SPA Sample Return Addresses Several Critical Lunar Science Questions

1. Basin Formation
   Chronology
SPA Sample Return Addresses Several Critical Lunar Science Questions

1. Basin Formation Chronology
2. Composition/Stratigraphy of Crust/Mantle
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1. Basin Formation Chronology
2. Composition/Stratigraphy of Crust/Mantle
3. Large Impact Processes
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2. Composition/Stratigraphy of Crust/Mantle
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4. Lunar Formation / Lunar Evolution
SPA Sample Return Addresses Several Critical Lunar Science Questions

1. Basin Formation Chronology
2. Composition/Stratigraphy of Crust/Mantle
3. Large Impact Processes
4. Lunar Formation / Lunar Evolution
5. Lunar Volcanism
SPA Sample Return Addresses Several Critical Lunar Science Questions

1. Basin Formation Chronology
2. Composition/Stratigraphy of Crust/Mantle
3. Large Impact Processes
4. Lunar Formation/Evolution
5. Lunar Farside Volcanism
M³ Analysis: Major Goals

1. Identify and map the surface distribution of critical sample types across SPA
M³ Analysis: Major Goals

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2. Understand the compositional structure of SPA

Lunar Volcanism
M³ 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

Heterogeneous Annulus

SPACA

Mg-Pyroxene Annulus
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
Local Stratigraphy at Bhabha (central SPACA)
LOLA Topography

Smooth, low crater density
LOLA Topography

SPACA

Central Depression

Mafic Mound
SPACA Composition

SPA Materials

Reflectance vs. Wavelength (nm)

1 μm Band Center (nm)

1100

1050

1000

950

900

2 μm Band Center (nm)

SPA Materials vs. Pure Pyroxenes

Pure HC-CPX
Pure LC-CPX
Pure OPX
SPA OPX
SPA Mare
Wo50 Pyroxenes
Increasing Ca/Fe
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

1. Basin Formation Chronology
2. Composition/Stratigraphy of Crust/Mantle
3. Large Impact Processes
4. Lunar Formation / Evolution
5. Lunar Farside Volcanism
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 Mound
5-20 km crater density
Mafic Mound vs. Volcanic Complexes: Topography

Gardner
Mons Rumker
Compton-Belkovich
Mafic Mound

Lunar Volcanic Complexes

Distance (km)

Topography (GLD100)

0
20
40
60
80
100

100 km