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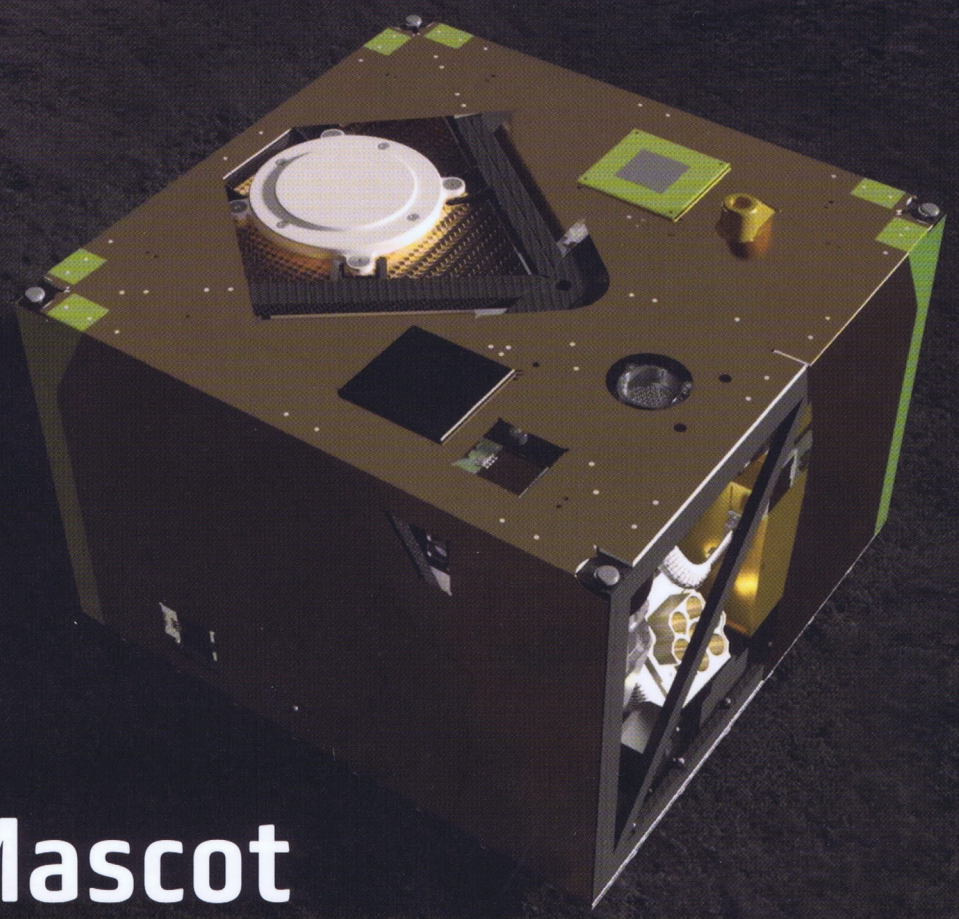
CENTRE NATIONAL D'ÉTUDES SPATIALES

JAXA
Japan Aerospace Exploration Agency

DLR



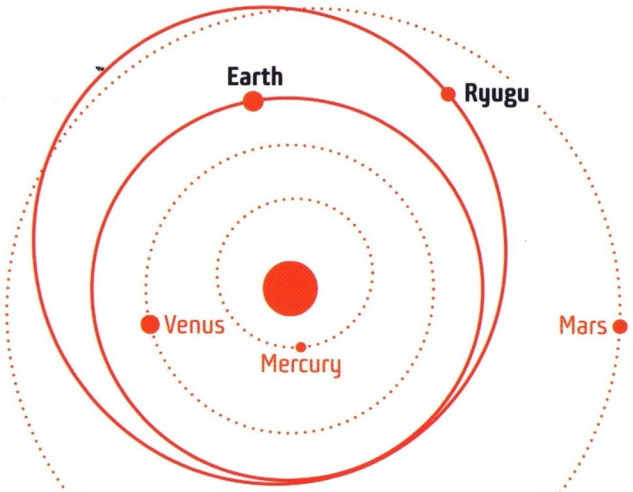
Mascot

Mobile Asteroid Surface Scout

HAYABUSA2

HAYABUSA means *peregrine falcon* in Japanese.

Japan's Hayabusa2 probe, developed by the Japan Aerospace Exploration Agency (JAXA), was launched on 3 December 2014 and reached its destination—the Ryugu asteroid—in June 2018. From its orbit around this near-Earth object spanning 900 metres, the probe should jettison three robots on Ryugu's surface in autumn 2018: two Japanese Minerva mini-rovers, and the French-German MASCOT lander. Hayabusa2 will carry out various observations and analyses remotely, and samples will be collected before the mission's return to Earth in late 2020.



ENCOUNTERING AN ASTEROID

The mission's scientific objective is to learn more about the primitive state of our solar system, understand its origins and evolution, and get a closer look at the early materials that may have contributed to the emergence of life on Earth.

The 'small bodies' of our solar system, such as comets or primitive asteroids, have changed very little since their initial formation. This is almost certainly the case for the Ryugu asteroid.

By mid-2019, the Hayabusa 2 probe will launch an impactor towards Ryugu at a speed of 2 km/s, producing an artificial crater. It will then descend closer to the crater and use its sampling horn to collect subsurface material. The samples will then be brought back to Earth.

3 GOALS

1 ASCERTAIN Ryugu's composition remotely, from the Hayabusa2 probe

2 ASCERTAIN the asteroid's composition in situ, using instruments on the MASCOT lander

3 COLLECT samples to be returned to Earth (for mineralogical analysis)

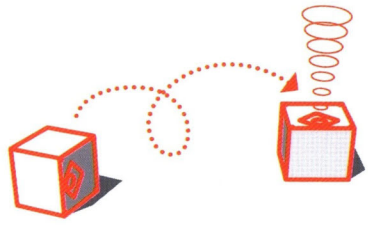
MASCOT, THE SCOUT !

MASCOT is due to land on the Ryugu asteroid in October 2018. This miniature 10 kg laboratory will separate from its mothership, Hayabusa2, some 60 m above the surface.
Like the Rosetta mission's Philae lander, MASCOT has been developed jointly by the German space agency, DLR, and CNES.

HOW WILL IT WORK?

MASCOT will take 10 minutes to float down to Ryugu's surface due to microgravity (100,000 times weaker than on Earth). It will then bounce on the asteroid's surface.

MASCOT's mobility mechanism enables the lander to right itself in order to carry out analyses and even hop to two more sites, a few metres apart.

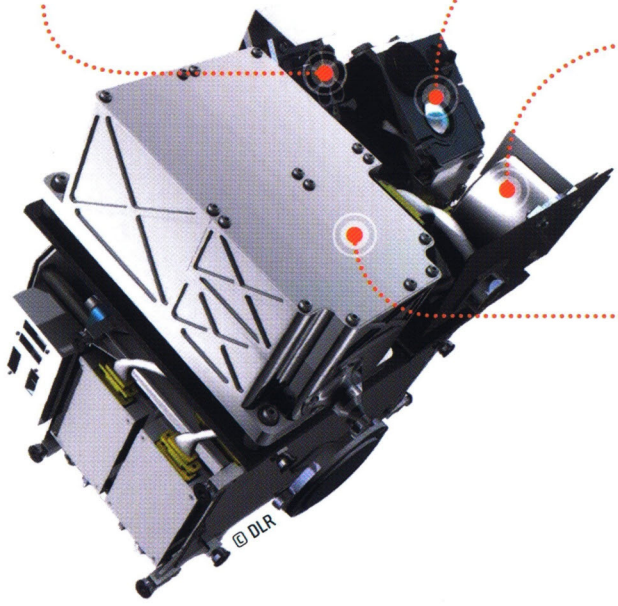


The aptly-named MASCOT will scout out this barely-known asteroid located more than 300 million kilometers away from Earth. Its lifetime is restricted by its battery, which is its only source of energy. Its mission will last 12 to 15 hours, during which time it must transmit all the data collected to Hayabusa2 using antennas designed by CNES.

4 SCIENTIFIC INSTRUMENTS

MARA

A radiometer for determining the asteroid's surface temperature and thermal inertia, developed by the DLR (Berlin).



CAM

A multispectral wide-angle camera for taking geological images of each site visited, developed by the DLR (Berlin).

MAG

A magnetometer developed by the Technical University of Braunschweig (Germany), for measuring the asteroid's magnetic field.

MICROMEGA

(main instrument)

A hyperspectral infrared microscope for in situ mineralogical analysis of the surface, developed by the IAS space astrophysics institute in Orsay, France, and overseen by CNES.

TARGET 'MA-9'

Three sites were chosen in August 2018 for the Hayabusa2 mission: one for the probe to collect surface soil samples, one for the Minerva mini-rovers and the final one for MASCOT's landing and analysis.

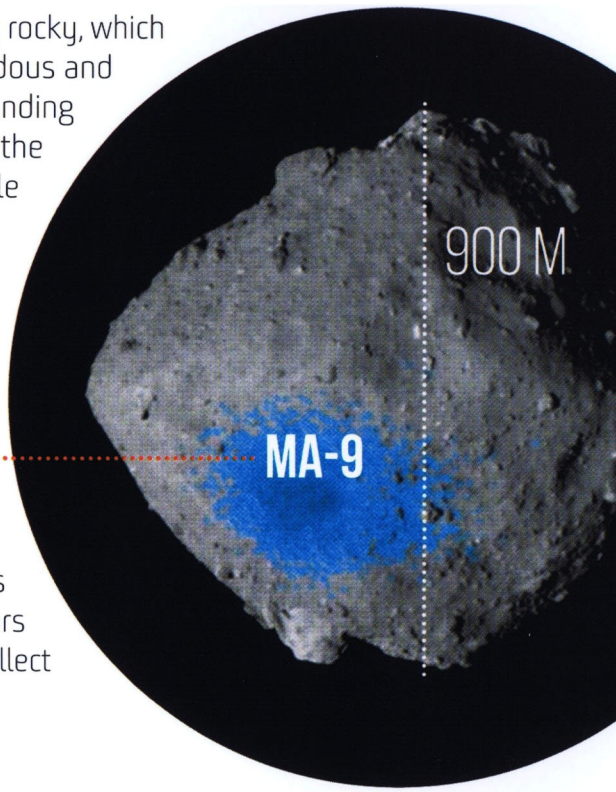
RYUGU
is the dragon god of the sea in Japanese mythology

A LANDER WITHOUT LEGS

Ryugu is not a very hospitable asteroid. It is very rocky, which makes any contact with its surface both hazardous and risky. The MA-9 site chosen for MASCOT's landing takes into account these difficulties, as well as the lander's possible bounces and movements, while still meeting the intended scientific objectives.

MA-9 is in the asteroid's southern hemisphere and fulfils the technical criteria required for the lander to operate as intended, including a suitable thermal environment, illumination conditions and radiofrequency link with the Hayabusa2 probe.

The Japanese Minerva rovers will land on Ryugu fifteen days before MASCOT. These solar-powered 'demonstrators' will be able to take small hops over the asteroid's surface so that their sensors (cameras, thermometer and accelerometer) can collect precious data.



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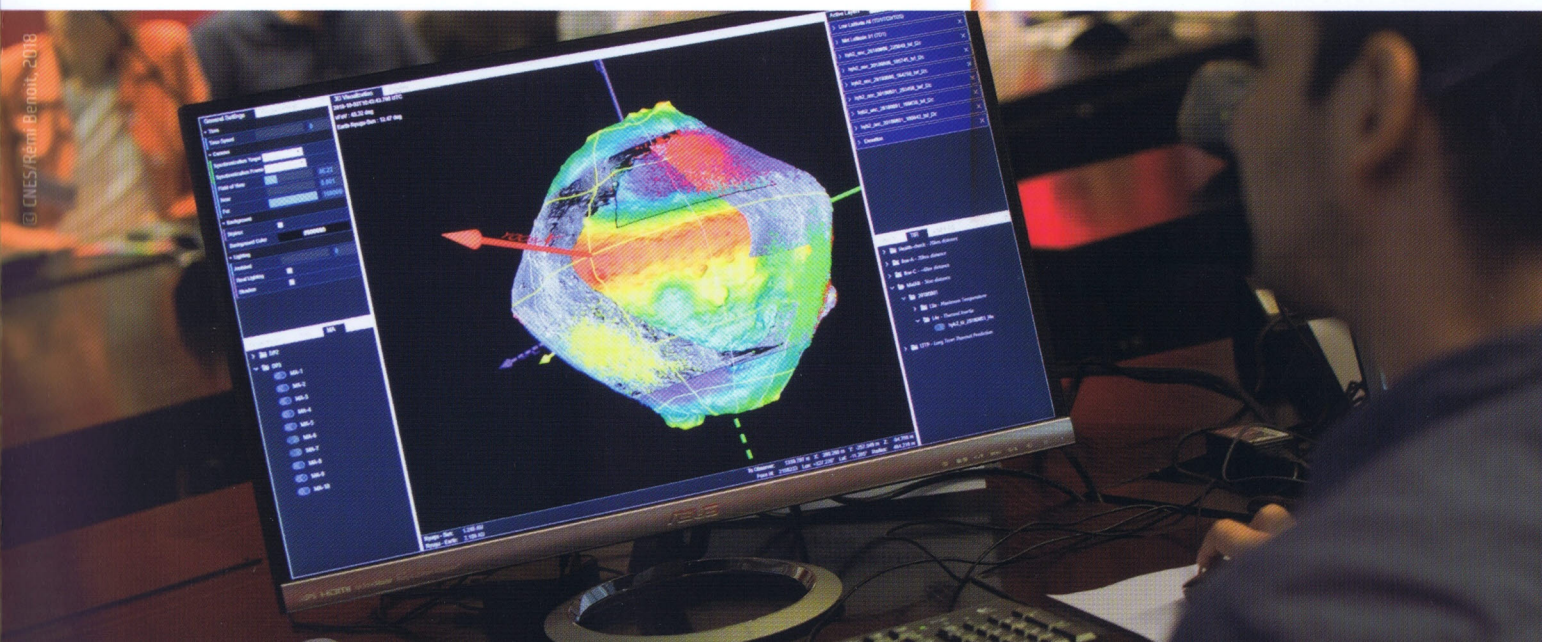
CNES teams used their unique and world-renowned expertise in spaceflight dynamics to shortlist several possible sites, as previously demonstrated in their choice of Philae's landing site on Churyumov-Gerasimenko during the 2014 Rosetta mission.



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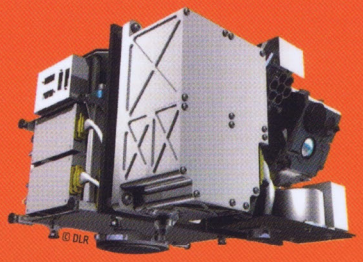
WHAT IS A C-TYPE OR CARBONACEOUS NEAR-EARTH ASTEROID?

It is an asteroid whose orbit around the Sun crosses the Earth's orbit.
Approximately 75% of asteroids are of this type.
They are very dark, similar to carbonaceous chondritic meteorites. Their chemical composition is close to that of the early solar system minus the light, volatile elements such as ice.

MASCOT VS PHILAE



MASCOT was launched just one month after Philae landed on comet Churyumov-Gerasimenko as part of ESA's Rosetta mission. It benefits from the legacy of both Philae and the Hayabusa1 mission to explore the Itokawa asteroid.

MASCOT

4
INSTRUMENTS
Philae 10 instruments

12/15 H
OF OPERATION
Philae 60 hours

10
KG
Philae 100 kg

30
CM^3
Philae 1 m^3

15
CM/S
LANDING SPEED
Philae 40 cm/s

350
MILLION
KM
EARTH-ASTEROID
DISTANCE
AT LANDING
Philae 510 million km

THE ROLE OF CNES AND ITS PARTNERS

CNES

CNES provided the following subsystems:
· **the main battery** and the power distribution subsystem that supplies MASCOT's power,
· **the antennas**,
· **the MicrOmega instrument**.

It is also responsible for:
· **mission analysis** during MASCOT's landing (release, descent and landing),
· the link budget between the lander and probe, including the performance of the **antennas** and the **communication unit** provided by JAXA.
In addition, CNES supported the DLR when integrating its contributions on board MASCOT. It is also involved in the preparation and execution of all French subsystem activities. CNES's support during the asteroid mission includes strong involvement in **selecting the landing site**.

IAS

The **IAS space astrophysics institute (Orsay)** developed the main instrument with CNES's support. MicrOmega is a hyperspectral microscope in the visible and near infrared range, and the only instrument on MASCOT capable of analysing the composition of Ryugu's surface.

DLR

The **DLR (German space agency)** has overseen development of the MASCOT lander. It is responsible for MASCOT's engineering and integration, the designation and preparation of its tasks, MASCOT's mobility on the asteroid's surface, and the development of secondary payloads (the CAM multispectral camera, the MARA radiometer and the MAG magnetometer). It has also developed technological subsystems.

UTB

The **Technical University of Braunschweig (Germany)** developed the MAG magnetometer.

JAXA

JAXA, the Japanese space agency, is responsible for the Hayabusa2 mission as a whole. It will closely monitor the return of samples.

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