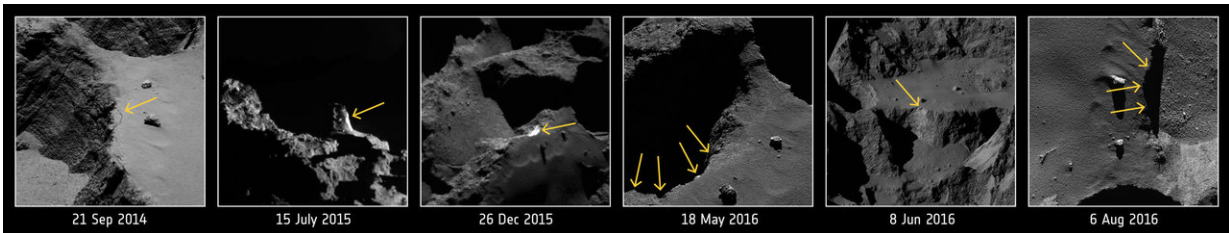


# Landslides, avalanches may be key to long-term comet activity

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Sequence of images showing different views of the Aswan cliff collapse on Comet 67P/Churyumov–Gerasimenko. The first image shows the fracture long before it gave away on 10 July 2015. Images taken on 15 July and 26 December show the bright, pristine material exposed in the cliff collapse, which is thought to have occurred on 10 July. Although not obvious from these images, the brightness had faded by about 50% by the 26 December image, showing that much of the exposed water-ice had already sublimated by that time. The images from 2016 show different views of the new cliff top. By August 2016, much of the cliff face had returned to the average brightness of the comet. Arrows are used to mark the fracture and the exposed water-ice, and to delineate the new cliff top outline. Credit: ESA/Rosetta/MPS for OSIRIS Team  
MPS/UPD/LAM/IAA/SSO/INTA/UPM/DASP/IDA

The release of gases through sublimation is the defining process of comets, but a new paper by Planetary Science Institute Research Scientist Jordan K. Steckloff and Senior Scientist Nalin H. Samarasinha says that periodic landslides and avalanches, known as mass wasting,

may be responsible for keeping comets active over a long time.

These escaping gases loft dust off of the [comet](#), forming a dust cloud visible from the Earth. This gas release can even change the [spin state](#) of the comet. However, this process has long been expected to shut down as the ice present at the surface of the comet sublimates away, leaving a dust layer at the surface that insulates the remaining subsurface ice. It has therefore been unknown how comets remain active, rather than fade into non-active objects.

According to "The sublimative torques of Jupiter Family Comets and mass wasting events on their nuclei" in the journal *Icarus*, mass-wasting activity can excavate and expose buried ices to the surface of the comet , giving the comet fresh ice to sublimate. However, mass-wasting leads to a flattening of features on the surface of the comet over time, which in turn reduces the number and frequency of mass wasting events.

"Nalin and I independently developed our own models to study how sublimating gases that escape from a comet's surface generate torques that change the comet's spin state," Steckloff said. "However, our models approached this problem from two completely different perspectives: Nalin's model is based on Earth-based observations of comet light curves and observed gas sublimation rates. In contrast, my model considers how gases push on the surface of the comet as they escape, accounting for the effects of a comets' activity, shape, and topography. Despite these different perspectives, these two models must necessarily be consistent with one another if they are to accurately describing the same phenomenon."

By comparing their models, Steckloff and Samarasinha found that their models can only agree with one another if these sublimative torques originate primarily from steep, mass-wasting-prone slopes. This suggests that mass wasting events such as [landslides](#) and [avalanches](#) are critical to

maintaining sublimative activity on comets. This is an important result, as it was previously unknown how comets maintain their activity over many, many orbits.

Moreover, this mass-wasting process provides a mechanism for reactivating dormant comets. If spin state changes or other processes can trigger a mass-wasting event on a dormant comet, the resulting exposed ice can reestablish vigorous sublimative activity. This may explain how comets such as 2P/Encke remain active. Comet Encke took so long to evolve into its current orbit, that it should have long ago run out of ices to sublimate. This dynamical evolution timescale is 200 times longer than the sublimative timescale.

It has been proposed that Comet Encke was therefore dormant for the majority of this time, but this requires a mechanism for reactivating the comet. A large mass-wasting event may have been the mechanism that reactivated Encke into the active comet that we observe today.

"We were trying to understand how cometary activity would affect their rotation," said Samarasinha. "In the process, we were able to explore the long-term evolution of cometary activity and conjecture how the surface layers of short-period comets might evolve. By understanding the physical processes occurring on the surfaces and in the surface layers of comets, we can provide the overall context to accurately interpret observations of comets. An in-depth understanding of comets help us ascertain the role played by these building blocks of the giant planets in the formation of the solar system and also the various roles played by comets throughout the history of the solar system."

**More information:** Jordan K. Steckloff et al. The sublimative torques of Jupiter Family Comets and mass wasting events on their nuclei, *Icarus* (2018). DOI: 10.1016/j.icarus.2018.04.031

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