

Curation protocol of Phobos sample returned by Martian Moons Exploration (MMX)

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The Martian Moons Exploration (MMX) aims to return the regolith samples from the Martian moon, Phobos. After the topographic and spectroscopic observation, the spacecraft will land on the surface of Phobos to conduct the sampling operation [1–2]. Pneumatic and coring samplers will collect > 10 g Phobos grains from two different sites. The collected samples will be retrieved from the capsule and transferred to the curation facility in 2029.

Sample analyses for the Phobos grains are the key to achieving the MMX mission goals [3]. The mineralogy, petrology, geochemistry and isotopic compositions (e.g. O and Cr) of bulk-scale Phobos grains will, define the origin of Martian moons. Chronology using noble gases and moderately volatile isotopes will determine the timing of geologic events on Phobos. Organic chemistry is also a powerful tool for the origin of small bodies in the case of capture origin. In addition, grains from Mars, possibly incorporated into the Phobos samples, may be the first Martian samples collected by sample return missions.

The MMX' s Sample Analysis Working Team (SAWT) designed the flow of the sample analysis of Phobos samples [4]. Before the sample analysis, Phobos samples will be stored in a clean glove box under purified N₂ condition, called the "clean chamber." The operation phase of Phobos grains within the clean chamber is termed "curation." The design of the curation protocol is critical for the sample allocation and subsequent sample analysis phase. Based on the knowledge of the preceding sample return mission of Hayabusa 2, MMX introduces a new concept of curation, that is, the cooperation of curation with the

remote-sensing teams and interdisciplinary Science Strategy Teams (SSTs). This study reports the curation protocols and refined sample analysis flow defined by SAWT with the support of JAXA's curation team and MMX remote-sensing instrument teams.

We assume 10 g for the whole sample amounts and 300 micrometers for the typical size of Phobos grains [5] as the nominal case. The curation protocol consists of three phases: 1) Quick Analysis, 2) Pre-basic Characterization, and 3) Basic Characterization. (1) First, we assess the degree of the leak of terrestrial air by collecting the gas filled within the sample container (Quick Analysis). (2) After collecting the container headspace gas, the sample corers will be introduced into the clean chamber. Subsequently, Phobos grains will be observed with an optical microscope, a visible multi-band microscope, and a near-infrared imager (Pre-basic Characterization). (3) Finally, the samples will be further investigated in the clean chamber, and an aliquot will be selected for the sample analysis team (Basic Characterization).

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