PROPERTIES OF THE POLAR REGOLITH

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Research goals

- To determine the geographic details of the moon’s polar regolith, specifically:
  
  - Composition
  - Depth
  - Development
The Lunar Poles

- The North pole, defined as 80° to 90°
- The South pole, defined as -80° to -90°
The lunar regolith

- A layer of dust, debris, and broken rock covering the surface of the moon
- It was created by lunar bombardment over billions of years
- Commonly referred to as the lunar soil
Why the regolith? Why the poles?

- Knowledge of the regolith is necessary to understand the formation of the moon and history of the earth.

- The poles are a distinct area that has not been extensively studied yet.
Composition

- There is a high content of Hydrogen in the soil.
- We were able to collect this data from the Apollo missions.
Property 1: Composition

- The team managed to find data in its raw form; but were unable to interpret it or find the data in a more usable form.
- Without the ability to interpret the raw data, no composition was determined.
- High solar incidence angles obscured some spectrometer readings.
- Radioscopic dating was not a viable tool for this project.
Property 2: regolith depth

- The depth can help us understand more about the history of the moon.

- Knowing the depth could also help with determining the composition.

- Several methods exist that could be used to discover the depth of the regolith.
Method one

- Discovered by Quide and Oberbeck

- They found that the regolith depth $= (K - \frac{D_F}{D_A}) D_A \tan(\alpha)/2$

- The polar regolith should be about 7 meters if consistent with the trends found in another study, “Global Regolith Depths revealed”
Method one results

- This method cannot be applied to the poles due to the heavy shadows present.

- The shadows obscure the inner floor diameter ($D_F$), an important variable in their formula.
Method two

- Hypothesis: If we examine the impact cratering on the lunar polar surface, then we will be able to estimate the regolith depth.

- This hypothesis is based off of research suggesting a link between crater morphologies and regolith thickness.

- Two major revealing features are the layering of the regolith and the diameter of boulders.
Layering

- The presence of layering on crater rims provides additional definition and depth to the visual image.

- If it is true that the layering is part of the regolith, then an assumption can be made that the layering may be used to measure the depth of the regolith itself.
Boulders

- Large chunks of bedrock created by surface bombardment, also known as blocks.
- The size of the boulders present can indicate the relative depth of the regolith.
- If small boulders are apparent, then the regolith would be shallow in depth. Inversely, if only large boulders are visible with no smaller boulders present the regolith would be relatively deep.
Step One

- We used the polar NAC viewer, and examined each subsection above our latitude cutoffs.
Step One (continued)

- Within each section we looked at shadow-free craters, noted their morphology, and identified boulders and layering.
The Boulder System

- NAC viewer used only provides a meter/pixel scale, and our team could not find a pixel ruler.
- Instead, we physically measured the boulders using images on a constant zoom level and screen size.
- This method does not provide the actual size of the boulders, so we accounted for this by making a Boulder class system.

Type E boulders: <1mm
Type D boulders: 1mm
Type C boulders: 1mm-2mm (inclusive)
Type B boulders: 2mm-3mm (inclusive)
Type A boulders: >3mm
Step Two

- We then examined some topographic maps to estimate a rough depth using the layering
South Pole Data

- Total of 132 boulder groups found
  - 2% Type A
  - 9% Type B
  - 6% Type C
  - 41% Type D
  - 40% Type E

- In each case of boulders, Type E were always present so no relative depth estimates could be determined in the manner predicted.

- There were many cases of large and medium sized craters that completely lacked boulders. If we assume that the impacts did indeed hit bedrock, then where are their boulders?

- Our team theorizes that if our initial statement of boulders is correct, then these areas might be deeper than their surroundings.

- No Cases of Layering were found.
North pole data

- Total of 43 boulder groups found on the north poles
  - 2.3% Type A
  - 2.3% Type B
  - 2.3% Type C
  - 21% Type D
  - 72% Type E

- 3 Cases of Layering seen

- Estimates of depth using the layering were effected by Strateographic inversion
17 Boulders were inside rim

- Class A is more than 3 MM
- Class B is 2 to 3 MM
- Class C is 1 to 2 MM
- Class D is 1 MM
- Class E is less than 1 MM

- Only Class D and E were found
- Class E distances ranged from 1mm up to 20mm from rim
- Class D was a single boulder 115mm from rim
North pole data

Layering:

- Layers were identified and measured in two craters.

- The smaller crater was estimated to be ±60 meters thick. The larger crater layer was estimated to be ±325 meters thick.

- We determined that the thicknesses were affected by stratigraphic inversion, making them significantly thicker than the estimated depth of the regolith.
Conclusion

- In conclusion, there is great deal more work to be done at the poles particularly in acquiring more user-friendly data.

- We need better methods for measuring regolith layering.

- Without the ability to determine the depth, we were unable to fully pursue development.
Works Cited

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