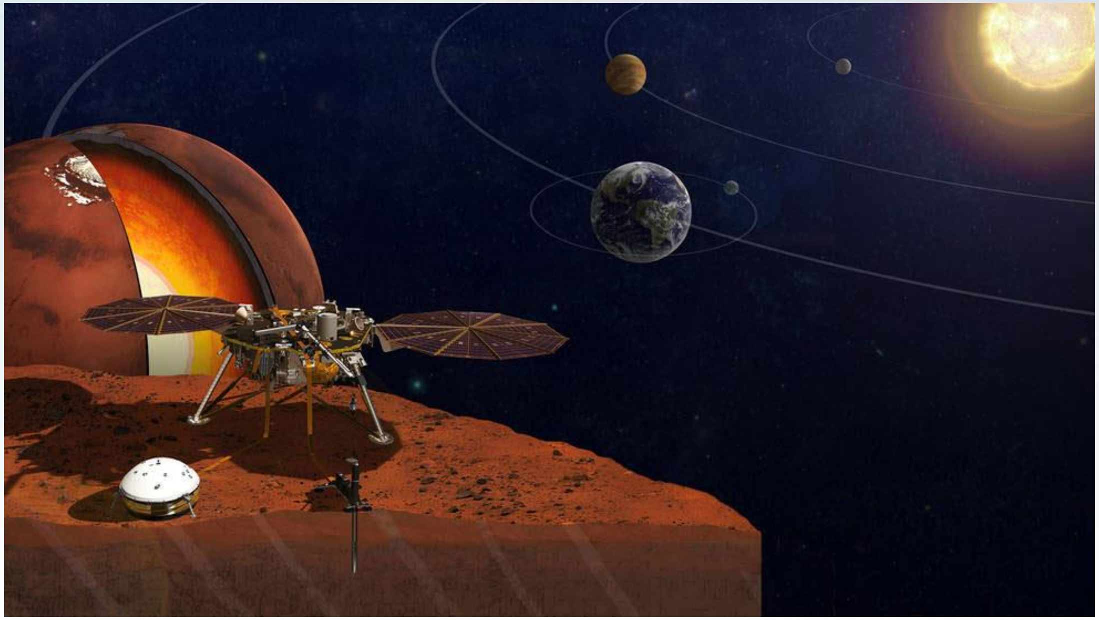
Off to Mars! Programming Ideas for the InSight Launch

The webinar will begin at 1:00 p.m. (MT) and will be recorded.



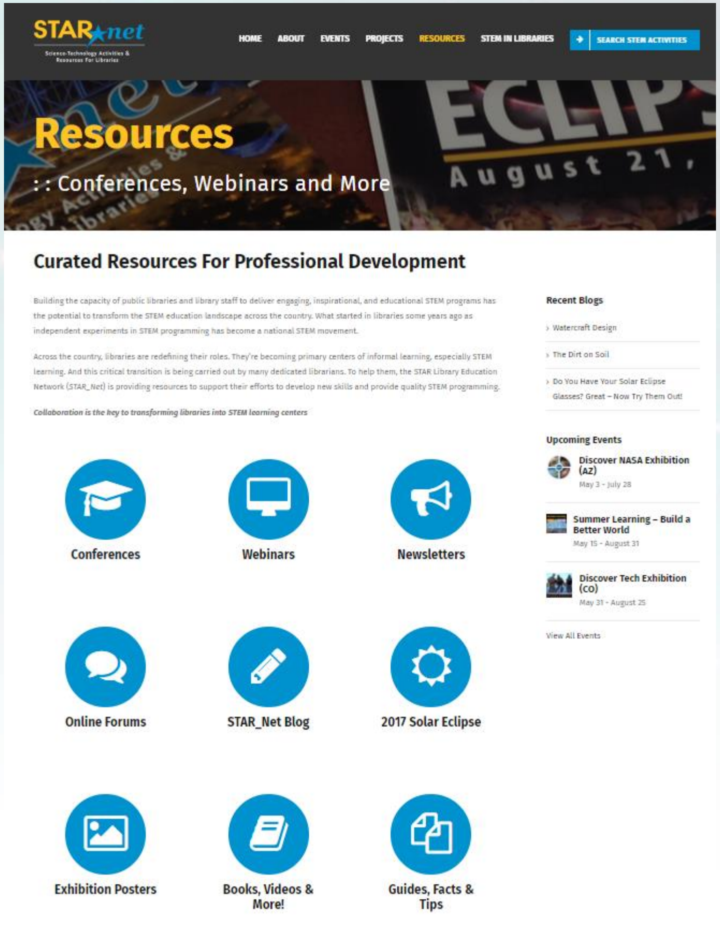
Audio problems? Click and highlight the button at the top of your screen. You can also click "Meeting" > "Audio Setup Wizard". You will not need microphone capabilities.

Agenda for Today

- Introduction and Reminders
- What Makes InSight So Special?
- Hands-on STEM: Recipe for a Planet
- Steve Lee Presentation
- Q&A

A National Earth and Space Science Initiative that Connects NASA, Public Libraries and their Communities

Join STAR Net!

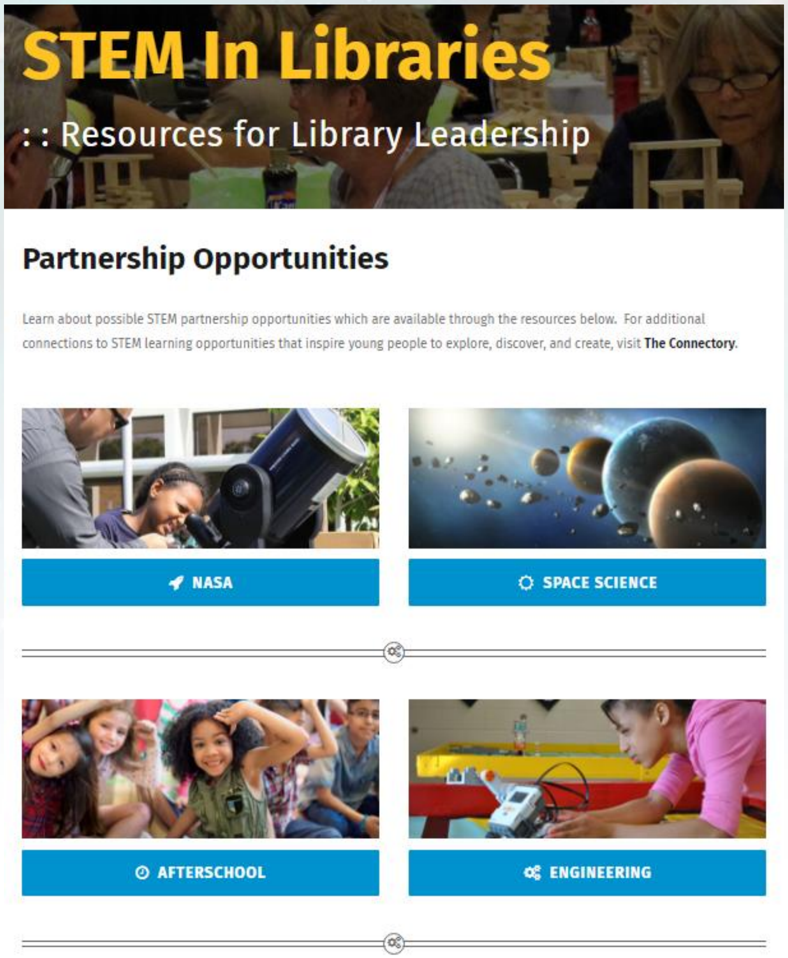


Professional development resources, including webinars, newsletters, blogs, forums, videos, and much more!

FREE Resources

- Reports and Tools for Library Leaders
- STEM Activity Clearinghouse
- Professional Learning Opportunities
- Blogs
- *STAR Net News*

Reminders



- www.starnetlibraries.org/stem-in-libraries/collaboration/partnership-opportunities/

Earth Day

- April 22
- Earth Day Landing Page
- Earth Day Collection (Weather and Citizen Science)
- Earth Science Collection
- Celebrate 60 Years of Earth Observations with NASA

Reminders

The Parker Solar Probe Launch: How Will Your Library Be Involved?

Thursday, May 17, 2018 at 3:00 p.m. (EDT), 2:00 p.m. (CDT), 1:00 p.m. (MDT), 12:00 p.m. (PDT)

Register Here

Why Makes InSight Special?

1) First mission to study the deep interior of Mars
2) Teach us about planets like our own
3) Try to detect Marsquakes for the first time
4) First interplanetary launch from the West Coast
5) First interplanetary CubeSat
6) Could teach us how Martian volcanoes were formed
7) Mars is a time machine!

Recipe for a Planet

- Activity Link

Recipe for a Planet

Overview

Recipe for a Planet is a 45 minute activity in which children ages 8 to 13 build edible models of Earth and Mars to compare their sizes and illustrate their internal layers.

What's the Point?

- Mars is about half the size of Earth.
- Mars and Earth have internal layers, including cores, mantles, and crust.
- Earth has a solid inner core and molten outer core; Mars most likely has a molten core.
- Surface features on a planet provide clues to their internal processes.
- Volcanos on a planet's surface suggest that the interior of the planet is – or was recently – sufficiently hot to create magma, molten rock.
- Models are tools for understanding the natural world.
- Models — such as the children are using here — can be tools for understanding the natural world.
- Geologists use comparisons between features on Earth and other planets, like Mars, to help them identify differences in how the features may have formed or changed.

Making Earth

Earth's inner metallic core: a donut hole
Earth's molten outer core: red icing
Earth's mantle: 3 1/2 Rice Krispies Treats
Earth's oceanic crust: blue sprinkles or "jimmies"
Earth's continental crust: 1/2 of a Rice Krispies treat covered in green sprinkles or "jimmies"

Have each team tear one of their Rice Krispies treats in half and set one half aside. Mash the other half together with 3 more Rice Krispies Treats so they make one "mega treat." Have them form the treat into a flat rectangle, about 4 inches by 6 inches. Starting in the center of the flattened "mega treat," smooth a thin sheet of the red icing to within one inch of each edge; they should use about half of the icing and save the rest for later. Place the donut hole in the middle. Gently wrap the Rice Krispies Treats around the donut hole — with the icing side against the donut hole — to form a ball. Roll it around and squeeze it to make it firm.

Invite the children to add continental and oceanic crusts to their Earth. Have them place their Earth sphere in the baggie with the blue sprinkles. Roll it around until it is thoroughly covered in blue. Remove and set it aside.

Now invite them to make the continental crust — the land on Earth. Ask them to take the Rice Krispies Treat half they set aside earlier and flatten it into a thin layer. Have the children create four or five continent shapes, then gently press one *side* of each continent into the green sprinkles until covered. Have them gently press each continent onto the Earth sphere with the sprinkle side up. In reality, the thicker continental crust does not "sit" on top of the oceanic crust; both sit above the Earth's mantle.

Making Mars

Mars' inner core: 2 tablespoons of red icing
Mars' mantle: 2 Rice Krispies Treats
Mars' crust: red sprinkles

Have the teams shape their Rice Krispies Treats into a rectangle about four inches by two inches. Place the red icing in the center and *gently* wrap the Rice Krispies Treat around it, shaping it into a ball.

- What color is the surface of Mars from space? *Mostly red.*

Have the children place their Mars sphere in the baggie with the red sprinkles and roll it around until it is thoroughly covered in red. Remove and set aside.

Other Mars Activities

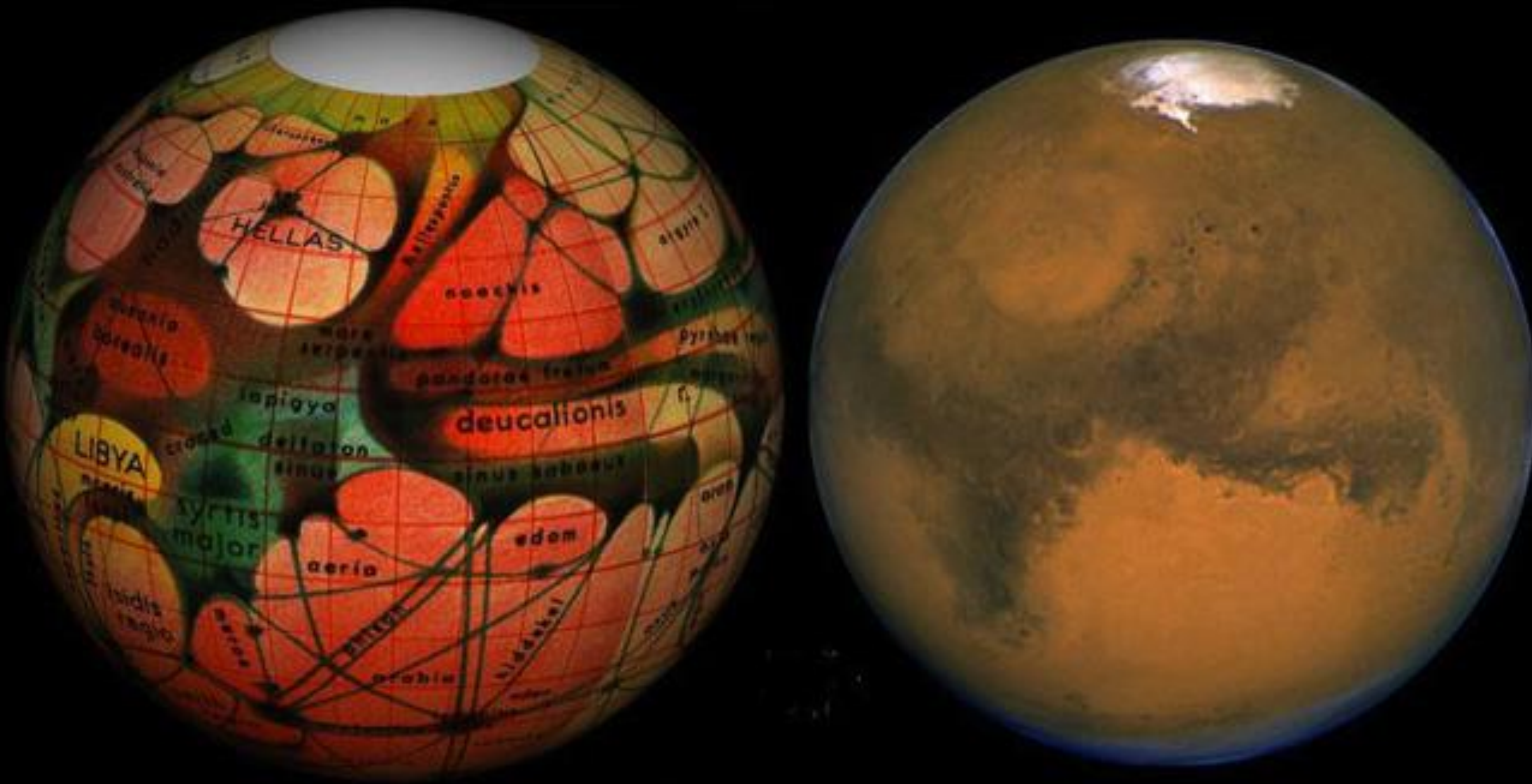
- Search For Life
  - Participants learn about the characteristics of life and conduct an experiment, searching for life in different soil samples
- Dunking the Planets
  - Participants place scale models of the planets, represented by fruit and other foods, in water to determine their density
- Mars Match Game
  - Patrons view images of Earth and Mars to compare features, just like a scientist (planetary geologist) would. After matching pairs of Earth features with Mars analogues, they discuss why they matched the pairs together.
- Build a Space Colony
  - Participants design technology to provide air to breathe, plentiful food, shielding from ultraviolet light, power, and more for space explorers.
- Strange New Planet
  - In this simulation of space exploration, participants plan and carry out five missions to a “planet” and communicate their discoveries to their family or a friend.

Today's Speaker

Dr. Steve Lee, Space Scientist

- Space Scientist in the Adult & Children's Programs Department at the Denver Museum of Nature and Science (DMNS)
- Senior Research Scientist at the Space Science Institute (SSI) in Boulder, CO.
- Science advisor to the DMNS *Space Odyssey* exhibition, and frequently participates in the development and delivery of Museum public programs – helping to bring the latest discoveries in planetary and space sciences to many of the nearly two million visitors seen at DMNS annually.
- He received a PhD in Planetary Geology from Cornell University, and has been at DMNS since 2001 and SSI since 2006.
- Steve's research focuses on the interaction between the surface and atmosphere of Mars -- primarily by mapping the patterns of wind-blown dust deposits across the planet utilizing spacecraft observations. He was part of a team that observed Mars with the Hubble Space Telescope for more than a decade following launch in 1990.
- He is also a Co-Investigator on two of the camera systems launched aboard the Mars Reconnaissance Orbiter in 2005; data have been streaming back from Mars since late-2006. These observations help refine our understanding of Martian weather and long-term climate variations, and how Martian landforms have been shaped over time.

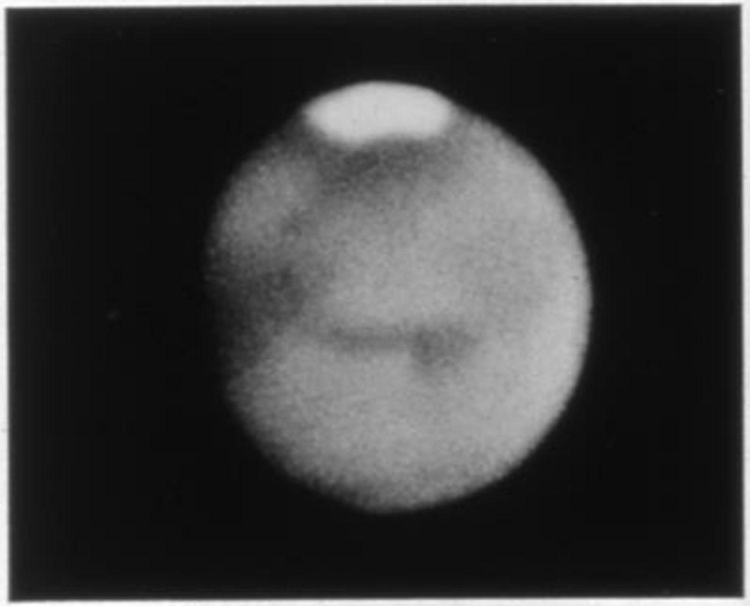
Exploring Mars



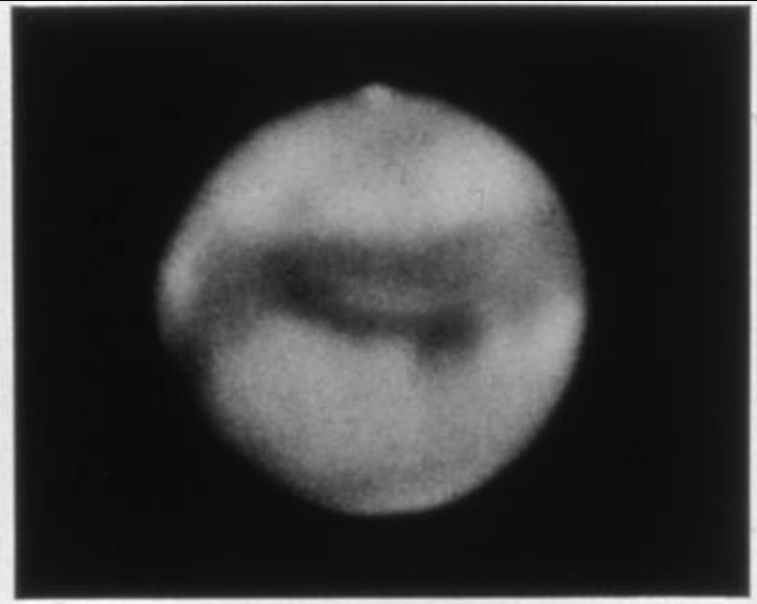
Steve Lee
Space Science Institute &
Denver Museum of Nature & Science

Christiaan Huygens

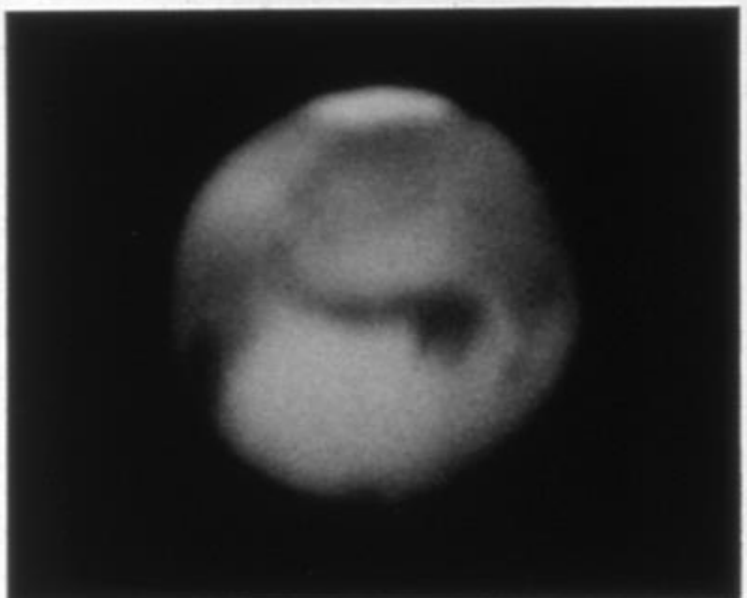
1659



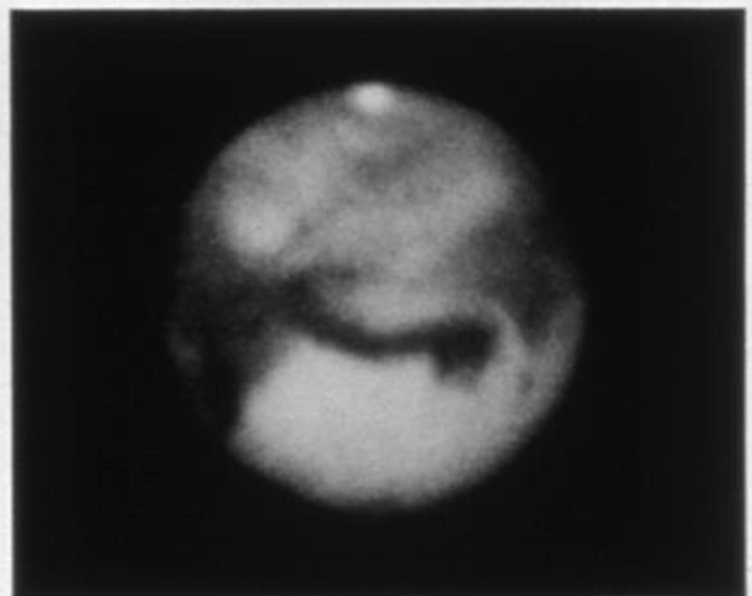
3. 1924
May 11 M.D.



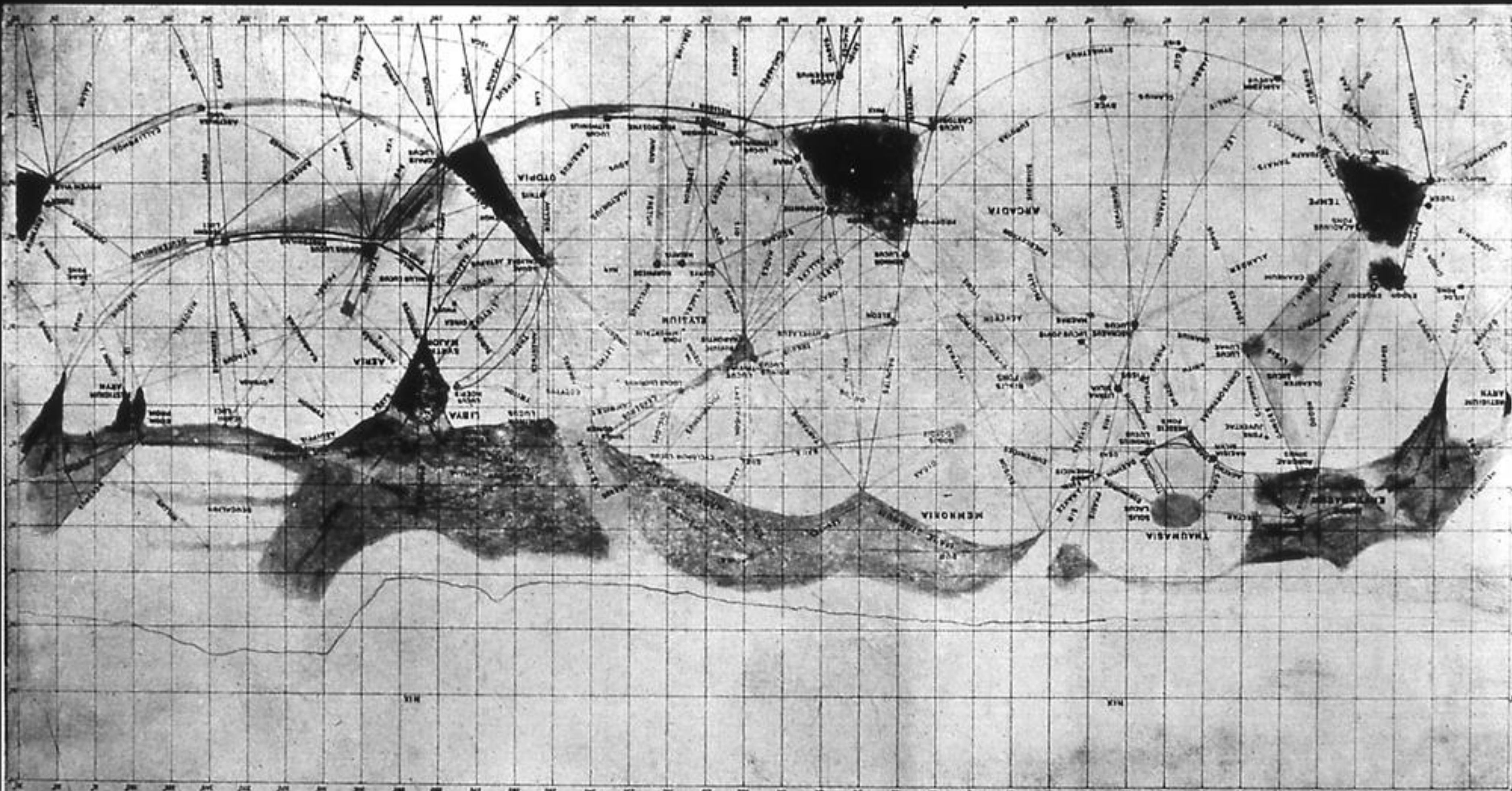
4. 1926
Aug 1 M.D.



5. 1939
May 2 M.D.



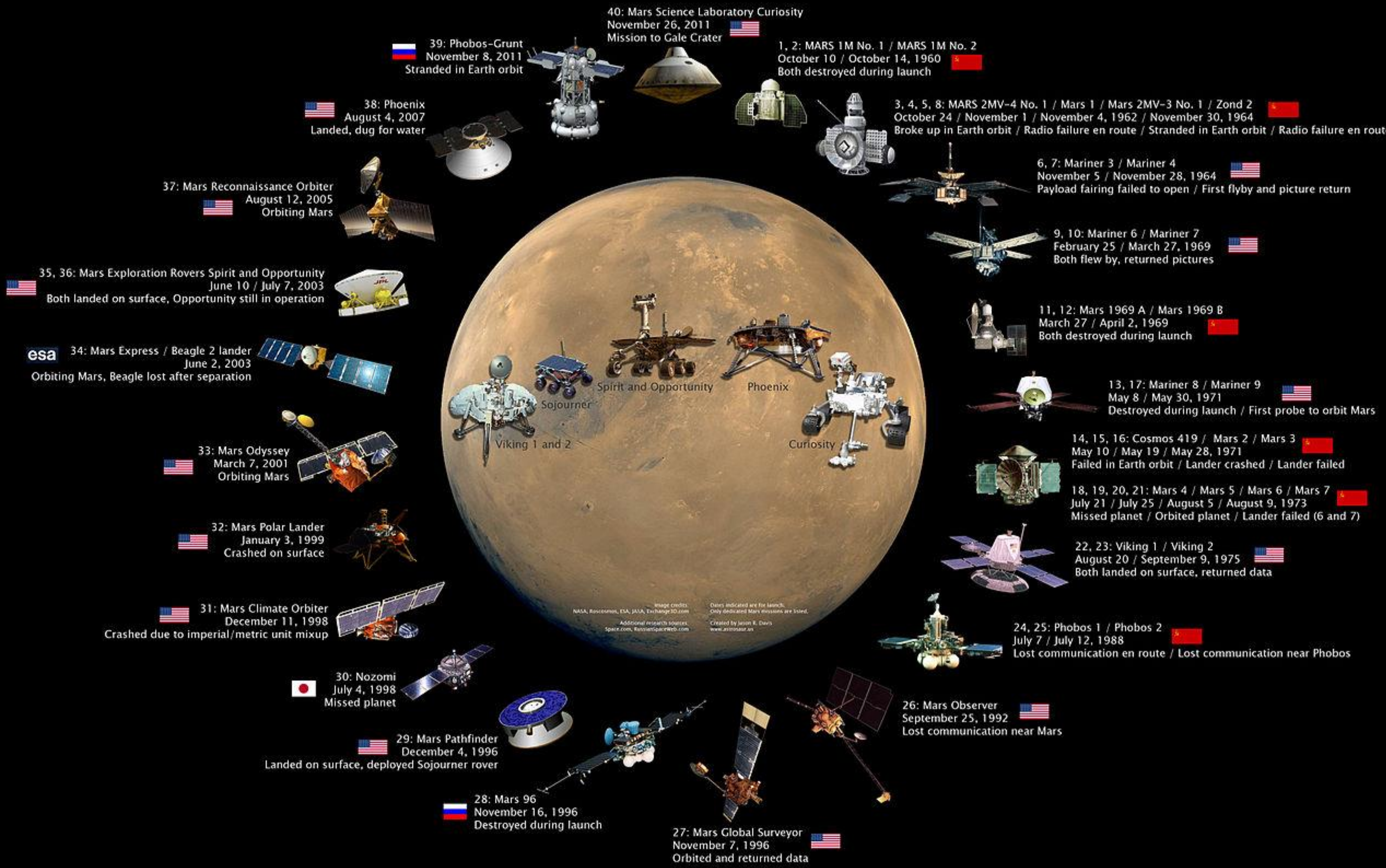
6. 1941
July 11 M.D.

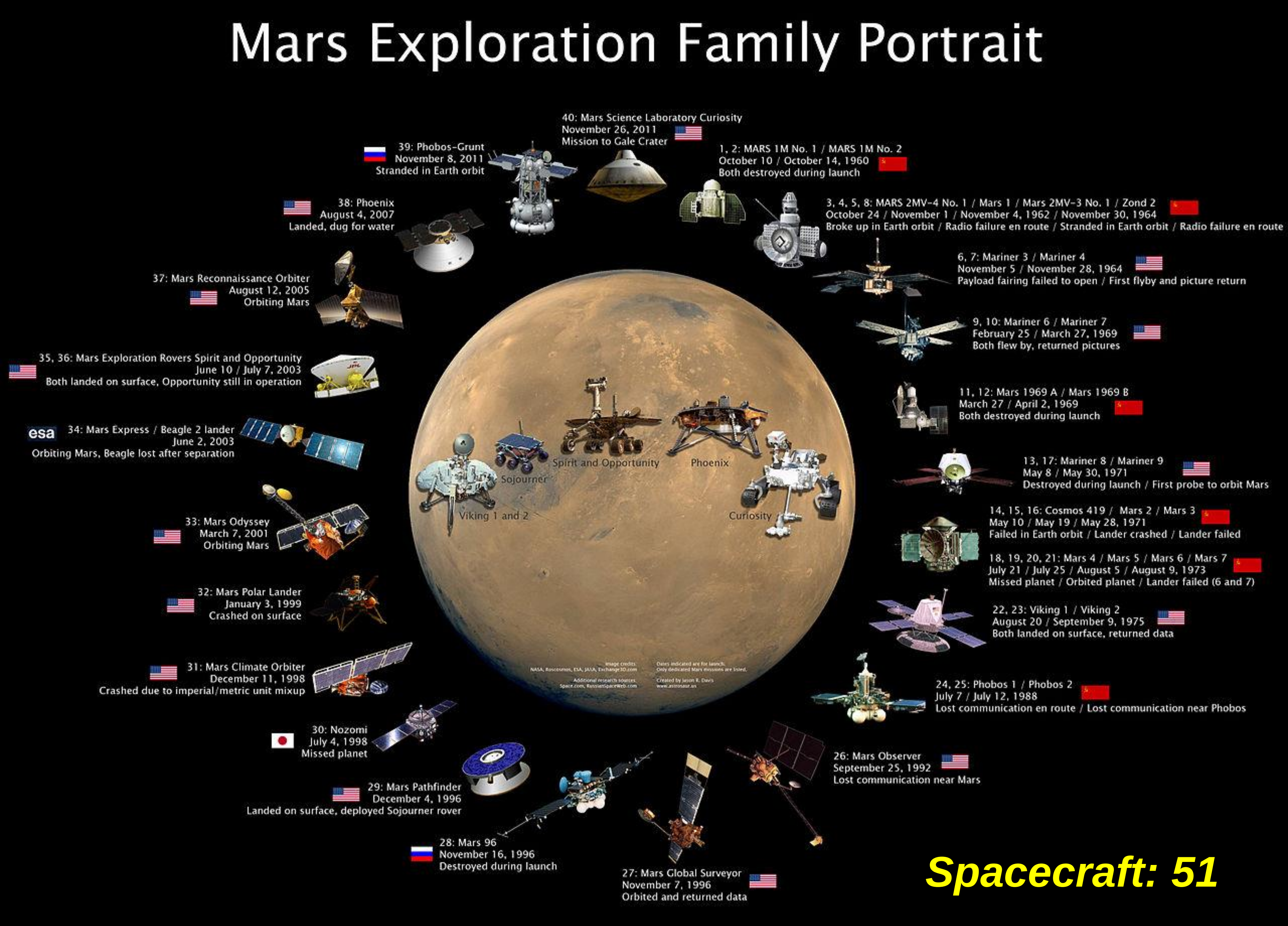


Lowell Observatory.

MARS—1905.

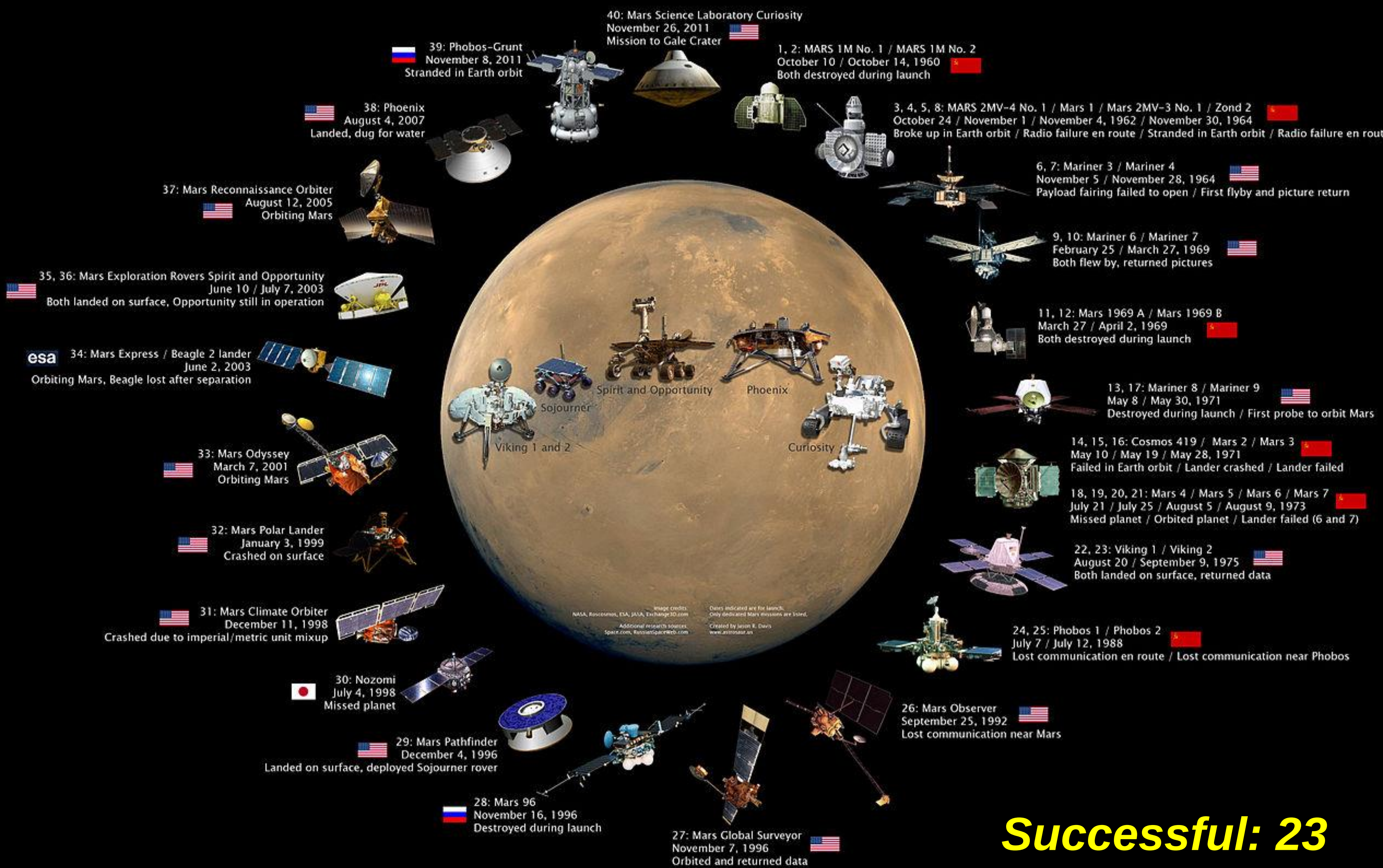
Mars Exploration Family Portrait



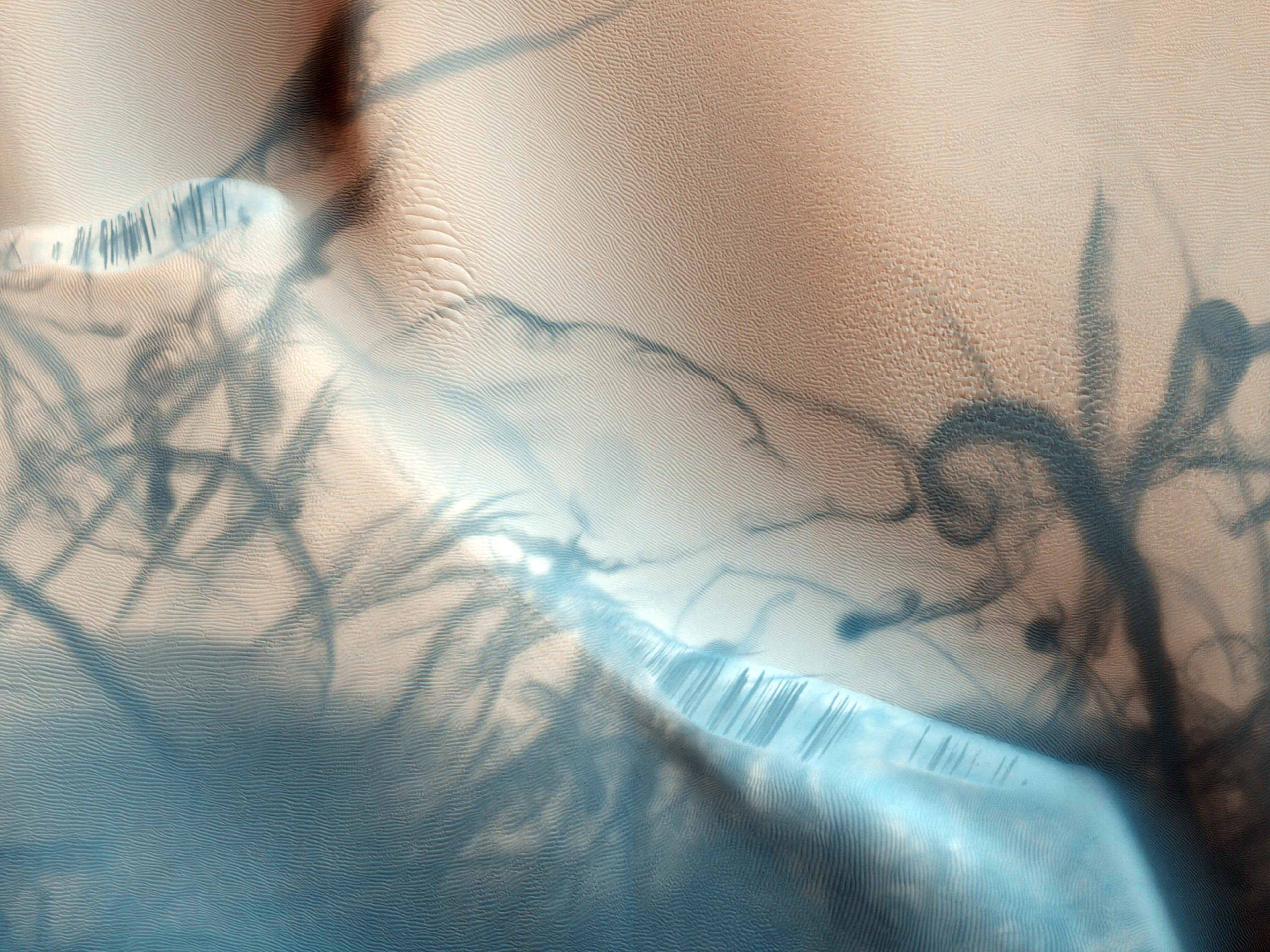


Spacecraft: 51

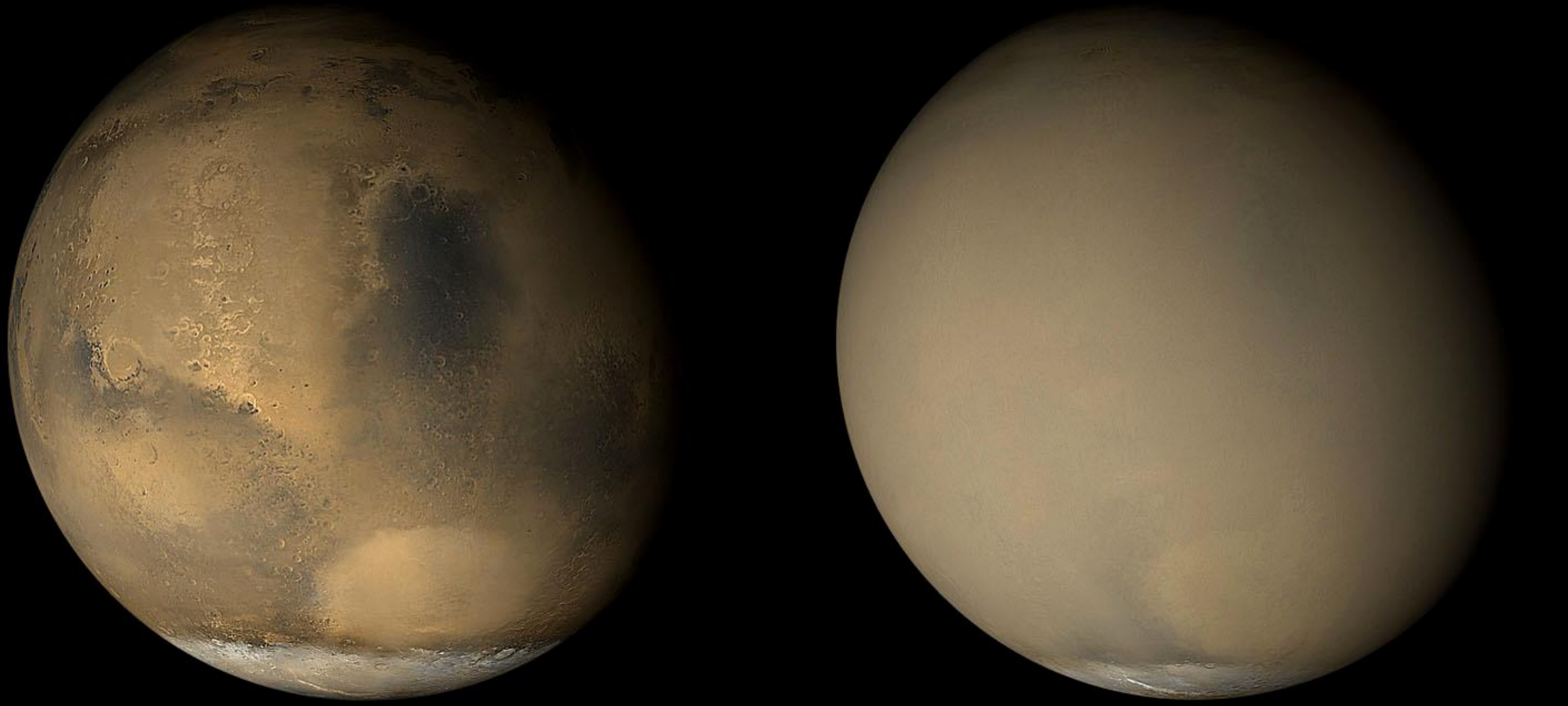
Mars Exploration Family Portrait

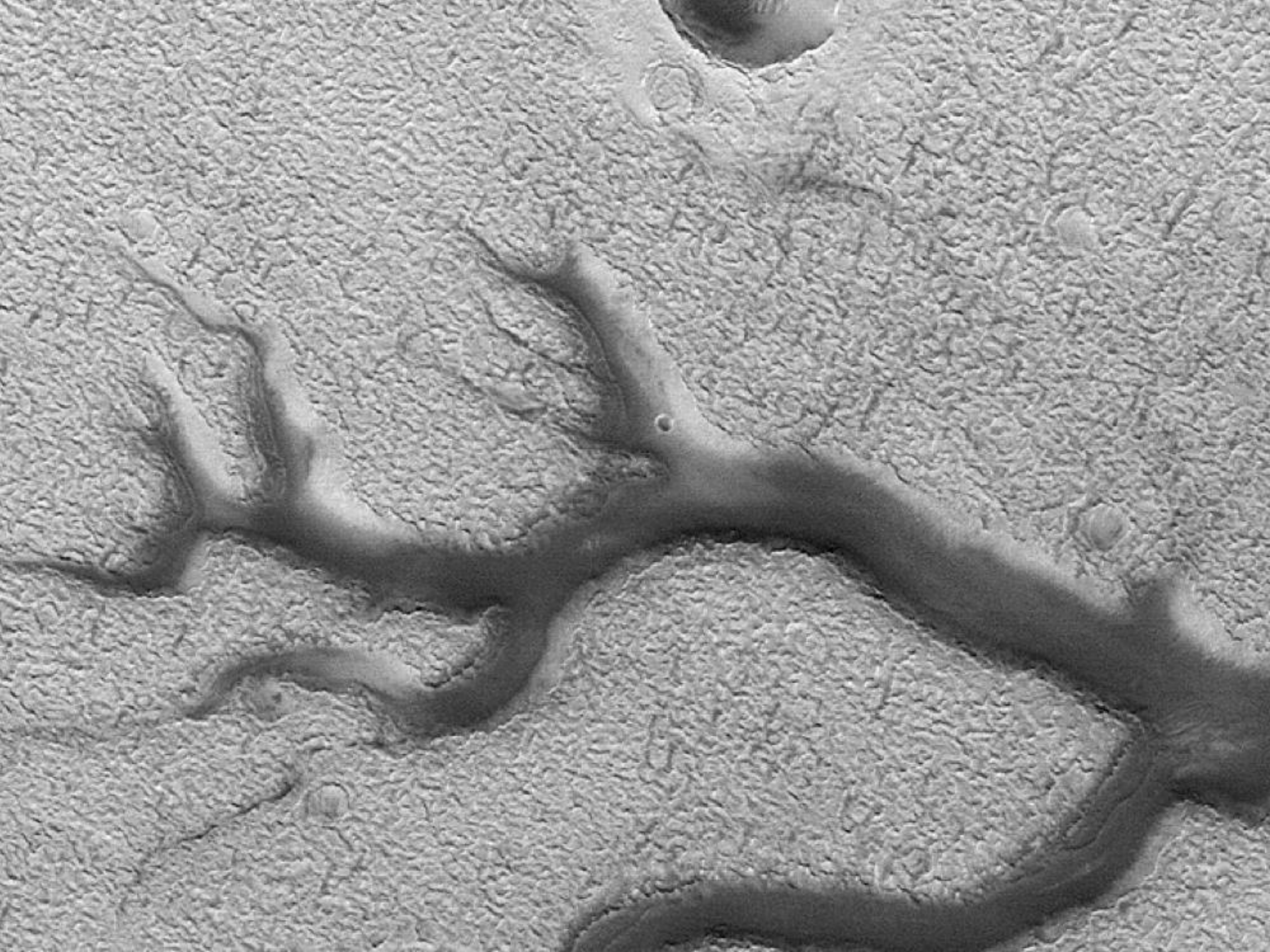


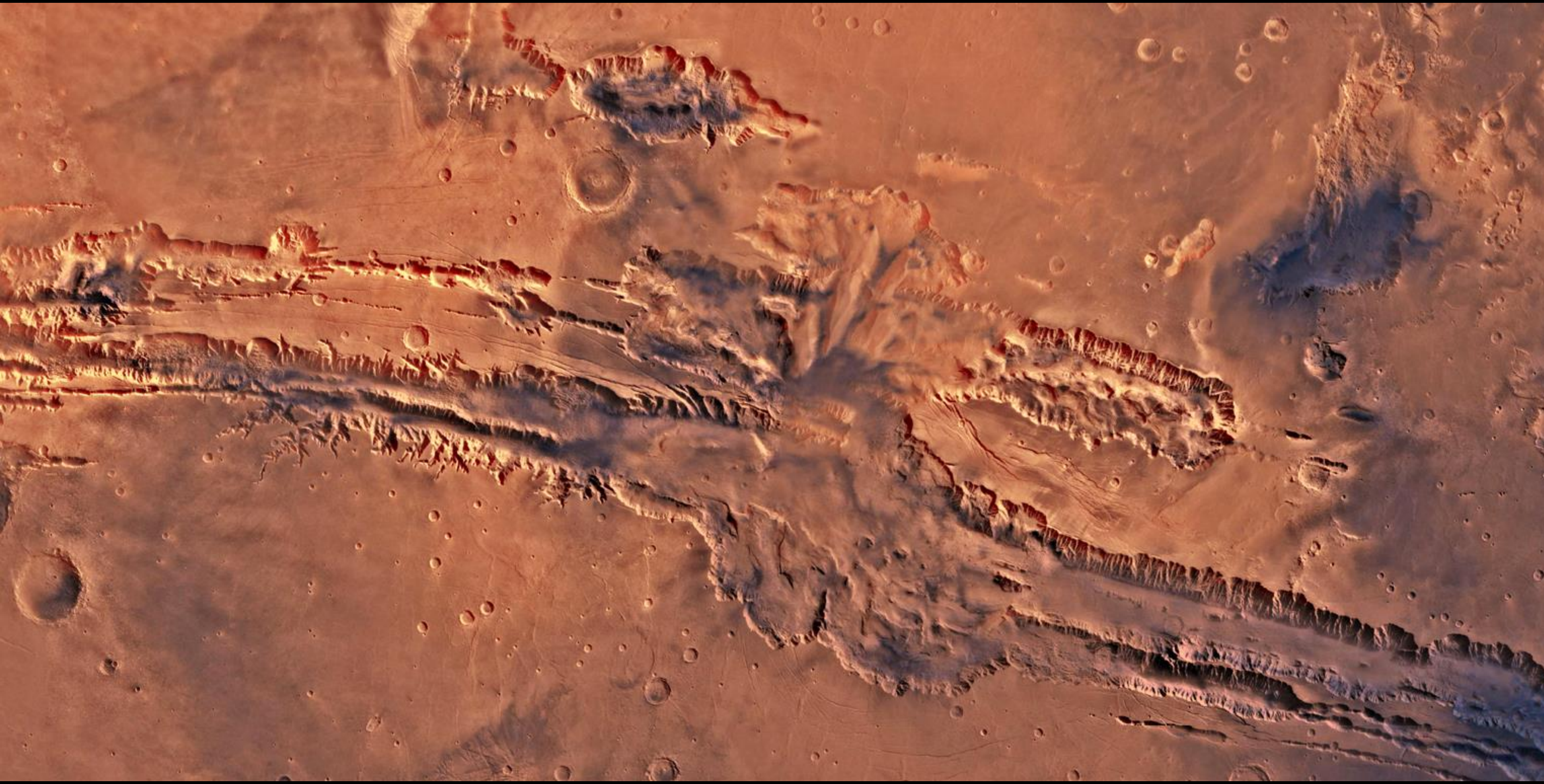
Successful: 23

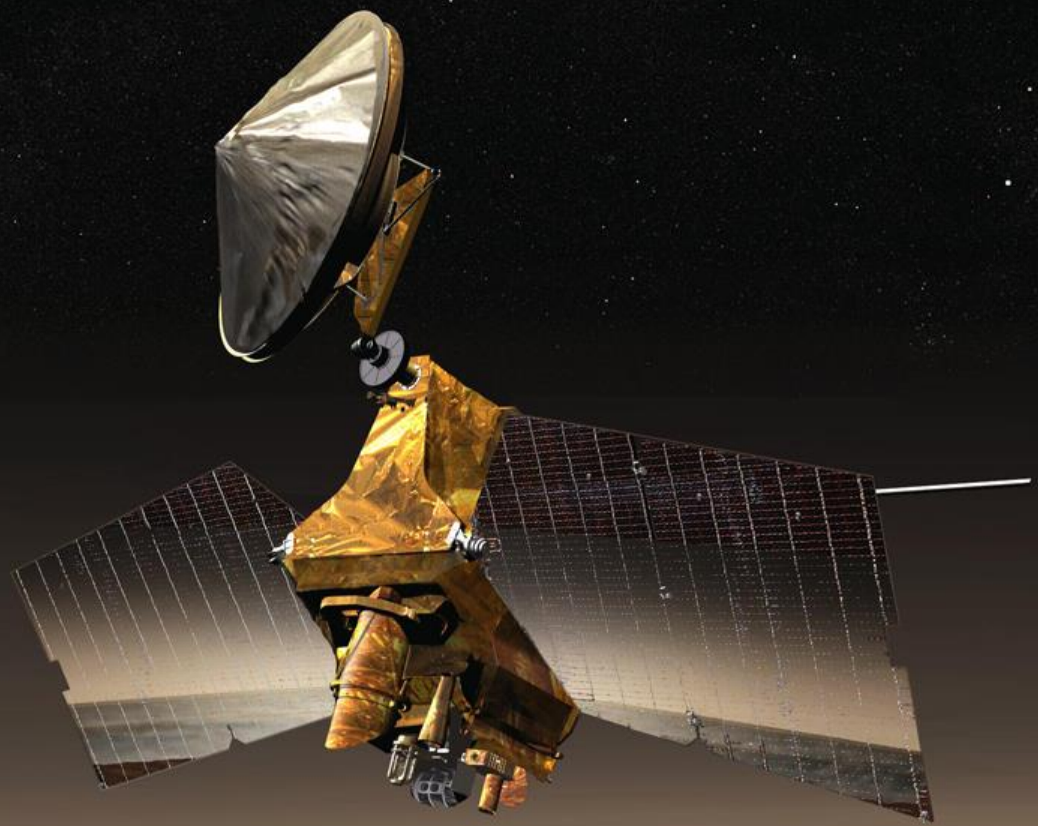



N
150 km



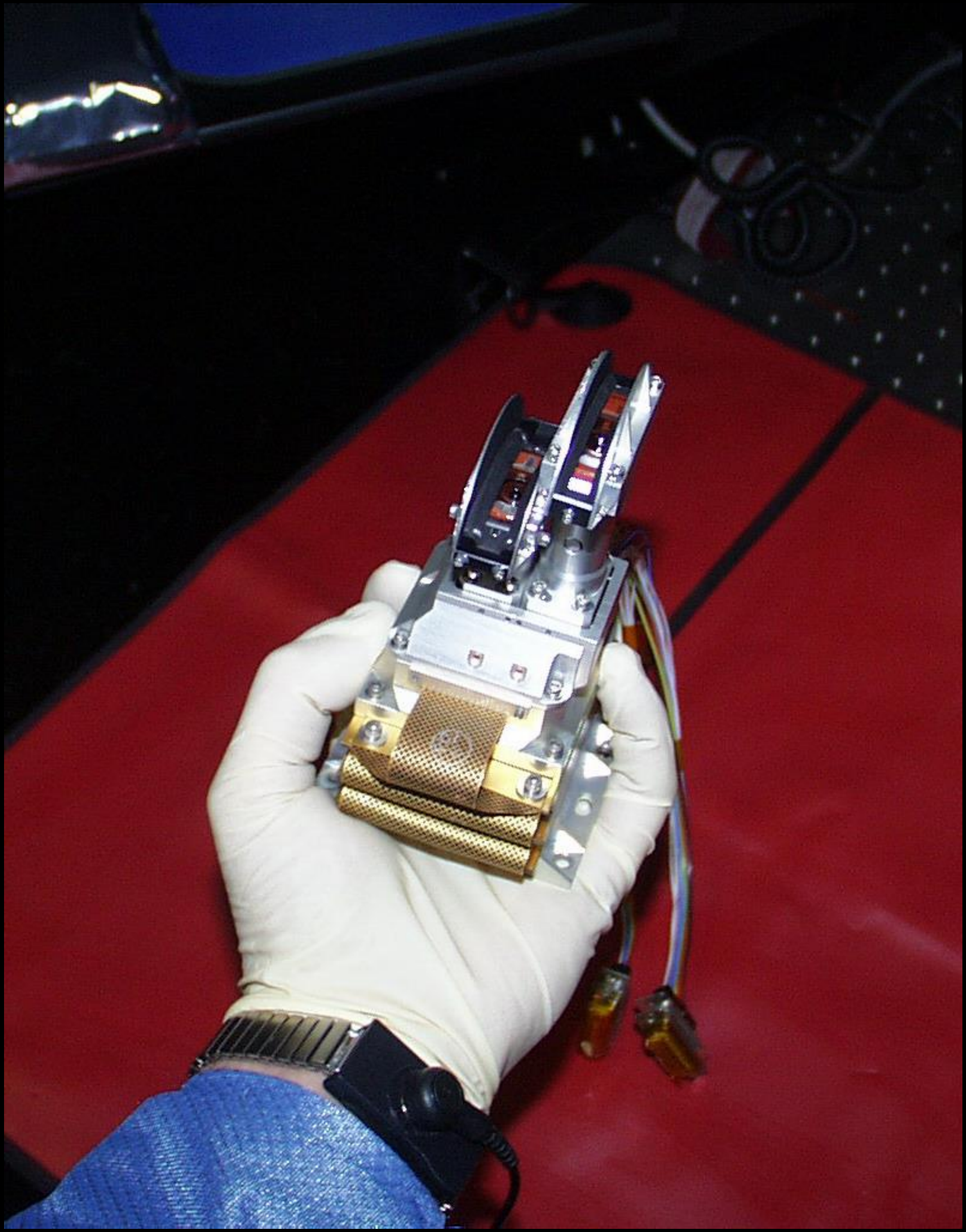






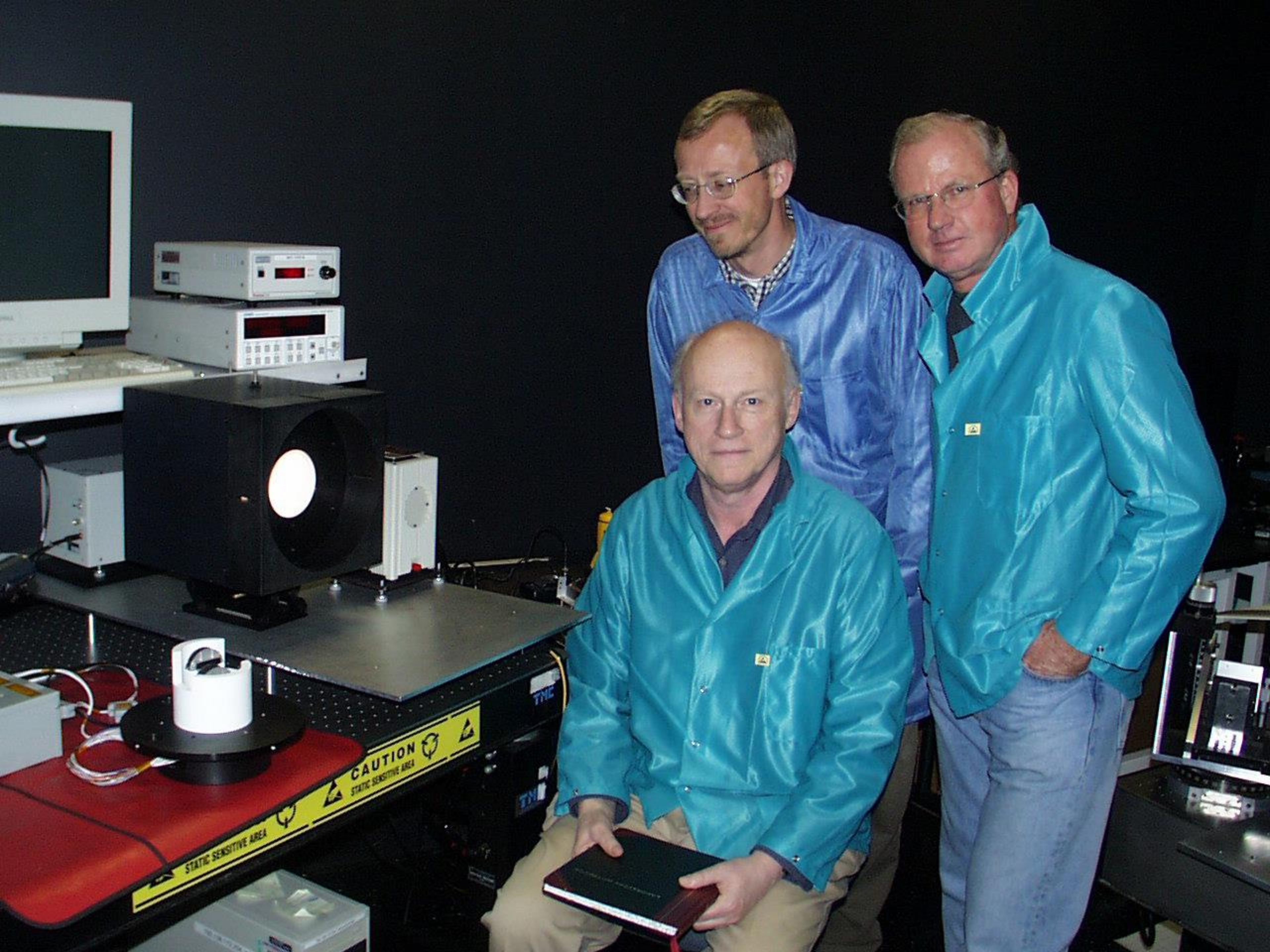
Mars Reconnaissance Orbiter

Launch: August 12, 2005
Mars Orbit Insertion: March 10, 2006
Operational: September 29, 2006



Mars Color Imager (MARCI)

- First True-Color Camera in Mars Orbit
- Daily Global Maps
- Long-term History of Surface & Atmospheric Activity


CAUTION
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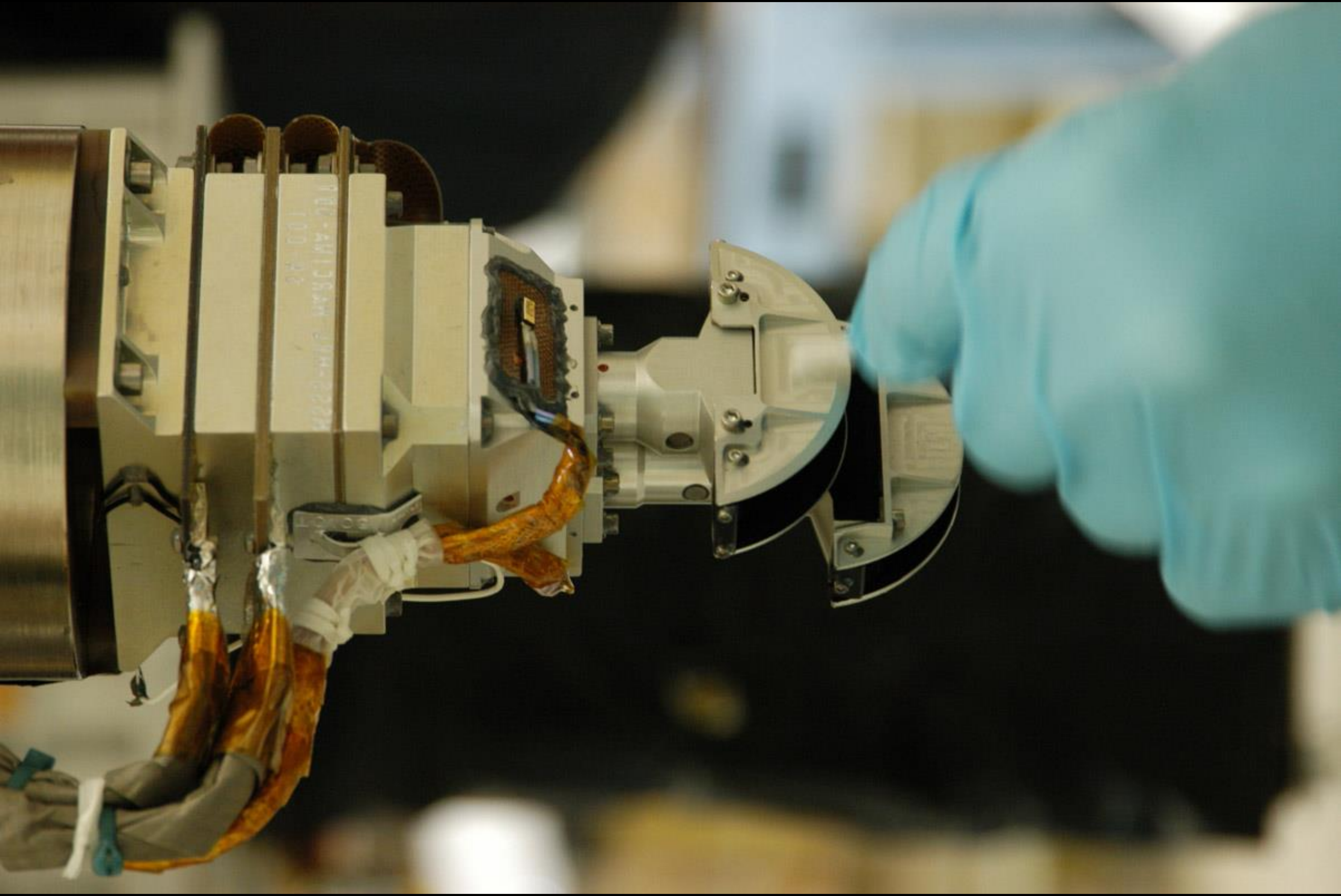

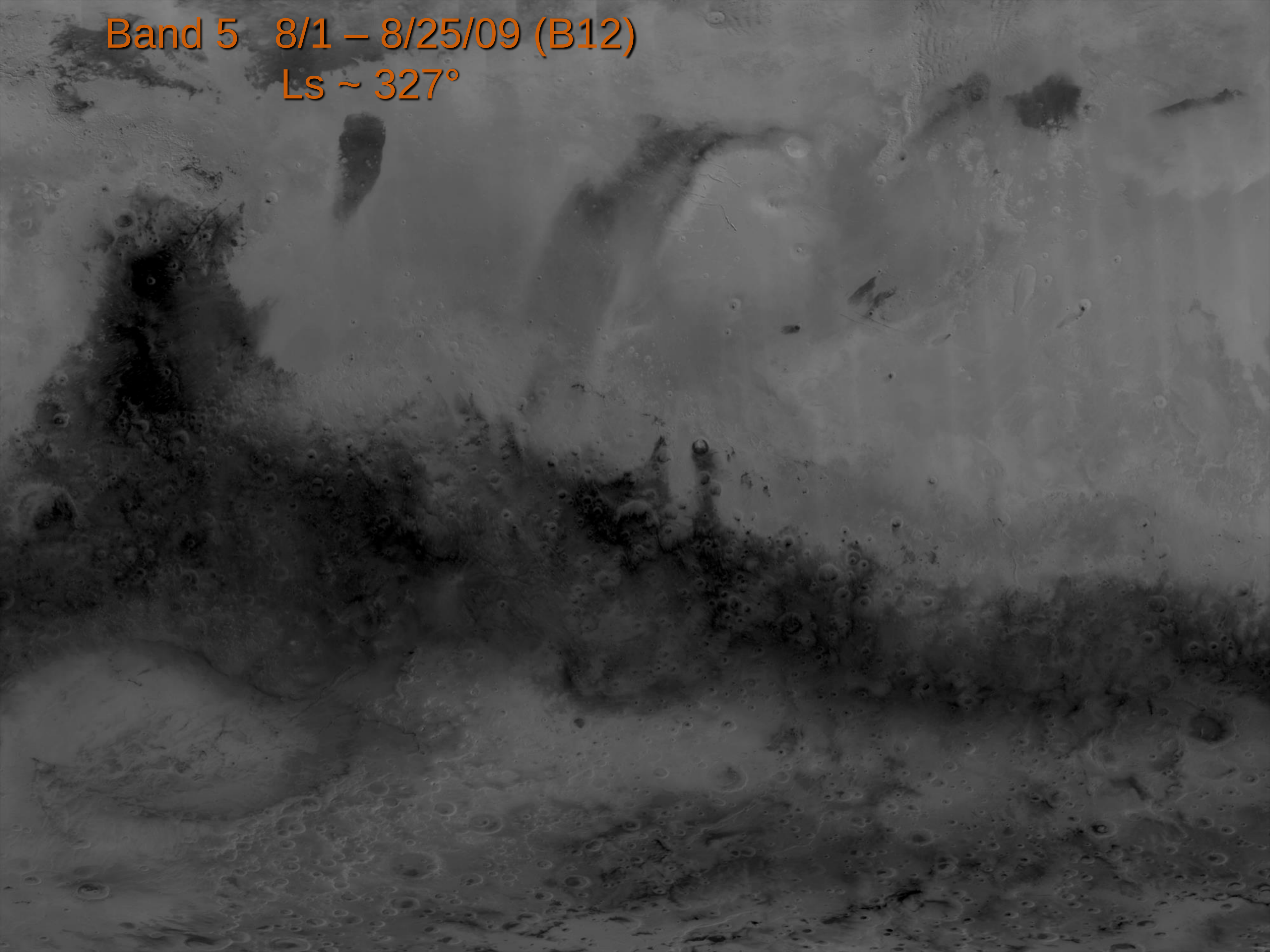
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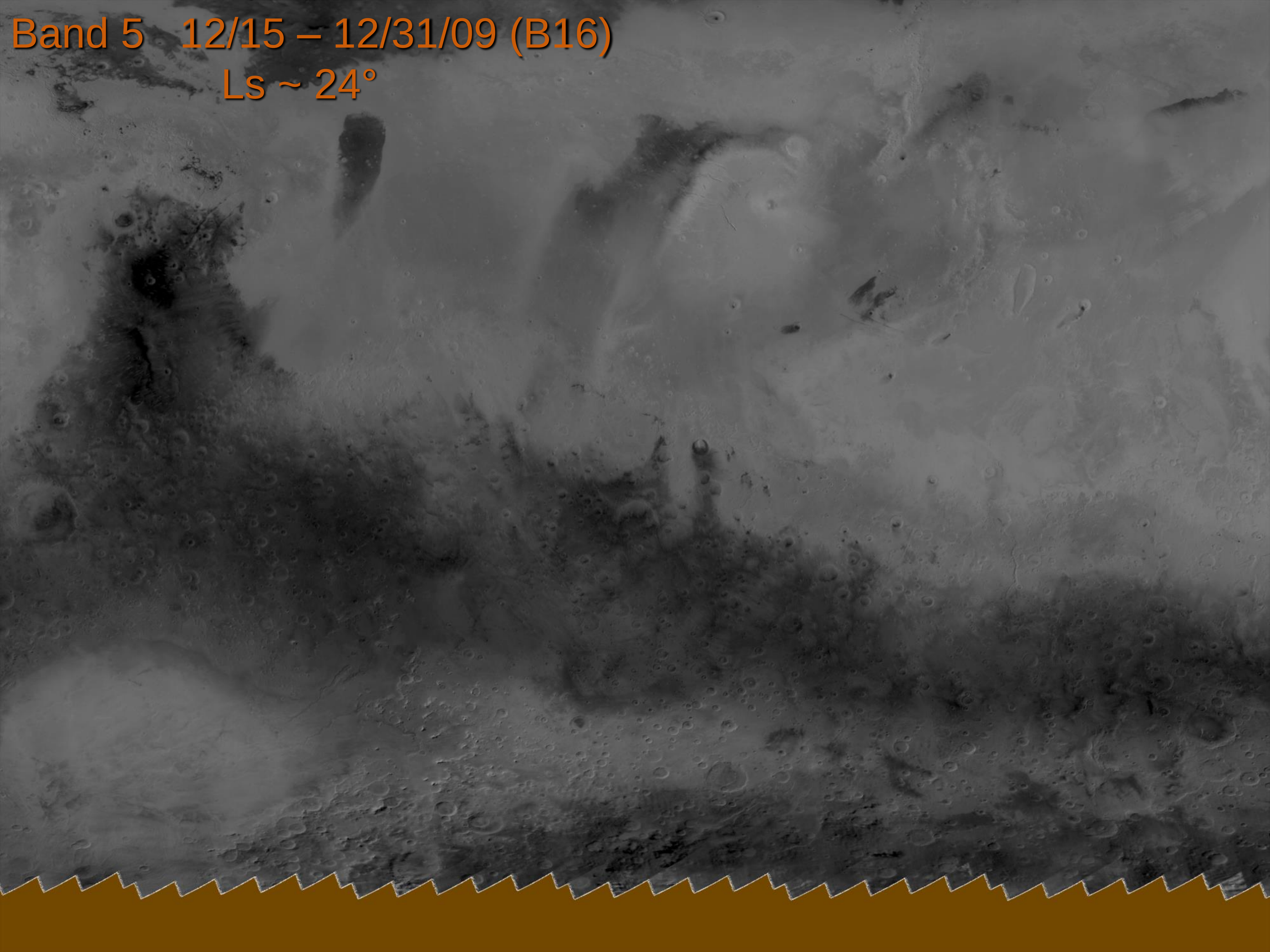
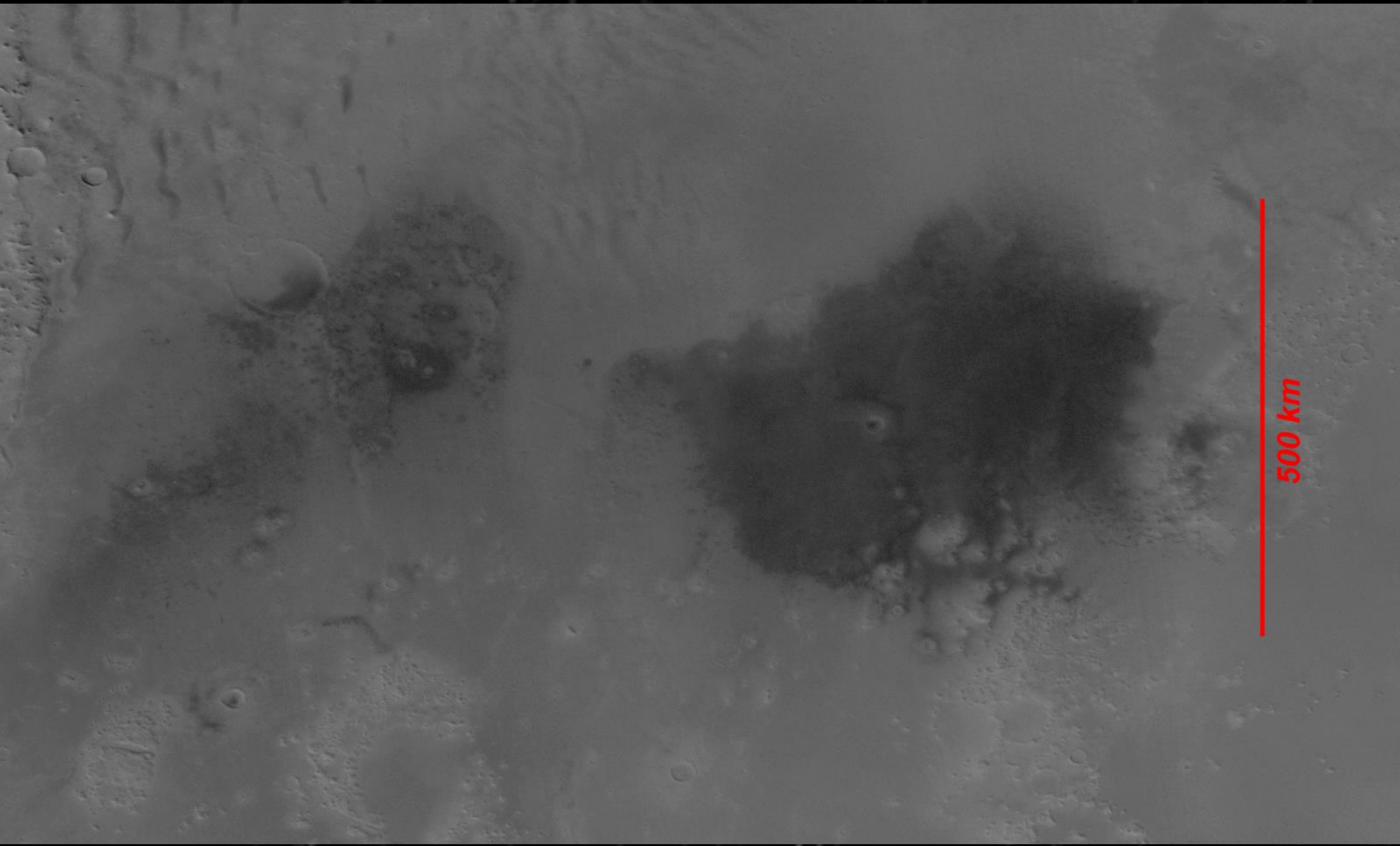
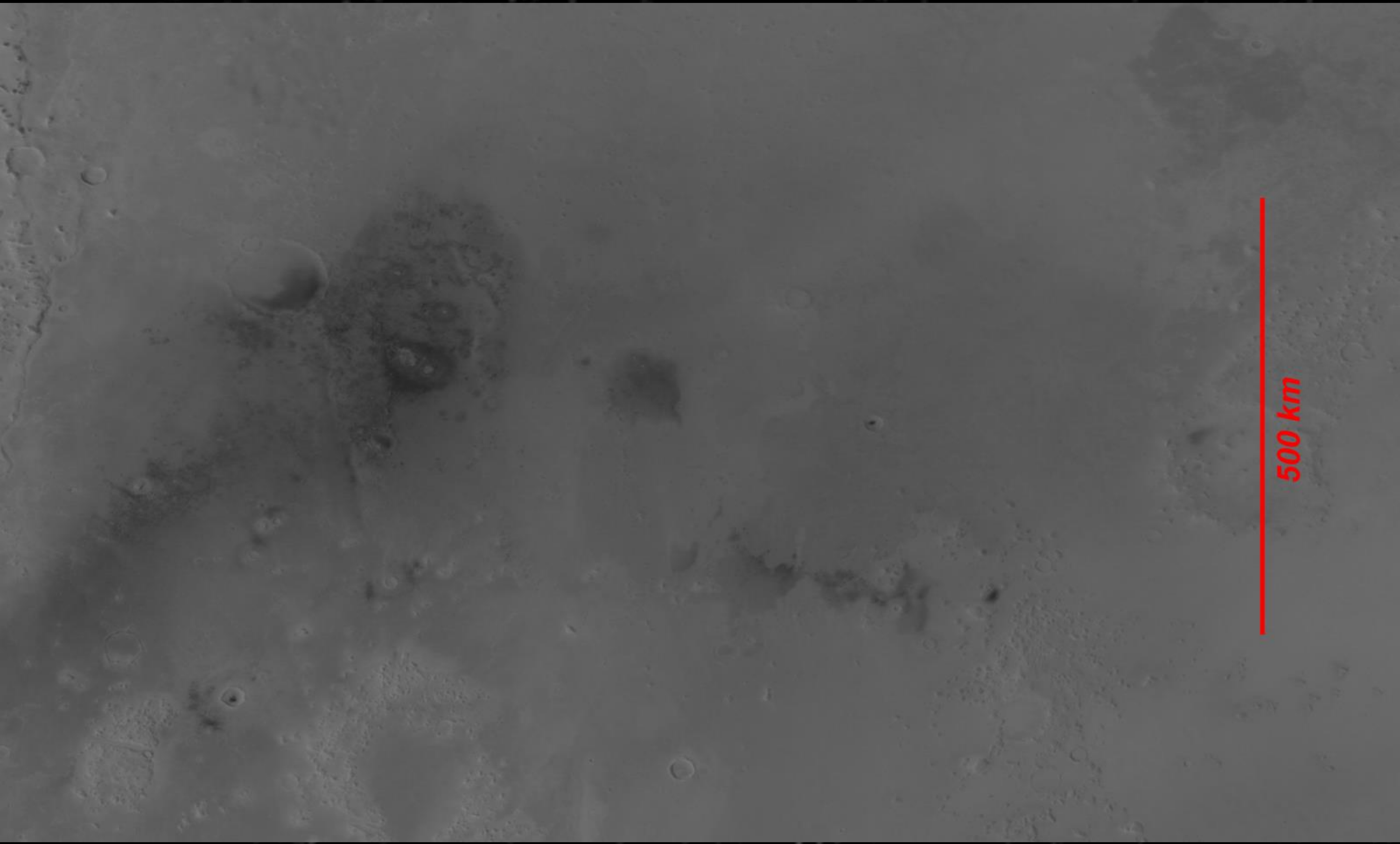
Ls ~ 327°

Band 5 12/15 – 12/31/09 (B16)
Ls ~ 24°



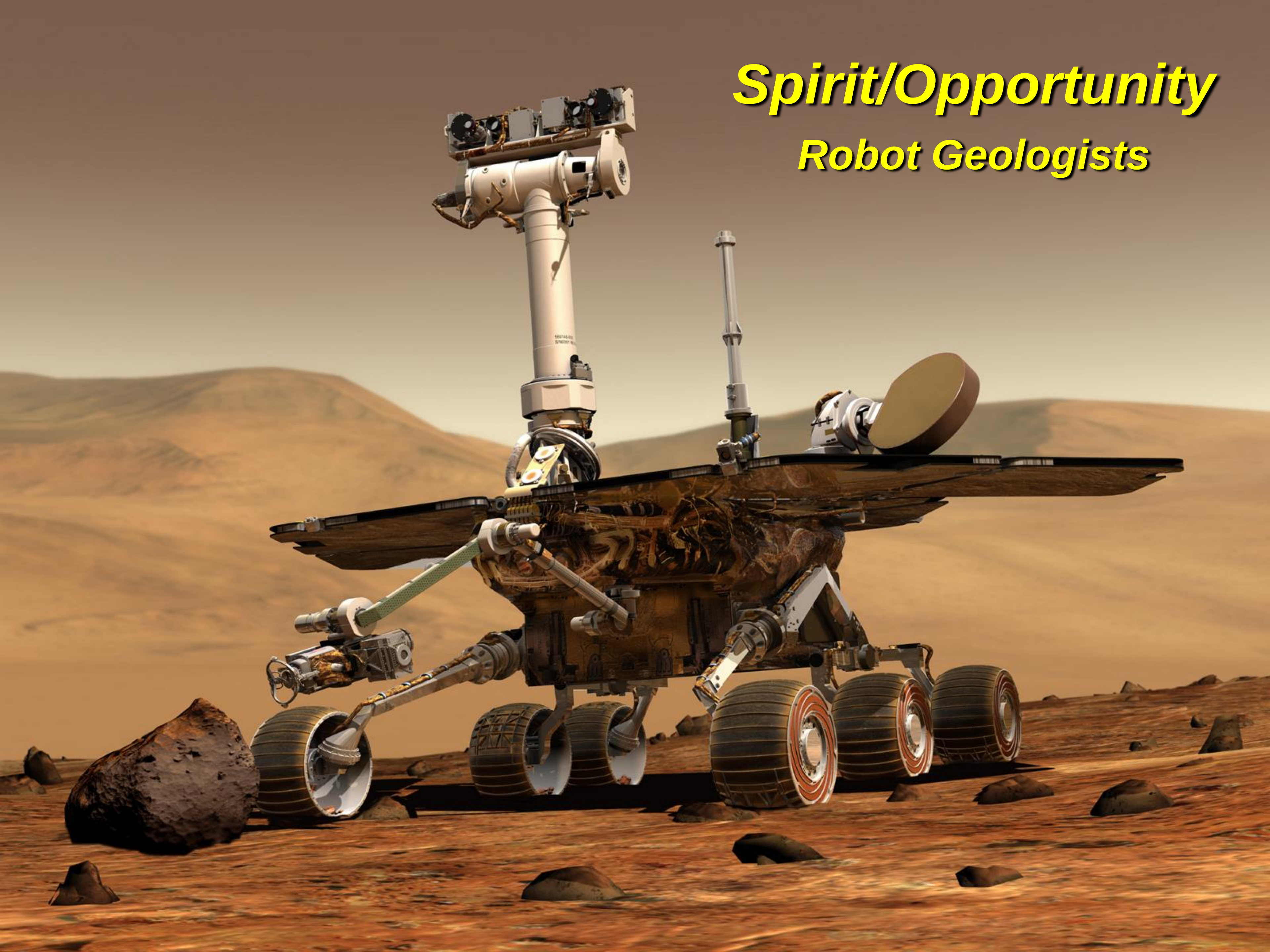


Band 5 8/1 – 8/25/09 (B12)
L_s ~ 327°



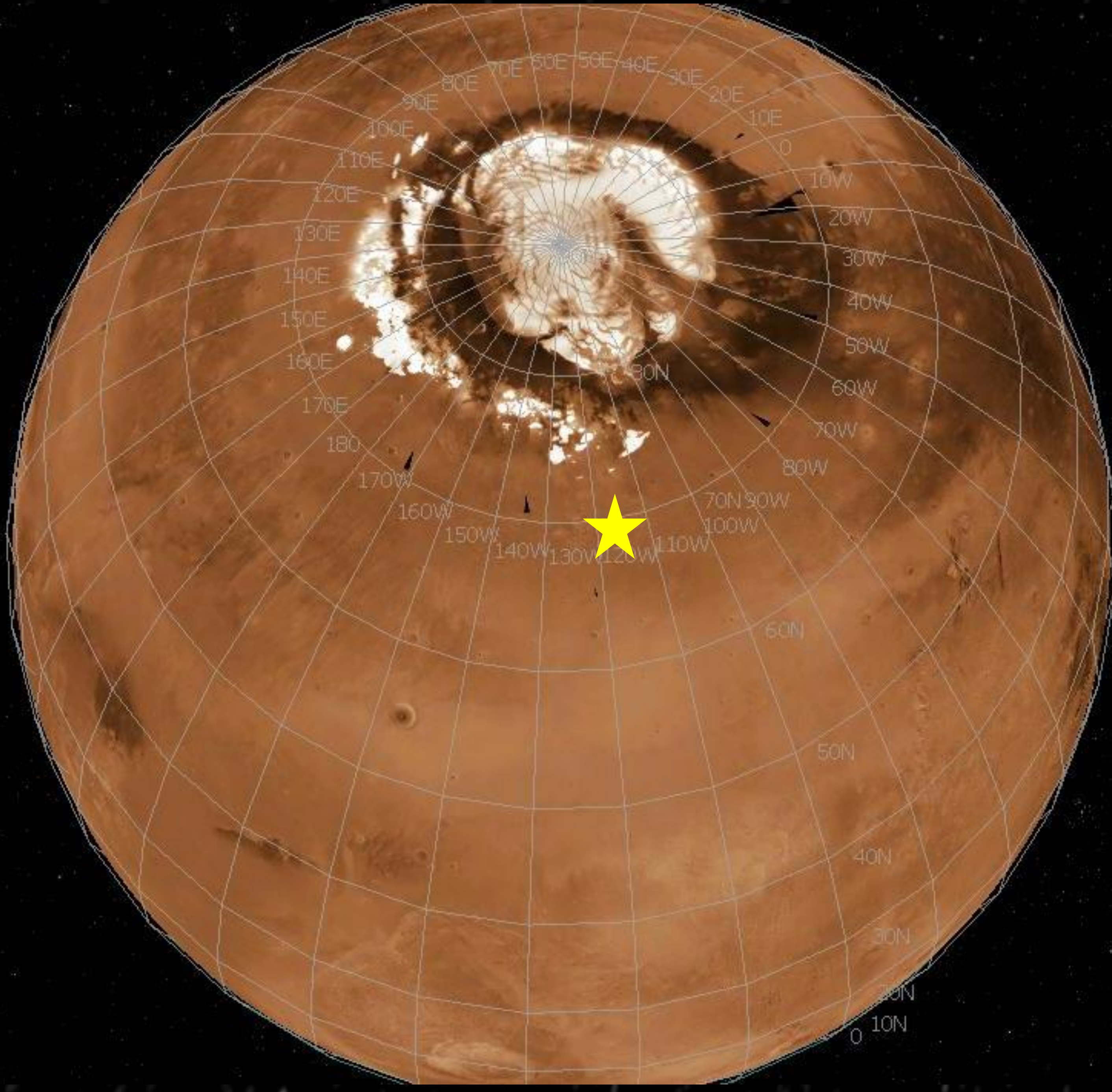
Band 5 12/15 – 12/31/09 (B16)

$L_s \sim 24^\circ$


Spirit/Opportunity
Robot Geologists


Curiosity
Robot Geochemist


Phoenix
Robot Arctic Explorer



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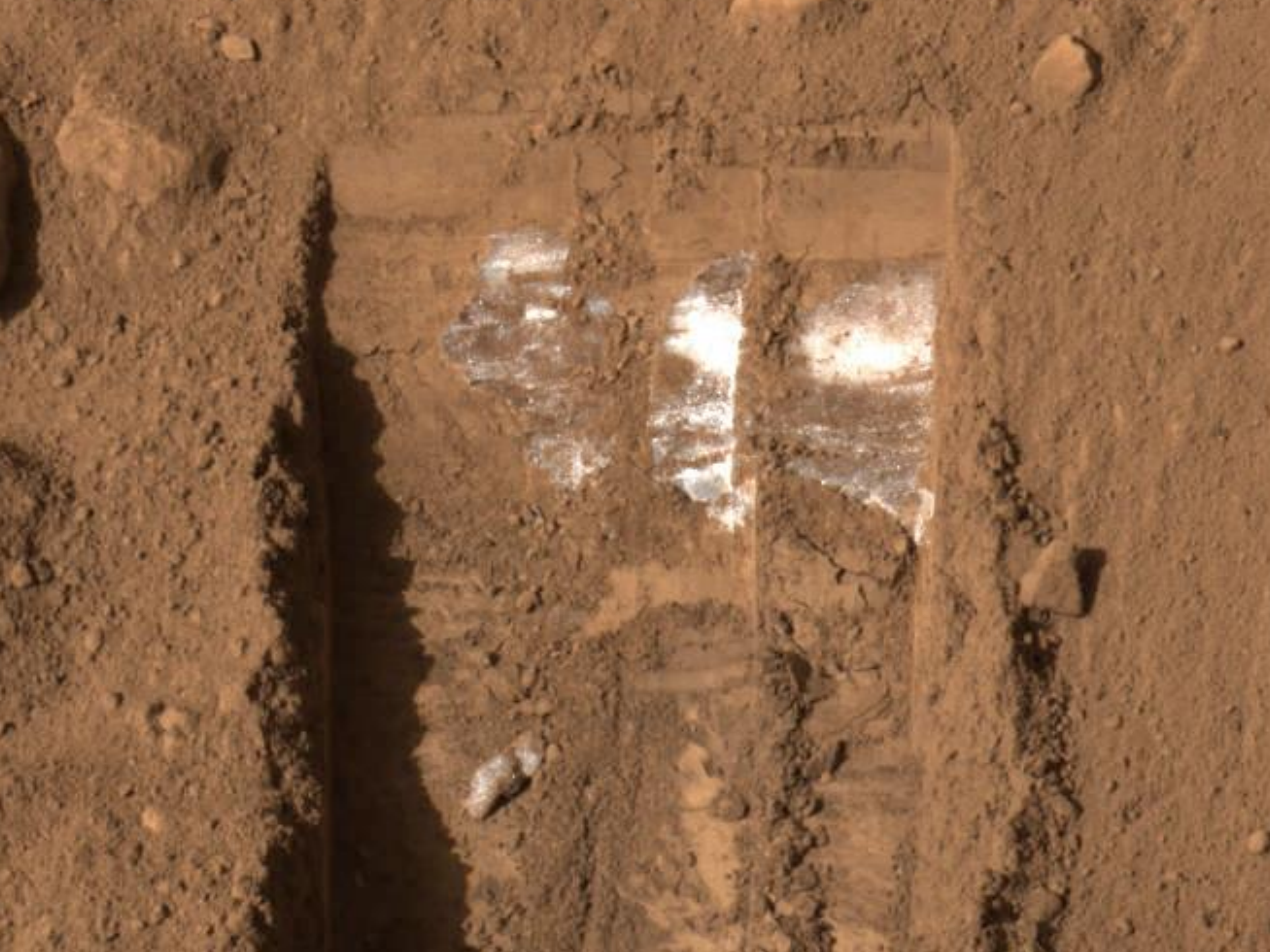
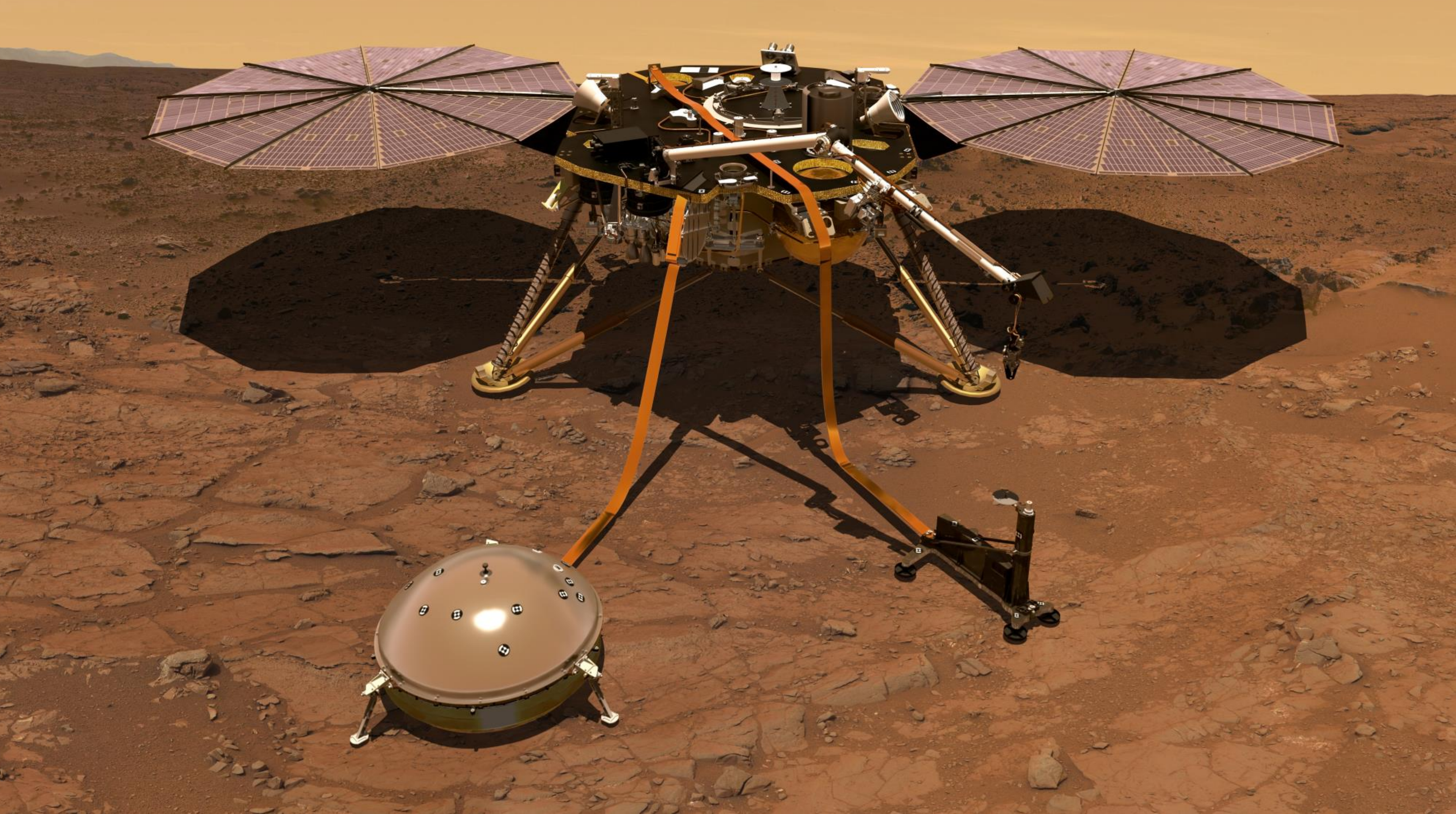
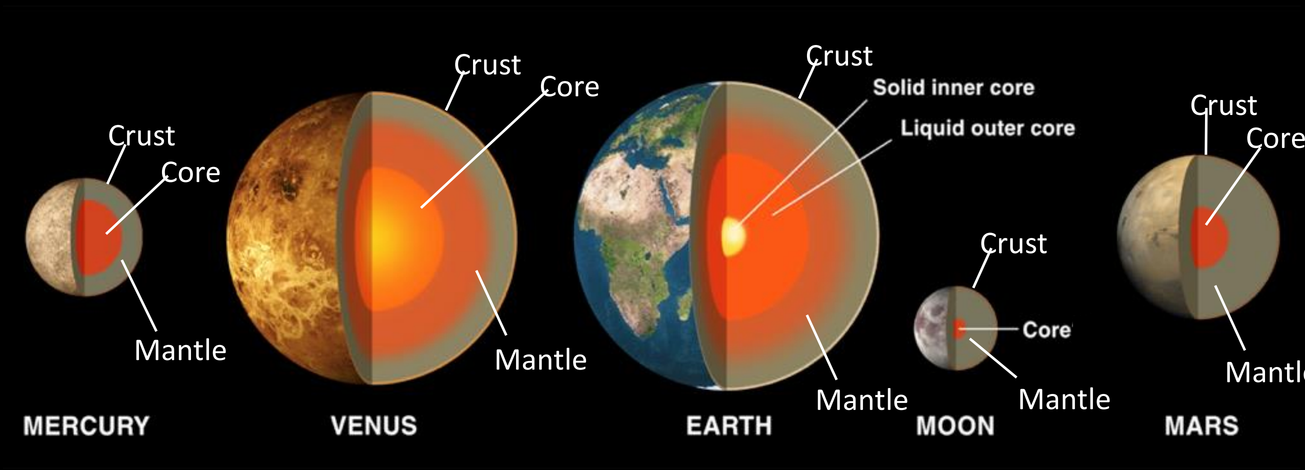


InSight

Interior Exploration using Seismic Investigations, Geodesy and Heat Transport



InSight Mission Science

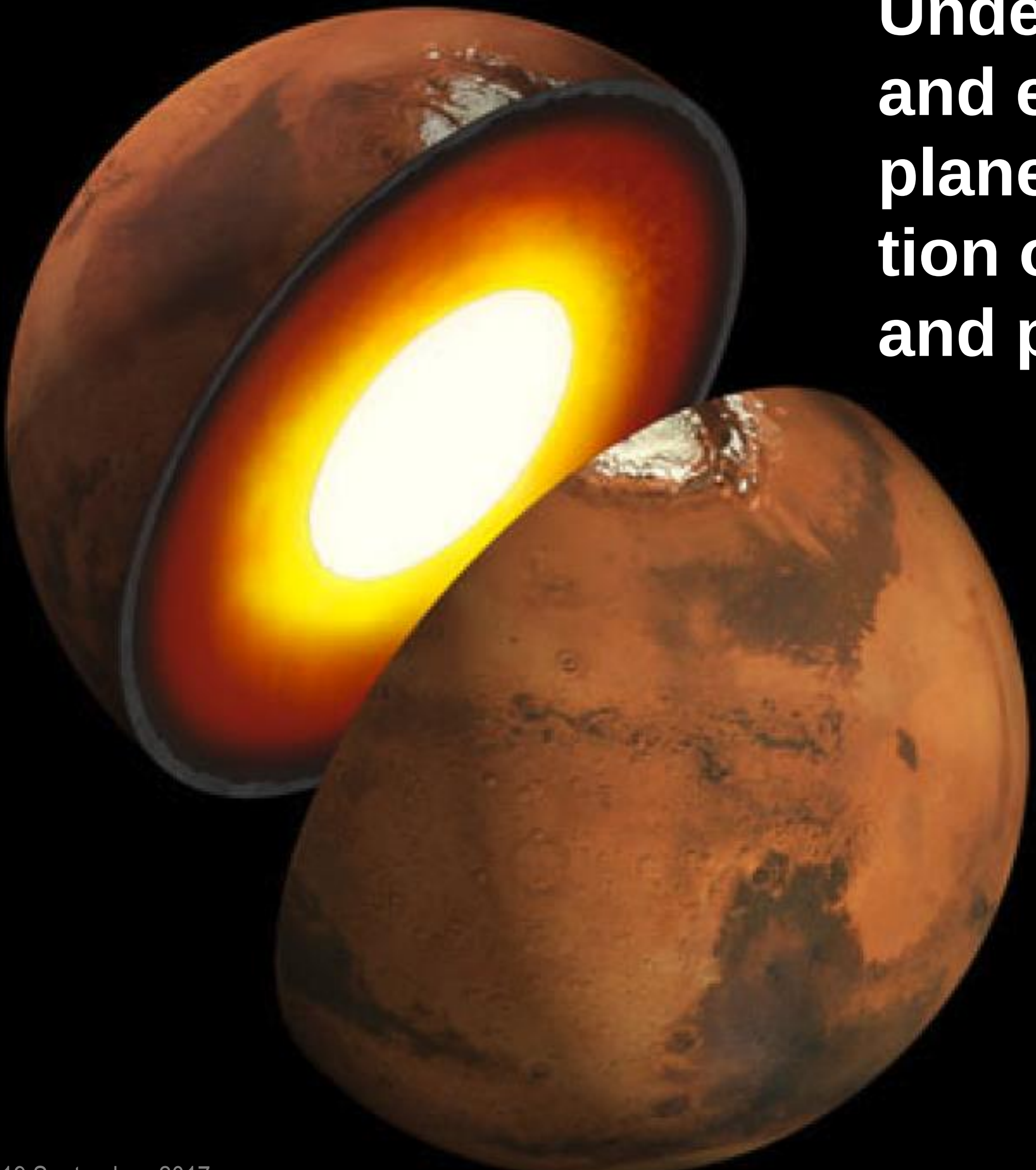


You Can Think of InSight as a Time Machine…

- Its measurement goals travel back in time more than a hundred years, to terrestrial seismology at the turn of the 20th century:
  - What is the thickness of the crust?
  - What is the structure of the mantle?
  - What is the size and density of the core?
  - What is the distribution of seismicity?

- Its science goals travel back in time 4.5 billion years, to the beginnings of our solar system:
  - What were the processes of planetary differentiation that formed the planets, and the processes of thermal evolution that modify them?

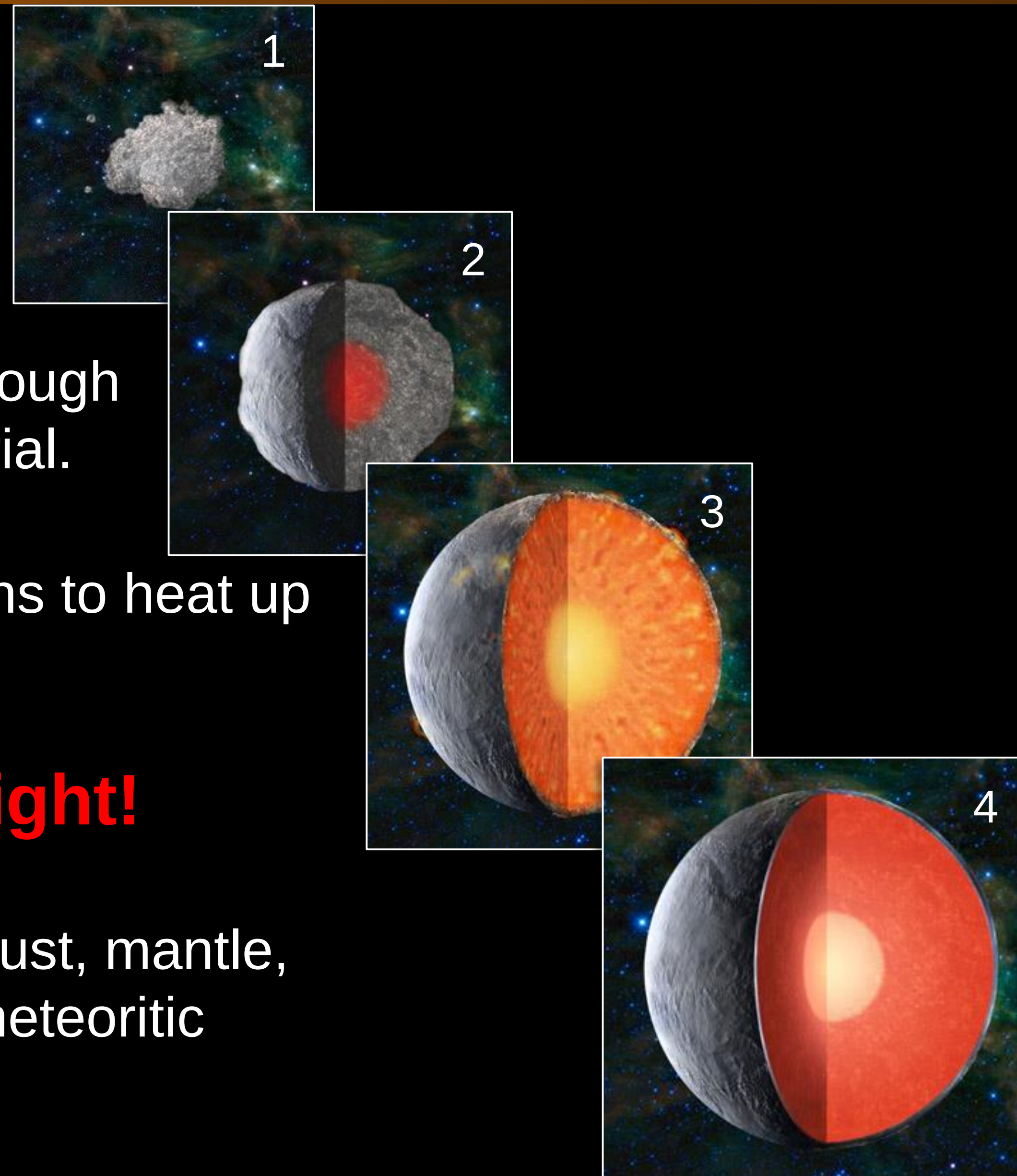
InSight Science Goal:



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

- **Seismology**
- **Precision Tracking**
- **Heat Flow**

How Does a Terrestrial Planet Form?



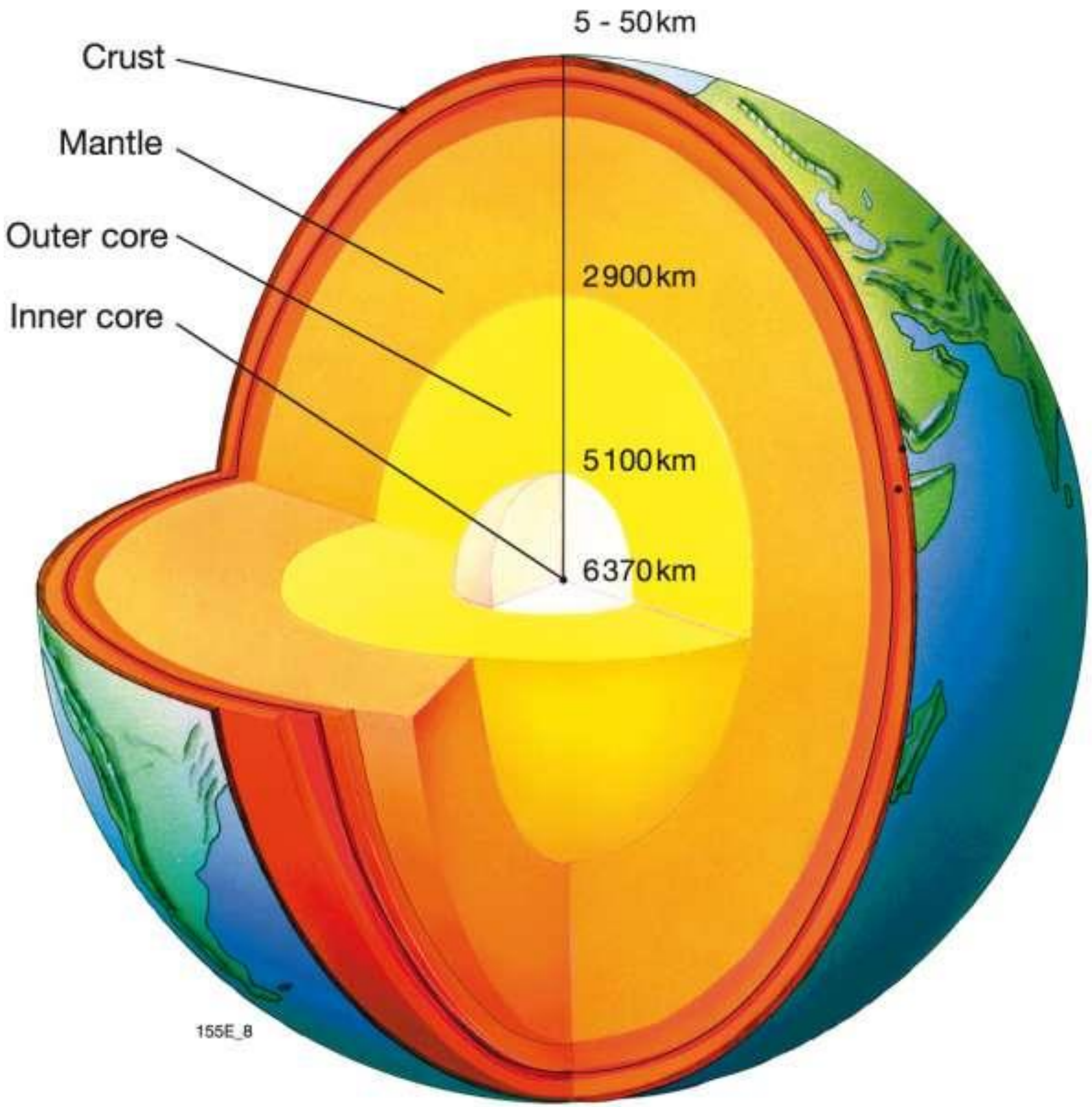
1. The planet starts forming through accretion of meteoritic material.

2. As it grows, the interior begins to heat up and melt.

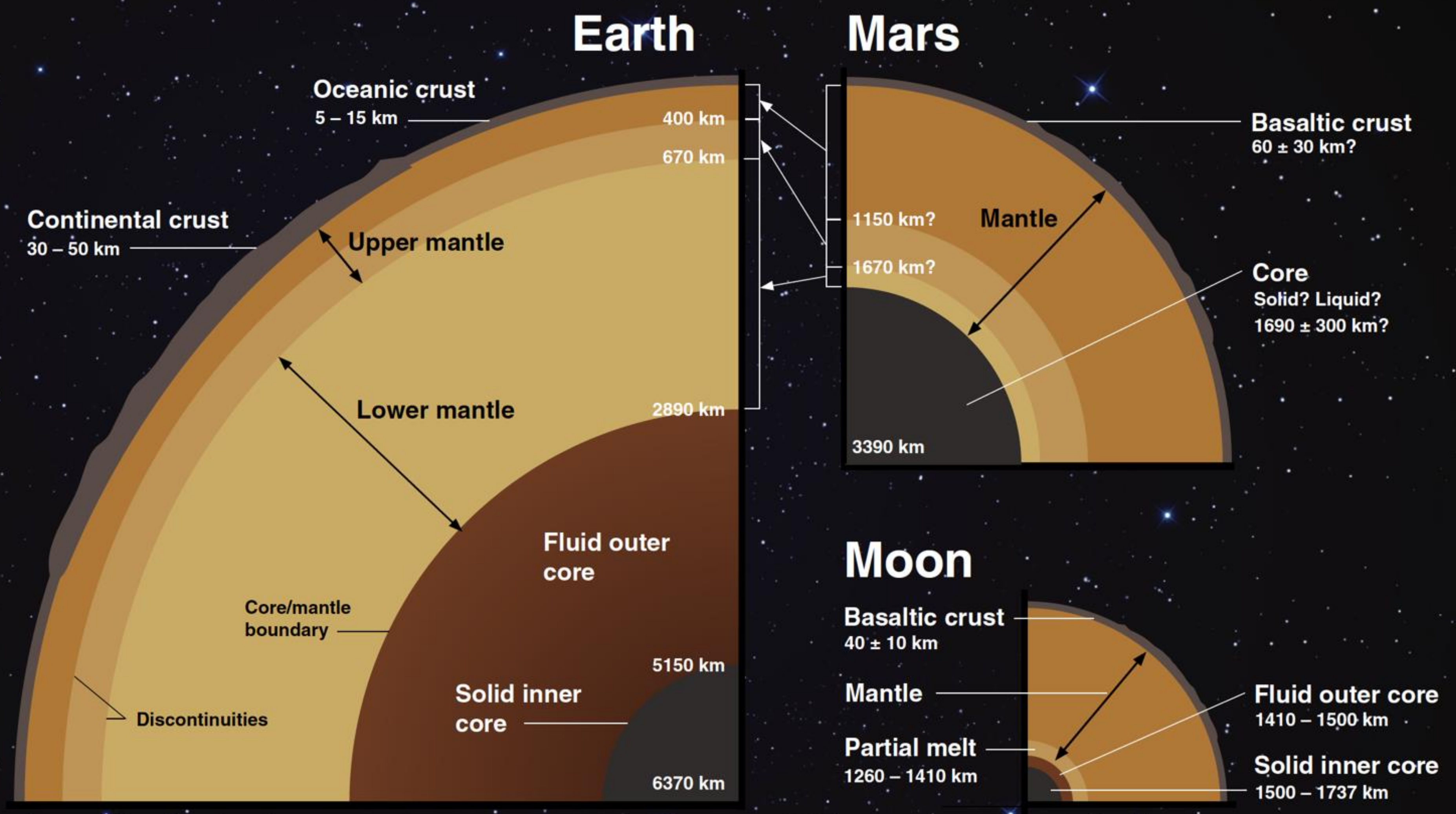
3. Stuff happens! ← **InSight!**

4. The planet ends up with a crust, mantle, and core with distinct, non-meteoritic compositions.

For the Earth, we know the inside structure very well



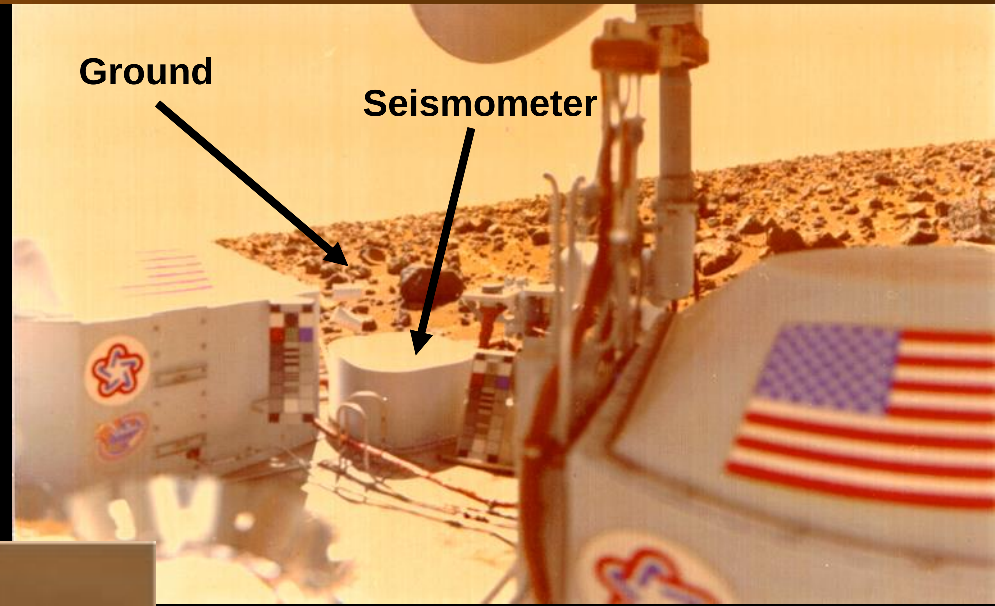
Mars Structure Compared to Earth and Moon

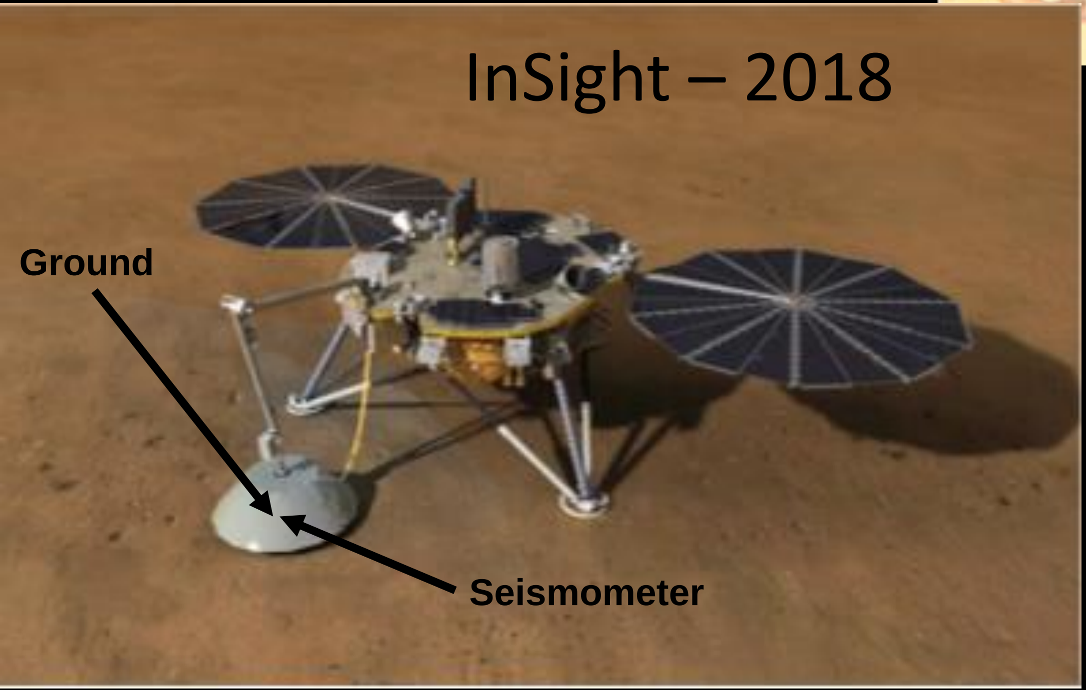


Surface Deployment is Key to InSight Measurements

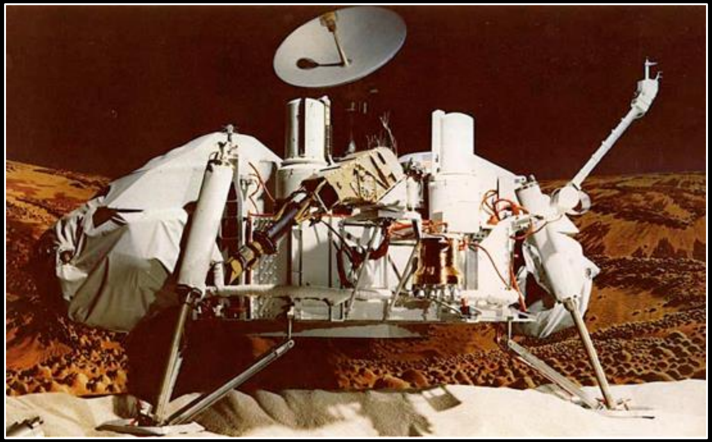
The quality of a seismic station is directly related to the quality of its installation.

But after traveling 650 million km to Mars, the instruments are still ~1 m from the ground…

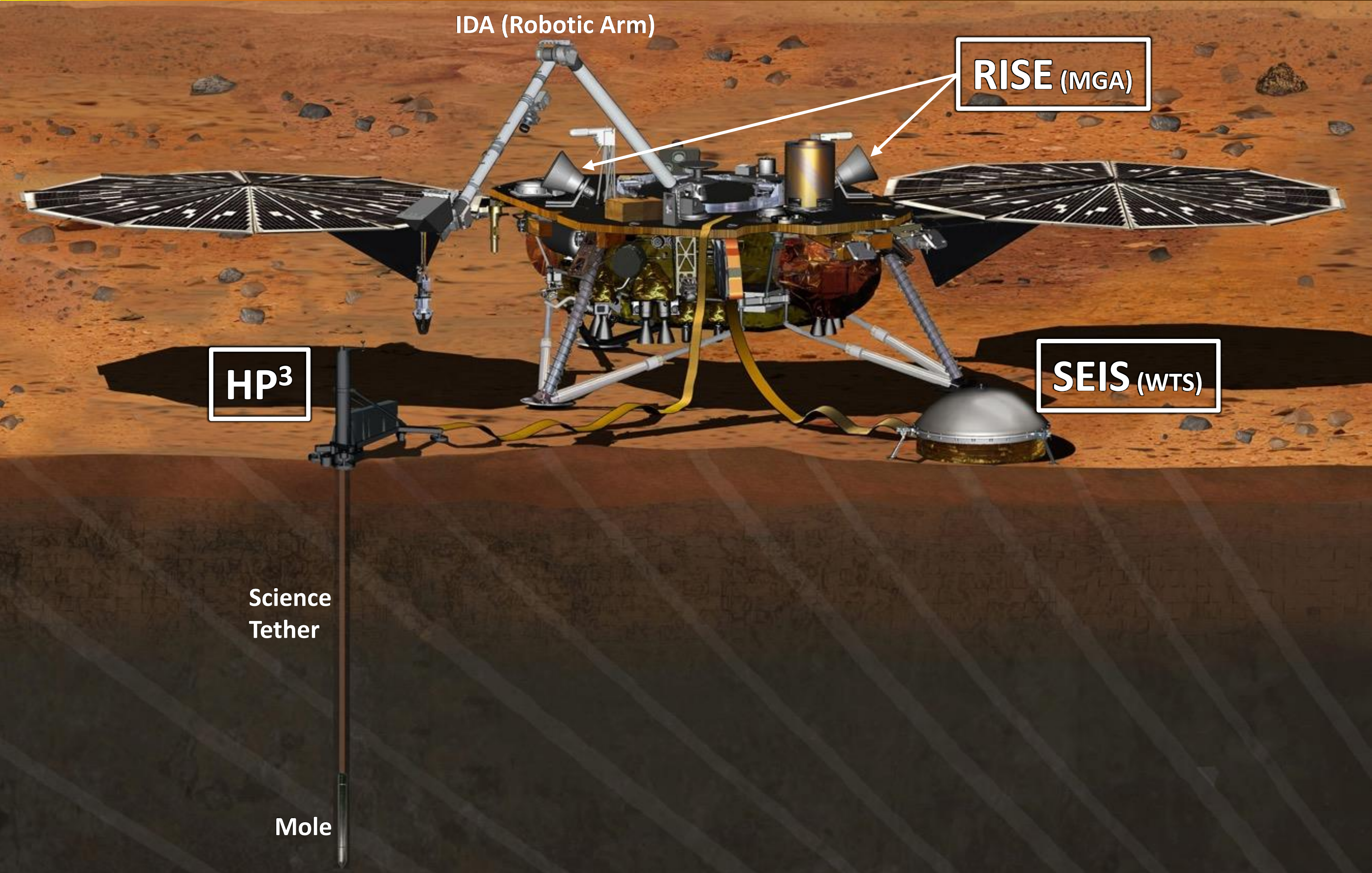




Viking 1 – 1976



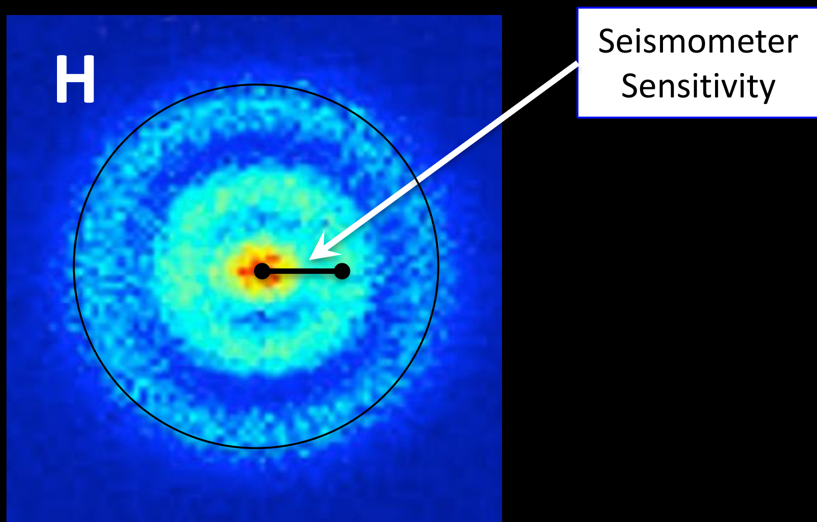
InSight Payload Configuration

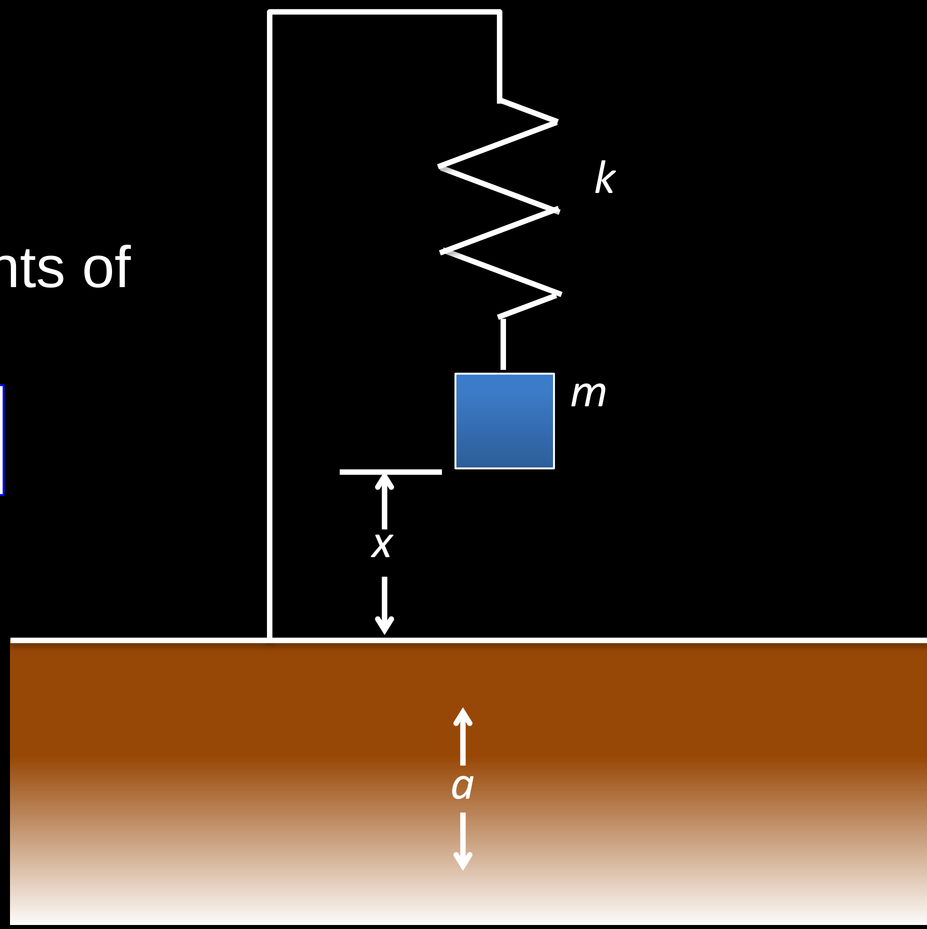


Seismometer Sensitivity

- Acceleration noise requirement over 1 Hz: $\leq 10^{-9}$ m/s^2/Hz$^{1/2}$
  - For oscillatory motion, $x = a/\omega^2 = a/4\pi^2 f^2$

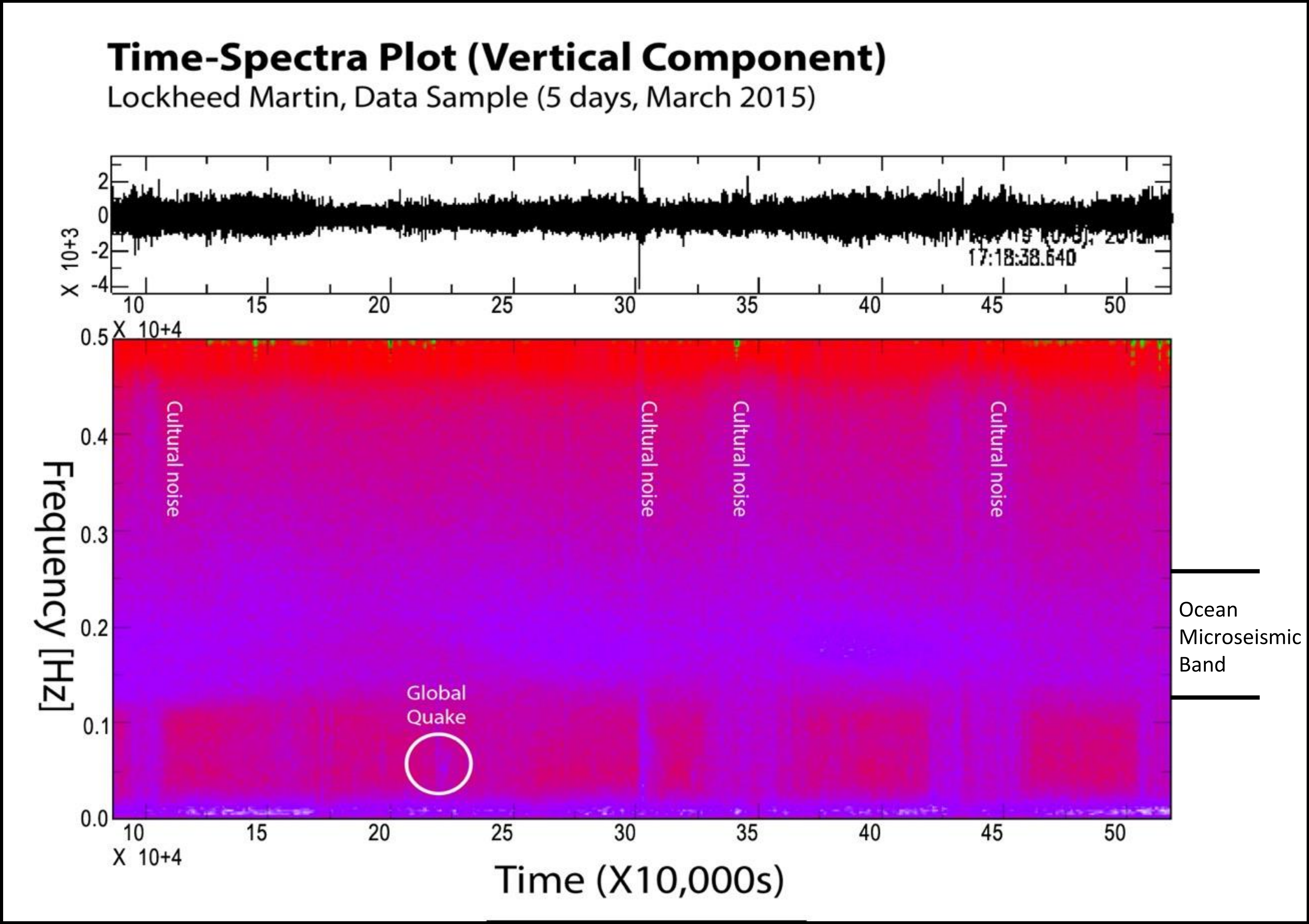
$\Rightarrow$ SEIS is sensitive to displacements of ~2.5×10^{-11}m



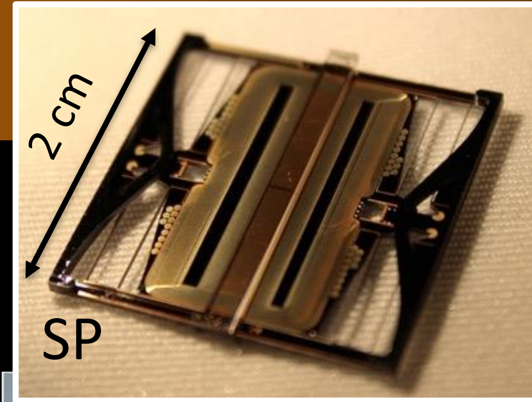


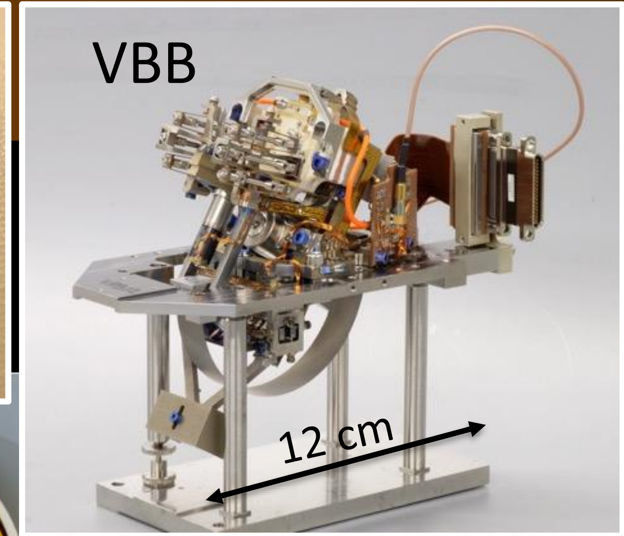
Or half the Bohr radius of a hydrogen atom

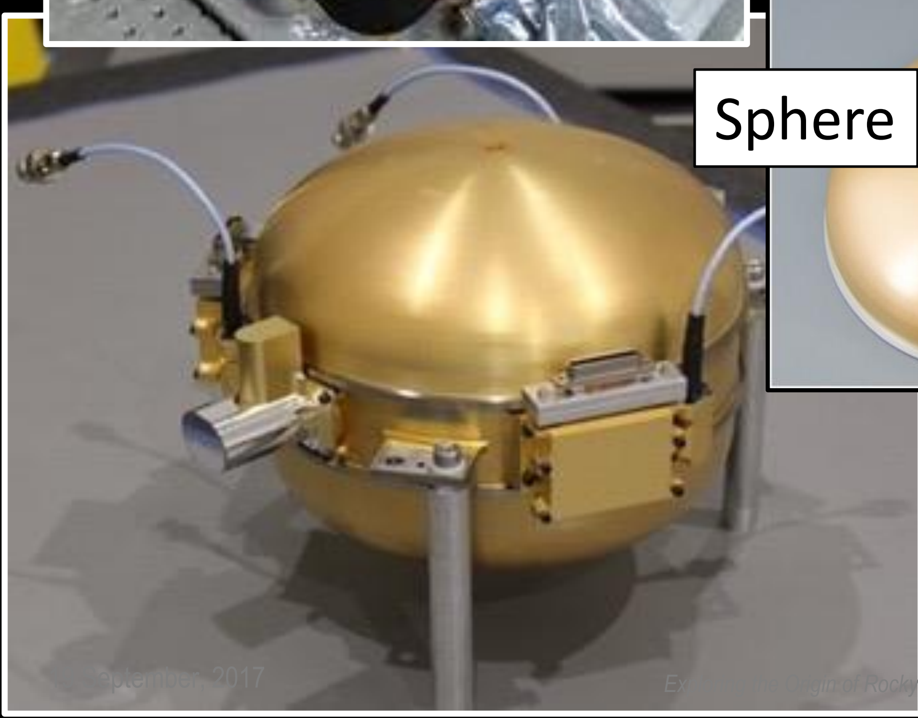
Seismometer Sensitivity – Beach Noise in Denver, CO

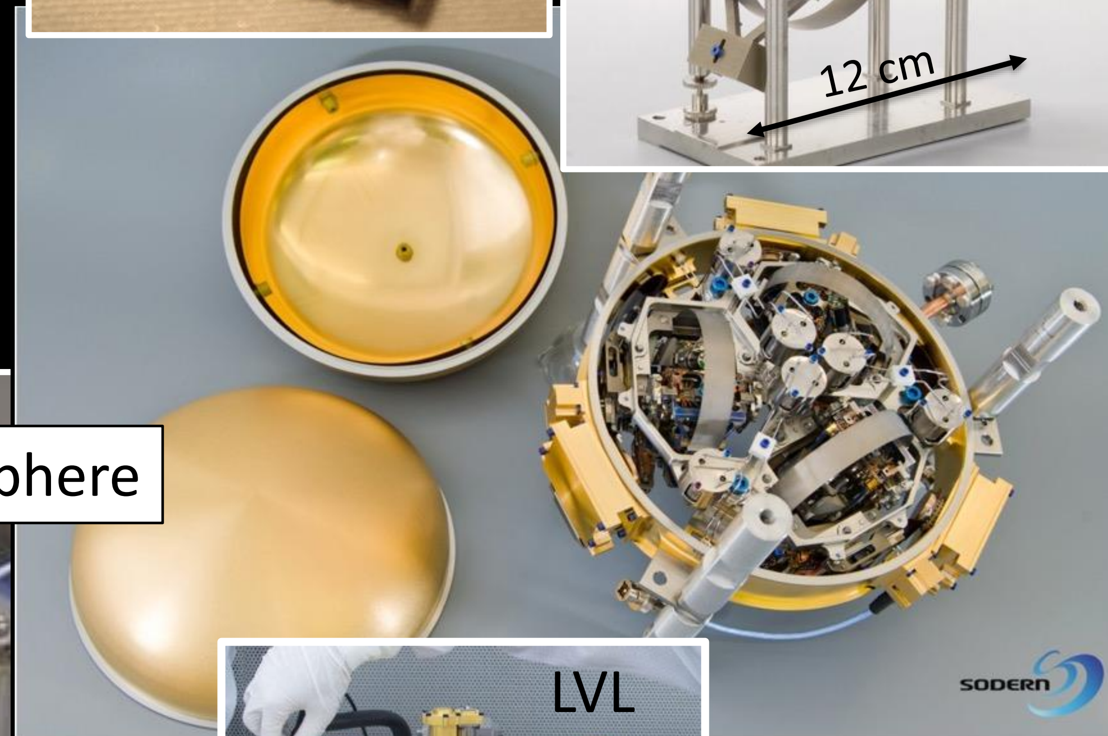


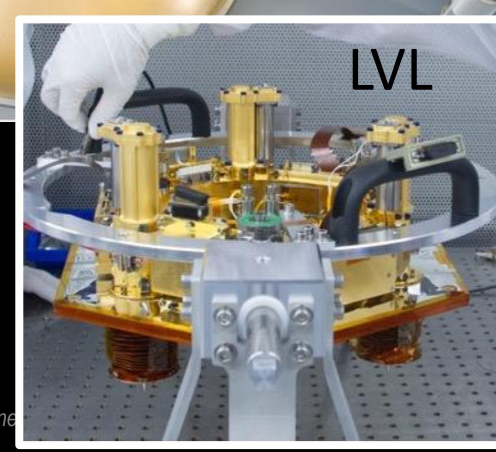
SEIS Sensors



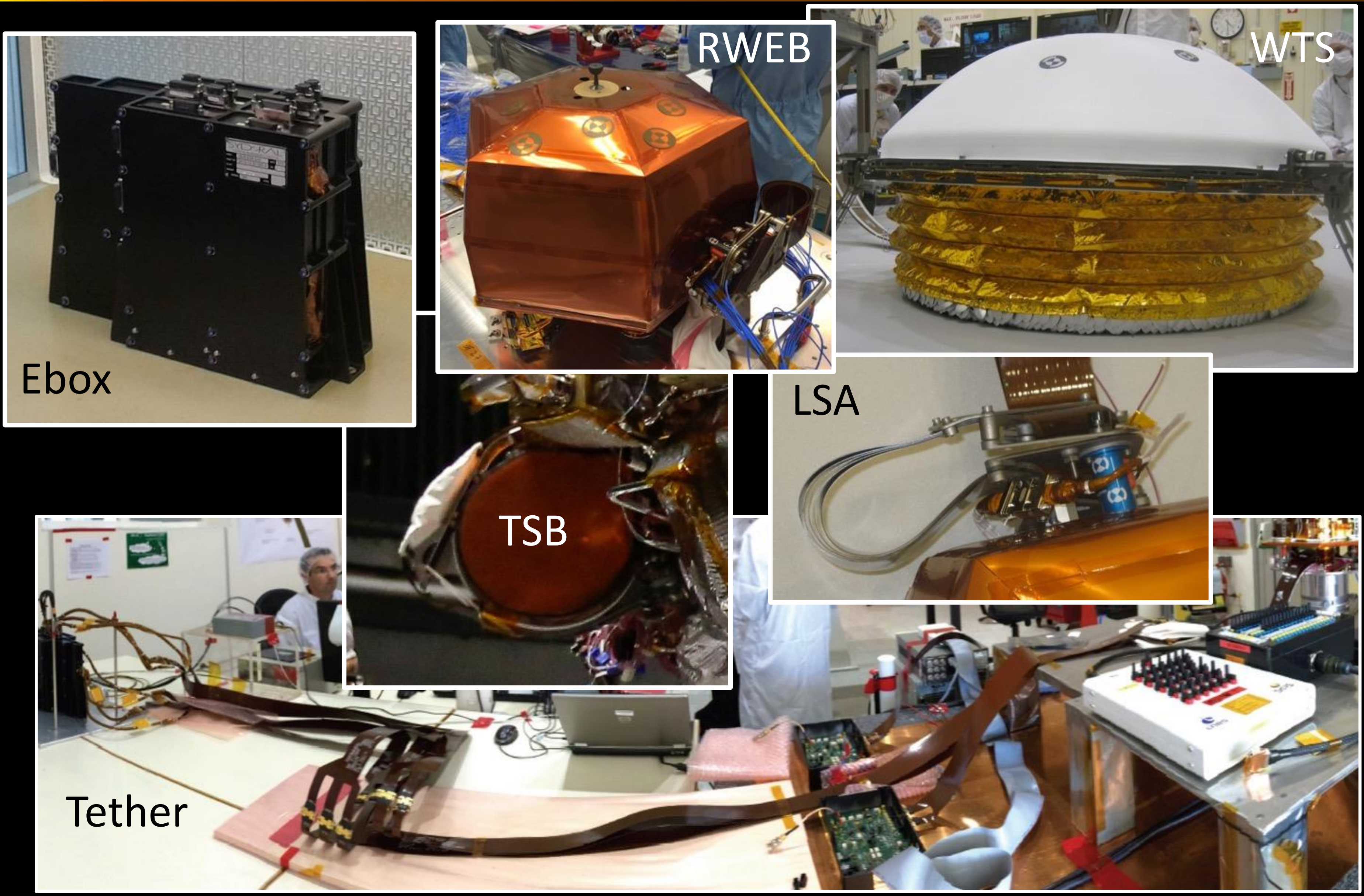




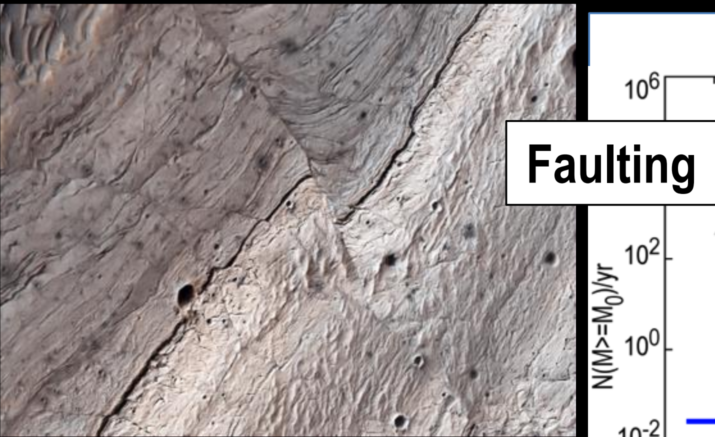




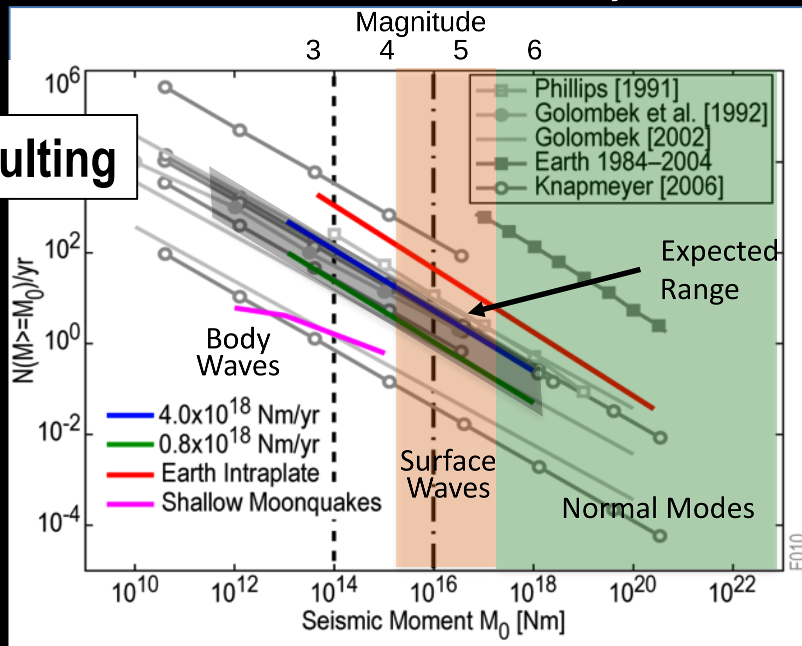
Other SEIS Components

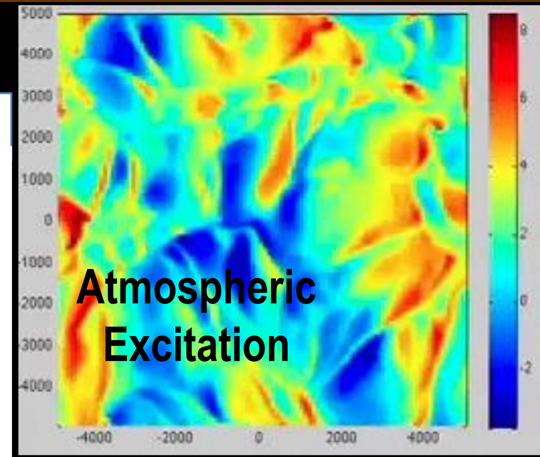


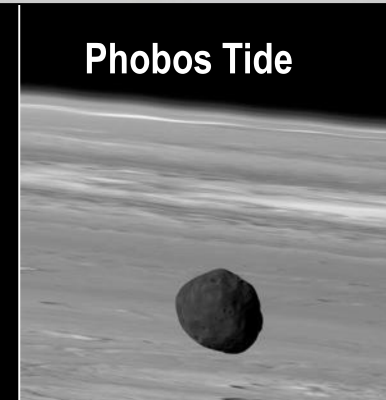
Martian Seismology – Multiple Signal Sources

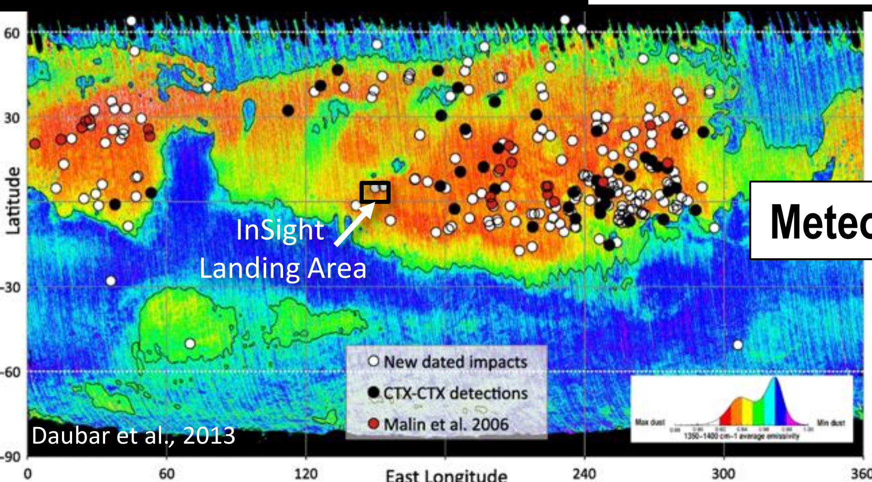


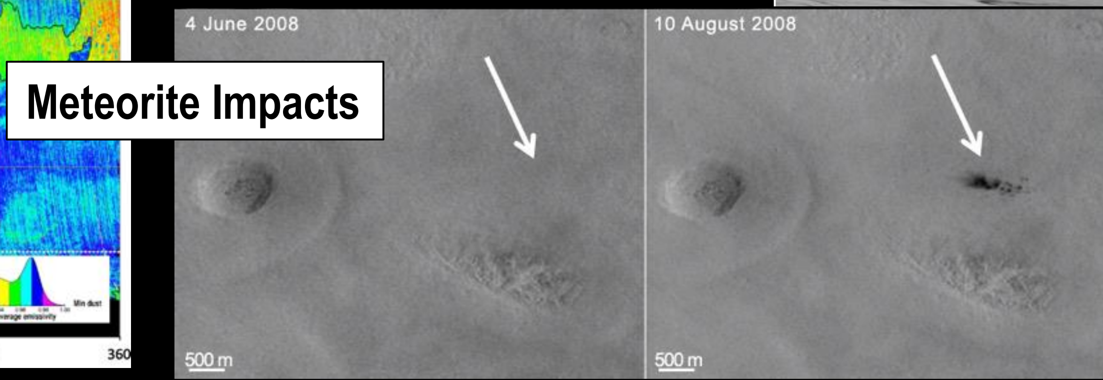
Rate of Seismic Activity



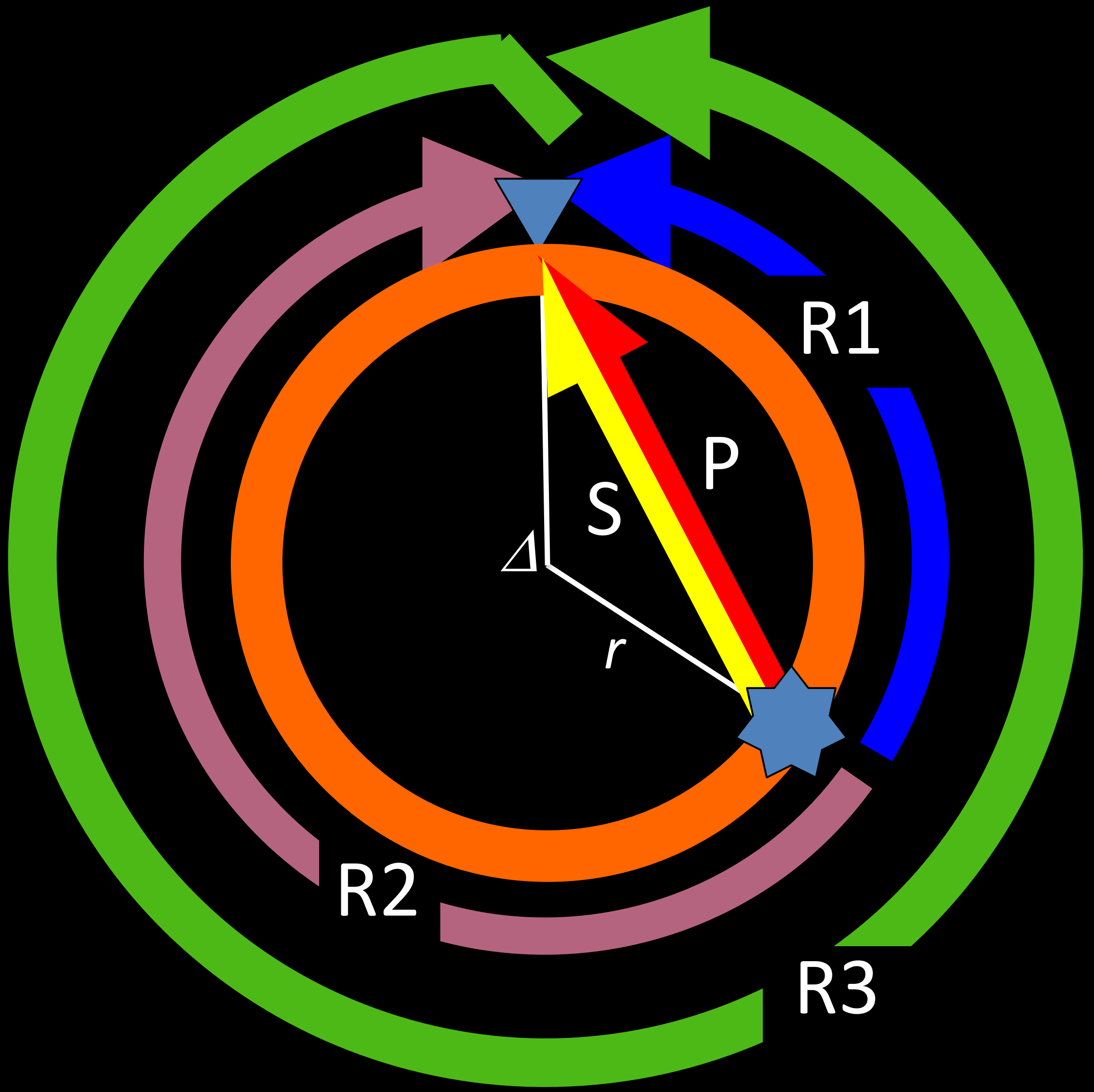








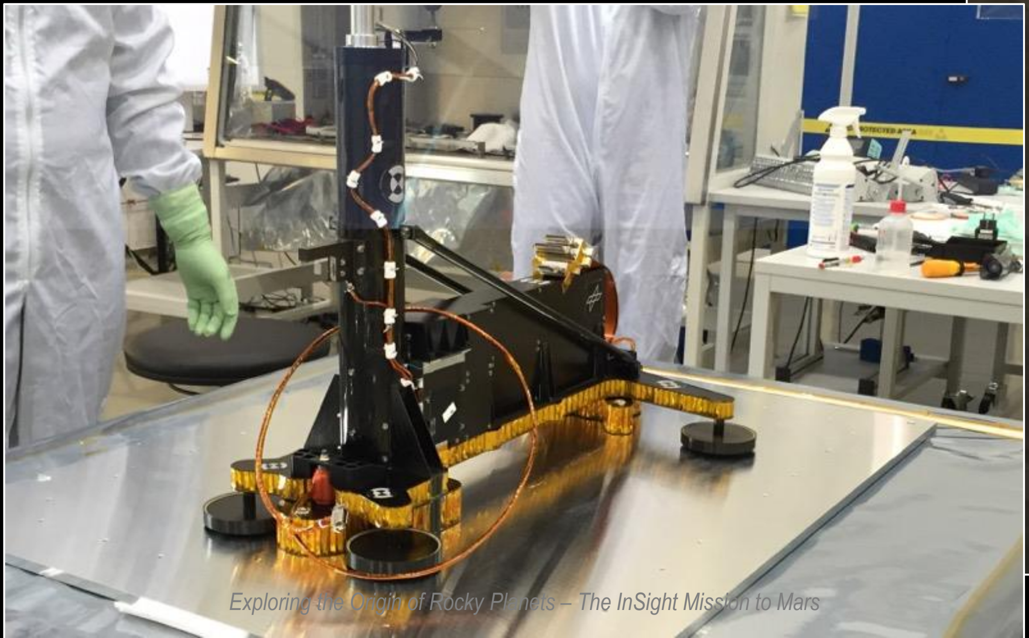
Event Location and Seismic Velocities from a Single Record



Heat Flow Measurement – HP^3

- HP^3 (Heat Flow and Physical Properties Probe) has a self-penetrating "mole" that burrows up to 5 meters below the surface.
  - Cable contains precise temperature sensors every 35 cm to measure the temperature changes with depth.

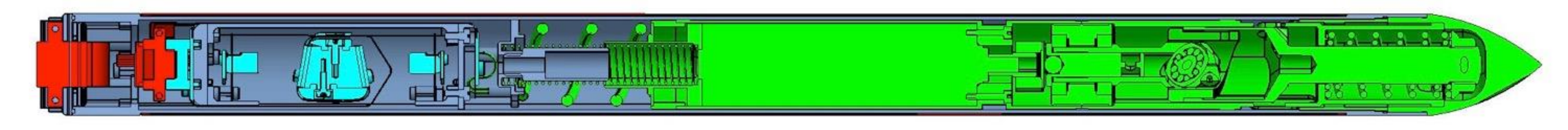
- This will yield the rate of heat flowing from the interior.



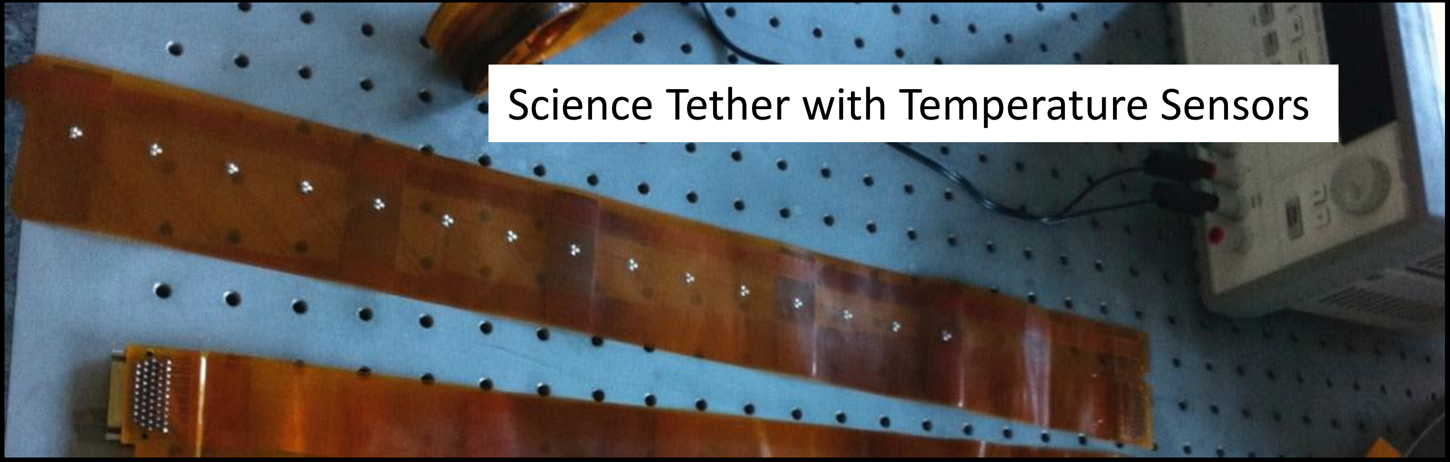
Mole and Science Tether

~19 in.

Tilt meters Motor Hammer Mechanism

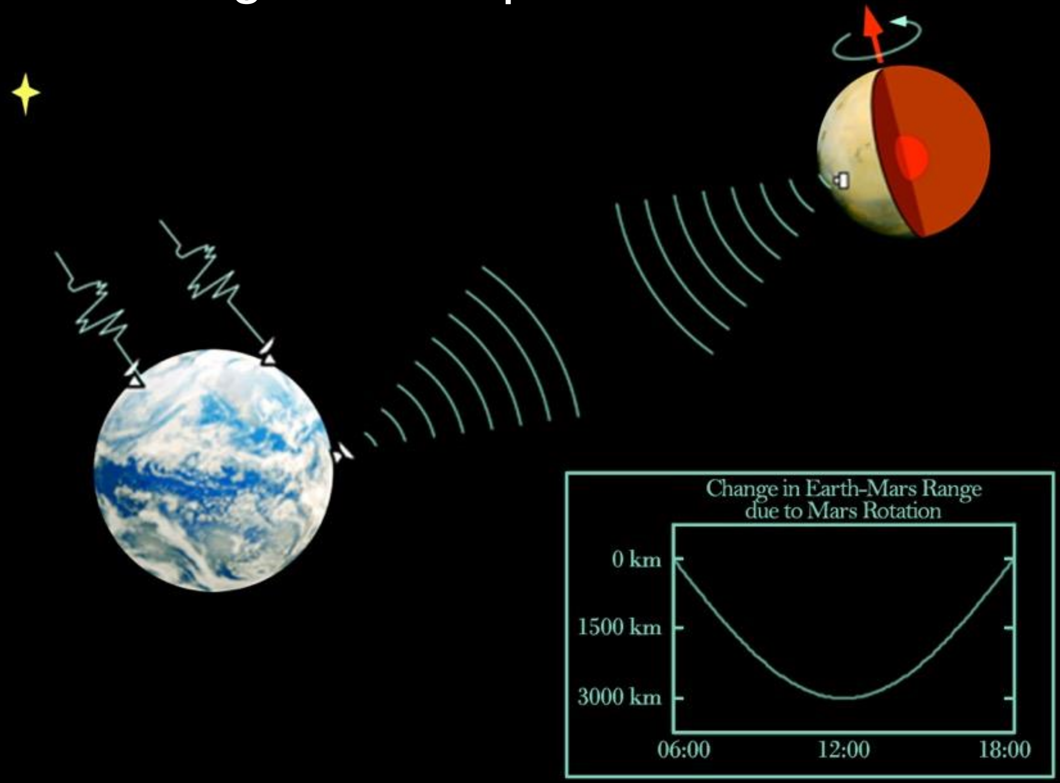


Heater foils within Mole outer hull



Precision Radio Tracking – RISE

- Measurement of the timing and Doppler shift of the X-band radio signal between the Earth and InSight allow us to track the location and motion of the lander to within **less than 10 cm**.
- By tracking the lander location for about an hour several times a week over the length of the mission, we will be able to determine extremely small changes in the pole direction of Mars.

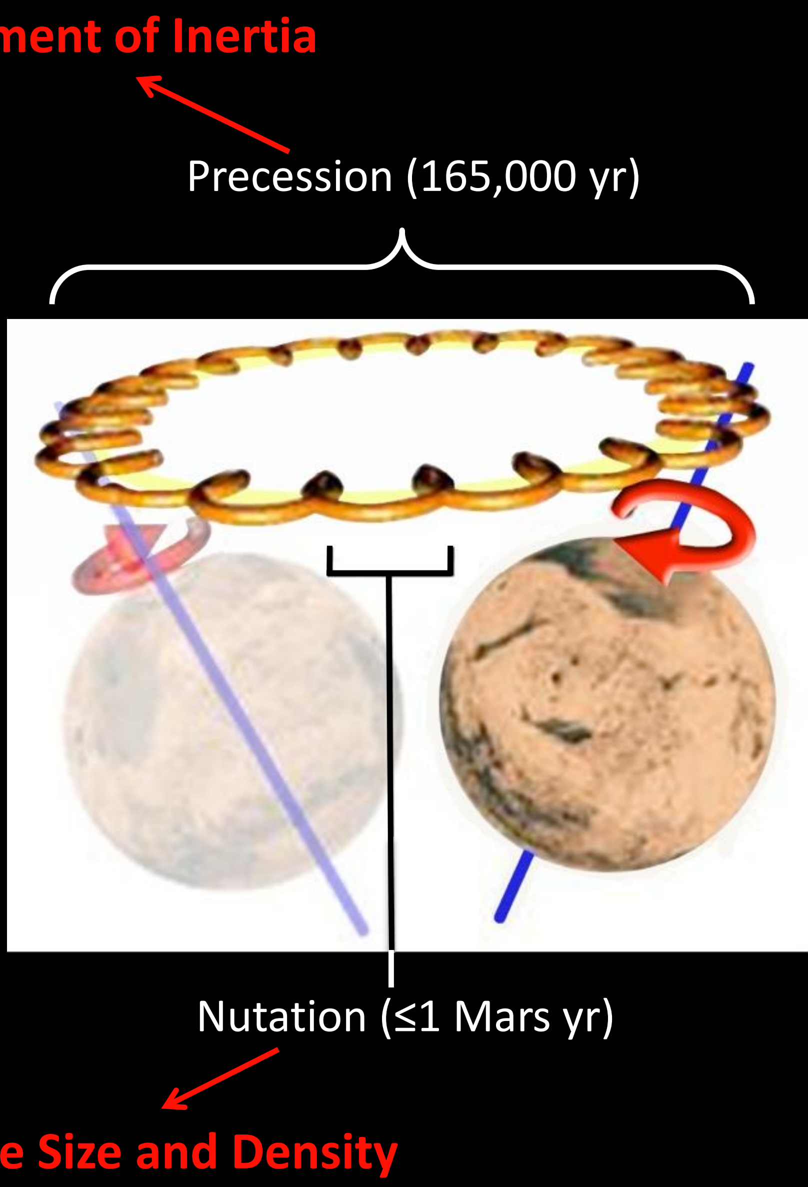


Precision Radio Tracking – RISE

- First measured constraint on Mars' core size came from combining radio Doppler measurements from Viking and Mars Pathfinder, which determined spin axis directions 20 years apart.

- InSight will provide another snapshot of the axis 20 years later still.

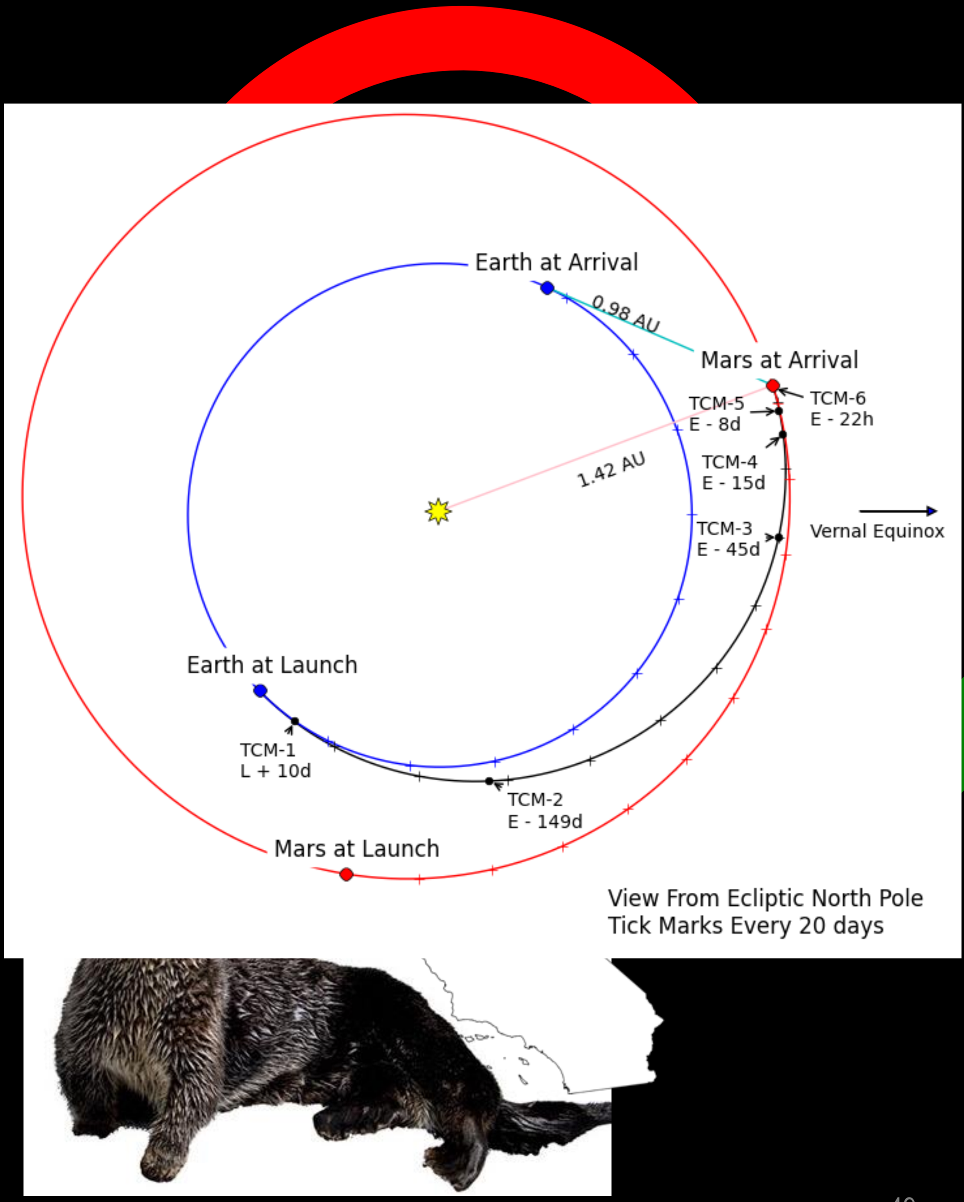
- With 2 years of tracking data, it will be also be possible to determine nutation amplitudes and frequencies.

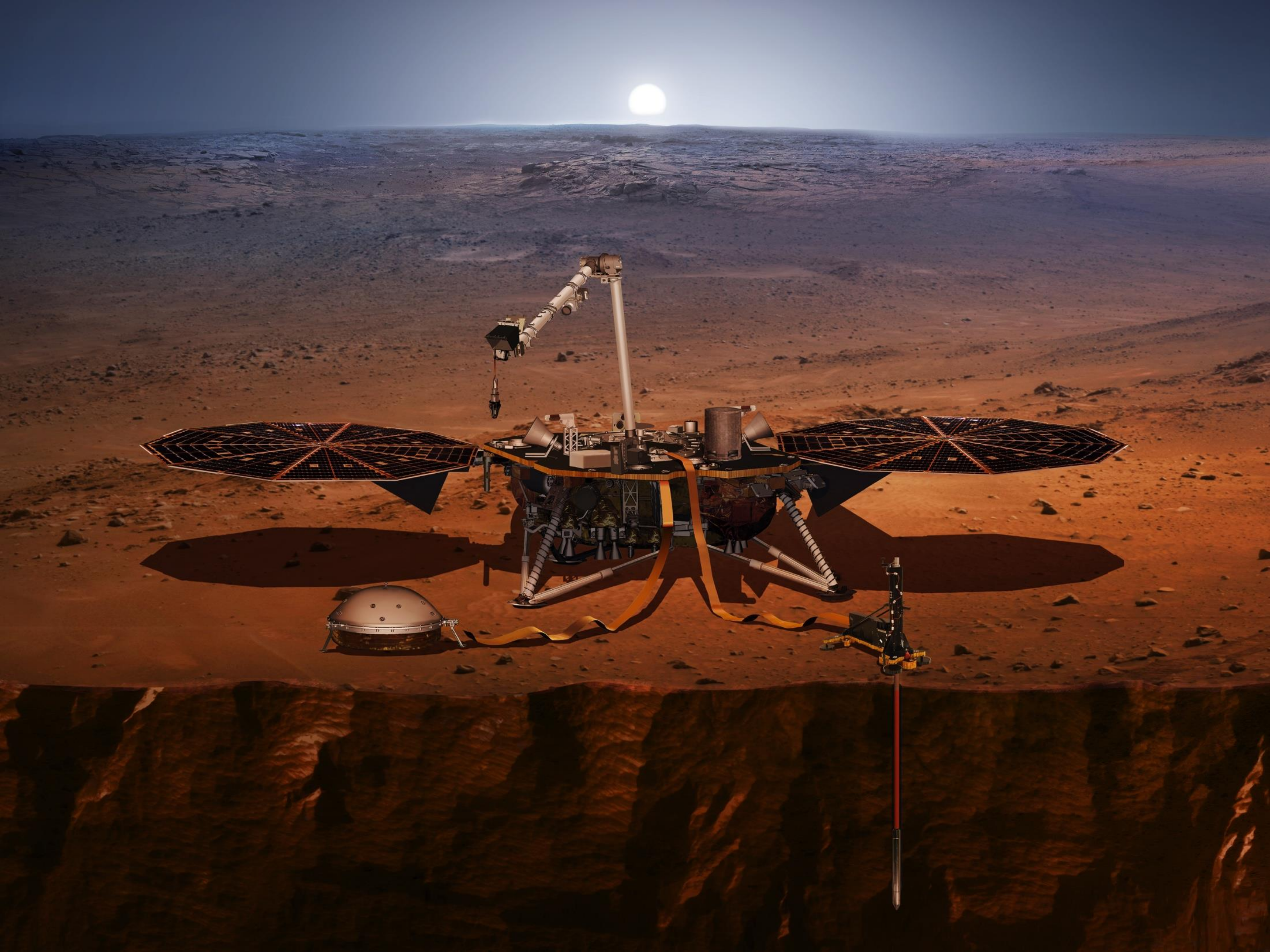


InSight Mission Description

InSight (2.0) Mission Summary

- InSight will fly a near-copy of the successful Phoenix lander
- Launch: May 5-June 8, 2018, Vandenberg AFB, California
- Fast, type-1 trajectory, 6-mo. cruise to Mars
- Landing: November 26, 2018
- Two-month deployment phase
- Two years (one Mars year) science operations on the surface; repetitive operations
- Nominal end-of-mission: November 24, 2020





Questions?

Thank You!

- Survey Monkey - https://www.surveymonkey.com/r/STAR_Net
- Archived and Upcoming Webinars: http://www.starnetlibraries.org/resources/webinars/
- Parker Solar Probe Webinar Registration - **https://starlibrarynetwork.adobeconnect.com/parkerevent/event/registration.html**
- Main Mission Page - https://mars.nasa.gov/insight/
- Questions? Email Brooks at bmitchell@spacescience.org