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
MARE TYRRHENUM QUADRANGLE
M 5M -15/248 G, 1978
I-1073 (MC-22)

NOTES ON BASE

This map sheet is one in a series covering the entire surface of Mars at a nominal scale of 1:5,000,000 (Batson, 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 usage of the International Astronomical Union (IAU, 1971). Latitudes are areographic (de Vaucouleurs and others, 1973).

CONTROL

Planimetric control is provided by radio-tracked positions of the spacecraft and telemetered camera pointing angles. 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 inconsistencies may be as large as 50 km.

MAPPING TECHNIQUES

Selected Mariner 9 pictures were transformed to the Mercator projection (Green and others, 1975) and assembled in a series of mosaics at 1:5,000,000 (Batson, 1973)

CONTOURS

Since 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).

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).

MC-22:	Abbreviation for Mars Chart 22
M 5M–15/248 G:	Abbreviation for Mars 1:5,000,000 series; center of sheet, 15° S latitude, 248° longitude; geologic map, G.

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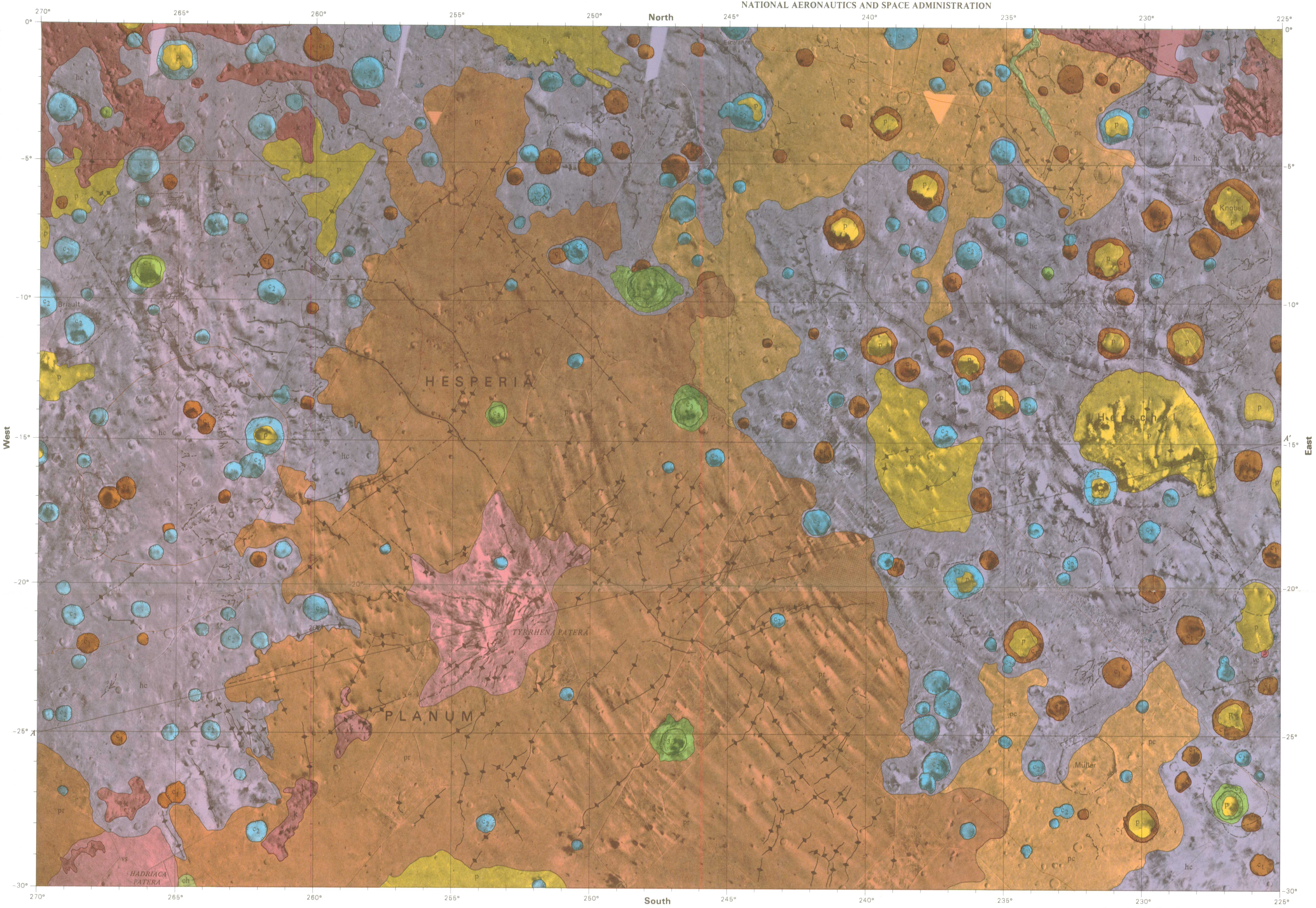
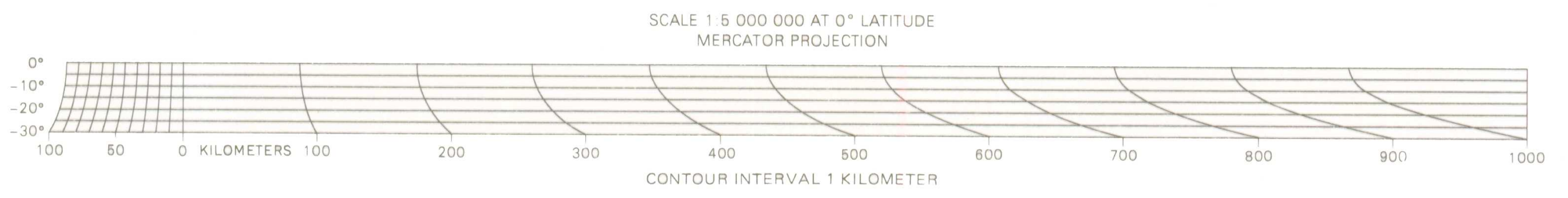


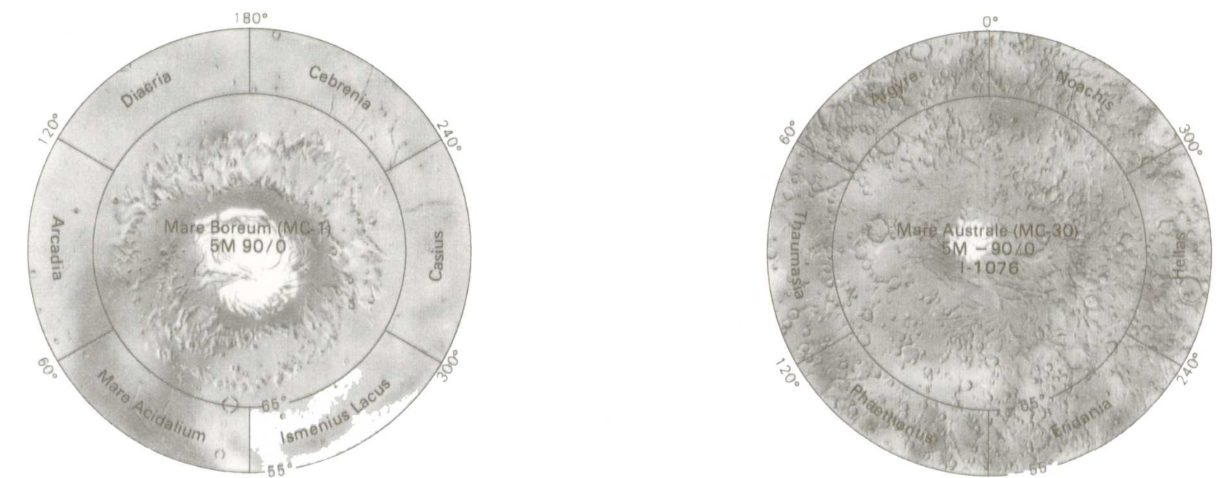
Prepared on behalf of the Lunar and Planetary Programs Office, National Aeronautics and Space Administration under contract W-13,709 in cooperation with University of Houston, Texas (NASA grant NGR-44-005-131)

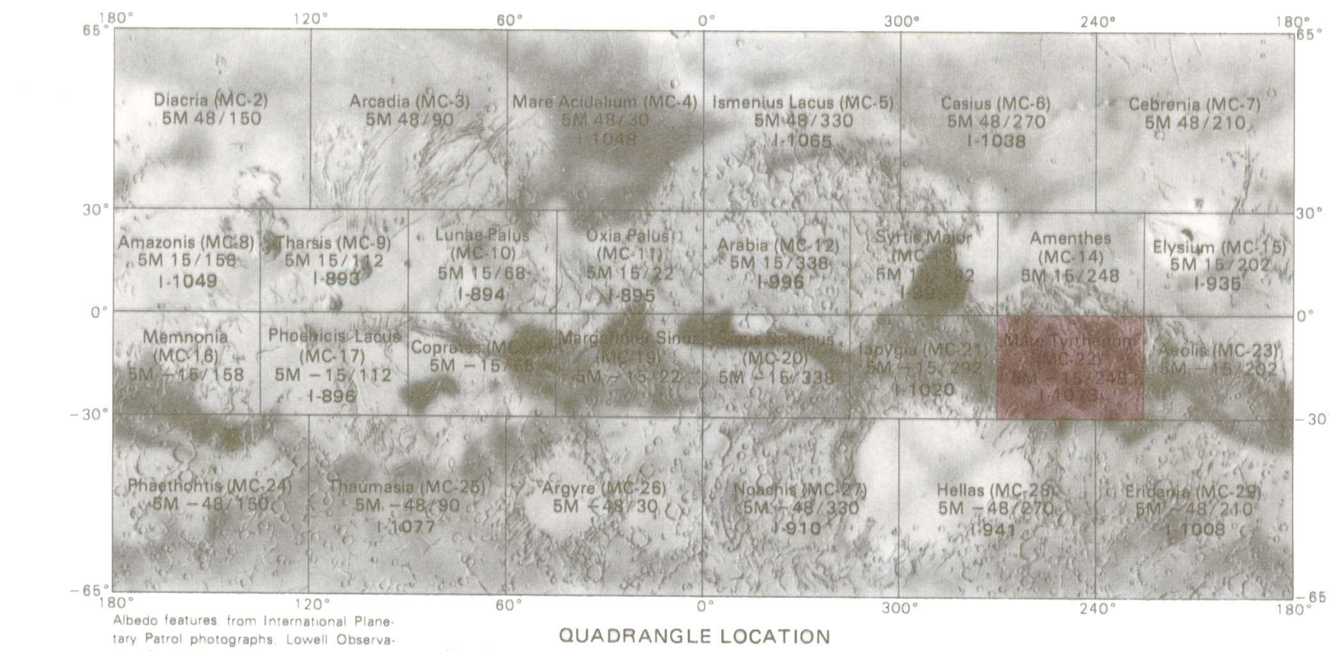


SCALE 1:5 000 000 AT 0° LATITUDE
MERCATOR PROJECTION

KILOMETERS

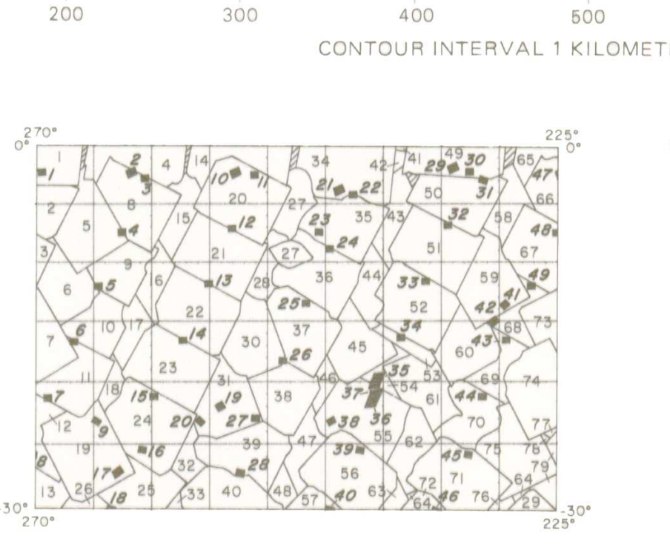
CONTOUR INTERVAL 1 KILOMETER





QUADRANGLE LOCATION

Number preceded by I refers to published geologic map



A-camera pictures

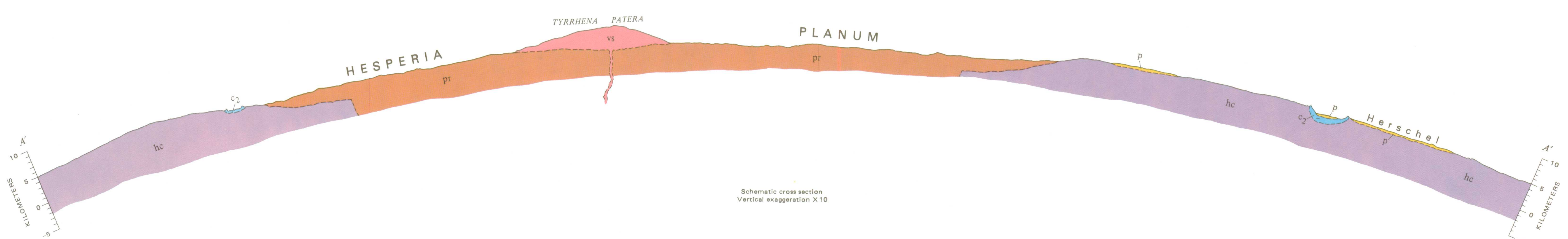
Index No.	DAS No.	Index No.	DAS No.	Index No.	DAS No.
1	7291163	28	8909359	55	7578303
2	7290813	29	6318863	56	6175153
3	7290743	30	8909289	57	6175083
4	7363123	31	8909219	58	9053279
5	8765579	32	8909149	59	9053209
6	8765509	33	8909079	60	9053139
7	8765439	34	7506973	61	9053069
8	7362773	35	7506623	62	9052999
9	7362703	36	7506553	63	9052929
10	7362633	37	7506483	64	5488663
11	7362563	38	7506413	65	7650823
12	7362493	39	7506343	66	7650473
13	8837189	40	6103793	67	7650403
14	7435083	41	7507043	68	7650333
15	8837539	42	7507463	69	7650263
16	8837469	43	8981389	70	7650193
17	8837399	44	8981319	71	6247043
18	8837329	45	8981249	72	6246973
19	8837259	46	8981179	73	9125029
20	7434733	47	8981109	74	9124959
21	7434663	48	8981039	75	9124889
22	7434593	49	7578933	76	9124819
23	7434523	50	7578583	77	7722083
24	7434453	51	7578513	78	5704753
25	6031303	52	7578443	79	6318933
26	6031233	53	7578373		
27	8909429	54	5416703		

High-resolution B-camera pictures

Index No.	DAS No.	Index No.	DAS No.
1	*7290848*	*26*	*7506448*
2	*7363088*	*27*	*7506378*
3	*7362808*	*28*	*6103228*
4	*7362738*	*29*	*7578898*
5	*7362668*	*30*	*7578618*
6	*7362598*	*31*	*9053384*
7	*7362528*	*32*	*7578548*
8	*5959378*	*33*	*7578478*
9	*8837294*	*34*	*7578408*
10	*7435048*	*35*	*10311914*
11	*7434768*	*36*	*10311844*
12	*7434698*	*37*	*7578338*
13	*7434628*	*38*	*12901343*
14	*7434558*	*39*	*6175188*
15	*7434488*	*40*	*6175118*
16	*6031338*	*41*	*12150257*
17	*11974099*	*42*	*12150397*
18	*6031268*	*43*	*7650298*
19	*12901203*	*44*	*7650228*
20	*8909184*	*45*	*6247078*
21	*7506938*	*46*	*6247008*
22	*7506658*	*47*	*7650788*
23	*8909604*	*48*	*7650438*
24	*7506588*	*49*	*7650368*
25	*7506518*		

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. 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.



Schematic cross section
Vertical exaggeration X10

Interior—Geological Survey, Reston, Va.—1978—G77166

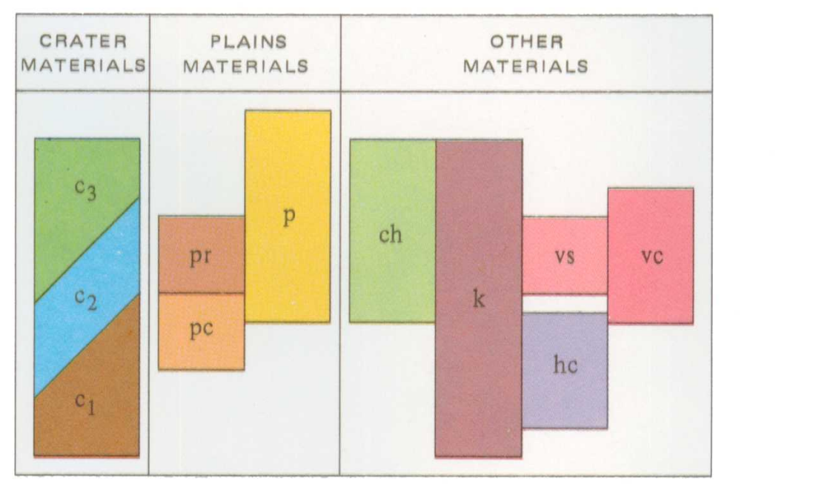
GEOLOGIC MAP OF THE MARE TYRRHENUM QUADRANGLE OF MARS

By

Elbert A. King

1978

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

CRATER MATERIALS

Craters of diameter greater than approximately 30km

c_3 Material of craters having fresh, sharp morphology with prominent and continuous raised rim and peripheral ejecta blanket; steep, rough inner wall and rough floor with or without central peak. Secondary craters from craters in this class are visible in Mariner 9 B-frames

c_2 Material of craters having moderately subdued morphology; raised narrow rim; little if any peripheral ejecta visible in Mariner 9 A-frames; steep and eroded inner wall; floors mostly flat and generally below the level of surrounding terrain. Some c_2 craters moderately dissected by rilles, channels, and dendritic channels

c_1 Material of craters having most subdued morphology; raised rim is absent, very subdued, or discontinuous; gently sloping, highly eroded inner wall; flat featureless floor near elevation of surrounding terrain; dendritic channels commonly head on and cut deeply into rims and floors of some c_1 craters; no peripheral ejecta visible at A-frame resolution from Mariner 9 imagery

Interpretation: Impact craters showing various degrees of degradation and infilling; state of degradation is commonly a misleading criterion for relative age of craters owing to the abundant erosive and depositional work of eolian, sedimentary, and volcanic processes that have occurred on the Martian surface

PLAINS MATERIALS

p PLAINS MATERIAL–Featureless to slightly cratered plains; generally with high apparent albedos, includes some materials of relatively low albedo. Forms locally isolated patches apparently filling lower elevations, including crater floors. *Interpretation:* Local accumulations of eolian detritus sufficiently thick to mantle older map units and to obscure older landforms. Differentiated from other deposits of eolian origin primarily by thickness. Some of the relatively low albedo material in particular may be volcanic flows and (or) pyroclastic rocks (see especially occurrence at lat 20° S. to 22° S. and long 225° W. to 227° W., which is adjacent to volcanic cone). Mapped only where thickness is great enough to obscure previous surface at A-frame resolution

pr RIDGED PLAINS MATERIAL–Smooth to slightly cratered and rolling plains characterized by long narrow ridges similar to wrinkle ridges on the lunar maria; particularly well developed in the central part of the quadrangle. Crater density less than unit pc but greater than unit p; embays units hc and pc. Apparent albedo less than that of other plains units except possibly where covered with thin accumulations of eolian detritus. Most craters are morphological types c_2 and c_3. *Interpretation:* Relatively young basaltic lava flows similar to the lunar maria in surface morphology. Probably contemporaneous with and partially derived from Tyrrhena Patera

pc CRATERED PLAINS MATERIAL–Level and relatively smooth plains within unit hc and along the contact of units hc and pr in eastern part of quadrangle; substantially fewer and smaller craters than on unit hc, but more and larger craters than on units pr and p. Embays unit hc and is embayed by unit pr. Intercrater areas relatively flat compared with unit hc but contain numerous subdued ridges, small dendritic channels, and lobate scarps. *Interpretation:* Basaltic lava flows overlying unit hc and overlain by unit pr. Overlain and intertongued with eolian and sedimentary deposits

OTHER MATERIALS

ch CHANNEL DEPOSITS–Floor of channel ranging in width from less than 10 km to more than 25 km and more than 200 km long; channel walls are steep and sharp; channel floor mostly flat to gently sloping and featureless at A-frame resolution. *Interpretation:* Channel cut by fluid flow on the surface along previous faults and joints; deposits on floor produced by deposition from this flow, accumulations of eolian detritus, and mass wasting from channel walls

k KNOBBY MATERIAL–Small (mostly less than 10 km in diameter) irregular to conical mountains or knobs and groups of knobs and mountains giving a generally rough, high-relief appearance to the unit. Generally stands at higher elevations than surrounding hilly and cratered or plains material; some irregular and conical peaks substantially higher than adjacent terrain, especially in western part of quadrangle. Contact with adjacent units, particularly hc, is mapped on the presence of abundant knobs and some larger mountains. Interknob areas and depressions and slopes are mostly smooth with only a few small craters. *Interpretation:* Mostly brecciated and shock-metamorphosed basin ejecta. In the western part of the quadrangle, this unit probably consists of eroded patches of blocky ejecta from the Hellas Basin and Isidis Basin; somewhat similar material mapped in the northeast part of the quadrangle probably are in part eroded scarp and cliff remnants

vc VOLCANIC CONE MATERIAL–Forms a single dark conical peak approximately 15 km in diameter in southeastern part of quadrangle surrounded by unit hc (lat 22° S., long 226° W. approx.). *Interpretation:* Stratovolcano or large pyroclastic cone, probably andesitic to basaltic in composition; probable source of at least part of the immediately adjacent small area of unit p

vs VOLCANIC SHIELD MATERIAL–Dark smooth large mountains whose low slopes contain abundant linear and elongate flows and channels. Summits have irregular composite craters. Crater densities approximately the same as unit pr, but small area of exposures makes quantitative comparisons of crater densities of questionable value. *Interpretation:* Basaltic volcanic shields with summit calderas. Tyrrhena Patera (south-central part of the quadrangle) is the probable source of much of the surrounding ridged plains material (unit pr)

hc HILLY AND CRATERED MATERIAL–Rough to moderately smooth terrain with a high density of craters, especially large and degraded c_1 and c_2 craters, buried craters, and circular rimless depressions. Abundant dendritic channels at higher elevations on sloping surfaces. Forms most of the highest terrain within the quadrangle. Most of the surface is highly dissected, eroded, and rough at all scales. *Interpretation:* Ancient impact breccias and impact melts, as well as volcanic rocks ejected from large basins, particularly the Hellas Basin; mixed with older and younger crater ejecta; mantled by thin to locally thick eolian deposits and intertongued with some volcanic rocks. Channeling and erosional features on steeply sloping crater rims and regionally sloping surfaces suggest aqueous erosional processes together with, presumably accompanying, aqueous depositional processes

——— Contact

Crater rim crest–Shown only for craters with diameters greater than 30 km

Greatly subdued or buried crater rim crest

Rectilinear to arcuate escarpment–Probably a fault; bar and ball on downthrown side; dashed where location uncertain

Narrow dendritic to rectilinear channel

Linear feature–Probable fault with little or no vertical relief or displacement uncertain

Broad to narrow ridge–Dashed where location uncertain. *Interpretation:* Includes features interpreted as mare-type wrinkle ridges resulting from structural deformation of flood lava fill or igneous intrusion and old large crater rim crests only partly preserved and not certainly recognizable

Irregular rimless depression–Probable volcanic collapse feature

Escarpment

LOCATION AND PHYSIOGRAPHIC SETTING

The Mare Tyrrhenum quadrangle is bounded by lat 0° and 30° S. and long 225° W. and 270° W. The central part of the quadrangle is dominated by Tyrrhena Patera, a large shield volcano, and associated low-albedo ridged plains that probably are basaltic lava flows similar to the lunar maria. The western, northern, and eastern margins of the quadrangle are located in cratered terrains of higher elevation. The great Hellas Basin is located to the southwest of the mapped area, and the central part of the quadrangle contains a number of arcuate scarps, faults, and ridges that appear to be concentric to Hellas. The southwestern part of the quadrangle contains patches of old knobby terrain that may be ejecta and structurally deformed blocks associated with the formation of the Hellas Basin (Schaber, 1977). Prominent scarps structurally related to the Isidis Basin, located immediately northwest, are prominent features in the adjacent Iapygia quadrangle but do not extend into the mapped area. Patches of knobby material in the northwestern part of the quadrangle may be ejecta and structurally deformed areas associated with the formation of the Isidis Basin (Meyer and Grolier, 1977).

The largest craters occur in the eastern highlands of the Mare Tyrrhenum quadrangle, generally in the area farthest from the Hellas Basin. Most of the craters are very subdued (class c_1) and may be parts of the ancient cratered pre-Hellas terrain showing through thinner ejecta and ballistic sediment cover that was emplaced by the Hellas event.

PREVIOUS WORK

The map compiler has profited substantially from the work of authors of adjacent quadrangle maps. In particular, Schaber (1977), Potter (1976), De Hon (1977) and Meyer and Grolier (1977) have struggled with similar to identical stratigraphic and mapping problems in immediately adjacent areas. Previously published preliminary geologic maps (Wilhelms, 1972; Carr and others, 1973; Saunders and others, 1976) have set the stage for later mappers, especially with the recognition of ancient cratered terrains and younger plains units.

GEOLOGIC SUMMARY

The map was compiled from map units that were traced on individual Mariner 9 A-frame imagery. All available image versions were seen. There are very real differences in resolution between frames owing to the different times at which images were taken during the mission, because of clearing of atmospheric dust and other atmospheric phenomena, and the variable distance from the spacecraft to the surface. High-resolution B-frames from Mariner 9 were observed, but were of limited use in mapping because of the small number of images and the lack of contiguous coverage. These images were very helpful, however, in the interpretation of map units.

STRUCTURE

Most of the major structural features of the Mare Tyrrhenum quadrangle appear to be related to the event that formed the Hellas Basin immediately to the southwest. There are two extremely prominent directions of orientation of structural features. One is roughly northeast-southwest, approximately radial to the Hellas Basin. Landforms parallel to this direction are linear features, probably faults that have uncertain amounts and senses of displacement, and ridges, especially in the ridged plains material (unit pr) where ascending basaltic magma appears to have used the previously existing faults as planes of least resistance and channelways to the surface. The second major direction of orientation of structural features is best seen in the central and western part of the quadrangle and is roughly northwest-southeast or concentric to the northeastern margin of the Hellas Basin. Features of this trend include linear features and faults of uncertain displacement, ridges, and scarps. Some of the most prominent scarps appear to be faults that are covered by ridged plains material and may also have served as pathways for the ascent of basaltic magma that formed the ridged plains material. Curiously, the sense of displacement of several prominent faults of this type appears to be with the downthrown side away from the Hellas Basin. A few linear features and faults in the extreme northwestern part of the mapped area appear to be radial to the Isidis Basin and may be related to the event that formed the basin. No clearcut transection relation can be observed between the structural features thought to be related to the Isidis Basin and those related to the Hellas Basin, leaving unresolved the relative ages of the two basins based on observations in this quadrangle.

The orientation and occurrence of major structural features in the northeastern part of the quadrangle appear less ordered. Some of the faults and ridges may be related to some of the large old craters visible in this region, but there are many other faults and ridges whose origins do not appear to be clearly related to visible features.

STRATIGRAPHY

Hilly and cratered material (unit hc) occupies the greater part of the higher terrain in the Mare Tyrrhenum quadrangle. This unit has the greatest crater density of any map unit in the area (Hodgkinson, 1974). The unit is separated by the younger ridged plains material into a western and an eastern part. The largest craters in the quadrangle occur as very subdued c_1 craters and buried crater rims in the eastern part of the hilly and cratered material. If this unit is composed largely of Hellas ejecta and reworked Hellas ejecta, the eastern part of the area, which is farthest from the Hellas Basin, is likely to have a thinner blanket of Hellas ejecta. The large, subdued old craters in the eastern part of the hilly and cratered material may include a substantial number of ancient large impact craters formed on the primitive pre-Hellas surface that were large and distinct enough to show through the relatively thinner Hellas ejecta cover.

The intercrater areas of the hilly and cratered material are level or flat to rough and highly irregular. Much of the surface probably consists of impact metamorphosed and brecciated ancient volcanic rocks from ejecta blankets of impact craters, many of which are formed in the already brecciated Hellas ejecta. Numerous small dendritic to irregular channels are developed on steeper slopes and higher elevations. Some of these channels may be volcanic in origin, but many appear to be the result of the runoff of surface fluids, possibly rainfall. The density of erosional channels is greater on this unit than on any other map unit in the quadrangle, but the occurrence of small channels is not restricted to hilly and cratered material. The brecciated ancient volcanic and shock-metamorphosed rocks probably are interbedded locally with eolian and fluid-deposited sedimentary rocks as well as with some contemporaneous volcanic rocks.

Knobby material (unit k) includes a variety of materials, probably of different origins. Some of these materials may be among the oldest in the quadrangle, as they appear to be associated with the Hellas Basin in the southwestern part of the mapped area and the Isidis Basin in the northwestern part. These terrains are characterized by peaks and knobs that stand above the surrounding surface. The same types of materials occur in the Iapygia quadrangle, where they are concentric to the margins of the Hellas and Isidis basins (Schaber, 1977) and in the Syrtis Major quadrangle, also peripheral to the Isidis Basin (Meyer and Grolier, 1977). In this quadrangle these materials contain virtually no craters larger than 30 km; however, the locally steep slopes and the differences of elevation within the area underlain by knobby material probably do not contribute to the preservation of craters. And because the total surface underlain by materials mapped as knobby material is small, the crater density may not be a reliable indicator of relative age.

In the northeast corner of the quadrangle, knobby material probably is more erosional in origin. It appears to be remnants related to the erosional retreat of scarps. Some of this terrain appears anomalous, however, and may be of a still different origin.

Cratered plains material (unit pc) clearly is younger than the hilly and cratered material, which is embayed by cratered plains throughout its occurrence in the eastern half of the quadrangle. The crater density of the unit is substantially less than that of the hilly and cratered material (Hodgkinson, 1974), and the diameters of the largest craters that occur in this unit are much smaller than the diameters of the largest craters that can be seen in the hilly and cratered material. There are many c_1 and c_2 craters in the cratered plains, generally much smaller than craters of similar morphology in the hilly and cratered material. The relative age classification of craters in the cratered plains may in part be the result of flooding and infilling by processes related to the formation of the cratered plains material and its subsequent history.

The intercrater areas of the cratered plains material tend to be flat and planar with very little local relief. Some small ridges and channels occur on the seemingly level surface of the unit, but the density of such features is much less than on the hilly and cratered material. The cratered plains material is interpreted as relatively old volcanic plains, probably composed of basaltic lava flows whose surfaces have been modified by accumulations of eolian sediments and impact-crater ejecta.

The central part of the quadrangle is occupied by ridged plains material (unit pr), which is characterized by ridged low-albedo smooth to rolling plains with low crater density. This unit is younger than the hilly and cratered material and the cratered plains material, both of which are embayed by the ridged plains material. Hodgkinson (1974) found that this unit is the youngest of the three most widespread map units (units hc, pc, pr) in the Mare Tyrrhenum quadrangle based on impact-crater size-frequency distributions and crater densities. As the name "ridged plains material" implies, ridges are an important landform on this unit. Some of these ridges appear to be continuous for more than 300 km, but most are much shorter. The ridges have two strongly preferred directions or orientation, generally northeast-southwest and northwest-southeast, that appear to be major structural directions inherited from the Hellas event. Genetically and temporally associated with the ridged plains material is Tyrrhena Patera (unit vs), which is surrounded by ridged plains. Tyrrhena Patera is interpreted as a basaltic shield volcano with a complex summit caldera. This feature may be the source of many of the surrounding lava flows that make up part of the ridged plains material. An older basaltic shield (Hadriaca Patera) lies immediately southwest of the mapped area in the Hellas quadrangle (Potter, 1976), and a part of the shield and associated flows (unit vs) extends into the southwestern-most part of the Mare Tyrrhenum quadrangle.

Isolated patches of plains material (unit p) have been mapped in various parts of the quadrangle. This unit contains very few craters, and those that are present are rather small. Most of the unit is further characterized by relatively high albedo. The plains are interpreted as local, relatively thick accumulations of eolian sediments that fill topographic depressions and (or) mantle older volcanic plains and impact-ejecta. Some occurrences, such as that between lat 20° S. to 22° S. and long 225° W. to 227° W., may be local volcanic deposits of pyroclastic origin or flows thinly mantled by eolian detritus. In general, these areas probably are the youngest plains material in the map area, and many of these occurrences may still be accumulating eolian sediments at the present time.

Near the eastern margin of the Mare Tyrrhenum quadrangle at approximately lat 22° S. and long 226° W. is a conical mountain that is unique in this quadrangle (unit vc). The feature is interpreted as a volcanic cone approximately 15 km in diameter across the base and probably is either a stratovolcano or very large cinder cone, the only feature of its type recognizable on the Mariner 9 imagery in this quadrangle. The albedo of the cone is low relative to the surrounding hilly and cratered terrain and adjacent plains material. The cone clearly is younger than the hilly and cratered terrain, but its age cannot be stated with certainty. It appears "fresh" on A-frame imagery; no B-frame coverage is available.

Channel deposits (unit ch) have been mapped in one large channel in the northeast corner of the quadrangle. The orientation of major segments of the channel apparently is controlled by earlier joints and faults, but the channel is sufficiently large and extensive to justify a separate map unit. This unit is interpreted to include eolian and fluvial deposits together with products of mass wasting. The age of the channel is presumed to be rather recent because 1) it postdates the cratered plains unit in which the channel is developed, and 2) no impact craters are visible within the channel nor are any immediately adjacent to it such that they impinge upon its outline.

CRATERS

Virtually all of the large craters in the quadrangle appear to have been produced by hypervelocity impact. Some craters, however, especially in the smaller size ranges visible on B-frames, are almost certainly low-velocity impact craters resulting from the impacts of secondary ejecta from the larger hypervelocity impacts. The only notable exceptions are the summit caldera on Tyrrhena Patera and a rimless depression located approximately at long 264° W. and lat 18° S., which appears to be a volcanic collapse feature resulting from the withdrawal of magma. However, the resolution of the available imagery is not sufficient to exclude possible ablation of permafrost as the cause of the collapse.

An extensive study of the size frequency distribution of impact craters in the quadrangle has been performed by Hodgkinson (1974), which is in agreement with the relative ages of the major map units proposed herein.

The impact craters have been classified as c_1, c_2, and c_3 on the basis of the morphology of the craters: c_3 are the freshest and sharpest, c_1 the most eroded and subdued, c_2 are intermediate (for further details, see explanation). Ideally by, c_1 should be the oldest, c_3 the youngest. There probably are many exceptions to this ideal correlation of crater morphology and relative age produced by varying atmospheric conditions and image resolution at different times during the Mariner 9 mission, selective flooding by younger volcanic flows, selective infilling by eolian sediments, different rates of erosion at different localities, and many other possible variables. Despite these variables, there is a general correlation between average crater size on different stratigraphic map units with crater freshness. For example, the old hilly and cratered material contains the largest craters, the crater-size frequency distribution of the greatest mean value, and the greatest proportion of subdued (class c_1) craters, whereas the relatively young ridged plains material contains fewer craters, fresher appearing craters of much smaller mean diameter, and many fewer class c_1 craters (none larger than 30 km diameter).

GEOLOGIC HISTORY

A glimpse of the pre-Hellas geologic aspect of the Mare Tyrrhenum quadrangle may be dimly visible through the Hellas ejecta in the eastern part of the mapped area, where the primitive and densely cratered ancient surface of Mars still affects the present topography. The ancient remnants of huge craters and small basins ranging in diameter to approximately 400 km can still be discerned. This record is extremely obscure, however, because of the ubiquitous Hellas ejecta that now covers the surface.

The hilly and cratered material is believed to be composed mostly of Hellas ejecta reworked by many subsequent impacts. Craters as large as 130 km in diameter are superposed on this terrain. The knobby materials also probably are related, in part, to major basin-forming events.

After a period of bombardment that postdates the Hellas event, massive amounts of magma were generated in the interior of the planet. The eruption of these magmas onto the Martian surface covered some of the hilly and cratered material with basaltic lava flows. These basaltic rocks were, in turn, impacted by the declining flux of planetesimals, asteroids, and small comets in Mars-crossing orbits. The resultant cratered plains material was covered, in part, with a still later series of basaltic lava flows, together with other parts of the older hilly and cratered material. This ridged plains material, of basaltic lavas, covered an immense area of the central part of the quadrangle, and simultaneous eruptions built up the large shield volcano of Tyrrhena Patera. The ridged plains were cratered, and are still being cratered, by an extremely low flux of impacting bodies compared with that of early Martian history.

Local accumulations of eolian detritus have left higher albedo deposits on the surfaces of the relatively lower albedo basalts and breccias. Although these eolian processes may have been active since the evolution of the Martian atmosphere, the movement of the eolian particles in the atmosphere and along the surface is clearly one of the most dominant surface processes at the present time.

Many of the small dendritic channels on Mars appear to be well preserved and relatively fresh; their age relative to the other stratigraphic and map units in the quadrangle cannot be determined reliably with the available imagery. It appears that fluids have eroded the Martian surface in the past and may be eroding this surface intermittently at present. Some of these fluids may be surface liquids, possibly water (Milton, 1973).

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