Colour mapping of the Shakespeare (H-03) quadrangle of Mercury

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Data set

Mosaicking process

Mapping of Shakespeare

Preliminary spectral analysis - comparison with the geology

Conclusion

Outline:

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- MESSENGER MDIS-WAC $\Rightarrow$ EDR (raw) data available on pds-imaging.jpl.nasa.gov
- Shakespeare / H-03 quadrangle: $22.5° < \text{lat} < 65°$ $180° < \text{long} < 270°$

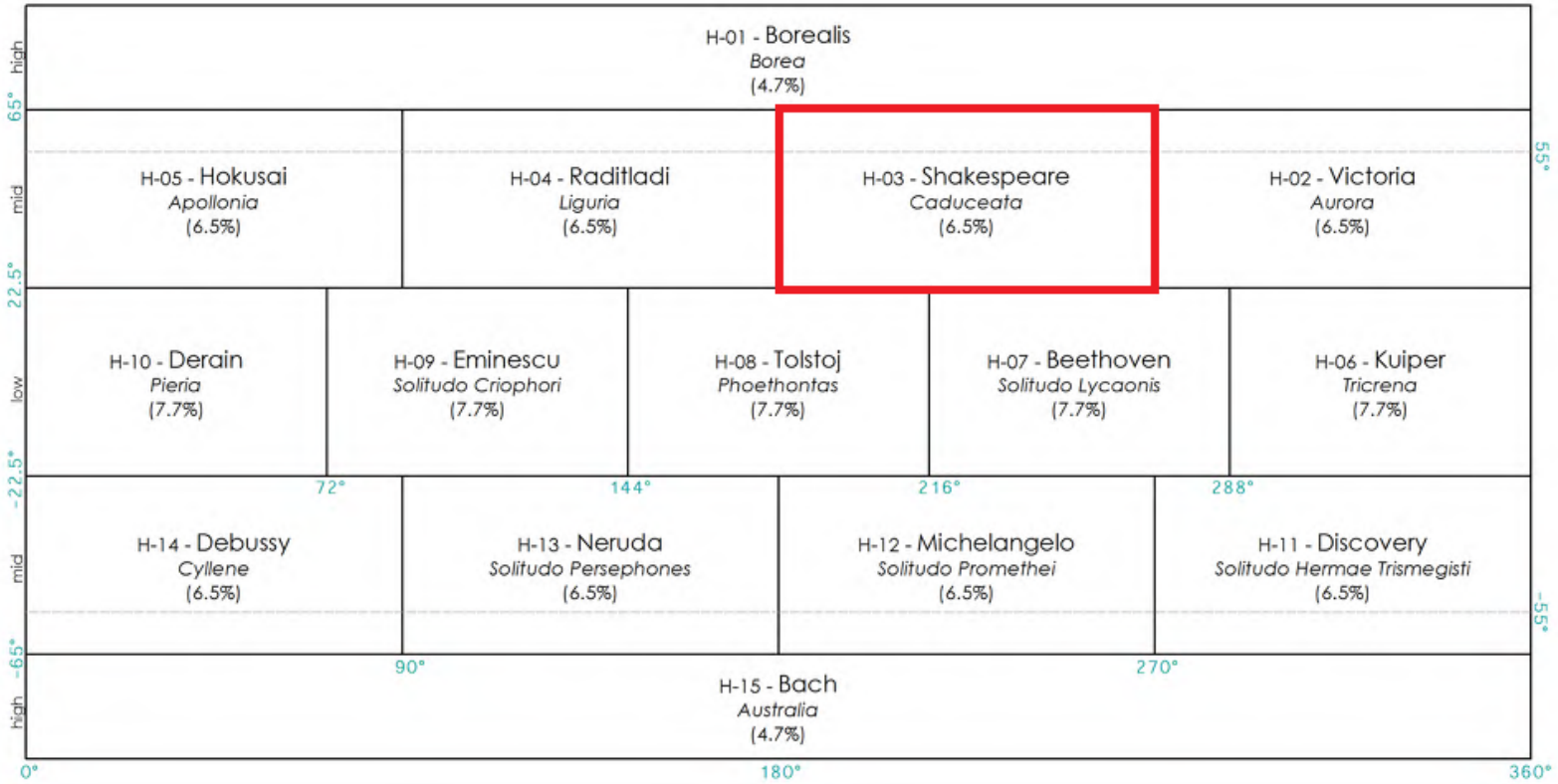

Figure: The 15 quadrangles of Mercury

Filter	Center wavelength (nm)	Bandpass width (nm)	# images available
A	698.8	5.3	49
B	700	600.0	40
C	479.9	10.1	772
D	558.9	5.8	996
E	628.8	5.5	770
F	433.2	18.1	2300
G	748.7	5.1	6163
H	947.0	6.2	48
I	996.2	14.3	2305
J	898.8	5.1	759
K	1012.6	33.3	48
L	828.4	5.2	992

Table: Basic informations on MDIS-WAC filters. Those in grey are not used for the mapping (too few data or used for calibration).

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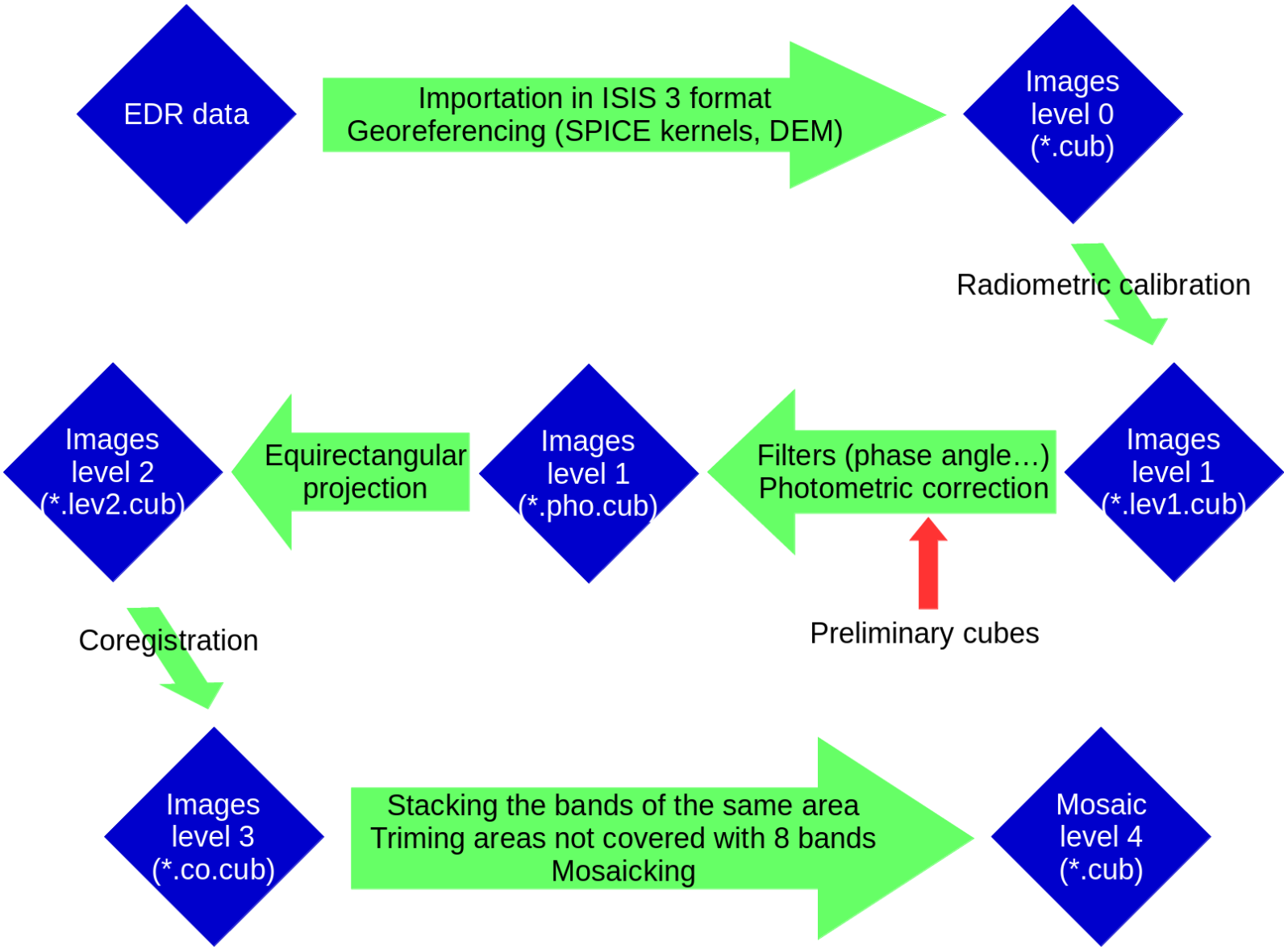


Figure: Mosaicking process

Photometric correction

- Kaasalainen-Shkuratov model [Domingue et al. 2016]
- For each pixel P of each image:

$$P_{\mathrm{norm}} = \frac{P}{KS_3} KS_3(i = 30^\circ, e = 0^\circ, \alpha = 30^\circ) \qquad (1)$$

where:

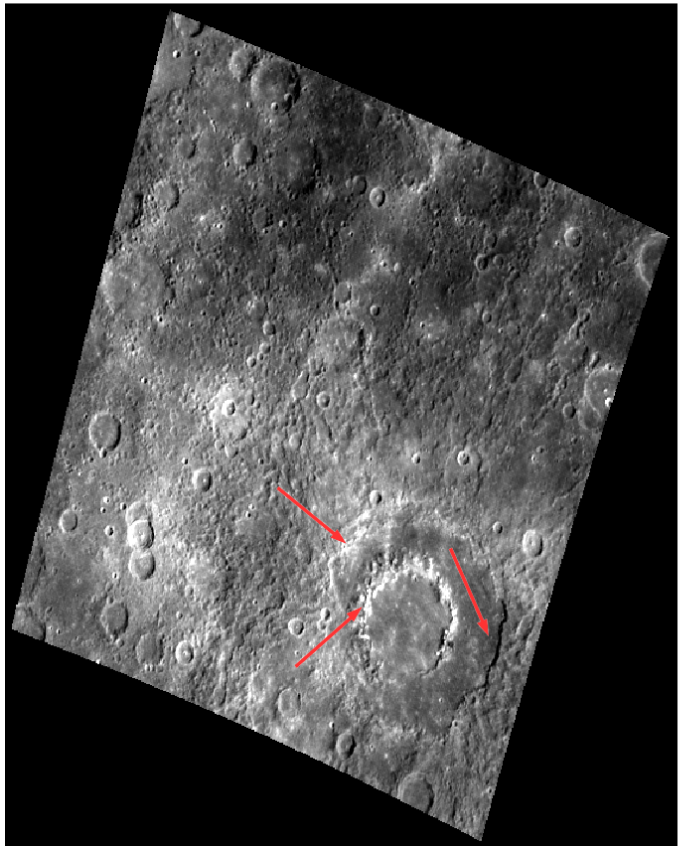
$$KS_3 = A_N e^{-\alpha\mu} \left[c_l \left(\frac{2\cos i}{\cos i + \cos e} \right) + (1 - c_l)\cos i \right] \qquad (2)$$

with:

i incidence angle
e emission angle
α phase angle
A_N normal albedo
μ phase function parameter
c_l disk function parameter

Comparison of photometric correction using Hapke model [Domingue et al. 2015] or Kaasalainen-Shkuratov model [Domingue et al. 2016]:

Hapke



Kaasalainen-Shkuratov

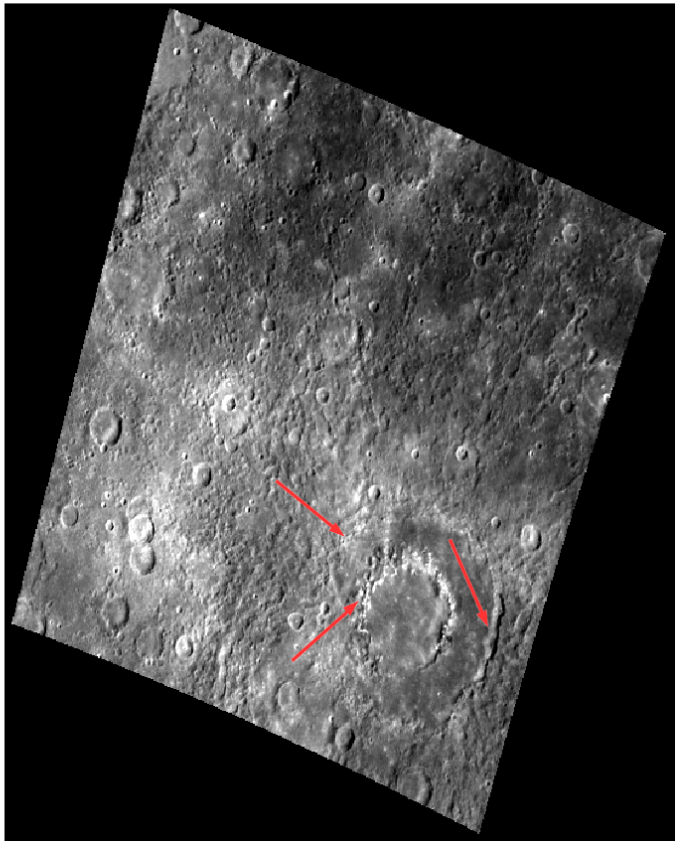


Figure: Image used: EW0211458777I (996.2 nm). Red arrows show where are the differences between the two corrections

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R=996.2 nm - G=748.7 nm - B=433.2 nm

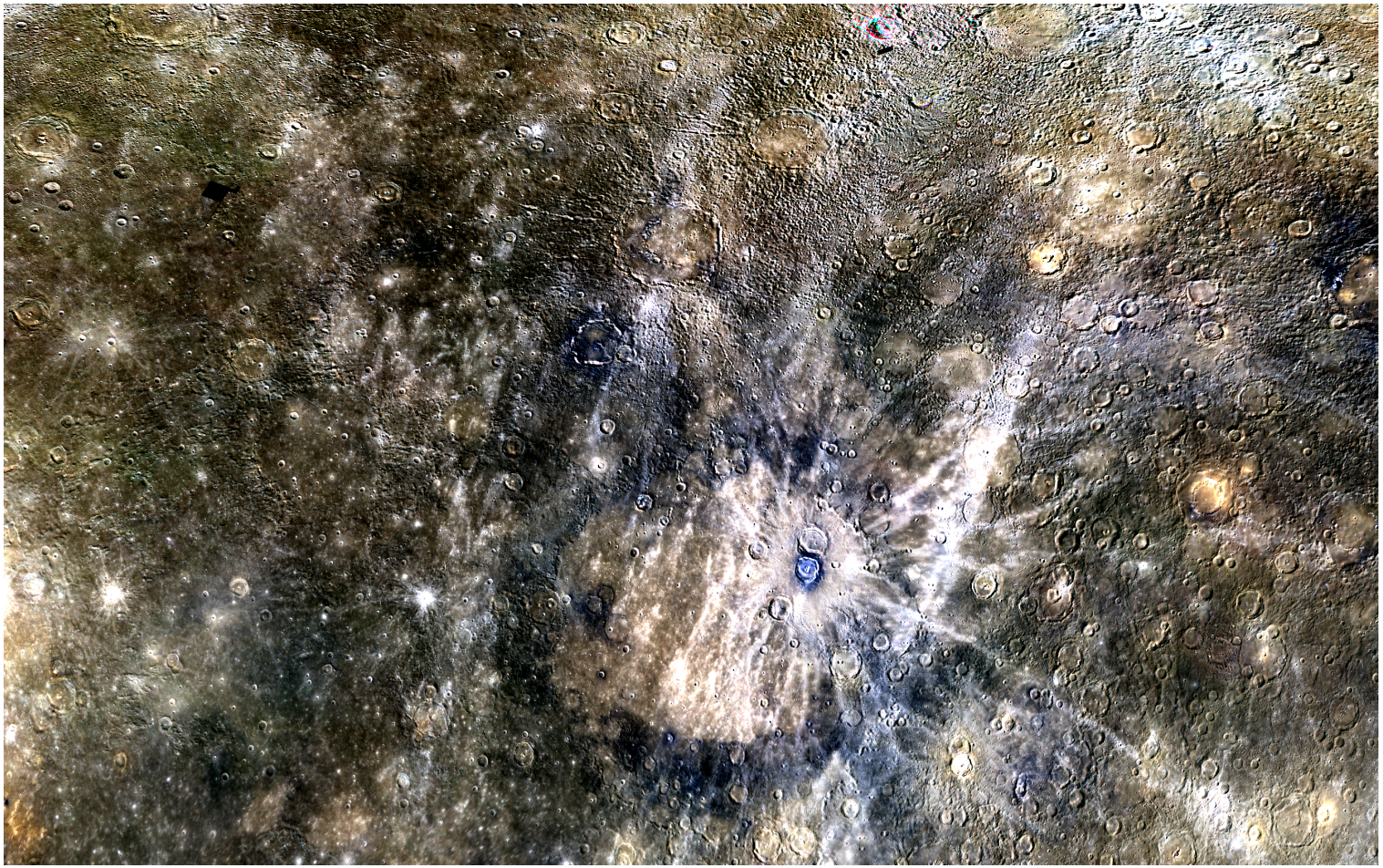

Figure: Enhanced color map of Shakespeare (4.7 Mpx, 1059 m/px)

Enhance color variations across the quadrangle:
yellow ⇒ pyroclastic deposits ; color dichotomy East/West

R=433/558 nm - G=433/828 nm - B=558/828 nm

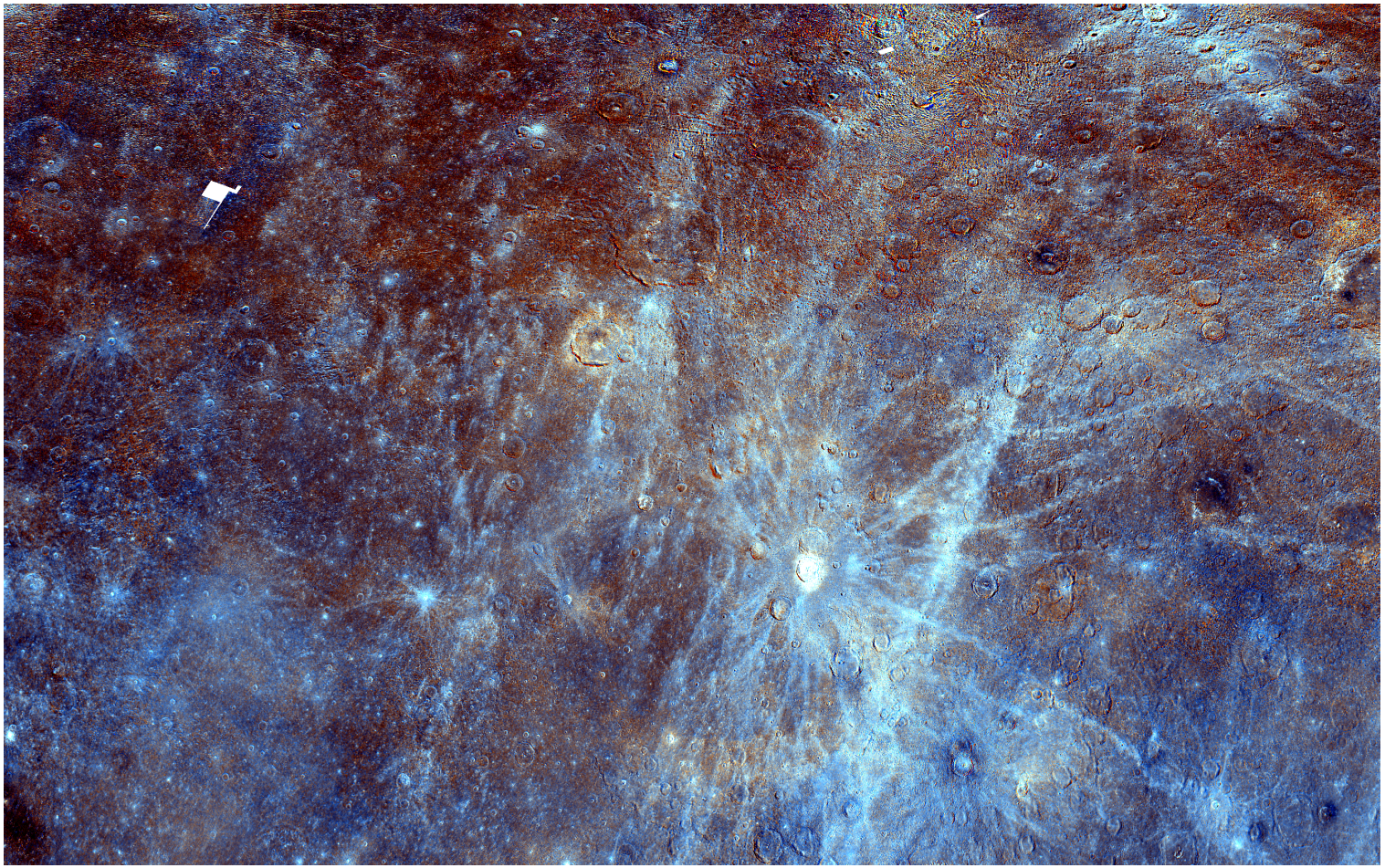

Figure: Enhanced color map of Shakespeare (ratios)

Enhance spectral slope variations across the quadrangle:
red ⇒ bluer slope in visible ; blue ⇒ bluer slope in NIR

R=-PC2 - G=PC1 - B=433/996 nm

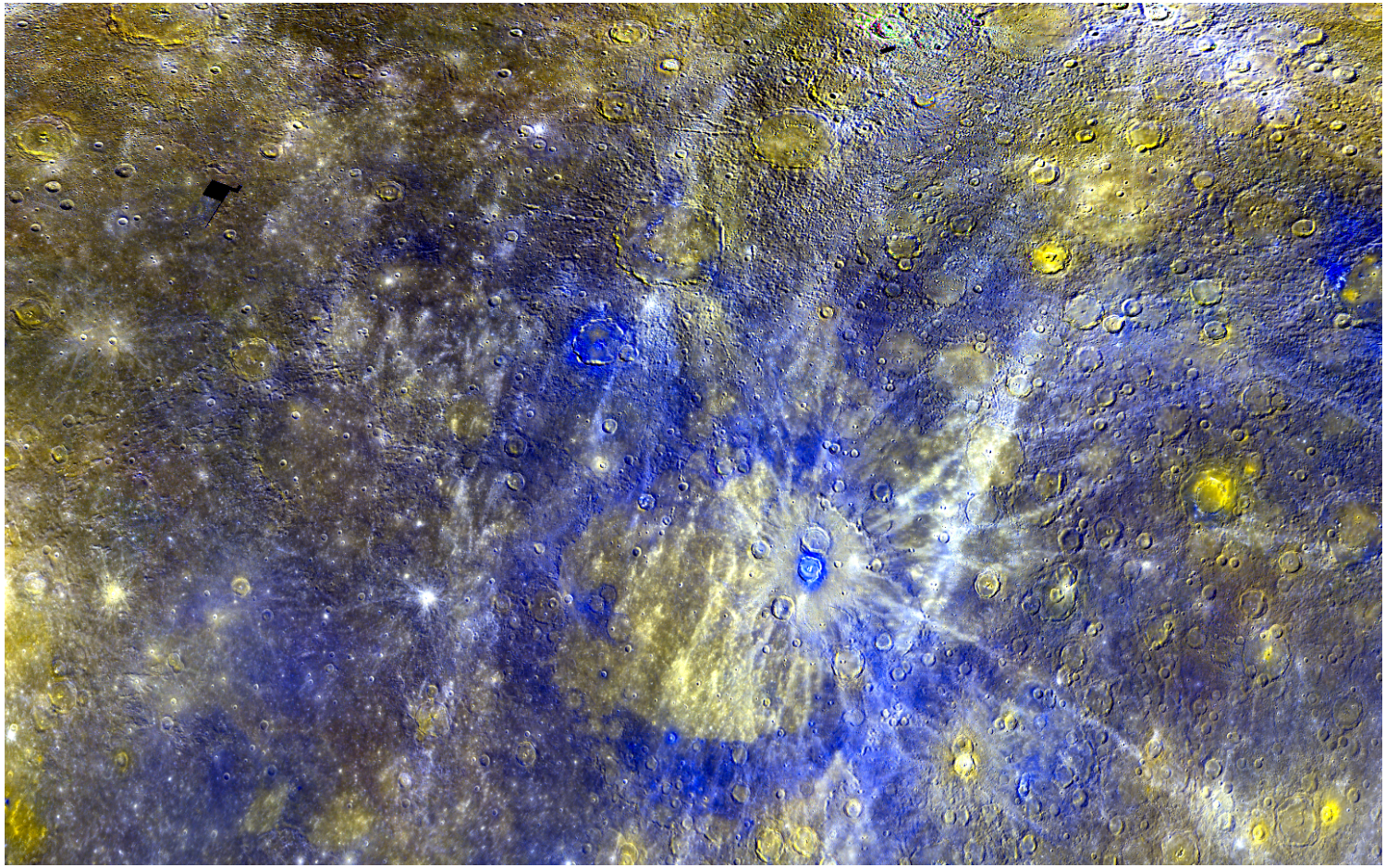

Figure: Enhanced color map of Shakespeare (PC + ratio)

Enhance color variations across the quadrangle:
dark blue ⇒ LRM; cyan ⇒ hollows; yellow ⇒ pyrocl. dep.

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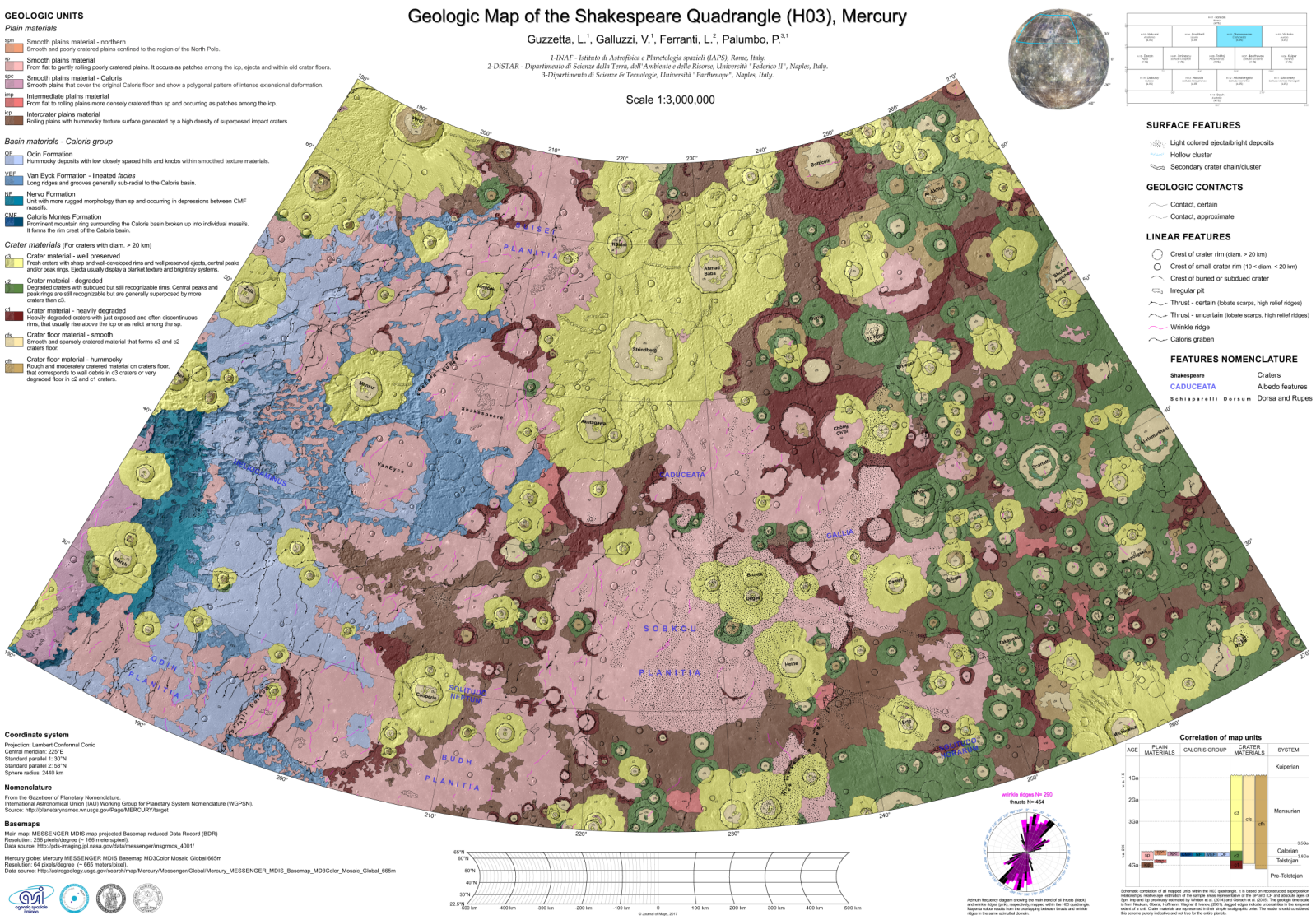

Figure: Geological map of the Shakespeare quadrangle [Guzzetta et al. 2017, Journal of Maps]

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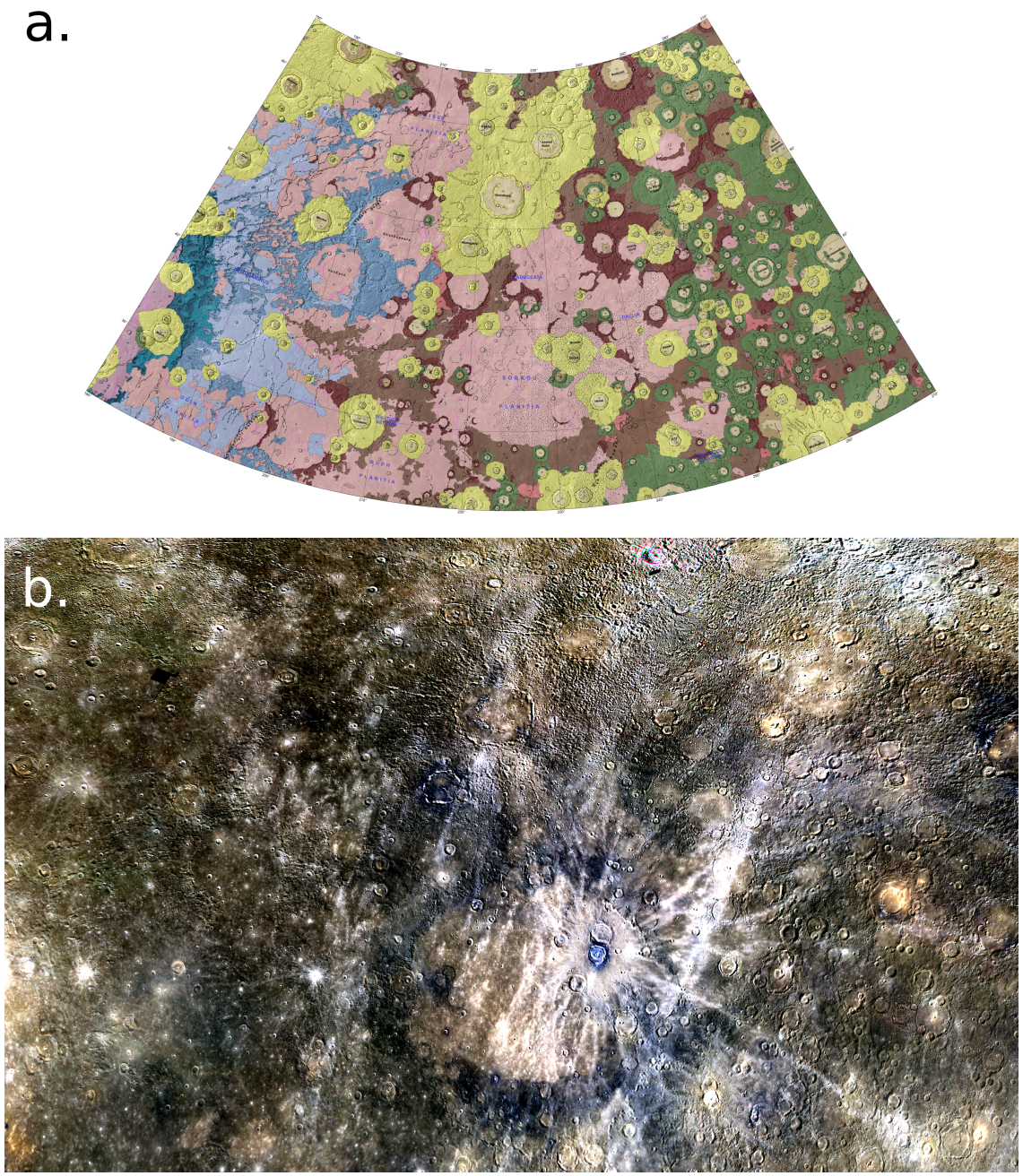

Figure: a. Geological map; b. RGB (996nm-749nm-433nm) map

Color map = geological map

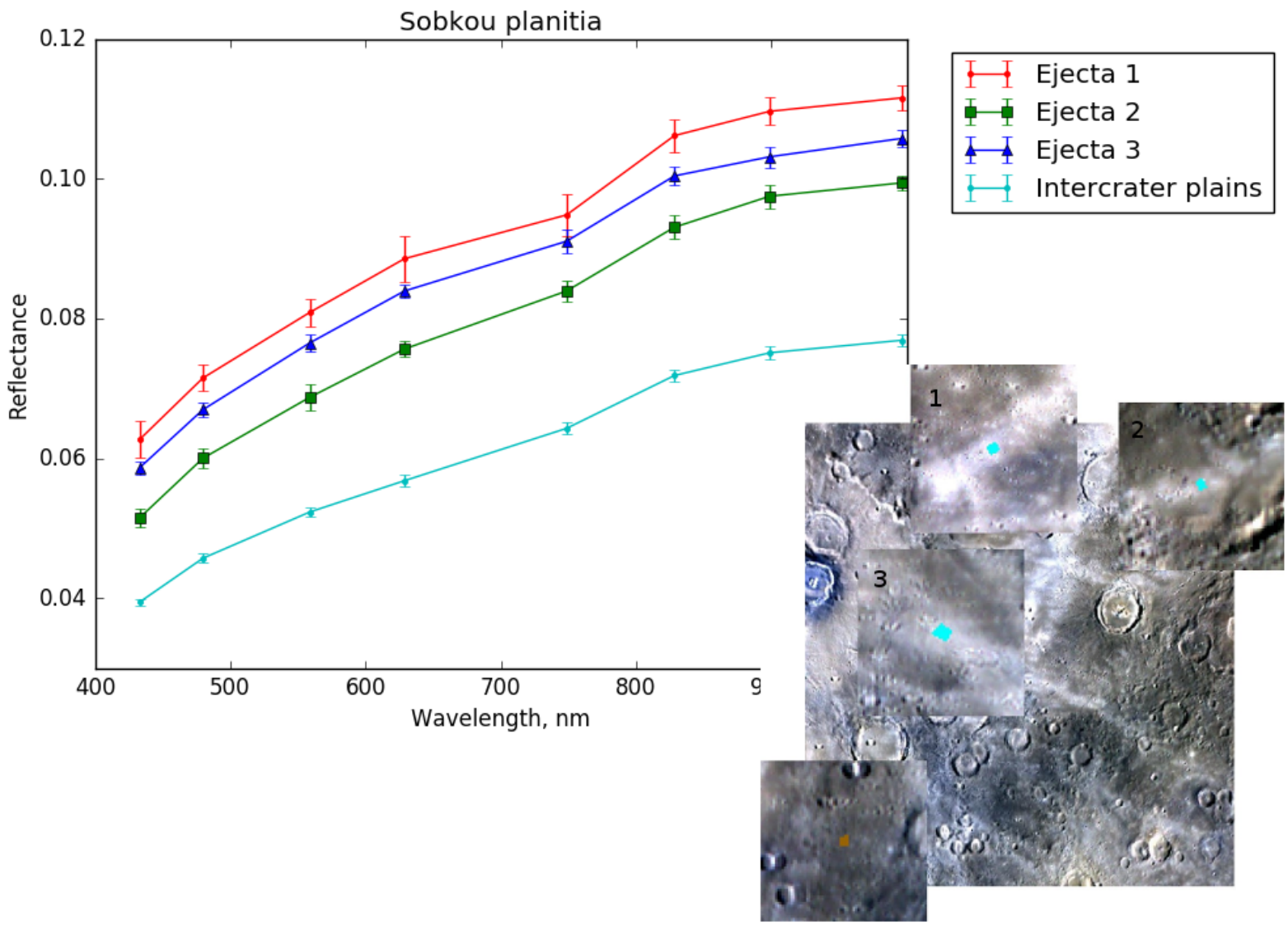

Figure: Spectrum of intercrater plains compared to spectra of ejectas from Sobkou planitia. RGB = 996nm-749nm-433nm

Color map $\neq$ geological map

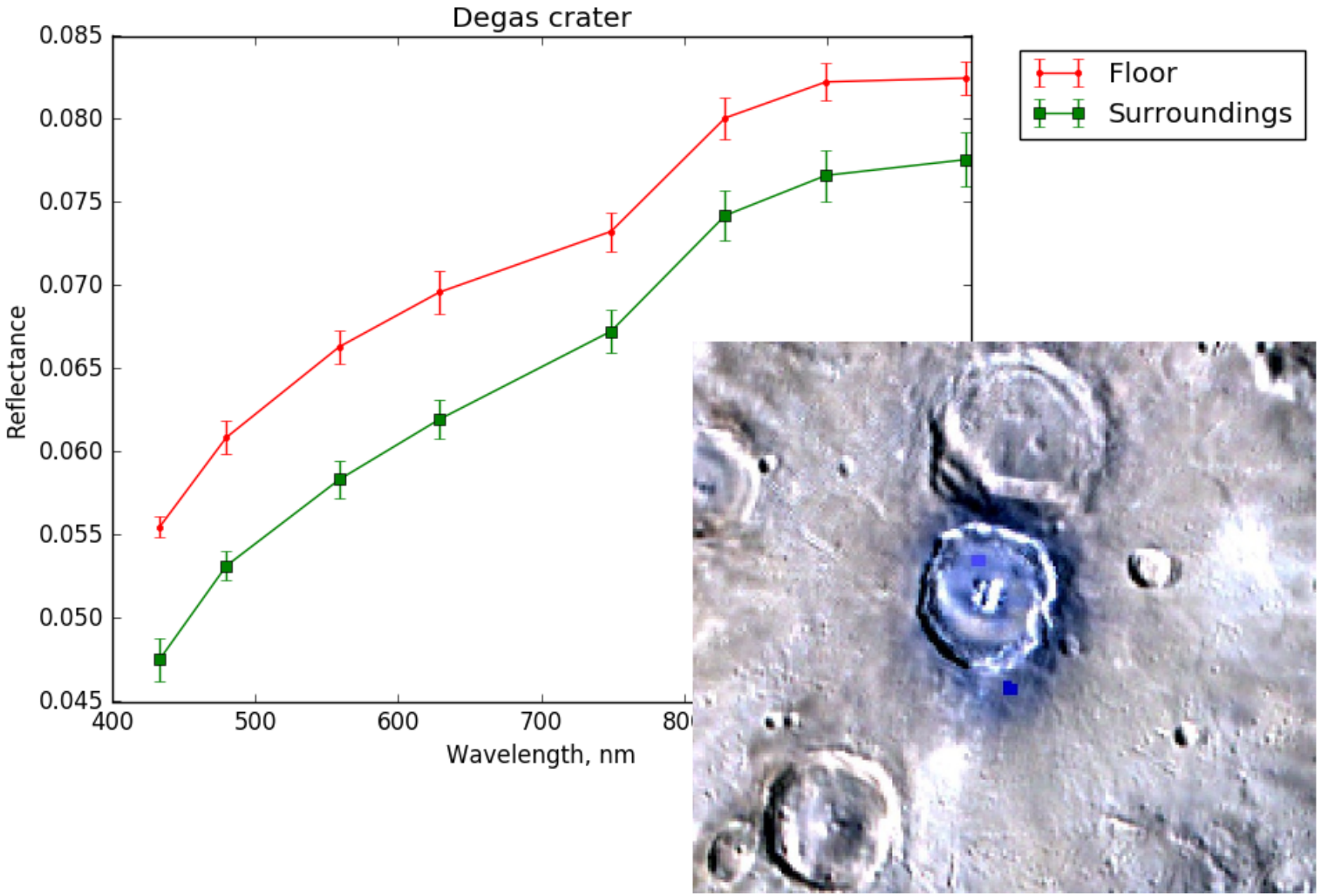

Figure: Spectrum of Degas crater's floor compared to spectrum of its surroundings. RGB = 996nm-749nm-433nm

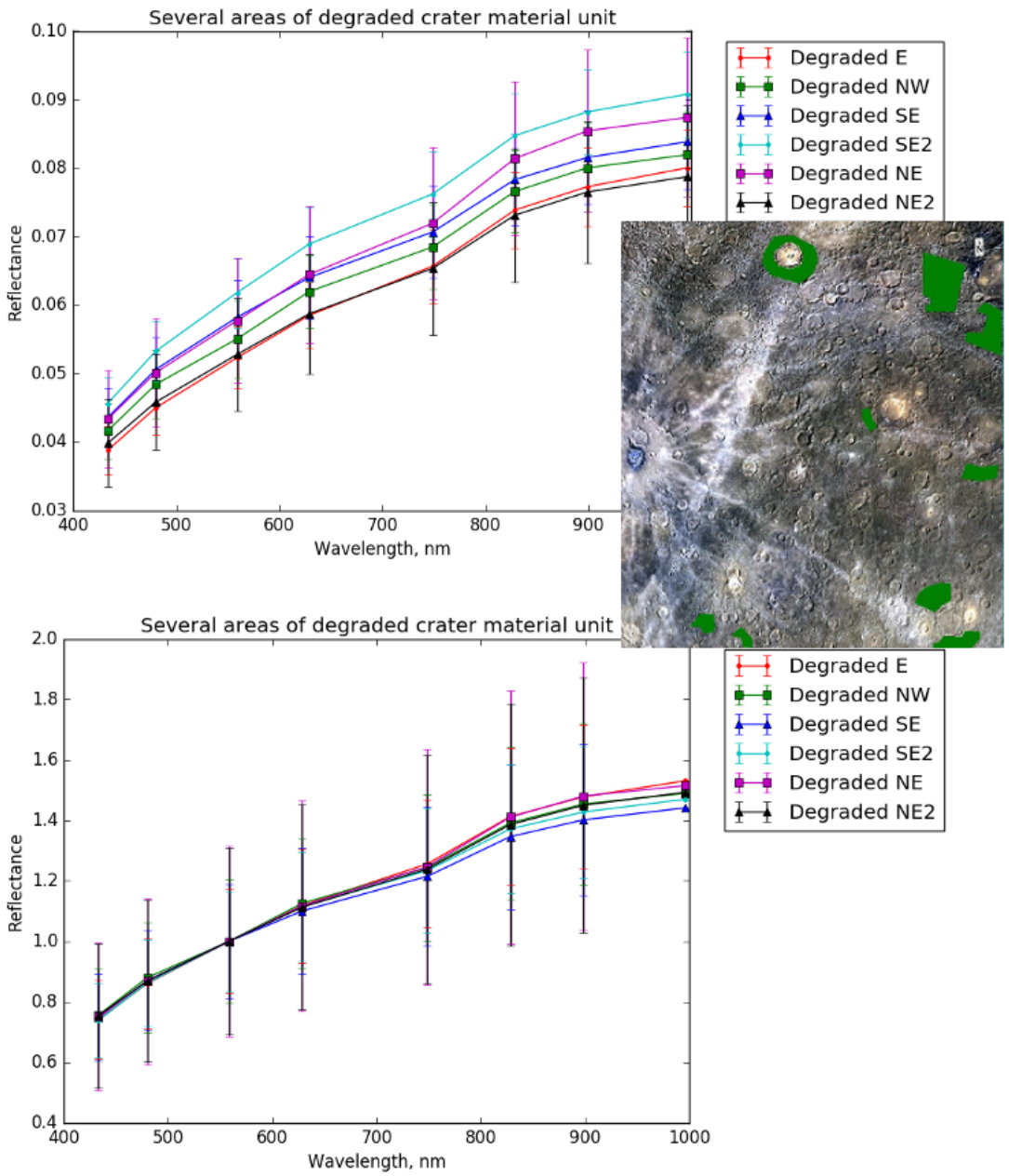

Figure: Spectral variations for the same geological unit. RGB = 996nm-749nm-433nm

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Not relevant to do spectral classification following the geological units $\Rightarrow$ k-means clustering:

- K-means parameters: 8 bands, 10 iterations $\Rightarrow$ $k = 5$ classes

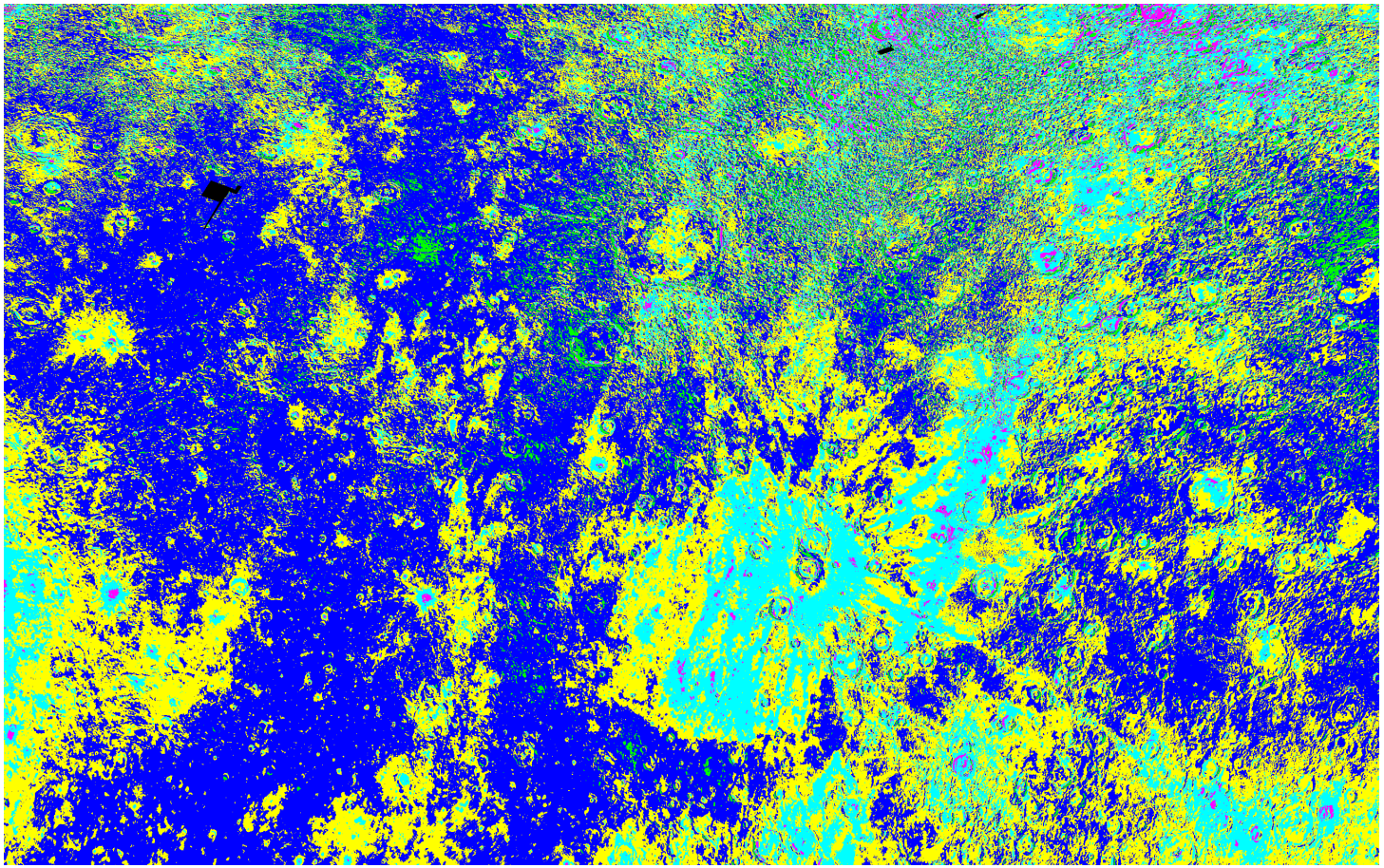

Figure: Shakespeare K-means results

Same dichotomy between West/East parts of Shakespeare

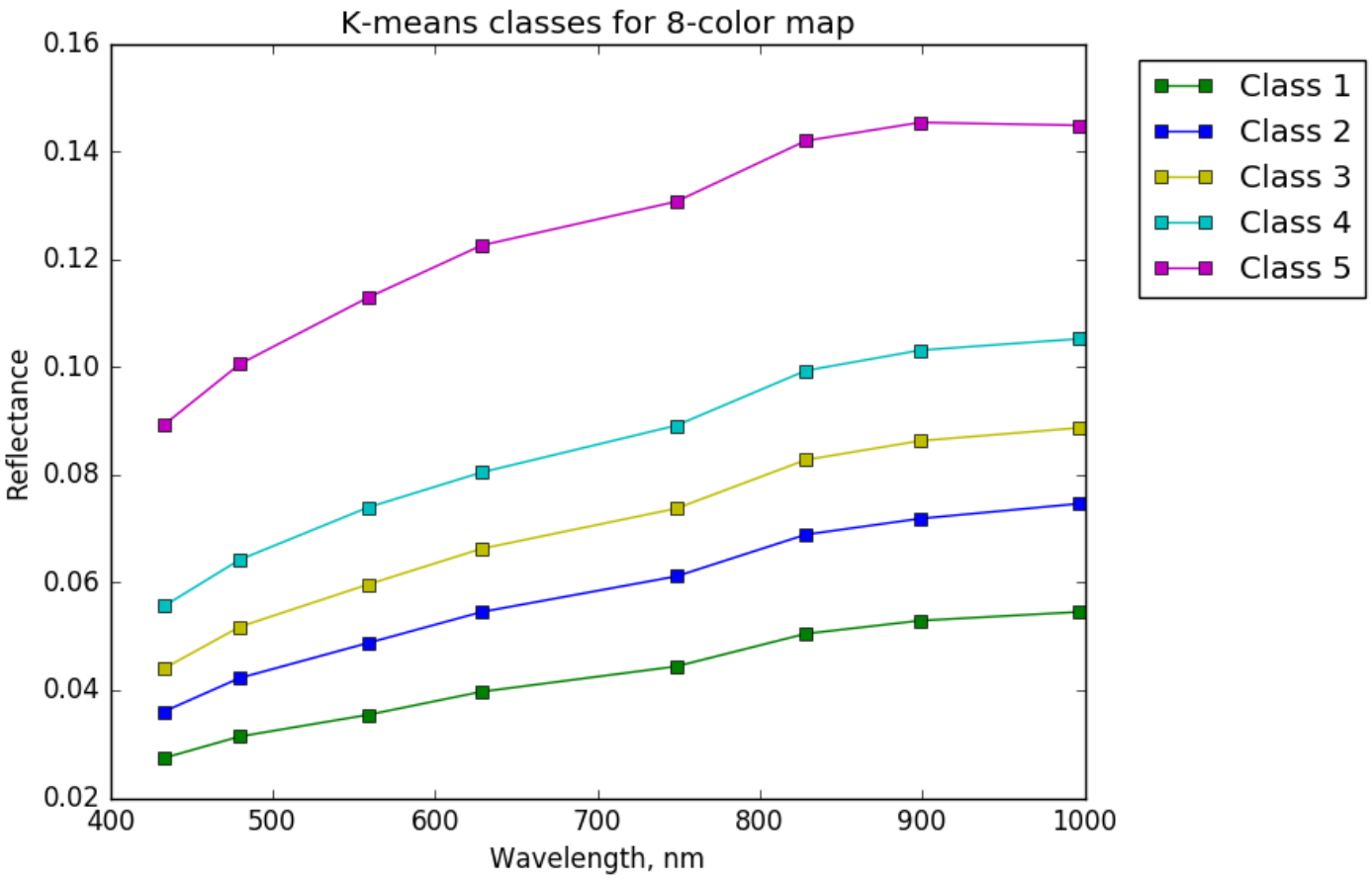

Figure: Shakespeare K-means classes

East old part (most cratered) has a global lower reflectance than the West young part ⇒ space weathering on Mercury? difference in mineralogy?

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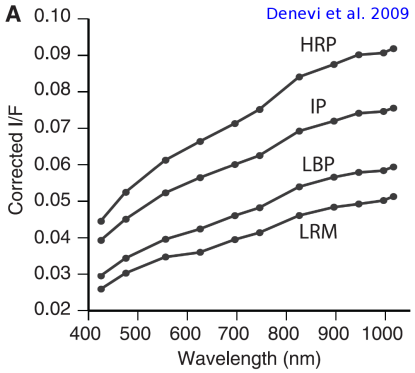
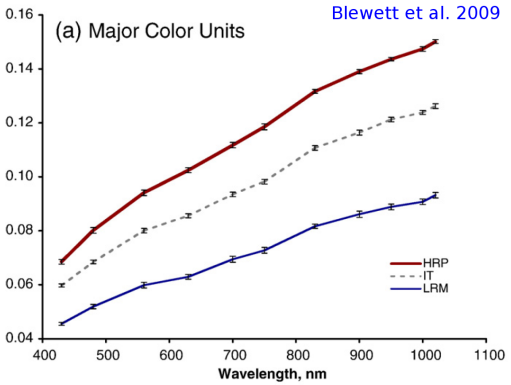
- Visual comparison color/geological units evidenced:
  - ⋆ Color contrast West/East parts of Shakespeare
  - ⋆ In many cases, color units correlate morpho-stratigraphic units... but some features do not show in geological map a specific unit like in color map (e.g. Degas crater)
- However, spectral analysis highlighted:
  - ⋆ Same dichotomy West/East parts of Shakespeare ⇒ old part bluer than young part ⇒ specific space weathering on Mercury? difference in mineralogy?
  - ⋆ Important spectral variations in the same geological unit
  - ⋆ Hard to distinguish spectra of each geological unit
  - ⋆ 5 spectral classes have been identified from 8-color map ⇒ correspond to reflectance/color major units evidenced in literature [Denevi et al. 2009, Blewett et al. 2009]?





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Future works:

- Improve resolution and coregistration of the maps
- Identify spectral units and combine them with geological units (and geochemical units? [Vander Kaaden et al. 2016])
- Explore MASCS data (0.3-1.45 µm) ⇒ caracterize more precisely regions of interest in support to BepiColombo mission

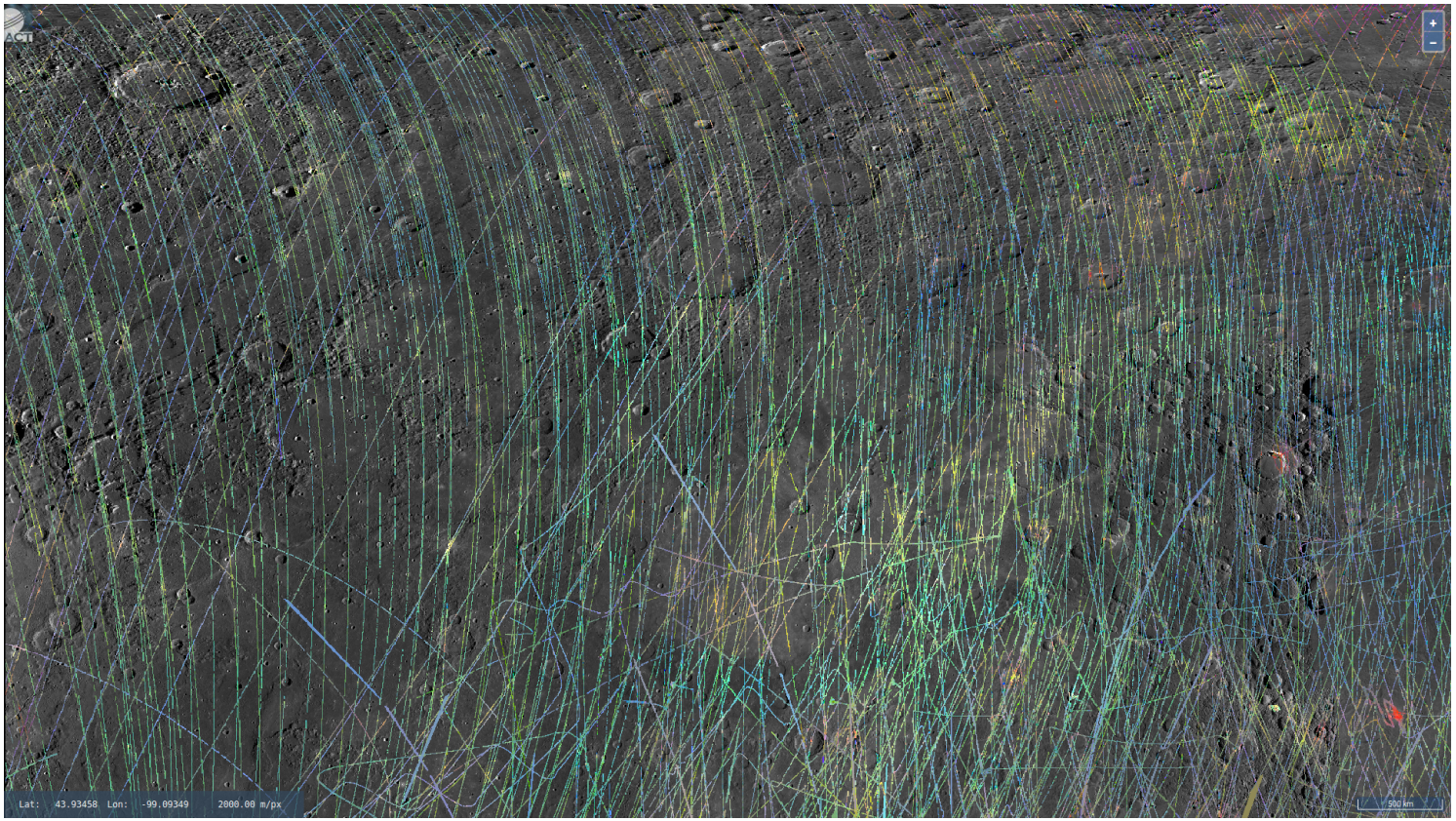

Figure: MASCS data available for the Shakespeare quadrangle (Credit: messenger-act-actgate.com)

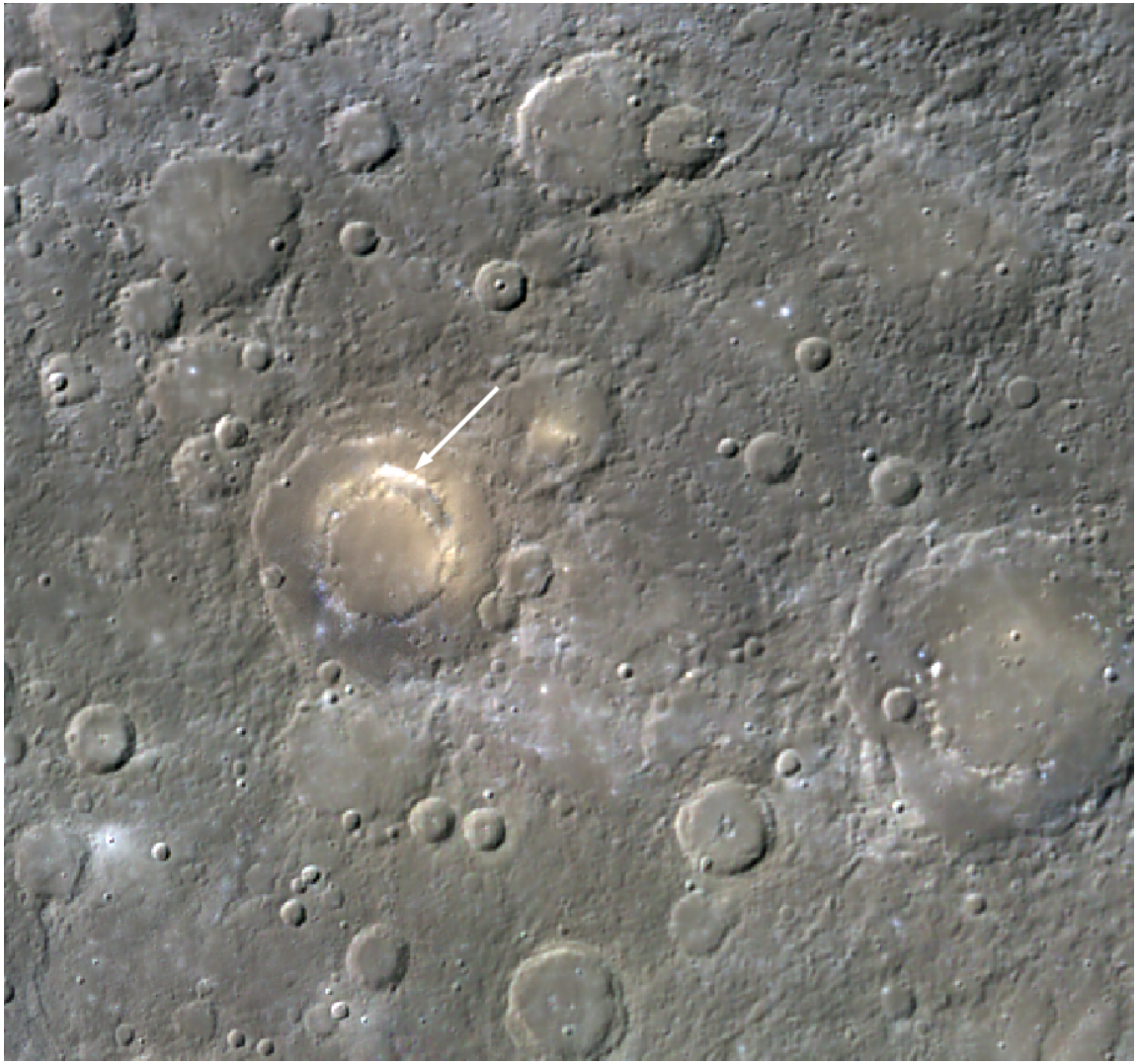

Figure: Example of pyroclastic deposits

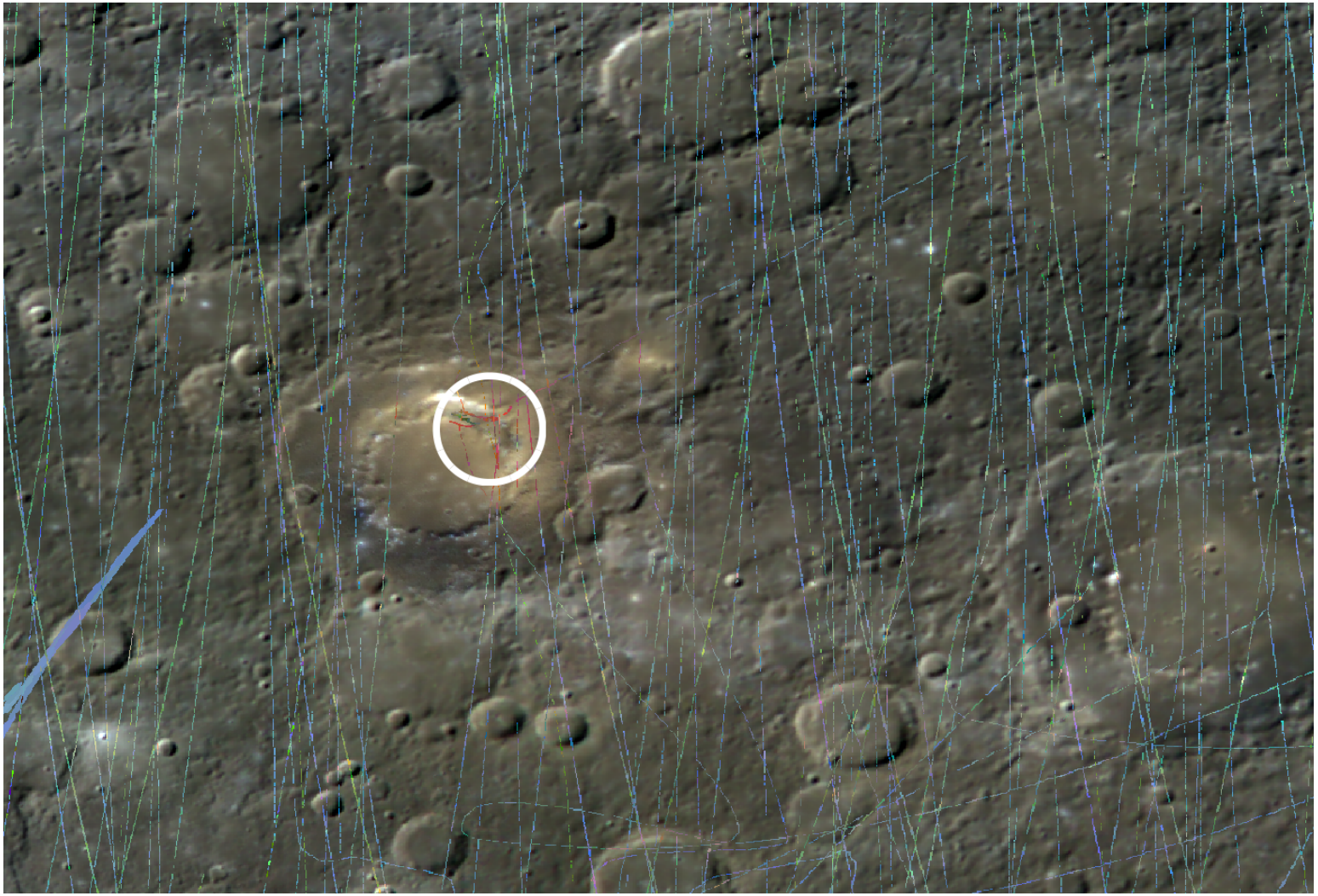

Figure: Pyroclastic deposits evidenced by MASCS data

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- Explore MASCS data (0.3-1.45 µm) ⇒ caracterize more precisely regions of interest in support to BepiColombo mission
- Continue the laboratory experiments (heating and cooling, irradiation)
- Reduce and analyse NSA spectra (in progress)

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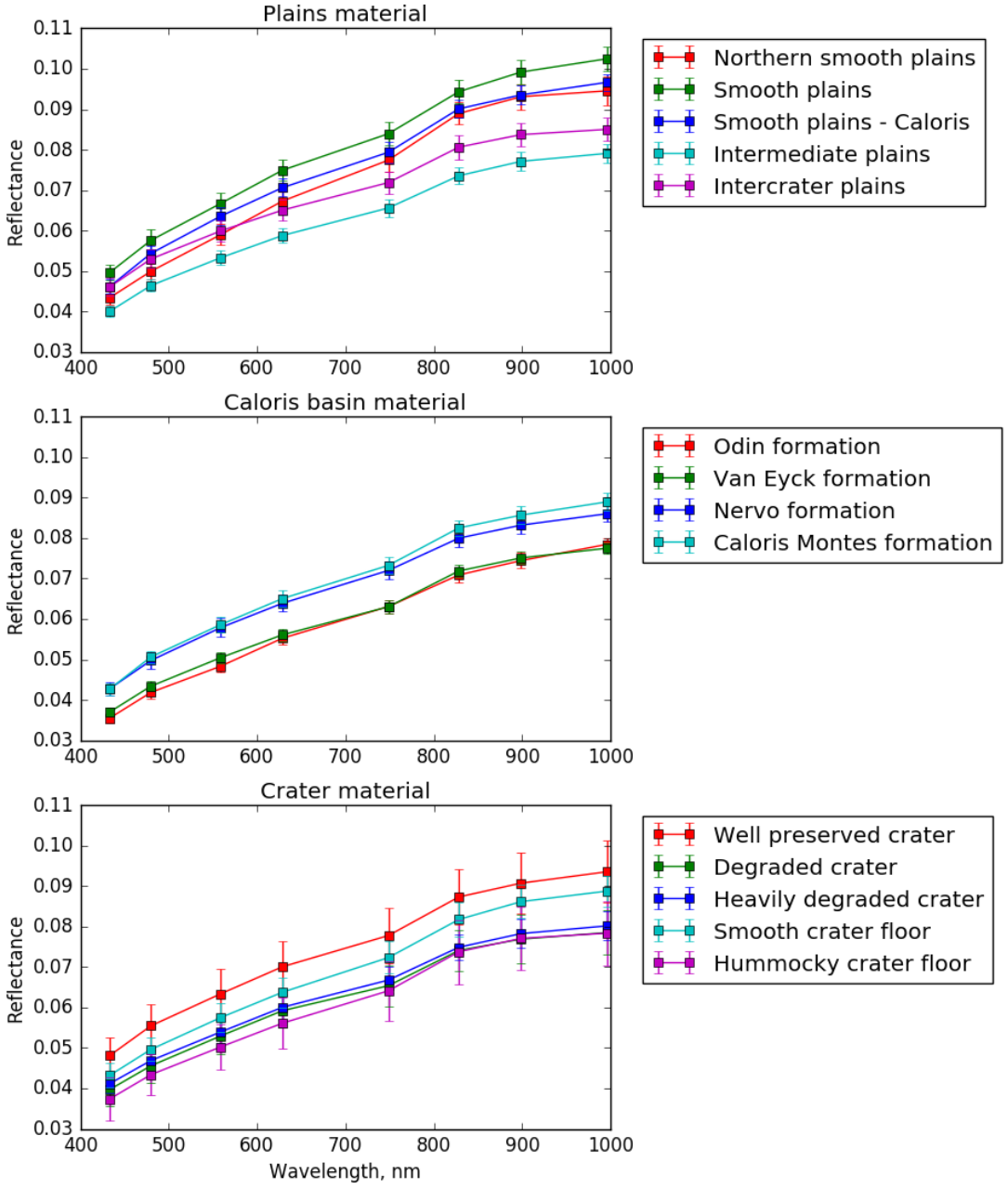

Figure: Spectral variations between all the geological units

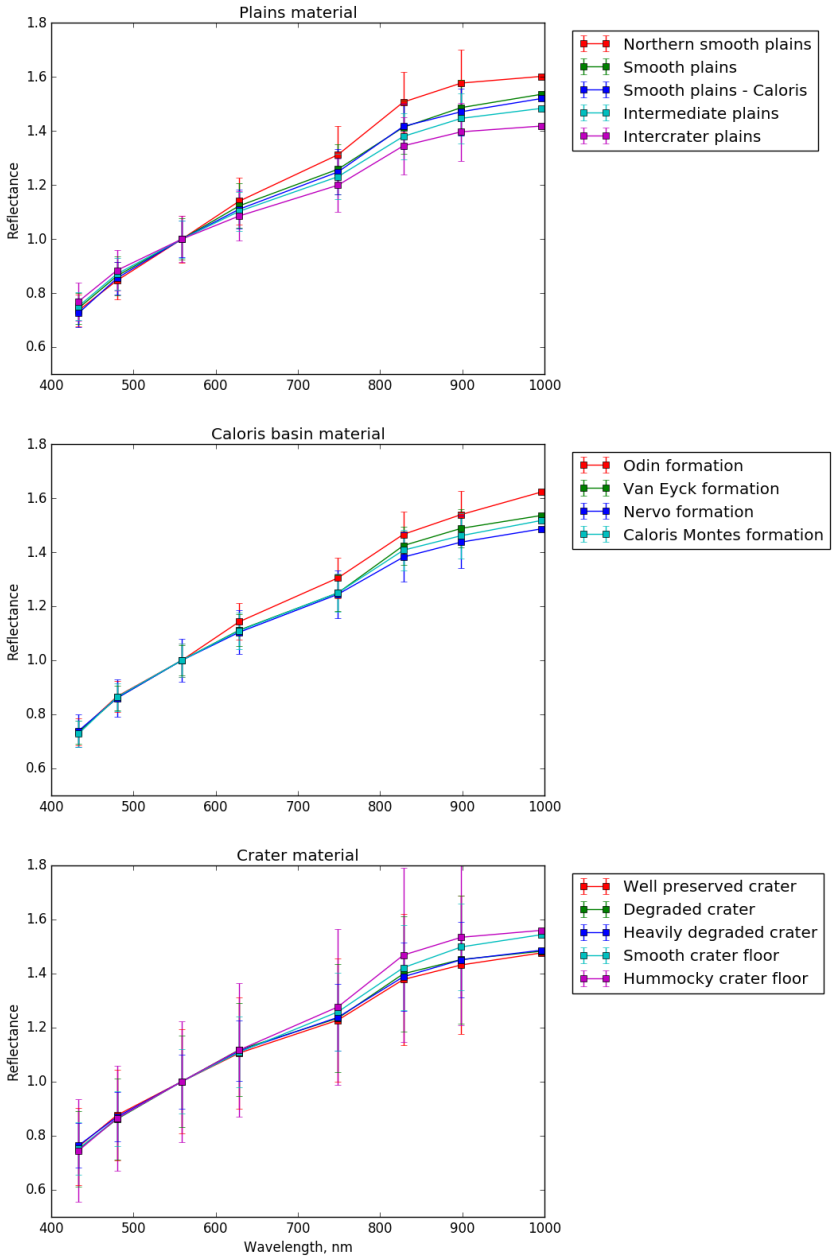

Figure: Spectral slope variations between all the geological units