A MINI-RF RADAR ANALYSIS OF THE MOON'S SOUTH POLE-AITKEN BASIN. T. M. Aldridge[1], B. J. Thomson[2], P. R. Stoddard[1], J. T. S. Cahill[2], D. B. J. Bussey[2], and the Mini-RF Science Team, [1]Department of Geology and Environmental Science, Northern Illinois University, Dekalb, IL, [2]The Johns Hopkins University Applied Physics Laboratory, Laurel, MD, (taldridge@niu.edu).

Introduction: Previous studies have shown a correlation between returned radar backscatter strength and lunar regolith composition [1,2]. In particular, a comparison of Earth-based radar backscatter with multispectral Clementine-derived TiO_2 and FeO estimates of Mare Imbrium, Mare Fecunditatis, Mare Tranquilitatis, and Oceanus Procellarum suggest a correlation [3]. This is significant as it implies radar can be used as a tool to estimate and potentially corroborate multispectral, gamma-ray, and neutron derived estimates of composition. However, the use of radar as a compositional analysis tool requires better characterization and development. Several concurrent studies [4,5], including this one, are addressing this issue using multiple radar wavelengths and regions of the Moon.

Because Earth-based radar data sets are limited to perspectives of the lunar nearside, the farside has yet to be viewed with radar. The South Pole-Aitken (SPA) basin, located on the southern farside, has not been characterized at radar wavelengths and is an area of great scientific interest as it may have excavated lower-crust, perhaps even lunar mantle materials [6]. NASA's Lunar Reconnaissance Orbiter (LRO) has allowed the collection of some of the first global radar coverage including significant coverage of SPA basin [7]. Here we use this data set to search for potential correlations between SPA radar backscatter and Clementine-derived TiO_2 and FeO estimates.

Regional Geology: The SPA basin is a geologically diverse basin on the lunar farside. The basin is pre-Nectarian in age and is the oldest and largest lunar basin on the Moon [8]. The SPA basin is centered at 56ºS and 180ºW with a diameter of 2500 km [9] and a rim to basin floor depth of 12 km [10]. Superimposed on the basin and rim are several large craters, including Apollo, Schrödinger, and Ingenii, which have excavated the floor of SPA [9]. The basin also exhibits rings at the outer 2500 km crest, a 2000 km depression, and a possible inner ring at 1800 km [10].

Pieters et al. [6] used Clementine multispectral data to analyze rock types in the SPA region and inferred that the surface materials consist of exposed lower crustal material and possibly excavated mantle. The upper crust has been removed by the original basin-forming impact and the basin was subsequently filled with a melt sheet and impact breccia [6]. TiO_2 and FeO concentrations estimated by Lucey et al. [11] using Clementine data indicate TiO_2 and FeO concentrations of 0.5 to 1.5 weight percent and 7 to 14 weight percent, respectively. Earth-based 70-cm radar studies suggest a correlation between low CPR and high TiO_2 content and, conversely, between high CPR and low TiO_2 [5].

Instruments and Data Sets: The Miniature Radio Frequency (Mini-RF) is a synthetic aperture radar (SAR) aboard NASA's LRO mission. The instrument operates in S-band (12.6-cm) and X-band (4-cm), both with zoom and baseline modes [12]. Clementine, launched in 1994, was a joint mission between NASA and the U.S. Department of Defense. The mission included UV-VIS-NIR instruments designed to map the global mineral signatures on the Moon [13].

Methods: Using Mini-RF S-band zoom we derive the Stokes (S_1), and circular polarization ratio (CPR) parameters. The S_1 parameter represents the total average power of the returned radar signal. The circular polarization ratio (CPR) is the ratio of same sense and opposite sense (SC/OC) of the returned signal. From global Clementine UVVIS-NIR data, we derive estimated TiO_2 and FeO maps using the methods of [14,15] for comparison with radar data products.

Image Analysis: Clementine-derived TiO_2 concentrations across SPA range in value from 0 to 10 wt% (Fig. 1). In comparison with the previously observed range of 0.5 to 1.5 wt% [11], these values are quite high. A possible explanation for this inconsistenty may be due to the higher resolution of our TiO_2 map. Coinciding with locations of SPA basin maria basalts, higher TiO_2 is found between latitudes of 30°S to 50°S. Areas of low radar backscatter may indicate concentrations of TiO_2. Oppenheimer crater, located at 35°S, 166°W, contains high amounts of TiO_2 (>7.0 wt%), making the crater a prime site for radar correlation studies. The ranges of Mini-RF S_1 and CPR radar parameters are shown in Figures 2 and 3.

S1 vs. TiO_2. A visual, inverse correlation is observed between high TiO_2 concentrations and low backscatter strength (S_1). Weaker S_1 signals (<0.10, Fig. 2) are present in Apollo (36°S, 158°W) and Oppenheimer craters. Low backscatter in Apollo is found in areas of known mare locations in the central ring and western and southern basalts of the outer ring. Oppenheimer crater exhibits low S_1 on its western limb, with contrasting higher values of the central and eastern portions where mare are absent.

CPR vs. TiO_2. Further correlation is found for Apollo in CPR values. High CPR (>0.70 Fig. 3) mirror locations lacking mare basalts in Apollo and Oppenheimer craters. The average CPR of these craters is 0.70, possibly indicating a larger concentration of non-mare basalt areas within Apollo and Oppenheimer.

In contrast to Apollo and Oppenheimer crater basalts, Mare Ingenii displays higher S_1 and CPR backscatter values. This discrepency may be the cause of surface roughness or subsurface rocks that have enhanced radar backscatter strength.

Discussion: The SPA basin exhibits a wide range of radar backscatter strength S_1 and CPR, indicating a variety of geological features and compositions. Such a variety of compositions could possibly indicate the incorporation of mantle material excavated from the impact. As in agreement with previous studies [11], few concentrations of TiO_2 (>2 wt%) are observed, although notable exceptions are in Apollo and Oppenheimer craters. Similiarily, Mini-RF S_1 and CPR mosaics show stronger backscatter values as opposed to low, possibly indicating low concentrations of TiO_2 across SPA basin.

Summary: We present a preliminary global analysis of SPA basin using for Clementine derived TiO_2 and Mini-RF derived S_1 and CPR data products. Comparisons of TiO_2 and S_1 radar backscatter suggest plausible regions that are spatially correlated. A wide range of CPR has been found for SPA basin. Ongoing characterization of the relationship between TiO_2, S_1 and CPR values will provide a better understanding of SPA surface/subsurface roughness and composition.

References: [1] Thompson T. W. (1970) *Radio Science, 5*, 253-262. [2] Pollack J. B. and Whitehill L. (1972) *JGR*, 77, 4289-4303. [3] Campbell B. A. et al. (1997) *JGR*, *102*, 19-307-19,320. [4] Gillis J. J. et al. (2010) *LPSC 42*, this issue. [5] Campbell B. A. et al. (2009) *GRL*, *36*, L22201, doi:10.1029/2009GL041087. [6] Pieters C. M. et al. (2001) *JGR*, *106*(E11), 28,001-28,022. [7] McAdams M. et al. (2010) *LPSC 42*, this issue. [8] Head J. W. et al. (1993) *JGR*, *98*(E9), 17,149-17,181. [9] Wilhelms D. (1987) *USGS Prof. Pap. 1348*, 302 pp. [10] Spudis P. D. et al. (1994) *Science*, *266*(5192), 1848-1851. [11] Lucey P. G. et al. (1998) *JGR*, 103, 3701-3708. [12] Chin G. et al. (2007) *Space Sci. Rev.*, *129,* 391-419. [13] Nozette S. et al. (1994) *Science*, *266*(5192), 1835-1839. [14] Gillis J. J. et al. (2003) *JGR*, *108*, 5009, doi:10.1029/2001JE001515. [15] Gillis J. J. et al. (2004) *GCA*, 68, 3791-3805.

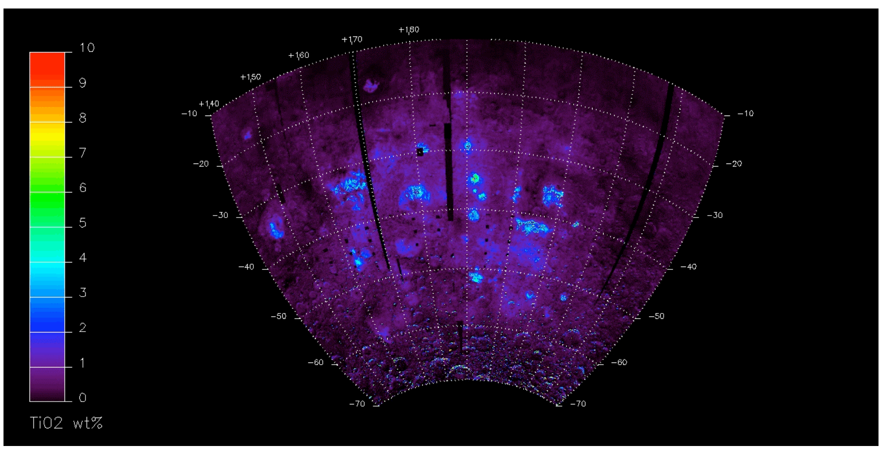

Figure 1. Clementine estimates of TiO_2 abundance in South Pole-Aitken basin.

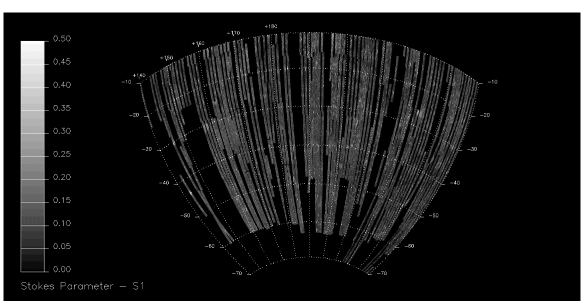

Figure 2. Mini-RF coverage of South Pole-Aitken basin in the S_1 Stokes Parameter.

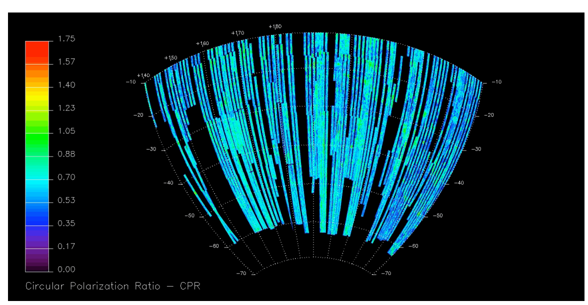

Figure 3. Mini-RF coverage of South Pole-Aitken basin in the CPR parameter.