A Radar Survey of Lunar Dome Fields. Lynn M. Carter[1], Bruce A. Campbell[2], B. Ray Hawke[3] and Ben Bussey[4], [1]NASA Goddard Space Flight Center, Planetary Geodynamics Lab Code 698, Greenbelt, MD 20771, lynn.m.carter@nasa.gov, [2]Center for Earth and Planetary Studies, Smithsonian Institution, Washington DC 20013, [3]Hawaii Institute of Geophysics and Planetology, University of Hawaii, Honolulu HI 96822, [4]The Johns Hopkins University Applied Physics Lab, Laurel, MD, 20723

Introduction: The near side of the Moon has several areas with a high concentration of volcanic domes. These low relief structures are considerably different in morphology from terrestrial cinder cones, and some of the domes may be similar to some terrestrial shields formed through Hawaiian or Strombolian eruptions from a central pipe vent or small fissure [1]. The domes are evidence that some volcanic lavas were more viscous than the mare flood basalts that make up most of the lunar volcanic flows. It is still not known what types of volcanism lead to the creation of specific domes, or how much dome formation may have varied across the Moon.

Prior work has shown that some domes have unusual radar polarization characteristics that may indicate a surface or subsurface structure that is different from that of other domes. Such differences might result from different styles of late-stage volcanism for some of the domes, or possibly from differences in how the erupted materials were altered over time (e.g. by subsequent volcanism or nearby cratering events).

For example, many of the domes in the Marius Hills region have high circular polarization ratios (CPRs) in S-band (12.6 cm wavelength) and/or P-band (70 cm wavelength) radar data [2]. The high CPRs are indicative of rough surfaces, and suggest that these domes may have been built from overlapping blocky flows that in some cases have been covered by meters of regolith [2, 3]. In other cases, domes have low circular polarization ratios indicative of smooth, rock-poor surfaces or possibly pyroclastics. The ~12 km diameter dome Manilius 1 in Mare Vaporum [1], has a CPR value of 0.20, which is significantly below values for the surrounding basalts [4]. To better understand the range of surface properties and styles of volcanism associated with the lunar domes, we are currently surveying lunar dome fields including the Marius Hills, Cauchy/Jansen dome field, the Gruithuisen domes, and domes near Hortensius and Vitruvius.

Data Description: We have obtained S-band (12.6 cm wavelength) data of the lunar nearside dome fields using Arecibo Observatory and the Green Bank Telescope in a bistatic configuration [5]. The radar system transmits a circularly polarized wave and receives two orthogonal circular polarizations. These same-sense (SC) and opposite sense (OC) circular polarizations are used to generate the Stokes polarization parameters and the circular polarization ratio. These images have a resolution of 80 m/pixel and the incidence angle varies depending on the observing geometry.

The Mini-RF radar on Lunar Reconnaissance Orbiter produces slightly higher resolution (15x30 m) imagery at S-band that can be useful for comparison. Mini-RF transmits a circularly polarized wave and receives orthogonal linear H and V polarizations, which are used to derive the Stokes polarization parameters. The radar images are typically ~12 km wide with incidence angles ranging from ~46-54°.

Hortensius Dome Field: The Hortensius dome field, located at 7.5° N and 332° E, is one example of how radar properties can vary across a dome field. Several domes are located north of the crater Hortensius (Fig 1) and can be seen in Arecibo radar images (Fig 2). The lunar domes are generally very low relief and require low sun angles and high radar incidence angles to be clearly visible as higher elevation features.

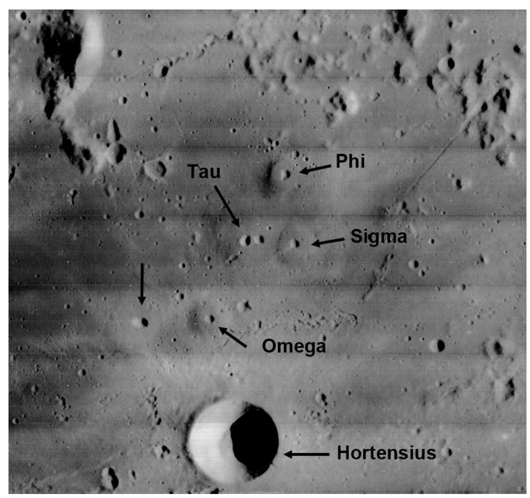

Fig 1: Lunar Orbiter IV 133 image showing the Hortensius dome field. The crater Hortensius is 15 km across. An unlabeled arrow marks the position of an unnamed dome.

In radar images, the domes are generally dark with radar bright pit craters. The radar backscatter power is not measurably different from that of the surrounding cratered mare. For most of the domes, the circular polarization ratios are low (<0.25), but match those of the surrounding mare. This suggests that there is a fairly consistent regolith layer across the domes and mare that leads to similar centimeter-sized rock abundance in the upper meter. The central pit craters of the domes have high CPR values that are larger than those of most nearby secondary impact craters. Blocky material may shed down the steep caldera walls leading to a rougher surface. Alternatively, blocky outcrops may be present in some of the calderas.

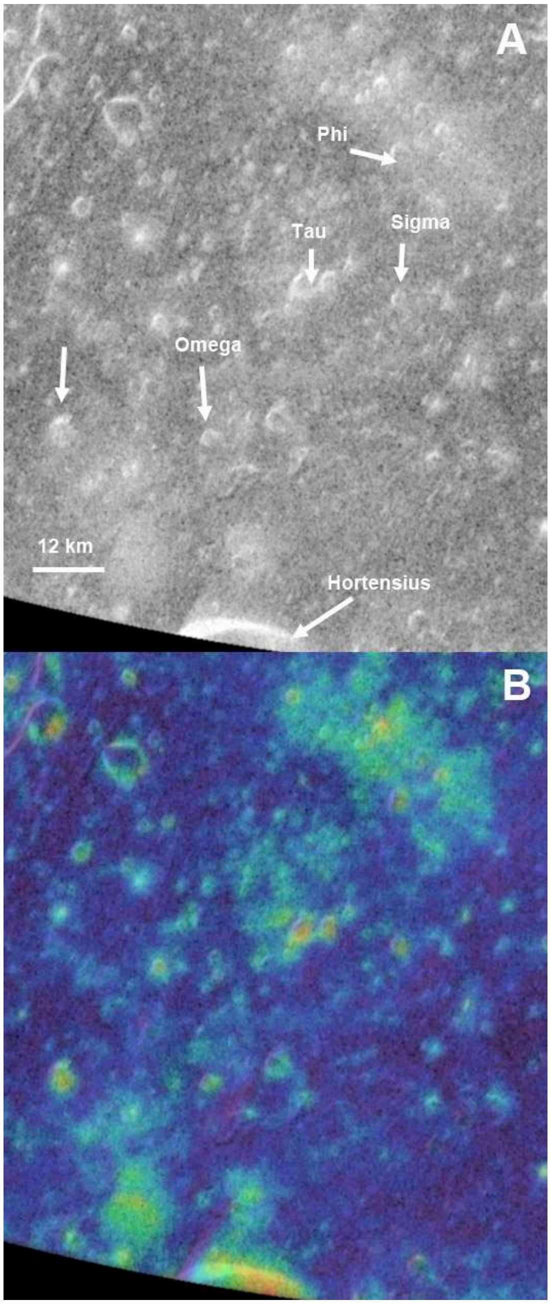

Fig. 2: Arecibo-GBT derived images of the Hortensius dome field. A.) Radar SC image. B.) Circular polarization ratio, stretched from 0-1 on a color scale, and overlaid on the SC image.

Tau Hortensius and Phi Hortensius have higher circular polarization ratio than the surrounding domes. Phi Hortensius most likely has a higher CPR due to secondary craters that blanket the northern flank of the dome. Tau Hortensius is somewhat larger and has a slightly shallower relief than the other nearby domes. Mini-RF images (Fig. 3) show that the northwest side of the dome is cratered and has lineations not present on the southern side, which is consistent with the distribution of CPR values in the Arecibo data. It is likely that the southern side of the dome has a thicker, rock-poor covering that leads to lower CPR values.

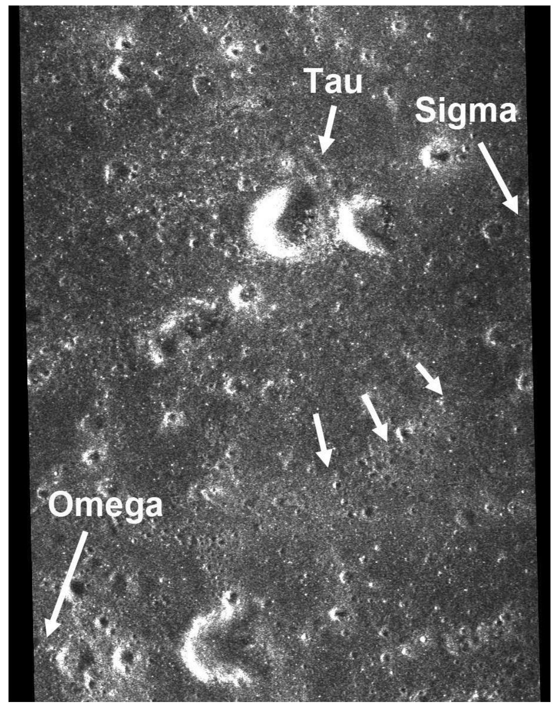

Fig. 3: A Mini-RF image of the Tau Hortensius dome. Small arrows mark the edge of the dome on the southern side. The image is ~12 km across.

Future Work: Preliminary work on the Hortensius, Cauchy, and Marius Hills dome fields suggests a variety of different surface types for lunar domes, including rough blocky deposits, mantling regolith that often is indistinguishable from the surrounding areas, and possible evidence of pyroclastics. A systematic compilation of the polarization and radar backscatter properties of the domes in the survey, combined with available imagery and terrestrial analogs, will help to understand how the domes were emplaced.

References: [1] Head and Gifford (1980) *Moon and Planets, 22,* 235-258. [2] Campbell, B. A. et al. (2009) *JGR, 114,* E01001, doi:10.1029/2008JE003253. [3] Campbell, B. A. et al. (2011) *LPSC 42,* this conference. [4] Carter et al. (2009) *JGR, 114*, E11004, doi:10.1029/2009JE003406. [5] Campbell, B. A. et al. (2010) *Icarus, 208*, doi:10.1016/j.icarus.2010.03.011.