CCD NARROWBAND FILTER IMAGING OF LUNAR CRATER RAYS; James F. Bell and B. Ray Hawke, Planetary Geosciences Division, University of Hawaii, Honolulu 96822.

We are attempting to better understand the origin and emplacement histories of lunar crater rays by studying their composition as well as the composition of their source craters and surrounding substrates. In previous work [1,2] we have reported some limited compositional information for the Bessel crater ray in Mare Serenitatis using 25-km CVF point spectroscopy. Those data showed variations in pyroxene (as evidenced by 0.9-1.0 μm band depth) along the SW-NE trending ray near the 16-km Eratosthenian crater Bessel [3] as well as near the 27-km Copernican crater Menelaus. Because of our large CVF aperture size, however, we were not able to detect the faint ray signature in darker, uniform mare regions farther from these craters. In order to more fully understand textural and/or compositional variations along this and other crater rays, we have obtained narrowband filter Charge-Coupled Device (CCD) images of 5 prominent lunar rays in 6 colors from the near-UV to the near-IR.

The data were acquired using a STAR 384 X 576 pixel CCD camera (Photometrics Inc., Tucson), cooled to -45° C. The camera and an uncooled filter wheel were mounted to the Air Force/University of Hawaii 61-cm telescope at Mauna Kea Observatory. Images of 90 X 130 arcsec areas of the Moon were obtained on November 29 and 30, 1990 UT. Weather at the observatory was fair though not photometric on the 29th (some light cirrus, 60-80% relative humidity, 1" seeing) but was exceptional on the 30th (clear and photometric, 20-30% humidity, 0.5" seeing or better). Spatial resolution ranged from 1-2 km near the center of the Moon during the best seeing to 4-8 km during worse seeing and near the lunar limb.

Previous imaging and spectroscopic studies of the lunar surface [*e.g.* 4, 5] and of crater rays in particular [6] have shown that compositional heterogeneity on the Moon, though subtle, can be detected and mapped using high signal-to-noise data in the right wavelength range. In particular, the 0.9-1.1 μm and 1.8-2.2 μm regions are particularly diagnostic for the detection of olivines and pyroxenes [7]. Additionally, spectral slope in the 0.4-0.7 μm region is used as an indicator of titanium content [8]. In an attempt to map possible spatial variability of absorption features such as these, images were obtained in 6 narrowband filters (300 Å FWHM) at the following wavelengths (Å): 4000, 7330, 8660, 9000, 9660, 10000. Five rays were chosen for detailed study: (1) The Bessel Ray region in central Mare Serenitatis, latitude 23° N, 18° E; (2) A ray passing through the crater Rosse in Mare Nectaris, 16° S, 36° E; (3) A ray passing through the crater Kies in Mare Nubium, 26° S, 23° W; (4) The intersection of a Copernicus and Tycho ray in Mare Vaporum, 13° 30' N, 1° 20' E; and (5) A prominent Copernicus ray, 20° N, 19° W. These regions were selected because each exhibits a relatively long and continuous bright ray superimposed on a darker mare substrate, maximizing the spectral contrast between ray and substrate materials.

Data reduction has followed the standard format for CCD image data: dark current (bias) images were obtained and subtracted from the raw images. Spatial non-uniformities in the CCD pixel sensitivity and the filter opacity were corrected using flatfield images at each wavelength. Figures 1 and 2 present 0.4 μm (4000 Å) imaging data for the Bessel and Rosse regions at this stage of the reduction. Further reduction of this data set will concentrate on: attempting to calibrate the images to reflectance or albedo using the standard star κ Cetus (G8III) or lunar standard spot MS2, co-registering and map projecting the data, and producing spectral ratio images in an attempt to map mineralogic variations along the rays.

These imaging spectroscopic data will be directly comparable to previous observational and theoretical work [6,9] on textural and compositional variations along a ray with increasing distance from the source crater. Additionally, this data set will be useful in the continued interpretation of newly acquired 3.8-cm radar images of the same areas [1,2]. The combination of high spatial resolution radar and spectral reflectance data sets should yield significant new information on the composition (maturity, highlands vs. mare component) and texture (morphology, cm-scale roughness) of lunar crater rays.

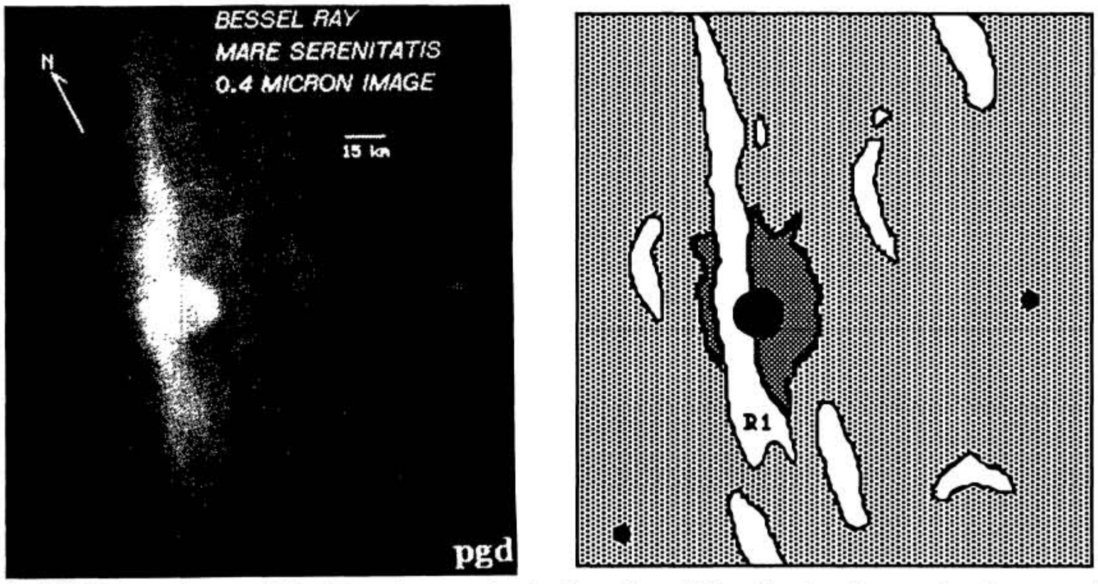

Figure 1: (left) 0.4 μm image of the Bessel ray region in Mare Serenitatis, showing the prominent ray passing just west of the 16-km crater Bessel. (right) Sketch map of the region showing the major units: the Bessel ray (labeled R1) and other filamentary, ray-like deposits in white, impact craters in black, surrounding dark mare unit in light stipple, Bessel crater ejecta in dark stipple.

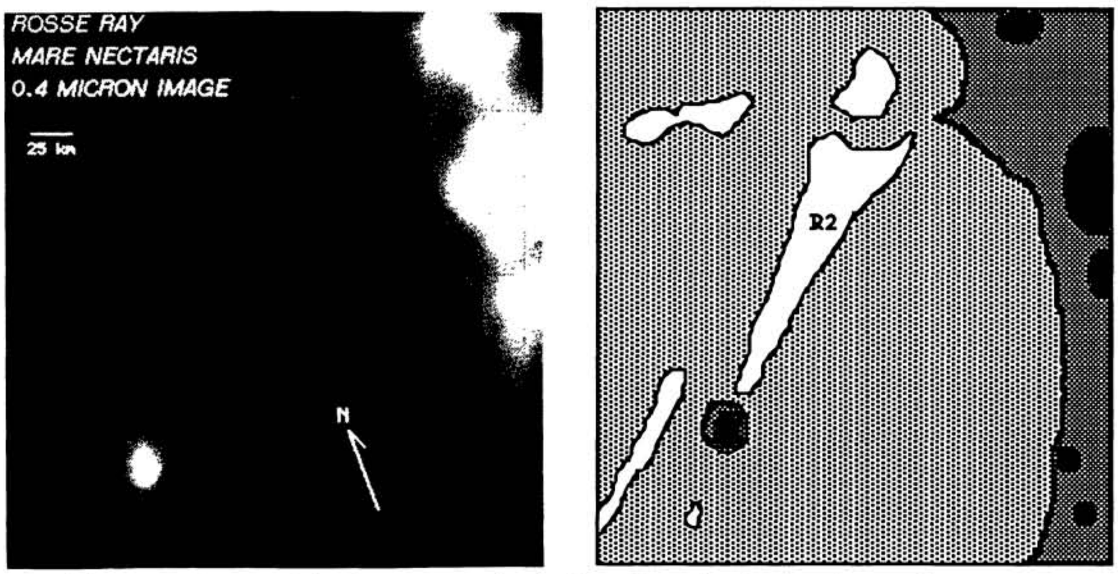

Figure 2: (left) 0.4 μm image of the Rosse ray region in Mare Nectaris, showing the prominent ray passing through Nubium to the 12-km crater Rosse. (right) Sketch map of the region showing the major units: the Rosse ray (labeled R2) and other filamentary, ray-like deposits in white, impact craters in black, surrounding dark mare unit in light stipple, highlands and crater ejecta in dark stipple.

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References: [1] Campbell B.A., B.R. Hawke, J.F. Bell III, and S.H. Zisk (1989) *Lunar Planet. Sci. XX* (abstract), 139-140. [2] Campbell B.A., S.H. Zisk, J.F. Bell III, and B.R. Hawke (1990) *Lunar Planet. Sci. XXI* (abstract), 159-160. [3] Carr M.H. (1966) *USGS Map I-489 (LAC-42)*. [4] McCord T.B. *et al.* (1981) *J. Geophys. Res., 86,* 10883-10892. [5] McCord T.B. *et al.* (1972) *J. Geophys. Res., 77,* 1349-1359. [6] Pieters C.M. *et al.* (1985) *J. Geophys. Res., 90,* 12393-12413. [7] Adams J.B. (1974) *J. Geophys. Res., 79,* 4829-4836. [8] Adams J.B. and McCord T.B. (1971) *Science, 171,* 567. [9] Oberbeck V.R. (1975) *Rev. Geophys., 13,* 337-362.