

# Building blocks of life found among organic compounds on Comet 67P – what Philae discoveries mean

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The building blocks of life are lurking on the dark and barren surface of Comet 67P. ESA/Rosetta/NAVCAM, CC BY-SA

Scientists analysing the latest data from Comet 67P Churyumov-Gerasimenko have discovered molecules that can form sugars and amino acids, which are the building blocks of life as we know it. While this is a

long, long way from finding life itself, the data shows that the organic compounds that eventually translated into organisms here on Earth existed in the early solar system.

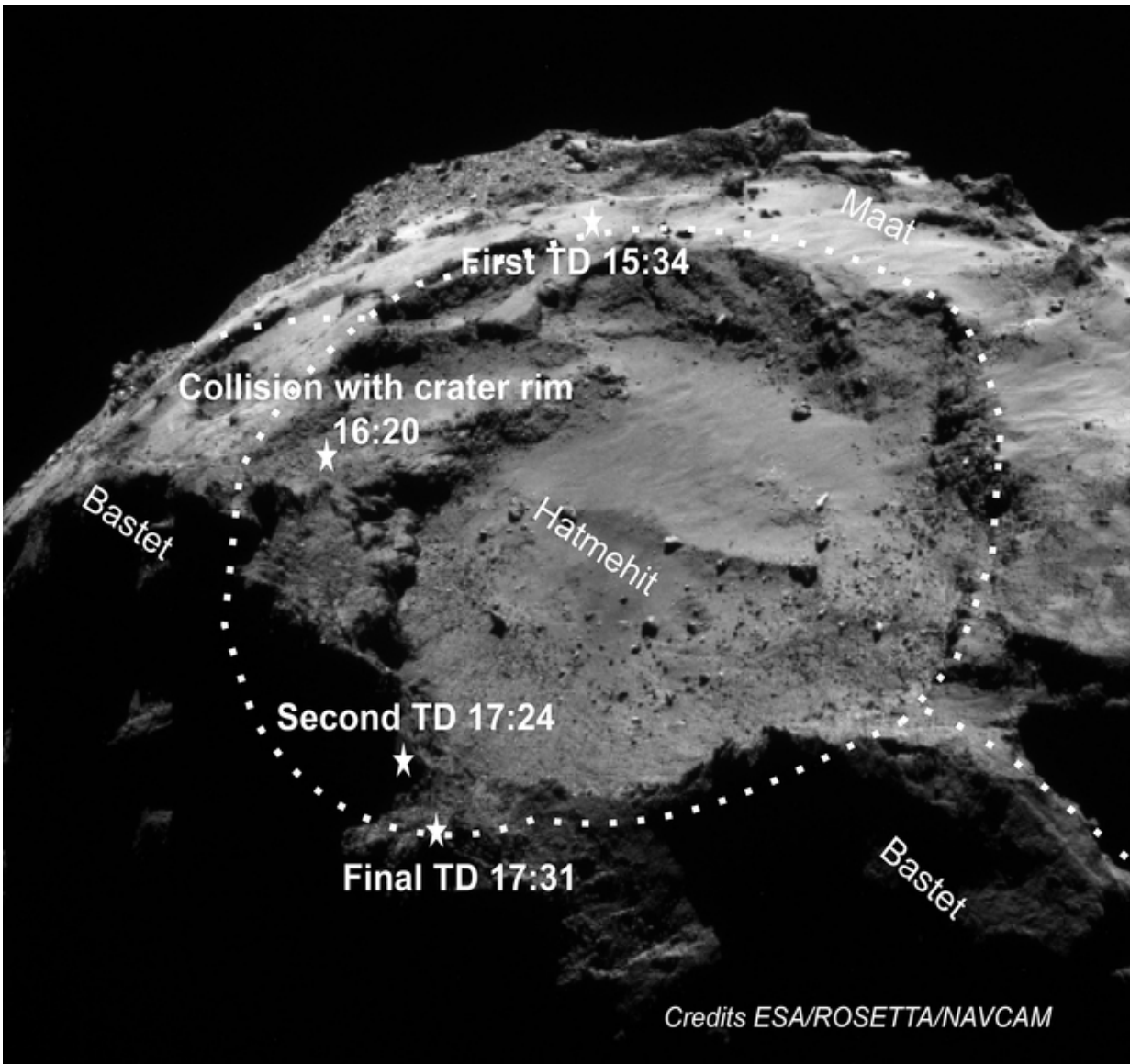
The results are [published](#) as two independent [papers](#) in the journal *Science*, based on data from two different instruments on comet lander Philae. One comes from the German-led [Cometary Sampling and Composition](#) (COSAC) team and one from the UK-led [Ptolemy team](#).

The data finally sheds light on questions that the European Space Agency posed 22 years ago. One of the declared goals of the [Rosetta mission](#) when it was approved in 1993 was to determine the composition of [volatile compounds](#) in the cometary nucleus. And now we have the answer, or at least, an answer: the compounds are a mixture of many different molecules. Water, carbon monoxide (CO) and carbon dioxide (CO<sub>2</sub>) – this is not too surprising, given that these molecules [have been detected many times before](#) around comets. But both COSAC and Ptolemy have found a very wide range of additional compounds, which is going to take a little effort to interpret.

At this stage, I should declare an interest: I am a co-investigator on the Ptolemy team – but not an author on the paper. But the principal investigator of Ptolemy, and first author on the paper, is my husband Ian Wright.

Having made this clear, I hope that readers will trust that I am not going to launch into a major diatribe against one set of data, or a paean of praise about the other. What I am going to do is look at the conclusions that the two teams have reached – because, although they made similar measurements at similar times, they have interpreted their data somewhat differently. This is not a criticism of the scientists, it is a reflection of the complexity of the data and the difficulties of disentangling mass spectra.

## Deciphering the data



New images show Philae's landing spots on comet when bouncing around and taking measurements. ESA/ROSETTA/NAVCAM/SONC/DLR

What are the two instruments? And, perhaps more to the point, what

exactly did they analyse? Both COSAC and Ptolemy can operate either as [gas chromatographs](#) or [mass spectrometers](#). In mass spectrometry mode, they can identify chemicals in vaporised compounds by stripping the molecules of their electrons and measuring the mass and charge of the resulting ions (the mass-to-charge ratio,  $m/z$ ). In gas-chromatography mode they separate the mixture on the basis of how long it takes each component in the mixture to travel through a very long and thin column to an ionisation chamber and detector.

Either way, the result is a mass spectrum, showing how the mixture of compounds separated out into its individual components on the basis of the molecular mass relative to charge ( $m/z$ ).

Unfortunately, the job doesn't end there. If it were that simple, then organic chemists would be out of a job very quickly. Large molecules break down into smaller molecules, with characteristic fragmentation patterns depending on the bonds present in the original molecule. Ethane,  $C_2H_6$  for example, has an  $m/z$  of 30, which was seen in the spectra. So the peak might be from ethane, or it might be from a bigger molecule which has broken down in the ionisation chamber to give ethane, plus other stuff.

Then again, it might be from  $CH_2O$ , which is formaldehyde. Or it might be from the breakdown of polyoxymethylene. Or it might be from almost [any one of the other 46 species](#) which have an  $m/z$  of 30. Figuring out what it is exactly is a tough job and the main reason why I gave up organic chemistry after only a year – far too many compounds to study.

Of course, the teams didn't identify every single peak in isolation, they considered the series of peaks which come from fragmentation. This helps a bit, in that there are now many more combinations of compounds and fractions of compounds which can be matched.

So where does this leave us? Actually, with an embarrassment of riches. Have the teams come to the same conclusions? Sort of. They both detected compounds which are important in the pathway to producing sugars – which go on to form the ["backbone" of DNA](#). They also both note the very low number of sulphur-bearing species, which is interesting given the [abundance of sulphur in the solar system](#), and the ease with which it can become integrated into [organic compounds](#).

The COSAC team suggests that nitrogen-bearing species could be relatively abundant, whilst Ptolemy found fewer of them. This is important because nitrogen is an essential element for life, and is a fundamental [part of the amino acids](#) which eventually make up the central core of DNA. Conversely, the Ptolemy team has found lots of CO<sub>2</sub>, whilst COSAC hasn't detected much.

These differences are probably related to sampling location: COSAC ingested material from the bottom of Philae, while Ptolemy sniffed at the top. Did Ptolemy breathe in cometary gases, whilst COSAC choked on the dust kicked up during the brief touchdown? If so, then the experiments have delivered wonderfully complementary sets of data.

Most importantly, both of those sets of data show that the ingredients for life were present in a body which formed in the earliest stages of [solar system](#) history. Comets act as messengers, delivering water and dust throughout the solar system – now we have learnt for certain that the ingredients for life have been sown far and wide through the 4.567 billion years of solar system history. The challenge now is to discover where else it might have taken root.

What else is certain is that both teams are keeping fingers crossed that the Philae-Rosetta communications link stabilises, so that they can get on with their analyses. This is just the start.

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