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Geoconservation and geoscience in England: a mutually beneficial relationship

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ABSTRACT

Geoconservation in England, as in Great Britain more widely, is very well established. Sites of national or international scientific importance, as determined by a systematic site assessment and selection exercise, can be protected by designation as Sites of Special Scientific Interest. Sites of local importance e.g. Local Geological Sites may also be taken into account when planning decisions are made that could have an impact on them. As a whole, the network of conserved geosites represents the key elements of our current understanding of the geology and geomorphology of England. Site selection and safeguard and management of this network are dependent on geoscience information, and in return continued geoscience fieldwork is dependent on having conserved sites available for study. Here, we review the relationship between geoconservation and geoscience, and how it has developed since the first geoconservation legislation nearly 70 years ago. We discuss the achievements, challenges and where and how this relationship needs to strengthen further to meet future needs of both geoscience and nature conservation. In a changing world, there will continue to be a need for innovative geoscience supported by effective geoconservation. Those interested in conserving England's geological heritage will need to engage the wider geoscience community more than ever to deliver a shared vision for the natural environment.

1. Introduction

The geology of England has been studied and described for more than 200 years and although scientific methods may have changed, the ability to access sites to undertake research remains important, as illustrated by papers in this Special issue. During the late 18th and 19th centuries, construction of canals, railways and roads and a plethora of small quarries supporting development associated with the Industrial Revolution, combined with natural exposures in coastal and river cliffs and upland crags, provided the field exposures that underpinned the early development of geoscience. By the middle of the 20th Century, however, increased development pressure from expanding towns and cities, fewer but larger quarries, coastal protection schemes and infill and encroachment of vegetation into older disused quarries, meant that many key localities were becoming obscured or destroyed and lost to science.

The 1940s saw a growing government interest in conserving the natural environment, including important geological and geomorphological features and sites (Burek and Prosser, 2008a,b; Prosser, 2008, 2012, 2013b). In 1949, the National Parks and Access to the Countryside Act, with a provision to conserve geological and physiographical (geomorphological) features on a statutory basis as Sites of Special Scientific Interest (SSSIs), was enacted. In addition to SSSIs, the Act also allowed for sites that are managed primarily for their nature conservation interest, to be declared as National Nature Reserves (NNRs). More recently, non-statutory Local Geological Sites (LGS) (also known as Regionally Important Geological/geomorphological Sites (RIGS)), identified through local, usually county based, geoconservation groups (Nature Conservancy Council, 1990; Prosser and King, 1998; Whiteley and Browne, 2013) and internationally recognised UNESCO sites, namely the Jurassic Coast World Heritage Site in Dorset and Devon and two UNESCO Global Geoparks (the North Pennines AONB and

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the English Riviera), have also been added to the geoconservation portfolio in England (Larwood et al., 2013; Prosser, 2013a). Marine geoconservation too is now being explored (Burek et al., 2013; Gordon et al., 2016 Gordon et al., 2016) although this is still in its early stages in England. Most recently, aspirations have moved to delivering integrated conservation of all aspects of nature through establishing large-scale resilient landscapes and seas (Natural England, 2016a).

Since 1949, and especially since about 1990, geoconservation has developed considerably in terms of practice, participation and profile and is now established as a discipline within geoscience (e.g. Brown et al., 2014; Gordon et al., 2017; Henriques et al., 2011). It encompasses the principles and practice of undertaking geoconservation from a site-based to landscape scale; it includes the functional role of geodiversity in the ecosystem approach, ecosystem services and natural capital, and increasingly demonstrates the cultural value of geodiversity. There is a growing evidence base and an increasingly active (and global) geoconservation research community which have enabled the establishment of the journal Geoheritage, launched in 2009, covering all aspects of geoheritage and its protection, whilst geoconservation papers are encouraged and are amongst the most highly cited papers in the *Proceedings of the Geologists' Association* (Brown et al., 2017). The relationship between geoscience and geoconservation has been fundamental throughout the history of geoconservation, especially in relation to the conservation and management of SSSIs and NNRs, but also in relation to LGS and internationally recognised UNESCO sites. Here, we examine the role of scientists in selecting, safeguarding and managing SSSIs, the importance of SSSIs and NNRs for research and the links between science and other geodiversity designations. We conclude by discussing some of the successes that have arisen from partnership working between geoconservationists and geoscientists and highlight opportunities for strengthening this partnership in the future.

2. Geodiversity and geoconservation

Geodiversity can be defined as 'the natural range (diversity) of geological (rocks, minerals, fossils), geomorphological (landforms, topography, physical processes), soil and hydrological features. It includes their assemblages, structures, systems and contributions to landscapes' (Gray, 2013, p. 12). Geodiversity is also a fundamental part of nature and ecosystems; it underpins the character of landscapes, the natural processes that shape them, and their associated habitats and species. The huge value of geodiversity to both science and society has been widely described (e.g. Díaz-Martínez and Fernández-Martínez, 2015; Gordon and Leys, 2001; Gordon et al., 2012; Gray, 2013; Gray et al., 2013; Henriques et al., 2011; Prosser, 2013a; Prosser et al., 2013). It is part of our natural capital, namely natural resources or assets such as geology, soils, air, water and all living things (World Forum on Natural Capital,http://naturalcapitalforum.com/about/), and also delivers a variety of abiotic ecosystem services, which are reviewed by Gray (2013) and Gray et al. (2013).

There are many threats to geosites and in maintaining geodiversity in England today. These range from the disruption or constraint of natural processes by coastal or river engineering works, through obscuring or loss of access to sites by landfill, infrastructure development, coastal protection or forestry operations, to removal of finite features such as caves (and associated sediments) or fossil material by quarrying or specimen collecting. Natural processes such as erosion, mass movement and, in particular, unchecked vegetation growth can also remove or obscure valuable geosites and resources (see Prosser et al., 2006; Gray, 2013 Chapter 5). Climate change, and especially the human response to climate change in terms of coastal and river engineering, also threatens geodiversity (Brown et al., 2012; Prosser et al., 2010).

Gray (2013) argues that if geodiversity is both valued and threatened then there is a clear need for geoconservation, which is defined as 'action taken with the intent of conserving and enhancing geological, geomorphological and soil features, processes, sites and specimens, including associated promotional and awareness-raising activities, and the recording and rescue of data or specimens from features and sites threatened with loss or damage' (Prosser, 2013a, p. 568Prosser, 2013aProsser, 2013a, p. 568). Geoconservation has generally been carried out using a site-based approach. Since the beginning of this millennium, however, there has been an increasing recognition that integrating geoconservation with nature conservation and environmental management more widely is likely to bring greater rewards (Anderson and Ferree, 2010; Brazier et al., 2012; Gordon and Leys, 2001; Gordon et al., 2012, 2017; Hjort et al., 2015; Prosser et al., 2011, 2013). Geoconservation in England currently involves many partners and stakeholders, including the government conservation agency Natural England, the voluntary geoconservation sector (including many local geoconservation groups), geoscientists in academia and industry, UNESCO World Heritage Site and Global Geopark teams, learned societies such as the Geologists' Association and the Geological Society of London, the British Geological Survey, some mineral extraction companies and geoconservation partnerships such as the English Geodiversity Forum. Fundamental throughout this, however, is the relationship between those working to conserve and promote important geosites and those geoscientists that use, understand and publish work describing and interpreting these sites.

3. The role of geoscientists in geoconservation

3.1. The first SSSIs

The geoscience community has been involved in the government-led national geoconservation effort since before the first national nature conservation legislation in England, the *National Parks and Access to the Countryside Act 1949*. In planning for conservation legislation, the Geological Reserves Sub-Committee of the Nature Reserves Investigation Committee, was formed. Comprising a number of geologists nominated by either the Geological Survey (now the British Geological Survey) or the Geological Society of London, it was assisted in its work by a further fifty 'local' geological advisers (see Prosser, 2008). It proposed 390 geological sites (Herbert Smith, 1945) suitable for conservation. These sites formed the basis for the designation of geological SSSIs in England and Wales from 1950 (Prosser, 2012, 2013b). In 1977 a new approach to selecting nationally important geological sites for conservation was developed, the Geological Conservation Review (GCR).

3.2. The Geological Conservation Review

The paramount example of partnership working between geoscience and geoconservation was the development in 1977 of a systematic and rigorous audit of geodiversity identifying sites of national or international importance across Great Britain. This was initiated by the Nature Conservancy Council (NCC), the government agency that replaced the Nature Conservancy in 1973. This site assessment and selection processes is known as the Geological Conservation Review (GCR) and has resulted in very close partnership working between geoscientists and geoconservationists. The main phase of the GCR audit work in terms of site selection and description spanned the period from 1977–1991,

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