REMOTE SENSING STUDIES OF THE CRÜGER REGION OF THE MOON; B. Ray Hawke, Cassandra R. Coombs, and Paul G. Lucey, Planetary Geosciences Division, Hawaii Institute of Geophysics, University of Hawaii, Honolulu, HI 96822.

INTRODUCTION: The 46-km diameter Crüger crater (~17°S; 67°W) is a conspicuous geologic feature in the lunar highlands southwest of Oceanus Procellarum. Crüger is located south of the Grimaldi basin and near the contact between the inner and outer facies of the Hevelius Formation[1], a deposit emplaced during the formation of Orientale basin. The origin of Crüger crater as well as the other geologic units in the region has been the subject of considerable controversy.[2,3]

McCauley[2] and Wilshire[3] noted that Crüger had some characteristics in common with a class of 30 smooth-rimmed craters identified on the lunar near side by Wilhelms and McCauley.[4] These workers[2,3,4] suggested that these craters, typified by Kopff on the floor of Orientale, might either be calderas or the products of unusual low-velocity and/or low-density impacts distinct from those that produced the rough, high-rimmed craters of the main physiographic sequence.[2] Whatever the origin of Crüger crater, the geologic maps produced by several workers[1,2,3,4] indicate that Orientale deposits are superposed on Crüger crater exterior deposits. However, in a recent publication, Wilhelms[5] questioned the previously determined age relationships in the region.

The purposes of this study include the following: 1) to investigate the origin of Crüger crater, 2) to determine the composition, origin, and mode of emplacement of the dark mantle deposits on the south flank of Crüger, 3) to determine the composition of the various highlands units in the region, and 4) to investigate the relationship of the various highlands units to the Orientale impact event.

METHOD: A variety of photographic and remote sensing data was utilized to address the unanswered questions in the Crüger region. Seven near-IR spectra (0.6-2.5µm) were obtained for the various geologic units in the region using the Planetary Geosciences Division CVF spectrometer at the UH 2.2-m telescope on Mauna Kea (Fig. 1). These spectra were reduced, processed, and analyzed using the procedures, techniques, and conventions presented by McCord et al.[6] and McCord and Clark.[7] In addition, the 3.8-cm and 70-cm radar data sets of Zisk[8] and Thompson[9] were used to study the various deposits in the Crüger region. Finally, the color-difference photograph of Whitaker[10] as well as earth-based and spacecraft photographs with a wide variety of viewing geometries and sun angles were studied in order to help better define the geologic relationships in the Crüger crater region.

RESULTS AND DISCUSSION: All of the highland terrain in the Crüger region appear relatively "red" (low UV/VIS values) in the color-difference photograph produced by Whitaker.[10] In contrast, the mare materials in the region are relatively "blue" with the deposits within Crüger appearing slightly bluer than the others. An intermediate TiO_2 abundance for the basaltic fill is indicated.

Two near-IR spectra were obtained for the mare deposits within Crüger. Both exhibit characteristics typical of spectra collected for mature mare deposits elsewhere on the lunar near side. They have "1µm" absorption bands centered at about 0.98µm which indicates that the mafic mineral assemblage is dominated by high-Ca clinopyroxene.[11] Even though the deposit is relatively small, there is little evidence for contamination of the mare surface with highlands debris. This may be in part due to the relatively young Eratosthenian age of this mare deposit. Wilshire[3] noted that this unit exhibited far fewer superposed craters than mare material assigned to the Imbrium System in adjacent regions.

A dark mantle deposit which has a distinctly lower albedo than surrounding material occurs on the south flank of Crüger crater.[3] This unit is spectrally distinct in the color-difference photograph; it is much bluer than the adjacent highlands. Wilshire[3] interpreted this deposit to be volcanic material of probable pyroclastic origin. This interpretation is supported by an analysis of the 3.8-cm radar data for this region. There is a direct correlation between the dark mantle and an area of very low radar returns.

Two near-IR spectra were obtained for this dark mantle deposit. Both exhibit broad, composite "1µm" absorption features which we interpret to be due to the presence of an olivine-pyroxene mixture. These spectra are similar to the Group 3 spectra of localized pyroclastic deposits identified by Lucey et al.[12] Pyroclastic glass may or may not be present. Although no obvious volcanic source vents are visible in the dark mantled area, this does not rule out a pyroclastic origin. We suggest that this dark mantle deposit was emplaced by explosive eruptions during an early phase of the flooding of Crüger crater and that the source vent or vents were subsequently buried by mare lava. In addition, we have identified a previously unmapped dark mantle deposit NW of Crüger crater and SW of Mare Aestatis. This thin deposit appears to have been erupted from a vent in the southern-most portion of Aestatis.

Spectra were also obtained for a variety of highlands units in the region. The spectrum for the west rim of Crüger exhibits a very shallow "1µm" band centered at 0.93µm. The spectral parameters indicate that the area for which the spectra was obtained is composed of noritic anorthosite. It appears that this area is surfaced with material emplaced as a result of the Orientale impact event. The spectrum for Darwin C, a relatively fresh 16-km impact crater SW of Crüger (~20°30'S; 71°W), has a band centered at 0.92µm. Darwin C also exposes a deposit composed of noritic anorthosite. Both of these areas have a composition very similar to that determined for highlands deposits on the interior of Orientale basin by Spudis et al.[13] However, the spectrum for one feature in the Crüger region is very different. The Crüger G crater (diameter = 8 km) spectrum exhibits a "1µm" feature centered longward of 0.95µm. A gabbroic anorthosite composition is indicated. Crüger G is located SW of Crüger and exposes material from beneath the Orientale ejecta deposit.

REFERENCES:

1) Scott, D. et al. (1977) USGS *Map I-1034.*
2) McCauley, J.F. (1973) USGS *Map I-740.*
3) Wilshire, H.G. (1973) USGS *Map I-755.*
4) Wilhelms, D. and McCauley, J. (1971) USGS *Map I-703.*
5) Wilhelms, D. (1987) USGS *Prof. Paper 1348.*
6) McCord, T. et al. (1981) *JGR*, 10883.
7) McCord, T. and Clark, R. (1979) *Pub. A.S.P. 91*, 571.
8) Zisk, S. et al. (1974) *Moon 10*, 17.
9) Thompson, T.W. (1987) *Earth, Moon, and Planets 37*, 59.
10) Whitaker, E. (1976) Personal Comm.
11) Adams, J.B. (1974) *JGR 79*, 4829.
12) Lucey, P. et al. (1984) *LPS XV*, 495.
13) Spudis, P. et al. (1984) *PLPSC 15*, C197.

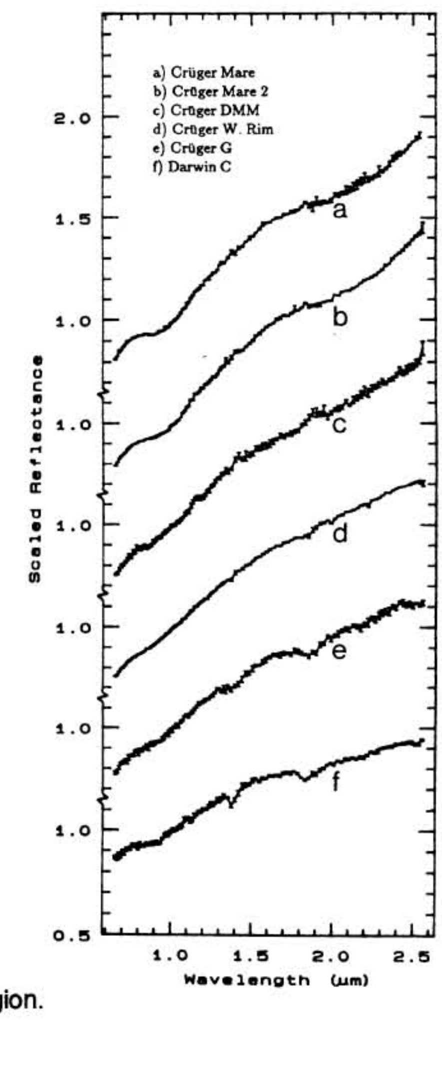

Figure 1. Near-infrared spectra obtained for units in the Crüger region.