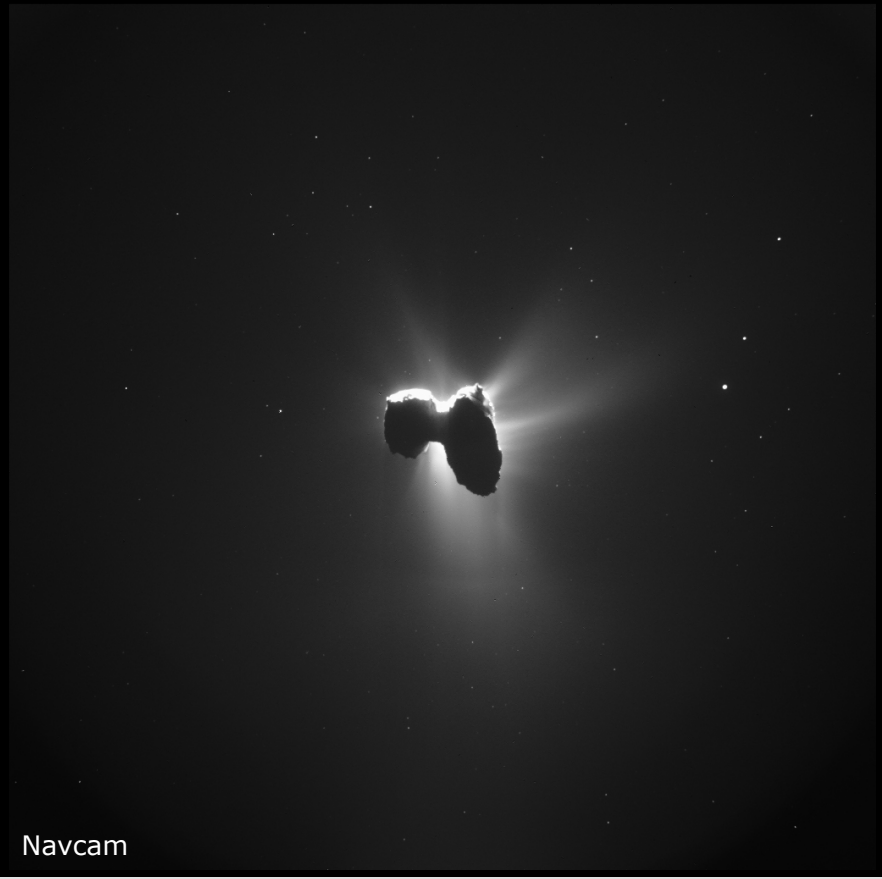

esa
COMETARY ACTIVITY
esa European Space Agency

Cometary Activity - Definition



"Activity" : Ensemble of physical processes leading to the release of gas and dust from the nucleus to millions of km away.

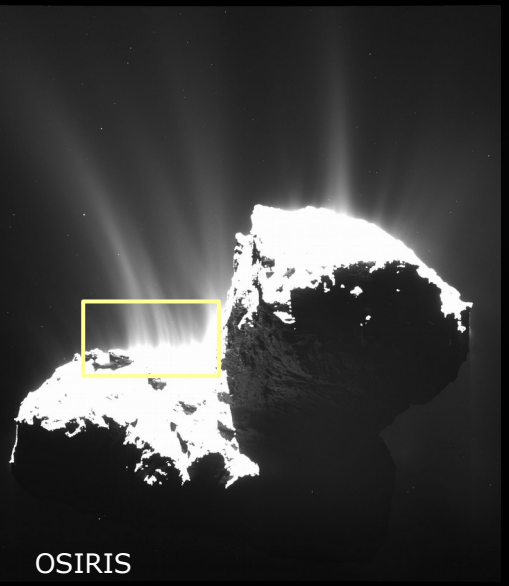
Controls the comet surface evolution, and orbital changes.

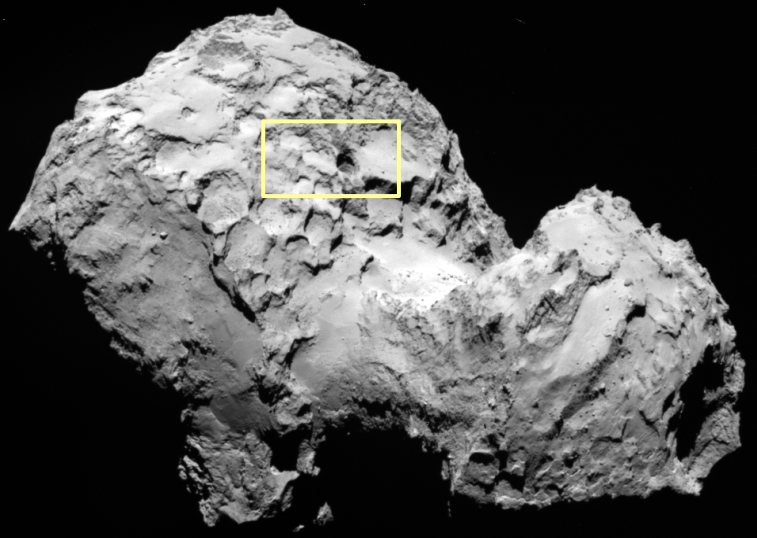
Relates to how dust and ice are mixed into the nucleus, can reveal potential heterogeneities.

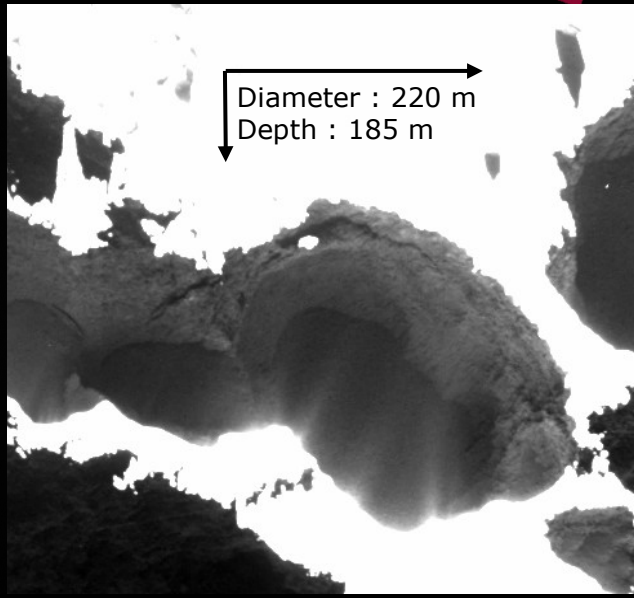
Understanding activity is necessary to reconstruct how comets were formed

Varies with seasons and heliocentric distance. Can only be studied by a rendez-vous mission like Rosetta.

Cometary Activity – Active sources

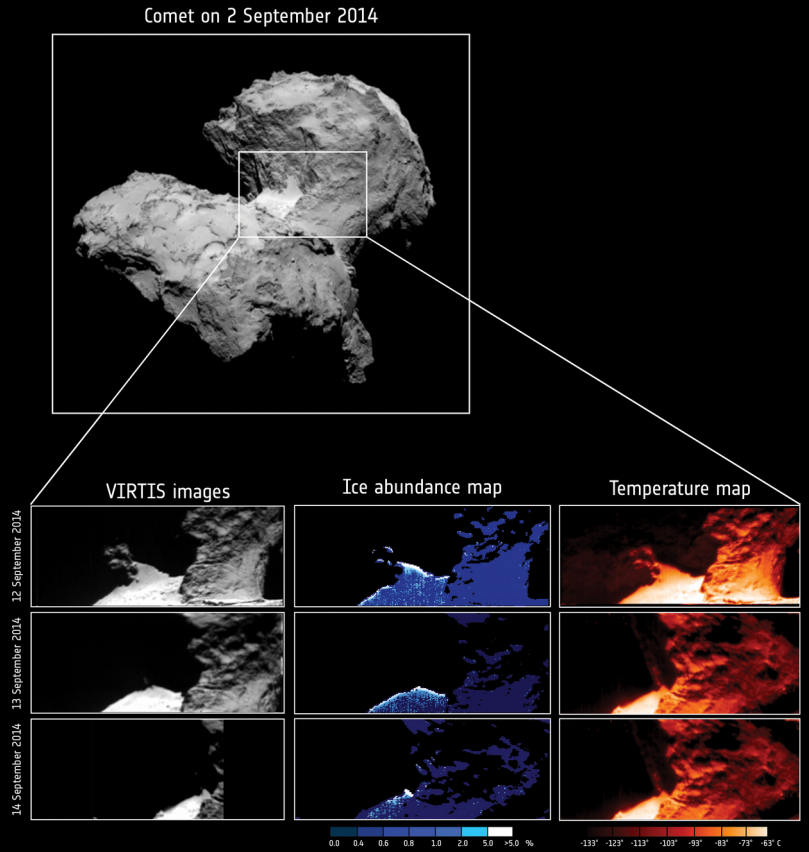


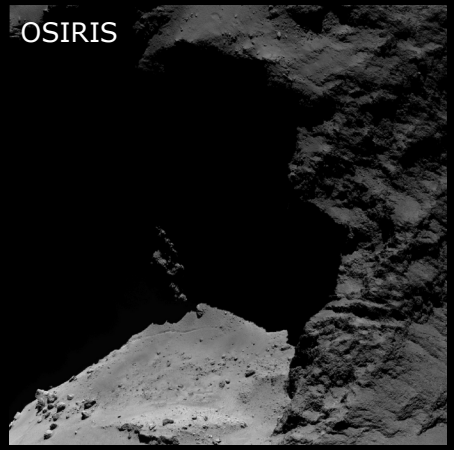


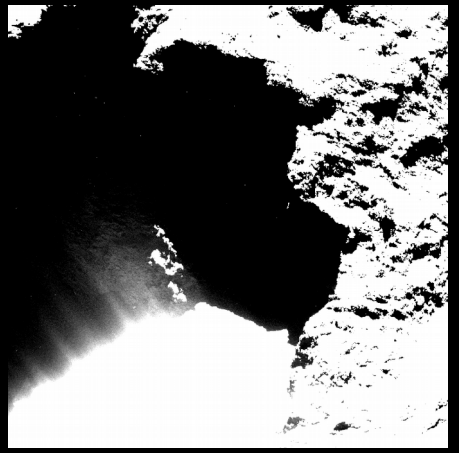


Dust and gas streams can be traced back to specific topographic features (cavities, cliffs, pitted terrains on smooth plains), enriched in volatile material.

Cometary Activity – Water cycle



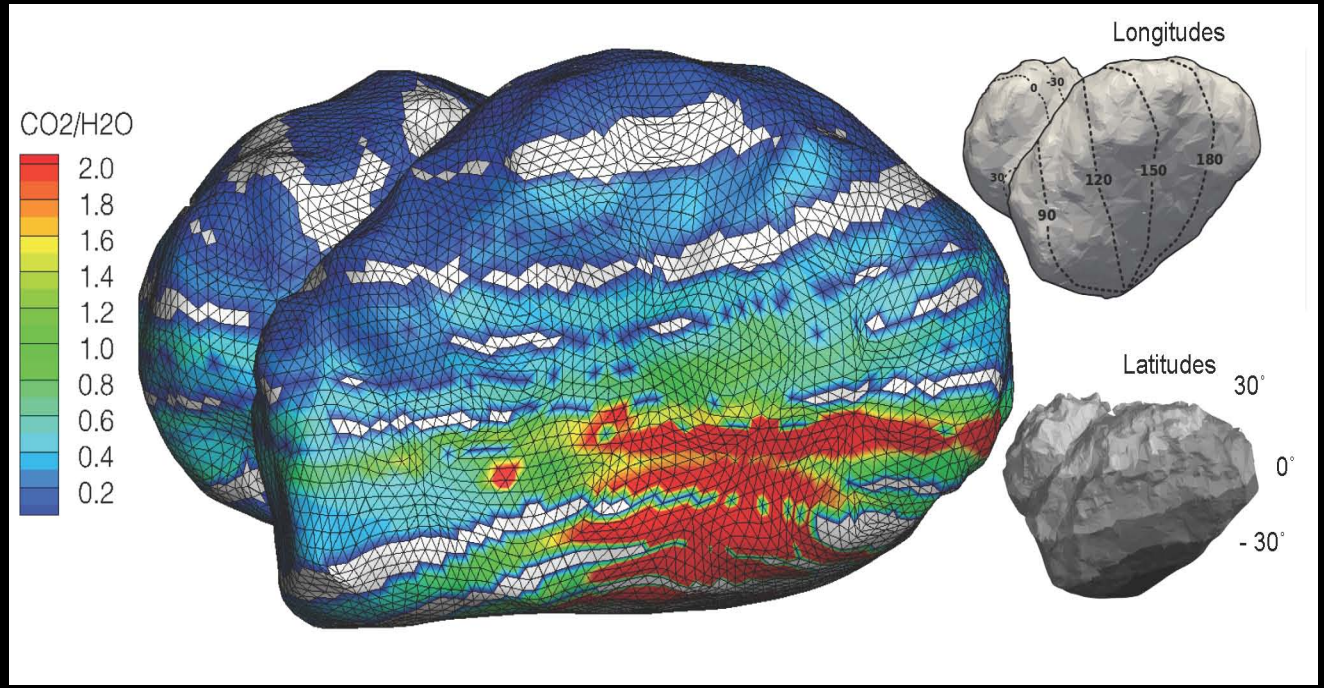




Multi-instrument analysis of the activity revealed a cometary water cycle.

Ice sublimates during the day. Gas from the coma and the subsurface layers freezes during the night.

Cometary Activity – More than water



ROSINA measurements

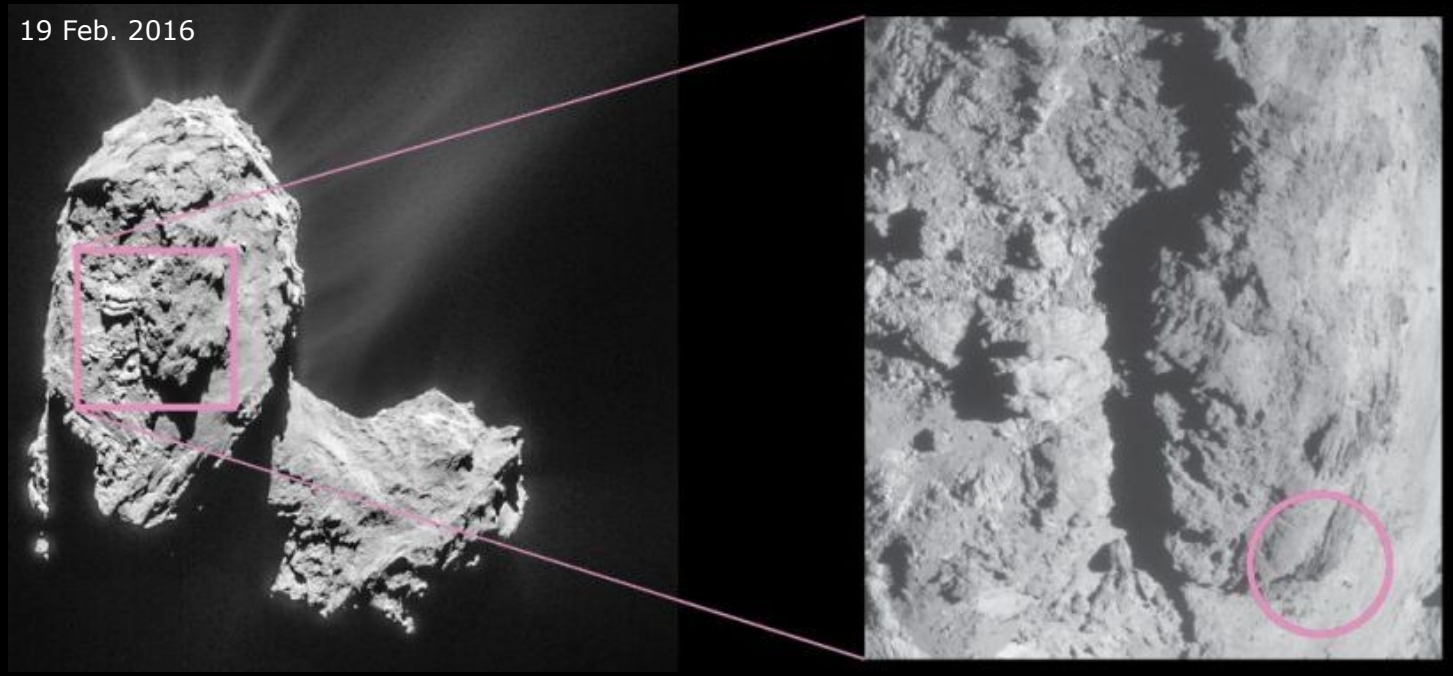
Active areas expand and migrate with the seasons, slowly following the maximum insolation.
As new regions come into sunlight, different gases are released into the coma.

Cometary Activity – Summer Fireworks

Although very dynamic in nature, jets are mostly controlled by the local topography and the reservoirs of volatile material.
They mostly repeat from one rotation to the next.

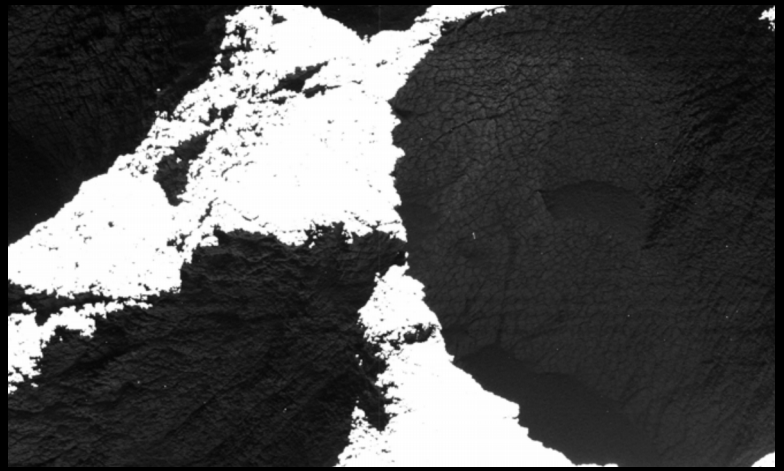
Many times during the mission, but more often around perihelion, we detected transient events ejecting up to 200 tons of material in a few minutes.

Cometary Activity – Surface evolution



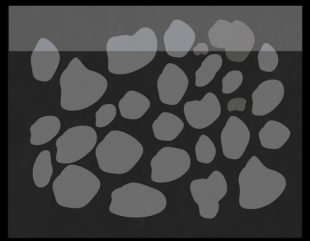
When traced back to their source on the nucleus, jets and outbursts reveal a connection to changing terrains: new depressions appearing on smooth surfaces, or collapse of existing topography. These areas are more prone to thermal stresses and or pressure build-up.

Cometary Activity – Surface evolution

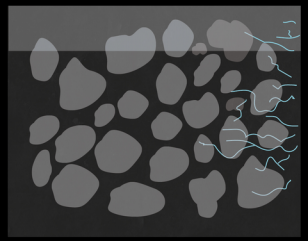


Activity and fracturing lead to a lateral erosion of the comet, with walls collapsing and retreating all over the surface.

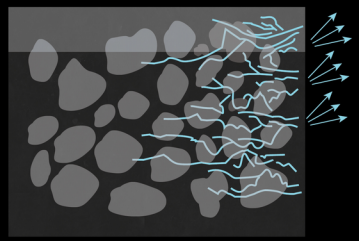
Activity and topography are interdependent at all scales.



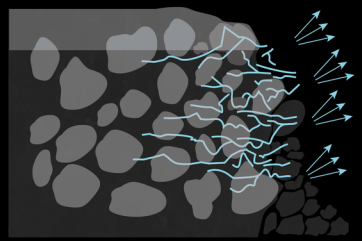
1. Cliff with insulating layer of dust covers mix of ice and dust



2. Cracks generate and propagate from cliff edge due to thermal and mechanical stresses

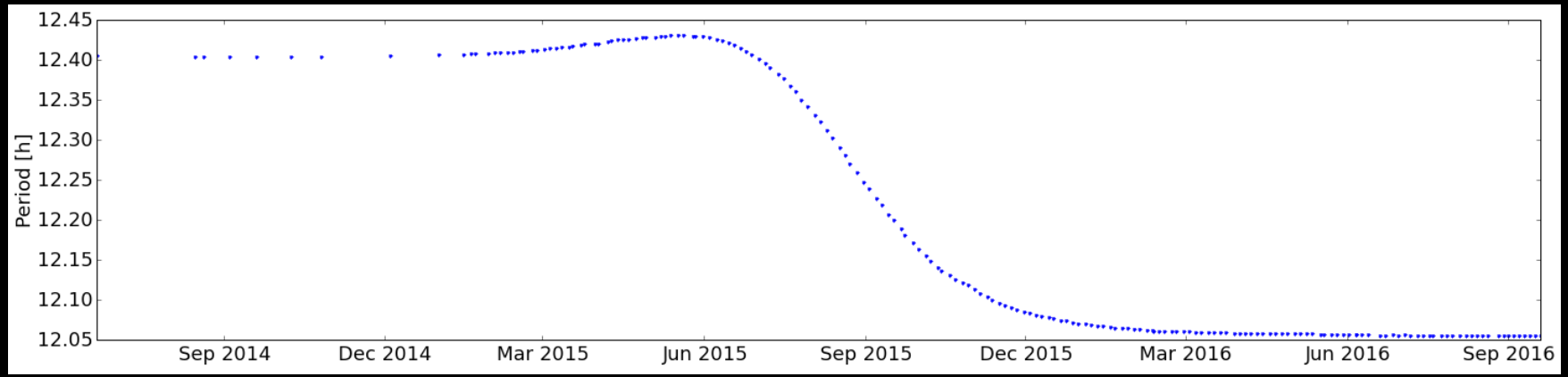


3. Heat reaches buried ices, sublimation intensifies cracking



4. Weakened wall collapses; freshly exposed ices and fallen boulders generate additional activity

Cometary Activity – Period changes



Activity spins up the nucleus by 21 min every orbit :

rotation period in 2009 = 12h 45 min
rotation period in 2014 = 12h 24 min
rotation period in 2016 = 12h 03 min

Cometary Activity – Summary

- Rosetta gave us the first opportunity to study cometary activity with very high spatial resolution (<15cm/px) and for extended periods of time.
- Established unambiguous link between activity and morphologic features.
- Most active spots are enriched in volatile material close to the nucleus surface and appear to be sustained by a diurnal cycle of sublimation/deposition of water.
- Activity evolves with seasons, with jets following closely the subsolar point.
- Activity reshapes the surface locally with continuous erosion or sudden events like the outbursts. But it is not the only source of surface changes !
- On a larger scale, dust and gas release can explain the changes of rotation period.