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
IAPYGIA QUADRANGLE
M 5M –15/292 G, 1977
I-1020 (MC-21)

NOTES ON BASE

This is one map in a series of preliminary mosaics covering the entire surface of Mars at a nominal scale 1:5,000,000 (Batson, 1973). 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.

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 (latitude 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 and assembled in a series of mosaics at 1:5,000,000.

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). This datum is a triaxial ellipsoid with semi-major axes of A=3394.6 km, B=3393.3 km, and a semi-minor axis of C=3376.3 km. The semi-major axis A intersects the Martian surface at long 105°.

The contour lines (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 contour-line accuracy 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), except the following name which is provisional:

MC-21: Abbreviation for Mars Chart 21.
M 5M –15/292 G: Abbreviation for Mars 1:5,000,000 series; center of sheet, 15° S latitude, 292° longitude; geologic map, G.

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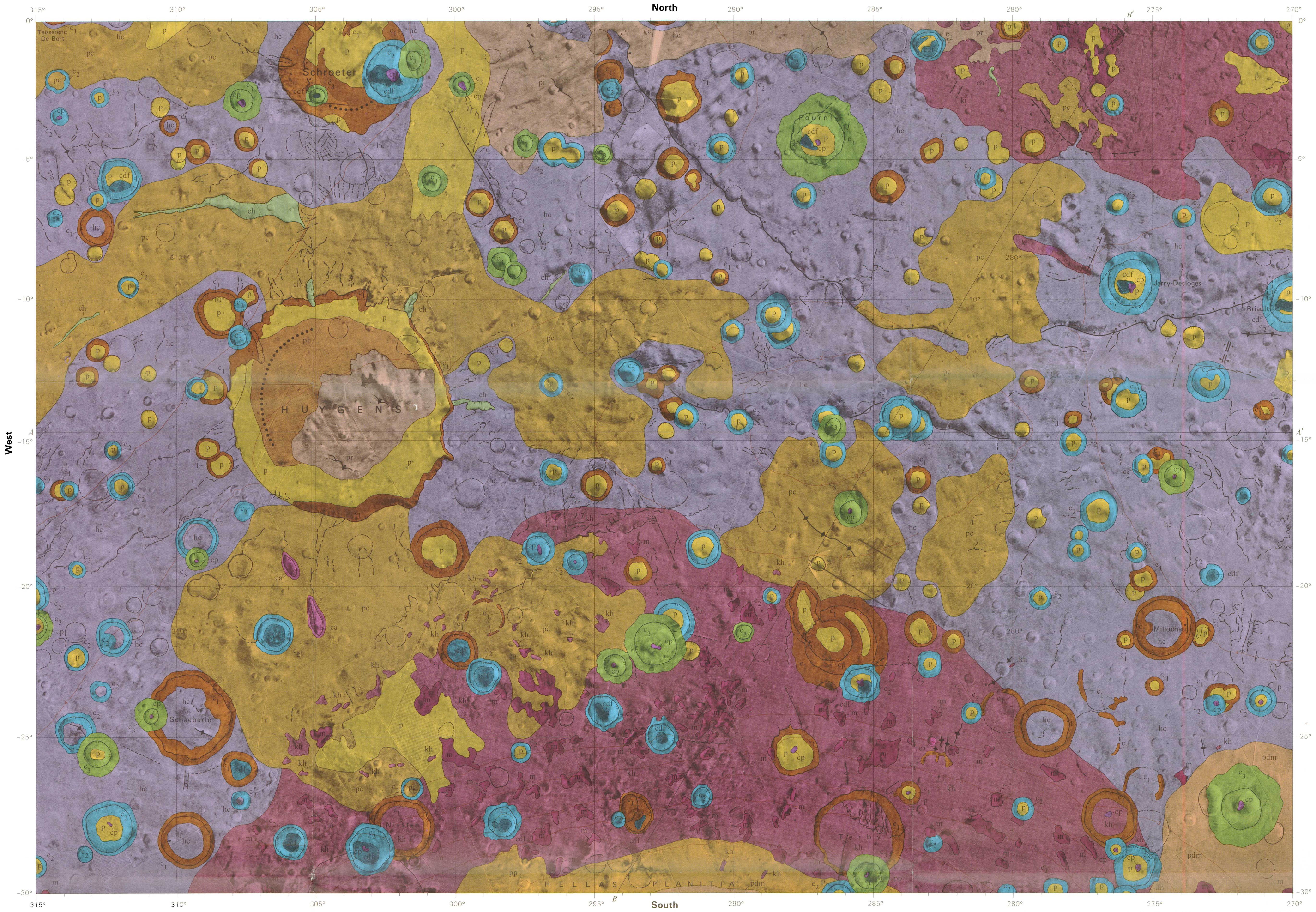
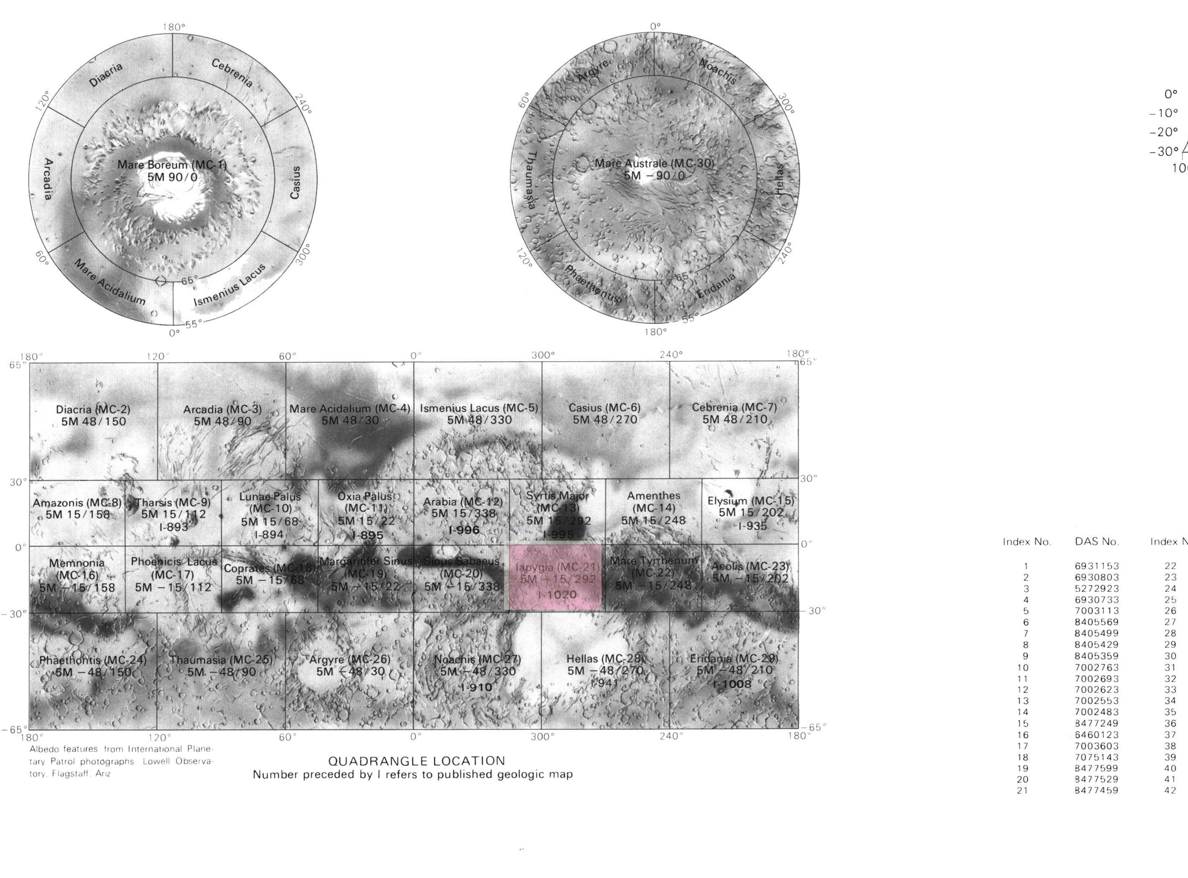
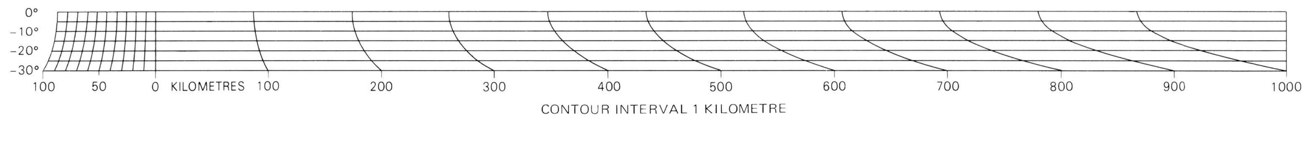
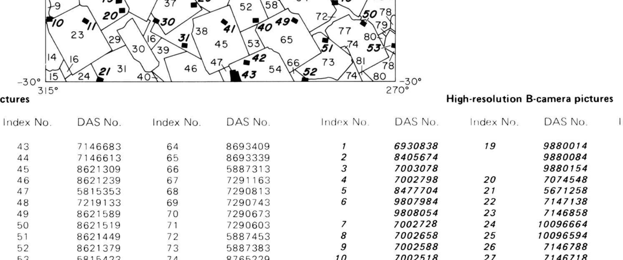



QUADRANGLE LOCATION
Number preceded by I refers to published geologic map





A-camera pictures

Index No.	DAS No.	Index No.	DAS No.	Index No.	DAS No.	Index No.	DAS No.
1	6931153	22	8477389	43	7146683	64	8693409
2	6930803	23	8477319	44	7146613	65	8693339
3	5272923	24	5671223	45	8621309	66	5887313
4	6930733	25	7074793	46	8621239	67	7291163
5	7003113	26	7074723	47	5815353	68	7290813
6	8405569	27	7074653	48	7219133	69	7290743
7	8405499	28	7074583	49	8621589	70	7290673
8	8405429	29	7074513	50	8621519	71	7290603
9	8405359	30	8549349	51	8621449	72	5887453
10	7002763	31	8549279	52	8621379	73	5887383
11	7002693	32	7075213	53	5815423	74	8765229
12	7002623	33	7147173	54	8693269	75	8765439
13	7002553	34	8549629	55	7218783	76	8765369
14	7002483	35	8549559	56	7218713	77	8765299
15	8477249	36	8549489	57	7218643	78	7362493
16	6460123	37	8549419	58	7218573	79	5959413
17	7003603	38	5743463	59	7219203	80	5959343
18	7075143	39	5743393	60	7219623	81	5959273
19	8477599	40	5743323	61	8693619	82	7003113
20	8477529	41	7146823	62	8693549	83	8549629
21	8477459	42	7146753	63	8693479	84	7218573

High-resolution B-camera pictures

Index No.	DAS No.	Index No.	DAS No.	Index No.	DAS No.
1	*6930838*	*19*	*9880014*	*38*	*11797451*
2	*8405674*		*9880084*	*39*	*7218608*
3	*7003078*		*9880154*	*40*	*7218538*
4	*7002798*	*20*	*7074548*	*41*	*8621344*
5	*8477704*	*21*	*5671258*	*42*	*5815388*
6	*9807984*	*22*	*7147138*	*43*	*8692814*
	9808054	*23*	*7146858*		*8692884*
7	*7002728*	*24*	*10096664*		*8692954*
8	*7002658*	*25*	*10096594*		*8693024*
9	*7002588*	*26*	*7146788*	*44*	*7291128*
10	*7002518*	*27*	*7146718*	*45*	*7290778*
11	*8477354*	*28*	*7146648*	*46*	*7290708*
12	*7075108*	*29*	*7146578*	*47*	*7290638*
13	*7074828*	*30*	*8549384*	*48*	*7290568*
14	*7074758*	*31*	*5743428*	*49*	*8693374*
15	*7074688*	*32*	*8219098*	*50*	*8765334*
16	*9880574*	*33*	*7218818*	*51*	*5887418*
17	*10024564*	*34*	*7218748*	*52*	*5887348*
	10024634	*35*	*7218678*	*53*	*5959378*
	10024704	*36*	*11797311*		
18	*7074618*	*37*	*11797241*		

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, 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.

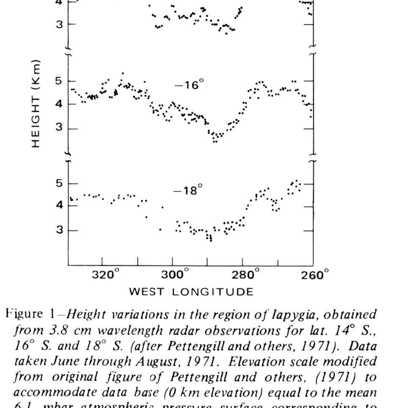


Figure 1—*Height variations in the region of Iapygia, obtained from 3.8 cm wavelength radar observations for lat. 14° S., 16° S. and 18° S. (after Pettengill and others, 1971). Data taken June through August, 1971. Elevation scale modified from original figure of Pettengill and others, (1971) to accommodate data base (0 km elevation) equal to the mean 6.1 mbar atmospheric pressure surface corresponding to the triple point of water. (see U.S.G.S., 1975 topographic map).*

Interior—Geological Survey, Reston, Va.—1977—G76299
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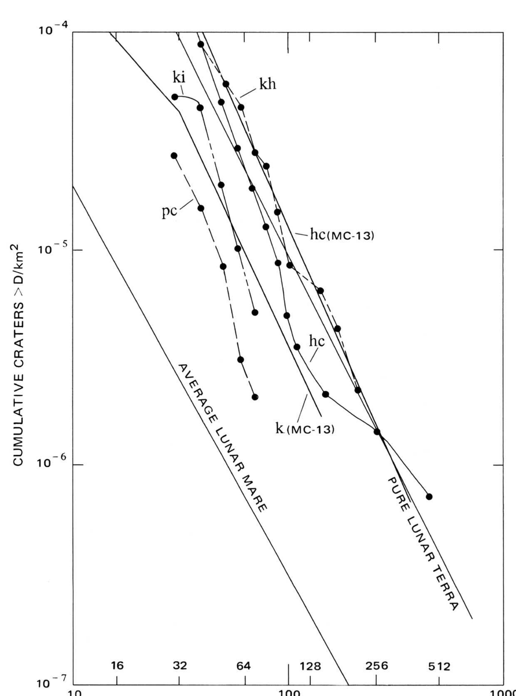
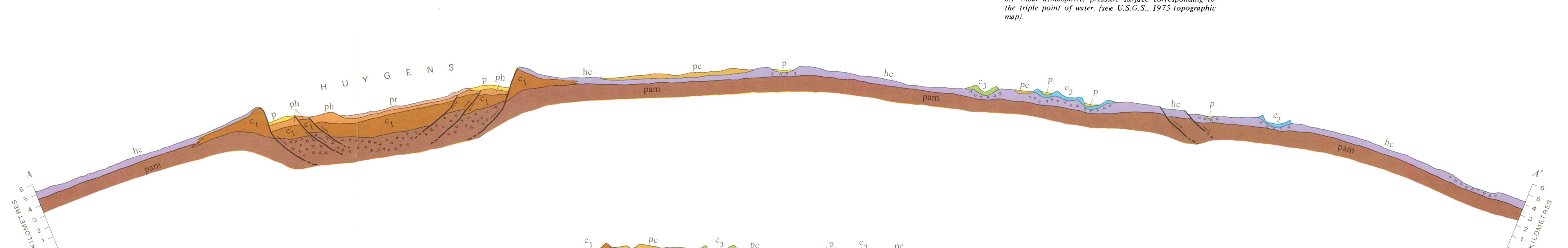
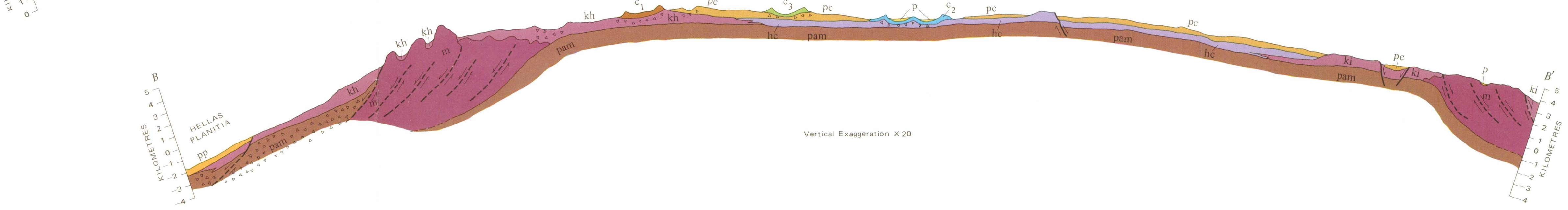


Figure 3—*Cumulative crater size frequency curves for geologic units: Hilly and cratered, knobby (Hellas), knobby (Isidis) and cratered plains. Knobby, and hilly and cratered unit crater frequency data from MC-13 (Syrtis Major Quadrangle) (Meyer and Grolier, 1977) included for comparison. Average lunar mare and pure lunar terra crater frequency curves are also included.*



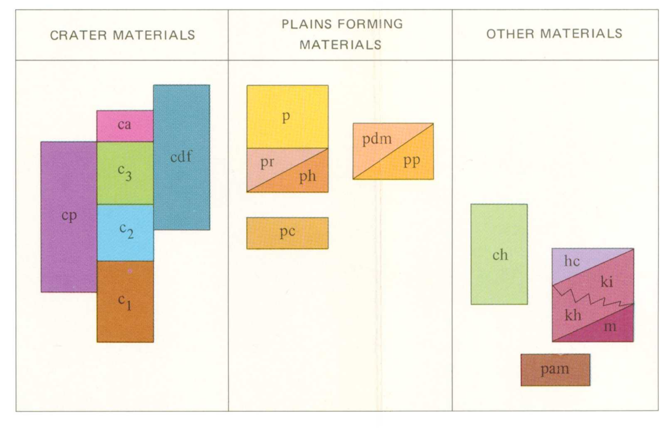


GEOLOGIC MAP OF THE IAPYGIA QUADRANGLE OF MARS

By
Gerald G. Schaber

1977

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

CRATER MATERIALS (CRATERS > 30 KM DIAMETER)

cdf CRATER DARK FLOOR MATERIAL—Appears in A frames as very low albedo, smooth surfaces partially or totally filling many c_1 and c_2 crater floors; craters extremely sparse. *Interpretation:* Recent and variable dunes of eolian origin too small to be seen by analogy with dune fields imaged by Mariner 9 wide-angle camera (B-frames 09807499, 09807429 and 08548829) in Hellespontus, possibly mafic composition

ca ABNORMAL CRATER MATERIAL—Occurs with cratered plains material south of Huygens (19° S, 306° W and 21° S, 305° W) as two sharply alined, elongate craters with well-developed, fresh rims (B-frames 09880014 and 09880154); present within knobby material northeast of Terby (25.1° S, 283° W) as a circular, rimless, deep depression with stepped inner wall. Craters at 19° S and 21° S associated with smooth to ridged, sparsely cratered material issuing from area of raised rim and covering slightly more surface of cratered plains material. Crater at 25.1° S associated with low-albedo surface mantle at rim. *Interpretation:* Craters of volcanic origin; elongate craters, fissure eruptions alined along zone of structural weakness; circular crater, collapsed pit crater; both sources of probable basaltic materials

cp CRATER CENTRAL PEAK MATERIAL—Occurs in fresh (c_3) to old (c_1) craters as a single hill or a small cluster of hills rising above the crater floors near center of craters. *Interpretation:* Brecciated rocks uplifted and deformed at the time of impact

c_3 MATERIAL OF CRATER HAVING FRESHEST MORPHOLOGY—Pronounced raised rim with peripheral ejecta blanket (B-frame 07003078); steep, irregular inner wall; rough floor with or without central peak (crater Fournier (115 km diameter) has plains material in floor). Craters < 30 km diameter are typically bowl-shaped; central peak not always visible in A frames. Secondary craters from freshest craters visible in B frames (B-frames 08621344; 07218608)

c_2 MATERIAL OF CRATER HAVING MODERATELY SUBDUED MORPHOLOGY—Narrow raised rim with little peripheral ejecta; generally steep and variably eroded high inner wall; floors generally flat, some containing plains material; floors generally below level of adjacent terrain; older craters moderately dissected by dendritic channels

c_1 MATERIAL OF CRATER HAVING MOST SUBDUED MORPHOLOGY—Raised rim absent, subdued or incomplete; gently sloping, highly eroded, low inner wall. Flat floor nearly same elevation as intercrater terrain (in largest craters, floor is below intercrater level); plains material fills floor of many craters. *Interpretation:* Impact craters displaying degradation and infilling in varing degrees; state of degradation can be misleading criterion for age owing to eolian and sedimentary processes that have been active on the planet

PLAINS-FORMING MATERIALS

p PLAINS MATERIAL—Forms featureless to slightly cratered plains, generally of high albedo; occupies many c_1 and c_2 crater floors, including the periphery of floor of Huygens (B-frame 10024564) and a part of the floor of Schroeter. Lies in lower elevation regions of the knobby material surrounding the Isidis basin; large patch of plains material occurs within the knobby material surrounding Hellas north of the crater Niesten. *Interpretation:* Eolian deposits sufficiently thick in many places to mantle older rocks and obscure older landforms; interbedded locally with volcanic deposits and sedimentary materials. Primary source of plains materials within quadrangle is from the north in Syrtis Major Planitia and Isidis Planitia

pr RIDGED PLAINS MATERIAL—Smooth to slightly cratered and rolling plains characterized by long wrinkle ridges and light and dark streaks (B-frame 09880574); crater density greater than in plains material but less than in cratered plains material. Apparent albedo generally lower than that of other plains units. Embays hilly and cratered, cratered plains, and knobby materials. *Interpretation:* By analogy with dark materials and wrinkle ridges on lunar maria, basaltic lava flow materials covered by a thin mantle of eolian materials. Light and dark streaks of eolian origin. Dunes may be present on surface

ph HUMMOCKY PLAINS MATERIAL—Material of smooth to rolling, hummocky topography on the northwest part of floor of Huygens; surface represents highest elevation within floor and slopes, as does the entire basin floor, toward the east-southeast. Contains 50 km wide band of low albedo hills, concentric to the basin rim. *Interpretation:* Basaltic lava flows in various stages of erosion and mantling by eolian and sedimentary materials; low albedo hills probably related to crest of highly subdued inner structural ring of Huygens

pdm DARK MOTTLED PLAINS MATERIAL—Appears in A frames to be smooth to slightly rough, darker than pp and mottled with high albedo splotches. Crater density lower than on the knobby material but higher than on the peripheral plains material; locally, contact with peripheral plains material markedly and broadly lobate but elsewhere gradational. *Interpretation:* Flood lavas that have issued from the northern furrowed shield described by Potter (1976) and other volcanic centers in MC-28; mottled appearance produced by thin, uneven mantling by eolian sediment

pp PERIPHERAL PLAINS MATERIAL—Occurs at northern and northeastern periphery of the Hellas basin and contains widely and irregularly scattered nubbins of knobby materials (B-frames 08692814, 08692884, 08692954 and 08693024); low crater density; grades into knobby material but generally occurs at lower elevation than knobby material contact with dark mottled plains material at lower elevation on basin floor generally gradational but locally broadly lobate. B-frame 08692814 shows presence of isolated conical hills with summit crater. *Interpretation:* Volcanic fields of flood lavas lightly to heavily mantled with eolian deposits derived from the Hellas basin floor; peripheral plains partly continuous with ridged plains material in MC-28, that have almost completely buried rough mountain and knobby landforms of the Hellas basin inner wall. Conical hills probable volcanic cinder cones

pc CRATERED PLAINS MATERIAL—Smooth (A frame resolution) plains within the hilly and cratered material throughout the quadrangle; few craters smaller than 30 km diameter; most large craters subdued and buried. Crater density lower than on hilly and cratered material but generally greater than the ridged plains or plains materials. Surface centered around 17.5° S at 287° characterized by wrinkle ridges (B-frame 07218608), lobate mesas, and wide channels with smooth to very knobby surfaces at B frame resolution (B-frames 11797311 and 11797451). *Interpretation:* Basaltic lava-flow materials overlying the hilly and cratered material intertongued with eolian and sedimentary deposits

OTHER MATERIALS

ch CHANNEL DEPOSITS—Floors of channels <10 km to 20 km wide, hundreds of kilometres long; channel walls steep and sharp to deeply eroded; channel floors generally flat and featureless at A frame resolution; circular depression at head of many channels; smaller scale dendritic channels common on hilly and cratered material are mapped with separate symbol (see explanation of symbols). *Interpretation:* Channels cut by fluid flow; deposits on floor produced by deposition from this flow, eolian deposits, and mass wasting from channel walls

hc HILLY AND CRATERED MATERIAL—Moderately rough to smooth terrain having a high density of small of large c_1, c_2, and c_3 craters, buried craters, and circular rimless depressions. More sloping surfaces contain abundant dendritic channels. Surface of unit for the most part highly dissected and eroded at small scale (B-frame 08477704). *Interpretation:* Accretionary crustal material in the form of brecciated basin ejecta mixed with older and younger crater ejecta; possibly mantled by thin wind-blown deposits and intertongued with local and regional volcanic materials. Channeling and scalloping on degraded crater materials and regional sloping surfaces suggest early aqueous erosional processes currently not active. Surface of hilly and cratered unit within Iapygia resurfaced by erosional and/or depositional processes after Hellas event (see text)

ki, kh KNOBBY MATERIAL—Small (< 5 km) irregular to conical or clustered knobs or groups of knobs with a generally rough appearance. Elevation of knobby material generally higher than surrounding plains or hilly and cratered surfaces (B-frame 07219098); forms bands concentric to the Hellas and Isidis basins and grades into mountain materials. Knobby material surrounding Hellas (kh) contains more large (to 200 km diameter) c_1 craters but fewer c_1 craters of <30 km diameter than hilly and cratered unit. Knobby material surrounding Hellas contains more craters with central peaks (41% of all mapped) than any other map unit; contact between knobby and hilly and cratered materials mapped on basis of presence of knobs and mountain material; areas between knobs are generally smooth with few small craters. Knobby material associated with Isidis basin (ki) has lower albedo than those related to Hellas. *Interpretation:* Remnants of ejecta blankets from Hellas and Isidis basin impacts; may not be contemporaneous; partly buried by erosional debris from the mountain materials, volcanic rocks and eolian deposits; materials probably brecciated Martian crustal rocks similar to those of the mountain materials

m MOUNTAIN MATERIAL—Forms larger mountain masses irregular to elongate in plan with steep, deeply eroded sides and sharp to multi-peaked to flattened summits (B-frames 05743428, 05671258); isolated ranges of mountain material cover up to 13,000 km²; relief on individual ranges may be 1-3 kilometers. Protrudes above the knobby material surrounding the Hellas and Isidis basins; material associated with Hellas appears to have higher albedo than that related to Isidis. *Interpretation:* Eroded remnants of thickest part of ejecta blanket from the Hellas and Isidis basins; includes isolated massifs of pre-basin Martian crust disrupted and tilted at the time of basin impact. Grades into thinner part of ejecta blanket (knobby material); many mountains are partly buried by lava flows and sedimentary materials of the cratered plains, peripheral plains, ridged plains and plains; probably largely brecciated; lower albedo material associated with Isidis basin may be more mafic than those of Hellas by analogy with petrology of lunar mare and terra rocks

pam PRIMITIVE ACCRETIONARY MATERIAL—Primitive impact melt and breccia formed during late stages of planetary accretion. Not exposed on surface of quadrangle; shown only on cross section

Contact

Crater rimcrest—Mapped where diameter >30 km, serves as contact where interior units(s) are labeled; delimits flatfloored, embayed and highly degraded craters where used alone within regional geologic unit

Greatly subdued or buried crater rimcrest

Rectilinear or arcuate escarpment—Probably a fault, balls on downthrown block; dashed where approximately located

Narrow channel

Lineament—Probable fault with no vertical relief or uncertain displacement

Narrow ridge—Interpreted as mare-type wrinkle ridge resulting from shrinkage of flood lava fill or igneous intrusion

Broad major ridge—Interpreted as structural feature related to the formation of the Hellas basin

Irregular sawtooth escarpment—Hatchures point downslope; shows contact between units in some places; interpreted as the sharp steep walls of broad channels of fluid origin; in the crater Terby (286°; 26° S) symbol used to indicate steep scarps on flat lobate mesas; possibly lava flow fronts

Shock breccia related to crater impact

Schroeter, Huygens inner structural ring

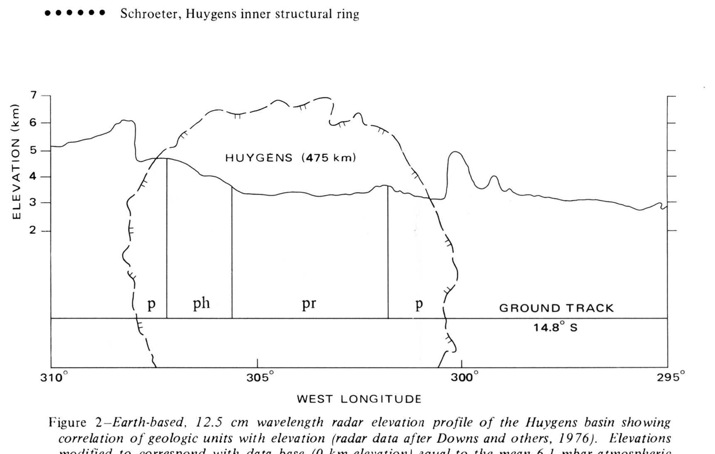


Figure 2—*Earth-based, 12.5 cm wavelength radar elevation profile of the Huygens basin showing correlation of geologic units with elevation (radar data after Downs and others, 1976). Elevations modified to correspond with data base (0 km elevation) equal to the mean 6.1 mbar atmospheric pressure surface equivalent to the triple point of water, (see U.S.G.S., 1975 topographic map). Huygens basin traversed by radar groundtrack as shown.*

PHYSIOGRAPHIC SETTING

The Iapygia quadrangle, in the equatorial region of Mars just north of the Hellas basin, is mainly ancient, hilly, and cratered upland terrain. The southern one-third of the quadrangle is dominated by mountain and knobby materials representing mountains of pre-Hellas material and material related to the Hellas basin and mappable in a 500-km-wide zone circumjacent to it. The northeast quadrant of the quadrangle contains two large arcuate structural scarps and moderately low-albedo mountain material and knobby deposits, both associated with formation of the Isidis basin (Meyer and Grolier, 1977). The major part of the Iapygia quadrangle is mapped as hilly and cratered upland materials units with subordinate various plains deposits. Although the southern rim of the Syrtis Major basin coincides with the northern margin of the quadrangle along the equator from 285° to 295° W., no structural features or ejecta associated with this basin have been identified in either the Iapygia or Syrtis Major (MC-13) quadrangles. A dominant feature of the landscape within Iapygia is the 475-km-diameter basin-crater Huygens, which shows subtle evidence of having an inner ring structure (Wilhelms, 1973). A second basin-sized crater, Schroeter (265-km-diameter), shares its northern rim with the Syrtis Major quadrangle (MC-13) and has a more distinct inner ring structure than Huygens.

The mean elevation of the cratered uplands within the quadrangle is about 3.5 km above datum, the mean 6.1 mbar atmospheric pressure surface corresponding to the triple point of water. Total relief within the cratered uplands exceeds 3 km (2 km to 5+ km) but maximum regional slope (0.5°) within the mapped area occurs from the northern rim of the Hellas basin (3 km elevation) south into the basin floor (approx. -2 km at 291° W., 30° S).

The Iapygia quadrangle appears to lie in a large (2,000-km diameter) 2+ km deep depression in the equatorial uplands that is well shown on Earth-based radar profiles (fig. 1). Pettengill and others (1971) proposed that the depression centered at 293° W. long and 10° S. lat represents a large crater of the mare basin type. Photogeologic evidence and planet-wide topographic data (U.S.G.S., 1975), however, indicate that the depression does not have the morphologic characteristics of a basin of impact or volcanic origin but rather is a broad low area enclosed on the west by a large northeast-southwest-trending rise (5,900 km long, 2+ km high), on the south by the raised rim of the Hellas basin, and on the east by a 2-km high, 1,100-km-diameter topographic high centered at 265° W. long and 16° S. lat. The depression characterizing the Iapygia quadrangle is open only to the north into the plains of the Syrtis Major Planitia and Isidis Planitia.

PREVIOUS WORK

Two geologic maps that include the equatorial belt of Mars have been published. The preliminary geologic map at a scale of 1:15,000,000 by Wilhelms (*in* McCauley and others, 1972) showed the predominant cratered surface within the Iapygia quadrangle as moderately cratered terrain. On the second map, at a scale of 1:25,000,000 Carr and others., (1973) used the term cratered deposits, undivided, for this ancient surface of the planet. Mountainous rim deposits associated with both the Hellas and Isidis basins were identified on both previous maps as was the large arcuate scarp concentric to the Isidis basin but within the Iapygia quadrangle.

GEOLOGIC SUMMARY

Subdivision of geologic units adopted by earlier authors into subunits and recognition of additional geologic units results from more detailed geologic mapping at a larger scale. Observations and interpretations needed for the compilation of this geologic map were made on low-resolution Mariner-9 A-frames and corroborated with the use of high-resolution Mariner-9 B-frames where available.

Structure and Stratigraphy of Basins

Although post-basin erosion and deposition was extensive, structural features and geologic materials associated with at least two of the three basins (Hellas and Isidis) can still be recognized within the quadrangle (see cross section B-B′). The Iapygia quadrangle lies uniquely between three major basins of probable impact origin (Hellas, Syrtis Major, and Isidis) (McCauley and others, 1972; Carr, 1973; Wilhelms, 1973). Two large arcuate scarps recognized only in the northeast quadrant of the Iapygia quadrangle, nearly concentric to and face the center of Isidis Planitia, appear to be related to the formation of the basin. The inner, well-defined structure (295°, 0° to 270°, 9.5° S), lies approximately 1,500 km from the center of the basin; the outer, less well defined structure (300°, 3.5° S to 280°, 15° ~~S), lies about~~ 1,900 km from the center. The ratio of the diameters of the outer ring with the inner ring is 1:3. This is close to the ratio of 1:4 relation first described by Hartmann and Kuiper (1962) for rings of lunar basins. From this, Isidis Planitia is taken to be a multiringed basin of impact origin.

The mountain and knobby materials mapped on the rims of the Hellas and Isidis basins are thought to represent the most ancient materials within the Iapygia quadrangle and perhaps on the entire planet. The larger massifs nearest the rim crests of the basins probably represent brecciated fault blocks of uplifted ancient crust or thick ejecta deposits, whereas most of the smaller knobby materials could be interpreted as basin ejecta. The mountain material and knobby materials are thought to represent only the higher remnants of extensive mountainous basin-rim deposits that were subdued by embayments of younger volcanic deposits, mass-wasting, and eolian sedimentary materials and lowered by substantial erosion.

The absence of recognizable ejecta from the Syrtis Major basin suggests that strong and complex surface wind regimes in this area (Sagan and others, 1973) may have completed the destruction of any high-standing rim deposits. Erosion and denudation may have been accompanied by thick mantling of surface materials by post-basin plains deposits.

The age relations between Hellas and Isidis and Syrtis Major are uncertain because of intense erosion, plains-forming episodes, and the absence of recognizable secondary craters from any of the basins. Overlapping rim and concentric ring relations between Syrtis Major and Isidis, however, indicate that Isidis is the younger of these two (Meyer and Grolier, 1977). Two smaller basins, Huygens (475 km diameter) and Schroeter (265 km diameter), probably represent the last major impacts in the Iapygia quadrangle during the basin-forming period. These smaller basins appear to be considerably younger than the major basin structures, as neither Huygens nor Schroeter appears to have been sculptured by ejecta from the larger basins, and their inner walls are still quite steep.

A complex system of widely spaced linear to curvilinear scarps extends southwest from a breach in the southwestern rim of the Huygens basin and continues into the Sinus Sabaeus quadrangle (MC-20). The scarps originally may have been structural in origin and related to the formation of the Huygens basin; however, there is evidence that they have been channels for fluid (water or lava) transport early in Mars history. Crater densities in the vicinity of the scarps indicate they date back to the time of formation of the hilly and cratered upland surface. The northern and eastern rim of the Huygens basin are highly channeled (B-frame, DAS 07074688; A-frame, 09880609), indicating that fluid activity has been associated with the basin.

Stratigraphy of Uplands and Plains

The major part of the Iapygia quadrangle forms uplands mapped as hilly and cratered material, exposed primarily in the southern latitudes of the planet (Carr and others, 1973) but extends to 40° N. around the 330° meridian. Flat-floored, nearly rimless craters abound on this surface, and intercrater areas are locally flat to undulating and featureless except for a number of systems of dendritic erosional channels on sloping surfaces (A-frame, DAS 08549489; B-frame, DAS 08477704). Earth-based radar returns from these channeled surfaces indicate substantial roughness (root mean square slope values) at the 20-to 60-m scale (Downs and others, 1973). The hilly and cratered unit, on a regional scale, probably consists of primitive crustal rocks in the form of reworked basin and crater impact breccias but locally includes younger volcanic and eolian deposits (Carr and others, 1973).

The hilly and cratered material within the Iapygia quadrangle appears to be slightly younger than such units elsewhere on the planet (example in the Syrtis Major quadrangle) and has a reduced population of old, flat-floored craters with diameters >40 km.

Earth-based radar observations of Mars (Downs and others, 1973) have shown that the hilly and cratered unit between 14° and 18° S. and west of 309° long (western rim of Huygens basin) has sharply reduced rms slopes (slope lengths = 30 m) relative to the hilly and cratered surfaces east of Huygens. This flatter, more subdued cratered surface continues across the Sinus Sabaeus quadrangle (MC-20) to the west. The reduced rms slopes, west of Huygens (309°), may be related to ancient fluid transport of materials in this area as discussed here.

The cratered plains material is distinguished by the lack of older c_1 and c_2 craters with diameters greater than about 30 km, few dendritic surface channels, and the presence of moderately to well developed surface wind features such as variable light and dark streaks. The cratered plains are patchy within the Iapygia quadrangle, and appear to embay the older hilly and cratered surfaces, but are, in turn, overlapped by the younger plains material (unit p). The cratered plains are interpreted as consisting primarily of eolian materials intermixed in part with local volcanic deposits derived locally or from the general area of Syrtis Major Planitia and Isidis Planitia to the north.

The hummocky plains material is found only within the floor of Huygens, where they occupy the highest terrain within the basin floor. It is characterized by a low crater density and rolling hummocky topography. This unit, like the entire irregular surface of the basin floor (fig. 2; cross section A-A′), slopes up to the west-northwest. Within the hummocky plains on the western side of Huygens is a 40-km-wide low-albedo region of low hills concentric to the basin rim; they may be associated with an inner structural ring of the basin (A-frame, DAS 09808019). The possible existence of this inner ring was first suggested by Wilhelms (1973).

The ridged plains material mapped by Meyer and Grolier (1977) in Syrtis Major extends to 5° S. (at meridian 298°) into Iapygia and are distinguished by lunar mare-type wrinkle ridges and numerous well-developed light and dark wind streaks. Ridged plains occupy the low central floor of Huygens basin (fig. 2, cross section A-A′). South-facing scarps mapped at the northern contact of hummocky plains and ridged plains within Huygens floor indicate that the streaks may be formed from the upper surface of the hummocky plains by wind erosion. The ridged plains, like the hummocky plains, have a low crater density.

The youngest plains material (unit p) mapped within the quadrangle is characterized by the lowest crater density of all geologic units, at least down to the 1-km-diameter size, and a high apparent albedo. The presence of young plains material thoughout topographically low regions, including crater floors and other topographic traps within the quadrangle, supports the hypothesis that it consists largely of wind-blow deposits.

The percentage of crater floors filled with young plains material increases within Iapygia toward the north into the topographically lower Syrtis Major Planitia and Isidis Planitia, these regions being the probable source of abundant wind-derived materials. In the region of the Hellas mountain and knob deposits, there are fewer plains-floored craters.

Age and Distribution of Craters

On the Moon, crater size-frequency distributions have been used to estimate absolute ages of widespread surfaces associated with basin ejecta deposits and plains materials (Soderblom and Lebofsky, 1972; Boyce and others, 1975). On Mars, however, such widespread and well-defined rock units are not common because of erosional processes acting on the planet. For this reason, Martian surfaces have been compared to one another in terms of their relative crater frequencies determined after each of the Mariner missions: Mariner 4 (Leighton and others, 1965); Mariner 6 and 7 (Leighton and others, 1969) and Mariner 9 (Murray and others, 1971). The limitations of the crater density dating method are discussed by Hartmann (1973) and Soderblom and others, (1974).

The Iapygia quadrangle lies in the Martian latitudes where 15 to 35 percent of the surface is covered by rimless craters with diameters > 20 km (Soderblom and others, 1974). The region has a high population of small craters (0.6-10 km diameter) and is statistically well suited for studies of relative age by crater size-frequency distributions. Three hundred and six craters with diameter of 30 km or more were mapped in the total quadrangle area of 3.88 X 10^6km². Plots of cumulative crater frequency relative to crater diameter for four major surfaces within the quadrangle are shown as figure 3.

The increased number of total craters >40 km diameter on the Hellas knobby ejecta relative to the hilly and cratered materials confirms the photogeologic observation that no surfaces within the quadrangle are older than those associated with the Hellas impact event. The crater size-frequency distribution curve for the hilly and cratered unit in Syrtis Major to the north (Meyer and Grolier, 1976) is seen on figure 3 to exactly overlie the Hellas knobby unit curve within Iapygia. These data provide evidence that the Hellas ejecta and the hilly and cratered surface within MC-13 are nearly contemporaneous in age, whereas the hilly and cratered unit within Iapygia is slightly younger, having been resurfaced soon after the major basin impacts. Resurfacing of the hilly and cratered units could have been brought about by erosion, or more likely, by deposition of sediment and (or) volcanics in early post-Hellas time.

The > 30-km-diameter crater density on the Isidis basin knobby ejecta is 1.90 times greater than that of the cratered plains material, 2.4 and 2.9 times, respectively less than that of the Hellas knobby or hilly and cratered units (fig. 3).

Central peak craters (> 30 km diameter) were found to be three times more numerous on the Hellas knobby unit than on the hilly and cratered unit within the quadrangle.

Wind Features

The primary wind-associated features within Iapygia are light and dark streaks (Arvidson, 1974) extending from small crater rims and low-albedo dune fields (Cutts and Smith, 1973), forming dark floor materials in many craters (B-frame, DAS 07218818). Wind streaks are not as common within Iapygia as in many other Martian regions (Sagan and others, 1973; fig. 1) but rather are concentrated on the ridged and cratered plains and are restricted to latitudes north of 19° S. These streaks indicate wind directions ranging between northwest to northeast with a minor southeastern wind. Streaks are found in isolated, smoother parts of the hilly and cratered unit but are not a consistent feature of that surface within Iapygia. Wind directions indicated within the hilly and cratered unit are from the north-northeast and northwest, to a minor degree from the southeast.

It is clear that the major winds within the quadrangle are from the lowlands of Syrtis Major Planitia and Isidis Planitia to the north, little or no wind coming from Hellas Planitia to the south. The rough, knobby terrain of the Hellas rim materials is free of wind streaks but does contain some dark floored craters. The lack of clear evidence for winds coming from the south indicates that there was no major movement of Hellas floor debris northward during dust storm activity. This data is consistent with the Earth-based observation of Martin (1974; fig. 2), who reported that the major 1971 September dust storm started in the Serpentis-Hellespontus region (3.5° W; 27° S) at the northwestern rim of the Hellas basin and spread to the east and west, avoiding all but the extreme southern and southeastern part of the Iapygia quadrangle. The lack of observable wind streaks and small dendritic channels in these regions of the quadrangle may result from the relatively slow deposition of dust following such storms.

Geologic History

The interpretable geologic history within the Iapygia quadrangle begins with the impact of planetisimals that produced the large Hellas and Syrtis Major basins, followed, soon after, by the formation of the Isidis basin. The primitive accretionary surface on which these projectiles impacted is not recognizable within the quadrangle, possibly obliterated by a large-scale atmosphere-(water, wind) related processes during or subsequent to the late stages of high impact flux. This episode is inferred to have ceased concurrently with the massive resurfacing of the ancient cratered terrain by probable volcanic activity (Wilhelms, 1974; Hartmann, 1973; Chapman, 1974; Soderblom and others, 1974). Within Iapygia this surface is mapped as the hilly and cratered uplands. The smaller basins, Huygens and Schroeter, were probably formed early in this period. Subsequent, less intense, obliteration episodes involving atmospheric and volcanic processes occurred at the end of c_2 crater time, resulting in the formation of plains much less cratered, such as the cratered plains unit (Jones, 1974). More recently, the same processes further obliterated any craters remaining from the rapid decrease of the accretionary flux and resulted in the formation of the younger plains materials such as the ridged plains, the hummocky plains and the plains. Material of the most recent geologic features on these surfaces is represented by the light and dark wind streaks, crater floor plains and crater floor dune materials. The atmospheric processes that help create the diverse Martian terrains are still active today but perhaps are much less intense than during earlier periods in the geologic history of the planet. It has been postulated, however, that increased periods of atmosphere ~~related~~ obliteration may be cyclic, perhaps related to long-period variations in the latitude of maximum solar insolation (Soderblom amd others, 1974).

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