

Lunar & Planetary Laboratory



Using the Rock Shadow Counter (ROSCO) to Determine Size Frequency Distributions of Boulders On Martian Ice Sheets

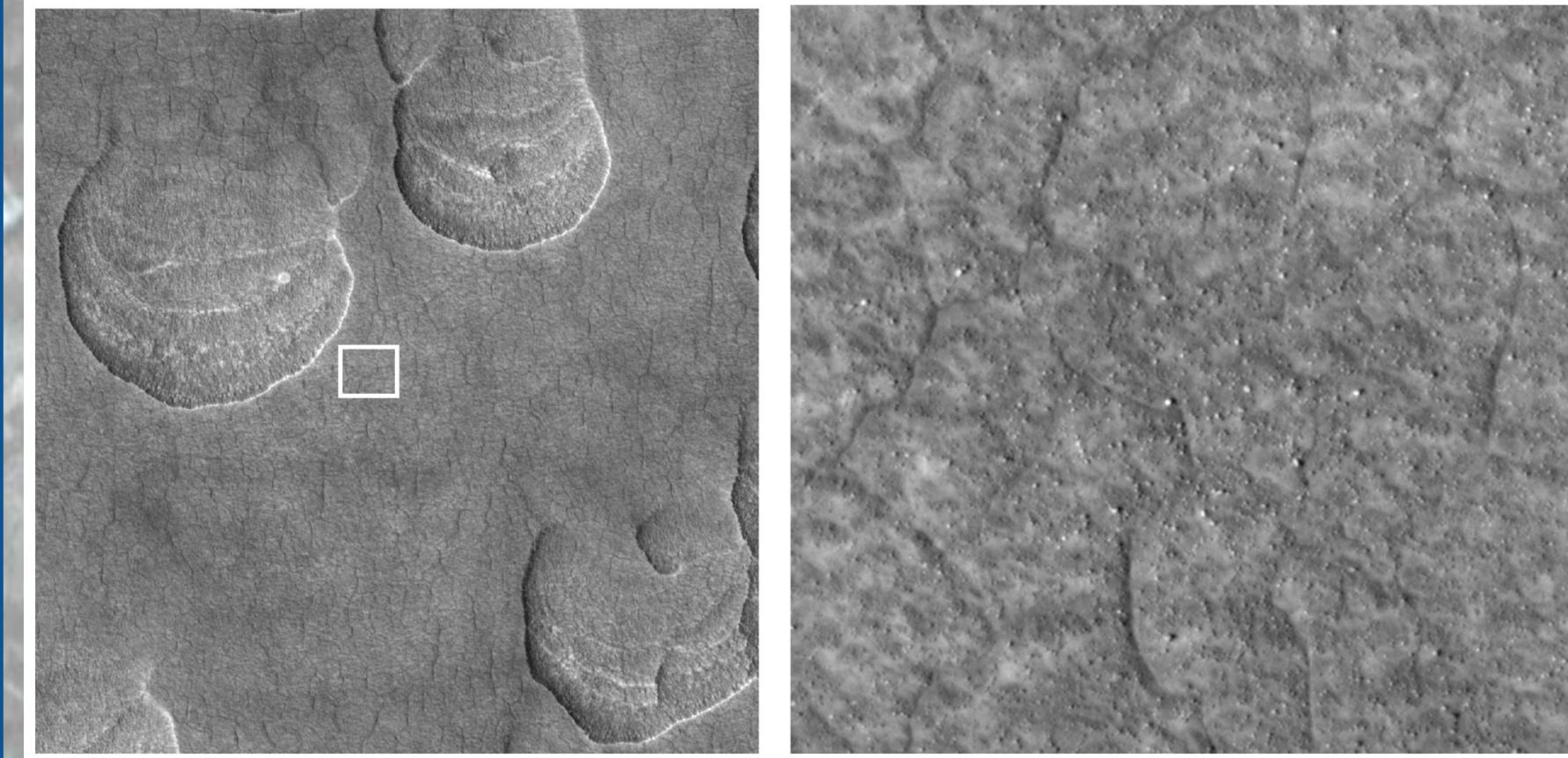
USGS
science for a changing worldC. Singh¹, S. Byrne¹, M. P. Golombek², M. R. Trautman², C. M. Dundas³, N. R. Williams²¹Lunar and Planetary Laboratory, The University of Arizona. ²Jet Propulsion Laboratory, California Institute of Technology. ³U.S. Geological Survey

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By quantifying the size frequency distributions of boulders on ice sheets and around craters, we can understand the origin of boulder emplacement, which can inform us about the climate and habitability of Mars over time.

Boulders On Ice Sheets

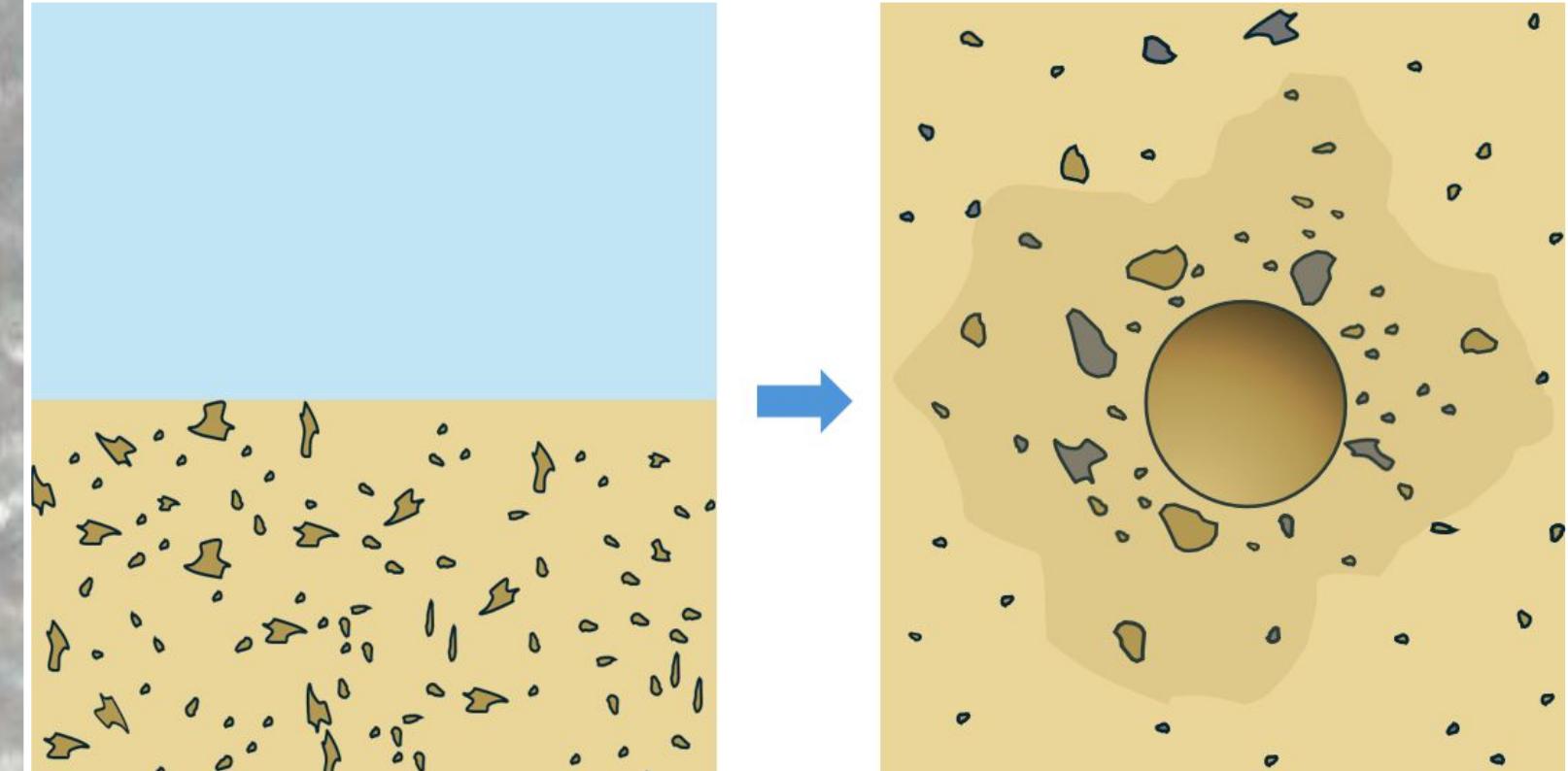
- Numerous lines of evidence show thick (decameters) sheets of regolith-covered ice exist in the martian mid-latitudes [1]



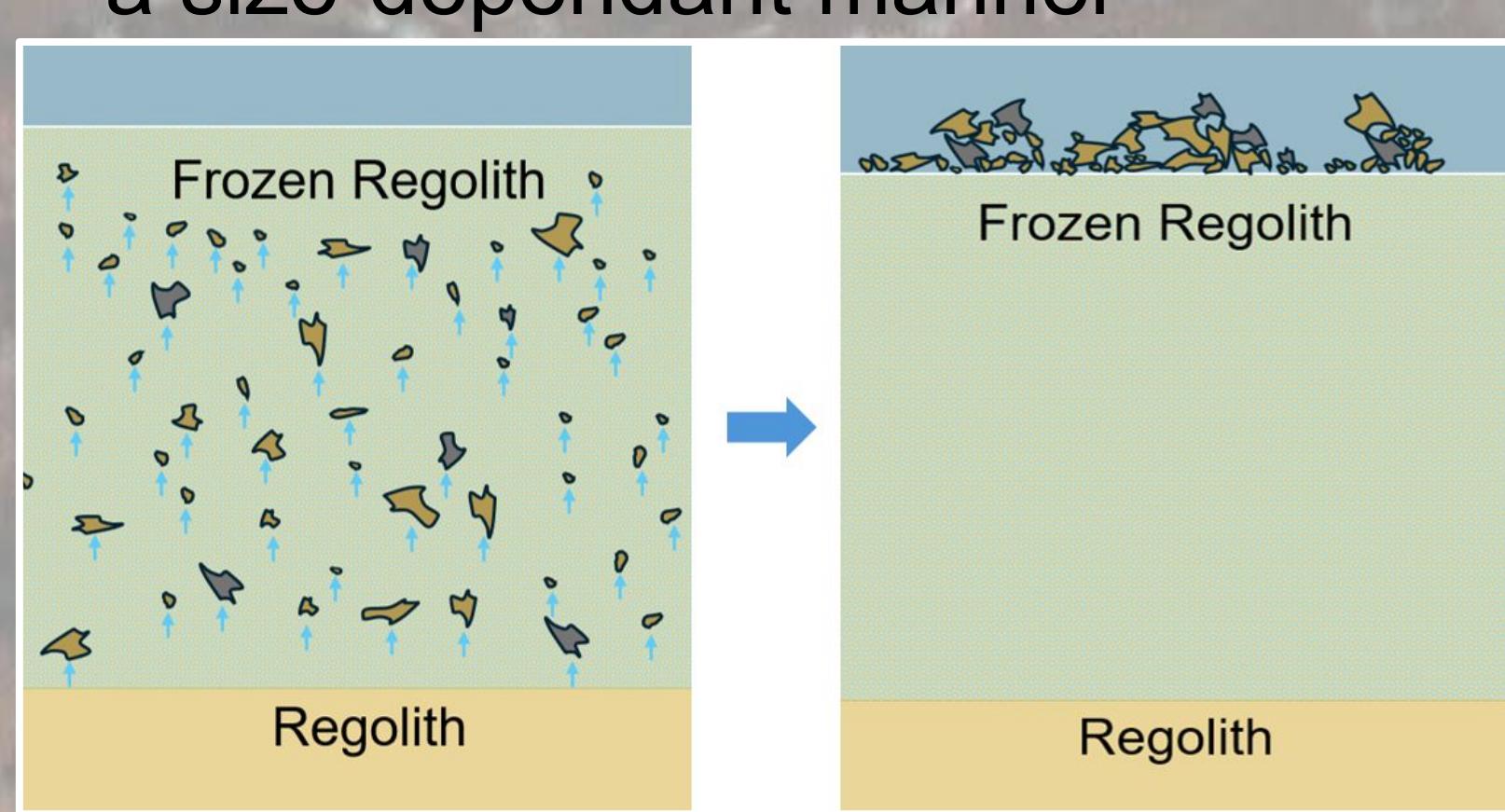
Portion of HiRISE image ESP_036802_2265. Left panel shows Utopia Planitia scallop features interpreted as sublimation thermokarst landforms in an area that radar data show to have thick excess ice [16]. In the thermokarst model, the uncollapsed area between scallops must still have excess ice present. White box (~150m across) shows location of right panel where abundant meter-scale boulders are visible.

- Boulders are commonly observed on these surfaces; several hypotheses exist to explain their presence e.g.

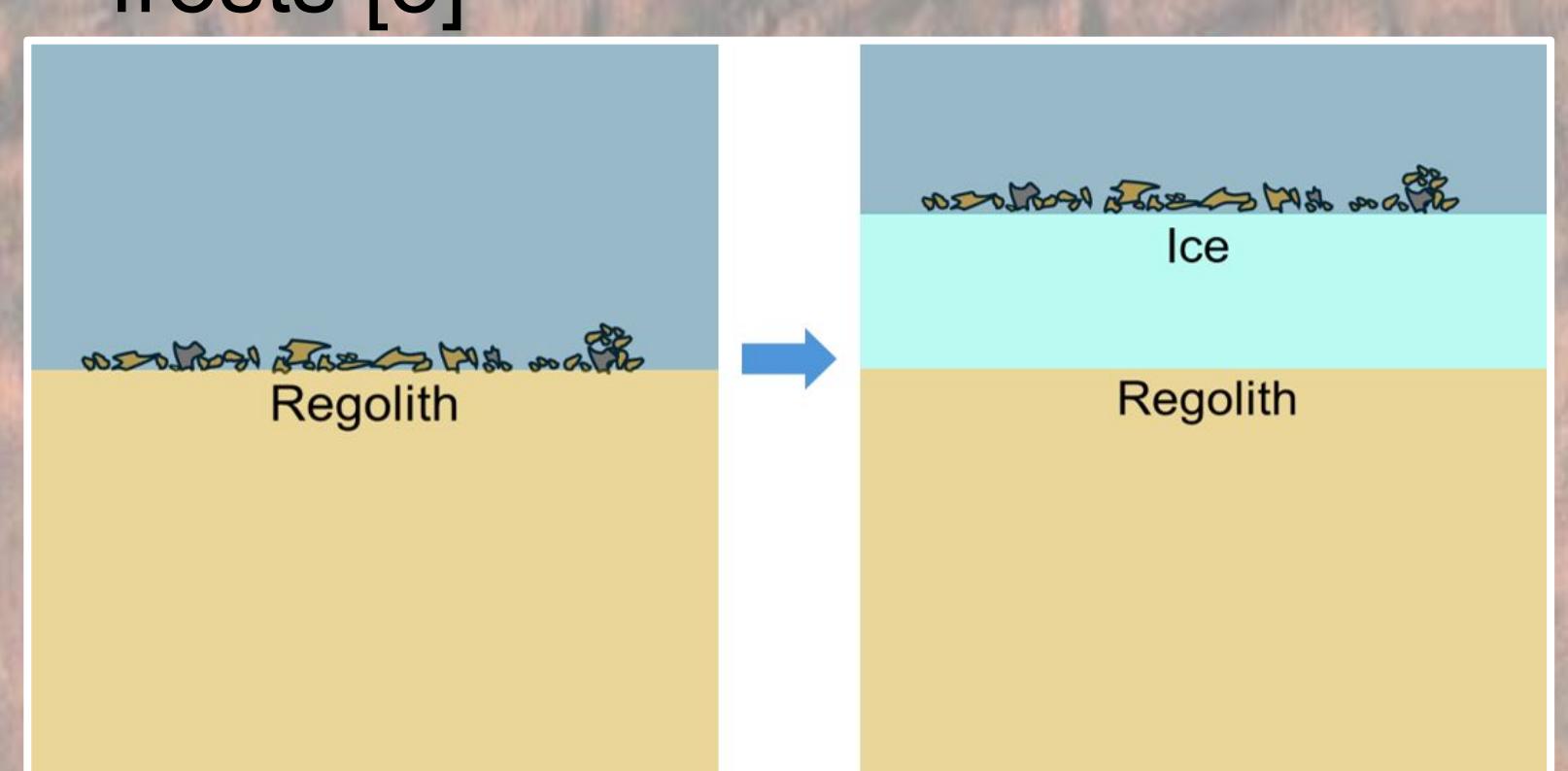
1. Boulders are excavated by impacts and accumulate on the ice over time



2. Periglacial processes [2] create ice lenses that uplift boulders, perhaps in a size-dependant manner



3. Boulders are locked at the surface of an accumulating ice layer by seasonal frosts [3]



- Boulder population statistics can be used to distinguish between these emplacement mechanisms. These data are collectable using semi-automated tools such as ROSCO [4,5,6]

ROSCO Overview

Current Workflow

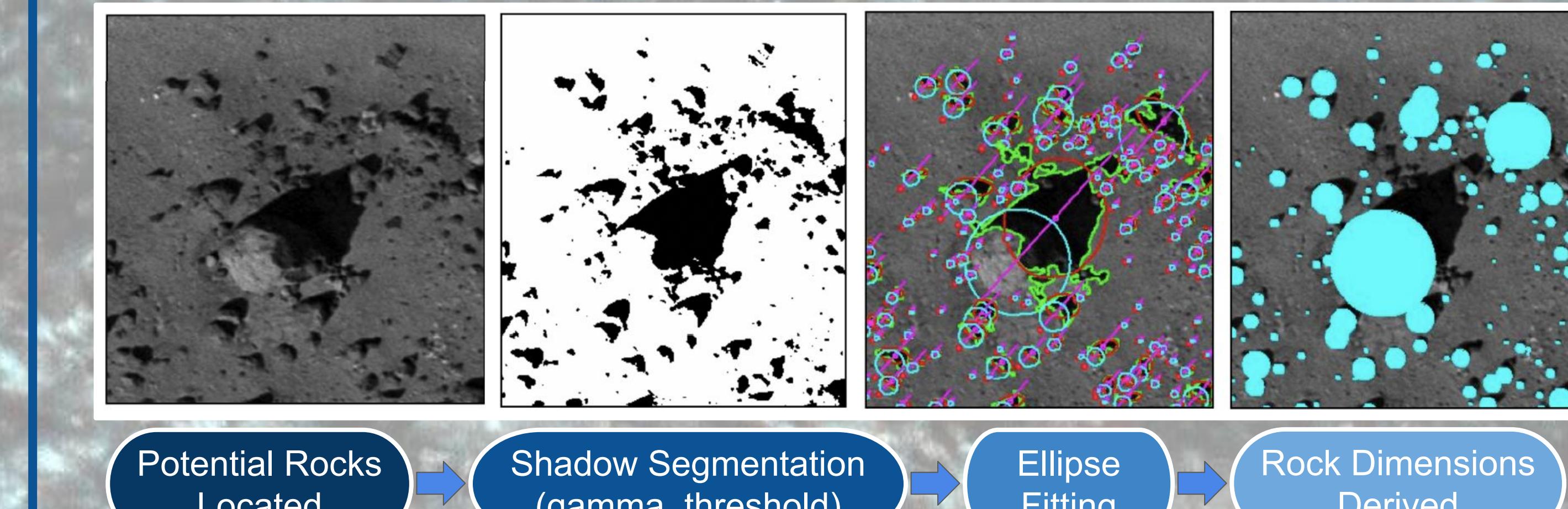
- Image Preparation
 - Sharpening (MATLAB)
 - Grid generation (Python)
 - Select grid tiles to run, visit, and group (GIS)



- Rock Detection
 - Input parameters (GSD, incidence angle, sub-solar azimuth)
 - Manual Tuning (gamma, override threshold)
 - Shadow Segmentation
 - Ellipse fitting
 - Save detections as .txt

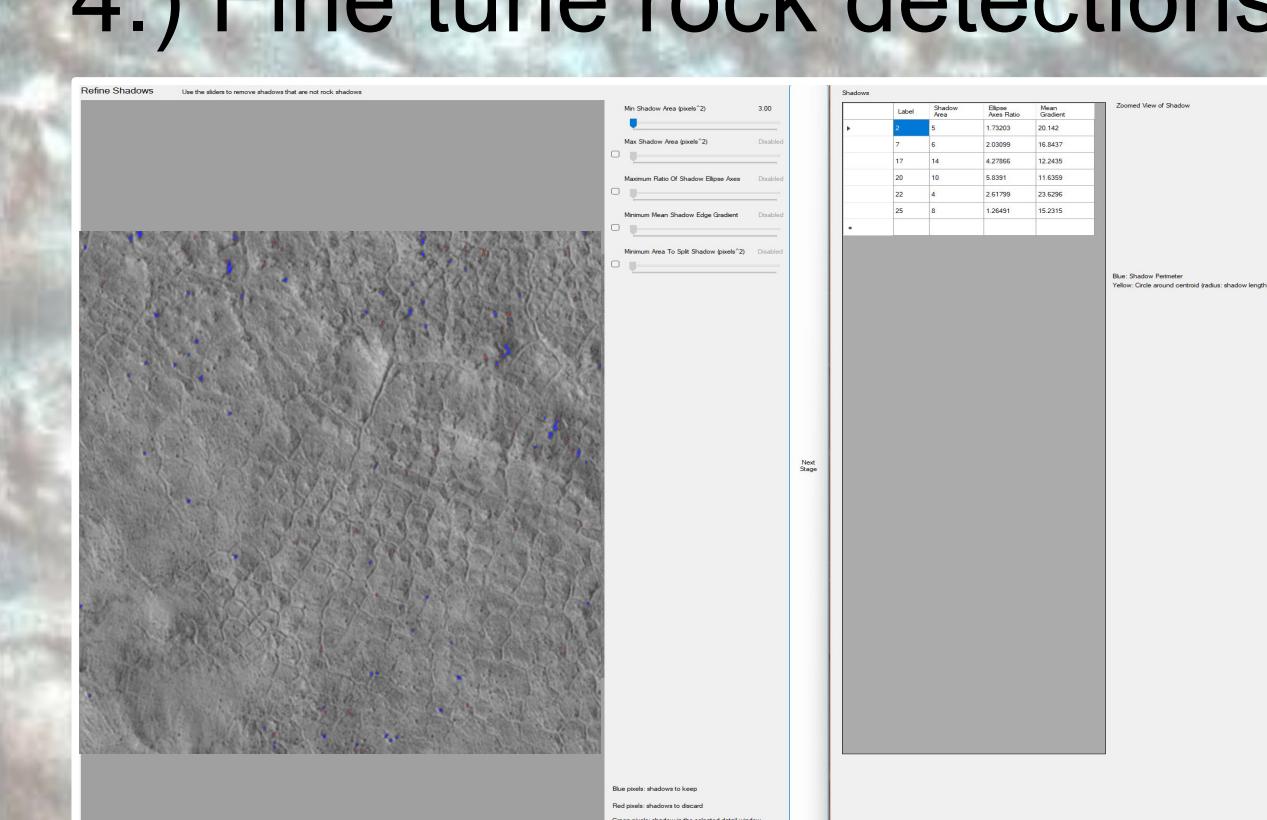
- Results
 - Convert .txt to .shp (Python)
 - Display in GIS
 - Create CFA plot (Python)

Rock Identification

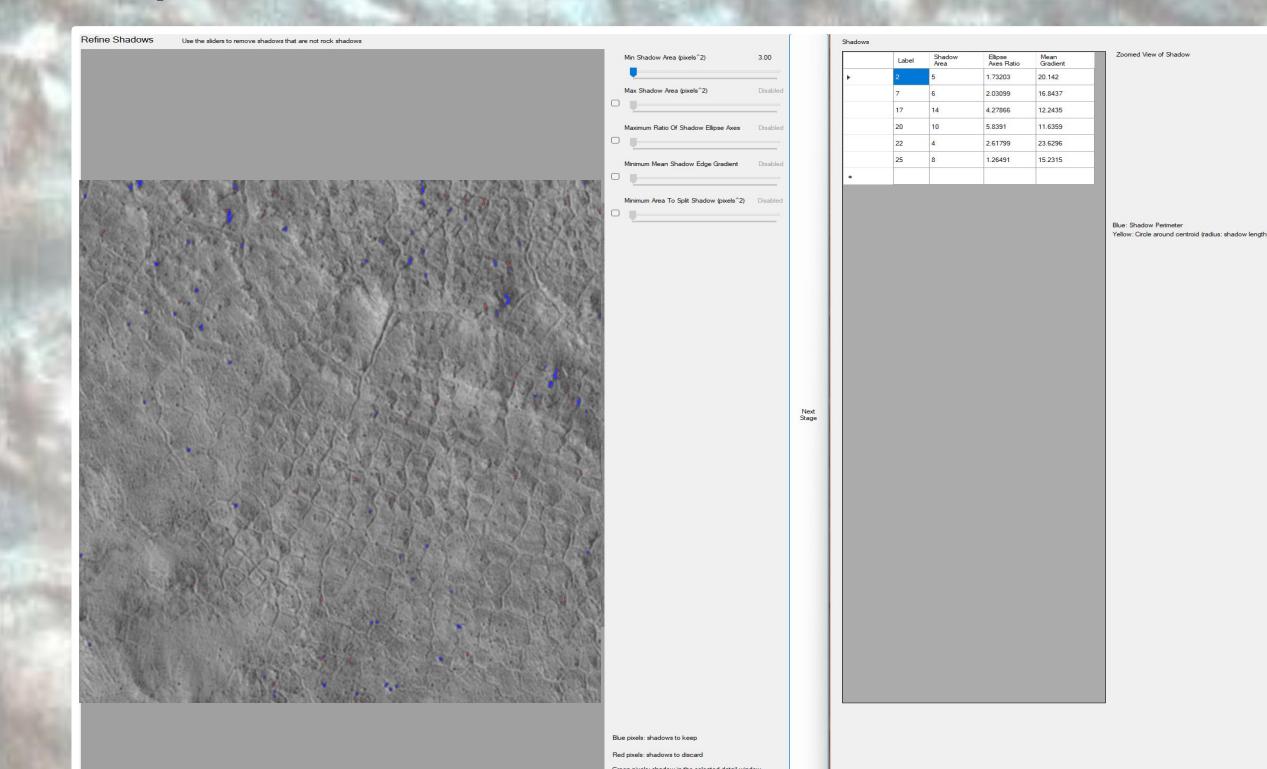


ROSCO Interface

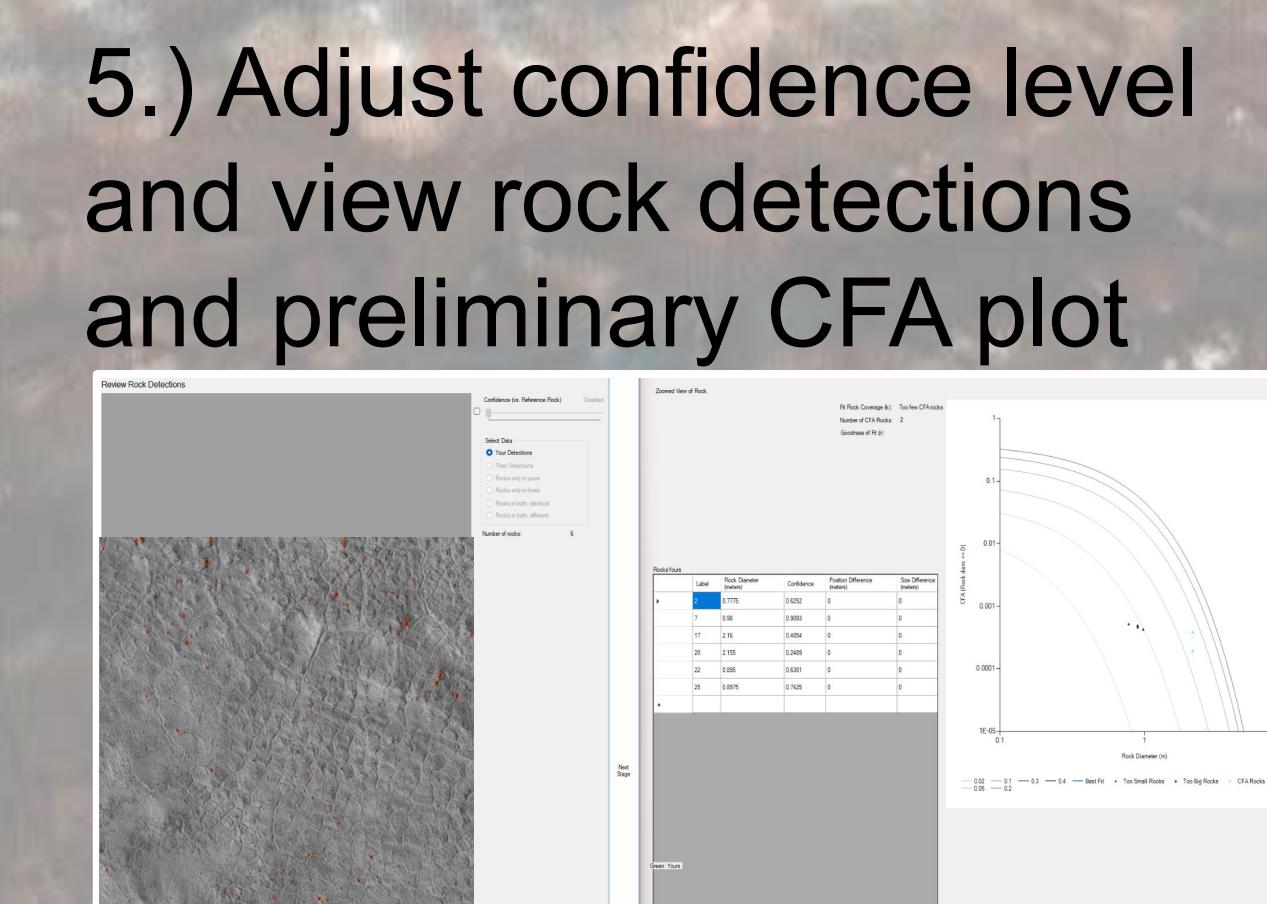
- 1.) Load image and parameters



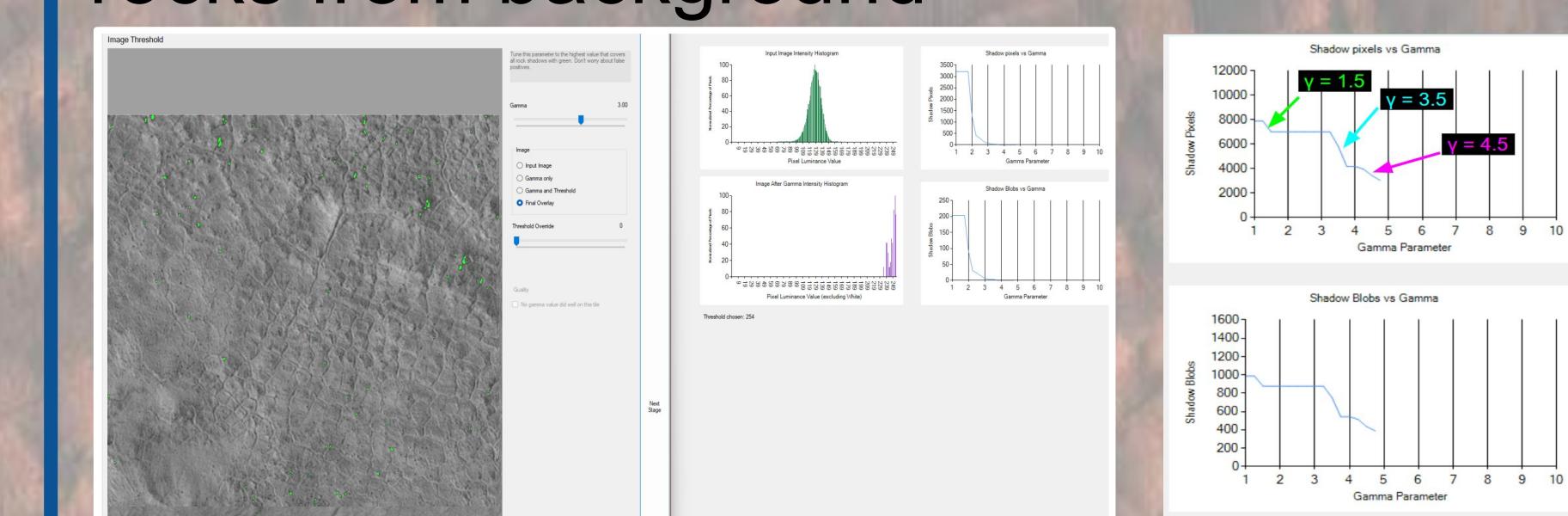
- 4.) Fine tune rock detections



- 2.) Choose tile to visit



- 3.) Adjust gamma and threshold parameters to accentuate rocks from background



Use plots of shadow size and number vs. gamma to choose gamma values

Future Work

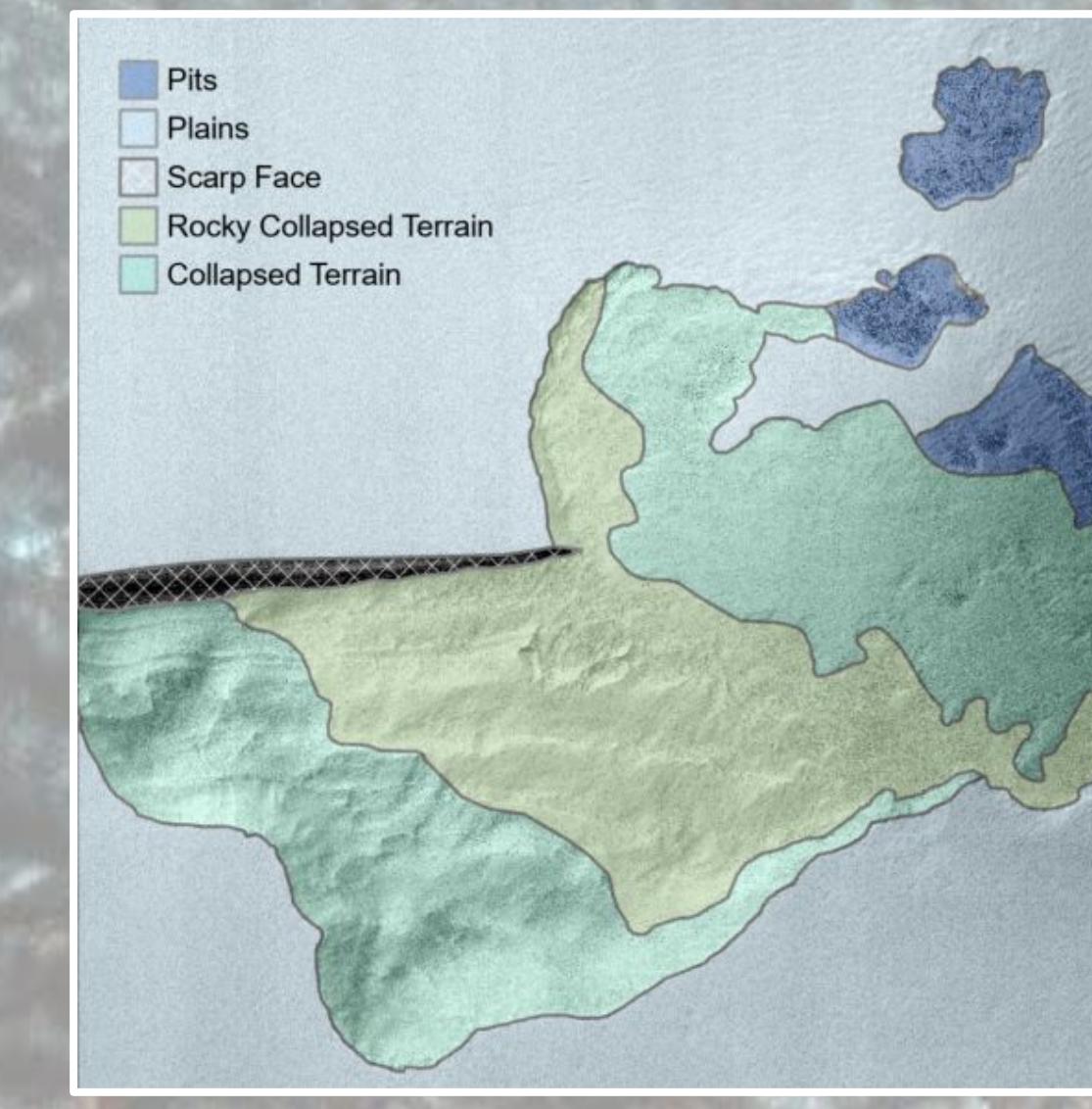
- Refine boulder detections on complex terrain (around craters, icy scarps, lobate debris aprons, etc...)
- Quantify impact-generated boulder populations, pre-existing boulder counts in the InSight landing ellipse, and boulder production for craters 100s of meters in diameter
- Catalog boulders throughout the mid-latitudes and boulder populations near icy scarps and thermokarsts
- Monte Carlo modeling of impact generated boulder populations to investigate timescales needed to reproduce observed populations

Image Preparation Steps In GIS

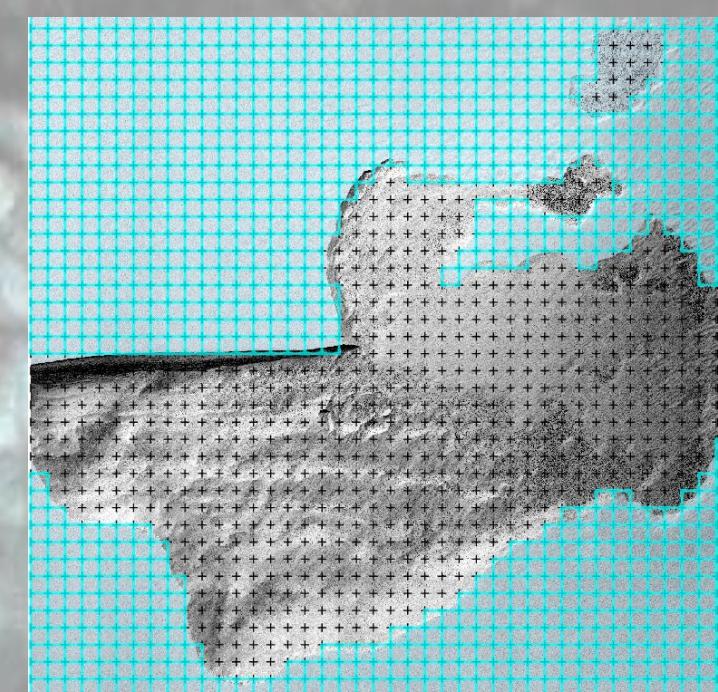
- 1.) Open attribute table

FID	Shape	tile num_x	tile num_y	tp_px_col	tp_px_row	mn	visit	group	APPLY_SET
1	126 Polygon	3	1500	-1500	TRUE	TRUE	PLAINS	FALSE	
2	137 Polygon	14	3	7000	-1500	TRUE	TRUE	PLAINS	FALSE
3	141 Polygon	24	3	12000	-1500	TRUE	TRUE	PLAINS	FALSE
4	155 Polygon	35	3	17000	-1500	TRUE	TRUE	PLAINS	FALSE
5	536 Polygon	3	1500	4500	TRUE	TRUE	PLAINS	FALSE	
6	547 Polygon	24	13	12000	4500	TRUE	TRUE	PLAINS	FALSE
7	557 Polygon	35	13	17000	4500	TRUE	TRUE	PLAINS	FALSE
8	568 Polygon	25	22	-17500	11000	TRUE	TRUE	PLAINS	FALSE
9	927 Polygon								

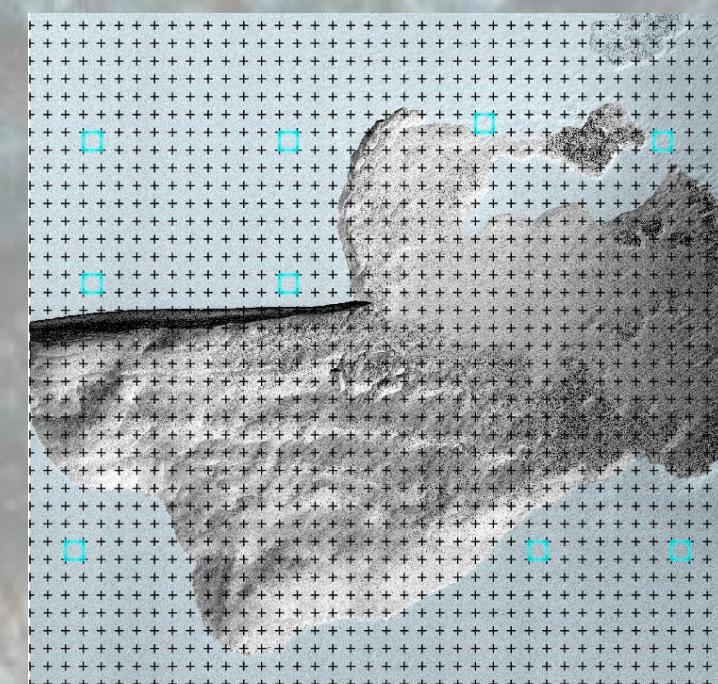
- 2.) Divide image into different terrain types based off boulder populations



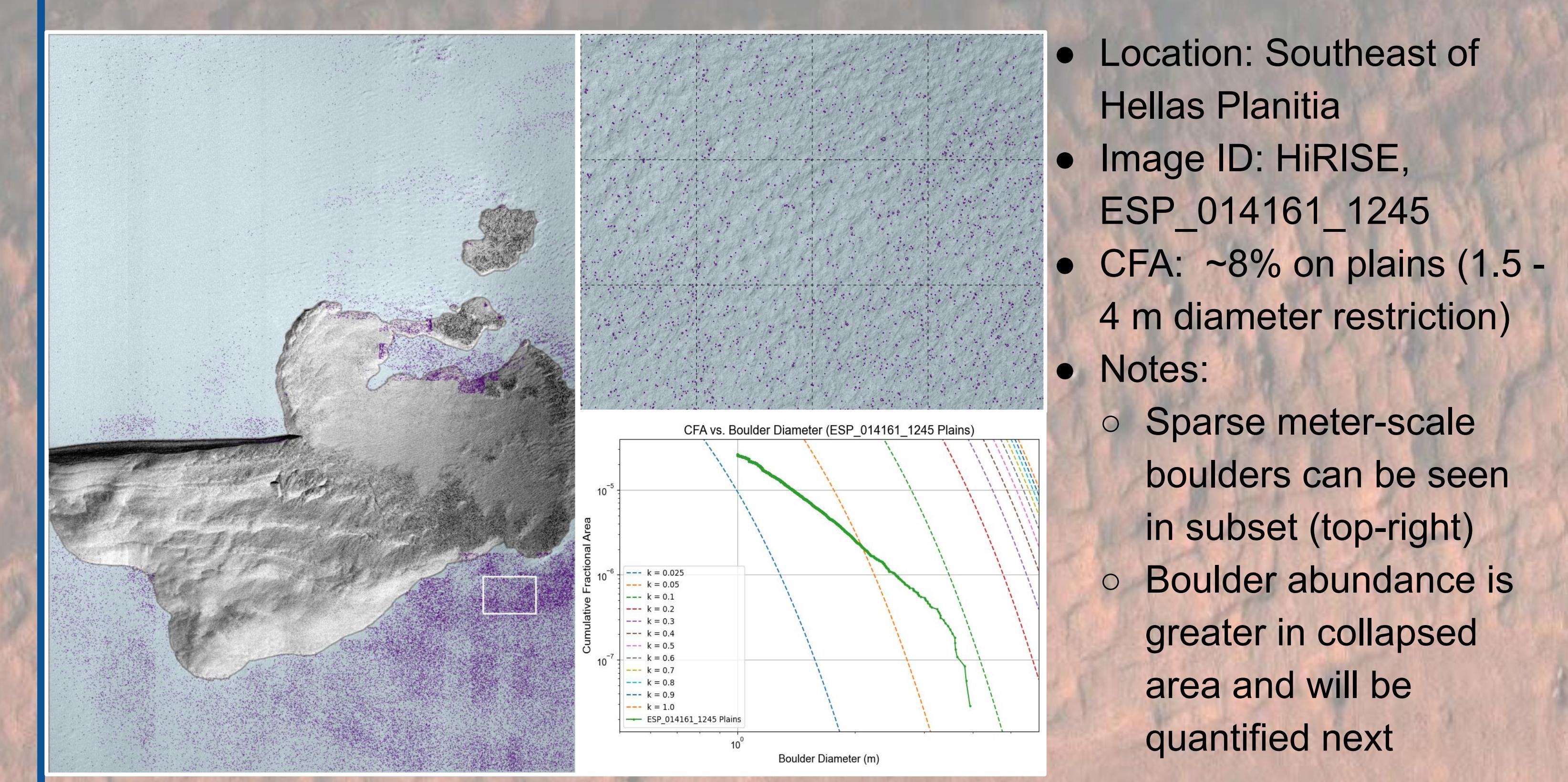
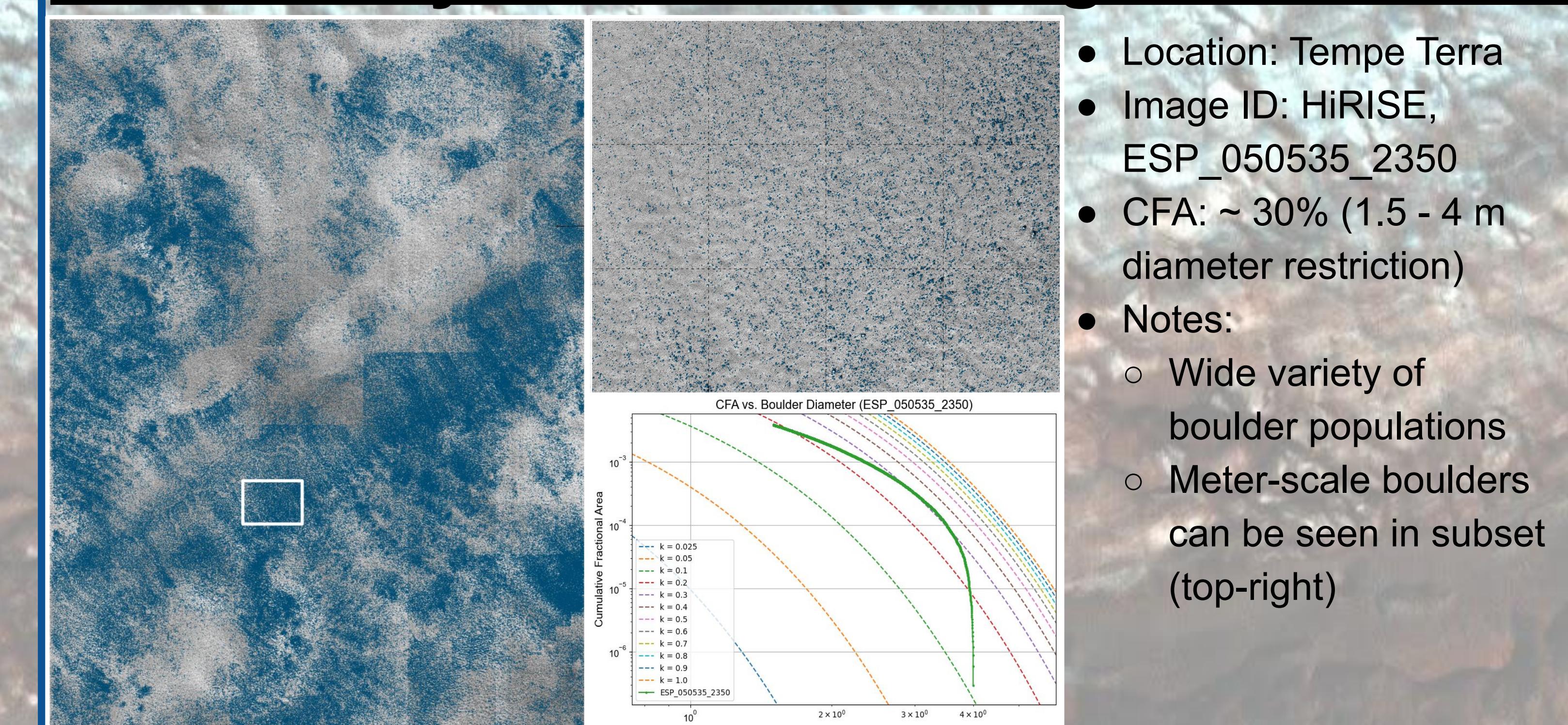
- 3.) Select tiles within a certain terrain type to include in a "group" (i.e. plains) and set "run" = TRUE to perform detections on those tiles



- 4.) Set tiles within the group to "visit" = TRUE to calibrate detections with these tiles



Preliminary Results on Periglacial Terrain



References & Acknowledgements

- [1] Morgan, G. A., et al. 2021. Nature Astronomy 5, 230-236. [2] Fisher, D., et al. 2022. Icarus 387, 115198. [3] Orloff, T. C., et al. 2013. Icarus 225, 992-999. [4] Golombek, M. P. et al. (2008) JGR, 113, e00A09. [5] Golombek, M. P. et al. (2012) Mars, 7, 1-22. [6] Huertas A. et al. (2006) IEEE Aerospace Conference, 14.

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