# Investigating the clay-bearing unit of Oxia Planum, the landing site of the ExoMars 2020 mission

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**Abstract**

The ExoMars rover mission, due to land in early 2021, will be dedicated to exobiology studies of the surface and subsurface of Mars. In this context, the mission will land on Oxia Planum, a site hosting a geological setting attesting to an extensive history of water-rock interactions during the Noachian. Of particular exobiological interest is that Oxia Planum exhibits a wide (> 300 km) layered and fractured clay-bearing unit. In addition to behave as excellent catalysts for organic reactions and traps for organic matters due to their mineralogical structure in sheets, the type of clays present at Oxia Planum most likely formed during chemical conditions favorable to life emergence and stability. Moreover, this unit is exposed in more than 70% of the rover landing ellipse and the probability to reach it in a 5 km drive is very high (> 99%). Hence, detailed investigation of this Noachian clay-bearing unit with the instrumental suite of the ExoMars rover is one the main objectives of the mission. Here we analyze data from the High Resolution Imaging Science Experiment (HiRISE), the Colour and Stereo Surface Imaging System (CaSSIS) and the Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) instruments to characterize at high-spatial resolution the mineralogical variability of the fractured clay-bearing unit at Oxia Planum.

At high spatial resolution, especially in HiRISE visible color products, the fractured unit exhibits textural and color variations. It is composed of a stack of at least three different subunits. The subunit responsible for the clay signature detected from orbit forms the lower part of the stratigraphy. The fractured unit's base consists of vermiculite-type clays that

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have a reddish tone in HiRISE color products. The blueish-toned middle portion is interpreted as a mixture of clay and olivine and displays an increase in the polygonal fracturing size. Finally, the upper portion of the fractured unit consists of a thin olivine-rich layer, with no clay phase detected from orbit. This subunit is only exposed locally under the deltaic deposits. While high-resolution hyperspectral data coverage at Oxia Planum is not optimal, these changes of mineralogy are tracked through color variations in the HiRISE and CaSSIS datasets. Outcrops of the fractured clay-bearing unit are widely distributed in the ellipse to a wider extent than estimated by the previous clay spectral map. The western part of the landing ellipse appears homogeneous and consists mostly of outcrops consistent with the lower vermiculite-rich subunit, while the eastern part appears more diverse, with the vermiculite and the vermiculite/olivine subunits often coexisting at the kilometer scale.

As we observe a smooth transition between the lowest and the highest subunits of the Oxia Planum Noachian fractured unit, it may have recorded a gradual transition of conditions during its deposition and/or alteration. In the case that the unit first emplaced as an aerial deposit (*e.g.* ash) and was subsequently altered via pedogenic processes, the change of composition would record a decline in the surface weathering rate. This would form clays in the early volcanic deposits, covered by a localized less altered unit. If the fractured unit was formed by material deposition in a subaqueous environment, this would not necessarily imply a decline of the weathering rate. Rather it would involve a decrease of the altered continental inputs and/or an increase of igneous materials, potentially linked with volcanic activity. Regardless the scenarios of formation and alteration of the fractured unit, the highest parts of the stratigraphy might probably have protected the lower clay-rich subunit and helped organic matter preservation over time.
*In situ* examination of the diffuse contact between the lower and upper members of the fractured clay-bearing unit would provide key observations to understand the continuous transition in Oxia Planum between deposition of a material that is now altered and a material that appears less clay-rich from orbit. Finally, vermiculite-type spectra happen to be the most representative of clay detections on Mars from analysis of global datasets. Investigation of the western and central parts of the landing area, where the percentage of area with vermiculite-rich rocks is the highest, would provide insights into the alteration history of Mars. Investigation of a more diverse geology would be achieved by landing in the eastern part of the landing area, with the different subunits often reachable within a few hundreds of meters-drive.