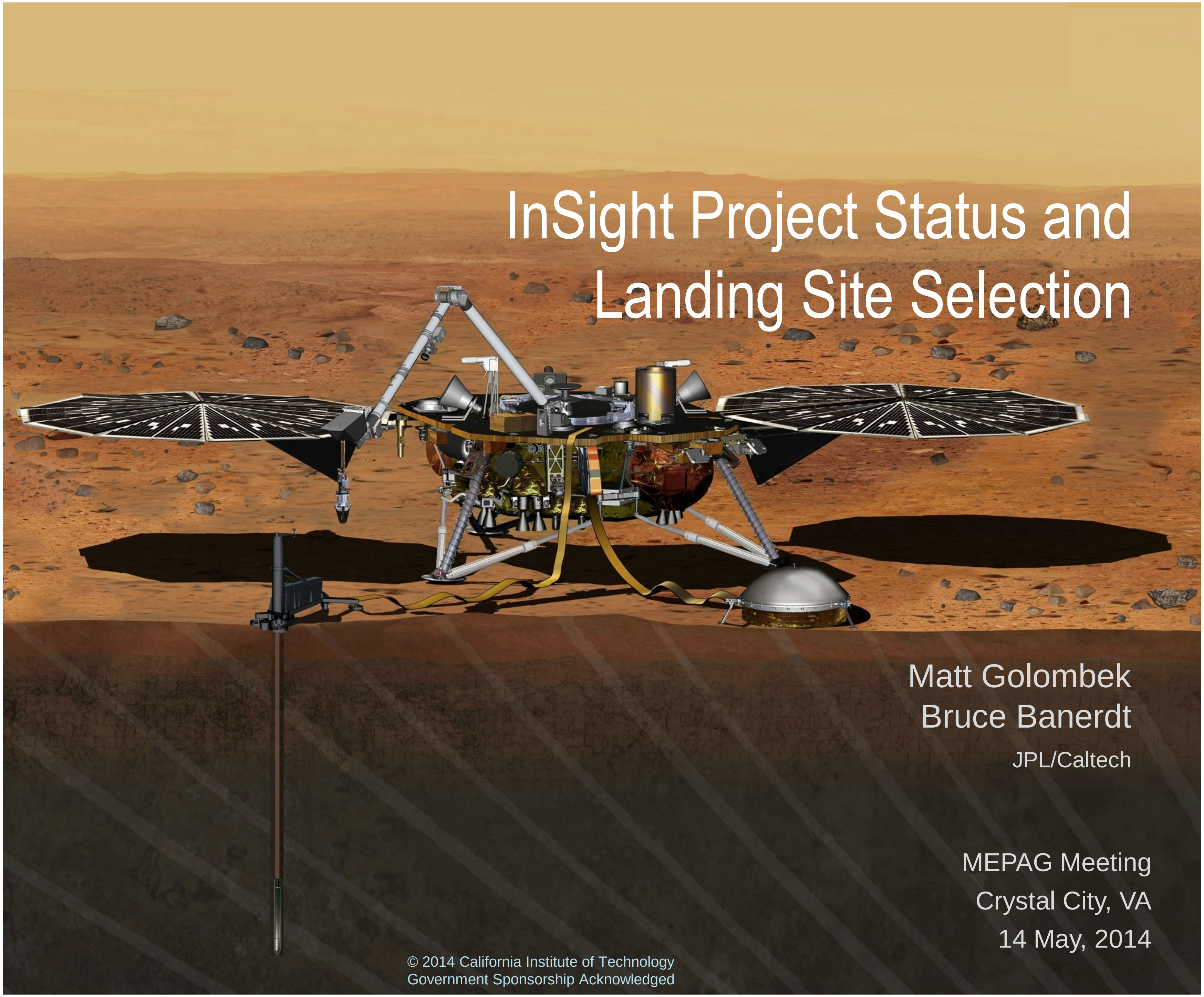
InSight Project Status and Landing Site Selection



Matt Golombek
Bruce Banerdt
JPL/Caltech

MEPAG Meeting
Crystal City, VA
14 May, 2014

InSight Science Goal:

Understand the formation and evolution of terrestrial planets through investigation of the interior structure and processes of Mars.

Directly Addresses NASA SMD and 2011 Decadal Survey Objectives:

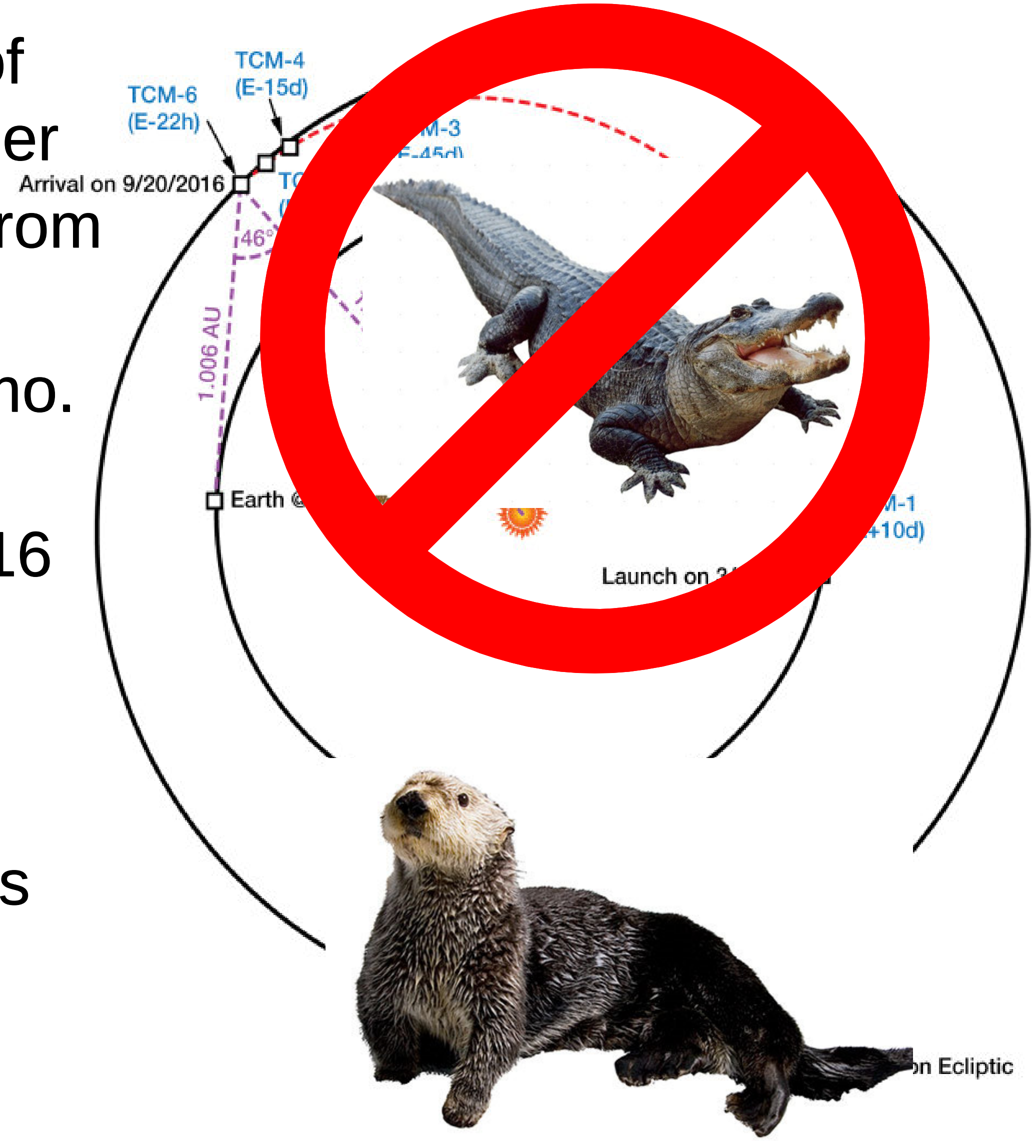
- "Understand the origin and diversity of terrestrial planets."
- "Understand how the evolution of terrestrial planets enables and limits the origin and evolution of life."

InSight Will Measure Interior Structure with Unprecedented Precision

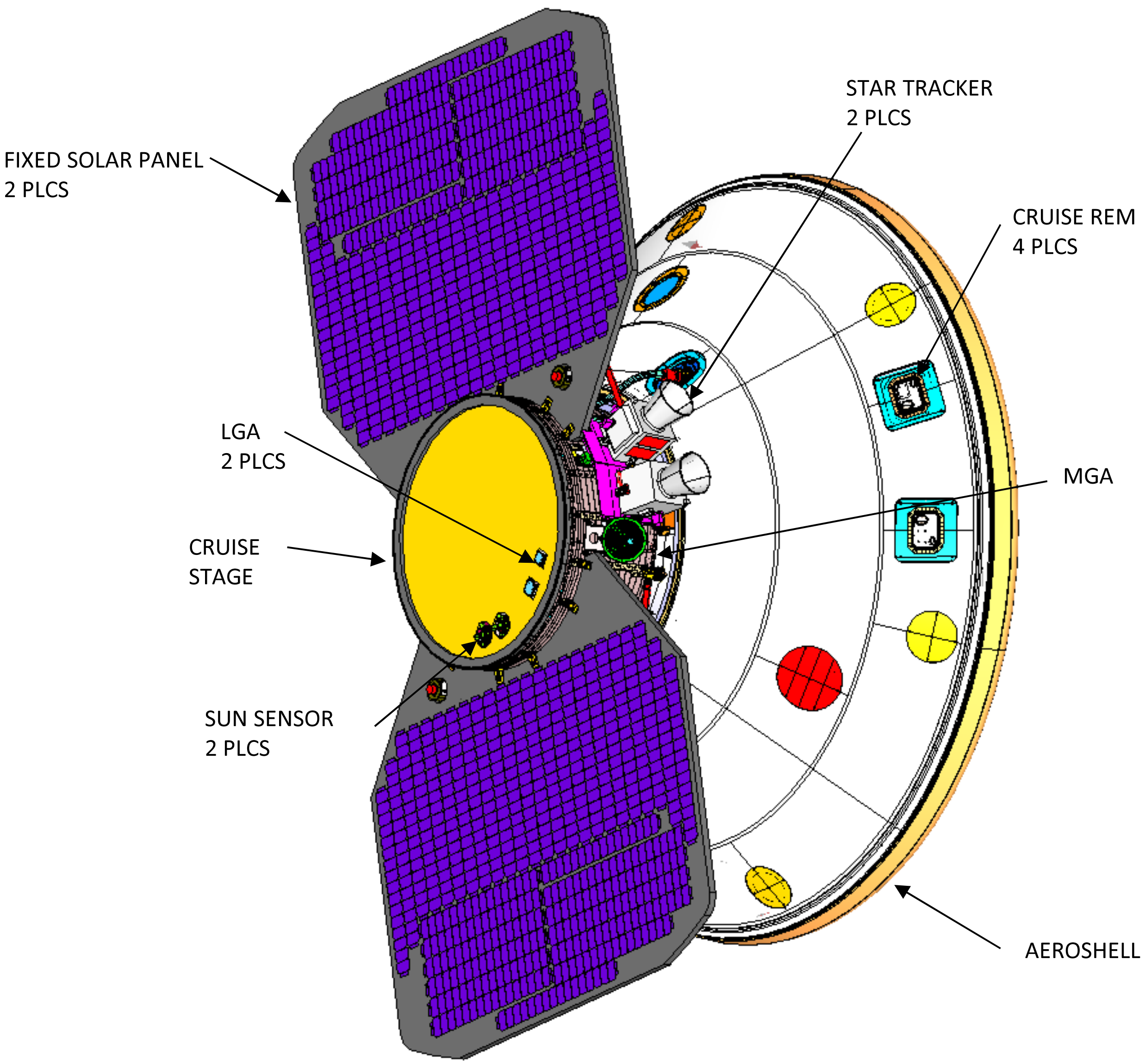
Measurement	Current Uncertainty	InSight Capability	Improvement
Crustal thickness	65±35 km (inferred)	±5 km	7X
Crustal layering	no information	resolve 5-km layers	New
Mantle velocity	8±1 km/s (inferred)	±0.13 km/s	7.5X
Core liquid or solid	“likely” liquid	positive determination	New
Core radius	1700±300 km	±75 km	4X
Core density	6.4±1.0 gm/cc	±0.3 gm/cc	3X
Heat flow	30±25 mW/m^2 (inferred)	±3 mW/m^2	8X
Seismic activity	factor of 100 (inferred)	factor of 10	10X
Seismic distribution	no information	locations ≤10 deg.	New
Meteorite impact rate	factor of 6	factor of 2	3X

InSight Mission Summary

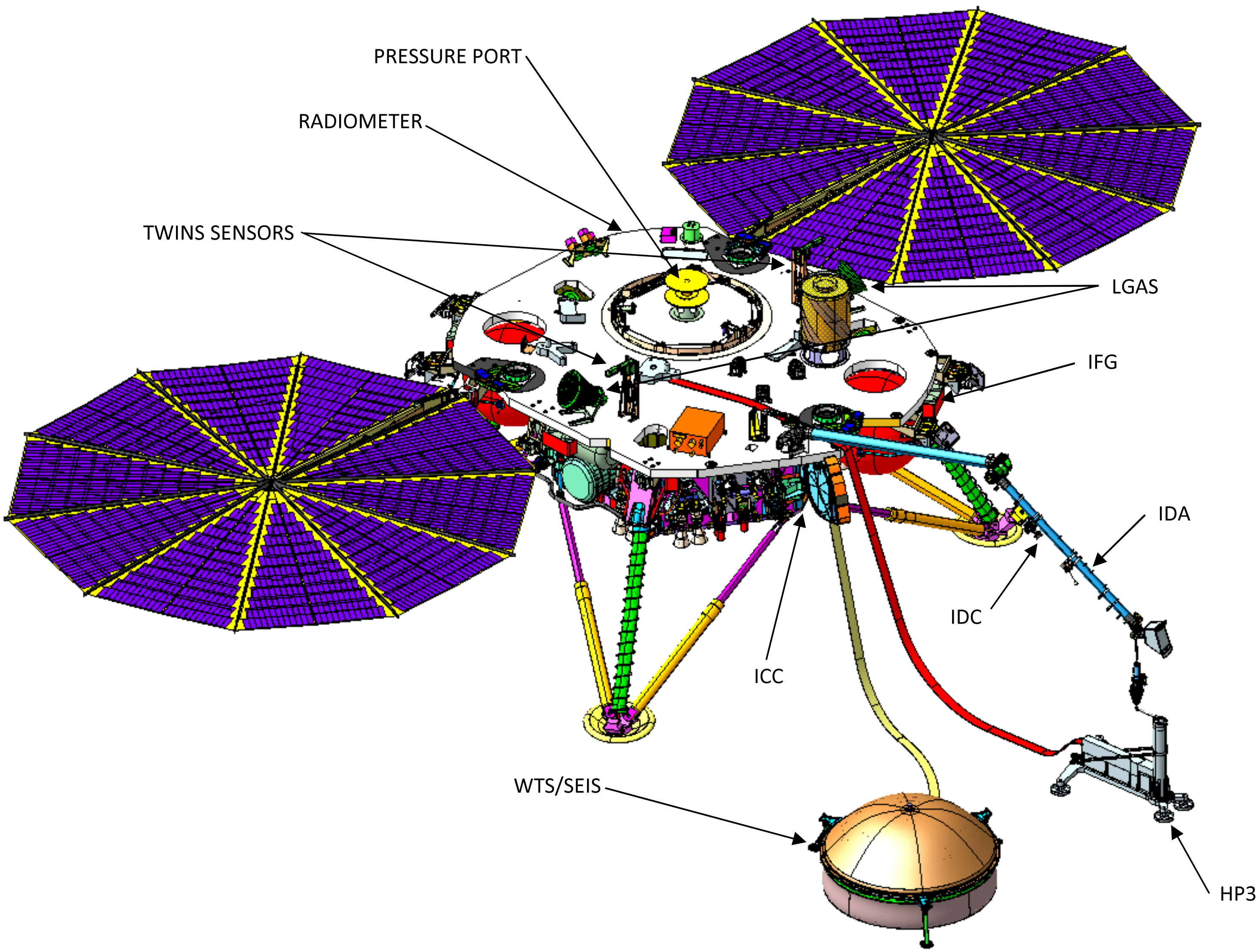
- InSight will fly a near-copy of the successful Phoenix lander
- Launch: March 4-24, 2016 from **Vandenberg AFB**
- Fast, type-1 trajectory, 6.5-mo. cruise to Mars
- Landing: September 28, 2016
- 67-sol deployment phase
- Two years (one Mars year) science operations on the surface; repetitive operations
- Nominal end-of-mission: October 6, 2018



InSight Spacecraft: Cruise Configuration



Instruments Deployed



InSight Payload

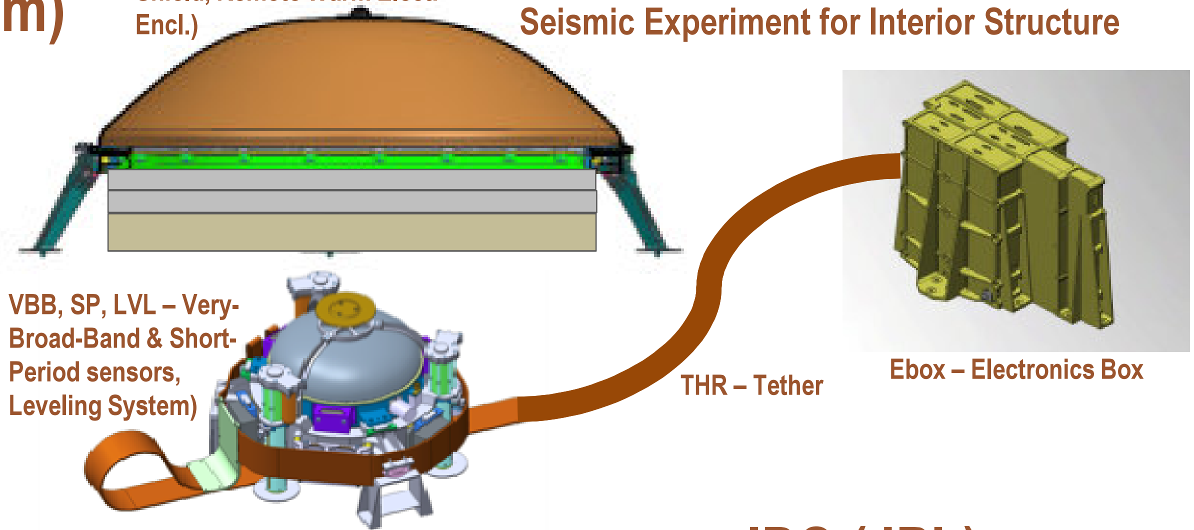
Small Deep Space Transponder

RISE (S/C Telecom)

Rotation and Interior Structure Experiment

SEIS (CNES) (also IPGP, ETH/SSA, MPS/DLR, IC/Oxford/UKSA, JPL/NASA)

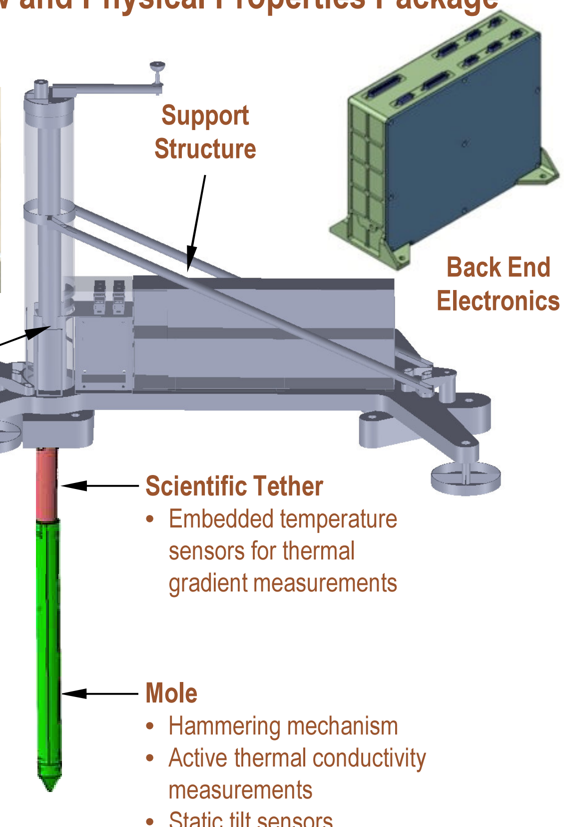
Seismic Experiment for Interior Structure



HP^3 (DLR)

Heat Flow and Physical Properties Package

Radiometer



Pressure Sensor (Tavis)

TWINS (CAB) – Temp. and Wind for INSight

IFG (UCLA) InSight Fluxgate

APSS (JPL)

Auxiliary Payload Sensor Suite

IDS (JPL)

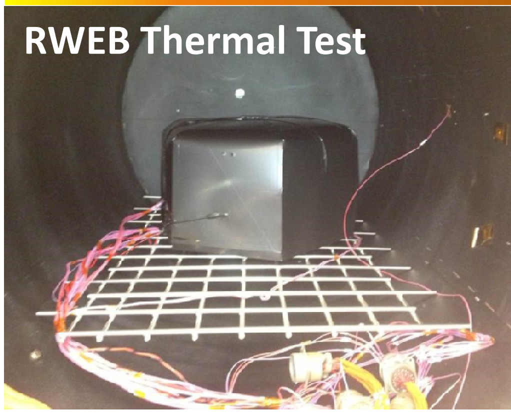
Instrument Deployment System

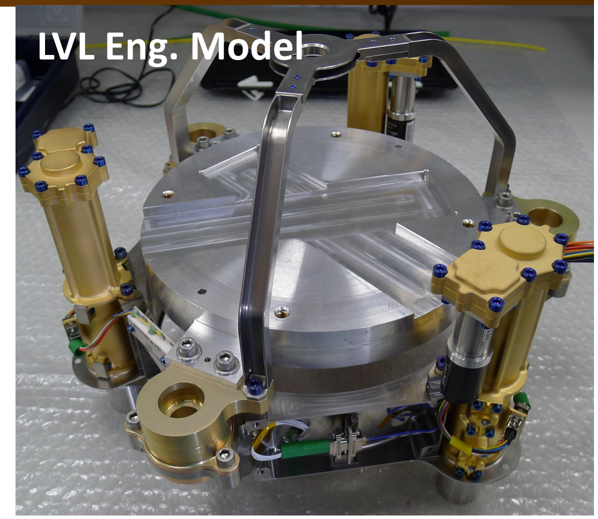
IDA – Instrument Deployment Arm

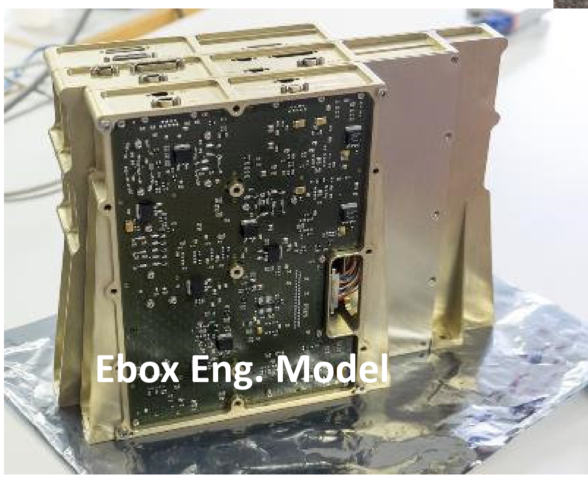
IDC – Instrument Deployment Camera

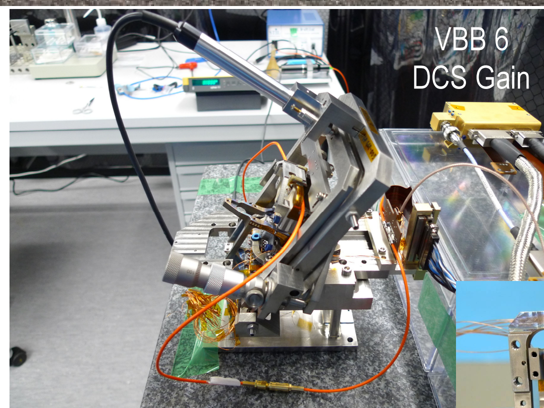
ICC – Instrument Context Camera

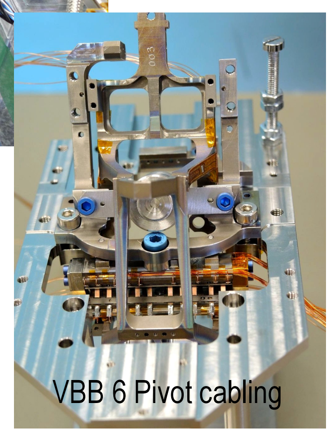
SEIS Development Proceeding on Tight Schedule



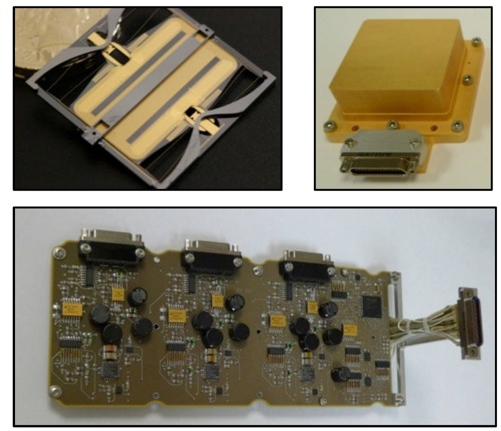




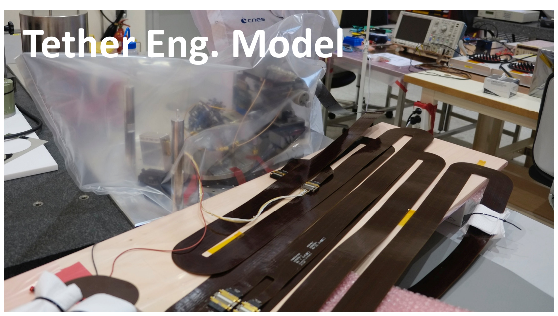




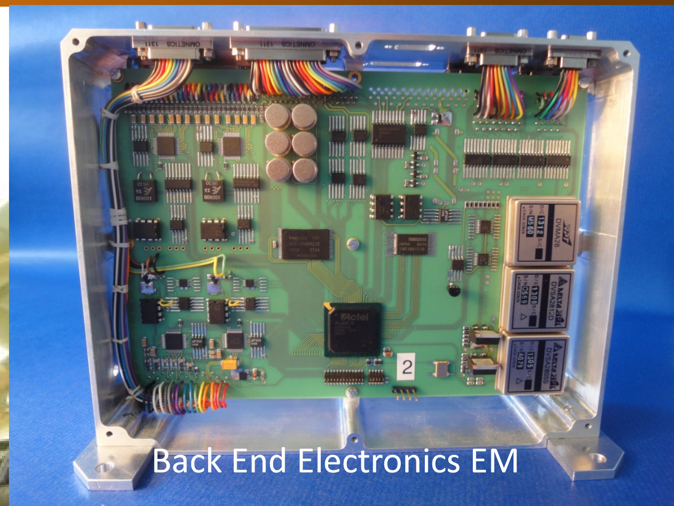
VBB Qual. Model



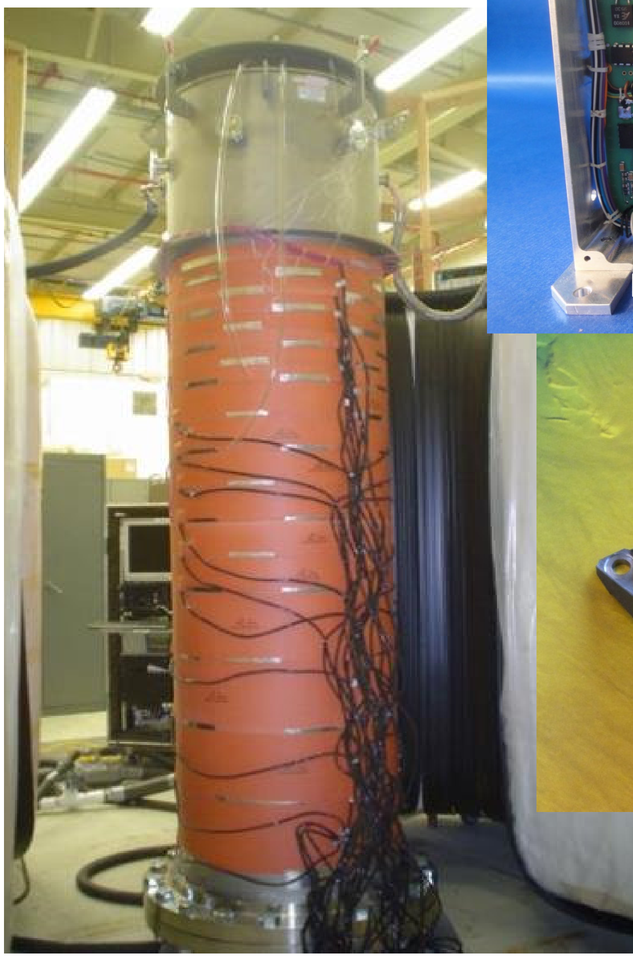
SP EM Sensor and Electronics



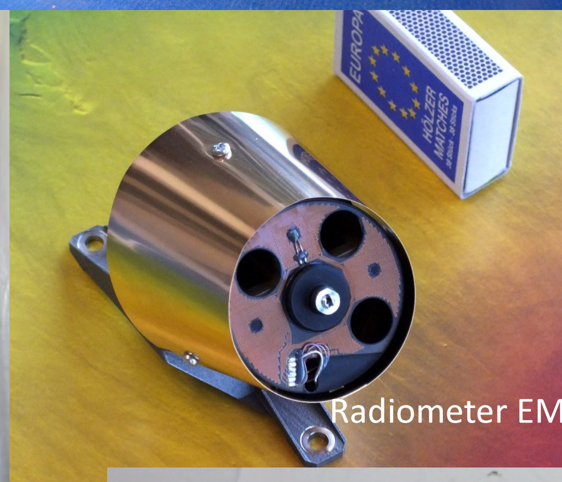
HP^3 Back on Track After Mole Redesign



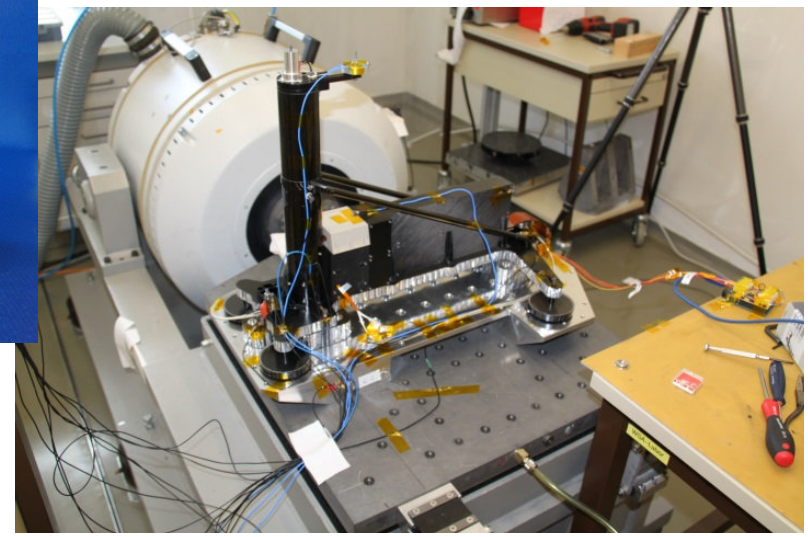
Back End Electronics EM



Geothermal Test Bed (GTB) @ JPL

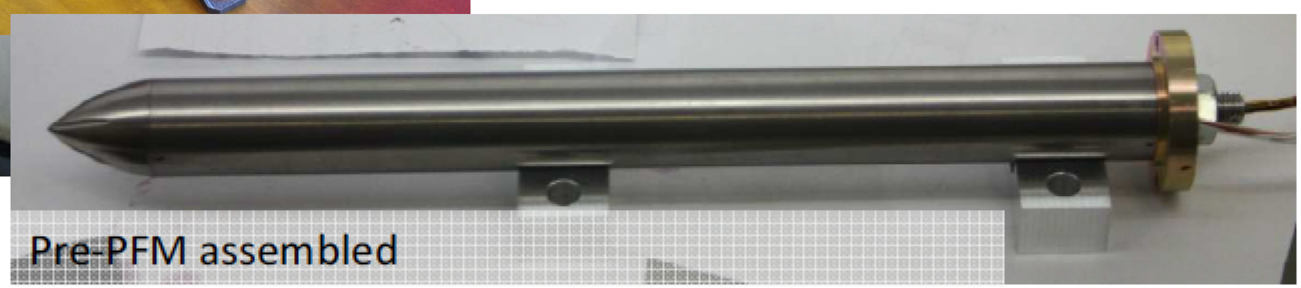


Radiometer EM



Support Structure EM
in Vibration Testing

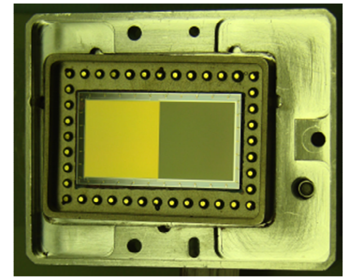
Mole Pre-Protoflight Model



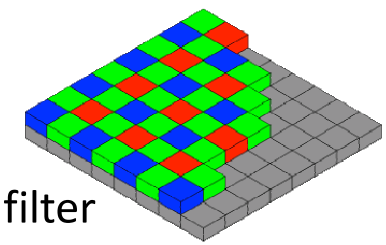
Pre-PFM assembled

Adding Color to Instrument Deployment Camera

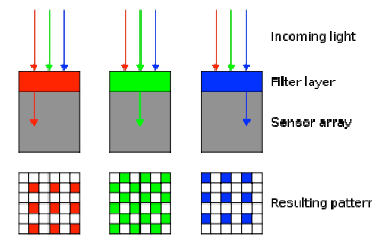
- Construct a color IDC camera by upgrading the CCDs in existing InSight spares.
- Continue with the existing BW cameras in the test bed and integration flow, and replace with color unit if this program is successful and on time.

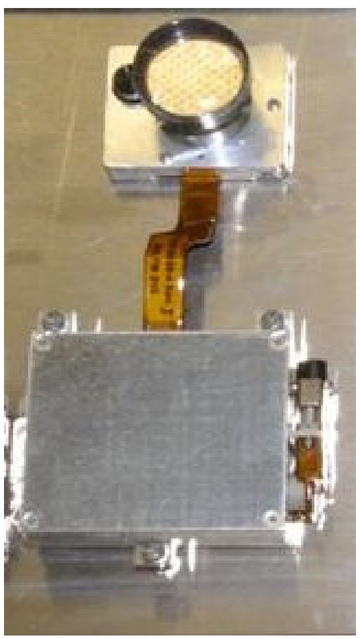


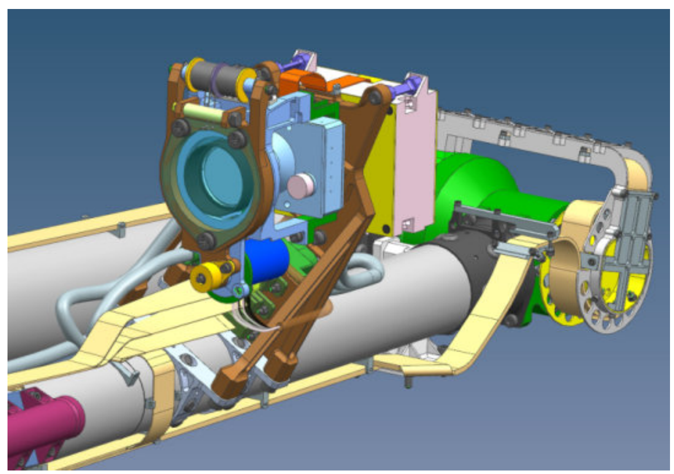
Existing CCD



Bayer filter



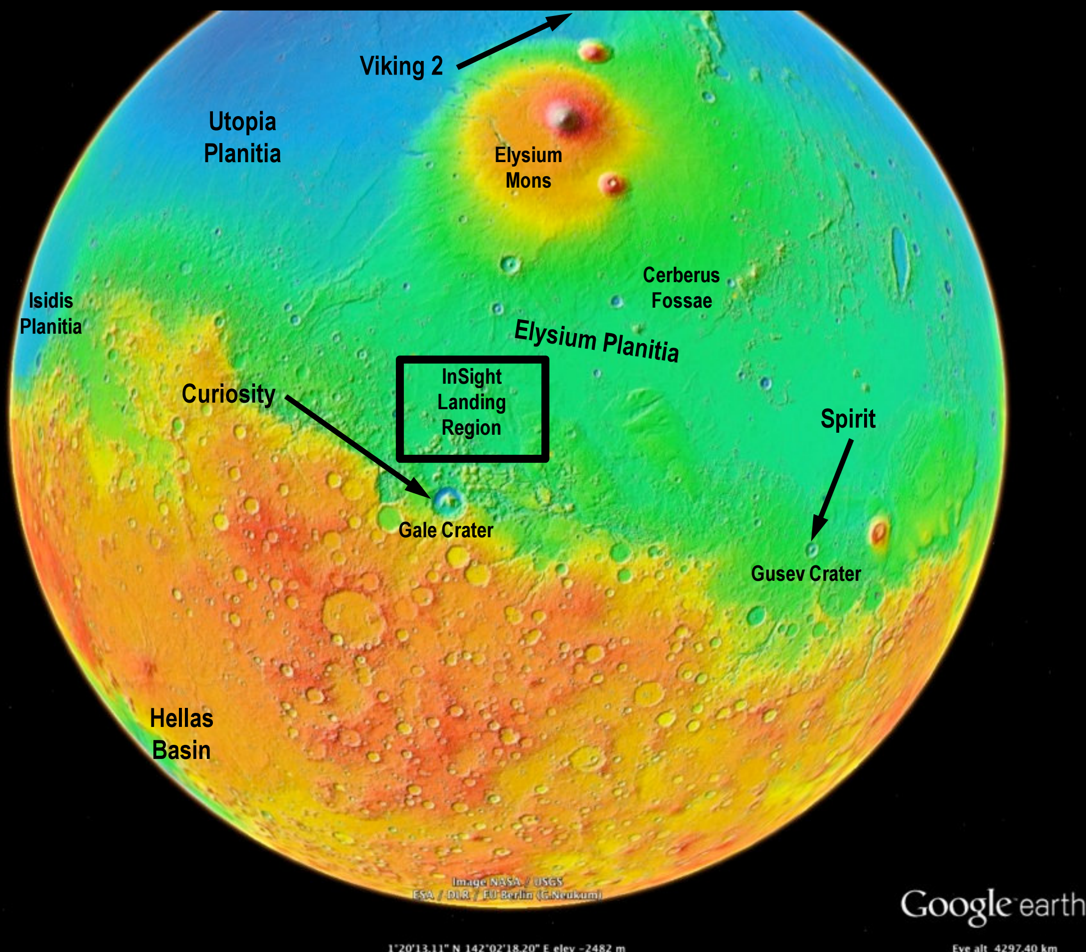




Status and Schedule – Key Milestones

- Passed PDR and Confirmation Review
  - In Development and Fabrication
- On Budget – Reserves Exceed NASA Guidelines
- On Schedule – Margins Exceed what Proposed
- Instrument & System Capabilities Exceed All Science Reqs
- May 2014: Critical Design Review
- October 2014: System Integration Review
- January 2015: Deliver instruments to ATLO
- Participating Scientist Program
  - ~dozen new scientists before launch
- November 2015: Confirm landing site
- December 2015: Ship to Vandenberg
- March 2016: Launch
- September 2016: Landing
- October 2018: End of primary mission

InSight Landing Region: Elysium Planitia

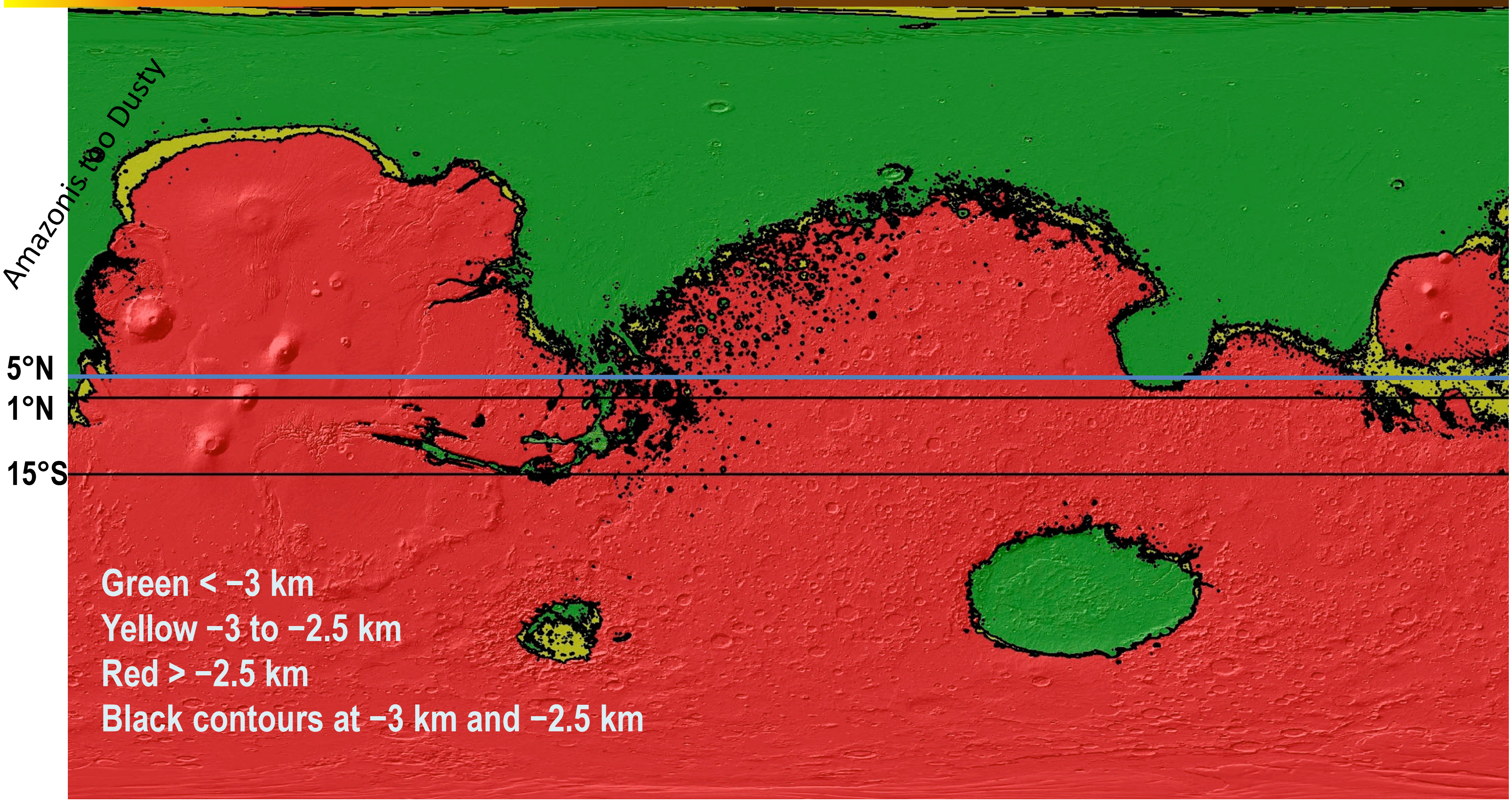


Landing Site Constraints

- **Latitude:** 15°S to 5°N: Sufficient Solar Power Margins
  - 5°N to 3°N, ~~2°S~~ Elysium Planitia; Thermal
- **Elevation:** <−2.5 km MOLA: Sufficient Atmosphere for EDL
- **Ellipse Size:** 139 km × 27 km [99.5% ellipse];
  - 130 x 27 km → 110 x 25 km
- **Thermal Inertia:** >100−140 J m^{-2} K^{-1} $s^{-1/2}$
  - Avoid surfaces with thick dust that is not loading bearing
  - Prefer ~200 J m^{-2} K^{-1} $s^{-1/2}$ for uncemented or poorly cemented soil
  - Radar reflective surface
- **Rock Abundance:** <10%
  - 99% Safe Landing and Opening Solar Panels
- **Smooth Flat Surface:** No large relief features
  - Slopes <15° for Safe Touchdown and Radar Tracking (1-5 m & 84 m)
- **Deploy Instruments: [<10% Rock Abundance, <15° Slope]**
- **Broken up regolith >5 m thick:** Hesperian Cratered Surface
  - Penetration of the Mole

No Other Science Requirements: Just Land Safely

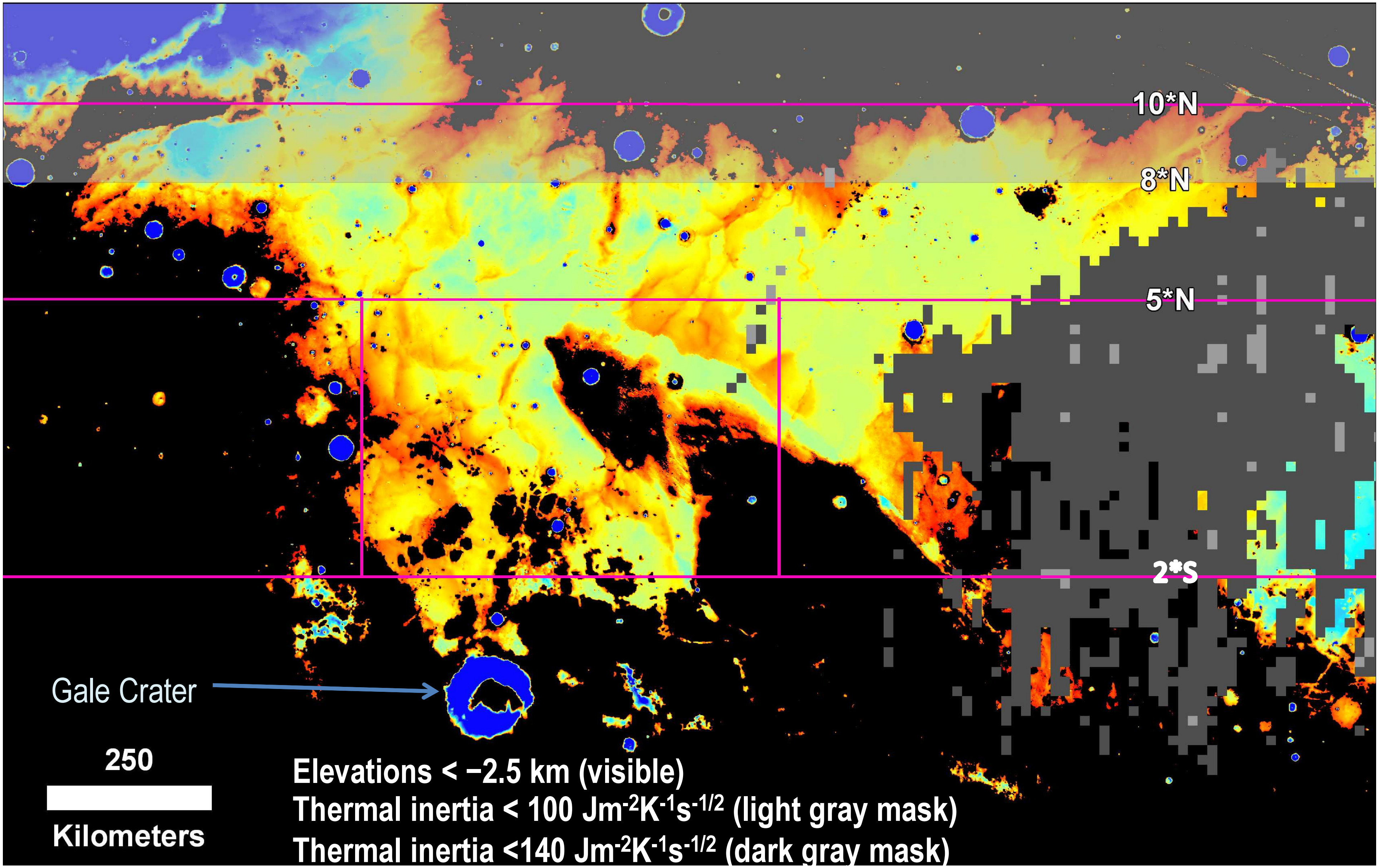
Global Latitude and Elevation



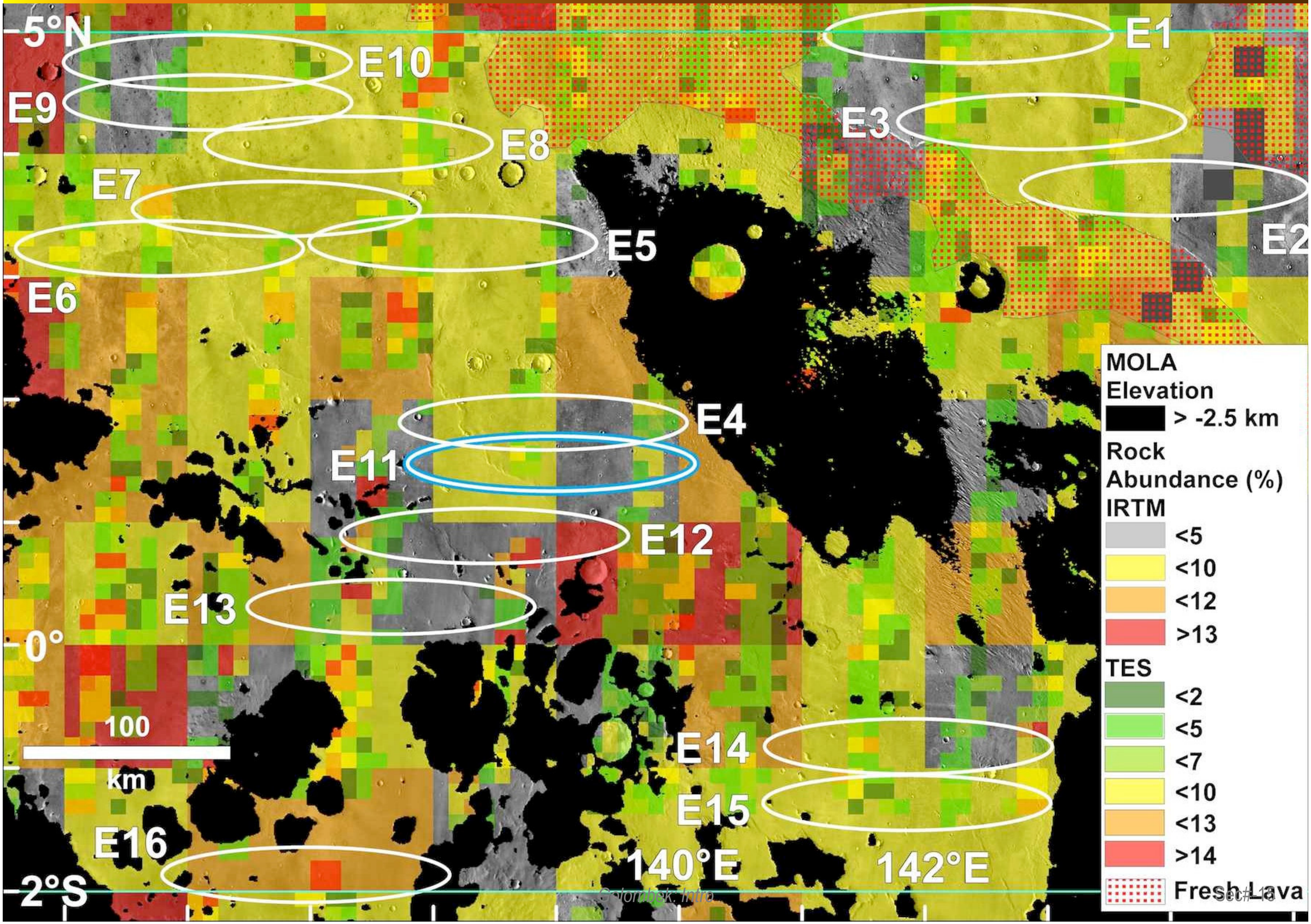
Valles Marineris & S Chryse Outflow
S Isidis Planitia
Both Rocky
Elysium

Expect S Chryse and Isidis Windy
GCMs Storm Tracks High N Lat.
Valles Marineris Canyons Windy
S Elysium Low Winds

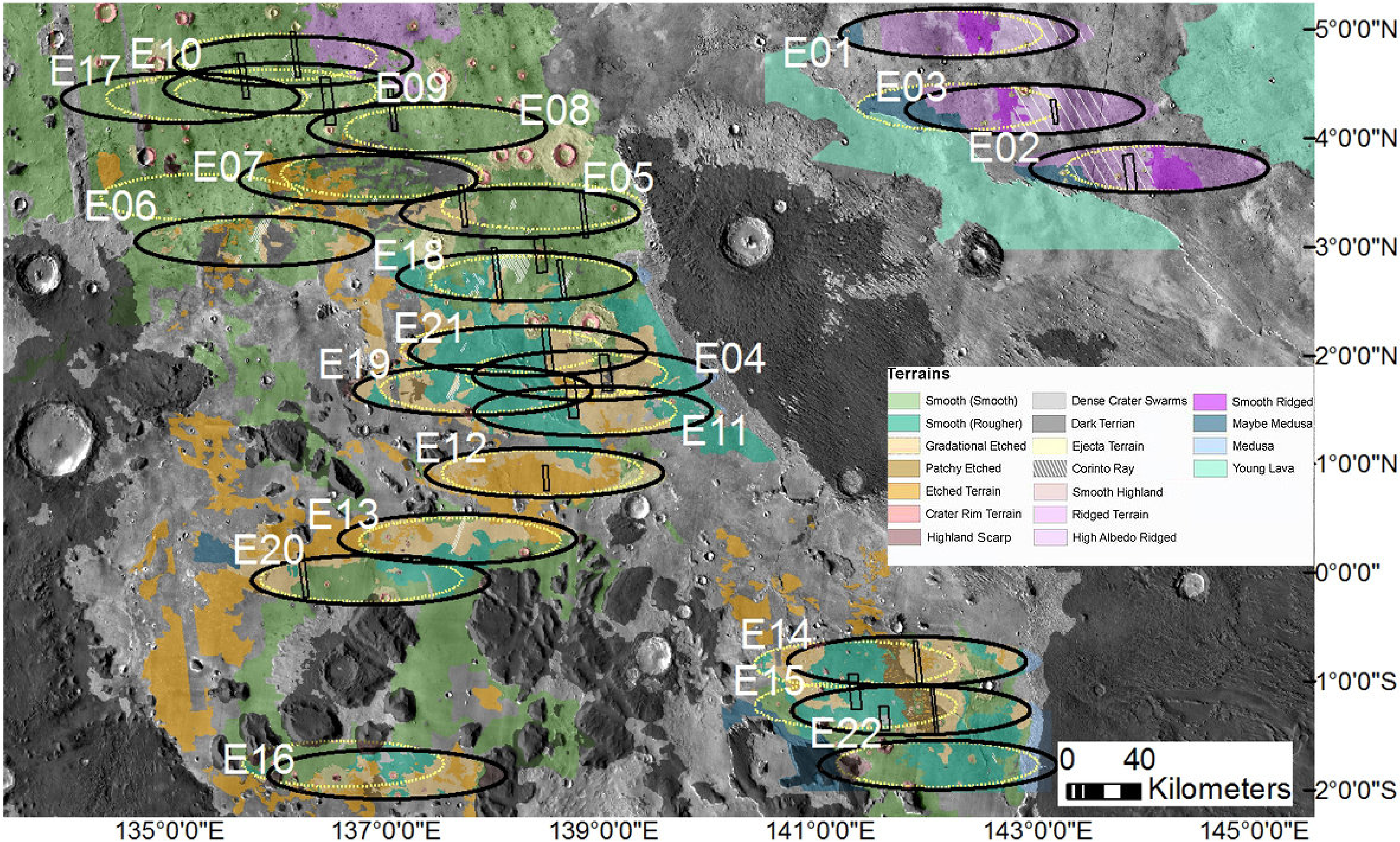
Elysium Planitia Elevation, Latitude & Thermal Inertia



Elysium Planitia InSight Ellipses at End Phase A



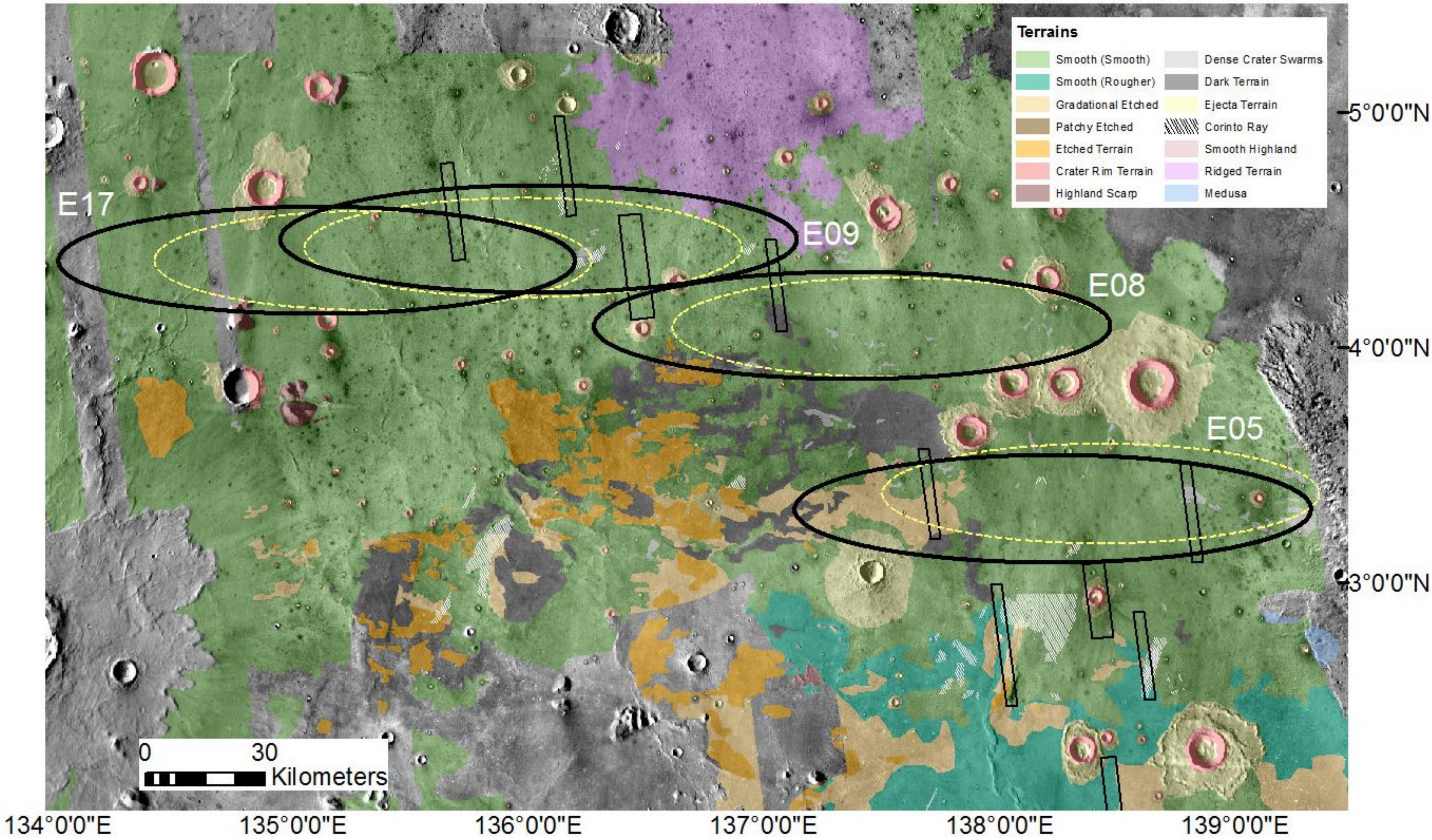
Terrain Map & Ellipses



Prior to Downselection

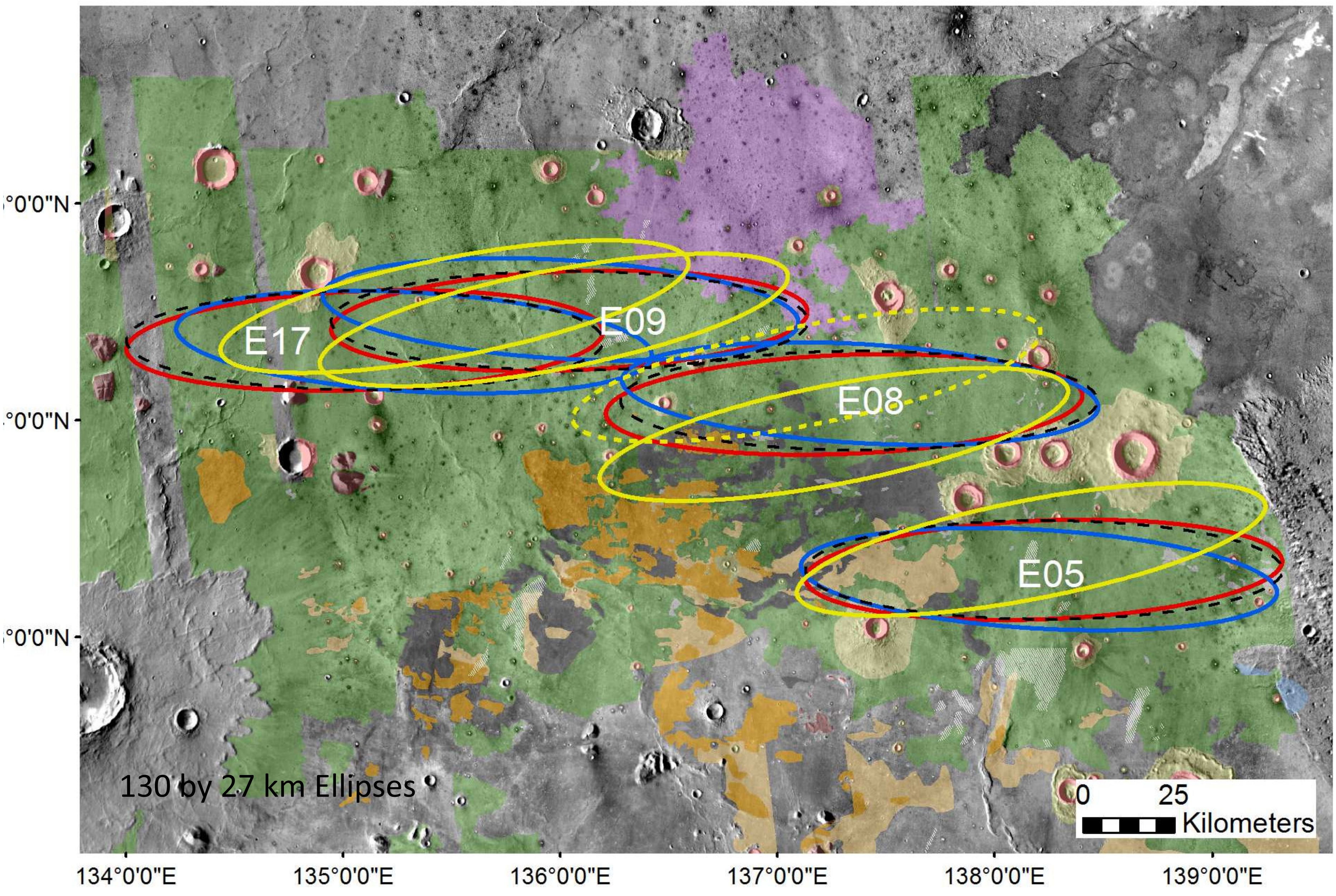
20 HiRISE Footprints at PDR

Final Four Ellipses

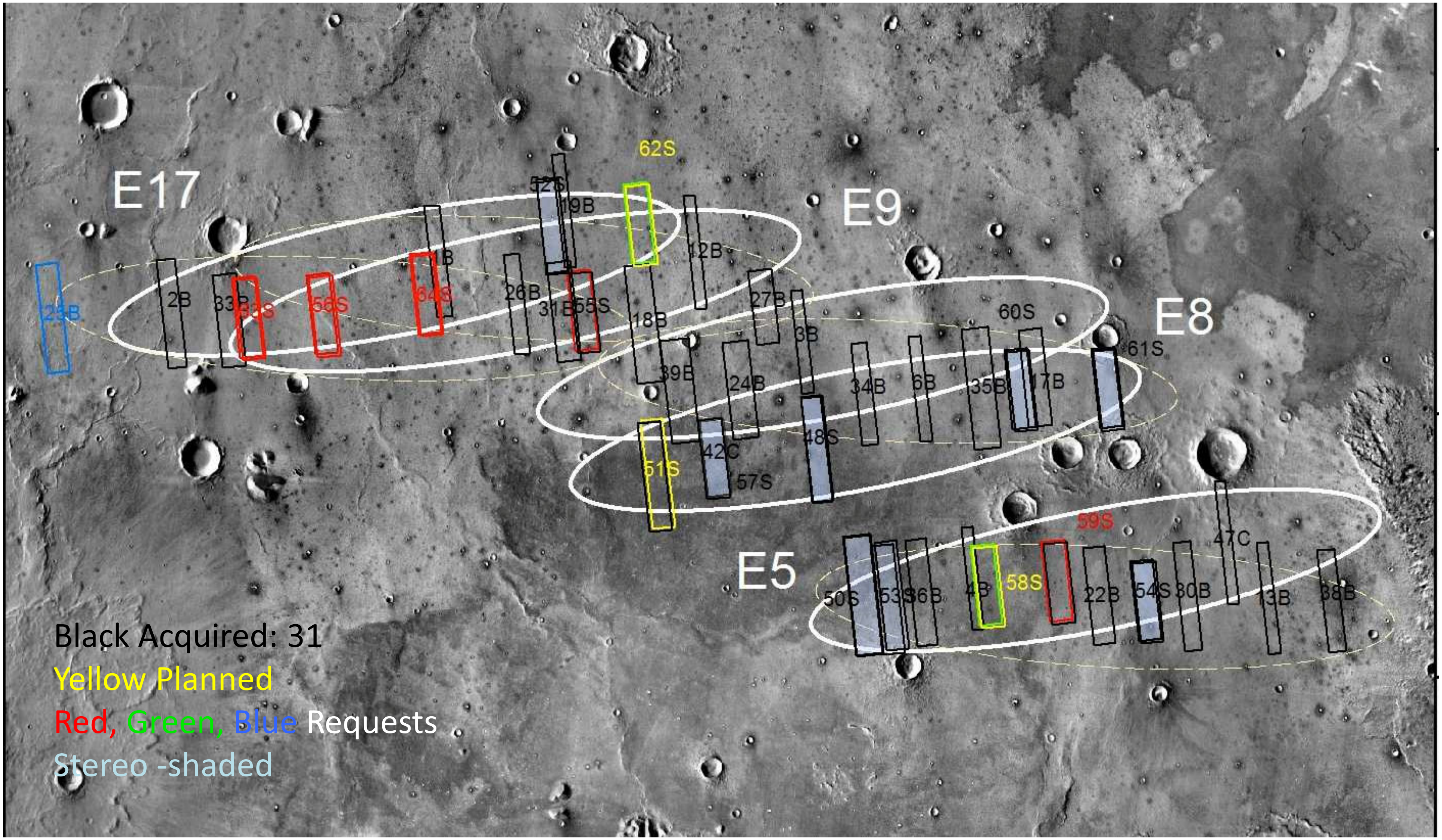


HiRISE Images at PDR

Azimuthal Change at Open, Middle & Close

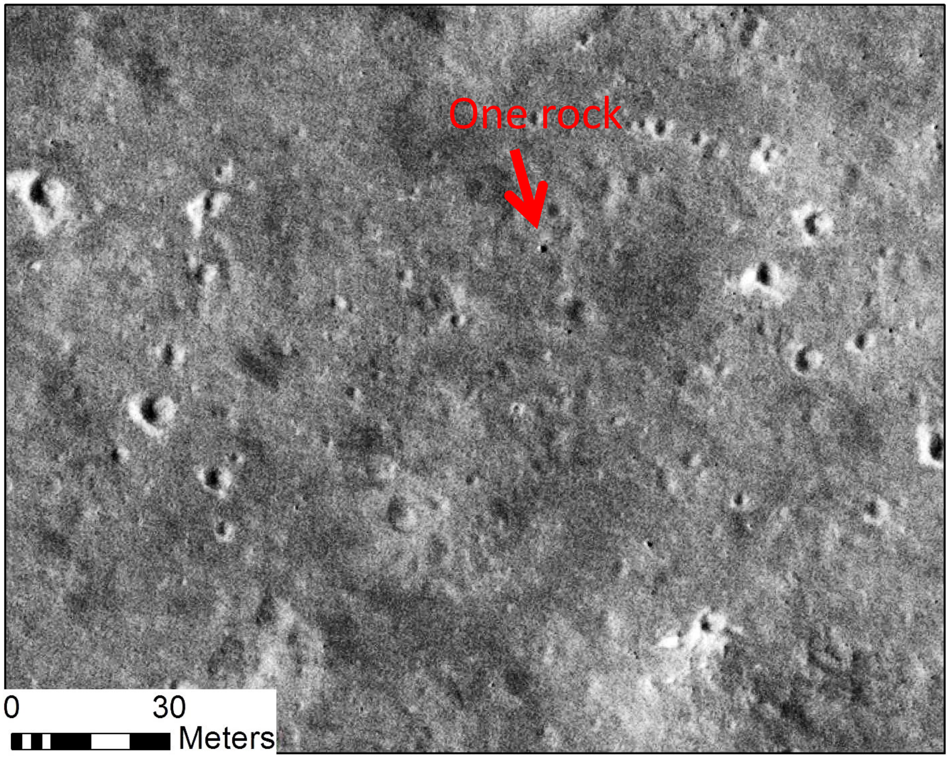


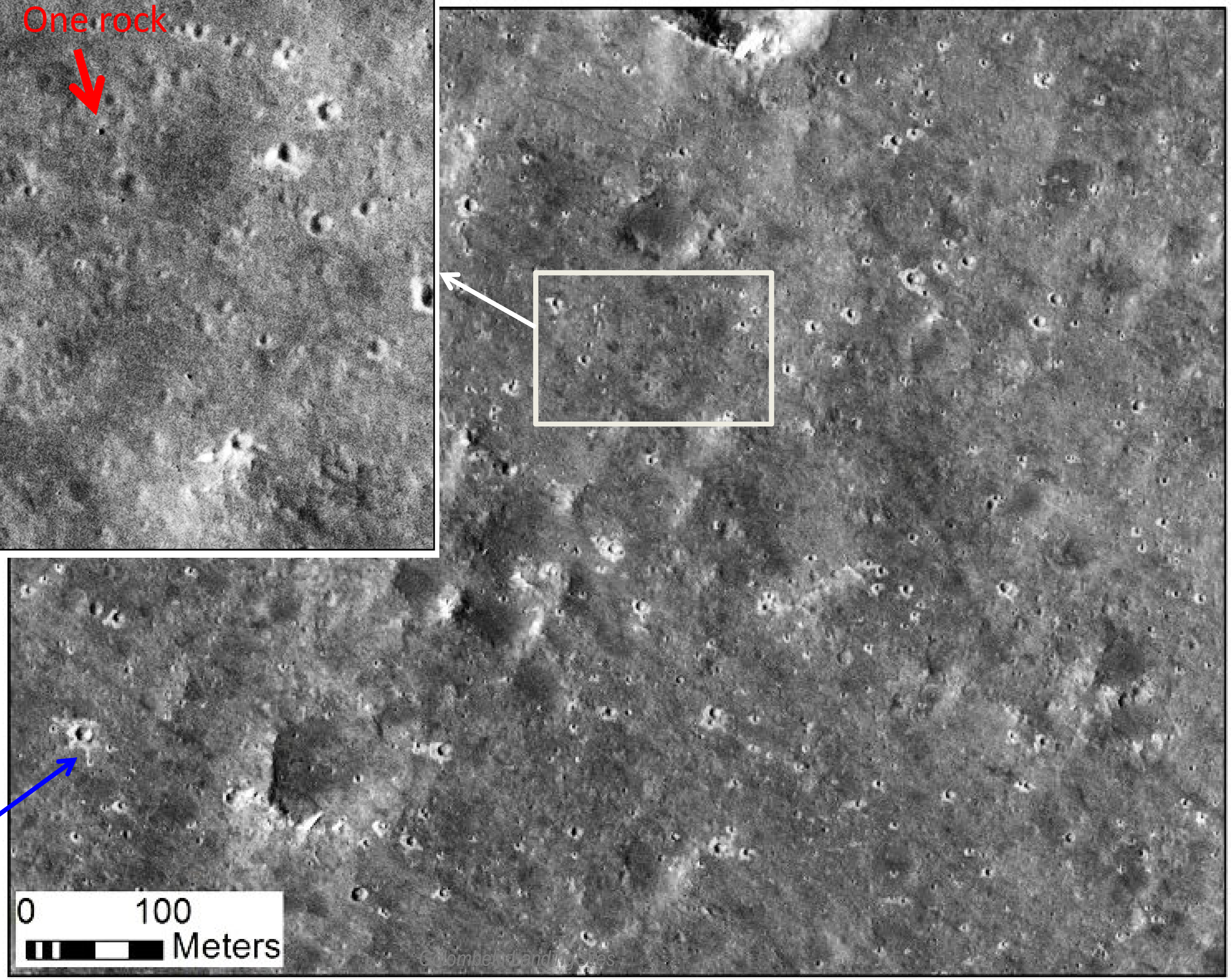
HiRISE Images as of 5/6/14



Coverage Sufficient
No More Surprises

Smooth Terrain: HiRISE





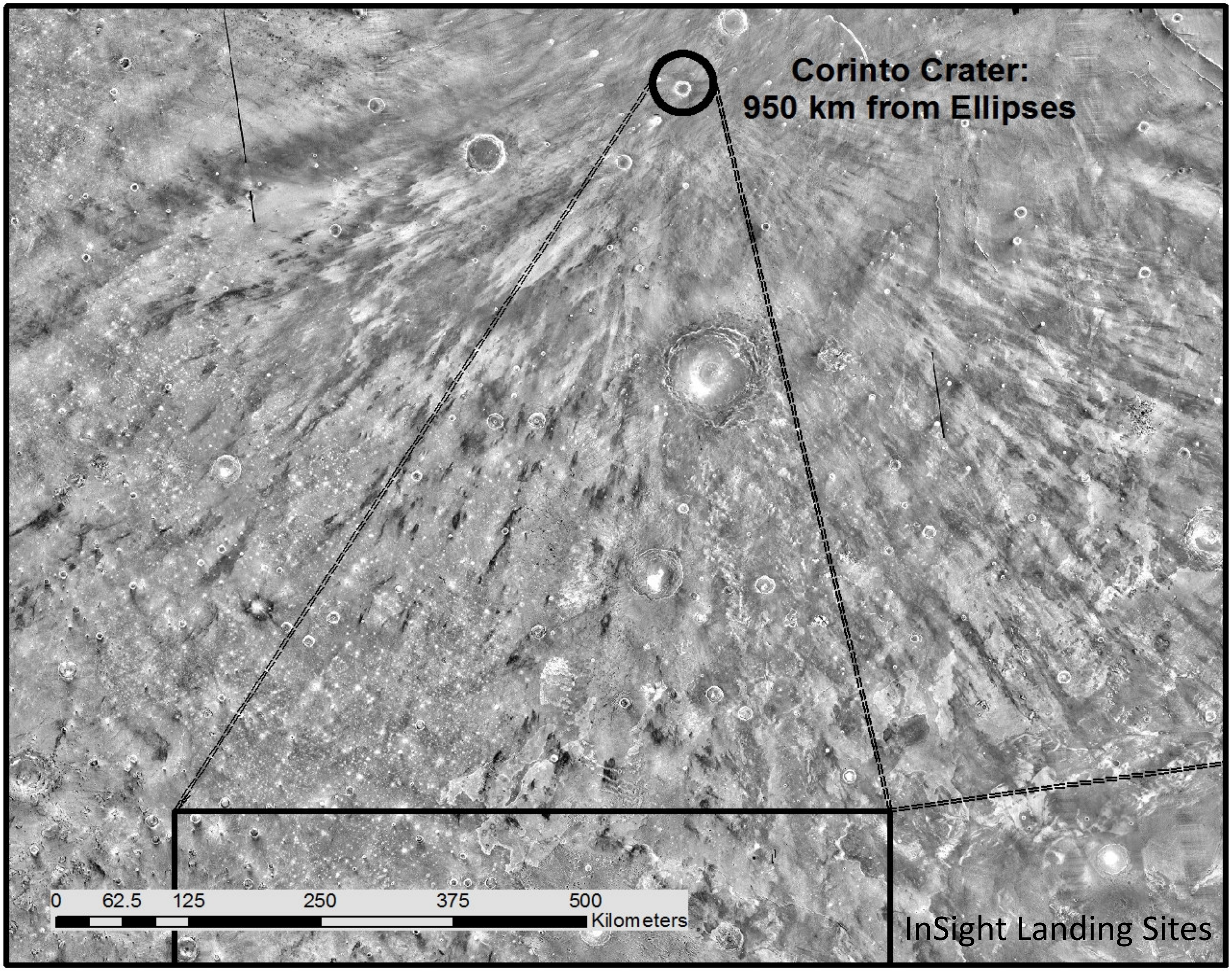
Exceptionally Benign

Very Low Slopes

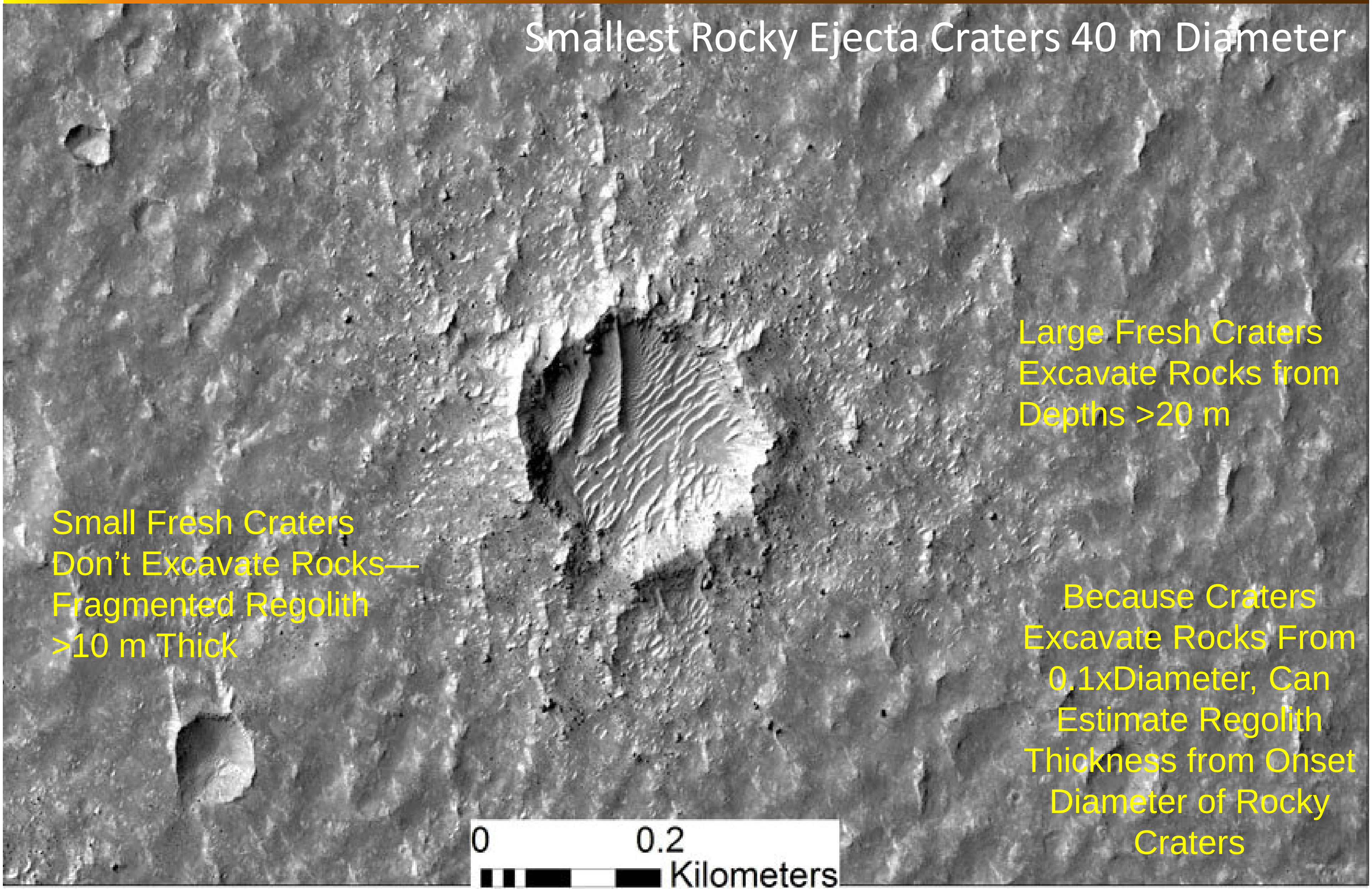
Few % Rock Abundance

Small Secondary Craters

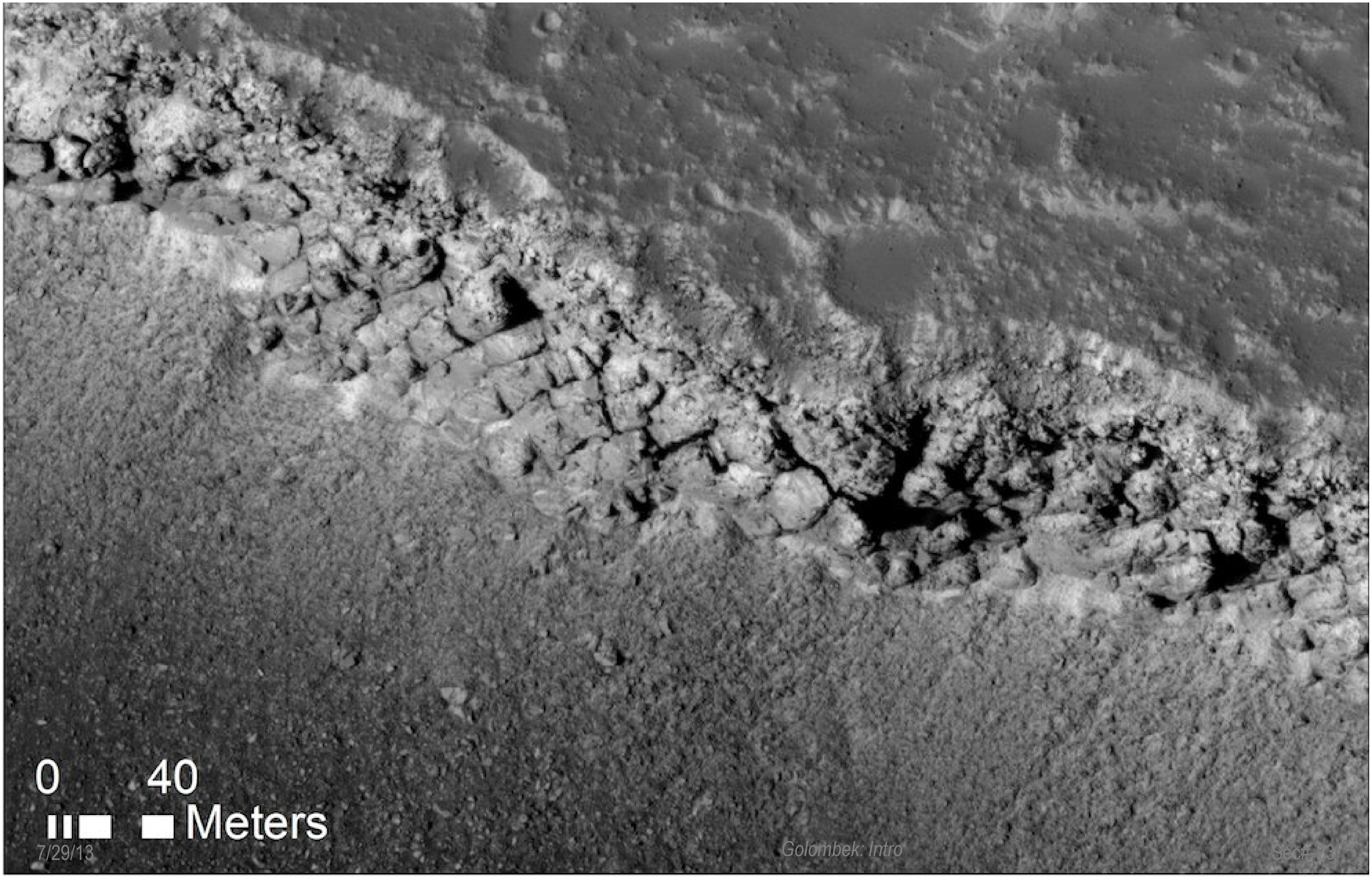
Secondary Crater Rays from Corinto: THEMIS IR Night



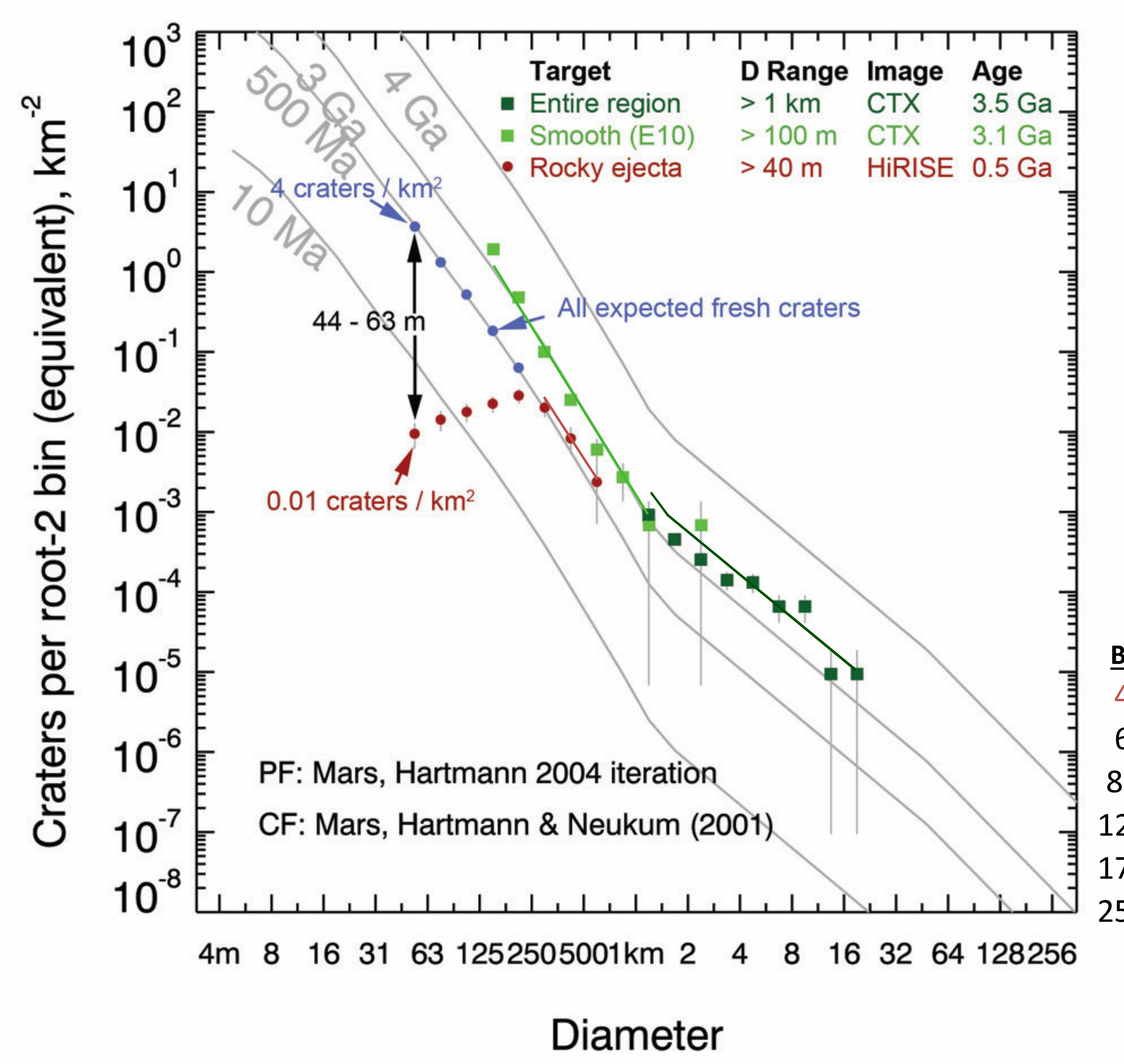
Fresh Craters = Boulders and Bedforms



Cross Section of Regolith



Regolith Thickness

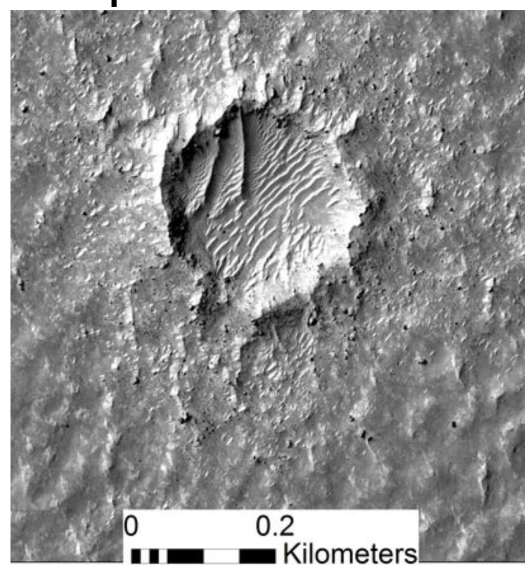


99.75% of area
> 5 m of regolith

Bin (m)	Excavation Depth (m)	% of Expected
44-63	4.4 - 6.3	0.25
63-89	6.3 - 8.9	1.3
89-125	8.9 - 12.5	3.9
125-177	12.5 - 17.7	10
177-250	17.7 - 25.0	48
250-354	25.0 -35.4	100

Landing Site Hazards

- Some Non-Smooth Terrain in Some of Ellipses
  - Higher Slopes and more Rocks
  - Estimated Increased Risk due to More Rocks and Higher Slopes
- Secondary Craters Have Steep Slopes (>15°)
  - Area covered is Small and Non Uniform
  - Risk is Estimated at ~0.4%-1.2% for Different Ellipses
- Rocky Ejecta Craters →
  - Sprinkled Uniformly Across Region
  - <1% of Area has Higher Rock Abundance
  - ~0.1-0.2% Added Risk
- Sum All Risks
  - ~1.4-2.2% Risk



Will Find Acceptable Ellipse(s) ~97-99% Safe

Schedule

- CSR End Phase A, 16 Ellipses in Elysium Planitia, May 24, 2012
- First Landing Site Workshop, 6/27/13
- First Landing Site Downselection, 7/29/13
  – Downselected from 22 to 4 Ellipses
- Presently Half Way through Process
- Second Landing Site Workshop, Summer/Fall 2014
  – Full discussion of everything known about sites
- Second Landing Site Downselection, Fall 2014
  – to 2-3 ellipses
- Complete HiRISE Coverage, Stereo Samples, Certification
- Landing Site Selection
  – Project Recommendation/Selection, 8/15
  – Peer Review, PPO Review, NASA Hq Concurrence, ~10/15