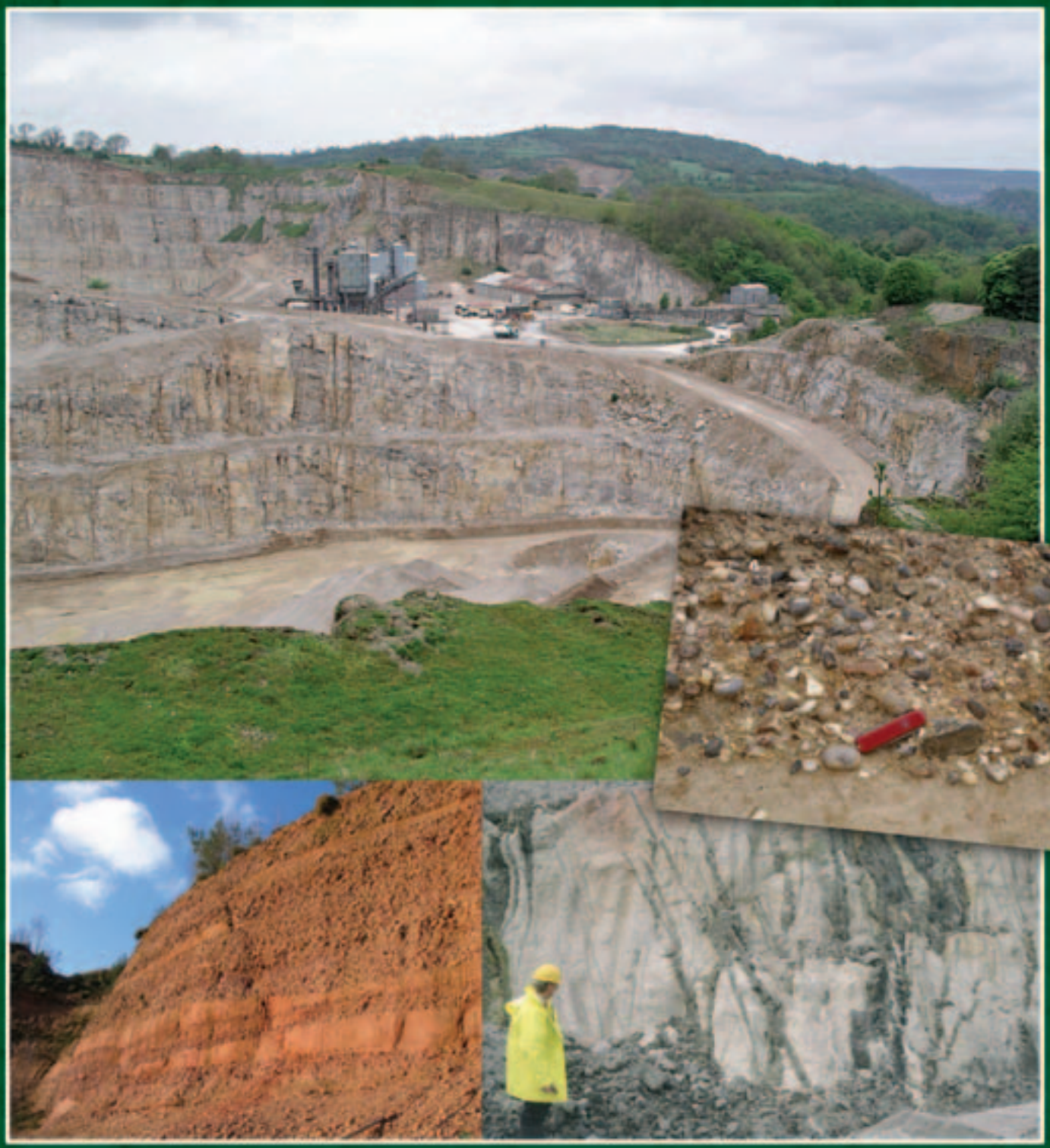
The Geodiversity Profile Handbook

Peter W. Scott, Robin Shail, Clive Nicholas and David Roche



DAVID ROCHE
Geo Consulting

GeoValue: valuing geodiversity for the community

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David Roche Geo Consulting	Peter Scott, David Roche, Clive Nicholas
Camborne School of Mines, University of Exeter	Robin Shail, Peter Scott
Cornwall Wildlife Trust	Victoria Whitehouse, Sue Hocking
British Geological Survey	Andrew Bloodworth, David Harrison
English Nature	Jonathan Larwood
Health and Safety Executive	Helen Turner
MIRO	Abbie Richards
Cornwall RIGS Group	Peter Ealey
Somerset Geology Group	Hugh Prudden
University of Plymouth	Jim Griffiths

The RIGS Groups / County Geology Trusts listed below are thanked for testing the Geodiversity Profile at sites in their local areas and providing feedback on the procedure.

Oxfordshire Geology Trust
Warwickshire Geological Conservation Group
East Yorkshire RIGS Group
Cornwall RIGS Group
Bedfordshire RIGS Group
Buckinghamshire RIGS Group
Borders and Lothian RIGS Group
North East Yorkshire Geology Trust
Somerset Geology Group

Some members of these groups and others also participated in a discussion seminar at Exeter in December 2005, where a draft of the Geodiversity Profile was launched.

A preliminary version of the Geodiversity Profile was developed and published following an initial scoping study in 2004-2005 (see David Roche Geo Consulting, 2005).

The quarrying industry is thanked for allowing access to many sites to determine the Geodiversity Profile.

The second component of GeoValue has examined the legal and safety issues in accessing geological sites, particularly active quarries. These are discussed in a companion publication:

Scott, P.W., Nicholas, C., Turner, H. Roche, D.P. and Shail, R.K. 2007. Access and safety at geological sites: a manual for landowners, quarry operators and the geological visitor. David Roche Geo Consulting, Exeter, UK, 52pp.

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Cross-bedding in Lower Cretaceous, Lower Greensand overlain by Gault Clay. Pratts Quarry, Leighton Buzzard, Bedfordshire.

The Geodiversity Profile Handbook

1. Introduction

This handbook provides the information needed for the determination of the Geodiversity Profile, an independent procedure for describing and valuing geodiversity at a geological site. It is particularly designed for use in quarries. Examples determined by the authors and others are given along with a short commentary on each. Determination of the Geodiversity Profile requires a knowledge of the geology and geological literature of the area and fieldwork at the site. The photographs on the covers and through the text illustrate some of the wide variety of geodiversity found in England.

Geodiversity is the natural range (diversity) of geological (rocks, minerals, fossils), geomorphological (landform and processes) and soil features; it includes their assemblages, relationships, properties, interpretations and systems (Gray, 2004). It underpins much of England's economy, natural heritage and cultural identity (English Nature, 2002; Webber *et al*., 2006; Stace and Larwood, 2006). It has a parallel with, and complements, biodiversity. Geodiversity is promoted by public and voluntary organisations such as Natural England (formerly English Nature), groups involved with Regionally Important Geological and Geomorphological Sites (RIGS), county geology and wildlife trusts, national and regional geological societies, and geoscience education bodies. Geodiversity Action Plans (GAPs) are being introduced at local and county levels (LGAPS) (English Nature, 2004; Burek and Potter, 2004; 2006). These further raise awareness of the importance of geodiversity and aid geoconservation.

The minerals industry has a critical role in the management of geodiversity and there are already many examples of good practice (e.g. English Nature, Quarry Products Association and Silica and Moulding Sands Association, 2003), and in a Memorandum of Understanding between English Nature and the Quarry Products Association (2005) the quarrying industry recognised the importance of conserving, enhancing and promoting geodiversity. Quarry operators are being encouraged to produce their own Company Geodiversity Action Plans (cGAPs) that should acknowledge sites of high geodiversity value on their properties (Thompson *et al*., 2006). The UK Government Planning Policy Statement 9 (Office of the Deputy Prime Minister, 2005) sets out policies on the protection of biodiversity and geological conservation in England through the planning system by "…sustaining, and where possible improving the quality and extent of geological and geomorphological sites..". The Association of UK RIGS Groups Development Strategy 2006-2010 (UKRIGS, 2006) has an objective to "…. promote standards within RIGS groups for recording, assessing, nominating and notifying RIGS sites".

The potential 'value' or function of geodiversity to society is diverse. Four main value categories have been defined in recent studies: appreciation, knowledge, products and function (English Nature, 2002; Webber *et al*., 2006). The approach adopted here has been to focus on those geodiversity components that are most readily evaluated by the geoscience community themselves, i.e. following the traditions established through Sites of Special Scientific Interest (SSSI), Geological Conservation Review (GCR) sites, RIGS/County Geology sites and, most recently, LGAPs; these primarily reflect knowledge and/or appreciation (Figure 1). The product and function (sub)categories excluded here are important aspects of geodiversity value, see for example, Stace and Larwood (2006); however, they are typically evaluated by other agencies as part of the wider economic and environmental impact of proposed site development.

The Geodiversity Profile has been developed as an independent, standardised, quantitative procedure for describing and valuing the knowledge and appreciation contribution of geodiversity at geological sites, particularly quarries. It provides the essential information about

The social functions of geodiversity: 24 categories relevant to UK geology and geomorphology

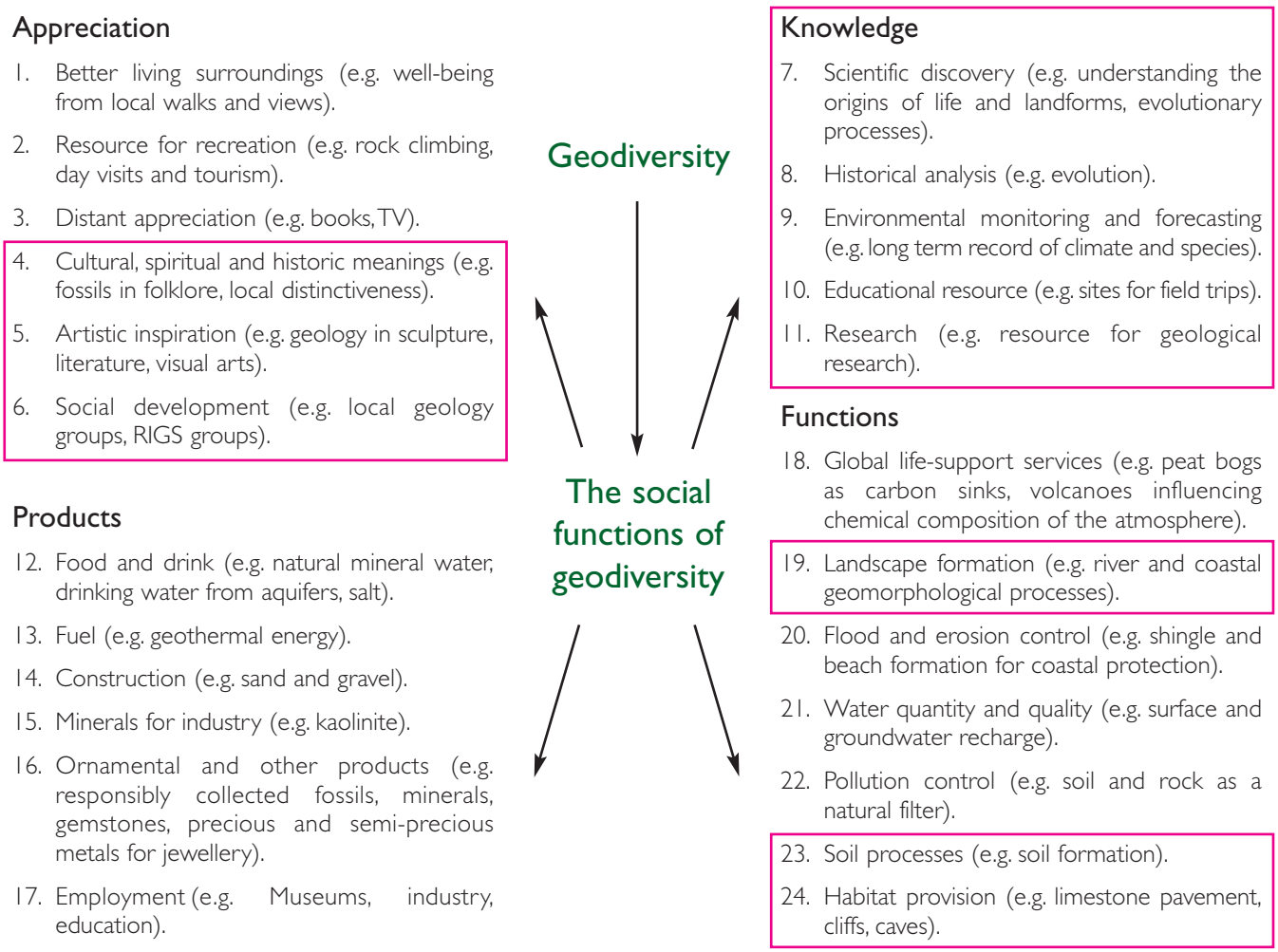


***Figure 1**. The social functions of geodiversity from Webber* et al. *(2006) with highlighted categories in red that are partly or wholly evaluated within the Geodiversity Profile.*

the significance of a site that can be used to inform stakeholders in decision-making, including the implementation of GAPs, cGAPs and RIGS designation. It may have a role in the planning process for minerals extraction and site restoration and can be used as the basis for resolving conflicting views regarding the geodiversity significance of non-designated geological sites.

The Geodiversity Profile is not intended as a site designation, but as a tool to inform decisions of stakeholders, and is presented as a fully justified open-book 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.

2. The background and basis of the Geodiversity Profile

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 (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. A review and further discussion of GCR and RIGS selection is given in David Roche Geo Consulting (2005).

The Geodiversity Profile has been developed as an independent procedure for describing and valuing geodiversity. Although it uses elements of best practice adopted for site designation by many RIGS and county geology groups, it has a wider application. The profile is a statement of the features of the geodiversity along with a set of values which record the scientific, educational and collectively, historical, cultural and aesthetics importance arising from the geodiversity at the site. Determination of the Profile requires a knowledge of the geology (including geomorphology) of the site and the surrounding area, gained by a desk study of relevant literature and/or prior experience, followed by fieldwork. The Profile is fully supported by a written justification under headings on a two page form. Both pure and applied geology elements of geodiversity are considered, and any observed links with biodiversity are reported.

The profile has been developed specifically for application at rock exposures in working, disused and abandoned quarries, although it can be applied to any man-made or natural rock exposure and most small geomorphological sites. It is not suitable for use with large geomorphological landscape features. 'Rock' is used in its geological sense to include unlithified sediments such as sands, clays, soliflucted and landslide material. Geology and geodiversity are taken to include geomorphology throughout. Although soils form an important component of geodiversity, the profile is not designed to take account of their special features.

The profile is designed to be determined by one or more competent persons who have appropriate knowledge, geological training and experience. Their names go on the form once the profile is completed.

Very large active aggregate operation in Ordovician granodiorite. Mountsorrel Quarry, Leicestershire.

3. The purpose and application of the Geodiversity Profile

The Geodiversity Profile 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 sites 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.

4. The structure of the Geodiversity Profile

The Geodiversity Profile has three parts (Table 1).

Part A: Geodiversity Measure
Part B: Geodiversity Values
(1) Scientific
(2) Educational
(3) Historical, cultural and aesthetics
Part C: Ecological Component

Table 1. *The three components of the Geodiversity Profile*

4.1. Part A: Geodiversity Measure

This is a brief audit of the geological features (i.e. the geodiversity) at a site. It is a statement of the geodiversity as observed at the date of the determination. The quality of the rock exposure or other site characteristics and the broad geological interest categories are 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.

4.2. Part B: Geodiversity Values

These 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 (see Section 4.5). 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.

4.3. Part C: Ecological Component

This 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. Examples in Appendix 4 illustrate some ecological links with geodiversity in Cornwall.

4.4. Recording the Geodiversity Profile

The Geodiversity Profile is recorded on a two-page form. This provides a short statement of the geodiversity, gathered from published literature and a field visit, and a written assessment of its value, fully justified using the defined criteria. A photographic record of the major features of geodiversity gives support to the Profile. A blank copy of the form is given in Appendix 2, along with a summary of the criteria. Electronic copies of the form and criteria are available from the authors.

4.5. Exclusion of non-geological criteria

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.

4.6. Prior designation

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.

Trent Valley Quaternary sand and gravel with sand martin nests. Besthorpe Quarry, near Newark, Nottinghamshire. (Geodiversity Profile in Appendix 3)

5. The determination of the Geodiversity Profile

The information needed for the Geodiversity Profile is gathered in two stages: an initial desk study, followed by fieldwork at the site and, as necessary, at other sites of the same geological setting in the same defined area. Details of the major features of geodiversity are recorded along with a justification for the valuing.

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.

5.1. Preliminary desk study

A familiarity with the local geology relevant to the site, a knowledge of the geological features displayed by other sites with the same geological setting in the surrounding area, and of the relevant published literature is required as a pre-requisite to determining the Geodiversity Profile. This knowledge must be gained through a desk study and/or fieldwork. Prior knowledge and experience of the geology at the site and surrounding area, or acquiring this through a third party, shortens the time needed for determination of the profile.

The desk study should involve an examination of the published geological map (1:50,000), Geological Survey Memoir (if one exists), any popular geology publications and local field guides, books devoted to the local or regional geology, and literature in regional, national and international journals that make specific references to the site and surrounding area. Such information is readily available in local university libraries, the Geological Society of London Library, the library of the British Geological Survey, and often in the personal collections of geologists living and/or working in the area. Journal literature in regional (e.g. Proceedings of the Yorkshire Geological Society, Geoscience in south-west England) and national publications (e.g. Proceedings of the Geologists' Association) and specialist books (e.g. Geologists' Association Guides; Geological Conservation Review Volumes) are particularly important for gaining knowledge of the scientific importance of a site and the local geological setting. Increasingly, relevant and up-to-date information on local geology is found on the internet (e.g. www.ex.ac.uk/geomincentre provides information and a comprehensive bibliography on sites of geology and mineralization in Cornwall; www.dor-mus.demon.co.uk/gbibcontents. provides a comprehensive bibliography of geological literature on Dorset; and www.earth.ox.ac.uk/MCK/field_trip/Ox_refs_strat.doc provides a comprehensive bibliography on the geology of Oxfordshire).

5.2. Completion of the Geodiversity Profile Form

The headings below refer to each box on pages 1 and 2 of the blank Geodiversity Profile Form in Appendix 2.

5.2.1. File reference

A shortened location name is given for easy reference.

5.2.2. Location

The full name of the site (e.g. quarry name), or the nearest landmark (e.g. River bank 200m downstream from named bridge) is given.

5.2.3. Profile status

The status as preliminary, draft or final can be given.

5.2.4. Grid Reference

At least a six figure reference plus two letter National Grid prefix, taken from a 1:25,000 or 1:50,000 Ordnance Survey Map or GPS set to OSGB Datum is recorded. The centre of the site is stated for a small exposure. It may be appropriate to show the limits of a larger site through recording two or more grid references.

5.2.5. Type and extent of site, including rock exposure

The scale of sites varies enormously. The precise extent to which the assessment applies is reported here. The site is described in terms of its major physical feature(s) and scale. For example:

- Small active quarry with two rock faces each 5m high, each extending 250m laterally
- Natural cliff exposure extending 400m from x to y
- Small abandoned sand and gravel pit 25m diameter
- Approximately 50m^2 rock exposure in small disused roadside quarry

Steeply dipping sandstones and shales of Bude Formation (Carboniferous). This site contains most but not all of the same features of geodiversity found in a nearby active aggregate quarry within the same formation. Small historic roadside quarry, Rosemoor, near Great Torrington, Devon.

The Geodiversity Profile can be applied at all scales. A large site containing the same geological setting (e.g. a quarry with several very long faces, or a very long cliff exposure) can be sub-divided so that the relative merits of different parts can be assessed and compared.

5.2.6. *Summary of geodiversity*

This is a statement of the main geological features that can be seen at the site at the time of the fieldwork. It includes the names of all lithostratigraphical units (taken from a recent Geological Survey map, memoir or other literature), along with any structures, fossils, minerals, stratigraphical relations, geomorphological features or processes, and any aspects of applied geology interest. Significant geological features reported in the published literature are also included (e.g. the type locality for a lithostratigraphical unit; it provided the first recorded fossil genus; a mineral found here is named after the site; the site is the sole source of an industrial rock or mineral).

5.2.7. *Part A: Geodiversity Measure*

This is a summary of the geodiversity found at the site. One or more **geological interest categories** will be present. Eight categories are recognised (Table 2).

The site is classified and recorded as A, B, C or D on the basis of whether single or multiple geological interests are observed and the clarity of exposure or development, using the criteria given in Table 3.

The geological interest category (or categories) must be clearly exposed or well developed for recording the geodiversity measure as A, B or C. For example, a site with two geological interest categories, yet only one is considered to be clearly exposed or well developed, will be recorded as C and not B. Within each geological interest category there can be any number of geological features. It is not uncommon for two relatively unrelated geological interest categories to be present in a single site (e.g. an igneous rock and a geomorphological feature).

Part A. Geodiversity Measure
Geological Interest Categories:

- Sedimentary rocks (including glacial or recent sediments)
- Igneous rocks
- Metamorphic rocks
- Structural / tectonic features
- Palaeontology / palaeoecology
- Minerals / mineralization
- Stratigraphical relations
- Geomorphology (including features and processes)

Table 2. *Geological Interest categories for the Geodiversity Measure*

Steeply dipping Silurian greywacke turbidites unconformably overlain by almost horizontal Carboniferous Limestone. Dry Rigg Quarry, Northwest Yorkshire.

Andalusite crystals developed in hornfelsed Devonian slates within metamorphic aureole of Tregonning – Godolphin Granite. Foreshore at Rinsey Cove, near Porthleven, Cornwall.

Part A. Exposure / site characteristics:

D. Poor exposure and/or poorly developed geological interest

C. Clearly exposed single geological interest

B. Clearly exposed multiple geological interest (two categories)

A. Clearly exposed multiple geological interest (three or more categories)

Each geological interest category can be represented by one or more features

Table 3. *Exposure and site characteristics for the Geodiversity Measure*

The determination is made by direct assessment in the field. No account is taken of the potential for the exposure to be excavated (for geoconservation purposes or by further quarrying) to reveal other interest categories, not visible at the time of the fieldwork, but known to be present from the literature. The determination could therefore change at a later date.

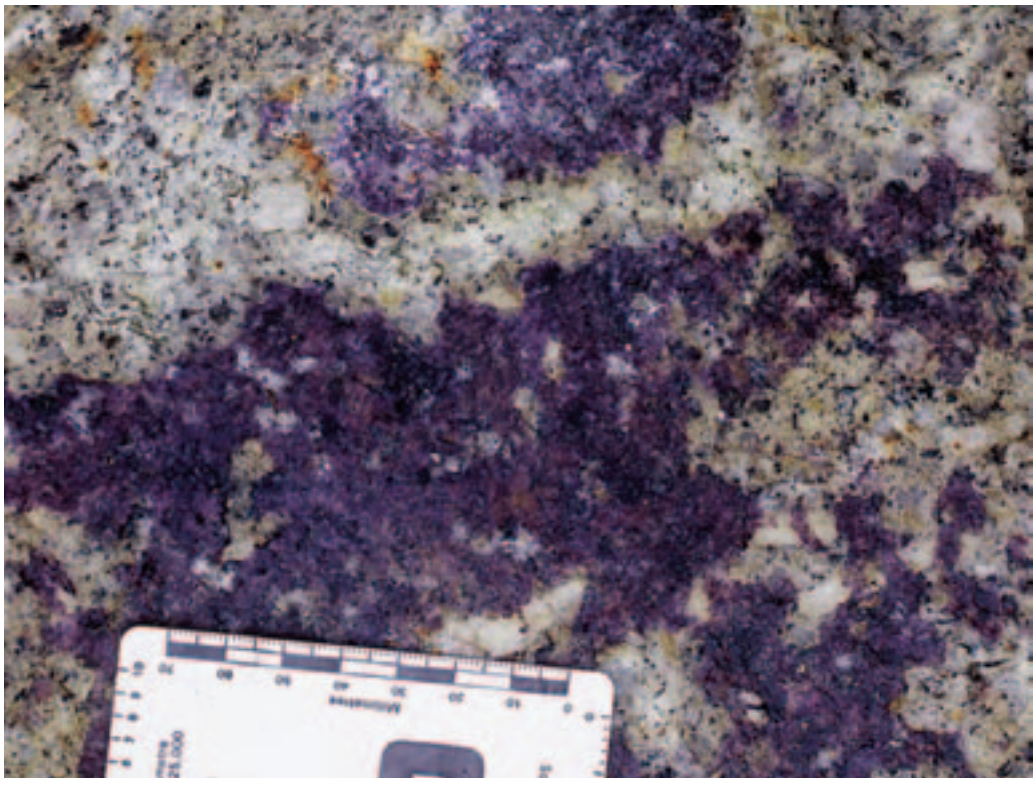
The guidelines below, although arbitrary in part, are intended to facilitate reproducibility when dealing with sites that include potentially ambiguous classifications.

Rock type

Usually a clear distinction can be made between sedimentary, igneous and metamorphic rocks. However, where sedimentary (or igneous) rocks have undergone very low to low grade (sub-greenschist facies) regional metamorphism (e.g. Devonian and Carboniferous successions of SW England), they should not be classified as both sedimentary and metamorphic (i.e. a lithology must only be classified into one category). In most cases, where protolith features are dominant, lithologies should be classified as the protolith; however, the presence of a well developed cleavage or folding would merit an additional tick in the structural/tectonic features category (see below). In a high grade metamorphic terrain, such as one dominated by migmatite, unless there is a clearly defined igneous rock present, the geological interest category is metamorphic.

Structural/tectonic features

At least one clearly defined structural or tectonic feature is necessary for the inclusion of this category in the profiling process. For example, a well developed fold or cleavage is present. Gently dipping strata is not classified as a clearly defined tectonic/structural feature in its own right. Unless joints provide a clear insight into tectonic/structural evolution, they should not be included (although they may be relevant when determining the Applied Geology Scientific Value, see below).



Fluorite mineralization within granite. Wheal Martyn China Clay Pit, St Austell, Cornwall.

Palaeontology and palaeoecology
Evidence of macrofauna/flora or trace fossils is required, or the literature should provide a record of a clearly identified microfauna/flora, such that microscopic examination of collected material would reveal such a microfauna/flora. In a situation where the macro- or microfauna/flora are very rare but have been previously reported, the exposure may gain a value within Part B by recognising its biostratigraphical and/or process/environmental significance, but should not be included as a geological interest category in Part A, as it is poorly developed.

Minerals/mineralization
There should be a clear mineralogical interest and/or the site should provide an insight into the mineralization process. A mineralogical interest may be the occurrence of one or more minerals that might be uncommon, or an occurrence of a more common mineral that is unusually large and/or with well-developed faces, or an unusual form or paragenesis. These should be visible in the field, or literature should indicate that microscopic examination of recovered material would reveal the mineral(s). In cases where the mineral is very rare, but has been previously reported, the site may gain a value within Part B by recognising its process significance, but should not be included within the geological interest category of Part A, as it is poorly developed. A mineralization interest should provide clear evidence of mineralization (typically an increase in abundance of one or more minerals) and/or its cause(s).

Stratigraphical relations
Stratigraphical relations refer to clearly demonstrable conformable, unconformable (angular unconformable, nonconformable, disconformable) and intrusive igneous boundaries between lithostratigraphical units that enable a relative chronology to be established. A conformable succession of sedimentary rocks (e.g. an alternation of limestones and shales) *within* a lithostratigraphical unit does not show stratigraphical relations in the context of the Geodiversity Measure. However, an exposed boundary, whether conformable or unconformable, between two lithostratigraphical units does provide important stratigraphical constraint. Intrusive contacts between different igneous bodies (e.g. between two granites of different textures and/or mineralogy) do show stratigraphical relations, as a relative chronology can be established.

Rock exposures that represent the type location of a formation or member are recognised in Part B, as is the contribution of the succession to understanding geological processes and history. A present-day soil developing directly above a rock does not indicate stratigraphical relations; but, Quaternary sediments above older strata often show clearly exposed stratigraphical relations.

Exposure of granite forming locally iconic geomorphological feature. Hound Tor, Dartmoor, Devon.

Algal stromatolites within dolomite of Permian Lower Magnesian Limestone. Historic quarry, South Elmsell, near Leeds.

Geomorphology

Geomorphological features and processes can apply to a surface expression or a rock (including unlithified sediment) exposure. Examples of features are frost wedges, karst, and head. The existence of a clearly developed glacial feature (e.g. sand and gravel exposed within an esker, kame or drumlin) or an active landslide also qualifies for the inclusion of geomorphology as a geological interest category. The geomorphological feature or process should be clearly developed and present or clearly visible from within the site boundary for it to be included within the Geodiversity Measure. If it is solely external to the site then it should not contribute to the measure, although its existence can be noted in the Additional Comments section of the form. The Geodiversity Profile is not designed to apply to large scale geomorphological features, forming part of the landscape.

Applied geology categories, such as engineering geology and hydrogeology, are not included within the geological interest categories here, and thus are excluded from the Geodiversity Measure. They relate to the interaction between man and the geology and the properties of the rock, rather than the rock itself. However, applied geology is considered an essential component of geodiversity, not least for science and education. The applied geology importance is considered within Part B.

The Geodiversity Measure is deliberately not numerical, to avoid confusion between the measure and the Geodiversity Values.

5.2.8. *Part B: Geodiversity Values*

There are three parts. These determine the scientific, educational, and collectively, the historical, cultural and aesthetics importance of the site (Table 4).

The scientific value recognises the relative importance of a site for research in the past, present and its future potential. It is subdivided according to its importance in British stratigraphy (litho/bio/chronostratigraphy), geological history and process, and applied geology.

The educational value establishes its importance for demonstrating geological features, and the associated processes and history to which they attest. No account is taken of the needs of different educational groups (i.e. primary, secondary, university, or general interest), the view being taken that many sites possess features that can be utilized in different ways at different levels. The

Part B. Geodiversity Values

1. Scientific (i.e. research) value
    a. Litho/bio/chronostratigraphy
    b. Geological history and process
    c. Applied geology
2. Educational value
    a. Pure geology
    b. Applied geology
3. Historical, cultural and aesthetics value

Table 4. *Criteria for the Geodiversity Values*

Geodiversity Measure provides sufficient information to enable an understanding of the suitability of a site for visits by educational groups of different needs and abilities. At sites where there might be differences in the educational value between end-users, the highest value should always be used. Further assessment of logistics, access and safety are necessary prior to establishing the suitability of a site for young children or other vulnerable members of the community to visit.

The historical, cultural and aesthetics value shows the importance of a site for past or present socio-cultural or socio-economic activities directly related to the geodiversity. Some sites have a significance for the history of geology; others may have other historical associations. This part of the Profile includes any direct cultural connection the geodiversity of a site has had or may continue to have with the local or wider community, and it addresses the importance of any visual contribution it makes to the landscape.

The three sections are valued separately, using different criteria. The three sub-sections within the scientific importance are also valued separately, but the criteria are similar for each. Although educational importance is subdivided into pure and applied geology, a single value is recorded for whichever gives the higher number.

5.2.9. Part B.1. The Scientific Value

The three parts of the Scientific Value are determined using the criteria given in Table 5. These are based on the number of sites having similar attributes in the surrounding area. A value is given and reported on the Profile Form (Appendix 2). The justification records the detail on which the value is based, such as giving the locations of other sites having similar attributes, or explaining why the site is unique, and cannot be compared with others.

The choice of geographical area for consideration of sites with similar attributes may vary according to the terms of reference of the person determining the profile. It could be the county or extend over a larger or smaller area. More objectively, it should relate to the scale of change of the geology, a suitable reference being the Natural Areas defined by the former English Nature or the Joint Character Areas defined by English Nature and the Countryside Commission (now both Natural England). This is discussed further in section 5.2.16. The chosen area is recorded on page 2 of the profile form.

In general, sites with similar attributes are considered at the level of the lithostratigraphical formation. However, where the formation contains one or more members, it may be appropriate to consider sites with similar attributes at this level.

Intrusive igneous rocks are not usually defined lithostratigraphically using formation or member terminology. It is usually appropriate for larger bodies of intrusive igneous rock to make site comparisons at the scale of the formally/informally named body, e.g. Bodmin Moor Granite; Great Whil Sill. Smaller un-named sheet-like intrusive bodies, that form part of a more widespread magmatic event, should be compared against other sites within the defined area, where the event has an expression. The approach taken should be outlined in the justification statement.

Geomorphological sites without exposed rock do not have a formal stratigraphy. To accommodate such sites, the number of sites with similar attributes for their

Part B. 1a. Lithostratigraphy / biostratigraphy / chronostratigraphy

Sites with similar stratigraphical attributes are:

1. Common (>10 sites)
2. Uncommon (5-10 sites)
3. Rare (<5 sites)
4. The site provides unique stratigraphic data and/or is the type locality

Part B. 1b. Geological history and process

Sites exposing 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.

Part B. 1c. Applied geology

0. The site has no significance for applied geology

Sites with similar attributes are:

1. Common (>10 sites)
2. Uncommon (5-10 sites)
3. Rare (<5 sites)
4. The site uniquely demonstrates a feature within applied geology.

Table 5. *Procedure for determining the Scientific Value*

surface feature or process is used to provide a value under Part B1a. For example, if the feature is rare within the chosen geographical area it is given a value of 3.

The scientific interest categories of applied geology are given in Table 6.

Features of applied geology can apply equally to quarry sites and natural exposures. For example, a natural cliff exposure can have engineering geology (e.g. rockfall potential), applied geomorphology (e.g. an active landslide) and hydrogeology (e.g. springs) interest, or even interest for resource geology (e.g. oil seepage). The site can have an applied geology significance for one or more of the scientific interest categories. Each must be considered in the determination and the value awarded for the feature with the highest importance.

Resource geology: both active and disused quarries may be recognised as significant for their economic product, and could be valued 3 or 4 if the rock or mineral extracted is, or was, rare or unique. Where a site has provided a rock with special properties (e.g. one where the aggregate product has very high skid resistance), it can have an uncommon, rare, or exceptionally, unique importance, even though there are several or many other sites in the same area within the same lithostratigraphical unit. However, a single working quarry in an area where there are many other disused or abandoned quarries in the same lithostratigraphical unit is not given a value of 4 reflecting its uniqueness, as the resource potential could be demonstrated at the other sites as well. Working and abandoned quarries need to be considered collectively in awarding a value appropriate to the number of sites.

Engineering geology: features of interest (e.g. discontinuities creating potential stability problems) are ubiquitous in quarries and many natural rock exposures, but they are not always well developed. A high value (3 or 4) is likely to be given only where the engineering geology features are well developed at the site but not at others in the same defined area, or where a particularly rare or unique feature is present.

Applied Geomorphology: features of interest (e.g. landslides in a cliff site) may overlap partly with engineering geology.

Hydrogeology: features of hydrogeology are likely to be found in many sites. As with engineering geology, values of 3 or 4 are likely to be awarded only where very unusual hydrogeology features exist within a site.

Environmental geology: The principal interests are likely to be related to subsidence in areas of former mining activity (also related to engineering geology) and contaminated land. Acid mine drainage overlaps with hydrogeology. Exposures exhibiting evidence of relatively recent seismicity are exceptionally rare.

A value of zero is needed where there is no applied geology significance (e.g. many natural exposures). A zero value is not appropriate for the litho/bio/chrono stratigraphic importance or geological history and process importance, as the rock exists in the exposure and has a Geodiversity Measure. Therefore, it has an importance for stratigraphy, history and process, even though it may be exposed in many places elsewhere. Type localities for stratigraphy and sites that exposure unique geological features have high values.

Applied Geology: Scientific interest categories
• Resource geology
• Engineering geology
• Applied geomorphology
• Hydrogeology
• Environmental geology

Table 6. *Scientific interest categories of applied geology*

5.2.10. *Part B.2. Educational Value for Pure and Applied Geology*

This is determined and recorded on the Profile Form using the criteria given in Table 7. The scientific categories of applied geology are given in Table 6.

Each geological interest category has to be considered separately and a decision made on whether the site affords an opportunity to clearly demonstrate associated geological processes. For example, a site exposing sandstone, where bedding is poorly defined, and there are few additional sedimentary structures (e.g. cross bedding, grainsize variation, interbedded mudstones etc.) would be valued 1. The minerals within a granite would need to be demonstrable in order for a site with this single geological interest category to be valued 2. If the granite were clearly exposed on a tor (geomorphological interest) it would be valued 3 or 4. Although data collection by direct measurement at an active quarry face usually should not be undertaken because of the danger of injury from rockfall (The Quarries Regulations,

Part B. 2. Educational Value for Pure and Applied Geology

Field-based studies at the site for pure and/or applied geology would provide:

1. Very 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 used.

Table 7. *Procedure for determining the Educational Value*

1999 and quarry company safety policies generally prevent direct access to a rock face), remote data collection is usually possible along with hands-on examination of blocks etc. of rock away from the face (e.g. fossils within blocks in a limestone quarry). Thus, a value of 4 would be awarded, assuming there were two or more geological interest categories clearly exposed. The distinction between 3 and 4 rests on the geological interest category being well developed in a clearly exposed rock, so that data collection of the features of interest can be made.

Pure and applied geology interest categories are considered separately and the higher of the two values are reported. The justification records the features that can be demonstrated clearly and the types of practical data collection that are possible.

5.2.11. Part B.3. Historical, Cultural and Aesthetics Value

A single value is given for any history, culture and aesthetics of the site that are a direct consequence of the geodiversity. The determination represents the highest of the three attributes. The value is recorded on the Profile Form using the criteria given in Table 8. Details for awarding the value are given in the justification. Many sites have no importance for history, culture or aesthetics. Some local background knowledge is needed in order to assess this value. A search through relevant literature will often uncover any historical associations. Geological Survey Memoirs, popular geology books, guides and articles on local geology, and local conservation and related groups' web sites usually make reference to historical or cultural associations.

The historical attribute relates mainly to sites which have a significance for the history of geology. These are sites which enabled a major advance in geological knowledge to be made, and are likely to be of national or international importance only. For example, the sites of Hutton's unconformities, and the Jurassic rocks in the cliffs at Lyme Regis where Mary Anning collected her fossils would be valued 4, as internationally important. Without a direct connection to the geodiversity, historical buildings, other heritage structures (e.g. old industrial buildings or machinery) or archaeological remains on the site do not imply an historical, cultural or aesthetics importance within the Geodiversity Profile.

A rock or mineral taken from an active quarry as aggregate or for other purposes contributes to the local, county or national economy; by itself, this is regarded of only indirect cultural significance and of no importance. However, if the product from an active or disused quarry contributes to a local or county distinctiveness (i.e. readily identified as a building stone) or has been used in nationally significant buildings or monuments, it does have a cultural significance and a value of 1, 2, or 3 (or extremely rarely, 4) is appropriate. An active quarry is considered for its economic product in the valuing of its scientific applied geology importance (i.e. its resource geology) (See 5.2.9. above).

In the context of the Profile, aesthetics means a valuing of the appreciation of the landscape at a site. Aesthetics is a component of human culture. Thus linking culture and aesthetics in a combined value is appropriate. For

Part B.3 Historical, Cultural and Aesthetics Value

For history, culture and landscape, the site has:

0. No importance
1. Local importance (within 10 km radius, approximating to a parish)
2. County importance
3. National importance
4. International importance (very rare).

Table 8. *Procedure for determining the Historical, Cultural and Aesthetics Value*

Gabbro of Lizard Ophiolite with sheeted dykes of basalt and lighter coloured and later plagiogranite. This foreshore exposure contains all of the elements of 'pure geology' geodiversity found in an adjacent active aggregate quarry, and they are better displayed. However, the important geotechnical features and resource aspects of the rock are illustrated better in the quarry. Manacles Point adjacent to West of England Quarry, Lizard, Cornwall.

example, sites exposing Carboniferous limestone in Cheddar Gorge and the granite tors in south west England would be valued 3 for aesthetics. They are national cultural icons as well. Coastal sites mostly will be valued at least 2 or 3 for their aesthetics (e.g. sites along much of the coastline of Dorset, Devon and Cornwall should be considered nationally important (value 3) for their aesthetics). In some special locations (e.g. rock exposed within Lulworth Cove in Dorset) an international importance (value 4) may be justified for its aesthetics. Many sites, particularly quarries would have no value placed on them for aesthetics, although a quarry with a good view of the landscape would have to be considered as having an aesthetics value.

In valuing the historical, cultural and aesthetics value, it is essential to consider a wide perspective (i.e. to assess the significance on a national and international scale). There is likely to be a tendency towards assessing a site as more important than it is, if one has an extensive local knowledge. The question

"would someone coming from another county or country, with an equivalent level of knowledge and experience, given the relevant background information, come to the same decision?"

needs to be asked in making the assessment of these criteria.

5.2.12. Total

The individual components of the Geodiversity Value can be added to give a total, although the individual values for the separate criteria determined in Part B, along with Parts A and C, are important in understanding the geodiversity of the site.

Each constituent of Part B is worth a maximum of 4. No differential weighting is applied to the individual components. This would distort the total in favour of the part(s) which are given the highest weighting. The maximum total is 20 and the minimum is 3. The lowest value recognises that the site has one geological interest category that is clearly exposed, without any other merits, and there are many similar sites in the same defined area.

A Geodiversity Value can be calculated for a site with a poor exposure. Exceptionally, such sites may receive a high value for one or more of the scientific importance criteria (e.g. if it was the type locality for a formation and the site had degraded badly), and could receive a high value for its historical, cultural and aesthetics importance. In these circumstances the Geodiversity Profile recognises that the site has poor exposure, but is of significance. In general, without a clear exposure or other potentially high value attributes, determining the Geodiversity Profile has little merit. Although the maximum total is 20, it is unlikely that any sites will achieve this sum.

Part of a large quarry extracting cement raw materials. The quarry exposes a complete sequence of Middle Jurassic strata. The view shows Lincolnshire Limestone Formation, Rutland Formation ('Upper Estuarine Series'), Blisworth Limestone Formation, Blisworth Clay Formation, Abbotsbury Formation (Cornbrash), and Kellaways Beds (clay and sands). A large variety of fossils found at the site include ammonites, bivalves, echinoids, gastropods and rare vertebrate remains. There is minor faulting. Ketton Quarry, near Stamford, Lincolnshire.

There are competing arguments as to whether a total has a useful role in establishing the value of geodiversity in an exposure or site. A very high total does show that the geodiversity has several high quality attributes. In contrast, a moderate total can be achieved by either an exposure with several modest attributes or a single high valued attribute. A total does enable a very easy comparison to be made between many exposures, but it does mask the individual attributes. For a full understanding of the Geodiversity Profile the individual components are important, and thus the total should not be considered in isolation.

5.2.13. *Part C: Ecological Component*

Geology has strong links with biodiversity (see for example, Cottle, 2004 and Humphries and Donnelly, 2004). The Ecological Component states these links. The purpose is to show how the geodiversity seen at the site contributes to an understanding of the ecology of the habitats and species within the environment of the site. It is not an ecological survey. For the purpose of the Geodiversity Profile a very basic approach is adopted (Table 9). The Ecological Component is recorded simply as a number and letter on page 1, along with any details on page 2 of the Profile Form.

At many sites there is likely to be a some form of direct link (or relationship) between geodiversity and biodiversity. The link may be obvious and easily demonstrated at some sites, but less obvious at others. Examples of obvious links that can be easily demonstrated are:

- Distinctive plant-life associated with limestone pavements and karst,
- Distinctive lichens developing on ultramafic rocks,
- Heathland vegetation developed on sands,
- Calcareous grassland developed on the Chalk
- Sand martins nesting in the face of a sand pit.

Further examples from Cornwall, where there is often a distinctive ecology directly related to the geodiversity, are illustrated in Appendix 4. Cottle (2004) provides a detailed review of direct links between biodiversity and geodiversity within England.

The direct relationship can be of two types:

1. 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.

2. The rock exposure or geomorphology at the site enables the ecology of habitats developed in the landscape of the immediate area to be understood.

In many situations a direct link may be less obvious or cannot be clearly demonstrated. This may be exhibited

by the ecology of the site showing apparently different flora or fauna relative to its surroundings, or different ecological habitats developing on adjacent strata of different lithologies. Elsewhere it may not be possible to demonstrate a link (e.g. where the site is within land improved by intensive agriculture).

Indirect links between the geodiversity and biodiversity relate to the situation of the site, which has provided a suitable physical or chemical environment for a specific habitat to develop, but not the in situ rock lithology. Indirect links of this type are common in disused quarries. Examples are:

- The provision of shelter by a rock face,
- Waterlogged ground providing a suitable environment for aquatic flora and some invertebrates.
- Scree slopes or a waste pile as suitable sites for mosses, some invertebrates and small mammals.
- Bare ground communities developing on a quarry floor

Where an obvious relationship between the geodiversity and biodiversity exists, the determination of the Ecological Component can be made by the geologist. This person can also indicate that a link may be present but not clearly demonstrated or, no link can be demonstrated. The basis for the determination is stated on the Profile Form. Without any formal ecological training, however, it is likely that only the more obvious links can be fully confirmed by the geologist (for example, those given above), and non-obvious links may be missed.

An absence in demonstrating any geodiversity / biodiversity link does not imply that there is none present. Any dispute on the validity or accuracy of the Ecological Component should be solved by employing an experienced professional ecologist. This person should have the ability to identify habitats and their main plant species, as well as a capability to identify the more usual birds, mammals and invertebrates to genus level. She/He should also have an awareness of how these habitats and species relate to the underlying soils and geology. A preliminary desk study of the ecology of the area in and around the site may be needed.

Part C. Ecological Component

This is reported as a number and letter on the basis of:

1. **There is no link demonstrable.**
2. **A link may be present but cannot be clearly demonstrated.**
3. **A link can be clearly demonstrated.**

The geodiversity and biodiversity link can be direct, indirect or both, and is reported as a, b or ab respectively.

Table 9. *Procedure for determination of the Ecological Component*

5.2.14. Name of person(s) making the assessment

This should be the competent geologist. If more than one person is involved then all names are recorded. If an ecologist is employed to determine the Ecological Component than that person's name is also recorded.

5.2.15. Date

This is the date of the fieldwork. The Geodiversity Profile may change with time, for example, as a face in a working quarry advances, or as an exposure becomes overgrown with vegetation or otherwise degrades.

5.2.16. Geographical area chosen for site comparison in determining Scientific Value

(see also section 5.2.8, above).

This will depend on the purpose for the assessment, and the Scientific Values may change if the area selected changes.

Ideally, and objectively, the area chosen for site comparison should be decided by taking into account the scale of change of the geology. That is, the value awarded is related to the number of sites of comparable type within a broadly defined area of similar geology, and the value is independent of political or other geographical boundaries. The areal extent could be several 100s of km^2 where the geology is uniform (e.g. inland working and abandoned clay deposits or sand and gravel pits), or much less than $100km^2$ where there are rapid facies or lithological changes. The emphasis is on there being similar attributes, and as the areal extent is widened, the frequency of this applying will diminish. In cases where the same named formation has an exceptionally large areal extent >100km strike, it would be appropriate to make comparisons at a more local or regional scale. Suitable guides for selecting the areal extent are the Natural Areas defined by the former English Nature or the Joint Character Areas defined by English Nature and the Countryside Commission (now both Natural England). These broadly follow geological change.

A geographical or political area (e.g. a county or district) may be chosen for comparison if this fulfils the terms of reference for determining the profile. For example, the relative values of sites in a local authority area may be needed, and it would be inappropriate to select a wider area for comparison. The profile relates only to that area, yet remains valid within its terms of reference. In the examples presented in Appendix 3, the geographical area chosen is sometimes the county, as the determination was made for the benefit of the local RIGS Group.

5.2.17. Additional Comments, Parts A and B: Geodiversity Measure and Geodiversity Values

Further details of the features within each geological interest category within the Geodiversity Measure, and further justification (if necessary) for the Geodiversity Values are presented here. The statement should include any information from fieldwork that are used to justify the Measure or Values, and is not apparent from the literature.

5.2.18. Additional Comments, Part C: Ecological Component

The details of the direct and/or indirect link(s) as observed by the geologist are stated. The need for a professional ecologist to confirm observations may also be indicated. Some examples of ecological links in Cornwall are provided in photographs in Appendix 4, and a review of the relation between geodiversity and biodiversity in England is given in Cottle (2004).

5.2.19. Main literature references and other sources of information

The most important references are given. These should make specific reference to the site, or be overviews of aspects of the geodiversity found at the site and surrounding area. If the site is the type locality for a stratigraphic formation, the principal reference should be provided. Any personal communications with individuals having expert knowledge of the site and giving information to the person making the assessment should be stated (with their agreement).

5.2.20. Existing designation(s) of site?

Many geological sites have a prior designation as a consequence of their geodiversity, having been established within the Geological Conservation Review (GCR), and many have been notified and confirmed as Sites of Special Scientific Interest (SSSI), or designated as Regionally Important Geological or Geomorphological (RIGS) or County Geology Sites.

Prior designation is recognised as part of the Geodiversity Profile, but is not given a value. Its inclusion would bias the value against other sites, which may have equal value to those with existing designations. This would remove the independence of the Geodiversity Profile. However, as prior designation may be relevant to any decision made for a site, it is recorded on the Profile Form.

Many GCRs / SSSIs encompass large areas of landscape or multiple rock exposures. In these circumstances, it is important to state that the area to which the Geodiversity Profile applies is within the prior designated site, and does not include it all. Where the site is the type locality for stratigraphy, it illustrates unique geological processes, or it has a value to history of geology and/or landscape, it is accounted for in the Geodiversity Values, but on these merits and not as a consequence of any prior designation.

There are presently two European Geoparks in England (Northern Pennines; Abberlay and Malvern Hills), and others elsewhere in Britain, and two World Heritage sites (Dorset and East Devon Coast, and Cornwall and West Devon Mining Landscape) with geological importance. Two other World Heritage Sites (Hadrian's Wall and Ironbridge Gorge) have geological interest. Sites within these locations and any future Geoparks or Heritage Sites so designated should be indicated on the Profile Form.

Rock exposures and areas of geomorphological interest are often found in locations designated for their biological / ecological importance or for different combinations of their geological, geomorphological (i.e. mainly landscape), biological / ecological and recreational importance. There are numerous UK and European designations including:

National Parks
National Nature Reserves (NNR),
Local Nature Reserves (LNR)
Special Areas of Conservation (SAC)
Special Protection Areas (SPA)
Ramsar sites
Country Parks
Area of Outstanding Natural Beauty (AONB)

Sites which fall within any of these or other designations should be indicated on the Profile Form, as their existence may be relevant in any decision-making process which involves the site.

Pale brown bioclastic limestone of Jurassic, Upper Lias, Ham Hill stone. Embayments are joints with slickensides showing movement, along with recrystallised calcite rhombs. Other exposures of Ham Hill Stone in the same area show similar but not all of the features of geodiversity seen in this active building stone quarry. Hamdonhill Quarry, near Yeovil, Somerset. (Geodiversity Profile in Appendix 3)

5.2.21. *Photographic record made?*

The existence of any photographic record is stated here and details of ownership are given.

6. The personnel making the determination of the Geodiversity Profile

A 'Competent Person' is required to determine the geodiversity profile (see definition in Appendix 1). Normally, a relevant, formal academic or professional qualification is required.

A suitable definition of competence is:

The ability to perform activities within an occupation or function in such a manner as to engender the confidence of the individual, the employer, the end user and the community at large." (Engineering Council).

This implies that the person(s) determining the Geodiversity Profile is a geologist, with appropriate training and experience in the type of geological setting being assessed, and a good knowledge of the geology of the United Kingdom. The person also has awareness of, and access to the geological literature relevant to the site.

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Appendix 1

Definition of terms and acronyms

AONB	Area of outstanding natural beauty. An AONB is designated for its landscape and scenic beauty.
cGAP	Company Geodiversity Action Plan. See Geodiversity Action Plan.
Competent person	A 'Competent Person' is defined as someone having the knowledge and skills necessary to perform the task required through training, qualification, experience or a combination of these.
Country Park	A Country Park is an area designated for people to visit and enjoy recreation in a countryside environment.
County Geology Site	A geological conservation site designated by a RIGS (*q.v.*) Group or other similarly constituted body.
Ecological Component	A record of any direct or indirect relationship between the ecology and geodiversity at a site. A component of the Geodiversity Profile.
Educational Value	A numerical value with written justification showing the importance of a site for education in either or both of pure and applied geology. It is based on the number of *geological interest categories* (*q.v.*) which can be clearly demonstrated and whether practical data collection is possible.
GAP	Geodiversity Action Plan. A document developed by a public body or industry (cGAP) (*q.v.*) which reviews the geodiversity of an area (usually county), or company's properties, highlights areas of geodiversity interest and proposes a management plan.
GCR	Geological Conservation Review. A systematic site selection exercise carried out throughout Great Britain between 1977 and 1990 to identify sites of international geological importance; sites that are scientifically important because they contain exceptional features; and, sites that are nationally important because they are representative of a geological feature, event or process which is fundamental to understanding Britain's geological history.

Geodiversity Measure	A summary statement of the geodiversity at a site as observed at the date of determination. It records the *geological interest categories* (*q.v.*) and provides information of the main geological features within each category. A component of the Geodiversity Profile.
Geodiversity Profile	An independent, standardised, quantitative procedure for describing and valuing the knowledge and appreciation contribution of geodiversity at geological sites. It is a statement of the features of the geodiversity along with a set of values which record the scientific, educational, and collectively the historical, cultural and aesthetics importances arising from the geodiversity at a site. It includes details of any link between geodiversity and ecology at a site.
Geodiversity Values	The importance of the geodiversity at a site on the basis of scientific, educational and collectively, historical, cultural and aesthetics criteria. A component of the Geodiversity Profile.
Geological interest categories	The major subdivisions of geological features: sedimentary rocks, igneous rocks, metamorphic rocks, structural / tectonic features, palaeontology / palaeoecology, minerals / mineralization, stratigraphical relations, features and processes of geomorphology.
Historical, Cultural and Aesthetics Value	A numerical value with written justification of the highest of the historical, cultural and aesthetics attributes of the geodiversity at a site, based on it having a local, county, national or international importance, or no importance.
LNR	Local Nature Reserve. A nature reserve of statutory designation by a local authority.
NNR	National Nature Reserve. An area which is among the best examples of a particular habitat. NNRs are of national importance. They are in many cases owned and managed by the statutory authority, (for example English Nature, part of Natural England), but not always. NNRs have national statutory designation.
National Park	National Parks in the UK are areas which were mostly set aside in the 1950s and 1960s by the state because of their outstanding value in terms of natural beauty, ecological, archaeological, geological and other features, and recreational value.
Ramsar Site	A Ramsar Site is a wetland of international importance.
RIGS	Regionally Important Geological and Geomorphological Sites. These are designated at a county level by a local body formalised as a RIGS Group, Geology Trust or other similarly named geological conservation body. The sites are called RIGS or County Geology Sites. They have no statutory significance, but are often taken into account in the planning process.
Scientific Value	A set of three numerical values, each with written justification, of the relative importance of a site for research. Sites are given a value on the basis of the number of sites with similar attributes. The Scientific Value is subdivided into litho/bio/chronostratigraphy, geological history and process, and applied geology.
SAC	Special Area of Conservation. A network of protected sites across the EU.
SPA	Special Protection Area. An area designated under EC Directive to safeguard the habitats of migratory birds and certain particularly threatened birds.
SSSI	Site of Special Scientific Interest. A designated site with statutory protection for its biodiversity and / or geodiversity. The criteria for designation by English Nature (now Natural England) are based on scientific importance.

Appendix 2

Blank Geodiversity Profile sheet and summary of criteria

(See following three pages)

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

Value

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

1. Scientific Value

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

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:**

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.

Appendix 3

Examples of Geodiversity Profiles with commentary

The procedure for the Geodiversity Profile has been tested at many sites in England and a few in Scotland. Most sites have been active or former quarries. The coverage of different geological settings has been wide. Examples are presented here to illustrate the type of information to be recorded within the profile when dealing with different types of geodiversity. The examples are given in stratigraphic order approximately with the oldest first. The Profiles have been determined by various people from the GeoValue Project team and local RIGS / County Geology Groups. Further examples of the Geodiversity Profile, determined on other sites used in developing and testing the procedure, are reported in David Roche Geo Consulting (2007).

Brief comments on each site are given below:

1. Mancetter Quarry Mawbournes site, Warwickshire. The site is part of a large active quarry complex within the Nuneaton Inlier. Cambrian sedimentary rocks containing fossils have been intruded by igneous sills. The values for the stratigraphy (B1a) (3) and geological history and process (B1b) (4) are given on the basis of the number of sites (including others within the same quarry complex) with the same two types of strata. The site is one of only a few yielding high skid resistant aggregate (high PSV) in the area, justifying a value of 3 for the Applied Geology science (B1c). It is a high value site (4) for education, and has an importance for the history of geology of national significance.

2. Balk Quarry, Church Cove, Lizard, Cornwall. A small former quarry with complex relationships between three metamorphic rocks, plus loessic head. The site is not unique for stratigraphy, geological history and process, although there are few others of equivalence in the area. The engineering geology gives the site a high value for its applied geology scientific importance (B1c) (3). There is much hands-on opportunity for education, but probably only at an advanced level. It has a cultural relationship locally, but its coastal location gives it a wider importance for its aesthetics (Part B3).

3. Traprain Law, East Lothian. Former quarry with additional geomorphological interest. The site is unique for its combination of igneous rock and intrusive type (laccolith) combined with the geomorphology giving the maximum values for stratigraphy (B1a), geological history and process (B1b), and education (Part 3). It is valued for its aesthetics locally as a prominent landmark.

4. Dene Quarry, Wirksworth, Derbyshire. A large active Carboniferous limestone quarry in the Peak District. It has a high value for education (Part 3), pure geology interest categories being limestone lithology and palaeontology, structure, and mineralization. Additionally there are two interest categories in applied geology for education, namely engineering geology and the limestone resource. Its scientific values (Part B1) are low, there being many comparable sites elsewhere within the White Peak area of Derbyshire. The method of restoration of former quarry faces is a significant aspect of the applied geology (B1c) at the site, even though sites elsewhere are similarly preserved. Note: the high value for education assumes safe access to at least some of the quarry faces would be made possible.

5. Breedon Hill Quarry, Leicestershire. A large working Carboniferous limestone quarry in Leicestershire. Much of the geodiversity within the limestone is comparable with Dene Quarry, Wirksworth (No. 4, above), yet the values are significantly higher as the geographical area is different. There are fewer comparable sites within the area, and there are additional geological interest categories. Note: the high value for education assumes safe access to at least some of the quarry faces would be made possible.

6. Craigleith Quarry, Edinburgh. A former important dimension stone quarry in sandstone of Carboniferous age. It is the type section for the Craigleith Sandstone and a marine band. Hence it receives the highest value for litho/bio/chronostratigraphic importance (4). There are a few other comparable sites for illustrating the geological history and process within the same formation, therefore the value is 3. The stone from the quarry was used for major buildings in Edinburgh and has other cultural significance at an international level.

7. Tedbury Camp Quarry and adjacent valley, Somerset. A complex site with significant geodiversity. It has high scientific and educational values in illustrating the geological history and processes of the Carboniferous and Jurassic Limestones of the eastern Mendips and the geomorphological features in the incised valley. The same stratigraphy (but not the geomorphology) can be seen in several active quarries nearby, although access to observe the geological features at close quarters in these quarries is likely to be severely restricted.

8. Hamdon Hill Quarry, Ham Hill Stone, near Yeovil, Somerset. One of several sites in the area exposing Ham Hill stone. Profiles made of three other nearby sites exposing the same strata demonstrate a similar geodiversity, although the totals for the values are lower (12 or 13). At Hamdon Hill Quarry additional features are visible including slickensided reactivated joint planes, and as it is a working quarry, the site enables an understanding of the relationship between the jointing and method of working of the limestone to be gained.

9. Wicklesham Quarry, Farringdon, Oxfordshire. An important site for the Farringdon Sponge gravel, which is only exposed in two other locations. Thus, the site has high scientific (B1a. and B1b) importance for its stratigraphy and geological history / process. It has little importance for applied geology. The educational value in demonstrating sandstones and limestones and their contained faunas is high.

10. Kings Dyke Brick Pit, Whittlesey, Peterborough. Exposures of Oxford Clay in the Peterborough area are rare and only found in active brick clay pits. A separate Geodiversity Profile of the adjacent RIGS outside the brick pit has the same values for each category, except it is valued at 3 for the stratigraphy (B1a.). The type section for the Peterborough Member is the brick pit and not the RIGS site, which exposes only part of the succession. The site has high value for resource geology, being one of only two in the area where this organic rich clay is extracted for use in brickmaking. The site is internationally important for the development of understanding of vertebrate palaeontology, and thus has a high value for its historical, cultural and aesthetics importance.

11. Humber Bridge Country Park, Hessle, East Yorkshire. Although the site merits low scientific value for its stratigraphy and geological history / process, it has high value for education as many features of the Chalk can be demonstrated. For applied geology, the site is important for its hydrogeology.

12. Besthorpe Quarry, near Newark, Nottinghamshire. The site is one of many active sand and gravel operations within the Trent Valley with no special significance. Thus, it merits a low scientific value. It has some educational value for demonstrating the sedimentology of the sands and gravels, and the general geomorphology of the area adjacent to the River Trent. It has no historical, cultural or aesthetics value.

13. Birch Quarry, near Colchester, Essex. A Quaternary sand and gravel pit with a single geological interest category of sedimentary strata. It has low scientific and educational values and no historical, cultural and aesthetics value. There are several other pits within the same lithostratigraphic unit in the area.

14. Buckingham Sand Pit, Page Hill Avenue, Buckingham. A Quaternary site of till and associated esker. Compared with other sand and gravel pits of Quaternary age this site has high value for its scientific importance for stratigraphy and geological history / process.

Reference

David Roche Geo Consulting, 2007. GeoValue: valuing geodiversity for the community. Report of MIST Project MA/5/2/001. David Roche Geo Consulting, Exeter, Project 2504/1.

Geodiversity Profile *Sheet 1 of 2* File Reference: Mancetter, Warwickshire

Location:	Mancetter Quarry, Mawbournes site, Warwickshire	Profile Status:	
		Grid Reference:	SP 3065 9620

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

Large quarry partly working, partly backfilled, approximately 0.5 x 1.0 km. Long, inactive face exposes Cambrian sedimentary and igneous rock.

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

Large exposure of laminated mudstones and siltstones of Cambrian Outwood Shale Formation in contact with a number of spessartite lamprophyre sills. The Mawbournes site displays all lithologies clearly.

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): **A**

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)*: **3**

The site is rare in exposing the Outwood Shales in contact with the igneous rocks. This is rarely seen elsewhere. An adjacent quarry within the Mancetter complex (Griff No. 4) shows the same relationships.

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

Only Griff No. 4 quarry (SP36188870) nearby demonstrates somewhat similar geological processes in the form of its igneous sill intrusions but the shales are nowhere near as fossiliferous.

1.c. Applied geology importance *(insert justification below - 4 lines max)* *(0-4)*: **3**

There are several active quarries within the Nuneaton Inlier. This site has provided stone with high PSV, which is rare. The geotechnical features of the site can be seen in many quarries elsewhere.

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

The site is one of the few Midland locations where Cambrian rocks are exposed. A sedimentological and palaeontological study of the shales enables an understanding of the palaeoenvironment to be gained. Typical morphological features of a sill are exposed. Hydrogeological issues such as that of acidic groundwater and the associated pyrite decay in the shale are demonstrable.

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

Lapworth visited the original quarry, which forms part of this site, in 1882. He demonstrated from the palaeontology that the Outwood Shales Formation (then known as the Oldbury Shales) were Cambrian in age and not Carboniferous as had been previously thought. It proved the existence of Cambrian in the Nuneaton Inlier. It is of significance for the history of geology in UK.

TOTAL VALUE (Part B only): **17**

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

2

(a,b,ab)

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

Name(s) of person(s) making the assessment:	Date:
Katie Snape, Alan Cook, Martyn Bradley (Warwickshire Geological Conservation Group)	June 2006

Geodiversity Profile *Sheet 2 of 2* File Reference: Mancetter Mawbournes, Warwick

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

The Nuneaton Inlier area.

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*):

Part A

The composition of the lamprophyre sill varies throughout the area with some parts hornblende rich. Fossils have been found in the Outwoods Shale formation including trilobites, brachiopods, sponges, hyolithids and ostracods

Fossil trilobites were found in 1882 by Lapworth. Geologists such as Illing, who was here 1912-1915, Lake (1906 – 1946), did not make any more finds. However, between 1964 and 1969 Rushton and Taylor did find fossils here. Leicester, Birmingham and Aston University fieldtrips between 1970 - 80 frequently produced finds. A.F. Cook has collected here since 1965 and has specimens in many collections, held for example at the BGS, Leicester, Birmingham and Newcastle universities. R. Kennedy also collected from the site very complex mineralised veins in 1968-72 associated with the sills. These included goethite, galena, pyrite, barytes, sphalerite and calcite. Olenus austriacus is rare from Purley. Around eight other olenus species have been found here.

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

Acidic water from the oxidation of sulphides in the shales are likely to affect the colonisation of plants in the quarry. An ecological survey is needed to confirm any relationship. There may be further indirect links.

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

Bridge, D et al 1998. The Geology of the country around Coventry and Nuneaton. Memoir of the British Geological Survey, Sheet 169 (England and Wales).
Cook, A.F. 2000. The Mawbournes, Unpublished Notes
Lake, P 1919. 1906 – 1946: British Cambrian Trilobites. Monogr. Palaeontological Society London, 73-78, 79, 83, 88, 341 – 342, Plate VIII.
Lapworth, C. 1882. On the discovery of Cambrian rocks in the neighbourhood of Birmingham. Geological Magazine (Dec. 2), 9, 563 – 565.
Lapworth, C. 1886. On the sequence and systematic position of the Cambrian rocks of Nuneaton. Geological Magazine (Dec. 3), 3, 319 – 322.
Lapworth, C. 1898. Sketch of the geology of the Birmingham district. Proceedings of the Geologist's Association, 15, 315 – 389.
Noble et al 1993. Lower Palaeozoic and Precambrian igneous rocks from eastern England, and their bearing on late Ordovician closure of the Tornquist Sea: constraints from U-Pb and Nd isotopes. Geological Magazine, 130, 835 – 846.
Strahan, A. 1886. On the rocks surrounding the Warwickshire Coalfield and the base of the Coal Measures. Geological Magazine (Dec. 3), 3, 540 – 557.
Taylor, K. & Rushton, A.W.A 1972. the Pre-Westphalian geology of the Warwickshire Coalfield. Bulletin of the Geological Survey of Great Britain, No. 35.
Rushton, A.W.A. et al 2000. British Cambrian to Ordovician Stratigraphy (GCR Volume No. 18). Joint Nature Conservation Committee, London.
Worral, J. 2003. Purley Quarry Geodiversity Management Plan 2004 – 2009. WGCG, University of Warwick.

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.GCR site			Whole ☒	Part ☐	Extends beyond ☒
2.			Whole ☐	Part ☐	Extends beyond ☐
3.			Whole ☐	Part ☐	Extends beyond ☐
Photographic record made:	Yes ☒	No ☐	Holder:		

Geodiversity Profile

Sheet 1 of 2 **File Reference: Balk Quarry, Cornwall**

Location:	Balk Quarry, Church Cove, Lizard, Cornwall	**Profile Status:**	
		Grid Reference:	SW 714129

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

75x 75m double benched former serpentinite quarry on coast, used for ornamental serpentine in the 19thC and aggregate for Predannack airfield in WW11. The higher bench and presumably older part of the quarry is separated from the lower by a 5m face.

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

Serpentinised lherzolite, Kennack Gneiss, Landewednack Schist (amphibolites) in tectonic juxtaposition, Calcite and serpentine vein mineralization. Thrust plane, pre and syn emplacement structures. Major Lizard post emplacement normal fault with well-developed fault breccia, Contact of loessic head with underlying Landewednack Schists well exposed in entrance cut. Lithological and extensional fault control of adjacent coastal configuration.

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): **A**

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)*: **3**

Serpentinised lherzolite, Kennack Gneiss, Landewednack Schist (amphibolites). One of 3 sites where these three lithologies can be seen in juxtaposition ((Cook et al., 2002). (Accessibility is best at Balk)

1.b. Geological history and/or process importance *(insert justification below - 5 lines max)* *(1-4)*: **3**

Rare exposure of Goonhilly Downs thrust zone, separating the Goonhilly Downs and Basal Nappe with syntectonic emplacement of Kennack Gneiss. The present NW dipping contact has been rotated from an original SE thrust direction by later block faulting. Exposure of major north dipping extensional fault plane on the south side of the quarry, with serpentinite downfaulted against Landewednack amphibolites. This fault continues westwards across the southern Lizard and is exposed at Pentreath Beach, near Kynance Cove.

1.c. Applied geology importance *(insert justification below - 4 lines max)* *(0-4)*: **3**

The properties of serpentinite in the hanging wall, ie upper face, differ markedly from those in the thrust zone below which is much more sheared and broken up. This phenomenon is rarely seen elsewhere on the Lizard and may be unique. Influence of rock types and faults on coastal stability and configuration.

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

Hands on collection of rock types and minerals, measurement of faults, thrust plane, mylonitic shear zones and mineral lineations (pre-and syn emplacement). Measurements of clast size matrix granulometry of head.

3. Historical, Cultural and Aesthetics value *(insert justification below – 4 lines max)* *(0-4)*: **2**

Wide ranging coastal view northwards to Pedn Boar
Quarry documented as important source of ornamental serpentine in 19th C (Flett,1912; Sagar-Fenton, 2005.) In WW11 it provided roadstone for Predannack airfield (Bates and Schofield, 1996)

TOTAL VALUE (Part B only): **15**

Part C: Ecological Component

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

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

(a,b,ab): **b**

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

Name(s) of person(s) making the assessment:	**Date:**
Peter Ealey (Cornwall RIGS) and Peter Scott	14/09/2006

Geodiversity Profile *Sheet 2 of 2* File Reference: Balk Quarry, Cornwall

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

Lizard Peninsula, characterised by variable lithostratigraphic and complexly arranged units

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)*

Derelict quarry floors, occasionally waterlogged, bare and vegetated faces. Coastal location.

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

COOK C.A., HOLDSWORTH, R.E. and STYLES M.T. 2002. The emplacement of peridotites and associated oceanic rocks from the Lizard Complex, southwest England. Geological Magazine, 139, 27-45.
FLOYD P.A., EXLEY C.S. and STYLES M.T. 1993. Igneous rocks of south-west England.
Chapman and Hall, London
FLETT J.S. and HILL J.B. 1912. Geology of the Lizard and Meneage (Sheet 359). Memoir of the Geological Survey of Great Britain, 1st edn, HMSO, London
FLETT J.S. 1946. Geology of the Lizard and Meneage (Sheet 359). Memoir of the Geological Survey of Great Britain, 2nd edn, HMSO, London.
HALL. A. 1979. West Cornwall. Geologist's Association Guide No. 19, 41.
SAGAR-FENTON M. 2005. Serpentine. Truran, Truro.
BATES R. AND SCOLDING B. 1996. Five walks from The Lizard. Landewednack Parish Council and Cornwall County Council.
POWER M.R., SHAIL R.K., ALEXANDER A.C. and SCOTT P.W. 1996.A re-interpretation of the internal structure of the Lizard complex ophiolite, south Cornwall. Proceedings of the Ussher Society, 9, 063-067.

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:		

Geodiversity Profile *Sheet 1 of 2* File Reference: Traprain Law, East Lothian

Location:	Traprain Law, East Lothian	Profile Status:	
		Grid Reference:	NT582747

Type and extent of site, including rock exposure: *(4 lines max)*
Rocky hill, 1 km, x 400m x 221m in height,with former quarry, 300m long, 50m high on SE side.

Summary of geodiversity (lithologies, structures, fossils, minerals, geomorphology, applied geology – *8 lines max*):
Fine example of laccolith, composed of phonolite, c340m yrs old, and of glacial Crag and Tail.

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): **A**

Part B: Geodiversity Values

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

1. Scientific Value

1.a. Litho / bio / chronostratigraphic importance *(insert justification below - 5 lines max)* — *(Range) (1-4)*: **4**
Phonolite lithology is unique to the Traprain Law laccolith among the intrusions associated with the Garleton Hills Volcanic Rocks.

1.b. Geological history and/or process importance *(insert justification below - 5 lines max)* — *(1-4)*: **4**
Traprain Law, which forms an impressive landmark feature in the south of East Lothian, is a classical example of a laccolith. This was formed during the Lower Carboniferous period, when magma was intruded into sedimentary rocks and formed a `mushroom' shape, with a flat lower surface and a domed upper. Only comparable site is essexite laccolith of Craigleith, an inaccessible island off North Berwick.

1.c. Applied geology importance *(insert justification below - 4 lines max)* — *(0-4)*: **1**
One of many examples of a former quarry from which aggregate was produced.

2. Educational value for pure and applied geology *(insert justification below - 4 lines max)* — *(1-4)*: **4**
Text-book example of a laccolith. Quarry shows internal structure, rock specimens show variety of minerals. Quarrying history can be demonstrated. Crag and tail feature well developed.

3. Historical, Cultural and Aesthetics value *(insert justification below – 4 lines max)* — *(0-4)*: **2**
The site is a prominent East Lothian landmark.

TOTAL VALUE (Part B only): **15**

Part C: Ecological Component

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

- ☐ 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)*: **b**

Name(s) of person(s) making the assessment:	Date:
David McAdam (Lothian and Borders RIGS)	08/2006

Geodiversity Profile *Sheet 2 of 2* File Reference: Traprain Law, East Lothian

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

Garleton Hills Volcanic Rocks area , the Lower Carboniferous volcanic rocks of East Lothian.

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*):

The laccolith is composed of phonolite, a late-stage alkaline rock, being the depleted residue of the volcanic magma. The pinkish grey rock is coarsely crystalline. The phonolite has phenocrysts of oligoclase and cryptoperthite with scarce clinopyroxene, apatite and corroded hornblende, in a matrix of antiperthite, aegerine-augite, fayalite, sodalite, nepheline and magnetite. Thin veinlets contain late crystallising minerals: analcime, calcite, apophyllite and alkali feldspar. Prehnite, pectolite, natrolite, datolite, anhydrite, selenite, and stilpnomelane have also been recorded. The phonolite has similarities to the rocks forming the Bass Rock and North Berwick Law. There are frequent outcrops, especially on the south side where there are steep cliffs. Exposures in the former quarry illustrate many of the key features of the internal structure of this rock body, including colour banding and jointing.
The Law is an excellent example of a glacial "crag-and-tail" formed as a result of the hard igneous rock obstructing ice as it moved in an ENE direction during the Pleistocene.
In addition to the geological significance, the Law is one of the best-known prehistoric monuments in Scotland, and is a designated Scheduled Ancient Monument.

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

Peregrine Falcons live on rock faces.
Flora in quarry.

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

Scottish Natural Heritage / British Geological Survey, 1997. East Lothian – A Landscape Fashioned by Geology.
Edinburgh Geological Society 1986. Lothian Geology – an Excursion Guide, pp 115-6.
RIGS Leaflet, 2006. Traprain Law.
British Geological Survey, 1978. I:50,000 geological map, Sheets 33W and part Sheet 41, Haddington (Solid and Drift editions).
British Geological Survey, 1978. I:50,000 geological map, Sheets 33E and part Sheet 41, Dunbar (Solid and Drift editions).
McAdam, A D, and Tulloch W. 1985. Geology of the Haddington district. Mem Geological Survey of Great Britain, HMSO.

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.Scheduled ancient monument			Whole ☒	Part ☐	Extends beyond ☐
2.			Whole ☐	Part ☐	Extends beyond ☐
3.			Whole ☐	Part ☐	Extends beyond ☐
Photographic record made:	Yes ☒	No ☐	Holder:		

Geodiversity Profile *Sheet 1 of 2* File Reference: Dene Quarry, Derbyshire

Location:	Dene Quarry, Wirksworth, Derbyshire	Profile Status:	
		Grid Reference:	SK 287563

Type and extent of site, including rock exposure: *(4 lines max)*
Large working limestone quarry with multiple faces. 80m+ of exposed strata, area of 500m by 700m approx.

Summary of geodiversity (lithologies, structures, fossils, minerals, geomorphology, applied geology – *8 lines max*):
Carboniferous Limestone; Eyam Limestone, including reef knoll facies, and Monsal Dale Limestone.
Overall dome structure with some small scale faulting. Fossils of crinoids, brachiopods, rare corals and others.
Minor calcite, barytes, galena and fluorspar mineralization.
Applied geology interest in restoration of faces and as an example of limestone aggregate resource

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): **A**

Part B: Geodiversity Values

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

1. Scientific Value

1.a. Litho / bio / chronostratigraphic importance *(insert justification below - 5 lines max)* — *(Range) (1-4)*: **2**

Exposure of the relationship between Monsal Dale Limestone and Eyam Limestone is common, however exposure of the stratigraphical relationship between Eyam Limestone and the Eyam Limestone knoll-reef is uncommon.

1.b. Geological history and/or process importance *(insert justification below - 5 lines max)* — *(1-4)*: **2**

Exposure of the Eyam Reef Limestone with Eyam Limestone demonstrating paleo-environment is uncommon. There are few exposures of carbonate mounds in the White Peak.

1.c. Applied geology importance *(insert justification below - 4 lines max)* — *(0-4)*: **2**

Large limestone quarries producing aggregates are common in this area, however, restoration on the upper faces to mimic natural dale cliffs is uncommon and a good example of this restoration type is present here.

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

A number of features in sedimentology, structural geology, mineralization and applied geology can be seen and measured.

3. Historical, Cultural and Aesthetics value *(insert justification below – 4 lines max)* — *(0-4)*: **2**

Dene Quarry was a source of historic building stone 'crinoidal marble' used for decorative purposes in a number of important London buildings

TOTAL VALUE (Part B only): **12**

Part C: Ecological Component

The link between geo- and biodiversity is reported as a number and a letter

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

(1,2,3): **3**

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

(a,b,ab): **a**

Name(s) of person(s) making the assessment:	Date:
David Minchin, David Harrison (BGS), Peter Scott	17/05/2006

Geodiversity Profile *Sheet 2 of 2* File Reference: Dene Quarry, Derbyshire

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

White Peak Area of Derbyshire and Staffordshire. Corresponds to English Nature Natural Area No. 30.

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*):

Dene Quarry is the source of 'Crinoidal marble' for Heathrow Terminal 2 and the Royal Festival Hall in London.

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

There is a direct link seen between limestone bedrock and lime grasslands seen both on quarry benches, restored faces and surrounding area.

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

Aitkenhead, N. 1985. Buxton, Leek and Bakewell. Memoir Sheet 111. British Geological Survey.
Smith E.G. 1967. Chesterfield, Matlock and Mansfield. Memoir Sheet 112. Institute of Geological Sciences Frost D.V. 1979. Area North of Derby. Memoir Sheet 125. Institute of Geological Scviences.
Aitkenhead, N. 2002. Pennines and adjacent areas, 4th Edition. British Regional Geology 8. British Geological Survey.
Foundations of the peak. www.bgs.ac.uk/foundation-web
Cox, F.C. and Harrison, D.J. 1980. The limestone and dolomite resources of the country around Wirksworth, Derbyshire. Description of 1:25,000 resource sheet SK25 and and part of SK35. Mineral Assessment Report Institute of Geological Sciences No. 47.
Ford, T.D. The Carboniferous Limestone. In: Sylvester-Bradley, P.C. (Ed.) The geology of the East Midlands. Leicester University Press.

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: Peter Scott

Geodiversity Profile *Sheet 1 of 2* File Reference: Breedon Hill, Leicestershire

Location:	Breedon Hill Quarry, Leicestershire	Profile Status:	
		Grid Reference:	SK 407234

Type and extent of site, including rock exposure: *(4 lines max)*
Active limestone quarry. 900m x 200m. Roughly 100m deep.

Summary of geodiversity (lithologies, structures, fossils, minerals, geomorphology, applied geology – *8 lines max*):
Lithologies: Milldale Limestone Fm, Ticknall Limestone Fm, (Carboniferous) Gunthorpe Member of the Sidmouth Mudstone Formation (Triassic).
Fossils: crinoids, brachiopods, nautiloids, ammonoids, corals, echinoids, the trace fossils *Thallasinoides* and *chondrites*. Structures: Steeply dipping beds, overturned bedding, folding, unconformity, faults.
Minerals: calcite, dolomite, galena, malachite and others.
Geomorphology: Caves. Palaeocaves infilled with Triassic sediment.
Applied geology: Interest in large, deep working quarry with very high faces. Mouldic porosity showing potential as oil reservoir.

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): **A**

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)*: **4**
One of only two exposures of the Carboniferous (Dinantian) Milldale Limestone in Leicestershire. Only exposure of a Carboniferous Waulsortian reef in Leicestershire.

1.b. Geological history and/or process importance *(insert justification below - 5 lines max)* *(1-4)*: **3**
Exposures of mud reef, basal breccia on unconformity and excellent example of Triassic cave filling are rare.

1.c. Applied geology importance *(insert justification below - 4 lines max)* *(0-4)*: **3**
Only one other similar large quarry, displaying features of interest to resource / engineering geologists can be found in the area (Cloud Hill).

2. Educational value for pure and applied geology *(insert justification below - 4 lines max)* *(1-4)*: **4**
Can demonstrate clearly features in lithology, stratigraphy, palaeontology, structure and geomorphology.

3. Historical, Cultural and Aesthetics value *(insert justification below – 4 lines max)* *(0-4)*: **2**
Aesthetic appeal is considered to be of importance to the county due to the excellent view of Breedon Hill Church pearched atop the cliff of a high quarry face that can be seen from far afield, including Charnwood Forest.

TOTAL VALUE (Part B only): **16**

Part C: Ecological Component

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

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

Name(s) of person(s) making the assessment:	Date:
David Minchin, Keith Ambrose (British Geological Survey)	22/08/2006

Geodiversity Profile *Sheet 2 of 2* File Reference: Breedon Hill, Leicestershire

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

Leicestershire.

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*):

Excellent examples of carboniferous sedimentary sequence in this area with unique Waulsortian mud mound reef and a wide variety of fossils.
Excellent example of Triassic unconformity with Triassic basal breccia at unconformity.
Good examples of faulting and folding.
Excellent examples of open caves and caves filled with collapse breccias.
One of 5 exposures of Carboniferous dolostone in Leicestershire.
Very good example of a cave infilled by Triassic sediment. Cave filled by collapse breccia.
Features seen can only be seen elsewhere in Cloud Hill Quarry. Dolostone also exposed at Barrow Hill, Grace Dieu and Osgathorpe but access not easy.
Good variety of minerals present.
Relict inselburg.

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

Good plant growth on large abandoned face beneath church. Also good recent plant growth on unworked benches (However this will be removed as the quarry extends)
Colonised by peregrine falcons

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

AMBROSE, K, AND CARNEY, J N. 1997. The geology of the Breedon on the Hill area (SK42SW). British Geological Survey Technical Report WA/97/42.
AMBROSE, K, AND HORTON, H. 1998. Excursion to Breedon on the Hill Quarry. Mercian Geologist, Vol. 14, 145-147
FOX-STRANGWAYS, C. 1905. The geology of the country between Derby, Burton-on-Trent, Ashby-de-la-Zouch and Loughborough. Memoir of the Geological Survey of Great Britain, Sheet 141 (England and Wales).
MITCHELL, G.H. & STUBBLEFIELD, C.J. 1941a. The Carboniferous Limestone of Breedon Cloud, Leicestershire, and the associated inliers. Geological Magazine, 78, 201-219
MONTELEONE, P.H. 1973. The Carboniferous Limestone of Leicestershire and South Derbyshire. Unpublished PhD Thesis, University of Leicester.
PARSONS, L.M. 1918. The Carboniferous Limestone bordering the Leicestershire Coalfield. Quarterly Journal of the Geological Society of London, 73, 84-110.
STRONG, G E, AND LOTT, G K. 1995. Petrography of Carboniferous Limestone specimens from the Breedon Hill area, Leicestershire. British Geological Survey Technical Report WG/95/12.
SIMMS, M.J. 1990. Triassic Palaeokarst in Britain. Cave Science, 17, 93-101.

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:		

Geodiversity Profile *Sheet 1 of 2* File Reference: Craigleith Quarry RIGS, Edinburgh

Location:	Craigleith Quarry RIGS, Edinburgh	Profile Status:	
		Grid Reference:	NT32269 6745

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

Craigleith Quarry RIGS is a former Dimension Stone Quarry, originally >60m deep and almost completely backfilled. The main face, about 6 m high in the east wall, extends for about 280 m. A much smaller section of similar height is present in the former west face by the petrol station.

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

Craigleith Quarry is the type section for the Craigleith Sandstone. The fine to medium grained, off-white, quartzose sandstone is part of the Lower Carboniferous (Asbian) Gullane Formation (Strathclyde Group) dipping to the SE at about 16 degrees. Thought to be about 60-90 m thick hereabouts, the sandstone is overlain by an upward fining succession that includes the thin Craigleith Marine Band in a bituminous mudstone/irony limestone facies.

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): **A**

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)*: **4**

Type section for the Craigleith Sandstone and Craigleith Marine Band. In the lower part of the Gullane Formation (Strathclyde Group) sites are rare showing the above features including oil-shale (bituminous mudstone) and fossils.

1.b. Geological history and/or process importance *(insert justification below - 5 lines max)* *(1-4)*: **3**

Rare site illustrating fluvial, lacustrine and marine processes in the Lower Carboniferous Gullane Formation with decent sedimentological features

1.c. Applied geology importance *(insert justification below - 4 lines max)* *(0-4)*: **2**

An example of a former dimension stone quarry of which there are several in the area, although historically others are not as important historically as Craigleith Quarry. The landfill in the quarry has a venting system for gas.

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

Well exposed section showing sedmentology and lithostratigraphy and with visible fossils; how the sandstone was extracted can be demonstrated and the consequences of landfilling demonstrated.

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

The site is of historical and cultural importance because of the use of building stone in key historic buildings (Edinburgh Castle, Holyrood Palace, Old College and the National Monument); arguably of international importance as the stone was exported from Scotland. 19th century stereo pair photos have survived, several paintings and a mention in an RL Stevenson Short Story.

TOTAL VALUE (Part B only): **17**

Part C: Ecological Component

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

- ☒ 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:
Mike Browne, Lothian and Borders RIGS Group	October 2006

Geodiversity Profile *Sheet 2 of 2* File Reference: Craigleith Quarry RIGS, Edinburgh

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

City of Edinburgh and the three Lothian local authorities areas of the Midland Valley of Scotland

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*):

The site is now the location of 'The Quarry' Shopping Development. There are two areas where the bedrock at the top of the original faces can still be inspected (with permission in the main case from Sainsburys).

Cross bedding and soft sediment deformation (convolutions and ball and pillow) are visible. Apart from the marine fossils including *Schizodus* and *Lingulae*, plant remains and non-marine bivalves (*Naiadites obesus*) occur along with the trace fossil *Chondrites* and the locality is famous for its large fossil trees (*Pitus withami*) recovered in the 1800s and now to be seen in the Royal Botanic Gardens in Edinburgh and in museums in the UK. Craigleith was a key building stone quarry from 1615 until it effectively closed in 1905. Faulting with slickensides is present in a small part of the main face.

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

No link demonstrable

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

McMillan AA, Gillanders, RJ, and Fairhurst, JA. 1999. Building Stones of Edinburgh. 2nd edition, Edinburgh geological Society.

Craigleith Quarry; Lothian and Borders RIGS Group Leaflet

British Geological Survey. 1:50000 Geological Survey Map Bedrock Sheet 32E (Edinburgh)

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:		

Geodiversity Profile *Sheet 1 of 2* File Reference: Tedbury Camp Quarry, Somerset

Location:	Tedbury Camp Quarry and adjacent valley, Somerset	Profile Status:	
		Grid Reference:	ST 74644898

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

Site includes a small former limestone quarry approx. 200 x 200m and adjoining narrow incised valley, from where access to the quarry is achieved.

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

Jurassic limestones, unconformably overlying limestones of Carboniferous age. Limestone of Carboniferous Clifton Down Limestone Formation with chert bands dipping 40-50° NNW in lower faces of quarry. Horizontal surface of main quarry floor shows strike direction. Carboniferous limestone faulted on western side of quarry floor with associated well developed zig-zag folding picked out by chert bands. Fauna of corals and brachiopods common,along with trace fossil borings. Continued below:

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): **A**

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)*: **2**

Within the defined area, the same limestones with the same stratigraphic relations occur in several other locations (e.g. several locations in Vallis Vale, Cloford Quarry, Colemans (Holwell Quarry complex), Whatley Quarry, Merehead Quarry (Torr Works)).

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

Other sites in the area show the same stratigraphy, stratigraphical relations and palaeontology. The geomorphology (e.g. incised valley, cave) and structures can also be seen separately elsewhere. However, this site is unique as all geological interest categories can be observed together.

1.c. Applied geology importance *(insert justification below - 4 lines max)* *(0-4)*: **2**

There are several working and further disused quarries where the engineering and resource geology is similar (e.g. several locations in Vallis Vale, Cloford Quarry, Colemans Quarry (Holwell Quarry complex), Whatley Quarry, Merehead Quarry (Torr Works))

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

The site provides an opportunity for examination of contrasting limestone sedimentology and palaeontology in the two formations, clear stratigraphical relations, folding and faulting structures and at least two components of geomorphology (incised valley and caves). Abundant opportunity for data collection is possible.

3. Historical, Cultural and Aesthetics value *(insert justification below – 4 lines max)* *(0-4)*: **2**

The Jurassic limestone provides an example of building stone used locally. The landscape associated with the incised valley is likely to be appreciated beyond the local area.

TOTAL VALUE (Part B only): **14**

Part C: Ecological Component

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

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

(a,b,ab): **ab**

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

Name(s) of person(s) making the assessment:	Date:
Hugh Prudden, Peter Scott, David Roche	08/05/2006

Geodiversity Profile *Sheet 2 of 2* File Reference: Tedbury Camp Quarry, Somerset

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

Quarries and other exposures in the eastern Mendips area

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*):

The quarry has small lower face 2m high intermittently exposing Carboniferous limestone. Main quarry floor has unbroken horizonal surface exposure of same limestone. Upper continuous exposed face over 300m long and 3-7m high of Jurassic Limestone. Other natural and former quarry exposures and blocks of Carboniferous limestone are found in valley sides.

Part A:
Carboniferous limestone is overlain unconformably by horizontally bedded Jurassic limestone of Inferior Oolite Group containing bivalves, brachiopods, gastropods and echinoids. Jointing well developed in both limestones. Quarry situated on side of narrow incised valley cut through both limestones. River in valley, unlike other 'dry' valleys of the Mendips.
Other exposures of steeply dipping Carboniferous limestone present in valley sides. Some show folding and/or faulting. Valley side also has small cave with flowstone and cemented breccia limestone in widened joints, and there is an exposure of conglomerate with re-cemented rounded limestone boulders.
Steeply dipping Carboniferous limestone and horizontal Jurassic limestone have contrasting geotechnical properties. Both presumably were used as sources of aggregate and/or building stone.
Very minor poorly exposed Pb mineralisation known to be present in Jurassic limestone.

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

There is abundant plant colonisation in and around the quarry with silver birch, buddleia etc. The bare limestone on quarry floor may have ecological significance. There is a wide biodiversity in the incised valley. An ecologist is needed to determine fully any direct or indirect relationships.

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

Duff, K.L., McKirdy, A.P. and Harley, M.J. 1985. New sites for old: a students' guide to the geology of the east Mendips. Nature Conservancy Council, 192pp.
Wilson, C. (Ed.) 1994. Tedbury Camp Quarry, Somerset. In Earth Heritage Conservation. Geological Society of London and Open University.
Cole, A.R. and Palmer, T.J. 1999. Middle Jurassic worm borings and a new giant ichnospecies of Trypanites from the Bajocian / Dinantian unconformity, southern England. Proceedings of the Geologists Association, 119, 203-209.
Green, G.W. 1992. Bristol and Gloucester Region. British Regional Geology, 3rd Edition. London. HMSO, 188pp.
British Geological Survey. 1:50,000 Geological map: Frome District, sheet 281.
Harrison, D.J., Buckley, D.K. and Marks, R.J. 1992. Limestone resources and hydrogeology of the Mendip Hills, British Geological Survey, Technical Report SA/92/19. 172pp.

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:	Peter Scott	

Geodiversity Profile *Sheet 1 of 2* File Reference: Hamdon Hill Quarry, Somerset

Location:	Hamdon Hill Quarry, Ham Hill Stone, near Yeovil, Somerset	Profile Status:	
		Grid Reference:	ST482162

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

Working building stone quarry approx. 5ha. Approx 20m high single rock face exposed. Other smaller faces much overgrown with vegetation within quarry limits.

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

Ham Hill Stone. Jurassic, Upper Lias. Pale brown bioclastic limestone in beds 10cm to 1m approx thick. Well developed trough cross-bedding. Thin conglomerate at base mostly of calcareous sandstone intraclasts. Interbedded with sandy limestone at top of face (not accessible). Fossils of ammonites (fragments), belemnites, bivalves. Trace fossils (burrows and trails). Major joints (170o and 110o) with horizontal striations on slickensides. Aggregates of flat calcite rhombs up to 2cm developed on some joint surfaces. Complex pattern of gulls. Whole formation dips approx 5o to SW at western end of quarry.

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): **A**

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)*: **2**

One of several (approx 10) exposures of the same Ham Hill Stone in the local area. Exposures are in one other working quarry and abandoned quarry faces now forming part of the Country Park.

1.b. Geological history and/or process importance *(insert justification below - 5 lines max)* *(1-4)*: **3**

One of only a few exposures of Ham Hill Stone where limestone sedimentology, structural features (e.g. joint movements, slickensides, development of calcite) are clearly exposed. Fossils (ammonites, belemnites, bivalves) found in basal units.

1.c. Applied geology importance *(insert justification below - 4 lines max)* *(0-4)*: **3**

The largest but not the only quarry in Ham Hill Stone showing the method of working controlled by bedding and major joint directions.

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

Limestone lithology, bedding, cross-bedding, jointing, method of working and palaeontology / palaeoecology can be clearly demonstrated. Loose blocks enable good hands-on observation.

3. Historical, Cultural and Aesthetics value *(insert justification below – 4 lines max)* *(0-4)*: **2**

Montacute, a few surrounding villages and several other prestige buildings in Somerset and Dorset are built of Ham Hill Stone.

TOTAL VALUE (Part B only): **14**

Part C: Ecological Component

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

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

(a,b,ab): **ab**

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

Name(s) of person(s) making the assessment:	Date:
Peter Scott, Clive Nicholas, Hugh Prudden	14/10/2005

Geodiversity Profile *Sheet 2 of 2* File Reference: Hamdon Hill Quarry, Somerset

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

Area of Ham Hill Country Park, adjacent to quarry and other exposures in Somerset in approx. 10 mile radius around Yeovil.

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*):

Part A
Ham Hill Stone forms a well-defined plateau area. Although some other sites of Ham Hill Stone enable this geomorphological feature to be viewed, it is not visible from this site.

Part B.
3. Historical, cultural and aesthetic importance:
Ham Hill Stone has been quarried since at least Roman times and was used widely in Dorset and Somerset as a prestige building stone from Norman times onwards (Simms, 2004).

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

Vegetation in the area may be specific to the limestone presence as a capping to the hill, surrounded by sandy strata. Old scree slopes of waste rock debris are carbonate-rich but low in organic content and have developed unusual herb-rich flora.
The quarry and presence of standing water may provide habitats for fauna or flora which are linked to the presence of limestone and/or the physical environment of the site.

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

Simms, M. 2004. Geological Conservation Review, Lower Jurassic stratigraphy, p.102.
Wilson, V. et al. 1958. Geology of the country around Bridport and Yeovil. Memoir of the Geological Survey of Great Britain, Sheets 327 and 312, HMSO.
Geological Survey of Great Britain, 1973. 1:50,000 Geological Survey Map, Sheet 312. Institute of Geological Sciences.
Jefferson, D.P. 1993. Building stone: the geological dimension. Quarterly Journal of Engineering Geology, 26, 305-320.
Hugh Prudden, Somerset Geological Group. Personal knowledge.
Simms, M.J., Chidlaw, N., Morton, N and Page, K.N. 2004. British Lower Jurassic Stratigraphy. Geological Conservation review, No 30. JNCC. 458pp.

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:	Peter Scott	

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

Location:	Wicklesham Quarry, Farringdon, Oxfordshire	Profile Status:	
		Grid Reference:	SU 2925 9420

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

Semi-active sand and gravel quarry. Approx. 500m by 200m with near continuous exposure in rock faces around the perimeter. Faces range from 3-8 m high. Stockpiles of excavated material are also present.

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

Immature, poorly cemented coarse sands of the Faringdon Sponge Gravels (Lower Greensand Fm.; Upper Aptian; Uppermost Lower Cretaceous) (FSG) unconformably overlays hard, coralliferous limestones of the Coral Rag Mb. (Stanford Fm.; Oxfordian; Upper Jurassic) in the N.E corner and is previously recorded to unconformably overlay the Kimmeridge Clay Fm. (Kimmeridgian; Upper Jurassic) in the S.E corner (NB: Not seen during site visit). Material is extracted for use as building sand and rockery stone.

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): **A**

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)*

The Faringdon Sponge Gravels (FSG) are extremely limited in outcrop and are only seen at 3 sites: Wicklesham Quarry, Coxwell Pit and Faringdon Pit North. — **3**

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

The only site at which the unconformable contact between the FSG and underlying Coral Rag Mb. is clearly seen. — **4**

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

Sand pits of this nature are common in the region however, economic exploitation of the strata can be clearly demonstrated at the site. — **1**

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

The site presents numerous opportunities for the clear demonstration of pure geological principles such as palaeoecology, sedimentology, lithological variation and unconformities. — **4**

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

Some use of FSG for building stone in Faringdon i.e. the Corn Exchange. — **1**

TOTAL VALUE (Part B only) — **13**

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, — **1**
- ☐ 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:
Jane Worral, Ian Brewer, Peter Scott	25/04/2006

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

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

The FSG are only found in the Faringdon area and as such, the geographical area is restricted by outcrop.

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*):

Description of Lithologies:

FSG: Poorly cemented, coarse grained ferruginous sands with occasional pebble bands. Consists predominantly of well rounded, poorly sorted quartz fragments and contains a diverse fauna including Cretaceous sponges, sponge/echinoid spicules and nautiloids as well as derived, blackened Jurassic fossils including bivalves, brachiopods, corals, echinoid spines and belemnite sections. Iron in the FSG has been oxidized to give a distinctive reddy brown colour.

The FSG becomes finer grained, much better sorted and shows well developed cross bedded in the upper parts – more alike to the typical facies of the Lower Greensand that has been observed elsewhere

Coral Rag: Hard, bored limestone (biosparite), packed with corals and echinoid spines. The upper surface of the Coral Rag undulates and shows clear evidence of substantial erosion and the subsequent development of a hard ground. Occasional, large chunks of weathered Coral Rag (c. 30 cm) occur just above the surface of Coral Rag outcrop, in the base of the FSG.

N.B: The water table appears to have risen above the floor of the quarry in the S.W corner causing a body of standing water to be present. It is apparent that this water obscurers the unconformable contact between the FSG and Kimmeridge Clay Fm.

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

No link observed during site visit. An ecological report that has previously been compiled for the site also shows a low ecological value.

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

Arkell, W. J. 1947. The geology of Oxford. Oxford Univ. Press, Oxford. 267pp.
Casey, R. 1961. The stratigraphic palaeontology of the Lower Greensand. Palaeontology, 3, 487-621.
Krantz, R. 1972. Die Sponge-Gravels von Faringdon (England). Neues Jahrbuch fur Geologie und Paläontologie, Abhandlungen, 140(2), 207-231.
Powell, P. 2005.The Geology of Oxfordshire. Dovecote Press, Dorset. 108pp.
Sherlock, R. L. 1947. British Regional Geology: London and Thames Valley. Her Majesty's Stationery Office, London. 69pp.

Website: The Geology of Faringdon
Oxfordshire Geology Trust RIGS documentation
English Nature SSSI Citation

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: Oxfordshire Geology Trust		

Geodiversity Profile *Sheet 1 of 2* File Reference: Kings Dyke Brick,Cambridgeshire

Location:	Kings Dyke Brick Pit, Whittlesey, Peterborough, Cambridgeshire	Profile Status:	
		Grid Reference:	TL 248 967

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

Large working quarry with at least three large faces (each 100m plus in width) of the Peterborough Member of the Oxford Clay Formation, Middle Jurassic.

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

Complete section of Peterborough Member of Oxford Clay and upper part of Kellaways Formation (sandy mudstone) (approx 20m total thickness of sequence). Oxford Clay contains ammonites, bivalves, belemnites, gastropods, serpulides, and rarely vertebrate remains. Sand and gravel (approx. 3m) (probably River Nene terrace) is present unconformably above Oxford Clay.

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): **A**

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)*: **4**

The adjacent Saxon Pit exposes the same sequence of Oxford Clay. The sequence at the Kings Dyke Pit is taken as the Type Section (Hudson and Martill, 1994). The adjacent RIGS site which is outside the curtilage of the brick pit exposes only part of the sequence.

1.b. Geological history and/or process importance *(insert justification below - 5 lines max)* *(1-4)*: **3**

The Kings Dyke and Saxon working pits enable a similar interpretation of the geological history and processes to be made. The Peterborough brick pits are important sites for fossil fish, marine reptiles and dinosaurs.

1.c. Applied geology importance *(insert justification below - 4 lines max)* *(0-4)*: **3**

This is one of only a few places where the Oxford Clay in the Peterborough area can be seen. The Oxford Clay is a unique clay raw material for brickmaking. It has 4% organic matter enabling it to make use of its own source of fuel in the manufacturing process.

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

Direct observation of the lithology, and measurement of the rock sequence can be made. Fossils can be collected.

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

The Leeds collection of fossil reptiles, which is of international significance for the history of development of vertebrate palaeontology, was made from the Peterborough brick pits.

TOTAL VALUE (Part B only): **18**

Part C: Ecological Component

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

Name(s) of person(s) making the assessment:	Date:
Peter Scott, David Roche, Jonathan Larwood	10/11/2005

Geodiversity Profile *Sheet 2 of 2* File Reference: Kings Dyke Brick, Cambridgeshire

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

Exposures in the Peterborough area. Although Oxford Clay is exposed in brick clay pits in the Bedford area, this is considered to be a separate area.

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*):

Part B, 1c. Part of the exposure shows degrading faces, common in exposures of clay.
Water management (i.e. pumping) of the site is necessary. This is common in low lying areas, the water table being only 1-2m below the surface.
The soft nature of the clay enables it to be worked using a clay planer. These are rare in UK
Part B3. The value of 4 is for the importance of the Oxford Clay in the development history of vertebrate palaeontology. A value of 4 is also justified as the fossils from the Oxford Clay can be seen in museums the world over (Martill and Hudson, 1991)
The Oxford Clay also has an historical/cultural significance for brickmaking at a national level (scoring 3). Its use enables bricks to be made more cheaply than using clay from other locations. This has had and continues to have a considerable affect on the markets for bricks and brick production nationally.

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

Sand martins nests are present within the sandy unit of the river terrace sand and gravel.
An early succession of bareground flora is developing in the floor of the pit.

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

Hudson, J.D. 1994. Oxford Clay studies. Journal of the Geological Society, 151, 111-112.
Hudson, J.D. and Martill, D.M. 1994. The Peterborough Member (Callovian, Middle Jurassic) of the Oxford clay Formation at Peterborough, UK. Journal of the Geological Society, 151, 113-124.
Martill, D.M. and Hudson, J.D., (Eds) 1991. Fossils of the Oxford Clay. The Palaeontological Association, Field Guide to fossils, No 4. London.
Cox, B.M., Hudson, J.D. and Martill, D.M. 1993. Lithostratigraphic nomenclature of the Oxford Clay (Jurassic). Proceedings of the Geologists' Association, 103 (for 1992), 343-345.
Callomon, J.H. 1968. The Kellaways Beds and the Oxford Clay. In Sylvester-Bradley P.C. and Ford, T.D. (Eds) The geology of the East Midlands. Leicester University Press, 264-290.
Page, K.N. 2002. Peterborough Brickpits, Cambridgeshire. In: Cox, B.M. and Sumbler, M.G. Middle Jurassic Stratigraphy. Geological Conservation Review Series, No 26, 266-273.

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: Peter Scott		

Geodiversity Profile *Sheet 1 of 2* File Reference: Humber Bridge, East Yorkshire

Location:	Humber Bridge Country Park, Hessle, East Yorkshire	Profile Status:	
		Grid Reference:	TA019257

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

Large disused chalk quarry, 20 hectares (approx 300 x 750m). Chalk exposure around edge up to 10 m high. Former quarry with associated windmill used for crushing chalk for whiting.

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

Chalk with marls and flints of the Upper Cretacaous, Welton Formation, Terebratulina lata zone. 10-20m of the lower half of the 50m thick formation is exposed. Fossils are present but rare and are generally broken Inoceramus shells. Some faulting with minor displacements can be seen. A small lake is fed by chalk springs.

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): **A**

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)*: **2**

One of around 7 sites where Welton Formation chalk is exposed.

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

Flinty Chalk of Turonian age is exposed in many locations within East Yorkshire.

1.c. Applied geology importance *(insert justification below - 4 lines max)* *(0-4)*: **3**

One of several sites which are or were used for the manufacture of chalk whiting, justifying a value of 2. The site is rare for its hydrogeology as a spring can be seen clearly to be issuing from within the chalk. This justifies a value of 3.

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

The site is suitable for examining and measuring the stratigraphic section of the Chalk, demonstrating the presence of flints and marls and the throw on the minor faults. In addition, the spring feeding the lake enables a demonstration of the water table.

3. Historical, Cultural and Aesthetics value *(insert justification below – 4 lines max)* *(0-4)*: **2**

The site has an attractive setting adjacent to the Humber Bridge, and is known locally as 'Little Switzerland'.

TOTAL VALUE (Part B only): **12**

Part C: Ecological Component

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

(a,b,ab): **ab**

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

Name(s) of person(s) making the assessment:	Date:
Barrie Heaton, Mike Horne, Stuart Jones (East Yorkshire RIGS Group)	07/07/2006

Geodiversity Profile *Sheet 2 of 2* File Reference: Humber Bridge, East Yorkshire

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

East Yorkshire. Note: Welton Formation chalk is also exposed in North Lincolnshire, but the latter exposures are not included in the valuing process applied here.

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*):

The site is formerly know (in geological literature) as Hessle APCM Quarry. It is a former SSSI for its geology, and now is a RIGS. It is locally known as "Little Switzerland" and is a popular area for walks and picnics.

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

The site has been a local nature reserve since 2002. The site includes orchids, newts, willows, and is likely to have specific calcareous-loving plants.

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

Sheppard T 1903 Geological Rambles in East Yorkshire. A Brown and Sons, Hull. 235pp.
Wood C J & Smith E G 1978. Lithostratigraphical classification of the Chalk in North Yorkshire, Humberside and Lincolnshire. Proceedings of the Yorkshire Geological Society. 42, 263-288.
Personal knowledge, Mike Horne.

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.Local Nature Reserve			Whole ☒	Part ☐	Extends beyond ☐
2.			Whole ☐	Part ☐	Extends beyond ☐
3.			Whole ☐	Part ☐	Extends beyond ☐
Photographic record made:	Yes ☒	No ☐	Holder:		

Geodiversity Profile *Sheet 1 of 2* File Reference: Besthorpe Quarry, Nottinghamshire

Location:	Besthorpe quarry, near Newark, Nottinghamshire	Profile Status:	
		Grid Reference:	SK 820630

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

Large active sand and gravel quarry working river alluvium and Holme Pierrepont glaciofluvial river terrace. Approx 1km^2 of workings (active, restored and planned) working up to 8m of gravel.

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

River terrace sand and gravel showing numerous features of fluvial deposition including cross bedding, polymict gravel (evidence of sources from a variety of upstream formations), decomposed organic matter, gravel with sand layers and lenses. Facies changes between fluvioglacial sheet flood river terrace deposits and recent silt overbank deposits are well exposed. Mercia Mudstone poorly exposed in drainage channels at base of gravel working. Contact is not exposed. Therefore there is no direct evidence of the unconformity.

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): **B**

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)*

Fluvioglacial river terrace and overbank deposits are well exposed but are common in other sand and gravel workings along the Trent Valley.

1

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

Fluvioglacial sheet flood river terrace deposits are commonly exposed in many sand and gravel workings along the Trent Valley.

1

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

Examples of glaciofluvial terrace deposits being used as a sand and gravel resource are common in the Trent Valley.

1

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

Geological interest in the sedimentology of the sands and gravels and geomorphology can be demonstrated, however geomorphological data collection would not be possible.

3

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

This quarry has no historical, cultural or aesthetic value.

0

TOTAL VALUE (Part B only) **6**

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

3

(a,b,ab)

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

ab

Name(s) of person(s) making the assessment:	Date:
David Minchin (BGS), Andrew Bloodworth (BGS), Peter Scott	18/05/2006

Geodiversity Profile *Sheet 2 of 2* File Reference: Besthorpe Quarry, Nottinghamshire

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

Trent valley and Rises Natural Area as defined by English Nature.

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*):

This quarry is a good example of a working river terrace sand and gravel operation with ample opportunity to view and measure fluvioglacial river terrace deposits.

The conveyor leading to the Trent allowing 50% of the 500,000 Tpa of sand and gravel produced at the quarry to be transported to Leeds by barge gives an indirect applied geology interest. Barge transport is rarely used elsewhere.

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

Sand martins nesting in sand layers on dormant faces show a direct connection between geology and ecology. A heronry has been established in a worked out and flooded area of the site.

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

Edwards, W.N. 1967. Geology of the cuintry around Ollerton. Sheet 113. Memoir of the Geological Survey of Great Britain. HMSO.
Aitkenhead, N. 2002. Pennines and adjacent areas, 4th Edition. British Regional Geology 8. British Geological Survey.
Gozzard, J.R. 1975. The sand and gravel resources of the country around Besthorpe, Nottinghamshire. Mineral Assessment Report Institute of Geological Sciences No. 17, 96pp

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: Peter Scott

Geodiversity Profile *Sheet 1 of 2* File Reference: Birch Quarry, Essex

Location:	Birch Quarry, near Colchester, Essex	Profile Status:	
		Grid Reference:	TL925192

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

Working sand and gravel quarry, approx. 200 by 300m with large sub-vertical faces of sand and gravel on four sides. Operated by Hanson plc.

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

Sand and gravel (up to 20m approx) exposed through most of quarry. Gravel dominates in lower and upper part, middle part (3-4m) is mostly sand. A few 10-20cm thick lenses of sand within gravel units. Some cross-bedding seen in sandy parts. NW face of pit has 3-4m of brown sandy pebbly clay overburden to the sand and gravel, presumably till. It appears conformable with the sand and gravel.

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): **C**

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)*: **2**

One of several working quarries in the area around Colchester. Other exposures of poor and degrading quality also present nearby in disused and partly restored quarries. All of these quarries are within the Kesgrave Sands and Gravels Group and several within the Colchester Formation.

1.b. Geological history and/or process importance *(insert justification below - 5 lines max)* *(1-4)*: **2**

Illustrates typical features of Kesgrave Sands and Gravels lithologies in the Colchester area. One of several working quarries.

1.c. Applied geology importance *(insert justification below - 4 lines max)* *(0-4)*: **2**

One of several working sand and gravel quarries in the area around Colchester, each using similar methods of extraction and processing. Continuous pumping maintains depression in water table locally to enable dry excavation.

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

Clearly exposed example of sand and gravel in a working quarry.

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

None. (Note: Archaeological dig (Roman site) in progress behind west face at time of survey)

TOTAL VALUE (Part B only): **8**

Part C: Ecological Component

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

(a,b,ab): **a**

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

Name(s) of person(s) making the assessment:	Date:
Peter Scott	11/11/2005

Geodiversity Profile *Sheet 2 of 2* File Reference: Birch Quarry, Essex

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

Area around Colchester and east Essex.

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*):

Kesgrave Sand and Gravel now given Group status with Colchester Formation proposed for the sand and gravel in this area (Bridgland, 1988; Whiteman, 1992). Sands and gravels here belong to either the Wivenhoe or Lower St Osyth Gravels (see Whiteman, 1992).
Ambrose (1973) map has glacial sand and gravel with overlying till, the latter contact striking NE-SW across the site.

Pebbles in gravel mostly flint with minor quartzite, sand grains virtually all sub-rounded to rounded quartz. London Clay is sometimes found at the base of the sand and gravel (not visible at time of survey). Frost heave possibly present on north-east face, but poorly developed.

Applied geology: Sand and gravel in the area is an important resource, and there are several working quarries in the Colchester Formation.
There is some face instability with slumping and there are some well developed mud/sand flows where surface water run off has incised the face.

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

Virtually no vegetation developed within the quarry.
One thin sandy unit in NE face has holes from sand martin nests.

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

Ambrose, J.D. 1973. The sand and gravel resources of the country around Layer Breton and Tolleshunt D'Arcy, Essex. Description of 1:25,000 resource sheet TL91 and part of TL90. Report Institute of Geological Sciences No. 73/8. 34pp.
Ambrose, J.D. 1974. The sand and gravel resources of the country west of Colchester, Essex. Description of 1:25,000 resource sheet TL92. Report Institute of Geological Sciences No. 74/6. 68pp.
Bridgland D.R. 1988. The Pleistocene fluvial stratigraphy and palaeogeography of Essex. Proceedings of the Geologists' Association, 99, 249-260.
Whiteman, C.A. 1992. The palaeogeography and correlation of pre-Anglian-Glaciation terraces of the River Thames in Essex and the London Basin. Proceedings of the Geologists' Association, 103, 37-56.
Lucy, G. 1999. Essex Rock. Essex Rock and Mineral Society, 128pp.

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: Peter Scott

Geodiversity Profile *Sheet 1 of 2* File Reference: Buckingham Pit, Buckinghamshire

Location:	Buckingham Sand Pit, Page Hill Ave., Buckingham	Profile Status:	
		Grid Reference:	SP 700 344

Type and extent of site, including rock exposure: *(4 lines max)*
Disused sand pit now a nature reserve. Two main faces each c. 20 m length and c. 5 m in height. Site, including nature area, is 1.8 ha.

Summary of geodiversity (lithologies, structures, fossils, minerals, geomorphology, applied geology – *8 lines max*):
Quaternary site with sands and gravels. Till (Anglian) and associated esker deposit. Although largely worked out, some of the linear and sinuous esker landform can still be detected. Local lithologies as well as those of Scandinavian origin are to be found as clasts in both deposits. Cross-stratification visible in the esker as well as pebble imbrication and graded bedding. Fossils (derived and mostly Jurassic) are found in both deposits. Small organic-rich lenses in association with esker sands.

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): **B**

Part B: Geodiversity Values

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

1. Scientific Value — Value *(Range)* *(1-4)*

1.a. Litho / bio / chronostratigraphic importance *(insert justification below - 5 lines max)*
The only exposed till and esker deposit in Buckinghamshire. Sections through esker sands and gravels are rare in other areas of the UK. — **3**

1.b. Geological history and/or process importance *(insert justification below - 5 lines max)* *(1-4)*
Exposed esker deposits (sections) are not common features throughout the UK, although a number of them exist elsewhere in England and Scotland as geomorphological features. The till is an important example of Anglian till away from the well-known coastal sections of East Anglia, displaying the variable and regional nature of this deposit. The organic lenses may yield chronostratigraphic and/or environmental data if researched. — **4**

1.c. Applied geology importance *(insert justification below - 4 lines max)* *(0-4)*
A former and small sand and gravel pit of which there are many in the defined area — **1**

2. Educational value for pure and applied geology *(insert justification below - 4 lines max)* *(1-4)*
The sand and gravel lithologies and sedimentary structures can be examined.
Although the linear and sinuous esker can be seen, it is difficult to demonstrate — **3**

3. Historical, Cultural and Aesthetics value *(insert justification below – 4 lines max)* *(0-4)*
it is an example of a sand and gravel pit which supplied a local market — **1**

TOTAL VALUE (Part B only) — **12**

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

3

(a,b,ab)

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

Name(s) of person(s) making the assessment:	Date:
Jill Eyers (Bedfordshire and Buckinghamshire RIGS)	19/07/2006

Geodiversity Profile *Sheet 2 of 2* File Reference: Buckingham Pit, Buckinghamshire

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

Eastern England.

Additional Comments, Parts A and B: Geodiversity Measure and Geodiversity Value:
(Futher 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*):

The site is unique for Bucks and also a distinct lithology to Anglian till found elsewhere.
This site relies on the management services of Aylesbury Vale Countryside Services (AVCS) which is part of Aylesbury Vale District Council. If left unmanaged the sands and till soon become overgrown with vegetation (within one year), including penetrating tree roots. This Geodiversity value is therefore highly changeable.

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

Badgers use the esker deposit as it is easily excavated. Burrowing bees or wasps can be seen in both faces.

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

Aylesbury Vale District Council 2005 Buckingham Sand Pit LNR: Management Plan 2005-2010
www.aylesburyvaledc.gov.uk/avdc/get//assets/docs/Sandpit%20Management%20Plan%202005%20to%202010.pdf
Eyers, J. 1999. Geological walks in North Bucks. Rocks Afoot Series. 1-904898-03-3
Sumbler, M. G. 1996. British Regional Geology: London and the Thames Valley. HMSO for the British Geological Survey.
Buckingham sand pit. www.rocksafoot.com/buckingham.htm

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.Local Nature Reserve			Whole ☐	Part ☐	Extends beyond ☐
2.			Whole ☐	Part ☐	Extends beyond ☐
3.			Whole ☐	Part ☐	Extends beyond ☐
Photographic record made:	Yes ☒	No ☐	Holder:	Jill Eyers	

Appendix 4

Examples from Cornwall illustrating the Ecological Component

The Ecological Component of the Geodiversity Profile reports any link between the geodiversity and ecology at a geological site. The link may be a direct relationship between the ecology and chemical composition or physical structure of a rock exposure, or indirect, the ecology relating to the situation of the site, but not the *in situ* rocks. This appendix illustrates some links from sites in Cornwall. A full assessment of the biodiversity at a geological site requires the expertise of a professional ecologist who has experience of habitats, flora and fauna in the local area.

A typical stand of Lizard Heath from the Lizard peninsula shows a clearly demonstrable link between ecology and geology. This community is characterised by the rare heather, Cornish heath, in combination with western gorse, black bog-rush and purple moor-grass. It occurs in England only on the Lizard because Cornish heath relies on the magnesium rich soils derived from the underlying serpentinite rocks.
(Photo: Victoria Whitehouse, Cornwall Wildlife Trust)

A stand of Western heath from Penwith, West Cornwall. Although apparently similar to the preceding photograph, there are subtle differences. Here the western gorse is accompanied by different ericaceous species - bell heather and cross leaved heath, and the grass is bristle bent. This community has developed on granite but has a more widespread distribution, being reliant upon nutrient poor acidic soils rather than a specific rock type.
(Photo: Cornwall Wildlife Trust)

This wetland community is characterised by purple moor-grass and rushes but contains rare associates such as the meadow thistle (pictured) and whorled caraway. The habitat occurs on a variety of lowland soils with impeded drainage across southern Britain but shows a clear link with the geology in the south-west of the country where its distribution correlates with the Upper Carboniferous Culm Measures of North Cornwall and Devon.
(Photo: Cornwall Wildlife Trust)

A link between a calcareous substrate and the ecology is illustrated by the maidenhair fern which relies on the interbedded limestone and dolomite of the Tredorn slate formation, Prince of Wales quarry near Wadebridge, Cornwall.
(Photo: Paul Gainey)

A direct link between the physical properties of the geology and the ecology is shown by sand martins which excavate their nesting holes in the soft sand layers of a sand pit face.
(Photo: Cornwall Wildlife Trust)

This habitat is dominated by tussocky purple moor grass. It develops in response to impeded drainage and not as a direct response to the underlying rock type. Rosemanowas Quarry, Longdowns, near Penryn in Cornwall. (Photo: Cornwall Wildlife Trust)

The Pearl bordered fritillary butterfly is present in response to the shelter created by the aspect of a quarry and the grassy slopes which support the dog violet it feeds on. It is not specifically rock type dependent. De Lank Quarry, St Breward, near Bodmin, Cornwall. (Photo: J B and S Bottomley)

The lanceolate spleenwort is not rock type specific and will occur in any damp quarry. Its presence is related to the hydrological regime rather than the chemical composition of the substrate. (Photo: Ian Bennallick)

Photographs Front cover

A large active quarry in Carboniferous Limestone containing bedded and reef knoll facies, dipping approximately 30°.
Dene Quarry, Wirksworth, Derbyshire. (Geodiversity Profile in Appendix 3)

A face in a large active sand and gravel operation in Triassic Budleigh Salterton Pebble Bed.
Blackhill Quarry, near Exmouth, Devon.

Stockwork of greisen bordered quartz/tourmaline veins cutting kaolinised granite.
China Clay Pit, St Austell, Cornwall.

Flint and quartz pebbles with a sandy matrix. Quaternary, Kesgrave Sand and Gravel Formation.
Birch Quarry, near Colchester, Essex.

Back cover

The foreshore and cliff below the castle expose a small Variscan granite boss in contact with metamorphosed, tectonised Mylor Slates, Devonian. The granite has greisen bordered veins containing cassiterite, stannite, wolframite and other minerals.
St Michael's Mount, Cornwall.