# Pits of 67P/Churyumov-Gerasimenko
# What do they tell us on comets?


***S. Besse, A. Guilbert-Lepoutre, C. Leyrat***

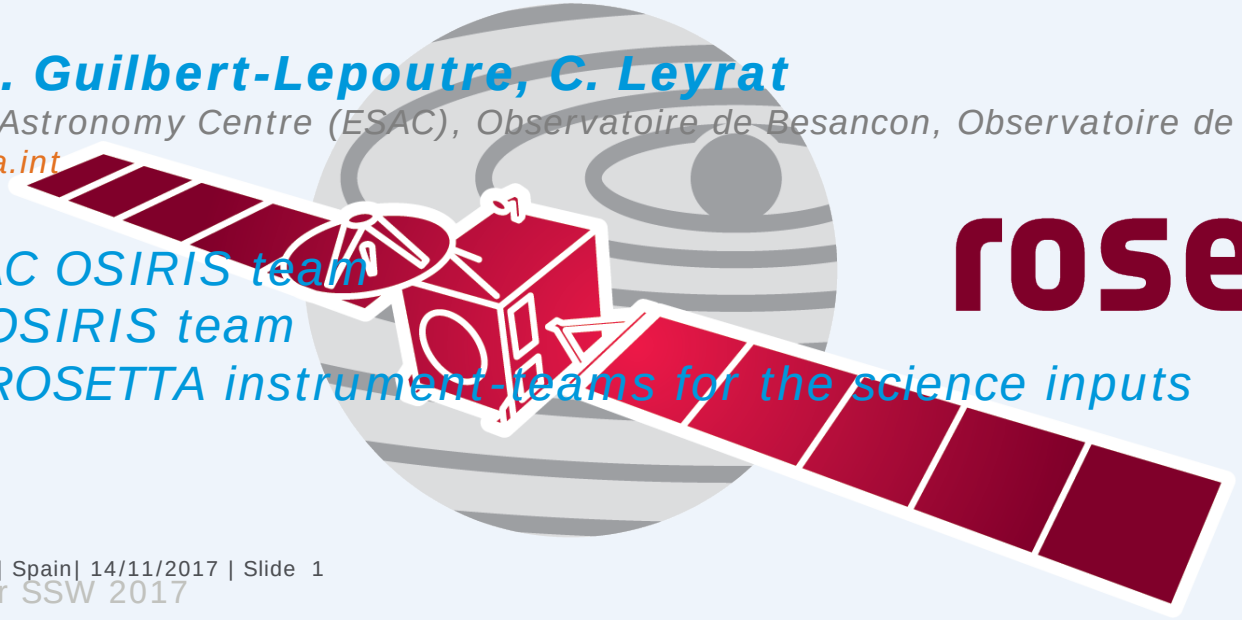
*European Space Astronomy Centre (ESAC), Observatoire de Besancon, Observatoire de Paris*

*sbesse@sciops.esa.int*


*And the ESAC OSIRIS team*

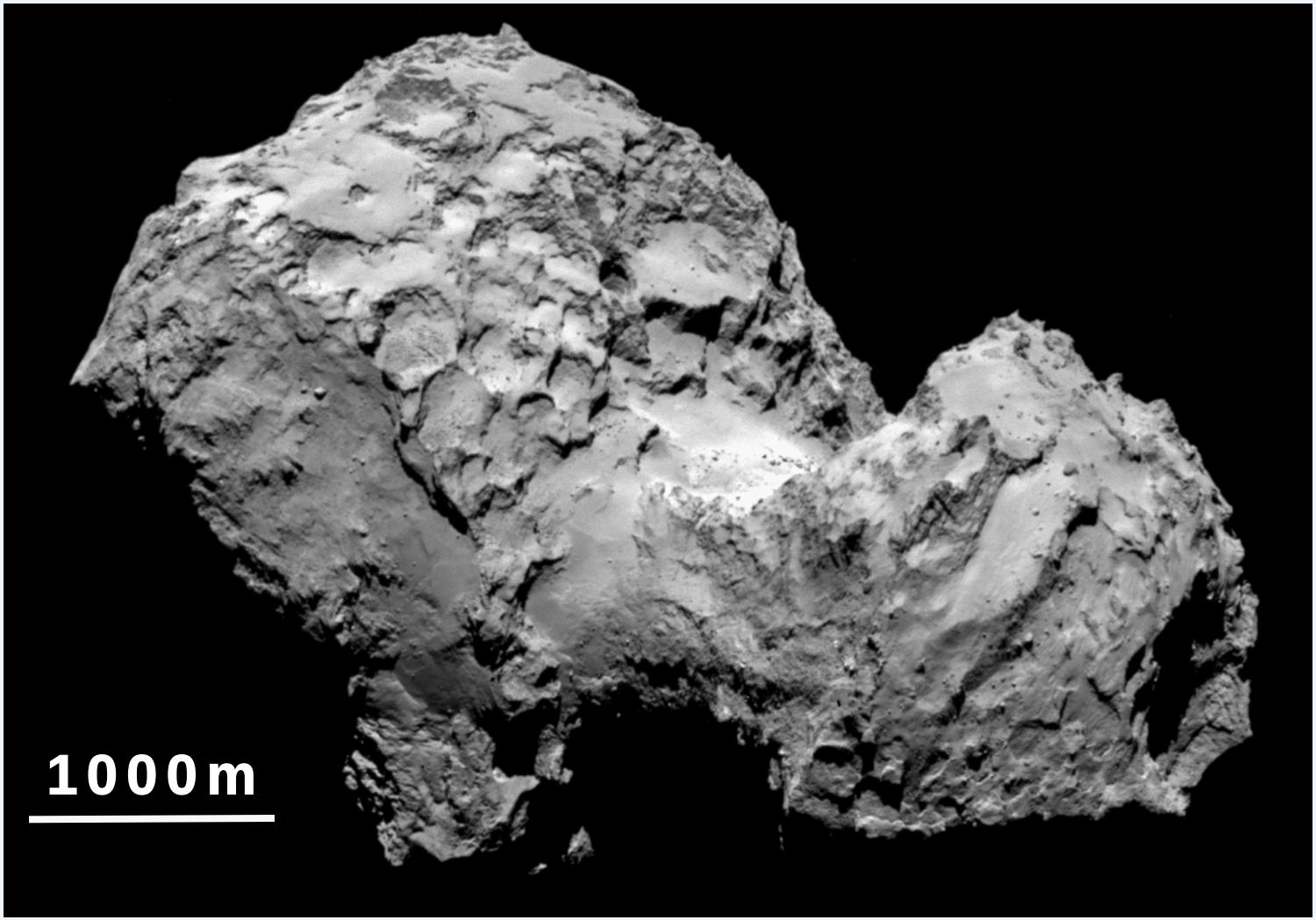
*And all the OSIRIS team*

*And all the ROSETTA instrument-teams for the science inputs*



rosetta

# 67P/Churyumov-Gerasimenko



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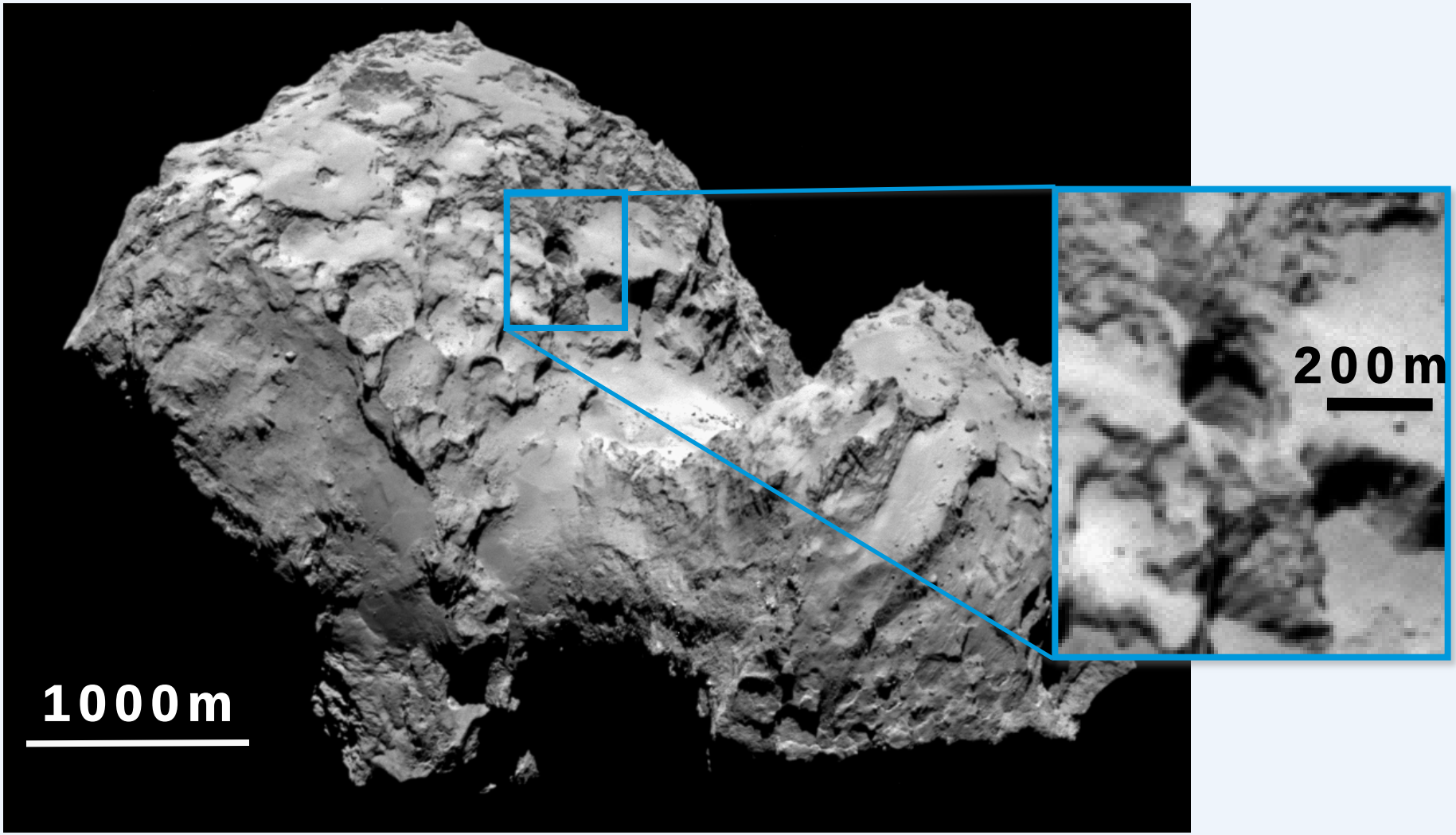

# How can your schedule go totally wrong

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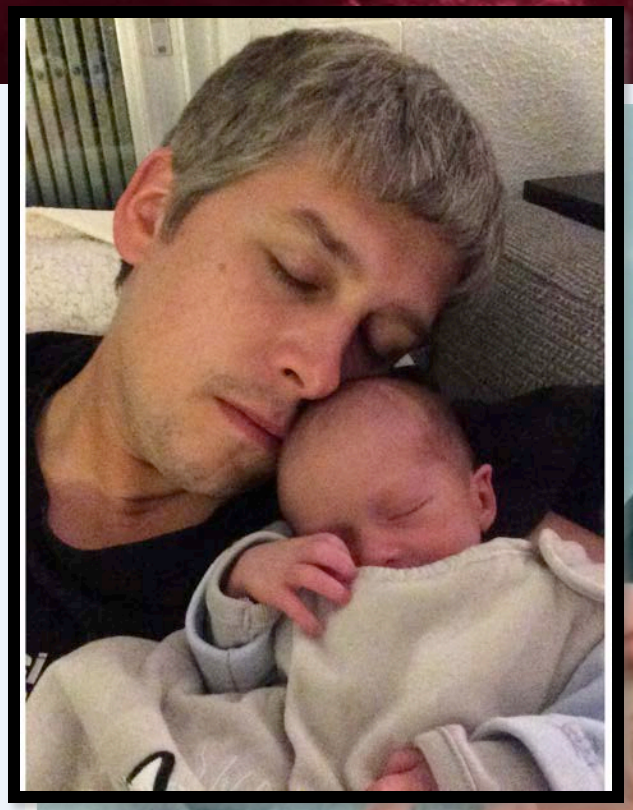

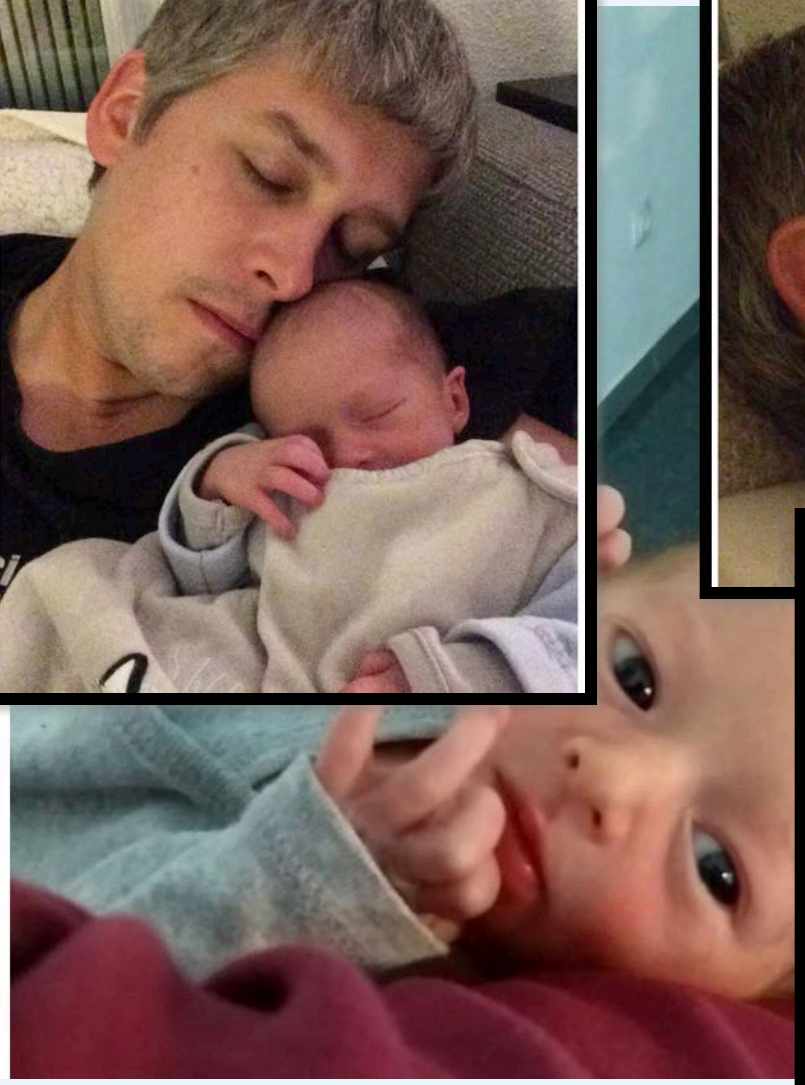

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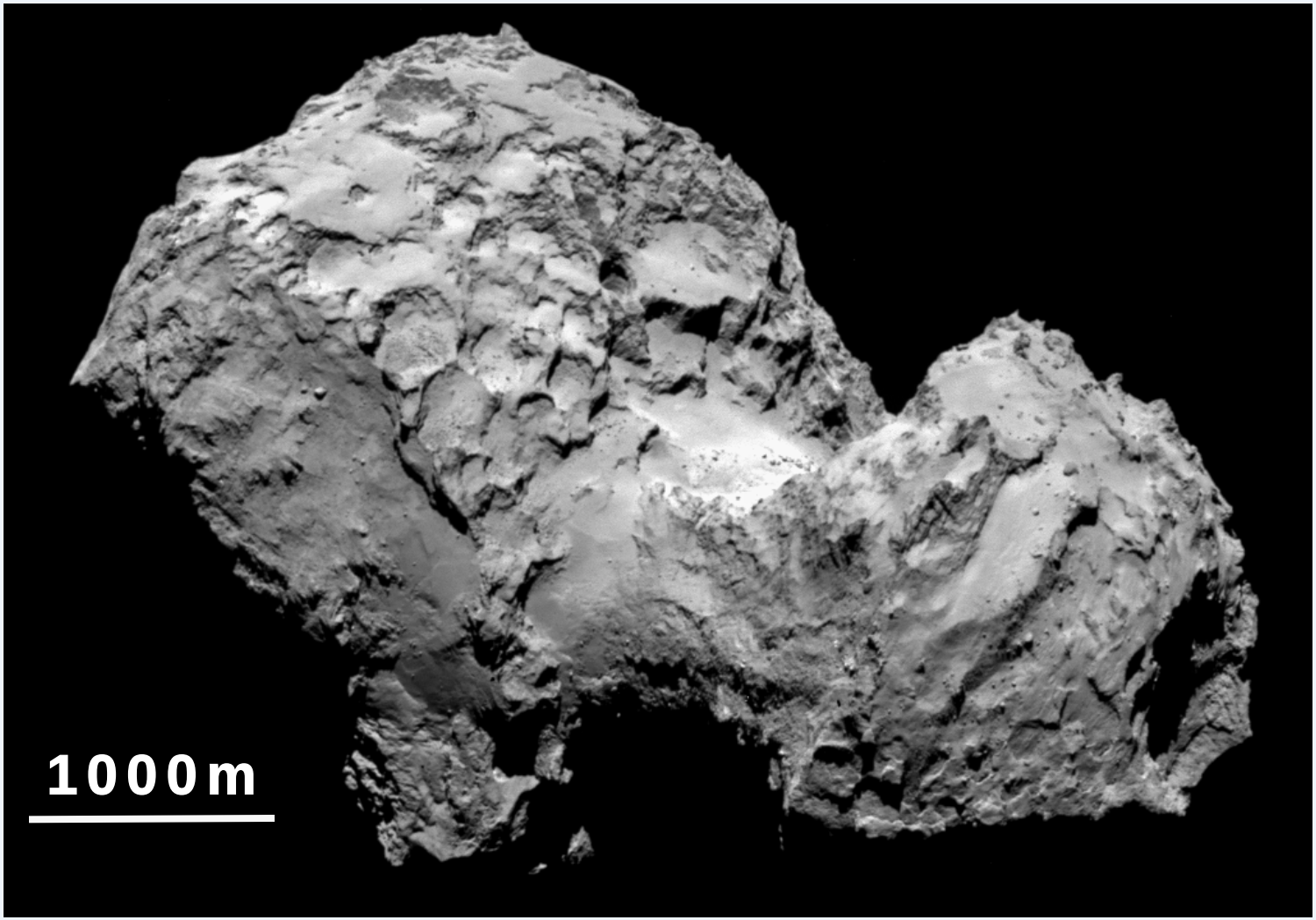
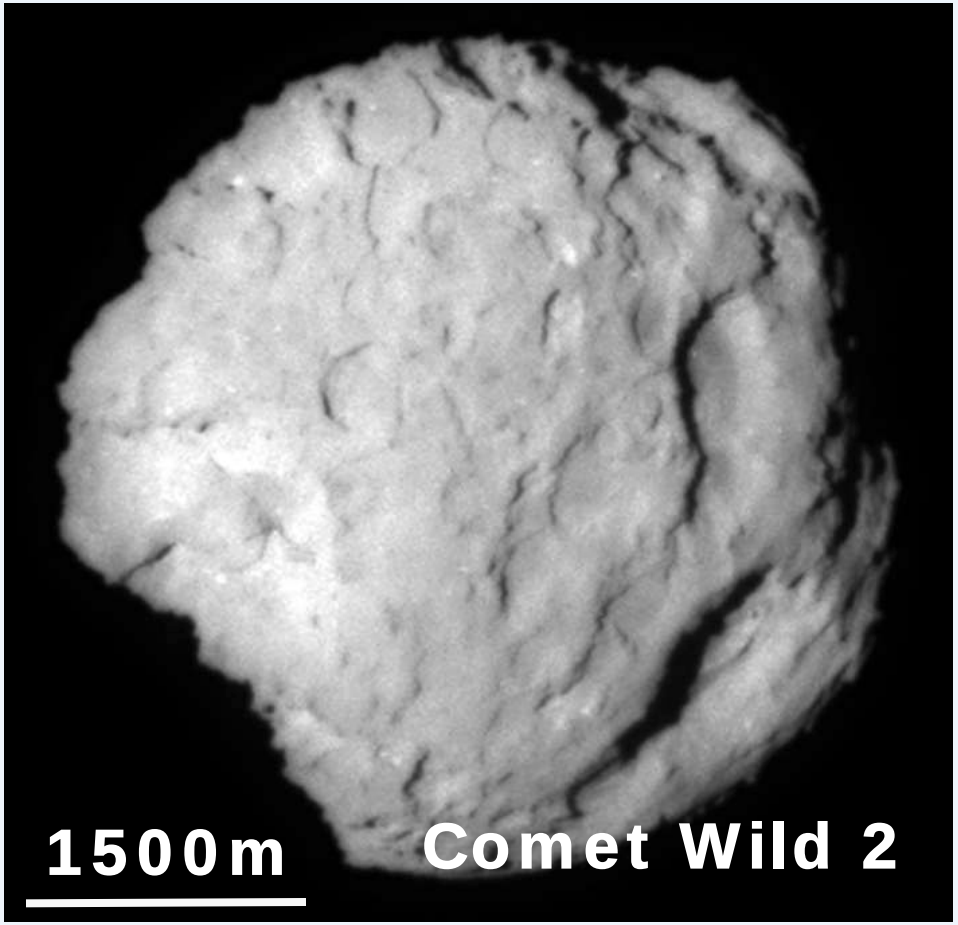
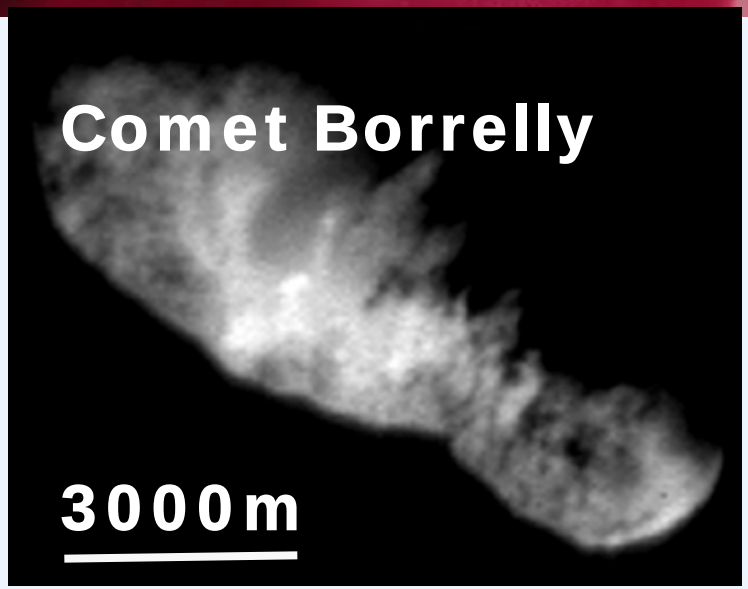
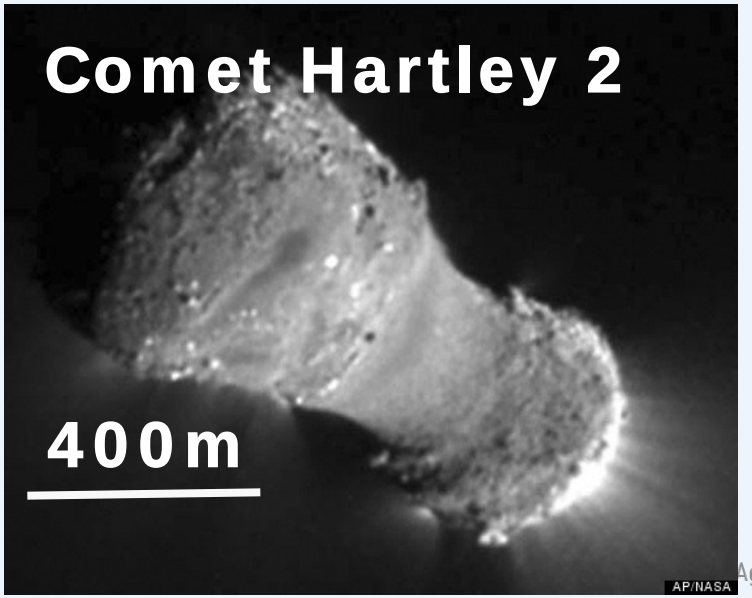


# Applicable to other comets as well ?

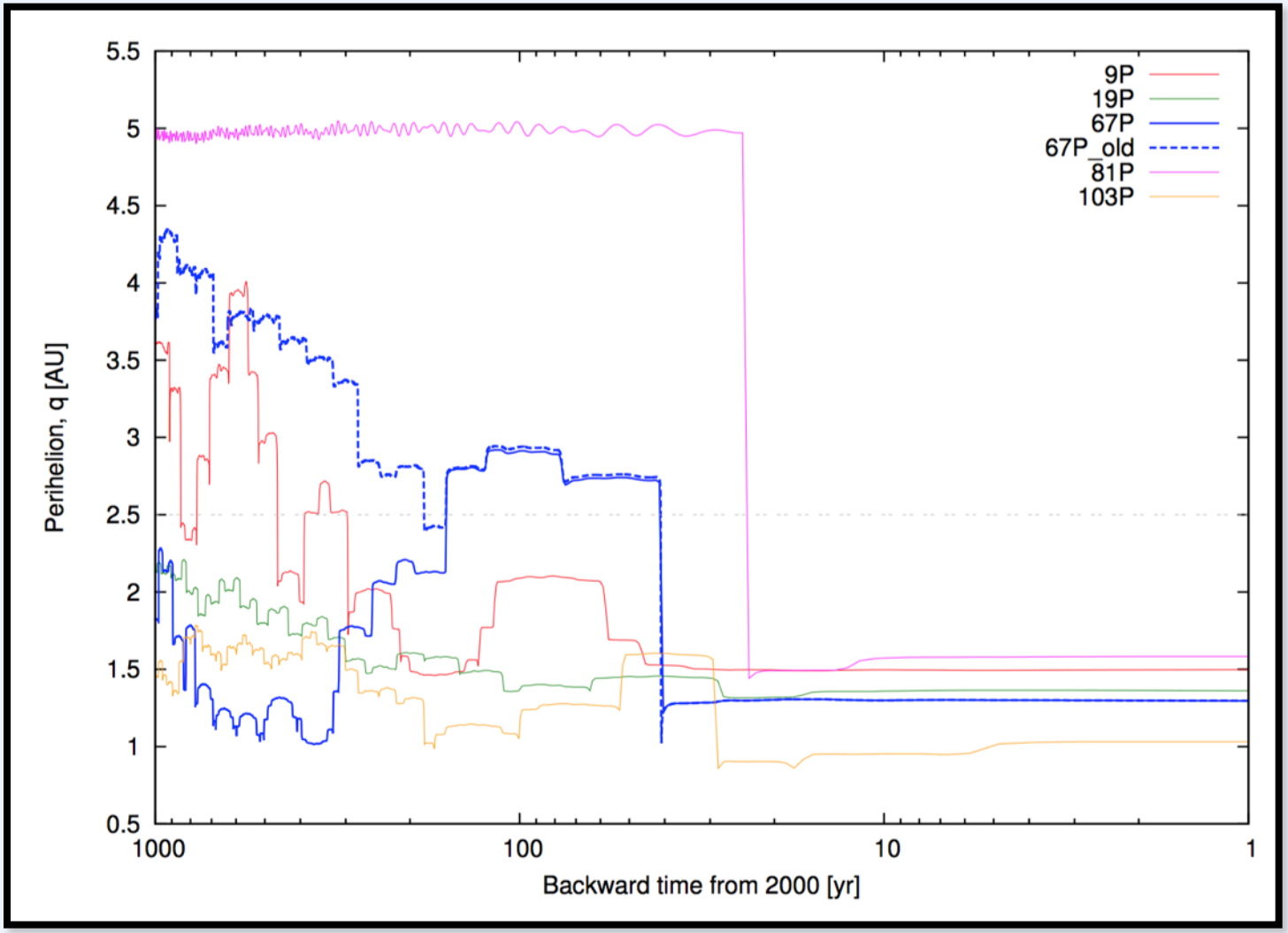


# Difficult to compare comets to comets

Wing-Huen et al, 2015



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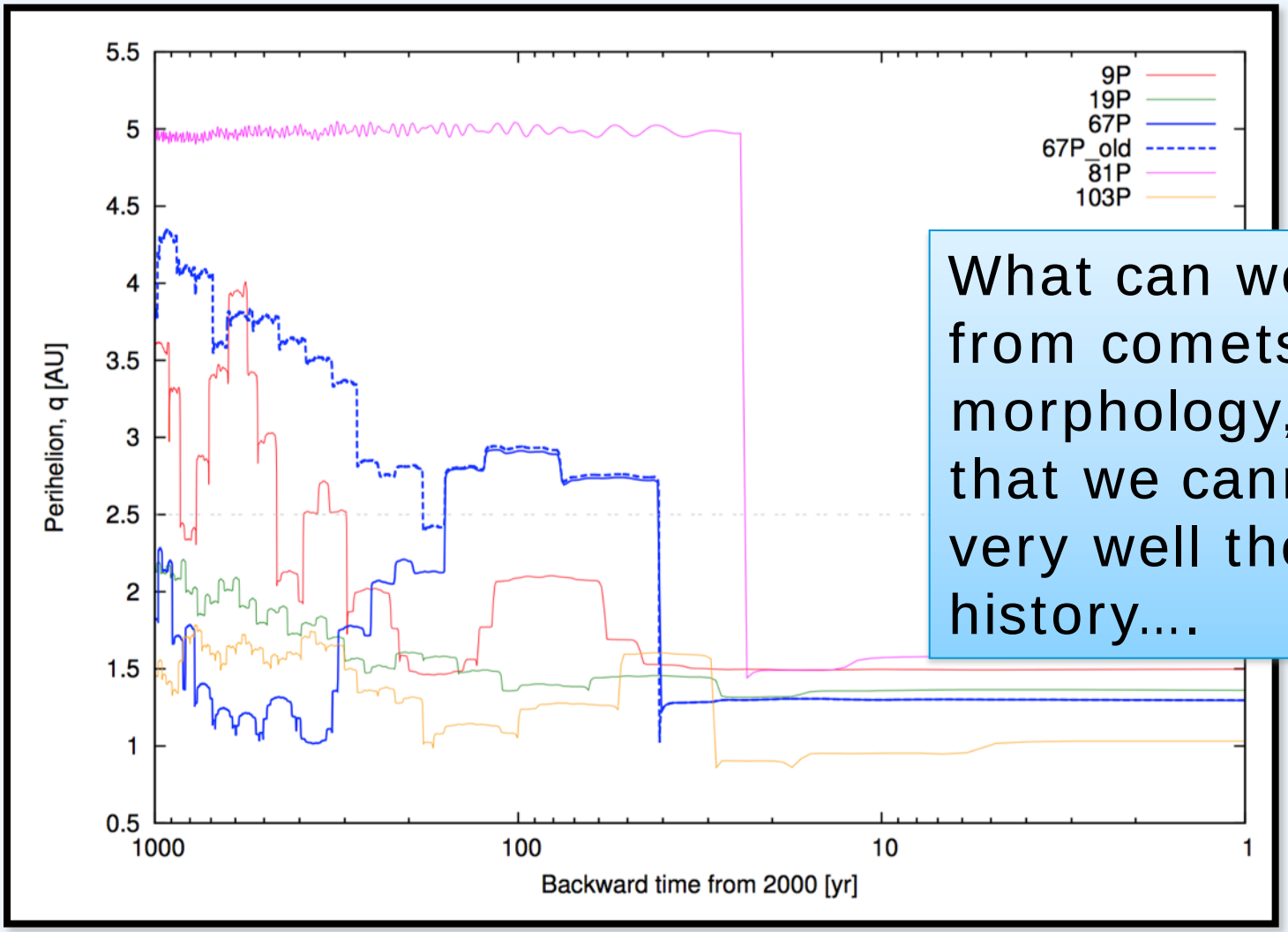



What can we learn from comets morphology, knowing that we cannot predict very well their history….

# What can we learn from those pits?

- We study comets because they have preserved (to a certain point) the original building blocks of the Solar System?

- By staying far away from the Sun (>2.5 AU), do they preserve their original chemistry, morphology and history of formation?
  - ✓ This is the point to be questioned here!

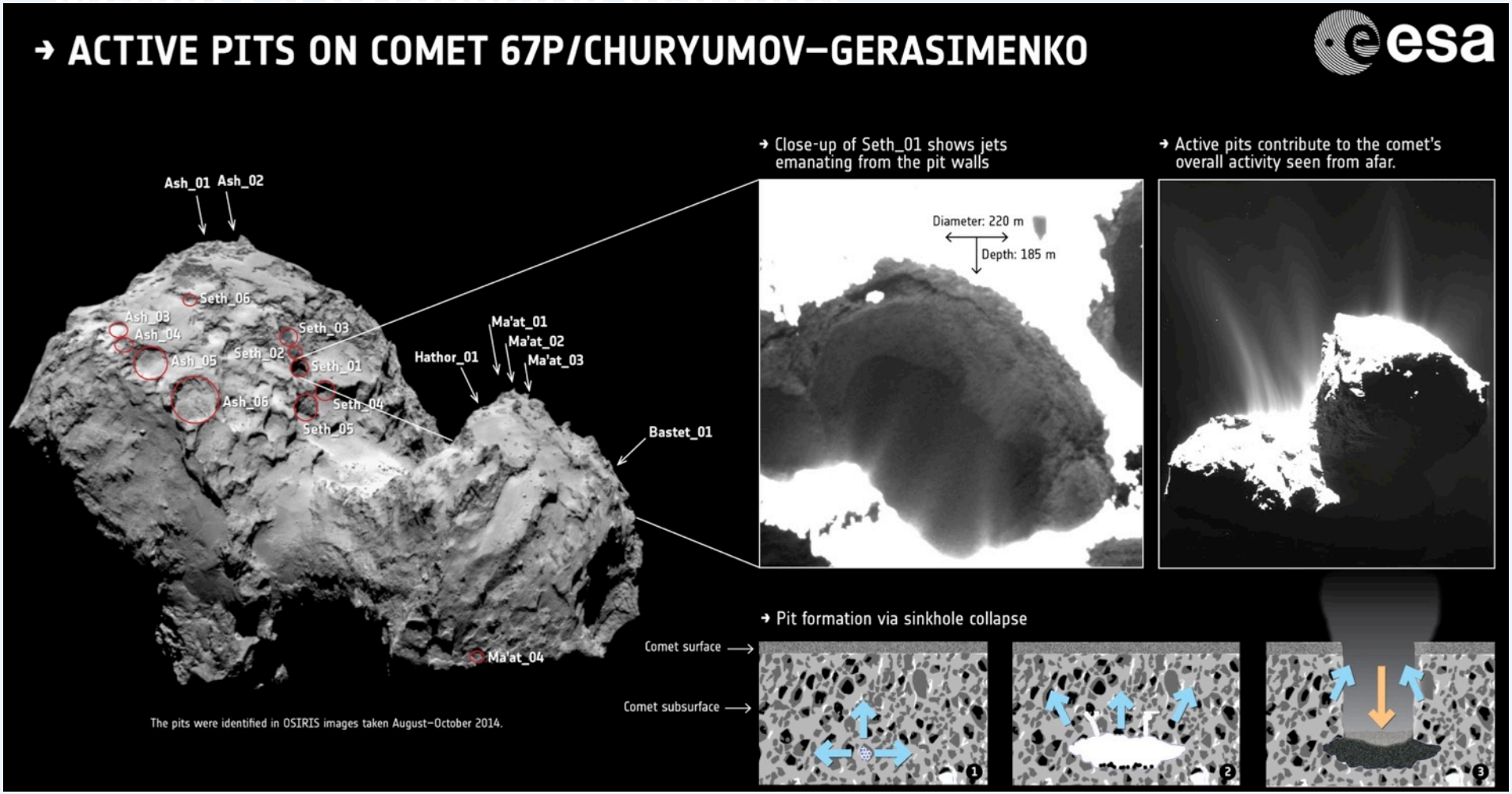
**Are the pits providing a view inside the primitive composition and morphology of comets?**

**What are they, how do they form, what do they tell us?**

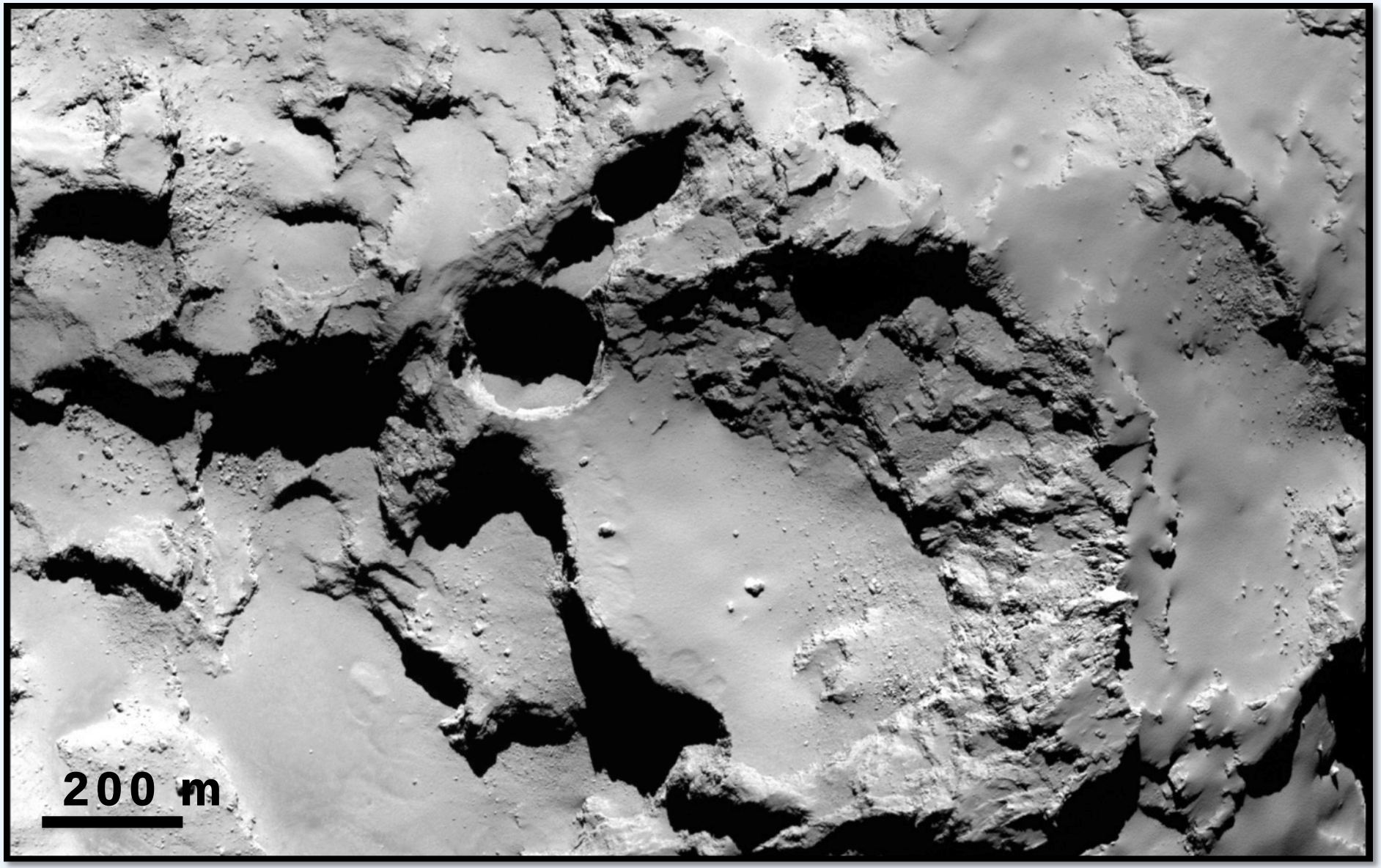
1. Good characterization of the features → Geologist background
2. Good understanding of the evolution processed → Modeler background

# 67P/Churyumov-Gerasimenko

Vincent, Bodewits, Besse et al., 2015



# Seth region



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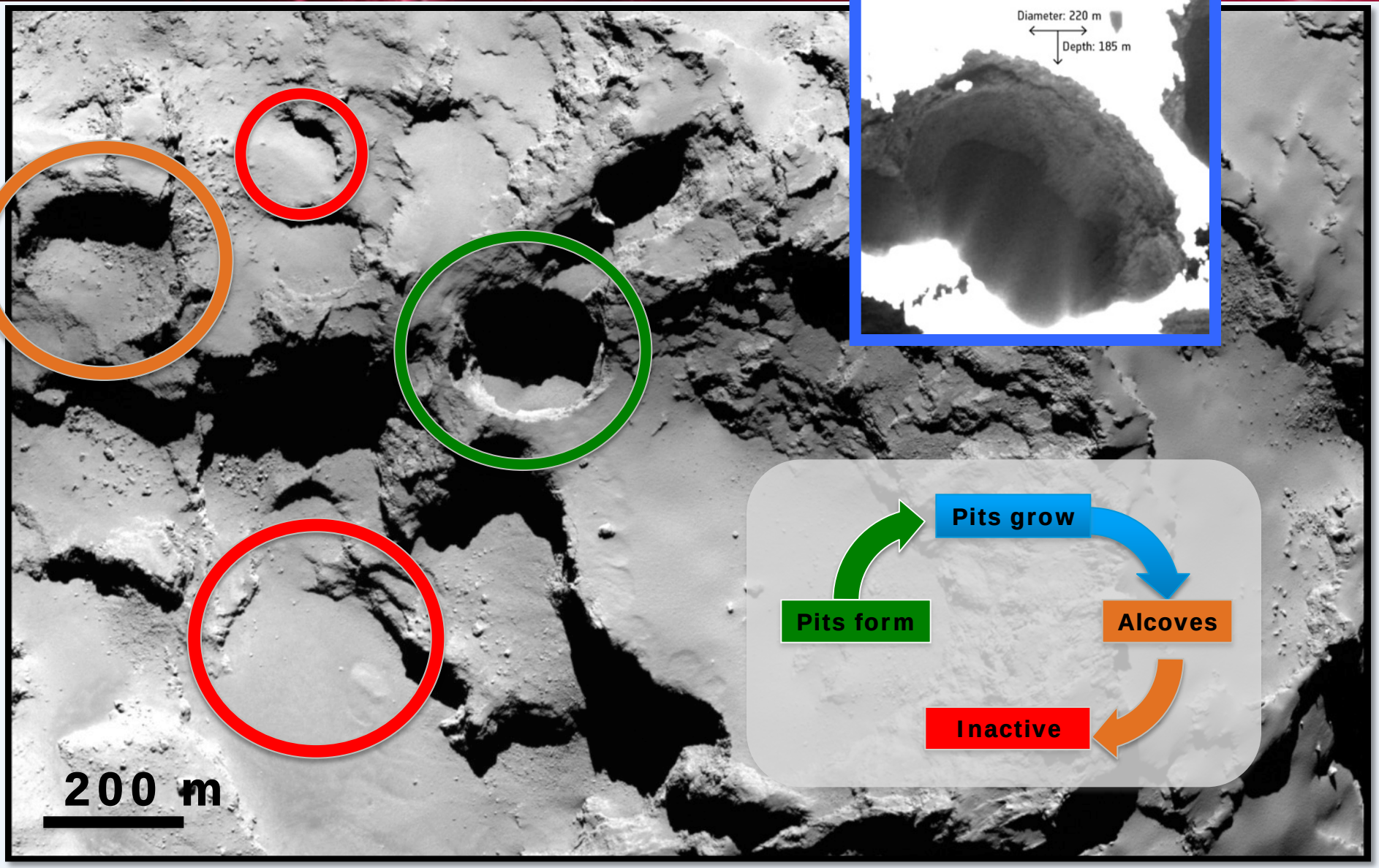
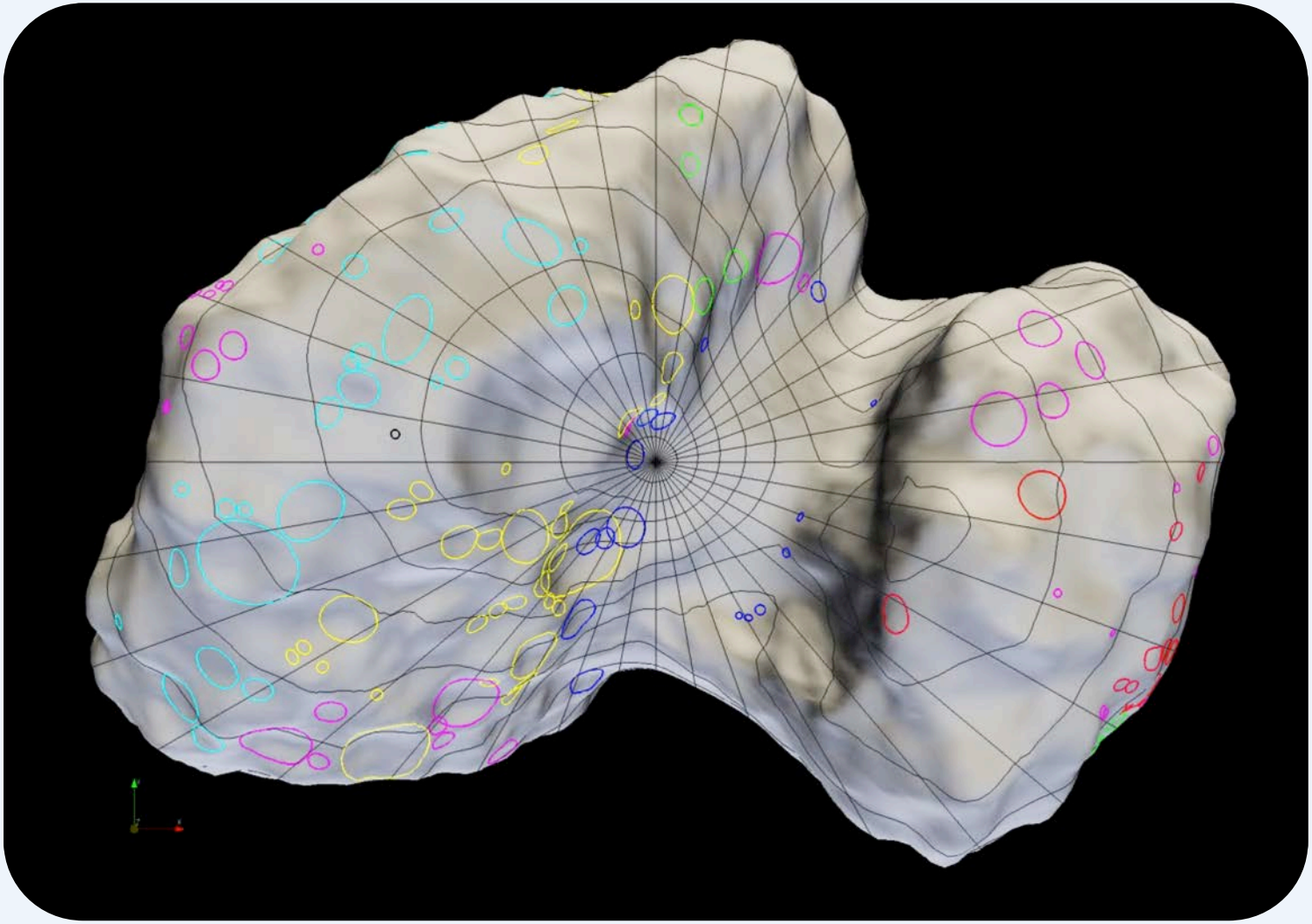

Diameter: 220 m
Depth: 185 m
Pits grow
Alcoves
Inactive
Pits form
200 m

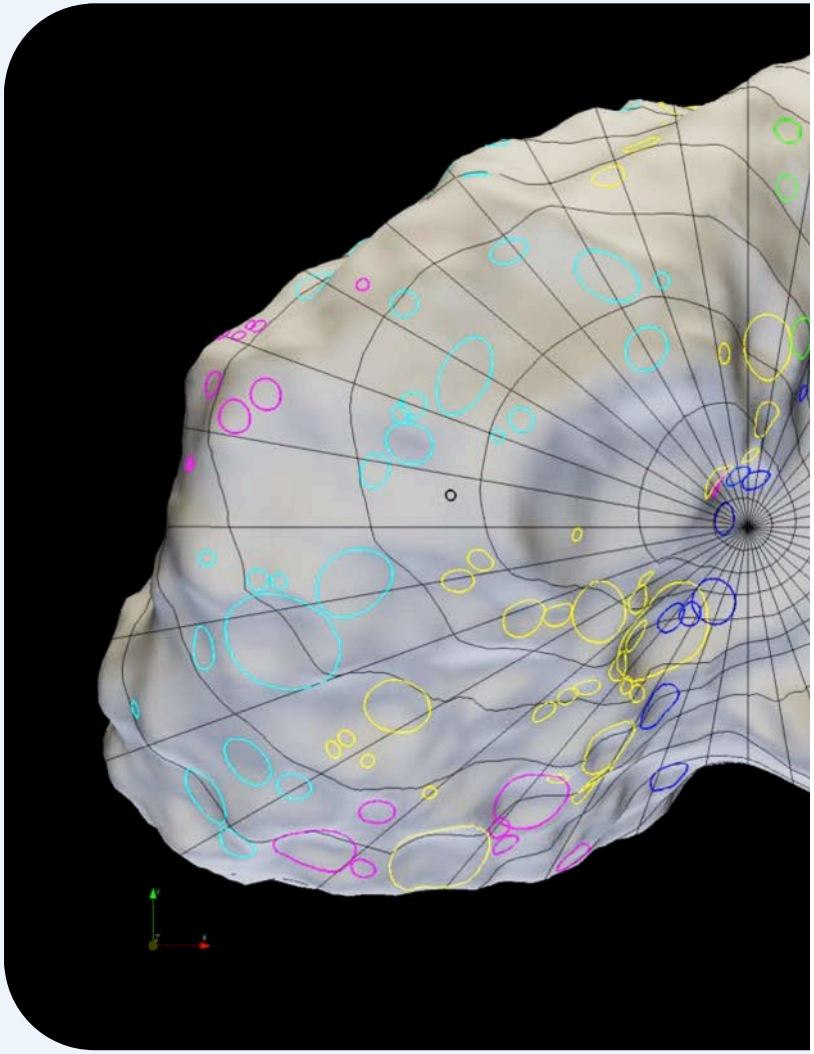
# Mapping

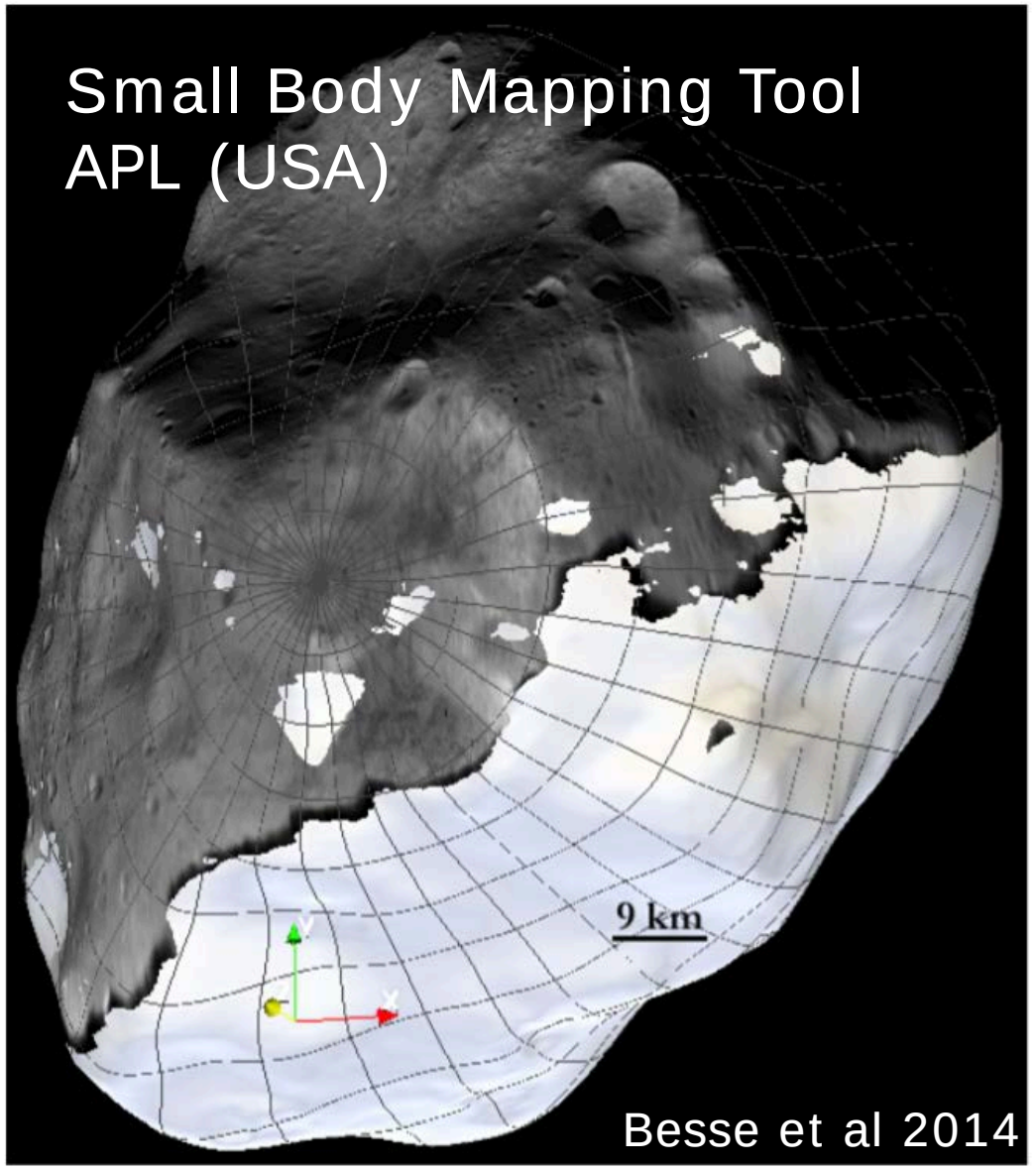


Northern Hemisphere

Colors for regions

# Mapping with Faculty funding ☺





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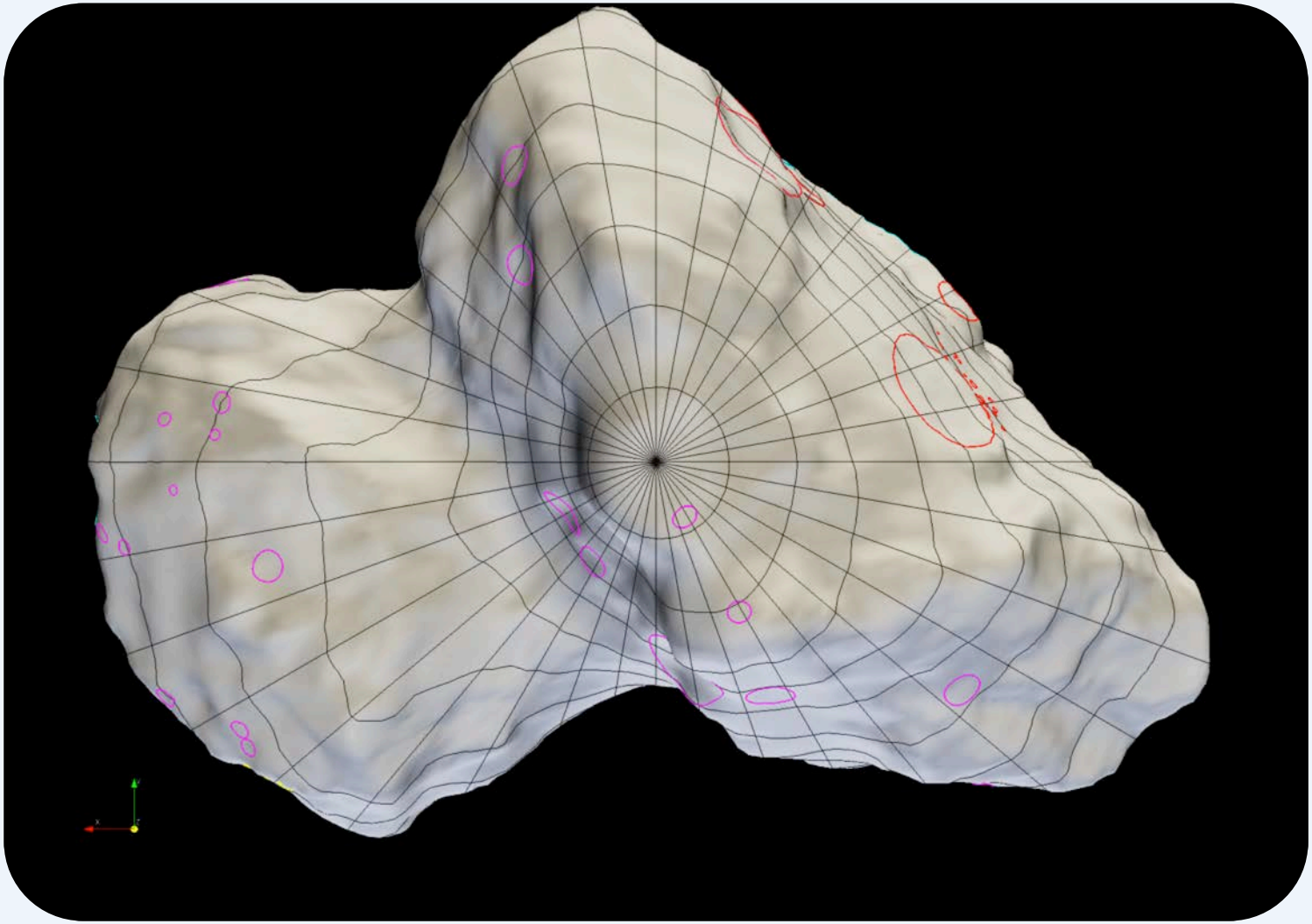
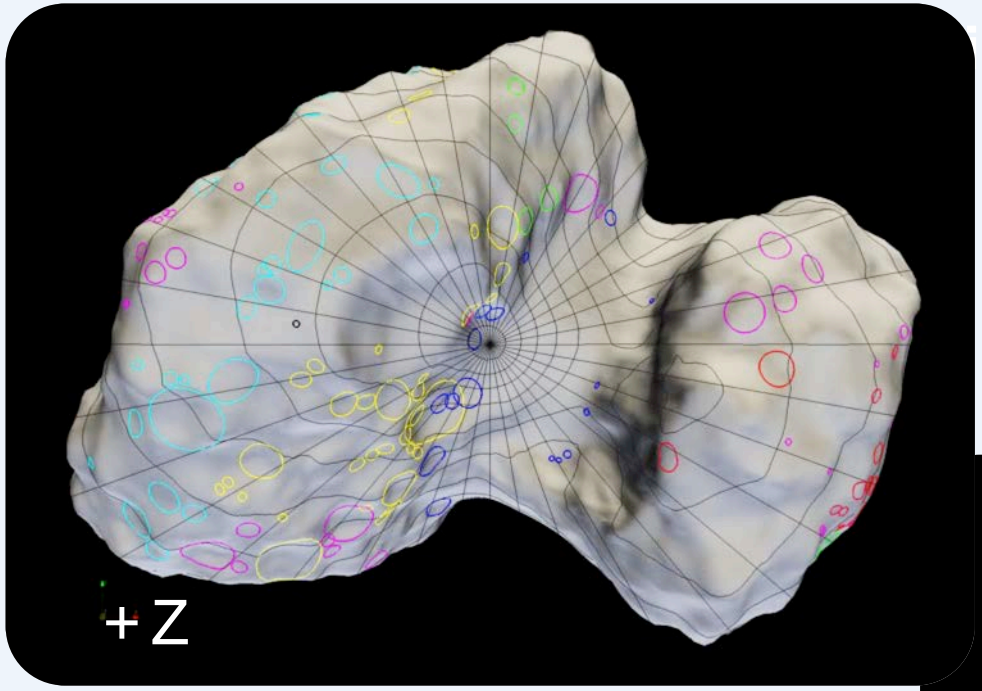
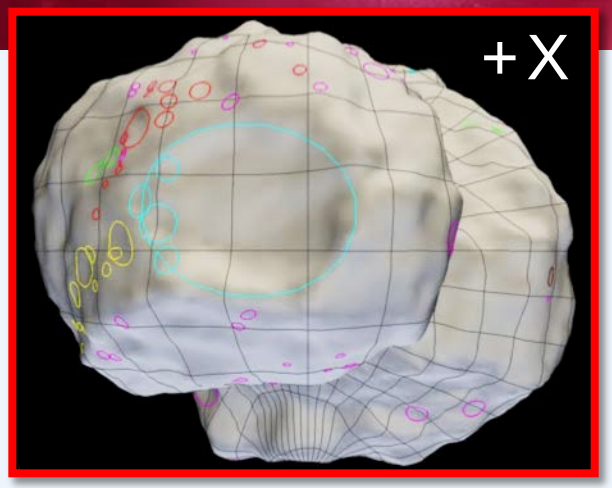


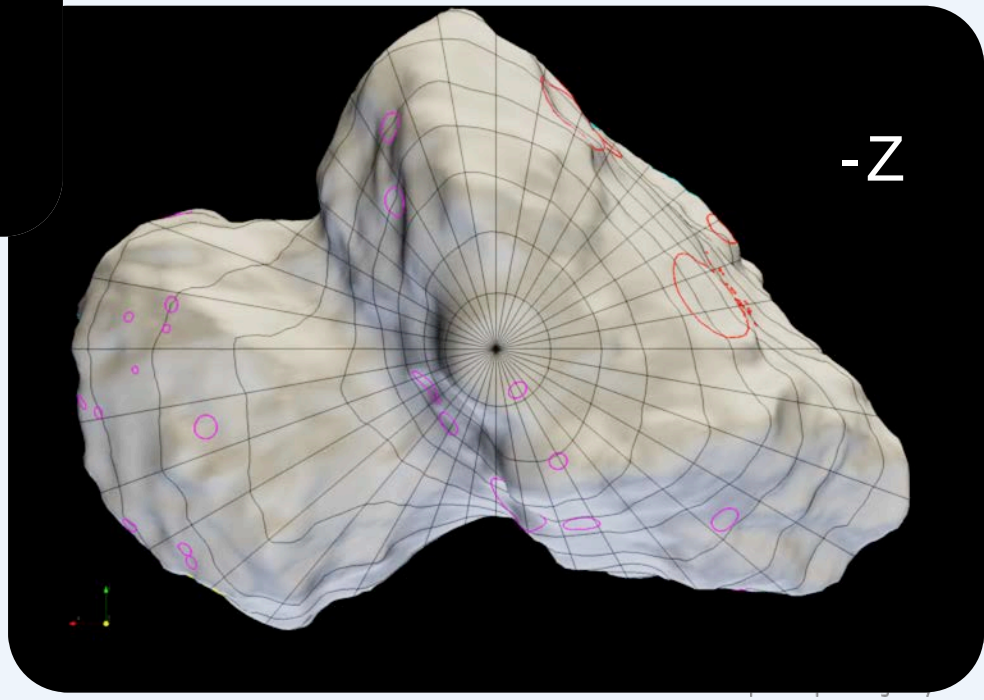
Southern Hemisphere

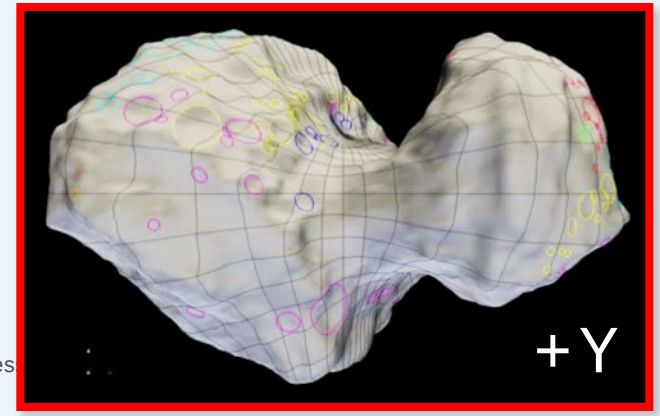
Colors for regions

# Multiple views



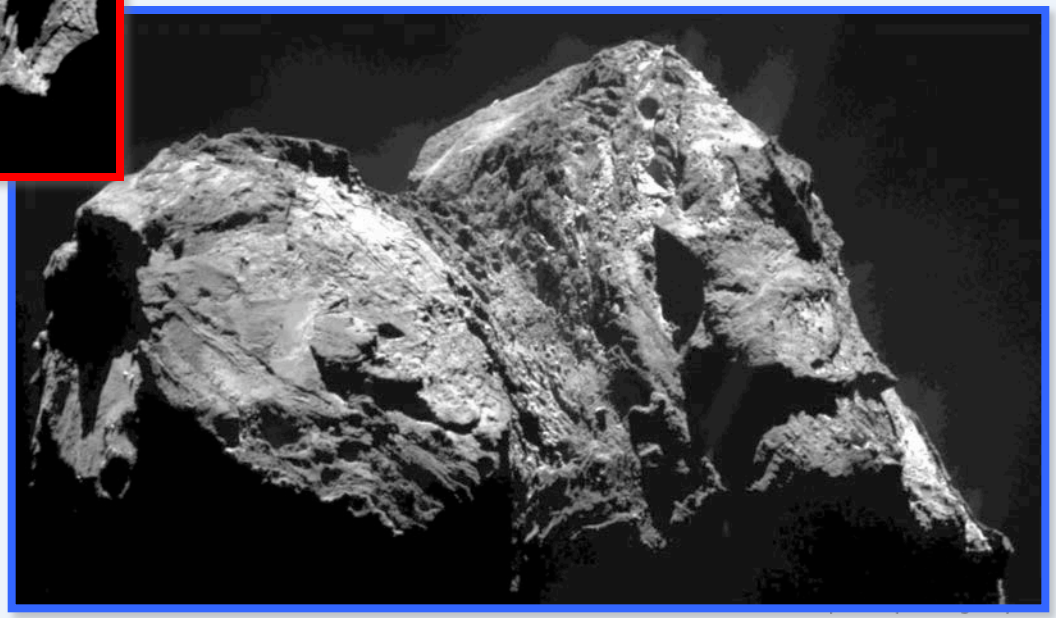



# Hapi-Seth (N) Vs. Sobek-Anhur (S)

El-Maarry et al. 2015 (N), 2016 (S)



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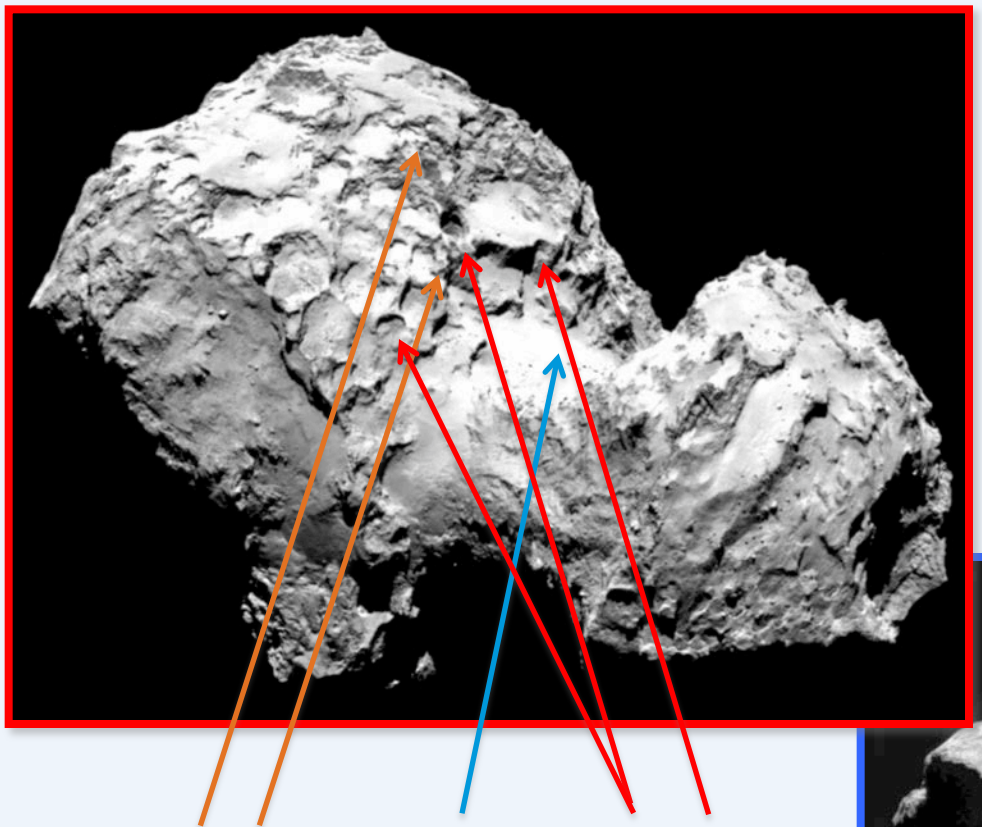
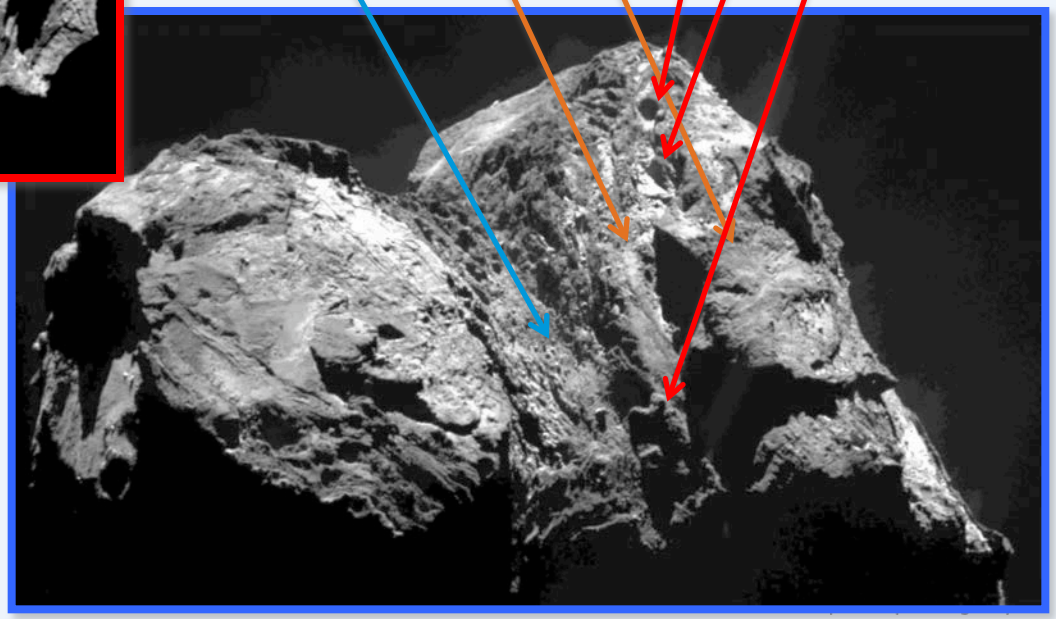
Massironi et al. 2015



Terraces – Neck – Pits
Alcoves

Neck – Terraces – Pits/Alcoves



# How did we get there

- Are the Terraces and Pits relic of an ancient world?
  - ✓ **Very likely but to which extend?**

- Are the Pits primordial?
  - ✓ **Most likely not primordial voids, but they tell us about the primordial heterogeneity**

**What do we really need to answer**

→ Which mechanisms and material form the pits (e.g., sinkhole, ices, etc..)?

→ What is the time scale of formation/preservation?

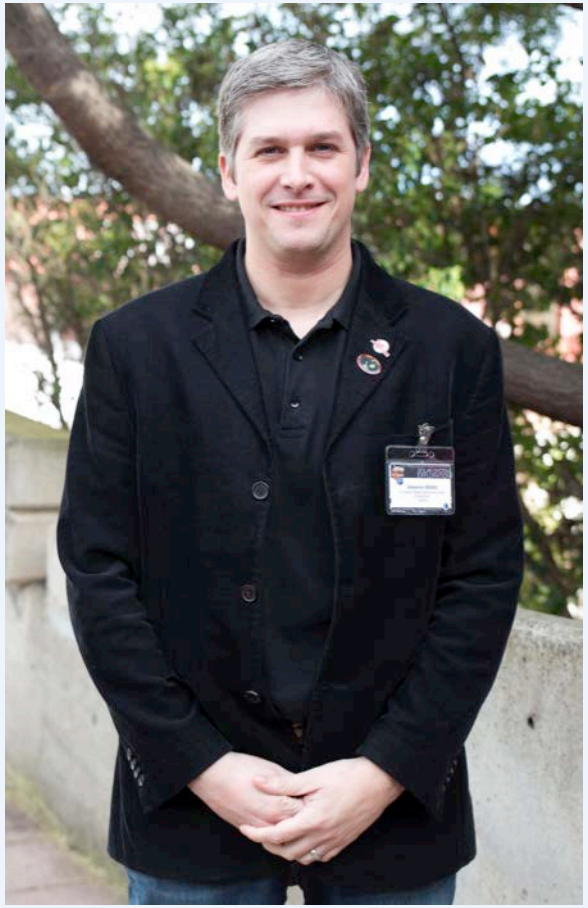
→ Is 2 years of Rosetta data consistent with the formation of pits in a reasonable timescale?

# ESTEC Fellowship 2012 team ☺

## Smart Modeler

Aurelie Guilbert-Lepoutre

## Geologist



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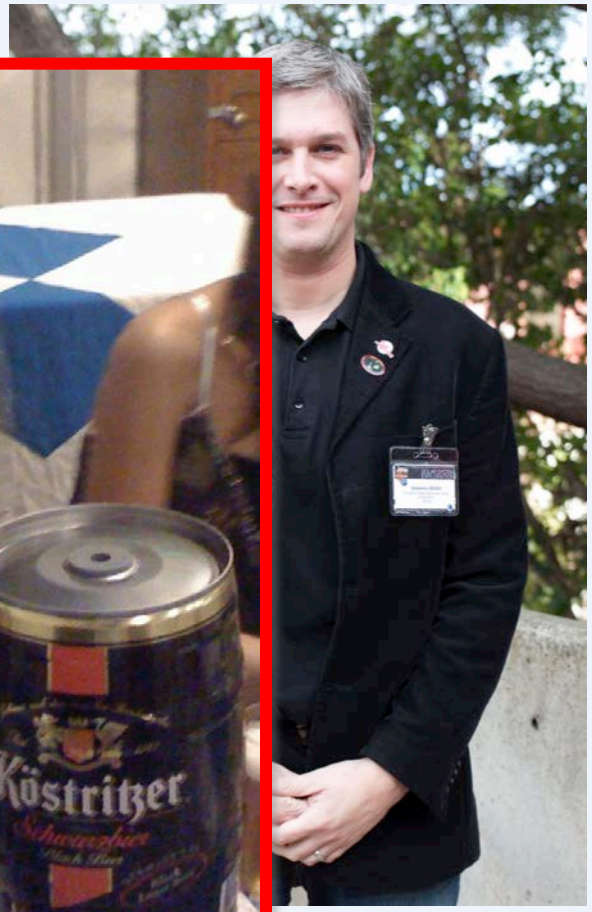
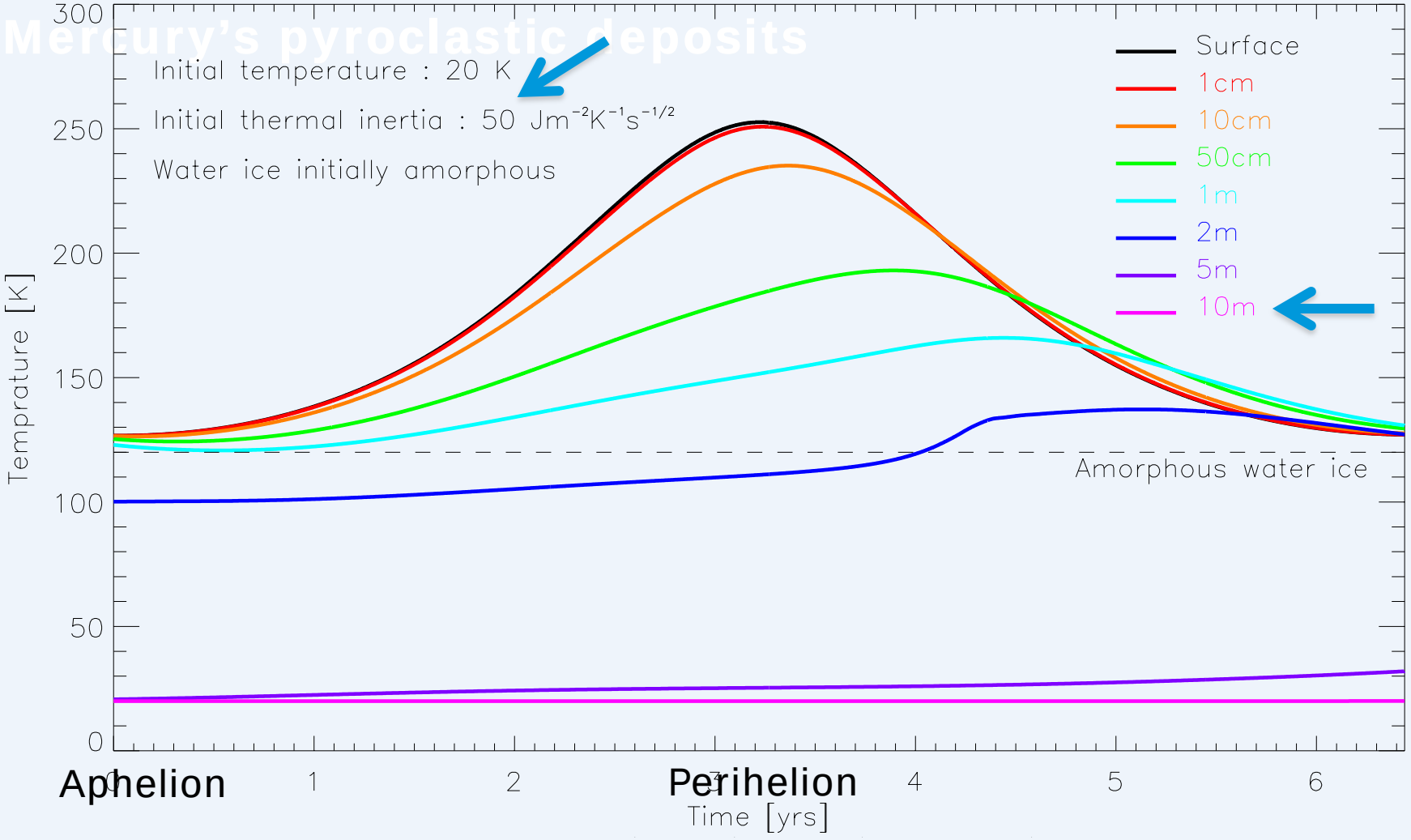


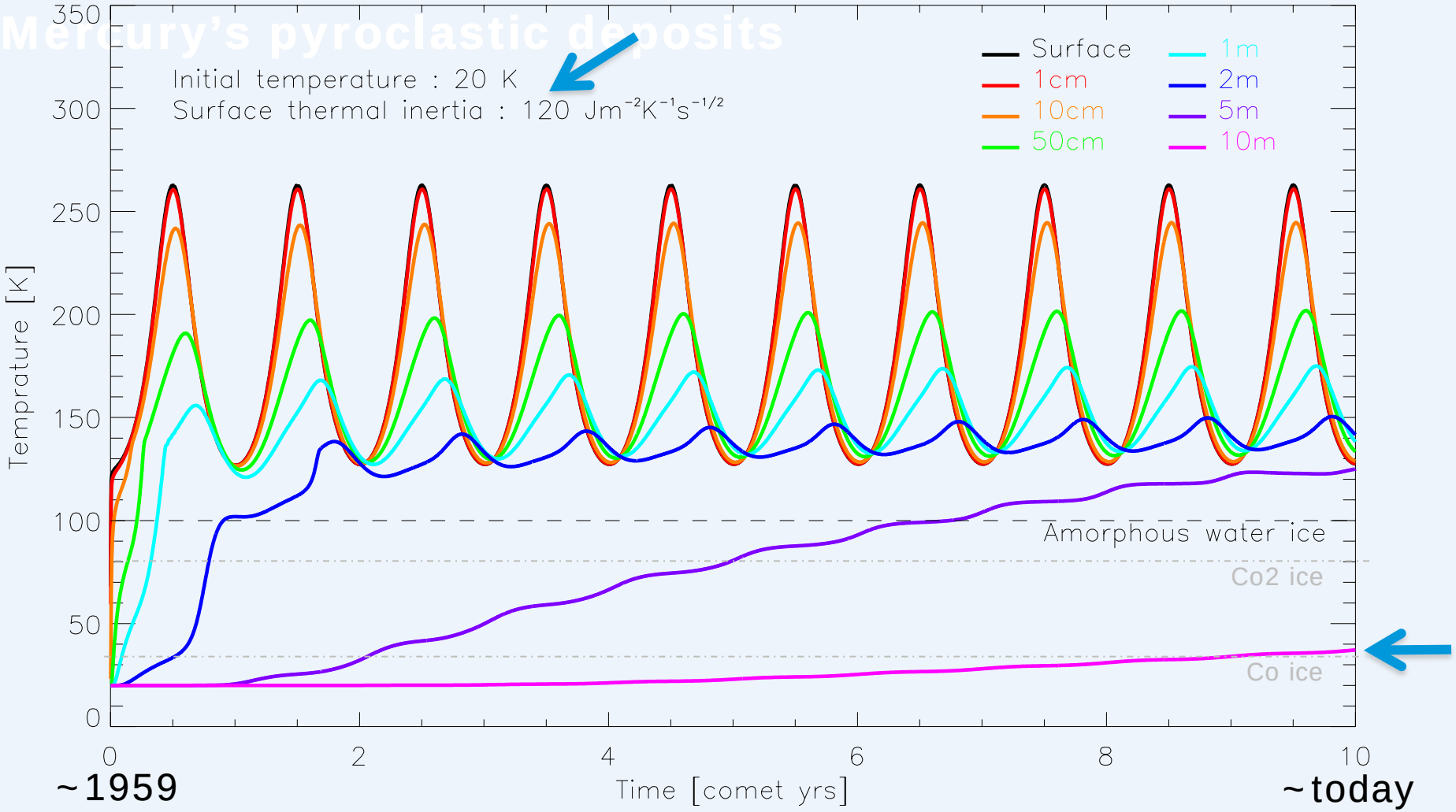
Smart Modeler


Aurelie G

# One comet revolution



# Ten comet revolutions



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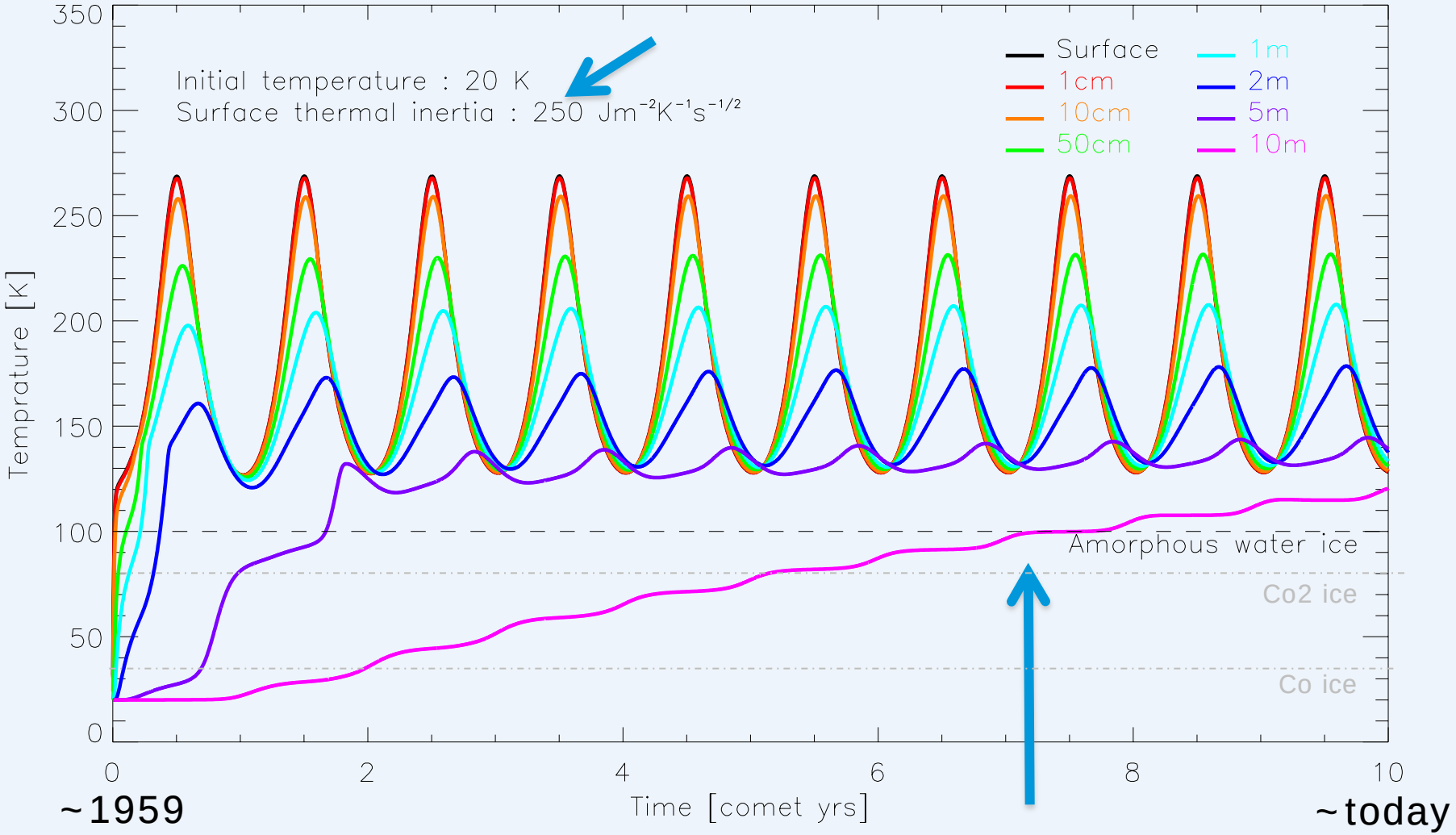
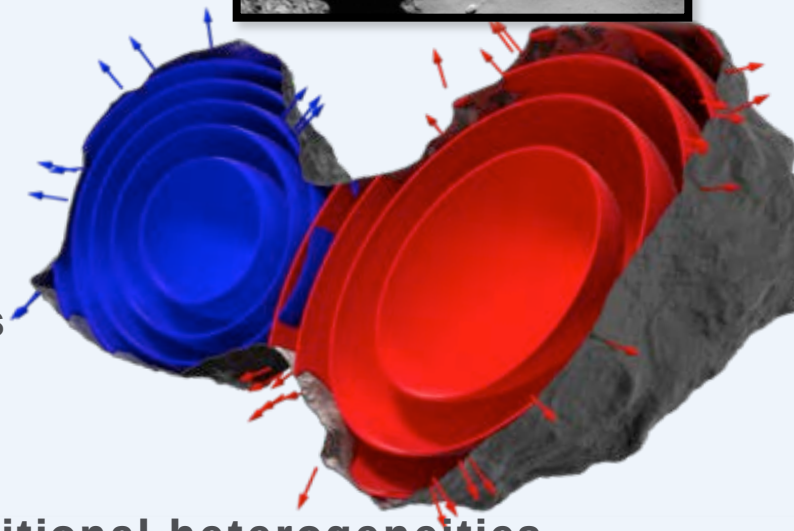


# Some ideas on what's going on (1)

- *Forming the pits from crystallization, sublimation, clathrate destabilization?*
  - ✓ **Very unlikely within one orbit of 67P**
  - ✓ **Difficult to reach 100m in 60 years**
  - ✓ **Should be the main driver for morphology**

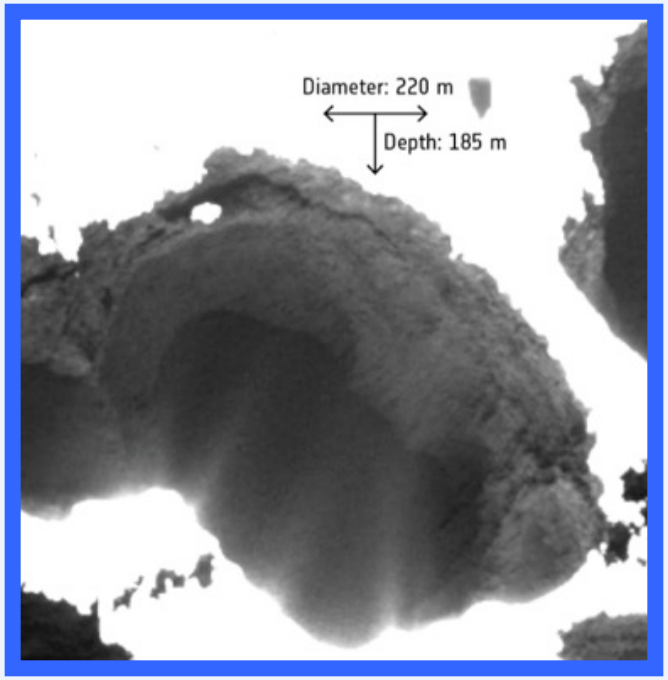
- *Are the Pits primordial?*
  - ✓ **Intimately linked to the layers, thus primordial origin**
  - ✓ **But different erosion states**
  - ✓ **Change in thermal balance (e.g. close encounter) could be a trigger for the creations of pits**



- *What do the pits tell us?*
  - ✓ **Erosion pattern points to compositional heterogeneities**
  - ✓ **Within the heterogeneities, it is homogeneous (N/S, Lobes)**

# Maybe some conclusions (2)

- Which mechanism is likely forming the pits?
  - ✓ **Creation by an impact very unlikely**
  - ✓ **Ancient impact can create defects that act has point of focus for the depression evolution (by sublimation)**




- How can the pits be active if they are that old!
  - ✓ **Is the activity linked to the frost deposition?**

- What do the pits tell us on comets
  - ✓ **That we do not understand thermal evolution of small bodies**
  - ✓ **That we do not understand the formation of comets**

Improvements and hopefully a paper!

- Refine thermal models, smaller granularity
- Explore the link pits/layer

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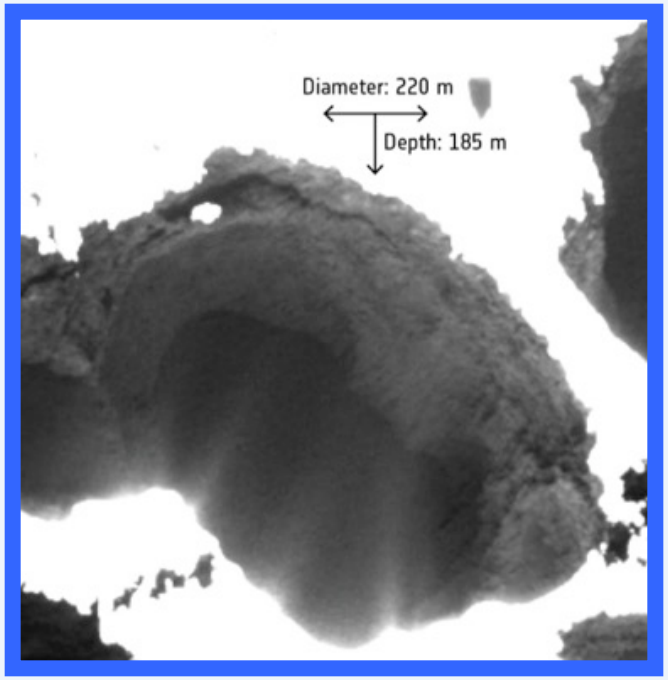


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All data in the PSA archive

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