

Sample analysis of Phobos regolith returned by JAXA's Martian Moons eXploration (MMX) mission and its scientific objectives

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Japan Aerospace Exploration Agency (JAXA) will launch a spacecraft in 2024 for a sample return mission from Phobos (Martian Moons eXploration: MMX). Touchdown operations are planned to be performed twice at different landing sites on the Phobos surface to collect >10 g of the Phobos surface materials with coring and pneumatic sampling systems on board. The Sample Analysis Working Team (SAWT) of MMX is now designing analytical protocols of the returned Phobos samples to shed light on the origin of the Martian moons as well as the evolution of the Mars-moon system. Observations of petrology and mineralogy, and measurements of bulk chemical compositions and stable isotopic ratios of, e.g., O, Cr, and Ti can provide crucial information about the origin of Phobos. If Phobos is a captured asteroid composed of primitive chondritic materials, as inferred from its reflectance spectra, the nature of organic matter as well as isotopic compositions of, e.g., H and N characterize the volatile materials in the samples and constrain the type of the captured asteroid. Cosmogenic and solar wind components, most pronounced in noble gas isotopic compositions, can reveal surface processes on Phobos. Long- and short-lived radionuclide chronometry such as ⁵³Mn-⁵³Cr and ⁸⁷Rb-⁸⁷Sr systematics can date pivotal events like impacts, thermal metamorphism, and aqueous alteration on Phobos. It should be noted that the Phobos regolith is expected to contain a small amount of materials delivered from Mars, which may be physically and chemically different from any Martian meteorites in our collection and thus are particularly precious. The analysis plan will be designed to detect such Martian materials, if any, from the returned samples dominated by the endogenous Phobos