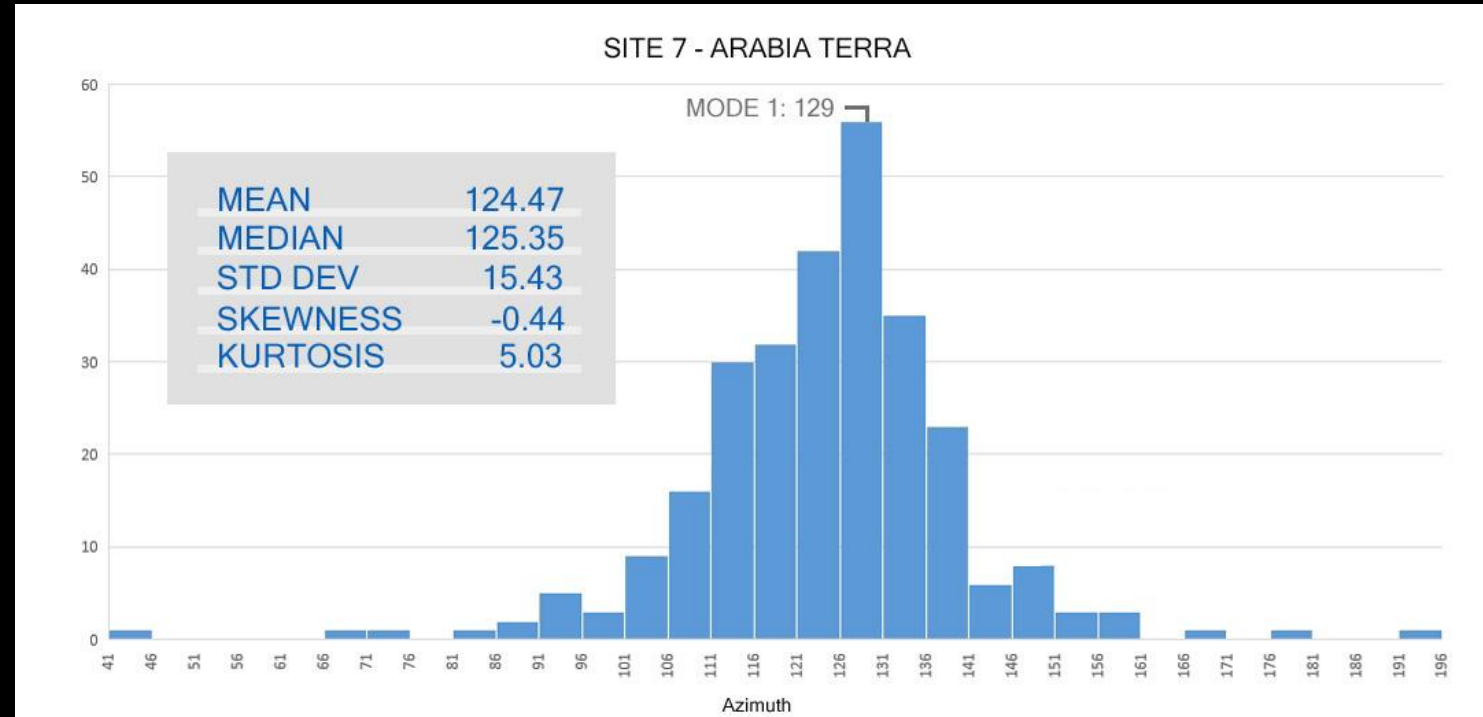
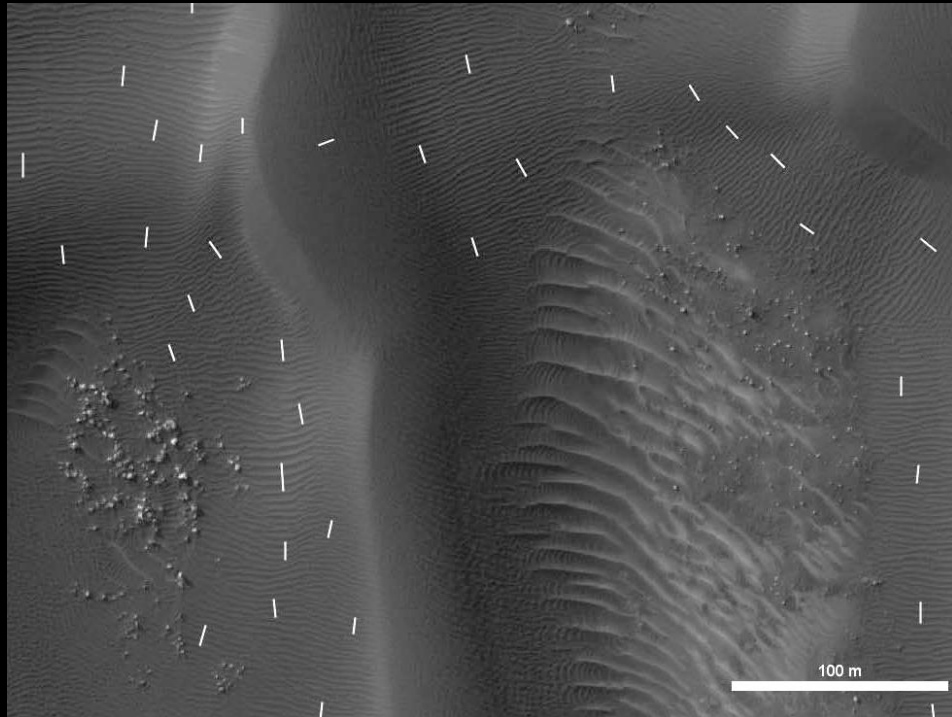


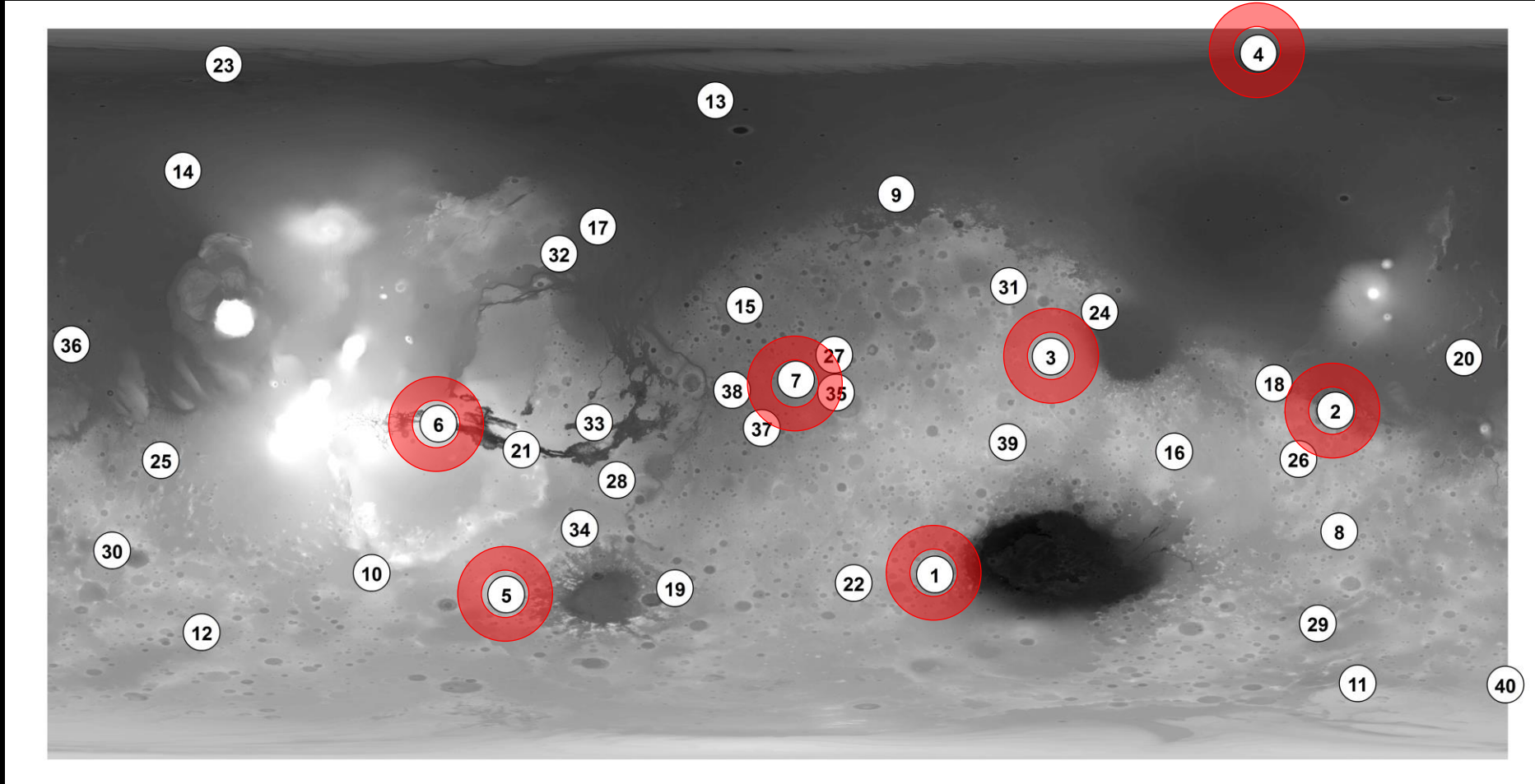
# Ripple Orientations on Martian Dunes

## Document Diverse Wind Flow Patterns

James R. Zimbelman, Molly B. Johnson, Jennifer O'Brien  
Center for Earth and Planetary Studies, National Air and Space Museum  
Smithsonian Institution, Washington, DC 20013-7012



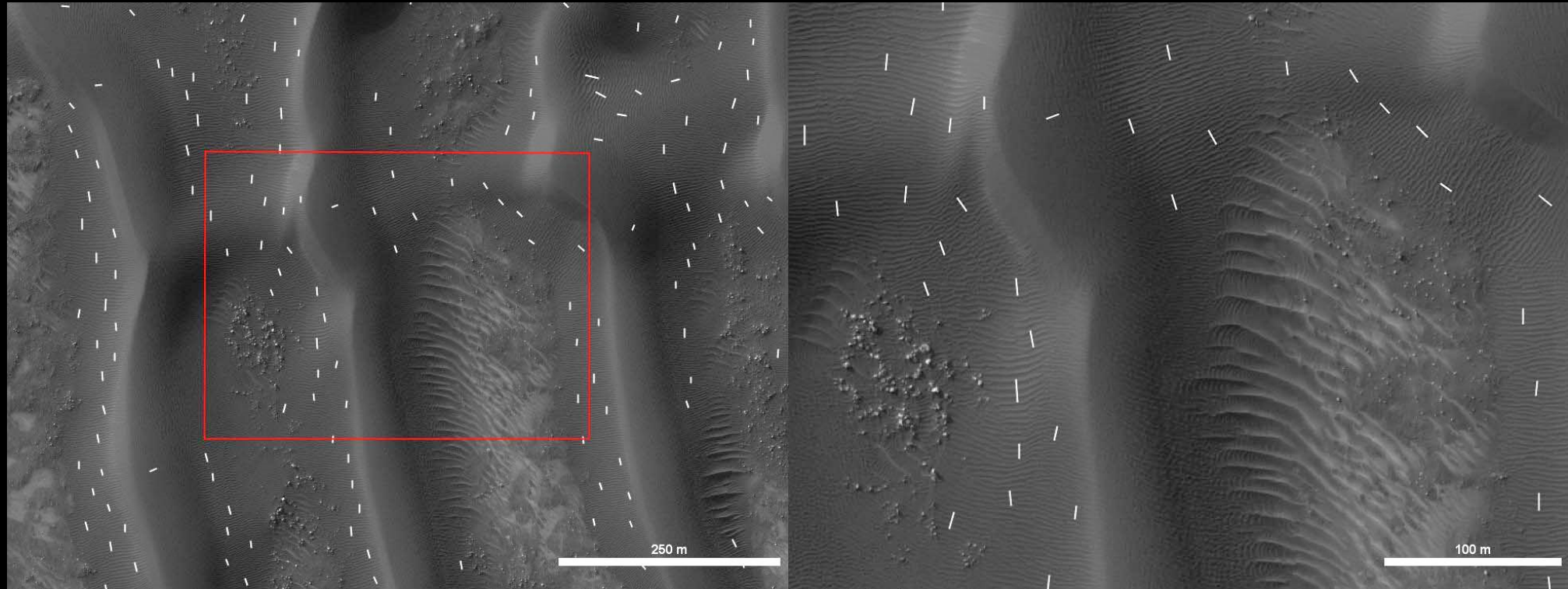
40 study sites were examined; 7 with JMARS, 33 with ArcGIS



Here we present results from the first 7 locations, measured using JMARS software

MDAP grant NNX12AJ38G

# Ripples Mapping Procedure



- Only Small Dunes (small or no slip face)
- Avoid places with superposed ripples
- Avoid places near slip face, if present
- Draw line perpendicular to crest, (crests of three adjacent ripples)

# Statistical 'Moments' of a Distribution

“Moments are the sums of the integer powers of the values”

**Mean** – First moment; value around which clustering occurs

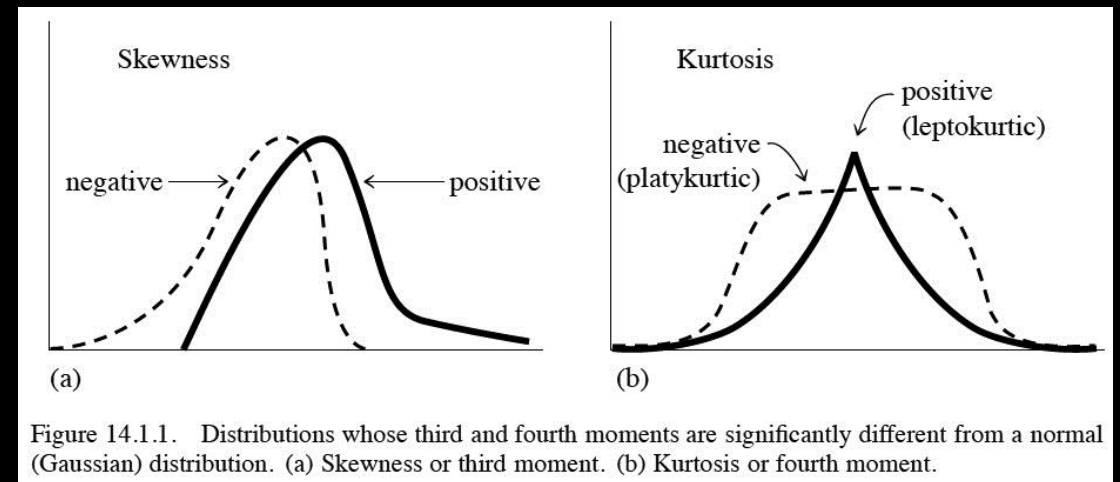
**Variance** – Second moment; ‘width’ or ‘variability’ around mean  
(Standard Deviation is square root of the variance)

**Skewness** – Third moment; degree of asymmetry around mean

**Kurtosis** – Fourth moment; ‘peakedness’ or ‘flatness’ relative to a normal (Gaussian) distribution ( $K=3$ )

**Median** – value for which larger and smaller values are equally probable

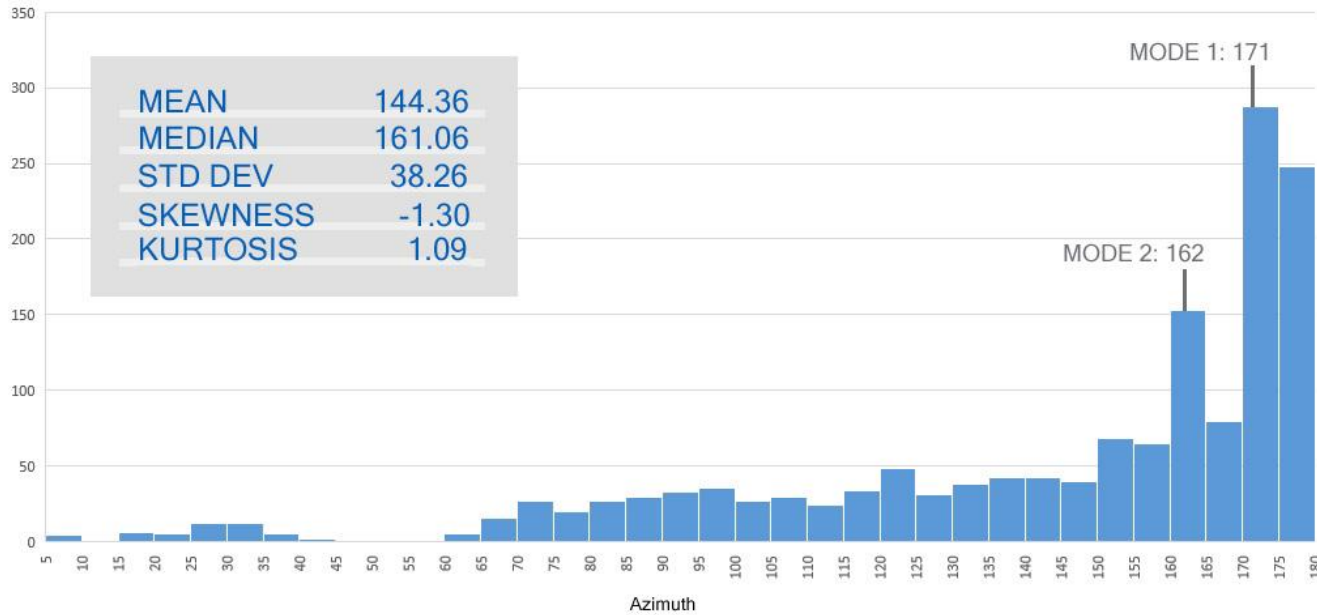
**Mode** – value where distribution is a maximum





# 1 – Hellespontes

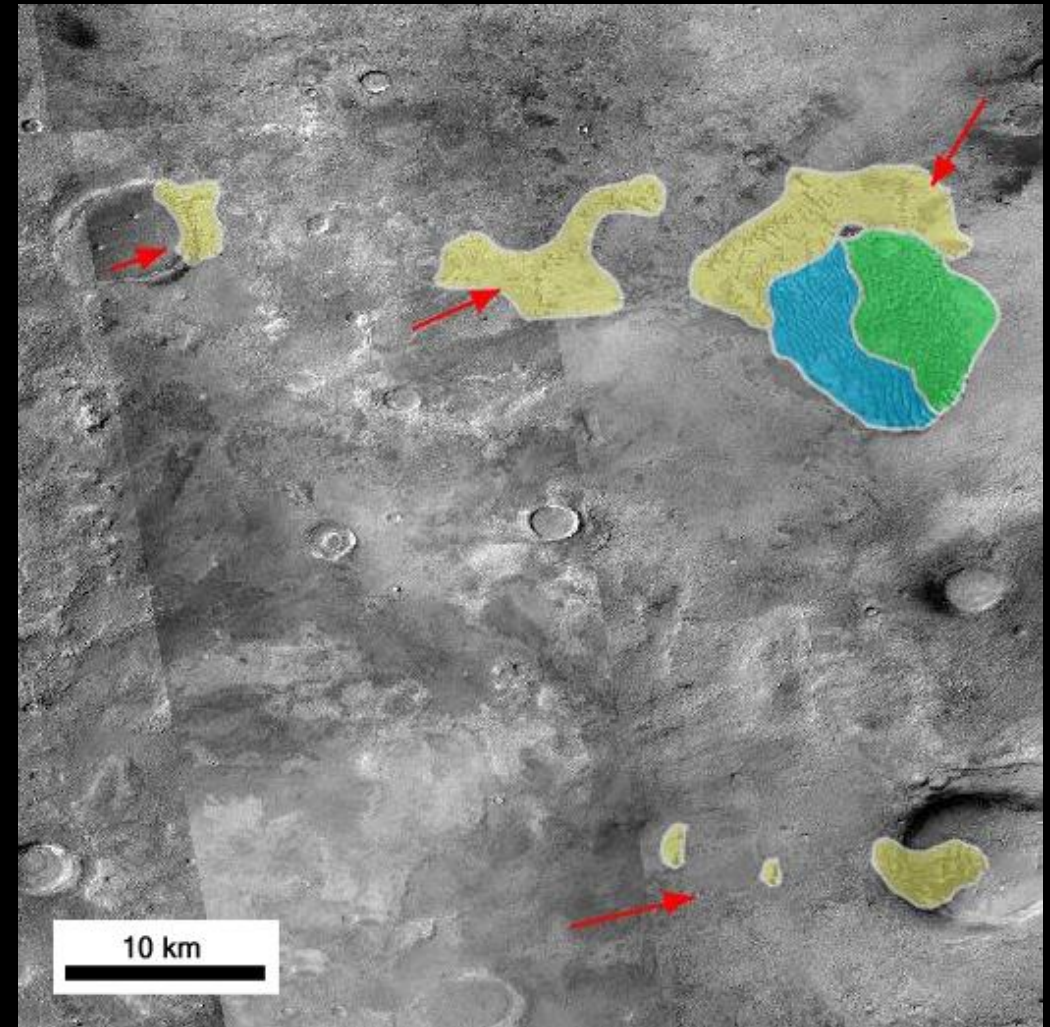
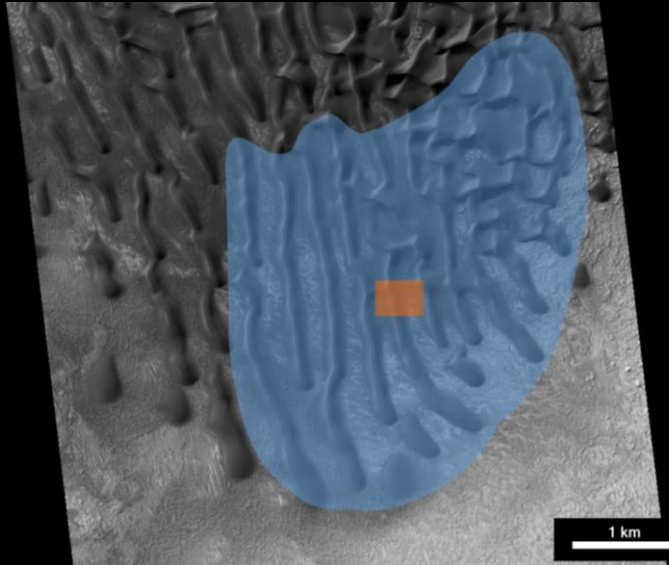
SITE 1 - HELLESPONTES



n = 1493

Weak bimodal, with  
pronounced wing

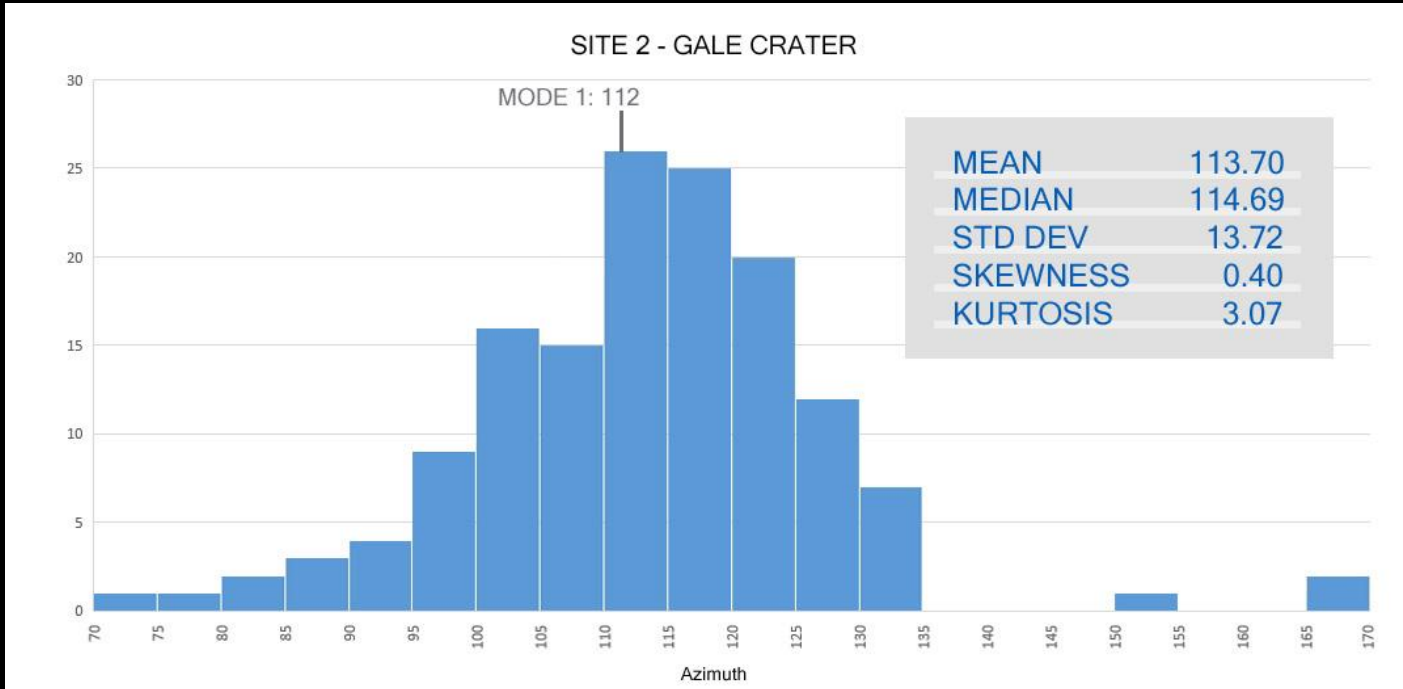
Longitudinal,  
(transverse)



Regional map by Y. Ku (CTX images)

HiRISE frame PSP\_007633\_1350, 44.86 S, 38.80 E

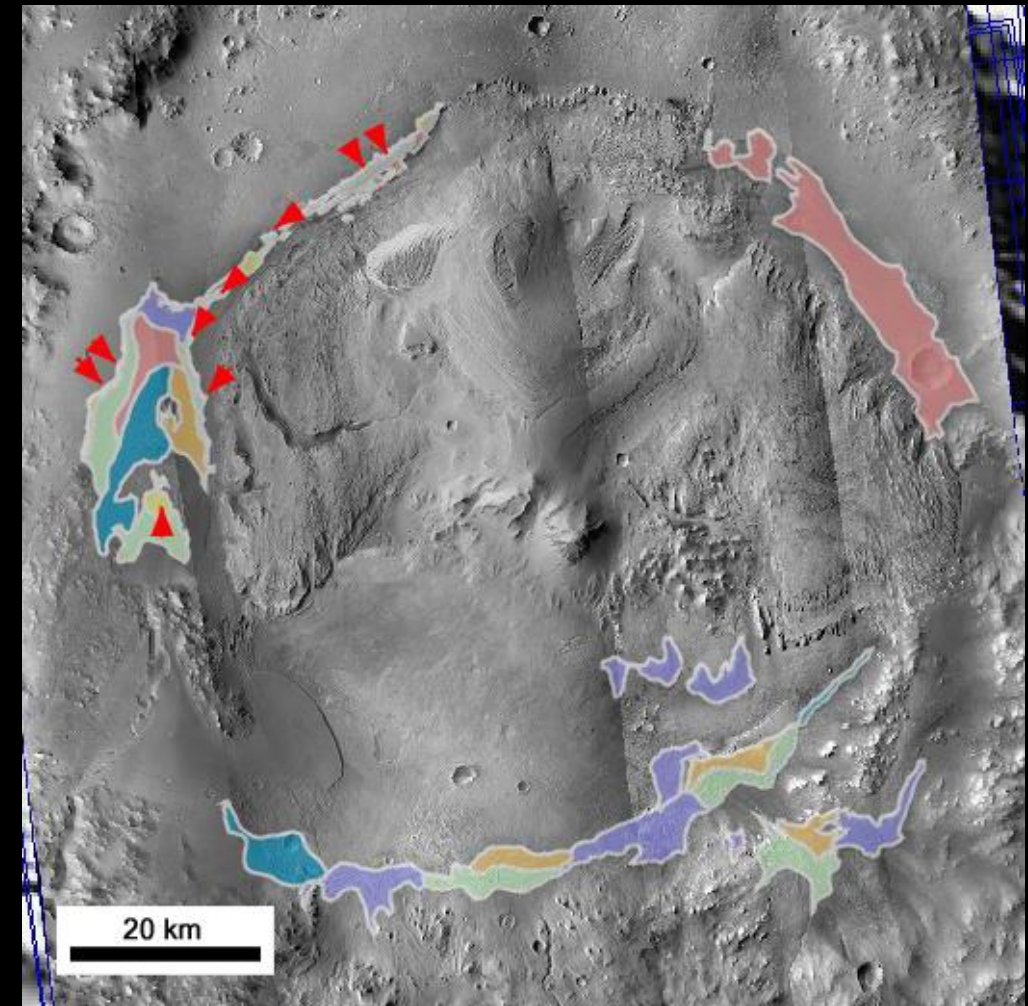
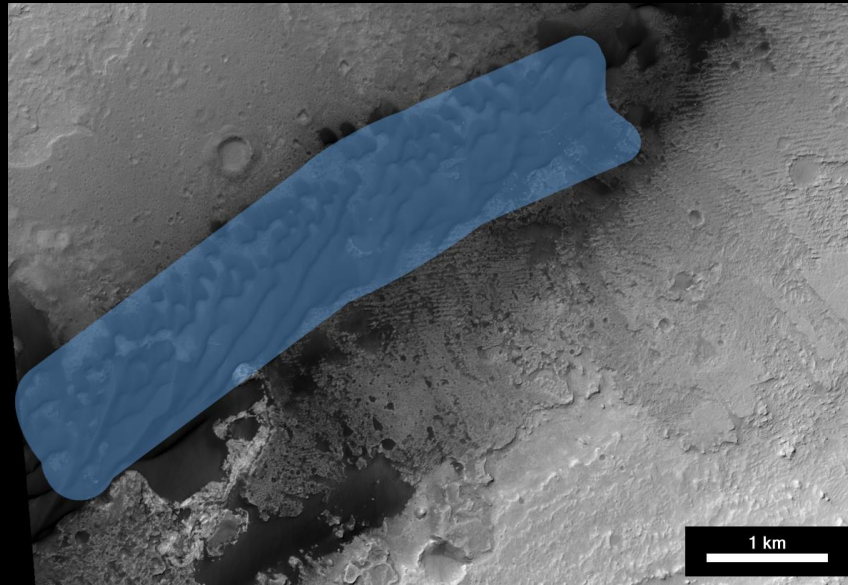
# 2 - Gale Crater



n = 144

Unimodal

Longitudinal,  
barchanoid

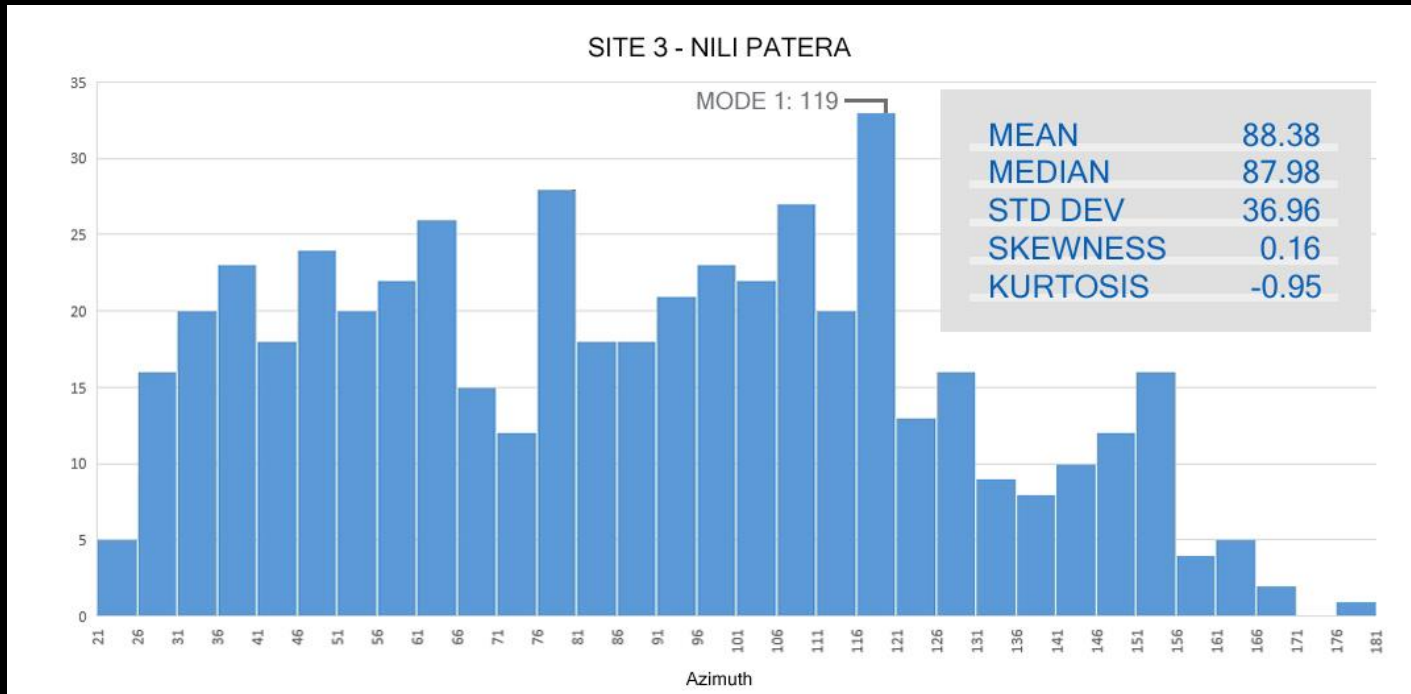


Regional map by Y. Ku (CTX images)

HiRISE frame PSP\_009571\_1755, 4.46 S, 137.50 E



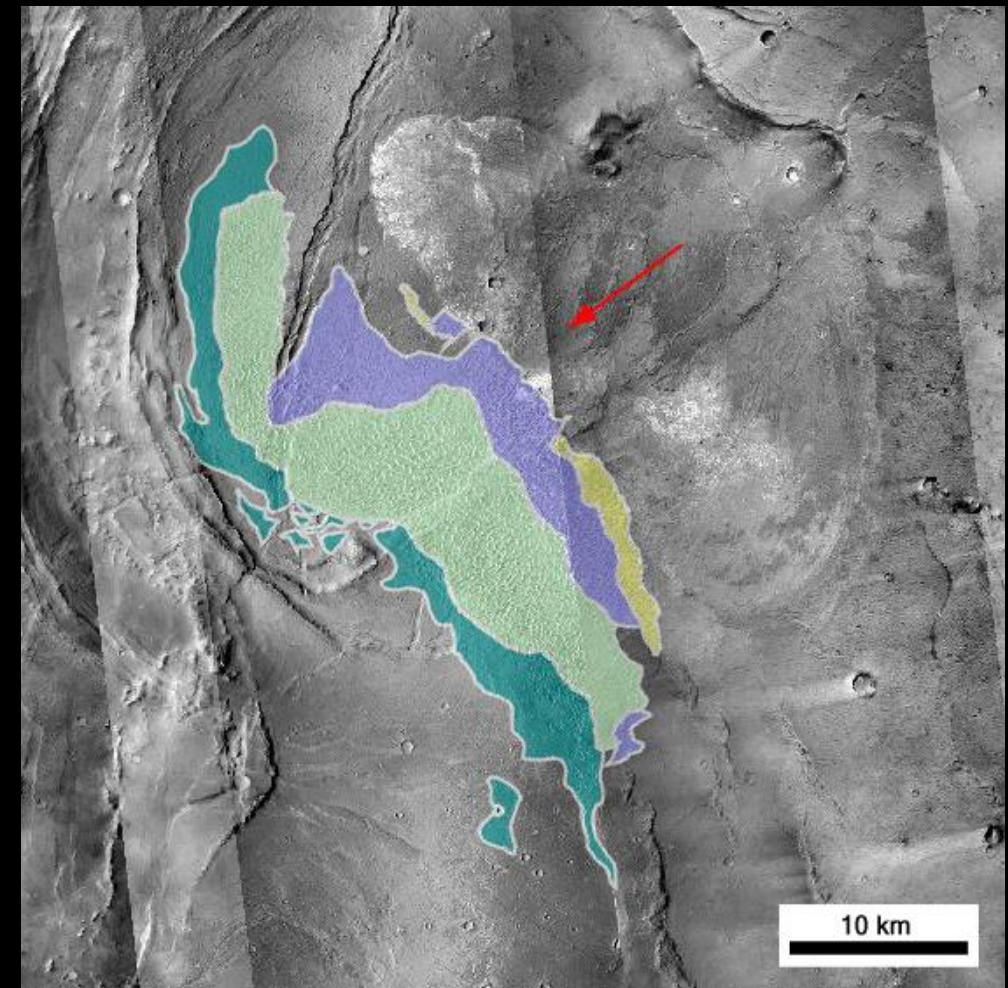
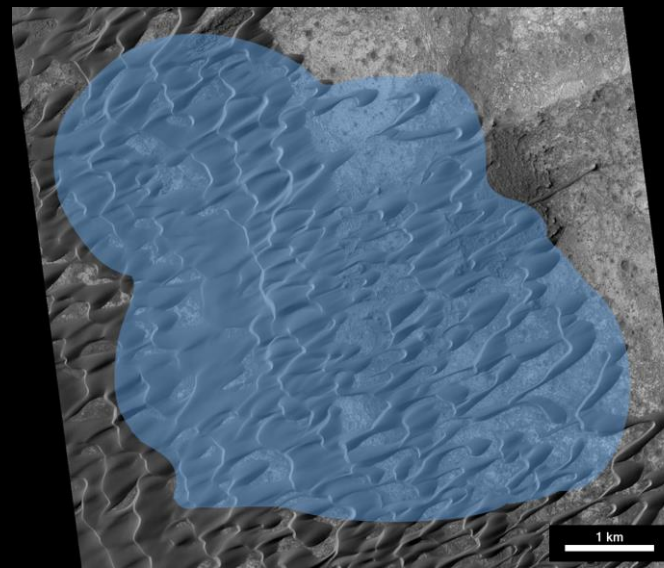
# 3 - Nili Patera



n = 507

Non-modal,  
(nearly random)

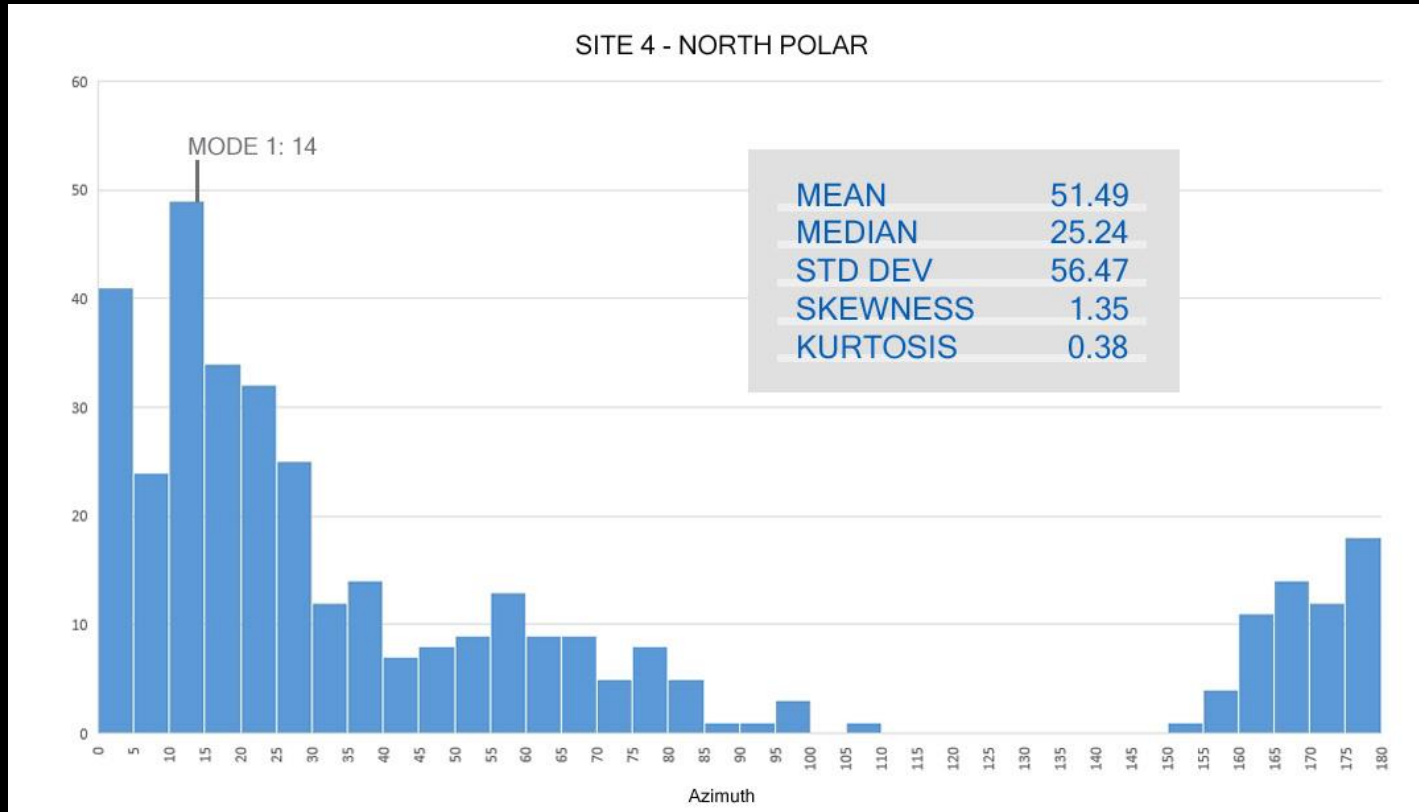
Barchan,  
barchanoid ridge



Regional map by Y. Ku (CTX images)

HiRISE frame PSP\_017762\_1890, 8.78 N, 67.32 E

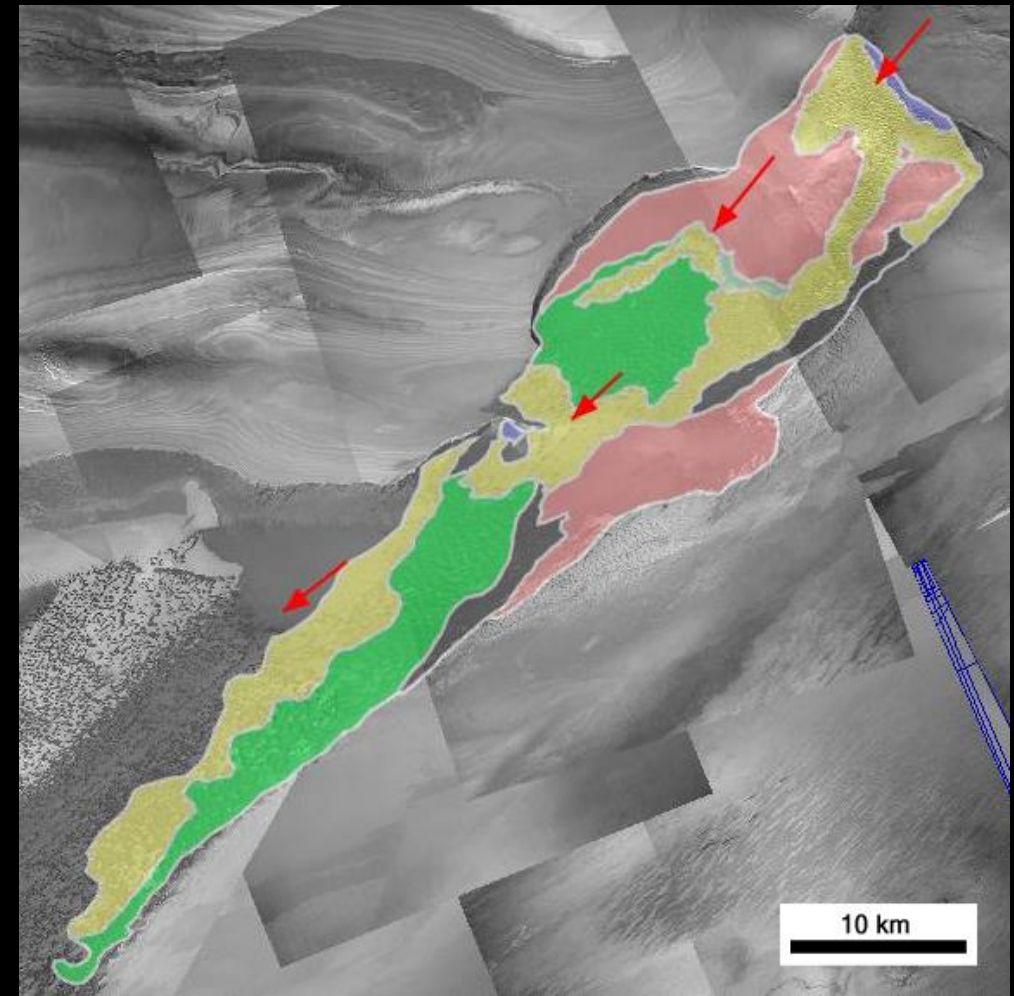
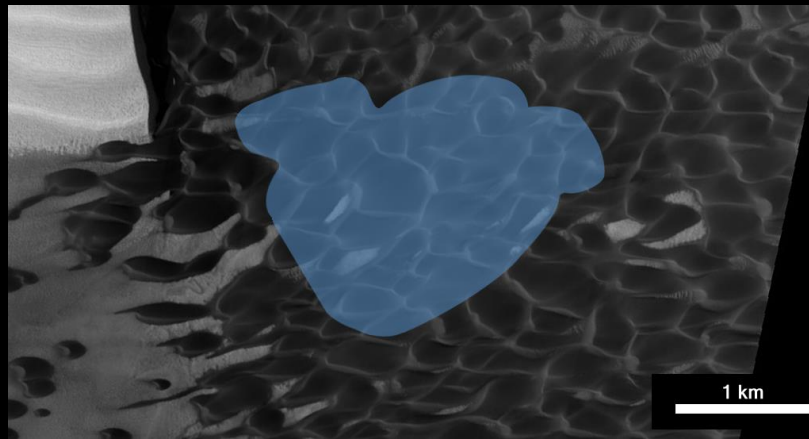
# 4 - North Polar Erg



n = 370

Unimodal,  
with wing

Barchanoid

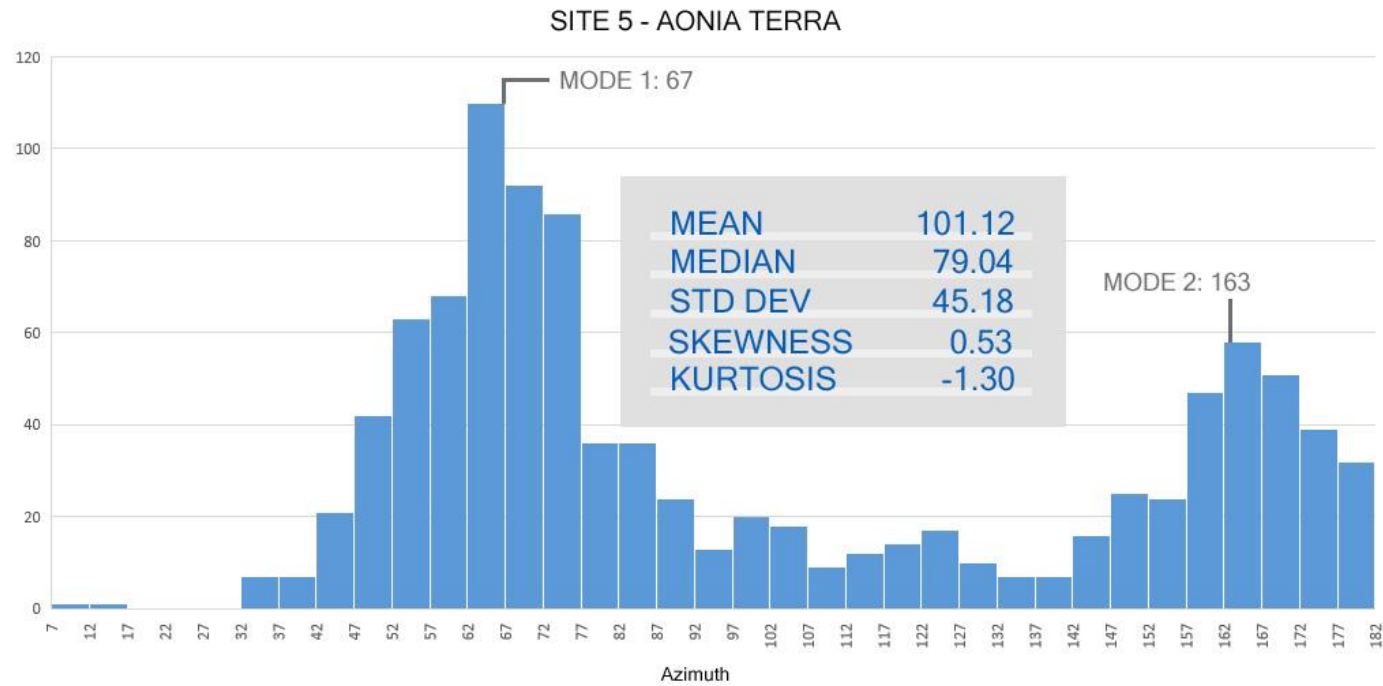


Regional map by Y. Ku (CTX images)

HiRISE frame PSP\_010019\_2635, 83.51 N, 118.54 E



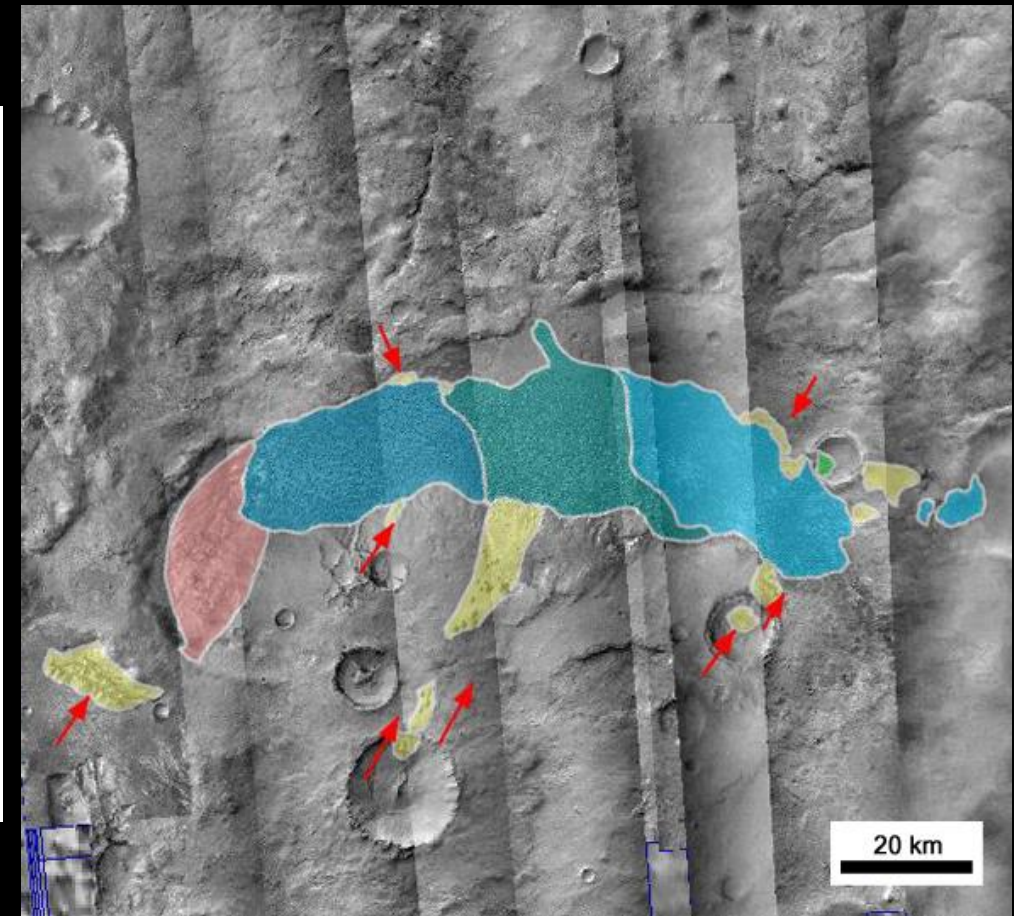
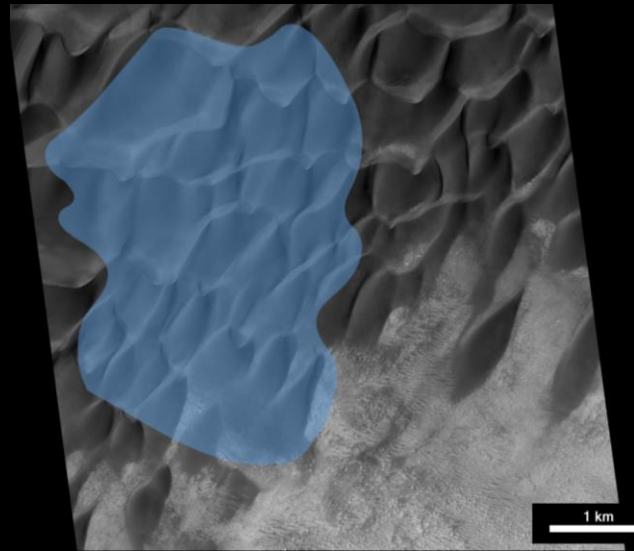
# 5 - Aonia Terra



n = 1112

Bimodal, with  
wing

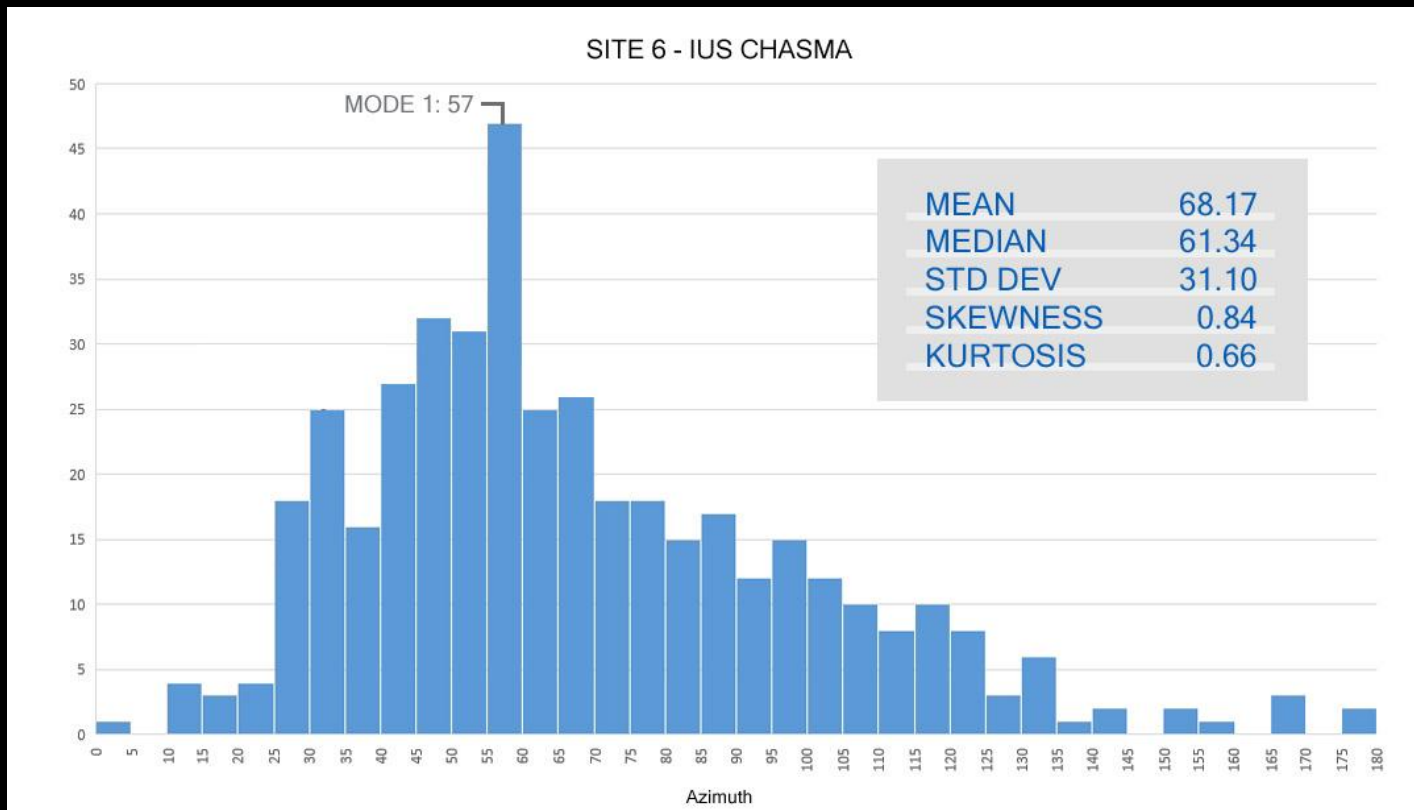
Transverse



Regional map by Y. Ku (CTX images)

HiRISE frame ESP\_013785\_1300, 49.80 S, 293.10 E

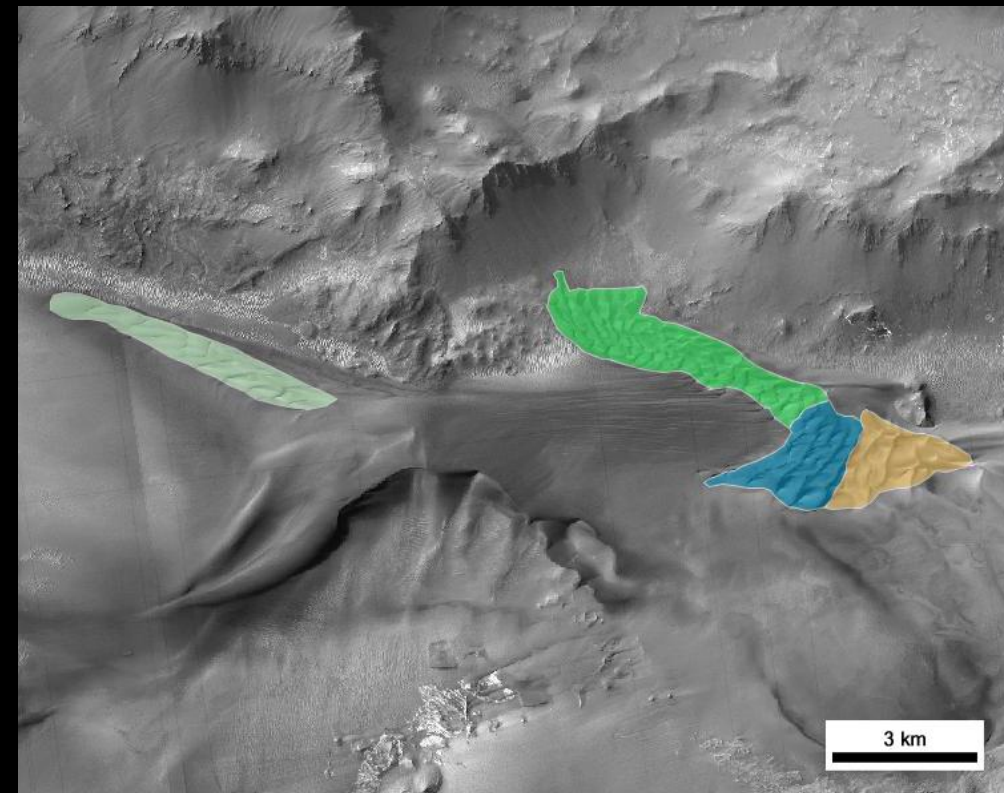
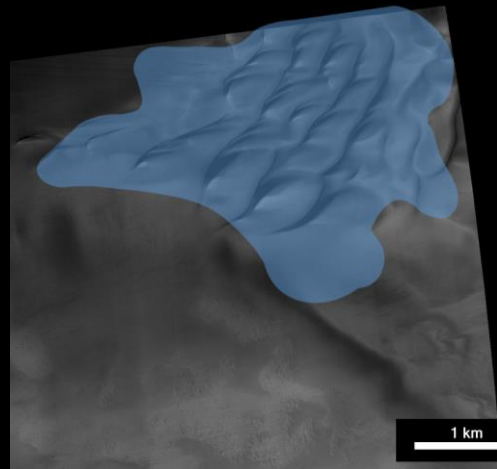
# 6 - Ius Chasma



n = 422

Unimodal, with  
pronounced wing

Transverse ridge

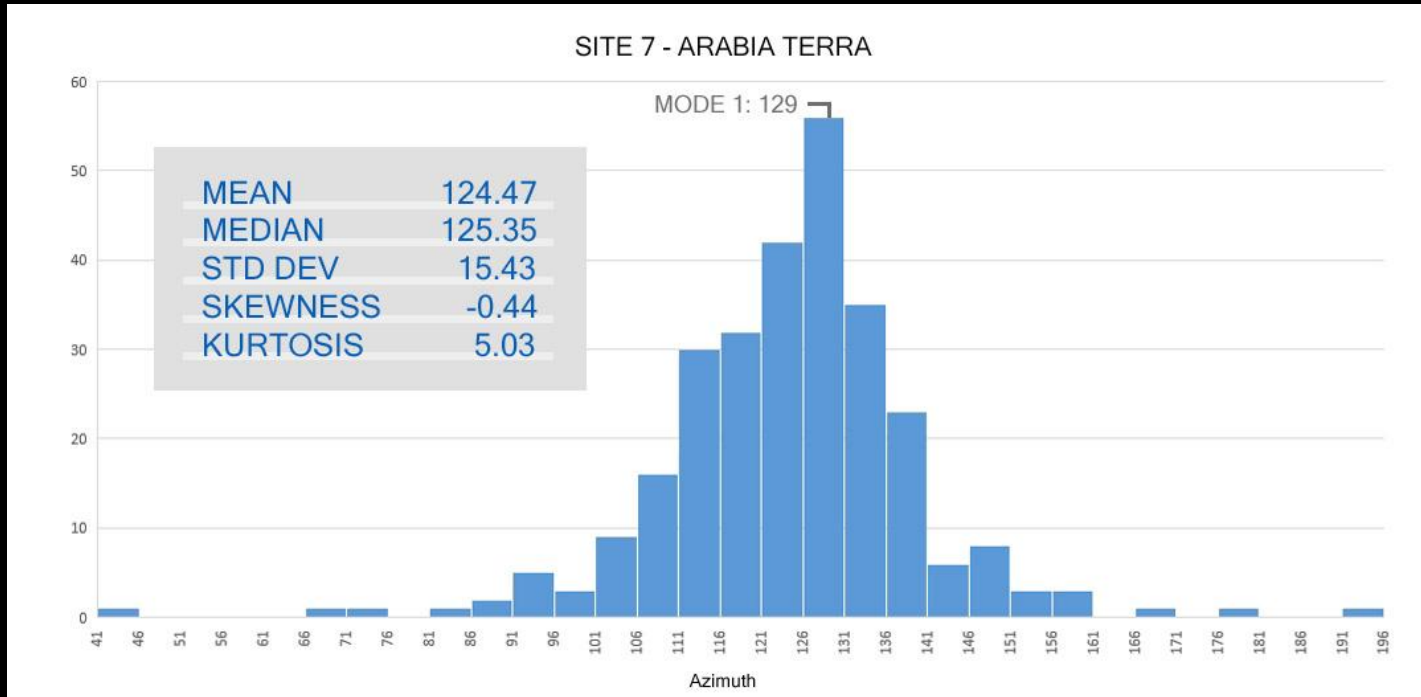


Regional map by Y. Ku (CTX images)

HiRISE frame ESP\_027341\_1720, 7.72 S, 276.39 E



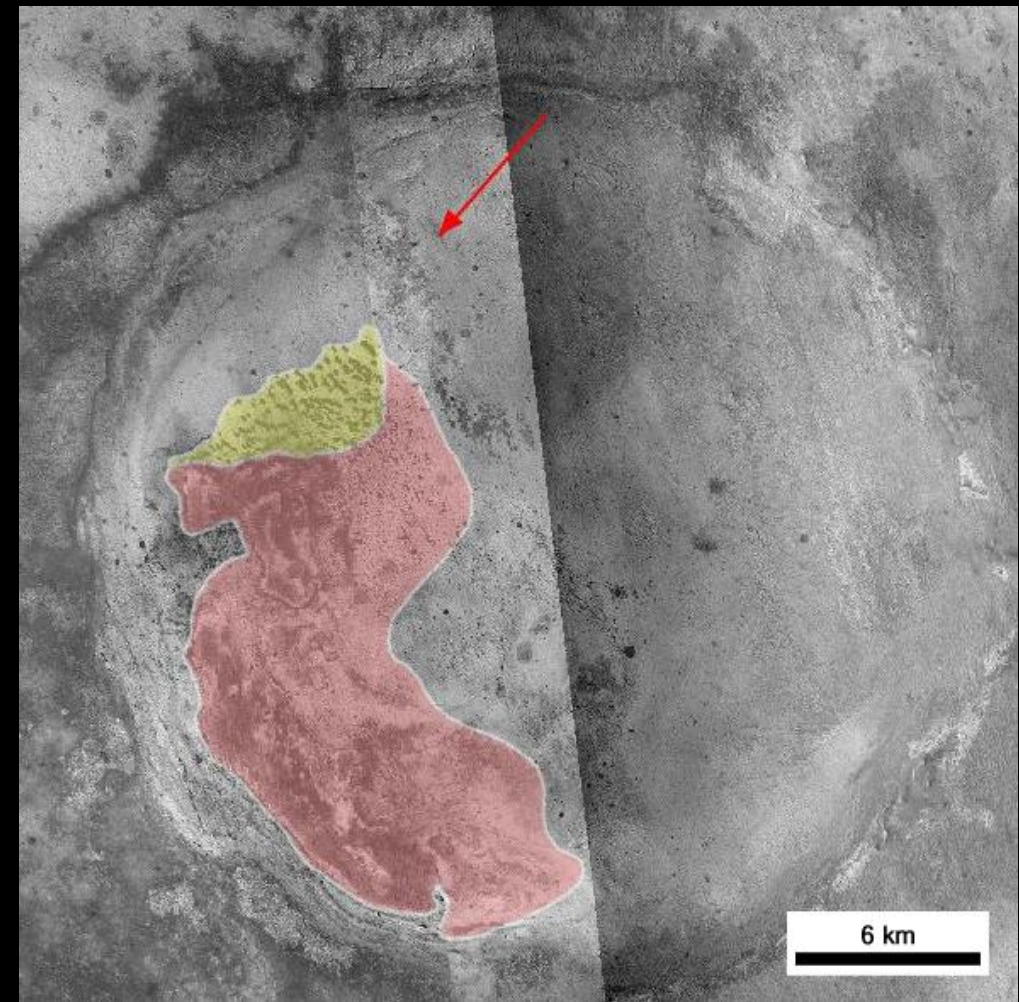
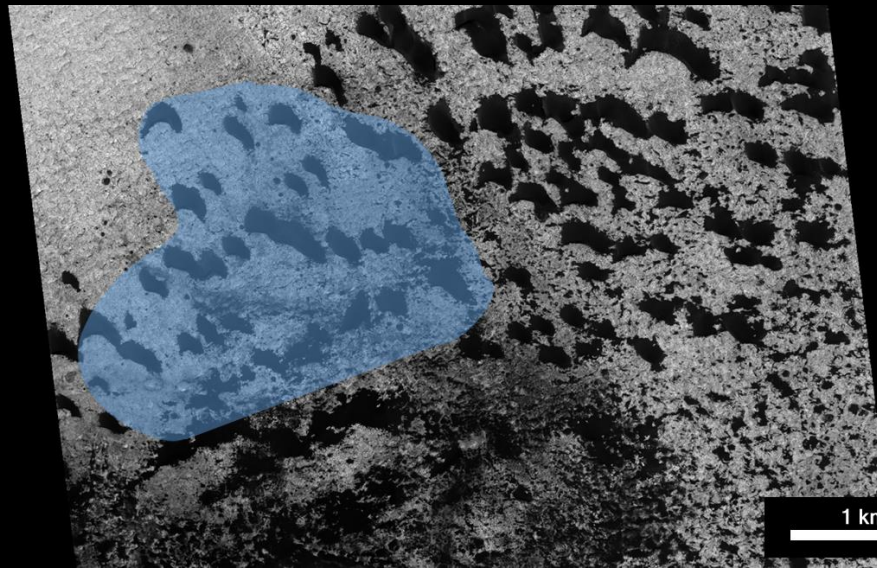
# 7 - Arabia Terra



n = 279

Unimodal, with  
wings

Barchan



Regional map by Y. Ku (CTX images)

HiRISE frame ESP\_016459\_1830, 3.12 N, 4.55 E

# Conclusions

Three 'classes' of ripple orientation:  
unimodal, bimodal, and 'random'

No association with regional setting,  
elevation, dune type

Dune surface slope direction may be  
a factor in orienting surface wind