Rosetta scientists unveil the source of ice and dust jets on comet 67P

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Comet 67P and its mysterious jets. Credit: ESA/Rosetta/MPS for OSIRIS Team MPS/UPD/LAM/IAA/SSO/INTA/UPM/DASP/IDA, CC BY-SA

After a decade-long journey through space, the Rosetta spacecraft has spent the past year less than 100km from the nucleus of comet 67P Churyumov-Gerasimenko, capturing some stunningly detailed images. But despite this wealth of visual evidence for researchers there is a lot we still don't know about the comet – including why it is covered in organic material rather than just ice and what causes its powerful jets of dust and ice.

One of the big surprises of the Rosetta mission has been discovering just how dark 67P is: completely unlike an "dirty snowball", which was how astronomer Fred Whipple described comets in the 1950s. Although images from missions to other comets have shown surfaces that are more likely to be mixtures of ice and rock, findings from an instrument called the Visible and Infrared Thermal Imaging Spectrometer onboard Rosetta have shown that 67P is rocky and almost completely covered in a layer of organic compounds – which was not expected. So where is all the ice?

Now researchers using the same instrument have come up with an answer. They discovered a day-night cycle of ice sublimation (where solid turns to a gas without first turning to liquid) and re-condensation linked to the amount of sunlight. In short, when parts of the comet are in shadow, it is cold enough for ice to form; when the sun shines on the surface, the ice disappears.

Yes, it might sound a bit obvious, but to dismiss this as "not exactly rocket science" is woefully unjust. The effects are not only on the surface, but extend to depths of several centimetres, leading to production of a layer where water could be active.

The information has even been used to uncover the mechanism by which the jets which shoot up from 67P's surface form – one of the major goals of Rosetta's mission. When the comet is lit up by the Sun, the boost in surface temperature triggers release of gas as the water ice sublimes. The study also helps explain how the comet's surface has eroded: regions which are more deeply in shadow will experience a more reduced cycle of sublimation and condensation than regions where more sunlight can fall, leading to different patterns of rock fracturing and dust removal.

Rock as far as the eye can see. Credit: ESA/Rosetta/MPS for OSIRIS Team MPS/UPD/LAM/IAA/SSO/INTA/UPM/DASP/IDA, CC BY-SA

It is a beautiful example of how one set of results can help interpret a whole set of apparently unrelated phenomena. The idea of temperature cycles could be taken further to look at transport of molecules in the subsurface layers and to investigate whether there is sufficient energy below the surface to allow chemical reactions to occur.

Probing the solar wind

Having found out how the jets of dust and ice form, Rosetta is now taking a three week break away from the nucleus, to travel to a more exotic location closer to the Sun. However, Rosetta will not be on holiday – far from it. Although the spacecraft will be 1500km away from the nucleus, it will still be observing the comet very closely. The excursion takes Rosetta to the bow of the comet, the region where the comet meets the solar wind.

Imagine that you are walking head-on into a fierce wind. As the wind hits you, it hurts! This is what is happening to 67P. The solar wind is a fast-moving stream of charged particles (mainly protons and electrons); 67P is a solid object moving against the flow. When the two meet, it is 67P which comes off the worst. The dust and gas around the nucleus get swept away, to form the tails of the comet.

The reason why Rosetta is taking the trip is because the bow shock of a comet has never been observed in detail before. Other cometary missions have flown past or through the shock region, but have never lingered. Studying the interface between the solar wind and the plasma region around another body is important because it will help us understand the physics of the interactions that are taking place between the particles. This is necessary because we have our own bow shock region where the Earth meets the solar wind.

Currents in the solar wind, which are modified at the bow shock, lead to changes in space weather (which affect satellite communications). While it might seem a bit of a stretch to suggest that measurements taken at a comet 270m kilometres (168m miles) away will help your mobile phone signal, it is by making such measurements that we will eventually be able to predict and ameliorate the effects of the solar wind at the Earth. Electronic devices work using information brought to them as electromagnetic radiation, but charged particles from solar flares can interfere with such devices, producing random signals.

So Rosetta's excursion to the Sun will help keep us all in touch. Now, where's Philae's phone number..?

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