Call for nomination of sub-team leaders of Initial Analysis Team for Hayabusa2 returned samples

We call for nomination of sub-team leaders of Initial Analysis Team (IAT), led by S. Tachibana (Hokkaido U.), for Hayabusa2 returned samples. 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.

Nomination

Nomination should include the following items in PDF format. **The whole nomination package is to be submitted by e-mail to tachi@ep.sci.hokudai.ac.jp by November 20, 2016**. Details of the mission and the initial analysis are found in subsequent sections. When you recommend a person for a sub-team leader, please also send the following items.

***Nomination Letter** (1-2 pages)*. This must clearly describe what sub-team the candidate can lead, including the candidate's scientific contributions to the cosmochemistry field and their experience in sample return missions.

Analysis and Team Plan (*3-4 pages*). This should detail what scientific objectives the sub-team can pursue with what analytical techniques. The availability and/or plan of instruments and funds to support the analysis should be specified (No fund is available for the initial analysis from the project). The new views and insights that can be stimulated by the sub-team and/or through integration of data obtained by remote-sensing and the initial analysis are also relevant. This also includes a list of candidates of sub-team members (~10 researchers with their expertise), which does not require acceptance from the candidates. One or two candidates of deputy sub-team leader, who can be a scientist having a research base outside Japan, are desirable to be specified.

***Curriculum Vitae** (1-2 pages)*. A summary of the candidate's curriculum vitae that includes the candidate’s name, address, history of employment, degrees, research experience, and honors.

***Selected Bibliography** (2 pages)*. A list of selected publications by the candidate, relevant to cosmochemistry, planetary science, analysis of extraterrestrial samples, and sample-return missions.

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), and a lander (MASCOT).

Hayabusa2 sampler

The concept and design of the Hayabusa2 sampler are basically the same as the original Hayabusa (Tachibana et al., 2014; Okazaki et al., 2016; Sawada et al., in revision). In order to collect sufficient amount of samples compliant with both monolithic bedrock and regolith targets, a 5-g Ta projectile will be shot at 300 m/s at the timing of touchdown, and the ejecta will be put into a sample catcher through an extendable sampler horn and a conical horn under a microgravity condition. Three projectiles are equipped for sampling at three surface locations.

The sample catcher of the Hayabusa2, located at the top-end of conical horn, has three chambers to store samples obtained at three locations separately. An inlet to the sample catcher is rotatable to select a chamber to store samples at each location. The size of sample catcher is almost the same as that of the original Hayabusa with two chambers, and the total volume is ~45 cm^3. The sample catcher has a design that is much easier to be taken apart during curation at the ground than that of the original Hayabusa.

After three sampling operations, the sample catcher is transported into the sample container inside the 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 that happened for the Hayabusa container (Okazaki et al., 2011). The new aluminum metal seal is designed to allow only a leak of 1 Pa air for a week at atmospheric pressure. 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.

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 put into the sample catcher by deceleration of the spacecraft.

Samples to be analyzed

The characteristics of the Hayabusa2 sample container leads to classification of returned samples into three categories; (1) mm-sized coarse grains stored separately in three chambers, (2) <100 μm-sized fine grains that may be mixed in the sample container, and (3) volatiles extracted from the container prior to its opening. Coarse grains should represent 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 grained samples will also provide insights into the global average surface features 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.

Initial analysis and curation work 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.

Hayabusa2 Sample Allocation Committee (HSAC)

The initial analysis of returned samples will be carried out for limited amounts of samples for limited duration, the details of which will be determined by the Hayabusa2 Sample Allocation Committee (HSAC). The HSAC is established under the Hayabusa2 Joint Science Team (HJST). HSAC will (1) oversee curatorial work of Ryugu samples at ISAS (Phase-1 curation) and at institutes outside ISAS (Phase-2 curation), (2) determine the amount and/or fraction of samples used for curatorial work and initial analysis, and (3) approve members of the Initial Analysis Team and oversees initial analysis of Ryugu samples by the IAT.

HSAC members are: Hayabusa2 Project Manager (Yuichi Tsuda), Hayabusa2 Project Scientist (Sei-ichiro Watanabe), ISAS Astromaterials Science Research Group Leader (Hisayoshi Yurimoto), Hayabusa2 Curation PI (Masanao Abe), Hayabusa2 Initial Analysis PI (Shogo Tachibana), and include nominees from International collaborators (Gabriele Arnold (Germany), Bernard Marty (France), Trevor Ireland (Australia), and Anthony Carro (US)), and a member of ISAS Curation Steering Committee (CSC) (Hiroko Nagahara). All the HSAC members should be approved by HJST and CSC.

Addition, resignation, and replacement of HSAC member should be made by consensus of the current members and should be approved by HJST and CSC. HSAC members can be members of the IAT, but they should not be included in the approval of the nomination.

Initial Analysis and Sub-teams

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, which covers from the presolar history to the current geological activity of the near-Earth asteroid. See also Tachibana et al. (2014) *Geochemical J.* **49,** 571–587 (https://www.terrapub.co.jp/journals/GJ/pdf/4806/48060571.pdf).

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Procedure of Selection

November 20, 2016	Nomination deadline
Late November, 2016 (at earliest)	Evaluation of nomination by HSAC
December, 2016 (at earliest)	Sub-team leaders recommendation and approval by HJST

Contact

Shogo Tachibana
Department of Natural History Sciences, Hokkaido University
N10 W8, Sapporo 060-0810, Japan
e-mail: tachi@ep.sci.hokudai.ac.jp