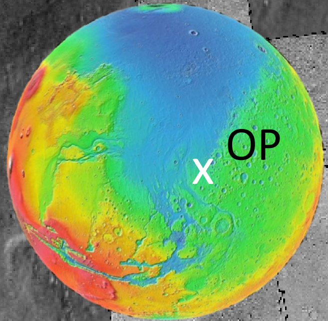

Using CaSSIS imagery and fracture morphology to characterise Oxia Planum's clay-bearing unit

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1-sigma opening ellipse
3-sigma opening ellipse
1-sigma closing ellipse
3-sigma closing ellipse

- At Oxia Planum, the landing site for the Rosalind Franklin rover (see background including landing ellipses), current mapping of the clay unit is constrained by coverage of the highest resolution (18m/pixel) CRISM spectrometer data, and the resolution of the OMEGA data (300m/pixel) and of the remaining CRISM data (100-200m/pixel)
- Recent research has identified the presence of at least two clay subunits at Oxia, and that Colour and Stereo Surface Imaging System (CaSSIS) imagery can differentiate them
- This, along with CaSSIS's higher resolution (4.5m/pixel) and that it will have near 100% coverage of the site by the time Rosalind Franklin arrives, mean improved maps of the clay unit can be made, which will be of use for future rover traverse planning

- In addition, fracture networks at Oxia Planum and Gale crater are being studied
- This is being done as, depending on their formation mechanism, surrounding environment and various properties of the host material, fracture networks can vary greatly
- By comparison of those fractured units observed at Oxia Planum with those characterised by Curiosity at Gale Crater, the fracturing at Gale Crater can be used to make predictions on Oxia's history and its material properties

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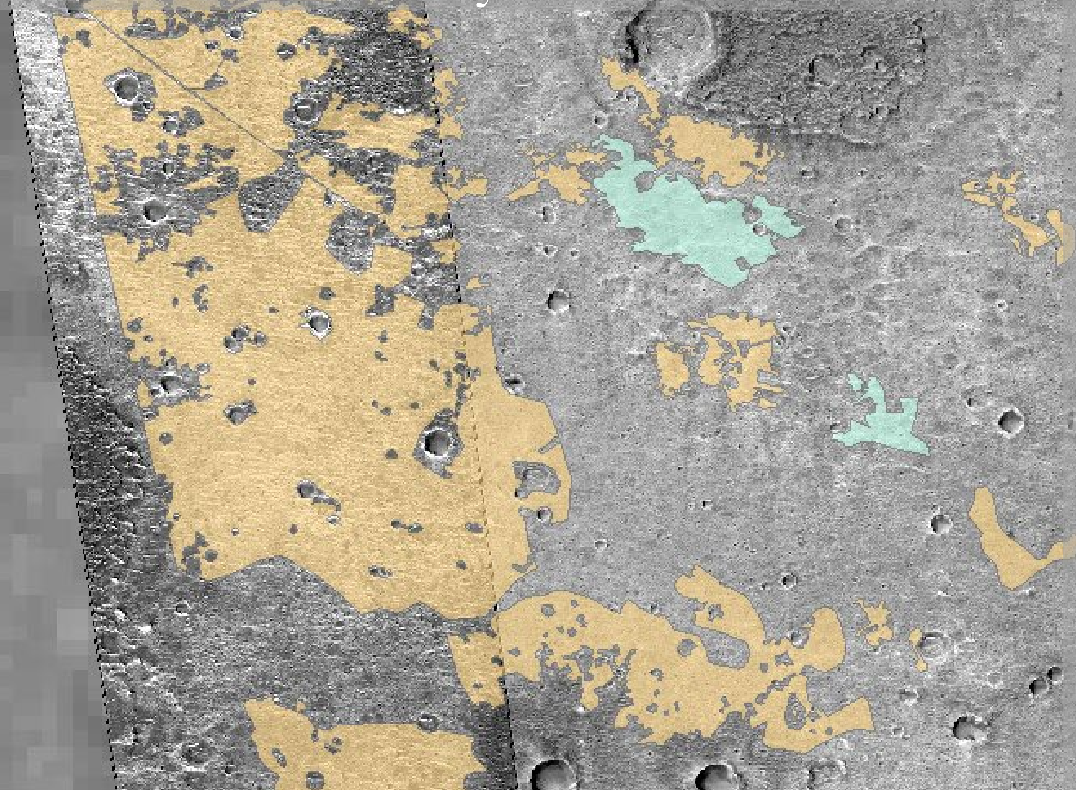
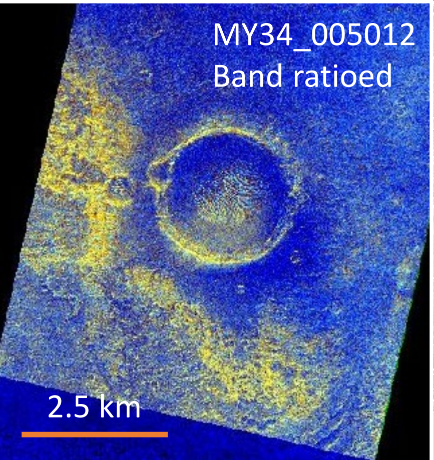
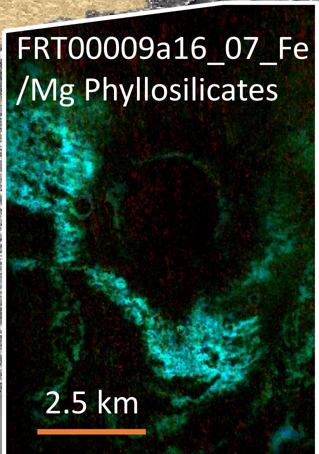
CaSSIS mapping: relating ferric and ferrous material to clay detections



- CaSSIS is a VNIR colour imager with 4 colour bands; NIR, RED, PAN and BLU
- Previous work[1] has shown that certain CaSSIS band ratio's (NIR÷BLU, PAN÷BLU, PAN÷NIR composite inset left) can detect and distinguish between ferric and ferrous (yellow and blue inset left) materials, band ratioing being the process where one image colour band is divided by another on a pixel by pixel basis
- Using CaSSIS, with co-analysis from CRISM and HiRISE colour imagery, two clay subunits were found to exist at Oxia Planum[2]. These were a lower lying "orange" member rich in Fe/Mg clays possessing metre-scale fracturing, and an over lying "blue" member with CRISM signatures of both Fe/Mg clay and Olivine, which possesses decametre-scale fracturing
- This work also found that ferric detections from band ratioed CaSSIS imagery correlated well with CRISM clay detections (compare inset left and the CRISM Fe/Mg phyllosilicate spectral map inset centre) and that its two subunits were differentiable by this imagery
- Following this CaSSIS band ratio's, in conjunction with HiRISE RED data to observe fractures size, is currently being used to map these two sub-units. The map as it stands is shown, set on the HiRISE RED images used and with a THEMIS day IR background.

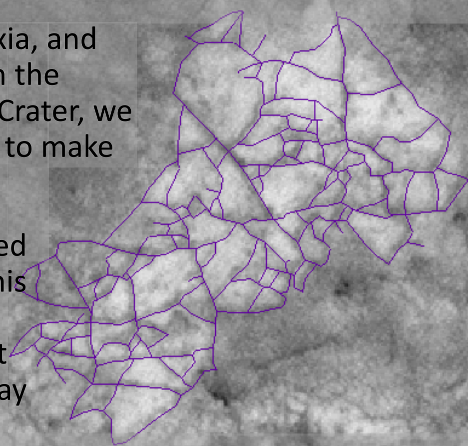


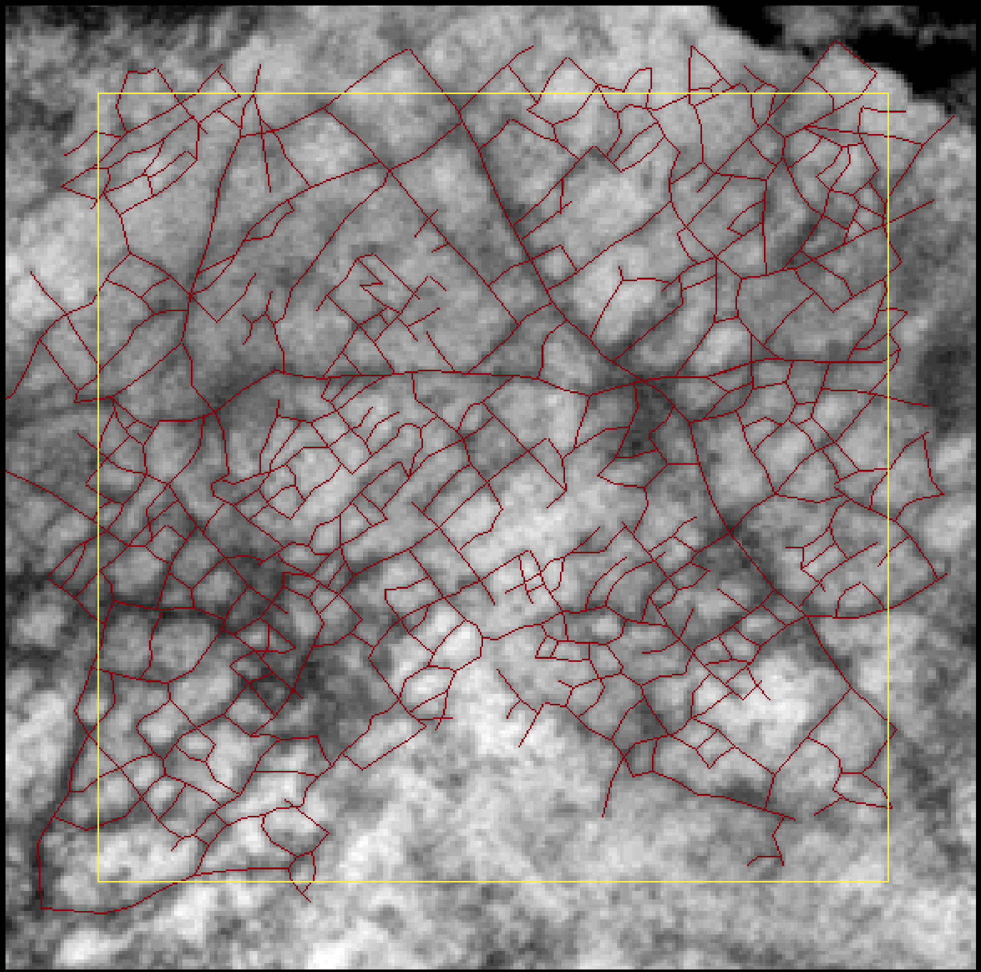


1; Tornabene L L. et. al., 2017. *"Image Simulation and Assessment of the Colour and Spatial Capabilities of the Colour and Stereo Surface Imaging System (CaSSIS) on the ExoMars Trace Gas Orbiter."* Space Sci Rev 212, 2; Mandon, L. et. al. (in review). *"Stratigraphy and spectral diversity of the clay-bearing unit at the ExoMars 2020 landing site Oxia Planum"* Astrobiology

Fracture analysis: mapping of the networks and visualising data

- The various physical properties of a fracture network depend on a mix of factors. For example, length and area of fracture polygons are partly related to grain size as well as to the depth of the fractured area[3]. Intersection angle meanwhile can be an indicator of formation mechanism and a measure of how evolved the fracture network is[4]
- By mapping fracture networks at Oxia, and comparing them to networks within the well characterised surfaces at Gale Crater, we can use what we know of the latter to make predictions about the former
- Suitable fracture sites were identified and mapped out at the two sites, this being done at a 50 x 50 m scale. Examples of the fracture network at two Gale Crater sites, Yellowknife Bay and at Vera Rubin Ridge, are shown respectively in the left and right figures
- Following this Kernel Density Estimation (KDE) diagrams were used to visualise and compare the data, while 2-sample Kolmogorov-Smirnov tests were used to determine whether each data set could have originated from the same population to a 95% level of probability





3; Kindle, E. M., 1917, *"Some Factors Affecting the Development of Mud-Cracks"*, The Journal of Geology 25(2): 135-144., 4; Goehring, L., et al., 2010, *"Evolution of mud-crack patterns during repeated drying cycles."* Soft Matter 6(15): 3562.

Fracture analysis: comparison of Oxia Planum and Gale Crater

- Two sites at Gale showed similarities to those at Oxia; one in the Sheepbed member at Yellowknife Bay (YKB), similar to both a network within Oxia's clay (OC) unit (site 8, see background figure), and one within an olivine-rich unit (site 9). Neither of these sites were themselves similar to each other. The other was on Vera Rubin ridge (VRR), comparing to two networks within sites OC 4 and 7; these were themselves similar to each other
- The Oxia sites that YKB and VRR are comparable to are limited, with these networks not being limited to a specific region or what is nominally the same unit. This suggests a more complicated history of Oxia Planum's clay unit than CRISM and OMEGA maps alone would indicate; in what particular way is still being determined

- Comparing between the networks at Oxia Planum shows two groupings. Two networks in the clay unit, sites 7/8, located near the large capping units are distinct to those elsewhere, while site 1 in the clay unit and site 9, adjacent to a large delta fan, also form their own distinct group
- OC 7/8 possess metric distributions dissimilar to the other networks, with the exception of OC 4 which has consistent similarities to OC 7. The networks could have formed under significantly different conditions to those in the SE of the landing ellipse, or perhaps were better preserved due to being more recently uncovered by erosion of the adjacent capping unit. Given the similarity with OC 4 however these suggestions may be too simplistic a conclusion; further work needs to be done to help determine this
- The two networks directly adjacent to the delta fan, OC 1 and the olivine-rich unit, both have very similar metric distributions and are distinct to those seen elsewhere at the site. Given their location and strong differences in comparison to the other networks, it is likely that the event which formed these fractures was linked to or influenced by the emplacement of the delta and may have occurred at a different time