics and Space Administration, under contract W-15,814 through Grant NSG-7146 to the University of Arizona

Manuscript approved for publication, September 23, 1988

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

PLAINS MATERIALS

pvs — **Very smooth plains material**—Most common east of long 70° in depressions within smooth plains material; occurs elsewhere in craters of c_2 to c_5 age. Distinguished by extremely smooth surface and near absence of superposed craters. Nearer terminator, relief is more detectable and surface is slightly hummocky. *Interpretation:* Impact melt in youngest craters or volcanic material in older depressions such as crater floors

ps — **Smooth plains material**—Commonly in c_2 to c_5 craters and widespread to local depressions, particularly east of long 90°. Distinguished by smooth to moderately rough surfaces (appearance rougher near terminator) and few superposed craters (mostly c_4 and c_5 and their secondaries). Associated with scarps and ridges. *Interpretation:* Impact melt in younger craters and volcanic material in older craters and in extensive intercrater areas

psi — **Intermediate plains material**—Forms large intercrater areas east of long 85° and floors some craters of c_1 to c_3 age; superposed by some c_2 craters and larger c_3 to c_5 craters. Intermediate in texture and crater density between smooth plains and intercrater plains units. Moderately rough texture pockmarked by many small craters and secondaries. May be interbedded with ejecta of craters and basins of c_2 to c_4 age. *Interpretation:* Volcanic materials in c_1 craters and intercrater plains. May be volcanic or impact melt within younger craters

pi — **Intercrater plains material**—Forms large tracts exterior to craters, embaying rims of c_1 and c_2 craters. Surfaces are heavily cratered and textured by knobs, ridges, and pits; superposed craters of many sizes, some aligned in clusters or chains. Age relations to c_1 craters commonly ambiguous. *Interpretation:* Volcanic. Interbedded with ballistically emplaced ejecta of c_1 to c_3 craters and basins; overlain by ejecta from craters of all ages

CRATER AND BASIN MATERIALS

[These materials are divided into three associated facies: crater materials, mapped to the break in slope of the exterior rim and including central peak and peak ring materials (in large craters and basins); floor materials; and a radial facies. Secondary crater chains are mapped as a distinct unit. Crater morphologic age is divided into five classes similar to those used in lunar mapping. Classification criteria are also similar, allowing for gravitational differences between the Moon and Mercury, and are virtually the same as those of McCauley and others (1981). Craters smaller than 15 km in diameter not mapped. *Interpretation of craters:* Formed by impact, surrounded by ballistically emplaced ejecta]

c_5 — **Material of very fresh craters**—Craters characterized by sharp rims, crisp interior forms (for large craters), rays, and very few superposed craters. Unit includes crater floor material except where mapped separately on basis of floor-wall contact and floor morphology

cp_5 — **Central peak material of c_5 craters**—Forms isolated or grouped hills and arcuate ridges that, in larger craters, may be aligned along lineament directions. *Interpretation:* Highly shocked and deformed country rock elevated during impact

cf_5 — **Crater floor material of c_5 craters**—Hummocky to smooth; very few superposed craters. *Interpretation:* Impact melt and fallback ejecta

cr_5 — **Radial facies of c_5 craters**—Smooth to hummocky deposits radial to primary crater. *Interpretation:* Material ejected from c_5 craters during formation; debris followed ballistic trajectories to impact around craters, fragmenting local bedrock and regolith

cs_5 — **Secondary crater chains radial to c_5 craters**—Continuous to discontinuous chains of small craters radial to a primary crater at lat 67° S., long 56°, lying outside its radial facies. *Interpretation:* Craters formed from material ejected from c_5 craters, as described for radial facies

c_4 — **Material of fresh but slightly modified craters**—Distinct but visibly modified rims and interior features; well-preserved radial facies around larger craters

cp_4 — **Central peak material of c_4 craters**—Like central peak material of c_5 craters but modified by superposed small impacts and depositional degradation

cf_4 — **Crater floor material of c_4 craters**—Some more hummocky than very smooth or smooth plains materials. *Interpretation:* Same as crater floor material of c_5 craters

cr_4 — **Radial facies of c_4 craters**—Continuous ejecta blanket beyond exterior rim's break in slope; discontinuous ejecta facies at greater distances. Degraded by smaller impacts (c_5 craters and their secondaries). *Interpretation:* As for radial facies of c_5 craters but surrounds c_4 craters

cs_4 — **Secondary crater chain radial to a c_4 crater**—Only one mapped (lat 71° S., long 176°), well beyond radial facies of crater Marti. *Interpretation:* As for secondary crater chains radial to c_5 craters but older

c_3 — **Material of modified craters**—Relatively low, semirounded but continuous rims and subdued interior landforms

cp_3 — **Central peak material of c_3 craters**—Like central peak material of c_5 craters but modified by subsequent impacts, ejecta, and seismic shaking. Partly buried by plains units

cf_3 — **Crater floor material of c_3 craters**—Hummocky

cr_3 — **Radial facies of Bernini and Bach basins**—Continuous ejecta blanket radially striated by crater chains and ridges. Overlies intercrater plains unit and is locally embayed by smooth plains material

cs_3 — **Secondary crater chains radial to c_3 basins and large craters**—Like secondary crater chains radial to c_5 craters but some lie on top of radial facies of c_3 craters; degraded by subsequent impacts

c_2 — **Material of strongly modified craters**—Low rims and shallow interior relief. Interior forms scarce; secondary crater fields absent

cp_2 — **Central peak material of c_2 craters**—Rare. *Interpretation:* As for central peak material of c_5 craters but severely degraded

c_1 — **Material of extremely subdued craters**—Low, partial rims. Some craters barely distinguishable from surrounding plains materials. Interior features rare. Secondary crater fields absent

cp_1 — **Central peak material of c_1 basins and craters**—Severely subdued remnants of hills and hummocks in vaguely arcuate to circular arrays. Clearly identified only in Cervantes basin, but materials there can also be interpreted as rim remnants of a nested crater degraded by formation of plains materials. Unit may occur also as extremely degraded mound in crater at lat 68° S., long 68°. *Interpretation:* As for central peak material of c_5 craters but severely degraded

csu — **Material of secondary crater chains, undivided**—In troughlike, elongated depressions or connected lines of closely spaced small craters. Relation to larger craters cannot be recognized; age indeterminant. *Interpretation:* Secondary craters of a primary located past terminator

Contact—Dashed where approximately located; dotted where buried; queried where doubtful

Arcuate scarp—Line at base of scarp; barb points downslope; dotted where buried. Abrupt boundary separating surfaces of different elevation. Interpreted to be scarp of probable thrust fault

Ridge—Interpreted as formed by faulting or extrusion. Crest commonly flat. Symbol on crest

Lineament—Linear segment of crater rims, ridges, or scarps of low relief. Interpreted to be joints in newly cooled, stressed rock later faulted during periods of stress

Crater rim crest—Distinct, generally continuous; dashed where approximately located; queried where doubtful

Crater rim crest, subdued—Buried by younger material or degraded by age

Area of ray material—Bright, high-albedo patches or streaks roughly radial to fresh c_5 craters, noted more commonly at higher sun angles. Interpreted to be freshly excavated ejecta from either primary or secondary craters

INTRODUCTION

The Bach region encompasses the south polar part of Mercury poleward of lat 65° S. About half of the region was beyond the terminator during the three Mariner 10 encounters and hence not visible. The entire mapped area was covered by near-vertical photography from the second encounter, and the eastern part, from long 15° to about 110°, was covered by oblique photography from the first encounter. No third-encounter images were acquired. The entire visible area may be viewed stereoscopically by combining images from the first and second encounters taken at different viewing angles or by combining second-encounter images of the same area taken at different viewing angles. These combinations provided excellent qualitative control of topographic relief and a good quantitative photogrammetric base. However, sun-elevation angles of the images are limited to less than 25°, and image resolutions are no higher than about 0.5 km per picture element. Therefore, the south polar geologic map reflects mostly large-scale processes and topographic information, whereas other Mercurian quadrangle maps benefit from greater albedo discrimination and, in some cases, higher resolution.

The imaged part of the Bach region covers about 1,570,000 km². Its surface consists of craters of a wide variety of sizes and morphologies, as well as plains units, scarps, and ridges. It includes three double-ring basins that range from 140 to 200 km in diameter: Bach (after which the region is named), Cervantes, and Bernini. Another large crater, Pushkin, is 240 km in diameter and occurs at the map boundary at lat 65° S., long 25°. Both Bach and Bernini display extensive fields of secondary craters. An unusual area between lat 69° and 80° S. and long 30° and 60° consists of young, relatively smooth plains marked by many flat-topped ridges unlike any seen in other areas of Mercury. Scarps similar to Discovery Rupes (in the Discovery quadrangle adjacent to the north) are relatively common throughout the Bach region. The most common terrain units in the region are the plains units, which display a wide range of small-crater densities.

STRATIGRAPHY

CRATER AND BASIN MATERIALS

Superposition relations among craters and basins, and their ejecta, provide the best means of establishing the relative time-stratigraphic order of crater and basin materials. Relative to the Moon, stratigraphic relations among Mercurian craters are more clearly discerned because Mercury has a lower density of large craters (Malin, 1976a), and its enhanced gravitational acceleration has restricted the distribution of ejecta (Gault and others, 1975). These attributes of the Mercurian crater population allow stratigraphic sequences to be constructed over large regions.

The degree of crater degradation is determined by qualitative assessment of their landforms such as rim crests, interior wall terraces and slumps, central peaks, continuous ejecta deposits, and secondary crater fields (see Malin and Dzurisin, 1977; McCauley and others, 1981). To the extent that degradational changes are systematic with increasing age, they can be used to correlate local and regional stratigraphic sequences over the map region. On the basis of this morphologic evaluation, five crater ages are defined and used to make stratigraphic assignments. However, the low sun angle at which images in the region were acquired may make craters appear younger than in other parts of Mercury where images were taken at higher sun angles.

The attributes of the five morphologic classes, as illustrated by McCauley and others (1981) and Leake (1982), are given in the description of map units. However, these attributes are valid only for a given size crater and in a relative sense. A representation (fig. 1) of the classification scheme has two important constraints. (1) A given set of criteria, as in a fresh secondary-crater field, denotes an older age for larger craters than for smaller ones, because the landforms of larger craters take longer to degrade than analogous features of smaller craters. (2) The lines of "constant morphology" converge slightly at larger crater diameters. Thus less morphologic distinction occurs among large craters than among small ones.

Of the region's three double-ring basins, Bach (200 km in diameter) and Bernini (140 km in diameter) are moderately fresh (of c_3 age) and have well-defined secondary-crater fields, whereas Cervantes (200 km in diameter) is degraded (c_1). The inner rings of the three basins are about half the diameter of the outer rings. Bach's inner ring, the most complete, is open only to the southeast; it consist of an almost continuous series of sharp-crested hills. The area within it and part of the area between it and the outer ring are filled with smooth plains material. The inner rings of Cervantes and Bernini consist of discontinuous, low, rounded hills; Bernini has a small central peak.

As first noted by Gault and others (1975), the continuous ejecta blankets and secondary crater fields surrounding Mercurian craters are smaller than their lunar counterparts, and the boundary between the two features is much less distinct. As a consequence, continuous and discontinuous ejecta are mapped together in the Bach region as "radial facies." With this exception, the morphological elements of Mercurian craters are virtually identical with those on the Moon. Therefore, all of the craters within the Bach region are probably the result of impact by meteorites, small planetesimals, and possibly comets.

PLAINS MATERIALS

About 60 percent of the map area consists of tracts of planar surfaces having a variety of small-scale textures. These tracts range in size from a few square kilometers within craters to areas larger than 10,000 km² that surround and separate large craters: the so-called "intercrater plains" (Trask and Guest, 1975; Malin, 1976b). The origin of the plains material is uncertain. Strom and others (1975), Malin (1976b), Trask and Strom (1976), Strom (1977, 1979), and Leake (1982) presented arguments in favor of volcanism, whereas Wilhelms (1976) and Oberbeck and others (1977) argued for an impact-related origin through processes similar to those responsible for the lunar Cayley Plains (fluidized ejecta sheets or ballistically deposited secondary-crater ejecta).

In general, our intercrater plains and intermediate plains units correspond to "intercrater plains," and our smooth plains and very smooth plains units correspond to deposits previously mapped as "smooth plains" (Trask and Guest, 1975). Plains formation occurred throughout the period when visible craters were formed and most likely throughout the period of intense impact cratering (Malin, 1976b; Strom, 1977). The time scale for production and retention of plains units is crudely similar to that for the production and retention of craters.

The oldest and most extensive plains material in the Bach region, the intercrater plains material (unit pi), is characterized by a gently rolling surface and a high density of superposed craters less than 15 km in diameter. Most of these small craters occur in strings or clusters and are irregularly shaped; they appear to be secondaries from craters of c_2 through c_5 age. Therefore, the intercrater plains unit is thought to be older than most c_2 craters. Its relation to c_1 craters is not clear. The highly degraded nature of c_1 craters makes it impossible to determine whether the craters predate, postdate, or are contemporaneous with the intercrater plains unit. However, the presence of shallow depressions, which may be ancient craters, within the intercrater plains suggests that the unit flooded a preexisting population of craters and therefore was emplaced sometime during the period of late heavy crater bombardment. The two proposed origins for this plains unit, as volcanic or impact material, cannot be distinguished on the basis of morphology. However, a volcanic origin is favored because of (1) the widespread distribution of the plains material throughout the imaged regions of Mercury, (2) the apparent lack of source basins large enough to supply such great amounts of impact melt, and (3) the restricted ballistic range of ejecta on Mercury.

The intermediate plains material (unit psi) is concentrated mostly in the northeastern part of the Bach region. It is similar in morphology to intercrater plains material but has a lower density of small craters. On the basis of the reasoning applied to the intercrater plains material, the intermediate plains unit is also tentatively ascribed a volcanic origin.

Materials of the smooth plains (unit ps) and very smooth plains (unit pvs) are also concentrated mainly in the eastern part of the map area. The smooth plains unit has a lower density of small craters than does intermediate plains material and a somewhat hummocky surface with scattered small hills and knobs. The hummocks within fresh c_5 craters may be mantled floor materials or incipient peak rings (see, for example, crater Callicrates at lat 66° S., long 32°; FDS 27402). The very smooth plains unit has virtually no visible small craters and displays smoother planar surfaces than those of the smooth plains unit. It occurs in the lowest areas within smooth plains material (including areas within buried crater depressions) and commonly within older craters. The areas of greatest concentration of smooth and very smooth plains materials also contain the most ridges, which suggests that ridges and the younger plains units are genetically related. Very smooth plains material commonly lies at the base of ridges or scarps. It occurs as small patches within the smooth plains unit that fill the crater Pushkin. Smooth plains material embays the ejecta blanket of a c_3 crater on Pushkin's rim at lat 66° S., long 28° (FDS 27402) and fills the interior and part of the outer-ring area of Bach. The distribution of these two youngest plains units may indicate that the smooth plains material as mapped is nothing more than a thin, discontinuous layer of very smooth plains material that mantles the older units. In this respect, it is similar to the lunar Cayley Formation, which is probably basin ejecta. However, unlike plains material of the lunar uplands, no source basin is evident for the Mercurian smooth and very smooth plains units within the imaged part of the Bach region. Although such a source basin may lie within the part not imaged, intervening areas do not contain smooth or very smooth plains materials. For these reasons we tentatively ascribe a volcanic origin to most of the smooth and very smooth plains material. The ridges appear to be of volcano-tectonic origin; the fracturing may have provided the means by which lavas reached the surface to form these younger plains units. Some very smooth and smooth plains materials that form the floors of c_5 and c_4 craters may be impact melt.

STRUCTURE

The map region displays a wide variety of structural features, including lineaments associated with ridges, scarps, and polygonal crater walls. Joint-controlled mass movements are most likely responsible for the polygonal crater-wall segments; segments as long as 100 km suggest that these fractures extend deep into the lithosphere. The most conspicuous trends of these lineaments are east-west, N. 50° W., and N. 40° E. (fig. 2). Other trends are north-south, N. 20° E., and N. 70° E.

Large ridges and scarps are the most prominent structural features in the low-sun-angle Mariner 10 pictures of the Bach region. They are most numerous between long 0° and 90°, where they have no preferred orientation.

Ridges may have been formed by several processes, including tectonism and extrusion, or they may be buried crater-rim segments. Several large ridges may represent uplift of plains materials by normal faulting. Other ridges are arcuate to circular, which suggests that they are segments of old, subdued crater and basin rims. Near Boccaccio (centered at lat 81° S., long 30°), ridges are domical in cross section and have smooth tops with small irregular or rimless craters along their crests; they appear to overlap both a c_3 and a c_1 crater (FDS 166751). In turn, these ridges are superposed by c_3 craters and c_4 ejecta. The ridges may be volcano-tectonic features, composed of extrusives along fissures. However, they are mapped only as ridges because we cannot determine if they are volcanic material that should be mapped as a separate unit or uplifted intercrater plains. These same structures may have been the source of younger plains units.

Lobate scarps are the most common structural landforms in the Bach region. Almost all have convex slope profiles, rounded crests, and steep, sharply defined lobes. Three types are seen in the map region: (1) very small (<50 km long, ~100 m high), irregular scarps that commonly enclose topographically depressed areas; they are restricted to the intermediate and smooth plains units in the eastern part of the map region; (2) small (~100 km long, ~100 m high), arcuate or sinuous scarps, also confined primarily to the intermediate and smooth plains units in the eastern part of the map region; and (3) large (>100 km long, ~1 km high), broadly arcuate but locally irregular or sinuous scarps that deform plains units and crater materials. Several of these scarps (lat 83° S., long 80°) deform craters and offset preexisting features vertically (FDS 166751). The morphology and structural relations of the scarps suggest that most result from thrust or reverse faults. However, an extrusive origin has been suggested by Dzurisin (1978) for a scarp more than 200 km long that extends from about lat 70° S. to the map border between long 45° and 52°; he based this interpretation on albedo differences between the two sides of the scarp and on partial burial of craters transected by it.

Age relations among structural features are not readily apparent. In the Bach region, the youngest craters cut by a scarp are of c_4 age; the oldest crater to superpose a scarp is a c_3. These relations suggest that scarp formation occurred in c_3 to c_4 time. Very smooth plains material flanks some scarps and ridges and, if the material is ponded extrusives or mass-wasted products, may postdate the structures. Scarps and ridges are abundant in intercrater, intermediate, and smooth plains units, but they are not embayed by intermediate and intercrater plains materials. These relations suggest that the structures began to form after emplacement of these two oldest plains units. Some of the oldest craters and basins, such as Cervantes, have polygonal shapes at least as marked as more recent craters, suggesting that some structural lineaments are older than c_1 craters.

GEOLOGIC HISTORY

Murray and others (1975) proposed that Mercury's history could be divided into five periods: (1) accretion and differentiation, (2) "terminal heavy bombardment," (3) formation of the Caloris basin (centered off map sheet at lat 30° N., long 195°; U.S. Geological Survey, 1979), (4) filling of the large basins by "smooth plains," and (5) a period of light impact cratering. Although these divisions have withstood well the assessments of subsequent investigators, they do not define a stratigraphy. Because the geologic map of the Bach region constitutes a synthesis of observation with interpretation, we shall explore several aspects of the region's geologic development.

The history of the region begins prior to the formation of any presently visible surface, when Mercury's internal evolution played a key role in determining subsequent landform development. Because it is the planet nearest the Sun, Mercury represents one extreme in possible cosmochemical models of planet formation. Even before the Mariner 10 mission, Mercury's high density and photometric properties suggested a large core, presumably iron, and a lithosphere of silicate materials. Evidence for an intrinsic dipolar magnetic field (Ness and others, 1974) reinforces interpretations favoring a large core. This core, which formed partly as a result of radiogenic heating, produced additional heating, leading to global expansion and the formation of extensional fractures in the lithosphere (Solomon, 1976, 1977). These fractures may have provided egress for the eruption of the oldest plains material during the period of heavy bombardment. Also about this time other structural lineaments developed, possibly as a result of stresses induced by tidal spin-down from a more rapid rotation rate (Burns, 1976; Melosh, 1977; Melosh and Dzurisin, 1978). The major east-west lineament trend in this polar region (noted in previous section) conforms to a prediction of Melosh (1977) for the orientation of normal faults. However, no unambiguous evidence for tensional faults occurs in the Bach quadrangle.

A population of large, very indistinct, degraded craters, first noted in stereoscopic images by Malin (1976b), occurs within the oldest (intercrater) plains material and is thought by most workers to be coeval with or older than that material. The intercrater unit, presumably volcanic extrusions through tensional fractures, is the most voluminous plains material in the map region. Many large c_1 and c_2 craters have shallow interiors but moderately well preserved rim features, suggesting that at least some of these craters have undergone topographic adjustment due to isostatic phenomena (Schaber and others, 1977). This adjustment may have been facilitated by a high-temperature mantle that was conducive to "crustal plasticity" (Malin, 1976b; Malin and Dzurisin, 1977). The lesser amount of intermediate plains material indicates decreasing plains formation, some localized within older basins.

Scarps such as Vostok Rupes (in the Discovery quadrangle adjacent to the north) are apparently the expression of thrust faults; they suggest that planetary contraction may have stressed the lithosphere (Strom and others, 1975) at about the time that c_3 craters and smooth plains material were formed. Following core formation, lithospheric cooling and consequent contraction may have closed the conduits, restricting formation of plains material (Solomon, 1977). By c_4 time, such formation was greatly reduced.

Theoretical studies by Melosh (1977), based on observations recorded by Dzurisin (1978), suggest that tidal spin-down combined with core or lithospheric contraction could explain many of the tectonic features of Mercury. The scarps occurring in the polar regions do appear to be the result of thrust faulting, which substantiates the suggestion that contraction occurred concurrently with spin-down. Linear structures (other than some ridges) are thus interpreted to form as a result of these two active processes. Fracture and lineament patterns around the Caloris basin (Strom and others, 1975) suggested to Pechmann and Melosh (1979) that Mercury's despinning period began before global contraction started and ended during the contraction's early phases.

Plains formation and cratering continued at reduced rates during the early phases of planetary cooling and contraction. C_5 craters are distinguishable by partial retention of secondary craters and by locally prominent morphologic features (McCauley and others, 1981). These characteristics suggest a decreasing rate of resurfacing and of crater modification (Malin and Dzurisin, 1977). The smaller extent of the smooth and very smooth plains units, compared with that of older plains materials, suggests considerable heterogeneity of Mercurian crustal materials. Subcrustal zones of tension may have allowed molten materials to reach the surface through fractures beneath craters, even during the period of global contraction (Solomon, 1977). Ridges of domical cross section cut some c_4 craters and, at places, flank areas of young, very smooth plains material. Thus, possible volcanic extrusions associated with tectonic activity may have continued into the period of formation of c_4 craters and the oldest very smooth plains material.

The period of tectonic adjustment of the Mercurian lithosphere lasted at least through the time of formation of smooth plains material; c_4 craters that formed during this period are cut by scarps and are superposed on them. Some very smooth plains material, most of which postdates c_4 craters, appears to postdate the scarps that it commonly embays. Superposition relations of scarps in other regions of Mercury indicate that tectonic activity may have continued into c_5 time (Leake, 1982).

However, the time of formation of c_5 craters and very smooth plains material has, for the most part, been tectonically quiescent. During this period, with the exception of a scattering of extremely fresh craters and some minor mass wasting (Malin and Dzurisin, 1977), almost no geologic activity has occurred near the Mercurian south pole. The youngest smooth plains and the very smooth plains materials that occur within c_5 craters may be impact melts.

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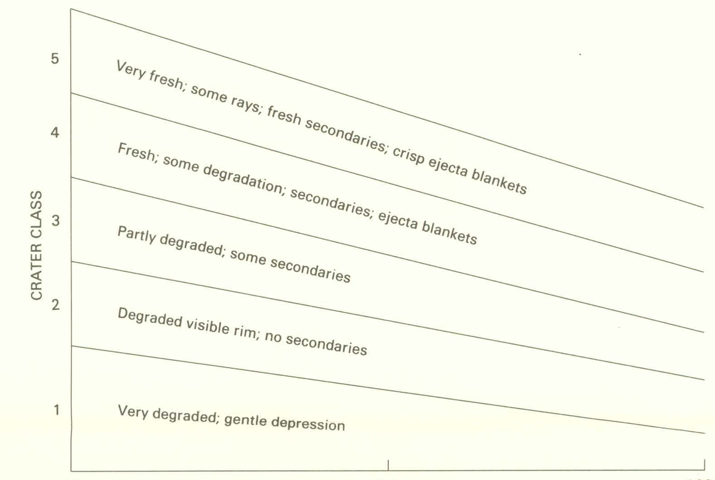


Figure 1. Diagrammatic representation of crater classes, showing effects of crater size on retention of morphological features.

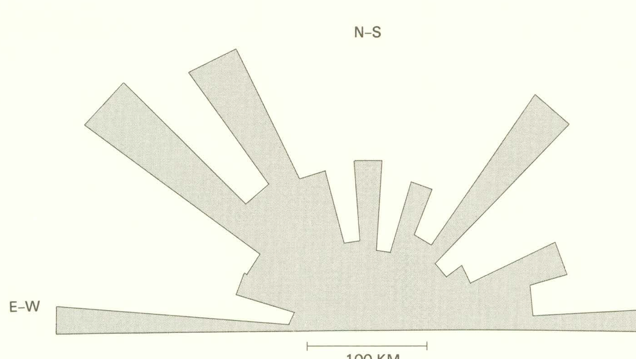
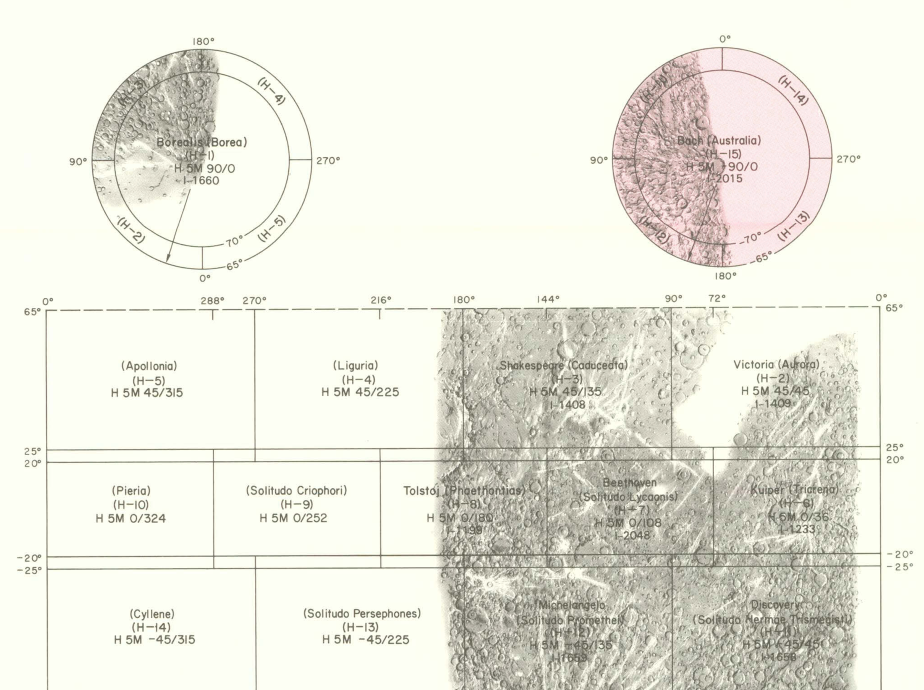
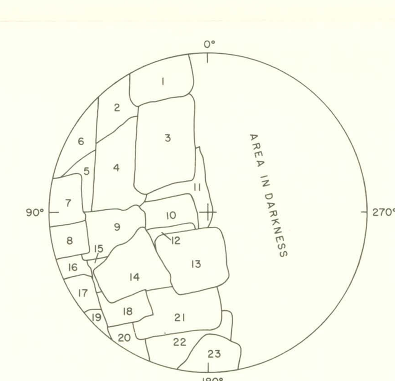


Figure 2. Azimuth-frequency distribution of cumulative lengths of linear crater-wall segments.



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.



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

GEOLOGIC MAP OF THE BACH REGION OF MERCURY

By

Robert G. Strom, Michael C. Malin, and Martha A. Leake

1990

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