EXOMARS 2018: THE CANDIDATE LANDING SITES. D. Loizeau[1], J. Flahaut[2], J. L. Vago[3], E. Hauber[4], J. C. Bridges[5], the ExoMars LSSWG[6] and the ExoMars team, [1]Université de Lyon, France (damien.loizeau@univ-lyon1.fr), [2]VU University Amsterdam, The Netherlands (jessica.flahaut@ens-lyon.org), [3]ESA-ESTEC, The Netherlands, [4]DLR, Berlin, Germany, [5]University of Leicester, UK, [6]ExoMars 2018 Landing Site Selection Working Group: F. Westall, H. G. Edwards, L. Whyte, A. Fairén, J.-P. Bibring, J. Bridges, E. Hauber, G. G. Ori, S. Werner, D. Loizeau, R. Kuzmin, R. Williams, J. Flahaut, F. Forget, J. L. Vago, D. Rodionov, O. Korablev, O. Witasse, G. Kminek, L. Lorenzoni, O. Bayle, L. Joudrier, V. Mikhailov, A. Zashirinsky, S. Alexashkin, F. Calantropio, and A. Merlo.

Introduction: The ExoMars Programme consists of two missions, scheduled in 2016 and 2018. The 2018 mission will land a rover, provided by ESA, making use of a Descent Module contributed by Roscosmos.The rover's scientific objectives are to search for signs of past and present life on Mars and to investigate the water/geochemical environment as a function of depth in the shallow subsurface. To this purpose, the rover will carry a comprehensive suite of instruments (the Pasteur payload) dedicated to geology and exobiology research [1]. The rover will be able to travel several kilometres and analyze surface and subsurface samples down to a 2 meter depth. The very powerful combination of mobility with the ability to access in-depth locations, where organic molecules can be well preserved, is unique to this mission. The rover will also perform numerous investigations on rocks and soils, also contributing to the mission objective of characterizing the surface environment [1].

Landing site constraints: On December 2013, an invitation was sent to the scientific community to propose scientifically compelling landing sites (LS) [2], which respect the main engineering constraints for landing and operation. These include a landing ellipse of 19 km × 104 km (with varying azimuth between 90°-127°, depending on the launch date and latitude), an altitude < -2 km, a latitude between 5°S and 25°N, and a thermal inertia >150 J m^{-2} $s^{-0.5}$ K^{-1}.

Scientifically interesting LS include locations with evidence for long duration or frequently recurring aqueous activity, low energy transport and deposition, fined-grained, recently exposed sediments, and/or hydrated minerals such as clays or evaporites. The outcrops of interest must be distributed over the landing ellipse to ensure that the rover can access some over a short distance. LS must also comply with planetary protection requirements: They must not contain features currently considered as Mars Special Regions (some gullies, recurrent slope lineae) [2].

Eight proposed sites: The received proposals have been reviewed by the Landing Site Selection Working Group (LSSWG). Initially, eight LS were found to be compliant with the science, engineering, and planetary protection requirements [3]. These sites were presented by their proposers and discussed at the first LS workshop that took place in ESAC, Spain, 26-28 March 2014. The received proposals are available at http://exploration.esa.int/mars/53944-proposed-landing-sites-for-exomars-2018-mission/.

Given the strict engineering contrains of the mission, three large areas of the martian surface have been identified as potentially accessible: Chryse Planitia, Isidis Planitia, and southern Elysium. One proposed LS is located in Isidis Planitia, whereas the other seven are spread around the Chryse Planitia area (Fig. 1).

Landing site selection: Following the first LS workshop, four sites were selected for further investigation, on the basis of their higher potential for long lived water activity and the presence of fine-grained sediments. Moreover, the high concentration of potential targets over the whole landing ellipse [3] strongly favours these sites. The study of these sites, both in term of scientific interest and engineering safety, is still on-going, and a second workshop took place at the ALTEC facility, in Torino (Italy, December 2014).

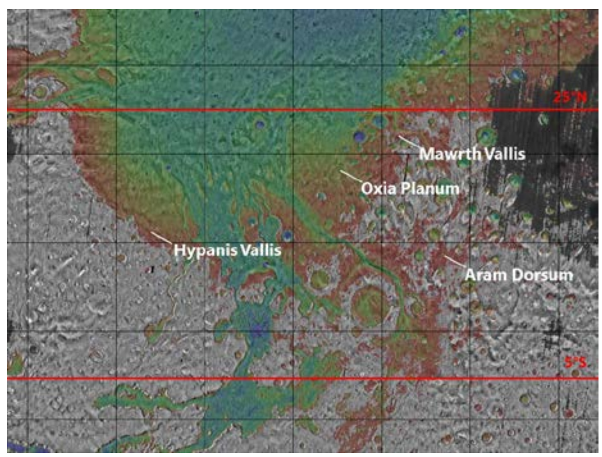

Figure 1: Location of the four final candidate landing sites. Coloured areas are below the elevation threshold of -2 km, latitude limits are shown by red lines, and dark grey areas mark surfaces where the thermal inertia is too low.

Landing site overview: We describe hereafter the geology of these four LS as they have been presented at the workshops.

Aram Dorsum (previously called Oxia Palus; 7.9°N, 348.8°E). The proposed ellipse lies in a local topographic low, ~100 km north of Crommelin crater in the large Oxia Palus region [4]. The site comprises layered sedimentary rocks and a distinct inverted channel system (>80 km long). The superposing materials that comprise the rest of the site appear to be a mixture of sedimentary deposits and suggest that the inverted channel system has only relatively recently been exhumed. The overlying unit would be late Noachian/early Hesperian, indicating an ancient age for the channel. Potential targets include the inverted channel, the channel margins, a channel transition unit, and pits present within the floodplain.

Hypanis Valles (11.8°N, 314.96°E). The proposed ellipse is located at the margin of the fluvial fan/deltaic systems at the termination of Hypanis Valles, just below the transition between the highlands and the plains around Chryse [5]. Another deltaic deposit is in Magong crater at the terminus of Sabrina Vallis, just SW of the proposed LS. This LS targets fan-like deposits that were interpreted to be the remnants of a prograding delta. The lower strata of the Hypanis delta appear to be enriched in Fe/Mg-rich phyllosilicates as suggested by CRISM observations, as well as the Sabrina delta. Potential targets include mainly outcrops of expected fine-grained sediments on the smooth transition unit that surrounds the delta/fan, and units around the rim of Magong crater.

Mawrth Vallis (22.16°N, 342.05°E). The proposed LS is in middle to late-Noachian terrains south-west of the Mawrth Vallis channel [6,7]. The region surrounding Mawrth Vallis contains one of the largest exposures of phyllosilicates detected on the Martian surface [8]. These phyllosilicates occur in light-toned layered deposits of unknown origin (most possibly aqueous and/or aeolian sediments, or pyroclastic deposits, or deposits from an ancient ice cap [9-11]). Outcrops at the proposed landing site show a general sequence of Al-phyllosilicates on top of Fe-smectites, indicating a long wet history. The rocks show the highest degree of alteration identified on Mars. The deposition and alteration are ancient (mostly > 3.8 Ga), and the rocks are well preserved. Potential targets include the numerous clay sequence outcrops and some ancient channels.

Oxia Planum (24,55°E ; 18,2°N). The ellipse covers large exposures of Fe/Mg-phyllosilicates rich rocks detected on both OMEGA and CRISM multispectral data [12]. These detections are associated with layered rocks in a topographic low and may represent the south-western extension of the Mawrth Vallis clay-rich deposits, pointing to an extended alteration process. The crust there is ancient (> 4 Ga) and has undergone intense erosion > 3.6 Ga ago, although the phyllosilicate bearing rocks have been exposed only recently (< 100 Ma ago). Potential targets include the clay-rich outcrops as well as channels and inverted channels and delta-fan deposits.

Future work: New data are being actively acquired by the HRSC, HiRISE and CRISM teams to support the ExoMars 2018 landing site selection process. The ellipses are large and new data are important for characterizing the potential science targets and evaluating the safety of the sites. The proposing teams, the ExoMars project team and the LSSWG will continue their analysis and comparison of the sites, aiming to complete the certification of at least one site by September 2016 —in time for the start of the mission's Critical Design Review (CDR). The final selection of the landing site is expected within 2017.

Acknowlegments: The LSSWG wishes to thank all the proposers and workshop participants for their insightful contribution to the landing site selection process of the Exomars 2018 mission.

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