CURIOSITY

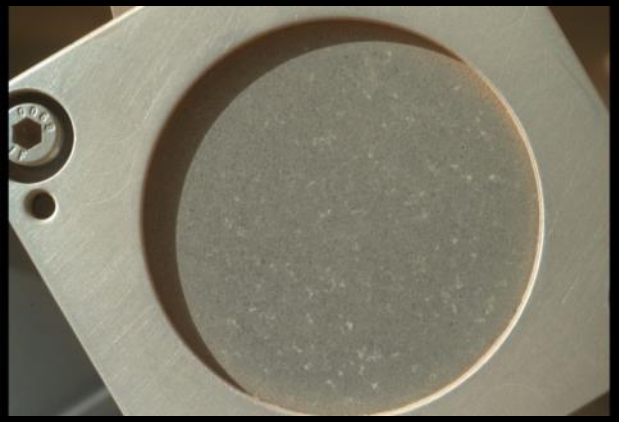
Results from the Mars Science Laboratory

Horton Newsom
MSL Science Team
7/28/2015

Acknowledgements

There are more than 250 scientists (and untold engineers) working on the Mars Science Laboratory mission…

The UNM team - Horton Newsom, Ines Belgacem, Ryan Jackson, Zach Gallegos, Beth Ha, Penny King (now ANU), Nina Lanza (now LANL), Ann Ollila, Suzi Gordon (now LANL), Jeff Berger (now Guelph), Josh Williams (now Western Washington), Amy Williams (now UC Davis) , with Wolf Elston, Anya Rosen-Gooding (now United World College),and other colleagues – and BT2!

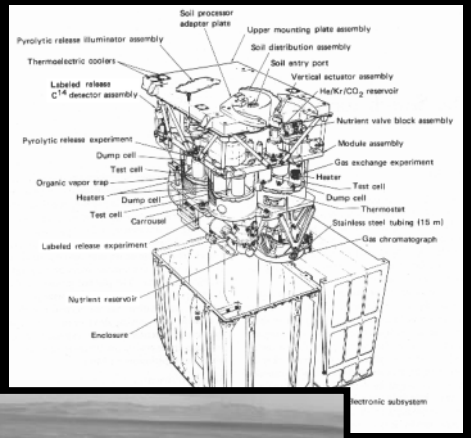


BT2 –basalt from NM, APXS Calibration target, cut and polished in Northrop Hall

Curiosity's Science Objectives

Synergy with other missions and Mars Science

- Early missions – Explains Viking Life detection results – presence of perchlorate confirmed
- Other missions – Helps interpret results for Opportunity at Endeavor crater (e.g. L. Crumpler, NMMNH)
- Martian meteorites – Study of NWA 7034 meteorites at UNM will provide detailed data to help interpret data from Curiosity



ChemCam team – Roof of the Observatory of Paris

Team meeting – Paris!

Transit of Venus – Ceiling of our meeting room in the Observatory of Paris (founded by Louis the 14th).

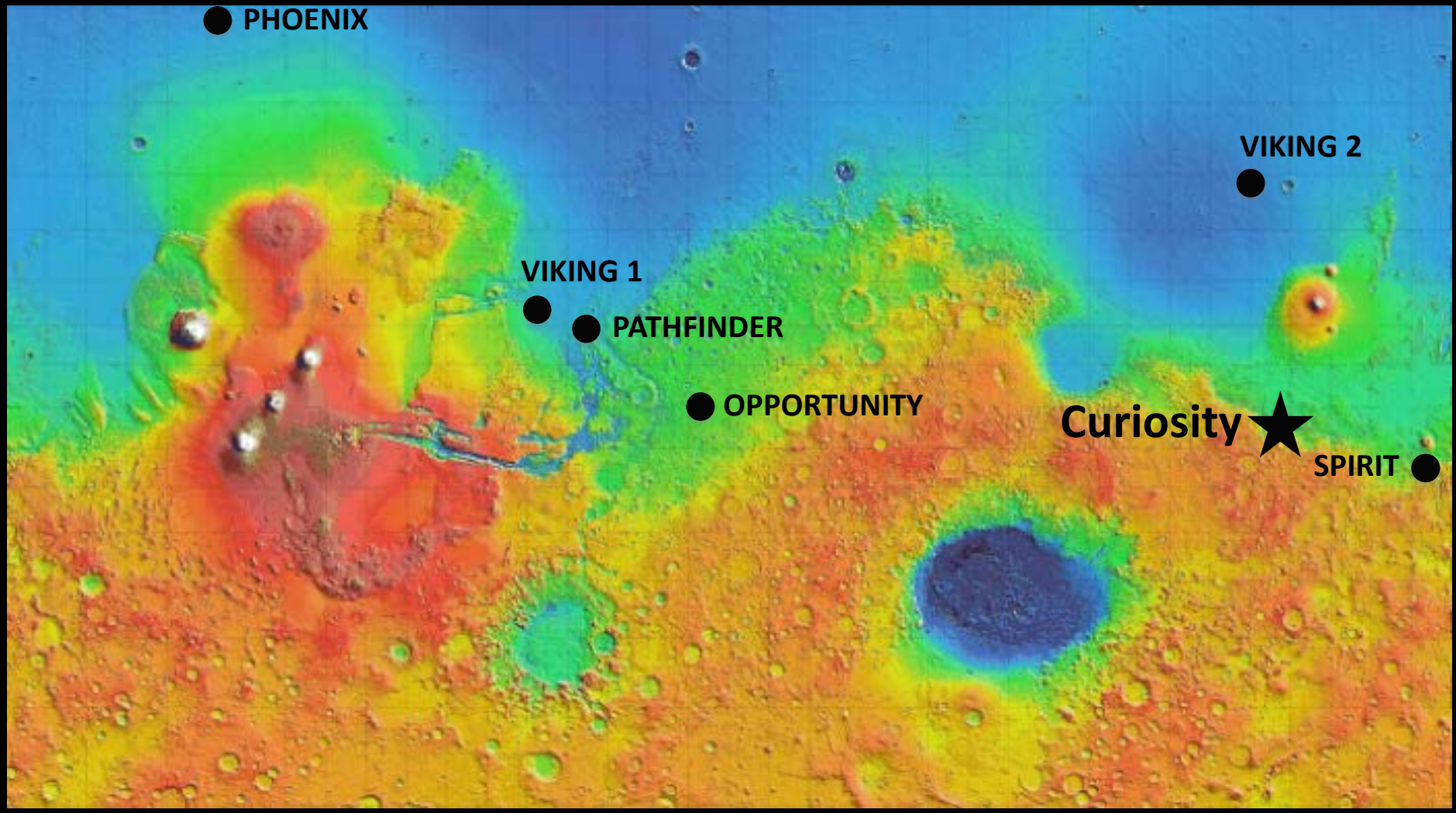
CURIOSITY

At the test-bed during Operational Readiness Test in March

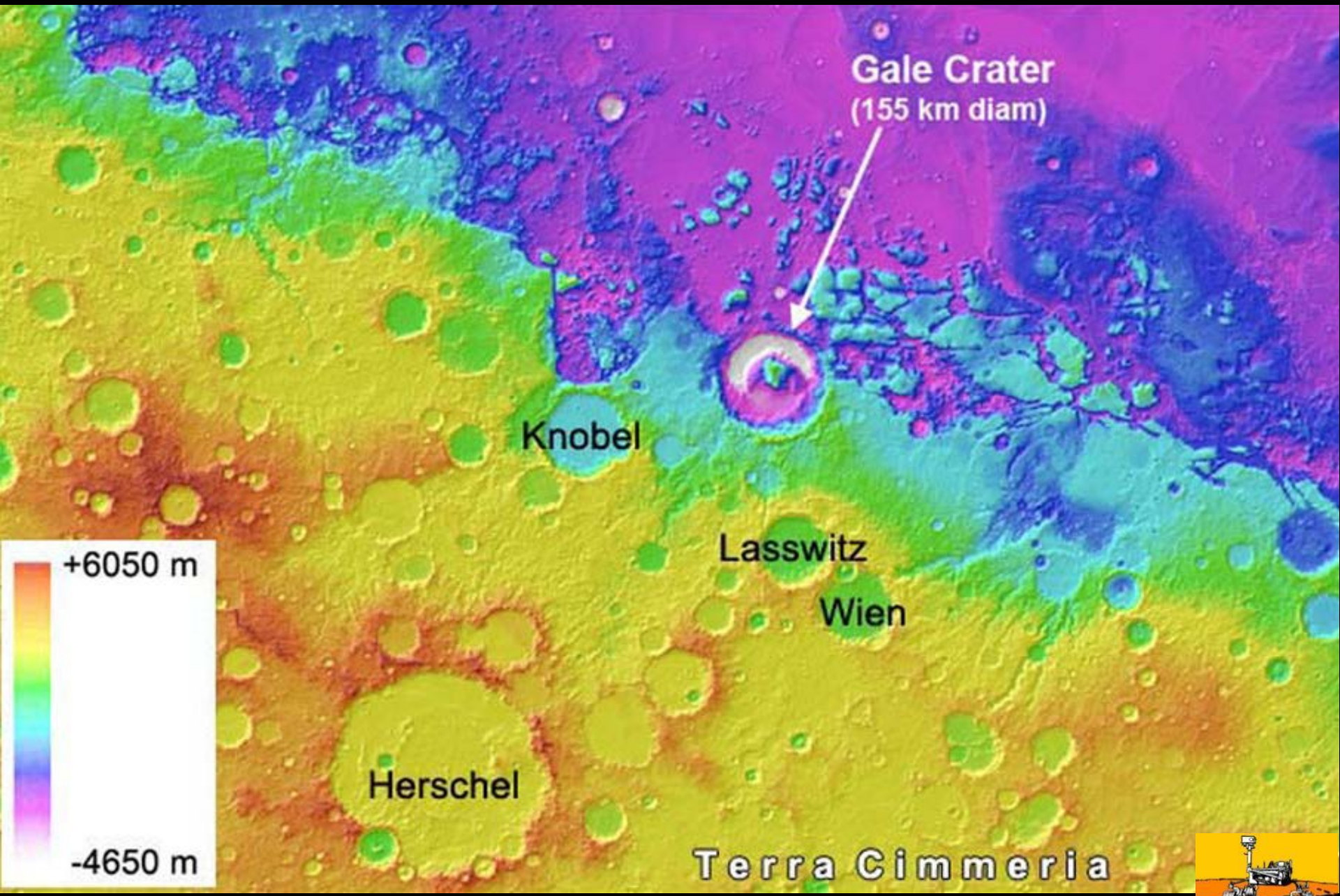
Wheel Base:	**2.8 m**
Height of Deck:	**1.1 m**
Ground Clearance:	**0.66 m**
Height of Mast:	**2.2 m**
Mass:	**900 kg**

The Target – Gale Crater

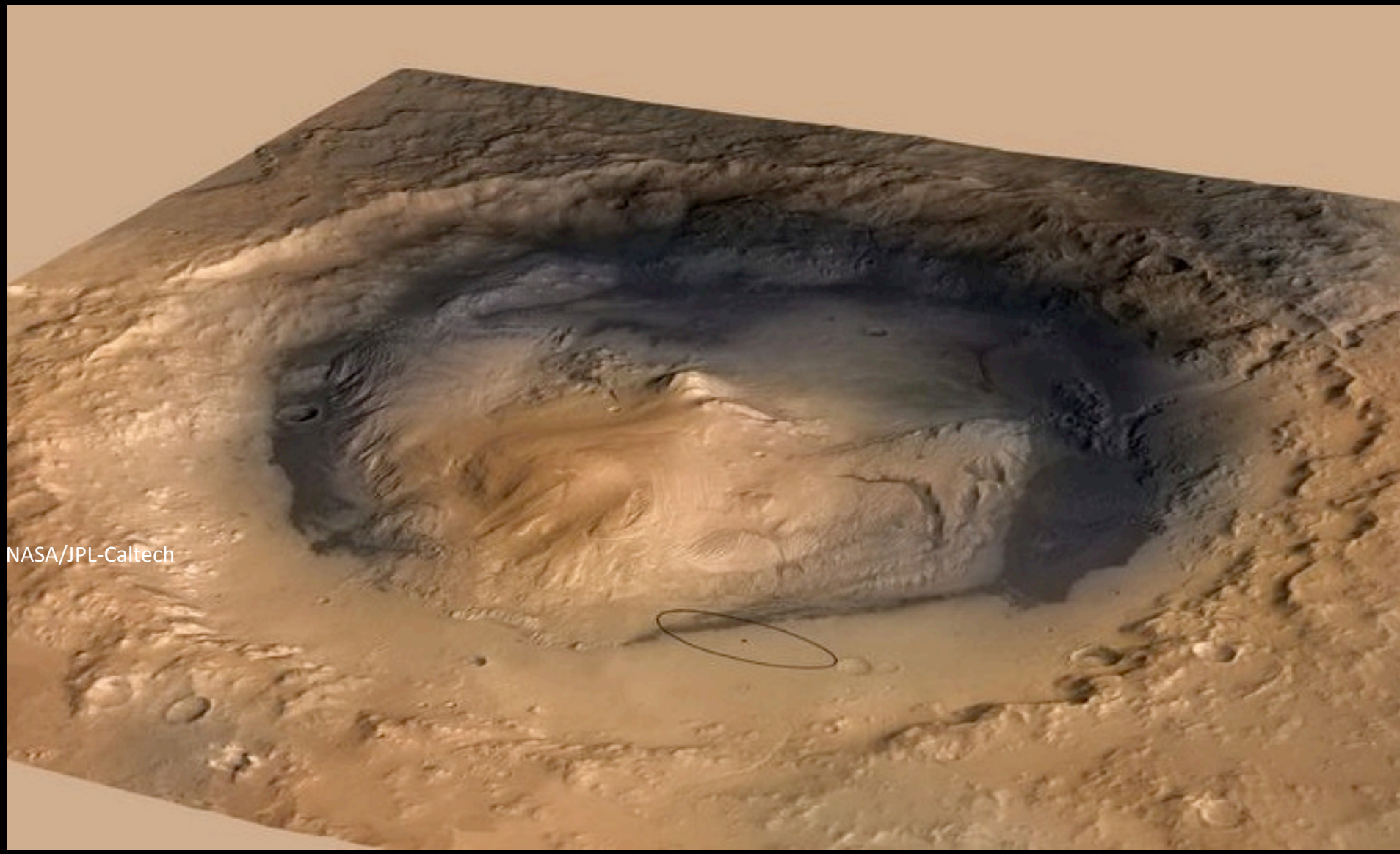
Martian Landing Sites



A field of approximately 54 different landing sites was ultimately narrowed down to Gale Crater



http://www.jpl.nasa.gov/spaceimages/details.php?id=PIA15958



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Target: Gale Crater and Mount Sharp (5.5 km, 18,000 ft high)

Launch

Cape Kennedy -Just before launch!


Nov. 26, 2011…

Descent and First Observations at Bradbury Landing

Kicking up dust just prior to landing

Lecture Hall
at Cal Tech
just after
landing!

“Touchdown confirmed.”
“Let’s see where Curiosity will take us.”

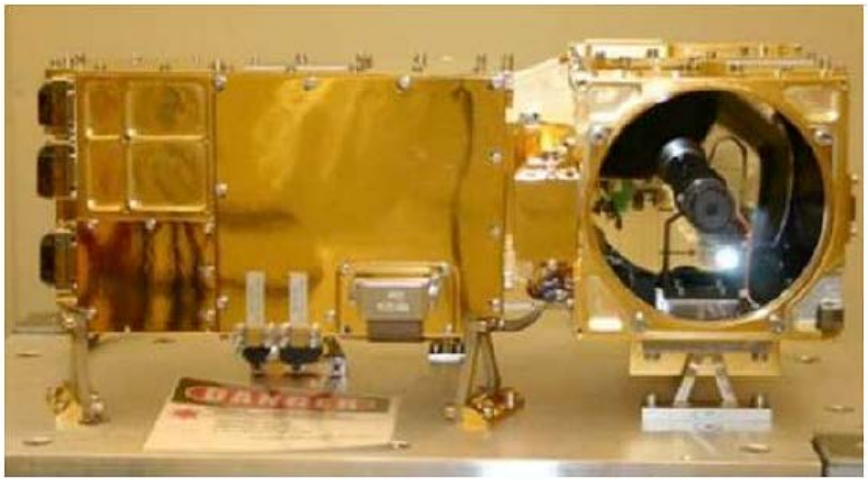
NASA/JPL-Caltech/MSSS

Mastcam mosaic of Mount Sharp, descent rocket scours, and rover shadow

ChemCam instrument

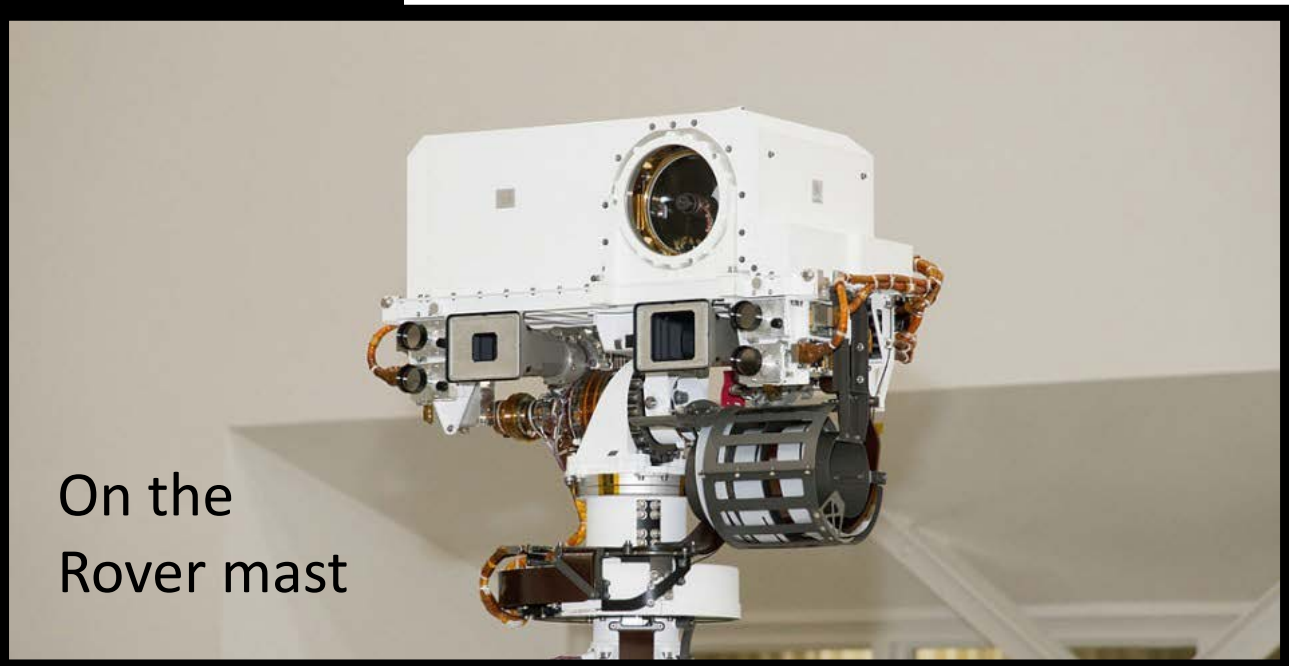
- Remote Chemistry by LIBS (To date over 200,000 laser shots on Mars!)
- Remote spectroscopy
- High resolution imaging

ChemCam instrument



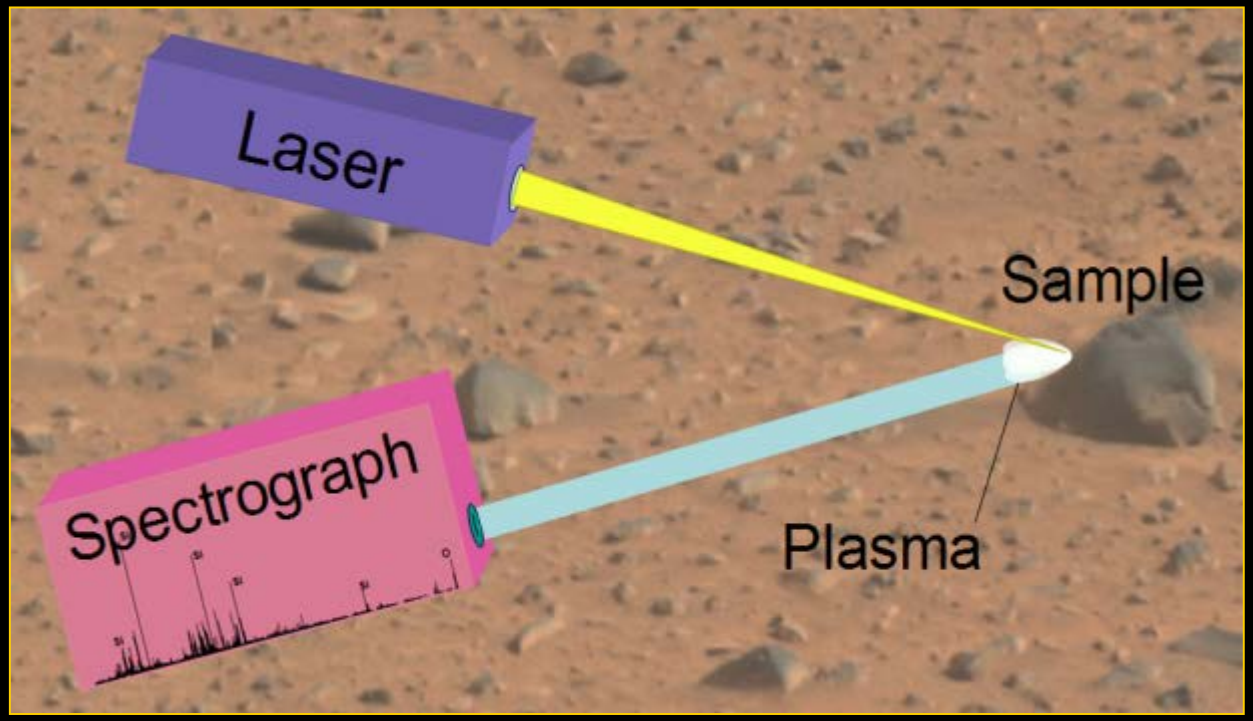
Mast Unit

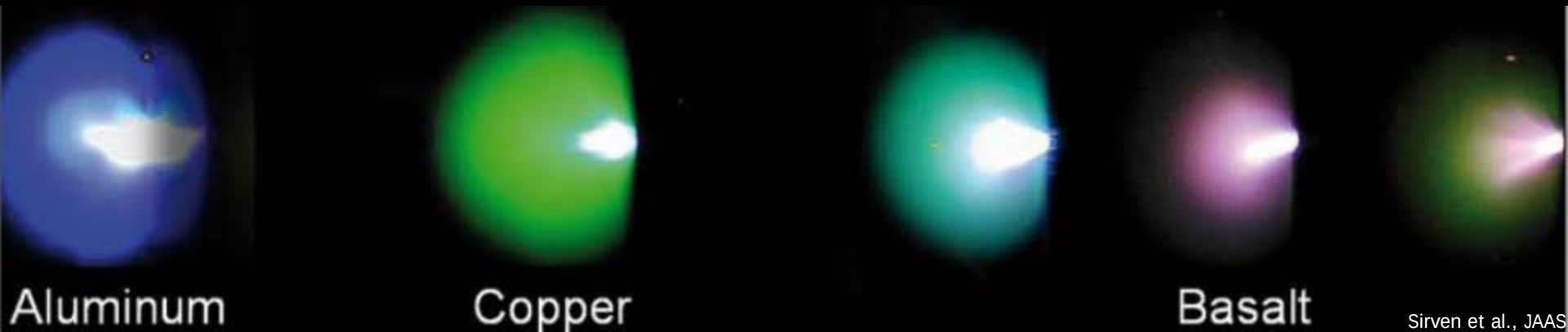
Body Unit



On the
Rover mast

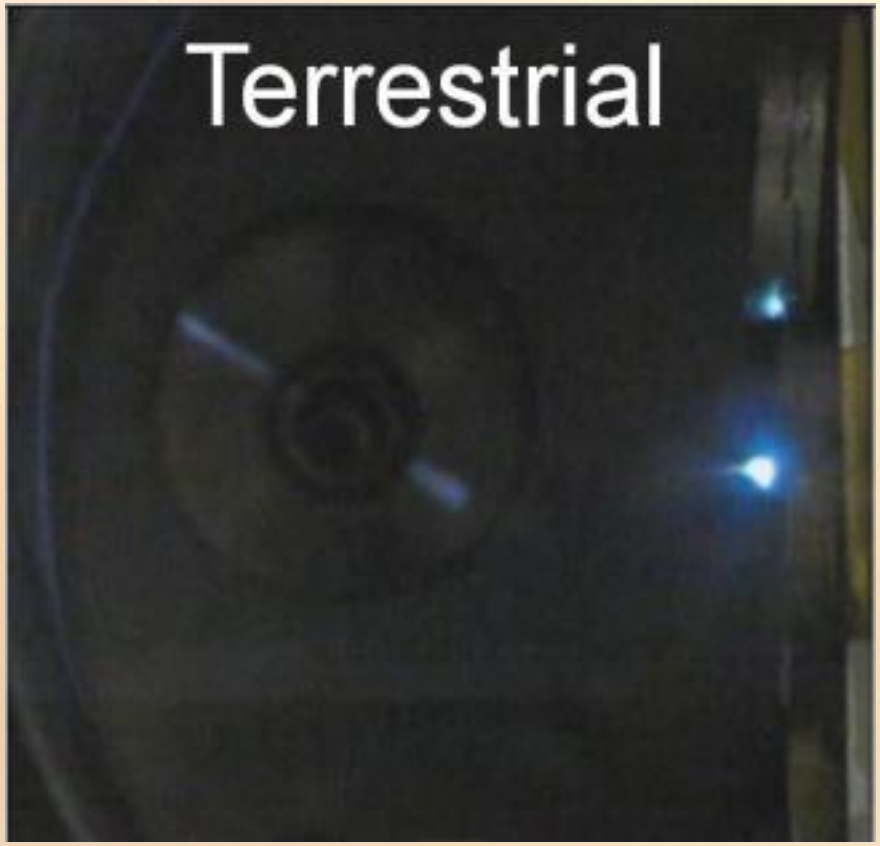
Laser-Induced Breakdown Spectroscopy (LIBS)

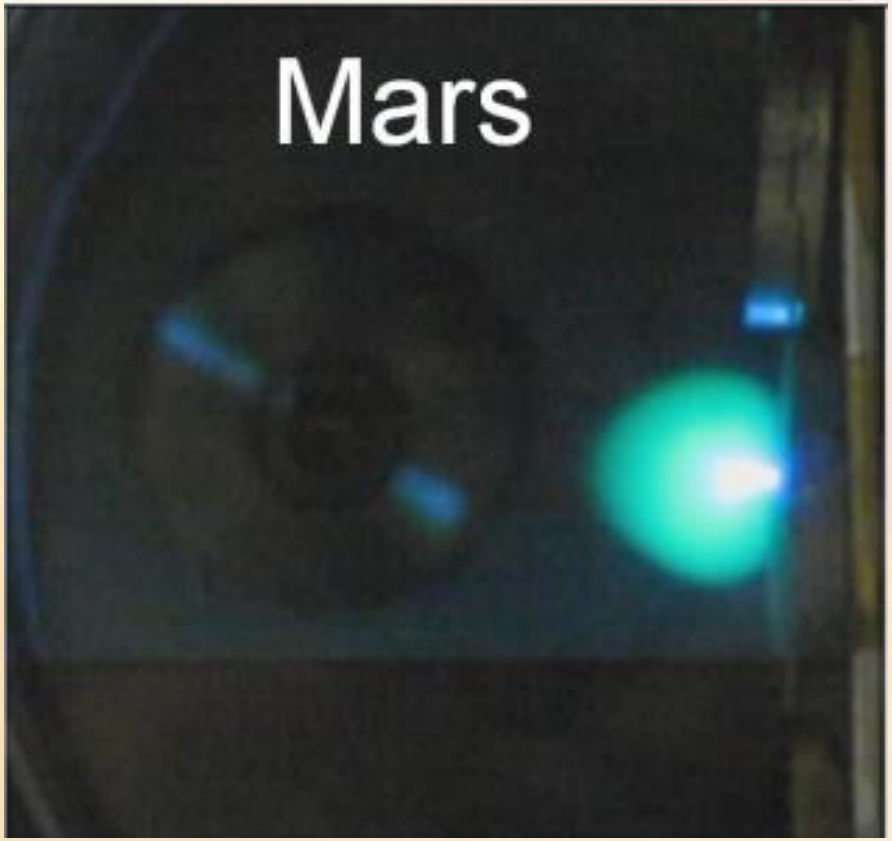




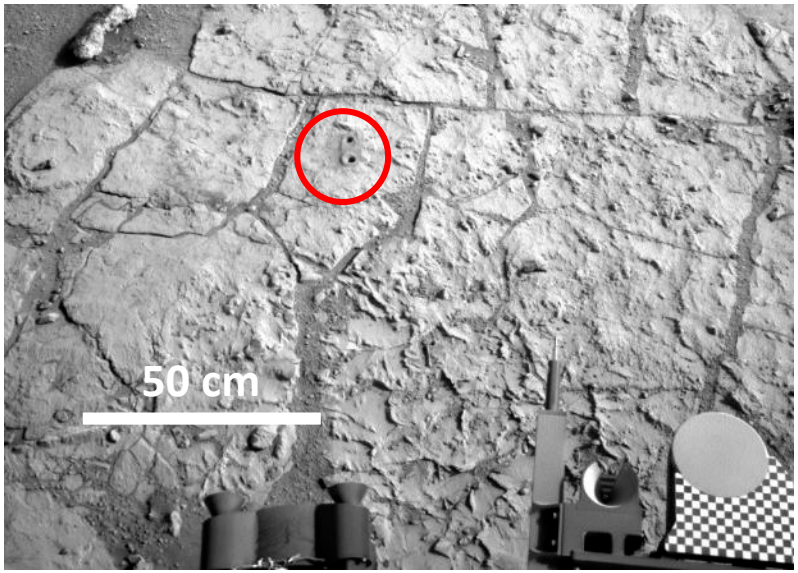
Sirven et al., JAAS

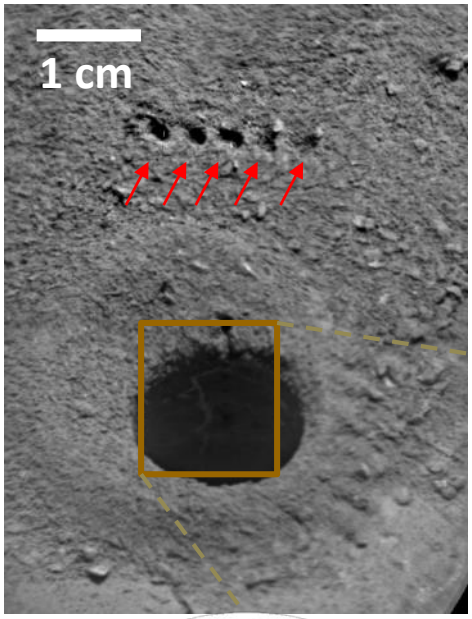
LIBS Plasmas In Different Atmospheres

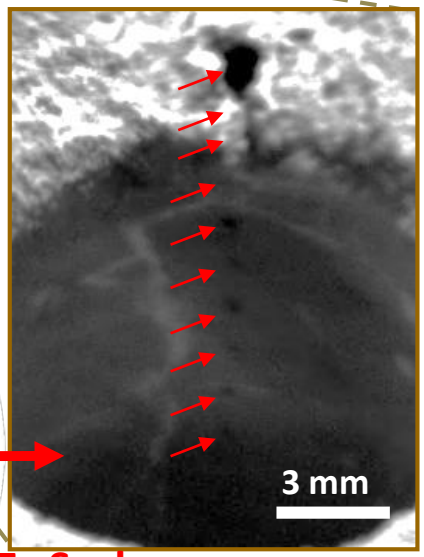




3”

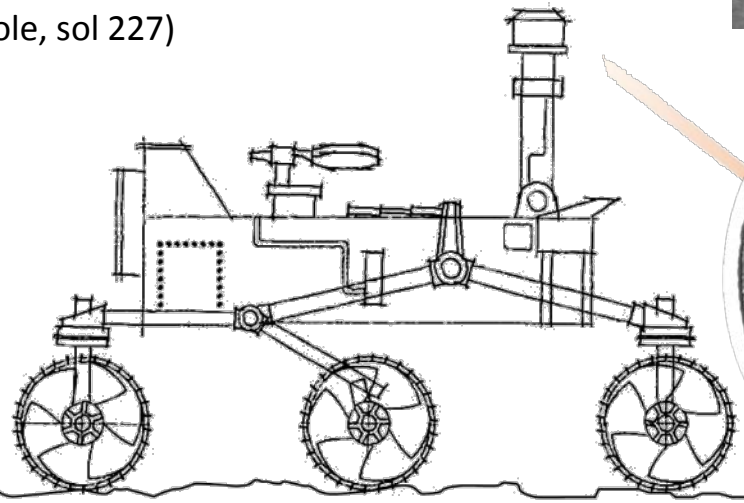


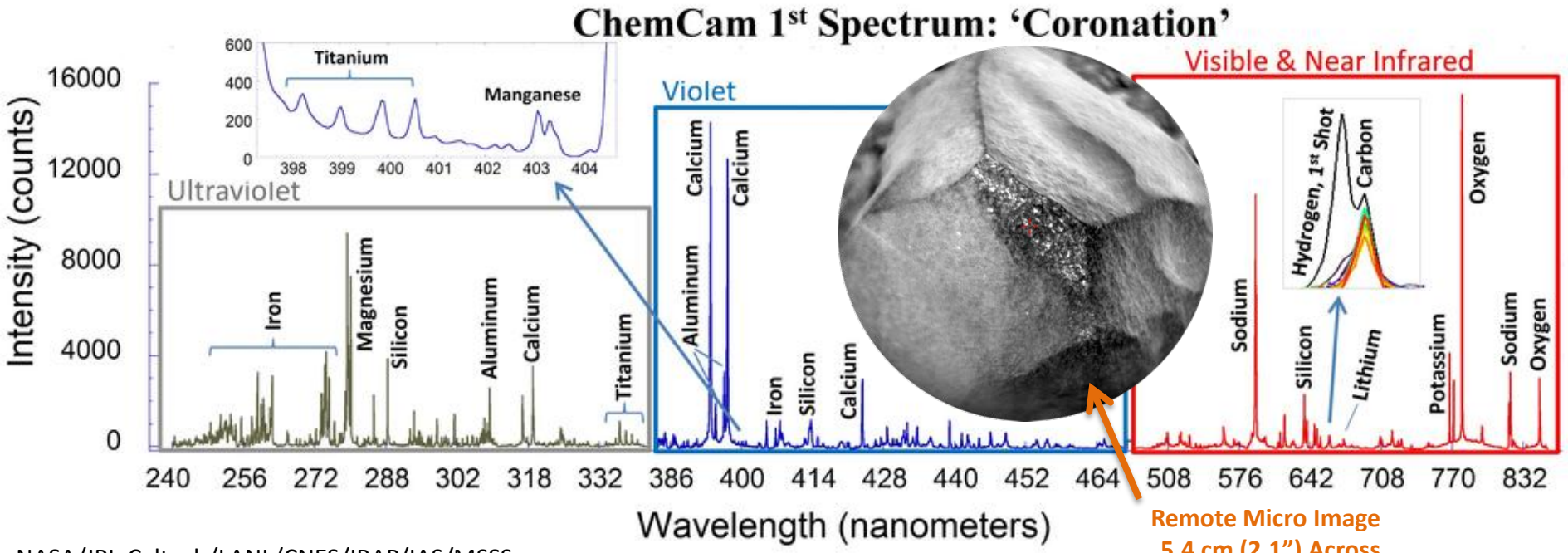




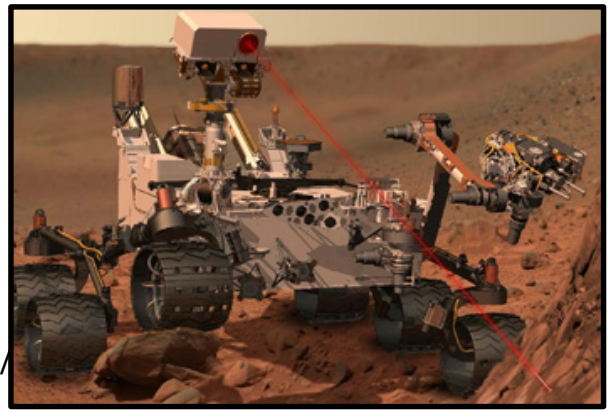
To Scale

(Drill hole, sol 227)

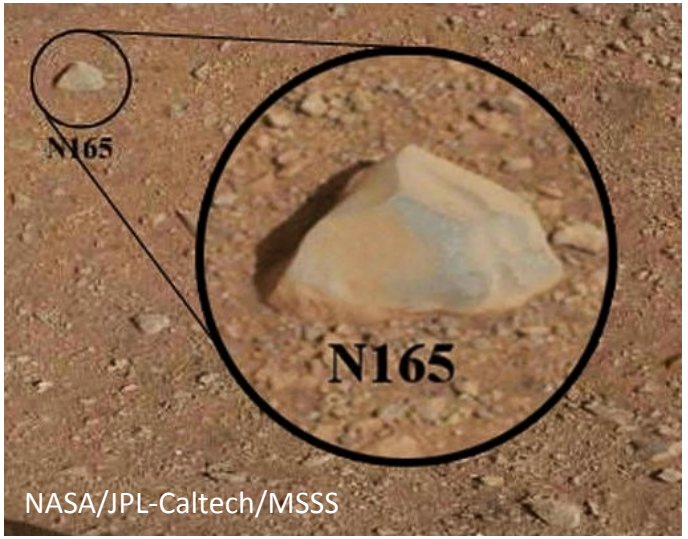




NASA/JPL-Caltech/LANL/CNES/IRAP/IAS/MSSS
NASA/JPL-Caltech/LANL/CNES/IRAP

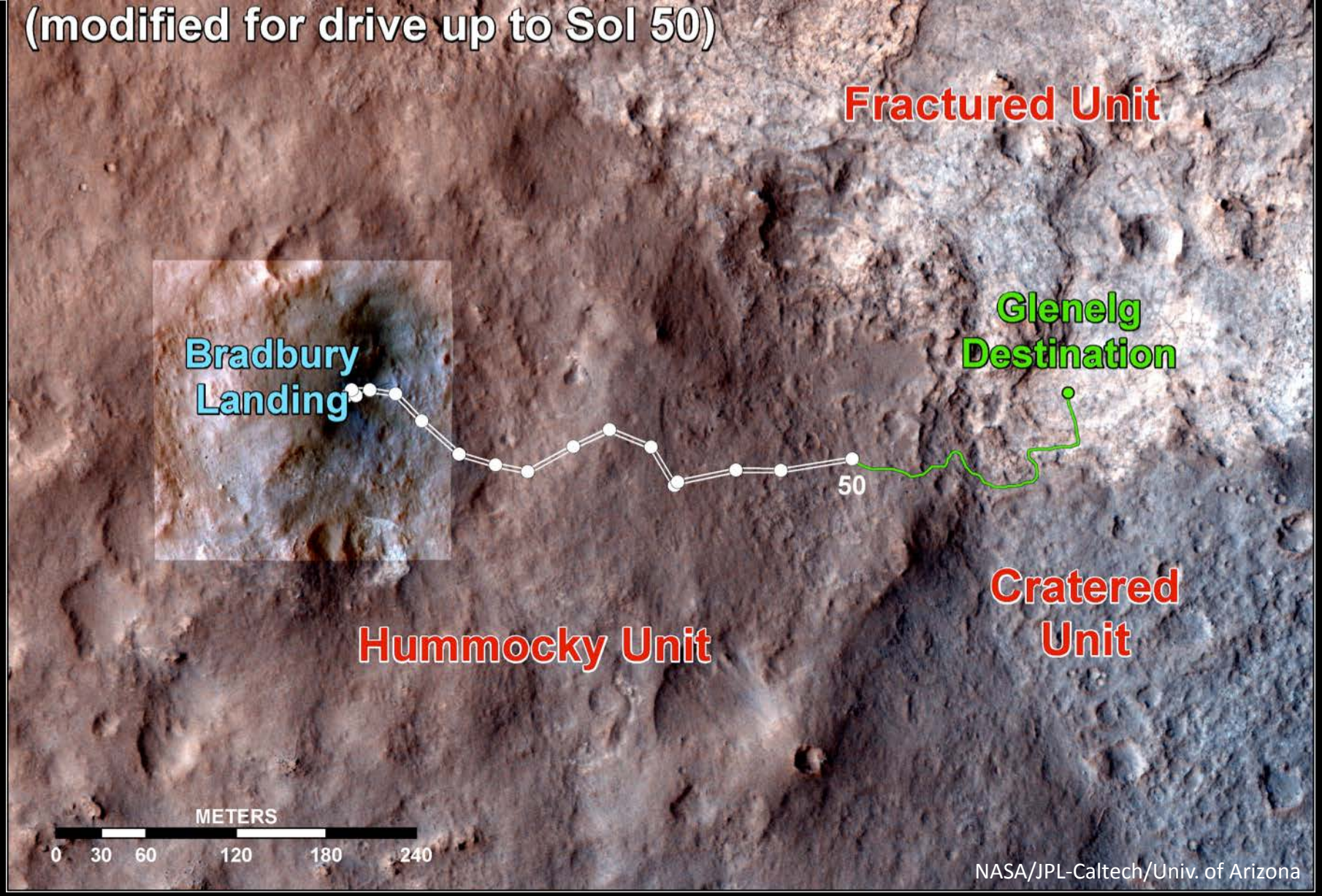


NASA/



NASA/JPL-Caltech/MSSS

Trek toward Glenelg and Discovery of Conglomerate



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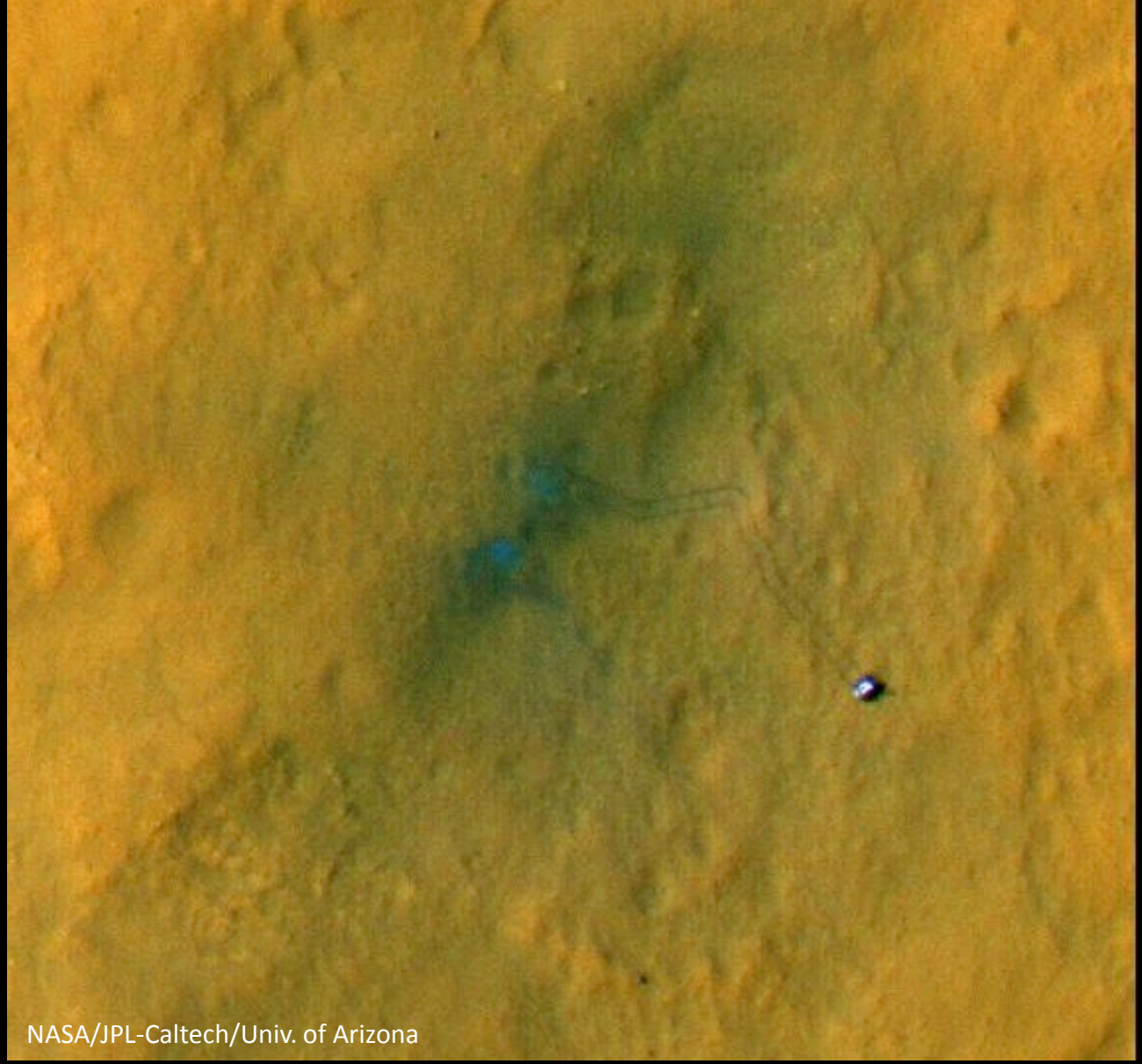
Curiosity progressed toward Glenelg, where three distinct terrain types meet



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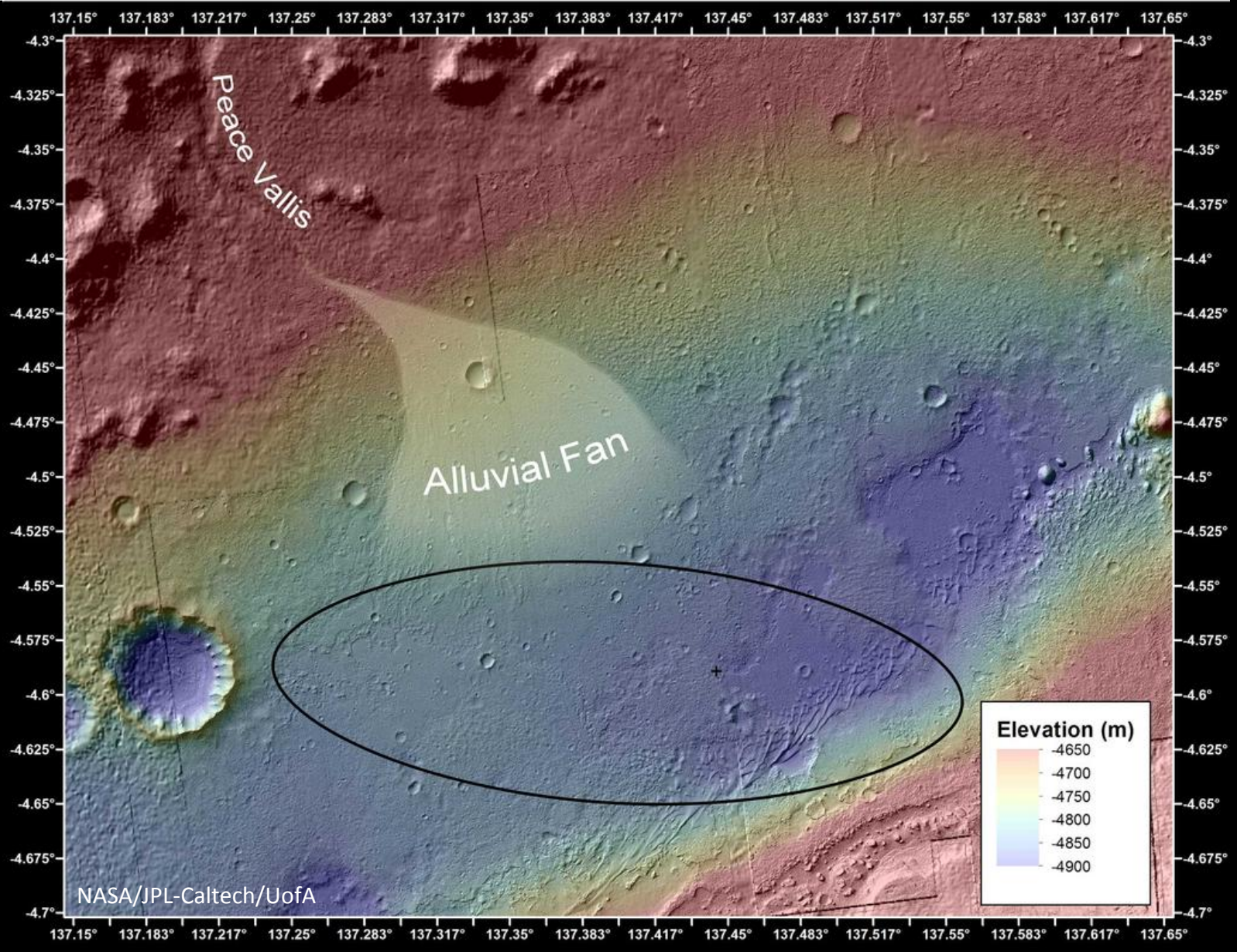
Curiosity and its tracks captured by HiRISE on the Mars Reconnaissance Orbiter

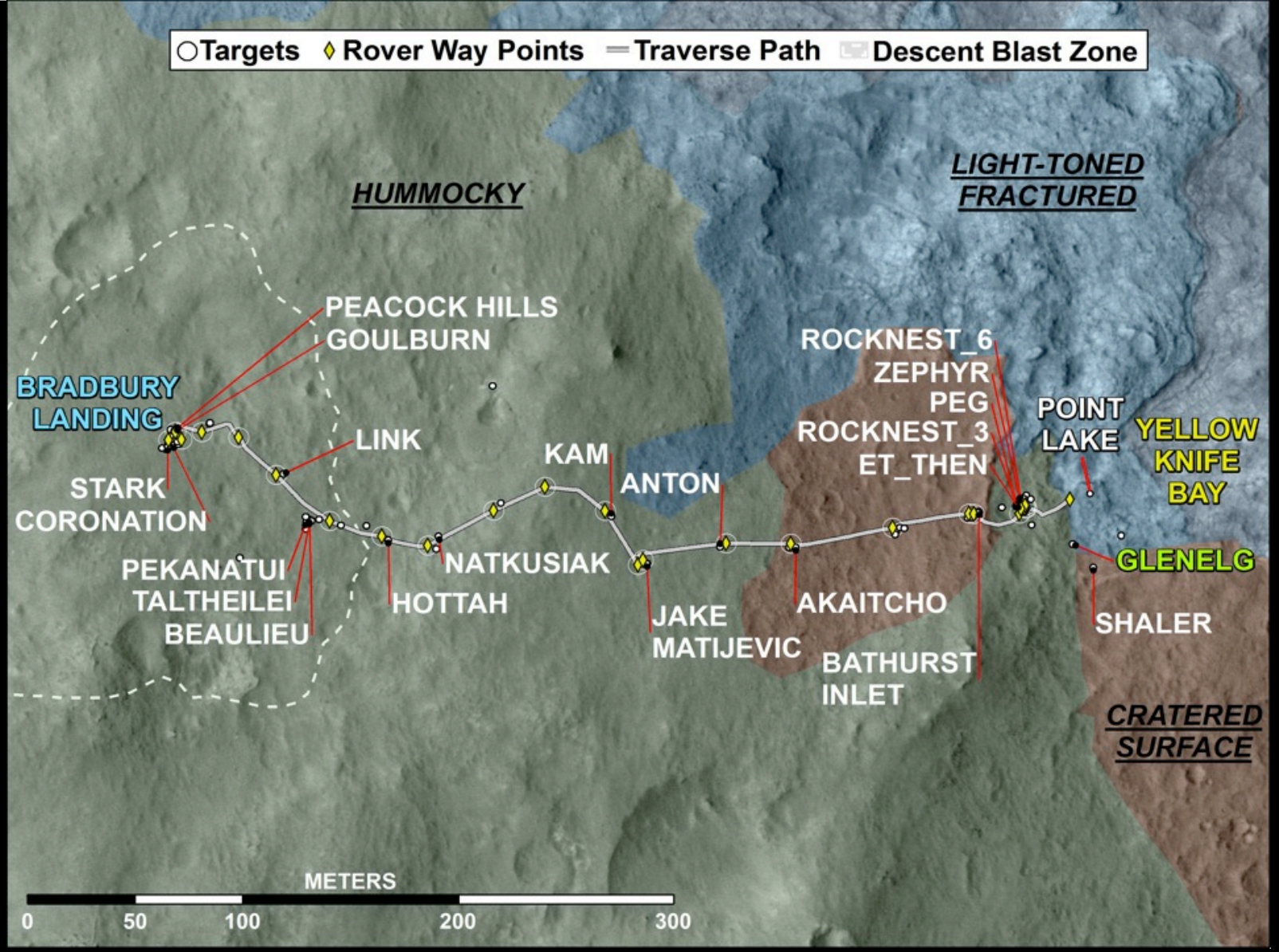
CURIOSITY

The conglomerate “Link” with associated loose, rounded pebbles



The conglomerate reveals an ancient streambed, likely originating at the northern crater rim

The Glenelg Region and Yellowknife Bay



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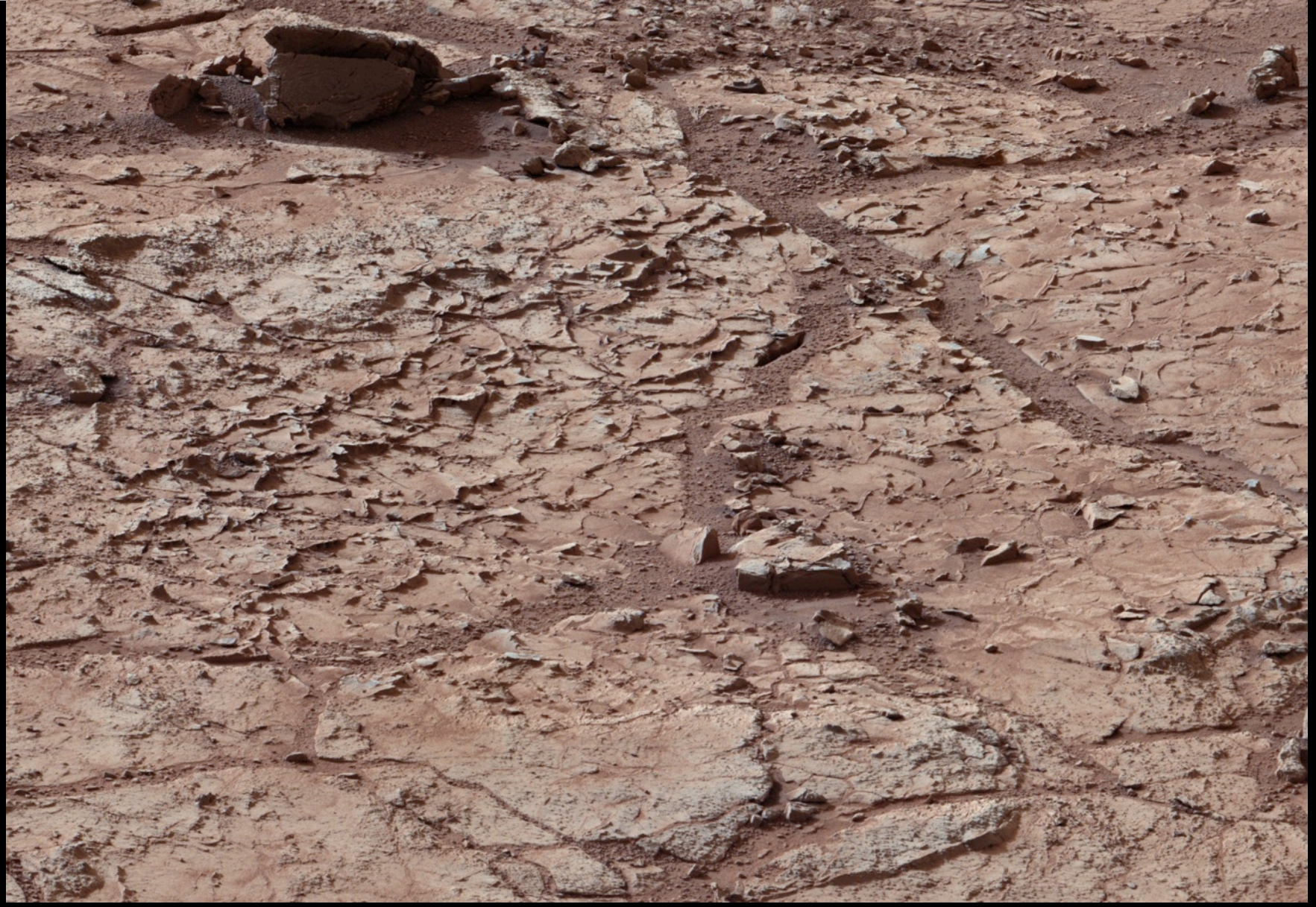
Curiosity explored Yellowknife Bay, a basin within the Glenelg region

NASA/JPL-Caltech/MSSS

CURIOSITY

Heading into Yellowknife Bay

Drill Campaign at John Klein, Yellowknife Bay



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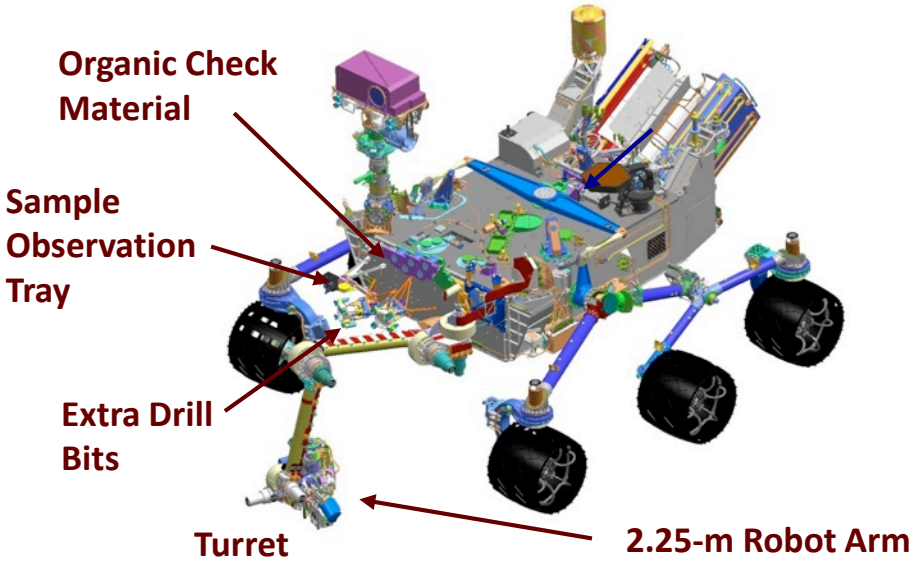
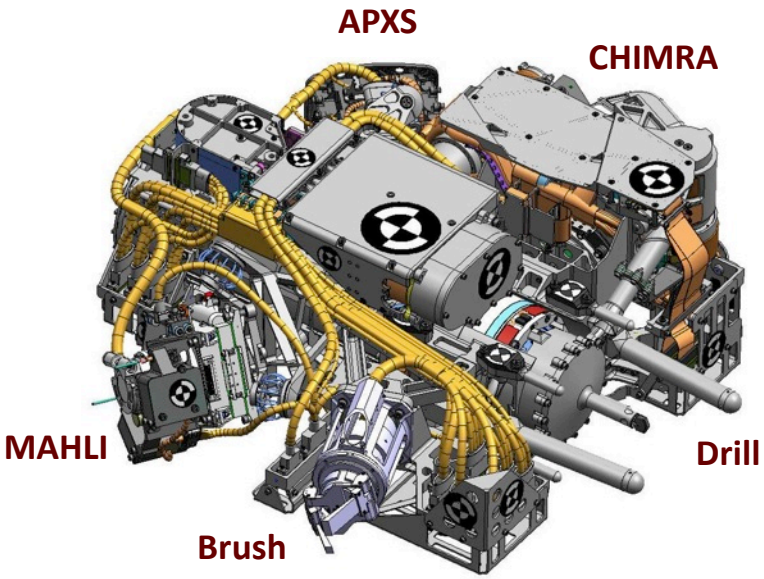
CURIOSITY

John Klein drill site showing fractured bedrock and ridge-forming veins

NASA/JPL-Caltech/D. Bouic

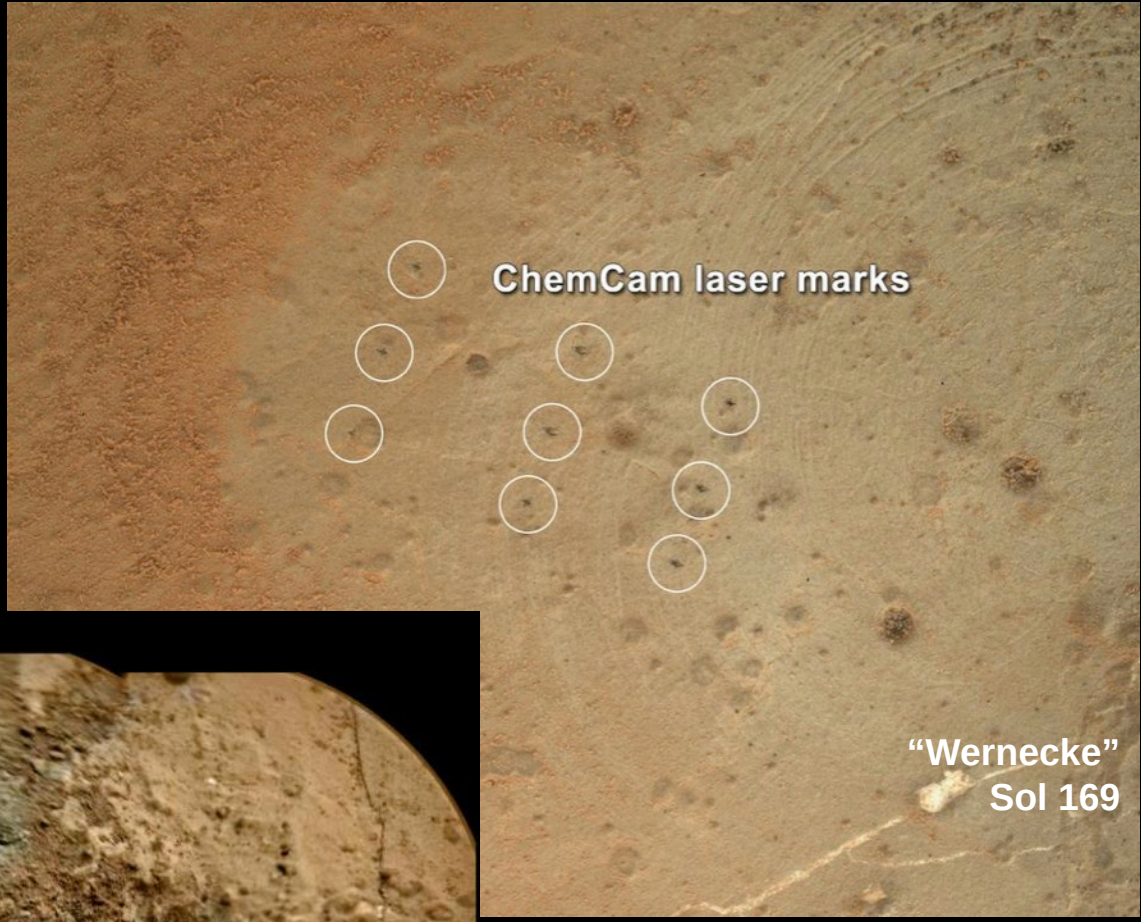
Arm deployed at John Klein





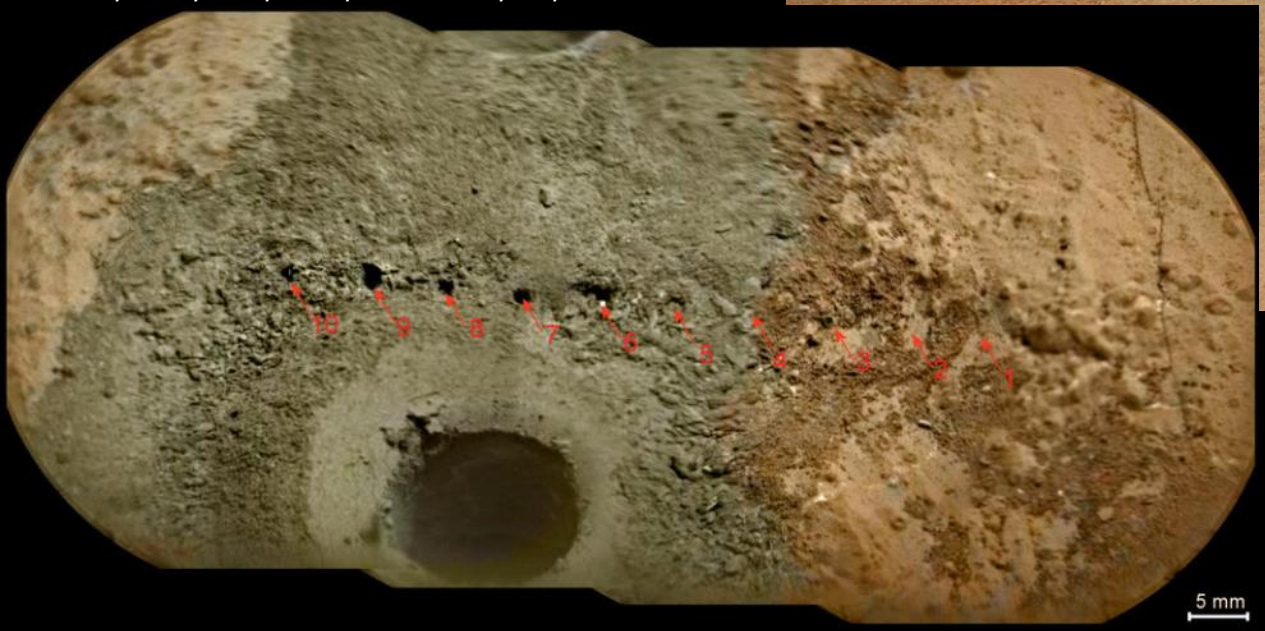
- Cleans rock surfaces with a brush
- Places and holds the APXS and MAHLI instruments
- Acquires samples of rock or soil with a powdering drill or scoop
- Sieves the samples (to 150 µm or 1 mm) and delivers them to instruments or an observation tray
- Exchanges spare drill bits

Curiosity's Sampling System

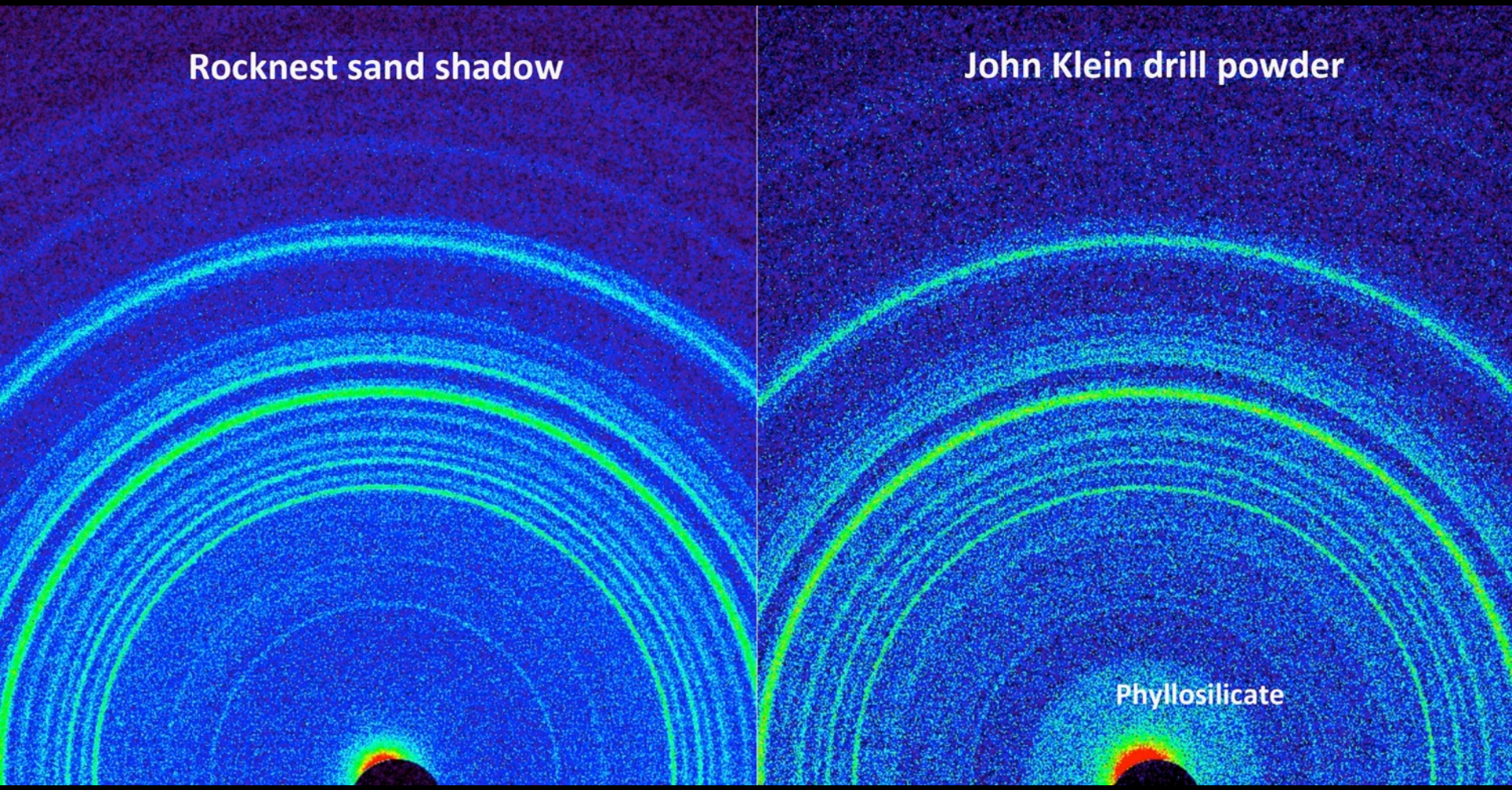


NASA/JPL-Caltech/MSSS/Honeybee Robotics/LANL/CNES

NASA/JPL-Caltech/LANL/IRAP/CNES/LPGNantes/IAS/



ChemCam laser shots of brushed rock and drill tailings pile



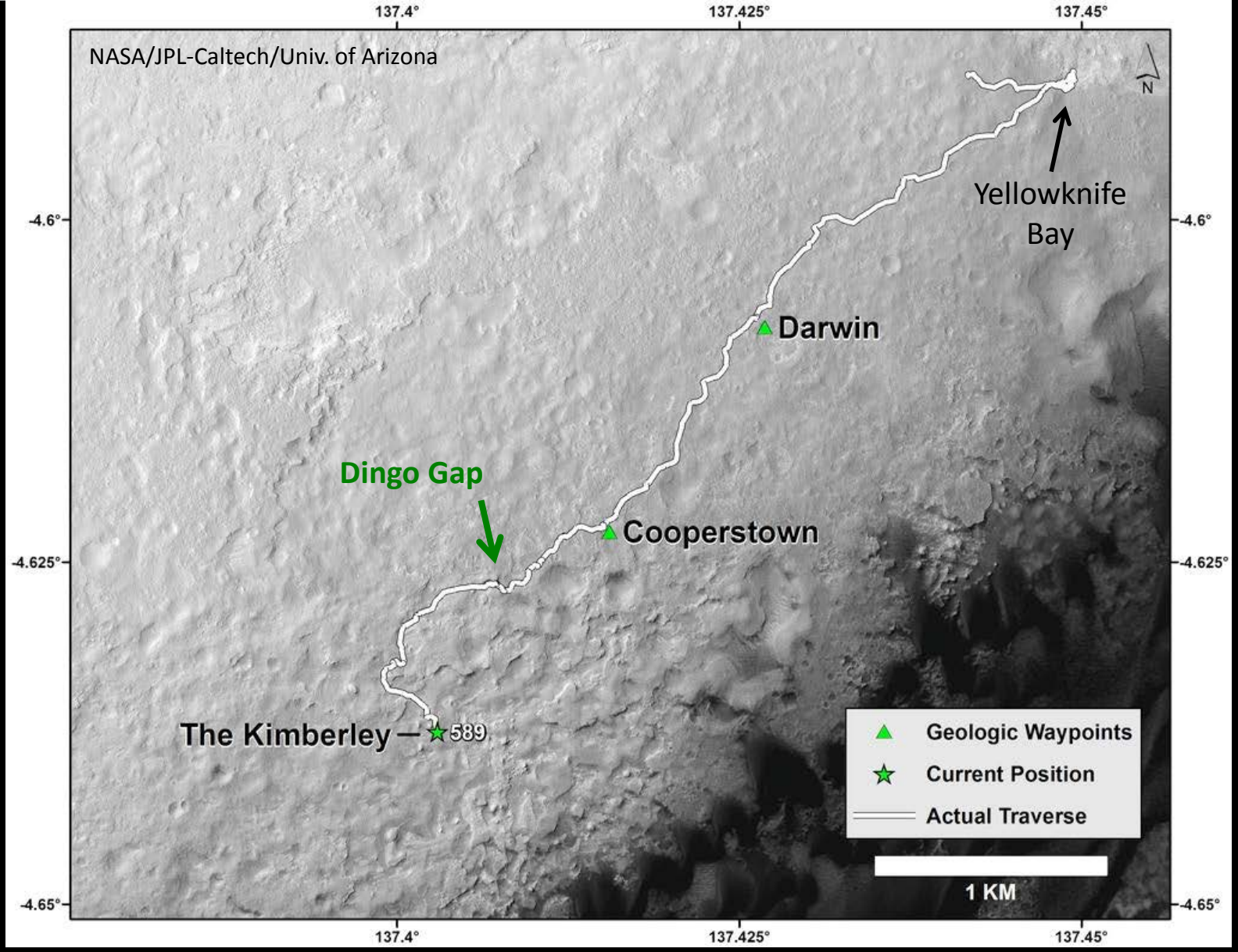
NASA/JPL-Caltech/Ames

The drill powder contains abundant phyllosilicates (clay minerals), indicating sustained interaction with water

CURIOSITY

X-ray diffraction patterns from Rocknest (left) and John Klein (right)

Yellowknife Bay to the Kimberley

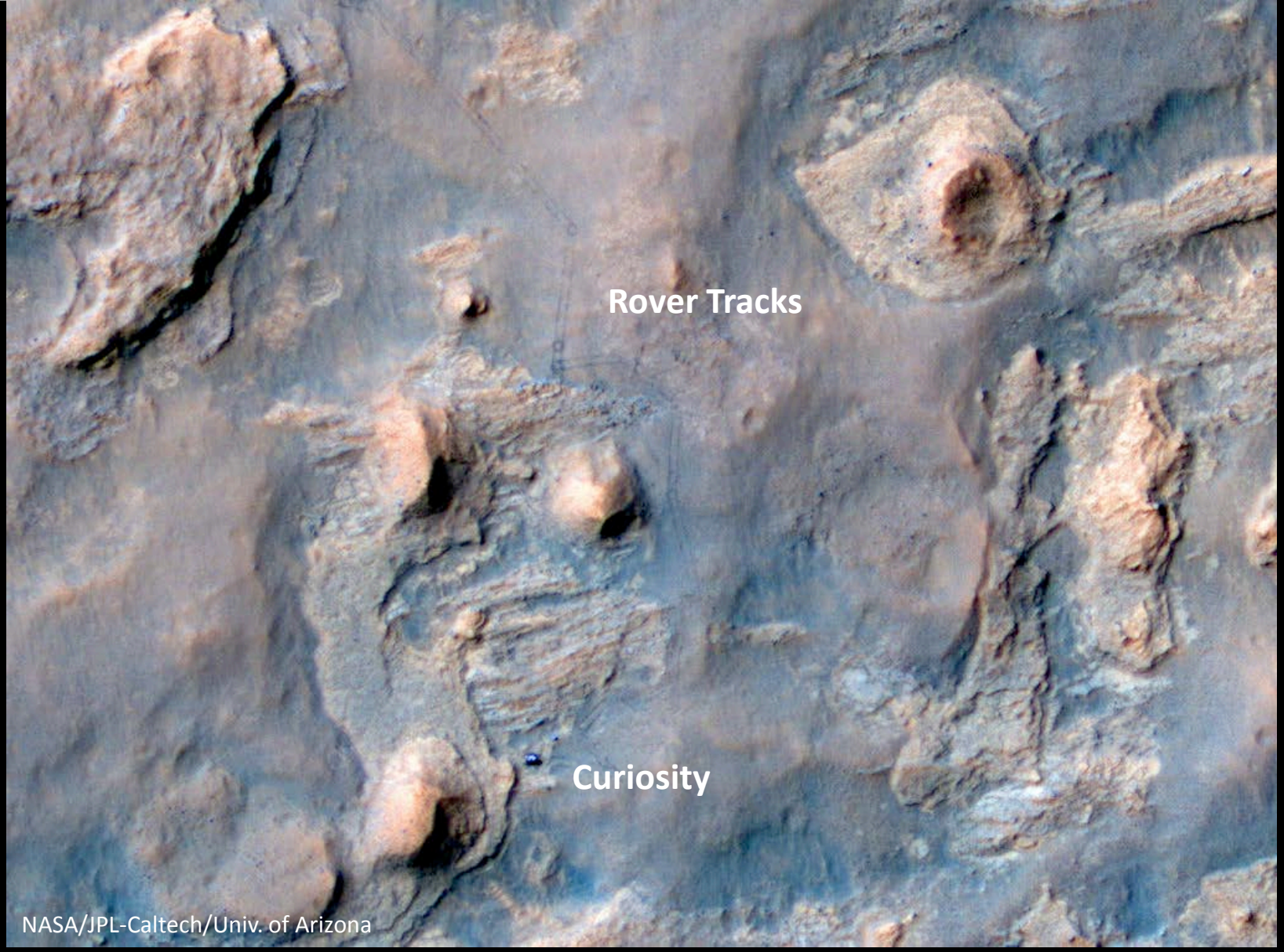


CURIOSITY

Curiosity's traverse to the Kimberley, via waypoints Darwin and Cooperstown

CURIOSITY

Crossing Dingo Gap dune form



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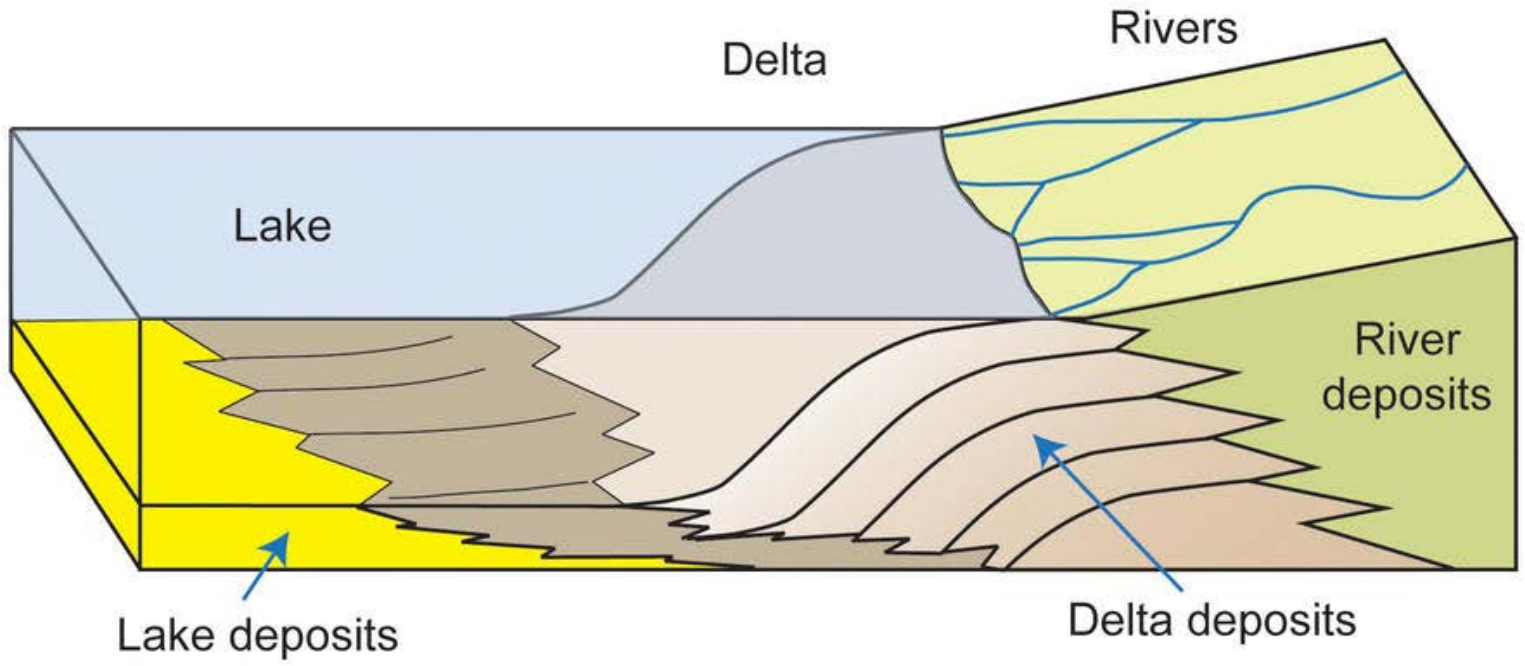
Curiosity at the Kimberley, where four rock types typical of Gale's plains come together

NASA/JPL-Caltech/MSSS

The Kimberley is a wonderland of bedded, sedimentary rock, likely deposited by water in a delta originating from the crater rim

CURIOSITY

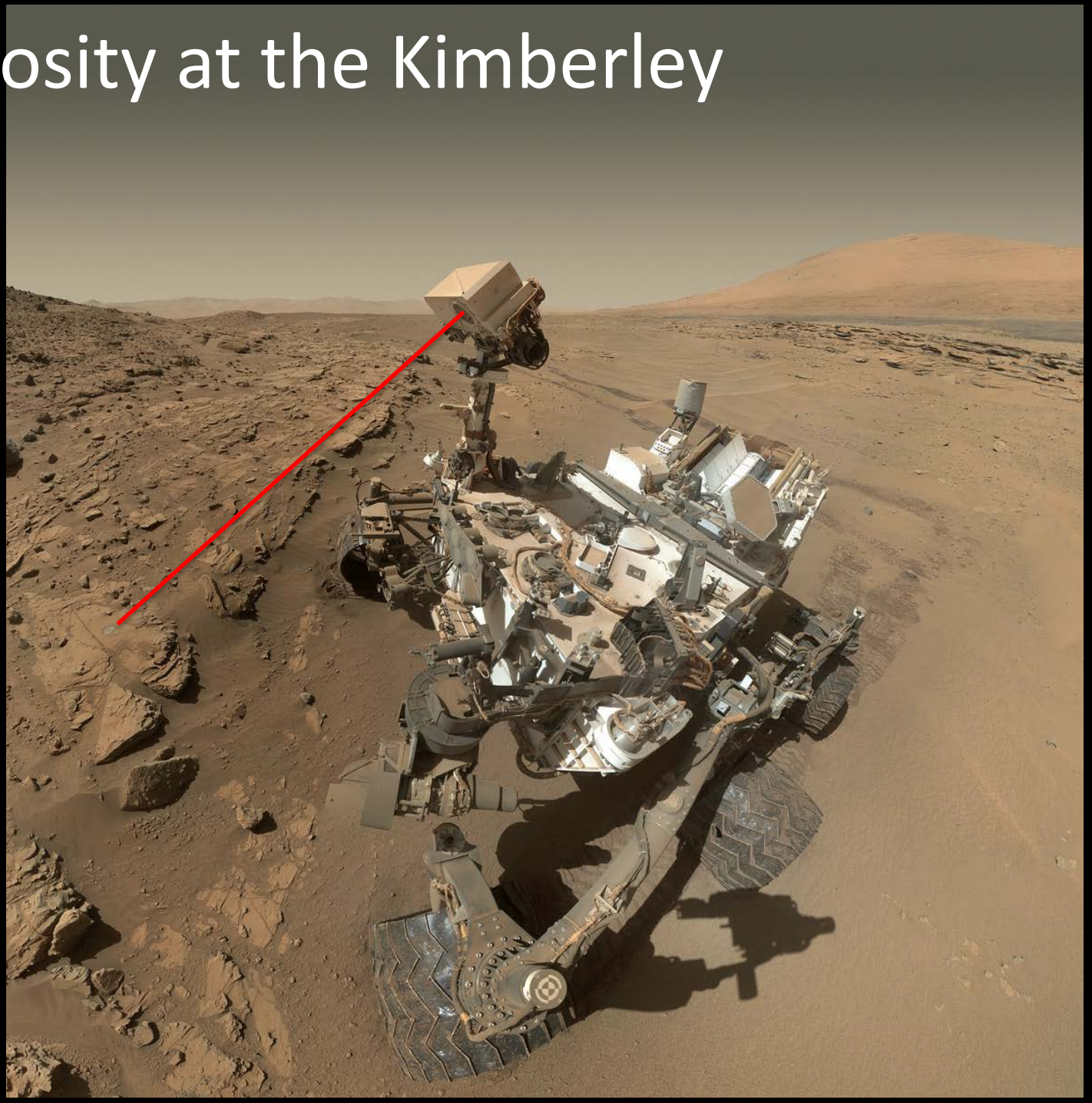
Delta formation

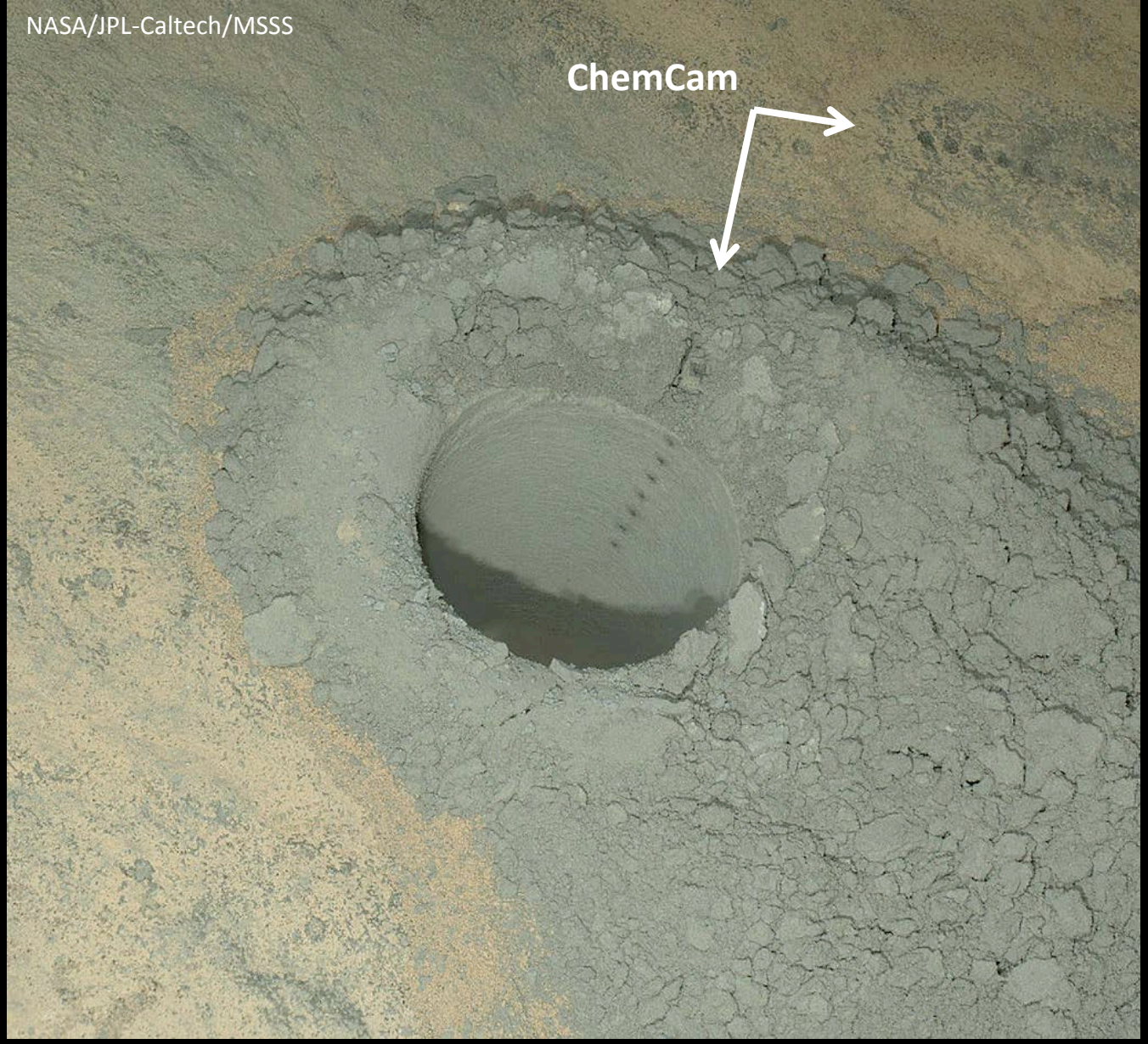


Clinoforms

Curiosity at the Kimberley

Curiosity at the Kimberley





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Nighttime image of Windjana drill hole illuminated by MAHLI LEDs and showing ChemCam spots

An Ancient Habitable Environment at Yellowknife Bay

- The regional geology and fine-grained rock suggest that the John Klein site was at the end of an ancient river system or within an intermittently wet lake bed
- The mineralogy indicates sustained interaction with liquid water that was not too acidic or alkaline, and low salinity. Further, conditions were not strongly oxidizing
- Key chemical ingredients for life are present, such as carbon, hydrogen, nitrogen, oxygen, phosphorus, and sulfur
- The presence of minerals in various states of oxidation would provide a source of energy for primitive organisms

Mount Sharp,
First results from the base of our prime destination

NASA/JPL-Caltech/Univ. of Arizona

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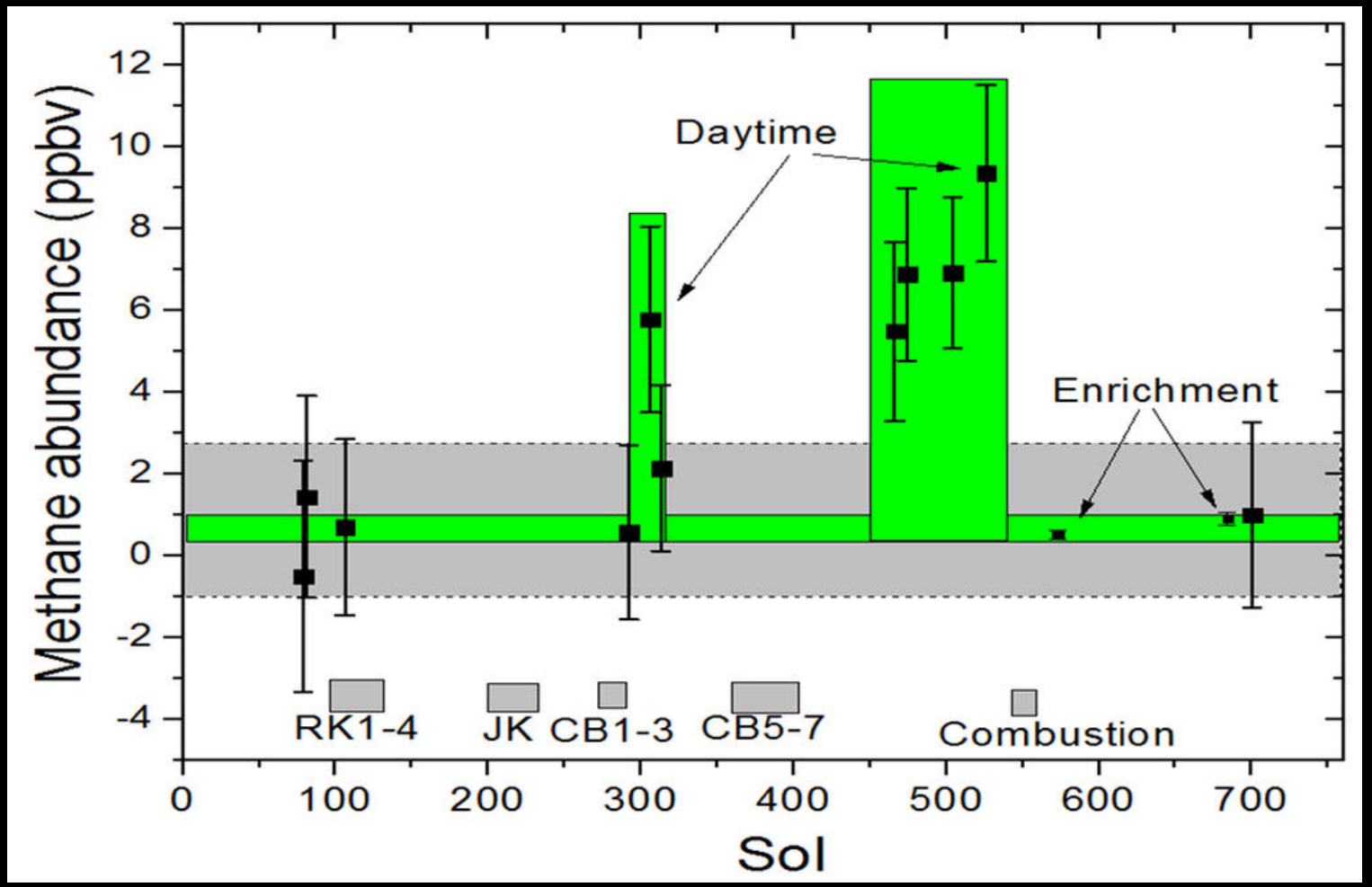
Curiosity's ultimate goal is to explore the lower reaches of the 5-km high Mount Sharp

Curiosity in the Pahrump Hills in the Murray formation

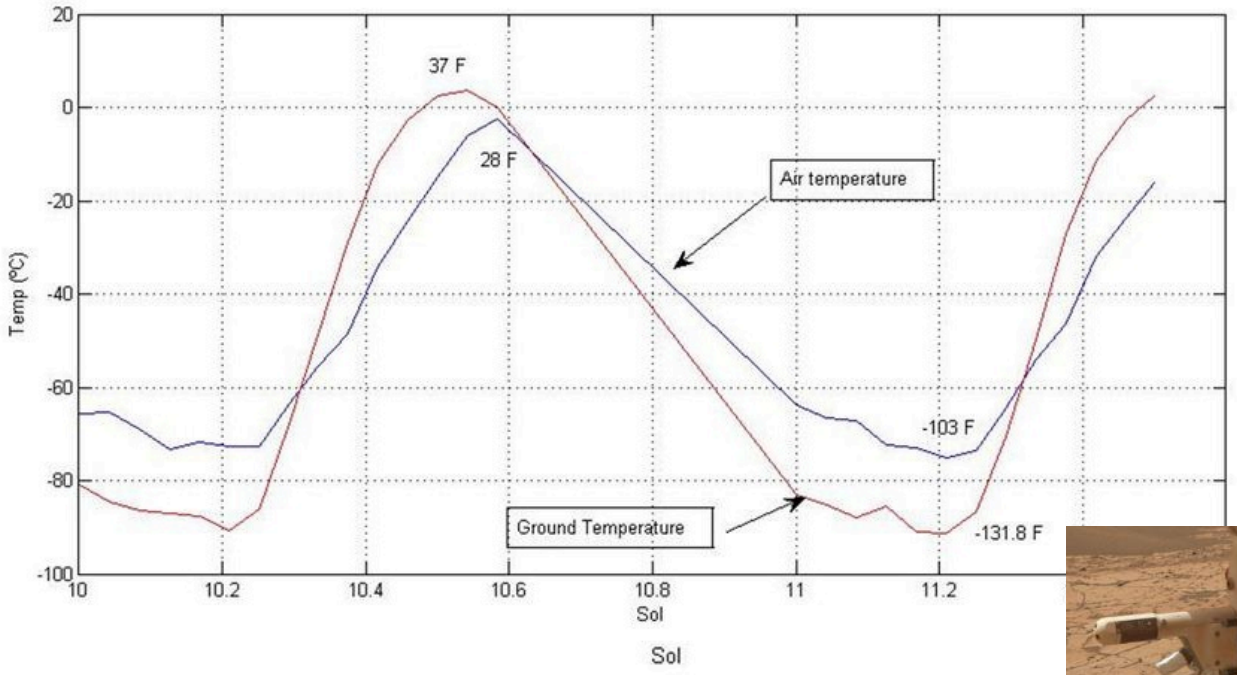
Measurements of Mars' Atmosphere and Environment

Methane detection



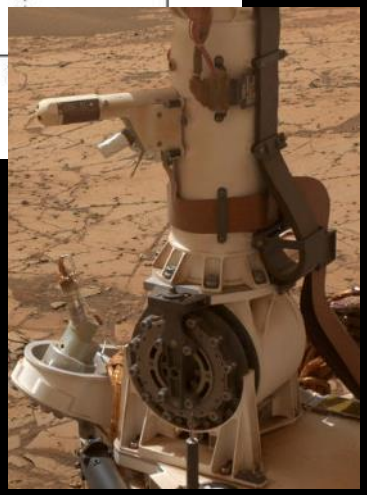
The source of the methane is unknown and could be abiotic or biotic. The short duration of the signal could be due to passage of the rover over a source (fault?) or a local episodic release.

GROUND AND AIR TEMPERATURE SENSOR



REMS' ground and air temperature sensors are located on small booms on the rover's mast

The ground temperature changes by 90°C (170 degrees Fahrenheit) between day and night



The air is warmer than the ground at night, and cooler during the morning, before it is heated by the ground

NASA/JPL-Caltech/CAB(CSIC-INTA)

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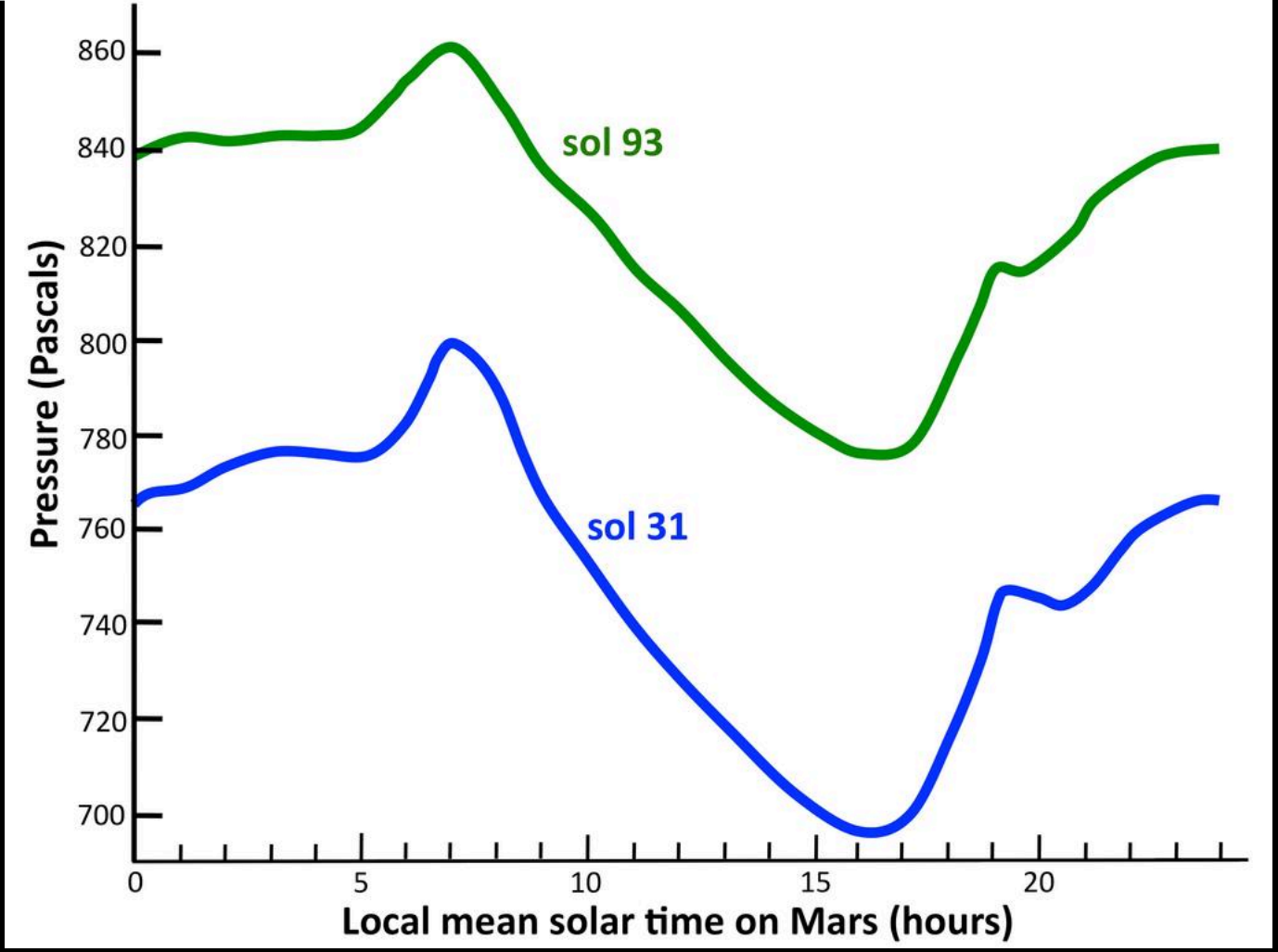
Curiosity's Rover Environmental Monitoring Station is taking weather readings 24 × 7



NASA/JPL-Caltech/CAB(CSIC-INTA)/FMI/Ashima Research

Each day the pressure varies by over 10%, similar to the change in pressure between Los Angeles and Denver

Solar heating of the ground drives a pressure "tidal wave" that sweeps across the planet each day

Overall, the pressure is increasing as carbon dioxide sublimates from the southern seasonal polar cap

Earth's atmosphere = 101,325 Pascals, or about 140 times the pressure at Gale Crater

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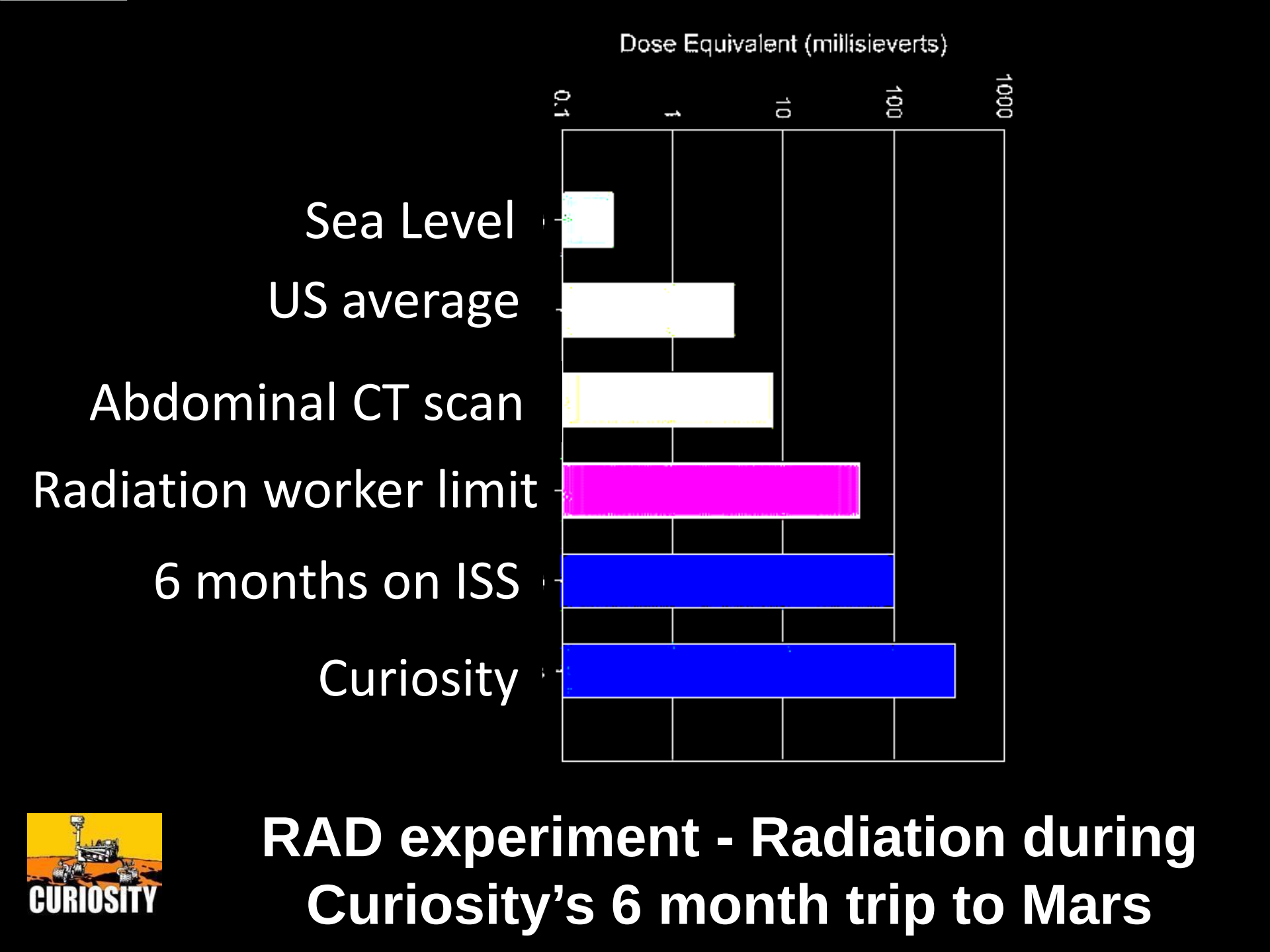
REMS pressure measurements detect local, regional, and global weather phenomena



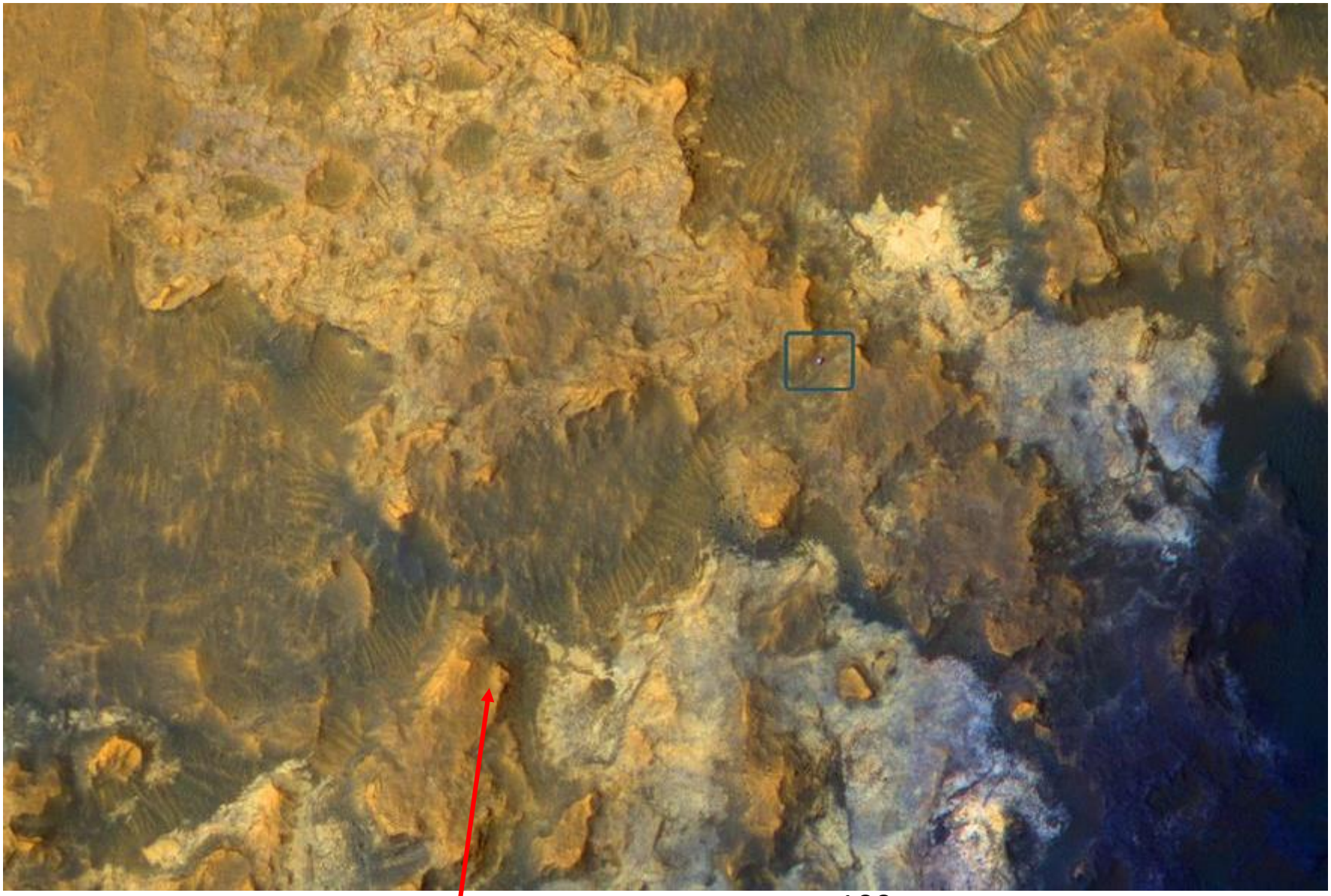
CURIOSITY

RAD experiment - Radiation during Curiosity's 6 month trip to Mars

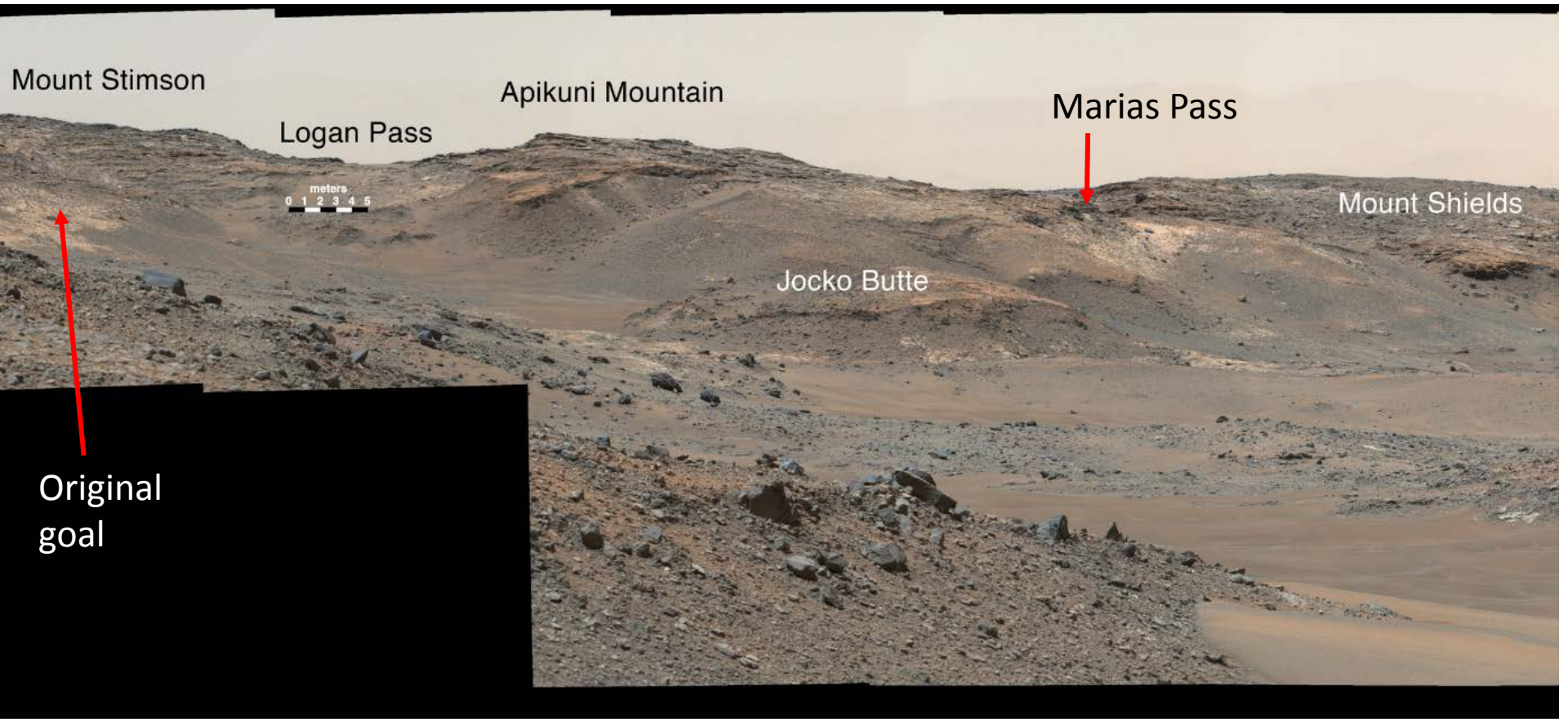
May – July 2015

- Video report
- Artist's Drive to Logan's pass
- Logan's run
- Conjunction
- Detour to Marias pass
- Contact studies - Misoulla area
- Drilling at Lion area – This weekend!

Rover in Artist's drive

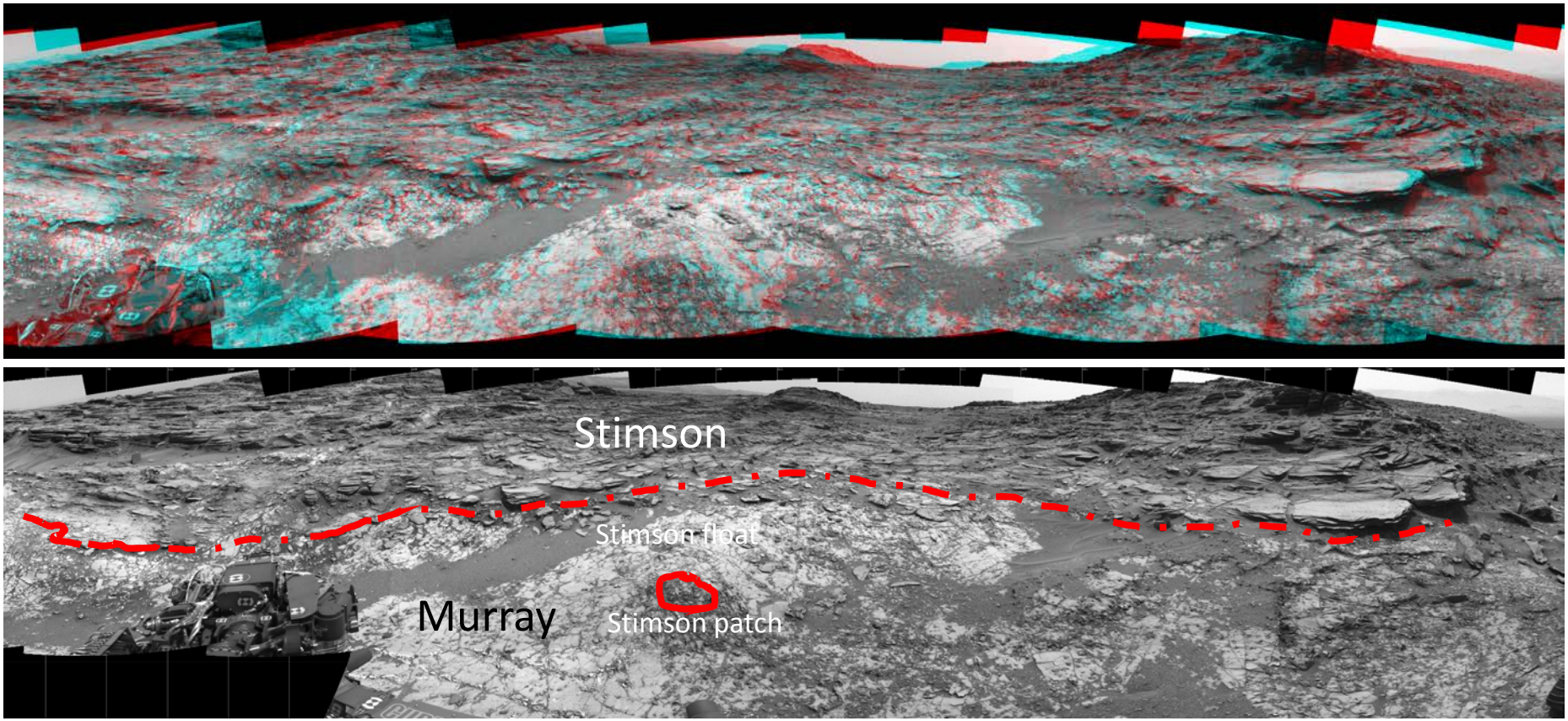


Logan Pass and detour to Marias Pass

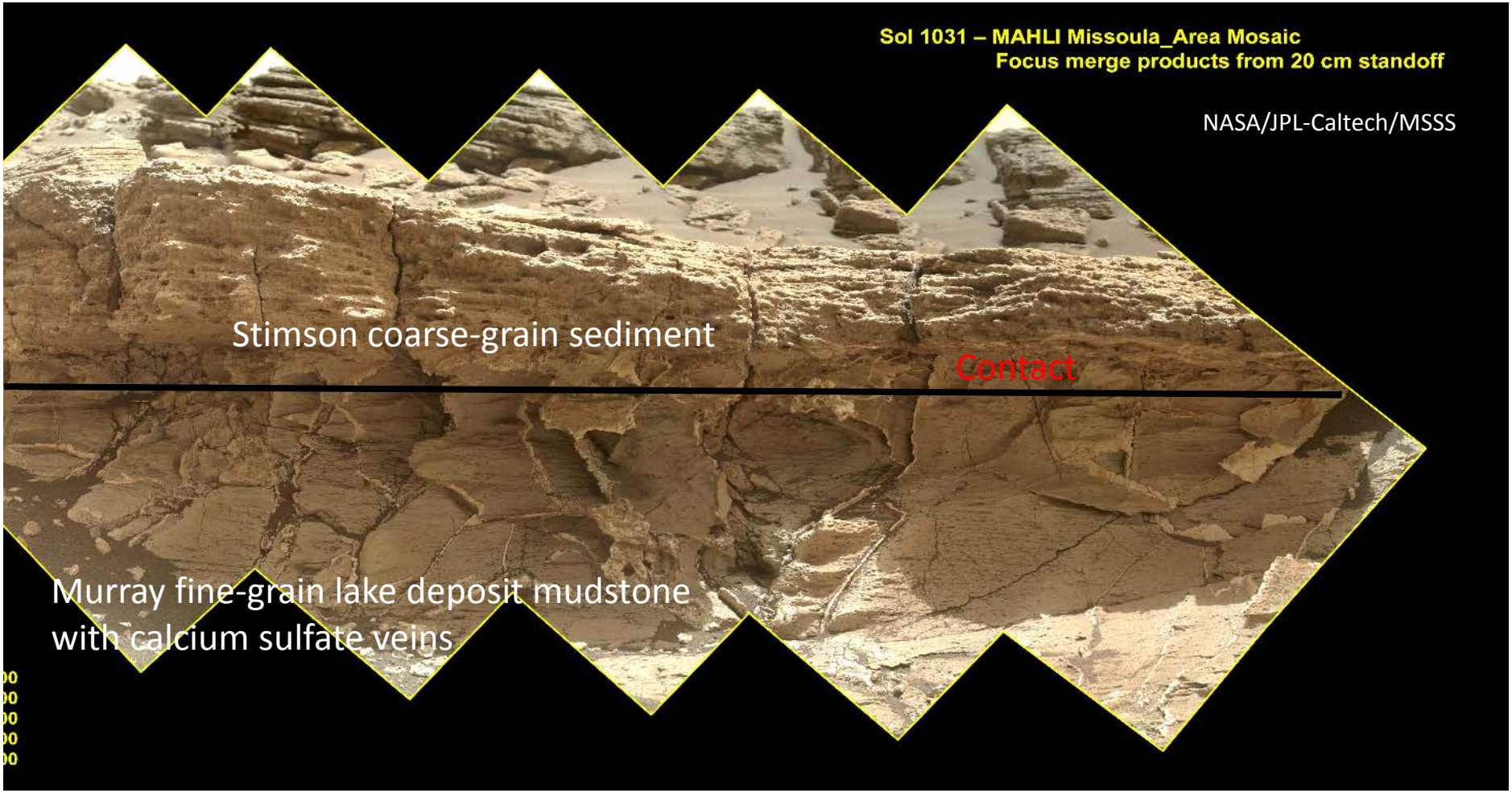


Logans pass and Mount Sharp

Murray – Stimson contact area – Sol 955

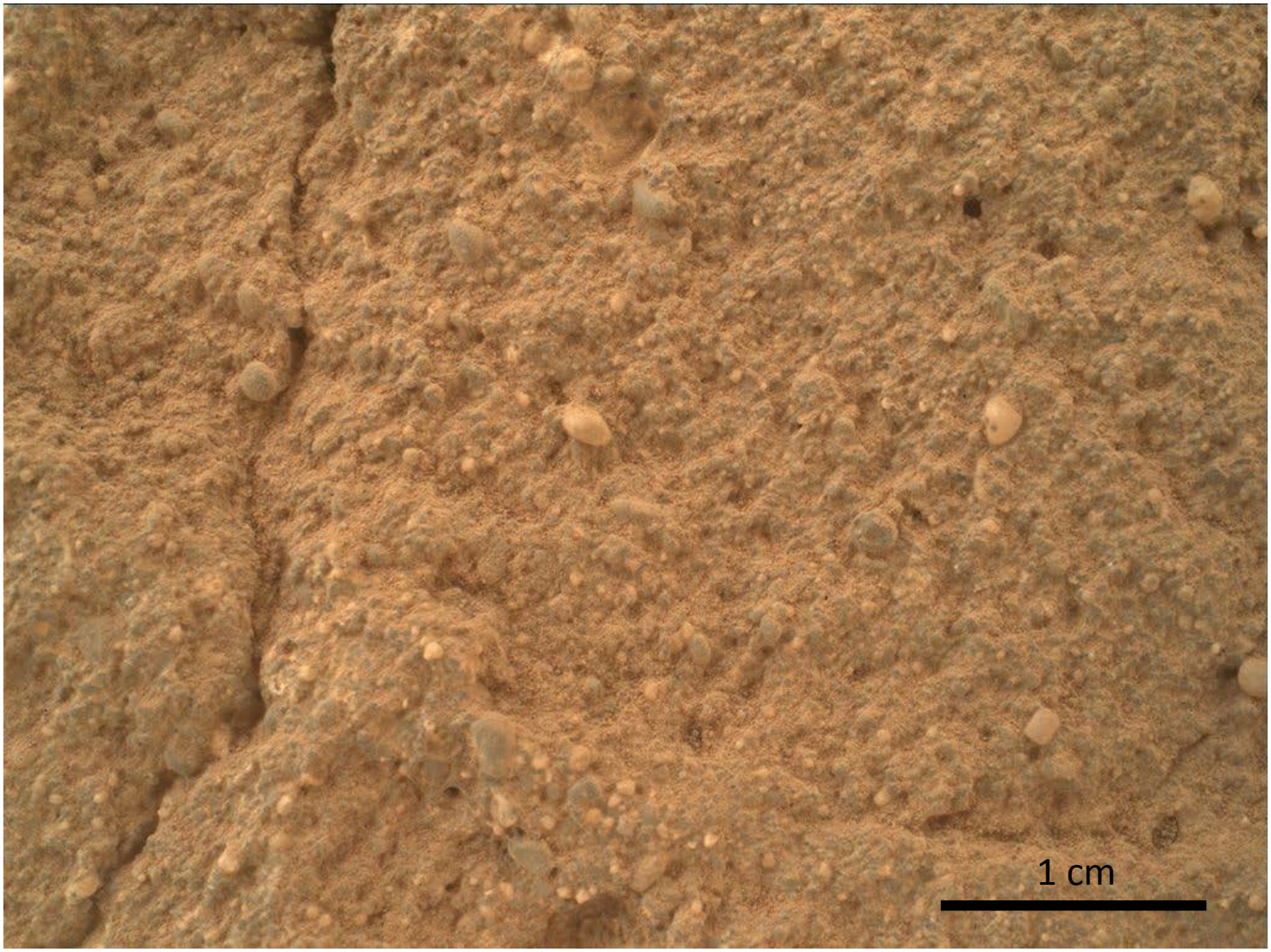


Contact - view from MAHLI to right of Missoula



NASA/JPL-Caltech/MS

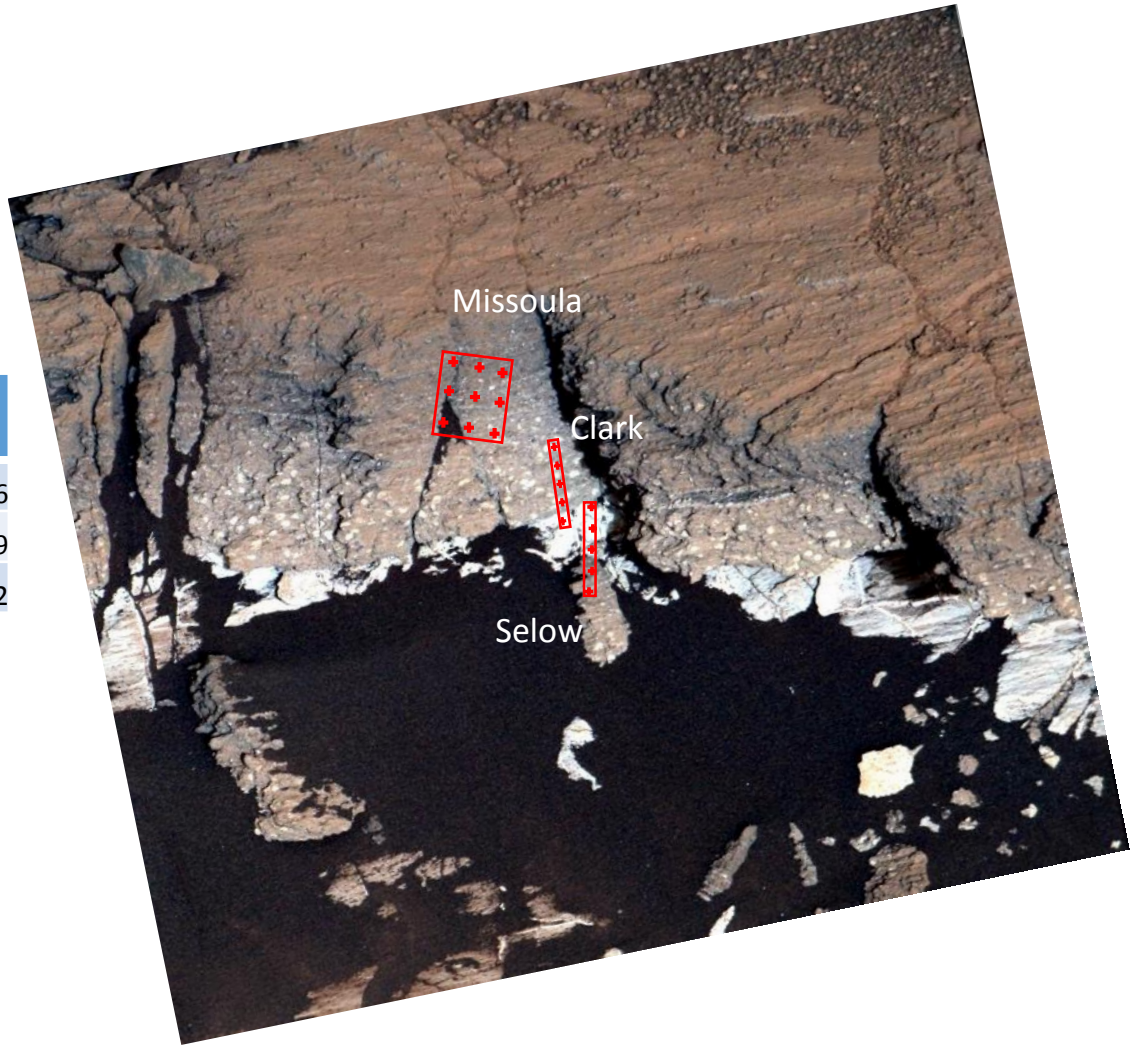
Sedimentary Rock – Big Arm

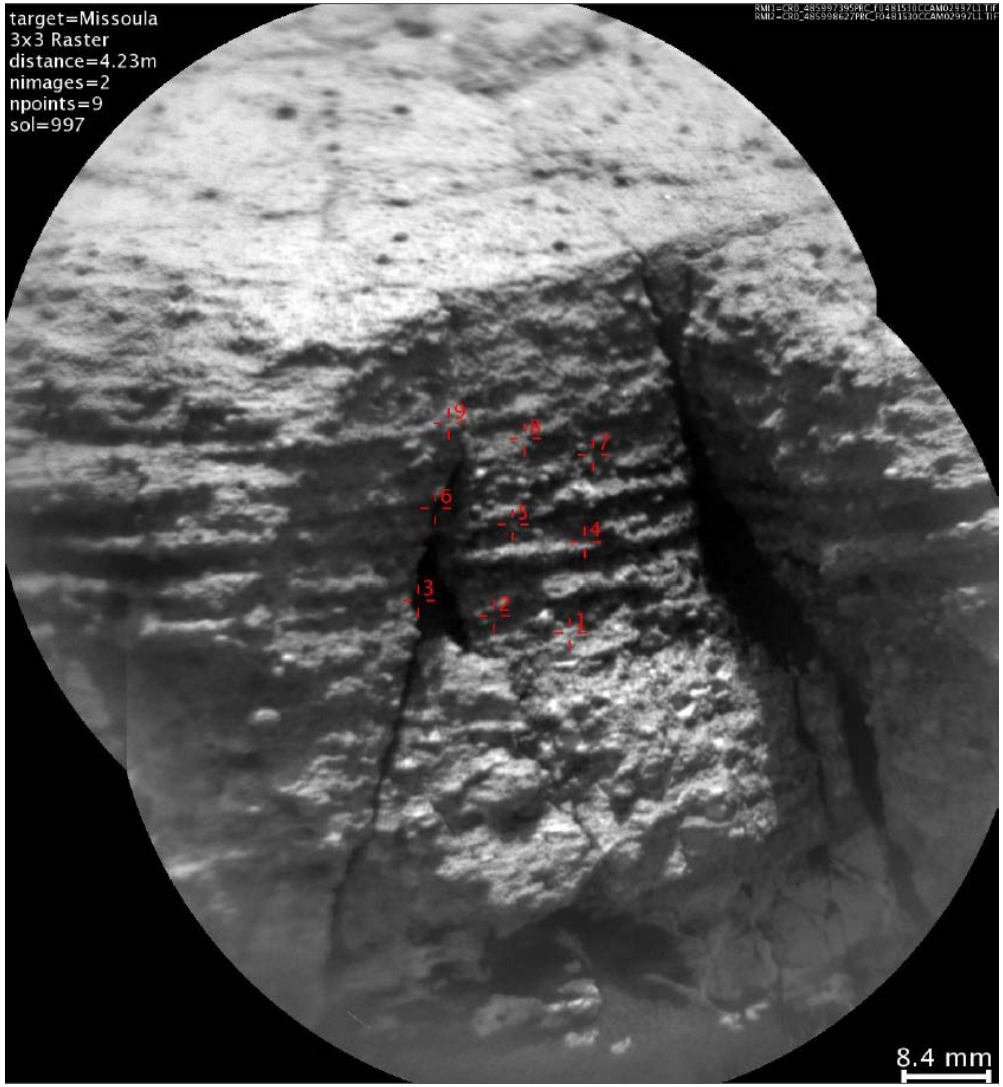


NASA/JPL-Caltech

Characterization of the contact

SOL	Target	A/B contact	Mean distance to contact (cm)
997	Missoula	Above	3.6
1031	Clark	Above	0.9
1031	Selow	Below	-1.2



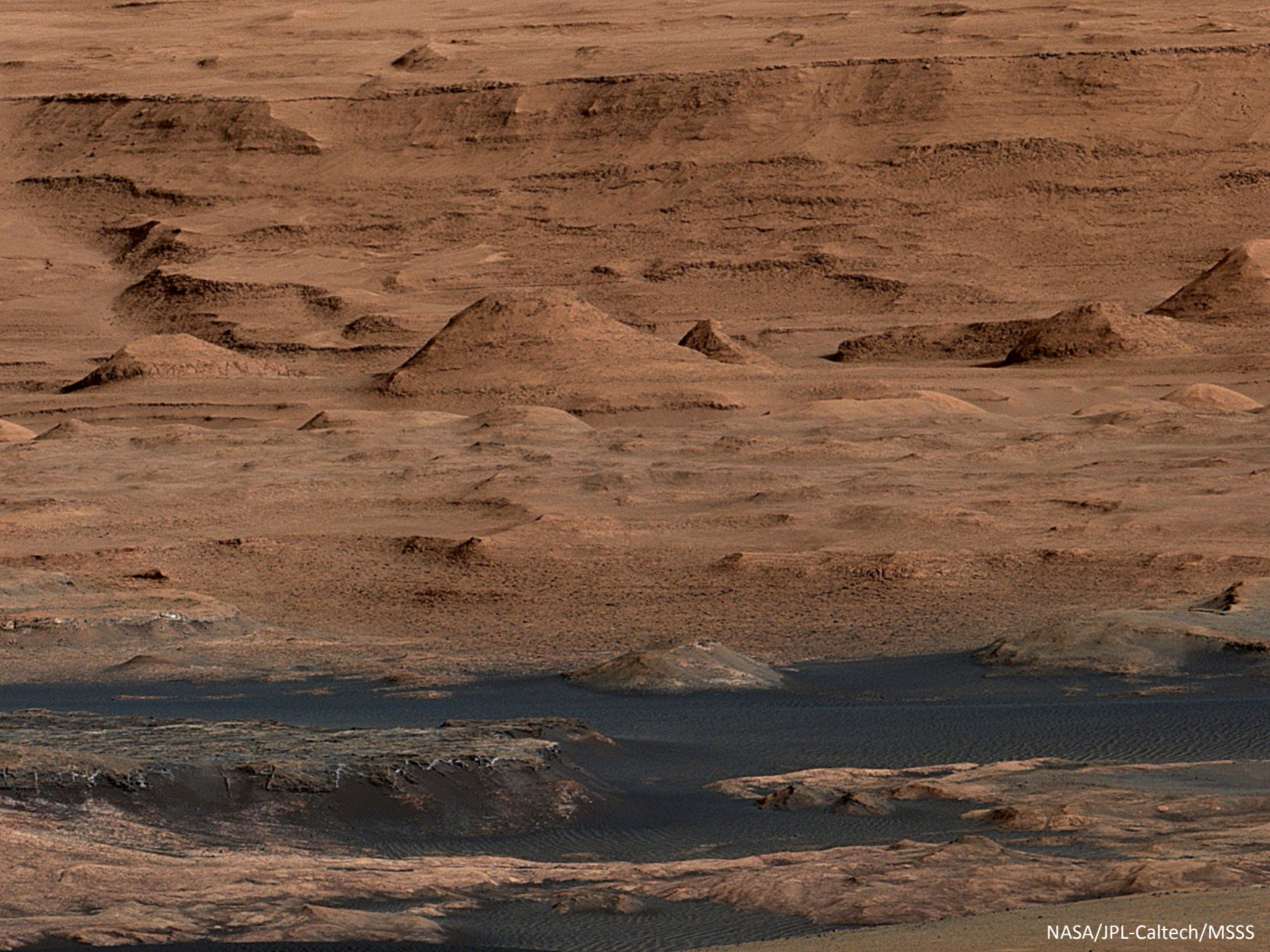

target=Missoula
3x3 Raster
distance=4.23m
nimages=2
npoints=9
sol=997
9
8
7
6
5
4
3
2
1
8.4 mm

NASA/JPL-Caltech

Lamoose – Si Rich rock

- High levels of silica could indicate ideal conditions for preserving ancient organic material, if present, so the science team wants to take a closer look.

  The rock is about 4 inches (10 centimeters) across. It is fine-grained, perhaps finely layered, and etched by the wind. The image was taken on the 1,041st Martian day, or sol, of the mission (July 11, 2015).


NASA/JPL-Caltech/MSSS

Sunset over Gale crater Rim