GEOVALUE: VALUING GEODIVERSITY FOR THE COMMUNITY

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Abstract

This paper summarises GeoValue, a project suppported by the Aggregates Levy Sustainability Funds. There are two components: developing a procedure for the determination of the Geodiversity Profile, and secondly, examining the issues for geological visitors to gain access to sites, particularly quarries to examine the geological features. The Geodiversity Profile is an independent standardised procedure for measuring the geodiversity and valuing it. It can be used to inform stakeholders involved in decision-making about the future of a site, including geodiversity action plans. Different landowners have different policies and practices for allowing access to their land. The Quarries Regulations 1999 are always applied to geological visitors to active quarries. There are several facilities that could be developed by quarry operators for the geological visitor so that improved access can be achieved. These include: viewing areas, refuges, pedestrian routes, access to safe faces, boulder parks and rock collecting or fossil hunting zones. Accepting visitors at times when there is no mobile plant activity would enable safer pedestrian movement and hence a better observation of the geology.

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Introduction

There are innumerable geological sites in the United Kingdom where features of interest (i.e. geodiversity) can be seen. They include active, abandoned and historic quarries as well as natural and other man-made exposures of rock. In much of lowland England away from the coast, active and other quarries are of major importance in illustrating geodiversity, natural rock exposures being virtually absent. Sites are visited by the geological community as part of scientific, professional, educational or recreational activities. Some have protected status as Sites of Special Scientific Interest (SSSI). Some others are designated locally as Regionally Important Geological or Geomorphological Sites (RIGS), also sometimes known as County Geology Sites. Most geological sites have no designation, yet may have significant geodiversity, as illustrated by the development of Local Geodiversity Action Plans (LGAPS) at a county level in recent years (English Nature, 2004; Burek and Potter, 2004; 2006).

Quarry operators see community involvement by the geological visitor as an important part of public relations, and for developing a wider understanding of the role of the industry in modern society. In general, visits to quarries to observe the geology are encouraged by the industry. Geodiversity is regarded as an important component of our natural heritage. This is now recognised in a Memorandum of Understanding between English Nature (now Natural England) and the Quarry Products Association (2005) (see also English Nature *et al.*, 2003) and the development of company Geodiversity Action Plans (cGAPS) (Thompson *et al.*, 2006).

GeoValue was supported by the Aggregates Levy Sustainablity Fund (ALSF). There are two components. A new procedure for describing and valuing geodiversity at geological sites, known as the Geodiversity Profile, has been developed and tested. The second component has examined the legal and safety issues in accessing geological sites, particularly active quarries. The full details of the procedure for determining the Geodiversity Profile and it applications are described along with examples in Scott, *et al.* (2007a), which should be used as an essential aid in determining the Geodiversity Profile of a site. A complementary publication (Scott *et al.*, 2007b) reviews the legal and safety issues for visitors to geological sites, especially quarries. This paper provides an extended summary of these two publications.

The Geodiversity Profile

The Geodiversity Profile has been developed as an independent, standardised, quantitative procedure for describing and valuing geodiversity at geological sites, particularly quarries. It provides the essential information about the significance of a site that can be used to inform stakeholders in decision-making, including the implementation of LGAPs, cGAPs and RIGS designation.

It is presented as a fully justified statement. Data are gathered through a desk study supported by fieldwork at the site and surrounding area. By recording and evaluating the geodiversity contribution of a site, the Geodiversity Profile enables comparisons to be made between sites of broadly similar geology and the recognition of sites of high geodiversity value.

Background, Purpose and Application

The Geological Conservation Review (GCR), launched in 1977 (Ellis *et al.*, 1996), developed a procedure for the selection of geological sites of high value in Britain, based on their contribution to the science of geology. GCR sites are selected because of their international importance to Earth science, because they contain exceptional features that are nationally important, or because they represent an Earth science feature fundamental to Britain's Earth history. These sites are distributed throughout Britain, and were selected by a peer review process, followed by consensus using available expert opinion. GCR sites that have been notified and confirmed as Sites of Special Scientific Interest (SSSI) have statutory protection. The process is ongoing and the scope of SSSI selection remains entirely within the importance of the site for geological science.

Regionally Important Geological and Geomorphological Sites (RIGS) were proposed in 1990 by the Nature Conservancy Council (a predecessor of English Nature and now Natural England, the Countryside Council for Wales and Scottish Natural Heritage) (Nature Conservancy Council, 1990). There are more than 50 local groups within Britain. Suitable sites for designation on the basis of their value to geodiversity are typically selected on a county basis by the corresponding RIGS, County Geology Trust or Wildlife Trust, using broader criteria than those adopted by the GCR. Practice varies, although nationally agreed criteria recommend assessment of a site on its value for educational purposes in life-long learning, its value for study by amateur and professional earth scientists, and for its historical and landscape value from an Earth science perspective (RIGS, 2000). There is a diversity of procedures between different RIGS groups. Site selection usually involves peer review and 'committee' consensus of interested parties locally.

The Geodiversity Profile uses elements of best practice adopted for site designation by many RIGS and county geology groups, but has wider application. It is a statement of features of the geodiversity along with a set of values arising from the geodiversity at the site. The profile is developed specifically for application at rock exposures in working, disused and abandoned quarries, although it can be applied to any man-made or natural exposure and most small geomorphological sites. It is intended as a basis for informing discussion on the value of the geodiversity at a site and, when necessary, to aid any decision-making process on a site's future management. It is relevant to all stakeholders including landowners, quarrying companies, planning authorities, conservation bodies and others. The Geodiversity Profile is not intended to be designatory nor replace existing statutory (i.e. GCR/SSSI) or other (RIGS/County Geology Site) designations. As a scheme for use in assessing geodiversity it is intended for general use, and not to be 'owned' or administered by any single stakeholder. The Geodiversity Profile has a broad aim as an assessment tool and there is no preconception or presumption for conservation or preservation of a site. It is an open-book (i.e. transparent) statement of the geodiversity at a site, placing a value on it so that it can be compared with other sites with a similar geological setting. The criteria on which the profile is based are clearly defined.

The Geodiversity Profile has potential applications in the following areas:

- providing local, regional and national government with a standardised procedure for assessing geodiversity as part of the planning process.
- aiding the development of Geodiversity Action Plans (GAPs) and company GAPs by highlighting those sites that make a significant contribution to geodiversity.
- acting as an aid in resolving conflicts between stakeholders by providing a tool for expert witnesses to use in arguing the relative merits of the geodiversity at a site during an inquiry.
- informing discussions between quarry owners and mineral planning authorities over quarry developments (e.g. by showing relative merits of geodiversity at different sites).
- informing discussions between quarry operators and conservation groups.
- informing conservation groups on the relative merits of using a standardised procedure.
- giving quarry operators and others knowledge to propose suitable alternative sites for visiting educational groups and researchers, if appropriate.
- for quarry operators in prioritising rock faces for conservation, such as in planning restoration.
- enabling planning authorities to understand the relative quality of geodiversity at sites, so that geodiversity and geoconservation can be considered in developing or re-appraising mineral or other consultation areas.
- as a learning exercise for students to examine a site, report on its geodiversity and discuss its value for geoconservation.

The profile is a statement of the geodiversity made at the time of assessment, with knowledge of the geological literature that refers to a site. The criteria are clearly defined, although there is scope for some different interpretation. This may result in minor variations between the profiles for the same site determined by different people. Such variations can aid further debate on the value of the geodiversity at a site.

The profile is designed to be determined by one or more competent persons who have appropriate knowledge, geological training and experience.

The Determination of the Geodiversity Profile

The information needed for the Geodiversity Profile is gathered in two stages: an initial desk study of relevant geological literature which refer to the site and surrounding geology, followed by fieldwork at the site and, as necessary, at other sites of the same geological setting in the same defined area. The Geodiversity Profile is recorded on a standardised form (Table 1)

Experience by the GeoValue Project Team and others has shown that determining the Geodiversity Profile of a site requires about two days of work by a single competent individual, assuming that geological maps and literature are readily accessible for the desk study, and the person has some previous knowledge of the geology of the area, including location of principal natural outcrops and quarries. Additional time would be required if the person is unfamiliar with the area or geological literature.

The Structure and Recording of the Geodiversity Profile

The Geodiversity Profile has three components: the Geodiversity Measure, the Geodiversity Values and the Ecological Component.

The Geodiversity Measure is a brief audit of the geological features at a site. It is a statement of the geodiversity as observed at the date of the determination. The geological interest category(ies) are recorded (Table 1) along with a summary of the main geological features within each category The quality of the rock exposure or other site characteristics and the broad geological interest categories are also recorded, along with a summary of the important features of the geodiversity within each category. Although the Measure is an audit of the geodiversity, it is not intended as a comprehensive statement of every geological feature.

The Geodiversity Values show the importance of the site geodiversity on the basis of (1) scientific, (2) educational and (3) historical, cultural and aesthetics criteria. The Scientific Value is subdivided into three categories: stratigraphical importance, geological history and process importance, and applied geology importance. Each is valued according to the number of other sites in the surrounding area with the same geological setting that have similar geodiversity attributes. The area is defined according to the scale of change of the geology (e.g. a well defined natural area), or other geographical or political designation (e.g. a county). The Educational Value is determined on the basis of the variety of geological interest categories and whether practical data collection is possible. Both pure and applied geology are considered. The Historical, Cultural and Aesthetics Value is determined on its importance at a local, county, national or international scale. Each of the values is numerical and is given with a supporting written justification. The values can be totalled to give an overall value, although the individual values are equally significant in emphasising a site's important characteristics. Background geological information on the site and surrounding area is needed for determining the profile. This is gained from a desk study of geological maps and literature which make reference to the site, and can be supported by previously acquired local knowledge. Fieldwork in the surrounding area to gain knowledge of the range of sites with a similar geological setting may be required.

The Ecological Component records any observed direct or indirect relationship between the ecology and the geodiversity at a site and surrounding area at the date of the determination. It links the geodiversity with any biodiversity; but, it is done by the geologist and is not a substitute for a full assessment of the biodiversity done by a professional ecologist with local knowledge of habitats and flora/fauna.

The two page form (Table 1) provides a short statement of the geodiversity, gathered from the published literature and a field visit, along with a written assessment of its values, fully justified using the defined criteria. A summary of the criteria used for recording the Geodiversity Values are given in Table 2.

Criteria such as ease of access, and issues of safety, ownership, vulnerability and other practical considerations do not form part of the profile. Obviously, these have relevance to those making visits to sites and for conservation or management purposes, but they do not contribute to the geodiversity. The geodiversity of a site is an intrinsic property, even though access may not be possible or safe. If a site is recognised as having high value through its Geodiversity Profile, engineering works could enable safe assess to be achieved, for example, if it forms part of any management plan. If ease of access became part of the Geodiversity Profile, potentially high geodiversity value sites could remain unrecognised.

The Geodiversity Profile acknowledges any prior designation that applies to a site or its surroundings, as this information is pertinent to any discussion or decisions which may need to be made. However, the existence of prior designation does not contribute to the valuing procedure for a site.

Testing the Geodiversity Profile

The procedure for the Geodiversity Profile has been tested at many sites in England and a few in Scotland. Most have been active or former quarries. The coverage of different geological settings and ages of strata has been wide, confirming that the procedure has general applicability. Determinations at the same site by different members of the project team show the procedure to be reproducible. Examples are presented in Scott *et al.* (2007a) and David Roche Geo Consulting (2007).

Access and Safety at Geological Sites, Particularly Quarries

It is very important to ensure that geological visits to quarries are correctly managed so that risks to health and safety are minimised, and that the legal requirements, including those given in the Quarries Regulations 1999, are followed.

As a second part of the GeoValue project, a desk study and fieldwork has been undertaken on land ownership in England, the law relating to access to land, occupiers' liability, health and safety legislation, the quarries regulations and codes of practice. A cross-section of

Geodiversity Profile *Sheet 1 of 2* **File Reference:**

Location:		**Profile Status:**	
		Grid Reference:	

Type and extent of site, including rock exposure: *(4 lines max)*

Summary of geodiversity (lithologies, structures, fossils, minerals, geomorphology, applied geology – *8 lines max*):

Part A: Geodiversity Measure

Geological interest categories at the site *(mark all that apply)*

- ☐ **Sedimentary rocks**
- ☐ **Igneous rocks**
- ☐ **Metamorphic rocks**
- ☐ **Structural/tectonic features**
- ☐ **Palaeontology/palaeoecology**
- ☐ **Minerals/mineralization**
- ☐ **Stratigraphical relations**
- ☐ **Geomorphology**

Criteria and Category:

A – 3 or more categories exposed
B – 2 categories clearly exposed
C – single category clearly exposed
D – poor exposure / poorly developed geological interest

(A,B,C,D)

Part B: Geodiversity Values

There are three parts. Brief criteria given on sheet 3. Profile handbook has further details with examples.

Value *(Range)*

1. Scientific Value

1.a. Litho / bio / chronostratigraphic importance *(insert justification below - 5 lines max)* *(1-4)*

1.b. Geological history and/or process importance *(insert justification below - 5 lines max)* *(1-4)*

1.c. Applied geology importance *(insert justification below - 4 lines max)* *(0-4)*

2. Educational value for pure and applied geology *(insert justification below - 4 lines max)* *(1-4)*

3. Historical, Cultural and Aesthetics value *(insert justification below – 4 lines max)* *(0-4)*

TOTAL VALUE (Part B only)

Part C: Ecological Component

The link between geo- and biodiversity is reported as a number and a letter *(1,2,3)*

- ☐ **1 – There is no link demonstratable,**
- ☐ **2 – A link may be present but cannot be clearly demonstrated,**
- ☐ **3 – A clear link can be demonstrated**

The geo-and biodiversity link is direct (a), indirect (b) or both (ab) *(a,b,ab)*

Name(s) of person(s) making the assessment:	**Date:**

Table 1. *Geodiversity Profile recording template.*

Geodiversity Profile ***Sheet 2 of 2*** **File Reference:**

Geographical area chosen for site comparison in determining Scientific Value: *(4 lines max)*

Additional Comments, Parts A and B: Geodiversity Measure and Geodiversity Value:
(Further details of the geodiversity. Include any information from fieldwork and literature that is used to justify the Measure or Value, and is not given above – *18 lines max*):

Additional Comments, Part C: Ecological Component
Details of direct or indirect link: *(7 lines max)*

Main literature references and other sources of information (including personal knowledge – *17 lines max*):

Existing designation(s) of site:			**Designation applies to whole, part, or extends beyond site**		
Site of Special Scientific Interest (SSSI)	**Yes** ☐	**No** ☐	**Whole** ☐	**Part** ☐	**Extends beyond** ☐
RIGS / County Geology Site	**Yes** ☐	**No** ☐	**Whole** ☐	**Part** ☐	**Extends beyond** ☐
Any other(s) please state:					
1.			**Whole** ☐	**Part** ☐	**Extends beyond** ☐
2.			**Whole** ☐	**Part** ☐	**Extends beyond** ☐
3.			**Whole** ☐	**Part** ☐	**Extends beyond** ☐
Photographic record made:	**Yes** ☐	**No** ☐	**Holder:**		

Table 1. *(continued). Geodiversity Profile recording template.*

Geodiversity Profile

Criteria for determining Parts B, Geodiversity Value, and C, Ecological Component
(Note: Geomorphology is included within geology and may be particularly important in Parts B1b, B1c and B2)

Part B.1. Scientific Value is determined (0-4) in three parts as follows:

1.a. Lithostratigraphy / biostratigraphy / chronostratigraphy
Exposures with similar attributes for their stratigraphy are:
1. Common (>10 sites)
2. Uncommon (5-10 sites)
3. Rare (<5 sites)
4. The site provides unique stratigraphical data and/or is the type locality

1.b. Geological history and/or process
Sites in the same area of broadly equivalent lithostratigraphical units that demonstrate similar geological history and processes are:
1. Common (>10 sites)
2. Uncommon (5-10 sites)
3. Rare (<5 sites)
4. The site provides unique constraints on one or more aspects of geological history and/or processes.

1.c. Applied geology
0. The site has no significance for applied geology
Sites with similar attributes in the same area are:
1. Common (>10 sites)
2. Uncommon (5-10 sites)
3. Rare (<5 sites)
4. The site uniquely demonstrates a feature within applied geology.

The geological interest categories of applied geology are:
Resource geology, Engineering geology, Applied Geomorphology, Hydrogeology, Environmental geology

Part B.2. Educational value is determined (1-4) as follows:
Field-based studies at the site for pure and/or applied geology would provide:
1. Limited or no opportunity to demonstrate clearly any geological interest category in pure or applied geology.
2. An opportunity to demonstrate clearly a single geological interest category in pure or applied geology.
3. An opportunity to demonstrate multiple geological interest categories in pure or applied geology (2 or more categories, one of which must be clearly demonstrated).
4. An opportunity to demonstrate clearly multiple geological interest categories in pure and/or applied geology and practical data collection is possible, assuming safe access can be achieved.

Pure and applied geology are valued separately and the higher of the two values is reported.

Part B3. Historical, cultural and aesthetics value. This is determined (1-4) as follows:
A single value is used to represent the highest of the three attributes (historical, cultural, aesthetics).
For history, culture and aesthetics, the site has:
0. No importance
1. Local importance (within 10km radius, approx. Parish)
2. County importance
3. National importance
4. International importance (very rare).

Total
The values for Part B should be totalled to give a single value, although the values for the separate criteria determined in Part B, along with Parts A and C, remain important in understanding the significance of the site. The minimum overall value is 3, the maximum is 20.

Part C. Ecological component.
The link between geodiversity and biodiversity can be direct or indirect, as follows:
Direct links: One or more elements of the flora and/or fauna developed at the site have a direct relationship with the chemical composition or physical structure of the rock exposure. A direct link also exists if the rock exposure or geomorphology at the site enables the ecology of habitats developed in the landscape of the immediate area to be understood.
Indirect link: The situation of the site (e.g. provision of shelter, waterlogged ground, scree, waste pile), but not the *in situ* rock lithology, provides a suitable physical or chemical environment for a specific habitat to have developed.
The Ecological Component is reported as a number and letter on the basis of: (1) a link is not demonstrable, (2) a link is possible but not clear, or (3) there is a clear link. The link is (a) direct, (b) indirect, or (ab) both.
Note: A professional ecologist may be needed to verify and report on any link.

Full details of the procedure for determining the Geodiversity Profile, along with examples are given in the Geodiversity Profile Handbook.

Table 2. *Parameters for determining Geodiversity Value and Ecological Component (Scott* et al.*, 2007a).*

different types of landowners has given information on their views, policies and procedures for allowing access to their properties by geological visitors. Similarly, a large number of quarry operators, and managers in quarrying companies have been personally contacted to obtain an understanding of current practices for allowing access to active quarries by geological visitors.

The main findings of the study are:

- Unless a geological site is on a public right of way or in an area where a legal or voluntary arrangement has been granted (e.g. an area designated under the Countryside and Rights of Way (CROW) Act 2000), permission from the landowner for access is required, and the visitor has to adhere to any conditions under which any visit is allowed, such as timing and safe behaviour.
- The Occupiers' Liability Acts (1957 and 1984) require that landowners of geological sites take reasonable care so that visitors and also trespassers will be reasonably safe in undertaking their activities. The duty is more than that to avoid negligent acts, but risks willingly accepted by the visitor on behalf of themselves or others would appear to be excluded. Some abandoned quarry sites are present within 'right to roam' land, and there is a need for such sites to be clearly marked with notices warning of the hazards.
- All geological sites present hazards to the visitor. Falling rock is a particular hazard at all quarry sites, and vehicle movements present a major hazard at active quarries. The risks from hazards should be addressed and mitigated by the geological visitor as well as the landowner or quarry operator.
- There is no evidence that there have been any accidents to geological visitors at active quarry sites. However, this does not imply that there have been no accidents.
- Visitors to geological sites have at least some legal responsibility for their own safety and that of others with them. At active quarries, the primary responsibility rests with the operator.
- Different landowners have different practices for allowing access to their land. In general, establishment and public bodies, and charities have a presumption for granting access. Some have formal procedures. Individuals, private and public companies owning land generally lack formal policies and procedures for granting access.
- Although the Quarries Regulations 1999 (Health and Safety Commission 1999) are designed for those at work in a quarry, they are generally applied also to protect the health and safety of visitors. Important points for the geological visitor are:
    - The operator's arrangements for safety must be accepted.
    - Geological visitors cannot expect to have unrestricted access to observe the geology.
    - As geological visitors are unlikely to be competent persons under the terms of the Regulations, they have to be accompanied at all times.
    - The visitor has to receive an induction safety briefing prior to a visit.
    - Parts of the quarry may be 'out of bounds' to all personnel.
    - Pedestrian access may be restricted or not allowed.
    - Personal protective clothing is required to be worn at all times.
- As the geological visitor's need for access to quarries to observe the geodiversity goes beyond that of general visitors, restrictions required by the Quarries Regulations may mean that the objectives of a visit are not met.

Facilities developed for the geological visitor to quarries could include: external or internal viewing areas, refuges at suitable locations, special pedestrian routes, safe access to faces well away from mobile plant activities, boulder parks and rock collecting or fossil hunting zones. Accepting visitors at times when there is no mobile plant activity would enable safer pedestrian movement and hence a better observation of the geology.

The study has also shown that published guidelines on safety and 'Codes of Practice' for geological fieldwork are out of date. They require comprehensive revision and updating. The development of a 'certificate of competence scheme' for leaders of geological visits to quarries could enable less resource to be given by the operator in supervising a visit.

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