Asteroid explorer, Hayabusa2, reporter briefing

January 8, 2019

JAXA Hayabusa2 Project

Topics

Regarding Hayabusa2:

- Results from the solar conjunction operation
- Status of the plan for touchdown
- Place names on the surface of Ryugu

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1. Current status and overall schedule of the project
2. Results from the solar conjunction operation
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Overview of Hayabusa2

Objective

We will explore and sample the C-type asteroid Ryugu, which is a more primitive type than the S-type asteroid Itokawa that Hayabusa explored, and elucidate interactions between minerals, water, and organic matter in the primitive solar system. By doing so, we will learn about the origin and evolution of Earth, the oceans, and life, and maintain and develop the technologies for deep-space return exploration (as demonstrated with Hayabusa), a field in which Japan leads the world.

Expected results and effects

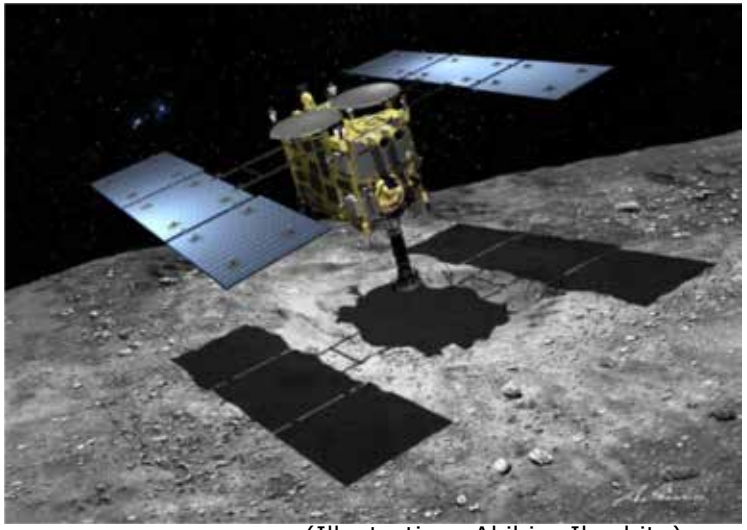
- By exploring a C-type asteroid, which is rich in water and organic materials, we will clarify interactions between the building blocks of Earth and the evolution of its oceans and life, thereby developing solar system science.
- Japan will further its worldwide lead in this field by taking on the new challenge of obtaining samples from a crater produced by an impacting device.
- We will establish stable technologies for return exploration of solar-system bodies.

Features:

- World's first sample return mission to a C-type asteroid.
- World's first attempt at a rendezvous with an asteroid and performance of observation before and after projectile impact from an impactor.
- Comparison with results from Hayabusa will allow deeper understanding of the distribution, origins, and evolution of materials in the solar system.

International positioning:

- Japan is a leader in the field of primitive body exploration, and visiting a type-C asteroid marks a new accomplishment.
- This mission builds on the originality and successes of the Hayabusa mission. In addition to developing planetary science and solar system exploration technologies in Japan, this mission develops new frontiers in exploration of primitive heavenly bodies.
- NASA too is conducting an asteroid sample return mission, OSIRIS-REx (launch: 2016; asteroid arrival: 2018; Earth return: 2023). We will exchange samples and otherwise promote scientific exchange, and expect further scientific findings through comparison and investigation of the results from both missions.



(Illustration: Akihiro Ikeshita)

Hayabusa 2 primary specifications

Mass	Approx. 609 kg
Launch	3 Dec 2014
Mission	Asteroid return
Arrival	27 June 2018
Earth return	2020
Stay at asteroid	Approx. 18 months
Target body	Near-Earth asteroid Ryugu

Primary instruments

Sampling mechanism, re-entry capsule, optical cameras, laser range-finder, scientific observation equipment (near-infrared, thermal infrared), impactor, miniature rovers.

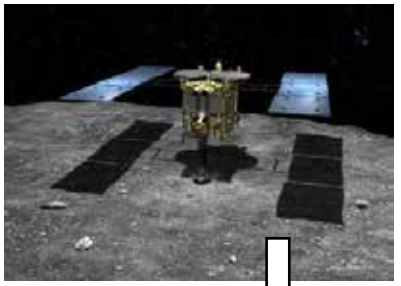
Mission Flow

Launch
3 Dec 2014

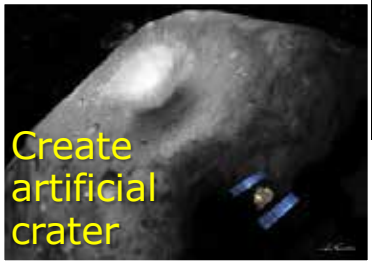
Earth swing-by
3 Dec 2015

Arrival at asteroid
June 27, 2018

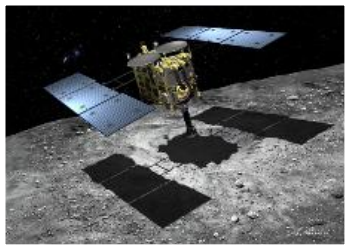
Examine the asteroid by remote sensing observations. Next, release a small lander and rover and also obtain samples from the surface.



Use an impactor to create an artificial crater on the asteroid's surface



After confirming safety, touchdown within the crater and obtain subsurface samples



Depart asteroid
Nov–Dec 2019

Earth return
late 2020

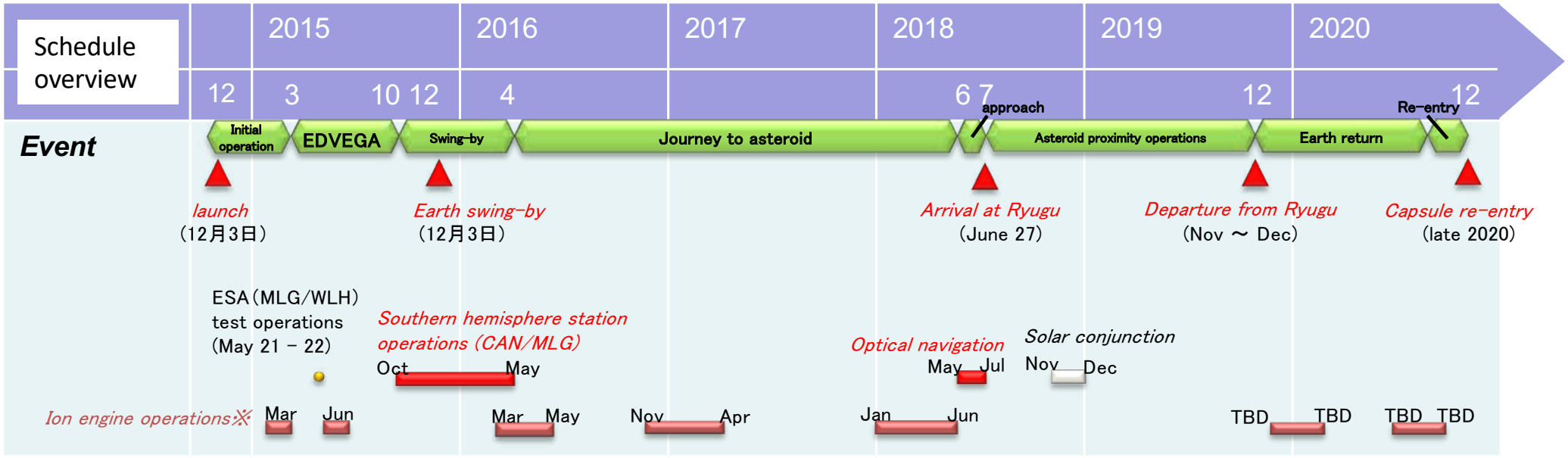
Sample analysis

(Illustrations: Akihiro Ikeshita)

1. Current project status & schedule overview

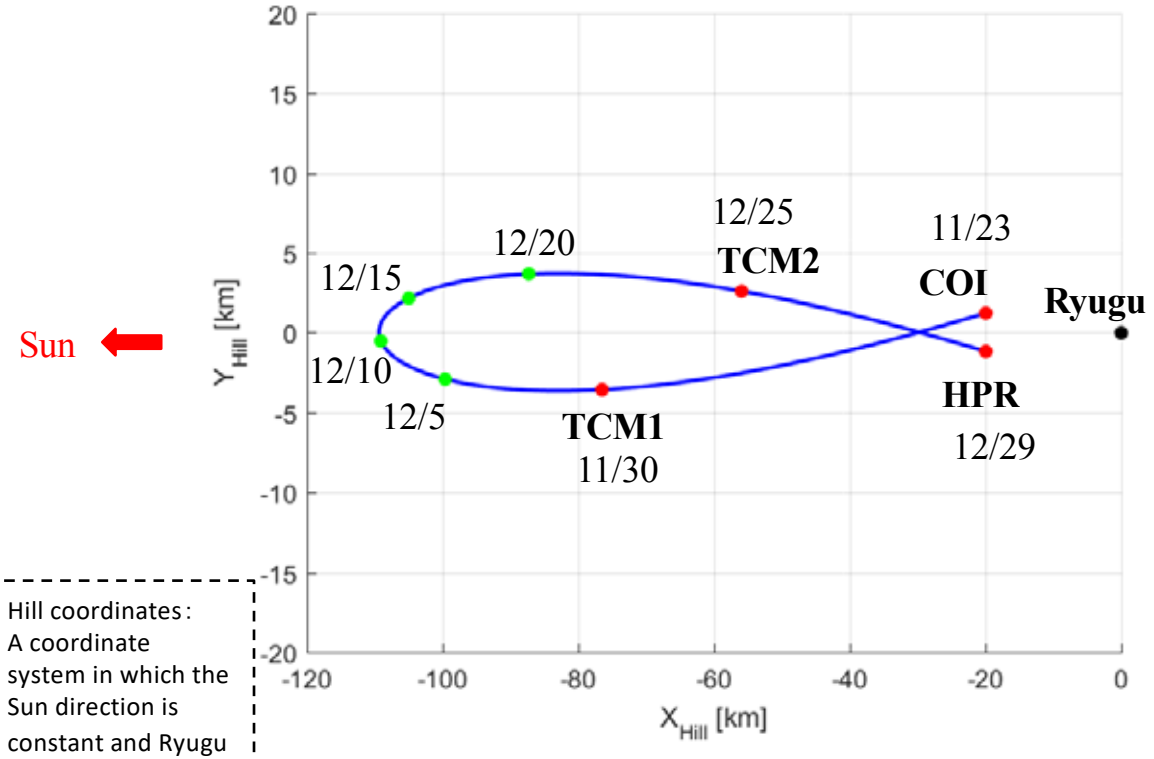
Current status:

- Solar conjunction ended on December 29, 2018 and operations for 2018 were completed on December 31.
- Operations for 2019 began on January 4.
- BOX-B operation is scheduled for January.



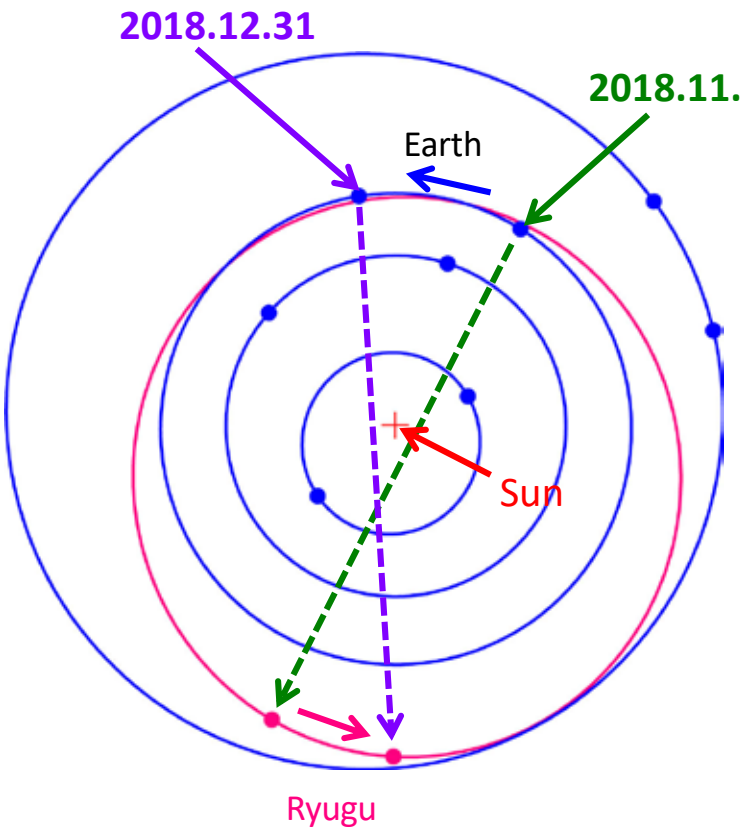
2. Results of the solar conjunction operation

- Solar conjunction：11/23～12/29
- Ran as scheduled.



Hill coordinates：
A coordinate system in which the Sun direction is constant and Ryugu is at the origin.

Position of the spacecraft in the Hill coordinate system



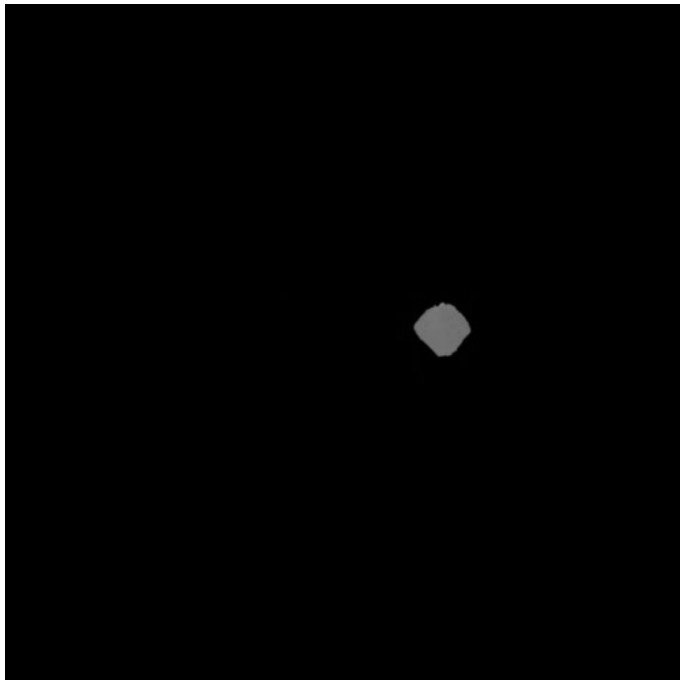
Relative position of the Earth and Ryugu
（image credit：JAXA）

2. Results of the solar conjunction operation

Solar conjunction orbit control operations:

Name	Date	Degree of orbit control
COI	2018/11/23	~14cm/s
TCM1	2018/11/30	~ 0.4cm/s
TCM2	2018/12/25	~ 1cm/s
HPR	2018/12/29	~ 14cm/s

COI : Conjunction Orbit Insertion
TCM : Trajectory Correction Manoeuvre
HPR : Home Position Recovery

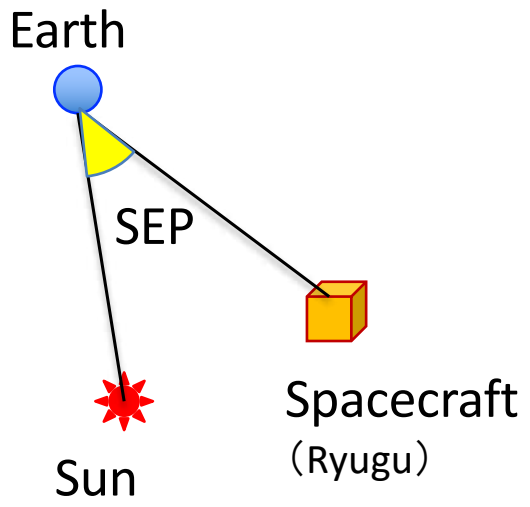


Ryugu imaged with the Optical Navigation Camera – Telescopic (ONC-T) on December 11 at around 21:00 JST. The distance to Ryugu was about 110 km. This data was transmitted to the spacecraft on December 21. (Image credit : JAXA)

2. Results of the solar conjunction operation

Beacon operation during solar conjunction

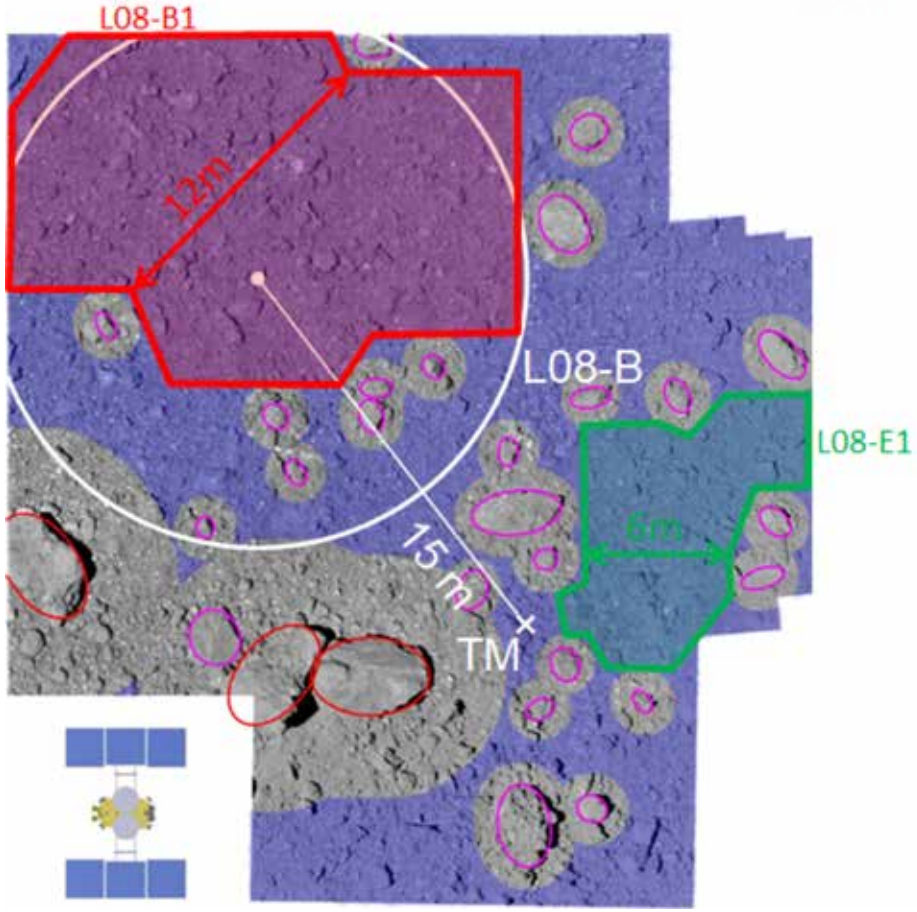
- When the spacecraft is located in the direction of the Sun as seen from Earth, communication with the spacecraft becomes difficult due to radio waves emitted by the Sun and its surrounding plasma.
- Information from the spacecraft can be transmitted by using radio wave signal strength to express either a “0” or “1” = Beacon operation.
- 1byte=8bit of information is repeatedly transmitted five times and the received radio fields superimposed. The transmission takes about 10 minutes.
- Beacon operation was performed between 2018/11/30～2018/12/21. However, we managed to receive some form of telemetry during most operations (from using the high gain antenna).
- At the smallest SEP angle on December 11, telemetry could not be received, but beacon operation was still established.



On 12/11, the SEP angle was about 0.5 degrees.

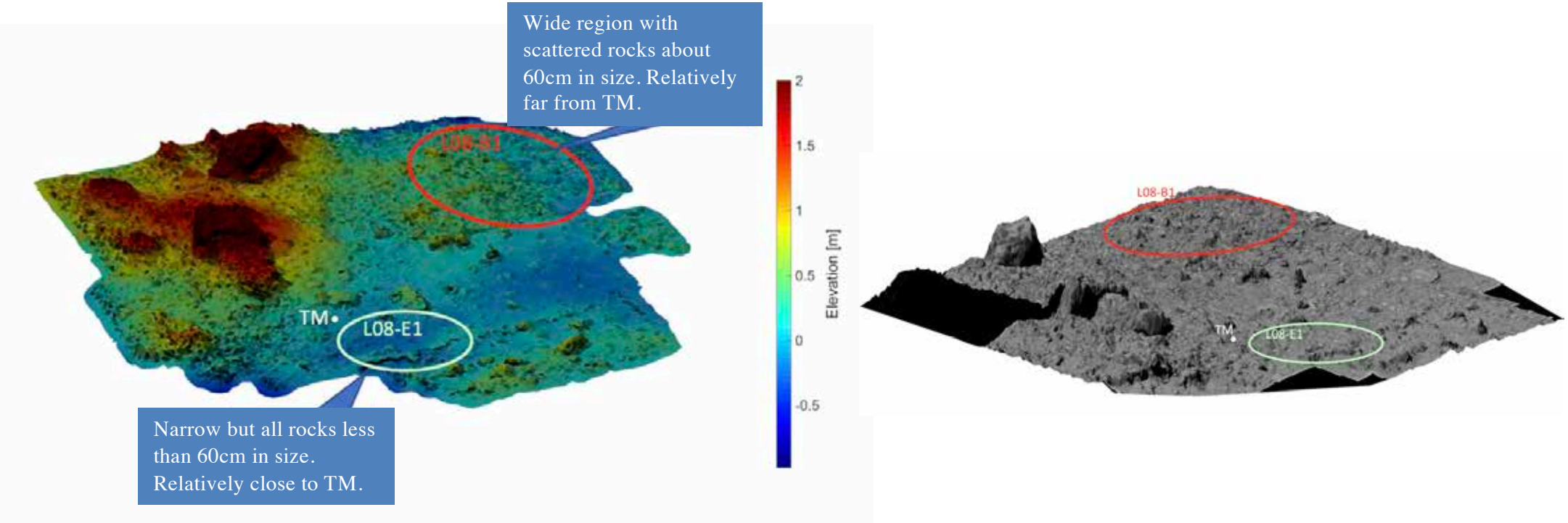
3. Status of the plan for touchdown

- The first touchdown (TD1) is planned for the week of February 18 (backup week is March 4).
- Another target marker will not be dropped. The target marker (TM-B) that has already landed will be used.
- Touchdown candidate sites currently under consideration are L08-B1 and L08-E1 (see right-hand figure).



TM-B position and touchdown candidate sites

3. Status of the plan for touchdown



The DEM (Digital Elevation Map) used to accurately estimate the rock shapes near the touchdown candidate site.

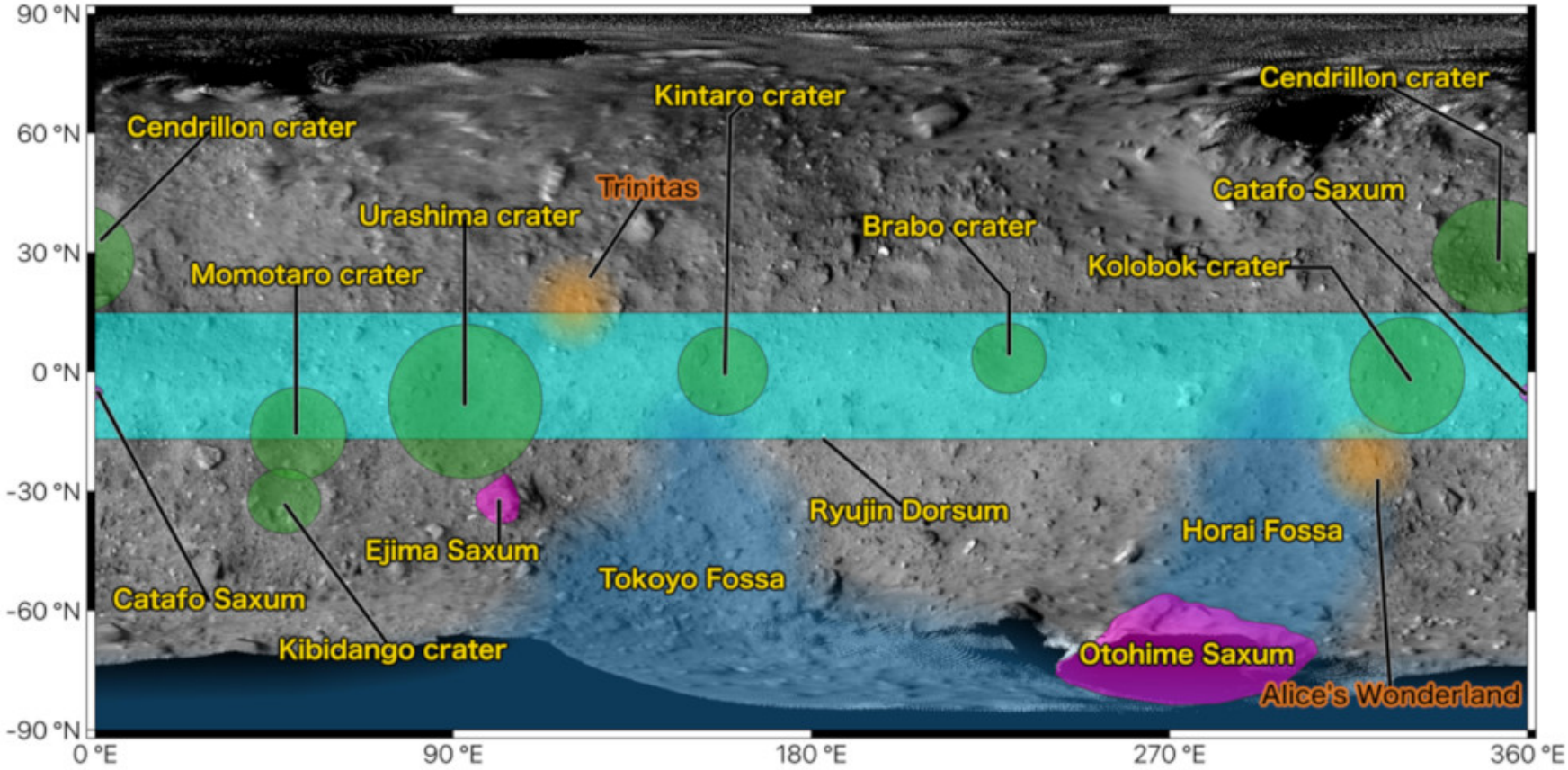
（Image credit：JAXA）

4. Place names on the surface of Ryugu

- Place names on the asteroid surface were discussed by the IAU (International Astronomical Union) Division F (Planetary Systems and Bioastronomy) Working Group for Planetary System Nomenclature (hereafter referred to as WG).
- We first proposed a theme of "children's stories" to the WG for place names on Ryugu. (June 28, 2018).
- This theme was accepted by the WG (September 25) and we applied to the WG to name 13 notable geographical features that have been picked up in science papers. (Application date: October 12).
- After an exchange with the WG, 9 names were accepted as proposed and 4 names were corrected and then accepted.
- 4 different features types were named:
  - Dorsum = peak or ridge
  - Crater = crater
  - Fossa = groove or rut
  - Saxum = boulder

4. Place names on the surface of Ryugu

Official names

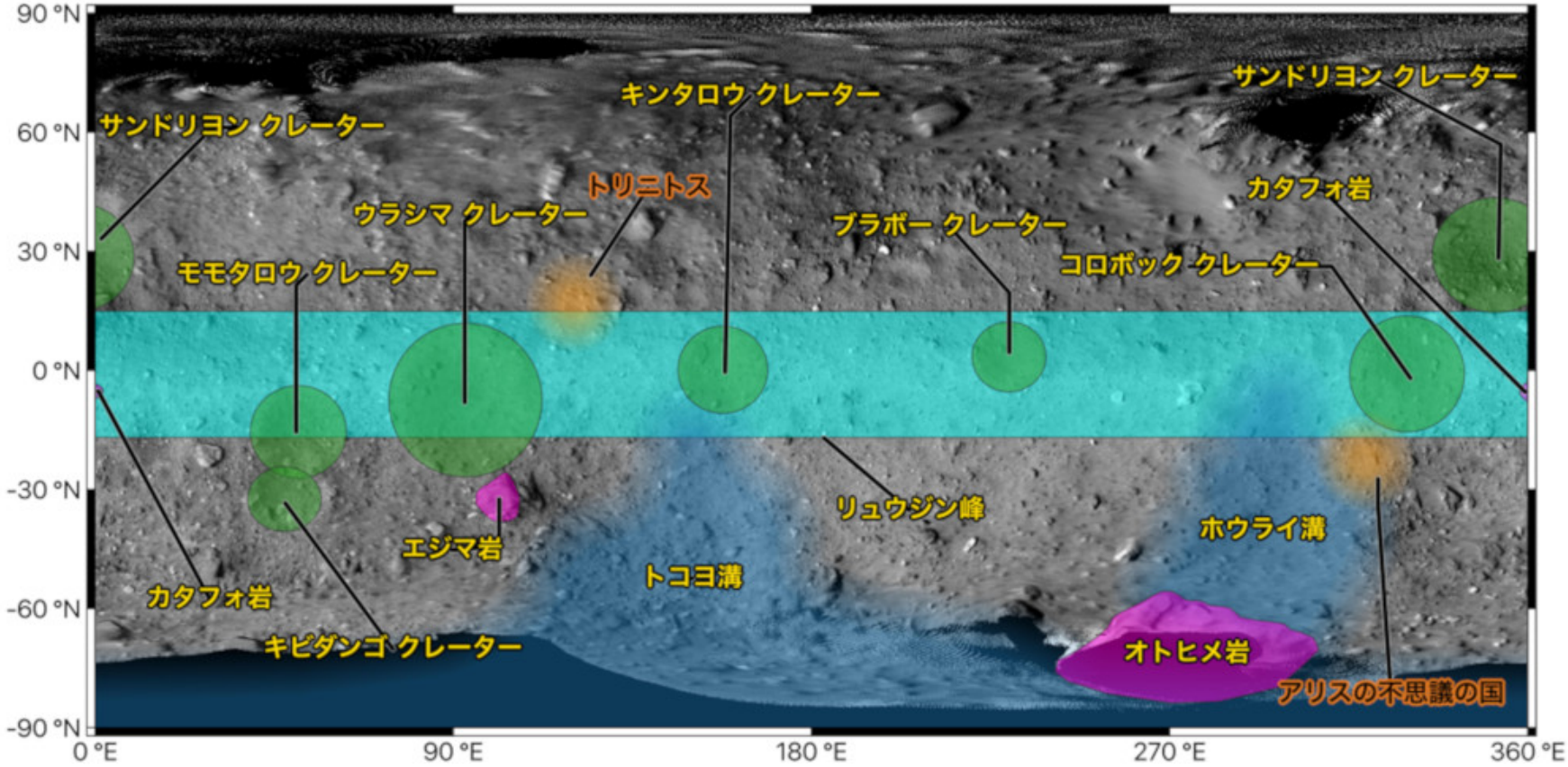


(Image credit: JAXA)

Note: Trinitas and Alice's Wonderland are nicknames of the MINERVA-II1 and MASCOT landing sites, respectively, and not place names recognised by the IAU.

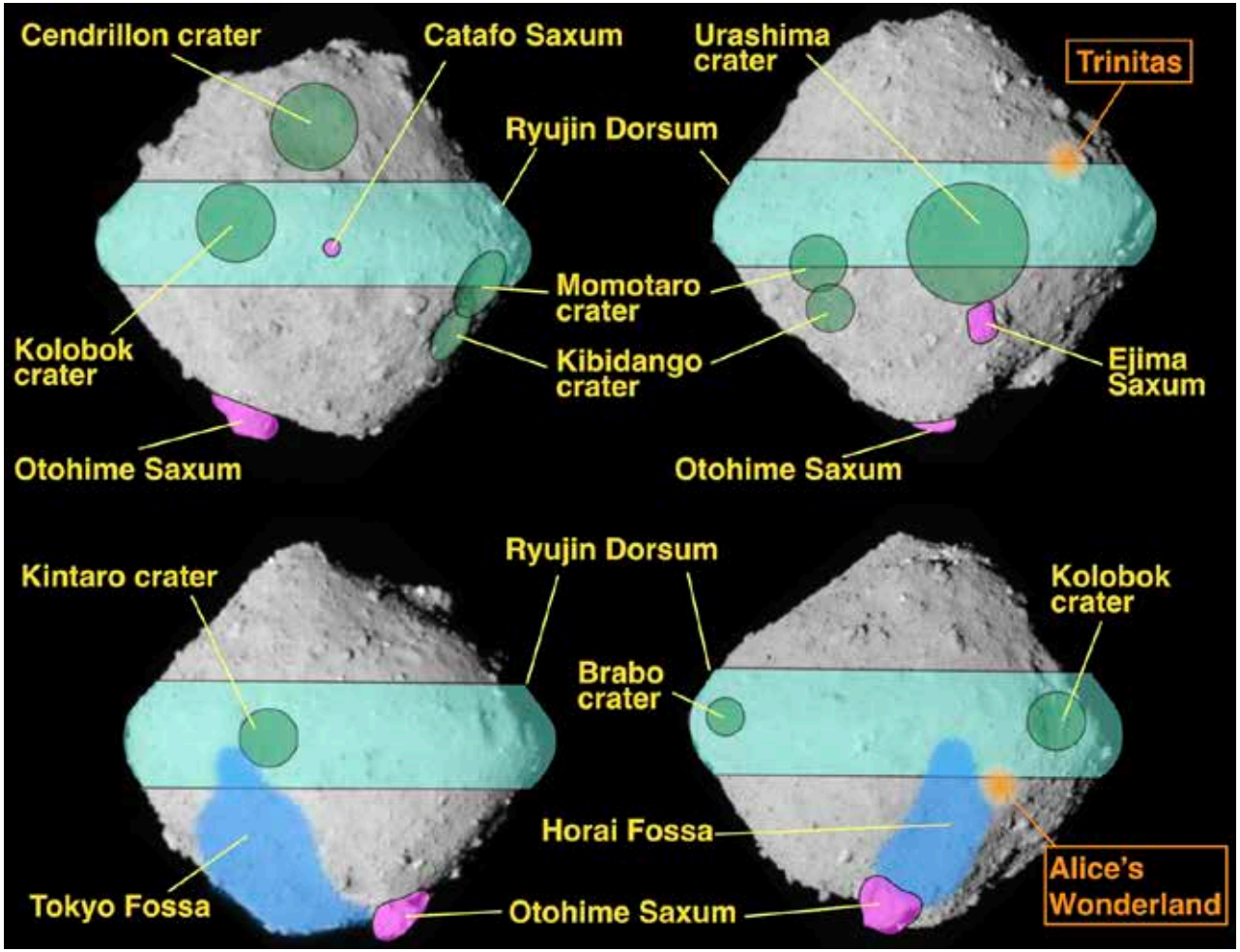
4. Place names on the surface of Ryugu

Official names in Japanese



（Image credit：JAXA）

4. Place names on the surface of Ryugu



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(image credit: JAXA)

4. Place names on the surface of Ryugu

Name	Type	Terrain description	Original story	Country	Origin of name
Ryujin	Dorsum	Equatorial ridge	Urashima Taro	Japan	Dragon god who is Princess Otohime's father
Urashima	Crater	Biggest crater on Ryugu	Urashima Taro	Japan	Fisherman who rescued the turtle
Cendrillon	Crater	One of the biggest craters outside the equatorial ridge	Cinderella	France	The French name for Cinderella ※1
Kolobok	Crater	Typical crater on the equatorial ridge	Kolobok	Russia	A small round bread that ran away from home ※2
Brabo	Crater	Typical crater on the equatorial ridge	Brabo and the giant	Netherlands	The brave young man who defeated a giant ※3
Kintarou	Crater	5th largest crater on Ryugu	Kintarou	Japan	The child with super strength who grew up on Mt Ashigara
Momotarou	Crater	4th largest crater on Ryugu	Momotarou	Japan	The boy born from a peach who fought against an ogre
Kibidango	Crater	6th largest crater on Ryugu	Momotarou	Japan	Food that Momotarou gave his friends
Tokoyo	Fossa	Ryugu's largest groove-shaped depression	Urashima Taro	Japan	Tokoyo, a faraway land across the sea, the land of eternal life
Horai	Fossa	Ryugu's 2nd largest groove-shaped depression	Urashima Taro	Japan	Horai, the utopia in the sea
Catafo	Saxum	Boulder that denotes the prime meridian on Ryugu	Cajun Folktales	America	Boy who cleverly marked a route to avoid losing his way. ※4
Otohime	Saxum	Ryugu's biggest boulder	Urashima Taro	Japan	The princess who lived in Ryugu castle and entertained Urashima and who gave him the treasure box (tamatebako).
Ejima	Saxum	One of the boulders that holds the key to Ryugu's formation history.	Urashima Taro	Japan	Where Urashima rescued the turtle and left for Ryugu Palace.

※1 "Cinderella" was proposed, but modified to the original French by the WG. ※2 "Peter Pan" was proposed but changed due to copyright issues. ※3 "Sleeping Beauty" was proposed but it was suggested that the character number was too long, so "Brabo" was proposed and accepted. ※4 "Oz" was proposed but this is used for Charon (moon of Pluto) so was changed by the WG.

4. Place names on the surface of Ryugu

Supplement on naming : boulders

Many boulders are distributed on the surface of Ryugu, including a huge boulder near the South Pole. The existence of boulders is important for characterising the surface layer of Ryugu and so we decided to name these features.

There was no precedent for the naming of boulders so no established name type. Therefore, we proposed a name type for the boulders along with with the place name application.

Since the type is normally given in Latin, we suggested Saxum (meaning “rocks and stones” in Latin) as a boulder type and this was adopted by the IAU.

Note : At the time of the Hayabusa mission, boulders on the surface of the asteroid Itokawa were not permitted to be named.

Asteroid Ryugu

(Image credit: JAXA / University of Tokyo / Koichi University / Rikkyo University / Nagoya University / Chiba Institute of Technology / Meiji University / University of Aizu / AIST)

4. Place names on the surface of Ryugu

Supplement on naming: Otohime

As Otohime is an important person in the story of Urashima Taro, we wanted to use the name as one of the places on Ryugu, whose name is from the dragon palace in the same story.

As there is already a place named “Otohime Tholus” on Venus, the proposed name was initially refused by the IAU. However, it was accepted after the team appealed on the grounds of the importance of the name of Otohime in the Urashima Taro tale.

(Image source: p. 8 Princess Otohime imparts Urashima Tarō with a tamatebako, in 教育昔話. 浦島太郎,Heikichi Matsuki (松木平吉) (1899) from Wikipedia Commons https://commons.wikimedia.org/wiki/File:Matsuki_Heikichi(1899)-Urashima-p08.jpg)

5. Other

“Imagining Ryugu” space art contest winning entries

- The winning entries announced on December 27 on the Hayabusa2 Project website.

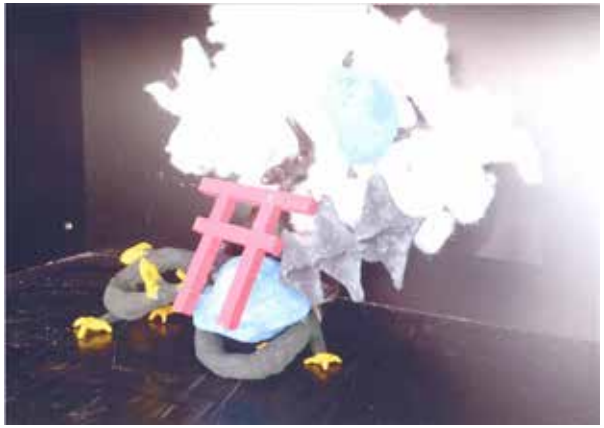
“Ryugu Look Alike” Grand Prize

永田龍己/ 6th grade elementary school student [Akashi Municipal Planetarium]

“Most Fun” Grand Prize

宮崎七乙/ Lower grade elementary school student, Osaka Prefecture [Japan Young Astronauts Club]

“Most Imaginative” Grand Prize



渡部吏子/ 3rd grade high school student / Fukushima Prefecture [Sekizaki Kaisei Museum, Oita]

※ There were a further 15 winning entry announcements for different categories and age, 6 from overseas and 6 for the best effort.
http://www.hayabusa2.jaxa.jp/topics/20181227_Contest/

（Image credit: each creator）

6. Future Plans

■ Scheduled operations

- Future operations: Main focus is the BOX-B operation during January
- Touchdown : Week of February 18 (backup week of March 4)

■ Press briefings

- February 6 (Wednesday) 15 : 00 Press briefing @ Ochanomizu