2018 Landing Site Selection

J. L. Vago, L. Lorenzoni, D. Rodionov,
and the ExoMars LSSWG (composition in presentation)

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20-21 May 2014, Washington DC (USA)

Objective

EXOMARS

esa

POCKOCMOC

Identify a suitable landing site for the ExoMars 2018 mission:

- **Scientifically compelling** —high probability of achieving the science objectives.
- **Safe for landing** —no safe landing, no science.
- **Safe for surface operations** —energy generation, locomotion, etc.
- **Planetary Protection** —no landing on or access to Mars special regions.

Credit: Mamers Valles, MEX/HRSC

Science Requirements

- From a science point of view, a landing site satisfying the Rover mission's search-for-life requirements would also be extremely interesting for the Surface Platform Science.

For the ExoMars Rover to achieve results regarding the possible existence of biosignatures, the mission has to land in a **scientifically appropriate setting**:

1. The site must be **ancient** (older than 3.6 Ga) — from Mars' early, habitable period: Pre- to late Noachian (Phyllosian), possibly extending into the Hesperian;
2. The site must show abundant morphological and mineralogical evidence for long-duration, or frequently reoccurring, **aqueous activity**;
3. The site must include numerous **sedimentary rock outcrops**;
4. Outcrops must be **distributed** over the landing ellipse to ensure the rover can get to some of them (the expected rover traverse range during the 218-sol nominal mission is a few km);
5. The site must have **little dust** coverage.

Credit: Echus Chasma, MEX/HRSC

Engineering Requirements

- No safe landing, no science.
- Landing safety will be a major discriminant.
  This is why **all candidate sites must be scientifically compelling!!!**

1.	Landing latitude band:	5° S to 25° N, no longitude restrictions;
2.	Maximum landing altitude:	–2 km MOLA;
3.	Size and azimuth of landing ellipse:	104 km x 19 km, 88° to 127° (clockwise from N);
4.	Terrain slope requirements:	See call;
5.	Rock abundance requirements:	< 7%;
6.	Radar reflectivity requirements:	See call;
7.	Thermal inertia requirements:	≥ 150 J m^{-2} $s^{-0.5}$ K^{-1};
8.	Atmospheric parameters requirements:	≤ 25 m/s from 10 km to 1 m above ground (landing);
9.	Rover terrain navigation requirements:	See call.

Credit: Meridiani Planum, Odyssey/ASU

Multi-Step Approach

- **Call for Letters of Application for Membership in the 2018 Landing Site Selection Working Group (LSSWG)—opened on 1 Nov 2013**
  - Who: Scientists interested in forming part of the LSSWG send a letter plus their CV.
  - A group consisting of ESA, Roscosmos/IKI, and independent experts from the science community will select scientists based on the required scientific expertise necessary to support the work.
  - The LSSWG will review candidate landing site proposals, but LSSWG members will not be able to propose landing sites or be part of LS proposals.
  - The LSSWG will include scientists, PSs, ESWT representatives, project and industry members.
- **Work of LSSWG members—kicked off on 6 Dec 2013**
  - The LSSWG will work mostly via telecon/videocon.
  - Their first task will be to prepare the Call for Landing Site proposals.
- **Release of Call for Landing Site Proposals—18 Dec 2013**
  - Proposals will be requested to demonstrate compliance of site with mission's scientific and lander engineering requirements.
- **Landing Site Proposals are received—28 Feb 2014**
  - The LSSWG will analyse the proposals received in response to the call to assess their compliance with engineering, science, and planetary protection requirements. The LSSWG will contact proposers in case additional information or clarifications are necessary. Sites deemed to be non compliant will be rejected and proposers informed.
- **First Landing Site Selection Workshop at ESAC—26–28 Mar 2014**
  - The LSSWG will present the information compiled on all proposals: Sites will have received a preliminary classification in terms of safety and science interests (green, yellow, red).
  - Proposers will be invited to present their candidate site, which will be discussed by all participants.

Credit: Mamers Valles, MEX/HRSC

LSSWG

#	Name		Expertise	Country
1	Frances Westall	CNRS-Orléans	BIOSIGNATURES/ESWT/PPWG: Preservation, ancient geology	FR
2	Howell Edwards	Bradford U.	BIOSIGNATURES: Preservation, mineralogy, Raman	UK
3	Lyle Whyte	McGill	BIOSIGNATURES: Arctic microbiology, cold drilling	CAN
4	Alberto Fairén	Cornell U.	BIOSIGNATURES: Mars hydrogeology and biosignatures	USA
5	Jean-Pierre Bibring	IAS	GEOLOGY/ESWT: Hydrated minerals, Mars history	FR
6	John Bridges	U. of Leicester	GEOLOGY: LS mapping, topography	UK
7	Ernst Hauber	DLR	GEOLOGY/PPWG: Topography, layered deposits, alluvial fans	DE
8	Gian Gabriele Ori	IRSPS	GEOLOGY: Sedimentary geology, mapping	ITA
9	Stephanie Werner	U. Oslo	GEOLOGY: Dating, mineralogy, resurfacing processes	NO
10	Damien Loizeau	U. Lyon	GEOLOGY: Dating, geomorphology, mineralogy	FR
11	Ruslan Kuzmin	IKI	GEOLOGY: Ice/water processes	RUS
12	Becky Williams	IPS	GEOLOGY: Fluvial geomorphology and sedimentary processes	USA
13	Jessica Flahaut	VUAmsterdam	GEOLOGY: Mineralogy, layered deposits, mapping	NL
14	François Forget	LMD	ATMOSPHERICS: Atmospheric Modelling	FR
15	Jorge L. Vago	ESA	SCIENCE: ExoMars Project Scientist	ESA
16	Daniel Rodionov	IKI	SCIENCE: ExoMars Project Scientist	RUS
17	Oleg Korablev	IKI	SCIENCE/ESWT: IR mineralogy and atmospheric aerosols	RUS
18	Olivier Witasse	ESA	SCIENCE: TGO Project Scientist	ESA
19	Gerhard Kminek	ESA	SCIENCE/PPWG: Planetary Protection, organics degradation	ESA
20	Leila Lorenzoni	ESA	PROJECT: ExoMars EDL and landing site engineer	ESA
21	Olivier Bayle	ESA	PROJECT: ExoMars EDM systems engineer	ESA
22	Luc Joudrier	ESA	PROJECT: ExoMars Rover GNC and operations engineer	ESA
23	Viktor Mikhaylov	TsNIIMASH	PROJECT: ExoMars EDL & ground testing manager	RUS
24	Alexander Zashirinsky	Lavochkin	INDUSTRY: ExoMars EDL engineer	RUS
25	Sergey Alexashkin	Lavochkin	INDUSTRY: ExoMars DM Chief Designer	RUS
26	Fabio Calantropio	TAS-I	INDUSTRY: ExoMars EDL engineer	ITA
27	Andrea Merlo	TAS-I	INDUSTRY: ExoMars Rover GNC engineer	ITA

Credit: Mamers Valles, MEX/HRSC

1st ExoMars LSS Workshop

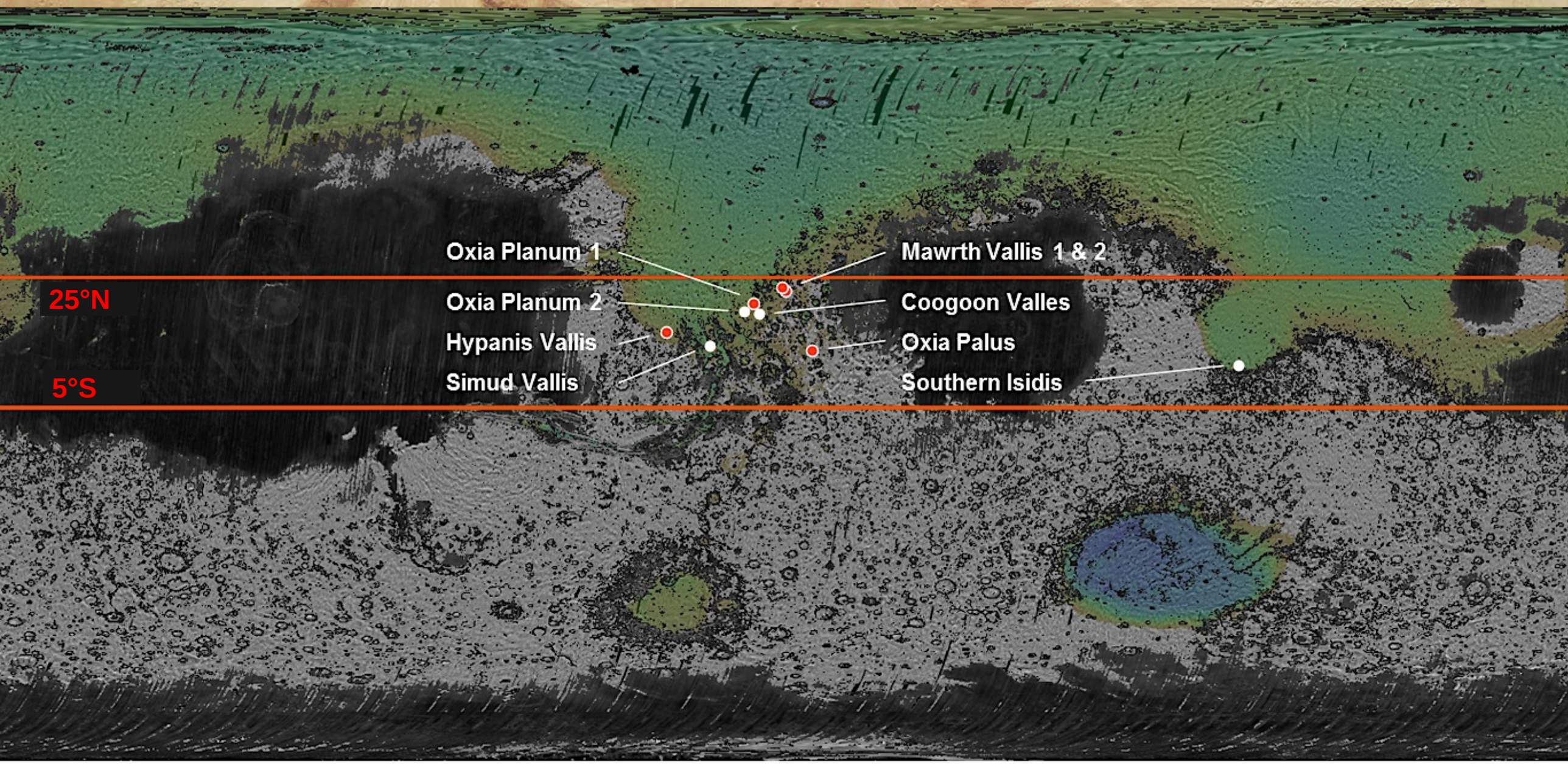
- **Eight sites were discussed (ordered from N to S):**

LS Name	Ellipse pattern's centre coordinates	MOLA altitude: max (avg) km
Mawrth Vallis 2	22.25° N, 342.00° E	–2.0 (–2.2)
Mawrth Vallis 1	22.16° N, 342.95° E	–1.8 (–2.2)
Oxia Planum 1	18.20° N, 335.45° E	–2.8 (–3.1)
Oxia Planum 2	16.63° N, 333.16° E	–2.5 (–2.7)
Coogoon Valles	16.50° N, 336.50° E	–2.6 (–2.7)
Hypanis Vallis	11.80° N, 314.96° E	–2.3 (–2.7)
Simud Vallis	8.49° N, 325.24° E	–4.9 (–5.0)
Oxia Palus	7.90° N, 348.80° E	–1.9 (–2.1)
Southern Isidis	4.35° N, 86.20° E	–3.4 (–3.8)

  - Mawrth 1 & 2 where at the same location (single site). The Oxia Planum proposal identified two ellipses.
  - **http://exploration.esa.int/mars/53944-proposed-landing-sites-for-exomars-2018-mission/**

Credit: Hephaestus Fossae, MEX/HRSC

1st ExoMars LSS Workshop



Elevation is acceptable

Elevation is too high

Too much dust

Credit: Mamers Valles, MEX/HRSC

1st ExoMars LSS Workshop

- **Eight sites were discussed**
  - Workshop followed a format adapted from those used in MER and MSL landing selection exercises.
  - First: Presentations from the project team on mission, LSS process, landing system, science, engineering, and planetary protection requirements.
  - Then: Very complete presentations by each proposing team about their sites.
  - Discussion: All aspects of science and engineering constraints were addressed, in as much detail as possible.
  - Voting: Participants were requested to indicate their ranked preference for the four sites they thought could best accomplish the mission's objectives.
  - The information was compiled in two ways: a) assigning different weights to 1st, 2nd, 3rd, and 4th rankings—to show which site(s) received the highest consideration; and b) with the same weight—to identify sites having the broadest support across all participants.
  - **Four sites received a higher science consensus: Mawrth Vallis, Oxia Planum, Hypanis Vallis, and Oxia Palus.**
    - Mawrth Vallis and Oxia Planum correspond to very ancient, massive clay formations.
    - Hypanis Vallis and Oxia Palus are more traditional sedimentary settings (a delta and a meandering river, respectively).
- **Next:**
  - The LSSWG will use all the gathered information and the preferences expressed during the workshop for its considerations.
  - All proposing teams had until 16 April 2014 to confirm the position of their ellipses.
  - More data (HiRISE, CRISM, CTX, HRSC, OMEGA) are needed.

Credit: Mamers Valles, MEX/HRSC

Multi-Step Approach

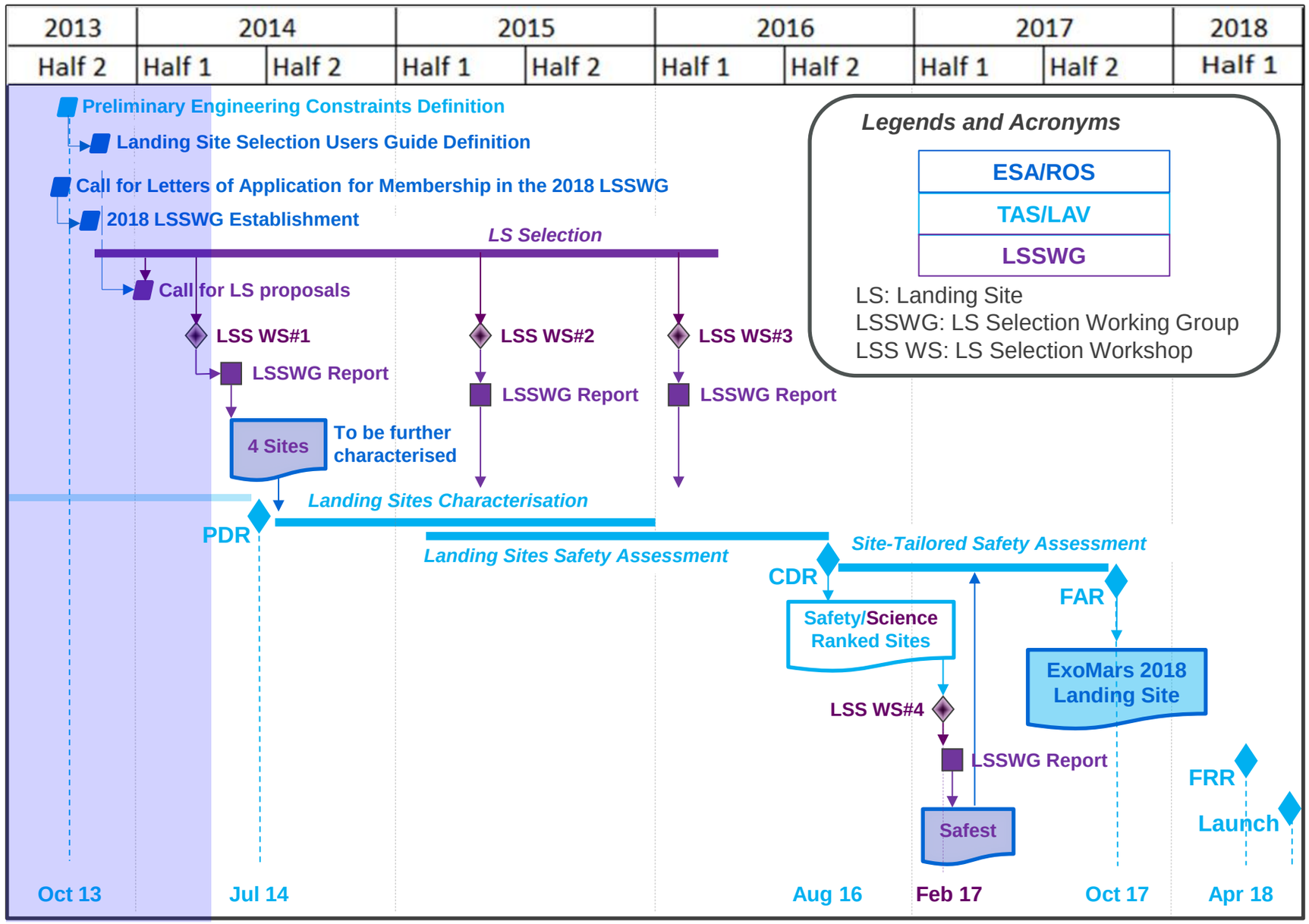
- **After first Landing Site Selection Workshop**
  - The LSSWG will take into account the information presented at the workshop, plus the outcome of discussions for the various site proposals, and the interest of participants as expressed during the workshop to produce a ranked list of candidate landing sites.
  - No more than four sites will be recommended for further, detailed evaluation.
  - All four sites must be scientifically compelling, and all four sites must be safe for landing (based on the available information).
- **Thereafter**
  - A very detailed assessment of the sites' landing safety will be performed by the LSSWG, Project Team, and Industry.
  - Likewise, the proposers and the LSSWG will continue to study the sites' science interest.
  - Please note:

    Some sites will be more scientifically interesting than others. Equally, some sites will be considered safer than others.

    As long as all four candidate landing sites are judged scientifically compelling, safety can be used to establish a preference for one or the other.
- **Other Landing Site Selection Workshops**
  - Additional LSS workshops will be organised to inform the science community of the progress performed in the characterisation of candidate sites and to receive additional information and scientific feedback from the science community—typically once a year, or as deemed useful by the LSSWG.

Credit: Reul vallis, MEX/HRSC

LSS Process



- A preliminary analysis of proposals was presented and discussed at the first LSS Workshop, where the science community had the chance to express their views to the LSSWG and Project.
- The science community will be informed through further LSS workshops and consulted by the LSSWG for specific sites.

LSS Schedule

Date	Activity
1 Nov 2013	Call for Letters of Application for Membership in the 2018 Landing Site Selection Working Group (LSSWG).
25 Nov 2013	Letters of Application due.
Early Dec 2013	Review of Letters of Application and appointment of LSSWG members.
18 Dec 2013	Release of Call for Landing Site Proposals.
28 Feb 2014	LS Proposals due.
Feb/Mar 2014	Screening of candidate LS proposals by LSSWG.
26–28 Mar 2014	First LSS Workshop at ESAC.
Apr/May 2014	LSSWG prioritisation of candidate LSs (based on science, engineering, and Planetary Protection requirements).
Jun 2014	Up to four top landing locations identified by LSSWG for further, more detailed study.
…	Characterisation work continues. Other science conferences help to further refine findings. Aim to have at least a site certified by CDR (planned for Sep 2016).
Oct 2017	Final LSSWG recommendation to D/SRE and appropriate Russian authorities prior to mission's FAR.

Credit: Kasei Valles, MEX/HRSC

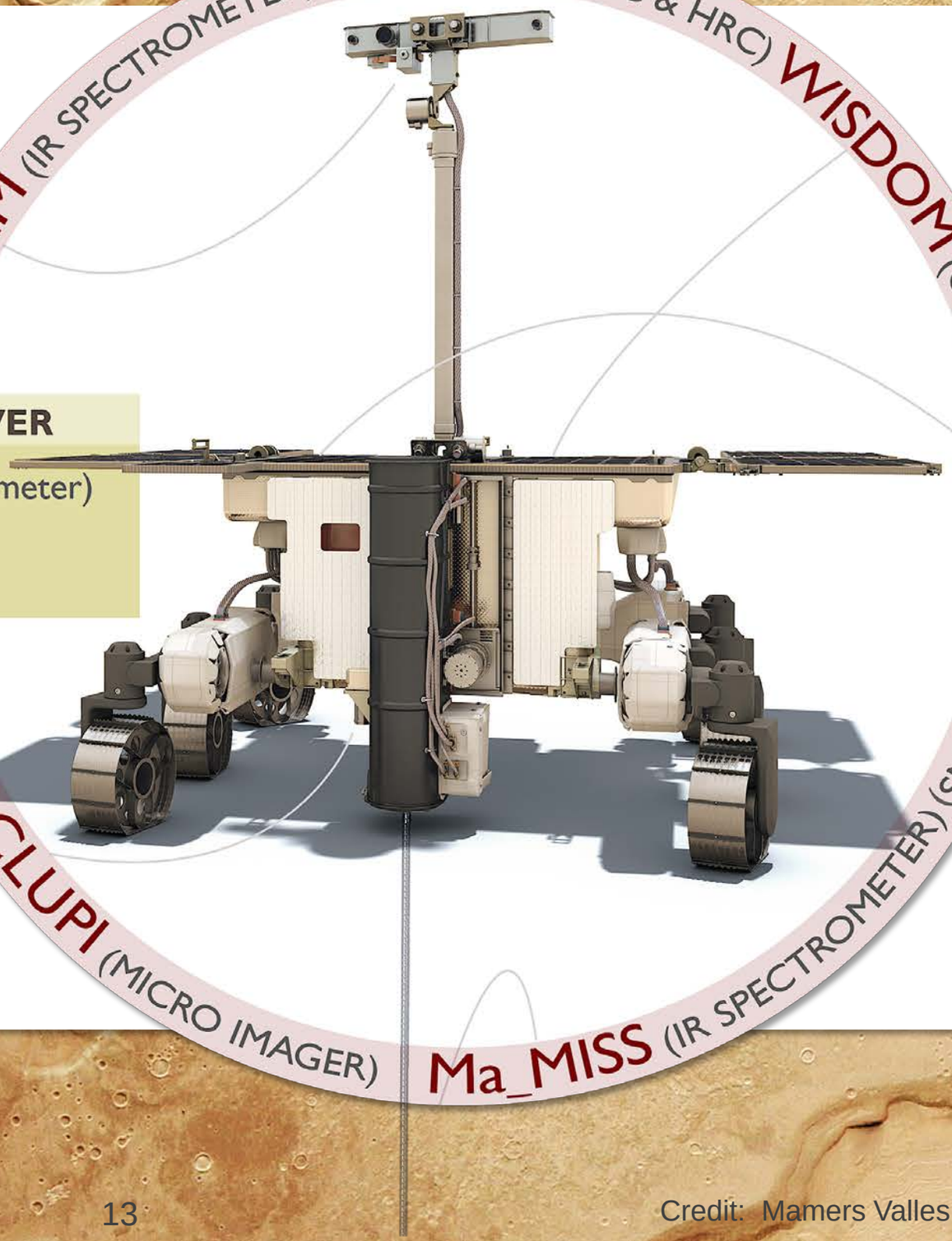
Thank You

EXOMARS

ANALYTICAL LABORATORY DRAWER

MicrOmega (VIS + IR Imaging Spectrometer)
MOMA (Organic Molecule Analyser)
RLS (Raman Spectrometer)

ISEM (IR SPECTROMETER) PanCam (WAC & HRC) WISDOM (GPR) ADRON (NEUTRONS)



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Credit: Mamers Valles, MEX/HRSC