DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

Prepared for the
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

ATLAS OF MARS
1:5,000,000 GEOLOGIC SERIES
AMENTHES QUADRANGLE
M 5M 15/248 G, 1979
I-1110 (MC-14)

NOTES ON BASE

This map sheet is one of a series covering the entire surface of Mars at nominal scales of 1:25,000,000 and 1:5,000,000 (Batson, 1973; 1976). The major source of map data was the Mariner 9 television experiment (Masursky and others, 1970).

ADOPTED FIGURE

The figure of Mars used for the computation of the map projection is an oblate spheroid (flattening of 1/192) with an equatorial radius of 3393.4 km and a polar radius of 3375.7 km. This is not the height datum which is defined below under the heading "Contours."

PROJECTION

The Mercator projection is used for this sheet, with a scale of 1:5,000,000 at the equator and 1:4,336,000 at lat 30°. Longitudes increase to the west in accordance with the usage of the International Astronomical Union (IAU, 1971). Latitudes are areographic (de Vaucouleurs and others, 1973).

CONTROL

Planimetric control is provided by photogrammetric triangulation using Mariner 9 pictures (Davies, 1973; Davies and Arthur, 1973) and the radio-tracked position of the spacecraft. The first meridian passes through the crater Airy-O (lat 5.19° S) within the crater Airy. No simple statement is possible for the precision, but local consistency is 5–10 km.

MAPPING TECHNIQUE

A series of mosaics of Mercator projections of Mariner 9 pictures was assembled at 1:5,000,000.

Shaded relief was copied from the mosaics and portrayed with uniform illumination with the sun to the west. Many Mariner 9 pictures besides those in the base mosaic were examined to improve the portrayal (Levinthal and others, 1973; Green and others, 1975; Inge and Bridges, 1976). The shading is not generalized and may be interpreted with nearly photographic reliability (Inge, 1972).

Shaded relief analysis and representation were made by Anthony G. Sanchez.

CONTOURS

Because Mars has no seas and hence no sea level, the datum (the 0 km contour line) for altitudes is defined by a gravity field described by spherical harmonics of fourth order and fourth degree (Jordan and Lorell, 1973) combined with a 6.1 millibar atmospheric pressure surface derived from radio-occultation data (Kliore and others, 1973; Christensen, 1975; Wu, 1975, 1978).

The contour lines on most of the Mars maps (Wu, 1975) were compiled from Earth-based radar determinations (Downs and others, 1971; Pettengill and others, 1971) and measurements made by Mariner 9 instrumentation, including the ultraviolet spectrometer (Hord and others, 1974), infrared interferometer spectrometer (Conrath and others, 1973), and stereoscopic Mariner 9 television pictures (Wu and others, 1973).

Formal analysis of the accuracy of topographic elevation information has not been made. The estimated vertical accuracy of each source of data indicates a probable error of 1–2 km.

NOMENCLATURE

All names on this sheet are approved by the International Astronomical Union (IAU, 1974; 1977).

MC-14:	Abbreviation for Mars Chart 14.
M 5M 15/248 G:	Abbreviation for Mars 1:5,000,000 series; center of sheet, 15°N latitude, 248° longitude; geologic map, G.

REFERENCES

Batson, R. M., 1973, Cartographic products from the Mariner 9 mission: Jour. Geophys. Research, v. 78, no. 20, p. 4424–4435.

——— 1976, Cartography of Mars; 1975: The American Cartographer, v. 3, no. 1, p. 57–63.

Christensen, E. J., 1975, Martian topography derived from occultation, radar, spectral, and optical measurements: Jour. Geophys. Research, v. 80, no. 20, p. 2909-2913.

Conrath, B. J., Curran, R. K., Hanel, R. A., Kunde, V. G., Maguire, W. W., Pearl, J. C., Pirraglia, J. A., Welker, J., and Burke. T. E., 1973, Atmospheric and surface properties of Mars obtained by infrared spectroscopy on Mariner 9: Jour. Geophys. Research, v. 78, no. 20, p. 4267–4278.

Davies, M. E., 1973, Mariner 9: Primary control net: Photogramm. Eng., v. 39, no. 12, p. 1297–1302.

Davies, M. E., and Arthur, D. W. G., 1973, Martian surface coordinates: Jour. Geophys. Research, v. 78, no. 20, p. 4355–4394.

Downs, G. S., Goldstein, R. M., Green, R. R., and Morris, G. A., 1971, Mars radar observations, a preliminary report; Science, v. 174, no. 4016, p. 1324–1327.

Green, W. B., Jepsen, P. L., Kreznar, J. E., Ruiz, R. M., Schwartz, A. A., and Seidman, J. B., 1975, Removal of instrument signature from Mariner 9 television images of Mars: Applied Optics, v. 14, no. 1, p. 105-114.

Hord, C. W., Simmons, K. E., and McLaughlin, L. K., 1974, Mariner 9 ultraviolet spectrometer experiment: Pressure altitude measurements on Mars: Icarus, v. 21, no. 3, p. 292–302.

Inge, J. L., 1972, Principles of lunar illustration: Aeronaut. Chart and Inf. Center Ref. Pub., RP-71-1, 60 p.

Inge, J. L., and Bridges, P. M., 1976, Applied photointerpretation for airbrush cartography: Photogramm. Eng., v. 42, no. 6, p. 749–760.

International Astronomical Union Commission 16, 1971, Physical study of planets and satellites, *in* Proc. 14th General Assembly, 1970: Internat. Astron. Union Trans., v. XIVB, p. 128–137.

——— 1974, Physical study of planets and satellites, *in* Proc. 15th General Assembly, 1973: Internat. Astron. Union Trans., v. XVB, p. 105–108.

——— 1977, Physical studies of planets and satellites *in* Proc. 16th General Assembly, 1976, Internat. Astron. Union Trans., v. XVIB, p. 325, 331–336, 355–362.

Jordan J. F., and Lorell, Jack, 1973, Mariner 9, an instrument of dynamical science: Presented at AAS/AIAA Astrodynamics Conf., Vail, Colo., July 16–18, 1973.

Kliore, A. J., Fjeldbo, Gunnar, Seidel, B. L., Sykes, M. J., and Woiceshyn, P. M., 1973, S-band radio occultation measurements of the atmosphere and topography of Mars with Mariner 9: Extended mission coverage of polar and intermediate latitudes: Jour. Geophys. Research, v. 78, no. 20, p. 4331–4351.

Levinthal, E. C., Green, W. B., Cutts, J. A., Jahelka, E. D., Johansen, R. A., Sander, M. J., Seidman, J. B., Young, A. T., and Soderblom, L. A., 1973, Mariner 9–Image processing and products: Icarus, v. 18, no. 1, p. 75–101.

Masursky, Harold, Batson, R. M., Borgeson, W. T., Carr, M. H., McCauley, J. F., Milton, D. J., Wildey, R. L., Wilhelms, D. E., Murray, B. C., Horowitz, N. H., Leighton, R. B., Sharp, R. V., Thompson, T. W., Briggs, G. A., Chandeysson, P. L., Shipley, E. N., Sagan, Carl, Pollack, J. B., Lederberg, Joshua, Levinthal, E. C., Hartmann, W. K., McCord, T. B., Smith, B. A., Davies M. E., De Vaucouleurs, G. D., and Leovy, C. B., 1970, Television experiment for Mariner Mars 1971: Icarus, v. 12, no. 1, p. 10–45.

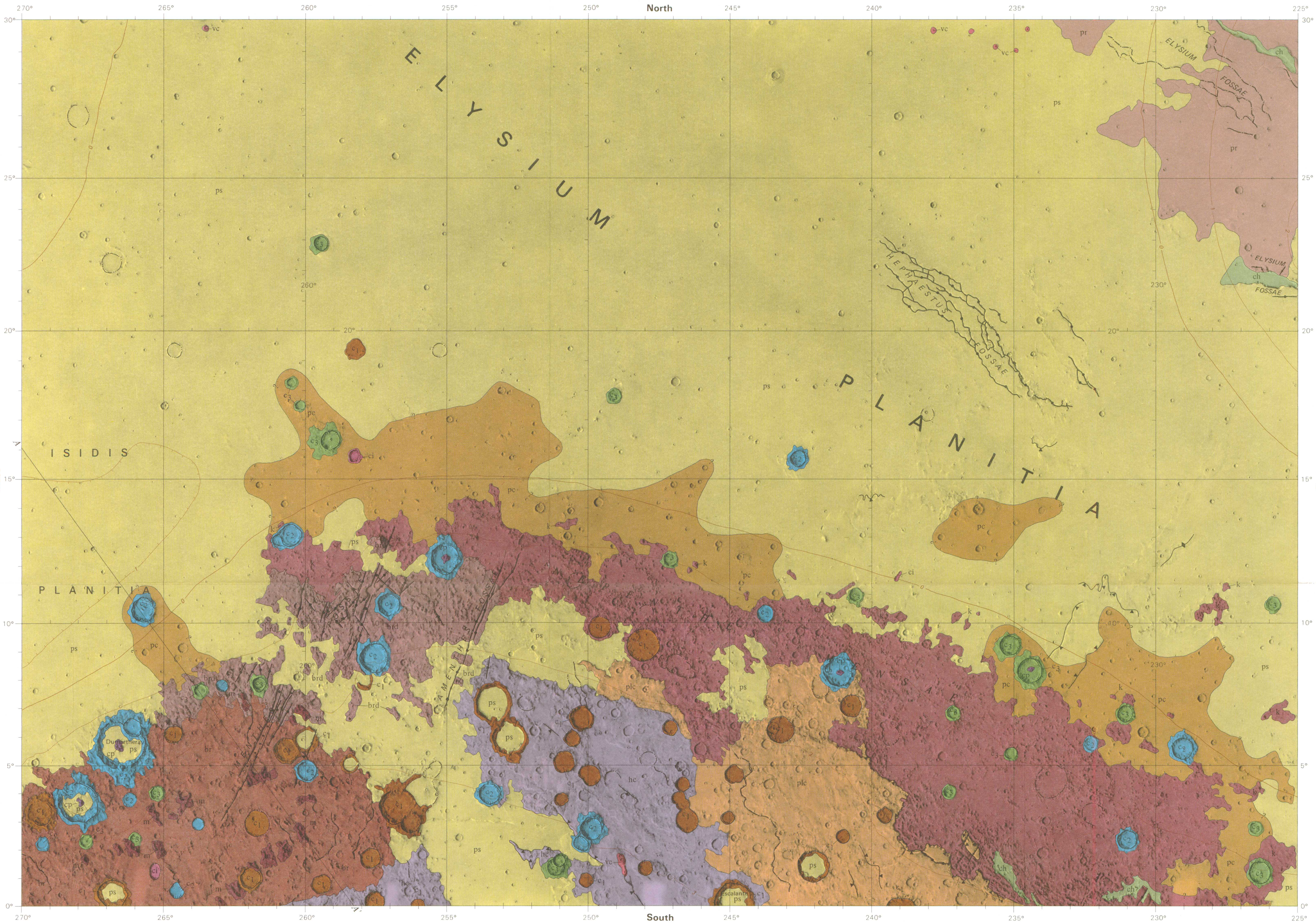
Pettengill, G. H., Rogers, A. E. E., and Shapiro, I. I., 1971, Martian craters and a scarp as seen by radar: Science, v. 174, no. 4016, p. 1321–1324.

de Vaucouleurs, G. D., Davies, M. E., and Sturms, F. M., Jr., 1973, The Mariner 9 areographic coordinate system: Jour. Geophys. Research, v. 78, no. 20, p. 4395–4404.

Wu, S. S. C., 1975, Topographic mapping of Mars: U.S. Geol Survey Interagency Report: Astrogeol. 63, 191 p.

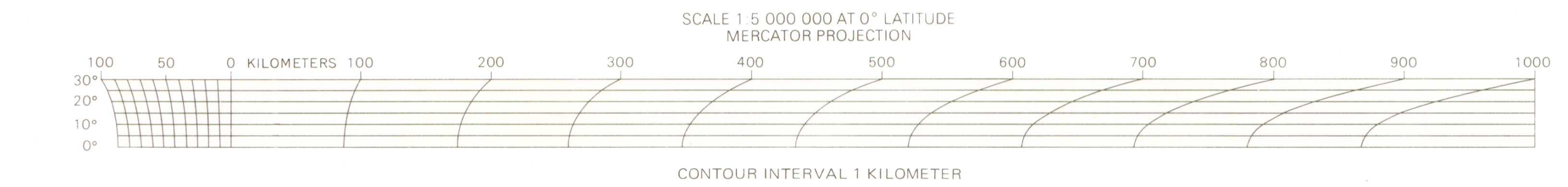
——— 1978, Mars synthetic topographic mapping: Icarus, v. 33, no. 3, p. 417–440.

Wu, S. S. C., Schafer, F. J., Nakata, G. M., Jordan, Raymond, and Blasius, K. R., 1973, Photogrammetric evaluation of Mariner 9 photography: Jour. Geophys. Research, v. 78, no. 20, p. 4405–4410.



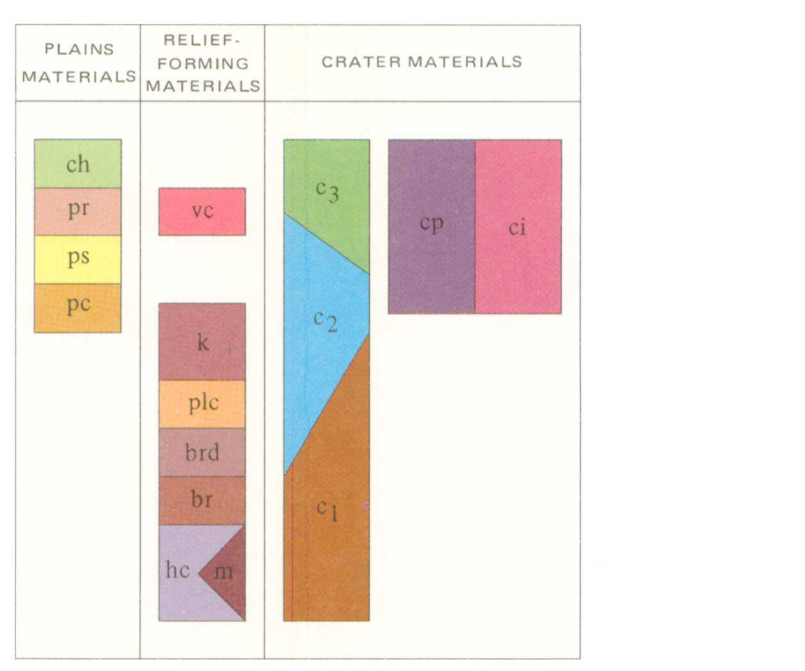
Interior—Geological Survey, Reston, Va.—1979—G78131

Prepared on behalf of the Planetary Geology Program, Planetary Division, Office of Space Science, National Aeronautics and Space Administration under contract W-13,709 in cooperation with the University of Munich.



CONTOUR INTERVAL 1 KILOMETER

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

PLAINS MATERIALS

ch CHANNEL DEPOSIT—Occurs mostly in sinuous depressions. Smooth appearance and low crater density. B frames show typical fluvial and wind erosion forms, such as triangular islands. *Interpretation:* Depressions represent grabens eroded mainly by water flooding and finally shaped by wind erosion. Channel floors now represent young deposits of windblown material

pr ROLLING PLAINS MATERIAL—Smooth and uneven appearance; in B frames, lobate scarps visible. Albedo low compared to surrounding plains; $N(10^{-6} km^{-2})$: 2100; age 3.6–3.7 b.y. *Interpretation:* Mainly lava flows, most originated around Elysium Mons. Light areas probably mantled by thin layer of eolian debris

ps SMOOTH PLAINS MATERIAL—Forms extensive area in lowlands. Albedo high. Smooth and featureless in low-resolution pictures. Light-toned wind plumes indicate winds from northeast to southwest in the lowlands and from northwest to southeast in the highland plains. B frames show lobate scarps, ridges, and hilly areas. Old craters partly buried in many places. A topographically high zone, marked by several buried crater outlines, seems to separate Isidis Planitia from northern plains. Crater density low, $N(10^{-6} km^{-2})$: 2000–4000; age 3.6<ps<3.8 b.y. *Interpretation:* Plains lavas comparable to lunar maria have flooded older units. Mostly thin but in some areas thick layer of eolian debris

pc CRATERED PLAINS MATERIAL—Occurs mostly between smooth plains and highlands. Similar to unit ps but shows lower albedo and rougher appearance. Old craters less buried. Lobate scarps and ridges visible; $N(10^{-6} km^{-2})$: 4000–10,000; age 3.8<pc<3.9 b.y. Boundary with unit ps poorly defined. *Interpretation:* Oldest plains unit, flooded by lavas of smooth plains material (unit ps)

RELIEF-FORMING MATERIALS

vc VOLCANIC CONE MATERIAL—Occurs mainly in northern part of quadrangle. Small cones with summit craters and dark half circles around bases. *Interpretation:* Craters of non-impact origin, believed to be volcanic

k KNOBBY MATERIAL—Forms zone between densely cratered highlands in the south and relatively smooth lowland plains in the north. Consists of rounded to subangular small hills of similar size; in some places forms rectilinear mesas. B frames show triangular facets and in some places layering within knobs. Old, buried craters barely visible. *Interpretation:* Remnants of plateau materials produced by erosional retreat of highlands. Blocky patterns controlled by fractures and faults

plc CRATERED PLATEAU MATERIAL—Occurs in uplands; flat-appearing surface, lobate scarps, narrow sinuous channels. Craters mostly of frying-pan type with flat debris-filled floor and subdued rim. Boundary with hilly and cratered material (unit hc) difficult to determine. Separated from knobby material (unit k) by a high scarp; $N(10^{-6} km^{-2})$: 5000–15,000; age 3.8<plc<4.0 b.y. *Interpretation:* Relatively thin layer of ancient low-viscosity lava partly covering hilly and cratered material (unit hc), channels represent lava tubes

brd DISSECTED BASIN RIM MATERIAL—Continuation of basin rim material (unit br), but dissected by two fault systems of different orientation and age. Barely visible older system oriented northwest and northeast; younger faults trend north-northeast. Unit broken up into mesas and large knobs; $N(10^{-6} km^{-2})$: 24,000; age 4.1 b.y. *Interpretation:* Isidis basin rim material. Intense erosion facilitated by shearing of rocks. Older fractures part of a global tectonic grid, younger fractures due to regional, Isidis-related forces

br BASIN RIM MATERIAL—Occurs in half circle southeast of Isidis Planitia. Embays two chains of mountainous material. Surface shows many small hummocks and hills but appears mainly smooth. High crater density, $N(10^{-6} km^{-2})$: 60,000; age 4.3 b.y. Craters slightly to highly eroded. Some narrow long sinuous channels. *Interpretation:* Old martian crust, shocked and tilted by the Isidis event. Impact melt and probably lava extrusions have smoothed and subdued the surface. Channels probably remnants of aqueous erosion or lava runoff

m MOUNTAINOUS MATERIAL—Forms chains of high-rising massifs in basin rim material (unit br). Concentric to Isidis Planitia. Steep, eroded walls and many small craters. *Interpretation:* Eroded remnants of two rings of Isidis basin. Represents tilted and uplifted hilly and cratered material (unit hc)

hc HILLY AND CRATERED MATERIAL—Most extensive unit in southern part of planet. $N(10^{-6} km^{-2})$: >100,000, age 4.3 b.y. High density of craters up to 80 km in diameter; most are age of highly eroded craters (unit c_1) and frying-pan type and highly degraded. Crater floors mostly covered with eolian debris. Intercrater areas with many hills and ridges. *Interpretation:* Oldest exposed unit in the quadrangle. Probably remnants of the early martian crust

CRATER MATERIAL

Craters less than 20 km diameter are not mapped. Craters in classes c_1–c_3 and ci are probably formed by impact.

c3 SLIGHTLY ERODED CRATERS—Sharp appearance, complete rims and steep walls. Floors only partly filled with eolian debris; in small craters floors are bowl shaped. Central peaks sharply defined; ejecta blankets visible in places

c2 MODERATELY ERODED CRATERS—Rim crest broken by erosional and tectonic processes. Floors partly filled and smoothed by eolian debris. Central peaks mostly absent

c1 HIGHLY ERODED CRATERS—Rim crest barely visible, of knobby appearance or frying-pan type. Floors smooth and in places filled to elevation of surrounding terrain. Central peaks absent

ci IRREGULARLY SHAPED CRATERS—Oval craters with sharp rims; two occurrences, one has well-developed ejecta blanket (16°N 258°W). Probably produced by overlapping primary impacts or breakup of a single meteorite

cp CENTRAL PEAK MATERIAL—Occurs in all large c_3 craters and some c_2 craters; forms single hill in crater center. *Interpretation:* Shocked floor material uplifted during late stages of crater formation

Contact—Queried where poorly defined

Fault—Ball and bar on downthrown side

Scarp—Barb points downdip; line marks base of slope. In places marks contact

Ridge

Narrow graben

Narrow sinuous channel

Crater rim crest

Crater rim crest, remnant or buried

Brecciated floor material

INTRODUCTION

The Amenthes quadrangle includes two main physiographic and geologic subdivisions. In the southern part of the quadrangle, densely cratered plateaus rise about 3 km above sparsely to moderately cratered plains. The low plains that form Elysium Planitia also build the eastern flank of the Isidis basin, which mostly lies within the adjacent Syrtis Major quadrangle to the west; the Elysium region, one of the main volcanic centers of Mars, is located to the east. Some of the geologic and tectonic units in the Amenthes quadrangle are related to this volcanic and uplifted zone.

Geologic mapping is based mainly on morphological criteria together with some albedo, superposition, and crater-density data from both high- and low-resolution Mariner 9 images. Interpretations of rock units were made by comparison with well-known geologic features on the Earth and the Moon. To determine the absolute ages of map units, crater-counting methods in connection with an updated version of the crater-frequency curve of Neukum and Wise (1976) (fig. 1) were used. However, the application of this method in the Amenthes region is limited by the low resolution and lack of optimum image quality.

STRATIGRAPHY

Relief-Forming Materials

The southern part of the quadrangle is dominated by high plateaus rising about 2–4 km above the plains. They have a high crater density comparable to that of the lunar highlands, and the sculptured intercrater surfaces are marked by lobate scarps, numerous hills, and by long, narrow channels and grabens. Highly degraded remnants of large craters and knobby terrain are evidence of intense erosion. Fine-grained sediments have accumulated along channels and in the lower parts of the highlands. Predominant wind directions are often shown by light-colored wind plumes in the lee of topographic obstacles.

The hilly and cratered and cratered plateau materials belong to the primary martian crust and represent the end of the accretional phase of the planet's history. The cratered plateau material consists of low-viscosity lava flows that buried the hilly and cratered material. The hilly and cratered material was heavily bombarded by large meteorites. The biggest impact event of that period formed the Isidis basin, excavating and tilting a large part of the crust and causing the development of regional tectonic features. Ejecta material, impact melt, and lava extrusions, resulting from deep penetration of the meteorite into the thin crust that existed, filled and smoothed the roughened area between the basin rings; the basin rim material provides evidence of this process. The mountainous material, embayed in the basin rim material, is believed to be eroded remnants of two rings of Isidis, which consist of high mountains, alined in two chains concentric to Isidis.

The dissected basin rim material is inherently the same as the basin rim material except that the surface is broken up into mesas and large knobs. The different appearance of the dissected basin rim material is probably due to erosion subsequent to and facilitated by the intense shearing of the rocks; due to various stages in the erosional process, all boundaries of this unit are transitional and therefore only poorly defined. At least two graben systems of different orientation and age transect the terrain.

A zone of relief-forming material, mapped as knobby material, occurs over most of the planet (Scott and Carr, 1976) and marks the transition zone between the southern highland complex and the north-extending lowland plains. In this quadrangle it is called Nepenthes Mensae. The knobs appear to be remnants of the highland rocks that have been faulted and eroded by wind and water, probably assisted by ground ice sapping, causing the plateau to retreat southward as much as 400 km. Some large craters have been exhumed by this process. The knobby material consists of closely arranged round or triangular inselbergs of uniform size and a few large rectangular mesas. High-resolution images show layering in many of the knobs.

In the northern plains some specific features of unknown origin were mapped as volcanic cone material. These features consist of small domes with a summit crater and a dark semicircle around their base. Plains areas that include the cones are more densely cratered than adjacent plains; however, crater density is similar to adjacent plains if the cone craters are omitted, suggesting that the domes have an endogenic origin.

Plains Materials

Elysium Planitia is part of the circumplanetary plains of the northern hemisphere of Mars. At A-frame resolution the whole area appears flat and extremely smooth. A relatively high albedo and generally low crater density distinguish the plains from the dark, rough-appearing, densely cratered highlands. However, high-resolution images provide information to subdivide the plains into other units. The oldest of these units, cratered plains material, shows a highly sculptured surface with many lobate scarps and raised features resembling lunar wrinkle ridges. Crater density is nearly as high as that of the youngest highland units; albedo is relatively low compared to other plains materials.

The most extensive of the plains materials is the smooth plains material, which even in B-frame pictures, shows only a poorly sculptured surface, low crater density, and high albedo. Light wind plume streaks have been formed behind obstacles in some areas. Old craters are buried and are visible only as dark spots or a typical circle of knobs. Most probably, low-viscosity lava flows have formed both of these plains units as well as the rolling plains material that is associated with Elysium Mons to the east, outside the map area. The flows flood large downwarped parts of the early martian crust and huge impact basins like Isidis. Volcanic flooding extended over a long period of time, and smooth and rolling plains units represent the last stage in this process. The lobate scarps, low crater density, and large fault systems associated with the rolling plains indicate that they are young lava flows in a tectonically active zone.

Light windstreaks in the lowland plains area provide evidence of an active wind regime predominantly from the northeast. Within topographic depressions and crater floors of the southern highlands, plains materials also occur; these consist mainly of thick blankets of eolian sediments. Light wind plumes on these plains units, in contrast to the northeast winds of the lowland plains, indicate wind directions predominantly from the northwest. A comparatively large number of ghost craters together with the accumulation of eolian features exist in a zone extending northwest from the dissected basin rim unit. The terrain in this area may be slightly higher than the plains on either side and may represent the northeastern segment of the rings of Isidis basin.

The youngest unit in the quadrangle is represented by a channel deposit occurring in wide graben systems. It consists of debris deposited by water flooding (Milton, 1973) and may be partially covered by eolian material.

Crater Materials

Craters on Mars are modified in their appearance by wind, water, and tectonic processes; effects vary depending on the size of the crater, its duration of exposure, and its location. Age dating on the basis of crater morphology is thus not very satisfactory, and impact craters are therefore assigned to only three categories, based on their erosional stage. Exhumed, buried, or extremely eroded craters with barely visible contours are not classified but marked with a special symbol. In the highland units, craters of the frying-pan type, with mostly denuded rims, steep walls, and flat debris-filled floors, are common. A few nonoverlapping twin craters, at an identical erosional stage, probably represent doublets (two craters formed simultaneously by a breakup of the impacting body). Two small craters mapped as irregularly shaped craters have oval rims; one of them also shows a well-developed ejecta blanket. The origin of these features is not known. They may represent secondary craters or an overlapping of two or more primary impact craters.

STRUCTURE

Two main zones of tectonic activity are distinguishable in the quadrangle, (1) Hephaestus and Elysium Fossae, and (2) Amenthes Fossae. Hephaestus Fossae are a network of narrow grabens with steep walls and a zig-zag course that trends generally northwest; single lineaments show azimuths of 100°, 150° and 180°. The same trend is apparent in the huge graben systems of Elysium Fossae, which extend from the Elysium quadrangle in the east as far as the northeastern corner of the mapped area. The extreme width of these features is clearly related to crustal extension, caused by the updoming of the Elysium volcanic center (Scott and Allingham, 1976); however, the trends in the Elysium Fossae are not everywhere radial to the center of uplift.

The lineaments in both Elysium and Hephaestus Fossae can be related to a planetwide tectonic grid (Binder and McCarthy, 1972). Further topographic modeling is due to regional processes such as the updoming of parts of the crust, water erosion, wind deflation and deposition, and possibly lava erosion. Amenthes Fossae, the network of faults in the western highlands, appear to be the result of even more complicated tectonic forces. In this region at least two structural systems, differing in age and orientation, are detectable. The older, which is highly subdued by erosion, trends northwest and northeast; the younger system trends north-northeast. However, the younger system bears no distinct relation either to the planetwide grid or the the adjoining Isidis impact basin. Most probably it represents an accumulation of impact-related and global tectonic forces.

GEOLOGIC HISTORY

Like the Moon, the observable geologic history of Mars began with high meteorite impact flux on an early-formed crust. This period is characterized by large multi-ringed impact basins like Isidis, numerous impact craters, and the development of a planetwide tectonic grid. Most of the highland materials in the southern part of the quadrangle are remnants of this period.

During the subsequent period of waning impact flux, the martian surface was modeled predominantly by volcanic processes. Large-scale extrusions of low-viscosity basalt flooded downwarped parts of the crust and floors of impact basins, thus creating vast plains mainly in the northern part of the mapped area. They are characterized by flat-appearing surfaces, relatively low crater density, and lobate flow fronts. Concomitant with the creation of the plains, intense erosion took place, and the northern edge of the highlands complex was denuded to mesas and small knobs. In a narrow zone, plains lava flows overlapped this area of active highland erosion.

Towards the end of this period, the volcanic material seems to have changed to more viscous lava. The large volcanoes of the Elysium region, with their surrounding plains, were then built up. Their location is related to uplift and doming in this area (Scott and Allingham, 1976) that opened the preexisting tension faults of Elysium Fossae. Unlike the Earth, there is no evidence of further development of the martian crust into dissected plates. The martian surface, however, is still being actively transformed by the erosion of the ancient plateau materials and craters into knobby terrain and by transport of eolian materials, mainly in the lower plains area.

REFERENCES

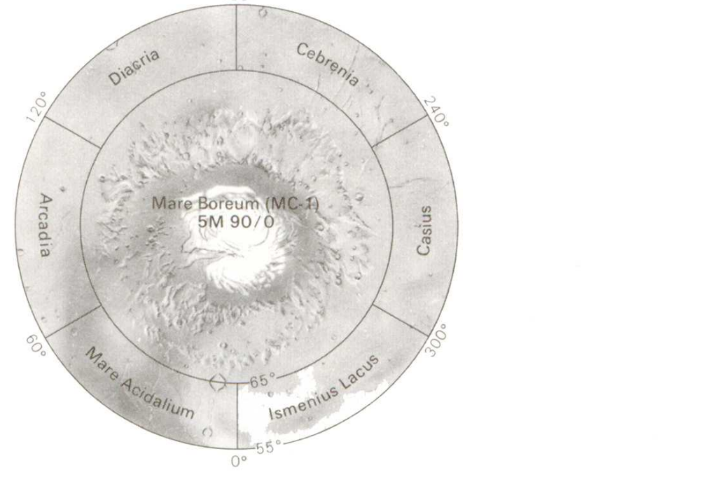
Binder, A. B., and McCarthy, D. W. 1972, Mars, The lineament systems: Science, v, 176, p. 276–281.

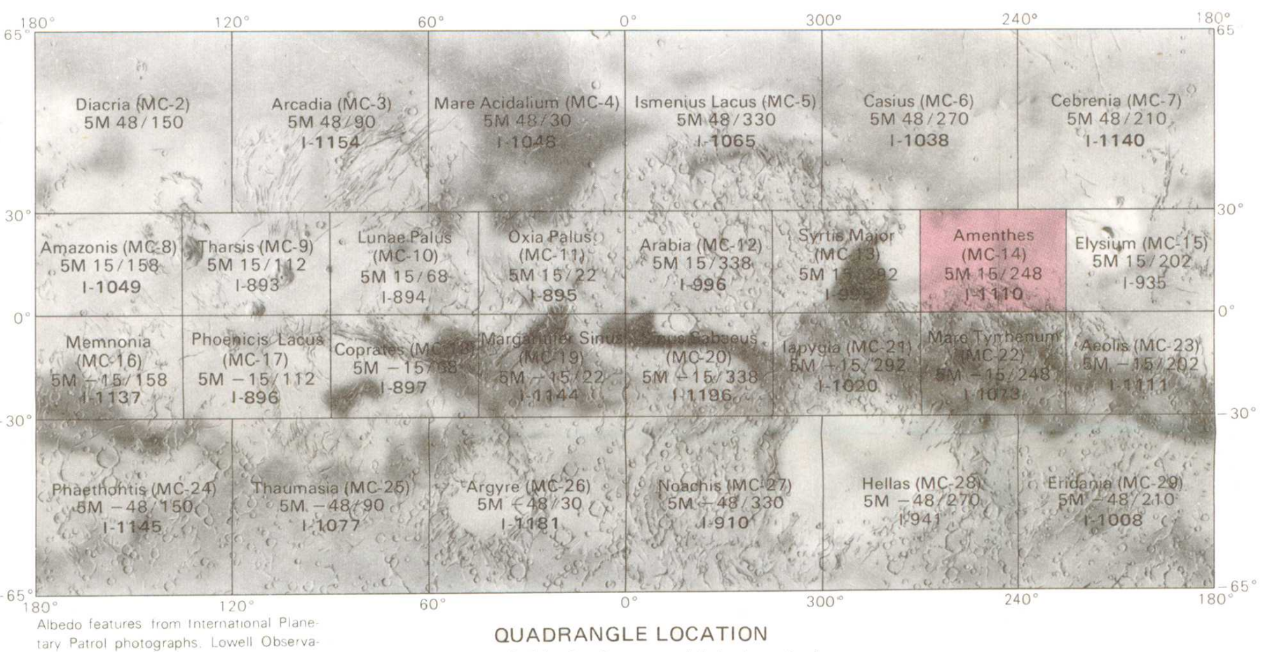
Milton, D. J., 1973, Water and processes of degradation in the martian landscape: Jour. Geophys. Research, v. 78, no. 20, p. 4037–4047.

Neukum, Gerhard, and Wise, D. U., 1976, Mars: A standard crater curve and possible new time scale: Science, v. 194, p. 1381–1387.

Scott, D. H., and Allingham, J. W., 1976, Geologic map of the Elysium quadrangle of Mars: U.S. Geol. Survey Misc. Inv. Map I-935, scale 1:5,000,000.

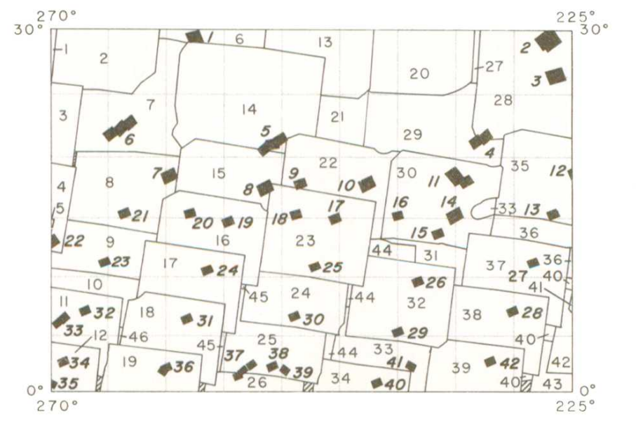
Scott, D. H., and Carr, M. H., 1976, Geologic map of Mars: U.S. Geol. Survey Open-file Rept. No. 76-573, scale 1:25,000,000.





QUADRANGLE LOCATION
Number preceded by I refers to published geologic map

ALBEDO MARKINGS AND CONTOURS
Contour interval 1 kilometer. Surface markings derived from selected Mariner 9 photographs.



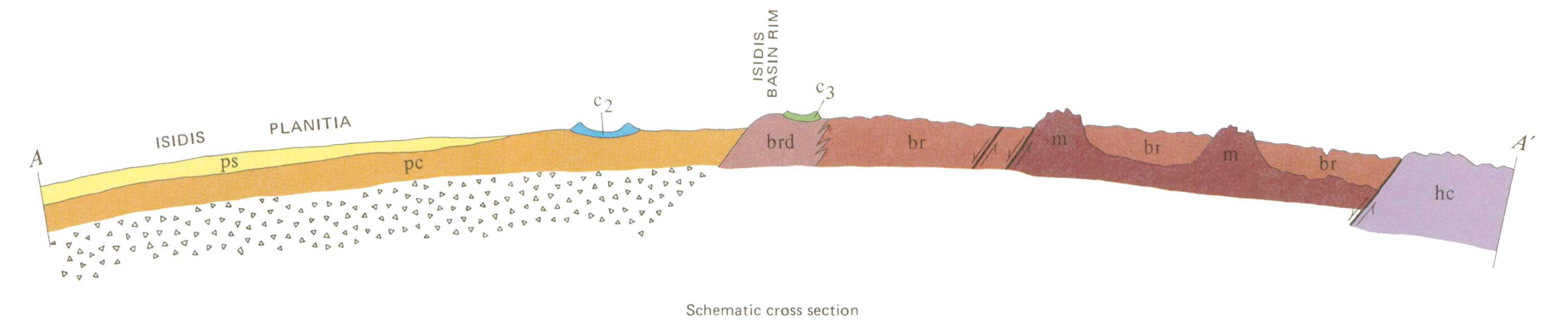
INDEX TO MARINER 9 PICTURES
The mosaic used to control the positioning of features on this map was made with the Mariner 9 A-camera pictures outlined above, identified by vertical numbers. Useful coverage is not available in cross-hatched areas. Also shown (by solid black rectangles) are the high-resolution B-camera pictures, identified by italic numbers. The DAS numbers may differ slightly (usually by 5) among various versions of the same picture.

A-camera pictures

Index No.	DAS No.	Index No.	DAS No.
1	8550889	24	7435223
2	8622849	25	7435153
3	7219763	26	7435083
4	7219413	27	8910694
5	7219348	28	7507748
6	8694879	29	7507603
7	7291793	30	7507253
8	7291443	31	7507538
9	7291373	32	7507113
10	7291303	33	7507043
11	7291233	34	7506973
12	7291163	35	7579213
13	8766839	36	7579148
14	7363753	37	7579073
15	7363403	38	7579003
16	7363333	39	7578933
17	7363263	40	7579428
18	7363193	41	7650968
19	7363123	42	7650893
20	8838799	43	7650823
21	7435713	44	7435573
22	7435363	45	7363613
23	7435293	46	7291653

High resolution B-camera pictures

Index No.	DAS No.	Index No.	DAS No.	Index No.	DAS No.
1	*11349780*	*11*	*10241214*	*29*	*7507078*
2	*10313874*	*12*	*7579528*	*30*	*7435188*
	10313804	*13*	*7579178*	*31*	*7363228*
3	*7435888*	*14*	*7507568*	*32*	*7291268*
4	*12902043*	*15*	*7507218*	*33*	*12685953*
	12902113	*16*	*6104138*		*12686023*
5	*11975079*	*17*	*7435328*	*34*	*7291198*
	11975289	*18*	*6032248*	*35*	*8693724*
	11975149	*19*	*7363368*	*36*	*7363158*
6	*12686303*	*20*	*5960288*		*8765684*
	12686233	*21*	*7291408*	*37*	*11974869*
	12686373	*22*	*10169394*		*11974659*
7	*7291758*	*23*	*7291338*		*11974729*
8	*7363718*	*24*	*7363298*	*38*	*7435118*
9	*6032388*	*25*	*7435258*	*39*	*8837644*
10	*7435678*	*26*	*7507148*	*40*	*7507008*
11	*10241354*	*27*	*7579108*	*41*	*8981494*
	10241284	*28*	*7579038*	*42*	*7578968*



Schematic cross section

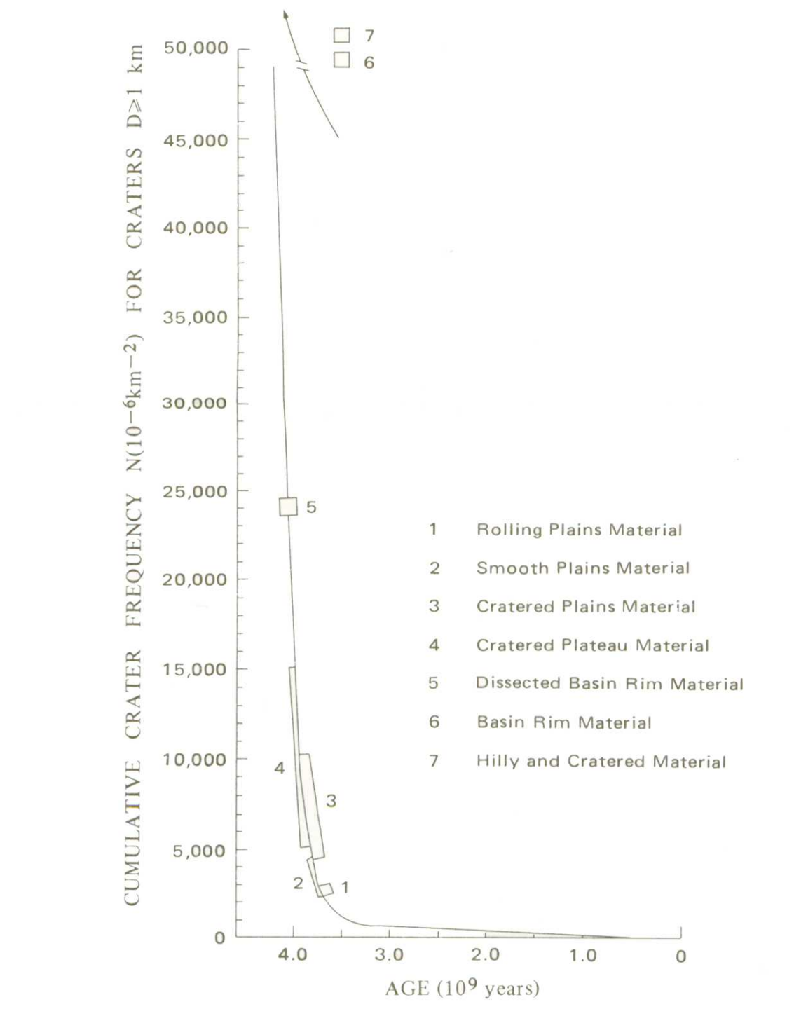


FIGURE 1

GEOLOGIC MAP OF THE AMENTHES QUADRANGLE OF MARS

By

Konrad H. Hiller

1979

For sale by Branch of Distribution, U.S. Geological Survey, 1200 South Eads Street, Arlington, VA 22202, and Branch of Distribution, U.S. Geological Survey, Box 25286, Federal Center, Denver, CO 80225