MINERALOGY OF THE OXIA PLANUM CATCHMENT AREA ON MARS AND ITS RELEVANCE TO THE EXOMARS ROSALIND FRANKLIN ROVER MISSION.

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Introduction: The European Space Agency ExoMars *Rosalind Franklin* rover is scheduled to land on Mars in 2023 [1], with the goals of searching for evidence of past or present life by investigating the geochemical environment of the surface and shallow subsurface at Oxia Planum [2].

Located on the boundary between Arabia Terra and Chryse Planitia, remote sensing datasets have shown Oxia Planum (OP) to be a clay-rich plain approximately 200 km wide containing a (~4Ga) Fe/Mg-clay unit. The clay rich basement is associated with the topography of the Coogoon Vallis (CV) valley (Fig. 1) but is also overlain by a younger, sediment fan remnants enriched in silica associated with a younger part of the CV channels. [1, 3-5]. Whilst the exact relationship between CV and OP is obscured by Kilkhampton Crater, model results supported by geomorphological observations show that OP is the sink to a catchment area of ~2.1 × 10^5 km^2 that has been fluvially active at least twice in its history [6].

In this work we use available CRISM data [7] to explore the mineralogy in the proximal part of the catchment and compare this to mineral detections made in the landing site. We consider the geological context of these catchment observations and their relationship to OP to explore the possible origin and mineralogy of sedimentary deposits that may be identified by the *Rosalind Franklin* rover.

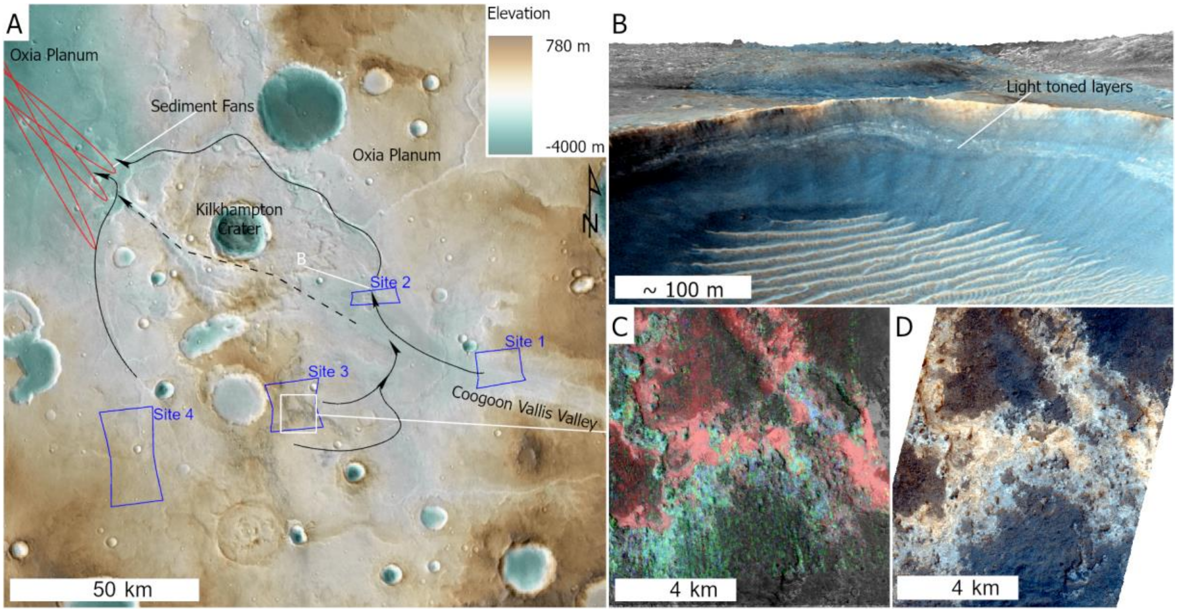

Figure 1: (A) The study areas and the ExoMars 2022 landing site (ellipses shown in red) overlain on MOLA elevation data. Sites 1 and 2 are directly linked to the landing through the narrow section of Coogoon Vallis, but were also likely connected to the Oxia Planum area by a wide valley prior to the formation of Kilkhampton crater. (B) At site 2 distinct light toned strata exposed in a crater wall is comparable to strata in the landing site and are very strongly associated with clay bearing terrains in this region. Site 3 has a diverse composition of clay minerals (C; CRISM; R=D2300 (Fe/Mg phyllosilicates), G=BD2210 (Al phyllosilicates), B=MIN2200 (kaolinite) [8]) which bare a strong relationship to geological units identified in (D) CASSIS color observation (MY35_007424_019_0). Site 3 has undergone extensive erosion since the deposition of the (D) light blue and orange toned clay bearing terrains and the most likely sediment pathway for this sediment is north east into the Coogoon Vallis valley. Site 4, in the plains south of Oxia Planum, is directly connected to the landing site by a set of low sinuous channels.

Datasets and Analytical Techniques: Pre-existing targeted CRISM [7] TRDR v3 (NASA PDS) scenes located within the modelled catchment area were processed and analyzed using the CAT v7.4 extension to ENVI/IDL. Standard CRISM analysis techniques of band map [8] generation to target regional spectral ratios with comparison to spectral library for mineral identification were used for this study [e.g. 9-10].

The contextual Geomorphological observations of each site have been made using ConTeXt (CTX) [11] data as the base map with CASSIS [12] and HiRISE [13] data providing; color, detailed textural information. 2 CTX HiRISE DTMS have been used to understand the stratigraphic of the CRISM derived mineralogy. The topographic relationship with the landing site in OP and the study areas has been assessed using HRSC [14] and MOLA [15] elevation data with the fluvial pathways database reported in [6].

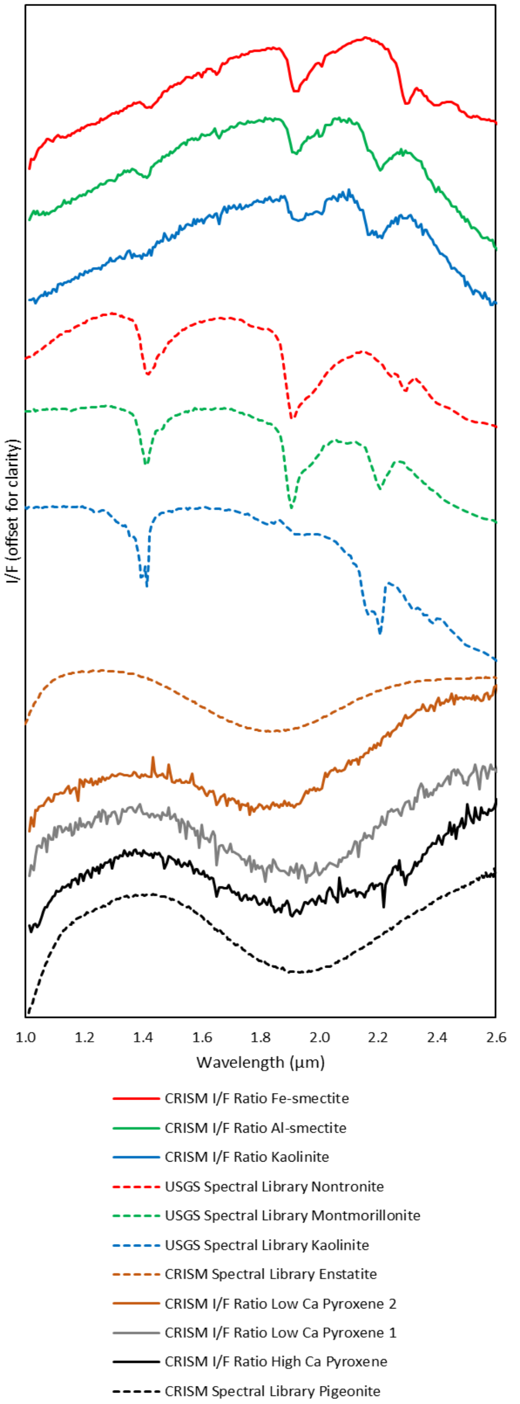

Figure 2: Spectra extracted from CRISM scenes in the Oxia Planum catchment area compared to CRISM and USGS spectral libraries.

Observations: CRISM band maps showed evidence for pyroxenes and hematite near the channel within the catchment area (sites 1 and 2; Figure 1A). Band maps and spectral analysis indicated the presence of pyroxenes of varying Ca content, with high Ca pyroxene (Figure 2) and hematite at the bottom of the channel with low Ca pyroxene (low Ca pyroxene 1; Figure 2) at higher elevation with evidence of low Ca pyroxene further down the channel towards the ExoMars landing ellipses (low Ca pyroxene 2; Figure 2).

An area to the south-west of Coogoon Valles (site 3; Figure 1A) shows spectral absorptions consistent with a variety of phyllosilicates. Analysis CRISM scenes FRT00008438 and FRT00010FE9 showed a 2.3 µm absorption indicating the presence of Fe/Mg phyllosilicates, highlighted by the red band in Figure 1c. Exposures of Al-phyllosilicates indicative of montmorillonite, as indicated by an absorption at 2.21 µm (blue band; Figure 1C), however an absorption ~2.16 µm has also been identified and is consistent with kaolinite (green band; Figure 1C). Spectra were extracted from these three localities and are compared to library spectra in Figure 2. A previous study for CRISM scene FRT00008438 also showed the presence of kaolinite and suggested the area may be an erosional window into the Mawrth Valles stratigraphy [16]. This compositional variation by CaSSIS imagery in Figure 1D, where the orange and blue toned units clearly correlate to respective CRISM Fe/Mg and Al phyllosilicates highlighted in Figure 1C.

Summary: This study has found evidence for pyroxenes of varying Ca content, as well as Fe/Mg and Al phyllosilicates in the Oxia Planum catchment area that feeds in to the Oxia Basin, where the *Rosalind Franklin* rover is scheduled to land in 2023.

Figure 2 shows that the Fe/Mg phyllosilicates present at site 4 (Figure 1) are spectrally comparable to nontronite. This differs to the Oxia Basin where vermiculite and saponite have been [4], neither of which have been observed so far in this study.

References: [1] Quantin-Nataf et al., (2021). Astrobiology, 21(3). [2] Vago et al., (2017). Astrobiology, 17(6-7), pp.471-510. [3] Carter et al., (2019). EPSC Abstracts Vol. 13, No. 445. [4] Carter et al., (2016). LPSC Vol. 47, No.2064. [5] Turner and Bridges, (2017). LPSC Vol. 48, No.2228. [6] Fawdon et al., (2019). LPSC Vol. 50, No.2356. [7] Murchie et al., (2007). JGR: Planets, 112, E05S03. [8] Viviano-Beck et al., (2014) JGR: Planets, 119(6), 1403-1431. [9] Ehlmann et al., (2009). JGR: Planets, 114, E00D08. [10] Turner et al., (2016). JGR: Planets, 121, 608-625. [11] Malin et al., (2007). JGR: Planets, 112, E05S04. [12] Thomas et al., (2017). Space Science Reviews, 212(3-4), 1897-1944. [13] McEwen et al., (2007). JGR: Planets, 112, E05S02. [14] Jaumann et al., (2007). PSS, 55(7-8) 928-952. [15] Smith et al., (1999). Science, 284(5419), 1495-1503. [16] Noe Debrea et al., (2010). JGR: Planets, 115, E00D19.