EXOMARS LANDING SITE CHARACTERISATION AND SELECTION. J. C. Bridges[1], R. A. Henson[1], J. L. Vago[2], D. Loizeau[3], R. M. E. Williams[4], E. Hauber[5], E. Sefton-Nash[6] and the ExoMars Landing Site Selection Working Group, [1]Space Research Centre, Univ. of Leicester, UK j.bridges@le.ac.uk, [2]ESTEC 2200 AG Noordwijk, The Netherlands, [3]Université Paris XI, Orsay, France, [4]Planetary Sciences Inst., US, [5]DLR, Berlin, Germany, [3]Birkbeck College, University of London, UK.

Introduction: The ExoMars rover is due for launch between 2018 and 2020, and its landing site has now been downselected to three candidates: Oxia Planum, Aram Dorsum and Mawrth Vallis (Fig. 1). This has been done through workshops and a Landing Site Selection Working Group.

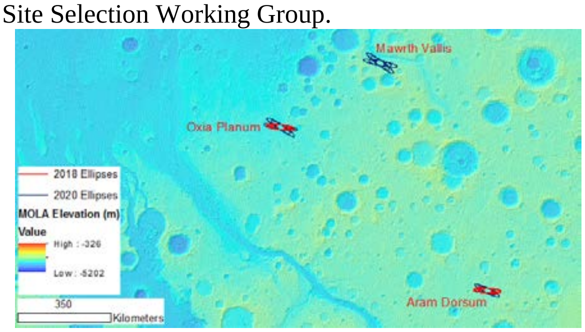

Figure 1. Overview of landing site locations.

Site Selection: Table 1 shows a summary of the ExoMars landing site characteristics. The landing locations have been analysed as regions encapsulating all possible azimuth ranges, rather than single ellipses, in order to allow for adjustment in the ellipse locations. Percentages therefore correspond to these regions as a whole. The exception to this is the slope data, which has been calculated by the proposing teams. There may therefore be variations in technique and coverage of the sites, so standardisation between the methods will be made by LSSWG before a direct comparison.

Oxia Planum: Oxia Planum (Fig. 2) has been recommended as the primary candidate for the 2018 launch opportunity, but has to be verified before selection is finalised. It is thought to be a layered, clay-rich Noachian deposit, which has subsequently had a long-lived aqueous system, including an early Hesperian delta, and a volcanic capping unit [1, 2, 3]. The region inludes an ancient, finely layered, clay-bearing unit which has been intensely eroded, revealing surfaces as young as 100 My [3]. The continuous erosion and recent exposure of surfaces may expose biosignatures preserved by the capping unit [2, 3]. The clays found in Oxia are representative of the clays found globally on Mars [2].

The entire landing region in Oxia Planum is below the –2 km MOLA constraint. The region also complies with both the thermal inertia and albedo constraints. Slopes have been calculated for a number of landing ellipses by Quantin et al. [1], with the least compliant slopes seeming to be the 330 m slopes as calculated by CTX DTM giving 5% of the region as being uncompliant [1]. Some regions of Oxia Planum are saturated with Transverse Aeolian Ridges (TARs) with a mean density of 6.5% in the region sampled, which may impact upon traversability for the rover.

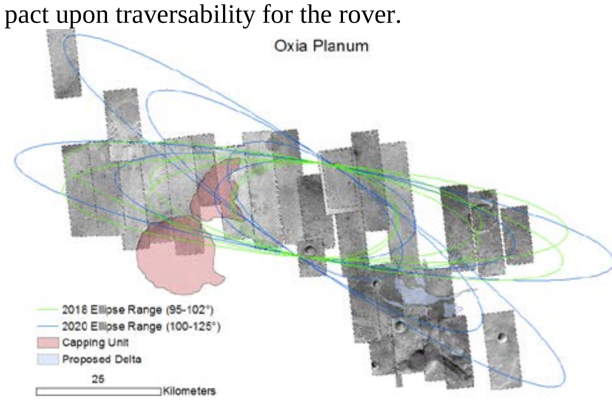

Figure 2. HiRISE coverage of Oxia Planum with capping unit and possible delta annotated.

Aram Dorsum: The landing site region in Aram Dorsum (Fig. 3) is an exhumed channel system part of a regional alluvial system, which could be representative of a wider alluvial landscape [4, 5]. There is a main inverted channel with subsidiary channels at varying levels, implying long-duration aggradation of sediment which was subsequently exhumed [4]. It is therefore believed to be a good location for preserved biosignatures and fine-grained sediments. There is currently no mineralogy available in the ellipses, but nearby dust-free windows have shown possible hydrated minerals, with sulphates found in a crater south of the region and Fe/Mg and Al phyllosilicates found north of the region.

Over the entire landing region of Aram Dorsum, approximately 7% of the terrain is above the threshold of –2 km MOLA. However, this is largely at the ends of the three-sigma ellipse and therefore could be avoided through selection of a final azimuth, were Aram Dorsum to be selected. For the ellipses calculated by Balme et al. [6], the 2-10 km slopes were the least compliant, with 3.9% of the landing ellipse being greater than 8.6°. The region fully complies with the albedo constraints, with only 1% being outside the thermal inertia constraints. The TAR coverage is lower than in Oxia Planum, with a mean of 2.3% in the region sampled.

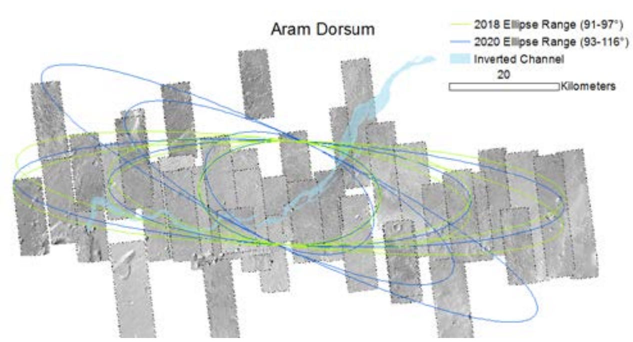

Figure 3. HiRISE coverage of Aram Dorsum.

Mawrth Vallis: Mawrth Vallis (Fig. 4) is a mineralogically diverse location [7], with the landing region being adjacent to an eroded channel. The spectral signatures found for the Mawrth Vallis region indicate hydrates silica, Fe/Mg and Al phyllosilicates and sulphates [8]. The absence of mixed layer clays means biosignatures may be well preserved, with the recent exhumation of material below the dark capping unit adding to the potential of the region [7]. The presence of a channel to the north of the landing region indicates local fluvial activity in the past [9].

Mawrth Vallis is unsuitable for a 2018 launch opportunity, and the 2020 launch azimuth region has approximately 11% above –2 km MOLA. However, adjusting the ellipse centre can allow this percentage to be reduced. For the ellipses calculated by Poulet et al. [7], 7 m slopes are the least compliant, with 9.8% of the region having slopes greater than 12.5°. The albedo and thermal inertia are again within the acceptable ranges, with only 0.5% of the landing region being outside the thermal inertia constraints.

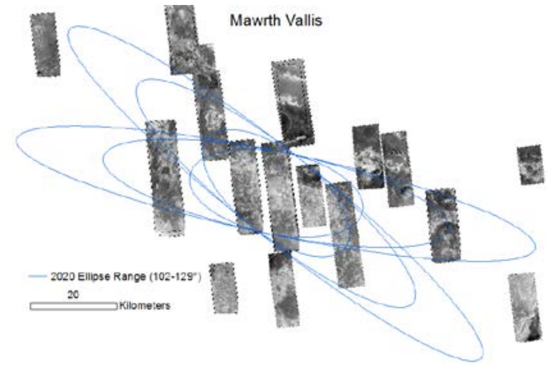

Figure 4. HiRISE coverage of Mawrth Vallis.

Conclusion: For a 2018 launch, Oxia Planum is the leading candidate landing site and its site characteristics e.g. rock abundance [10], aeolian cover and predicted atmospheric conditions, are currently being checked. For a 2020 launch, Oxia Planum is one of the two candidate landing sites, with a second to be selected from Aram Dorsum and Mawrth Vallis during 2016.

References: [1] Quantin C. et al. (2014) ExoMars LSSW#1. [2] Quantin C. et al. (2015) ExoMars LSSW#3. [3] Quantin C. et al. (2015) EPSC2015-704. [4] Sefton-Nash E. et al. (2015) *EPSC* 2015-684. [5] Balme M. et al. (2015) ExoMars LSSW#3. [6] Balme M. et al. (2014) ExoMars LSSW#1. [7] Poulet F. et al. (2015) ExoMars LSSW#3. [8] Carter J. et al. (2015) EPSC2015-661. [9] Loizeau D. et al. (2007) *JGR*, 112, 10.1029/2006JE002877. [10] Sefton-Nash E. et al. (2016) *LPS XXXXVII*.

Table 1. Summary of landing site characteristics

	Oxia Planum		**Aram Dorsum**		**Mawrth Vallis**	
Lat, Long	18.14 N, 335.76 E		7.869 N, 348.8 E		22.16 N, 342.05 E	
Azimuth Range	2018: 95-102° 2020: 100-125°		2018: 91-97° 2020: 93-116°		2018: - 2020: 102-129°	
Semi-Major Axis	2018: 50 km 2020: 60 km		2018: 50 km 2020: 50 km		2018: - 2020: 60 km	
Elevation	100% <-2 km -3.6 km to -2.66 km		≥ 93% <-2 km -2.57 km to -1.88 km		≥ 89% <-2 km -3.02 km to -1.46 km	
Slopes	**Baseline**	**% Compliant**	**Baseline**	**% Compliant**	**Baseline**	**% Compliant**
	2-10 km	> 98 [1]	2-10 km	96.1 [5]	2-10 km	96 [6]
	330 m	95 [1]	330 m	> 98.6 [5]	330 m	97 [6]
	7 m	N/A	7 m	96.2 [5]	7 m	87 [6]
	2 m	N/A	3 m	97.2 [5]	2 m	N/A [6]
Thermal Inertia	100% ≥150 J m^{-2} $s^{-0.5}$ K^{-1}		99% ≥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		100% 0.1 - 0.26	
TAR Coverage	6.5 ± 7.8 %		2.3 ± 2.5 %		N/A	