Hot Science Cool Talks

UT Environmental Science Institute

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The 2004 Mars Exploration Rover Mission: Evidence for Water and Prospects for Life

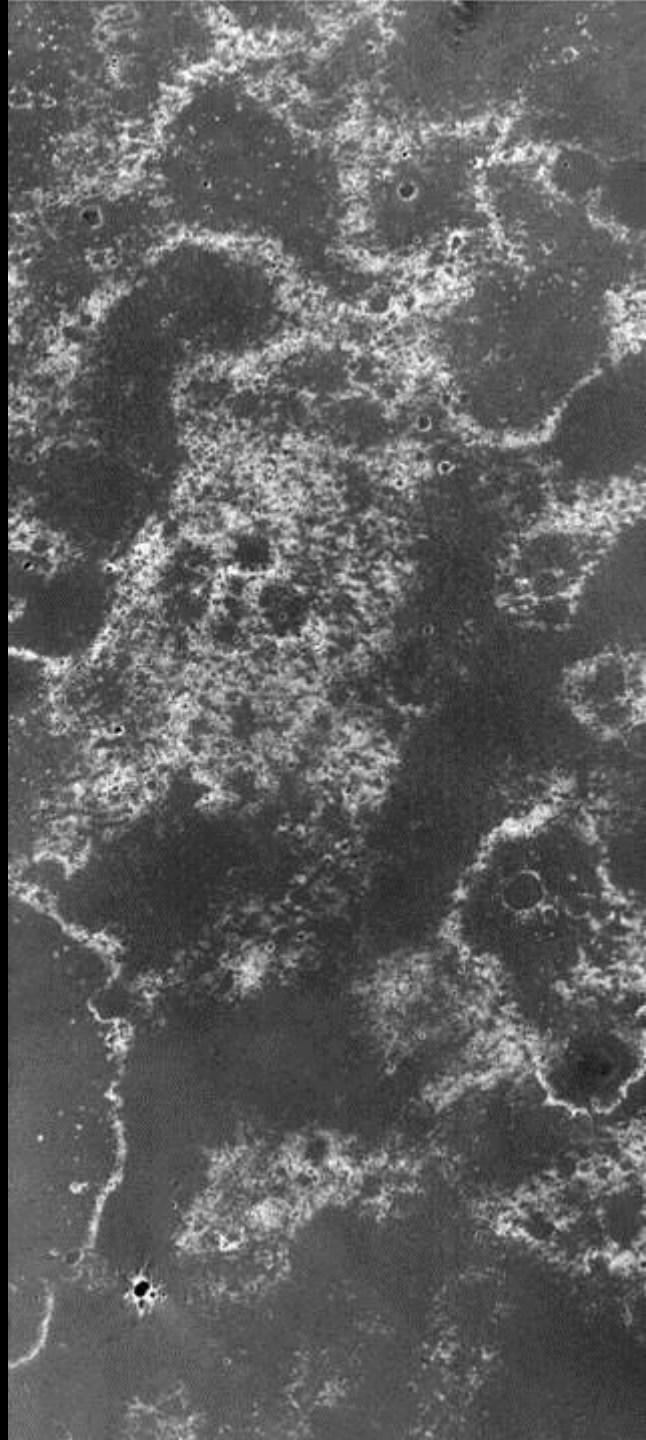
Dr. John Grotzinger

October 13, 2005

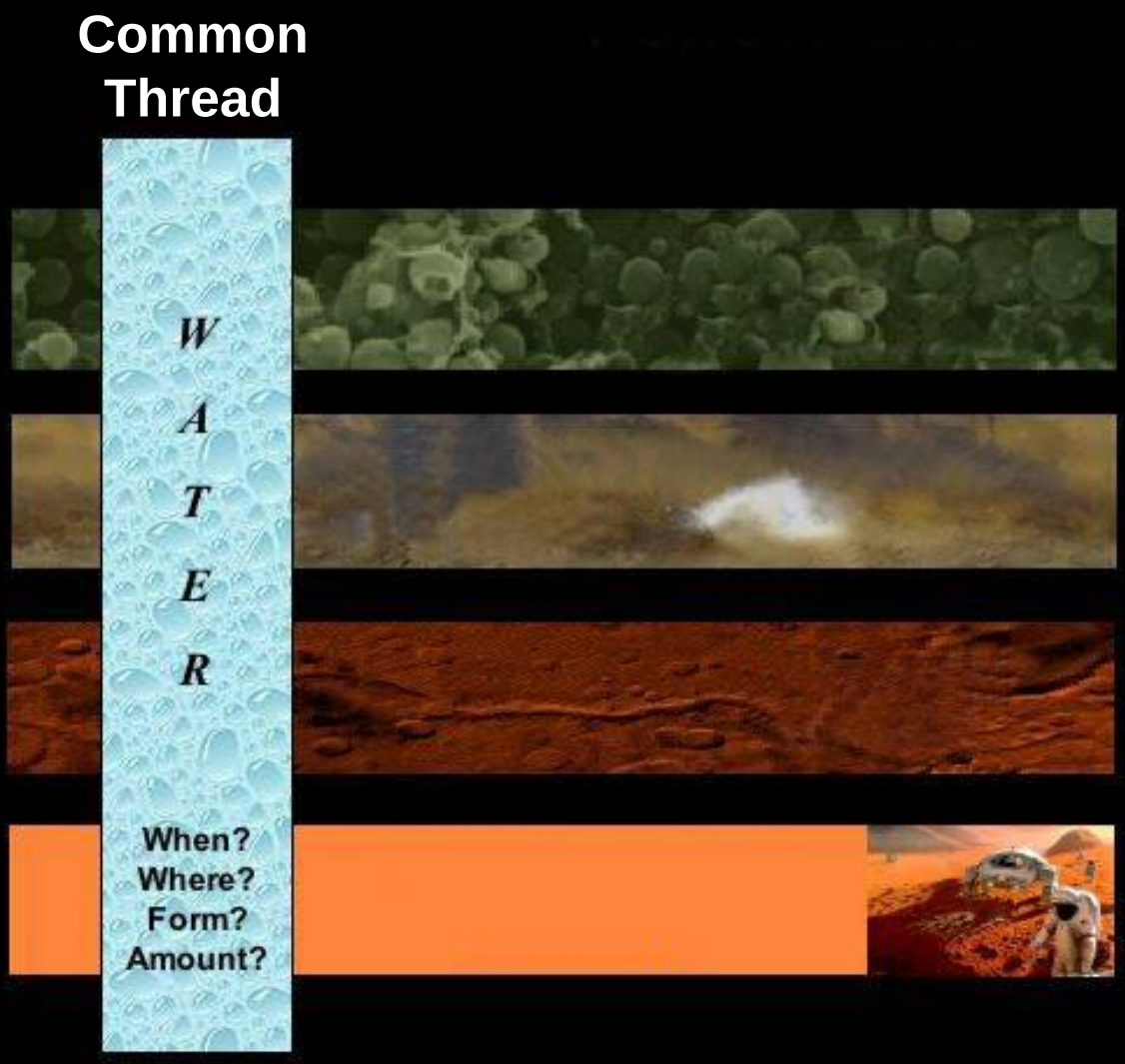
The 2004 Mars Exploration Rover Mission:

Evidence for Water and Prospects for Life

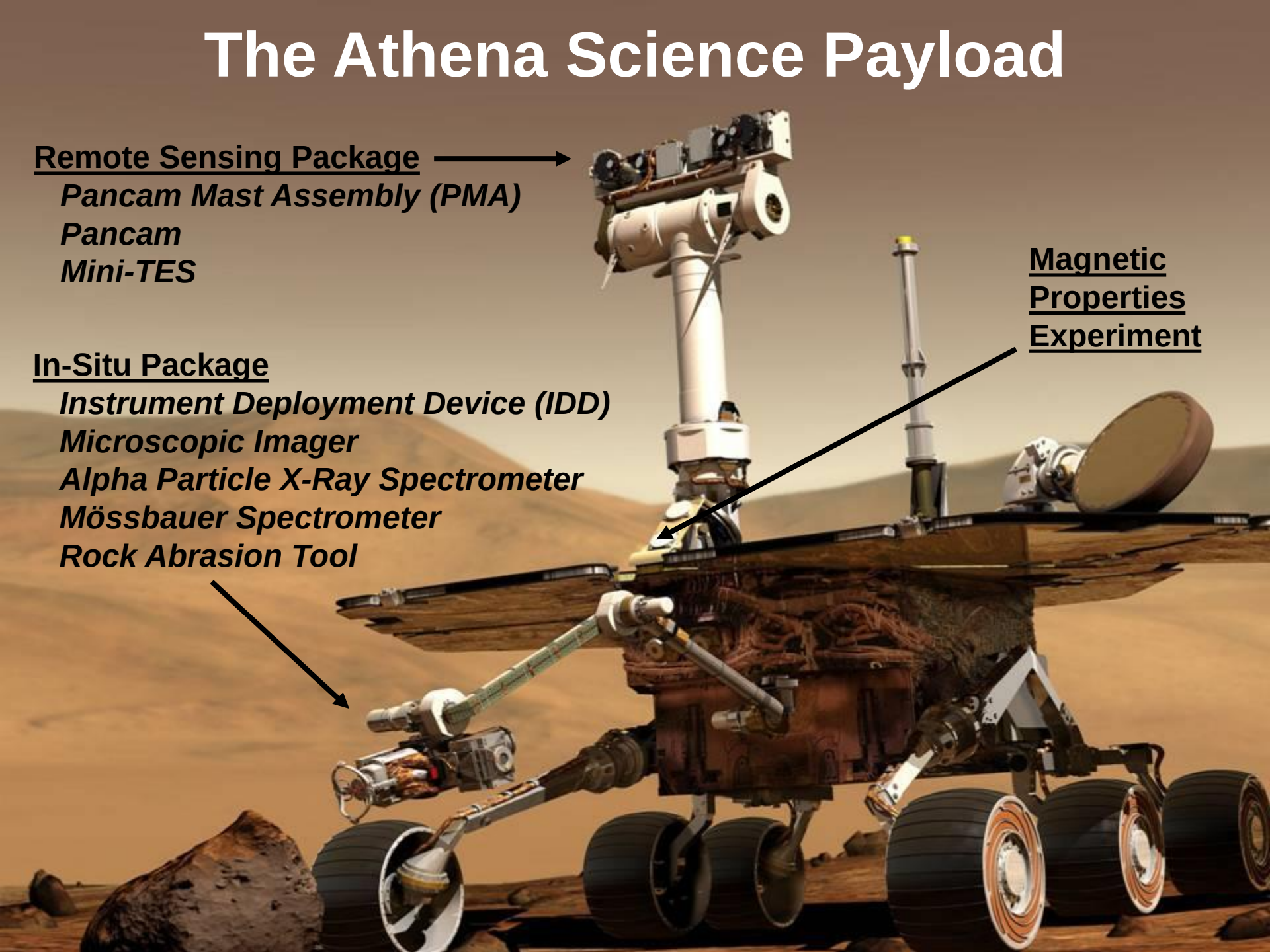
John Grotzinger
on behalf of
MER Athena Science Team



Mars Science Strategy: Follow the Water!



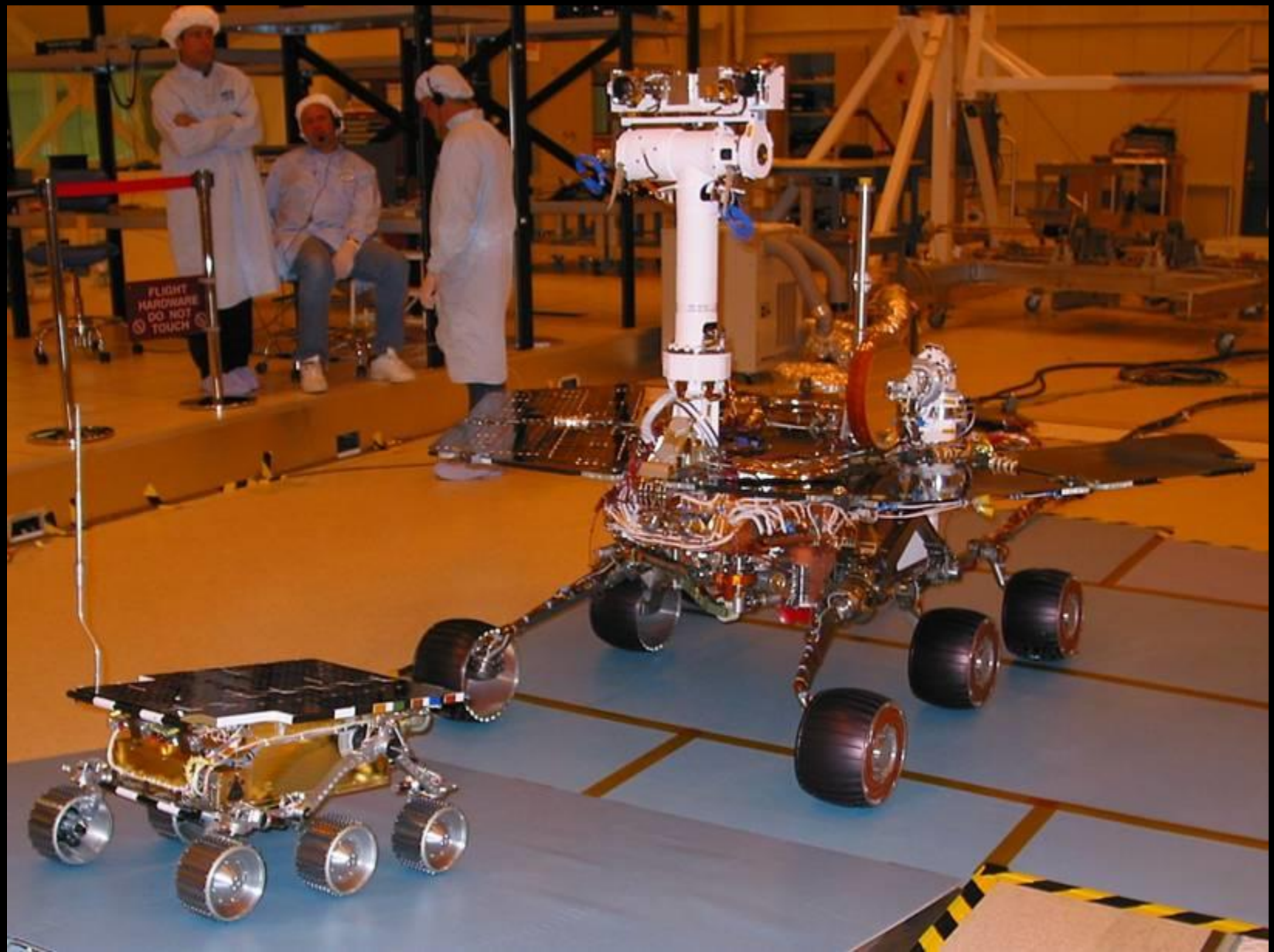
The Athena Science Payload



The Team

Mars Pathfinder

The MER Rover



Wrap it up and cram it in……

The Three Challenging Mission Phases

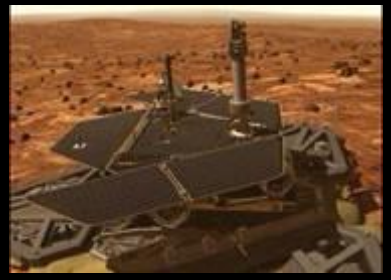
Launch & Cruise



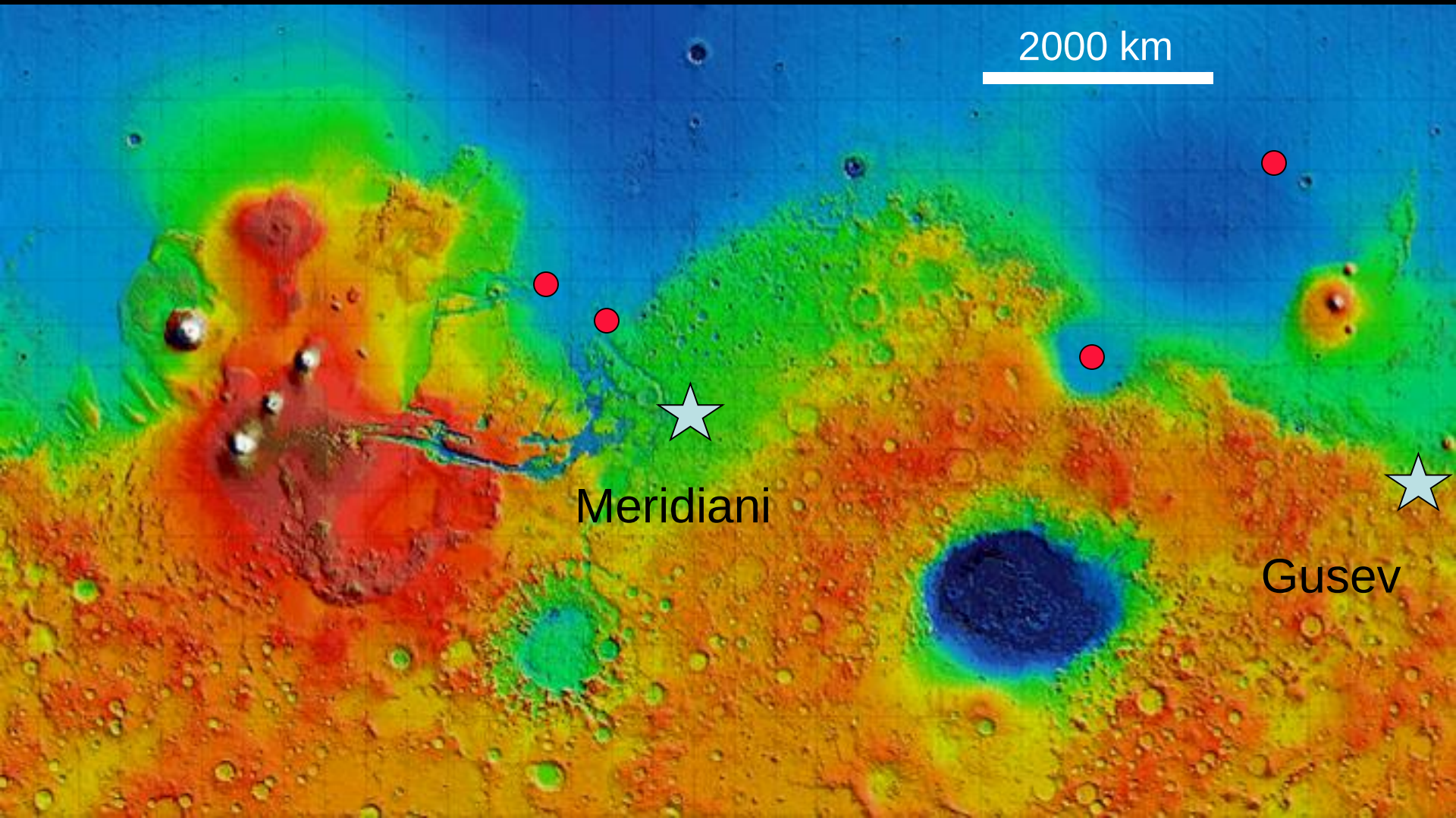

Entry, Descent & Landing



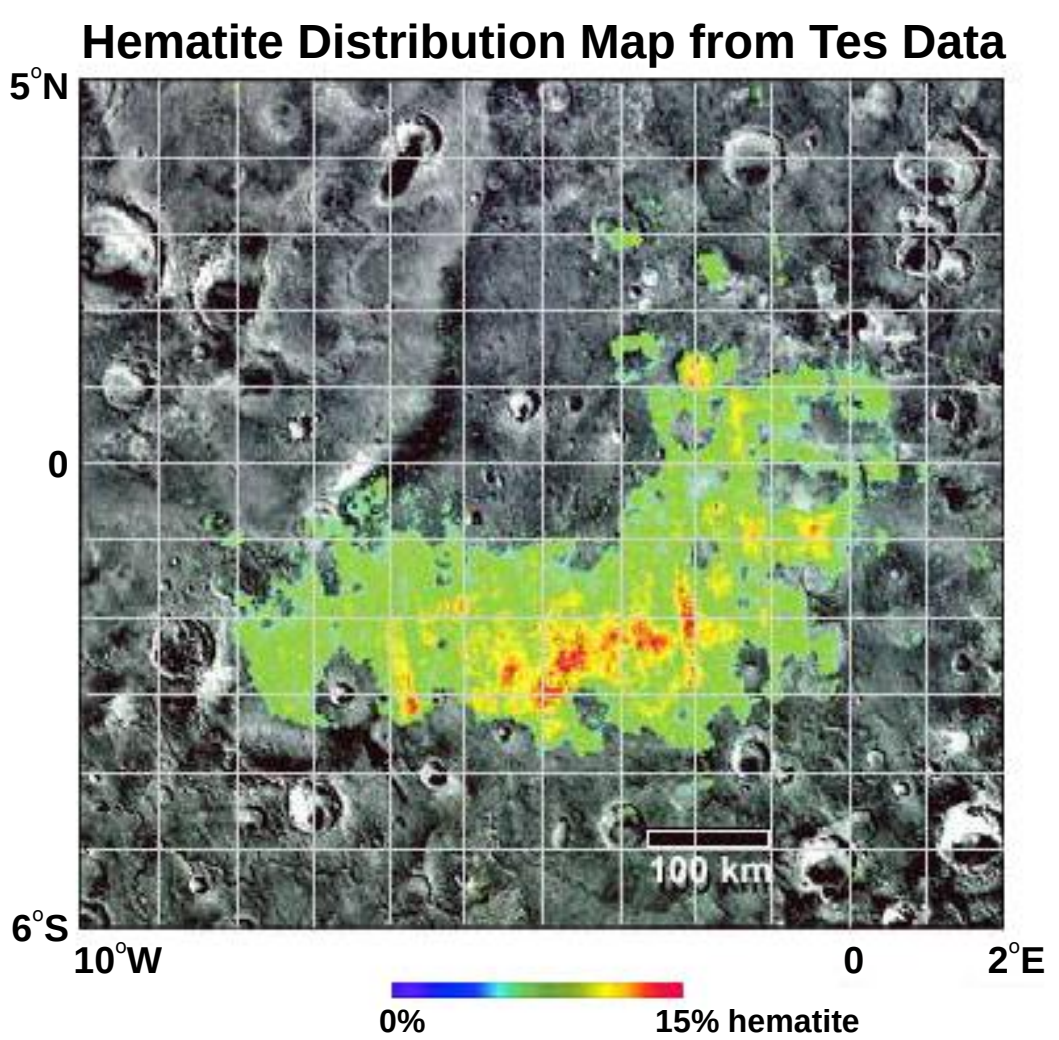

Egress & Surface Operations

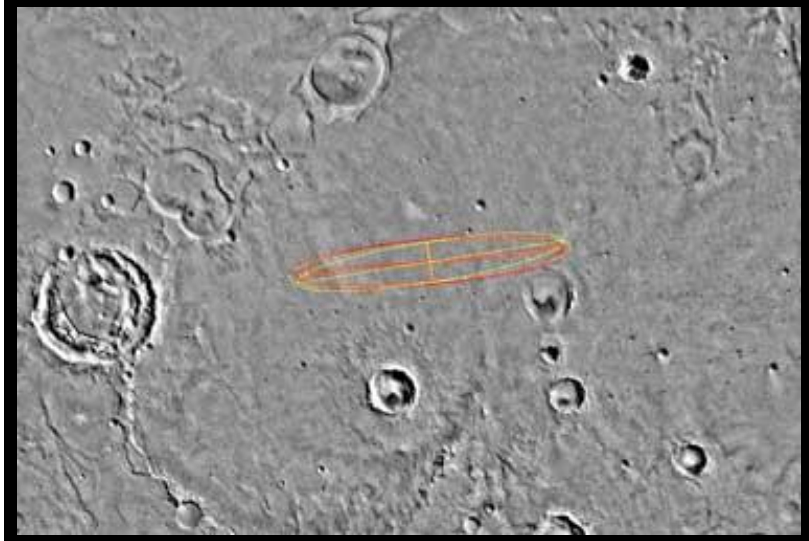
Opportunity at Meridiani Planum



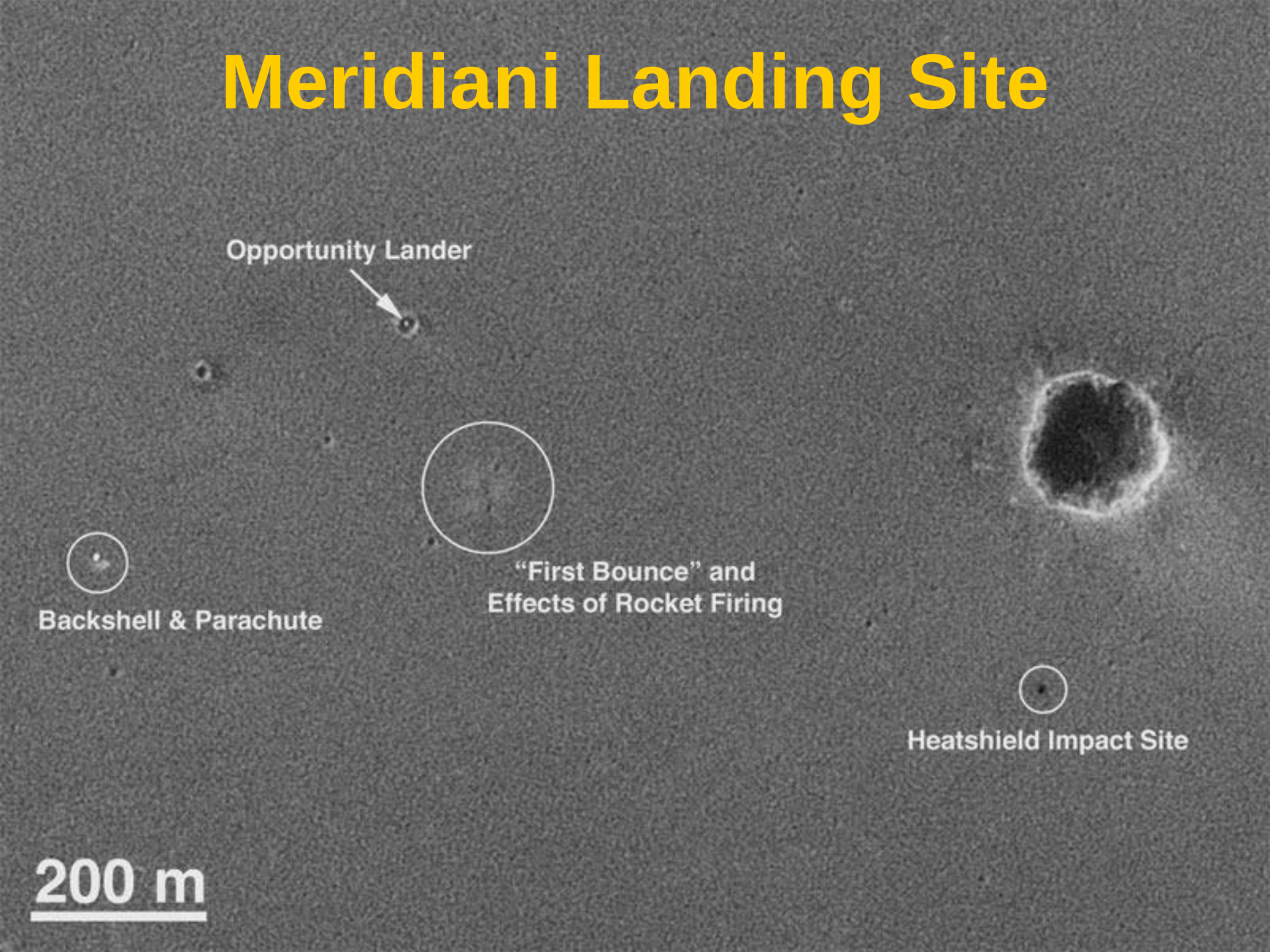
Hematite: Mineralogic Beacon



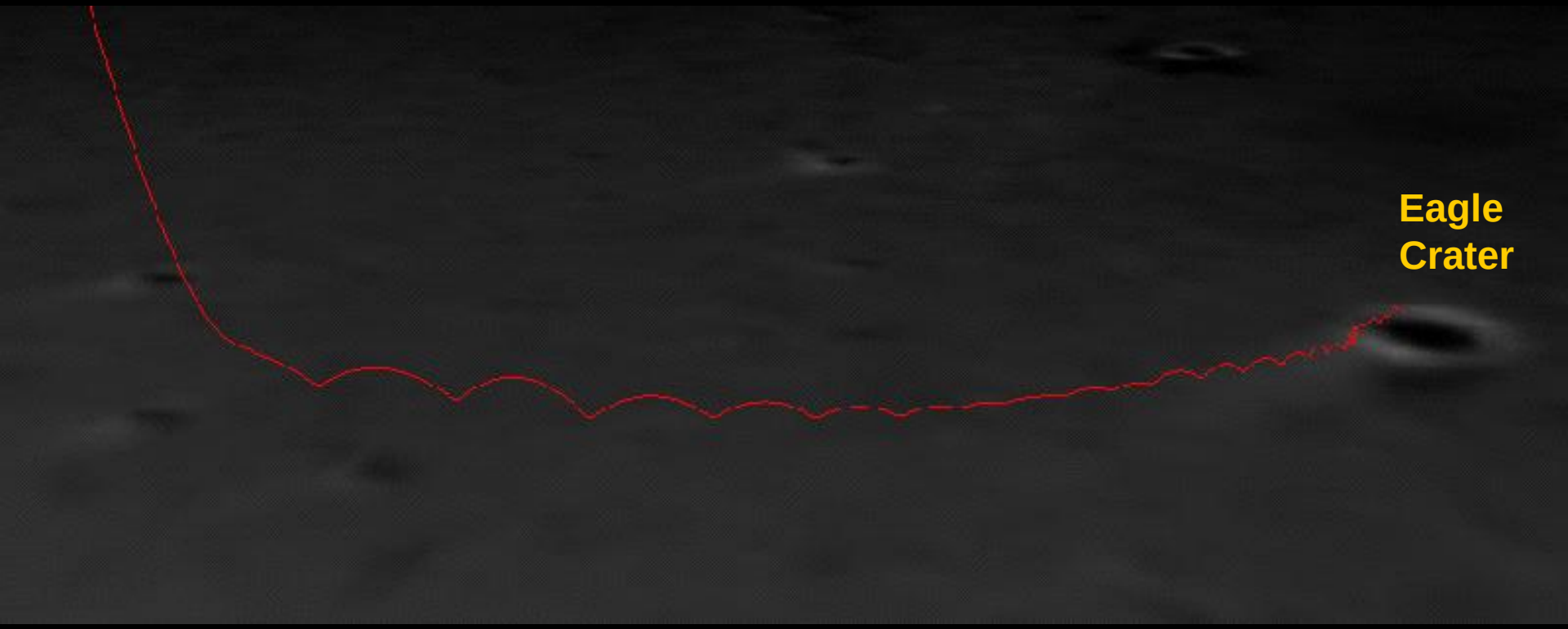
(Figure based on Christensen et al., (2001) JGR, v. 106(E10), Plate 2, p.23,877.)

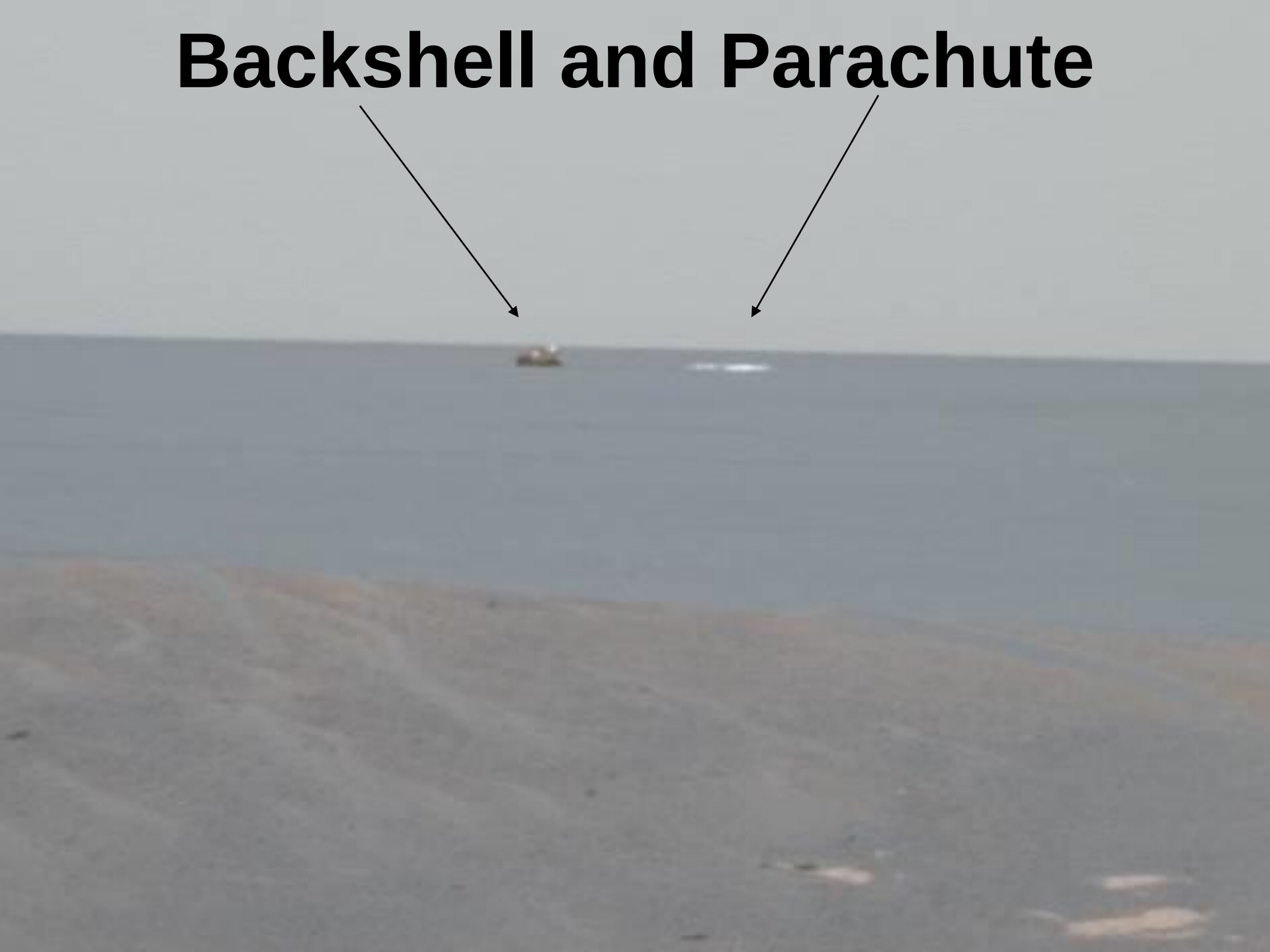


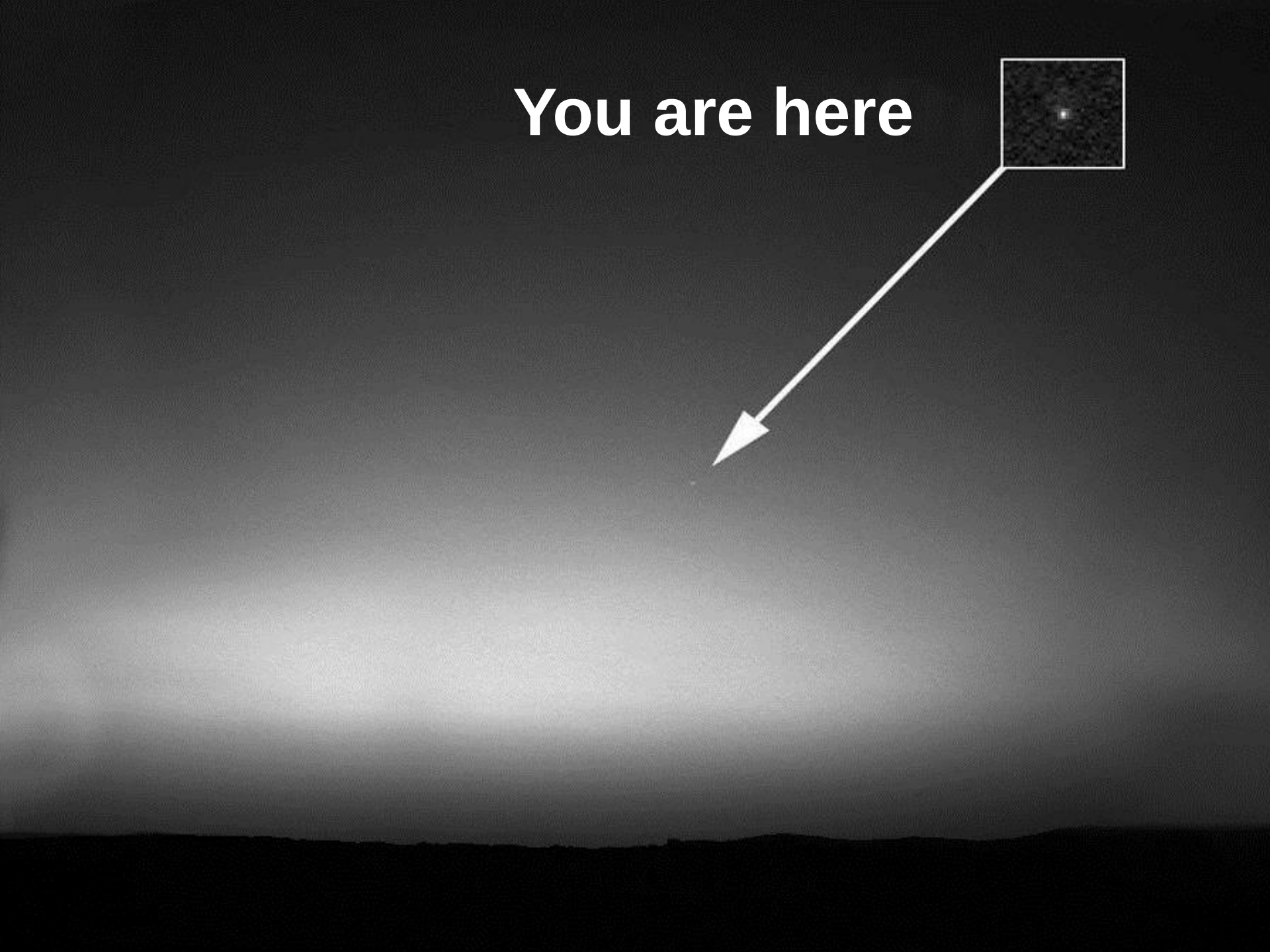
Meridiani Landing Site



Hole in One

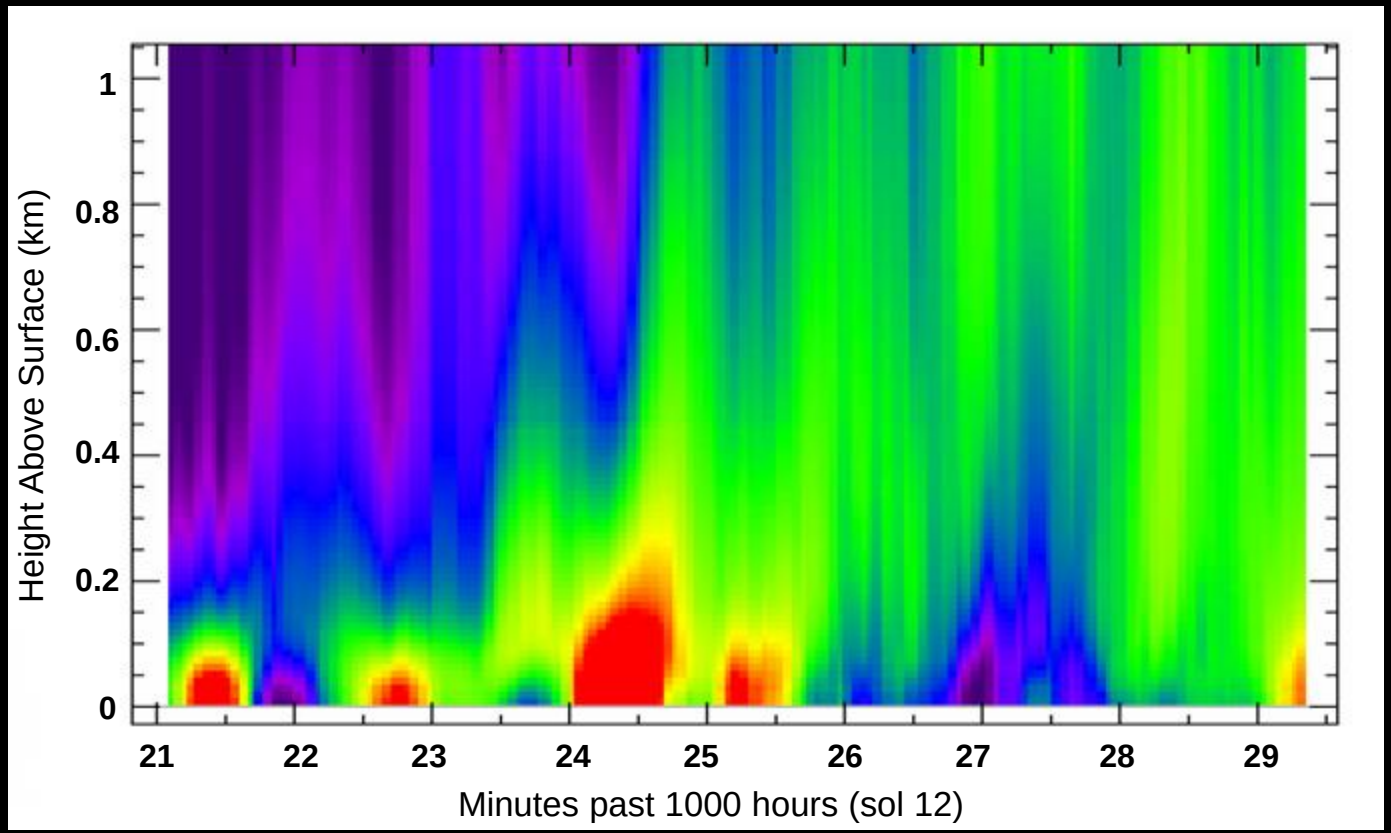



Backshell and Parachute


You are here

A Martian Eclipse

Short-Timescale Temperature Excursions



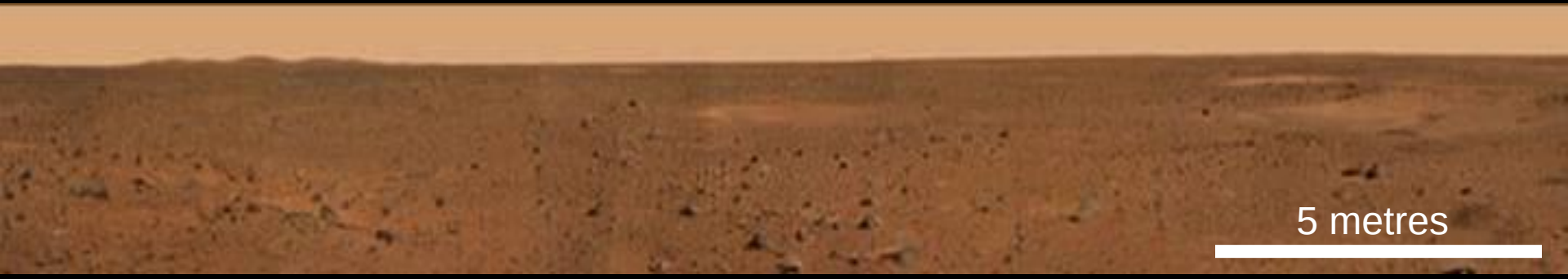
Red = hot
Purple = cold

Red to purple is 2 K **(degrees Kelvin)**

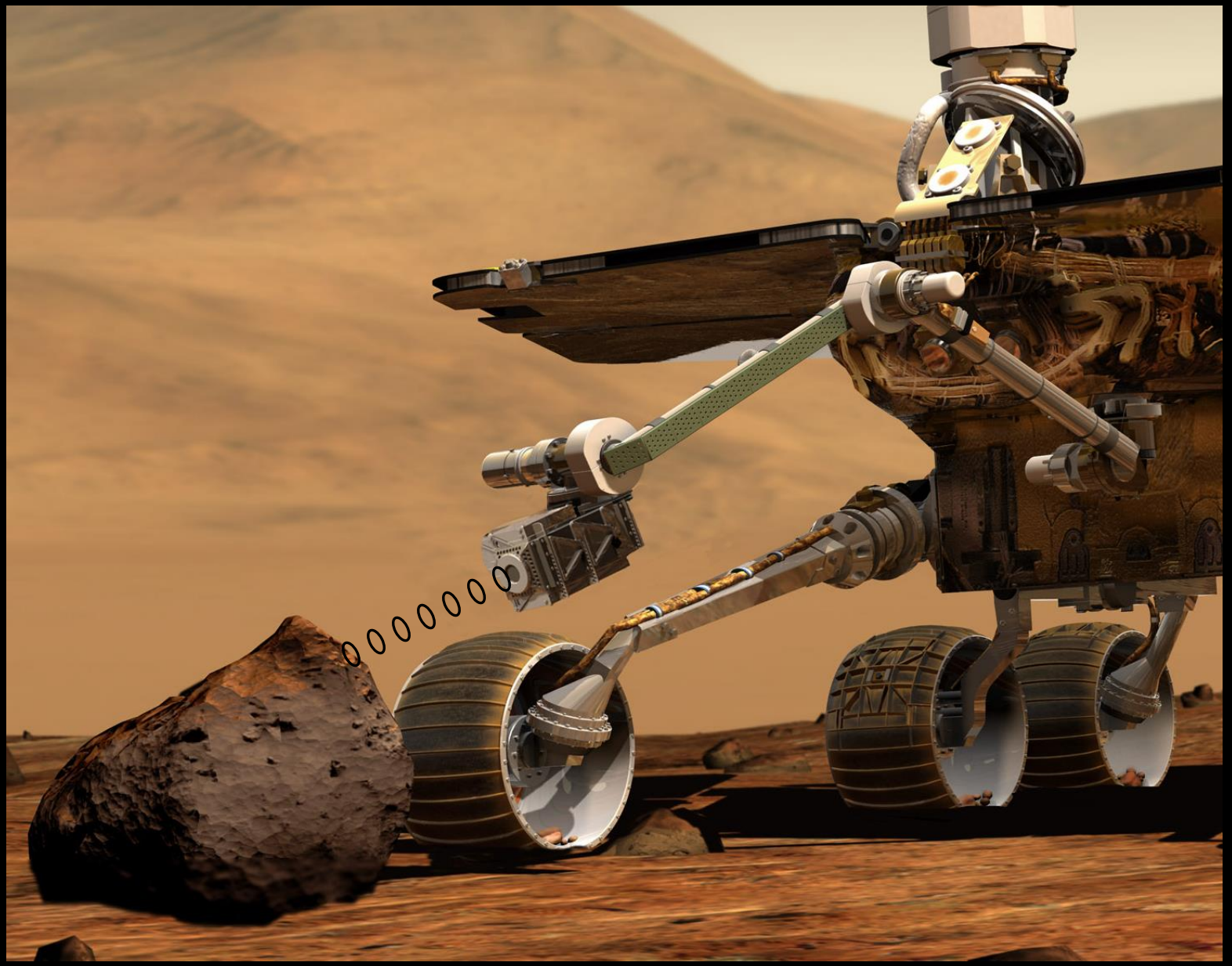
- Largest temperature variations confined to lowest 100 meters or so
- Appears that temperature perturbations propagate upward

Dust Devils

Spirit: View from Lander

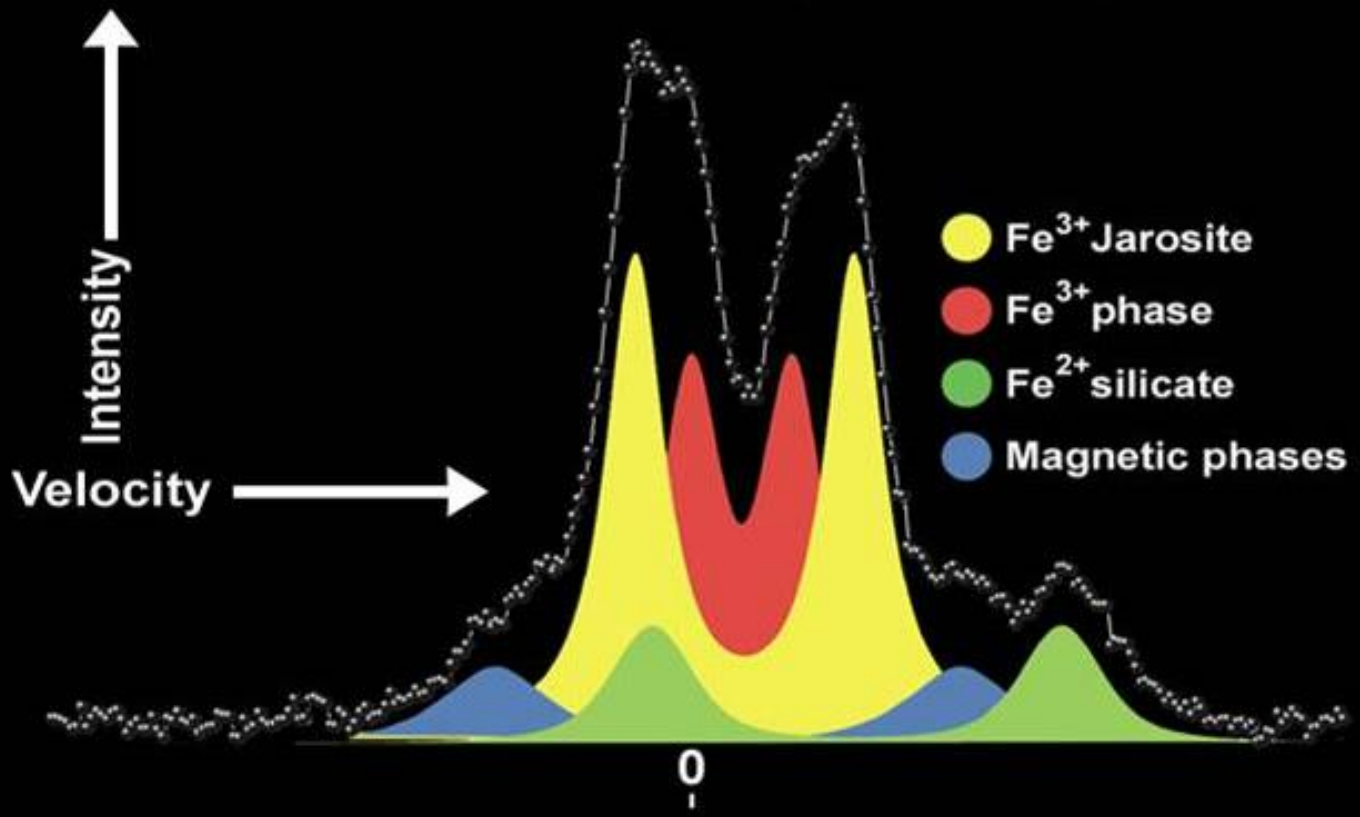


Opportunity: View from Lander



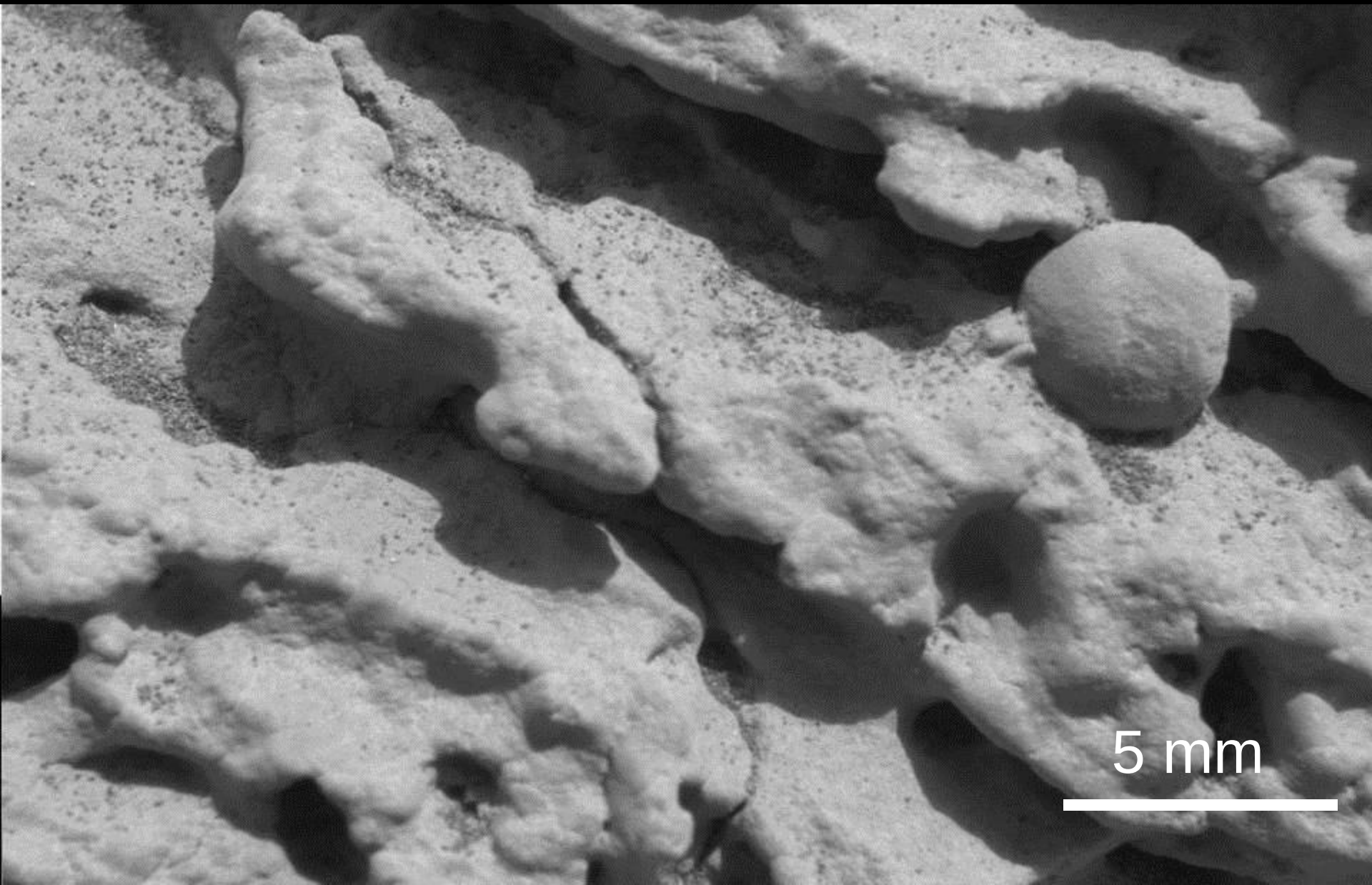
Mössbauer Spectrum of El Capitan:

Meridiani Planum Jarosite: $(K, Na, X^{+1})Fe_3(SO_4)(OH)_6$



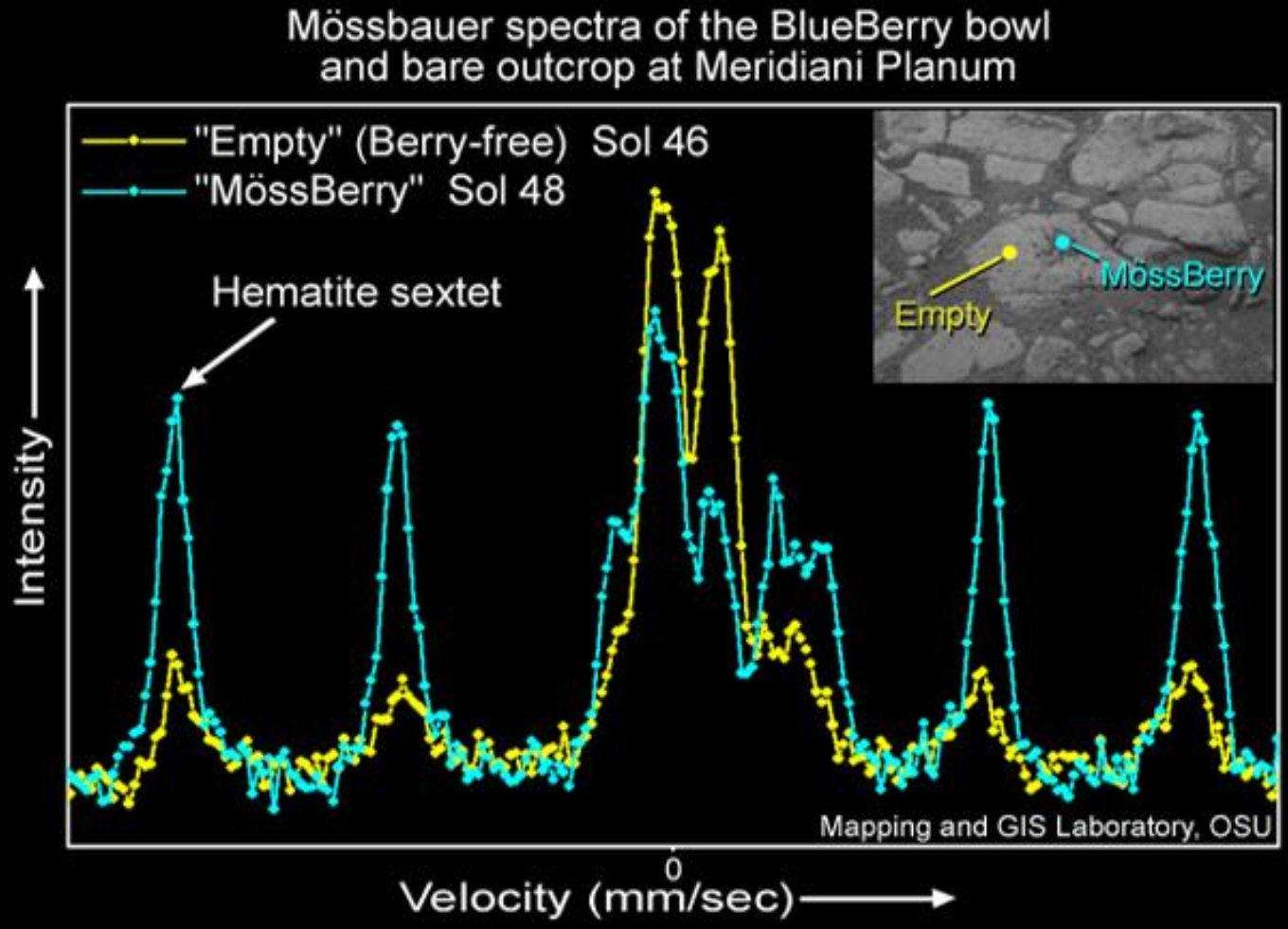
Rio Tinto, Spain

Spherules



The “Berry Bowl”

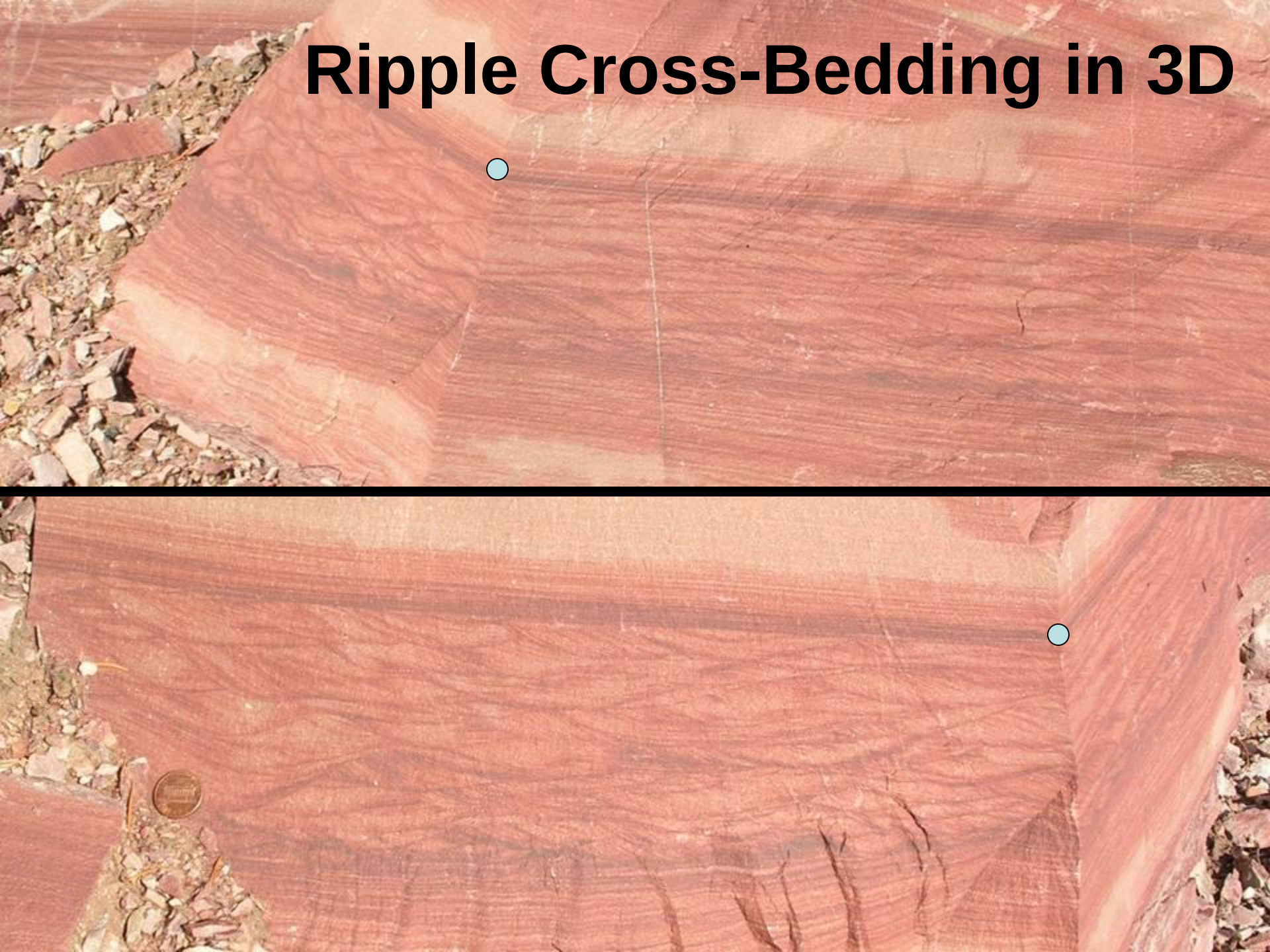
Mössbauer on the Berry Bowl



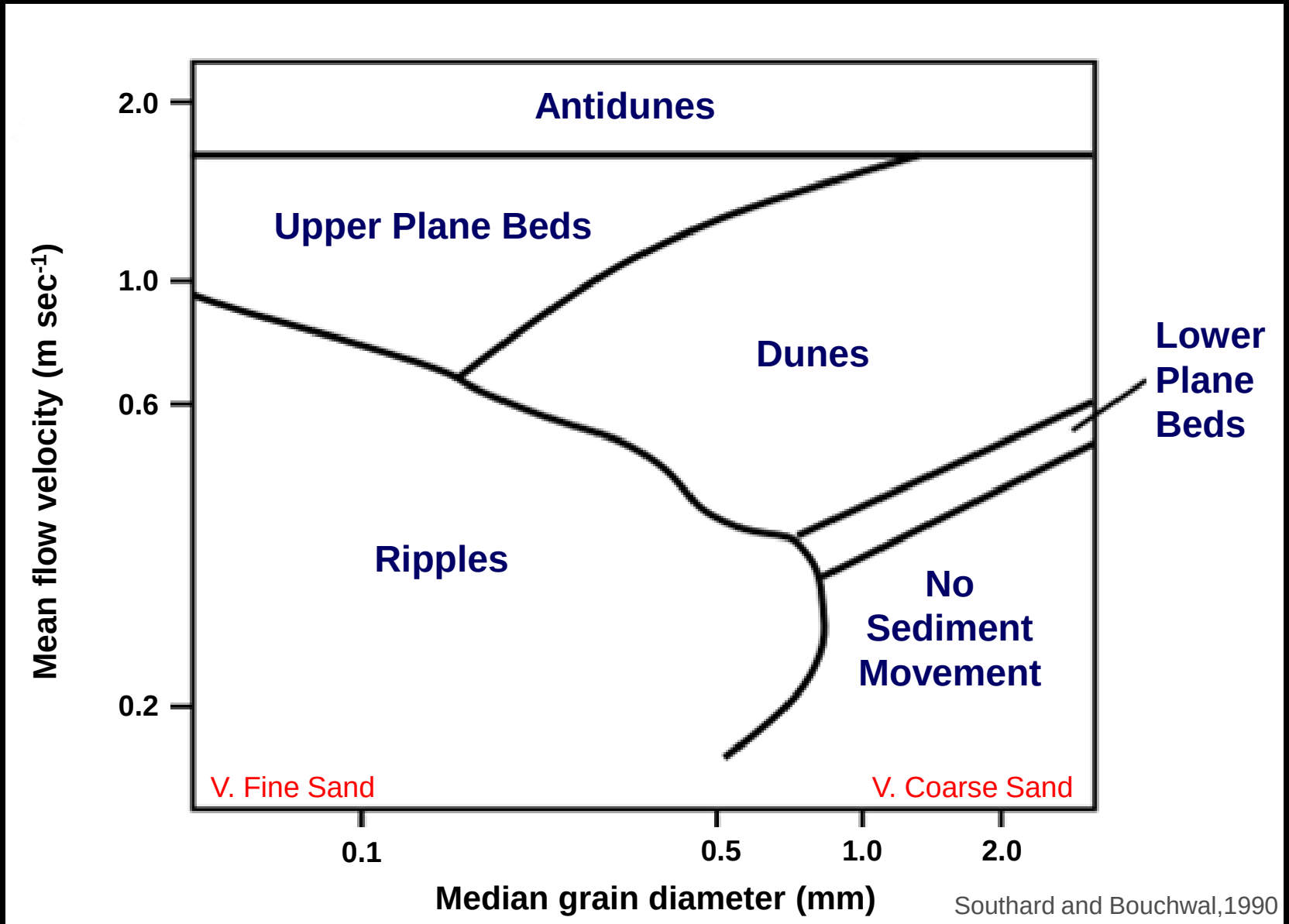
Sediment Bedforms (e.g. Ripples)

Ancient Terrestrial Ripples: 1.4 Billion Years Old

Ripple Cross-Bedding in 3D



Bedforms in Flowing Water



Southard and Bouchwal,1990

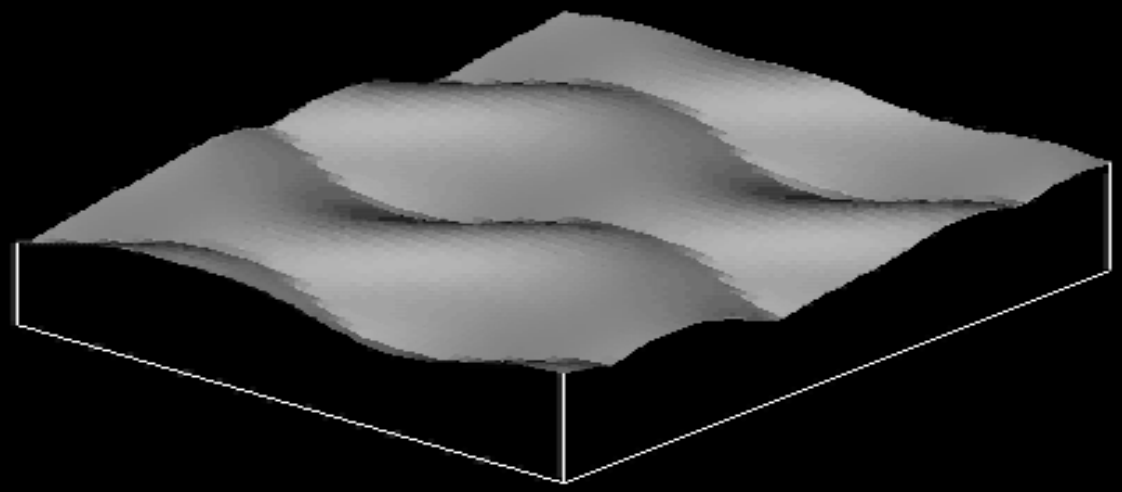
Current Ripples in Water

6 hours of ripple migration

Image is 60x40 cm

Flume experiments by Dave Rubin and Jon Nelson, USGS

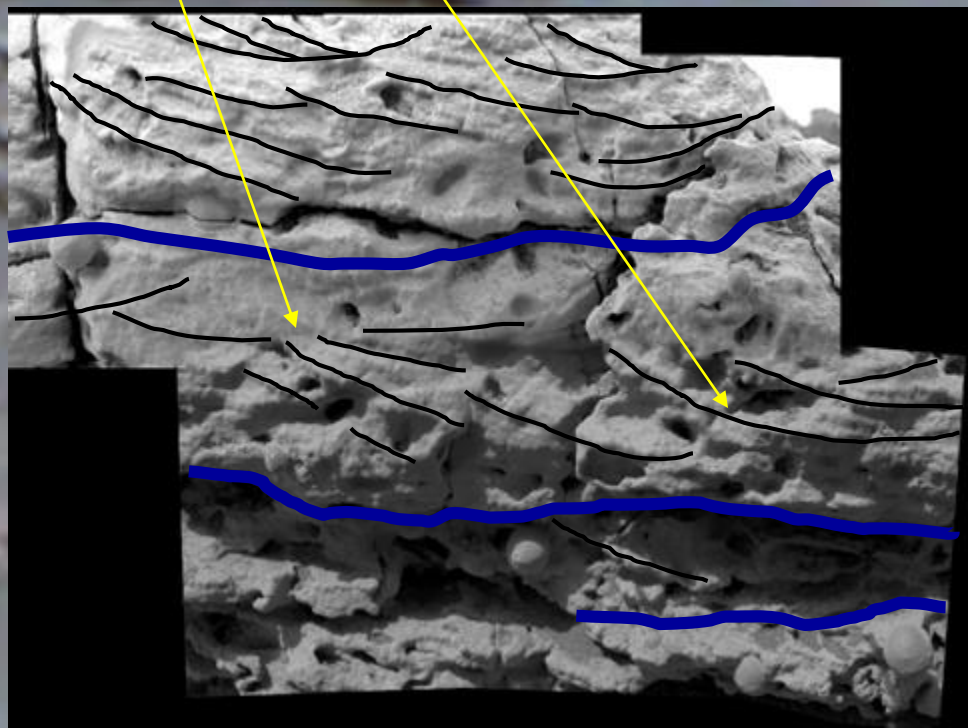
Current Ripples in Cross Section



Simulation by Dave Rubin, USGS

Festoon Cross-Bedding on Earth

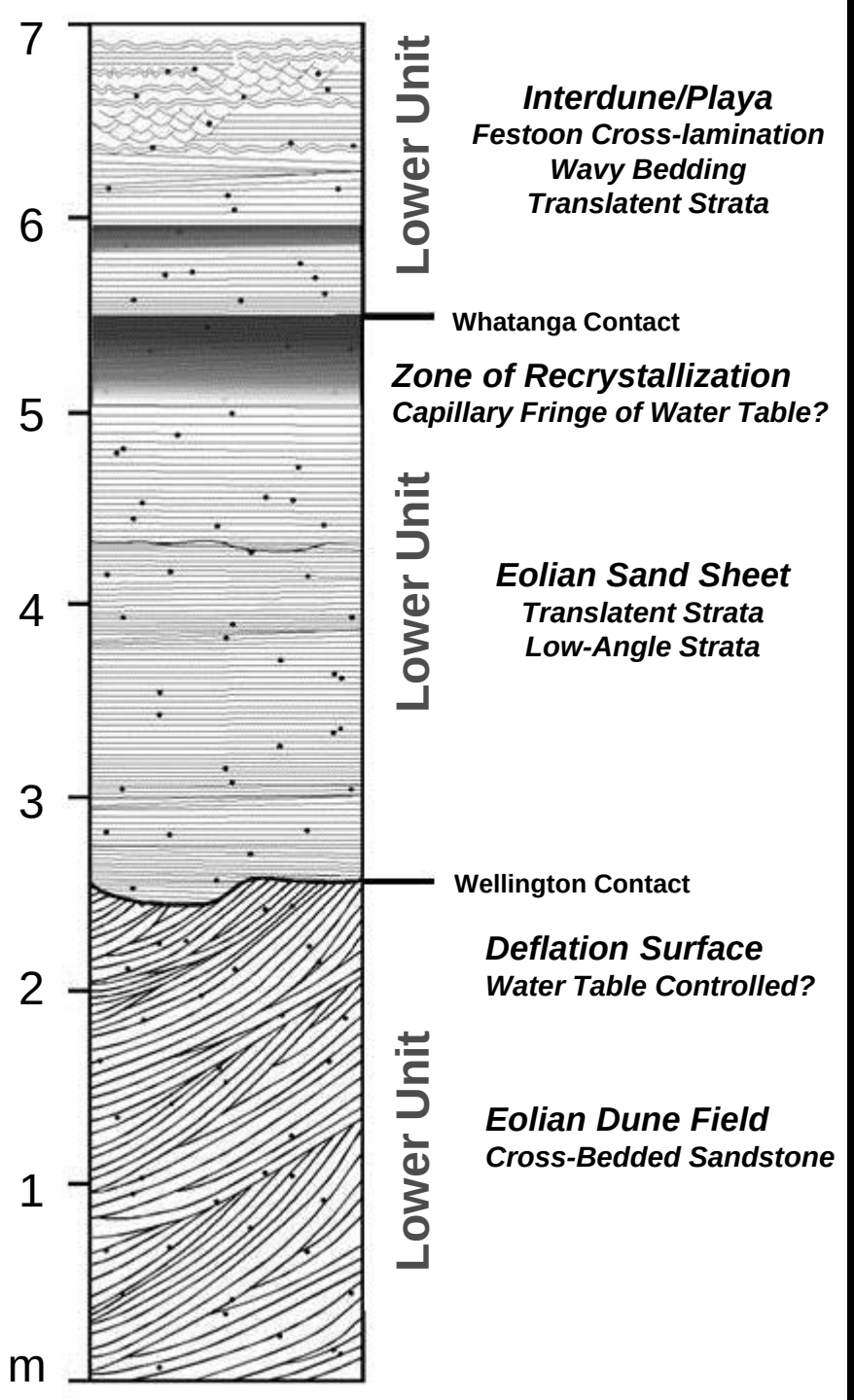
Festoon Cross-Bedding on Mars



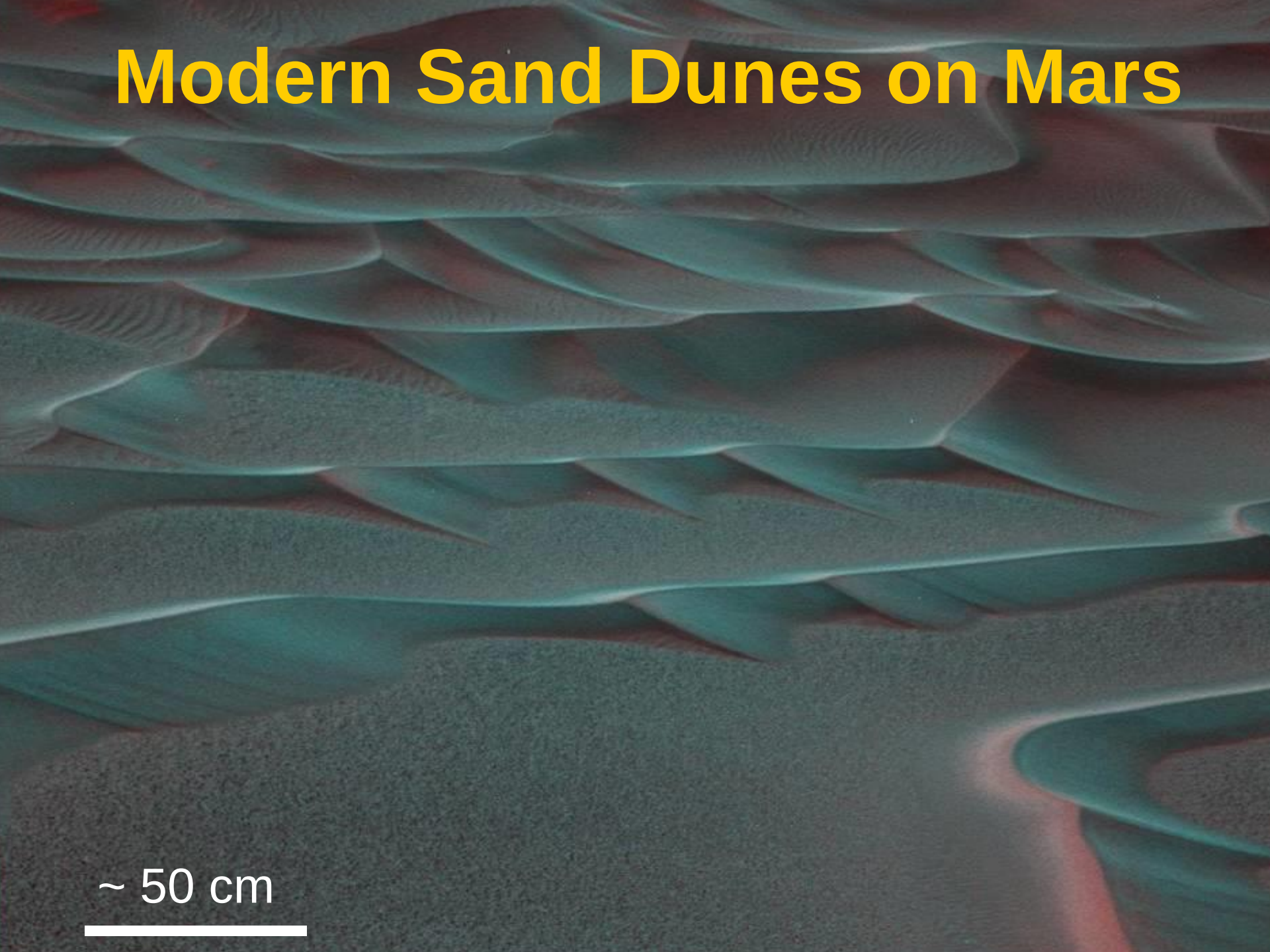
Burns formation

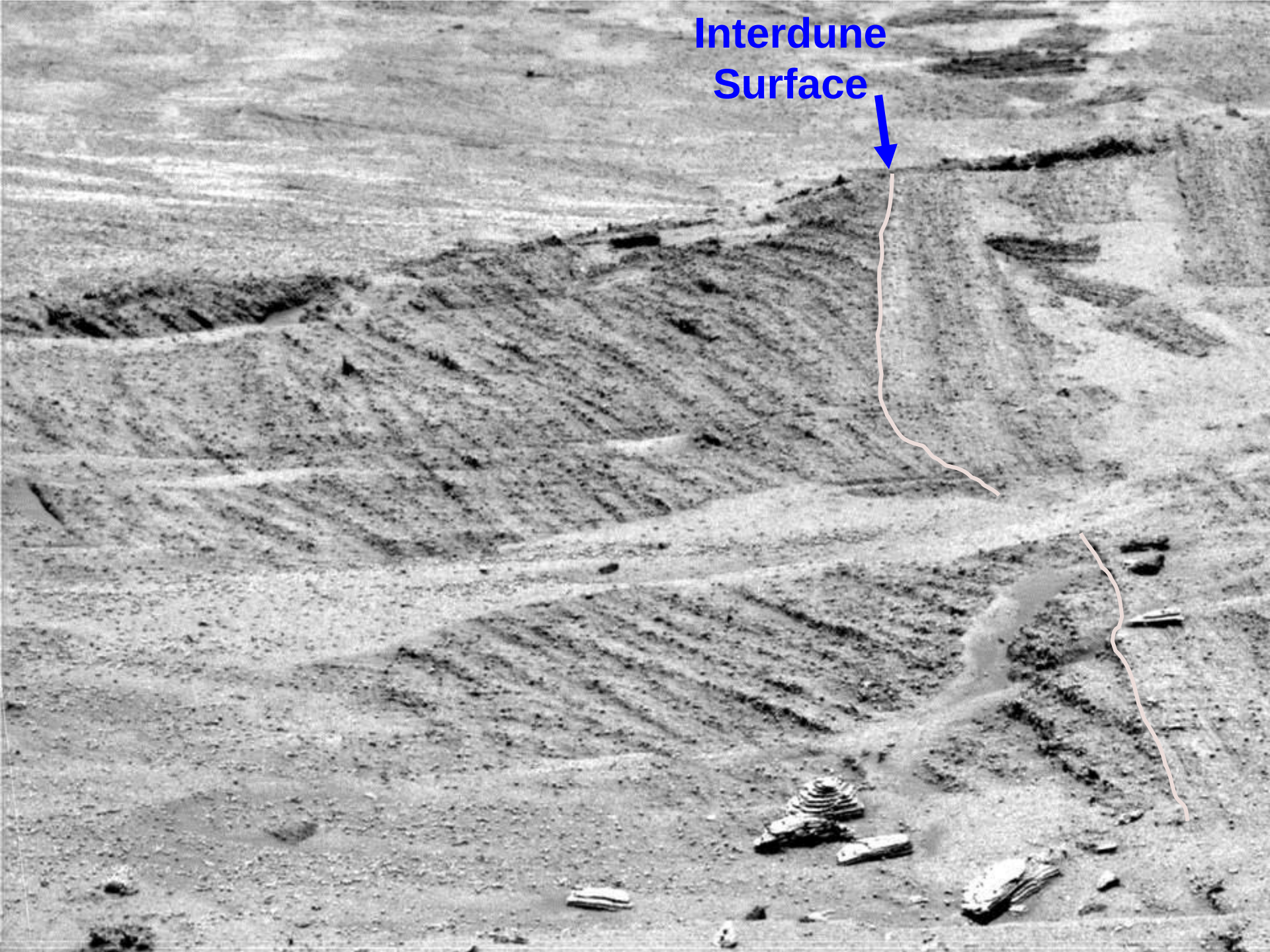
(Endurance crater)

Burns Stratigraphy



Modern Sand Dunes on Mars



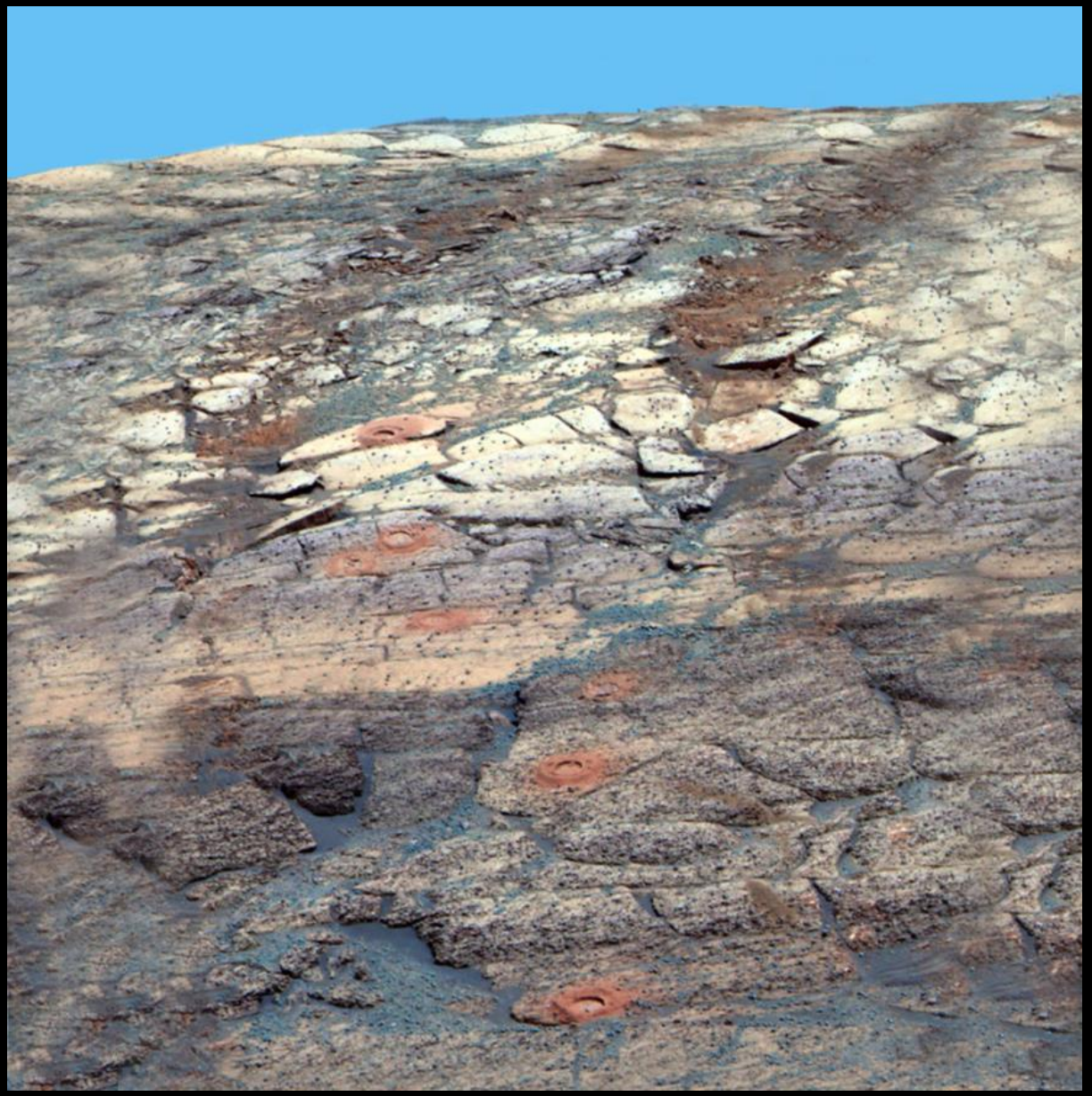

Interdune
Surface

Interdune Deflation Surface

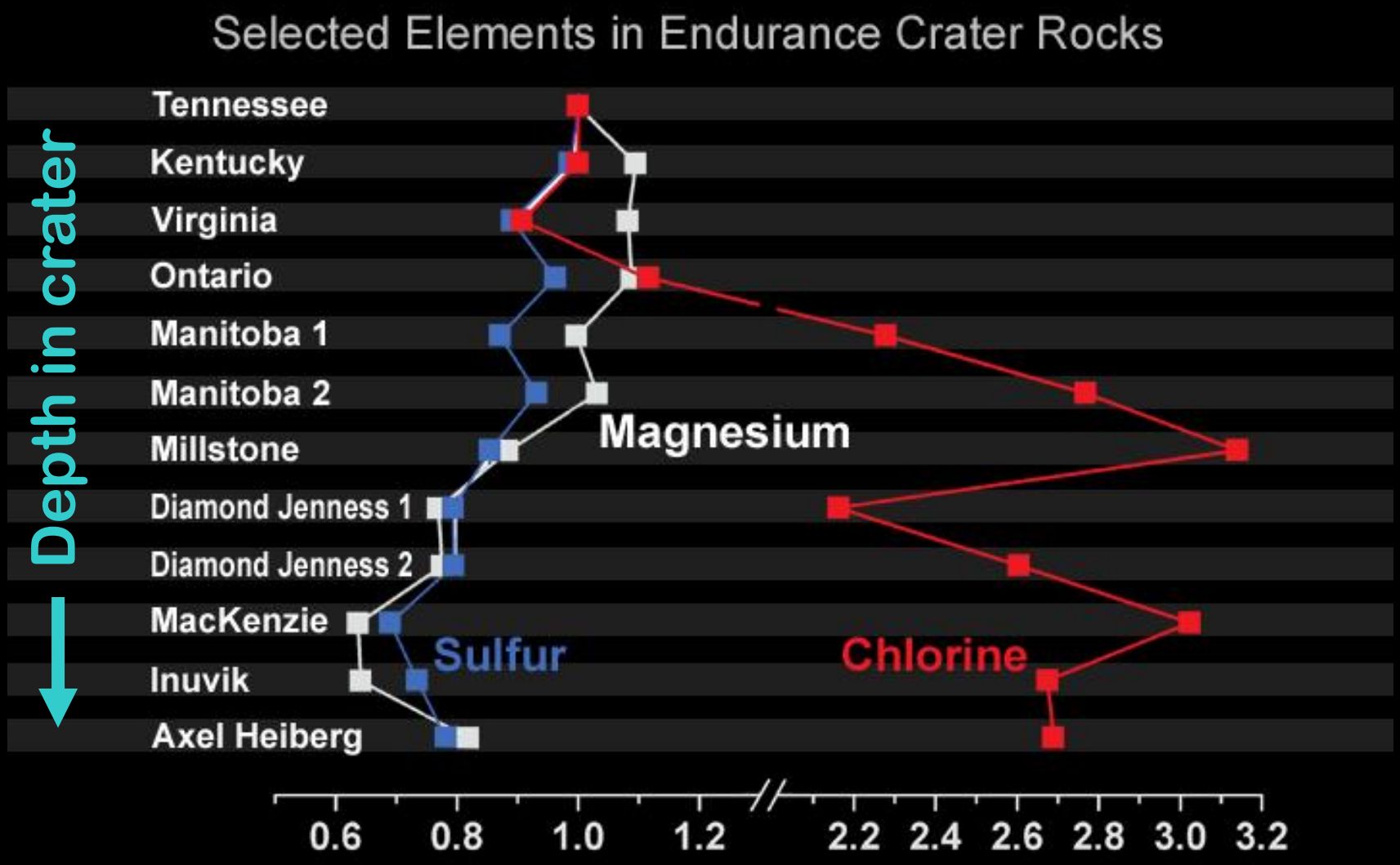

Modern Mars Analog:
Um Asamin

Modern Interdune Depression

Endurance Chemostratigraphy



Ratio to surface rock average



Changes Down Section: Texture

Ontario

Diamond Jenness

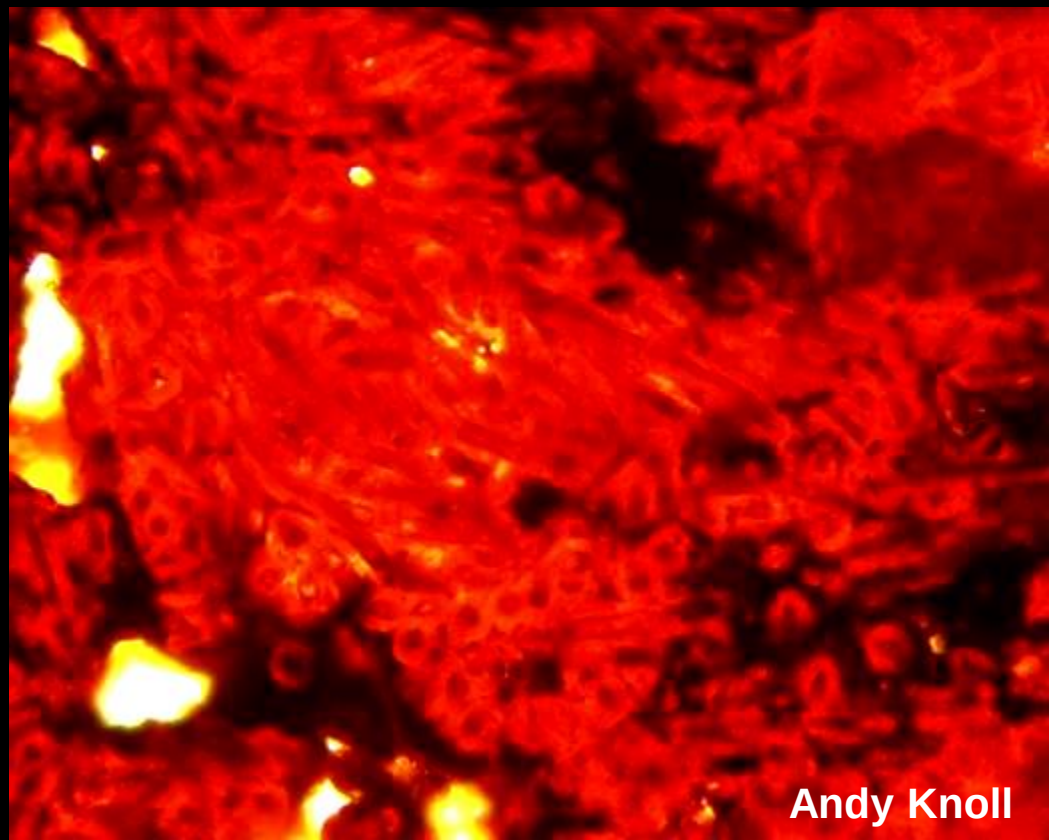
- Meridiani environment appears to have been acidic, hypersaline, and only intermittently wet.
- Life exists at such extremes on Earth.
- But Meridiani data suggest potential challenges to origin as well as persistence of life.

Rio Tinto Extremophiles

The Good News

- Evidence of any life that might have existed might well be preserved in chemical sediments and concretions.
- Chemical and textural details of Meridiani salts and iron oxides likely to reveal much about environmental history.

- *All this favors Meridiani Planum as a target for sample return.*



Summary

- Rovers have:
  - Operated for over 1200 days
  - Returned over 100,000 images
  - Analyzed dozens of rocks and soils

Summary

- Evidence for water:
  - Mössbauer detection of jarosite
  - Crystal molds, concretions, diagenesis
  - Festoon ripple cross-bedding
  - Stratigraphic succession of environments

Summary

- Prospects for Life:
  - Preservation potential is good
  - But did life originate under such extreme conditions?

Dr. John Grotzinger

Fletcher Jones Professor of Geology
California Institute of Technology

John Grotzinger is a field geologist interested in the co-evolution of surficial environments and life on Earth and Mars. His research addresses the chemical development of the early oceans and atmosphere, and the environmental context of early evolution. Field mapping studies are the starting point for more topical laboratory-based studies involving geochemical, paleontological, and geochronological techniques.

Currently, his research is focused on the reconstruction of environmental conditions associated with the Cambrian radiation of animals in Oman, Namibia and Siberia. In 2004, he served as a member of both the Geology and Long Term Planning Groups for the Mars Exploration Rover mission.