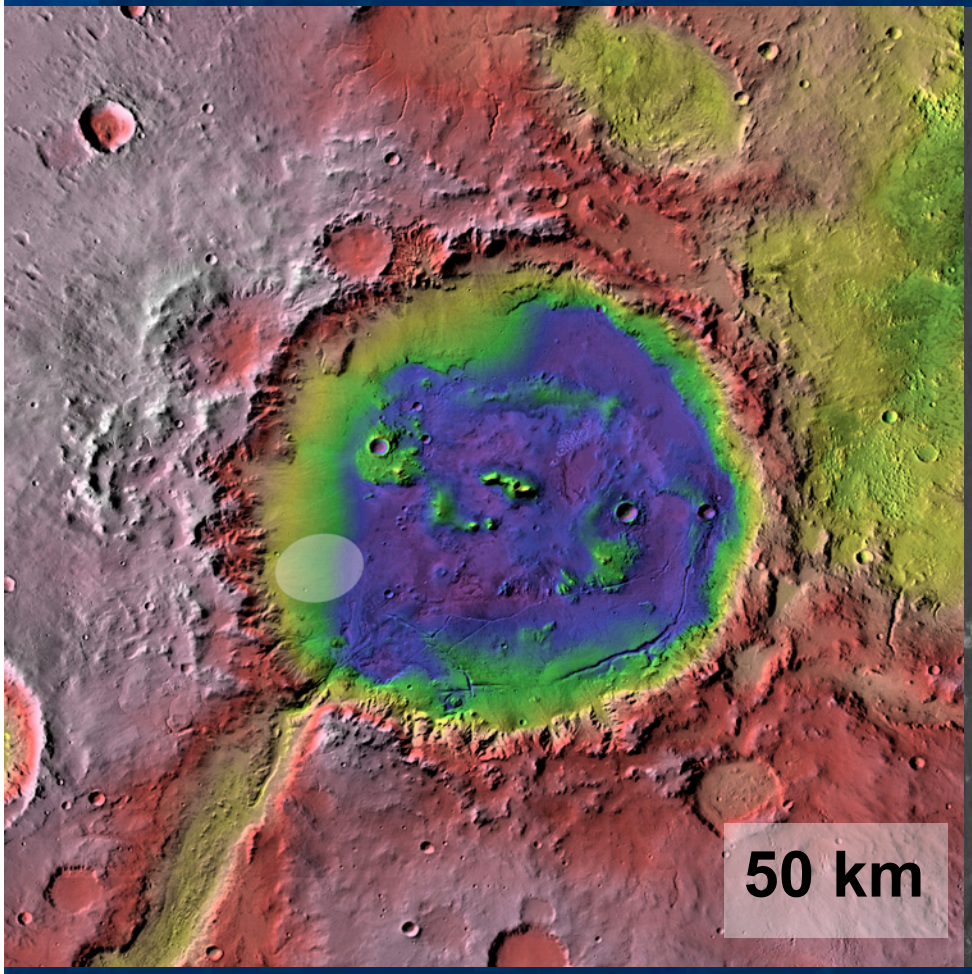
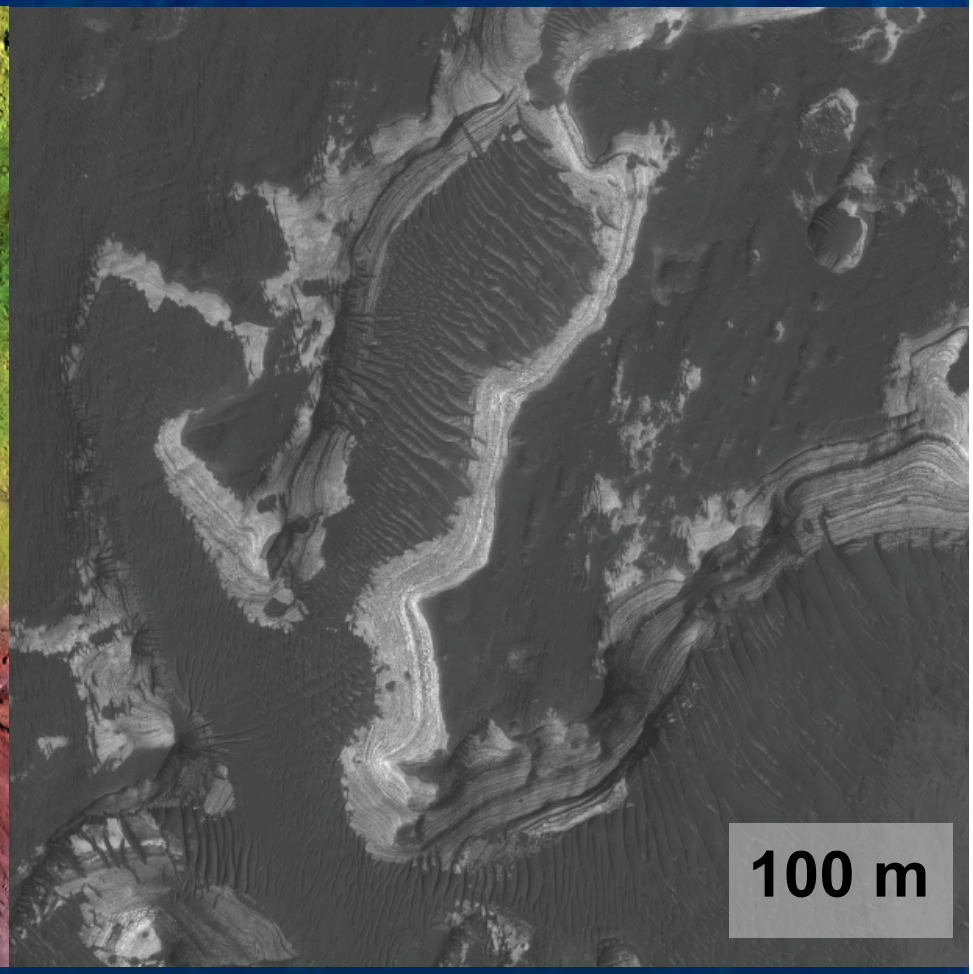
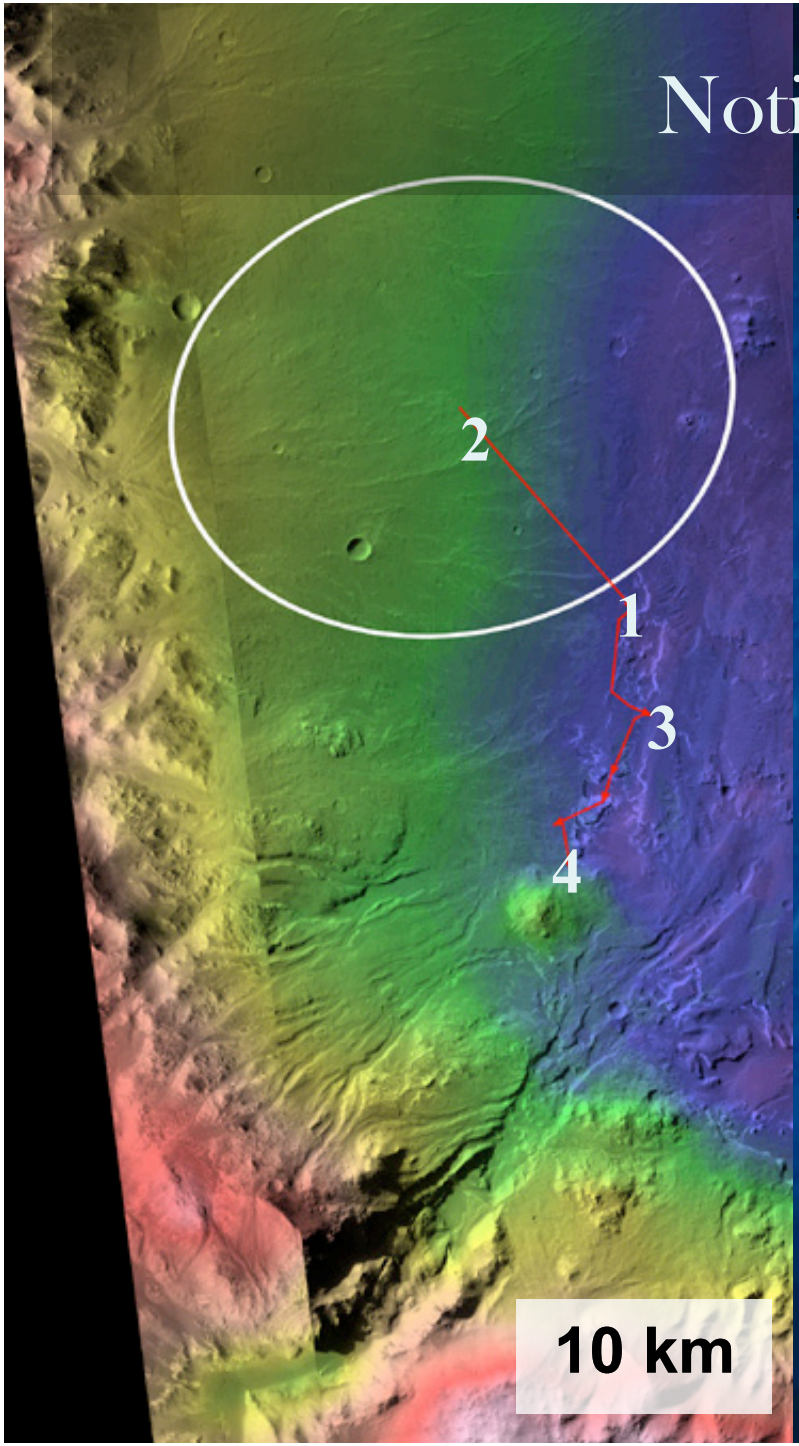
Notional Traverses and Science Targets in Holden Crater



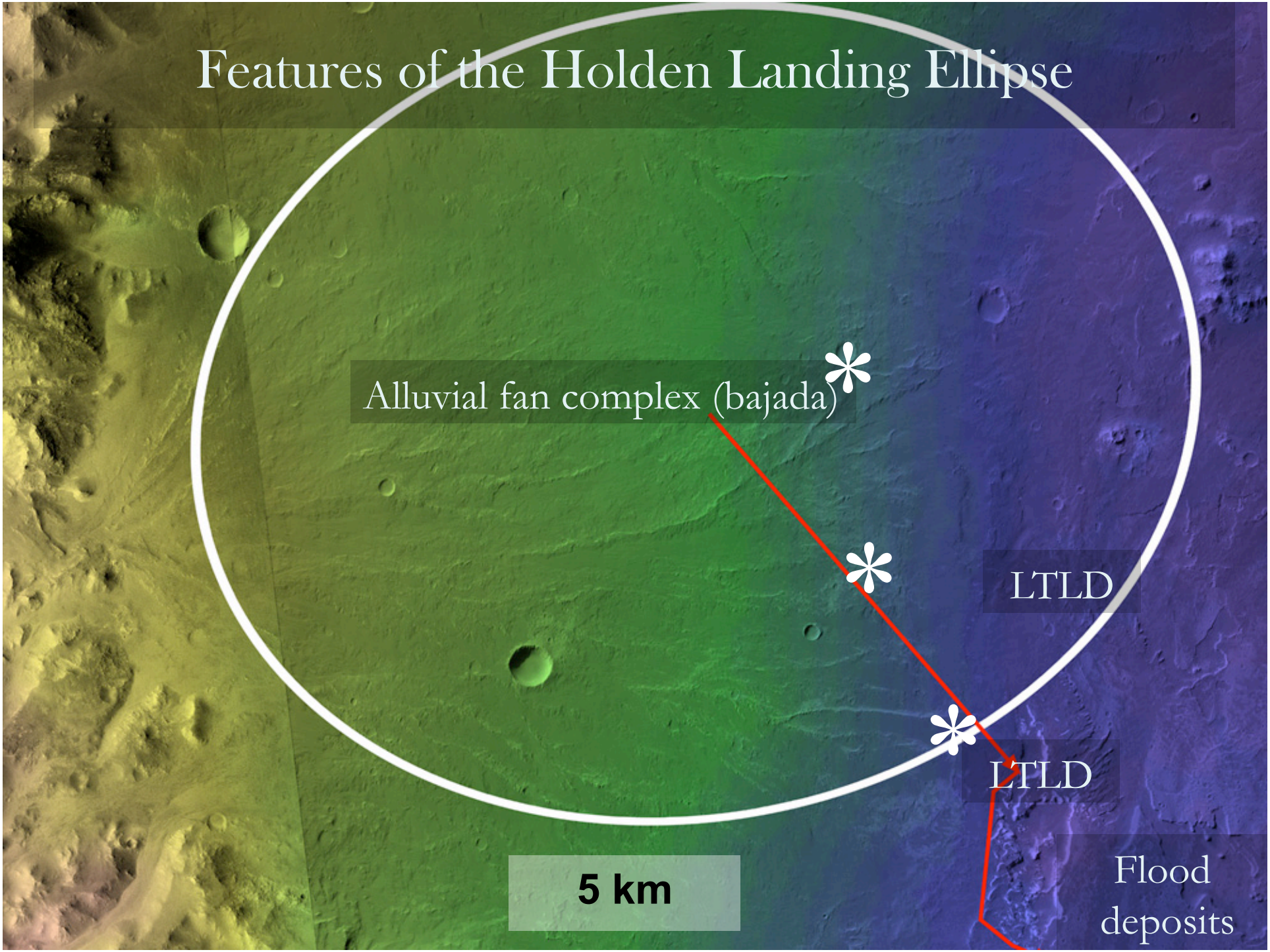


Ross Irwin
Smithsonian Institution

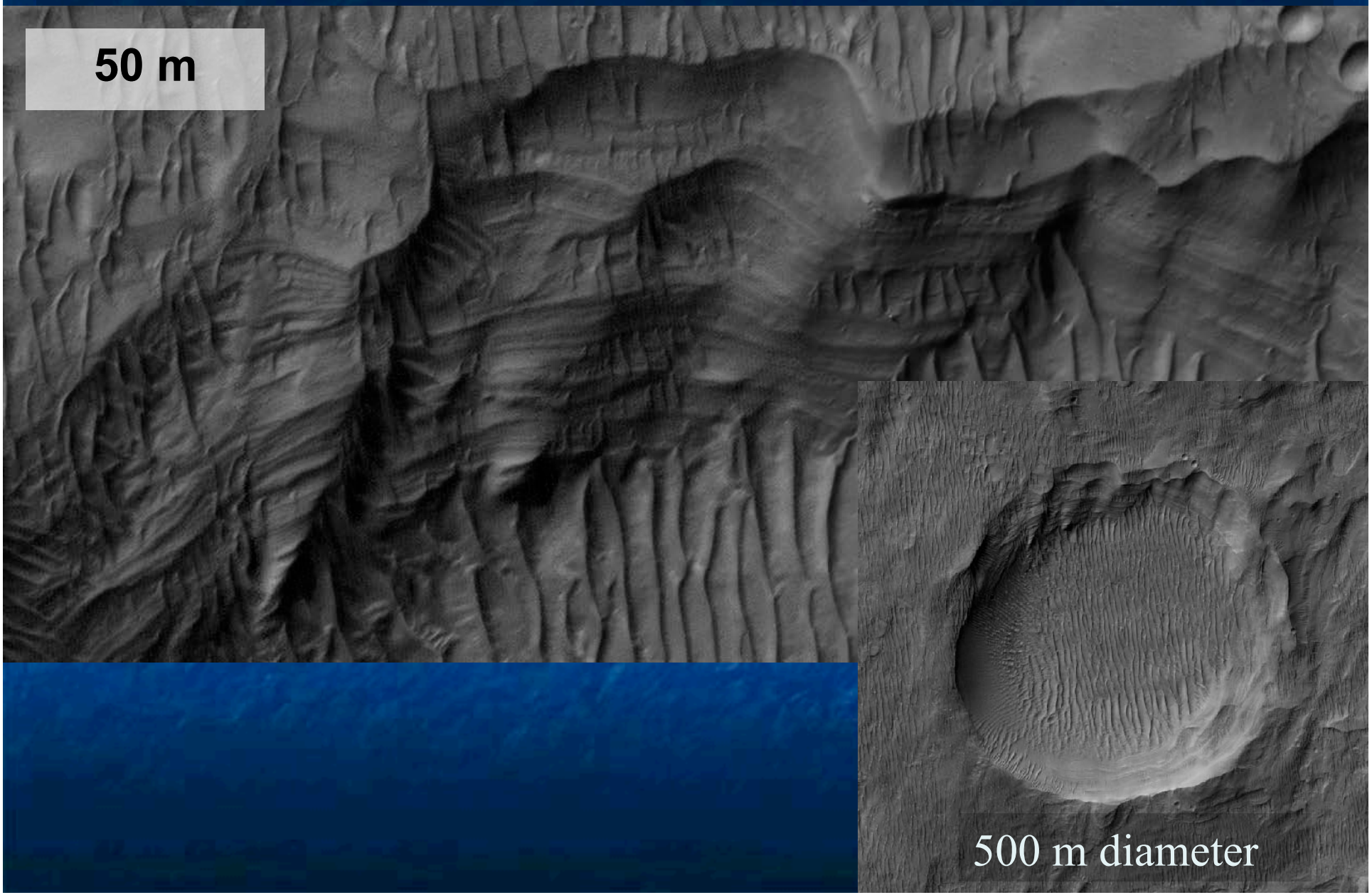
Notional Traverse



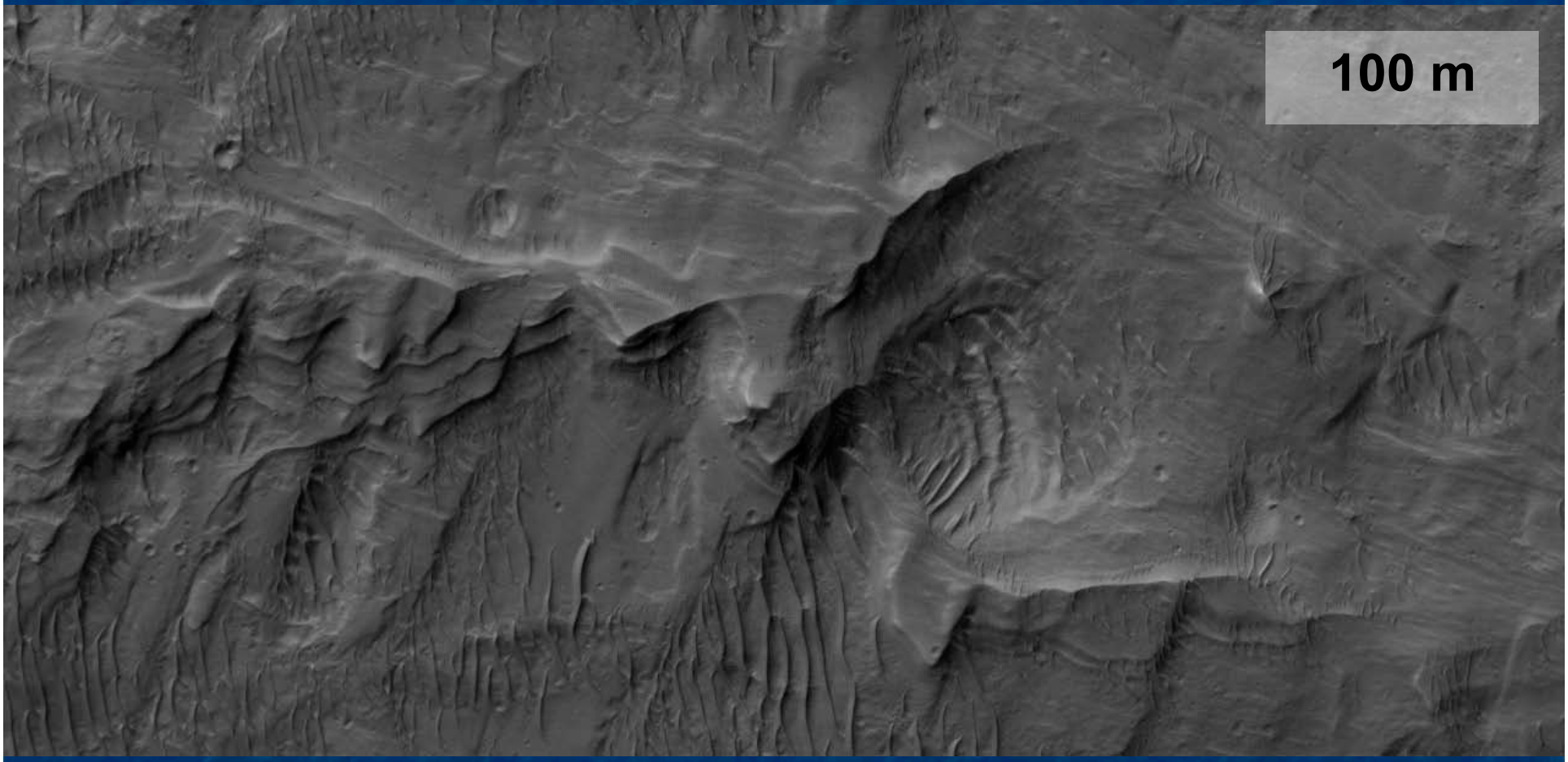
Target by priority	Distance from ellipse center
2. Alluvial fans	<0.5 km
1. LTLDs	11.5 km
3. Uzboi flood deposits	18 km
4. Bedrock outcrop	26 km


Features of the Holden Landing Ellipse
Alluvial fan complex (bajada)
LTLD
LTLD
Flood deposits
5 km

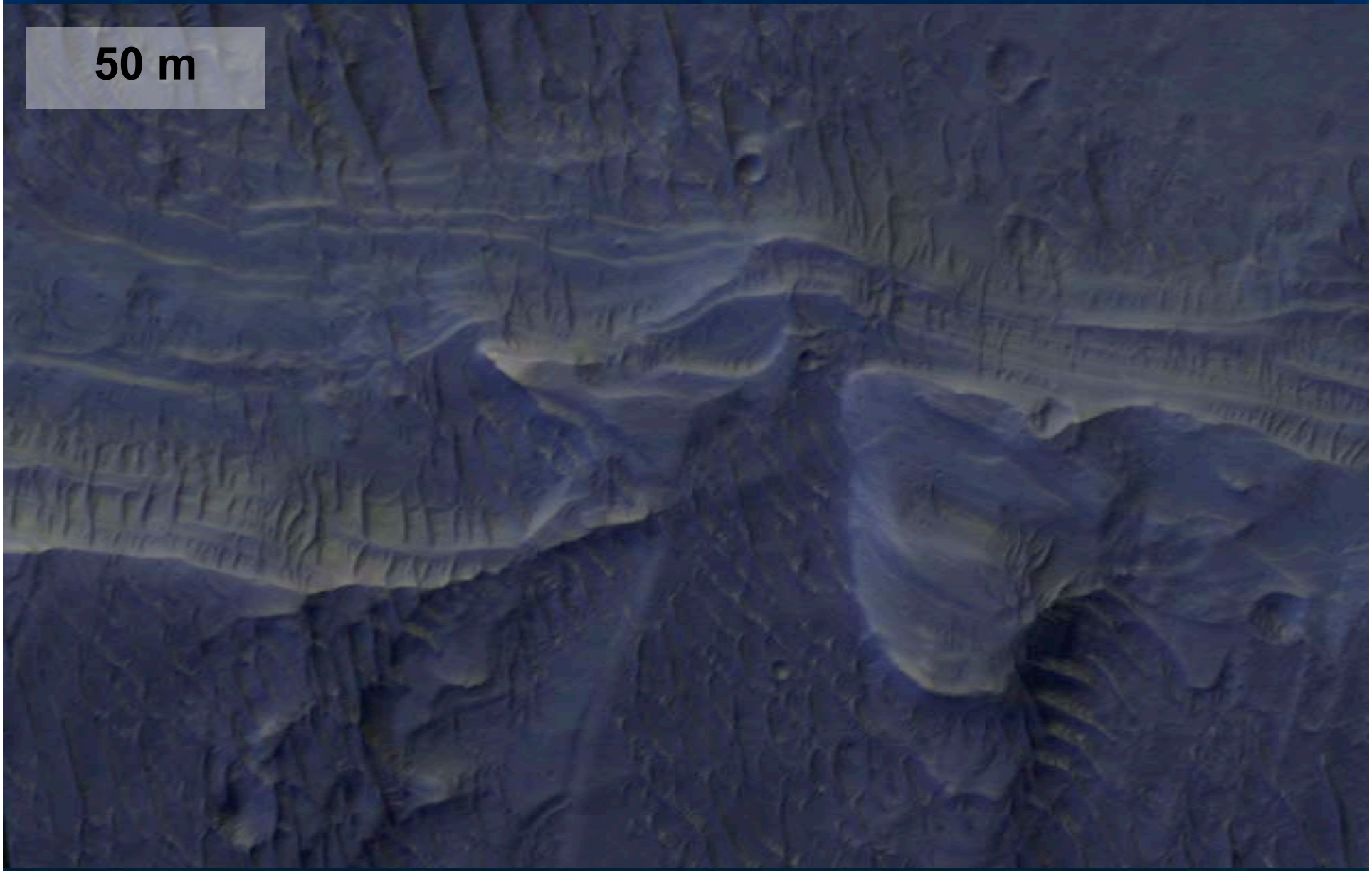
Notional Traverse, Target 2: Alluvial Fans



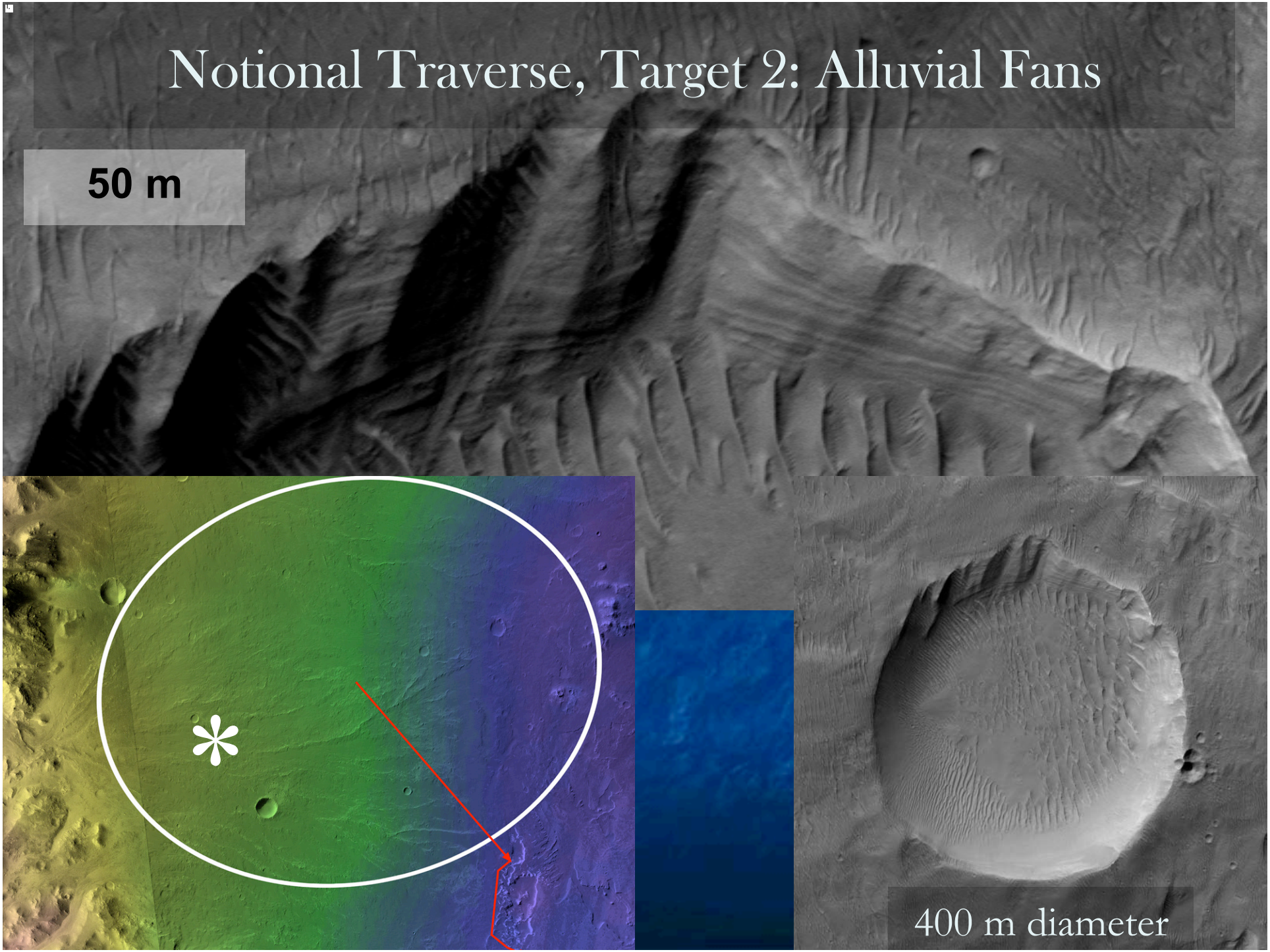
Notional Traverse, Target 2: Alluvial Fans



Notional Traverse, Target 2: Alluvial Fans



Notional Traverse, Target 2: Alluvial Fans



MSL Investigation of Alluvial Fans

I. Lithology of alluvial sand, gravel, and boulders

1. Diversity of transported highland material from >1 km sequence of the crater wall

II. Pre-erosional and post-depositional weathering environment

1. Diagenetic modification processes in wall rock before the Holden crater impact
2. Physical and/or chemical weathering of wall rock to produce transportable particles
3. Post-depositional weathering processes on alluvial sediment, contrast with Gusev
4. Composition and origin of finer-grained matrix in fan deposits, similar to LTLD?
5. Composition of intermediate-sized component, reworked in aeolian ripples?

MSL Investigation of Alluvial Fans

III. Fluvial transport processes and environmental implications

1. Matrix- or clast-supported deposits (debris flow or fluvial transport processes)
2. Grain size, rounding and down-fan changes (flow intensity and mechanism)
3. Bedding and sorting (more sustained or short, high-intensity flows)
4. Paleosols or duricrusts between beds? (intervals of activity)
5. Post-depositional cementation or loose lag (preservation mechanism of deposits)
6. Rough paleodischarge and precipitation runoff estimate from slope, grain size, width
7. If observed, lenticular gravelly deposits at the fan toe could help determine channel width

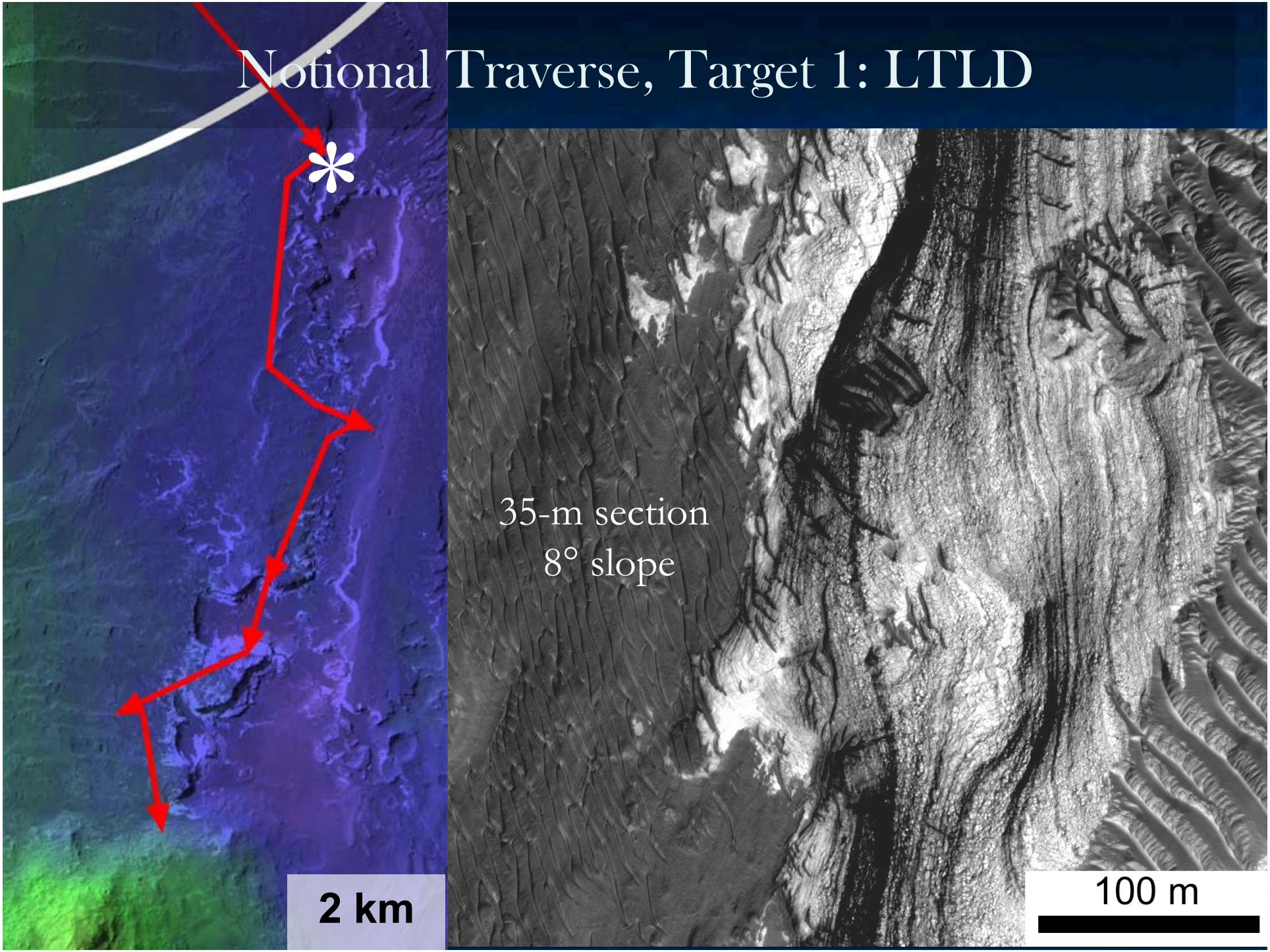
IV. Detailed sedimentary sequence and relative timing of major stratigraphic units

1. Incision of fluvial flows into LTLD? (change in base level)
2. Interfingering of coarse and fine deposits (test contemporary age of fans and LTLDs)

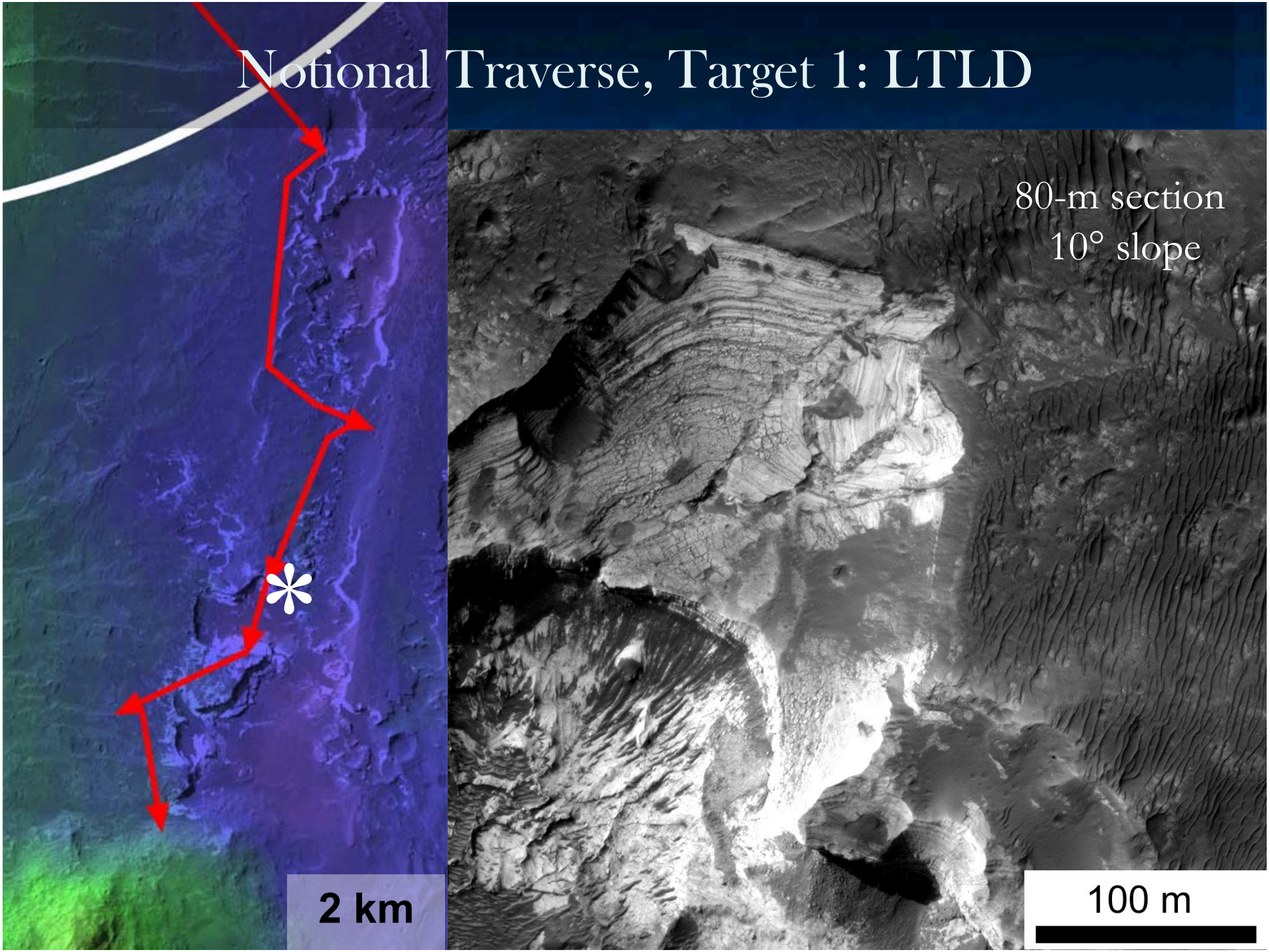
V. Implications of the above observations for paleoenvironment and habitability

1. Paleoclimate required to yield observed fluvial deposits
2. Atmospheric water supply and changes over time

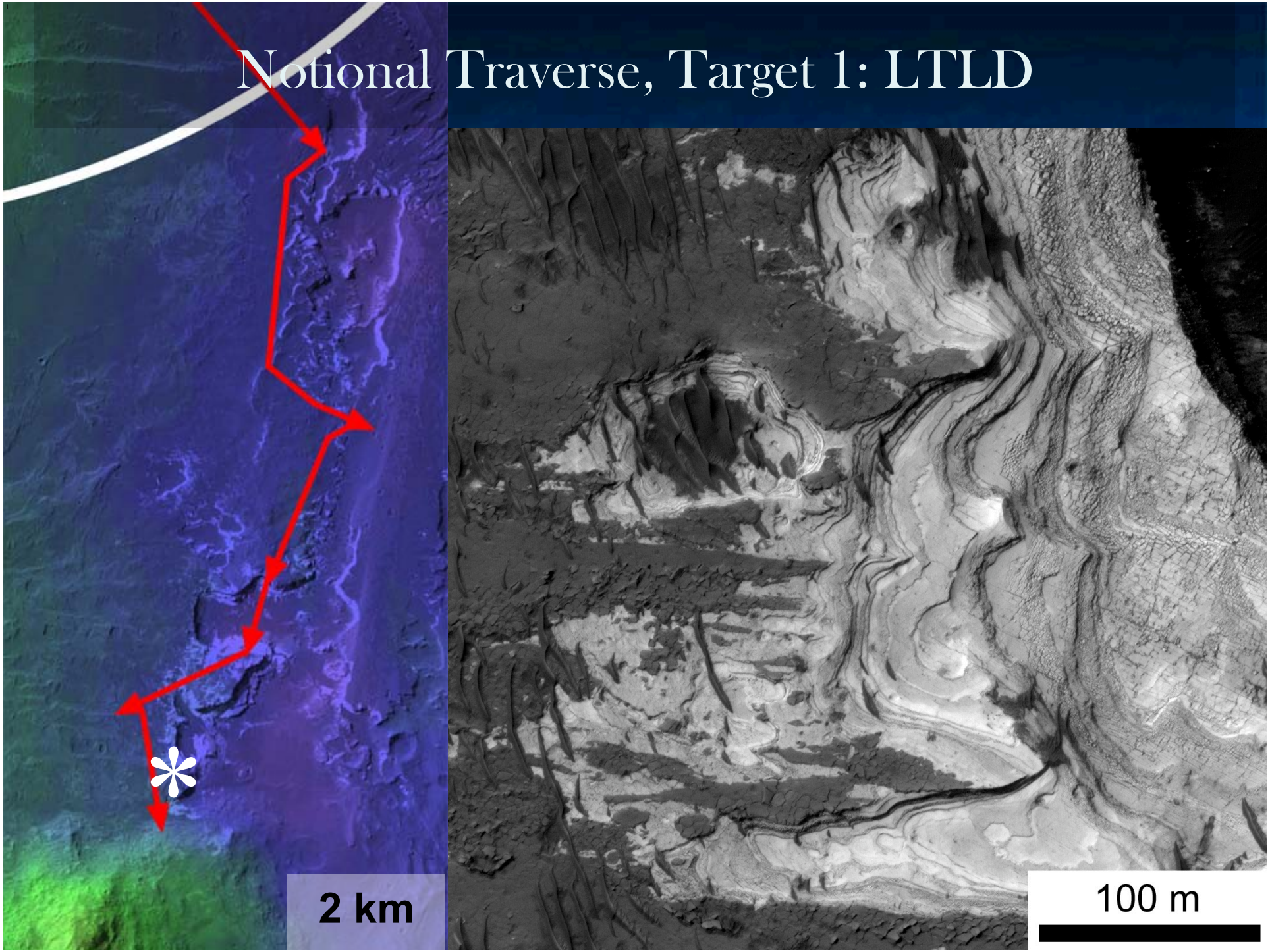
Notional Traverse, Target 1: LTLD



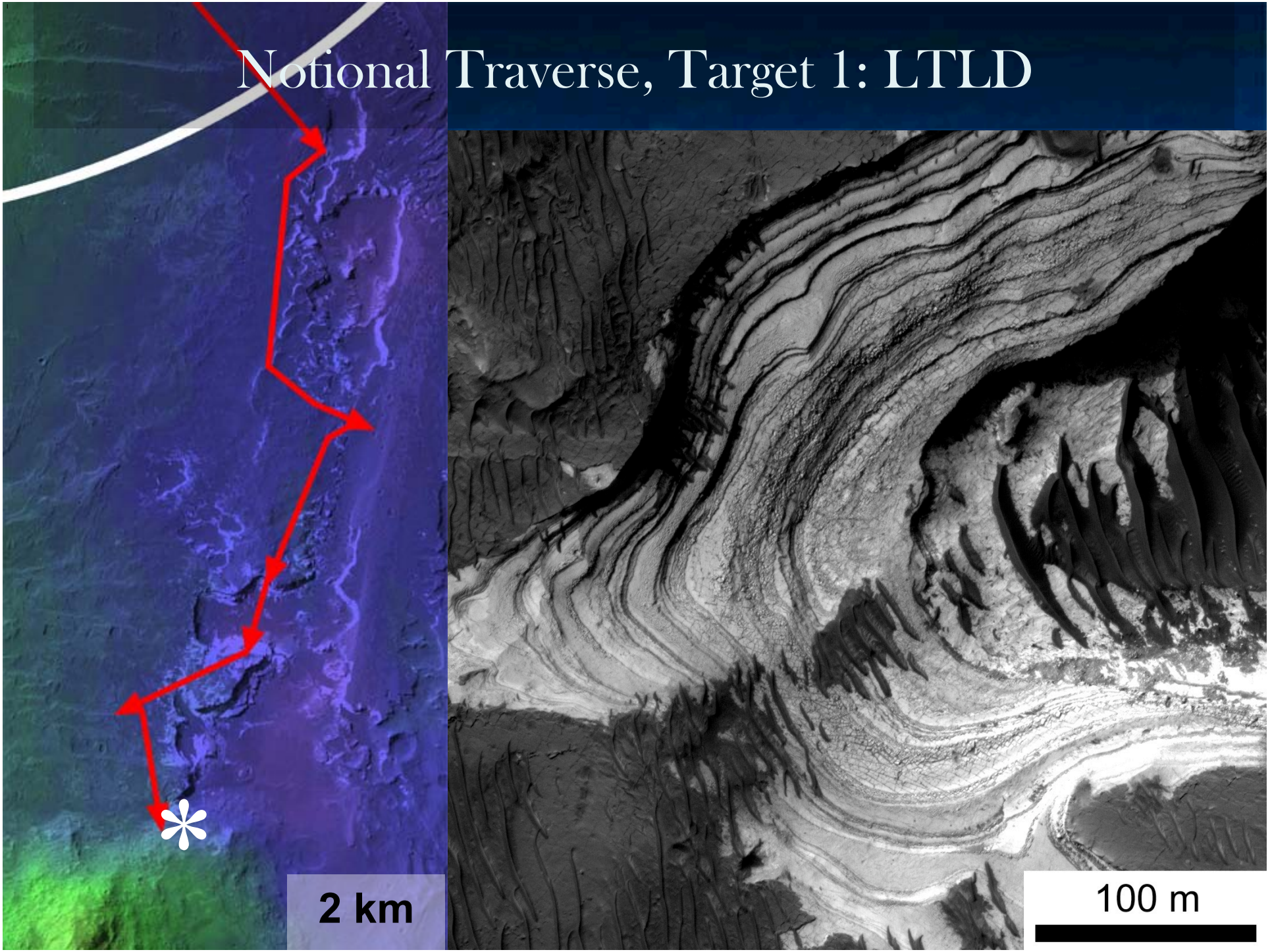
Notional Traverse, Target 1: LTLD



Notional Traverse, Target 1: LTLD



Notional Traverse, Target 1: LTLD



MSL Investigation of LTLD

I. Composition of sedimentary deposits freshly exposed by wind

1. Mineralogy and diversity (advanced weathering products, other sediments)
2. Grain size (energy of depositional setting)
3. Vertical changes in mineralogy and sedimentology in the section (temporal change)
4. Evaporites in or throughout the section? (deep lake, recharge/discharge playa?)
5. Cementation, diagenesis, concretions, crystal growth (latest aqueous activity)

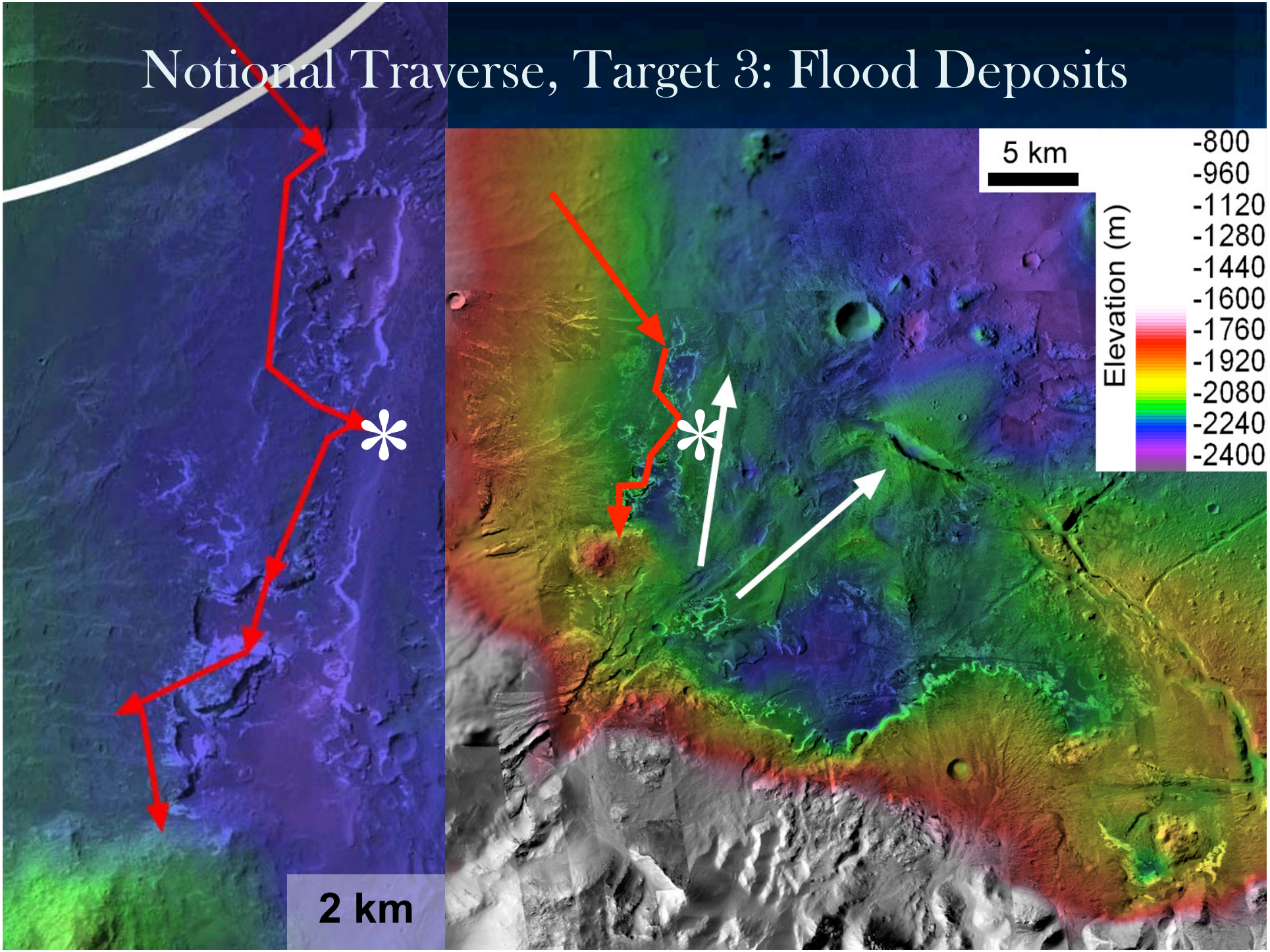
II. Sedimentary structures

1. Bed thickness and sorting, variability thereof (sustained or pulsed sediment supply)
2. Ripples or cross-bedding? (surface or shallow lacustrine flows vs. pelagic settling)
3. Mudcracks, deflated surfaces, paleosols, duricrusts between beds? (subaerial exposure)
4. Unconformities within the LTLD? (major intervals of non-deposition)
5. Other materials in lenses? (contemporary geological activity)

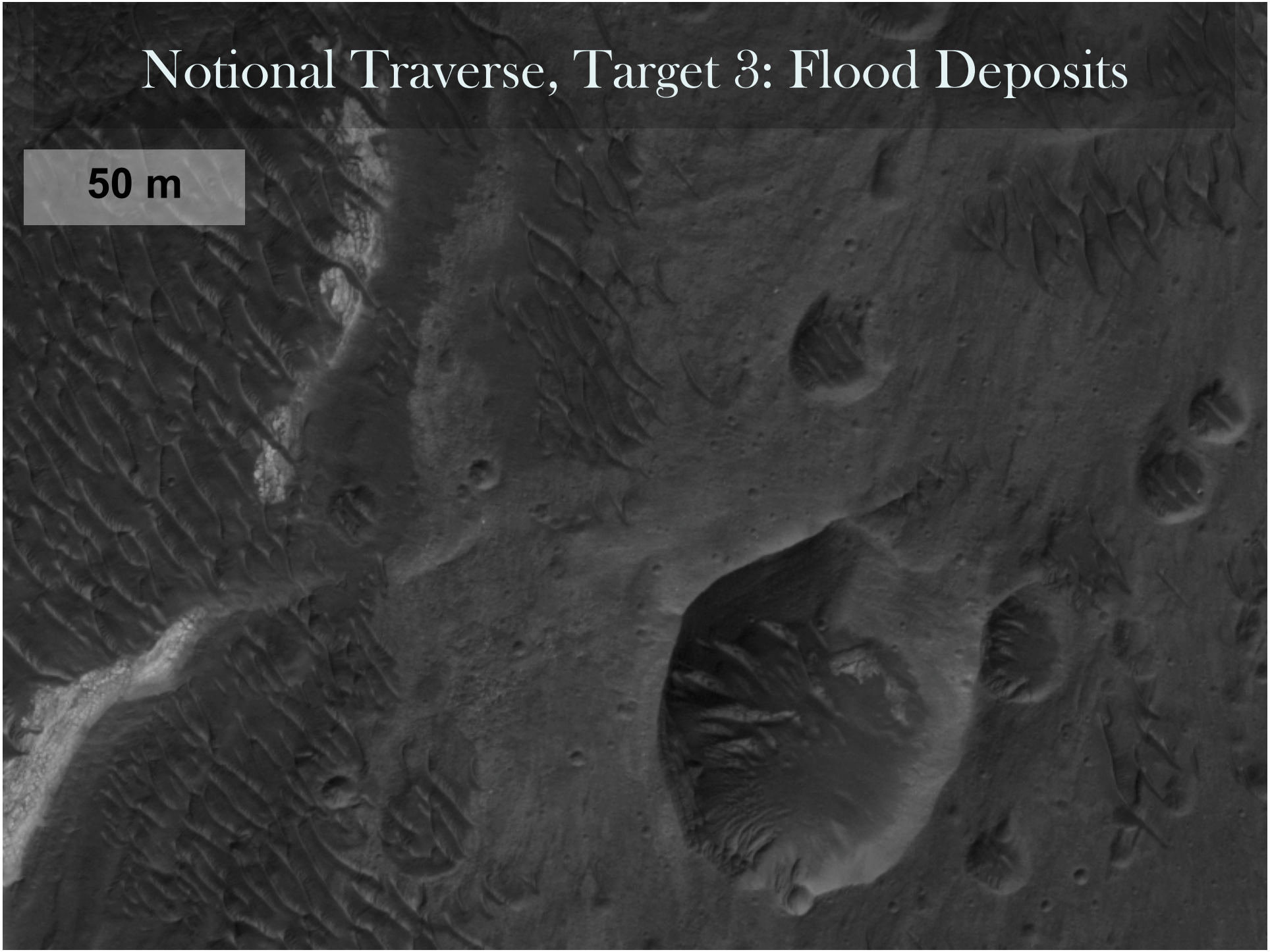
III. Habitability

1. Geochemical environment (inferred pH, dissolved solids and concentration, change or continuity through time: favorability for or effects of biological processes)
2. Preservation, nature, and inventory of organic compounds
3. Inventory the chemical building blocks of life (C, H, N, O, P, S).

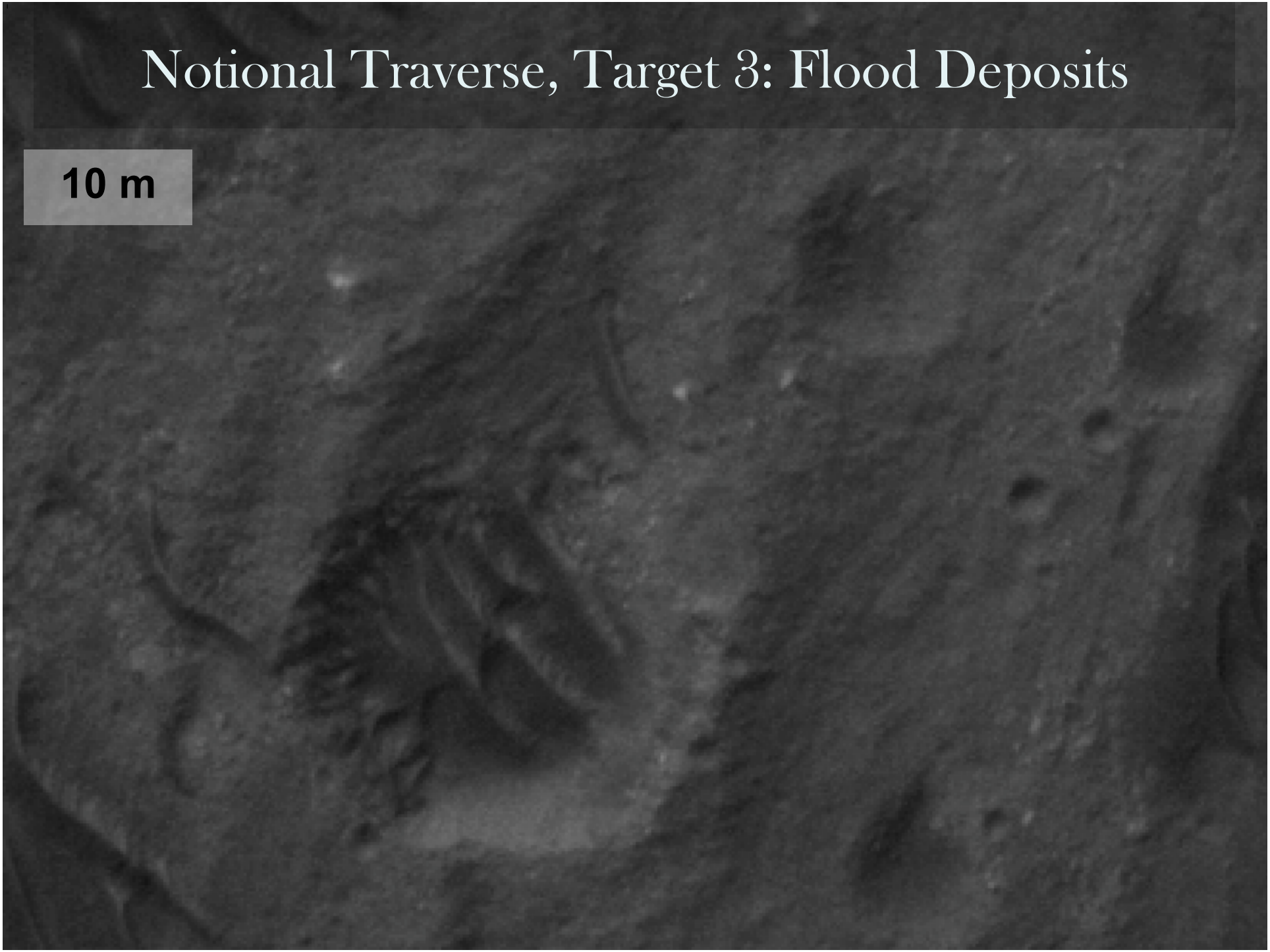
Notional Traverse, Target 3: Flood Deposits



Notional Traverse, Target 3: Flood Deposits



Notional Traverse, Target 3: Flood Deposits



MSL Investigation of Flood Deposits

I. Lithology of gravel and boulders derived from 2 km of the crater rim

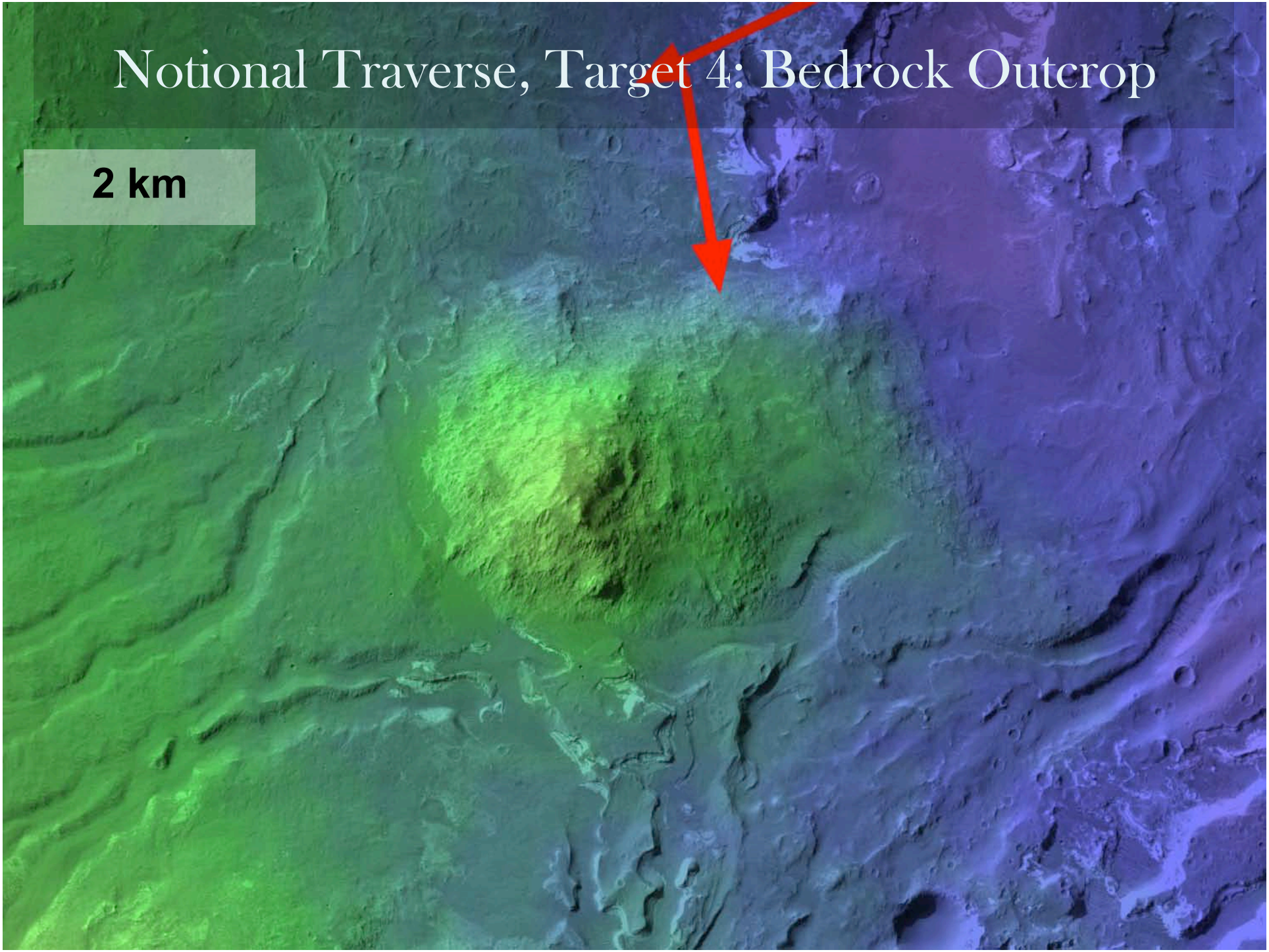
II. Grain size and sorting (pulsed discharge, slowly declining, or sustained inflow)

III. Post-depositional environment for flood deposits

1. Remnants of fine-grained sediment from settling? (similar to LTLD or not?)
2. Post-depositional cementation?
3. Post-depositional weathering rinds on flood deposits, contrast with Gusev

IV. Implications for paleoenvironment and habitability

1. Geochemical environment (inferred pH, dissolved solids, change or continuity through time: duration and characteristics of the second epoch of flooding in the crater)
2. Preservation, nature, and inventory of organic compounds; effects of biological processes
3. Inventory the chemical building blocks of life (C, H, N, O, P, S).


Notional Traverse, Target 4: Bedrock Outcrop
2 km

MSL Investigation of Bedrock Outcrop

I. Mineralogy/petrology, compared to materials derived from crater walls in fans

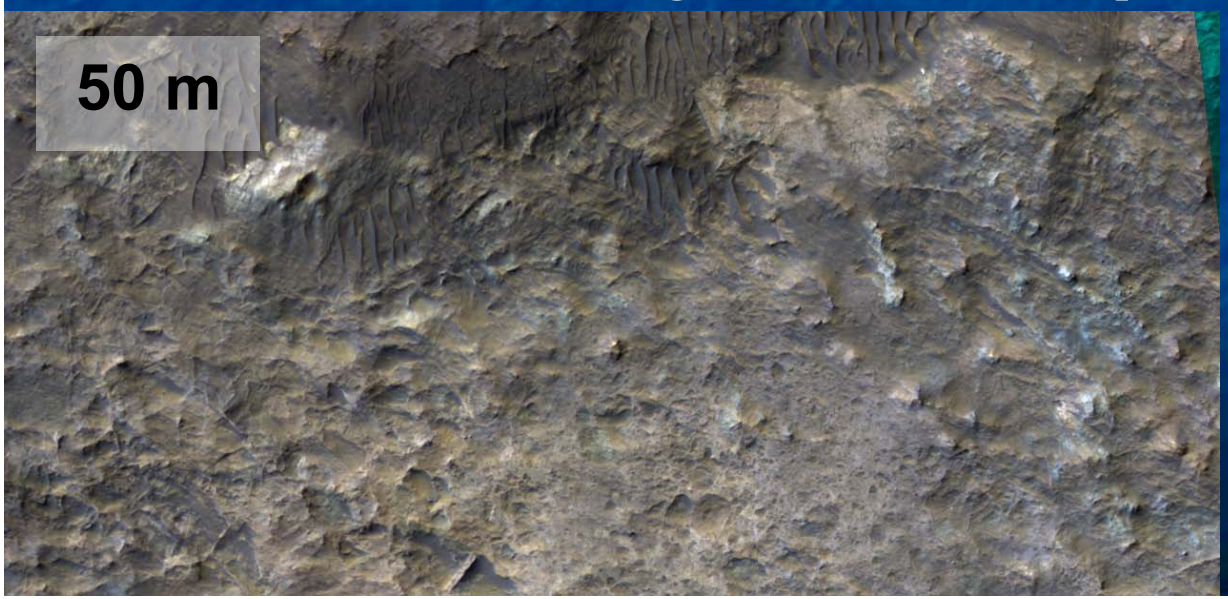
1. Changes in mineralogy/petrology with depth in the Martian crust
2. Diagenetic modification before, during, shortly after, long after the impact (low/high-T)
3. Characteristics of impact melt, if present

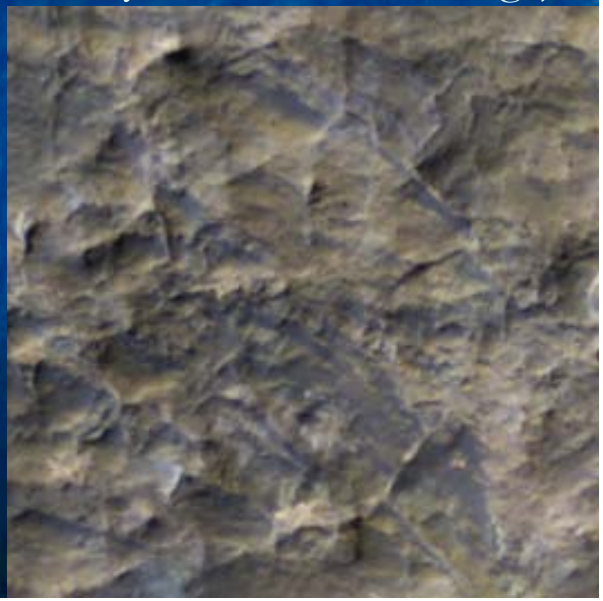
II. Noachian surface weathering of in-place bedrock

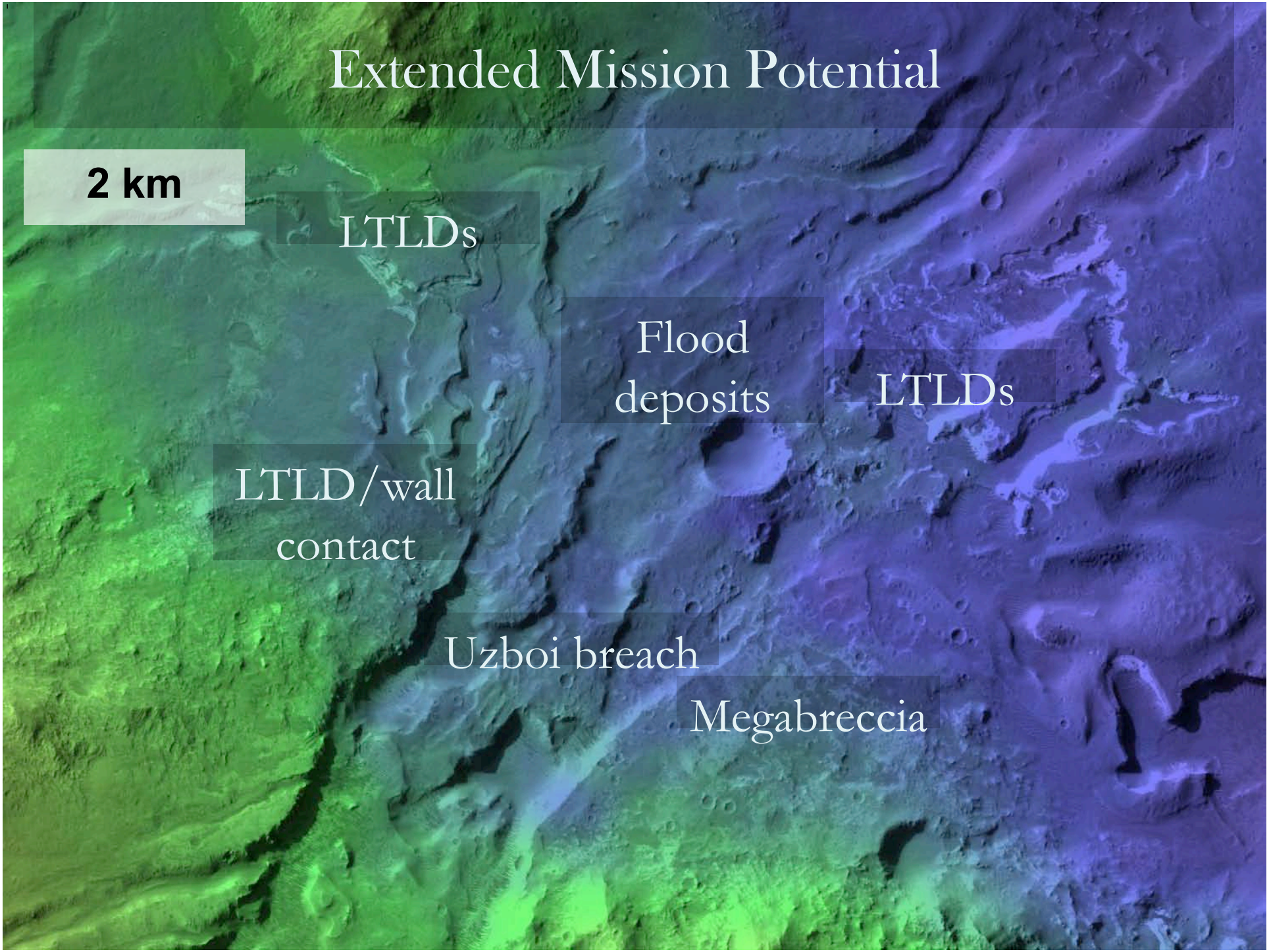
1. Compare longer exposure to Noachian weathering with transported sediment

III. Habitability

1. Geochemistry of Noachian subsurface materials and fluids
2. Possible chemical energy sources for life (impact craters as hydrothermal settings)





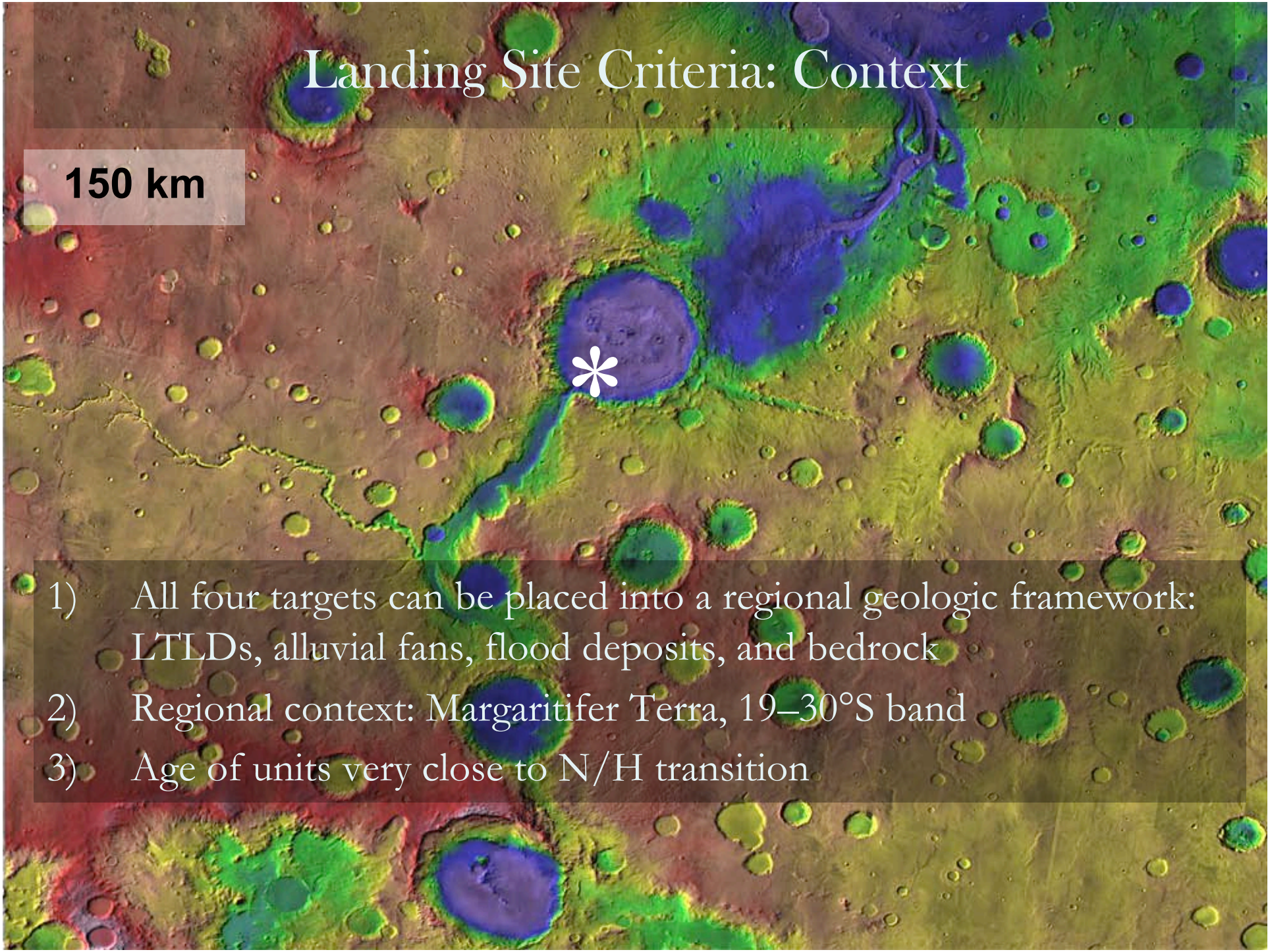

Extended Mission Potential
2 km
LTLDs
Flood deposits
LTLDs
LTLD/wall contact
Uzboi breach
Megabreccia

Landing Site Criteria: Diversity

1 km

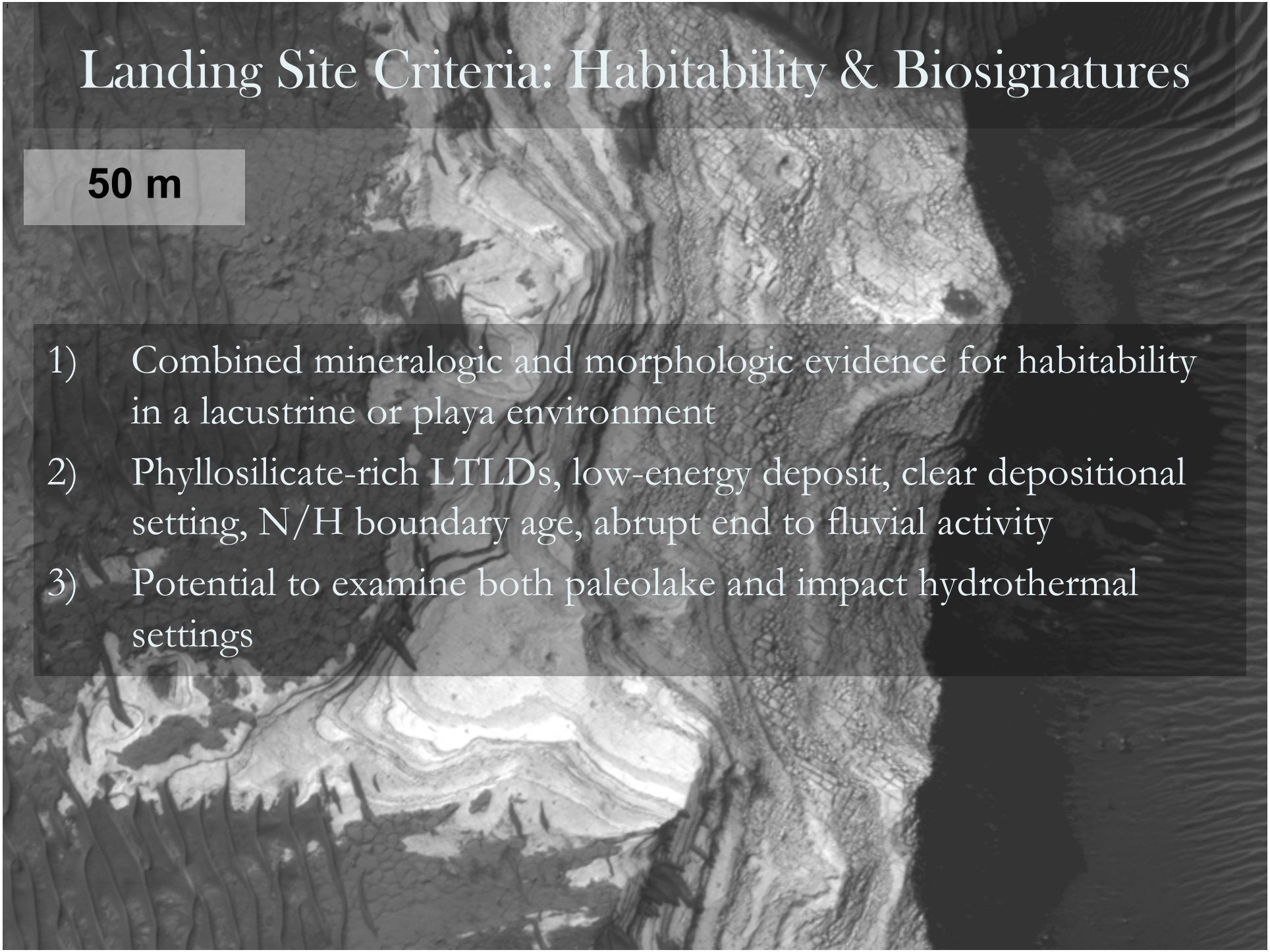
1) Multiple rock units: LTLDs, alluvial fans, flood deposits, bedrock
2) Well-defined stratigraphic and cross-cutting relationships
3) Diverse mineralogic and geomorphic features
4) Features and units that formed through interaction with water
5) Multiple working hypotheses testable with MSL payload

Landing Site Criteria: Context



1) All four targets can be placed into a regional geologic framework: LTLDs, alluvial fans, flood deposits, and bedrock
2) Regional context: Margaritifer Terra, 19–30°S band
3) Age of units very close to N/H transition

Landing Site Criteria: Habitability & Biosignatures



1) Combined mineralogic and morphologic evidence for habitability in a lacustrine or playa environment
2) Phyllosilicate-rich LTLDs, low-energy deposit, clear depositional setting, N/H boundary age, abrupt end to fluvial activity
3) Potential to examine both paleolake and impact hydrothermal settings

MSL Mission Objectives

I. Assess the biological potential of at least one target environment.

1. Determine the nature and inventory of organic carbon compounds.
2. Inventory the chemical building blocks of life (C, H, N, O, P, S).
3. Identify features that may represent the effects of biological processes.

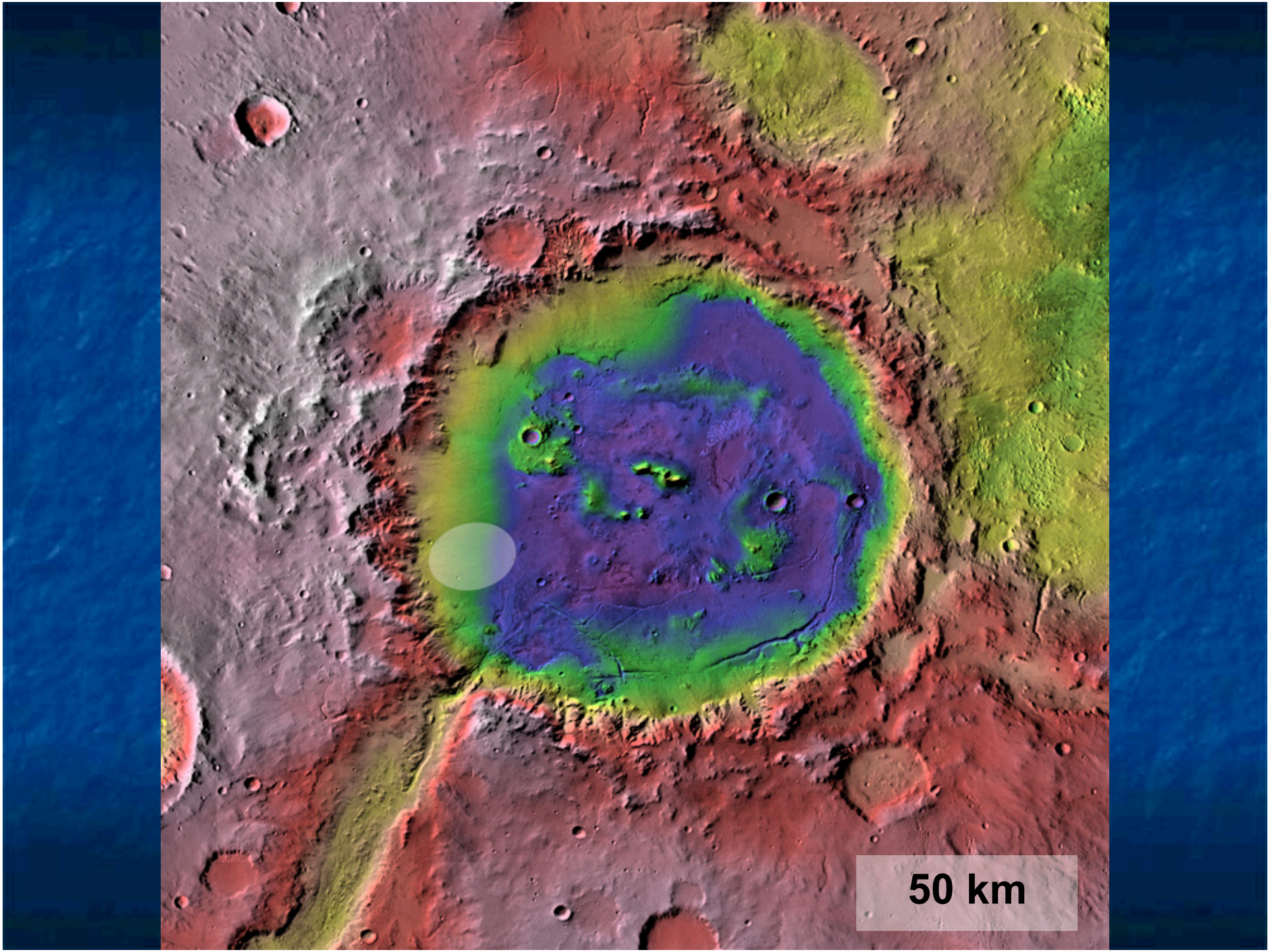
II. Characterize the geology and geochemistry of the landing region at all appropriate spatial scales.

1. Investigate the chemical, isotopic, and mineralogical composition of Martian surface and near-surface geological materials.
2. Interpret the processes that have formed and modified rocks and regolith.

III. Investigate planetary processes of relevance to past habitability, including the role of water.

1. Assess long-timescale (i.e., 4-billion-year) atmospheric evolution processes.
2. Determine present state, distribution, and cycling of water and CO_2.

IV. Characterize the broad spectrum of surface radiation, including galactic cosmic radiation, solar proton events, and secondary neutrons.


50 km