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HIGH RESOLUTION LUNAR RADAR STUDIES-PRELIMINARY RESULTS

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High resolution 12.6cm radar data for the lunar surface were acquired over fourteen sites in June and November 1990 using the new 10MHz data taking system at the Arecibo Observatory. The raw data collected for each site covers an area approximately 100km by 400km and will be processed using delay-Doppler techniques into images of backscatter cross section with three to four independent looks. Five of the sites were observed with a spatial resolution potentially better than 50m and the other nine at mixed spatial resolutions better than 150m. All observations transmitted a circularly polarized signal and both senses of circular polarization were received containing the polarized and depolarized components of the backscatter signal. The relative power in these two polarizations provides useful information on properties of the surface, in particular surface roughness.

The effort to date has focused on the initial data analysis with new software being written to perform a full synthetic aperture focusing on the raw radar data. The resulting image data data will be analyzed to: 1) study the scattering mechanisms, particularly, the polarization properties, associated with fresh impact craters, impact crater rays and volcanic flow units; 2) attempt to measure the dielectric constant and, hence, the porosity of the tenuous upper layer by mapping the ratios of the appropriately oriented linearly polarized components of the echo received from high incidence angle observations of the lunar mare; 3) investigate interferometric techniques in an attempt to derive lunar surface topography by unwrapping the interference fringes between two time delayed observations of the same site. This analysis will involve the use of complementary high resolution optical and topographic data sets to aid interpretation of surface scattering mechanisms.

The fourteen sites include the Dawes and Euler complex impact craters which were imaged at incidence angles of ~30° and ~40° respectively, the Gruithuisen domes which may be similar to the many domes on the Venus surface revealed by the Magellan spacecraft, the Hadley-Apennine and Littrow-Tarus regions near the Apollo 15 and 17 landing sites for comparison with ground truth information, the Aristarchus Plateau which has anomalously low radar backscatter at 3.8cm wavelength indicating a very smooth surface and/or regolith material with a high loss tangent [1], mare at high incidence angles for possible regolith dielectric constant measurements and Mare Orientale which is thought to be the youngest impact melt on the lunar surface and was recently imaged by the Galileo spacecraft [2]. Initial multilook images of the 17km complex impact crater Dawes are anticipated in mid spring. At the better than 50m resolution expected for the Dawes crater site we hope to analyze the radar echoes from smaller morphologic elements including the crater hummocky floor deposits, slump terraces within its walls, scalloped rim and the ejecta blanket. Of particular interest are the polarization signatures of the inner wall and ejecta which may provide a quantitative assessment of the blockiness and linear structures in these features. There is extensive supporting data for this area including Apollo metric and panoramic imaging, Earth based multispectral imaging and 1:50,000 scale (5m contour) Lunar Topo Photo maps. Quantitative assessment of the high resolution radar characteristics should provide useful insights into the local structural elements of this complex crater.

The analysis of lunar data will continue with the fresh crater Bessel, the complex crater Euler, volcanic rilles, flows and domes, mare regolith dielectric properties and interferometric analysis.

The dielectric constant of the lunar regolith at radar wavelengths is a measure of the porosity of the tenuous upper layer and is estimated from the ratio of the backscatter in the local horizontal and vertical linear polarizations. This estimate is based on the assumption that the observed backscatter is from the subsurface material only. High incidence angle observations of the lunar mare are preferred for regolith dielectric constant measurements because of the assumed low surface backscatter and good coupling of the vertical polarization to the surface when imaged near the Brewster's angle (incidence angle $\sim 60°$). Interferometric analysis requires observations with a viewing geometry limited to $\sim 0.01°$ and, hence, fortuitous alignment of the Earth-Moon system when visible from Arecibo Observatory.

Due to the libration of the moon some areas on the lunar surface are observable from Arecibo Observatory at incidence angles varying by as much as 10°. We will take advantage of this to try to quantitatively estimate variations in the relative quasi-specular and diffuse radar echoes with incidence angle which should aid interpretation of the scattering mechanisms. A third observing run at Arecibo Observatory is planned for late summer 1991 in which we will revisit some of the sites previously observed at the highest resolution to collect information suitable for multiple incident angle and interferometric analysis.

References:

[1] Zisk, S., et al., *The Moon*, **17**, 59, 1977; [2] Head, J.W., et al., *PLPSC*, **22**, 547, 1991.