Jet Propulsion Laboratory
California Institute of Technology

CELS & Mars Exploration @ NBI

MARS 2020 PERSEVERANCE

MASTCAM Z
MARS 2020 ROVER

MARS 2020 SUPER CAM

MOXIE
MARS OXYGEN ISRU EXPERIMENT

2021-09-27, Welcome meeting at Centre for ExoLifeSciences (CELS), Morten Bo Madsen, NBI-UCPH

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Image: ASU; NASA/JPL-Caltech

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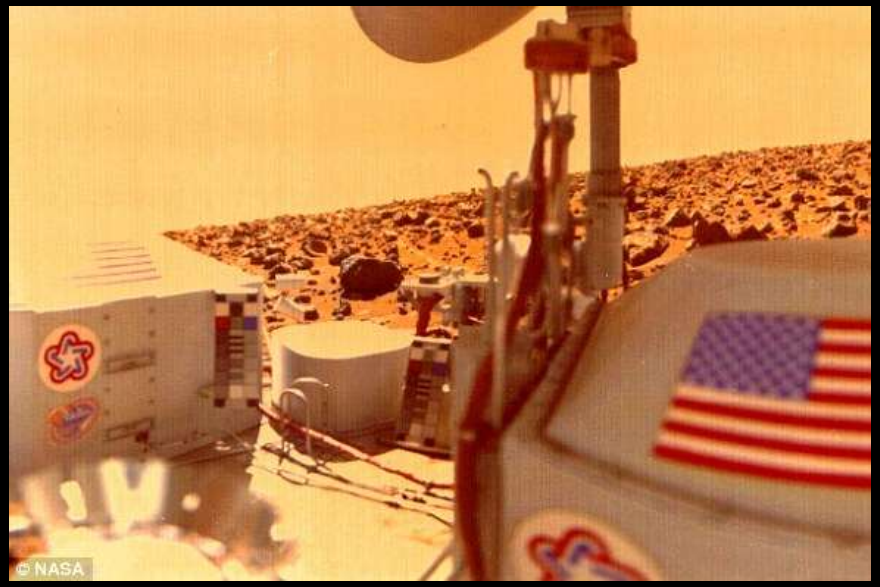
Work on Mastcam-Z is supported by the CARLSBERG FOUNDATION

How Mars Exploration (re-*)started in Denmark

Jens Martin Knudsen (1930 – 2005)

Studying meteorites Jens Martin Knudsen became interested in a group of meteorites believed to originate on Mars.

He read everything published about the surface of Mars.



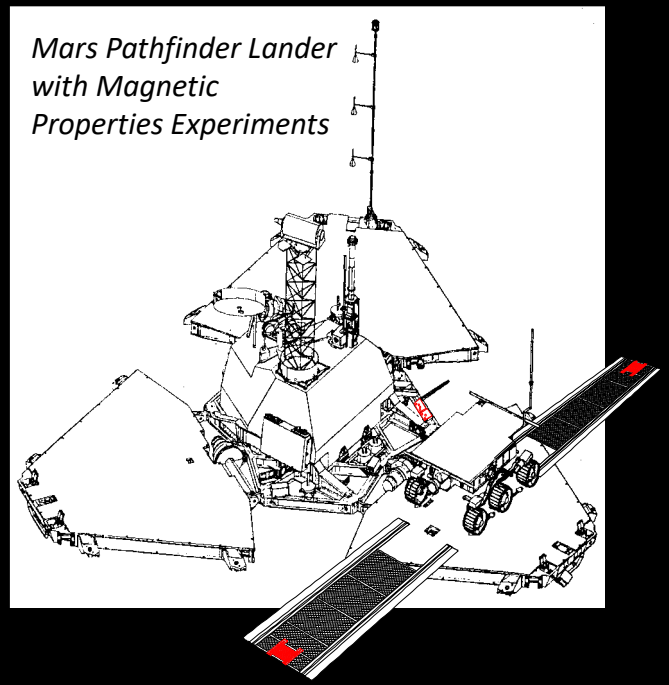
The evolution of the Mars surface is reflected in mineralogy of soil and dust.

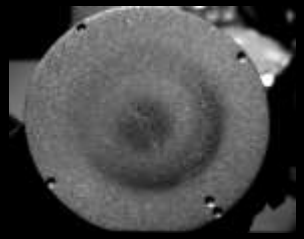
Mössbauer spectroscopy has the potential to provide answers. So has – to some degree – magnetic properties experiments.

Image of Jens Martin Knudsen: Poul Hjort.

*First initiated (remotely) by Tycho Brahe (1546 – 1601).

NASA's Mars Pathfinder, 1997

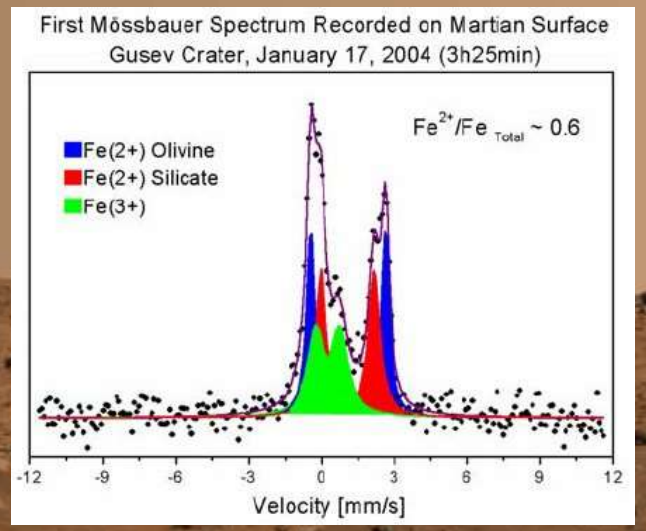




Images: Univ. Arizona; Max Planck Inst. f. Aeronomie; NASA/JPL-Caltech; NBI-UCPH

This work was supported by DFF.

NASA's 2004 Spirit Mars Exploration Rover



Mössbauer Spectrum of Adirondack Rock
(Sol 18, Gusev Crater, Mars)

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New analysis of the Mössbauer spectra of olivine basalt rocks from Gusev crater on Mars

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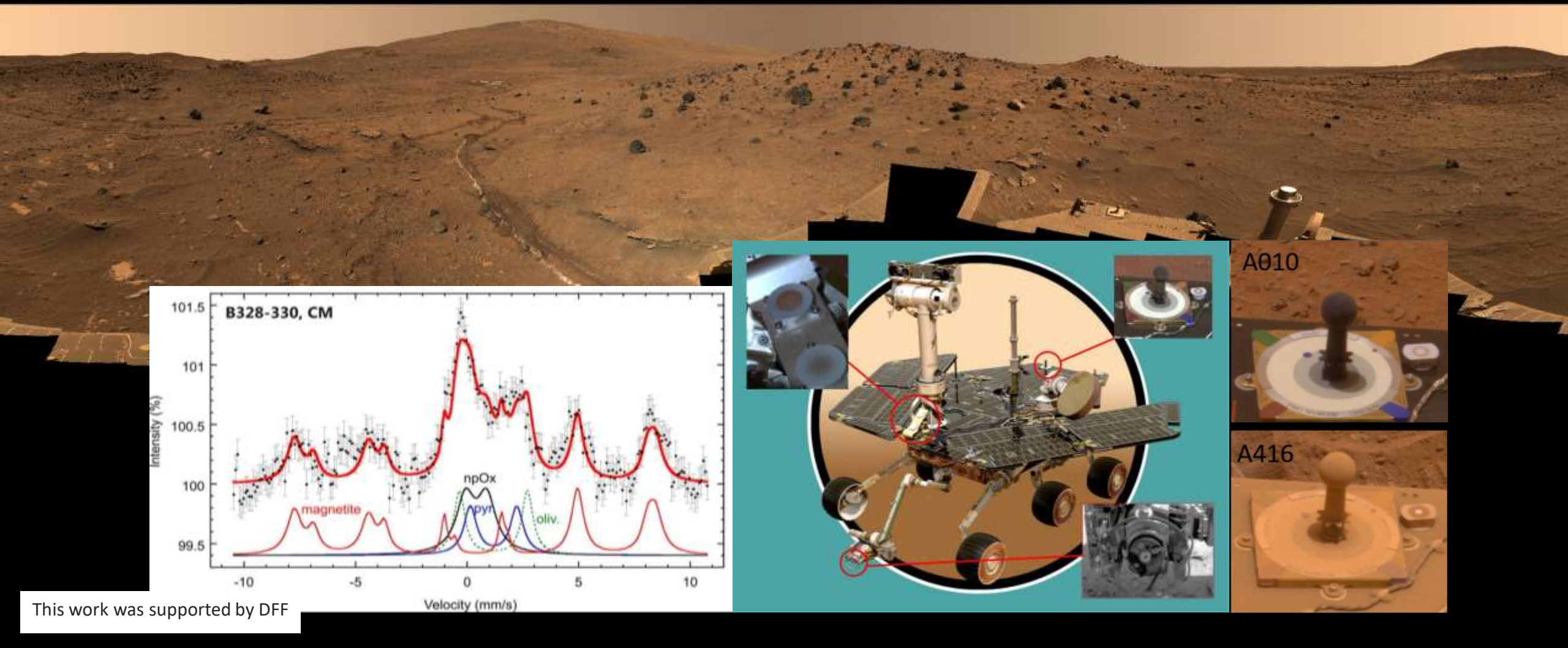
Images: Cornell Univ.; NASA/JPL-Caltech, Univ. Darmstadt

This work was supported by DFF

Spirit Rover in Gusev Crater

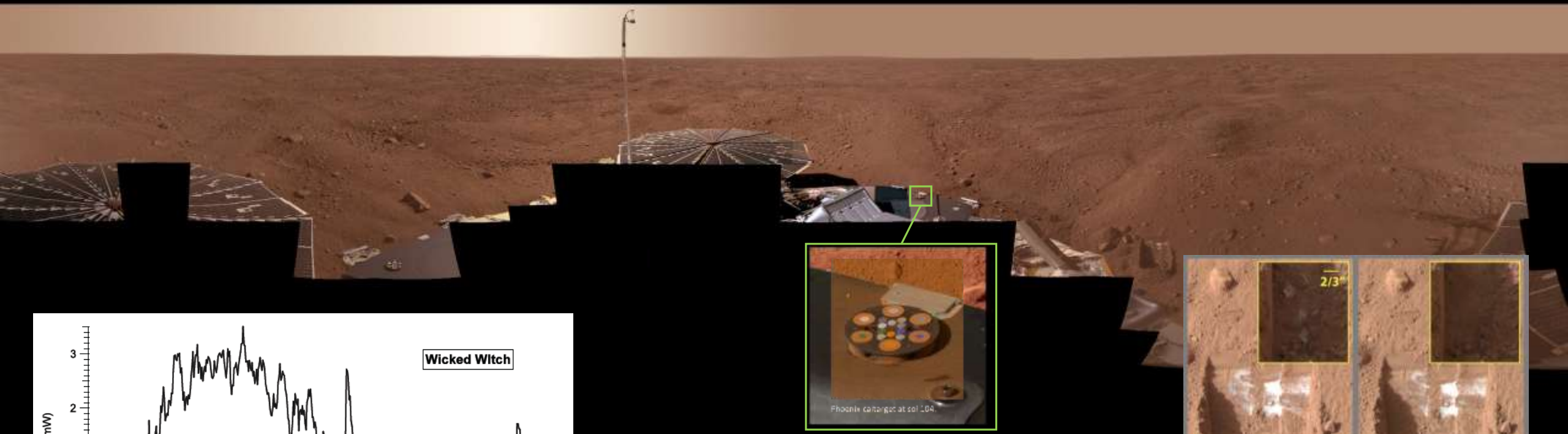
Images: Cornell Univ.; NASA/JPL-Caltech, Univ. Darmstadt

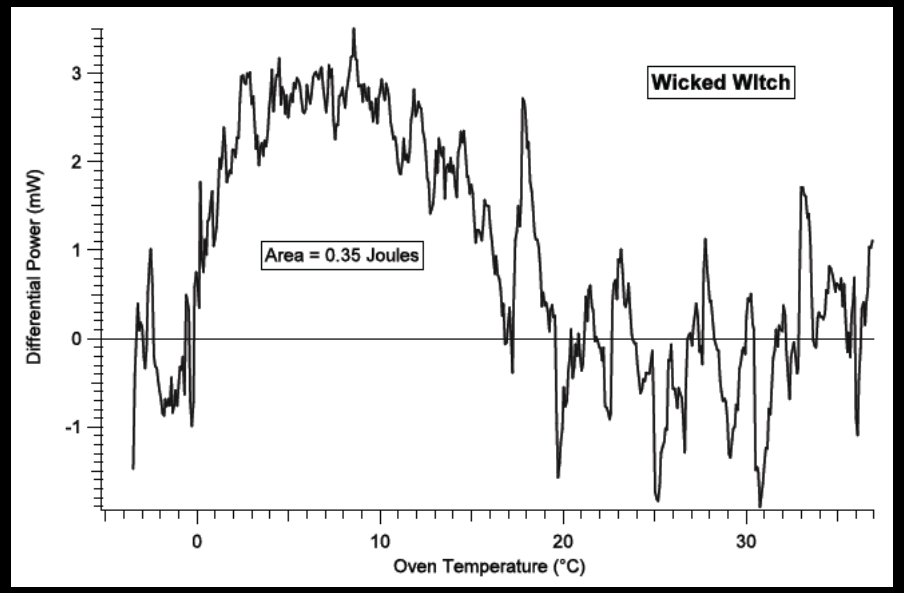


This work was supported by DFF

2008 Phoenix, Vastitas Borialis

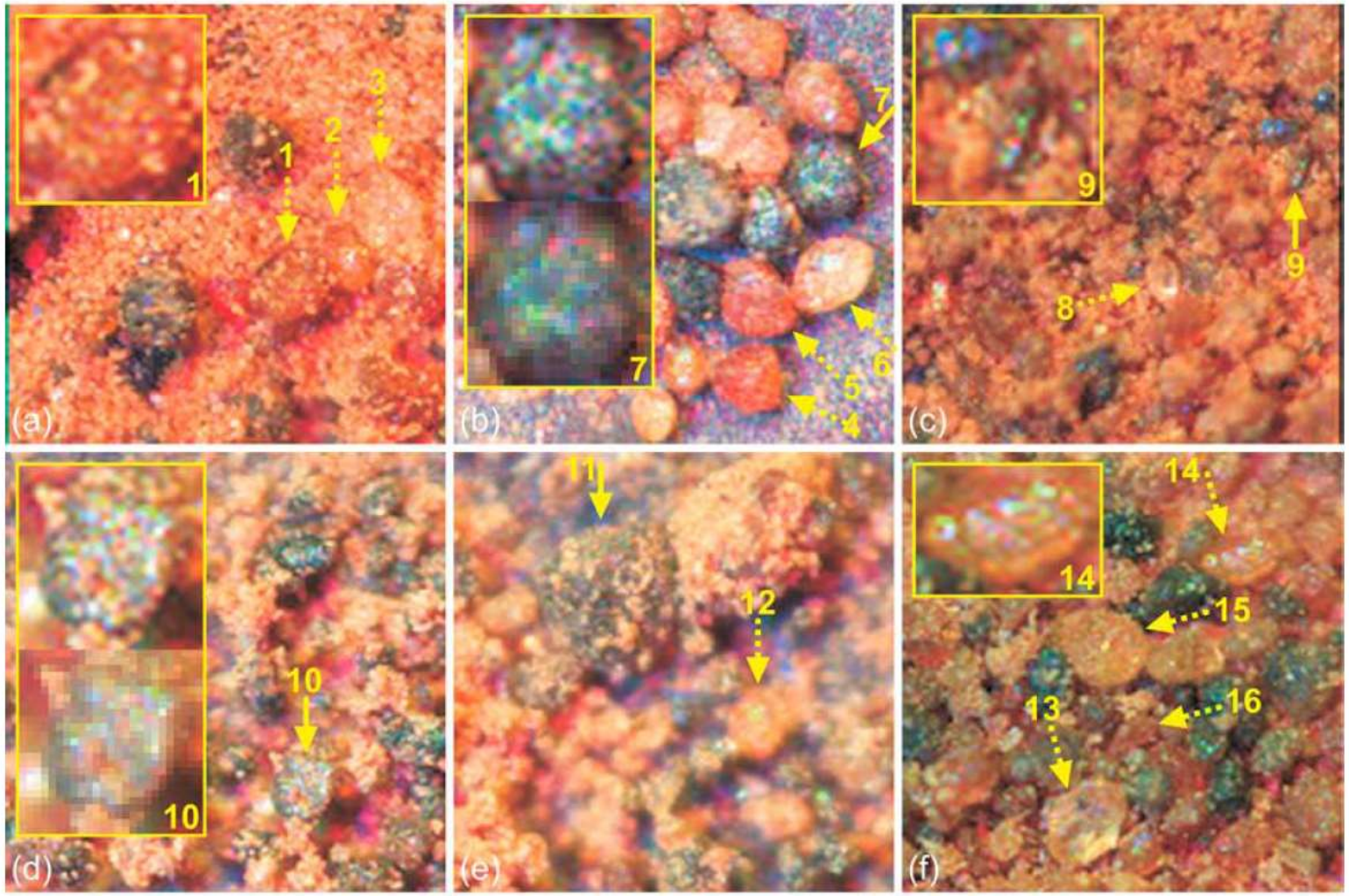
Univ. Arizona; Max Planck Inst. Aeronomie; Canadian Space Agency; Univ. Neuchatel;
Imperial College London; NASA-JPL/Caltech; NBI-UCPH; IFA, Aarhus Univ.;
Texas A&M Univ.; Finnish Meteorological Institute.





Phoenix proved that there is water(-ice) below the surface where Phoenix landed – and found that the oxidant (discovered by Viking) present in the soil is a perchlorate-compound.

Results from Optical Microscope in Phoenix Microscopy Station



What is the red fluffy stuff?

"Why does Mars have the color it has?"

(title of) Proposals to DFF and to NASA PS program.

NASA proposal selected, but DFF proposal was not.

Univ. Arizona;
Max Planck Inst. Aeronomie;
Univ. Neuchatel;
Imperial College London;
NASA-JPL/Caltech;
NBI-UCPH.

NanoGeoScience Research Center by Susan Stipp

Approaches

Experimental

Field studies

sample collection

Classical methods

X-ray diffraction, etc.
Wet-chemical methods
(spectrometry)

Nano-techniques

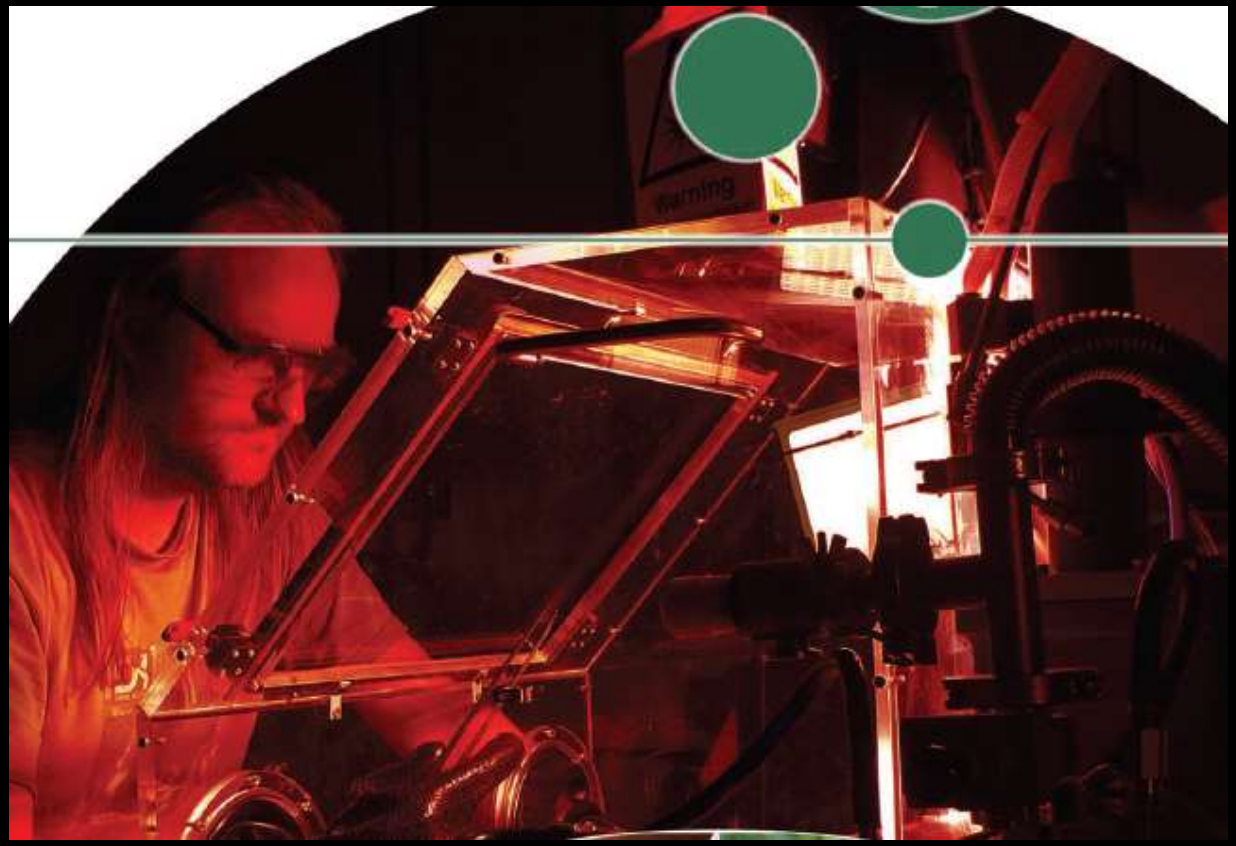
Atomic Force Microscopy
Surface Spectroscopy
Electron Microscopy
X-ray Scattering and
Other Synchrotron
Radiation Techniques

Theoretical

Molecular Modelling

Density Functional Theory
Molecular Dynamics

JMMC (version 1) by Asmus Koefoed (2010-2011)



Using a simple glove-boxAsmus Koefoed initiated construction of a Mars simulation Chamber with the hope to later raise funding for a “vacuum suitcase” to move prepared samples to the analysis facilities @ Center for NanoGeoScience.

Proved difficult to explain to planetary geologists why we needed a UHV chamber – and to physicists that surfaces of “dirty” minerals could be investigated by state-of-the-art surface physics techniques.

So, we never succeeded raising funding.

And new missions appeared!

Image: Asmus Koefoed, NBI-UCPH.

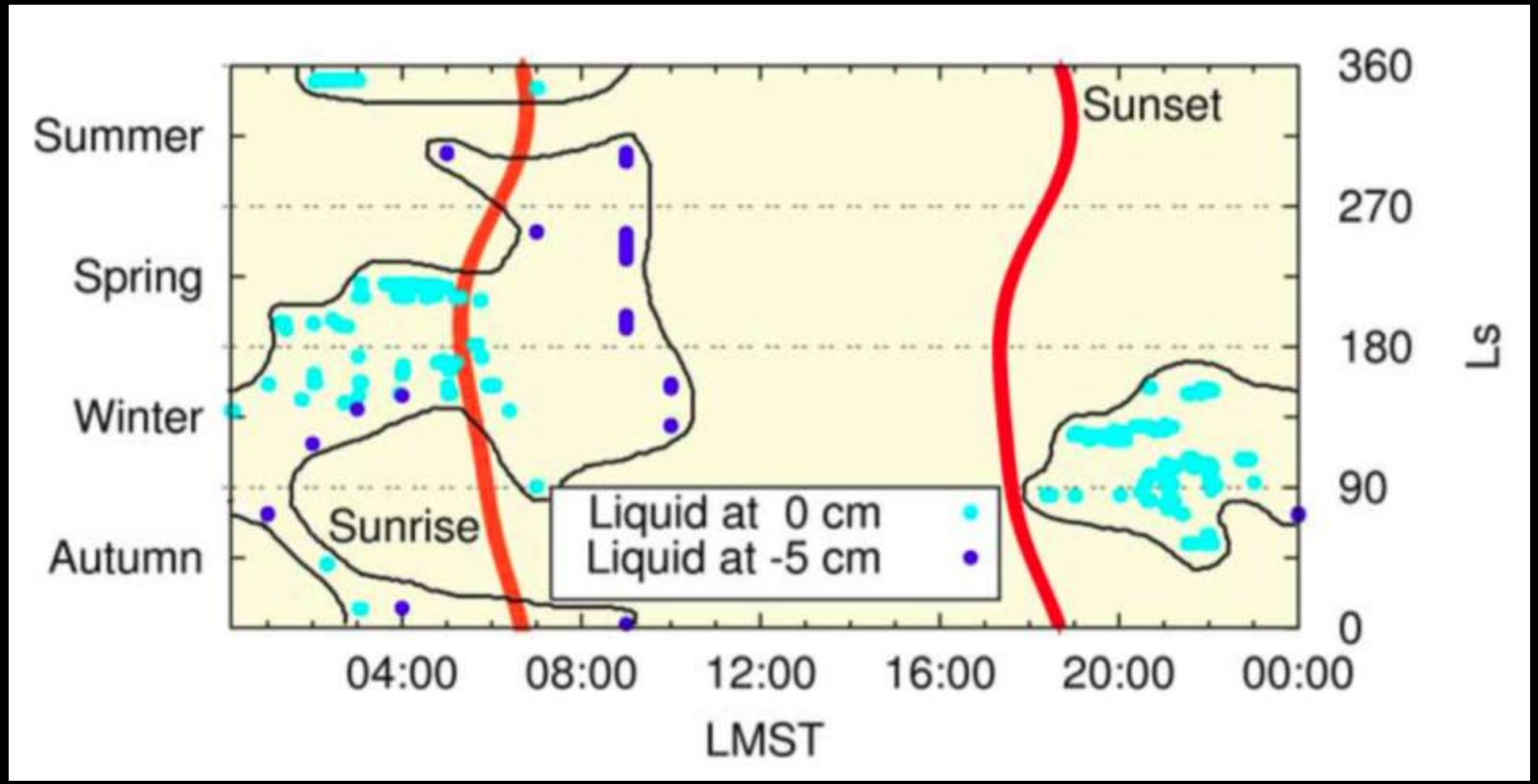
Curiosity “selfie” recorded on sol 177 by MAHLI

Images: NASA/JPL-Caltech; MSSS

Curiosity's (rover) environmental monitoring station (REMS) measures

Temperature and air humidity

DAN measures backscattered neutrons (hydrogen (/water) in the subsurface)



J. Martin-Torres, Nature 2015

Mars Environment Simulation Chamber by Rita Kajtar (2013-2014)

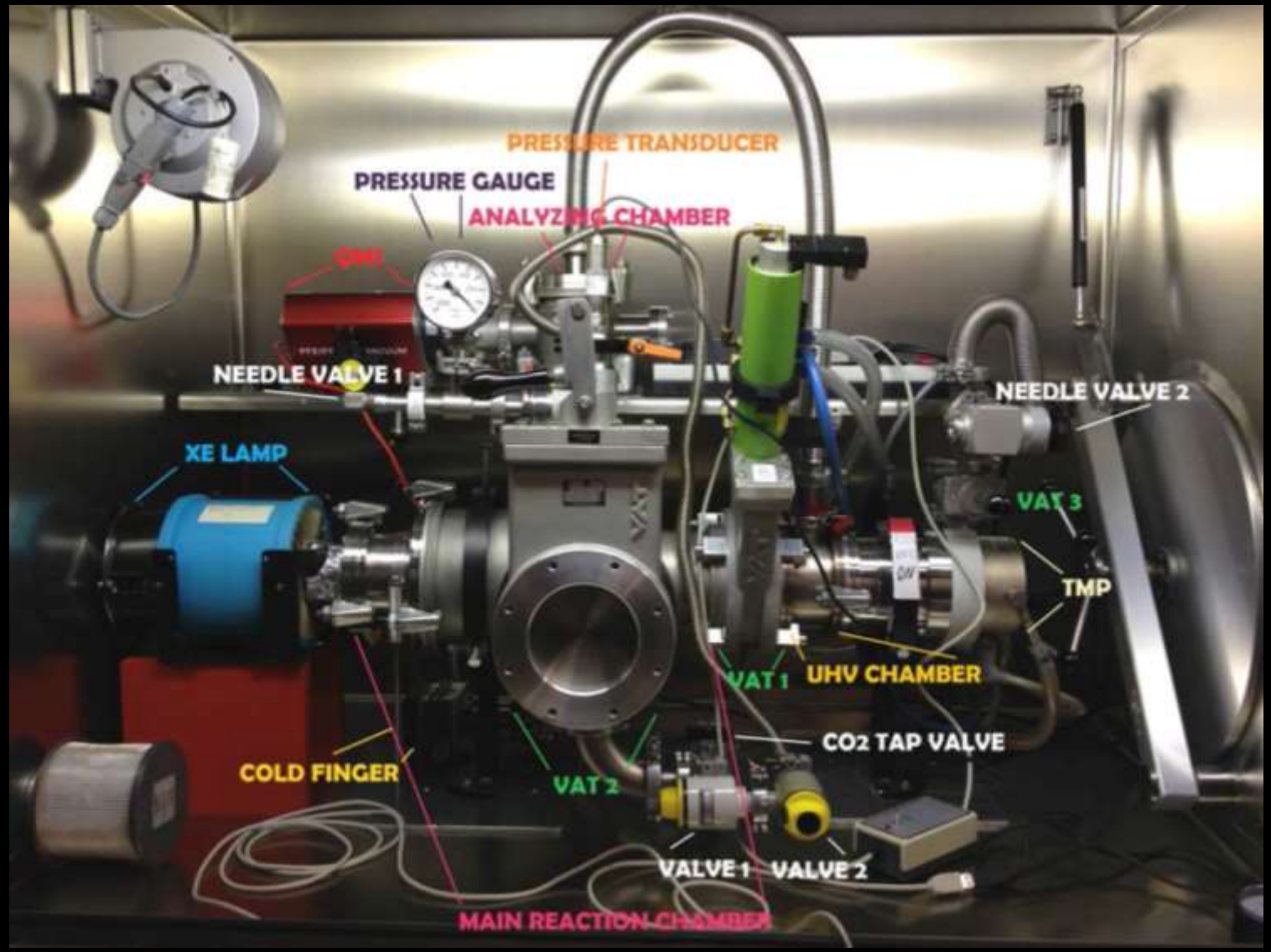


Image: Rita Kajtar, NBI-UCPH.

Rita Kajtar (almost) started all over again with new equipment based on a profesional (commercial) glove box borrowed by Asmus Koefoed from Dept. Chemistry, UCPH.

Rita moved to Sweden – and borrowed the chamber.

Returned and was rebuilt, modified and improved by

Poul Kari Madsen

Cecillie P. Knudsen and

Angeliki Christakopoulou

(not yet complete).

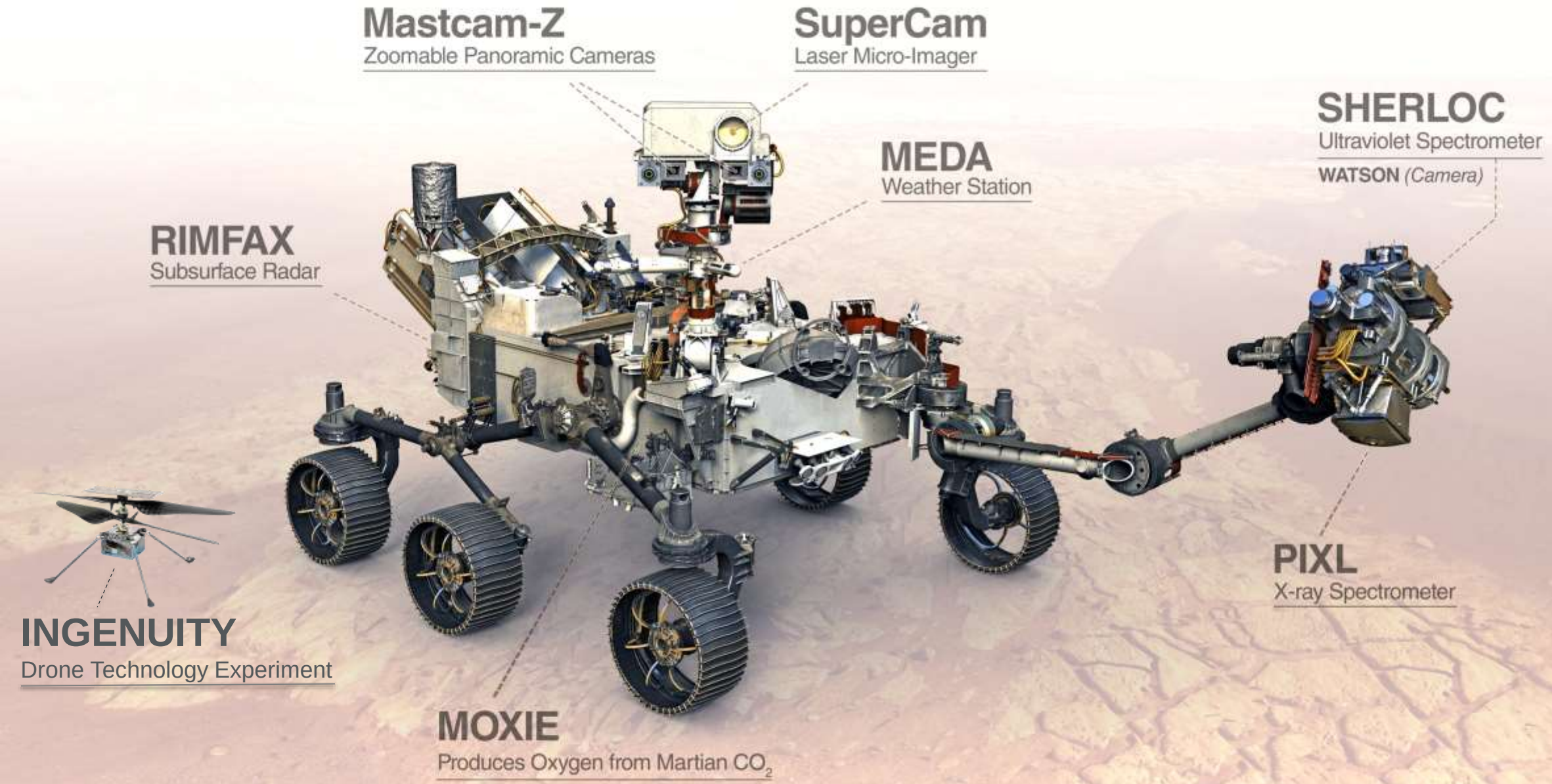
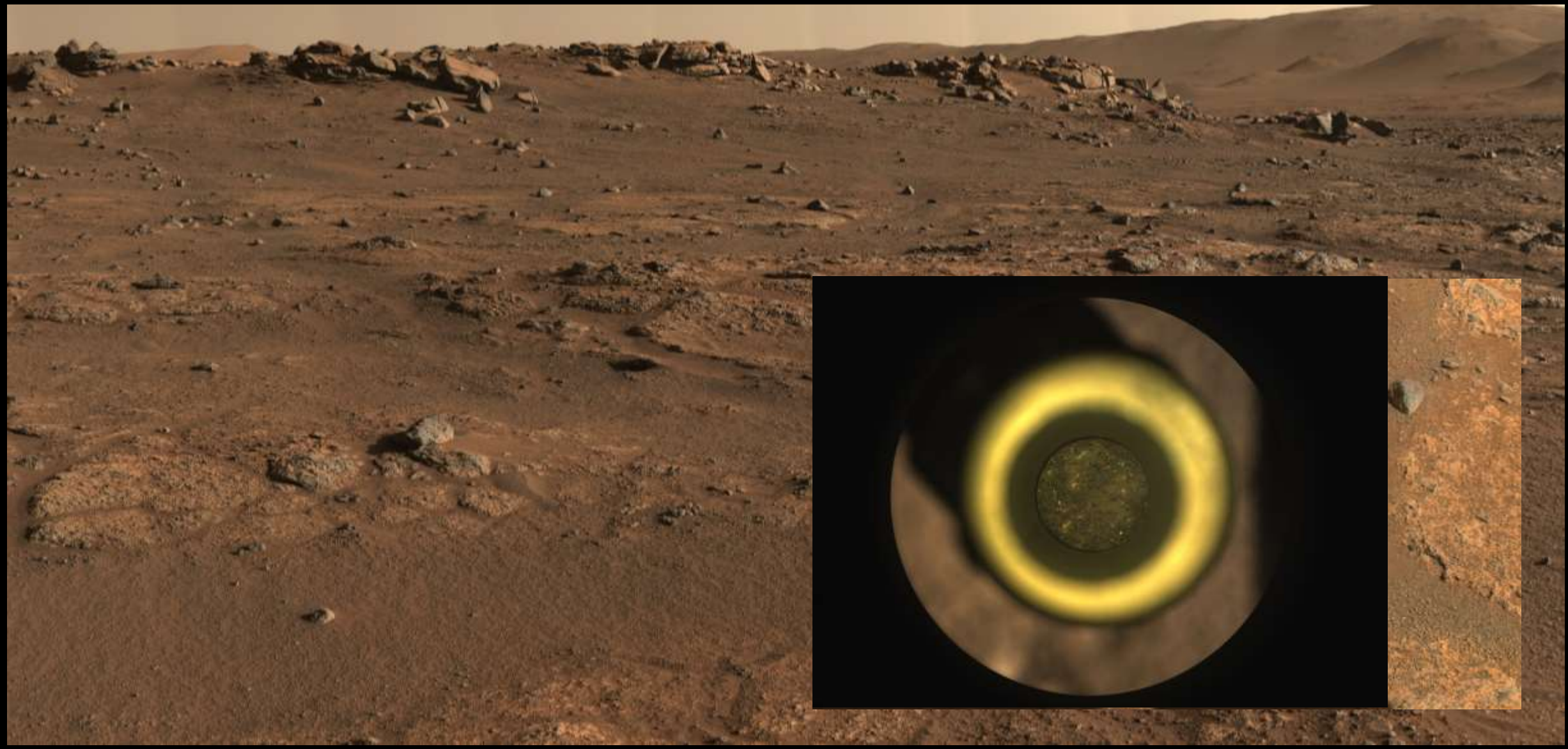


Image: NASA/JPL-Caltech; modif. by MBM, NBI.

Returned Sample Science Objectives (edited, not complete)

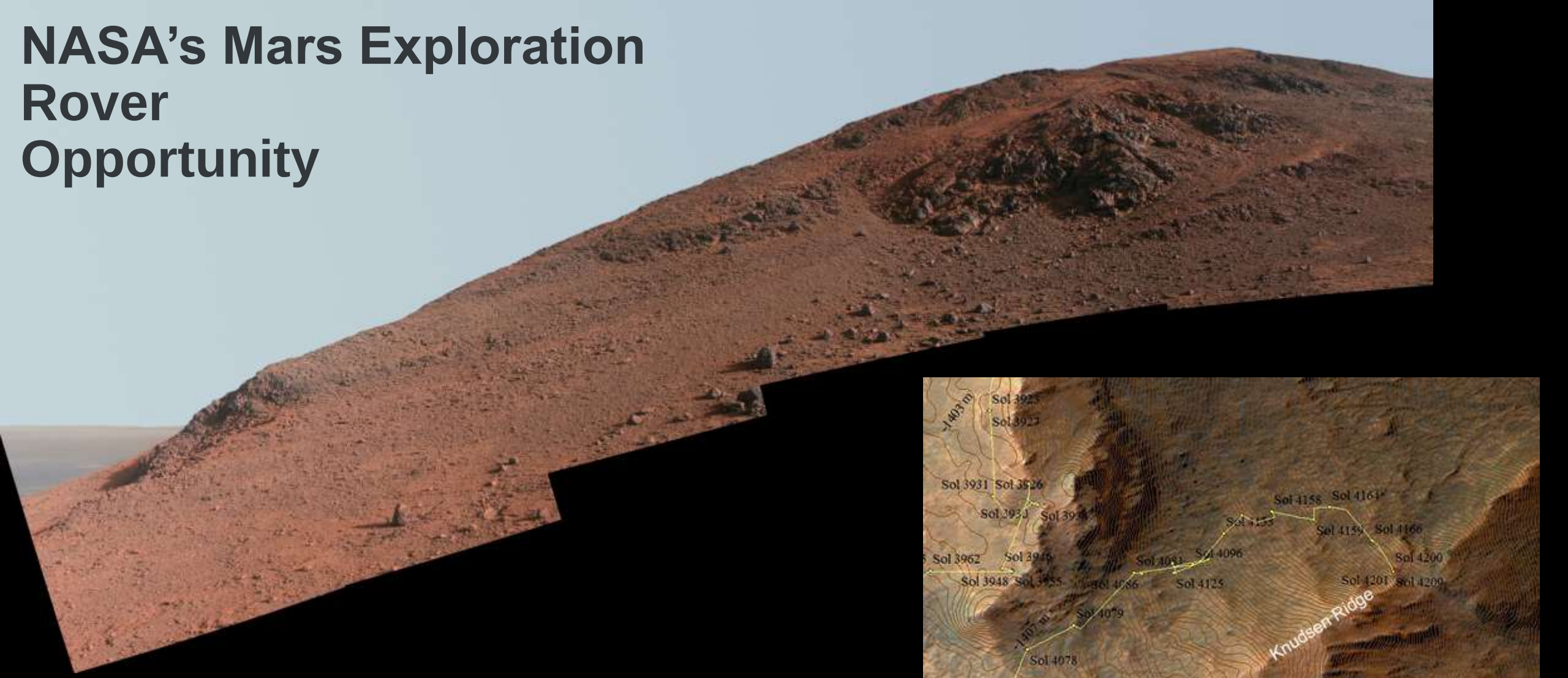
- LIFE
  - Determine if fine-grained lower delta strata and carbonate-bearing units contain biosignatures, and show evidence for past martian life
- GEOCHRONOLOGY
  - Seek to determine age of basement materials and Isidis impact, Jezero impact, and carbonates from detrital sediments and in-situ samples. Constrain fluvio-lacustrine history.
- CARBON CYCLE
  - Investigate the Martian carbon cycle through geochemical analysis of detrital deltaic, lacustrine precipitates, and in situ alteration-derived carbonates
- EARLY MARS CLIMATE
  - Determine the timing of valley network activity from deltaic samples and bounding units, atmospheric density, and escape rates from carbonate isotopes

NASA’s Perseverance Rover 1st samples acquired



Images: ASU; MSSS; NASA/JPL-Caltech

NASA's Mars Exploration Rover Opportunity



Opportunity in Marathon Valley 2015 (after 42+ km).

In 2016 the ridge above was named after

Jens Martin Knudsen

Images: Cornell Univ.; NASA/JPL-Caltech.