Surface roughness in the South Pole-Aitken Basin

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The Benefit of Face-to-Face Meetings

- Conversation at NESF 2014 with Bill Bottke, Becky Ghent, and Sara Mazrouei
  - Diviner data reveal an apparent lack of rocky, large craters in SPA
  - Yesterday this was discussed during M. Kreslavsky’s talk
  - Where are the immature craters?
- What does the various views of roughness in SPA tell us about its history

LROC WAC
June 2012 Mosaic
Multiple Approaches to Measure “Roughness”

- **Mini-RF**
  - Direct measure of surface/near surface blockiness
- **LOLA**
  - Roughness at varying baselines
- **LROC-NAC**
  - DTM derived topographic variation at the meter scale

Kreslavsky et al., 2013, Icarus [LAMA projection]
Cahill et al. (2014): “Mini-RF is detecting an increase in radar scatterers in the surface to near subsurface (1–2 m depth). These materials must be at least centimeter- to meter-scale cobbles and boulders on the surface or near subsurface.”
In the m-chi deconvolution, SPA is “blue”, indicative of a single-bounce, suggestive of a 1-2 meter thick regolith with smaller than wavelength (12.6 cm) scatterers
LOLA Roughness – 5 Spot Scale

Neumann et al., 2015
LOLA Derived km-scale roughness – 1.8 km baseline

Kreslavsky et al., (2013, Icarus)
LOLA Derived km-scale roughness – 0.46 km baseline

Kreslavsky et al.,
(2013, Icarus)
LOLA Derived km-scale roughness – 115 m baseline

Kreslavsky et al.,
(2013, Icarus)
Kreslavsky et al., (2013, Icarus)
LOLA Derived km-scale roughness – RGB Composite

Kreslavsky et al., (2013, Icarus)
LOLA Derived km-scale roughness – RGB Composite

Kreslavsky et al.,
(2013, Icarus)
RIS$^4$E - Quantitative roughness patterns

- Derive surface roughness (at any scale)
  - Space bourn, airborne, or in-situ
- Using a variety of data types
  - Light Detection and Ranging (LiDAR)
    - Method being used in support of RIS$^4$E
  - Radar
  - Photogrammetry
    - LRO NAC DTM’s
      - Method used here
- Identify patterns in roughness
  - Co-occurrence statistics
    - Whelley et al. IEEE TGRS, 2014
NAC DEM to roughness

- Start with NAC DEM
  - 2 m pixels

- Export as XYZ point cloud
  - One point per 2 m pixel

- Calculate 6 m roughness
  - Fit 6 m planes to point data
  - Standard deviation of residuals = roughness
Roughness in Bhabha East Plain

LRO NAC M112646261 (2 m resolution)

6 m roughness. Objects between 2 and 6 m contribute to roughness.

Roughness (6 m resolution)
- Lacks obvious features alone
- Further processing necessary
Roughness patterns

- Quantifies distribution of rough regions
  - Randomly or Homogenously

Red: Homogeneity
Blue: Entropy (randomness)

Clear relationships emerge
Roughness patterns – LROC NAC

- Quantifies distribution of rough regions
  - Randomly or Homogenously

Smooth plain: High HOM
Crater rims: High ENT
Fresh crater: High ENT

Buried crater rim? : Low ENT
Degraded crater rim: Low ENT
Crater floor: High HOM

-> Roughness patterns reveal surface textures on the Moon
LOLA Roughness at 1.8 km scale

Schiller-Schickard

SPA
Roughness in SPA

• Variations in surface roughness reflect differences in formation and age (?)
  – Smooth mare basalts and ancient mare basalts/plains units
  – Rougher surfaces, like that at Mafic Mound…
  – Mini-RF data illustrates a number of small, fresh craters, but no large fresh craters, consistent with Diviner RA
What’s Happening In SPA?

• There are a number of craters with rough interiors but these are not rocky in the eyes of Diviner (cm-scale blocks)
• SPA is “smooth” at short baselines
• Not all of this smoothness is due to volcanism
• Effect of SPA formation, influence of Imbrium/Orientale formation?
• Attend the SPA focus group meeting!
Backup