

Newsletter of
The Farnham
Geological Society

Volume 26, Number 4, November 2023

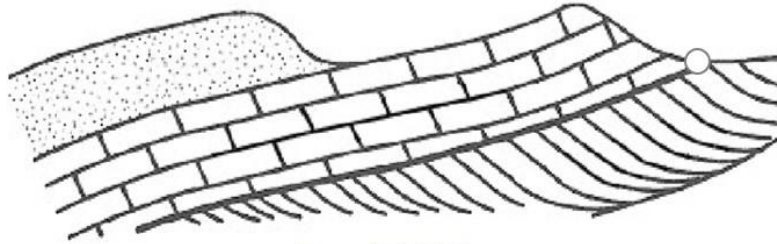


*The Island of Stromboli, Italy ... Lower "fire fountain" Crater
Thursday, 8 April 1982*

Farnham Geological Society



*Farnhamia
farnhamensis*



Founded 1970



A local group
within the GA

Volume 26, No. 4

Newsletter

November 2023

Issue No. 122

www.farnhamgeosoc.org.uk

Editorial

Welcome to the last edition of the FGS Newsletter for 2023. This month's Newsletter brings you some very interesting articles, including an excellent report by **Mike Millar** on his visit to **The Etches Collection Museum of Jurassic Marine Life** in the village of Kimmeridge in Dorset. Having been there myself a few years ago I would thoroughly recommend a visit for anyone interested, both young and old, in Jurassic fossils.

Our next lecture will be the last this year at **The Maltings** on **Friday, 10 November**. Unfortunately, the original speaker Dr. Bob Maurer from HHGS will not be able to present his talk entitled "**The rotating Earth and plate tectonics**" this month; he is now scheduled to present it, via Zoom only, in December. Our very own **Mike Millar** has stepped in and will present "**Asteroids and Comets – An Introduction**"... should be a good one! Hope to see you in **The Barley Room** at **The Maltings**. If you are unable to join us in person then we will also be providing a **Zoom-in** option.

AGM

As you will be aware our AGM is scheduled for **Friday, 12 January 2024**, and it has been decided by the FGS Committee to again hold the meeting as **Zoom-only**. However, at that meeting the committee would like to propose to change the date of **future AGM's from January to April** (together with the reporting of our finances to the end of March) so that we can return to **The Maltings** for the meeting. This will require a **two-thirds** majority of the votes of members present at the January AGM and a subsequent change to our constitution.

If you have any questions regarding this matter please feel free to contact any Committee Member.

Please look out for the notification of the AGM nearer the time and the Committee would urge as many members as possible to attend the meeting online.

Although we are still in November, the next newsletter is in February, so this is my last chance to wish you all a very **Merry Christmas** and a brilliant, peaceful and **Happy New Year**.

We are still looking for members to both join the FGS Committee, as well as help with organising and volunteering for the Societies various activities. Please contact our Interim Chair Mick Caulfield or any other Committee Member if you would like to help.

All of the information contained herein, both graphics and text, is for educational purposes only, as part of the Society's objective. There is no commercial gain for their use.

The views and opinions represented in the articles do not necessarily represent the views of the FGS Editorial Board or the FGS Committee.

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Front Cover

This month's Front Cover was taken by **Abu Hussain** on 8 July 1982, while on a Birkbeck College, University of London BSc geological field trip to Sicily and the Aeolian Islands led by Frank Fitch RIP and attended by FGS Member Mick Caulfield.

Stromboli is an island in the Tyrrhenian Sea, off the north coast of Sicily, containing Mount Stromboli, one of the four active volcanoes in Italy. It is one of the seven Aeolian Islands, a volcanic arc north of Sicily.

Stromboli is widely known for its spectacular eruptions which jet fountains of molten rock from its lava-filled central crater. Because these eruptions are so distinctive and well known, geologists use the word "**Strombolian**" to clearly describe similar eruptive activity at other volcanoes.

Farnham Geological Society Committee 2023

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

Meeting Programme 2023

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

Asteroids and Comets - An Introduction

Mike Millar Fri, 10 November
FGS

Committee Wed, 6 December

The Rotating Earth and Plate Tectonics

Dr. Bob Maurer Fri, 8 December
HHGS

FGS AGM

Fri, 12 January 2024

Field Trip Programme

Tessa Seward is investigating possible day trips to the Folkestone landslip, Dryhill Quarry Sevenoaks and Charmouth/Lyme Regis or the Steve Etches Collection plus residential trips (4 days) to Northern Ireland in 2024 and to the Glamorgan Coast (3 days) in 2025.

She would welcome you contacting her at wessa2006@hotmail.co.uk if any of these appeal to you, as she would like to gauge the interest.



Geologists' Association Lecture Programme 2023

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

The Festival Of Geology

UC London Sat, 4 November

The extinction of a giant apex predator: implications on a food web structure

Amy Shipley Fri, 1 December

Reading Geological Society Lecture Programme 2023

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

The Rutland Ichthyosaur: Digging up a 'Dragon'

Dr. Emma Nichols Mon, 6 November
Oxford University Museum of Natural History

Experimental taphonomy: Unravelling the Burgess Shale

Dr. Nic Minter Mon, 4 December
Portsmouth University

Mole Valley Geological Society Lecture Programme 2023

<http://mvgs.org.uk>

The Wealden Iron Industry

Jeremy Hodgkinson FSA Thu, 9 November
Wealden iron researcher

Horsham Geological Field Club Lecture Programme 2023

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

Jurassic ammonites from Brittany and their value in stratigraphy

Dr. Bob Chandler Wed, 8 November
HGFC President

Next Lecture

Friday, 10 November 2023

7.30 pm for 8.00 pm

Asteroids and Comets - an introduction

Mike Millar, FGS

Left-overs from the formation of the Solar System, asteroids and comets have had a significant impact on planetary geology within the Solar System and are probably responsible for the water on the surface of the Earth, and maybe life itself.

This will be a brief look into some of the smaller bodies that inhabit the Solar System. We will review what we understand by the asteroids and comets, how they formed, what they are made of, and where we find them. We will also look at the impact they have had on Earth, including potential hazards they may pose.

It will include brief reviews of asteroid and comet exploration to date and into the near future.

Firgrove Hill Roadworks: Network Rail will be carrying out maintenance on the Firgrove Hill railway bridge between **Mon 02 October** and **Tue 17 November**. A road closure will be imposed between **8pm and 6am** Monday to Friday.

Forthcoming Lecture

Friday, 8 December 2023

7.30 pm for 8.00 pm

The rotating Earth and plate tectonics

Dr. Bob Maurer, HHGS

Bob Maurer graduated as a mining metallurgist in South Africa and worked in gold, uranium and diamond mines before studying electro-chemistry at the University of London. This took him into research



projects on the growth of single crystals of Alpha-Uranium crystals and the hydrogen embrittlement of high tensile steels, and to a career in engineering. After a number of jobs related to fluid flow measurement he set up **Maurer Instruments Ltd** where he developed a range special purpose Turbine Flow meters and a range of Crude Oil Sampling equipment, in addition to meter calibration systems. Bob has delivered a large number of papers on Flow Measurement, Meter Proving and Crude Oil Sampling in the UK, Europe and the USA. His main hobbies are now related to mineral and fossil collecting. It was this hobby that took Bob to the Bolivian Andes and led him on to look at the forces associated with Tectonic Movements.

This presentation offers an alternative analysis based on the forces associated with the rotational velocity of the Earth to explain supercontinent break-up followed by tectonic plate movements, subduction, and orogenic processes. This is in contradiction to current wisdom which accepts that the movement of a continental plate (CP) is the result of the 'pulling action' applied to it by the subduction of the higher density oceanic lithosphere (OL) as it descends below the CP. The direction of the heated convection currents considered to cause subduction must vary over time and distance. It was this inability to reconcile the long term (Mya's) unidirectional movements of tectonic plates in an omnidirectional convection current based force environment, that prompted the author (Maurer 2002 to 2020) to analyse the constant forces generated by the rotational velocity of the Earth.

Lecture Summary

Friday, 15 September 2023

On Friday, 15 September 2023, 13 FGS attendees in The Maltings & a minimum of 11 FGS attendees via Zoom, welcomed Dr. Jeremy Young.



Coccoliths and coccolithophores a brief introduction

Dr. Jeremy Young, UCL
email: jeremy.young@ucl.ac.uk

Coccoliths are the smallest of the microfossils, being only 1 to 10 microns across. Indeed they are possibly the smallest organic remains which are routinely identified to species level. They are, however, enormously abundant. Individual coccoliths are calcareous plates which form part of a composite exoskeleton, the coccosphere, of a single celled alga, the coccolithophore. So, we talk about organisms *coccolithophores* which have a sort of shell, the *coccosphere*, formed of numerous plates or *coccoliths*. Geologists, however, often prefer to talk about *nannofossils* (or just nannos) since we also find other similar size fossils which might not be formed by coccolithophores (e.g., discoasters and sphenoliths, Fig. 3 C, D).

Biologically coccolithophores are a sub-group of the **phylum Haptophyta**, which are a group of predominantly marine flagellates. Morphologically they are fairly simple unicellular organisms, typically with spherical or ellipsoidal cells dominated by the nucleus, a pair of golden-brown chloroplasts, mitochondria and golgi body. The flagellate stages are, however, distinctive with two similar smooth flagella and a third coiling, flagellum-like structure. This structure, the haptoneema, is unique to them. Most haptophytes produce resistant organic scales, these are produced intracellularly in golgi-derived vesicles and then exocytosed to form a cell covering. In coccolithophores this process is modified with calcification occurring on the scales to produce much larger and more robust structures, the coccoliths (Young *et al.* 1999).

Coccolith formation, like scale-formation, occurs inside the cell, within a golgi-derived vesicle. It is a remarkably finely-controlled process with precise biotic determination of both crystal nucleation and growth. After coccolith formation has ended the coccolith vesicle, which can occupy much of the cell, migrates to the edge of cell and fuses with the cell membrane exocytosing the coccolith

(Taylor *et al.* 2007). The coccolith then is emplaced within the coccosphere which is an extracellular structure (i.e. outside the cell membrane).

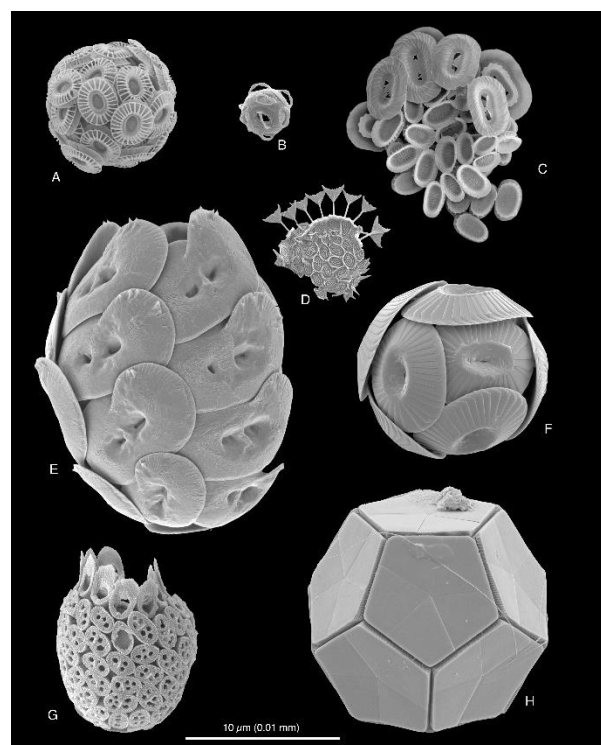


Figure 1. Coccolithophore diversity. Seven extant species, collected from plankton samples, showing the wide range of shapes and sizes in both the complete coccospheres and their constituent coccoliths.

A. *Emiliana huxleyi*, B. *Gephyrocapsa ericsonii*, C. *Syracosphaera azureaplaneta*, D. *Pappomonas borealis*, E. *Helicosphaera carteri*, F. *Coccolithus pelagicus*, G. *Poricalyptra isselii*, H. *Braarudosphaera bigelowii*. All images at the same scale.

Coccolithophores are not an exceptionally diverse group, with only about 250 known species (Young *et al.* 2003, 2005), however they do show a remarkable range of cell morphologies. Coccolith morphologies are equally diverse, but the dominant coccolith types are circular or elliptical disks with more or less elaborate rims. They are formed of a radial array of complexly shaped interlocking calcite crystals.

The typical coccoliths just described are termed *heterococcoliths* and a complication is that many coccolithophores have a two phase life cycle - producing *heterococcoliths* during

the diploid phase of their life-cycle and a different type of coccoliths, *holococcoliths* during the alternate, haploid, phase (e.g. *Young & Henriksen 2003, Billard & Inouye 2004*). The holococcoliths are formed of numerous minute (ca 0.1 μm) euhedral calcite rhombohedra (*Fig. 1G*). These holococcoliths are important biologically, but they have much lower preservation potential than heterococcoliths and so are much less likely to be encountered.

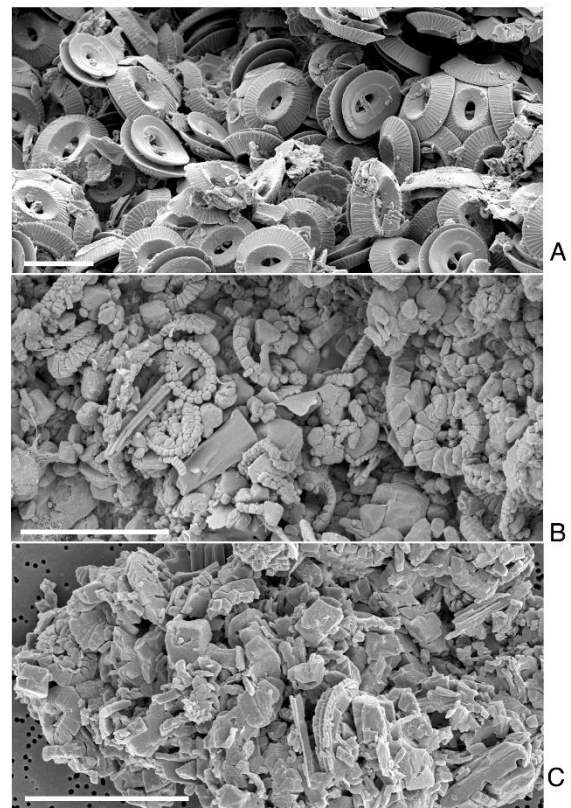
Geological distribution

In the modern ocean coccolithophores are an important component of the **phytoplankton**. They probably only contribute about 5-10% of total primary productivity but they are ubiquitous, occurring from the Arctic to the Equator and from high productivity upwelling zones to the centre of oceanic gyres. Across the open ocean they are, with planktonic foraminifera, the dominant calcifiers and the pelagic oozes formed of coccoliths and forams cover vast areas of the sea bed.

Coccoliths first occur in the Late Triassic (ca 210Ma) but at low abundances and diversities. They underwent a major radiation in the Early Jurassic and then became gradually more abundant and diverse through the Jurassic and Cretaceous (*Bown et al 2004*). The Late Cretaceous was a time of very high global sea-levels which brought open marine sedimentary conditions onto the continental shelves and resulted in chalk being a very widespread rock type. Late Cretaceous chalk is often predominantly (70-90%) composed of coccoliths and this was clearly a high point for the group in terms of both diversity and abundance.

At the end of the Cretaceous (66Ma) the mass extinction severely affected the group (e.g., *MacLeod et al. 1997, Bown 2005*). Only a very few species survived and none of the common Cretaceous species. Subsequently there was a radiation of new forms during the Paleocene (66-56Ma) but the new Cenozoic assemblages are distinctly different to the Mesozoic ones. During the Paleogene coccoliths probably recovered to similar abundance levels in the open ocean to those seen in the Cretaceous

although lower sea levels mean that calcareous ooze/chalk sedimentation was largely confined to deep sea sediments. Through the Neogene coccolithophores have become less abundant, possibly due to global cooling and/or competition with diatoms and now form a smaller proportion of deep sea calcareous sediments (typical 10-30%) (*Sucheras-Marx & Henderiks 2014*).



*Figure 2. Coccolith appearance on SEM surfaces. Three rock samples showing coccoliths on broken surfaces. A. Quaternary chalk from the Caribbean showing abundant pristine *Coccolithus pelagicus*. B. A typical Cretaceous chalk surface (chalk fill of the Uffington White Horse, UK) showing numerous moderately-well preserved ringlike coccoliths and rod-like nannoliths. C. Poorly preserved coccoliths and nannoliths in a fragment of hard chalk, from the base of a medieval artefact. Scalebars 10 μm .*

For geologists coccoliths are invaluable both for **biostratigraphy** (determining the age of sedimentary rocks) and **palaeoceanography** (studying the oceanic record of environmental change). Several factors contribute to this:

Small size – the minute size of nanofossils means that assemblages can be collected from very small samples – in a chalk there can be several billions specimens per gram of sediments. This is critical for use in samples from industrial or scientific drilling.

Fast evolution and wide distribution – like other plankton groups (e.g., ammonites, graptolites, planktic forams), coccolithophores show rather low diversities but very wide geographic distributions and rapid turnover of species, making them ideal for biostratigraphy.

Diverse morphology – unlike some other plankton groups, nanofossil are very variable in appearance, which makes learning their taxonomy and using them in biostratigraphy relatively straightforward.

Rapid preparation and study – with the right microscope a simple smear slide can be prepared in minutes and then rapidly scanned to identify the species present. Taken together these factors have made nanofossils one of the most widely used palaeontological tools in modern geology.

Recognition of coccoliths

Hand specimen - coccoliths are too small (<1/100 mm) to seen by the naked eye, with a hand lens or a regular light microscope. En masse they will appear as fine powder, with the Late Cretaceous chalk being the archetypal example.

Thin section - typical rock thin sections are prepared to 35 µm thickness, whilst coccoliths are only 5-10 µm thick, so they are usually not easily seen but rather contribute to the very fine carbonate fraction - micrite. The presence of coccoliths can, however, be checked for by examining fine particles at the edge of the slide, in cross-polarised light at high magnification.

Scanning electron microscopy - coccoliths are near the limit of resolution even for electron microscopes but most instruments are capable of imaging them (Fig. 2). In pristine sediments identification is easy (Fig. 2A) but with even mild diagenesis dissolution and overgrowth can make the forms less regular and less obviously biogenic (Fig. 2B, C). However, the

combination of a ring or disk-like shape, a radial structure formed of multiple crystals and consistent rather complex morphologies are all strongly characteristic. If they are common, it should also be relatively easy to confirm that they really are nanofossils by using standard references to identify the most abundant forms.

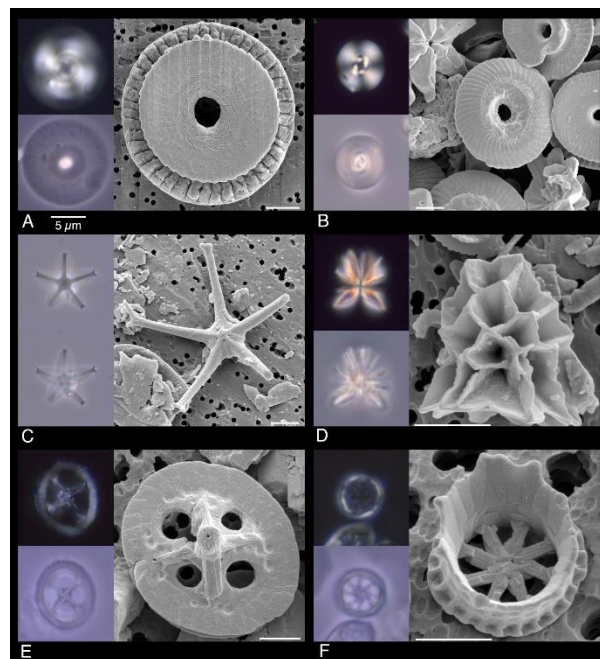


Figure 3. Coccoliths in the light microscope. Images of six nanofossil species, each illustrated in cross-polarised light, phase contrast and by scanning electron microscopy. The pairs of light microscope images are of the same specimen the SEM image is of the same species but a different specimen.

A. *Calcidiscus macintyreii* (Pliocene heterococcolith) B. *Cyclicargolithus floridanus* (Miocene heterococcolith); C. *Discoaster pentaradiatus* (Pliocene nannolith); D. *Sphenolithus moriformis* (Miocene nannolith); E. *Grantarhabdus coronadventis* (Cretaceous heterococcolith); F. *Rotelapillus crenulatus* (Cretaceous heterococcolith).

All light micrographs at the same scale (scalebar below A); SEMs scalebar = 2µm.

Polarised light microscopy - coccoliths are formed of calcite which is the most birefringent common mineral ($\beta=0.172$) so they show bright interference colours in cross polars. Indeed, coccoliths and other nanofossils are typically only 1 to 5 µm thick and so show bright first order birefringence colours whilst most other minerals of this size, include clay, quartz and

biogenic silica show very low birefringence. Moreover, since most heterococcoliths are radial arrays of calcite crystals they typically show pseudo-extinction crosses (Fig. 3 A, B). These are readily seen in cross-polars and since different coccoliths have different crystal arrangements they also are useful for identifying species. So cross-polarised light is the standard routine technique used for both for testing for the presence of coccoliths and for assemblage analysis.

Sources of further information

There is a large specialist literature on fossil coccoliths. The most accessible reference work is the book **Calcareous nannofossil biostratigraphy** (Bown 1998), an older but still valuable synthesis is provided by Perch-Nielsen in the book **Plankton Stratigraphy** (Bolli et al. 1985). For discussion of broader topics there have been recent reviews on coccolith **functional morphology** (Monteiro et al. 2016), **biogeographic distribution** (Poulton et al. 2017) and **ecology** (Balch 2018).

The single most accessible source is, however, provided by the **website Nannotax** (www.mikrotax.org/Nannotax3). This site has been developed over the past decade and includes a comprehensive taxonomic catalog of original descriptions and illustrations linked to a database of modern taxonomic concepts. It includes ca. 20,000 images and covers all extant and fossil species. This is one of the most comprehensive databases available for any group of fossils and has become a standard reference source for workers in the subject. For non-experts it allows easy look up of any taxon name to obtain reliable data on the modern taxon concept, and geological range. Identification of taxa on the site requires some knowledge but is facilitated by the facility to search by morphological characters and or geological age, and by illustrated overviews which allow browsing through the taxonomy.

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Article

The Etches Collection, stories from deep time, a world from over 150 million years ago.

Mike Millar, with thanks to the Etches Collection website.

The Etches Collection Museum of Jurassic Marine Life is in the village of Kimmeridge, Dorset, in the middle of the World Heritage UNESCO Jurassic Coast. It houses an outstanding collection of Late Jurassic fossils, mostly found and curated by Dr Steve Etches MBE.



Figure 1: The Etches Collection logo on the museum building.

Steve Etches is a plumber by trade and began collecting fossils from the Kimmeridge Clay

over 40 years ago. His collection began at the age of 5 with a flint fossil sea urchin which he found in his back garden. Completely self-taught, what began as a hobby has now resulted in a collection of over 2800 fossils, about 10% of which are displayed in the museum.

The museum opened in 2016 and features the fossil gallery, a workshop and laboratory, archaeological displays of Kimmeridge's Romano-British history, and the Wolfson Discovery room with geological and palaeontological interactive displays, library, microscope and fossil handling collection.

The museum fully lives up to its claim to tell stories about life and death in the Kimmeridgian seas during the time of the dinosaurs, using CGI imagery of Jurassic marine life swimming above the amazing fossils in the museum gallery.

The entrance hall really sets the scene, we see full sized models of a fish being eaten by an ichthyosaur, which in turn is being eaten by a pliosaur, all based on fossils found in the Collection.



Figure 2: The entrance hall

The collection is almost exclusively Kimmeridgian in age, c. 152 – 157 Ma, and collected locally. There is a display which explains the Kimmeridge Clay outcrops just to the south of the museum at Kimmeridge Bay. We see that the formation is composed of interbedded dolomitic limestones, pyrite rich organic shales, and silty, quartz rich mudstones. Deposition was largely based on changes in sea level and climate, which

influences water temperature, sediment supply and biological productivity. The deposition appears to be cyclical.

The fossils found in these rocks help us understand their age, their depositional environment, and the predator-prey relationships. Ammonites, evolve quickly and are abundant, so can be used to date the strata. Other invertebrates such as bivalves, and coprolites and burrows are also common. Fish fossils are quite common, but largely vertebrates such as ichthyosaurs and plesiosaurs are less common.



Figure 3: Schematic of the cliffs at Kimmeridge Bay.

A second display shows the extent of the outcrops of Kimmeridge Clay in Dorset and the rest of England, and also its presence buried beneath the North Sea. This burial has allowed the Kimmeridge Clay to be thermally mature as an oil source rock and is the basis of much of

the North Sea oil industry. In contrast, the Kimmeridge Clay in Dorset has not been buried deep enough to be a mature source rock, and the sources of the oil for the local fields, including Kimmeridge and Wytch Farm, are Lower Jurassic claystones.

The main gallery is treasure trove of Jurassic marine life. Thanks to some spectacular graphics, you have the impression you are in an aquarium with ammonites, belemnites, fish, sharks, ichthyosaurs and plesiosaurs all swimming around and above us.

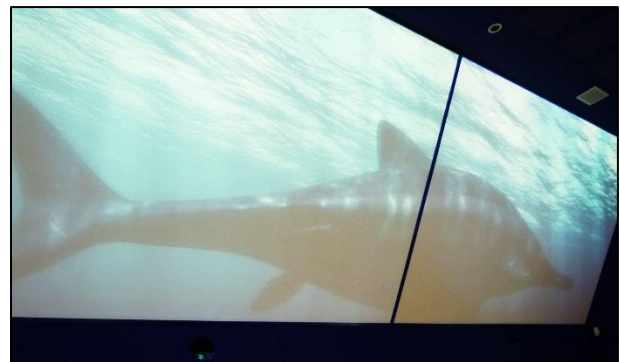


Figure 4: An ichthyosaur swims around us in the main gallery.

This gallery shows fantastic examples of fossils along with clear and concise explanations of the creatures that left their remains and how those creatures fitted into the marine world of the late Jurassic.

We have great examples of invertebrates, including squid and ammonites. There are rare impressions of soft body tissue from squids and examples of ammonite eggs, these being the first to be discovered. The displays try to explain how to tell the difference between male and female ammonites. There is also a fossilised dragonfly wing, the first to be found in the Kimmeridge Clay. There is a slab of rock showing dozens of shrimp fossils in a possible mass mortality event.

Fish, rays and sharks are also well represented in the collection. There are possible new species of fish, and almost complete fossils of rays. As we move up the food-chain, we see examples of sharks and larger fish, including a fast-swimming predator that is similar to modern day tuna. A display of coprolites helps us to understand predation.



Figure 5. Fossil Ray

Continuing up the food chain we have many examples of marine reptiles, ichthyosaur, plesiosaur, marine crocodiles, and the apex predator, the pliosaur. We see the remains of the skull and lower jaw of *Torvoneustes*, a new species of marine crocodile, which probably grew to 5m long. The ichthyosaur and the plesiosaur are shown to be both predators and prey.

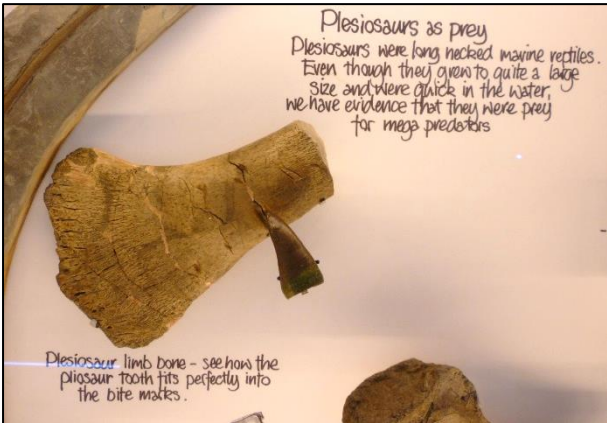


Figure 6. Plesiosaurs as prey.

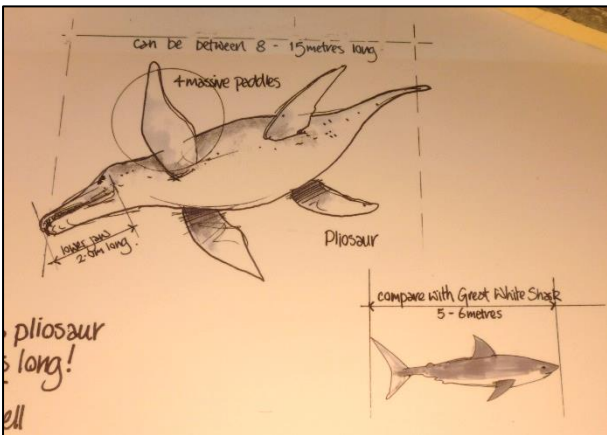


Figure 7. Pliosaur sketch compared to modern day great white shark.



Figure 8. Pliosaur jaws



Figure 9. Pliosaur paddle.

So, what is big enough to prey on ichthyosaurs and plesiosaurs? The pliosaur was a large marine reptile with a short neck, large head and massive teeth and jaws. It could grow from 8 to 15m in length and had four large paddles to propel itself through the water.

As well as marine fossils, there are a few non-marine examples as well. These are from creatures that died and got swept into the Kimmeridge sea. We have some examples of dinosaurs, including a stegosaurus vertebra. And falling from the air, bits of broken wing and hip bone from a pterosaur.

This is a truly great museum, well worth a trip down narrow Dorset lanes. We found parking no problem on a Saturday morning in June and coffee and pastries in Clavell's café over the road.

References:

All photographs credit M Millar.

For more information, please see the Etches Collection website;

<https://www.theetchescollection.org/>

Interesting Images 1

Aerial view of Lake Magadi and Ngorongoro Crater in Tanzania



© Robert Harding World Imagery / Offset

If we were to zoom in on this image, we might see a great variety of animals in the green expanse below. In fact, it's home to nearly every species of wildlife in East Africa. Ngorongoro Crater, sometimes called the **'Eden of Africa'**, formed roughly 2 to 3 million years ago when a massive volcano erupted and then collapsed, forming a wide caldera. At 2,000 feet deep and with a 100-square-mile floor, Ngorongoro is the largest intact, unfilled and inactive volcanic crater on Earth.

Lake Magadi, in the centre of the image, is a seasonal alkaline lake that supports a large population of lesser flamingoes. The crater itself is home to around 25,000 large animals, including many wildebeest, zebras and gazelles. Cheetahs, rhinos, hippos and lions are found here as well, but in smaller numbers. This wilderness and its wildlife fall under the protection of the Ngorongoro Conservation Area.

Reference:

<https://www.bing.com/images/search?q=ngorongoro+crater&filters=IsConversation:%22True%22+BTWLKey:%22NgorongoroCraterTanzania%22+BTWLType:%22Trivia%22&trivia=1&qft=+filterui:photo-photo&form=M403J9&first=1&cw=1857&ch=932>

New eruptive phase at Iceland's Fagradalsfjall volcano

Date: 13/07/2023

Location: Iceland

Credit: European Union, Copernicus Sentinel-2 imagery



This Copernicus Sentinel-2 image from 11 July 2023 shows the lava flows and the plume emitted by the Fagradalsfjall volcano in Iceland. The eruption began on the same day the image was acquired, following an intense seismic swarm in the region.

The eruption site is an uninhabited valley near the Litli-Hrútur mountain, approximately 30 kms southwest of the capital, Reykjavik. Icelandic authorities have warned tourists and citizens, urging them to stay away from the erupting volcano due to the toxic gas emissions.

Copernicus satellites facilitate the monitoring of volcanic activity worldwide, which is essential for taking action to mitigate the risks and hazards stemming from eruptions.

Reference:

<https://www.copernicus.eu/en/media/image-day-gallery/new-eruptive-phase-icelands-fagradalsfjall-volcano>

Ga	(giga-annum)	billion years
Ma	(mega-annum)	million years
ka	(kilo-annum)	thousand years

News

75 million-year-old 'forgotten lord of the oasis' titanosaur fossils from Egypt fill a 'black hole' in dinosaur history

By Cameron Duke, LiveScience
13 October 2023

A newly described titanosaur species, named after an ancient Egyptian deity, fills a gap in our understanding of Africa's dinosaurs.



A reconstruction of *Igai semkhu*, a 75-million-year-old titanosaur unearthed in an oasis in Egypt. (Image credit: Andrew McAfee and Talia Mastalski, Carnegie Museum of Natural History)

A strange species of tiny titanosaur has finally been given a name, nearly 50 years after its bones were unearthed from the Egyptian desert.

The newly described species, called *Igai semkhu*, lived 75 million years ago in what is now the Kharga Oasis.

The name *Igai semkhu* translates to "Forgotten Lord of the Oasis" in ancient Egyptian and can be represented in hieroglyphics. "It's named after a deity the Ancient Egyptians would have worshiped in the oasis it came from," study author Matthew Lamanna, a paleontologist at the **Carnegie Museum of Natural History**, told **Live Science**.

The relatively diminutive titanosaur, which was a "mere" 33 to 50 feet (10 to 15 meters) long, was described July 2023 in the **Journal of Vertebrate Paleontology**.

"It's definitely something to get excited about," Lamanna said. "It is helping fill in this black hole in our understanding of the final 30 million years of the Age of Dinosaurs on one of the largest landmasses on Earth."

German researchers first chipped *Igai semkhu* from rocks in the Western Desert in Egypt in 1977, but the specimen was forgotten for decades until Lamanna and his colleagues took a second look.

It turned out *I. semkhu* was a previously unknown genus and species of titanosaur, which is a subgroup of sauropods. Sauropods were plant-eating dinosaurs with small heads, long necks and big, elephant-like bodies.

But 75 million years ago, when *Igai semkhu* was likely to be alive, most sauropods were already extinct, leaving titanosaurs as the only existing sauropod lineage in the Cretaceous era (145 million to 66 million years ago).

Despite their name, titanosaurs weren't all titanic. "Titanosaurs range from some of the smallest sauropods ever found, about the size and weight of a cow, all the way up to the size of a humpback whale," said Lamanna. They were "the largest land animals to have ever existed."

Igai semkhu sits somewhere in between these extremes. Eric Gorscak, study co-author and paleontologist at Midwestern University, estimated *I. semkhu*'s size from a pair of leg bones — the tibia and fibula. The upper estimate, about the length of a school bus, would place it "slightly below average" in size, Lamanna said.

Because all that remains of *I. semkhu* is a few leg bones and some vertebrae, it is impossible to know exactly what it looked like, Lamanna said.

But despite the scant fossils available, *I. semkhu* is one of the most complete dinosaur fossils ever unearthed in Africa, where known dinosaur fossils are relatively rare.

"When you are talking about continental Africa, the last 30 million years of the dinosaur record are almost non-existent," Lamanna said.

Partly, that's because paleontologists haven't been digging in Africa for as long as they have in other places. In addition, while the continent harbours many Cretaceous-era rocks, very few are easily accessible. Many potential fossil sites are either covered by thick vegetation or deep desert sands.

This rarity makes the newly described titanosaur important.

"*Igai* is, although still fragmentary, complete relative to the rest of the record, and is therefore a pretty significant addition to our understanding," John Whitlock, professor of Anatomy at Mount Aloysius College in Pennsylvania, who was not involved with the study, told **Live Science**.

Reference:

https://www.livescience.com/animals/dinosaurs/75-million-year-old-forgotten-lord-of-the-oasis-titanosaur-fossils-from-egypt-fill-a-black-hole-in-dinosaur-history?utm_term=8DEBC9E5-6C7F-4337-AFFF-D9A51CC6C2C0&lrh=840a98cbe34ba22d824f6df096d90a0be8fe4763876a779b0361304855882d8f&utm_campaign=368B3745-DDE0-4A69-A2E8-62503D85375D&utm_medium=email&utm_content=5F6773A9-AF17-4C21-A0C5-59C0C6A07B68&utm_source=SmartBrief

As UK's offshore oil & gas industry slashes emissions, low-carbon era inches closer

*Melisa Cavcic, Offshore Energy
October 12, 2023*

The UK's representative body for the offshore energy industry, Offshore Energies UK (OEUK), has revealed in a new report that Britain's offshore oil and gas industry has taken decarbonization challenges by the horns and made strides towards ushering in a low-carbon future by curbing its emissions footprint by 24% compared to 2018 levels.

Offshore Energies UK's **Emissions Report 2023** estimates that emissions from the production, transport, and processing of oil and gas in the UK fell to the equivalent of **14.28 million tonnes of CO₂** in 2022, compared with the 2018 figure of 18.9 m tonnes, representing a **fall in emissions of 24%**. The good news does not end there, as the oil and gas industry also **halved flaring and venting and cut methane emissions by 45%** compared to 2018. OEUK claims that this demonstrates the sector's continuous commitment to decarbonization.

Furthermore, these emission reductions are in line with the ambitious commitments under the North Sea Transition Deal, in which the industry committed to reduce emissions by 10% by 2025, 25% by 2027, and 50% by 2030. OEUK explains that most of the reductions made so far have been achieved through operational improvements, process optimization, and the decommissioning of older assets.

However, this report also warns that the UK's carbon footprint has the potential to **increase by 50 million tonnes** of CO₂e by 2050 – the equivalent of the entire UK population flying from London to Glasgow almost five times over – if no new investment in domestic oil and gas production is made. This is due to the country being in danger of becoming increasingly reliant on imported liquid natural gas (LNG), which is often produced and shipped to the UK from countries with less commitment to reducing the environmental impacts of production.

Moreover, Offshore Energies UK forecasts that in a best-case scenario, where investment in domestic oil and gas production is sustained to prevent a rapid overreliance on imports, the industry could still provide 50% of Britain's oil and gas needs by 2030. In this scenario, the sector is expected to halve its emissions by 2030, meet net-zero by 2050, and continue to support UK jobs and the economy while developing solutions like **wind, hydrogen, and carbon capture**.

Michael Tholen, OEUK Sustainability and Policy Director, commented: "*We have a key*

role to play in helping the UK tackle the energy trilemma: reducing emissions and energy costs while improving the availability of secure supplies of energy. The sector has shown continuous commitment to decarbonization – achieving a third consecutive year of emissions reductions, halving flaring and venting, and cutting methane emissions by 45% in 2022.

“Even though the sector is making big strides, progress is starting to slow. The low-hanging opportunities, like operational improvements and cuts to flaring and venting, having already been achieved. Further reductions will now rely on large-scale, capital-intensive projects – so we need to make sure the UK becomes an irresistible place to do business to scale up these solutions.”

Four policy pillars to boost investment

The trade body elaborates that most of the offshore oil and gas industry’s emissions come from generating the energy needed to power offshore installations, including safety systems, plus electricity and heat for the workforce. Therefore, further emissions reductions are anticipated to increasingly rely on major capital projects, such as powering offshore rigs with renewable electricity, known as electrification.

As a result, OEUK underscores that these solutions will only be viable with timely access to the National Grid as well as “an attractive environment” for investors to support the installation of wind farms. With this in mind, the trade body has laid out four policy actions for the government to attract the investment needed to cut emissions and ensure the UK makes the most of its domestic energy resources.

The **first** of these actions points out that the government needs to turn Britain into an attractive destination for investment in offshore energy. Bearing this in mind, the OEUK emphasizes that the **Energy Profits Levy** casts a shadow on investment and makes it much harder to secure long-term investments in the production assets and infrastructure needed to electrify offshore operations. While decarbonization mechanisms, now seen as part of the fiscal regime, serve a vital role in facilitating investment across the energy

sector, they are expensive, thus, this should be taken into account and tackled.

The **second** of these actions recommends the adoption of a whole-system approach to decarbonization that accounts for upstream and downstream activity, with clear accountabilities for the industry, regulators, and government. This will require alignment between regulatory, government, and industry bodies to ensure the decarbonization of offshore assets is timely, consistent with the delivery of emissions targets, and reflects the wider business environment, says OEUK.

The **third** action indicates the need to ensure the UK’s oil and gas production facilities are seen as part of a wider integrated energy system. OEUK underlines that the remit of the future system operator (FSO) needs to adopt a cross-sector approach that aligns with other regulators’ remits while infrastructure development needs to make the most of the UK’s energy resources both onshore and offshore to support the growth of the economy.

The **fourth** and final action outlines that the government should ensure the UK Emissions Trading Scheme (ETS) supports progressive decarbonization and avoids prematurely shutting down activity, as the volatility of the UK ETS scheme has made it harder to plan long-term investments.

“Our energy future can be secure, sustainable and provide growth opportunities for UK businesses and people – but only if we have the right support from governments to make the most of our supply chain, skills, and infrastructure. The decarbonization of our sector, and indeed the entire UK economy, will rely on supportive energy policy across the whole energy landscape, so we welcome any action from government that aims to attract investment and accelerate our drive to net-zero,” concluded Tholen.

The report shows that the **UK greenhouse gas emissions were 417 million tonnes in 2022**, and **the offshore oil and gas sector contributed 3.4% of that**. While the carbon footprint of UK gas is on average almost four times lower than imported LNG, it is more than twice as large as pipeline imports from Norway,

whose basin is similar to the UK Continental Shelf (UKCS). As a result, the low carbon intensity of Norwegian gas should act as a spur to further clean up UK production.

David Whitehouse, Offshore Energies UK CEO, said: *“The decarbonization of our economy is one of the greatest opportunities and challenges of our time – policy decisions made today will impact opportunities of the future. We know that prioritizing a homegrown transition – protecting our country’s energy security, jobs and communities – will unlock the greatest benefits to the UK economy. If delivered successfully, it will spur economic growth, support jobs, and allow reliable supplies of homegrown, cleaner energy in the UK, for the UK.*

“The reality of the energy transition is that we need both oil and gas and renewables in an integrated system to protect the UK’s energy needs. We must create an irresistible investment environment in the UK if we are to realize the full scale of opportunities – billions of pounds worth – that we see in wind, hydrogen, and CCS, alongside oil and gas, and grow a UK energy supply chain to match, making the most of our North Sea heritage.”

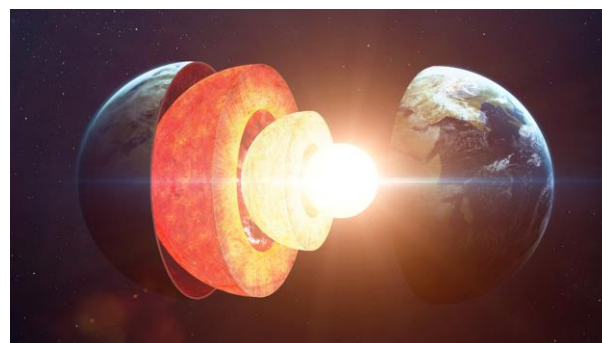
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Earth's solid inner core is 'surprisingly soft' thanks to hyperactive atoms jostling around

By Harry Baker, LiveScience.com
5 October 2023

Atoms within the enormous ball of iron in the Earth's inner core may move around much more than previously thought, which could explain recent findings about the core's surprising softness.



An artist's interpretation of what the Earth's crust, mantle, outer core and inner core might look like when separated. (Image credit: Shutterstock)

Scientists recently discovered that **Earth's inner core**, which was long thought to be an unmoving ball of solid metal, **might be a lot less rigid than we expected**. Now, a new study suggests this surprising softness may be caused by **hyperactive atoms** that move around within their molecular structure much more than we realized.

The inner core is a massive spherical lump of metal, predominantly iron, that spans roughly 760 miles (1,220 kilometers) and dates back to at least 1 billion years ago. The inner core is enveloped by the outer core — a sea of swirling liquid metals — that is in turn surrounded by a massive layer of molten rock, known as the mantle, which sits just below the solid crust we live on.

The pressure at the heart of our planet is immense, so experts initially believed the core must be completely solid and that the iron atoms within it, which are arranged in a massive hexagonal lattice, must be permanently held in place.

But in 2021, seismic waves from earthquakes revealed that there were lots of inconsistencies within the inner core, which led some scientists to describe it as a **"mushy hidden world."** Subsequent studies suggested this may be caused by swirls of liquid iron being trapped inside the core or that the core exists in a "superionic state," where atoms from other elements like carbon and hydrogen are constantly sloshing through the core's massive lattice of iron atoms.

The new study, published October 2 in the journal *Earth, Atmospheric and Planetary Sciences*, provides an alternative explanation for what is going on inside the inner core.

The researchers recreated the intense pressure within the inner core in the lab and observed how the iron atoms behaved under these conditions. The scientists then fed this data into a computer-learning program to create a simulated virtual core that they dubbed the "supercell." Using the supercell, the team was able to see how the iron atoms moved within their supposedly rigid structure.

The results suggest the atoms inside the inner core can "move much more than we ever imagined," study co-author Jung-Fu Lin, a geophysicist at the University of Texas at Austin, said in a statement.

The supercell simulations show that some of these atoms can move around in groups, taking up other positions in the lattice without compromising its overall shape — kind of like how dinner guests change seats at a table without adding or removing chairs, researchers wrote in the statement. This type of movement is known as "collective motion."

"This increased movement makes the inner core less rigid [and] weaker against shear forces," Lin said. This could explain why the inner core is "surprisingly soft," he added.

The researchers believe that the new findings could also reveal new insights into other inner core mysteries, like how it helps to generate Earth's magnetic field.

"Now, we know about the fundamental mechanism that will help us with understanding the dynamic processes and evolution of the Earth's inner core," Lin said.

Reference:

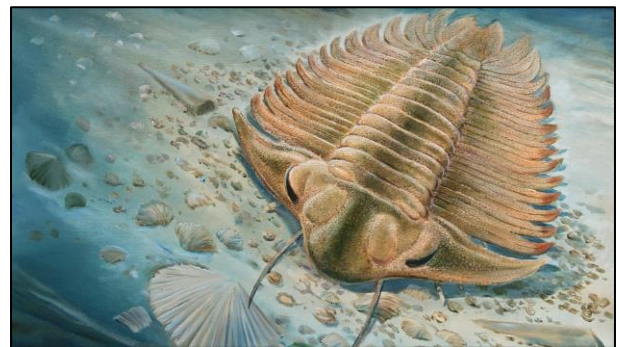
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A fossilized trilobite stomach can show us clues to Cambrian cuisine

The 465-million-year-old gut contents reveal similarities between the ancient arthropod and modern crabs.

By Laura Baisas, *Popular Science*
27 September 2023



An illustration of *Bohemolichas* feeding on the seafloor, moments before it is engulfed, buried, and preserved by an underwater mud flow. (Credit: Jiri Svoboda)

About 465 million years ago, a now extinct arthropod called a **trilobite** was eating its way across the present day Czech Republic. After it died, the passage of time actually preserved the plentiful contents of this specimen's prehistoric guts. A team of paleontologists is using this full fossilized belly to learn more about the feeding habits and lifestyle of these common fossilized arthropods. The findings are detailed in a study published September 27 in the journal *Nature*.

More than 20,000 species of trilobite lived during the early Cambrian to the end-Permian period roughly 541 to 252 million years ago. They are some of the most common fossil specimens from this time period, yet paleontologists do not know much about their feeding habits since gut contents usually disappear over time, and until recently there

were no known fossil specimens with them intact.

In the study, a team from institutions in Sweden and the Czech Republic examined a fossil specimen of *Bohemolichas incola* first uncovered near Prague over 100 years ago. Study co-author and paleontologist Petr Kraft from Charles University in Prague had long suspected that this specimen may have a gut full of food intact, but did not have a suitable technique to look inside the trilobite's innards. Study co-authors and paleontologists Valéria Vaskaninova and Per Ahlberg from Uppsala University in Sweden suggested using a **synchrotron** in one of their fossil scanning sessions. This machine is a large electron accelerator that produces powerful laser-like x-rays to take high-quality scans of the fossil

"The results were fantastic, showing all the gut contents in detail so that we could identify what the trilobite had been eating," Ahlberg tells **PopSci**. "Remains of ostracods (small shell-bearing crustaceans, still around today), hyoliths (extinct cone-shaped animals of uncertain affinities) and stylophorans (extinct echinoderms that look like little armor-plated electric guitars). These are all kinds of animals that lived in the local environment."

The team believes that *Bohemolichas incola* was likely an opportunistic scavenger. It also was potentially a light crusher and a chance feeder, which means that it ate both dead or living animals, which either disintegrated easily or were actually small enough to be swallowed whole. However, after this particular *Bohemolichas incola* died, the circle of life continued and the scavenger became the scavenged. Vertical tracks of other scavengers were found on the specimen. These unknown creatures burrowed into this trilobite's carcass and targeted its soft tissue, but avoided its gut. Staying away from the gut implies that there were some noxious conditions inside *Bohemolichas incola*'s digestive system and potentially ongoing enzymatic activity.

"We were able to draw conclusions about the chemical environment inside the gut of the living trilobite. The shell fragments on the gut have not been etched by stomach acids, and

this shows that the gut pH must have been close to neutral, similar to the condition in modern crabs and horseshoe crabs," says Ahlberg. "This may indeed be a very ancient shared characteristic of trilobites and these modern arthropods."

Future studies into trilobites could use similar techniques to look for more gut fills. Since this group is a very diverse group of animals, it can't be assumed that this particular species is representative of the feeding habits for all.

"This project shows how cutting-edge technology can come together with really old museum specimens. The trilobite was collected in 1908, and has been in a museum ever since, but it is only now that we have the technology to unlock its secrets," says Ahlberg. "This illustrates not only the rapid technological progress of our time, but also the importance of well-maintained museum collections."

Reference:

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Rosebank oil field given go-ahead by regulators

**By Mary McCool & Nichola Rutherford
BBC Scotland News**

27 September 2023

The controversial Rosebank offshore development off Shetland has been granted consent by regulators.

Located **80 miles west of Shetland**, Rosebank is the **UK's largest untapped oil field** and is estimated to contain up to **300 million barrels of oil**.

Development and production approval has been given to owners *Equinor* and *Ithaca Energy*, following reassurances over environmental concerns.

The plan has faced widespread criticism due to its impact on climate change.

Supporters of the project say it is vital for the energy security as it will reduce reliance on imports.

Its owners say it will create about 1,600 jobs during the height of construction, support 450 UK-based jobs during its lifetime, and provide "a significant amount of tax revenues for the treasury".

It comes after the UK government said in July that it would issue hundreds of new licences for oil and gas exploration in the North Sea.

But last month 50 MPs and peers from all major parties raised concerns Rosebank could produce 200 million tonnes of carbon dioxide and urged then Energy Secretary Grant Shapps to block it.



It has been predicted that Rosebank could produce **69,000 barrels of oil a day** at its peak, and about **44 million cubic feet of gas per day** in its first 10 years.

Production is expected to begin in 2026/27 but a senior executive with Norwegian state oil company Equinor has admitted the new field will not be electrified at that point.

Electrification of the extraction process is one of the key industry pledges for reducing its production emissions.

The oil and gas regulator, North Sea Transition Authority, said approval had been awarded "in accordance with our published guidance and taking net zero considerations into account throughout the project's lifecycle".

Prime Minister Rishi Sunak said it "makes sense" for the UK to use its own oil and gas supplies as the UK makes the transition to renewables.

The UK has a target to hit net zero - emitting no more greenhouse gases such as carbon dioxide than the amount taken out of the atmosphere - by 2050.

"This is the right long-term decision for the UK's energy security," he added.

Meanwhile **Energy Security Secretary Claire Coutinho** said its value to the economy would give the UK greater energy independence.

"We will continue to back the UK's oil and gas industry to underpin our energy security, grow our economy and help us deliver the transition to cheaper, cleaner energy," she added.

Opponents argue the oil and gas produced from Rosebank will be sold at world market prices, so the project will not cut prices for UK consumers.

"It won't make the slightest difference to people's energy bills", the **Green Party MP Caroline Lucas** claimed on BBC Radio 4's Today programme.

Equinor - which is the majority owner of Rosebank - confirmed that during a briefing for journalists earlier.

"If the UK needs Rosebank oil, it will go to the UK through open market mechanisms", said Arne Gurtner, Equinor's senior vice president for the UK.

'Concerns unaddressed'

Scotland's Energy Secretary Neil Gray raised concerns that the majority of what will be extracted from Rosebank will go overseas rather than contribute to domestic energy security.

"We are therefore disappointed that approval has been given by the UK government while these concerns remain unaddressed," he added.

His colleague Stephen Flynn - the SNP's Westminster leader and MP for Aberdeen South, a constituency with strong links to the

oil and gas industry - did not oppose the oil field outright.

He said that if the UK government was considering oil and gas projects "through the prism of energy security, net zero, jobs, opportunities and concurrent renewables investment ... then of course it should go ahead."

"Where I have concerns is I don't think the UK government is looking at projects through that prism," he said.

Labour leader Sir Keir Starmer has confirmed that his party will not revoke the licence for Rosebank if it wins the election. But he added that no new licences would be granted if Labour gained power.

He told the BBC's Political Thinking with Nick Robinson podcast that allowing the North Sea exploration to go ahead would provide "the stability that we desperately need in our economy"

Meanwhile it was condemned as an "utter catastrophe" by the Scottish Greens, the SNP's partners in the Scottish government.

Climate spokesperson Mark Ruskell said it was the "worst possible choice at the worst possible time" and showed "total contempt for our environment and future generations".

He was among dozens of climate activists demonstrating against the Rosebank decision out the UK government offices in Edinburgh.

Another, Bryce Goodall, said: "We absolutely outraged that this has been decided in the midst of a cost of living crisis... this oil field is not going to do anything to lower energy bills or provide energy security whatsoever so I'm absolutely incensed with anger here."

Juliet Dunstone, who was also part of the protest, said: "We need to have a just transition and we need to prioritise people who are working in oil and gas to give them those green jobs and get them out of these polluting jobs that they're stuck in because we need to avert the climate crisis immediately or millions of people will die."

But **Russell Borthwick, chief executive of Aberdeen and Grampian Chamber of Commerce**, said: "Rosebank will make an important contribution to UK and European energy security, create several hundred new jobs here in Scotland and result in over **£6bn** being spent within the UK supply chain which is anchored in Aberdeen and Aberdeenshire.

"Today's announcement is a welcome shot in arm for the UK energy sector which will give investors, operators and the wider supply chain confidence as they strive to provide the power we need here and now and transition towards a net zero future."

Analysis by James Cook, BBC Scotland

For more than half a century, North Sea oil has been at the heart of economic and political debate in Scotland.

The discovery of the "black gold" turned Aberdeen into the oil capital of Europe and fuelled the Scottish independence movement.

Critics of the UK's approach say it should have followed Norway's lead by investing revenue generated by the boom in a sovereign investment fund.

Now the industry has moved westwards into the stormy waters of the North Atlantic ocean, the focus of the debate has switched to the environmental impact of drilling but those old arguments about economic benefit have been revived too.

For decades Shetland prospered handsomely from oil thanks to a deal the local council struck with energy firms to allow the construction of a terminal at Sullum Voe.

However, the oil from Rosebank will not be processed on Shetland but offloaded by tanker and sold on the international market.

Supporters say the project, run by the Norwegian state energy firm Equinor, will create hundreds of jobs and bring in billions of pounds in investment. But critics say the biggest winner is Norway.

Reference:

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Net zero boost as carbon storage licences accepted

North Sea Transition Authority
15 September 2023

- 21 licences shared by a total of 14 companies.
- Almost 10% of total UK greenhouse gas emissions could be stored in new licence locations.
- Bacton could be Energy Transition Hub – home to carbon storage, offshore wind, and hydrogen production.

The North Sea Transition Authority (NSTA) today (15 September 2023) announced the list of companies which have accepted licences following the UK's first-ever carbon storage licensing round.

A total of **14 companies** have been awarded **21 licences** in depleted oil and gas reservoirs and saline aquifers which cover around 12,000 sq km – an area equivalent to the size of Yorkshire.

The locations could store up to 30 million tonnes of CO₂ per year by 2030, approximately 10% of UK annual emissions which were 341.5 million tonnes in 2021.

Shell, Perenco and ENI have all been awarded licences off the coast of Norfolk in sites which could form part of the **Bacton Energy Hub** – a carbon storage, hydrogen and offshore wind project, which could provide low-carbon energy for London and the South East for decades to come and help in the drive to net zero greenhouse gas emissions.

Other locations include sites off the coasts of Aberdeen, Teesside, and Liverpool.

Stuart Payne, NSTA Chief Executive, said:

“Carbon storage will play a crucial role in the energy transition, storing carbon dioxide deep under the seabed and playing a key role in hydrogen production and energy hubs.

“It is exciting to award these licences and our teams will support the licensees to bring about first injection of carbon dioxide as soon as

possible. We will also continue to work with industry and government to enable further licensing activity and back the UK's drive to net zero emissions.”

It is estimated that as many as 100 storage licences will be needed to meet the requirements for reaching net zero and the volume of applications received for the first round demonstrated the industry's desire for further opportunities.

The NSTA will assess the response and the quality of opportunities in locations across the UK before deciding when to run a second round.

Six licences have already been granted by the NSTA and the Government recently announced £20bn funding for the progression of these existing projects. Two locations, Hynet and the East Coast Cluster, have been selected as Track 1, while Acorn and Viking CCS projects have been chosen as the Track 2 clusters.

The cluster sequencing process was set up to give industry the certainty it requires to deploy carbon storage at pace.

Ruth Herbert, Chief Executive at the Carbon Capture and Storage Association, said:

“The CCSA welcomes the acceptance of carbon storage licences, a significant step towards achieving net zero. These licences mark a substantial milestone towards widespread deployment of CCS.

“With the potential to store almost 10% of the UK's greenhouse gas emissions in these new locations, starting to develop these sites paves the way for a cleaner and more sustainable future. The next step is a carbon capture deployment plan to enable us to fully exploit our future CO₂ storage capacity.”

Lord Callanan, Minister for Energy Efficiency and Green Finance, said:

“The UK has one of the largest potential carbon dioxide storage capacities in Europe, putting us in prime position to be world leaders in carbon capture – which is why we've committed an unprecedented £20 billion to

develop the early stage development of carbon capture, usage and storage (CCUS).

“These new licences confirmed today will be vital to realising our CCUS potential, playing a key role in the energy transition to help boost our energy security and achieve our net zero targets, while also bringing in private investment and supporting thousands of jobs.”

The NSTA, The Crown Estate (TCE) and Crown Estate Scotland (CES) are working in close collaboration to help meet the UK Government’s ambitious carbon storage targets of 20-30 million tonnes of CO2 emissions per year by 2030, and over 50 million tonnes by 2035, and make a significant contribution to net zero.

Reference:

<https://www.linkedin.com/pulse/net-zero-boost-carbon-storage-licences%3FtrackingId=qGfoMjlnSJ5W%252BVeSUpJCSw%253D%253D/?trackingId=qGfoMjlnSJ5W%2BVeSUpJCSw%3D%3D>

Why was the Morocco earthquake so deadly?

The quake, which has killed thousands, was unusually large for Morocco and struck a region where most buildings are not earthquake-resilient.

**Michael Marshall, Nature
14 September 2023**

Morocco is dealing with the aftermath of its most devastating earthquake for decades. The tremor, which hit on 8 September in the High Atlas mountain range, around 70 kilometres southwest of Marrakesh, has killed more than 2,800 people, with thousands more injured. The death toll seems likely to rise as rescue and recovery efforts continue.

There are also cultural losses. The Tinmel Mosque in the High Atlas, listed as a potential World Heritage Site by the United Nations scientific and cultural organization UNESCO, has suffered extensive damage. Geologist Mohamed Najib Zaghloul at Abdelmalek

Essaâdi University in Tangier, Morocco, describes it as “destroyed completely”.

“Tinmel was not just any building,” says Hicham Si Mhamdi, a geoscientist at Moulay Ismaïl University in Meknes, Morocco. “It was a symbol of architectural and cultural heritage that had withstood the test of time for nearly nine centuries.”

Why was the quake so deadly?

Multiple factors have contributed, according to seismologists and disaster risk-reduction specialists.

The first was magnitude. At **6.8**, the earthquake was not huge — the one that devastated parts of Turkey and Syria in February, for example, was magnitude 7.8. But it was unusually large for Morocco. “It’s exceptional for the region,” says Rémy Bossu, secretary-general of the Euro-Mediterranean Seismological Centre in Bruyères le Châtel, France.

Northern Africa is moderately seismically active. Tremors are caused by the ongoing collision of the African and Eurasian tectonic plates. “The collision explains the seismicity from Turkey to Gibraltar,” says Bossu.

Both are continental plates, adds Ziggy Lubkowski, associate director of seismic design at the engineering consultancy Arup in London. The collision has forced rock upwards, creating the Atlas Mountains in the region where Friday’s quake happened. “It’s a rather complex, old collision.”

However, the actual fault responsible for this earthquake has not been determined, says Si Mhamdi. He says the epicentre was close to a fault that was responsible for a 1960 quake in Agadir and is therefore a potential culprit.

Maximum magnitude unknown

Because the region is only moderately active, really big earthquakes are rare, happening only once every few hundred years. Unfortunately, seismological records do not go back far enough to say how big earthquakes in this region can get, says Bossu. “It is challenging to evaluate the maximum magnitude, especially

in moderate-seismicity environments, because our observations are far too short.”

A further complication is the nature of the plate boundary. In some regions, such as Turkey, there is a single clear boundary. But in northern Africa there is “a network of faults in a much larger area”, says Bossu. Instead of a localized region with a high risk of tremors, a large area has a low but still significant risk.

The quake was particularly intense because a lot of energy had accumulated between some faults in the southern border of the High Atlas belt, says Zaghoul.

However, the biggest contributor to the disaster has been lack of preparedness, says disaster researcher Ilan Kelman at University College London. “Earthquakes don’t kill people, collapsing infrastructure does,” he says. “This was so devastating simply because people were not ready for it.”

“Regrettably, in Morocco, we lack earthquake prevention measures and early warning systems,” adds Si Mhamdi.

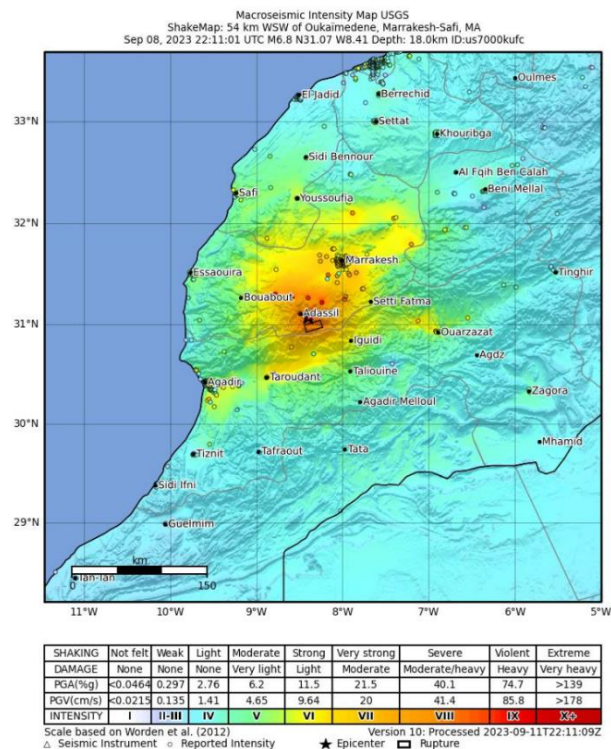
Even moderate earthquakes can be lethal if societies are not prepared, says Kelman. He highlights the magnitude-5.9 quake that struck Agadir in Morocco on 29 February 1960. About one-third of the city’s population was killed and another third injured, mostly by collapsing buildings. Although this was not a huge tremor, the US Geological Survey calls it “the most destructive ‘moderate’ quake (magnitude less than 6) in the 20th Century”.

Lack of preparation

Before the quake on 8 September, there was reason to believe Morocco could experience strong earthquakes. Kelman highlights a 2007 study that counted 1,739 major earthquakes — defined as greater than magnitude 3 and not including aftershocks — whose effects were felt in the country between 1045 and 2005, based mostly on historical descriptions (Ref 1).

And yet most buildings in the affected area were built of masonry and ‘aggregate’ — particulate matter such as gravel or sand — which is prone to collapse, says Kelman. Strengthening buildings with stronger materials

such as reinforced concrete can help, but such measures might not have been practical for the area, which has high levels of poverty, he says.



Strong ground motion map of M 6.8 - Morocco, 8 Sept 2023, Marrakech and Atlas Mountains (Ref: Wikipedia).

Buildings in Morocco are often designed to control for extremes of temperature, which are an ever-present risk, whereas earthquake resilience has taken a back seat, in part because they are rarer, says Kelman. However, in some other regions traditional building materials such as masonry or adobe have been successfully adapted to be earthquake-resilient. “We know we can do it,” he says.

When attempting to make buildings more resilient to earthquakes, the most important thing is to talk to local people, says Kelman. “They know their architecture, they know what works for their needs,” he says.

Kelman says it is also crucial to think about earthquake resilience as part of sustainable development. People are often advised to have a ‘go bag’ that contains essentials like bottled water, non-perishable food, medicines and a means of communication — but they need to

have enough money to be able to afford to maintain it.

As a result, he says, building earthquake resilience means tackling broader societal problems such as poverty and lack of education. "All aspects of disasters are political," says Kelman. "All disaster risk reduction is about development."

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1. Peláez, J. A. et al. *Seismol. Res. Lett.* 78, 614–621 (2007)
2. <https://www.nature.com/articles/d41586-023-02880-3>
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Rare iron meteorite could help reveal secrets of early solar system

The sample is the first iron meteorite from a parent body with a known orbit.

*By Robert Lea, Space.com
17 August 2023*

Scientists have studied a rare iron meteorite in detail, discovering what orbit its parent body occupied before crashing into Earth. It is the first iron meteorite for which such an orbit has been calculated.



A rare iron meteorite that fell to Earth from a fireball that blazed up over Sweden in 2020. (Image credit: Andreas Forsberg and Anders Zetterqvist.)

The 12-inch-long (30cm), 30-pound (14kg) chunk of space rock fell to Earth after a fireball erupted over Sweden in **2020**. Iron meteorites

such as this constitute just around 2% of the space rocks that make it to Earth's surface, so the object became a rare and valuable sample for researchers.

Iron meteorites are believed to be fragments of molten metallic cores at the heart of planetesimals, small bodies that existed around 4.5 billion years ago. Many of these bodies eventually came together back then to form the solar system's planets, including Earth.

As such, the studies of meteorites like this can reveal valuable information about the state of the solar system in its infancy and the sorts of elements that ended up becoming incorporated into the planets, study team members said.

"An excellent opportunity for research occurred when a bright fireball, mainly observed by the Finnish Fireball Network, on November 7, 2020, over Sweden, produced the first iron meteorite with a possibility to derive its pre-atmospheric trajectory," Jaakko Visuri, an analyst with the Finnish Fireball Network and Ursa Astronomical Association, said in a statement. "This provided us a unique chance to study the delivery mechanism of iron meteorites and to look for iron-rich reservoirs in the solar system."

Seizing this opportunity was a team of astronomers from Ukraine, led by Irina Belskaya, the head of the Department of Physics of Asteroids and Comets at Kharkiv National University's Institute of Astronomy. The research was conducted as part of a project started in 2020 dedicated to studying metal-rich asteroids, which are the parent bodies of iron meteorites.

"For the very first time, this discovery presents a documented trajectory of an iron meteoroid, showcasing a record-breaking fireball descent at a mere 7 miles (11.4 km) above the Earth's surface and also unraveling the celestial pathways it traversed before gracing our planet," said Finnish Geospatial Research Institute researcher Maraia Gritsevich. *(Meteoroids are small space rocks; they become meteors when they hit Earth's atmosphere and burn up. Pieces of these rocks*

that make it to Earth's surface are called meteorites.)

"This achievement not only provides insights into the remarkable journey it endured but also contributes to our understanding of the origins and dynamics of iron-rich space objects, thereby deepening our insight into the broader solar system," Gritsevich added.

Among the information the scientists collected about the meteorite were clues about the conditions and processes that led to its formation. This could help determine how chemical resources are distributed through the solar system.

Such work could, in turn, potentially help prepare future space missions that hunt for metal-rich asteroids that could be enticing space-mining targets.

Calculating the orbit of the meteorite's parent body helps paint a picture of the celestial mechanics at play in the early solar system, including interactions between other bodies in our cosmic backyard and the gravitational forces at play.

In addition, better predicting the path of this object could help constrain the orbits of other asteroids, with implications for planetary defense, study team members said. As such, this small iron-rich rock from space could become a stepping stone for a wealth of future space science.

Reference:

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Clue to Pterosaur Origins Found in Fossil of Flightless 'Rabbit Reptile'

A Brazilian team's finding helps fill in the fossil record to explain how the flightless reptiles evolved in the dinosaur era.

By Kate Golembiewski, *The New York Times*

16 August 2023

Pterosaurs, the flying reptiles that lived alongside the dinosaurs, are an evolutionary mystery. They appear in the fossil record fully formed, some with 33-foot wingspans, and there is very little evidence of the ancestors that came before them. A new fossil, described Wednesday in the journal **Nature**, provides an elusive glimpse of a group of reptiles most closely related to pterosaurs.

"For the first time, we are looking into the face of a pterosaur precursor, and this animal is so bizarre," said Rodrigo Temp Müller, a paleontologist at the Federal University of Santa Maria in Brazil and an author of the study.



An artist's life reconstruction of Venetoraptor gassenae, a Triassic lagerpetid, a group of animals whose name means "rabbit reptile." (Credit - Caio Fantini)

Dr. Müller found the fossil in 2022 while doing fieldwork in **Rio Grande do Sul**, Brazil's southernmost state. He spotted a piece of thighbone in the rust-red earth, and "it was clear that it was a special fossil," he said.

The bone belonged to a **lagerpetid**, a group of animals whose name means "rabbit reptile." **Lagerpetids were once considered early relatives of dinosaurs, but a study published in 2020 provided evidence that they were actually more closely related to pterosaurs.**

Lagerpetid fossils are in short supply, especially the bones from the animals' heads and hands. Dr. Müller found, in addition to the thighbone, extensive remains, including the tip of a curved beak and a nearly complete lower arm, ending in curved claws shaped like scimitar blades.

Dr. Müller said that he and his fellow paleontologists had “no idea” what lagerpetids really looked like until they found this new specimen, and that their sharp beaks and claws struck him as “very strange.”

Dr. Müller and his colleagues named the creature *Venetraptor gassenae*, which nods to its place of discovery near Vale Vêneto, its raptor-like features and Valserina Maria Bulegon Gassen, who helped found the Federal University of Santa Maria's paleontology center.



Venetraptor fossils discovered by Rodrigo Temp Müller, a paleontologist at the Federal University of Santa Maria in Brazil. “It was clear that it was a special fossil,” he said. (Credit - Janaína Brand Dillmann)

In life, 230 million years ago, *Venetraptor gassenae* was about three feet long, including its tail, and weighed between 9 and 18 pounds. Like many other early reptiles, its skin was most likely covered in feather-like filaments. Its hooked beak, Dr. Müller said, is “mysterious.” Similar structures in modern birds have various purposes, including tearing into flesh, attracting mates or eating fruit.

Unlike its pterosaur relatives, *Venetraptor* would not have been able to fly. However, Dr. Müller hypothesizes that *Venetraptor*'s large hands and curved claws could have helped it

to climb trees, a behavior that may have eventually led to jumping between branches, gliding and, eventually, true flight.

Analyzing *Venetraptor*'s skeletal traits and comparing them with its fellow Triassic reptiles revealed that the precursors of dinosaurs and pterosaurs were more diverse than previously thought. Dr. Müller said that the study challenges the belief that “earlier forms were simpler and fated to extinction to give space to the more evolved dinosaurs and pterosaurs.”

Emma Dunne, a paleontologist at the Friedrich Alexander University Erlangen-Nuremberg in Germany who was not involved with the study, said that when teaching, she often uses pterosaurs as an example of a fossil whose origins are murky. As such, she said, this discovery helps illuminate the pterosaur family tree.

“Any piece of evidence that we can get on this tree is adding to this really fragmentary story that we have about pterosaur evolution,” Dr. Dunne said.

Dr. Dunne, who has studied the lingering effects of colonialism on paleontology, also noted that she was pleased to see that the research was done by a team largely composed of Brazilian and South American scientists. “It's very important to have this kind of research situated in the country that is bearing the specimens,” she said. “It keeps the knowledge filtering through those countries where it should be, and also means that collaborative networks can be much broader and more diverse.”

Dr. Müller said that as a Brazilian, he hopes “people see the importance of Brazilian fossils, in order to make the science in Brazil more relevant.”

Reference:

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'Like swallowing a dinner plate': 180 million-year-old fish may have choked to death on its supersized supper

The fossil was hidden in a museum drawer for decades before researchers reexamined it to uncover a story about prehistoric life — and death.

By Ethan Freedman, *Live Science*
15 August 2023

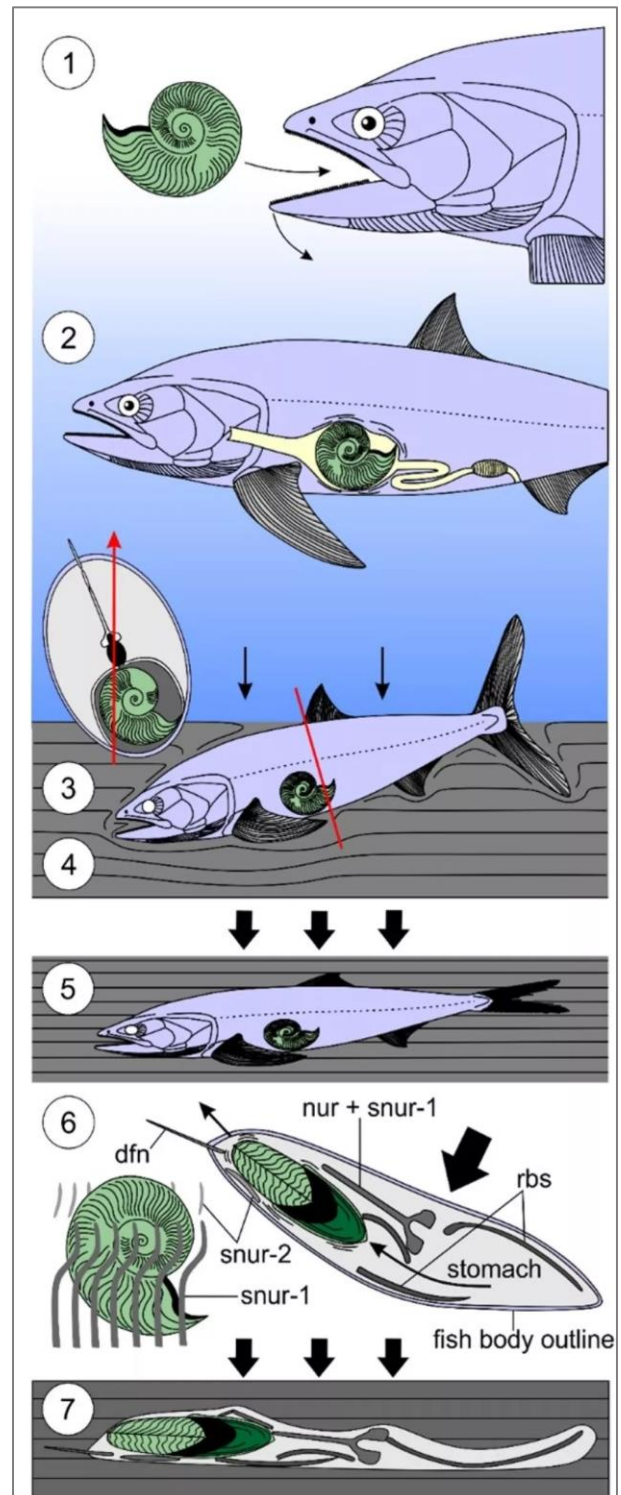


The tuna-like *Pachycormus macropterus* got an ammonite lodged inside its body just before it died, researchers found. (Image credit: Samuel Cooper)

A dinosaur-era fish appears to have died after getting eyes too big for its stomach and ingesting a giant shell, researchers have found. The fish may have then choked to death on it, or the shell tore its stomach as it swallowed, the team said.

Scientists in Germany found the fish with the shell of an ammonite — an extinct group of marine molluscs — stuck inside it. This is the first time a fossilized fish has been discovered with an intact, large ammonite inside its body,

Samuel Cooper, a doctoral candidate at the State Museum of Natural History Stuttgart in Germany, told *Live Science*.



Cartoon showing what likely happened to the Jurassic-era fish that died from eating a shell. (Image credit: Samuel Cooper)

The fossil was first dug up near Stuttgart in 1977 and stored in a museum drawer until

researchers recently took a closer look and pieced together how this prehistoric fish died.

"If you want to make a really exciting discovery in paleontology, you don't always need to visit the quarry or a cliff or even go fossil hunting," Cooper said. "All you've got to do is just go to your local museum and ask to open some drawers." Cooper and his colleague published a description of the fossil on July 24 in the journal **Geological Magazine**.

Around 180 Ma ago, during the Jurassic (201 Ma to 145 Ma ago), southwest Germany was covered in a warm, shallow sea that was home to giant marine wildlife like ichthyosaurs and plesiosaurs.

But hidden among those titanic animals was an array of smaller marine life, including *Pachycormus macropterus* — a sleek, tuna-like fish about 3 ft (0.9 m) long. Paleontologists believe that *Pachycormus* fish ate soft foods like squids, Cooper said. But one day, one fish decided to change things up.

The fossil clearly shows the imprint of a 4-inch-wide (10 cm) spiral ammonite shell lodged up against the fish's spine. And for a fish of this size, that's likely way too big to swallow.

"I suppose it's equivalent of you and I swallowing a small dinner plate," Cooper said. He speculates that the fish may have confused the shell for a more edible bit of food, or accidentally swallowed the shell while eating around it.

Researchers previously knew that the museum held a fossilized fish with an ammonite, but they thought this pairing was likely a coincidence, Cooper said. Perhaps, for example, the fish and ammonite had simply fallen in the same spot and been fossilized next to each other.

But by closely examining the specimen, Cooper found that parts of the fish were on top of the ammonite fossil and other parts were below it — showing that the shell was inside the fish when it died.

In addition, some of the aragonite — a mineral that makes up much of the ammonite's shell — is remarkably well-preserved. Aragonite tends

to break down in fossils, making it rare to find, Cooper said. But in this case, the fish's stomach may have provided a protective barrier for the shell and prevented total deterioration of the aragonite.

By piecing together the clues and finding out how these long-dead creatures lived and died, researchers can start to bring this Jurassic-era marine ecosystem back to life.

"For me," Cooper said, "it just paints a really interesting picture of what was actually going on."

Reference:

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Ancient ice age could have caused the first Europeans to go extinct

By James Ashworth, NHM
10 August 2023

Melting polar ice caps may have pushed some of the first ancient humans out of Europe.

New research suggests that meltwater shut down an important current bringing heat to the continent, with our early relatives unable to adapt to the chilly conditions.

Extreme climate change may have temporarily wiped humans out in Europe over a million years ago.

A sudden drop in ocean temperature would have caused the continent to become much colder, meaning that ancient humans unable to make fire or clothing wouldn't have been able to cope and so leaving the continent empty for hundreds of thousands of years.

Professor Chris Stringer, a Natural History Museum scientist who co-authored the paper, says, 'Such a large change in temperature

would have hit these humans hard, and they didn't quickly recover.'

'It would have led to changes in the flora and fauna as well, which could have left these humans with limited food options. Smaller cold stages later on would have delayed any recovery further, meaning that western Europe was probably depopulated for a long period of time.'

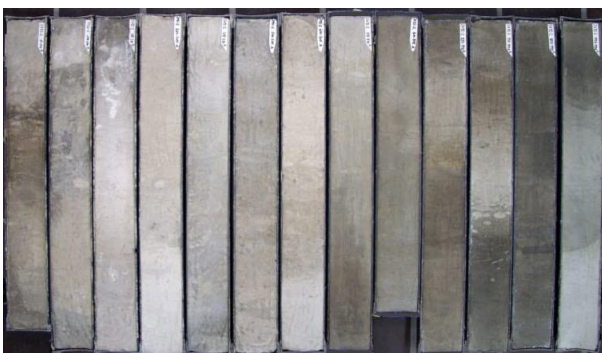
The findings of the study were published in the journal **Science**.

The first humans in Europe

The earliest evidence of humans in Europe comes from Dmanisi in Georgia, where fossils and stone tools dating back around 1.8 million years were unearthed. These fossils are usually assigned to the species *Homo erectus* and are generally agreed to be the first evidence of humans outside Africa.

While some ancient humans continued travelling deeper into Asia, others moved west into Europe. Stone tools and fossils of ancient humans are known from Italy and southern Europe from between 1.4-1.5 million years ago, while others have been found in Spain from about 1.2 million years ago.

'In general, the evidence for humans in Europe at this time is quite sparse and fragmentary,' Chris explains. 'However, it had been assumed that once humans arrived they were present more or less continuously, even if they were in small numbers.'



Changes in the lightness of sediment cores reflect the climate cycles of the distant past, allowing researchers to compare the timings with fossils. (Image © Hannes Grobe, AWI, licensed under CC BY 3.0 via Wikimedia Commons.)

At the time, the climate of the Mediterranean region was generally similar to the present, but with wetter conditions that supported a mix of woodland, shrubland and wetland that provided a range of different food sources for humans and other wildlife. These periods of warmer conditions alternated with periods of relatively mild cold stages.

Until recently, it was thought that these variable conditions continued until around 900,000 years ago, when changes to climate cycles meant that Europe's cold periods became longer and more intense. But this new study has revealed that around 1.1 million years ago there was a much harsher cold snap which had potentially fatal consequences for the humans living in Europe at the time.

The researchers used the marine cores taken from the coast of Portugal to calculate the ocean temperature at the time by examining the levels of organic molecules produced by a type of marine plankton. They also looked at pollen levels to get an idea of how the ecosystems on land were changing too.

Professor Axel Timmermann, a climate expert who co-authored the paper, says, 'According to the sediment core data, temperatures rapidly dropped by 5-7°C in the eastern Atlantic about 1.12 million years ago.'

'Our modelling of this event suggests that it would have resulted in a widespread and long-lasting cooling of Europe by at least 3°C. I was quite surprised to see such a massive cooling event happening so early, as we were only aware of much younger events.'

The team believe that this cooling was caused by the melting and rapid disintegration of a large ice sheet covering the Arctic, as well as parts of North America and Europe. The large amount of freshwater entering the ocean would have disrupted the **Atlantic Meridional Overturning Circulation (AMOC)**, which brings warm water from the tropics into the north Atlantic, and weakened it by as much as 95%.

Professor Chronis Tzedakis, another co-author of the research, adds, 'While there is a large body of evidence suggesting that glacial

activity intensified around the North Sea at that time, we're not sure why.'

'It's possible that this may have something to do with the particular configuration of the Earth's orbit at that time. In any case, this is probably the first time that the glacial cycle became elongated, leading to long lasting changes in the planet's climate.'

How did Europe change 1.1 million years ago?

As Europe became colder, the world our ancient relatives were used to would have changed dramatically.

The scientists estimated that the amount of habitable Mediterranean coastline for our ancestors would have halved, with overall plant growth dropping by a similar amount. Instead, semi-desert conditions similar to the steppes of Asia today would have become more prevalent.

The team found that pollen associated with steppe plants, such as grasses and shrubs, was about 45% more common in the sediment following the temperature change.

As these plants are not especially nutritious for humans, it would have been more difficult for them to find enough food to survive. They may also have lacked additional fat reserves meaning they were less adapted to cold conditions.

As a result, the humans who didn't immediately die during the harsh conditions would likely have looked for more hospitable places to live outside of Europe. While the team's research focused on Spain and Portugal, they suspect that the inhospitable conditions might have extended further along the Mediterranean coast, and perhaps even reached southwestern Asia.

If this was the case, then Europe may have been empty of humans for around 200,000 years. When humans did return between 850,000 and 950,000 years ago, they were quite different from the people they replaced.

'When humans came back to Europe, as evidenced by ancient footprints in Happisburgh in the UK and similar aged sites, they were

tolerating colder winters than today,' Chris says. 'It suggests they may have adapted to become more resilient to the cold, or had developed new hunting techniques, for example, to help them survive.'

'It's assumed that these humans were *Homo antecessor*, based on the timing, but without human fossils at Happisburgh we can't be sure.'

While the researchers' findings represent a past instance of climate change, they also act as a warning about modern climate change. A recent paper, for instance, predicted that the melting of Greenland's ice caps could cause the AMOC to shut down sometime this century.

Even if this prediction comes to pass, however, history will not repeat itself. The extent of climate change means that any cooling effect will be cancelled out by rising temperatures, leaving modern humans to face a very different challenge to the one their ancestors did 1.1 million years ago.

Reference:

<https://www.nhm.ac.uk/discover/news/2023/august/ancient-ice-age-could-have-caused-first-europeans-go-extinct.html>

Thanks to *Mike Millar* for suggesting this article.

Jurassic Coast: West Bay beach cordoned off after large rock fall

BBC News
9 August 2023



Dorset Council warned people to stay away from the edge and base of cliffs. (IMAGE SOURCE, WEST BAY PHOTOGRAPHY)

Part of a Dorset beach has been cordoned off after a large rock fall. Part of the cliff at East Beach, in West Bay, near Bridport, collapsed on Tuesday evening. Another large fall happened in the same area of the Jurassic Coast in May.

A Dorset Council spokesman said West Bay coastguard had cordoned off the beach, adding: "Our rangers will check the area, make sure there are signs warning people of the dangers and checking the coast path."

The authority said it was notified of the incident by Solent Coastguard. The spokesman added: "The Jurassic Coast is a wonderful place to visit but it's important to use common sense and caution - stay away from the edge and base of cliffs and always pay attention to warning signs, safety messages and the tides."

"Golden rules" on the Jurassic Coast

- Stay away from the edge of the cliff top - admire the view from a safe distance.
- Stay away from the base of cliffs: rock falls and landslides can happen at any time. If you are under a rock fall, the likelihood is you will die.
- Pay attention to warning signs - they are there for your safety.
- Check tide times before you set off to avoid being cut off by incoming tides.
- Keep dogs on leads near the cliff edge.

Source: Dorset Council

The rockfall follows a period of heavy winds and rain as a result of **Storm Antoni**. The National Coastwatch Institution team at Lyme Bay cautioned visitors to "take extra care" near the cliffs following the rockfall which was "possibly due in part to recent rain", and said other slips could occur.

One of the biggest landslips in recent years took place last month in nearby Seatown.

The council said it would continue to monitor active cliffs in the area.

The **Jurassic Coast** is a UNESCO World Heritage Site and home to rocks and fossils dating back 185 million years.

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2. <https://www.bbc.co.uk/news/av/uk-england-dorset-66467059>

Spectacularly Preserved Jellyfish Found in 500-Million-Year-Old Rock

By Michelle Starr, Nature
2 August 2023

Something truly and wonderfully special has been found in a 505-million-year-old Canadian fossil bed.

There, preserved in the especially fine silt of a *lagerstätte*, paleontologists found more than 170 exquisite fossils of ancient jellyfish that swam Earth's waters hundreds of millions of years before the first dinosaurs trod its soil.



An artist's impression of Burgessomedusa phasmiformis. (Credit: Christian McCall)

The find is incredible because soft tissues are so rarely preserved in the fossil record, and these are so beautifully immortalized that even anatomical details, like their little jelly tentacles, are visible. And the newly discovered species, ***Burgessomedusa phasmiformis***, now represents the earliest known jellyfish on the planet.

"Although jellyfish and their relatives are thought to be one of the earliest animal groups to have evolved, they have been remarkably hard to pin down in the Cambrian fossil record," says paleontologist Joe Moysiuk of the University of Toronto and Royal Ontario Museum in Canada. "This discovery leaves no doubt they were swimming about at that time."



A slab with two specimens of *Burgessomedusa phasmiformis* with tentacles intact. (Credit: Jean-Bernard Caron © Royal Ontario Museum)

Most of the fossil record we have consists of hard bony bits that are better able to survive the various fossilization processes. Soft tissue is much more delicate and degrades more quickly, so the records of it are few. If it will be retained at all, a type of fossil bed called a *lagerstätte* is the place to look.

The Burgess Shale in Canada is a famous *lagerstätte* that has preserved many soft animals from the Cambrian period. It was once the bed of a body of water; animals that lived therein fell into the fine silt, where time and pressure worked their long magics to preserve them, often soft tissue and all.

Jellyfish, belonging to the **phylum Cnidaria**, are very soft tissue, so we don't expect them to be preserved all that often, if at all. Cnidarian preservation is not unknown, though. Cnidarians of the polyp variety – those that are anchored to rocks – have been found in fossil beds dating up to 560 million years ago.

Polyps are the early life stage of modern jellies, but there are some polyps that remain polyps. Scientists believe that, evolutionarily, polyps came first and later transitioned into free-swimming creatures – Cnidarians of the medusa variety, otherwise known as jellyfish.

But the absence of medusae in the fossil record made this change difficult to characterize. There were some previous fossils thought to be jellyfish, but they were later classified as comb jellies, belonging to a different phylum entirely, **Ctenophora**.

The discovery of *Burgessomedusa* gives us a new baseline for calculating the timeline of jellyfish evolution. And it drives home the diversity of Cambrian marine ecosystems, which have the appearance of domination by hard-shelled creatures, as those are more readily preserved as fossils. Instead, they would have been rich and complex, with a range of squishy predators, too.

"Finding such incredibly delicate animals preserved in rock layers on top of these mountains is such a wondrous discovery," says paleontologist Jean-Bernard Caron of the Royal Ontario Museum.

"*Burgessomedusa* adds to the complexity of Cambrian food webs, and like *Anomalocaris*, which lived in the same environment, these jellyfish were efficient swimming predators. This adds yet another remarkable lineage of animals that the Burgess Shale has preserved, chronicling the evolution of life on Earth."

The research has been published in the **Proceedings of the Royal Society B Biological Sciences**.

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New fossil whale might have been the world's heaviest-ever animal

By James Ashworth, NHM
2 August 2023

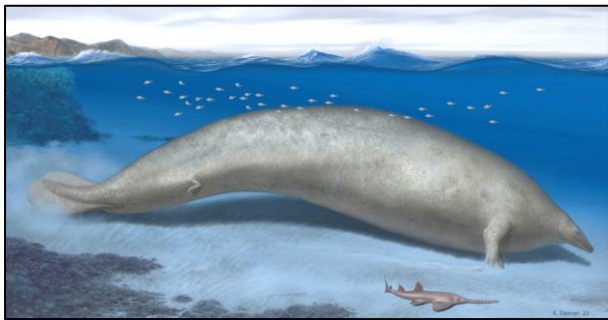
A new species of early whale might be the heaviest animal which has ever lived.

While its exact weight is a matter of debate, its unusual bones mean scientists can be certain that it was no ordinary cetacean.

Fossils found in Peru are redefining the history of whale evolution.

Named for its size and country of origin, a new paper estimates that *Perucetus colossus* could

have weighed **as much as 340 tonnes**. If correct, the ancient whale would have weighed twice as much as the current record holder, the blue whale.



Living between around 40 and 38 million years ago, *Perucetus* is a very early example of gigantism in the whale family. (Image © Alberto Gennari)

While researchers aren't sure that the 40-million-year-old cetacean would have been quite this heavy, its extraordinary fossils point to it being unlike anything alive today.

Dr. Travis Park, who researches whale evolution at the Museum and was not involved in the study, says, '*Perucetus* is the size of a whale but would have had a way of life more like a manatee or dugong.'

'While it may not have been as heavy as 340 tonnes, it pushes back the occurrence of extreme body mass in the cetaceans by about 30 million years. It demonstrates just how important Peru is to study ancient marine fossils, and that the cetaceans have many more surprises left in store.'

The findings of the study were published in the journal **Nature**.

The heaviest animal ever?

As soon as *Perucetus*' fossils were discovered in Peru's Ica Valley, it was immediately obvious that it was a very unusual species, even compared to the giant penguins and proto-whales which have previously been found in the region.

In total 18 bones were found, including 13 vertebrae, four ribs and part of the right hip. All of these bones are much larger than those of other whales from this time period, around 3.5

time bigger when compared to *Cynthiacetus*, one of its best-preserved relatives.



The bones of *Perucetus* are much denser than any from living whale. (Image © Giovanni Bianucci)

There are two main reasons for this difference. Firstly, the bones show a condition known as *osteosclerosis*, where cavities inside the bone have been filled in, while the bones are also *pachyostotic*, meaning extra bone has grown around the outside.

While it's possible these features may be pathologic, meaning the animal was suffering from disease, all of the bones were affected equally. These conditions are also found naturally in the bones of some modern animals such as dugongs and manatees, known together as **sirenians**.

Together, this suggests that the bones may have evolved to be extraordinarily dense. In sirenians, this is thought to be an adaptation to try and keep the large, buoyant marine mammals underwater as they feed, so it could have been similar for *Perucetus*.

To calculate just how much this unusual whale's skeleton weighed, the researchers used the size and density of the bones in addition to comparisons to Museum specimens, such as **Hope the blue whale**. They estimate it weighed between 5.3 to 7.6 tonnes, the heaviest of any mammal and about the same as a fully grown African elephant.

Estimating how much the animal would have weighed when it was alive, however, is trickier. This is in part because *Perucetus* belongs to a group of extinct cetaceans known as **basilosaurids**, which were unlike almost any other living animal.

'The body plan of large basilosaurids like *Basilosaurus* itself are almost serpentine, and there's no living mammal like them today,' Travis says. 'Therefore, trying to use modern animals to estimate what *Perucetus* would have been like will never be completely accurate.'

To try and make an estimate, the researchers used a value known as **the skeletal fraction (SF)**, which represents the amount of overall body mass made up of bones. This means that if you know the size and weight of a skeleton, it can be used to give an estimate of total body weight.

By using the SF of manatees and cetaceans, the researchers found that *Perucetus*' overall weight was **likely somewhere between 85 and 340 tonnes**.

If this upper limit is correct then *Perucetus* would have been the heaviest animal ever to exist, but even at its lightest, it would still have been heavier than any land animal that's ever lived, including the titanosaurs.

But regardless of being a potential record holder, *Perucetus*' extreme size also means that it is rewriting the history of whale evolution.

'In the overall history of cetacean body size, *Perucetus* is definitely an outlier,' Travis says. 'We knew that one of its relatives, *Basilosaurus*, was reaching around 20 metres in length but it was nowhere near as heavy.'

'Other whales didn't reach a similar weight until the evolution of baleen whales tens of millions of years later. Even if it's not heavier than a blue whale, it is probably pretty close to the threshold of how big these animals can be.'

How did *Perucetus* live?

Due to the unusual characteristics of the skeleton and its incompleteness, the researchers can't be completely certain how *Perucetus* would have lived. However, based on its relatives scientists have been able to make a few inferences.

'As a basilosaurid, *Perucetus* was among the first cetaceans that were really adapted for oceanic life,' Travis explains. 'They were the first cetaceans to have a truly global reach and

were generally adapted for coastal environments.'

The extremely dense bones suggest that *Perucetus* probably had a similar lifestyle to modern dugongs and manatees, with the combination of dense bone and lighter blubber allowing it to more easily control its buoyancy.

While the hip bones of *Perucetus* suggest it likely had small back legs, these were probably just evolutionary leftovers from its land-living ancestors and wouldn't have been able to support its weight.

Like manatees and dugongs, it would have lived its whole life in the water, using its large tail to swim slowly through coastal waters, occasionally surfacing to breathe.

As for what it ate, the jury is out. Because of its size, it would have needed to eat a huge amount of food, and probably spent most of its day doing so. But without a skull it can only be speculated what it might have been eating.

'The authors of the paper suggest that it might have eaten animals found on the seafloor, like molluscs and crustaceans,' Travis says. 'To eat so many of them each day, I would be surprised if it had a similar skull to its relatives, and instead it possibly would have had some kind of specialisation, perhaps suction or an expandable mouth cavity.'

Proving what it ate would mean finding more *Perucetus* fossils. If scientists are lucky, a more complete skeleton may be lying beneath the Peruvian plains, just waiting to resurface.

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Hemel Hempstead boy finds megalodon shark tooth at Walton-on-the-Naze

Kate Scotter, BBC Science
1 August 2023

A 13-year-old boy has found a shark tooth believed to have belonged to a giant prehistoric creature.

Ben discovered the 10cm-long tooth at Walton-on-the-Naze in Essex during a summer holiday weekend break. The teenager's dad, Jason, said his son was "over the moon" with the find and knew the second he saw it "it was something".

Essex Wildlife Trust said it was a **megalodon tooth** and intact ones, like the one found, were a "rare find".

Jason and his son were on a weekend break from their home in Hemel Hempstead, Hertfordshire especially to go searching for fossils.

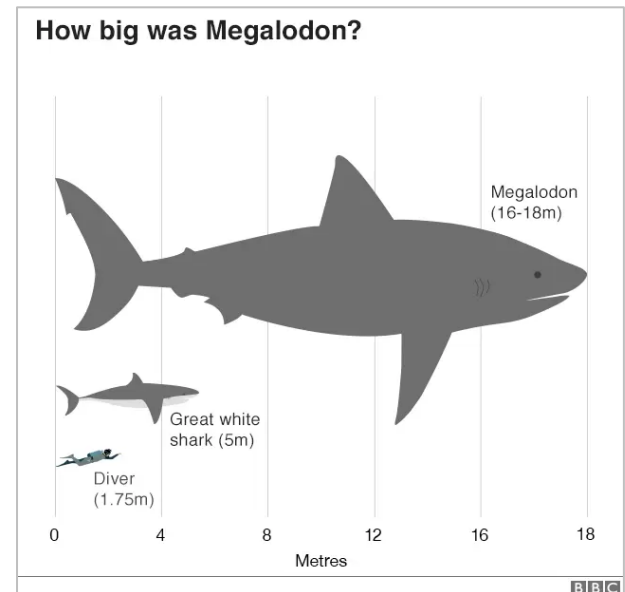
They arrived on Friday evening and by Sunday morning had already clocked up 16 miles (26km) of walking along the coast.



The 10cm-long (4in) tooth Ben found at Walton-on-the-Naze in Essex. Essex Wildlife Trust said the tooth found by Ben was a megalodon. (Image source: BBC News)

They were up at the crack of dawn on Sunday and were down at the beach first thing when Ben found the giant tooth under rocks at about 07:00 BST.

Jason, 50, said: "We could just see the edge of it, sticking out, and Ben knew straightaway it was something and pulled it out of the sand."



The pair took their find to Essex Wildlife Trust's Discovery Centre at Walton-on-the-Naze where they were told it was a megalodon tooth.

Megalodon was a maximum of 16 - 18 metres long, great white sharks are 5 metres and humans about 1.75 metres

Jason said he and his son go to Walton-on-the-Naze to go fossil hunting once a year and also to the Jurassic Coast, a 95-mile (153km) long stretch of coastline in southern England.

He said Ben wants to be a palaeontologist when he is older and the giant tooth was a "great addition" to his collection.

Essex Wildlife Trust said the tooth would be from 20 million to 3.6 million years old. It said several had been found at The Naze but more commonly they were fragments of the teeth.

The megalodon

The cartilaginous fish (whose skeleton is made of cartilage rather than bone) was a carnivore and had no known predators.

- It could eat anything it liked, but its favourite food was whales, although seals would also have been on the menu.
- Most of this shark's hunting was in the open sea (juveniles lived closer to shore) and it

attacked its prey near the surface, when it came up for air.

- Megalodon could swim at high speed in short bursts so tended to rush its prey from beneath.
- It would first aim to disable its prey by injuring a flipper or the tail, then once unable to swim properly, the victim would be easier to finish off.
- Lived from about 20 million years ago, long after the dinosaurs became extinct 65 million years ago.



Megalodon was a giant and dwarfed all other sea creatures. (Image Source: Getty Images)

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What is an oil and gas licence?

By Michael Race, Business Reporter, BBC News
31 July 2023



Credit: Getty Images

Around 100 new oil and gas licences for the North Sea are up for grabs, with the first of the new permits set to be awarded in the autumn.

Prime Minister Rishi Sunak says the licences are part of the UK's plans to bolster its energy security and make the UK less reliant on other countries for supplies.

But critics argue that extracting oil and gas is not the right approach for the environment.

What is an oil and gas licence?

In very simple terms, an oil and gas licence is permit for a company to explore and potentially extract oil and gas from a defined area of land either onshore or offshore.

There are two types of licence:

Exploration - this licence allows the holder to explore a specific area for fossil fuels but not produce them. Exploration licences are issued less often and are usually wanted by companies that wish to conduct seismic surveys and then sell information onto other firms.

Production - this type of licence enables a company to explore for and then drill to extract oil and gas. It is subject to further permits and companies holding these licences have to apply for consents and approvals along the way.

In the current round, **all of the 100 available are for production licences.**

That might sound like lots of oil and gas drilling happening. But the North Sea Transition Authority (NSTA) which is responsible for issuing the licences, says that the majority of production permits issued "do not end up with production actually taking place".

Oil and gas analyst Nathan Piper says to be awarded a licence, companies bid against each other.

But this is not about companies throwing cash around. Companies who are bidding have to commit to carrying out a certain amount of work on a site for a certain amount of time, which can typically be between two or three years.

During this period, firms will explore the area for oil or gas and carry out scientific tests, before deciding whether it is worth investing millions of pounds. They will then apply for a

new licence to drill and potentially create oil wells to produce fuel.

How many licences have been issued in recent years?

First, a brief bit of history. After being discovered in the 1960s, oil and gas exploration in the North Sea kicked off in the 1970s, around the time of the Iranian oil crisis.

There have been 33 licensing rounds since, with the latest beginning in October 2022.

There is no set time for when licensing rounds occur - it can depend on various factors such as current permits ending or new scientific information.

In the 32nd licencing round in 2020, 113 permits were awarded while so far in the latest round, 115 applications have been made. The NSTA is now considering those bids and will hand out licences to the winners in the autumn.

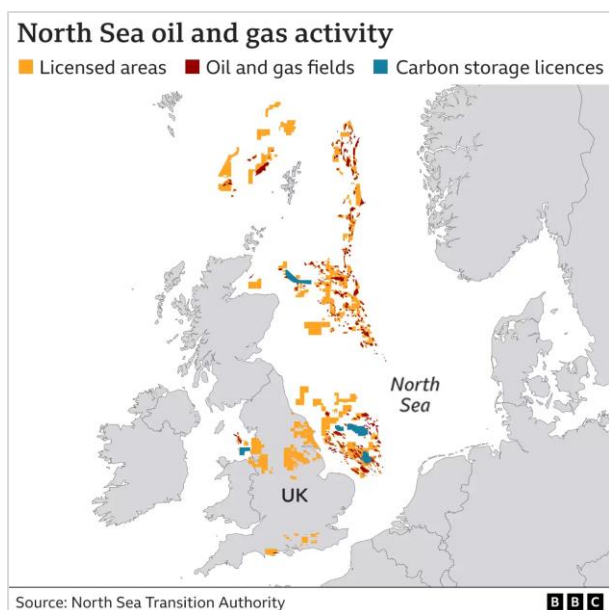


IMAGE SOURCE: NSTA, BBC

Is North Sea oil and gas extraction going up or down?

North Sea oil and gas production has been declining on the whole since it peaked in the late 1990s, but it is slightly higher now than it was in 2014.

In 2000, production was nearly 250 million tonnes of oil equivalent (Mtoe), but it had almost halved a decade later.

In 2022, production was less than 80 Mtoe and is forecast to continue to decline in the coming years, largely to the North Sea being a "mature" site and supplies dwindling.

Demand for fossil fuels is also expected to fall as technology for renewable energy continues to grow.

To date, more than 48 billion barrels of oil and gas has been extracted from UK waters. It is thought there is about 4 billion barrels left, but there is no guarantee that will or can be extracted.

The government is now offering 100 or so new licences in a bid to curb that trend, arguing it will "secure" the UK's domestic energy supply.

If new wells are opened, domestic production could be boosted, but it is a "risky" business, according to Mr Piper, especially given the North Sea has already been extensively explored.

"The interesting thing is how many exploration wells will be committed on the back of this exploration round," says Mr Piper.

In recent years, oil and gas firms have been taxed heavily on their UK profits and there has been concerns in the industry that this might put off companies from investing in areas such as the exploration of new oil and gas wells.

The current windfall tax - used by the government to target firms benefiting from high energy prices fuelled by the war in Ukraine - is 75% compared to 40% previously.

The government announced last month that the higher tax could be scrapped if energy prices fall back to normal levels for a sustained period. But no final decision has been made yet.

What does this mean for the UK's Net Zero targets?

Mr Sunak has said "even when we've reached net zero in 2050, a quarter of our energy needs will come from oil and gas".

He argues he would rather have this come from "supplies we have here at home", rather than "hostile states".

But environmental campaigners have called the decision "wrongheaded". Oxfam's climate change policy advisor Lyndsay Walsh says extracting more fossil fuels from the North Sea sends a "wrecking ball" through the UK's climate commitments.

Friends of the Earth says Rishi Sunak's decision is "pouring more fuel on the flames" of the unprecedented wildfires and heatwaves across the globe.

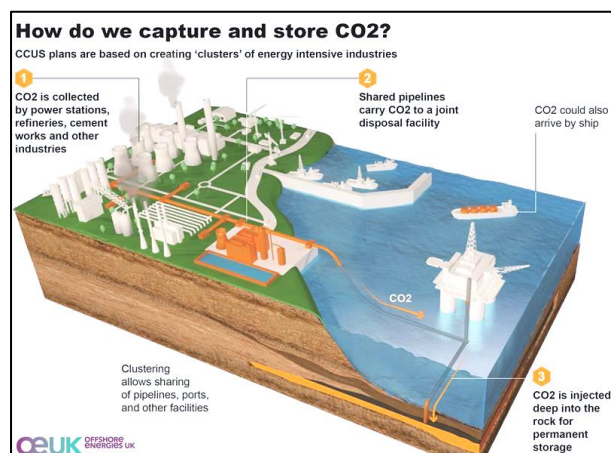
Reference:

<https://www.bbc.co.uk/news/business-66358380>

North Sea licences and carbon capture projects boost energy security and the drive to net zero

Press Release
31 July 2023

Offshore Energies UK, the leading trade association for energy firms from oil and gas to carbon capture, offshore wind and hydrogen, has greeted the government's commitment to the 33rd licencing round and its carbon capture announcements as important steps forward for long-term energy security and jobs.



Today's go-ahead for the **ACORN** and **Viking** carbon capture projects, respectively in Aberdeenshire and Humberside, is welcome news for firms that need an attractive environment to invest in energy production and to establish new technologies and jobs across the UK.

Unlocking private sector capital is the key to making the transition to a low carbon world, and companies across the energy mix are keen to see long-term, stable energy policies that help them build that future.

In addition, HM Treasury has announced a review of the oil and gas fiscal regime "to ensure the regime delivers predictability and certainty, supporting investment, jobs and the country's energy security."

David Whitehouse, OEUK CEO comments: "Domestic production is the best pathway to net zero and the UK Government's commitment to licences is a welcome boost for energy security and jobs.

"Oil and gas fields decline naturally over time. The UK needs the churn of new licences to manage production decline in-line with the maturing basin. There are currently 283 active oil and gas fields in the North Sea, by 2030 around 180 of those will have ceased production due to natural decline. If we do not replace maturing oil and gas fields with new ones, the rate of production will decline much faster than we can replace them with low carbon alternatives.

"Developing our new carbon capture industry and its high-value jobs needs significant investment from our energy producing companies. This means that the bedrock to success and delivering growth in the economy can only be collaboration between private and public capital.

"The UK's skilled offshore workforce, its engineering expertise and its geology have given our nation a unique opportunity to lead the way in building a net zero world building on the expertise of our sector in Scotland and around the UK.

"OEUK members share the vision and ambition of all parties on delivering a home-grown energy transition and net zero with potential to spend almost £200 billion over the decade. The majority of this could be spent in offshore wind, carbon capture and storage and hydrogen in the right investment environment. To deliver net zero, an unprecedented amount of private investment needs to be unlocked.

“These announcements, taken together with the launch of the fiscal review by HM Treasury, should help to foster much needed confidence in the UK’s energy sector.”

The Viking CCS project, run by OEUK members Harbour Energy alongside partner bp, and **The Acorn Project**, set up by Storegga, Shell UK, Harbour Energy and North Sea Midstream Partners, were selected as the next projects to receive government support from the £20 billion CCS fund announced in this year’s Spring Budget.

Together, the chosen projects will help to decarbonise industrial clusters in England, Wales and Scotland by capturing CO2 from heavy-emitting sectors, like oil and gas refining and steel manufacturing, and transporting the carbon via ships or pipelines to be permanently stored under the North Sea.

Combined, the projects could capture and store tonnes of carbon per year and generate up to £100bn worth of work for UK manufacturing companies by 2050. Some of the clusters will also supply hard-to-decarbonise sectors with hydrogen to power operations as a low-carbon alternative to fossil fuels.

Commenting, OEUK sustainability and policy director Mike Tholen said: “Carbon capture and storage will be a key tool in the global fight against climate change, and developing this technology is now a matter of national interest to our economy and our environment.

“This is a solution that can allow the UK to maintain reliable supplies of energy while cutting emissions, generating jobs and creating huge export opportunities. Deploying CCS at scale in the UK can help energy intensive industries to decarbonise at pace, generating jobs and creating huge export opportunities.

“We have the capabilities necessary to make this a success – large industrial clusters, millions of tonnes worth of storage capacity, and thousands of skilled people from the offshore energy industry with transferrable expertise.

“But to really kickstart the UK’s CCUS economy, we need to maintain momentum.

That means continued, targeted and urgent progress from government and industry alike.”

Fast facts:

- UK targets to store 20-30 million tonnes pa of CO2 by 2030 – meeting this target needs four clusters to be operational before 2030.
- The Climate Change Committee estimate the UK will need up to 100 million tonnes of CO2 per annum being captured and stored by the 2040s.
- UK has 78 billion tonnes of CO2 geological storage capacity under the seas around the UK in depleted oil and gas fields and saline aquifers.
- The first Carbon Storage licence round was announced by the North Sea Transition Authority in Q3 2022, with results expected in Q4 2023, as many as 100 CO2 stores will be needed by 2050.
- The UK has a target to generate 10 GW of low carbon hydrogen by 2030 which will require CCUS clusters to be commissioned and in operations.

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New dinosaur species discovered in Thailand

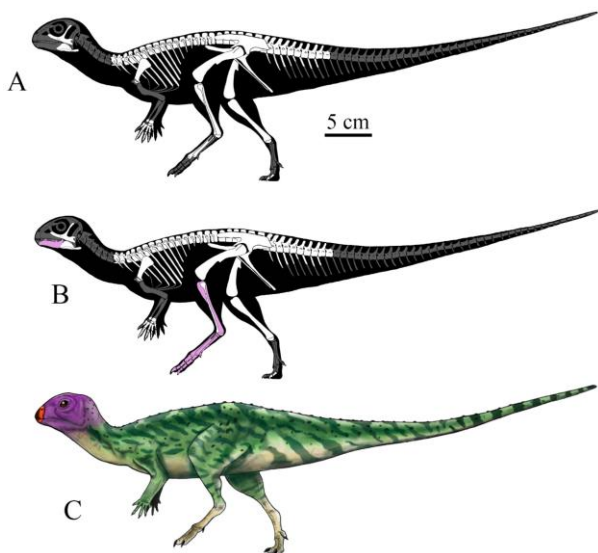
by Bob Yirka, Phys.org
28 July 2023

A multi-institutional team of paleontologists has identified a new dinosaur species dug up in Thailand in 2012. In their paper published in the journal **Diversity**, the group describes where the fossil was found, its characteristics and its condition.

The fossil was uncovered at a dig site in Phu Noi, in Northern Thailand. The geological area is known as the **Phu Kradung Formation**. The dig site has yielded a large number of fossils over the years. In this new effort, the research team focused their effort on a fossil embedded in stone that was in good condition. It is a

previously unknown species, now named *Minimocursor phunoiensis*.

The research team describes the fossil as an "exceptionally articulate skeleton," and suggest it is one of the most well-preserved dinosaurs ever discovered in Southeast Asia. They found it to be of the neornithischian clade, which were plant-eating dinosaurs.



Reconstruction of Minimocursor phunoiensis gen. et sp. nov. (PRC 150) in left lateral view (except reversed images of the right jugal). Recovered elements of the holotype shown in white (A); holotype with referred materials, which are not to scale, shown in light purple (B); and life restoration (C). Drawings by Wongwech Chowchuvech (A,B) and Sita Manitkoon (B). (Credit: Sita Manitkoon et al, Diversity (2023). DOI: 10.3390/d15070851)

The researchers also found that the dinosaur was not yet mature when it died. It had four limbs but walked on two legs. It also had a long body and long tail, and a beak-like snout with a bony lump on its jaw known as a jugal boss. It also had a ridge along its pelvis. It has been dated to 145 to 163 Ma ago. The team estimates that when full grown, the dinosaur would have been approximately 2m long.

Overall, its physical characteristics suggest it ate vegetation and was able to run quite fast to avoid being eaten by predators. The researchers note that other fossils of the same type of dinosaur have been found in the same general area, suggesting that they were very common.

The team concludes by noting that study of the fossil is still underway; some of its bones still need processing, including its skull. Once that is complete, they add, much more will be learned about the dinosaur and its place among others of its time.

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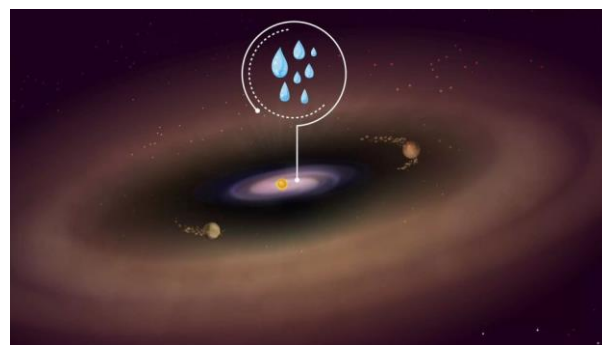
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James Webb Space Telescope spies water near centre of planet-forming disk in cosmic 1st

Some rocky worlds may have lots of water from birth.

By Charles Q. Choi, Space.com
24 July 2023

Astronomers have for the first time discovered that rocky alien worlds could possess large amounts of water from the moment they form, a new study finds.



Artist's illustration of the PDS 70 system's planet-forming disk. James Webb Space Telescope observations detected water in the inner disk, where normally terrestrial planets form. Two gas giant planets carved a wide gap in the disk made of gas and dust during their growth. (Image credit: MPIA)

Life is found virtually wherever there is water on Earth. As such, the search for potentially habitable exoplanets has mainly focused on hunting for the presence of water.

Previous research suggested that the newborn Earth got a lot of its water from water-bearing asteroids bombarding our young planet's surface after it formed. Now scientists may have discovered evidence that water could also serve as one of the initial ingredients of rocky planets available at birth.

In the new study, the researchers focused on the young star **PDS 70**, located about 370 light-years from Earth. About three-quarters the mass of the sun, PDS 70 is only about 5.4 million years old, compared to our sun's age of about 4.6 billion years.

"PDS 70 is a star similar to our sun, just younger and cooler," study lead author Giulia Perotti, an astrophysicist at the Max Planck Institute for Astronomy in Heidelberg, Germany, told Space.com. "By observing it, we can trace back how the planets in our solar system formed and what their chemical composition was before they fully formed."

Using the mid-infrared instrument (MIRI) on NASA's **James Webb Space Telescope**, the scientists discovered water near the center of the planet-forming disk of gas and dust surrounding PDS 70, in the form of hot vapor at a temperature of about 625 degrees F (330 degrees C).

"Our result shows that water is present in the inner disk of this iconic system where planets similar to Earth may be assembling," Perotti said.

In our solar system, this central zone is where Earth and the other rocky planets formed. These new findings suggest that any rocky planets originating in PDS 70's central zone would draw from a substantial reservoir of water, improving their chances of habitability later on.

PDS 70 is the first relatively old planet-forming disk where scientists have discovered water. Previous research failed to detect water in the central regions of disks of similar age, leading astronomers to speculate that harsh radiation

from newborn stars might destroy nearly all water. But these new findings challenge that idea.

"In the PDS 70 system, there is quite a lot of water available during the process of rocky planet formation," study co-author Thomas Henning, an astrophysicist and managing director of the Max Planck Institute for Astronomy, told **Space.com**.

So far, the scientists have not actually detected any planets near the center of PDS 70's disk. Discovering any such worlds requires larger telescopes, such as the Atacama Large Millimeter/submillimeter Array (ALMA) in Chile, Henning noted.

Still, they have detected two gas giant planets farther out, dubbed PDS 70 b and c. The gravitational influence of these giant worlds is actually preventing the influx of ice-rich rock from the outer parts of the disk to its center, Henning said.

One possible explanation for the presence of this water is that it was left over from a water-rich nebula that gave birth to the PDS 70 system, with dust and other material in the planet-forming zone potentially shielding this water from the star's destructive radiation, the researchers said. Another possibility is that oxygen and hydrogen gas entering the outer rims of the PDS 70 disk might have combined to form water vapor that could in turn drift closer to the star.

Future research could examine more planet-forming disks around young stars to see if PDS 70 is an unusual exception, Perotti said.

The scientists detailed their findings online in the journal **Nature**.

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[R_PF018_ECOM_GL_PHSS_ALWYS_D](https://www.nature.com/articles/s41586-023-06317-9?utm_medium=affiliate&utm_source=co)
[EEPLINK&utm_content=textlink&utm_ter](https://www.nature.com/articles/s41586-023-06317-9?utm_medium=affiliate&utm_source=co)
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[cac11ee8354c1f40a18b8fb](https://www.nature.com/articles/s41586-023-06317-9?utm_medium=affiliate&utm_source=co)

Thanks to **Liz Aston** for suggesting this article.

The Anthropocene: Canadian lake mud 'symbolic of human changes to Earth'

11 July 2023

By **Jonathan Amos**, *BBC Science Correspondent*



Crawford Lake is a limestone sinkhole that has filled with water. (Credit: Conservation Halton)

Crawford Lake, a small body of water in **Ontario, Canada**, is being put forward as the location that best records humanity's impacts on Earth.

Scientists are trying to define a new geological time period to recognise the changes we've made to the planet, and Crawford is their model example. Its sediments have captured fallout from intense fossil fuel burning, and even the plutonium from bomb tests. The muds would be symbolic of the onset of a proposed **Anthropocene Epoch**.

Researchers want to acknowledge their significance by making them a "golden spike",

or more properly a **Global Boundary Stratotype Section and Point**.

Other great transitions in geological time are associated with a GSSP. Often, it's literally a brass nail hammered into some cliff face deemed to be of major scientific importance.

But for Crawford, it would be a brass plaque next to a frozen section of the sediments, kept in a museum in the Canadian capital, Ottawa.

"Crawford is just brilliant for this," explained Dr Simon Turner from University College London. "A core from its bottom muds looks like a massive dirty lollipop, but it contains these beautiful, annually laminated sediments.

"Those annual layers record fossil fuel combustion products, plutonium, changes in geochemistry, changes in micro-ecology - all the sorts of things that chart environmental change," the secretary to the Anthropocene Working Group (AWG) told **BBC News**.



Drilling through the ice-covered lake to recover its bottom muds. (Image Source: F.McCarthy/Brock University)

You may have seen the famous **Chronostratigraphic Chart** featured in textbooks and on school classroom walls, detailing the 4.6-billion-year history of Earth. Its blocks of time - like Triassic, Jurassic and Cretaceous - trip off the tongue.

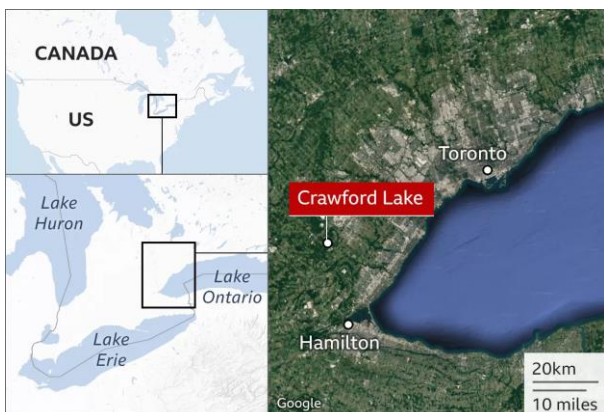
We currently live in the **Holocene Epoch**, which covers the time from the end of the last ice age, 11,700 years ago.

It's been the job of the **AWG** for the past decade to try to establish whether or not the

chart should be updated. On this question, the AWG is convinced the case has been made. A formal start date has also been identified - the 1950s.

This decade marks the beginning of the "**Great Acceleration**", when the human population and its consumption patterns suddenly speeded up. It coincides with the spread of ubiquitous "techno materials", such as aluminium, concrete and plastic.

In Crawford's sediments, scientists are able to detect the quickening, year on year.

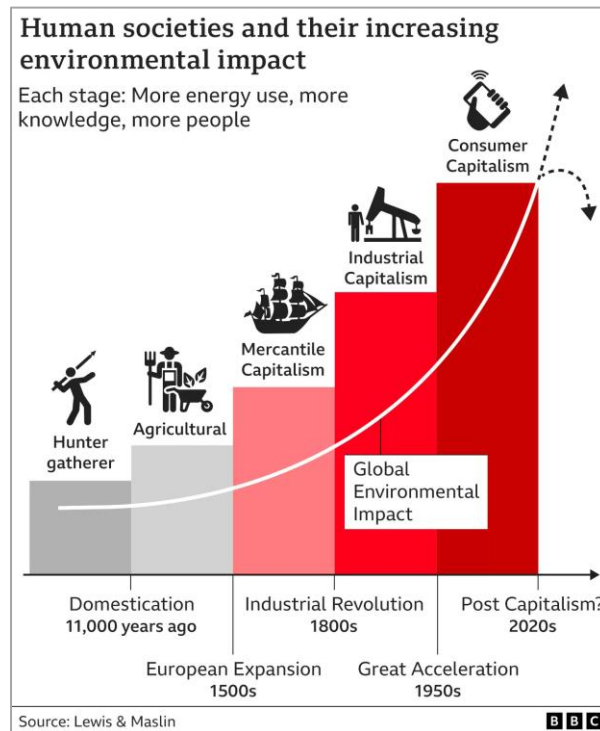


Location of Crawford Lake in Canada. (Source: BBC)

In warm summer months, the growth of algae prompts the lake water to produce tiny chalk crystals (calcite) that fall to the lake bottom as a white layer; in cold winter months, the algae and other organisms die back and their organic matter settles out as a brown/black layer. But captured within these light-dark bands are the broader environmental changes around the lake. It's almost as if the scientists are reading a barcode at a supermarket check-out.

"We see these **spheroidal carbonaceous particles** - 'fly ash' - that are produced by the very high temperature combustion of fossil fuels, primarily coal," said Prof. Francine McCarthy from Brock University in St Catharines, Ontario. "And the reason, of course, for the increase in these SCPs is that just a few 10s of km up wind from Crawford is the largest industrial city in Canada, Hamilton, where steel mills had been operating through most of the 20th Century and into the present day."

Another key marker - indeed, the primary marker - is **plutonium**. Samples of the Crawford muds were sent to the UK earlier this year to try to determine where exactly in the muddy layers the presence of the radioactive element first appears and then ticks upward.



New phase in geological history of Earth

Period	Epoch	Age
Quaternary	Anthropocene	Crawfordian – present (1950)
		Meghalayan
	Holocene	Northgrippian
		Greenlandian – 11,700 years ago
		Upper
	Pleistocene	Chibanian
		Calabrian
		Gelasian – 2.58m years ago

Source: International Commission on Stratigraphy

The proposed change to the Chronostratigraphic Chart: Epochs are subdivided into Ages, or Stages. The first Age of the Anthropocene may well be called the Crawfordian after the lake.

"We see plutonium in sediments and other materials from about 1945 onwards, relating to the atomic weapons testing programme. But

really the point at which plutonium deposition went global was following high-yield thermonuclear bomb tests, starting in 1952," said Prof Andrew Cundy.

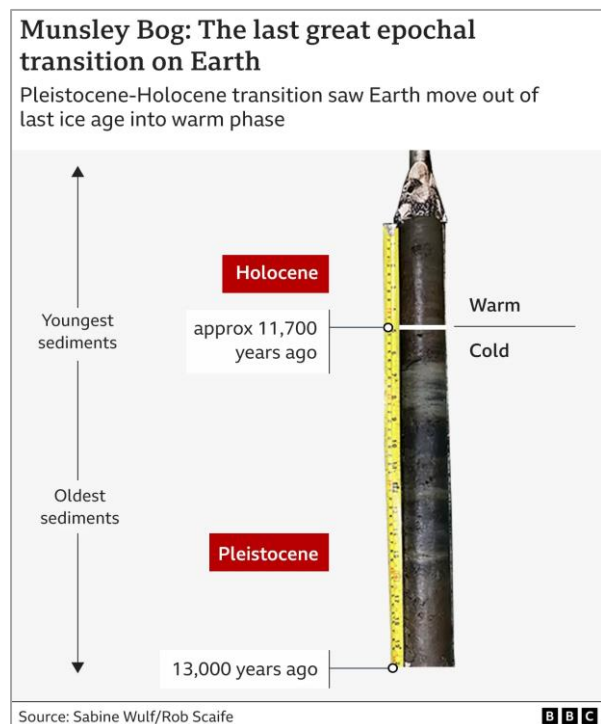
"One of the plutonium isotopes we're looking at has a half-life of 24,000 years, so it will be visible in the sediments for at least 100,000 years. Beyond that, the SCPs will still be detectable," the University of Southampton scientist told BBC News.

The AWG want to pick a specific year for the start of the **Anthropocene Epoch**, and the Southampton tests will influence this decision.

It's an extraordinary idea that geologists many millennia from now could be studying today's sediments to understand the profound changes earlier humans had imposed on Planet Earth. But this is how stratigraphy - the study of layered deposits through time - is done.

Take for example Munsley Bog on the Isle of Wight, off the south coast of England.

There, if you pick the right place in the soggy ground, it's possible to pull up mud layers that record the last great epochal transition - from the Pleistocene into the Holocene.



Traces of pollen track the loss of Arctic-Alpine plants and the invasion of birch and willow, as

Northern European glaciers recede and temperatures rise.

"When we look back, what we are learning is that some of these transitions can be really quick, in just 30 or 40 years; so within a generation," explained Prof Sabine Wulf from the University of Portsmouth.

The AWG will present its recommendations on establishing a new epoch to the wider geological community later this year. Ultimately, it will be up to the International Commission on Stratigraphy as to whether it wants to update its famous chart.

Reference:

<https://www.bbc.co.uk/news/science-environment-66132769>

Massive 1,100-pound bone of 'world's biggest dinosaur' found

The Archaeologist
7 July 2023

Now, this is one bone you don't want to pick with.



Maxime Lasseron, who is researching his doctorate at the National Museum of Natural History of Paris, inspects the femur of a Sauropod on July 24, 2019, after it was discovered earlier in the week during excavations at the palaeontological site of Angeac-Charente, near Châteauneuf-sur-Charente, south western France. (Credit: GEORGES GOBET/AFP/Getty Images)

Paleontologists have unearthed a 140 Ma old dinosaur bone, 6.5 feet in length, weighing 1,100 pounds in France. The thigh bone was discovered in **Charente**, an area that dates

back 140 Ma (*to the beginning of the Cretaceous*) and has been a treasure trove for researchers in the past.

"This is a major discovery," Ronan Allain, a paleontologist at the National History Museum of Paris said in an interview with *Reuters*. "I was especially amazed by the state of preservation of that femur."

"These are animals that probably weighed 40 to 50 tons," Allain added.

More than 7,500 fossils have been found in Charente since 2010, including those from 40 different species. It's unclear exactly what sauropod the bone belongs to just yet, but the group includes brachiosaurus and brontosaurus, seen famously in "**Jurassic Park**."

"This femur is huge! And in an exceptional state of conservation," Angouleme Museum curator Jean-François Tournepiche told The Local.

Allain added that it is "very rare" to find fossils this size, as they usually collapse on themselves and break up into fragments.

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Evidence of a new volcanic process on the Moon has been discovered

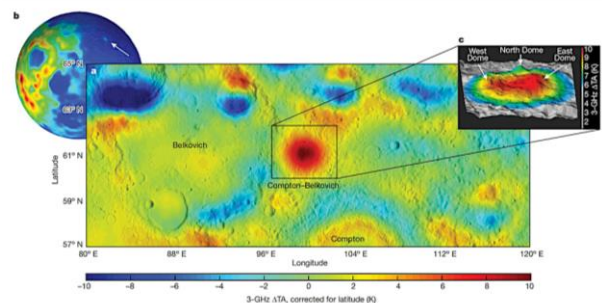
**By Keith Cowing, Spaceref
Press Release, PSI
6 July 2023**

A new instrument type has discovered evidence of a volcanic process on the Moon that had only been seen on Earth.

"Before the 1950's, most scientists thought the craters on the Moon were from volcanoes,

then, studies associated with the Apollo missions showed that they were nearly all from impacts," said **Matthew Siegler**, Senior Scientist at the **Planetary Science Institute** and author of "**Remote Detection of a Lunar Granitic Batholith at Compton-Belkovich**" that appears in *Nature*. PSI's Jianqing Fang is a co-lead author, and PSI funded students Katelyn Lehman and Mackenzie White are co-authors.

"There was plentiful volcanism, with flood basalts, thin flowing lavas, covering about 16% of the Moon, but not much in the way of thicker, silicic lavas that could form something that we would call a volcano," Siegler said.

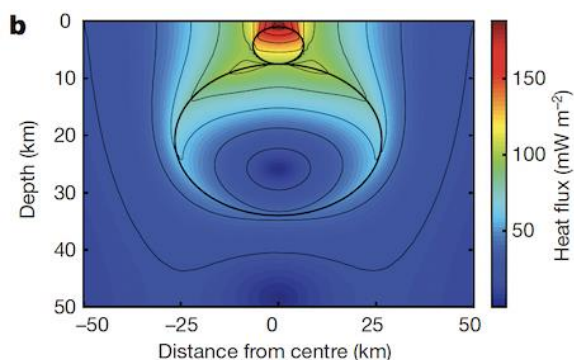
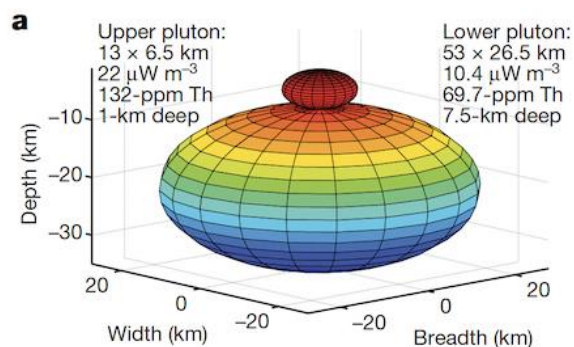


Latitudinally corrected 3-GHz TA shown at midnight local time. (a) These data show a clear localized antenna temperature (TA) enhancement of about 9 degrees Kelvin centered on the mapped Compton–Belkovich topographic feature. This feature is not explainable by topography, surface rock distribution or material properties and is seen at all frequencies and times of day. (b,c) The context globe shows Lunar Prospector-measured thorium scaled 0–35-ppm Th (b) and the perspective view shows the TA superimposed on the central surface feature resembling a volcanic system topography (c). (Credit: Matthew Siegler, PSI)

"Using an instrument looking at microwave wavelengths – longer than infrared – sent to the Moon on both the Chinese Chang'E 1 and 2 orbiters, we have been able to map temperatures below the surface. What we found was that one of these suspected volcanoes, known as *Compton-Belkovich*, was absolutely glowing at microwave wavelengths," Siegler said. "What this means is that it is hot, not necessarily at the surface, as you would

see in infrared, but under the surface. The only way to explain this is from extra heat coming from somewhere below the feature within the deeper lunar crust. So *Compton-Belkovich*, thought to be a volcano, is also hiding a large heat source below it.”

Surface evidence shows this volcano likely last erupted 3.5 billion years ago so the heat is not from molten lava or anything of that sort, but instead comes from the radioactive elements in the now solid rock. The only type of rock that really contains enough of those radioactive elements is granite. So the data collected with a fundamentally new type of microwave instrument shows that a large volcano on the Moon was once fed by a much larger granite magma chamber below it – the most Earth-like volcanism on the Moon.



The favoured *Compton-Belkovich* pluton model based on (a) fitting of the surface heat flux enhancement, (b) the resulting heat flux. (Credit: Matthew Siegler, PSI)

A granitic batholith is a huge body larger than 20 kilometers of what was once subsurface lava that never erupted. Batholiths lie below volcanic chains, like the Andes or the Cascade mountain ranges, and are basically the plumbing system that feeds them. When these plumbing systems cool, they form granite.

Granites, nearly absent in the Solar System outside of Earth, are a type of rock that is basically cooled-off lava that never made it to the surface.

“It was a neat project in that China made their data public – as does NASA – and we were able to work with this unique data set to figure out something really interesting about the Moon. Following the rules, we could not collaborate with Chinese researchers directly and all funding came only from NASA, so we had to follow the breadcrumbs to crack this dataset open” Siegler said. “Jianqing’s ability to come to the U.S. through the J visa system to navigate the data and existing literature on the topic was very valuable. It is a great example of what can be done if science and politics can work together.”

Siegler’s and Feng’s work on the project was funded by a grant to PSI from NASA’s Lunar Data Analysis program and Lunar Reconnaissance Orbiter mission.

Reference:

<https://spaceref.com/science-and-exploration/evidence-of-a-new-volcanic-process-on-the-moon-has-been-discovered/>

New Dinosaur species discovered in Utah lived in an era of epic ecological changes

By PLOS
4 July 2023

New insights into how dinosaurs weather mid-Cretaceous ecological change.

*A new study reveals how a newly discovered dinosaur species, named *Iani smithi*, provides crucial insights into significant ecological changes that transpired in North America around 100 Ma ago. Living during the early Late Cretaceous, *Iani smithi*, discovered in Utah’s Cedar Mountain Formation, belonged to an early branch of ornithomimid dinosaurs. This discovery, coupled with others from the same geologic formation, shows that despite the era’s ecological upheavals, several major dinosaur groups endured. Furthermore, the*

authors point out the discovery's significance in connecting the extinction of early ornithopods in North America to a notable global warming interval, which intriguingly mirrors our current climate crisis.

A new species of dinosaur from Utah sheds light on major North American ecological changes around 100 Ma ago, according to a study published June 7, 2023 in the open-access journal **PLOS ONE** by Lindsay Zanno of the North Carolina Museum of Natural Sciences and colleagues.

The boundary between the Early and Late Cretaceous Period saw major reassembly of global ecosystems associated with a peak in global temperatures. In the fossil record of western North America, this ecological shift has been well-documented for marine habitats, but less study has been done regarding terrestrial life. In this study, Zanno and colleagues identify a new dinosaur from the early Late Cretaceous Cedar Mountain Formation of Utah.

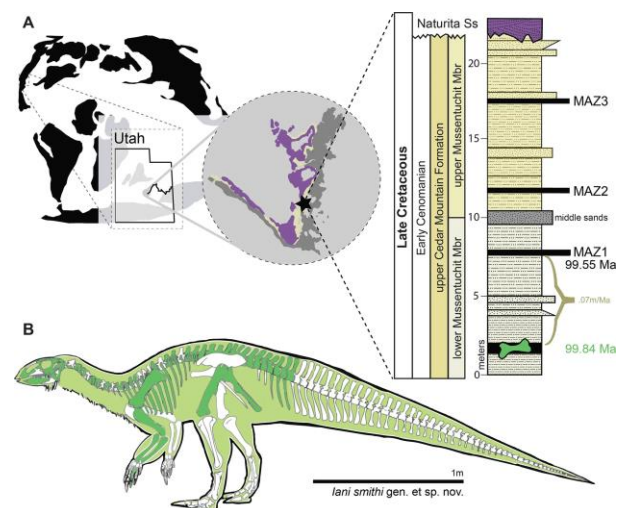


Artist's reconstruction of *Iani smithi*. This newly discovered dinosaur provides significant insights into the considerable ecological shifts that occurred around 100 million years ago in North America. Its survival during a period of global warming parallels the present-day climate crisis. (Credit: Jorge Gonzalez)

The new dinosaur, named *Iani smithi*, lived around 100 Ma ago and is known from a single fossil specimen including a well-preserved skull and parts of the spine and limbs. The name derives from Ianus, a Roman deity who presided over transitions, referencing the changing world of the mid-Cretaceous.

Iani is a member of an early branch of the ornithomimid dinosaurs, a group of mostly bipedal herbivores that also includes famous examples like *Iguanodon* and *Tenontosaurus*. *Iani* is the first early-diverging ornithomimid known from the Late Cretaceous of North America.

This discovery, along with other recent reports from the same geologic formation, indicates that several major groups of dinosaurs survived into the early Late Cretaceous despite the ecological changes of the time, but exactly what these survivors were doing and how long they lasted is still unclear. Since *Iani* and its closest cousins are typically found in ancient coastal habitats along the shores of the now-vanished Western Interior Seaway, the authors suggest that more investigation into coastal deposits of similar age might yield further evidence to address these lingering questions



Location of holotype locality for *Iani smithi*. (A) Global map showing location of Mussentuchit Member outcrop in central Utah, western North America, and a stratigraphic section at the quarry with dated ash horizons; and (B) graphical representation of preserved skeletal elements of the holotype specimen. Preserved elements are colored on the left-facing skeletal view whether they derive from the right or left side of the body. Exact positions of chevrons and ribs unknown due to poor preservation. (Credit: Zanno et al., 2023, PLOS ONE, (CC-BY 4.0))

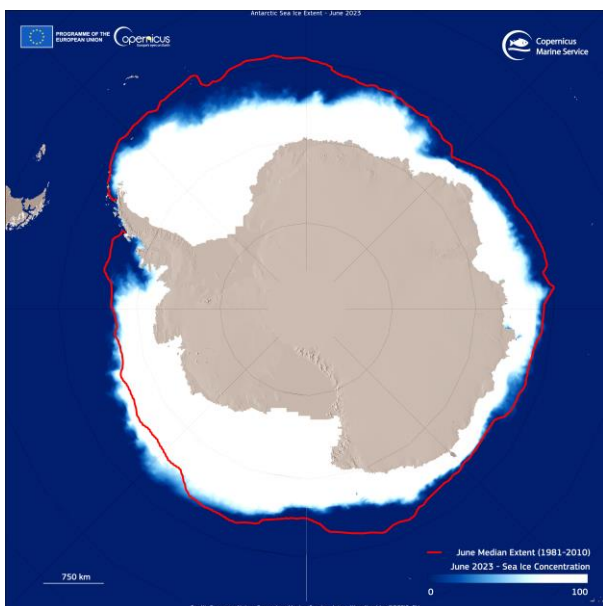
The authors add: "Early ornithomimids were once a common part of North American ecosystems, but we did not know they survived into the Late

Cretaceous. The discovery of *Iani* helps us link their extinction on the continent with a major interval of global warming, one with striking similarities to our current climate crisis.”

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1. https://www.scitechdaily.com/new-dinosaur-species-discovered-in-utah-lived-in-an-era-of-epic-ecological-changes/?fbclid=IwAR1rAYWMaw96KYctD4iGEBvKfEEKipg7AwP1EHwvz89W8EJaSrTFblee-lw&expand_article=1
2. For more on this research, see Dinosaur *Iani* May Have Been Species’ “Last Gasp” in a Changing Planet.
<https://scitechdaily.com/newly-discovered-dinosaur-iani-may-have-been-species-last-gasp-in-a-changing-planet/>
3. “An early-diverging iguanodontian (Dinosauria: *Rhabdodontomorpha*) from the Late Cretaceous of North America” by Lindsay E. Zanno, Terry A. Gates, Haviv M. Avrahami, Ryan T. Tucker and Peter J. Makovicky, 7 June 2023, PLOS ONE.
DOI: 10.1371/journal.pone.0286042
<https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0286042>

The Antarctic sea ice reaches the lowest level ever recorded in June



This image, which visualises the Antarctic sea ice extent based on **Copernicus Marine Service data**, shows the negative Antarctic sea ice anomaly of June 2023, when the ice surface stood at circa 2.5 million km² below the average area for the period.

For several weeks in a row, the negative Antarctic sea ice anomaly increased, until it reached the current historic gap, while ice growth has been much significantly slower than usual. In addition, last February also saw a new record low for the seasonal minimum.

Copernicus services continuously monitor Antarctic and Arctic areas, providing crucial satellite data to better understand the impacts of climate change on these fragile regions.

Date: **4 July 2023**
Location: Antarctica
Credit: European Union, Copernicus Marine Service data

Reference:

<https://www.copernicus.eu/en/media/image-day-gallery/antarctic-sea-ice-reaches-lowest-level-ever-recorded-june>

Brazilian fossil provides earliest evidence of evolutionary trait that enabled dinosaurs to become giants

by **André Julião, FAPESP**
20 June 2023

The missing link has just been found between the earliest dinosaurs, whose size ranged from a few centimeters to at most three meters in length, and more recent giants that could be more than twice the length of a bus and have so much appeal to the popular imagination.

Macrocollum itaquii, buried 225 Ma ago in what is now Agudo, a town in Rio Grande do Sul state, South Brazil, is the oldest dinosaur studied hitherto with structures called **air sacs**.

These bone cavities, which persist in present-day birds, enabled dinosaurs to capture more oxygen, keep their bodies cool and withstand the harsh conditions of their era. They also

helped some become giants: *Tyrannosaurus rex* and *Brachiosaurus*, for example.



Bone cavities called air sacs appeared in the ancestors of long-necked dinosaurs about 225 Ma ago, according to the analysis of a specimen found in Rio Grande do Sul state, South Brazil. The study also shows that air sacs did not evolve as linearly as scientists believe. (Credit: Márcio L. Castro)

An article on the study that led to the discovery is published in **The Anatomical Record** journal. Two of its authors are researchers at the State University of Campinas (UNICAMP) in São Paulo state.

"Air sacs made their bones less dense, allowing them to grow to more than 30m in length," said Tito Aureliano, first author of the article. The study was conducted as part of his Ph.D. research at the Institute of Geosciences (IG-UNICAMP).

"*M. itaquii* was the largest dinosaur of its time, with a length of about 3m. A few million years before then, the largest dinosaurs were about 1m long. Air sacs certainly facilitated this increase in size," Aureliano added.

The study was a stage of the project "**Taphonomic landscapes**". Taphonomy is the study of how organisms decay and become fossilized or preserved in the paleontological record.

The principal investigator for this project was Fresia Ricardi-Branco, penultimate author of the article and a professor at IG-UNICAMP. "This was one of the first dinosaurs to walk the Earth, in the Triassic period," she said. "The air sac adaptation enabled it to grow and withstand the climate in this period and later, in

the Jurassic and Cretaceous. Air sacs gave dinosaurs an evolutionary advantage over other groups, such as mammals, and they were able to diversify faster."

In a previous study, the group showed that the earliest fossils found so far did not have air sacs, taking their absence as a sign that this trait evolved at least three times independently.

M. itaquii was a biped, a sauropodomorph, and an ancestor of the giant quadrupeds with a small head, and a neck at least as long as the trunk.

Nonlinear evolution

Until air sacs were discovered in *M. itaquii*, these vertebral cavities were known to consist of either camerate or camellate tissue, the former referring to hollow spaces observed by microtomography, and the latter to spongy bone. According to the authors, in this case they found "internal pneumatic chambers," which are "neither camerate nor camellate, but a new type of tissue with an intermediate texture." They propose to call the new structures "protocamerate," as they "are not large enough to be considered camerae, but also present a camellate array internally."

"The most widely held hypothesis until now was that the air sacs began as camerae and evolved into camellae. Our proposal, based on what we observed in this specimen, is that this other form existed first of all," Aureliano said.

The vertebrae in which the air sacs were found also change what was known about the evolution of these structures. Based on the fossils analyzed previously, other research groups proposed that air sacs first appeared in the abdominal region and did not appear in the cervical region until the early Jurassic (190 Ma ago), a long time after the period in which *M. itaquii* was alive. Here, however, the authors found clear evidence of air sacs in the cervical and dorsal regions, with no sign of the structures in the abdominal region.

"It's as if evolution had conducted different experiments until it arrived at the definitive system, in which air sacs run from the cervical region to the tail. It wasn't a linear process," Aureliano said.

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1. <https://phys.org/news/2023-06-brazilian-fossil-earliest-evidence-evolutionary.html?fbclid=IwAR3jv8pnLcXTVbHqUaE9DnuO4I58UfzkvOq-BHmHoYhrenSHj9npPxtM6wA>
2. Tito Aureliano *et al*, The origin of an invasive air sac system in sauropodomorph dinosaurs, *The Anatomical Record* (2023). DOI: 10.1002/ar.25209
<https://anatomypubs.onlinelibrary.wiley.com/doi/10.1002/ar.25209>

Podcast

What's at stake if we mine the deep sea?



Presented by Ian Sample, with Chris Michael and Dr. Diva Amon.

18 Jul 2023

As the International Seabed Authority gathers in Jamaica to thrash out regulations for mining the deep sea, Chris Michael of the Guardian's Seascope team gives Ian Sample the background to this highly contested decision. Ian also hears from the marine biologist Dr. Diva Amon about why some scientists are sounding the alarm.

Reference:

<https://www.theguardian.com/science/audio/2023/jul/18/whats-at-stake-if-we-mine-the-deep-sea-podcast>

Canadian lake could mark the start of new geological epoch



Presented by Ian Sample, with Damian Carrington and Francine McCarthy.

27 Jul 2023

Plutonium from nuclear weapons, industrial waste, and human activity more broadly have left such a mark on the Earth that a new epoch

called the **Anthropocene** has been proposed. Scientists are debating the specific geological site to define this epoch, with the frontrunner being an unassuming lake in Canada: **Crawford Lake**.

What is it about this spot that holds the secrets to this period of history? From hydrogen bombs to hens' bones, how do we define the Anthropocene, the beginning of the human era on Earth?



(Credit: Peter Power/AFP/Getty Images)

Reference:

<https://www.theguardian.com/science/audio/2023/jul/27/canadian-lake-could-mark-the-start-of-new-geological-epoch-podcast>

Interesting Images 2



The oldest Octopus fossil is 296 Ma old, predating the dinosaurs.

Reference:

Learn Geology (Ancientzen)
<https://www.facebook.com/groups/1796038703980671/user/100087527913755/>

“Landslide Graveyard” Holds Clues to Long-Term Tsunami Trends

By S. Bull, S. J. Watson, J. Hillman, Ha. E. Power, L. J. Strachan

3 June 2022

A new project looks to unearth information about and learn from ancient underwater landslides buried deep beneath the seafloor to support New Zealand’s resilience to natural hazards.

Summarised here with additional tsunami information by *Liz Aston, FGS*

Tsunamis are dangerous natural hazards, usually caused by earthquakes, associated with tectonic movements, such as in Japan (11 March 2011) from a M 9.0 quake, caused by a rupture during subduction of the Okhotsk Microplate, NW Pacific, under Honshu Island, Japan, when a section of the subduction zone, ca. 300km long x 150km wide moved 50 m ESE and was thrust up ca. 10m. A major sector of Honshu Island was devastated.

Also in Banda Aceh on 26 December 2004 – the Indian Ocean Earthquake & Tsunami (Sumatra–Andaman earthquake). This was another undersea megathrust quake M 9.1–9.3, caused by a rupture along the fault between the Burma and Indian Plates. Its epicentre was between Simeulue and mainland Sumatra. Communities were devastated and ca. 227,898 people killed in 14 countries around the Indian Ocean. It is one of the deadliest natural disasters in recorded history - the third-largest earthquake ever recorded with the longest duration of faulting (8-10 minutes shaking) ever observed. It caused the planet to vibrate as much as 10mm which then triggered an earthquakes in Alaska. NASA determined that it slightly changed the planet's shape, shifted N Pole by cm and slowed the Earth's rotation and decreased the length of day slightly. Those tsunamis were both major ocean-wide events. Other tsunamis can be equally disastrous for the area(s) affected but do not cross oceans.

There are smaller, more localised tsunamis associated with volcanic eruptions, as recently from Hunga Tonga–Hunga Ha’apai, 15 January 2022, when a powerful underwater volcano was captured from a satellite, showing the sheer power for the explosive event. A vast plume from the volcano rose like a giant mushroom as a shockwave extended out from one of the 170 islands that make up the South Pacific kingdom of Tonga. The eruption created a tsunami >1m high that hit Tonga's capital of Nuku’alofa, which is ~65km S of the volcano. A sonic boom from the eruption was heard across the Pacific Ocean, reaching as far away as Alaska, according to the Associated Press.

In Tonga (Fig. 1) and on another occasion, in Solomon Islands (Fig. 2) the force of the magma entering the magma chamber and/or the

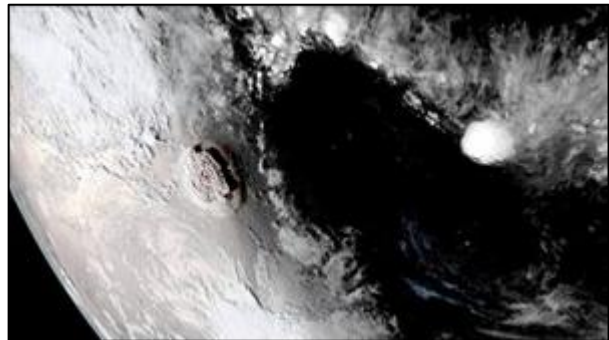


Figure 1: Tonga



Figure 2: Solomon Islands

intense explosive eruption will shake the ground and the sudden explosive release of magma and gases into the sea causes the tsunami. The underwater volcanic eruption visible in this image was at Kavachi, Solomon Islands, Pacific Ocean in 2021.

There is also a suggestion that the sudden release of clathrates* that have accumulated in sediments on upper continental shelves have caused tsunamis, this has been used as the cause of the disasters in the Bermuda Triangle.

* *Very simplified explanation: Clathrate hydrates are solids physically resembling ice, in which gaseous molecules are trapped inside a net-like structure; when the ice 'melts', the gas is released as a huge bubble. See Wikipedia for full explanation.*

Another source of 'local tsunamis' is the massive wave which can affect coastal inlets along Alaska, Greenland, Chile, etc., when a large glacier 'calves' suddenly – one in Alaska transported a fishing party in a boat several km along the inlet and left the boat in trees ~15-20m high up the side of the inlet.

But after a recent tsunami at Palu, Indonesia, where a M 7.5 quake occurred in September 2018 which was assumed to be the source/cause of the tsunami, but detailed analysis showed that tectonic seafloor deformation was minimal; it was a series of landslides in Palu Bay that had generated the tsunami. This relationship of submarine landslides and tsunamis has been supported by recent studies of the seafloor offshore New Zealand (in the Tasman Sea) with details of similar events. The following is a summary of their research results.

The Tasman Sea, located between Australia and New Zealand probably experienced multiple tsunamis in the Plio-Pleistocene that probably originated near the W coast of New Zealand, travelling >2,000km to devastate Australia. However there is little obvious surficial evidence of these situations.

The W coast of New Zealand has minimal subduction zone processes (nor associated quakes) however, it is surrounded by steep and, at times, tectonically active submarine slopes, where landslides can occur. These can create 'silent' tsunamis which are now being investigated in New Zealand as shown in the adjacent image.

Area of NZ's Silent Tsunami project shows seafloor bathymetry & existing seismic data. The outline of the most recent giant landslide (Pleistocene) is shown, overlain by tracks from the TAN2111 voyage, October 2021.

Six giant underwater landslides dating from the Plio-Pleistocene have been discovered beneath the modern seafloor in the E Tasman Sea (Fig. 3). The most recent, probably ca. 1 Ma ago, is the largest documented landslide in New Zealand, covering >22,000km² (larger than Wales) with a volume of ca. 3,700km³. This landslide was bigger than the Storegga Slide, which resulted from 3 massive submarine landslides on the continental shelf off W Norway roughly 8,200 years ago - these are some of the largest known and caused massive tsunamis that devastated much of N Europe's coastline, including Scotland.

Underwater landslides are rarely included as tsunami sources in hazard assessments because data are sparse - lack of research into frequency, rate of

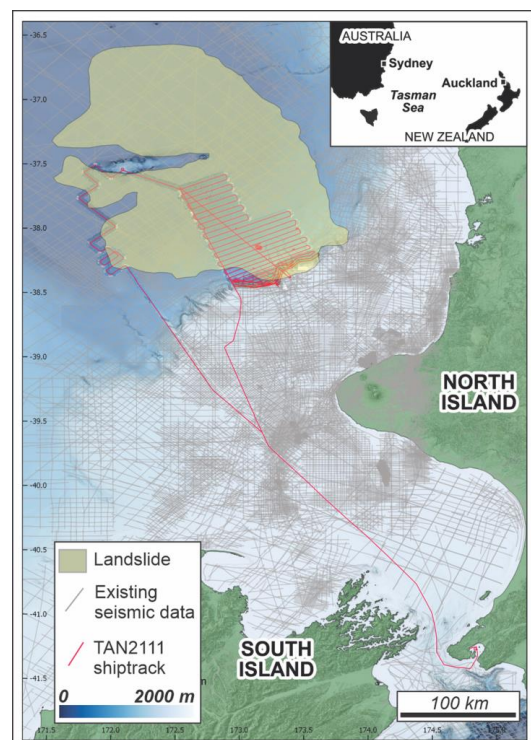


Figure 3: East Tasman Sea.

recurrence and difficulty/expense of deep water sampling. Australia and New Zealand have created the Silent Tsunami /Te Tai-o-Rēhua Project.

Throughout the Plio-Pleistocene, huge volumes of material were eroded from the rising Southern Alps and transported to the coast and along the shelf to end up at New Zealand's NW continental margin. There they formed unstable sediment piles, perched precariously near the interface of the Pacific and Australian plates on top of steeply dipping surfaces (up to 1,500m tall). This was a tectonically active area and inevitably (and regularly) the piles collapsed into the deep ocean as catastrophic submarine landslides with accompanying tsunamis.

Evidence for these Tasman Sea landslides is not easily visible – from lack of detailed seafloor mapping; the slides were quickly buried under sediment. However past seismic surveys in the area show evidence for these events (Figs. 3 & 4). The new project will analyse how basin filling interacts with tectonic processes and determine the source, accurate original volume of landslides (before burial and compaction), use of modelling to simulate landslide motion, tsunami generation and hazards (inundation extents, wave amplitudes, wave arrival times, and current velocities).

They consider that during highstands of sea level, as today, transport of sediment to deep ocean decreases. However, the paucity of information from the Tasman Sea region means that no precise measurement of transport or sediment accumulation can be determined nor what could trigger a future landslide event.

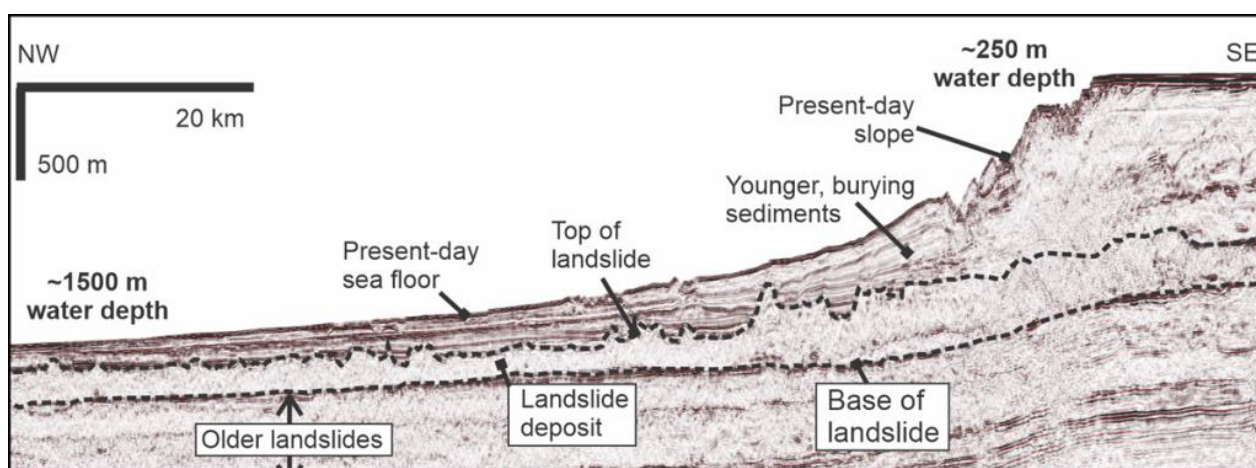


Figure 4: Ancient landslide deposits beneath modern seafloor are evident in this seismic reflection profile produced from data before Silent Tsunami project.

Older seismic images show “megablocks” exposed through modern seabed in the recent Tasman Sea landslide deposit. These megablocks are large clasts or “rafts” of material transported within the landslide which have remained ‘whole’; they can form irregular seafloor topography in the immediate aftermath of an underwater landslide creating localized sediment traps when normal sedimentation resumes. Future seismic surveys hope to find these features to sample.

New seafloor mapping has mapped the seafloor at high resolution with ca. 100km of new data from New Zealand's N Island (Fig. 5).

Note the images of canyons, numerous pockmarks, and recent small-scale slope failures along the continental slope (Figure above Left top) and the deep seafloor littered with numerous angular, often elongated ridges and peaks up to 100m in relief, the exposed tops of megablocks some with surrounding “moats” winnowed by the action of recent ocean currents. These ridges are from the most recent Tasman Sea landslide, still making their mark on the seafloor ca. 1 Ma later.

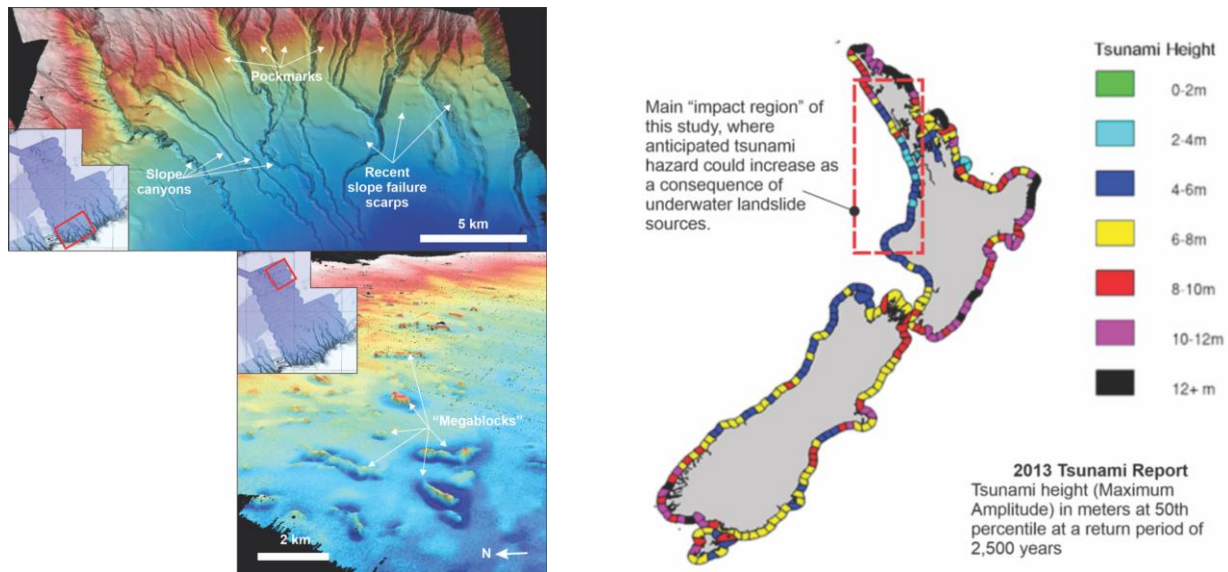


Figure 5:

Left (top): New views of bathymetric data showing shelf-slope canyons, pockmarks, evidence of small, recent slope failures; and Left (bottom). tops of megablocks from the most recent ancient landslide rising above the modern seafloor of the continental rise at water depths of 1,500–1,700 m.

Right: New Zealand National Tsunami Hazard Model showing expected tsunami heights along the country's coastline, published in 2013, it is continually updated.

Once sampled, the landslide material (from both the blocks and the surrounding sediments) should provide the physical properties, sedimentology and origin of the landslide, also refine the fluid dynamics models and the rate and patterns of modern sediment accumulation. The samples recovered during the latest trip included:

- Sticky muds in the “mud drape” - continuous rain of fine-grained sediment that accumulates normally over many years
- Fist- to paving slab-sized clasts of more consolidated mud and fine sand, which we cautiously assumed to be landslide material.

A 4m core from a flat-topped megablock at ca. 1,500m depth is now under intense investigation – it is part of the 79m of core that were recovered from both megablocks and areas between them.

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Film Review

“65” review – Adam Driver v dinosaurs in almost fun enough thriller

A scrappy adventure, shot two years ago and getting unceremoniously dumped, isn't as bad as its backstory would suggest but it's missing something

**Benjamin Lee, *The Guardian*
9 March 2023**



Adam Driver in 65. (Photograph: Patti Perret/AP)

It's almost impossible sitting down to watch the loopy sci-fi thriller 65 without being niggled by a familiar sinking feeling, like you're about to eat a meal that you know won't agree with your system. Despite the intriguing presence of Adam Driver, whose post-Star Wars roles have typically prioritised art over commerce, and a magnetically gonzo premise that sees a pilot crash-land on prehistoric Earth, it's arriving weighed down by baggage heavy enough to flatten any hopes the thrillingly nutty trailer might have inspired.

Not only has the film, shot two years ago, already missed five prior release dates but it's landing last minute without much of a visible campaign (it was only officially scheduled last month) and almost entirely without screenings for critics (I attended the only one in New York, taking place just hours before release). Inevitably, this then lowers even the most optimistic of optimist's expectations to beneath ground level, a cursed backstory for something seemingly so awful that studio Sony would

rather bury it than have anyone actually watch it. But as is often the case with such a lead-in, it's more ho-hum than horrible, a mess but not a hugely embarrassing one.

Perhaps if it had been truly tell-everyone-on-Twitter terrible, then maybe it would at least be remembered by the time it swiftly lands on plane movie rotation but 65 veers between fine and slightly less than, never quite bringing the fun we were expecting,

Unusually, for an elevator pitch genre film such as this, it starts off in far shakier territory than where it ends up. Driver's pilot, Mills, is saying goodbye to his wife and sick daughter (cue performed light cough) before he goes on a two-year mission. Shot during early Covid, we rush through the scene-setting to avoid anything that might prove logistically difficult for what's essentially a two-hander, an understandable sacrifice given the time, but the frantic pace continues once he crash-lands on a mysterious planet, clumsily sprinting us through what should have been a more delicately effective buildup. The first act has the feeling of something that caused sleepless nights in the edit suite, jankily jumbled together, short and choppy scenes ending before they should, giving it a distractingly arrhythmic quality (criminally, the discovery that the planet contains dinosaurs (!) is truly fumbled). Once Mills finds a fellow survivor (an excellent, understated Ariana Greenblatt), the pair must make their way across dangerous terrain to an escape pod.

It's a pretty unremarkable survival movie from then on, but efficiently so in the shortest of bursts, thanks to a physically committed Driver taking it all rather seriously and some moments of decent enough jeopardy. We're teased something gnarlier, something that might have distanced it even further from the family-friendly Jurassic Park franchise other than quality and budget, but it's all a little too restrained to be the extreme and extremely silly B-movie it could and should have been. One tellingly funny scene has Greenblatt's cute kid rescue a friendly dinosaur before it gets promptly ripped apart by others but that's as

knowingly nasty as it gets – we’re otherwise stuck with a makeshift family melodrama squeezed in between some mostly unscary scare sequences. Rather than build up genuine suspense, as writers Scott Beck and Bryan Woods did in their breakout script for *A Quiet Place*, as writer-directors here they rely on an annoying overdose of jump scares, most of which cause yawns rather than jolts. In the slightly more involving final act, Beck and Woods lean further into the goofiness of their premise, as danger starts quite literally falling out of the sky, but it’s a case of too little, too late.

It’s not quite the toxic disaster it’s being treated as but 65 is nowhere near the giddy lark it should have been, crash-landing somewhere in the middle instead.

Reference:

<https://www.theguardian.com/film/2023/mar/09/65-review-adam-driver-dinosaurs>

TV Review

Earth review – Chris Packham steps confidently into David Attenborough’s shoes

This grand, wise nature epic reveals the fiery terror of prehistoric global warming – plus how Packham has evolved so much that the BBC need no longer rely on Attenborough

Jack Seale, *The Guardian*
17 Jul 2023



No natural history programme can, or should, be made these days without the climate crisis as a looming subtext at the very least. Chris

Packham’s confidently grand new series **Earth**, a guide to “five pivotal moments” in the planet’s history, might look like an exception, since its first episode is set 252 million years ago. But unfathomably distant as that is, it is painfully relevant because of what happened at the close of the Permian period: Earth grew warmer, ending life as it existed then.

A volcanic eruption, a thousand times greater than any ever seen by humans, covered one percent of Earth’s only land mass, Pangea, with liquid fire and released four million cubic kilometres of lava, greenhouse gas and ash. Mass extinction followed: Packham, squatting nimbly by a cliff face, demonstrates it by hammering a lump out of a thin seam of coal, left there when a lot of organic matter died suddenly. Then he chips at the rock above, finding it to be smooth and featureless, a relic of a time when nothing died because not much had survived.

Packham has evolved from a domestic nerd on *Springwatch*, parting foliage to reveal a vole, into a big-name presenter who can carry the sort of planet-sized show that would once have relied on David Attenborough. Earth is keen to have an epic sweep – which, in a BBC era of slashed budgets and hostile scrutiny, is not straightforward. Fail to present enough fresh footage showing the presenter and the programme looks like a *PowerPoint* presentation. Too far the other way – flying to Mauritius or the Galapagos to film next to lush vegetation or azure seas, when a bought-in shot would suffice – and it is seen as a holiday at licence-payers’ expense.

Packham strikes a wise balance, having discovered that the Canary Islands contain an eclectic enough array of landscapes for almost a whole episode. A trip round the beaches, dunes and groves of the Canaries, with Packham looking sharp in a brown Fred Perry polo buttoned right up, plus a jaunt to Italy – in taupe Fred Perry, buttoned right up – does the job. Stock footage of volcanoes, forests and desert is thriftily sprinkled in the gaps.

The result is a big story, sturdily told and with an eye for pertinent detail. Perhaps the most useful strand is about how not all the

consequences of a cataclysm are obvious. After the surface eruptions stopped, magma that remained underground, not ostensibly incinerating any flora or fauna, burned up coal reserves that created yet more CO₂, and set fire to salt that pumped halogen into the air, dissolving the ozone layer and subjecting pollen to mutations caused by unfiltered UV rays. Alternatively, it's possible that pollen was bent out of shape by acid rain, but the point stands: one thing led to another, and plants died *en masse*. Carbon dioxide, meanwhile, was reacting with the warming seas, deoxygenating them and encouraging the growth of algae that decomposed and poisoned the water. "Sulphurous tides lap barren shores," Packham says with a nice curt lyricism, transporting us to the seaside a quarter of a billion years ago.

After the extinction, Earth had lost **70% of its land vertebrates** and **96% of marine life**. We won't suffer anything on remotely that scale, but similar processes are observable. Off the coast of the Canary Islands, the warmer Atlantic waters enable an algae that is poisonous to dolphins to thrive. When dolphins eat the fish that ate the fish that ate the algae, they die.

It takes more than a catastrophic warming and all its nasty corollaries to kill a planet, though. In the Dolomites, a layer of sandstone is evidence of the weather event that followed the fiery terror: it rained and rained and rained. New greenery grew, the Triassic period dawned. Packham puts his hand in a dinosaur footprint, expressing the same child-like glee as when he goes dolphin-spotting.

At the end of the hour, Packham seems to realise that he has given succour to fatalist cynics who say hey, the world has seen warming worse than this. His thesis is that extinction boosts evolution; losing most of the life on Earth enabled everything we know now to exist. A quick speech about having "all of that suffering" on our conscience if we plough on with our answer to the Great Dying feels like an afterthought. But for the majority of us, who are rightly terrified and don't need a pep talk on why collapsing ecosystems are bad, Packham

has added another layer to our understanding – and his status as a great nature presenter is starting to be set in stone.

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<https://www.theguardian.com/tv-and-radio/2023/jul/17/earth-review-chris-packham-steps-confidently-into-david-attenboroughs-shoes>

Five ice-age mammoths unearthed in Cotswolds after 220,000 years

David Attenborough will tell of 'pristine' skeletons found with other extinct species
(Available on BBC iPlayer)

Dalya Alberge, The Guardian
19 Dec 2021

Five ice-age mammoths in an extraordinary state of preservation have been discovered in the Cotswolds, to the astonishment of archaeologists and palaeontologists.

The extensive remains of two adults, two juveniles and an infant that roamed 200,000 years ago have been unearthed near Swindon, along with tools used by Neanderthals, who are likely to have hunted these 10-tonne beasts. More are expected to be found because only a fraction of the vast site, a gravel quarry, has been excavated.



An artist's impression of the Steppes mammoth.
(Photograph: Beth Zaiken/Reuters)

Judging by the quality of the finds, the site is a goldmine. They range from other ice-age giants, such as elks – twice the size of their descendants today, with antlers 10ft across –

to tiny creatures, notably dung beetles, which co-evolved with megafauna, using their droppings for food and shelter, and freshwater snails, just like those found today. Even seeds, pollen and plant fossils, including extinct varieties, have been preserved at this site.

All these will now offer new clues into how our Neanderthal ancestors lived in the harsh conditions of ice-age Britain, a period of prehistory about which little is known. The exceptional discoveries will be explored in a **BBC One** documentary, **Attenborough and the Mammoth Graveyard**, to be aired on 30 December, in which Sir David Attenborough and evolutionary biologist Professor Ben Garrod join archaeologists from DigVentures to film the excavation.

Garrod told the Observer: “This is one of the most important discoveries in British palaeontology.” While the odd mammoth bone often turns up, he said, finding such complete skeletons is “incredibly rare”. “Where these mammoths lie in the ground is exactly where they died a quarter of a million years ago – next to incredible things like stone tools and the snails they trampled underfoot.

“We have evidence of what the landscape was like. We know what plants were growing there. The little things are really revealing the context of these big, iconic giants. It’s a glimpse back in time. That’s incredibly important in terms of us understanding how climate change especially impacts environments, ecosystems and species.”

Lisa Westcott Wilkins of DigVentures, an archaeology social enterprise, said: “Exciting doesn’t cover it. Other mammoths have been found in the UK but not in this state of preservation. They’re in near-pristine condition. You can’t take it in.”

She added: “Archaeological sites from this period are rare, and critical for understanding Neanderthal behaviour across Britain and Europe. Why did so many mammoths die here? Could Neanderthals have killed them? What can they tell us about life in ice-age Britain? The range of evidence at this site gives us a unique chance to address these questions.”

The researchers believe that the mammoth remains and the artefacts date to around 220,000 years ago, when Britain was still occupied by Neanderthals during a warmer interglacial period known as MIS7. Falling temperatures had forced Neanderthals south, and this site was then a lush, fertile plain to which both animals and humans were drawn.

The earliest mammoths came from Africa about five million years ago. This particular species, the Steppe mammoth, was the largest of them, and lasted from about 1.8m years ago to about 200,000 years ago.



Archaeologists excavating the mammoth bones. (Photograph: DigVentures)

Garrod, professor of evolutionary biology at the University of East Anglia, said the species weighed up to 15 tonnes, twice or three times the weight of an African elephant: “This was the largest species of mammoth ever. By the time they were about to be gone, they had dropped down to 10 tonnes, which still sounds a lot. We think that was an adaptation to the change in environment, climate and resource availability. It was becoming colder at that time, resources were getting sparser, and it drove that shrinking of the species. On top of that, there

would have been undoubtedly local pressure from hunting and competition from other species.”

Speculating on why so many animals died at this site, he added: “Was there a massive glacial flood that washed these poor animals down? By looking at the mud, it doesn’t look like there was. It’s very uniform all the way down. Were they hunted by people? Were Neanderthals crouching down in the rushes and chasing them into the water? Possibly. There is definitely an association between a wonderful hand-axe and other stone tools and these bones. Did they chance upon this bunch of dead mammoths and have a mammoth buffet?”



Close inspection of the excavated bones, some of which have possible butchery marks. (Photograph: DigVentures)

“Or was it just really muddy? With elephants today, if a juvenile gets stuck, often the adults won’t leave the site. They’ll try and help them. This is very thick mud. I’ve grown up near the seaside, near estuaries; you don’t need to be very heavy to get stuck in mud very quickly.”

The excavations also revealed further evidence of Neanderthal activity on the site, including flint tools that would have been used for cleaning fresh hides. Some of the bones have possible butchery marks.

DigVentures is a team of archaeologists that specialises in public outreach. They were called in after a Neanderthal’s hand-axe was found with the initial discovery of mammoth remains by amateur fossil-hunters Sally and Neville Hollingworth.

DigVentures raised the funding from Historic England, dug the site and is coordinating the

analysis and research. They hope to continue excavations once further funds have been raised. The site is now protected from fossil hunters by natural flooding.

Westcott Wilkins praised the Hills Group, the quarry owners, for allowing them as long as they need: “There are also early discussions about wanting to build a public outreach centre where we can display some of the finds.” Other finds are expected to go to the Bristol Museum.

She noted that the mammoths were barely five metres below ground level and close to a busy road: “People are whizzing by, not realising that feet underneath their car is this scene. It’s very surreal. We’re all still trying to get our heads around what we found.”

Reference:

<https://www.telegraph.co.uk/tv/2018/01/07/attenborough-sea-dragon-review-fun-detective-story-starring/>

Attenborough and the Sea Dragon review: a fun detective story starring the great nonagenarian

(Available on BBC iPlayer)

**Jasper Rees, *The Daily Telegraph*
7 January 2018**

David Attenborough has always been a prehistory fan. In a documentary I can carbon-date to 1984, he forensically pieced together the story of the pterodactyl via its avian descendants. There was a similar piece of reverse engineering to **Attenborough and the Sea Dragon**, in which the physiology of an ichthyosaurus was elucidated by comparing it to sharks and crocs and dolphins.

But this was also the story of an actual dig. Crikey, it looks like hard work being palaeontologist Chris Moore. It took much heavy hammering on a Dorset sea cliff to liberate the slabs of limestone rock containing the sea dragon’s fossils, and then almost a year to chip away at those stones to expose, like Michelangelo with his chisel, the creature lurking within.



Attenborough with a temnodontosaurus skull.

In this detective story, you found out all sorts of unexpected things thanks to the limitless cleverness of university scientists and their amazing gizmos. Talk about niche – in Portsmouth they've even got a pathologist who investigates causes of death in prehistoric creatures. It was particular fun to see a vast fossil X-rayed at the Royal Veterinary College, the only place with a large enough machine for the job.

One sequence involving leatherback turtles was cost-savily shot on the same Caribbean beach featured in Blue Planet II. But make no mistake, Attenborough the prehistorian presenter is slightly different from the biologist who explains living species. He asked many more questions and, as he chopped open a pebble to expose a perfect ammonite fossil, gave way to school boyish giggles.

The great nonagenarian showed his age only once. "So, this was the king of the Jurassic sea?" he asked Emily Rayfield of Bristol University. "Or queen," she replied. The *Attenboroughsaurus* can be carbon-dated to the Jurassic era of gender politics.

Reference:

<https://www.telegraph.co.uk/tv/2018/01/07/attenborough-sea-dragon-review-fun-detective-story-starring/>

Further Reading



1. The distributions and variations of Quaternary Thames River Terrace deposits of Greater London

Authors: **Elizabeth Rosemary Aston** (FGS) and **Philippa Jane Mason**

https://www.lyellcollection.org/doi/10.1144/qjegh2023-016?fbclid=IwAR2jT_lb0RunoFYWpAdsalLntb7TF5WFSGaz2srmkRhZEjoqdK6RCnkDOi8

2. The day an Underwater Volcano almost wiped out a Nation

As suggested by **Angela Snowling** (FGS)

<https://www.washingtonpost.com/science/interactive/2023/hunga-tonga-submarine-volcano-eruption/>

3. The latest maps of the world's eighth continent

New research on the geology of Zealandia is revealing how it formed – and why it sank

<https://www.bbc.com/future/article/20230928-the-mysteries-of-the-worlds-eighth-continent>

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5. 'We were freaking out': Scientists left 'flabbergasted' by detailed dinosaur footprints covering a cliff in Alaska

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7. Future of deep-sea mining hangs in balance as opposition grows

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8. NASA's Curiosity Mars rover reaches perilous ridge on Red Planet after 3 failed attempts

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As suggested by **Liz Aston**

9. Images from NASA's Perseverance may show record of wild Martian river

<https://mars.nasa.gov/news/9399/images-from-nasas-perseverance-may-show-record-of-wild-martian-river/?fbclid=IwAR2uiBfl8MMmwahlsAFx9SxEVMR2zeCtL4Wm1bMtoqIW1VSYxhbv4YLfGp0>

10. Giant Mars mountain Olympus Mons may once have been a volcanic island

https://www.space.com/mars-mountain-olympus-mons-volcanic-island?utm_term=8DEBC9E5-6C7F-4337-

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11. The Earth moves far under our feet: A new study shows the inner core oscillates

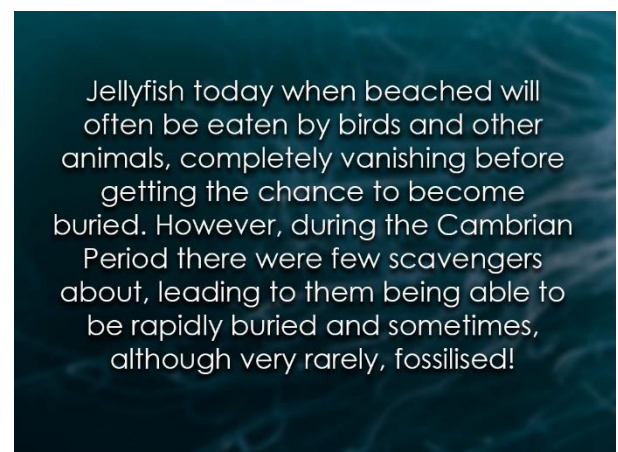
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12. There's a lot of noise in the debate over North Sea oil and gas - but the numbers tell a different story

<https://news.sky.com/story/why-the-debate-over-north-sea-oil-and-gas-is-a-storm-in-a-teacup-12931351>

13. Norway throws importance of oil & gas for Europe's energy security into stark relief

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Jellyfish today when beached will often be eaten by birds and other animals, completely vanishing before getting the chance to become buried. However, during the Cambrian Period there were few scavengers about, leading to them being able to be rapidly buried and sometimes, although very rarely, fossilised!

(Credit: The Etches Collection)

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www.geologistsassociation.org.uk

