20-M RESOLUTION RADAR STUDIES OF THE ARISTARCHUS PLATEAU AND REINER GAMMA FORMATION.

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Introduction: We are collecting 20-m resolution, dual circular-polarization, Earth-based radar images of areas on the Moon that may contain useful resources, such as pyroclastic deposits, and to address the detailed geology of enigmatic features. We report here on new data for the Aristarchus Plateau and the Reiner Gamma formation.

Data: We transmit a 13-cm wavelength, circularly-polarized signal from the Arecibo radio telescope, and receive the echoes from the Moon in both senses of circular polarization using the Greenbank Telescope in West Virginia. A coded signal with time resolution of 0.1 μs, and a 50-min coherent integration time, provide 20-m spatial resolution for areas at moderate to high incidence angles that are close to the Moon's apparent spin axis on the day of observation.

We correct for the intrinsic variations in range and Doppler shift of a point on the lunar surface by a "patch focusing" method. This process applies a time-varying delay and phase offset to the center of a particular image region, and maps the resulting focused small area (typically ~8 km square). Large focused maps are built up from a series of such chunks. Data collected in August, 2005 for the two targets studied here are being reduced.

The high-resolution data are complemented by ongoing mapping at 70-cm wavelength. The 70-cm data use the same focusing method, but cover a larger area at lower resolution (450 m/pixel). The advantage is that the longer wavelength signals penetrate to depths of 3-5 m in the maria, and up to 10's of meters in low-loss highland regolith.

Aristarchus Plateau: The Aristarchus Plateau represents the largest known pyroclastic deposit on the Moon [1, 2]. Such deposits are likely to be many meters in thickness, and are comprised of abundant glass beads that may contain resources for in situ exploitation. We are particularly interested in identifying those regions of the Plateau that are characterized by thick, rock-poor (and thus easily excavated) layers of this volcanic debris. Radar echoes that can probe the upper 1-10 m of the deposits, and are sensitive to decimeter-scale rock abundance, provide a strong complement to infrared measurements of surface geochemistry.

A quick-look 13-cm image of the Cobra Head region (Fig. 1) shows some evidence of low relief, lobate margins for the deposits near the vent. We will use the full-resolution data to determine whether the vent is surrounded by lava-like deposits fed by the eruption column. We will use both the 13-cm and the 70-cm data (Fig. 2) to study the abundance of decimeter-scale rocks across the Plateau, which has clearly undergone significant local modification due to ejecta from Aristarchus and smaller craters.

Fig. 1. Unfocused (~200 m/pixel) 13-cm radar image of the Cobra Head region on Aristarchus Plateau. 34-km diameter crater Herodotus at center bottom.

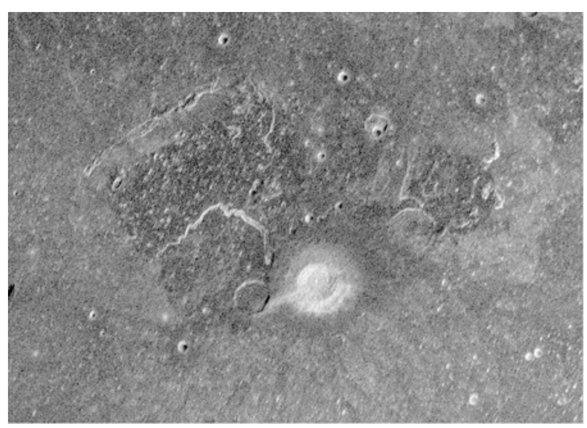

Fig. 2. 70-cm wavelength focused radar image of the Aristarchus Plateau. Aristarchus is bright crater at center (40 km diameter).

Reiner Gamma Formation: The Reiner Gamma formation is a high-albedo "swirl" extending across several hundred km of Oceanus Procellarum (Fig. 3). This feature and a few similar swirls observed across the Moon are of enigmatic origin.

Theories cited in [3] for swirl formation include an unusual aspect of fresh crater ejecta deposits, sublimates released due to a nearby impact, or the interaction of the regolith with volatiles from a cometary impact. The Reiner Gamma formation has an associated magnetic anomaly, and the swirl has strong photometric variations (though perhaps not compositional differences) relative to the background maria [4]. Understanding the detailed nature of the regolith is an important aspect of interpreting these features - while any possible volatiles have long since disappeared, clearly some degree of modification has survived, and may be elucidated by analysis of regolith morphology.

The quick-look 13-cm radar image (Fig. 4) shows an area of higher radar return generally correlated with the central oval region of the swirl, but little evidence for variations associated with the more filamentary high-albedo features. We will use the full (20-m) resolution data to study small craters to determine whether the swirl is correlated with any changes in the depth or rock abundance of the mare regolith.

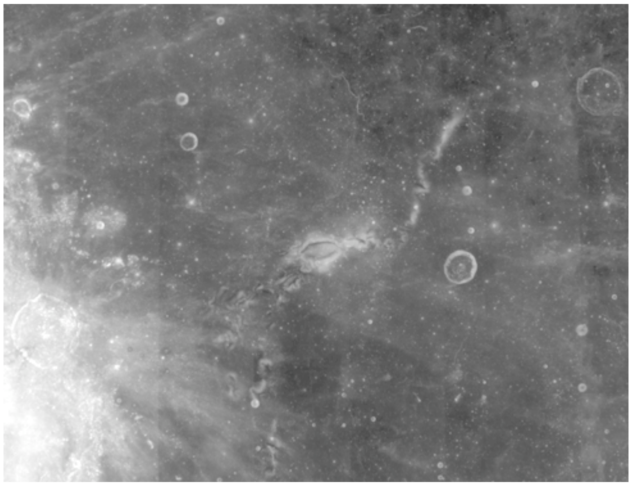

Fig. 3. Clementine 750-nm view of Reiner Gamma formation.

References: [1] Zisk, S.H. et al. 1977. The Moon, 17, 59-99. [2] Gaddis, L.R., Pieters, C.M. and Hawke, B.R. 1985. Icarus, 61, 461-489. [3] Schultz, P.H., Moon Morphology, Texas Press, 1972. [4] Pinet, P.C., A. Cord, S. Chevrel, and Y. Daydou, LPSC XXXV, #1660, 2004.

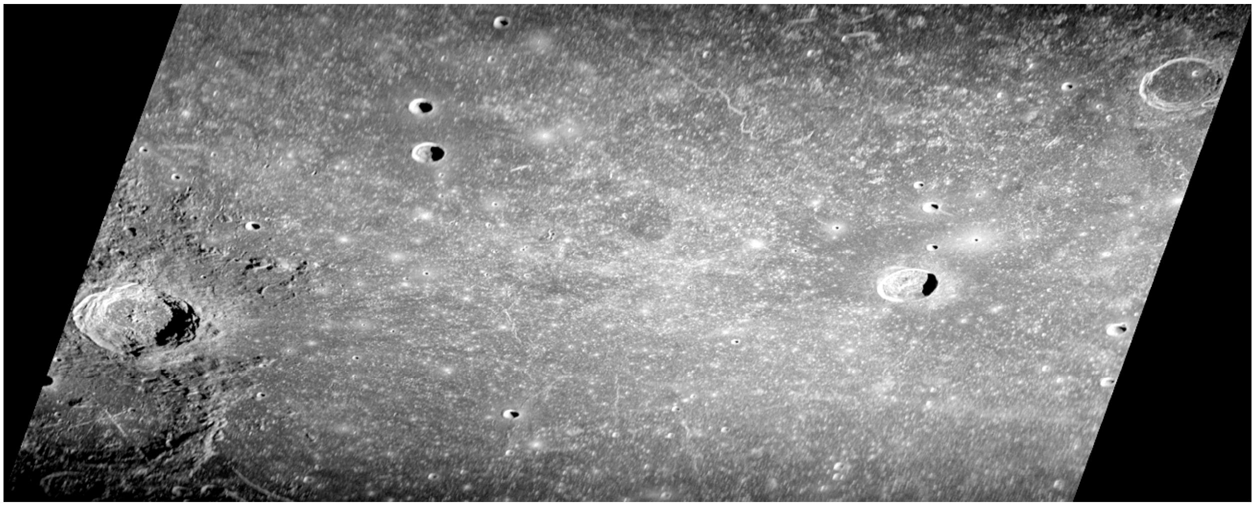

Fig. 4. Quick-look, unfocused 13-cm radar view of the Reiner Gamma formation. Area roughly similar to Fig. 3. Craters Cavalerius (57 km) and Hevelius at lower left. Crater Reiner (29 km diameter) at center right.