A study of the curation protocol by sample analysis working team (SAWT) in Martian Moons eXploration (MMX) project

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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). The major scientific goals of MMX are to constrain (1) the origin of Phobos and Deimos and (2) the evolution of the Mars-moon system [1]. The touchdown operations are planned to be performed twice at different landing sites on the Phobos surface to collect > 10 g of the surface materials [2]. After the return to the Earth, the Phobos samples will be collected from the individual sample canisters and introduced to the clean chamber installed at ISAS (Institute of Space and Astronautical Science). The Sample Analysis Working Team (SAWT) of MMX designed the procedure of Phobos sample analysis mainly conducted by the initial analysis teams [3]. For the next step, the SAWT will define the procedure of the curation process (mostly non-destructive analysis) of the Phobos samples, which will be presented here.

The protocols of the Phobos sample curation are illustrated in figure 1. First, the headspace gas from the sample container will be collected during the Quick Analysis phase. The Quick Analysis will be operated by the sampler and curation teams in ISAS/JAXA. The terrestrial leak and contamination from the sampling systems will be tested using a quadrupole mass spectrometer equipped with a gas sampling system. Second, the bulk Phobos sample will be observed in the clean chamber under purified-N_2 gas with an ambient condition (Pre-basic Characterization) within three weeks. This phase will be operated by the curation team in ISAS/JAXA and the instrument team of the MMX mission. The consistency between the data from the instruments in the clean chamber and the spacecraft will then be evaluated.

Subsequently, the curation will distribute the small amount of Phobos samples to the Initial analysis team of MMX to conduct the "Preliminary Examination". The objectives of the preliminary examination are to provide (1) feedback on the subsequent sample allocation process, (2) preliminary scientific results that will address parts of MMX mission goals, and (3) evaluation of the sampling system and terrestrial alteration on Phobos samples. Because multiple models are proposed for the origin of Phobos [1] (e.g., giant impact, the capture of asteroids), the chemical and mineralogical characteristics of Phobos must be assessed before the allocation of the samples to the individual Initial Analysis teams. The Preliminary Examination will start after about 1 month from the sample return. Simultaneously, the curation team in JAXA will observe the individual grains and aliquots of the samples in the clean chamber (Basic Characterization). The results obtained in Preliminary Examination will be investigated with several SSTs (Science Strategy Teams). Based on the results, the curation team will decide on the sample amounts to allocate to the Initial Analysis team. After 6 months from the Preliminary Examination, Initial Analysis will be started to perform the comprehensive analysis for Phobos samples within 1 year.

The curation protocols the SAWT proposes here are partly based on those in Hayabusa & Hayabusa2 missions [4]. However, our strategy enables us to utilize larger amounts of return samples compared to the previous sample return missions. Also, the chemical/mineralogical characteristics of Phobos will be quickly understood throughout the non-destructive and destructive analyses in the curation process.

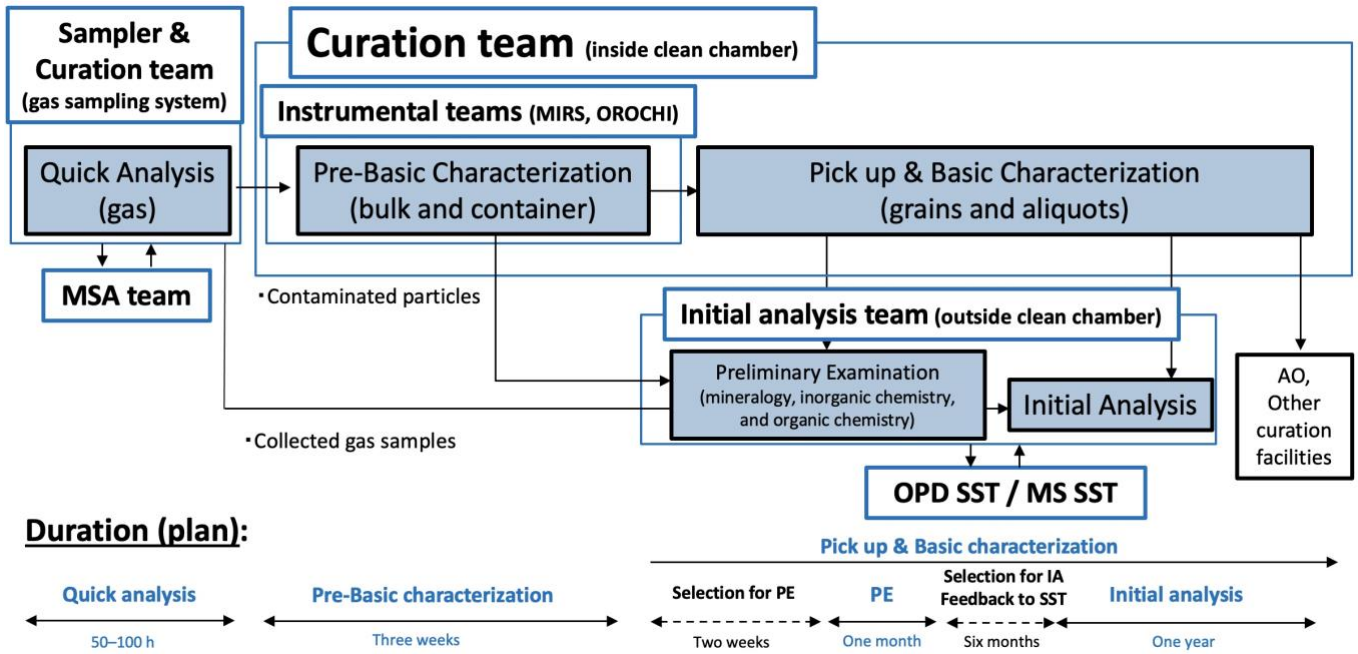

Fig. 1: Curation protocols for the Phobos samples.

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