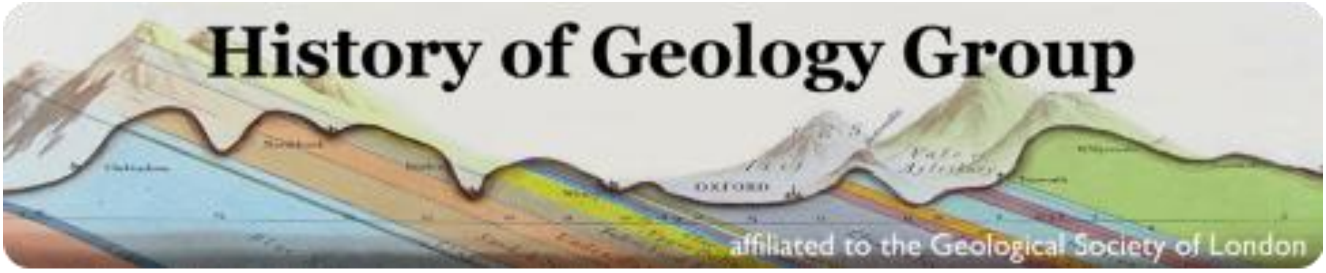

Open Meeting

Wednesday 9th May 2018

ABSTRACTS

Compiled and edited by Christopher Duffin

HISTORY OF GEOLOGY GROUP OPEN MEETING

Wednesday 9th May 2018

Geological Society, Burlington House,
Piccadilly, London W1J 0BD

Convenor : Dr Chris Duffin

PROGRAMME

9:30-9:45	Registration
9:45-9:50	Welcome, Housekeeping and **Session 1 – Chair : Tom Sharpe**
9:50-10:10	***Derek Morris*** - Joseph Banks and Geology on Cook's First Voyage
10:10-10:30	***Duncan Hawley*** - Rudler of Aberysytwyth and the 1853 geological map of Ireland
10:30-10:50	***Mike Howgate*** - Benjamin Waterhouse Hawkins, James Tennant and the commercialisation of Dinosaurs
10:50-11:10	***Leucha Veneer*** - Specimens and Speculations: William Daniel Conybeare's ichthyosaurs and plesiosaurs
11:10-11:40	Coffee
11:40	**Session 2 – Chair : Chris Duffin**
11:40-12:00	***Tom Sharpe*** – The scientist most to be pitied: geology on the Imperial Trans-Antarctic Expedition 1914-17
12:00-12:20	***Phil Stone*** - The geological legacy of the Scottish National Antarctic Expedition, 1902-1904
12:20-12:40	***John Smallwood*** – Early field measurements of Earth's mean density
12:40-1:00	***Brian Roy Rosen*** – The man who 'knew so much': an iconography of Arthur Holmes' prescient representation of the Himalaya-Tibet orogeny in successive editions of his 'Physical Geology'.

1:00 – 1:50	Lunch (provided)
1:50	**Session 3 – Chair : John Henry**
1:50--2:10	***Consuelo Sendino*** – Sloane : The British Legacy
2:10-2:30	***Chris Duffin*** - Glossopetrae
2:30-2:50	***Richard Howarth*** - The enigmatic Robert J. Adcock and the Figure of the Earth
2:50	Tea and Coffee
3:20	**Session 4** – **Chair : Tom Sharpe**
3:20-4:20	***John Dewey*** – History of Tectonics

Joseph Banks and Geology on Cook's First Voyage

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In 2018 major exhibitions at the British Library and the Royal Academy will be celebrating the 250th anniversary of the departure of Captain James Cook on his First Voyage to the Pacific. It is therefore an appropriate time to make some observations on the geology and geophysical activities that engaged Cook, and his two naturalists Joseph Banks and Daniel Solander.

Amongst the many instructions given to Cook before the First Voyage was the need to "to observe the Nature of the Soil, and the Products thereof … and in case you find any Mines, Minerals or valuable stones you are to bring home Specimens of each."

The question then arises of why the Australian mineralogist T. G. Vallance, wrote of Cook's first voyage that

> there are no observations, let alone collections, of rocks and minerals to stand with the wealth of material relating to the animal and vegetable kingdoms as souvenirs. ... Rocks … did travel on *Endeavour*, [but] as ballast.

A similar view was taken by Professor Hugh Torrens, who noted that

> Geology, … seems to have occupied little time on the *Endeavour* voyage of 1768-1771, despite the 1768 "hints on minerals and fossils" offered to the expedition by James Douglas (1702-1768), president of the Royal Society.

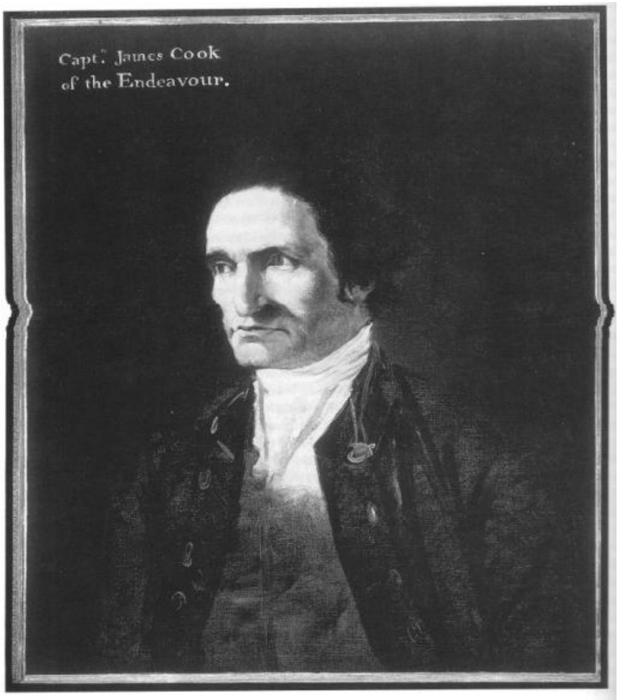
Whether Banks and Solander had time to collect rocks and minerals whilst they collected over 31,000 plants and thousands of birds, insects and animals was not considered by Vallance. He also ignored the fact that *Endeavour* twice had to shed all its ballast: implying that the new ballast that was taken on-board would have been rocks from, first, the area of the Endeavour River, and later Batavia, and any rocks collected earlier and used as ballast were lost.

In order to understand the problems raised by these authors the paper briefly considers four aspects of the First Voyage

- Banks's geological knowledge prior to the voyage
- The opportunities on the voyage for collecting rocks and minerals, and the observations
- made on the geology
- The coal, jade and gold deposits that might have been but were not discovered
- Cook's magnetic observations

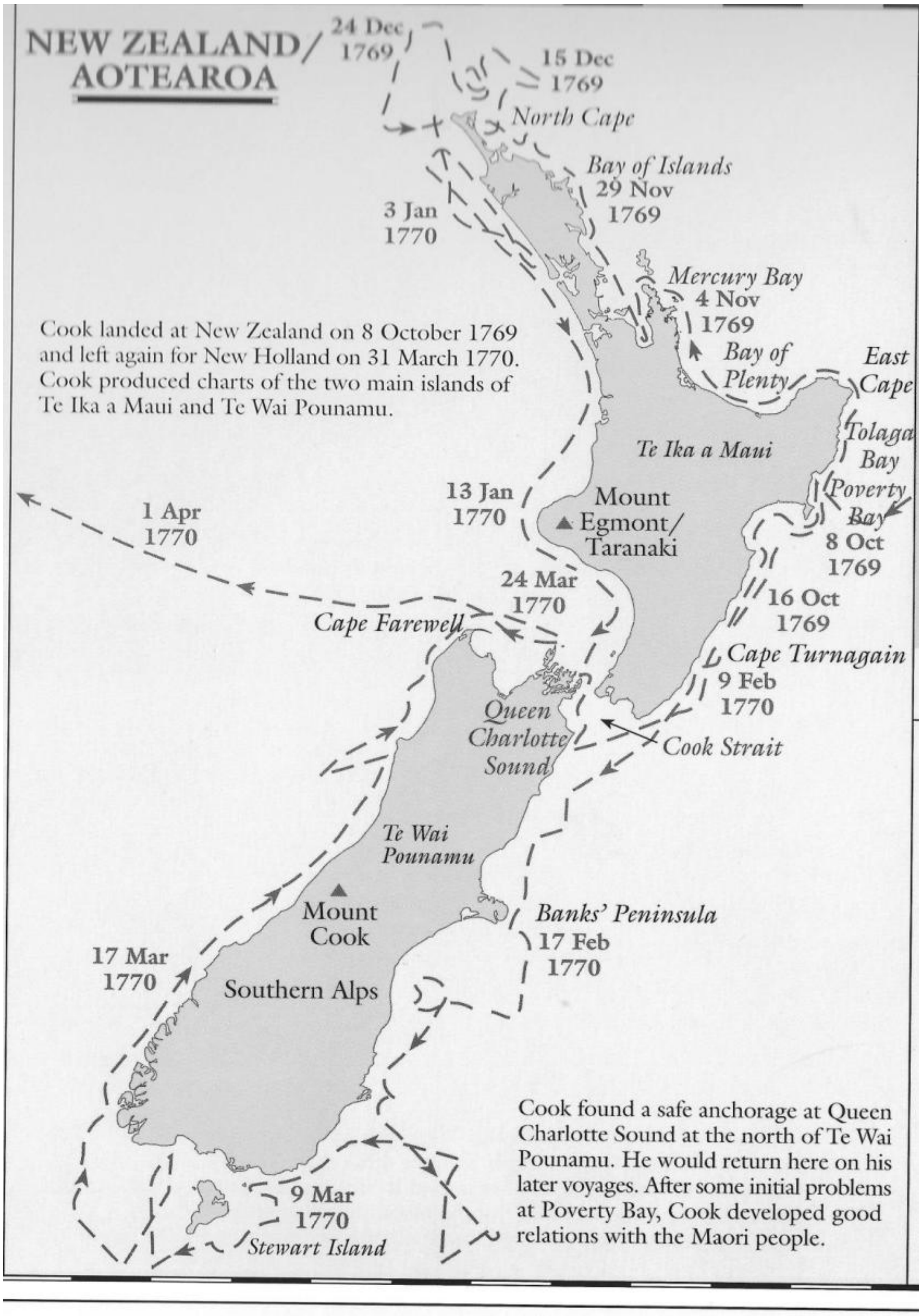
Vallance's rather harsh, but correct conclusion concerning the lack of rocks collected by Banks needs to be tempered by understanding that Banks had a geological training that would have enabled him to identify outcropping veins and deposits of important economic minerals, but his ability to do so was limited by Cook's instructions and priorities, and the difficulties of communicating with the population of New Holland. Banks did make a number of geological observations and for future geologists the First Voyage was important for several reasons. Banks, Cook and others brought back many artefacts made of agate, pounamu (jade or greenstone) and marcasite.

Banks learnt many lessons from his time with Cook. One result, was that, when planning the voyage to Australia of HMS *Investigator*, (1801-5), under Mathew Flinders, he ensured that a man with practical knowledge of mining was appointed: John Allen, a miner from Derbyshire.



Captain James Cook

Sir Joseph Banks



Cook's route around New Zealand

F.W. Rudler of Aberysytwyth and the 1853 geological map of Ireland

Duncan Hawley (Independent Scholar)
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Geological maps are an enduring source of fascination and can help humanise the science of geology through the stories they tell of their creation and ownership. This talk outlines the story of a copy of Richard Griffith's 1853 geological map of Ireland and its three-fold provenance that includes a mystery, unexpected connections, a tale of benevolence and another of preoccupation with all things geological.

Richard Griffith published the first geological map of Ireland in 1838 in a parliamentary report on the development of railways in Ireland. A year later he issued a larger version of the map at a scale of a quarter inch to the mile (1:253,440), priced at 20 shillings. In 1853 he issued an updated version of map at a much-reduced scale of 9/16 inch = ten miles (1:1,126,400) to accompany an instruction book for 'Valuators' who were engaged on a detailed survey of the value of every property in Ireland (for tax assessment purposes). In his 'day job', Griffith was 'Commissioner of Valuation' overseeing the land use survey. There was another issue of this map in 1855 at the original scale on a topographic map showing much greater detail.

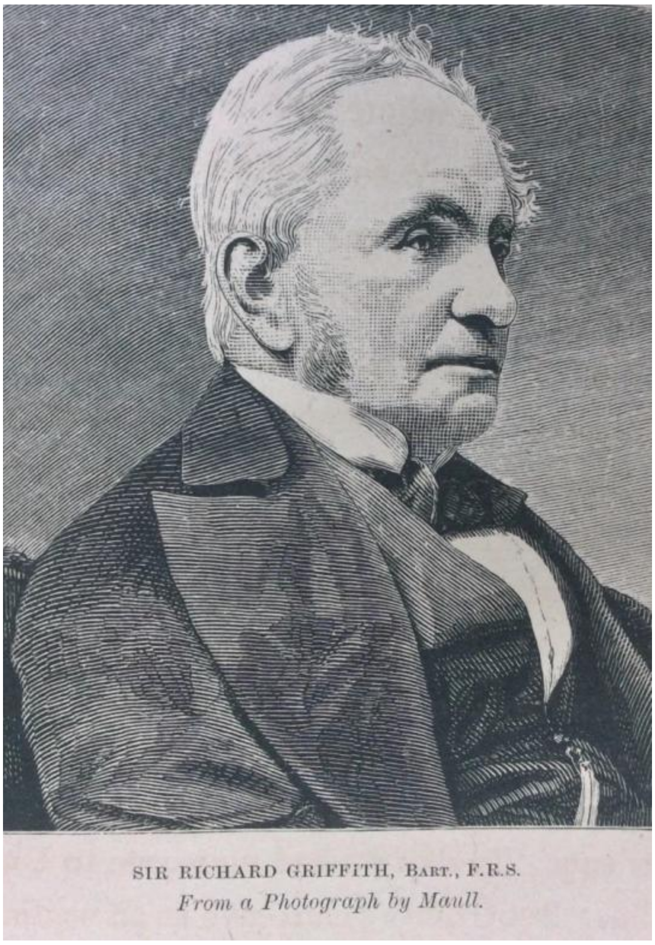
The signature of "F.W. Rudler" appears on the linen cloth of a copy of the 1853 map 'discovered' by the author. To many, Rudler's name may not have a significance but to those who have studied geology at Aberystwyth University, it registers as the moniker of the former student geological society 'The Rudler Club". Rudler took up a post at the new University College of Wales Aberystwyth in 1876 although resigned in 1879, returning to London and the staff of the Geological Survey as curator, librarian and keeper of the Royal School of Mines and Museum of Practical Geology.

A range of 'commercial' geological maps of Ireland had been produced by 1876 which begs the question as to why Rudler had a copy of the 1853 Griffith map and what it was used for. After his death in 1915 his personal collection was donated to the Geology Department although officially purchased by the College on the recommendation of Professor O.T. Jones. However this map (and many other artefacts) was not in the list of items belonging to the Rudler Collection when the College library became its official custodian.

Investigation into the second owner of the map revealed it had belonged to Arthur Sansbury who had arrived in Aberystwyth as a child in 1913. Arthur did well at school and in 1926, aged 18, he was appointed as a laboratory assistant in the Geology Department under W.P. Pugh who argued with the College authorities over his rate of pay. In 1928 Arthur became a student and went on to graduate with a 2.1 honours degree in geology from the College in 1931. After graduation Arthur became a geography and geology teacher in Hampshire and Rudler's 1853 map of Ireland accompanied him. Arthur was an enthusiast and curious about all manner of things, which made him an avid collector of rocks and any other interesting 'objects' that seemed to come his way, He rarely discarded the artefacts he acquired, and it is perhaps this acquisitive trait that helps explain the existence of Rudler map in his effects.

The full story of how Rudler's Irish map was first acquired, used and then 'handed down' can be only reasonably supposed but what is certain is that the map has had three owners and the significance of the Aberystwyth connection has allowed its provenance to be exposed and has ensured its survival.

F.W. Rudler's copy of the Griffith 1853 geological map of Ireland.



Portrait of Richard Griffith. Source: Geikie, A. (1875) : Life of Sir Roderick I. Murchison, vol. 2, 124.

Portrait of FW Rudler, not dated, but taken in his younger years (probably not long before his appointment to UCW Aberystwyth). Source: BGS Asset Bank Special collections/ Survey staff photographs. Geological Survey and Museum and Royal School of Mines, 1850-1910. IGS1.639 P575807. ©NERC

Arthur Sansbury in 1932 (aged 24) - taken a year after he graduated from Aberystwyth

Benjamin Waterhouse Hawkins, James Tennant and the World's firstcommercially available prehistoric models

MICHAEL E. HOWGATE

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On the evening of Wednesday the 17th. of May 1854 Benjamin Waterhouse Hawkins gave a talk ' On Visual Education as Applied to Geology – illustrated by Diagrams and Models of the Geological Restorations at the Crystal Palace'. As I explained in a previous talk these models are probably the ones which now reside in Wisbech Museum.

After Waterhouse Hawkins' presentation there was time for discussion which was transcribed and added to the report published in the 'Journal of the Society of Arts'. The chairman, made a very prescient suggestion, which was reported thus "He should be glad to see those models multiplied at a price which would enable them to be introduced into village and ordinary schools, as everyone could not visit the Crystal Palace"*. At the end of the meeting Waterhouse Hawkins "stated his readiness to lend his aid in carrying out the suggestions made for multiplying the models in a form which would render them attainable and useful to society at large". * Fortunately for posterity the man who was to become the wold's first Dinosaur entrepreneur was also at the meeting - James Tennant ,Professor of Geology at Kings College and a noted mineral dealer.

Tennant must have reached an agreement with Waterhouse Hawkins immediately about producing a series of models based on his Crystal Palace reconstructions as he also arranged with the Society of Arts to use their report of the meeting as a prospectus for the proposed series of models.

Tennant's prospectus announced the forthcoming models as follows " Mr. TENNANT … expects shortly to supply the various Educational Institutions, Museums and the Public with these very instructive models, which Mr. W. Hawkins is preparing for casting, with the anatomy as shown in the fossils on one side, while the other will present an entire restoration of these extraordinary British animals." ** This must have come as a great surprise to Waterhouse Hawkins when he read it.

Tennant's original plan was still-born, but a series of 'in the round' plaster models, based on Hawkins' one inch to one foot maquettes were produced. These were the Megalosaurus, Iguanodon, Labyrinthodont, Pterodactyl and a diorams of two Plesiosauri and a large Ichthyosaurus. They were marketed by James Tennant through his business in the Strand and also became available in the USA through Professor Henry Ward of Rochester, from whom the full set could be had for a mere thirty dollars.

* Discussion after 'On visual education as applied to geology' by B. Waterhouse Hawkins (1854) in Journal of the Society of Arts Vol.2 Pgs. 444-9.

** Appendix A in' The Crystal Palace Dinosaurs, the story of the World's First Prehistoric Sculptures' by Steve McCarthy and Mike Gilbert (1994), The Crystal Palace Foundation.

Iguanodon model by Benjamin Waterhouse Hawkins in the Palaeontology Dept. Natural History Museum.

Specimens and Speculations: William Daniel Conybeare's ichthyosaurs and plesiosaurs

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The scientist most to be pitied: geology on the Imperial Trans-Antarctic Expedition 1914-17

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Following the achievement of the South Pole independently by both Amundsen and Scott, in late 1913 Sir Ernest Shackleton announced plans for an expedition to cross the entire continent. One ship, the *Endurance*, would transport Shackleton and his party to the Weddell Sea while another, the *Aurora*, would take a group to the Ross Sea from where they would lay supply depots across the Ross Ice Shelf for the use of the transcontinental party.

Shackleton also proposed an ambitious programme of science. Each ship would have a biologist, geologist and physicist; from a base at the head of the Weddell Sea, a geological party would explore Graham Land to the west while another headed east towards Enderby Land; the six-man transcontinental party would include a geologist or glaciologist; and a geologist would be with the depot-laying party approaching from the Ross Sea.

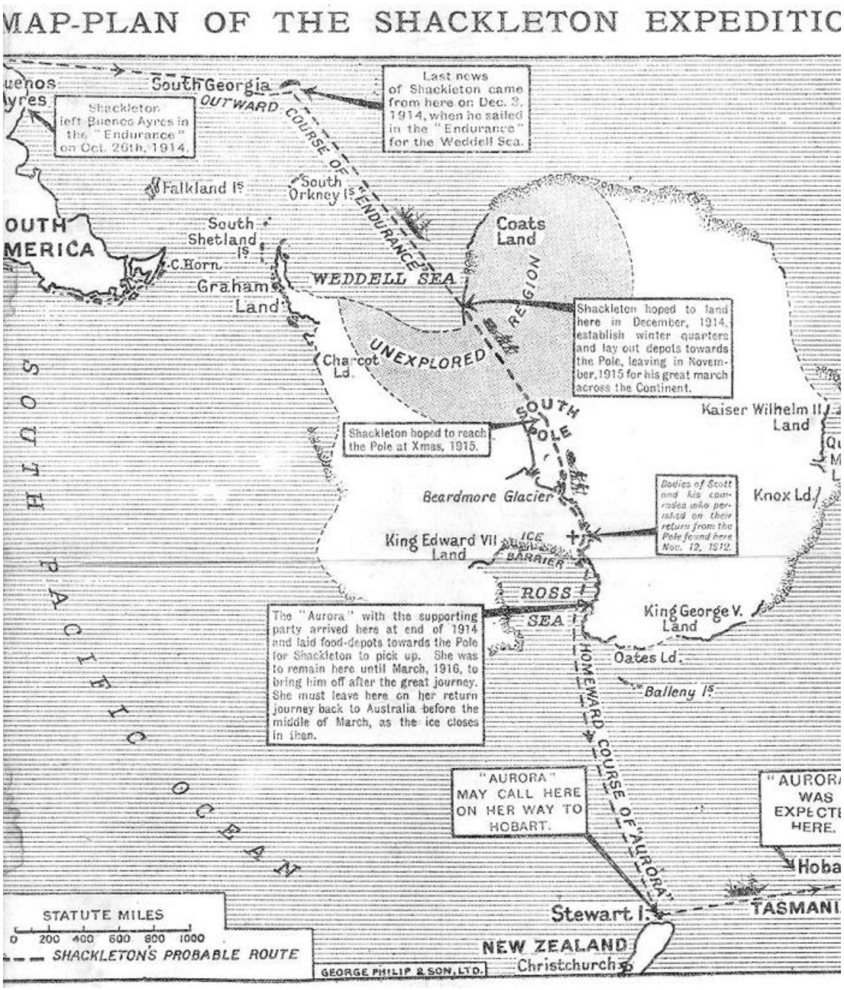
Two geologists were appointed to join the *Endurance*: James Mann Wordie (1889-1962) and Vivian Mortlock Studd (1891-1951), and a third, Alexander Stevens (1886-1965), was assigned to the Ross Sea Party. However, with war imminent as the expedition was about to depart in August 1914, Studd withdrew.

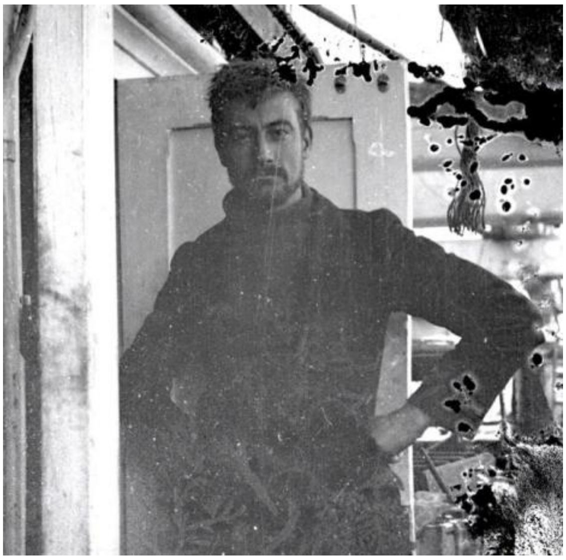
Events severely limited the scientific work of both the Weddell Sea and Ross Sea parties, with the latter stranded when the *Aurora* was blown adrift from her moorings and unable to return. The *Endurance* crew likewise, and more famously, suffered the catastrophic loss of their ship when she was beset, crushed and sunk by the pack ice of the Weddell Sea.

With the *Endurance* trapped in the pack for ten months, Wordie was considered ‘the scientist most to be pitied on this expedition’ by his shipmate Thomas Orde Lees. However, ‘the geologist was’, according to Shackleton, ‘making the best of ... an unhappy situation’: examining rocks dredged from the sea floor, stones embedded in icebergs, and pebbles from the stomachs of emperor penguins. During this time and subsequently when camped for five months on drifting ice floes, he also had a unique opportunity to study the origin, motion and behaviour of the pack ice.

When Shackleton’s party eventually reached land on remote Elephant Island and were marooned there for a further four and a half months, Wordie spent time collecting glacial erratics and collecting from outcrop. Only the latter material was retrieved when rescue came at the end of August 1916.

Despite the loss of almost all of his collections, in 1921 Wordie published a series of three papers which included a new interpretation of the age and structure of South Georgia’s geology; the first description of the rocks of Elephant Island; his speculations on the geology of Coats Land and on the relationship of Graham Land with the Antarctic continent; the first details of the nature of the Weddell Sea floor; and an important contribution on the Weddell Sea pack ice: a remarkable output given the circumstances in which he found himself.


MAP-PLAN OF THE SHACKLETON
South Georgia
Shackleton left Buenos Ayres in the "Endurance" on Oct. 26th, 1914.
OUTWARD COURSE OF "ENDURANCE"
Last news of Shackleton came from here on Dec. 3, 1914, when he sailed in the "Endurance" for the Weddell Sea.
Falkland Is.
South Orkney Is.
South Shetland Is.
C. Horn
Graham Land
WEDDELL SEA
Coats Land
UNEXPLORED REGION
Charcot Ld.
Shackleton hoped to land here in December, 1914, establish winter quarters and lay out depots towards the Pole, leaving in November, 1915 for his great march across the Continent.
SOUTH POLE
Shackleton hoped to reach the Pole at Xmas, 1915.
Kaiser Wilhelm II Land
Beardmore Glacier
Knox Ld.
Bodies of Scott and his comrades who perished on their return from the Pole found here Nov. 12, 1912.
King Edward VII Land
ICE BARRIER
ROSS SEA
King George V. Land
The "Aurora" with the supporting party arrived here at end of 1914 and laid food-depots towards the Pole for Shackleton to pick up. She was to remain here until March, 1916, to bring him off after the great journey. She must leave here on her return journey back to Australia before the middle of March, as the ice closes in then.
Oates Ld.
Balleny Is.
HOMEWARD COURSE OF "AURORA"
"AURORA" MAY CALL HERE ON HER WAY TO HOBART.
SOUTH PACIFIC OCEAN
Stewart I.
STATUTE MILES
SHACKLETON'S PROBABLE ROUTE
NEW ZEALAND
Christchurch



The geological legacy of the Scottish National Antarctic Expedition, 1902-1904.

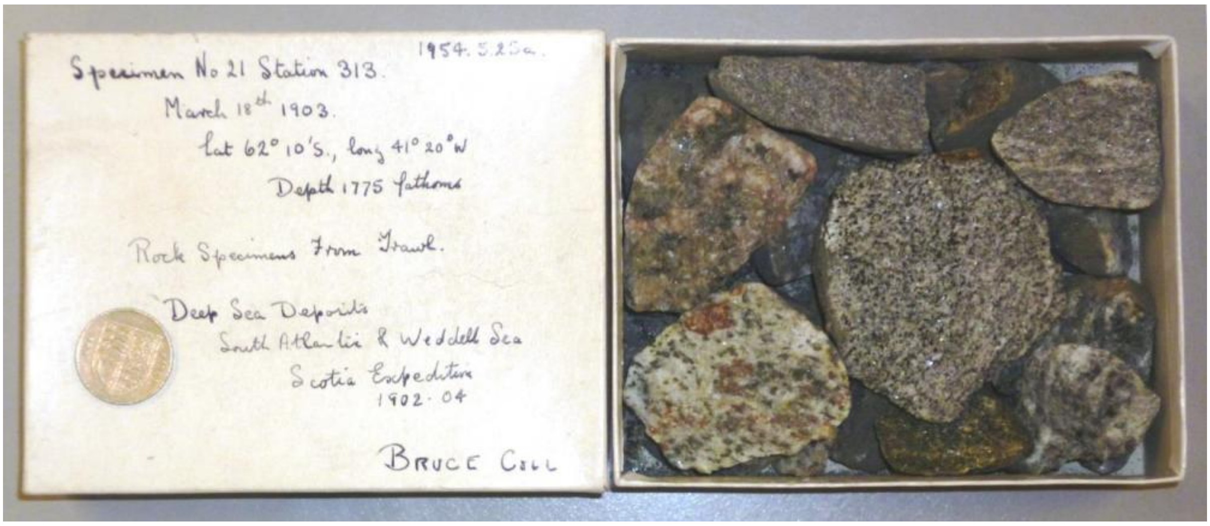
PHIL STONE

British Geological Survey, Edinburgh

The Scottish National Antarctic (*Scotia*) Expedition (1902-1904) is one of the least celebrated enterprises of the 'Heroic Era' of Antarctic exploration. Led by William Speirs Bruce (1867-1921) it resulted in the first topographical survey and scientific investigation of Laurie Island, one of the South Orkney Islands, and an extensive oceanographical research programme in the Scotia and Weddell Seas. It was controversial from the outset, being seen by the British Antarctic establishment as unwelcome competition for the contemporaneous, 'official' expedition led by Robert Falcon Scott: the British National Antarctic (*Discovery*) Expedition (1901-1904). Further controversy was then engendered by Bruce's transfer of the facilities that were established at Laurie Island to the Government of Argentina, which has operated the site ever since as the *Orcadas* scientific base.

The Scottish expedition's surgeon and geologist, James Hunter Harvey Pirie (1878-1965), provided competent descriptions of the tectonised siliciclastic succession (now known as the Greywacke-Shale Formation) that made up Laurie Island, but these were largely overshadowed by his misidentification of an obscure plant fossil as a graptolite. Erroneous confirmation by eminent British palaeontologists led to Triassic rocks being regarded as Lower Palaeozoic for fifty years. The mistake arose from the familiarity of all concerned with the geology of the Scottish Southern Uplands and a preconception that, as in Scotland, deformed 'greywacke-shale' successions would contain Lower Palaeozoic fossils. Other, more successful aspects of the expedition's geological investigations are less well-known. Fossils acquired in the Falkland Islands expanded that archipelago's poorly known Devonian brachiopod fauna, but arguably the most important palaeontological discovery lay unrecognised for ten years. A limestone block dredged from the bed of the Weddell Sea contained Early Cambrian archaeocyath fossils which, had they been promptly identified, would have been the first record of this important Antarctic palaeofauna. Instead, the Weddell Sea material complemented fossils recovered on the opposite, Ross Sea side of the Antarctic continent during Ernest Shackleton's British Antarctic (*Nimrod*) Expedition (1907-1909).

When the expedition returned to Scotland, Bruce embarked on an ambitious attempt to publish the expedition's scientific results in a series of high-quality reports. Sadly, by the time it came to Volume Eight (Geology), his funds were exhausted, and the series was abandoned. Nevertheless, many of the contributions that had been intended for that volume were produced; some were published elsewhere whilst unpublished proofs and archive notes survive for others. From these various sources the volume as planned by Bruce can be reconstructed. The key contributor was Pirie, and archive material illuminates the ways in which his unpublished work came to be preserved. The survival of proof copies for his account of the geology of Laurie Island can be credited to the intervention of two geologists who later became leading figures in British Antarctic exploration: Dr Ray Adie and Sir Vivian Fuchs.


Specimen No 21 Station 313.
1954.5.25a.
March 18th 1903.
Lat 62° 10'S., long 41° 20'W
Depth 1775 fathoms
Rock Specimens From Trawl.
Deep Sea Deposits
South Atlantic & Weddell Sea
Scotia Expedition
1902-04
BRUCE COLL

Early field measurements of Earth's mean density

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A number of 17th-19th Century field experiments were conducted to determine Earth's mean density, prior to their being superceded by laboratory-based experiments (Poynting 1894; Bullen 1975; Hughes 2006). I have revisited a number of these with the benefit of modern topography and gravity data to compare the results of the field measurements. The first experimental attempt to determine Isaac Newton's concept that a vertically-hanging plumbline would be deflected by the mass of a mountain was undertaken by Pierre Bouguer at Chimborazo, in Ecuador (then Peru) in 1738, although he worked in difficult conditions, and did not realise the accuracy of that his determination (Smallwood 2010). Nevil Maskelyne's 1774 "Schiehallion Experiment" was the first to produce a reasonable quantitative estimate of the density value, after considerable effort surveying the mountain, processed by Charles Hutton, and supplemented by geological mapping by John Playfair (Smallwood 2007; 2009). Hutton suggested that a plumbline deflection experiment be undertaken at the pyramids of Egypt to benefit from the regularity of the structure (Hutton 1821). I have completed a virtual realisation of an experiment at the Giza pyramids to investigate how Hutton's concept might have emerged had it been undertaken as he suggested. The attraction of the Great Pyramid would have led to inward north-south deflections of the vertical totalling 1.8 arc-seconds (0.0005°), and east-west deflections totalling 2.0 arc-seconds (0.0006°), which although small, would have been within the contemporaneous detectable range, and potentially given, as Hutton wished, a more accurate Earth density measurement than he reported from the Schiehallion experiment (Smallwood 2018). A further plumbline deflection experiment in more benign conditions was undertaken at Arthur's Seat in Edinburgh by James & Clarke in 1855. An alternative for measuring Earth's mean density was to determine the oscillation period of a pendulum, or rather measuring the variable length of the "seconds pendulum" as it varied spatially and with height. Pendulum timing experiments which have also been revisited with the benefit of recent satellite topographic data include those conducted by Bouguer, in 1737, during his South American expedition, Carlini in the European Alps in 1821 and Mendenhall on Mt. Fuji, Japan in 1880. I show how appreciation of the Earth's mean density might have evolved differently had the field skill of those taking the astronomical and length measurements been complemented by more detailed knowledge of the topography.

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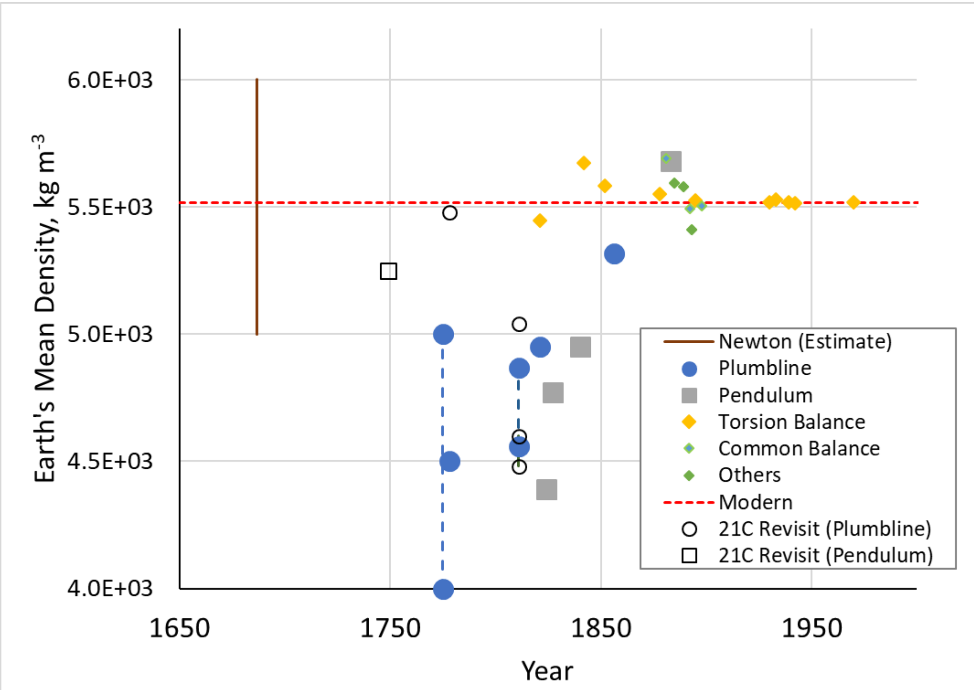

Figure 1 Historical evolution of selected determinations of Earth's mean density. This study concerns plumbline (circles) and pendulum (square) experiments. Those experiments revisited with the benefit of recent topography and/or density/gravity data shown as open symbols.

The man who 'knew so much': an iconography of Arthur Holmes' prescient models of the Himalayan-Tibet orogeny in successive editions of his *Physical Geology* text book.

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A recent lecture by Danny Clark Lowes (abstract, 2017) stimulated reflections on how models of Himalayan tectonics have changed over the years, most obviously with the emergence of the plate tectonics paradigm. Historically, prescient models of the origin of the Himalaya and Tibetan Plateau (HTP) in successive editions of the well-known text book by Arthur Holmes (1890-1965), *Principles of Physical Geology* (1944, 1965, 1978, 1993) are of particular interest. This is not because of their research value as such (Holmes did not work in the region and the models are only very schematic), but because they are vignettes which encapsulate his globally broader visionary thinking. His HTP model in his Second Edition (1965) (Fig.3) came remarkably close to 'inventing' plate tectonics.

Holmes' HTP models appeared only in his text book. Although text books are generally compendiums of received wisdom and salient facts, he notably also included his own big ideas about global geology and dynamics, especially with respect to the causes of continental drift (Drift). Over this time, there was little acceptance of Drift amongst leading Earth scientists, who insisted that there was no convincing mechanism. Holmes' own ideas were heavily criticized by geophysicists in particular. It might seem that he was therefore taking a risk with his largely student readership, and with his own very high professional standing, by including such criticized ideas. However he admitted lack of sufficient evidence for them, while believing, nevertheless, that it was important to use them to stimulate his readers. In fact, he was vindicated shortly after his death. Lewis (2000) has pointed out how his pioneering of radiometric dating ultimately led to the plate tectonics breakthrough, by providing the critical age-based evidence for sea floor spreading.

Holmes' HTP models followed from an earlier paper (1931) on mantle convection currents. In his First Edition, his HTP model (Fig 1) is an almost symmetrical one with rocks squeezed upwards and outwards by vice-like closure of opposing foreland masses. While this was conventional, Holmes also conjectured how closures could be driven by mantle convection (Fig.2). Opposing currents beneath the forelands, meet, merge and descend as one beneath orogenic belts (by famous but flawed analogy with convection cells in simmering porridge!).

In his Second Edition (Fig. 3), the convection cells and forelands in his HTP model (reproduced in his Third Edition) no longer meet symmetrically. Instead Holmes conjectured an asymmetric current system which has dragged the leading edge of the Indian foreland c 1000 Km northwards beneath the leading edge of Asia (as in his figure caption here). He also proposed that the resulting doubling of continental crust (sial) caused the isostatic uplift and great elevation of the Tibetan Plateau. This is a 'proto-plate-tectonics' model in all but name. It effectively reappears in plate tectonics guise, but without mention of Holmes, in the posthumous Fourth Edition (Fig. 29.2(b)), but the revising authors relegated it in favour of a 'modern' version (Fig. 29.2(c)). However, as explained in the talk, there is a postscript twist to this ending, since Holmes' Second Edition model seems to live on, 'ghost-like', in recent HTP thinking (e.g. Searle 2013).

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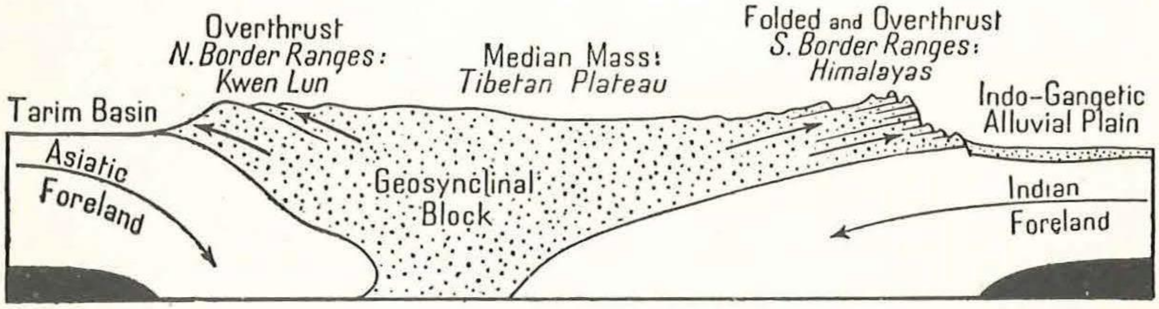

FIG. 199

Hypothetical section across the asymmetrical orogenic belt of the Himalayas and Tibet (folding of the marginal ranges omitted)

Figure 1. Holmes' HTP model in his First Edition (1944).

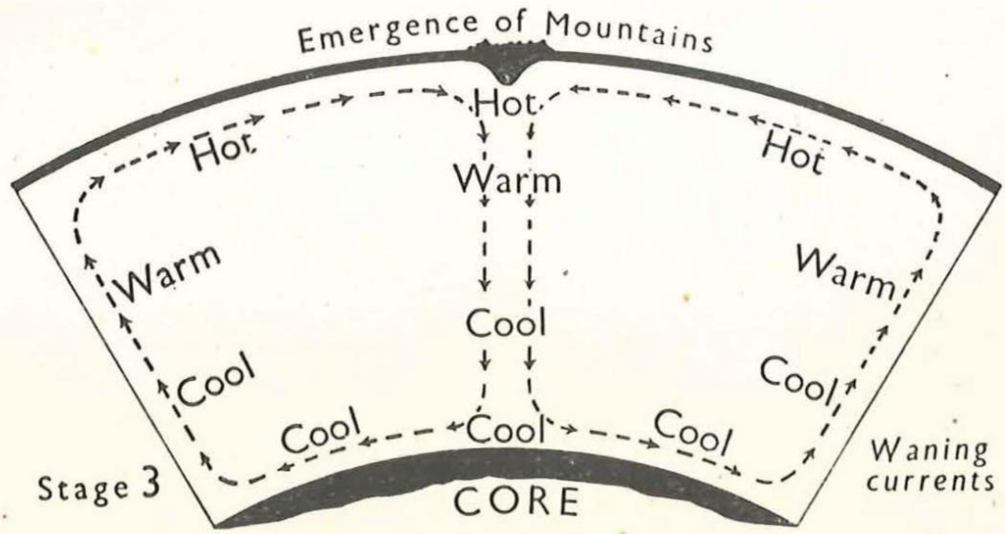

Fig. 215

Sections through the earth to illustrate the possible correlation between the successive stages of an orogenic cycle and those of a hypothetical convection current cycle

Figure 2. Holmes' conjectured general model in his First Edition (1944), showing how orogenies might be driven by mantle convection currents. (Only the lowermost of the three diagrams of his figure is shown here.) See also related diagrams in Holmes (1931).

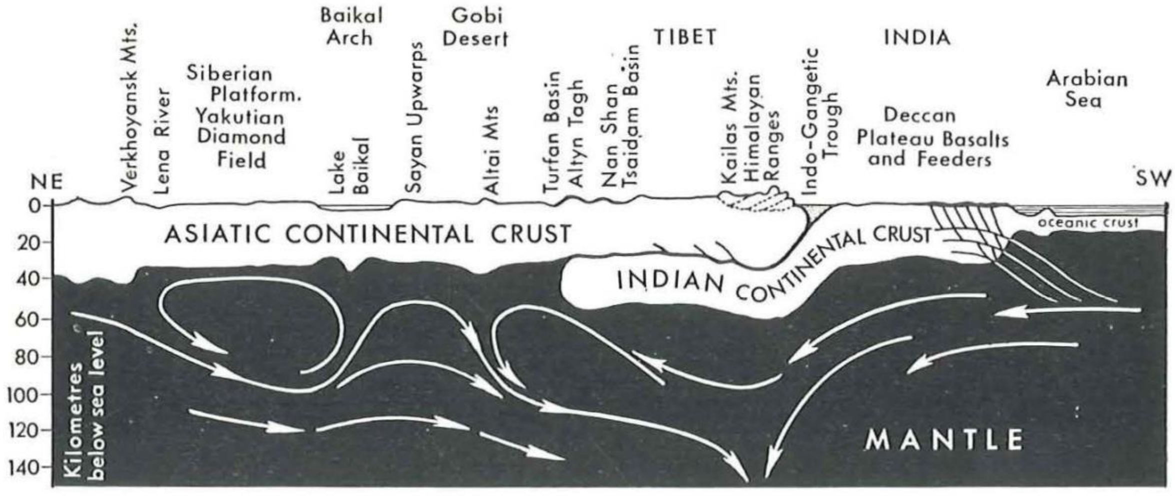

Fig. 798 Section across Asia from the Verkhoyansk Mts to the Arabian Sea to illustrate a possible cause for the great height of Tibet and the Himalayas—the underthrusting of the Asiatic crust by a northern extension of the Indian crust. The current system shown in the mantle is purely hypothetical and makes no pretence to be more than suggestive. A possible source for the plateau basalts of the Deccan is indicated. Length of section about 9,000 km

Figure 3. Holmes' asymmetric HTP model in his Second and Third Editions (1965, 1978) showing how mantle convection currents could have driven Indian continental crust c 1000 Km beneath Tibet.

Sloane : the British Legacy

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Sir Hans Sloane, the Founder of the British Museum, accumulated a large number of fossilised remains of animals and plants throughout his life. His collection, including curiosities from all around the known world, was acquired by the British Government in 1753 as part of Sloane's bequest to the nation. It formed the core of the fossil collection of the Department of Natural History in the British Museum, and is now conserved in the Department of Earth Sciences at the Natural History Museum in London.

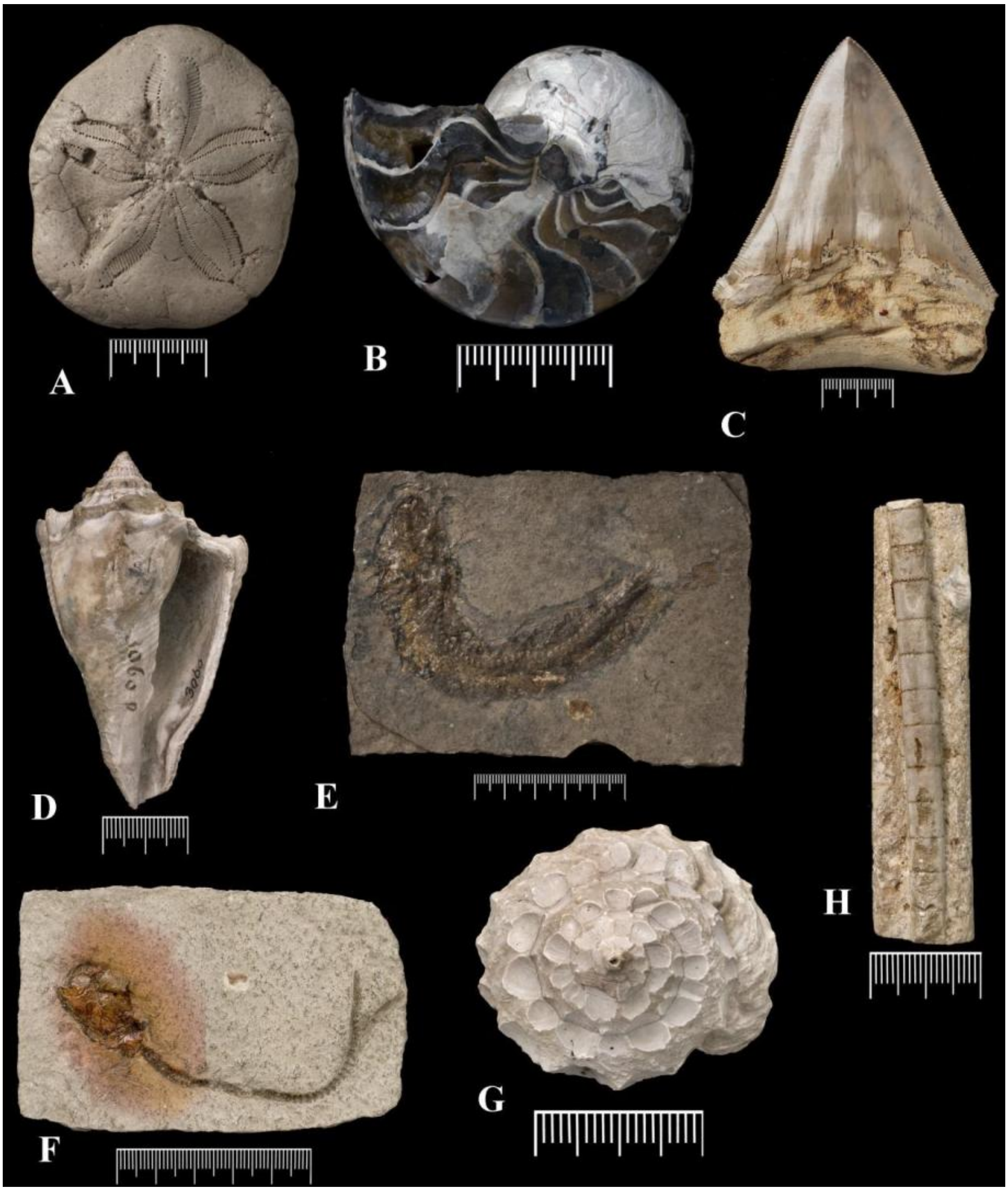
Sloanes's collections were the object of interest not only for British scholars and scientists, but also to all manner of distinguished visitors from Britain and abroad. They were displayed in his house with the exceptions of some "Rarities" that Sloane donated particularly to one of his former servants, Don Saltero. Saltero ran a coffee-house in Chelsea, where he exhibited this donation alongside other specimens to attract members of the public, following a contemporary trend for joining coffee-houses and museums because of their entertainment value.

Among Sloane's natural history specimens now located in the Department of Earth Sciences at the Natural History Museum are about 150 fossils and other geological samples. This number represents a drastic reduction from the at least 15,250 geological specimens in the original collection that included 4,000 fossil vertebrates, invertebrates and plants. Some of Sloane's specimens were disposed of at the beginning of the nineteenth century, as they lacked associated scientific information or were considered to be inferior duplicates of other specimens. The 110 fossils remaining were the object of a study initiated in 2010 to mark the 350th birthday of Sloane.

One of Sloane's main interests was palaeontology. Sloane generally referred to his fossils as petrified remains of once living animals and plants. Exceptions were fossil sharks' teeth and belemnites. The former are often referred to as 'glossopetra' (tongue stones) in Sloane's catalogues, alluding to the belief that these fossils were serpents' tongues petrified by Saint Paul after being shipwrecked on Malta. In the case of the belemnites, Sloane followed the belief of most of his contemporaries that they were inorganic minerals and not the fossilised internal shells of extinct squid-like animals we know them to be today.

The Sloane Collection of fossils includes, from the highest proportion to the least, molluscs (27% bivalves, 19% gastropods and 7% cephalopods), fishes (10% chondrichthians and 5% actinopterygiians), echinoderms (11% echinoids and 1% crinoids), brachiopods (10%), cnidarians (5%), mammals (2%), reptilians (2% and crustaceans (1%). One-third of Sloane's fossils lack provenance, with the localities and stratigraphy unknown. Among those with recorded provenance, most come from the UK, Russia, Switzerland, Germany and Malta. Stratigraphically, there are specimens from the Late Palaeozoic of Germany, the Mesozoic of Europe and the Cainozoic worldwide, including Jamaica.

Important fossils to highlight in the Sloane Collection are a stingray tooth from Maryland, USA described and figured by Sloane in Vol. 19 (1695–1697) of the *Philosophical Transactions of the Royal Society*, and the molar tooth of a mammoth from Siberia. The ray tooth was found by the English physician, Sir Tancred Robinson (*c*. 1658–1748), and sent to Sloane, who recognised it as a tooth very similar to those he saw in living rays during his visit to Jamaica.



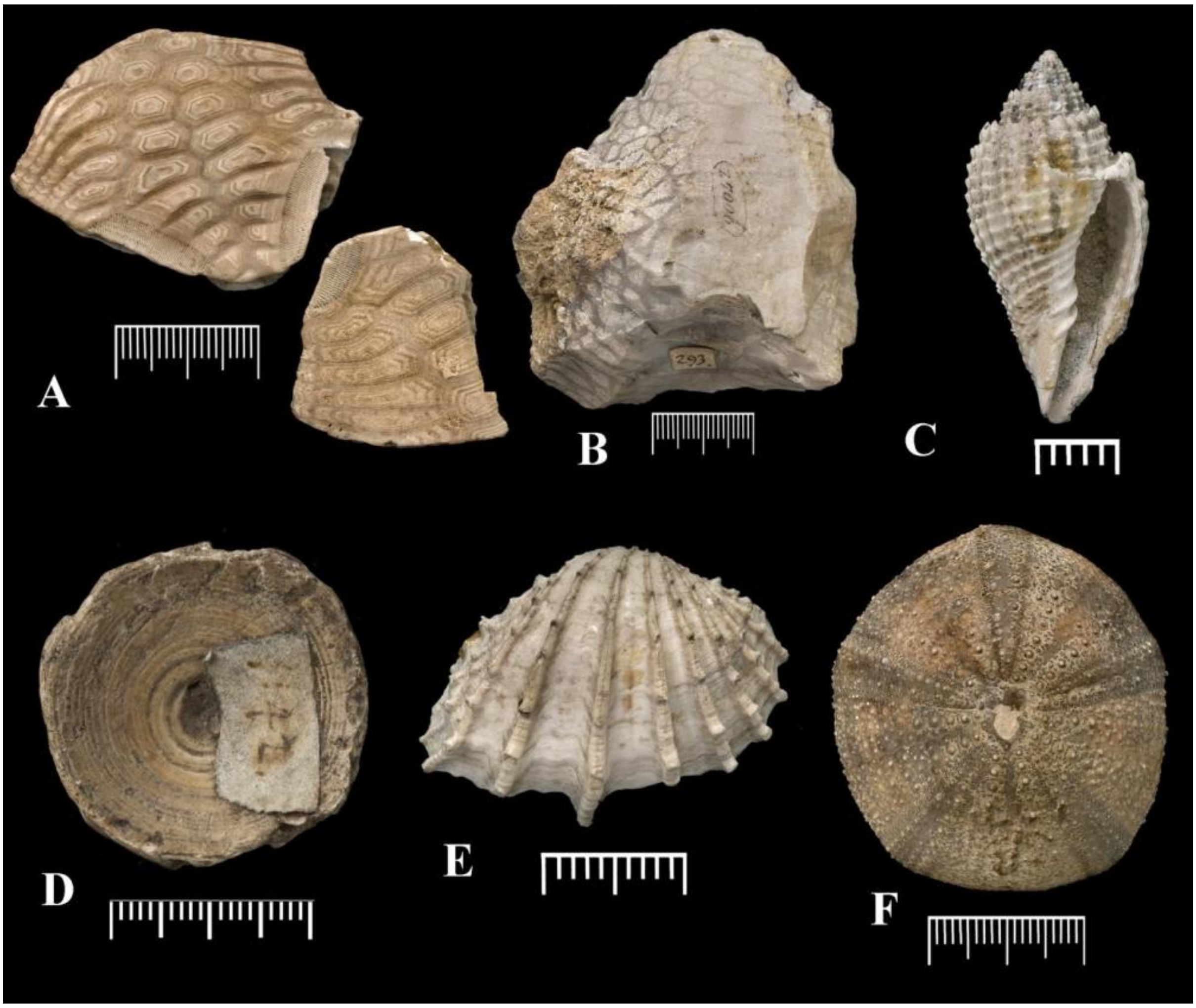


Fig. 1. (A) A fossil molar tooth of a rare species of mammoth from the Pleistocene of Siberia. (B) Part of a page of Sloane's catalogue with information about the mammal molar tooth from Siberia, specimen number 1807.
Fig. 2. Specimens from different collectors. (A) Sand dollar, *Mellita*, from the Tertiary of Maryland from Dr Robinson. (B) Coral, *Pseudodiplocoenia oblonga,* from the Portlandian (Jurassic) of Wiltshire from Mr Beaumont. (C) *Volutocorbis scabricula* from the Eocene from Mr Petiver. (D) Vertebra of Carchariidae? from the phosphate beds of the Carolinas from Mr Catesby. (E) *Cardium fittoni* from the Tertiary of Russia from Dr Klem. (F) *Stomechinus* from the Jurassic of Neuchatel (Switzerland) from Dr Lavater.
Fig. 3. Striking specimens. (A) An echinoid, *Clypeaster batheri*, from Jamaica. (B) A nautiloid, *Cimomia imperialis,* from the London Clay of Surrey. (C) *Carcharodon megalodon* from the Miocene of Malta. (D) *Athleta (Volutospina) luctator* from the Palaeogene of Lymington, Hampshire. (E and F) *Tharsis dubius* from the Jurassic of Eichstadt (Germany). (G) *Xenophora agglutinans* from the Eocene of the Paris Basin. (H) A crinoid from the Silurian of Gotland.

Glossopetrae

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The earliest reference to Glossopetrae, so-called because their shape shows some resemblance to a tongue, was by Pliny the Elder in his *Naturalis Historia* written


GLOSSOPE
TRA

The enigmatic Robert J. Adcock and the Figure of the Earth

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Following the astronomer Giovanni Cassini's discovery that the planet Jupiter was flattened at the poles, in 1687 Isaac Newton showed that a spheroid composed of a homogeneous fluid with a mean density of 'about 5 to 6 times that of water' rotating under gravitational attraction would flatten slightly at its poles, its equatorial radius (r_e) exceeding the polar radius (r_p) by $r_e = r_p/(1 - f)$, where the flattening $f \approx 1/230$. Although much of the mathematics underpinning his result was either unclearly expressed or omitted, it provoked numerous attempts in succeeding years to determine the 'Figure of the Earth,' either by measuring the lengths of a 1° arc at different latitudes or from gravity observations, and by the 1870s it had become clear that, in reality, f was about 1/290 - 1/300.

In March 1872, an American mathematician, Robert Jackson Adcock (1826-1895), published an 8-page tract, *Gravitation to the sphere and the two ellipsoids of revolution: Ratio of the axes of a rotating fluid mass*, to accompany a talk he would give at the 21st. meeting of the American Association for the Advancement of Science, Dubuque, Iowa, on 26th August. This three-dimensional reworking of Newton's approach showed that f was 'between 1/232.016 and 1/232.698', thus confirming Newton's result, but Adcock completely ignored the fact that it bore no resemblance to reality. Today, Adcock's work has been forgotten and he is known largely for several short notes, published in 1874-8 on how to best-fit a straight line through a set of data points, which relate to the 'method of least squares.' Very little has been published about his life. This contribution puts together what facts there are and eliminates as author several contemporary namesakes (with one of whom at least he has been confused).

Born in Kanawha City, West Virginia, Adcock's family moved to Henderson Grove, Knox County, Illinois, in 1830. Possibly home-schooled, in 1847 he began his tertiary education at Knox College, Galesburg, and in 1850 transferred to the third-year class at the Western (later Kentucky) Military Institute, Frankfort, Kentucky. Evidently recognised as an exceptional mathematician, in June 1851 he was appointed to the staff as 'Assistant Professor of Mathematics,' receiving his AB degree retrospectively that August. By 1858 he was 'Professor of Mathematics, Mechanics and Astronomy' and a successful and well-liked teacher. The death of his father in May 1859, and the increasingly difficult climate in the South with the on-coming Civil War (Adcock appears to have been an Abolitionist), may have contributed to a mental break-down: he was confined in the Illinois State Hospital for the Insane, Jacksonville, from December 1859 until August 1861. Following a brief attempt to teach in local schools, he embarked on a successful career as a farmer but between 1872 and 1895 he also wrote numerous short mathematical contributions in *The Analyst*. Unfortunately, his life was again interrupted by spells of confinement in December 1868 - May 1871 (during which time his tract was probably written) and March-April 1887. He died of pneumonia in 1895.

Meet the Speakers

Derek Morris read geology and physics at Queen Mary College, and then held a Shell Scholarship in Geophysics at the Royal School of Mines. After a short time with the Geological Survey, his career was spent working world-wide in the search for oil, minerals and water with Hunting Geology and Geophysics Ltd, becoming the Managing Director. In retirement the discovery that his family lived in Mile End opposite Captain James Cook, the famous explorer, has led to extensive research on eighteenth-century Stepney and the writing of four books on the social history of the area, together with numerous articles, and an interest in Cook's voyages. He is an Associate member of the University of Portsmouth, Port Towns & Urban Cultures Project.

Duncan Hawley was first exposed to the achievements of the 'greats' of the heroic age of geology at school. Studying at UCL consolidated the 'tradition' of geology, with tales of early pioneers featuring in lectures, drawing rocks and fossils collected by Greenough and reading Geikie's 'Founders of Geology' in the Geology Department's library. In his final year was elected President of the student 'Greenough Club' - named after GBG. Duncan has enjoyed a varied career in education, teaching geography and geology in both state and independent schools, at a field centre in the Forest of Dean and at university in Swansea. As an advocate for physical geography, enthusing and improving the quality teachers' work in the classroom he is the recipient of the Geographical Association's 'Award for Excellence' (2012) and 'Award for Excellence in Leading Geography' (2018). He is a past Chair of the Earth Science Teachers' Association. Duncan works on the geology of the Old Red Sandstone and contributed to the latest BGS maps for Brecon, Talgarth and Hay-on-Wye. He is involved in geo-conservation through the Sheffield Area Geology Trust. He has explored the work of geological pioneers in mid-Wales and traced the footsteps of Murchison to establish the site of 'The first true Silurian' (in the Wye Valley). He has a particular interest in the development of early geological maps. Duncan has organised HOGG field trips on W.D. Conybeare in South Wales and the discovery of Murchison's 'Brecon Anticlinal'. He was a speaker at the William Smith bi-centenary conference and is organising a like event in 2020 to celebrate the publication of G.B. Greenough's map. Duncan currently serves on the HOGG committee.

Michael Howgate has worked as a geologist on oilfields in Libya, Indonesia and the North Sea. After gaining a Masters in Vertebrate Palaeontology at U.C.L. he became a teacher while following up research into *Archaeopteryx* and avian evolution, in which he still has an interest. In the 1980's he became a tutor then course organiser for the London Region of the Worker's Educational Association. He was also a field trip leader and lecturer for the Education Department of the Natural History Museum. He has been a member of H.O.G.G. for 15 years.

Tom Sharpe was Curator of Palaeontology and Archives at the National Museum of Wales for 35 years and now works as a guide and lecturer, mainly in the polar regions. He has interests in the maps of William Smith, the life of Henry De la Beche and the history of Antarctic geology. He is a trustee of Lyme Regis Museum and is the current Chair of HoGG.

Phil Stone is an Honorary Research Associate with the British Geological Survey, based in Edinburgh, having retired from that organisation in 2010. He is a graduate of University College, Cardiff, and began his career with the British Antarctic Survey working on the island of South Georgia. Two outcomes of this work were a Ph.D. from Birmingham University (1975) and the award of a Polar Medal (1986). With the British Geological Survey, he has worked mostly on the Lower Palaeozoic geology of southern Scotland and northern England, has contributed to mineral exploration projects, and has acted as geological adviser to the Falkland Islands Government. He has published over 70 peer-reviewed papers and a wide range of reports and popular articles, a history of research recognised in 2016 by the award of the Edinburgh Geological Society's Clough Medal.

John Smallwood is currently studying for an M.Sc. in Geophysical Hazards at UCL, with a research project underway at the Mullard Space Science Laboratory in forecasting cold winters in the UK. My interest in historical geophysics stems from a web-search for papers on “Schiehallion” when I worked on the oil field of that name in the West of Shetlands, and I learnt of that mountain’s place as the site of the 1774 experimental determination of Earth’s mean density. I have worked as a geophysicist and manager for a number of companies, mostly in oil & gas exploration, since receiving my Ph.D. in Marine Geophysics from Cambridge University in 1997. My role has afforded me the opportunity to live for periods in the Faroe Islands, Kuala Lumpur (Malaysia) and Perth (Australia). I am a Chartered Geologist and also a keen fell runner and triathlete.

Consuelo Sendino is a palaeontologist working as a curator of palaeoinvertebrates in the Department of Earth Sciences of the Natural History Museum, London, since 2008. She is responsible for the fossil bryozoans, sponges and worms, as well as the Fossil Historical Collections. Consuelo has more than 20 years' experience, previously working as a curator at the National Museum of Natural Sciences in Madrid and as a project coordinator for GBIF. Her work includes not only the care of the collections, but also participation in exhibitions, specimen-based research, fieldwork and public outreach to promote the collections, digital curation and making sure the collections fulfil the Museum Policy. She has a PhD in Geology and has experience in teaching Masters students and co-advising PhDs.

Chris Duffin recently retired from school teaching; he was Senior Master, Director of Sixth Form, Head of Biology and Head of Critical Thinking at Streatham and Clapham High School in south London. He is currently a Scientific Associate in the Earth Science Department at The Natural History Museum. Originally qualifying as a geologist, he has Ph.D. degrees in Vertebrate Palaeontology from University College London, and the History of Medicine from Kingston University. He has published extensively (over 200 papers) on a wide range of fossil groups, but is particularly concerned with sharks and their allies. He co-authored the *Handbook of Paleoichthyology Volume 3D . Chondrichthyes. Paleozoic Elasmobranchii : Teeth* (2010, Friedrich Pfeil Verlag) and has edited several volumes on the History of Geology. Chris received the Palaeontological Association's *Mary Anning Award* for outstanding contributions to palaeontology in 2011.

Richard Howarth is a geologist who has specialised in the statistical interpretation of geological and geochemical data. Graduating from the University of Bristol, he has worked at Shell International, the Applied Geochemistry Research Group at Imperial College, the University of Georgia and British Petroleum; and is currently Hon. Professor of Mathematical Geology, University College London. He now mainly writes on the history of the use of quantitative methods in geology and early geophysics. His statistical and historical interests led to his *Dictionary of Mathematical Geosciences with historical notes* (2017). He was awarded the William Christian Krumbein Medal of the International Association for Mathematical Geology in 2000 and the Sue Tyler Friedman Medal of the Geological Society of London in 2016.