BASALTS IN MARE HUMORUM AND S.E. PROCELLARUM. Terence Hackwill[1], John Guest[2] and Paul Spudis[3]. [1, 2] Department of Earth Sciences, UCL, 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 presence of basaltic lava flows on the surface of the moon is indicative of volcanic activity and study of their sequence of eruption and volumes may help to indicate the amount of heating required to produce them. We have studied the mare basalts of Mare Humorum and S.E.Procellarum (30ºW-50ºW, 0º-40ºS) using Clementine and Lunar Orbiter IV images to age the basaltic units and indicate their depths. This is part of a larger, on-going project that is being co-ordinated by P.D.Spudis using the same method to assess the history and depth or eruptions for all of the mare on the lunar surface.

Method

Ultraviolet and visible wavelength images from the Clementine mission can be used in conjunction with algorithms devised by various workers [1,2,3] to determine variations in FeO and TiO_2 wt% on the lunar surface. Each lava flow will have its own thermal history and this may produce a characteristic chemical composition with differences in FeO and TiO_2 wt% that may be used to delineate individual flows.

Four Clementine images were used: (1) FeO wt% content, (2) TiO_2 wt% content, (3) “true” colour from Clementine’s 450nm (blue), 750nm (green) and 950nm (red) camera filters, (4) “false” colour from the ratios 415/750nm (blue), 750/950nm (green), and 750/415nm (red). These were supplemented with Lunar Orbiter IV images were used to provide resolution down to about 60m (compared with about 200m for Clementine).

The borders of the units have been drawn on to the false colour image as a layer in Adobe Photoshop. Many of the units are obvious on the FeO and TiO_2 images and their boundaries were easily determined. Variations in FeO and TiO_2 wt% give subtle variations in colour and so the “true” and “false” colour images were also used and these proved useful to determine less obvious ones. Questionable boundaries were added to the false colour image at this stage. 12 TiO_2 wt% measurements were taken for each unit. If there was less than one standard deviation difference between adjacent units then they were combined and considered to be the same unit.

Crater densities can be used to assess relative ages of geological units on the Moon [4]. Scanned Lunar Orbiter IV high resolution frames were displayed on a PC to crater count each unit. The “paintbrush tool” was used as a circle with the correct number of pixels to display 500m. It was placed over each crater to determine if it was more than 500m diameter. Obvious secondary craters were ignored.

Returned samples can be radiometrically dated [4]. Schultz and Spudis [5] selected two such units (Apollo 12 and 15) and plotted them against the crater counts for those units. They also plotted some inferred ages against crater counts. Their crater densities were determined using craters having diameters greater than 500m. Their results are shown in Fig. 1.

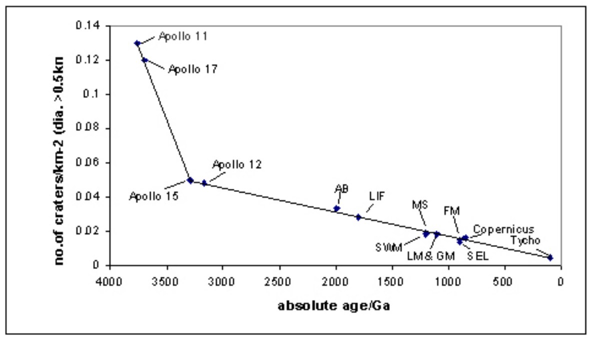

Fig 1. Density of craters having diameter >500m versus age. Redrawn from [5] with Apollo 11 and 17 added. AB: area B in [6], LIF: late Imbrium flows, MS: Mare Smythii, SWM: South-west of Maestlin, LM: Letronne mare, GM: Gruithuisen mare, FRM: Flamsteed Ring mare, SEL: South-east of Lichtenberg, Copernicus (ejecta), Tycho (ejecta).

The graph in Fig.1 was used to date units from Mare Humorum and S.E.Procellarum. We found that small units had too few 500m craters to produce a reasonably accurate age and so we only quote ages for the 35 large units.

Small impact craters have been used to assess the depth of the basalts. Croft [7] shows that small, bowl-shaped craters have a diameter to depth ratio of about 10:1. The diameter and depths can be calculated from a pixel count across the diameter of these craters. This gives a minimum basalt depth where the impact does not penetrate through to the highland. Where an impact has penetrated through to the highland, the ejecta is a mixture of two end members, basalt and highland. We used their proportions to calculate the depth of the basalt-highland boundary and thus the depth of the basalt.

Results

Our 109 units were aged. There appear to be two distinct trends when the average FeO and TiO_2 wt% for each unit are plotted against each other. The low FeO/TiO_2 wt% units generally occur as thin islands of basalt in the south while the high FeO/TiO_2 wt% occur as thick, contiguous units in Mare Humorum and the north. A separate source seems the most likely explanation for these differences.

We find that the middle unit of Mare Humorum is the oldest with the surrounding units (that could be dated) appearing later. We suggest that the middle unit sank because if its weight, causing subsidence and bending of the lithosphere [8,9] creating dykes which allowed intrusion of lava to flow into the basin above. The surrounding units (except the dark mantling deposit of the Dopplemayer Formation) progressively increase in FeO and TiO_2 wt% content with time.

References

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