

<b>Institution:</b> University of Birmingham		
<b>Unit of Assessment:</b> 7 – Earth Systems and Environmental Science		
<b>Title of case study:</b> The Lapworth Museum of Geology as a vehicle to change public understanding, learning and education in Earth Sciences		
<b>Period when the underpinning research was undertaken:</b> 2000-2020		
<b>Details of staff conducting the underpinning research from the submitting unit:</b>		
<b>Name(s):</b>	<b>Role(s) (e.g. job title):</b>	<b>Period(s) employed by submitting HEI:</b>
Dr James Bendle	Reader	2012–present
Dr Ian Boomer	Senior Research Fellow	2005–present
Professor Richard Butler	Professor	2013–present
Dr Kirsty Edgar	Senior Lecturer	2016–present
Professor Ian Fairchild	Professor	2003–2016
Dr Sam Giles	Senior Research Fellow	2018–present
Dr Sarah Greene	Lecturer	2017–present
Dr Jason Hilton	Reader	2003–present
Dr Stephen Jones	Senior Lecturer	2009–present
Dr Tom Dunkley Jones	Senior Lecturer	2012–present
Dr Stephan Lautenschlager	Lecturer	2017–present
Dr Marco Maffione	Lecturer	2017–present
Professor Tim Reston	Professor	2006–present
Dr Ivan Sansom	Senior Lecturer	1992–present
Dr Carl Stevenson	Senior Lecturer	2007–present
Dr Alan Thomas	Senior Lecturer	1988–2010
Dr Sebastian Watt	Senior Lecturer	2013–present
Dr James Wheeley	Senior Lecturer	2007–present
<b>Period when the claimed impact occurred:</b> 1 January 2014–31 December 2020		
<b>Is this case study continued from a case study submitted in 2014?</b> No		
<p><b>1. Summary of the impact</b></p> <p>Funded by the National Lottery, a re-imagined Lapworth Museum opened in 2016 as a unique <b>collaboration between researchers and museum professionals</b>. The Museum has since become a focal point of public engagement activities in Earth Sciences across the region and beyond, facilitating <b>research-led engagement with diverse audiences</b>. The radical transformation of the Lapworth, and the step-change in reach achieved, has received considerable recognition. Importantly, this includes <b>professional evaluation</b> via Arts Council England who awarded the Museum National Portfolio Organisation status in 2018. The Lapworth is also used to nationally <b>enhance Earth Sciences and Geography education</b>, with University of Birmingham research underpinning a range of examples including changes to syllabi.</p>		
<p><b>2. Underpinning research</b></p> <p>The research strengths of the University of Birmingham in Earth Sciences are in three key areas: <b>Palaeobiology, Palaeoclimates and Dynamic Earth Processes</b>. University of Birmingham researchers have undertaken fundamental research into the understanding of marine and terrestrial ecosystem evolution, the impacts of mass extinctions, systematics of major fossil groups, patterns and processes of climate change, and the key stages in the Earth's tectonic development: continent formation and breakup, seafloor spreading, subduction initiation and magma emplacement.</p> <p>The Lapworth Museum of Geology has a core mission of communicating this research, as well as other research of the University of Birmingham, to non-academic audiences. However, the</p>		

Lapworth collections also form a critical repository for specimens collected and used during Earth Sciences research, supporting >200 publications since 2000, including >50 by Birmingham researchers. These dual missions provided the rationale for the 2014–2016 redevelopment, in which the content of the new permanent displays was co-produced by >10 University of Birmingham researchers working together with museum professionals.

The new displays in the museum were **fundamentally informed, influenced and underpinned** by the body of internationally leading and internationally excellent research in Earth Sciences conducted at the University of Birmingham from 2000–2020. Our research strengths were directly mapped onto the two key themes of **Evolution of Life** (Palaeobiology, Palaeoclimates) and **Active Earth** (Palaeoclimates, Dynamic Earth Processes), which together occupy over 75% of the Museum space.

Here, we provide **highlighted examples** drawn from the large number of explicit links between individual University of Birmingham research outputs and exhibition content (examples 1–5), research-driven temporary exhibitions (examples 4–5) and schools activity (example 6).

1. Research on the evolution of Palaeozoic vertebrates, including the morphology, evolution and diversity of the earliest fish, and trackway evidence for the earliest land vertebrates, drove display of Ordovician–Permian research specimens and content in the Evolution of Life gallery. These include, for example, specimens of the early fish *Astraspis* and *Arandaspis* discovered by University of Birmingham researchers, and internationally significant fossil trackways from the Carboniferous of Shropshire and the West Midlands [R1].
2. Research on carbonates and palaeoclimates from the Precambrian to the Quaternary led to display of numerous samples from our research collections (e.g. stromatolites from Greenland; Proterozoic glacial lake deposits from Svalbard; speleothems from the UK, Spain and Ireland) in the Evolution of Life and Active Earth galleries [R2].
3. Research on Silurian marine ecosystems from the Midlands and the Welsh Borders improved understanding of palaeoenvironmental setting and evolution, as well as the diversity and ecology of components of these ecosystems (e.g. trilobites, echinoderms). This work underpinned object selection, content and layout for the extensive display of Silurian fossils from the Wenlock Limestone in the Evolution of Life gallery [R3].
4. Research on dinosaur evolution, such as new insights into dinosaur origins based on fossils from Tanzania, underpinned temporary exhibition development and media activity, as well as displays on Mesozoic ecosystems in the Evolution of Life gallery [R4].
5. Research on using micropalaeontological and biomarker data from ocean drilling projects to study long-term climate change in deep time underpinned temporary exhibition development and linked educational activities, as well as displays in microfossils and climate change in the Active Earth gallery [R5].
6. Research on new concepts in seafloor spreading, especially investigating large offset 'oceanic detachment faults', led to a University of Birmingham-led NERC research project, involving the participation of the first ever UK 'Teacher-at-Sea' in the Birmingham-led Expedition 132 of the RV James Cook, underpinning educational activity and syllabus change [R6].

### 3. References to the research

[R1] Meade, L.E., Jones, A.S., **Butler, R.J.** 2016. A revision of tetrapod footprints from the late Carboniferous of the West Midlands, UK. *PeerJ*, **4**: e2718. DOI: 10.7717/peerj.2718

[R2] **Fairchild, I.J.**, *et al.* 2006. Modification and preservation of environmental signals in speleothems. *Earth-Science Reviews*, **75**: 105–153. DOI: 10.1016/j.earscirev.2005.08.003

[R3] Ray, D.C., and **Thomas, A.T.** 2007. Carbonate depositional environments, sequence stratigraphy and exceptional skeletal preservation in the Much Wenlock Limestone Formation

(Silurian) of Dudley, England. *Palaeontology*, **50**: 197–222. DOI: 10.1111/j.1475-4983.2006.00607.x

[R4] Nesbitt, S.J., **Butler, R.J.**, *et al.* 2017. The earliest bird-line archosaurs and the assembly of the dinosaur body plan. *Nature*, **544**: 484–487. DOI: 10.1038/nature22037

[R5] Prentice, K., **Dunkley Jones, T.**, *et al.* 2014. Trace metal (Mg/Ca and Sr/Ca) analyses of single coccoliths by Secondary Ion Mass Spectrometry. *Geochimica et Cosmochimica Acta*, **146**: 90–106. DOI: 10.1016/j.gca.2014.09.041

[R6] **Reston, T.J.**, Ranero, C.R. 2011. The 3-D geometry of detachment faulting at mid-ocean ridges. *Geochemistry, Geophysics, Geosystems*, **12**. DOI: 10.1029/2011GC003666

#### 4. Details of the impact

Open since 2016, the new Lapworth Museum represents a **collaboration between researchers and museum professionals to enhance the preservation and interpretation** of a unique Arts Council designated collection. Funded by the Heritage Lottery Fund [S1] and driven by the latest science, a team of over ten University of Birmingham researchers worked with Lapworth staff over the two-year redevelopment period to deliver the detailed content to underpin the general themes and broad layout of the new permanent exhibits (see examples in underpinning research e.g. R1, R2, R3; Fig. 1).

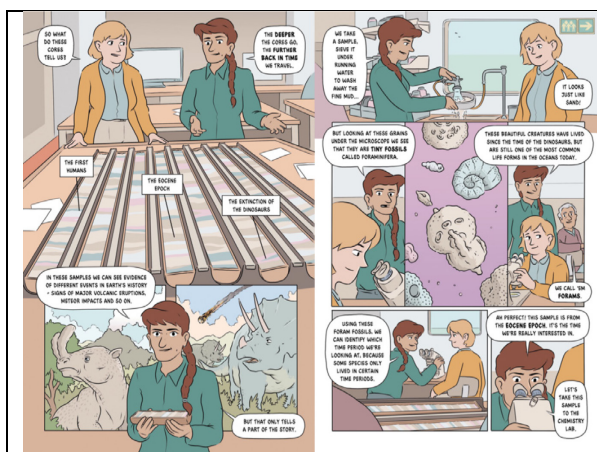


**Figure 1.** A) Evolution of Life gallery of the new Lapworth Museum; B) Displays of Carboniferous footprints from the West Midlands worked on by Birmingham researchers (e.g. R1); C) Family visitors in the Evolution of Life gallery; D) Display in Active Earth gallery on use of microfossils to elucidate past climates [R5]; E) New education room which is used for school sessions, teacher training and other engagement activity.

The Lapworth also benefits from a temporary exhibition space, which enables cutting-edge, research-led exhibitions to be hosted which **stimulate public interest in the latest research**. For example, the *Drawing out the Dinosaurs* temporary exhibition was directly based on Butler's research [R4], which was covered in >360 media articles in c.250 news sources from 2014–2020, with a media reach of c.72m people and an advertising value equivalent of £1.38m. This exhibition was designed to coincide with the 2018 *Dippy on Tour* exhibition at the Birmingham Museum and Art Gallery, where Butler also acted as an academic consultant. Together, the two exhibitions attracted >250,000 visitors. A second example comes from the temporary exhibition *Mysteries of the Deep*, led by Dunkley Jones (Fig. 2). Thanks to **innovative public engagement approaches**, such as the use of interpretative comic books, the exhibition was viewed by over 16,000 people including 390 attendees on a family fun-day.



## Impact case study (REF3)



**Figure 2.** Section of the comic book designed for *Mysteries of the Deep*, which presented NERC-funded palaeoclimate research (e.g. R5) within the context of 50 years of scientific ocean drilling by the International Ocean Discovery Program. The exhibition website attracted >750 visitors from 42 countries, including 225 downloads of educational materials for use in school and university teaching sessions in counties including the UK, Italy, Australia and Taiwan. The exhibition artwork is now being used for outreach internationally (e.g. exhibitions in Italy and New Zealand).

The new development has been praised for its **research-led engagement with diverse audiences** [S3], with more accessible interpretation aimed at family, school and non-specialist audiences (including text written for these audiences, and much greater incorporation of animations and graphics). This, along with a more physically accessible space, has led to **greater cultural participation**, particularly with under-engaged and diverse audiences within the region. **In-person visitor numbers have tripled to c.220,000** from mid 2016 to early 2020 (pre-COVID). This includes a significant increase in the proportion of school group visitors from BAME backgrounds which has increased from c.5% pre-redevelopment (representative of the 4.1% of BAME student intake for A-level geology nationally in 2019) to >60% post-redevelopment. Regular family fun-days attract 300–700 visitors per day, and free evening ‘Lapworth Lates’ bring University researchers together with young adult audiences, attracting up to 200 visitors at each event. Visitor feedback has been excellent as demonstrated by surveys, focus groups and online reviews (e.g. 603 Google reviews, average 4.7/5\* feedback; 103 TripAdvisor reviews, average 4.5/5\* feedback).

However, the impact of this change is best evidenced by **professional evaluation**, notably the 2018–2022 award of National Portfolio Organisation (NPO) status by Arts Council England, the national development agency for creativity and culture [S2]. The Relationships Manager (Midlands, Museums) of Arts Council England testified that the investment (£418,914) in the Lapworth was made in recognition of the:

[...] ambition building on the success of the National Lottery Heritage Fund investment in the redevelopment which provided the opportunity to refocus on public engagement. Through the museum’s work to date we have seen the development and delivery of a diverse programme of research-led exhibitions and events which has brought under-represented communities into the museum, to examine, investigate and interpret the collections [S3].

NPO status was confirmed following shortlisting of the Lapworth for the 2017 Art Fund Museum of the Year, the largest single museum arts prize in the world. The Museum was profiled in the BBC2 documentary of the same name [S4]. At shortlisting, Art Fund highlighted:

[the transformation] from a niche academic institution into a dynamic, public-facing museum telling the story of the world’s four billion-year history [S5].

Museum of the Year was just the pinnacle of **media coverage** for the Museum over the REF period with the Lapworth being the subject of c.480 media articles in >200 different news sources across the world from 2014–2020 (reach of c.66m people and news value of £1.45m). The nomination and heightened profile contributed to an increase in overseas visitors from 1% to 4% and also led to broader **influence on best practice within the wider museum sector**. The enhanced profile created by the redevelopment led to the Lapworth being a founding member of the international Science in University Museums network, which builds partnerships and shares best practice and innovation across museums in Oxford, Cambridge, Manchester, Newcastle, Harvard, Porto and Porto Alegre. Moreover, representatives of >10 other museums across the UK visited since 2016, using the Lapworth to inform their own redevelopment, exhibition and engagement plans. The Fossil Coordinator from Brymbo Heritage Trust stated:

We were particularly impressed by the success of the Lapworth in integrating the cutting-edge geological and palaeontological research of the University of Birmingham into the permanent and temporary exhibitions, and into a dynamic and successful programme of school and public engagement and events. Our visit to the Lapworth was an important influence on the development of our own project plans, including our successful National Lottery Heritage Fund application [S6].

#### Impacts on learning and teaching by sharing best practice and influencing syllabi

The redevelopment of the Lapworth Museum kickstarted a new programme of school engagement activity leading to a **nationwide enhancement of Earth Sciences education**. Spearheaded by two new Learning & Community Development Officers, specifically focused on launching and delivering school sessions, more than 470 onsite educational sessions were delivered to more than 12,000 pupils from 280 schools between 2016 and 2020. The Lapworth has also delivered onsite training sessions for >115 trainee geography and science teachers since 2018, helping **educators to develop best practice** skills in teaching geological aspects of the science and geography curricula. A curriculum leader at Solihull Sixth Form College testified:

I was particularly impressed by the access that we were given to research activity, via the content within the museum [...] the visit brought to life the work of geoscientists in the real world of research [...] Opportunities and encounters such as this really raise the aspirations of students at the beginning of their academic journeys [S7].

In 2019, the Lapworth acted as host for the Earth Science Teachers Association annual course and conference. This included a day focused on University of Birmingham research and how it can be translated into classroom teaching, with workshops for educators delivered by University of Birmingham researchers. Among other topics, this workshop highlighted the UK's first 'Teacher-at-Sea' (Angela Bentley) who participated in the JC132 cruise in 2016 [S8]. This research on new concepts in seafloor spreading, led by Reston, has **led to changes in syllabi** at both GCSE (including geophysical techniques used during the cruise) and A-level (concepts of oceanic detachment faulting and core complex development [R6]) for WJEC and OCR exam boards, impacting >2000 students annually who are studying Geology at GCSE and A-level [S9]. Angela Bentley was awarded the Patrick Moore Medal for Education by the Royal Astronomical Society to recognise her Teacher-at-Sea work and subsequent pedagogical activities.

#### **5. Sources to corroborate the impact**

S1. Lapworth Museum of Geology: Evaluation of HLF Supported Development and Activities. External report by A. Meredith Associates (Malvern, Worcestershire), January 2019.

S2. Lapworth Museum of Geology, Arts Council England NPO — Annual review and feedback 2018/19.

S3. Elizabeth Neathey, Relationship Manager (Museums, Midlands), Arts Council England. [Dated 30 November 2020]

S4. *Museum of the Year* (2017). BBC 2 Television, 3 August 2017. [Available on request]

S5. Art Fund press release – [Museum of the Year 2017 Finalists Announced](#), 27 April 2017. [Accessed 12 February 2021]

S6. Dr Tim Astrop, Fossil Coordinator, Brymbo Heritage Trust, Wrexham. [Dated 15 January 2021]

S7: Dr Karen Greaves, Humanities Curriculum Leader, Solihull Sixth Form College, Solihull. [Dated January 2020]

S8: Angela Bentley, Head of Earth Science, Aquinas College, Manchester.

S9: Peter Loader, Chair of the Geological Society Education Committee; Chief Examiner for A-level Geology, WJEC-Eduqas.