Geology Matters

January 2020

Editorial

So goodbye 2019 and hello 2020. I'm sure that we will experience the repeat of many of the issues that were vexing us last year and the emergence of some new ones as well. But putting all those into an airtight container for now, this is geology – it is as challenging and intriguing as ever. New discoveries will no doubt emerge and leave us happily bewildered.

Speaking of being bewildered, I decided to dedicate this edition to some geological curiosities – and there are lots of those around. Now sit back and enjoy.

Several years ago

I remember standing with Dick Harris at a rock face besides the River Teme in Ludlow trying very hard to discern the presence of seismites – and failing. If, on the other hand we had been here, then we could not have failed.

The photograph was taken in that fascinating geological venue the Valley of the Dead Sea, the seismites are the wiggly formation in the centre. So what, you might reasonably ask, are they and how were they formed.

Sediments are usually layers of material laid down in water – in a lake or in the sea. They contain air, water and organic material. Over time the layers become thicker as new sediment is laid on top and the weight of this slowly expels the air and water. If the sediment is left undisturbed for several thousand years it will slowly heat up as it is forced further downwards. And eventually it will lithify ie turn into solid rock. The organic material might become a fossil.

If, somewhere in the intervening period, while the rock is still semi-solid an earthquake should occur then the sediment could be disturbed sufficiently to form the rather convoluted patterns seen above.

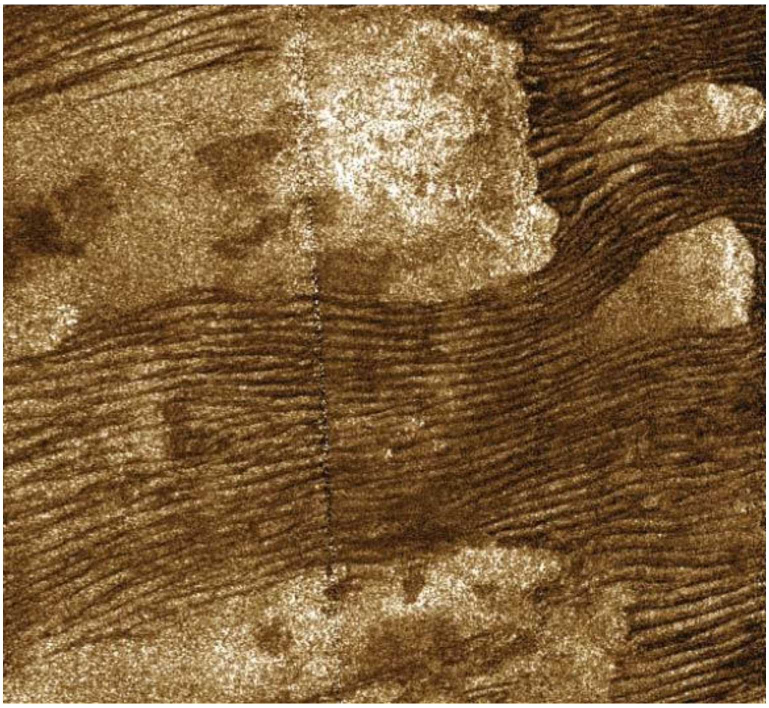
Do you recognise this?

I know that there are a lot of very smart people in our Group, but it is rather a difficult question to answer and I would be surprised if many of you came up with the answer that it is the Saturnian moon Titan. It is the largest moon of Saturn and the second-largest natural satellite in the Solar System. It is the only moon known to have a dense atmosphere, and the only known body in space, other than Earth, where clear evidence of stable bodies of surface liquid has been found.

Titan is primarily composed of ice and rocky material, which is likely to be differentiated into a rocky core surrounded by various layers of ice, including a crust of ice and a subsurface layer of ammonia-rich liquid water. Much as with Venus before the space age, the dense opaque atmosphere prevented understanding of Titan's surface until the Cassini–Huygens mission in 2004 provided new information, including the discovery of liquid hydrocarbon lakes in Titan's polar regions. The geologically young surface is generally smooth, with few impact craters, although mountains and several possible cryovolcanoes have been found.

The atmosphere of Titan is largely nitrogen; minor components lead to the formation of methane and ethane clouds and nitrogen-rich organic smog. The climate, including wind and rain, creates surface features similar to those of Earth, such as dunes, rivers, lakes, seas (probably of liquid methane and ethane), and deltas

Using a radar system this image of a dune system has been obtained.



The image shows dark streaks carved into dunes reminiscent of those we might find on a beach on Earth or raked with flowing lines in a Japanese Zen garden. While our sand is composed of silicates, the 'sand' of these alien dunes is formed from grains of organic materials about the same size as particles of our beach sand. The small size and smoothness of these grains means that the flowing lines carved into the dunes show up as dark to the human eye. While previous images have spotted these eerily familiar patterns on Titan's dunes, this new image (colourised) shows them in greater detail. These are vast longitudinal dunes up to 100 m in height in the equatorial deserts of the moon and are one of the

Solar System's most monumental surface structures, but the chemical composition of their dark organics remains a fundamental, unsolved enigma, with acetylene ice detected near the dunes implicated as a key feedstock.

A few million kilometres nearer home

We find ourselves at an abandoned silver mine at Pulpi in Almeria, southern Spain, the site of the discovery of a giant geode or sphere.

The geode of Pulpi is an 11-metre hollow ovoid with crystal-panelled walls. It is like those familiar couplets of stone interiors covered with bright crystallites, but so large that several people can fit inside. The crystals, of up to two metres in size, are so transparent that they look like ice crystals.

Like the giant crystals of Naica in Mexico, the crystals of Pulpi are gypsum (calcium sulphate with two water molecules). To reveal their formation has been a very tough task because unlike in the case of Naica, where the hydrothermal system is still active, the large geode of Pulpi is a fossilized environment.

A team performed a study of the geology and geochemistry of the abandoned mine where the geode was found, including a detailed mapping of the underground mining works, which has been used to allow tourist visits in the mine.

They found that the crystals of Pulpi formed at around 20°C, at a shallow depth where the temperature fluctuations of the climate are still perceptible. These temperature fluctuations, being below the maximum solubility of gypsum (40 °C), led to the dissolution and recrystallisation amplifying a maturation process that is known as Ostwald maturation (that's one for the Chemists)

If you would like to try a video visit and practise your Spanish then try this link:

https://www.youtube.com/watch?v=dItEmYzZknI

The weird and wonderful world of the Cambrian

High in Canada's Rocky Mountains, the animals of an ancient ecosystem can be seen battling for life. The fossils of the Burgess Shale offer a glimpse at the incredible diversity of early life on Earth, frozen in time and locked in stone — you just have to go digging to see it.

Working at 2,500 metres above today's sea level, a group of scientists from the Royal Ontario Museum chipped away at a prehistoric, tropical sea floor that was once a thriving community of the planet's first animals. The fossils of the Burgess Shale are very special. First discovered in 1909 in Yoho National Park by famed naturalist Charles Walcott, the fossil beds have preserved, in incredible detail, the strange animals from our distant past.

Typically, only bone or hard shells become fossilized over millions of years, while soft tissues like cartilage, skin and muscle decay very quickly. But here in the Burgess Shale, the conditions were just right for preventing decomposition, an underwater landslide trapped ancient animals in mud and perfectly preserved them for over half a billion years.

During Earth's more than four-billion-year infancy, the planet's only life was simple and microscopic. But around 635 million years ago, that began to change. The first large, multi-celled organisms appeared, like cnidarians (including corals and jellies) and sponges. Then, about 540 million years ago, something else changed ... dramatically.

It was the time of the Cambrian Explosion, an eruption of life when Earth's very first animals began appearing in the fossil record — the ancestors of all major animal groups that we know today. Here are some visualisations of the weird, wonderful and extinct.

A digital recreation of Anomalocaris

A digital recreation of Hallucigenia

A digital recreation of Opabinia

Rock of the month

So let the weirdness continue. The video link below will show you a sample of sandstone, but not just any old example – it is flexible sandstone. Take a look:

https://www.youtube.com/watch?v=ojsfYeurY8M

The flexibility of these sandstones has puzzled geologists for many years and led to much discussion about why it's so wobbly. Flexible sandstone was first discovered in the small area of Morro do Itacolomi in Brazil in 1822. It was thought to be a new type of rock, gaining it the name Itacolumite. Unfortunately, it wasn't a new rock and it was actually a sandstone formed from the decomposition of gneisses which contained feldspar grains.

This sediment accumulated together just like any old sandstone, but the feldspar grains continued to decompose. This would have left lots of empty spaces within the rock leaving it a lump of loosely interlocking grains of quartz. Where the quartz grains interlink with their neighbours, quartz crystals have grown creating joints, these are like your elbow or knee and allow the rock to manoeuvre like a wobble board. But in case you were wondering, the whole cliff or bed where this was lying wasn't all wobbly, it's only flexible when you cut it into thin sheets.

If you would like to see a sample of this curiosity then there is an example in the Lapworth Museum at Birmingham University.

Editorial contact

geoffrey.carver@btinternet.com