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Oxia Planum: a suitable landing site for ExoMars 2018 Rover

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Abstract

We suggest the landing of ExoMars in Oxia Planum between 16° and 19° of latitude north and -23° to -28° of eastern longitude, and below -2 km of MOLA elevation. This region exhibits one of the widest Mg/Fe phyllosilicates exposures as mapped globally with OMEGA and with CRISM multispectral data. The outcrop of Mg/Fe phyllosilicates is so wide that several potential landing ellipses (19 x 110 km) fitting the engineering constraints is possible. The exposed terrains are 4 Ga old (Hartmann's age system) and have undergone intense erosional processes until 3.6 Ga. The region also reveals fluvial related morphologies such as valleys and a delta fan attesting the water-related history of this region. Moreover, the region is current under erosion so that the exposition age of the fresher phyllosilicate rich surfaces is younger than 100 My attesting the potential preservation of putative biosignature. This proposed site fulfills ExoMars objectives.

1. Introduction

The ExoMars 2018 mission (ESA) has for scientific objectives to search for signs of past and present life on Mars, to investigate the water/geochemical environment as a function of depth in the shallow subsurface, to study to Martian atmospheric trace gases and to characterize the surface environment [1]. The Exomars rover will carry a suite of instruments dedicated to geology and exobiology and will be able to travel few kilometers searching for past and present traces of life while its landing ellipse is 19 km by 104 km. The Rover will collect and analyze samples from outcrops and from subsurface drills down to 2 m depth to look for well preserved organic molecules [1]. The landing site has to be relevant as regards of these objectives while fitting the restrictive engineering constrains. From the scientific point of view, the site must be ancient, from the Early Mars period, for which many scientific evidences favor the existence of water-related cycle. The site must bears abundant morphological and mineralogical evidence of long-lived aqueous activity, the site must expose sedimentary rocks that are good candidate for organic matter preservation and more important the relevant outcrops must be distributed over the landing ellipse to ensure that the rover will catch one of them while the rover traverse range is restricted to few kilometer [1]. In this paper, we present the unique place Oxia Planum, a wide clay bearing plain located between 16° and 19° of latitude north and -23° to -28° of eastern longitude. We will discuss the geological context of these clay-bearing deposits, their mineralogy at both global and local scale, the age of the deposits and the water-related morphologies observed in the unit. We will finally discuss the results in term of implications for ancient Mars

history as well as recommendations for ExoMars 2018 landing.

2. Site description

Oxia Planum is located on the south west margin of Arabia Terra and exhibits Noachian terrains that become increasingly eroded towards the crustal dichotomy [2]. The region is located just between Mawrth Vallis and Ares Vallis (Figure 1). This margin is dissected by outflows and diverse channels converging toward Chryse Planitia. Several alluvial fans or deltas have been preserved at the outlets of those valleys into hundred kilometer scale basins.

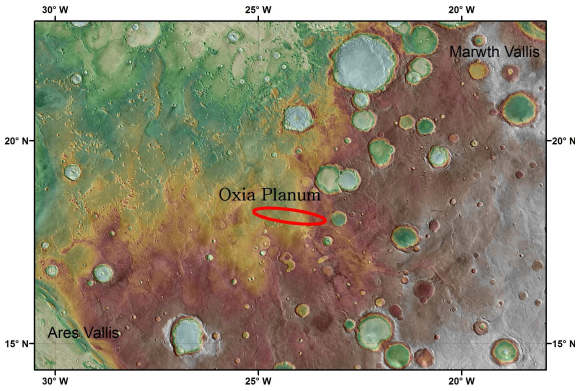

*Figure 1: Regional context of Oxia Planum and potential landing ellipse for ExoMars 2018 (red ellipse is 19*104 km)). Background is MOLA topography.*

Regional compositional mapping of Oxia planum is achieved based on near-infrared, nadir-pointed OMEGA data at a 2.5 km pixel scale as well as CRISM multispectral data at 200 m/pix. Mg/Fe phyllosilicates are identified and mapped based on their diagnostic absorptions at ~1.4, ~1.9 and ~2.3 µm [3]. Phyllosilicate coverage is about 80% of the ellipses based on conservative mapping at low resolution. Several hyperspectral targeted CRISM cubes at full (~20m/pixel) and half (~40m/pixel) resolution are also available over the Oxia Planum region and confirm widespread occurrence of Mg/Fe phyllosilicates in association with layered light toned unit similar to Marwth Vallis.

The entire unit composed of phyllosilicates corresponds to a light toned layered unit that is observed over a large range of elevations while the layered formation is about 100 m thick. This may suggest that like in Marwth Vallis region, the layered formation overlaps a pre-existing topography [4]. The layered formation displays lot of fluvial features such as former valleys and channels that are some time inverted. Rarely the unit is capped sporadically by a scattered unit, several meters thick, with no phyllosilicate signature. On the edge of this capping unit, we find the youngest exposures of the underlying phyllosilicate rich unit, which is as young as 100 My based on crater retention age assessment. This may suggest that putative biosignature may have been preserved by the capping unit from the cosmic ray exposure during the past 4 Gy, which is the estimated age of the phyllosilicate bearing unit.

3. Conclusion

Oxia Planum exhibits outcrops of Noachian phyllosilicates over hundreds of kilometers of terrain that has been affected by subsequent and/or contemporaneous sedimentary and fluvial activity. Hence, this site is extremely relevant to fulfill the ExoMars objectives. Deciphering the formation environment for such an extensive deposit would in particular provide constraints on the paleo-climate and habitability of Mars during the Noachian.

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