SPECTRAL HETEROGENEITY OF LUNAR LOCAL DARK MANTLE DEPOSITS. M.S. Robinson[1], E.M. Shoemaker[1], and B.R. Hawke[2], [1]*U.S. Geological Survey, 2255 N. Gemini Drive, Flagstaff, AZ, 86001*, [2]*Planetary Geosciences, University of Hawaii, 2525 Correa Road, Honolulu, HI, 96822.*

We are currently investigating the spectral properties of lunar dark mantle deposits (DMD) utilizing Clementine UVVIS and HIRES image data (25-150 m/pixel). Local dark mantle deposits (LDMD) are identified by their very low albedo, smooth texture, and small size relative to the regional DMDs [1]. DMDs are mostly composed of glass spheres [2,3,4] and LDMD are thought to be mixtures of olivine, pyroxene, host rock and glasses formed during maar-type eruptions [1]. We find that maar deposits in Alphonsus crater, Atlas crater, and the Schrödinger basin exhibit interdeposit spectral variations. Some of the maars in the Alphonsus region show intradeposit spectral variations and may be the result of maturity differences, admixture of surrounding material [5], crystallinity variation and/or true mineralogical differences [6].

Apollo missions, especially Apollos 15 and 17, returned pyroclastic material composed of green, orange and black spheres. These samples confirmed the morphologic interpretation that DMDs are deposits laid down by lunar explosive volcanism. Twenty-five types of lunar pyroclastic glasses have been identified from the Apollo samples [7]. Of these major types of lunar pyroclastic material three have been extensively examined for both spectral and chemical properties: green and orange glass and black spheres [3,4,7]. The green glass is iron rich, exhibits a spectral maximum at ~550 nm and has the highest albedo of the glasses. The orange glass is iron *and* titanium rich; the titanium causes a strong absorption edge into the visible (thus its orange color) and has a darker albedo than the green glass [3,4]. Finally, the black spheres are the crystalline equivalents of the orange glass [2]; they are very dark and have greatly reduced color contrast in the visible, with a distinctive broad absorption near 0.650 μm [4, Fig. 4].

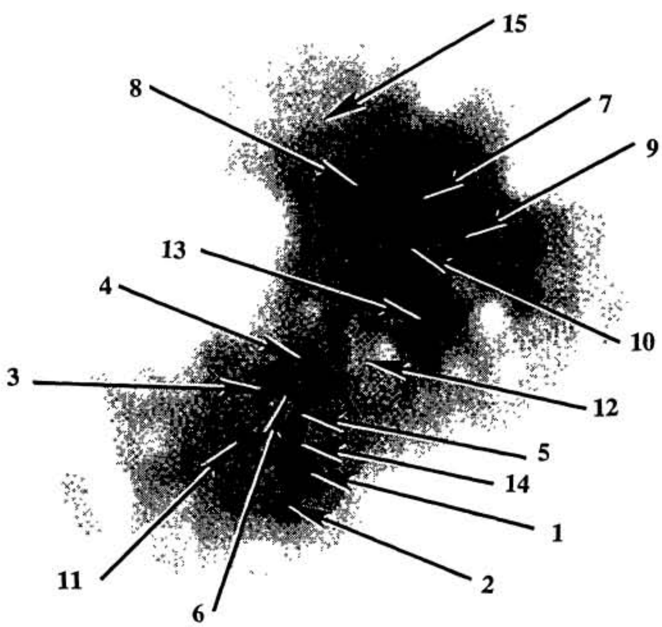

Fig. 1. Contoured image of western Alphonsus maar complex, original color image formed as composite of 415 nm (blue), 750 nm (green), and 1000 nm (red). Arrows and numbers show locations of spectral measurements presented in Figure 2. Note the general bright-to-dark gradient from outside of deposit to interior. The darkest central portions occur on the rim or inside maar craters. Units were selected based on their colors in the original composite. North is to the top, long axis of deposit is about 10 km (13.5°S, 356°E). Units 16-18 (Table 1) are from Alphonsus floor deposits outside the area shown.

Morphometric analysis of the Alphonsus maar deposits has shown that the LDMD have a volume greater than that of the maar, thus the deposits contain a juvenile component [8]. This juvenile material may contain crystalline caprock material and/or ejected magma in the form of glass or poorly crystalline rock. The juvenile material may not be compositionally homogeneous. Figs. 1 and 2 show the spectral heterogeneity of one LDMD within Alphonsus crater. A general darkening from the outer margins to the interior of the deposit, consistent with an admixture of surrounding highlands material [5]. The dark interior units (di) seen in Fig. 1 are identifiable as two color units in the original composite (units 2,4,5; units 1,3,7,8,9). These units, dark-1 and dark-2 respectively, are distinguishable in the band ratio plot (Fig. 2) as having a deeper mafic band (750/1000 nm) than the outer blanket (dmd) and the Alphonsus floor materials. However, the overall redness (750/415 nm) of the two dark interior units is highly variable. The relative errors for 750/415 nm are greater due to the slight blurring of the 415 nm data; however, this is a second order effect. Earth-based spectral data of the Alphonsus maar deposits have shown them to be relatively mafic, tentatively interpreted to contain abundant olivine and orthopyroxene [9], and our data are consistent with this interpretation. To identify the mineralogy of these spectral units requires our completion of processing the Clementine NIR image data to fix the diagnostic "2 micron" band. However, we have shown that lunar LDMD have a broad range of intradeposit spectral units which may be due to heterogeneous mineralogy.

area #	morph	spectral unit	area #	morph	spectral unit
1	di	dark 2	9	di	dark 2
2	di	dark 1	10	dmd	dmd
3	di	dark 2	11	dmd	dmd
4	di	dark 1	12	dmd	dmd
5	di	dark 1	13	dmd	dmd
6	mfl	dark 1 + 2	14	dmd	*dmd
7	di	dark 2	15	dmd	dmd
8	di	dark 2	16-18	alph	highlands

Table 1. Summary table of sampled portions of the Alphonsus west local dark mantle complex. "Morph" represents geomorphological class (di - dark interior deposit, mfl - maar floor, dmd - dark mantle deposit, alph - Alphonsus crater floor materials) while the spectral unit is determined from Fig 2. *see Fig. 2 caption.

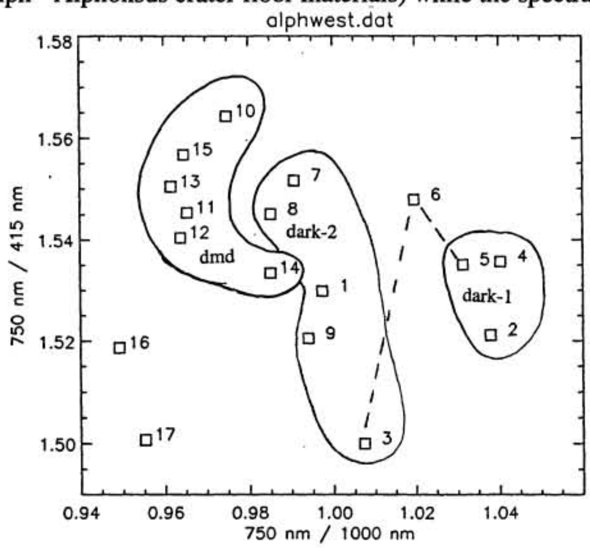

Fig. 2. Band ratio plot of units identified in Fig. 1 and Table 1. Unit 6 is the floor of a maar crater below units 5 and 3 and is thus consistent with an immature mixture of units 3, 5. Unit 14 appears in the color composite as an unusually colored dmd deposit; thus it may be transitional between dmd and di. The interior units are not resolvable from Earth based spectra, and the composition of the interior may better represent the composition of the whole deposit (relatively free from admixed floor materials, etc.). Note that Unit 18 (immature highlands) falls off the plot at x=0.958 y=1.421

[1] Gaddis, *et al.* (1985), *Icarus*, 61, 489. **[2]** Heiken, *et al.* (1974) *Geoch. Cosm. Acta*, 38, 1703. **[3]** Pieters, *et al.* (1974), *Science*, 183, 1191. **[4]** Adams, *et al* (1974), *Proc. Fifth Lun. Sci. Con., Geoch. Cosm. Acta,* Suppl. 5, 171. **[5]** Shoemaker, *et al.*, (1970), *Proc. Apollo 11 Lunar Sci. Conf.*, 3, 2399. **[6]** Robinson and Shoemaker (1995), GSA Abstract Vol. 27, no 6, A-289. **[7]** Delano, (1986) *J. Geophys. Res.*, 91, B4, D201. **[8]** Head and Wilson, (1979), *Proc. Lun. Planet. Sci. Conf 10th*, 2861. **[9]** Hawke et al., (1989) *Proc. Lun. Planet. Sci. Conf 10th*, 255.