Documentation of Recent Surface Winds on Small Dunes West of Mars' Hellas Basin

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Abstract # 2809

1. Introduction

The High Resolution Imaging Science Experiment (***HiRISE***) provides the capability to obtain orbital images of Mars with a resolution of 25 cm/pixel [1,2]. HiRISE images are then of sufficient resolution to record ***wind ripple patterns*** on the surfaces of sand dunes, which have been proven to be capable of providing valuable insights into aeolian erosion and deposition on Mars [3-5]. In this study, we mapped the sand ripple orientations and created ***surface process maps*** to evaluate the ***recent wind flow*** over the dunes. The results of local wind flow studies are expected to facilitate the research on martian wind modeling.

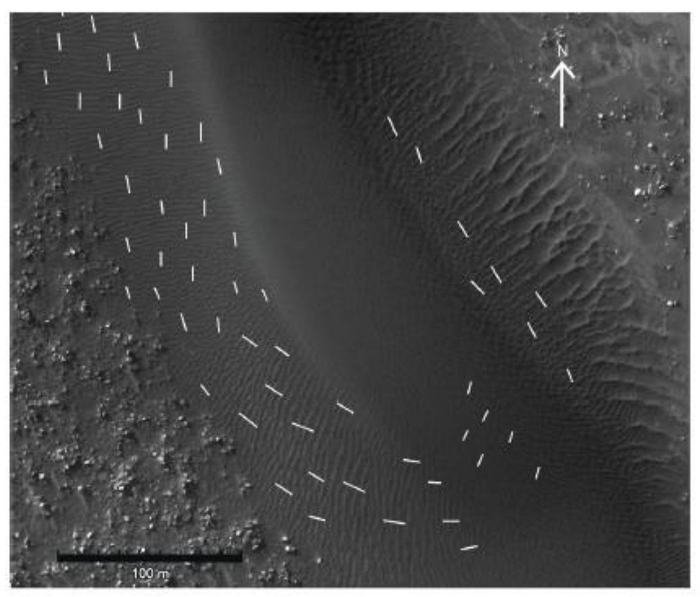

Fig. 1. Mapping method on sand ripples used by Johnson and Zimbelman. Mapped white lines represent the length across three ripple crests, and are oriented to be perpendicular to these ripples.

This study was conducted in an attempt to expand upon the findings of Johnson and Zimbelman [4,5]. Instead of mapping small dunes globally [4,5], this study focused on producing more ***detailed geological maps*** in chosen regions. In addition, detailed maps with carefully examined dune morphology and sand shadows not only allow us to interpret the bimodal wind patterns [4,5] but also the ***actual wind orientations***.

2. Methodology

We adapt the mapping method of dunes on Earth, based on Nielson and Kocurek [6], and establish a procedure to (1) ***map sand ripples on Mars in HiRISE images*** and (2) ***interpret the direction of wind and airflow***. We first define the mapping units, which include primary crestlines, secondary crestlines, ripple marks, transverse aeolian ridges (TARs), frost (when present), wind direction and inferred airflow. To distinguish mapping ripples from TARs, TARs typically have wavelengths of 20 to 60 m and high albedo [7], while ripples usually have wavelengths < 10 m. We incorporate a HiRISE image into ArcGIS and create shapefiles for lines and polygons.

3. Mapping Procedures

1. Map primary and secondary crestlines in a broad view (at a scale of 1:2000)
2. Map frosts and define their boundaries
3. Map wind ripples (at a scale of 1:500)
4. Standardization of ripple marks:
   (1) Map spacing: 60-100 m; Map length: 60-100 m for each ripple marks
   (2) Density of Ripple marks (DR)
   = 100*[total length (m) / dune areas (m^2)] ~ 5-7 (100/m)
5. Map TARs following the same standard as for wind ripple marks
6. Map ***airflow*** (long arrows) in arc shape; airflow marks are perpendicular to ripple marks
7. Map ***wind direction*** (short arrows); wind direction marks are perpendicular to ripple marks

Geological Units

- **Primary Crestline**
- **Secondary Crestline**
- **Ripple mark**
- **TARs**
- **Wind Direction**
- **Airflow Direction**
- **Frost**

References: [1] McEwen, A.S., et al. (2007) *JGR, 112,* E05S02. [2] McEwen, A.S., et al. (2010) *Icarus, 205(1)*, 2-37. [3] Bridges, N.T., et al. (2007) *GRL 34*, L23205. [4] Johnson, M. B. and Zimbelman, J.R. (2013) *LPS 44th,* Abstract #2111. [5] Johnson, M. B. and Zimbelman, J.R. (2014) *LPS 45th,* Abstract #1518. [6] Nielson, J. and Kocurek, G. (1987) *Geological Society of America Bulletin 99*, 177-186. [7] Wilson, S.A. and Zimbelman, J.R. (2004) *JGR, 109*, E10003.

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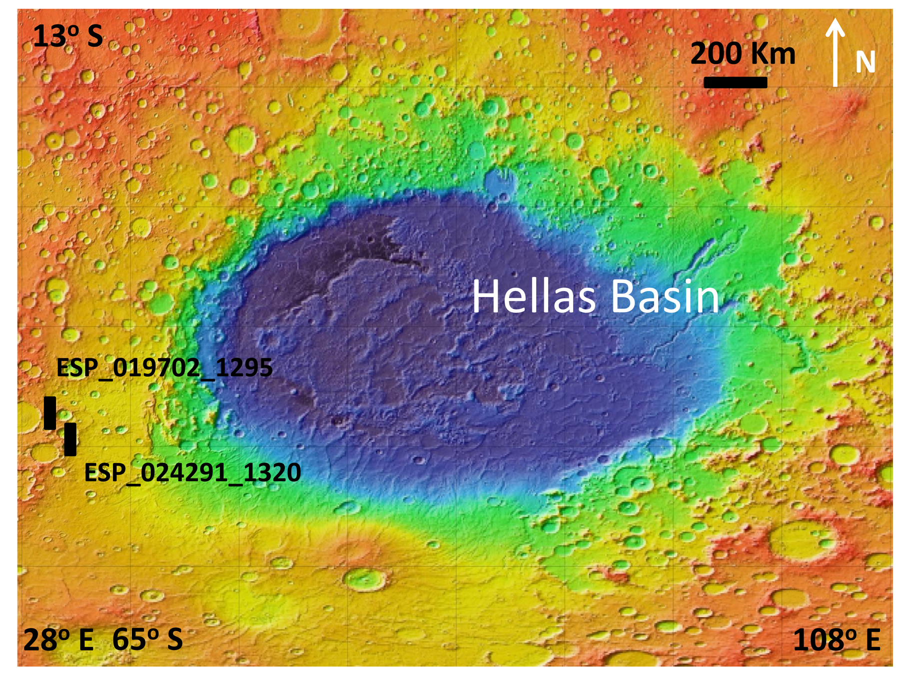


4. Mapping Areas

The initial effort of this study has included mapping sand ripples in HiRISE ESP_019702_1295 and ESP_024291_1320, which cover sand fields west of Hellas Basin.

HiRISE Images	Lon Lat	Cm /pixel	Season	Date
ESP_019702_1295	32.6 E 50.0 S	50	Northern summer	09 Oct 2010
ESP_024291_1320	30.4 E 47.6 S	50	Northern Spring	02 Oct 2011

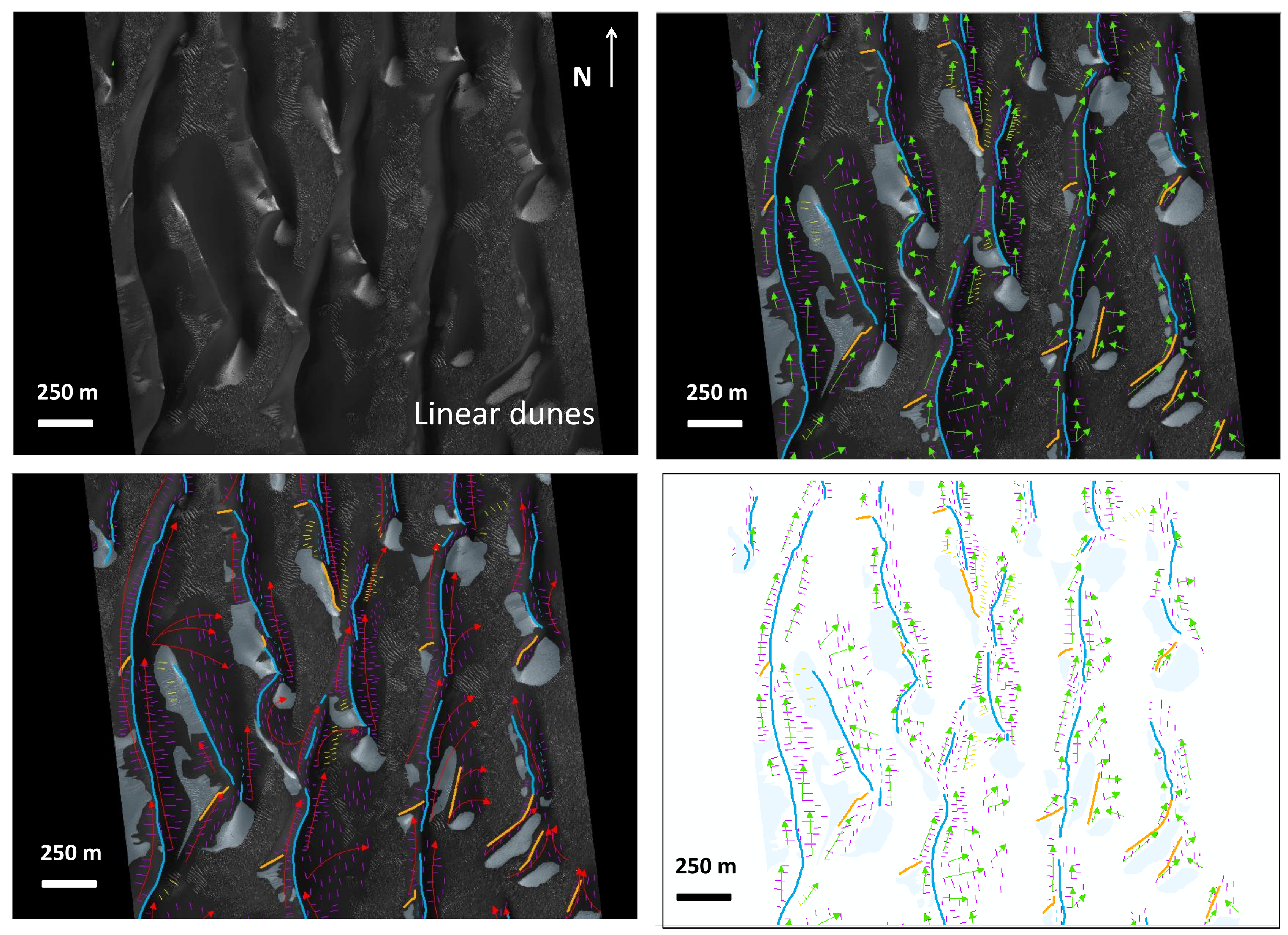
7. Discussions

Based on rose diagrams of crestlines, ripples and wind direction, interpreted ***local wind direction is strongly correlated with the dune crest orientation*** in these regions. By analyzing small martian dunes in HiRISE images, wind regimes in these areas can be inferred and compared to current terrestrial and martian wind models.

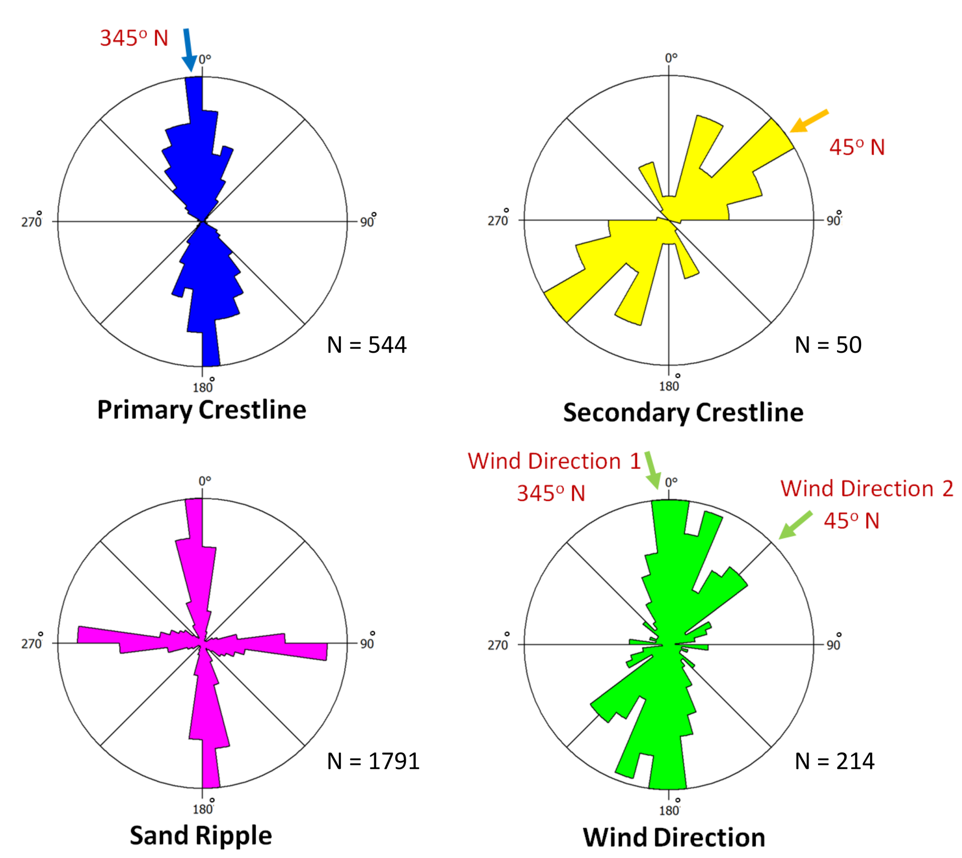
Surface process maps for two closely located dune fields show different local wind regimes, suggesting ***martian surface wind patterns are complex***.

5. Result -- ESP_019702_1295

Local wind direction: S → N



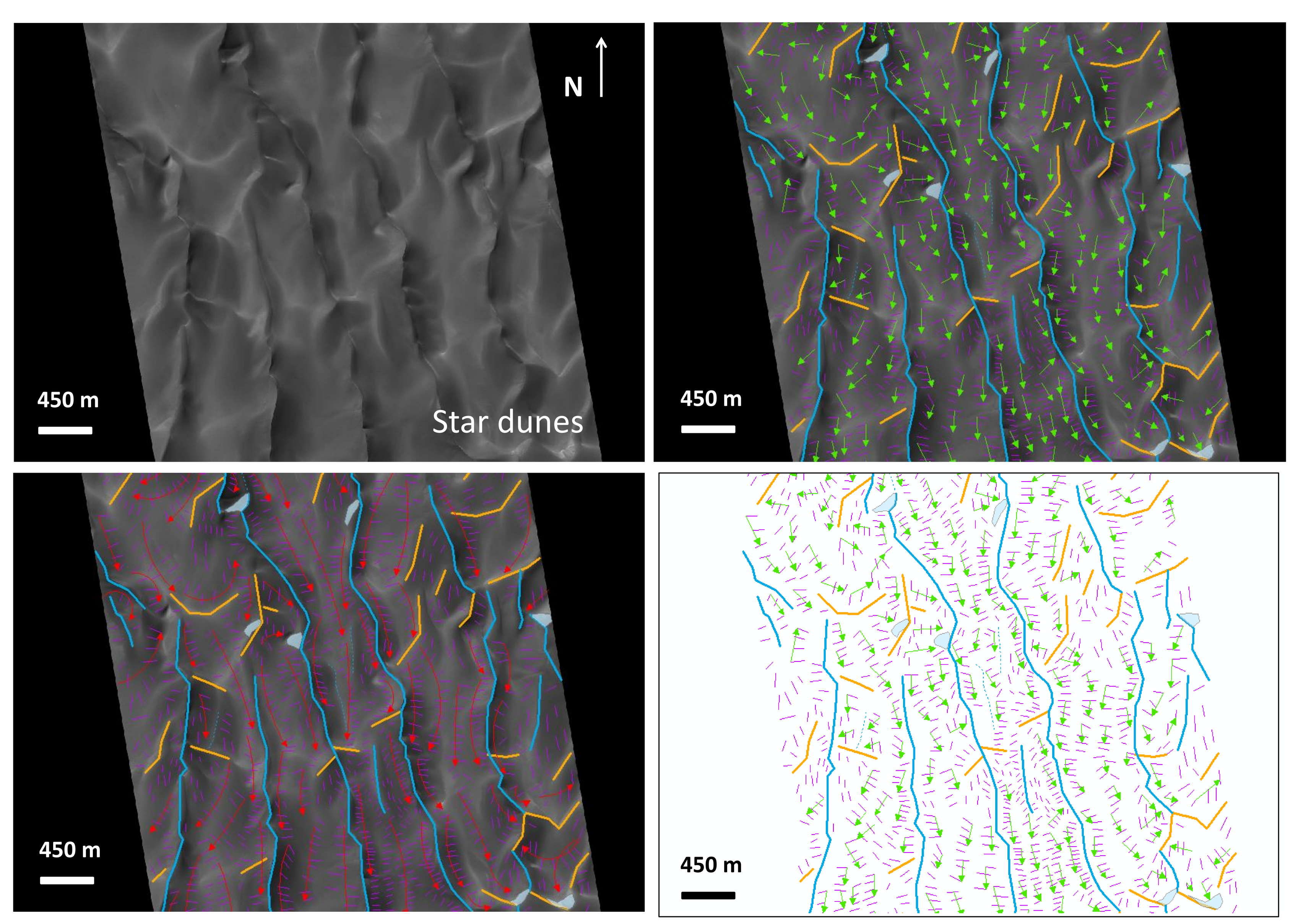
Rose Diagrams



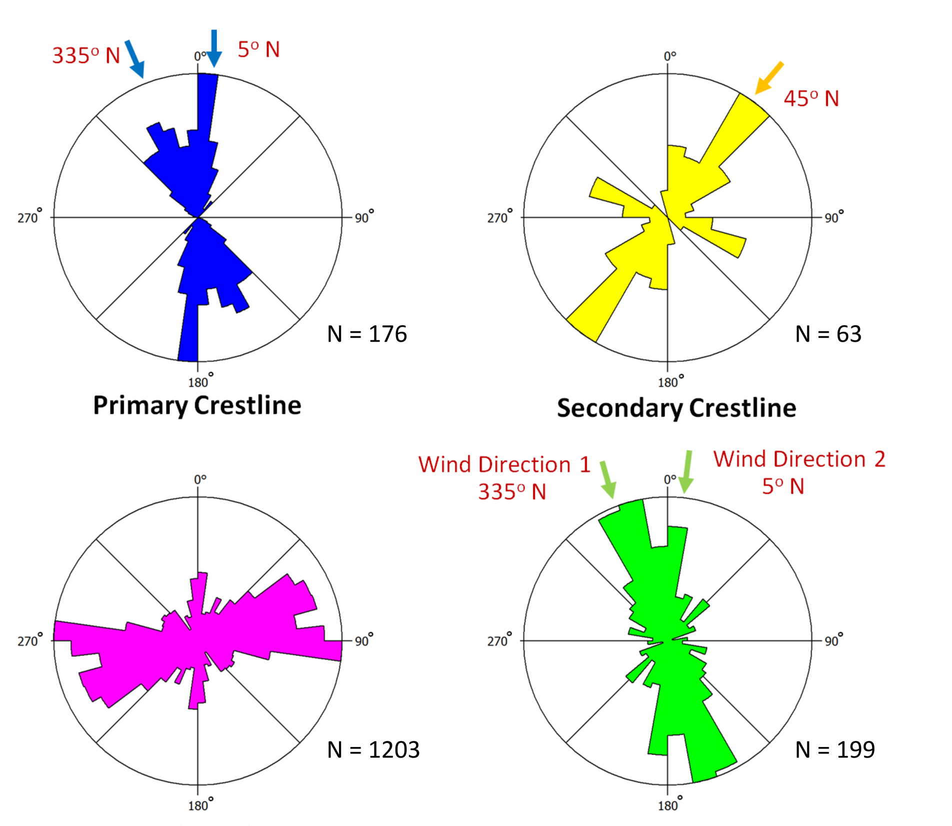
Wind direction 1 is correlated with primary crestline orientation (345° N) and wind direction 2 is correlated with the secondary crestline orientation (45° N).

6. Result -- ESP_024291_1320

Local wind direction: N → S



Rose Diagrams



Wind direction 1 is correlated with primary crestline orientation 1 (335° N) and wind direction 2 is correlated with the primary crestline orientation 2 (5° N).