THE COMPOSITION OF PHOBOS AND DEIMOS: CONSTRAINTS AND QUESTIONS.
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Phobos and Deimos were discovered well over a century ago. The first spacecraft data returned for the satellites arrived nearly forty years ago. Yet fundamental information about the composition of these bodies is still a matter of some controversy, and almost nothing about them is universally accepted. Establishing their composition is critically important for understanding the early history of the solar system (and Mars specifically), placing them in the proper context vis-à-vis the other small bodies of the solar system, and determining their suitability as bases for expanding human presence to Mars.

The first results from Mariner and Viking found Phobos and Deimos to be low-albedo, low-density objects with flat reflectance spectra when the available data were pieced together [1,2]. This pointed toward a carbonaceous-chondrite-like composition for the martian satellites, with the low density perhaps indicating abundant internal ice, and an origin as objects captured from the mid-asteroid belt. This paradigm is still often held today, although the intervening years have found numerous inconsistencies with it.

First, groundbased and spacebased observations since the late 1980s found both Phobos and Deimos to have extremely red-sloped (if featureless) reflectance spectra through the visible and near-infrared [3,4]. Such spectra are much more akin to the outer-belt and Trojan asteroids, which are associated with organics-rich mineralogies with abundant internal ice. However, as the first well-constrained asteroid densities became available, it was seen that low densities like those of Phobos and Deimos can arise via collisional breakups and reaccretion and do not necessarily imply internal ice [5]. Furthermore, dynamicists had great difficulty creating models where Mars captured Phobos and Deimos from the outer asteroid belt, where their spectral slope implied they were formed [6].

In the last ten years, whole-disk spectral work has put tight constraints on the presence of hydrated minerals on the martian satellites, and reanalysis of data from Phobos 2 has shown the presence of regional-scale differences on Phobos as two different spectral units along with hints of smaller-scale variation [7,8,9]. As the importance of regolith maturation (or "space weathering") on asteroids has been recognized, both the lack of hydrated minerals and the difference between the spectral units have been interpreted in terms of space weathering as well as due to composition alone [7,8,10].

The lack of deep absorption features in the reflectance spectra of Phobos and Deimos have allowed a number of possible analogs to be ruled out, though they have also made it difficult to make any positive identifications.

I will present our best current understanding of the composition of Phobos and Deimos, focusing on visible and near-infrared spectroscopy, and the implications possible compositions have for the origin of the satellites. I will also discuss the prospects for future measurements.

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