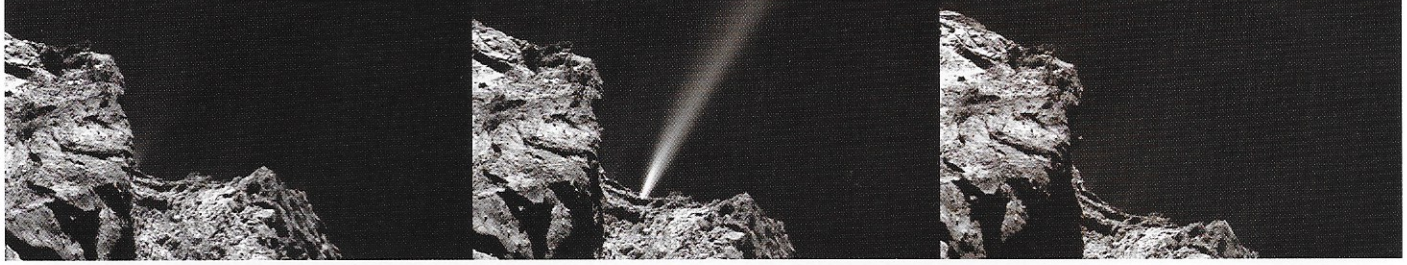
PHILAE'S LAST STAND?

By Henry M. Holden



OVER THE past few months we have been reporting on the decade-long journey of the Rosetta spacecraft and its piggy-back lander Philae. Rosetta arrived in orbit around comet Churyumov-Gerasimenko (67P) on August 6, 2014, nearly 10 years after launching into space.

We also covered the successful four-billion mile set up and orbit of 67P. Philae successfully landed on November 12, 2014, albeit not where it was supposed to land. And then things took a down-turn. Philae wound up under a rock outcropping and its solar batteries were unable charge. After 57 hours the lander went silent.

Months later, as the comet got closer to the Sun, the lander's batteries recharged and it reported some astounding news: Earth could have been kick-started by a comet strike. Philae transmitted the discovery of organic compounds, described as "carbon and nitrogen-rich." Some of the compounds play a key role in the prebiotic synthesis of amino acids, sugars and nucleon bases – the ingredients for life.

Then the mission approached an important landmark called perihelion, a point in its orbit where it is closest to the Sun, about 185 million km (115 million miles). Comet 67P, Rosetta, and Philae, are travelling at nearly 75 000 miles per hour and came closest to the Sun on August 13.

END IN SIGHT?

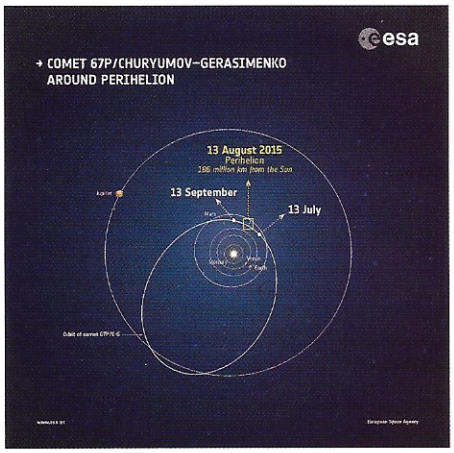
The Philae lander's mission could be coming to an end as scientists have warned. Philae is undergoing the most dangerous part of its mission through space. Jets of gas and dust have been thrown out of the comet, which could throw Philae off into space, or 67P could break up entirely.

An expert said there is a roughly 20 percent chance that the comet would break-up, but that it was unlikely to happen during the mission.

At the time of writing, Philae had not been heard from since July 9, and scientists are now anxious to see what will happen to it during the difficult period.

"Obviously the activity is dangerous for Philae," said Philae operations engineer Barbara Cozzoni. "First, the dust can prevent Philae from collecting energy. And Philae is not anchored, so it might change the attitude of Philae — but we don't think it's going to send it into space."

The Rosetta spacecraft, which orbits the comet to support the Philae lander during its mission, has been moved away from the comet to ensure its safety. It is now sitting 327-kilometres from the comet.



Above: *The orbit of Comet 67P/Churyumov–Gerasimenko and its approximate location around perihelion, the closest the comet gets to the Sun. The positions of the planets are correct for August 13, 2015.* Photo: ESA/Rosetta/MPS

Top: *A short-lived outburst from Comet 67P/Churyumov–Gerasimenko was captured by Rosetta's OSIRIS narrow-angle camera on July 29, 2015. The image at left was taken at 13:06 GMT and does not show any visible signs of the jet. It is very strong in the middle image captured at 13:24 GMT. Residual traces of activity are only very faintly visible in the final image taken at 13:42 GMT. The images were taken from a distance of 186 km from the centre of the comet.*

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

Measurements by the Rosetta orbiter suggest that up to 300 kilograms of water vapour – equivalent to two filled bath tubs –- are spewing out of the comet every second. This is 1 000 times more water than was observed a year ago. When the spacecraft first approached the comet, it was giving off only about two small glasses of water per second.

The comet may also be shedding up to 1 000 kilograms of dust per second, threatening to cloud Rosetta's sensitive instruments and obscure its star tracking navigation equipment.

The first occurred on July 29 when bright jet of gas and dust was seen erupting from the comet's neck region at between 10 and 30 metres per second. Osiris principal investigator, Dr Holger Sierks, said there was a strong likelihood of the comet breaking in half, but not just yet.

Activity is expected to increase even further over the next few weeks as the Sun's "thermal pulse" works its way through the comet.

A fracture, 500 metres long, and up to 2,4 metres wide, has been observed crossing the comet's neck.

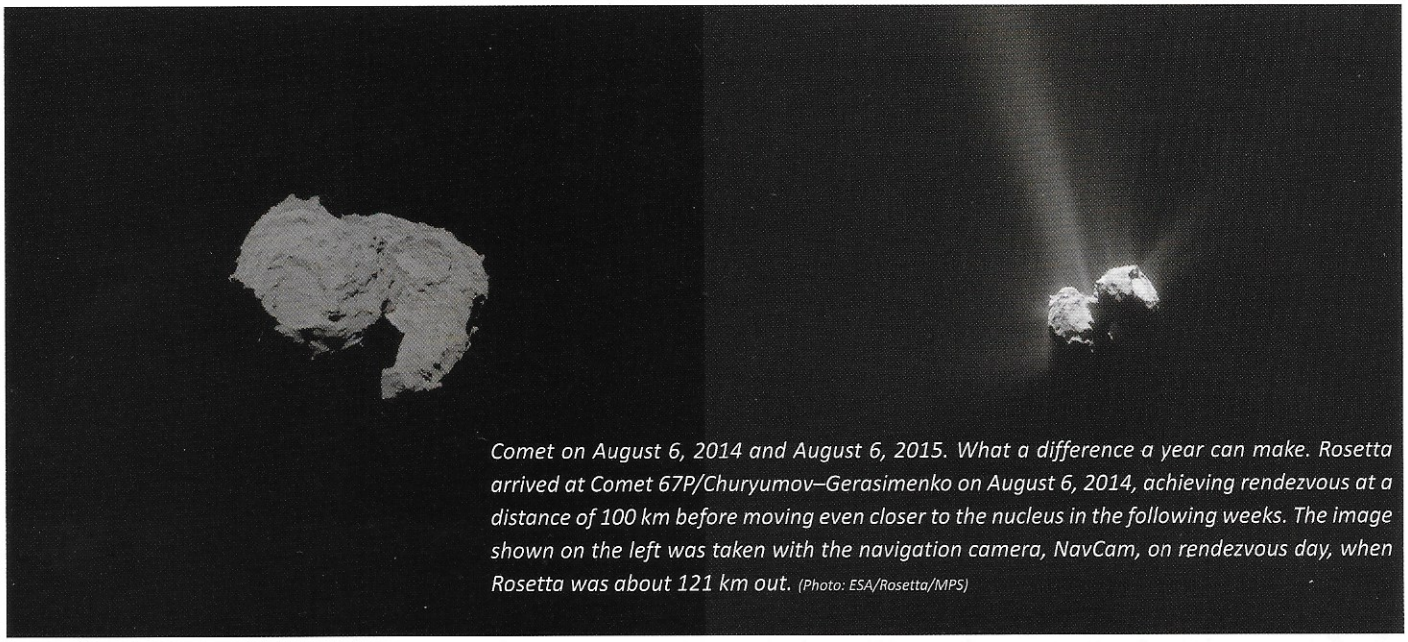
Asked about the possibility of Rosetta witnessing the comet splitting in two, Dr Sierks said: "Let me phrase it this way: I think there are good chances it will break up, but not in this orbit. The probability of it breaking up is in the region of 20 percent. But the chances it will break up while we are there are very minute."

"We will see it again in the spring, next year, and then we'll compare before and after to see how the crack has changed," Dr Sierks added.

Scientists have revised their plans for the lander Philae and are now focusing on getting images and drill samples if communications are restored.

Philae woke up in June, delighting scientists from the ESA, who came up with plans for several experiments they wanted to run before working up to the most risky one – drilling into the surface.

But with the 100 kg washing-machine size



Comet on August 6, 2014 and August 6, 2015. What a difference a year can make. Rosetta arrived at Comet 67P/Churyumov–Gerasimenko on August 6, 2014, achieving rendezvous at a distance of 100 km before moving even closer to the nucleus in the following weeks. The image shown on the left was taken with the navigation camera, NavCam, on rendezvous day, when Rosetta was about 121 km out. (Photo: ESA/Rosetta/MPS)

lander having been silent for .several weeks now, those plans have been revised.

"The problem is not power, but communications," Aurelie Moussi from space agency CNES said. "We have to find something to do in a shorter duration."

She said the priorities were now to get pictures from the surface and also to drill into the surface, which Philae was not able to do when it first landed in November.

Scientists hope that samples from the surface of the 67P will help show how planets and life are created since the rock and ice that make up comets preserve organic molecules like a time capsule.

The Rosetta spacecraft, which is orbiting the comet and through which communications with Philae are relayed to Earth, has spent two weeks at a different part of the comet. But since August. 11, it has been back in an area where it should be able to communicate with Philae.

No contact has been established though and the data from the last communications shows one of the lander's transmitters is broken. Its two receivers were also not working as they should, Barbara Cozzoni, Philae operations engineer said.

Scientists have also observed powerful gas jets, though Cozzoni said it was unlikely that Philae could be pushed off into space by a jet.

Activity is already exploding on 67P. In late July, Rosetta's camera caught a jet erupting in the space of less than half an hour. And because it takes about a month for the comet to get its warmest, this means that activity is expected to peak in a few short weeks.

"The key to the Rosetta mission is that it is there for the long haul. It is there to watch and observe changes in the comet over time, with the same suite of instruments, as opposed to a fly-by — or maybe different missions having fly-bys at different times with different instruments," said Joel Parker, an interdisciplinary scientist on the mission.

"This is creating the baselines for all future study of comet activity for us to understand what is going on at the small scale that cannot be observed from Earth or near-Earth observations" said Parker.

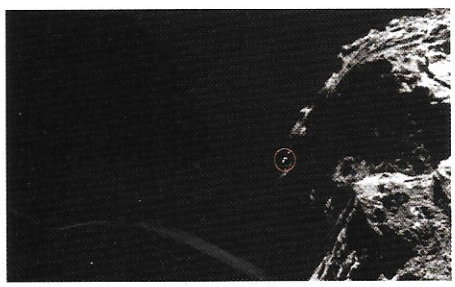
SOLAR SYSTEM FORMATION

Comets such as 67P are considered chunks of what the solar system appeared to be early in its formation, before the planets and moons were formed. Studying comets and asteroids therefore helps researchers understand the make-up of the young solar system shortly after its formation 4,5 billion years ago.

Rosetta is the first spacecraft to orbit a comet and also the first to drop a lander on a comet's surface. Among other findings, the Rosetta mission revealed that the type of water on the comet is different than that of Earth, meaning that comets like 67P could not have delivered water to this planet.

"There has been some discussion (and dispute) among the Rosetta researchers as to whether the comet's out-gassing will change as the object gets closer to the Sun," said Paul Weissman, another Rosetta interdisciplinary scientist.

Solar heating could unveil deeper regions of the comet that were untouched for millions or billions of years, depending on how much bled away when 67P passed by the Sun.



This image, taken with Rosetta's OSIRIS narrow-angle camera on July 30, 2015, show a boulder-sized object close to the nucleus of Comet 67P/Churyumov–Gerasimenko.

Photo: ESA/Rosetta/MPS

"This comet has this unusual 'ratio' of the constituents of hydrogen in water, specifically the ratio of a rarer type of hydrogen, called deuterium, to hydrogen," Weissman said. "We're curious to see if that changes as it goes around the Sun and as it gets more active.

COMET BRIGHTNESS

"It is notoriously difficult for even professional astronomers to predict how bright a comet will appear when it swings by Earth. This is because it is difficult to see the nucleus (heart) of the comet," Parker said, "so measurements are made from observing the comet or atmosphere.

"As Rosetta observes 67P up close, the spacecraft will see how much gas is coming out, what dust the gas is dragging out and how big the gas particles are," Parker added.

Weissman pointed out that these particles could be a centimetre across or larger, which is big enough for the comet's imaging instruments to resolve the individual particles and potentially, track their movements.

The team will also be observing how the solar wind, the constant stream of gas from the Sun, interacts with the comet's surface and causes changes. The researchers will additionally watch how the coma of the comet – the dusty envelope around its nucleus – flexes when it is hit by the solar wind.

Rosetta's current mission ends on September 30, 2016, when the mission will be operating at about four astronomical units or AU from Earth. (One astronomical unit is the Earth-sun distance, about 93-million miles or 150-million km.).

"At that point, the spacecraft will be so far from the Sun that it will be difficult for its solar panels to collect the energy required to continue operating, so further work after that is unlikely," according to Weissman. ✈