BASALTS IN MARE HUMORUM AND S.E. PROCELLARUM.

Terence Hackwill[1], John Guest[2] and Paul Spudis[3]. [1, 2] Department of Earth Sciences, University College London, Gower Street, London. WC1E 6BT t.hackwill@ucl.ac.uk john.guest@ucl.ac.uk [3] Applied Physics Laboratory, Johns Hopkins University, Laurel, MD 20723-6099 paul.spudis@jhuapl.edu

Introduction. The Clementine mission provided filtered wavelength images at ultraviolet and visible wavelengths of the Moon [1]. The algorithms of Lucey [2,3] and refinements [4,5] provide almost global coverage of FeO and TiO_2 wt% down to 200m/pixel. These algorithms have been used in conjunction with the Clementine images to produce maps showing the variations in FeO and TiO_2 wt% on the surface. We have used these maps to study the mare basalts of Mare Humorum and S.E. Procellarum (30ºW-50ºW, 0º-40ºS) using "true" and "false" colour Clementine images and Lunar Orbiter IV frames to determine individual basaltic units. We have used impact craters to suggest the depth of the basalt and provide an indication of the volume of basalt in Mare Humorum. Additionally, we have investigated the spatial distribution of the units in terms of FeO and TiO_2 wt%.

Method. Potential geological units were determined from the Clementine FeO and TiO_2 wt% maps. A discreet rock unit was considered to exist if its TiO_2 wt% was statistically different from that of adjacent units. 109 units were found. Crater densities of the 34 largest units were determined from Lunar Orbiter IV images. The units were aged using an extended version of the plot of crater density against age from [6]. A more detailed account of our method is given in [7]. We used small impact craters to assess the thickness of the basalt. [8] showed that small, bowl-shaped craters exhibit a diameter to depth ratio of 10:1. We used this to imply the minimum depth of basalt where impacts have failed to pierce through to the highland material underneath. Where an impact has pierced through to the highland, the depth of the basalt/highland boundary was determined by assuming that the proportions of basalt and highland material in the ejecta blanket is the same as the proportion of volumes of basalt and highland material that existed before it was ejected: $E = XM + (1-X)H$ where E = ejecta blanket FeO wt%, X = %, M = mare soil FeO wt% and H = highland FeO wt%. Therefore the percentage, X, of basalt in the ejecta blanket is: (E-H)/(M-H). For each crater where the impact has ejected highland material; 12 separate FeO wt% measurements were taken from the ejecta blanket. Ejecta (E) forming the distal 25% of the blanket was avoided because it is thin and has experienced considerable regolith gardening [9]. Ejecta forming the 25% proximal to the crater rim was also avoided because of layering and the high percentage of deeper excavated material [10]. The 12 measurements were averaged. 12 FeO measurements were also taken of nearby soil and averaged (M). Similarly, 12 FeO measurements were taken from nearby highland rocks and averaged (H). There is an assumption that these highland rocks are of the same composition as that exposed inside the crater. The estimates of crater depths and minimum depths were used to assess the volume of basalt within Mare Humorum. An imaginary radius was rotated around 360° from the centre of the basin. The distances from the centre to craters were plotted against depth to give a radial profile. Two estimates of volume were made. One provided a minimum volume of basalt simply by joining the depths of the craters as shown in Fig. 1.

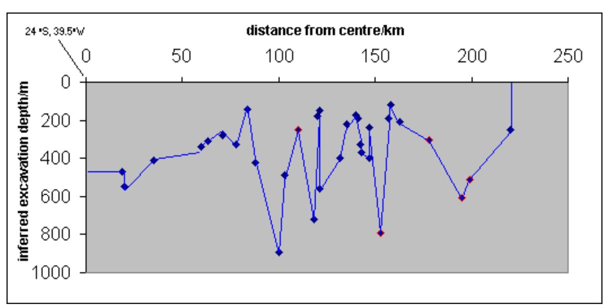

Fig.1. Minimum volume profile based on crater depths. Blue points: crater minimum depth. Red points: craters that have exposed highland material.

A second estimate, Fig. 2, was made with a more realistic profile of the basalt/highland boundary.

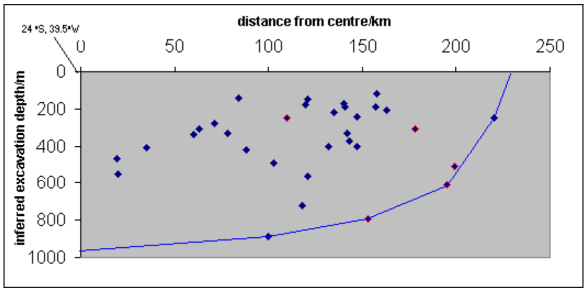

Fig. 2. Minimum volume profile based on crater depth but with a more realistic base than Fig. 1.

Results. The profile in Fig. 1 indicates the minimum volume of basalt to be ~60,500km^3 while the profile in Fig. 2 indicates the volume to be ~111,000km^3.

FeO and TiO_2 wt% in the units. The FeO and TiO_2 wt% values for all 109 units were plotted against each other as shown in Fig. 3.

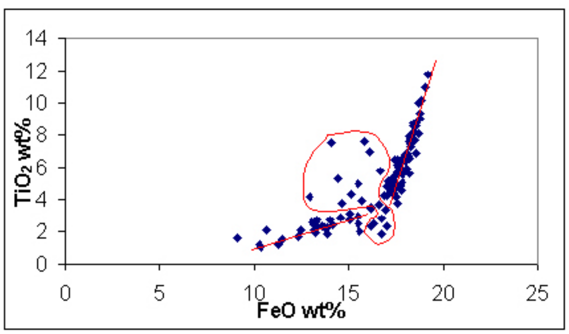

Fig. 3. FeO and TiO_2 wt% plots for the 109 units. Two trends are shown. Those plots that could not be confidently assigned to either trend are encircled.

Two trends became apparent and are indicated with straight lines: one low FeO/TiO_2 and one high FeO/TiO_2 wt%, while a few points could not be assigned to either trend with certainty and these are encircled. The units were colour-coded and are shown in Fig. 4. Those units on the low FeO/TiO_2 wt% trend are generally isolated and thin basaltic units. Those on the high FeO/TiO_2 wt% trend mainly form deep, contiguous units while those unassigned to a trend in Fig. 3 generally form units that may be of intermediate depth as they are on the edge of deep maria and so probably occur on the slope.

Conclusion: We suggest that vertical mixing from impacts has caused highland material to contaminate thin basalts considerably. The inefficiency of vertical mixing [11,12] means that less contamination of the deeper basalts has occurred while the thickest basaltic units have experienced the least contamination.

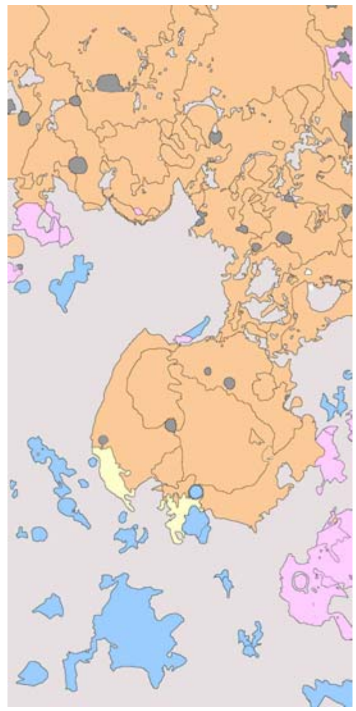

Fig. 4. Low FeO/TiO_2 wt%: blue. Intermediate: pink. High: brown. Highland: light grey. Large craters, ejecta and very small units: dark grey. Dark mantling material: yellow.

References: [1] Nozette *et al.* (1994) Science 266, 1835-1839. [2] Lucey *et al.* (1995) Science 268, 1150-1153. [3] Lucey *et al.* (1996) LPSC XXVII, 781-782. [4] Blewett *et al.* (1997) JGR 102, 16319-16325. [5] Lucey *et al.* (2000) JGR 105, 20297-20305. [6] Schultz and Spudis (1983) Nature 302, Mar 17. [7] Hackwill *et al.* (2004) LPSC XXXV, CD ROM 1062. [8] Croft (1980) LPSC XXI, 2347-2378. [9] Oberbeck (1975) Rev. Geophysics and Space Physics, 13 337-362. [10] Stöffler *et al.* (1975) JGR 80, 4062-4077. [11] Li and Mustard (1999) XXX, LPSC CD ROM 2012. [12] Gault *et al.* (1974) LPSC V, 2365-2386.