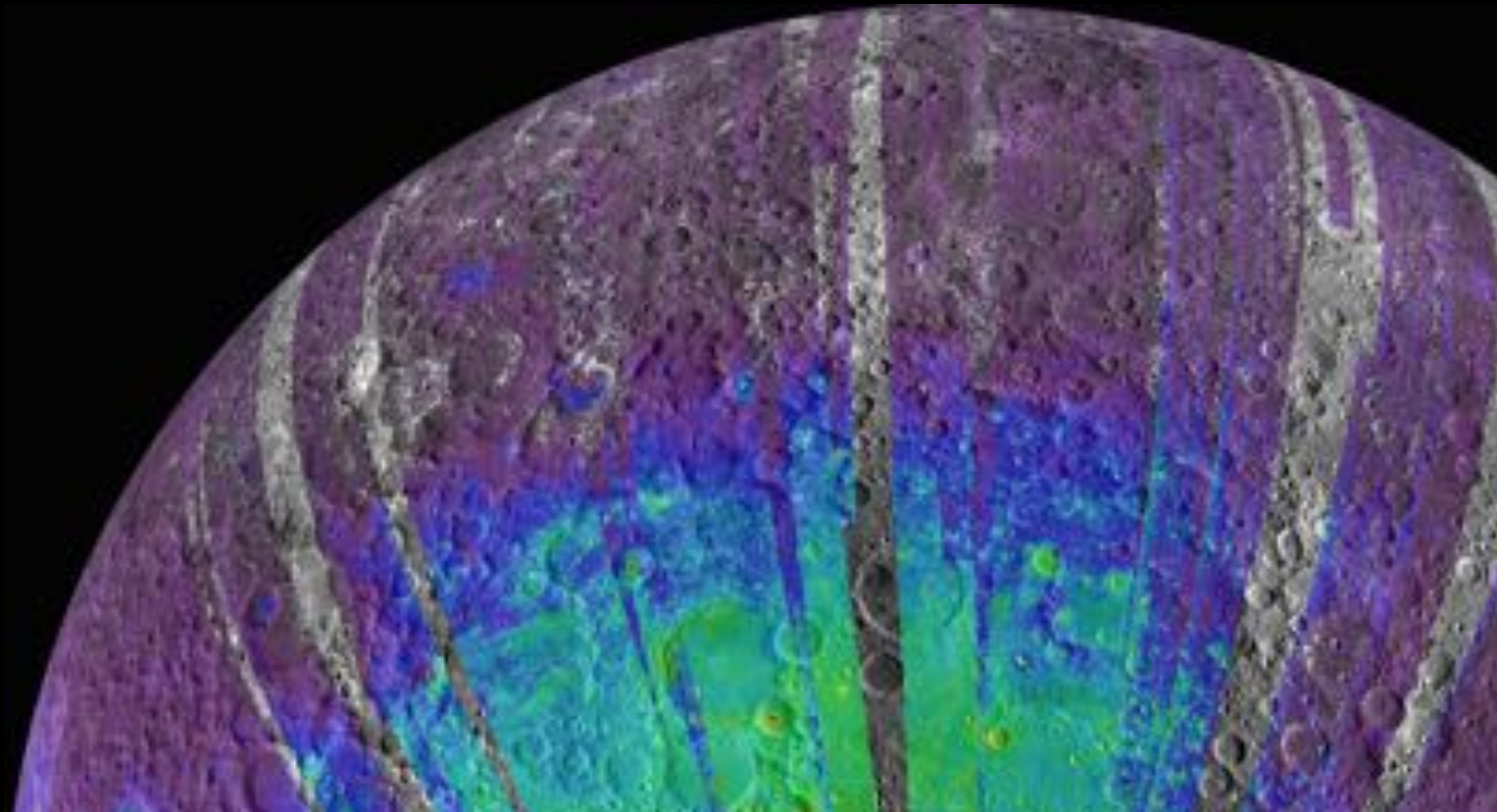
South Pole – Aitken Sample Return
Insights from Moon Mineralogy Mapper Data

Daniel P. Moriarty III • Noah E. Petro
Carle M. Pieters • Bradley L. Jolliff



SPA Sample Return Addresses Several Critical Lunar Science Questions

1. Basin Formation Chronology

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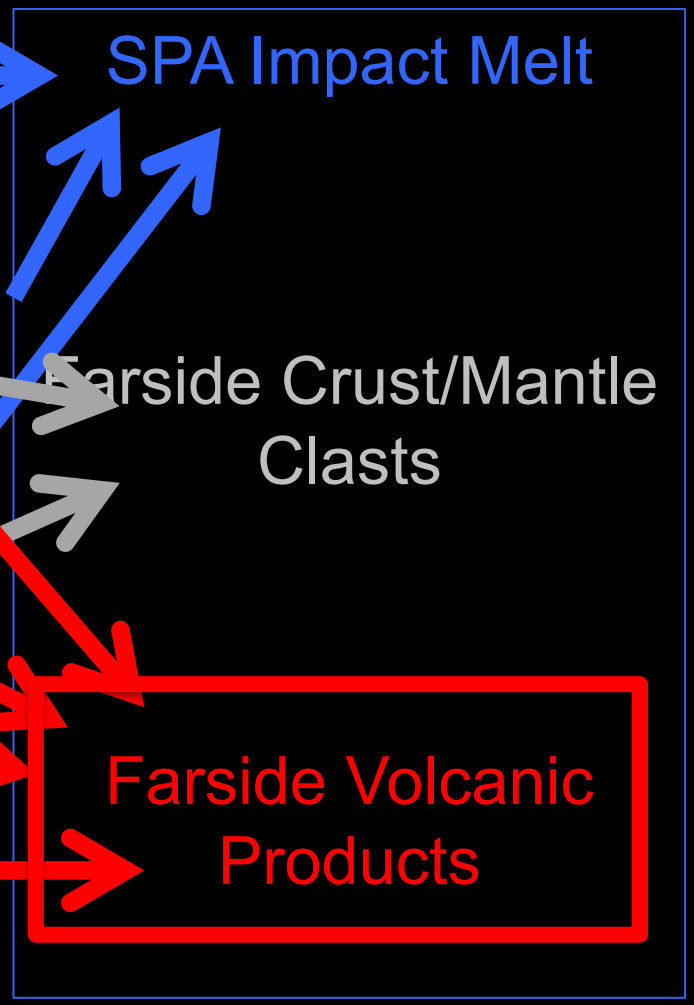
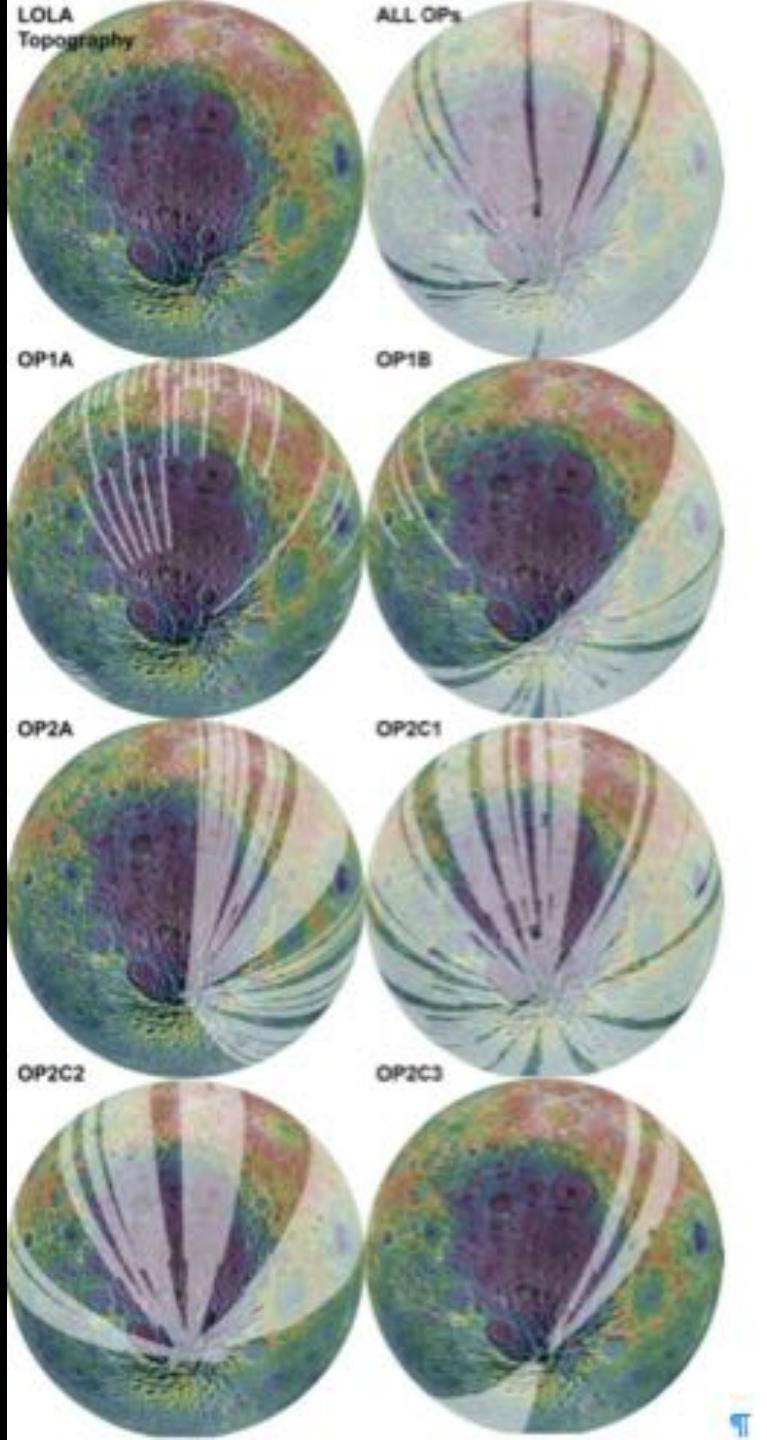
3. Large Impact Processes
4. Lunar Formation /Evolution
5. Lunar Farside Volcanism



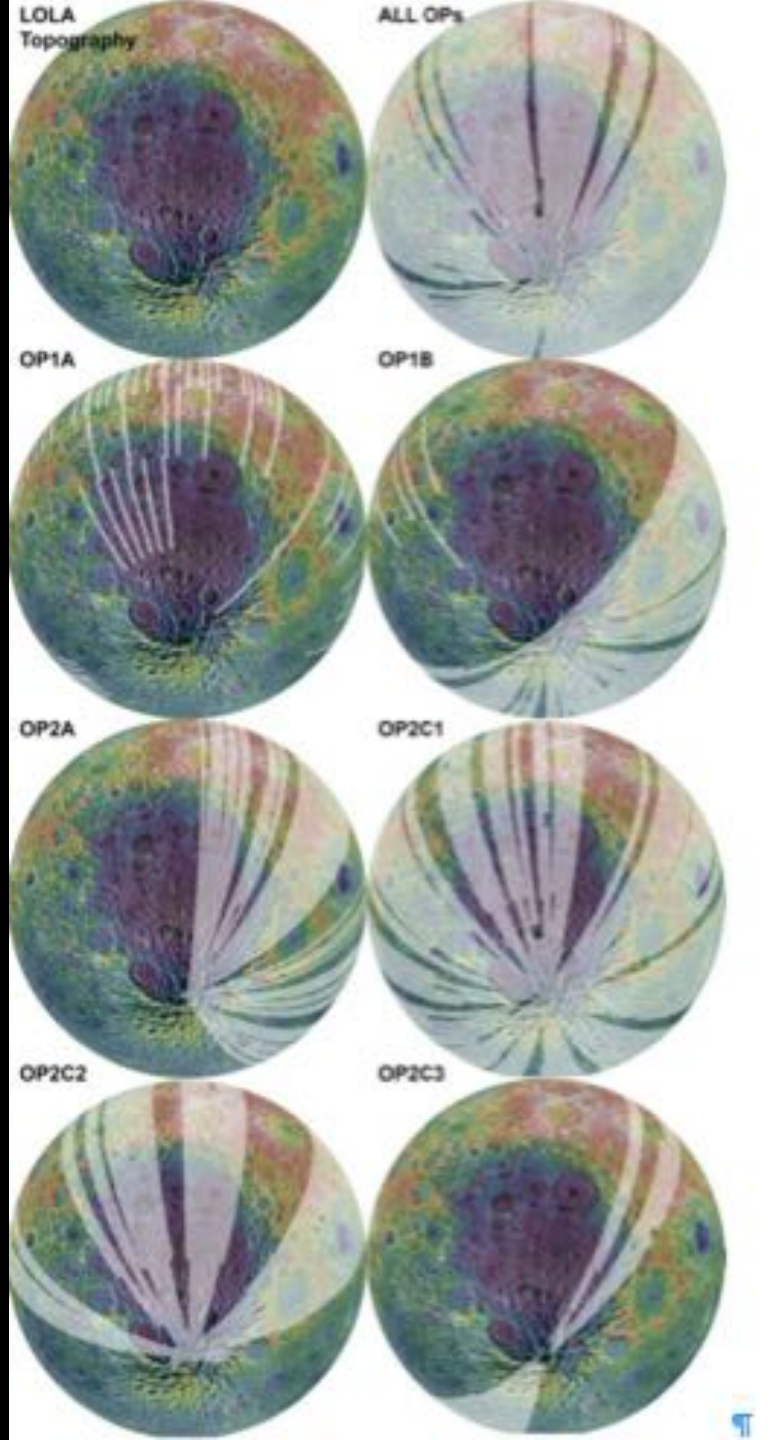
M^3 Analysis: Major Goals

1. Identify and map the surface distribution of critical sample types across SPA



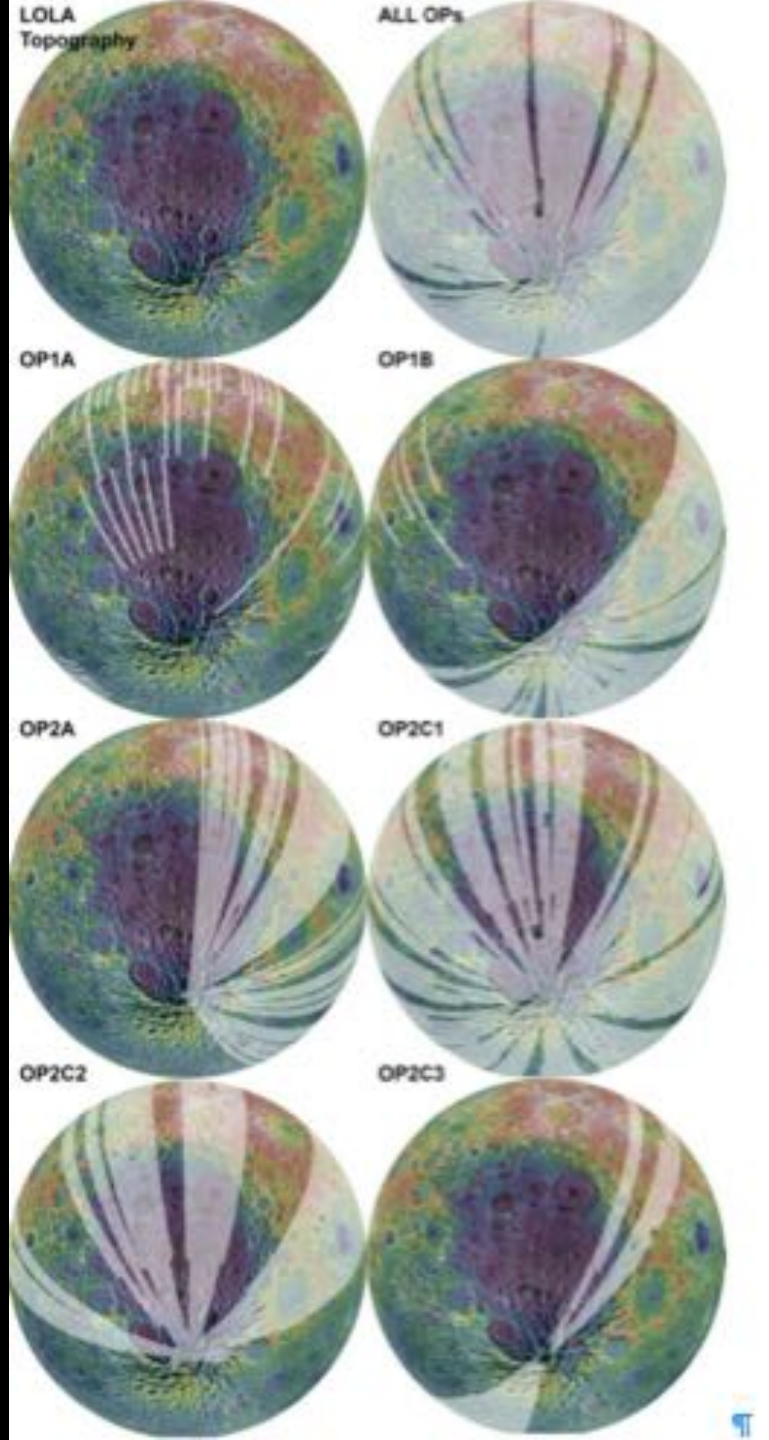
M^3 Analysis: Major Goals

1. Identify and map the surface distribution of critical sample types across SPA
2. Understand the compositional structure of SPA



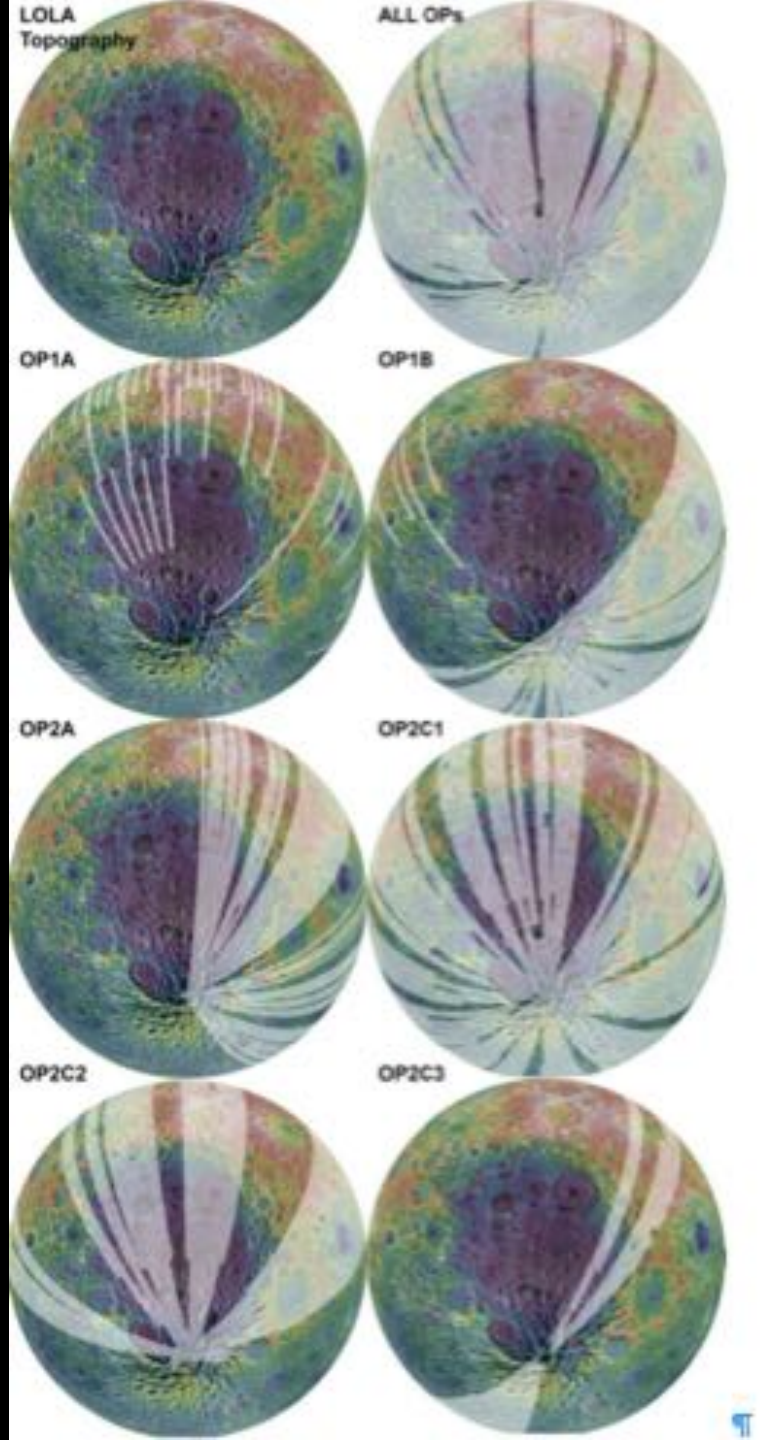
M^3 Analysis: Major Goals

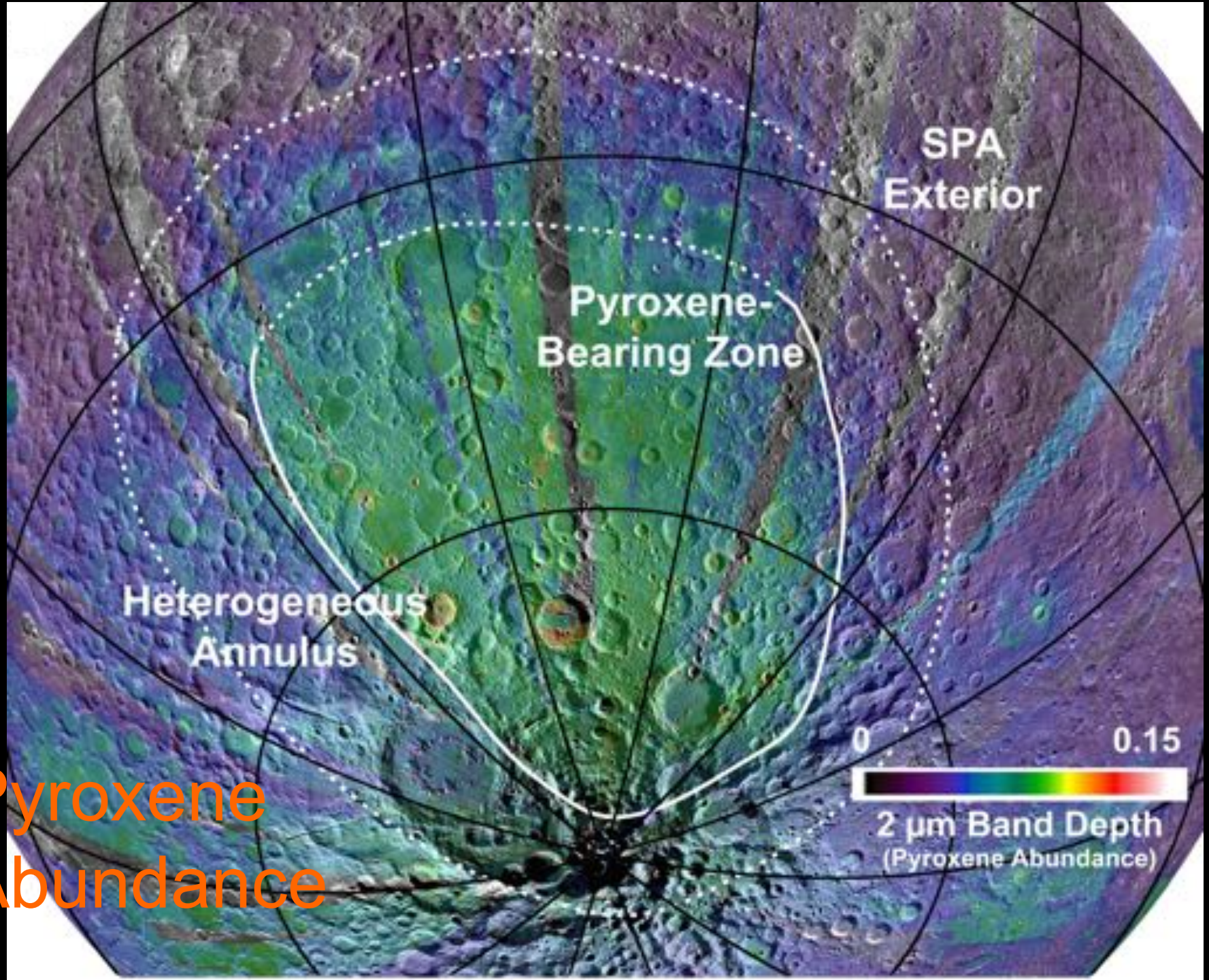
1. Identify and map the surface distribution of critical sample types across SPA
2. Understand the compositional structure of SPA
   A. Improve context for sample analysis



M^3 Analysis: Major Goals

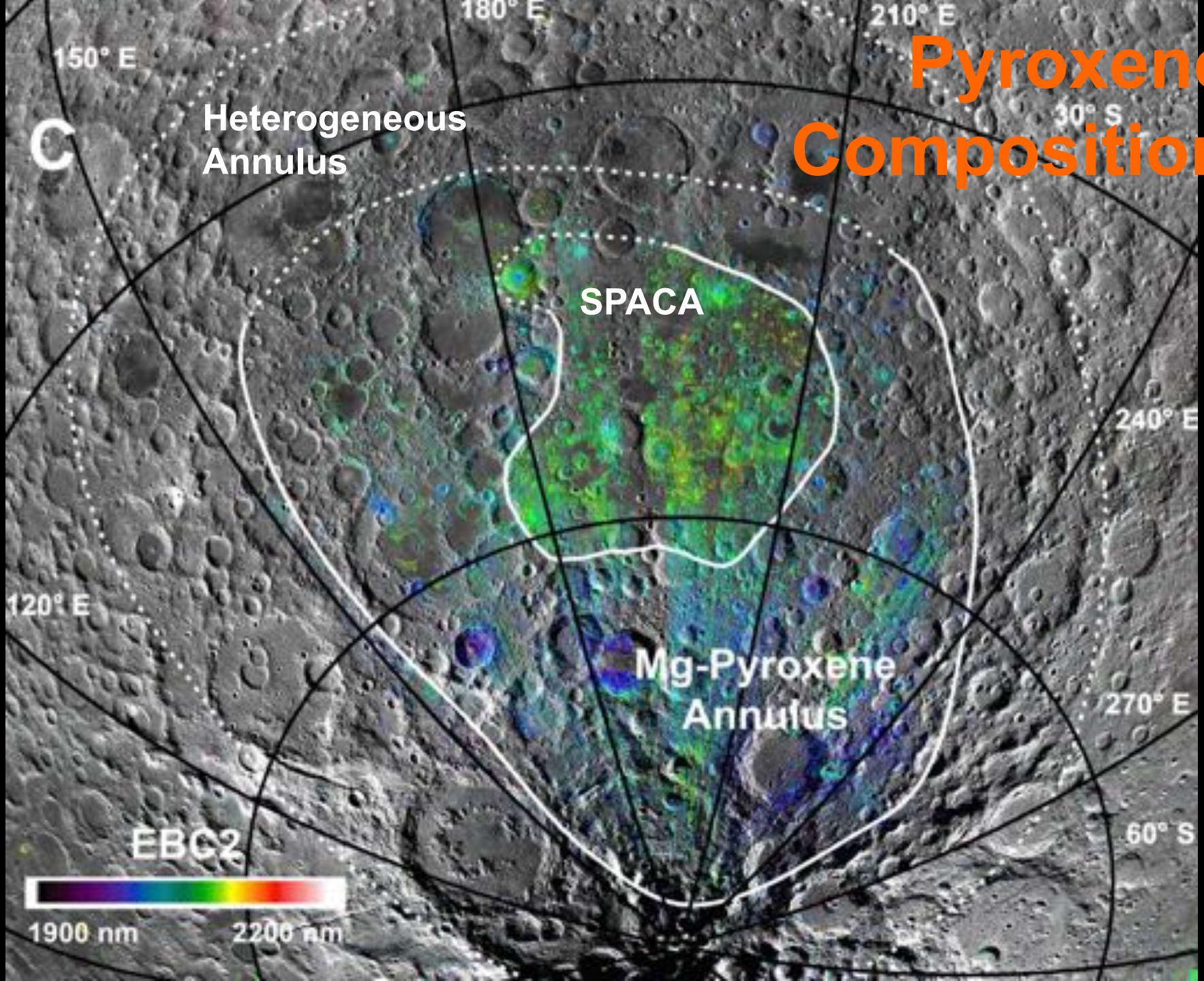
1. Identify and map the surface distribution of critical sample types across SPA
2. Understand the compositional structure of SPA
   A. Improve context for sample analysis
   B. Directly address critical science questions identified in the Decadal Surveys

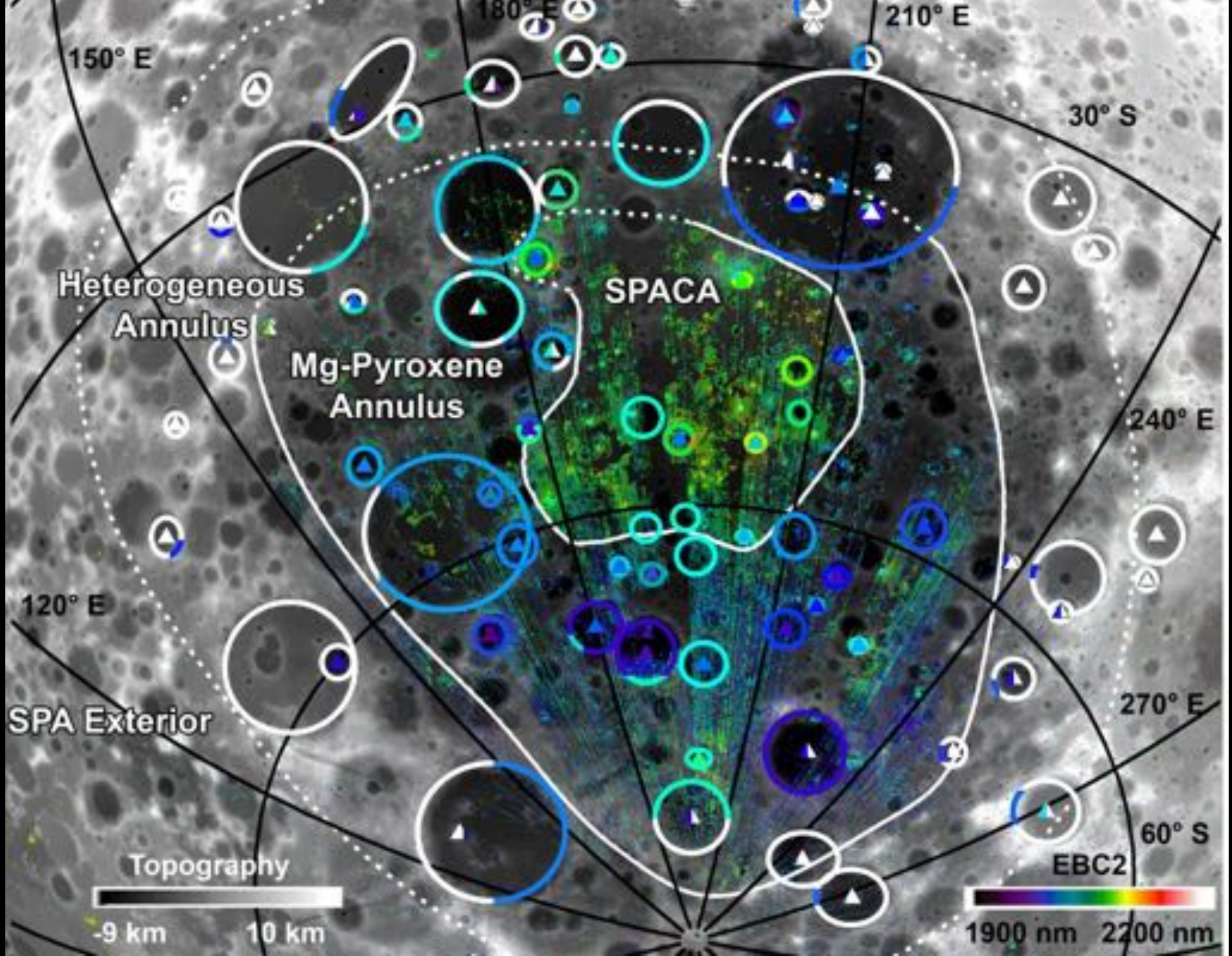


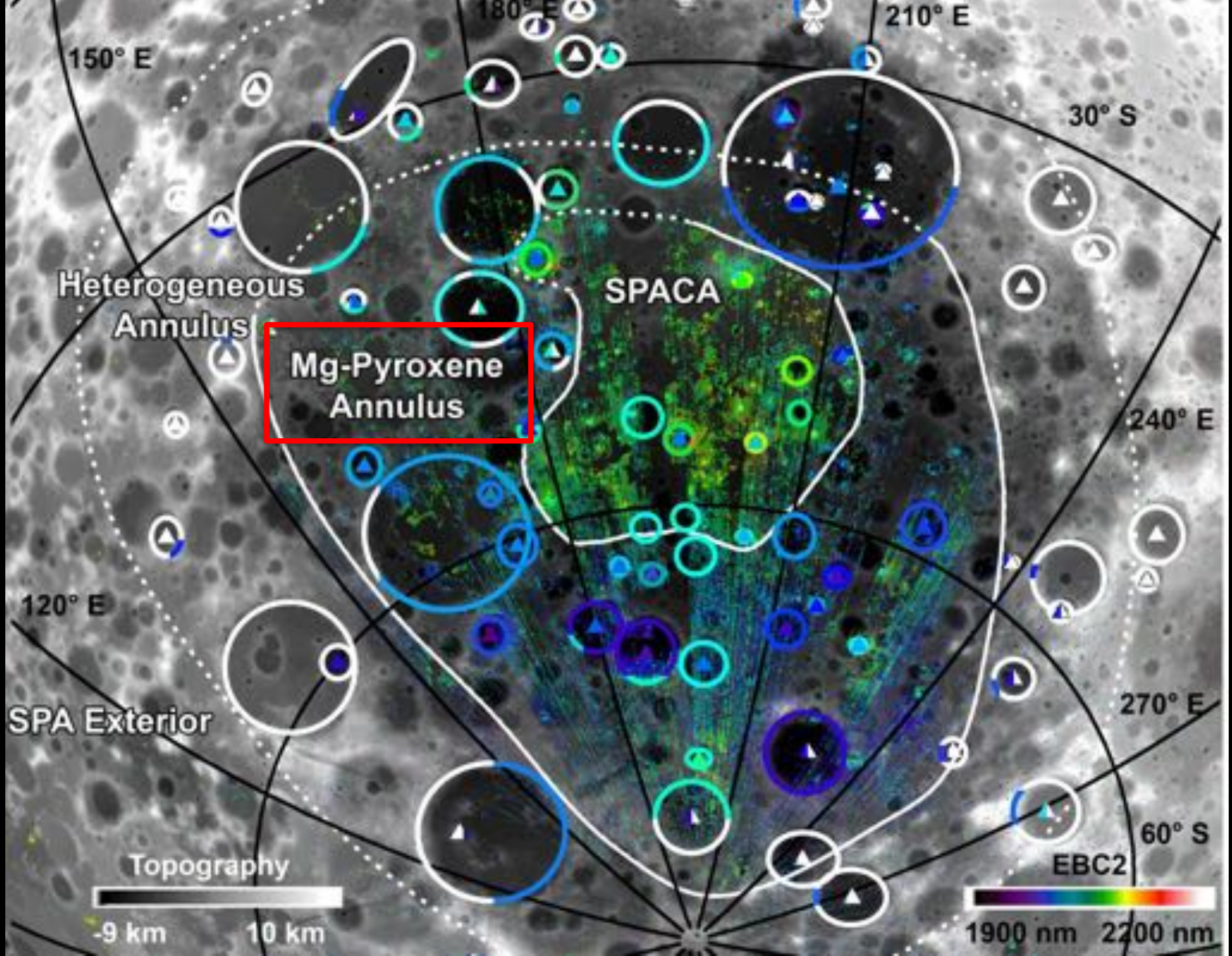


Pyroxene Abundance

Pyroxene Composition




180° E
210° E
150° E
30° S
Heterogeneous Annulus
SPACA
Mg-Pyroxene Annulus
240° E
120° E
SPA Exterior
270° E
60° S
Topography
-9 km
10 km
EBC2
1900 nm
2200 nm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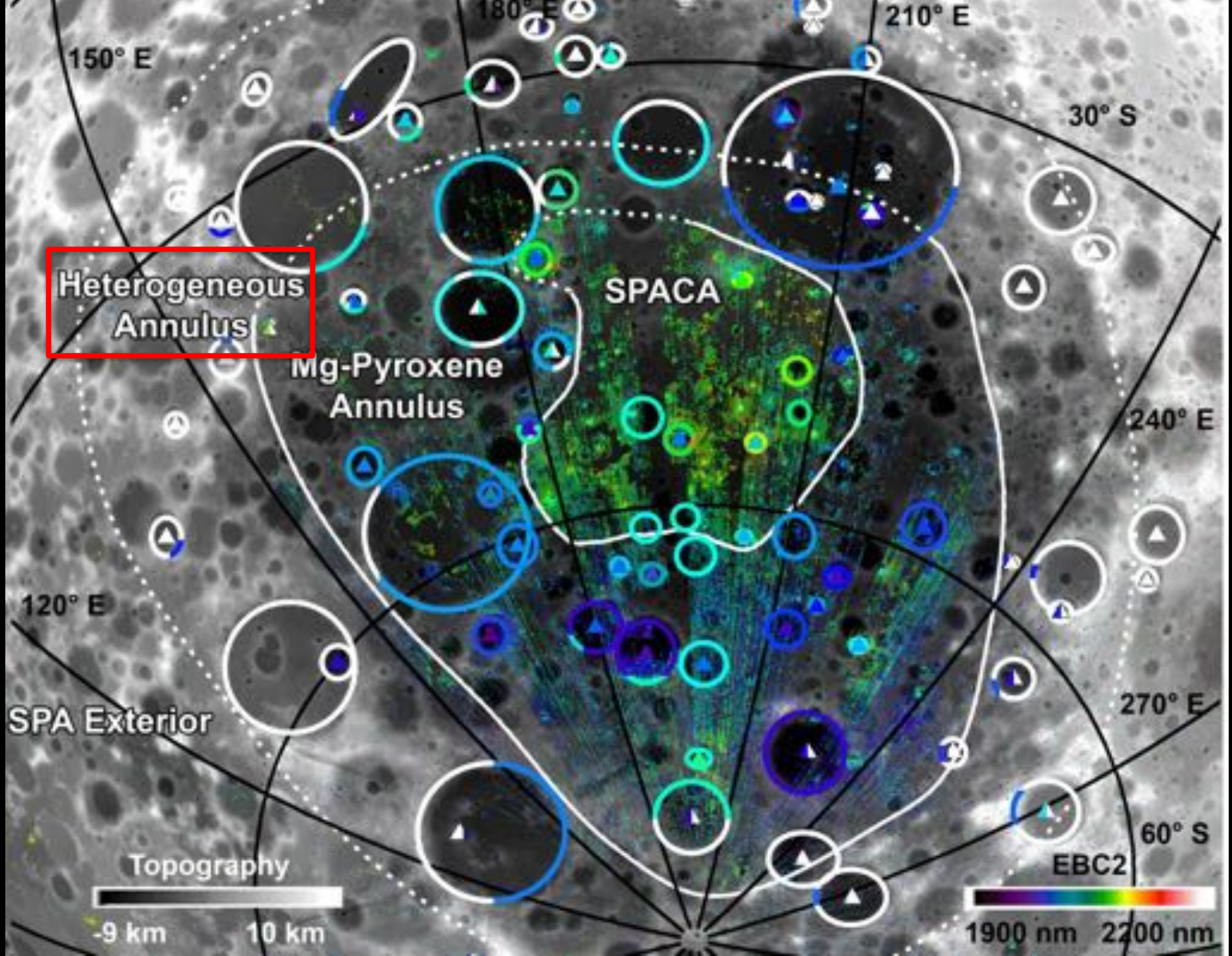
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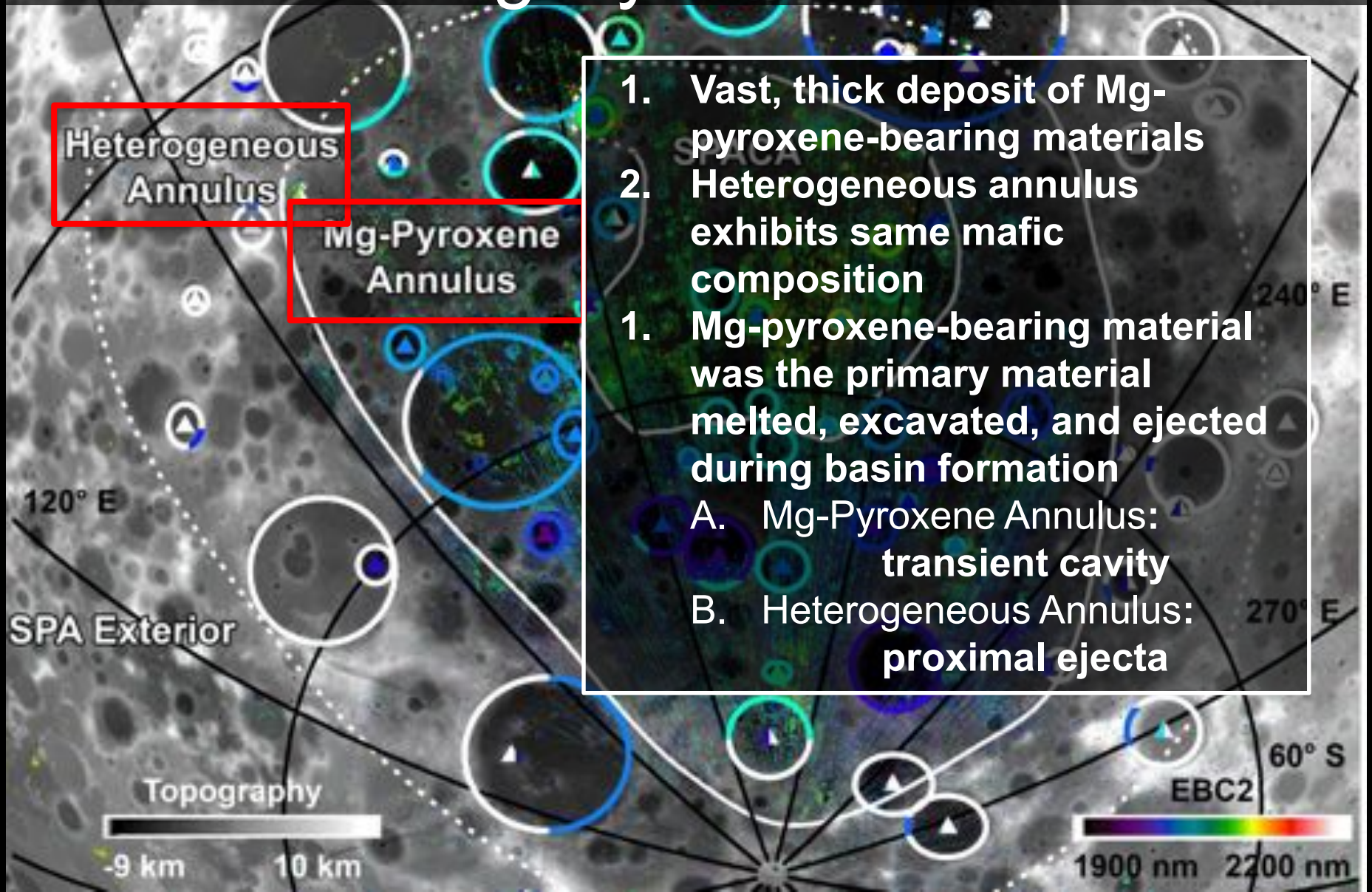
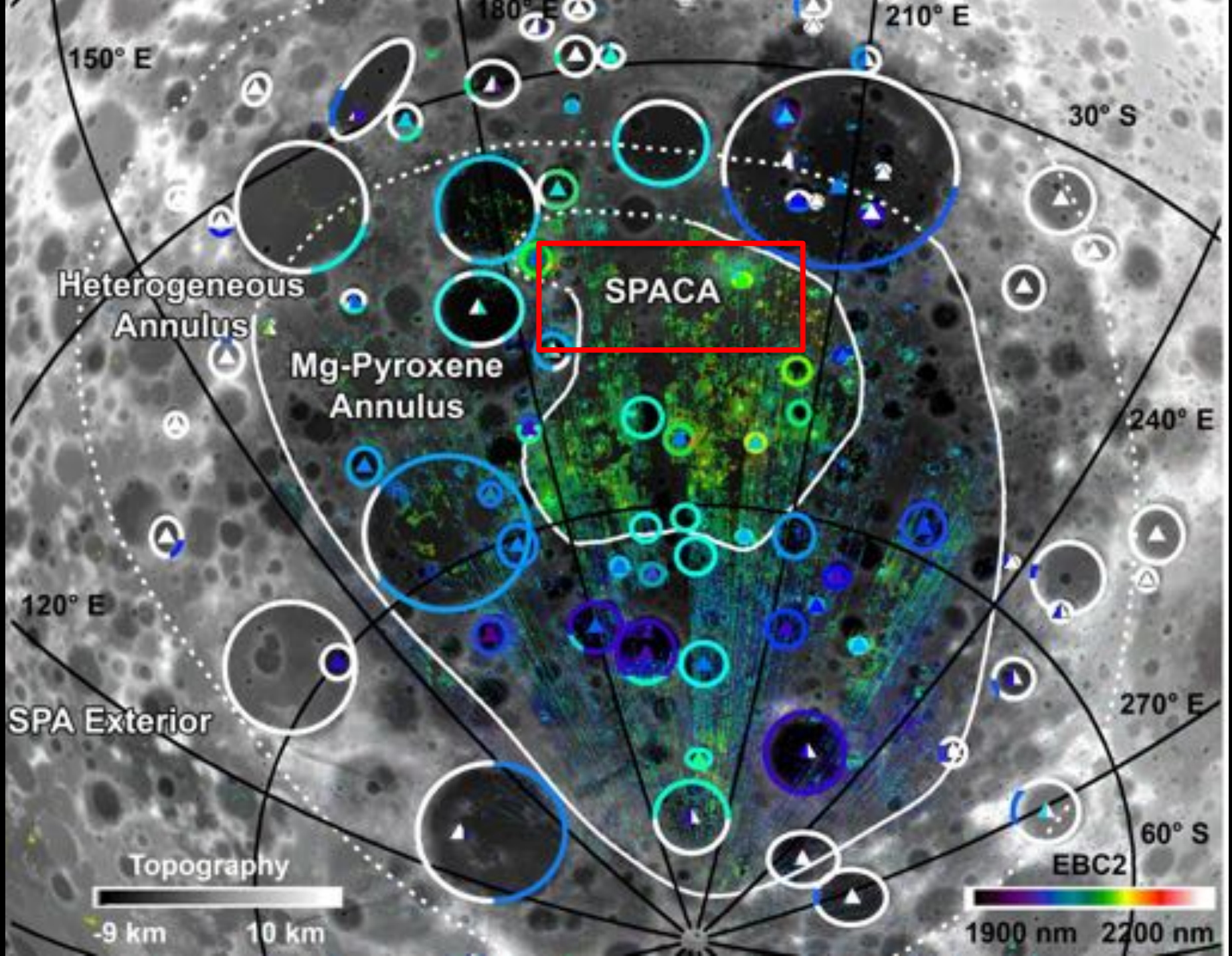
SPA Science Conclusions: Mg-Pyroxenes



1. **Vast, thick deposit of Mg-pyroxene-bearing materials**
2. **Heterogeneous annulus exhibits same mafic composition**
1. **Mg-pyroxene-bearing material was the primary material melted, excavated, and ejected during basin formation**
   A. Mg-Pyroxene Annulus: **transient cavity**
   B. Heterogeneous Annulus: **proximal ejecta**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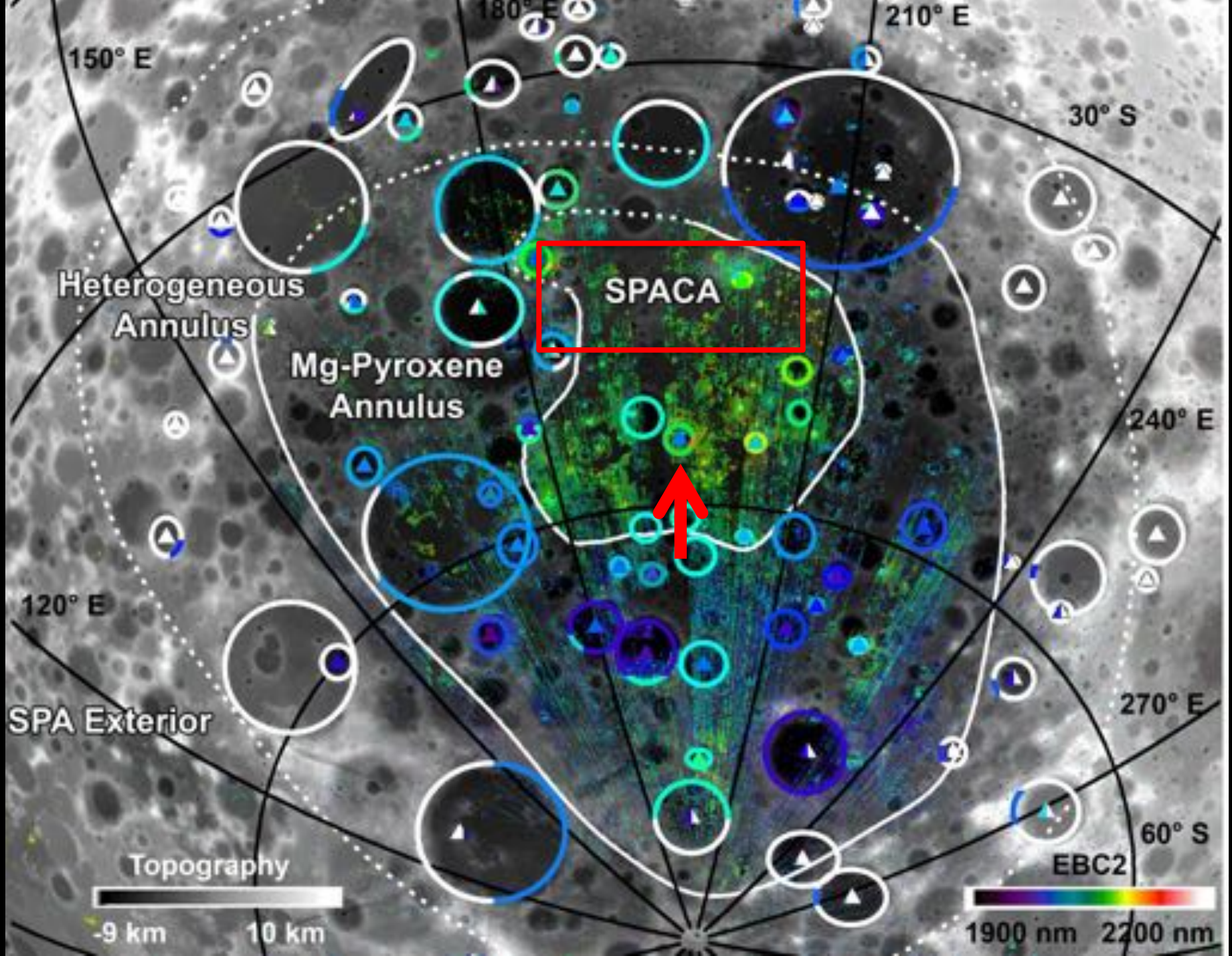
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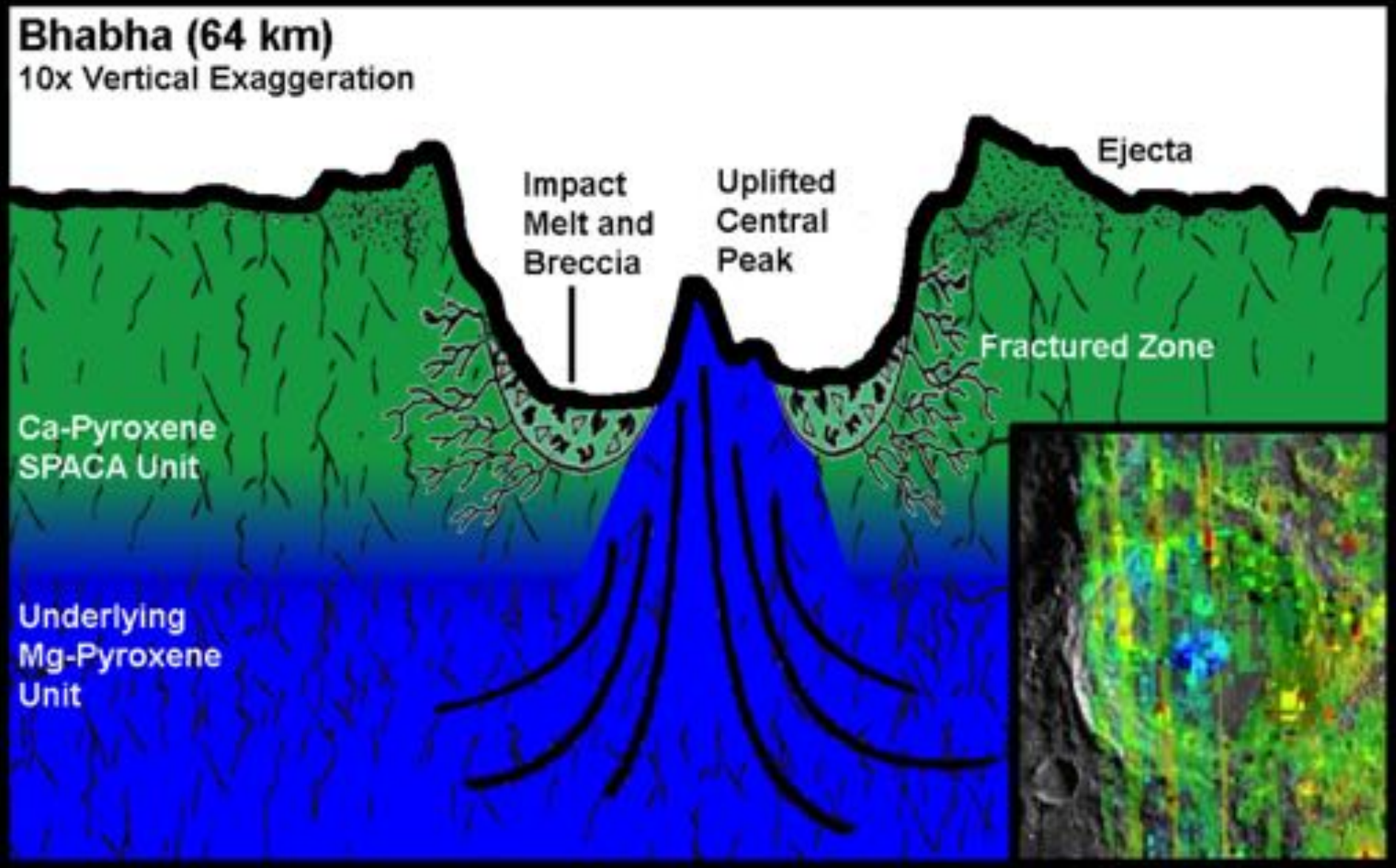
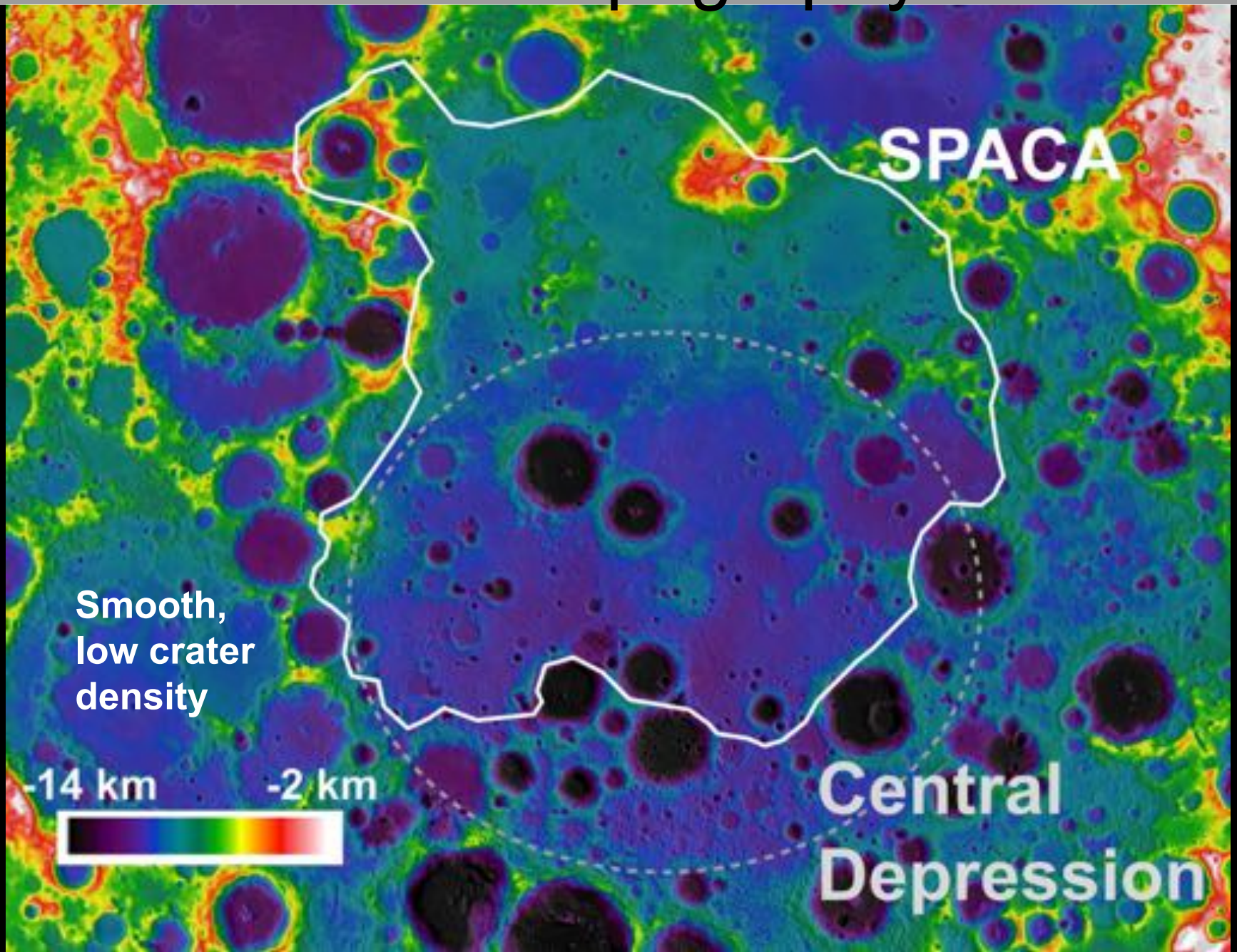
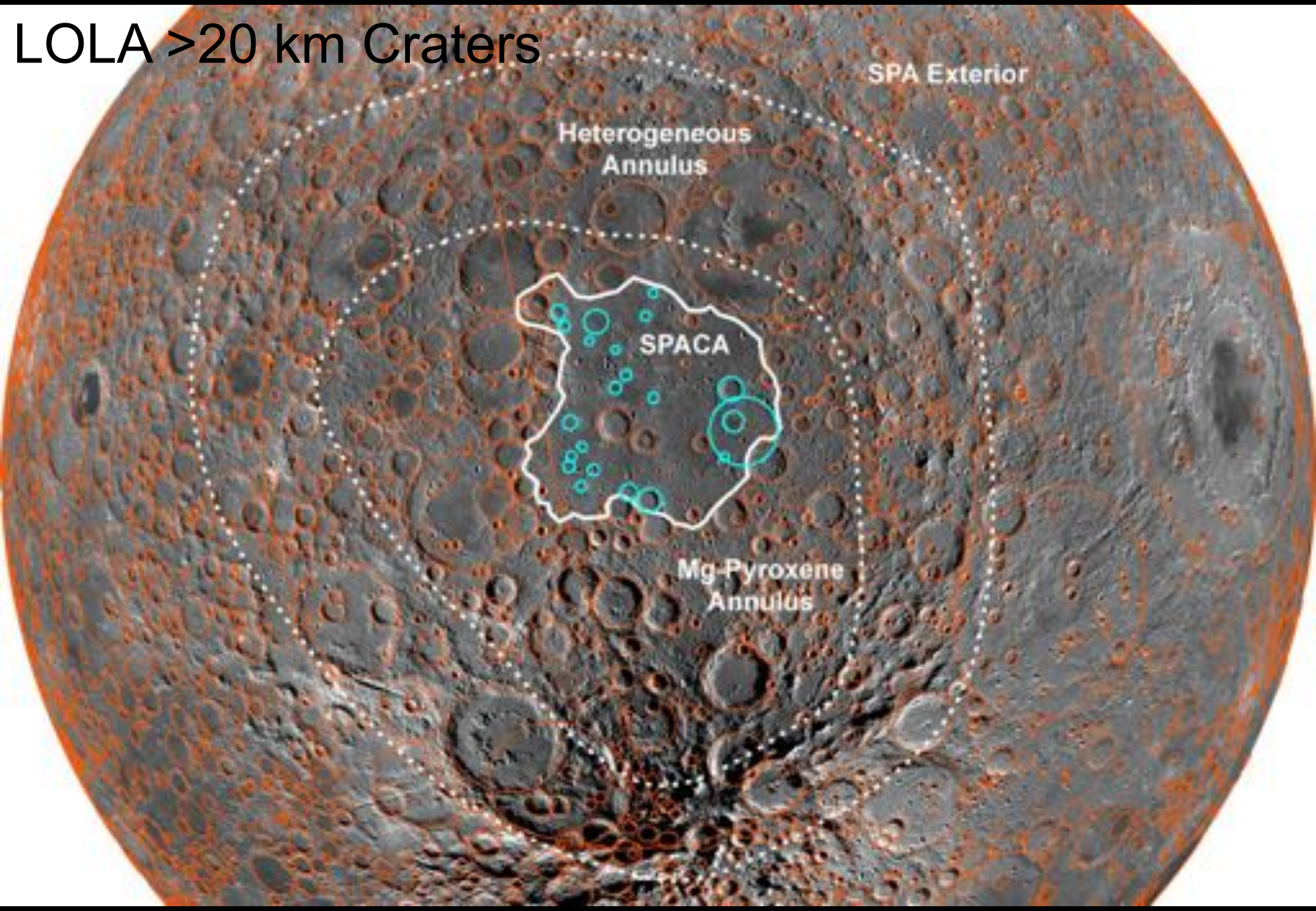
Local Stratigraphy at Bhabha (central SPACA)



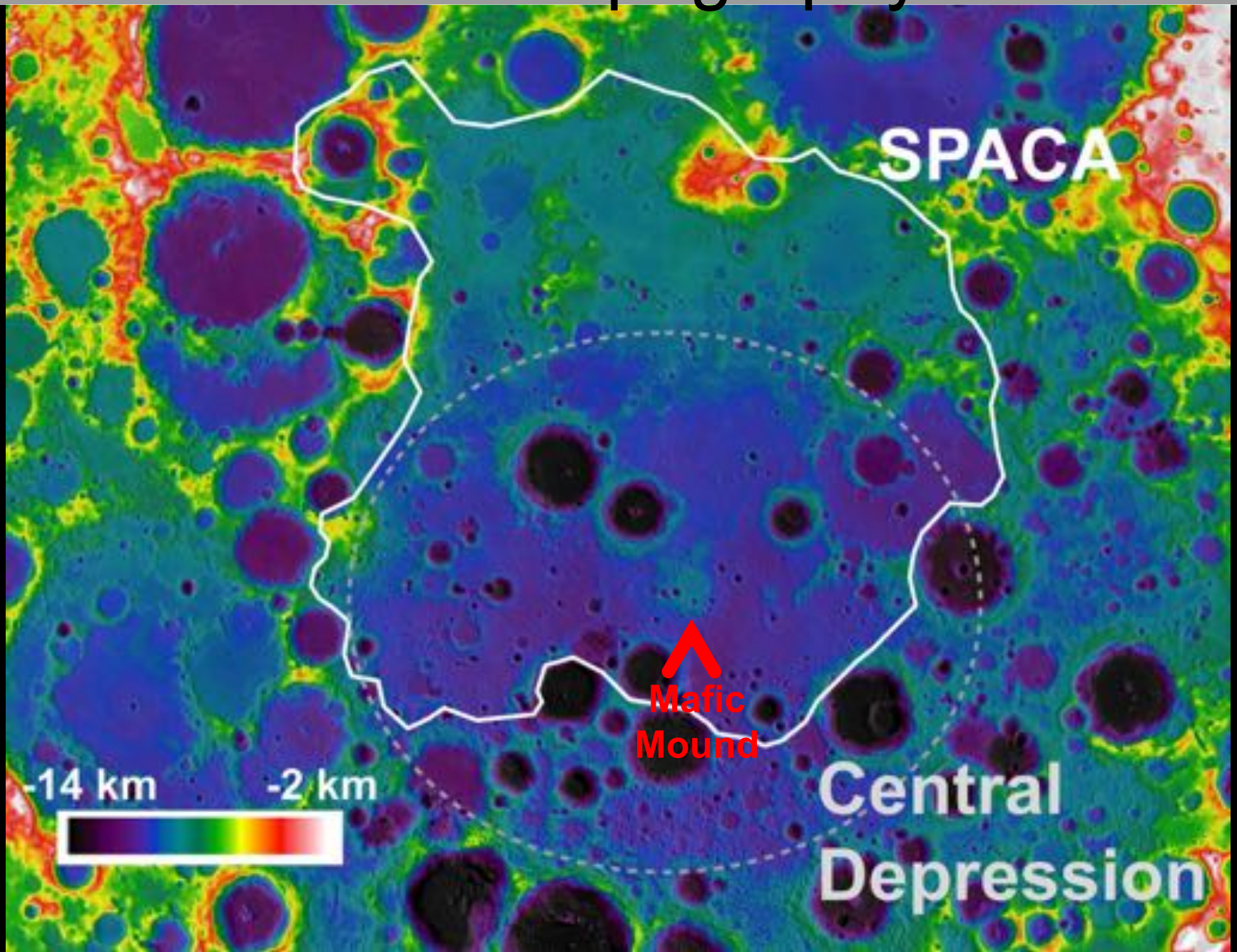
LOLA Topography



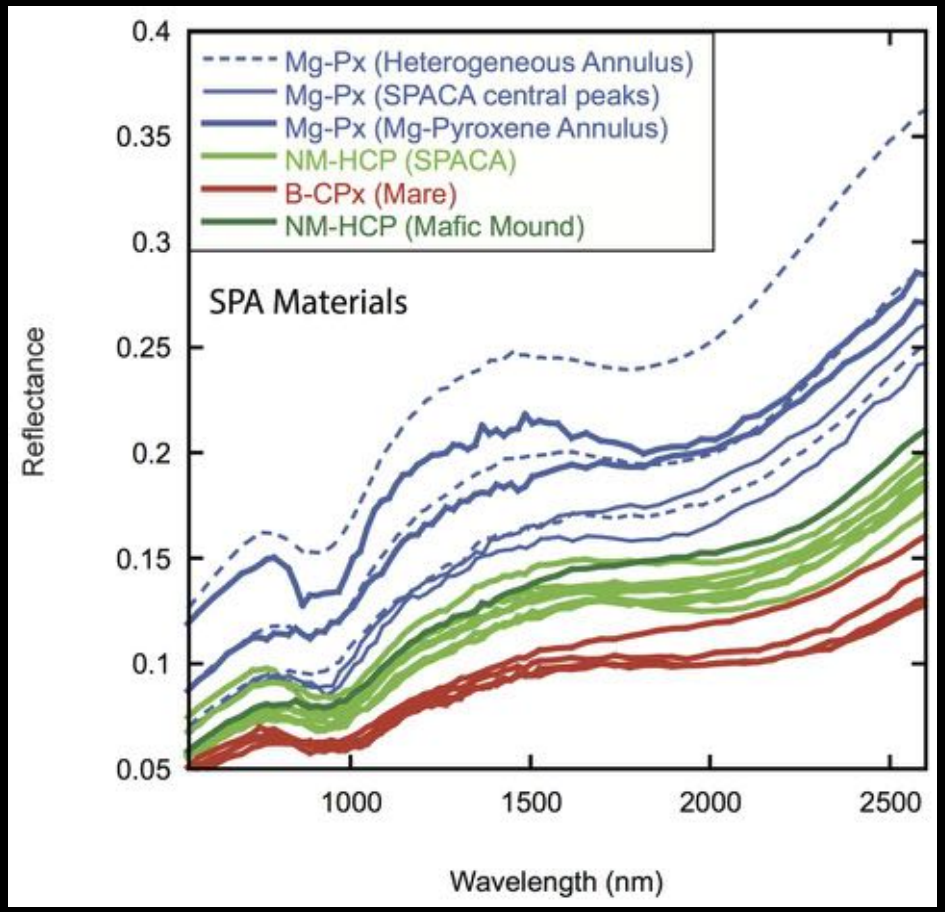
LOLA >20 km Craters

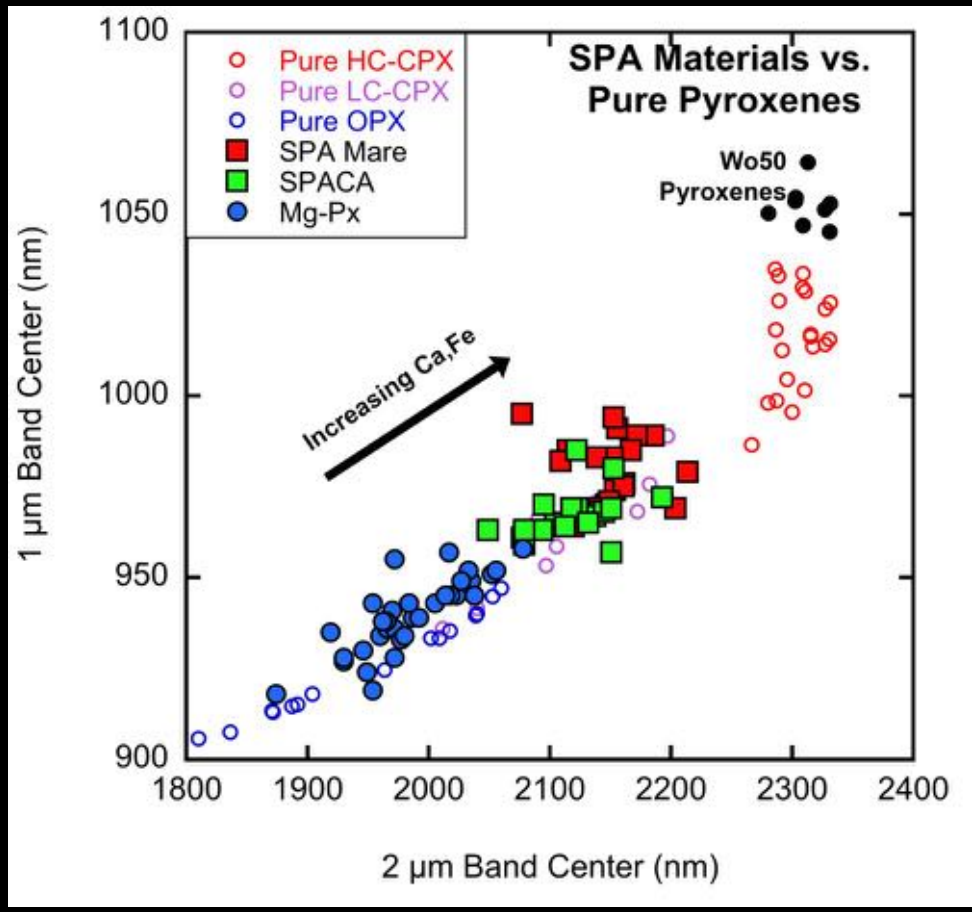


LOLA Topography

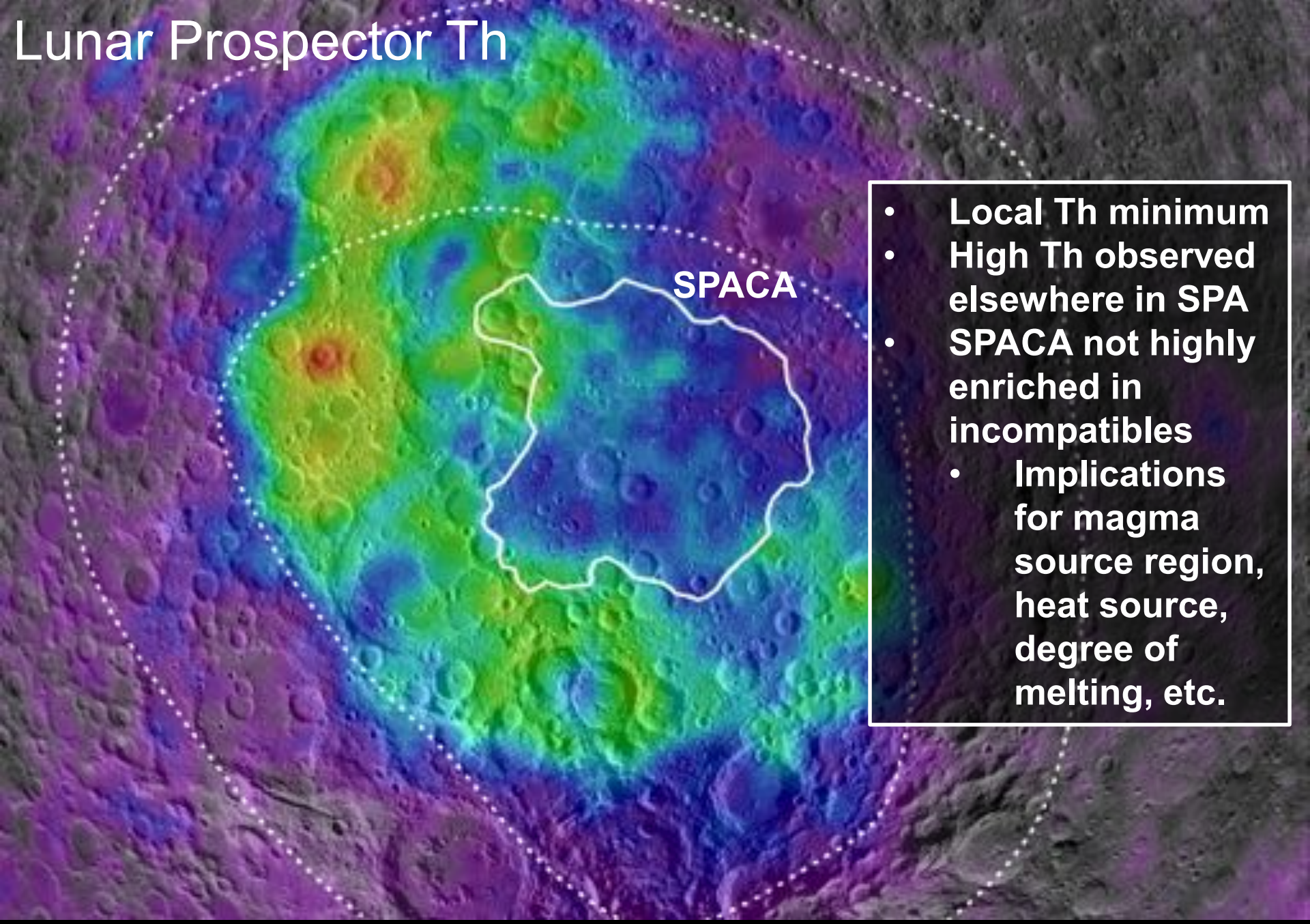


SPACA Composition





Lunar Prospector Th



- Local Th minimum
- High Th observed elsewhere in SPA
- SPACA not highly enriched in incompatibles
  - Implications for magma source region, heat source, degree of melting, etc.

SPA Science Conclusions: SPACA

2. SPACA is an enigmatic ~700 km wide zone in central SPA, currently unsampled
   A. Evidence for Resurfacing
      i. Paucity of >20 km impact craters
      ii. The Ca,Fe-pyroxene-rich surface composition is ~5 km thick and is underlain by Mg-rich pyroxene-bearing material
      iii. Presence of Mafic Mound (volcanic construct with similar composition)
   B. Could the extreme geophysical environment of SPA have produced unusual mantle melts?
      i. Localized mantle convection?
      ii. Extended pressure-release melting?
      iii. Unusually long-lived impact melt solidification/differentiation?

Sample Return from SPACA Potentially Addresses ALL SPA Science Questions

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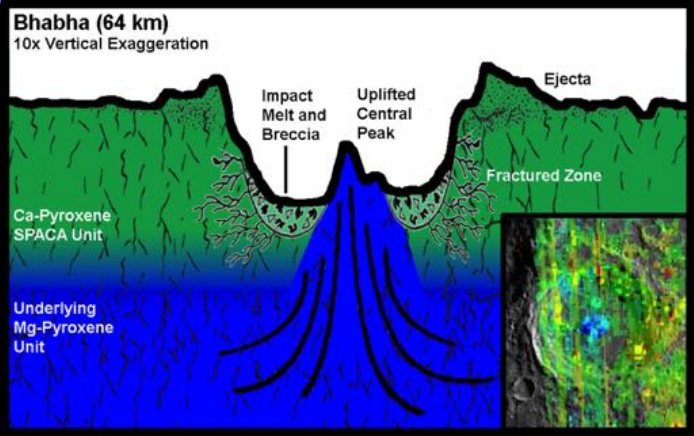
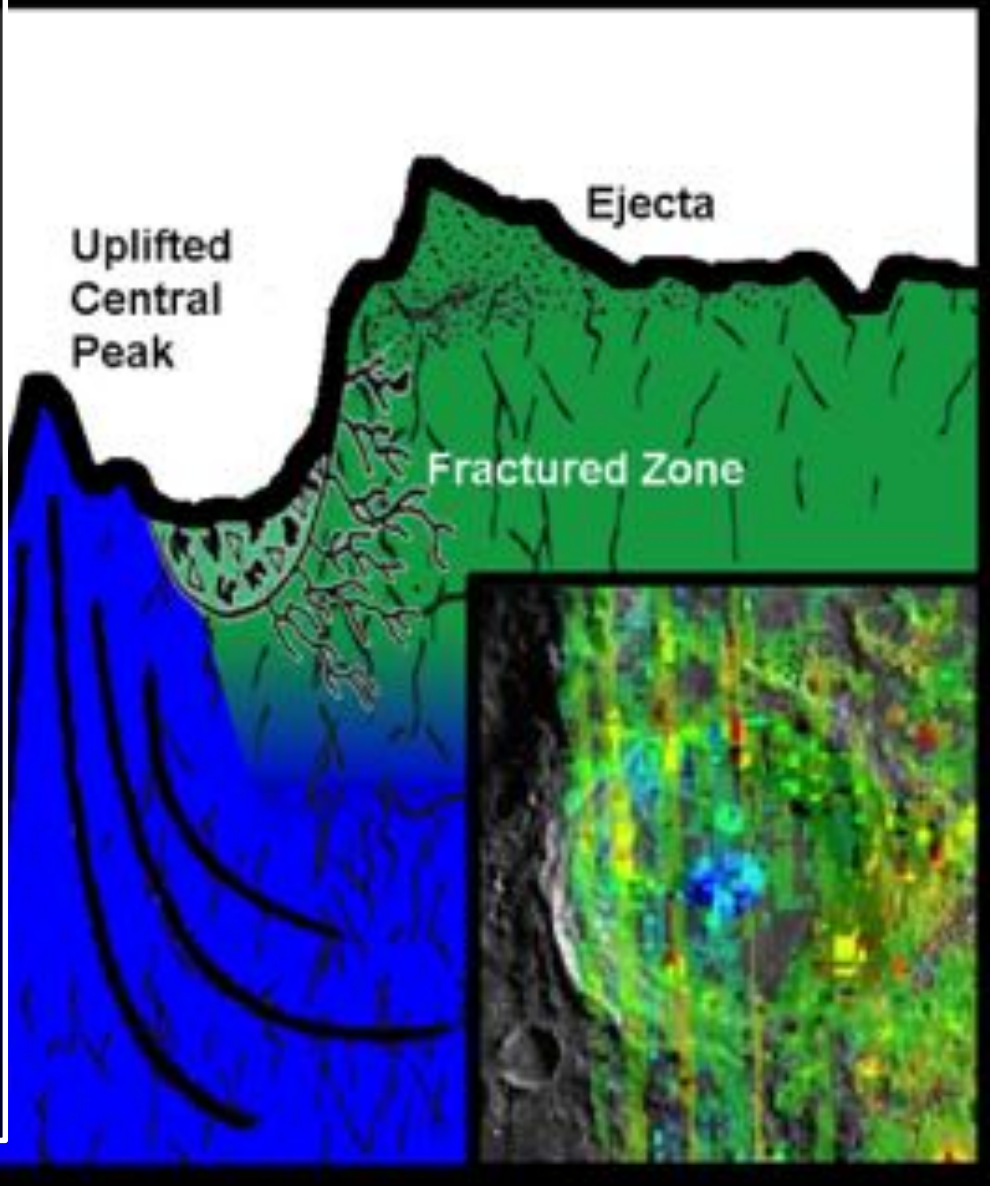
SPACA Central Peak Crater

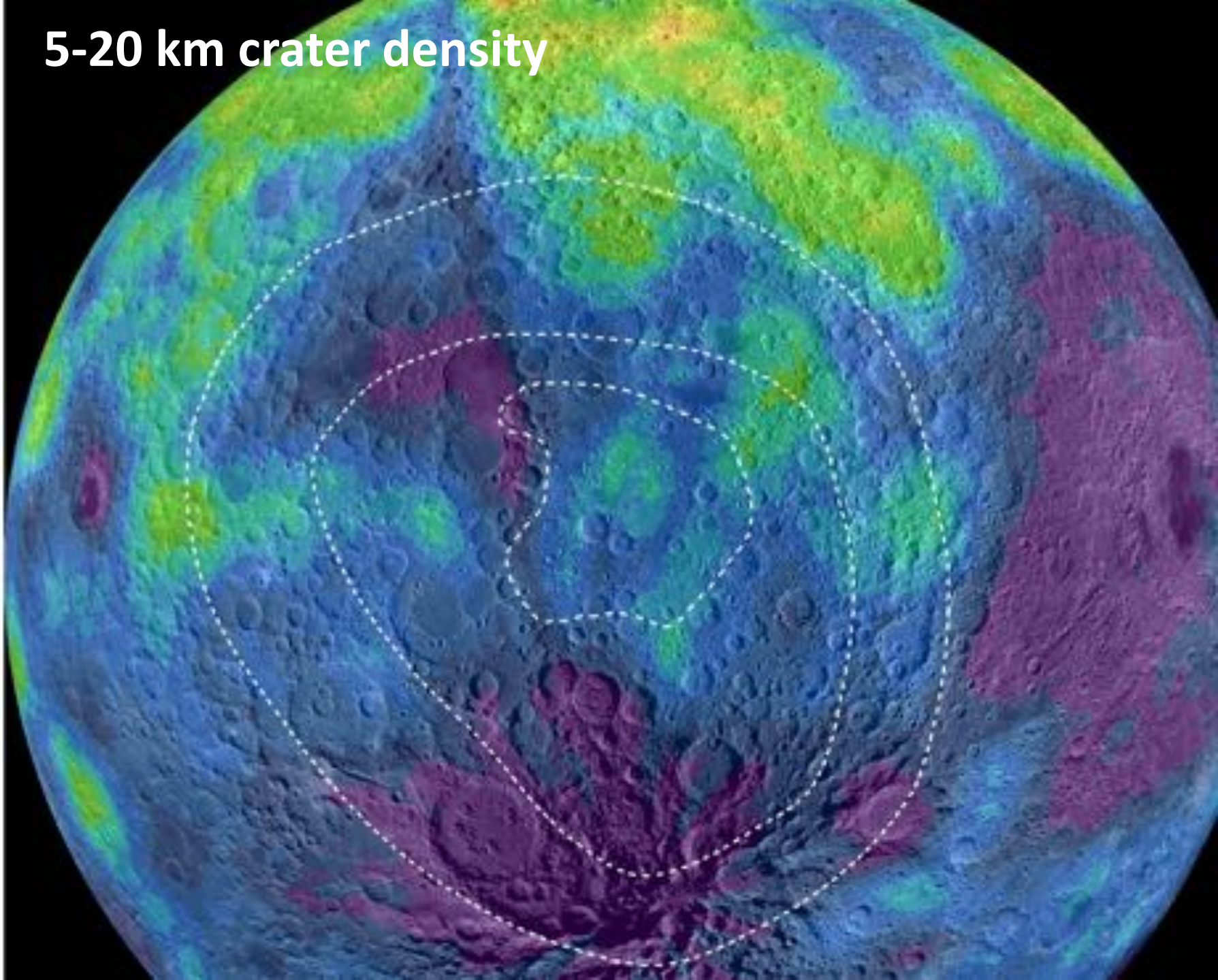


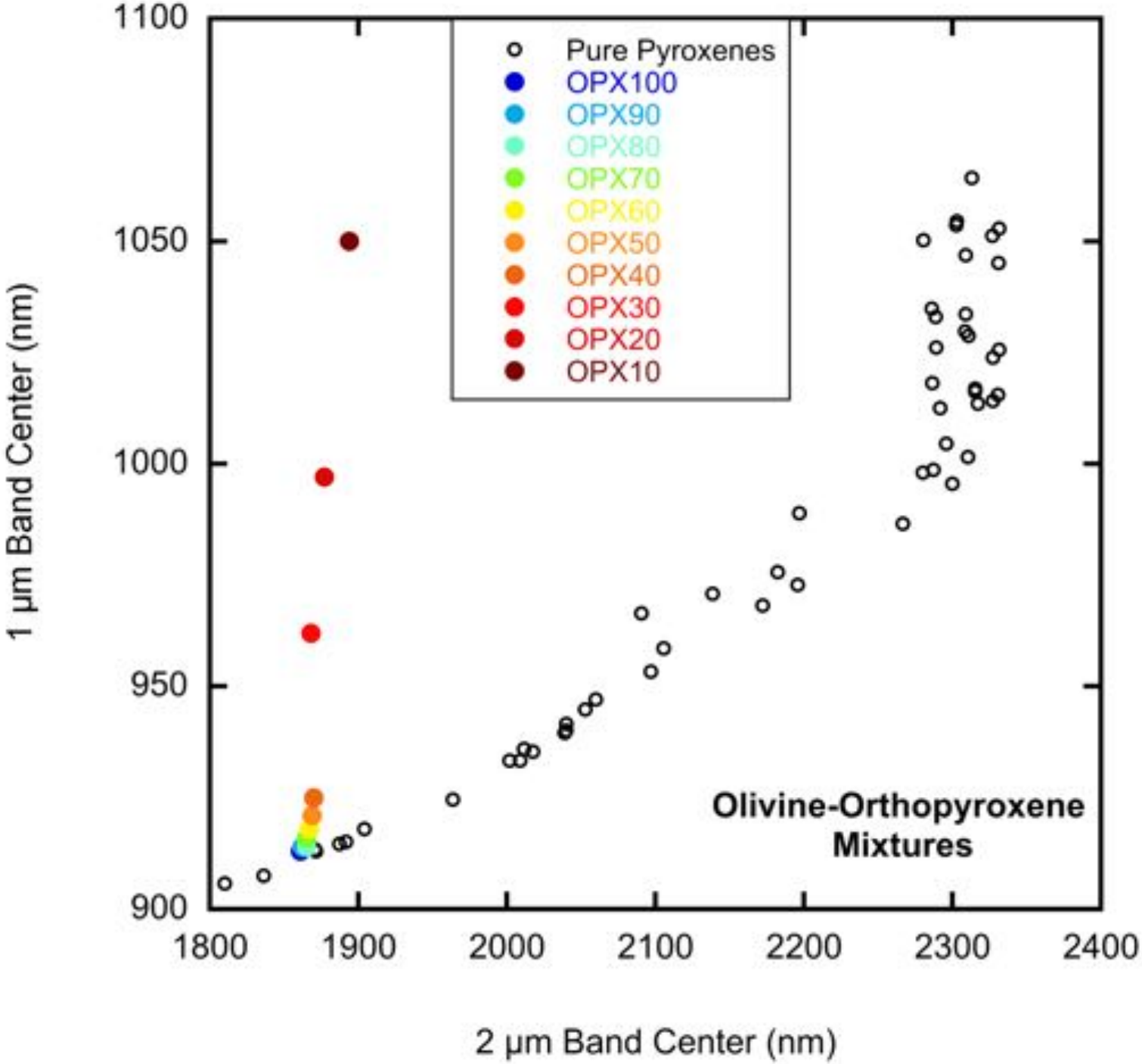
Local Stratigraphy at Bhabha (central SPACA)

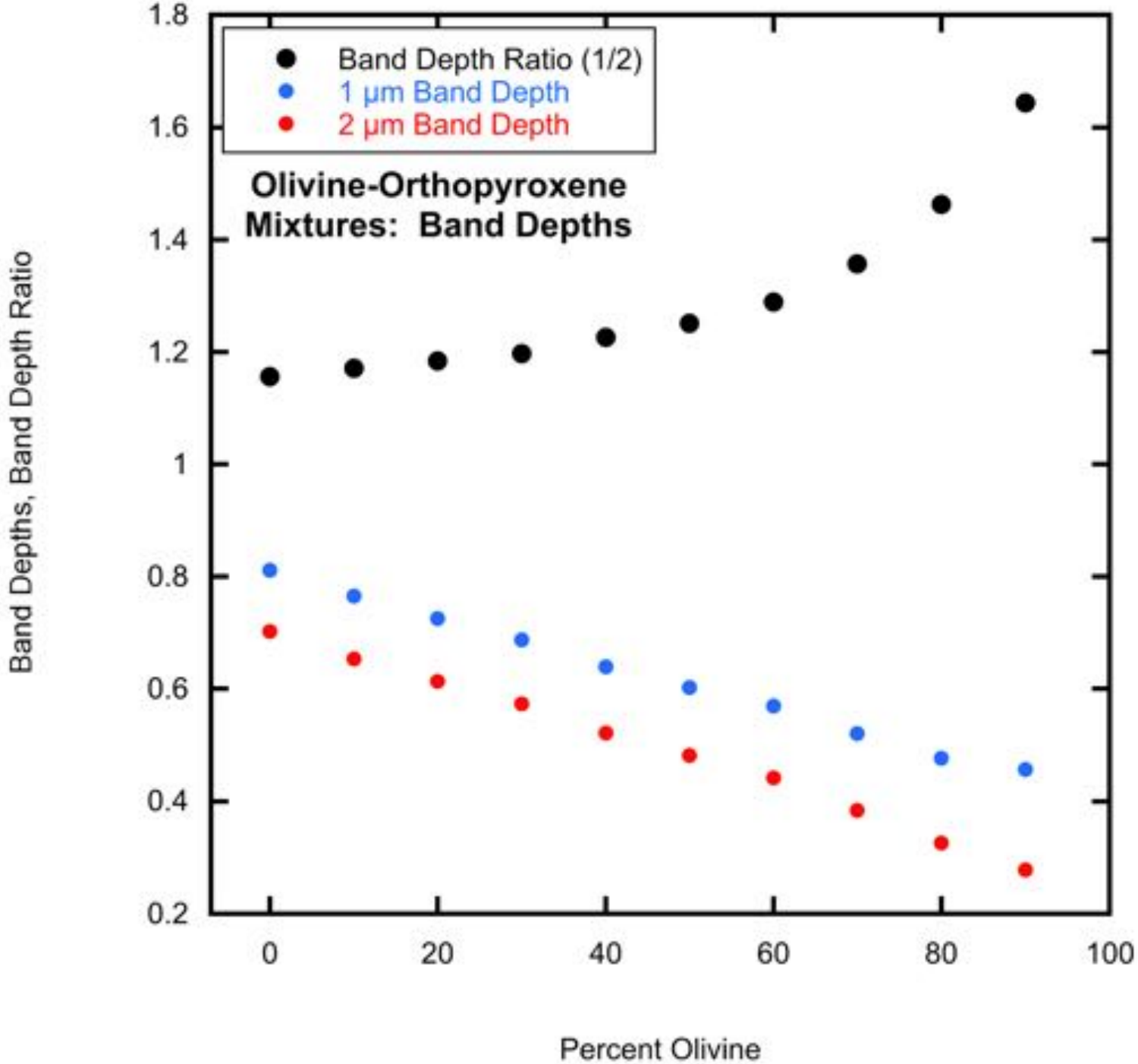
- Several lines of evidence for extensive, several km thick resurfacing deposit
  - Mafic Mound (volcanic construct)
  - Paucity of large impact craters
  - Compositional stratigraphy
- SPACA surface composition is not a veneer – observe in walls/peaks of several complex craters. Mafic



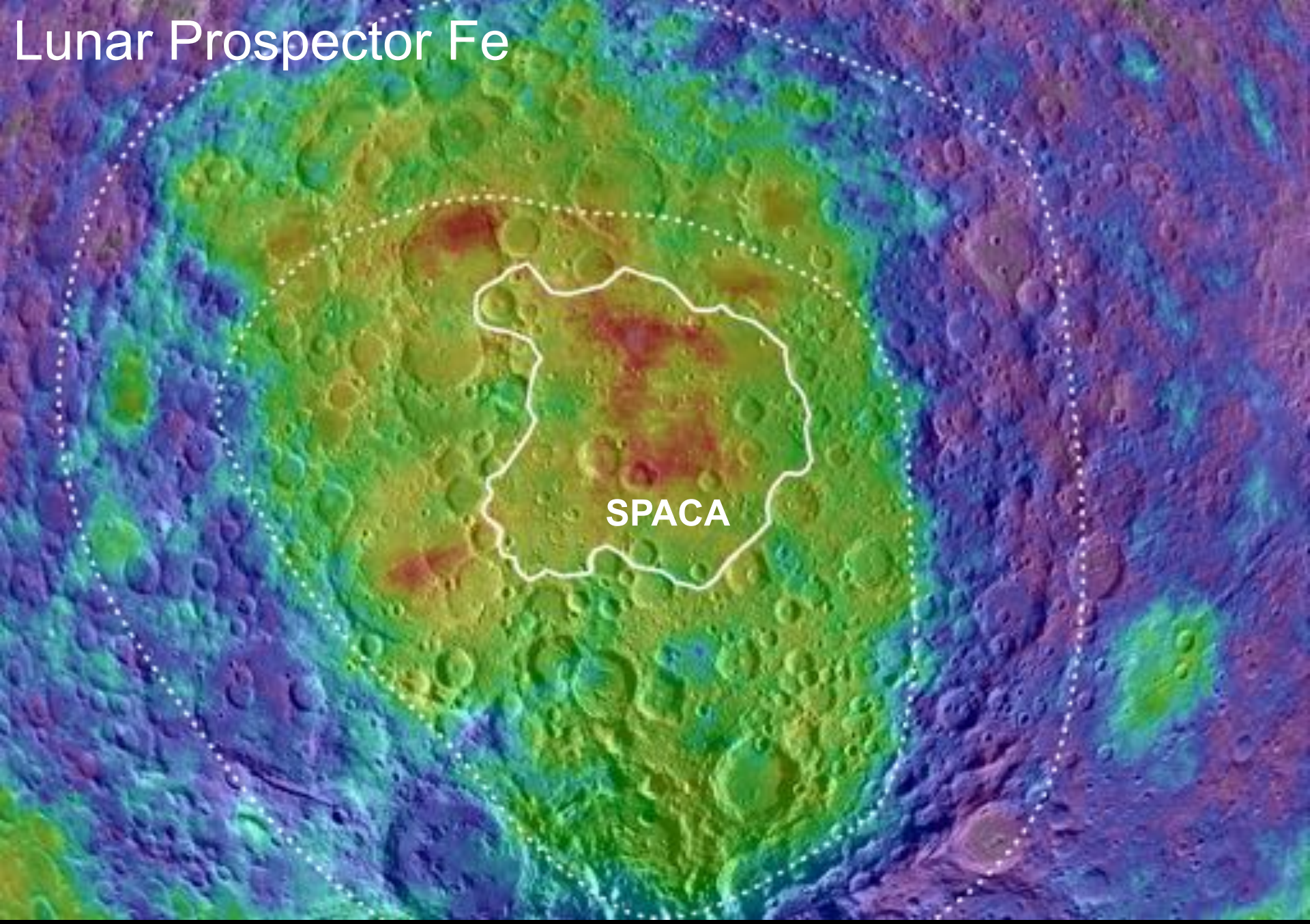
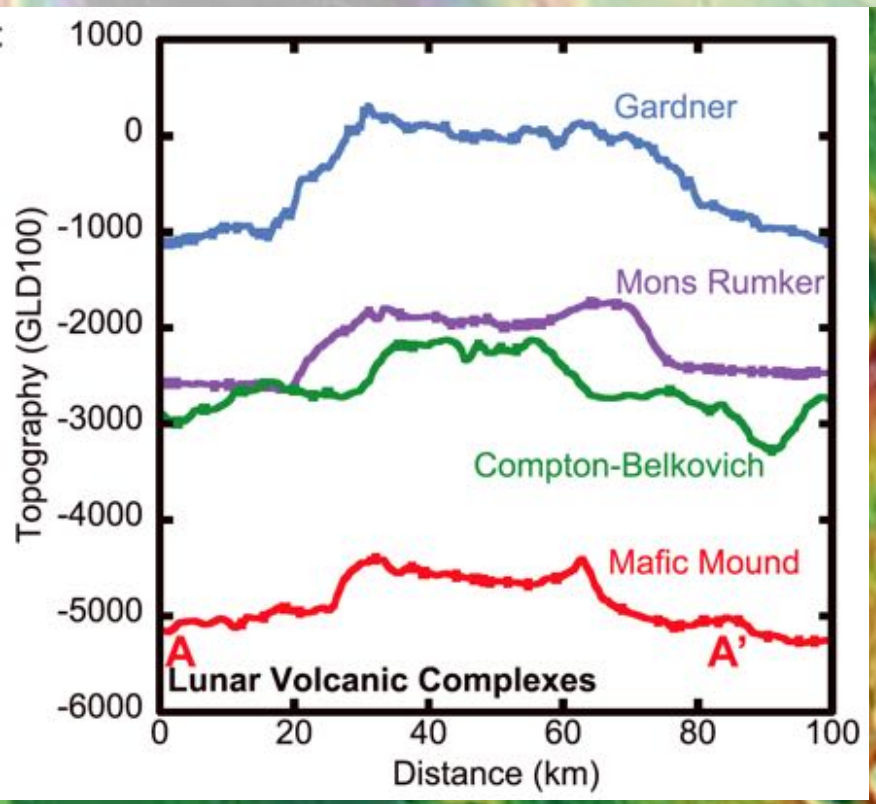
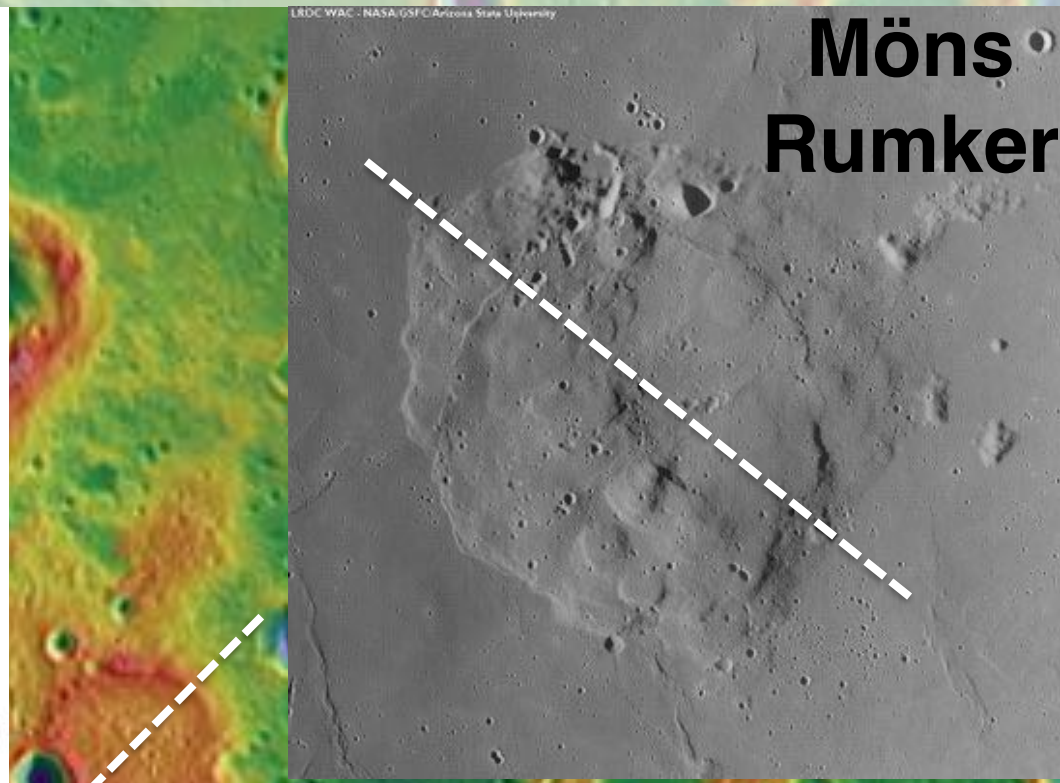
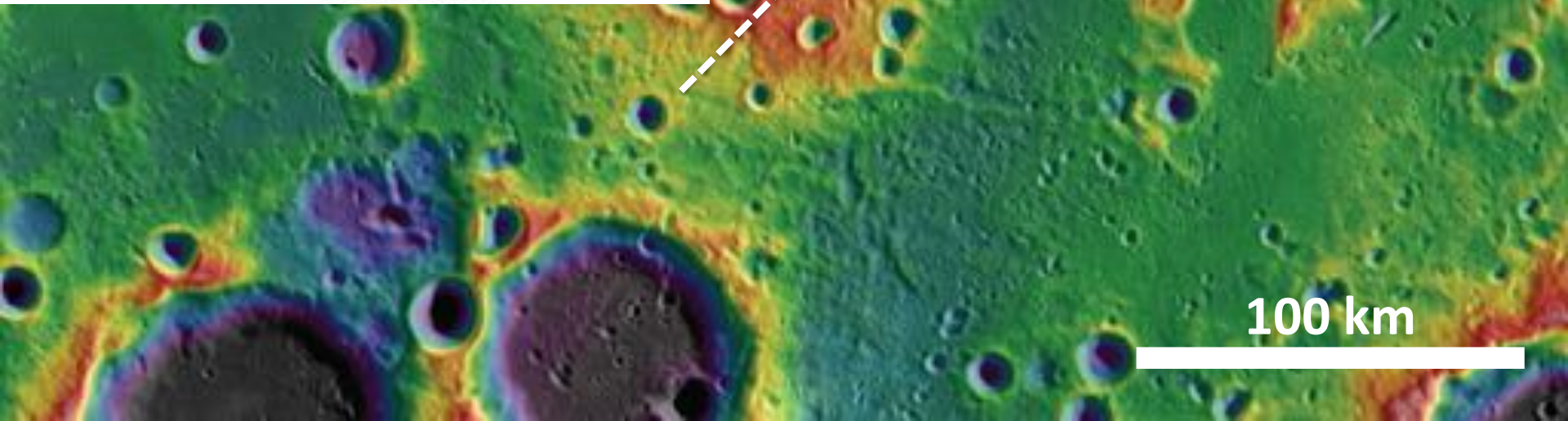
5-20 km crater density




Pure Pyroxenes
OPX100
OPX90
OPX80
OPX70
OPX60
OPX50
OPX40
OPX30
OPX20
OPX10
Olivine-Orthopyroxene Mixtures
1 µm Band Center (nm)
2 µm Band Center (nm)
1100
1050
1000
950
900
1800
1900
2000
2100
2200
2300
2400


Band Depth Ratio (1/2)
1 µm Band Depth
2 µm Band Depth
Olivine-Orthopyroxene
Mixtures: Band Depths
Band Depths, Band Depth Ratio
Percent Olivine
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
20
40
60
80
100

Lunar Prospector Fe



Mafic Mound vs. Volcanic Complexes: Topography