LAVA FLOWS IN MARE IMBRIUM, PART II: EVALUATION OF ANOMALOUSLY LOW EARTH-BASED RADAR REFLECTIVITY[1/]

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A new comparison of photogeology with Earth-based mapping of color and radar reflectivity in the western two thirds of Mare Imbrium shows that, in general, good correlation exists between very weak 70 cm wavelength radar reflectivity and "blue" mare deposits of Eratosthenian age and Imbrian age in the Imbrium Basin (Fig. 1); the agreement is especially striking with the youngest Eratosthenian eruptives. Reflectivity variations on the 3.8 cm wavelength Earth-based radar maps agree generally with those at 70 cm but only poorly characterize mare units of different age in the Basin, possibly due mainly to a strong backscattering effect of the abundant 1 cm to 10 cm-size rocks that are common to the explored mare surfaces.

The present study summarizes and evaluates those physical and chemical parameters that most likely could be responsible for the anomalously low radar backscatter; namely (i) low surface roughness and slopes at various scales, (ii) regolith and basalt substrate chemistry leading to high attenuation, (iii) low crater and surface rock frequency distributions, (iv) thick attenuating regolith. Thompson, et al. (1) showed that rock populations on the surface and in the shallow subsurface in the vicinity of impact craters were directly responsible for observed positive thermal (infrared) and positive 3.8 cm and 70 cm radar anomalies. The present study and others by Pieters et al. (2) and Thompson et al. (3) have indicated, however, that the very weakest depolarized radar backscatter signals are probably not simply due to reduced surface rock populations, but instead may be sensitive to one or more parameters, such as TiO_2 content innate to mare materials with low visible albedo and "blue" color.

Surfaces of the three different Eratosthenian basalt units in Mare Imbrium defined by Schaber (4) dramatically decrease in radar backscatter ability with increasing youth (Fig. 1). In test areas (within the boundaries of figure 1) the percentages of area with 70 cm depolarized reflectivity less than 40-50% of the average intercrater level of reflectivity are: phase I, 17%; phase II, 33%; and phase III, 64%. The parameters responsible for abnormally weak diffuse scattering must increase substantially for lava phases I, II and III, respectively. Although the effects on the radar backscatter of regolith depth, crater populations and surface smoothness were investigated during the present study, none were found to satisfactorily explain the radar behavior. Chemistry-related, signal attenuation could locally be the dominant effect. The signal attenuation hypothesis is strengthened by the data of Charette et al. (5) who, utilizing spectral reflectivity data, inferred a high value of 6-8% TiO_2 in the regolith for areas of Mare Imbrium centered at 38° 45'N and 22° 40'W and 41° 05'N and

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25° 00'W. These locations are underlain by Eratosthenian lavas of the oldest phase-I eruptive cycle (Fig. 1). If we assume that the attenuation of radar signals is totally attributed to increased TiO_2 in the soil, then the lower backscatter values from the youngest phase-III flows may indicate remarkably high TiO_2 contents; perhaps even higher than the 8-10% found at the Apollo 17 site.

References

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Figure 1 - Areal distribution of weakest, depolarized, 70 cm wavelength radar reflectivity in the Imbrium Basin (dotted pattern) and its correlation with three phases of Eratosthenian age lavas mapped by Schaber (4). Mare color data taken from recent data by Whitaker (personal communication) are shown by letters; R (red); MR (medium red); MB (medium blue) and B (blue). Hatchured lines mark the foot of most extensive flow scarps observed for lava phases II and III. Short dashed line marks the partial rim of the Sinus Iridum crater. Long dashed lines indicate area of detailed radar reflectivity/lava flow investigation. Mare materials not enclosed by solid lines are of Imbrian age.

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