GALILEO IMAGING RESULTS FROM THE SECOND EARTH-MOON FLYBY: LUNAR MARIA AND RELATED UNITS;

R. Greeley(1), M.J.S. Belton(2), J.W. Head(3), A.S. McEwen(4), C.M. Pieters(3), G. Neukum(5), T.L. Becker(4), E. M. Fischer(3), S. D. Kadel(1), M.S. Robinson(6), R.J. Sullivan(1), J.M. Sunshine(3), and D.A. Williams(1). *(1) Arizona State University, Tempe, AZ; (2) NOAO, Tucson, AZ; (3) Brown University, Providence, RI; (4) U.S. Geological Survey, Flagstaff, AZ; (5) German Aerospace Research Establishment (DLR), Inst. for Planetary Exploration, Berlin/Oberpfaffenhofen, Germany; (6) University of Hawaii, Honolulu, HI.*

The second flyby of the Earth-Moon System by Galileo occurred on December 7, 1992, on its trajectory toward Jupiter. The flyby took the spacecraft over the lunar north polar region from the dark farside and continued across the illuminated nearside. This provided the first opportunity to observe northern and northeastern limb regions with a modern, multispectral imaging system [1] with high spatial resolution (up to 1.1 km/pixel). Scientific objectives included compositional assessment of previously uncharacterized mare regions, study of various light plains materials, and assessment of dark mantle deposits (DMD) and dark halo craters (DHC). Color composite images were prepared from ratios of Galileo SSI filter data (0.76/0.41 → red; 0.76/0.99 → green; 0.41/0.76 → blue) and used for preliminary comparison of units [2]. The 0.41/0.76 ratio has been empirically correlated to Ti content of mare soils (blue is relatively high, red is relatively low) [3]. The relative strengths of the ferrous one micron absorption in mafic minerals can be compared using the 0.76/0.99 ratio. In addition, relative ages of units analyzed spectrally were determined from crater statistics using Lunar Orbiter images following the techniques of Neukum et al. [4]. Mare deposits analyzed include Mare Humboldtianum, central and eastern Mare Frigoris, Mare Crisium and other deposits in the Crisium Basin, and isolated mare patches on the northeastern lunar limb. Preliminary results show a diversity of 0.41/0.76 micron signatures, implying a wide range of titanium contents. Some light plains units are similar to units found at the Apollo 16 site; others may be ancient mare materials. Dark mantle deposits (DMD) analyzed also are variable.

Analyses of the maria show that:

1) Mare Humboldtianum contains two distinct units. The western two-thirds is composed of red (lower-Ti) mare basalts, whereas the eastern third is bluer (higher in Ti) and has a stronger 0.76/0.99 ratio.

2) Previously uncharacterized basalts in Mare Anguis are red, similar to the low-Ti Eimmart basalts [5] in Mare Crisium.

3) Previously uncharacterized basalts in Mare Undarum, Mare Spumans, and the mare patch in crater Firmicus are similar to each other and to the medium-high-Ti Alhazan basalts [5] in Mare Crisium.

4) The mare deposit in Mare Fecunditatis, which includes the Luna 16 site, appears bluer than previously mapped [6], and is composed of two distinct units.

5) A small, unusually dark mare deposit south of crater Mercurius (43.6 N, 63.8 E) is relatively blue, and is the only Ti-rich mare deposit on the northeastern limb which may not be associated with an impact basin.

6) Small areas of Ti-rich mare may be present in Mare Marginis and in craters Goddard and Neper. Both Mare Marginis and Mare Smythii have strong 0.76/0.99 micron signatures.

Dark mantle deposits (DMD) were examined in the craters Gauss, Messala, Atlas and Franklin. The DMD in Gauss and Messala are red, perhaps similar to the red deposits on the Aristarchus Plateau [7,8]. In contrast, DMD in Atlas, Franklin, and a newly discovered site in Crater Hahn (31.8 N, 74.5 E) are blue. Comparisons with previously identified DMD are currently underway.

GALILEO IMAGING RESULTS: Greeley, R. et al.

Light plains deposits are found in many regions of the Moon, as sampled at the Apollo 16 site. The largest concentration of light plains is found in the north polar region, north of Mare Frigoris [9]. In general, light plains may be of diverse origins and ages [10,11]. Galileo results show that light plains north of eastern Mare Frigoris have 0.41/0.76 micron ratios and surface morphologies comparable to those of the Apollo 16 site; impact crater frequencies indicate a cratering model age of 3.71 ± 0.05 Ga. In contrast, light plains near craters Carpenter and Philolaus have different signatures, and impact crater frequencies indicating ages from 3.9-4.0 Ga.

Some lunar surfaces appear to involve ancient mare deposits that have been thinly mantled with high albedo material such as impact crater ejecta. Dark halo craters in these regions are interpreted to represent impacts that penetrated the mantling deposits to excavate the underlying mare material [12,13]. Termed *cryptomaria* [14], such deposits extend the geographic distribution of maria and age range of volcanism on the Moon. There is evidence for an early, Ti-rich stage in the mare filling of eastern Mare Frigoris. The 8 km DHC Gärtner D (58.5 N, 33.9 E) excavated blue mare materials from beneath the light plains unit of northeastern Mare Frigoris. In addition, there is a patch of blue mare exposed at the extreme eastern end of Mare Frigoris. Another exposure of this unit may be present in the plains just north of crater Galle. SSI EM-2 data show moderate to low albedo zones over regions north of eastern Mare Frigoris, east of Mare Marginis, and southwest of Mare Smythii, which suggest the possibility of cryptomaria in these regions. Cryptomaria tentatively identified from Galileo EM-1 total $\sim 6 \times 10^5$ km^2. Combined with previously known mare deposits, this makes a total of ~19% of the lunar surface involving mare volcanism. Alternatively, some of these deposits may be of other origin [15]. Cryptomaria observed in EM-1 data indicate that significant mare volcanism occurred prior to the Orientale event. Thus, lunar volcanism is seen over a wider area for a longer period of time than previous estimates.

References:

[1] Belton, M.J.S. et al. (1992) *Space Sci. Rev., 60,* 403-455.
[2] McEwen, A.S. et al. (1993) *Lunar Planet. Sci., XXIV.*
[3] Charette, M.P. et al. (1974) *J. Geophys. Res., 79,* 1605-1613.
[4] Neukum, G. et al. (1975) *The Moon 12,* 201-229.
[5] Head, J. et al. (1978) *Mare Crisium: The View from Luna 24,* 43-74.
[6] Pieters, C. (1978) *Proc. Lunar Planet. Sci. Conf. 9,* 2825-2849.
[7] Gaddis, L. et al. (1984) *NASA Tech. Memo. TM-87563,* 399-401.
[8] Lucey, P. et al. (1986) *Proc. Lunar Planet. Sci. Conf. 16,* D344-D354.
[9] Howard, K. et al. (1974) *Rev. Geophys. Space Phys. 12,* 309-327.
[10] Neukum, G. (1977) *The Moon 17,* 383-393.
[11] Greeley, R. et al. (in press) *J. Geophys. Res.*
[12] Schultz, P.H. and Spudis, P.D. (1979) *Proc. Lunar Planet. Sci. Conf. 10,* 2899-2918.
[13] Hawke, B. and Bell, J. (1981) *Proc. Lunar Planet. Sci. Conf. 12,* 665-678.
[14] Head, J.W. and L. Wilson (1992), *Geochima Cosmochima Acta 56,* 2155-2175.
[15] Head, J.W. et al. (1993) *Lunar Planet. Sci., XXIV.*