A SPECTRAL SURVEY OF THE CRISIUM REGION OF THE MOON;

D. T. Blewett, B. R. Hawke, P. G. Lucey, Planetary Geosciences, Univ. of Hawaii, 2525 Correa Rd., Honolulu, HI 96822; P. D. Spudis, Lunar & Planetary Inst., Houston, TX 77058

This report presents preliminary results of a near-IR spectral study concerning a variety of surface units in the Crisium region, including Mare Crisium, the terra associated with the Crisium Basin, northern portions of Mare Fecunditatis, and the light plains deposits north of the crater Taruntius. Issues to be addressed include (1) the nature and origin of light plains deposits, (2) the existence and distribution of possible cryptomaria, (3) the origin of geochemical anomalies in the region, (4) the composition of highlands units associated with the Crisium Basin, and (5) the stratigraphy of the Crisium target site.

INTRODUCTION: The Crisium Basin is a multiring impact structure on the eastern portion of the Moon's Earth-facing hemisphere. Stratigraphic relations deduced from photogeologic mapping [*e.g.*, 1, 2] indicate that the basin formed in Nectarian time. The basin-forming impact may have occurred at 3.895 Ga, based on the dating of material returned by the Luna 20 spacecraft [3]. The rings and deposits of the Crisium Basin have been discussed by [2].

DATA & ANALYSIS: Near-infrared (0.6-2.5 μm) reflectance spectra were collected with the Planetary Geosciences CVF spectrometer mounted on the University of Hawaii 0.61m and 2.24 m telescopes at Mauna Kea Observatory. Moonlight is admitted to the spectrometer detector through a circular focal plane aperture; apertures used in the observations described here correspond to spot sizes of 2-25 km at the center of the lunar disc. Data collection and reduction techniques were standard and are described elsewhere [4]. In order to derive mineralogical information, an analysis focusing on the mafic mineral absorption band near 1 μm was conducted for each spectrum [5]. In addition, spectral mixing relationships were studied using a linear model [6].

RESULTS and DISCUSSION: Findings for individual lunar features are given below.

I. Crisium highlands

A. Proclus crater. Proclus (16.1° N, 46.8° E; 28 km diam.) is a Copernican age crater with a markedly asymmetric ray pattern located in the highlands west of Crisium. A spectrum of the east rim of Proclus was presented by Pieters [7], who interpreted it as indicative of noritic anorthosite. It was noted, however, that the spectral parameters fell outside the range typical of other noritic anorthosite spectra. The interior of Proclus was observed for this study. This spectrum was determined to have a band minimum located at 0.93 μm and a band depth of about 4%, consistent with noritic anorthosite.

B. Circum-Crisium massifs. Spectra were obtained for locations in the highlands massifs bounding the Crisium basin to the north, southwest and south. These spectra have band minima located at 0.92-0.94 μm, with band depths of 2-4%. A noritic anorthosite composition is indicated, though slightly steeper continuum slopes in several spectra with deeper bands may attest to the presence of anorthositic norite.

C. Eimmart A. This 7 km crater (24.0° N, 65.7° E) is on the rim of a highlands crater northeast of Crisium, just at the edge of Mare Anguis. Previous work interpreting a spectrum for Eimmart A [7, 8] noted its extremely strong (21%) absorption band, and favored an olivine/pyroxene mixture to account for the position of the band minimum and broad band shape. On this basis, Eimmart A was proposed as the possible source crater for the Antarctic meteorite ALHA81005 [7, 8, 9].

D. Taruntius peak. Located at 5.6° N, 46.5° E, the 56 km-diam. Copernican age crater Taruntius lies southwest of Crisium and the central peak of Taruntius probably exposes pre-Crisium material. A spectrum for the peak has spectral characteristics generally consistent with a noritic anorthosite or anorthositic norite. The band depth (5.6%) is greater than that of the circum-Crisium highlands spectra described above, and the continuum slope is steeper. This suggests that the material exposed in the peak is slightly more mafic (anorthositic norite) than that composing the circum-Crisium highlands.

II. Light Plains and Cryptomaria

A. Light plains northeast of Taruntius. Orbital geochemical data, in conjunction with

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morphological considerations, led to the suggestion that the light plains NE of Taruntius were formed by the extrusion of post-Crisium Basin mare units followed by contamination of these deposits by highlands material [10, 11]. Spectra for two spots on the plains have band minima longward of 0.95 µm and band depths of 6-7%, clearly indicating a significant mare basalt component. Further evidence for mare basalt is provided by the dark-halo impact crater Taruntius C (~12 km) on the northwest rim of Taruntius. A spectrum of this crater has a band minimum of 0.98 µm and a 7% depth, demonstrating that mare basalt was excavated from beneath the deposits of Taruntius.

B. "Arrowhead" shaped plains. A triangular patch of plains material is found in the circum-Crisium highlands due north of Taruntius at ~10° N, 46.3° E. A number of factors distinguish this area: it has a low albedo compared to the surrounding highlands and is distinctive in multispectral images (cited by [12]). Additionally, this area possesses a high Mg/Al ratio, similar to that of mare soils, as determined from Apollo orbital geochemical measurements [13]. The area corresponds to exposures of Imbrian age (units Ip and Its) on the geological map of the region [12]. A reflectance spectrum of the arrowhead plains has a stronger absorption band (~5%) than the nearby highlands massifs, demonstrating a greater abundance of pyroxene in the plains surface. In order to evaluate the possibility of a mare basalt component in the plains, a linear mixing analysis [6] was conducted on the spectrum. The endmembers employed were a mature mare spectrum ("Mare Crisium C" [14]) and a spectrum for a typical mature highlands soil (Apollo 16). The model indicates that a roughly 50-50 mixture of the mare and highlands spectra produce a reasonable fit to the spectrum of the arrowhead plains.

C. Dark highlands southwest of Crisium. The highlands along the eastern shore of Mare Tranquilitatis contain a distinctive strip of low-albedo plains, at ~9.5° N, 43.5° E. This "smooth terra material (Its)" unit has been described as having an uncertain origin, possibly thin mare flows mantling the terra [12]. The spectrum obtained for this area has spectral parameters similar to that of the arrowhead plains described above. The relatively strong absorption band indicates a mare basalt component and a mixing analysis determined that approximately equal amounts of flux were contributed to the dark highlands spectrum by mare and highlands spectral types.

III. Mare Basalt Deposits

A. Picard. Extensive work on the stratigraphy, geologic history and remote sensing characteristics of Mare Crisium has been published [14, 15]. Additional spectra for several features in the mare have been collected. The crater Picard (14.6° N, 54.7° E; 23 km diam.) is located in western Mare Crisium. It has been proposed [15] that the floor of Picard contains mature non-mare soil, based on the floor's relatively high brightness, and on its high 0.95/0.56 µm ratio value. If this is the case, then it could be inferred that the Picard impact penetrated the mare deposits and exposed subjacent highlands material. However, spectra for the center of the crater have band minima at 0.96-0.97 µm and band depths measuring 12-13%. Thus the reflectance spectra show that the floor is composed largely of mare basalt.

B. Luna 16 region. Two reflectance spectra were obtained for mare surfaces in the vicinity of the site sampled by Luna 16 in Mare Fecunditatis. A spectrum for a fresh crater has spectral parameters expected for an immature mare basalt. The absorption band is very strong (22%) and the band minimum occurs just longward of 0.95 µm. A spectrum for a mature surface was found to have a band minimum at 1.01 µm, and a band depth of 4.5%.

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