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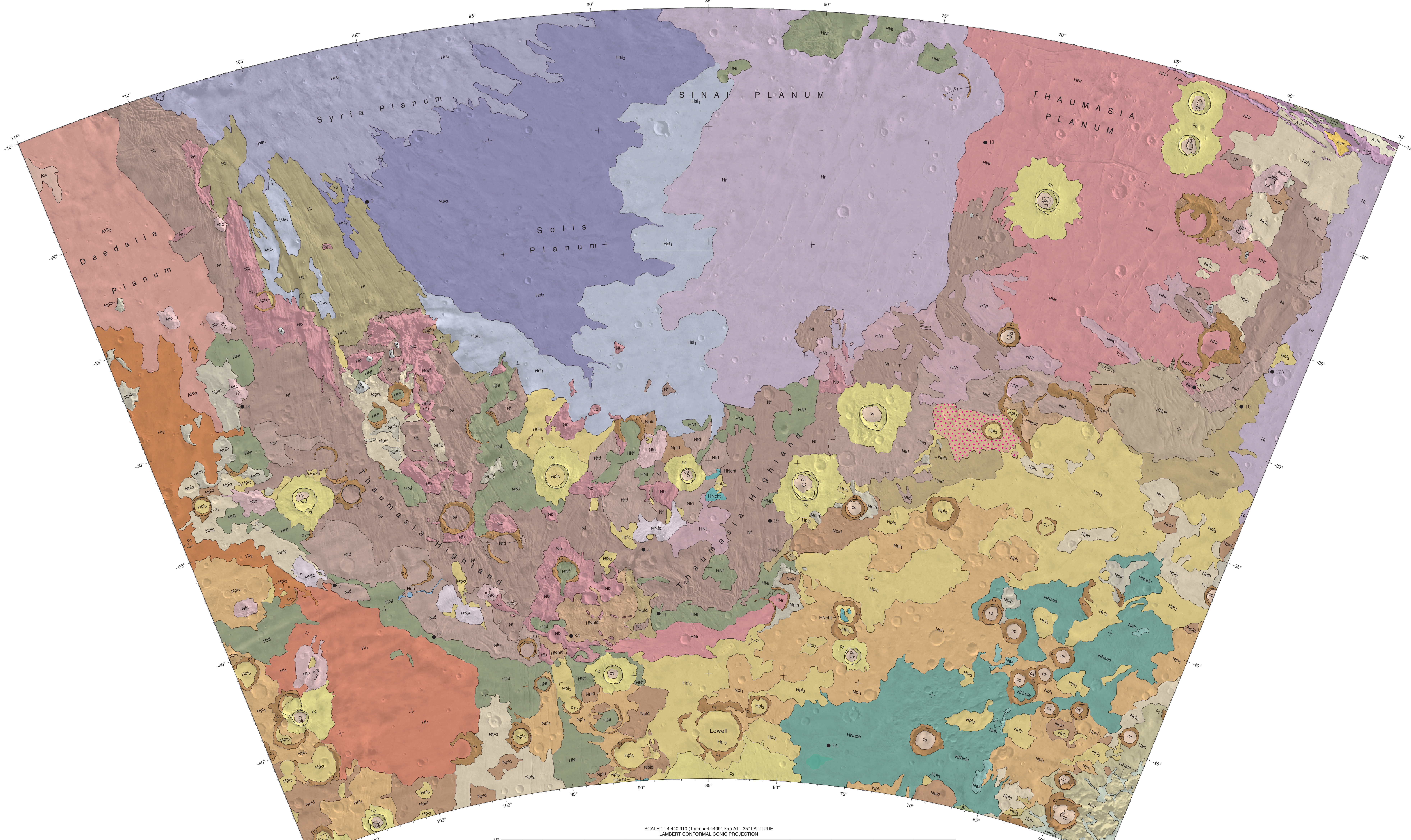
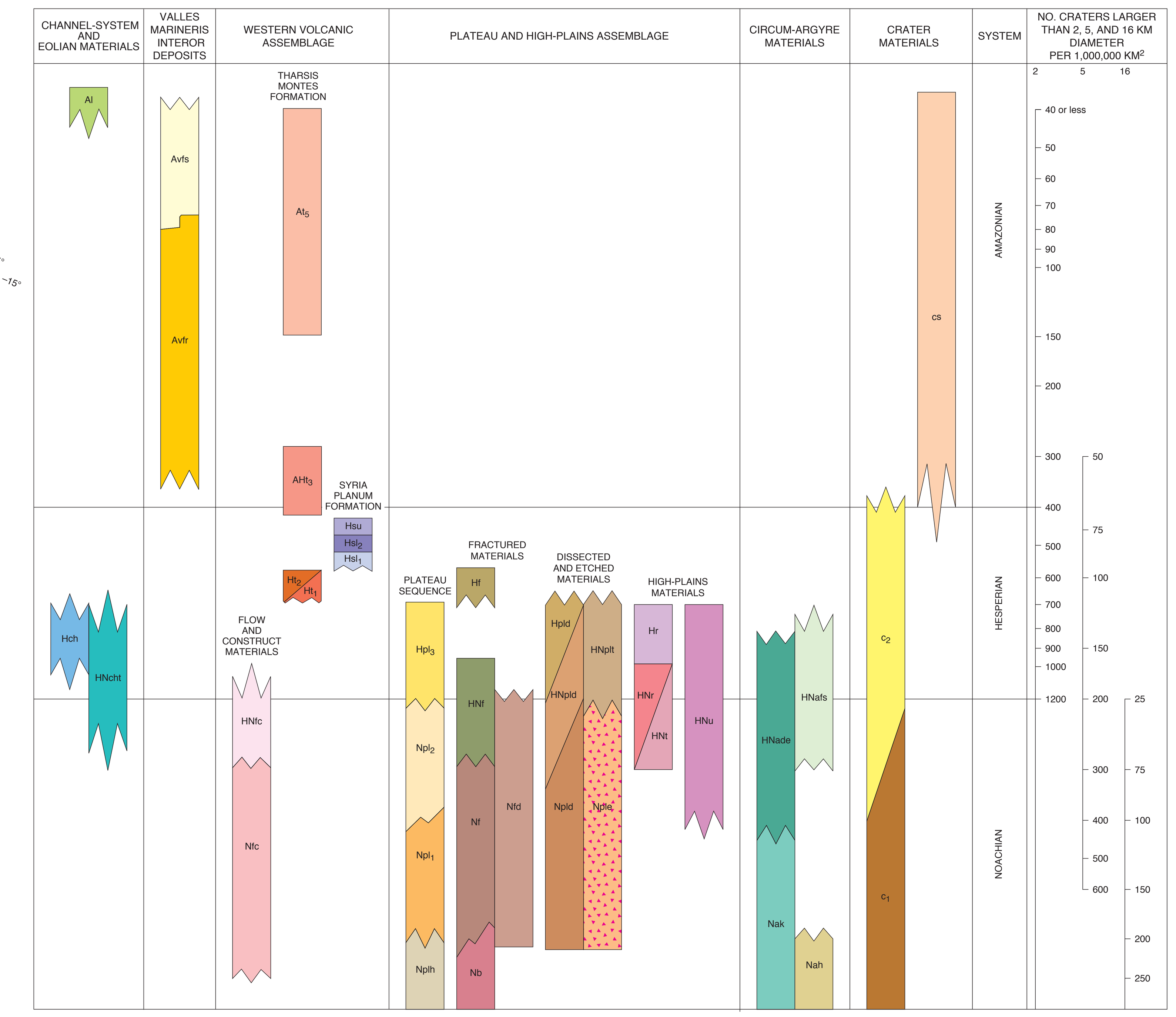
U.S. GEOLOGICAL SURVEY

Prepared for the
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

GEOLOGIC INVESTIGATION SERIES I–2650
ATLAS OF MARS: THAUMASIA REGION
SHEET 1 OF 3



SCALE 1 : 4 440 910 (1 mm = 4.44091 km) AT –35° LATITUDE
LAMBERT CONFORMAL CONIC PROJECTION



INTERIOR—GEOLOGICAL SURVEY, RESTON, VA—2001

Prepared on behalf of the Planetary Geology and Geophysics Program, Solar System Exploration Division, Office of Space Science, National Aeronautics and Space Administration

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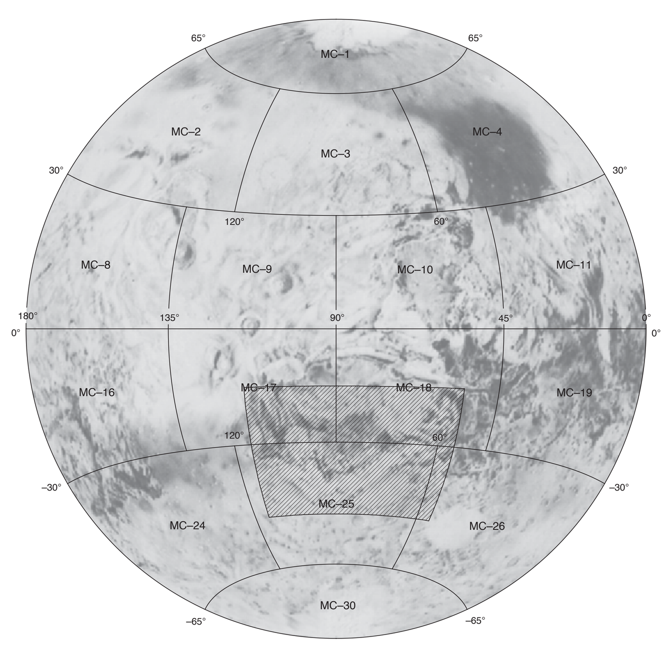

QUADRANGLE LOCATION
Photomosaic location is shown in the western hemisphere of Mars. An outline of 1:5,000,000-scale quadrangles is provided for reference.

DESCRIPTION OF MAP UNITS

[Though the origin and composition of many units are obscured or controversial, interpretations are based on objective descriptions of morphologic characteristics visible on Viking images. Age relations are determined by stratigraphic positions and crater counts (table 1). Many of the units were previously described and mapped at 1:15,000,000 scale by Scott and Tanaka (1986); we preserve their nomenclature and interpretations where possible]

CHANNEL-SYSTEM AND EOLIAN MATERIALS

Al — **Linear material**—Forms linear, ripplelike features in topographic low centered at lat 50.0° S., long 66°; wavelength of ripples about 1 km. Unit originally recognized by Scott and Tanaka (1986) as unit Ae. *Interpretation*: Dune field

Hch — **Channel and flood-plain material**—Forms smooth channel and crater floors and outwash plain in discharge area centered at lat 39.5° S., long 104°; partly buries intermediate fractured material (unit HNf); abruptly terminated on upslope end near graben. *Interpretation*: Channel material deposited by discharge of ground water via graben

HNcht — **Chaotic material**—Forms irregular patches of closely spaced knobs of similar heights; occurs near highly faulted and dissected areas and within impact crater. Unit not recognized by Scott and Tanaka (1986). *Interpretation*: Erosional remnants formed by disruption of terrain by ground-water release and tectonic activity or by mass wasting

VALLES MARINERIS INTERIOR DEPOSITS

Avfs — **Smooth floor material**—Occurs along canyon floors as smooth to undulatory materials of low relief. *Interpretation*: Primarily eolian and colluvial deposits

Avfr — **Rough floor material**—Forms rough surface of canyon floor centered at lat 16.0° S., long 57.3°. *Interpretation*: Mixture of landslides and debris flows from canyon walls and eolian deposits

GEOLOGIC MAP OF THE THAUMASIA REGION, MARS

By
James M. Dohm, Kenneth L. Tanaka, and Trent M. Hare
2001

WESTERN VOLCANIC ASSEMBLAGE

Tharsis Montes Formation—Includes lava flows of large shield volcanoes of Tharsis Montes; members 4 and 6 (Scott and Tanaka, 1986) not present in map area

At_5 — **Member 5**—Forms light-colored, elongated flows with frontal lobes; overlaps member 3 (unit AHt_3); occupies small area in northwest part of the map region. *Interpretation*: Lava flows of the Arsia Mons region; high albedo may be produced by eolian mantle

AHt_3 — **Member 3**—Forms a plain of light and dark flows that overlaps member 2 (unit Ht_2) and embays highland materials in the northwest part of the map region; fewer lobate fronts than the superposed member 5 of the Tharsis Montes Formation; cut by few northwest-trending grabens. *Interpretation*: Lava flows of the Arsia Mons region; contrasting albedo may represent distinct lava flow types typified by surface texture or the presence or lack of eolian mantles

Ht_2 — **Member 2**—Forms a relatively smooth plain of flows having broad, subdued, lobate fronts; fewer fronts than the overlying member 3 of the Tharsis Montes Formation; cut in few places by northeast-trending grabens; overlaps member 1 (unit Ht_1) and intermediate fractured material (unit HNf) and embays highland materials along part of the western margin of the Thaumasia highland province. *Interpretation*: Lava flows of the Arsia Mons region

Ht_1 — **Member 1**—Forms a relatively smooth to hummocky plain in southwest part of the map region that is cut by northeast-trending grabens; flow fronts rare; partly buries intermediate fractured material (unit HNf) and in places, wrinkle ridges of an older, underlying surface. *Interpretation*: Lava flows of the Arsia Mons region

Syria Planum Formation—Includes lava flows that originated from northern Syria Planum and Noctis Labyrinthus regions (north of the northwest part of the map region). Lower member of Scott and Tanaka (1986) divided into younger and older flows

Hsu — **Upper member**—Mottled light and dark flows form complex, interfingering, elongated tongues with distinct lobe fronts in northwest part of map region; overlaps younger flows of lower member (unit Hsl_2) and younger and older fractured materials (units Hf and Nf, respectively); cut by few northwest-trending grabens of Claritas Fossae and several northeast-trending and curvilinear grabens; marked in few places by chains of pit craters. *Interpretation*: Lava flows

Hsl_2 — **Younger flows of lower member**—Similar to upper member but elongated tongues of flows and their lobe fronts are less distinct, and faulted by northwest-trending grabens of Claritas Fossae; overlaps older flows of lower member (unit Hsl_1) and younger fractured material (unit Hf). *Interpretation*: Lava flows

Hsl_1 — **Older flows of lower member**—Forms a relatively smooth plain unlike overlying younger flows of lower member (unit Hsl_2); flow fronts visible in places; cut by few northwest-trending grabens of Claritas Fossae; overlaps younger fractured material (unit Hf) and younger ridged plains material (unit Hr) and embays highland materials along part of northern margin of Thaumasia highland province. *Interpretation*: Lava flows subdued by eolian deposition and erosion

Flow and construct materials

HNfc — **Younger flow and construct material**—Forms mountains of high relief in the southwest part of the Thaumasia highlands province; radial channels and dissecting grabens common, central depressions less common; lobate fronts in places; flat-floored troughs and lobate scarps may be present on or near some of the mountain flanks as at lat 40.5° S., long 101.0° similar to those of Apollinaris and Hadriaca Paterae. Unit not recognized by Scott and Tanaka (1986). *Interpretation*: Volcanoes and lava flows and (or) eroded high-standing outcrops of plateau material in places

Nfc — **Older flow and construct material**—Forms conical mountains in parts of the Thaumasia highlands that partly resemble younger flow and construct material (unit HNfc), but larger relief and more highly cratered; may be embayed by Noachian and (or) Hesperian materials. Unit not recognized by Scott and Tanaka (1986). *Interpretation*: Ancient volcanoes and (or) eroded high-standing outcrops of plateau material in places

PLATEAU AND HIGH-PLAINS ASSEMBLAGE

[Forms ancient highland terrain and local tracts of younger deposits]

Plateau sequence

Hpl_3 — **Smooth unit**—Occurs mainly in southern half of map region as large areas of flat, relatively featureless plains; in places forms smooth to moderately rough floors of some impact craters, cut by grabens, and marked by subdued wrinkle ridges; embays rock outcrops of several older units of the plateau and high-plains assemblage. *Interpretation*: Probably various materials having smooth surfaces at image resolution, including lava flows, and eolian, mass-wasted, and fluvial deposits that bury most underlying rocks

Npl_2 — **Subdued cratered unit**—Forms highland plains characterized by subdued and partly buried older crater rims; cut in places by grabens; rare flow fronts; locally grades into younger (unit Hr) and older (unit HNr) ridged plains materials. *Interpretation*: Thin layer of lava flows and fluvial and eolian deposits that partly bury underlying rocks; colluvial materials may also be present as at lat 42.0° S., long 55.5°

Npl_1 — **Cratered unit**—Consists of highly cratered, rough, irregular material of moderate relief; grabens, channels, and large scarps in places. *Interpretation*: Mixture of impact breccia, crater-rim materials, lava flows, and sedimentary deposits, which include eolian and fluvial materials

Nplh — **Hilly unit**—Forms mesas, knobs, and broad areas that rise above surrounding materials; marked in few places by large ridges and scarps as at lat 28.0° S., long 110.5°. Embayed and (or) partly buried by material of several younger units of the plateau and high-plains assemblage. *Interpretation*: Impact breccia, volcanic materials, and possibly older crustal materials; high elevation caused by tectonic uplift and impact-basin formation during period of heavy bombardment

Fractured materials—The origin and rock type of these units are only inferred because fractures and grabens have obscured original surface characteristics in most instances. *Interpretation*: The units consist of impact breccia, crater-rim materials, lava flows, and sedimentary deposits, which include eolian and fluvial materials. Faults caused by crustal extension and warping

Hf — **Younger fractured material**—Forms relatively smooth surfaces in northwest part of the map region; moderately cut by northwest-trending grabens. Embays older fractured material (unit Nf), basement complex (unit Nb), and older flow and construct material (unit Nfc) but partly buried by lava flows of the Syria Planum Formation

HNf — **Intermediate fractured material**—Forms relatively smooth surfaces of moderate relief with fractures and grabens; moderately cratered. Overlies other highly deformed terrain materials but is embayed and partly covered by older flows of lower member of Syria Planum Formation (unit Hsl_1), younger ridged plains material (unit Hr), members 3, 2, and 1 of Tharsis Montes Formation (units AHt_3, Ht_2, and Ht_1, respectively), and smooth unit of plateau sequence (unit Hpl_3). Unit not recognized by Scott and Tanaka (1986)

Nfd — **Fractured and dissected material**—Similar to older fractured material but dissected by small valleys, valley networks, and troughs; marked in places by triangular-shaped scarps, tilted beds, and ridges along parts of southern margin of the Thaumasia plateau. Unit not recognized by Scott and Tanaka (1986). *Interpretation*: Origin same as that of older fractured material but more highly modified by fluvial and sapping processes and sediment deposition. Cuestas and hog backs formed by differential erosion of tilted beds of warped and extended crust

Nf — **Older fractured material**—Similar to intermediate-age fractured material but more rugged, faulted, and cratered; deformation has destroyed primary morphologic characteristics

Nb — **Basement complex**—Forms knobs, mesas, and broad areas of prominent relief similar to hilly unit but characterized by highly complicated structure of undifferentiated material; dissected in places; embayed and (or) partly buried by materials of several younger units of the plateau and high-plains assemblage and Syria Planum and Tharsis Montes Formations. *Interpretation*: Assemblage of undifferentiated rocks of many origins, which may include igneous and metamorphic rock outcrops and impact breccia, comprising complicated tectonic structure

Dissected and etched materials—Dissected and etched materials include the eroded rock and superposed sediment deposited by the resurfacing agent because they generally cannot be mapped separately; their relative-age ranges reflect both materials. The origin and rock type of the eroded rock are only inferred in most instances because channels and furrows have modified original surface characteristics

Hpld — **Younger dissected material**—Areas of relatively young smooth materials along parts of the southern margin of the Thaumasia plateau; dissected by small, sinuous valleys and valley networks that trend downslope from the Thaumasia highlands and southern part of the Coprates rise toward low-lying regions. Type area: lat 34.5° S., long 71°. Unit not recognized by Scott and Tanaka (1986). *Interpretation*: Relatively young, alluvial and colluvial deposits, which may include older rock surfaces, modified by fluvial and sapping processes

HNplt — **Troughed material**—Moderately cratered, uneven surface dissected by numerous large troughs along the southeastern margin of the Thaumasia plateau centered at lat 29.5° S., long 61.0°; many troughs abruptly terminated on up-slope end at large grabens and depressions; marked in places by dissected wrinkle ridges. Unit not recognized by Scott and Tanaka (1986). *Interpretation*: Fluvial erosion and sapping of easily eroded volcanic (possibly pyroclastic) materials or rock outcrops of the plateau and high-plains assemblage, which may include intermediate dissected material (unit HNpld), fractured and dissected material (unit Nfd), older fractured material (unit Nf), and basement complex (unit Nb); troughs enlarged by fluvial and eolian activity and mass wasting

HNpld — **Intermediate dissected material**—Similar to younger dissected material but more well-defined drainage systems. Unit not recognized by Scott and Tanaka (1986). *Interpretation*: Fluvial erosion and sapping of materials, which largely include fractured and dissected material (unit Nfd), older fractured material (unit Nf), and basement complex (unit Nb), and structures along parts of the southern margin of the Thaumasia plateau

Npld — **Older dissected material**—Similar in occurrence and appearance to subdued cratered and cratered units but more highly dissected by channels and troughs; also occurs in places on ancient impact crater rims and near older flow and construct materials. *Interpretation*: Origin same as that of subdued cratered and cratered units but more eroded by fluvial and sapping processes

Nple — **Etched material**—Irregular surface furrowed by sinuous, curved to flat-bottomed grooves and troughs exhibiting irregular scarp edges. *Interpretation*: Material probably same as troughed material but groove and trough enlargement influenced more by eolian activity and mass wasting than fluvial erosion

High-plains materials

Hr — **Younger ridged plains material**—Forms smooth plains marked by long, nearly parallel, linear to sinuous wrinkle ridges resembling those of lunar maria in Sinai and Coprates east provinces; moderately cratered; flow margins visible in places; ridges generally trend north-northeast, are tens of kilometers apart, and extend as much as 100 km; partly buries the rock surfaces and associated structures of older ridged plains material (unit HNr) in the western part of the Thaumasia Planum province, which includes part of the ejecta blanket of impact crater centered at lat 21.25° S., long 73.25°, intermediate fractured material (unit HNf) in the northern part of the Sinai province, and terraced material (unit HNt) in the northeastern part of the Thaumasia highland province; gradational with the overlapping older flows of the Syria Planum Formation (unit Hsl_1). *Interpretation*: Low-viscosity lava flows from local and regional centers, which may include the Syria Planum region; ridges mainly compressional features

HNr — **Older ridged plains material**—Similar to younger ridged plains material but cut by grabens and more densely cratered; partly buries subdued cratered unit (unit Npl_2), older fractured material (unit Nf), older flow and construct material (unit Nfc), and material of degraded craters (unit c_1) along the western margin of the Coprates province, but overlapped by younger ridged plains material (unit Hr) of Sinai province; small occurrence centered at lat 43.5° S., long 86.5°. Unit not recognized by Scott and Tanaka (1986). *Interpretation*: Similar to that of younger ridged plains material (unit Hr)

HNt — **Terraced material**—Forms rugged, uneven plains marked by irregular scarps; also includes subdued wrinkle ridges and grabens. Partly buried by younger ridged plains material (unit Hr) and gradational, in places, with older ridged plains material (unit HNr). Unit not recognized by Scott and Tanaka (1986). *Interpretation*: Older ridged plains material stripped and degraded by wind erosion and possible tectonic activity and fluvial modification (sapping) exposing older basal materials in places

HNu — **Undivided material**—Forms rugged walls interrupted by spurs and gullies of Valles Marineris and large depressions along northeast edge of map region. *Interpretation*: Basement, most of plateau sequence, intermediate fractured material, and ridged plains materials exposed by faulting and erosion including slumping, mass-wasting, and sapping

CIRCUM-ARGYRE MATERIALS

[Consists of units in northwest part of Argyre Planitia]

HNafs — **Smooth floor unit**—Forms areas of smooth, relatively featureless plains in valleys that trend downslope toward basin floor of Argyre Planitia. Embays and partly buries basin-rim unit of Argyre (unit Nah). Unit not recognized by Scott and Tanaka (1986). *Interpretation*: Probably sedimentary deposits of eolian, mass-wasted, fluvial, and possibly glacial origin in structurally controlled valleys primarily formed by the Argyre impact event

HNade — **Dissected and etched unit**—Moderately cratered plateau surface marked by large valley forms, irregular depressions, drainage basins comprising valley networks, and highly subdued ridges of all shapes and sizes. Surface also furrowed in places by sinuous, intersecting, curved to flat-bottomed grooves, producing an etched or sculptured surface. Unit not recognized by Scott and Tanaka (1986). *Interpretation*: Cratered unit, which may locally include ejecta materials related to the Argyre impact, partly mantled by eolian, alluvial, and colluvial deposits that have been modified by eolian, mass-wasting, sapping, fluvial, and (or) possibly glacial resurfacing

Nak — **Knobby unit**—Forms irregular clusters of abundant small, knoblike hills that in part resemble chaotic material. Unit not recognized by Scott and Tanaka (1986). *Interpretation*: Knobby material formed by eolian, fluvial, and possibly glacial erosion of basin-rim unit (unit Nah) or cratered unit (unit Npl_1) or by tectonic activity related to impact-basin formation

Nah — **Basin-rim unit**—Material of Argyre basin rim. Rugged, hilly material that in part resembles hilly unit (unit Nplh) and basement complex (unit Nb). Unit not recognized by Scott and Tanaka (1986). *Interpretation*: Materials uplifted by the Argyre impact event

CRATER MATERIALS

[Impact craters are assigned relative ages on basis of morphologic appearance and superposition relations. With increasing age, craters become progressively more degraded and subdued in appearance, and their ejecta deposits are discernible only near rim crest. On correlation of map units, overlaps are indicated between crater-age classes and time-stratigraphic boundaries. Craters with rim crests mostly >50 km in diameter are mapped. Scott and Tanaka (1986) did not separate impact crater materials into three separate units]

cs — **Smooth crater floor material**—Forms smooth to moderately rough floors of most impact craters that have continuous rims. *Interpretation*: Mainly eolian, mass-wasting, or fluvial deposits largely of Amazonian age

c_2 — **Material of fresh to subdued craters**—Slightly to moderately eroded craters having continuous rims and ejecta blankets that extend at least one crater diameter beyond rim crest; central peaks or central pits in places. Superposed on member 1 of the Tharsis Montes Formation and smooth unit, intermediate and older fractured materials, fractured and dissected material, older ridged plains material, and subdued cratered and cratered materials of the plateau and high-plains assemblage

c_1 — **Material of degraded craters**—Deeply eroded craters; rims commonly incomplete; central peaks scarce. Often embayed by Upper Noachian and younger materials

Contact—Dashed where approximately located or gradational

Depression or caldera

Dome—Interpreted as ancient volcano or older crustal materia

Crater rim crest

Crater central peak

Crater central pit

● 2 **Center of figure**

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