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Investigating potential sources of enhanced rock abundances near Tsiolkovskiy Crater

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Abstract

Analyses of data from the Diviner Lunar Radiometer have indicated an area of elevated rock abundance and nighttime soil temperature in and around Tsiolkovskiy Crater on the lunar farside. This presentation will describe the observations and investigate several potential formation mechanisms.

1. Introduction

Using data from the Diviner Lunar Radiometer, we have discovered an area of higher than normal (relative to other craters of similar size and age) rock abundance and nighttime soil temperatures near Tsiolkovskiy Crater (Figure 1). The thermophysical anomaly includes areas on the crater floor and within one crater diameter outside the crater rim from the northeast clockwise to the southwest. Potential formation mechanisms include: (1) unusually high local-derived impact melt, (2) ejecta/impact melt from Aristarchus at Tsiolkovskiy's antipode, and (3) remnant iron-metal from a large iron-rich impactor.

1.1 Diviner and other datasets

Diviner is a nine channel pushbroom mapping radiometer with two broad solar reflectance channels (0.3 to 3 μm), three narrow channels near 8 μm to characterize silicate mineralogy, and four broad channels that span the thermal infrared (13 to 400 μm) [3]. Diviner's spatial resolution is ~200 m from the nominal 50 km mapping orbit [3].

The data used in this study are derived from three of Diviner's broad thermal channels between 13 and 100 μm. The derivation of rock abundance and nighttime soil temperatures leverages the three different wavelengths with spectral anisothermality caused by pixels containing warm rocks and cooler soil [1]. These data are available in PDS Geosciences node. We also have used publicly available products from the Lunar Reconnaissance Orbiter LROC and LOLA instruments.

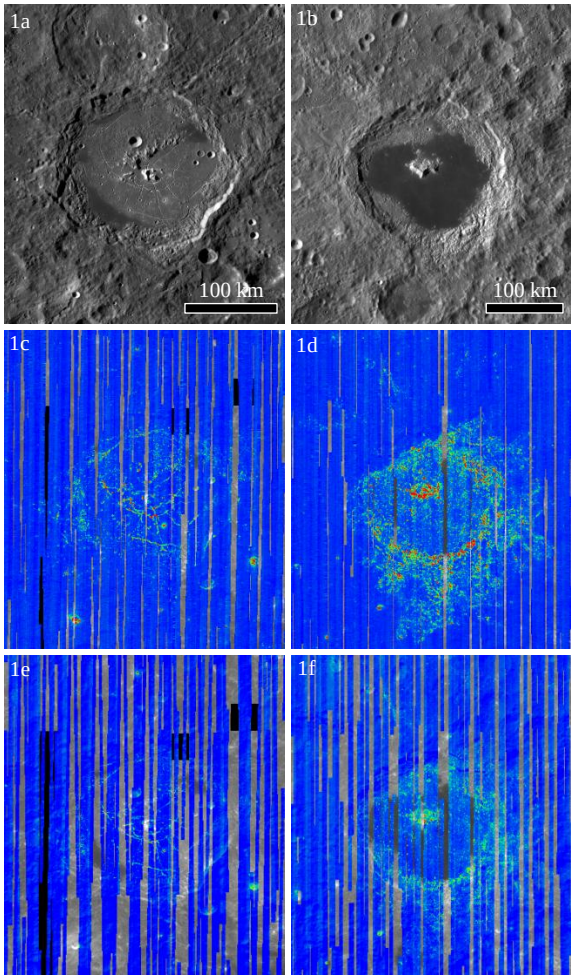

Figure 1: Tsiolkovskiy Crater (right; 1b, 1d, 1f) is shown here compared to Humboldt Crater (left; 1a, 1c, 1e), which displays typical thermophysical properties for a lunar crater of similar age and size (LROC WAC 1a, 1b; Diviner rock abundance 1c, 1d; Diviner nighttime soil temperature 1e, 1f).

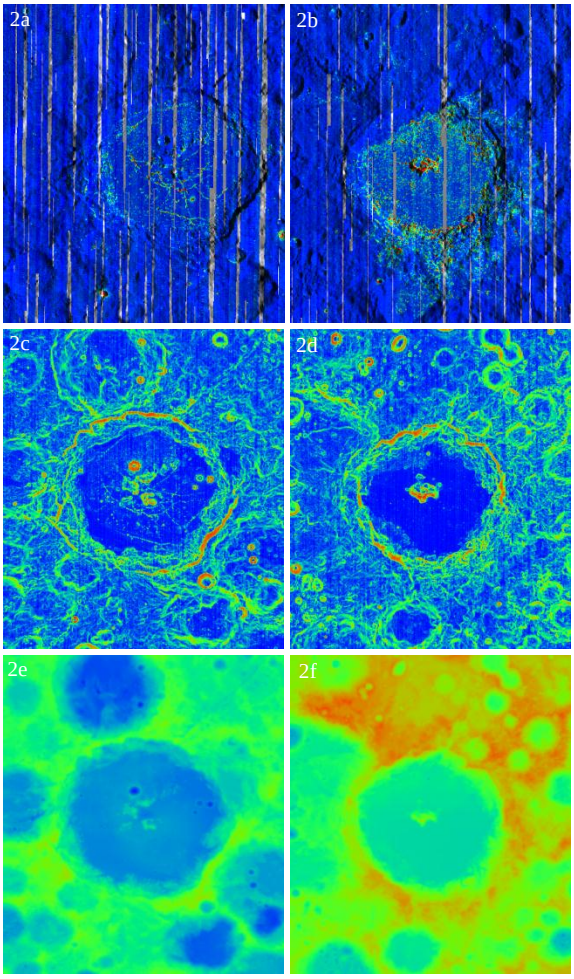

Figure 2: Humboldt Crater (left; 1a, 1c, 1e) and Tsiolkovskiy Crater (right; 1b, 1d, 1f). Compared here are Diviner rock abundance overlain on LOLA shaded relief (1a, 1b), LOLA slope (1c, 1d), and LOLA elevation (1e, 1f).

2. Discussion

We propose three hypotheses for the formation mechanism of the rock abundance anomaly.

First, the Tsiolkovskiy impact crater forming event may have produced an unusually high abundance of impact melt in the near-crater ejecta and the enhanced rock abundances are due to the weathering of a massive melt deposit. LOLA topography data of Tsiolkovskiy do not indicate any unusually large relief or slopes (Figure 2). However, LROC NAC imagery of this area correlates rocks with brighter (presumably immature) exposures (Figure 3).

Second, the enhanced rocks could be impact melt from Aristarchus Crater. Significant deposits of enhanced rock abundance materials have been observed at the antipode of Tycho Crater, far from any large fresh impact crater. The antipodal point of Aristarchus falls just off the southeast of rim of Tsiolkovskiy. This could be a coincidence as Aristarchus may not be large enough to produce a significant antipodal deposit. However, silica-rich materials have been observed in the local Aristarchus ejecta [2], so any observed enhancement of silica-rich materials at Tsiolkovskiy would strongly support this hypothesis.

Third, if Tsiolkovskiy Crater was formed by an iron metal-rich impactor, the unusual thermophysical properties may be caused by large quantities of remnant iron metal in the surrounding terrain. Iron metal has a high thermal inertia and could cause nighttime (and daytime) thermal anomalies.

3. Conclusions

Tsiolkovskiy Crater has an unusual rock abundance population for a crater of its age and size. We have proposed three hypotheses for the formation mechanism that will be investigated for this presentation.

References

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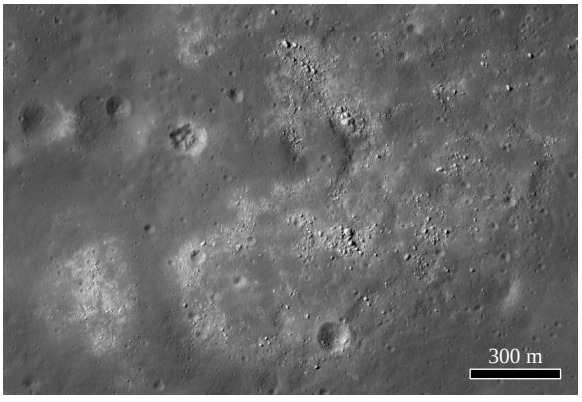

Figure 3: Portion of a LROC NAC frame showing unusual rocky area near Tsiolkovskiy Crater