What we learnt from Hayabusa mission

Tadashi Mukai

Kobe University, Japan

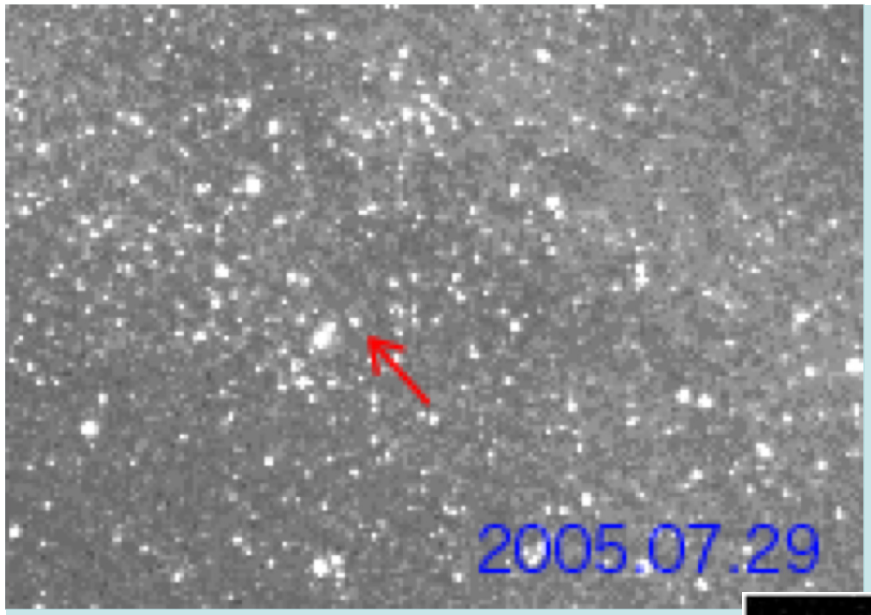
with S.Abe and N.Hirata

Kobe Planetary School '06, Dec.4-6

Dec.6, 13:30-14:20

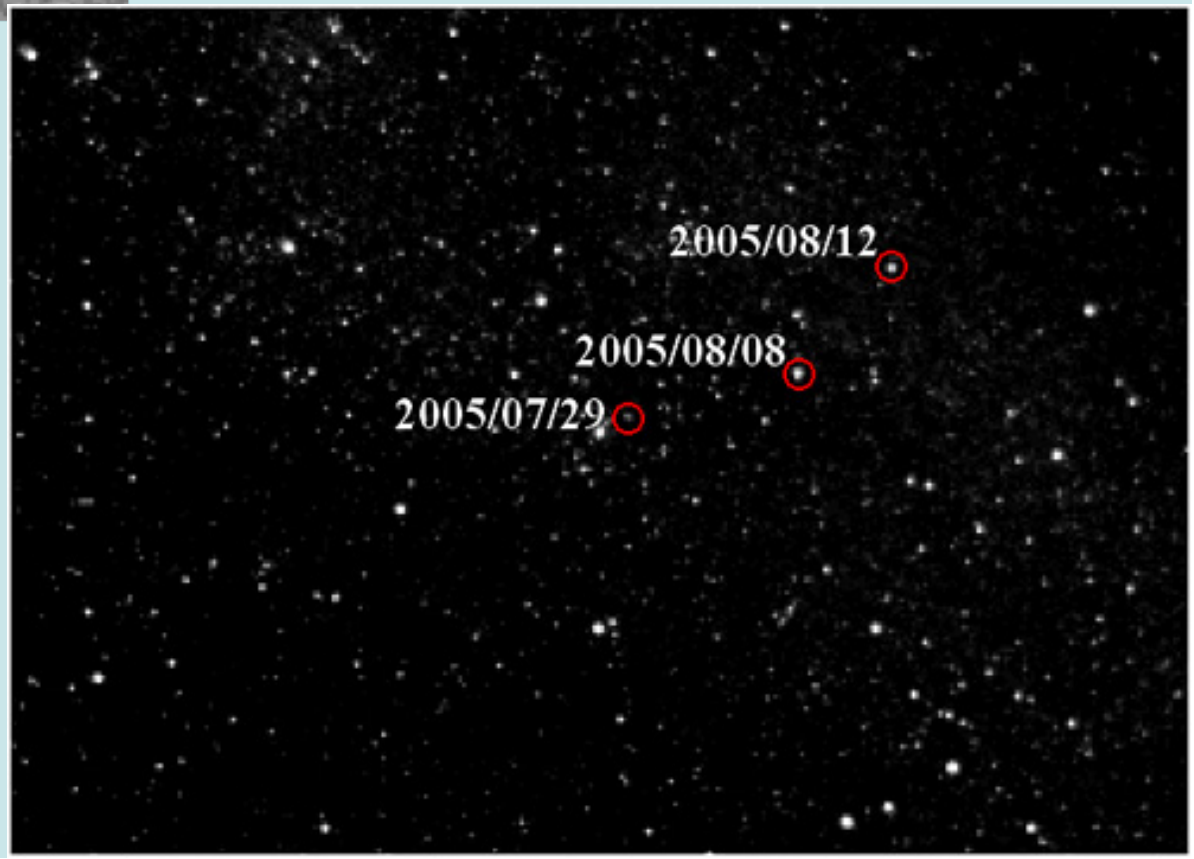
What we have learnt on

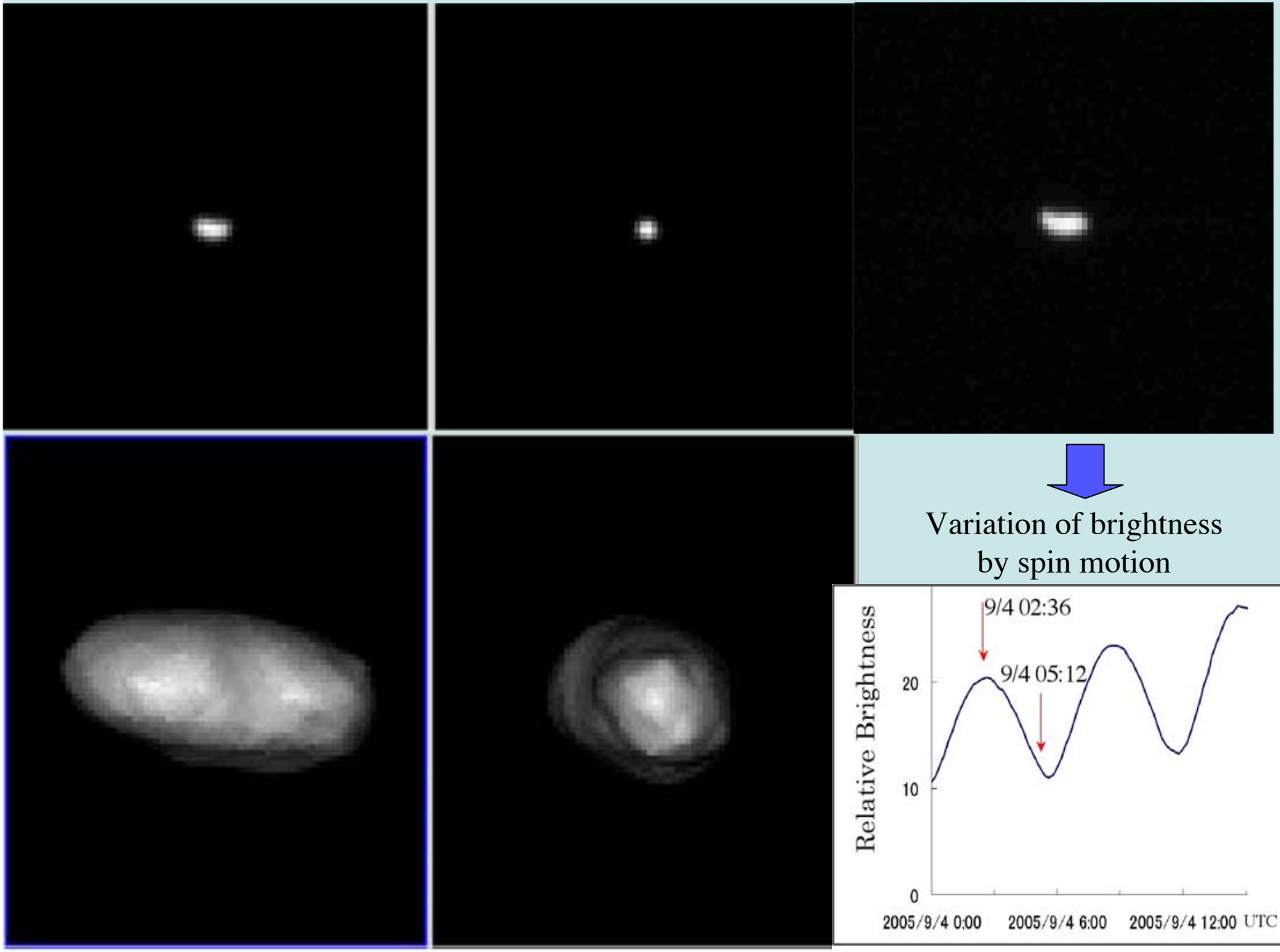
size, shape and surface structures.

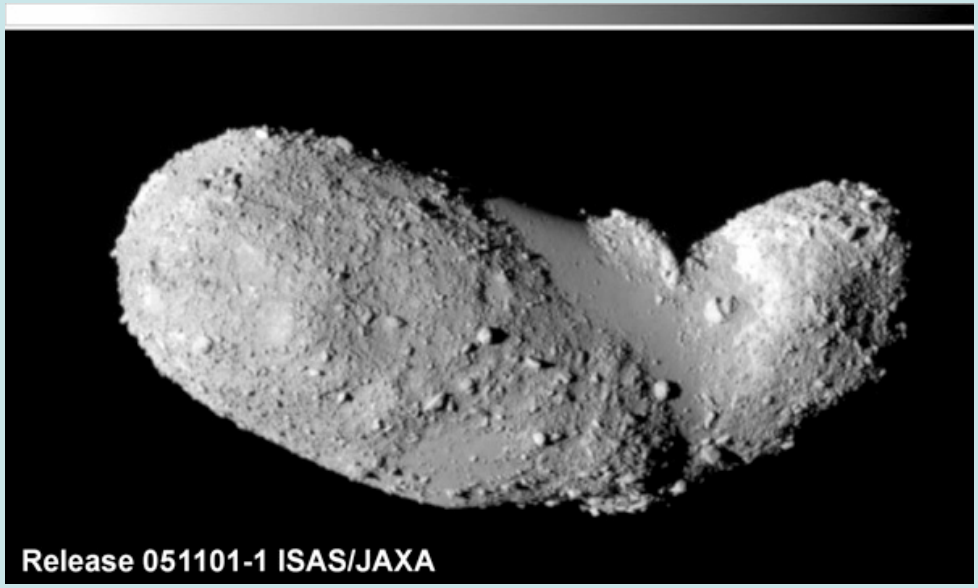


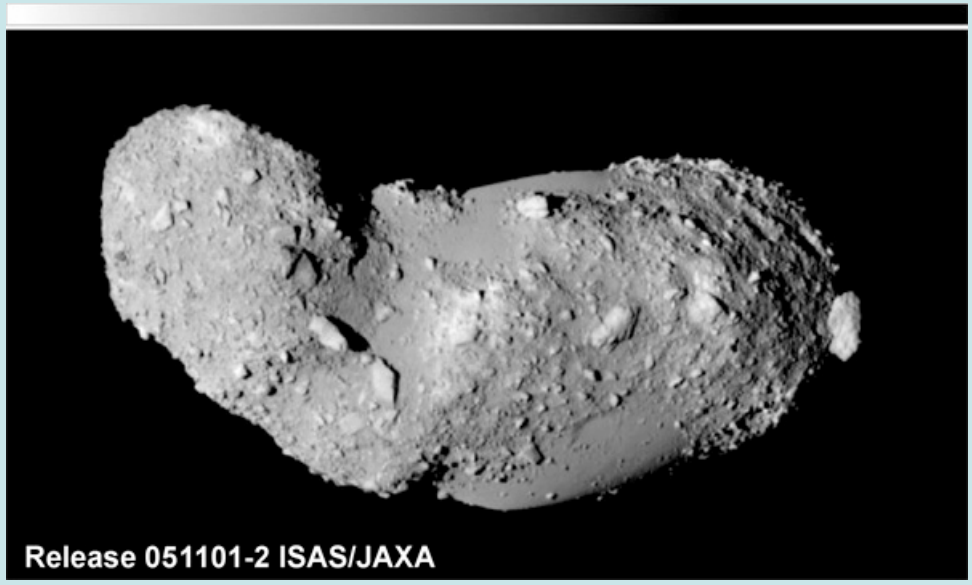
Approach phase

July to August, 2005




Variation of brightness
by spin motion
9/4 02:36
9/4 05:12
Relative Brightness
20
10
0
2005/9/4 0:00
2005/9/4 6:00
2005/9/4 12:00 UTC





Arrival at Itokawa on 2005.9.12

20km (Gate Position)

Size

535x294x209m

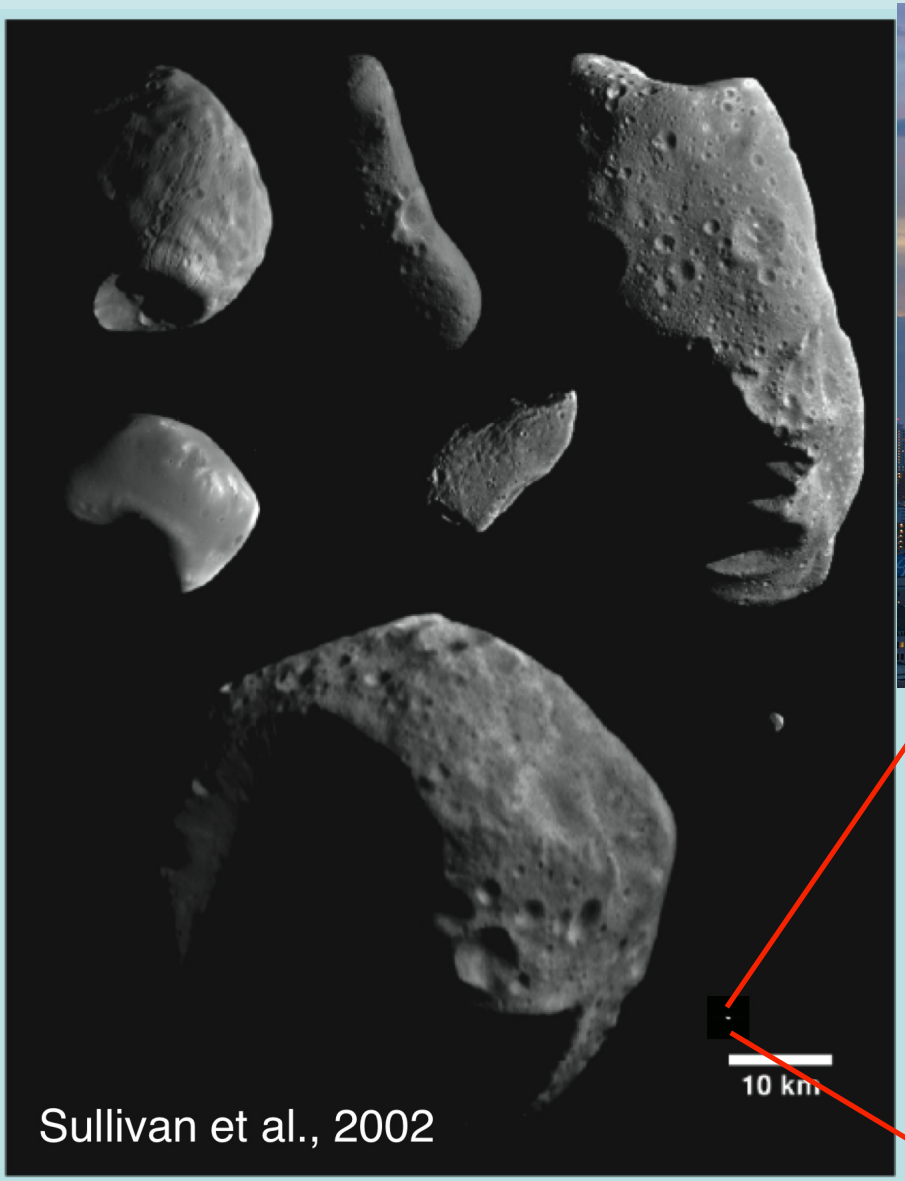
(～ 0.5 km)

Spin motion

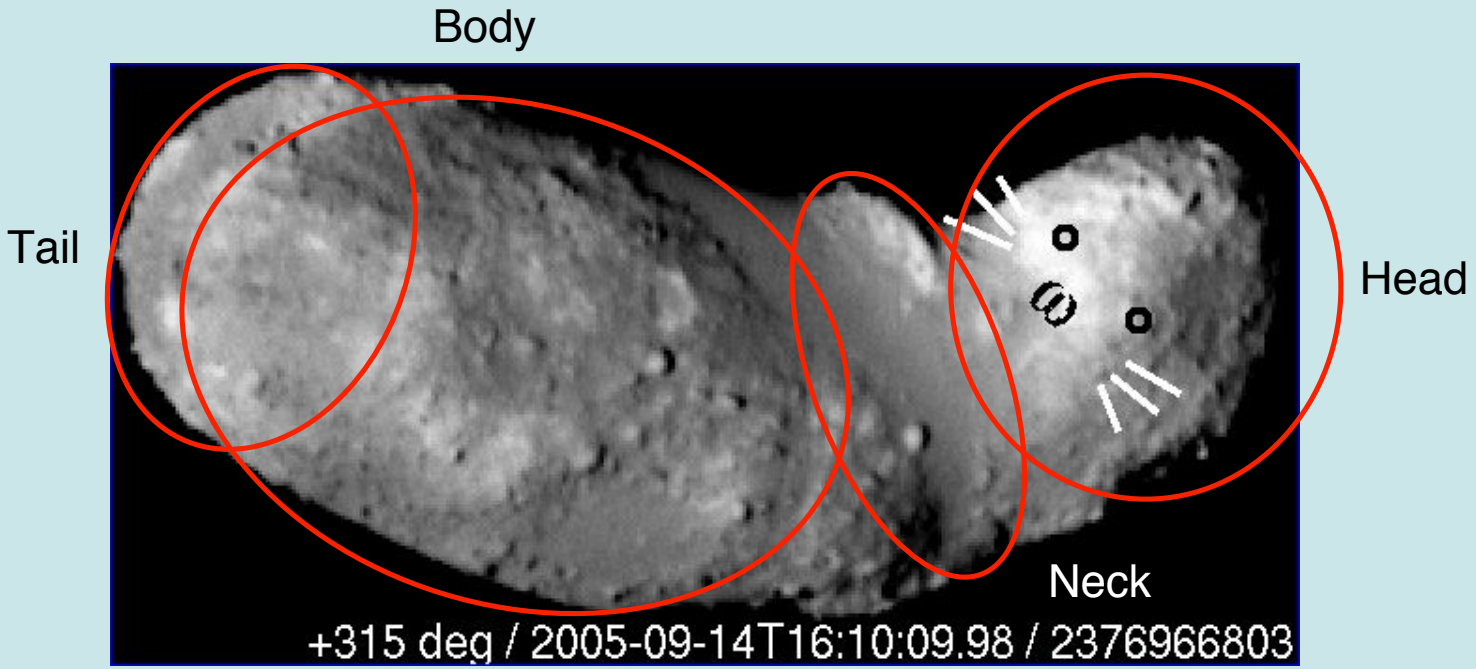
period =12hrs

retrograde

Itokawa is tiny asteroid!!



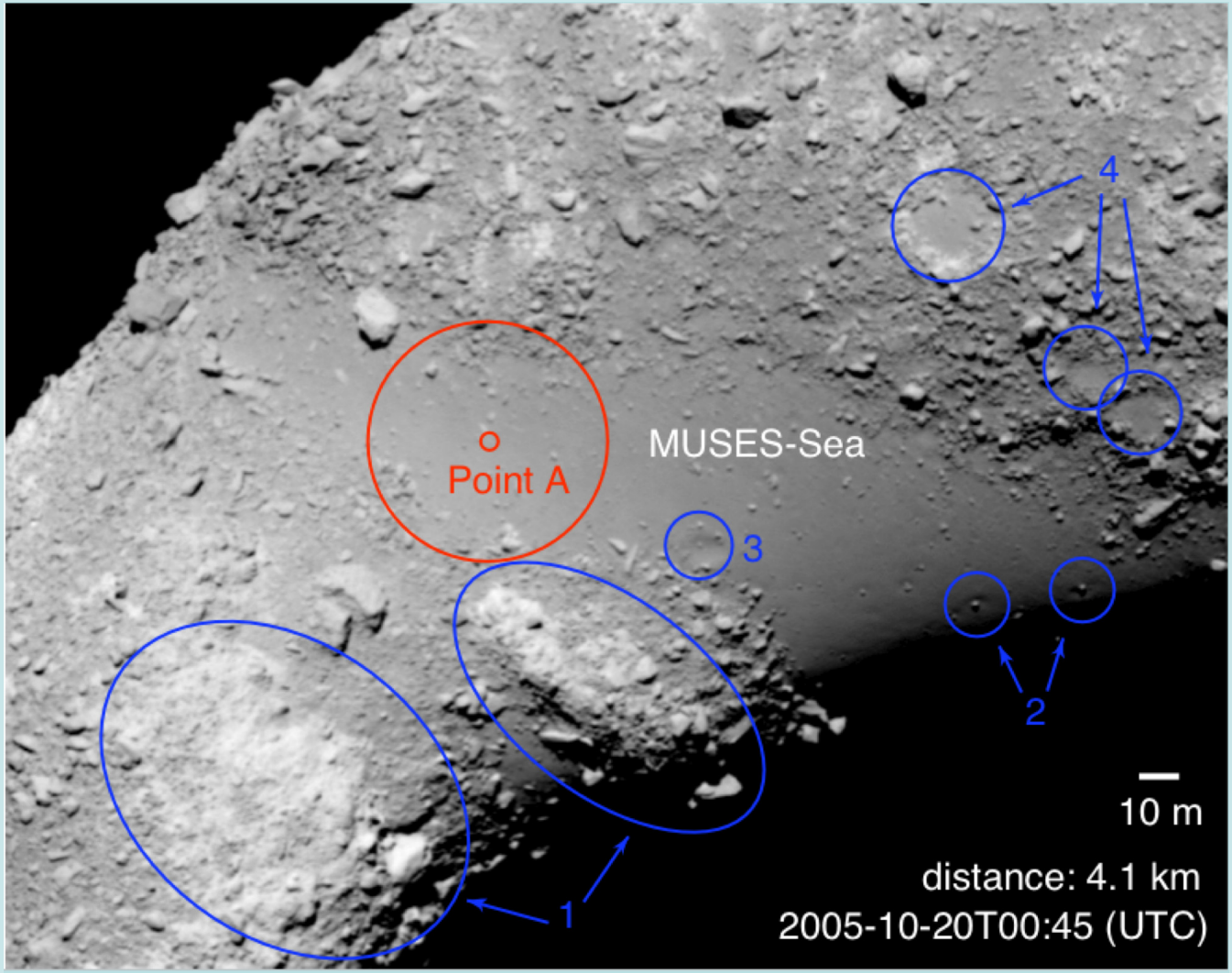
Shape ⇒ Sea Otter



Itokawa may consist of two-components, i.e. head and body.

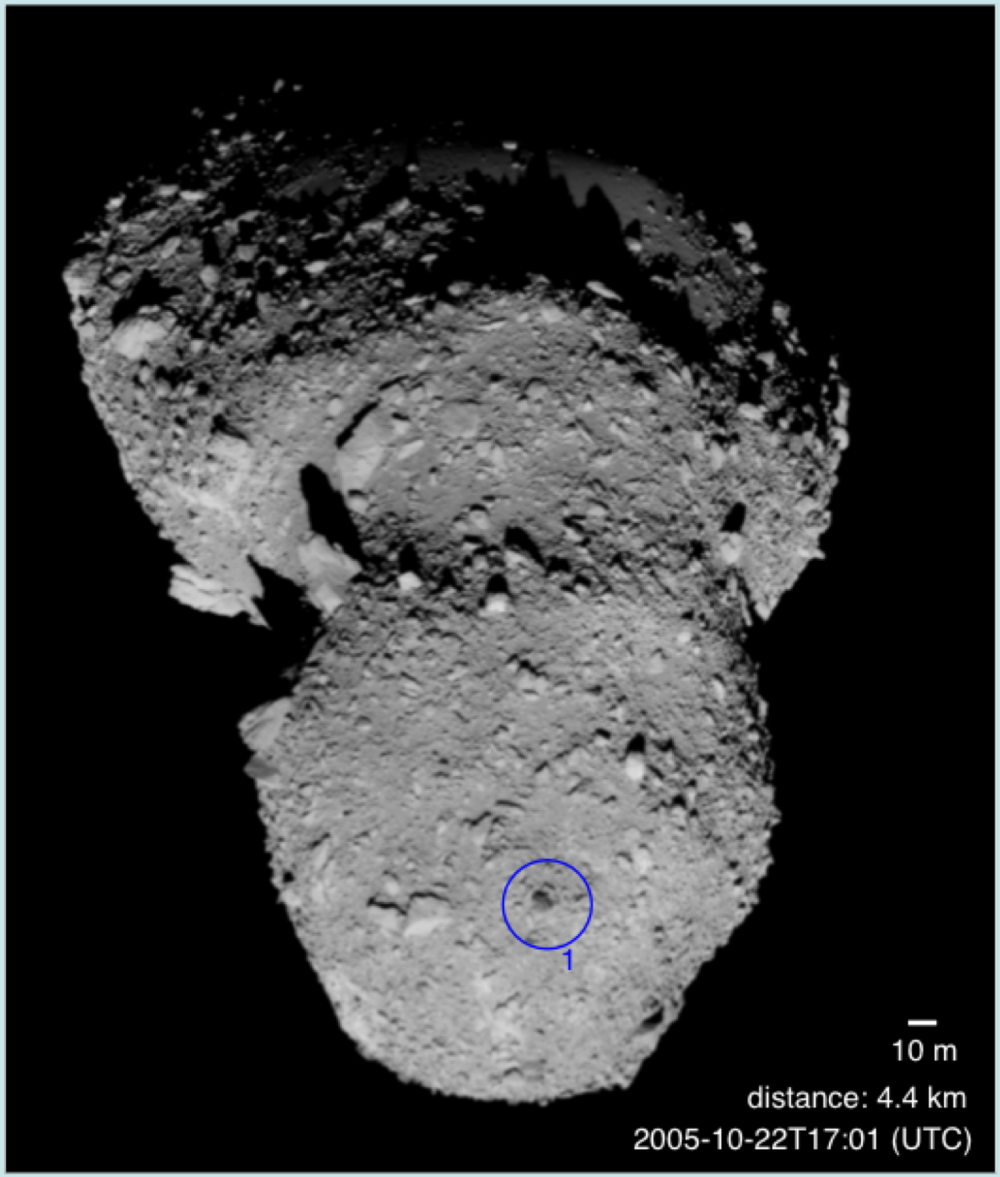
Surface structure; large rough area with many boulders(a few m<) and narrow smooth area.

Point A: candidate for sampling site

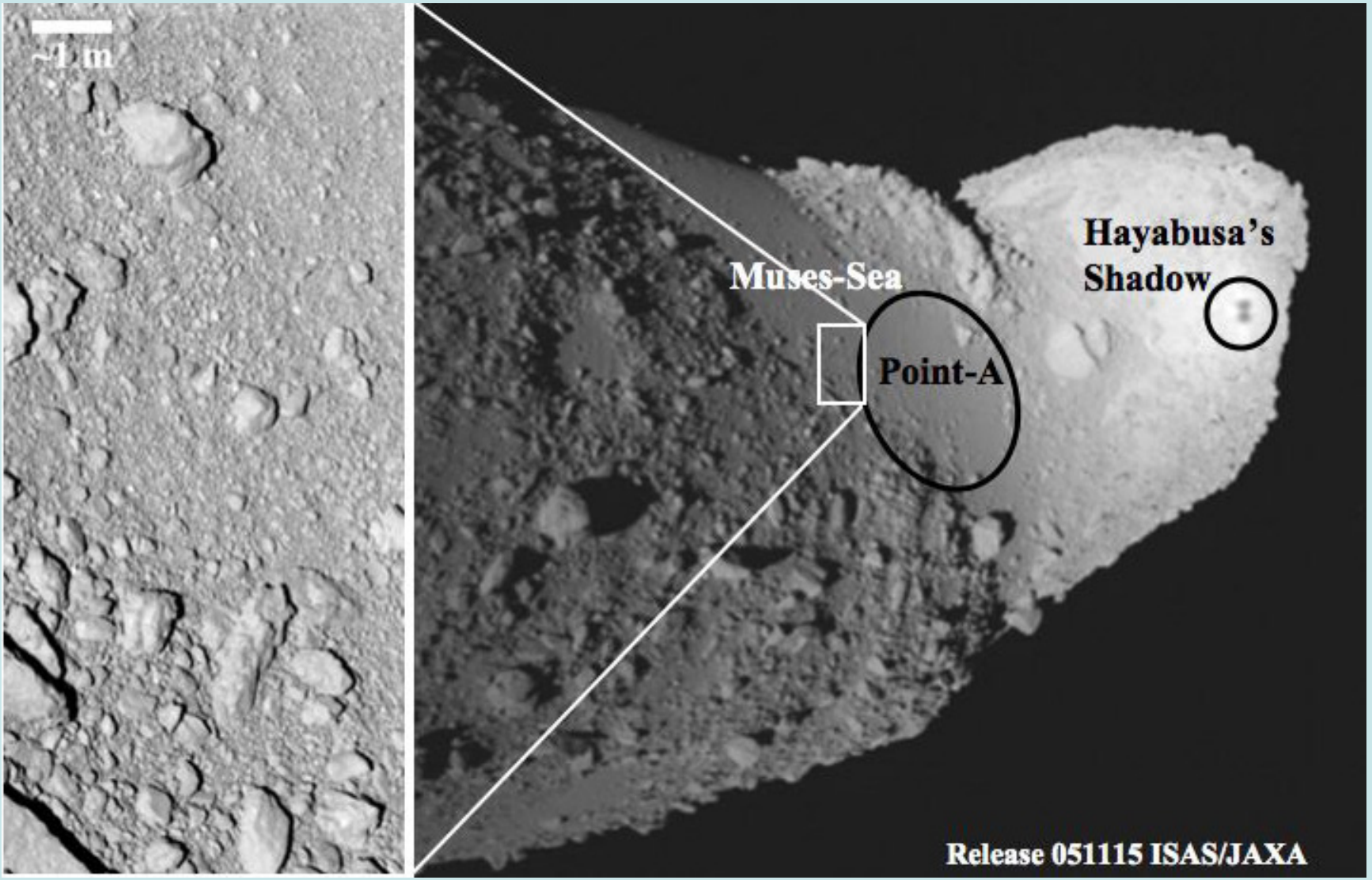


Meridian of longitude 0° on Itokawa （peculiar black boulder）

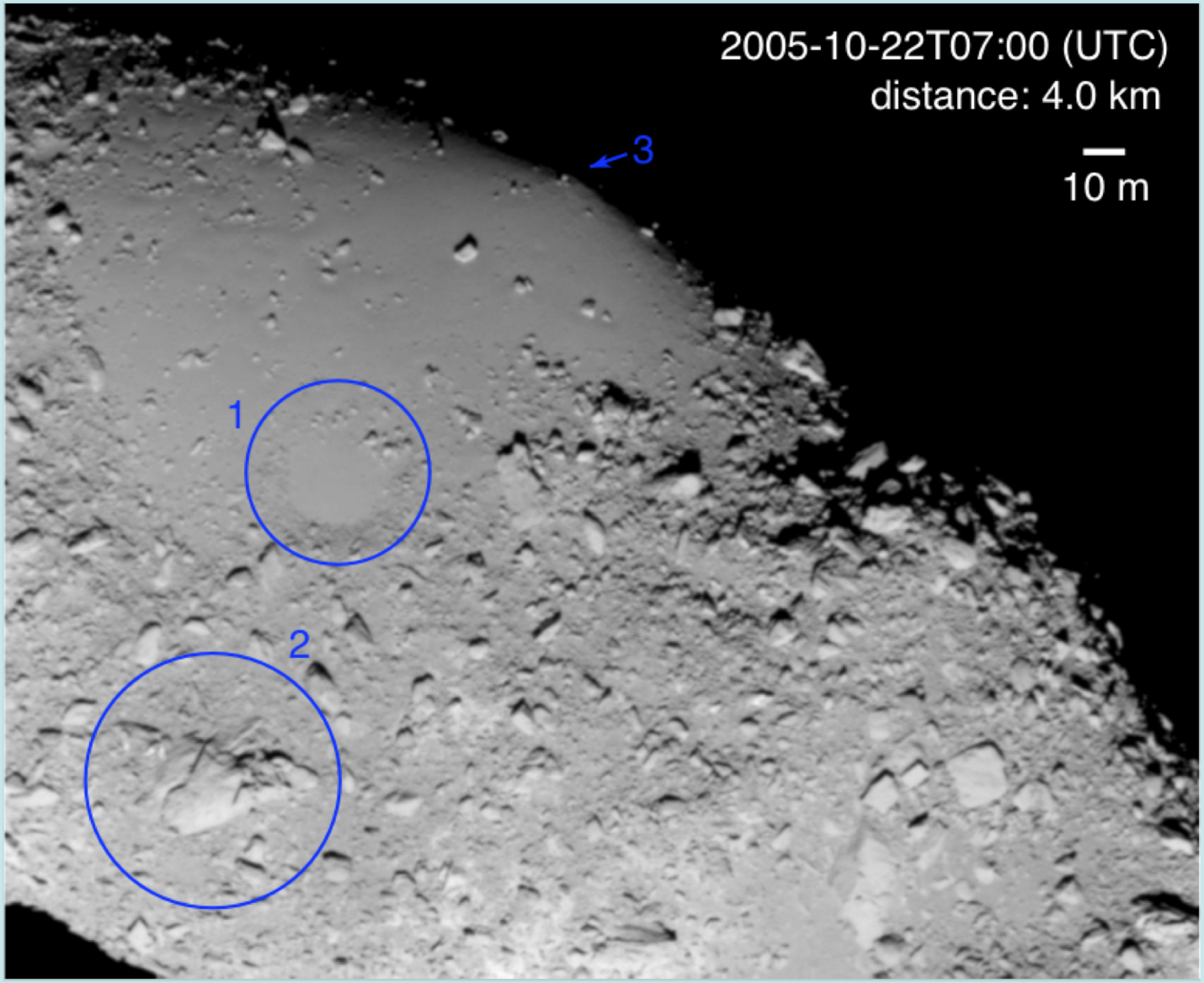
（Greenwich on the Earth）



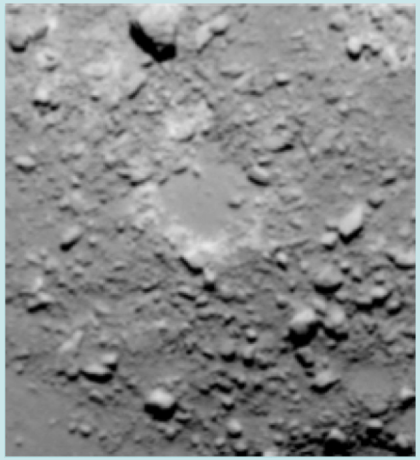
Boundary area between flat region (Muses-Sea) and rough region

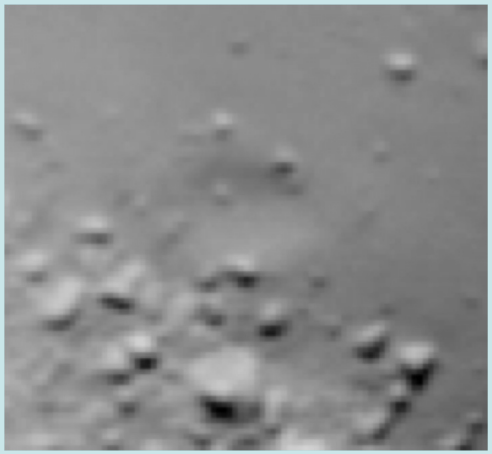


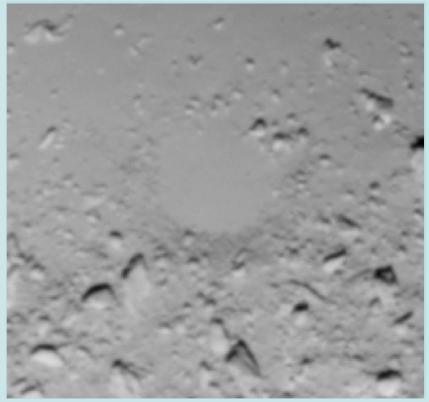
Hidden crater (1) and broken boulder (2)

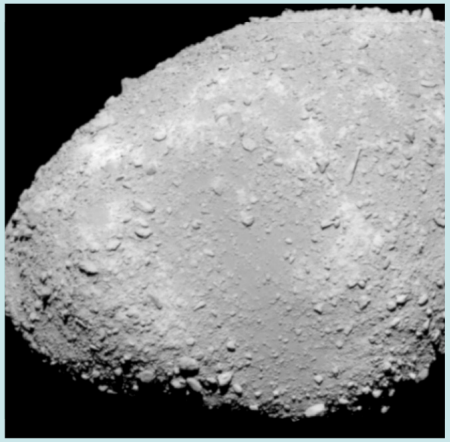


Craters on Itokawa





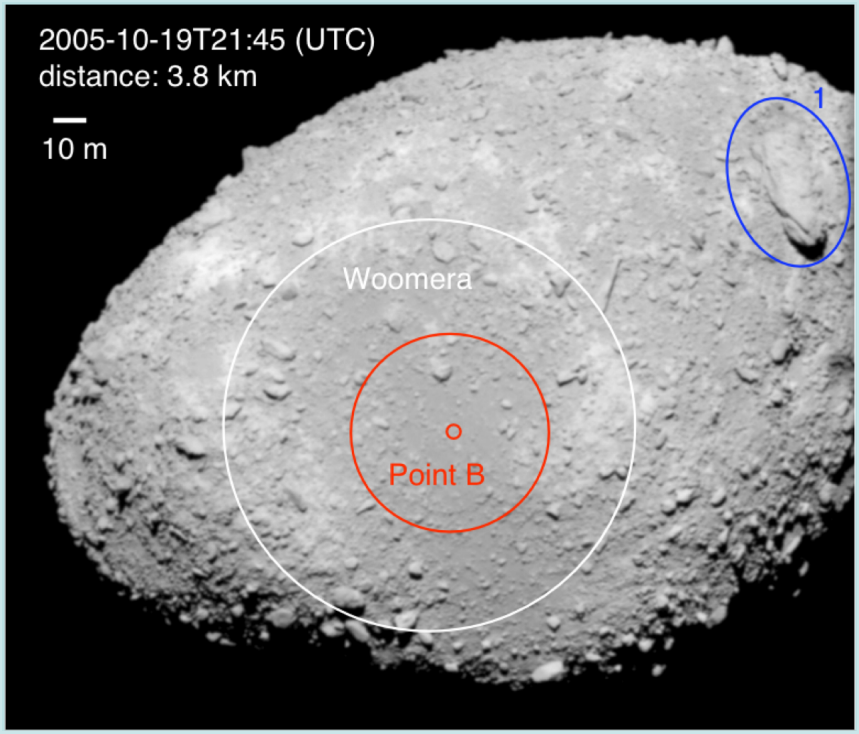




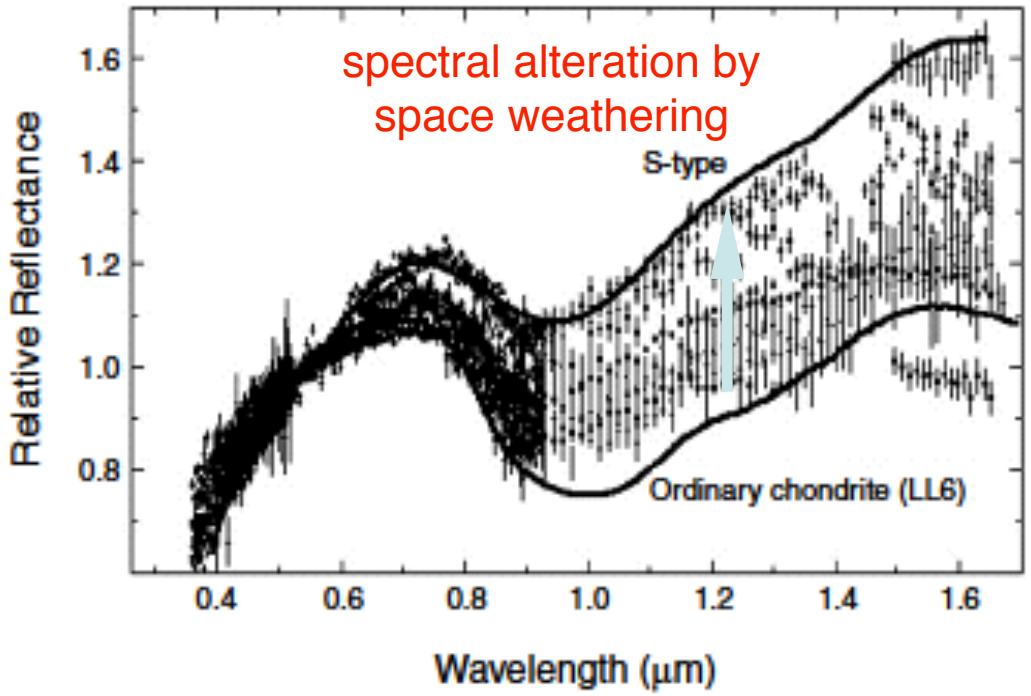
- **very inconspicuous**
- **concealing by boulders**
- **buried with fine material**
- **originally shallow**

Boulders on rough terrain

- 80 % of the surface is boulder-rich rough terrain
- The largest boulder, Yoshinodai, is unlikely large as a boulder from a crater on Itokawa
- Most boulders were formed at the impact disruption of the Itokawa parent body



Answer on spectral mismatching

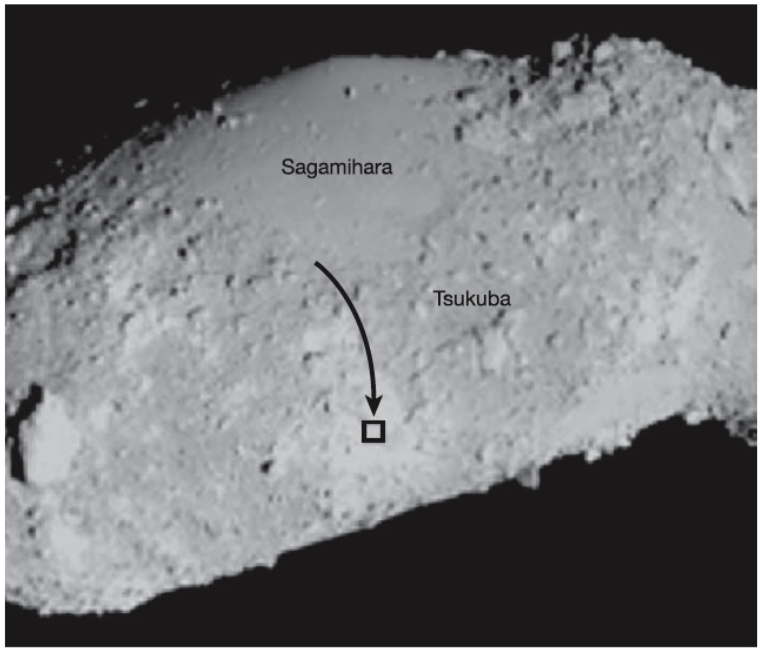


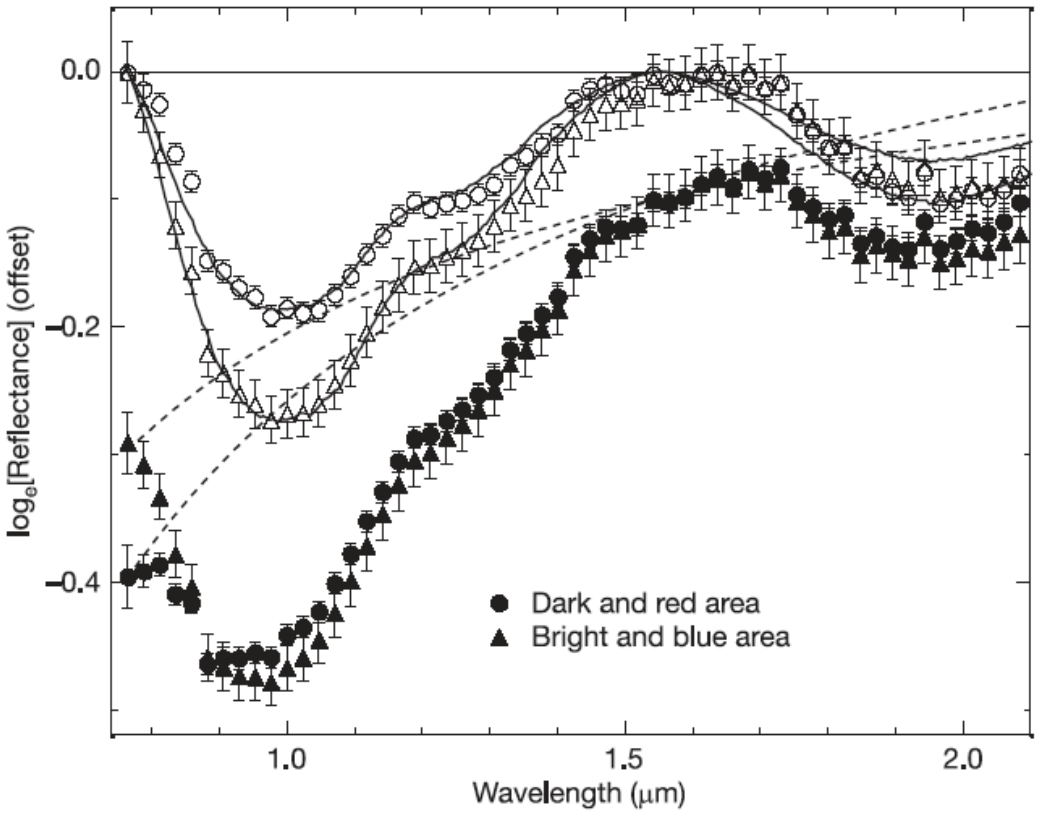
Binzel 2002

- Ordinary chondrite and S-type asteroid
- Space weathering hypothesis

Developing space weathering on the asteroid 25143 Itokawa,

T.Hiroi et al. (2006) Nature 443, 56-58

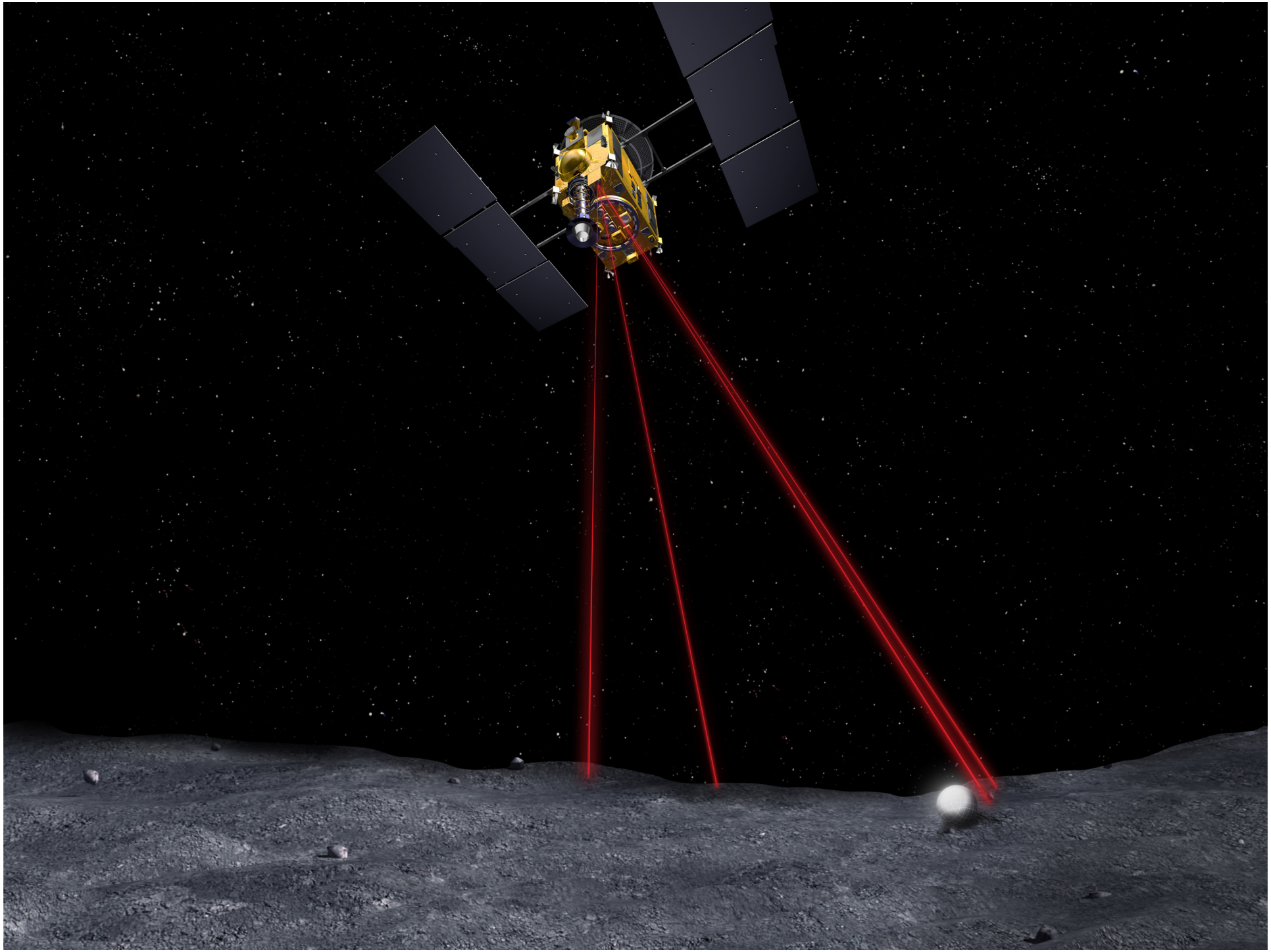




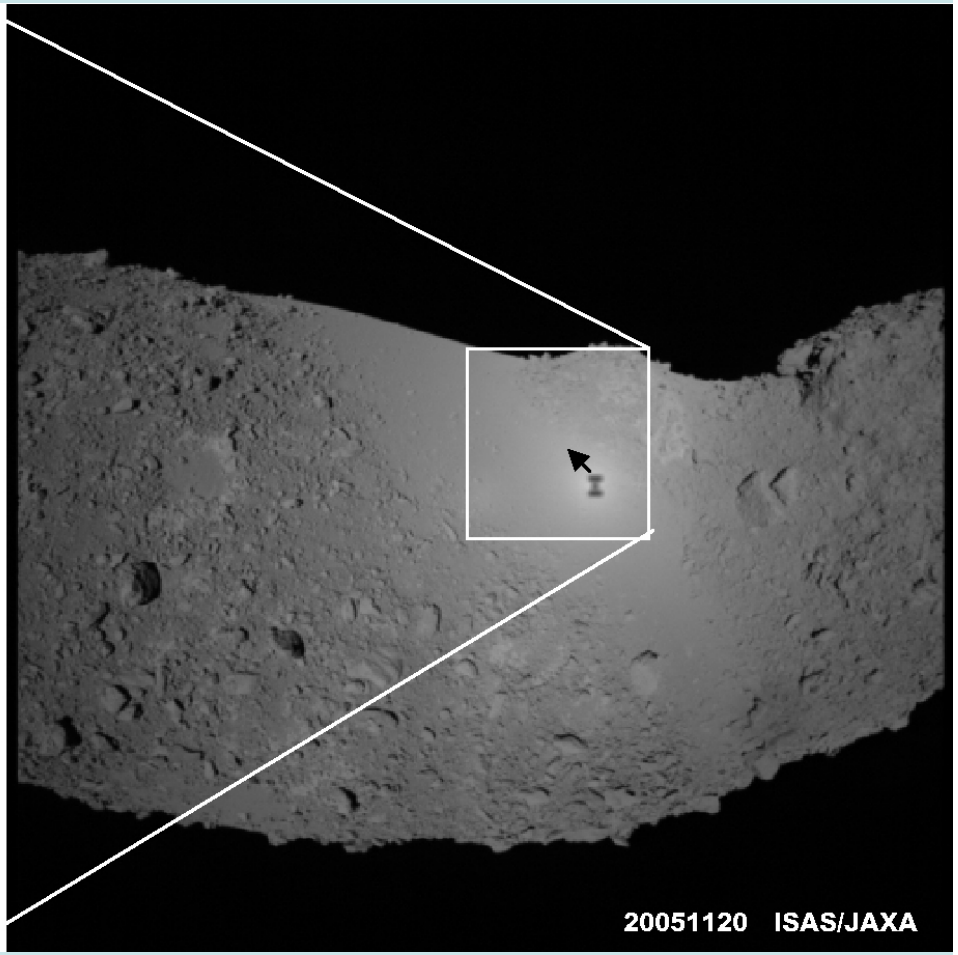
NIRS data from HAYABUSA

What we have learnt on

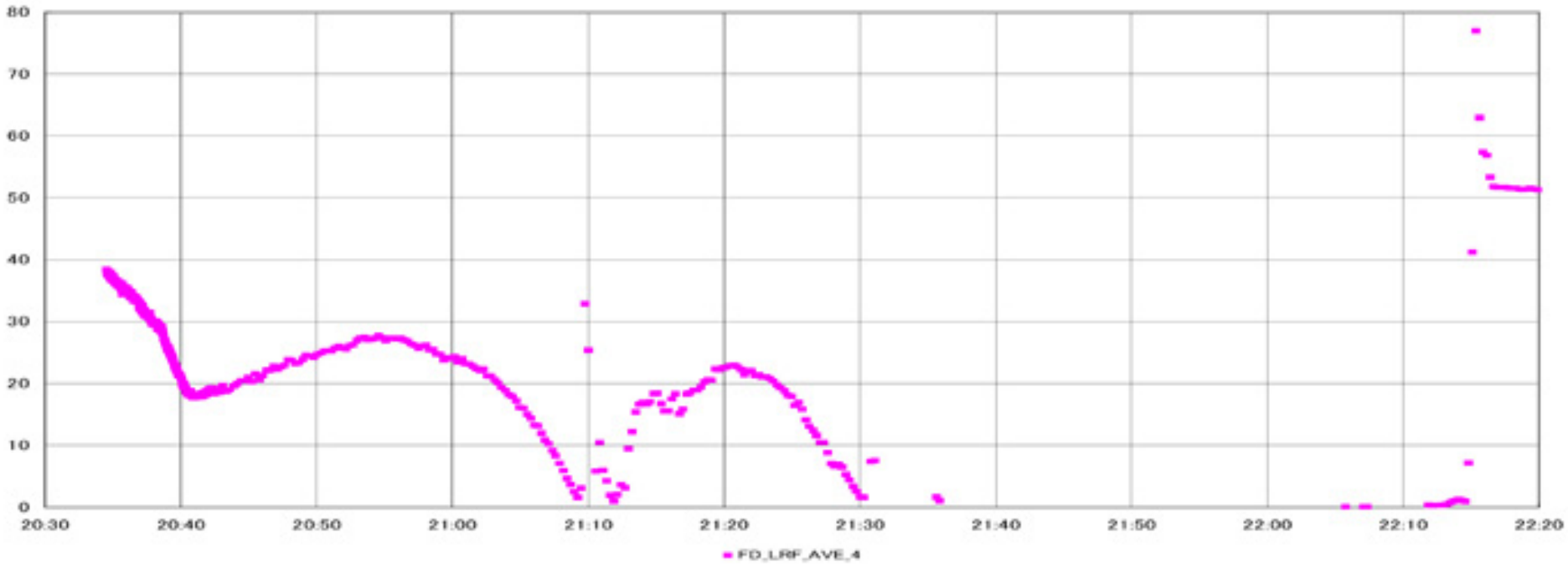
mass, internal structure and its origin.



Target marker (inside a circle) and shadow of HAYABUSA

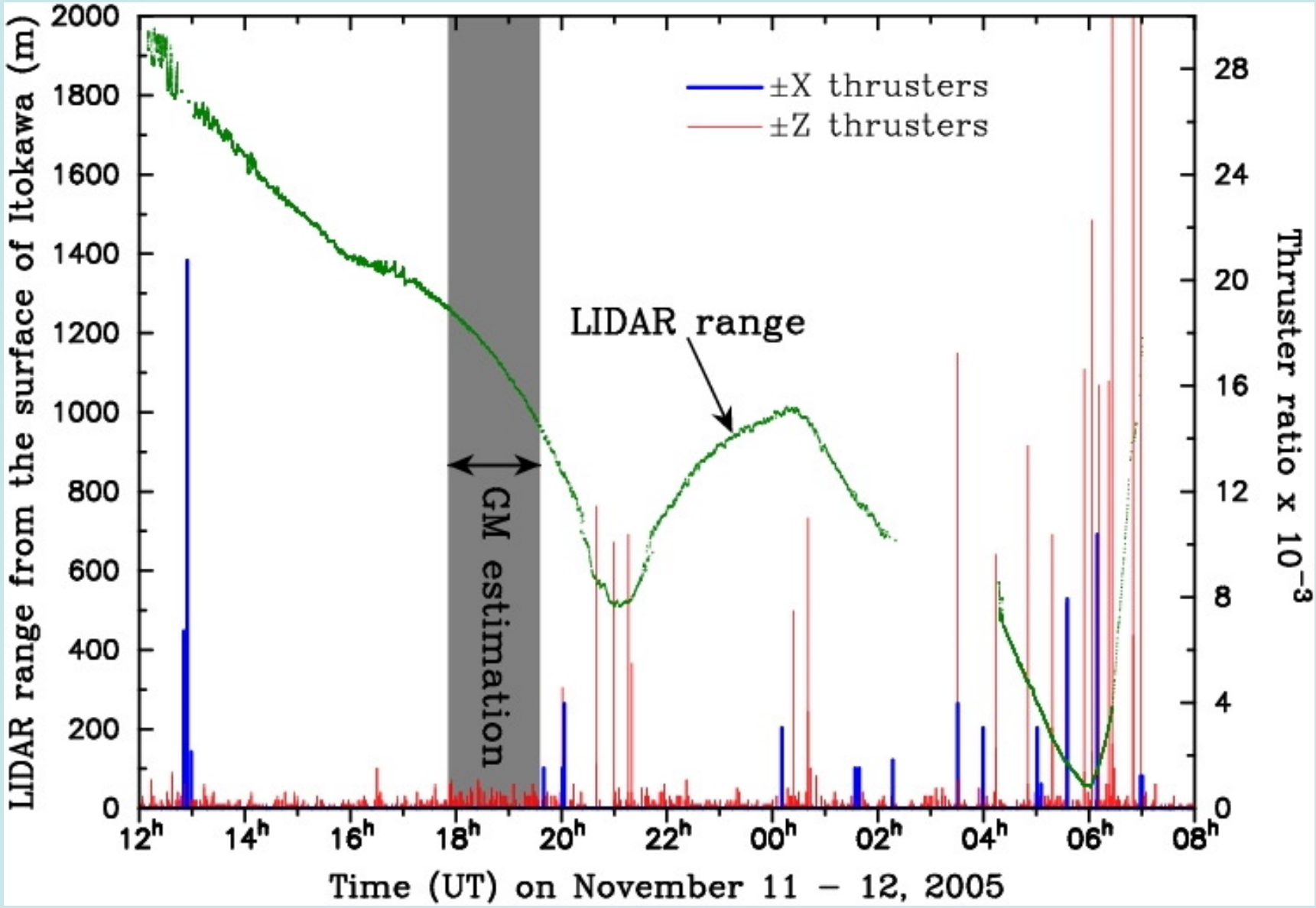


HAYABUSA landed on the surface for about 40 min on November 19, 2005 during the 4th descent phase and the 1st touch- down)

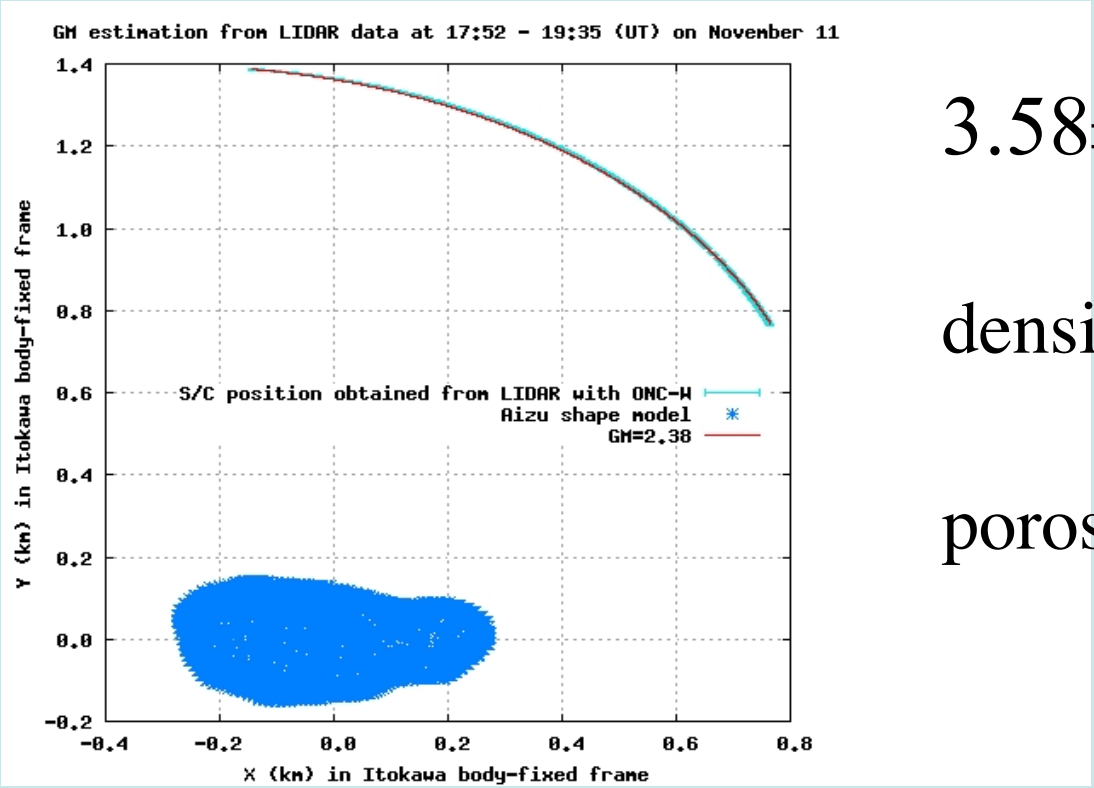


Surface material may be blown up and be captured inside the sample receptacle.

Gravity measurements of asteroid during the descent phase



Mass of Itokawa



$3.58 \pm 0.18 \times 10^{10}$kg

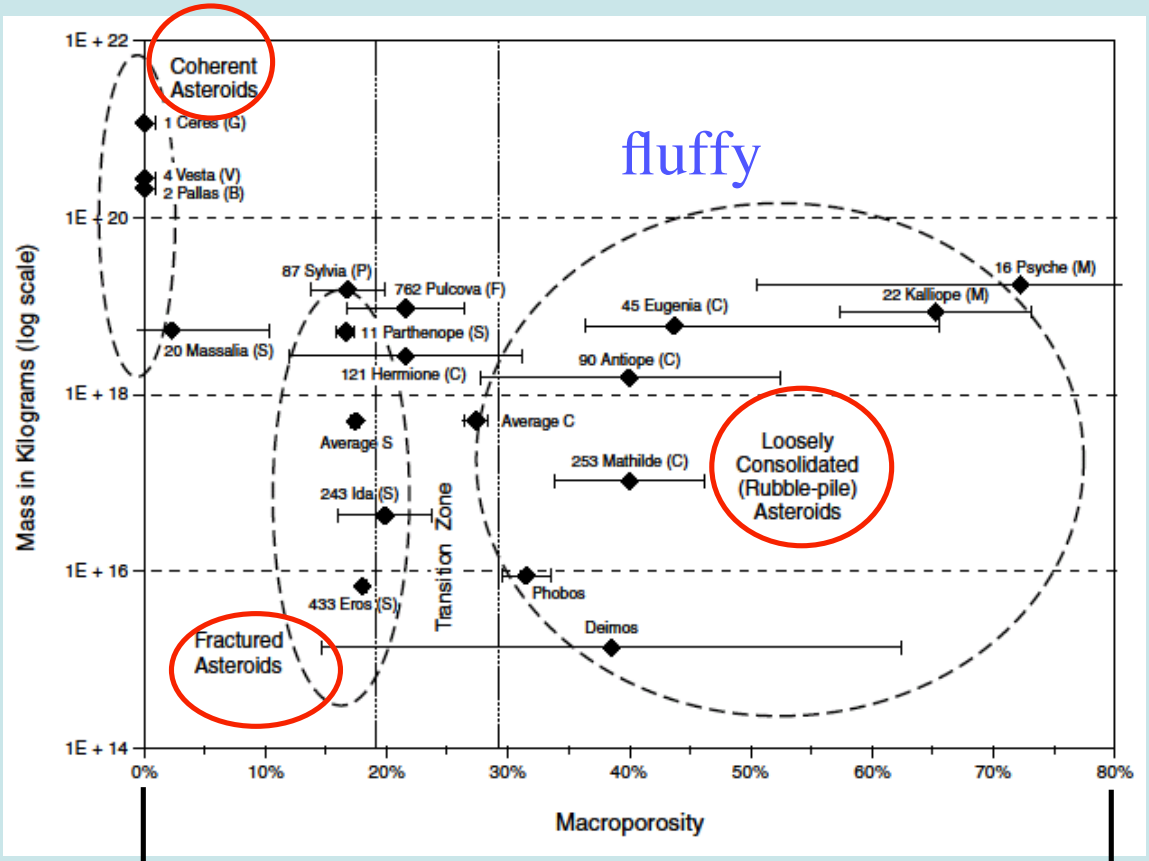
density: 1.95 ± 0.14 g/cm^3

porosity: ~40 %

Porosity of asteroid

hard

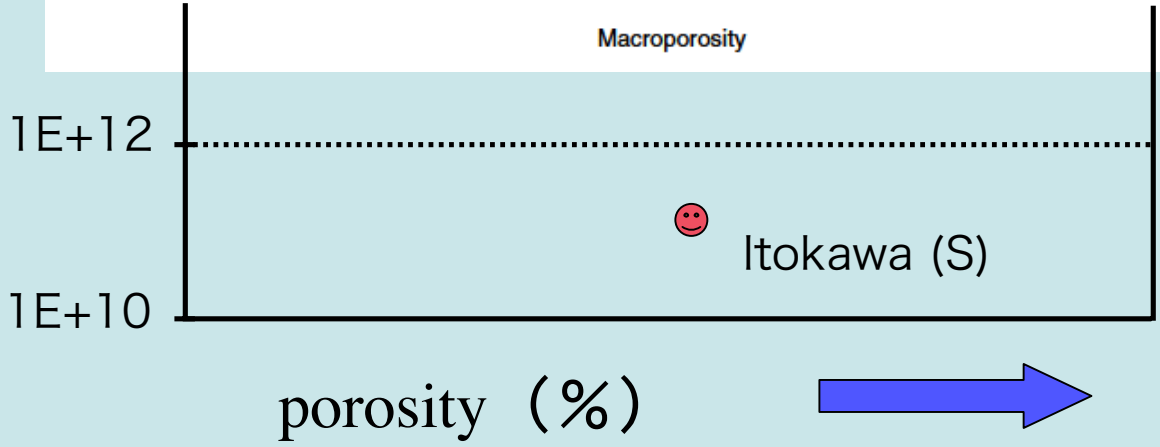
mass (kg)



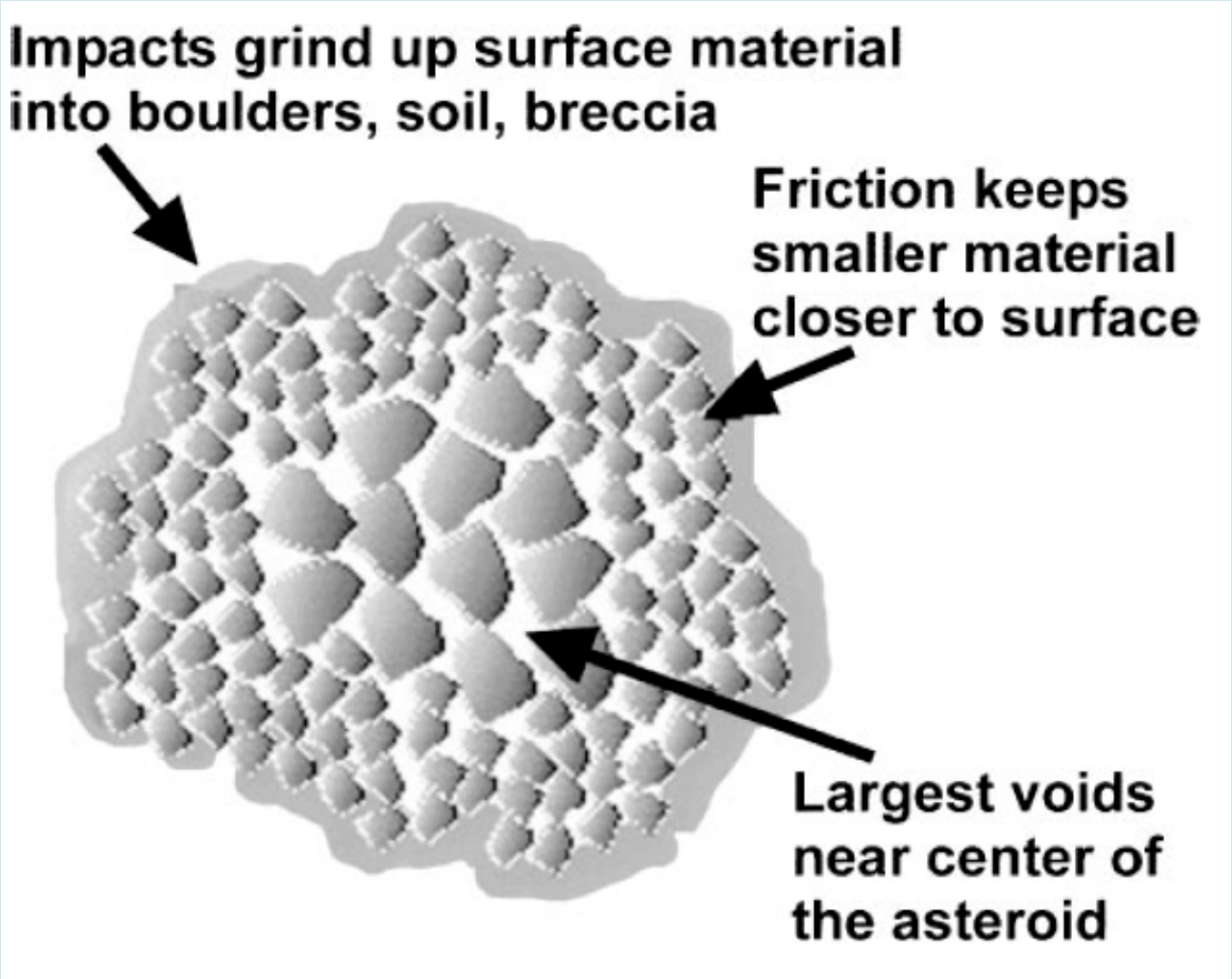
Rubble-pile structure

Itokawa

Very small, high porous asteroid



Rubble piles



Britt and Consolmagno(2001, Icarus 152, 134)

Monolithic asteroids

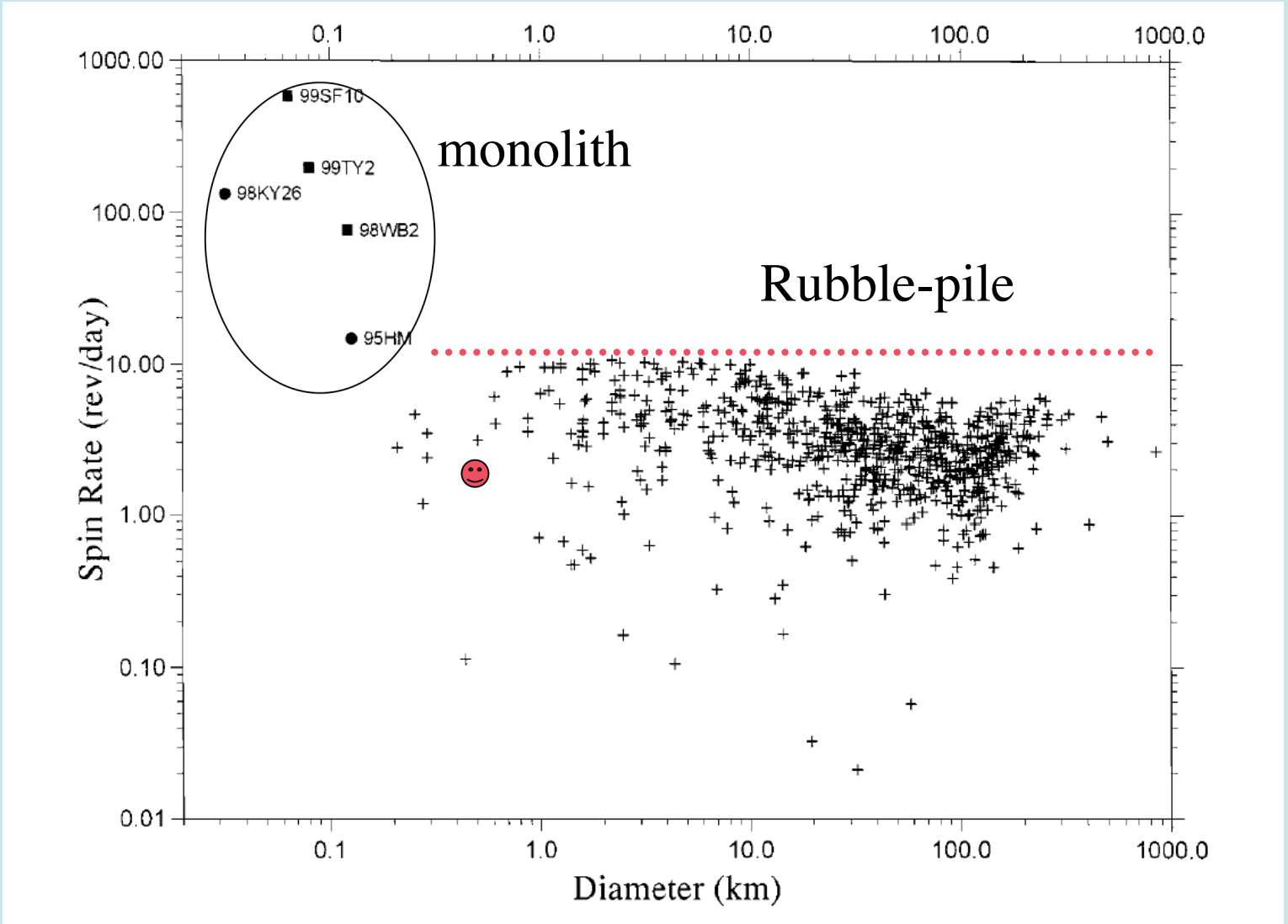
Whiteley et al.(2002)

- ～40
- fastest；spin period 78sec ($2000DO_8$)
  <<<<<<
- 97.2 min (1995HM)、107.5 min($2000EB_{14}$)

all small asteroids

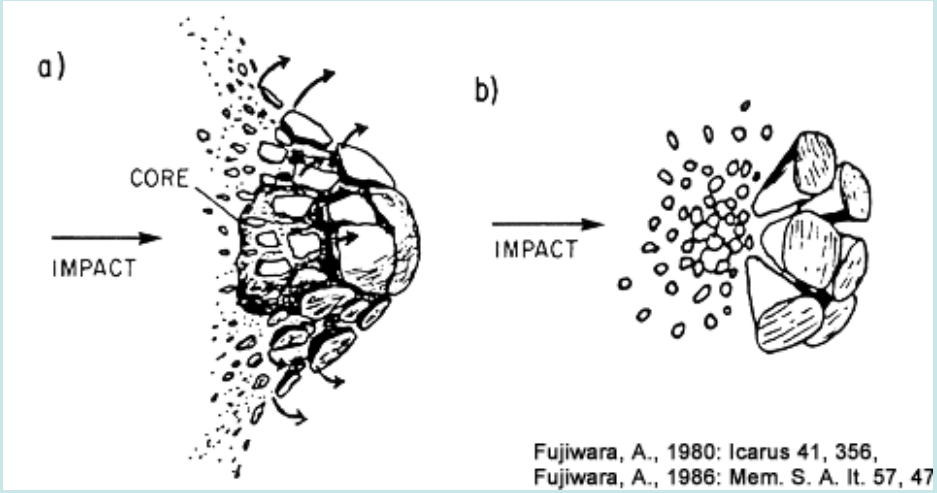
(a few 10 to a few 100 m)

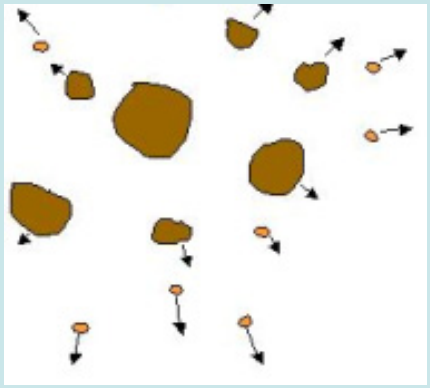
Iokawa ; slow spinning (12hrs) small asteroid with rubble pile structure



Pravec et al. (2000, Icarus 147, 477)

Origin of Itokawa





- Catastrophic disruption of larger parent body
- Aggregation of debris (rubble-pile structure)

Current status of HAYABUSA

- No problem in telemetry（from February, 2006）
- After checking ion engines, it will leave for the Earth in December 2006
- Return in June, 2010
- What sample we can see?