SPECTRAL REFLECTANCE STUDIES OF THE HUMORUM BASIN REGION; C.A. Peterson, B.R. Hawke, P.G. Lucey, G.J. Taylor, D.T. Blewett, Planetary Geosciences, SOEST, University of Hawaii, Honolulu, HI 96822; P.D. Spudis, Lunar and Planetary Institute, Houston, TX 77058.

SUMMARY. A portion of the mare-bounding (MB) ring of Humorum Basin is composed of pure anorthosite while other parts of the ring are composed of noritic anorthosite. An episode of mare volcanism emplaced basaltic units in the region northwest of the MB ring after the Humorum impact event. Subsequently, large impacts emplaced a veneer of highlands material atop the basalt flows. Some mare material could have been mixed with this highlands debris either by local mixing by secondary craters or by vertical mixing. Spectra for most other highlands units in the region indicate a noritic anorthosite lithology. Spectra of mare basalts in Mare Humorum and nearby mare flooded craters show relatively deep absorption bands due to the presence of abundant high-Ca pyroxene. An analysis of spectra for a small number of craters in the highlands west of the outer ring of Humorum reveals the presence of high-Ca pyroxene. This suggests the possible presence of an extensive gabbroic province.

INTRODUCTION. Humorum Basin is a large multiringed impact structure of Nectarian age located on the southwestern portion of the lunar nearside. The most complete ring is 440 km in diameter [1] and bounds Mare Humorum. A rimlike scarp almost twice as large (820 km) and resembling the Cordillera ring of the Orientale basin lies outside of this mare-bounding ring.

Many unresolved problems exist in this region. These include: 1) The composition of the highlands units surrounding the Humorum Basin; 2) The stratigraphy of the lunar crust in the Humorum target site; 3) The composition and extent of possible cryptomare deposits in the region; 4) The nature and origin of local light plains units; and 5) The distribution of pyroclastic deposits in the region. In order to address these issues, we have been conducting a variety of spectral studies of this portion of the lunar surface. The purpose of this paper is to present the results of an analysis of a large number of near-infrared reflectance spectra obtained for geologic units in the Humorum region.

METHOD. Near-IR reflectance spectra were obtained utilizing the University of Hawaii 2.24-m and 0.60-m telescopes at the Mauna Kea Observatory. The Planetary Geosciences indium antimonide spectrometer was used. This instrument successively measured intensity in each of 120 wavelengths covering a 0.6-2.5 μm region by rotating a filter with a continuously variable band pass. By using the f/35 oscillating secondary mirror on the 2.24-m telescope in its stationary mode, it was possible to collect spectra for relatively small areas (5-10 km). Differential atmospheric refraction limited such high-resolution observations to periods when the Moon was near zenith.

The lunar standard area at the Apollo 16 landing site was frequently observed during the course of each evening, and these observations were used to monitor atmospheric extinction throughout each night. Extinction corrections were made using the methods described by McCord and Clark [2]. These procedures produce spectra representing the reflectance ratio between the observed area and the Apollo 16 site. These relative spectra were converted to absolute reflectance utilizing the reflectance curve of an Apollo 16 soil sample. Analyses of pyroxene band positions and shapes as well as continuum slopes were made using techniques described by McCord *et al.* [3].

RESULTS AND DISCUSSION. At least a portion of the mare-bounding (MB) ring of Humorum is composed of pure anorthosite. Spectra were collected for Mersenius C (diameter=14 km), Liebig A (diameter=12 km), Liebig B (diameter=9 km), and the Gassendi E and K complex. These small impact craters expose fresh material from beneath the surface of massifs in the mare-bounding ring. These spectra exhibit either no "1 μm" absorption features or extremely shallow bands. Only very minor amounts of low-calcium pyroxene are present in the areas for which these spectra were obtained; an anorthosite lithology is indicated. The diameters of the areas for which spectra were obtained for Mersenius C and the Gassendi E and K complex varied from ~3 km to ~20 km. None of these spectra has a significant "1 μm" band. This indicates that anorthosite does not just occur on some small portion of the interiors of these craters; it is the dominant rock type in the ring massifs in this region.

While the northwestern part of the MB ring appears to be composed of pure anorthosite, spectra for other sectors of the ring indicate that both anorthosite and more pyroxene-rich material are present [4,5,6]. A spectrum of the east wall of the crater Vitello, located on the southern part of the MB ring, shows it also to be composed of pure anorthosite. However, the central peaks of Gassendi and the craters Dunthorne (diameter=16 km), Loewy A (diameter=7 km) and others on or near the MB ring expose noritic anorthosite.

Several spectra were collected for an area with interesting spectral properties located to the northwest of the MB ring. The craters Gassendi G and F are both 8 km in diameter, and both exhibit partial dark haloes. Analysis of spectra obtained for areas of various sizes in this region has revealed details of the local stratigraphy. The spectrum of Gassendi F indicates the presence of major amounts of mare basalt with only minor amounts of highlands debris. The spectrum obtained for the center of the Gassendi G interior (aperture diameter=5 km) indicates the presence of mare basalt that is contaminated by a somewhat higher percentage of highlands material. In contrast, the spectrum of the dark halo immediately south of Gassendi G (aperture diameter=5 km) indicates that this area is composed almost totally of mature mare basalt. The spectrum obtained for a relatively large area (diameter=18 km) that included both the Gassendi G interior and the dark halo has spectral parameters that are intermediate between the other two spectra.

The spectral data have important implications for the stratigraphy of the Gassendi G and F target sites. A relatively thin highlands-rich surface layer overlies a mare basalt unit which occurs above a deposit of pure highlands material. Gassendi G fully penetrated the upper two layers and highlands debris is exposed on the crater interior. An episode of mare volcanism emplaced basaltic units in this region after the formation of the Humorum Basin. Subsequently, large impacts in the vicinity, such as those which formed Gassendi, Mersenius, and Letronne craters, emplaced a veneer of highlands atop the basalt flows. Some mare material could have been mixed with this highlands debris either by local mixing by secondary craters during ejecta emplacement or by vertical mixing due to small crater-forming impacts in the area.

One spectrum was obtained for Billy A, a 7-km impact crater that excavated material from the northwestern portion of the outer Humorum ring. Analysis of this spectrum indicated that noritic anorthosite is present in this segment of the outer ring. Spectra were also collected for a number of highlands units in the area surrounding Humorum. These include the craters Mersenius S, Billy D, Gassendi zeta, and Gassendi A. Analyses of the "1μm" band positions and shapes as well as continuum slopes indicate that these features exhibit many common spectral characteristics. These spectra indicate the presence of relatively fresh highlands rocks dominated by Fe-bearing plagioclase and Ca-poor pyroxene. Noritic anorthosite is the major rock type present in all of the areas for which these spectra were obtained. Our results are consistent with those of a recent CCD-imaging study of Gassendi crater presented by Chevrel and Pinet [7].

Spectra for regional pyroclastic deposits dominated by Fe^{2+} bearing glass are characterized by a broad absorption band centered longward of 1 μm [8,9]. We have obtained several spectra which support previous interpretations concerning the existence of a glass-rich regional pyroclastic deposit which mantles a substantial part of the southwestern portion of Mare Humorum between the west rim of Vitello crater and the crater de Gasparis [e.g., 8]. Localized pyroclastic deposits also occur inside the crater Mersenius and in the vicinity of Agatharchides.

Craters in Mare Humorum such as Gassendi J and Gassendi Y show the deep absorption band centered between 0.95 μm and 1 μm produced by the high-Ca clinopyroxene typical of mare basalts. Similar mare basalt signatures can be seen in the spectra of the mare flooded crater Billy as well as mare basalt covered regions to the north and east of the MB ring.

An intriguing area lies to the west of the outer basin ring. The crater Byrgius A and the southeast rim of the crater Prosper Henry expose highlands material, but their spectra indicate the presence of high-Ca pyroxenes. This marks a gabbroic, rather than a noritic, lithology. Other spectra in the region appear to show a component of high-Ca pyroxene as well. The spatial extent of this gabbroic province remains to be determined, and we are continuing our research in this area.

REFERENCES. [1] Wilhelms D.E. (1987) *U.S.G.S. Prof. Paper 1348*. [2] McCord T.B. and Clark R.N. (1979) *Publ. Astron. Soc. Pac., 91*, 571-576. [3] McCord T.B. *et al.* (1981) *J. Geophys. Res., 86*, 10883-10892. [4] Spudis P.D. *et al.* (1992) *Lunar Planet. Sci. XXIII*, 1345-1346. [5] Hawke B.R. *et al.* (1991) *Geophys. Res. Lett., 18*, 2141-2144. [6] Hawke B.R. *et al.* (1991) *Lunar Planet. Sci. XXII*, 539-540. [7] Chevrel S. and Pinet P.C. (1992) *Proc. Lunar Planet. Sci. Conf. 22nd*, 249-258. [8] Gaddis L.R. *et al.* (1985) *Icarus, 61*, 461-489. [9] Lucey P.G. *et al.* (1986) *Proc. Lunar Planet. Sci Conf. 16th*, D344-D354.