Geology of the “Elysium” Site (or, low wind ≠ low science)

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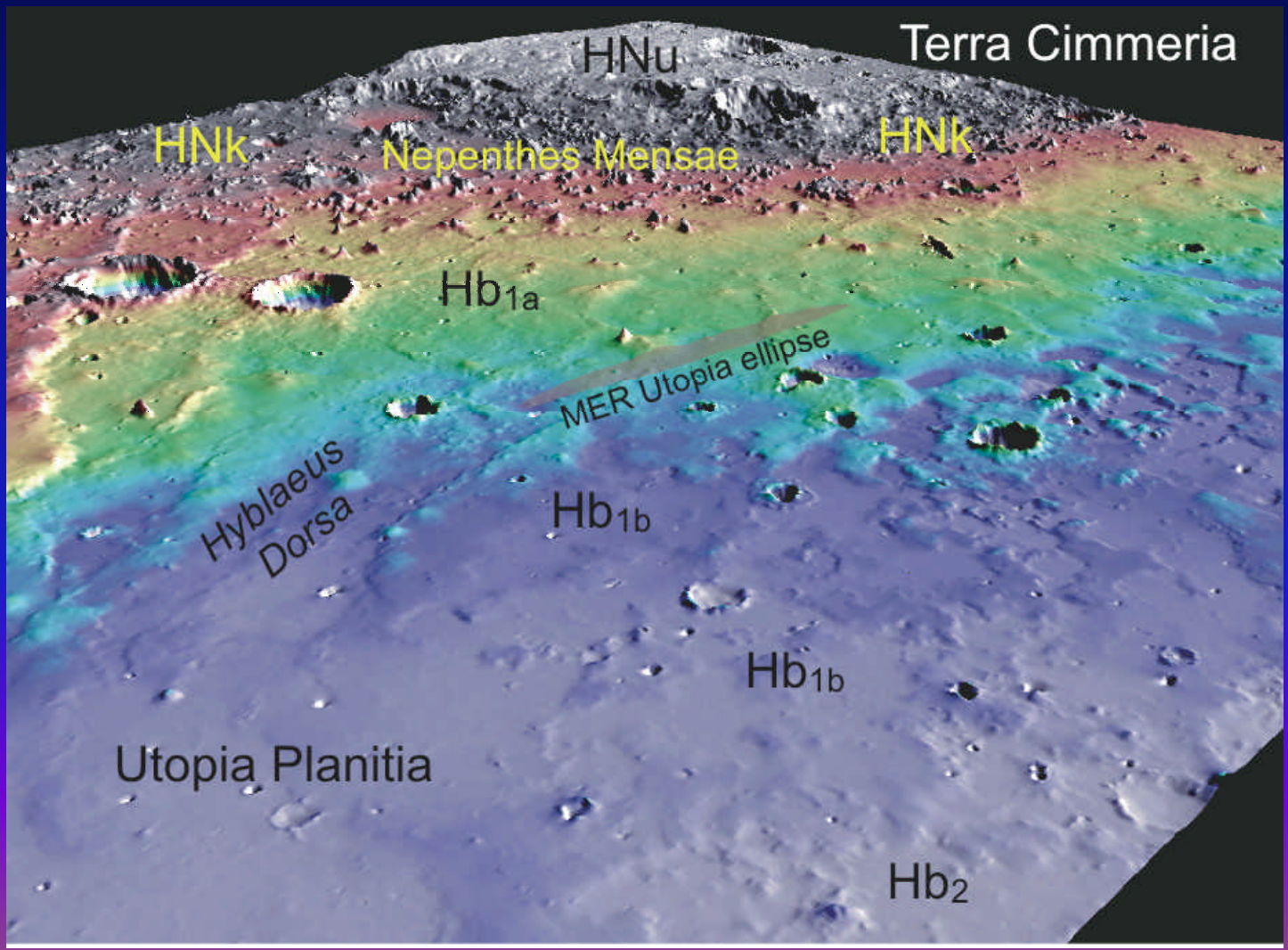
Overview

- Geologic setting
- Ellipse landforms (MOLA, THEMIS, MOC)
- Geologic interpretations
- Ellipse landform slope hazards
- Rover views
- Testing hypotheses with Athena instruments

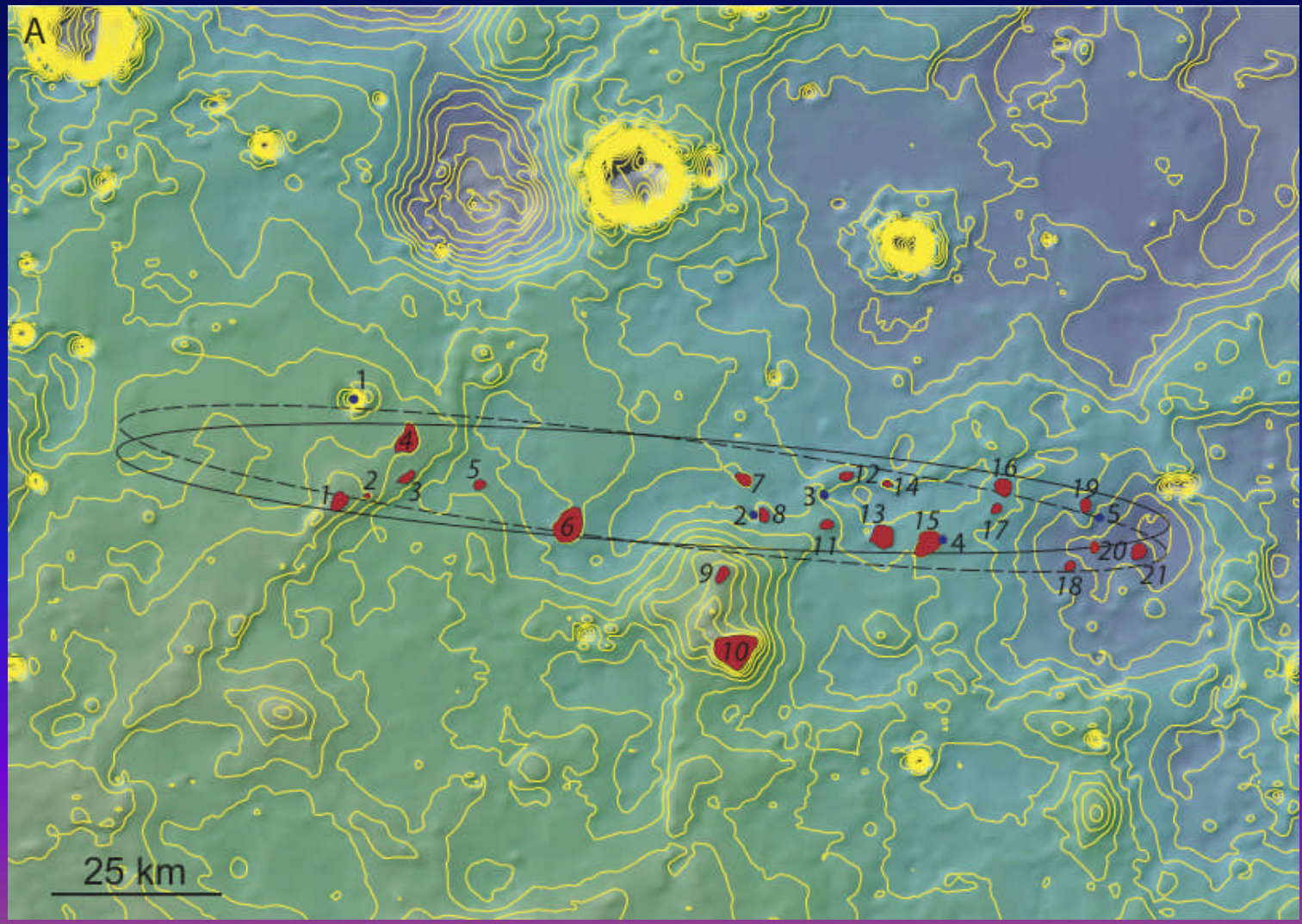
“Elysium” Site Geologic Setting

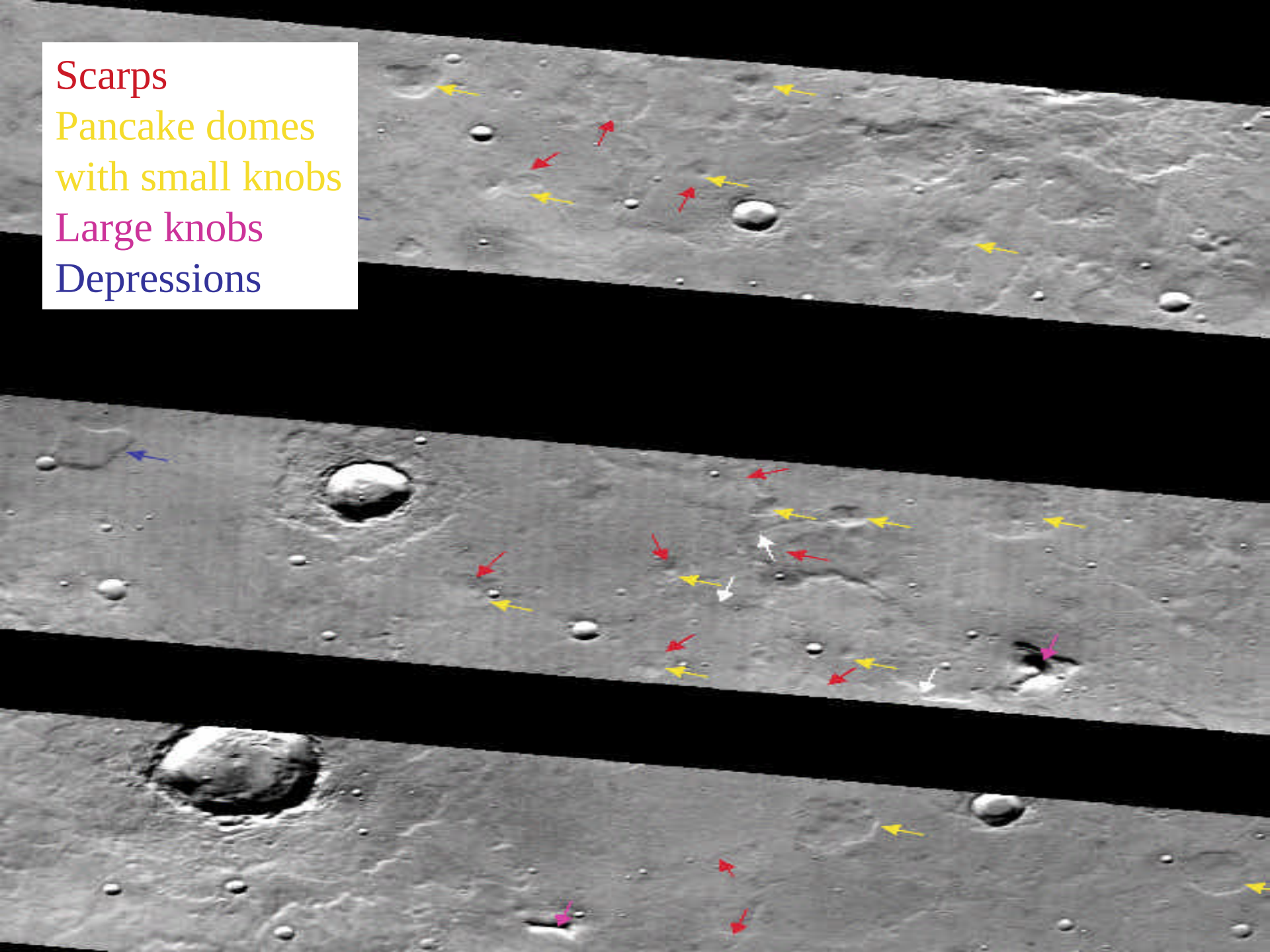
- Boundary plains of southeastern Utopia basin/Planitia (no longer Elysium Planitia)
- Below Terra Cimmeria highlands
- On western margin of Hyblaeus Dorsa (NNE-trending wrinkle ridge system separating Utopia/Elysium Planitiae)
- Fields of knobs--highland outliers
- Bands of arcuate depressions in plains

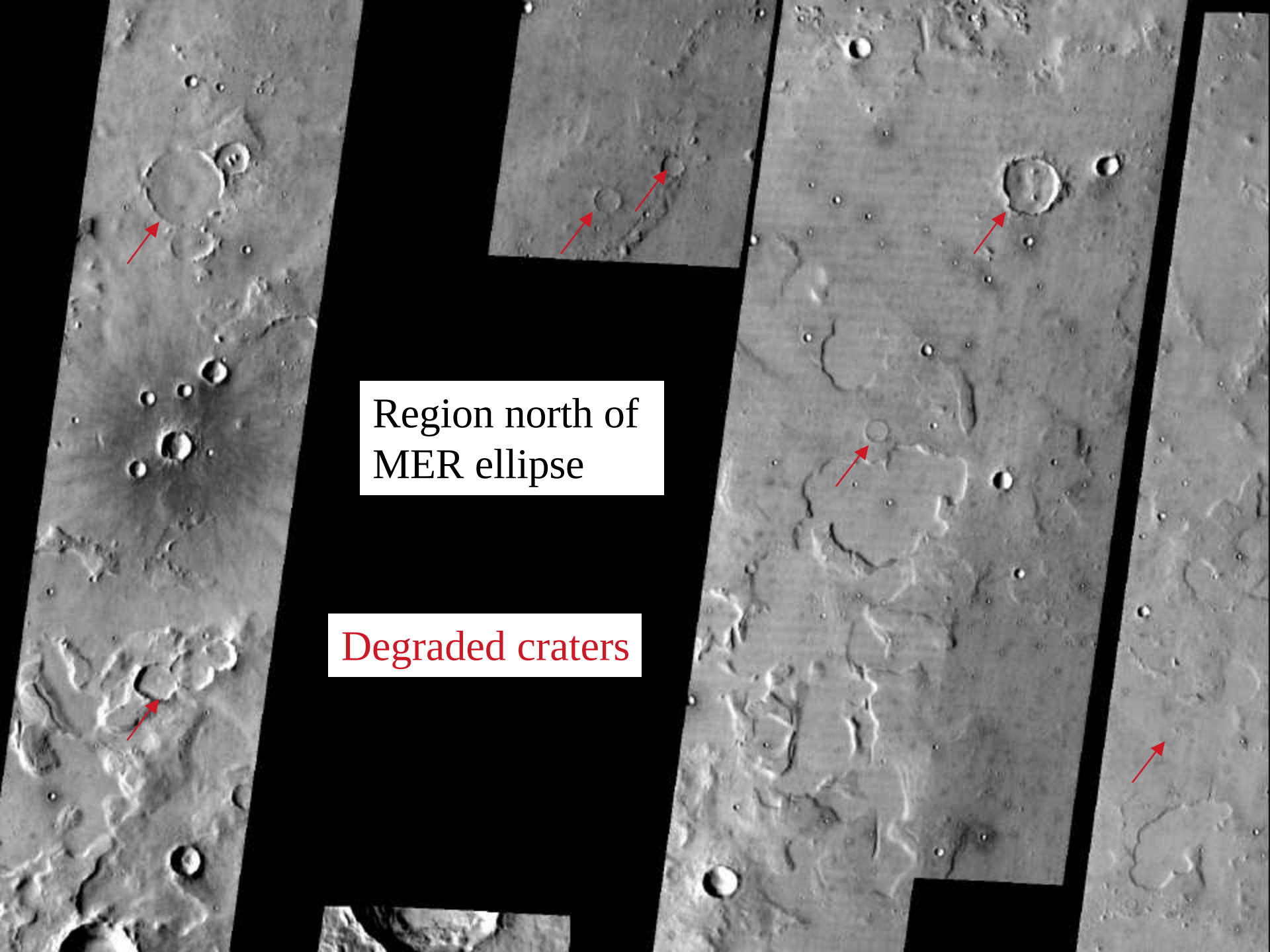


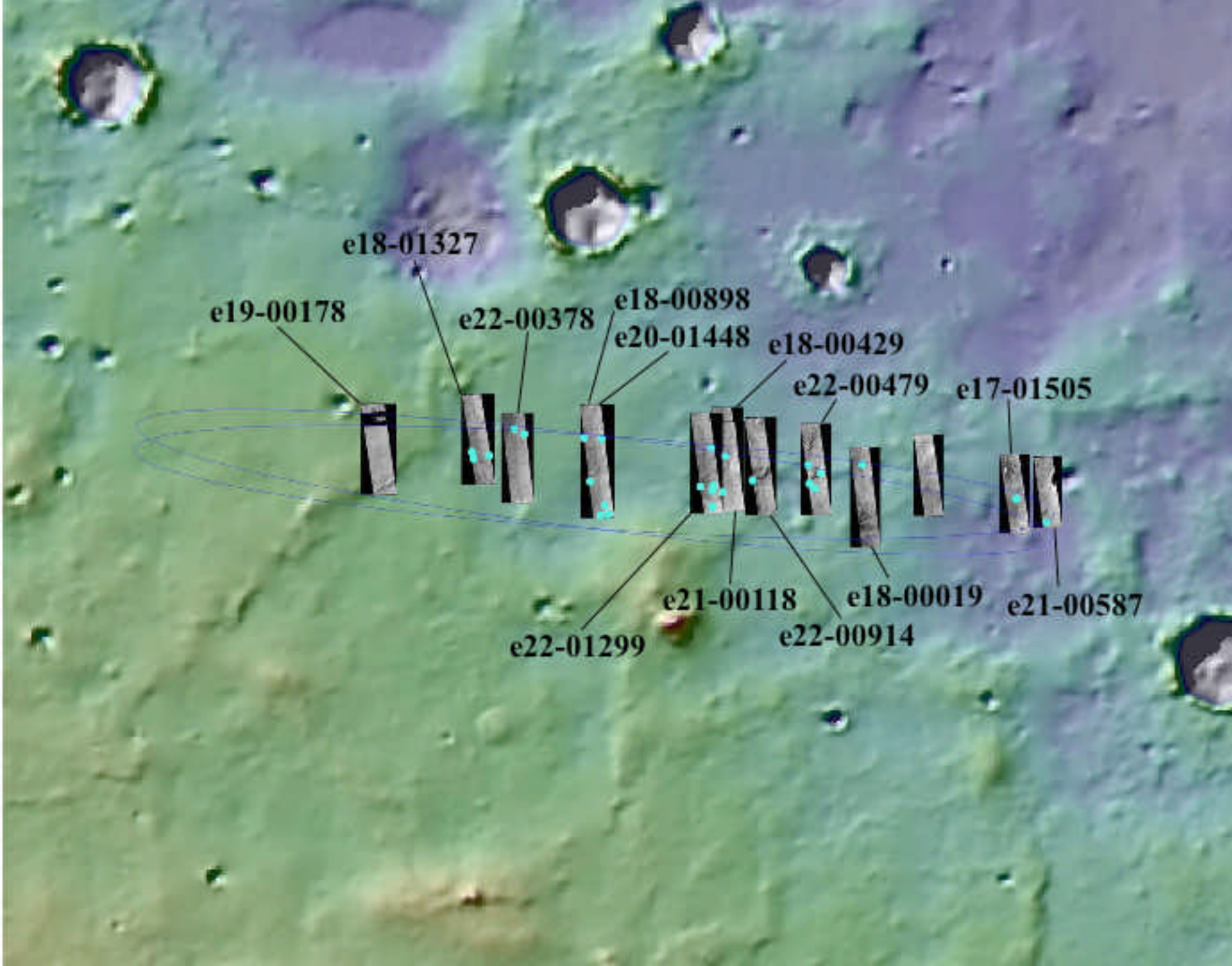
- Wrinkle ridges (2 large ones plus widespread, subtle forms
- Craters (4 >1 km diameter)
- Knobs (wrinkle ridge arches, crater rims, outliers of older materials, and mud and/or silicate volcanoes)
- Irregular depressions (center and east end of ellipse; possibly related to collapse)

Ellipse landforms seen in MOLA




Scarps
Pancake domes
with small knobs
Large knobs
Depressions


Region north of MER ellipse
Degraded craters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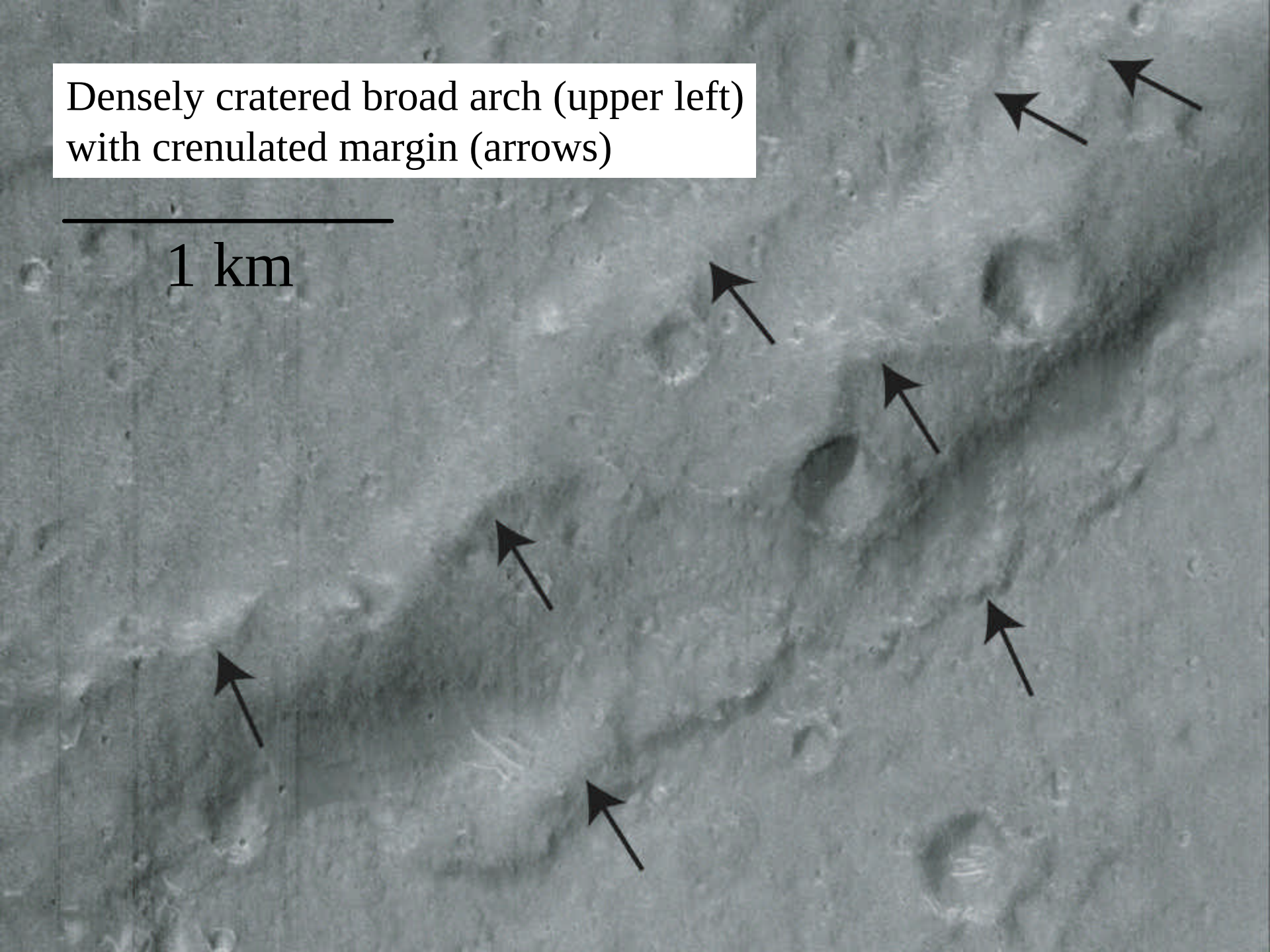
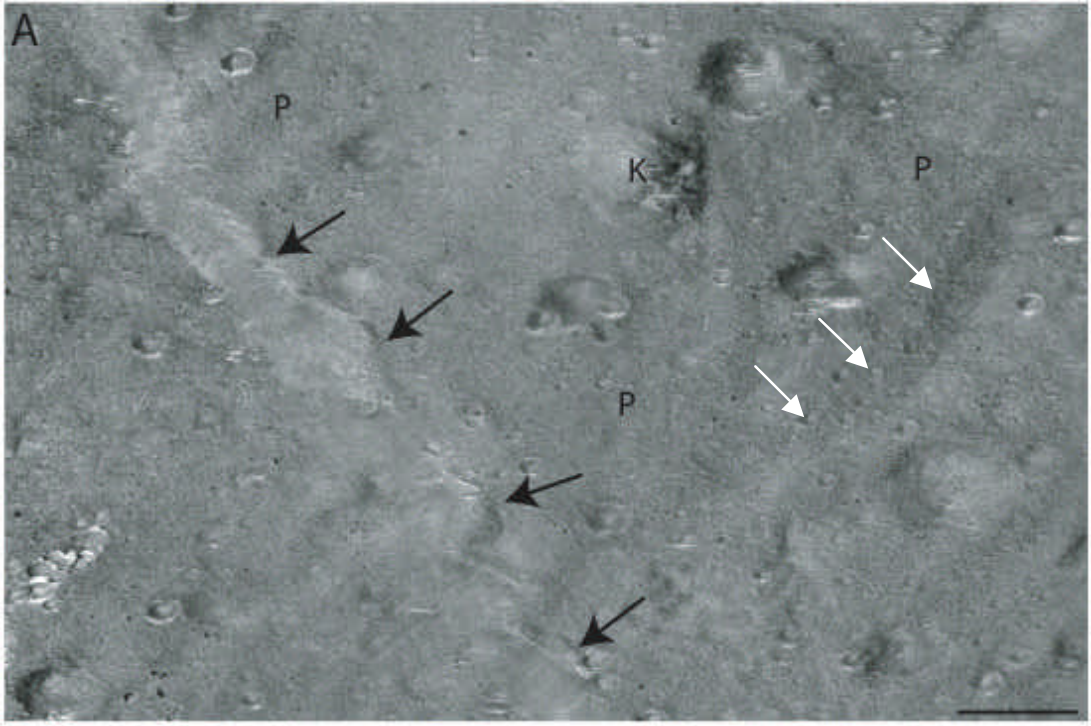
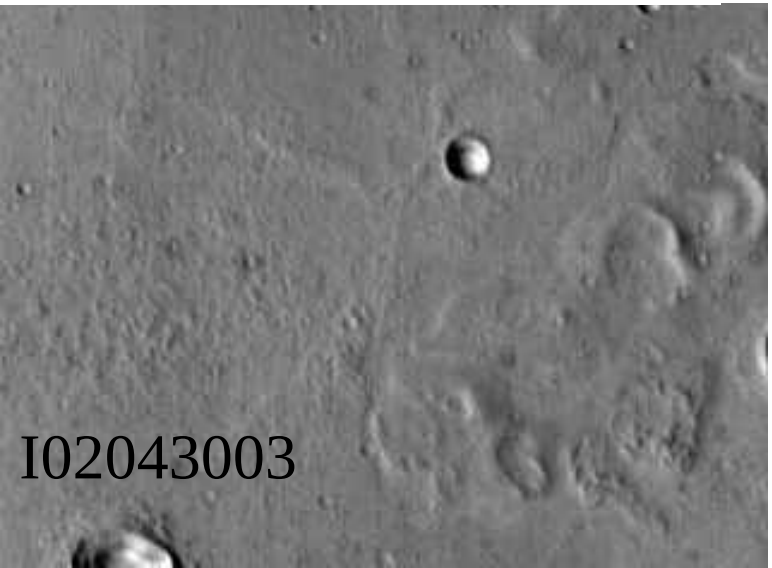
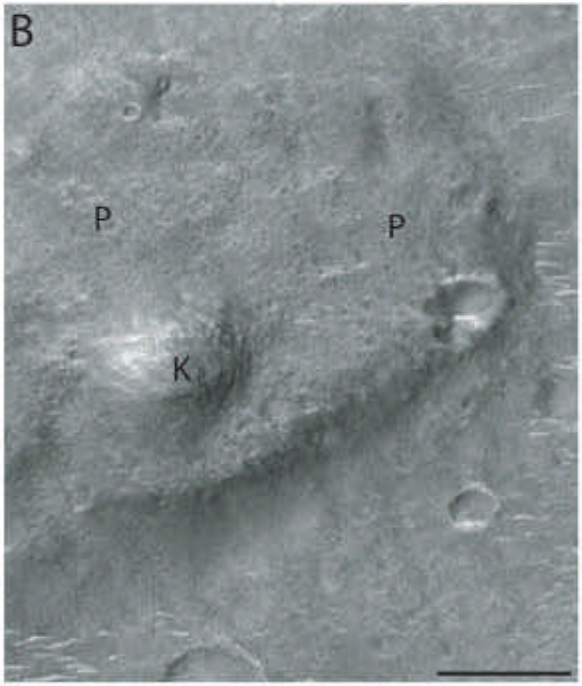

Densely cratered broad arch (upper left)
with crenulated margin (arrows)
1 km

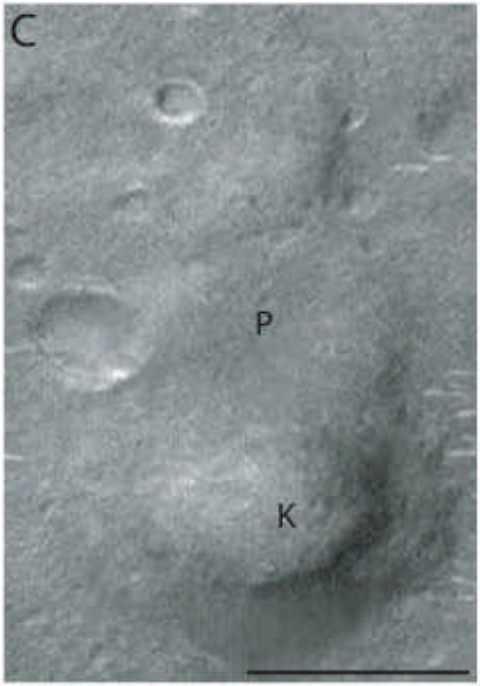
Examples of pancake domes (p) with 300-m knobs (k). Note ridge along dome margin (black arrows) and possible embayment by plains flow (white arrows)



Rounded, pitted mound complex, S. Utopia Pl.

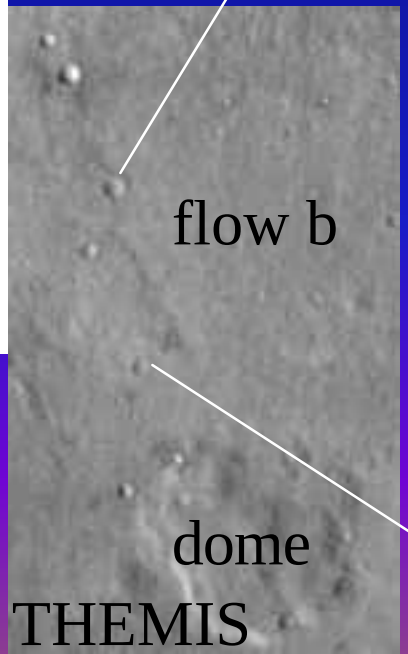


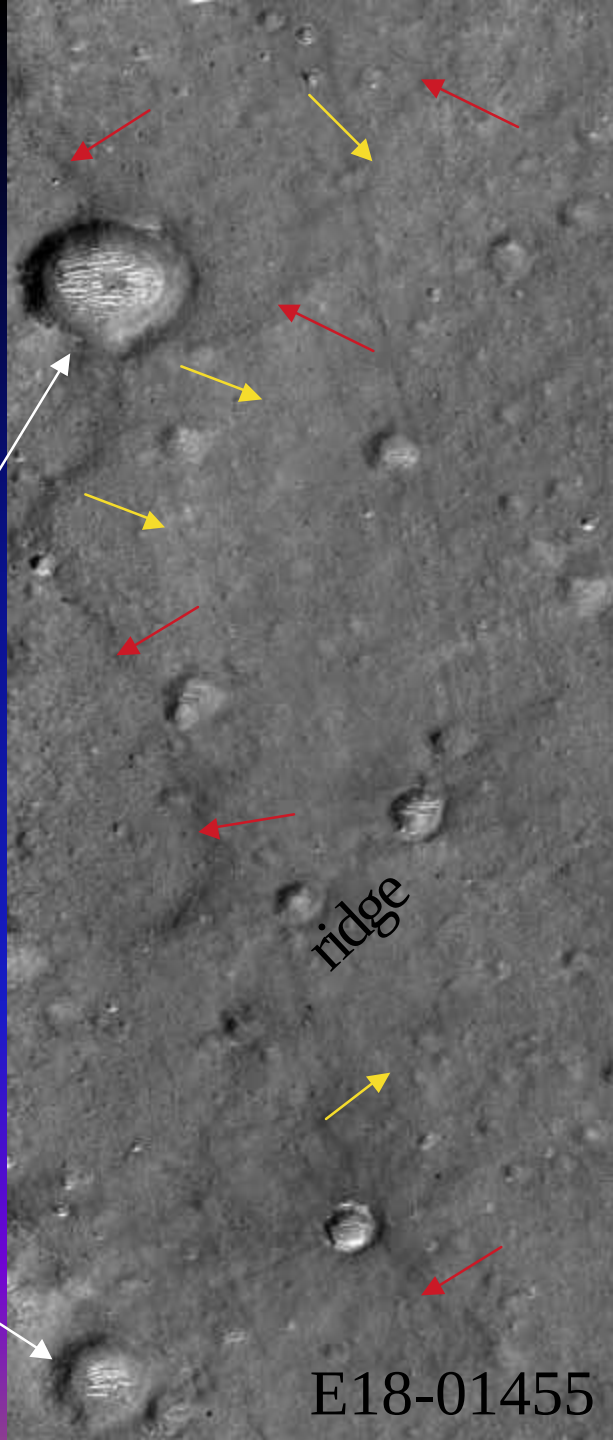




Left: Mass flows (?) in plains near base of Terra Cimmeria south of MER ellipse

Right: Examples of scarps bounding rougher flow A (red arrows) and flow B (yellow arrows); flow A surrounds dome. North central part of ellipse.

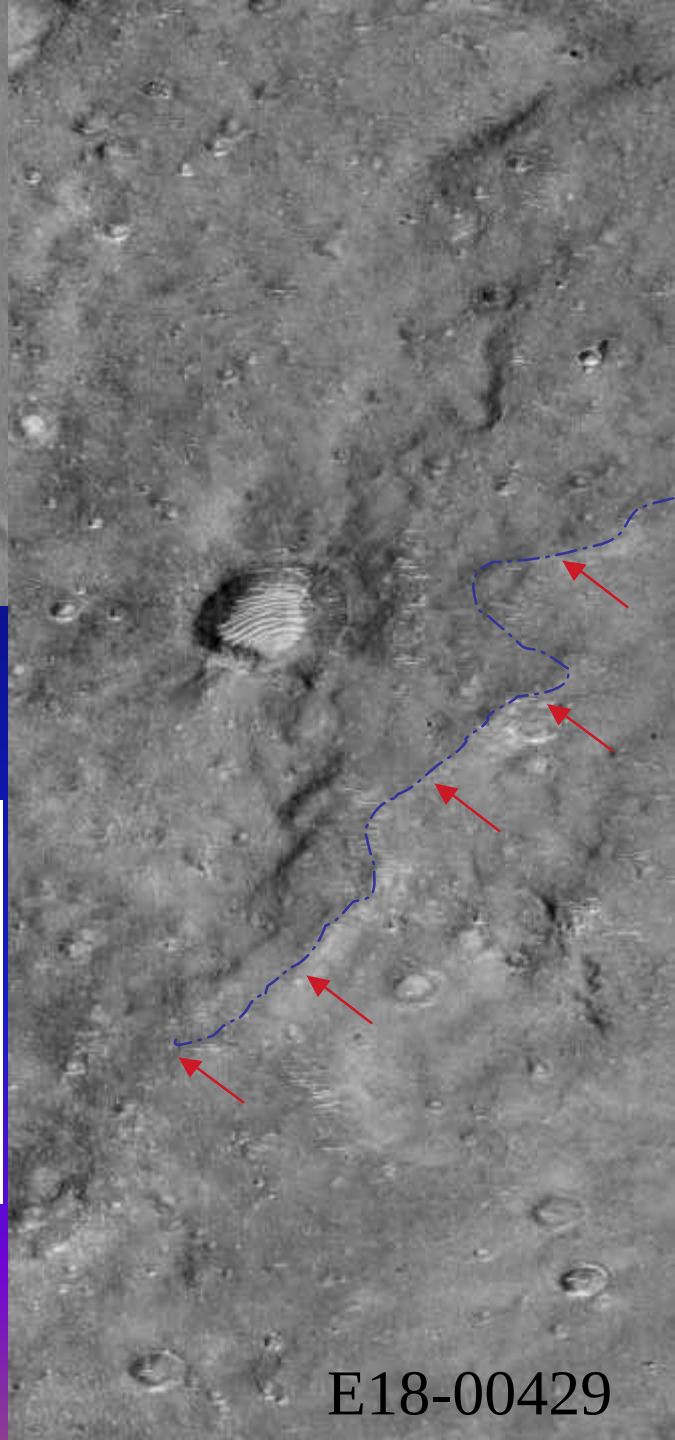




Discharge sites of Hephaestus Fossae

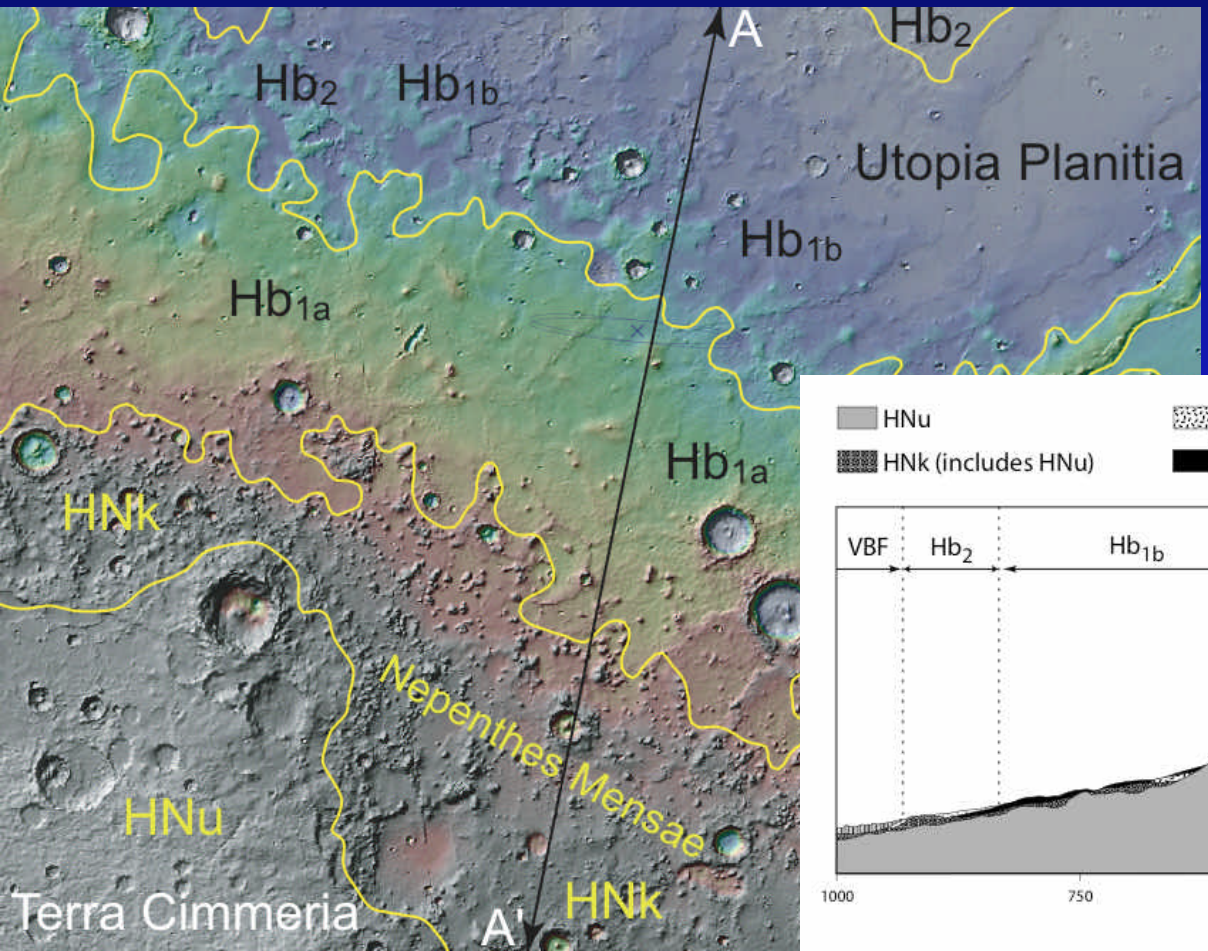
Spring discharges?

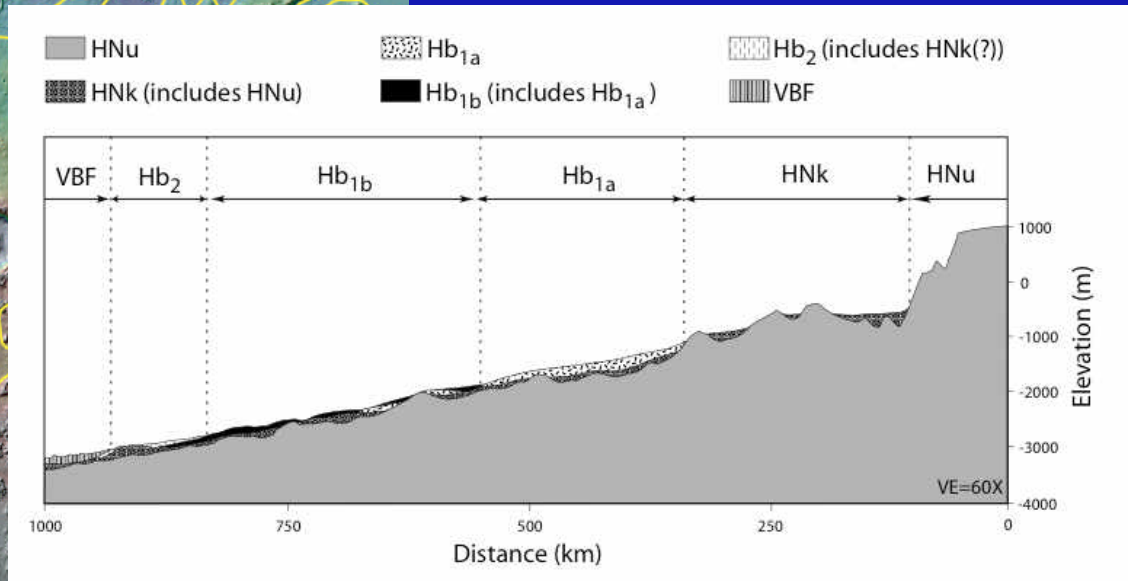
Possible channel at base of wrinkle ridge, north-central part of ellipse



MER "Elysium" Site Regional Geology

- Degraded highland boundary
- Series of eroded units and plains materials
- Vastitas Borealis Formation lies below





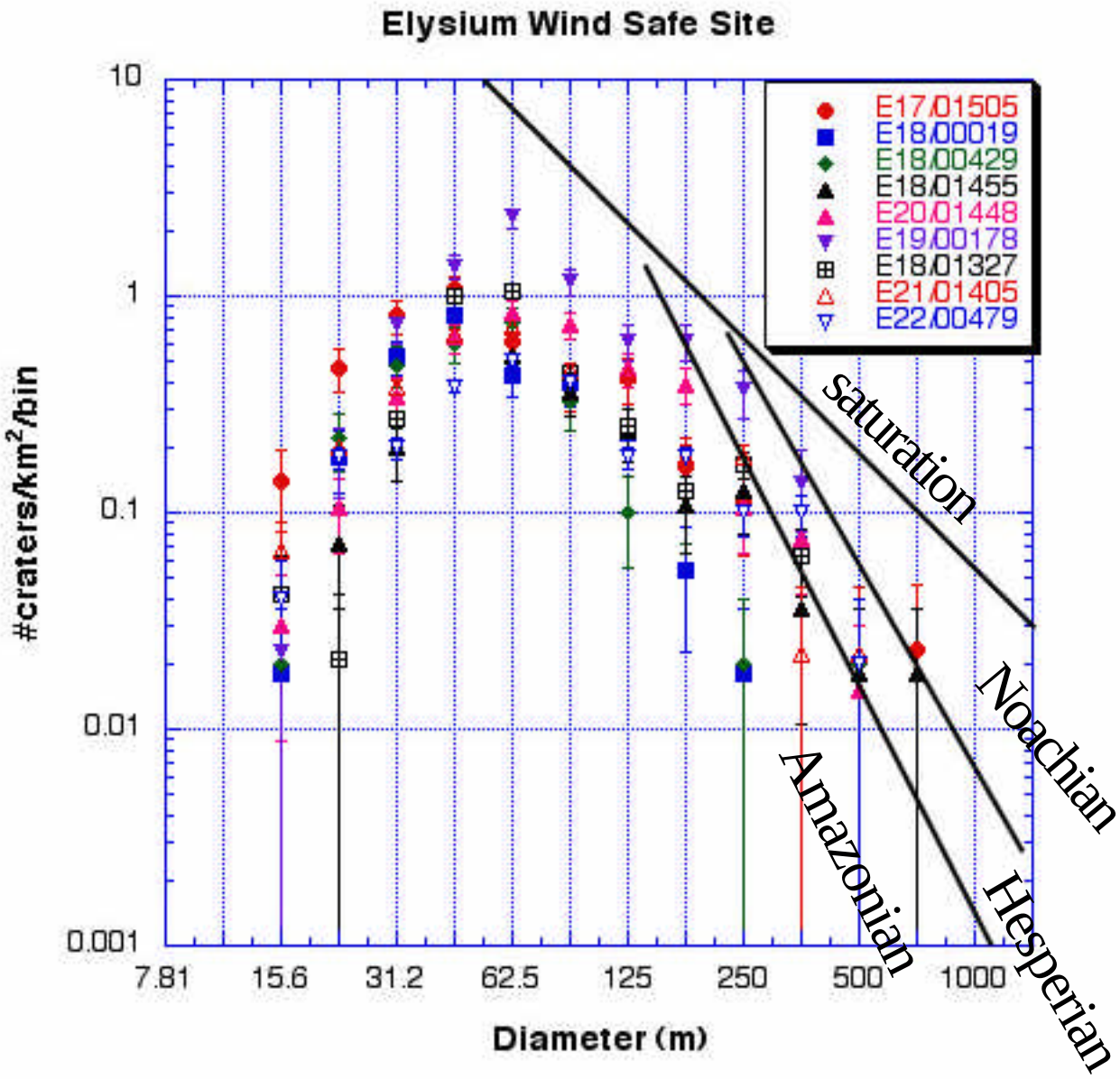
Regional unit crater densities

Unit	Unit symbol	Superposed or total count	Area (10^6 km^2)	N(5)	N(16)	Age[1]
Elysium channeled material	Aech	s	2.06	73±6[2]	5±2[2]	EA
Elysium lobate material	Ael	s	1.22	91±9[2]	7±3[2]	EA
Vastitas Borealis Formation	AHv	s	3.64	77±5	4±1	LH/EA
Boundary plains unit 2	Hb_2	s	0.33	79±16	3±3	LH
Boundary plains smooth unit	Hbs	s	0.23	151±26	4±4	EH
Boundary plains unit 1b	Hb_{1b}	s	0.26	151±24	34±11	EH
Boundary plains unit 1b	Hb_{1b}	t	0.26	204±28	49±14	LN/EH
Boundary plains unit 1a	Hb_{1a}	s	0.51	172±18	24±7	EH
Boundary plains unit 1a	Hb_{1a}	t	0.51	180±19	26±7	EH
Knobby unit	HNk	s	0.46	201±21	50±11	LN/EH
Knobby unit	HNk	t	0.46	233±23	72±13	LN
Highland material	HNu	t	0.49	571±34	173±19	N/EH

Based on data of N.G. Barlow

MOC NA crater counts

Analysis: Broad arch in western part of ellipse appears to be Early Hesperian; other lower surfaces covered by flows and domes largely Late Hesperian to Early Amazonian

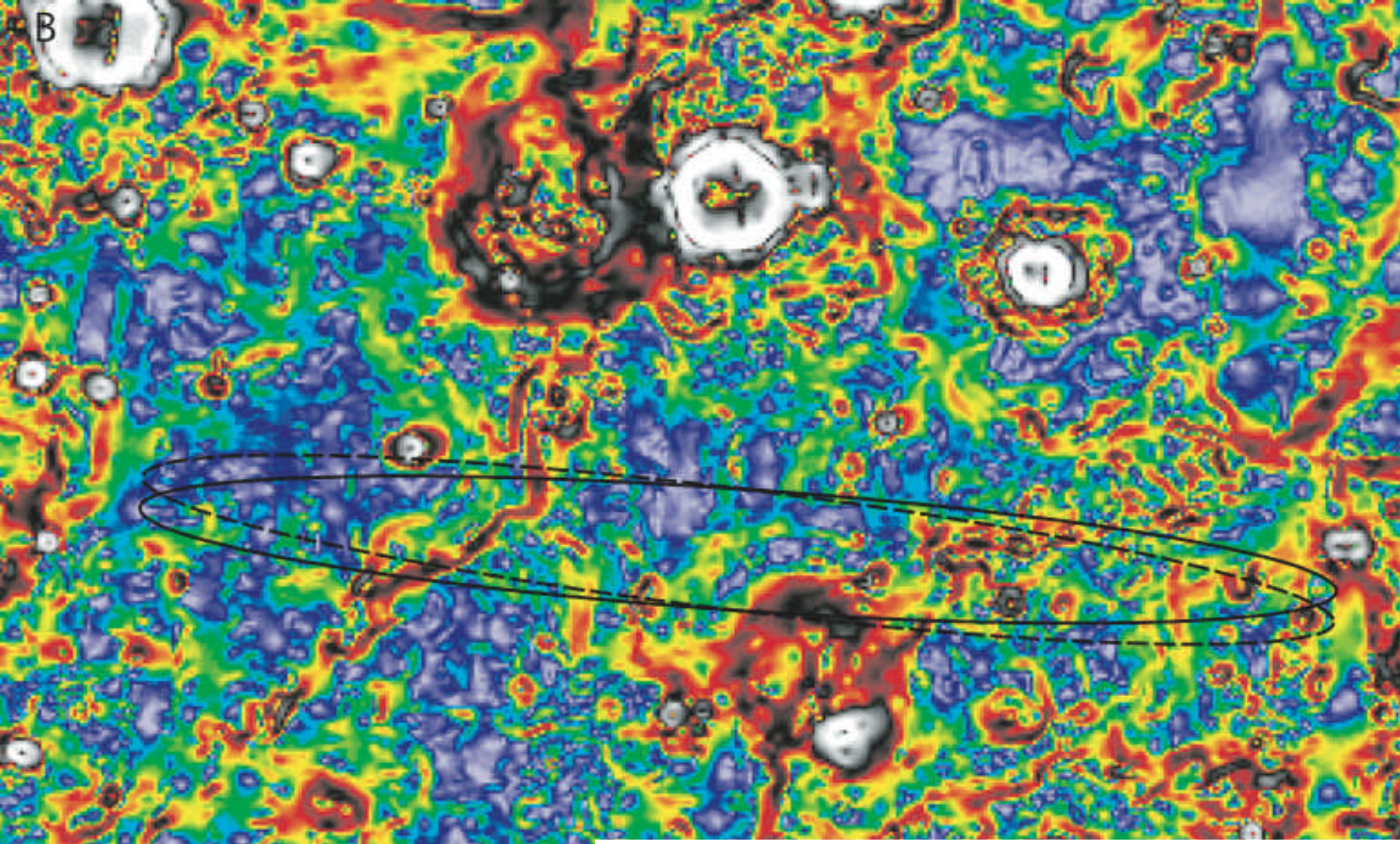


“Elysium” ellipse geologic history

- LN/EH: Highland boundary degradation; mass wasting, collapse [Tanaka et al.]; intrusion? [Squyres, Wilhelms et al.]; volcanic resurfacing? [Head et al.]
- EH/LH: Tectonic contraction, indicative of mechanical discontinuity 2 km depth [Okubo]; marine sedimentation? [Parker]
- LH/EA: Local collapse?; mud/silicate volcanic resurfacing; minor contraction; spring discharge along faults?
- LA: Local dune formation in craters and along scarps

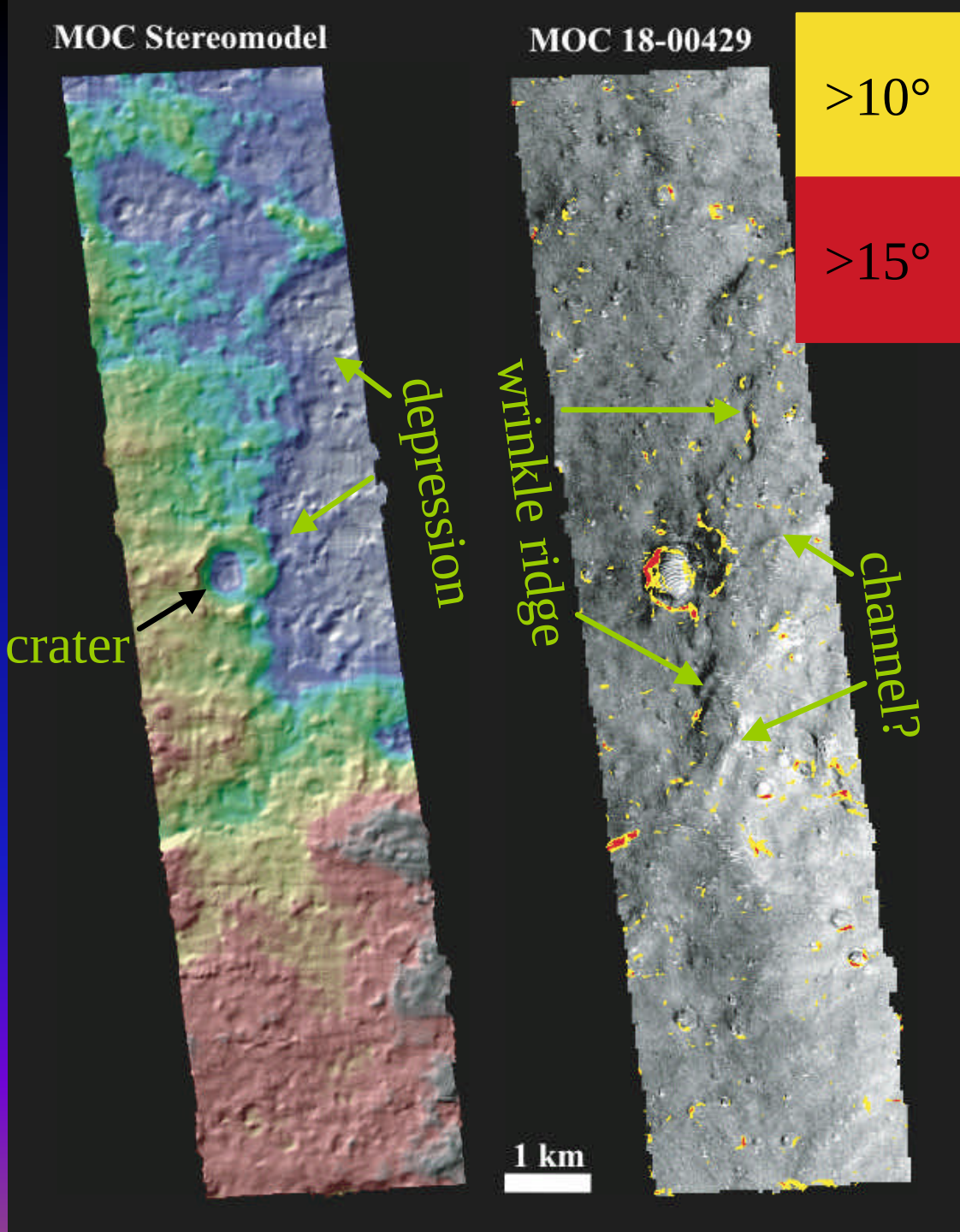
Landform Interpretations

+ = *supports* --- = *N/A or equivocal*	Lava flows	Marine sediments	Highland colluvium	Mud volcanism
Highland boundary setting	---	+	+	+/---
Large knob and bench	---	+	+	---
Small knobs/ low domes	+/---	+/---	---	+
Wrinkle ridges	+	---	---	---
Thin flows	+/---	+/---	+	+
Depressions	---	---	---	+

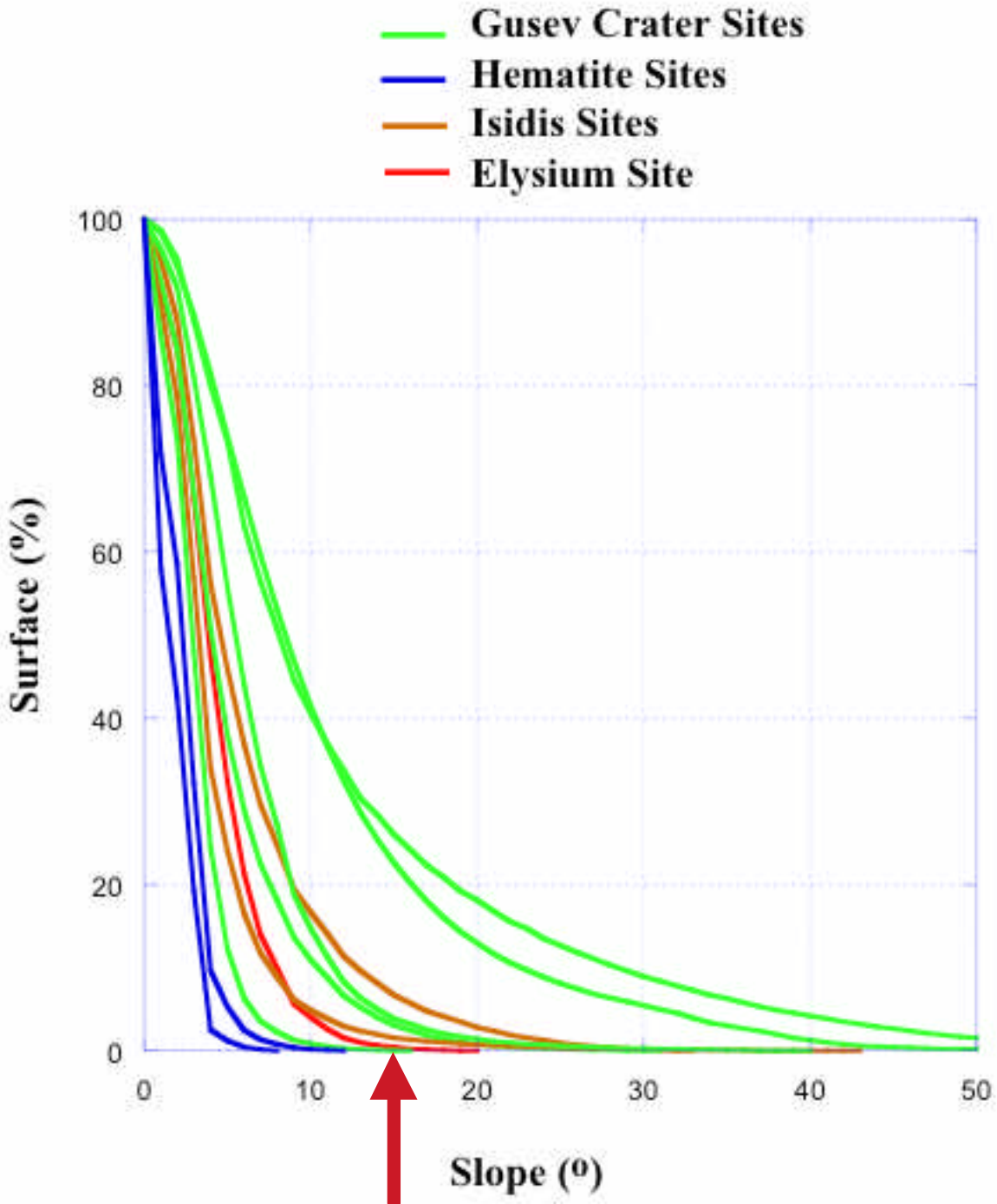


- MOLA 1/128° DEM (~460 m/pixel)
- Slope range: 0 to 6.75°
- Slope mean/median: 0.773°/0.612°

- 1 model, 10 m/pixel [Kirk et al.]
- 0 to 34° slope range
- >15° =0.46%, >10° =4.1%
- Slope mean = 3.8° (Meridiani < Elysium < Isidis < Gusev)
- Hazards = mostly rims of craters >200 m in diameter; wrinkle ridge and trough scarps
- Other parts of ellipse would have comparable to moderately higher slopes
- Depression formed by collapse?

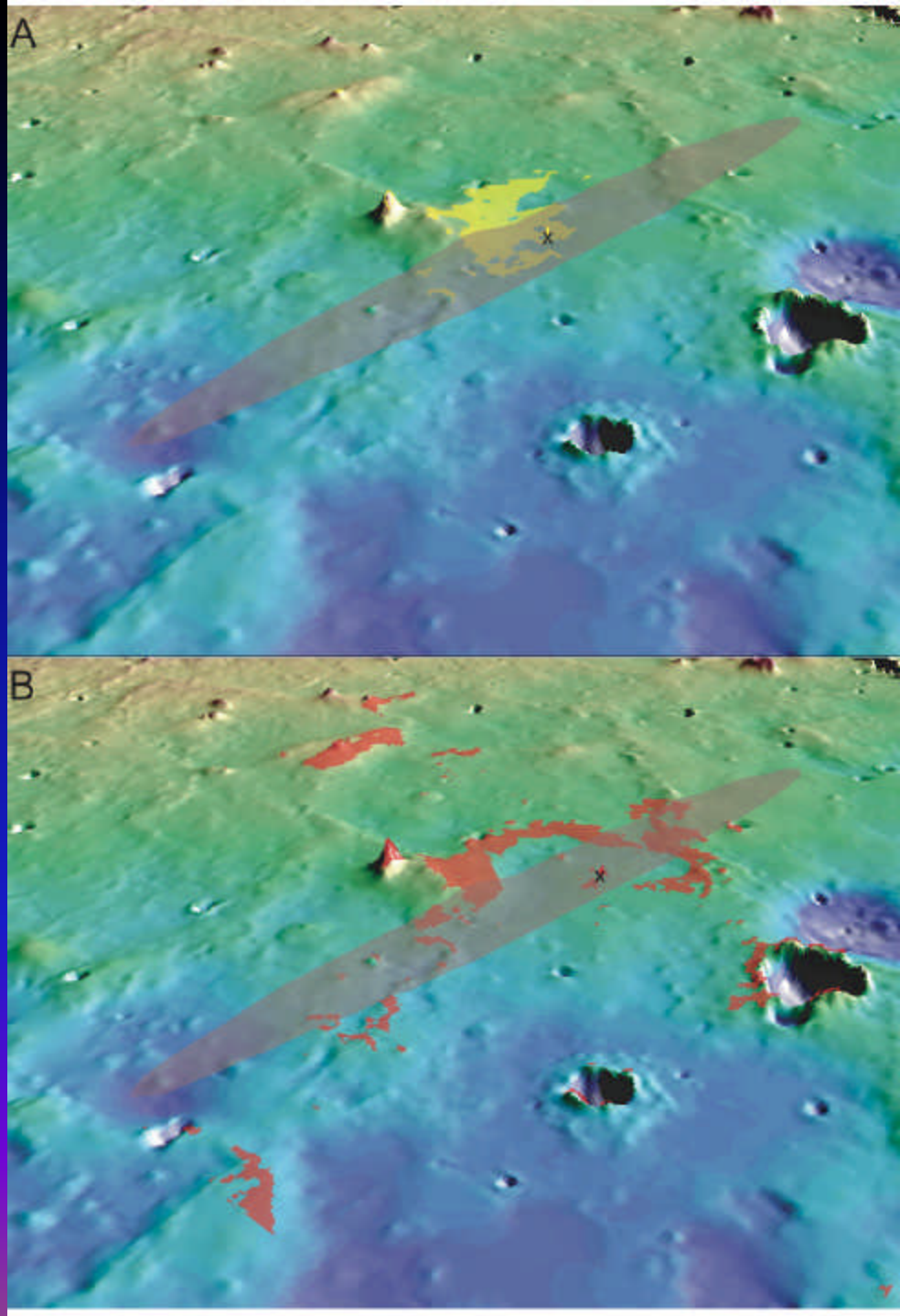


Slopes in MOC stereo: Roughness mainly function of crater density?



Rover "Viewsheds"

- Line-of-sight landscapes seen from rover based on MOLA DEM
- *Top:* From center of ellipse (within trough)
- *Bottom:* From high area near ellipse center



Science Investigations for Athena Payload

Key Observations

Testable Hypothesis	Mineralogy/ composition (MT, MS, MI, APXS, RAT)	Morphology (PC)	Rock texture and fabric (MI, PC, RAT)	Rock physical properties (RAT)
Highland colluvium; H_2O weathering	Mixture, hydrous	Terraces, flows	Poorly sorted, some rounding	Poorly consolidated
Mud volcanism, intrusion	Mixture, hydrothermal	Flows, vents, karst, dikes	Layering, soft sediment deformation, breccia	Poorly consolidated
Lava flows and vents	Lava	Flows, vents	Porphyritic, vesicles, jointing	Breccia
Marine sediments	Evaporites	Shorelines, ripple marks	Fines, sorted, layers, rounding	Poorly consolidated
Spring discharges	Evaporites, detritus	Channels, tufa, structure	Variable	Variable

MT=MiniTES, MS=Mössbauer Spectrometer, MI=Microscopic Imager; PC=PanCam

“Elysium” site science pros and cons

Pros

- Sample Noachian highland, dissected rocks
- Sample Hesperian lowland sediment
- Assess highland/lowland boundary geology
- Possible mud volcanism and spring discharge
- Relatively simple geologic setting
- Well-defined, testable hypotheses

Con

- May be primarily volcanic