There are a number of ways to combat natural gas flaring, but since there is no one-size-fits-all solution, a number of organisations need to come together to ensure a balance amongst government, business and private interests. Assumptions that associated gas is not worth gathering need to be challenged. So far, the best efforts to eliminate flaring look at the entire gas value chain and involve a combination of penalties, incentives, investment and inventive uses for the available gas.

For the Arctic, the role of both the scientific and international communities is of vital importance. As the Arctic has no single authority, international institutions and Arctic groups will be vital in supporting commitments to mitigate flaring activities. And as technology advances, there is also the hope that new methods and processes to deal with flared gas will become available. Since there are a number of ways to reduce flaring, this is a realistic and achievable step towards decreasing the presence of black carbon in the Arctic, most possibly in the next ten years. It is another step towards changing local behaviours that have tremendous global impacts.

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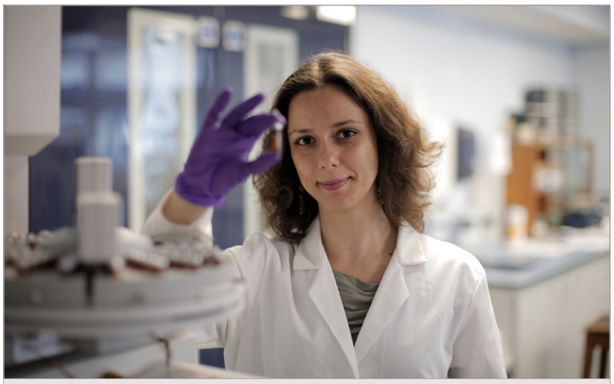
Molecules and meteorites: big impacts for life on Earth

You'd be forgiven for thinking that meteorite impacts only spell disaster for life on Earth, and there is plenty of evidence to suggest that an impact was bad news for the dinosaurs. However, a growing body of research suggests that asteroid and comet impacts early in our planet's history may actually hold the key to the origins of life on Earth. In terms of the global impact of a local event, they surely don't come much bigger than this.

As a geophysicist, I'm well aware of the problems that researchers in my field face in delving back in time to establish the geology of the early Earth. The challenge of doing a similar thing with organic molecules, which I guessed would be rather more ephemeral than the Earth's tectonic plates, seems a daunting prospect! Nonetheless, there are plenty of active researchers in this field, including at NASA and the European Space Agency (ESA). One academic collaborating with these organisations is Zita Martins at the Department of Earth Science and Engineering of Imperial College London. Ahead of her attendance to a symposium on the origins of life, I met with her to get some perspective on the extra-terrestrial influences on the beginnings of life on Earth.

The question of our 'alien origins' is usually taken with a good pinch of salt, as Martins explains. "It's important to appreciate that we're not talking about life being formed somewhere else in space and then being brought to Earth." However, it is entirely possible that the carbon-rich organic molecules contained within asteroids and comets, and delivered to Earth at the point of impact, do have a role to play in the initiation of life on our planet – and unpicking this biological history is a fascinating and multi-disciplinary science. Martins describes herself as an astrobiologist, but she has a background in chemistry and an understanding of physics and geology. "The beauty of astrobiology is that it draws together scientists from different fields, all trying to answer two big questions: how did life originate here on Earth, and is there life in other parts of our solar system?"


Zita Martins and a sample of space – in the lab at Imperial College London

So, what are the origins of life on Earth? There are a few theories which sit alongside a meteorite impact, including chemical reactions taking place around sea-floor hydrothermal vents. While Martins is happy to accept that there's room for contributions from many processes, she is drawn to a cosmogenic explanation in part because of a set of observations in our geological record. "We know that between 4.6 and 3.8 billion years ago the Earth suffered a heavy bombardment of comets and asteroids." Indeed, our whole neighbourhood was a risky place to be at this time, as there is evidence in craters on its surface that the Moon suffered the same astrophysical assault. "Geological records then show that life originated on Earth around 3.5 billion years ago," give-or-take the uncertainty in the geological dating method. So – cause and effect, or cosmic coincidence? Martins smiles: "As a scientist, I can't believe in coincidences!"

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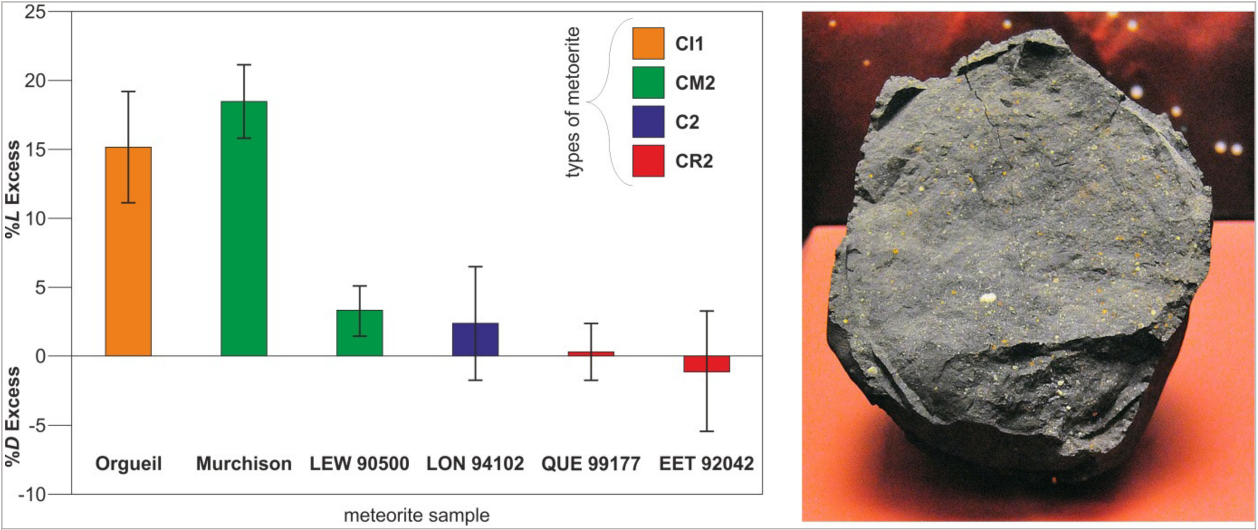

Bias towards *L*-isovaline amino acid in samples of several meteorites, as measured by Glavin and Dworkin (2009): positive percentages on the y-axis suggest that *L*-isovaline is dominant over *D*-isovaline in a sample. The bias is particularly strong in samples of the Murchison meteorite, a fragment of which is shown on the right. (Credit: Glavin and Dworkin, 2009 & Wikimedia user Basilicofresco)

The impact theory says that when a comet or asteroid strikes our planet, the pressure and temperature at the impact site are sufficient to set off a string of reactions among the molecules already on Earth and those within the meteorite. Among the results: amino acids – the components of proteins that are the building blocks of life. For Martins, it's no surprise to see the geological signatures of life taking hold in the period following a heavy bolide bombardment.

However, if the theory is sound, you might expect life on Earth to share some biochemistry with that of the amino acids held within asteroids and comets. Fortunately for astrobiologists, a frequent supply of meteorites rains samples of cosmogenic amino acids onto the Earth's surface. The biggest impact that these usually make is on the media (something that the residents of Chelyabinsk Oblast may dispute, following events of 2013) but even the smallest samples of certain meteorites are packed full of organic molecules, including amino acids, themselves a record of the early chemistry of space.

Certainly, the amino acids involved in our own biology are present within the extra-terrestrial samples. However, the reverse isn't true: while around 80 amino acids have been identified in meteorites (Martins and Septhon, 2009), biological organisms on Earth only use around a quarter of them. Nonetheless, there are subtle links in our own biology to molecular signatures in extra-terrestrial amino acids – and here, we enter the world of 'CSI: Outer Space'.

The clue concerns the chirality of a molecule – essentially, whether it is right- or left-handed. "Put your hands out in front of you," Martins explains (and naturally, I follow the instruction). "Your hands are mirror images of each other, so you cannot superimpose them – your thumbs are on opposite sides." It's the same with amino acids, which exist in left-handed (*L*-) and right-handed (*D*-) forms. On Earth the vast majority of organisms use *L*-amino acids, whereas meteorites contain *D*- and *L*-amino acids. Why is life so selective? It's possible that our biological preference for *L*-amino acids is the result of the chiral distribution of cosmogenic amino acids. Key evidence is given by the amino acid isovaline. *L*-isovaline is non-proteinogenic: it is not involved in any biological process on Earth, therefore any *L*-isovaline detected in meteorites cannot be a terrestrial contaminant. Observations show that the split between *L*- and *D*-isovaline is not fifty-fifty and, as shown in the graph at the top of the page, the samples present in meteorites are somewhat biased towards left-handed chirality. This bias is particularly evident in samples of the Murchison meteorite (pictured) which impacted Australia in September 1969. Martins suggests that "this little bit of excess of the *L*-form could have been enough to expand the use of *L*-amino acids in biological organisms on Earth."

Artist impression (not to scale) of ESA's Rosetta approaching comet 67P/Churyumov-Gerasimenko. (Credit: spacecraft: ESA/ATG medialab; comet image: ESA/Rosetta/NAVCAM)

Of course, the reason for the chiral imbalance of amino acids is yet to be explained, and Martins also questions why life on Earth makes use of only a few more than 20 amino acids when there is such diversity available in space. Nonetheless, I find this molecular form of evolution quite elegant, and it's amazing to think that our basic biochemistry has a direct link to a process occurring some 3.6 billion years ago.

If external processes hold the key to life on Earth, then why not life elsewhere? The icy moons of Saturn and Jupiter are prime candidates, since they are likely to contain organic molecules of their own and have certainly faced asteroid impacts at some point in their history. Astrobiology is now sampling further afield. Both NASA and ESA have probes journeying to asteroids and comets, such as

Rosetta (pictured), and ESA's JUICE mission will target Jupiter's icy moons. There is every chance of new insights into deep-space chemistry.

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Chasing ice: studying the stability of the Western Antarctica Ice Sheet

Out of all the world's glaciers, Pine Island Glacier (PIG) is currently making the single biggest contribution to global sea level rise. Scientists are trying to figure out why.

Clinging onto the edge of western Antarctica, PIG is the fastest shrinking glacier on the planet. With 56 Gt of ice careering into the ocean each year, knowing the future stability of the ice sheet is essential.

"The West Antarctica Ice Sheet (WAIS) is a glaciological hotspot," says Andy Smith who works at the British Antarctic Survey (BAS) in Cambridge, UK. "At the moment, the area is contributing the largest amount to global sea level rise – at around 3 mm per decade. Although this doesn't sound much, the little changes add up over time."

Tractor traverse on Pine Island Glacier. (Credit: Damon Davies)

With the return of the sun to the southern continent, scientists from BAS are kicking off the 2014 PIG research season. They will be setting off on the second of a 1000 km trek across the ice to measure snow accumulation at the top of the glacier. As they go, they will record snow density, collect ice cores and gather historical clues from rocks and isotopes to see how fast PIG is changing. "Over the six-year period we have been studying the melting so far, it has been getting worse," says Smith. "However what we don't know is if this is going to carry on or even off."

Living on the ice

To answer this question, the team will be spending 70 days living on the ice in temperatures barely reaching above -10 °C. Going out into the field involves transporting 80 tonnes of equipment including two tractors, tents, science kits and a shipping container, revamped into a dining room.

"Doing this means the science can happen more efficiently," says Simon Garrod, Field Operations Manager at BAS. "When you're living in the snow, a significant amount of time must be spent just living – pitching tents and melting snow for water. Being able to pull your dining room along with you means you have more time for science."

By pitching their tents at such chilly latitudes, they hope to figure out what's going on at PIG. "The reason why we think its changing so fast is because it's being forced by what's happening in the ocean," says Smith.

As warm water currents in the Amundsen Bay meet the underside of glacier's ice shelf, they speed up the melt. The amount of ice loss more than doubled in the past couple of decades. Ice discharge between 1992 and 2011 was reported at an average of 20 Gt per year but is now reaching 56 Gt per annum, which is equivalent to removing a block of ice 100 metres deep and about 1000 square kilometres wide from the ice shelf each year.

The WAIS is more vulnerable to oceanographic changes than the eastern side because the sheet sits on ground below sea level. The grounding line, the point where the ice lifts off the bed rock and starts

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