CRYPTOMARE IN THE LOMONOSOV-FLEMING REGION OF THE MOON. T. A. Giguere[1,2], B. Ray Hawke[1], D. B. J. Bussey[1], G. A. Smith[1], D. T. Blewett[1,3], G. Jeffrey Taylor[1], P. G. Lucey[1], and P. D. Spudis[4]. [1]Hawai`i Inst. of Geophys. and Planetology, University of Hawai`i, 2525 Correa Rd., Honolulu, HI 96822, giguere@higp.hawaii.edu. [2]Intergraph Corp., 2828 Pa`a St. Ste. 2150, Honolulu, HI 96819. [3]NovaSol, Inc., 1100 Alakea St, 23rd Flr, Honolulu, HI 96813. [4]Lunar and Planetary Institute, Houston, TX 77058.

Introduction: The Lomonosov-Fleming region is an ancient impact basin on the east side of the Moon. The basin, which is one of the oldest on the Moon, is just out of view from Earth at 19º north, 105º east and is positioned east and northeast of Mare Marginis (Figure 1). A number of unusual features exist in the Lomonosov-Fleming region, including: bright swirls, groove-like crater chains, dark halo craters, and a concentration of light plains deposits. This 620 km, pre-Nectarian basin is named for the Nectarian-aged crater Fleming (130 km, 15º N., 109.5º E.) and the lower Imbrian-aged crater Lomonosov (93 km, 27.5º N., 98º E.) which is mare filled. The degraded Lomonosov-Fleming basin has unusual topography [1; 2]. This feature appears as a quasi-circular, smooth surface of nearly constant elevation about 500 km across [3]. Such an expression of topography may be caused by infilling of the basin with ancient mare basalts, which were later covered by highland plains and reexposed as the ejecta of dark halo impact craters [4; 5]. This basin has long been suspected of being the site of a cryptomare [4]. Cryptomaria are ancient mare basalts deposits that are obscured by superposed higher albedo material [6, 7, 8]. As such, they represent a record of the earliest mare volcanism, and may be a significant volumetric contribution to the lunar crust.

Previous remote sensing and geologic studies have provided evidence for the distribution of ancient mare deposits. Schultz and Spudis [4] studied the distribution of dark-haloed impact craters in the lunar highlands and suggested that basaltic volcanism may have been widespread, predating the last major basin-forming impacts. Hawke and Bell [9, 10] used near-IR spectra to demonstrate that many dark-haloed impact craters excavated ancient mare units buried by basin and crater ejecta. Studies of the Apollo orbital geochemical data sets [11, 12, 13, 14] have shown that mafic geochemical anomalies on the east limb and far-side of the Moon are commonly associated with light plains deposits that exhibit dark-haloed craters. In recent years, both Earth-based and spacecraft remote sensing data have been used to characterize selected lunar cryptomaria [7, 8, 15, 16, 17], however, the Lomonosov-Fleming region has not been studied in depth. We have been using maps of FeO and TiO_2 abundances produced from Clementine multispectral images coupled with spacecraft images obtained for the east side of the Moon to investigate the nature and origin of ancient buried mare basalts in the Lomonosov-Fleming region.

Figure 1 – This Apollo 12 image of the east side of the Moon shows the Lomonosov-Fleming basin on the terminator. Major features are marked for orientation. NASA photograph: AP12-55-8226.

The goals of this study include the following: 1) to determine the origin and distribution of dark halo craters in the region, 2) to study the composition of surface units in and around the LF basin region, 3) to search for and map possible cryptomare and investigate the processes responsible for their formation, 4) to determine the composition of the buried mare unit and investigate whether or not these compositions vary from place to place within the basin, and 5) to investigate the processes responsible for the formation of the Lomonosov-Fleming light plains deposits.

Method: The primary data product used for this research were the CD-ROM based Clementine five-color UV-VIS digital image model (DIM) for the Moon published by the U.S. Geological Survey's Astrogeology Program in Flagstaff, Arizona, USA [18; 19; 20]. This calibrated data served as the basis for the production of a number of other data products used in this paper for the Lomonosov-Fleming region. The FeO and TiO_2 maps were prepared using the algorithms of Lucey *et al.* [21]. Optical maturity images were produced using the algorithms of Lucey *et al.* [22]. Both 1 km and 100 m resolution images were generated for the region.

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Characterization of dark halo craters: Numerous dark halo impact craters have been identified and mapped in the Lomonosov-Fleming region. Seventeen of these were selected for intensive study. These craters have excavated mafic material with FeO values of between 10 and 16 wt. %, which approach values of typical nearside mare basalts. These same dark halo craters have excavated material with TiO_2 values of between 0.4 and 4 wt. %. The low end of this range is close to the highlands background value. The high end of the TiO_2 range (4 wt. %) is higher than that of any other known dark halo crater ejecta.

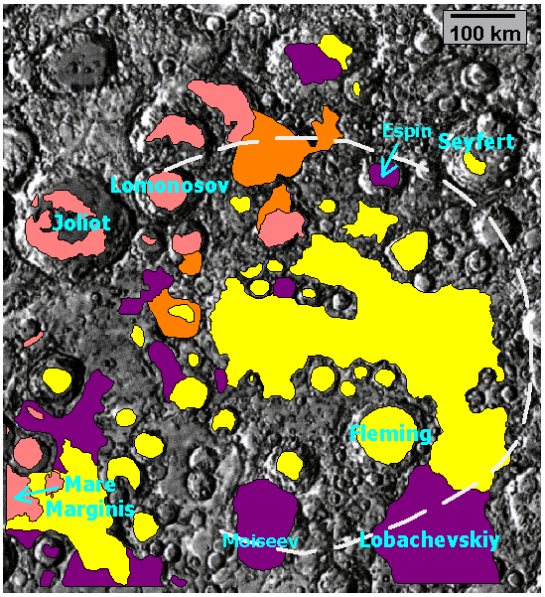
Spectra were extracted from the dark exterior deposits surrounding selected craters. These spectra have relatively strong "1 μm" absorption bands and have band parameters that suggest the dominance of high-Ca pyroxene. The spectra are very similar to those collected for fresh mare craters and the dark material for which the spectra were obtained are composed of immature mare basalt or immature mare basalt contaminated with varying amounts of highland debris.

The dark halo craters in the Lomonosov-Fleming region have excavated mare-like material from beneath a higher albedo, overlying surface. These dark halo craters are a key indicator of the existence of an underlying cryptomare. There are buried mare ponds in the region, however, the widespread distribution of the dark halo craters indicate that the mare material is not confined to small areas and indeed represents a large cryptomare.

Mapping the Cryptomare: Roughly one-third of the area under the basin may be made up of cryptomare (Figure 2). The largest cryptomare patch begins just west of the center of the basin, and extends east almost to the edge of the basin. This patch extends to the south almost to crater Lobachevskiy and a section of the cryptomare extends to the northwest towards Artamonov. Many of the craters within the basin have cryptomare mapped within them. Fleming is an example of this. This and other areas most likely represent mare ponds that have been obscured by highland material. The majority of the cryptomare mapped in the Lomonosov-Fleming region underlies the light plains material that occupies much of the basin. A lesser amount of cryptomare underlies materials associated with other highland units, such as material of relatively undegraded circular craters, which is the case at Lobachevskiy (Ic_2), Moiseev (Ec), and Espin (pNc).

Conclusions: The evidence confirms that the Lomonosov-Fleming region is the site of a major cryptomare. Mapping efforts (Figure 2) illustrate the extent of the the cryptomare. The FeO values in the dark-haloed craters approach the values of surface mare. The TiO_2 values of some of the DHC's are as high as 4 wt. %. These values are higher than any other cryptomare on the Moon.

Figure 2 – Cryptomare map of the Lomonosov-Fleming region. Legend - Cryptomare associated with Light Plains: yellow, Cryptomare associated with other highland units: purple, Mare basalt: red, Possible pyroclastic material: orange. The Lomonosov-Fleming basin ring is shown as a white-dotted partial ring [2].



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