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Phobos origin: a reappraisal

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The visible and near infrared spectra of Phobos, acquired both from the Earth and in Mars orbit, are totally distinct from those of Mars, whatever the martian surface unit mapped. Phobos spectra are essentially featureless, resembling those of dark asteroids considered parent bodies of primitive meteorites. This has long been considered suggesting that Phobos is a captured asteroid - as would Deimos be, for similar reasons.

From a dynamical standpoint, this assumption implies a complex scenario: the capture requires a huge loss of energy, for example through an impact on a third body. It would most likely lead to an ecliptic and excentric orbit, while the present one is circular and equatorial. Moreover, the scenario should be generic enough to have also worked for Deimos, of much lower mass. Altogether, it is highly unlikely (1).

Alternative scenarios for the origin of Phobos and Deimos can be advocated. We shall review and discuss them, on the basis of the data acquired, primarily from the hyperspectral imager OMEGA/Mars Express, with a special emphasis on the most promising one: Phobos and Deimos would originate from re-accretion in a disk formed by an early giant impact on Mars, similarly to the Earth Moon. The primitiveness of these small bodies would merely come from their size, small enough to have precluded further differentiation. Phobos would thus be in part made of Martian material.

The upcoming Phobos Grunt mission, both with its in situ measurements and the follow-on analyses on returned samples, compared to the in situ analyses of MSL, should severely constrain the Phobos origin, and open new avenues to the understanding of the early stages of solar system evolution.

[1] Peale S.J.: Origin and Evolution of the Natural Satellites, Ann. Rev. Astron. Astrophys. 37, 533-602, 1999