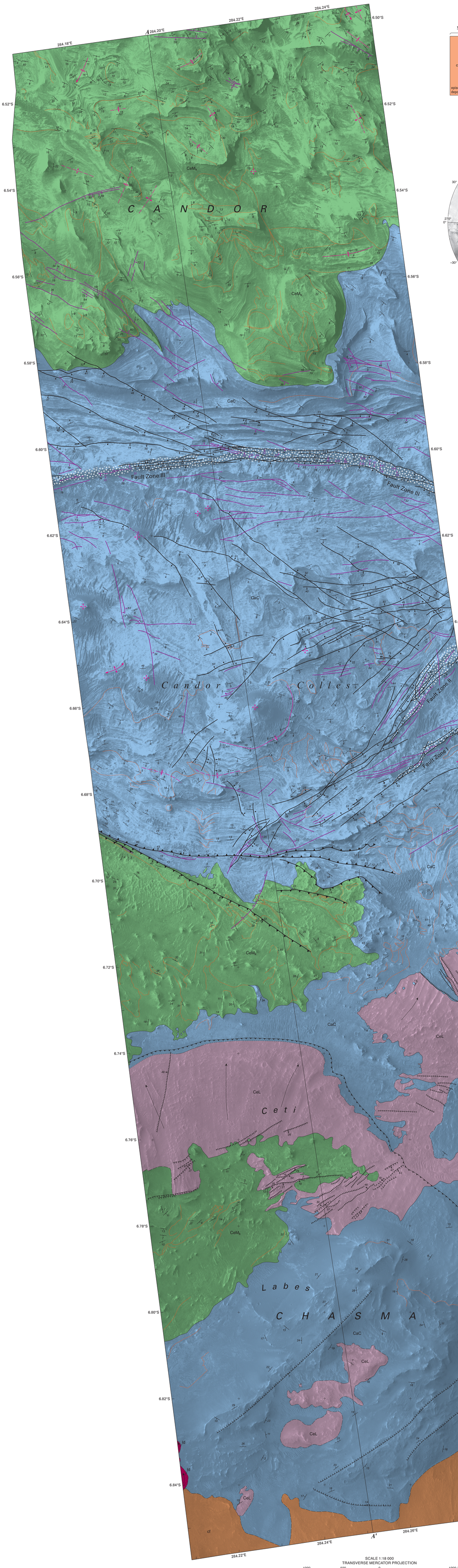
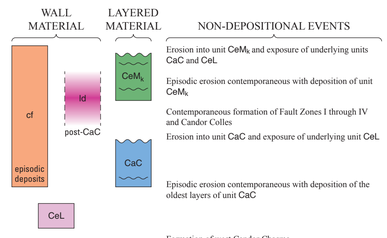
U.S. Department of the Interior
U.S. Geological Survey

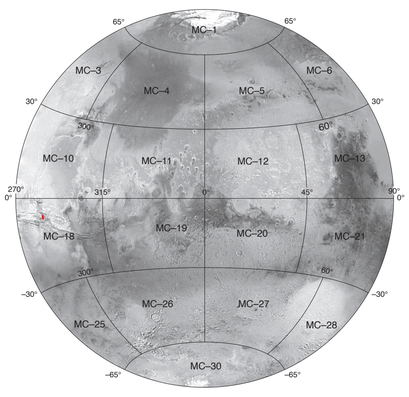
Prepared for the
National Aeronautics and Space Administration

Scientific Investigations Map 3309
Pamphlet accompanies map



CORRELATION OF MAP UNITS AND NON-DEPOSITIONAL EVENTS





MAP LOCATION
Photomosaic showing location of map area (in red). An outline of 1:5,000,000-scale quadrangles is provided for reference.

DESCRIPTION OF MAP UNITS

Unit Label	Unit Name and Definition	Additional Characteristics	Interpretation
	WALL MATERIAL		
cf	**Chasma foothill unit**—Forms smooth-lying material with occasional meter-scale boulders. Unit has low albedo	Covers lower slopes of south wall of west Candor Chasma	Colluvium and other sediments derived from southern wall of west Candor Chasma
Id	**Lobate deposit unit**—Forms small deposit with lobate margins. Contains ridged material with occasional meter-scale boulders. Buries unit CeL, coeval with unit cf. Unit has low albedo	Occurs in single deposit in southwest part of map area. Entire deposit sinuous in map view in CTX data	Debris flow deposit originating from south wall of Candor Chasma. Age unconstrained other than being younger than Candor Colles unit (CaC)
CeL	**Ceti Labes unit**—Forms low, broad hills covered by parallel ridges and grooves; includes hummocky terrain adjacent to south wall of west Candor Chasma. Makes up Ceti Labes. Layering not apparent. Oldest unit in map area. Unit has low albedo	Top of unit defined by prominent unconformity in some places; unconformity buried or partially obscured elsewhere; entire thickness of unit not exposed within map area. Scattered ~10- to 100-m-diameter mounds of moderate albedo material on surface	One or more landslides from southern wall of west Candor Chasma; hummocky terrain in southern part of unit represents landslide head region. Low, broad hills in northern part of unit reflects landslide toes; indicates that local floor of chasma at time of landsliding at similar elevation as present-day
	LAYERED MATERIAL		
CeMk	**Ceti Mensa knobby unit**—Forms irregularly shaped knobs. Layer surfaces appear even to curved and parallel; numerous unconformities. Occurs at elevations above approximately -100 m. Buries units CaC and CeL. Unit has moderate albedo	Unit traceable westward toward summit of Ceti Mensa. Entire thickness of unit not exposed within map area; only lowermost ~1 km section of unit exposed. Layers discontinuous owing to numerous unconformities. Unit drapes underlying topography and, where thin, may mimic meter-scale patterns, or ghost patterns, of underlying topography. Equivalent to youngest layers in structural maps of Okubo and others (2008) and Okubo (2010). Composed of hydrated sulfates (Murchie and others, 2009a).	Layered sediments formed through regional deposition and mantling of pre-existing topography, accompanied by episodic erosion and renewed deposition. Early deposition preserved primary landslide textures of underlying unit CeL, implying low energy environment.
CaC	**Candor Colles unit**—Forms stair-stepped morphology where layers exist in upper section of unit; forms broad slopes in lower sections. Consists of low, conical hills and semi-circular mesas of Candor Colles. Layer surfaces appear even to curved and parallel; numerous unconformities in lower sections. Occurs at elevations between ~720 m and –300 m. Buries unit CeL. Unit has moderate albedo	Top and bottom of unit defined by prominent unconformities. Unit ~1 km thick within map area. Uppermost ~650 m of unit has continuous layers traceable over multiple kilometers; stratigraphically lower layers discontinuous owing to numerous unconformities. Contains numerous fault and fracture traces, and linear ridges >1 km in length; ridges unconformably overlain by unit CeMk outside of map area (observed in adjacent HiRISE data). Local contorted bedding present throughout. Most hills of Candor Colles cored by massive material. Unit drapes underlying topography and, where thin, may mimic meter-scale patterns of underlying topography. Equivalent to oldest layers in structural maps of Okubo and others (2008) and Okubo (2010). Composed of hydrated sulfates (Murchie and others, 2009a).	Layered sediments formed through regional deposition and mantling of pre-existing topography, accompanied by episodic erosion and renewed deposition. Erosion negligible during formation of youngest layers. Early deposition preserved primary landslide textures of underlying unit CeL, implying low energy environment. Kilometer-scale ridges consist of fault-related damage zones. Candor Colles reflect erosional remnants of injectite megapipes; together with contorted bedding indicates soft-sediment deformation induced by seismicity; indicates water saturated and non-indurated state of sediments during seismicity. Numerous faults within unit represent potential seismic sources

EXPLANATION OF MAP SYMBOLS

Contact—Unconformity that bounds an allostratigraphic unit. Dashed where approximately located; dotted where concealed

Internal unconformable contact—Disconformity, paraconformity or angular unconformity located within an allostratigraphic unit. Long-dashed where approximately located; short-dashed where inferred; dotted where concealed

Faults

Normal fault—Showing dip. Ball and bar on downthrown block

Thrust fault—Showing dip. Sawteeth on upper (tectonically higher) plate

Fault—Breccia zone or zone of broken rock around fault

Fracture—Showing dip. Long-dashed where approximately located; short-dashed where inferred; dotted where concealed. Queried where identity or existence questionable

Unmapped fracture dip —Fractures too dense to show at map scale

Folds—Dashed where approximately located

Anticline—Identity and existence certain

Doubly plunging anticline

Syncline

Plunging syncline—Showing direction of plunge

Small, minor dome

Landslide Features

Head or main scarp—Inactive, subdued, indistinct, and (or) approximately located. Hachures point downscarp

Internal or minor scarp (distinct)—Showing dip. Inactive, sharp, and accurately located. Hachures point down scarp

Internal or minor scarp (indistinct)—Showing dip. Inactive, subdued, and approximately located. Hachures point down scarp

Main toe—Inactive, subdued, indistinct, and (or) approximately located. Sawteeth on overiding block

Tension crack or fracture

Direction of downslope movement

Inclined bedding—Showing strike and dip

Unconformity orientations—Showing strike and dip

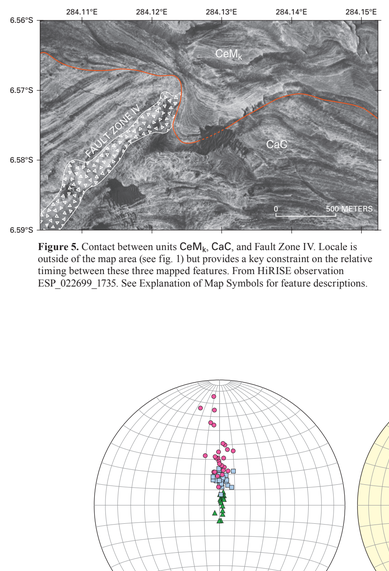


Figure 5. Contact between units CeMk, CaC, and Fault Zone IV. Locale is outside of the map area (see fig. 1) but provides a key constraint on the relative timing between these three mapped features. From HiRISE observation ESP_022699_1735. See Explanation of Map Symbols for feature descriptions.

Figure 1. Location of the map area and other geographic features in west Candor Chasma. Thumbnails of HiRISE images and footprints of CTX data used during mapping also shown. All HiRISE and CTX data are stereopairs, designated H1–H7 and X1–X4, respectively. Observation IDs for these stereopairs are listed in tables 1 and 2 (in pamphlet). The map area of this publication corresponds to stereopair H1 and lies within the MTM–05072 quadrangle. The Candor Colles are located within the shaded area as indicated. Base map is colorized Mars Orbiter Laser Altimeter elevation data overlaid with THEMIS daytime visible imagery.

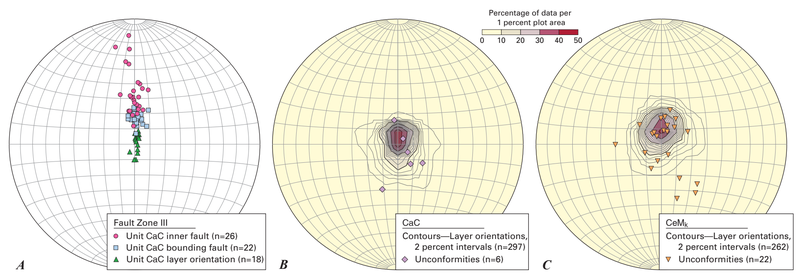


Figure 3. Stereonet plots showing layer and fault orientations within map area. All stereonets are in identical lower hemisphere, equal area projections. *A*, Poles to faults within fault zone III, as well as poles to bedding in surrounding unit CaC as much as 0.5 km from the fault zone. *B*, Contours of poles to layer orientations from unit CaC overlaid with poles to unconformities from the same unit. *C*, Contours of poles to layer orientations from unit CeMk overlaid with poles to individual unconformities with measurable orientations from the same unit.

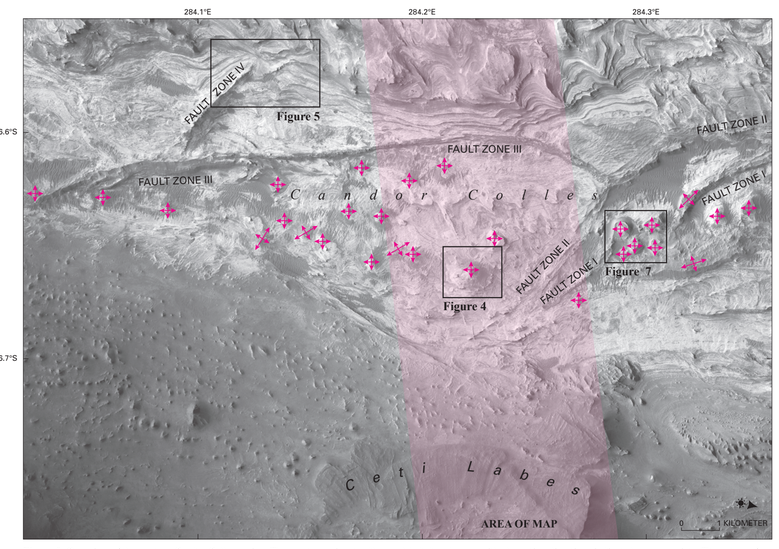


Figure 2. Overview of the western Candor Colles region. The most prominent colles are labeled as domes, with elongation directions indicated as appropriate. The extent of the map area in this region is shaded in pink – the map extends to the north and south of this figure. The location of fault zone IV and figure 5 relative to the map area is shown, as are the locations of figures 4 and 7. See Explanation of Map Symbols for feature descriptions.

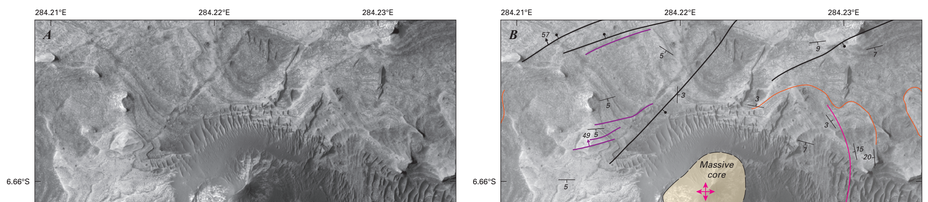


Figure 4. Image data (*A*) and mapped structure and topographic contours (*B*) of an isolated collis within the map area. The core of this colles is indicated in tan. The cores of many colles exhibit no clear bedding, breccia or other structure. Many of the surface textures of these core rocks appear to be erosional features in the full-resolution HiRISE data. See Explanation of Map Symbols for feature descriptions.

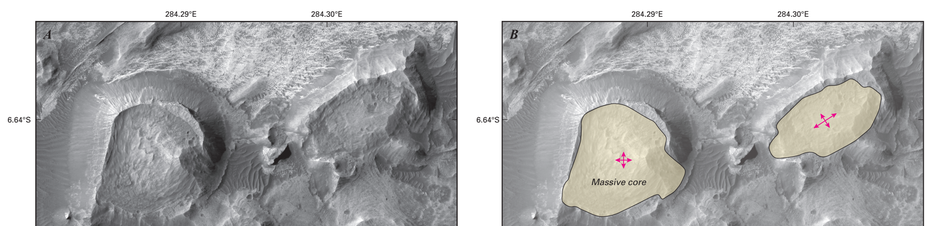


Figure 7. Image data (*A*) and annotated features (*B*) of a group of colles along Fault Zone I. While most colles exhibit a core of massive rock, some appear as domes of contorted layers, as shown by the collis in the lower left corner of this image. See Explanation of Map Symbols for feature descriptions.

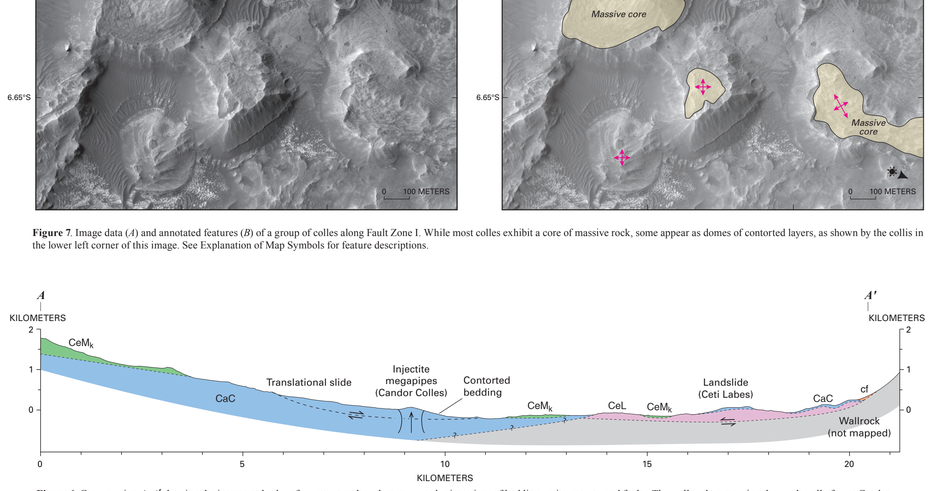


Figure 6. Cross section *A*–*A′* showing the interpreted subsurface structure based on measured orientations of bedding, unit contacts, and faults. The wall rock composing the south wall of west Candor Chasma crops out just outside of the map area and was not mapped. The wall rock is included here to show its location relative to cross section *A*–*A′*. No vertical exaggeration.

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

SCALE 1:18 000
TRANSVERSE MERCATOR PROJECTION
1000 500 0 1000 METERS
Planetocentric latitude and east longitude coordinate system

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Bedrock Geologic and Structural Map Through the Western Candor Colles Region of Mars

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