U.S. DEPARTMENT OF THE INTERIOR
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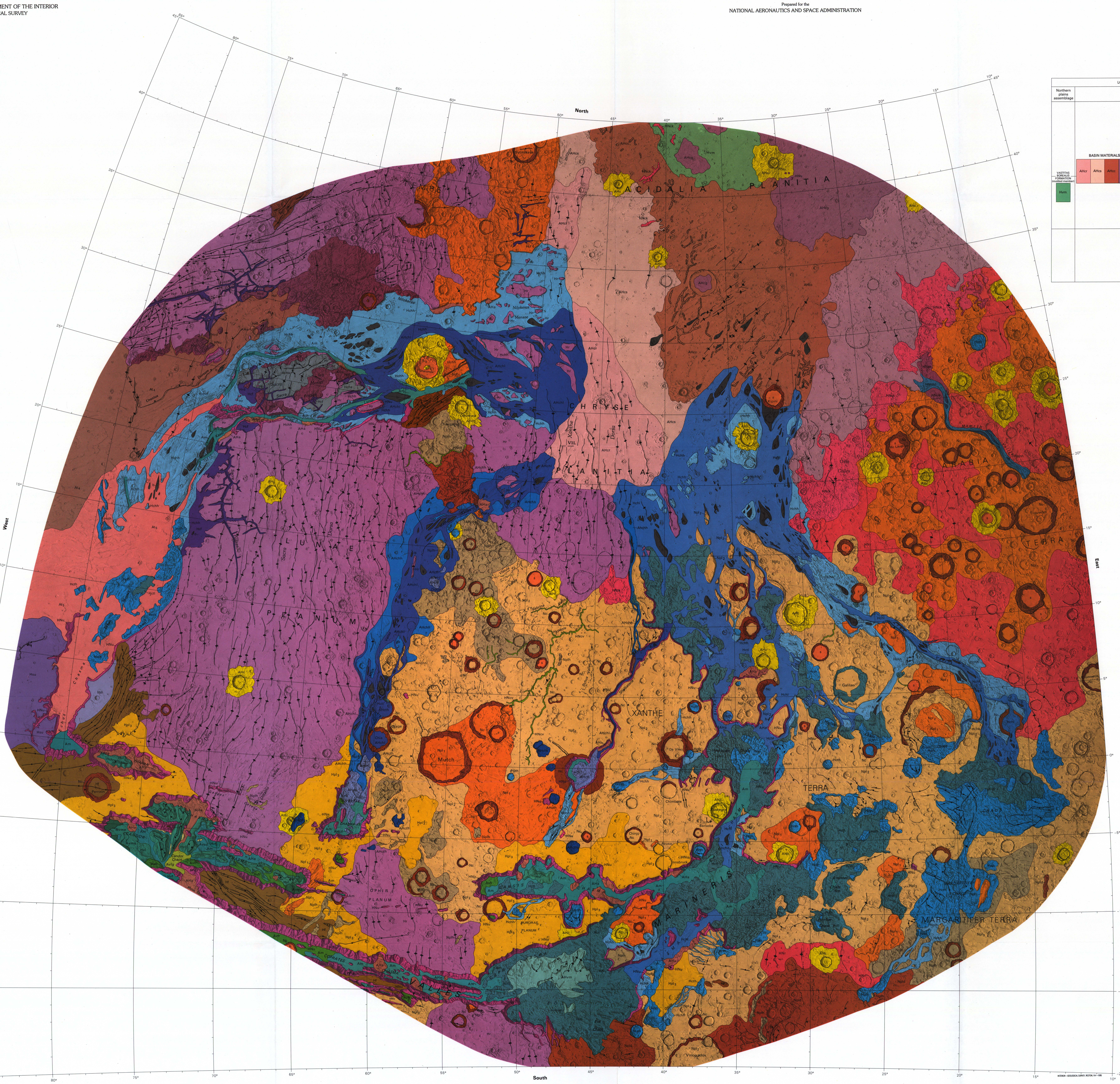
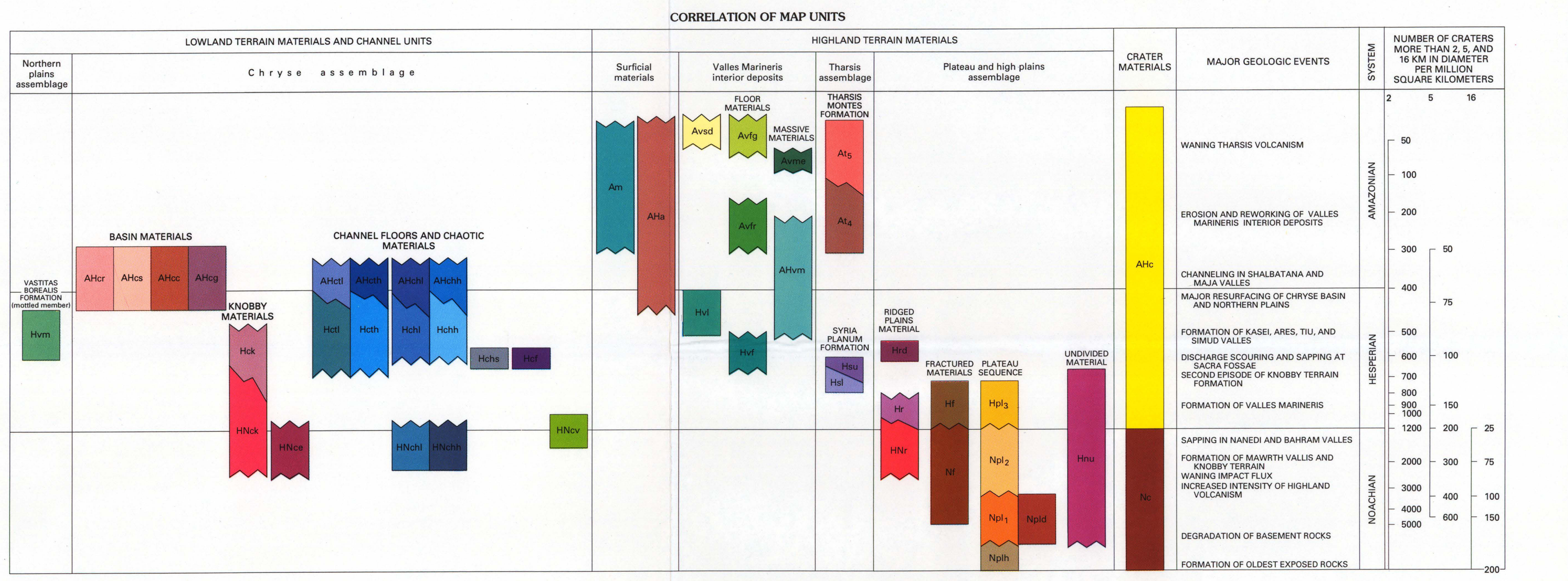
ATLAS OF MARS
GEOLOGIC SERIES
CHRYSE PLANITIA
M 5M 12/47 G,1995
MAP I-2441
Pamphlet accompanies map





DESCRIPTION OF MAP UNITS

Map units were distinguished and interpreted on the basis of morphology, texture, albedo, and stratigraphic position. Although most map units are rock materials, some channel floors are also considered units in order to highlight the erosional events that formed them. To portray the stratigraphic associations among these rocks and erosional surfaces, the units are grouped into a hierarchical system according to their geographic and geologic associations.

LOWLAND TERRAIN MATERIALS AND CHANNEL UNITS

Northern plains assemblage

Hvm **Mottled member of Vastitas Borealis Formation**—Smooth plains material characterized by crater ejecta that have higher albedo than intercrater material; some small knobs. Overlapped by grooved and complex basin units of Chryse assemblage. One exposure in northernmost part of map area. This and other members of formation widespread in northern plains outside map region (Scott and Tanaka, 1986). *Interpretation*: Possibly lacustrine and eolian sediments and local lava flows; mottled appearance likely caused by excavation of high-albedo material

Chryse assemblage

[Informal group of units that form outflow channel floors and chaotic terrain north and east of Valles Marineris and associated basin deposits within Chryse and southern Acidalia Planitiae]

Basin materials—Form lowland plains below mouths of outflow channels; interpreted to consist of sediments derived from outflow channels; possibly include volcanic and eolian deposits. Contacts between basin units gradational except as noted

AHcr **Subdued ridged unit**—Both exposures form plains marked by subdued wrinkle ridges. Larger exposure is flood plain at confluence of major outflow channels. *Interpretation*: Ridged plains material partly resurfaced by outflow-channel erosion and deposition

AHcs **Smooth unit**—Forms flat, relatively featureless plains that have sparse knobs, wrinkle ridges, and streamlined features; low albedo. East edge defined by sharp albedo contrast forming lobate outline that grades into scarps in places. *Interpretation*: Lacustrine deposits thick enough to cover most underlying wrinkle ridges

AHcc **Complex unit**—Characterized by one or more of the following: (1) hummocky topography; (2) small knobs (some superposed on mesas); (3) sinuous depressions about 10 km wide and tens of kilometers long; (4) sinuous ridges less than 1 km wide, some of which are medial in sinuous depressions, connect knobs, or traverse streamlined bars; (5) narrow, curvilinear, northeast-trending grooves; (6) northeast-trending streamlined hills; and (7) several mostly buried crater rims. Unit gradational with smooth and grooved basin materials. *Interpretation*: Relatively thick lacustrine deposits of most recent flooding. Various features result of fluvial and (or) glacial processes and compaction of sediments

AHcg **Grooved unit**—Forms dark plains marked by discontinuous grooves and troughs hundreds of meters wide in polygonal pattern. Gradational with complex unit and younger knobby material. *Interpretation*: Thick lacustrine sediments derived from highlands rocks carved by Chryse channels; mantled by low-albedo material. Patterned ground results from compaction and desiccation

Knobby materials

Hck **Younger knobby material**—Forms knobby plains in northeastern map area similar in appearance to mottled member of Vastitas Borealis Formation but has generally higher albedo, dispersed knobs, scattered north-trending degraded wrinkle ridges, and a few partly buried and modified crater rims. Cut by lowermost Ares Vallis; gradational with older knobby material and grooved unit; embays mouth of Mawrth Vallis. *Interpretation*: Basin sediments and perhaps lava flows that embay knobs of older degraded plateau material modified by extensive mass wasting

HNck **Older knobby material**—Small, closely spaced knobs on high, gently sloping plains along boundary between Martian lowlands and highlands (in this region, Chryse Planitia and Arabia Terra, respectively). Gradational with adjacent younger knobby and plateau materials. *Interpretation*: Remnants of plateau materials (knobs) and reworked deposits and lava flows (interknob plains)

HNce **Etched unit of Mawrth Vallis**—Forms smooth-topped mesas that have irregular edges; few rimless craters. Grades into cratered and knobby units; cut by mouth of Mawrth Vallis. *Interpretation*: Early flood-plain deposits of Mawrth Vallis etched by removal of interstitial ice and by eolian erosion

Channel floors and chaotic materials—Units that make up outflow channel systems that debouch into Chryse Planitia

AHctl **Younger lower chaotic material**—Forms patches of large and small knobs on floors of Maja and Shalbatana Valles near their heads. In Maja Valles, grades into higher channel floor material; in Shalbatana Vallis, embayed by mantle material. *Interpretation*: Jumbled blocks of plateau materials whose collapse was due to rapid discharge of ground water and removal of debris from relatively deep levels

AHcth **Younger higher chaotic material**—Forms small plateaus that make up mosaic patterns in generally circular depressions at approximately same elevation as surrounding plateau surfaces; within plateau materials near heads of Maja and Shalbatana Valles. *Interpretation*: Impact-crater fill and plateau-sequence materials collapsed because of removal of ground water and debris

Hctl **Older lower chaotic material**—Forms patches of knoblike hills within Kasei, Ares, Tiu, and Simud Valles, particularly at their heads, in chasmata, and in depressions surrounded mainly by subdued cratered unit. In places, grades into higher chaotic material (unit Hcth). Equivalent to chasma chaotic material of Witbeck and others (1991). *Interpretation*: Jumbled blocks of plateau materials whose collapse was due to rapid discharge of ground water and removal of voluminous debris at lower channel and chasma floor levels

Hcth **Older higher chaotic material**—Forms plateaus and mesas in mosaic patterns at approximately same elevation as adjacent plateau surfaces; associated with Kasei, Ares, Tiu, and Simud Valles; fills several craters. Roughly equivalent to plateau chaotic material of Witbeck and others (1991). *Interpretation*: Plateau material modified by collapse due to removal of subsurface material either (1) at higher channel-floor levels or (2) in relatively modest amounts at lower levels

AHchl **Younger lower channel floor**—Forms smooth, deeply incised part of Maja Valles and main branch of Shalbatana Vallis. In Kasei Valles, forms southern part of broad eastern channel plain and channels flanking Sacra Mensa that are buried by mantle material. Channels locally anastomosing; abundant streamlined bars. In Maja Valles, originates from margins of lower chaotic material at channel head. No crosscutting relations with other channel-floor units. *Interpretation*: Youngest erosional surfaces carved into plateau materials by catastrophic floods in Chryse region

AHchh **Younger higher channel floor**—Forms high-standing subdued terrain and flanks of more deeply carved channel floors of Maja Valles and north branch of Shalbatana Vallis. Streamlined features sparse; wrinkle ridges and impact craters clearly subdued. *Interpretation*: Terrain modified by most recent, low-energy fluvial erosion and (or) modest sedimentation over wide flood plains

Hchl **Older lower channel floor**—Smooth, broad surfaces; marked in most areas by streamlined features tens of kilometers or more long (that are mapped as bars, plateau material, or higher channel-floor units). In Ares-Simud-Tiu Valles system, forms broad channel plains and inner channels that originate from margins of chaotic material. *Interpretation*: Lowermost floors of largest outflow-channel systems

Hchh **Older higher channel floor**—Forms high-standing broad plains and anastomosing channels cut into highland rocks mainly in Kasei, Ares, and Tiu Valles. Marked by longitudinal grooves, terraces, and streamlined islands. Most exposures head in chaotic material. Cut by lower channel floors (unit Hchl) in places; in Kasei Valles embayed by lava flows of Tharsis Montes Formation. *Interpretation*: Areas eroded by early to intermediate stages of catastrophic flooding

Hchs **Sacra Mensa channel floor**—Forms relatively rough surface on Sacra Mensa marked by subtle streamlined features that trend northeast; some fossae and degraded wrinkle ridges. Grades into degraded ridged plains material, cut by fossae and channel floors of Kasei Valles. *Interpretation*: Ridged plains material eroded by floods issuing from fossae

HNchl **Lower floor of Mawrth Vallis**—Sinuous, mostly 20–40 km wide; surrounds a few streamlined bars; degraded grooves and terraces; gradational with adjacent etched and knobby materials. Channel emerges fully developed from area of large, ancient craters; cuts cratered material and older ridged plains unit. *Interpretation*: Eroded by catastrophic flooding; cratered source materials may have been highly permeable aquifer system

HNchh **Higher floor of Mawrth Vallis**—Forms high-standing, scoured surfaces and streamlined bars in Mawrth Vallis. *Interpretation*: Less eroded parts of channel floor

Hcf **Fossae floors**—Relatively smooth floors of Sacra and Labeatis Fossae; locally contain blocky debris. Fossae form branching rectilinear networks of steep-walled canyons that have narrow heads. Some exposures grade with higher floor levels of upper Kasei Valles and terraces of lower Kasei Valles. *Interpretation*: Erosional surfaces formed by ground-water and ground-ice sapping initially controlled by pre-existing fractures

HNcv **Valley floors**—Smooth floors of theater-headed valleys. Nanedi Valles cut subdued cratered material on northern Xanthe Terra; Bahram Vallis cuts ridged plains material on Lunae Planum. *Interpretation*: Formed by headward erosion due to ground-water sapping over extended period

HIGHLAND TERRAIN MATERIALS

Surficial materials

Am **Mantle material**—Smooth material covering stretches of outflow channels and most chasmata near scarps higher than 1 km; superposed craters rare. Overlain by and grades into apron material. *Interpretation*: Mass-wasted and eolian deposits

AHa **Apron material**—Forms pristine, sparsely cratered talus, slides, and rotated blocks of wall rocks on floors of chasmata and on channel floors in Kasei, Shalbatana, Simud, and Maja Valles. In Kasei Valles, some aprons cut by late-stage flooding. *Interpretation*: Deposits derived from mass wasting and slope failure of canyon walls

Valles Marineris interior deposits
(after Witbeck and others, 1991)

Avsd **Dark surficial material**—Forms small, low-albedo patches along base of walls in Candor Chasma; overlies fault scarps in places; extends into gullies above and below scarps. *Interpretation*: Mafic volcanic material erupted along fissures, partly redistributed by eolian activity

Hvl **Layered material**—Thick sequence of alternating dark and light layers, as much as hundreds of meters thick in places; forms irregularly shaped and tilted mesas in Hebes, Ophir, and Candor Chasmata that approach level of adjacent plateau. Mesas commonly capped by resistant layers; less resistant beds fluted and streamlined. *Interpretation*: Volcanic and (or) lacustrine material. Albedo variations and resistance to erosion may be due to different compositions or to degree of lithification; fluting by wind erosion; tilting indicates structural deformation

Avfg **Grooved floor material**—Forms grooved deposit marked by knobs and mesas in Candor Chaos. *Interpretation*: Sediments originating from channel and possible landslide in Ophir Chasma; subsequently broken up by removal of water or ice

Avfr **Rough floor material**—Rough surface of varied albedo; in Candor, Gangis, and Coprates Chasmata. *Interpretation*: Debris eroded from chasmata walls or eolian mantle burying landslides or other rugged deposits

Hvf **High floor material**—Forms two elevated terraces, locally faulted, in Candor Chasma. *Interpretation*: Older floor material left high by further lowering of adjacent canyon floors

Avme **Etched massive material**—Varied albedo; rough, pitted surface; overlies layered material; four patches in Candor Chasma. *Interpretation*: Volcanic or eolian material pitted and etched by wind

AHvm **Older massive material**—Undulatory surface of high relief and high albedo; between Capri and Eos Chasmata. Locally fluted; draped over chaotic material. *Interpretation*: Pyroclastic or eolian mantle

Tharsis assemblage
[Lava flows originating in Tharsis region]

Tharsis Montes Formation—Easternmost flows of large shields of Tharsis Montes; exposed in western part of map region. Members 1–3 and 6 not present in map area

At_5 **Member 5**—Marked by elongate, high-albedo flow lobes that have distinct margins; dark streaks in places; craters rare. Fills floor of Echus Chasma, broad floor of upper Kasei Valles (covers older higher channel floor), and some inner channels of Kasei Valles north of lat 15° N.; embays chaotic materials; overlies upper member of Syria Planum Formation. *Interpretation*: Lava flows from eastern flank region of Ascraeus Mons (centered at lat 12° N., long 104°)

At_4 **Member 4**—Relatively thin, elongate flow lobes; few craters. Overlain by member 5, which it resembles morphologically. Covers northwestern floor of Kasei Valles. *Interpretation*: Lava flows from northeastern flank region of Ascraeus Mons

Syria Planum Formation—Northeasternmost flows of formation

Hsu **Upper member**—Consists of narrow and sheet lava flows; few prominent lobate fronts; moderately cratered. West of and cut by Echus Chasma, originating from northeastern Noctis Fossae (at about lat 2° S., long 95°). Underlies Tharsis Montes Formation; embays younger fractured material. *Interpretation*: Basaltic lava flows

Hsl **Lower member**—Morphologically similar to upper member but more intensely cratered and faulted; east of and cut by Echus Chasma. Embays younger fractured material. *Interpretation*: Basaltic lava flows probably of local origin

Plateau and high plains assemblage
[Moderately to heavily cratered highland materials]

Hrd **Degraded ridged plains material**—Forms rough, faulted, and chaotic terrain on Tempe Terra and Sacra Mensa; cut by Kasei Valles. Some degraded wrinkle ridges. *Interpretation*: Younger ridged plains material broken up by interrelated ground-water sapping, collapse, and gravitational spreading

Hr **Younger ridged plains material**—Makes up smooth to undulatory high plains characterized by wrinkle ridges (similar to mare-type ridges on the Moon) that trend dominantly north. Widespread in west half of map area. Overlies Noachian plateau materials; cut by Valles Marineris, by troughs of Labeatis and Sacra Fossae, and by northeast-trending grabens of Tempe Terra; overlain by most channel-floor units. *Interpretation*: Extensive sheets of low-viscosity mafic lavas erupted from local fissures at high rates. Ridges result from compressional stresses generated by Tharsis rise

HNr **Older ridged plains material**—Smooth intercrater plains in Arabia Terra marked by wrinkle ridges that trend north to northwest and are typically curvilinear. Craters subdued. Unit locally buries cratered unit, grades into subdued cratered unit, and is overlain by older knobby unit. *Interpretation*: Low-viscosity lava flows. Ridges result of compressional stresses

Hf **Younger fractured material**—Fracture patterns generally concentric or parallel to adjacent Echus and Coprates Chasmata. Grades into younger ridged plains material, smooth unit of plateau sequence, and lower member of Syria Planum Formation; cut by Echus, Coprates, and Candor Chasmata. *Interpretation*: Lava flows of local origin; fracturing related to formation of Valles Marineris

Nf **Older fractured material**—Rugged; characterized by closely spaced, northeast-trending faults and grabens. Impact craters common, both superposed and partly destroyed by faulting. Patches in Tempe Terra and south of Sharonov crater. Embayed by younger ridged plains material, cut by Kasei Valles, gradational with hilly unit of plateau sequence. *Interpretation*: Possibly impact breccia, lava flows, or both. Faulting perhaps related to ancient stresses centered at Syria Planum (west of Valles Marineris)

Plateau sequence—Cratered highland and plateau units; mostly in southeastern part of map area

Hpl_3 **Smooth unit**—Featureless plains near Valles Marineris. Moderately cratered; cut by few west-trending normal faults and grabens. Embays Noachian plateau materials; locally grades into younger ridged plains material; cut by Valles Marineris. *Interpretation*: Low-viscosity lava flows

Npl_2 **Subdued cratered unit**—Smooth to undulatory intercrater plains; craters partly buried, mostly rimless, and flat-floored; low-relief flow fronts in places; widespread in southern part of map region. Overlies cratered unit, embayed by older and younger ridged plains materials, grades into older ridged plains unit. Cut by most channel-floor units and some narrow sinuous channels. *Interpretation*: Low-viscosity lava flows and eolian and fluvial deposits

Npl_1 **Cratered unit**—Forms irregular, undulatory, and rough plains on Arabia, Xanthe, and Tempe Terrae. Densely cratered; most large craters have degraded rims. Cut in places by valley networks and a few fractures. *Interpretation*: Impact breccia, lava flows

Npld **Dissected unit**—Similar in morphology to cratered unit but dissected by many small, sinuous channels a few kilometers wide or less that locally form networks; occurs near Bahram Vallis and east of Valles Marineris. *Interpretation*: Cratered material dissected by ground-water sapping or runoff

Nplh **Hilly unit**—Rough, hilly to mountainous material that crops out in Margaritifer Terra and sporadically north of Valles Marineris and makes up southeast rim of Chryse basin. Heavily cratered, cut by few fractures and narrow sinuous channels. Grades into or is embayed by all adjacent units. *Interpretation*: Ancient impact breccia and volcanic rocks and rim material of large impact basin

HNu **Undivided material**—Forms walls and interior topographic highs in chasmata and channels. *Interpretation*: Impact breccia and volcanic material of highlands exposed by faulting, channeling, and mass wasting

CRATER MATERIALS

Materials of impact craters 50 km or more in diameter, including central peaks.

AHc **Fresh crater material**—Fresh, bowl-shaped craters that have well-preserved ejecta blankets. Most larger than about 30 km in diameter have central peaks. *Interpretation*: Material that postdates widespread Noachian degradation

Nc **Degraded crater material**—Ejecta blanket absent, deeply eroded, or buried; crater rim degraded. Crater floor commonly smooth. *Interpretation*: Material subjected to widespread Noachian erosion; smooth floors indicate resurfacing by volcanic, eolian, or fluvial processes

Contact—Dashed where approximately located

Fracture or narrow graben

Graben—Bar and ball on downthrown side of graben-bounding fault

Wrinkle ridge—Symbol on ridge crest

Scarp—Symbols at base

Depression

Narrow sinuous channel

b **Bar**

Crater rim

Crater rim, partly buried or subdued

s **Smooth crater floor**

V1L **Viking 1 landing site**

GEOLOGIC/GEOMORPHOLOGIC MAP OF THE CHRYSE PLANITIA REGION OF MARS

By
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1995