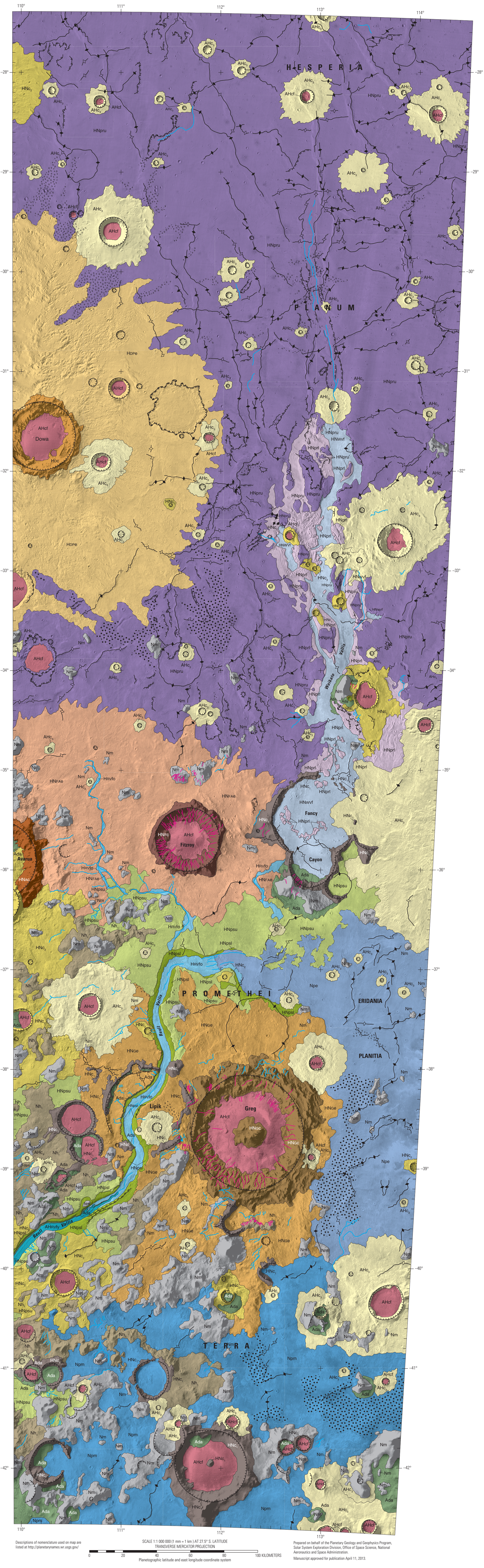

Descriptions of nomenclature used on map are listed at http://planetarynames.wr.usgs.gov/

SCALE 1:1 000 000 (1 mm = 1 km) AT 27.5° S. LATITUDE
TRANSVERSE MERCATOR PROJECTION
0 20 40 60 80 100 KILOMETERS
Planetographic latitude and east longitude coordinate system

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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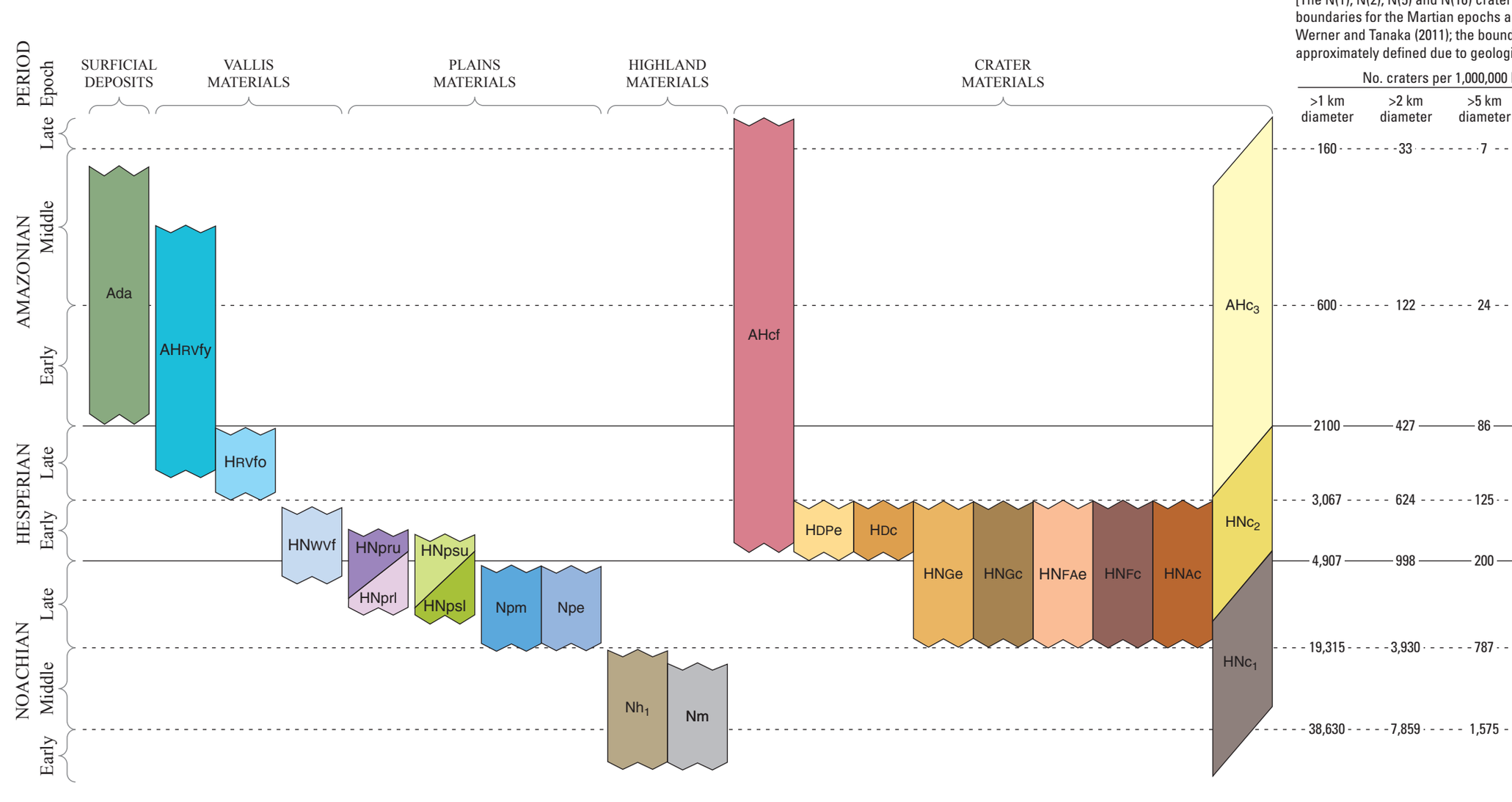
CORRELATION OF MAP UNITS

[Correlation based upon crater size-frequency distribution statistics (see table 1; Tanaka, 1986; Werner and Tanaka, 2011) and geologic relation (superposition, embayment, cross-cutting; see table 2)]



DESCRIPTION OF MAP UNITS

Unit label	Unit name and description	Location and type areas	Interpretation
	SURFICIAL DEPOSITS		
Ada	**Debris apron material**—Massif-associated features have uniform or mottled albedo and lobate frontal morphologies and appear composed of multiple coalescing lobes. Crater-associated features are relatively small and display mottled albedo, featureless surfaces, and arcuate to lobate fronts. In high-resolution images, deposits show pits and lineations; lineations consist of ridge-and-furrow features and elongated pits	Borders highland massifs, crater rims, and vallis walls. *Type areas:* lat 39.9° S., long 110.3° E. (massif); lat 38.8° S., long 110.7° E. (crater)	Deposits of unconsolidated material resulting from mass wasting of rugged highland massifs, crater rims, and vallis walls; mobility due to incorporation of water or ice or massive internal ice; pits may be from collapse of volatile-rich debris; elongated pits and lineations may indicate sorting of material within the flow or shearing of debris as it flowed
	VALLIS MATERIALS		
AHRvfy	**Younger Reull Vallis floor material**—Displays lineations and chains of elongated pits parallel to canyon walls	Forms floor of lower part of upper segment of Reull Vallis (formerly termed Segment 2 of Reull Vallis by Mest and Crown, 2001). *Type area:* lat 39.6° S., long 110.4° E.	Sedimentary material, eroded from surrounding plains materials and highland terrains, also consists of materials emplaced on canyon floor by mass wasting and (or) ice-rich flow. Lineations produced by differential shear of volatile- or ice-rich sediments as mass moved cross- and down-canyon
HRvfo	**Older Reull Vallis floor material**—Smooth deposits incised with narrow sinuous channels and low-relief scarps parallel to canyon walls; some channels braided; some channels converge at a narrow (1- to 2-km-wide) canyon downcutting into main canyon of Reull Vallis	Forms floors of canyons incised within Fitzroy/Avarua ejecta and upper part of upper segment of Reull Vallis (formerly termed Segment 2 of Reull Vallis by Mest and Crown, 2001). *Type area:* lat 38.5° S., long 111.4° E.	Sedimentary material eroded from surrounding ejecta, highlands, and plains materials and emplaced by fluvial processes
HNwvf	**Waikato Vallis floor material**—Smooth and mottled in low-resolution images; in high-resolution images, unit displays knobby and pitted texture	Forms floor of Waikato Vallis. *Type area:* lat 33.1° S., long 113.6° E.	Sedimentary material from surrounding ridged plains materials emplaced by a combination of collapse and fluvial processes. Texture likely produced by small-scale deflation and fluvial redistribution; pits may result from partial collapse of volatile-rich material
	PLAINS MATERIALS		
HNpru	**Ridged plains material, upper member**—Appears mottled at all resolutions with large areas of low and high albedo surfaces. Most inter-ridge areas have relatively smooth and featureless surfaces except for presence of low-relief scarps and small sinuous channels. High-resolution images show inter-ridge areas contain dune features, accumulations of smooth materials in low areas, and small knobs adjacent to some ridges. Parts of deposit, especially near Waikato Vallis, contain numerous sinuous and in some cases braided channels, scarp-bounded mesas, and long (hundreds of kilometers) arcuate scarps. Contains a high density of wrinkle ridges that form rings and linear features that display two dominant trends—northwest-southeast and northeast-southwest. Ridges display pristine and degraded morphologies	Found in northern part of map area. *Type areas:* lat 28.8° S., long 112.8° E. (north); lat 33.4° S., long 112.2° E. (south)	Previously interpreted as flood lavas, although no obvious flow fronts are visible. Likely sedimentary and (or) volcanic material modified by fluvial and eolian processes. Albedo variations and mottling due to emplacement of remobilized sediments and (or) volcanic materials (with no recognizable source vent) or erosion of overlying plains. Sinuous channels, scarps and scarp-bounded mesas fluvial in nature. Wrinkle ridges are mare-type features formed by contraction and faulting of plains materials; eroded and buried ridges exposed on floor and along margin of Waikato Vallis
HNprl	**Ridged plains material, lower member**—Displays smooth, mottled (in some places) surfaces that occur topographically lower than adjacent ridged plains material (upper member). Forms clusters of irregularly shaped, flat-topped polygons and knobs along and within Waikato Vallis. Some exposures contain fluvial channels	Forms boundary along much of canyon of Waikato Vallis and occurs as inliers within Waikato Vallis. *Type areas:* lat 32.0° S., long 113.3° E. (smooth); lat 32.5° S., long 113.4° E. (chaos)	Sedimentary and (or) volcanic material, likely ridged plains material, modified by collapse and fluvial erosion. Mottling caused by mantling of eolian and (or) fluvial sediments and (or) erosion of plains materials. Chaotic areas formed by collapse of plains materials
HNpsu	**Smooth plains material, upper member**—Displays smooth surfaces in low-resolution images; in high-resolution images, unit displays low-relief scarps, low-relief ridges, small channels, and shallow pits. Smooth plains material (upper member) fills low-lying areas and embays highland massifs	Forms exposures primarily adjacent to upper segment of Reull Vallis; some exposures occur among highland materials. *Type area:* lat 36.5° S., long 112.7° E.	Consists of sediments deposited (1) within transient body of water, (2) by erosion of adjacent highlands and deposited via valley networks, and (or) (3) via mass wasting. Low-relief scarps and channels likely fluvial in nature. Pits suggest sublimation and collapse of volatile-rich material
HNpsl	**Smooth plains material, lower member**—Generally smooth and relatively featureless and displays lower albedo than overlying upper member; contains few craters, and some exposures display layering	Forms lower wall/lower terraces along upper segment of Reull Vallis and is stratigraphically lower than upper member of smooth plains. *Type area:* lat 38.9° S., long 111.4° E.	Consists of sediments deposited (1) within a transient body of water, (2) by erosion of adjacent highlands and deposited via valley networks, and (or) (3) via mass wasting. Exposed by formation of Reull Vallis canyon
Npm	**Mottled plains material**—Displays mottled albedo and smooth, knobby, and pitted textures. Some areas (adjacent to highland terrains) dissected by narrow channels. Plains in southeastern part of map area display knobby texture with small (tens of meters in diameter) knobs surrounded by relatively smooth plains	Fills low-lying areas around highland massifs and degraded craters. *Type areas:* lat 40.8° S., long 113.5° E. (smooth); lat 41.4° S., long 114.4° E. (knobby); lat 40.9° S., long 112.6° E. (pitted)	Variety of textures suggests mottled plains material likely consists of sediments modified by different processes (fluvial, eolian, impacts) and (or) derived from different sources including (1) eroded from adjacent highland terrains, (2) deposited via mass wasting, (3) deposited by eolian processes, possibly related to regional mantling unit, and (4) ejected from nearby large (>20 km in diameter) degraded impact craters. Knobby texture may consist of remnants of distal ejecta deposit of 43-km-diameter degraded impact crater located ~47 km to southwest. Pitted areas due to collapse/modification of volatile-rich sediments
Npe	**Etched plains material**—Surface mottled in low-resolution images; in high-resolution images, mottling due to low albedo materials being eroded to form yardang-like features in some locations and being completely removed in other places to expose underlying higher albedo materials. Knobby texture found in plains east of crater Greg. Degraded wrinkle ridges in northern part of deposit. Braided channels found in southern part of deposit extending from contact with mottled plains material	Forms much of plains of western Eridania Planitia in map area. *Type area:* lat 38.6° S., long 114.8° E.	Sedimentary material emplaced in fluvial or lacustrine environment; some water may have been transported through Waikato Vallis from north and ponded on surface of plains. Deposits appear easily eroded by wind to form yardang-like features and knobs and by runoff to form braided channels. Knobby texture east of crater Greg consistent with eroded ejecta; knobs are remnants of crater Greg ejecta deposit. Wrinkle ridges formed by faulting of plains material
	HIGHLAND MATERIALS		
Nh_1	**Basin-rim unit**—Forms continuous exposures of rugged terrain with expanses of smooth and knobby surfaces. In low-resolution images, highland massifs appear mountainous and rugged. In high-resolution images, surfaces appear rounded. Highland valleys generally found within highland plateau material	Found in southern part of map area. *Type area:* lat 39.8° S., long 111.8° E.	Exposures consist of ancient crustal material uplifted during formation of impact basins (for example, Hellas) and craters subsequently modified by fluvial processes. Rounded nature due to mantling, possibly by eroded sediments and (or) regional mantling deposit
Nm	**Mountainous material**—Consists of rugged, isolated knobs and massifs. In low-resolution images, these massifs appear mountainous and very rugged. In high-resolution images, surfaces appear rounded	Found throughout map area. *Type area:* lat 40.1° S., long 112.0° E.	Contains materials previously mapped as basin rim unit or mountainous material (Greeley and Guest, 1987; Mest and Crown, 2001). Exposures consist of large blocks of ancient crustal material uplifted during formation of impact basins and craters. Rounded nature due to mantling, possibly by eroded sediments and (or) regional mantling deposit; peaks of some of steepest massifs show downslope removal of mantle via mass wasting
	CRATER MATERIALS		
AHcf	**Crater floor material**—Displays pits, arcuate ridges, grooves (concentric to crater walls), and lobate margins along interior crater walls	Found on floors of most craters in map area regardless of preservation state. *Type areas:* lat 38.5° S., long 110.7° E. (pitted); lat 37.4° S., long 110.9° W. (lineated)	Deposits consisting of fluvial, eolian, and (or) mass wasted materials derived from crater rim and wall materials and (or) regional mantling deposit. Pits due to partially collapsed volatile-rich materials. Concentric rings likely due to coalescing materials mobilized downslope from crater rims or reflects erosional pattern. Previously mapped as smooth floor material (Greeley and Guest, 1987)
HDPe	**Ejecta material, Dowa/Pál**—Continuous deposit characterized by smooth areas that transition into pitted and etched surfaces with yardang-like features, which distinguish the deposit from underlying plains	Surrounds impact craters Dowa (diameter, 41.5 km; lat 31.7° S., long 110.3° E.) and Pál (diameter, 78.7 km; lat 31.3° S., long 108.7° E.). Pál impact structure located entirely outside of map area. *Type area:* lat 32.7° S., long 110.7° E.	Consists of ejecta emplaced by impact events of craters Dowa and Pál. Pitted and etched surface likely due to eolian modification of deposit
HDc	**Crater material, Dowa**—Unit exhibits significant relief above surrounding materials, but some areas exhibit minor relief; interior walls exhibit terraces	Forms rim of crater Dowa (diameter, 41.5 km; lat 31.7° S., long 110.3° E.). *Type area:* lat 35.4° S., long 112.2° E.	Materials emplaced during crater Dowa impact event; terraces formed by slumping of crater walls
HNGe	**Ejecta material, Greg**—Exposures characterized by smooth to hummocky surfaces throughout; some areas etched or contain lineations. In high-resolution images, (1) etched appearance west of Reull Vallis formed by yardangs with northwest-southeast orientation (radial to Greg) and (2) lineations in northern deposit oriented radial to Greg. Parts of northern deposit display lobate edges to north. Deposits north and south of Greg dissected by sinuous channels; deposits along Reull Vallis dissected by sinuous channels and box-like canyons that intersect Reull Vallis	Forms deposits located in south-central part of map area that surround crater Greg (diameter, 69.6 km; lat 38.6° S., long 113.0° E.). Deposits separated by ridges of mountainous material and Reull Vallis. *Type area:* lat 37.5° S., long 112.9° E.	Consists of ejecta emplaced by impact event of crater Greg. Yardangs indicate eolian erosion; lineations radial to Greg may be due to internal shear of deposit during emplacement process
HNGc	**Crater material, Greg**—Unit exhibits significant relief above surrounding materials; central peak on floor of Greg exhibits relief above floor materials. Interior walls and rim highly dissected by gullies; walls superposed by viscous flow features. Northern crater wall mantled with deposits that exhibit lobate fronts and southern wall contains alcoves filled with materials exhibiting herringbone texture	Forms rim and central peak of crater Greg (diameter, 69.6 km; lat 38.6° S., long 113.0° E.). *Type area:* lat 39.2° S., long 112.7° E.	Materials emplaced during crater Greg impact event. Materials mantling crater walls believed to be part of volatile-rich regional mantle deposit, portions of which have subsequently moved downslope to form viscous flow features and flows with herringbone texture
HNFAe	**Ejecta material, Fitzroy/Avarua**—Continuous deposit characterized by smooth to irregular surface and lobate edges; dissected by sinuous, braided channels	Surrounds impact craters Fitzroy (diameter, 38.3 km; lat 35.7° S., long 112.0° E.) and Avarua (diameter, 47.4 km; lat 35.9° S., long 109.7° E.). *Type area:* lat 35.7° S., long 111.2° E.	Consists of ejecta emplaced by the impact events of craters Fitzroy and Avarua
HNFc	**Crater material, Fitzroy**—Unit exhibits significant relief above surrounding materials; some areas exhibit minor relief. Interior walls and rim highly dissected by gullies; walls superposed by viscous flow features. Northern crater wall mantled with deposits that exhibit lobate fronts, and southern wall contains alcoves filled with materials exhibiting herringbone texture	Forms rim of crater Fitzroy (diameter, 38.3 km; lat 35.7° S., long 112.0° E.). *Type area:* lat 35.4° S., long 112.2° E.	Materials emplaced during crater Fitzroy impact event. Materials mantling crater walls believed to be part of volatile-rich regional mantle deposit, portions of which have subsequently moved downslope to form viscous flow features and flows with herringbone texture
HNAc	**Crater material, Avarua**—Unit exhibits significant relief above surrounding materials; some areas of the rim exhibit minor relief. Interior walls and rim highly dissected by gullies; walls superposed by viscous flow features. Northern crater wall mantled with deposits that exhibit lobate fronts, and southern wall contains alcoves filled with materials exhibiting herringbone texture	Forms rim of crater Avarua (diameter, 47.4 km; lat 35.9° S., long 109.7° E.). *Type area:* lat 35.7° S., long 110.1° E.	Materials emplaced during crater Avarua impact event. Materials mantling crater walls believed to be part of volatile-rich regional mantle deposit, portions of which have subsequently moved downslope to form viscous flow features and flows with herringbone texture
AHc_3	**Crater material, well-preserved**—Characterized by pronounced, continuous crater rim elevated relative to surrounding materials and by well-defined, continuous ejecta blanket. Ejecta deposits within plains adjacent to Waikato and Reull Vallis. In southern part of map area, displays single or double rampart morphologies	Found throughout map area. *Type area:* lat 35.6° S., long 114.8° E.	Forms crater deposits—including ejecta, rim, and some floor materials—that exhibit little degradation; some crater floors contain deposits emplaced by mass wasting, eolian activity, and (or) fluvial processes
HNc_2	**Crater material, moderately degraded**—Characterized by crater rim that may exhibit only minor relief above surrounding materials and by discontinuous, poorly exposed ejecta	Found throughout map area. *Type area:* lat 36.6° S., long 110.4° E.	Forms crater deposits—including ejecta, rim, and some floor materials—that exhibit moderate degree of degradation; most crater floors contain deposits emplaced by mass wasting, eolian activity, and (or) fluvial processes
HNc_1	**Crater material, highly degraded**—Characterized by degraded crater rim that may be discontinuous and exhibits little relief relative to surrounding materials; displays little to no discernible ejecta materials and smooth, relatively flat crater floors	Found throughout map area. *Type area:* lat 42.4° S., long 112.6° E.	Forms crater deposits—including ejecta, rim, and some floor materials—that exhibit significant degradation. Ejecta and rim materials eroded or mantled by younger materials. Most crater floors contain deposits emplaced by mass wasting, eolian activity, and (or) fluvial processes

EXPLANATION OF MAP SYMBOLS

Secondary craters

Knobby terrain

Contact—Long-dashed where approximately located; short-dashed where inferred. Internal contact defines stratigraphic relations between similar units from different features

Valley with channel morphology

Valley with gully morphology

Ridge with degraded morphology

Ridge with pristine morphology

Topographic rim of impact crater

Topographic scarp—Barbs point downslope

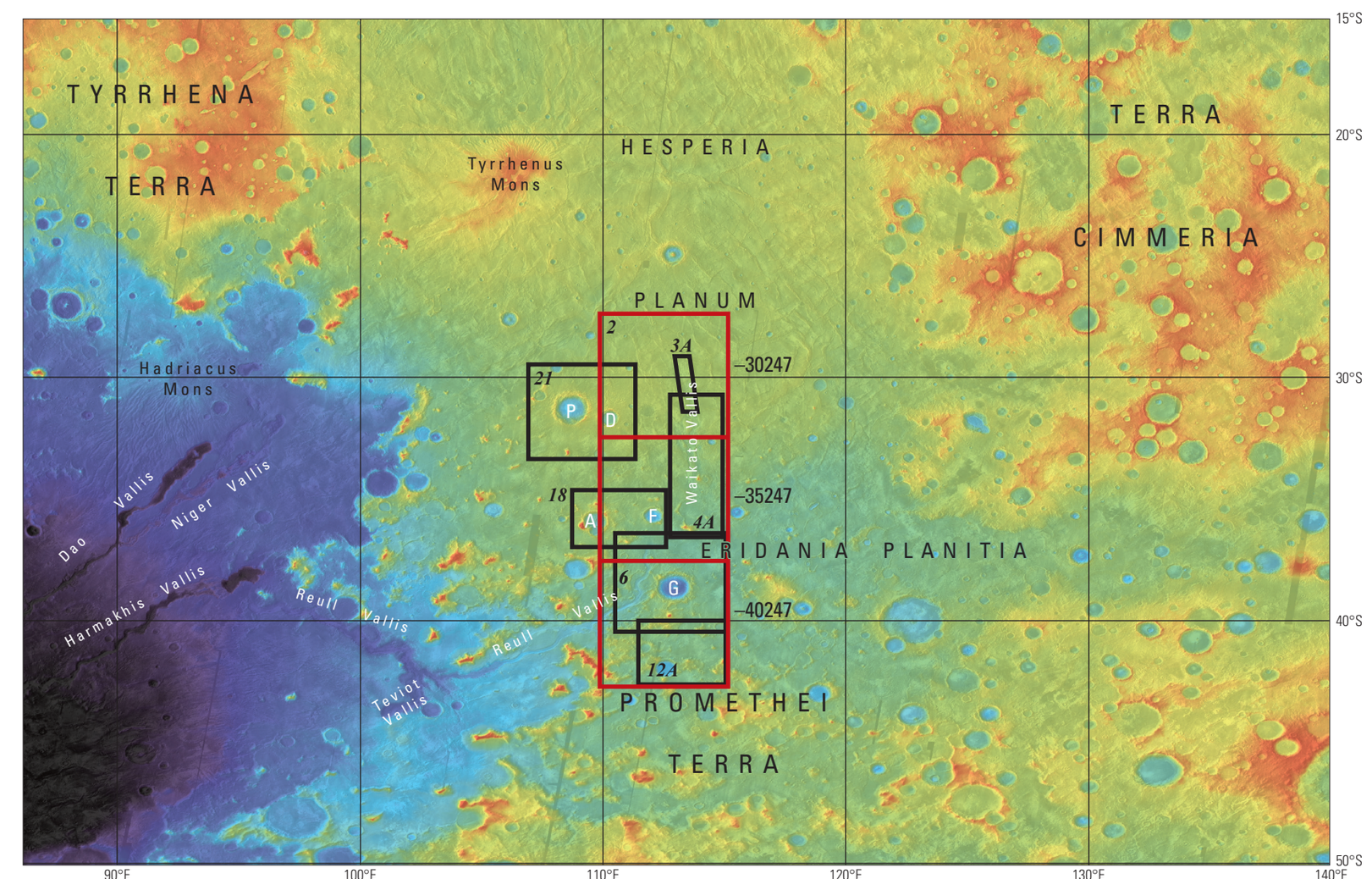
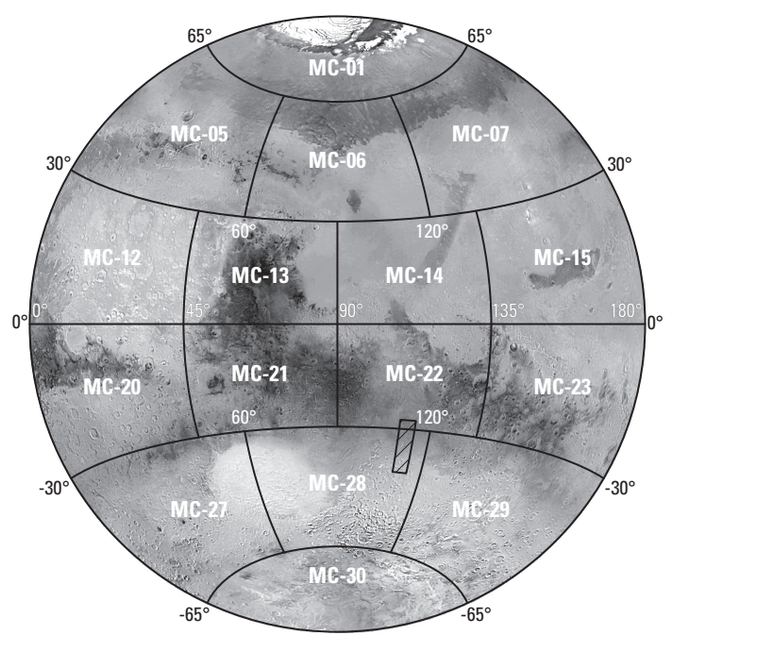


Figure 1. Regional MOLA colorized shaded-relief DEM (resolution, 128 m/pixel) showing physiographic provinces, vallis and mons features, and relevant craters Pál (P), Dowa (D), Avarua (A), Fitzroy (F), and Greg (G), as well as areas of MTM –30247, –35247, and –40247 quadrangles (red boxes) and locations of figures 2, 3*A*, 4*A*, 6, 12*A*, 18, and 21 (black boxes).



QUADRANGLE LOCATION
Photomosaic showing location of map area (hachured).

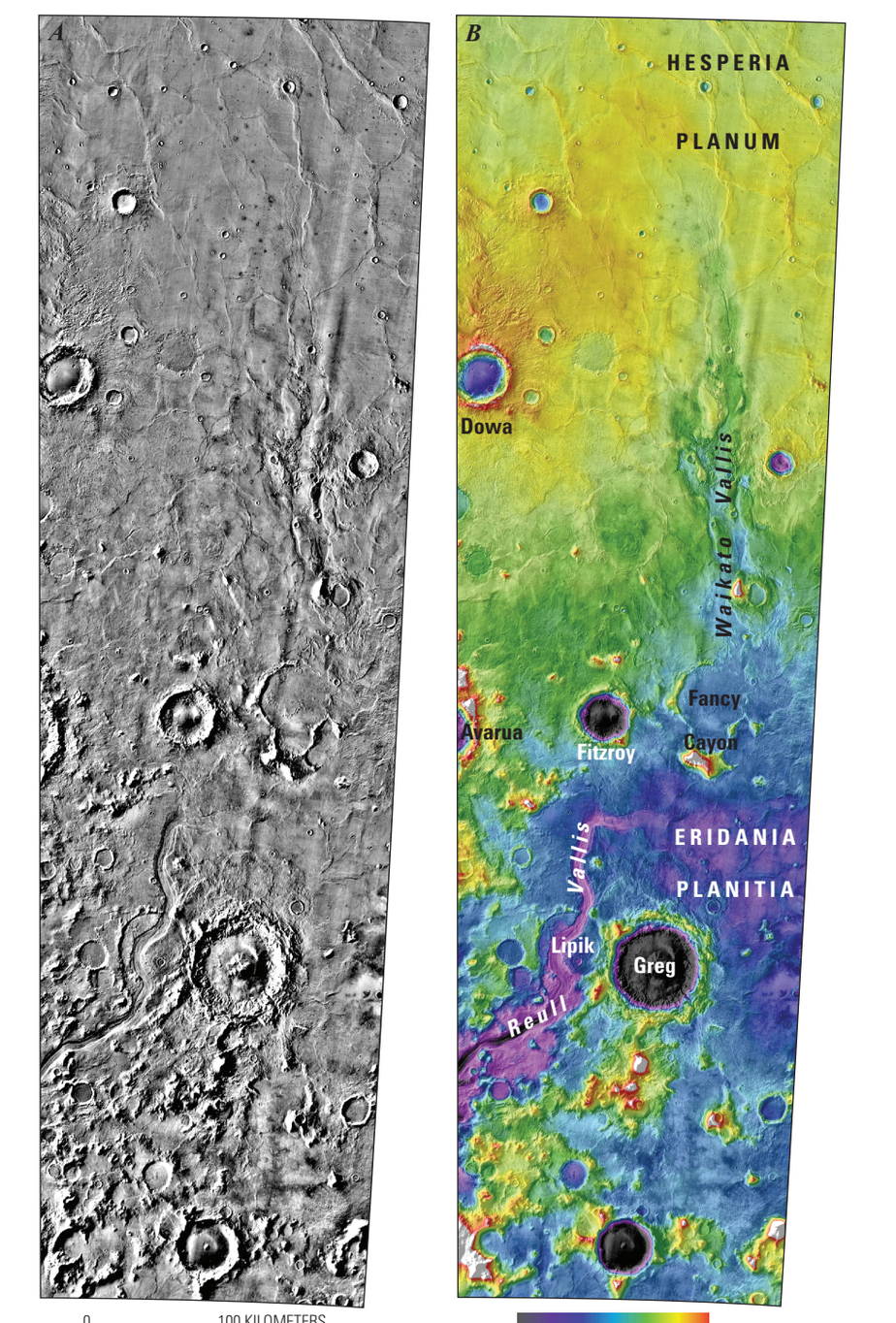


Figure 2. *A,* THEMIS daytime IR mosaic (resolution, 100 m/pixel) and *(B)* MOLA colorized shaded-relief DEM (resolution, 128 m/pixel) of MTM –30247, –35247, and –40247 quadrangles, showing locations of several named features. Note orthogonal sets of wrinkle ridges (northwest-southeast and northeast-southwest), especially prominent in northern part of map area. See figure 1 for regional location.

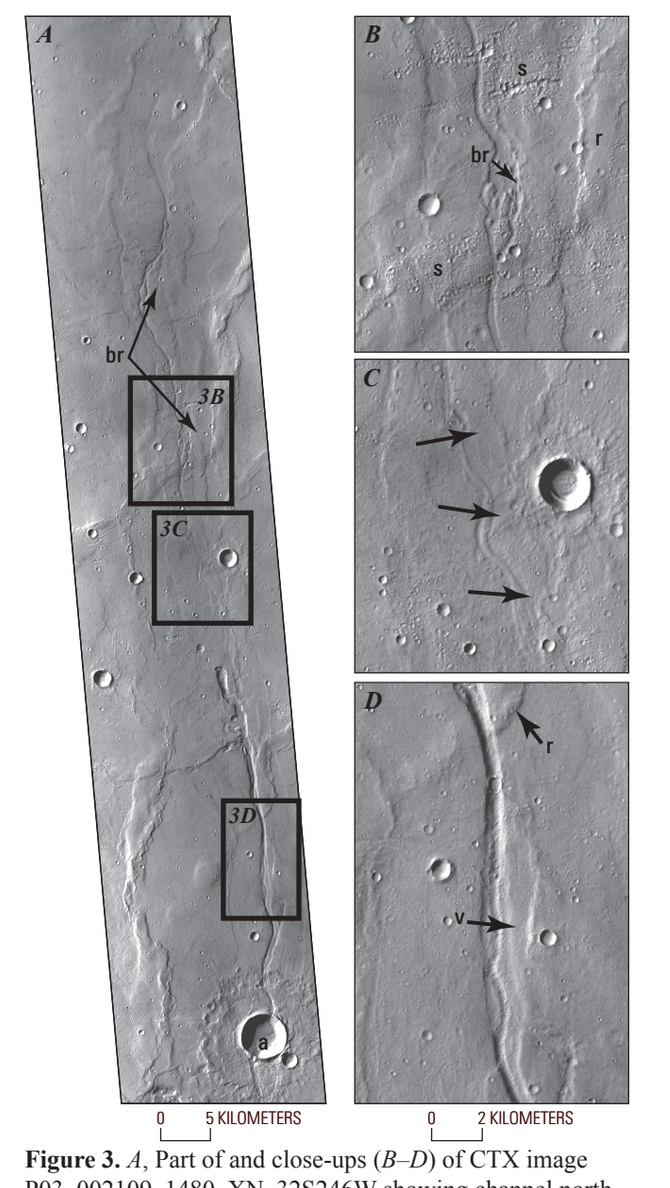


Figure 3. *A,* Part of and close-ups (*B–D*) of CTX image P03_002109_1480_XN_32S246W showing channel north of Waikato Vallis incised in ridged plains of Hesperia Planum. This channel breaches crater a (diameter, 5.5 km) near bottom of image and intersects Waikato Vallis just south of this crater. Northern part of the channel is narrow and sections are braided (br). Southern part is wider, starts at a theater-headed alcove, and contains an interior valley (v). Northern and southern channels are separated by plains materials, but northern channel appears to terminate as a positive relief feature (arrows) in the plains in 3*C*. Wrinkle ridges (r in *B, D*) are dissected, suggesting that channel formation post-dates ridge formation. Secondary crater fields (s in 3*B*), likely emplaced by Dowa and (or) Pál impact events to the west, superpose channel and ridges, indicating one or both impacts post-date channel and ridge formation. See figure 1 for location. Image resolution is 5.08 m/pixel; 3*A* centered at lat 30.4° S., long 113.5° E.

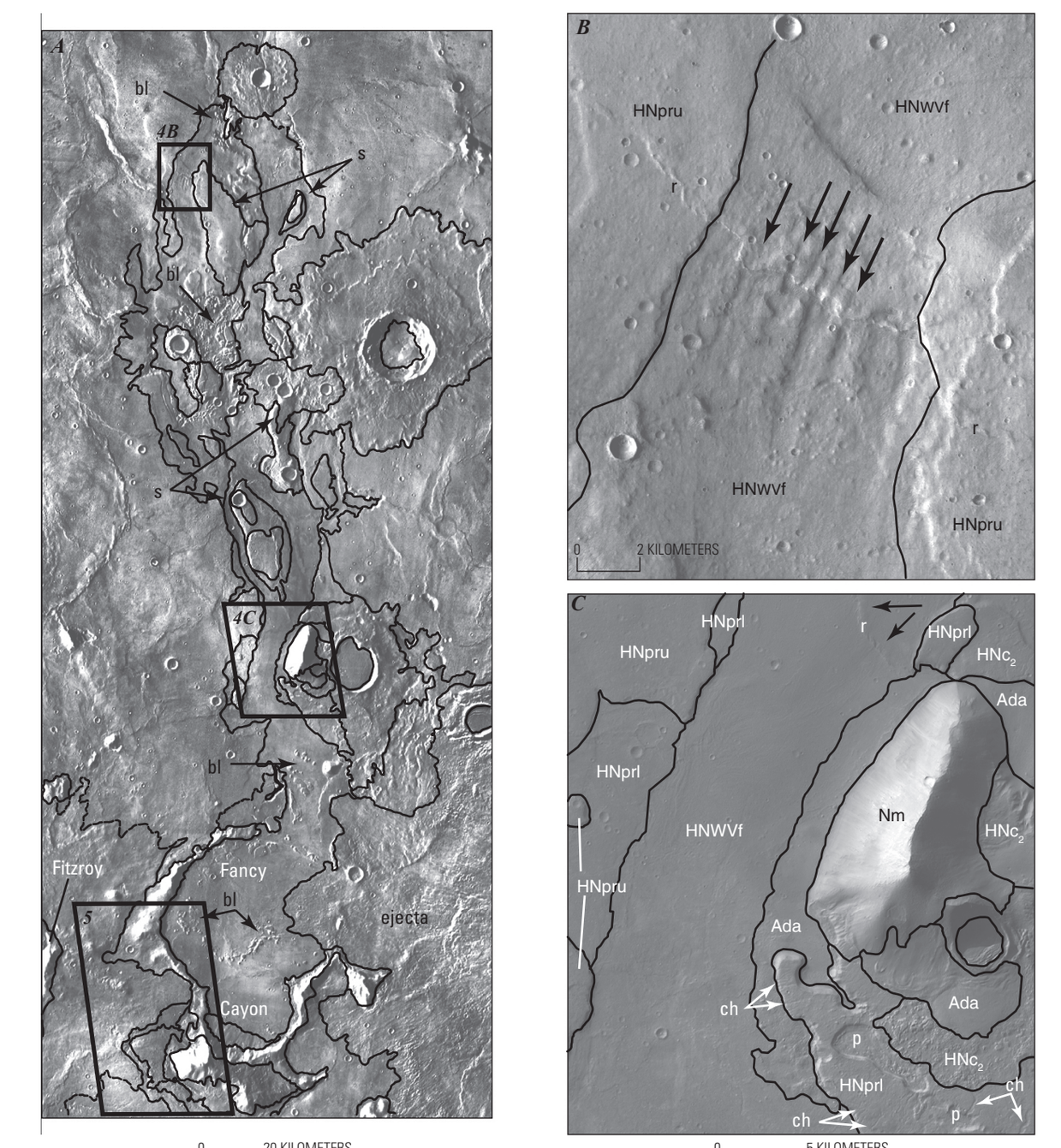


Figure 4. *A,* THEMIS daytime IR mosaic of Waikato Vallis incised in the ridged plains of Hesperia Planum. Canyon contains remnants of ridged plains material (lower member) exposed as chaotic clusters of blocks (bl), suggesting collapse of plains materials as volatiles were released, and streamlined features (s), suggesting surface flow down canyon to its terminus in craters Fancy and Cayon. Ejecta from crater Fitzroy (west of image) and a 34-km-diameter crater (east of image), labeled ejecta, obscures the terminus of Waikato Vallis and its transition to Eridania Planitia to the south. Location of figure 5 is shown. See figure 1 for regional location. Image resolution is 100 m/pixel; centered at lat 33.8° S., long 113.8° E. *B,* Close-up of floor of Waikato Vallis (HNwvf) in CTX image P06_003454_1467_XI_33S246W showing scours (arrows) that dissect a wrinkle ridge (r) within ridged plains material, upper member (HNpru), that crosses the canyon. Image resolution is 5.22 m/pixel; centered at lat 31.8° S., long 113.2° E. *C,* Part of CTX image B03_010640_1449_XN_35S246W showing a close-up of Waikato Vallis incised within ridged plains material, lower (HNprl) and upper (HNpru) members. Here, Waikato Vallis floor materials (HNwvf) contain numerous small craters, scarps, and channels. Wrinkle ridges (r) cross the canyon in some places and are incised with notches or scours (black arrows); canyon floor displays channels on downstream side of these ridges. Elongated pits (p) in adjacent plains and ejecta materials (HNc_2) suggest that collapse of volatile-rich materials are partly involved in formation of Waikato Vallis, whereas small channels (ch) observed here and elsewhere along Waikato Vallis indicate water also contributed to the canyon via surface flow. Lobate debris aprons (Ada) suggest mass wasting of volatile-rich material from highland massifs, such as mountainous material (Nm), or along the bank of Waikato Vallis. Image resolution is 5.05 m/pixel; centered at lat 34.2° S., long 113.8° E.

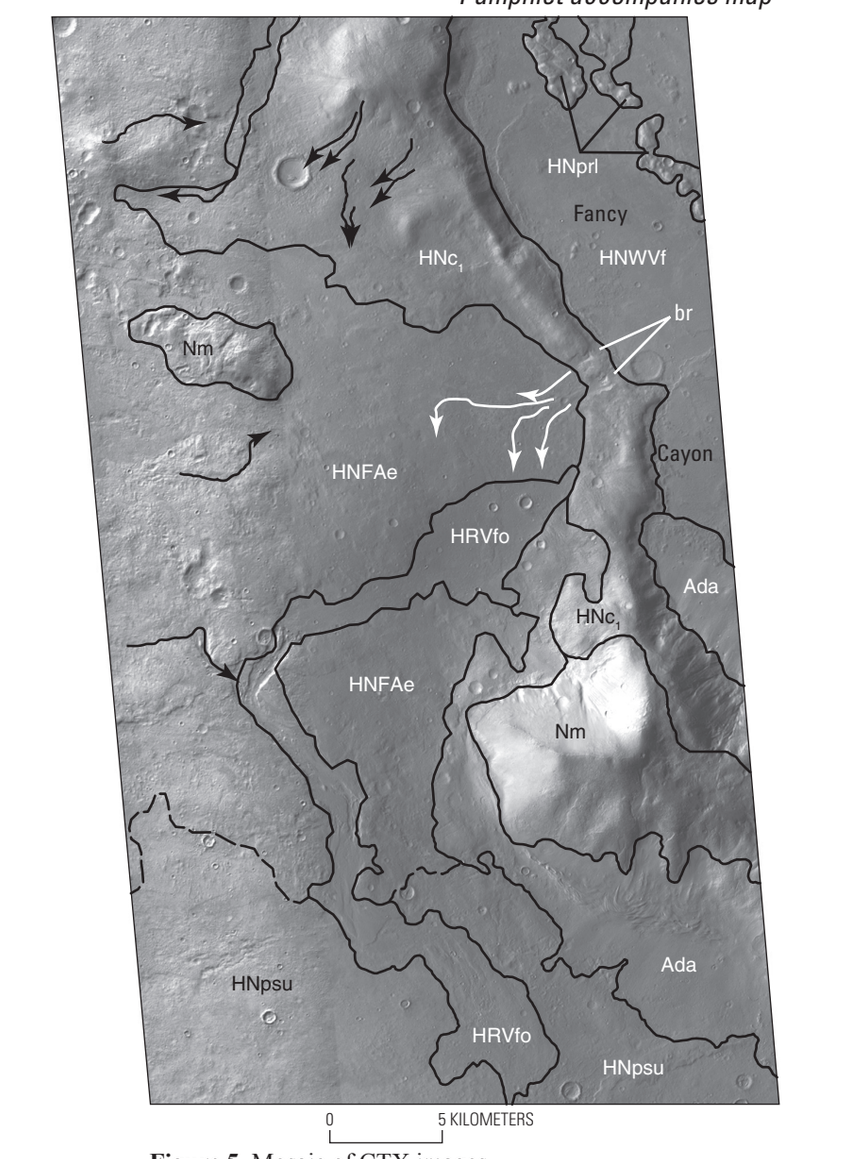


Figure 5. Mosaic of CTX images P17_007713_1442_XN_35S247W (left; resolution, 5.09 m/pixel) and P04_002531_1438_XN_36S246W (right; resolution, 5.08 m/pixel) located within central part of map area. Upper right corner shows western part of Waikato Vallis terminating within craters Fancy and Cayon (see figure 4*A* for location) (HNc_1) and peaks of mountainous material (Nm); Waikato Vallis floor material (HNwvf) in this location surrounds blocks of ridged plains material, lower member (HNprl). Gaps in the rim of Fancy suggest water may have breached the rim (br) and eroded the adjacent Fitzroy/Avarua ejecta deposit (HNFAe), becoming channelized (white arrows) in the center of this image; channel is filled with older Reull Vallis floor material (HRvfo). Several smaller valleys (black arrows) dissect the rim of Fancy and Fitzroy/Avarua ejecta, indicating surface flow apparently unrelated to Waikato Vallis. See figure 4*A* for location. Image centered at lat 35.9° S., long 113.1° E.

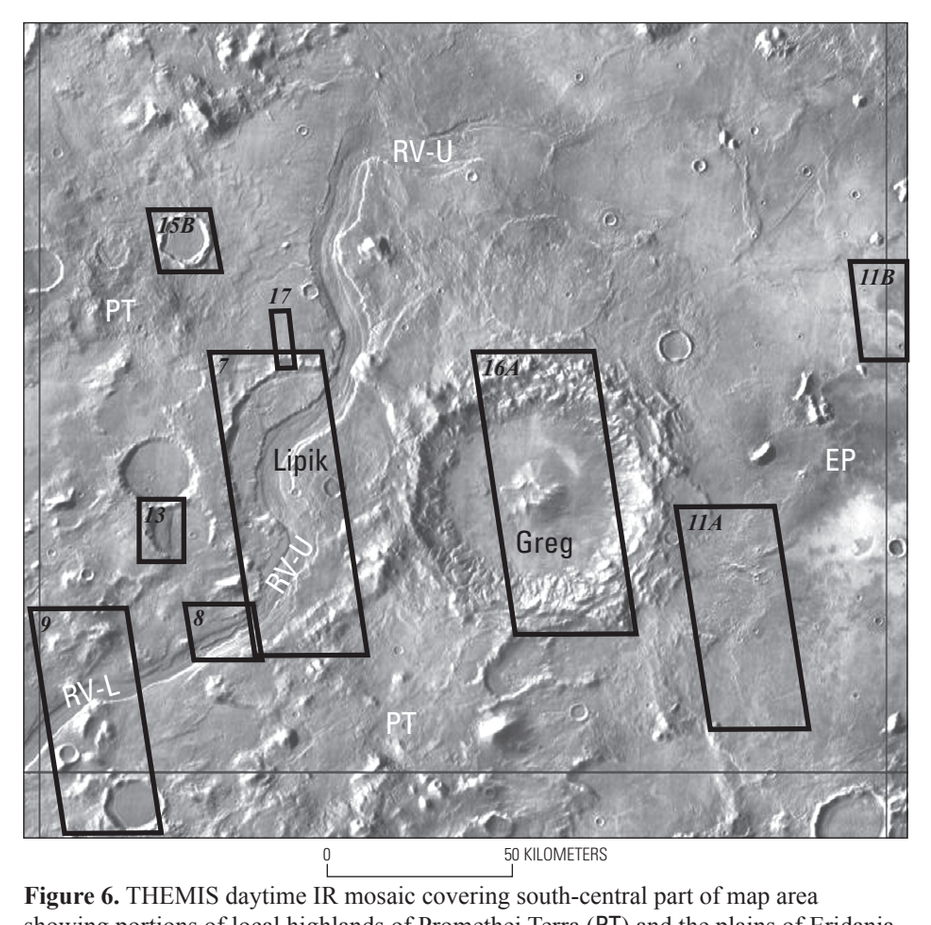


Figure 6. THEMIS daytime IR mosaic covering south-central part of map area showing portions of local highlands of Promethei Terra (PT) and the plains of Eridania Planitia (EP), crater Greg, upper segment of Reull Vallis (RV-U) where it heads within the plains, and transition to lower part of upper segment (RV-L). Locations of figures 7, 8, 9, 11*A*, 11*B*, 13, 15*B*, 16*A*, and 17 are shown. See figure 1 for location. Image resolution is 100 m/pixel; centered at lat 38.3° S., long 112.6° E.

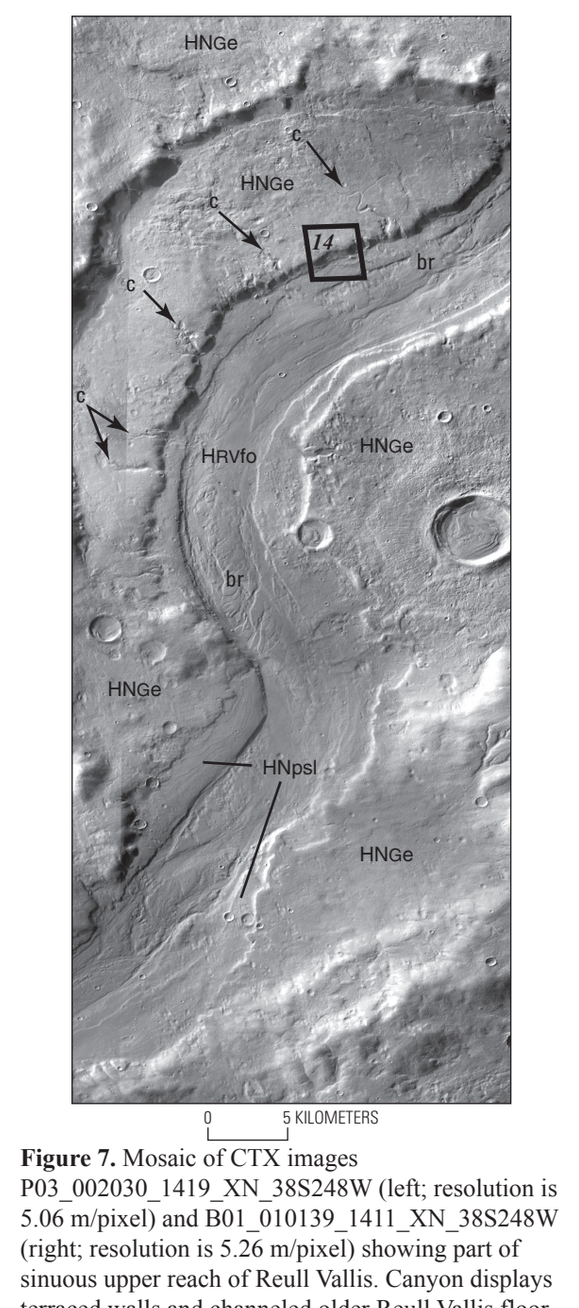


Figure 7. Mosaic of CTX images P03_002030_1419_XN_38S248W (left; resolution is 5.06 m/pixel) and B01_010139_1411_XN_38S248W (right; resolution is 5.26 m/pixel) showing part of sinuous upper reach of Reull Vallis. Canyon displays terraced walls and channeled older Reull Vallis floor material (HRvfo); some channels are braided. Reull Vallis dissects Greg ejecta material (HNGe) and underlying smooth plains material, lower member (HNpsl). Several short theater-headed canyons (c) dissect HNGe and intersect Reull Vallis. These tributary canyons are found incised only within Greg ejecta and primarily along the northern and western wall of Reull Vallis, suggesting they may represent dewatering of volatile-rich Greg ejecta following its emplacement and (or) result from erosion of unconsolidated ejecta deposits. Location of figure 14 is shown. See figure 6 for location. Image centered at lat 38.6° S., long 111.5° E.

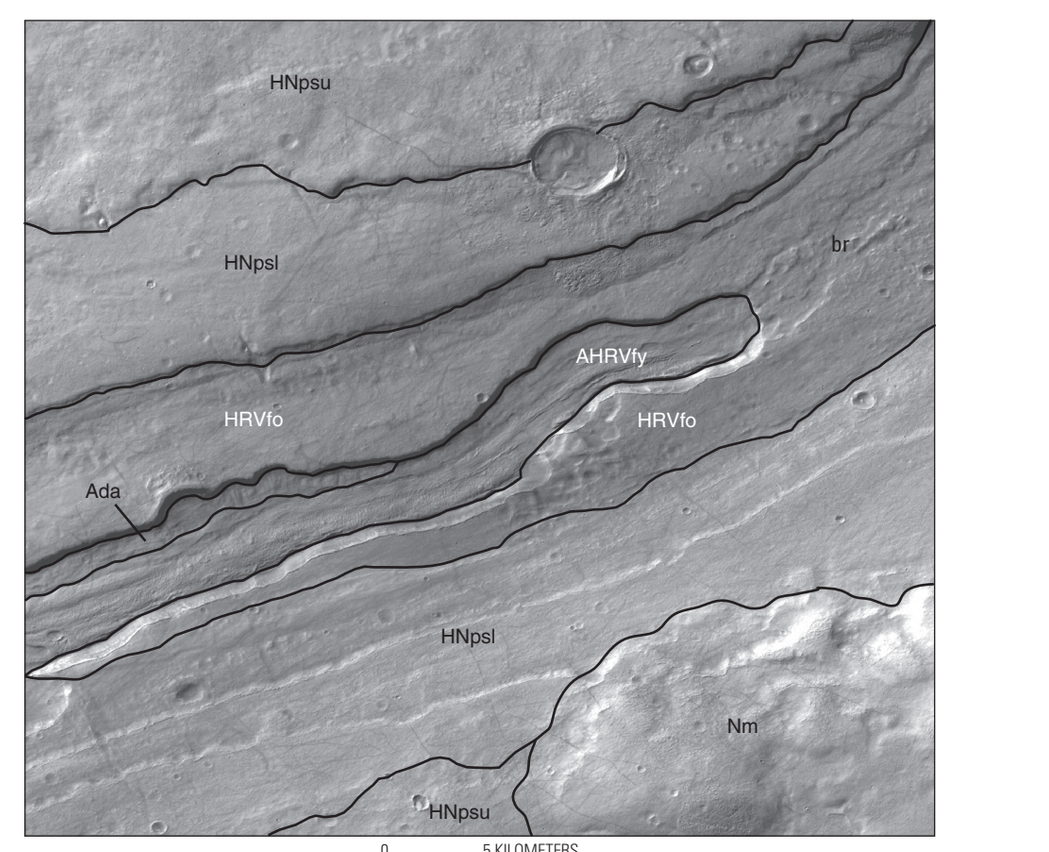


Figure 8. Part of CTX image P15_006922_1413_XN_38S249W showing a close-up of a narrow (~1.5-km-wide) theater-headed canyon incised within the main canyon of Reull Vallis that marks the transition between morphologically distinct reaches of the upper segment of Reull Vallis. In this location, vallis floor materials also transition from mostly smooth older Reull Vallis floor materials (HRvfo), which contains braided channels (br) that intersect at the head of the incised interior canyon, to the lineated younger Reull Vallis floor materials (AHRvfy) that begin within the interior canyon. This image also shows the main canyon of Reull Vallis incised within adjacent upper and lower smooth plains materials (HNpsu and HNpsl, respectively), which form erosional terraces parallel to the canyon, deposits of debris apron material (Ada) along the canyon wall, and a nearby massif of mountainous material (Nm). See figure 6 for location. Image centered at lat 39.3° S., long 111.2° E.

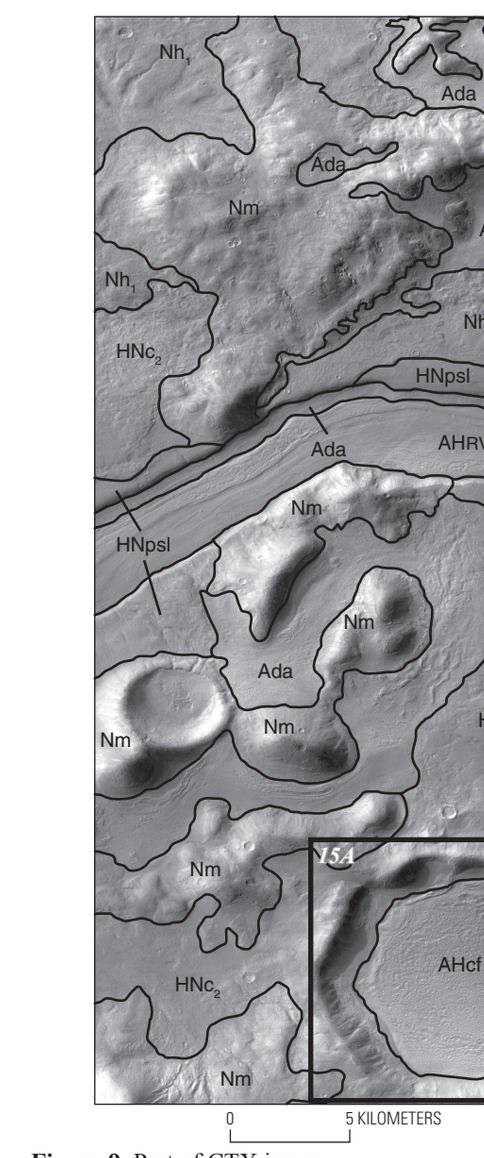


Figure 9. Part of CTX image P02_001885_1400_XN_40S249W showing part of upper reach of Reull Vallis and adjacent highlands of Promethei Terra. Canyon displays nearly constant width and straight walls and contains lineated younger Reull Vallis floor material (AHRvfy). Highland terrains consist of peaks of mountainous material (Nm), basin-rim unit (Nh_1), and rims of degraded craters. Low-lying areas are covered with ejecta (for example, HNc_2), smooth plains material, lower member (HNpsl), crater fill material (AHcf), and debris aprons (Ada). Some deposits are extensive and display lobate terminations, such as the massif-associated deposit in the center of the figure that surrounds several massifs of Nm, whereas others are limited in extent and show less evidence for flow, such as along south-facing wall of Reull Vallis and among highland massifs north of Reull Vallis, and may be akin to talus deposits or mass wasting of the regional mid-latitude mantle deposit (Mustard and others, 2001). Location of figure 15*A* is shown. See figure 6 for location. Image resolution is 5.06 m/pixel; centered at lat 39.8° S., long 110.4° E.

Figure 10. THEMIS VIS image V17009007 showing Fitzroy/Avarua ejecta material (HNFAe) and smooth plains material, upper member (HNpsu) dissected by a narrow flat-floored channel filled with older Reull Vallis floor material (HRvfo). Local slopes and orientations of islands of remnant ejecta and plains (bottom of image) and intersecting channels imply that water within the channel flowed to the south where it eventually terminates within smooth plains material adjacent to Reull Vallis. See figure 18 for location. Image resolution is 34.4 m/pixel; centered at lat 35.8° S., long 111.1° E.

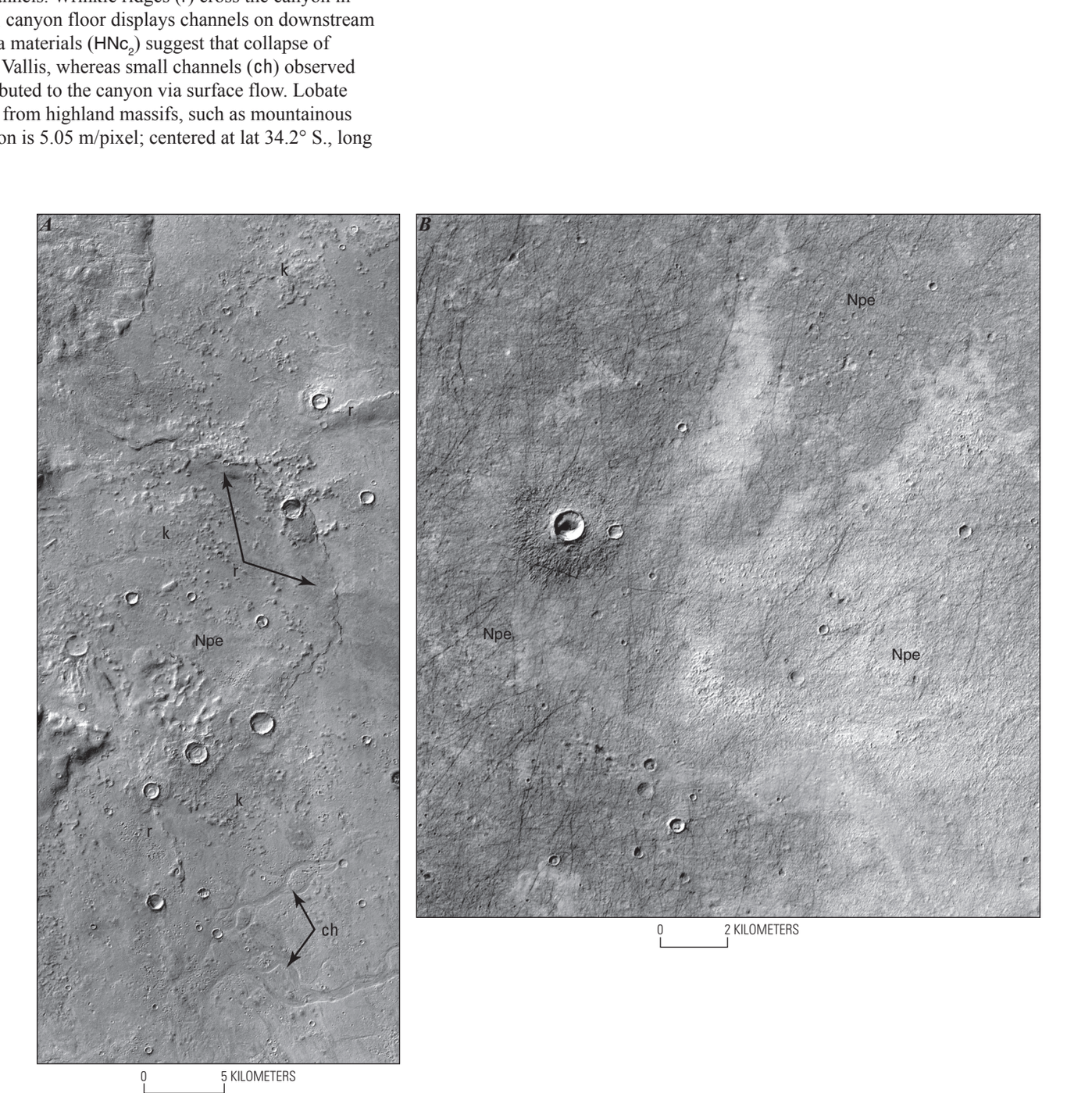


Figure 11. *A,* Part of CTX image P13_006144_1400_XN_40S245W showing etched plains material (Npe) adjacent to east rim of crater Greg. Plains and several degraded ridges (r) are superposed by knobs (k) that form clusters in some places and appear to be forming by degradation of a more continuous unit, possibly ejecta from Greg. A series of braided channels (ch) in the southern part of the image is incised within Npe and does not show knobs on the channel floor; rather, the channels erode around knobs. See figure 6 for location. Image resolution is 5.09 m/pixel; centered at lat 39.2° S., long 114.2° E. *B,* Part of CTX image P13_006289_1434_XN_36S245W showing eroded layers within the etched plains material (Npe) that gives portions of this deposit its mottled appearance. Low albedo material is being removed to expose high albedo material. Both materials have been sculpted to form an etched texture; presence of dust devil tracks (dark streaks) throughout unit indicate that this unit has been extensively modified by eolian processes. See figure 6 for location. Image resolution is 5.09 m/pixel; centered at lat 37.7° S., long 115.0° E.

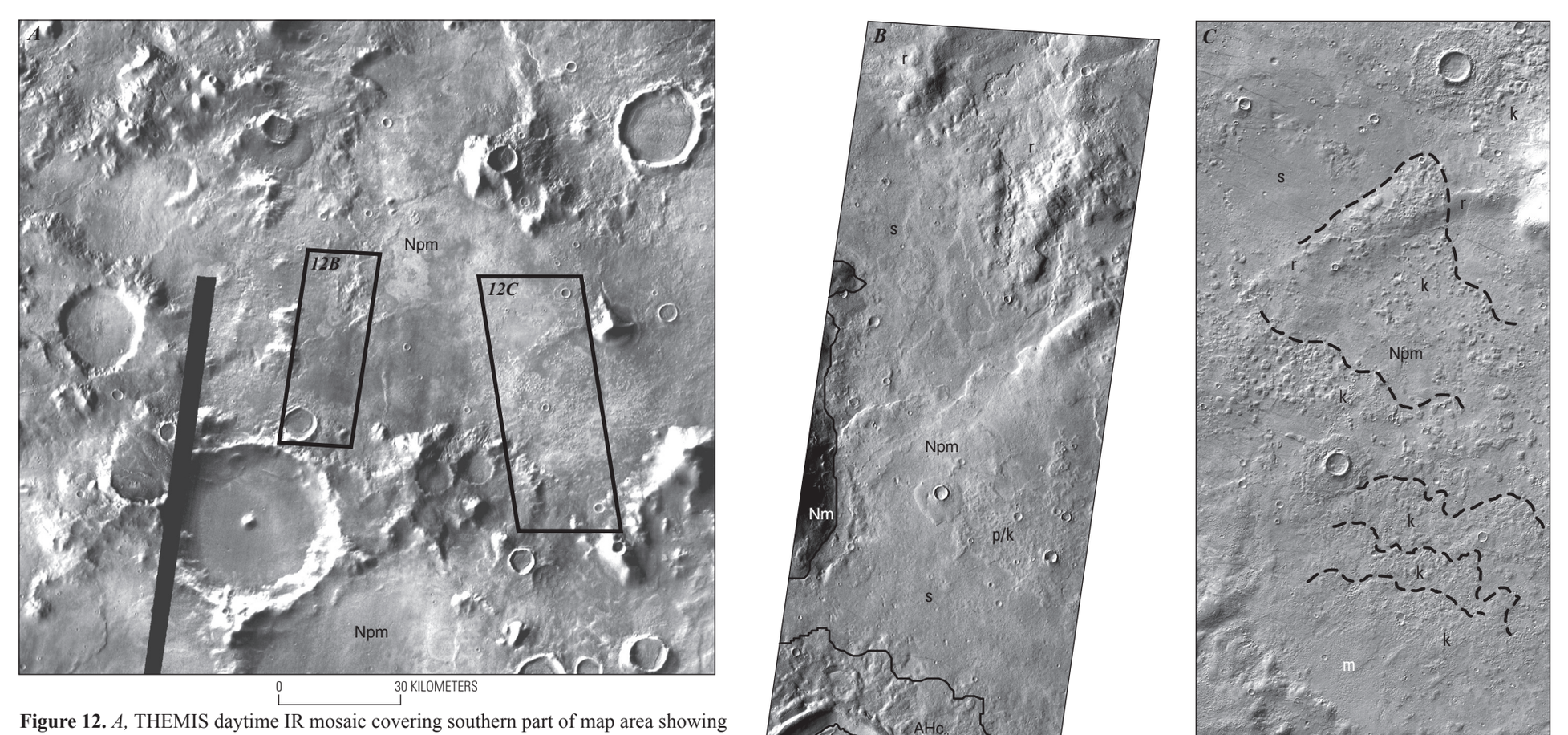


Figure 12. *A,* THEMIS daytime IR mosaic covering southern part of map area showing local highland terrain surrounded by deposits of mottled plains material (Npm). Locations of figures 12*B* and 12*C* are shown. See figure 1 for location. Image resolution is 100 m/pixel; centered at lat 41.2° S., long 113.2° E. *B,* THEMIS VIS image V26431011 showing a close-up of the mottled plains (Npm) that displays a mottled surface throughout the deposit but displays a number of textures, including smooth (s), pitted and knobby (p/k), and rugged (r) textures observed in the northern part of this image. Smooth materials appear to embay pitted/knobby textured materials. Image resolution is 17.2 m/pixel; centered at lat 41.2° S., long 113.0° E. *C,* Part of CTX image P17_007858_1372_XN_42S245W showing knobby terrain (k) that superposes smooth (s) mottled plains material (Npm) and wrinkle ridges (r) in the southeastern part of the map area. Edges of clusters of knobby terrain appear lobate in form (dashed lines) and may be composed of eroded remnants of ejecta from a ~40-km-diameter crater located ~50 km to the west, similar to knobby terrain located east of crater Greg. Surfaces in the southern part of this image are mantled (m) by mid-latitude mantling deposit of Mustard and others (2001), and knobby terrain may be remnants of this mantle or consist of mantle over eroded ejecta deposits. Image resolution is 5.08 m/pixel; centered at lat 41.5° S., long 114.2° E.

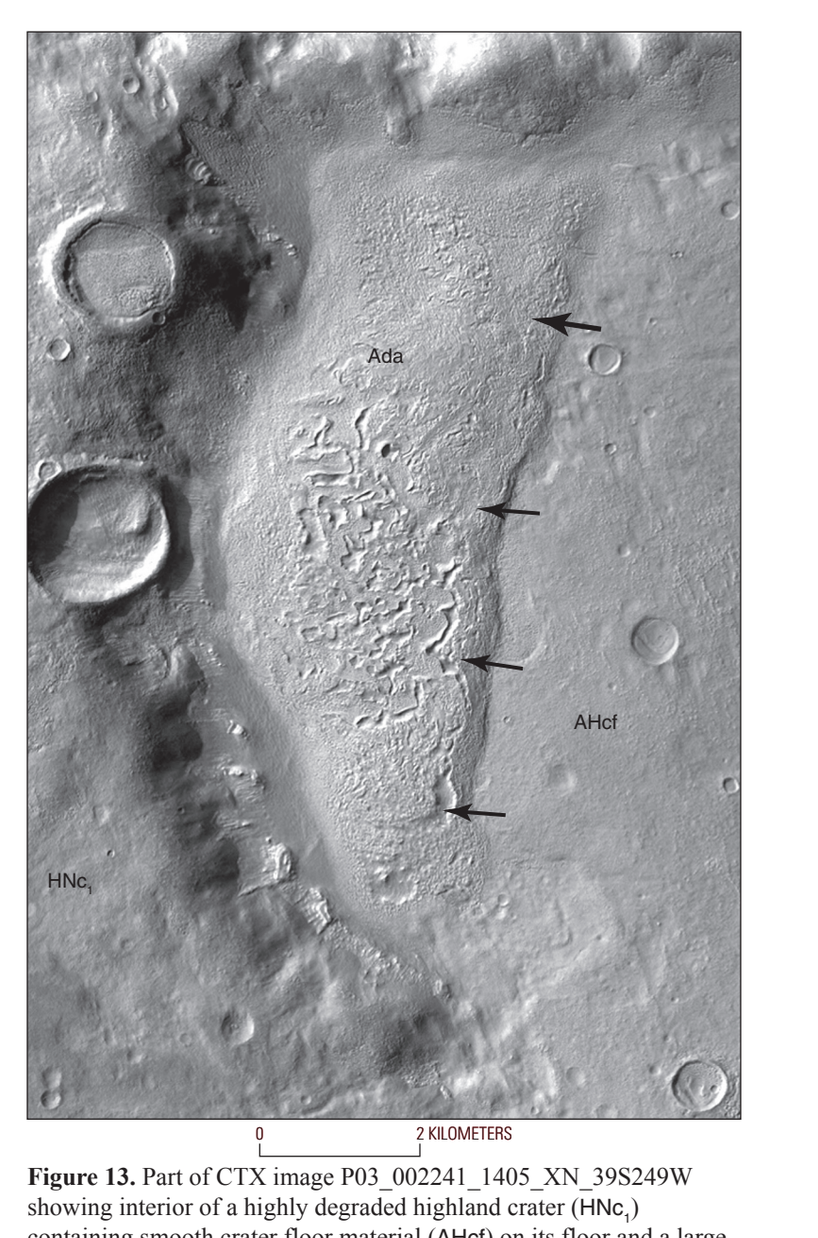


Figure 13. Part of CTX image P03_002241_1405_XN_39S249W showing interior of a highly degraded highland crater (HNc_1) containing smooth crater floor material (AHcf) on its floor and a large deposit of debris apron material (Ada) along its western wall. Toe of debris apron (black arrows) is less lobate than some observed in this region, and portions appear steep. Surface of deposit contains pits elongated roughly perpendicular to inferred direction of flow. See figure 6 for location. Image resolution is 5.06 m/pixel; centered at lat 38.8° S., long 110.7° E.

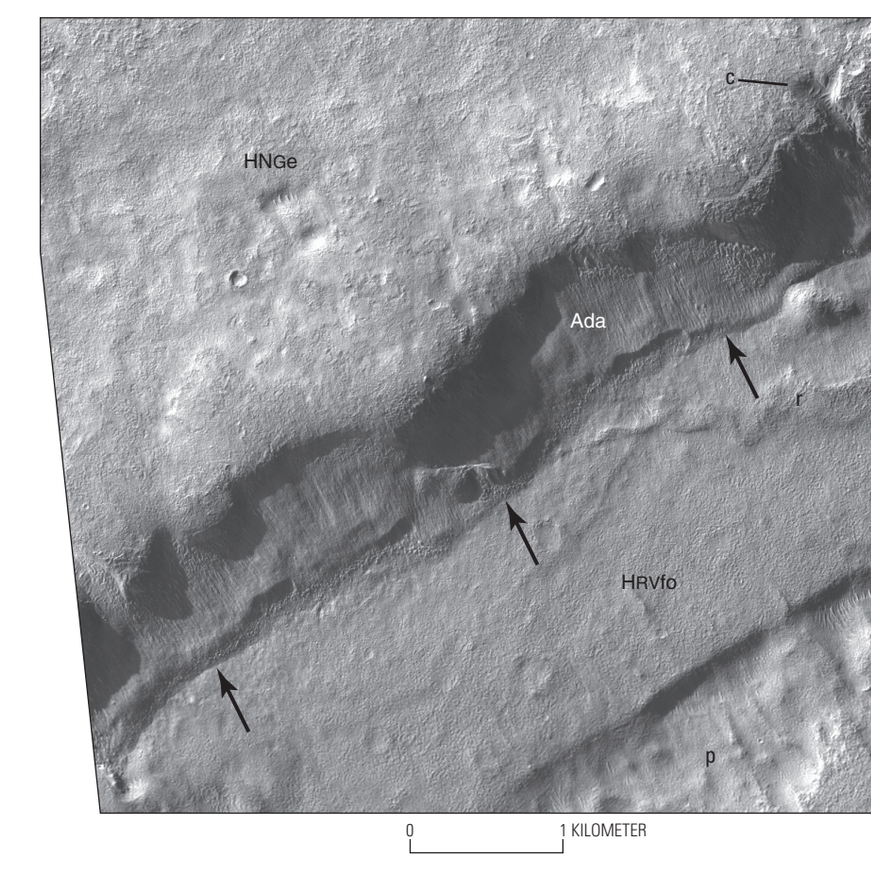


Figure 14. Part of HiRISE image PSP_010139_1410_RED showing a close-up of northern wall of upper reach of upper segment of Reull Vallis. Floor of Reull Vallis is covered with older Reull Vallis floor material (HRvfo) that is generally smooth in appearance except for a series of pits (p) elongated northwest-southeast and degraded ridges (r) observed in this image and channels observed elsewhere in the canyon (see figure 7). The adjacent plains are covered with ejecta from Greg (HNGe), southeast of this figure. Wall of Reull Vallis has been eroded by short, theater-headed tributary canyons (c), and northern wall contains a narrow exposure of debris apron material (Ada) along its base that exhibits lineations perpendicular to the canyon wall and a steep front (black arrows). See figure 7 for location. Image resolution is 50 cm/pixel; centered at lat 38.3° S., long 111.5° E.

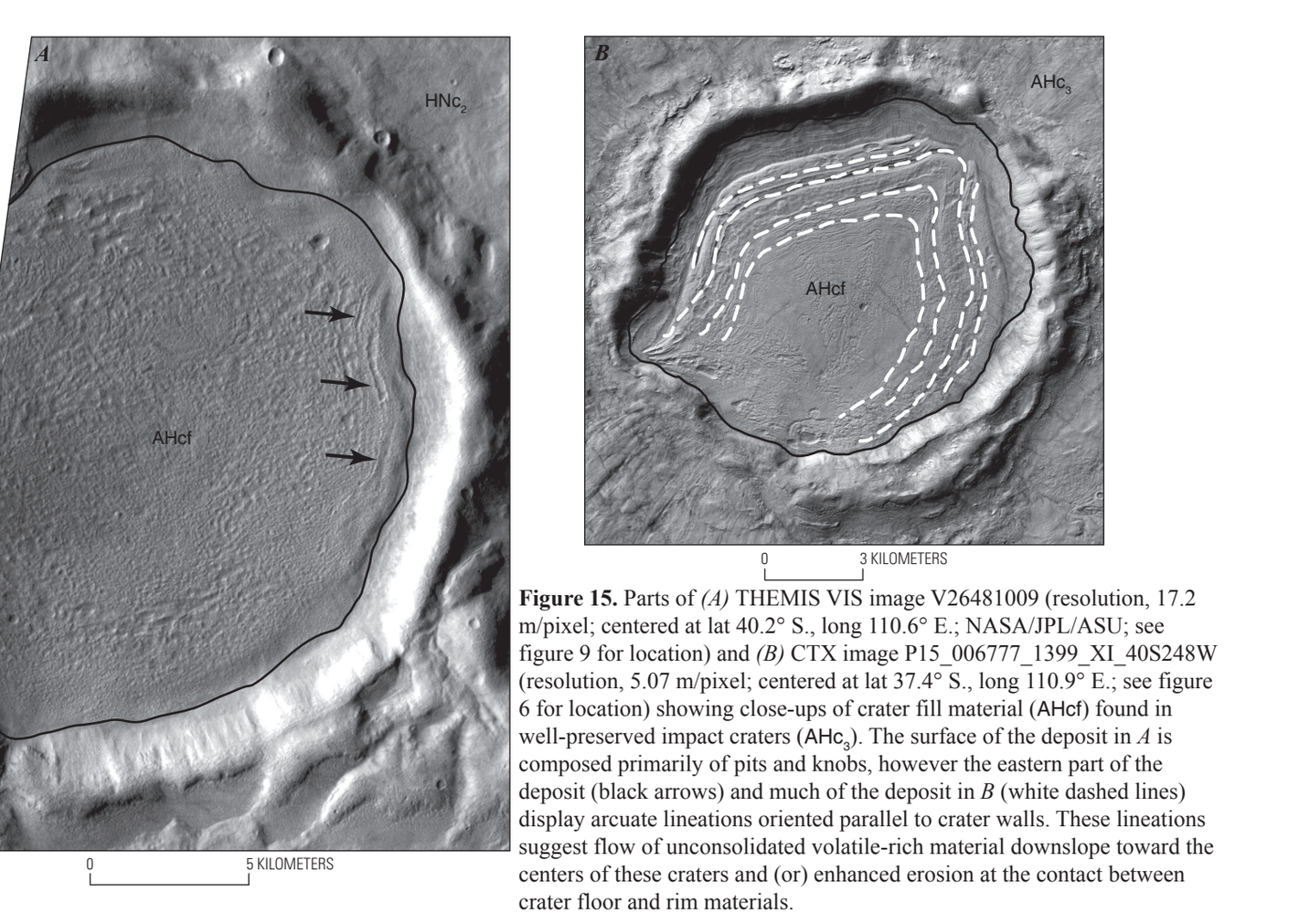


Figure 15. Parts of *(A)* THEMIS VIS image V26481009 (resolution, 17.2 m/pixel; centered at lat 40.2° S., long 110.6° E.; NASA/JPL/ASU; see figure 9 for location) and *(B)* CTX image P15_006777_1399_XI_40S248W (resolution, 5.07 m/pixel; centered at lat 37.4° S., long 110.9° E.; see figure 6 for location) showing close-ups of crater fill material (AHcf) found in well-preserved impact craters (AHc_3). The surface of the deposit in *A* is composed primarily of pits and knobs, however the eastern part of the deposit (black arrows) and much of the deposit in *B* (white dashed lines) display arcuate lineations oriented parallel to crater walls. These lineations suggest flow of unconsolidated volatile-rich material downslope toward the centers of these craters and (or) enhanced erosion at the contact between crater floor and rim materials.

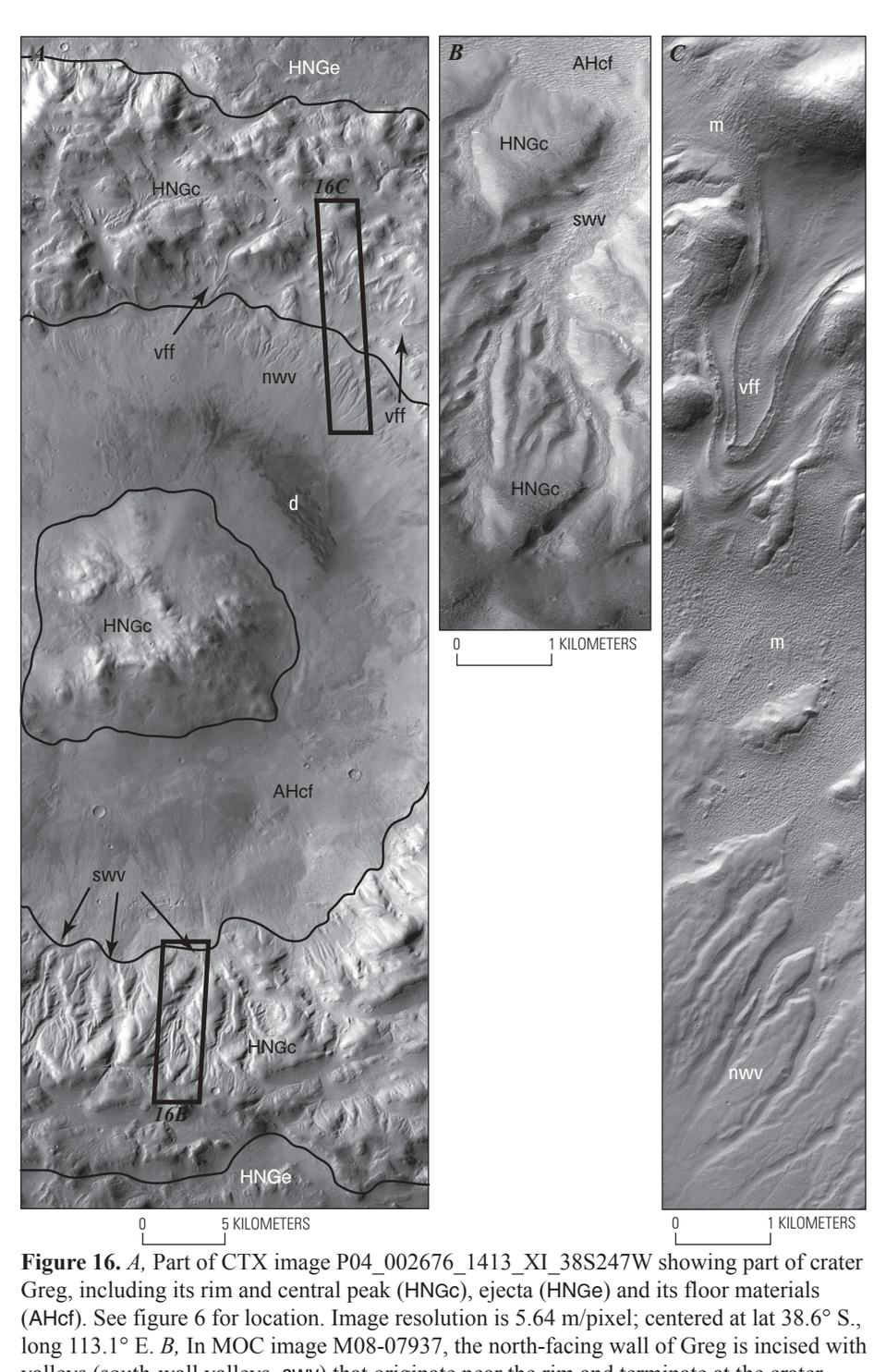


Figure 16. *A,* Part of CTX image P04_002676_1413_XI_38S247W showing part of crater Greg, including its rim and central peak (HNGc), ejecta (HNGe) and its floor materials (AHcf). See figure 6 for location. Image resolution is 5.64 m/pixel; centered at lat 38.6° S., long 113.1° E. *B,* In MOC image M08-07937, the north-facing wall of Greg is incised with valleys (south-wall valleys, swv) that originate near the rim and terminate at the crater floor; these valleys are filled with materials with herringbone surface textures suggesting flow down valley. Image resolution is 2.78 m/pixel; centered at lat 39.1° S., long 113.1° E. *C,* In MOC image M18-00897, the south-facing wall of Greg is morphologically different, showing a thin mantle along the lower half of the wall that is dissected by narrow parallel valleys (north-wall valleys, nwv), and the upper half of the wall is superposed by a disaggregated mantle that forms viscous flow features (Mustard and others, 2001; Milliken and others, 2003; Berman and others, 2009). Image resolution is 4.17 m/pixel; centered at lat 38.2° S., long 113.2° E.

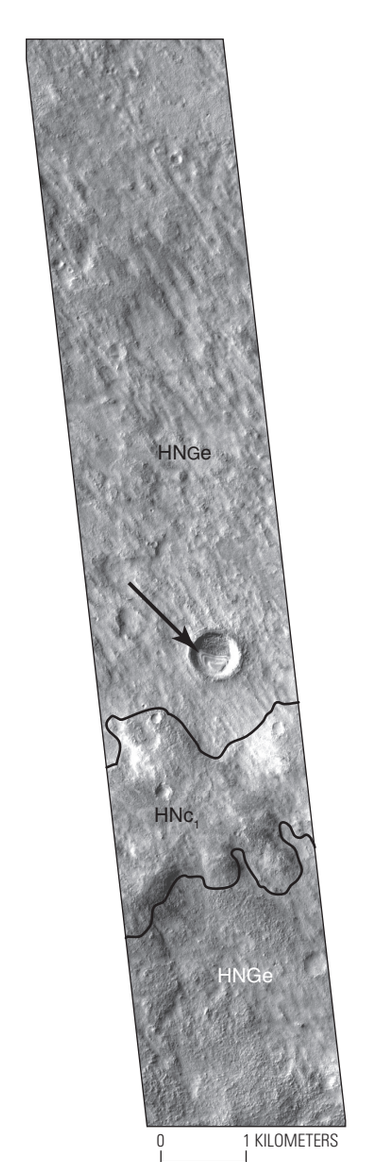


Figure 17. MOC image M04-01430 showing the region north of Reull Vallis and northwest of crater Greg. These plains show a lineated texture oriented northwest-southeast, roughly radial to Greg, and this material has been interpreted as Greg ejecta material (HNGe) that has been eroded by the wind to form yardang-like features. The ~600-m-diameter crater near the center of the image (arrow) has a fresh-looking rim, but its ejecta deposit has also been modified and (or) removed. Part of the rim of crater Lipik forms the deposit of highly degraded crater material (HNc_1) in the bottom half of the image. See figure 6 for location. Image resolution is 5.56 m/pixel; centered at lat 37.9° S., long 111.4° E.

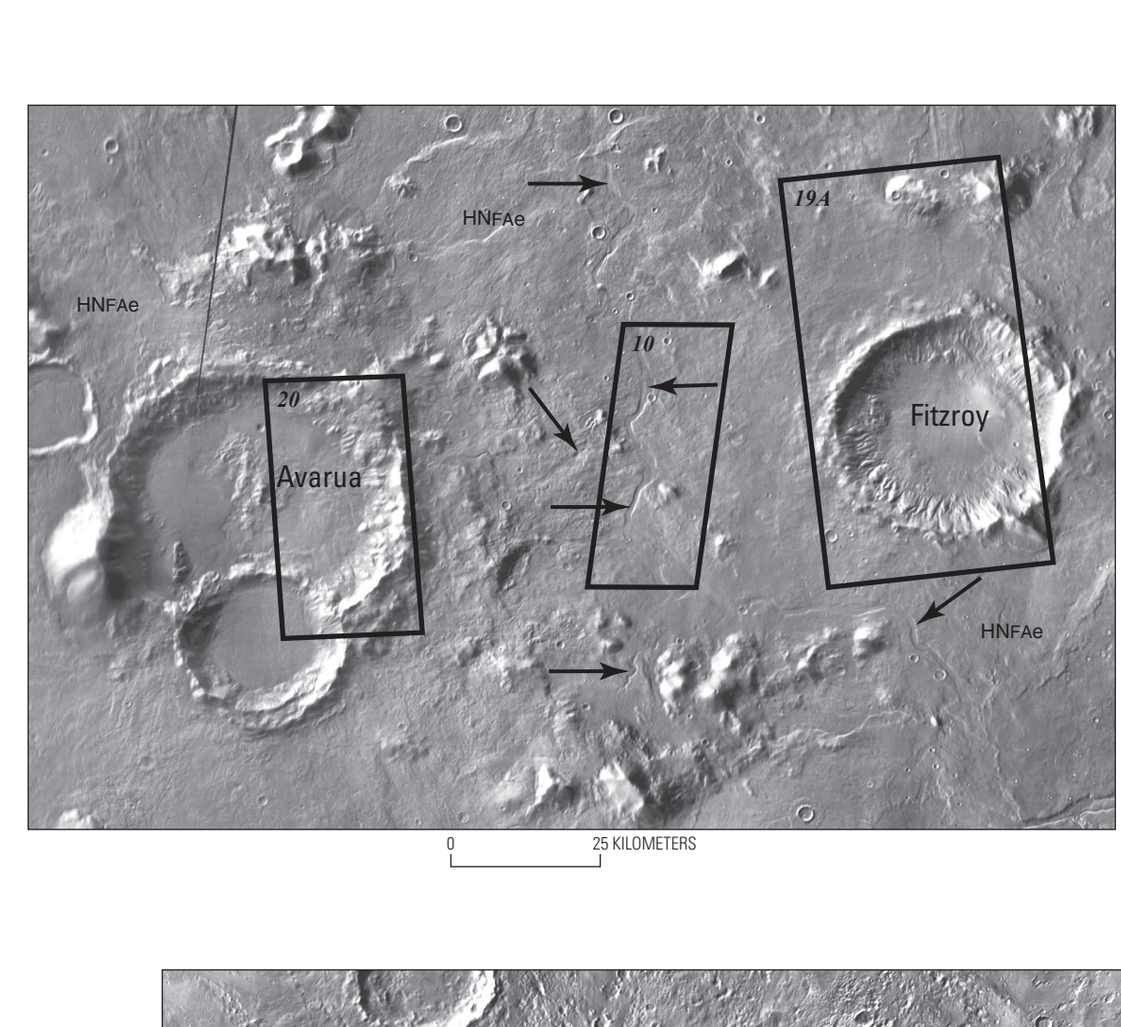


Figure 18. Part of THEMIS daytime IR mosaic (resolution, 100 m/pixel) showing craters Avarua (diameter, 50 km) and Fitzroy (diameter, 38.2 km). Much of the surrounding terrain is covered by ejecta materials from both craters (HNFAe), parts of which are dissected by sinuous channels (arrows). The locations of figures 10, 19*A*, and 20 are shown. See figure 1 for location. Image centered at lat 35.7° S., long 110.9° E.

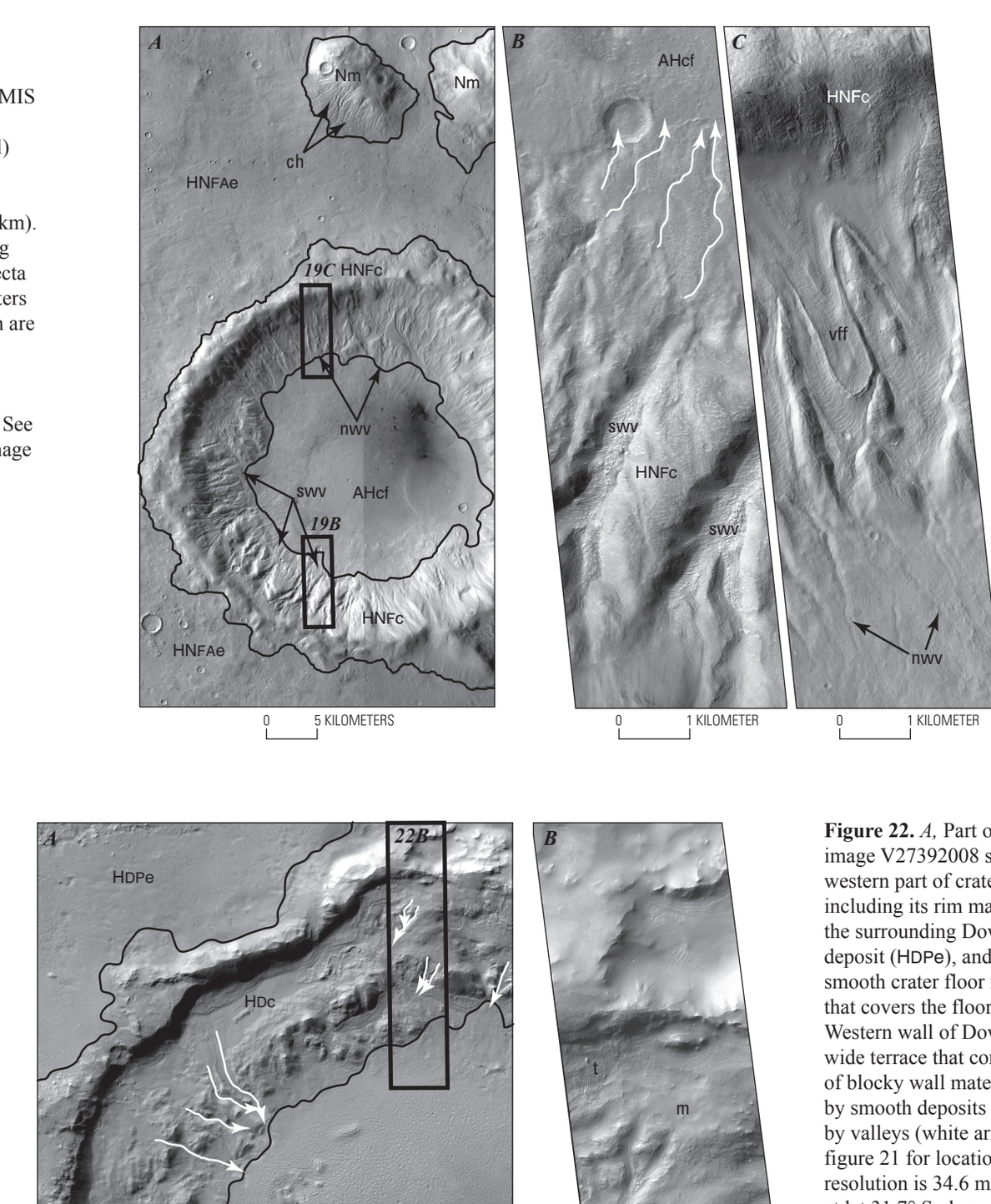


Figure 19. *A,* Mosaic of CTX images P03_002386_1444_XN_35S248W (left; resolution, 5.07 m/pixel) and P05_003164_1446_XI_35S248W (right; resolution, 5.14 m/pixel) showing crater Fitzroy (HNFc) and the surrounding Fitzroy/Avarua ejecta (HNFAe). Crater floor materials (AHcf) in Fitzroy appear mottled and smooth at this resolution. Valleys incised in interior wall of Fitzroy—north-wall valleys (nwv; see figure 19*B*) and south-wall valleys (swv; see figure 19*C*)—are morphologically similar to those observed in Greg. Channels (ch) incised along south-facing flank of a massif of mountainous material (Nm) could have formed by dewatering of a volatile-rich mantle—Fitzroy ejecta or mid-latitude mantling material (Mustard and others, 2001; Milliken and others, 2003; Berman and others, 2009). See figure 18 for location. Image centered at lat 35.5° S., long 112.0° E. *B,* Southern part of MOC image M04-02881 showing the south-wall valleys (swv) incised in north-facing wall of Fitzroy crater material (HNFc); valleys are filled with sediments with platy to herringbone surface textures suggesting down-valley flow. Wider swv terminate at a smooth deposit along base of wall, which is incised by narrower valleys (white arrows) that extend from swv termini and terminate at contact with this deposit and crater floor material (AHcf). Image resolution is 2.78 m/pixel; centered at lat 35.9° S., long 112.0° E. *C,* Northern part of MOC image M04-02881 showing north-wall valleys (nwv) incised in mantling material along lower half of south-facing wall of Fitzroy crater material (HNFc). Viscous flow features formed along upper half of Fitzroy's walls and are composed of disaggregated mantle materials that flowed down slope. Image centered at lat 35.5° S., long 111.9° E.

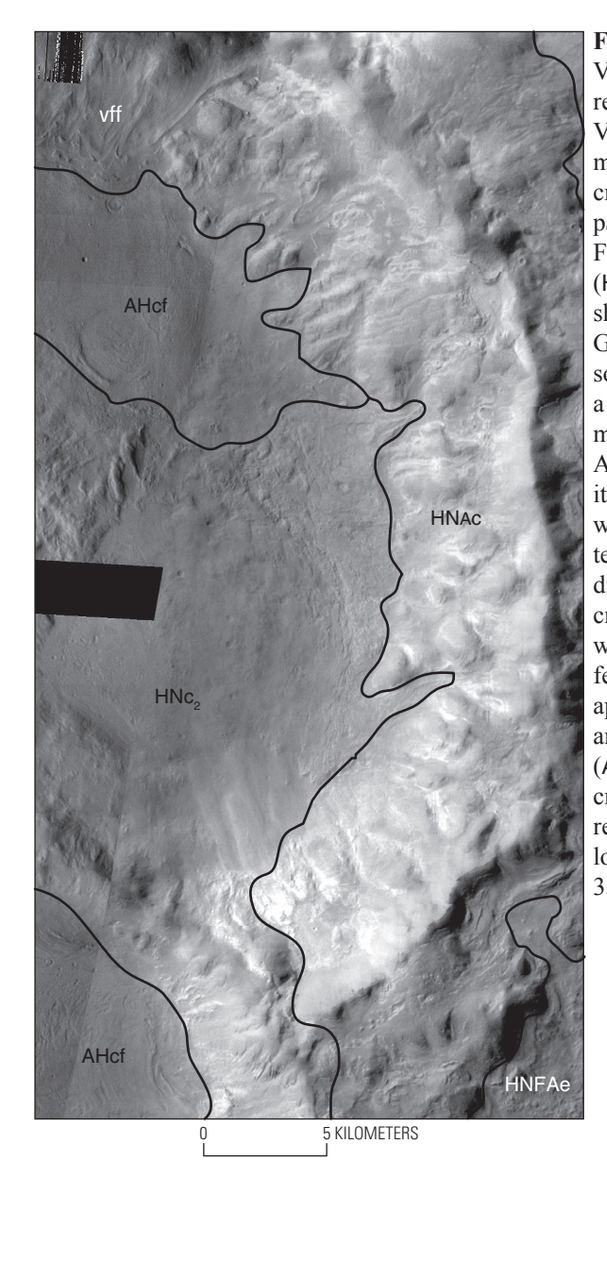


Figure 20. Mosaic of THEMIS VIS images V17034002 (left; resolution, 17.3 m/pixel) and V34728003 (right; resolution, 19.2 m/pixel) showing eastern half of crater Avarua (HNAc) and a small part of surrounding Fitzroy/Avarua ejecta deposit (HNFAe). Interior wall of Avarua shows similar morphologies as Greg and Fitzroy but are somewhat muted due to impact of a large (diameter, 25 km) moderately degraded crater on Avarua's south rim that distributed its ejecta (HNc_2) across floor and wall of Avarua and surrounding terrain. Southern wall of Avarua displays valleys that extend from crater rim to floor and northern wall displays viscous flow features (vff), but they do not appear as developed as in Greg and Fitzroy. Crater floor materials (AHcf) in Avarua and southern rim crater appear smooth at this resolution. See figure 18 for location. Image centered at lat 35.9° S., long 110.0° E.

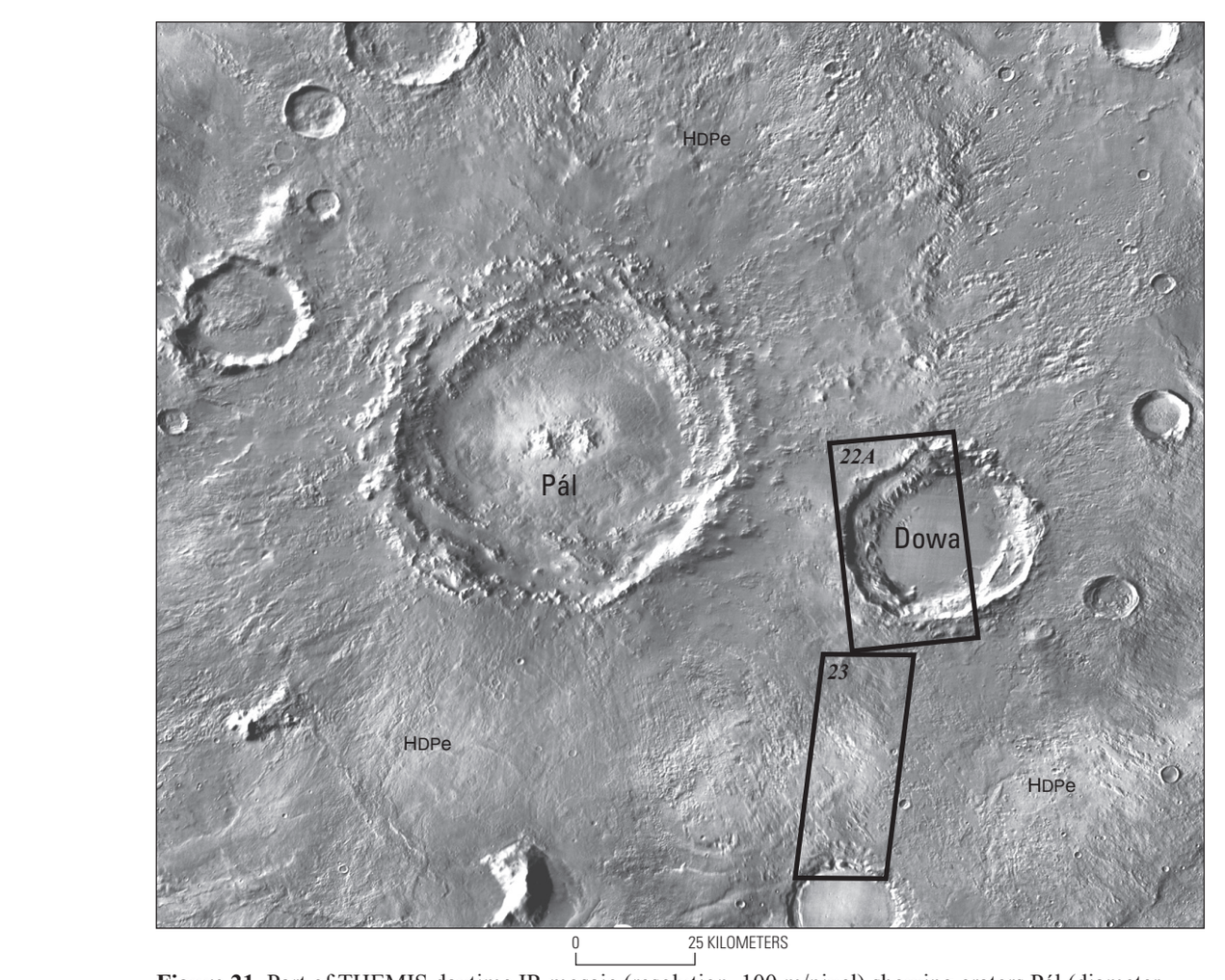


Figure 21. Part of THEMIS daytime IR mosaic (resolution, 100 m/pixel) showing craters Pál (diameter, 71.2 km) and Dowa (diameter, 40.8 km). Much of terrain surrounding these craters is covered by ejecta materials from both craters (HDPe), which appear heavily pock-marked with pits, lineations, and smooth-topped yardang-like mesas that all tend to be oriented radial to Pál or Dowa. Locations of figures 22*A* and 23 are shown. See figure 1 for location. Image centered at lat 31.4° S., long 109.4° E.

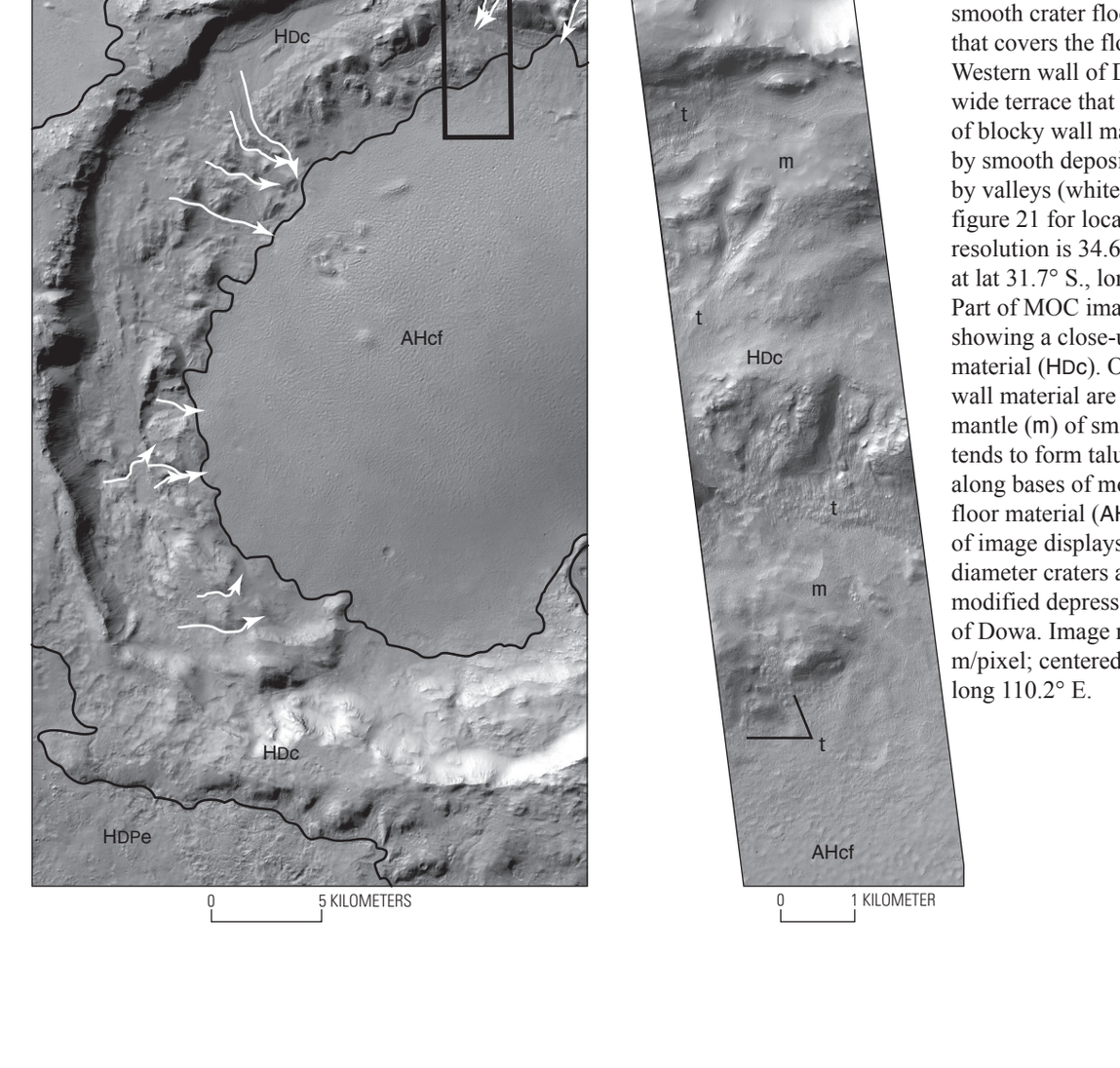


Figure 22. *A,* Part of THEMIS VIS image V27392008 showing the western part of crater Dowa including its rim material (HDc), the surrounding Dowa/Pál ejecta deposit (HDPe), and relatively smooth crater floor material (AHcf) that covers the floor of Dowa. Western wall of Dowa displays a wide terrace that contains outcrops of blocky wall material superposed by smooth deposits and is dissected by valleys (white arrows). See figure 21 for location. Image resolution is 34.6 m/pixel; centered at lat 31.7° S., long 110.1° E. *B,* Part of MOC image R17-00891 showing a close-up of Dowa crater material (HDc). Outcrops of blocky wall material are superposed by a mantle (m) of smooth material that tends to form talus deposits (t) along bases of most slopes. Crater floor material (AHcf) along bottom of image displays pits (small-diameter craters and (or) eolian modified depressions) in this part of Dowa. Image resolution is 2.95 m/pixel; centered at lat 31.4° S., long 110.2° E.

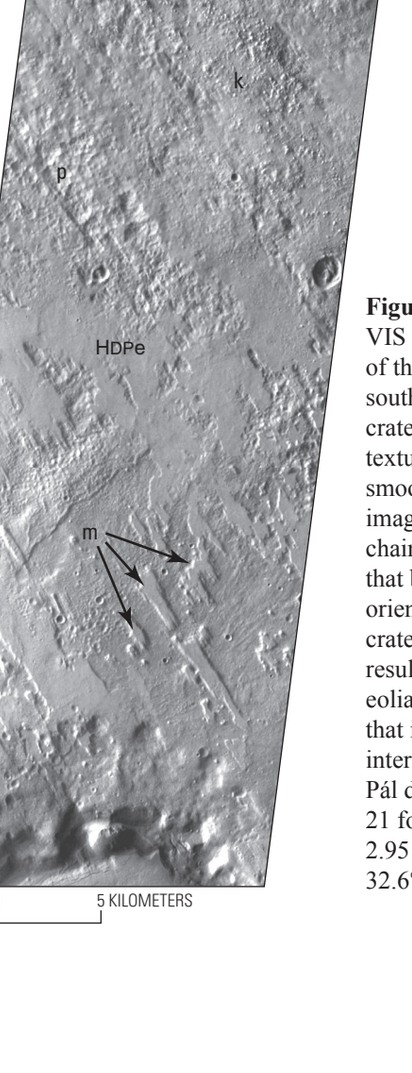


Figure 23. Southern part of THEMIS VIS image V27392008 showing part of the Dowa/Pál ejecta deposit (HDPe) south of crater Dowa and southeast of crater Pál. Deposit shows knobby (k) textures in upper part of image and smooth textures in southern part of image. Much of deposit displays linear chains of pits (p) or smooth mesas (m) that both show a northwest-southeast orientation, which is roughly radial to crater Pál. These textures and the resulting trend of features suggest eolian modification of ejecta deposit that is reflected predominantly in internal structure of ejecta from crater Pál during its emplacement. See figure 21 for location. Image resolution is 2.95 m/pixel; image centered at lat 32.6° S., long 109.9° E.

Geologic Map of MTM –30247, –35247 and –40247 Quadrangles, Reull Vallis Region of Mars

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