

ExoMars 2020 Landing Site Selection and Characterisation

J. C. Bridges¹, A. Parkes Bowen¹, P. Fawdon², M. Balme², D. Loizeau³, E. Sefton-Nash⁴, J. Vago⁴, R. M. E. Williams⁵, E. Hauber⁶, S. M. R. Turner, J. M. Davis⁷, P. Grindrod⁸, S.Gupta⁷, and the ExoMars Landing Site Selection Working Group.

¹Space Research Centre, University of Leicester, UK, j.bridges@le.ac.uk, ²Open University, UK, ³Laboratoire de Géologie de Lyon, France, ⁴ESTEC, The Netherlands, ⁵Planetary Sciences Institute, USA, ⁶DLR, Germany, ⁷Imperial College, London, UK, ⁸Natural History Museum, UK.

Introduction

Following the 4th workshop carried out by the Landing Site Selection Working Group (LSSWG) in 2017, the ExoMars rover has had its landing sites down-selected to two candidates; Oxia Planum (Fig. 3) and Mawrth Vallis (Fig. 9). Prior to selection of the final site, further imaging and assessment of their terrains will take place to assess compliance with engineering constraints, safety margins and science requirements. Here we present the current HiRISE image coverage of the landing sites, along with analysis of transverse aeolian ridges (TARs) and how use of the CaSSIS imager on board the TGO will aid characterisation efforts. Mapping has been conducted, led by the LSSWG, to evaluate the risk of encountering rocks that would be too large for the rover, and identify the area covered by aeolian bedforms and other types of loose material at the surface [1]. A summary of the sites' characteristics are shown in Table 1.

	Oxia Planum	Mawrth Vallis
Latitude, Longitude	18.14 N, 335.76 E	22.16 N, 342.05 E
Azimuth Range	100 - 125°	102 - 129°
Semi-Major Axis	60 km	60 km
Elevation (range)	100% <2 km -3.6 km to -2.66 km	≥ 89% <2 km -3.02 km to -1.46 km
Slopes	% Compliant	% Compliant
2-10 km	>94	>92
330 m	99	99
7 m	95	89
2 m	96	90
Thermal Inertia	100% ≥ 150 J m ⁻² s ^{-0.5} K ⁻¹	99.5% ≥ 150 J m ⁻² s ^{-0.5} K ⁻¹
Albedo	100% 0.1 - 0.26	100% 0.1 - 0.26
TAR Coverage	4.4 %	7.2 %
Rock Abundance (d≥18, d≥35 cm)	8, 5%	7, 4%
Crater distribution	No. per km ²	No. per km ²
(high priority targets)	3.7	1.2
(low priority targets)	4.2	2.9

Table 1: ExoMars candidate landing site characteristics. Each location has been analysed as a region encapsulating all possible azimuth ranges, and percentages therefore represent these regions.

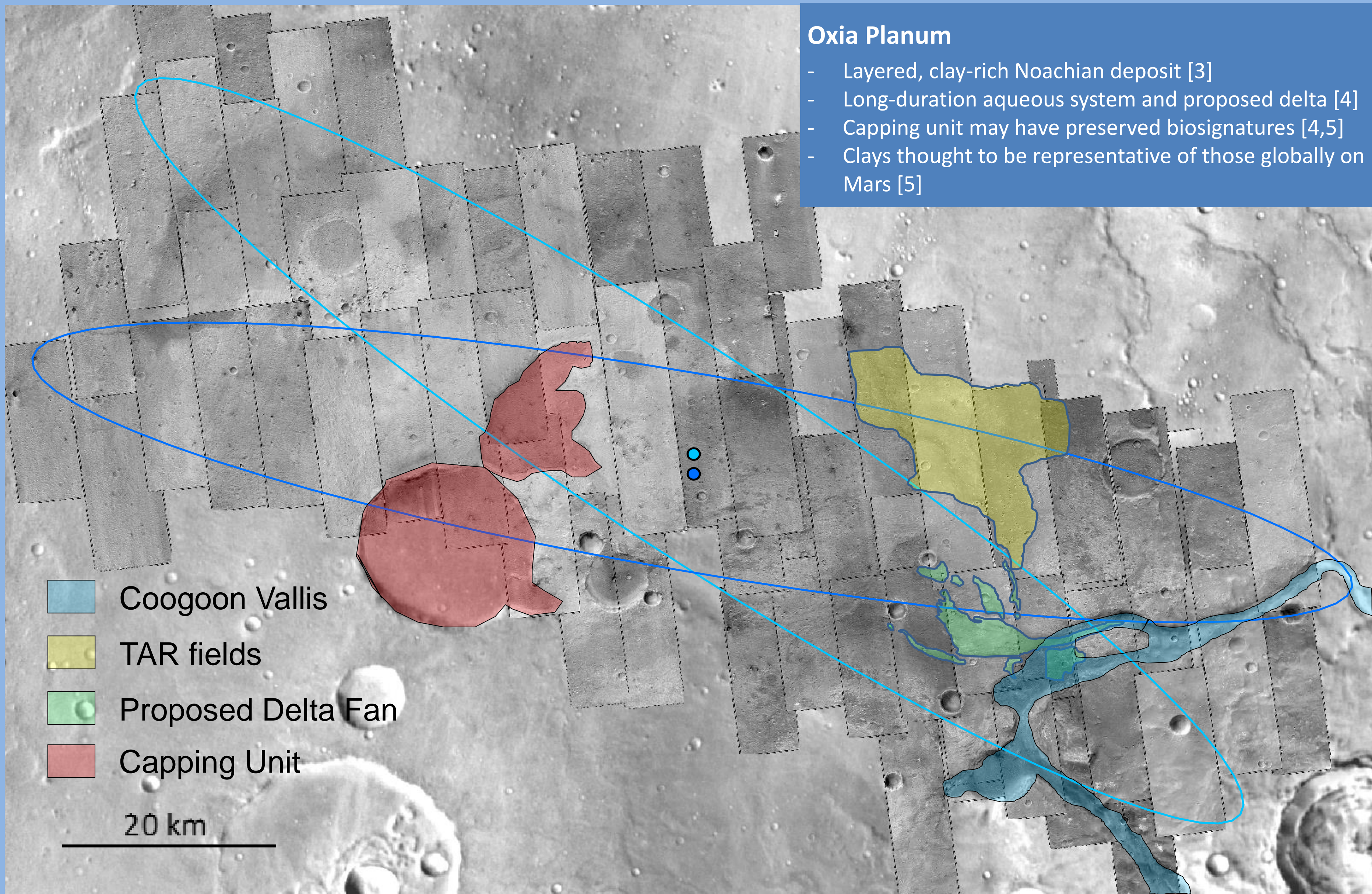


Figure 3: HiRISE coverage of Oxia Planum with THEMIS base layer.

Further Characterisation of the landing sites

Prior to down-selection to the final site, further HiRISE imaging and assessment of site terrains will take place to assess compliance with engineering constraints and hazards (Table 1) and develop science cases. In the case of HiRISE imaging, current coverage of the sites at its maximum resolution i.e. 0.9 m is near complete at Oxia Planum, while >90% of the Mawrth Vallis site is. This naturally needs to be brought up to 100% in the lead up to the final site selection in November 2018. Those images acquired are also in the process of being checked for defects e.g. image bit flips, intervening clouds/dust etc.

In terms of characterisation, the next stage will include assessing the record of water-rock interaction at the two sites. An important way of doing this, in addition to the ongoing work by site proposers, is comparison between HiRISE and in situ studies from the MSL mission (see Fig. 4-6). The Curiosity rover has directly observed fine-grain sediments (mudstone), as well as evidence of diagenetic alteration (see Fig. 8). In Gale Crater, evidence for diagenesis includes the formation of clays, sulphate veins, and silica-rich halos around fractures [7, 8]. In this way different hypotheses for the formation of the clay-rich secondary assemblages at Oxia Planum and Mawrth Vallis can be tested to help inform final site selection. It will also aid in target selection for the rover's eventual traverse.

Conclusions

The ExoMars rover is set to launch during 2020, with final site selection due to occur in early November 2018. In contrast to previous years neither candidate landing site has a clear advantage, meaning that 2018 may be crucial in deciding which site offers the greatest scientific returns for the mission.



Figure 8: MastCam image of raised ridges at Yellowknife bay, Gale crater. Such ridges likely formed in subaqueous conditions and are an example of a diagenetic feature.

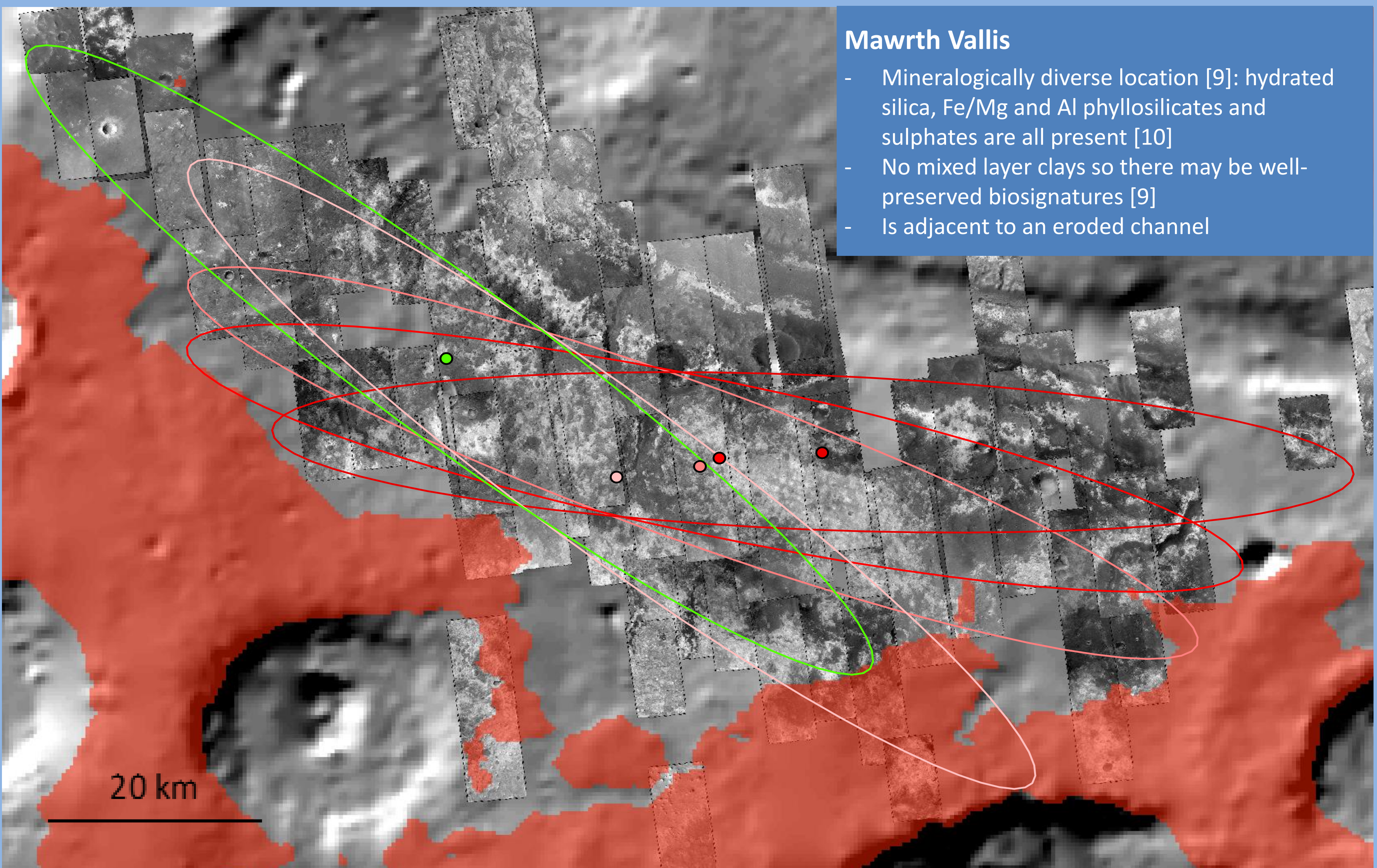


Figure 9: HiRISE coverage of Mawrth Vallis with MOLA base layer. Red areas have elevations higher than the 2km required to safely slow ExoMars on entry into the Martian atmosphere. Note that the green ellipse represents a an alternative max Azimuth ellipse shifted to improve the percentage of the ellipse matching the minimum height constraint.

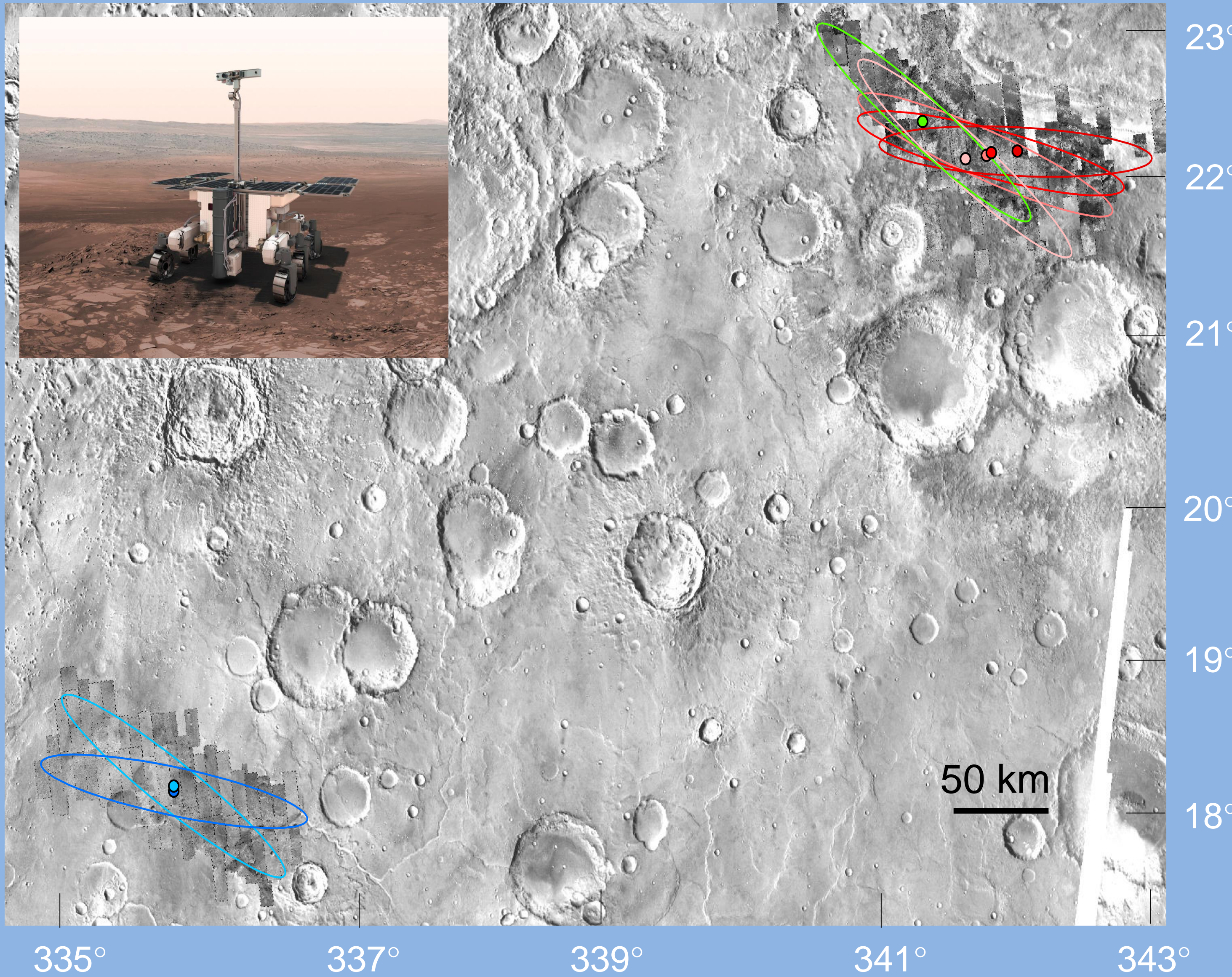


Figure 1/2: Top left; artists impression of ExoMars rover [2], Bottom right; regional view of ExoMars landing sites, located within the Chryse Planitia region. Note that the coloured dots correspond to the centre of the respective ellipse for figures 2, 3 and 9.

The ExoMars Rover

The ExoMars rover (see Fig. 1) will search for traces of past or present life, and ideally will land at an ancient site with good biosignature preservation potential. It will be equipped with a drill for obtaining sub-surface samples at depths of up to 2 m, and a suite of instruments for investigating the surface, including PanCam and ISEM for identification of targets and MicrOmega and RLS to carry out mineralogical studies.

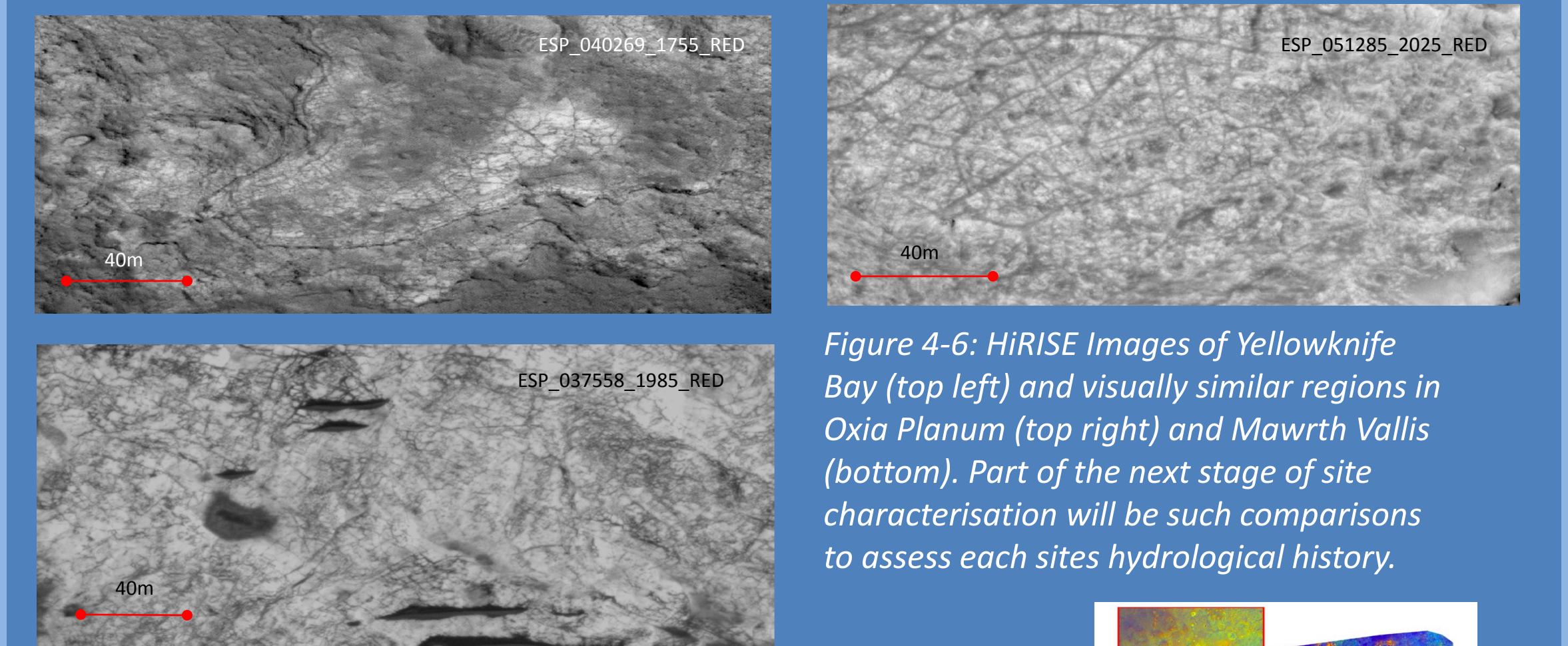


Figure 4-6: HiRISE Images of Yellowknife Bay (top left) and visually similar regions in Oxia Planum (top right) and Mawrth Vallis (bottom). Part of the next stage of site characterisation will be such comparisons to assess each sites hydrological history.

Use of CaSSIS to augment site characterisation

Once science operations have begun in late March/early April, the CaSSIS instrument will be able to provide complementary colour information to HiRISE over 9.5 km swaths, in different seasons, as well as allowing easier acquisition of stereo imaging within one pass of an image site [6]. Due to the sites being relatively dust-free, and consequently exposing their diverse range of minerals and lithology's, colour imaging of Oxia and Mawrth for terrain characterization may be particularly useful.

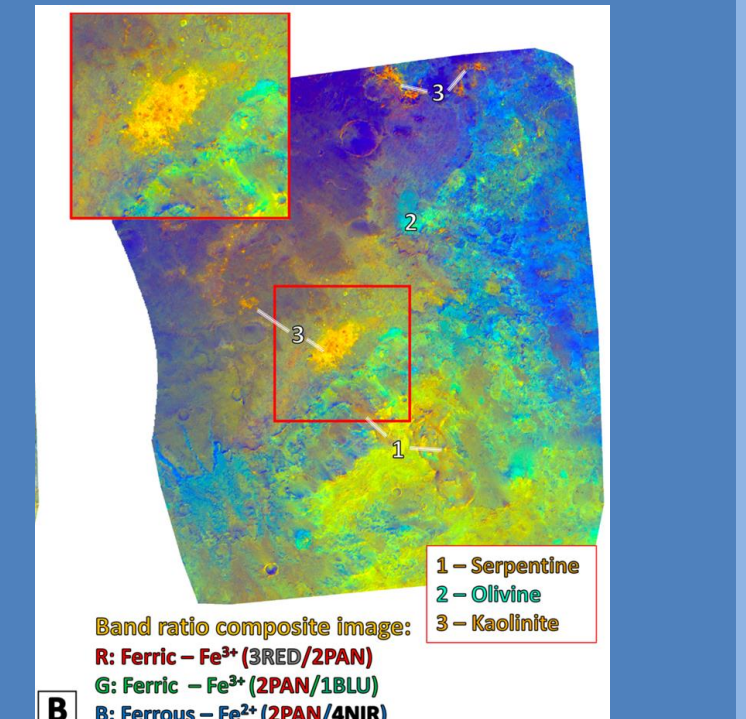


Figure 7: Simulated CaSSIS Fe-sensitivity band ratio colour composite image [6].