Background

On 14 Dec. 2013, China’s Chang’e 3 soft landed at 44.12°N, 307.49°E in Mare Imbrium [1, 2].

Goals of this study:
1) Investigate the change in reflectance at the landing site related to the impingement of rocket exhaust from the lander (blast zone, “BZ”) [3,4].
2) Use Lunar Reconnaissance Orbiter (LRO) Narrow Angle Camera (NAC) images to compare with reflectance before landing (Fig. 1) and to compare with 40-year old disturbances at the Apollo, Luna, and Surveyor landing sites.

Methods

Reflectance profiles - used to extract reflectance values within the BZ, and to measure spatial extent of disturbed area (Fig. 3).
1) a-a’ – across northernmost tip of BZ
2) b-b’ – across the center of BZ
3) c-c’ – N-S; crosses the lander. Also taken across the site before landing for comparison.

Hapke photometric modeling - used to fit reflectance (IoF) data, which is normalized to the Lommel-Seeliger function (IoF/LS) to reduce effects of different illumination geometries [5,6].

Fig. 2: Lower incidence angle image (M114371683L), showing Yutu rover tracks.

Results

• Reflectance profile shapes are consistent with trends observed at Apollo, Luna, and Surveyor landing sites [3].
• Magnitude of reflectance increase is ~12% after landing (at 45° phase angle; Table 1).
• Average area of Apollo BZ is 10 times larger than average Luna BZ and 80 times larger than average Surveyor BZ [3].
• The Chang’e 3 BZ area measurement falls close to the expected value, based on the Surveyor, Luna, & Apollo correlation (Fig. 4; Table 2) and variations in descent trajectory and topography.

Conclusions

• Reflectance increase at the Chang’e 3 landing site (Table 1) compares favorably with the average increase in reflectance for other landing sites [3].
• Variations in descent trajectory and maneuvering or different engine configuration and design likely contributed to BZ size variations between Apollo, Luna, Surveyor, and Chang’e 3 landing sites (Table 2).
• Based on reflectance changes (Table 1), we infer that lunar surface features (mm – cm scale) are not significantly altered on a time scale of decades by rocket exhaust impingement.

References