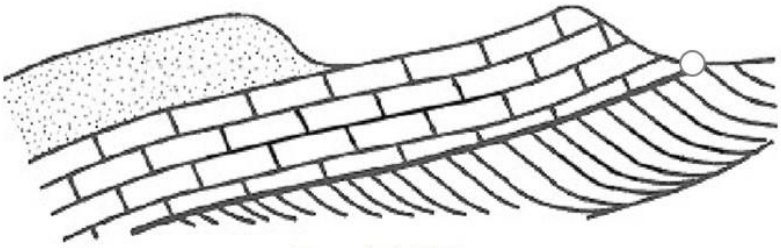
Newsletter of
The Farnham Geological Society

Volume 26, Number 1, February 2023

Argentine river gravels
by Janet Catchpole

Farnham Geological Society

Farnhamia farnhamensis



Founded 1970

A local group within the GA

Volume 26, No. 1 **Newsletter** February 2023
Issue No. 119

www.farnhamgeosoc.org.uk

Contents

Editorial

Welcome to the latest edition of the FGS Newsletter. I hope you are all well and had a wonderful Christmas and a very happy New Year.

As you may know, **John Williams** has stepped down from organizing the FGS Field Trips. We are all extremely grateful to John for all the hard work he has put in to organizing trips over the years. He has made an amazing contribution to the society and has chosen some excellent localities with a wide variety of rock types.

On the subject of field trips, you will find in this edition a report from the joint **Reading – Farnham Field Trip to Pembrokeshire** which was held in May 2022. The report first appeared in the October 2022 edition of the RGS Newsletter.

Our next lecture will be ***Zoom only*** on **Friday, 10 February** when we welcome Oxford University's **Dr. Ken Amor** who will be talking to us about **"Impact Craters and Planetary Science"** which, I am sure, will be a very interesting presentation.

As demonstrated at the AGM **Walter Bonnici** and **Bob Rusbridge** have put together a new look **FGS website**, which I hope you will agree, is an excellent upgrade on our previous website. If you have any comments, or suggestions to improve the new site then please feel free to contact myself or any of the committee members. We will be testing the site over the coming months and would greatly appreciate your feedback.

Also, we are still looking for members to join the FGS Committee. Please contact our Chair Liz Aston if you would like to be considered.

If there are any items you wish to be included in forthcoming Newsletters please feel free to forward them to myself, Mick Caulfield (caulfm@hotmail.com), for inclusion.

Obituaries

It is our sad duty at this time of year to reflect on those people who have been attached to the Society and who have died in the last year.

- **Liz Smith** … Sadly, Liz passed away peacefully in Pax Hill Nursing Home, Bentley on Monday, 14 November 2022. She went to convalescence after a hip operation following a serious fall. While her recovery from the operation was going well, she deteriorated very quickly due to Alzheimer related problems. Liz will be sadly missed, and we send our sincerest condolences to her friends and loved ones.

Front Cover

This month's Front Cover is another one of the entrants from the **2022 FGS Photographic Competition**. Taken by **Janet Catchpole** in March 2019 while on a Field Trip to Argentina.

The photo captures river gravels in front of the **Perito Moreno Glacier**, with the Andes in the background. The glacier is located in *Los Glaciares National Park* in SW Santa Cruz Province, Argentina. It is one of the most important tourist attractions in the Argentine Patagonia.

The 250 km^2 ice formation, 30 km in length, is one of 48 glaciers fed by the Southern Patagonian Ice Field located in the Andes system shared with Chile. This ice field is the world's third largest reserve of fresh water.

The glacier was named after the explorer Francisco Moreno, a pioneer who studied the region in the 19th century and played a major role in defending the territory of Argentina in the conflict surrounding the international border dispute with Chile.

Ref: FGS Newsletter May 2020, Vol. 23, No. 3

Congratulations are in order to **Sally Pritchard** our Membership Secretary; not only did her photo of the Aiguille du Dru, a mountain in the Mont Blanc massif in the French Alps, win our photography competition (see *FGS Newsletter, May 2022*) she also entered it in the **Geologists' Association's yearly competition and won that as well!** Furthermore, her photograph adorns January in the 2023 GA Calendar (https://geologistsassociation.org.uk/shop/ga-calendar/). **Well done Sally!**

Farnham Geological Society Committee 2023

Chair	**Liz Aston**
Treasurer	**Peter Luckham**
Secretary	**Judith Wilson**
Programme Secretary	**Janet Catchpole**
Membership Secretary	**Sally Pritchard**
Field Trip Secretary	*Tessa Seward**
Newsletter Editor	**Mick Caulfield**
Web Manager	**Bob Rusbridge**
Advertising	**Peter Crow**
IT/Sound	**Mike Millar**

**Will undertake the role in Summer 2023*

Meeting Programme 2023

Please note The Maltings and Zoom only meeting times:
7.30 pm for 8.00 pm start.

Impact Craters and Planetary Science
Dr. Ken Amor Fri, 10 February
Oxford University

Sir Alfred Russell and his Mineral Collection
Dr. Roy Starkey Fri, 10 March
Consultant

Bumps in the Bay
Dr. Dan Bosence Fri, 14 April
RHUL

Field Trip Programme 2023

Our programme for this year has yet to be organised.

Geologists' Association Lecture Programme 2023

https://geologistsassociation.org.uk/lectures/

Winchcombe meteorite
Dr. Ashley King Fri, 3 February

Excavating Plesiosaurs
Richard Forrest Fri, 17 March

The pebbles of the Ice Age Coast
Mike Horne Fri, 14 April

Reading Geological Society Lecture Programme 2023

https://readinggeology.org.uk/lectures.php

The Winchcombe Meteorite
Dr. Ashley King Mon, 6 February
NHM, London

Presidential Address
Prof. Alison MacLeod Mon, 6 March
University of Reading

Mole Valley Geological Society
Lecture Programme 2023

http://mvgs.org.uk

Lapis lazuli – the heavenly stone
Dr. Chris Duffin Thu, 9 February
NHM, London

Evidence of Palaeolithic 2022human cultural mixing revealed from bone artefacts in French caves
Dr. Claire Lucas Thu, 9 March
British Museum

Sea Level Change through the Phanerozoic and into the Anthropocene
Dr. Colin Summerhayes Thu, 13 April
Scott Polar Research Institute, Cambridge University

Horsham Geological Field Club
Lecture Programme 2023

http://www.hgfc.org.uk/

Slow-slip plate tectonics: New Zealand
Rebecca Hill, *Wed, 8 February*
Imperial College London

TBA
Dr. Bob Chandler, Wed, 8 March
HGFC President

Challenging ground and seismicity for deep high speed rail stations in Italy and California
Nick O'Riordan Wed, 19 April
Arup

West Sussex Geological Society
Lecture Programme 2023

https://www.wsgs.org.uk/

AGM + Isle of Wight fieldtrip
John Lonergan Fri, 17 February

The Stegosaurian Dinosaurs
Dr. Susie Maidment Fri, 17 March
NHM

Geotechnical Hazards of SE England
Roger Smith Fri, 21 April
U3A

Next Lecture

Friday, 10 February 2023

7.30 pm for 8.00 pm Zoom ONLY

Impact Craters & Planetary Science

Dr. Ken Amor, Oxford University

Impact craters are an often-overlooked feature of the 'rocky' planets and moons of our solar system, but their presence or absence can tell us much about planetary history, and the formation and evolution of our solar system. Unlike other geohazards such as earthquakes and volcanoes, asteroid impacts are the so-called black swan events of geology, with the potential for world changing consequences.

Dr. Ken Amor (BSc Reading, MSc Leeds, DPhil Oxon) is a stipendiary lecturer in Earth Sciences. His academic interests include geochemistry, sedimentology, stratigraphy and the physical and chemical processes of large meteorite impacts and their possible influence on biotic extinctions in the geological record.

He describes himself as a geologist using geochemistry to solve geological problems and conundrums. After completing his BSc in Geology at Reading he worked in industry for a while, before returning to the academic world, first at Leeds University and then at Oxford where he took his PhD. He has been at Oxford for almost 20 years in research and teaching and is currently teaching Physical Geography at St. Edmund Hall. His research interests are very broad but include the Stac Fada asteroid impact deposit in the Stoer Group of NW Scotland.

AGM Summary

Friday, 13 January 2023

On 13 January, 33+ attendees via Zoom welcomed our Chair Liz Aston, along with the FGS Committee members, in holding our AGM.

This was followed by an excellent presentation by Peter Crow, FGS.

Liz Aston, FGS

There were 33 attendees and 3 apologies for absence. The 2022 AGM minutes were approved with no matters arising so **Peter Luckham**, Treasurer for almost 50 years, gave a brief report on FGS Society accounts. One account was closed as HSBC charges increased significantly. Total operating costs were low, £1,095.54, and cash in hand at the end of the year was £2,593.61.

No subscriptions were charged in 2022 due to Covid but Peter has determined that costs in 2023 will be higher (costs from The Maltings, speakers and field trips); so, it is recommended that subscriptions should be reinstated at the existing level. Some members suggested increasing the fee to £25.00 for Ordinary Members but Peter preferred to keep them at the same level:

- £24.00 for Ordinary Members.
- £12.00 for Additional Family Members and Junior Members (under 18 or 21 if in full-time education).
- £12.00 for Associate Members living over 50 miles from Farnham.

Sally Pritchard will email membership forms for all to complete with their details.

Liz Aston, Chair, reported on the actions of the Committee and the key items were:

Sally Pritchard, Membership Secretary: membership stands at 89 and extends from Cornwall to Dorset, Gloucester, Hereford, Warwickshire, into Scotland. Sadly, we had to say goodbye to Elizabeth Smith – a very supportive member.

Janet Catchpole, Programme Secretary: 2022 started on Zoom but moved to The Maltings with Zoom. Topics ranged from current geological issues – Fagradalsfjall eruption, Iceland; Geology and the London Underground; continual rising of the Andes; occurrence of Lead and Zinc in the Pennine Ore Field; Glaciation of UK. Also, ancient palaeontological subjects – Burgess Shale fossils in British Columbia; Mass Extinctions in Devonian sandstones; Carboniferous Plants from Coseley; Dinosaurs' Colours and Feathers; Ice Age Carnivores. In March many enjoyed a social afternoon looking at rocks and fossils at Aldershot Cricket Club.

Zoom has worked well, benefiting older and distant members but is a disappointment for others. Janet found it easier to get a wider selection of busy, distant speakers. The committee decided that it is prudent to use Zoom for December to March inclusive and then to hold hybrid meetings for the other months. We have a relationship with the local geological societies of Reading, Harrow & Hillingdon and Mole Valley. It was a successful venture during the pandemic and will continue for 2023; it will be reviewed at the end of the year.

Field Trip Secretary, **John Williams** organised two trips – a visit to NHM in London led by Leone Biggenden and a trip to South Pembrokeshire when the FGS Joined with Reading Geol. Soc. who had organised the trip. John has now retired from the post and **Tessa Seward** has volunteered to take over from him after mid-year with help from others.

Mick Caulfield, Newsletter Editor: The Newsletter is published quarterly with news of Society events, technical and geological news items and the occasional crossword, quiz, etc. Mick is pleased to receive articles and summaries of FGS talks and field trips and other geological news from members so please continue to send them to him.

Mike Millar sorted out the communications required for FGS to conduct the hybrid meetings, where both lecturers and members can join Zoom meetings from The Maltings as if face to face.

Peter Crow has continued spreading the word and leaflets around the local area and as a result of this we were invited to talk to some Farnham Cubs – a great evening with 30 excited cubs, their leaders, parents, etc. exploring fossils, rocks, minerals and local geology. The Society also took this display to the Open University Geological Society meeting in Guildford where the 'audience' were older but equally interested.

The Society has a wonderful collection of rocks and minerals which Peter and Mary Luckham have housed for many years. It was sorted and reduced in size last year when suitable spare samples were given to schools, 'rubbish' was discarded, and the good specimens kept. Certain specimens were photographed and displayed at FGS events. The collection now needs a new safe dry storage area – ***SO IF YOU CAN HELP PLEASE NOTIFY*** **Liz Aston @ newsletters.fgs@gmail.com.**

The last and one of the most important items on the agenda was the updating of the website. **Walter Bonnici,** a new FGS member, enjoyed setting up a new website – based on the old one but with a brighter and more geological flavour. **Bob Rusbridge** was involved all the way through and is now going to manage the website for the Society. We are very lucky to have this talent within the Society and I am very grateful to them both for all their enthusiasm and skill – they have done a wonderful job and the new website will be fully working very shortly.

The 2023 Committee was elected:

- Liz Aston, Chair
- Peter Luckham, Treasurer (*until he reaches his 50-year stretch)*
- Judith Wilson, Secretary
- Sally Pritchard, Membership secretary
- Janet Catchpole, Programme Secretary
- Mick Caulfield, Newsletter Editor
- Mike Millar, Communications
- Peter Crow, Publicity
- Bob Rusbridge, Website Management
- Tessa Seward, Field Trip Secretary *(from July onwards)*

We will have a review at the Society's Members Meeting in July as we **WOULD STILL LIKE SOME YOUNG, TECHNICAL TALENT TO JOIN US – SO IF THAT IS YOU PLEASE CONTACT Liz Aston @ newsletters.fgs@gmail.com.**

Peter Crow, FGS

One small typo and two igneous adventures: Island hopping from the Scillies to Sicily

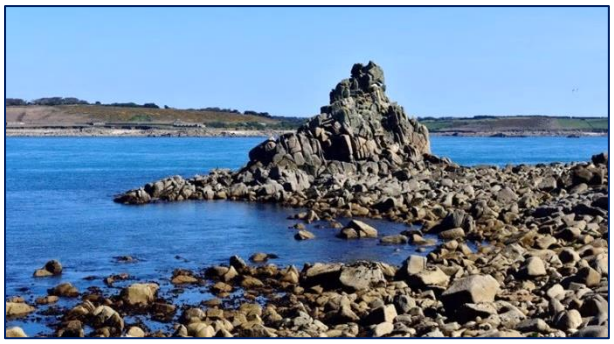
At the start of 2022, my partner and I were looking for a possible holiday destination and had heard good things about the Isles of Scilly. So off we went. In April. It was the start of the holiday season in the Scillies and many hotels were just opening up. And we had a great time. But when telling friends and family about out trip to the Scilly Isles, we would often get confused and say the 'Sicily Isles'. Or was it vice versa? So, to simplify things, we decided to visit the Italian one in September. Two very nice holidays, to two lovely locations. Both island bodies. And both, as it happens, of igneous origins, albeit formed by different mechanisms.

Igneous rocks are formed by two major types of activity; either extrusive rocks that are expelled through and onto the Earth's surface (such as volcanic eruptions), or intrusive rocks that migrate towards the surface, but do not break it. Because Intrusive rocks are surrounded by other crustal rocks, they cool slowly, allowing individual mineral crystals to form. Intrusive rocks, such as granites, can therefore usually be identified by their mineralogy that is clearly visible to the naked eye. Conversely, extrusive rocks are exposed to the sea or atmosphere, where they cool rapidly. Minerals are either very fine or invisible to the naked eye. Examples include basalts and obsidian.

The Intrusive Isles of Scilly

The Cornubian Batholith is a large mass of granite that underlies much of the peninsula of SW England. It is visible as six major plutons

(large igneous bodies that are now exposed as irregular outcrops), intruded into Devonian and Carboniferous aged metasedimentary and igneous rocks. Gravity survey data indicate that the granite is continuous at depth, is over 250 km long, 20-40 km wide and up to 10 km thick. The batholith owes its origin to the Variscan Orogeny, a mountain-building event caused by Late Palaeozoic continental collision between Euramerica (Laurussia) and Gondwana to form the supercontinent of Pangaea.



The six plutons can be roughly dated to two phases of activity. The granites that comprise the plutons of Scilly, Carnmenellis and Bodmin are typically aged over 290 Ma. Whereas the plutons that form Land's End, St Austell and Dartmoor are slightly younger at 282 Ma. The granites of the Scilly Isles are fine- to coarse-grained, rocks and both biotite and muscovite micas are common. Accessory minerals include tourmaline, andalusite, apatite, zircon, monazite, rutile and Ilmenite.

Granite blocks break the surface of the sea to form the islands, but many occur just below the surface resulting in very shallow and treacherous waters. Almost 1000 shipwrecks are recorded around the islands and the figureheads from many ships can be seen in a museum on the island of Tresco.

The granite overburden show signs of periglacial activity, with poorly sorted beds. The maximum extent of glaciation has been mapped just to the north and west of the islands (Ref. 1). Aeolian-derived sands and podzolic soils are abundant and the weathered granites form white sandy beaches that extend into the shallow seas. On a sunny day, the blue sky, blue sea, sandy beaches and striking rock formations make the Isles of Scilly a beautiful place to visit. The islands form a haven for sea birds, red squirrels and mature elm trees. The clean, warm, and moist atmosphere allow many varieties of lichens and moss to grow on weathered granite faces.

The (partly Extrusive) island of Sicily

Located just off the 'toe' of Italy, Sicily is the largest island in the Mediterranean. It sits on the junction between the African and European tectonic plates and the surrounding region has, and continues to be, subjected to significant tectonic activity. At the end of the Palaeozoic era, the area that was to become Sicily was located on the northern edge of the African Plate and the western edge of the Tethys Ocean. The latter was closing (subducted under Europe to the north).

In the Oligocene, a rift on the southern edge of the European Plate opened, moving a block of land that was to form the main part of Corsica and Sardinia slowly eastward. This opened the Provencal Basin between the European Plate and the 'Corso-Sardinian Block'. Around 15 Ma the Corso-Sardinian Block stopped, but the eastern part of the block then split along a north-south fault and continued to move east. This new rift would eventually become the Tyrrhenian Basin and the remaining fragment of the Corso-Sardinian Block continued eastward to form part of the Apennine mountains in Italy and the northern part of Sicily.

Whilst The Tyrrhenian Basin continues to spread eastward, the African Plate is moving north. The Ionian Basin (east of Sicily) is subducted under the edge of the African Plate and the expanding Tyrrhenian Basin. This creates the Aeolian volcanic arc that includes volcanic islands such as Volcano and

Stromboli. This subduction activity, combined with the bidirectional forces of the adjacent plates has created a hotspot on a fault system that forms Mount Etna on the eastern side of Sicily (Ref. 2).

Etna is an active stratovolcano and is one of the tallest active volcanoes in Europe with a height (July 2021) of 3,357 m. It is regularly active, adding to its height. Today, the south-eastern crater is now the tallest part of the volcano. Volcanic activity first took place at Etna about 500,000 years ago, with eruptions occurring beneath the sea off the coastline of Sicily. Activity has moved northwards to its current centre, and it is continuing towards the Mediterranean Sea at an average rate of 14 mm per year.

Etna's current activity consists of continuous summit degassing, explosive Strombolian eruptions, and frequent basaltic lava flows. The lavas are rich in magnesium and iron, but also have a lot of potassium, contributing to rich fertile soils that support Sicily's famous citrus, pistachio and wine industries. Towards the end of 2022, a moderate effusive eruption was active on the NE flank of the SE crater, with lava slowly advancing from the eruptive fissure vent.

References:

1. John, B. 2018. Evidence for extensive ice cover on the Isles of Scilly. ***Quaternary Newsletter*** *Vol. 146, October 2018, pp 3-27.*
2. Santagati, M. and Asero, V. 2019. Geological history of Sicily. **Athena Guide Series**. Alma editore.

Lecture Summary

Friday, 4 November 2022

On 4 November, 38+ attendees at The Maltings and via Zoom welcomed Danielle Schreve in presenting our external lecture.

Bite Club: Reconstructing palaeo-diets and responses to climate change in Ice Age carnivores

Prof. Danielle Schreve,
Department of Geography, RHUL

Today, the role of predators in structuring terrestrial ecosystems is widely acknowledged, for example the positive effect carnivores have on forest development through a complex trophic cascade effect, which involves reducing herbivore numbers, moderating prey movement and halting over-browsing. Large carnivores also benefit scavengers reliant on winter carrion, such as ravens and wolverines, as well as subduing numbers of medium-sized carnivores such as foxes, with associated benefits for birds and small mammals. Nevertheless, the importance of carnivores in shaping Pleistocene terrestrial ecosystems is often underestimated because carnivore species diversity and body size are much reduced in modern communities. The impact of large terrestrial predators on Pleistocene ecosystems may also be difficult to appreciate, because these carnivores interacted within much more species-rich guilds than exist today.

Danielle's talk covered a wide range of evidence (much drawn from her work on the assemblages from caves in the Mendip Hills of Somerset) that allows us to reconstruct Ice Age carnivore palaeodiet and predatory behaviour. These lines of evidence include carnivore tooth morphology and changes to the shape and size of teeth and jaws through time, body size change, patterns of gnaw marks, prey age profiles, dental microwear, carcass consumption sequences and stable isotope analysis. The results shed light on the changing predator guild over the last half a million years and the effects of climate-induced extinction events, as well as providing information on the prey choices of spotted hyaenas during the last cold stage, c.60,000 to 30,000 years ago, on the variability of brown bear diet in response to changing glacial-interglacial environments, and on the exceptional dietary flexibility of wolves, the ultimate generalists of the Pleistocene carnivore world. Fig. 1 (adapted from Flower *et al.* 2021) shows how Carbon and Nitrogen stable isotope studies from three sites in the south-west of England have revealed how

wolves switched prey and shared resources with other large carnivores. Further work on wolf diet, fossil and modern, will be done through a new NERC-funded major project, entitled “Nature of the beast? Resolving drivers of prey choice, competition and resilience in wolves”, led by Danielle and Dr Angela Lamb (British Geological Survey).

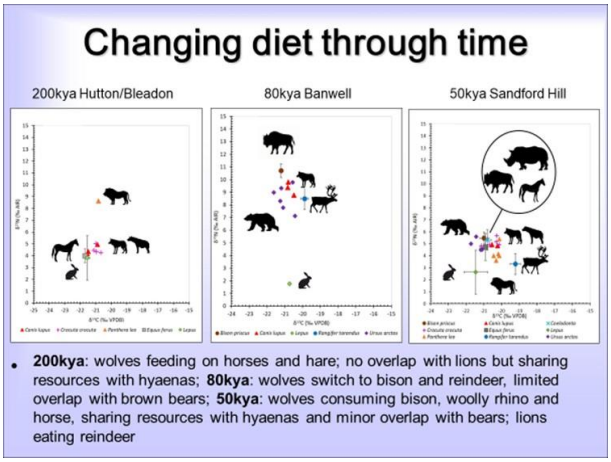


Figure 1: Changing competition and prey selection in British large carnivores in the Middle and Late Pleistocene (adapted from Flower et al. 2021).

Reference:

Flower, L., Schreve, D., & Lamb, A. (2021). Nature of the beast? Complex drivers of prey choice, competition and resilience in Pleistocene wolves (Canis lupus L., 1754). *Quaternary Science Reviews*, 272, 107212. https://doi.org/10.1016/j.quascirev.2021.107212 (a copy of this can be read at https://pure.royalholloway.ac.uk/en/publications/nature-of-the-beast-complex-drivers-of-prey-choice-competition-an).

Lecture Summary

Friday, 8 July 2022

On 8 July, 70 attendees at The Maltings and via Zoom welcomed FGS Members Colin Brash & Janet Catchpole in presenting our lecture.

Western Canada & the Burgess Shale

Colin Brash & Janet Catchpole, FGS

We have been to the Burgess Shale!

In the summer of 1992, some members of the Farnham Geological Society (FGS) decided to try and visit the Burgess Shale in Canada, which had been in the news. Janet Catchpole, Maureen Robertson, and Mary Andrews were going out together. Marybeth Hovendon, my wife Jill Brash and myself, Colin Brash, would travel to Vancouver and meet up with Marybeth’s brother Donald and travel self-driving around the Rockies. We would all meet at The Visitor Centre in the town of Field (British Columbia) within the Yoho National Park (Fig. 1).

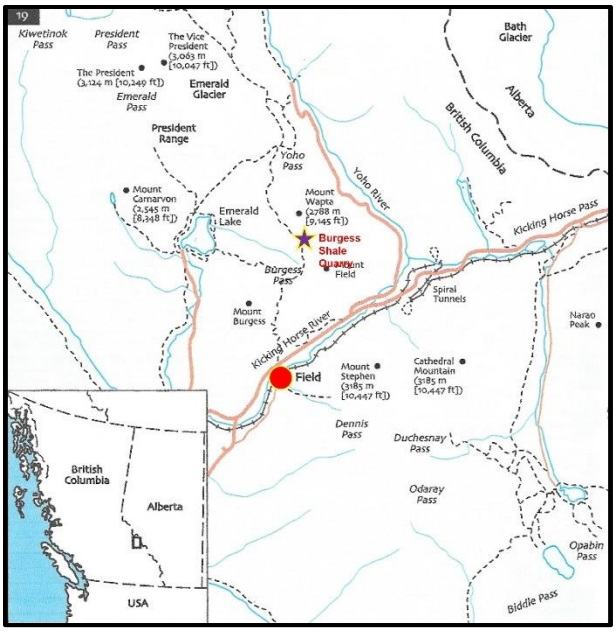


Figure 1: Yoho National Park, BC.

Eventually, on 28th August 1993, we all assembled at Cathedral Chalets (near Field) (Fig. 2 & 3), right next to the Kicking Horse River, to eat our evening meal of corn, potatoes and tomatoes all bought from farms on the way to our meeting point. An early bonus of the trip was being able to celebrate Maureen’s birthday by eating a birthday cake brought from England by Janet.

As the scheduled climb up to the Shales was not until the 30th, we were able to visit other local sites in the YNP. Marybeth, Donald, Jill and I drove to Emerald Lake (elevation: 4,262 ft) then walked up to the nearby Hamilton Falls below Hamilton Lake.

Figure 2: L to R: Mary, Maureen & Janet at Cathedral Chalets.

Figure 3: Road, rail and river next to the chalets.

After lunch back at the chalets we drove to Hoodoo Creek to see the magnificent Leanchoil Hoodoos which are pillars of naturally cemented gravel, sand and silt usually with a large capstone (Figs. 4 & 5).

Figure 4: The Hoodoos from above.

With time to spare we visited the nearby Wapta Falls (Fig. 6), on the Kicking Horse River, followed by looking at the two Spiral Railway Tunnels started in 1907 and completed in 1909 (Fig. 7).

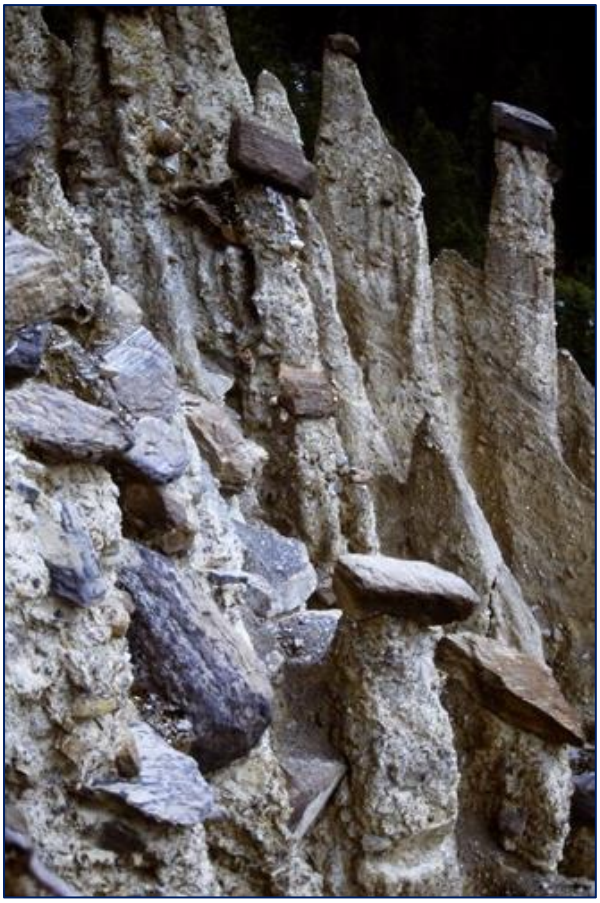


Figure 5: And from the side.

The second bonus was that Dr. Desmond Collins, of the Royal Ontario Museum, had just that day finished a summer season of working on the Burgess Shale and was going to give an evening lecture on the latest theories about the fossils found in the shales. We were all crammed into a darkened room, lit by a temporary generator which operated the

Figure 6: Wapta Falls.

projector as well. It was a fascinating talk about the very fossils we were going try and see the following day. Then back to the chalets to make sandwiches for the early start next day.

Figure 7: Diagram of the two tunnels.

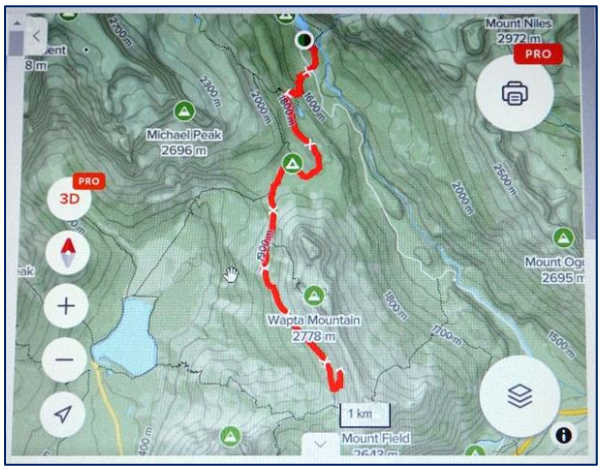


Figure 8: Route of our climb to the Burgess Shale.

On August 30th, the 84th anniversary of the discovery by Charles Walcott of the first fossils, Marybeth, Janet, Maureen, Mary and I crammed into one car and drove to Takakkaw Falls where the party assembled at 9am. We were met by Rosemary Power who was to be our guide, for 12 people, for this the last day of the season for climbing up to the Burgess Shale.

Jill and Donald were not keen on the fossils, so they drove to Lake Louise. Jill hired a horse for a ride and Donald went on a long walk around the lake.

Climbing slowly, passing the Hidden Lakes, then Yoho Lake, through the Yoho Pass (Fig. 10), round Wapta Mountain (8,300 ft) and along to the area of Walcott's Quarry at about 8,000 ft, using the very same track which Walcott had followed.

We lunched, at 1.30 pm, just below the quarry, at about 7,600 ft. then climbed up the steep scree slope and spent two hours in Walcott and Raymond's Quarries looking for signs of fossils, which we did find, but were not allowed to take away.

Figure 9: Passing above Emerald Lake.

Figure 10: Climbing through Yoho Pass.

Figure 11: More climbing up, nearly there!

Figure 12: Rosemary Power, Mary and Janet in Walcott Quarry.

Figure 13: Mary, Maureen, Colin, Marybeth and Janet in Walcott's Quarry.

From our viewpoint we could see Emerald Lake 3,000 ft. below and looked toward the Ottertail Range (Mt. Goodsir) to the south. We had climbed some 3,000 ft. and walked about 7.5 miles to get to this amazing spot. Now we had to turn round and work our way down back to Takakkaw Falls. We left at 4.30pm and got down at 8.00pm.

We spent a few more days at Cathedral Chalets, then said goodbye to Janet, Maureen and Mary and our little group went on to Lake Louise, then up the Icefield Parkway to see and walk on the Athabasca Glacier. We had to find somewhere to stay and ended up near Jasper at a group of chalets with a restaurant. To our surprise we met J, M and M in there, desperate for a shower, which we hosted for them, as there was no such facility at our previous chalets.

Figure 14: Fossils on a shale slab in the quarry.

Figure 15: More fossils.

Figure 16: In the Quarry looking toward Wapta Mountain.

We carried on with our tour of the Rockies, back to Vancouver, and I think the others were on their way home to England. So ended the geological trip of a lifetime.

Colin Brash

The Burgess Shale

What is it? Where is it? What is important about The Burgess Shale?

These are three questions I will attempt to answer.

The Burgess Shale fossil site is a Lagerstätten high on Mount Wapta in Yoho National Park in British Columbia, Western Canada. The fossils found there are of mid Cambrian age, 538 Ma and represent some of the earliest animals found and display many soft body features.

A **Lagerstätten** is an area of exceptionally well-preserved fossil biotas.

History of Discovery

In 1884 a surveyor employed by the expanding railway reported finding lots of fossils on Mount Stephen, British Columbia.

A few years later a geologist working for the Geological Survey of Canada followed up this rumour and high above Field on Mount Stephen he discovered a vast storehouse of ancient life.

Millions of yellow slabs yielded a profusion of trilobites. These beds are now known as the ***Ogygopsis* shales** after the abundant trilobite found. Specimens of a large arthropod, named as ***Anomalocaris*** were also found.

Enter **Charles Doolittle Walcott** onto the scene.

Walcott was a leading authority on Cambrian fossils and Secretary of the Smithsonian Institute in Washington DC in USA.

In 1909 on 31st August Walcott and his family were returning from fieldwork on horseback and the story goes that his wife's horse stumbled on a large boulder blocking the trail. When the block was broken open a large number of soft-bodied fossils were displayed. This is probably a legend but makes a good story. It was not recorded in Walcott's diary.

Many more fossils were found over the next few days from the scattered loose pieces of shale on the hillside.

The origin or mother lode was found a few metres above the trail, but snow curtailed more excavation that year.

Walcott, his family, and colleagues returned for several years from 1910 to 1917. About 65,000 fossils were collected and shipped to the Smithsonian Institute.

Walcott died in 1927 but many of his collected specimens remained undescribed. He misinterpreted many by attempting to place them in modern groups of phyla.

In 1925 and 1927 **Percy E. Raymond**, a Harvard professor of geology visited the *Ogygopsis* fossil site on Mount Stephen and in 1930 undertook a serious excavation of what had become known as Walcott's Quarry. He explored the hillside and opened up another quarry about 20 metres higher. The specimens were not as spectacular as in the lower quarry but demonstrated that this type of preservation was more widespread than first thought and it has since been found to be quite widespread in the Lower and Middle Cambrian deposits around the world.

In the 1960's the quarries were revisited by the Geological Survey of Canada who realised they had this important fossil site in their country but almost no fossils as they had all been transported to Smithsonian Institute in Washington DC, USA. Then as now access to the quarries was controlled by the Yoho National Park Authority and collecting of fossils is only permitted under licence.

The Geological Survey of Canada invited **Dr Harry Whittington** an Englishman, then working as Professor of Palaeontology at Harvard and an expert on trilobites to head up a group of scientists using modern techniques to reinvestigate the site and fossils. Harry Whittington spent two years, 1966 and 1967, excavating in Walcott's quarry. He returned to the UK and took a large number of Burgess

Shale fossils with him, where he set up a group at Cambridge to further research.

Initially **David Bruton** and **Christopher Hughes** were involved in the first assault on the Burgess Shale fauna. In 1972 two graduate students joined the team, **Derek Briggs** who opted to join the main team tackling the arthropods, and **Simon Conway-Morris** who agreed to study the worms in the fauna. They spent some time learning new techniques for study, photography, preparation of fossils and how to make detailed drawings all pioneered by Harry Whittington. In 1973 they travelled to the Smithsonian to trawl through the Walcott collection and arrange for shipment of specimens to Cambridge.

In the 1970's and 1980's **Desmond Collins** from Royal Museum of Ontario worked in Walcott's and Raymond's Quarries sometimes with Derek Briggs and Simon Conway-Morris. He carried out a series of excavations in the Field area looking for new locations. He has found many sites that yielded new collections. It was Desmond Collins that was working the quarries when we visited in 1993 and gave a talk in the evening before our visit to Walcott's Quarry *(see Colin Brash's article above).*

He collected over 150,000 specimens which went back to Ontario making it the largest collection in the world.

There are several theories put forward for the large number of soft bodied fossils found in this mid-Cambrian location.

Two "Oxygen Events" during Proterozoic caused a dramatic increase in oxygen resulting in an extinction event that killed off most anaerobic life in the oceans and enabled complex oxygen breathing organisms to fill the resultant faunal gap.

The Great Oxygeneration Event 2.4 to 2.0 Ga increased the free oxygen from 0.0001% to about 1-2%. The second event around 0.85 to 0.54 Ga increased oxygen to about 10.0%

Link to UV levels

Only after the second oxygen event could an effective ozone layer be formed to prevent excessive UV reaching and destroying life.

Whittington had discovered that photographing the fossils using ultraviolet radiation often produced good results. Many of the fossils were preserved as reflective films on the shale and by tilting the fossil relative to the UV lamp striking photographs could be obtained.

A modified dental drill with a percussive action was used to remove any shale covering the fossil, and photographs were taken of each stage to record different features.

Another technique involved the use of a camera-lucida to produce detailed drawings of the fossils.

The fauna lived in shallow water in or on a fine mud substrate below the Cathedral Escarpment. This was on a slight slope and periodically, due to localised tectonic movement, patches of mud and silt slumped downslope forming a dense cloud of turbulent sediment carrying the live animals, carcases and bits of algae on it a short distance into deeper water, rapidly burying the animals and flora in various orientations with the fine sediment seeping between limbs. The levels of oxygen were probably low thus reducing organic decay.

Fossils as described by the Cambridge group

The Burgess Shale fauna consist of over 160 species representing various arthropods, molluscs, brachiopods, cnidarians, sponges, polychaete worms, priapulid worms, echinoderms, chordates and a number of miscellaneous forms that cannot be accommodated in any recognised phyla. The species are not equally abundant, some are known from thousands of individuals, whereas some from a few or single specimens. Most of the specimens were small, up to 10 cm but some were larger.

Harry Whittington decided to work on the most abundant fossil found, ***Marrella*** *(Fig. 3.12),* and in 1969 at a convention of palaeontologists in Chicago gave the first account of the Burgess Shale fossils.

Examples of other species identified are as follows:

Canadapsis, a Crustacean. Five head segments bear two pairs of antennae and five pairs of legs behind the mouth.

Sarcotrocercus, a tiny arthropod with large eyes, a strong pair of feeding appendages and gill branches, swimming on its back.

Yohoia (Fig. 3.18).

Odontogriphus (Fig. 3.29).

Several specimens are shown in the following diagrams, drawn by Marianne Collins (with original figure numbers retained).

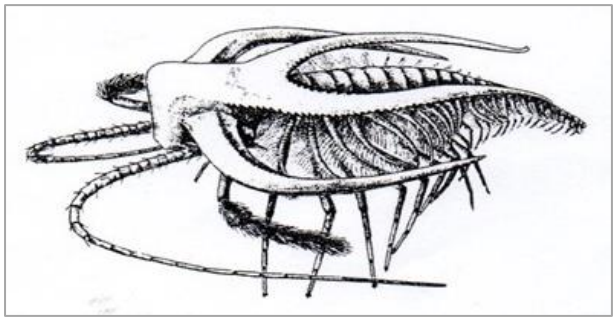


*Figure 3.12: Side view of **Marrella** showing spines curving back from the head with long antennae and many pairs of limbs on the trunk. The specimens are about 20mm long.*

*Figure 3.18: **Yohoia***

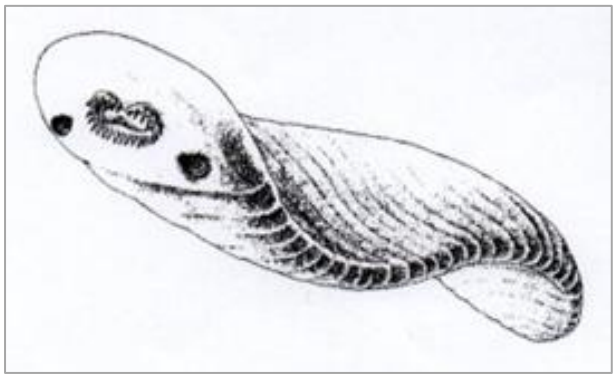


*Figure 3.29: The flattened swimming animal **Odontogriphus**. The mouth surrounded by tentacles and the pair of palps are shown on the underside of the head.*

*Figure 3.31: Three specimens of the stalked animal **Dinomischus**. One bends towards us, showing the openings of the mouth and anus.*

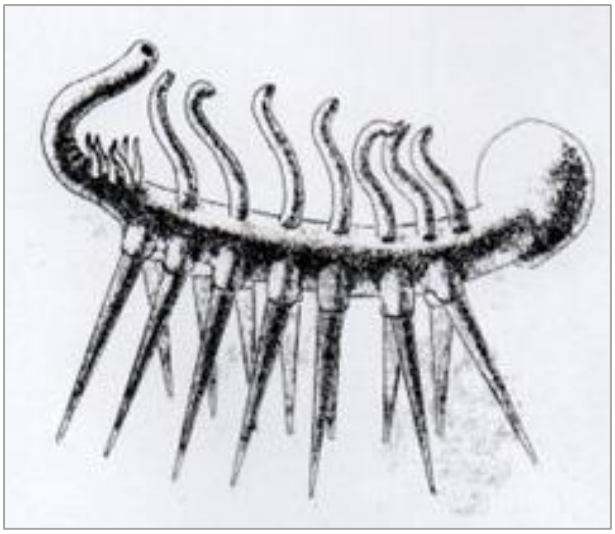


*Figure 3.34: **Hallucigenia**, supported by its seven pairs of struts, stands on sea floor.*

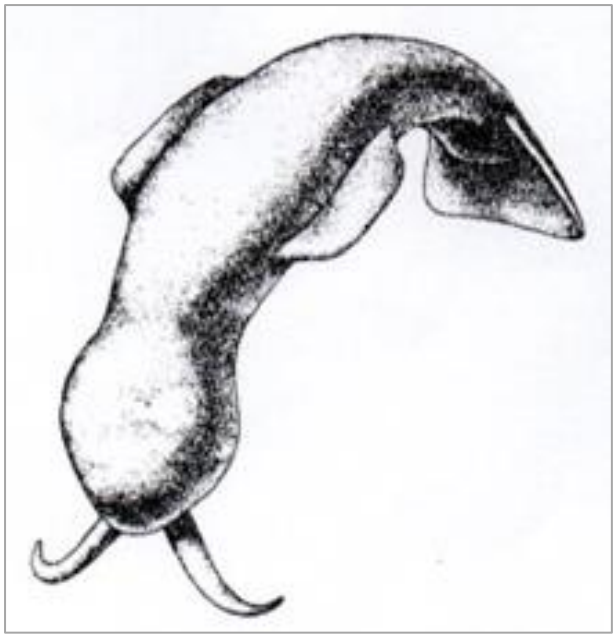


*Figure 3.32: The flattened swimming animal **Amiskwia**, with a pair of tentacles on the head, and side and tail fins behind.*

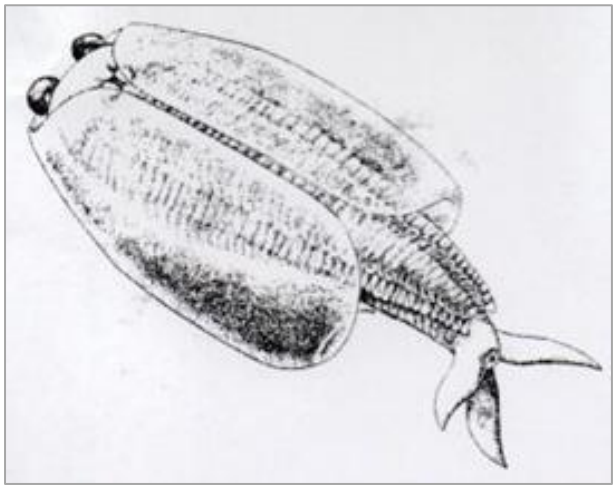
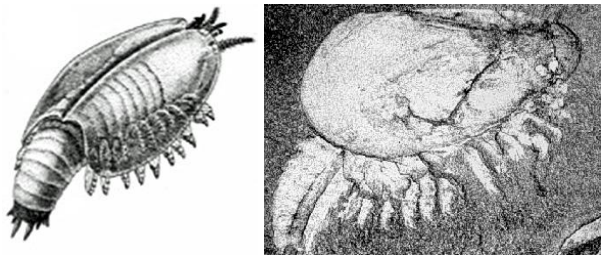


*Figure 3.45: **Odaraia**, swimming on its back. The numerous biramous appendages can be seen through the transparent tubular carapace. Also note the large eyes in front, the curious three-pronged tail behind, and the single pair of feeding appendages behind the mouth.*
(Note: A biramous appendage is one that has two branches.)



Canadapsis

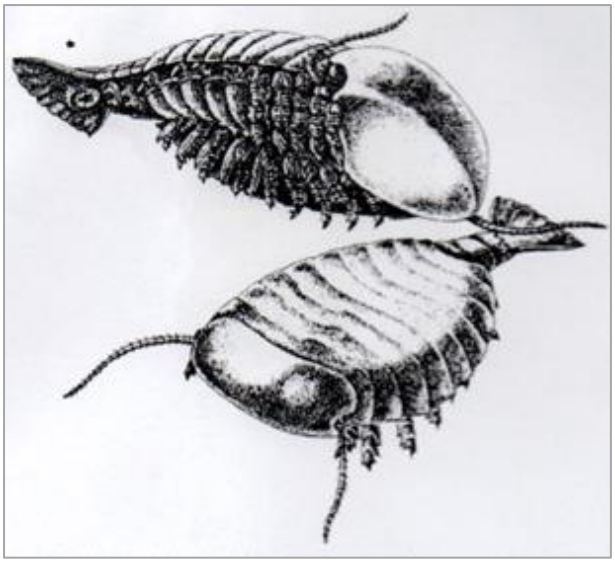


*Figure 3.46. Two views of **Sidneyia**: top, as seen from below, showing the form of the limbs and the attachment of the eyes and antennae; and bottom, as seen from above.*

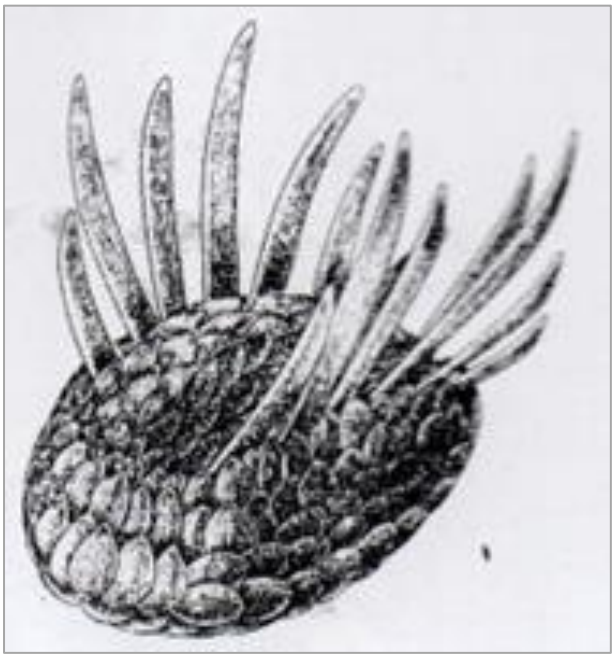
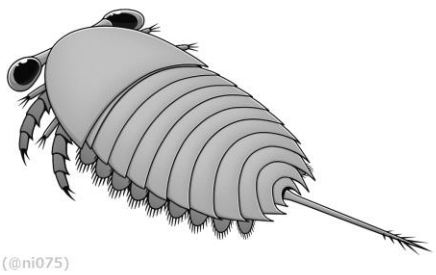


*Figure 3.58: **Wiwaxia** as it might have crawled on the sea floor.*



Sarcotrocercus

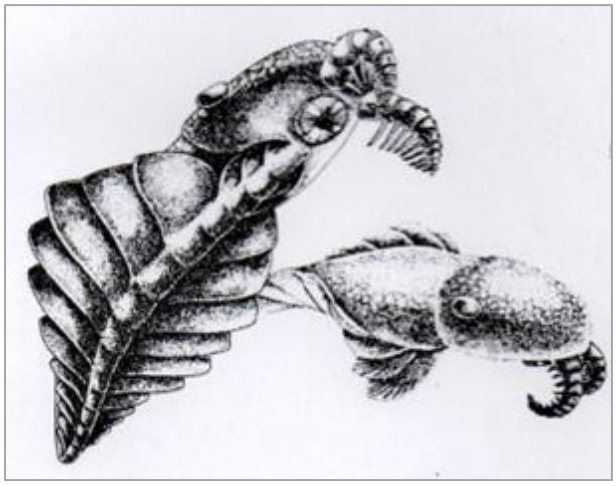


*Figure 3.66: The two known species of **Anomalocaris**: top, **Anomalocaris nathorsti** as seen from below, showing the circular mouth, misidentified by Walcott as a jellyfish, and the pair of feeding appendages; bottom, **Anomalocaris canadensis** as seen from the side, in swimming position.*

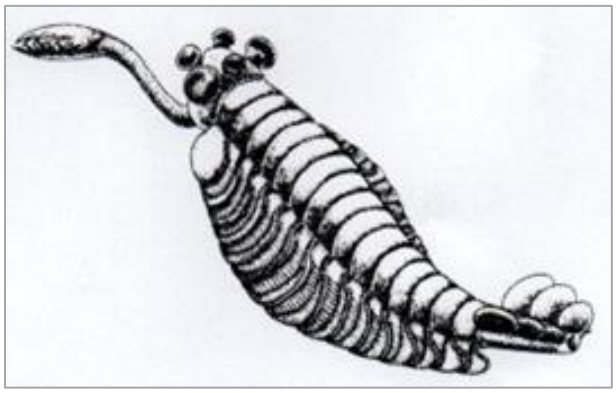


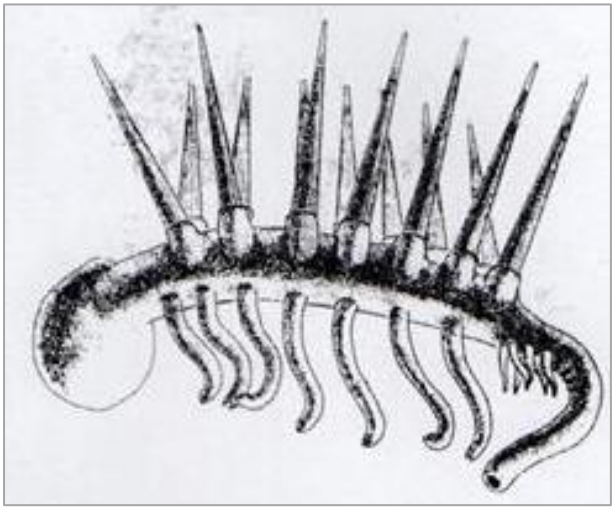
*Figure 3.21: **Opabinia**, showing the frontal nozzle with terminal claw, five eyes on the head, body sections with gills on top, and the tail piece in three segments.*

There were some rather bizarre specimens found that initially caused mistakes in identification.

One of these was ***Hallucigena***. This was originally called ***Canadia sparsa*** but differed from other ***Canadia*** specimens; it had seven pairs of enormous sharp spines on one side of an elongate body and a series of flexible tentacles on the other.

When similar animals were found in a new fossil site at Chengjiang in Yunnan Province in China the palaeontologists showed that ***Hallucigenia*** walked on set of tentacle-like legs and protected itself with a palisade of spines. In life this animal was about 25 cm in length.

*Figure 31: **Hallucigenia** (x13.0). This bizarre creature supported its trunk on seven pairs of stilt-like spines. The tentacles that arose from the dorsal surface of the trunk are also visible.*



***Hallucigenia.** Walks on tentacle-like legs. Head and tail unclear. Protective spines on the back.*

A problem also arose with *Anomalocaris*. Walcott identified what he thought was a jellyfish and named it *Peytoia*. Looked like a pineapple ring with centre cut out, 32 plates surrounded a centre hole. Walcott also described a sort of sea cucumber, but Conway-Morris was unsure. Back in Cambridge it was identified as a large limb. Harry Whittington and Derek Briggs looked at several examples and concluded that the different parts were all part of a large animal possibly up to one metre long. As well as a pair of anterior appendages probably used to hold and manipulate prey the body had a series of flexible lobes which may have propelled the animal through the water.

***Anomalocaris**: uncertain affinity. Very large carnivore, 1 metre in length.*

The *Anomalocaris* story is probably still not fully understood and recent discoveries cast some doubt on it being a fierce predator. It is probably some sort of arthropod.

Opabinia (Fig. 3.21) is another strange fossil with unknown affinities.

Pikaia seems to have a notochord and would therefore be classed as a chordate.

Other locations have been found for Burgess Shale type fossils:

- **Sirius Passet**, a Lagerstätte in Peary Land, Greenland was discovered by members of the Greenland Geological Survey in 1988 and work in 1989 established a huge cache of Cambrian fossils which are still being worked on in Copenhagen.
- In 1912 a French geologist found soft bodied fossils in the **Maotianshan** in Yunnan in China. Further finds were reported in 1957 and in 1984 the principal locality was found, and since then there have been extensive excavations at Chengjiang. The fossils are very similar to those of the Burgess Shale despite being somewhat older. There are good examples of *Hallucigenia* and *Anomalocaris*.

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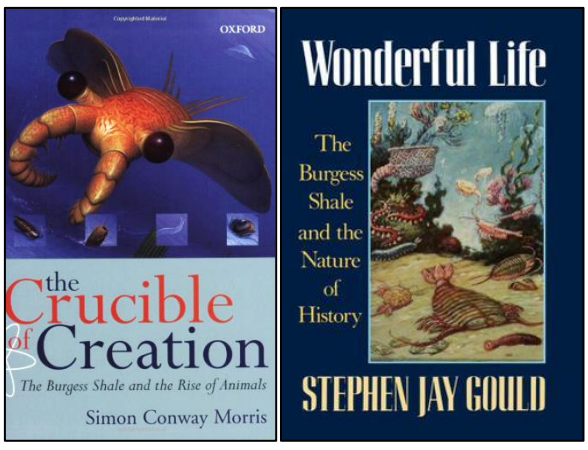

Reading Geological Society
and
Farnham Geological Society

Joint Field Meeting to South Pembrokeshire

Monday 16th – Thursday 19th May 2022
Led by Sid Howells

This visit was the first joint 4-day field meeting between the two societies. A total of 19 people came on this visit – 12 from Reading and 7 from Farnham. We were fortunate to find accommodation in Pembroke in the delightful Coach House Hotel, where we were made very welcome.

Our leader, **Sid Howells**, lives locally where he runs his small business – Geological & Educational Services (GES) Ltd. He carries out many educational field meetings for schools, colleges, and universities; he also works part time as the geologist at Bolton Hill Quarry, which we visited on our final day. Several images in this report have been taken from the handouts provided by Sid, and we are grateful to him for permission to use these.

DAY ONE PM
Monday 16th May 2022

Afternoon: Amroth
Grid ref: SN169 070

Report by Ailsa Davies.
Photos by Ailsa Davies and Roger York.

The day started early for the drive to Pembrokeshire to meet at Kilgetty. After lunch and a short briefing, we moved to nearby Amroth on Carmarthen Bay for our first look at the geology.

The glacial maximum occurred 20k years ago, so the sea was not present as it is today. An ice sheet moved west from the Brecon Beacons area, reaching approximately 20km to the east of Amroth. A river flowed through the middle of what is now the bay.

Here we are on the Carboniferous (Westphalian) Lower Coal Measures which comprise mostly sandstones, with some mudstones and marine bands. The outcrop trends roughly east-west across the Pembroke Peninsula, as with all other outcrops in the region.

The area is well faulted. Amroth is located on the Erroxhill Fault Zone which is the most south-western extension of the Church Stretton fault.

From the beach we could see the extent of the bay; from Monkstone Point in the west to Ragwen Point in the east. We set off westwards to look at the exposures along the beach.

Figure 1: Variscan folding and faulting.

The strata were well exposed and so the folding and faulting, mostly Variscan in age, were spectacular (Fig. 1). Other evidence of tectonic activity we found were tension gashes (Fig. 2).

Figure 2: Tension gashes.

Looking at the Amroth anticline we found the Kilgetty vein of the Carboniferous Lower Coal Measures. Coal mining was first recorded in this eastern area of the Pembrokeshire coalfield in 1324 and coal was exported from Saundersfoot until 1954.

Coal had been mined here for over 100 years as an open cast mine. The coal and iron ore, from a seam under the Pennant Sandstone Formation, were transported to ships on the beach by wheelbarrow. There used to be an iron works further west and then later in the Swansea Valley. The iron ore was extracted from iron nodules, but being poor quality ore, only pig iron was produced.

The coal in Wales is known as “Black Gold”. Here the seams are thin and highly distorted and broken; children were used to work the narrow seams. Anthracite coal is more highly metamorphosed than bituminous coals, so is harder, has a higher carbon content and with few volatiles it ignites with difficulty.

On a limestone platform we found a fossil forest at the top of the storm beach. The forest dates from 3-5k years ago when the ice was retreating. In this area there were also symmetrical, non-directional ripple marks, pyrite nodules, trace fossils of stigmaria (Fig. 3) and calamites. Some of the calamite’s trunks were, unusually, vertical (Fig. 4).

Figure 3: Stigmaria.

Figure 4: Vertical calamite’s trunks.

The strike of the Variscan folds trend NWN / SES.

As well as anticline structures (Fig. 5), reverse faults and faulted ‘S’ shaped folds are present (Fig. 6).

Figure 5: Anticline structures.

Figure 6: Reverse faults and faulted 'S' shaped folds.

Within the Pennant Sandstones we observed ball type structures within a layer of mudstone. These seemed to be 'attached' to the layer above but did not reach the base of the layer. These are load casts (Fig. 7) where soft sediments had been deformed by a more solid layer above. Here we also found bioturbation and a normal fault.

Figure 7: Load casts.

Pig Iron:

Pig iron, also known as crude iron, is an intermediate product of the iron industry in the production of steel which is obtained by smelting iron ore in a blast furnace. Pig iron has a very high carbon content, typically 3.8–4.7%, along with silica and other constituents of dross, which makes it very brittle and not useful directly as a material except for limited applications.

DAY TWO AM
Tuesday 17th May 2022

Morning: Freshwater East
Grid ref: SS02425

Report by Angela Snowling.
Photos by Angela Snowling and Sarah Cook.
Other figures courtesy of Sid Howells.

Aim

To explore the lithology, structural geology, and fossils within the rocks of the northern limb of the Freshwater East anticline – a site of Special Scientific Interest. The oldest Silurian sedimentary and volcanic rocks, found in the South cliff, were too unsafe to visit.

Period Covered

Early Silurian (Ludlow) to mid Devonian (Lower Old Red Sandstone (ORS)) and Quaternary deposits.

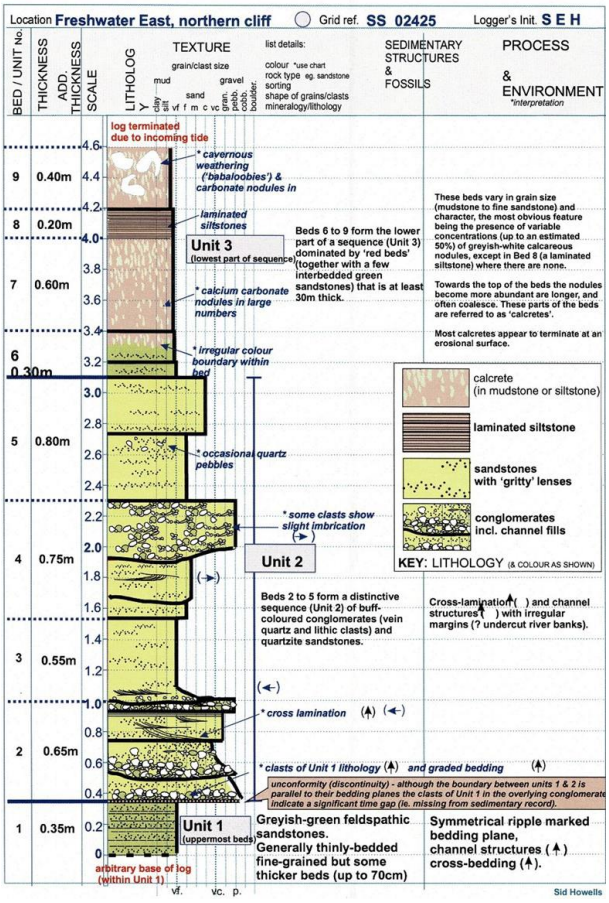

Figure 8: Log of north cliff at Freshwater East, courtesy Sid Howells.

Topology

On driving to the entrance to the bay we passed through 'ridge and vale' topology; the ridges comprise harder sandstones, the vales,

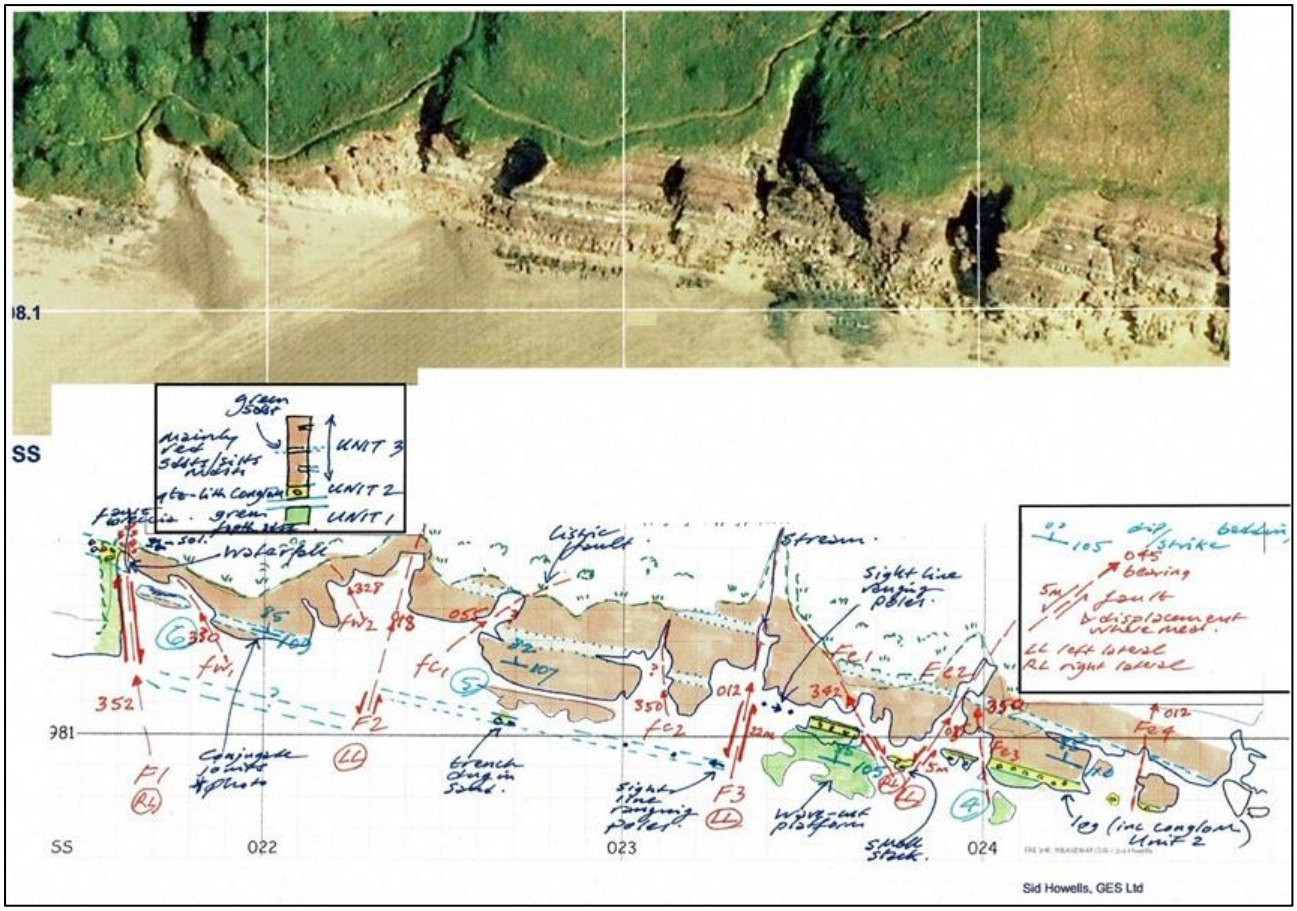

Figure 9: Aerial photograph of north cliff with interpretation

weathered limestones and shales. The centre of the Freshwater East anticline was obscured by climbing dunes deposited during a recent storm.

We were directed by our leader to the beach to watch current ripples developing first in single then in double channels before becoming braided near the shoreline. We were asked to remember this when looking at the cross bedding later in the north cliff exposure.

Structural Geology

The southern limb of the anticline dips at 040 SSW, the northern limb dips at 085 NNE, but the axis of the anticline is not visible. The northern limb faulting reflects compression during the Variscan period as the fused Avalonia and Laurussian plate moved north. Each gully on the north limb was marked by a fault; F1 at the waterfall was a right lateral fault with notable fault breccia, F2-F3 were left lateral faults whereas smaller faults were listric (Fig. 9).

Description of rocks (Fig. 8).

The discussion covered:

- The symmetrical ripple marks in the quartz rich basal conglomerate (Fig. 10).

Figure 10: Ripple marks in ORS basal conglomerate.

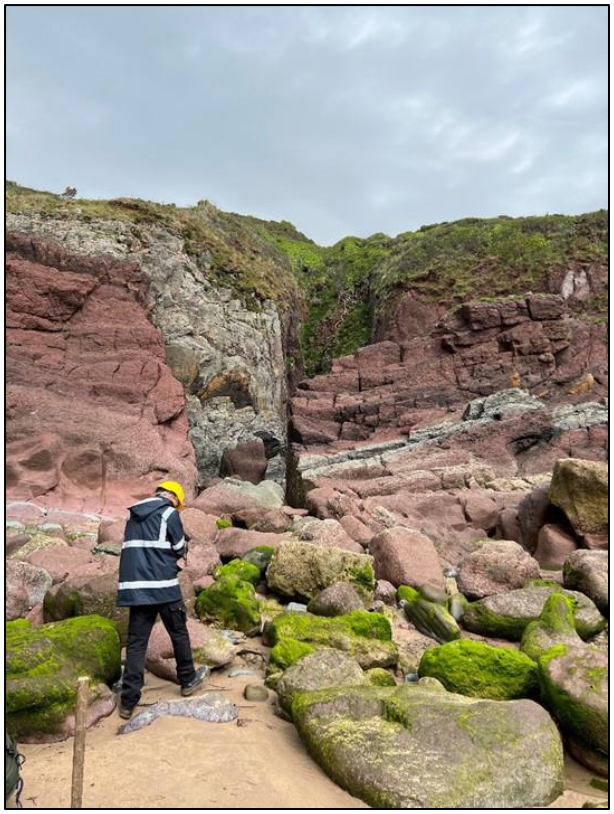

Figure 11: Measuring fault displacement.

Figure 12: Example of solifluction from an interglacial period c. 15,000 years ago. Glacial meltwater streams deposited inclined stones in the direction of the down slope movement.

Figure 13: Haematitic discoloration in the Old Red Sandstone sequence.

Figure 14: Example of variable oxidation boundary (red/green) within a dry desert channel.

- How tundra melt water aligned pebbles in the direction of flow during interglacial periods - solifluction (Fig. 12).
- Comparison of cross bedding from the lower marine unit with that in the dry land river system of the middle unit. The way up

was determined by channels as the beds were nearly vertical.

- The origin of the iron oxidation (Fig. 13), the frequency of monsoon events (10-100 years) and examples of non-bedding related red/green unoxidized boundaries (Fig. 14).
- The origin of the calcrete formation; mangrove type roots, occasionally bifurcated, infilled by calcium deposits during rare flooding events with subsequent leaching causing greenish drab halo discoloration around the roots.
- Large, weathered holes in the upper unit called locally *'Babaloobies'.*
- Exotic pebbles from other periods.

Figure 15: Tracks of giant water scorpions (Eurypterids).

Fossils found

- Brachiopods and the remains of dorsal fins of Cephalapsis fish from the late Silurian.
- Tracks of the water scorpion Eurypterid (Fig. 15). Sid is to be commended for his impersonation of how this top predator moved; you had to be there!

Full waterproofs were essential, and lunch was taken whilst the hunt for exotics took place. Sarah was the first to find a banded rhyolite from Anglesey.

DAY TWO PM
Tuesday 17th May 2022

Afternoon: Stackpole Quay
Grid Reference SR 99148 95772 *(in the rain)*

Report by Sarah Cook.
Photos by Sarah Cook and Roger York.

We travelled west along the coast to Stackpole Quay (Fig. 16) where we parked in the National Trust car park. The rocks in this area are Carboniferous limestones. Walking along the road to the north we came to a disused limestone quarry and an adjacent, well preserved lime kiln.

In the past the kiln used limestone from the quarry to make quicklime, which was made into mortar and lime wash to apply to the outside of houses and inside barns to sterilise the surfaces to keep things clean. The quicklime was also used as a fertiliser. Apparently when water is added to quick lime to make lime wash it spits and the workers used to protect themselves from burns by using butter. This was linked, by a well-read RGS member, to an obscure quote from the novel 'Cold Comfort Farm' by Stella Gibbons, where the vicar's sermon included the phrase 'there is no butter in hell', which could relate to this.

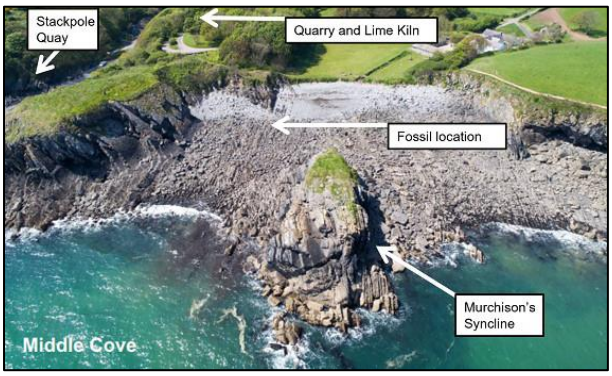

Figure 16: Stackpole Quay.

Figure 17: Antiform on northern edge of quarry.

At the end of its life the quarry produced stone for local roads. The quarry is quite overgrown around the edges but to the west huge flat sub-vertical bedding planes showing well developed fractures can be seen, while on the east the beds dip gently indicating an asymmetric fold must exist. An antiform was

visible on the northern edge of the quarry (Fig. 17) which could be related to the syncline seen on the beach to the south. The quarry has recently been repurposed as an outdoor activity centre and one of the steeply inclined bedding planes has been set up for wheelchair abseiling.

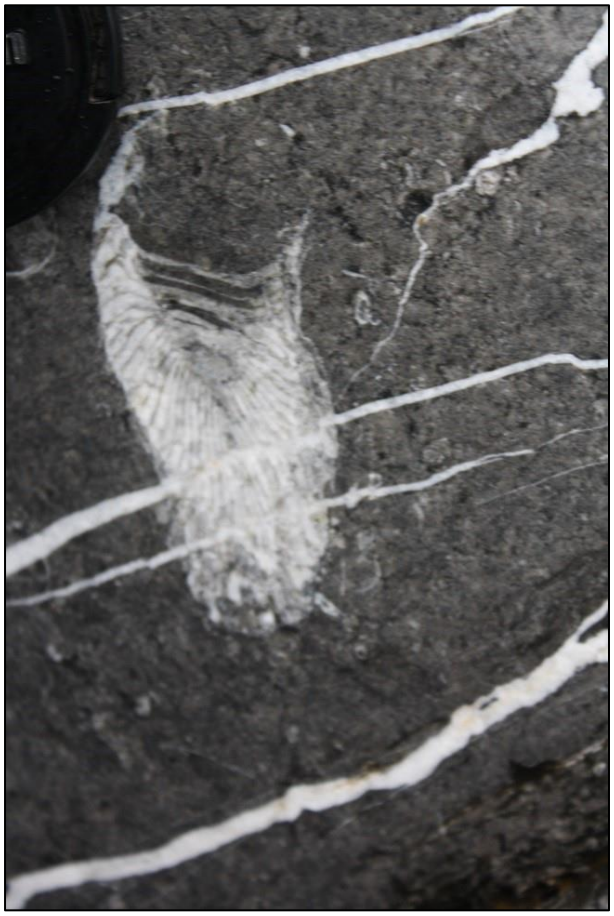

Figure 18: Fossiliferous carbonate mudstones.

We then moved south, back to the coast and onto the beach adjacent to an isolated stack on the fore-shore called 'Murchison's Syncline' that plunges out to sea. The well-developed bedding is emphasized by differential weathering; well cemented 'tempestites' - shallow water carbonate sands - that were moved offshore by storm events, are interbedded with less well cemented, deeper water carbonate mudstones.

The pebbles on the beach include glacial erratics. The most impressive of which was a football-size boulder of gneiss which must have travelled a very long way for it be deposited here. We also saw a lump of vein material, probably quartz, containing bright red haematite which was mined and used as iron ore in this area in the past.

On the west side of the beach the limestone beds are sub-vertical, the deeper water carbonate mudstones have weathered out and the tempestites stand proud of the beach. They are fossiliferous, containing solitary and Lithostrotian-type colonial corals, bryozoan colonies, large Productid-type brachiopods, large Bellerophon-type gastropods and crinoid fragments (Fig. 18).

We then moved back to the inlet at Stackpole Quay, where on the east side we saw a fault cutting through the tempestite limestone sequence with a 1m wide fault zone of crushed rock. The rocks adjacent to the fault showed prominent, spaced pressure solution seams perpendicular to the fault plane/bedding (Fig. 19). All a bit confusing and needs some more interpretation! The limestones at this location are all well cemented and show no bedding, with the former bed boundaries reduced to stylolitic contacts.

After an afternoon of constant rain, we retreated to the National Trust café for well-earned refreshments.

Figure 19: Pressure solution seams.

DAY THREE AM
Wednesday 18th May 2022

Morning: *Marloes Sands*
Grid Ref: *SM780 082*

Report by Sally Pritchard
Photos by Sally Pritchard and Roger York.

The group congregated at the top of the cliff in the NT car park from where we took the path through fields to the edge of the cliff. There the viewpoint allowed us to see SW over Raggle Rocks to Gateholm Island and Skokholm

Island (Fig. 20) in the far distance and SE towards Red Cliff.

Between the two points, shelf sediments of Silurian age (443 to 417 Ma) represent the final infilling of the marine basin that covered much of South Wales along with volcanic deposits representing associated periods of vulcanicity.

Figure 20: View from cliff top.

The Silurian rocks occur forming an almost complete sequence viewed as near vertical beds in the spectacular cliffs at the back of Marloes Sands (Fig. 21).

The aim was to walk as far along the beach as planned by our leader, Sid Howells, tide allowing, take our lunch then make our way back in the afternoon studying the outcrops we had omitted and examining lithology, fossils and structures in more detail.

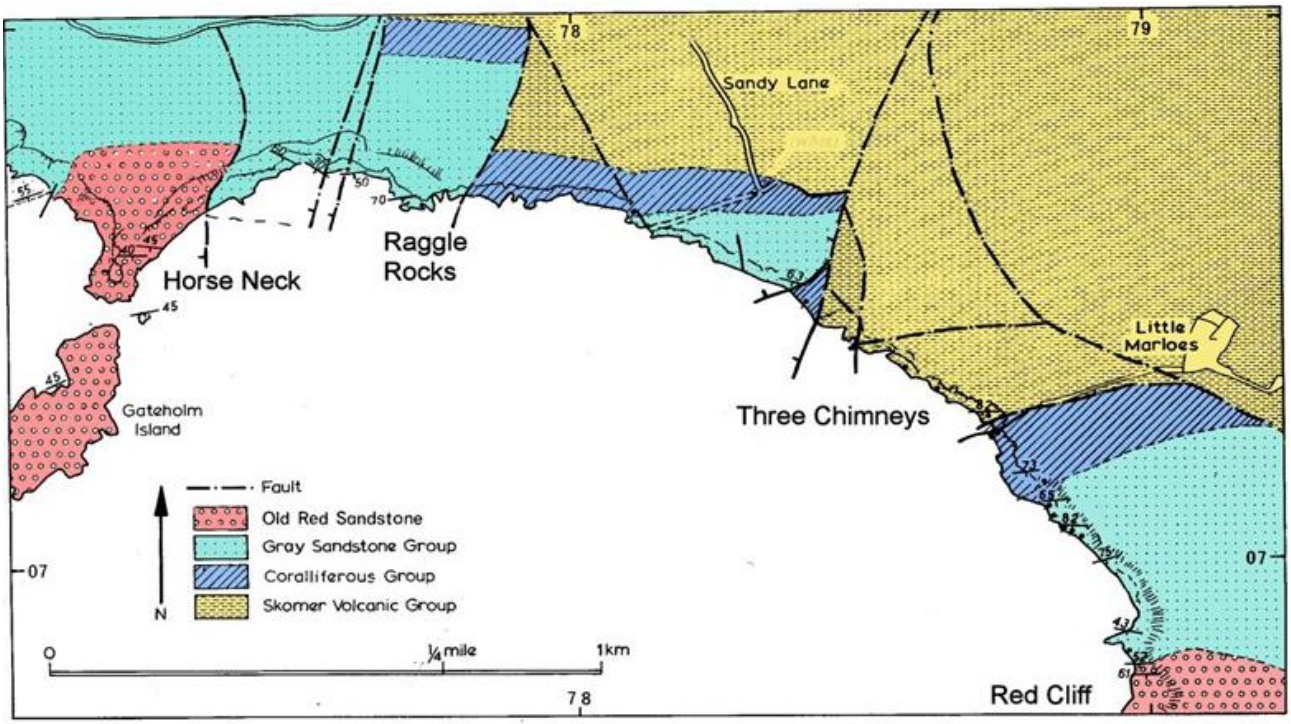

Figure 21: Marloes Sands geology.

However, some stops were made to note certain structural and lithological features and occurrence of specific fossils.

We descended a steep path joining the bottom of Sandy Lane, arriving in the middle of the bay, where rocks of the Coralliferous Series occurred. We crossed the storm beach onto the sand and progressing SE we stopped briefly to observe burrows with haloes in rocks of the Skomer Volcanic group. One theory is that the haloes were probably caused by change in oxidation levels while animals were actually burrowing into soft sediment. (Fig. 22).

Broken fossil crinoid stems indicative of a warm shelf sea high energy environment were observed in an adjacent outcrop. (Fig. 23).

Further on we noted more indications of a shallow sea environment, symmetrical ripples on bedding planes and erosional surfaces. (Fig. 24) Some rock surfaces were covered by en echelon tension gashes infilled with quartz produced by pressure solution. Nearby a stack of feldspathic sandstones were heavily iron stained, a possible result of hydrothermal fluid migration (Fig. 25). Another beach outcrop of

Figure 22: Haloes.

Figure 23: Crinoid debris.

Figure 24: Wave ripples.

Figure 25: Iron staining.

finely laminated siltstones and sandstones showed evidence of tidal rhythms.

We bypassed evidence of volcanic activity, to be studied in the afternoon and continuing south eastwards along the beach we passed the 'Three Chimneys' and areas of cliff collapse, while making our way to our lunchtime stop.

DAY THREE PM
Wednesday 18th May 2022

Afternoon: Marloes Sands *(continued)*

Report by David Ward.
Photos by David Ward, Roger York, Sarah Cook and John de Prey.

Apart from a rather strong wind, the weather was now very pleasant, with sunny intervals. This enabled us to enjoy the beautiful scenery.

After lunch, taken on rocky outcrops on the foreshore about 1km from where we left the Coast Path, the party started to return, carefully examining the cliffs.

Perpendicular sandstones, some coloured red, with alternating mudstones is the Grey Sandstone Formation, which we observed on the walk eastwards. Three very distinct nibs protruded and have the name "The Three Chimneys". Apparently, up to 20 years ago, there were 4. (Fig. 26). No fossils were found in this rock, but there were many erratics on the beach to hold our attention, indicative of glacial transport from the North.

A further 100m towards the start, a grey, fine-grained rock appeared in the cliff, with about a 30m exposure. (Fig. 27 & 28). Close examination showed this to be a volcanic rock,

a rhyolite, and therefore of the Skomer Rhyolite Group. Feldspathic green and white fragments within the rhyolite are indicative of an ash flow tuff. The Skomer Volcanic Group also includes sediments, rather confusing for the amateur! One side of this rock rested against an eroded surface in the sandstone, showing that the rhyolite had flowed over the sandstone before solidifying, thus giving us a “way up” indicator. A search of the beach yielded some very nice green epidote - but it was not clear whether this had come from the tuff or was of glacial transport origin.

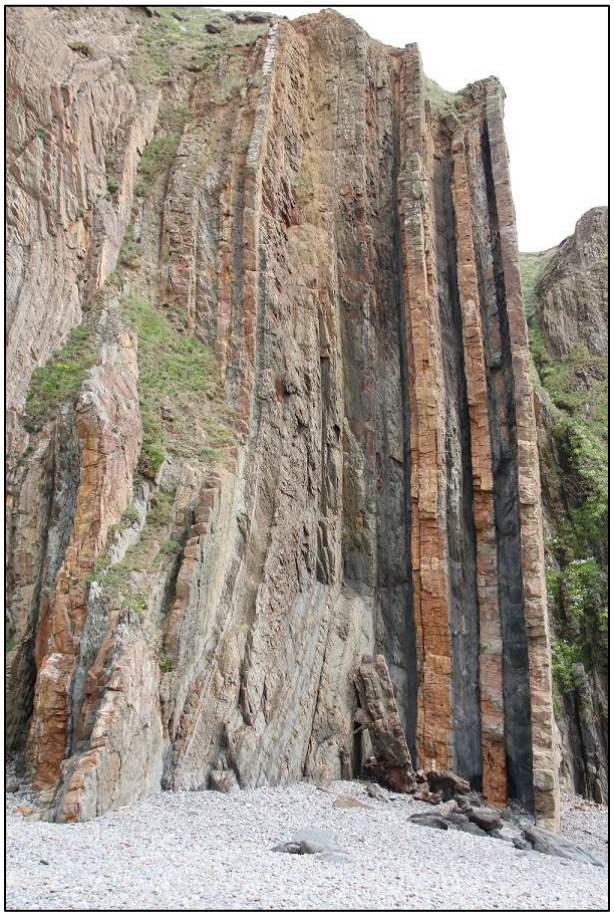

Figure 26: The Three Chimneys.

Another 300m along the beach, the rock composing the cliff changes again. Here, we had a red and grey “blobby” rock, which is interpreted as a lava flow (Fig. 29) An initial thought that this could be a pillow lava was dismissed – a reddened top indicated a subaerial flow had occurred and contraction joints were present.

Now the cliff had been eroded back to form a shallow valley, defined by faults on each side, these being marked by much alteration of the rocks by flows along the faults, showing limonite staining. The rock within the faults was a grey fossiliferous mudstone, of the Coralliferous Group.

The group descended onto the scree at the base, and nice specimens of fragmented trilobites and brachiopods were found along with some solitary and compound corals (Fig. 30 & 31).

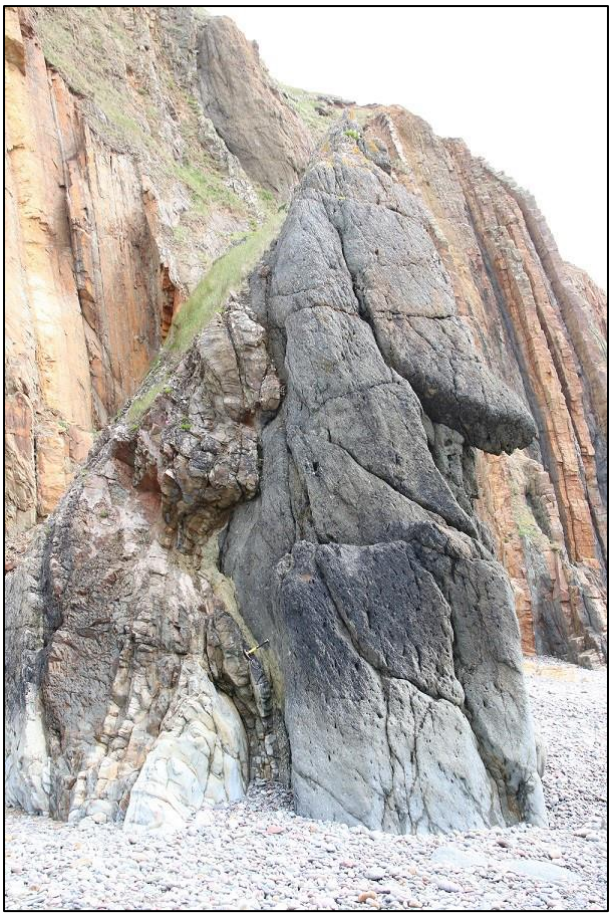

Figure 27: Rhyolite.

At this point, the RGS contingent showed their true colours – some members paddled, despite interestingly low water temperatures (Fig. 32).

Arriving back at the car park, there was some interest in a little further geology, so an intrepid few drove to Martins Haven car park and walked across – what we interpreted as a meltwater channel – onto Wooltack Point and up to the Lookout Station. Great views of Skomer and Skokholm islands, some distant views along the cliffs and a few less welcome tankers were seen.

At this point, the members realised that dinner and the bar called, so a return to Pembroke was made, concluding a very interesting day.

Figure 28: Pyroclastic flow

Figure 29: Basalt lava flow.

Figure 30: Trilobite.

Figure 31: Favosites colonial coral.

Figure 32: Paddling at Marloes.

DAY FOUR AM
Thursday 19th May 2022

Morning: Bolton Hill Quarry
Grid ref: SM 924 110

Report by Jim House.
Photos by Roger York and Carole Gregory.

Fifteen members of the group assembled in the car park of Bolton Hill Quarry just before 10:00, at Lat/Long 51.762341, - 5.024666. The quarry is owned and operated by G.D Harries & Sons Ltd, who kindly allowed our visit on a working day. The leaders of the visit were Sid Howells and Mike, the junior geologist at the quarry; both gave the party an in-depth safety briefing and all items of kit were checked. The rock extracted here is Pre-Cambrian diorite.

Figure 33: Bolton Hill old quarry.

Figure 34: Pre-Cambrian diorite thrust over the coal measures.

Figure 35: Showing a close up of the thrust plane.

After the safety briefing the group walked for a few minutes to view parts of the concrete batching and the bitumen coating plants. Mike explained how rocks from the quarry are crushed to different sizes (4 to 20mm) and used for making concrete and tarmac. The concrete includes sand dredged from the Bristol Channel, off loaded at Pembroke dock. The concrete plant has a capacity of 200m3 per day. The quarry supplies civil engineering projects across much of South and West Wales with a variety of materials.

The group were then transported in batches of five along the main road and through parts of the old quarry to location 51.762816, -5.017621 (Fig. 33) to see part of the Johnston Thrust.

After the vegetation was cut away the exposure of the Johnston Thrust showed the Pre-Cambrian diorite on top of the upper Carboniferous Westphalian sequence, with a thrust plane at approximately 40 degrees. Sid explained that the diorite had been thrust over the coal measures by a distance of approximately 4km and from a similar depth (Fig. 34).

The coal measures below the thrust plane were pulverised as a result of the tectonic activity. The material has no cohesion, very small grain size and is clay like in nature. This type of material is known technically as a Fault Gouge. It was unclear to what depth below the thrust plane the fault gouge continued, due to the limited nature of the exposure (Fig. 35).

Figure 36: View of quarry from haul road.

As part of the tour of the old quarry, Sid explained that it had stopped being worked in 2011 as supplies of diorite were not of high enough quality due to large scale hydrothermal alterations of the material in the southwest area of the workings.

The group was then transported to location 51.760580, -5.005839, (Fig. 36) a haul road in the new quarry, where we were given a brief

description of how the Johnston Thrust passed through the area we were on, but due to the spoil we were unable to see any direct indications.

The group then walked into the top area of the new quarry where we able to see four levels of extraction (L0, L1, L2, L3). A large number of big boulders were evident in L3 and it was explained that these were for a rock-armour project and would soon be transported to site.

The north wall of the quarry was the first to be developed, starting in 2008, and initially good quality diorite was recovered, however, as the extraction moved south two different problems were encountered (Fig. 37):

- A large area of hydrothermally altered diorite was found; this has a different colouration than the unaltered diorite and appears redder in colour and from the distance we were able to observe – more unconsolidated and fragmented.
- Additionally, as the quarry was being extended to get around the area of hydrothermally altered rocks, a glacial run off channel was found, filled with soil, clay and small stones – nothing of any commercial value and a significant problem, as explained by Gareth Phillips the quarry manager who briefly joined us for part of the visit.

The group walked down into the quarry to take a detailed look at the glacial channel, Sid and Mike explained that they had not yet found the bottom of the channel.

We were unable to get a closer look at the hydrothermally altered rocks as they were being excavated and fed into a very large, noisy and dusty crusher.

Figure 37: Bolton Hill New Quarry 2022.

The group were then transported back to the original car park where a debrief was held and some questions answered. Sid was thanked for leading this trip and presented with an RGS tankard.

Around 15:00 the members left to return home or to continue their exploration of Pembrokeshire.

The Etches Museum

You may like to know that the Etches Museum has a very interesting and rapidly expanding **YouTube Channel** that puts out videos every week. The channel is a **FREE** resource to watch and subscribe to … It is well worth checking out, but don't forget to subscribe to the channel and like the content.

https://www.youtube.com/c/TheEtchesCollection

Higgs boson: The 'God Particle' explained by Robert Lea

The Higgs boson is the fundamental force-carrying particle, responsible for granting other particles their mass. The field was proposed by Peter Higgs and named for him and his colleagues.

The particle was discovered on July 4, 2012, by researchers at the Large Hadron Collider (LHC), CERN, Switzerland, confirming the existence of the Higgs field and the mechanism that gives rise to mass and thus completed the standard model of particle physics.

By the end of the 20th Century particle physics had answered many uncertainties surrounding the fundamental building blocks of nature – they had discovered electrons, protons, bosons, and all types of quarks, but some things remained unanswered, including, why do some particles have mass?

The Higgs boson has a mass of 125 billion electron volts (i.e., 130 times more massive than a proton, CERN). It is also chargeless and the only elementary particle with zero spin. A boson is a "force carrier" functioning when 2 particles interact, and a boson is exchanged during the interaction. For example, when 2 electrons interact they exchange a photon - the force-carrying particle of electromagnetic fields.

Quantum fields fill the universe with wave mechanics, so a boson can also be described as a wave in a field. So, a photon is a particle and a wave that arises from an excited electromagnetic field and the Higgs boson is the particle or "quantized manifestation" that arises from the Higgs field when excited. That field generates mass via its interaction with other particles and the mechanism carried by the Higgs boson is called the Brout-Englert-Higgs mechanism.

The Higgs boson's nickname ('the God Particle') was founded by popular media when discovered probably from Nobel Prize-winning physicist Leon Lederman referring to it as the 'Goddamn Particle' in frustration – it had been so difficult to detect, and publishers changed this to **"The God Particle"** – it has had a troublesome connection with religion ever since.

The Higgs boson and the Higgs field in general is extremely important, without it particles would have no mass (no stars, planets, life).

Particles that interact with the Higgs field more strongly are granted greater masses - the Higgs boson itself gets its mass from its interaction with the Higgs field. One particle not granted mass by the Higgs field is the basic particle of light - the photon.

This mass-granting phenomenon only applies to fundamental particles like electrons and quarks. Particles like protons (made of quarks) get most of their mass from the energy that binds their constituents together.

The last step was to discover evidence of the Higgs field by detecting its force-carrying particle and required the most sophisticated machine so the Higgs boson itself has pushed both particle accelerator and detector technology to its limits in the Large Hadron Collider (LHC) providing the high-energy conditions of the early universe and allowing its discovery. The LHC creates a cascade of particles that quickly decay into lighter particles. The Higgs boson decays too rapidly to be spotted and was instead identified by detecting particle decays that indicated a particle with no spin and matched theoretical predictions for this missing boson.

The particle was detected by both the LHC ATLAS detector and the Compact Muon Solenoid (CMS) detector. The announcement of its detection was made at CERN in Geneva on July 4, 2012. It took until March the following year to confirm that the detected particle was indeed the Higgs boson. One of the major discoveries made since 2012 has involved confirmation of the decay of the Higgs. Investigation of the elusive particle will be extended during run 3 of the LHC once its upgrade is completed in 2029.

CERN estimates that following the upgrade each year the LHC will create 15 million particles rather than the 3 million Higgs bosons created by in 2017.

The is not the end of the story - namely the nature of dark matter which the Higgs boson - through its unique properties - could help solve.

Theories outside standard particle physics models predict 5 different types of Higgs bosons may be produced, scientists have already found evidence of a "magnetic Higgs boson."

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Summarised by Liz Aston, from report by science journalist, Robert Lea, U.K.

Follow him on Twitter @sciencef1rst.

Interesting Animation

Watch an ancient ice sheet cover the British Isles then vanish, in eerie time-lapse animation

The rapid decline of the British-Irish Ice Sheet thousands of years ago may hold lessons for how melting ice sheets in Greenland and Antarctica will influence sea-level rise in the future.

In an animation that spans tens of thousands of years, an ancient ice sheet grows to envelope land masses that would one day be known as Great Britain and Ireland. After thousands of years elapse, the ice then retreats to expose the land once more.

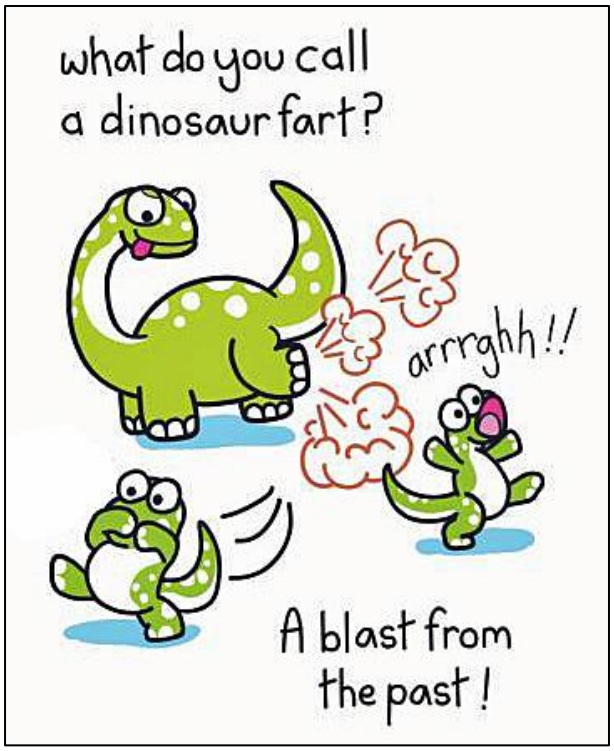
Representing years of research, this animation highlights how quickly the British-Irish Ice Sheet declined. And the data driving the animation may help scientists to better understand how modern ice loss due to climate change contributes to sea-level rise.

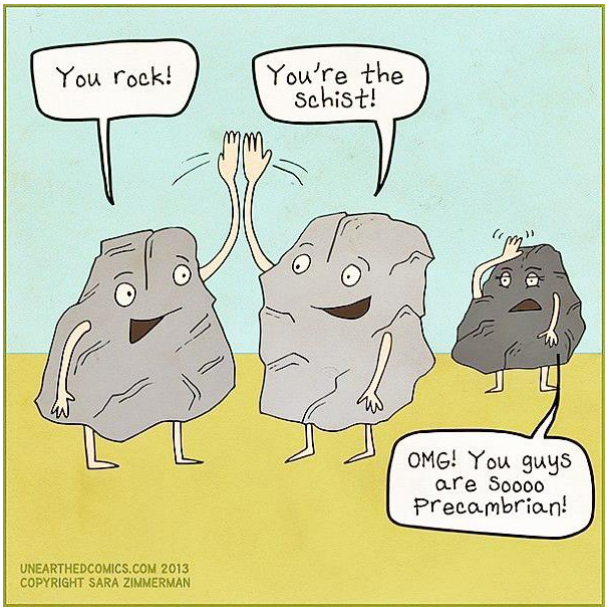
Reference:

https://www.space.com/ancient-ice-sheet-melt-britain-ireland?utm_campaign=58E4DE65-C57F-4CD3-9A5A-609994E2C5A9

Suggested by Liz Aston.

Cartoon Corner 1





Interesting Dinosaurs

Facebook: Dinosaurs 101
11 November 2022

This specimen named **Trix** (after former Netherlands' Queen Beatrix). Trix is among the most complete Tyrannosaurus found. Between 75% and 80% of its skeletal volume was recovered. Trix is around 12.5m in length. It's thought to have been at least 30 years old at death.

Presentation of the Tyrannosaurus specimen RGM 792.000 (Trix) in the 2016-2017 exposition "T. rex in town" of the Naturalis Biodiversity Centre, Leiden, the Netherlands.

Reference:

https://www.facebook.com/Dinosauria101

Interesting Non-Geological Film

Green Space Dark Skies

Green Space Stories brings together the stories of thousands of people from across the UK, sharing their relationship with nature and the landscape, whether hills or mountains, lakes or beaches, woodlands or local parks.

For **Green Space Dark Skies**, thousands of people from all paths in life became Lumenators, each carrying a low impact light into the landscape. Together, they experienced beautiful green spaces across the UK. Imagine thousands of lights making patterns on mountains, lakes and moorland across England, Scotland, Wales and Northern Ireland. These lights are sensitive to the night-time environment.

The finale of the project featured on BBC Countryfile on Sunday 30 October 2022. Available on ***BBC iPlayer*** the programme celebrated the project, at the UK's four highest mountains – Scafell Pike in England, Ben Nevis in Scotland, Yr Wyddfa/Snowdon in Wales and Slieve Donard in Northern Ireland.

It also highlighted the local volunteers, artists, community groups and places involved in the project, who have joined together to celebrate the countryside and connect people to the landscape.

Reference:

https://greenspacedarkskies.uk/films/four-peaks-finale/

News

Fossil site reveals giant arthropods dominated the seas 470 million years ago

By University of Exeter
13 December 2022

Fossils from the Fezouata Shale. From left to right, a non-mineralized arthropod (Marrellomorpha), a palaeoscolecid worm and a trilobite. (Credit: Emmanuel Martin)

Discoveries at a major new fossil site in Morocco suggest giant arthropods - relatives of modern creatures including shrimps, insects and spiders - dominated the seas 470 Ma ago.

Early evidence from the site at Taichoute, once undersea but now a desert, records numerous large "free-swimming" arthropods.

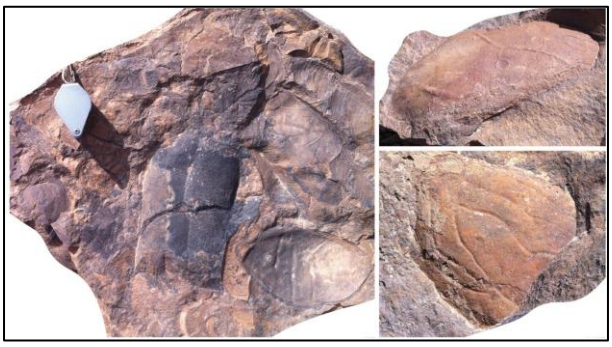
More research is needed to analyse these fragments, but based on previously described specimens, the giant arthropods could be up to 2m long.

An international research team say the site and its fossil record are very different from other previously described and studied Fezouata Shale sites from 80km away.

They say Taichoute (considered part of the wider "Fezouata Biota") opens new avenues for paleontological and ecological research.

"Everything is new about this locality - its sedimentology, palaeontology, and even the preservation of fossils - further highlighting the importance of the Fezouata Biota in completing our understanding of past life on Earth," said lead author Dr. Farid Saleh, from the University of Lausanne and Yunnan University.

Dr. Xiaoya Ma, from the University of Exeter and Yunnan University, added: "While the giant arthropods we discovered have not yet been fully identified, some may belong to previously described species of the Fezouata Biota, and some will certainly be new species.



Large fragments of nektonic arthropods. (Credit: Bertrand Lefebvre)

"Nevertheless, their large size and free-swimming lifestyle suggest they played a unique role in these ecosystems."

The Fezouata Shale was recently selected as one of the 100 most important geological sites worldwide because of its importance for understanding the evolution during the Early Ordovician period, about 470 Ma ago.

Fossils discovered in these rocks include mineralised elements (e.g., shells), but some also show exceptional preservation of soft parts such as internal organs, allowing scientists to investigate the anatomy of early animal life on Earth.

Animals of the Fezouata Shale, in Morocco's Zagora region, lived in a shallow sea that experienced repeated storm and wave activities, which buried the animal communities and preserved them in place as exceptional fossils.

However, nektonic (or free-swimming) animals remain a relatively minor component overall in the Fezouata Biota.

The new study reports the discovery of the Taichoute fossils, preserved in sediments that are a few million years younger than those from the Zagora area and are dominated by fragments of giant arthropods.

"Carcasses were transported to a relatively deep marine environment by underwater landslides, which contrasts with previous discoveries of carcass preservation in shallower settings, which were buried in place by storm deposits," said Dr. Romain Vaucher, from the University of Lausanne.

Professor Allison Daley, also from the University of Lausanne, added: "Animals such as brachiopods are found attached to some arthropod fragments, indicating that these large carapaces acted as nutrient stores for the seafloor dwelling community once they were dead and lying on the seafloor."

Dr. Lukáš Laibl, from the Czech Academy of Sciences, who had the opportunity to participate in the initial fieldwork, said, "Taichoute is not only important due to the dominance of large nektonic arthropods.

"Even when it comes to trilobites, new species so far unknown from the Fezouata Biota are found in Taichoute."

Dr. Bertrand Lefebvre, from the University of Lyon, who is the senior author on the paper, and who has been working on the Fezouata Biota for the past two decades, concluded: "The Fezouata Biota keeps surprising us with new unexpected discoveries".

The paper, published in the journal ***Scientific Reports***, is entitled: *"New fossil assemblages from the Early Ordovician Fezouata Biota."*

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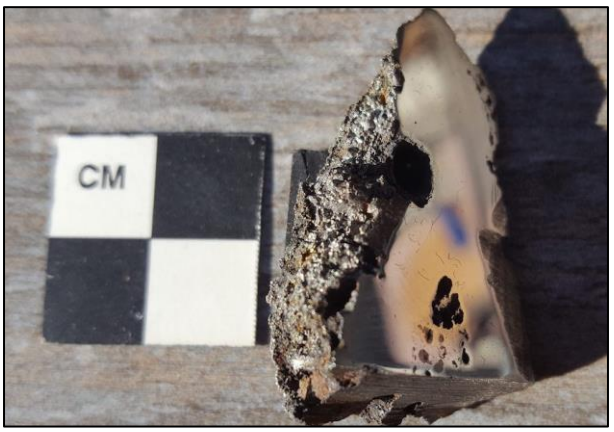
1. https://phys.org/news/2022-12-fossil-site-reveals-giant-arthropods.html
2. New fossil assemblages from the Early Ordovician Fezouata Biota, *Scientific Reports* (2022). DOI: 10.1038/s41598-022-25000-z

https://www.nature.com/articles/s41598-022-25000-z

New minerals discovered in a massive meteorite may reveal clues to asteroid formation

By Keith Cowing, University of Alberta
6 December 2022



A slice of the El Ali meteorite, now housed in the U of A's Meteorite Collection, contains two minerals never before seen on Earth.

A team of researchers has discovered at least **two new minerals** that have never before been seen on Earth in a 15 tonne meteorite found in Somalia — the ninth largest meteorite ever found.

"Whenever you find a new mineral, it means that the actual geological conditions, the chemistry of the rock, was different than what's been found before," says Chris Herd, a professor in the Department of Earth & Atmospheric Sciences and curator of the University of Alberta's Meteorite Collection. "That's what makes this exciting: In this particular meteorite you have two officially described minerals that are new to science."

The two minerals found came from a single 70-gram slice that was sent to the U of A for classification, and there already appears to be a potential third mineral under consideration. If researchers were to obtain more samples from the massive meteorite, there's a chance that even more might be found, Herd notes.

The two newly discovered minerals have been named **elaliite** and **elkinstantonite**. The first receives its name from the meteorite itself, dubbed the "El Ali" meteorite because it was found in near the town of El Ali, in the Hiiraan region of Somalia. Herd named the second mineral after Lindy Elkins-Tanton, vice president of the ASU Interplanetary Initiative, professor at Arizona State University's School of Earth and Space Exploration and principal investigator of NASA's upcoming Psyche mission.

"Lindy has done a lot of work on how the cores of planets form, how these iron nickel cores form, and the closest analogue we have are iron meteorites. So, it made sense to name a mineral after her and recognize her contributions to science" Herd explains.

In collaboration with researchers at UCLA and the California Institute of Technology, Herd classified the El Ali meteorite as an "Iron, IAB complex" meteorite, one of over 350 in that particular category.

As Herd was analysing the meteorite to classify it, he saw something that caught his attention. He brought in the expertise of Andrew Locock, head of the U of A's Electron Microprobe Laboratory, who has been involved in other new mineral descriptions including Heamanite-(Ce).

"The very first day he did some analyses, he said, 'You've got at least two new minerals in there,'" says Herd. "That was phenomenal. Most of the time it takes a lot more work than that to say there's a new mineral."

Locock's rapid identification was possible because the two minerals had been synthetically created before, so he was able to match the composition of the newly discovered natural minerals with their human-made counterparts.

Researchers are continuing to examine the minerals to determine what they can tell us about the conditions in the meteorite when it formed.

"That's my expertise — how you tease out the geologic processes and the geologic history of the asteroid this rock was once part of," says Herd. "I never thought I'd be involved in describing brand new minerals just by virtue of working on a meteorite."

Herd also notes that any new mineral discoveries could possibly yield exciting new uses down the line. "Whenever there's a new material that's known, material scientists are interested too because of the potential uses in a wide range of things in society."

While the future of the meteorite remains uncertain, Herd says the researchers have received news that it appears to have been moved to China in search of a potential buyer. It remains to be seen whether additional samples will be available for scientific purposes.

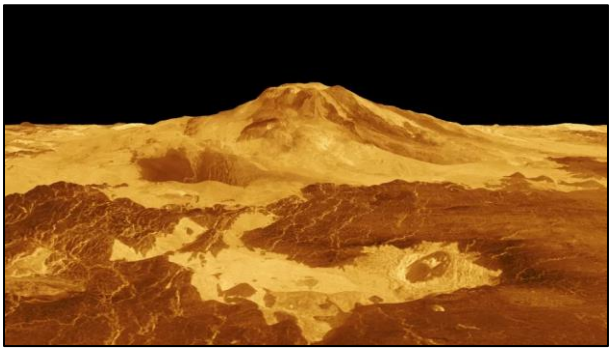
Herd described the findings at the **Space Exploration Symposium** on 31 Nov 2022.

Reference:

https://spaceref.com/science-and-exploration/new-minerals-discovered-in-a-massive-meteorite-may-reveal-clues-to-asteroid-formation/

Vast volcanic eruptions may have turned Venus from paradise into hell

Massive global volcanism covering 80% of Venus' surface in lava may have been the deciding factor that transformed Venus from a wet and mild world into the suffocating, sulfuric, hellish planet that it is today.



*One of the largest volcanoes on Venus is the 2-mile-tall **Maat Mons**, which has lava flows spilling for hundreds of miles around it. (Image credit: NASA/JPL)*

The surface temperature on Venus is 464°C, enough to melt lead, a huge pressure of 90 atmospheres comprising CO_2 and H_2SO_4. Venus has runaway greenhouse effects, amplified by being ~40 million km nearer the sun than Earth. However, there's growing evidence that Venus could once have been a temperate world similar to Earth.

Michael Way, of NASA's Goddard Space Flight Centre, has produced a paper - the team argue that Venus' volcanism could have caused the planet heat and clouds by sending vast amounts of CO_2 into the atmosphere.

In 1990s, NASA's Magellan spacecraft radar-mapped Venus's surface and found that much of the surface was covered in basalt, probably forming a 'large igneous province', the result of continuous volcanism over x Ka or even x Ma years (at some point in the past billion years). These events often occur within a few Ma and cover xx000 km^2 in lava and could have put so much CO_2 into the atmosphere - oceans would have boiled away, adding moisture to the atmosphere, accelerating the runaway greenhouse effect. Over time, the water would have been lost to space, but the CO_2, and the inhospitable world, remained.

The frequency with which LIPs have occurred on Earth implies that it is likely that several such events could have occurred on Venus within 1 Ma, scarring Venus forever.

Earth has had some 'super-volcanoes' and LIPs that have been connected to mass-extinction events on Earth over the past 500 Ma.

- The Late Devonian mass extinction at 370 Ma ago due to the Siberian Traps, an LIP, as well as a separate super-volcanic eruption in Australia.
- The Triassic–Jurassic mass extinction - the biggest LIP, the Central Atlantic Magmatic Province, 200 Ma ago.
- The death of the dinosaurs 65 Ma ago may have been due to the combination of an asteroid strike and super-volcanism in the Deccan Traps, a LIP in India.

An artist's impression of an active volcano on Venus. (Image credit: ESA/AOES)

Similar volcanic events on Venus were more widespread and instigated a runaway greenhouse effect that transformed the planet. On Earth, the CO_2-SiO_4 cycle exchanges CO_2 and greenhouse gases between the mantle and atmosphere over Ma, preventing Earth from following the same path as Venus.

Future NASA missions will attempt to resolve these issues in 2030s; ESA's **EnVision** mission also targets launch in 2030s; China may launch a mission to reach Venus in 2027.

"A primary goal of USA's mission is to establish the history of water on Venus - when it disappeared, how Venus' climate has changed over time" Way said. The findings were published in the ***Planetary Science Journal*** earlier this year.

*Reported in **Space.com** by Keith Cooper, science journalist and UK editor has a degree in physics and astrophysics from Manchester University, author of "The Contact Paradox: Challenging Our Assumptions in Search for Extraterrestrial Intelligence", has written articles on astronomy, space, physics and astrobiology for many magazines and websites.*

Summarised here for FGS by Liz Aston.

Reference:

https://www.space.com/venus-volcano-eruptions-large-igneous-province?utm_campaign=58E4DE65-C57F-4CD3-9A5A-609994E2C5A9

Mauna Loa

Wade Morales
1 December 2022

The Mauna Loa eruption in Hawaii and an incredible sunrise. The slow-moving stream of lava is making its way toward saddle road.

Reference:

www.theedgeexplorer.com

Winchcombe meteorite bolsters Earth water theory

By Jonathan Amos, BBC Science Correspondent
17 November 2022

A meteorite that crashed on the Gloucestershire town of Winchcombe last year contained water that was a near-perfect match for that on Earth.

This bolsters the idea rocks from space brought key chemical components, including water, to the planet early in its history, billions of years ago.

The meteorite is regarded as the most important recovered in the UK.

Scientists publishing their first detailed analysis say it has yielded fascinating insights. More than 500g (1lb) of blackened debris was picked up from people's gardens and driveways and local fields, after a giant fireball lit up the night sky.

The crumbly remains were carefully catalogued at London's Natural History Museum (NHM) and then loaned to teams across Europe to investigate.

The Winchcombe meteorite broke off an asteroid between Mars and Jupiter. (Credit: BBC Science)

Winchcombe meteorite's possible debris field. (Source: UK Fireball Alliance / BBC / Google)

Water accounted for up to 11% of the meteorite's weight - and it contained a very similar ratio of hydrogen atoms to the water on Earth.

Some scientists say the young Earth was so hot it would have driven off much of its volatile content, including water.

For the Earth to have so much today - 70% of its surface is covered by ocean - suggests there must have been a later addition.

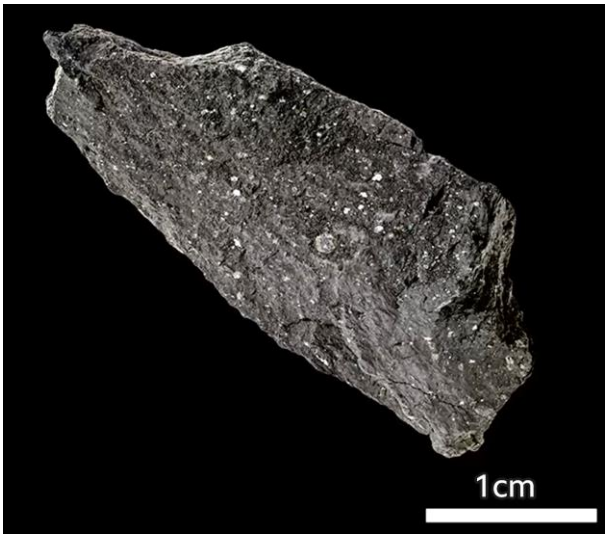
Some say this could have come from a bombardment of icy comets - but their chemistry is not a great match.

Carbonaceous chondrites, however - meteorites such as the Winchcombe one - most certainly are.

And the fact it was recovered less than 12 hours after crashing means it had absorbed

very little earthly water, or indeed any contaminants.

"All other meteorites have been compromised in some way by the terrestrial environment," co-first author Dr. Ashley King, from the NHM, told BBC News. "But Winchcombe is different because of the speed with which it was picked up. This means when we measure it, we know the composition we're looking at takes us all the way back to the composition at the beginning of the Solar System, 4.6 billion years ago. Bar fetching rock samples back from an asteroid with a spacecraft, we could not have a more pristine specimen."



Winchcombe material recently sold at auction for more than 120 times the value of its weight in gold. (Credit: NHM / BBC)

Precise trajectory

Scientists examining the meteorite's carbon- and nitrogen-bearing organic compounds, including its amino acids, had a similarly clean picture.

This is the type of chemistry that could have been a feedstock for biology to begin on the early Earth.

The new analysis also confirms the meteorite's origin. Camera footage of the fireball has allowed researchers to work out a very precise trajectory. Calculating backwards, this indicates the meteorite came from the outer asteroid belt between Mars and Jupiter.

Further investigations reveal it was knocked off the top few metres of a parent asteroid, presumably in some collision.

It then took only 200,000 to 300,000 years to arrive on Earth, the number of particular atoms, such as neon, created in the meteorite material through the constant irradiation from high-speed space particles, or cosmic rays, reveals.

"0.2-0.3 million years sounds like quite a long time - but from a geological perspective, it's actually very quick," Dr. Helena Bates, from the NHM, said. "Carbonaceous chondrites have to get here quickly or they won't survive, because they're so crumbly, so friable, they'll just break apart."

'More secrets'

The scientists first analysis, in this week's edition of the **Science Advances** journal, is just an overview of Winchcombe's properties.

A dozen more papers on specialist topics are due to come out shortly in an issue of the **Meteoritics & Planetary Science** journal.

And even they will not be the last word. "Researchers will continue to work on this specimen for years to come, unlocking more secrets into the origins of our Solar System," co-first author Dr. Luke Daly, from the University of Glasgow, said.

Reference:

https://www.bbc.com/news/science-environment-63631563

Life on Mars? Australian rocks may hold clues for Nasa rover

By Jonathan Amos,
BBC Science Correspondent
11 November 2022

Rocks in the Australian Outback dating back 3.5 Ga may help scientists work out whether there has ever been life on Mars.

Researchers studying the Australian rocks say only ancient microbes could have shaped them the way they are.

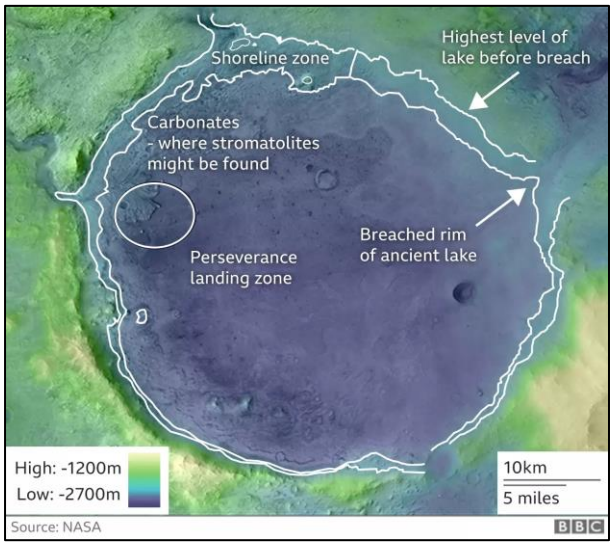
The stromatolite domes were first investigated by France-based, UK scientist Dr. Frances Westall. (Image Source: Frances Westall / CNRS Orléans)

Nasa's Perseverance rover should look for similarities when exploring rocks of a similar age on Mars, they say.

The wheeled robot is searching for evidence that biology took hold on the Red Planet early in its history.

Scientists from London's **Natural History Museum** working with NASA have described a range of features, both large and small, in a series of domes in western Australia that appear inarguably to have been made by ancient microbes.

Perseverance is exploring a large crater called **Jezero** and is expected to come across locations next year that may well display phenomena tantalisingly similar to what is seen in the Earth rocks.



Jezero Crater: A river from the west brought water into the lake, which then exited in the east.

These are preserved examples of what are called **stromatolites**. They are created when many millimetre-scale layers of bacteria and sediment build up over time into larger, dome-like forms. These edifices occur today at the edge of calm, nutrient-rich lagoons. But there are examples from billions of years ago preserved in the Australian Outback.

Indeed, some of the Aussie specimens identified by geologists represent among the earliest traces of life on our planet.

Dr. Keyron Hickman-Lewis, from London's Natural History Museum (NHM), and colleagues, looked in detail at one particular set of stromatolites. They're the oldest yet discovered, part of the Dresser Formation in the Pilbara region of the Outback and are dated to 3.48 Ga ago.

They don't contain little fossils of microbes, or even any organic (carbon-rich) compounds that might be indicative of past life. But the NHM-led team thinks it has managed to establish signatures that mark out the rocks' biological origin.

The Pilbara rocks have been dated to 3.48 Ga ago. (Image Source: Frances Westall / CNRS Orléans)

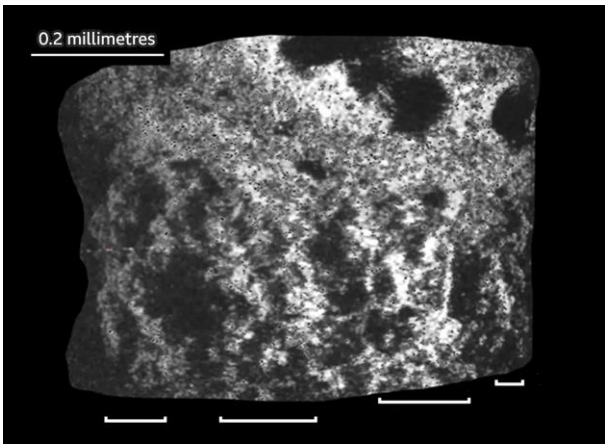
The researchers used a range of high-resolution analytical and imaging techniques to detail structures whose existence, they argue, can only really be explained by life's activity, as opposed to something that might result naturally in the environment.

One large-scale feature is the undulating top surface of the stromatolites, which arises as photosynthetic microbes grow towards the light. The undulations emerge because biology

doesn't grow at the same rate in the same way in three dimensions.

On the micro-scale, there are tiny columns or pillars within the rock that trace the connections between the individual "mats" of microbes that build the stromatolites.

"These are strongly, strongly representative of a kind of microbial growth texture, which we call palisade structures," Dr. Hickman-Lewis explained. "We know palisade structures abundantly from environments on the modern Earth; we can see examples that are of a similar size and of a similar arrangement. And these occur very much in these domed growth layers," he told BBC News.



The tiny whitish columns are the palisade growth structures. (Image Source: K.Hickman-Lewis et al)

The relevance here to Mars and the Perseverance rover is that Jezero Crater looks from satellite imagery to have held a large lake deep in its past. And at the edge of the crater are carbonate rocks that could represent the sediments laid down at the shoreline.

Might Jezero have had microbes growing stromatolites in the crater's calm, nutrient-rich, shallow waters?

The timeline would not be dissimilar to Earth, just a little earlier. Scientists think the lake existed about 3.7 Ga ago.

Perseverance will probably get to the crater edge towards the end of next year. At that point, it will be deploying its instruments to try to locate rocks that share some of the characteristics seen in the Pilbara stromatolites.

Stromatolites at Lake Thetis, Western Australia. Stromatolites readily form in calm, nutrient-rich waters. (Image Source: Getty Images)

Prof. Caroline Smith is head of the Earth science collections at the NHM and, like Dr. Hickman-Lewis, is working on the rover mission.

She said they would be using what they've learnt from Australia to steer some of the rover's investigations, looking for those tell-tale biological signatures.

"We could identify some of them using the imaging systems on the rover, but it will depend - first, obviously, on whether stromatolites were even there, and then how well preserved they might be.

"Are they preserved more on a macro or micro scale? Are they ubiquitous, or maybe they are going to be limited in a smaller area. So, if we're looking in the wrong place, then we won't necessarily see them," she cautioned.

A slam dunk identification of ancient biology in Jezero Crater is a very long shot. More likely would be the discovery of rock samples that represent excellent candidates for further study back on Earth.

This is the primary objective of Perseverance - to drill and store samples that can be collected by later missions and brought home for analysis.

Proving life existed will be difficult, but Dr. Hickman-Lewis believes his team's study has developed a template to do it: "If an archaeologist discovered the foundations of a ruined city, they would nonetheless know it

was built by people because it would bear all the hallmarks of being built by people - doorways and roads and bricks. In very much the same way, there are numerous structural elements integral to stromatolites that allow us to identify their processes of formation and decode their origins."

The analysis of Earth's oldest stromatolites is published in the journal ***Geology.***

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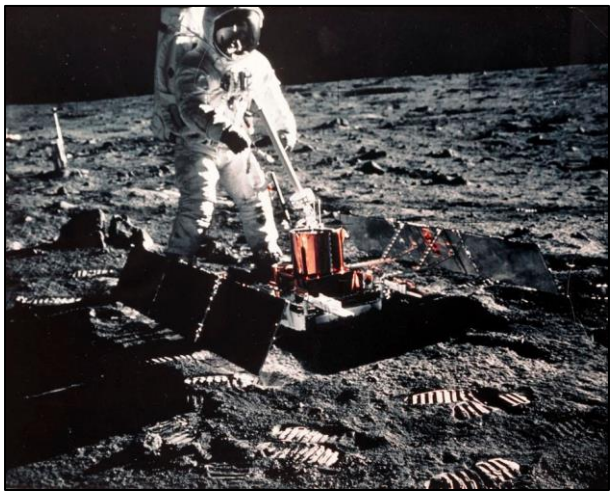
How the first men on The Moon got ready to geologize there

David Bressan, Forbes Contributor
16 July 2019



Buzz Aldrin deploying the Passive Seismic Experiments Package (PSEP) on the lunar surface. (Image: GETTY)

When President John F. Kennedy announced in 1961 that Americans would walk on the Moon by the decade's end, surprisingly little was known about the Moon's surface and geology. Moon maps were still drawn by hand and the names of most lunar mountains or craters remained unknown. To most astronomers the Moon did not seem very interesting and there weren't very useful techniques to study it.

The first telescopic observations were made in 1609 by Thomas Hariot and Galileo Galilei, showing mountains, craters and spots of dark terrain on the lunar surface. The dark terrain appears smooth rather than cratered like the bright highlands and German astronomer Johannes Kepler named it maria, Latin for lakes or oceans.

More than 30,000 craters are found on the Moon, however, the origin of the Moon's cratered surface remained unclear until the twentieth century. Some naturalists believed the craters were large bubbles of rock, formed when gases escaped the partially molten Moon. Another explanation suggested volcanoes, like those found on Earth. Astronomer William Herschel, who in 1781 discovered the planet Uranus, supposedly even spotted a series of volcanic eruptions: *"I perceive three volcanos in different places of the dark part of the new moon. Two of them are either already nearly extinct, or otherwise in a state of going to break out, which perhaps may be decided next lunation. The third shows an actual eruption of fire, or luminous matter... The volcano burns with greater violence than last night... All the adjacent parts of the volcanic mountain seemed to be faintly illuminated by the eruption and were gradually more obscure as they lay at a greater distance from the crater."*

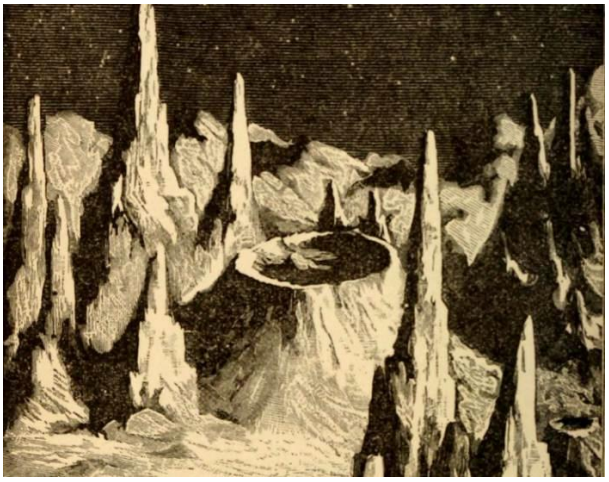
Earth seen from the surface of the Moon, by French artist and astronomer Lucien Rudaux, who created famous paintings of space themes in the 1920s and 1930s. (Image: L. RUDAUX)

In 1791 German astronomer Johann Hieronymous Schröter measured the height of mountains on the Moon using the shape and length of their shadows. He discovered that the material found around a crater correlates with the hole in the ground. Based on such

observations, in 1829 German astronomer Franz von Paula Gruithuisen proposed the impact theory to explain the origin of lunar craters: As a meteorite impacts on the lunar surface, it explodes, excavating a crater in the ground and ejecting material around it.

The modern geological exploration of the Moon started around 1959, with the first attempts by the Soviets to land space probes there. Two probes missed the target, but Luna 3 transmitted the first pictures of the dark side of the Moon back to Earth. On February 3, 1966, the probe Luna 9 made it safely to the surface, sending first pictures from there. The images showed vast lava fields and steep hills, causing quite some concerns. If the Moon was covered everywhere by such rugged terrain, landing a manned spaceship there would be extremely dangerous. Only later it was discovered that the images were distorted due to an error in decoding the radio signal.

At the time most scientists imagined the Moon to be a very strange, alien looking landscape. Mountains and rocky cliffs, not constrained in their height by gravitational pull as on Earth, were imagined to be extremely high and steep. In fact, some mountains found on the Moon rise above the surrounding terrain by more than 10,000 feet.



View of a lunar landscape, from Henry White Warren "Recreations in astronomy", published in 1879. (Credit: H.W. WARREN)

To land a manned spacecraft safe on the Moon, it was necessary to know in detail the terrain and composition of the lunar surface. From 1966 to 1968 Soviet space probes in orbit around the Moon mapped its surface. Between 1959 and 1964 the Americans launched the Ranger project, followed by the Lunar Orbiter, dedicated to the same goal. The Surveyor project also included some probes landing on the Moon. The U.S. Geological Survey established an astrogeology branch in Menlo Park California and Flagstaff, Arizona, to study the data.

At the University of Arizona, Gerard Kuiper and his team collected the best available pictures and used them to produce the first photogeologic map of the lunar surface. The best images of the Moon were projected on a 3-foot-wide white hemisphere. William Hartmann, a first-year graduate student at the time, was tasked with snapping photos of the hemisphere from different angles. The resulting images revealed lunar features as they would appear from the perspective of an astronaut flying overhead and were used to create a detailed Moon atlas as navigation help for the first astronauts. The new surveys showed that there were also fairly soft and rolling terrains to be found, where a spacecraft could safely touch down.

Mareta N. West, the first female astrogeologist at NASA. In the 1960s she selected the site for Apollo 11, the first manned lunar landing. The landing site was within a flat lava plain, which was chosen because it appeared to be a safe place to touch down. (Credit: NASA)

At the same time, Apollo astronauts were trained in basic geological field work. In 1964 NASA conducted geological drills with astronauts on sites like Barringer Crater and Grand Canyon in Arizona, Valles Caldera in New Mexico, McKenzie Pass in Oregon, Marathon Basin and Big Bend Park in Texas.

The Astrogeology Research Program even cleared shrubs and detonated explosives to create a realistic Moon-landscape for the astronauts at Cinder Lake Crater Field. Space enthusiast and pioneering planetary geologist Eugene Shoemaker organized the geological activities planned for the lunar landing. For seven years he helped to train the men who would eventually geologize on the Moon.

Apollo 11 astronauts Neil Armstrong, right, and Buzz Aldrin, on a geology field trip to west Texas in February 1969. (Credit: NASA)

Reference:

https://www.forbes.com/sites/davidbressan/2019/07/16/how-the-first-men-on-the-moon-got-ready-to-geologize-there/#6f29e5ac240f

Interesting Places

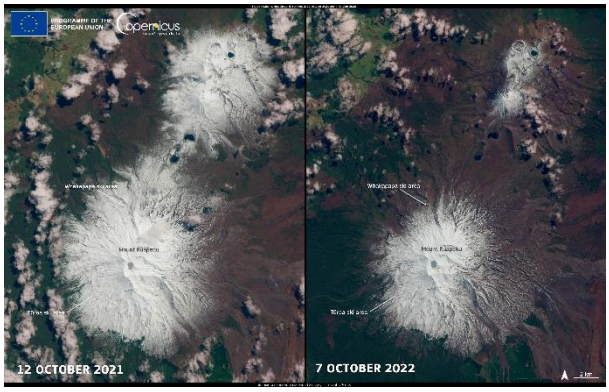
Low snow cover on Mount Ruapheu, New Zealand

Date: ***13 October 2022***
Location: ***New Zealand***

Credit: ***European Union, Copernicus Sentinel-2 imagery***

The austral winter season has just ended in New Zealand. According to the National Institute for Water and Atmospheric Research (NIWA), it was the warmest winter on record, with temperatures more than 1.2°C above average in several regions. Moreover, the season was especially wet and most of the country experienced higher-than-average rainfall.

These climatic conditions have affected some of New Zealand's landscapes and tourism infrastructure, such as the ski resorts located on Mount Ruapheu, which have been forced to close earlier than usual because of the extremely limited snow cover in the area.



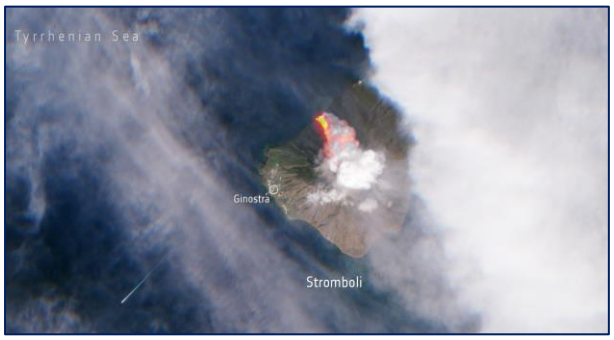
The lack of snow on Mount Ruapheu is visible when comparing these two images, acquired by Copernicus Sentinel-2 satellites on 12 October 2021 and 7 October 2022.

Mount Ruapehu is an active stratovolcano at the southern end of the Taupō Volcanic Zone and North Island volcanic plateau in New Zealand. It is 23km northeast of Ohakune and 23km southwest of the southern shore of Lake Taupō, within the Tongariro National Park. The North Island's major ski resorts and only glaciers are on its slopes.

Ruapehu, the largest active volcano in New Zealand, has the highest point in the North Island and has three major peaks: Tahurangi (2,797m), Te Heuheu (2,755m) and Paretetaitonga (2,751m). The deep, active crater is between the peaks and fills with water between major eruptions, being known as Crater Lake.

Italy's Stromboli eruption seen from space

By Keith Cowing, Press Release, ESA
22 October 2022



Volcano on the Italian island of Stromboli. (Credit: ESA)

A volcano on the Italian island of Stromboli erupted early on Sunday morning, releasing huge plumes of smoke and a lava flow pouring into the sea.

The Copernicus Sentinel-2 mission captured this image of the aftermath less than five hours after the eruption.

The eruption caused the partial collapse of the crater terrace which was followed by major flows of lava stretching to the sea and enormous plumes of smoke rising several hundred metres above the volcano. Italian civil protection authorities raised the alert from yellow to orange as the 'situation of enhanced volcano imbalance persists.'

This Sentinel-2 image has been processed in true colour, using the shortwave infrared channel to highlight the new flow of lava. The Sentinel-2 mission is based on a constellation of two identical satellites, each carrying an innovative wide swath high-resolution multispectral imager with 13 spectral bands for monitoring changes in Earth's land and vegetation.

The northernmost island of the Aeolian archipelago, located just off the northern tip of Sicily, Stromboli's volcano has been erupting almost continuously for the past 90 years.

Reference:

https://spaceref.com/earth/italys-stromboli-eruption-seen-from-space/

News

UK energy net import costs have increased 5-fold and could surge again if companies face further windfall taxes, warns OEUK

energy-pedia general news
15 November 2022

The UK faced a £39 billion net import bill for oil, gas, and electricity between January and September this year – a five-fold increase over the same period last year, according to the latest government trade statistics.

The money flowed abroad to buy the gas, petrol and diesel needed to keep the UK's homes warm, its vehicles on the road, its businesses running, and for generating electricity.

Details are contained in the latest import and export statistics released by the UK government on November 11, 2022.

The data has prompted **Offshore Energies UK (OEUK)** to warn that further import cost surges could follow, especially if windfall tax increases deter investment and so make the UK more reliant on imported energy.

The UK, like many countries, routinely imports and exports energy to manage supply and demand, but domestic gas production plays an important role in reducing reliance on imports. This is particularly relevant at times when global demand is high and therefore costs for European gas and international sources of Liquefied Natural Gas are higher.

While the UK has been a net importer of oil and gas for over a decade, domestic gas production continues to meet around half the UK's needs. OEUK has warned that uncertainty over the future of the North Sea, including future taxes and regulation, means production is falling and could fall faster.

This would result in the UK increasing its reliance on imported gas even further at a time of competitive global demand and shortages. The shortages are linked to global long-term

under-investment, exacerbated by Putin's invasion of Ukraine.

While there will always be imports and exports of energy to support the dynamic daily operations of meeting customer demand, the energy price crisis has underlined why the UK should make the most of its domestic resources. This produces direct benefits through taxes paid, jobs supported, direct influence over any emissions associated with their production, while also retaining the companies needed to invest in and drive the transition to cleaner UK energies.

Without such investment, OEUK warned, imports would surge so that by 2030, the UK would have to import 80% of its gas and 70% of its oil – and risk the loss of tens of thousands of industry jobs. Tax revenues would plummet too because, as with all imported goods and services, oil and gas from outside of the UK is not subject to UK production taxes.

Energy security is another key reason for maintaining UK production. About 24 million UK homes rely on gas for heating, while 32 million drivers have vehicles powered by petrol or diesel. Around 42% of the nation's electricity is generated by gas-fired power stations.

Replacing all this infrastructure with low-carbon alternatives is predicted to take at least three decades – during which secure supplies of oil and gas will be essential, albeit in diminishing amounts.

Deirdre Michie, chief executive of OEUK, said: 'While the UK will always import and export energy it makes sense that we make the most of the resources in our own back yard, meaning the North Sea, with all the benefits that brings such as generating UK taxes, jobs and energy security.

'We know that today, shortfalls in domestic gas production must be met by imports to help heat homes, power businesses and supporting UK manufacturing. But with the UK paying £39bn for imports, people will wonder why we are not prioritising gas produced here and encouraging companies to invest.

'Gas which is shipped to the UK from across the world will also always have greater emissions than gas which is piped to our shores from the North Sea because of the energy needed to compress it, transport it and then turn it back into gas.

'We are proud to pay our taxes, but the fresh uncertainty of further change risks the UK relying even more on other countries as companies struggle to attract investment.

'The UK and our industry are already in action, progressing a rapid transition to green energy – with UK companies set to invest up to £200 billion in offshore energies in this decade alone. But a homegrown transition will only happen if we have the companies, jobs and innovation we need, based here in the UK.'

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Mysterious gemstone found 100 years ago in King Tut's tomb likely formed when a meteorite hit Earth

David Bressan, Forbes Contributor
4 November 2022

On November 4, 1922, a boy accidentally stumbled on a stone that turned out to be the top of a flight of steps cut into the bedrock of the Valley of the Kings. The Valley of the Kings is a remote valley located in the desert west of the river Nile. In Pharaonic Egypt, this valley was considered the land of the dead and many pharaohs were buried here. In 1922, British archaeologist Howard Carter was searching here for the tomb of Tutankhamen, a relatively

The golden mask of Tutankhamun. (Image: Getty)

minor pharaoh who ruled over Egypt from 1332 to 1323 BCE.

One month later, Carter entered the pharaoh's tomb. Asked if he could see anything in the burial chamber, Carter allegedly responded: ”Yes, wonderful things.”

Tutankhamen's tomb was filled with statues made of ivory and precious metals, jewellery and even a complete golden chariot. In one treasure chest, Carter discovered a large breastplate, decorated with gold, silver, various precious jewels and a strange gemstone. The breastplate shows the god Ra as a winged scarab, made from the yellow, translucent gemstone, carrying the celestial bark with the Sun and the Moon into the sky.

Carter identified the gemstone at first as chalcedony, a common variety of the mineral quartz. Ten years later the British geographer Patrick Clayton was exploring the Libyan Desert along the border of modern Egypt and Libya. Here he discovered some strange pieces of glass in the sand. The pale yellow in colour and translucent material seemed to be identical to the gemstone found in Tutankhamen's tomb. Two years later he published a short note, suggesting that the pieces of **Libyan Desert Glass** (LDG) were the quartz-rich deposits of a dry lake. In 1998, Italian mineralogist Vincenzo de Michele analysed the optical properties of the gemstone in King Tut's breastplate and confirmed that it was indeed a piece of LDG.

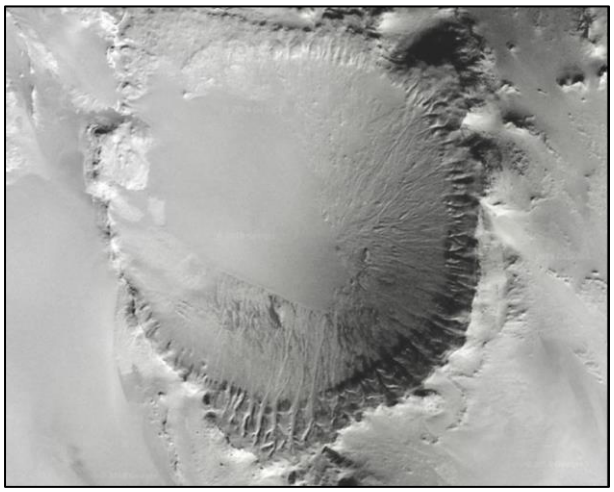
Tutankhamun's breastplate features a scarab carved from Desert Glass. (Image: J. Bodsworth / Wikipedia)

LDG is composed of almost pure silicon-dioxide, but it contains unusual traces of iron, nickel, chromium, cobalt and iridium. It is among the rarest minerals on Earth, as it is found only in the Great Sand Sea north of the Gilf Kebir Plateau, one of the most remote and desolate areas in the Libyan Desert.

Piece of Lybian Desert Glass in a meteorite collection. (Image: D. Bressan)

The origin of the dessert glass has long eluded geologists. Some suggested a volcanic origin, other proposed that the fragments found in the desert are tektites - solidified impact debris of a meteorite exploding and melting the vast sand deposits of the Sahara.

In 2020, analysing satellite images showing the terrain between the villages of Qaret Had El Bahr and Qaret El Allafa, Egypt, an international research team discovered what seems to be a previously unknown crater in the midst of the Sahara Desert. The supposed crater, tentatively named El Bahr Crater, is approximately 327m wide.



A previously unknown crater, likely of extra-terrestrial origin, was discovered in the Sahara Desert. (Image: Paris et al. 2020/Journal of the Washington Academy of Sciences)

The shape resembles a typical impact crater, like the famous Meteor Crater in Arizona. The researchers also found chemical traces supporting the idea that this landform was formed by a high-energy impact event. Depending on mineral content, rocks absorb or reflect different wavelengths of light. Using satellite images created by combining various wavelengths of light, the researchers identified a high concentration of orthopyroxene in the basalt rocks of the crater, while the surrounding rocks show a low concentration of this mineral. This observation suggests that the rocks were melted and then slowly cooling, formed large crystals of orthopyroxene.

If the LDG is a tektite, it formed about 28 to 26 Ma ago when an impact melted the quartz-rich sand of the desert. The unusual elements found in the LDG could be traces of the vaporized meteorite.

It is also unclear how the desert glass became part of Tutankhamen's treasures. Today, caravans rarely cross the Great Sand Sea. Archaeological evidence suggests that an ancient system of caravan routes existed around the Gilf Kebir Plateau, but it doesn't seem that the routes were used to search or trade for desert glass. It seems that the piece used for the scarab was discovered by chance or maybe was an exotic gift. It remains the only known example where an Egyptian artist used this mysterious material.

Reference:

https://www.forbes.com/sites/davidbressan/2022/11/04/mysterious-gemstone-found-100-year-ago-in-king-tuts-tomb-likely-formed-when-a-meteorite-hit-earth/?fbclid=IwAR06mEWilOxzwyF6oq052pygX8U2HSCMSHGm1y5bNoZLvcDmz96HrD5LMbo

One does not simply detonate a volcano into Mordor: A scientist explains the problems with that *Rings of Power* episode

by Ray Cas, The Conversation
18 October 2022

(Credit: New Line Cinema)

In the blockbuster fantasy series, **The Lord of the Rings: The Rings of Power**, one of the principal antagonists, the wicked Adar, diverted a river into the labyrinth of tunnels under a dormant Mount Doom to trigger an explosive volcanic eruption. This transformed the surrounding landscape into the bleak lands of Mordor—setting up the blighted kingdom of the orcs that features heavily in the Lord of the Rings movies.

The dramatic, and devastating scheme has led to many viewers wondering whether there's any real science behind this fantasy

terraforming plot. Can explosive volcanic eruptions actually be "engineered?"

What exactly is a volcanic eruption?

Volcanoes erupt molten rock, called magma, at temperatures between 700 and 1,300℃. Volcanic eruptions can be effusive, forming lava flows, or explosive, ejecting large fragments of magma and rock, fine ash and volcanic gas into the atmosphere. Mount Doom - or Orodruin - in The Rings of Power, is depicted as spectacularly doing the latter.

Some explosive eruptions are caused by high abundances of volcanic gases in magma. Others, called hydrovolcanic explosive eruptions occur when magma comes in contact with external water - such as groundwater, oceans, lakes, rivers, and glaciers or ice sheets - and superheats it to steam.

The heat energy of the magma is transformed into explosive mechanical energy in the steam as it expands in a process called thermal detonation.

Can a volcano create Mordor?

Many hydrovolcanic explosive eruptions have been witnessed, such as the 1963-1964 Surtsey volcano in Iceland, the fatal 2019 eruption of Whakaari White Island volcano, New Zealand, and the 2022 Hunga Tonga-Hunga Ha'apai volcano in Tonga.

Experimental simulations of this have been undertaken at the laboratory scale, using small volumes of remelted lava and similar materials.

The theory of hydrovolcanic explosions is based on our understanding of how water acts as a coolant fluid in nuclear and other power stations. In nuclear reactors the radioactive fuel, often uranium, generates heat as it undergoes radioactive decay in the core of the reactor.

This core is surrounded by a water reservoir which is heated by the fuel and converted to steam that drives turbines, generating electricity. If the core overheats, because the coolant water has escaped (potentially due to damage to the containment reservoir), the residual water may become superheated and explode. This happened during the 1986 Chernobyl power station disaster in Ukraine, and the 2011 nuclear disaster in Fukushima, Japan.

To generate maximum explosive intensity during such a fuel-coolant interaction, the ratio of water to fuel (or magma) has to be just right. Research into nuclear explosions indicates the optimum ratio of water to fuel is in the range of 2 to 5, whereas in volcanology it is about 0.1 to 0.3.

Galadriel, shortly after the explosion of Orodruin in The Rings of Power. (Credit: Prime Video)

If there is too little or too much water, steam is generated but explosions are local and small, and the magma will cool, fracture and solidify.

So, could we really make our own Mordor?

Triggering a hydrovolcanic explosive eruption is not easy. Getting enough water into the magma reservoir of dormant or active volcanoes many kilometres beneath Earth's surface is impossible because there are no Mount Doom-like tunnels, just highly compressed dense rock.

Volcanoes with an active lava lake in the crater won't have a river feeding into them because the craters will be perched at the elevated summit of the volcano. And even pouring water onto a lava lake surface would produce a lot of steam, but not necessarily strong explosive eruptions because the water will cause a cooled solid crust to form on the lava surface.

The only substantial hydrovolcanic explosive eruptions have occurred where significant volumes of magma have erupted rapidly up through a body of water such as groundwater,

a lake or ocean, and vigorously mixed with it triggering explosive interaction (e.g., Surtsey, Iceland; Hunga Tonga-Hunga Ha'apai, Tonga).

To trigger such a hydrovolcanic explosion, we would need to move a large amount of magma from a reservoir deep within Earth's crust to the surface, by propagating a huge network of fractures many kilometres deep. This is nigh impossible at the scale required, even using nuclear explosions. So, unfortunately, The Rings of Power's proposition is just a fantasy.

What would happen to Earth if we did engineer a volcanic eruption?

Even if we could engineer a volcanic eruption, we probably wouldn't want to. Global climate is affected by the volcanic gases and fine ash released into the stratosphere during large scale volcanic eruptions.

The gases can form sulphuric acid droplets, creating a haze that reflects incoming solar radiation, causing global atmospheric cooling. In addition, huge volumes of fine ash suspended in the stratosphere would also reflect solar radiation back to space.

Moderate size historical eruptions have had only a minor impact on global temperature. Only huge, explosive super-eruptions could potentially cause global atmospheric cooling for many years, triggering a major global cooling event.

There are huge problems with such human-made (or orc-made) geoengineering proposals to try to control climate. First as outlined above, it is physically impossible to trigger eruptions of large volumes of magma. Even if we could, we couldn't control the amount of cooling caused by a super-eruption. Do we really want continental ice sheets engulfing Europe, Asia, North America, and the consequent flood of cold climate refugees?

The global blanketing of the landscape by fine ash would cause crop failure, famine and poisoning of water reservoirs. The fine ash would also infiltrate machinery, including power plants, causing them to fail.

What we would be left with could be similar to Mordor in terms of habitability and horror - not suitable for Middle-earth or Earth.

Reference:

Provided by The Conversation

https://phys.org/news/2022-10-simply-detonate-volcano-mordor-scientist.html?fbclid=IwAR3JVYmzfFbLE08g-CcDUD6_xBXsKb4OFRLE9we-aQsx6IcEarXJi_gAx6M

UK: High Court upholds Loxley planning consent

energy-pedia exploration
14 Oct 2022

UK Oil & Gas (UKOG) has announced that by order of the Honourable Mrs Justice Lang DBE, the High Court has rejected legal challenges by Protect Dunsfold and Waverley Borough Council against the Secretary of State's decision to grant planning permission for Loxley, the conventional gas and hydrogen feedstock project in Surrey. Loxley planning consent therefore remains in full force and the Company's plans to implement the project remain unchanged.

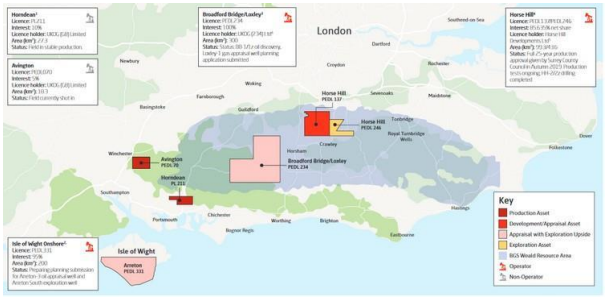
Mrs Justice Lang considered both challenges as 'unarguable' and ordered Waverley and Protect Dunsfold to pay costs of £8,835 and £3,000 respectively.

This follows the decision in June of this year by the Right Hon Stuart Andrew MP, Minister for Housing acting for the Secretary of State ('SoS') for Levelling Up, Housing and Communities, to overturn Surrey County Council's ('SCC') refusal of planning consent.

UKOG has consistently stated that Loxley can play its part in the government's **Hydrogen and British Energy Security Strategies** via the supply of its gas as feedstock for reformation into clean burning hydrogen.

It is the Company's and its legal counsel's view that, whilst further challenges by either claimant are to be expected, the emphatic rulings of both the SoS and Justice Lang make

the likelihood of their success highly doubtful. In any case, the Company will continue to rigorously defend its position in any subsequent action as and when it may occur.



UKOG's Weald Basin assets - including PEDL 234 (in pink) (Source: UKOG)

Stephen Sanderson, UKOG Chief Executive, commented: 'We welcome this further emphatic legal decision upholding planning consent for the Company's material conventional gas and hydrogen feedstock project in Surrey. Whilst we fully accept the right to review such material decisions, it cannot be fair or just that opponents to the decision are given so many opportunities to make the same argument repeatedly and seemingly regardless of prior dismissals. We therefore urge the government to swiftly implement its proposed changes to the planning system for key infrastructure projects if it is serious about delivering energy self-sufficiency and associated meaningful economic growth.'

Background

The Loxley-1 project, located within licence PEDL234 (UKOG 100%) in the Weald Basin, plans to appraise the significant Portland gas accumulation originally discovered and flow tested 8km to the west by Conoco's 1982 Godley Bridge-1 well.

Reference:

https://www.energy-pedia.com/news/united-kingdom/high-court-upholds-loxley-planning-consent-189331

In 200 Ma there will be only the Supercontinent of 'Amasia' on Earth, supercomputer simulation concludes

3 October 2022
David Bressan, Forbes Contributor

This is how the western hemisphere of the Earth may have appeared 200 Ma ago, with the supercontinent of Pangea stretching from pole to pole. (Source: GETTY)

New Curtin University-led research has found that the world's next supercontinent, **Amasia**, will most likely form when the Pacific Ocean closes in 200 to 300 Ma.

The researchers used a supercomputer to simulate how supercontinents form and found that the oceanic crust of "young" oceans, such as the 100 Ma old Atlantic or Indian oceans, is less likely to be subducted into Earth's mantle if compared to old oceans like the Pacific.

Lead author Dr. Chuan Huang, from Curtin's Earth Dynamics Research Group and the School of Earth and Planetary Sciences, said the new findings were significant and provided insights into what would happen to Earth in the next 200 Ma.

"Over the past 2 Ga, Earth's continents have collided together to form a supercontinent every 200 to 600 Ma, known as the supercontinent cycle. This means that the current continents are due to come together again in a couple of hundred of million years' time," Dr. Huang said.

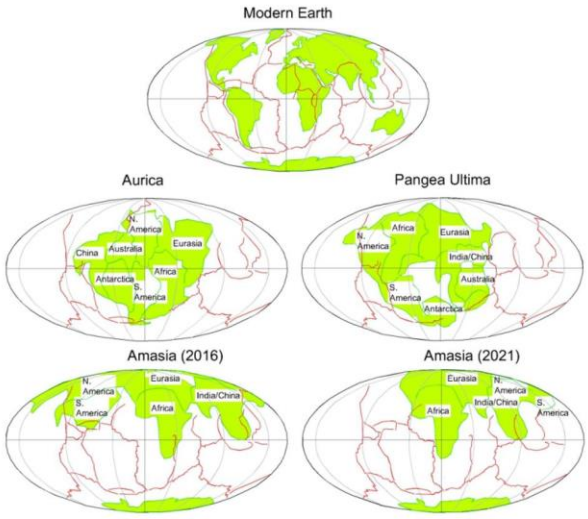
"The resulting new supercontinent has already been named Amasia because some believe that the Pacific Ocean will close (as opposed to the Atlantic and Indian oceans) when

America collides with Asia. Australia is also expected to play a role in this important Earth event, first colliding with Asia and then connecting America and Asia once the Pacific Ocean closes."

"By simulating how the Earth's tectonic plates are expected to evolve using a supercomputer, we were able to show that in less than 300 Ma time it is likely to be the Pacific Ocean that will close, allowing for the formation of Amasia, debunking some previous scientific theories."

In 1982, American geologist Christopher Scotese was one of the first scientists to speculate about a future supercontinent naming it **Pangea Proxima** - a continent very similar to the single landmass of Pangea as it existed 200 Ma ago.

In the late 1990s, British geophysicist Roy Livermore postulated a configuration that he dubbed **Novopangae**. Here all continents unite to form a large landmass stretching from pole to pole.

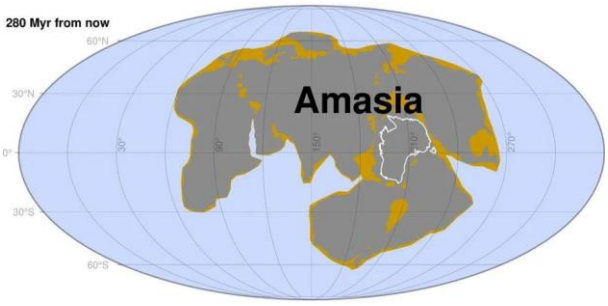


The modern configuration of continents and tectonic plates and various models of a future supercontinent. (Source: D. BRESSAM)

In 2016, American researchers proposed the future supercontinent of **Aurica**. Aurica is roughly similar to the Novopangaea hypothesis, but in this model, the continents will form one landmass clustering around the equator.

All models assumed that the Atlantic Ocean - getting roughly 4cm wider each year - will eventually reach a critical size and start to close again. But more recent discoveries suggest that this may not be the case.

Extrapolating from the gradual widening of the Atlantic, some researchers predict the Pacific Ocean closing as the Americas drift westward and collide with Africa, Australia, and Eurasia, forming in the end the supercontinent of **Amasia**. The exact configuration (like if Antarctica will be part of it) and position of this supercontinents remains highly speculative.



The updated version of Amasia configuration 280 Ma into the future. (Source: CURTIN UNIVERSITY)

The Pacific Ocean is what is left of the Panthalassa super ocean that started to form 700 Ma ago when the previous supercontinent started to break apart. It is the oldest ocean we have on Earth, and it started shrinking from its maximum size since the time of dinosaurs. It is currently shrinking in size by a few cm per year and its current dimension of about 10 thousand km is predicted to take 200 to 300 Ma to close.

Co-author John Curtin Distinguished Professor Zheng-Xiang Li, also from Curtin's School of Earth and Planetary Sciences, said that having the whole world dominated by a single continental mass would dramatically alter Earth's ecosystem and environment.

"Earth as we know it will be drastically different when Amasia forms. The sea level is expected to be lower, and the vast interior of the supercontinent will be very arid with high daily temperature ranges," Professor Li said.

"Currently, Earth consists of seven continents with widely different ecosystems and human cultures, so it would be fascinating to think what the world might look like in 200 to 300 million years' time."

The paper **"Will Earth's next supercontinent assemble through the closure of the Pacific Ocean?"** is published in the *National Science Review* (2022). Material provided by the Curtin University.

Reference:

https://www.forbes.com/sites/davidbressan/2022/10/03/in-200-million-years-there-will-be-only-the-supercontinent-of-amasia-on-earth-supercomputer-simulation-concludes/

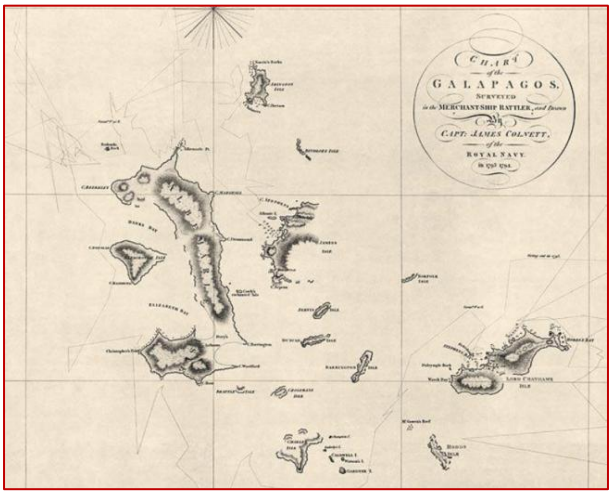
Darwin the geologist in Galápagos

David Bressan, The Forbes Contributor
12 February 2017

"I look forward to the Galapagos with more interest than any other part of the voyage. They abound with active volcanoes, and, I should hope, contain Tertiary strata. I am glad to hear you have some thoughts of beginning Geology. I hope you will; there is so much larger a field for thought than in the other branches of Natural History." - Darwin in a letter to his cousin William Darwin Fox.

Charles Darwin's scientific career is rooted deeply in geology. In August 1831 he accompanied Adam Sedgwick (1785-1873) on a geological field trip in Wales. Later the same year he was invited to join a survey mission on board of the Beagle to South America. Darwin was mostly self-taught in geology. Apart from an early passion to collect minerals, the field trip with Sedgwick and some private lectures with botanist-geologist John S. Henslow (1796-1861), he relied on the books in the library of the Beagle to study rocks and minerals. Geologist Walter. L. Manger once stated *"... travel widely and observe carefully, for geology is learned through the soles of your shoes, not the seat of your pants!"* The voyage of the Beagle around the globe was a perfect occasion to walk and observe.

During the five-year-long voyage of the Beagle Darwin wrote 1,383 pages of notes about geology, compared to a mere 368 pages of notes on plants and animals. He collected rock samples in Brazil, studied fossils in Argentina and Uruguay, measured geological layers in Tierra del Fuego and even experienced an earthquake in Chile. One of the most famous stops of Darwin includes the Galápagos archipelago, even if Darwin never mentions his famous finches in his **Origin of Species** (1859) and describe the islands only briefly in his travel account. However, fifteen pages are dedicated to the Galápagos in his book **Geological Observations on the Volcanic Islands**, visited during the Voyage of H.M.S. Beagle (1844).



Map of the Galápagos, by James Colnett (1798). Image in public domain. At the time of Darwin' s visit the only available maps were of very poor quality, the survey of the Beagle improved significantly the knowledge of this remote archipelago.

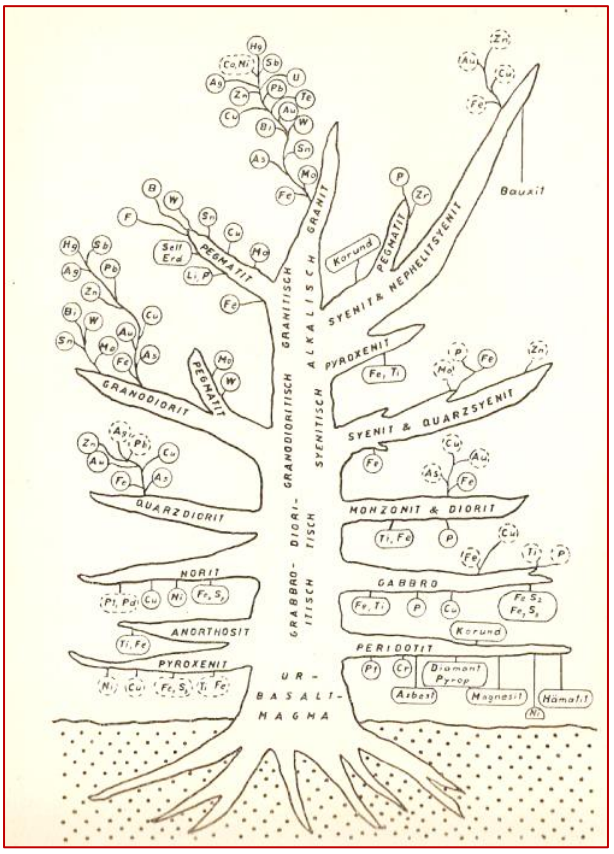
The Beagle arrived at the Galápagos on September 15, 1835, surveying first the coastlines of the island of Chatham (today San Cristobal) and landing there on September 17. The Beagle voyage was already long overdue, as the planned three years mission was now in its fifth year. Captain Robert FitzRoy (1805-1865) therefore planned only a short stop of 35 days. In this time Darwin visited and explored four of the 16 islands of the archipelago, resulting in 80 pages of notes on the geology and 25 pages on the zoology of Galápagos. The volcanoes were inactive at the time. The discovery by Darwin of a jug dated to 1683 buried by a lava flow suggested that eruptions happened in the recent past.

Darwin studying the fossil lava flows concluded that "The degree of fluidity in different lavas does not seem to correspond with any

apparent corresponding amount of difference in their composition." This is an erroneous conclusion as the viscosity of lava in fact depends on the amount of dissolved silica. However, Darwin correctly postulates that a mineralogical differentiation of magma is possible by segregation, a fundamental observation to explain the different lava types found on earth. Darwin writes: *"Much of the difficulty which geologists have experienced, when they have compared the composition of volcanic with plutonic formations, will, I think, be removed, if we may believe, that most plutonic masses have been, to a certain extent, drained of those comparatively weighty and easily liquefied elements, which compose the trappean and basaltic series of rocks."*

Geologist Paul N. Pearson suggests in a paper, that this insight into volcanic rocks on the Galápagos provided Darwin also with a first idea for his later formulated theory of evolution. The melted magma inside earth has a uniform composition, but the lava erupting from a volcano on the surface can significantly vary in its chemical composition. This can, as Darwin suggested, explained by magmatic differentiation and segregation of minerals by density inside the magma chamber. Grains of minerals form in the cooling magma, the heavy minerals (rich in iron) sink to the ground of the magma chamber. The residual melt is now impoverished in heavy elements but relatively enriched in light minerals (like quartz and feldspar). If this “light” melt is squeezed out from the magma chamber and erupts, light-coloured, iron-poor but silica-rich, rocks can form (like rhyolite). Finally, also the "heavy" melt from the base of the magma chamber, rich with heavy minerals, erupts, forming dark-coloured, iron-rich but silica-poor, rocks (like basalt). There is a sort of natural selection of minerals by gravity, leading to various lava types. Superficial very different rocks, from rhyolite to basalt, derive from a common "ancestor-melt."

The volcanic islands of Galápagos provide also a biological example of descend with modification from a common ancestor. On every island there exist different species of turtles, mockingbirds, and finches. Separated by the sea between the islands, an original population was naturally selected by the environment on every island to evolve into a distinct species. During droughts on one island, finches with a slightly larger beak, able to open hard seeds, have greater chances to find food and to survive as finches with small, weak beaks. Over time a population of large-beaked finches will evolve here. On another island with enough rain, finches with smaller beaks have an evolutionary advantage, as they don't need to waste energy to grow their beaks and can invest the saved energy into their offspring’s. Here over time a population of small-beaked finches will evolve. Like gravity can select minerals, the environment can select individuals.



The “evolutionary tree” of igneous rocks – with the most basic (found in earth´s mantle – like peridotite) on the base and the more derived (like granite) on top. (From KRÜGER, K. (1954): Das Reich der Gesteine. Image in public domain)

Darwin himself describes the Galápagos as “centres of creation” in a note. Historians have debated if Darwin already at this time of the

voyage was convinced of the transmutation (the term evolution was adopted only later) of species. It is quite possible. In South America he observed in the fossil record a succession of similar species over time. The Galápagos and other islands in the Pacific provided him with an example of succession of similar species in space. The volcanic rocks provided a mechanism how changes can occur governed by natural properties and laws, in this case density and gravity. Biological evolution is even more powerful as Darwin's last and famous words in The Origin of Species summarize:

"There is grandeur in this view of life, with its several powers, having been originally breathed into a few forms or into one; and that, whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being, evolved."

Reference:

https://www.forbes.com/sites/davidbressan/2017/02/12/darwin-the-geologist-in-galapagos/#8d686251a974

Earth from Space

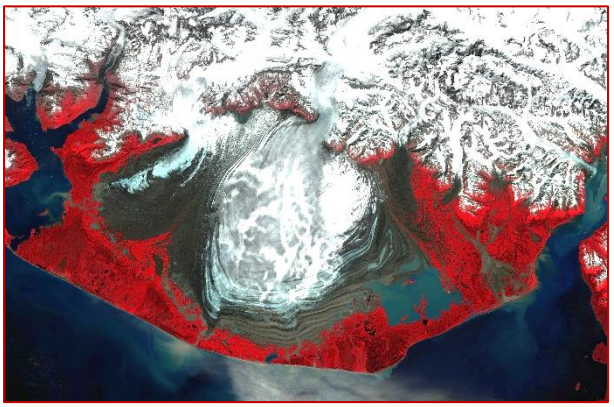
The Moraines of Malaspina, Alaska

European Space Agency
December 3, 2022

The remarkable moraine patterns of Malaspina Glacier – the largest piedmont glacier in the world – are featured in this false-colour image acquired by Copernicus Sentinel-2.

Malaspina Glacier is located west of Yakutat Bay in southeast Alaska, US. Covering an area of around 2900 sq. km, the glacier flows for around 80km along the southern base of Mount St. Elias and is around 300m thick.

Malaspina flows faster than the piedmont glaciers in Antarctica and Greenland. Piedmont glaciers flow from a steeply sided valley, where the ice is constrained by mountains, onto a flat plain. The change in environment from narrow to wide creates the piedmont's signature rounded lobe.



This Sentinel-2 image shows the central lobe of the glacier surging towards the sea. This image has been processed using the near-infrared channel to highlight vegetation in bright red. The wavy lines around the lower half of the glacier are rock, soil and other debris that have been deposited by the glacier – called moraines.

The colour of soil varies from light to dark brown in the image, while ice and snow appear bright white. The low Sun level at Alaska's high latitudes during this season is evident by the shadows cast north by the Elias Mountains. Clear waters of the Pacific Ocean appear dark blue, while turbid waters appear in cyan.

The Malaspina Glacier is widely studied by scientists around the world. Its vulnerability to climate change and its cycles of surges and retreats were studied by scientists using Copernicus and Landsat data. They found that in the event of sea level rise, induced by climate change, seawater could cause major changes in the glacier's terminus and lead to severe impacts on habitats in the area.

Reference:

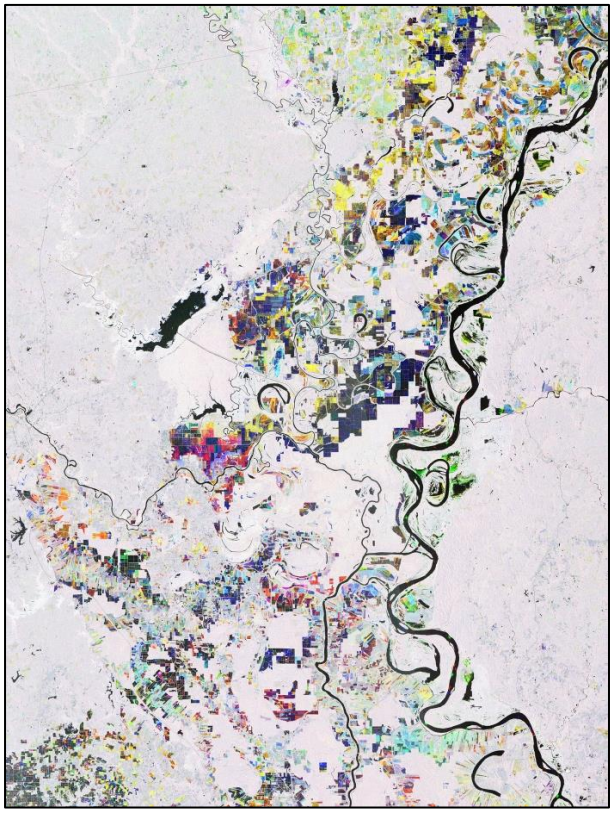
https://spaceref.com/earth/earth-from-space-the-moraines-of-malaspina-alaska/

The Mississippi River

European Space Agency
October 14, 2022

The Mississippi River is one of the world's major river systems in size, habitat diversity and biological productivity. The river flows 3,766km from its source at Lake Itasca through the centre of the continental United States to the Gulf of Mexico.

The area pictured shows where the Mississippi straddles the states of Louisiana and Mississippi. The image combines three radar acquisitions from the Sentinel-1 mission taken 12 days apart to show changes in crop and land conditions over time. Bright colours in the image come from changes on the ground that have occurred between acquisitions.



The Mississippi River. (Credit: ESA)

Water bodies, including the Mississippi River, visible in the far right, and Catahoula Lake, in the far left, appear black as water surfaces reflect the radar signal away from the satellite. If we take a closer look, we can see cargo ships travelling along the Mississippi. Ships from 7 April 2022 appear in red, those from 19 April appear in green, and those from 1 May appear in blue.

White areas in the image indicate the various types of vegetation that surrounds the river, including the Kisatchie National Forest – the only national forest in Louisiana. The Mississippi is a classic example of a meandering alluvial river with its loops and curls along its path leaving behind meander scars, cut-offs and free-standing 'oxbow lakes'.

The Mississippi River Basin is home to a variety of agricultural activity. Nutrient-rich soil from sediment deposits through the floodplain supports cropland close to the river and its tributaries. Rectangular fields in the image are cultivated land. The farming of cotton and soybean make up a significant portion of the area's economic production.

Sentinel-1A was the first satellite to be launched for Copernicus – the Earth observation component of the European Union's space programme. Looking ahead, the upcoming Sentinel-1C satellite scheduled to lift off on ESA's Vega-C rocket from Europe's Spaceport in French Guiana in the first half of 2023, will continue the critical task of delivering key radar imagery for a wide range of services, applications, and science.

The satellite is now at Thales Alenia Space's Cannes plant on the French Riviera after it successfully completed all integration tests this summer in Rome, Italy. It will now undergo a final series of tests in Cannes, including radiofrequency performance checks in the facility's anechoic chamber.

Reference:

https://spaceref.com/earth/earth-from-space-the-mississippi-river/

The Bay of St. Michel never ceases to surprise

Date: ***15 November 2022***
Location: ***France***

The island of Mont Saint Michel in France is one of the world's best-known UNESCO World Heritage sites.

Besides its bay, known for its spectacular tidal fluctuations, the site is home to a tidal island inhabited since the Middle Ages. The island is home to a millenary abbey, the Abbey of St.

Michel, whose central spire reaches an altitude of 170m.

At this time of the year, a unique spectacle can be observed from space. As shown in the image acquired on the 12 November, the shadow of the monastery projected onto the sand of the bay is visible from space.

(Credit: European Union, Copernicus Sentinel-2 imagery)

Reference:

https://www.copernicus.eu/en/media/image-day-gallery/bay-st-michel-never-ceases-surprise-us

Space from Space

Webb reveals new details in Pillars of Creation

28 October 2022
The James Webb Space Telescope

The James Webb Space Telescope has captured a new image of the famous **Pillars of Creation** - first imaged by the Hubble Space Telescope in 1995 - that reveals new details about the region. The three-dimensional pillars look like majestic rock formations but are far more permeable. These columns are made up of cool interstellar gas and dust that sometimes appear semi-transparent in near-infrared light.

Webb's new view of the Pillars of Creation will help researchers revamp their models of star formation by identifying far more precise counts of newly formed stars, along with the quantities of gas and dust in the region. Over time, they will begin to build a clearer understanding of how stars form and burst out of these dusty clouds over millions of years.

(Image Credits: NASA, ESA, CSA, STScI; Joseph DePasquale (STScI), Anton M. Koekemoer (STScI), Alyssa Pagan (STScI).)

Reference:

https://www.nasa.gov/image-feature/webb-reveals-new-details-in-pillars-of-creation

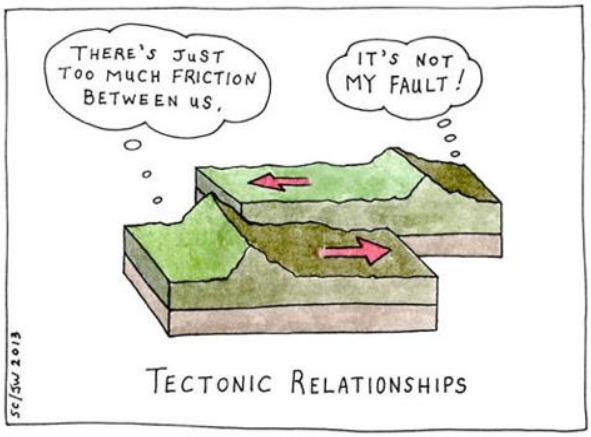
Further Reading

1. Why the weird Ediacara fauna didn't survive Earth's first known Mass Extinction

https://www.forbes.com/sites/davidbressan/2022/11/08/why-the-weird-ediacara-fauna-didnt-survive-earths-first-known-mass-extinction/

Cartoon Corner 2

13 December 2019 Blaming Climate Change
https://dilbert.com/search_results?terms=2019+climate+change



2. Scottish sites on list of world's top 100 geology

https://www.bbc.co.uk/news/articles/c89p4qgzp2wo

3. Hunga eruption: NZ team finds new activity at nearby volcanoes

https://www.nzherald.co.nz/nz/hunga-eruption-nz-team-finds-new-activity-at-nearby-volcanoes/TBFHIJNOERW6NHMKQBKNDXPCT4/

4. Tonga volcano eruption was among the most powerful ever observed, triggering atmospheric gravity waves that reached the edge of space

http://spaceref.com/earth/tonga-volcano-eruption-was-among-the-most-powerful-ever-observed-triggering-atmospheric-gravity-wave.html

5. Immense crater hole created in Tonga volcano

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6. Equinor facing protests over one of the biggest new oil and gas projects in UK

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