DEPARTMENT OF THE INTERIOR
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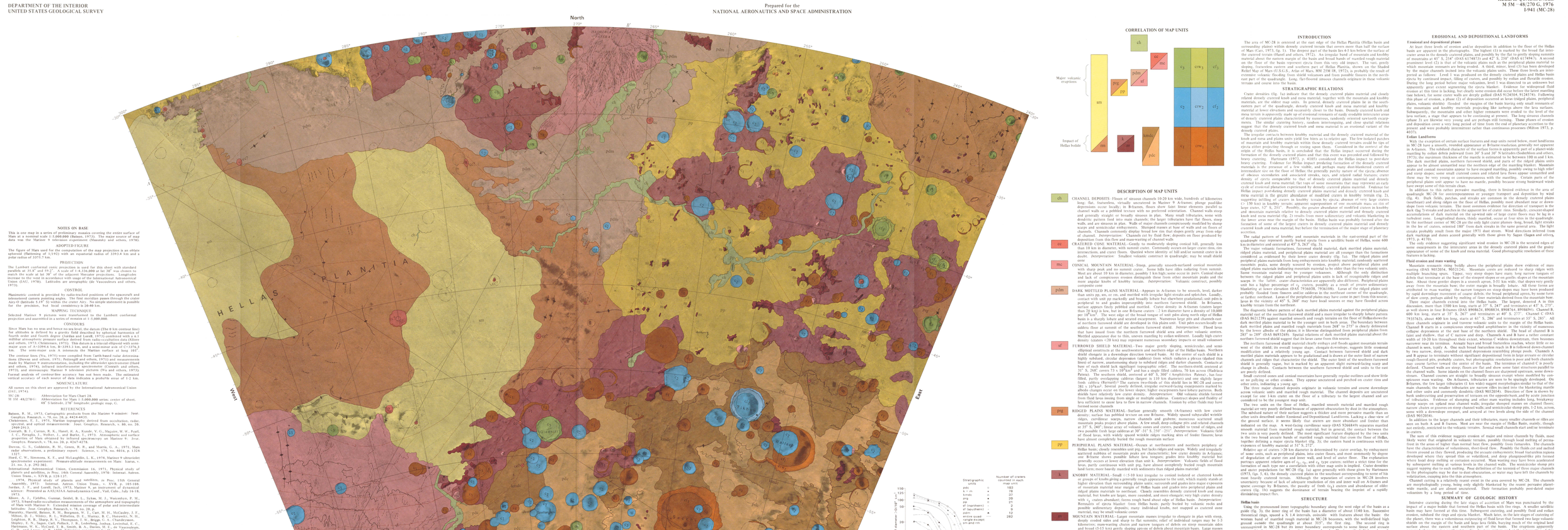
ATLAS OF MARS
1:5,000,000 GEOLOGIC SERIES
HELLAS QUADRANGLE
M 5M—48/270 G, 1976
I-941 (MC-28)



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SCALE 1 : 4 336 000 AT 30° LATITUDE
LAMBERT CONFORMAL PROJECTION

CONTOUR INTERVAL : 1 KILOMETRE

CORRELATION OF MAP UNITS

DESCRIPTION OF MAP UNITS

ch CHANNEL DEPOSITS–Floors of sinuous channels 10-20 km wide, hundreds of kilometres long. *Characteristics*: virtually uncratered in Mariner 9 A-frames; plunge pool-like depressions occur locally; in B-frames, floors show faint linear elements parallel to channel walls or a pebbled texture with no preferred orientation. Channel walls steep and generally straight or broadly sinuous in plan. Many small tributaries, some with dendritic pattern feed into main channels; the larger tributaries have flat floors, steep walls, and are sinuous in plan. Walls of major channels conspicuously modified by slump scarps and reticulate embayments. Slumped masses at base of walls and on floors of channels. Channels commonly display broad low rim that slopes gently away from edge of channel. *Interpretation*: Channels cut by fluid flow; deposits on floor produced by deposition from this flow and mass-wasting of channel walls

cc CRATERED COAL MATERIAL–Gently to moderately sloping conical hill, generally less than 10 km in diameter, with summit crater. Commonly occurs on larger crater rims, rim intersections, and crater floors. Operated where identity of hill and channel material in doubt. *Interpretation*: Smallest volcanic construct in quadrangle; may be small shield volcano

ms CONICAL MOUNTAIN MATERIAL–Steep, generally smooth-surfaced conical mountain 10-30 km in diameter, rising 1-3 km above surrounding plains. Commonly occurs in groups. Most are about 10 km in diameter, possibly 1 km high; some occur in pairs. Volcanic form and lack of conspicuous erosion distinguish these from other mountain peaks and the more angular knobs of knobby terrain. *Interpretation*: Volcanic construct, possibly composite cone

pdm DARK MOTTLED PLAINS MATERIAL–Appears in A-frames to be smooth, level, darker than units pp, sm, or rm, and mottled with irregular light streaks and splotches. Locally, contact with unit pp markedly and broadly lobate but elsewhere gradational; unit plies in peripheral to and grades imperceptibly into northern furrowed shield. In B-frames, surface appears finely pebbled and mottled. Crater density in A-frames is greater than 2σ less; in B-frames craters >2 km diameter have a density of 10,000 per 10^6 km^2. The west edge of the broad tongue of unit pdm along north edge of Hellas basin is a sharply lobate and scarped escarpment. Numerous large pits and channels east of northern furrowed shield are developed in thin plains unit. Unit pdm occurs locally on caldera floor at summit of the southern furrowed shield. *Interpretation*: Flood lavas that have issued from the northern furrowed shield and other volcanic centers. Mottled appearance due to thin, uneven mantling by eolian sediment. Locally high crater density (craters <20 km) may represent numerous secondary craters on basin floor

sf FURROWED SHIELD MATERIAL–Two major gently sloping, semicircular, and semi-elliptical constructs in the southwestern and northern edge of the Hellas basin. Each shield elongate in a downslope direction toward basin. At the center of each shield is a highly subdued, circular depression (caldera) from which radiates a pleated (ridge and lineal or narrow, anastomosing share to subdued ridges and darker channels. Contacts at base of shields are generally concealed by younger rims of the Hellas basin and unit pdm. Contacts between the southern furrowed shield and unit pdm to the east are poorly defined.

Small, low, and conical mountains have generally regular outlines and show little or no gullying or other erosion. They appear uncratered and perched on crater rims and floors of the largest craters.

The three major channel deposits originate in volcanic terrain and course downslope across volcanic units and mantled rough material. The channel deposits are uncratered except for one large crater on the floor of a tributary to the largest channel and are considered to be the youngest map unit.

pp PEDIMENTED PLAINS MATERIAL–Occurs at northeastern and northern periphery of Hellas basin; closely resembles unit pg, but lacks ridges and scarps. Widely separated to locally scattered nubbins of mountain peaks are characteristic; low crater density in A-frames; one B-frame shows possible lobate lava tongues; grades into knobby material but generally occurs at lower elevation than unit k. *Interpretation*: Volcanic fields of flood lavas, now partly dissevered with only pp, have almost completely been covered by younger land forms; more heavily mantled with sediments than ridged plains material

k KNOBBY MATERIAL–Small (<5-10 km) irregular to conical mountains or clustered knobs or groups of knobs giving a generally rough appearance to the unit, which mainly stands at higher elevation than surrounding plains units; surrounds and grades into pedestal mountains of mountain material near margin of Hellas basin and grades into peripheral plains and ridged plains materials to northeast. Closely resembles densely cratered mountain material, but knobs are larger, more rounded, and more elongate; very high crater density with c_3 craters abundant; forms rough band about edge of Hellas basin. *Interpretation*: Remnants of ejecta blanket (from Hellas basin; partly buried by volcanic rocks and sediments) and peripheral plains materials and possibly by younger mountain material, may be small volcanic cones

smdc DENSELY CRATERED KNOB AND MESA MATERIAL–Rough-surfaced variant of densely cratered plains, from which it is distinguished by numerous small (<10 km) knobs and mesas; closely resembles some knobby material but is characterized by mesas and sharper knobs. Very high crater density. *Interpretation*: Knobs and mesas erosional remnants of escarpment-bounded ejecta blankets and sediments of densely cratered plains material

pdc DENSELY CRATERED PLAINS MATERIAL–Very high crater density, contains largest craters in quadrangle; intercrater area varies from flat and smooth with conspicuous, randomly oriented saw-tooth escarpments to broadly rolling with associated dark markings as at 44° S, 255°; rougher intercrater areas equivalent to mottled rough material in MC-28; many small cratered cones on crater rims and floors; unit pdc closely associated with unit pdm and grades into it. Crater density in A-frames is greater than 2σ less; in B-frames, precision of count. Terrain in quadrangle may represent end stage of planetary accretion; escarpments produced by eolian and possibly fluviatile erosion of ejecta

sm MANTLED SMOOTH MATERIAL (floor of Hellas basin)–Generally featureless on A and B frames; a few ghost craters and possible cratered cones; vague broad light streaks; array of dark markings near 51° S, 290° along possible ridge. *Interpretation*: Fairnetellen surface attributed to obscuration by dust in part; mantling material might be sediments of lava craters probably more abundant and fresher than shown

rm MANTLED ROUGH MATERIAL (floor of Hellas basin)–Subdued ridges, craters, scarps, cratered cones, and irregular to gently rolling topography, all having mantled appearance; several ridges have dark markings along crest; occurs in two broad arcuate basins with internal ridges parallel to bands; irregular accumulation of dark material in eastern band. *Interpretation*: Ejecta blankets and volcanic material marking two broad rings of Hellas basin. Mantled by eolian deposits

CRATER MATERIALS. Craters >20 km diameter. *Interpretation*: Impact craters displaying various degrees of degradation and in-filling

c_3 Materials of crater having freshest morphology: pronounced raised rim with or without peripheral ejecta blanket; steep inner wall; sloping or rough floor with or without central peak. Craters <30 km diameter are typically bowl-shaped; central peak not visible in A-frames

c_2 Materials of crater having moderately subdued morphology: low rim or no raised rim; little or no peripheral ejecta blanket; generally steep and variably eroded high inner wall. flat floor below level of interior rim crest

c_1 Materials of crater having most subdued morphology: rim trace 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)

Where well defined in craters >40 km, the above three crater materials are further differentiated

crw_3 **crw_2** **crw_1** Undivided crater rim and wall materials

cf_3 **cf_2** **cf_1** Crater floor materials

*Barranal has not been classified as a "patera" (caldera) in the Martian nomenclature as it does not exhibit all requisite topographic criteria for this type of feature.

Contact–Dashed where location uncertain

Buried or highly subdued crater rim crest

Closed depression, probably produced by collapse

Arcuate to irregular steep escarpment at head of and along course of some channels and tributaries; probably produced by collapse

Crater rim crest–Mapped where size and morphology of crater allow demarkation

Cratered cone

Caldera–Generally highly subdued (filled). Those at 61° S, 298° and 32° S, 250° thought to be fresh with multiple concentric slump scarps

Short dashes show plexus of narrow ridges and channels on slopes of furrowed shields; solid line shows low escarpments and albedo boundaries inferred to be flow fronts; arrow indicates direction of flows.

Narrow channel

Curvilinear scarp–Probably fault; barb points downslope; shows contact between units in places

Narrow lineal trough–Probably a graben

Irregular sawtooth escarpment–Hachures point downslope; shows contact between units in places

Sharp crested ridge

Broad major ridge

Lineament–Unknown origin

Impact breccia (shown only in structure sections)

INTRODUCTION

The area of MC-28 is centered at the east edge of the Hellas Planitia (Hellas basin and surrounding plains) within densely cratered terrain that covers more than half the surface of Mars (Carr, 1973, fig. 1). The deepest part of the basin lies 6-8 km below the surface of the cratered terrain (Hartel and others, 1972). An irregular band of mountain and knobby material about the eastern margin of the basin and broad bands of mantled rough material on the floor of the basin represent ejecta from this very old impact. The vast, gently sloping, fan-shaped deposit of channel and flood lavas in the southwestern part of the quadrangle, in the Shaded Relief Map of Mars (U.S.G.S., Atlas of Mars, MM 2-2M-1R, 1972), is probably the result of extensive volcanic flooding from shield volcanoes and from possible fissures in the southeast part of the quadrangle. Long, fan-flowered sinuous channels originate in these volcanic terrains and course into the basin.

STRATIGRAPHIC RELATIONS

Crater densities (fig. 1a) indicate that the densely cratered plains material and closely related densely cratered knob and mesa material, together with the mountain and knobby materials of the rim of the Hellas basin, are the oldest units in general. Remnants of densely cratered plains material of the quadrangle, densely cratered knob and mesa material, and knobby material of lower elevation are found on the floor of the basin. The mountain and knobby material and mesa terrain is apparently made up of erosional remnants of easily erodable intercrater areas of densely cratered plains characterized by numerous, randomly oriented sawtooth escarpments. The similar cratering history, random interfingering, and close spatial relations suggest that the densely cratered knob and mesa material is an erosional variant of the densely cratered plains.

The irregular contacts between knobby material and the densely cratered material of the knob and mesa and plains units yield few hints as to relative age. The few isolated patches of mountain and knobby materials within these densely cratered terrains could be tips of ejecta either projectiles through or resting upon them. Considered in the context of the origin of the Hellas basin, it is concluded that the Hellas impact occurred during the period when the densely cratered plains material was being formed and produced a very heavy covering. Hartmann (1973, p. 4183) considered the Hellas impact to be a most-dense heavy cratering. Evidence for Hellas impact predating formation of the densely cratered materials is the *remnant* of a few visible, and perhaps many dark-blanketed craters of *intermediate* size on the floor of Hellas; the generally patchy nature of the ejecta; absence of *obvious* secondaries and *associated* streaks, rays, and related radial features; crater density of ejecta *comparable* to that of densely cratered plains material and densely cratered knob and mesa material; flat tops of some mountains that may represent an early cycle of erosional planation experienced by densely cratered plains material. Evidence for Hellas impact *postdating* densely cratered plains material and densely cratered knob and mesa material is the greater abundance of modified craters in knobby terrain (fig. 2), suggesting infilling of craters in knobby terrain by ejecta; absence of very large craters (>150 km) in knobby terrain; apparent superposition of one mountain mass on rim of densely cratered unit (fig. 1); and the presence of numerous small craters on the surface of heavy coverings. Hartmann (1973, p. 4183) considered the Hellas impact to produce a heavy cratering. Evidence for Hellas impact predating formation of the densely cratered materials is the *remnant* of a few visible, and perhaps many dark-blanketed craters of *intermediate* size on the floor of Hellas; the generally patchy nature of the ejecta; absence of *obvious* secondaries *and associated* streaks, rays, and related radial features; crater density of ejecta *comparable* to that of densely cratered plains material and densely cratered knob and mesa material; flat tops of some mountains that may represent an early cycle of erosional planation experienced by densely cratered plains material. Evidence for Hellas impact *postdating* densely cratered plains material and densely cratered knob and mesa material is the greater abundance of modified craters in knobby terrain (fig. 2), suggesting infilling of craters in knobby terrain by ejecta; absence of very large craters (>150 km) in knobby terrain; apparent superposition of one mountain mass on rim of densely cratered unit (fig. 1); and the presence of numerous small craters on the surface of heavy coverings. Hartmann (1973, p. 4183) considered the Hellas impact to produce a most-dense