PHOBOS SPECTRAL OVERVIEW: SUGGESTIONS FOR FUTURE ORBITAL MEASUREMENTS.

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Different measurements of Phobos spectral properties and density have been taken from space and from the earth's surface over the last 40 years. Many hypotheses have been evoked about its composition and origin, but with no certitude to date. This study summarizes the knowledge we have on Phobos based on the interpretation of the main data collected, and provides suggestions of future orbital measurements to better answer the remaining fundamental questions.

Based on a methodic overview of Phobos past and recent spectral investigations [1 to 10], the main facts presented by this study are reported in the discussion below.

Phobos spectral interpretation is made difficult by the spectral heterogeneity present on such a small body. However, the surface division may be linked to the relatively giant Stickney crater.

In light of its small size, it is more reasonable to suppose that Phobos is a homogeneous body coherent with the similar 1,65μm-normalized spectral slopes found by Rivkin *et al.* [9], and possibly covered by a thin dust layer, consistent with the fine-grained material mentioned by Roush and Hogan [8]. This would allow us to explain the spectral difference with geomorphologic effects related to the Stickney crater.

As the Stickney crater shock must have excavated Phobos's soil, the bluer unit is thought to be more representative of Phobos's internal composition than the redder one [7].

We saw that because of a lack of deep hydration feature, and a steeper spectral slope, Phobos could not be a (fresh) C-type asteroid [4].

In the study of Rivkin *et al*. [9], we noted that a D-type asteroid spectra could match both Phobos units but not with short wavelengths. The correlation between Phobos's bluer unit and a T-type asteroid remains the best compromise with an immediate good match.

Otherwise, the precise match between Phobos's bluer unit and the heated carbonaceous chondrite, could be explained if Phobos was a C-type asteroid that passed nearby the sun before being captured by Mars, on the condition that this is dynamically possible.

The last possibility is that Phobos was made of highly space-weathered mafic material, but Rivkin *et al.* found no pyroxene feature in Phobos spectra and the spectral match with lunar highlands is limited shortward of 2.4μm [9].

According to the incertitude and lack of data in past investigations, and in order to validate or disclaim the previous hypotheses, the following instruments /measurements are suggested for a future Phobos orbiter:

(i) Infrared Imaging Spectrometer: gather precise measurements at 1 and 2μm for mafic mineral absorption, 3 and 6μm for H2O and hydrated mineral absorption.

(ii) Thermal Emission Spectrometer: gather precise measurements of surface thermal inertia to physically characterize the external layer (particle sizes, coherence, and thickness).

(iii) Gamma Ray: determine the presence of ice in the subsurface.

(iv) Ground Penetrating Radar (short wavelengths): image the contrast between the expected thin-dry surface layer and an eventual presence of internal ice.

These instruments /measurements should complement the actual data and significantly help to determine what Phobos is made of and what its origin is.

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