



Determining the Age of an Unnamed Lunar Impact Crater in South Pole-Aitken Basin Using Boulder Size-Frequency Distributions



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Introduction

- Understanding how boulder distributions around lunar craters vary with crater age is important for testing models of boulder breakdown rates, with long-term implications for **understanding the Moon's regolith production rate**.
- The crater of interest in this study is an unnamed 3 km diameter crater ("SWMU") located southwest of Maksutov U crater on the far side of the Moon (41.41° S, 171.85° W).
- By comparing SWMU with boulder distributions from six other lunar impact craters with known ages, we can **place constraints on the age of SWMU**.

Mapping Boulders

- Lunar Reconnaissance Orbiter Camera (LROC) Narrow Angle Camera (NAC) images (0.5-2 m/pix) [1] were used to map boulder distributions.
- Boulders measured as ellipses using Crater Helper Tools [2] in ArcMap.
- Distance of each boulder from crater center determined using the haversine formula [3].

Fig. 1. Boulders (blue ellipses) near the rim SWMU. Elongated shadows are visible to the right of boulders.

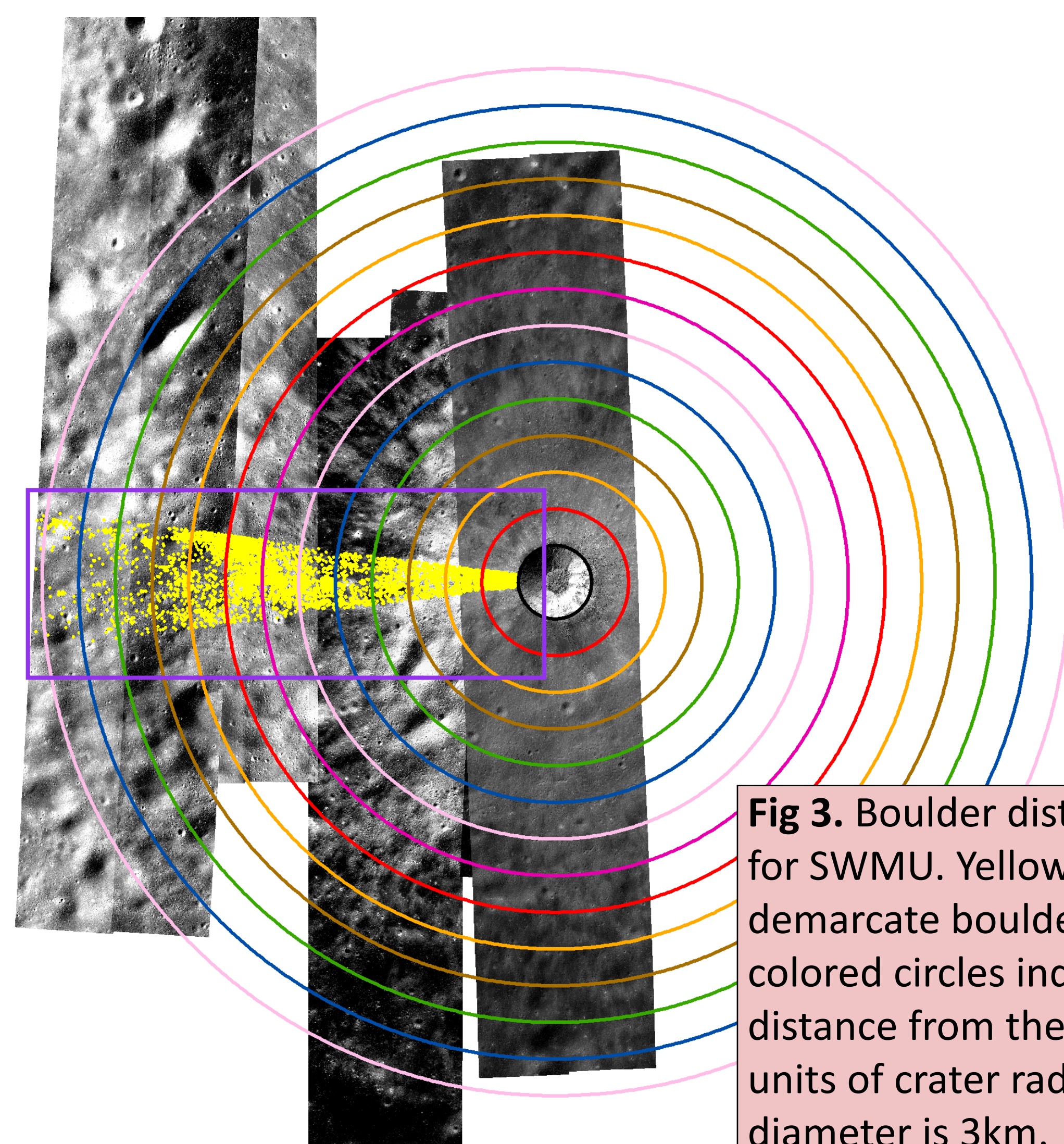
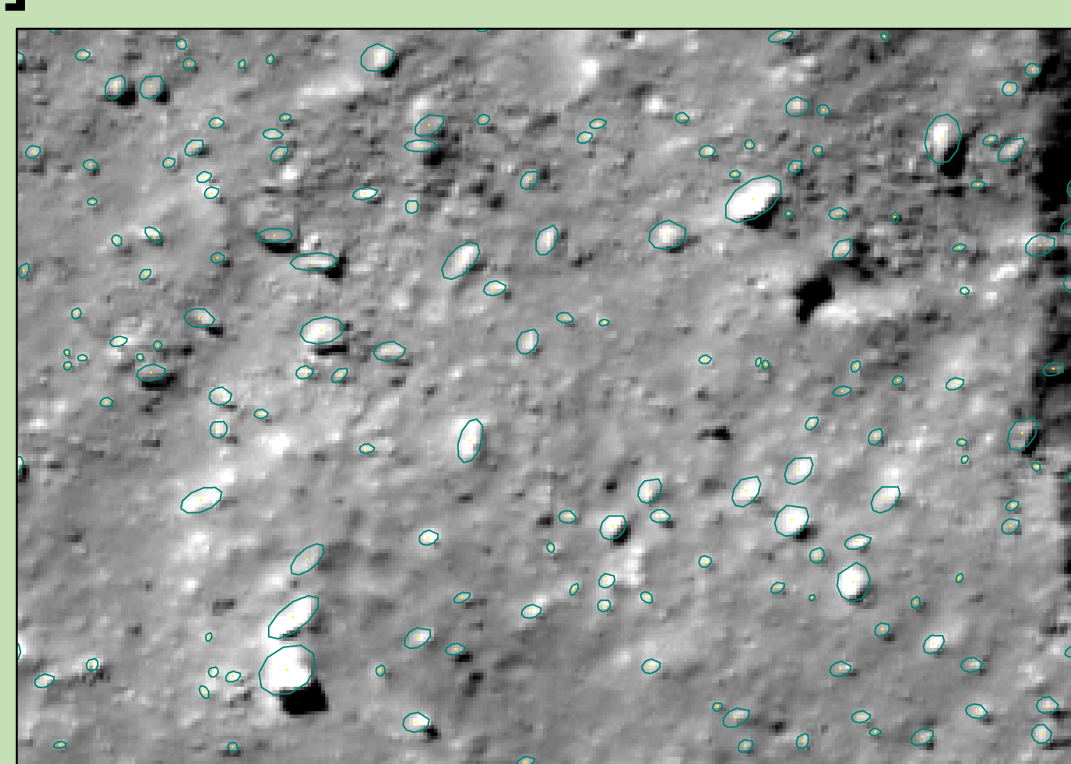


Fig 3. Boulder distribution for SWMU. Yellow ellipses demarcate boulders, colored circles indicate distance from the rim in units of crater radii. Crater diameter is 3 km.

Fig 3 and 4 NAC Images: M1235367461RE, M161081870RE, M161081870LE, M1235367461LE, M1130621053, M1176525639LE, M1176525639RE, M141031651LE, M141031651RE

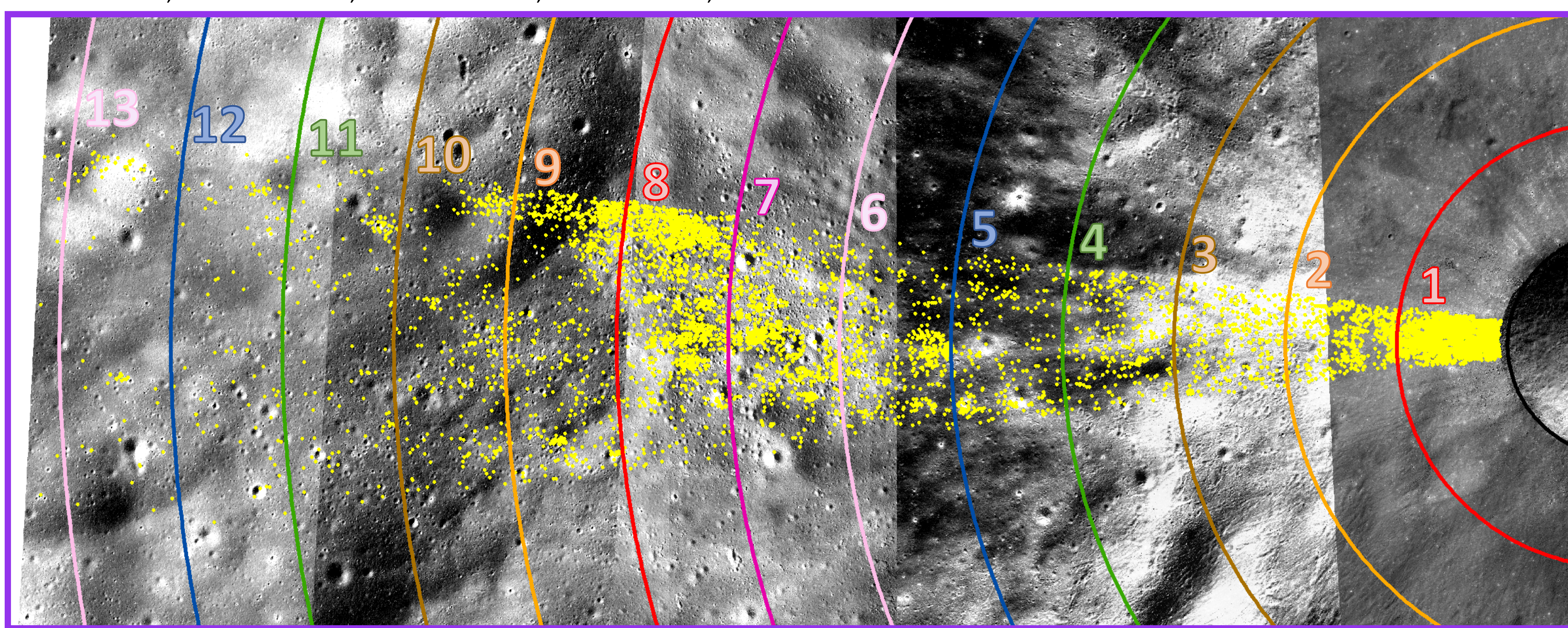


Fig 4. Inset to Fig. 3. Distribution of SWMU boulders (yellow) as a function of distance from the rim (in units of crater radii).

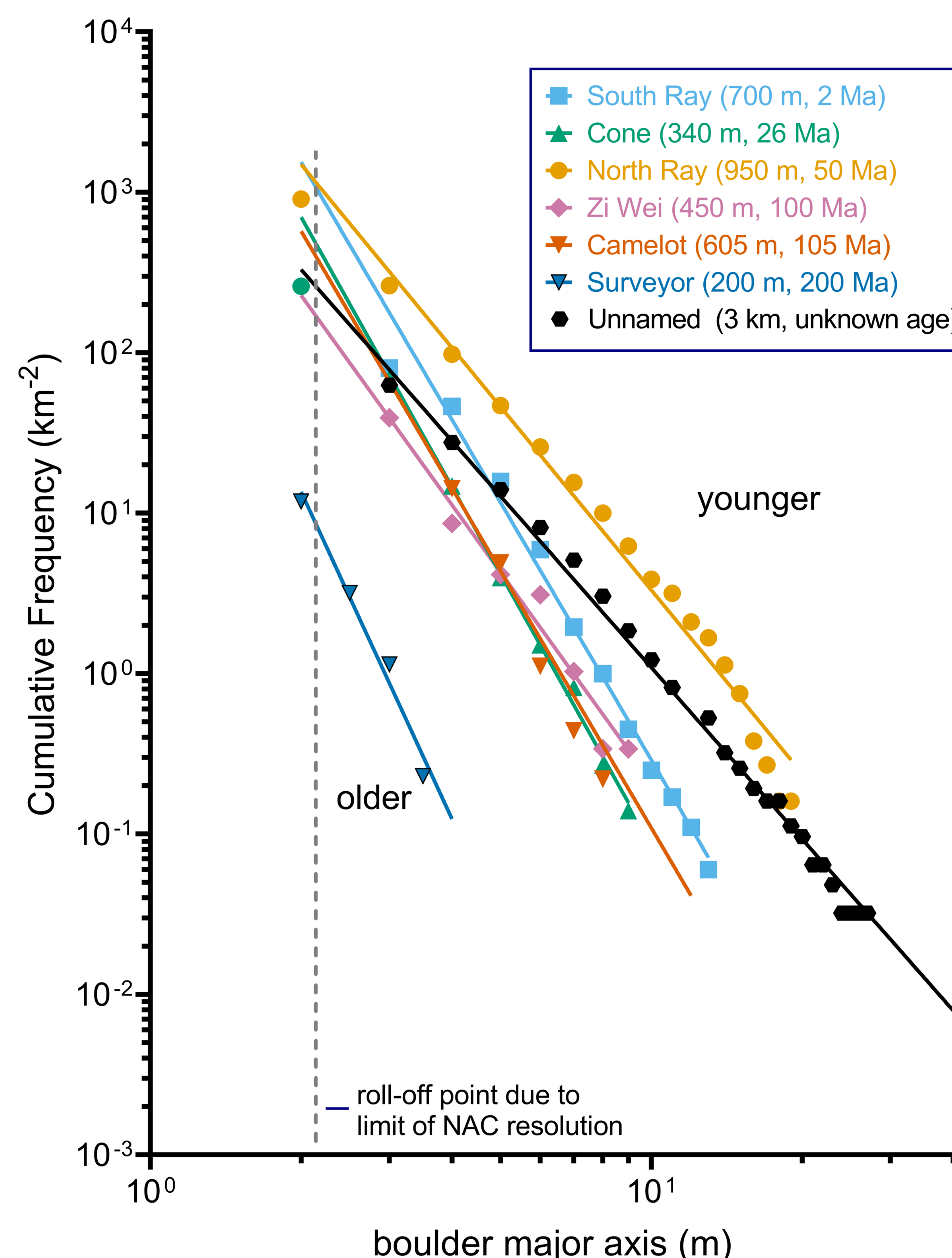


Fig. 2: Size-frequency distributions show that young craters have higher boulder populations. Each distribution is fit with a power-law function.

Comparing Boulder Distributions

- We investigated the **boulder size-frequency distribution (BSFD)** of SWMU and compared it to BSFDs of 6 craters with known ages – Cone, North Ray, South Ray, Surveyor, Camelot, and Zi Wei [4].
- BSFDs show the number of boulders at each observed size distributed around the crater. These distributions are presented using a size-frequency plot (Fig 2), which plots the diameter of boulders against their cumulative frequency per count area.
- Distributions were analyzed according to crater radii to normalize the boulders ejection distance at each crater.

SWMU Distribution Results

- We counted 7,903 boulders in a western slice surrounding SWMU (Fig. 3).
- The quantity of boulders decreases with increasing distance from the crater rim (Fig. 4) [4].
- The largest boulders occur closer to the rim, consistent with other studies [4-9].
- The largest measured boulder was 26.9 m.

SWMU BSFD Analysis

- The slope of SWMU's BSFD (Fig. 2) is slightly shallower than what we find at our other count sites, but it **matches well with results** demonstrated in previous studies [5-9].
- The shallowness of SWMU's BSFD may be due to a number of factors:
 - A greater population of large (>10 m) boulders
 - Impact conditions (e.g. velocity). Smaller impact velocity impacts may allow a crater to retain larger boulders owing to less fragmentation during impact [10].

Constraining the Age of SWMU

- We place constraints on SWMU's age by comparing its BSFD to that of 6 craters with known ages (Fig. 2).
- We estimate the age of SWMU to be <25 Ma due to:
 - The **placement of SWMU within the comparison plot** (Fig. 2).
 - The **presence of large (>10m) boulders** which tells us that this crater is fairly young owing, to a higher cumulative frequency of larger boulders throughout the count [4].
- Many factors influence BSFD plots (e.g. crater size, terrain type), therefore more analyses of boulder distributions around craters of similar size to SWMU are necessary to further constrain the age.
- Future work will involve comparison with the model of Diviner rock abundance vs. crater age [11] to continue working toward an accurate age constraint.

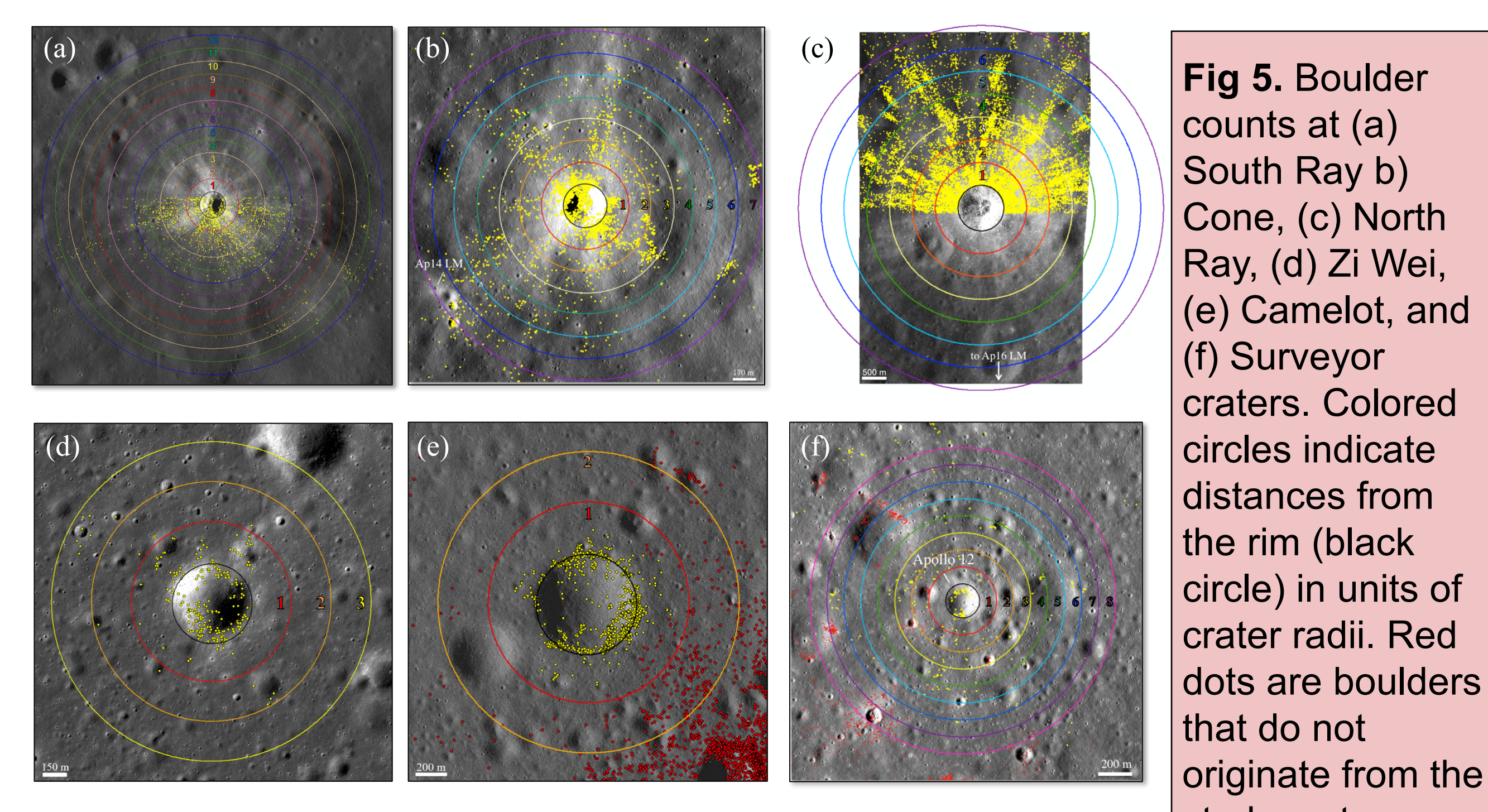


Fig 5 NAC Images: (a) M181065865L and M1108182629 (b) M150633128 (c) M152770233 (d) M1259058367L (e) M165645700 (f) M165998991R

Fig 5. Boulder counts at (a) South Ray b) Cone, (c) North Ray, (d) Zi Wei, (e) Camelot, and (f) Surveyor craters. Colored circles indicate distances from the rim (black circle) in units of crater radii. Red dots are boulders that do not originate from the study crater.

References

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