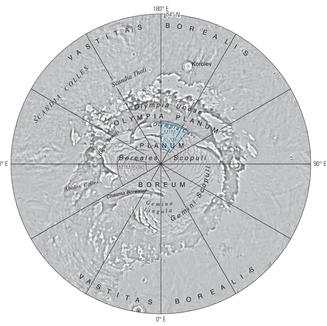
U.S. Department of the Interior
U.S. Geological Survey

Prepared for the
National Aeronautics and Space Administration

Scientific Investigations Map 3197
Atlas of Mars: MTM 85200 Quadrangle
Pamphlet accompanies map



QUADRANGLE LOCATION
Mars Digital Image Mosaic showing locations of MTM 85200 (map area) in blue and MTM 85080 (Herkenhoff, 2003) outline.

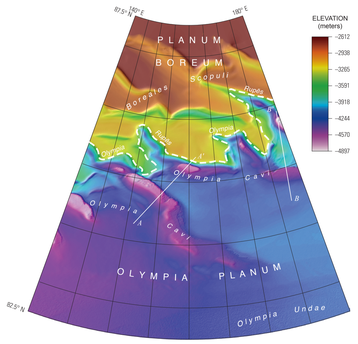


Figure 1. Color shaded-relief image of MTM 85200 constructed from a digital elevation model of Mars Orbiter Laser Altimeter data (512 pixels/degree; ~115 m/pixel). Underlying hillshade is artificially illuminated from the southeast (lower right). Dashed white line identifies Olympia Rupēs, sinuous scarps that roughly separate the narrow troughs of Boreales Scopuli (located within Planum Boreum) from the rugged depressions of Olympia Cavi (located within Olympia Planum). The height of the scarp is ~500 m. Lines *A*–*A*′ and *B*–*B*′ identify locations of the schematic cross sections.

Descriptions of nomenclature used on map are listed at http://planetarynames.wr.usgs.gov/

SCALE 1:500 000 (1 mm = 500 m) AT 87.5° LATITUDE
POLAR STEREOGRAPHIC PROJECTION
10 0 10 20 30 40 50 60 70 80 90 100
KILOMETERS

Prepared on behalf of the Planetary Geology and Geophysics Program, Solar System Exploration Division, Office of Space Science, National Aeronautics and Space Administration
Cartography by Darlene A. Ryan
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Geologic Map of the MTM 85200 Quadrangle, Olympia Rupēs Region of Mars

By
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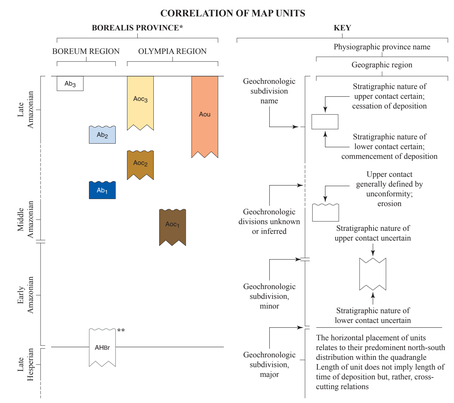
2012

CORRELATION OF MAP UNITS



* Physiographic province as defined by Tanaka and others (2005)
** Reference unit not found on this map. Represents Planum Boreum rupēs unit (HBb$_2$) of Tanaka and others (2008) and Tanaka and Fortezzo (2012).

DESCRIPTION OF MAP UNITS

The geologic units that occur within the boundaries of MTM 85200 quadrangle are part of the Borealis physiographic province, as defined by Tanaka and others (2005). Within this province, we group geologic units into Boreum region and Olympia region units. The paucity of impact craters in the map area precludes the confident assignment of stratigraphic divisions using crater statistics; epochs are assigned based on the contextual work of Blasius and others (1982), Herkenhoff and Plaut (2000), Tanaka (2005), Tanaka and others (2005, 2008), and Tanaka and Fortezzo (2012). Unit groupings, appearance, and stratigraphic relations were determined primarily by their appearance in base maps, which provided the most consistent areal extent and resolution; supplemental data sets provided unit characteristics, where they were consistently observed and critical to the interpretation (see text for elaboration). Relative ages, areas, and superposition relations are provided in table 1.

BOREALIS PROVINCE

GEOLOGIC UNITS OF THE BOREUM REGION

Ab$_3$ Planum Boreum 3 unit—Very high albedo, smooth (at decameter scale) unit. Occurs on inter-trough polar flats. Has sharp margins on equator-facing trough rims. South of Olympia Rupēs, margins serrated. Pole-facing margins commonly contain low-albedo sinuous striations and local pebbly surface textures. Drapes all underlying strata, including exposed layers of the Planum Boreum 1 and 2 units. Locally grades with Olympia Cavi 3 and Olympia Undae units. Locally contains linear ridges, swales, and subtle scarps (<10 m high). *Type locality*: lat 84.3° N., long 153.9° E. *Interpretation*: Extent of 1976 residual water-ice cap, which fluctuates interannually by tens to hundreds of meters (Byrne and others, 2008). Includes small amounts of dark dust and (or) coarse-grained ice, particularly on pole-facing slopes. "Pebbly" texture is patchy front cover. Marginal serrations may represent eolian redistribution of frost or lateral thinning of unit, which locally exposes subjacent units. Ridges formed by combination of sublimation and eolian processes. Scarps and swales may reside in subjacent units

Ab$_2$ Planum Boreum 2 unit—Intermediate albedo, smooth (at kilometer scale) unit. Weak, meter-scale stratification, with several pebbly-texture layers observed. Distinguished from underlying Planum Boreum 1 unit by lack of fine-scale, rhythmic stratification. North of Olympia Rupēs, occurs on pole-facing slopes near trough axes. South of Olympia Rupēs, forms narrow, layered outcrops at marginal crests of Olympia Cavi. Pole-facing outcrops contain low-albedo, sinuous striations and splotches. Buries (and locally grades with) the Olympia Undae and Cavi 3 units. Forms patches that fill shallow depressions within Olympia Cavi 2 unit. Buries (and locally truncates) layers of Planum Boreum 1 unit. Contains terminations of long, linear, topographically subtle scarps. *Type locality*: lat 85.3° N., long 177.6° E. *Interpretation*: Late Amazonian ice and dust layers of variable thickness. Layers represent annual to decadal (or longer) deposition due to climate fluctuations. Ice component accumulated through direct deposition from atmosphere. Lithic component derived from erosion of subjacent units and (or) through atmospheric fallout. Locally undergoing thermokarst degradation. Forms sharp-crested ridges that are buried by Planum Boreum 3 unit. Ridges formed by combination of surface scour and sublimation. Dark splotches and striations represent irregular exposure of internal layering

Ab$_1$ Planum Boreum 1 unit—High- to intermediate-albedo, finely stratified unit. Crops out on equator-facing trough walls, particularly north of Olympia Rupēs. Meter- to decameter-scale, parallel, and rhythmic stratification. Contains hundreds of layers, some locally truncated, that form sequences of cliffs and slopes. North of Olympia Rupēs, unit is >1,200 m thick. South of Olympia Rupēs, unit is 100–500 m thick and thins to the south. Buries irregular surface and truncated layers of Olympia Cavi 1 unit. Contains berms, scarps, benches, and knobs. *Type locality*: lat 85.1° N., long 153.6° E. *Interpretation*: Middle to Late Amazonian ice and dust layers of laterally uniform thickness. Layers represent decadal to millennial (or longer) deposition due to climate fluctuations, as well as large-scale (but far-field) volcanic or impact events. Ice component accumulated through direct deposition from atmosphere. Lithic component derived from erosion of subjacent units and (or) through atmospheric fallout. Internal layer truncations represent localized erosion, which grade into parallel unconformities that represent nondeposition. Erosion and redeposition of this unit partly formed the Olympia Cavi 2 unit. Unit constitutes the volumetric bulk of Planum Boreum

GEOLOGIC UNITS OF THE OLYMPIA REGION

Aou Olympia Undae unit—Low-albedo, lineated to hummocky unit. Forms patches within Olympia Cavi and a band along northern Olympia Planum. Concentrated near base of topographic lows. Contains duneform shapes oriented in southwesterly to westerly direction. Grades downslope with Olympia Cavi 3 unit. Locally grades with and buries Planum Boreum 2 unit. Spatially associated with erosion of Olympia Cavi units. Small patches (unmapped) occur near and grade from the downslope margin of Olympia Cavi 2 unit. *Type locality*: lat 84.9° N., long 149.8° E. *Interpretation*: Middle to Late Amazonian sand dunes. Transported and deposited by saltation via southwesterly winds or paleo-winds. Sourced from underlying Olympia Cavi units. May locally represent lag deposit. Lower contact temporally unconstrained. Upper contact represents cessation of (or ongoing) deposition or mobilization

Aoc$_3$ Olympia Cavi 3 unit—Low-albedo, smooth to diffusely lineated unit with diffuse margins. Locally includes high-albedo patches. Occurs on pole-facing slopes of topographic depressions, including polar troughs and swales. Forms patches within and grades into Planum Boreum 2 unit. Locally contains dark, sinuous striations, swirled patterns, and linear hummocks. Locally obscures details of subjacent topography. Meter-scale maximum thickness. Grades with Planum Boreum 2 and Olympia Undae units. *Type locality*: lat 84.8° N., long 176.1° E. *Interpretation*: Late Amazonian sand sheet and lenses of discontinuous areal extent and thickness. May be locally exposed due to exhumation from beneath adjacent, younger units. Composed of unstratified fine-grained particles and ice. Unit may be sourced from the erosion and redeposition of higher-standing (but stratigraphically subjacent) units. Represents most recent accumulation of lithic particles following erosion of Planum Boreum 2 unit

Aoc$_2$ Olympia Cavi 2 unit—Low- to intermediate-albedo, undulating, hummocky, and patchy unit. Occurs south of Olympia Rupēs, at base of scarps and on cavi slopes and floors. Distinguished from overlying Olympia Cavi 3 unit by occurrence of pits, scallops, and pebbly texture. Distinguished from underlying Olympia Cavi 1 unit by absence of tabular outcrops and benches. Locally forms on and buries narrow planar bench located above Planum Boreum 1 unit. Tens of meters maximum thickness. Locally forms irregularly shaped, layered patches on Olympia Cavi 1 unit. *Type locality*: lat 84.9° N., long 178.2° E. *Interpretation*: Middle to Late Amazonian dust and sand layered with (and bound by) ices. Drapes Planum Boreum 1 and Olympia Cavi 1 units and perhaps accumulated through the erosion and redeposition of those underlying units. Pits and scallops are thermokarst degradation landforms. Current outcrops may represent icy lag deposit. Lower contact temporally unconstrained. Upper contact represents period of erosion of indeterminate length

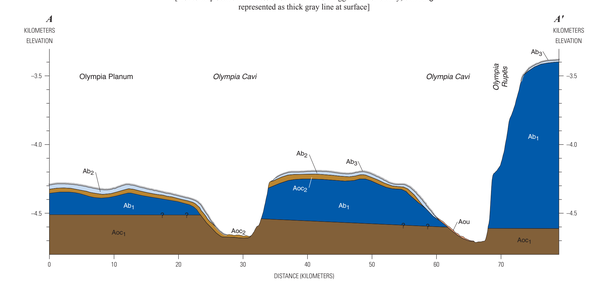
Aoc$_1$ Olympia Cavi 1 unit—Variable, though generally low albedo, rugged, tabular, and slabby unit. Crops outs as bright-cliff- and dark-slope-forming materials on the equator-facing slopes of Olympia Cavi. Forms intricate, swirled patterns of light and dark tabular benches on deep cavi floors. Represents the lowest stratigraphic unit within the quadrangle. Spatially associated with Olympia Undae unit. Forms narrow benches and scarps along Olympia Rupēs. Extensively buried by patchy outcrops of the Olympia Cavi 2 unit south of Olympia Rupēs. Hundreds of meters in maximum thickness. *Type locality*: lat 84.3° N., long 158.7° E. *Interpretation*: Early to Late Amazonian sand and dust layered with (and internally bound by) ices. Tabular nature represents alternating accumulations of dusty ice and sand (Herkenhoff and others, 2007; Byrne, 2009). Erosion provided sediment for transport and redeposition within overlying units. Lower contact temporally unconstrained. Upper contact represents period of erosion of indeterminate length. Represents eroded paleosurface upon which other mapped units were deposited. Lowermost strata may be partly equivalent to Planum Boreum rupēs unit mapped by Tanaka and Fortezzo (2012)

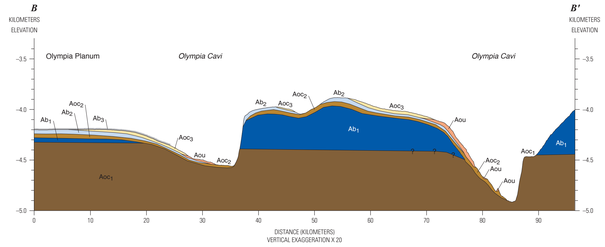
EXPLANATION OF MAP SYMBOLS

- **Contact**—Dashed where approximate
- **Ridge crest**—May represent extent and trend of multiple parallel ridges. Size of symbol may vary
- **Berm**
- **Unconformity**—Solid where angular truncations are observed; dotted where inferred parallel to local bedding
- **Swales**—Axis of topographic undulation; solid where bounded by slopes >2°; dashed where bounded by slopes between 1 and 2°; slopes <1° not mapped
- **Scarp crest**—Dashed where subdued or buried; hachures point downslope
- **Circular scarp or knob**
- **Depression**—Hachures point downslope
- **Sediment transport direction**—Determined from duneform shape
- **Craterform**

SCHEMATIC CROSS SECTIONS

[Not to map scale. Thickness of surficial units exaggerated for clarity; unit Ab$_3$ represented as thick gray line at surface]





For sale by U.S. Geological Survey, Information Services, Box 25286, Federal Center, Denver, CO 80225, 1–888–ASK–USGS

Digital files available at http://pubs.usgs.gov/sim/3197

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