**ANALYSIS OF HAYABUSA2 RETURNED SAMPLES.**

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**Hayabusa2 and Its Scientific Goal:** Hayabusa2 spacecraft will bring back surface samples of a near-Earth C-type asteroid (162173) Ryugu at the end of 2020. Because the C-type asteroids, of which reflectance spectra are similar to carbonaceous chondrites, are highly likely to record the long history of the solar system from the beginning to planet formation including the supply of volatiles to terrestrial planets, the main scientific goals of the Hayabusa2 mission are the investigations of (I) the origin and evolution of the solar system and (II) the formation process and structure of the asteroid. These scientific goals are further subdivided into (1) thermal evolution from planetesimal to near-Earth asteroid (thermal processes in a planetesimal in the early solar system; heating and space-weathering on the surface of near-Earth asteroid at its current orbit), (2) destruction and accumulation of rubble pile body (planetesimal formation; impact processes throughout the solar system history), (3) diversification of organic materials through interactions with minerals and water in planetesimal (origin and evolution of volatile components in the early solar system; final state of organic matter and water prior to their delivery to rocky planets), and (4) chemical heterogeneity in the early solar system (mixing of "fire" and "ice" components during dynamical evolution of the protosolar disk). To fulfill these scientific objectives, a tight linkage between on-site geologic observations (kilometer to millimeter scale) and return sample analyses (down to atomic scale) is crucial. The scientific instruments on board the spacecraft are a laser altimeter (LIDAR), a multi-band telescopic camera (ONC-T), wide-angle cameras (ONC-W1 and -W2), a near-infrared spectrometer (NIRS3), a thermal infrared imager (TIR), a small carry-on impactor (SCI), a deployable camera (DCAM3), a sampler (SMP) [1], and a lander (MASCOT).

**Samples and Analysis of Returned Samples:** Initial analysis will be done by the Hayabusa2 mission to maximize the scientific achievement of the project for 12 months after Phase-1 curation (sample description at the ISAS curation facility). The initial analysis should be a good showcase to prove the potential of the samples. Along with the initial analysis, the Phase-2 curation of returned samples will include integrated thorough analysis and description of samples to build a sample database and to obtain new scientific perspective from thorough analysis of samples. The Phase-2 curation will be done both in ISAS and also in several research institutes outside JAXA led by the ISAS curation facility.

**Initial Analysis Team:** Initial analysis of returned samples will focus on revealing the formation and evolution of Ryugu in the early Solar System. The scientific objectives of sample analysis are listed in the following table [2], which covers from the presolar history to the current geological activity of the near-Earth asteroid.

| Galaxy/Molecular Cloud | Protoplanetary Disk | Planetesimal | Main-Belt Asteroid | Near Earth Asteroid |
|---|---|---|---|---|
| **Presolar Grains** | **CAIs, Chondrules, and Metal** | **Aqueous Alteration Thermal and Shock Metamorphism** | **Shock Metamorphism** | **Space Weathering** |
| Nucleosynthesis | High temperature processes | | Conditions and timing | Ages, Regolith dynamics, |
| Galactic chemical evolution | Constraint on the timing of parent body formation | Conditions and timing | | Space environments, SW, |
| | | | **Galactic Cosmic Rays** | Surface activity, Orbital evolution |
| **Molecular Cloud Organics** | **Disk Organics** | **Diversity of Organics** | Exposure history | |
| Low temperature processes | Fischer-Tropsch type reactions | Mineral-Organics association | | **Thermal Metamorphism** |
| Enrichment of heavy isotopes (D, $^{15}$N) | | L-enantiomer excess of amino acids | **Bulk Density** | Heating by sunlight |
| | | | Internal structure | |
| **Spatial Variation/Heterogeneity of Returned Samples** | | | | |
| Planetesimal formation processes, Disk evolution | | | | |
| Parent body size, Parent body processes | | | | |
| **Comparison with Meteorites, IDPs, and OSIRIS-REx Samples** | | | | |
| Uniqueness and commonness | | | | |

Hayabusa2 project has called for nomination of sub-team leaders of Initial Analysis Team (IAT). The IAT consists of six sub-teams for 1) chemistry (elements and isotopes), 2) petrology and mineralogy of coarse grains (mm-sized grains), 3) petrology and mineralogy of fine grains (<100 μm-sized grains), 4) volatiles, 5) macromolecular organics (insoluble organic matter), and 6) organic molecules (soluble organic matter). Each sub-team will be an international team led by a researcher (sub-team leader) who can have a research base in Japan at least a year before the delivery of the samples (the end of 2020) and throughout the initial analysis phase (2021–2022). The sub-team leaders will make an analysis and work-flow plan in their sub teams with the IAT members to make a best effort in fulfilling the scientific goals of the mission through integration of analytical results from each sub-team and on-site remote-sensing data.

**References:** [1] Okazaki R. et al. (2016) Space Sci. Rev., doi:10.1007/s11214-016-0289-5. [2] Tachibana S. et al. (2014) *Geochemical J.* **49,** 571–587.