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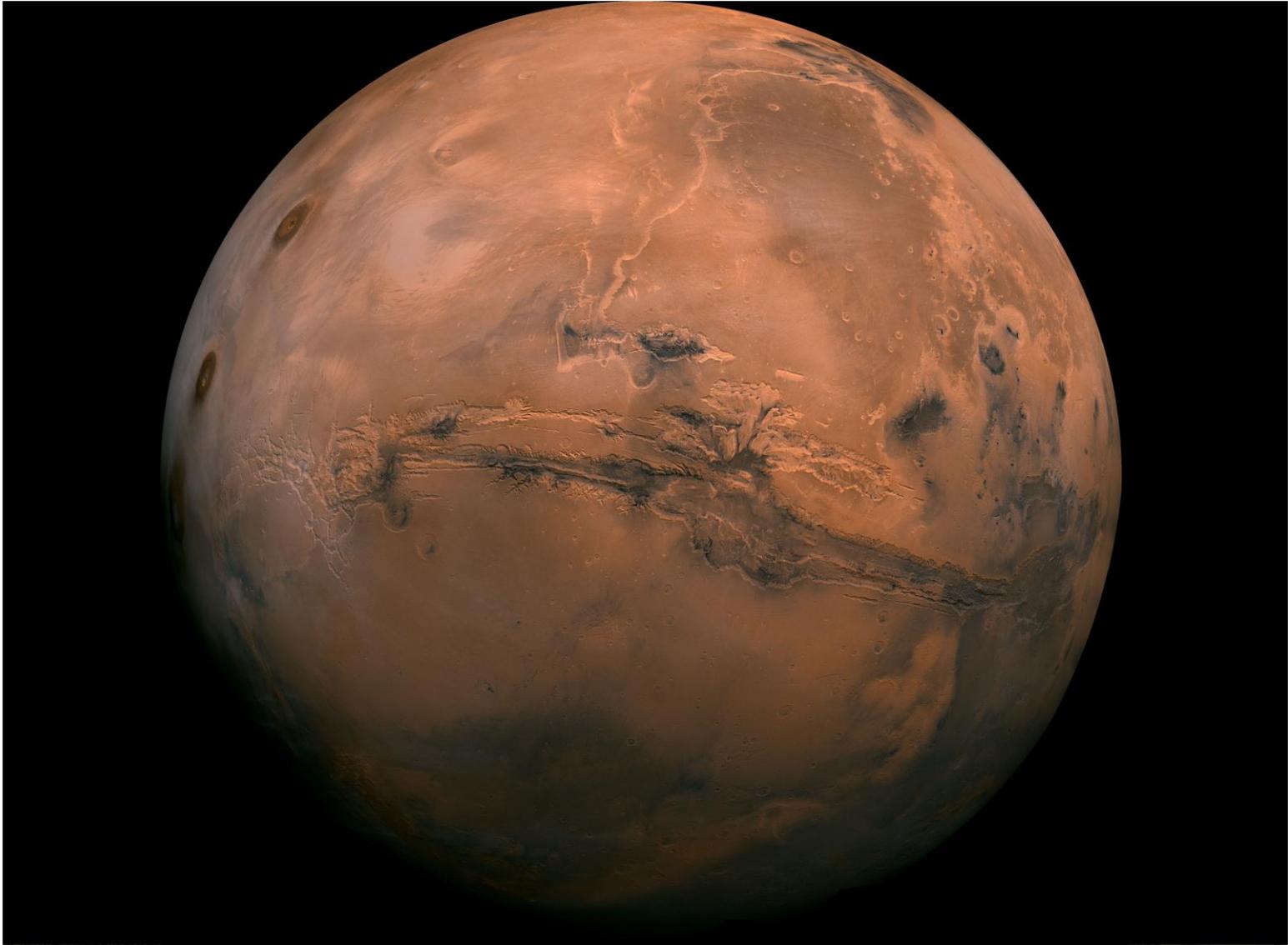
Exploring Mars with the Curiosity & Mars 2020 Rovers

Jeff Srinivasan, Deputy Flight System Manager
Mars 2020 Project
Jet Propulsion Laboratory
California Institute of Technology

JPL in Pasadena, CA ==> Mars!



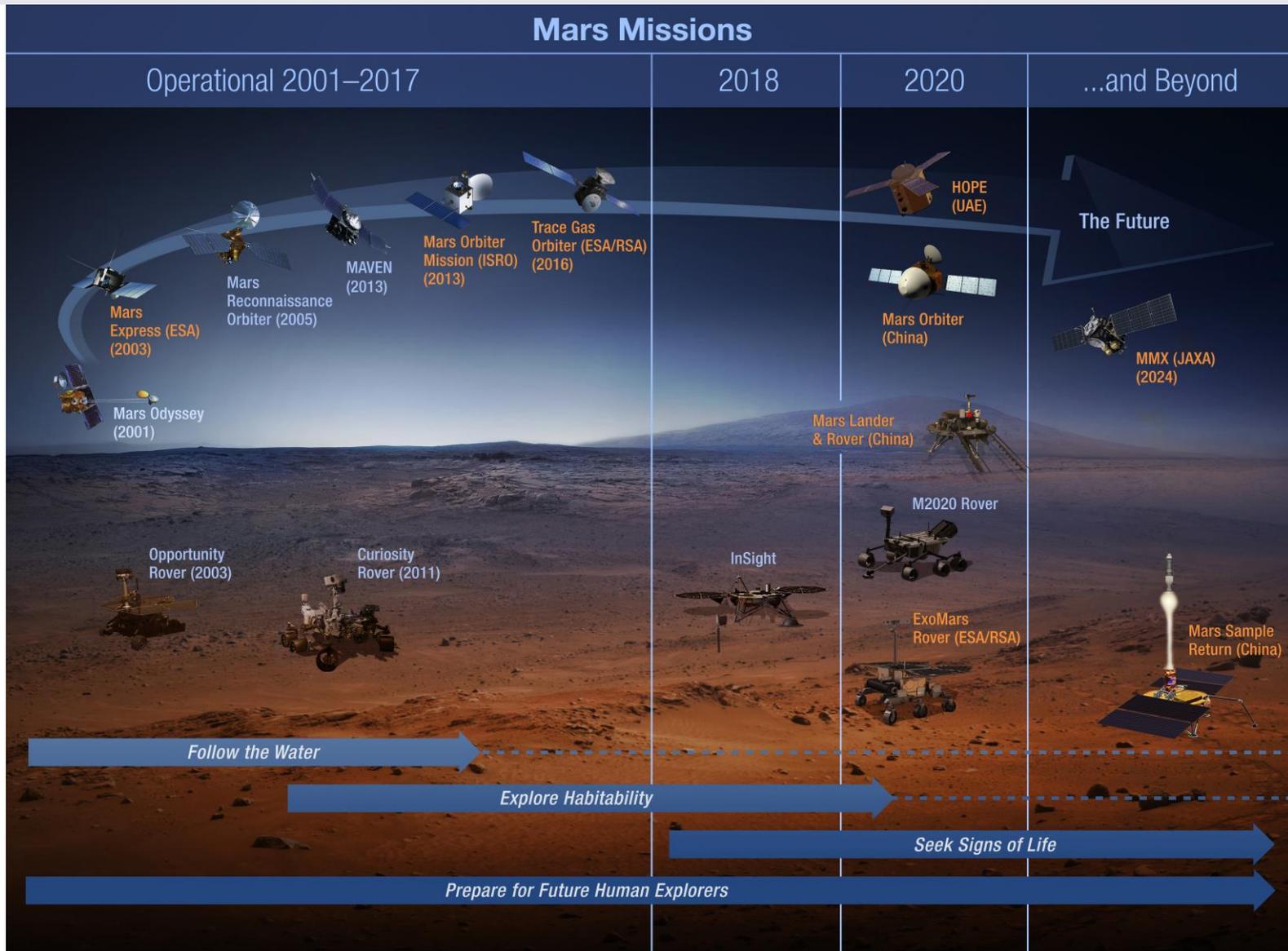
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Current & Future Mars Missions





Exploring Habitability with Curiosity 2011

Seven Minutes of Terror



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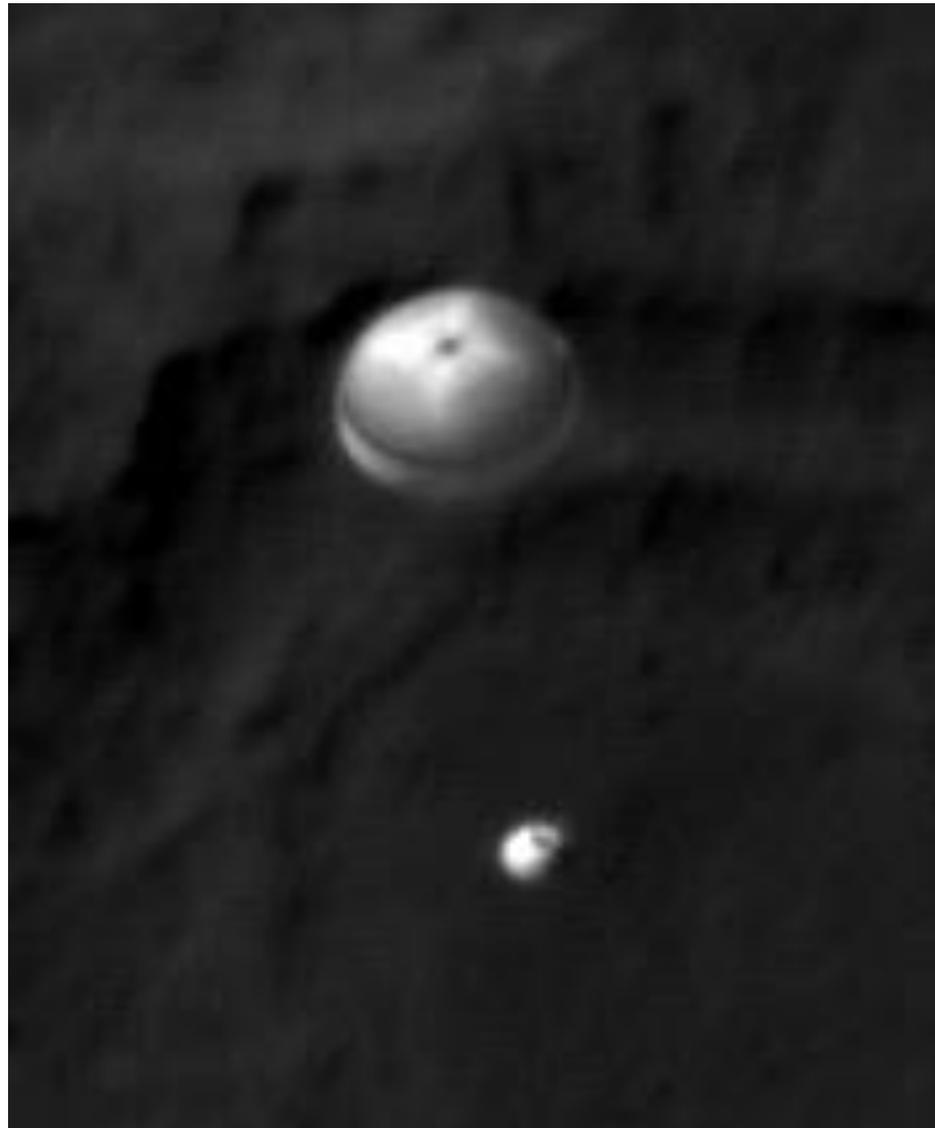
Mars Science Laboratory



MSL: As Seen from MRO



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Driving on Mars (Yikes!)



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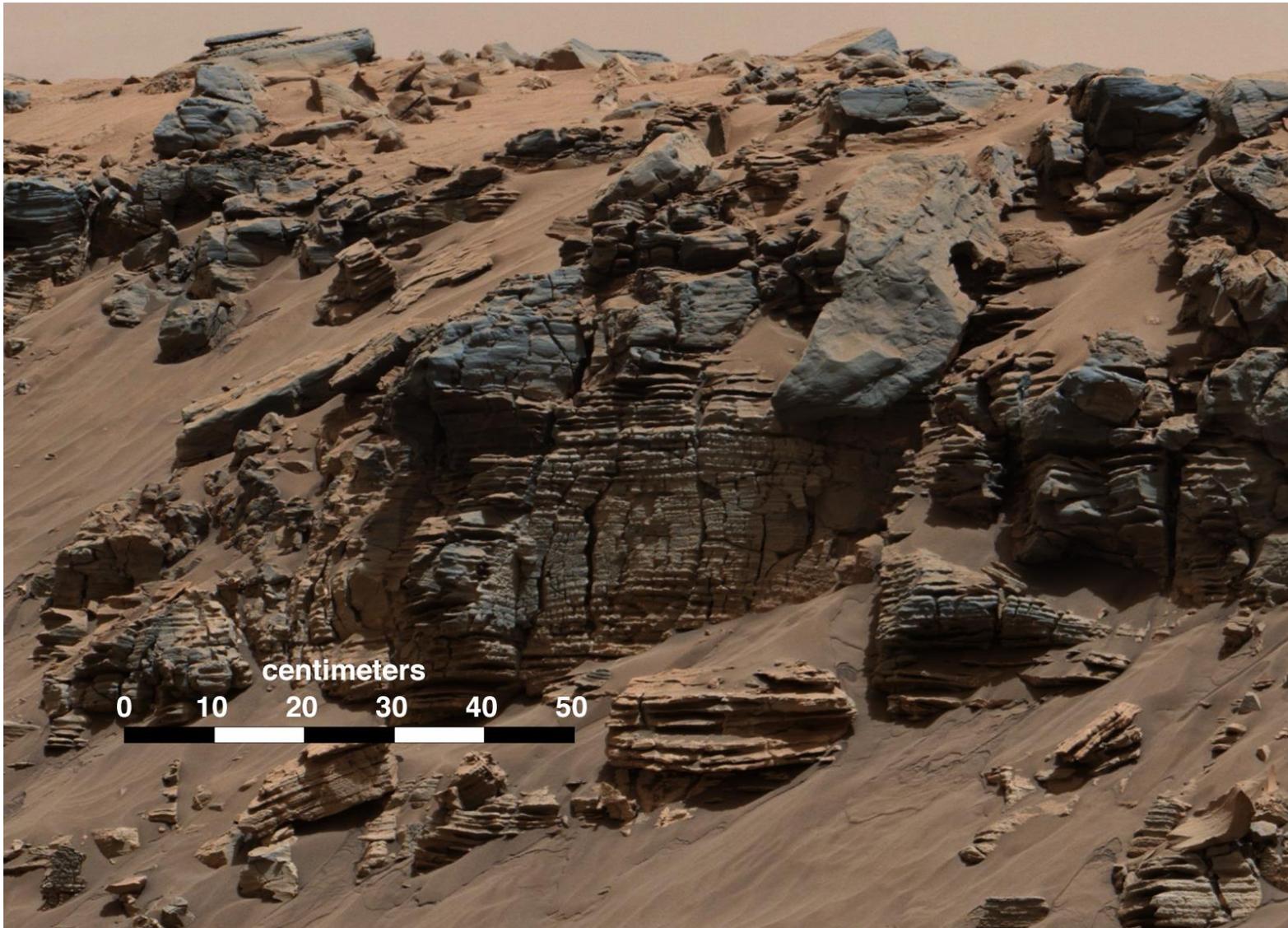
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Interesting Rocks: Martian Lakebed?



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Drill Hole: Collecting Powder



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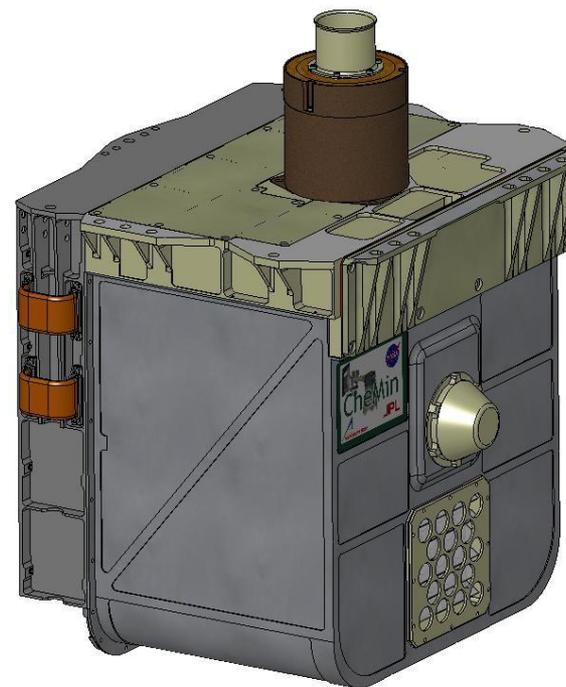
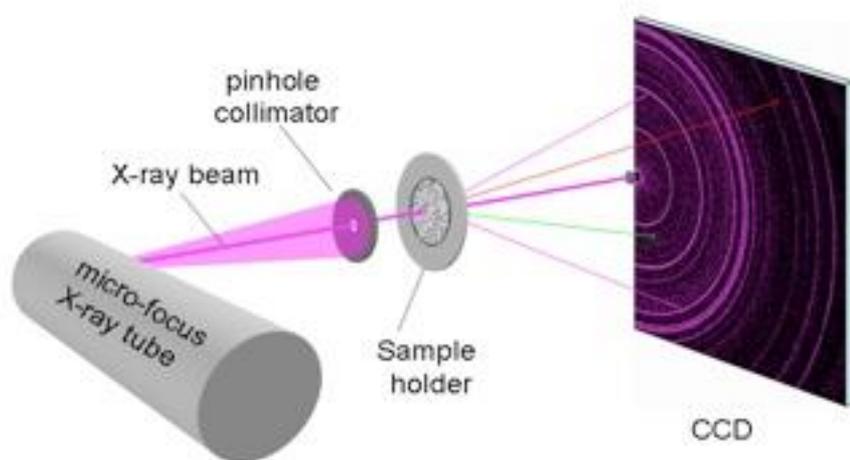
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CheMin X-ray Diffraction



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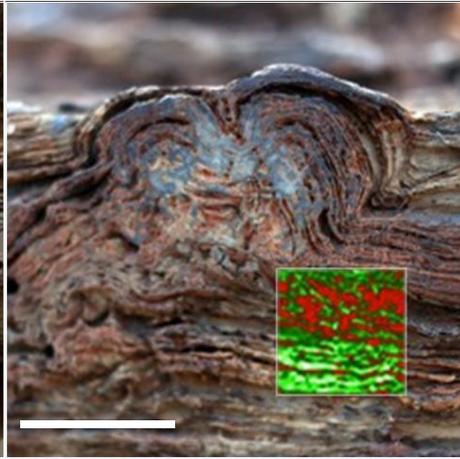
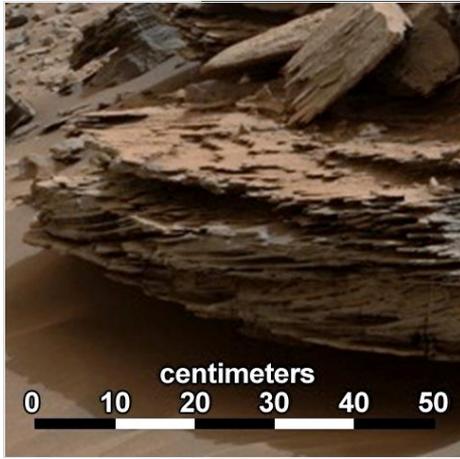


Seeking the Signs of Life with Mars 2020

Mars 2020 Mission Objectives



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GEOLOGY

- Explore an ancient environment on Mars
- Understand processes of formation and alteration

ASTROBIOLOGY

- Assess habitability of ancient environment
- Seek evidence of past life
- Select sampling locations with high biosignature preservation potential

SAMPLING

- Capability to collect ~40 samples and blanks, 20 in prime mission
- Include geologic diversity
- Deposit samples on the surface for possible return

PREPARE FOR HUMANS

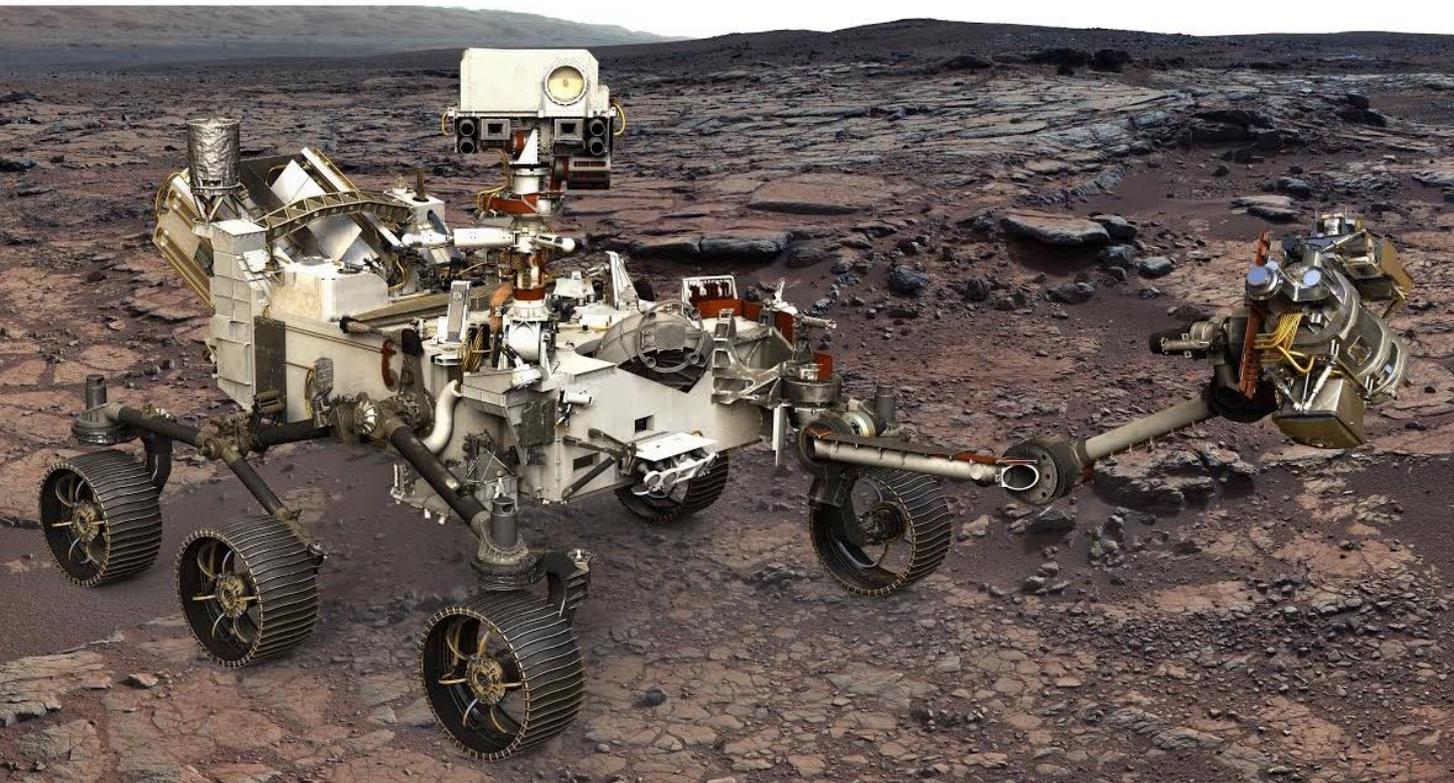
- Measure temperature, humidity, wind, and dust environment
- Demonstrate In Situ Resource Utilization by converting atmospheric CO₂ to O₂

The Mars 2020 Mission



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For Mars 2020, the first step towards potential Mars sample return
Exploration supports Sampling.

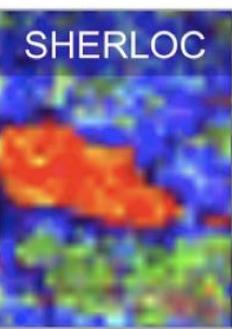
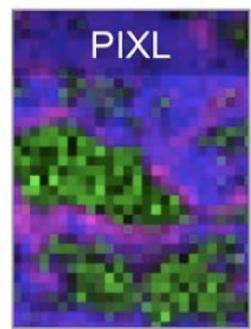
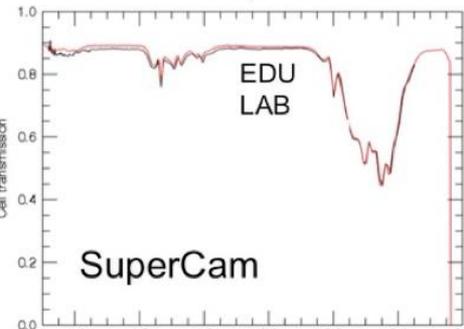
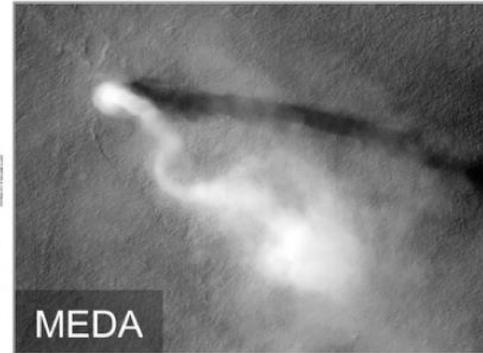
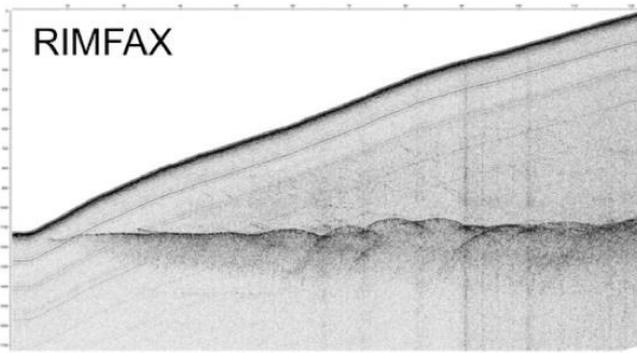


Mars 2020 Scientific Exploration Model



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- Develop the geologic and astrobiologic context of an ancient martian environment using observations made at a range of spatial scales, culminating in a search for potential biosignatures.
- Use the emerging model of deposition and alteration to guide the collection of samples that maximize opportunities to understand Mars as a planetary system and determine whether it was once habitable.



Remote chemistry/mineralogy

Proximity imaging

Proximity chemical/mineralogic mapping

Sampling and borehole science

Seeking Evidence of Past Life



3.4 billion year old stromatolite
(fossil microbial mat)



Mars 2020 can recognize
potential biosignatures as

1. concentrations of
biologically important
elements, minerals and/or molecules

particularly when they are

2. spatially associated with
biologically suggestive morphologies.



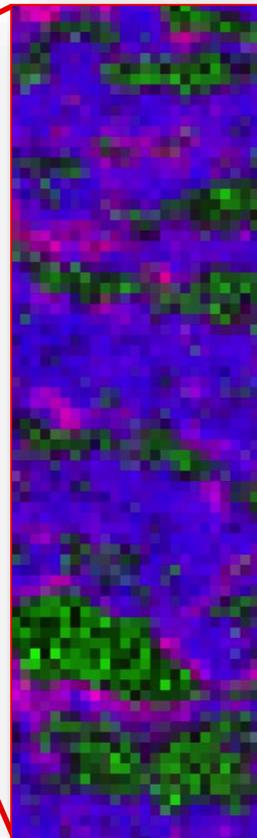
Seeking Evidence of Past Life



3.4 billion year old stromatolite
(fossil microbial mat)

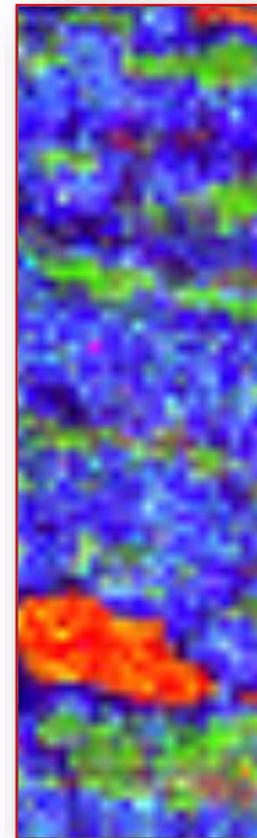


PIXL



Si Ca Fe

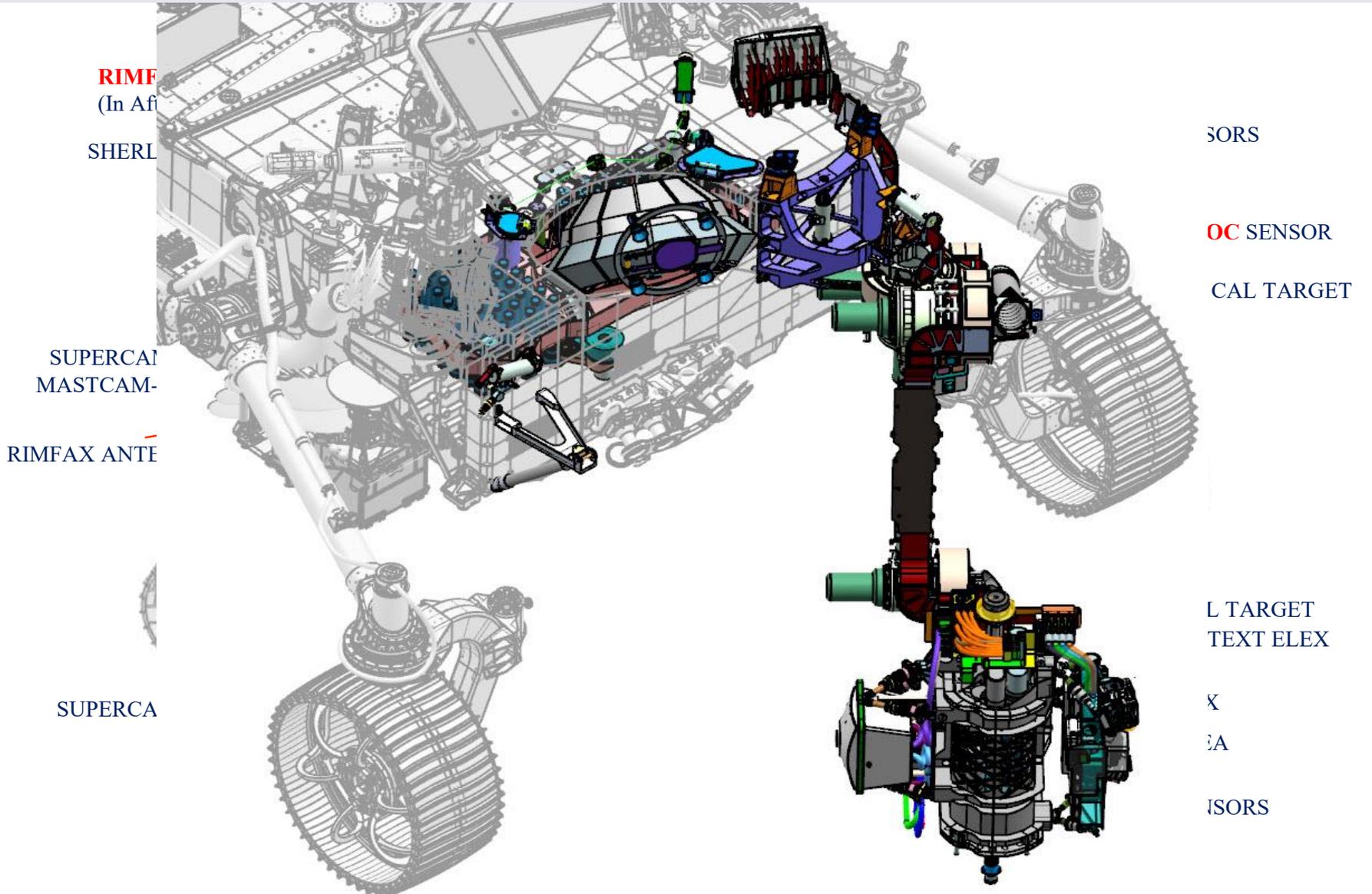
SHERLOC



quartz
dolomite
organic carbon

1 mm

Specially Selected Payload Suite & Coring Drill



Coring & Sampling



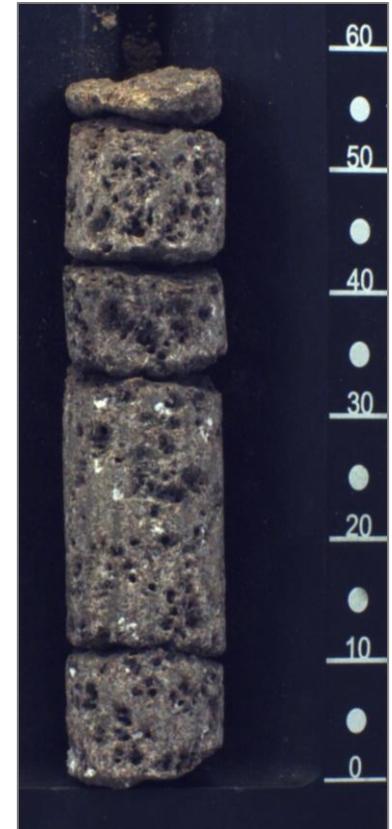
coring bit



hermetically sealed sample tube



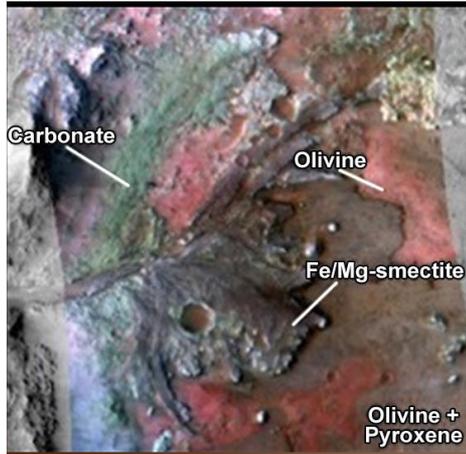
core sample
~ 5 cm long x
~ 1 cm diameter
~ 15 grams



Mars 2020 Candidate Landing Sites



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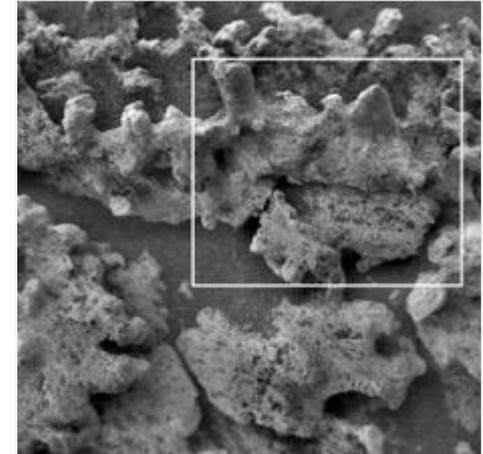
JEZERO

- Deltaic/lacustrine deposition with possible igneous unit and hydrous alteration
- Mineralogic diversity including clays and carbonates
- Shallow water carbonates?



NE SYRTIS

- Extremely ancient igneous, hydrothermal, and sedimentary environments
- High mineralogic diversity with phyllosilicates, sulfates, carbonates, olivine
- Possible serpentinization and subsurface habitability



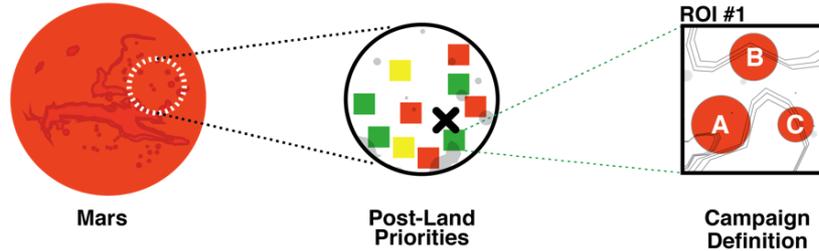
COLUMBIA HILLS

- Carbonate, sulfate, and silica-rich outcrops of possible hydrothermal origin. Hesperian volcanics.
- Potential biosignatures identified
- Previously explored by MER

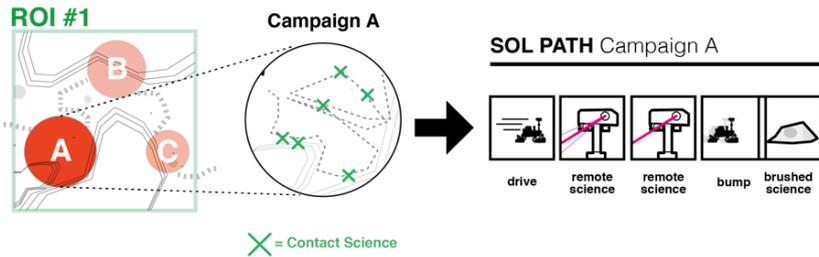
Mars 2020 Operations Process



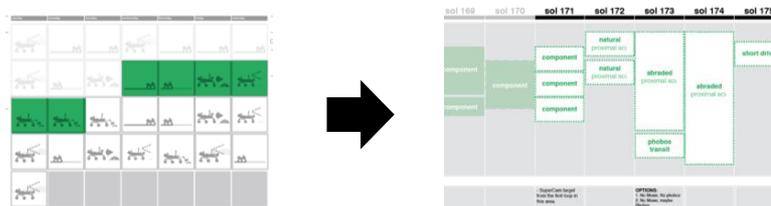
Strategic
Focus: whole mission



Campaign Planning
Focus: several months



Campaign Implementation
Focus: upcoming days (2 to 7)



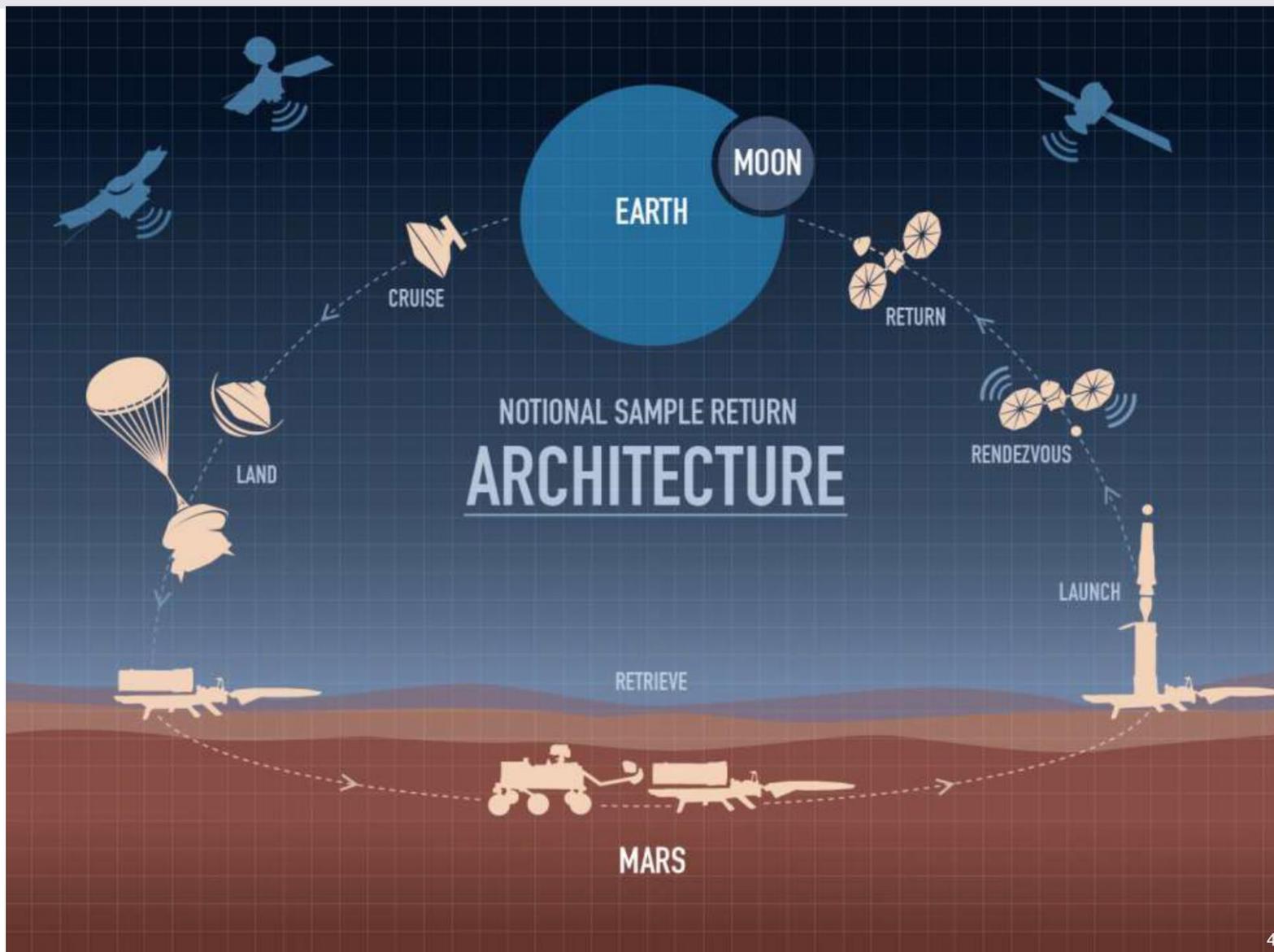
N+1



After Mars 2020: Potential Sample Return



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Stay Tuned!

<http://mars.nasa.gov/mars2020>

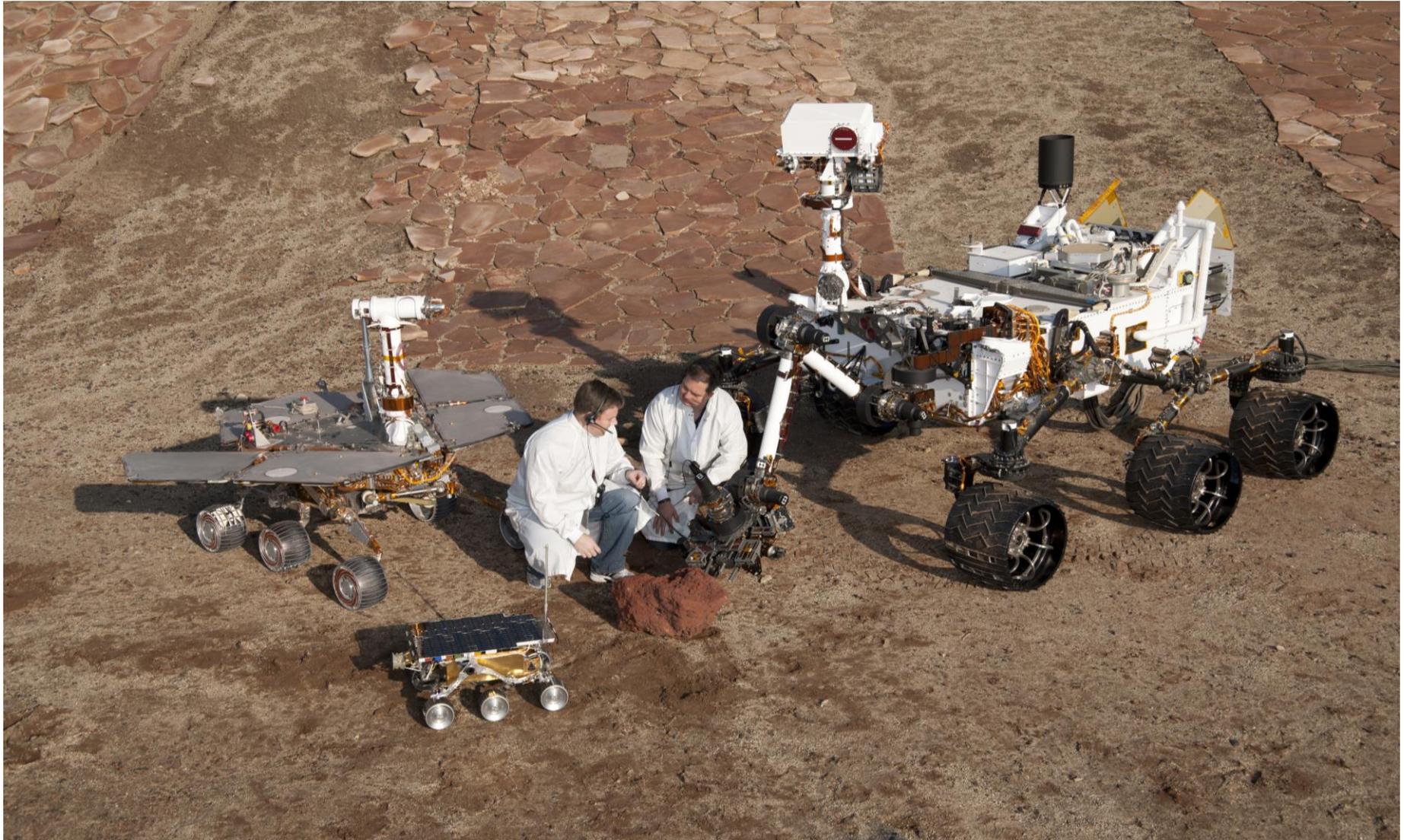


Backups

A Mars Family Portrait



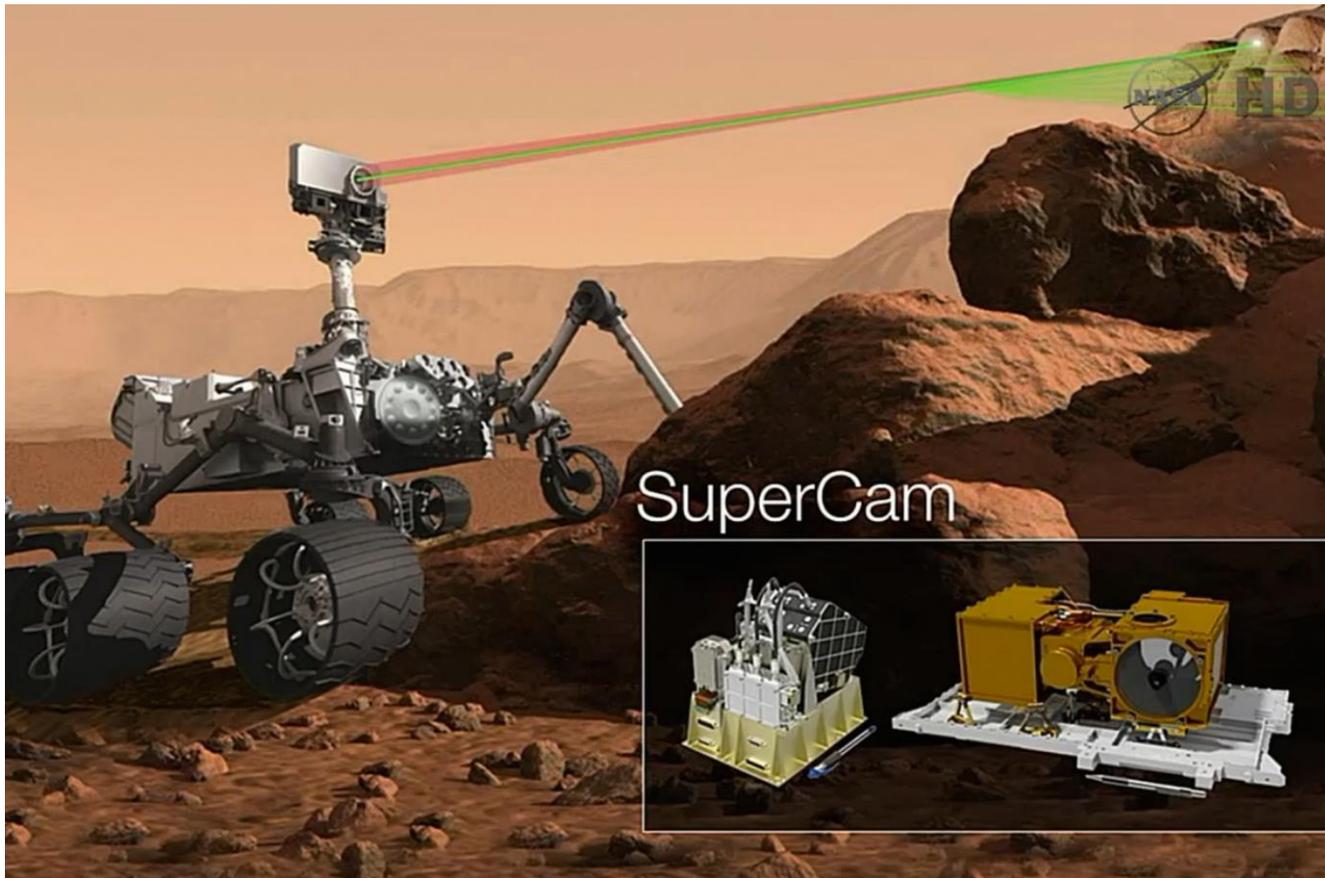
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Specially Selected Payload Suite



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PI Roger Weins, LANL, with major French and Spanish involvement
advancement on MSL Chemcam – has laser induced breakdown spectroscopy (LIBS) +
remote Raman and fluorescence spectroscopy + visible and infrared spectroscopy +
remote micro-imaging (“telescope”)

Specially Selected Payload Suite



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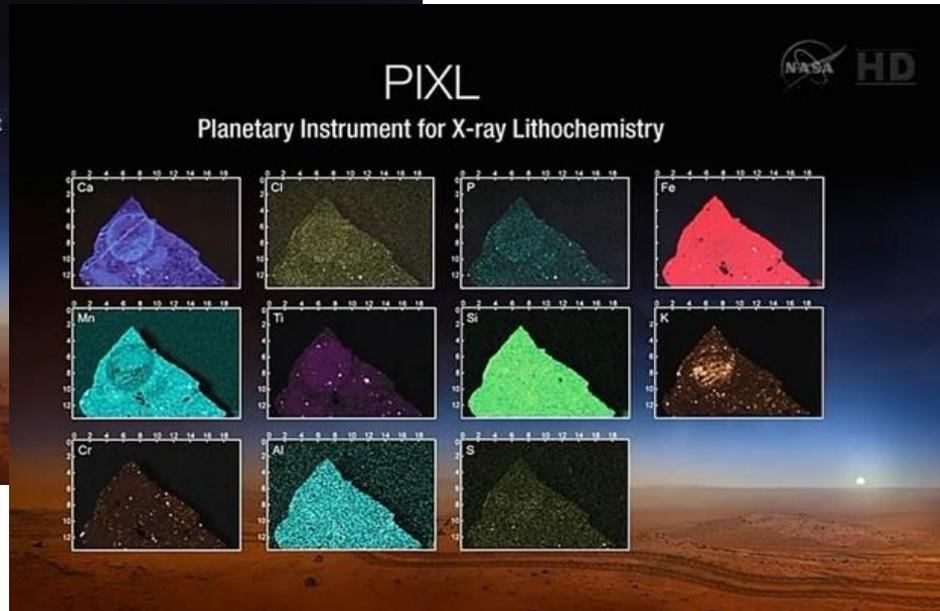
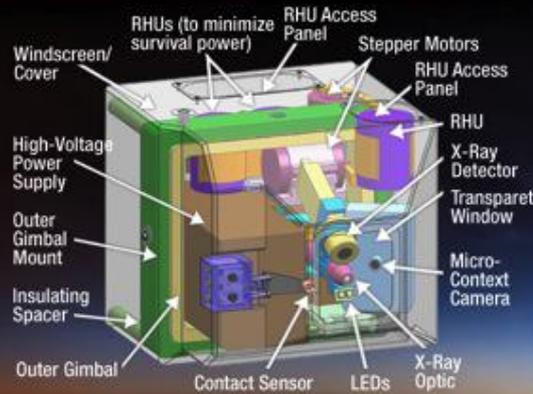


PI Luther Beegle, JPL

- laser induced fluorescence and Raman spectroscopy to identify minerals and organic molecules, high spatially resolved (~20 um scale)

Specially Selected Payload Suite

PIXL Arm-Mounted Sensor Head

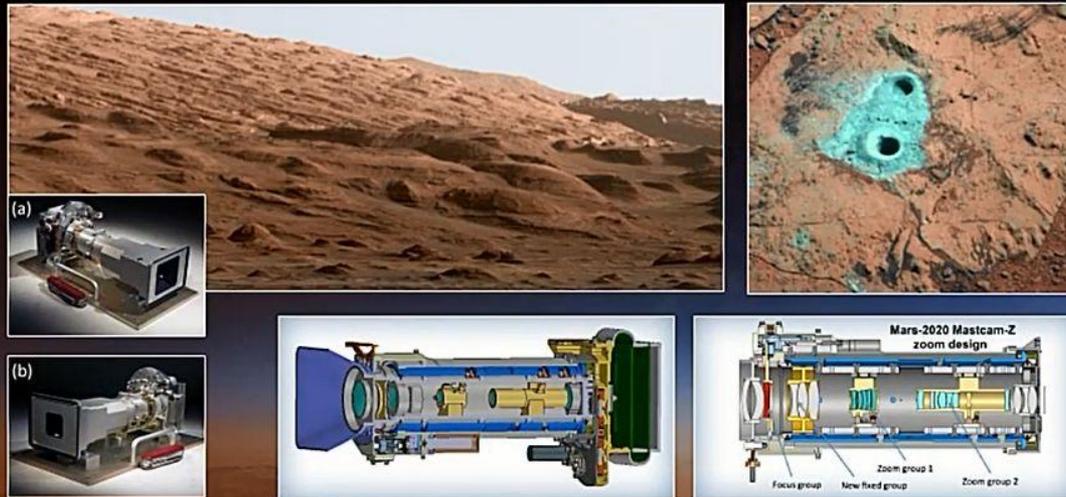


PI Abigail Allwood, JPL

- x-ray fluorescence technique to measure rock chemical composition at the ~100 um scale.

Mastcam-Z

A Geologic, Stereoscopic, and Multispectral Investigation for
the NASA Mars-2020 Rover Mission

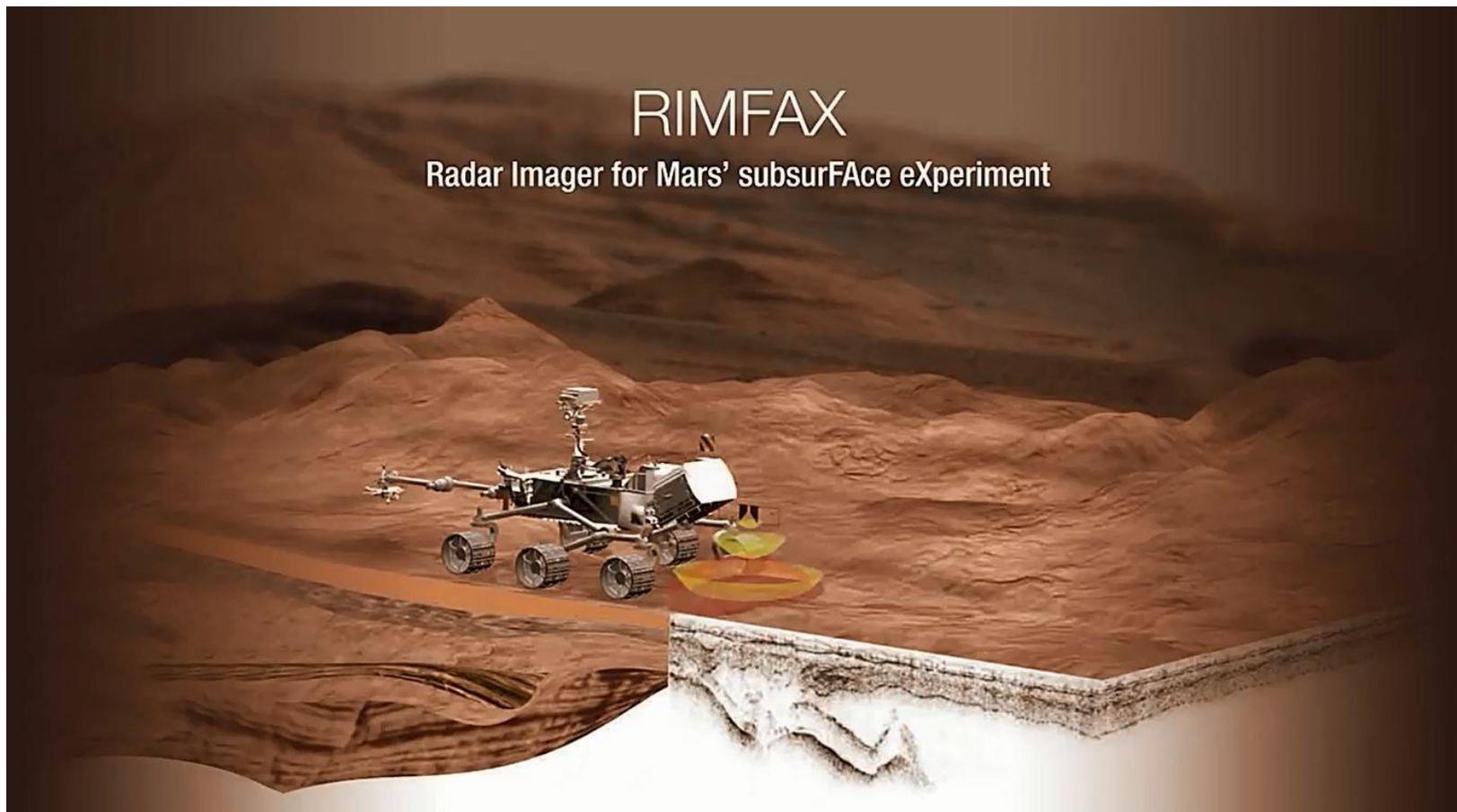


PI Jim Bell, ASU (with Malin Space Science Systems)

-improved stereo **zoom** camera with strong MSL heritage

RIMFAX

Radar Imager for Mars' subSURFACE eXperiment

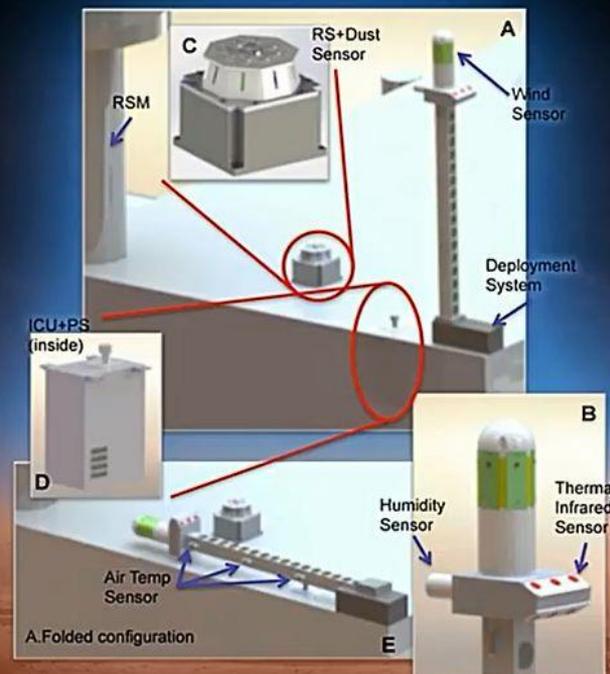


PI Svein-Erik Hamran, Norway

- discover and map sub-surface geologic structure down to 500 m depth with ground-penetrating radar

MEDA

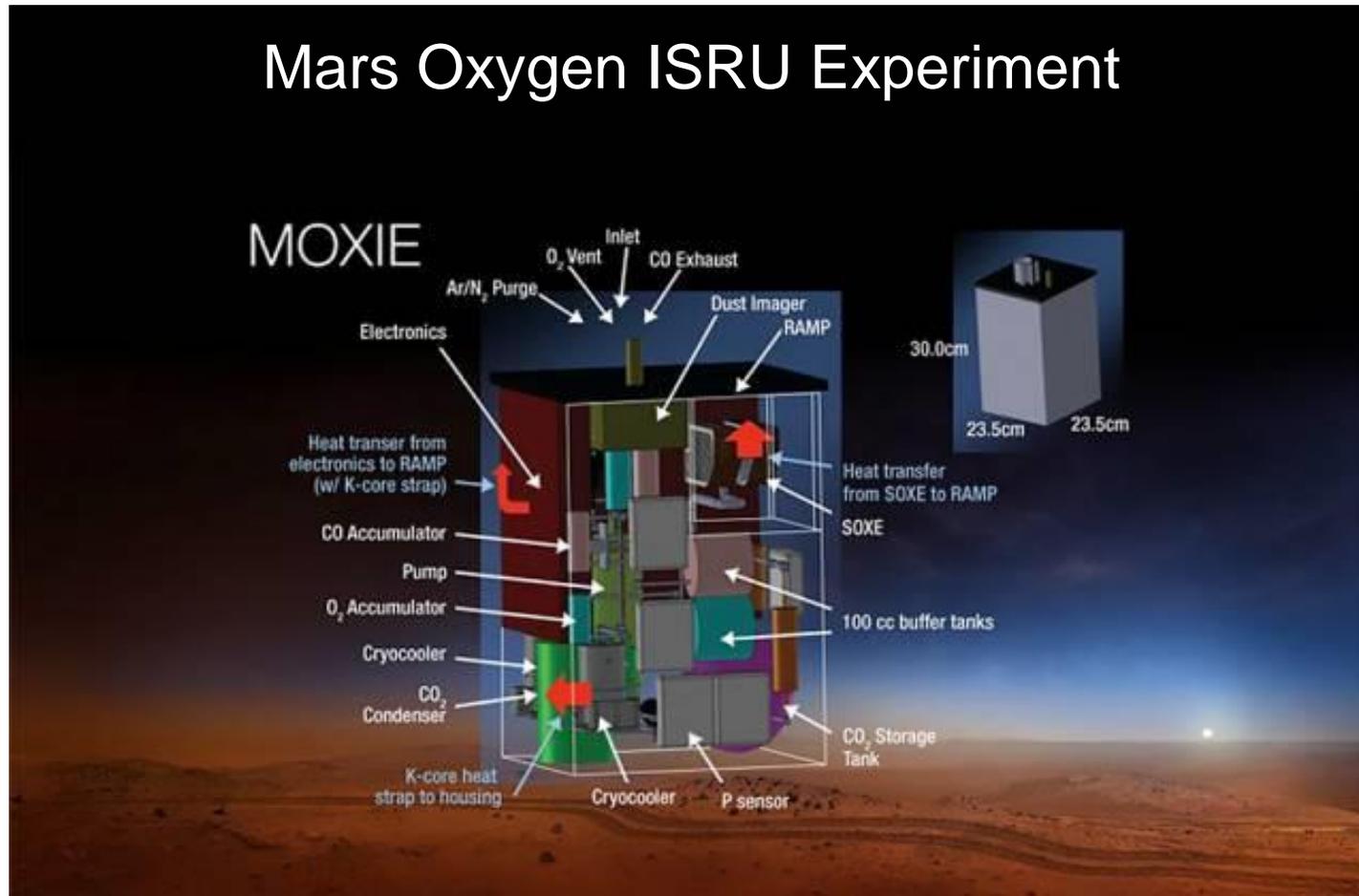
Mars Environmental Dynamics Analyzer



PI Jose Rodriguez Manfredi, CAB Madrid, Spain

- temperature, humidity, wind, dust analyzer with strong Mars mission heritage

Mars Oxygen ISRU Experiment



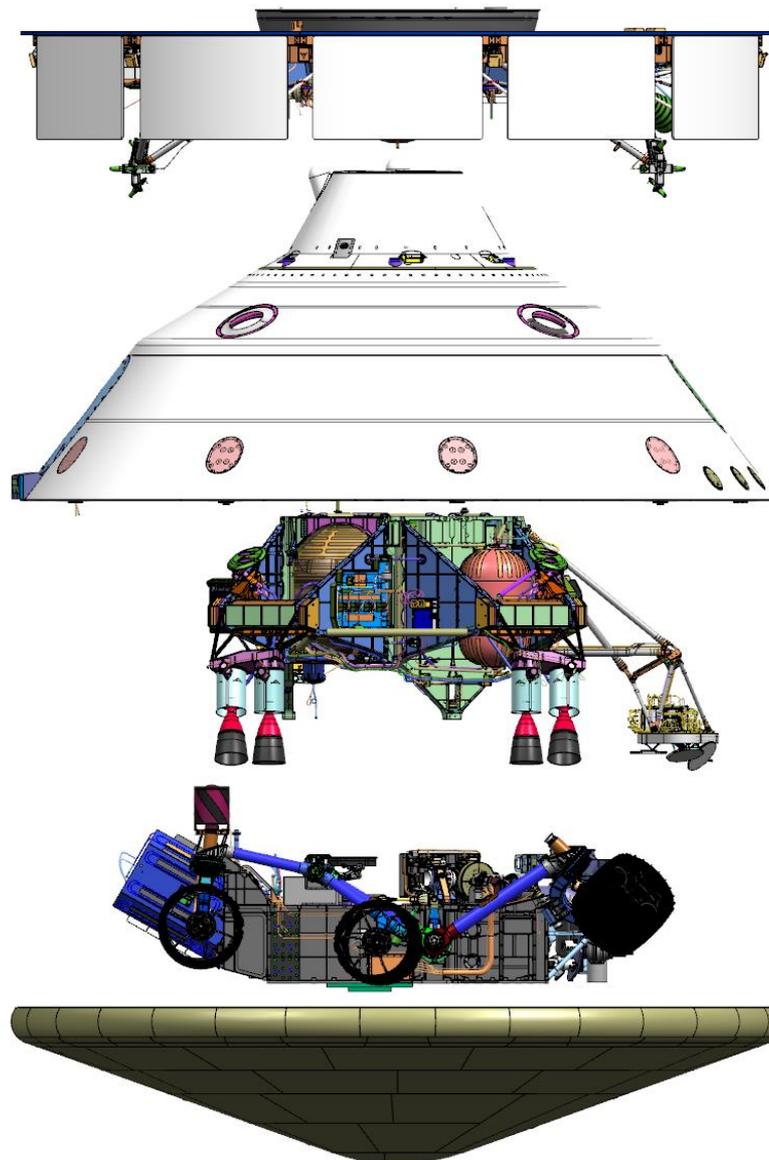
PI Michael Hecht, MIT with JPL build

-convert CO₂ to O₂ as possible future resource (oxidant);
Human Exploration and Operations Directorate contribution

Mars 2020 Spacecraft (Launch Stack)



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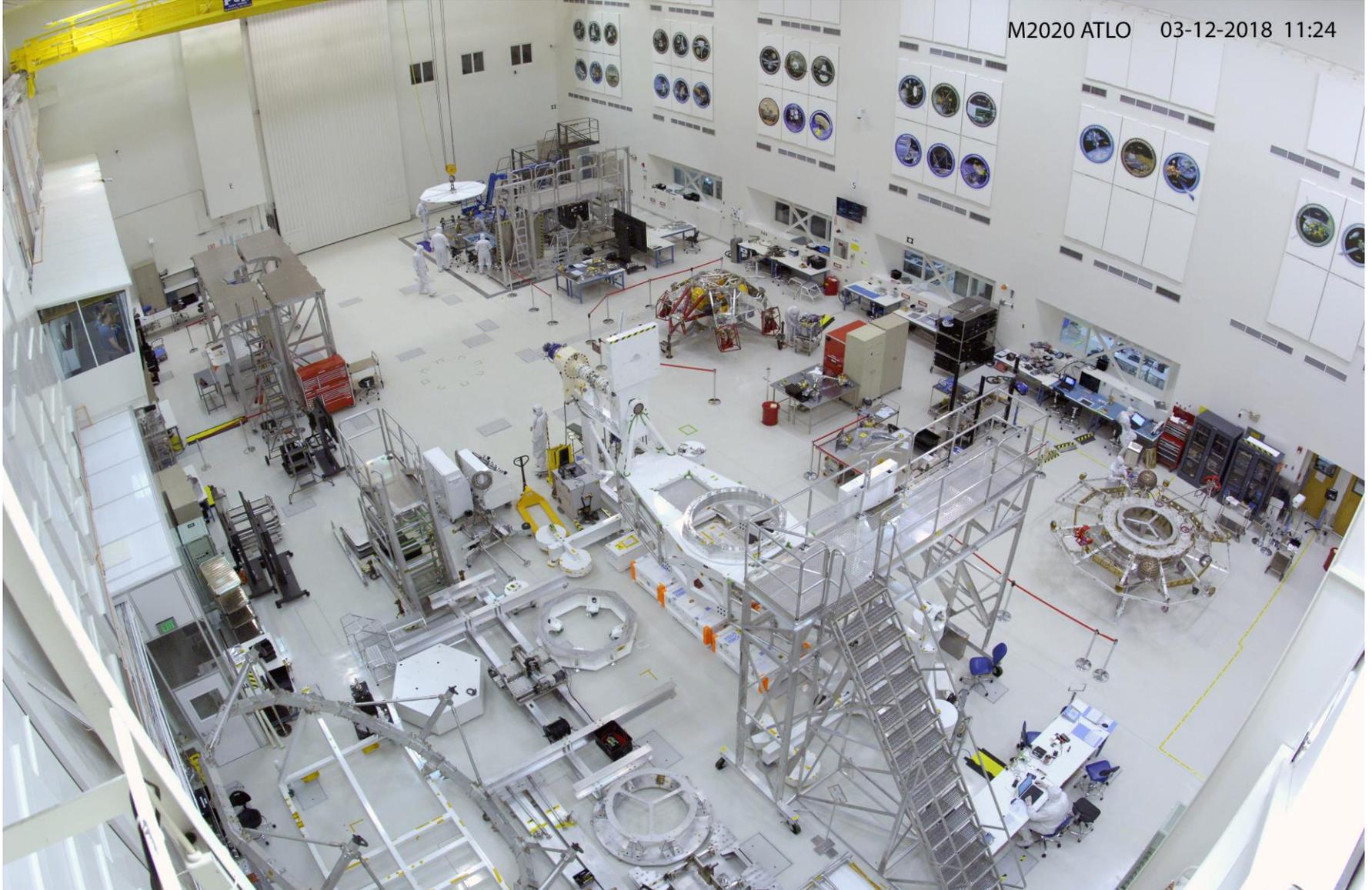


Mars 2020 Spacecraft Being Built



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