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JAXA's strategic small-body sample return program: From Hayabusa/Hayabusa 2 to MMX

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Japan Aerospace Exploration Agency (JAXA) has a strategic small-body sample return program to understand the formation, evolution, and migration of planetary building blocks, water, and organics in the early solar system. The JAXA's sample return program started with Hayabusa for S-type asteroid Itokawa in 2010, followed by Hayabusa-2 for C-type asteroid Ryugu in 2020, and the future mission of Martian Moons eXploration (MMX) for Phobos in 2029. My presentation covers the recent achievement of Hayabusa 2 curation and sample analysis. I also present an overview of MMX, particularly how we leverage the Hayabusa 2 experience to develop the MMX curation and sample science.

Hayabusa 2 team has completed the initial curation and sample analysis of the Ryugu samples. The Hayabusa 2 curation/sample analysis is unique in having a role as a "bridge" between the remote sensing and the sample analysis communities. Along with the conventional curation tools (e.g., optical microscope and balance), JAXA installed remote sensing instruments (e.g., ONC: Optical Navigation Camera) in the curation facility for ground truthing. Moreover, a flight spare of MicrOmega (infrared hyperspectral microscope) detected important minor phases (clays, carbonates, organics) in the "apparently black" Ryugu samples in the early stage of the curation. Following the initial sample analysis/curation activity, Ryugu samples are now publicly available <https://jaxa-ryugu-sample-ao.net/>.

JAXA plans a Phobos sample return mission MMX in 2024-2029. The MMX spacecraft is scheduled to be launched in 2024, orbit Phobos and Deimos (multiple flybys), and retrieve and return >10 g of Phobos regolith to Earth in 2029. The Phobos regolith represents a mixture of endogenous Phobos building blocks and exogenous materials that contain solar system projectiles (e.g., interplanetary dust particles and coarser materials) and ejecta from Mars and Deimos. The MMX Sample Analysis Working team started designing the curation and sample analysis protocol to identify Phobos' fragments with different origins. Under the condition that remote sensing observations guarantee the representativeness of the sampling sites in the geologic context of Phobos, laboratory analysis of the returned sample will provide crucial information about the moon's origin: the capture of an asteroid or in-situ formation by a giant impact.