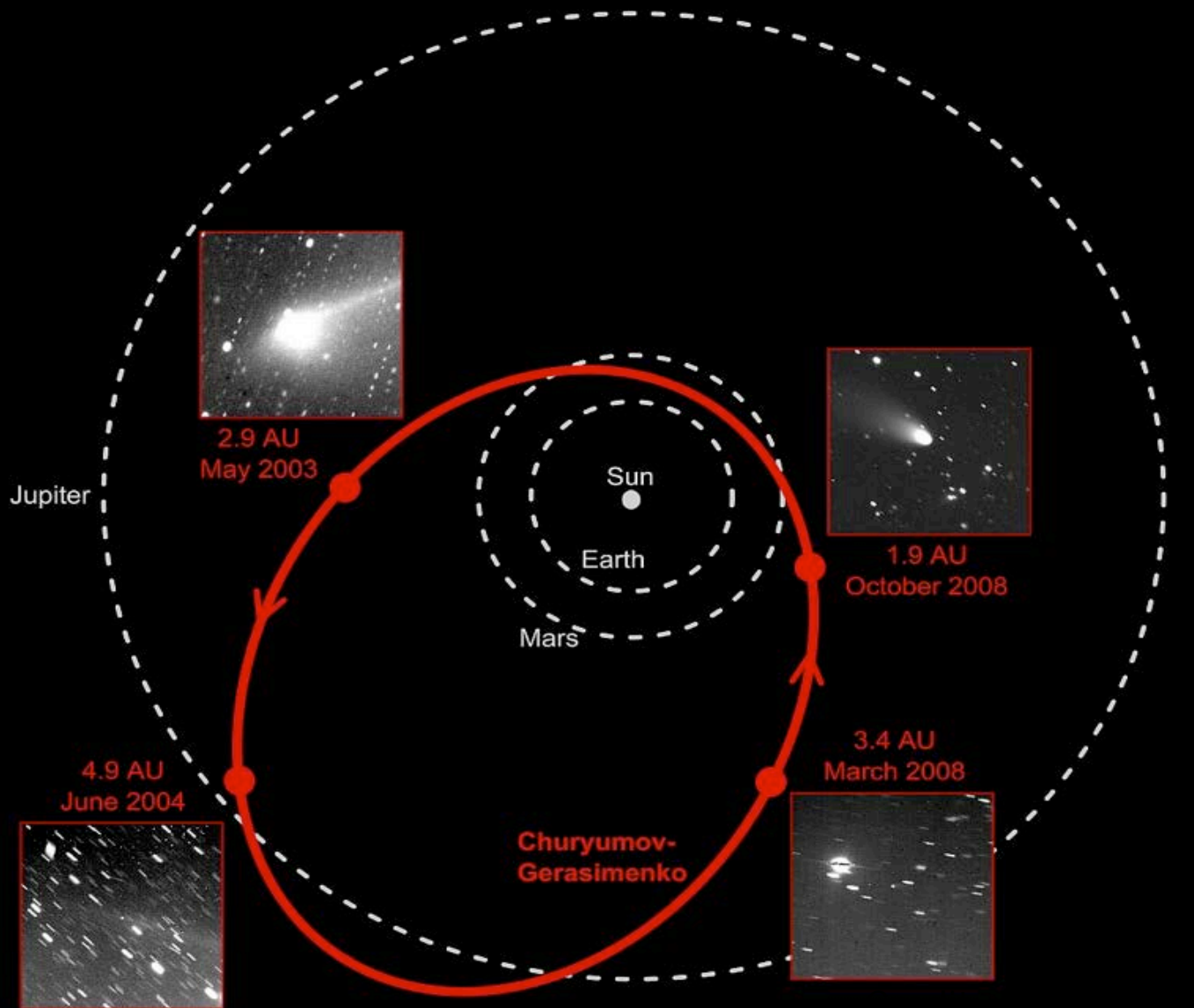


Rosetta:  
A voyage to a comet and to our origins

# 67P/Churyumov-Gerasimenko

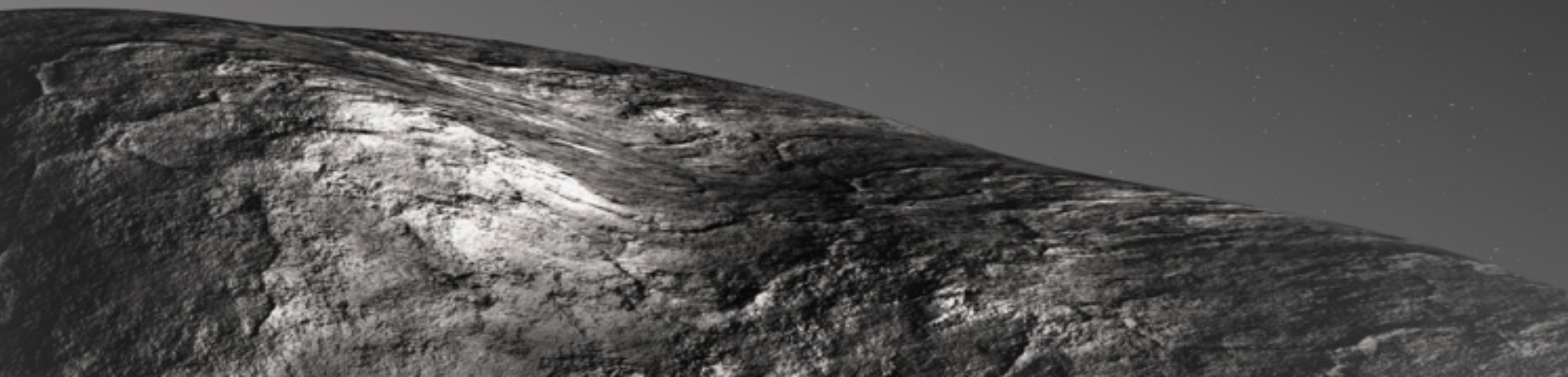


Klim Churyumov, Jean-Jacques Dordain (ESA), & Svetlana Gerasimenko at the launch of Rosetta

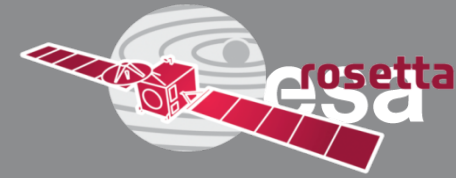




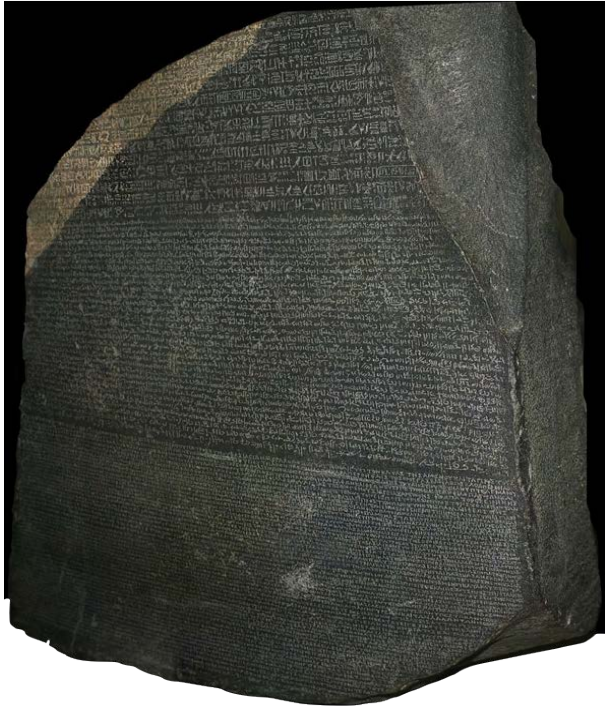
# Rosetta: The mission



# Rosetta



## Rosetta stone

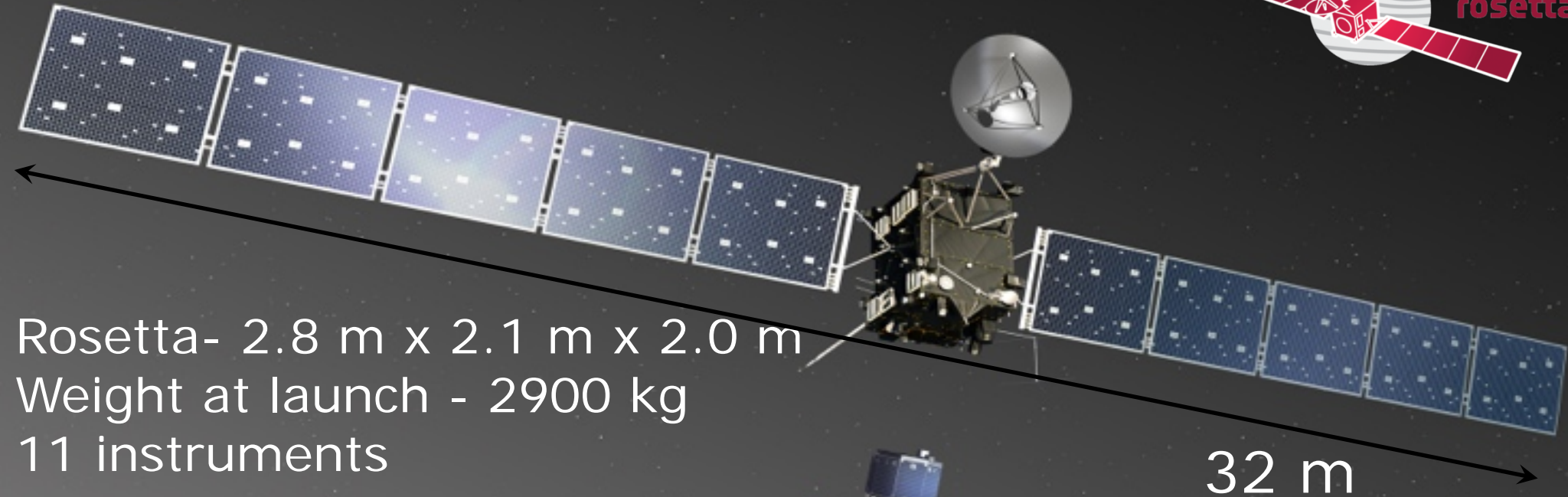


## Philae: temple of Isis



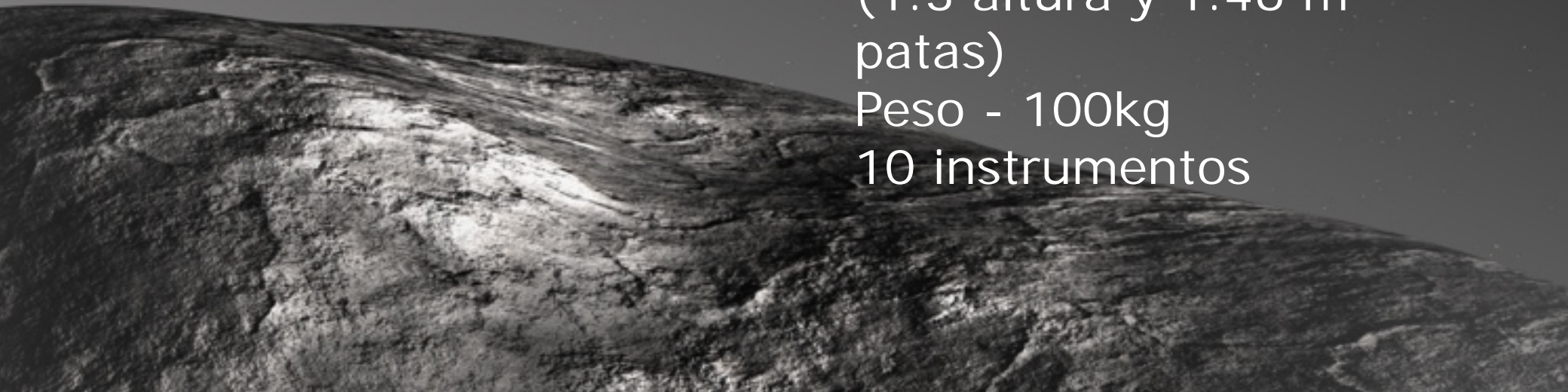
Agilkia: island in the Nile where  
Philae is now





Rosetta- 2.8 m x 2.1 m x 2.0 m  
Weight at launch - 2900 kg  
11 instruments

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



# Instrumentation (Orbiter)

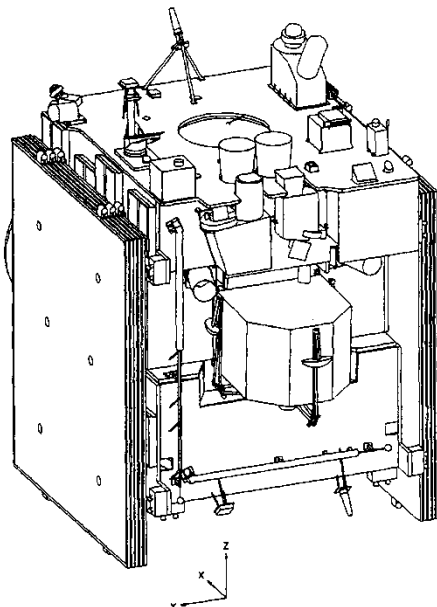


## Remote Sensing Experiments

ALICE Ultra Violet Spectrometry (70– 205 nm)  
OSIRIS Optical Science Imaging (250 – 1000 nm)  
MIRO Microwave Spectroscopy (1.3 mm and 0.5 mm)  
VIRTIS Visible and Infrared Mapping Spectrometry (0.25 – 5  $\mu\text{m}$ )

## Composition Analysis Experiments

COSIMA Dust Mass Spectrometry  
MIDAS Grain Morphology by Atomic Force Microscopy  
ROSINA Neutral Gas and Ion Mass Spectrometry



ISOMETRIC VIEW ON -X FACE

MATRA 1

## Nucleus Large Scale Structure

CONCERT Radio Sounding, Nucleus Tomography (operating with lander)

## Dust Flux, Dust Mass Distribution

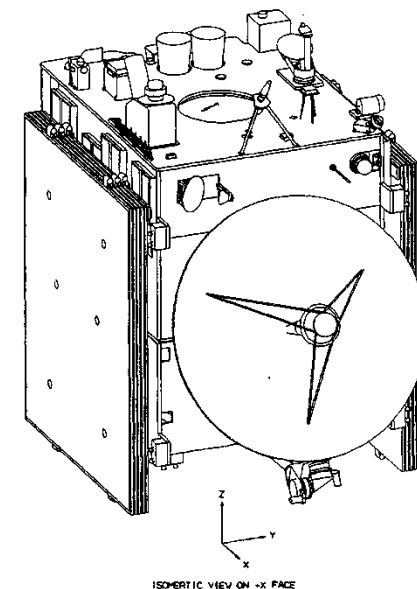
GIADA Grain Impact Analyser and Dust Accumulator

## Comet Plasma environment, Solar Wind Direction

RPC Rosetta Plasma Consortium

## Nucleus Mass

Radio Science Investigation RSI



ISOMETRIC VIEW ON -X FACE



# Instrumentation (Lander)

## Remote Sensing Experiments:

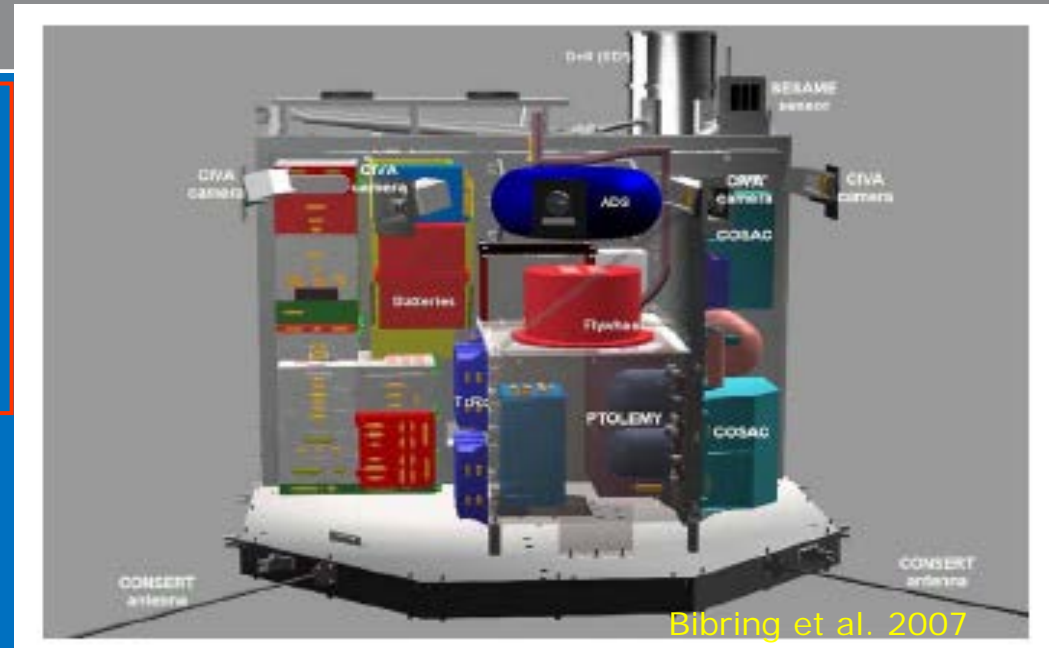
CIVA: Panoramic imaging and microscopy (vis. and near IR)  
ROLIS: Downward imaging  
APXS: X-ray spectroscopy

## Composition Analysis:

COSAC: Molecular composition and chirality  
PTOLEMY: Isotopic composition

## Large Scale Structure:

SESAME: Dust environment (impacts)  
ROMAP: Magnetic field  
CONSERT: (lander unit)



## Physical Properties:

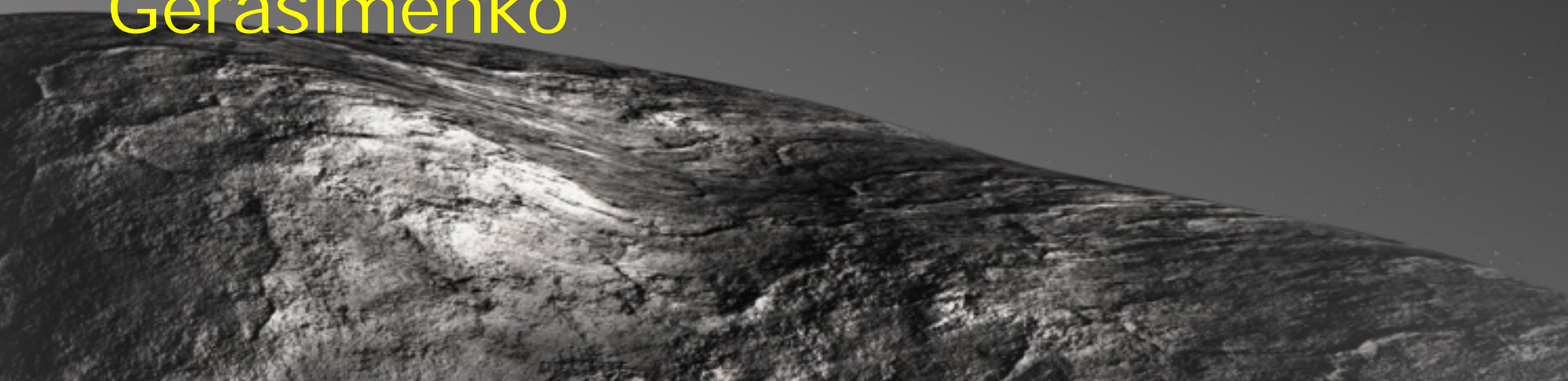
MUPUS: Porosity, Density, Thermal  
SESAME: Seismic and acoustic properties

## Other:

SD2: Drill and transfer of samples



The voyage of Rosetta: 10 years to arrive at comet 67P / Churyumov-Gerasimenko



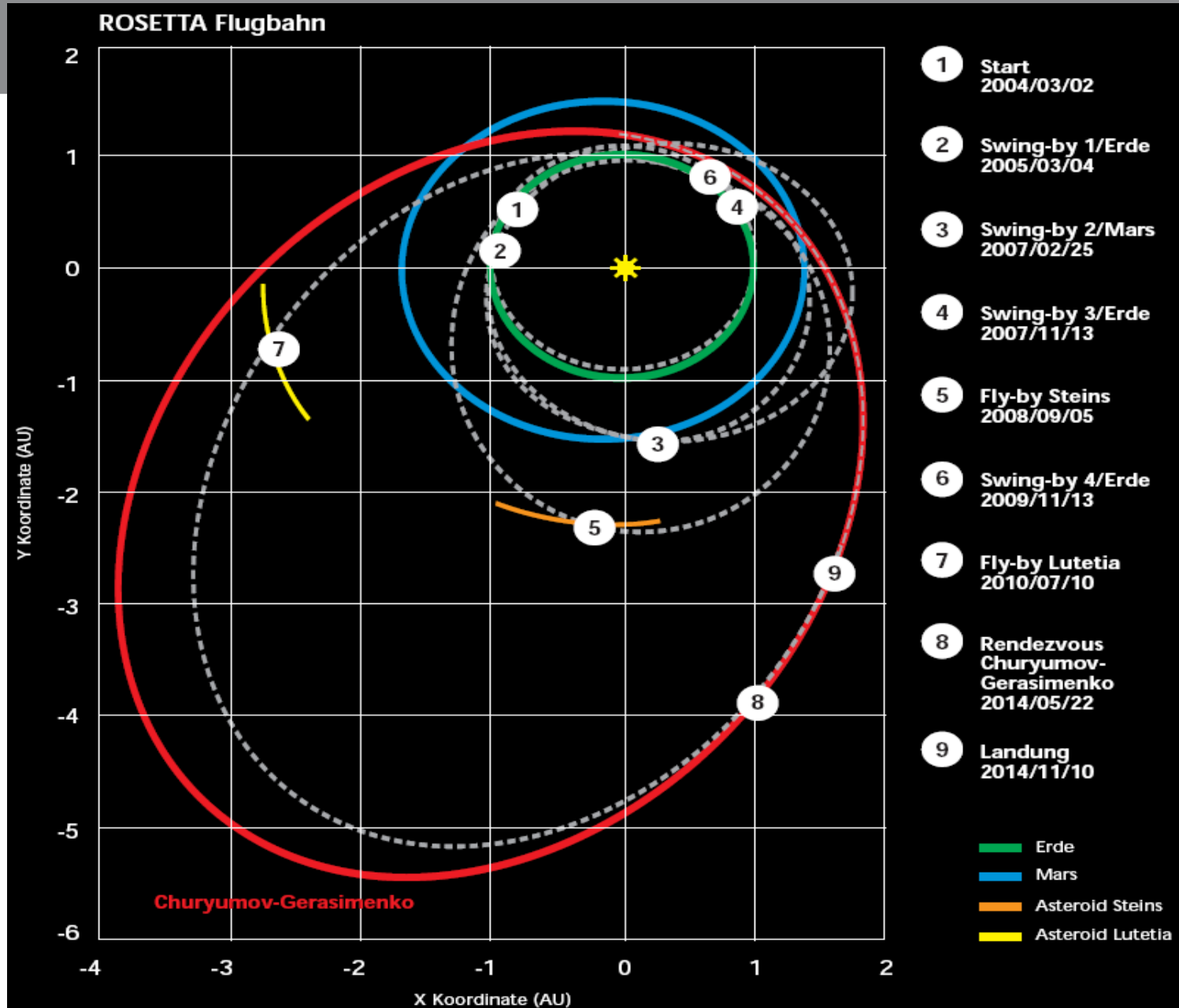


# Rosetta – Launch 02 March 2004



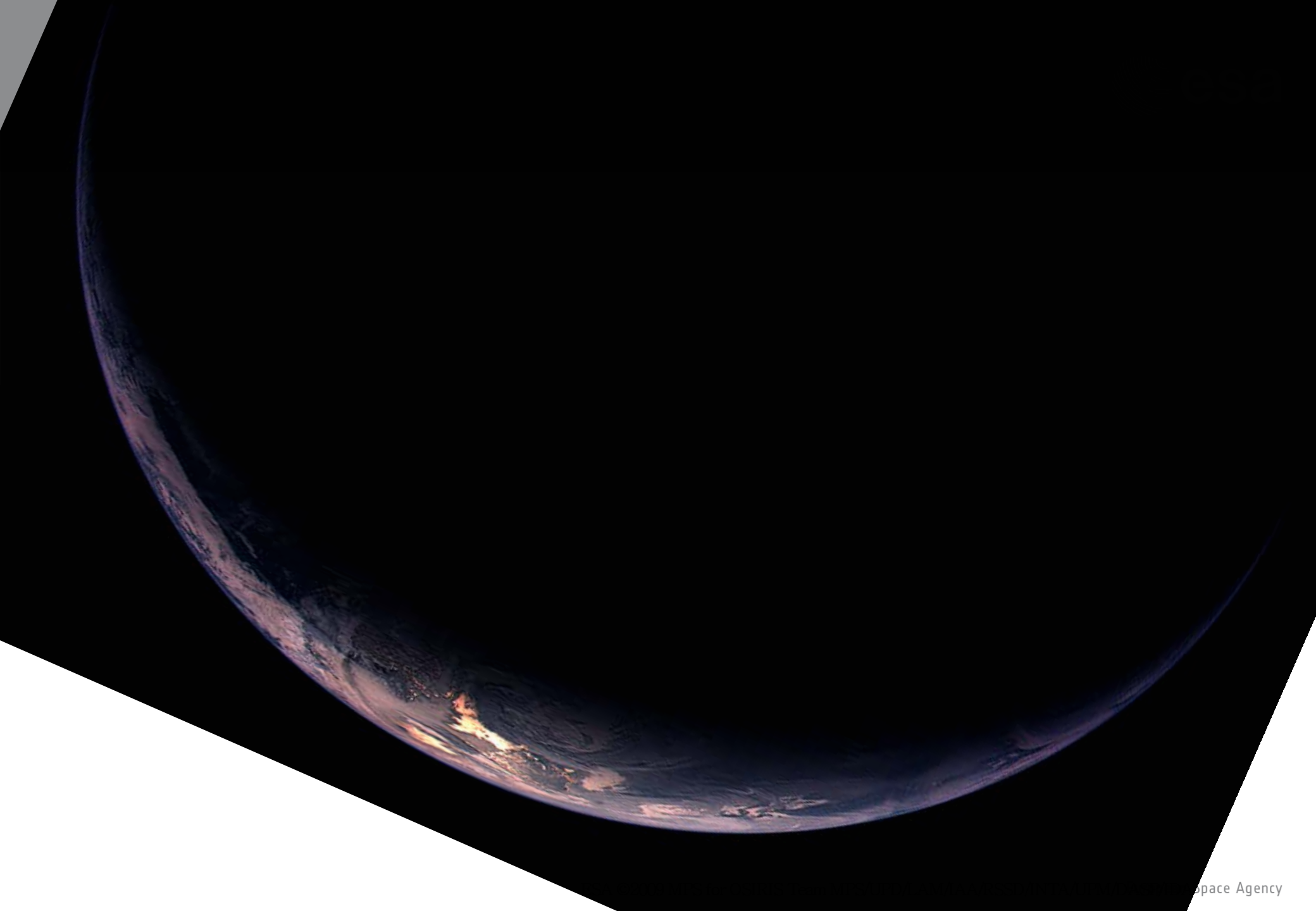
©2004 ESA - CNES - ARIANESPACE / Photo Service Optique Vidéo CSG

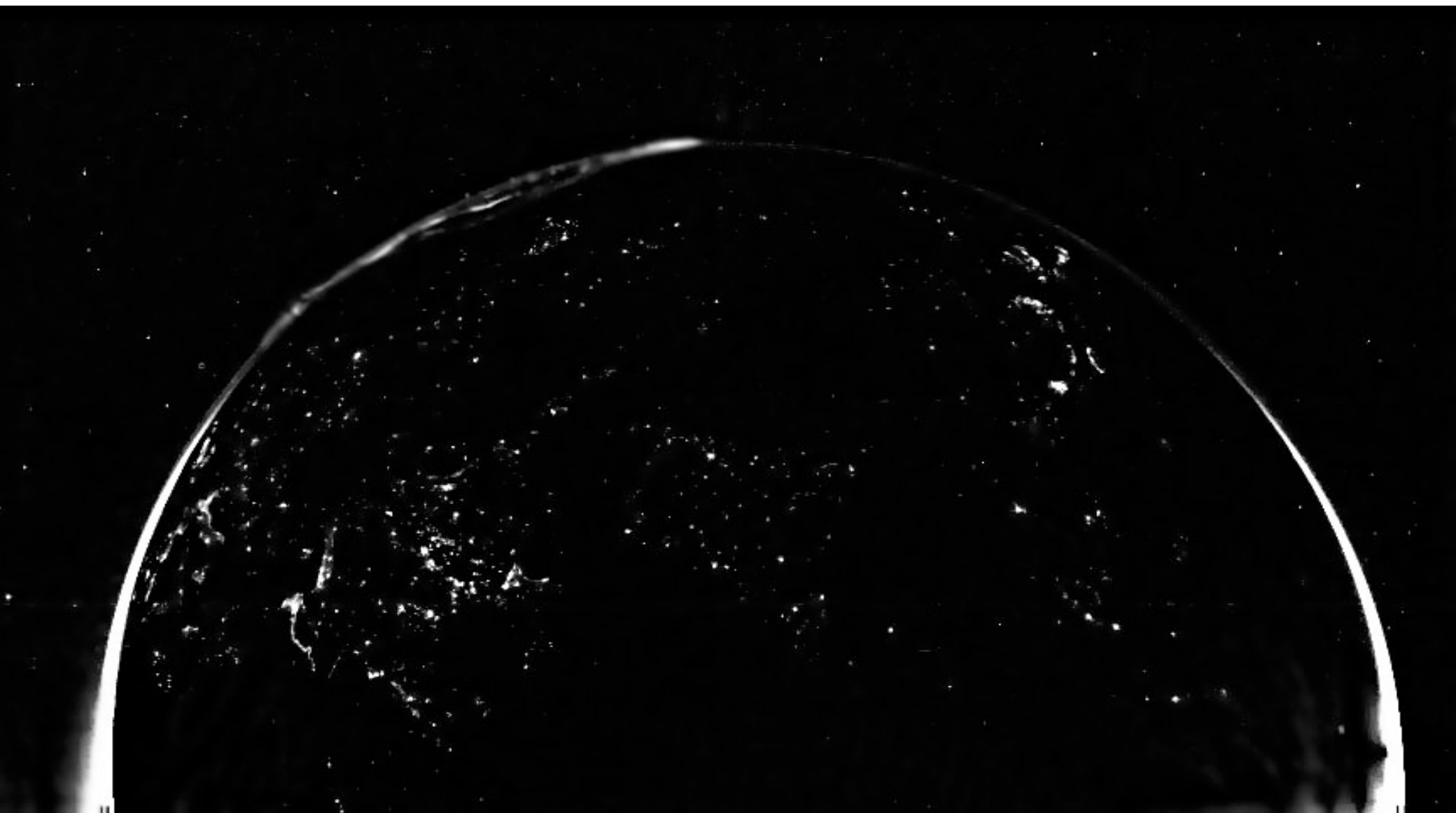
# Trajectory





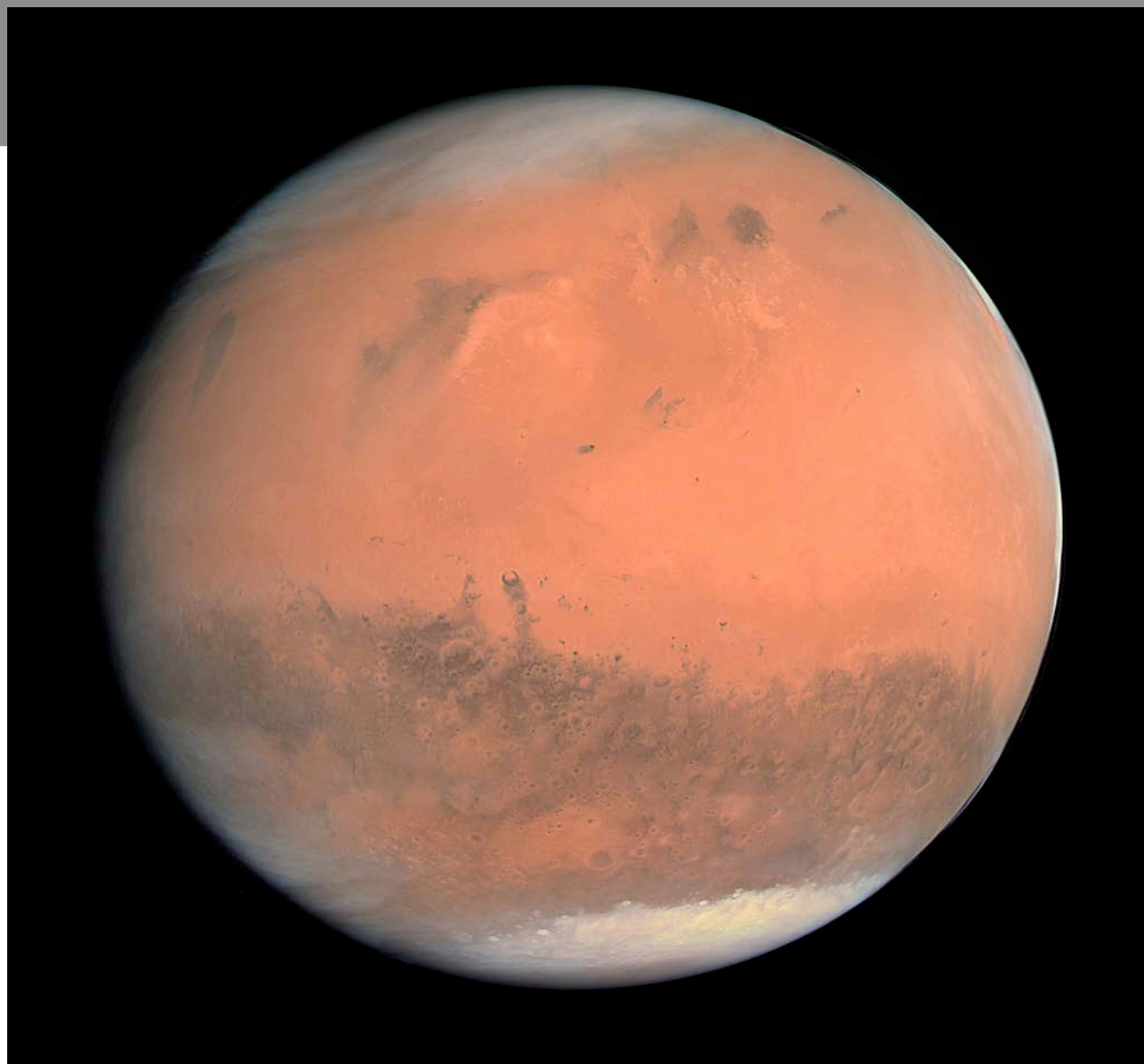
**ROSETTA ON ITS WAY  
TO  
67P/CHURYUMOV-GERASIMENKO  
IS VISITING  
STEINS AND LUTETIA  
ASTEROIDS**



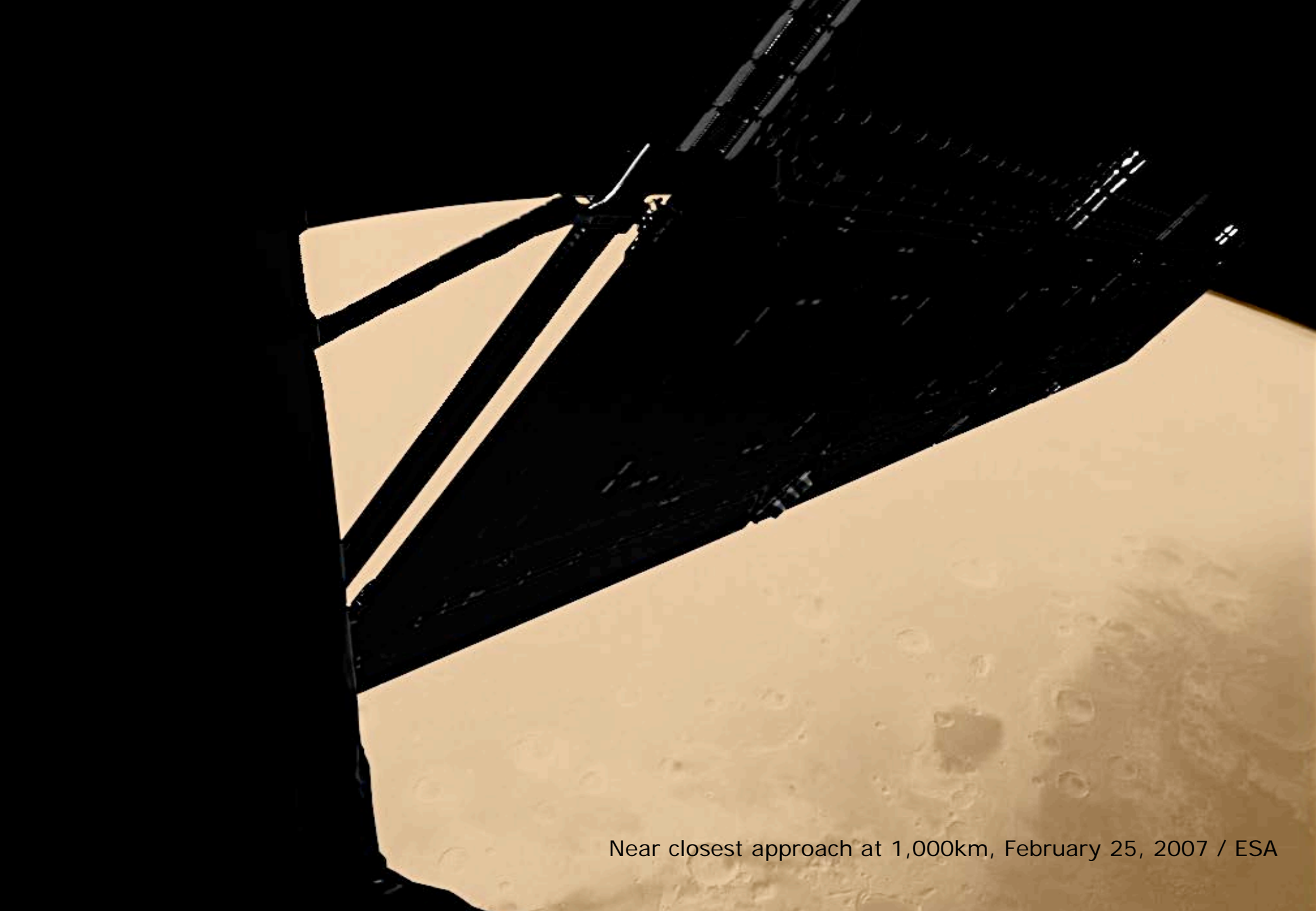








As seen at 240,000km, one day before fly-by on February 25, 2007 / ESA



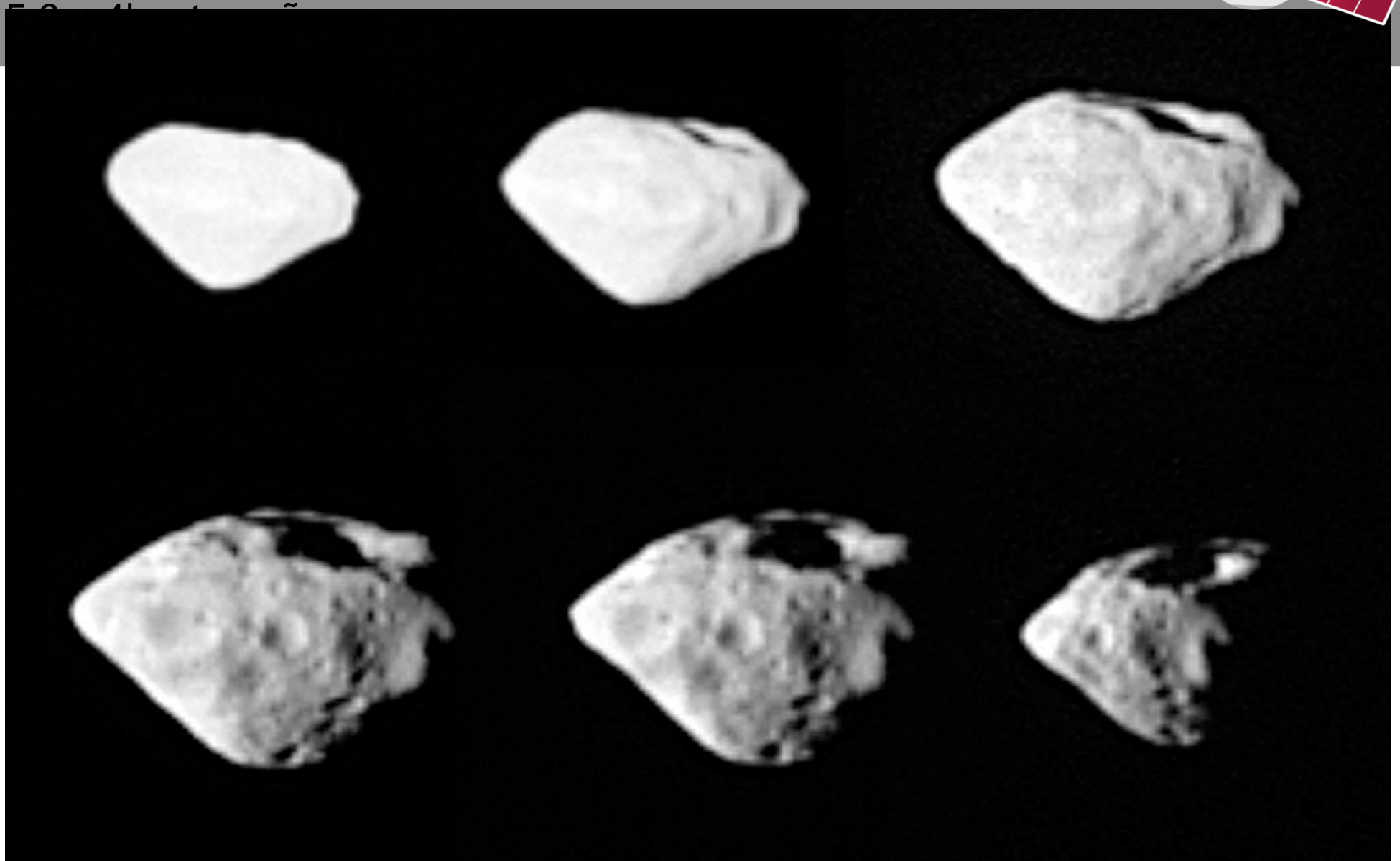
Near closest approach at 1,000km, February 25, 2007 / ESA





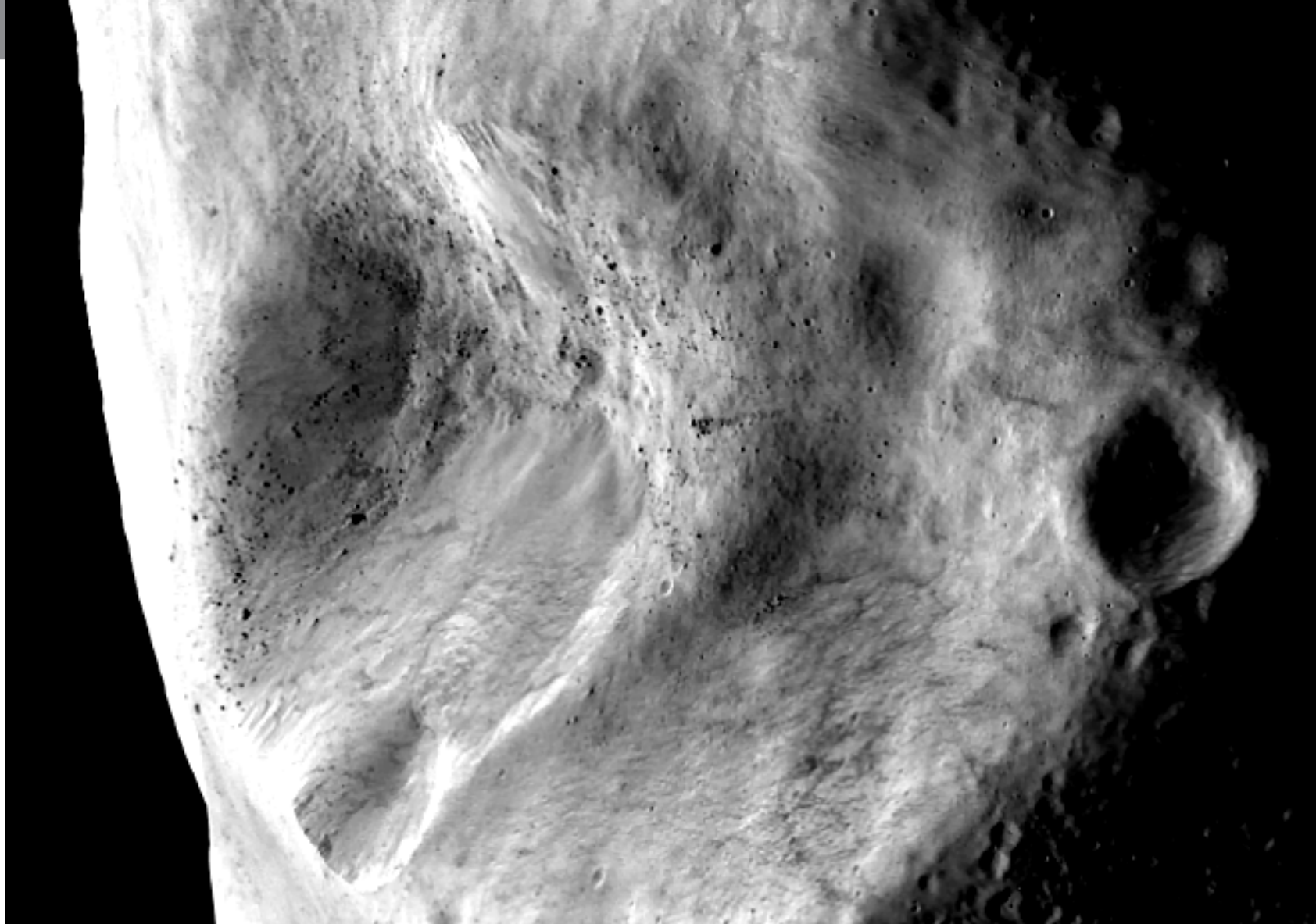
Rosetta Steins flyby, 05 Sep 2008

# Asteroide 2867 Steins

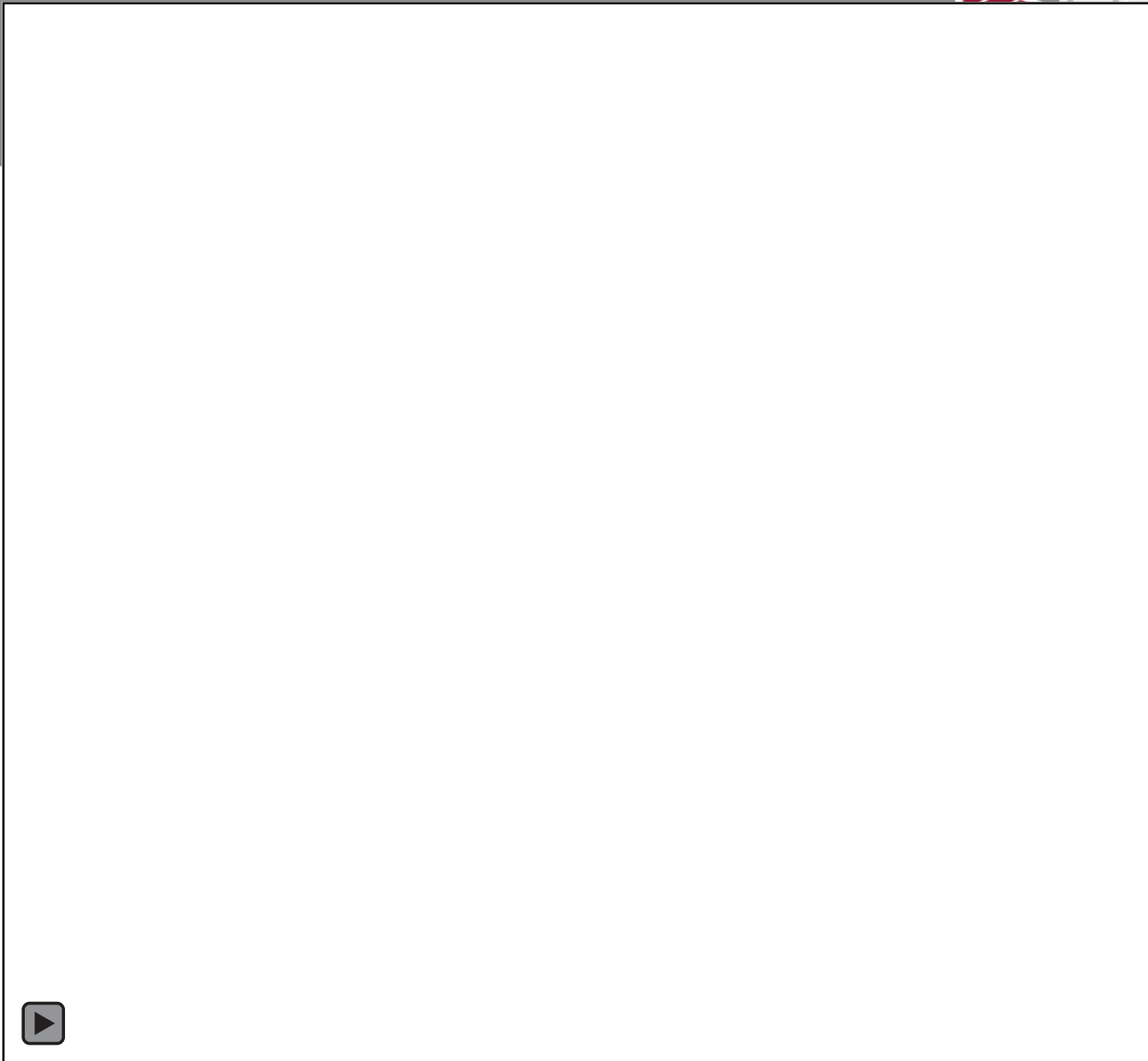
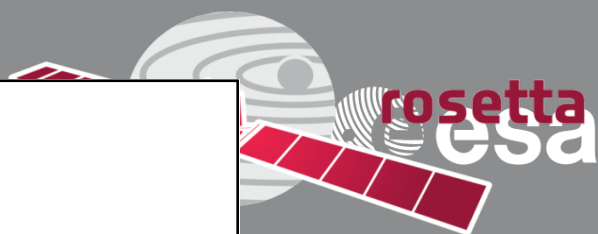


# Asteroide 21 Lutetia

121 km x 101 km x 75 km desde 3170 km





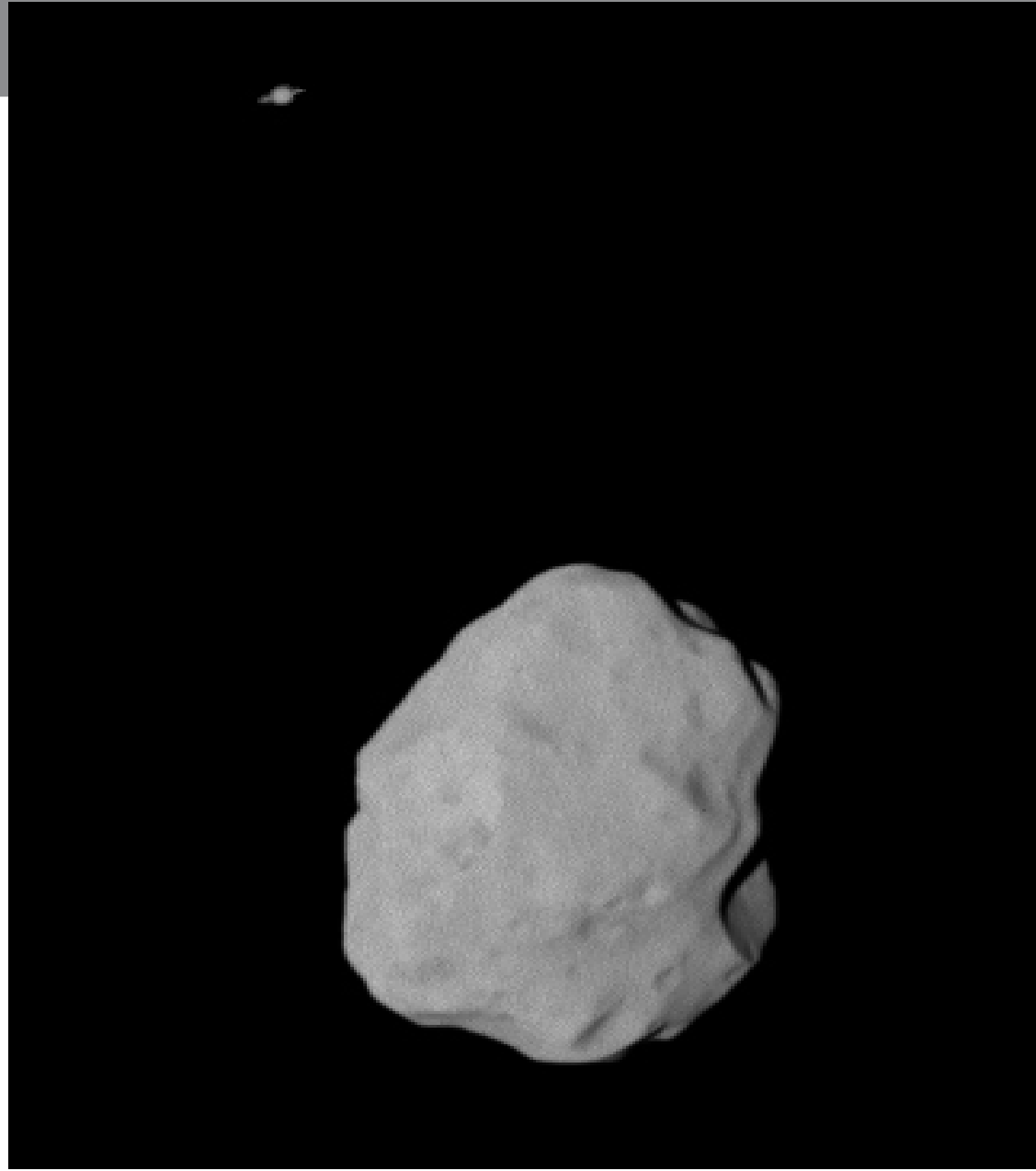


H. Sierks, et al., Science, 2011

Movie made from images taken by OSIRIS, released May 30, 2012 / OSIRIS, ESA

European Space Agency

# Lutetia & Saturno



# Rosetta – hibernation

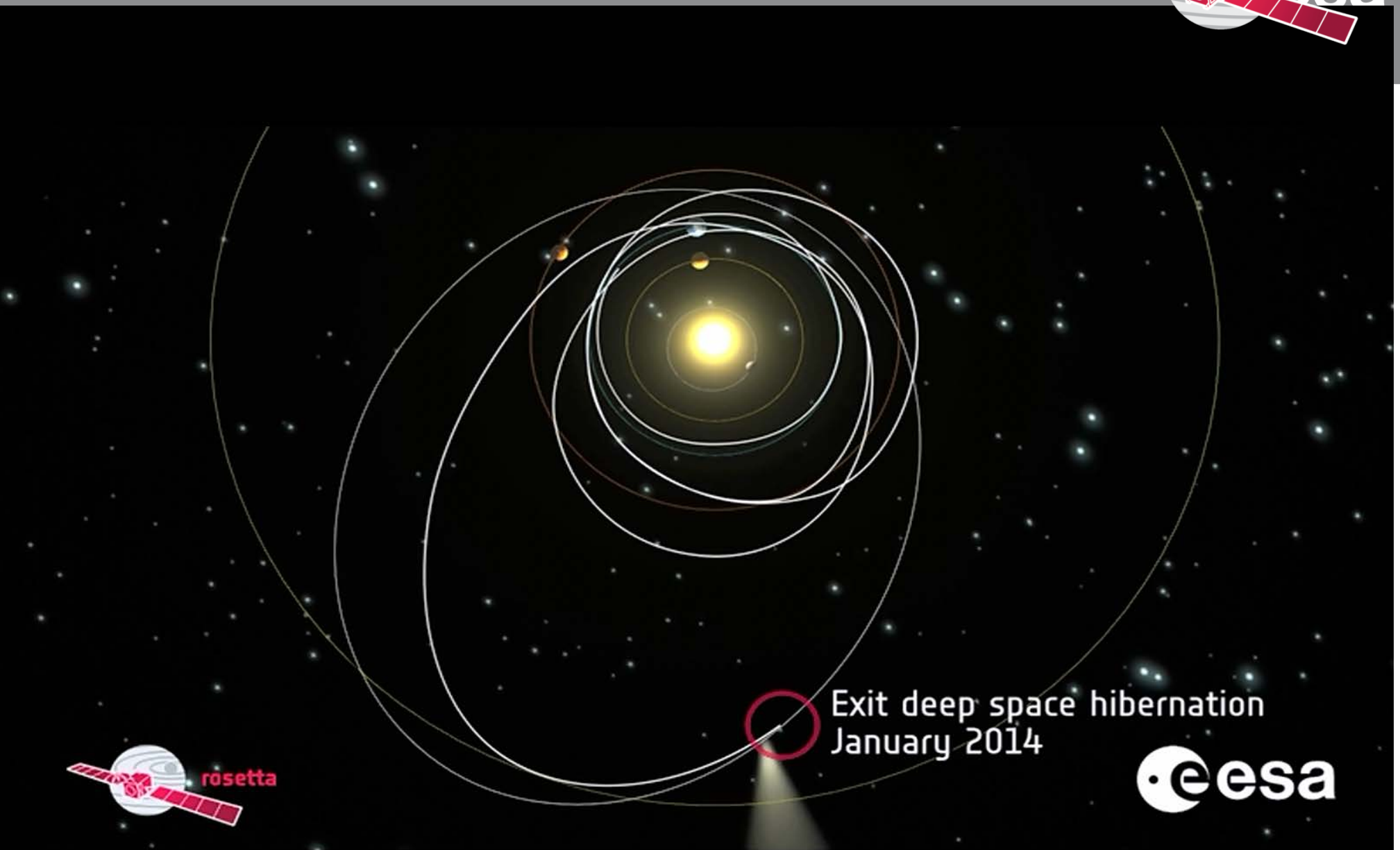


Enter deep space hibernation  
8 June 2011





# Rosetta – hibernación



Exit deep space hibernation  
January 2014





# #WakeUpRosetta

Help us shout out to Europe's  
comet chaser!



# Rosetta despierta – 20 ENERO 2014



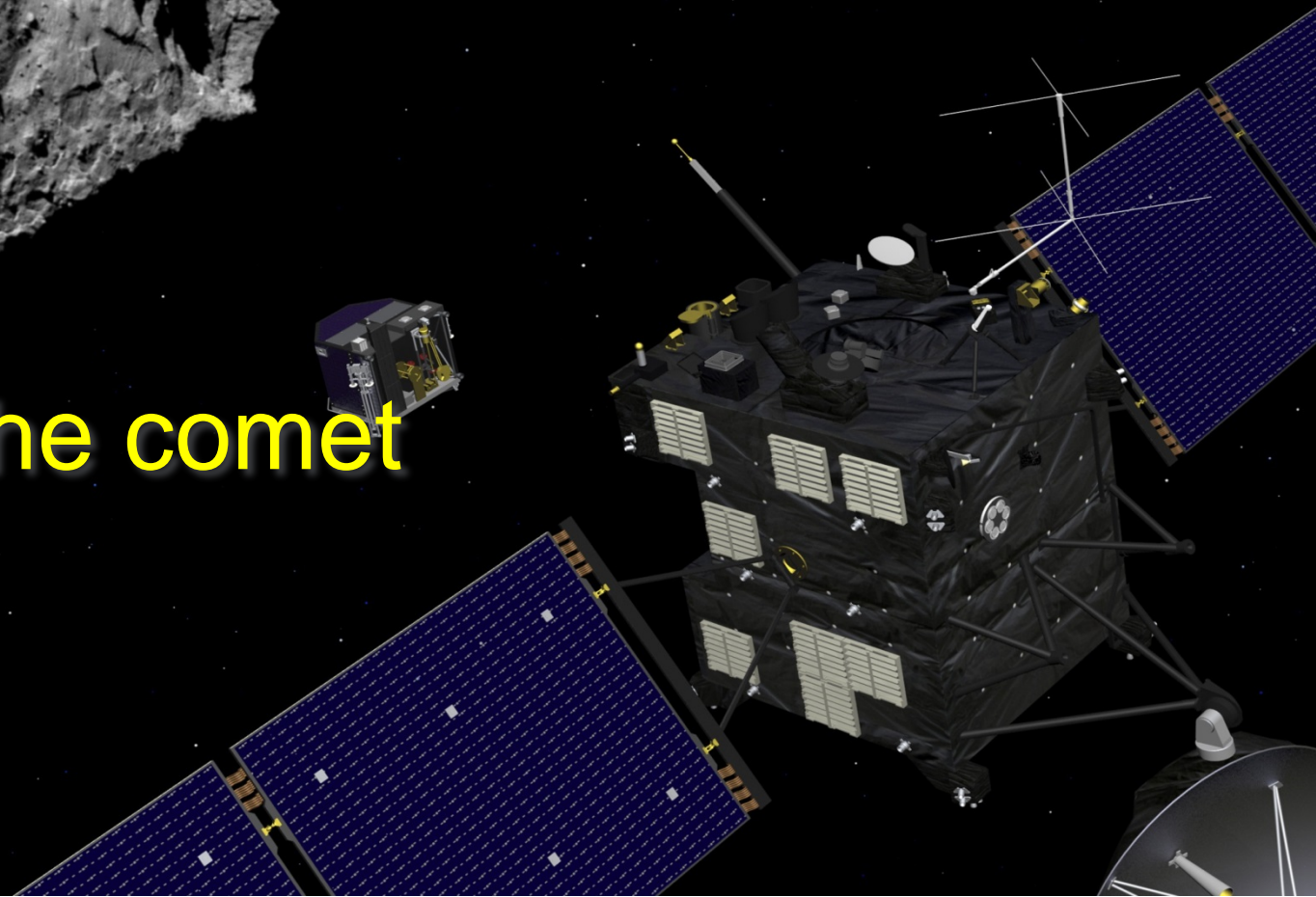
C.E.T.	19:17
U.T.C.	18:17
Goldstone	10:17
Canberra	05:17
Perth/IND	03:17
Malargue	16:17
Cebreros	19:17
Kourou	15:17

Goldstone	17:00:00z Spacecraft
Goldstone	17:45:00
Goldstone	18:00:00
Goldstone	18:10:00
Canberra	18:15:00
Spacecraft	18:45:00



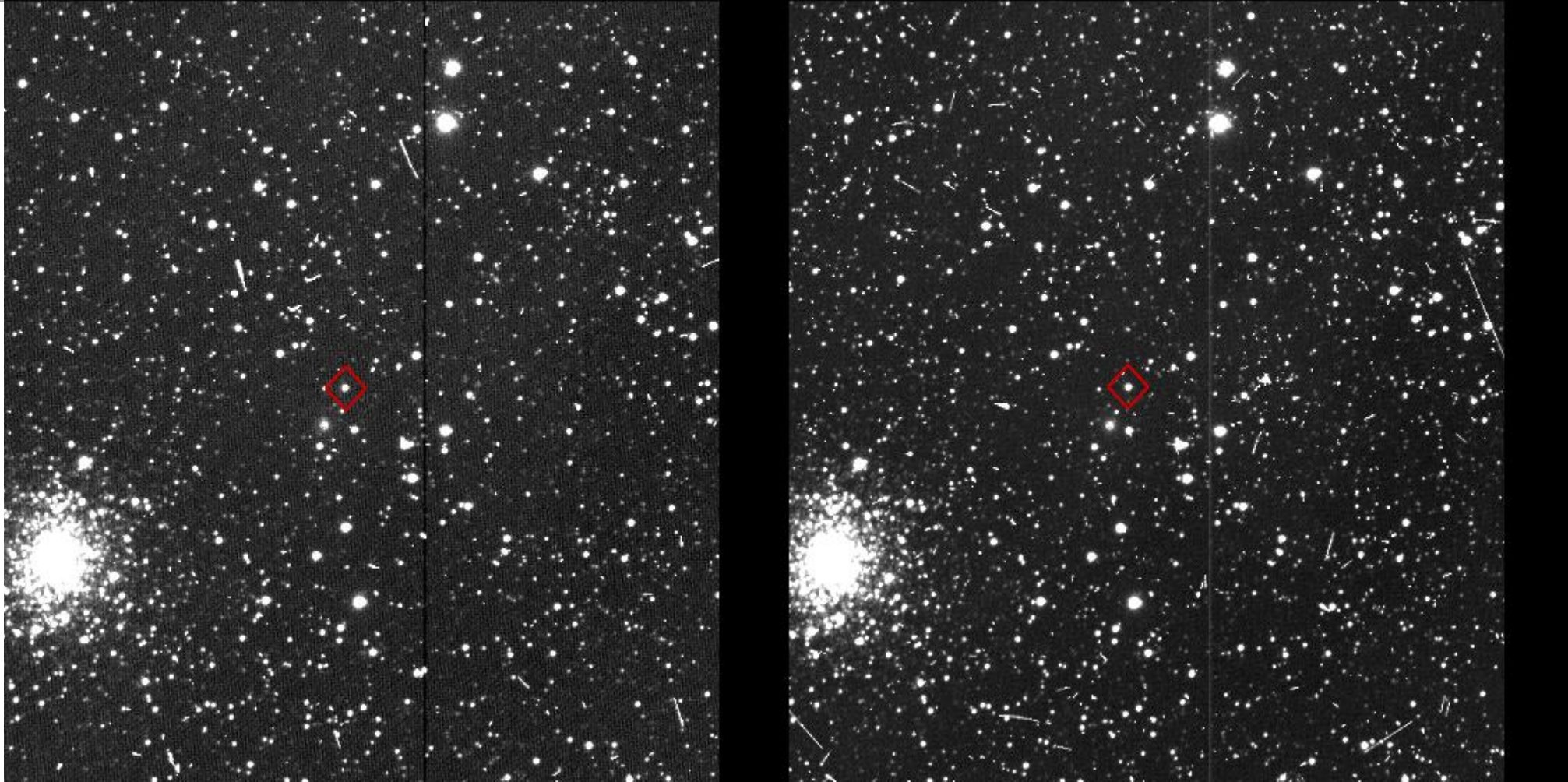


Rosetta at the comet



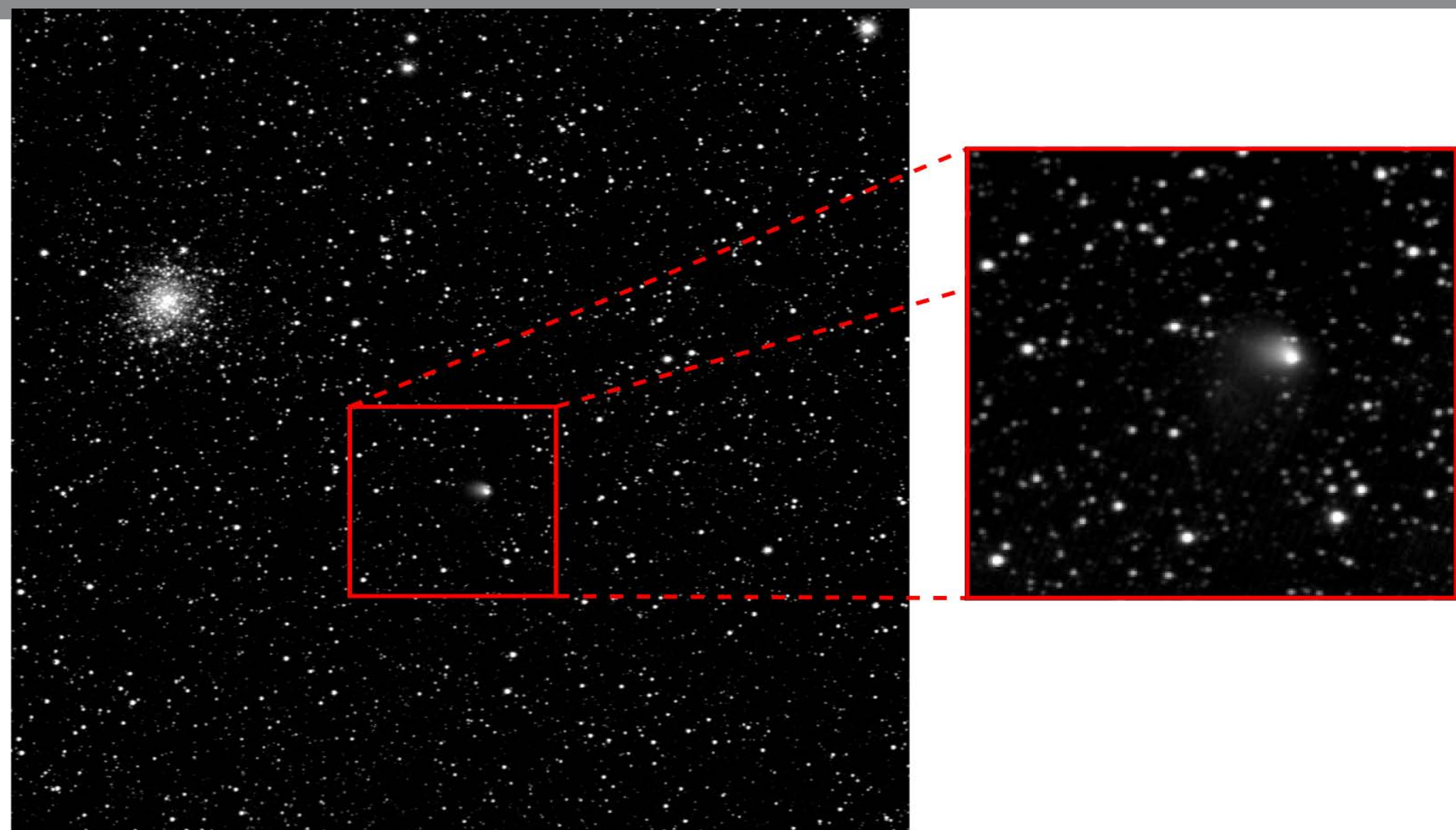


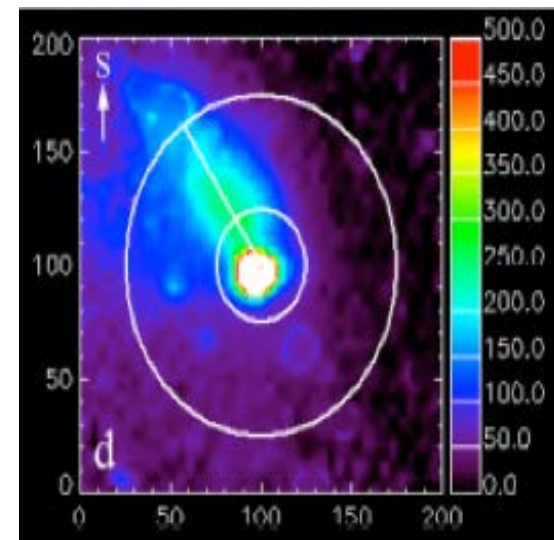
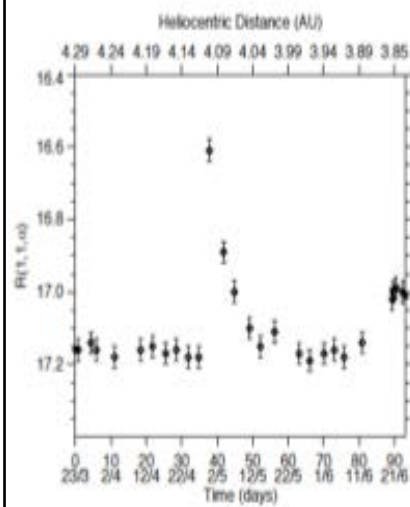
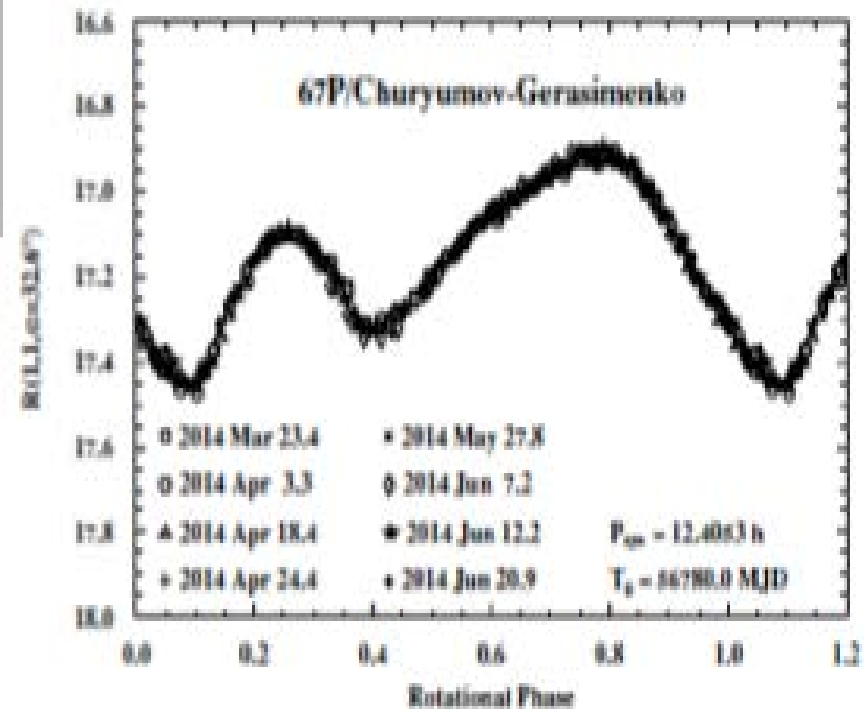
# First images of the comet in March 2014



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

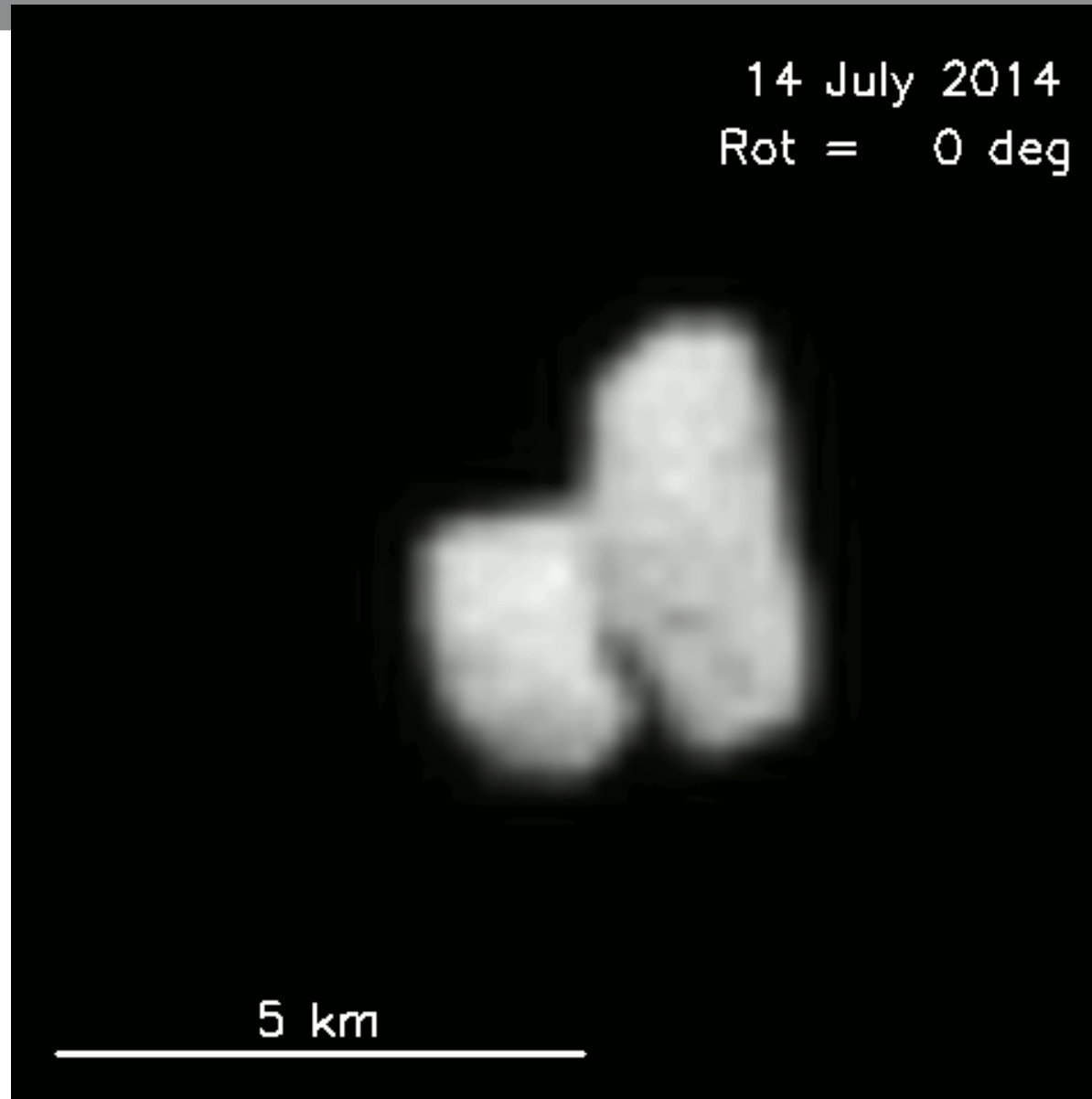
# Getting closer to the comet: First outburst 30 April 2014





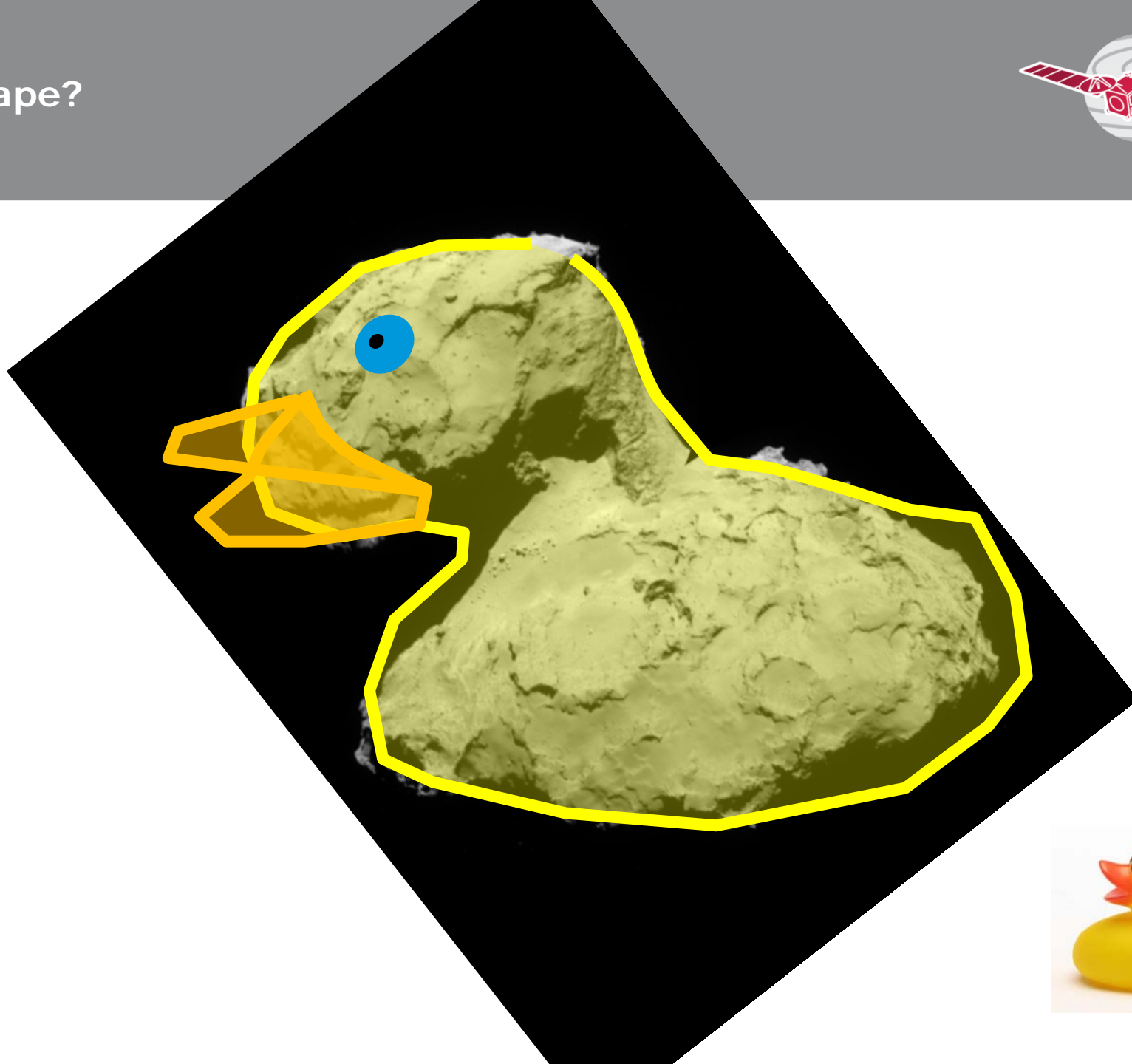
Getting closer

14 Julio 2014: Confirmation of rotation period



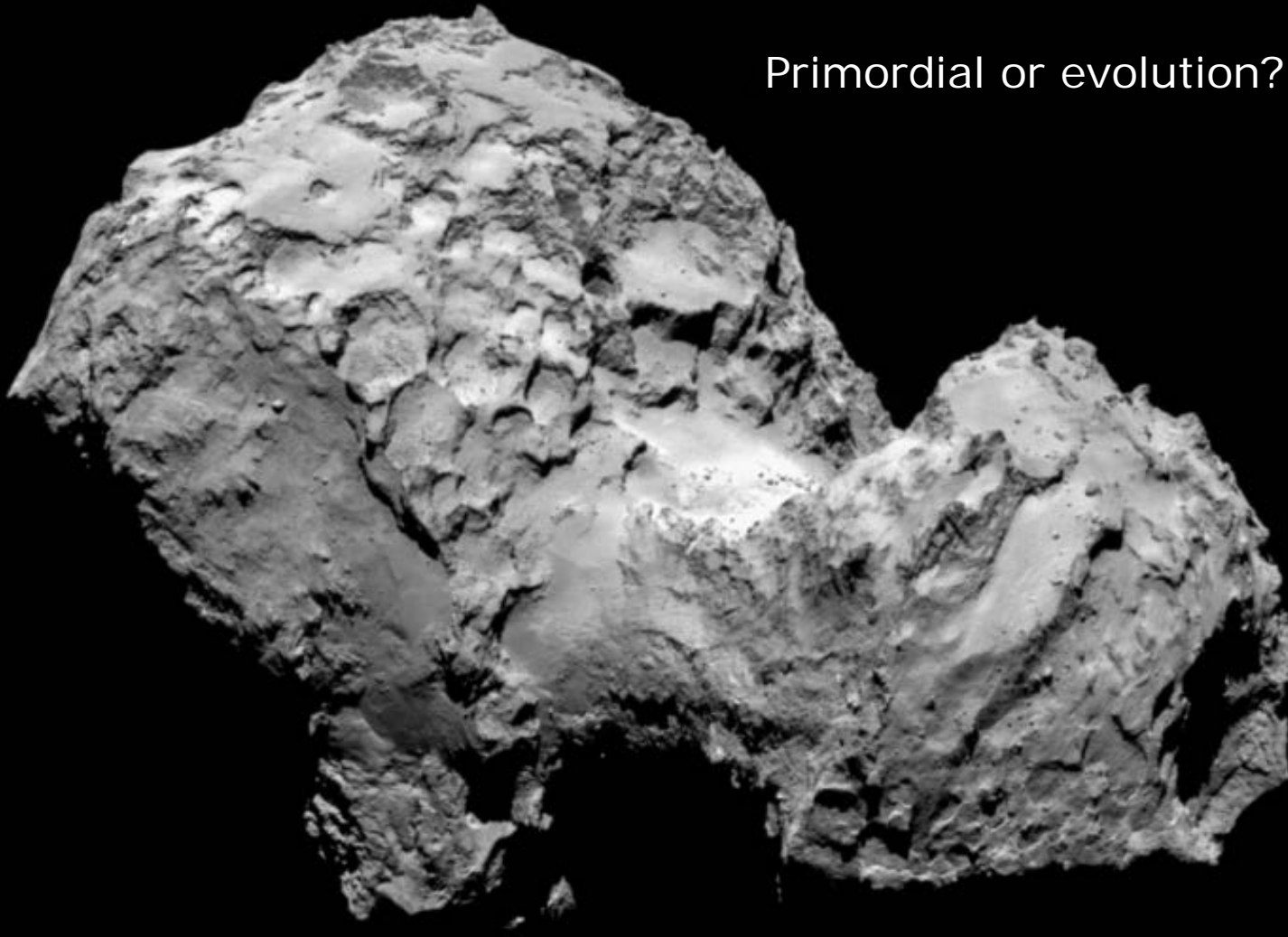


Shape?



## The nucleus: 3 regions

Primordial or evolution?





→ MADRID



AOLKIA

Plaza de Toros

Palacio Real

4100 m



www.esa.int

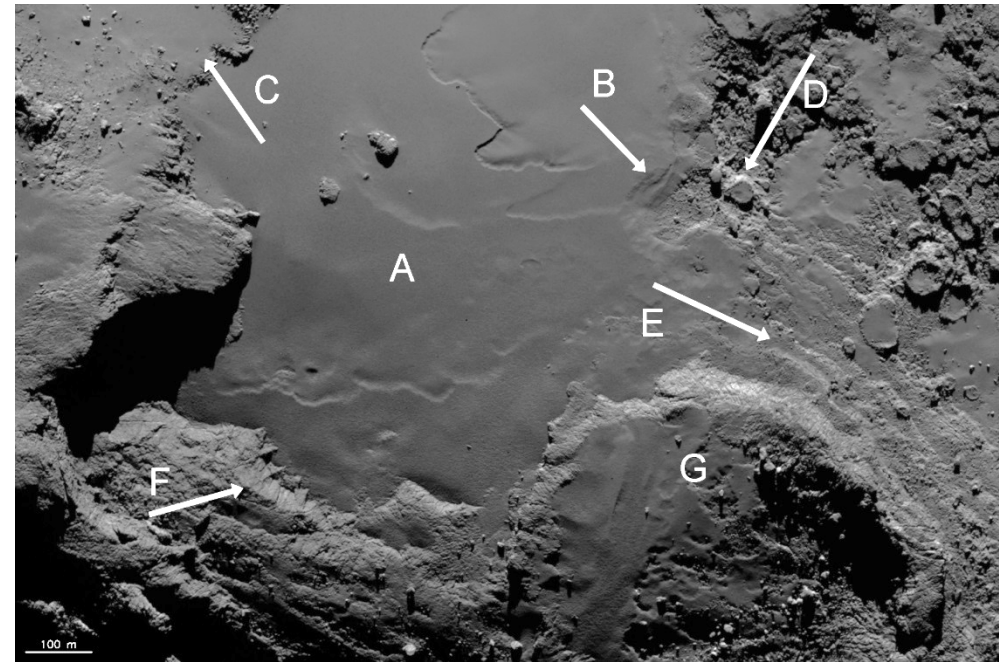
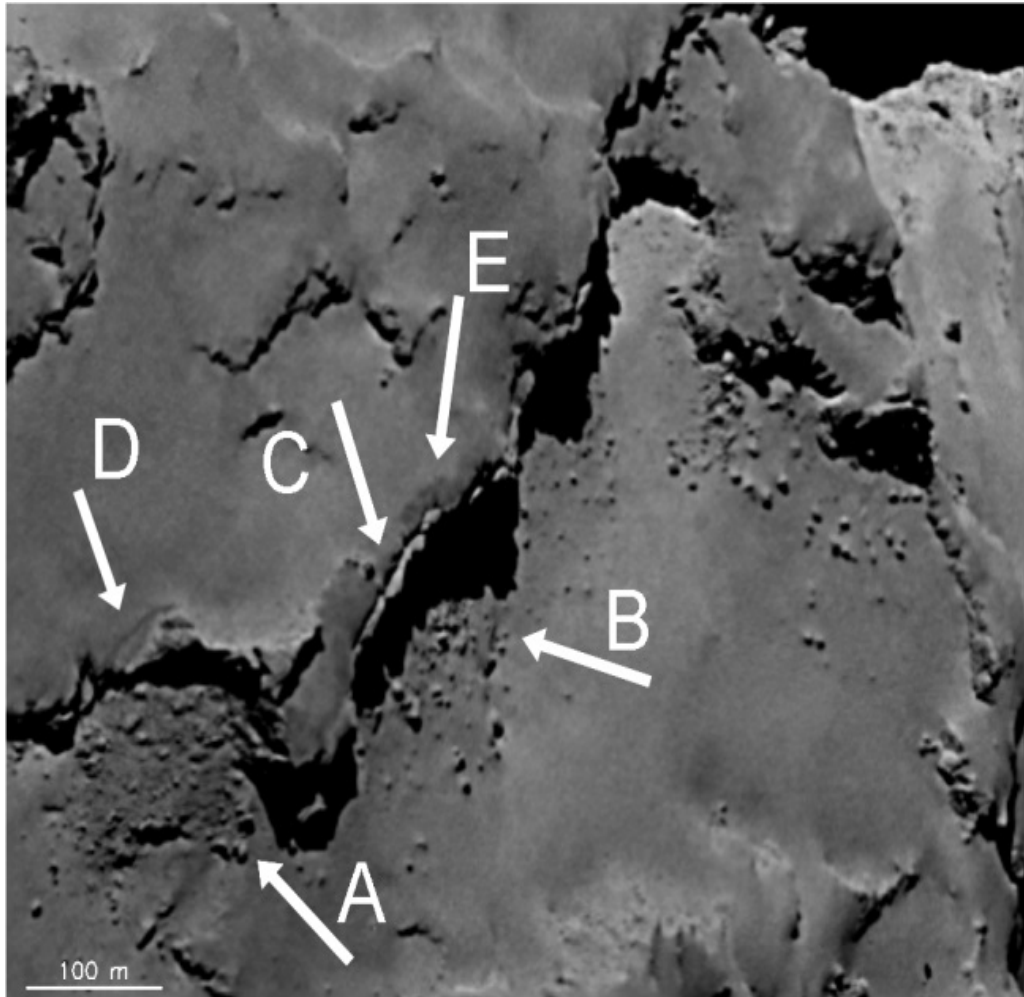
Map data ©2014 Google, Bluesky Google

European Space Agency

European Space Agency



# A dynamical surface



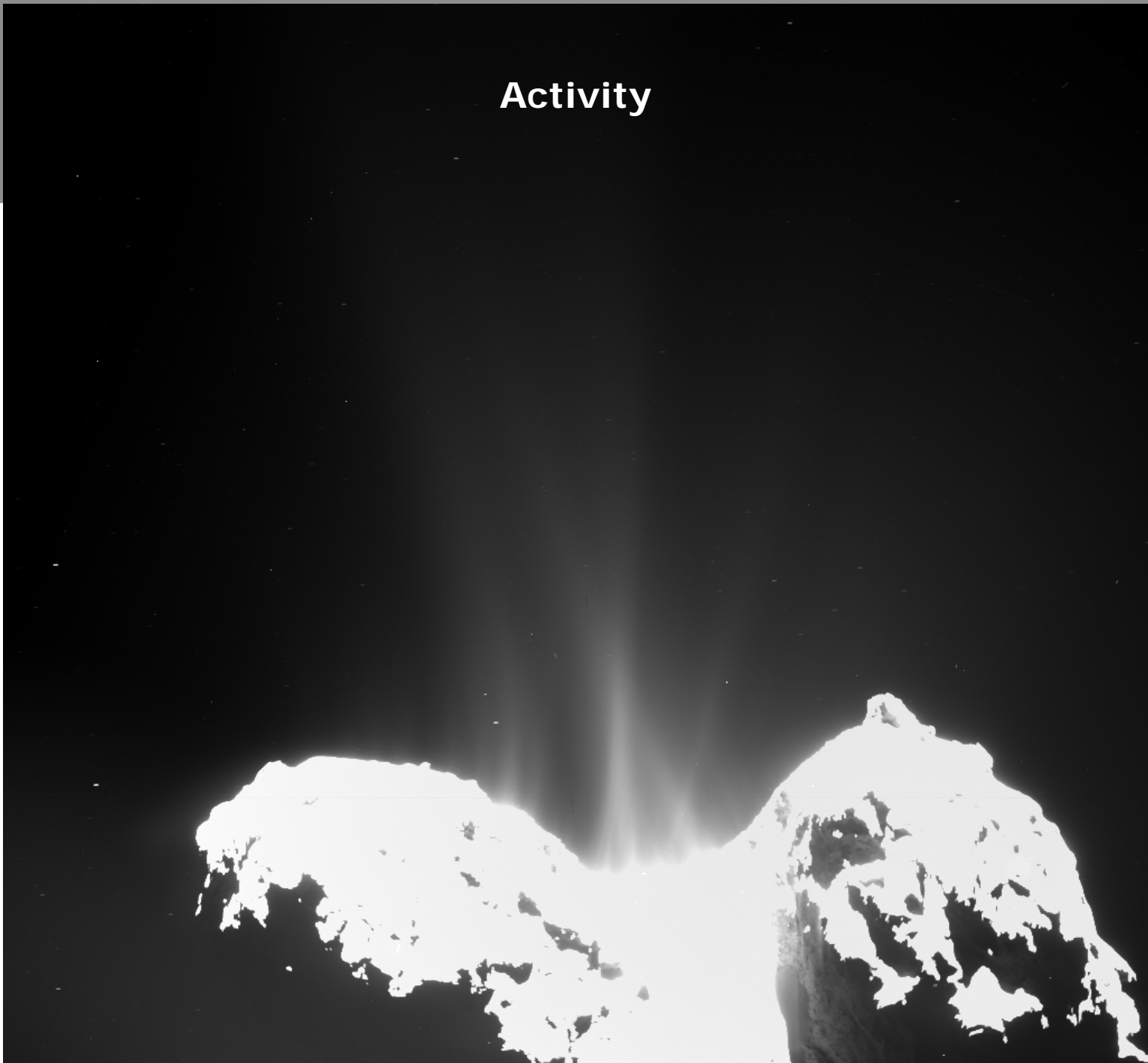
Fuente: Thomas et al., Science, 2015

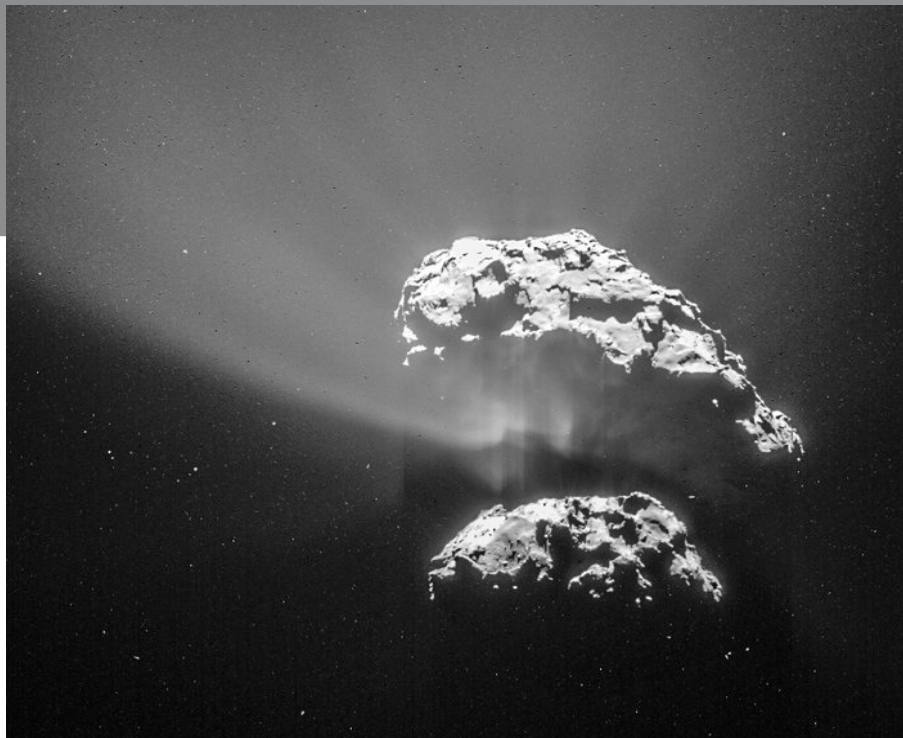


# Pebbles from the formation in the protostellar disk?

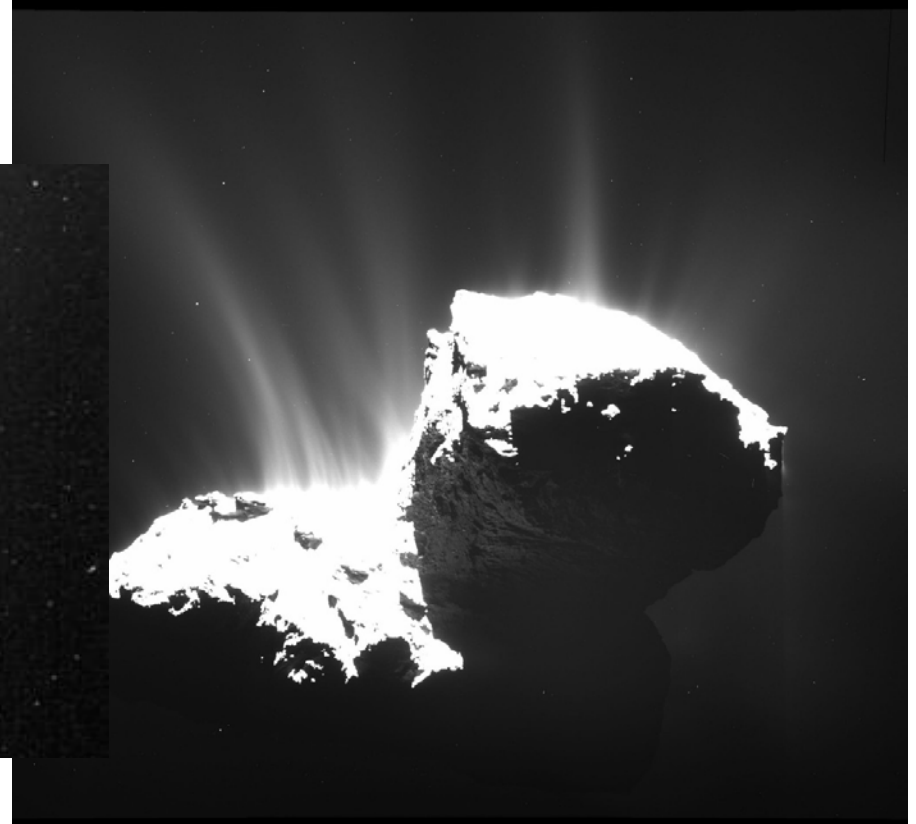


# Activity

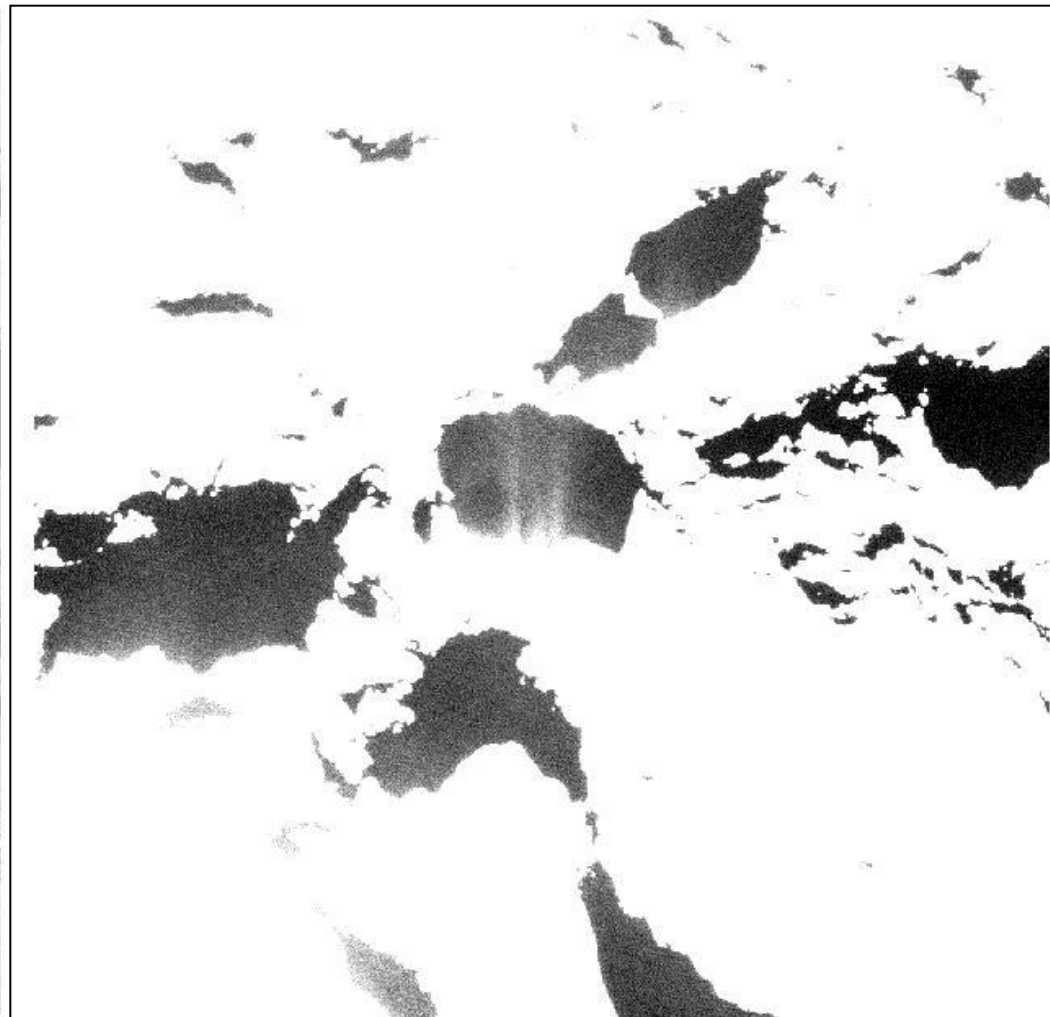
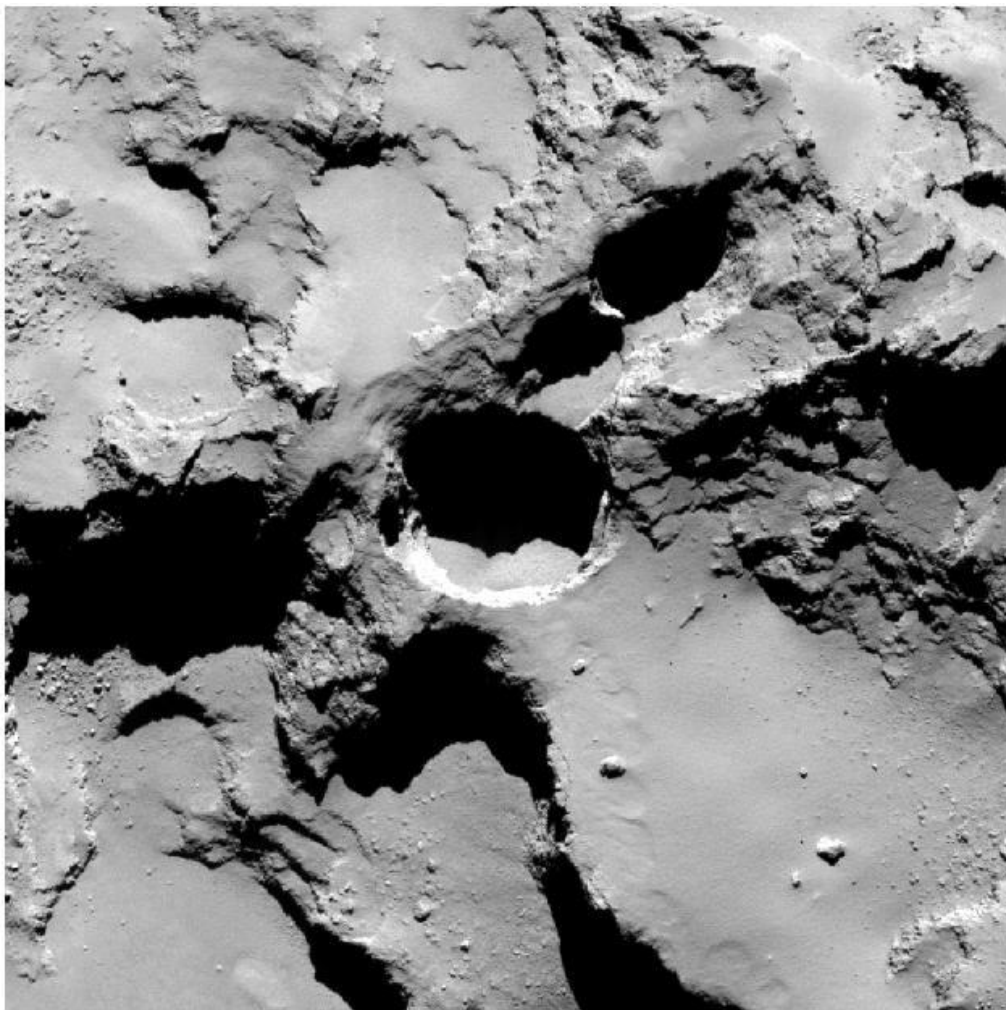




sa

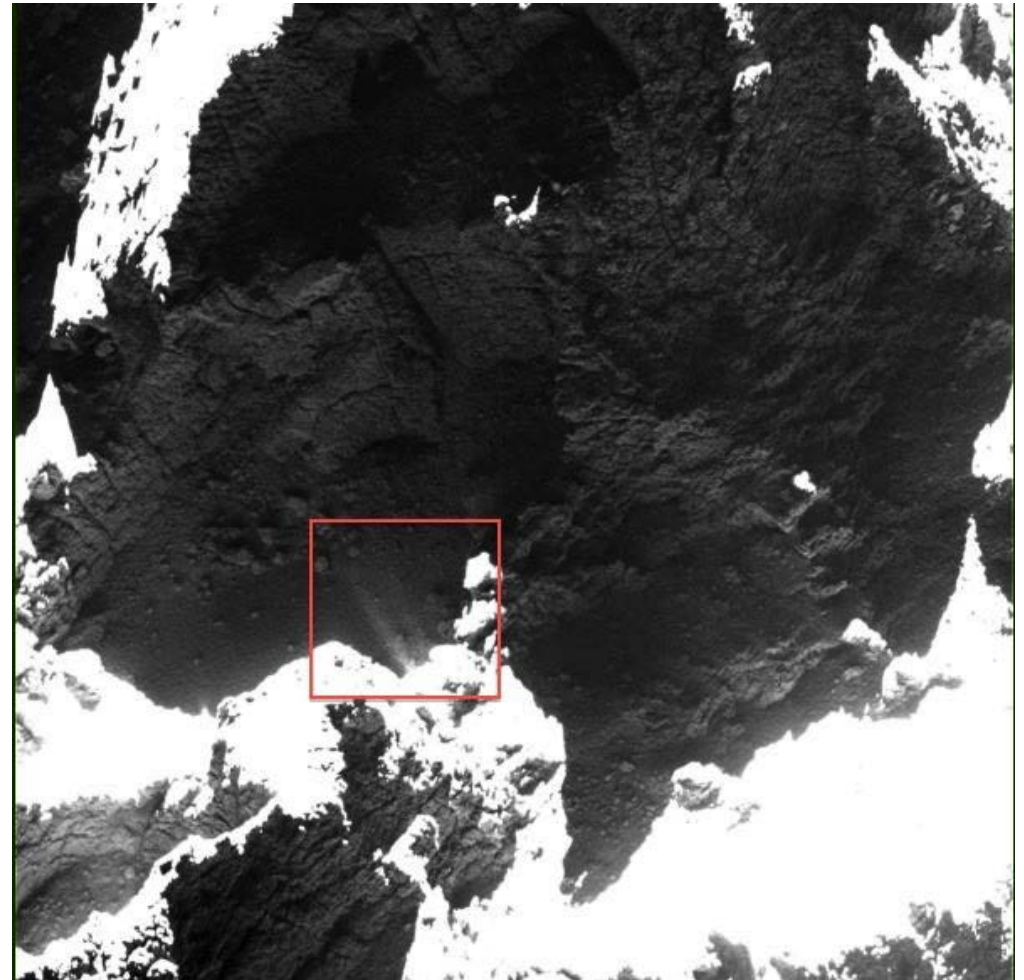
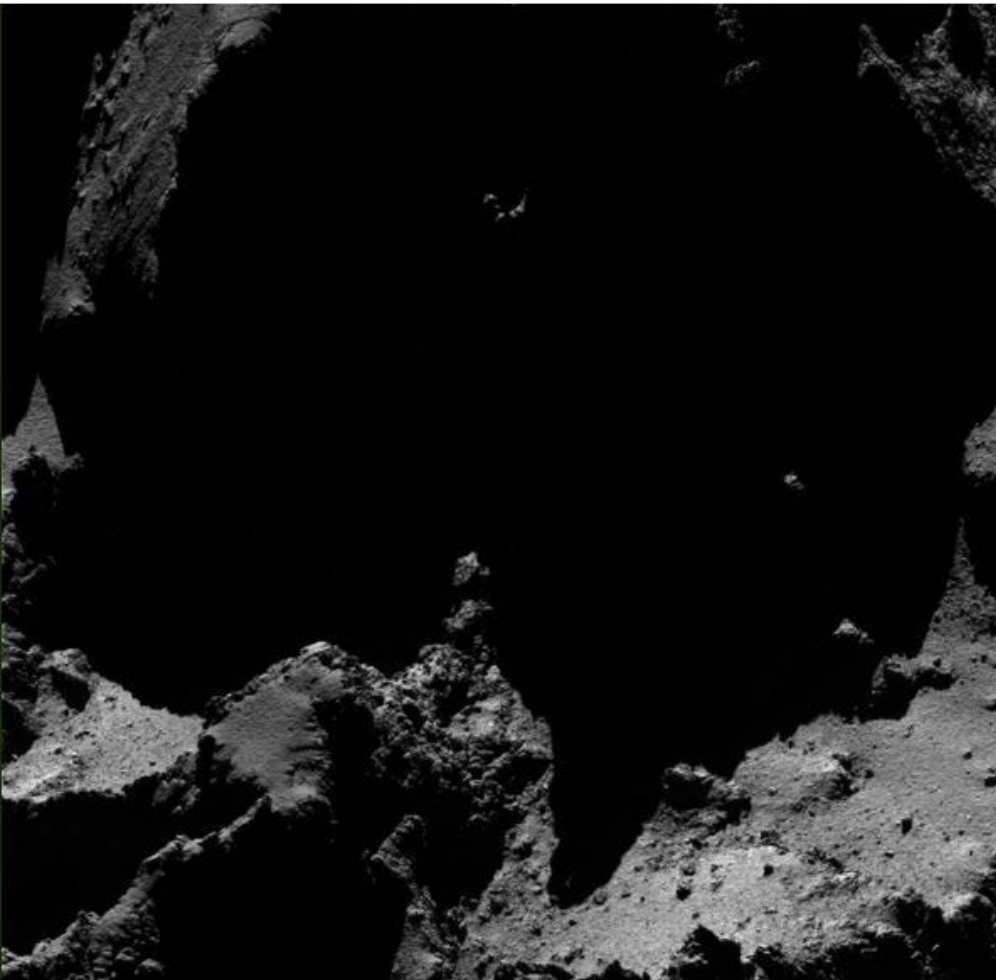


# Activity from pits

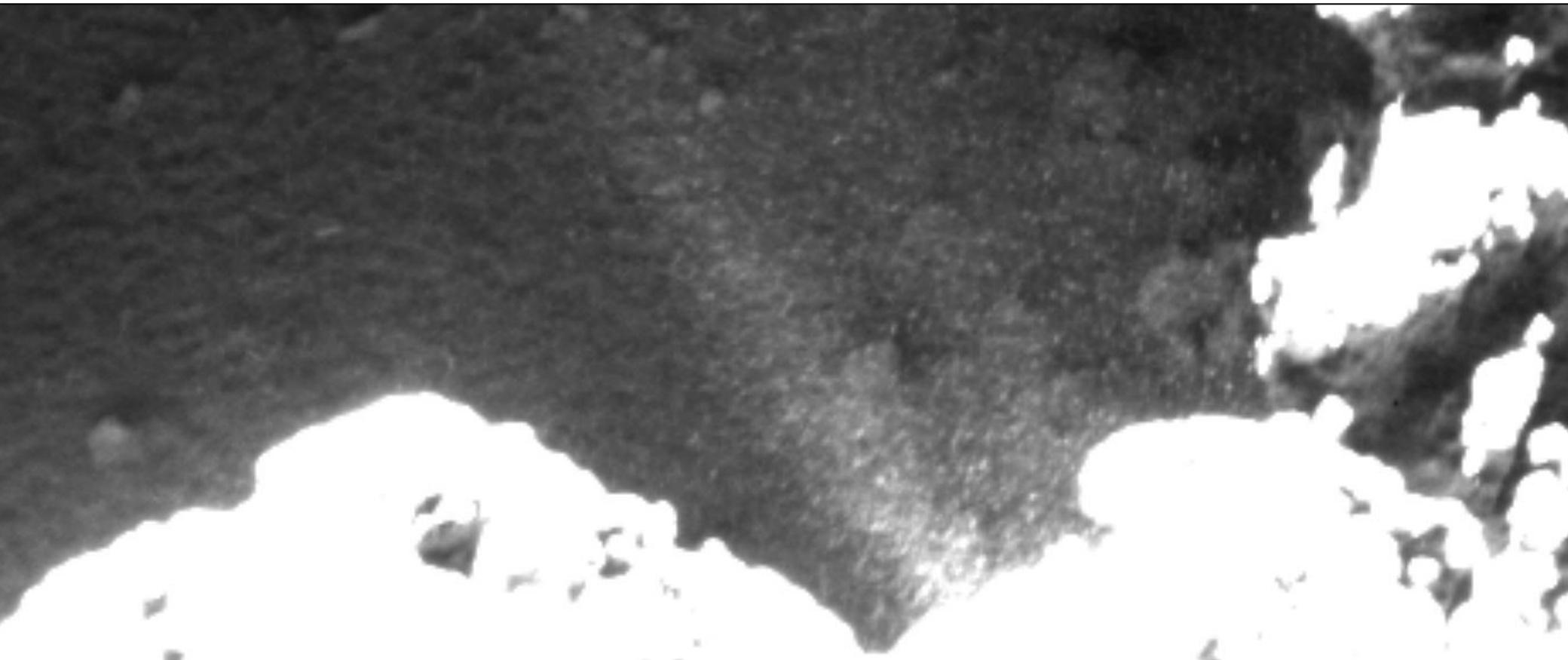




# Large particles: context



# Large particles



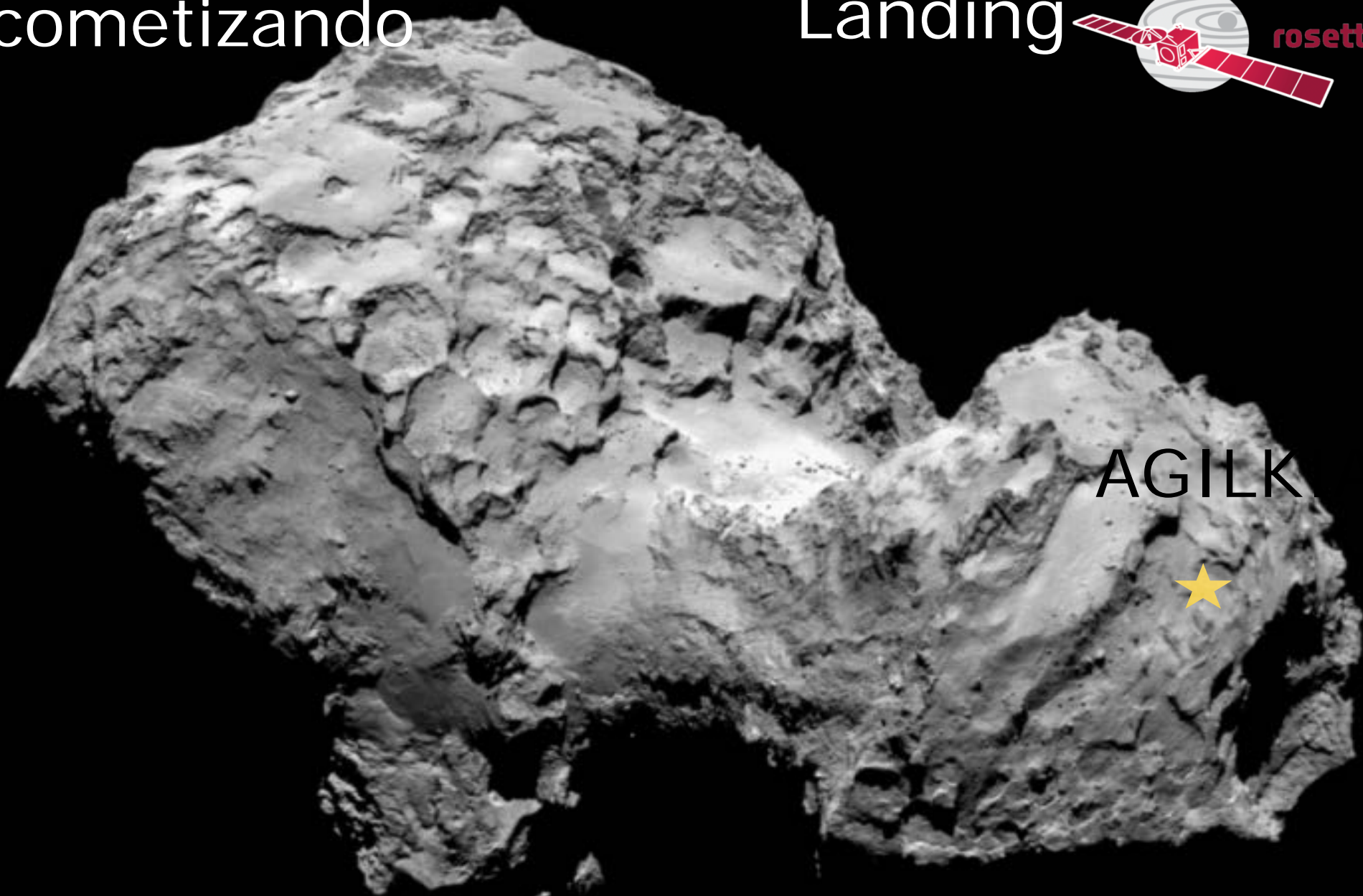
How does the activity of the comet work?

Acometizando

Landing



rosetta



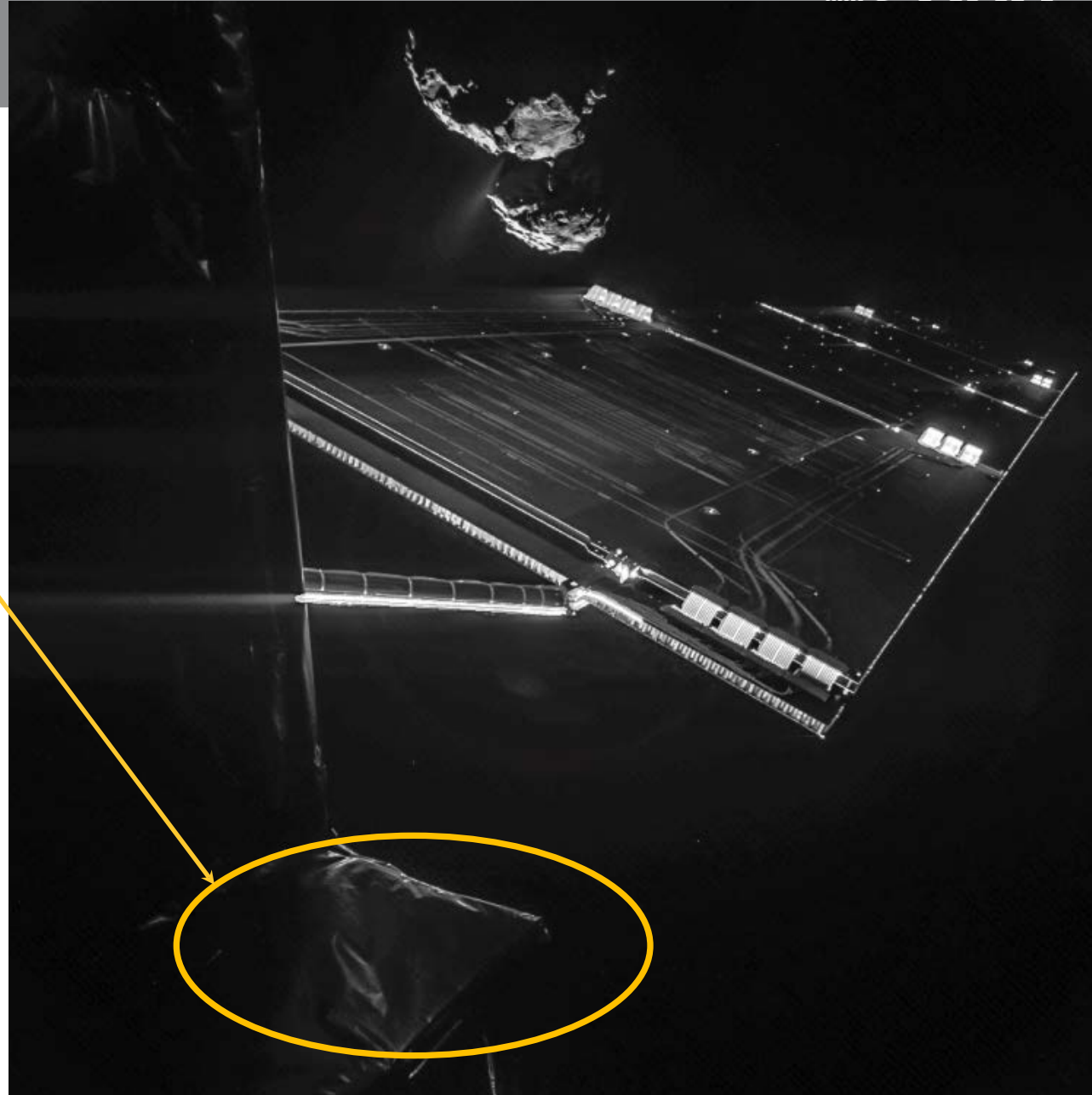
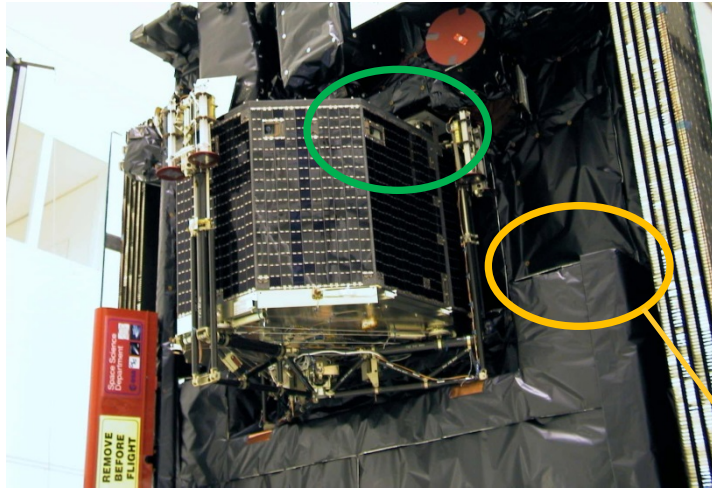
AGILK







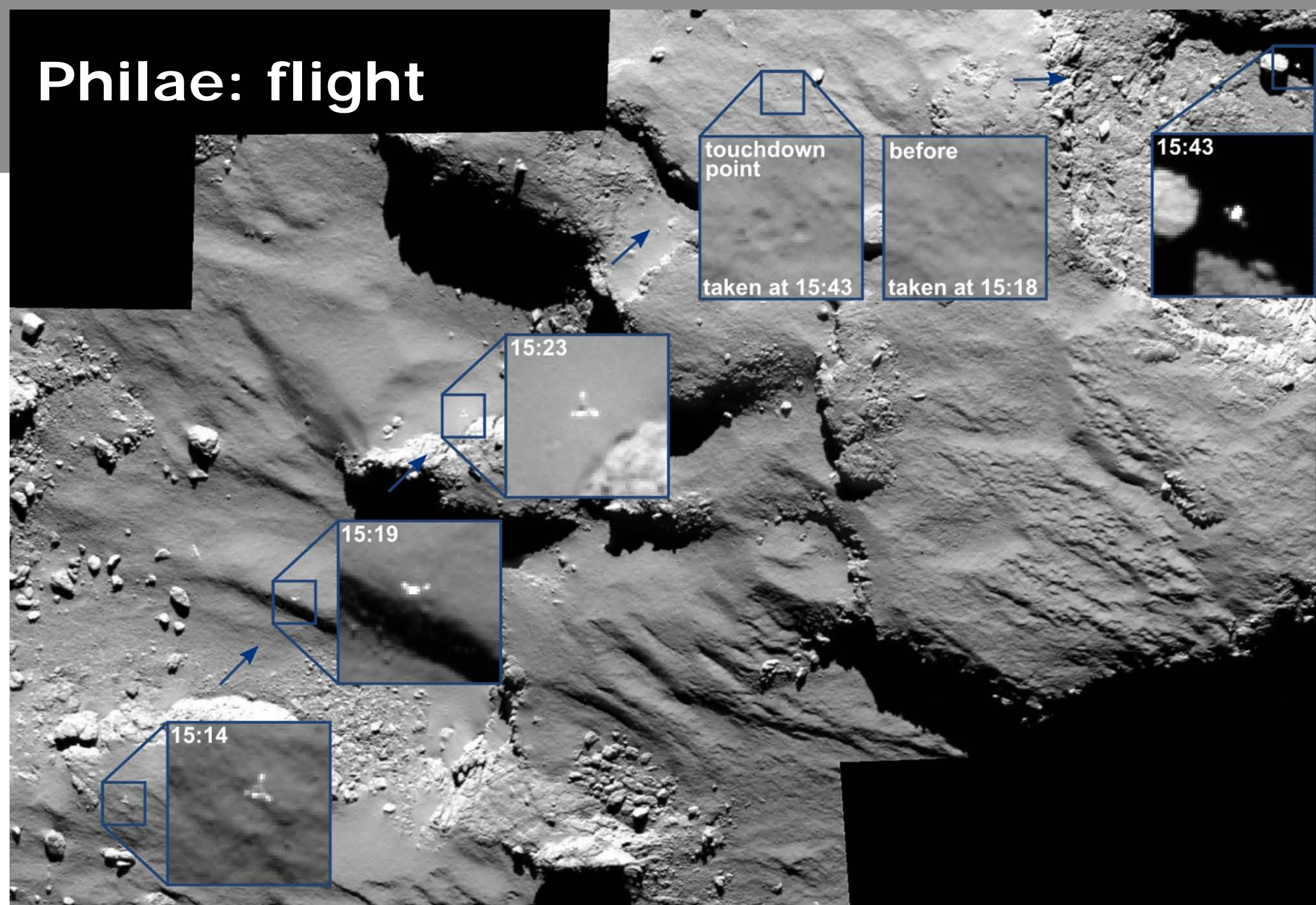
# The cameras: CIVA Distancia 50km





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

# Philae: flight





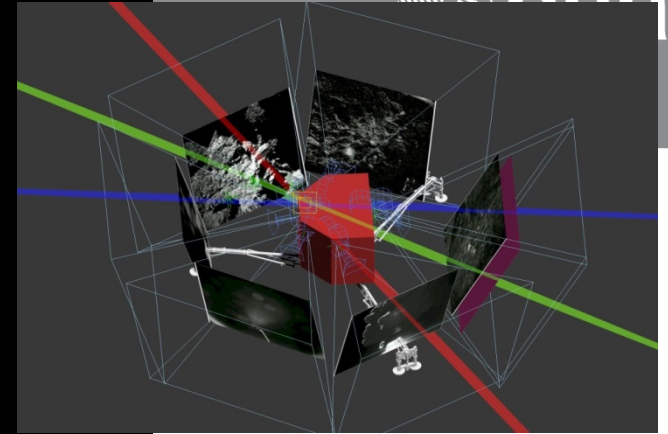
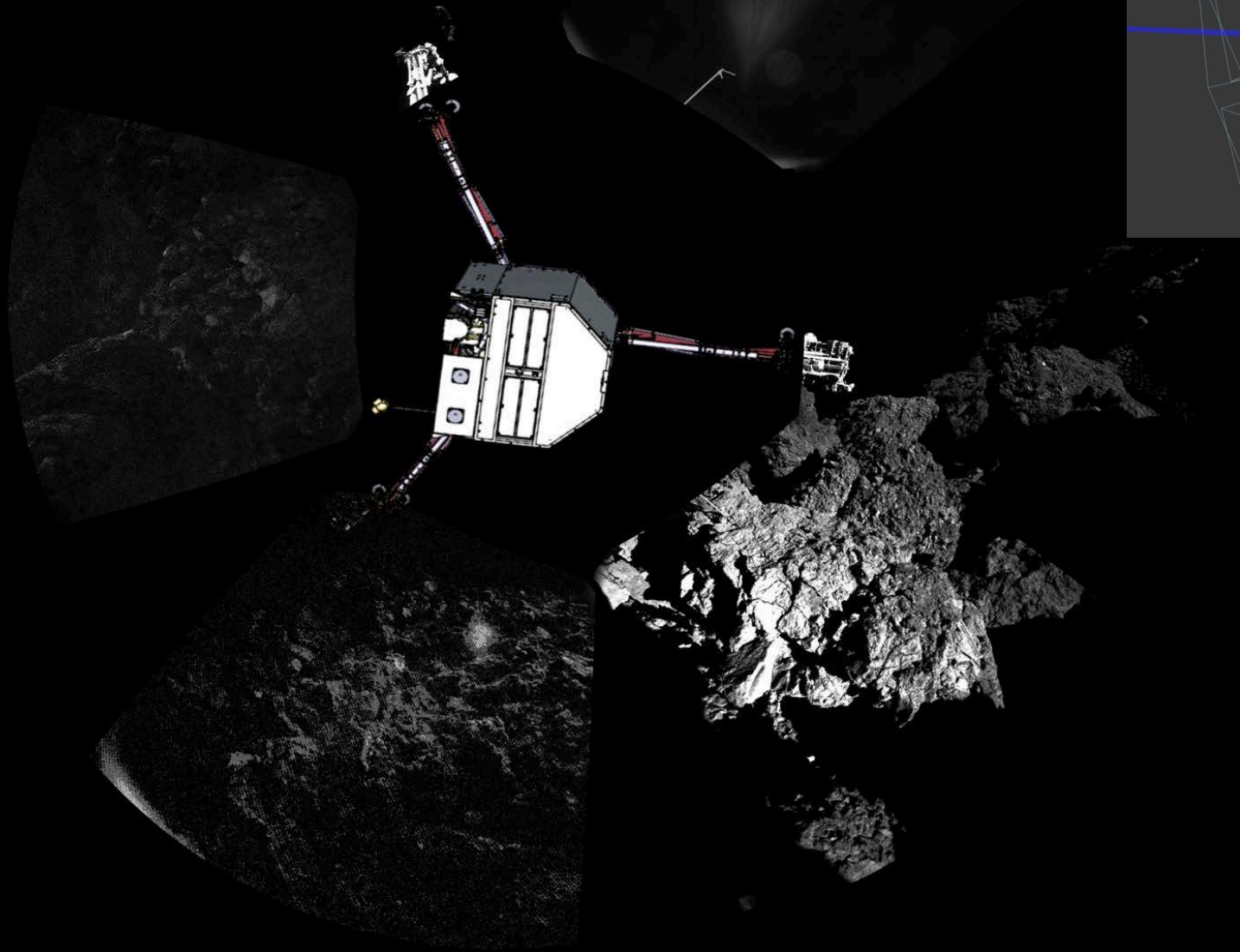
# First landing site from 40 m



ESA/Rosetta/Philae/ROLIS/DLR



# Panorama of the final landing site

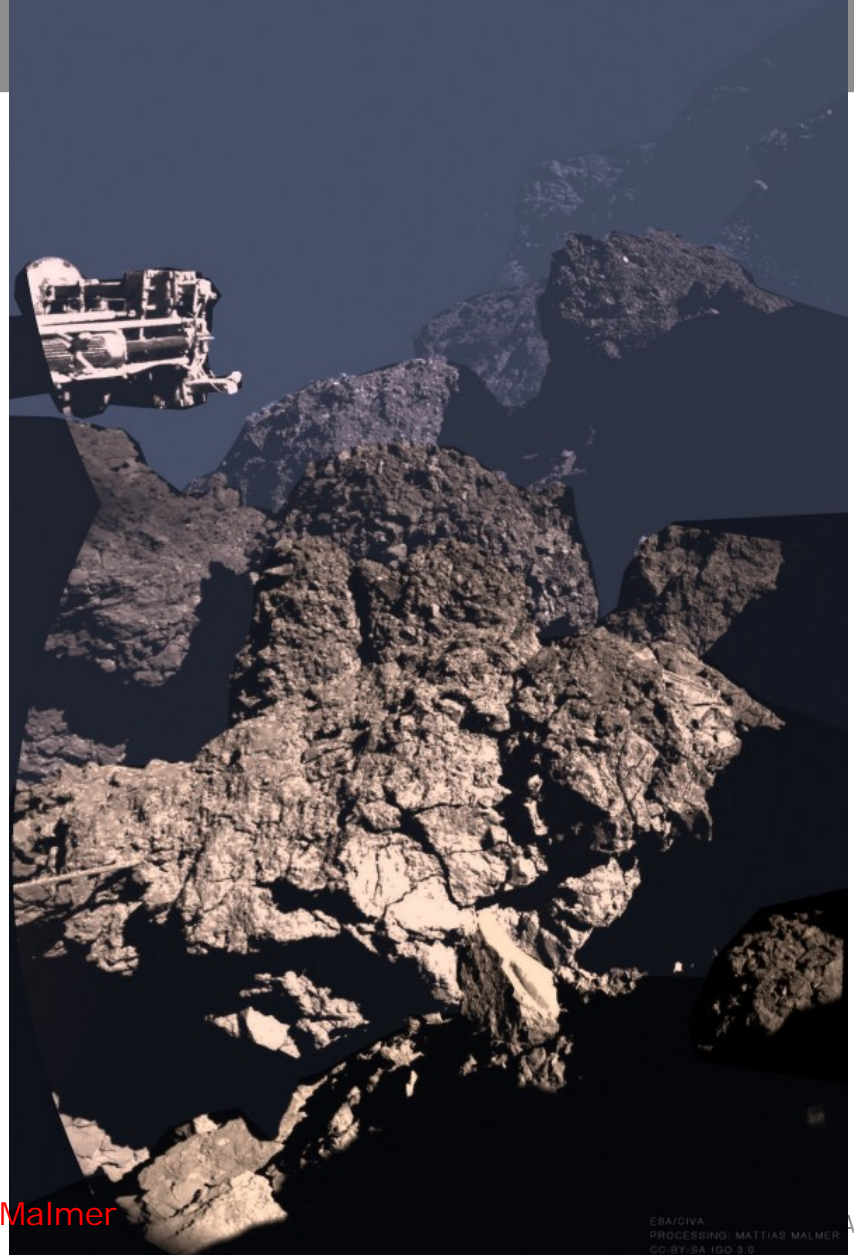


ESA/Rosetta/Philae/CIVA

Part of the panorama



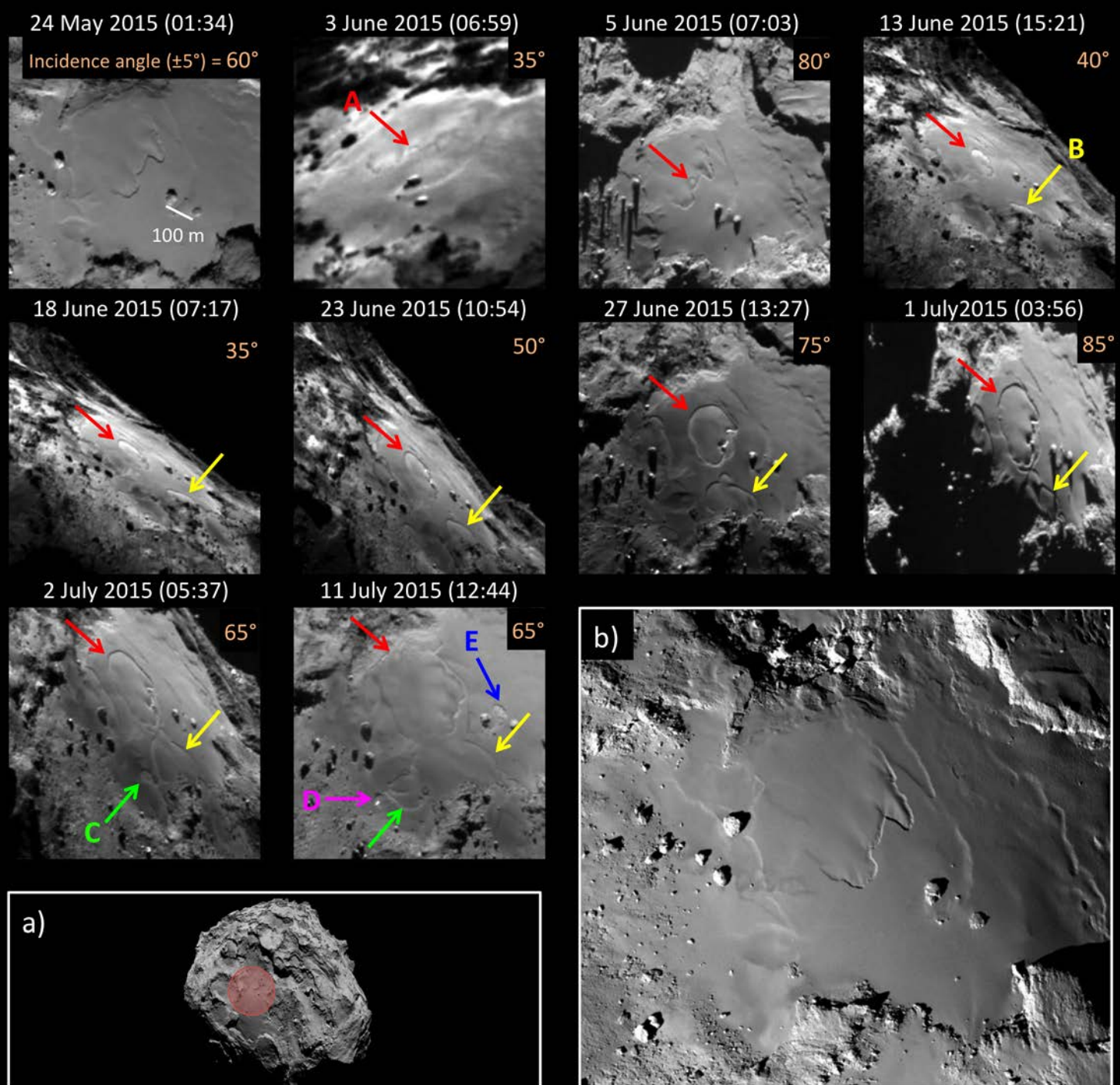
Artificial colour  
and "fog"



Source: Mattias Malmer



# Changes around perihelion

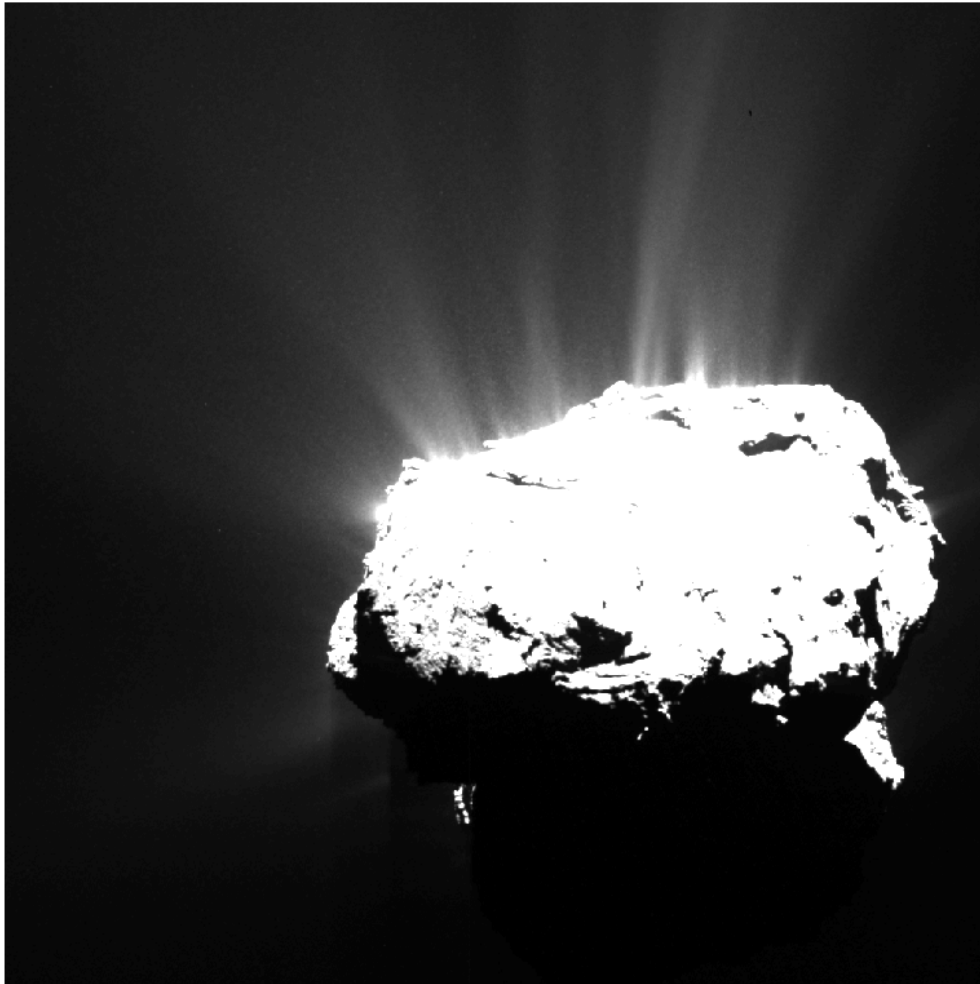


Groussin et al. 2015

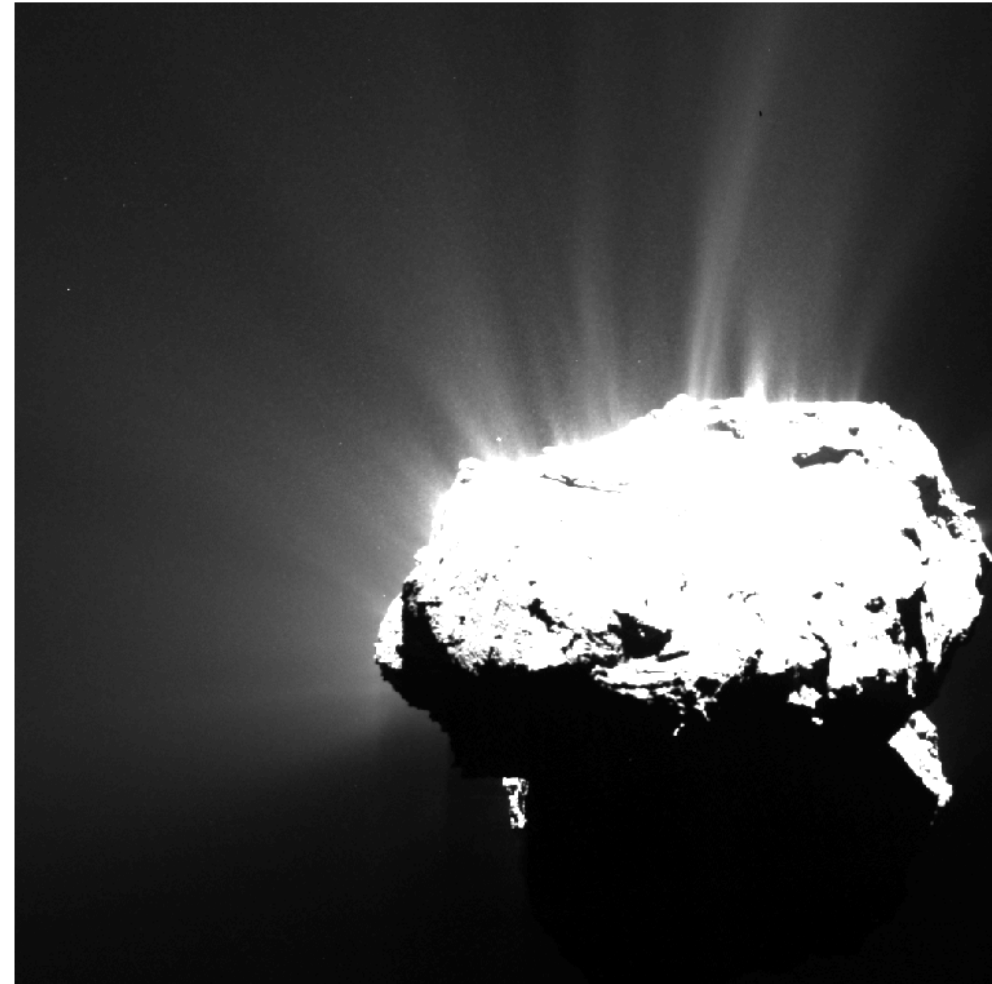
# Activity around perihelion: Images taken one rotation period part



NAC\_2015-08-09T12.09.49.525Z\_ID30\_1397549900\_F22.IMG



NAC\_2015-08-10T00.23.00.507Z\_ID30\_1397549800\_F22.IMG

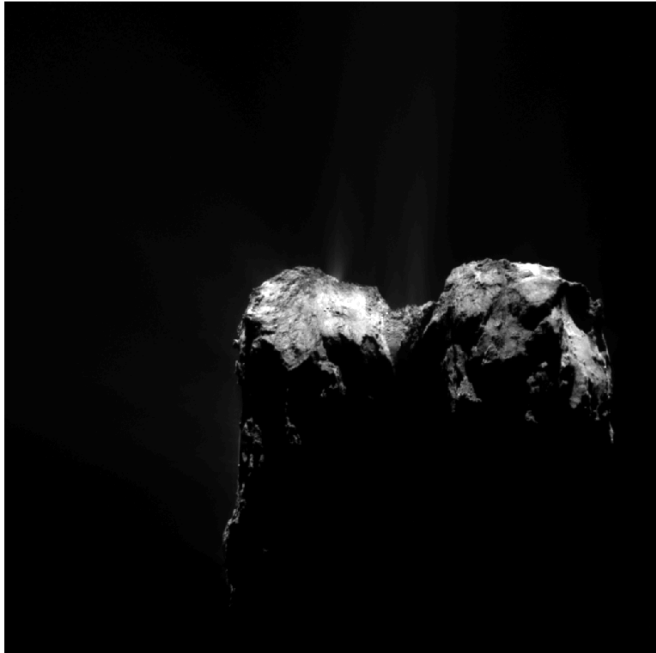




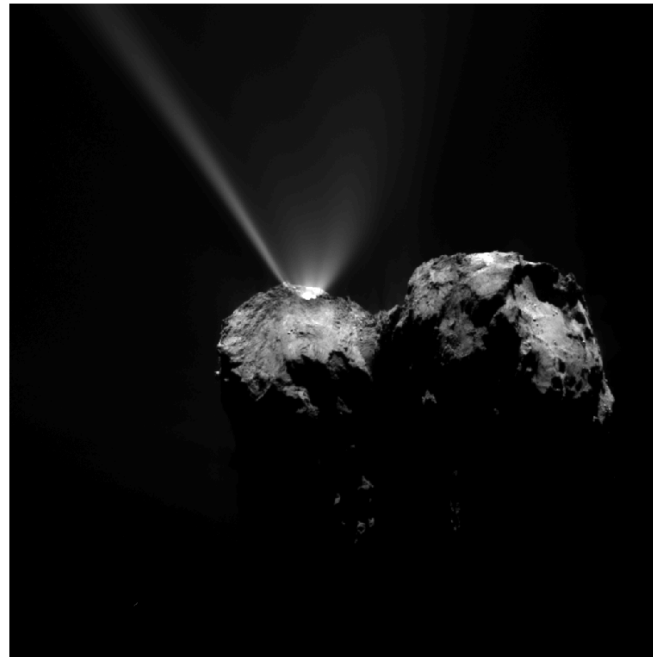
# Outburst around perihelion

Images each taken 30 minutes apart

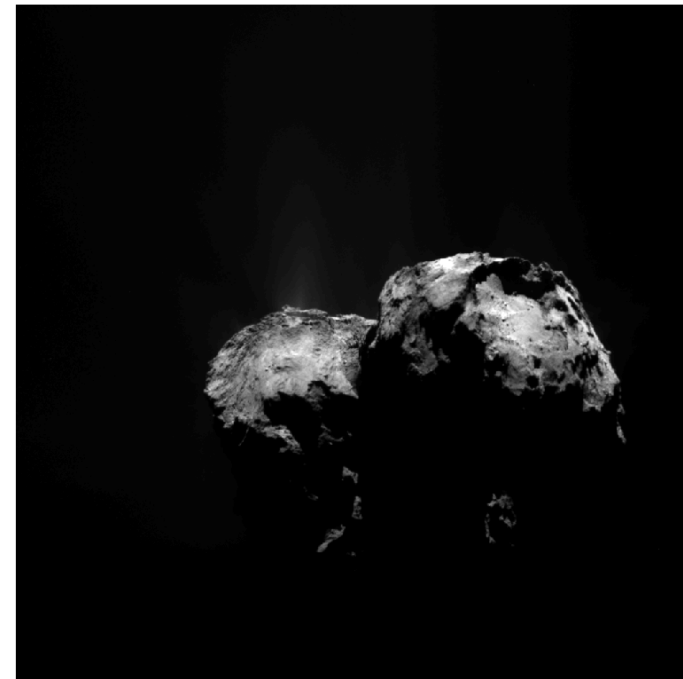
NAC\_2015-08-12T17.05.04.738Z\_ID30\_1397549300\_F22.IMG



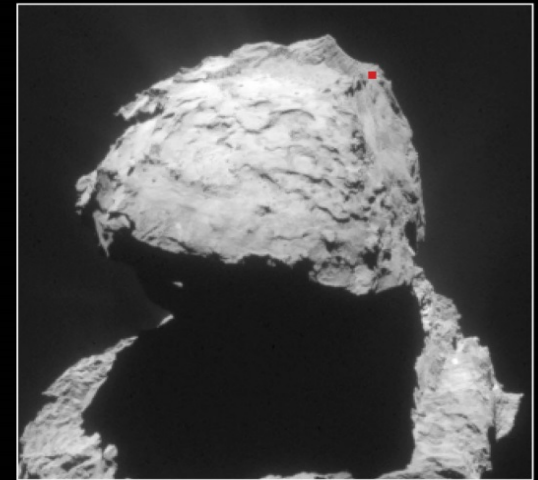
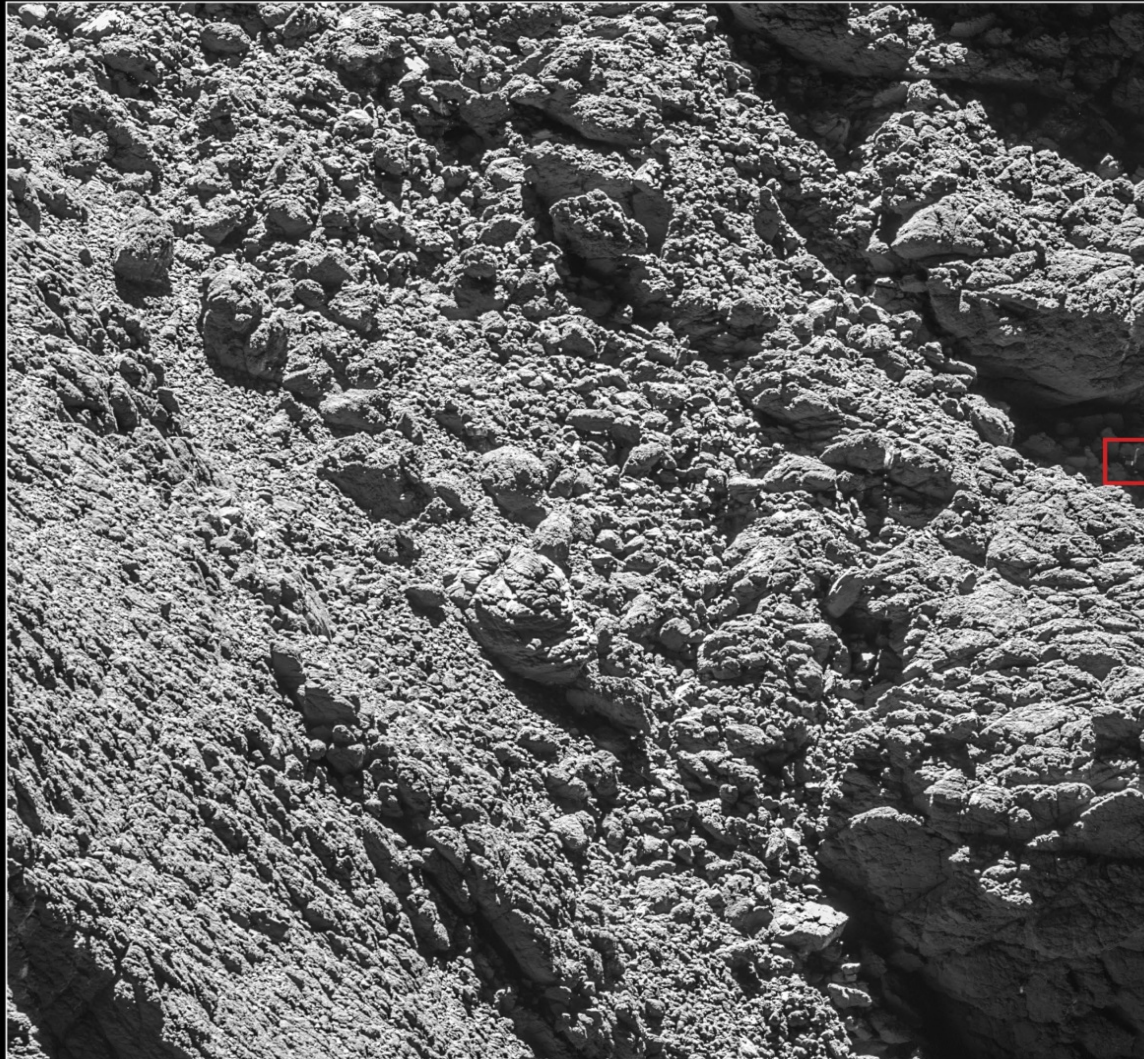
NAC\_2015-08-12T17.35.04.738Z\_ID30\_1397549000\_F22.IMG



NAC\_2015-08-12T18.05.04.763Z\_ID30\_1397549100\_F22.IMG



# Philae found!

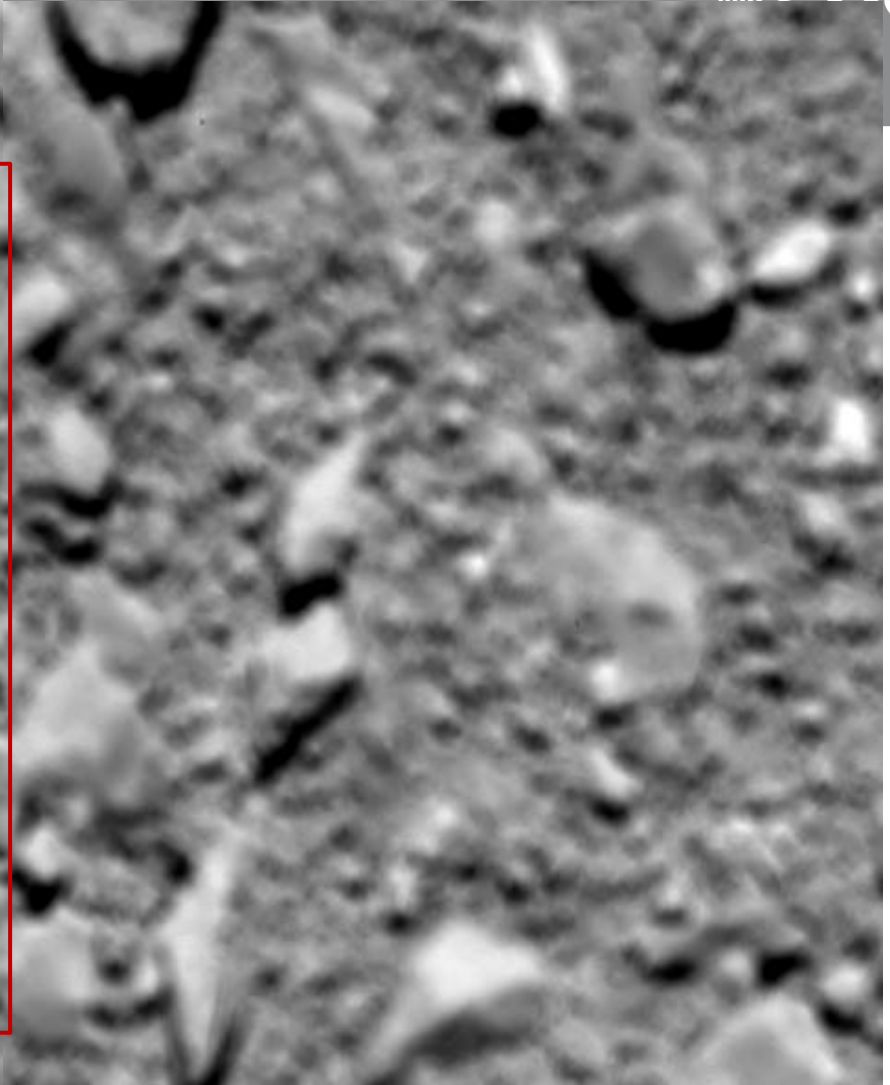




Last images

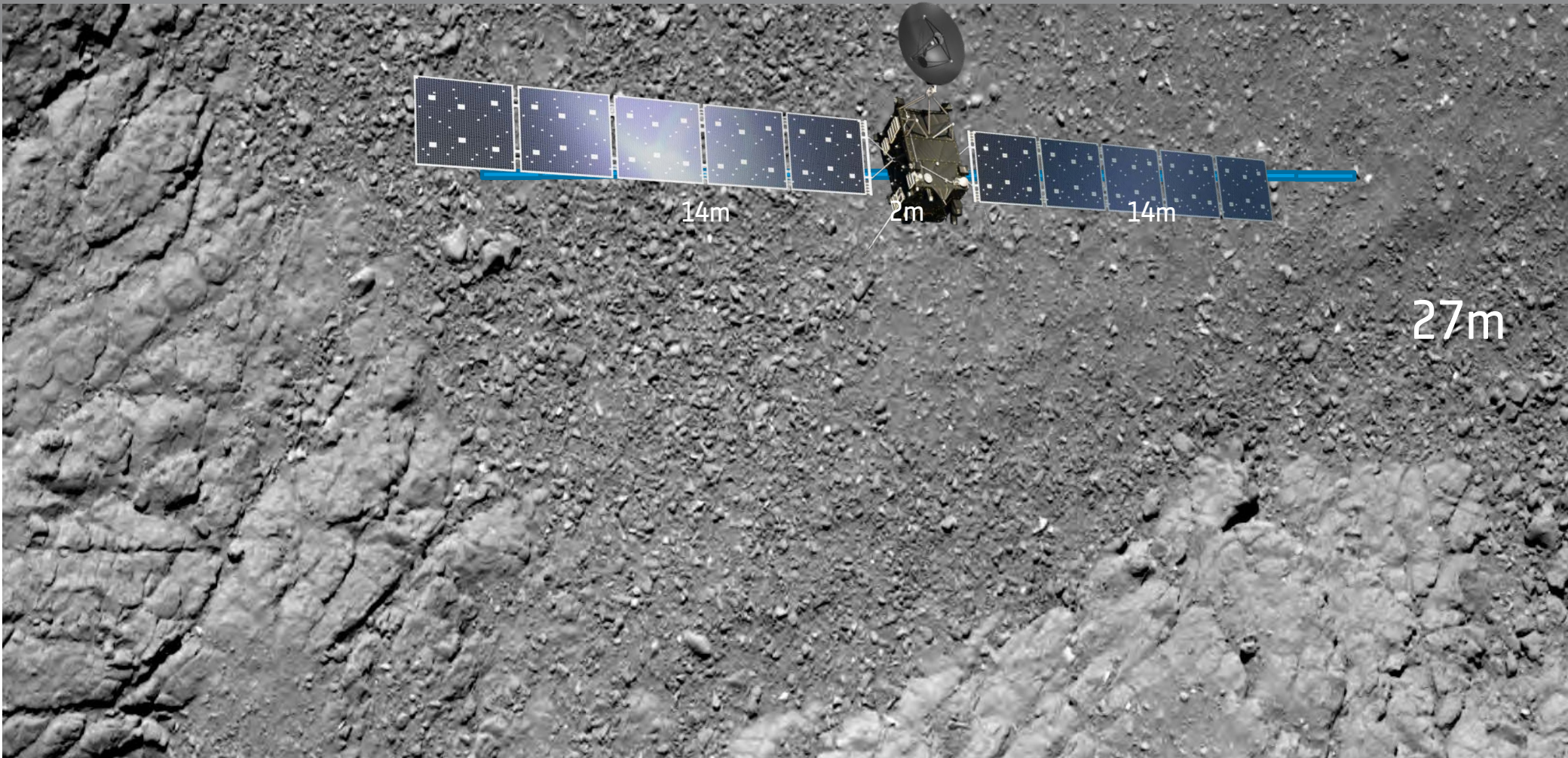


24.5m



20m

# End of mission



69m