Structural and compositional mapping of shear zones in northern Valles Marineris

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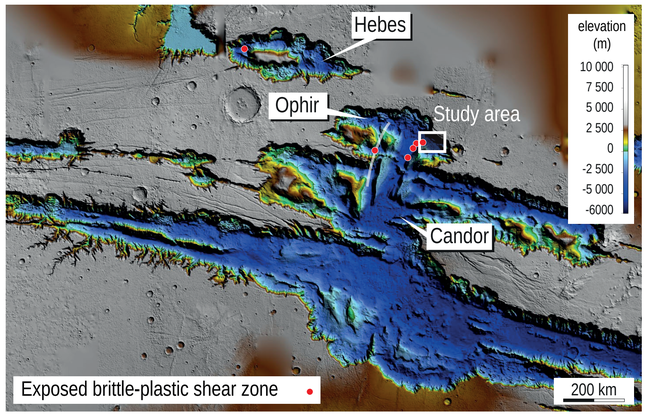
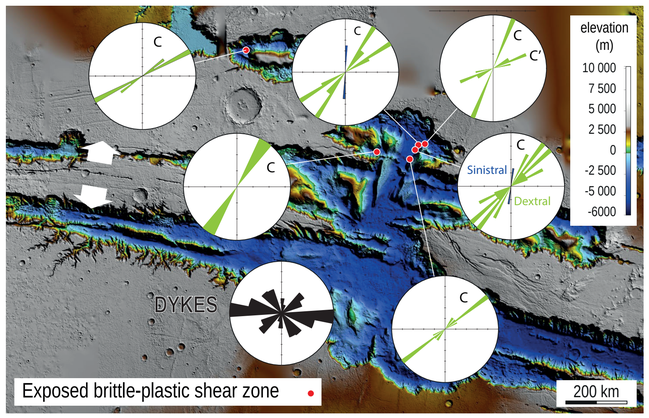
Introduction

The recent discovery of thick dykes on the floor of Ophir and Hebes chasmata indicates that these chasmata developed in response to extension and also intense erosion (Mège et al., 2017). The discovery of brittle-plastic shear zones at similar depth in Ophir and Hebes chasmata is consistent with substantial erosion. The mineralogical composition of the sheared rock (which is the same as the dyke-intruded rock) can provide useful constraints to the paleo-depth and heat flux at the time of deformation. We present results of structural mapping of the shear zone with the most complex geometry, located in eastern Ophir Chasma, and current stage of investigation of the host rock using the linear unmixing algorithm LinMin (Schmidt et al., 2014).

Location of brittle-plastic shear zone exposures in Valles Marineris



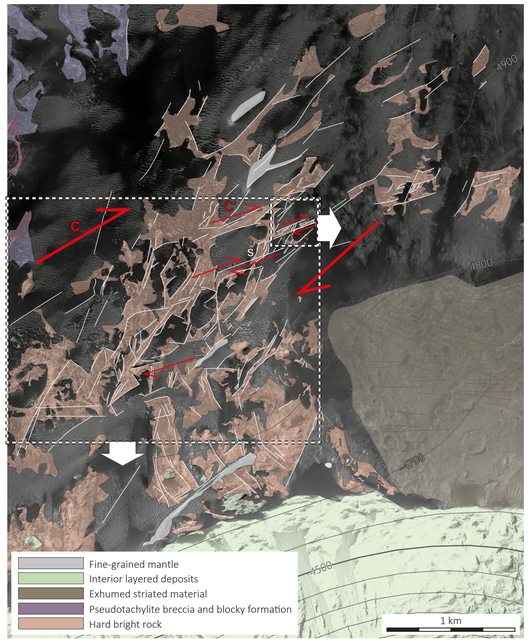
Orientation of the dykes and shear zones

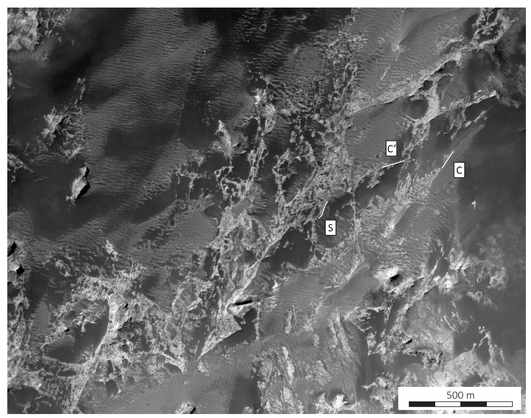


Shear zone orientation is indicated by the observed trend of C and C' shear planes. Dextral shears are reported in green and sinistral in blue. The white arrows indicate the direction of extension inferred from the dominant set of narrow grabens showing pure dip slip displacement.

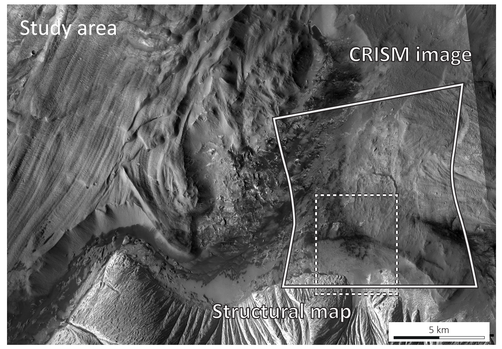
Structural mapping

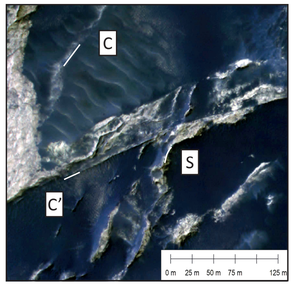
Structural mapping of the shear zone observed in eastern Ophir Chasma. The fabric points to brittle-plastic host rock rheology.

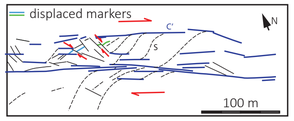




HiRISE image: ESP_016053_1755
Topographic contours after Mars Express/HRSC DTM







Light-toned rocks and a likelihood of their occurrence as shear zone host rock

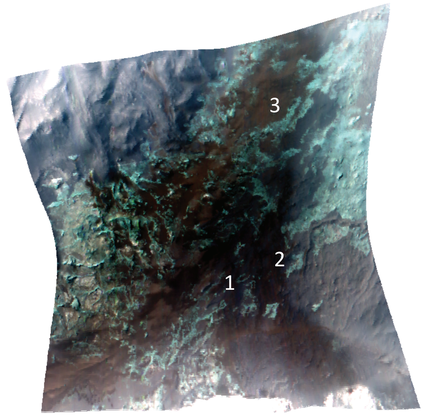
Unlikely	Possible	Further investigations needed
Anhydrite	Basalt altered in acidic conditions	Gneiss
Dolomite	Gabbroic rocks (incl. anorthosite)	Granite
Marble		Pegmatite
Serpentinite		Quartzite
		Pseudotachylite

References

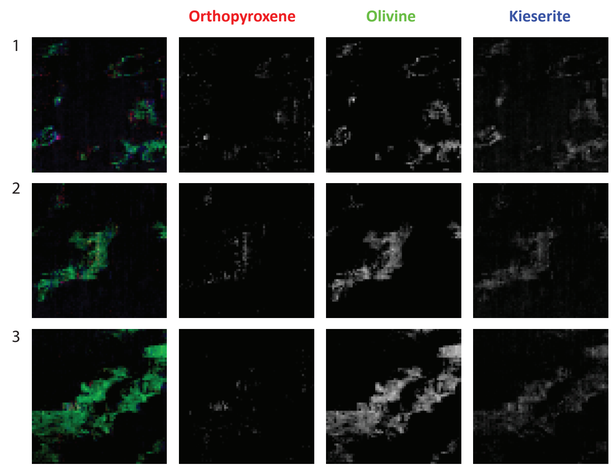
Flahaut, J. et al. (2012) Icarus 221, 420-435.
McCollom, T.M., et al. (2013), J. Geophys. Res. 118, 577-614.
Mège, D., et al. (2017) 48th LPSC, 1087.
Schmidt, F., et al. (2014), Icarus 237, 61-74.
Viviano-Beck, C.E., et al. (2017) Icarus 284, 43-58.

Compositional mapping

A list of potential host rocks, sedimentary, igneous and metamorphic, was considered, from which a library of 48 spectra of minerals commonly found in these rocks was prepared as an input to LinMin algorithm (Schmidt et al., 2014). Three sites (1-3) were the shear zone host rock is well exposed are shown.



CRISM data: frt00018b55_07_if165l_trr3, bands: R: 233, G: 78, B: 13



Conclusion

The rock hosting the shear zones observed in the Valles Marineris chasmata was deformed in the brittle-plastic transition rheological field. In the current stage of this work, this rock appears to be mafic, as found by Flahaut et al. (2012) and Viviano-Beck et al. (2017) in other areas of Valles Marineris. Its light-tone colour is attributed to kieserite, implying alteration in acidic conditions, perhaps in hydrothermal environment (McCollom et al., 2013).