SELECTION AND CHARACTERISATION OF THE EXOMARS 2020 ROVER LANDING SITES. J. C. Bridges[1], D. Loizeau[2], E. Sefton-Nash[3], J. Vago[3], R. M. E. Williams[4], M. Balme[5], S. M. R. Turner[1], P. Fawdon[6], J.M. Davis[6] and the ExoMars Landing Site Selection Working Group. [1]Space Research Centre, University of Leicester, UK (j.bridges@le.ac.uk), [2]Laboratoire de Géologie de Lyon [3]ESTEC, Netherlands, [4]Planetary Science Institute, [5]Open University, UK, [6]Birkbeck, University of London.

Introduction: Now due for launch in 2020, the ExoMars rover currently has three candidate landing sites: Oxia Planum, Aram Dorsum and Mawrth Vallis (Table 1). Selection and characterisation is being carried out through workshops and a Landing Site Selection Working Group (LSSWG). Here we present an update of this work.

The evaluation of the sites requires a large number of observations by the high-resolution remote-sensing instruments HiRISE [1], including DTM analysis to calculate slopes over different scales [2], and CRISM for mineralogy [3]. The major part of the Oxia and Aram landing ellipses are now covered with HiRISE at 25 cm/pixel (Fig.1-3). Mapping has been conducted, led by the LSSWG, to evaluate the risk of encountering rocks that would be too large for the rover, the surface covered by aeolian bedforms and other types of loose material at the surface [4]. A summary of the sites' characteristics is given in Table 1.

Oxia Planum: Is thought to be a layered, clay-rich Noachian deposit, with a tentatively identified Hesperian delta in the ESE of the ellipse (Fig. 1) [5,6,7]. The region includes an ancient, finely layered, clay-bearing unit that has been intensely eroded, revealing surfaces as young as ~100 Myr or less [7]. Roughly one third of the surface of this landing site is made of bedrock [4].

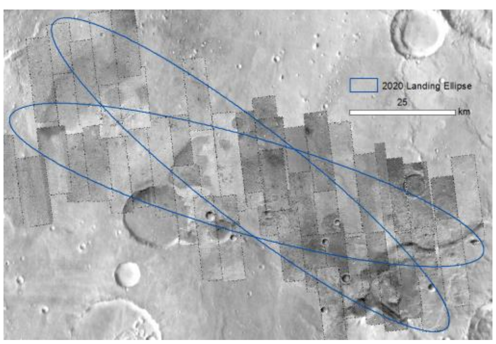

Figure 1. HiRISE coverage of Oxia Planum.

Aram Dorsum: (Fig. 3) is an exhumed channel thought to be part of a regional alluvial system [8]. There is a main inverted channel with subsidiary channels at varying levels, implying long-duration aggradation of sediment that was subsequently exhumed. As part of site selection, we have analysed recent CRISM spectra [3]. No mineralogical information is available in the ellipses due to dust masking the spectral signatures, but nearby dust-free areas have shown possible hydrated minerals, with with Fe/Mg and Al phyllosilicates in dust free windows to the north of the landing ellipses.

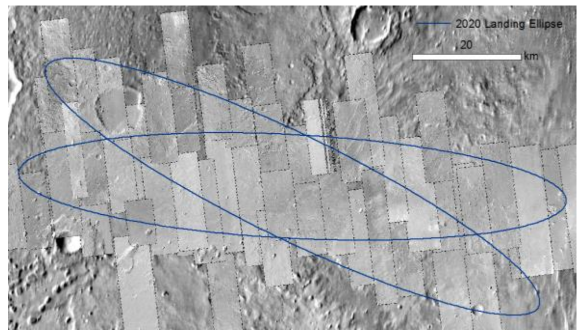

Figure 2. HiRISE coverage of Aram Dorsum.

Mawrth Vallis: The landing ellipses proposed for Mawrth Vallis (Fig. 4) are located adjacent to an eroded channel. Extensive work has previously been done on its spectral signatures, which indicate abundant hydrated silica, Fe/Mg and Al phyllosilicates and sulphates. About 85% Mawrth is covered by sand deposits or thin dust [4].

Rock Abundance: We use cumulative size frequency distributions of rocks resolved in HiRISE images [1] to infer the abundance of unresolved small rocks, based on the model of [9], Table 1. The model defines the cumulative fractional area, $f_k(d)$ that is covered by float rocks with a minimum diameter, d. The 'rock abundance factor', k governs the distribution of diameters. The model does not account for other shadow-casting features such as rocky outcrop. Manual counts contain some non-rock features, and consequently our retrievals of rock abundance factors for each site probably over-estimates float rock abundance. However, this 'apparent' rock abundance may more accurately quantify the total prevalence of short-baseline slopes relevant to lander safety and rover traversibility.

Geologically representative areas within landing ellipses were selected to sample rock abundance [10], though accounting for $\lesssim$1% of the total ellipse area.

Coverage will be improved in future results from automated counts.

To minimize contributions from ambiguous features near the resolution limit, and from large non-float rock features, which disproportionally inflate cumulative distributions, we find optimal least squares best-fits to the model occur when constraining diameters such that $1.5 \leq d \leq 2.25$ m, in agreement with [11].

If $d = 0$ then $f_k(d) = k$, yielding apparent rock abundance factors of 0.176, 0.138 and 0.122 for Aram, Oxia and Mawrth, respectively. We also calculate $f_k(d \geq 0.18)$ to evaluate the abundance of only hazardous-sized features (where 0.18 m is the surface platform clearance [12]), giving far lower abundances of 0.109, 0.082 and 0.071 for the same sequence of sites. Finally, features relevant to rover traversibility (i.e. larger than the rover's clearance of 0.35 m [12]) produce values of 0.069, 0.050 and 0.042, all lower than the 7% areal coverage nominal safety limit.

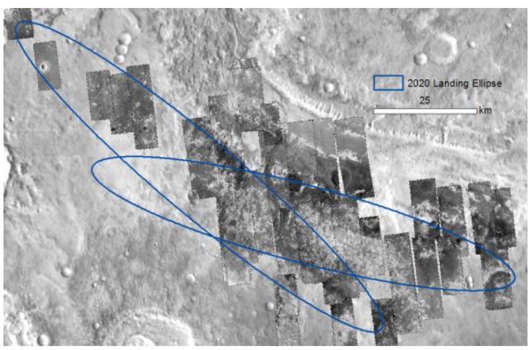

Figure 3. HiRISE coverage of Mawrth Vallis.

Transverse Aeolian Ridges and Loose Soil: TARs are a significant risk to rover mobility and so we conducted a grid-based mapping of the landing ellipses using HiRISE imagery. Approximately 7.2 x 10^8 m^2 of Aram Dorsum, 1.4 x 10^8 m^2 of Mawrth and 1.8 x 10^8 m^2 of Oxia Planum were mapped, at 1:2000 scale. The results show that Mawrth has a high abundance ~20% of this landform, and Aram Dorsum the least. Oxia and Aram both have localised areas of relatively high total aeolian cover <14 %. Oxia also has a very high N-S band to the east of the ellipses' centre with ≤43% composed of TARs. The mapped TARs are generally ~10 m scale in their transverse dimension, but bedforms 2-3 m across could still be a major hazard for ExoMars [13]. The results of a complementary mapping programme to determine the coverage of loose soil are summarised in [4].

References: [1] McEwen, A. S. et al. (2007), *J. Geophys. Res.* 112 (E05S02). [2] Fawdon, P., et al., (2017) LPSC 48, *this conference.* [3] Turner, S.M.R., and Bridges, J.C., (2017) LPSC 48, *this conference.* [4] Loizieau, D., et al., (2017) LPSC 48, *this conference.* [5] Quantin, C., et al., (2014) ExoMars LSSW#1. [6] Quantin, C., et al., (2015) ExoMars LSSW#3. [7] Quantin, C., et al., (2015) EPSC 2015-704. [8] Balme, M. R., et al., (2016) LPSC 47, #2633. [9] Golombek, M. and Rapp, D. (1997), *J. Geophys. Res.* 102 (E2) p. 4117–4129. [10] Sefton-Nash, E. et al. (2016), LPSC Abs. 1918. [11] Golombek, M. et al. (2012), *Mars Journal* 7, p. 1-22. [12] ExoMars 2018 Landing Site Selection User's Manual (2013), ESA (EXM-SCI-LSS-ESA/IKI-003). [13] Balme M. et al. (2017) LPSC 48, *this conference.*

Table 1. ExoMars 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	100-125°	93-116°	102-129°
Semi-Major Axis	60 km	50 km	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	**% Compliant**	**% Compliant**	**% Compliant**
2-10 km	> 99	>99	>98
330 m	98	99	98
7 m	94	95	88
2 m	95	95	92
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	4.1 %	1.4 %	20.3 %
Rock Abundance (d≥18, 35 cm)	8.2, 5%	10.9, 6.9%	7.1, 4.2%