

# Semi-automated surface mapping via unsupervised classification

Mario D'Amore<sup>1</sup>, Rémi Le Scaon<sup>2</sup>, Jörn Helbert<sup>1</sup>, Alessandro Maturilli<sup>1</sup>

<sup>1</sup> ([mario.damore@dlr.de](mailto:mario.damore@dlr.de)) Institute for Planetary Research, DLR, Rutherfordstrasse 2, Berlin, Germany; <sup>2</sup>Ecole Polytechnique, Université Paris-Saclay, Paris, France



# Keypoints

**Goal:** automated unsupervised characterization of body surface from remote sensing multi-instrument data.

## Steps :

- Multidimensional classification problem using no spatial information.
- Define surface “units” based on multiple data, mainly spectral.
- Characterization of surface “units”.
- Visualize units spatial distribution and correlate with other mapping efforts (expert geological/morphological units maps)

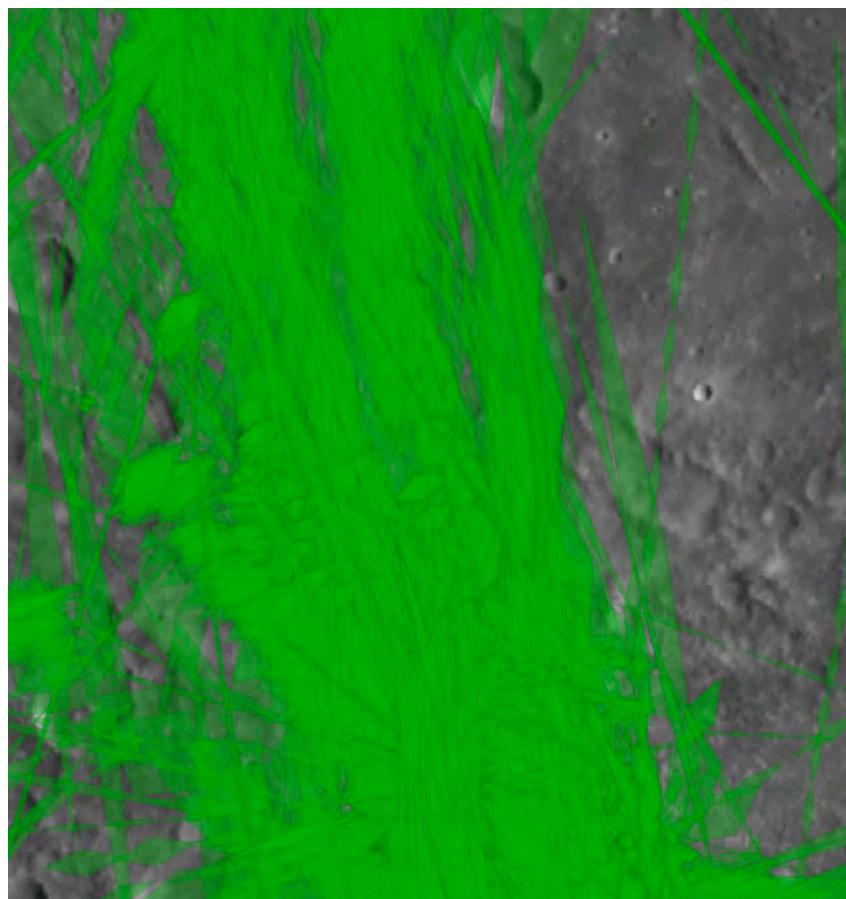
## Examples :

- MESSENGER : point-spectrometer MASCS VIS channel (vis/nir) range + X-ray spectrometer XRS for chemical composition
- DAWN VIR Vesta spectral cubes

Area of Interest and Polygons definition

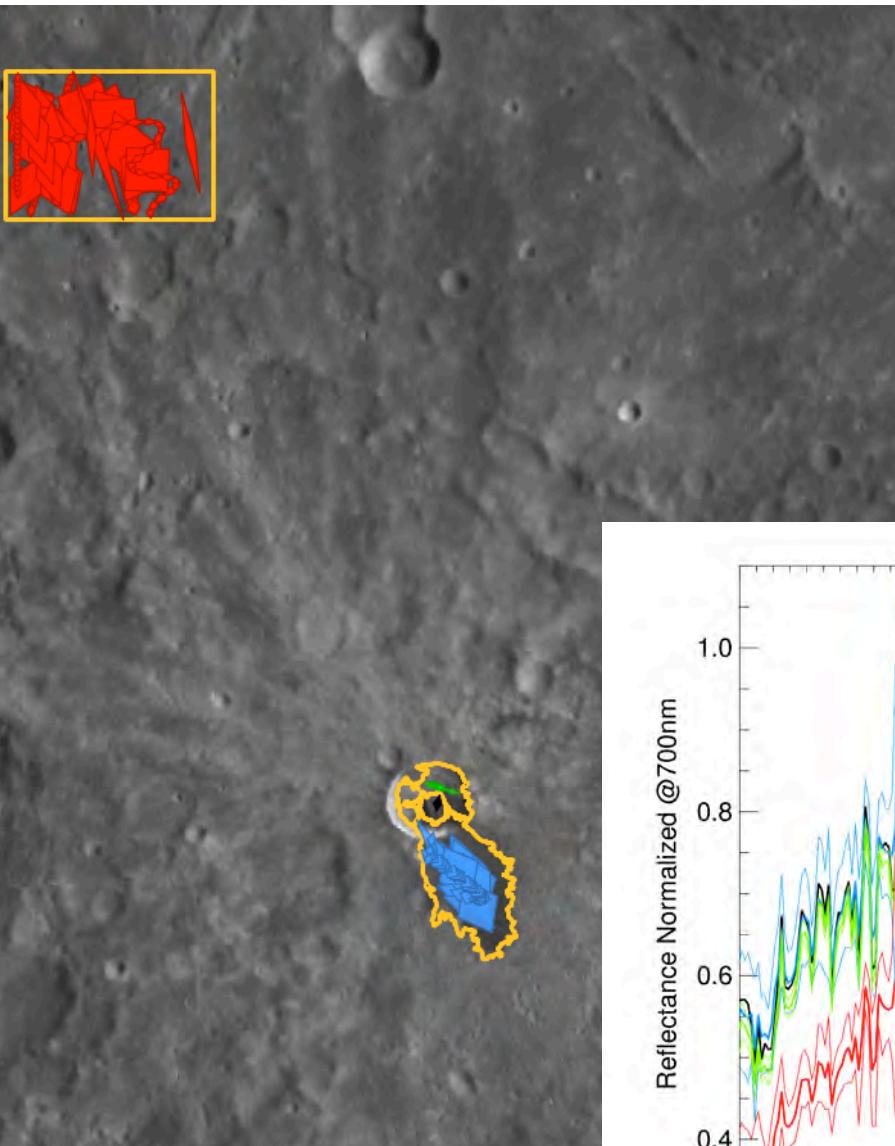


Spectra in the area

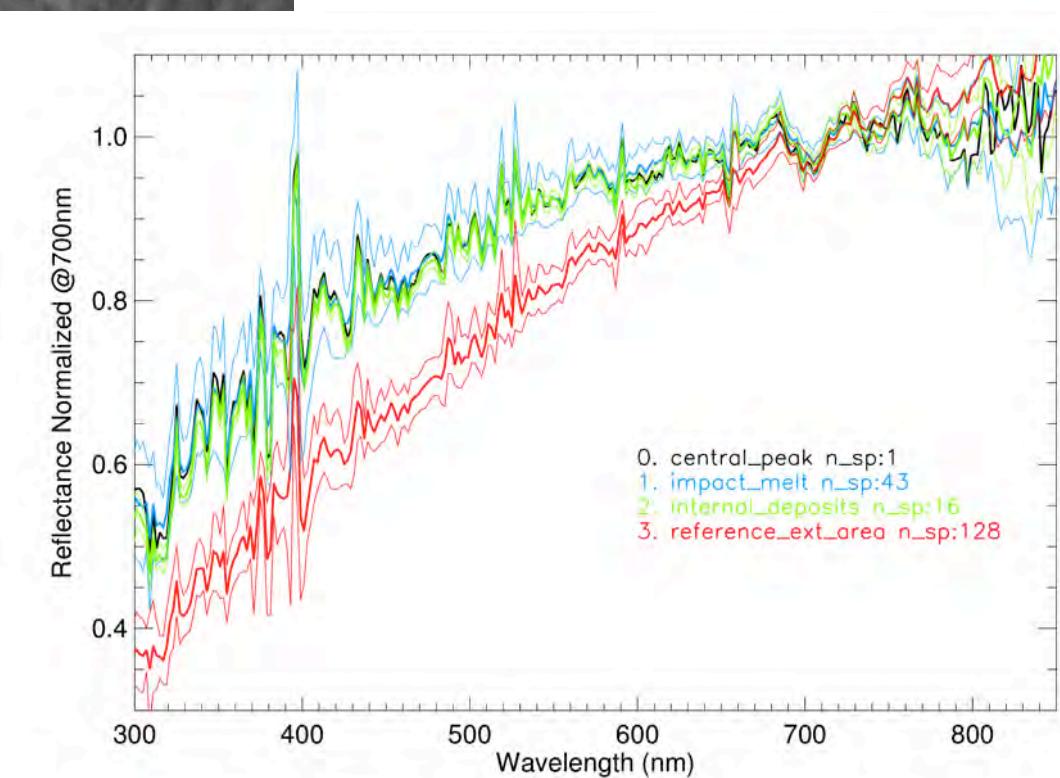


9740 spectra, in 4442.510 ms

# MASCS DLR Database – Data Extraction



Polygons and measurements intersection  
(automatically updated)



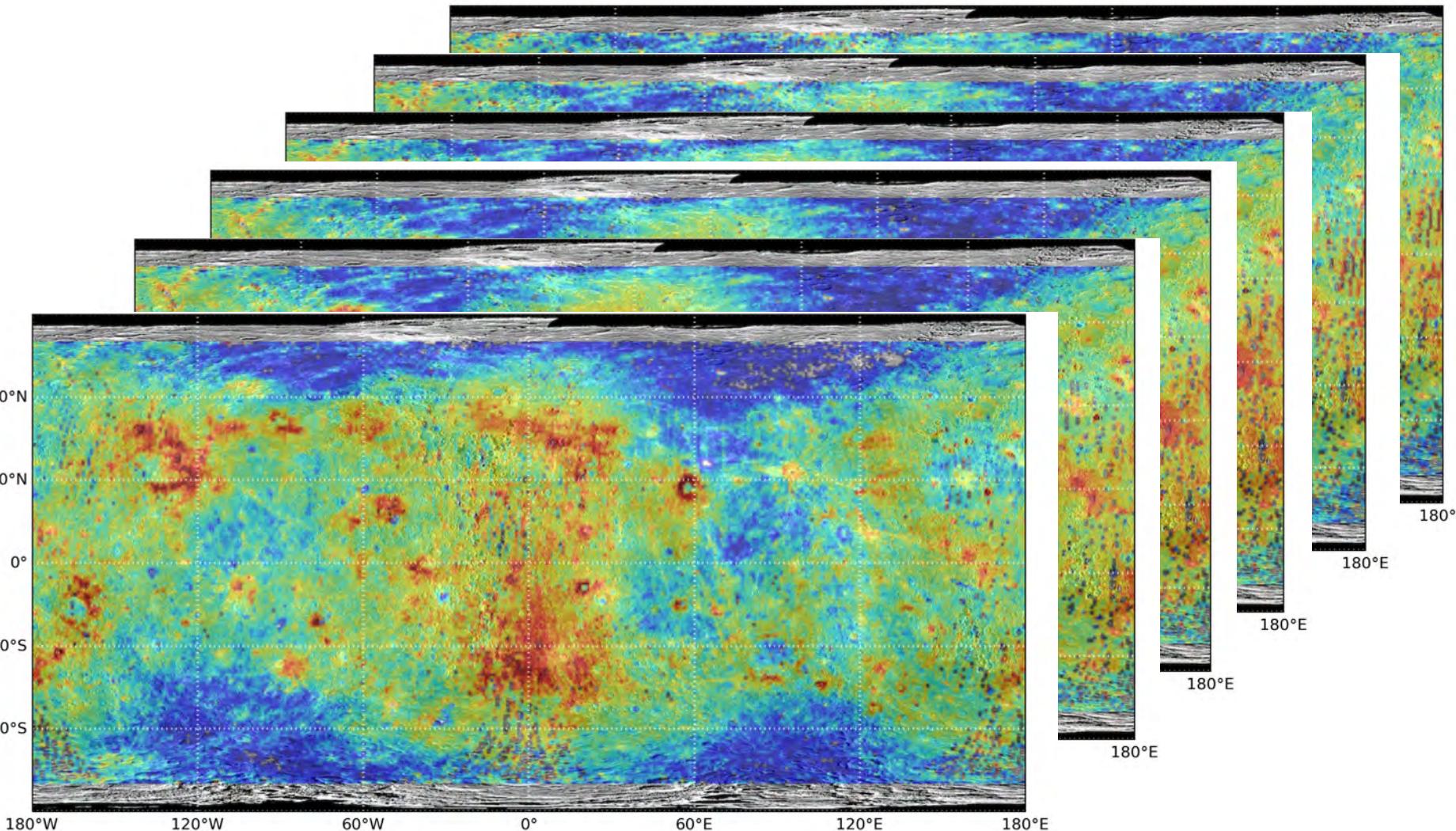
Spectra extraction

# MASCS DLR Database – Global Grid

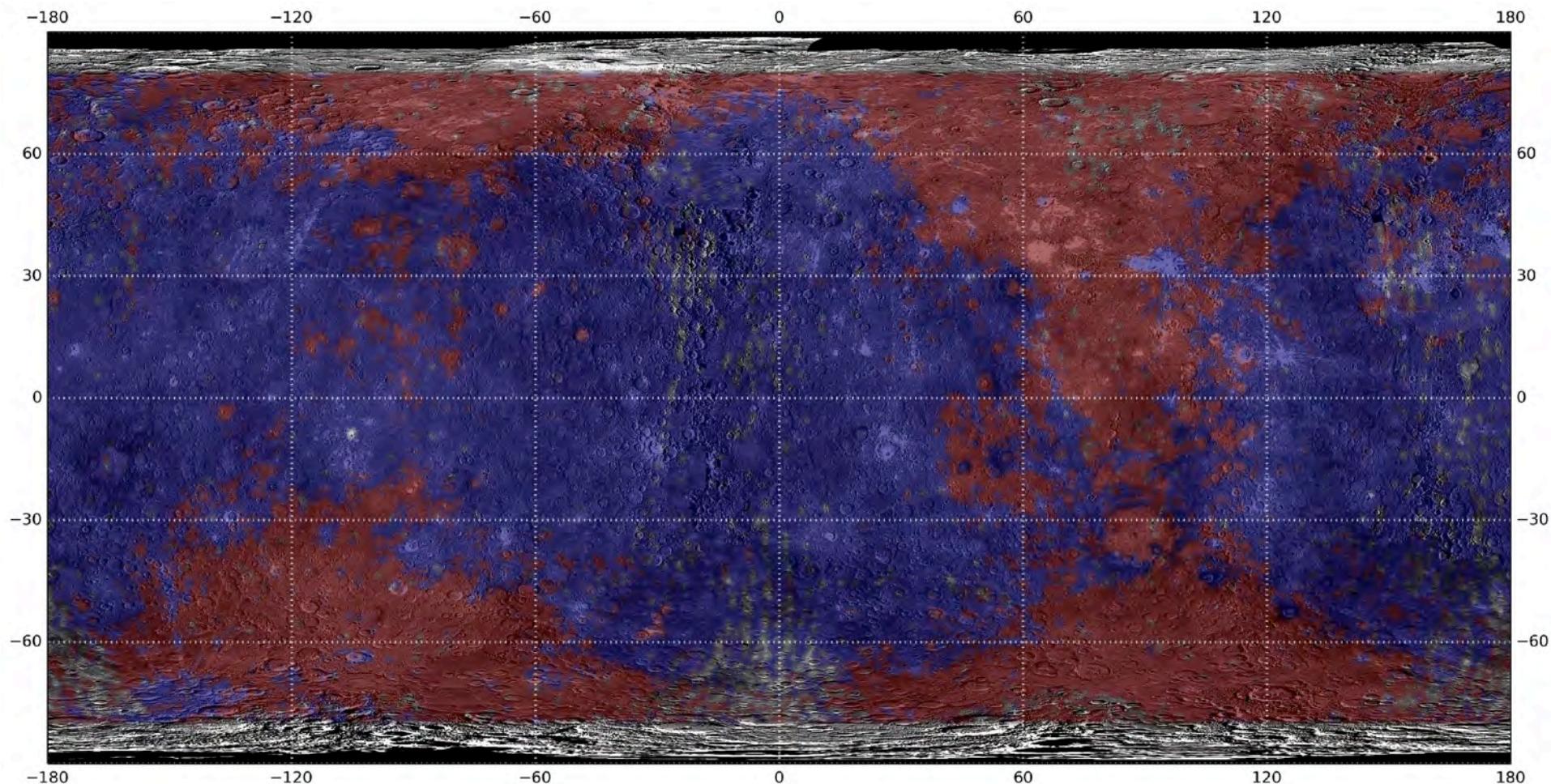
Reflectance( $X$  nm)/Reflectance(700-750 nm)

**1x1** degrees grid

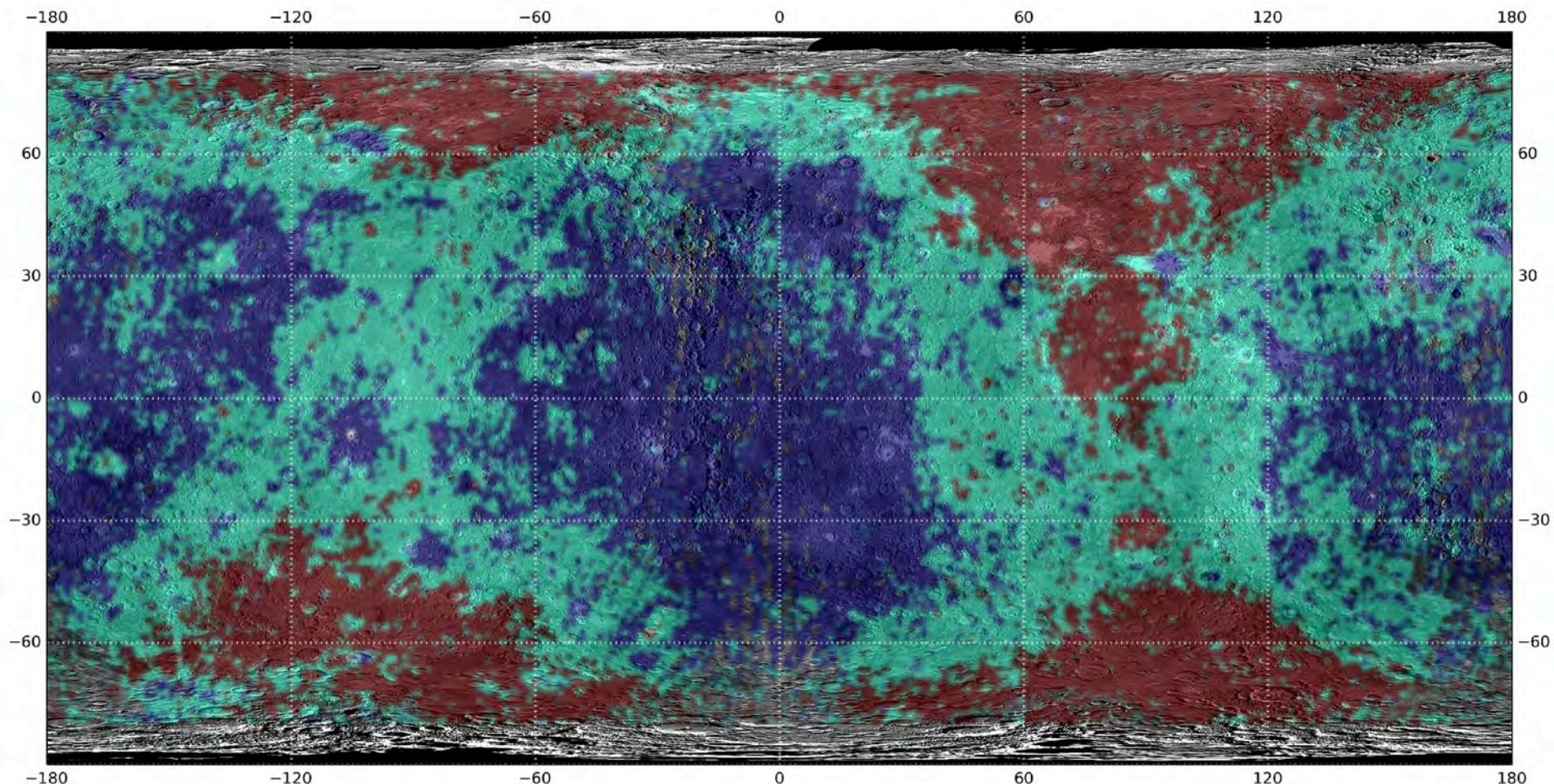
$X = \{350, 450, 500, 550, 600, 650\}$  nm



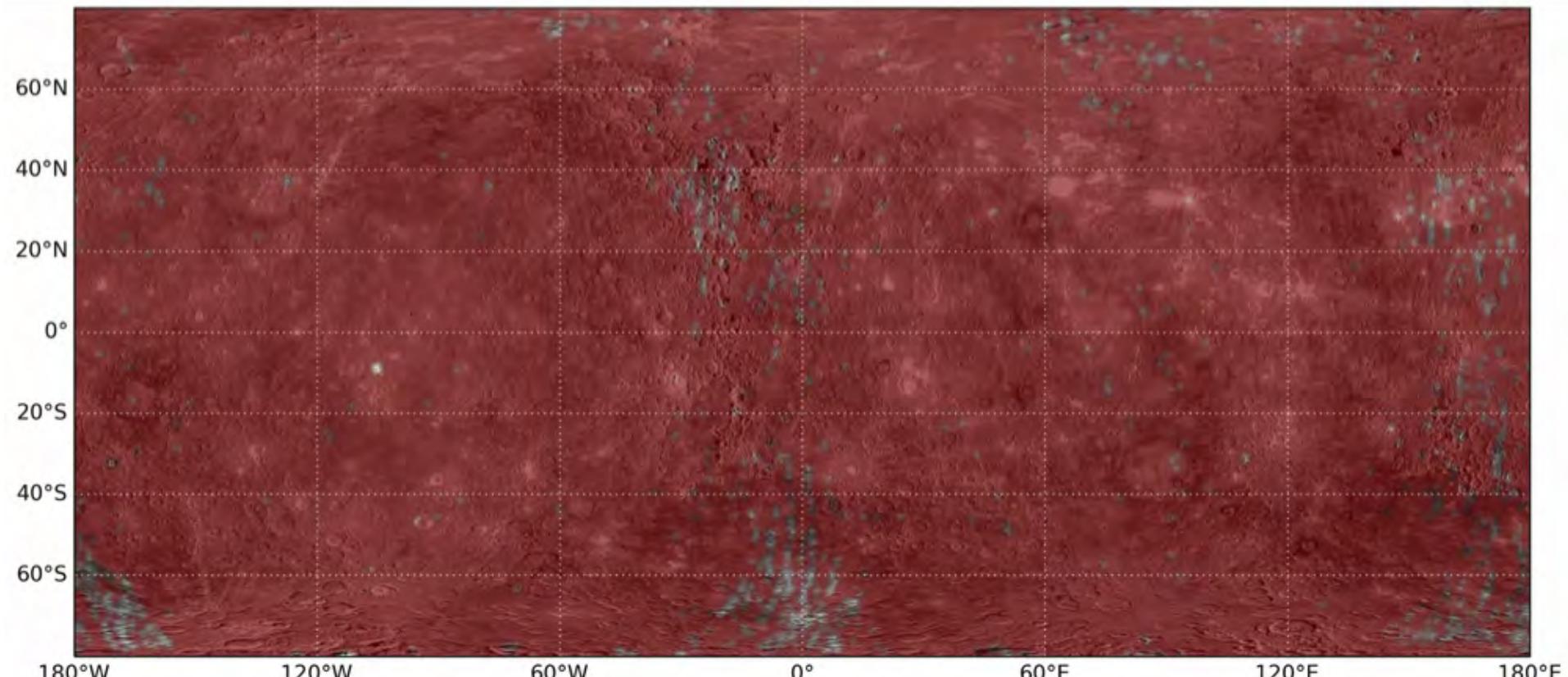
K-Means clustering, standardized features  
2 Classes Partition



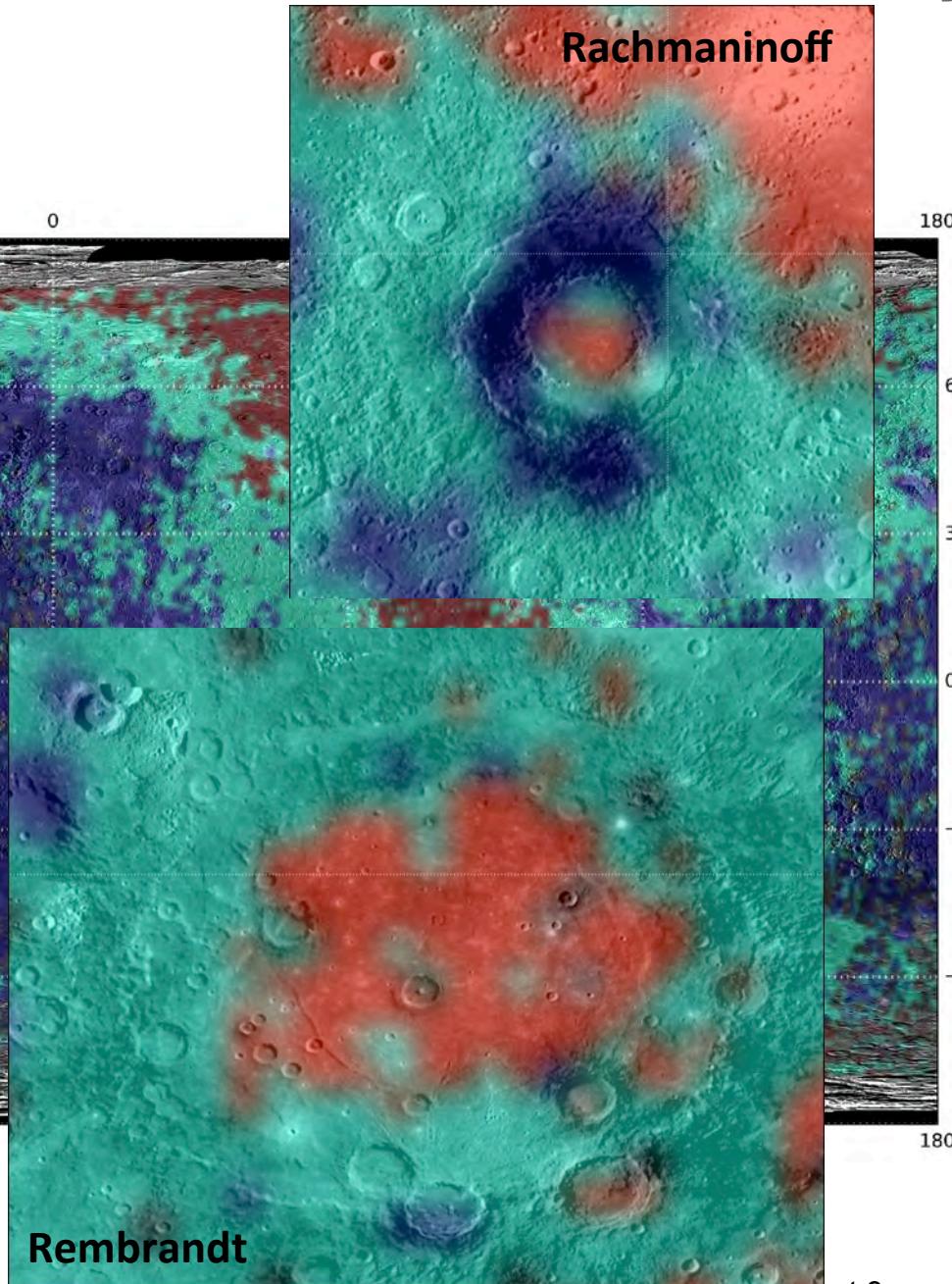
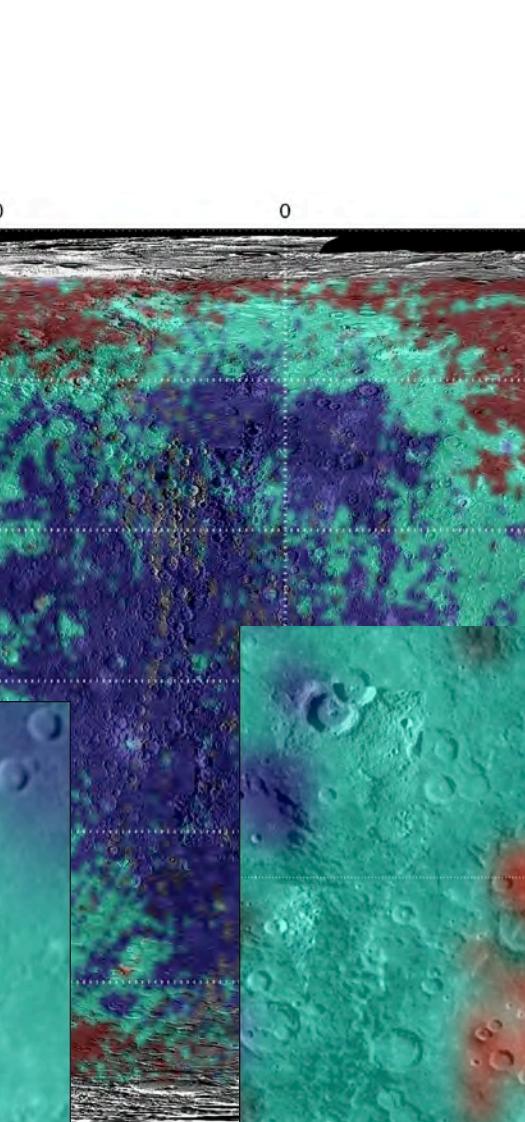
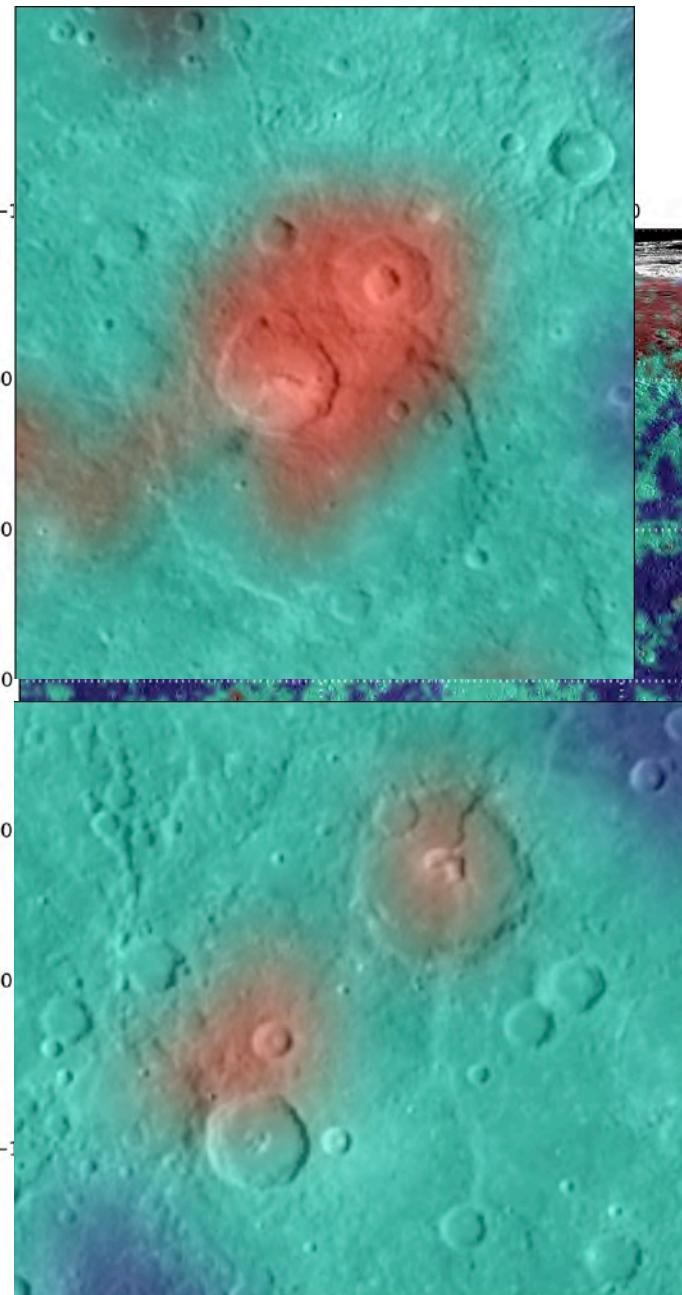
K-Means clustering, standardized features  
3 Classes Partition



K-Means clustering, standardized features  
Up to 30 Classes Partition



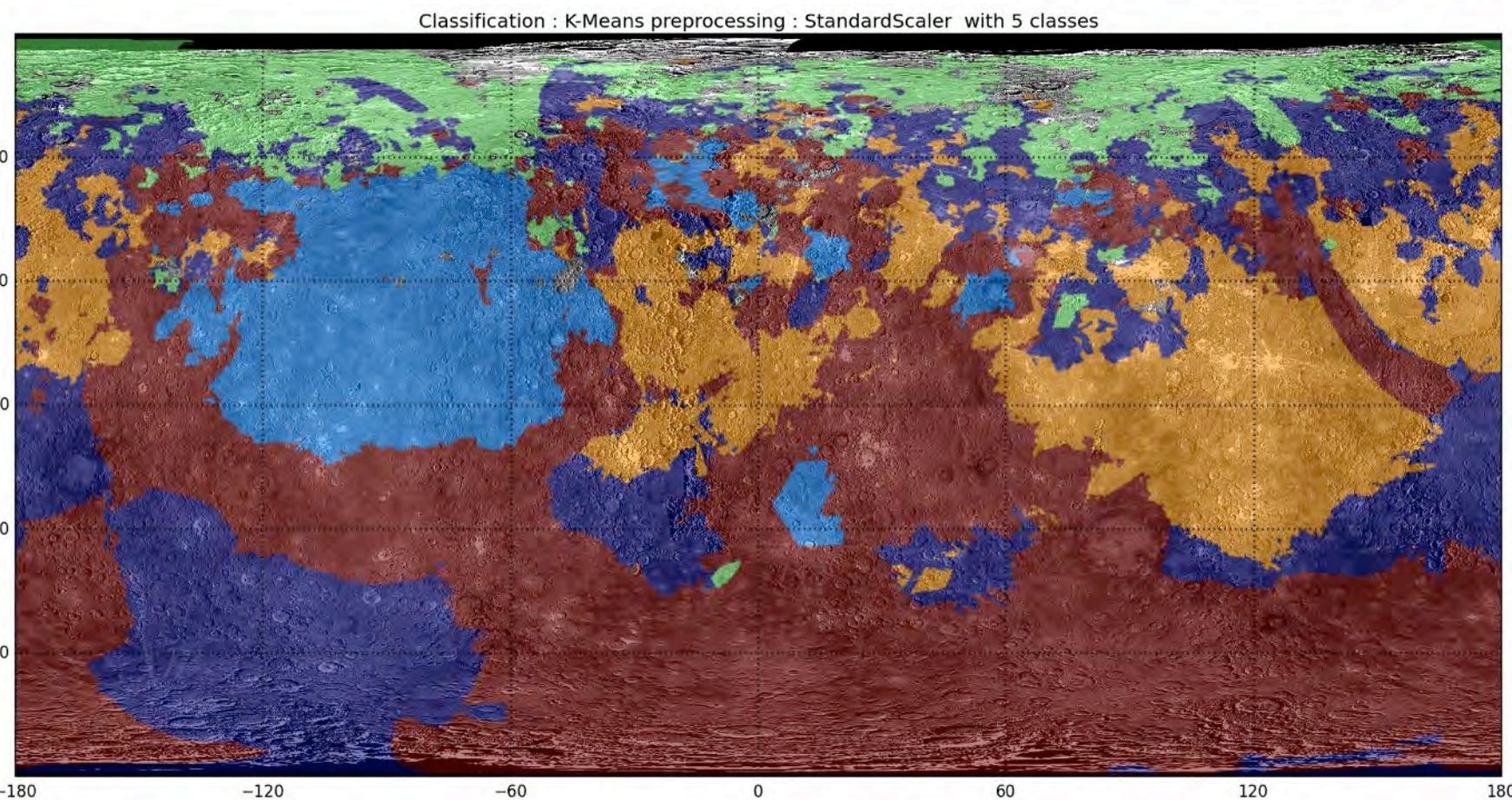
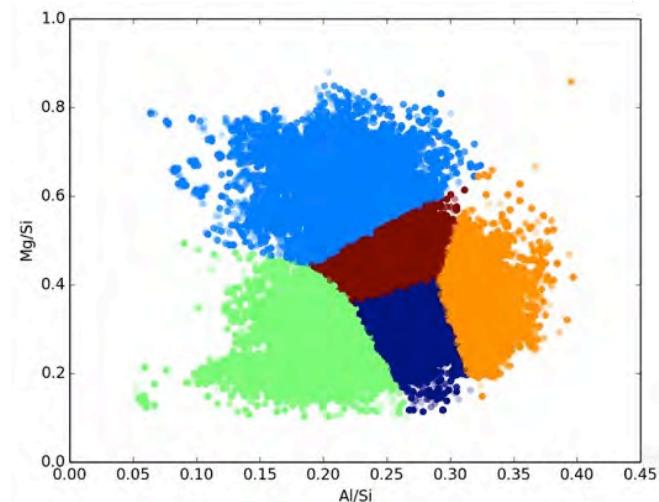
# MASCS Database – Global Classification



# MESSENGER XRS

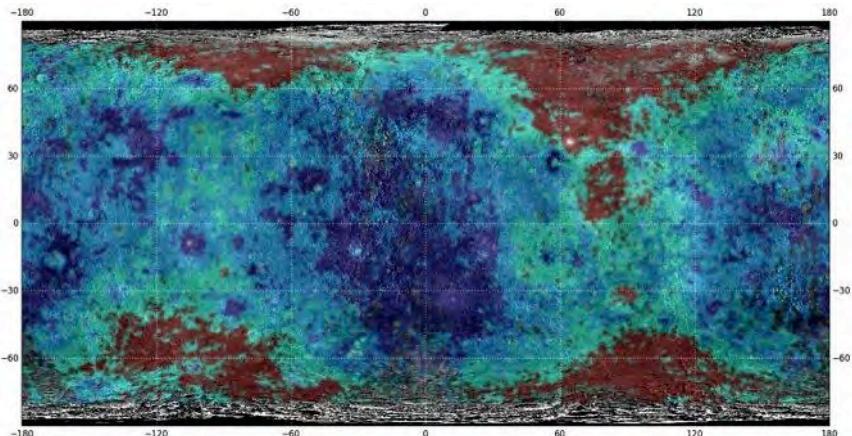
Classification of chemical composition data from XRS and spatial distribution.

Resolution in the south hemisphere is to low to be useful for local studies.

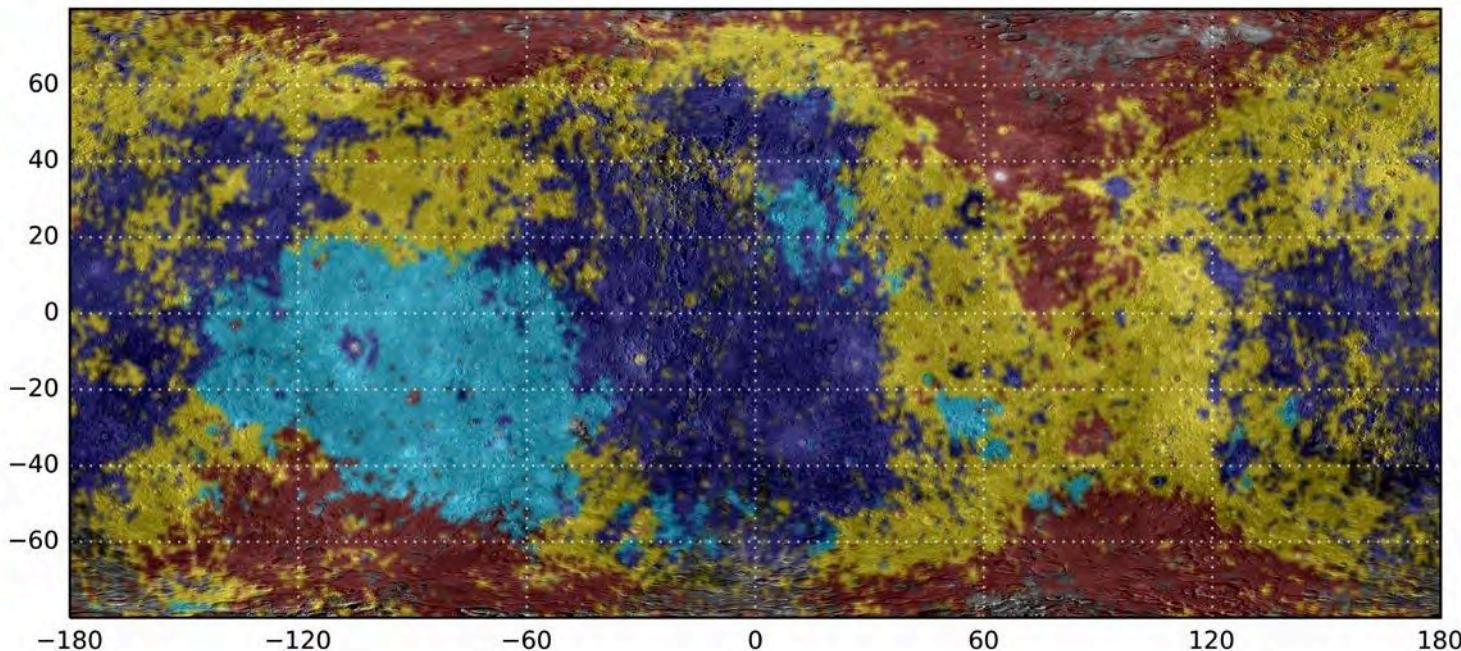
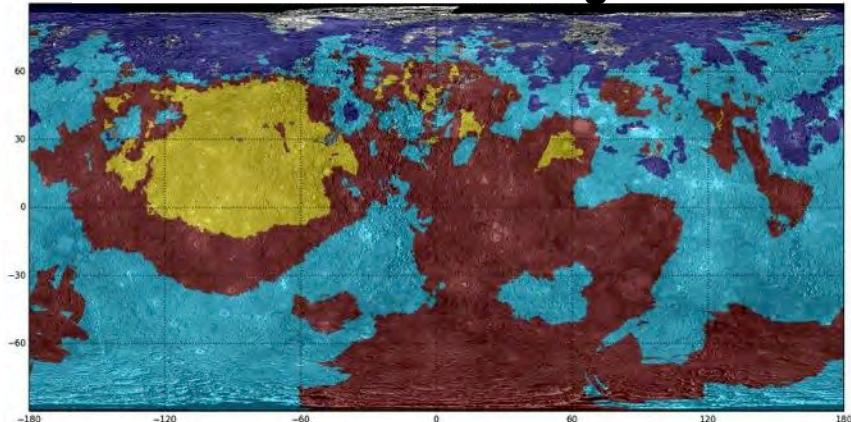


# MESSENGER MASCS + XRS

4 Classes MASCS



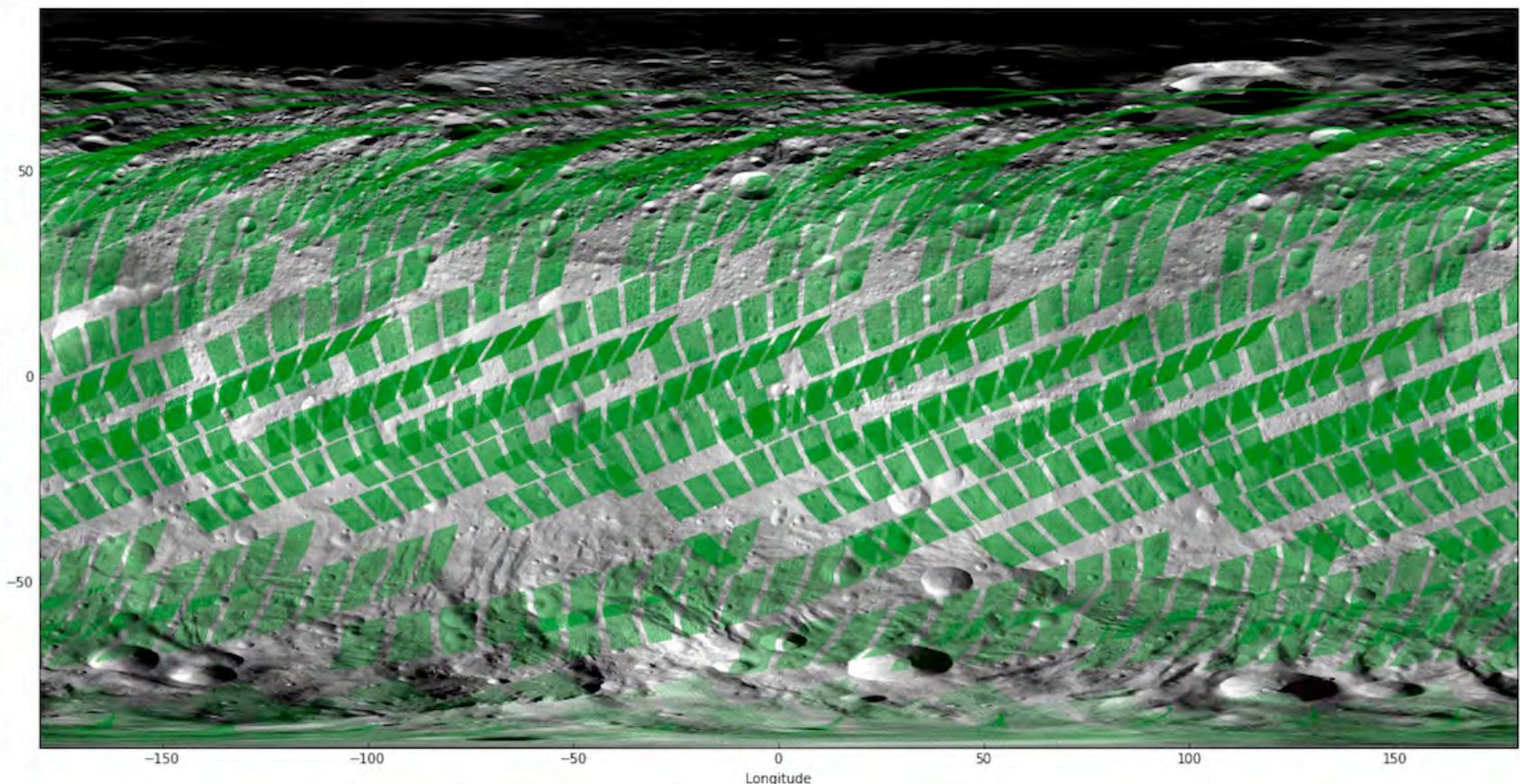
4 Classes XRS Mg+Al



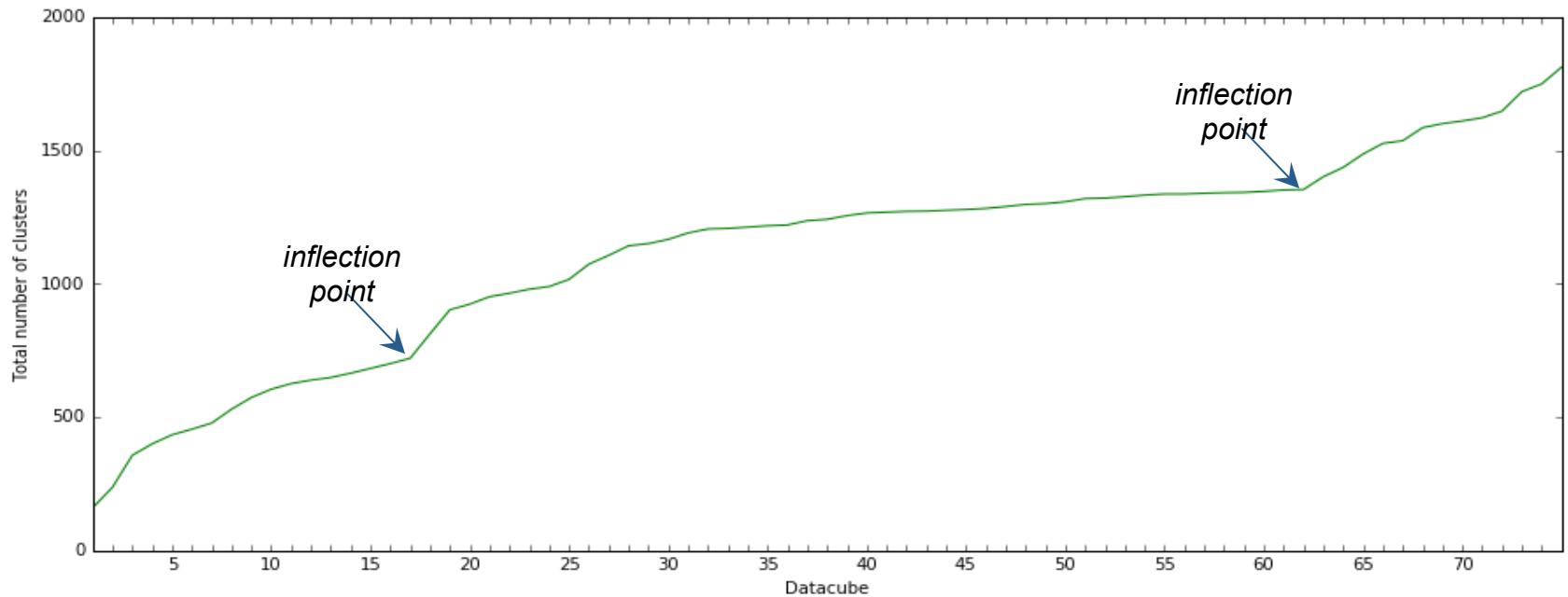
MASCS+XRS 4 Classes Partition

# VESTA DATASET

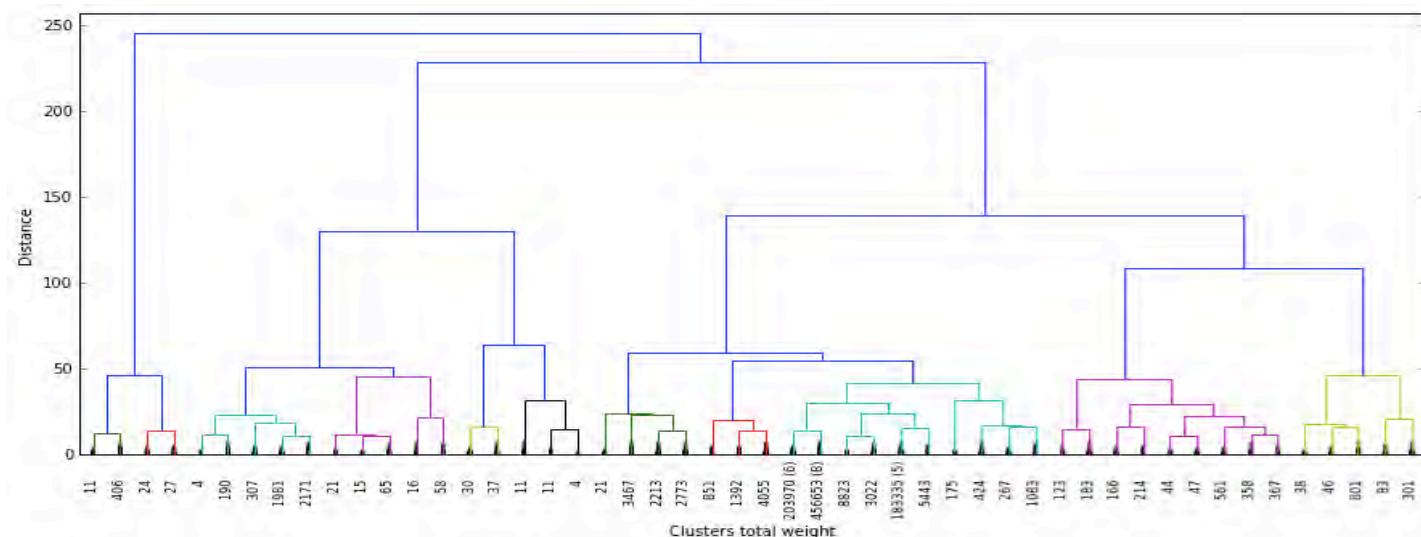
- 1830 hyper-spectral images
- 20 million measurements



# STREAM ALGORITHM



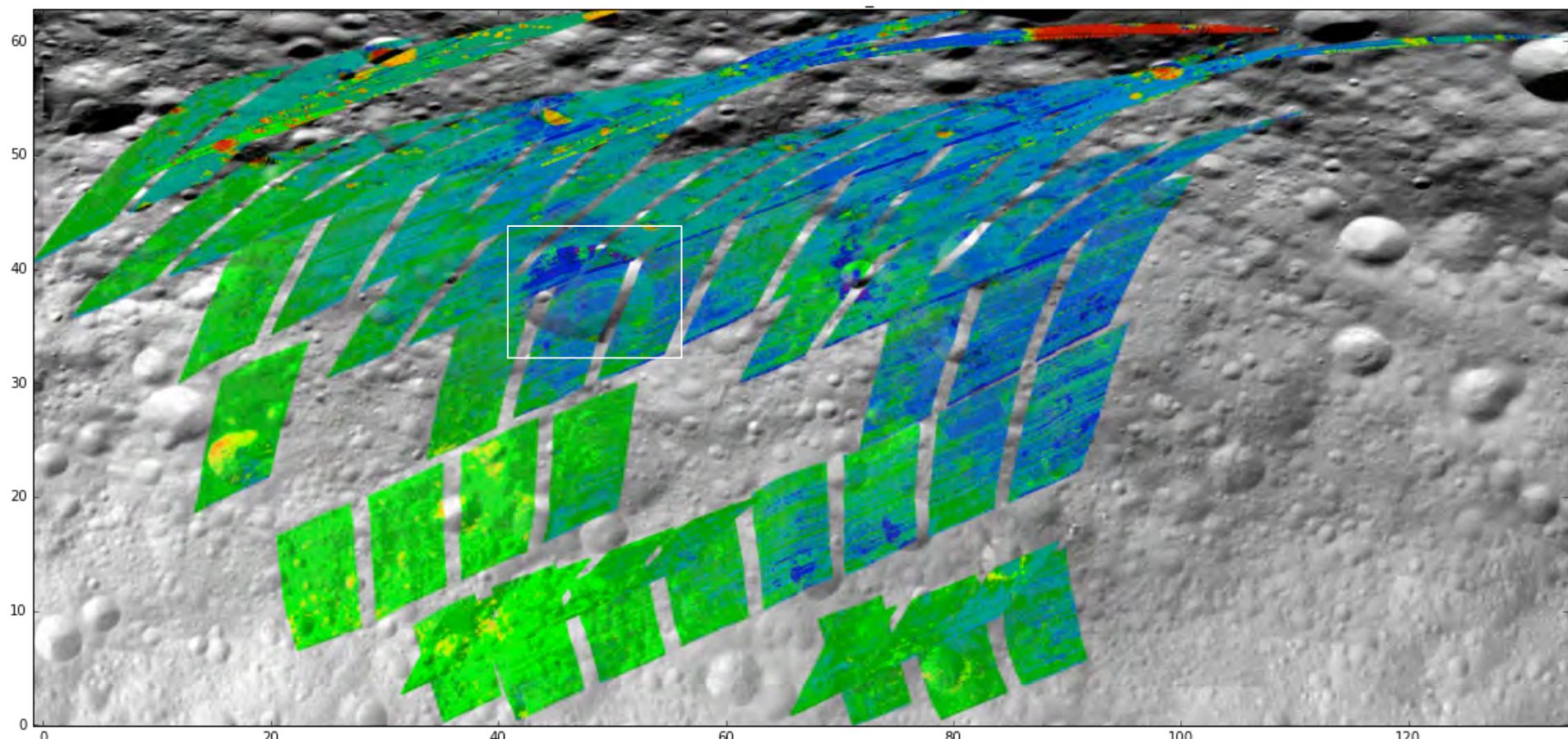
# HIERARCHICAL CLUSTERING



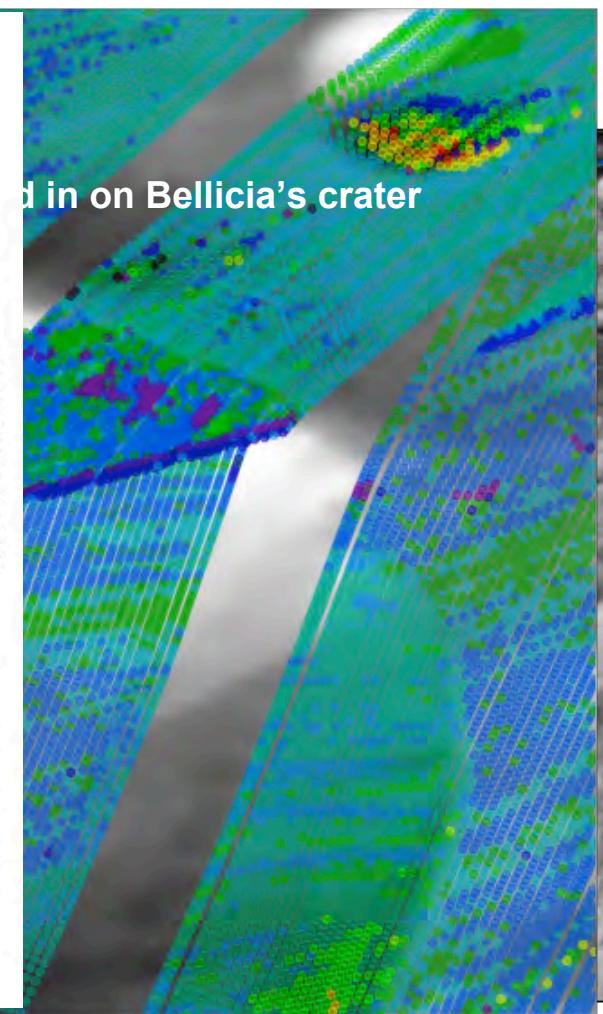
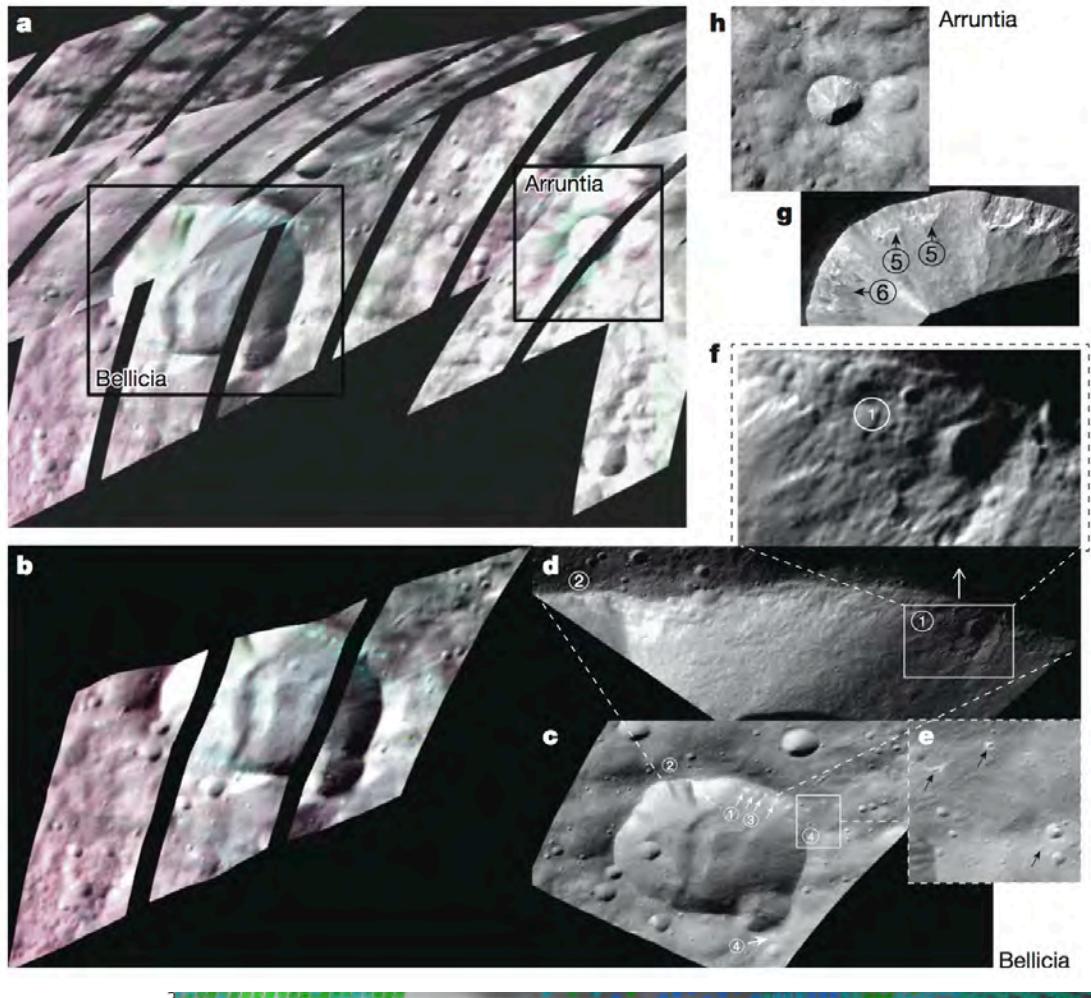
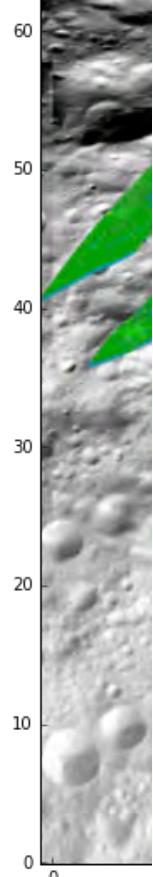
# UNSUPERVISED CLUSTERING

**Application :** 75 data-cubes, 800 000 measurements

**Result :** 19 core clusters, 1700 outlier clusters

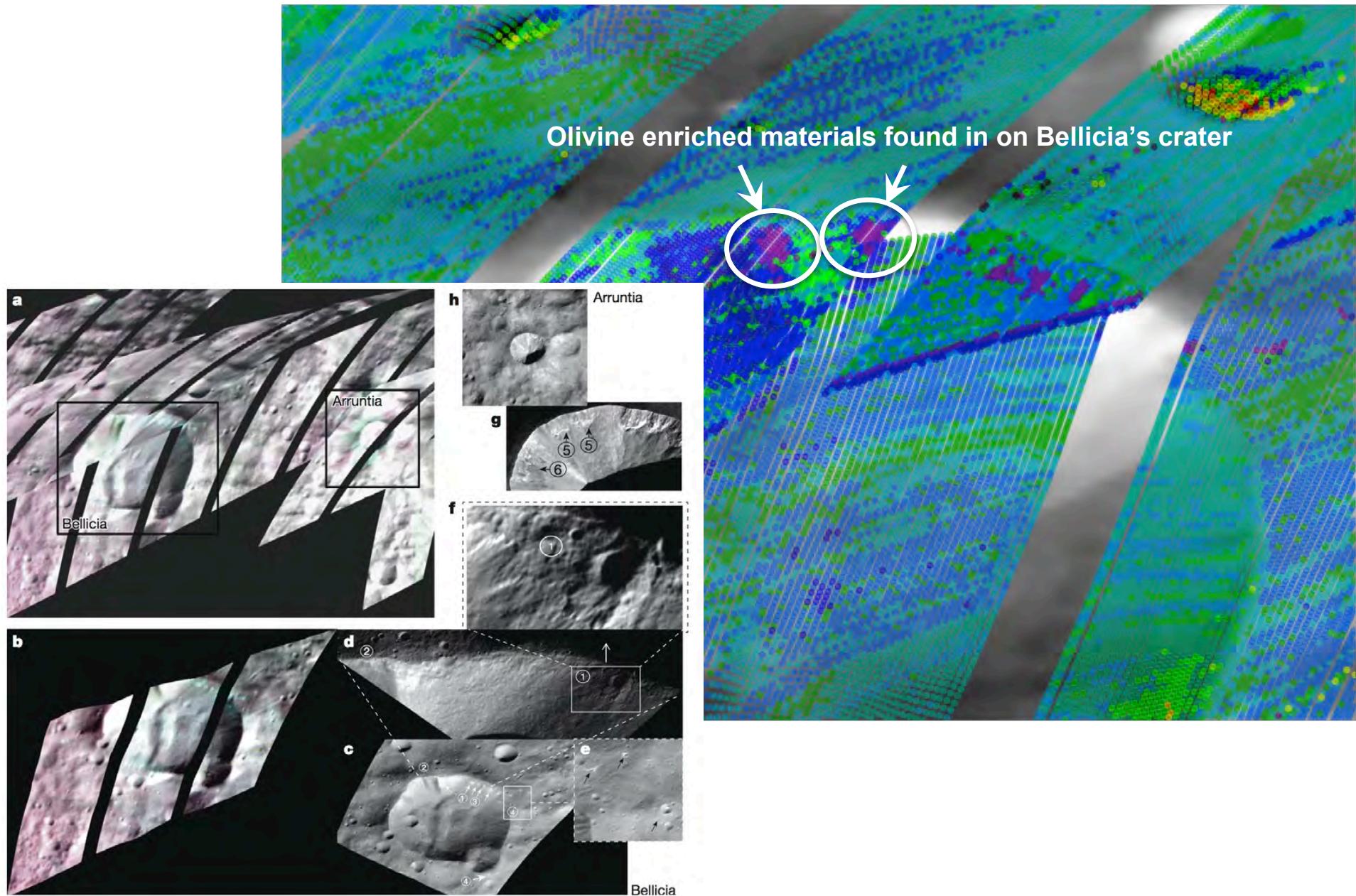


## UNSUPERVISED CLUSTERING

Appl  
Resu

d in on Bellicia's crater

# UNSUPERVISED CLUSTERING



# Conclusions

# Backup Slides

# MASCS Database Example – Regular Grid

Global Grid (reflectance@500nm normalized)

