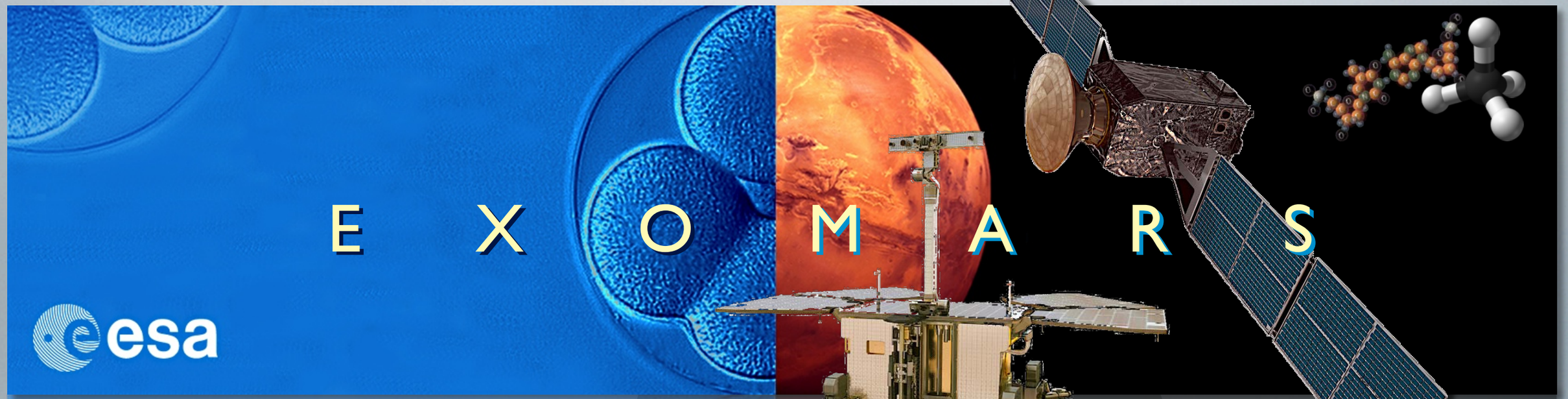
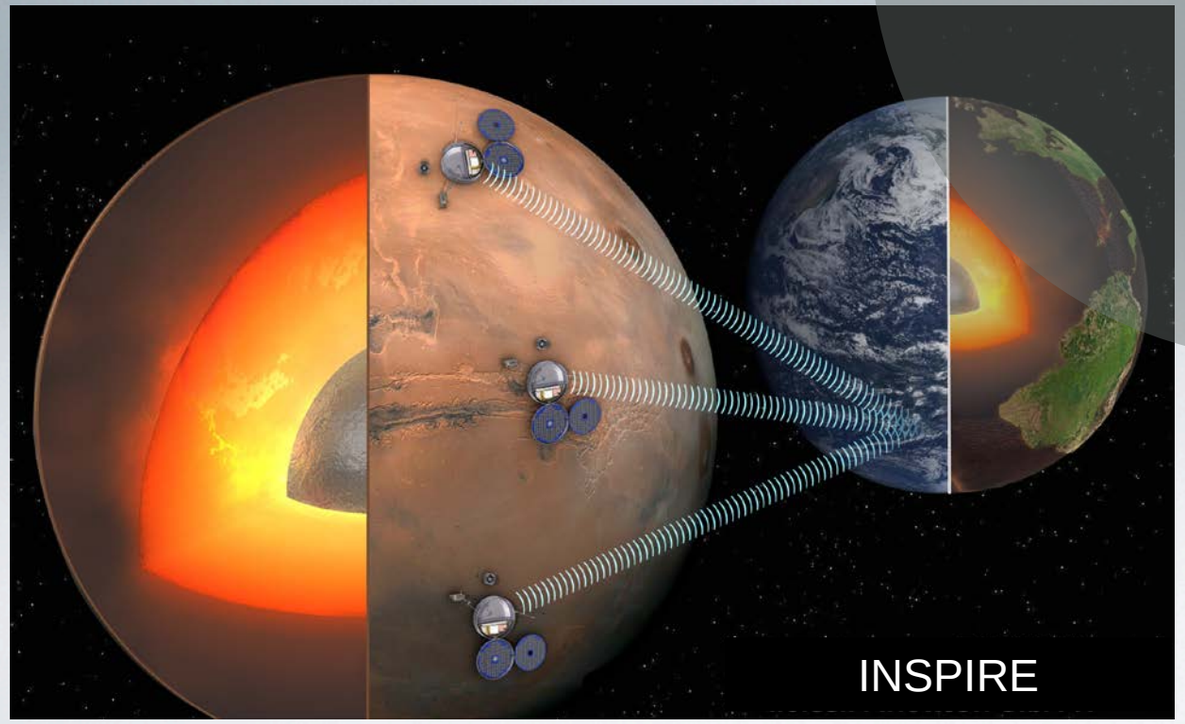
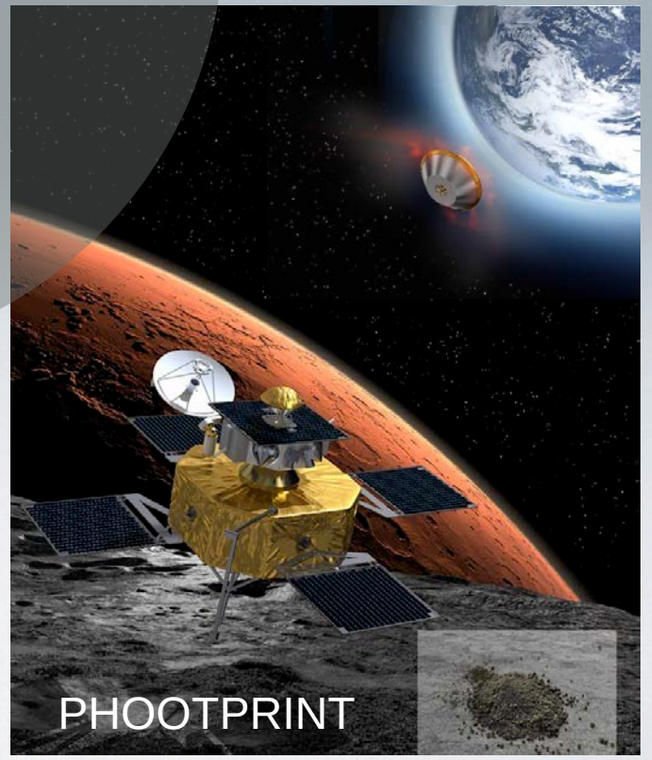


Mars Exploration Programme





J. L. Vago, and the ExoMars & MREP Teams

MEPAG#26

4 October 2012, Monrovia, CA (USA)

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Mars Exploration at ESA

ExoMars

- ExoMars: Constitutes the core of ESA's Mars Exploration Programme.
- ExoMars: An international collaboration between ESA and Roscosmos, with NASA contributions.
- ExoMars: Two missions — in the 2016 and 2018 opportunities.

Mars Robotic Exploration Programme (MREP)

- ESA is preparing its post-ExoMars missions and technologies through MREP.
- ESA is open to international participation in MREP missions.
- The target is to achieve collaboration either through 80/20 or 20/80 % schemes.

Credit: MEX/HRSC

2016 Mission Objectives

E X O M A R S

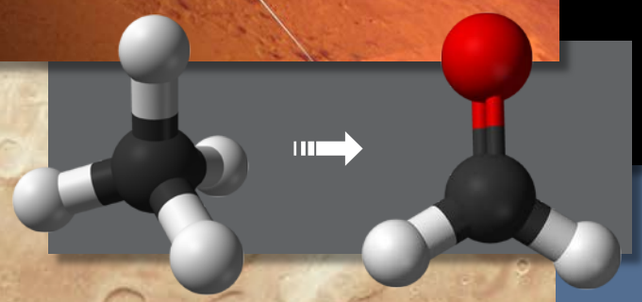
TECHNOLOGY OBJECTIVE

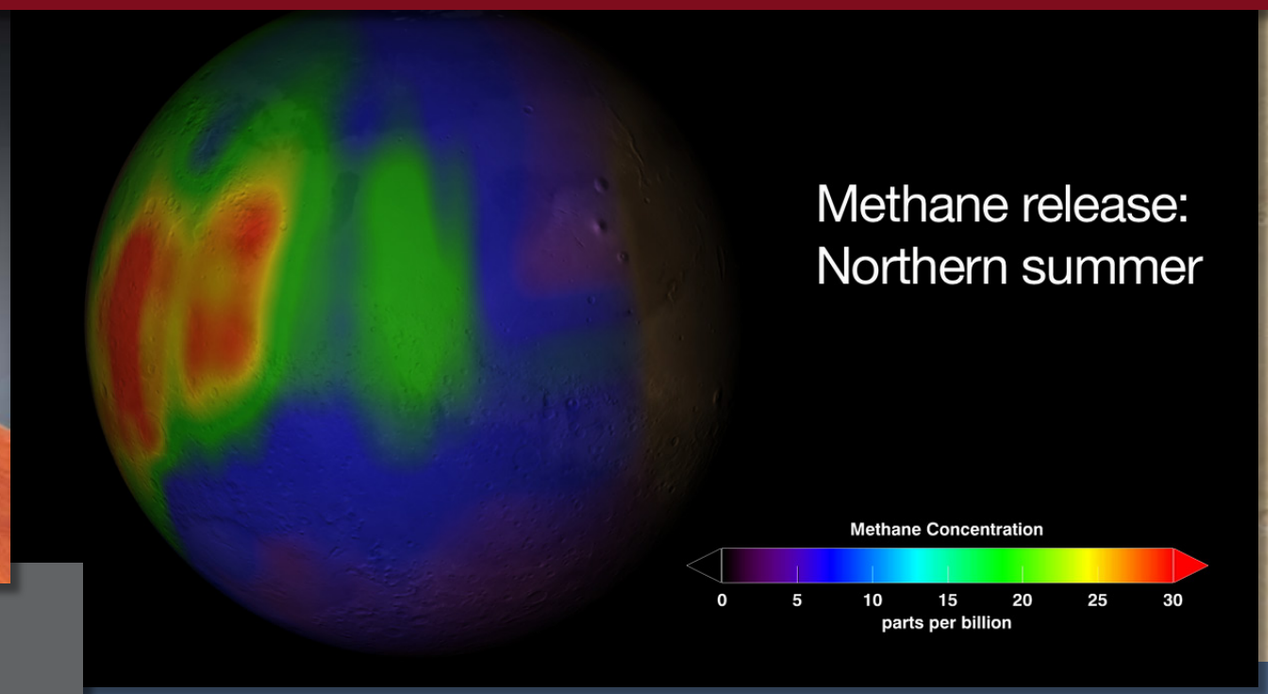
- Entry, Descent, and Landing (EDL) of a payload on the surface of Mars.

2016

SCIENTIFIC OBJECTIVE

- To study Martian atmospheric trace gases and their sources.
- To conduct surface environment measurements.





- Provide data relay services for landed missions until 2022.

Credit: MEX/HRSC

Trace Gas Orbiter

EXOMARS

NOMAD

High-resolution occultation and nadir spectrometers

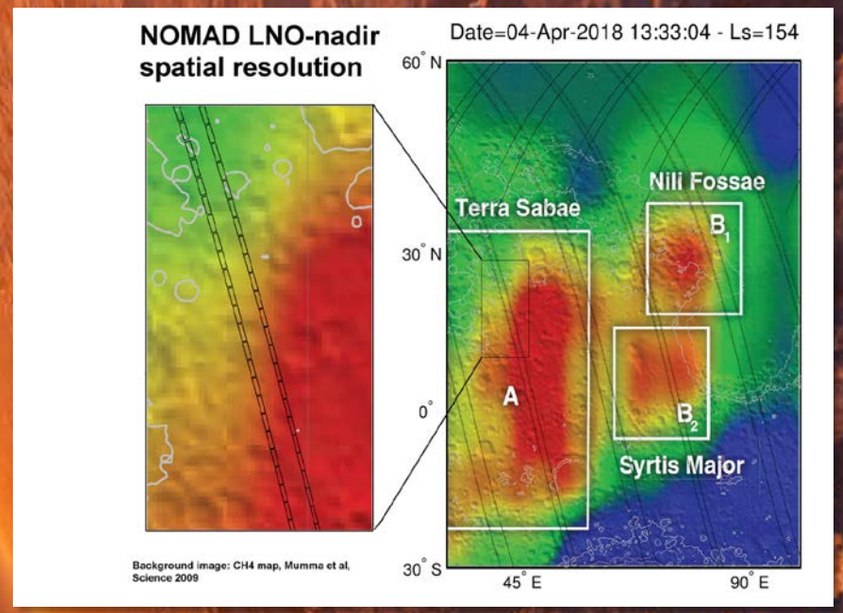
Atmospheric composition (CH_4, O_3, trace species, isotopes) dust, clouds, P&T profiles

UVIS (0.20 – 0.65 μm) λ/Δλ ~250	SO	Limb	Nadir
IR (2.3 – 3.8 μm) λ/Δλ ~10,000	SO	Limb	Nadir
IR (2.3 – 4.3 μm) λ/Δλ ~20,000	SO		

CaSSIS

High-resolution, stereo camera

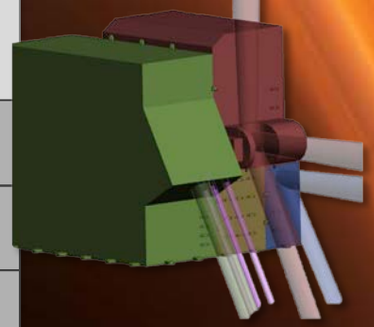
Mapping of sources
Landing site selection



ACS

Suite of 3 high-resolution spectrometers

Atmospheric chemistry, aerosols, surface T, structure

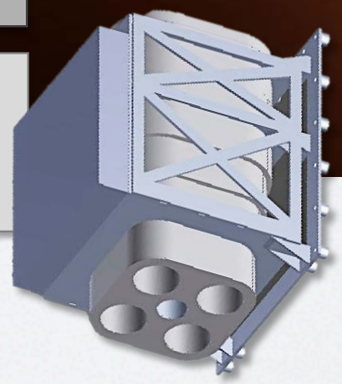


Near IR (0.7 – 1.7 μm) λ/Δλ ~20,000	SO	Limb	Nadir
IR (Fourier, 2 – 25 μm) λ/Δλ ~4000 (SO)/500 (N)	SO		Nadir
Mid IR (2.2 – 4.5 μm) λ/Δλ ~50,000	SO		

FREND

Collimated neutron detector

Mapping of subsurface water
And hydrated minerals



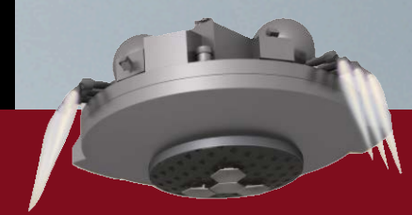
Credit: Kees Veenenbos

EDL Demonstrator Module

EXOMARS

EDM

- A technology demonstrator for landing payloads on Mars;
- A useful platform to conduct environmental measurements, particularly during the dust storm season.



EDM PAYLOAD

- Integrated payload mass: 5 kg;
- Lifetime: 4–8 sols;
- Measurements:
  - Descent science;
  - P, T, wind speed and direction;
  - Optical depth;
  - Atmospheric charging;
  - Descent camera.

2018 Mission Objectives

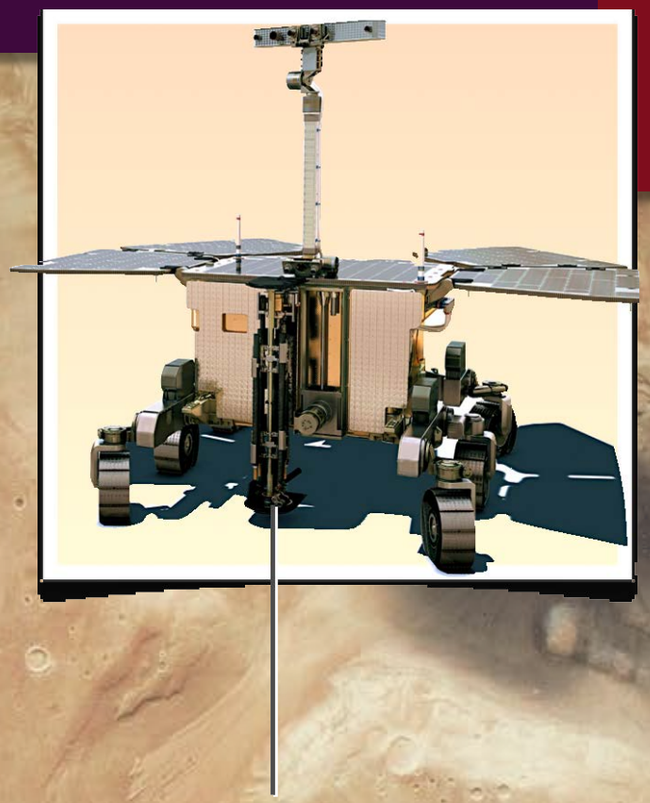
TECHNOLOGY OBJECTIVES

- Surface mobility with a rover (having several kilometres range);
- Access to the subsurface to acquire samples (with a drill, down to 2-m depth);
- Sample acquisition, preparation, distribution, and analysis.

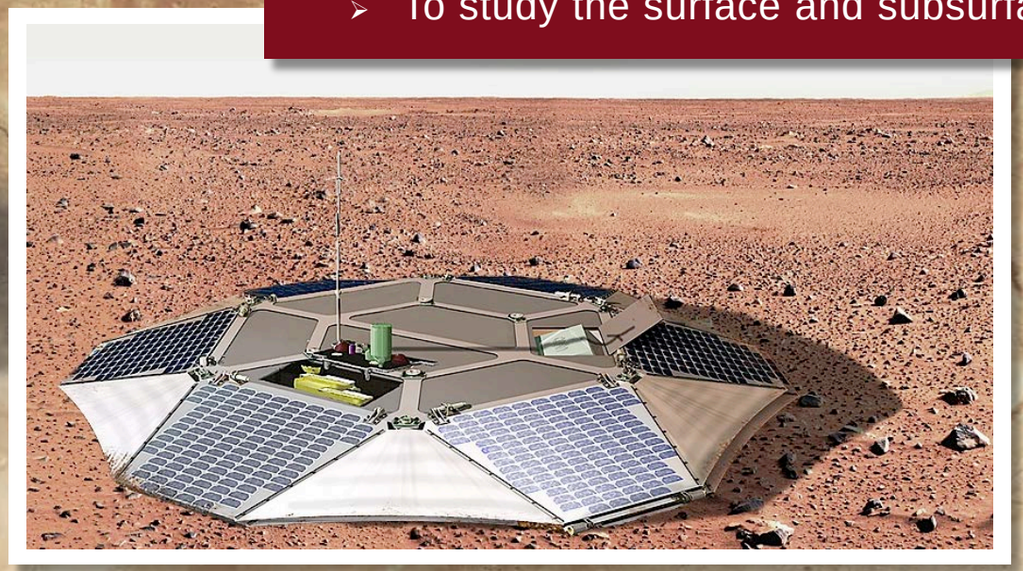
2018

SCIENTIFIC OBJECTIVES

- To search for signs of past and present life on Mars;
- To characterise the water/subsurface environment as a function of depth in the shallow subsurface.

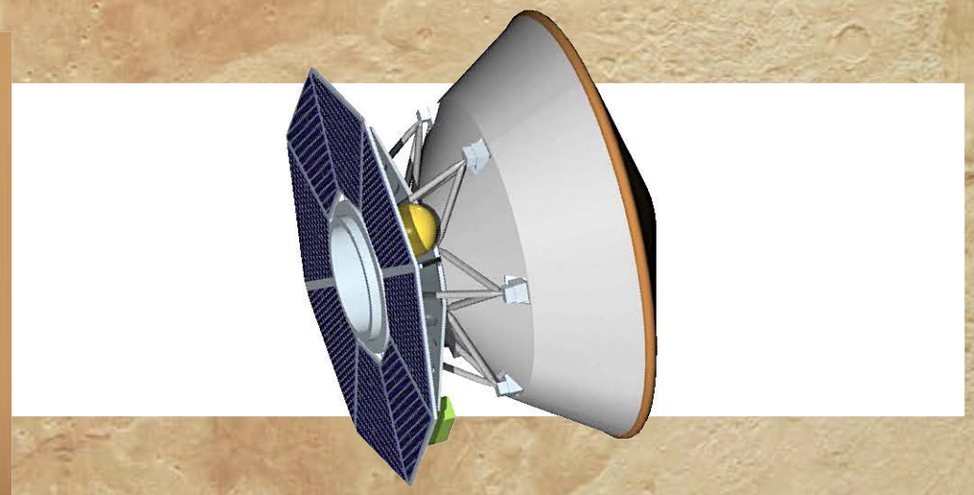


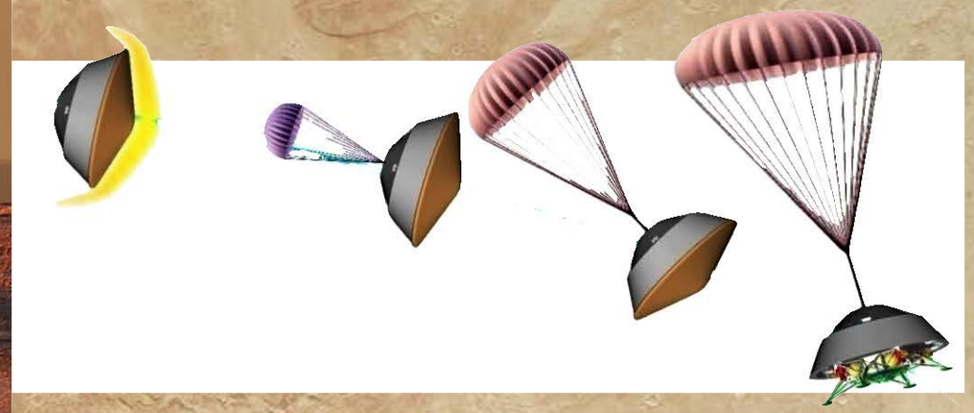
- To study the surface and subsurface environment.

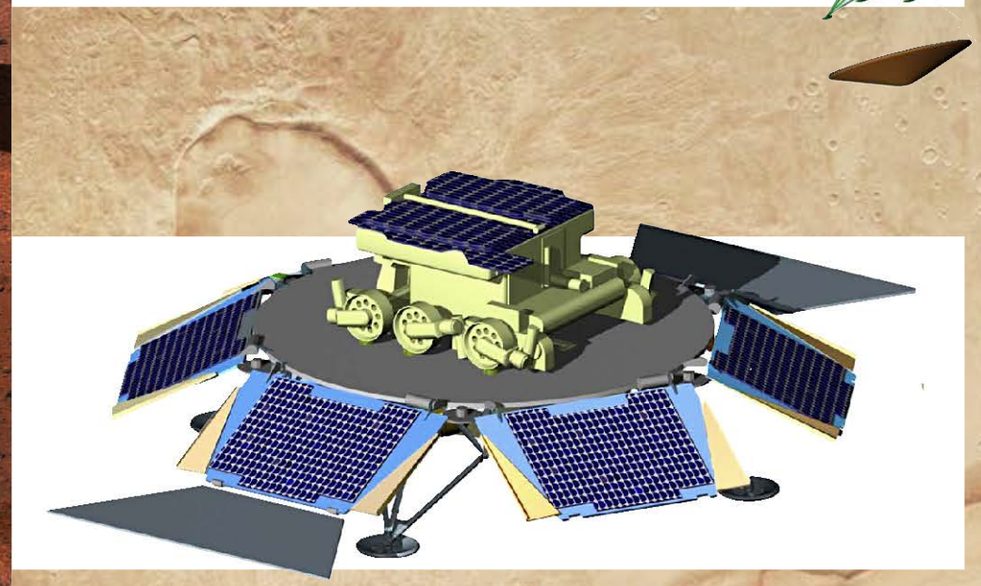


Credit: MEX/HRSC

Entry, Descent, and Landing

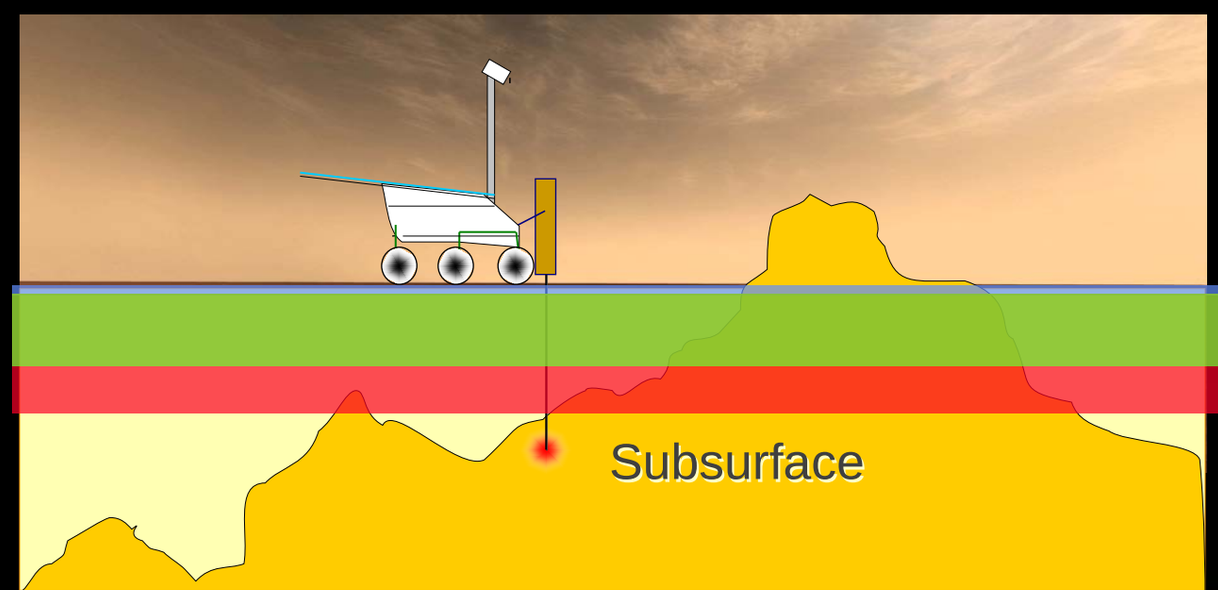






Credit: MEX/HRSC

Where to Search



Penetration of organic destructive agents

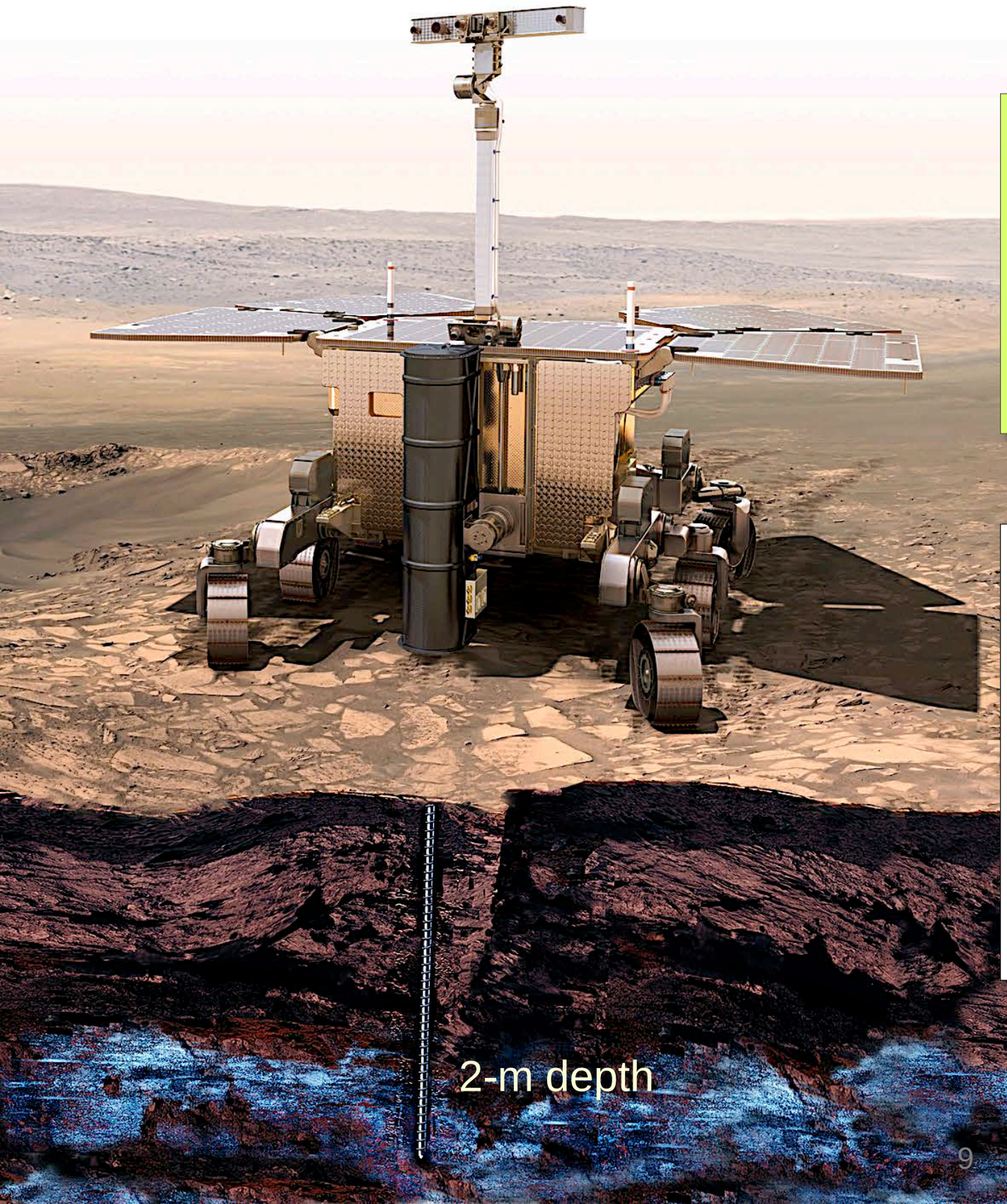
UV Radiation	~ 1 mm
Oxidants	~ 1 m
Ionising Radiation	~ 1.5 m

ExoMars exobiology strategy:

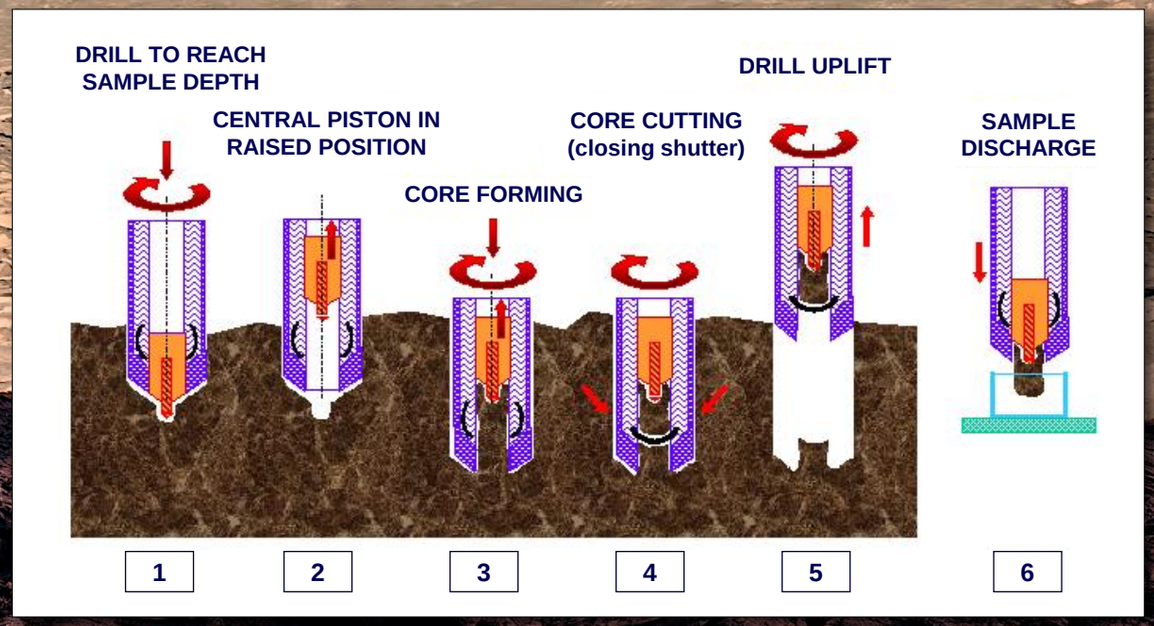
Identify and study the appropriate type of outcrop;

Collect samples below the degradation horizon and analyze them.

Mobility + Subsurface Access



Nominal mission:	220 sols
Nominal science:	6 Experiment Cycles + 2 Vertical Surveys
EC length:	16–20 sols
Rover mass:	300-kg class
Mobility range:	Several km



Credit: ESA/Medialab

Pasteur Payload

EXOMARS

PanCam
Wide-angle stereo camera pair
High-resolution camera

Geological context
Rover traverse planning
Atmospheric studies

WAC: 35° FOV, HRC: 5° FOV

ISEM
IR spectrometer on mast

Bulk mineralogy of outcrops
Target selection

λ = 1.15 – 3.3 µm, 1° FOV

CLUPI
Close-up imager

Geological deposition environment
Microtexture of rocks
Morphological biomarkers

20-µm resolution at 50-cm distance, focus: 20 cm to ∞

WISDOM
Ground-penetrating radar

Mapping of subsurface stratigraphy

3 – 5-m penetration, 2-cm resolution

FREND
Passive neutron detector

Mapping of subsurface
Water and hydrated minerals

Drill + Ma_MISS
IR borehole spectrometer

In-situ mineralogy information

λ = 0.4 – 2.2 µm

Analytical Laboratory Drawer

MicrOmega
VIS + IR Spectrometer

Mineralogical characterization of crushed sample material
Pointing for other instruments

λ = 0.9 – 3.5 µm, 256 x 256, 20-µm/pixel, 500 steps

RLS
Raman spectrometer

Geochemical composition
Detection of organic pigments

spectral shift range 200–3800 cm^{-1}, resolution ≤ 6 cm^{-1}

MOMA
LDMS + Pyr-Dev GCMS

Broad-range organic molecules at high sensitivity (ppb)
Chirality determination

Laser-desorption extraction and mass spectroscopy

Pyrolisis extraction in the presence of derivatisation agents, coupled with chiral gas chromatography, and mass spectroscopy

MREP-2

MREP-2 Objectives

- Build and sustain competence of European robotic exploration through a series of missions to Mars.
- Target a mission for every launch opportunity.
- Develop missions in cooperation, ensuring they are well integrated in the international context.
- Aim for first two missions to be European-led.
- Reinforce the exploration technology programme already started with MREP-1.
- Maintain Mars Sample Return (MSR) as medium to long-term goal.

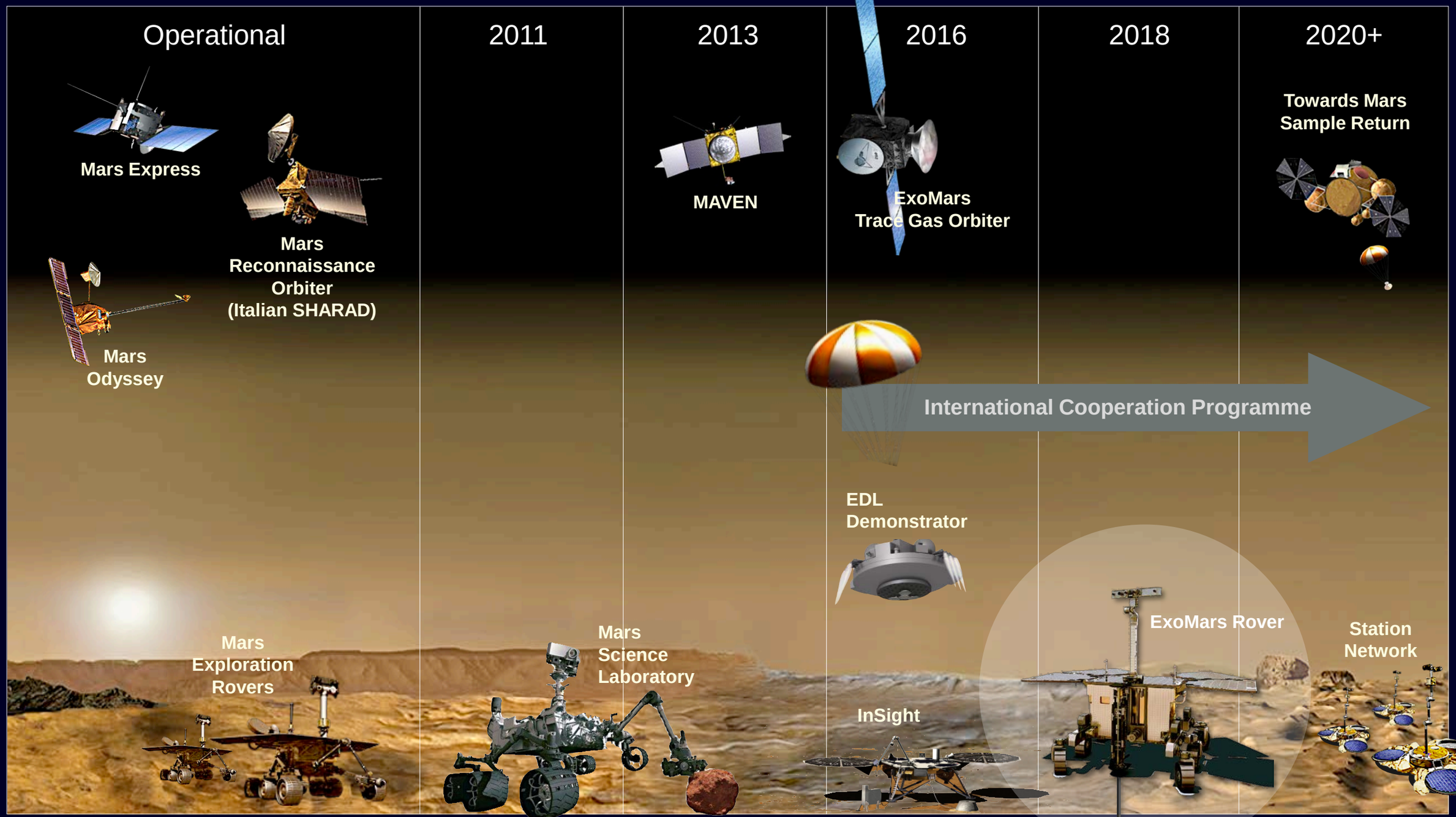
Candidate Missions

- Four candidate missions selected in May 2010 and studied:
  1. MSR Orbiter — implementation subject to the successful start of international MSR effort.
  2. Mars moon sample return.
  3. Mars network science mission.
  4. Mars precision lander — possibly as element of international MSR.

Two Missions Recommended

- For the 2022 and 2024 opportunities (which is first, still TBD):
  1. PHOOTPRINT: Phobos sample return.
  2. INSPIRE: Mars network science mission.

International Context



- **MSL**: powerful rover; large 2-D mobility.
- **ExoMars:** next-generation instruments; 3-D access.

Following on the results of MSL, ExoMars is the logical next step in international Mars surface exploration.

Conclusions

➔ 2016: ExoMars Trace Gas Orbiter

Its science will improve our understanding of Mars and of key atmospheric processes of potential astrobiological relevance.

An excellent base for international collaboration.

Master landing technologies for future European missions.

➔ 2018: ExoMars Rover

A great exobiology mission.

The first ever to combine mobility with access to the subsurface.

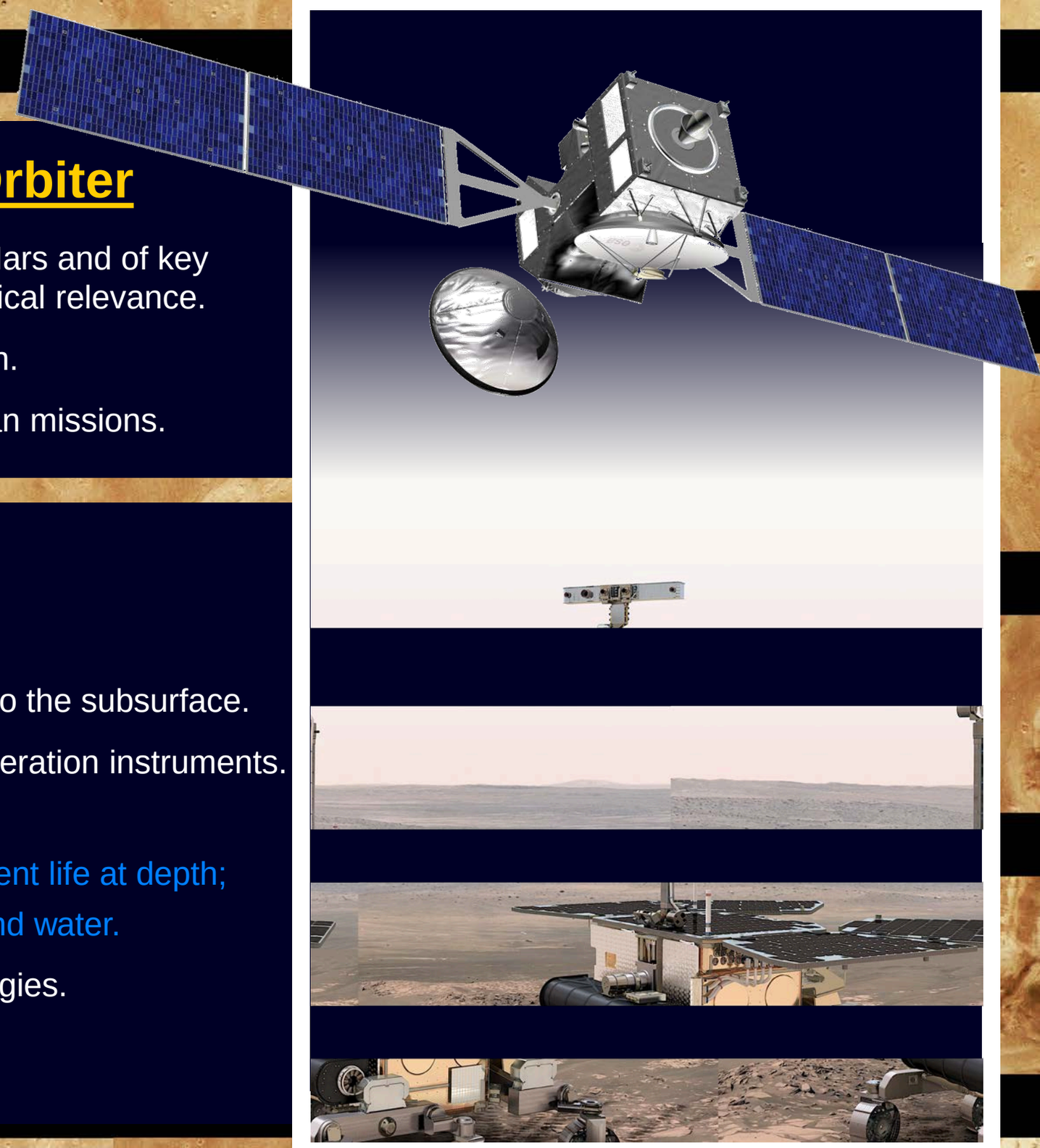
The rover's Pasteur payload contains next-generation instruments.

The rover will study, for the first time:

- Organics and biomarkers for past and present life at depth;
- Vertical characterisation of geochemistry and water.

New sample handling and locomotion technologies.

A step closer to Mars Sample Return.



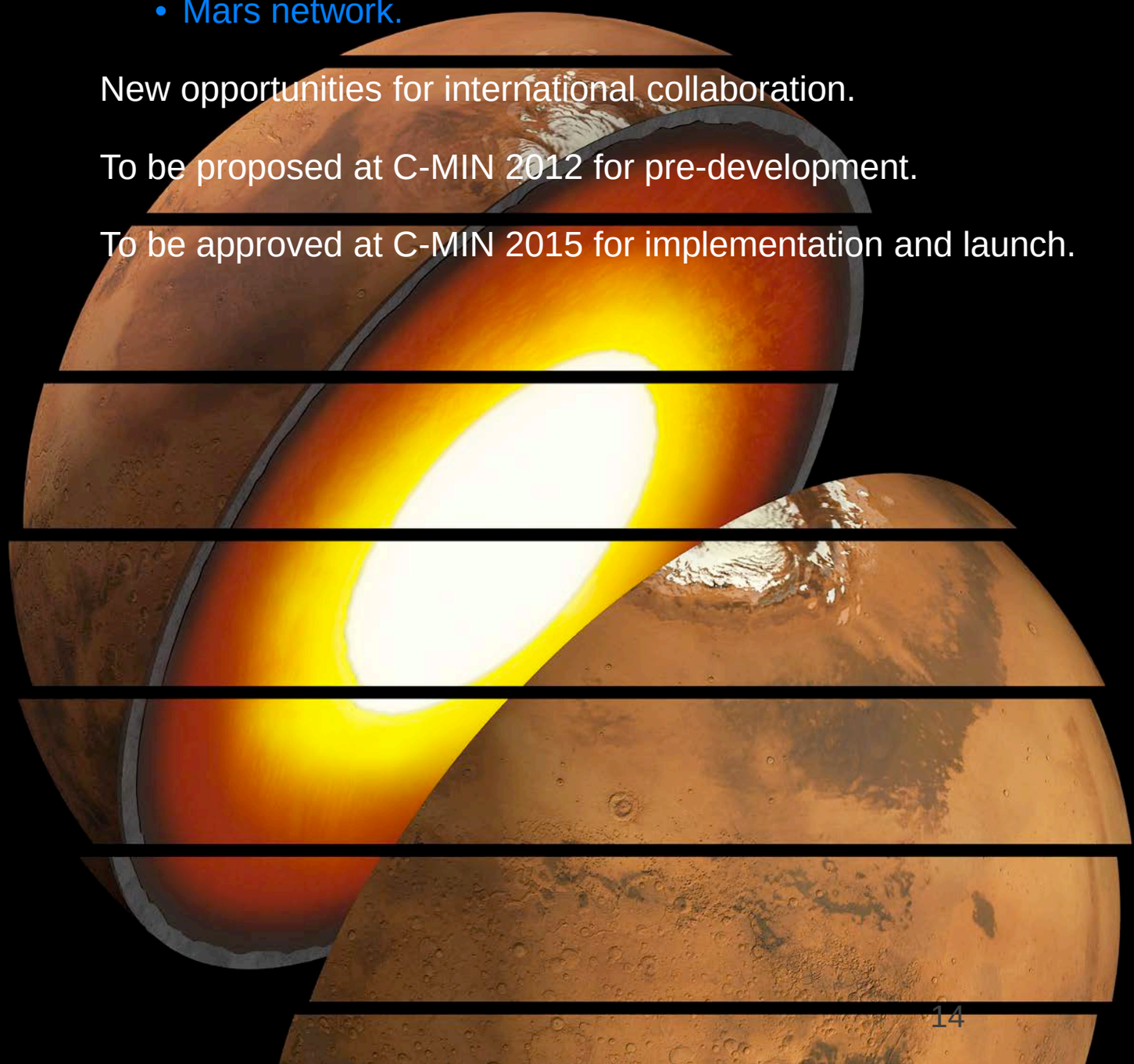
Conclusions

➔ 2022 and 2024: PHOOTPRINT & INSPIRE

Missions with a strong scientific and technology content:

- Phobos sample return;
- Mars network.

New opportunities for international collaboration.

To be proposed at C-MIN 2012 for pre-development.

To be approved at C-MIN 2015 for implementation and launch.