A SEARCH FOR ICE AT THE LUNAR POLES; N.J.S. Stacy, Defence Science and Technology Organisation, Salisbury, South Australia, Australia and D.B. Campbell, National Astronomy and Ionosphere Center, Cornell University, Ithaca, NY 14853.

Discovery of probable water ice deposits on permanently shadowed crater floors near the poles of Mercury [1,2] suggested the possibility of similar deposits near the lunar poles. The interpretation that ice is responsible for the anomalous radar echoes discovered with the Goldstone and Arecibo radar systems, rests primarily on the unusual radar backscatter properties of many icy surfaces in the solar system, high backscatter cross section and greater than unity circular polarization ratio. While ice, with a dielectric constant of 3.15, does not have an intrinsically high reflectivity, it has low loss and so may serve as a weakly absorbing material which could support volume scattering mechanisms such as the coherent backscatter opposition effect [3].

For earth based telescopes, the geometry for observations of the lunar poles is less favorable than for Mercury. As viewed from the lunar poles, the Arecibo observatory rises a maximum of about 6 deg above the horizon while, given the 1.5 deg inclination of the moon's equatorial plane to the ecliptic plane, the limb of the sun can be up to 2 deg above the horizon. This small difference means that a significant percentage of the area shadowed from the sun is also shadowed from the radar and, hence, not observable.

Radar images were obtained of the north and south polar regions of the moon in May and August of 1992 with the Arecibo 12.6 cm wavelength radar. A circularly polarized wave was transmitted and images formed in both senses of received circular polarization. The 4 look images have resolutions of approximately 150m and cover areas of approximately 400km x 400km. Figure 1 shows a 4x4 averaged image of the south pole in the expected sense of circular polarization (the polarization expected from a single mirror like reflection). The polarization ratio is the ratio of the backscatter cross section in the opposite (cross polarized) sense to that in the expected sense.

An examination of the images revealed no large area of high backscatter cross section and polarization ratio greater than unity, and no systematic association of such properties with impact craters. However, there are a number of isolated areas, especially near the south pole, which have high cross sections and polarization ratios near unity. Most of these are coincident with the radar facing inner walls of craters and are probably due to enhanced wavelength scale surface roughness. Similar behavior is observed for craters in other areas of the moon which are clearly not in permanent shadow. One small crater near the south pole, which may be in permanent shadow, has a radar facing inner wall with high cross section and a polarization ratio of about 2.5. If the high ratio is due to ice deposits, it is not clear why it would be associated with the radar facing inner wall. One possibility is that ice excavated by the impact is causing an enhancement of the polarization ratio. However, geometric effects, such as a double bounce from the crater floor, may also be responsible.

While there are a number of features at the lunar poles which warrent further study, there is no clear evidence from the Arecibo images for the presence of ice. Because of the difficult geometry for earth based observations, a complete search should be done from an orbiting spacecraft. Such a mission could also measure the topography in the polar regions to determine which areas may have been in permanent shadow for a significant fraction of the moon's age.

References.
[1] M.A.Slade et al, Science, 258, 635-640, 1992.
[2] J.K.Harmon and M.A.Slade, Science, 258, 640-643, 1992.
[3] B.Hapke, Icarus, 88, 407-417, 1990.

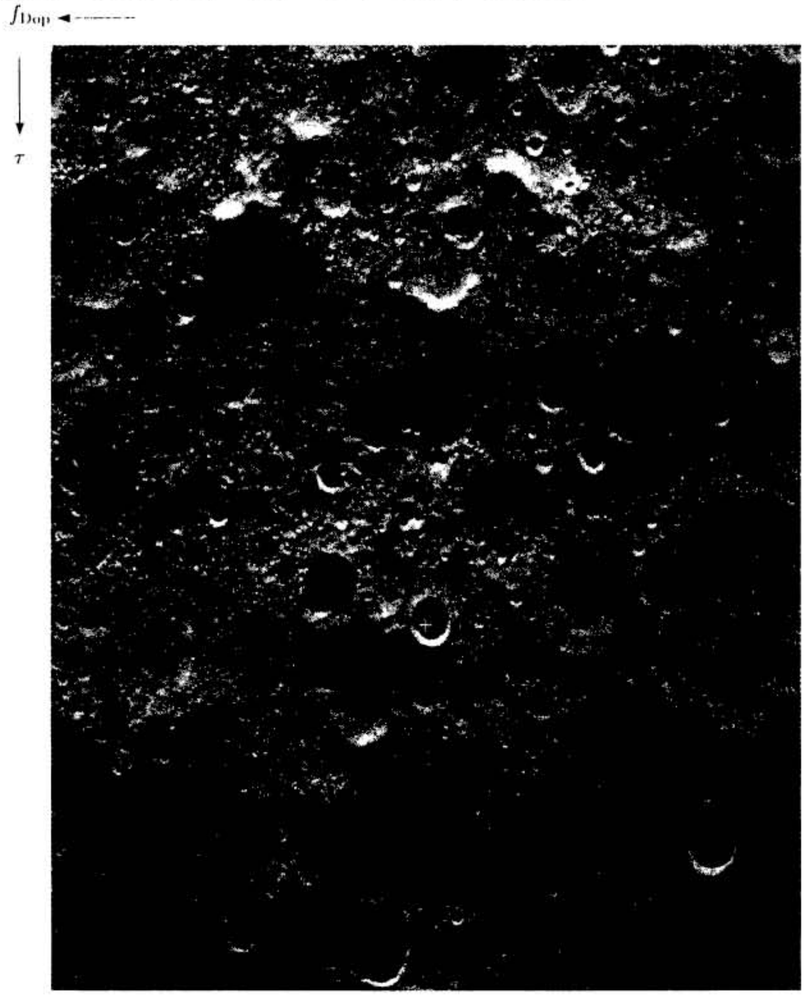

Figure 1. A delay-Doppler image of the south pole of the moon.