Search for Life on Mars
Rover FM
We Are Building a New Lander
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;
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 analyse them.
Radiolysis destruction can be described by:

\[ N / N_0 = e^{-k \cdot D} \]

- \( N / N_0 \): Molecule surviving fraction
- \( k \): Radiolysis constant (scales with molecular weight)
- \( D \): As a function of subsurface depth on Mars
Survival rate of a 100% amino acid mixture vs. depth after being exposed to 0.5 (blue), 1.0 (green), 2.0 (yellow), 3.0 (red) and 4.0 (purple) billion years of Mars near-surface ionising radiation.

Dose rate from MSL vs. depth, Hassler et al. (2014). Radiolysis constants $k$ measured by Kminek and Bada (2006).

Why amino acids?
- 63% of cell by dry mass.
- They can preserve biochirality.
- Survive for billions of years in cold martian subsurface (if not destroyed by radiation).
Clay Sample from 1.7 m Depth
ALD FM Complete

ESA / ExoMars / TAS-I / OHB
Use mineralogical + image information from μΩ to identify targets for Raman and MOMA-LDMS.

Imaging VIS + IR spectrometer:
256 x 256 pixels, 20 μm/pixel resolution, 0.95–3.65 μm spectral range, 320 steps

→ μΩ = 20 μm
→ Raman = 50 μm
→ LDMS = 200 x 400 μm

Raman: Spectral shift range 200–3800 cm⁻¹
Spectral resolution: 6 cm⁻¹

LDMS = Laser Desorption Mass Spectrometry
GCMS = Gas Chromatograph Mass Spectrometer
Characterisation of Organic Molecules
MOMA SWIFT to Enrich Molecules of Interest
Identification of Molecules

BENZOIC ACID

$C_7H_6O_2$
Candidate Landing Sites

Oxia Planum
Mawrth Vallis

Oldest terrains to be targeted
**Early Mars**

- **Pre-Noachian** (4.1 Ga)
- **Noachian** (3.7 Ga)
- **Hesperian**

**Mars**
- **Start of conditions compatible with life**
- **Early heavy bombardment**
- **Late heavy bombardment**
- **Clays**
- **Oxia Planum**

**Earth**
- **Beginning of terrestrial planetary accretion** (4.568 Ga)
- **Hadean** (4.4 Ga)
- **Archaean** (3.9 Ga)
- **Oldest preserved traces of life** (3.5 Ga)

**ExoMars**
- **Rosalind Franklin**
- **Perseverance**
- **Curiosity**
Launch

Launch date: 5 – 20 Oct 2028
Mars Arrival: 28 Oct 2030, 17:20 LTST
Landing Site: Oxia Planum, ~3 km MOLA
Ellipse: 90 km x 8 km

Earth departure

Mars arrival

Dust storm season
The mission’s science is compelling, timely, and of interest for Decadal Survey missions

- We will make a trip back in time to an epoch never explored, when Mars was more Earth-like.
- The unique landing site preserves the most ancient, water-altered deposits we know of.
- We will investigate the martian subsurface for the first time.
- We have a great payload to hunt for potential biomolecule relics and establish their geological context.
- Rosalind Franklin can make fundamental discoveries in organic chemistry, life sciences, and comparative planetology.
- Our findings will contribute to Mars Sample Return (MSR), Mars Life Explorer (MLE), and Dragonfly.
ESA-NASA Mars Projects

Mars 2020 Sample Caching
- Collect samples of rock, regolith, and atmosphere
- Cache samples on the surface for retrieval

Rosalind Franklin 2028
- Search for signs of life in the subsurface
- Understand ancient Mars

Sample Retrieval Lander
- Retrieve samples caged by Mars 2020 rover
- Launch samples into Mars orbit

Earth Return Orbiter
- Capture and contain samples in Mars orbit
- Return samples safely to Earth

Trace Gas Orbiter 2016
- Study atmospheric trace gas species
- Provide communications relay for landers