# MULTISPECTRAL STUDIES OF SELECTED CRATER- AND BASIN-FILLING LUNAR MARIA FROM GALILEO EARTH-MOON ENCOUNTER 1;

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New visible and near-infrared multispectral data of the Moon were obtained by the Galileo spacecraft in December, 1990 [1]. These data were calibrated with Earth-based spectral observations of the nearside to compare compositional information to previously uncharacterized mare basalts filling craters and basins on the western near side and eastern far side [1]. A Galileo-based spectral classification scheme, modified from the Earth-based scheme developed by Pieters [2], designates the different spectral classifications of mare basalt observed using the 0.41/0.56 µm reflectance ratio (titanium content), 0.56 µm reflectance values (albedo), and 0.76/0.99 µm reflectance ratio (absorption due to $Fe^{2+}$ in mafic minerals and glass) [3]. In addition, age determinations from crater counts and results of a linear spectral mixing model were used to assess the volcanic histories of specific regions of interest [3]. These interpreted histories were related to models of mare basalt petrogenesis in an attempt to better understand the evolution of lunar volcanism.

The following general results were obtained: 1) mare basalts on the western near side and eastern far side have much less variability in titanium content than near side maria [4]; and 2) weaker absorptions at 1 µm suggest these basalts may have an inherently different mafic mineralogy than those on the near side [4,5]. Spectral differences suggest evidence for compositional variations for maria in the Grimaldi, Orientale, Mendel-Rydberg, and Apollo basins, implying evolution in basalt composition or multiple source regions for these mare basalts [3]. Specifically, mare units in the Grimaldi basin (cratering model ages: 2.49-3.25 Ga) contain medium- (<4 wt.% $TiO_2$) and medium-high-titanium (3-7 wt.% $TiO_2$) basalts, whereas the mare units in the neighboring Crüger region have evolved from older medium-high-titanium (3-7 wt.% $TiO_2$) basalts to younger, medium-titanium (<4 wt.% $TiO_2$) basalts, spanning ~0.4 Ga (cratering model ages: 3.18-3.46 Ga) during the upper-Imbrian. The intermediate-titanium (<4-7 wt.% $TiO_2$) mare units in the Mendel-Rydberg basin (cratering model age: 3.44 Ga) show evidence of multiple lava flows with different compositions. Likewise, spectral variations in the Apollo maria (cratering model ages: 3.63-3.71 Ga) suggest the presence of multiple lava flows with different compositions. The youngest basalts in Apollo have high titanium contents (>6 wt.% $TiO_2$), and have been interpreted as part of an upper-Imbrian period of regional volcanism in the South Pole-Aitken basin [4]. Mixing model analyses suggest ancient maria covered by crater ejecta (cryptomaria) may be present in several old basins, including Schiller-Zucchius [6,7], Mendel-Rydberg (prior to the Orientale impact), and S.P.-Aitken after the basin impact in the pre-Nectarian [8].

These results show several general trends: 1) maria filling basins have higher titanium contents than maria filling small craters (most basin maria have ~3-7 wt.% $TiO_2$ vs crater maria having <4 wt.% $TiO_2$); 2) the only occurrence of high-titanium basalt (>6 wt.% $TiO_2$) on the lunar far side occurs within the 505 km diameter Apollo basin, which is superposed on the 2300 km diameter S.P.-Aitken basin; and 3) there is no global correlation of titanium content with cratering model age or crustal thickness; correlations seem to be related to specific geographic regions [3].

From these general trends several implications regarding basalt petrogenesis can be made: 1) higher-titanium magmas are restricted to regions where the crust is inferred to be thinner due to excavation by basin impacts (Procellarum or S.P.-Aitken); 2) denser high-titanium magmas apparently ascend to a buoyancy trap as diapirs and extrude on the far side surface only in regionally compensated areas of a superposed impact (Apollo) within S.P.-Aitken. This observation agrees with modeling of Head and Wilson (1992) [9]; 3) the compositional variations of western near side/eastern far side basalts implies there are local heterogeneities of basalt sources in specific geographic regions (assuming that differences in titanium content observed by Galileo are due to differences in primary magma composition); and 4) if convective overturn [10] is

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responsible for heterogeneity of mare basalts, it may have occurred on a regional, rather than global, scale to cause the apparent heterogeneities inferred for western near side/eastern far side regions. The next stage of this research is to analyze the spectral data of the western far side (eastern limb) and the north polar region of the Moon obtained by Galileo during Earth-Moon Encounter 2 (December, 1992), apply our classification scheme, and determine if the maria in this region of the Moon are more similar to the widely varying compositions of nearside maria or to the relatively homogeneous maria of the western near side and eastern far side.

**REFERENCES:** [1] Belton, M.J.S. et al. (1992), *Science 255*, 570-576; [2] Pieters, C. (1978), *Proc. 9th Lunar Planet. Sci. Conf.*, 2825-2849; [3] Williams, D.A. (1992), Masters Thesis, Arizona State University, 145 pp.; [4] Greeley, R. et al. (in review), *J. Geophys. Res.*; [5] Pieters, C.M. et al. (in review), *J. Geophys. Res.*; [6] Mustard, J.F. et al. (1992), *Lunar Planet Science XXIII*, 957-58; [7] Head, J.W. et al. (in review), *J. Geophys. Res.*; [8] Wilhelms, D.E. (1987), *USGS Prof. Paper #1348*; [9] Head, J.W. and L. Wilson (1992), *Geochima Cosmochima Acta 56*, 2155-2175; [10] Neal, C.R. and L.A. Taylor (1992), *Geochima Cosmochima Acta 56*, 2177-2211.

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