TEAM MAPPING OF OXIA PLANUM FOR THE EXOMARS 2022 ROVER-SURFACE PLATFORM MISSION.

E. Sefton-Nash[1], P. Fawdon[2], C. Orgel[1], M. Balme[2], C. Quantin-Nataf[3], M. Volat[3], E. Hauber[4], S. Adeli[4], J. Davis[5], P. Grindrod[5], A. Frigeri[6], L. Le Deit[7], D. Loizeau[8], A. Nass[4], O. Ruesch[9], S. de Witte[1], J. L. Vago[1] & the ExoMars RSOWG 'Macro' group.

[1]European Space Research and Technology Centre (ESTEC), European Space Agency, Noordwijk, The Netherlands (e.sefton-nash@cosmos.esa.int), [2]The Open University, Walton Hall, Milton Keynes, United Kingdom, [3]Laboratoire de Géologie de Lyon, Université de Lyon, Lyon, France [4]Institut für Planetenforschung, Deutsches Zentrum für Luft und Raumfahrt (DLR), Berlin, Germany, [5]Natural History Museum, London, UK, [6]Istituto di Astrofisica e Planetologia Spaziali (INAF-IAPS), Via del Fosso del Cavaliere, Roma, Italy, [7]Laboratoire de Planétologie et Géodynamique, Université de Nantes, France, [8]Université Paris Saclay, France, [9]University of Münster, Germany.

Introduction: Oxia Planum (OP) will be the landing site for the ESA-Roscosmos ExoMars Programme's 2022 mission (*Figure 1*). The descent module and landing platform, *Kazachock,* will transport the *Rosalind Franklin* Rover to OP. With the primary goal of searching for signs of past and present life on Mars, *Rosalind Franklin* ('RF') will investigate the geochemical environment in the shallow subsurface over a 211-sol nominal mission.

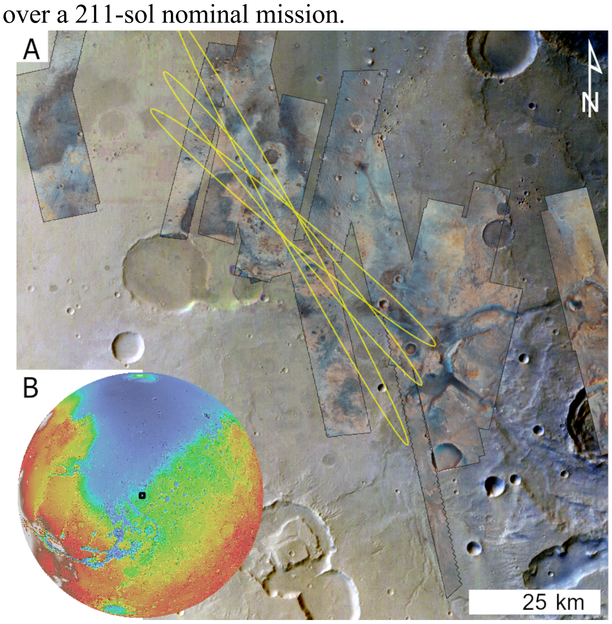


Figure 1: *A) OP and 1-sigma landing ellipses positioned on HRSC and CASSIS colour data on (B) Mars MOLA shaded relief.*

Oxia Planum: OP is located at the transition between the ancient terrain of Arabia Terra and the low lying basin of Chryse Planitia (Figure 1). OP forms a shallow basin, open to the north, characterized by clay-bearing bedrock, and episodic geological activity spans from the ~mid-Noachian to ~early Amazonian in age [2,3,4].

High resolution mapping campaign: Gaining a thorough understanding of Oxia Planum prior to operations will provide testable hypotheses that facilitate interpretation of results, and hence provide an effective approach to address the mission's science objectives. In pursuit of this, the 'Macro' sub-group, part of the Rover Science Operations Working Group (RSOWG), has performed a detailed group mapping exercise of the OP landing site. The work uses 116 $1 km^2$ quads covering the 1-sigma landing ellipses (*Figure 1*). Complementary CTX-scale mapping will covers the wider area around the landing site and is described elsewhere [5].

The objectives of the campaign include to: ***(1)*** Provide a detailed geospatial dataset comprising a geologic map, potential science targets, and surface features and hazards at OP. ***(2)*** Familiarize scientists from across the different instrument teams and disciplines represented on RF with the geology and geography of the landing site in anticipation of rover operations. ***(3)*** Reconcile and analyse data gathered during the exercise to compile a morpho-stratigraphic map of the landing site that can feed into rapid reconnaissance mapping (e.g. [6]), preliminary traverse planning, and allow development of hypotheses that are testable as part of the science operations strategy.

Data and Tools: A group at NASA/JPL have authored and open-sourced the Multi-Mission Geographic Information System (MMGIS) [7]. Additional functionality for geospatial analysis and mapping, 'CAmpaign Mapping and Planning' (CAMP), was developed for the NASA Mars 2020 Rover mission. We have deployed an instance of this tool at ESA ESTEC with the data and configuration necessary to facilitate group mapping.

The mapping campaign uses a HiRISE ortho image and DTM mosaic made on the MarsSI data processing service [8] and CaSSIS colour mosaic. These data are co-registered with a CTX DTM and orthomosaic, which in turn are georeferenced to the HRSC MC11W mosaic [9].

Organisation: The mapping campaign and coordination/leadership team began planning in Q4 2019 and work is arranged into phases [10]. Here, we provide reports on phases; 1. Training and Mapping, 2. Reconciliation, and; 3. Outcomes.

(1) Training and Mapping: 84 mapping volunteers associated with RSOWG were assigned and mapped quads at a fixed scale. In the *training phase*, the volunteers followed four training sessions on best mapping practices and contextual geology, four area discovery meetings on designated mapping areas, and a pre-mapping meeting. Before mapping start, mappers were presented with a 'unit guide' describing the main units and features preliminarily identified, and the mapping symbology and conventions to be used. In the *mapping phase,* many users concurrently mapped geologic contacts and surface features in their assigned quads and provided a 'quad abstract' capturing more interesting observations and hypotheses.

(2) Reconciliation: In this phase a small team reconciles scientific observations made by individual mappers to form a unified set of interpretations undertaken in the following stages:

Stage 1: Data ingestion. In addition to the geological units (Fig 2a), feature line work, and Points of Interest recorded by the mappers the reconciliation process will take into account; HiRISE and CASSIS colour data, CRISM and OMEGA hyperspectral data and selected classes from the NOAH-H (Novelty Or Anomaly Hunter for HiRISE) machine learning terrain classification project [11].

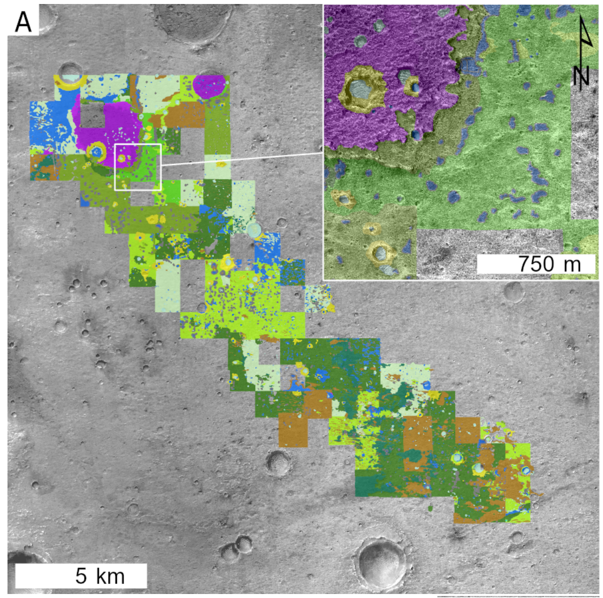
Stage 2: Scientific decisions. The geology of Oxia Planum is highly variable over short (10's of m), but homogenous over long (km), length scales. This terrain is challenging to differentiate and both map at an achievable scale and to still be relevant to rover operations. To approach this we are fusing the bedrock observations by the mappers with the colour and composition data, digitising contacts at a fidelity appropriate for a rover operations database that can be resampled for publication. In addition to this we are creating summary overlays of surficial features and units using selected NOAH-H ontological classes constrained by the mappers observations.

After we have completed these tasks, map sheets, cross sections and summary scientific publications will be produced. At the time of abstract submission the reconciliation team is completing stage 1 and moving on to stage 2 of this process (Fig. 2b).

(3) Outcomes: This exercise achieves a number of important advances for overall science readiness of the ExoMars 2022 mission:

- Team experience working, communicating and learning together, valuable for operations.
- Building team knowledge of the landing site, and the main scientific interpretations.
- Curated datasets and software available for team use in ongoing planning.
- High-resolution map data representing our geologic understanding of Oxia Planum. This is an input to ongoing RSOWG work to construct the mission strategic plan, which provides science traceability from mission objectives to rover activities.

A



B

Stage	Timeline	Progress
Data ingestion	Nov-Dec	
Scientific decision	Dec-Feb	
Internal review	March	
Publication preparation	March - May	
Input to hypothesis testing		

Figure 2: *(A) Preliminary mapping data input into the reconciliation phase overlain on a CTX mosaic.* ***Blue*** *and Yellow colors represent the aeolian and impact surface units.* ***Greens*** *indicate various clay baring bedrock units,* ***Brown*** *indicates eroded overburden units whilst* ***Purple*** *shows the 'dark capping units' in Oxia Planum. Sharp color contacts are due to different quads. (B) Shows the projected timeline of the project from November 2020 to May 2021.*

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References: [1] Vago, J. L. et al., (2017) *Astrobiology 17* (6–7), 471–510. [2] Carter, J. et al., (2013) *J. Geophys. Res. 118* (4), 831–858. [3] Quantin-Nataf, C. et al., (2021) *Astrobiol. 21 (3),* doi:10.1089/ast.2019.2191. [4] Fawdon P. et al., (2019) LPSC50 #2132 [5] Hauber, E. et al. (2021), *This conf.* [6] Balme, M. R. et al., (2019) *Planet. Space Sci. 165*, 31–56. [7] Calef, F. J. et al., (2019) in *4th Planet. Data Work.*, Vol. 2151. [8] Volat, M. et al., (2020), *EPSC*, #564. [9] Gwinner, K. et al., (2016) *Planet. Space Sci. 126*, 93–138. [10] Sefton-Nash, E. et al., (2020) in LPSC 51, #2417. [11] Barrett, A. M. et al., (2020), *EPSC,* #676.