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Origin of the Martian moons: Investigating their surface composition.

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Abstract

Here, we investigate the composition of the Martian moons to constrain their origin. We use MRO data for Phobos and Deimos as well as laboratory data of minerals and meteorites to investigate this question. Since two meteorites match quite well some resolved spectra of Phobos surface, we tested via ion irradiation experiments in the laboratory if an irradiated version of these meteorites would match all other resolved spectra of Phobos as well as Deimos spectrum.

1. Introduction

The origin of the Martian moons hasn't been solved yet and is one of the most intriguing puzzles of the inner solar system. The three proposed scenarios for the origin of the moons are the following: 1) Capture of two distinct outer main belt asteroids 2) Formation in place (The Moons accreted in their present position) 3) Origin as Mars impact ejecta. Dynamicists argue that the present orbits of Phobos and Deimos could not be produced following capture, and so they must have originated near Mars at 1.5 AU, where the satellites are found today. However, every observable physical property (albedo, VNIR reflectance,density, ...) indicates that the Martian satellites once resided in the outer belt (~3 AU), suggesting the objects must be captured [1]. Providing new constraints on the composition of the moons would bring us very close to the solution of this long standing issue.

Phobos and Deimos share similar visible-near infrared (0.4-2.5 μm) spectra suggesting that they have a similar surface composition. However, it appears that Deimos' spectrum is redder than any Phobos' spectrum. Further, a strong color difference is observed on Phobos itself: the spectrum covering the bright crater Stickney is much bluer than any spectrum scanning other regions of Phobos. Can these color differences be explained by space weathering [e.g., 2, 3]? Or is a variation of the surface composition the cause of the observed slope differences?

2. Immediate objective

We found two meteorites, Tagish Lake and WIS 91600, whose spectra match Phobos' blue spectrum (crater Stickney) but not Phobos' redder spectra, nor Deimos spectrum (MRO data, see [4]). We plan to test if space weathering processes are the cause of the strong color difference observed between Phobos's blue region (crater Stickney) and other parts of Phobos and Deimos. Said differently, we plan to test if space weathering processes can redden and darken the initially WIS 91600- or Tagish Lake-like spectrum of a fresh Phobos surface (Phobos blue; supposing the latter surface is fresh), transforming its appearance to that of a Phobos red or a Deimos spectrum. If not, this would imply that both meteorites differ in composition from the Martian moons.

3. Experimental techniques/results

To test this hypothesis, we started reproducing in the laboratory the effects of the solar wind ion irradiation on both meteorites. Such experiments were conducted at the Observatory of Catania (Italy) and at the University of Virginia (USA). Furthermore, a modal analysis of WIS 91600 was conducted at

NHM, London (UK) in a similar way [5] as previously done for Tagish Lake [6]. We will present the results of these experiments and their immediate implications.

References

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