MOUNDS IN THE EXOMARS 2022 LANDING SITE J. D. McNeil[1*], P. Fawdon[1], M. R. Balme[1], A. L. Coe[2], [1]School of Physical Sciences, The Open University, Walton Hall, Milton Keynes, MK7 6AA, United Kingdom [2]School of Environment, Earth and Ecosystem Sciences, The Open University, Walton Hall, Milton Keynes, MK7 6AA, United Kingdom *joe.mcneil@open.ac.uk

Introduction: Oxia Planum is a low-relief plain in north-western Arabia Terra, and has been selected as the landing site for the ExoMars 2022 rover, "*Rosalind Franklin*". The plain occupies a transitional area between the heavily-cratered southern highlands and the smooth northern lowlands, and is predominantly characterised by Noachian-aged clay-bearing plains material (CBP). A population of isolated mounds of sub-kilometre length and decametre height directly superpose the CBP in the landing site region, and are some of the most topographically significant features present in Oxia Planum (Fig. 1). There are up to 100 individual mounds proximal to, or within the sigma-3 landing ellipse (Fig. 1). The mounds become larger and more abundant to the north and the west around the margin of Chryse Planitia. This wider population is suggested to be derived from a layer, up to 500 m thick, that draped much of the margin of Chryse in the Noachian [1]. Their spatial correlation with fractured substrates (e.g., margins of ancient, buried craters) suggest the mounds represent zones within the pre-mound layer where groundwater-deposited minerals made the locale erosion-resistant. The mound-forming material may therefore be an appealing target for geochemical analysis using the rover's onboard Pasteur payload, alongside the primary target of the CBP [2].

Here, we present a study of the geomorphology, morphometry and stratigraphic characteristics of the mounds in Oxia Planum, performed using visible images and DEMs (CTX [3], CaSSIS [4], HiRISE [5]). Based on these observations we explore the stratigraphic interpretations of [2, 6] and consider the implications of the possible origins of the mounds on the science objective of the ExoMars rover mission.

General Observations: The mounds are easily distinguishable from the surrounding plains by their bright appearance in visible images (Fig. 2), which often contrasts with the underlying CBP. They are particularly conspicuous in CaSSIS images, where their bright white-orange tones contrast the blue-grey CBP. The mounds are often layered at the metre scale (Fig. 2c), and commonly contain positive-relief linear features (Fig. 2b) interpreted as infilled fractures [2, 6]. The mounds have characteristic low thermal inertias [6] and high albedos in THEMIS [7]. In Oxia Planum, they are generally lower in height (median: low 10s of metres, maximum ~150 m) and smaller in area than the greater population around the margin of Chryse Planitia (median: 68 m high, maximum: ~550 m) [2, 8]. Furthermore, they are more rounded than the greater Chryse population, and have simpler morphology.

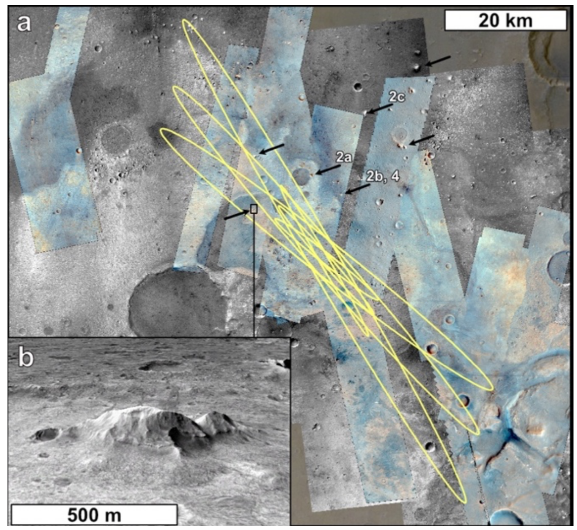

Figure 1: a) colour CaSSIS and panchromatic CTX mosaics of the Oxia Planum landing site showing the sigma-3 landing ellipses (yellow), and highlighting examples of mounds throughout the study area (arrows), b) 3D view of HiRISE draped over 2× exaggerated HiRISE DEM showing a mound with a planar lower contact with the CBP.

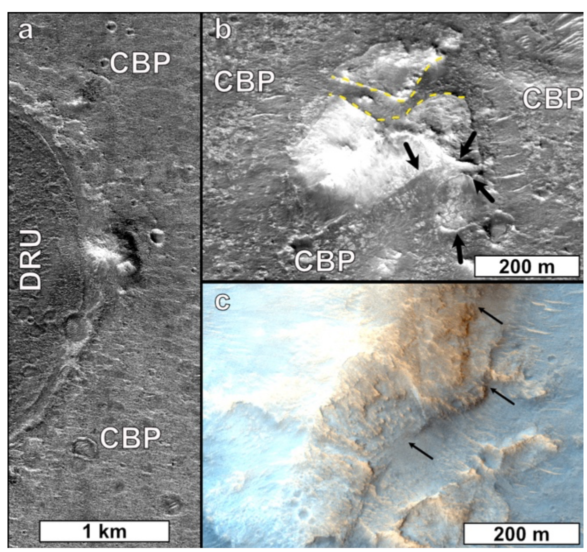

Figure 2: HiRISE images of a) a mound on the edge of a crater within the CBP that has been infilled by a dark resistant unit (DRU), b) a light-toned mound with positive-relief lineations on its surface (arrows),

as well as a wedge that appears to have detached from its main body (margins shown by yellow dotted line), and c) a mound showing evidence for layering (arrows) on its flank.

Detailed Observation of Individual Mounds: Individual large (area >1 km^2) mounds sometimes display unique morphologies that can reveal more about the history of Oxia Planum. For example, a triangular segment of the northern flank of the mound shown in Fig. 2b appears to have detached from the main body of the mound, either tectonically, or through slumping. The underlying clay bearing unit has been revealed in the gap created by this event. This detachment must have occurred after the middle-late Noachian erosion from pre-mound layer to mound [1]. The south-western portion of the detached body follows one of the positive relief lineations that cross the mound. A linear graben-like structure runs NNW-SSE alongside the eastern flank of the mound and the southern edge of the mound is perpendicular to this feature.

Relationship to Clay-bearing Plains: The mounds directly overlie regions of the CBP. The contact between the mound-forming material and the CBP is not always visible, but some examples show that the contact is highly planar (Fig. 1b). The mounds appear to be randomly distributed throughout the landing site, however, some examples are located atop, or adjacent to, the rims of craters that have impacted into the CBP (Fig. 2a). The CBP is also associated with a population of WNW-ESE trending, white-orange-toned, Periodic Bedrock Ridges (PBR, [9]) that fall within the sigma-1 landing ellipse. Many of the smaller mounds have similar white-orange tones in CaSSIS images and high albedos in HiRISE images (Fig 2c). The smallest mounds sometimes merge with, and often become indistinguishable from, these ridges.

The blue-toned fractured sub-unit of the CBP [6] is seen to continue several metres up into the flanks of several of the largest mounds (Fig. 3a), until they reach the planar contact with the mound-forming material. This suggests that a quantity of the blue fractured unit has been removed post-deposition and that the mounds have been eroded (Fig. 3b). We have calculated, assuming the lower contact of the mound material is relatively planar across the study region, that over 10 m of the CBP has been removed from the area around the mounds; the removal of this material may be greater away from the mounds which would explain the inconsistent crater size population and crater retention ages in [6, 10].

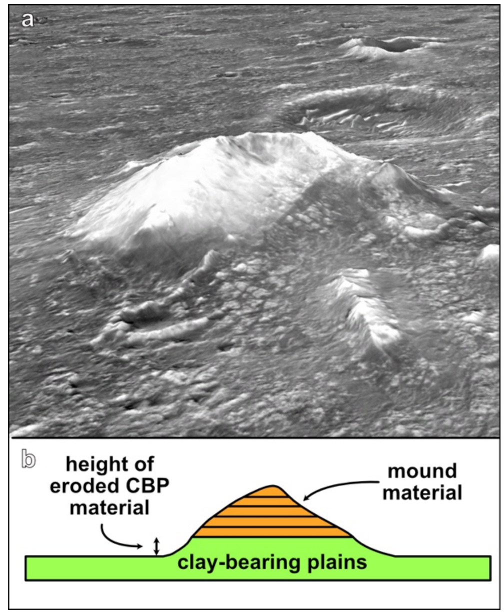

Figure 3: a) 2× exaggerated 3D HiRISE view of same mound as in 2b, looking to the northwest and showing that the fractured CBP material continues up the flank of the mound before transitioning to the lighter-toned mound material, b) schematic cross section of the mound showing the planar relationship between the mound material (orange) and CBP (green), and the amount of eroded CBP.

Conclusions: There is a population of mounds that overlie the ExoMars Rover landing site. They provide geomorphological evidence that the CBP was buried by the material that eroded away to leave these remnant mounds. The layer was up to several hundred metres thick in places. This erosion also removed more than 10 m of the CBP in the areas near the mounds. The positive-relief lineaments on the mounds are similar to those described in [1], and, along with the occurrence of mounds around impact crater margins, are another line of evidence that support the groundwater induration hypothesis of [1]. These observations and resultant interpretations provide insight into the complex erosional and depositional history of Oxia Planum, and offer hypotheses that can be tested using the *Pasteur* payload onboard the "*Rosalind Franklin*" rover.

References: [1] McNeil et al., 2021 (in review, JGR: Planets), [2] Vago et al., 2017; Astrobiology Vol.17, [3] Malin et al., 2007; JGR: Planets Vol.112, [4] Thomas et al., 2017, Space Sci Rev. Vol.212, [5] McEwen et al., 2007; JGR: Planets Vol.112, [6] Quantin-Nataf et al., 2021; in press, Astrobiology, [7] Christensen et al., 2002; Space Sci Rev. Vol.110, [8] McNeil et al., 2020, LPSC 51 Abstract #1948, [9] Montgomery et al., 2012; JGR: Planets Vol.117, [10] Fawdon et al., 2020 LPSC 51 Abstract #2240