QUANTIFYING THE WATER EQUIVALENT HYDROGEN ON PAST, PRESENT AND FUTURE MARS LANDING SITES.

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Introduction: The selection of a final Mars landing site is a complex, multi-step process that involves both the fulfillment of several engineering constraints and the accomplishment of scientific requirements [1,2]. Within the engineering criteria, the most important requirements, that have to be thoroughly evaluated concern latitude and longitude, elevation, the local and regional terrain slopes, rock abundances, thermal inertia, surface albedo and radar reflectivity [e.g. 3,4]. Certain criteria must be fulfilled during both the landing and the roving phase, and strongly vary from mission to mission – depending on the entry, descent and landing parameters, as well as on the rover design [5]. On the other hand, in the last decades the scientific threshold criteria for both NASA and ESA landers/rovers have mainly focused on the presence of both morphological and/or mineralogical evidence of the past presence of water. Such scientific requirements follow the approach that the most intriguing areas where exobiological life may have originated or flourished on Mars are those characterized by past presence of water. For this reason, searches for the best Mars landing spots have prioritized regions with i) subaqueous or hydrothermal sediments, ii) minerals indicative of aqueous phases, iii) surface ages dating back to the Noachian/Early Hesperian where large bodies of water were expected to be present on the surface of Mars, iv) morphological criteria for standing bodies of water and/or fluvial activity, such as deltaic deposits or shorelines, v) the presence of former water ice, glacial activity or its deposits [3,4].

Near subsurface hydrogen will be scientifically key for the next generation of rovers: The ESA ExoMars 2020 rover will be able to drill down 2 m into the Martian subsurface, and the NASA Mars 2020 rover will be able to scoop the surface in the first tens of centimeters. These capabilities make the identification of a hydrated Martian near subsurface pivotal, from the perspective of both exobiological research, and mineralogy. A recent analysis of the near subsurface hydrogen distribution on Mars, based on epithermal neutron data from the Mars Odyssey Neutron Spectrometer led to the discovery of hydrogen-rich mineralogy far from

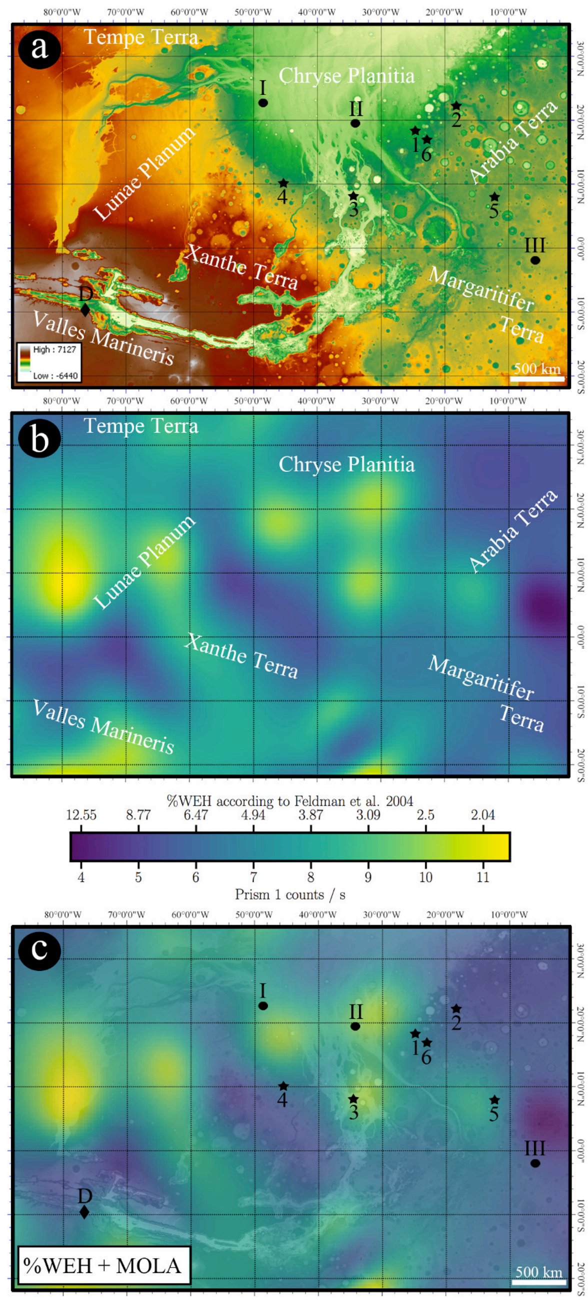

Figure 1: a) Altitude map from the Mars Odyssey Laser Altimeter (MOLA) [7], showing the locations of previous (I-III) and proposed future landing sites in the Chryse Planitia–Valles Marineris area. b) Map of Water-Equivalent Hydrogen (WEH) content, according to [8]. c) Overlay of both maps.

the poles, including areas with a water hydrogen equivalent (WEH) ranging from ~10% to >40%wt and strongly implying the presence of bulk water ice [6].

Given the importance of the global WEH Mars map presented in [6] for future evaluation of Mars landing sites, we present two case studies centered on the Valles Marineris – Chryse Planitia region (Fig. 1), and on the Syrtis Major – Isidis Planitia area (Fig. 2). We evaluate the subsurface hydration at the locations of past, present and proposed future landers/rovers in Table 1. The WEH measurements have a spatial resolution of 290 km, so must be considered regional averages, which may differ from the value at the landing site. Nevertheless, the maps clearly show hydrated areas with a resolution comparable to the main Martian geological features, and yield hydration measurements that are completely independent from the observed geological or mineralogical surface evidence of past watery environments.

ID	Landing Site	Lander/Rover	WEH (%)
A	Jezero Crater	Mars 2020	3.66
B	NE Syrtis	Mars 2020	4.33
C	Nili Fossae	Mars 2020	4.95
D	SW Melas Basin	Mars 2020	5.11
I	Chryse Planitia	Viking 1	3.27
II	Ares Vallis outlet	Pathfinder	2.61
III	Meridiani Planum	Opportunity	7.80
1	Oxia Planum	ExoMars	4.70
2	Mawrth Vallis	ExoMars	7.42
3	Simud Vallis	ExoMars	2.53
4	Hypanis Vallis	ExoMars	5.52
5	Aram Dorsum	ExoMars	4.49
6	Coogoon Valles	ExoMars	5.54
7	Southern Isidis	ExoMars	4.00

Table 1: Measurements of the near-subsurface Water-Equivalent Hydrogen content at all past (I-III) and proposed Landing Sites for the NASA Mars 2020 (A-D) and ESA ExoMars (1-7) missions.

Oxia Planum, which is considered the primary ExoMars 2020 landing site, presents a WEH content of only 4.70 wt.% Proposed landing sites on the rim of Isidis Planitia have similarly low water content, but the center of the basin reaches 7 wt.% WEH. Of future proposed landing sites, Mawrth Vallis has the highest WEH content, at 7.42 wt.%. Opportunity's landing site at Meridiani Planum has even greater WEH, immediately south of an area with WEH > 12.55 wt.%.

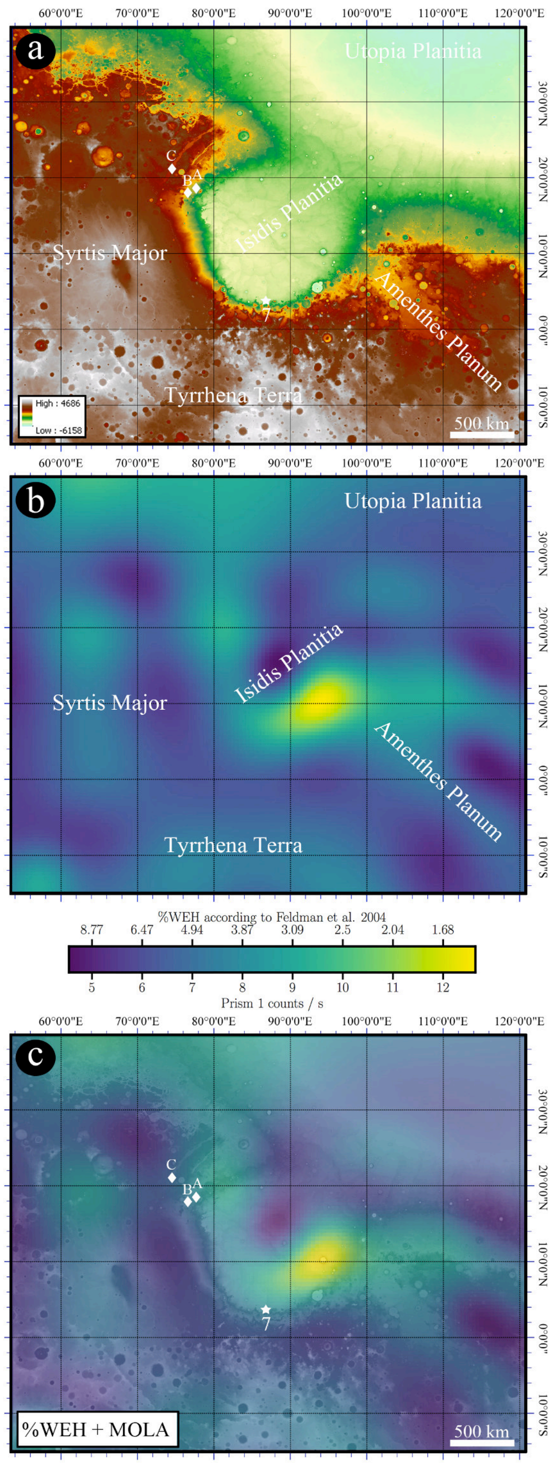

Figure 2: a) Altitude map [7] showing the locations of landing sites in the Syrtis Major – Isidis Planitia area. b) WEH map according to [8]. c) Overlay of the two maps.

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