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Absolute model ages of basalts in Mare Crisium

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Abstract

We have dated several mare basalt units in Mare Crisium. On the basis of our crater size-frequency distribution measurements (CSFD), we find Imbrian and Eratosthenian ages for the investigated basalts.

1. Introduction

Mare Crisium is one of the most prominent lunar basins, located on the eastern nearside. According to [1, 2], there are three major basalt groups within the basin, i.e., an Fe- and Mg-rich high Ti basalt similar to Luna 16 samples (Group I), a very low Ti ferrobasalt similar to Luna 24 samples (Group II), and a low Ti ferrobasalt similar to Apollo 12 samples (Group III) (Fig. 1). A similar spectral characterization was derived by [3]. On the basis of onlap and embayment relationships, it has been argued that the Group I basalts are the oldest deposits in the basin. These basalts are only exposed in the topographically higher SE of the basin (Auzout Basalts) and in the ejecta blankets of major post-mare impact craters in the W, including Picard, Peirce, Greaves, and Cleomedes F. The Group I Alhazan Basalts are exposed in the far E of Mare Crisium and are of uncertain age [1]. Group II basalts were presumably emplaced in two stages - first, around the NE (Eimmart Basalts) and SE (Agarum Basalts) outer edge of the basin (Group IIB), and then in the NNW of the basin (Group IIA; Swift Basalts). There are several small occurrences of Group IIA Swift Basalts in the S, the easternmost of which contains the Luna 24 landing site [1]. Group III basalts (Shapley Basalts) are the youngest basalts and are exposed in the SSE of the basin.

While stratigraphic relationships among the Mare Crisium basalts were investigated in detail [e.g., 1], absolute and relative ages remain under discussion. For example, the geologic map of [4] indicates that most of northern Mare Crisium is covered by Imbrian-age basalts (Im), which are not subdivided, as in the map of [1]. There is a small, isolated area of presumably Eratosthenian or Imbrian age NE of crater Einmart C. The easternmost region of the basin was also mapped as Eratosthenian or Imbrian basalts (EIm). This unit roughly corresponds to the Group I basalts of [1]. The geologic map of [5] also shows mostly Imbrian ages for the mare basalts in southern Mare Crisium, except for two small, isolated areas E of Picard X, which were mapped as Eratosthenian or Imbrian basalts (EIm).

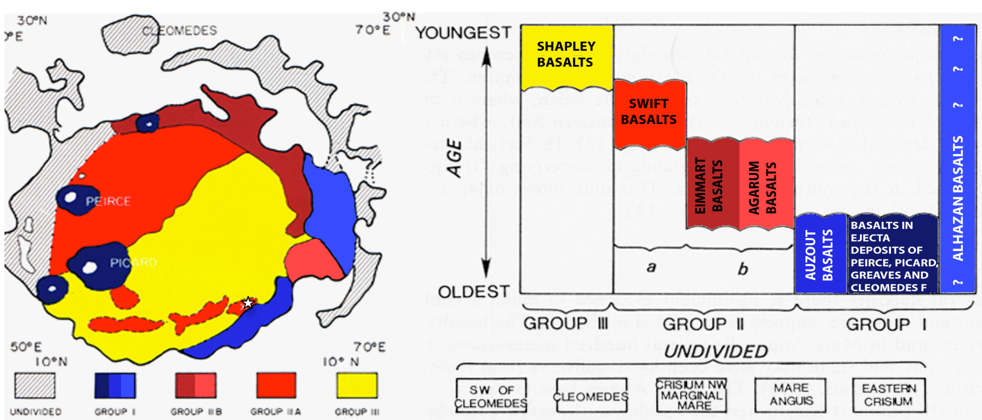

Fig. 1: Geologic units and their stratigraphy in Mare Crisium [after 1]. Luna 24 is marked with a white star.

According to the map of [6] (Fig. 2), ages range from 2.5 Ga close to the highland-mare boundary in the NE, S of crater Eimmart H; to 3.2 Ga in the N, NE, and S; to 3.5 Ga in most of the central region; to 3.65 Ga in the westernmost, the central and the easternmost parts of the mare. In general, the crater degradation ages [6] show a much wider range of basalt ages than the geologic maps [4, 5] and indicate that Eratosthenian basalts cover large areas of Mare Crisium.

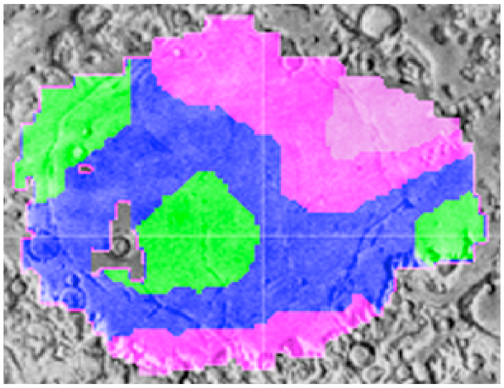

Fig. 2: Crater degradation ages of [6]. Transparent pink (2.5±0.5 Ga), solid pink (3.2±0.2 Ga), blue (3.50±0.1 Ga), green (3.65±0.05 Ga).

2. Results

Our CSFD measurements for Mare Crisium basalts yield a wide range of ages, similar to the map of [6]. According to our results, basalts in Mare Crisium range from 2.71 to 3.61 Ga, thus indicating Eratosthenian and Imbrian ages. We find that the unit containing the Luna 24 landing site is 3.4 Ga old, in excellent agreement with the radiometric ages of [7, 8]. These radiometric ages indicate ages of 3.34 to 3.44 Ga [7] or 2.52-3.45 Ga [8]. Crater degradation ages of [6] show an age of 3.50 Ga for the Luna 24 landing site (Fig. 2). Our oldest unit (3.61 Ga) is found along the western mare/highland boundary, west of crater Yerkes. Our second oldest unit (3.27/3.60) is located in the far E, consistent with the data of [1] and [6]. We find relatively young ages in the NE and E for the Group IIB basalts, i.e., 2.95-3.41 Ga. While mapped as Group IIB [1], basalts east of Cleomedes F are significantly older (3.50 Ga). The map of [6] also shows young ages of 2.5-3.2 Ga for the NE of Mare Crisium. We find young ages of 3.03 and 3.12 Ga for the area along the southern mare/highland boundary, which was dated to be 3.2 Ga old [6]. However, compared to the ages of [6], we do not find 3.65 Ga old basalts in the central region E of crater Picard. Our crater counts indicate ages that are significantly younger, i.e. 3.41-3.47 Ga. The unit W and N of crater Peirce has an absolute model age of 2.71 Ga, hence being much younger than the ages of the map of [6]. Our absolute model ages indicate that the northwestern Group IIA basalts are younger (2.78, 3.00, 3.38 Ga) than the southeastern Group III basalts (3.41, 3.47, 3.04/3.49 Ga).

3. Summary and Conclusions

On the basis of our crater size-frequency distribution measurements, we conclude that (1) due to their favorable illumination geometry and their high spatial resolution, LROC WAC images are well suited for accurate crater size-frequency distribution measurements, (2) our counts improve upon previous age determinations by [6] because they were performed on spectrally homogeneous units, interpreted to have formed by single eruptive events, (3) absolute model ages show a range of Imbrian and Eratosthenian ages from 2.71-3.61 Ga, (4) the absolute model age (3.40 Ga) of the unit that contains the Luna 24 landing site agrees well with the radiometric ages of the returned samples (3.34-3.44 Ga; [7]; 2.52-3.45 Ga; [8]), (5) the Alhazan Basalt shows an older age of 3.60 Ga with a resurfacing at 3.27 Ga, being consistent with the wide range of ages found by [1], (6) the Eimmart Basalts in the NE and the Agarum Basalt in the SE are younger than central basalts, (7) the Swift Basalt appears to be younger than the Shapley Basalts.

References

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