Rosetta, a la caza de un cometa

Miguel Pérez Ayúcar, 06 Abril 2022

Curso de Profesores CESAR, Small Bodies

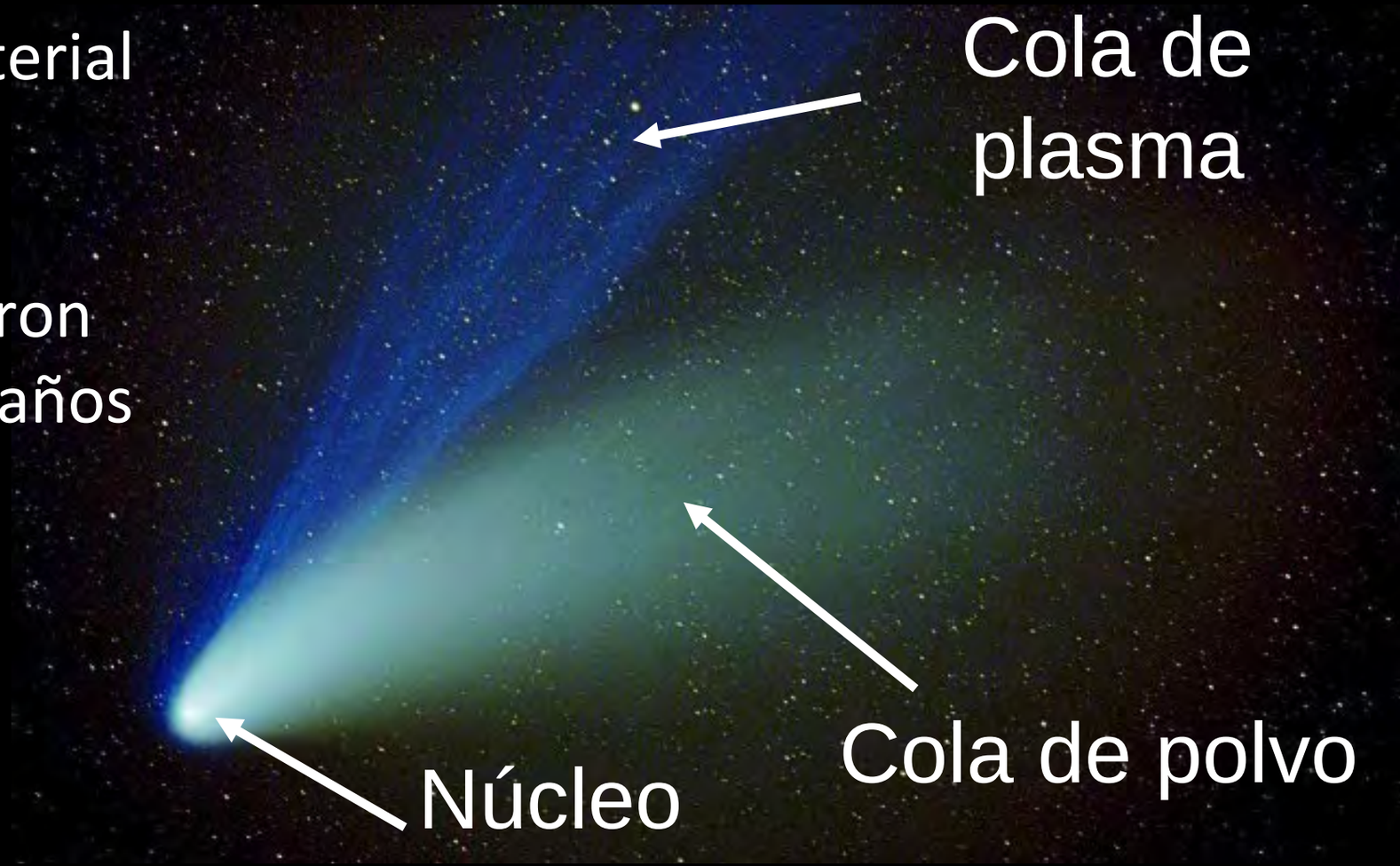
Ambition video

Asteroides vs Cometas

Asteroides «Rocas secas» (**ROCA**, metal, polvo,….) entre Marte & Júpiter

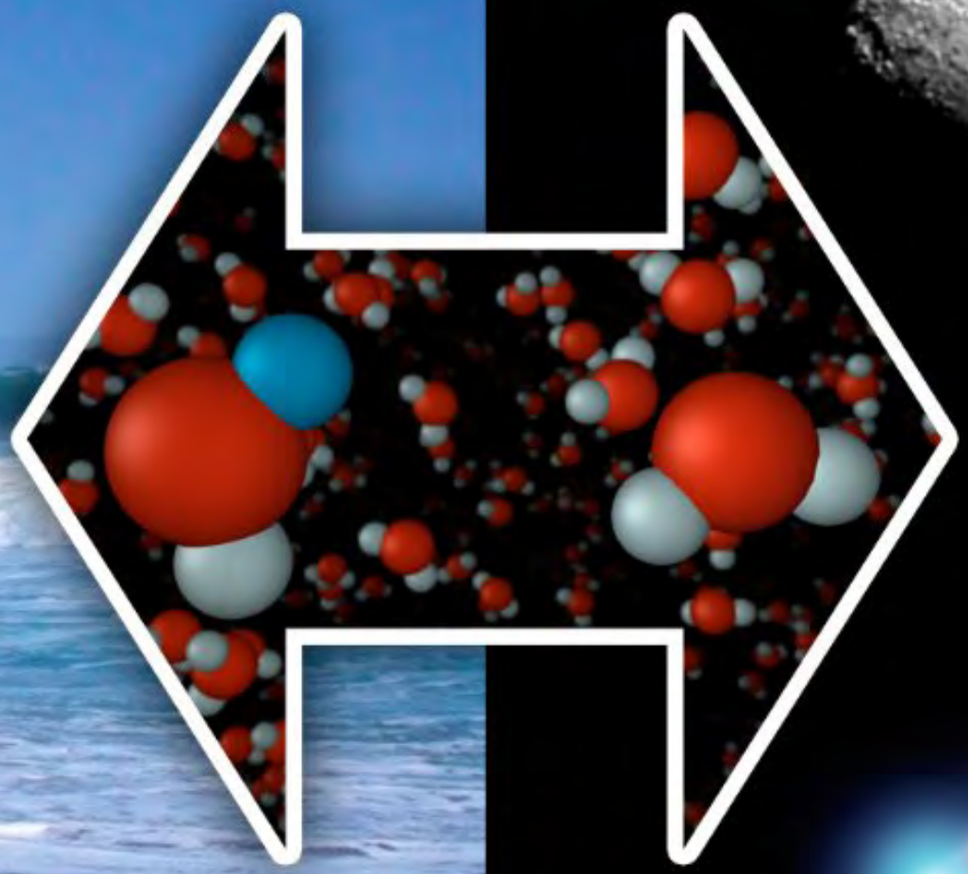
Cometas «Bolas de Nieve sucia» (**HIELO**, polvo y material orgánico) lejos del Sol.

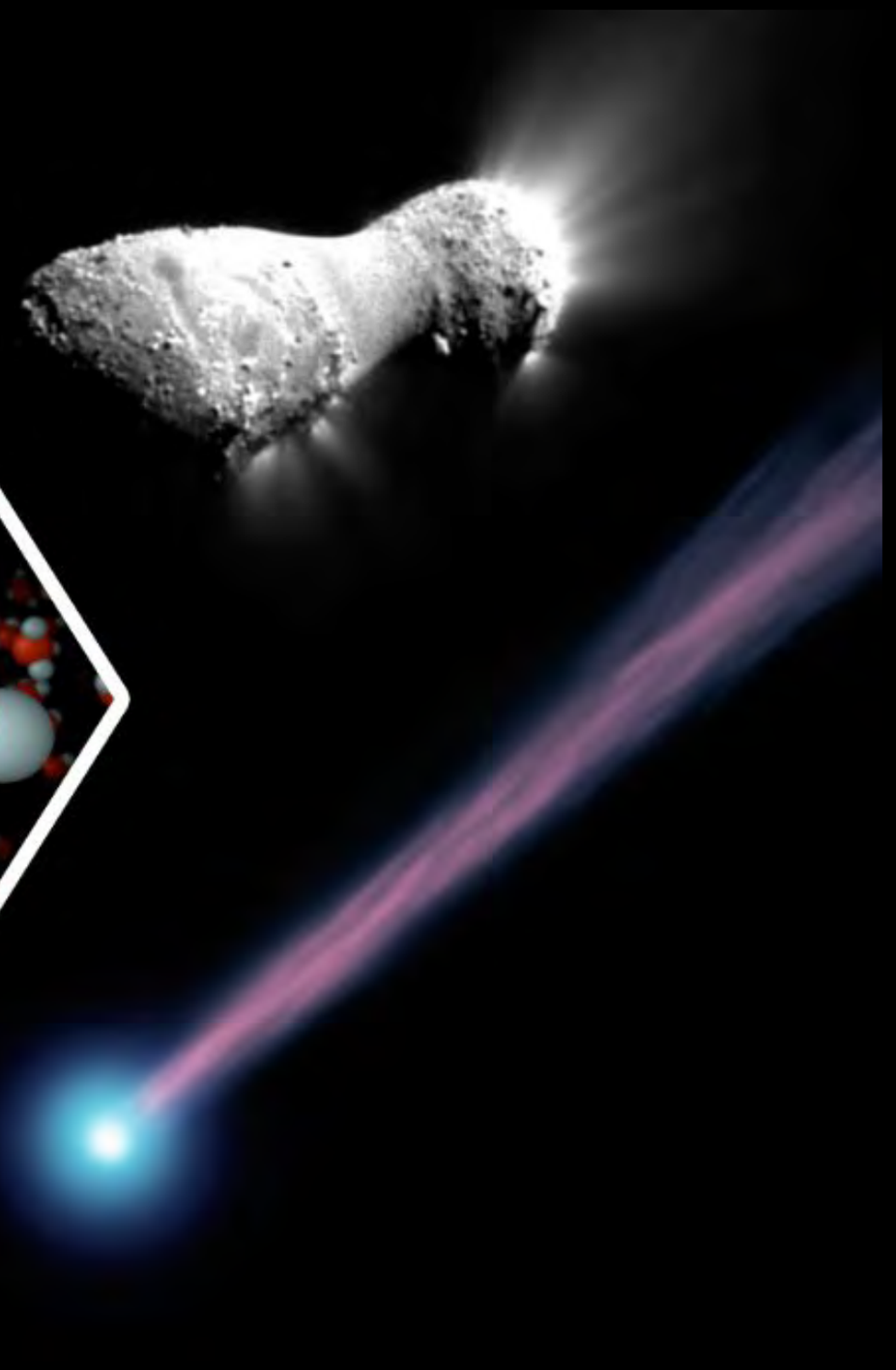
Primitivos: como se formaron hace miles de millones de años



POR QUÉ estudiar los cometas …

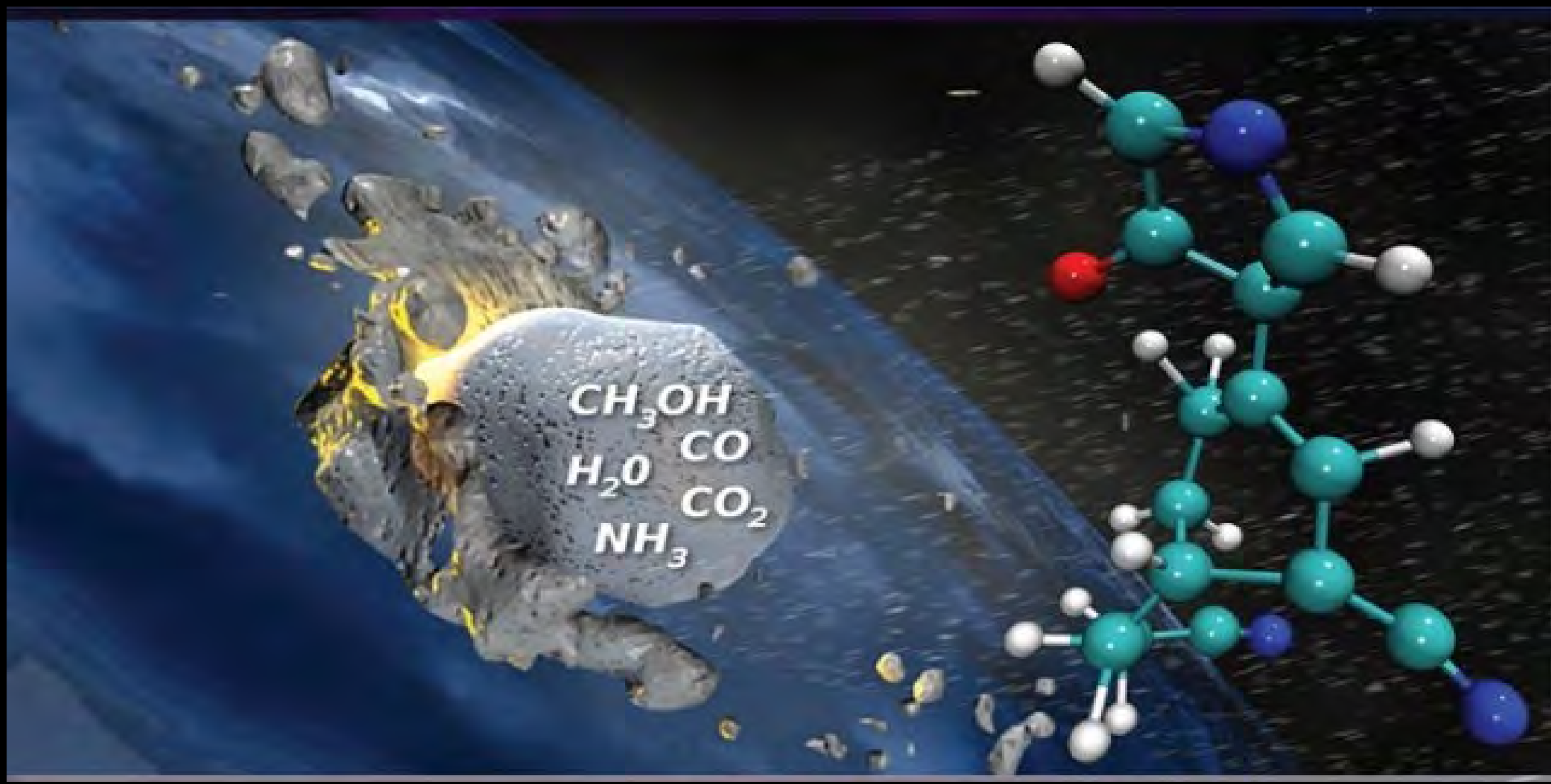
Cometas y el agua:
¿Proviene el agua de la Tierra de cometas?





POR QUÉ estudiar los cometas …

Cometas y la vida: ¿Trajeron los cometas las moléculas que formaron la vida en la Tierra? Aminoácidos, nucleótidos.



La misión Rosetta

Rosetta

Piedra de Rosetta

Philae: templo de Isis

Agilkia e reside
d

La Piedra de Rosetta y el obelisco de Philae fueron clave en descifrar los jeroglíficos egipcios.

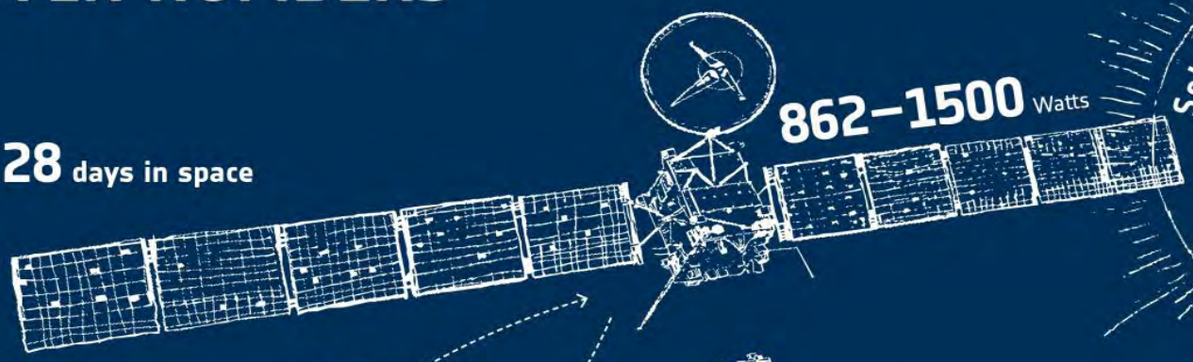
→ ROSETTA IN NUMBERS

esa

12 years **6** months **28** days in space

862–1500 Watts

Solar array output



Flybys

7.9
billion km travelled

Telecommands: **2** kbps

Telemetry: **14–91** kbps

Time on ground stations

14 900 hours in **2483** contacts

New Norcia
4635 hours in **592** contacts

Malargüe
3969 hours in **612** contacts

Cebreros
1694 hours in **318** contacts

Deep Space Network
4602 hours in **961** contacts

1st spacecraft to orbit and land a probe on a comet

218.25 GB
Science data collected

16 650+
Navigation Camera images

266
orbital correction manoeuvres

21 000+
individual science observations

1000–1500
commands executed per day at the comet

www.esa.int

Ground station times applicable 6 August 2014 – 30 September 2016; Navigation Camera images 20 January 2014 – 20 September 2016; Orbital correction manoeuvres May 2014 – September 2016; Science data: 6 August 2014 – 20 September 2016; Science observations: 20 January 2014 – 30 September 2016

European Space Agency

http://rosetta.esa.int/

mission

Rosetta launched in 2004 and arrived at Comet 67P/Churyumov-Gerasimenko on 6 August 2014. It is the first mission in history to rendezvous with a comet, escort it as it orbits the Sun, and deploy a lander to its surface. Rosetta is an ESA mission with contributions from its member states and NASA. Rosetta's Philae lander is provided by a consortium led by DLR, MPS, CNES and ASI.

from the blog

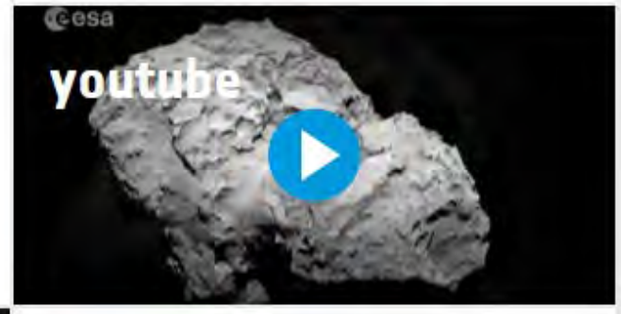
CometWatch 18 March

This single frame NAVCAM image was taken on 18 March at a distance of 81.4 km from the centre of Comet ...

23/03/2015 15:06

[Read more]

rosetta



from the portal

Rosetta makes first detection of molecular nitrogen at a comet

ESA's Rosetta spacecraft has made the first measurement of molecular nitrogen at a comet, providing clues about the ...

19/03/2015 20:00

[Read more]

@esa_rosetta

Earth friends can also find mission souvenirs (tshirts & hoodies) here: http://www.rosettashop.eu #souvenirsMW pic.twitter.com/jt84fFSlyA

Posted 2 hours ago

facebook

Starting the new week of #CometWatch images with this stunning shot, which was taken on 18 March ...

23/03/2015 15:12

[Read more]

events

13/08/2015

Closest approach to Sun

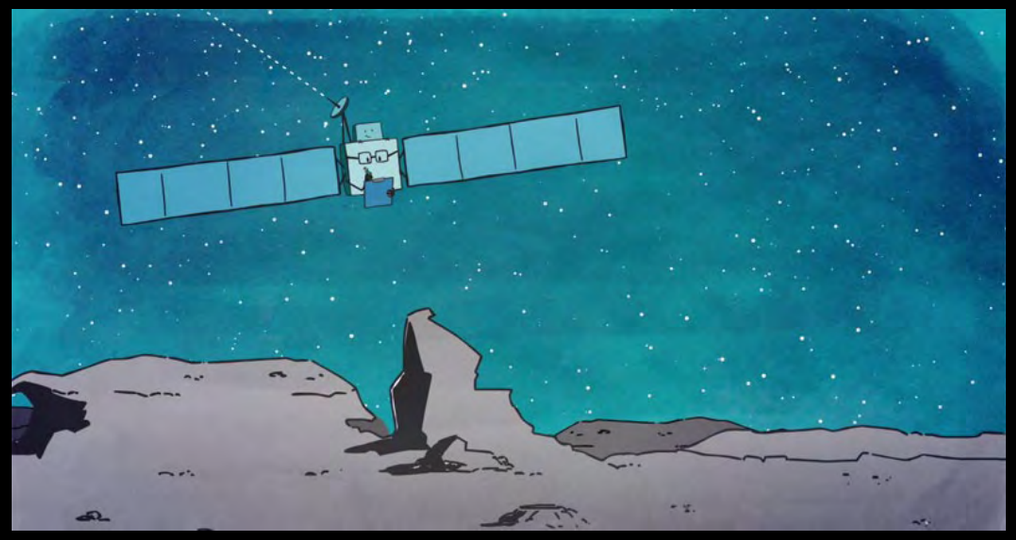
partners

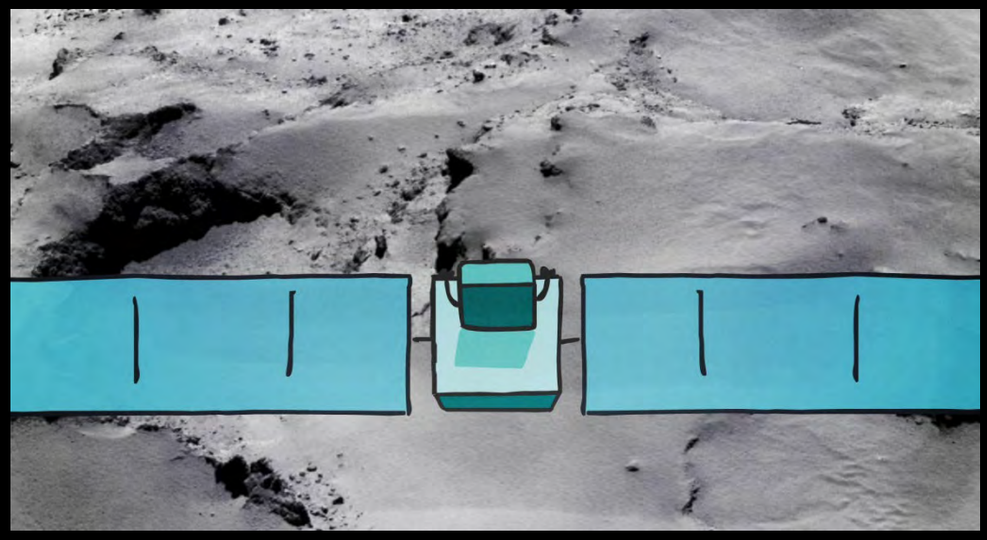
NASA DLR MPS cnes asi

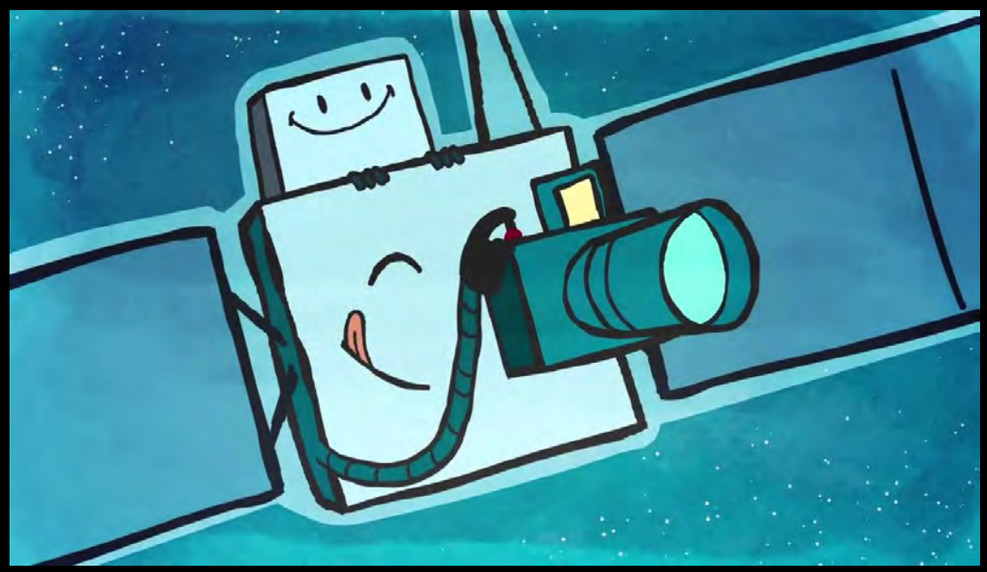
follow

http://www.esa.int/spaceinvideos/Videos/

or youtube channel Rosetta cartoons







Science

$10
23 JANUARY 2015
sciencemag.org

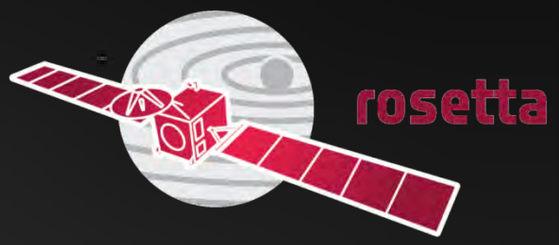
AAAS

Catching a comet

Rosetta follows a relic of the early solar system toward the Sun

pp. 358 & 387

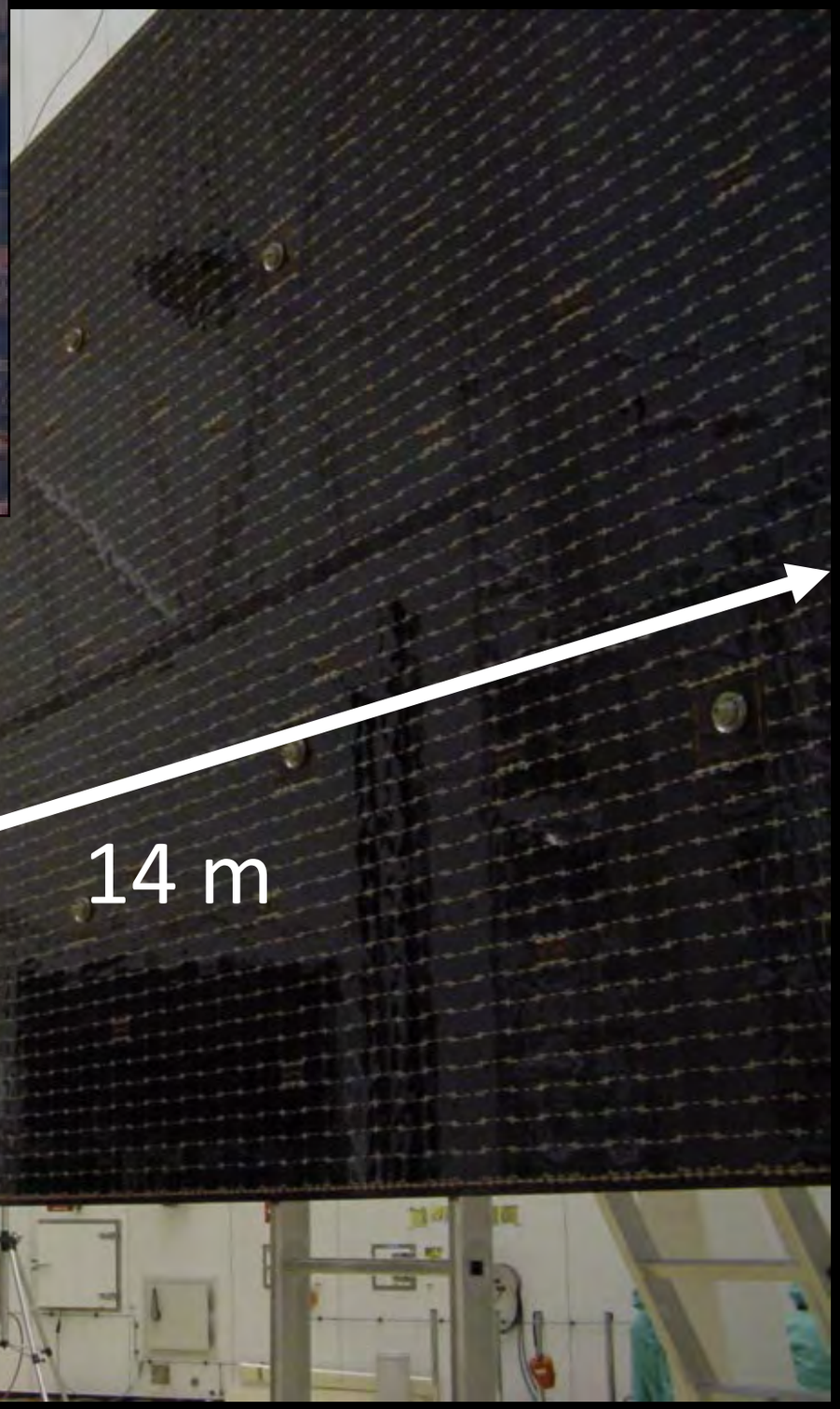
Rosetta- 2.8 m x 2.1 m x 2.0 m
Peso (lanzamiento) - 2900 kg
11 instrumentos



32 m

Philae - 0.85 x 0.85m
(1.3 altura y 1.46 m patas)
Peso - 100kg
10 instrumentos


32 m
Airbus A321


14 m

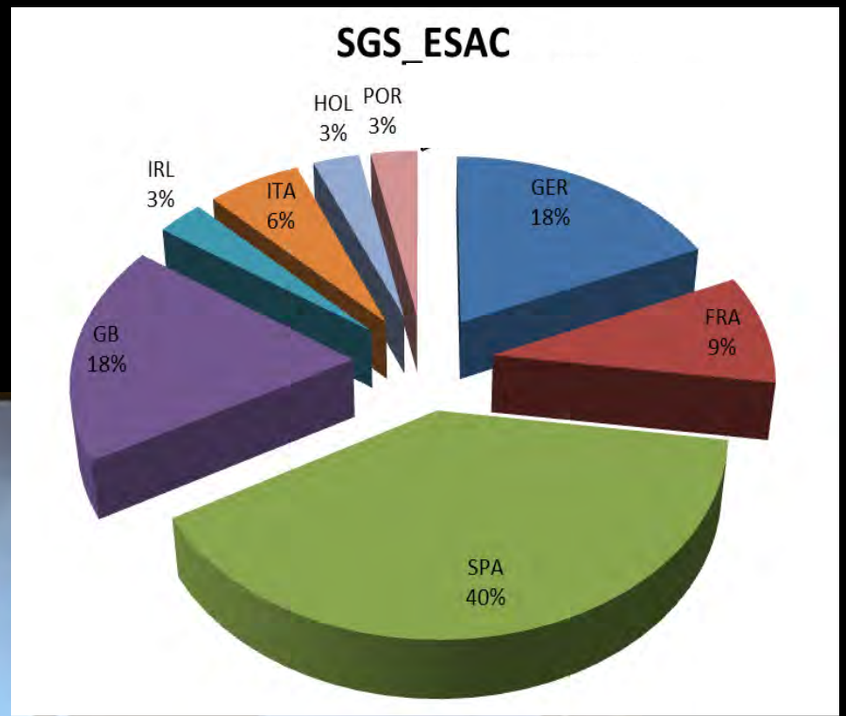
European Space Astronomy Centre (ESAC)
Villafranca del Castillo, Madrid

ESAC y las operaciones científicas de Rosetta-Philae

- En ESAC se encuentra:
  - Equipo de Operaciones Científicas (Science Ground Segment, SGS).
    - coordina todas las actividades científicas del orbiter Rosetta, así como las observaciones comunes con el dispositivo de aterrizaje Philae.
  - Archivo científico:
    - Legado científico de la misión, un archivo permanente de preservación de todos los datos científicos

Contribución española en ESAC a Rosetta

- Equipo Rosetta en ESAC para operaciones en el cometa:
  - ~25 ingenieros y científicos
  - ~11 de nacionalidad española (40%)



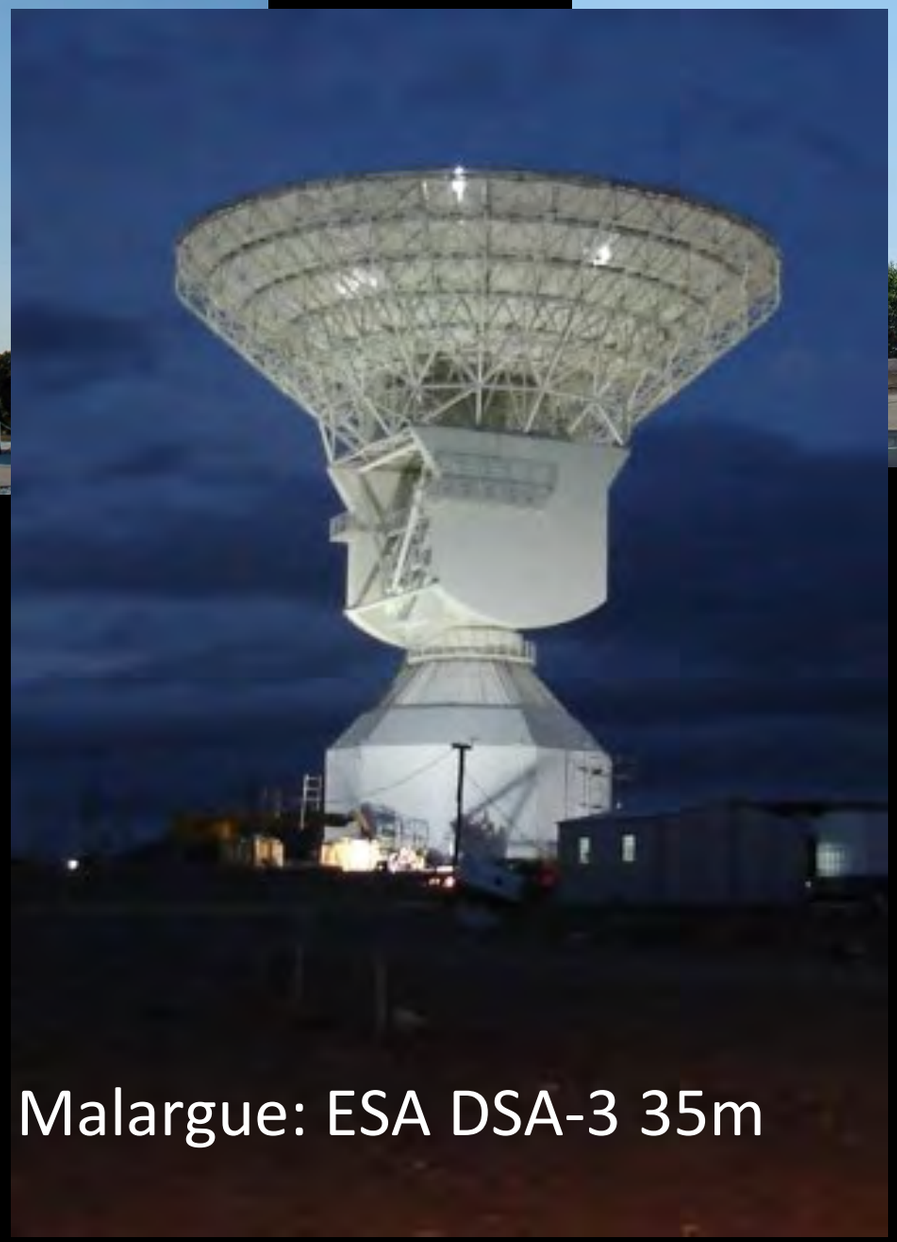
España/Argentina
labor fundamental en la comm con satélites

- Cebreros: ESA DSA-2
- Malargue: ESA DSA-3
- Robledo de Chavela: NASA DSN

Antenas de espacio profundo

Cebreros: ESA DSA-2 35m

Robledo de Chavela: NASA DSN 70m



Malargue: ESA DSA-3 35m

El viaje de Rosetta: 10 años para llegar al cometa 67P / Churyumov-Gerasimenko

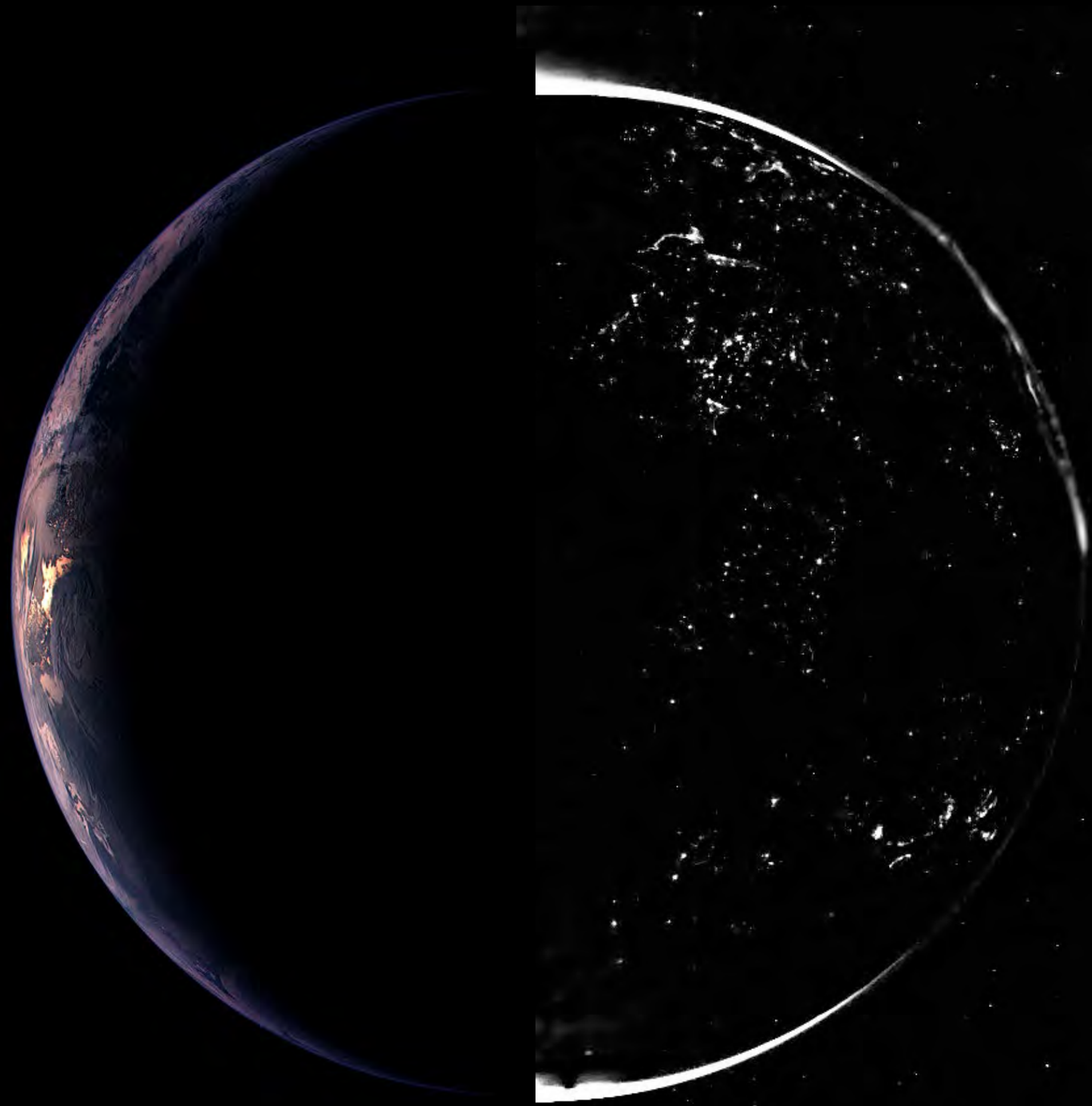
Rosetta – Lanzamiento 02 Marzo 2004

Vuelo interplanetario: 10 años, 4 vueltas al Sistema Solar

Sobrevuelos de la Tierra

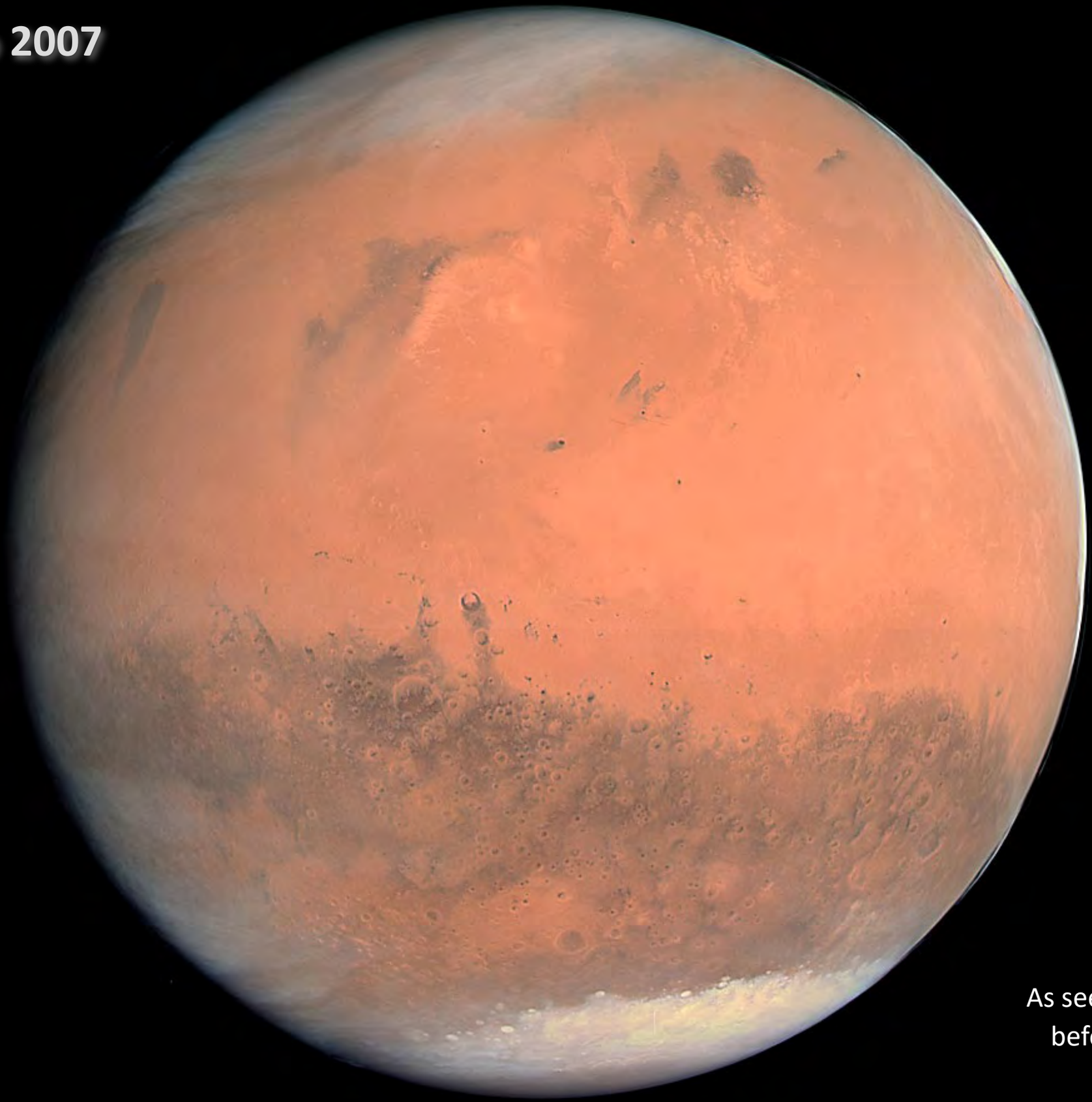
- 4 Mar 2005
- 13 Nov 2007
- 13 Nov 2009

NavCAM image on March 4, 2005 / ESA

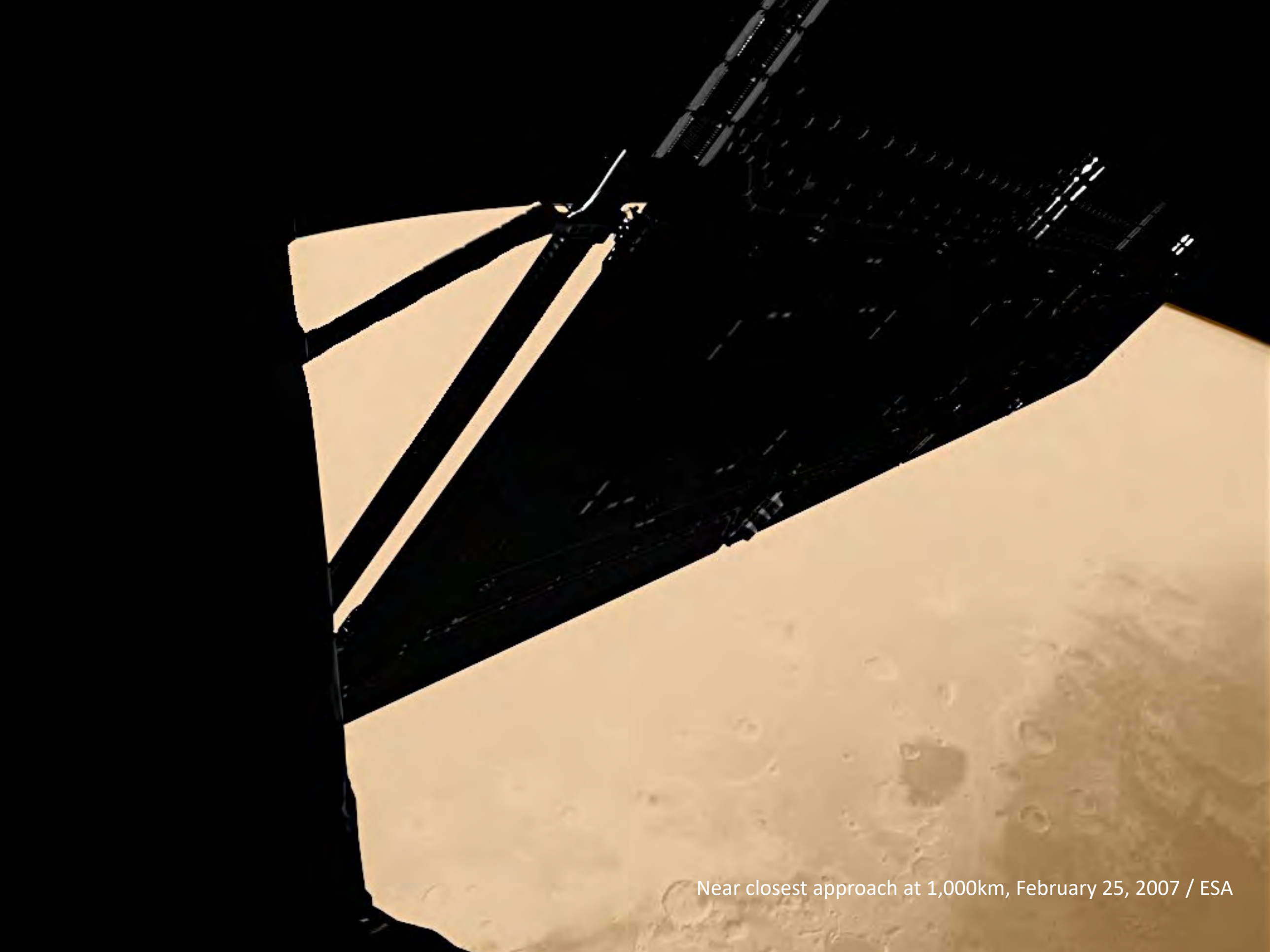


Sobrevuelo de Marte

25 Febrero 2007



As seen at 240,000km, one day before fly-by on February 25, 2007 / ESA

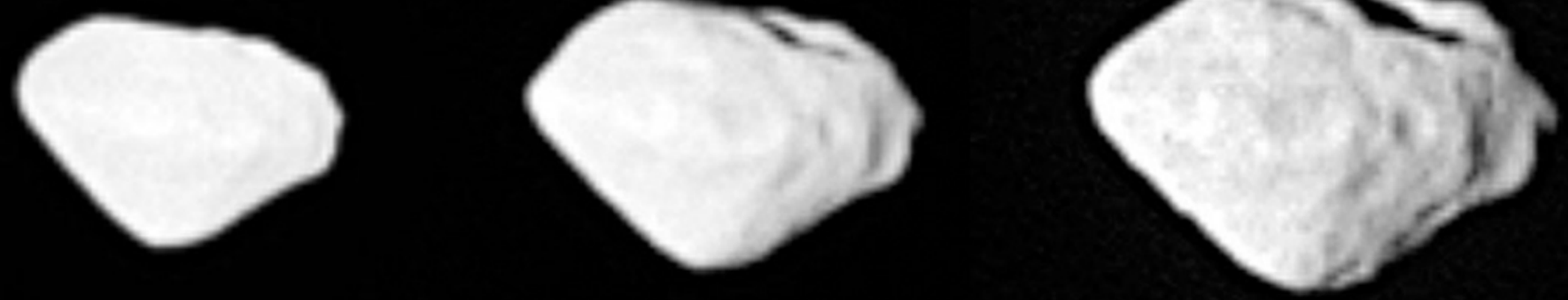


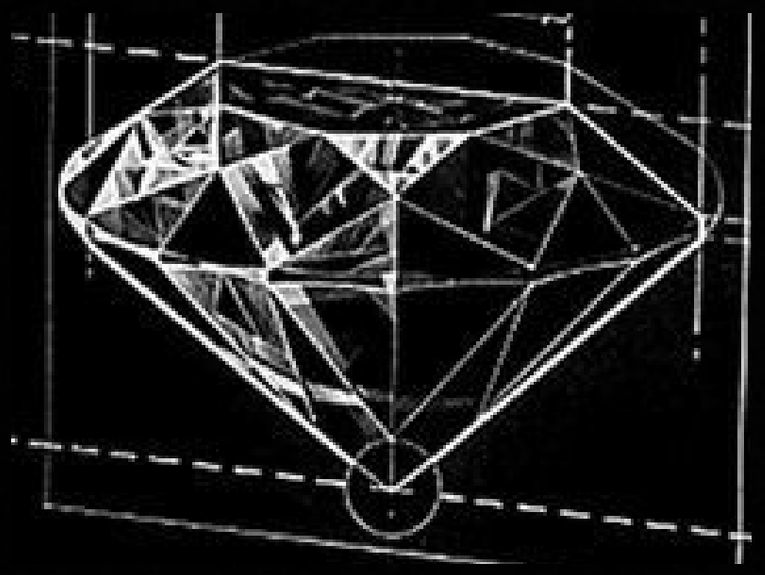
Near closest approach at 1,000km, February 25, 2007 / ESA

Sobrevuelo de Asteroide 2867 Steins

5th Sept 2008

5.9 x 4km





Sobrevuelo de As

10th Ju

121 km x
101 km x
75 km

Sobrevuelo Julio 10, 2010

ESA 2010 MPS for OSIRIS Team MPS/UPD/LAM/IAA/RSSD/I

Rosetta – hibernación
3 años

Enter deep space hibernation
8 June 2011

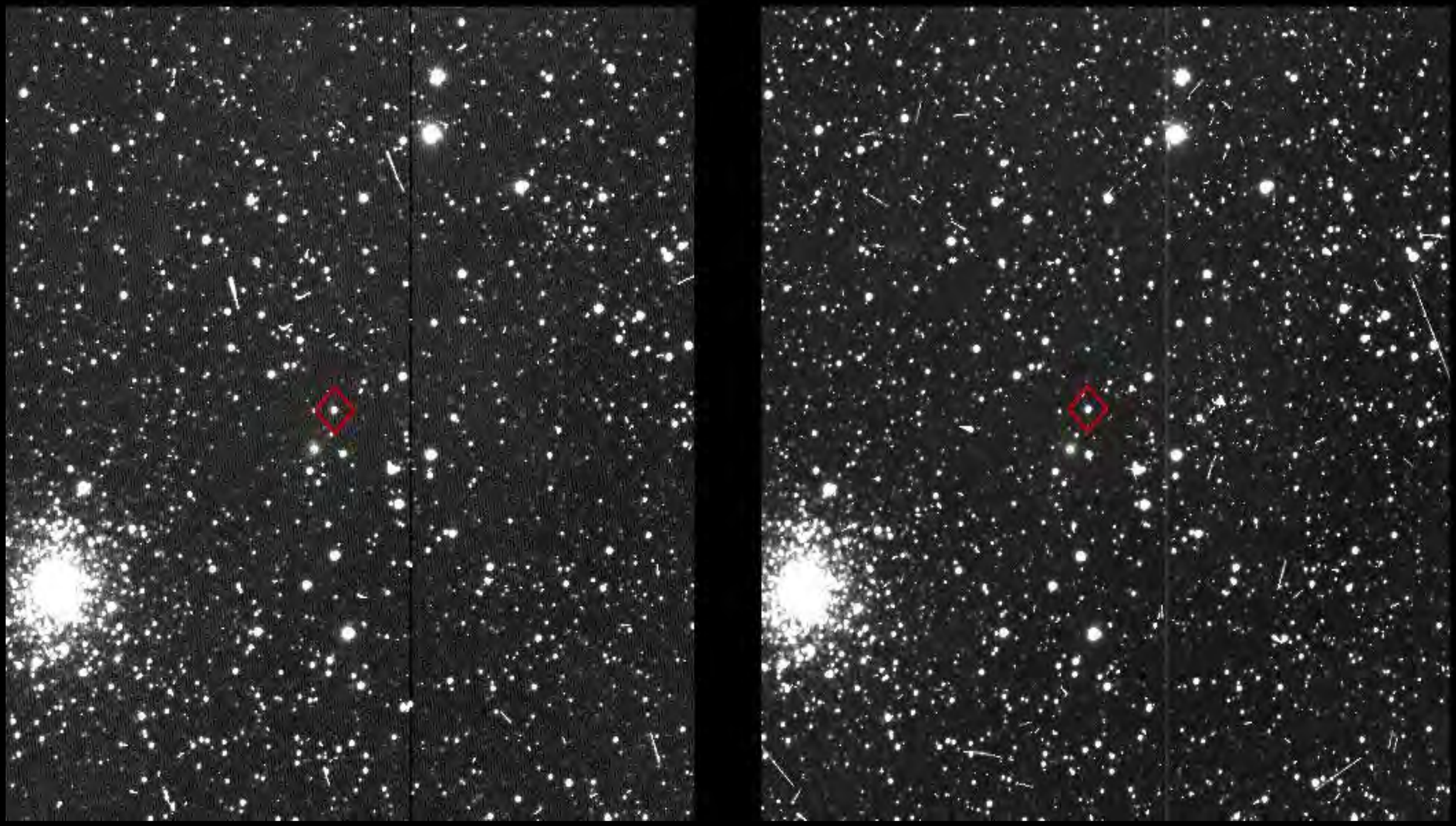
Exit deep space hibernation
January 2014

rosetta

esa

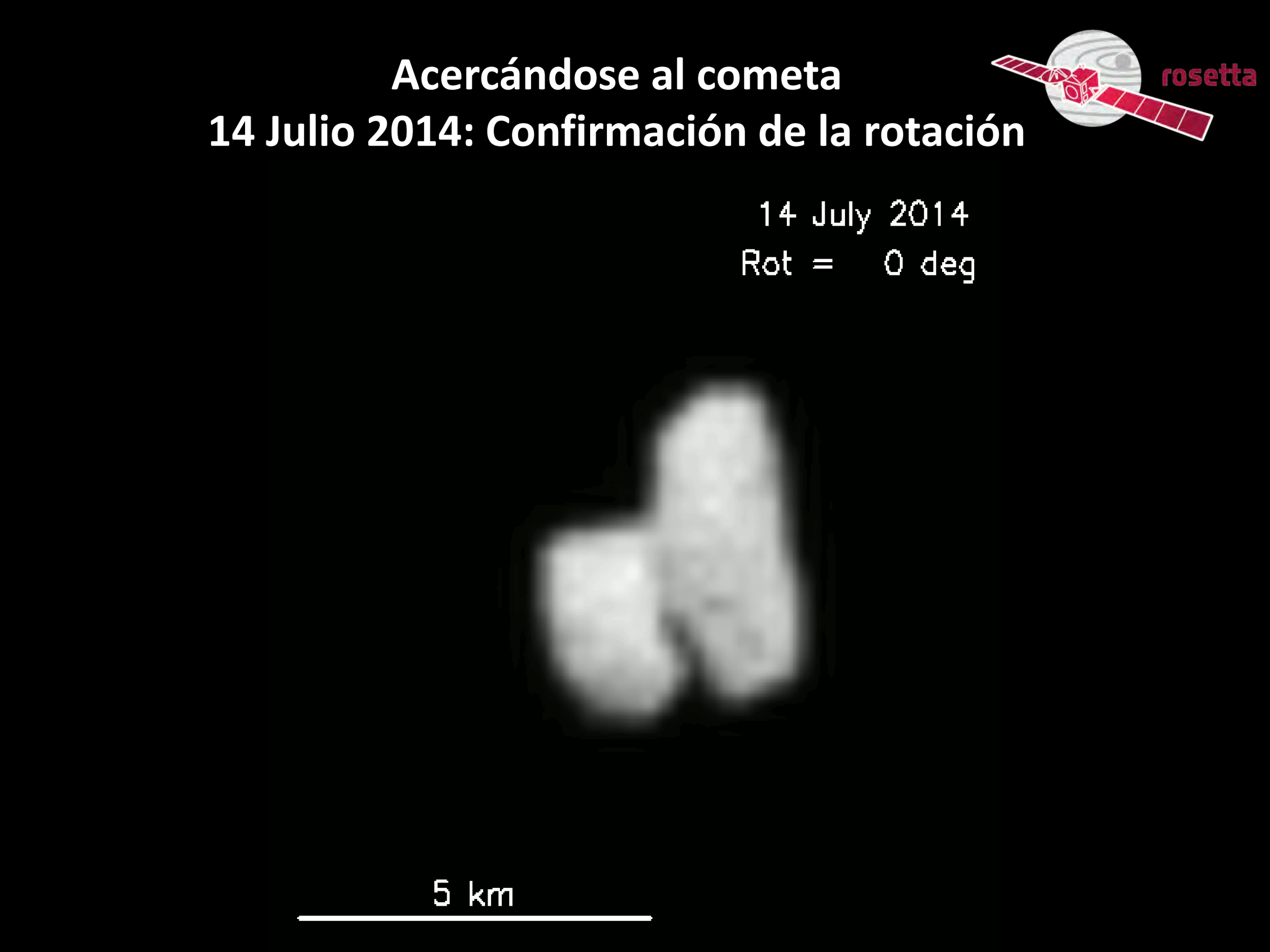
Rosetta despierta – 20 ENERO 2014

Primeras imágenes del cometa en Marzo 2014



Credit: ESA/Rosetta/MPS for OSIRIS Team MPS/UPD/LAM/IAA/SSO/INTA/UPM/DASP/IDA

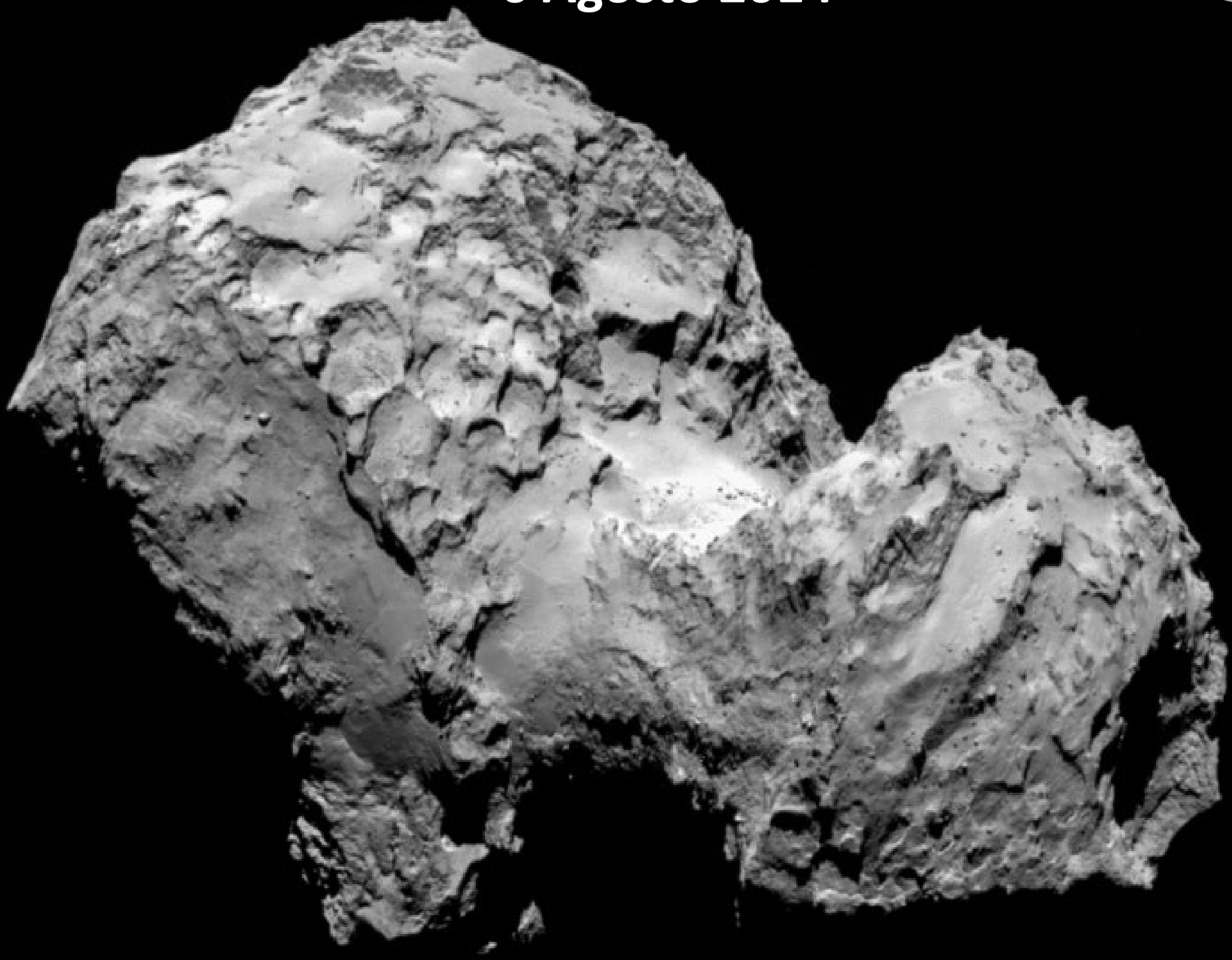
Acercándose al cometa
14 Julio 2014: Confirmación de la rotación



rosetta

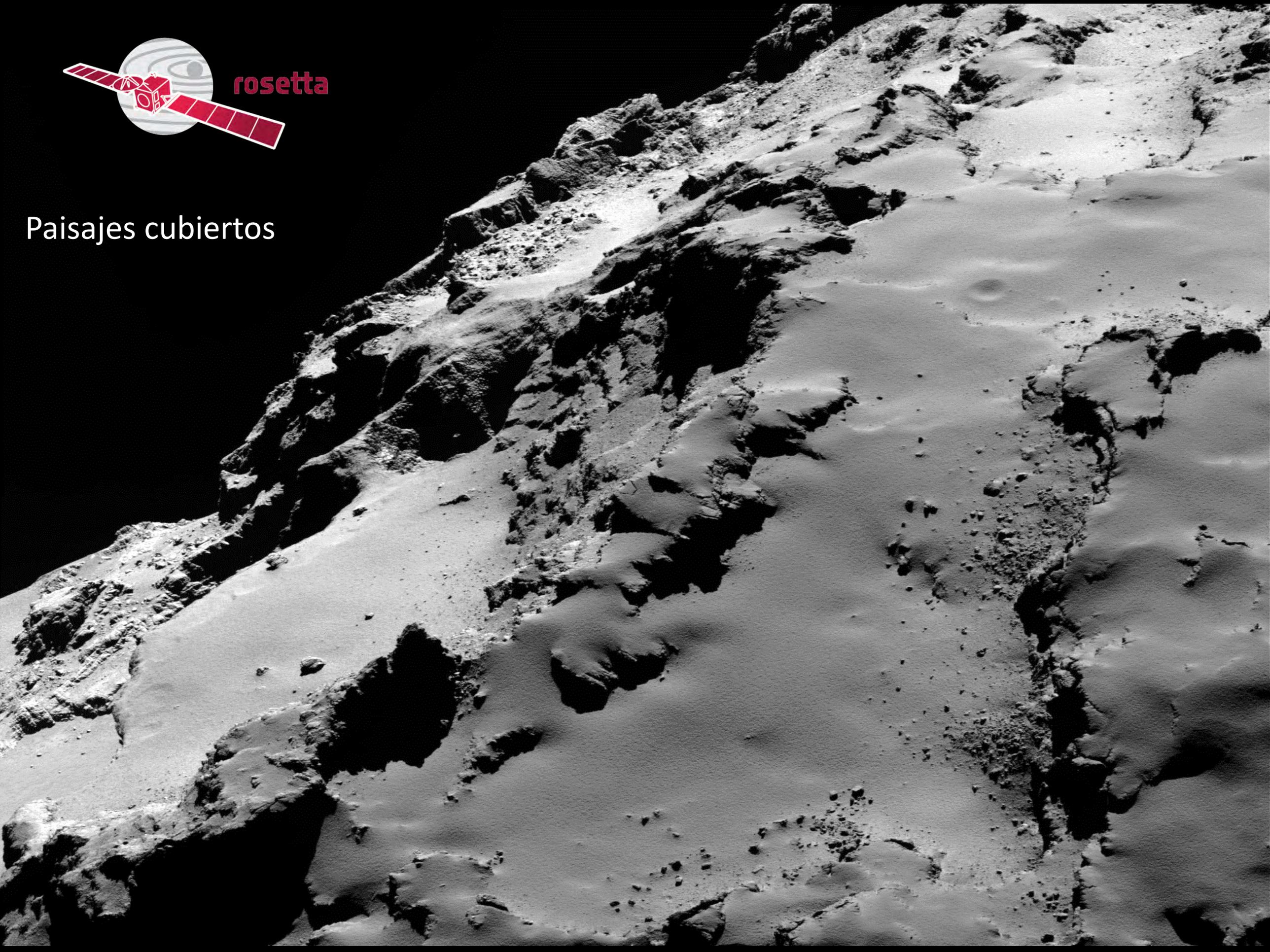
rosetta

Llegando al cometa
6 Agosto 2014

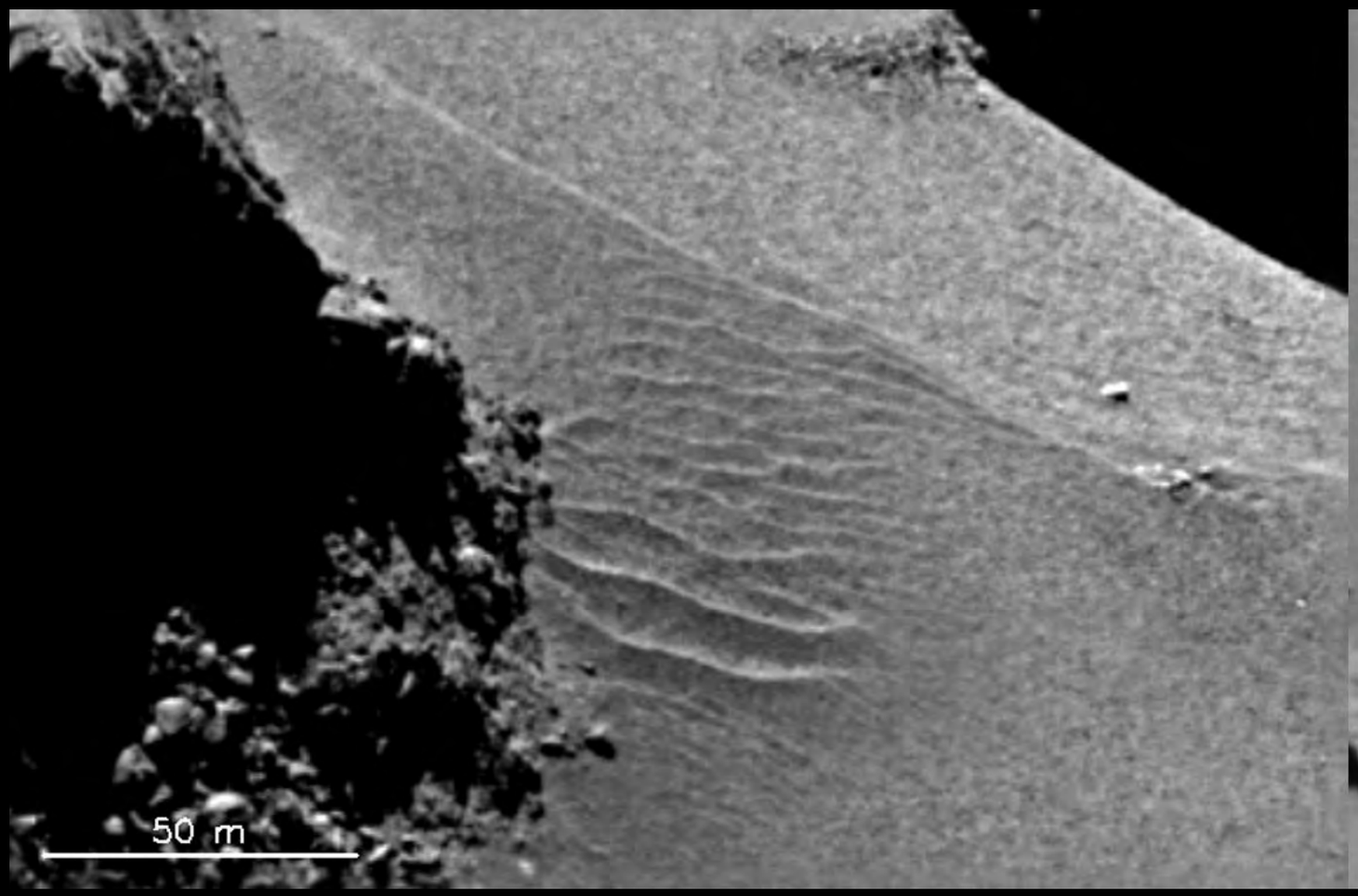


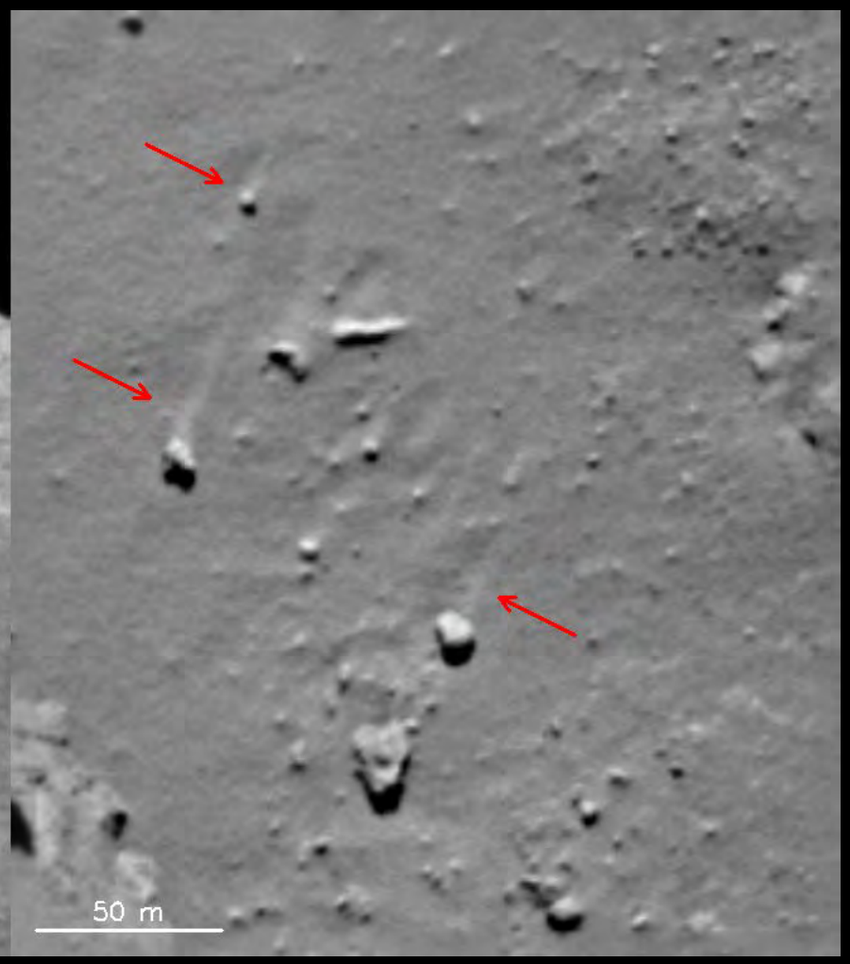
rosetta

Paisajes cubiertos



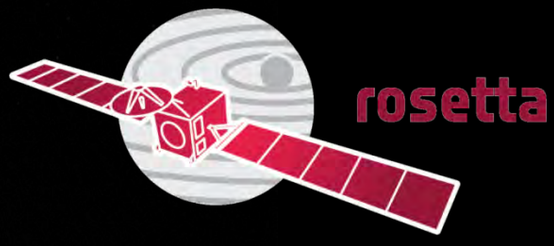
Dunas



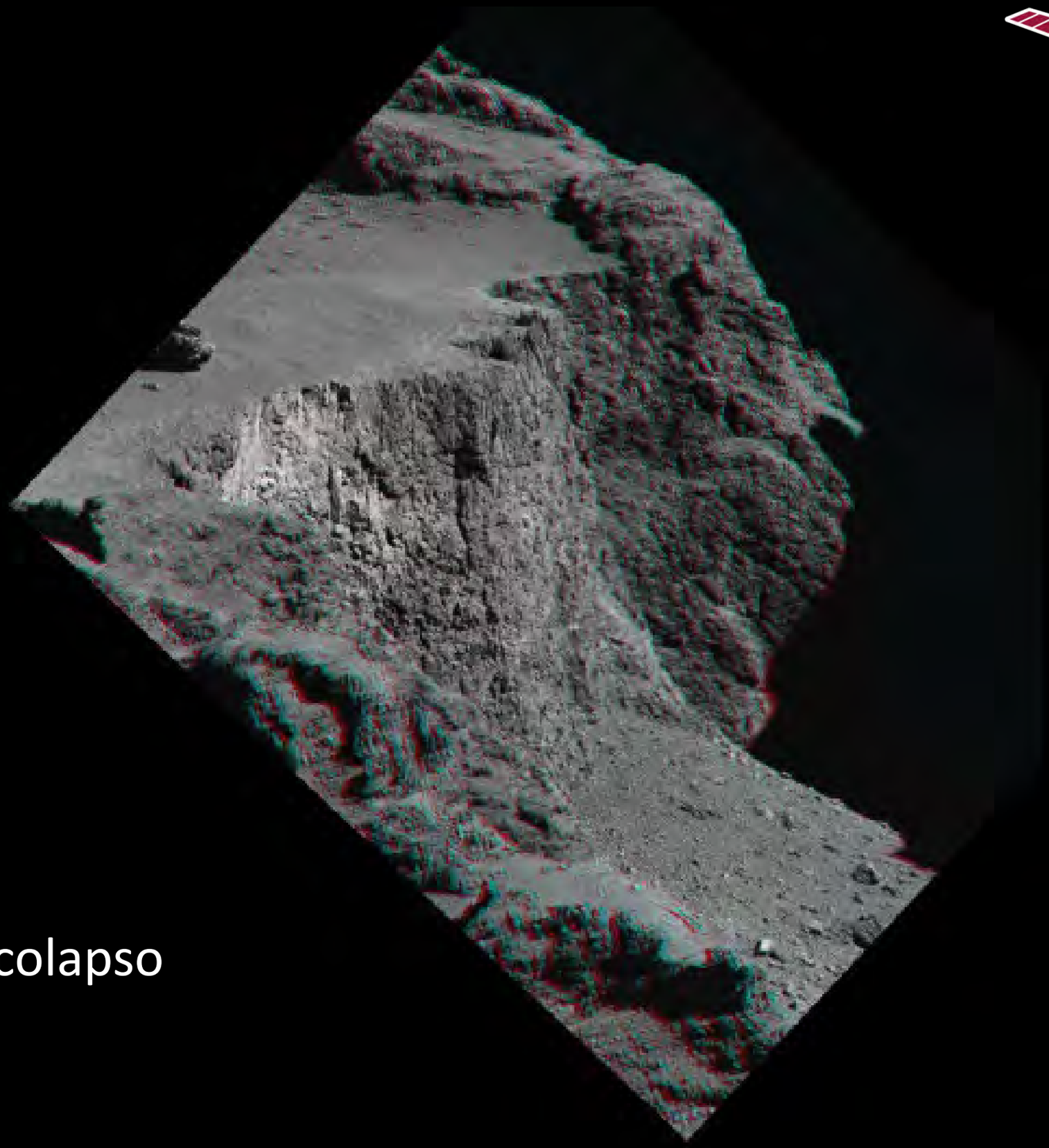


rosetta

Bloques en equilibrio



Acantilados



Acantilados - colapso

rosetta

rosetta

Boulders – Cheops 45m

rosetta

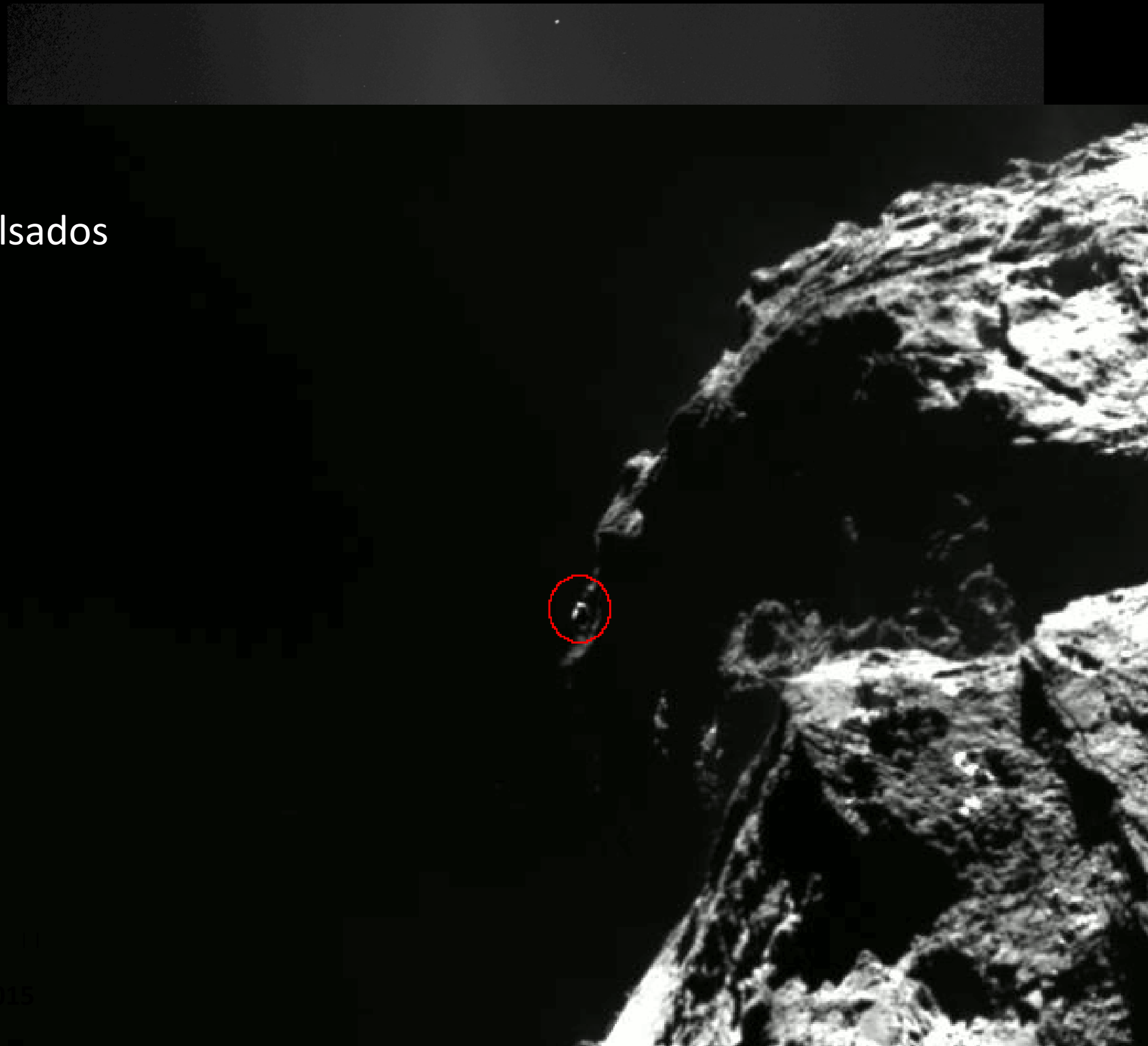
May 2015

Feb 2016

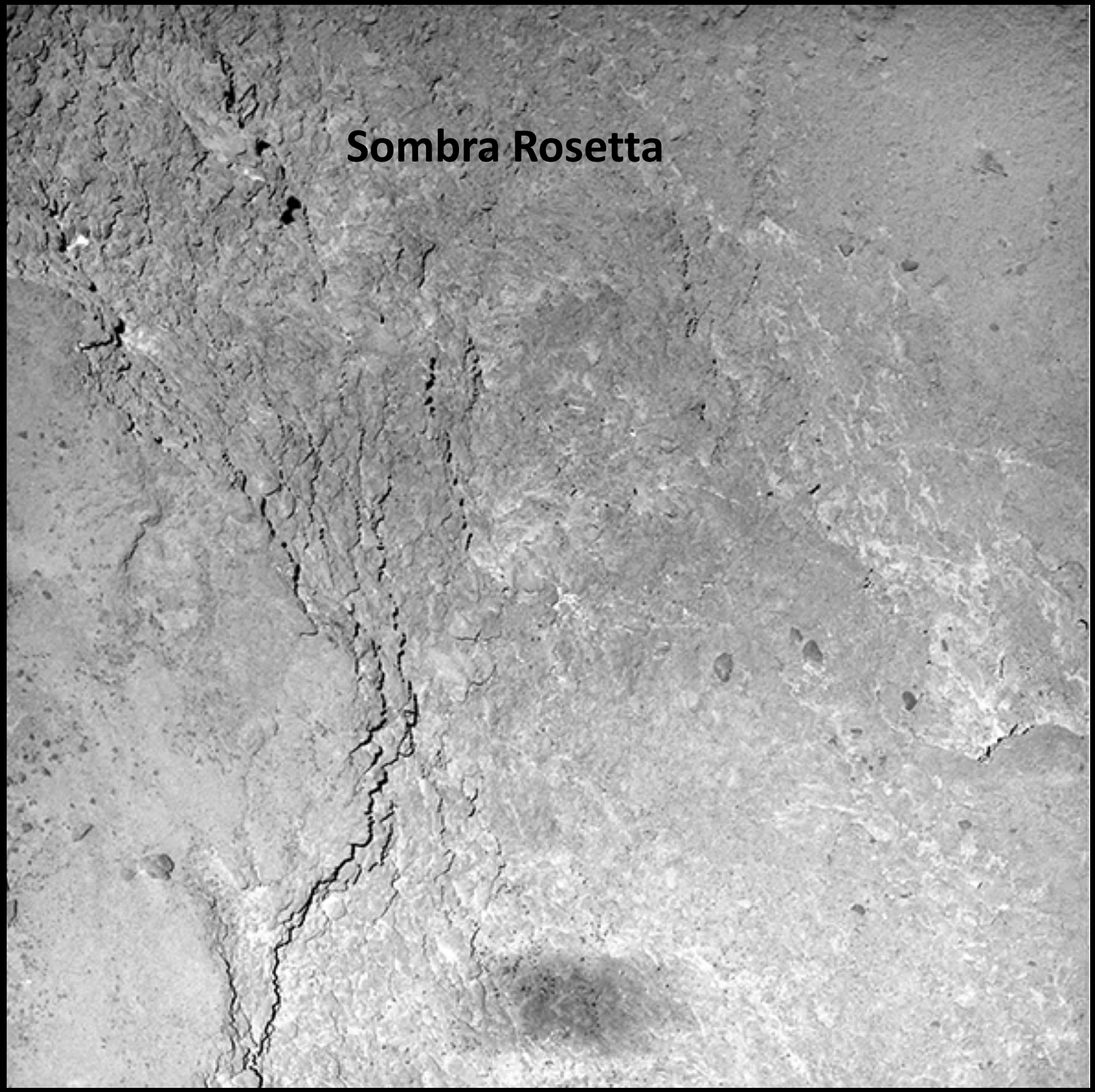
C

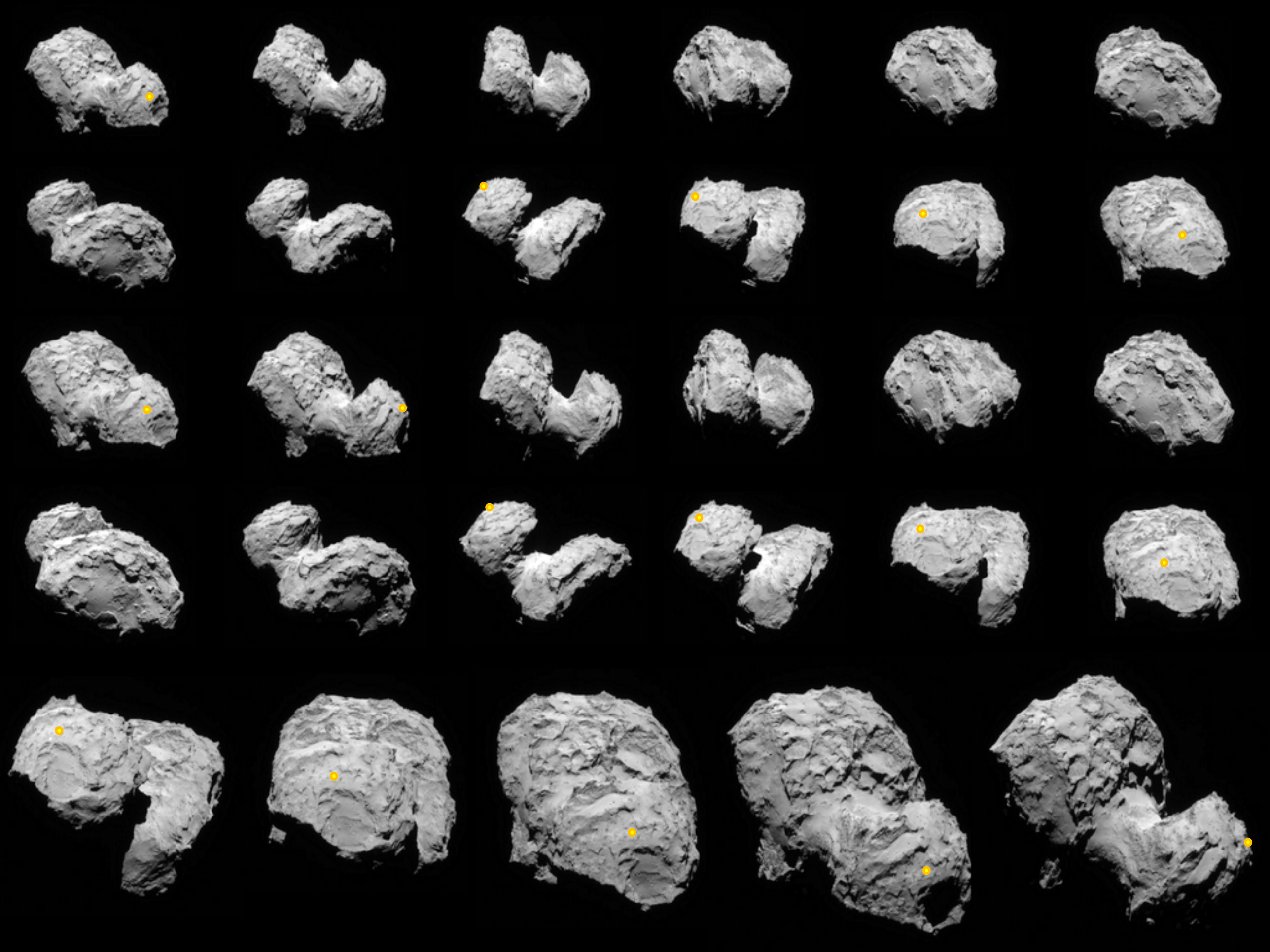
150 m

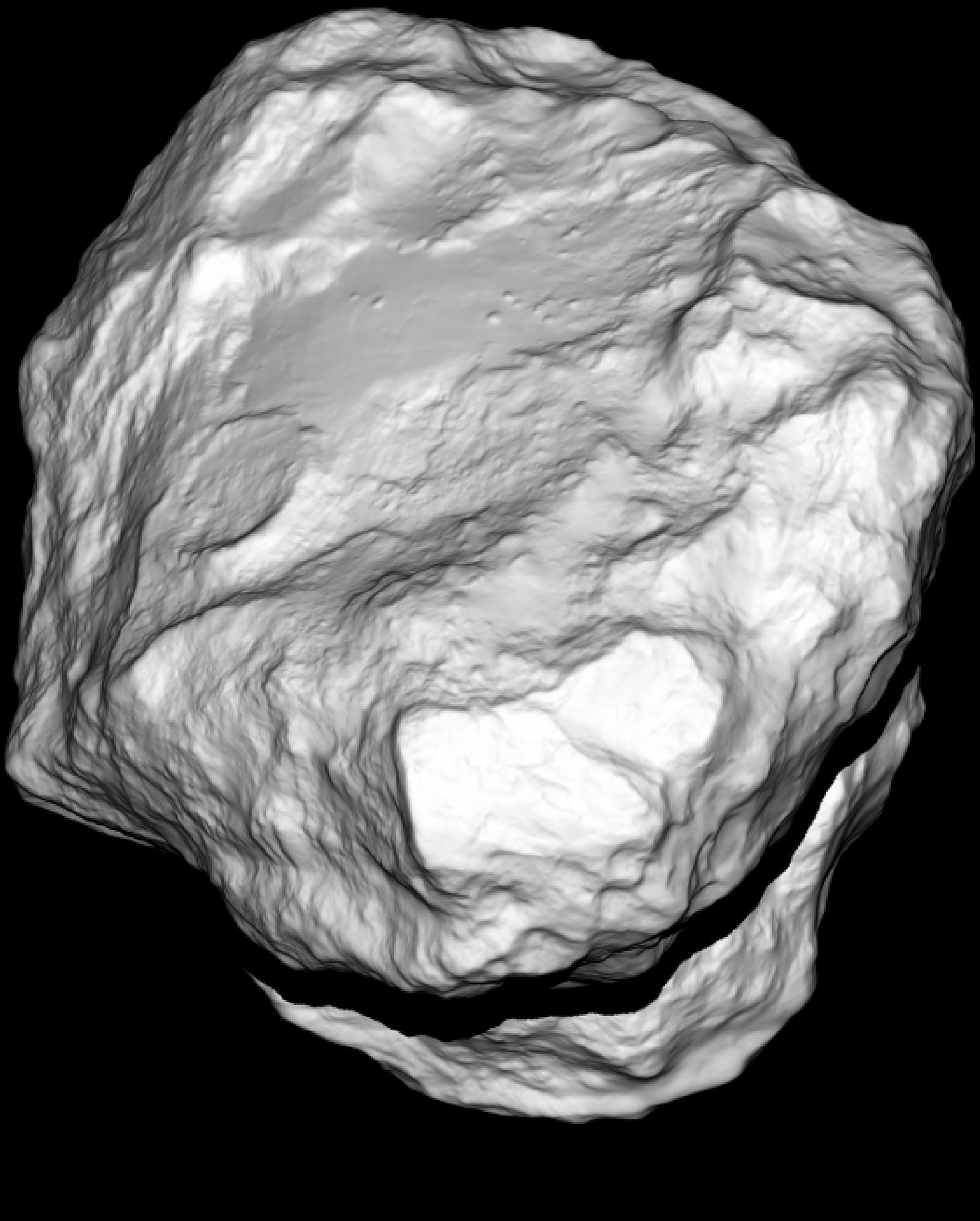
Bloques expulsados



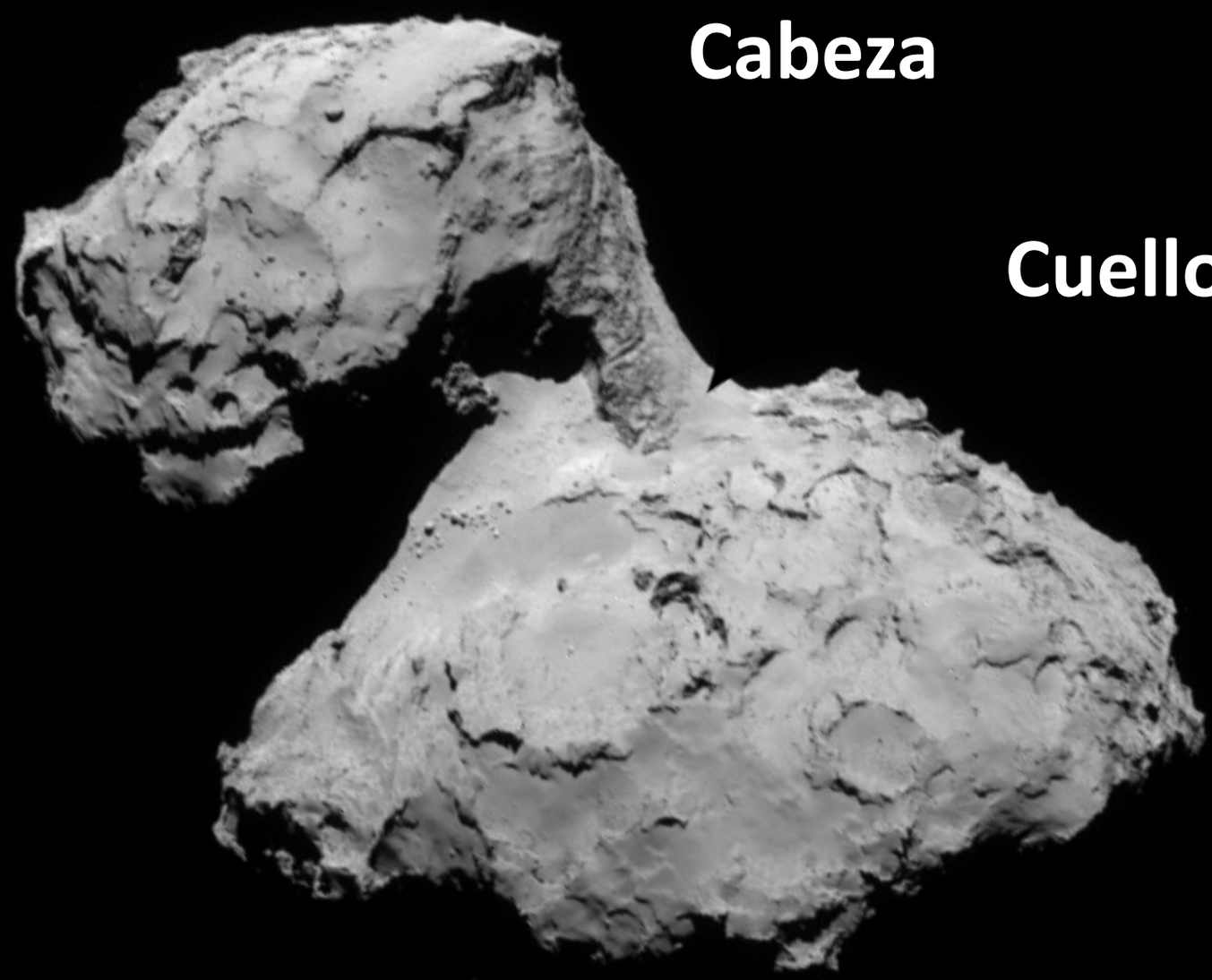
Sombra Rosetta



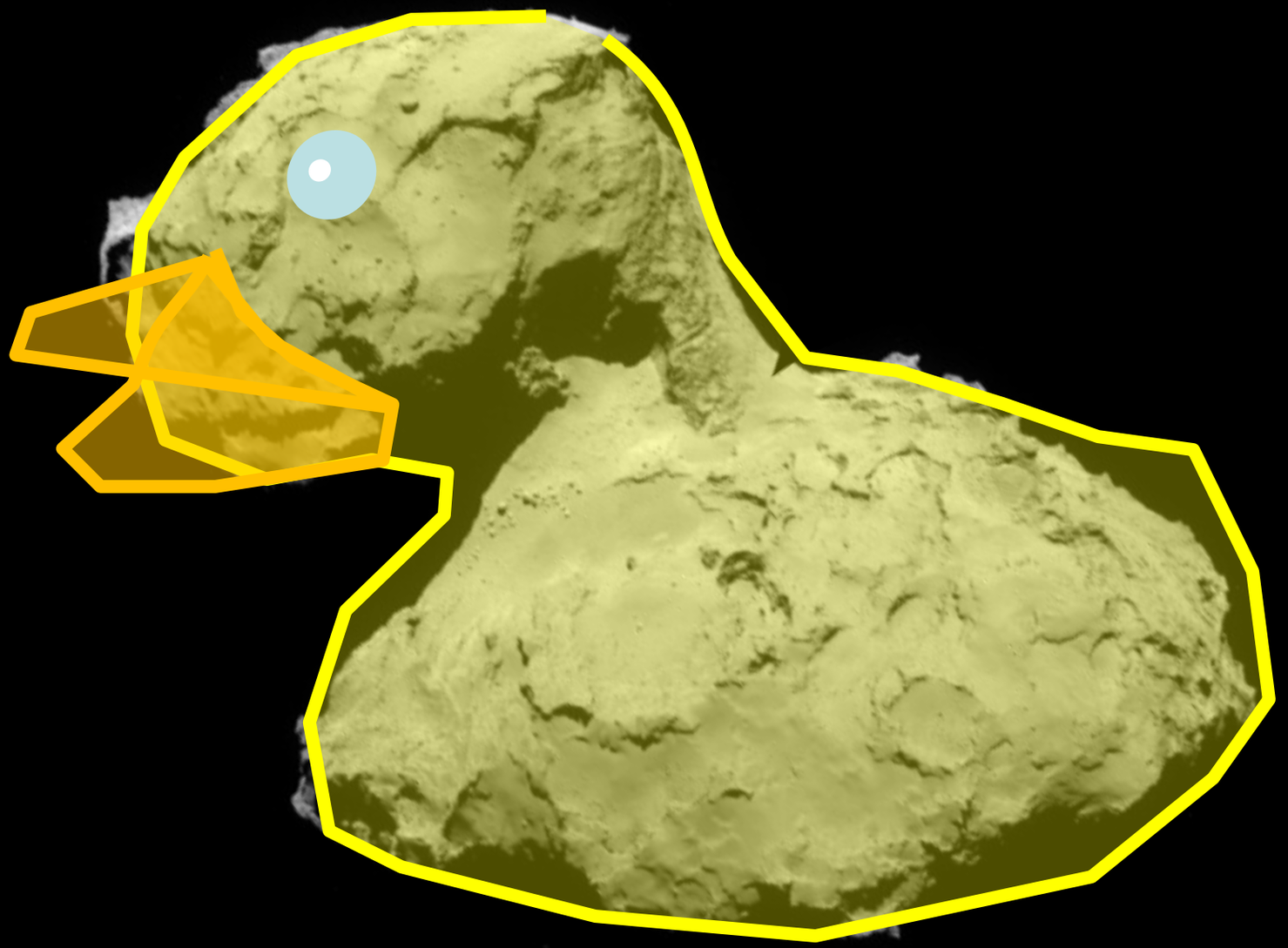


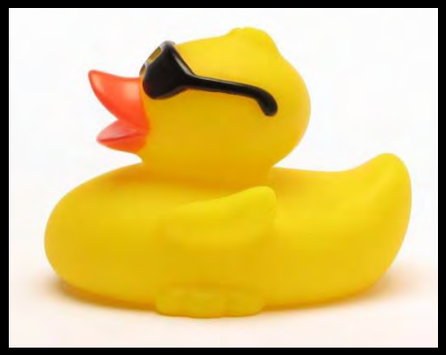


Forma de Chury?

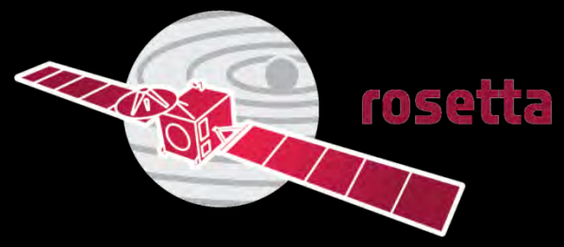


Forma de Chury?





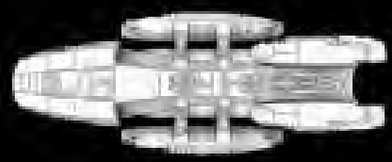
Tamaño relativo



4 km

67P/Churyumov-Gerasimenko

Enterprise



Galactica

Imperial
Star Destroyer

→ MADRID

esa

Plaza de Toros

Palacio Real

4100 m

rosetta

European Space Agency

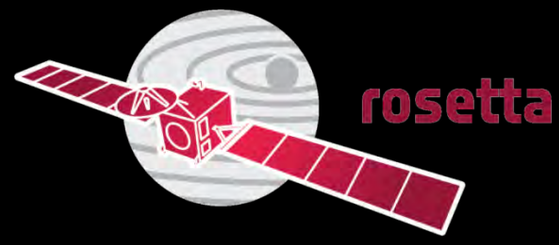
www.esa.int

Map data ©2014 Google, Bluesky Google

Color del cometa?

Credit : B.King

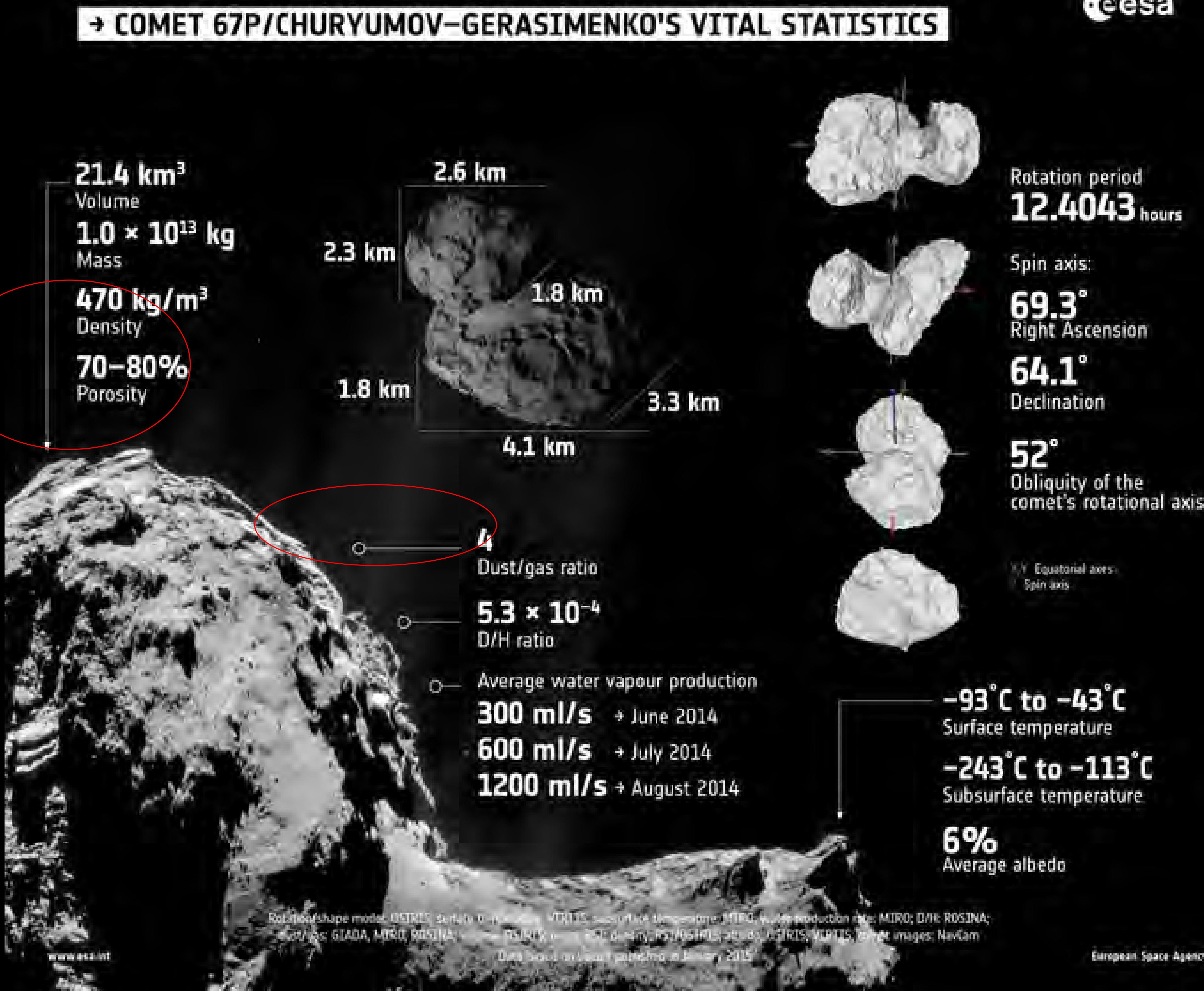
Gravedad. Cuanto pesas en el cometa?



La masa del cometa son 10 billones de toneladas…

La gravedad en la superficie del cometa es 100.000 veces menor que en la superficie de la Tierra

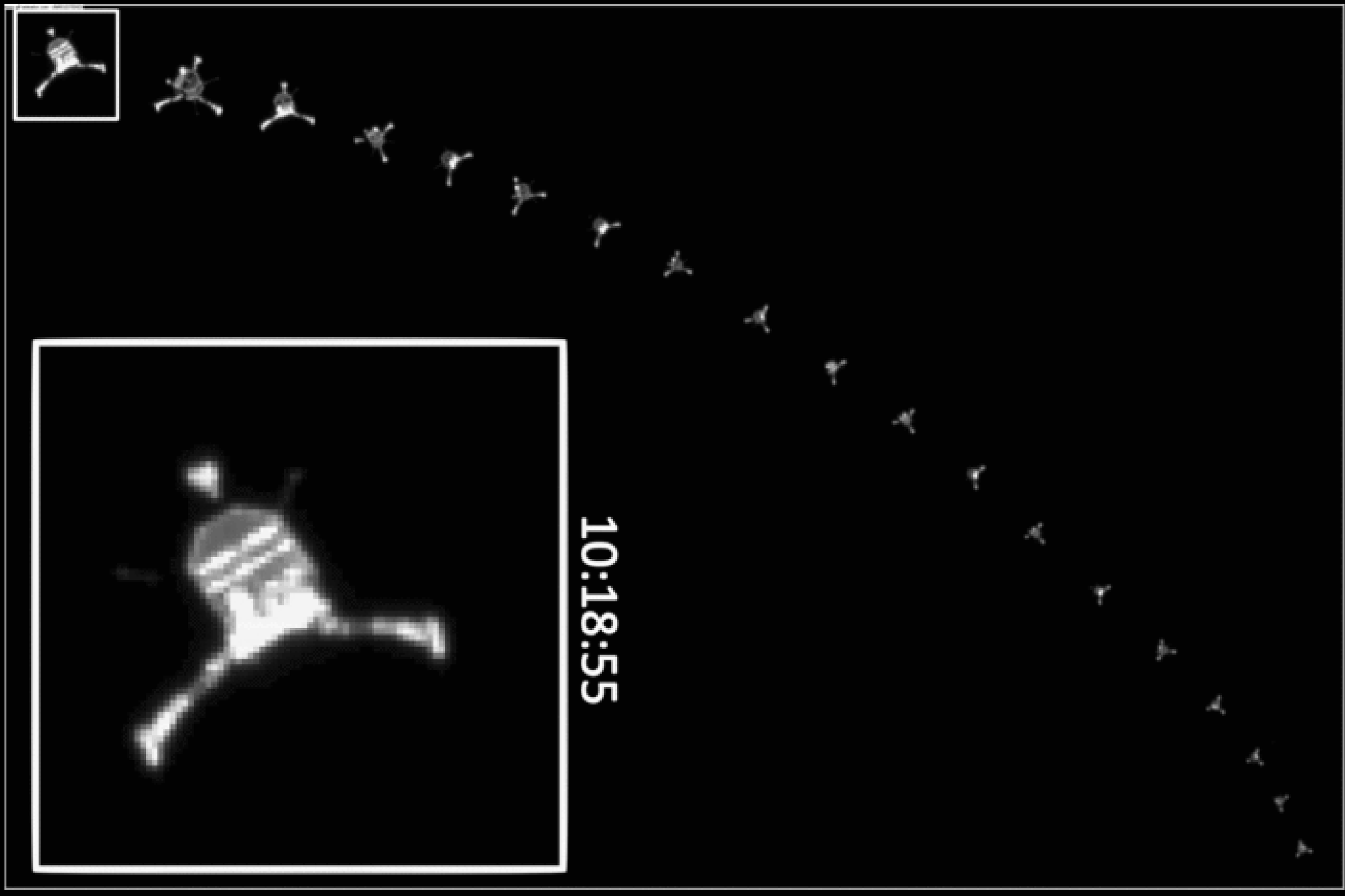
100 Kg ⟶ 1g


→ COMET 67P/CHURYUMOV–GERASIMENKO'S VITAL STATISTICS
21.4 km³
Volume
1.0 × 10¹³ kg
Mass
470 kg/m³
Density
70–80%
Porosity
2.6 km
2.3 km
1.8 km
1.8 km
3.3 km
4.1 km
4
Dust/gas ratio
5.3 × 10⁻⁴
D/H ratio
Average water vapour production
300 ml/s → June 2014
600 ml/s → July 2014
1200 ml/s → August 2014
Rotation period
12.4043 hours
Spin axis:
69.3°
Right Ascension
64.1°
Declination
52°
Obliquity of the comet's rotational axis
Equatorial axes
Spin axis
−93°C to −43°C
Surface temperature
−243°C to −113°C
Subsurface temperature
6%
Average albedo
www.esa.int
European Space Agency

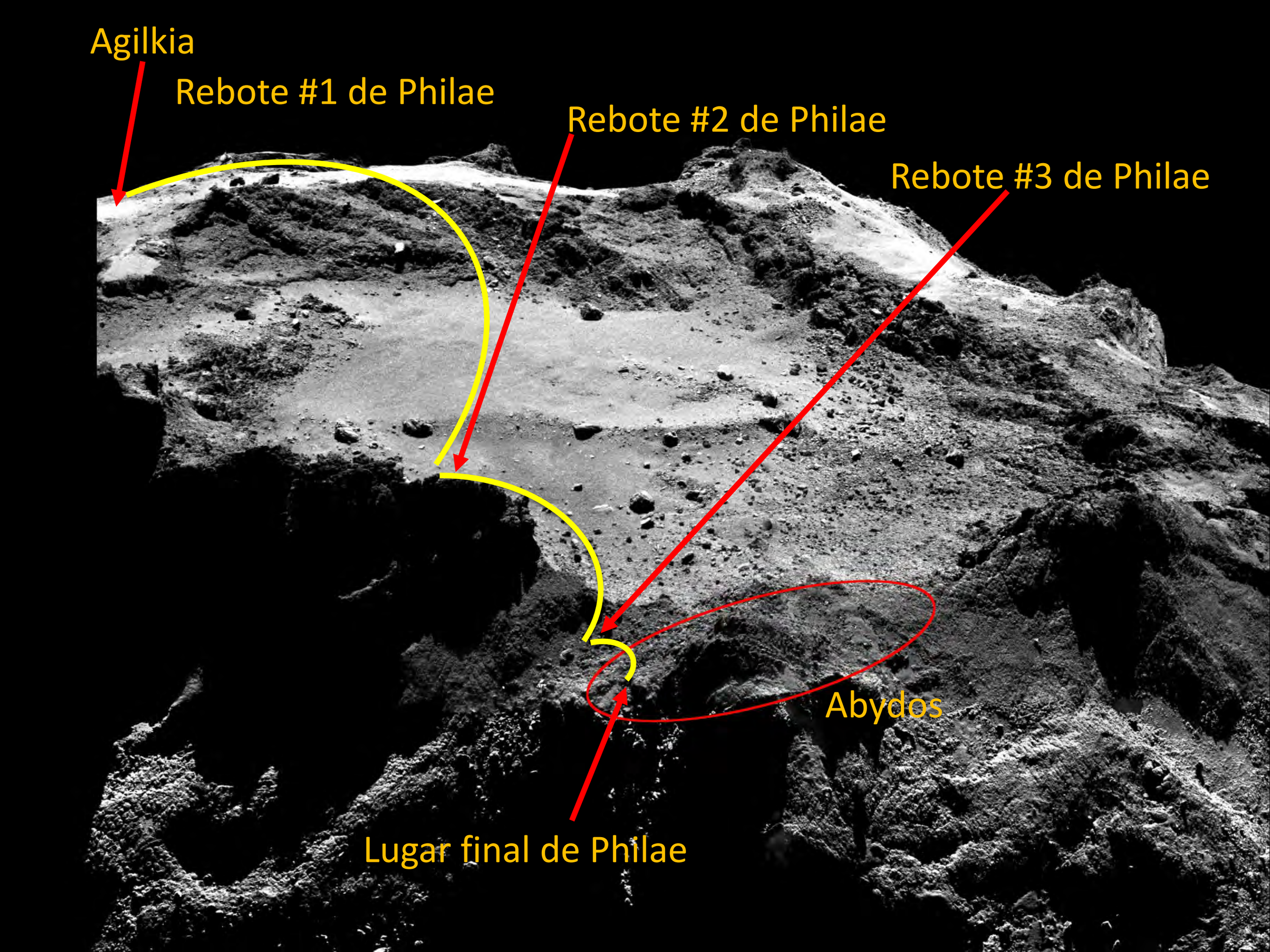
rosetta

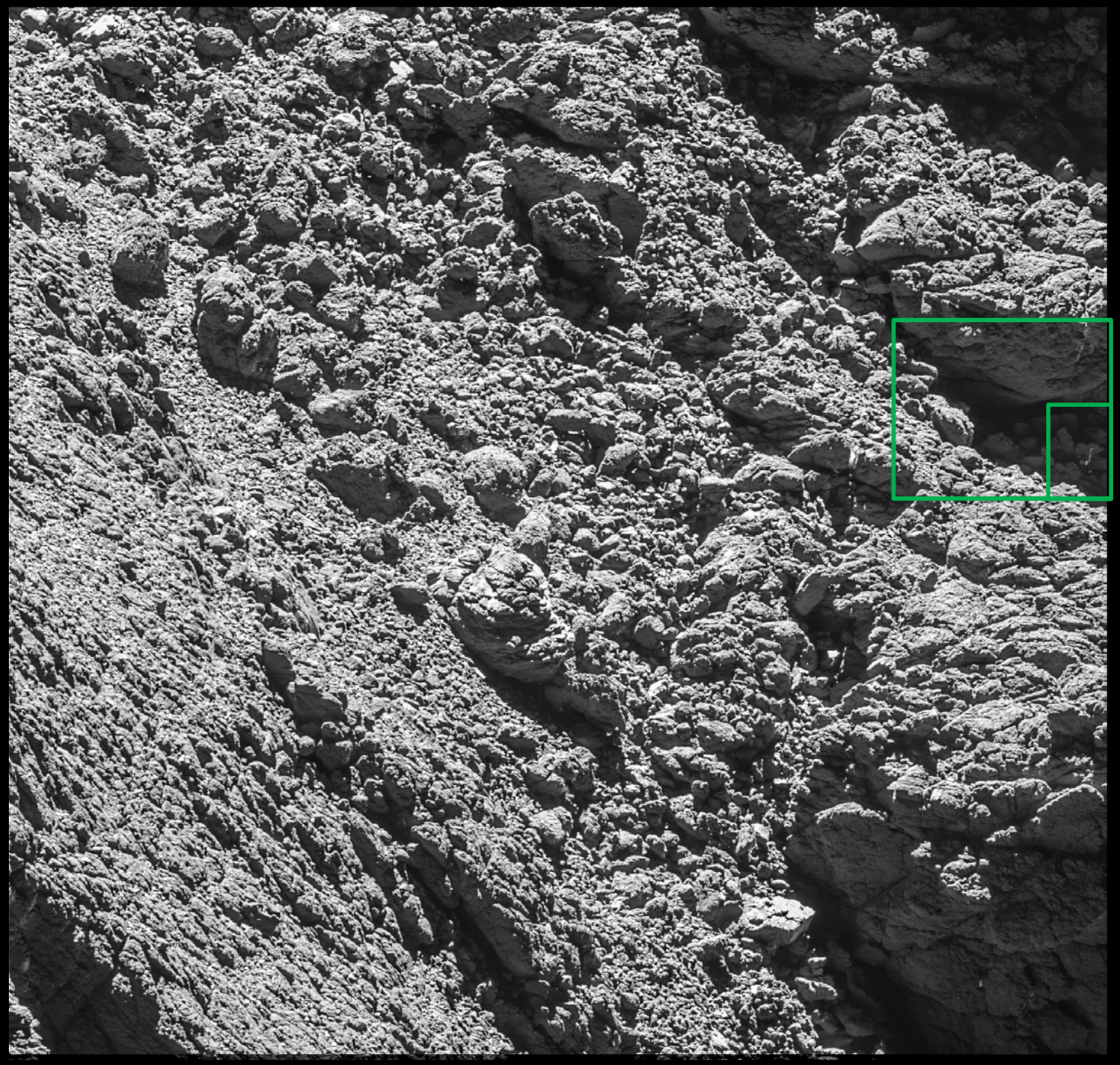
La aventura de Philae

rosetta

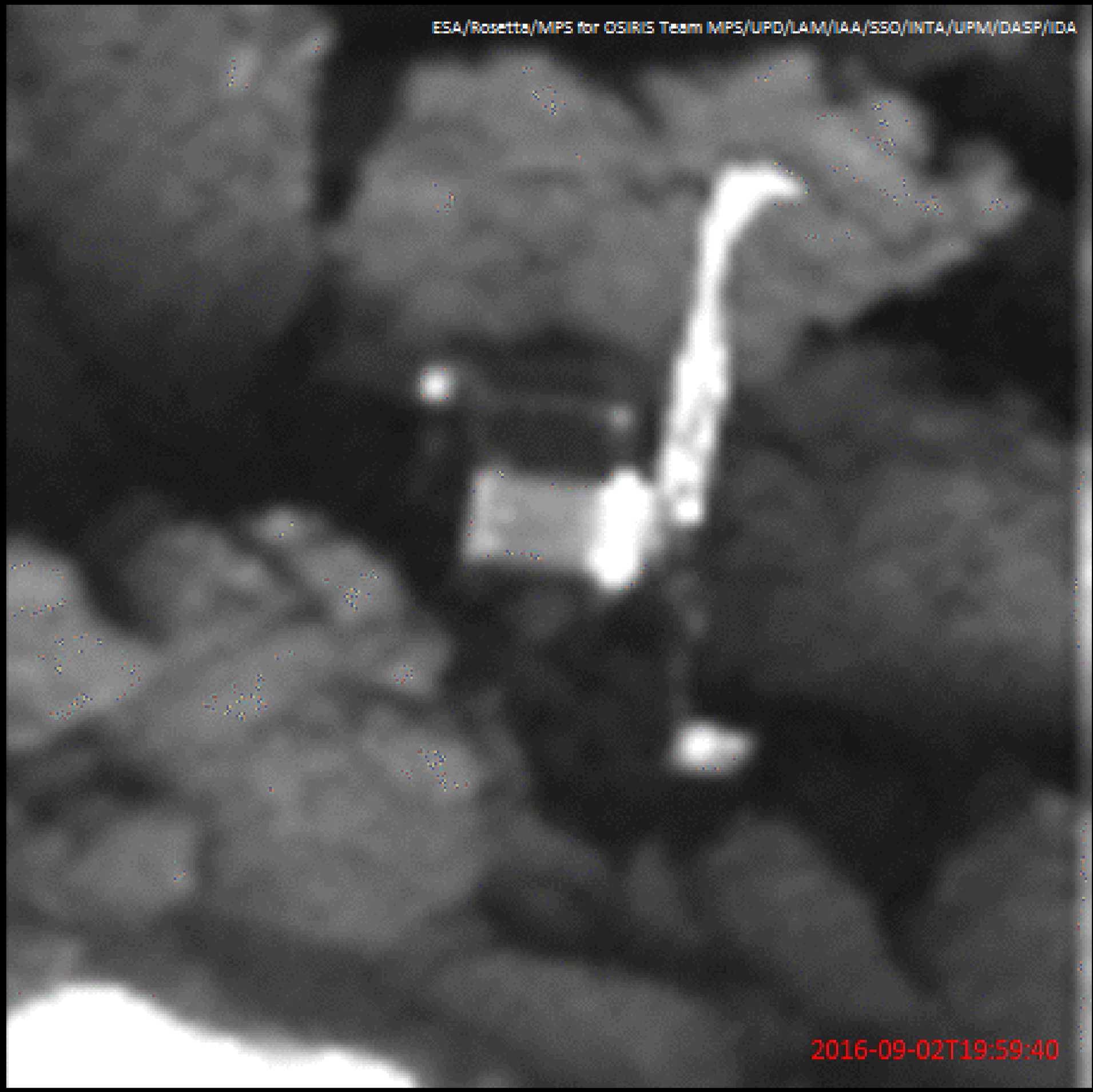


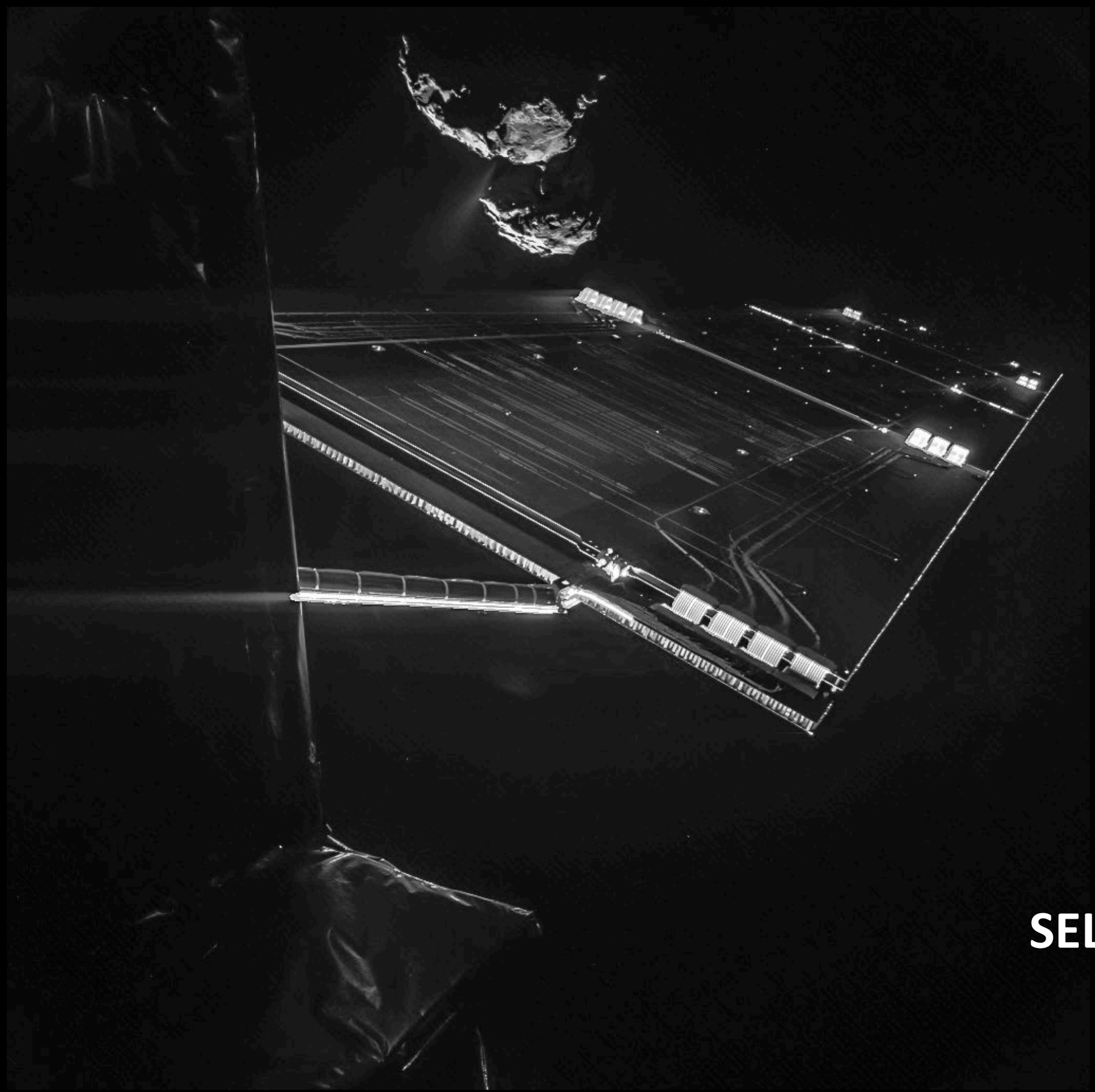
12 Nov 2014


Agilkia
Rebote #1 de Philae
Rebote #2 de Philae
Rebote #3 de Philae
Abydos
Lugar final de Philae



2 September 2016, 2.7 km


ESA/Rosetta/MPS for OSIRIS Team MPS/UPD/LAM/IAA/SSO/INTA/UPM/DASP/IDA
2016-09-02T19:59:40

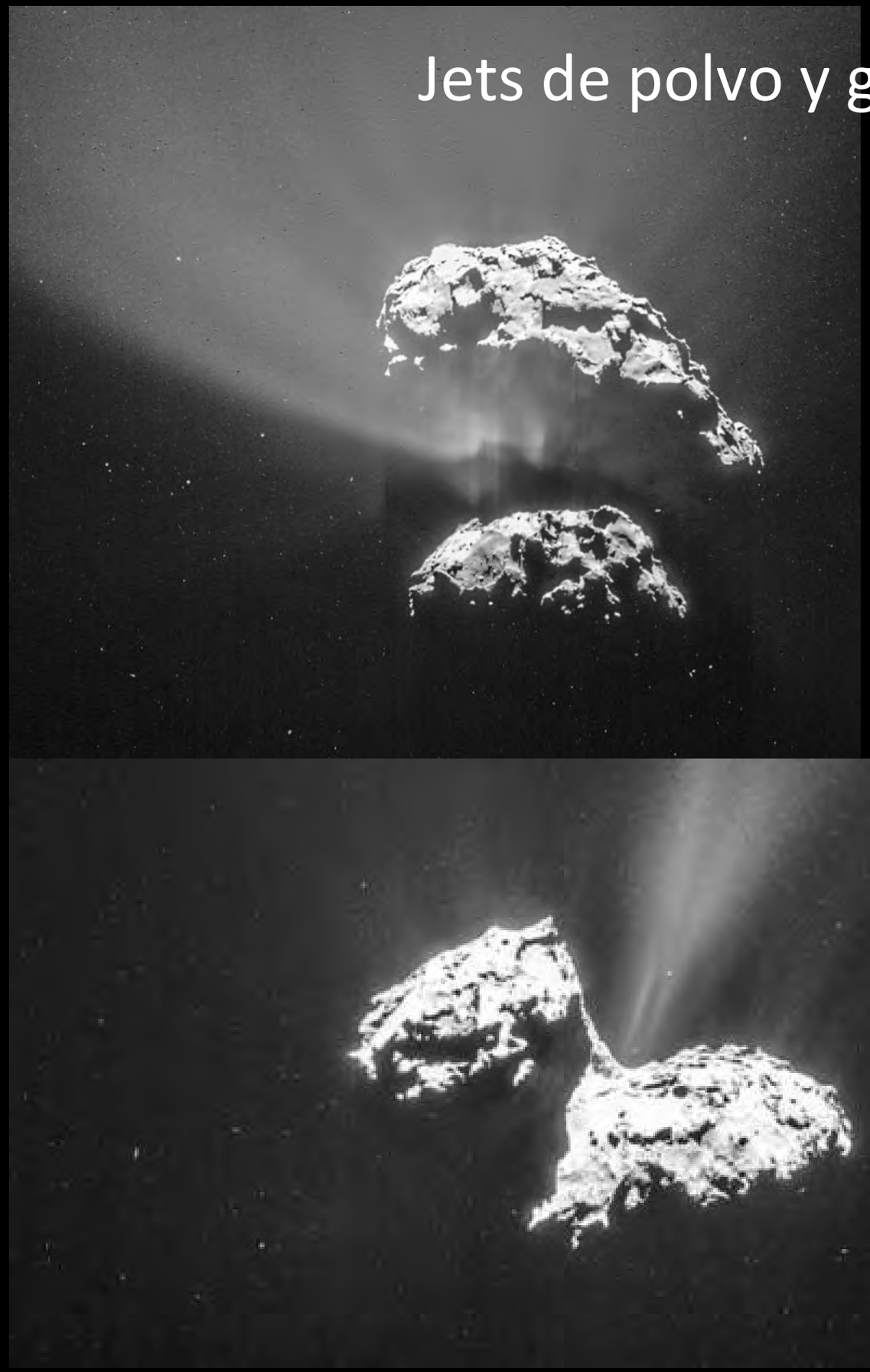


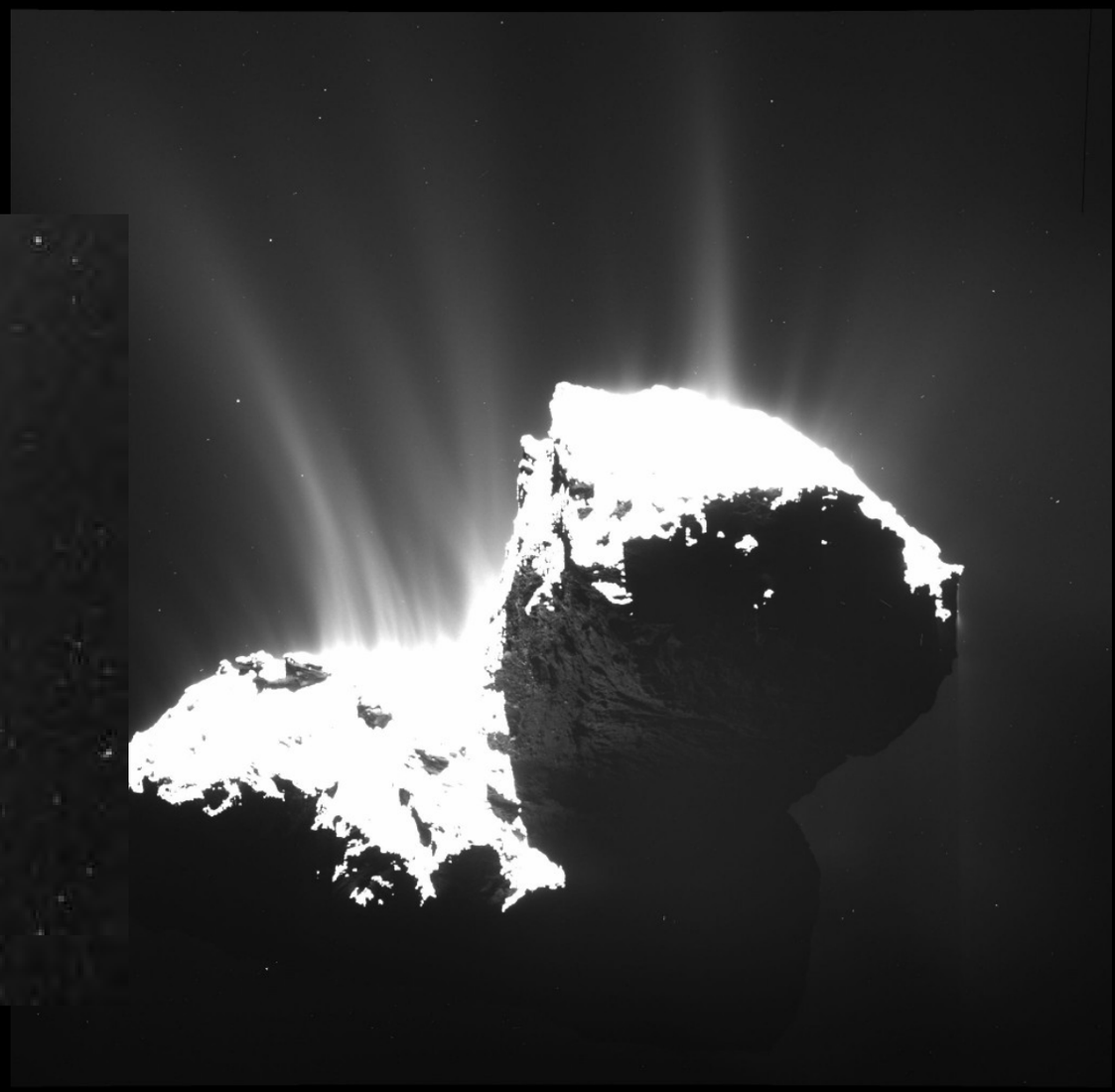
rosetta

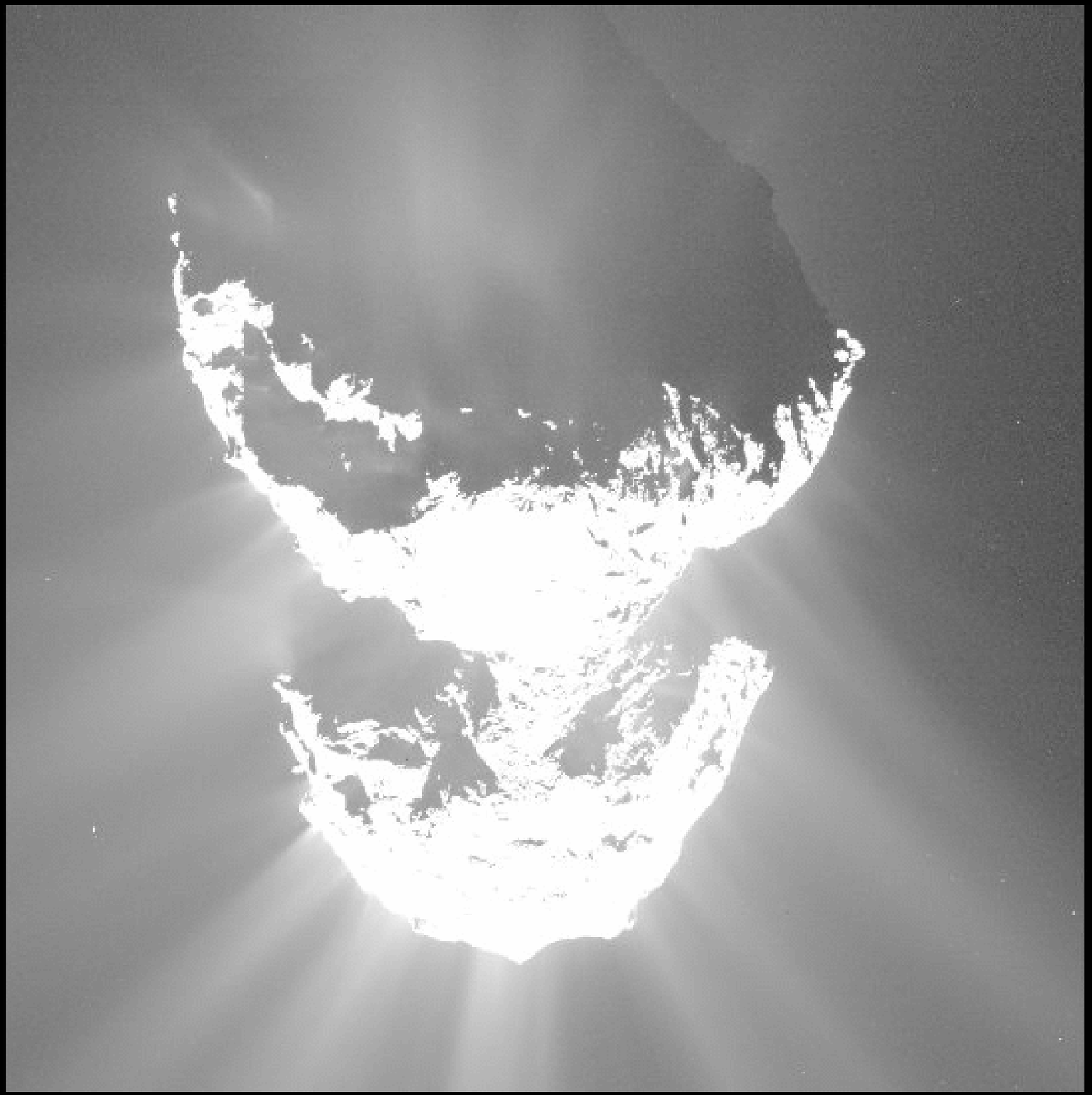
SELFIE!

rosetta

Jets de polvo y gas al acercarse al Sol

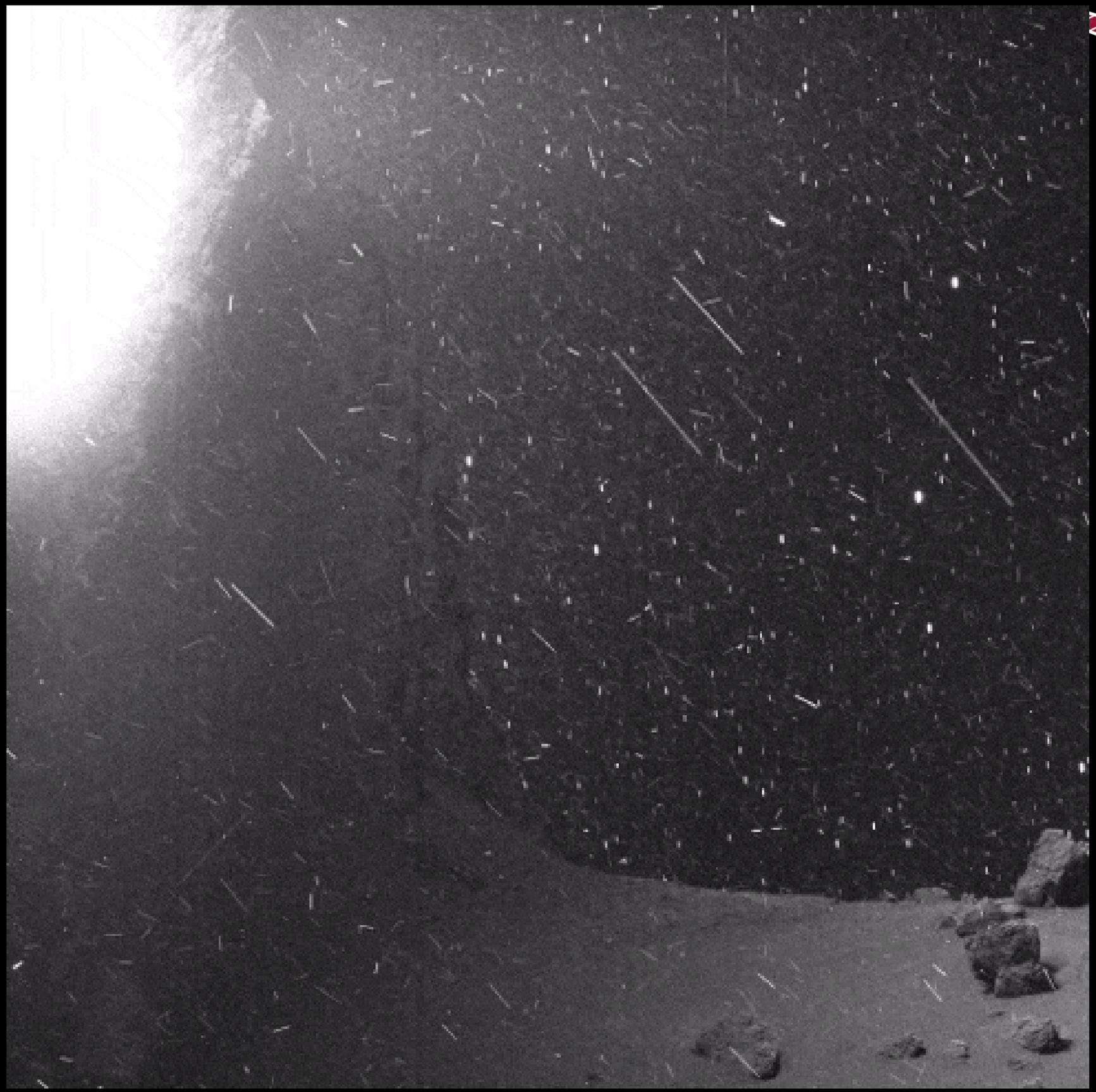






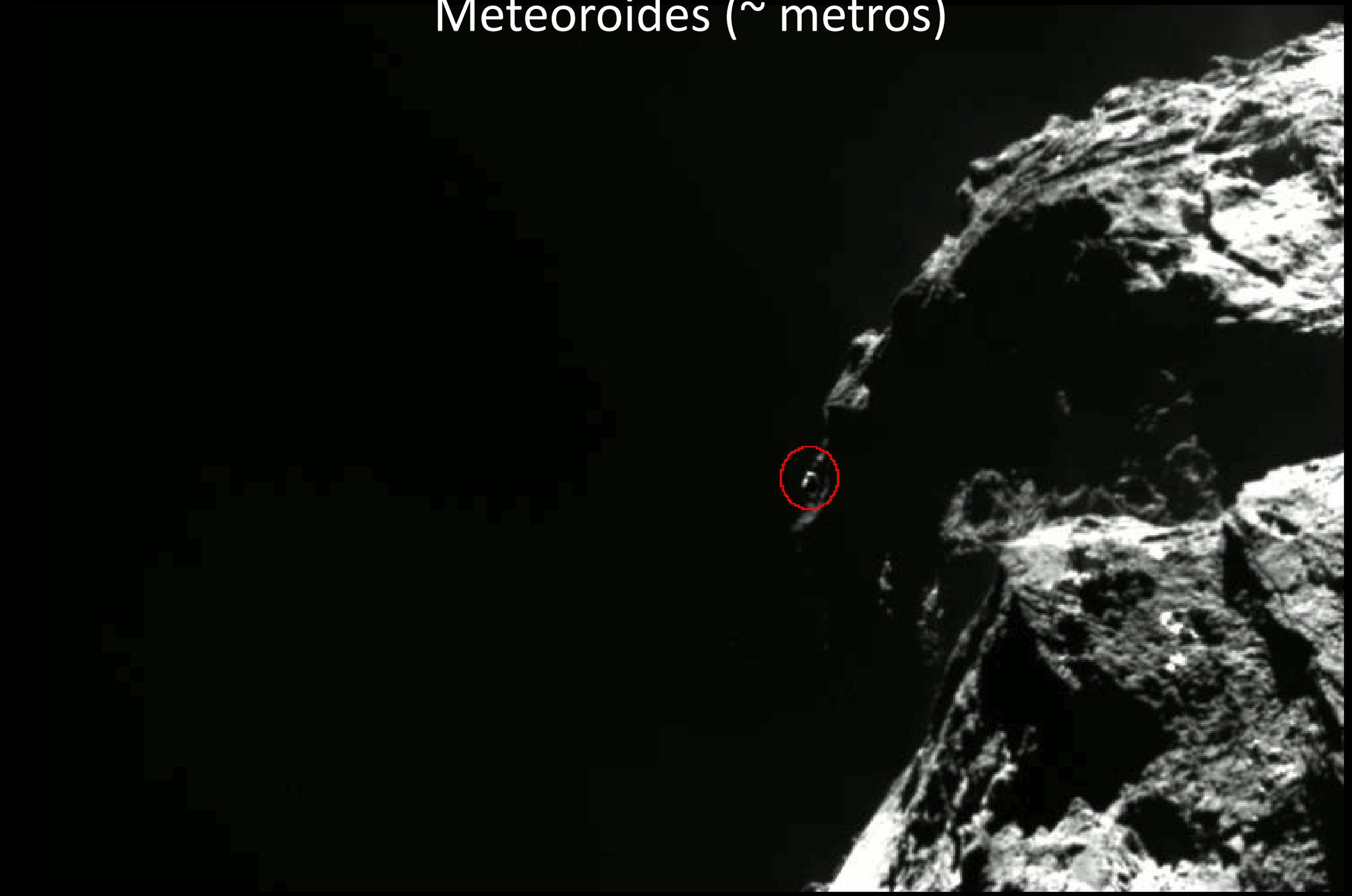
Meteoroides

El entorno de
Rosetta

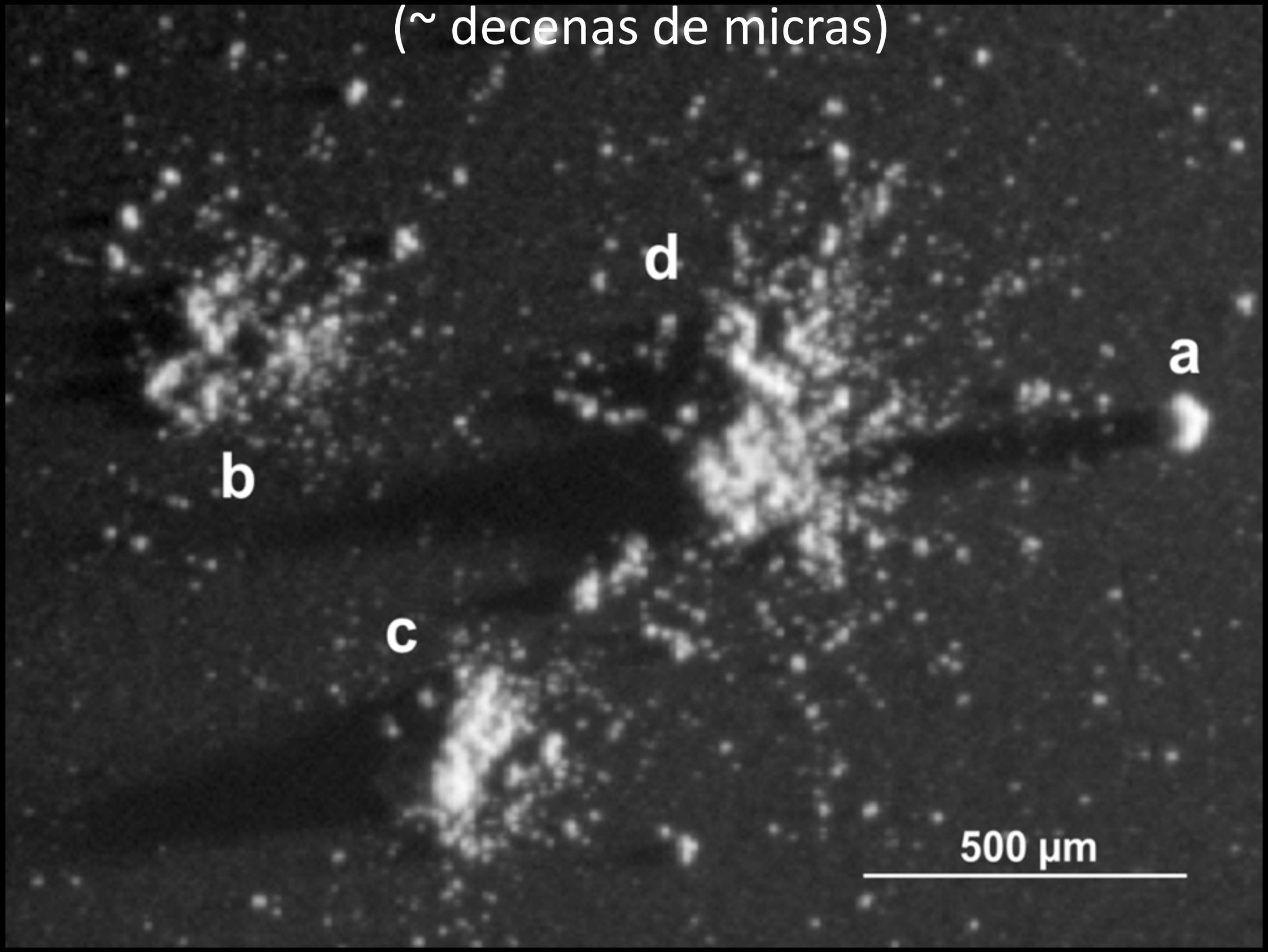


rosetta

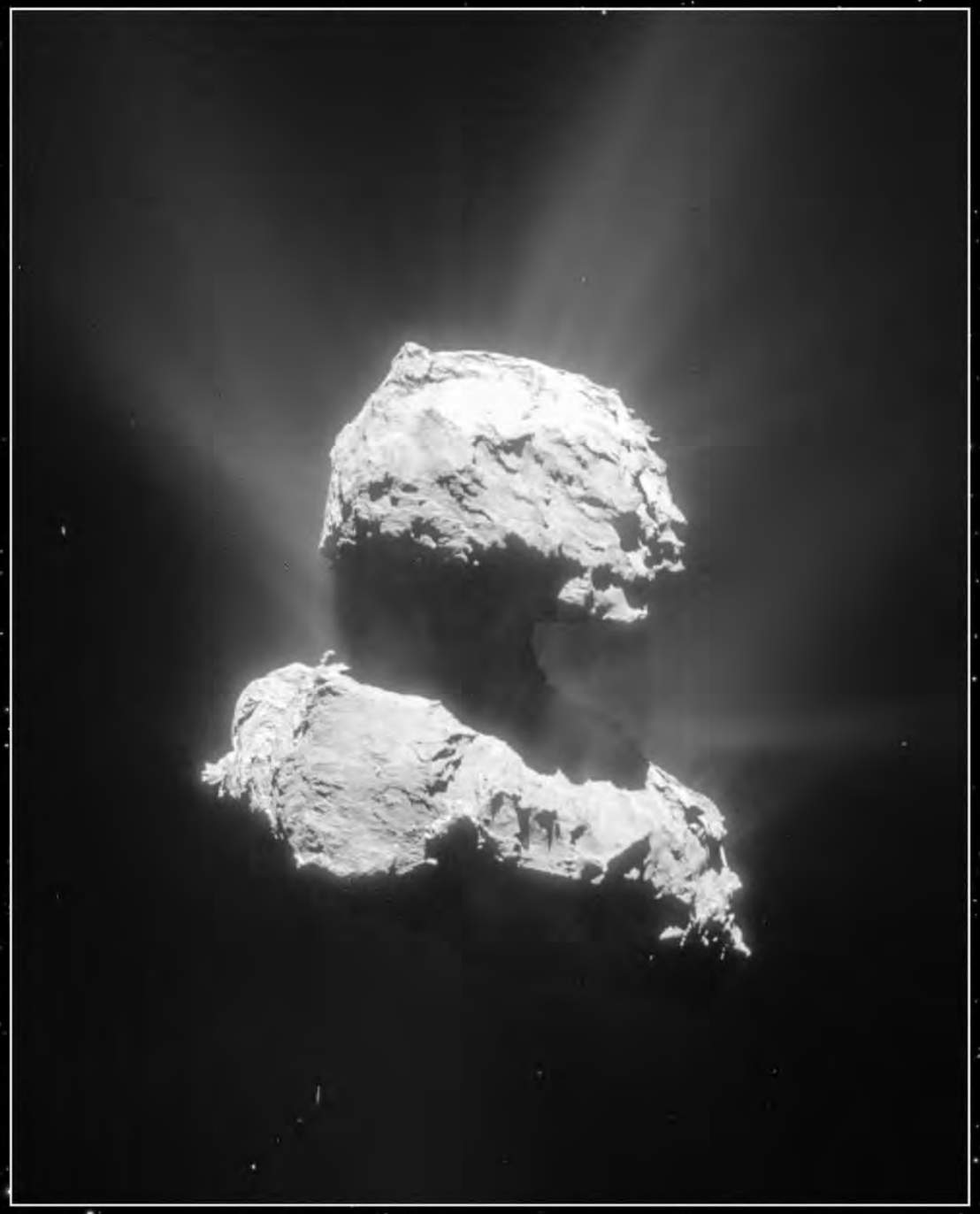
Meteoroides (~ metros)



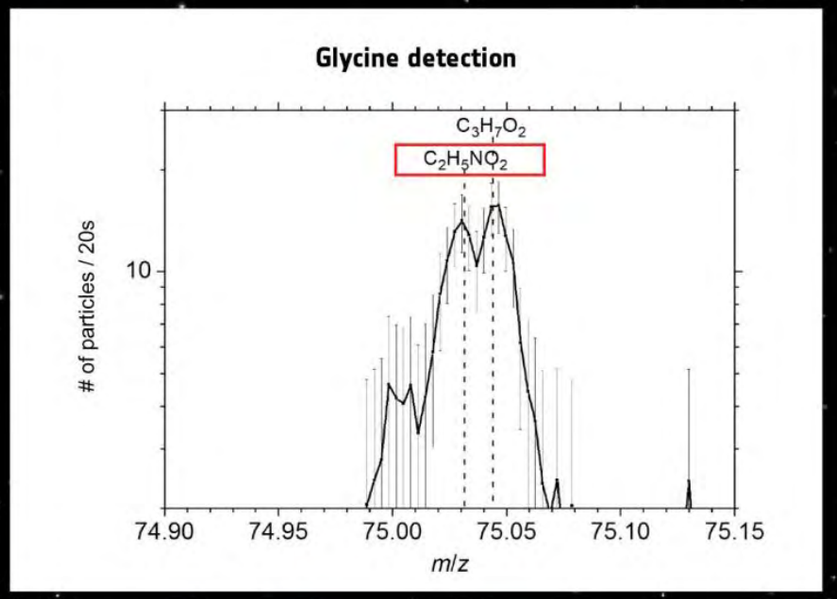
Micro-meteoroides primordiales
(~ decenas de micras)



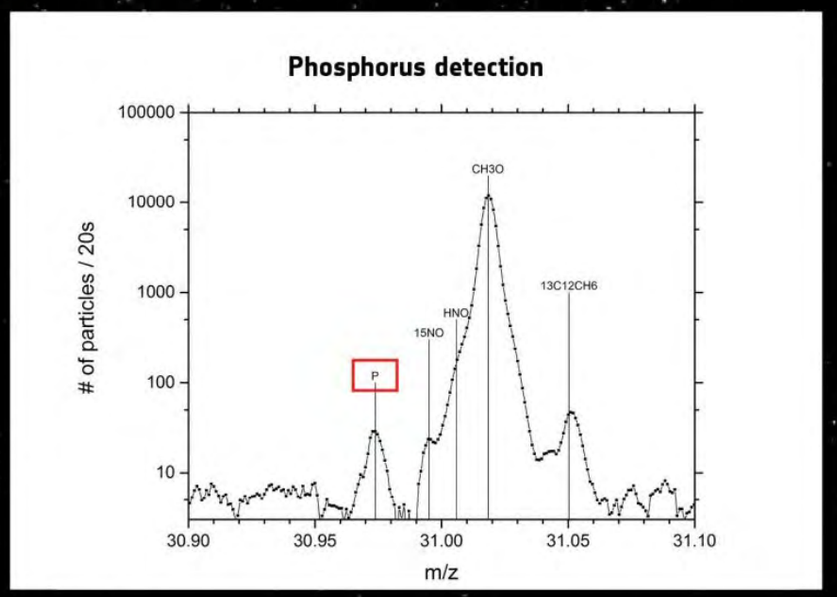
Ranking 1: glicina y fosforo, ingredientes de la vida



The measurements were made when Rosetta was between 10 and 200 km from the comet.



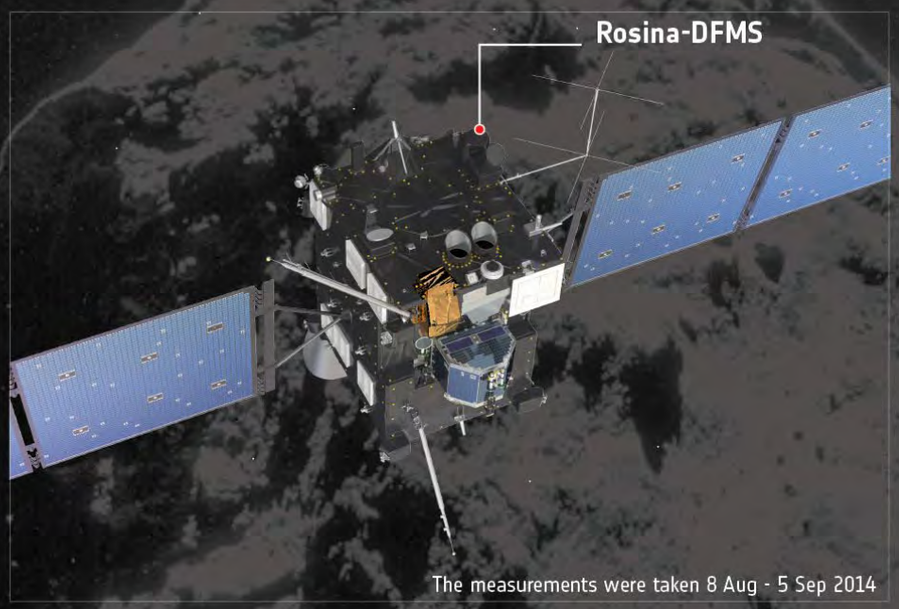
Spectrum indicating glycine ($C_2H_5NO_2$) detection on 9 July 2015. The simple amino acid glycine is a biologically important organic compound commonly found in proteins.



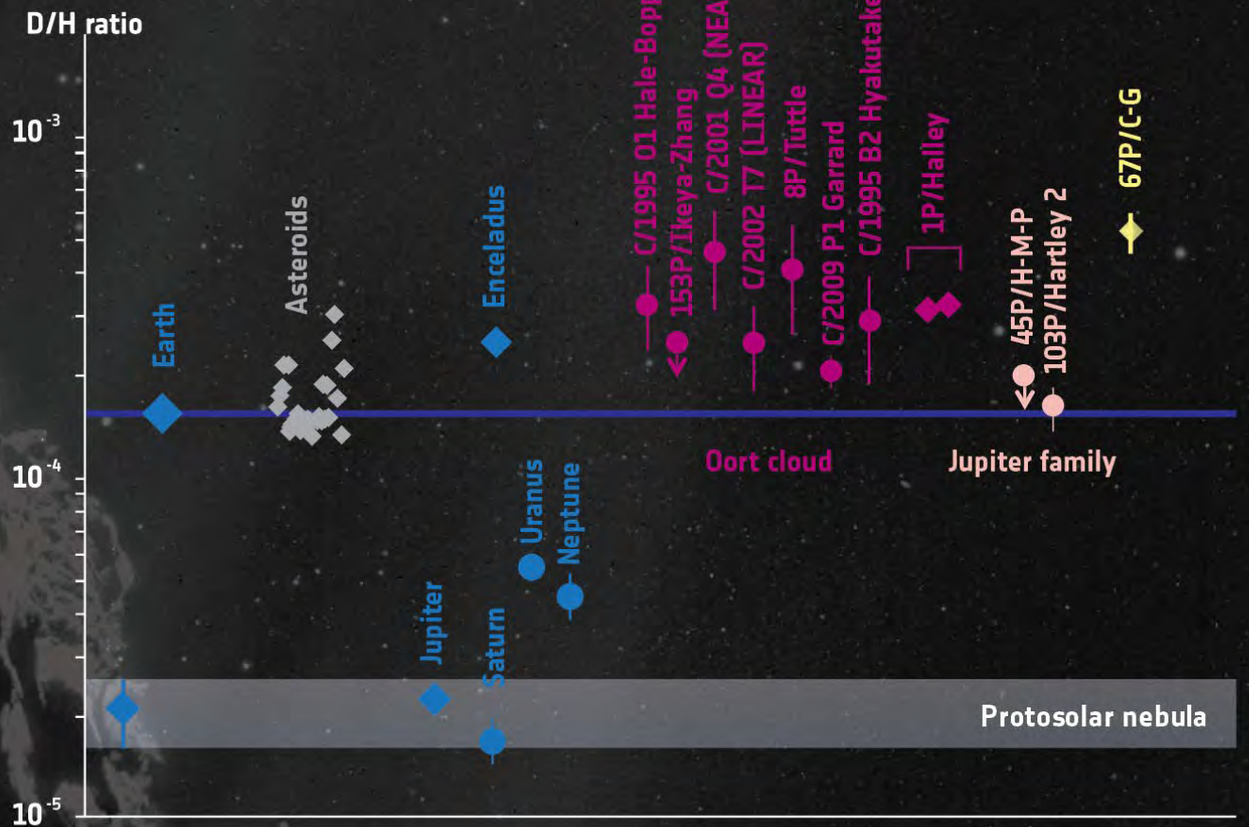
Spectrum indicating phosphorus (P) detection, along with other gases, on 26 October 2014. Phosphorus is a key element in all living organisms. It is found in DNA, RNA and in cell membranes, and it is used in transporting chemical energy within cells for metabolism.

Ranking 2: el agua del cometa no es como la de la Tierra

Rosetta's ROSINA instrument finds Comet 67P/Churyumov-Gerasimenko's water vapour to have a significantly different composition to Earth's oceans.

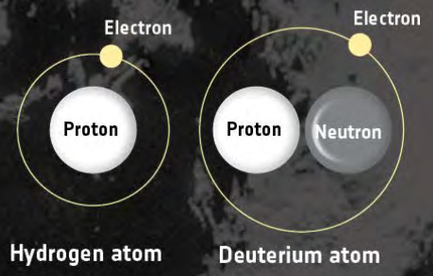


The measurements were taken 8 Aug - 5 Sep 2014



D/H ratio for different Solar System objects, grouped by colour as planets and moons (blue), chrondritic meteorites from the Asteroid Belt (grey), comets originating from the Oort cloud (purple) and Jupiter family comets (pink). Comet 67P/C-G, a Jupiter family comet, is highlighted in yellow. ◆ = data obtained in situ ●= data obtained by astronomical methods

The ratio of deuterium to hydrogen in water is a key diagnostic to determining where in the Solar System an object originated and in what proportion asteroids and comets may have contributed to Earth's oceans



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Spacecraft: ESA/ATG medialab; Comet: ESA/Rosetta/NAVCAM; Data: Altwegg et al. 2014 and references therein.

European Space Agency