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
ARABIA QUADRANGLE
M 5M 15/338 G, 1977
I-996 (MC-12)

### 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-0 (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).

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).

MC-12: Abbreviation for Mars Chart 12.
M 5M 15/338 G: Abbreviation for Mars 1:5,000,000 series; center of sheet 15° latitude, 338° longitude; geologic map, G.

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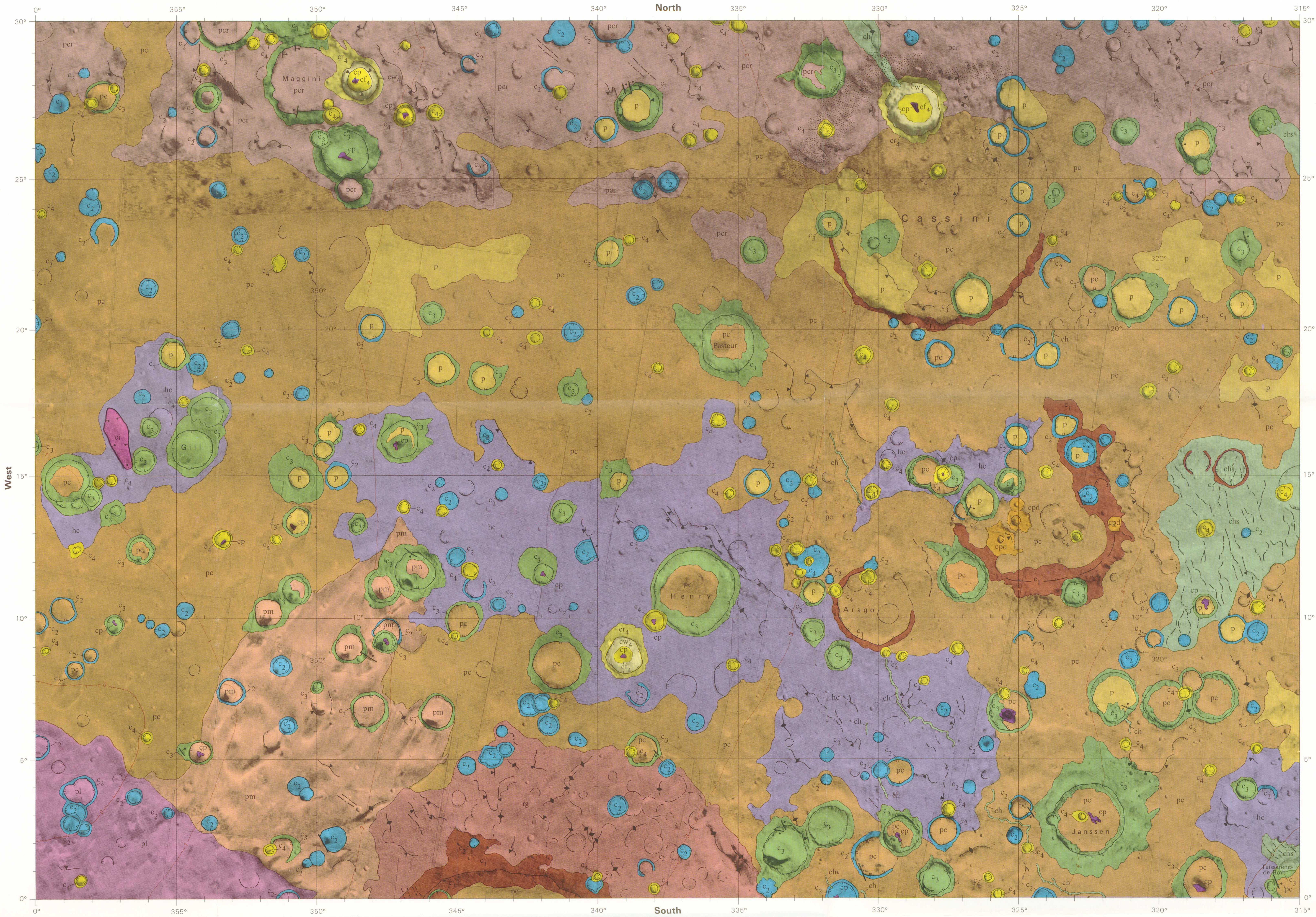


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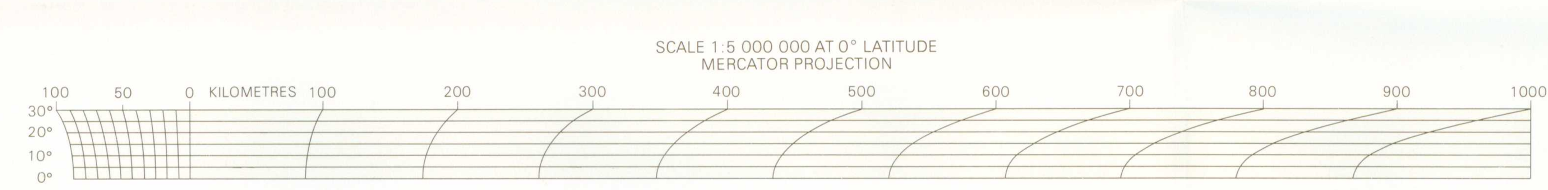
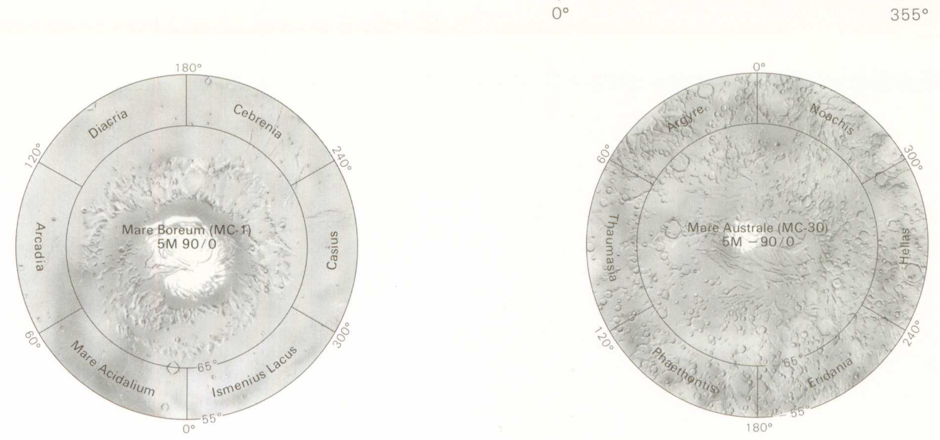
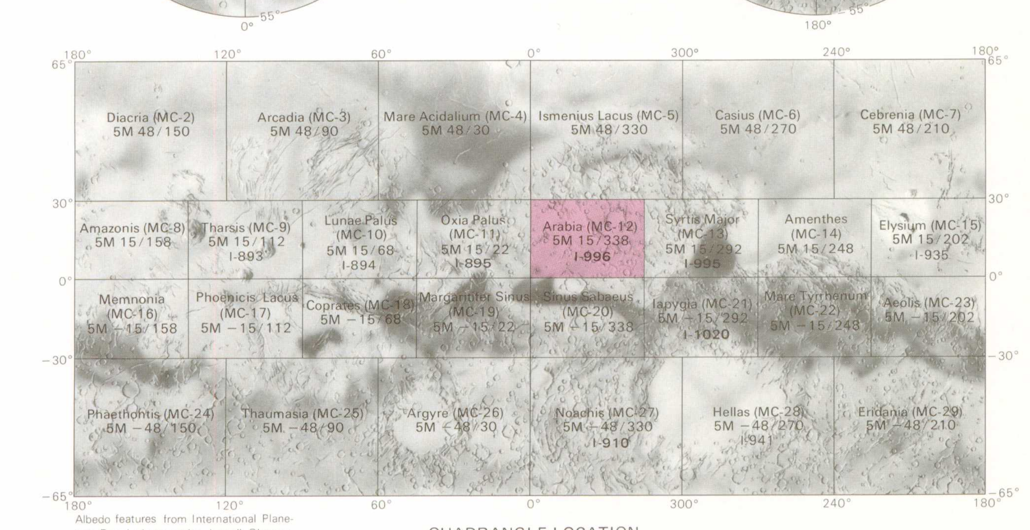
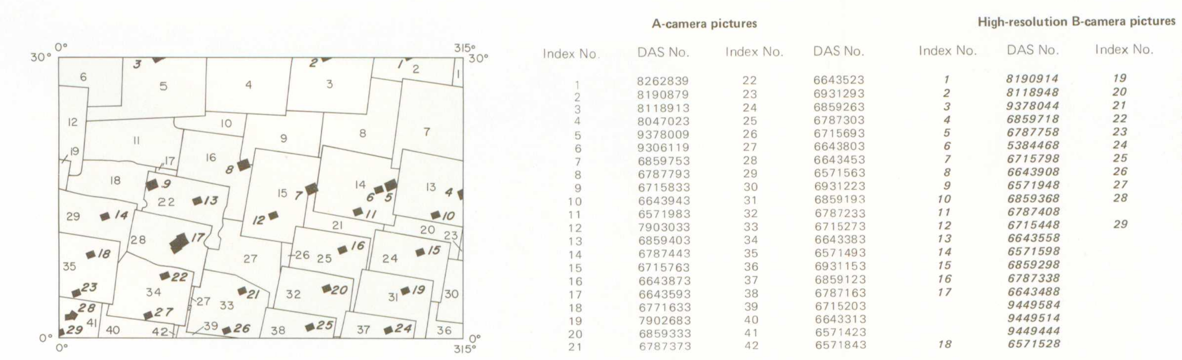
Prepared on behalf of the Planetology Programs Office, National Aeronautics and Space Administration under contract W-13,709 in cooperation with State University of New York at Buffalo (NGR-33-015-108)



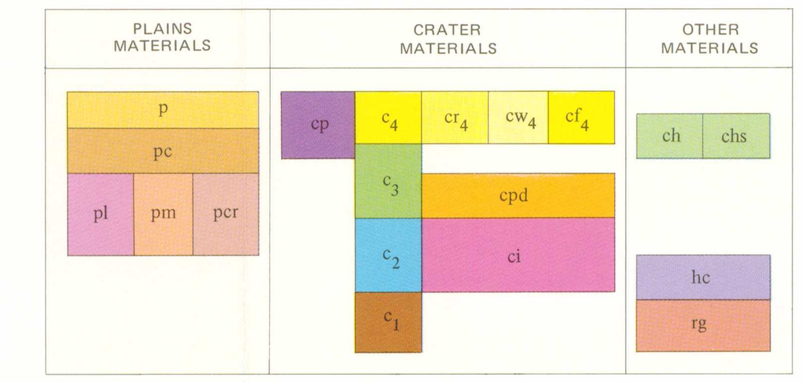




The mosaic used to control the positioning of features on this map was made with the Mariner 9 A-camera pictures outlined above, identified by vertical numbers. Useful coverage is not available in cross-hatched area. Also shown (by solid black rectangles) are the high-resolution B-camera pictures, identified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

# GEOLOGIC MAP OF THE ARABIA QUADRANGLE OF MARS

By
John S. King
1977

### CORRELATION OF MAP UNITS




### DESCRIPTION OF MAP UNITS

#### PLAINS MATERIALS

p — PLAINS MATERIALS—Featureless, relatively smooth, high albedo. Occurs as patches within cratered plains unit and covers floors of some $c_4$ and $c_3$ craters. REPRESENTATIVE LOCALITY: Southeast part of area of A-frame 06571988; 4166-90. *Interpretation:* Unconsolidated wind-blown deposits

pc — CRATERED PLAINS MATERIAL—Relatively smooth intercrater areas, some scarps and ridges and some channels. Moderate to high albedo. Many buried or partly buried craters. REPRESENTATIVE LOCALITY: South half of area of A-frame 06859758; 4176-90. *Interpretation:* Unconsolidated wind-blown material deposited on cratered surface. Older and (or) thinner cover than plains unit

pl — PLATEAU MATERIAL—Rolling, relatively high area having low to intermediate albedo with high-albedo plumes extending southwest from craters. REPRESENTATIVE LOCALITY: Southwestern part of area of A-frame 6643318; 4168-60. *Interpretation:* Eolian deposits mantling relatively old cratered surface of positive relief. High-surface suggests old age. Intermediate crater density implies degradation and cover

pm — MOTTLED PLAINS MATERIAL—Mottled appearance produced by irregular areas and streaks of high albedo that commonly show no direct relation to craters. Smoother intercrater area than plateau material. REPRESENTATIVE LOCALITY: Area of A-frame 6643388; 4168-66. *Interpretation:* Cratered surface smoothed by eolian scour and deposition

pcr — CRATERED ROLLING PLAINS MATERIAL—Undulating surface of moderate relief with prominences and depressions rounded and subdued. Albedo lower and less uniform than plains material. Cratering density similar to that of cratered plains unit, suggesting nearly equivalent age. Differs from cratered plains unit by showing greater relief. REPRESENTATIVE LOCALITY: Area of A-frame 09378014; 4251-40. *Interpretation:* Eolian deposits covering old cratered and subdued surface of moderate relief

#### CRATER MATERIALS

Craters of less than 20 km rimcrest diameter were not mapped. Crater subunits were differentiated where possible only on craters of greater than 40 km rimcrest diameter.

cp — CENTRAL PEAK MATERIAL—Occurs singly or in clusters rising above floors of most $c_4$ craters and some $c_3$ craters; as mapped, commonly includes hummocky material peripheral to peak. *Interpretation:* Material uplifted by rebound following impact

$c_4$ — CRATER MATERIAL, UNDIVIDED—Forms bowl-shaped craters with prominent raised rims; some have ejecta blankets extending from ⅓ to 1 crater diameter. Most craters show distinct central peak, mapped separately in larger craters. *Interpretation:* Materials of youngest impact craters

$cr_4$ — CRATER RIM MATERIAL—Irregular hummocky material, commonly limited to narrow band but may extend outward ½ to 1 crater diameter. Intermediate albedo

$cw_4$ — CRATER WALL MATERIAL—Terraced and hummocky material extending from crater rimcrest to floor

$cf_4$ — CRATER FLOOR MATERIAL—Relatively smooth material lacking extreme relief. Floors usually of higher albedo than walls

$c_3$ — CRATER MATERIAL—Forms craters similar to $c_4$ craters but more subdued. Prominent continuous rims; some have central peaks. *Interpretation:* Materials of impact craters

cpd — PEDESTAL CRATER MATERIAL—Forms small shieldlike craters concentrated in vicinity of 13° N. lat, 320-325° W. long. Partially surrounded by raised platforms with serrated frontal scarp which extend 1-2 crater diameters outward from central crater. *Interpretation:* Material of volcanic or ejecta constructs. Scarps probably formed by wind erosion, undercutting, and slump

$c_2$ — CRATER MATERIAL—Forms subdued craters, rimless or very narrow rims; some discontinuous. Floors smooth, flat; no central peaks. In many only wall material discernible. *Interpretation:* Materials of degraded impact craters partially filled by eolian material

ci — IRREGULAR CRATER MATERIAL—Forms elongate (50 x 120 km) elliptical depression near 16° N. lat, 0° long. Walls of depression appear to be nearly straight or composed of intersecting straight segments. *Interpretation:* Depression formed by faulting and collapse. Too young to be secondary crater from Hellas

$c_1$ — CRATER MATERIAL—Forms highly degraded, generally large craters (Cassini, 430 km diameter; Arago, 150 km diameter). Most craters characterized by discontinuous rims and smooth floors. *Interpretation:* Materials of oldest impact craters. Floors and parts of rims covered by younger plains material

#### OTHER MATERIALS

ch — CHANNEL MATERIAL—Occurs on floors of channellike depressions. Smooth, intermediate albedo. *Interpretation:* Materials of alluvial channels

chs — CHANNELED SURFACE MATERIAL—Appears as rough surface of intermediate albedo having sinuous or echelon subparallel shallow channels extending generally in a northwest direction. REPRESENTATIVE LOCALITY: Eastern half of area of A-frame 6859338; 4176-72. *Interpretation:* Materials of alluvial channels

hc — HILLY AND CRATERED MATERIAL—Projects above plains material and is embayed by it. Surface of intercrater area smooth and subdued but rougher than plains material. Heavily cratered. REPRESENTATIVE LOCALITY: Southern half of area of A-frame 6787448; 4173-81. *Interpretation:* Ancient cratered terrane

rg — RIDGED AND GROOVED MATERIAL—Appears as scaly surface having many overlapping and intersecting highly subdued crater rims ranging from 25-50 km diameter. Low albedo; narrow bands of intermediate to high albedo mark crater rims. REPRESENTATIVE LOCALITY: Center of area of A-frame 6715278; 4170-57. *Interpretation:* Ancient, heavily cratered crust or surface of flood basalt

Contact—Long dashed where inferred

Crater rimcrest—Mapped on craters >20 km diameter; used as contact on small craters

Buried crater rimcrest

Fault—Linear escarpment interpreted as fault. Bar and ball on downthrown side used as contact in places

Scarp—Line marks base; barbs point downslope

Ridge

Small channels

Dark mantle

### PHYSIOGRAPHIC SETTING

The Arabia quadrangle is located in the northern hemisphere of Mars; it extends 30° N. from the equator and 45° E. from the prime meridian. It is within the area of unmantled terrain defined by Soderblom and others (1973) and the planet-encircling band of old cratered deposits shown on the preliminary geologic map of Mars (Carr and others, 1973). Crater density in the Arabia quadrangle is similar to the heavily cratered regions located south of the equator owing to inclination of the great circle division between heavily and less cratered Martian terrains (Soderblom and others, 1974). None of the large prominent telescopically defined Martian surface markings dominate the Arabia quadrangle, although the northern tip of Meridiani Sinus projects slightly into the extreme southwest corner. The topographic map of Mars (U.S. Geol. Survey, 1976) indicates that elevations in the Arabia quadrangle rise toward the northeast. The entire region lacks high relief.

### MAPPING PROCEDURES

Geologic mapping and interpretation is based on 42 Mariner 9 "A" frames (wide angle, low resolution) that cover the area. Definition and relative age of the map units is based on superposition relations, topographic expression, albedo, and textural variations found within and immediately adjacent to the Arabia quadrangle. Interpretations of rock unit origins and composition were refined locally by reference to 30 "B" frames (narrow angle, high resolution) taken within the southern two thirds of the quadrangle.

### GEOLOGIC SUMMARY

Most craters in the Arabia quadrangle are of impact origin and are assigned to one of four general classes defined primarily by the degree of rimcrest degradation and secondarily by the presence or absence of central peaks and ejecta blankets. Two special crater classes accomodate morphologically distinct crater types whose shapes suggest unique origins.

The four general classes of crater material are ranked in relative age from $c_1$ (oldest) to $c_4$ (youngest). These classes probably overlap somewhat as both erosional agents and processes on Mars must have varied considerably from one location to another through time.

Although the oldest craters are the most degraded, many of their rimcrests are more prominent than those of younger $c_2$ craters, which are steep-walled, flat-bottomed circular depressions. On earth, craters of similar shape form as a result of collapse in volcanic areas (MacDonald, 1972). Within the Arabia quadrangle, these craters are interpreted to result from impact. The anomalous lack of rims relative to older craters which still show discontinuous but nonetheless distinguishable rims is believed to be primarily the result of size difference, as all of the largest craters in the quadrangle are older. These large craters which measure to 430 km rimcrest diameter were produced by major impact events that excavated a great deal of material, producing wide rims with great relief. The smaller $c_2$ craters (25-55 km rimcrest diameter) would have had less extensive rims of lower relief. This initial difference probably explains the persistence of the older $c_1$ rimcrests as, through time, the lower rimcrests would be more effectively degraded by erosion and more completely covered by aggradation of the surrounding surface with deposition of plains-type material.

The two younger classes of craters ($c_3$ and $c_4$) have well-developed, prominent raised rims and many have central peaks. Ejecta blankets occur around some $c_3$ craters, extending outward from the rimcrest about ¼ to ½ crater diameters. The $c_4$ craters, commonly bowl shaped, have no visible ejecta blankets and typically are small (20-30 km). Three larger craters assigned to this class because of their fresh appearance are exceptions and have rimcrest diameters to 100 km. They show ejecta blankets which extend outward from the rimcrest a distance of ¼ to 1 crater diameter. Two of these large young craters, located at 28° N. lat and 349° W. and at 27° N. lat and 339° W. long clearly show a concentric terrace within the rimcrest which is suggestive of lava-lake collapse characteristic of some terrestrial volcanic features (Greeley and King, 1975). A discontinuous scarp subparallel to the rimcrest in the southern part of Cassini may be a portion of a similar internal terrace.

One large irregular crater about 130 km long by 40 km wide occupies the extreme west center of the map area (16° N. lat, 357° W. long). It is bounded by conspicuous escarpments which appear sharpest on the western wall, where two linear segments intersect at about 140°. Although the trace of the eastern wall appears more curvilinear, the depression is nearly symmetrical with respect to its long axis, which trends approximately N. 20° W. The crater resembles some lunar secondary craters but at a much larger scale. A secondary crater of this size seems most easily interpreted as formed by ejecta from some large basin-forming event such as Hellas. The Hellas basin, however, (Potter, 1976) appears morphologically much older than this irregular crater. An alternative interpretation is that this crater could have been formed by a low angle primary impact. The linear aspect of the scarps, however. particularly on the west side, are more strongly suggestive of faulting associated with collapse and this interpretation is favored here.

Pedestal craters clustered near 13° N. lat and from 320° to 325° W. long consist of small 10 to 15 km diameter craters centered on irregular subcircular platforms that extend outward one to two crater diameters and are bounded by steep scarps. The platforms have been interpreted to be ejecta blankets derived from impact at the central crater and subsequently sculptured by eolian processes and slumping to form the outer scarps (Arvidson and others, 1975). Alternatively, the platforms could be small composite volcanic constructs composed dominantly of ash-flow tuffs with some interlayered lava flows. Ash flows derived from a central source tend to distribute radially around the source on a relatively flat surface, to be progressively less densely compacted away from the source, and to thin away from the source. The volcanic hypothesis of origin is favored for the pedestal craters within the Arabia quadrangle because of a lobate, flowlike front on one of the craters located at 12°30′ N. lat and 325°30′ W. long suggestive of a lava flow. If the platforms do consist predominantly of ash flows, the less competent distal material would be more susceptible to wind erosion causing undercutting and slump that would result in the steep retreating boundary scarps now visible (King and Reihle, 1974).

Two general classes of materials of regional extent are defined on the basis of their textural characteristics. An older class includes a hilly and cratered unit and a ridged and grooved unit. Both units are characterized by rough, densely cratered, irregular surfaces of moderate relief.

A high crater density is not as evident in the ridged and grooved unit as in the hilly and cratered unit because of the high degradation of most of the craters. The result of this intense degradation is a "scaly" surface produced by overlapping and intersecting crater rimcrests of very low relief. The ridged and grooved unit is interpreted to be the oldest unit in the map area. It occurs in a wide zone peripheral to the degraded rimcrest of the Schiaparelli Basin. The rimcrest outlines forming the rough scaly surface may be those of pre-basin craters now located in an area within the outer ring of the Schiaparelli Basin. A possible similar occurrence of preserved pre-Orientale Basin craters is recognized within the Cordillera ring of the Orientale Basin on the moon (Scott and McCauley, 1975).

The other general class of regional materials includes one plateau unit and four plains units, all characterized by low to moderate relief, in which topographic prominences are bevelled and rounded.

The plateau unit, located in the extreme southwestern part of the map, appears to be part of a prominent, broad hilly and cratered band that extends east-southeast across the adjoining Sinus Sabaeus quadrangle and conforms with an area of low albedo on telescopic photographs. The plateau unit does not appear to be heavily cratered in the map area but many craters are not mapped as they are highly degraded and their outlines are vague and only weakly discernible. As the extension of this region is more heavily cratered outside the quadrangle, however, the unit is assigned an age equivalent with two of the more densely cratered plains units.

The mottled plains of the southwestern and the cratered and rolling plains that extend across the northern part of the map have the same apparent crater density. These units are considered to be approximately equivalent in age to the plateau unit but older than the cratered plains unit, as they are embayed by it. The cratered plains is the most extensive of all rock units and dominates the center of the map area.

The plains unit, distinguished from the cratered plains by the total absence of craters at A-frame resolution, is assigned the youngest age of all the units. All plains units have been affected either by deflation or by eolian deposition of materials.

### STRUCTURE

No large or pervasive structures such as fault or fracture systems are obvious in the map area. However, a regional northwest structural trend present within the quadrangle is shown at widely separated locations by the approximate northwest alinement of channels and the northwest elongation of the single large irregular crater at 16° N. and 357° W. This trend is evident in the northwest alinement of the central peak in the $c_4$ crater located at 27° N. lat and 329° W. long and by polygonal rim segments of the $c_4$ crater at 9° N. and 339° W.

### WIND EFFECTS

Wind plumes and streaks are conspicuous in the southwestern part of the quadrangle, where they are commonly developed around crater rims as plumes of contrasting albedo extending to the southwest. These patterns indicate a prevailing northeast wind.

The typical plumes are of low albedo relative to the surrounding lighter surface but in many places are rimmed with bright streaks. The development of dark plumes may indicate removal of a thin cover of bright dust from an underlying dark surface in the wake of crater rims. The high-albedo rim of these dark plumes appears to be result of a local buildup of material forming a low rim of slightly greater relief.

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