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Characterizing Anomalous Wind Eroded Terrain on Mars

THE OLYMPUS MACULAE

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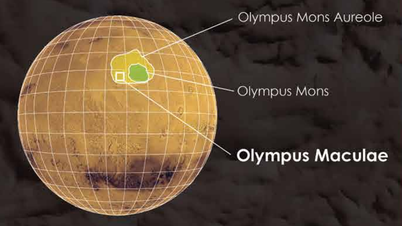
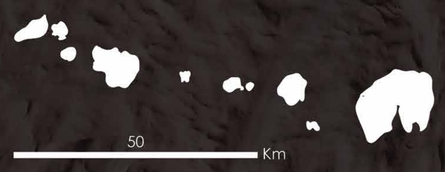
BACKGROUND

The **Olympus Maculae** are a series of irregular, generally **low albedo,** and **low dust** features spanning ~1,400 km^2 within Olympus Mons' aureole terrains. The Olympus Maculae themselves exhibit **elevated thermal inertia**, little to no topographic relief, non-definitive spectra, and **minimal surface dust** in an otherwise dusty region.



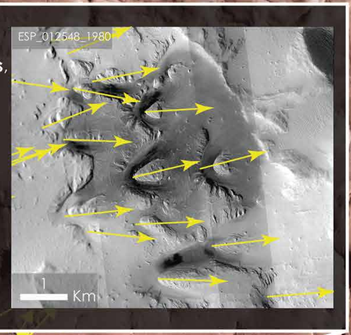
The relative lack of dust in the maculae showcases the surface expression of the uppermost stratigraphy of the hosting **Medusae Fossae Formation (MFF)**, thus providing **unique windows** into the origins, extent, and evolution of this enigmatic terrain.



This research aims to characterize and analyze the complex **aeolian** and **volcanic** landforms evident at multiple scales in the maculae region, including sand sheets, **crossbedding**, **yardangs**, transverse aeolian ridges (**TARs**), **ripples,** and dust, and how these landforms are affected by the presence of aureole ridges and lava flows.

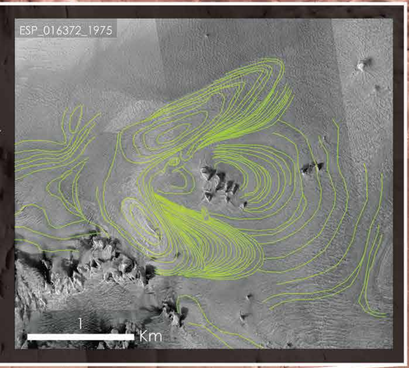
YARDANGS

In friable lithologies, such as **ignimbrites**, winds can erode U-shaped troughs around more resistant material[1]. The orientation of these features can be used to determine **dominate wind directions** during the time of formation (yellow vectors). About 3,000 **yardang orientation** measurements provided evidence for strong unidirectional, regional winds flowing toward the ENE (**65° ± 15° from North**).



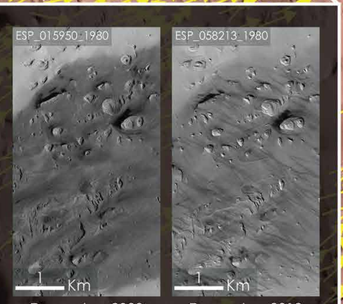
CROSSBEDDING

We have interpreted **concentric banding** within the maculae as cross-bedding[2], formed when sets of layered sedimentary deposits are eroded and another set is deposited, unconformably, on top. The morphology of cross-bedding can provide evidence for past sedimentary **depositional environments**. The paleoenvironment that formed the crossbedding observed within the maculae was most likely **climbing barchan dunes**[3] or repeated periods of sediment deposition and erosion into the **troughs of yardangs**.



DUST DEVILS

After the Mars **global dust storm** of 2018, we re-imaged several maculae with the orbiting HiRISE camera to monitor any **changes in dust deposition** or removal. We discovered a notable increase in **dust devil tracks** as well as a **change in the borders** of the maculae post dust storm. The low albedo of the maculae may contribute to a local increase in **surface temperature** relative to the surroundings causing uplift and increased vorticity, i.e., dust devils[4].

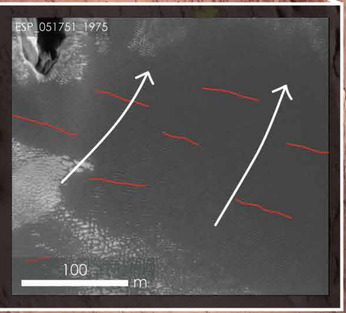


TARS

Transverse Aeolian Ridges (TARs) are observed almost everywhere across the maculae and are **common on Mars**. Some research has found that the paleo winds that formed these **immobile** features (arrows) likely flowed perpendicular to their crest[5] (orange lines). About 2,000 TARs provide evidence for **circumferential winds** controlled by **local topographic rises**.

RIPPLES

Ripples within the maculae are visually **dark** yet anomalously **immobile**, contradictory to other low albedo ripples across Mars[6, 7]. The wind that originally formed these features (arrows) flowed perpendicular to ripple crests (red lines). While it is still unknown why these features are immobile, we hypothesize that they may have been **indurated by salts**[8, 9].



SUMMARY

We interpret the maculae to be relatively dust-free windows into part of the **Medusae Fossae Formation (MFF)** ignimbrites which appear to have experienced **multiple cycles** of erosion and deposition, resulting in a diverse, complex, and ever-changing **volcanic-aeolian landscape**[e.g. 10-15]. The wide array of aeolian landforms and paleo wind indicators at different scales offers insight into this poorly understood region of Mars:

Increasing Wind Scale

- **Crossbedding** provides evidence for a paleoenvironment with complex sediment deposition and erosion
- **Yardangs** indicate dominant, unidirectional wind blowing ENE
- **TARs** provide evidence for circumferential winds around topographic rises
- **Dust devils** tracks may provide evidence for local vorticity that is actively removing dust from the maculae
- **Ripples** are dark and unusually immobile

While the lower albedo of the maculae may contribute to a sustained "heat island" effect, keeping them relatively dust-free, we do not yet know what mechanism initiated the maculae formation. Future work will explore potential formation mechanisms.

ACKNOWLEDGMENTS

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CITATIONS

1. de Silva, S.L. et al. (2010) Planetary and Space Science, 58, 459-471; **2.** Morris, E.C. and Tanaka, K.L. (1994). Geologic maps of the Olympus Mons region of Mars.; **3.** Rubin D.M. and Carter C.L. (1987) Cross-Bedding, Bedforms, and Paleocurrents.; **4.** Rennó, N.O. et al. (1998) JAS, 55, 3244-3252; **5.** Berman, D.C. et al. (2018) Icarus, 312, 247-266; **6.** Runyon, K.D. et al. (2017) EPSL, 457, 204-212; **7.** Bridges, N.T. et al. (2012) Nature, 485, 339-342; **8.** Bridges, N.T. et al. (2007) GRL, 34(23); **9.** Bridges, N.T et al. (2010) Icarus, 205, 165-182; **10.** Scott, D.H. and Tanaka, K.L. (1986) Geologic map of the western equatorial region of Mars; **11.** Greely, R. and Guest, J. E. (1987) Geologic map of the eastern equatorial region of Mars; **12.** Tanaka, K.L. (2000) Icarus, 144, 254- 266; **13.** Head, J. W. and Kreslavsky, M. (2004) LPSC XXXV, Abstract #1635; **14.** Ward, A.W. (1979) JGR, 84, 8147-8166; **15.** Mandt, K. et al. (2008) JGR, 113(E12)