Hayabusa2: Sampling and Sample Analysis

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Hayabusa2 is an asteroid exploration mission to return surface samples of a near-Earth C-type asteroid (162173) Ryugu, which potentially records the long history of the Solar System from the very beginning to the current surface geologic activity.

The Hayabusa2 samplind device (sampler) will shoot a 5-g Ta projectile at the surface of Ryugu to collect surface samples through an extendable sampler horn and a conical horn under a microgravity condition. Three projectiles are equipped for sampling at three surface locations. A back-up sampling method is also prepared; The tip of the sampler horn is turned up like the teeth of a comb, and surface pebbles will be lifted up by the tip of the horn during touch down. The lifted pebbles will be collected through the sampler horn and the conical horn by deceleration of the spacecraft.

The Ryugu samples will be stored in a sample catcher, located at the top-end of the conical horn. The sample catcher has three chambers to store samples obtained at three locations separately. After three sampling operations, the sample catcher will be transported into the sample container inside an Earth re-entry capsule and sealed. The container sealing method is changed from double fluorocarbon O-rings for Hayabusa to an aluminum metal seal to avoid the terrestrial air contamination after the Earth return. To avoid further potential contamination, volatile components will be extracted prior to the opening of the container. The container will be attached to a vacuum line, and the bottom of the container, a part of which is thinned, will be pierced with a needle to extract volatiles.

The characteristics of the Hayabusa2 sample container leads to classification of returned samples into three categories; (1) mm-sized coarse grains separately stored separately in three chambers, (2) <100 micron-sized fine grains that may be mixed in the sample container, and (3) volatiles extracted from the container prior to opening of the container. Coarse grains should represent the material properties at different locations, and petrologic and mineralogical studies of them will provide important constraints on understanding the history of the asteroid and the solar system. Fine grains will also provide insights into the global average surface feature and surface geologic processes such as space weathering and regolith formation. Volatile components will be the first-returned extraterrestrial volatiles and will be an important analysis target to investigate the origin and evolution of organic matter and water in the solar system and the final evolutional state of organics in asteroids prior to the delivery to the Earth.

The initial analysis of returned samples will be done for limited amounts of samples to maximize the scientific achievement of the project for 12 months after preliminary examination at the JAXA/ISAS curation facility. The analysis focus on revealing the formation and evolution of Ryugu in the early Solar System; (1) Galactic chemical evolution and Sun’s parent molecular cloud chemistry, (2) Pre-accretional chemical evolution and planetesimal formation in the protosolar disk, (3) Properties of the planetesimal and final evolutional stage of volatiles prior to delivery to planets, (4) Geological evolution of asteroid in the Solar System, and (5) Orbital evolution and surface geological processes of near-Earth asteroid.

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