

CLEMENTINE BI-STATIC RADAR EXPERIMENT: PRELIMINARY RESULTS ; S. Nozette ¹, C.L. Lichtenberg ², P. Spudis ³, R. Bonner ⁴, W. Ort ⁴, E. Malaret ⁵, M. Robinson ⁶, E. Shoemaker ⁶, ¹ USAF Phillips Laboratory, ² Naval Research Laboratory, ³ Lunar and Planetary Science Institute, ⁴ Protasis Inc, ⁵ Applied Coherent Technology Inc, ⁶ US Geological Survey,

The Clementine mission included a series of ad hoc bistatic radar experiments to search for ice in the lunar polar regions. Water ice and/or other cold-trapped volatiles are expected to exhibit backscatter enhancement and a high ratio of same sense (transmitted) to opposite sense polarization in the reflected radar signal, as the bi-static angle β approaches 0. This is due to volume scattering possibly combined with an associated Coherent Backscatter Opposition Effect (CBOE). Bi-static radar observations were made on seven Clementine orbits, four at the south pole (orbits 234,235,236,237) and three at the north pole (orbits 299,300,301). The magnitude and circular polarization ratio of the radar echo as a function of β was measured for selected lunar target areas. The permanently shadowed region at the south pole, containing 16,000 km² of permanently shadowed terrain (1), was only observed during orbit 234. The orbit 234 observations of the south polar region, yielded a 1.4 dB \pm 0.11 dB (38%) same sense/opposite sense polarization ratio enhancement at the exact backscatter condition ($\beta=0$). The backscatter enhancement was observed primarily in same sense polarization. The polarization ratio enhancement was only observed within 5 degrees latitude of the lunar south pole. The maximum polarization ratio magnitude observed was approximately -3dB (0.5), as compared with -4.0 to -4.4 dB (0.4 -0.36) for non polar areas. Radar observations of other periodically solar-illuminated lunar surface and the lunar north polar region yielded no obvious backscatter or polarization enhancements. The lunar north pole contains less than 2% of the permanently shadowed area observed at the south pole. This result is suggestive of the presence of low-loss volume scatterers, such as frozen volatiles including water ice associated with the permanently shadowed region at the south pole. The magnitude of the polarization ratio enhancement suggests possible frozen volatiles mixed with absorptive lunar regolith present in roughly 0.3-0.4% of the observed shadowed surface area (50-60 km²). The Clementine result is consistent with ground based synthetic aperture radar observations (2) which detected a small number of same sense polarization radar "bright" areas at the lunar south pole. These were not uniquely attributed to ice and other non-ice explanations are possible given the limited number of observations. However, another mechanism would have to account for a polarization ratio enhancement, at $\beta=0$, correlated only with the lunar south pole. This correlation with large areas of permanently shadowed terrain is suggestive of the presence of cold trapped volatiles in these regions.

1. Spudis P., Lunar Planet. Science, 1339, **XXVI**, (1995)
2. Stacy N.J.S. Ph.D. Thesis, Cornell University (1993)