National Aeronautics and Space Administration

Mars Science Laboratory

MEPAG

October 4, 2012

Michael Meyer
Lead Scientist
Mars Exploration Program

Reasons To Explore Mars

- Many of the key questions in ***solar system science*** can be addressed effectively at Mars:
  - Solar system history
  - Planetary evolution
  - Potential for life
- Mars provides the opportunity to approach, and possibly answer, origin and evolution of life questions
  - Clear potential for past and possibly present biological activity
- Mars has a well-preserved record of its climate and geologic evolution exposed at the surface
  - A comparable record of ancient planetary processes, including those possibly leading to the origin of life, exists on no other terrestrial planet, including Earth
- Mars is the most accessible place in the solar system where these highest-priority science questions can be addressed

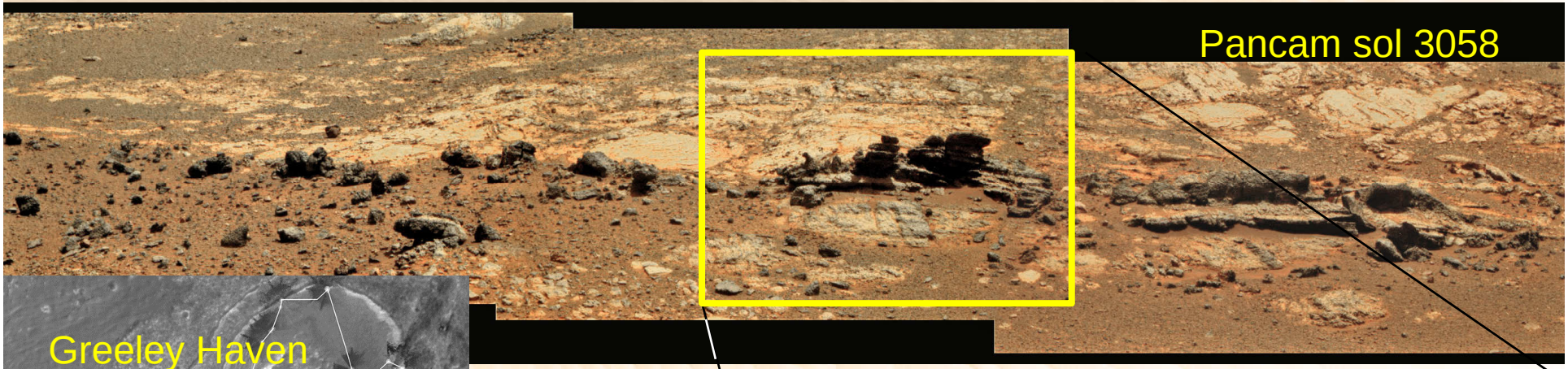
A well-executed program has brought us to where the next major step in exploration can be taken

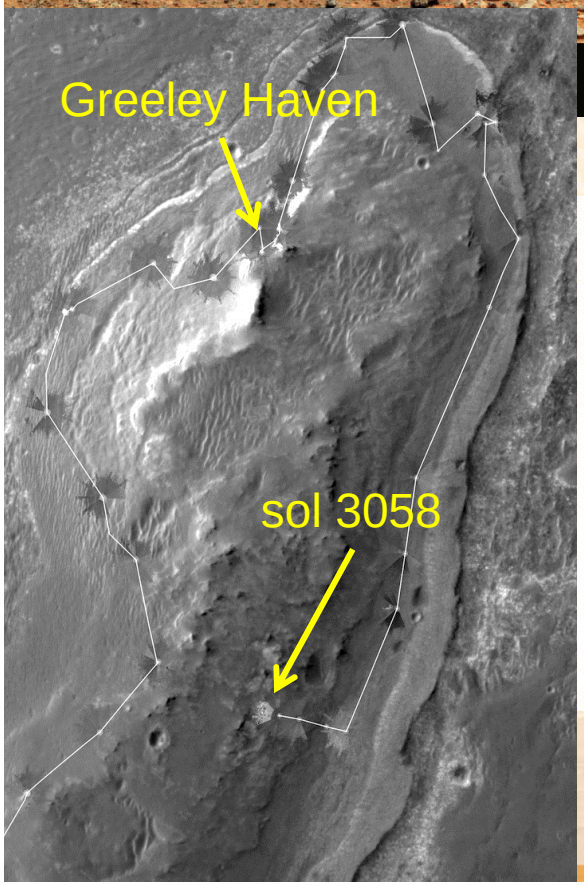
Mars Exploration Program

An Integrated, Strategic Program

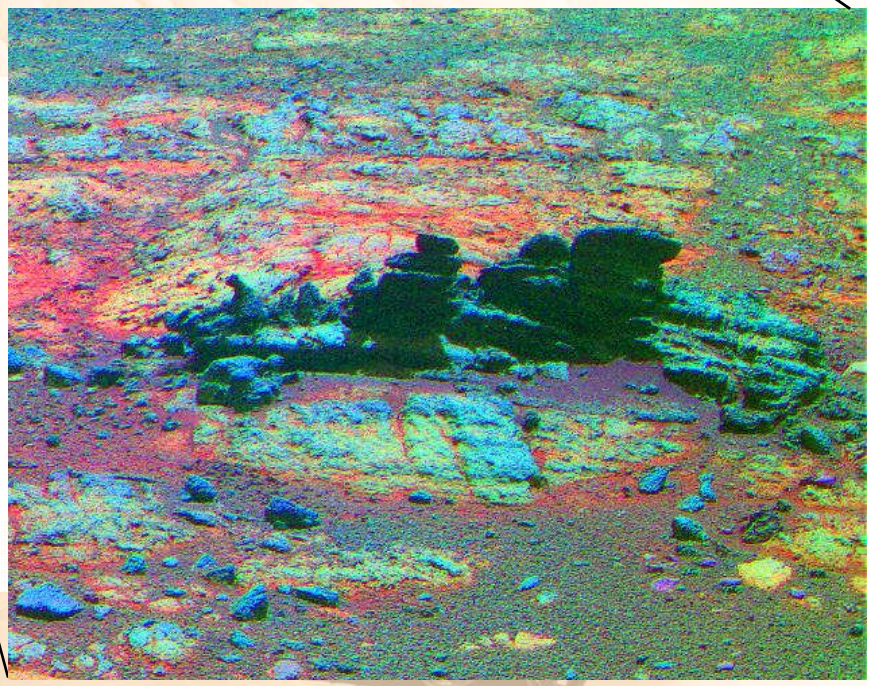
2001	2003	2005	2007	2009	2011	2013	2016 & Beyond
Odyssey	Mars Express Collaboration Spirit & Opportunity	MRO	Phoenix (completed)		MSL/Curiosity	MAVEN	*Mars future planning underway!*

Searching for Phyllosilicates on Cape York

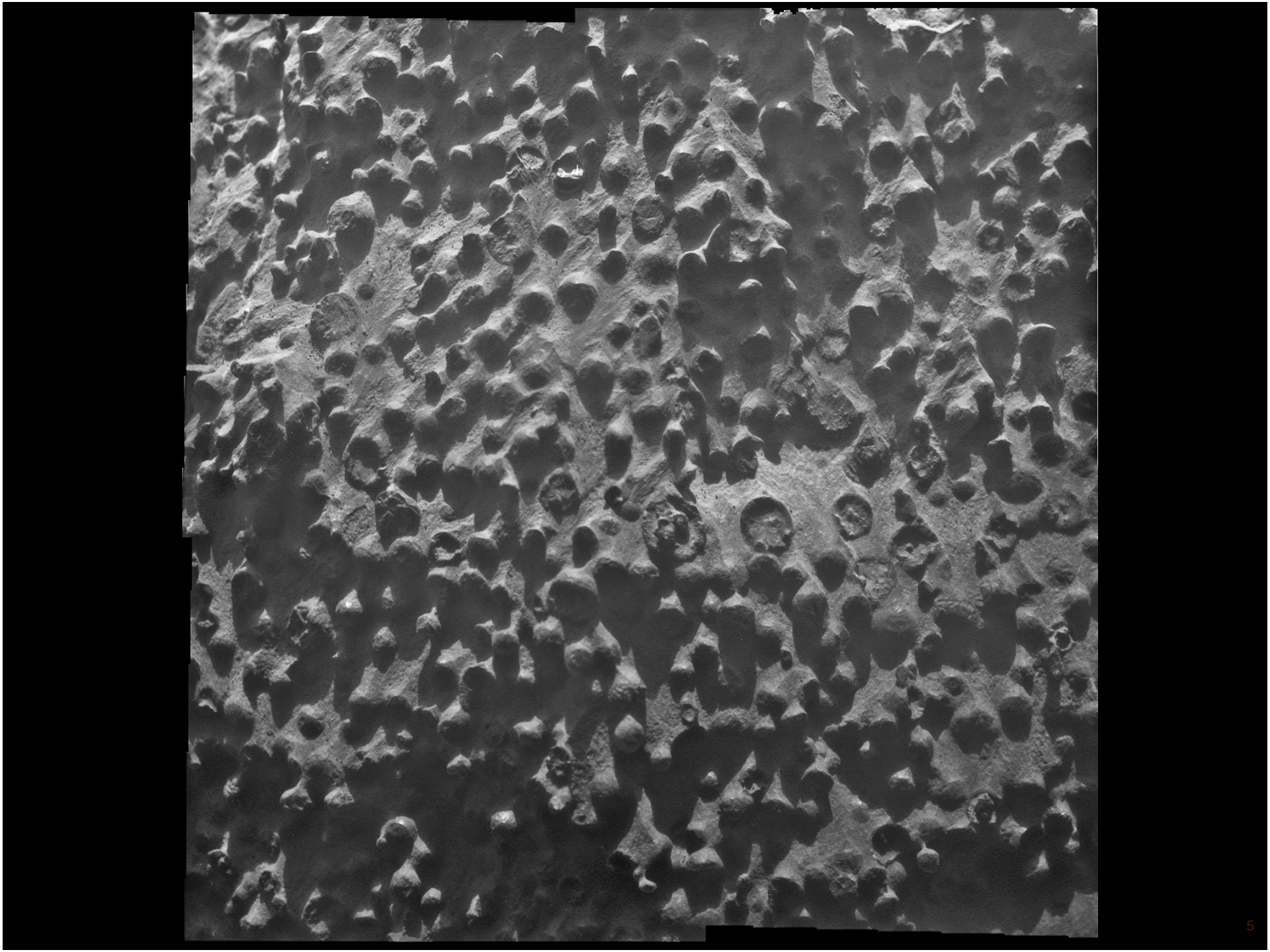




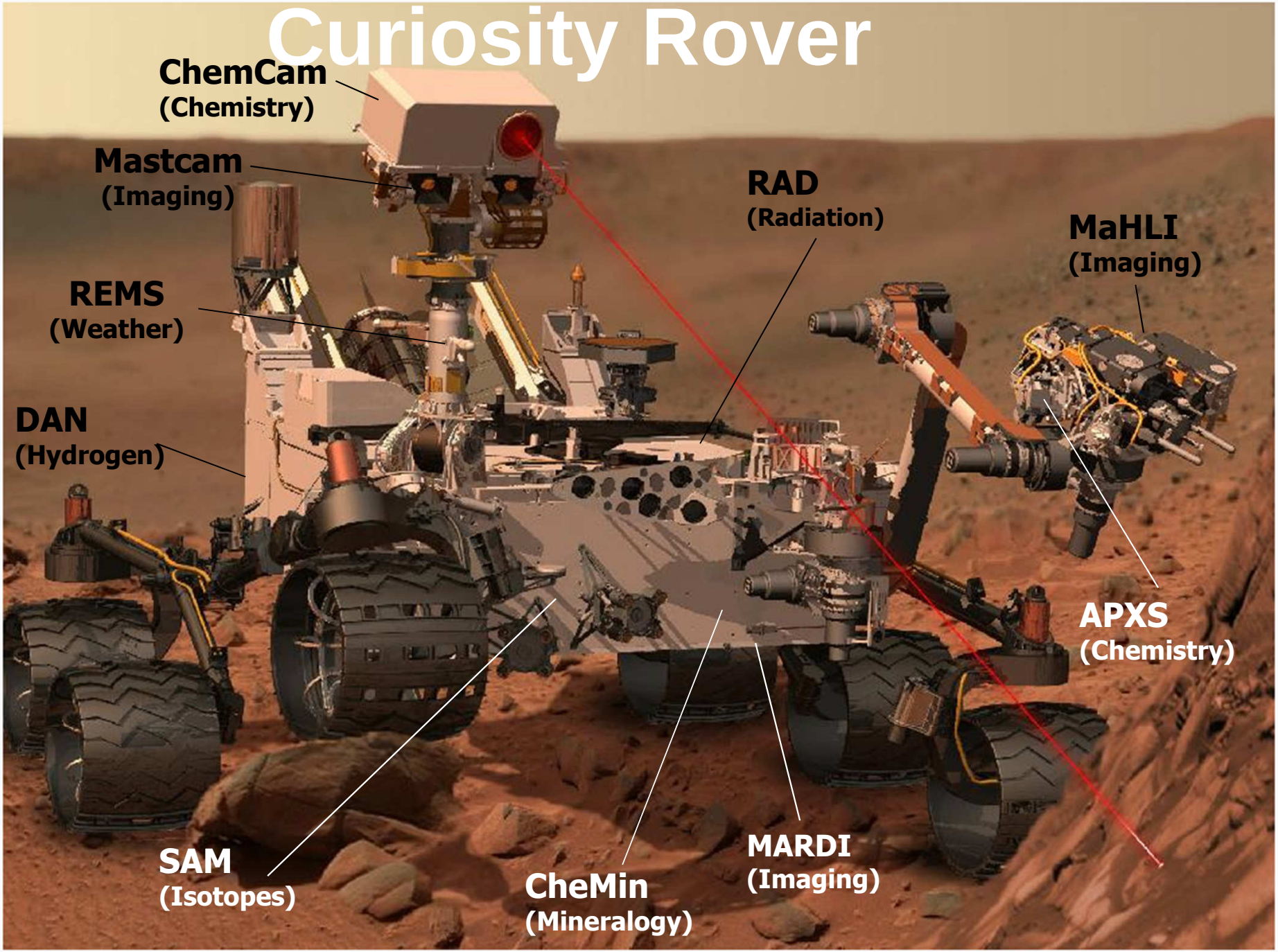
Opportunity has nearly completed its survey of the Cape York region containing CRISM clay signatures, and is ready to perform detailed IDD investigations of candidate targets.



spectral principal component stretch – W. Farrand

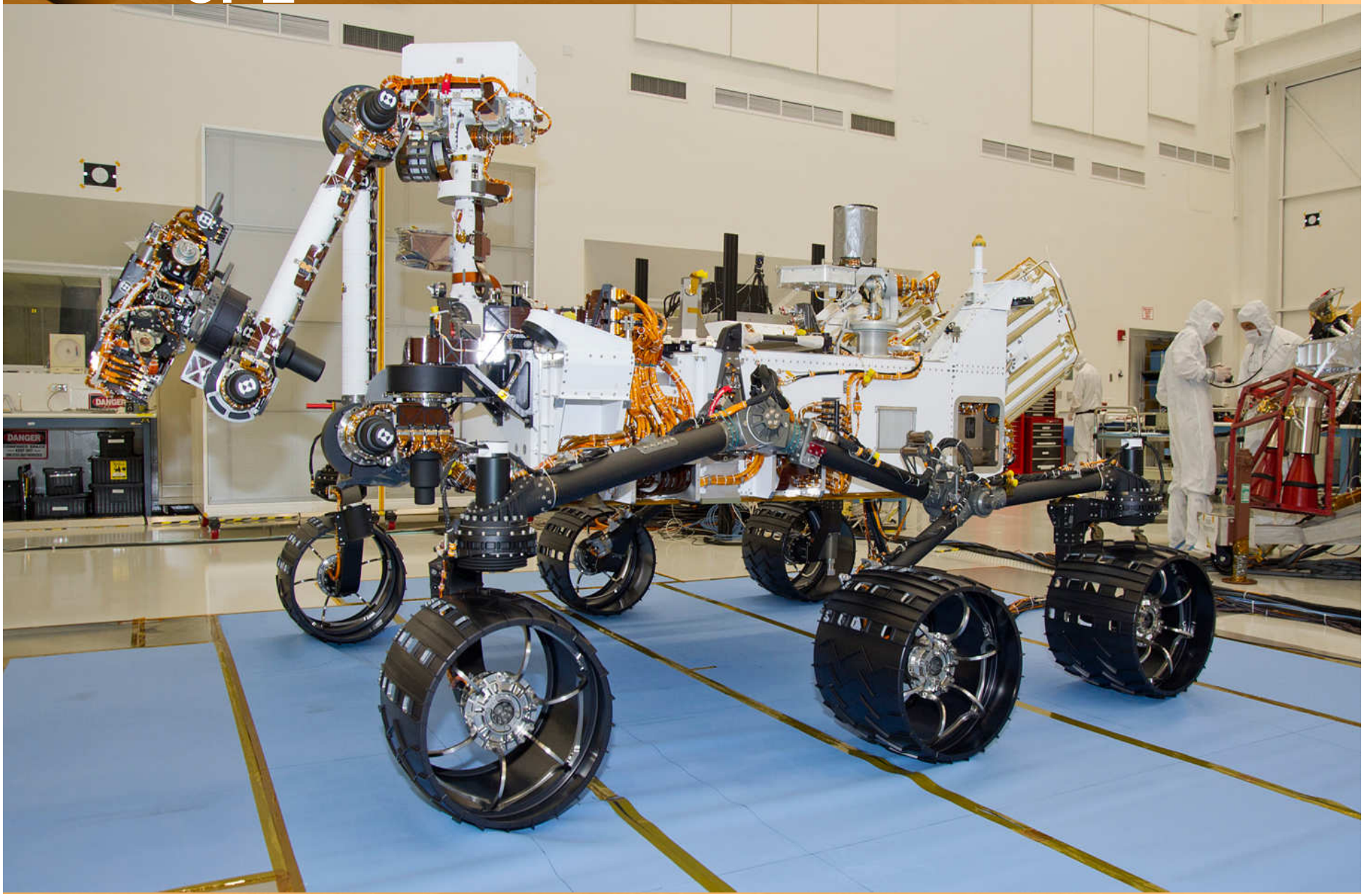


Curiosity Rover



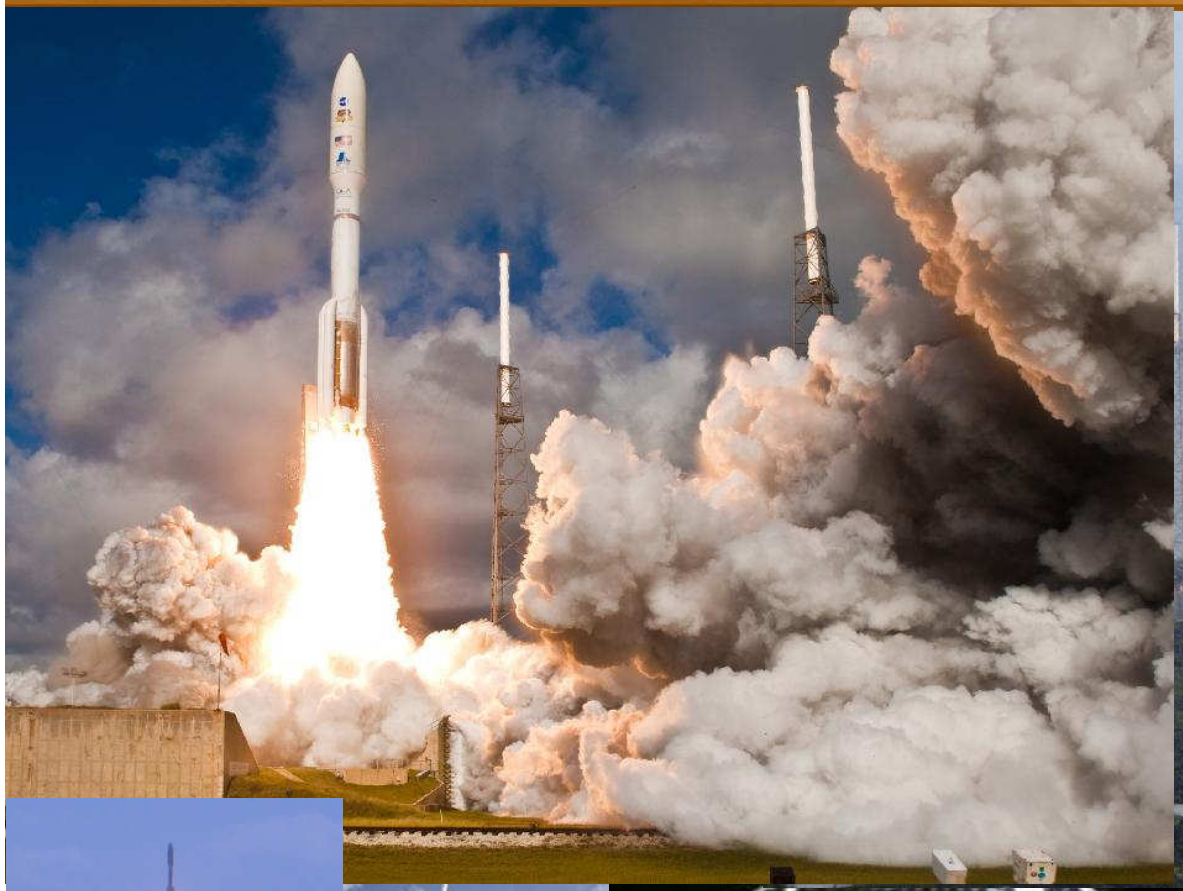
NASA/JPL-Caltech

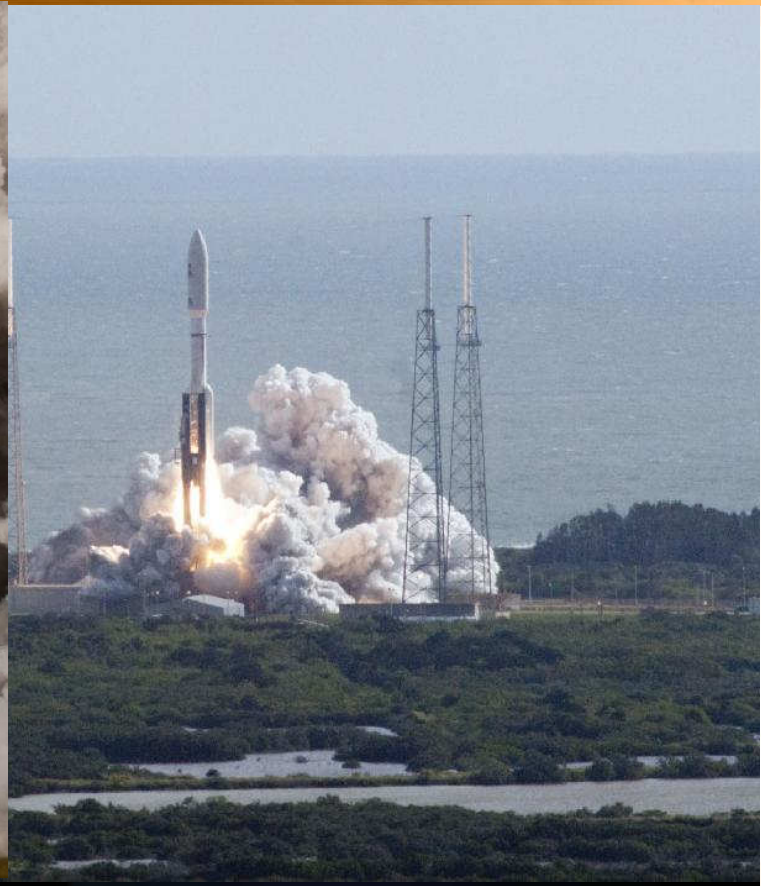
MSL “Curiosity” Rover Final Testing @ JPL

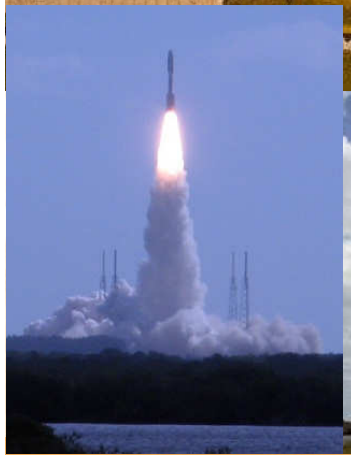


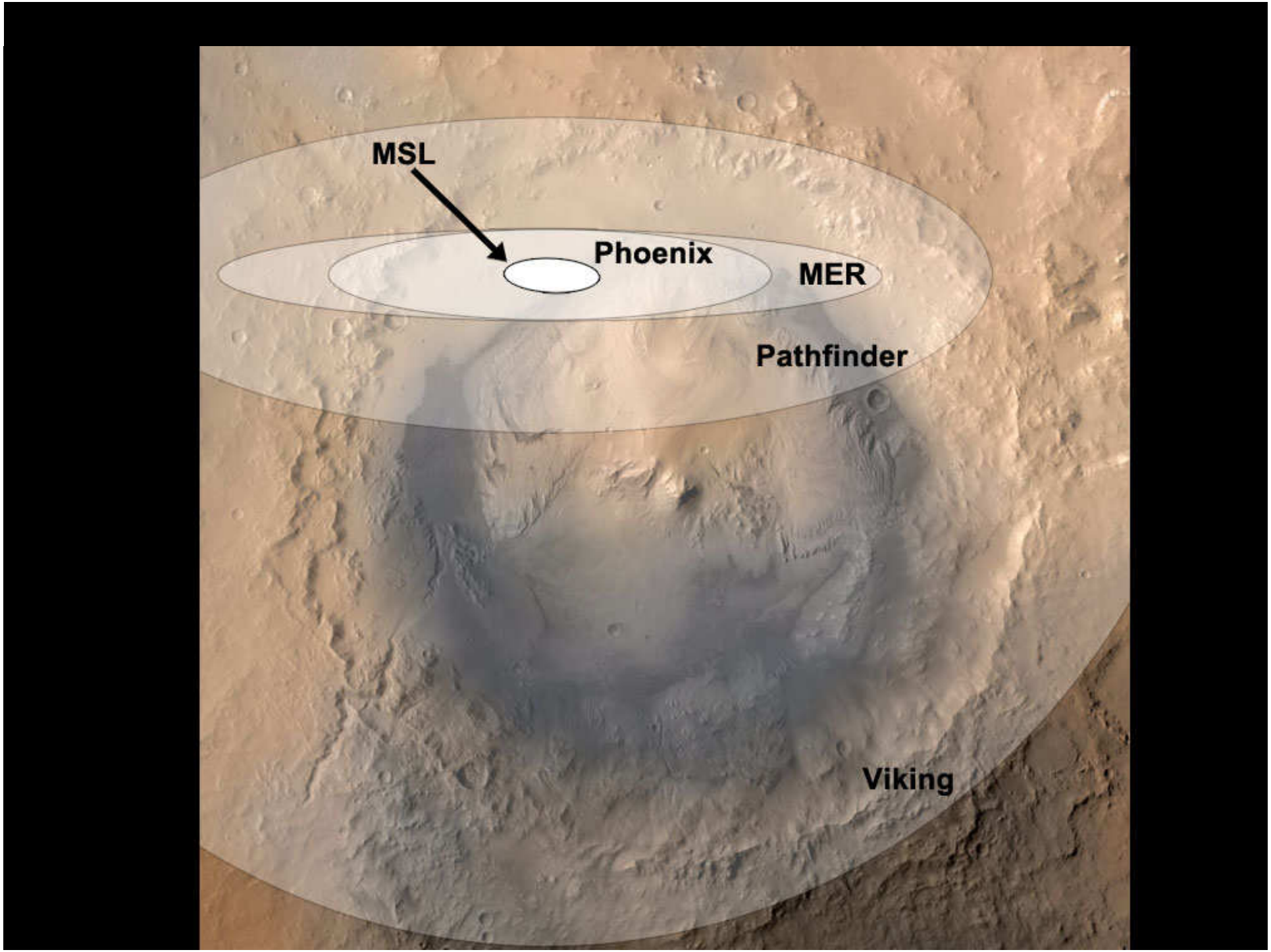
Final Stack

MSL/Curiosity Launch and Separation

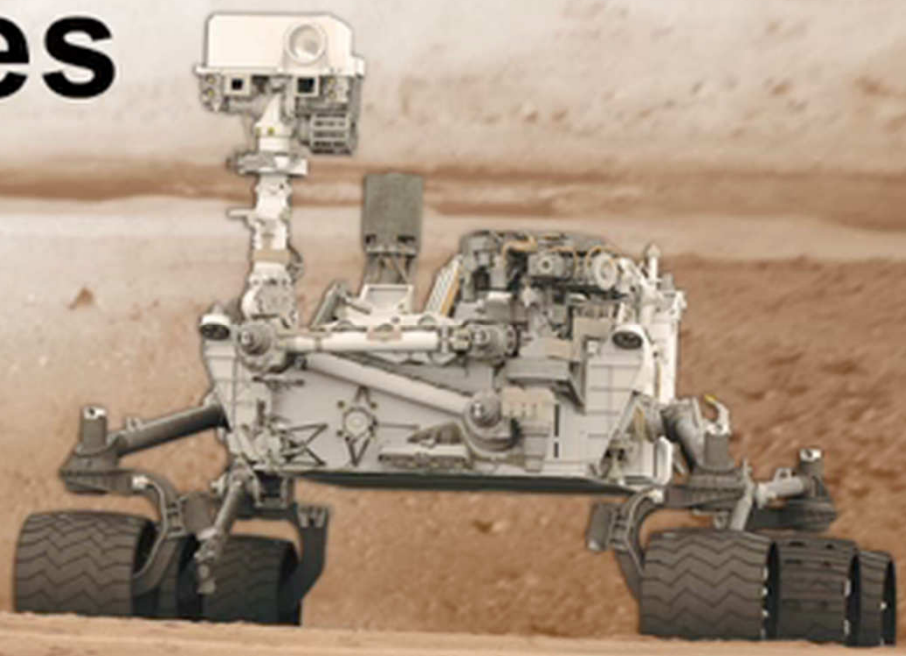


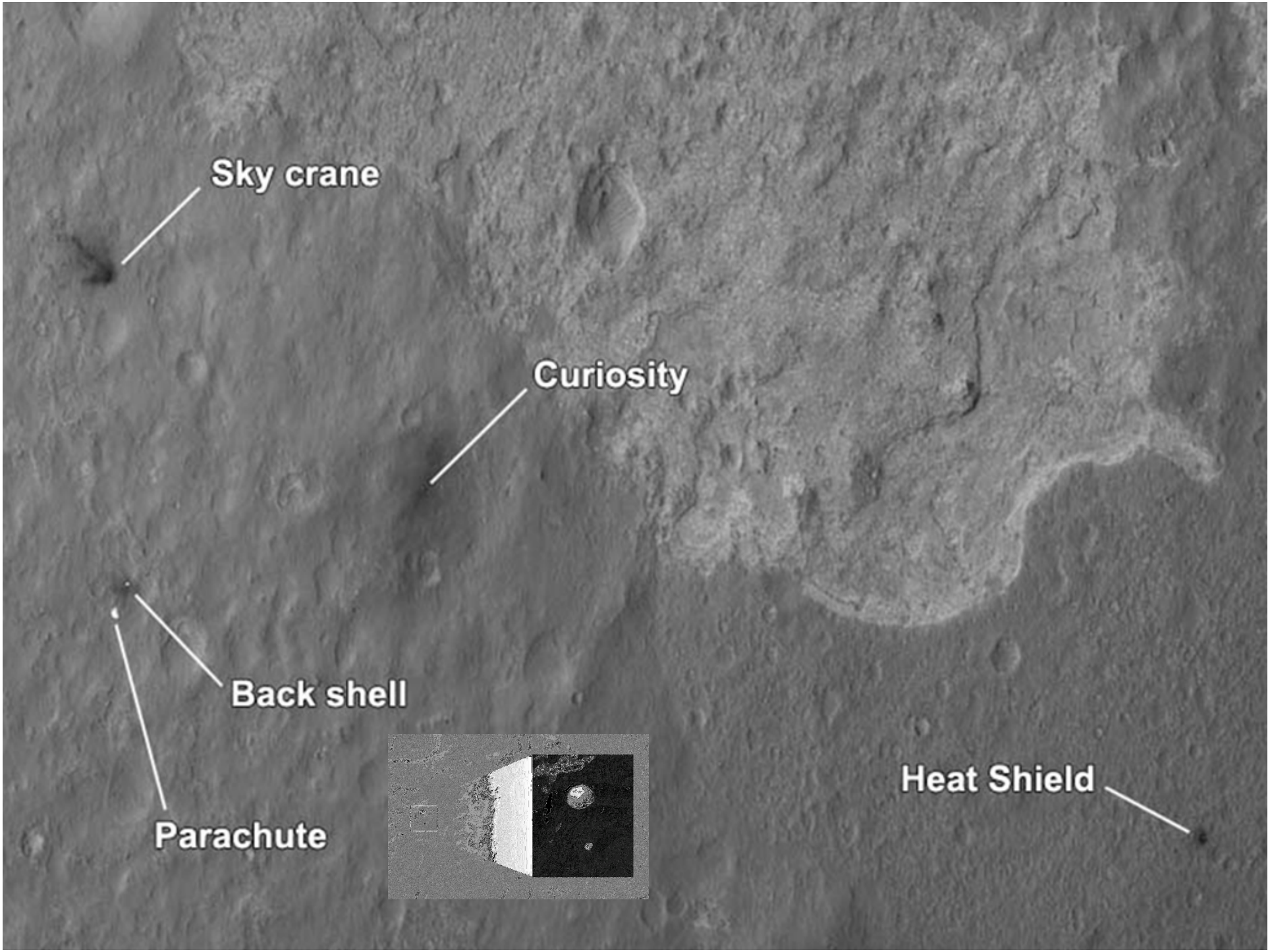





MSL
Phoenix
MER
Pathfinder
Viking

Dropping in on Mars in High-Res




Sky crane
Curiosity
Back shell
Parachute
Heat Shield

NASA/JPL-Caltech

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

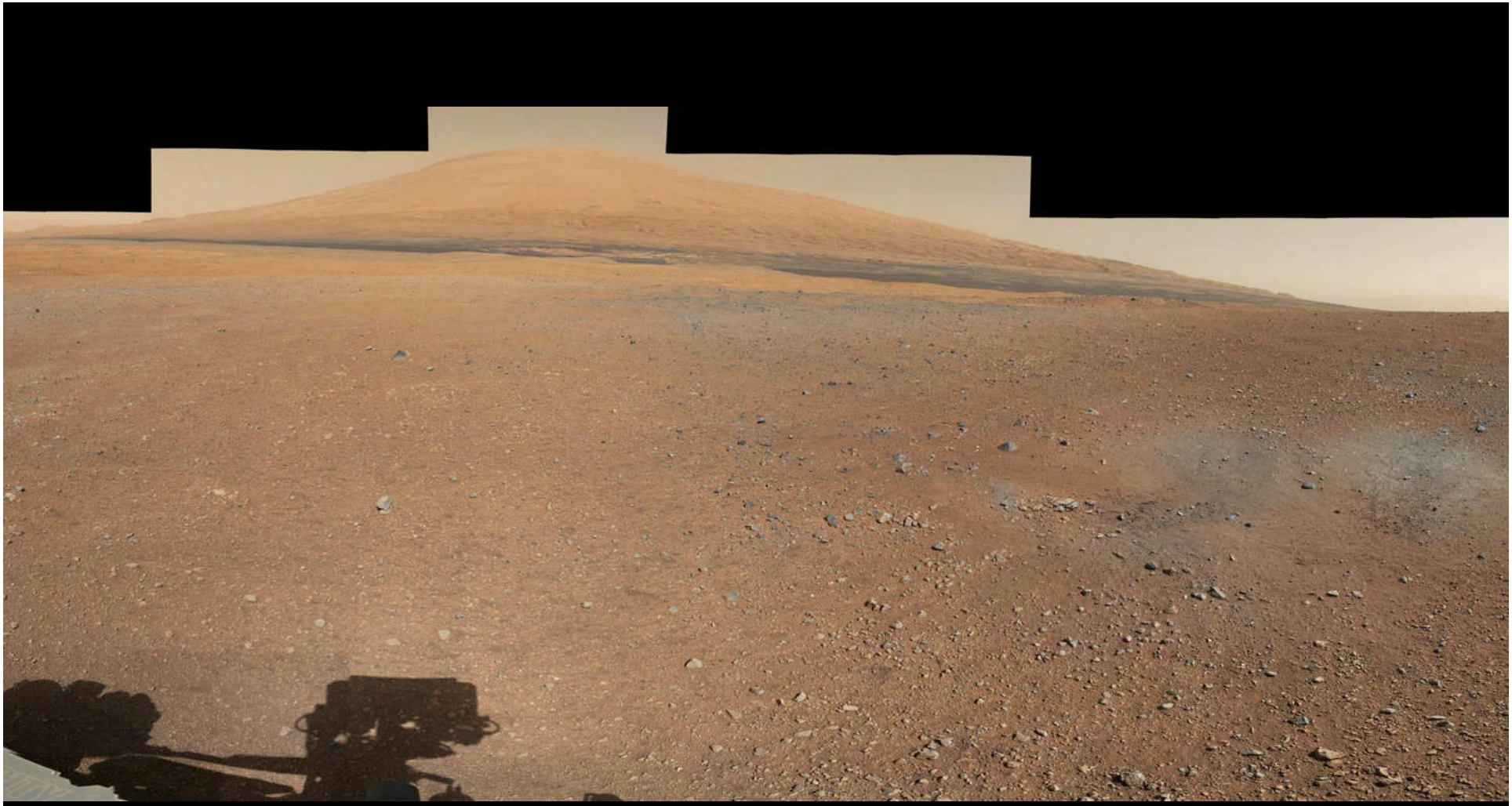
NASA/JPL-Caltech

Navigation camera image showing the surface scour marks and rocks on the rover's deck

NASA/JPL-Caltech/MSSS

CURIOSITY

Bedrock exposed by the landing engines in the scour mark named Goulburn



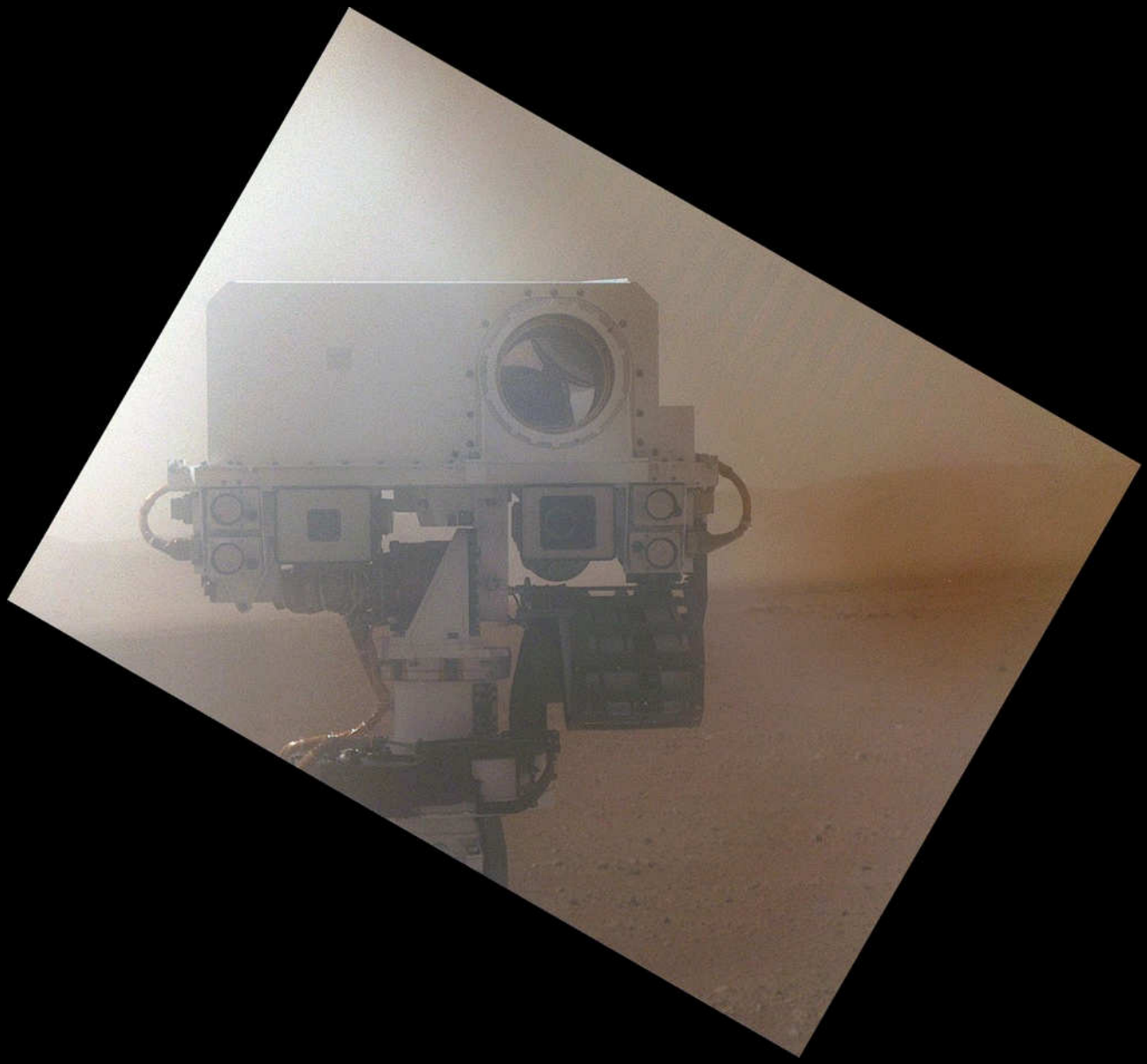
NASA/JPL-
Caltech/MSSS

Mastcam-34 mosaic of Mount Sharp, descent rocket scours, and rover shadow

NASA/JPL-Caltech/MSSS

CURIOSITY

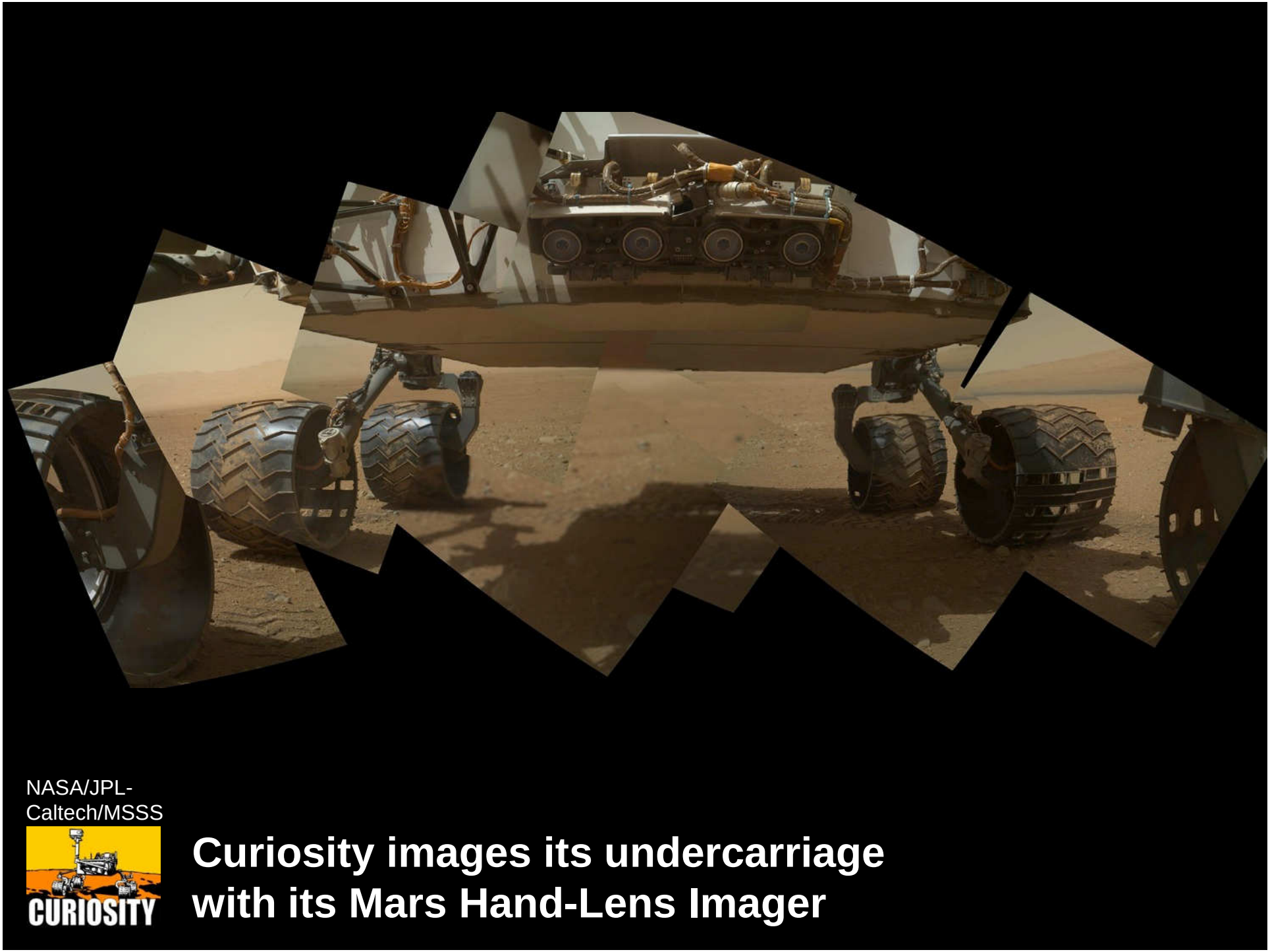
Mastcam-100 image of Mount Sharp's layers, canyons and buttes



NASA/JPL-
Caltech/MSSS

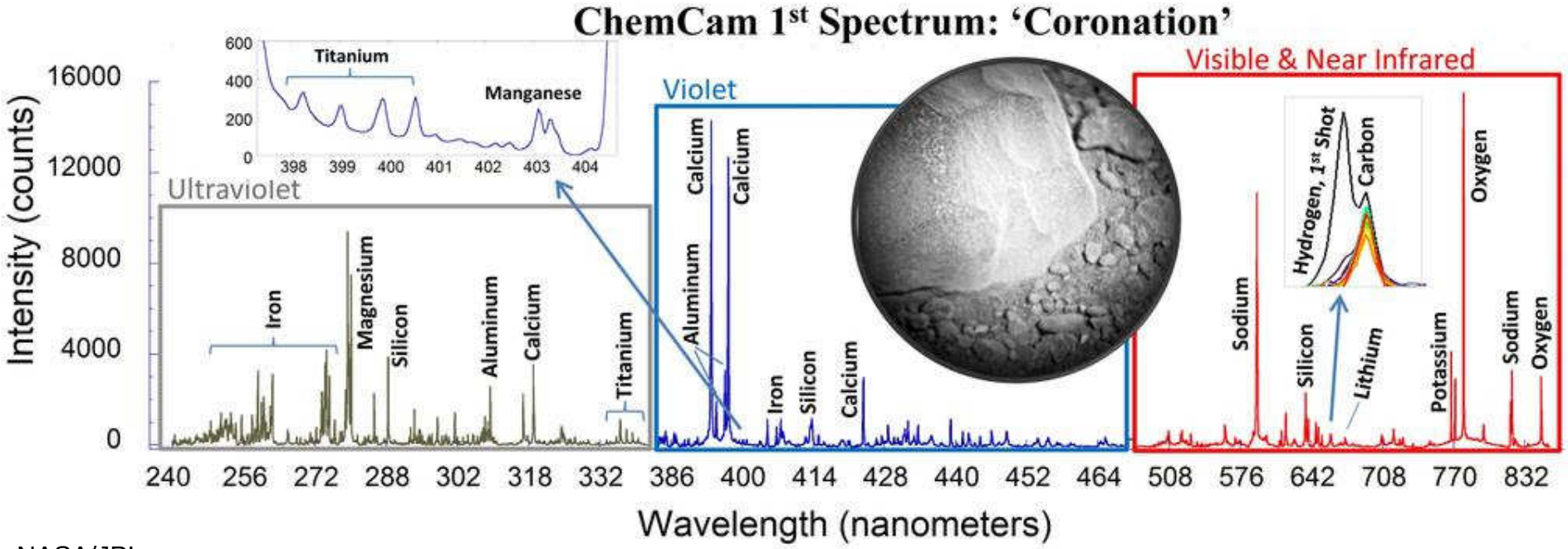
CURIOSITY

Curiosity self-portrait using the arm-mounted Mars Hand-Lens Imager, through dust cover



NASA/JPL-
Caltech/MSSS

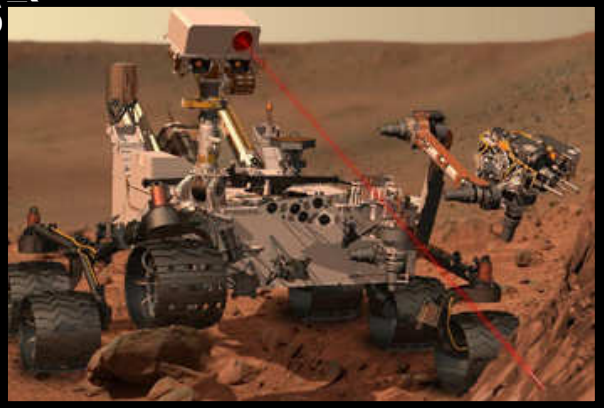
Curiosity images its undercarriage with its Mars Hand-Lens Imager



NASA/JPL-

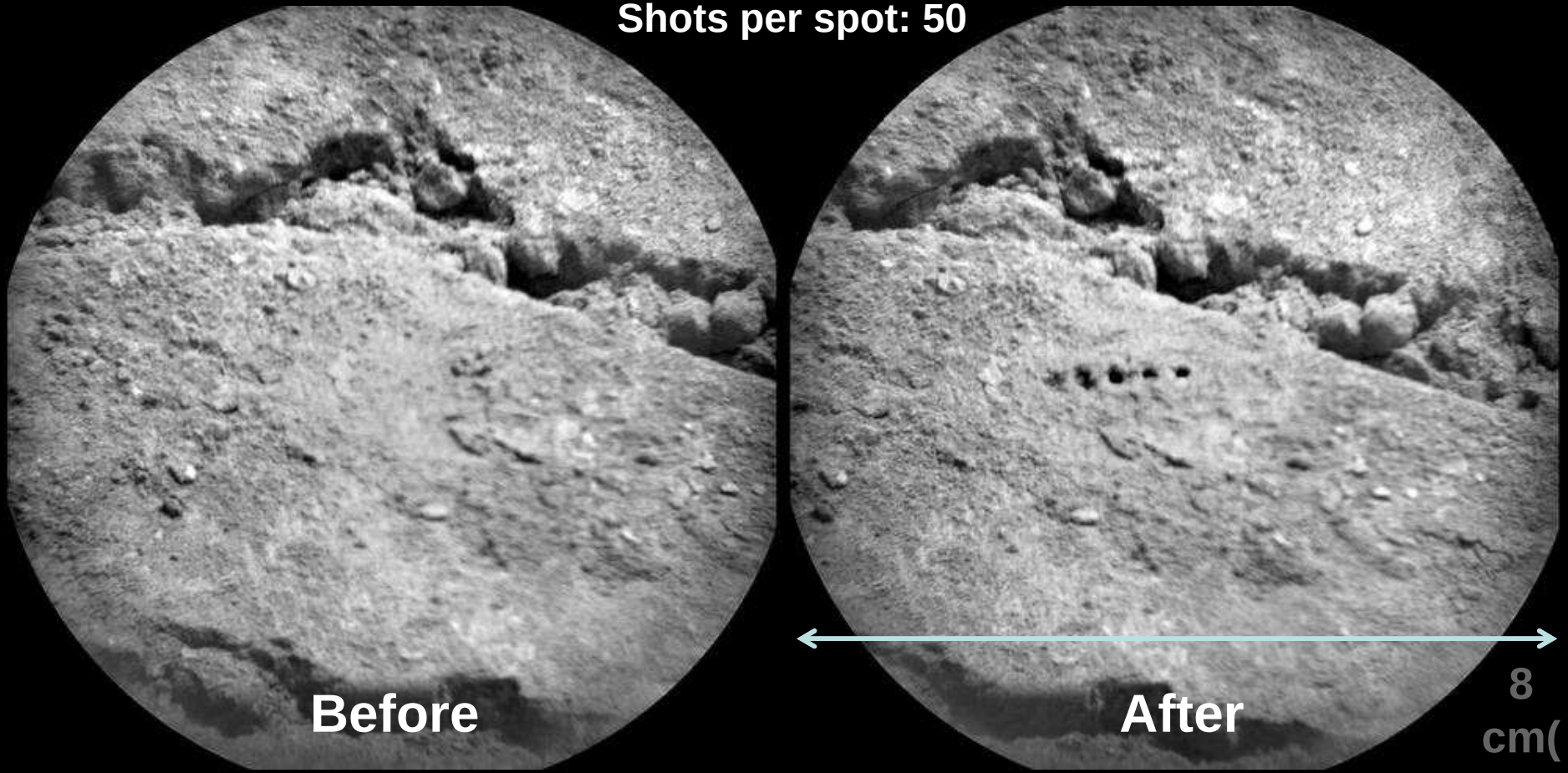
ChemCam spectra of Coronation

Target: Coronation (N16
Sol 13
Shots: 30



NASA/JPL-
Caltech/MSSS

Target: Beechey (Sol 19)
Power: 1 Gigawatt
Shots per spot: 50



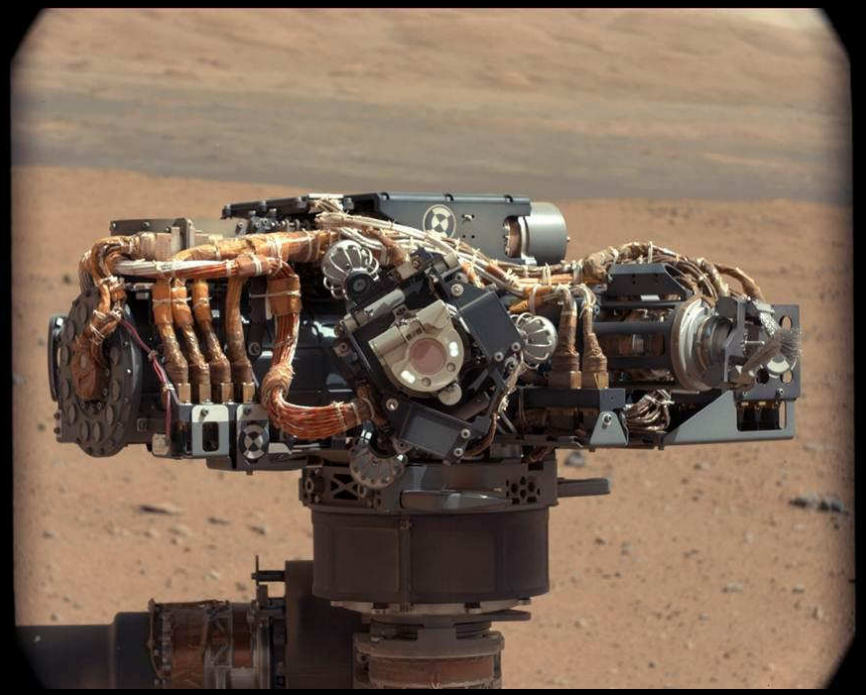
NASA/JPL-Caltech/LANL/CNES/IRAP/LPGN/CNRS

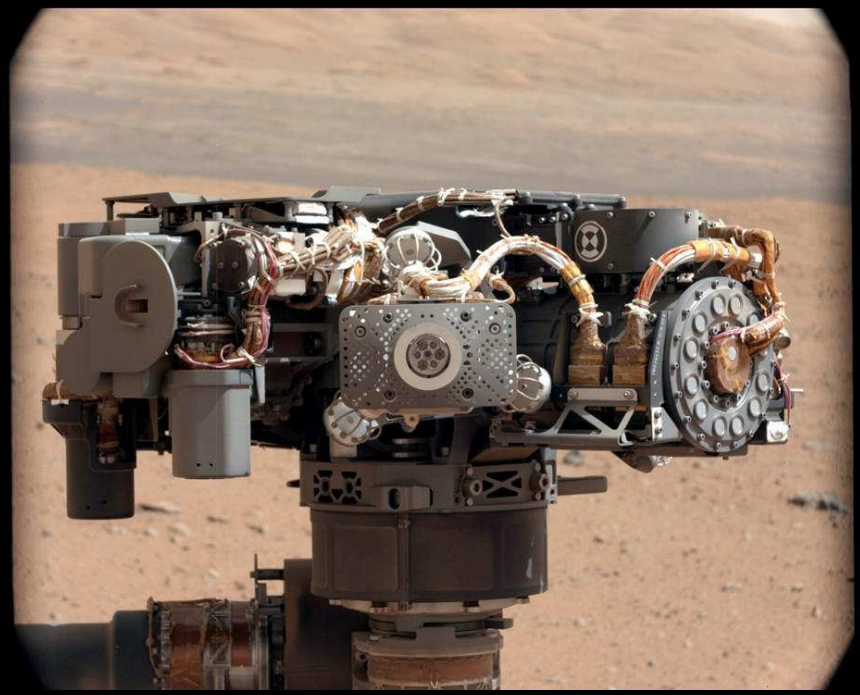
ChemCam’s laser induced breakdown spectrometer acquires a 5-spot raster

Navigation camera mosaic of Curiosity's robotic arm

CURIOSITY

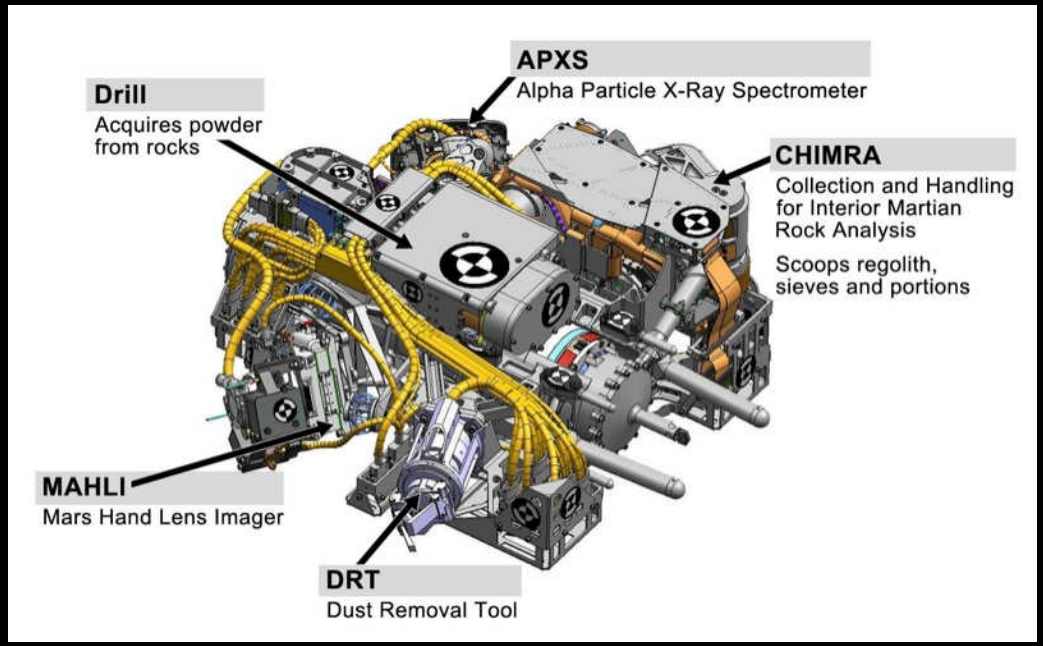
NASA/JPL-Caltech



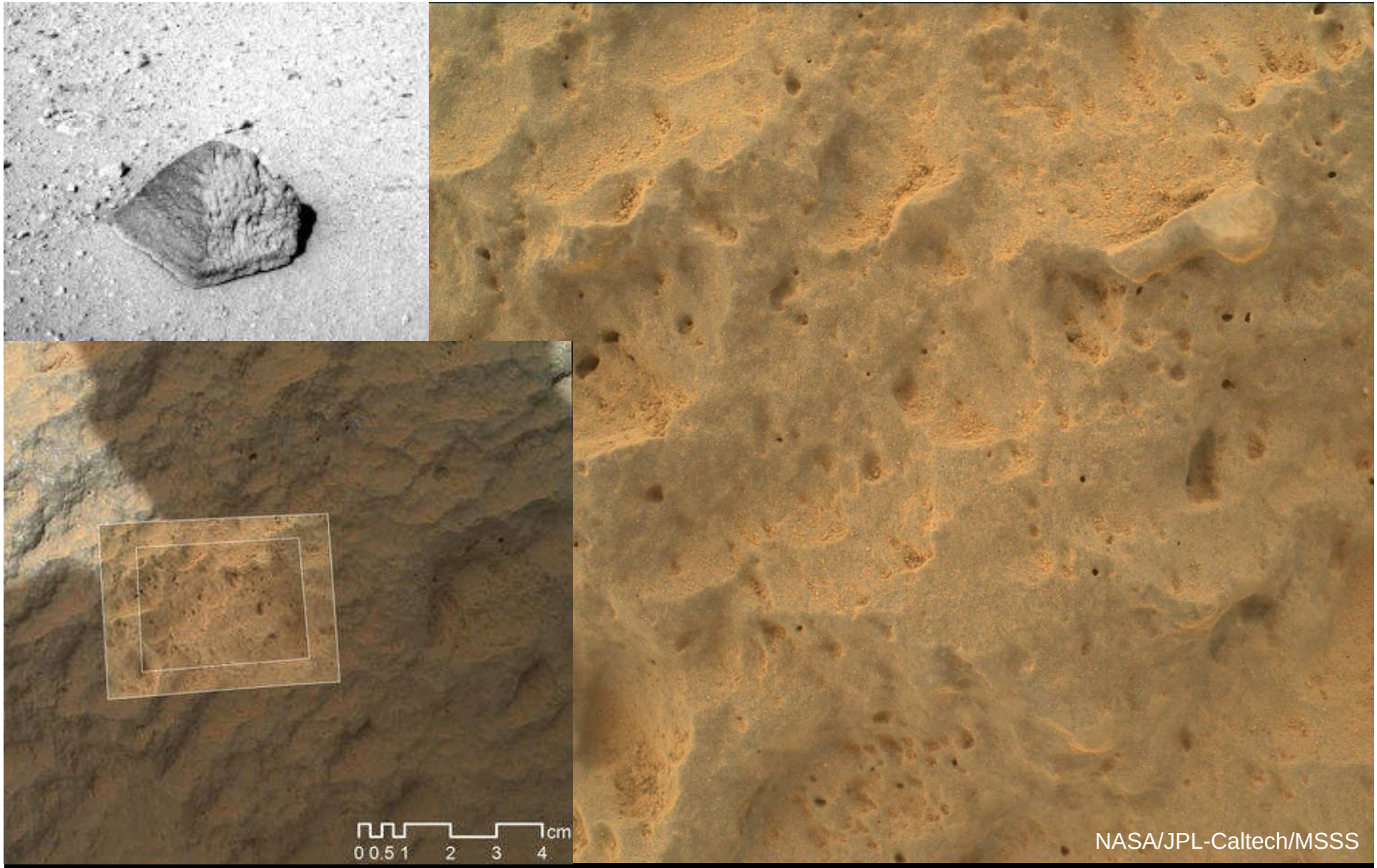


NASA/JPL-
Caltech/MSSS

Images of Curiosity's turret centered on MAHLI (left) and APXS (right)

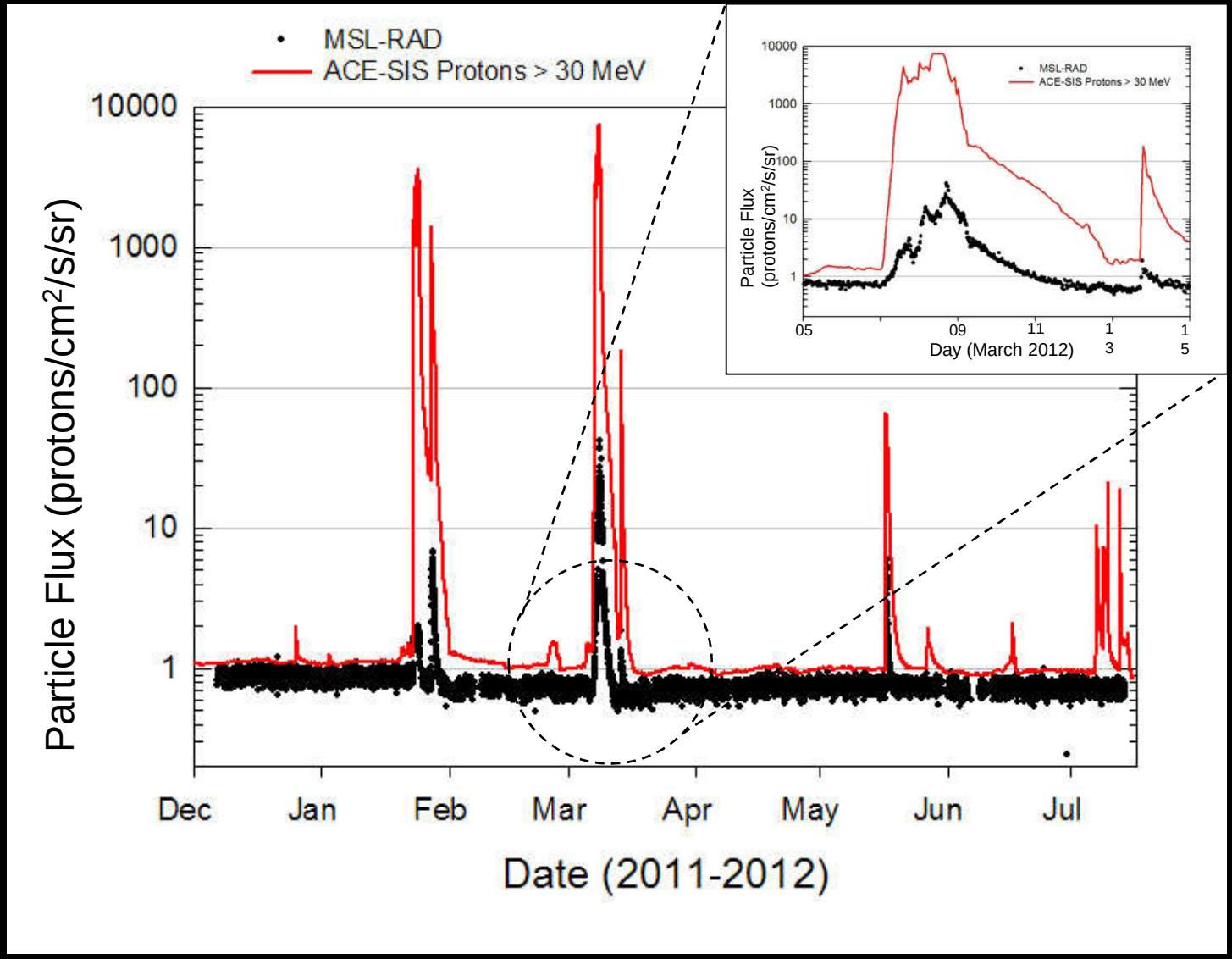


CURIOSITY



CURIOSITY

Nested, hand-lens imaging of the 25-cm (10”) high rock Jake Matijevic



RAD observed galactic cosmic rays and five solar energetic particle events

RAD was shielded by the spacecraft structure, reducing the observed particle flux relative to NASA's ACE satellite

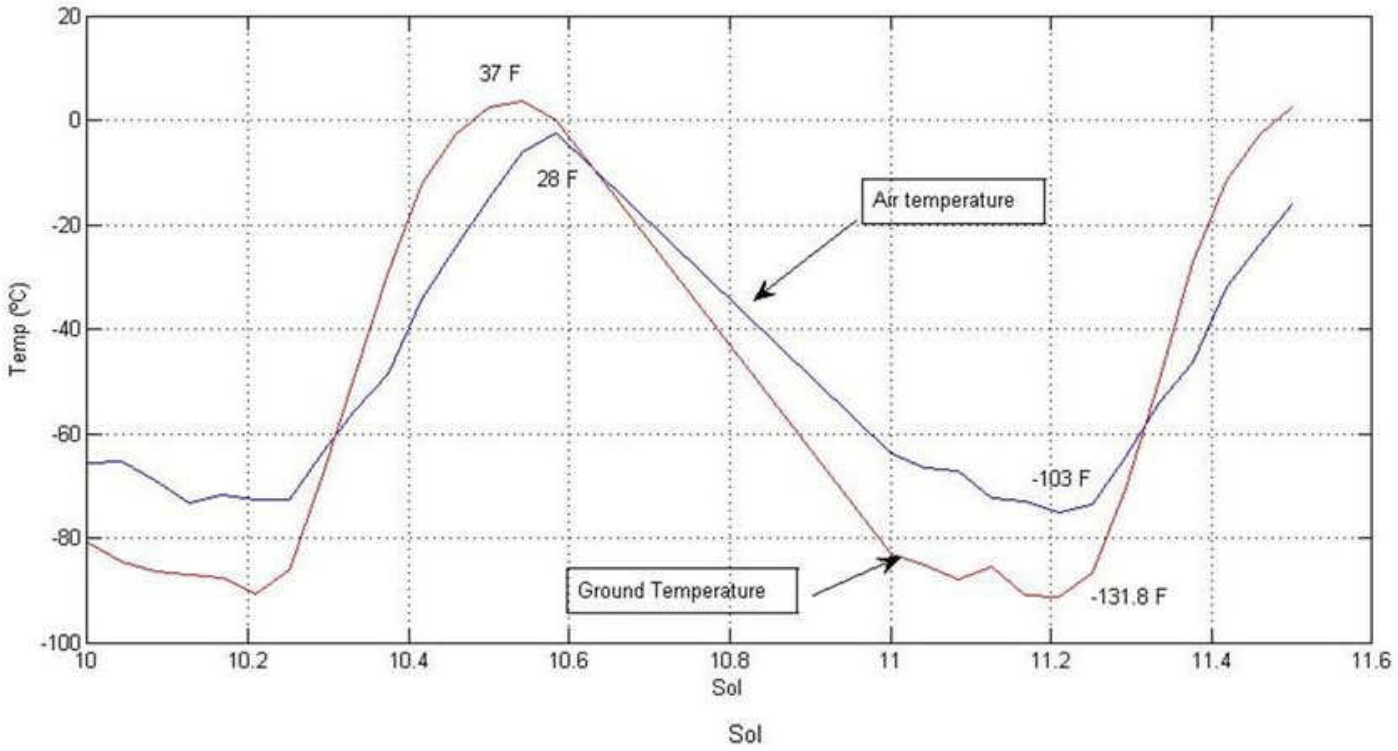
RAD is now collecting the first measurements of the radiation environment on the surface of another planet

NASA/JPL-Caltech/SwRI

CURIOSITY

Curiosity's Radiation Assessment Detector operated throughout the cruise to Mars

GROUND AND AIR TEMPERATURE SENSOR



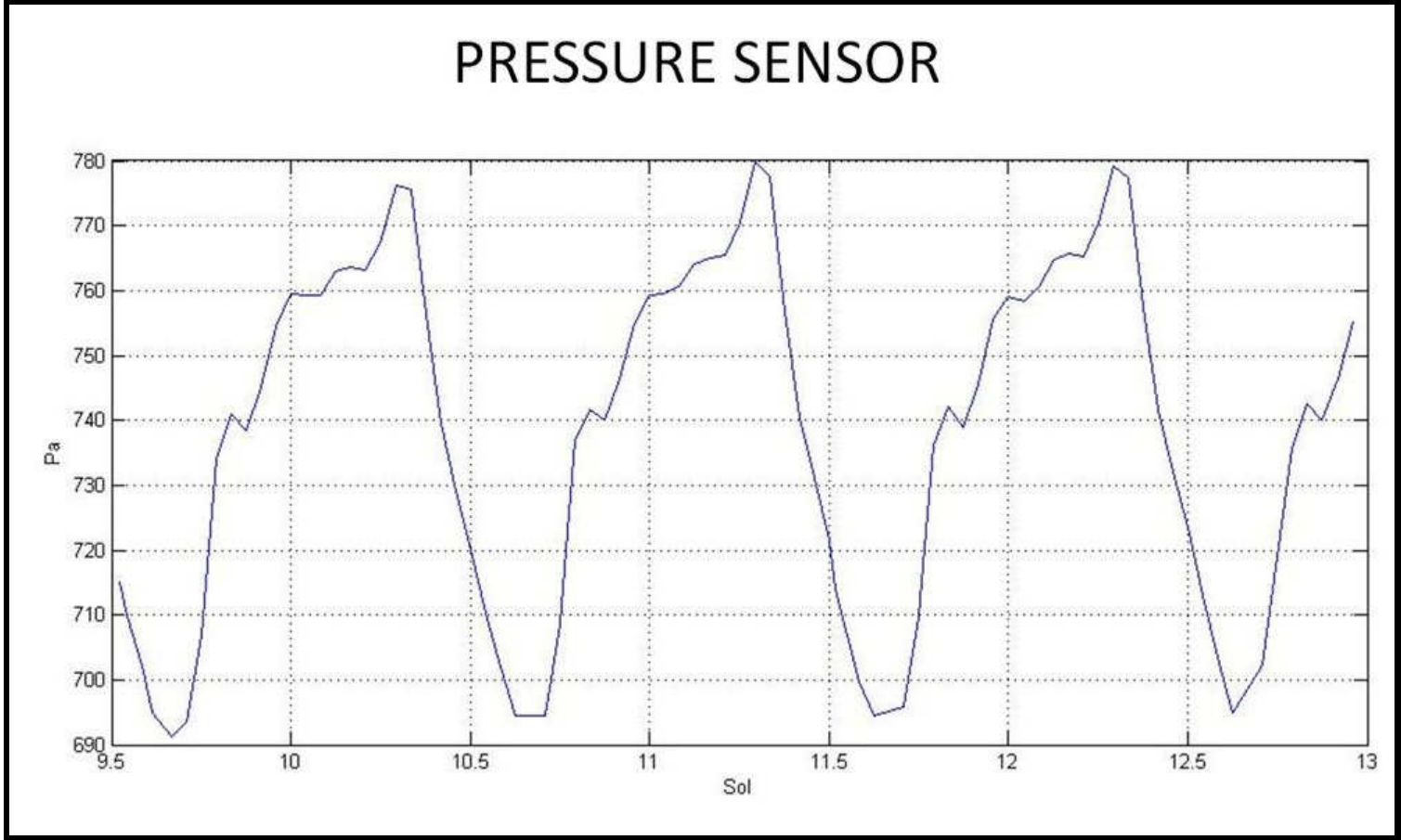
REMS' ground and air temperature sensors are located on small booms on the rover's mast

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)

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



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

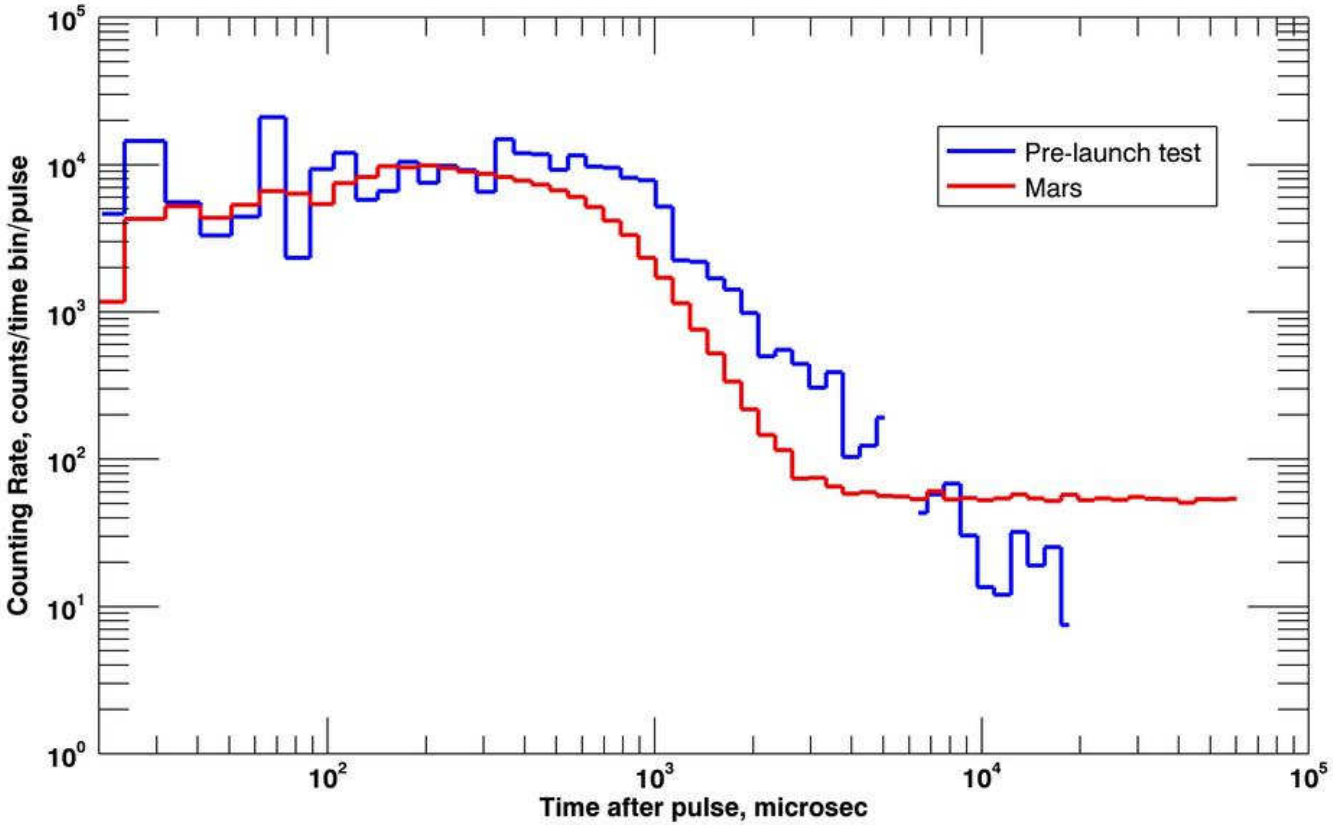
REMS' pressure sensor is located inside the rover's body

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 an atmospheric "tidal wave" that sweeps across the planet each day

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

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



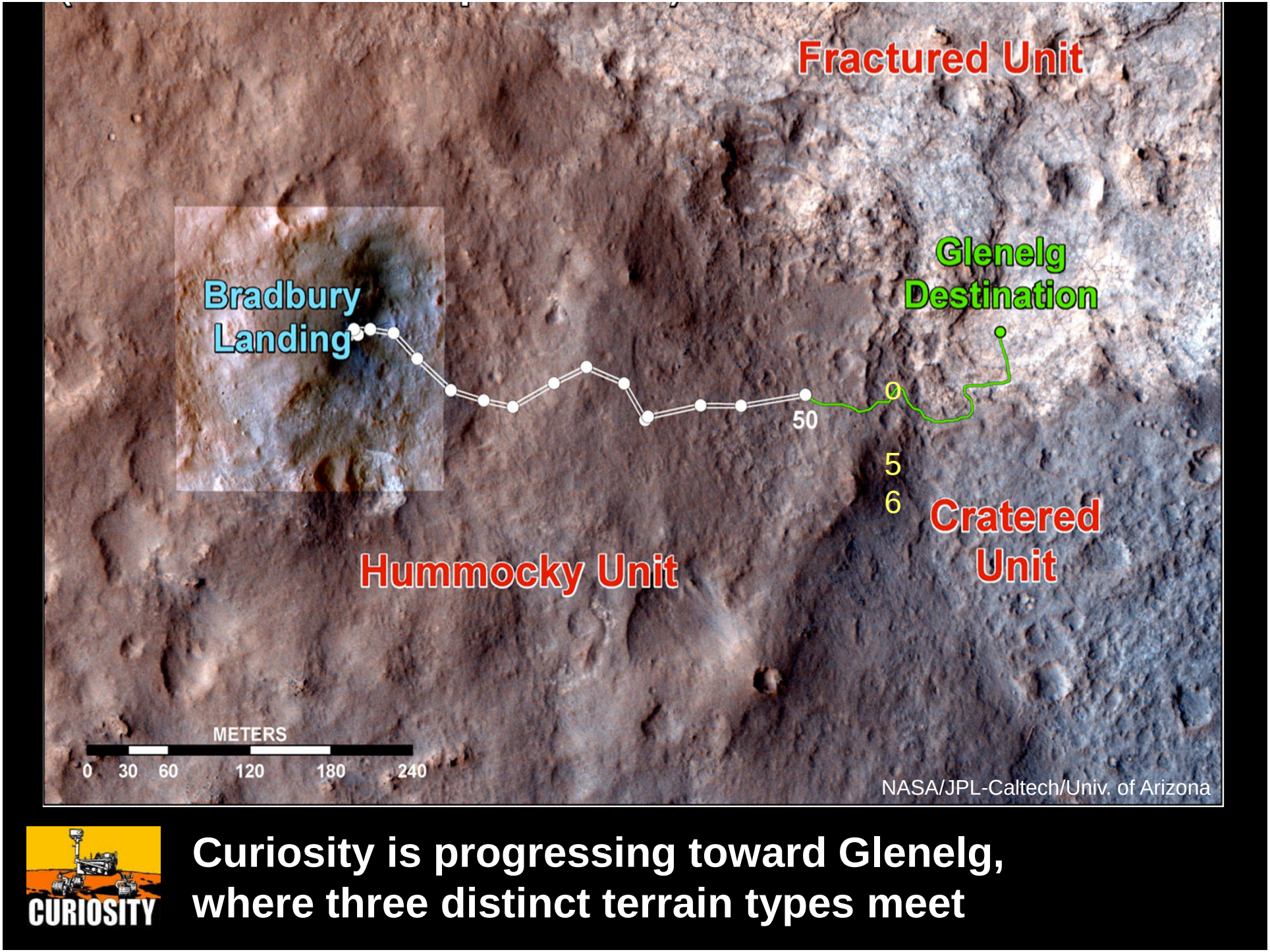
DAN sends ten million neutrons into the ground, ten times a second

The "echo" back is recorded. If hydrogen is present in the ground, perhaps in aqueous minerals, some neutrons will collide and lose energy

DAN is used to survey the upper one meter of the ground below the rover as it drives along

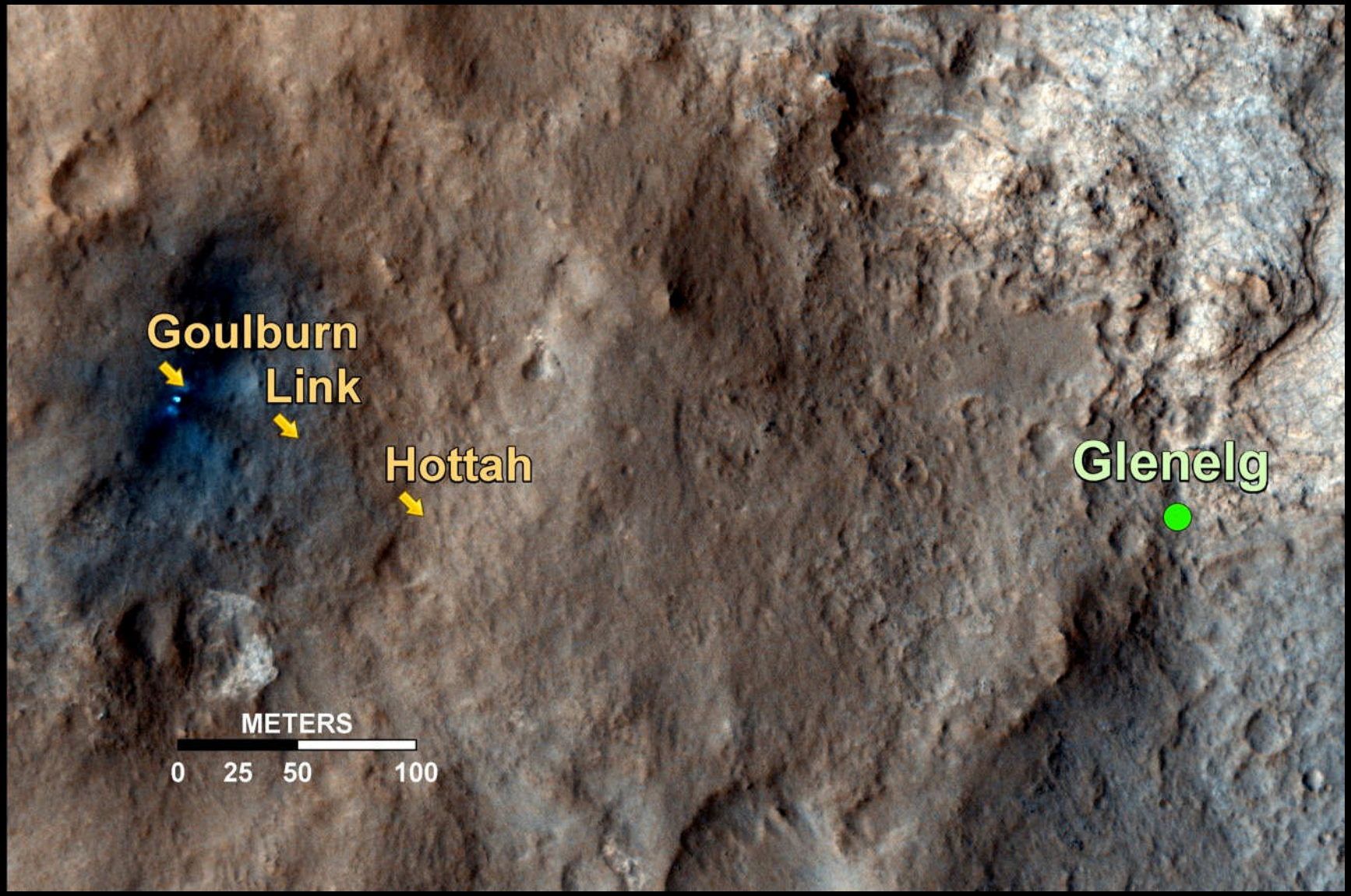
NASA/JPL-Caltech/Russian Space Research Institute

Curiosity's Dynamic Albedo of Neutrons experiment sounds the ground for hydrogen



CURIOSITY

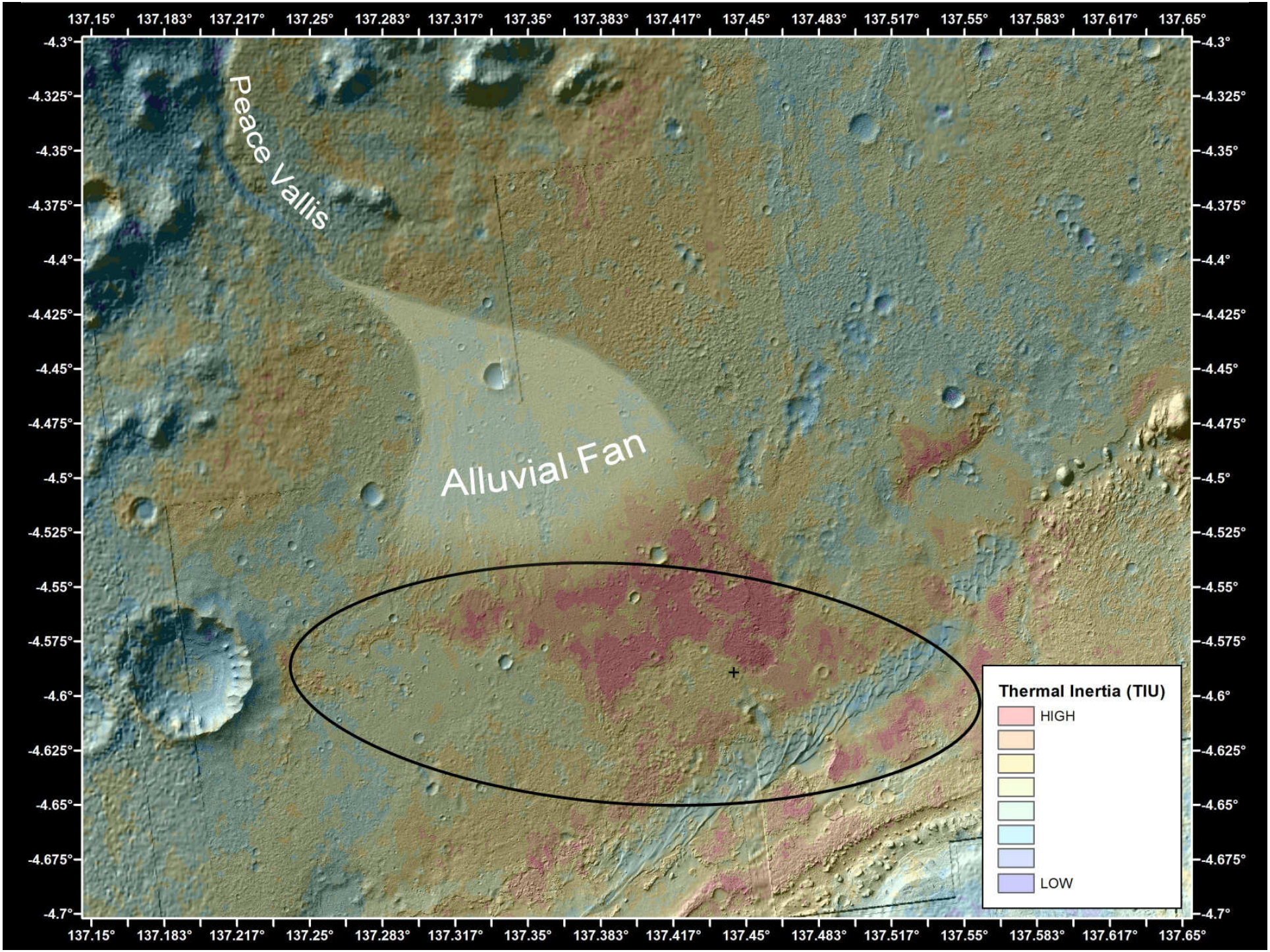
Curiosity is progressing toward Glenelg, where three distinct terrain types meet

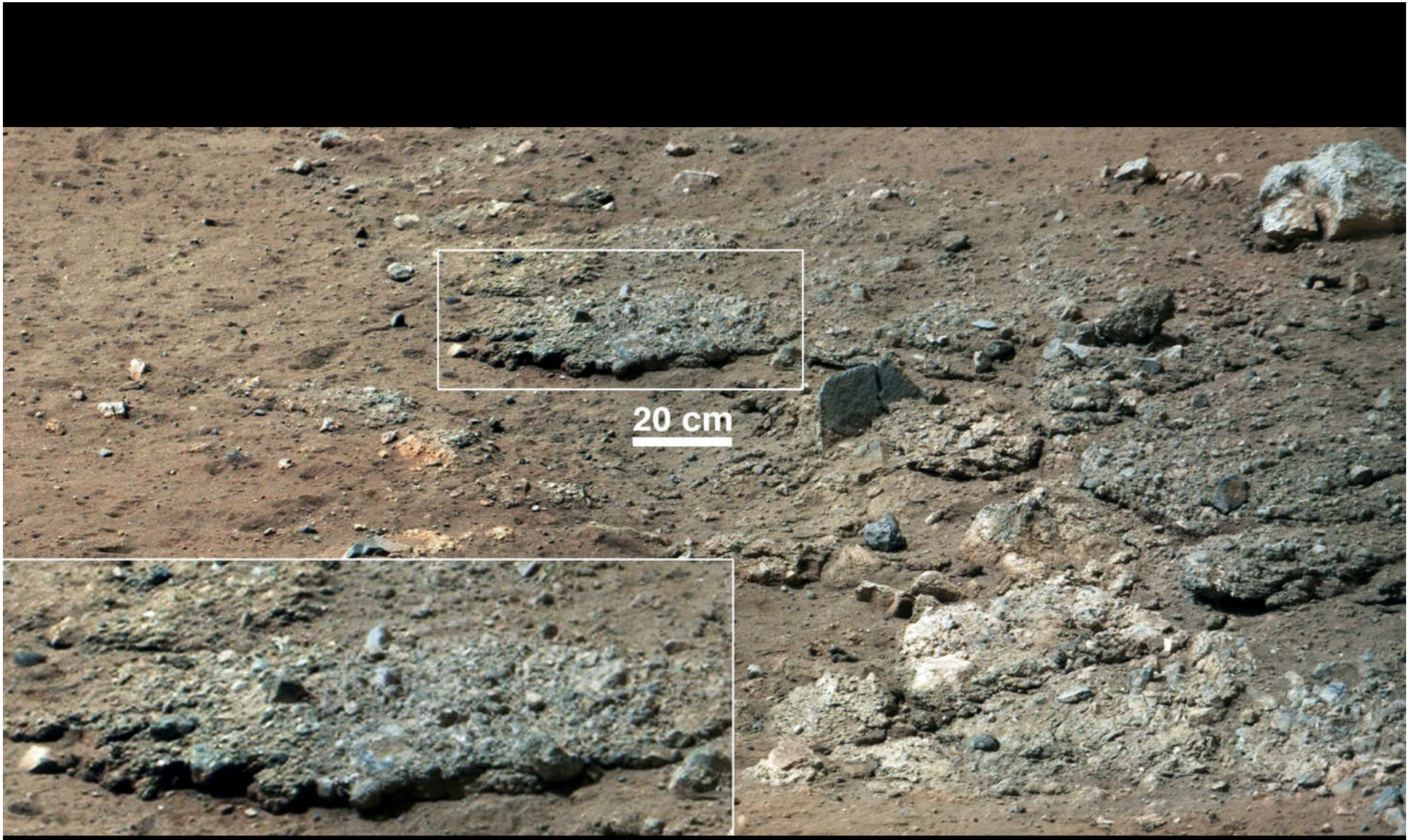


NASA/JPL-Caltech/Univ. of Arizona

CURIOSITY

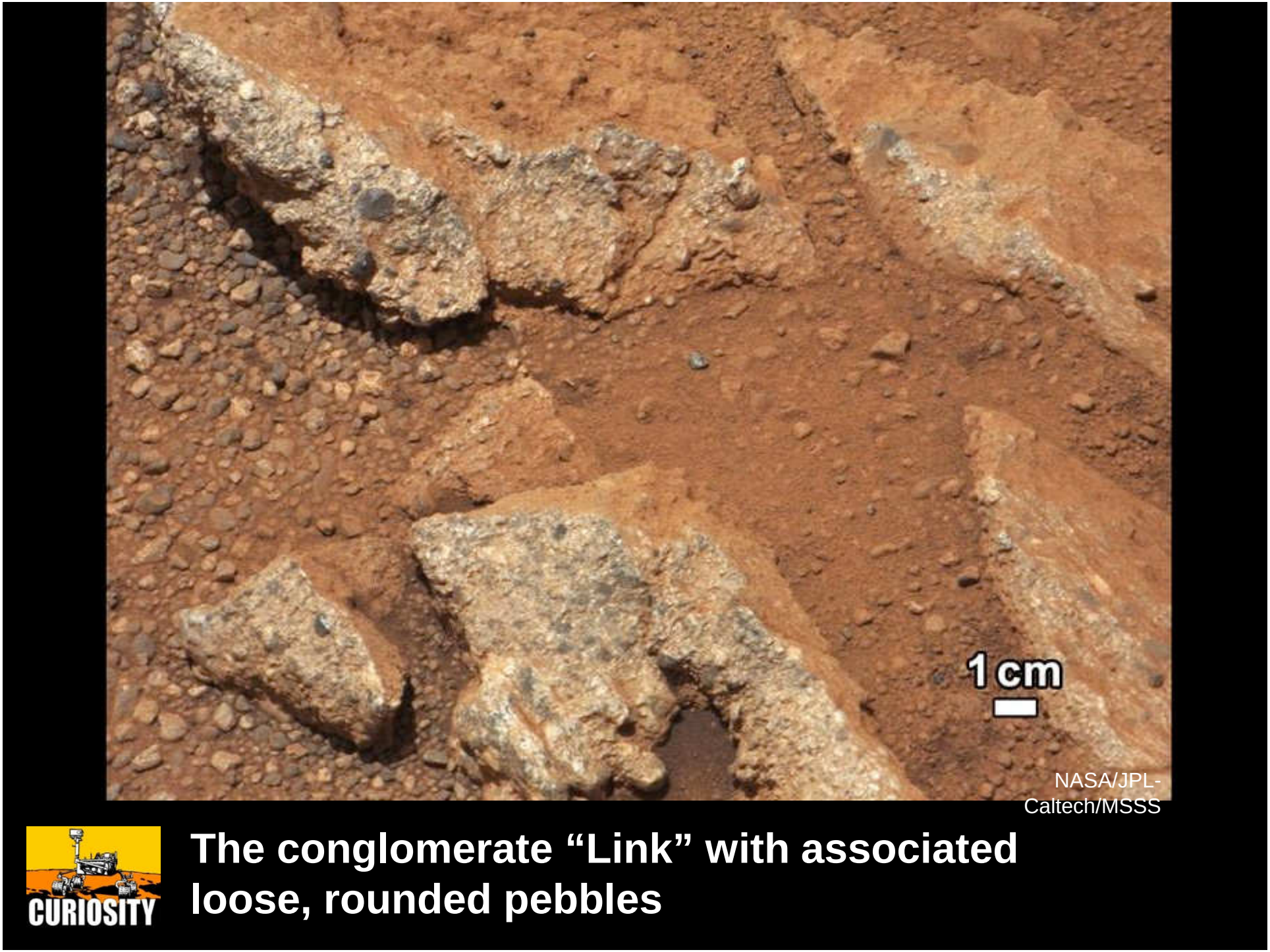
Map view of conglomerate outcrops (next slides)


137.15°
137.183°
137.217°
137.25°
137.283°
137.317°
137.35°
137.383°
137.417°
137.45°
137.483°
137.517°
137.55°
137.583°
137.617°
137.65°
-4.3°
-4.325°
-4.35°
-4.375°
-4.4°
-4.425°
-4.45°
-4.475°
-4.5°
-4.525°
-4.55°
-4.575°
-4.6°
-4.625°
-4.65°
-4.675°
-4.7°
Peace Vallis
Alluvial Fan
Thermal Inertia (TIU)
HIGH
LOW



NASA/JPL-Caltech/MSSS

The Goulburn scour revealed the first look at underlying bedrock

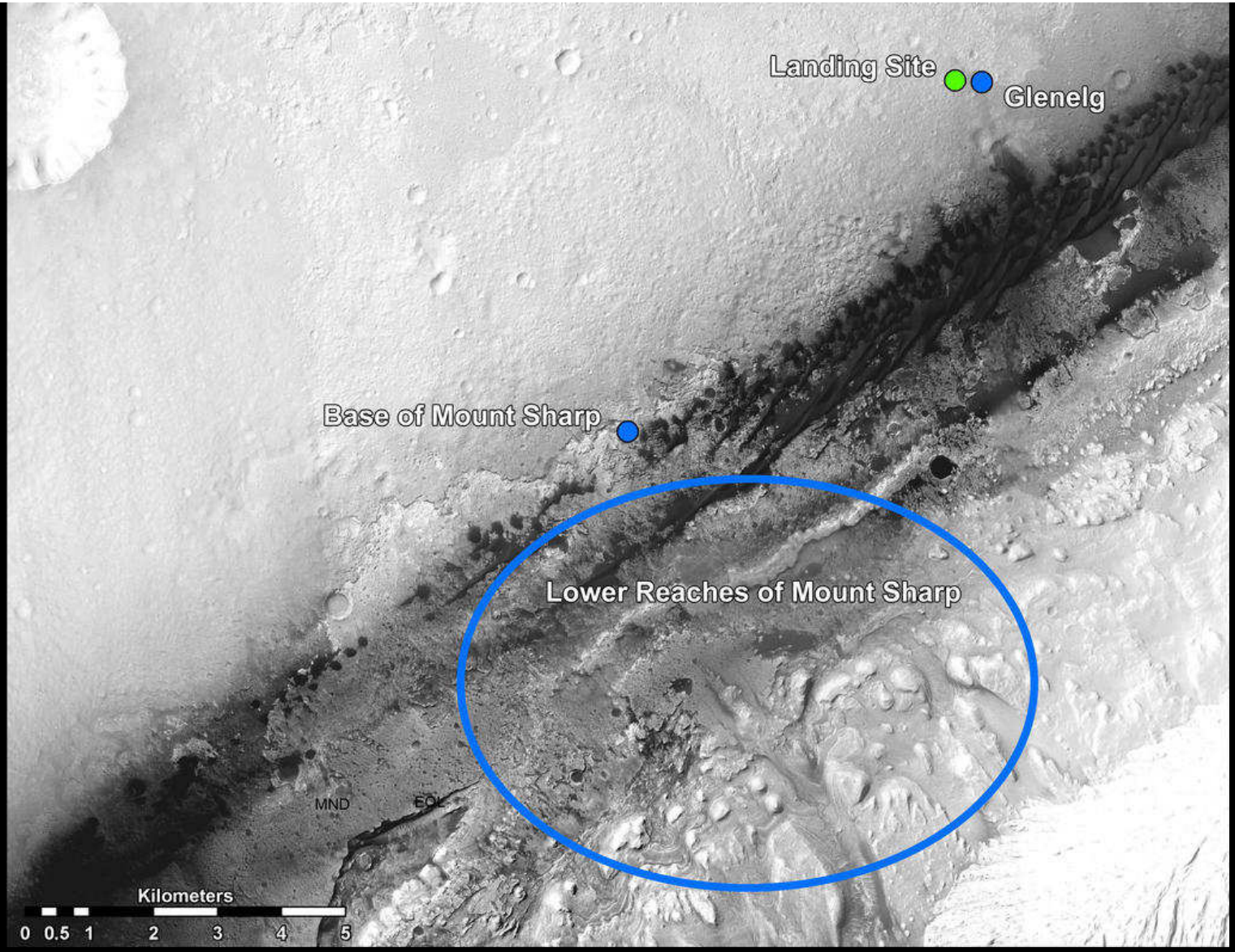


NASA/JPL-Caltech/MSSS

CURIOSITY

The conglomerate “Link” with associated loose, rounded pebbles

“Hottah” reveals additional conglomerate, evidence of an ancient streambed

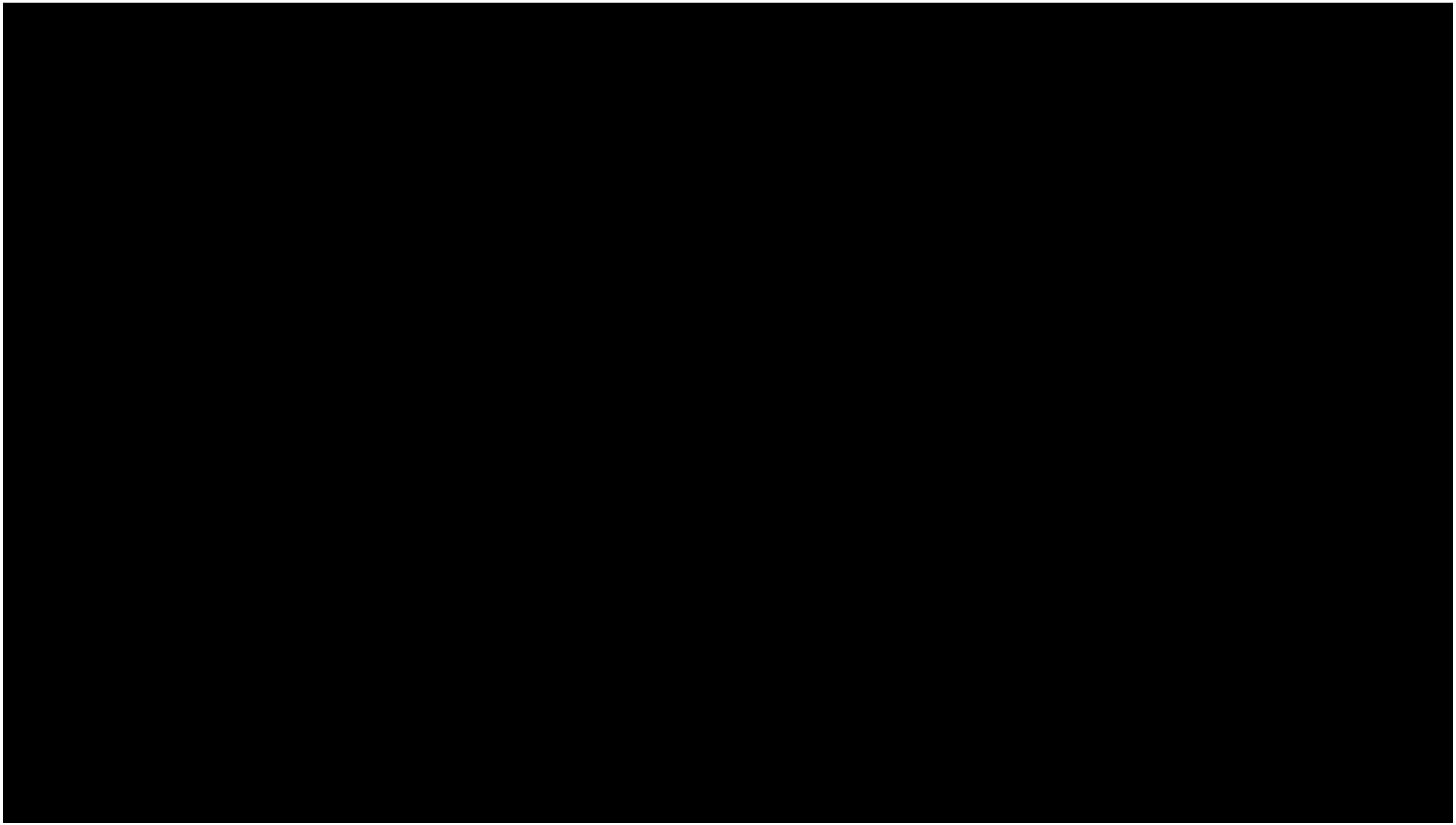


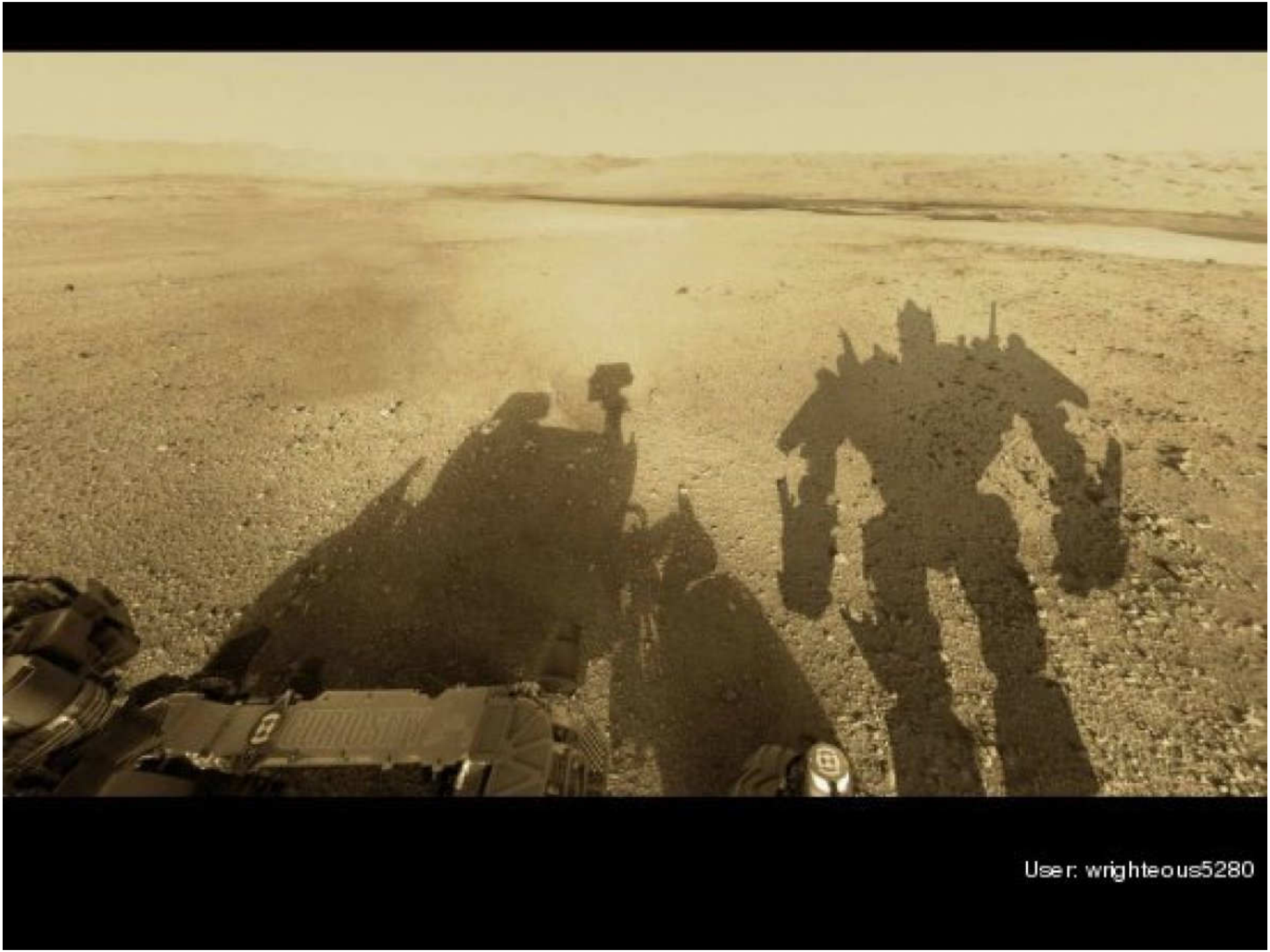
NASA/JPL-Caltech/Univ. of Arizona

CURIOSITY

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

Mars in a Minute




User: wrighteous5280