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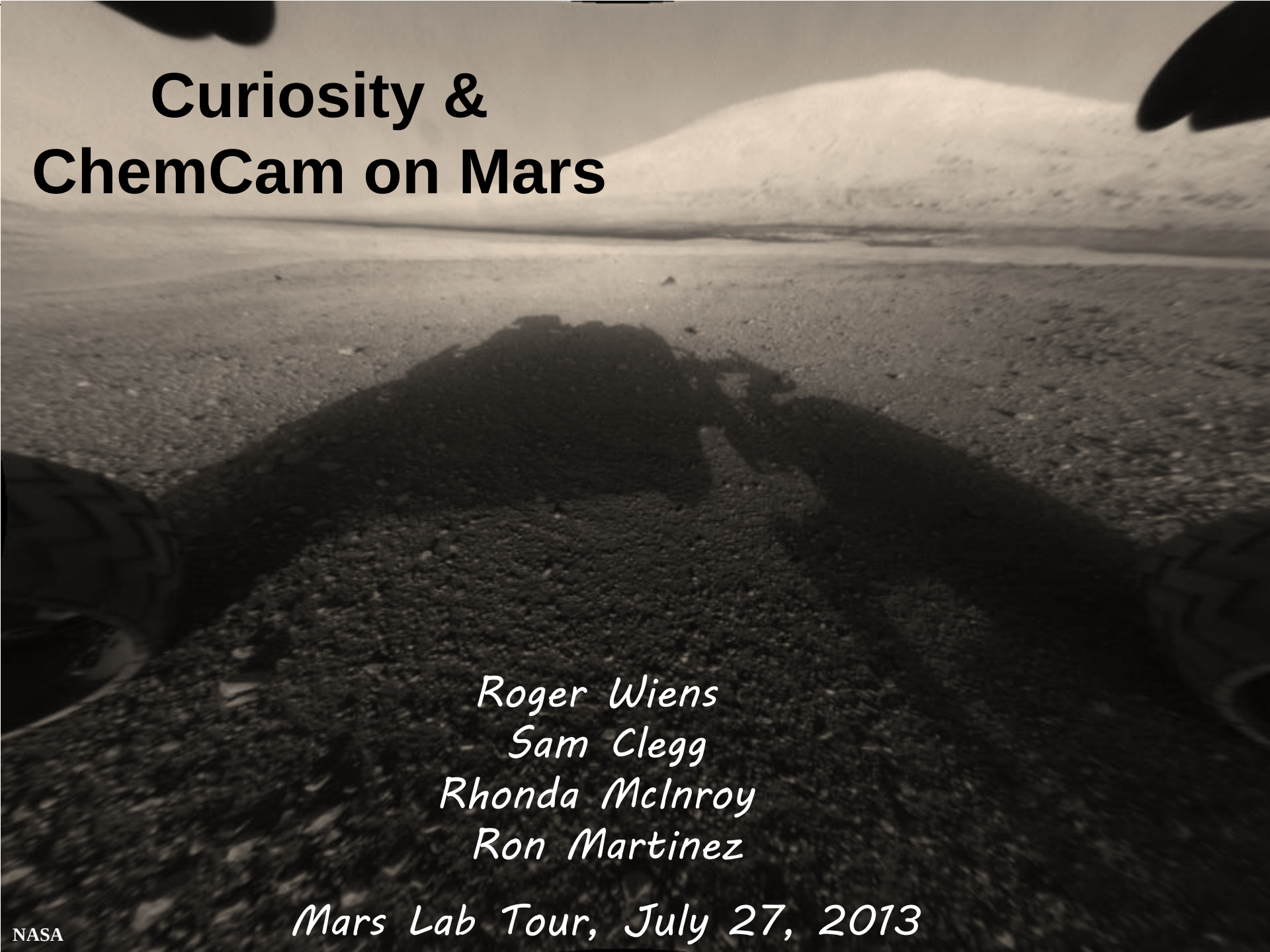


Curiosity & ChemCam on Mars

Roger Wiens
Sam Clegg
Rhonda McInroy
Ron Martinez

Mars Lab Tour, July 27, 2013

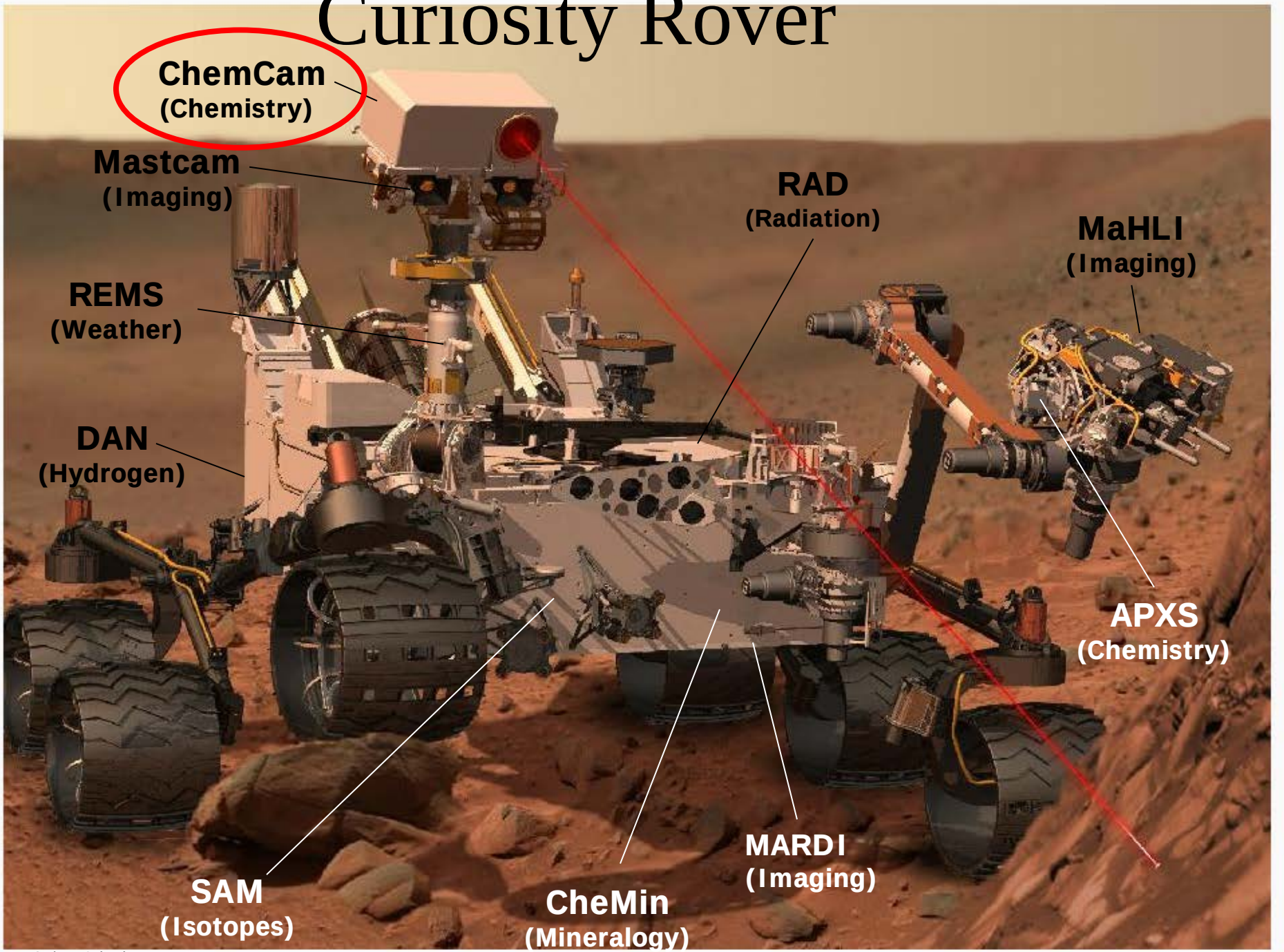
NASA

Abstract

This presentation and the associated flier will be used for the LANL Open House tour of the Mars lab. These explain about the Curiosity rover, highlighting the LANL-led ChemCam project.

The presentation includes on pg 4 a short video clip showing the instrument and the laser-induced breakdown spectroscopy plasmas. The video was provided by John Bass in the LANL Communications Office and was intended for public presentations.

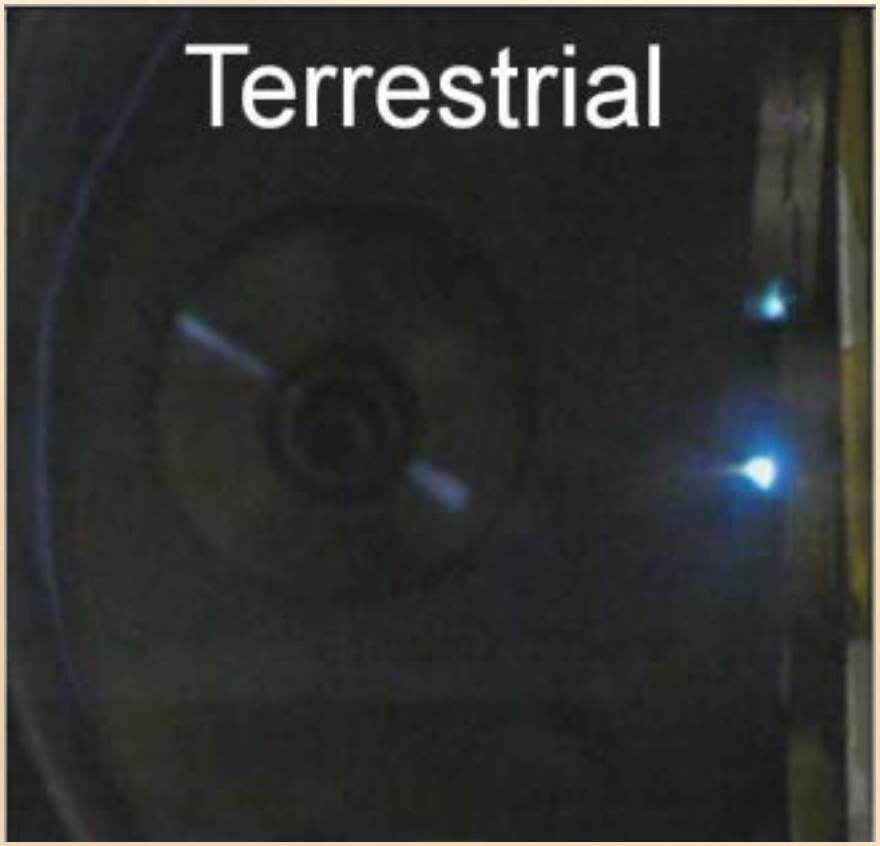
Curiosity Rover

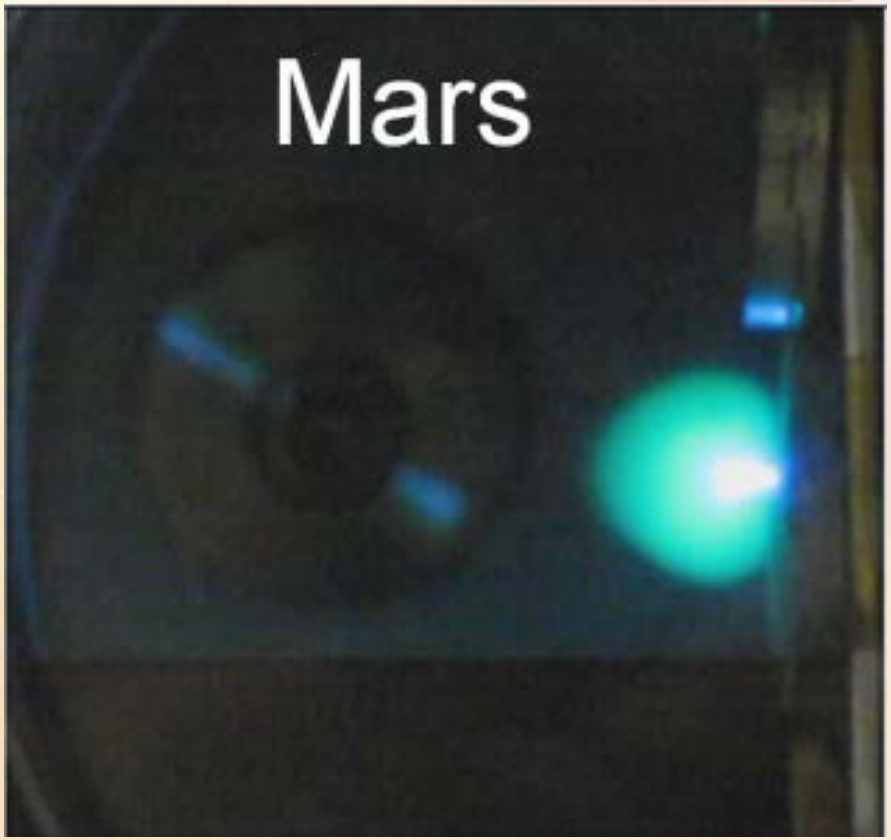


NASA/JPL-Caltech

NASA/JPL-Caltech

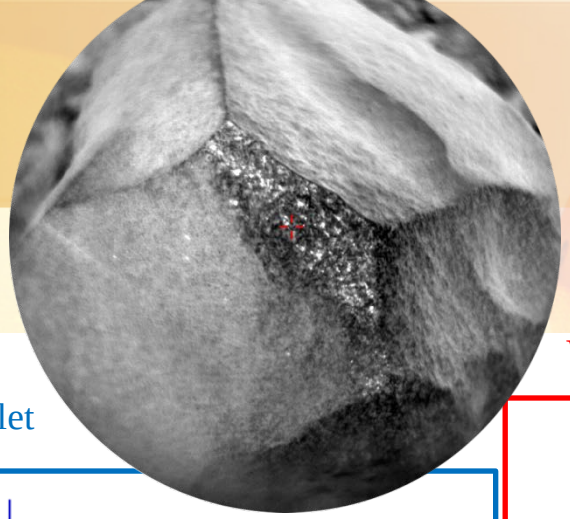
LIBS Plasmas In Different Atmospheres





3”

First Spectrum: Coronation



Field of view:
~ 6 cm

Visible & Near Infrared

Violet

Ultraviolet

Titanium

Manganese

Iron

Magnesium

Silicon

Aluminum

Calcium

Titanium

Aluminum

Calcium

Calcium

Iron

Silicon

Calcium

Hydrogen, 1st Shot

Carbon

Sodium

Silicon

Lithium

Potassium

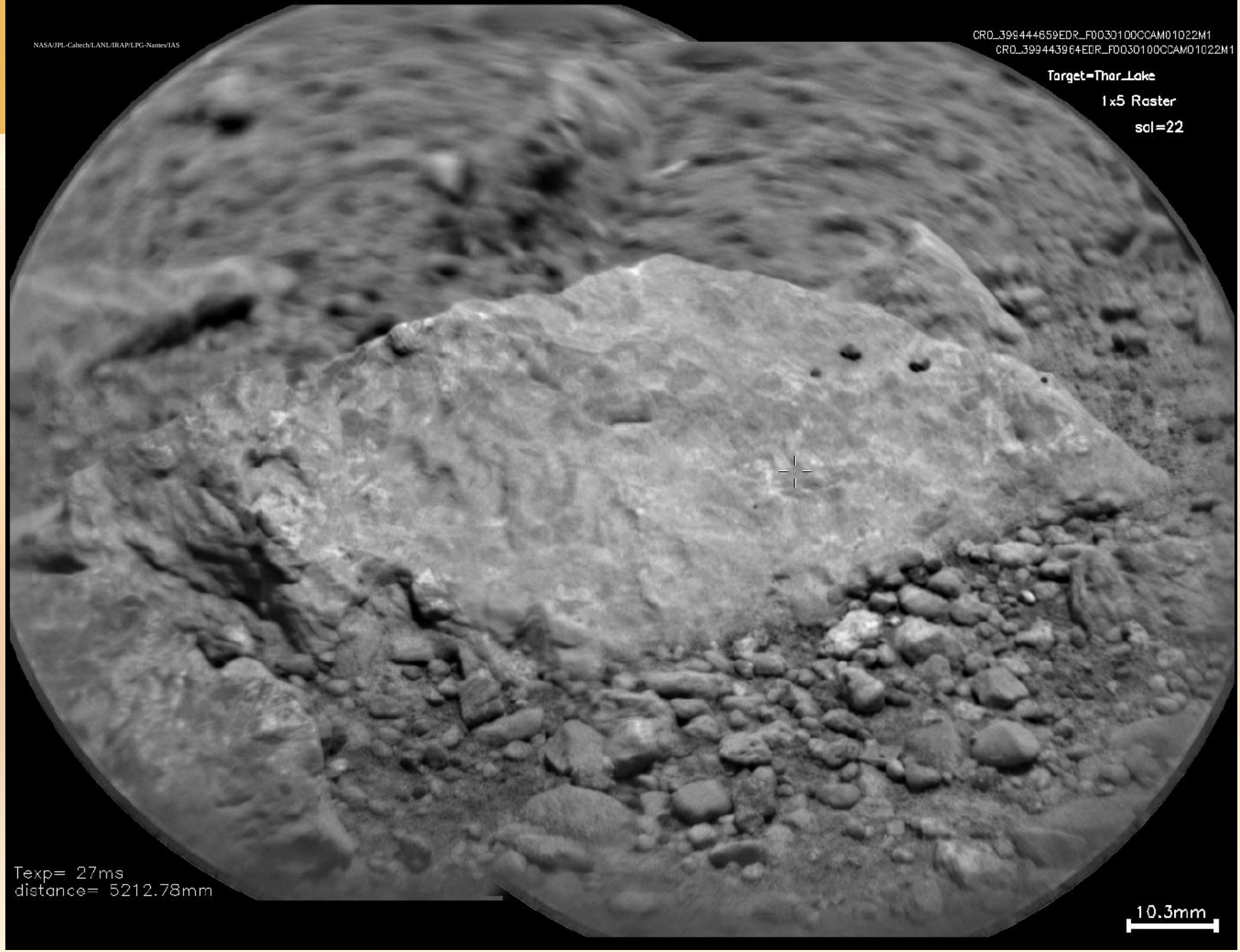
Oxygen

Sodium

Oxygen

Intensity (counts)

Wavelength (nanometers)


NASA/JPL-Caltech/LANL/IRAP/LPG-Nantes/IAS
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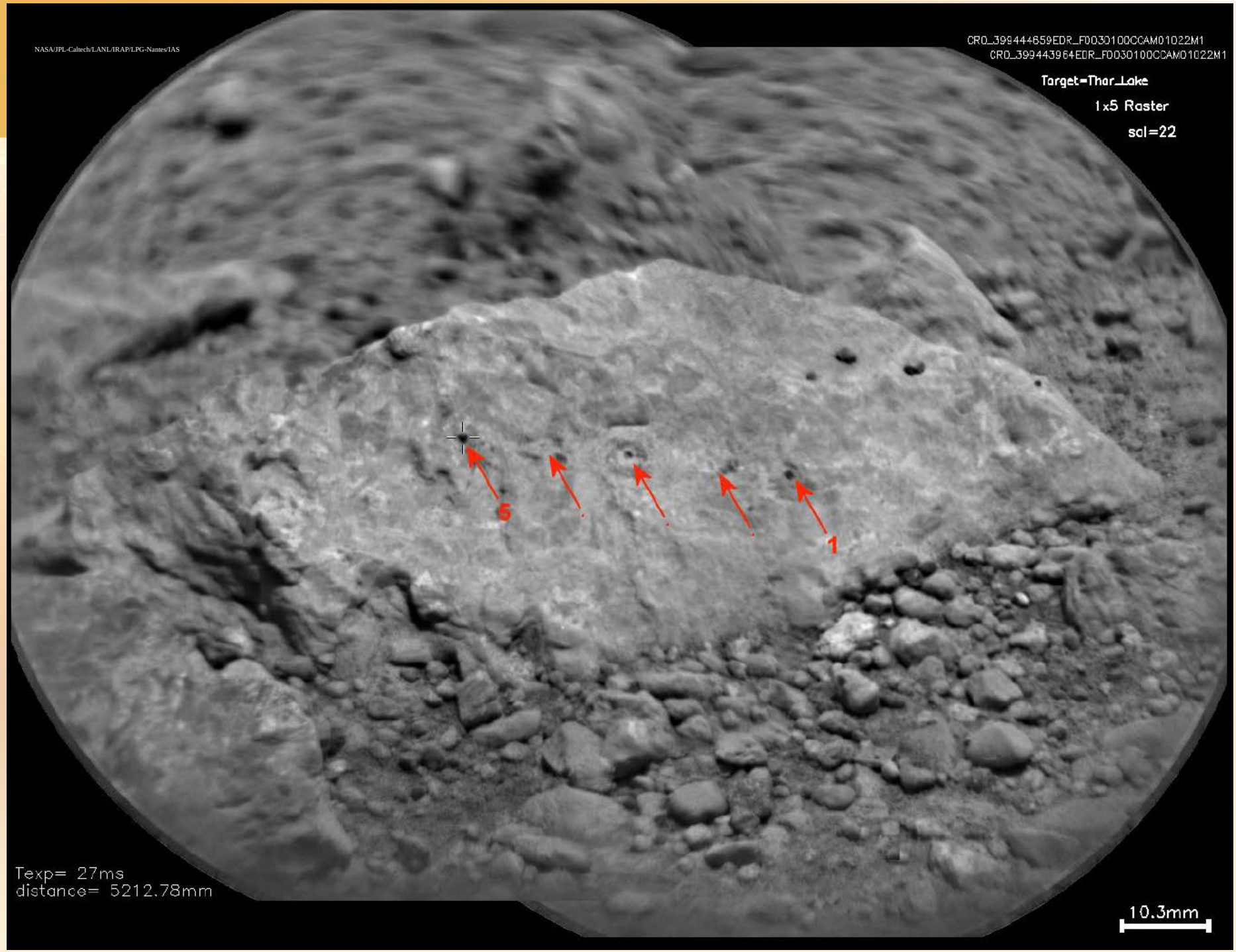
sol=22
Texp= 27ms
distance= 5212.78mm
10.3mm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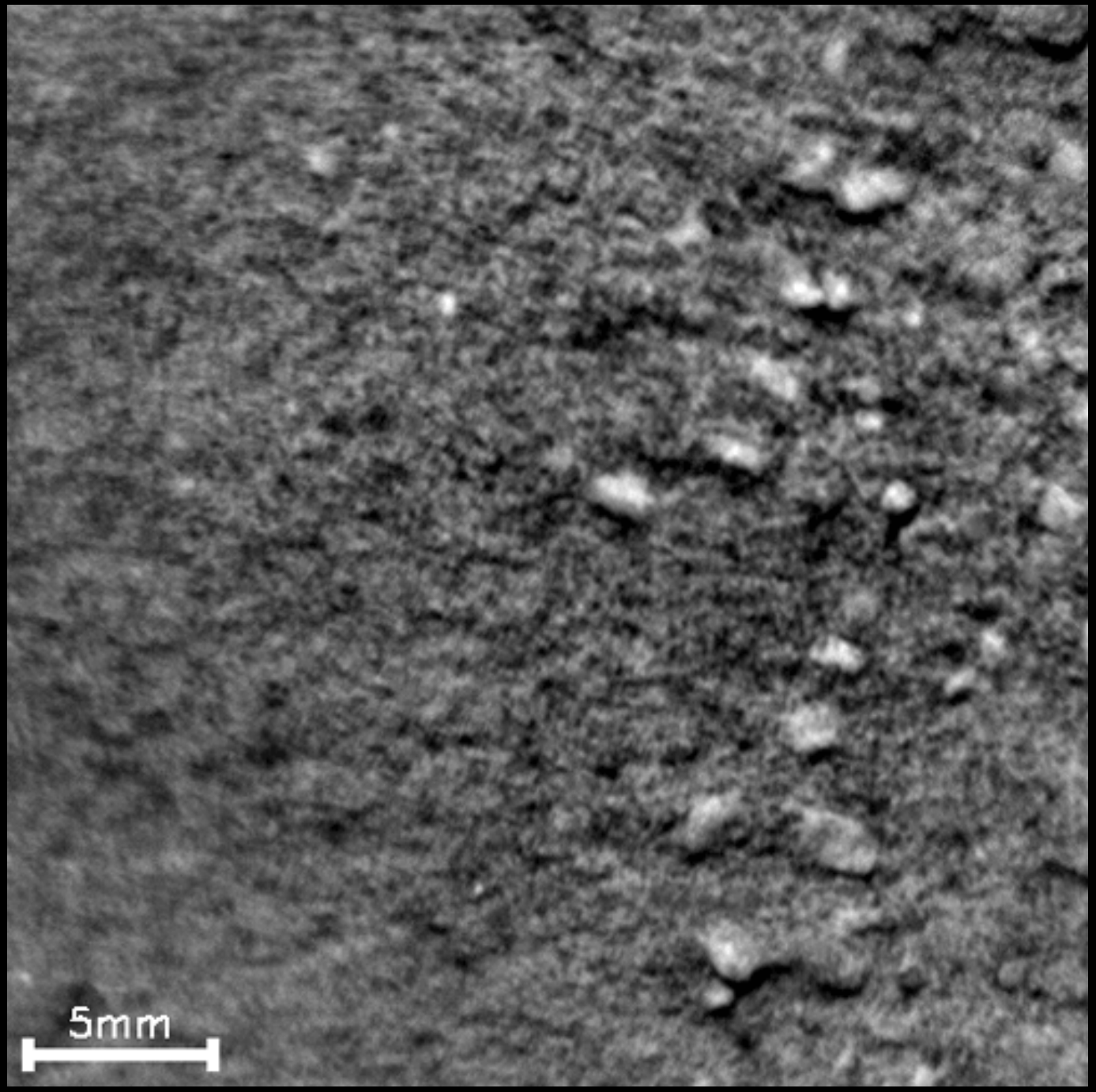
1x5 Raster
sol=22
5
1
Texp= 27ms
distance= 5212.78mm
10.3mm

NASA/JPL-Caltech/LANL/IRAP/IAS



How do you run a Mars rover laser?

LADailyPost.com

Answer: From our laptops downtown Los Alamos

How do you run a Mars rover laser?

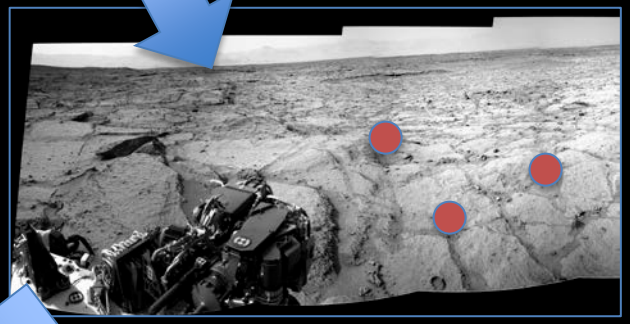
LADailyPost.com

Answer: From our laptops downtown Los Alamos

Operating on Mars

Drive

Downlink New Mosaic



Science Theme Group Selects Targets

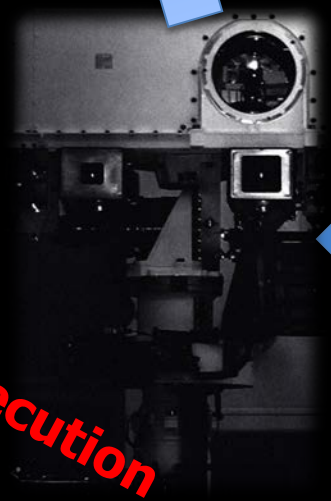
Long-Term Guidance

Lien List

Engineers Build Command Sequences

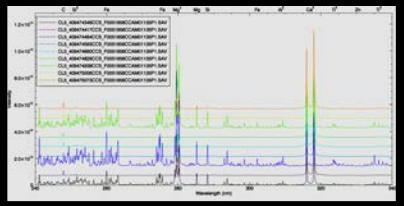
Combine into Master Sequence @ JPL

Uplink



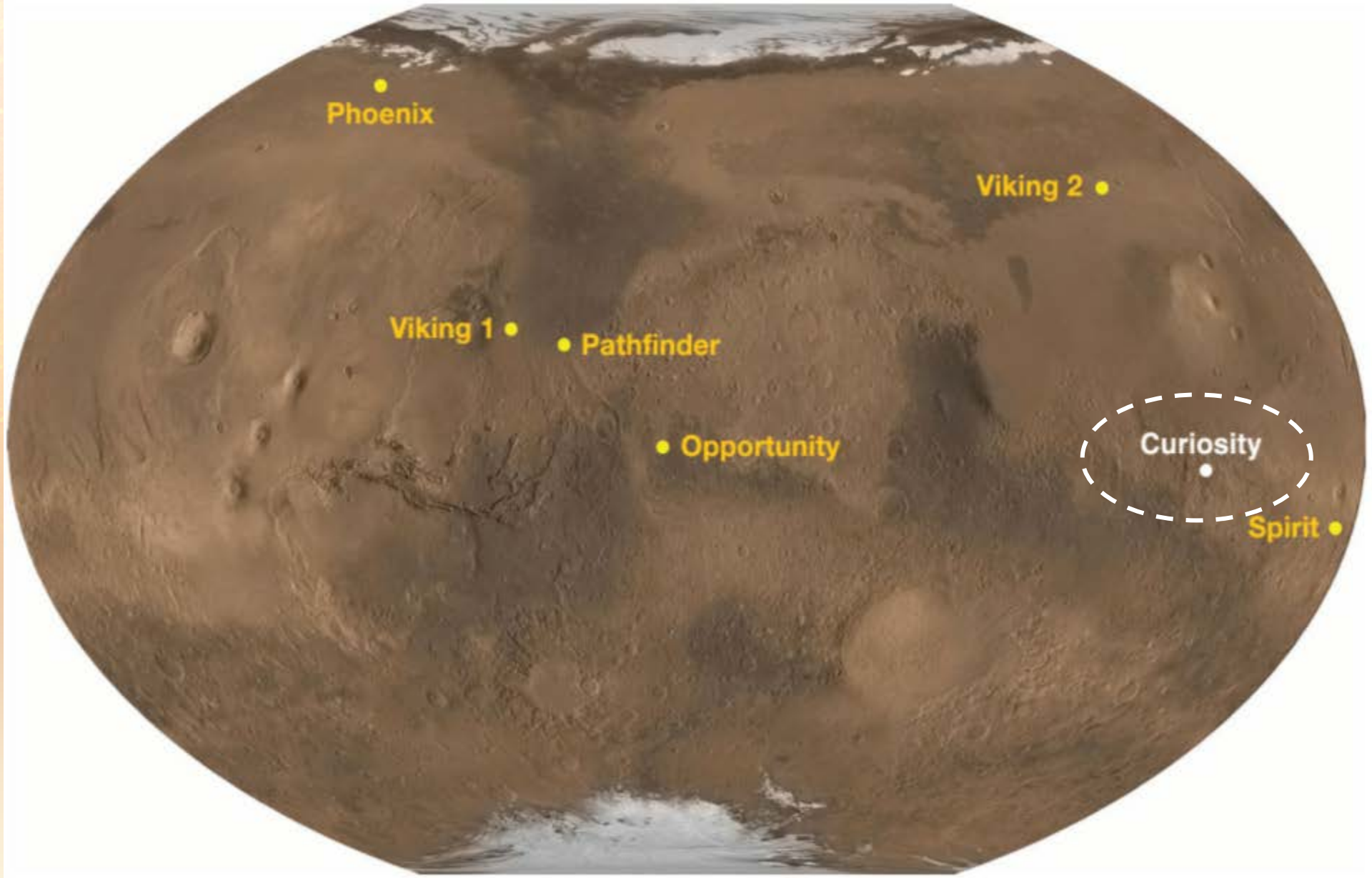
Execution

Down-Link



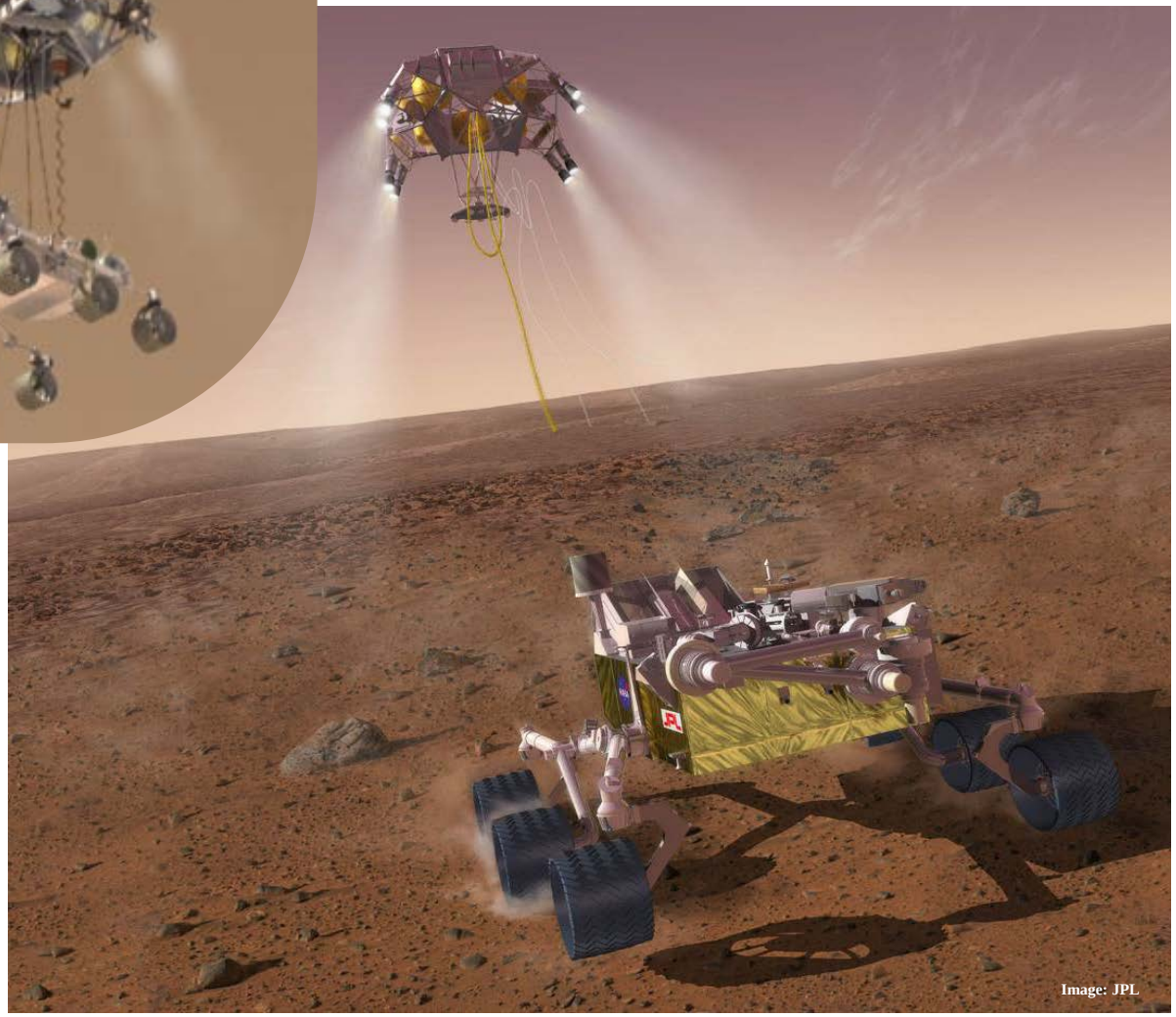
Investigate Eng. & Sci. Data

Mars Landing Sites



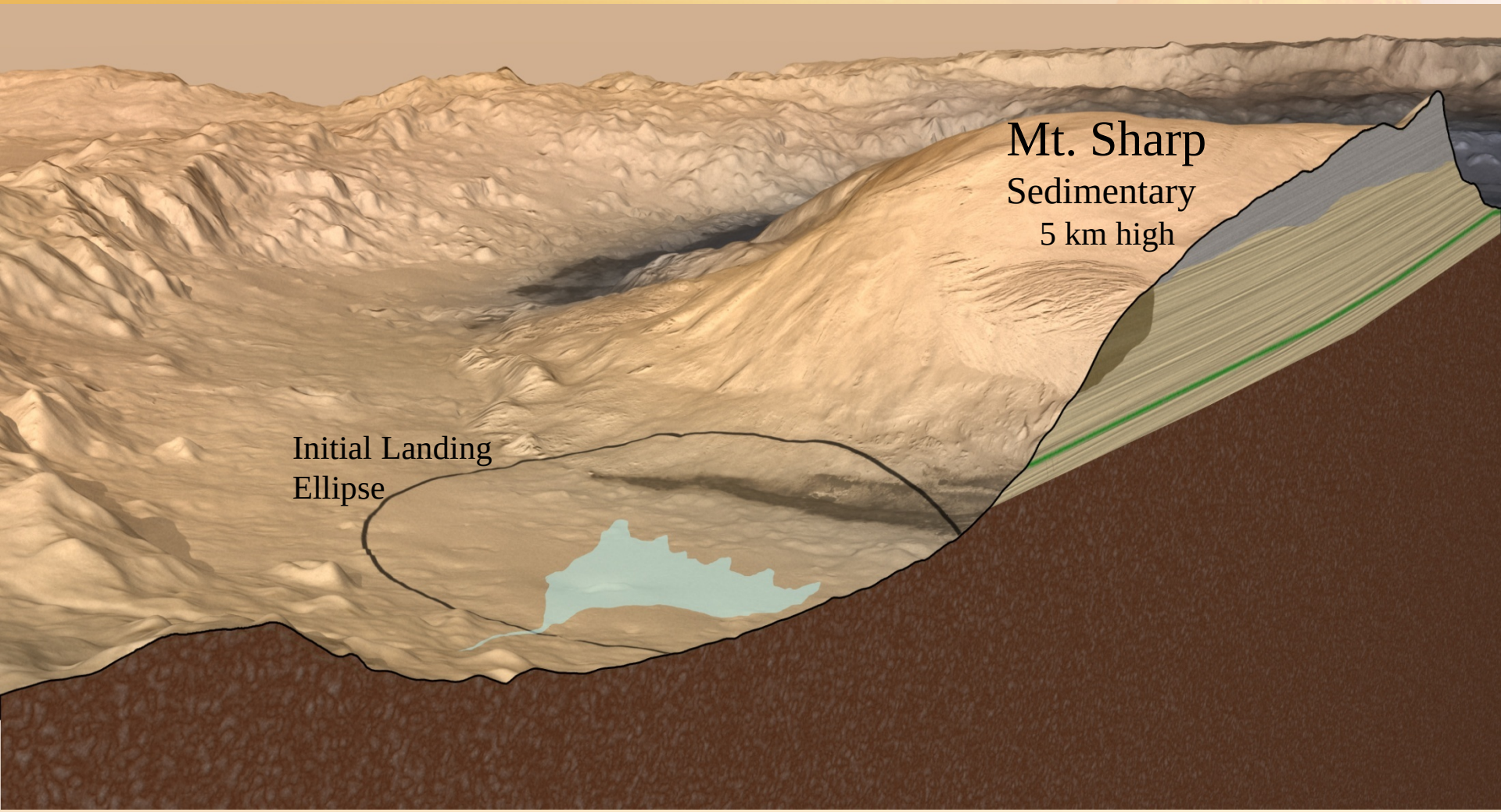
Curiosity Destination: Gale Crater

Mars Mission: Landing



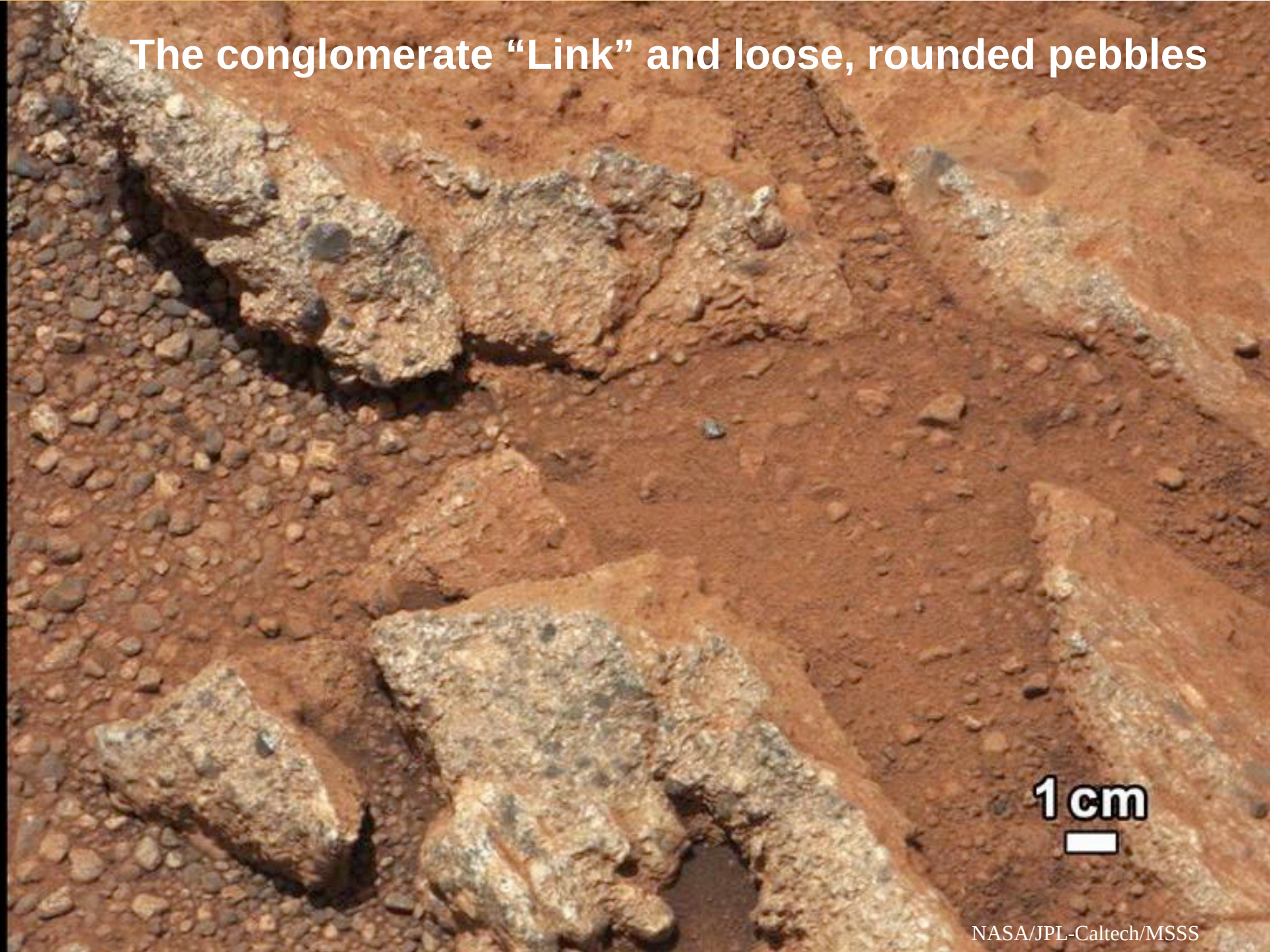
- *950 kg is too heavy for MER-type air bag landing*
- *MSL used a "sky crane"*
  - *Cables lowered it from a retro-rocket package*
  - *MSL lands on its wheels*

Landing on an Alluvial Fan

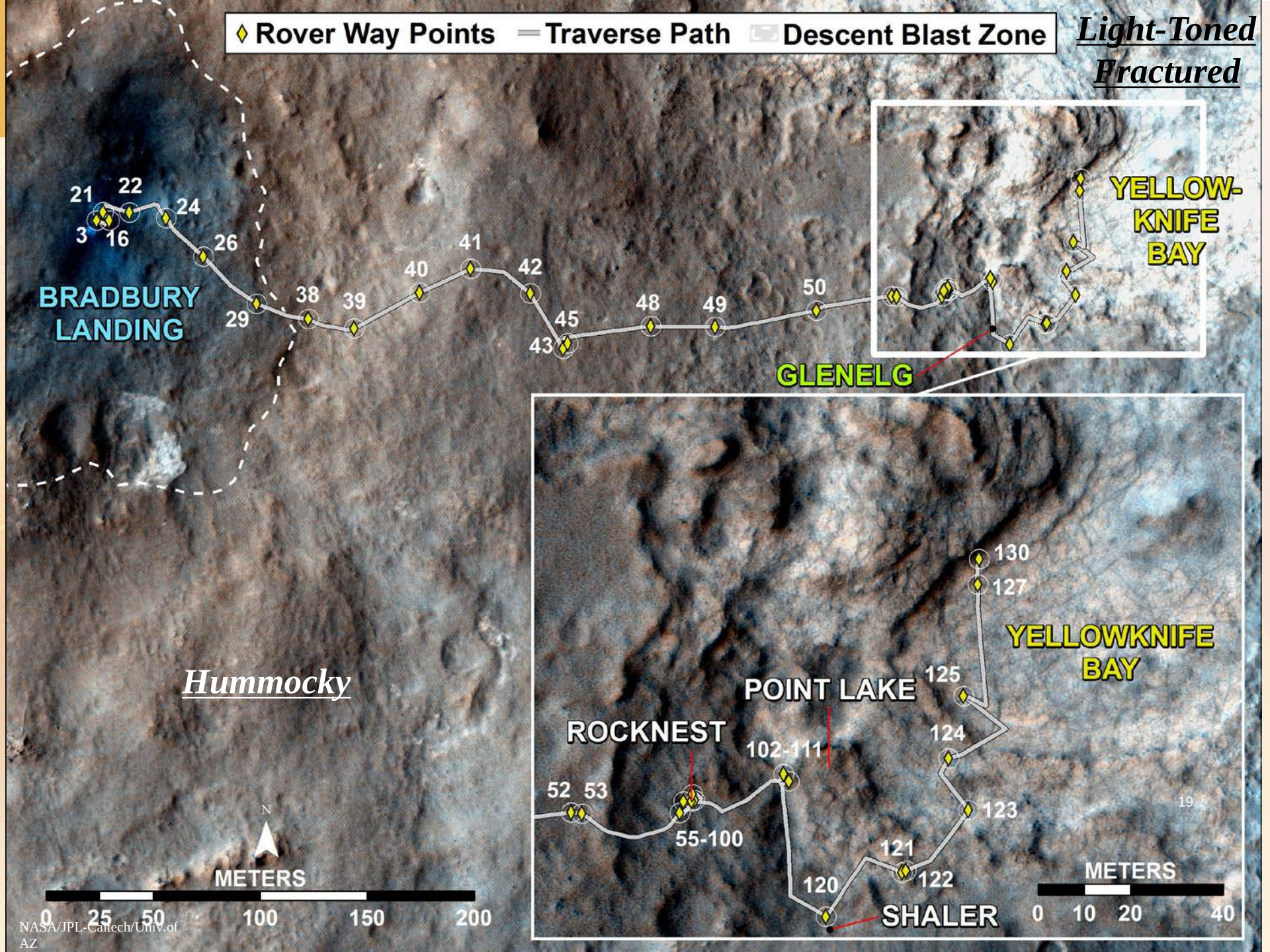



NASA/JPL-Caltech/MSSS

The conglomerate “Link” and loose, rounded pebbles



NASA/JPL-Caltech/MSSS


Rover Way Points
Traverse Path
Descent Blast Zone
Light-Toned Fractured
Hummocky
BRADBURY LANDING
YELLOW-KNIFE BAY
GLENELG
YELLOWKNIFE BAY
POINT LAKE
ROCKNEST
SHALER
21
22
24
3
16
26
29
38
39
40
41
42
43
45
48
49
50
130
127
125
124
102-111
52
53
55-100
123
121
122
120
N
METERS
0 25 50 100 150 200
METERS
0 10 20 40
19
NASA/JPL-Caltech/Univ.of AZ

NASA/JPL-Caltech/MSSS

CURIOSITY

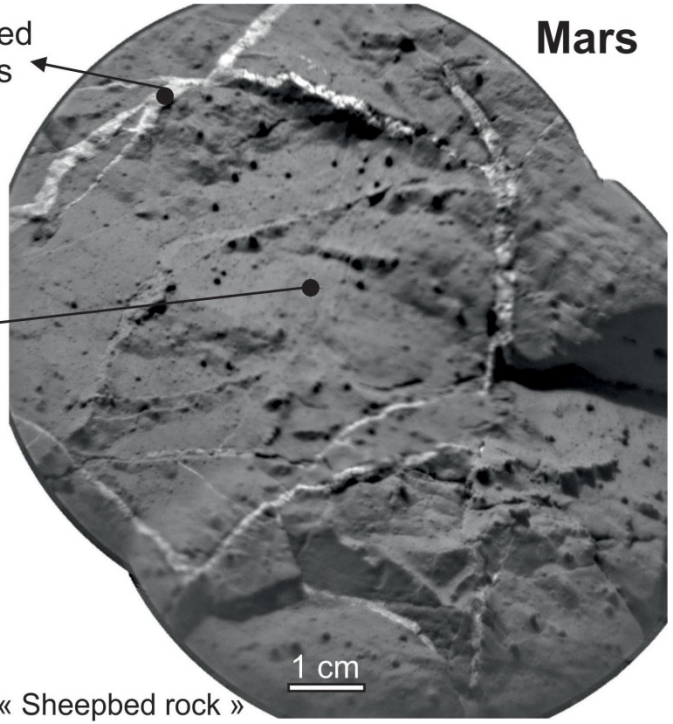
Heading into Yellowknife Bay

Veins of hydrated calcium sulfates

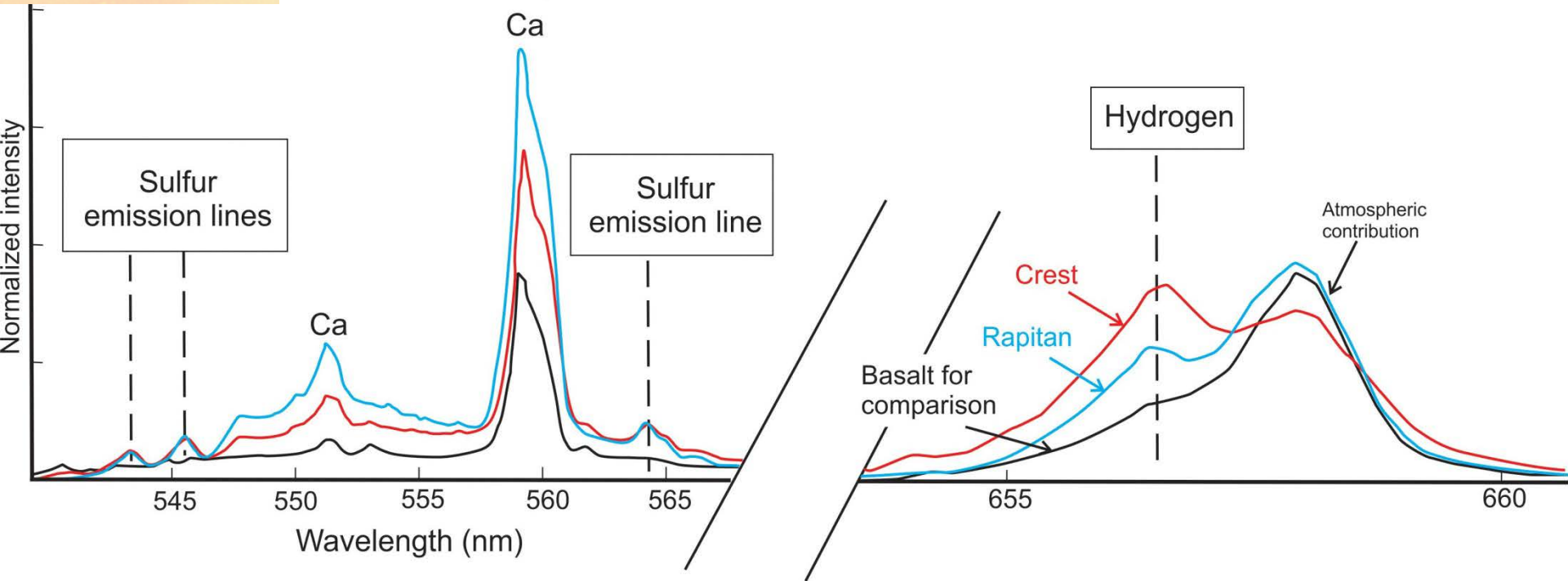
Sediments with basaltic composition

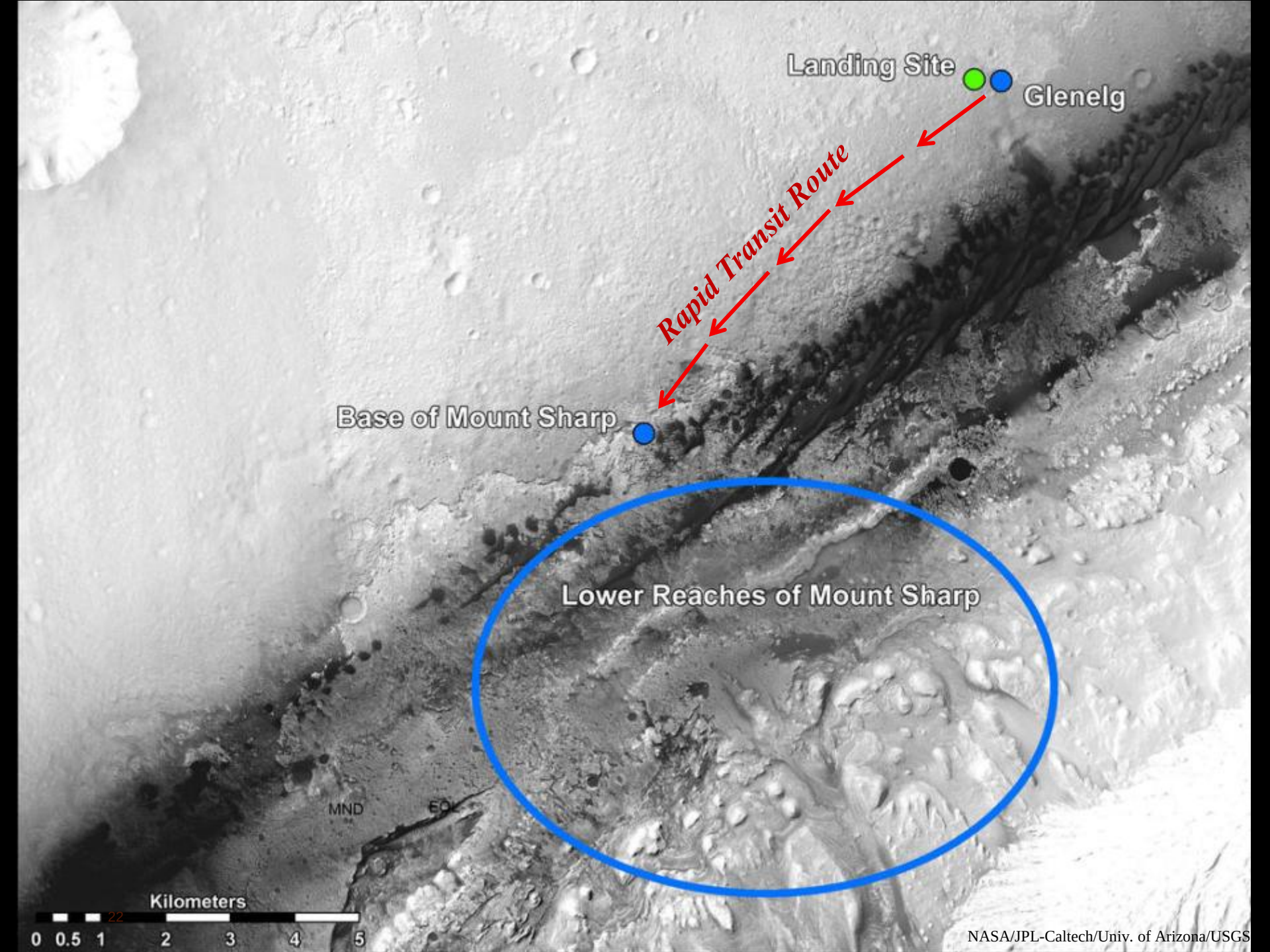
Mars

Earth



« Sheepbed rock »





NASA/JPL-Caltech/Univ. of Arizona/USGS

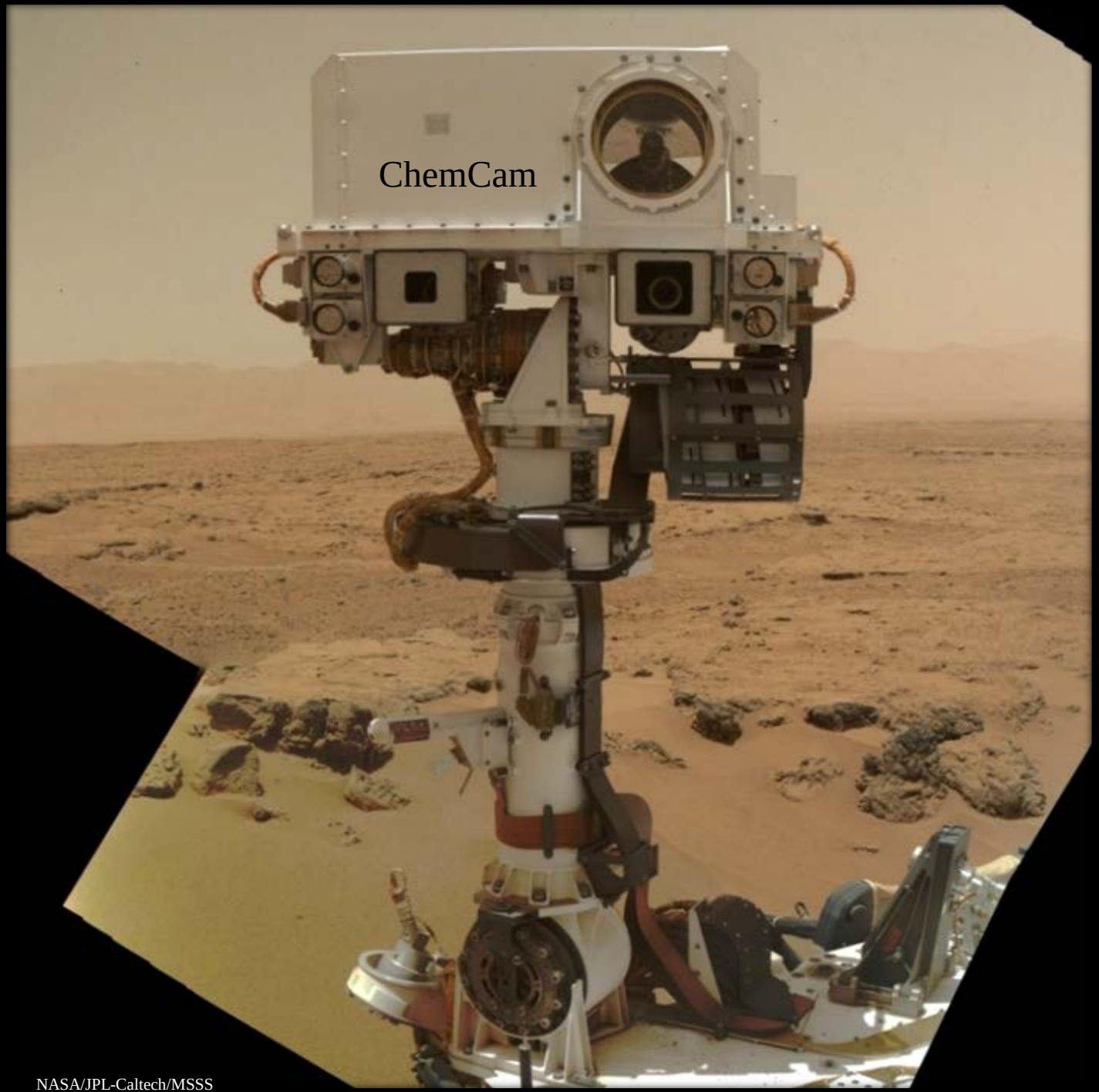
NASA/JPL-Caltech/MSSS

CURIOSITY

Mastcam image of Mount Sharp's canyons and buttes

ChemCam Discoveries

- Mars soil and dust is hydrated
  - ChemCam can also see local rock contributions in millimeter-size grains becoming part of the soil
- 1st observations of trace elements lithium, strontium, rubidium, barium
  - Lithium in particular helps us understand the origin of the martian soil
- Igneous rock diversity
  - New class of feldspar-rich rocks not expected on Mars
  - Conglomerates consist of small clasts of this material
- Atmospheric ozone and water vapor (passive sky observations)
- Calcium sulfate veins in Yellowknife Bay rocks
- Genetic relationships between rocks at different locations Curiosity has visited so far

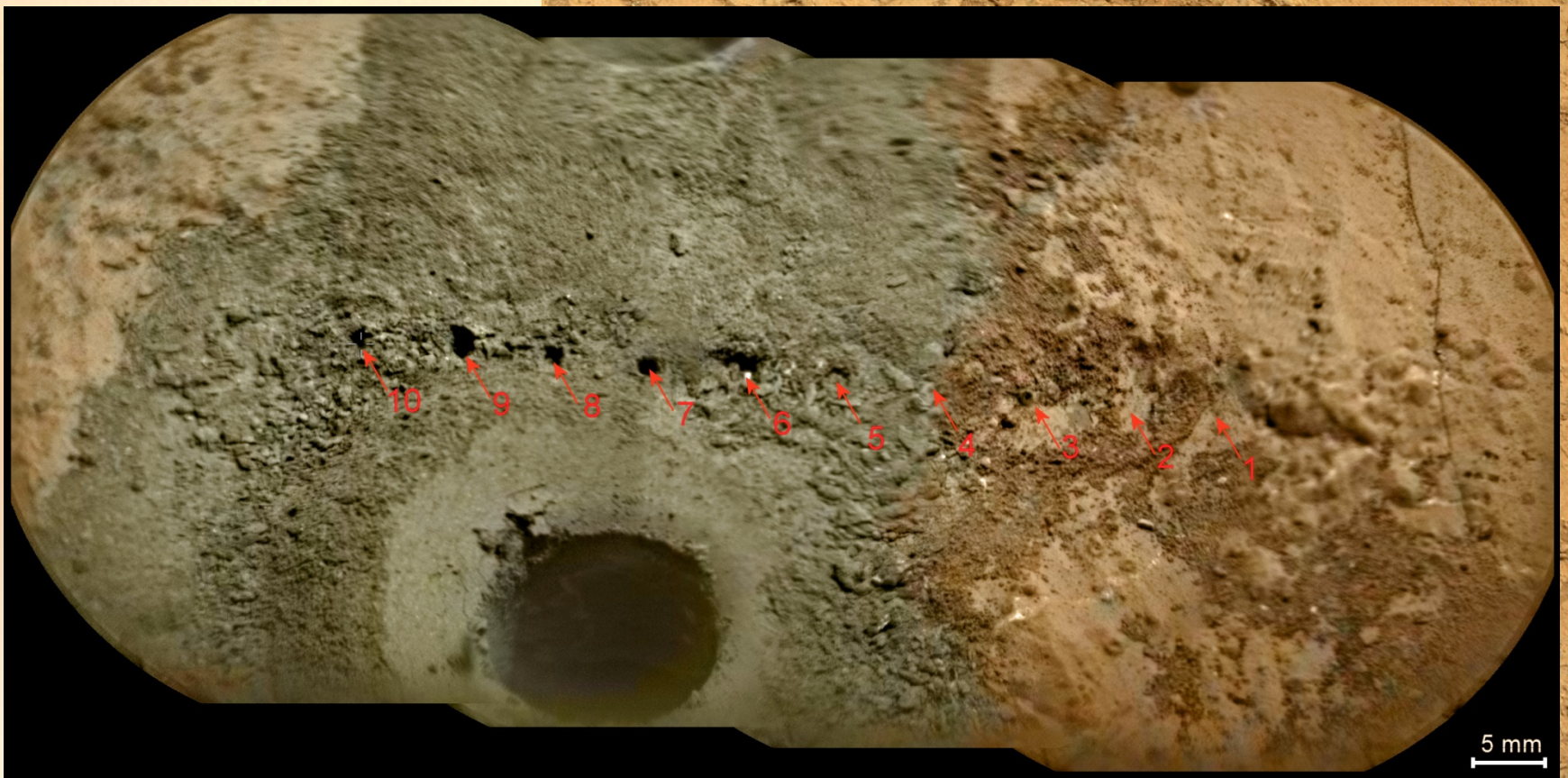


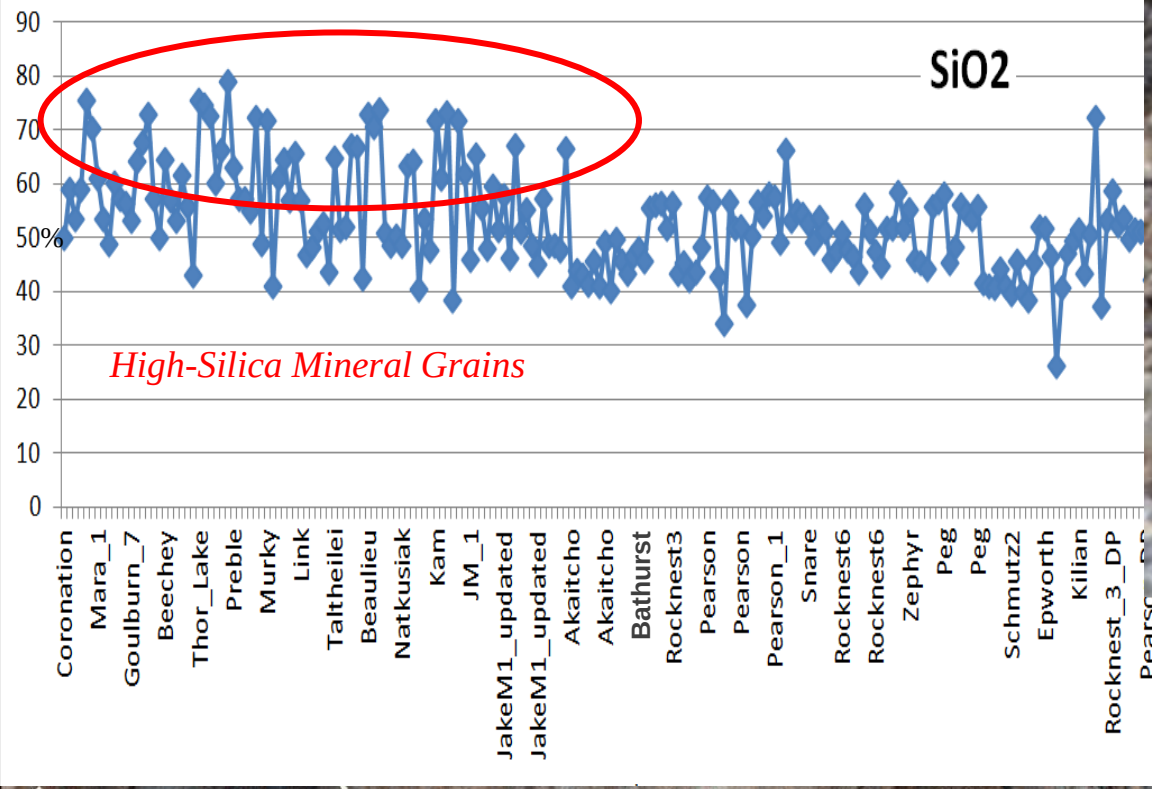
NASA/JPL-Caltech/MSSS

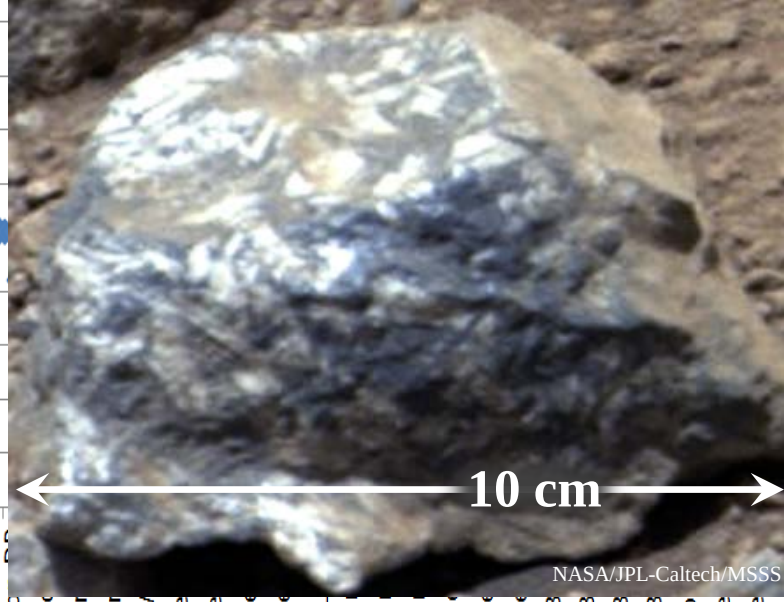
Additional Slides

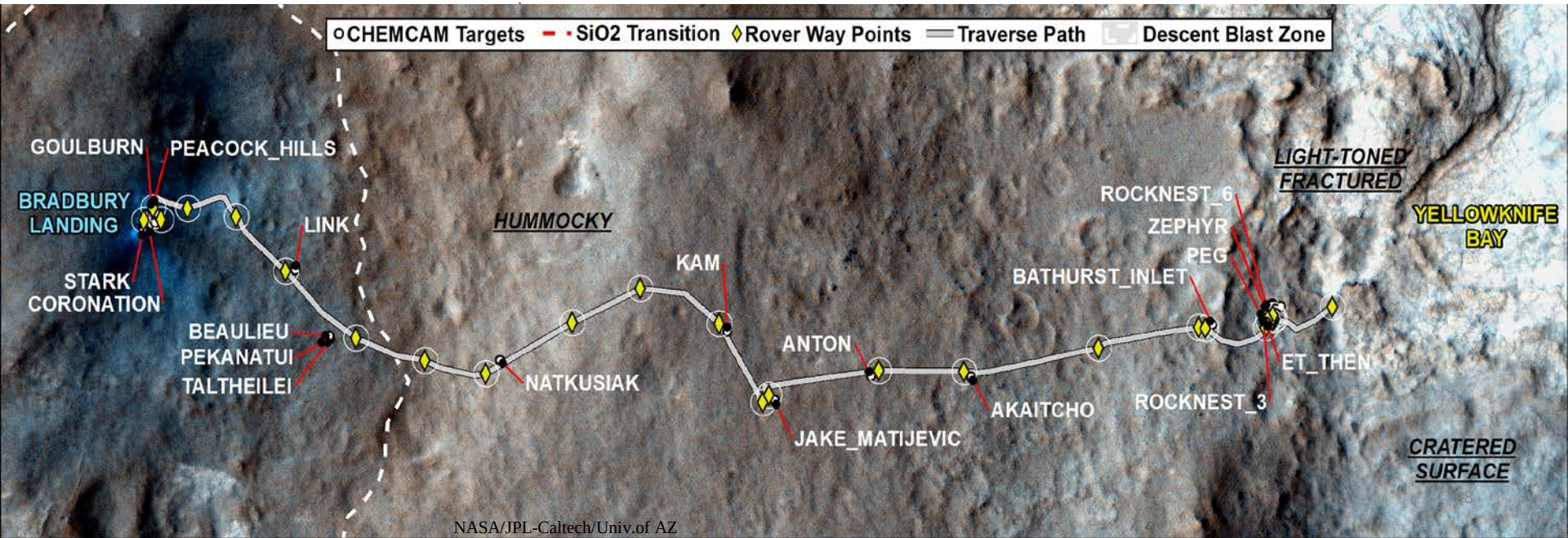
Drill Results

- *20% of material is clay*
- *Laid down in water*
- *Water had normal pH*

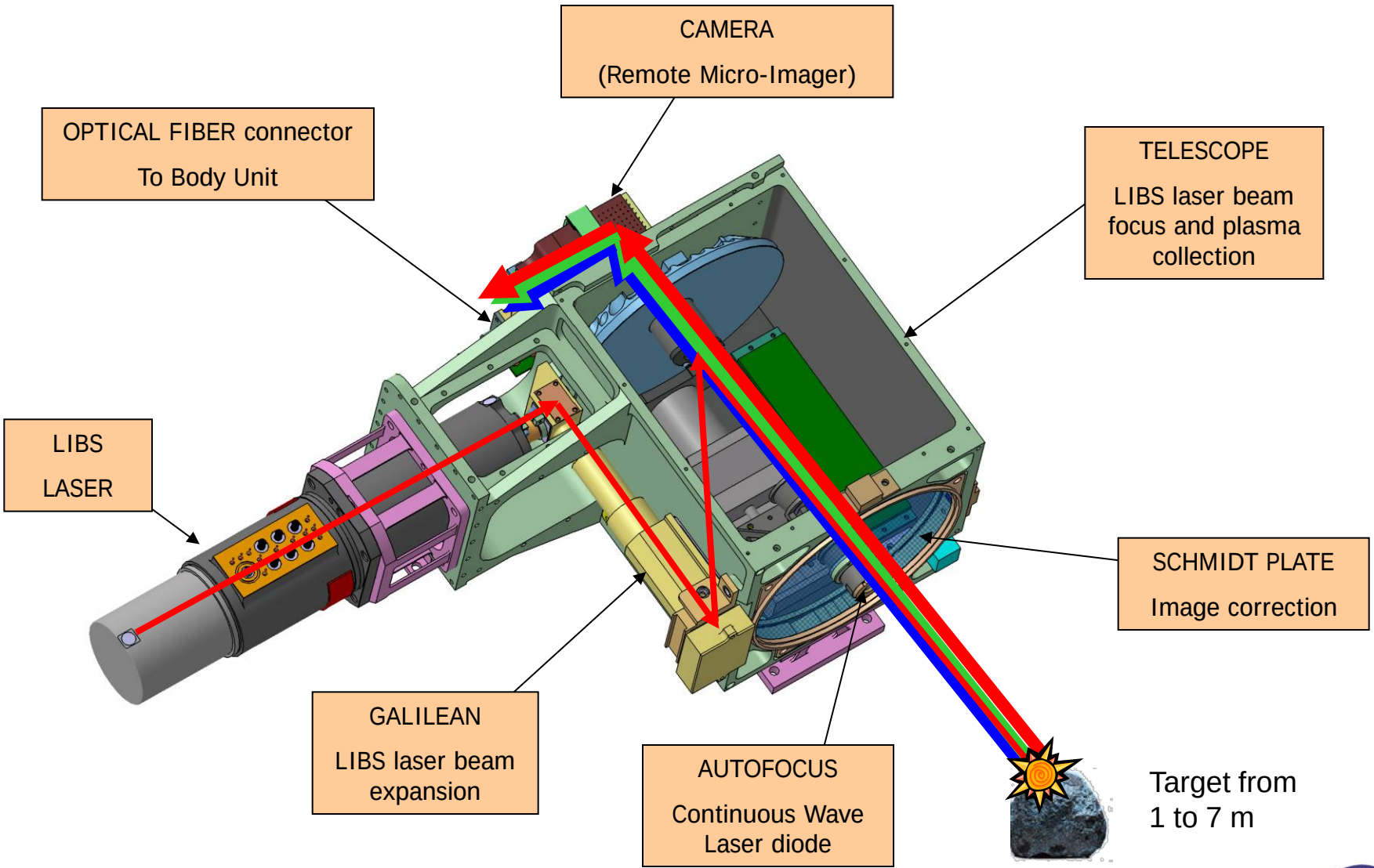



SiO2
90
80
70
60
50%
40
30
20
10
0
High-Silica Mineral Grains
Coronation
Mara_1
Goulburn_7
Beechey
Thor_Lake
Preble
Murky
Link
Taltheilei
Beaulieu
Natkusiak
Kam
JM_1
JakeM1_updated
JakeM1_updated
Akaitcho
Akaitcho
Bathurst
Rocknest3
Pearson
Pearson
Pearson_1
Snare
Rocknest6
Rocknest6
Zephyr
Peg
Peg
Schmutz2
Epworth
Kilian
Rocknest_3_DP


10 cm
NASA/JPL-Caltech/MSSS


CHEMCAM Targets
SiO2 Transition
Rover Way Points
Traverse Path
Descent Blast Zone
GOULBURN
PEACOCK_HILLS
BRADBURY LANDING
LINK
STARK
CORONATION
BEAULIEU
PEKANATUI
TALTHEILEI
HUMMOCKY
NATKUSIAK
KAM
ANTON
JAKE_MATIJEVIC
AKAITCHO
BATHURST_INLET
ROCKNEST_6
ZEPHYR
PEG
ROCKNEST_3
ET_THEN
LIGHT-TONED FRACTURED
YELLOWKNIFE BAY
CRATERED SURFACE
NASA/JPL-Caltech/Univ.of AZ

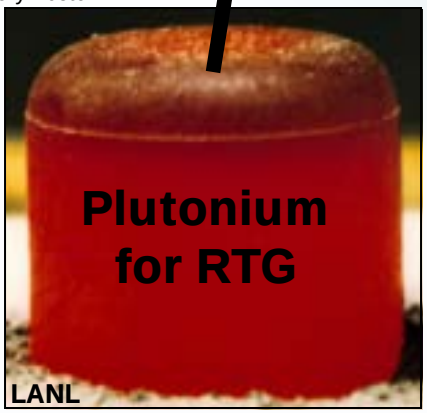
ChemCam Mast Unit : Optical Box



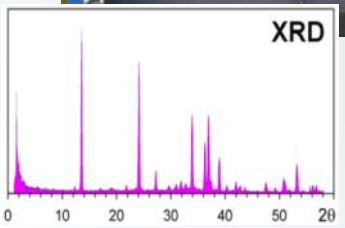
Los Alamos Involvement in Curiosity

NASA/JPL-Caltech /MSSS

NASA/Cory Huston



NASA/JPL-Caltech



CheMin

Science Co-lead is
from LANL

Los Alamos NATIONAL LABORATORY

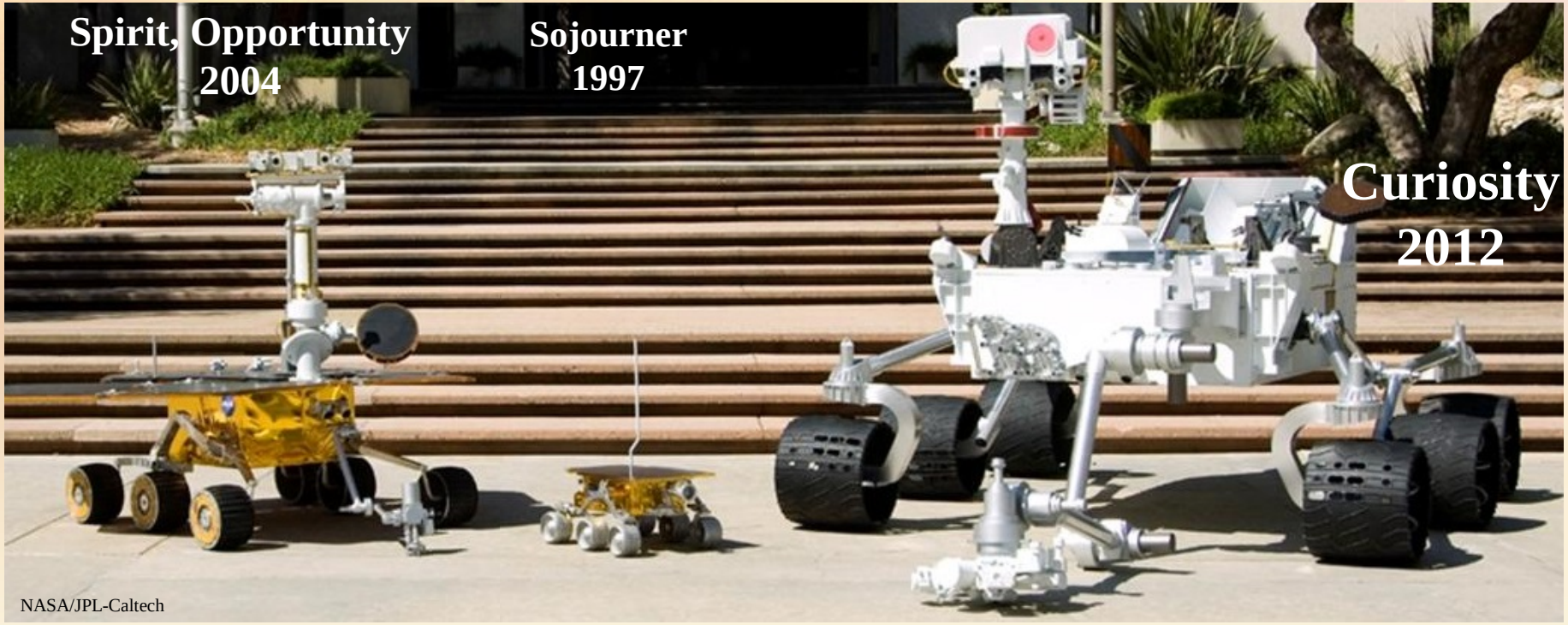
irap astrophysique & planétologie

cnes CENTRE NATIONAL D'ETUDES SPATIALES

NASA

Curiosity Rover Goals

- Assess Mars' biological potential by searching for:
  - organic carbon compounds,
  - chemical building blocks of life,
  - biologically relevant clues.
- Characterize the geology of the landing region
- Investigate Mars' past habitability (including the role of water)
- Characterize the human hazards on Mars



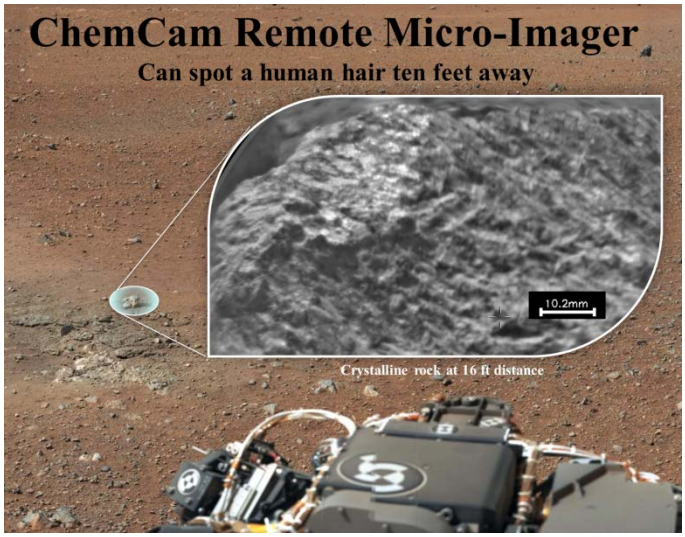
Los Alamos on Mars

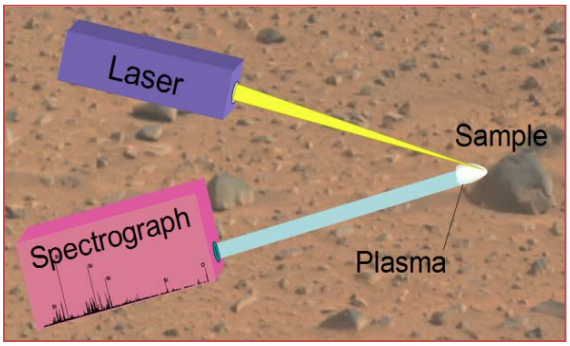
Curiosity Rover Facts

- Length: 10 feet
- Width: 9 feet
- Weight: 1,928 lbs
- Wheels: 20” dia.
- Payload: 10 instruments
- Payload mass: > 160 lbs
- Power: 2400 W-hrs/day
- Data Rate: ~40 MB/day
- Landed: August 6, 2012
- Mission: 2+ Earth years
- Distance plan: 13 miles
- Distance so far: 1 mile

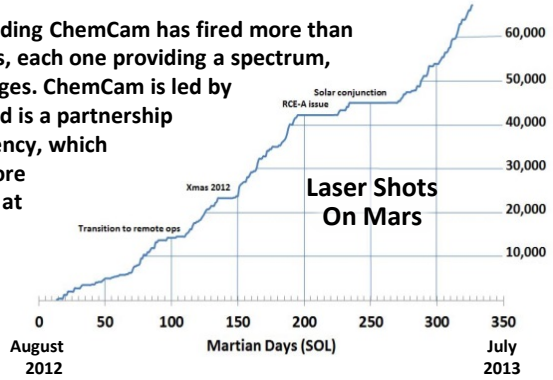
ChemCam Operation

1. Curiosity aims the ChemCam unit at a target.
2. ChemCam takes a close-up RMI image (black & white image, rt).
3. Powerful but invisible laser pulses are fired at the target.
4. A very small amount of material is blasted off the surface at a temperature around 10,000°C, making a bright flash (bottom image).
5. ChemCam collects some of the plasma light. An optical fiber sends the light from the Mast to the rover body, where spectrographs separate the light into a rainbow of colors (a color spectrum). The spectrum (below) contains atomic emission lines identifying the elements present and their abundances.
6. At the end of the Mars day the spectrum is sent to Earth. It is received by NASA's Deep Space Network of antennae located around the world. The data are sent to Jet Propulsion Laboratory.
7. ChemCam scientists in Los Alamos, NM and Toulouse, France process the images and spectra and report the results to the rest of the Curiosity team, and eventually, to the world.

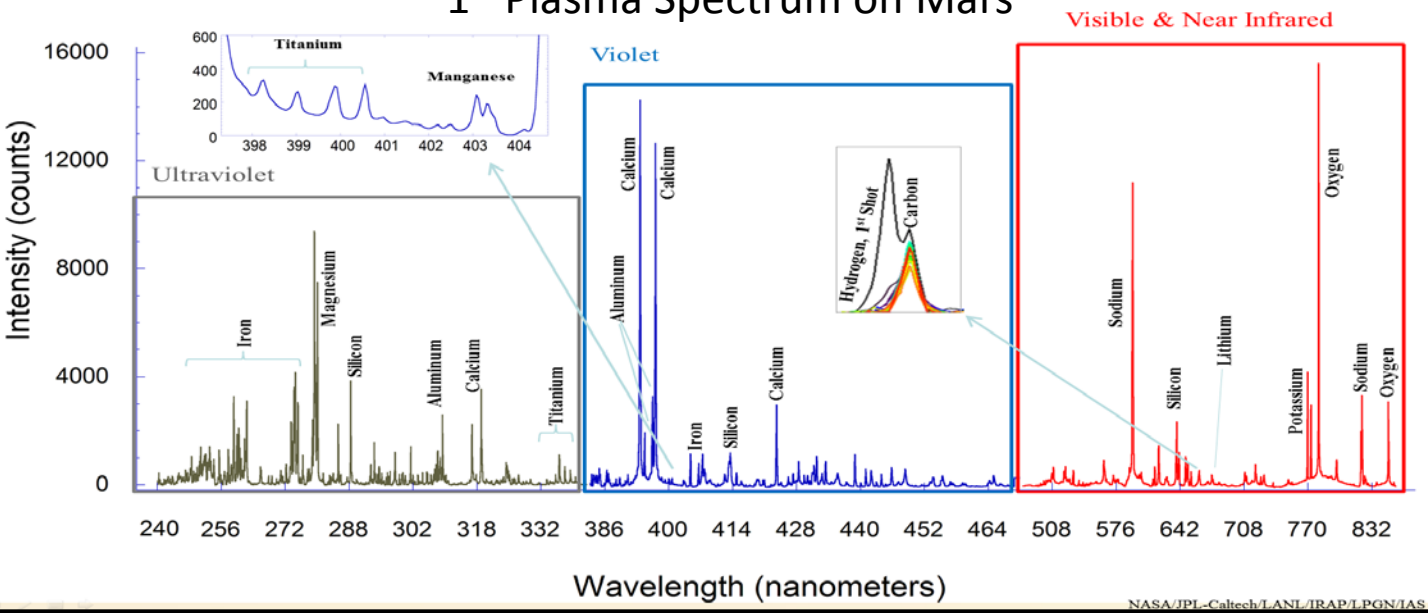




Since the August, 2012 landing ChemCam has fired more than 70,000 laser shots on Mars, each one providing a spectrum, and has taken > 1,000 images. ChemCam is led by LANL, funded by NASA, and is a partnership with the French Space Agency, which provided the laser. See more information on ChemCam at http://msl-chemcam.com and for more information on Curiosity go to mars.jpl.nasa.gov/msl



1st Plasma Spectrum on Mars



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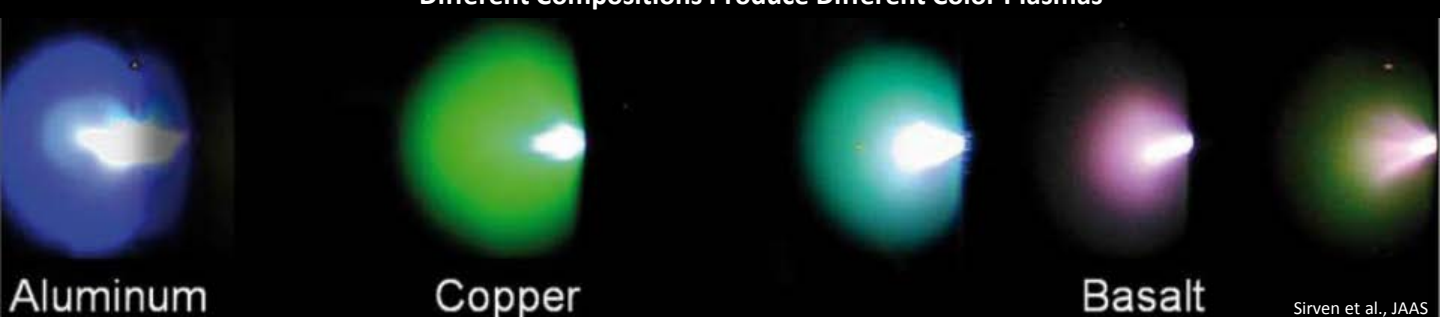
Different Compositions Produce Different Color Plasmas



Sirven et al., JAAS