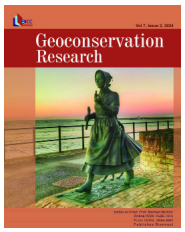

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Museums and Geoconservation

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Introduction

While museums have long been associated with the protection and interpretation of cultural, historical, and natural heritage, their role in geoconservation has only become more prominent in recent decades. Geoconservation focuses on the conservation of geological features, processes, and landscapes, and has gained recognition as an important area of environmental protection, particularly in the context of climate change and anthropogenic pressures on natural resources. Importantly, geoconservation is based on the fundamental scientific evaluation of those locations, such as open landscapes, coastlines, and quarries in terms of their regional and international significance.

Therefore, there are two roles for museums in connection with geoconservation, namely scientific and educational. Museums promote geoconservation through their collections, exhibitions, research, and public outreach. Different papers in the volume address questions of proper collecting practice and making links from the conserved geological sites to the curated collections in a museum, largely in the context of their scientific worth. Collecting on the land can be a fraught topic in the context of moving specimens from place to place, especially in moving them from one nation to another. What was once done without thought is now an important area of ethical debate. Such considerations are important also in education, where the choice of language and terminology can matter. Further, museums, like geoparks, rely on the support of visitors and it is important for all audiences to be considered in planning the educational and engagement activities in museums and integrating with nearby geosites. Partnerships between museums and geosites can present benefits for both.

The Role of Museums in Research

Museums, particularly natural history museums, have long been custodians of knowledge about the Earth's history and its geological processes. The key to their significance lies in their collections, and the value of the collections of the great museums of the world depends on the thoroughness of curatorial care over the decades. Museums may contain specimens from 200 years ago or more, documenting the work of some of the founders of geology. Everyone can agree on the value of the perpetual curation of rocks and fossils collected by such great early researchers as Hutton, Cuvier, Murchison, Humboldt, or Darwin. Such historical materials of course provide a buzz of excitement when they are shown to visitors, even to non-experts; 'this is a rock that Darwin collected, and It proved for the first time that the Pacific islands were formed from recent lava'.

This long-term care is particularly true of fossils, where the crucial type specimens – the name-bearers to which all modern researchers refer - must be preserved forever. This is a high demand, requiring protection from the ten agents of deterioration (physical forces, fire, pests, light, incorrect relative humidity, thieves and vandals, water, pollutants, incorrect temperature, and dissociation). High-grade, secure storage cabinets that maintain a constant environment are costly. In addition, the record-keeping must be punctilious. Labels and catalogs require care so that paper records are full and detailed and are also protected from deterioration, and digital copies are backed up. Important historical materials are living records, and as new waves of experts study the older specimens and add their new interpretations, new knowledge must be added to the documentation. Continuity of comprehension and funding is also massively important: can we ensure that all museums are thoroughly appreciated by their funders through the generations, and that curators of sufficient knowledge and care are in constant control of the materials? One slip in one generation, and all can be lost.

Local and regional museums have important additional roles in the conservation of research materials. Their collection policies generally focus on acquiring specimens from the local area, and this meshes with their role as civic spaces in their local communities. Alignment with the interests of local people can build loyalty and pride in their area, and the museum can communicate the scientifically important collections they hold, explaining their significance at national and international levels. Smaller museums can struggle to find funding to maintain high standards of curation and to provide the appropriate facilities for visiting researchers, such as microscopes and photographic facilities. They may also be located far from any university which limits their options in fostering student research projects, or student volunteers to help with curation and explanation tasks. However, sector organizations, such as Museum Development, and Subject Specialist Networks in the UK, can help here, as well as the increasing use of social media and online tools to access a wider pool of resources.

The Role of Museums in Education

Museums have always had a key role in education, but the nature of that role has changed through the years. Whereas museums before 1870 were often seen as the preserve of the educated (richer) classes, they have since then been opened step-by-step to a wider clientele. In the nineteenth century, ‘working men’ might be admitted on certain days for a small fee, but this small concession illustrated that the museum was still seen as a somewhat exclusive temple of knowledge. Many museums were in private hands or were fostered by a small group of fee-paying supporters.

Now, museums have generally democratized, and they are often at least partly funded through local and national governments. Modern museums are expected to demonstrate efforts to bring in underserved audiences - people who think museums are not for them. This sets challenges for curators and education staff to find ways to communicate their collections in new ways.

In the case of education, local and regional museums need not be disadvantaged in the ways they may be in supporting research activity. In terms of outreach and education, a local museum has an immediate focus, which is their city or county. Museums can strengthen civic cohesion and identity. Building from that pride, the curator or educator can develop stories for exhibits and learning materials that focus on a location that is known to many people, or a person or historical episode. Telling the story of a local person can engage people to see their environment through the eyes of the named individual, and they can follow their

story of discovery alongside them.

The endeavor to connect people emotionally to their part of the natural world can be massively enabled through links between museums and geosites. Placing the local natural world in a wider context can be validated by these means. Naturalists have always known the best places locally to see birds or collect fossils, but designation of biosites and geosites by a national or international agency can help validate these locations. The museum curator can use the information from the designation documents, such as 'a key site to understand karst development' or 'the type locality for a particular fossil fish' as a means to strengthen their explanations to local people, both adults and children. Who in Lyme Regis is not thrilled to hear stories about Mary Anning and how she brought the local fossils to the attention of the world over 200 years ago?

The Integration of Geoconservation Principles into Museum Practice

In recent years, there has been an increasing recognition within the museum sector of the importance of integrating geoconservation principles into museum practice. This includes not only the conservation of geological specimens but also the development of exhibitions and programs that emphasize the importance of protecting geological landscapes and processes.

Museums often develop exhibitions that explore the Earth's geological history, providing visitors with a deeper understanding of the forces that have shaped the planet over billions of years. These exhibitions can be powerful tools for communicating the value of geological features and the need for their conservation. For example, exhibitions on fossils or rock formations often explain how these features can offer insights into past environments, while also addressing the potential threats they face from human development or climate change.

Moreover, some museums take a more active role in advocating for the protection of specific geological sites, such as by developing "geotrails" that highlight the geological significance of particular landscapes. These projects are often in collaboration with local governments, conservation organizations, and universities, and aim to raise awareness of the need for site protection. For instance, in the United Kingdom, the Geodiversity Charter was developed to encourage local authorities and museum professionals to work together to safeguard important geological sites (Gray 2021).

Research and Collaboration

In addition to their educational role, museums are also involved in scientific research that supports geoconservation efforts. Many museums employ geologists, paleontologists, and other experts who conduct research on topics such as mineral conservation, fossil preservation, and landscape change. This research is often published in scientific journals or shared through conferences and seminars, contributing to the growing body of knowledge about the Earth's geological heritage.

Collaboration between museums and other stakeholders, such as universities, environmental NGOs, and governmental bodies, is also a key aspect of geoconservation. Museums often work in partnership with these organizations to conduct field surveys, monitor geological sites, and promote policies that support geoconservation efforts. The UNESCO Global Geoparks programme places a combined focus on geological significance of locations together with conservation and community engagement. These partnerships can help bridge the gap between scientific research, public education, and conservation practice, creating a holistic approach to protecting the Earth's geological heritage.

Museums can have a crucial role in providing a venue for citizen science initiatives in geocon-

servation. Ballard *et al.* (2017) investigated 44 citizen science programs across three museums (one U.K., two U.S.) to assess whether and how they contribute to conservation-relevant outcomes. They found that these initiatives support conservation both directly, through site and species management, and indirectly through research, education and policy impacts. The strength of the museum-geosite link is that they provide a venue for people to conduct their work, see specimens and receive training, report results, and see the outcomes of their communal efforts. Many of these studies were in the realm of biological conservation, where citizen scientists reported plants, insects, or birds they encountered. But citizen science can extend to rocks and fossils found in much-visited coastal locations, or literature- and web-based studies, where the citizen researchers measure features from photographs or drawings made available on websites or seek out information to build documentation of local and regional sites.

The Challenges Facing Museums in Geoconservation

Museums face many challenges. One of the primary obstacles is the lack of funding for geoconservation initiatives, especially in an era of economic constraints and shifting priorities in the museum sector. Many museums struggle to allocate resources for large-scale conservation projects or for developing new exhibitions focused on geology and conservation.

Another challenge is the need for specialized expertise in geology and conservation science. While museums traditionally focus on cultural and natural history, the integration of geoconservation requires a deep understanding of geological processes and conservation techniques that may not be present among a museum's existing staff. This gap in expertise can hinder the development of effective geoconservation programs and exhibitions.

Finally, museums must also address the challenges posed by climate change, which has the potential to damage geological sites and collections. Rising temperatures, increased frequency of extreme weather events, and the degradation of ecosystems all pose risks to the integrity of geological heritage. Museums must find ways to adapt their conservation strategies to these changing conditions, while also educating the public about the impact of climate change on geological features and landscapes.

Future Directions for Museums and Geoconservation

Despite the challenges, there are significant opportunities for museums to expand their role in geoconservation. One promising direction is the increased use of digital technology to enhance the conservation and research of geological sites and specimens. Digital tools such as 3D scanning, virtual reality, and Geographic Information Systems (GIS) can be used to create digital models of geological features, allowing for more detailed analysis and monitoring of these sites. For example, aerial drone-based Lidar surveys can show how sites are affected by wind and weather, especially for example sites showing dinosaur trackways (Bates *et al.* 2008; Petti *et al.* 2008). These technologies can also be used to create virtual exhibitions that bring geological sites and specimens to a wider audience, making geoconservation more accessible.

Another important area for growth is the development of interdisciplinary collaborations between museums, universities, and conservation organizations. By working together, these institutions can create more effective conservation strategies, raise public awareness, and advocate for stronger policies to protect geological heritage. Museums could also play a key role in influencing policy decisions related to land use and resource extraction, advocating for the protection of significant geo-

logical sites from human encroachment.

Finally, museums can continue to expand their role in public engagement by developing more interactive and participatory programming focused on geoconservation. This could include citizen science projects, community-based conservation initiatives, and educational campaigns that empower individuals to take action in protecting geological heritage.

Papers in the Special Issue

We publish 11 papers in this Special Issue, addressing different topics in the relationship of museums with geoconservation sites and objectives. Our authors come from many countries (UK, Germany, France, Morocco, Australia, and China) and reflect specific examples from each of these nations.

In two articles, the authors explore practical, legal, and ethical issues between geological sites and museums. Van Geert (2024) compares the presentation of geology in geopark museums and natural history museums, focusing on the French and Spanish Catalan region of Europe. He notes how the expansion of the geoheritage concept has led to profound changes in museums and the wider heritage sector as these institutions adapt to strengthening the link between natural and cultural heritage. He also sees real impacts from increasing awareness among professionals and the public for issues associated with decolonization issues and the climate crisis.

In their paper, Reedman *et al.* (2024) explore fossil collecting along parts of the Dorset and East Devon Coast World Heritage Site. Fossil collecting is managed through codes of conduct rather than laws. The codes operate on rapidly eroding coastlines where fossils may be found at any time and if they are not collected might be lost to erosion. This makes it impractical to mandate official collecting by licensed authorities only because they do not have the time to monitor many kilometers of coastline every few days. On the other hand, the hundreds of thousands of visitors could cause great harm by over-collecting and dispersing the fossils. A balance is struck, whereby visitors may collect common fossils such as ammonites, but are encouraged to report any particularly impressive specimens or marine reptile bones. It is unknown how many remarkable fossils are removed without being recorded, but sufficient specimens are recorded by the local museums along the coast that the authors conclude the codes of good practice are at least substantially effective.

Two papers, respectively from the UK and Australia, explore issues of decolonization and current issues between occupants of the land. Gelsthorpe (2024) provides a thoughtful consideration of decolonization as it affects a museum, in his case the Manchester Museum, that acquired specimens from all over the world in times when few questions were asked about ethical matters. He argues that ‘the repatriation of geological specimens can be regarded as a barometer of the progress of decolonization’. He provides an example of how the Manchester Museum returned a Cretaceous fossil bird specimen that had been purchased illegally to China and uses this as a wake-up call to encourage other museums to be proactive in contacting authorities in other nations to offer the return of specimens.

Hurst *et al.* (2024) explore live situations in Australia where scientists and museums have up to now often ignored the wishes and interests of the First Nations peoples. They note that museums in Australia, and more widely, exhibit numerous examples of First Nations art, and ethical considerations about how those artifacts were obtained and how they are exhibited and explained can be enormous. There are also major concerns ignored to a large extent hitherto about the land throughout Australia and how we approach and talk about

it. Every geological site is on the ancestral lands of a First Nations group, and Hurst *et al.* present ideas about proper engagement between Western-trained scientists and First Nations peoples. Sally Hurst pioneered an engagement scheme throughout Australia called 'Found a Fossil' survey, and the authors present results and examples of further outcomes between museums and geosites concerning dinosaur tracks, stone tools, and a film project that have brought together disparate interests and cultures around important geological themes.

We then present five articles that provide examples of different means of illustrating and disseminating information about geosites through museums. El Hamidy *et al.* (2024) show the National Ceramics Museum in Safi, Morocco (NCMSM) helps to promote geotourism and protect geosites through a variety of activities, including geosite visits, educational programs, interpretive panels, geotours, awareness campaigns, souvenir offers, and interactive applications. Lincoln and Colley (2024) provide an account of how a small geological museum in northern England, the Kendal Museum, used stories around some 'local heroes' to interest the local people and visitors in how geologists work and to make connections from the museum displays to local geosites that tourists can visit. In a similar way, Munt (2024) reports the history of a newer museum, the Dinosaur Isle Museum on the Isle of Wight, southern England, founded in 2001, and how it exhibits dinosaur fossils all found within at most a few kilometers of the museum. He argues that place is important in the location of this museum, allowing visitors and local people to realize the remarkable specimens on show are very local to the museum itself, and inspiring some at least to walk or drive on to see some of the original find spots of dinosaur skeletons and footprints. The fourth case study is from the IVPP museum in Beijing, China, where Wang *et al.* (2024) present a detailed account of the great wall murals that act as a backdrop to the collections on all three floors of the galleries. They show how they are a good representation of the state of knowledge of Chinese palaeontology in the early 1990s, and how the life restorations of animals can help visitors interpret the fossils they see in front of them and connect those back to the sites from which they came, many of them now incorporated into geoparks that are open to visitors. Finally, in this section, Schütrumpf *et al.* (2024) describe the 'Ask a Geologist' service at the Warwick Market Hall Museum in central England, where staff of the museum and volunteers from the county geoconservation group meet the public to answer questions and identify rocks and fossils.

The final two articles are about one of the longest-studied geological areas in the world, the Dorset coast in southern England. Davis (2024) describes the Lyme Regis Fossil Festival which has happened each year since 2005, attracting 15–20,000 people each time to the variety of stalls, scientific lectures, circus shows, and other events designed to link people to the geology and palaeontology and especially the geoconservation aspects of the Jurassic Coast World Heritage site. It all began with Mary Anning (1799–1847), and Pearson (2024) presents an evocative account of her involvement in the campaign to establish a statue in honor of the great fossil collector. In particular, she describes how Mary Anning has become a hero worldwide for her contributions and acts as an inspiration for young people, especially girls, to become scientists, but also to take an interest in geology, palaeontology, and geoconservation.

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