

Geodiversity Action Plan

Cornwall and the Isles of Scilly

2005

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Key Definitions

Geodiversity - geological diversity is the variety of rocks, minerals, fossils (i.e. the geology), together with the variety of soils, natural processes and landforms (the geomorphology) found within a particular region. These all combine with a region's biodiversity and human activities (farming, town-building, mining etc.) to provide the landscapes or scenery.

Geology - the study of the Earth as a whole; its origin, structure, composition and history (including the evolution of life) plus the natural processes which affect it. The term *earth sciences* is often used as an all encompassing term for geology, physical geography, climatology and oceanography.

Geomorphology - the study, description and identification of processes which affect the Earth's surface (*geomorphic processes*) and the features, such as rivers, beaches, granite tors etc. that result (*landforms*).

Geological resources - encompasses rock types, mineral deposits and building materials for which humans have a use; soils for habitat and agriculture/forestry; as well as the human skills involved in all aspects of geology, geomorphology and geoconservation.

Geoconservation - the conservation of geodiversity for its intrinsic, ecological and heritage values. Geoconservation seeks to maintain and conserve natural geological, geomorphological, soil and landscape features for their value as natural phenomena, not simply because of their direct usefulness to humans.

Geodiversity Action Plan (GAP) - a document with objectives, targets, action plans and indicators to measure success; which highlights priorities for, and focuses resources on, the conservation and promotion of geodiversity in a region. GAPs often include an audit of resources i.e. a study of what geological features, geomorphology, resources etc. there are in a particular region.

Biodiversity - biological diversity, literally meaning the variety of life found within a particular region. A more formal definition is the variability among living organisms and the ecological complexes (ecosystems) of which they are part. Biodiversity therefore encompasses all organisms, plant and animal species as well as the habitats and areas in which they are found.

Exposure sites - these are sites whose scientific or educational value lies in providing current exposures of a geological feature(s) which is laterally and vertically extensive or widespread below the surface; i.e. the actual features of interest could be exposed elsewhere if required, to form equally suitable exposures (e.g. by continued quarrying or on-going coastal erosion). Such 'exposure' sites are numerically the most common category of sites and include most cliffs, quarries, road-cuttings and natural outcrops. Their conservation depends on preserving suitable areas of exposure, and it is possible for new exposure sites of a feature to be created.

Integrity sites - these are sites whose scientific or educational value lies in the fact that they contain scarce deposits, features or landforms that cannot be recreated if damaged or destroyed. The usual situation is that the deposit or landform is of relatively recent age and of limited lateral extent, although many older geological features also fall into this category because of their rarity. Examples include periglacial deposits and unique mineral, fossil, stratigraphic, or structural features. 'Integrity' sites are, by definition, finite and irreplaceable. The approach to their conservation is to maintain the integrity of the feature and often implies active conservation and restriction of man-made changes.

Sustainable development - development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Implies aspects of growth and increase (i.e. development) but in an environmentally responsible manner.

A Glossary has been included at the end of this Action Plan to explain some of the more technical (geological) terms used.
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Executive Summary

Introduction

Some 400 million years ago, the geology in Cornwall and the Isles of Scilly evolved in a completely different manner to the rest of Britain; giving rise to a distinctive suite of rocks (slates, greenstones, serpentine, gabbro and granites) and generating one of the world's classic mineralised orefields.

As a result Cornwall and the Isles of Scilly have a great diversity of rocks, soils, landscapes and mineral deposits, reflecting their rich and varied geological heritage. Geodiversity is the name given to the variety of rocks, minerals and fossils (geology), together with the variety of soils, natural processes and landforms (geomorphology).

Geodiversity is important to Cornwall and Isles of Scilly because:

- Geology and landscape are the basis for much of Cornwall and Isles of Scilly's beautiful scenery and provide the resources for a variety of recreational and leisure activities.
- Within our towns, villages and workplaces, geodiversity provides the building materials, architectural heritage and physical landscape. Our natural heritage and historic environment are seen by many as major benefits of living and working in Cornwall and Isles of Scilly.
- Soils, rocks and landscapes are an integral part of the natural history of Cornwall and Isles of Scilly. They provide the raw materials for active processes to shape our moors, rivers and coasts; creating varied habitats and ecosystems and having an underpinning control on the diversity of wildlife.
- Cornwall and Isles of Scilly's geodiversity is important in the historical development of geology and mining and retains its importance today as a scientific, cultural and economic resource of national and international significance.
- Many locations in Cornwall and Isles of Scilly are recognised as Sites of Special Scientific Interest (SSSI) or County Geology Sites (RIGS) for their geological significance, and their conservation and continued protection is a responsibility we have to future generations.

There is a pressing need to conserve and manage geodiversity, in the same way that biodiversity conservation has already been incorporated into all levels of national and local policy making, industrial and economic development and education/lifelong learning.

Framework

The aim of this Geodiversity Action Plan (GAP) is to provide both a strategic framework for geodiversity in Cornwall and Isles of Scilly and to identify projects and actions which take the development or conservation of geodiversity forward in a

sustainable manner. The GAP includes an audit of Cornwall and Isles of Scilly's geodiversity, in order to identify and summarise the current status of our geological assets, and develops targets and action plans to help manage future work.

There are considerable resources and geological skills within Cornwall and the Isles of Scilly, but they are dispersed in various organisations and need harnessing and coordinating to effectively implement the Geodiversity Action Plan. The most critical action required from this GAP is to establish a network of partners willing to support its aims and objectives; with a shared and agreed view on how the action plans will be delivered and funded. The positive feedback received at the consultation stage suggests that establishing a steering group of key partners will be achievable.

Considerable progress on geological conservation in Cornwall and the Isles of Scilly has been made through the dedicated efforts of part-time, largely voluntary groups (in particular the Cornwall RIGS Group) and individuals; and work towards the aims and objectives of this GAP will continue. If geodiversity and its conservation is to reach parity with that now enjoyed by biodiversity and the historic environment, however, it needs proper funding and a more full time approach. This Geodiversity Action Plan therefore assumes that there is an individual (nominally called the Geodiversity Officer) tasked with its implementation. The absence of such an appointee should not, however, invalidate attempts to pursue the targets and actions outline in this Geodiversity Action Plan.

Whether future funding to support implementation of the Geodiversity Action Plan comes from a single, or a variety of sources, it is important that no one organisation should be seen to have ownership of the GAP and that responsibility for promoting, enhancing and conserving geodiversity in Cornwall and Isles of Scilly is shared by all partners.

Range & status of geodiversity sites

For almost all aspects of Cornwall and Isles of Scilly's geodiversity there are representative exposure and integrity sites available, although for reasons of safety (for example in relation to underground exposures or mineral resources) or land management (e.g. soils in cultivation) not all may be visible or accessible.

Away from the coastal regions and granite tors, the main sites for hard-rock features are provided by current mineral extraction activities and by abandoned mines and quarries. Soils, geomorphological features and the various landscape characters are largely under the stewardship of major landowners and/or agricultural interests. These natural resources achieve regional, national or even international importance in their own right; providing considerable geodiversity value and requiring good management and sustainable development.

Existing planning policies for minerals, environmental protection, character areas and use of resources are all aimed at maintaining this range of natural resources and promoting their sustainable development.

Although sufficient sites exist in Cornwall and Isles of Scilly to provide representative coverage of almost all aspects of geodiversity, this does not correlate directly with the range and number of sites protected under legislation, various conservation designations or planning policy.

Geodiversity Audit: key issues

1. Good designated site coverage for:
 - i. Trevone-South Devon Basin in west Cornwall
 - ii. Tavy Basin along north coast
 - iii. Culm Basin
 - iv. regional metamorphic effects on sediments and volcanics
 - v. Lizard Complex
 - vi. Cornubian granite batholith and associated rocks (exceptions shown in 2.iii.)
 - vii. key mineral species locations
2. Under-represented or poor designated site coverage for:
 - i. Trevone-South Devon Basin in east Cornwall
 - ii. Tavy Basin away from the north coast
 - iii. Carnmenellis and Isles of Scilly granite plutons; lamprophyres
 - iv. styles of mineralization and alteration
 - v. Tertiary sediments
3. Insufficient work carried out to date to confirm coverage for:
 - i. Gramscatho Basin
 - ii. Variscan and sedimentary basin structural geology
 - iii. integrity sites of the Quaternary
 - iv. soil sites, (particularly soil sub-groups and types)
 - v. geomorphological sites
 - vi. fossil fauna and assemblages
4. Revise and update County Geology Site (RIGS) descriptions. Review descriptions on SSSI citation sheets to identify any additional features of geodiversity interest that could be designated at regional (RIGS) level.
5. There are a number of issues relating to the collection and management of County Geology Sites (RIGS) data:
 - i. lack of standardised information collected,
 - ii. lack of up-to-date survey information for each site,
 - iii. lack of adequate computerised information for each site,
 - iv. lack of management plans/recommendations for each site.
6. Systems for the recording and wider reporting of temporary exposures of geological significance are not well developed. Formal watching briefs, such as those required for archaeological interests, could be established.
7. There is currently insufficient information pertaining to sites outside of the designated sites system i.e. sites in the wider landscape.
8. The audit has not established whether the museum and academic collections contain a comprehensive record of all the key mineral, rock and fossil specimens or species in Cornwall.
9. There is a need to audit and review the resources and skills available within existing partners, potential partners and other organisations or individuals.

Issues, opportunities and threats

Major Geodiversity Issues in Cornwall and Isles of Scilly				
Issue	Positive aspects	Negative aspects	Opportunities	Threats
Planning and conservation policies	Conservation designations protect reported sites. Planning policies restrict development on sites and promote prudent development of mineral resources.	Concept of geodiversity not fully integrated into policies. Perception that geodiversity is only valued if sites are designated.	World Heritage Site status could offer further promotion and protection of geodiversity. Geodiversity input into Mineral Development Framework.	Working practices and management plans overlook geodiversity.
Public awareness and appreciation	General appreciation of Cornwall and Isles of Scilly's natural heritage is widespread. Strong, enthusiastic base of skills/activities to build on.	Sustained improvement to awareness requires long term plan and numerous activities.	Informal branding of publicity literature to reinforce a common message.	Public fails to engage with message that geodiversity is important.
Minerals extraction and restoration	Geodiversity value of Cornwall's resources is of national/international significance. Quarries provide valuable exposure sites.	Loss of landscape features in areas of high sensitivity. Perception that all mining damages the environment.	Conservation and educational potential can be recognised as part of restoration plans.	Waste rock disposal impacts on land take. Poor management practices damage/neglect integrity sites.
Agriculture and forestry	Good land management practices promote soil conservation and landscape geodiversity.	Intensification of farming impacts on soil quality and structure.	Agri-environmental schemes to assist conservation	Poor working practices lead to soil erosion. Large plantations reduce geological exposure.
Waste disposal and derelict land	Many abandoned mine sites are significant for geodiversity as well as biodiversity and industrial archaeology.	Visual impact of derelict sites increases pressure for redevelopment.	Survey of old quarries may provide valuable geodiversity data and highlight sources of stone for building or hedging projects.	Unregulated waste disposal in abandoned quarries.
Built development	Use of local, distinctive building materials encouraged.	Loss of exposures and landforms, impact on soils and landscape.	Recording of geological features during temporary exposures.	Any decline in environmental quality threatens economy.
Tourism, amenity use and access	Key promoters of Cornwall and Isles of Scilly's natural environment. Many landowners have positive attitude towards geodiversity.	Concept of geodiversity not widely understood. Little direct involvement in geoconservation.	Potential to develop geotourism. WHS bid raises awareness of mining landscape.	Increased visits to geodiversity sites cause damage or exceed management capacity.
Coastal erosion and climate change	Cornwall and Isles of Scilly's geodiversity is valuable for research into sea-level and climatic changes.	Increased rates of erosion in coastal areas. Changes to fluvial systems.	May change range of geomorphology features and processes available for study .	Flood and coastal defence plans in conflict with protection of geodiversity.

Major Geodiversity Issues in Cornwall and Isles of Scilly				
Issue	Positive aspects	Negative aspects	Opportunities	Threats
Mineral and specimen collecting	Public collections provide excellent educational resource to introduce geodiversity	Excessive hammering and collection damages exposures.	Private collections may provide untapped source of conservation potential.	Lack of policy or code of practice to regulate collection.
Biodiversity and Historic Environment Links	Conservation bodies placing increased emphasis on linking geology to biodiversity. Protection of historic environment has a high profile in Cornwall and Isles of Scilly.	Some landowners, businesses respond poorly to nature and heritage conservation approach.	Develop geodiversity aspects to the watching brief archaeologists have for major and temporary excavations. Collaborative projects broaden potential funding sources. GAP could be linked with the Cornwall BAP process through the Biodiversity Initiative.	Geodiversity does not develop separate identity

Recommendations and action plans

The Geodiversity Audit and qualitative assessment of the main issues, opportunities and threats facing geodiversity has allowed targets and recommendations to be developed for future geological conservation work in Cornwall and the Isles of Scilly.

Action plans have been drawn up from each of the recommendations and targets identified. Action Plans delivering Recommendations 1 and 2 are the highest priority tasks and need to be addressed with immediate effect.

Recommendations are summarised on the following page.

Recommendations

Recommendation 1: Set-up infrastructure to deliver the GAP

Whilst this GAP will provide the framework for taking forward work related to geodiversity conservation, a robust infrastructure needs to be established if the GAP is to be delivered, including the creation of a small steering group representing the key partners.

Recommendation 2: Complete resources and skills audit

Audit and review the resources and skills available from existing partners, potential partners and other organisations or individuals. This should also include identifying areas (both topic-based and geographical) for future research.

Recommendation 3: Improve data coverage

Improve and extend data collection, analysis and designation of County Geology Sites to close gaps in conservation coverage, complete the assessment of status for various geodiversity aspects and enhance the storage of data.

Recommendation 4: Improve policy and working practices

Further enable organisations to incorporate geodiversity conservation into policy and strategic documents, management plans and working practices.

Recommendation 5: Raise public awareness

The key priority for promoting geodiversity must be to raise awareness of the wider significance of rocks, soils and physical processes as a key part of our natural heritage, landscapes and scenery. This will require a more co-ordinated approach, using action plans to help guide development of a whole range of activities.

Recommendation 6: Promote geotourism and amenity use

Work with the tourism sector to promote geotourism and a greater understanding of the landscape. The quality of the natural (and built) environment is the main attraction which brings visitors to the region and geotourism could allow the shoulder months of the tourist season to be extended.

Recommendation 7: Increase corporate awareness

Develop links with companies and businesses, highlighting their impact on geodiversity conservation and increasing their awareness of key issues.

Recommendation 8: Improve links with the biodiversity and historic environment sectors

Highlight areas where links exist between biodiversity, geodiversity and the historic environment, as a means of promoting closer working relations and collaboration.

Chapter 1 Introduction

1.1 Overview

Cornwall and the Isles of Scilly have a great diversity of rocks, soils, landscapes and mineral deposits, reflecting a rich and varied geological heritage that spans the last 500 million years of Earth's history.

For some 130 million years, during the Devonian and Carboniferous periods, the geology in Cornwall evolved in a completely different manner to the rest of Britain. Deep marine conditions predominated in what is now Cornwall, while the rest of Britain sweltered under first desert and then shallow, tropical water conditions. The sediments and lavas deposited in marine basins were then uplifted and deformed by mountain-building events, forming slates and greenstones, and bringing a slice of the ocean crust onto land, now exposed on the Lizard. Molten granite subsequently intruded these rocks and as it cooled and crystallised, metal-rich fluids associated with the granites moved into fractures in the rocks and deposited ore minerals in veins and lodes.

Many geological and geomorphological sites in Cornwall and the Isles of Scilly are of national and international importance and there is a growing recognition of the need to conserve and manage this highly distinctive geological heritage.

Geodiversity finds itself in the same position as biodiversity 15 years ago, before the 1992 Earth Summit in Rio de Janeiro successfully threw sustainable development and biological diversity issues onto the radar screens of policy and decision makers and triggered the much wider public awareness of biodiversity that is found today.

Within Cornwall and the Isles of Scilly there is a need to bring national and local targets for geological conservation together in a strategic plan that will provide a framework within which all geological resources and conservation projects can be assessed, prioritised, promoted and managed.

The aim of this Geodiversity Action Plan (GAP) is to provide both a strategic framework for geodiversity in Cornwall and the Isles of Scilly and to identify projects and actions which take the development or conservation of geodiversity forward in a sustainable manner.

The preparation of this Geodiversity Action Plan was initiated by Cornwall Wildlife Trust, through the Environmental Records Centre for Cornwall and the Isles of Scilly (ERCCIS), in collaboration with Cornwall RIGS Group. Cornwall RIGS Group is a voluntary organisation concerned with the conservation of important geology and geomorphology sites and raising awareness of Cornwall's unique geological heritage.

Funding was obtained from English Nature, through DEFRA's Aggregates Levy Sustainability Fund Grant Scheme, for a project entitled 'Exploring the Geodiversity of Cornwall'; the principal element of which was the preparation of the first local GAP for Cornwall and the Isles of Scilly.

1.2 Geodiversity Action Plan Objectives

1. *To audit the geodiversity of Cornwall and the Isles of Scilly, in order to identify and summarise the current status of our geological assets (Geodiversity Audit).*
2. *Use the Geodiversity Audit, together with a review of key issues affecting geodiversity, to inform the development of targets and action plans which provide for the future conservation and sustainable development of Cornwall and the Isles of Scilly's geology, geomorphology and landscape.*

The audit will seek to establish if the range and number of sites that have been identified are a representative reflection of the geodiversity in Cornwall and the Isles of Scilly, and highlight aspects of geodiversity that are not adequately represented or recognised in current conservation strategies.

Many locations in Cornwall and the Isles of Scilly are now legally protected as Sites of Special Scientific Interest (SSSI) for their geological importance, or have been recognised under the Regionally Important Geological/geomorphological Sites (RIGS) conventions, and their conservation and continued protection is a responsibility we have to future generations.

The audit will also draw attention to the significant natural resources found in the soils, rocks and minerals of Cornwall and the Isles of Scilly; resources which make an important contribution to the overall geodiversity of Cornwall and the Isles of Scilly. These features often achieve regional, national or indeed international importance in their own right; providing considerable geodiversity value and requiring careful management and stewardship. In many cases, such as temporary exposures in quarry faces or agricultural soils, designated conservation status would be impractical or inappropriate.

Geodiversity encompasses features and processes which by their nature are dynamic and ephemeral. Important landforms and geomorphic processes, such as sand dunes and fluvial (river) features, often occur on a small scale and are dependent on finely balanced conditions, changes to which can substantially alter their viability. While the vulnerability of such features makes their recognition and site management more significant in the short-term, conservation strategies need to recognise that some change and ultimately loss is inevitable if surface processes are to be allowed to develop naturally. Conservation of some features may therefore be limited in timescale and responsive to the dynamics of systems.

Development of action plans will enable delivery of local, site-based geological conservation of resources that are:

- Covered by legislation
- At risk or in decline
- Representative of the character or local distinctiveness of an area
- Rare

3. *Improve recognition of the economic and amenity value of Cornwall and the Isles of Scilly's natural resources, in particular its geology and landscapes, and promote the sustainable development of these resources.*

Rocks and landscapes are the basis for much of Cornwall and the Isles of Scilly's beautiful scenery and provide the resources for a variety of recreational and leisure activities. The landscape around us is the result of present day processes but also those that operated in the past. Within our towns, villages and industrial sites, geological resources and landscapes have provided the building materials, architectural heritage and physical backdrop. Cornwall and the Isles of Scilly's geological features are therefore of immense cultural, amenity and economic value.

The economic significance is particularly relevant to the tourism, agricultural and quarrying industries in Cornwall and the Isles of Scilly. Tourism is the largest single industry and the quality of the natural environment remains by far its most important attraction. The farming community plays a major role in the management, use and protection of our soils, rivers and landscapes; thereby also influencing habitats and ecosystems. Quarrying companies are major landowners and users of the geological resources in Cornwall and have a key role to play in geoconservation.

Human activities are therefore significant forces controlling the shape, quantity and quality of our geological resources and we need to develop strategies for their sustainable use.

4. *Promote awareness, at all levels from government policy makers through to school children and the wider public, of the following factors:*
 - *The exceptional scientific and cultural value of Cornwall and the Isles of Scilly's geological heritage.*
 - *The wider significance of rocks, soils and physical processes in our daily lives and as a key part of our natural heritage, landscapes and scenery.*

Cornwall and the Isles of Scilly's geological heritage is important in the historical development of geology and the broader earth sciences, particularly in relation to stratigraphy and economic geology. For example, the study of Cornish sites made a significant contribution to the original concept of the Devonian period of geological time. Our rocks, landscapes and mineral deposits retain their importance today as a scientific and cultural resource of national and international significance.

Cornwall and the Isles of Scilly contain numerous sites with geological evidence of past changes to sea-level and climate, sites that can be studied to help understand contemporary climate change and develop appropriate mitigation strategies.

Understanding environmental change on a variety of timescales, from comparison of climatic conditions and sea-levels to the long-term monitoring of impacts on ecosystems, requires knowledge of baseline conditions and trends. Geological systems provide some of this background data and it is therefore important to identify and protect those sites or landscapes which provide us with important information.

As well as specific sites, public (and private) collections of minerals, rocks and fossils have an important role to play in conserving Cornwall and the Isles of Scilly's geodiversity. Existing public collections have immense value as repositories of representative and/or rare samples of this geodiversity; and as a gateway for raising public awareness of our geological heritage.

At planning and decision-making levels, in both industry and local government, the sustainable management of Cornwall and the Isles of Scilly's natural resources needs further integration into policies and practices. Environmental education has a role to play in highlighting how special Cornwall and the Isles of Scilly's geology is, and in providing a better understanding of its links to landscapes, habitats and biodiversity, industrial heritage, built environment and mineral extraction.

5. *Encourage further involvement in geoconservation issues from local communities, industry, and the education sector.*

Interest in, and demand for, environmental and conservation based activities from community groups and individuals involved in lifelong learning has seen considerable growth in recent years. Highlighting the role of geodiversity within nature conservation will stimulate a greater appreciation of geoconservation within the community and lead to the inclusion of more geodiversity based activities within community projects and lifelong learning courses.

While the minerals industry has to some extent taken the lead in promoting its geodiversity credentials, there are other sectors such as tourism and the outdoor recreational industries, which rely just as heavily on the natural resources of Cornwall and the Isles of Scilly. Businesses in these sectors need to be encouraged to take a more active role in the conservation and promotion of the geodiversity that underpins their activities.

The environmental and sustainable development strands of the National Curriculum provide a suitable framework within which to introduce the subjects of geodiversity and geoconservation. Materials and projects aimed at the school sector will foster an interest in conservation which can lead to more active participation in subsequent years.

6. *Encourage wider collaboration between the earth science community and the biodiversity and historic environment communities.*

Soils, rocks and landscapes are an integral part of the natural history, cultural history and industrial archaeology of Cornwall and the Isles of Scilly. They provide the basis for the diversity of species and the active geomorphological processes that shape the moors, rivers and coasts to create varied habitats and ecosystems. Bedrock geology, soils and landforms have always had a critical influence on the places humans have chosen for all types of activities.

Geology and geomorphology have a fundamental role in determining habitat type and hence an underpinning control on biodiversity. There is a relationship between rocks, soils, habitats and species; most terrestrial habitats cannot exist without the supporting medium of soils to sustain plant growth and soils cannot form without the geological processes acting on underlying rocks. Cornwall and the Isles of Scilly's biodiversity is inextricably linked to maintaining and managing the geological features

and geomorphological processes that provide the physical settings for habitats and species.

Cornwall formed the comprehensive partnership known as the Cornwall Biodiversity Initiative (CBI) in 1996 and the Partnership's initial action was to produce a Biodiversity Action Plan (BAP) for Cornwall. This Plan entitled "Cornwall's Biodiversity" includes Audit and Priorities (Volume 1) and Action Plans (Volume 2). Volume 3 revises the earlier volumes to bring the BAP in line with more recent national guidelines. Implementation and monitoring of the Action Plans is ongoing under the auspices of the Cornwall Biodiversity Initiative. At present there is no BAP covering the Isles of Scilly.

Conservation strategies for biodiversity in Cornwall and the Isles of Scilly are therefore at a much more advanced stage than for geodiversity and there is an opportunity to promote and fast-track progress on geological conservation with help and assistance from this very active and successful Biodiversity Initiative; linking the Geodiversity Action Plan with the Cornwall BAP process.

Any exposures of rocks or sediments may also contain archaeological data and the sourcing of artefacts (ceramics, stone tools and building materials) is dependent on a good and accurate geological database. Mines, pits and quarries are of great interest to specialists from a range of disciplines, not least for their historic, industrial archaeological value. Quarries provided stone for dwellings, historic buildings and hedging, and remain significant as a source of materials for conservation and repair works.

The interest and value of historic environment sites is wide ranging and includes: the landscape context of sites and their impact on local environments, evidence for changes in site use and technology through time, surviving industrial structures and the impact of industry on the cultural landscape of the surrounding area (smallholdings, field systems, housing, chapels, institutes etc.).

In the near future there may be new opportunities to promote better working relationships between organisations and agencies involved in the historic environment, biodiversity and geodiversity. Parts of Cornwall's mining landscape have been nominated for World Heritage Site (WHS) status and the WHS Management Plan aims to promote such multidisciplinary links and their contribution to Cornwall's cultural distinctiveness.

1.3 Sources of Information and Consultation

The Geodiversity Action Plan (GAP) has been prepared by reviewing existing geodiversity information and holding discussions with members of the Cornwall RIGS Group and a number of consultees.

1.3.1 Key Sources of Information

A list of the key sources of information used in the production of this GAP is given in Appendix 1. In addition to these, the following data sources were also widely consulted:

- Cornwall RIGS Group archives
- Proceedings of the Ussher Society
- District Council Local Plans
- Memoirs and Sheets of the British Geological Survey
- English Nature Research Reports, Natural Area Profiles, Shoreline Management Plans

Websites and on-line databases from the following organisations were also important sources of information:

- UK RIGS (www.ukrigs.org.uk)
- Cornwall RIGS Group (www.cornwallwildlifetrust.org.uk/rigs)
- Cornwall County Council (www.cornwall.gov.uk)
- English Nature (www.english-nature.org.uk)

1.3.2 Consultation Process

The organisations and individuals consulted whilst producing the GAP are given in Appendix 2; they all had the opportunity to comment on an external consultation draft of the GAP and over a third responded with comments. Cornwall RIGS Group Executive Committee members discussed the contents of the GAP at a number of their committee meetings and also had the opportunity to comment on an earlier internal draft.

1.4 Summary

The aim and objectives of the Geodiversity Action Plan are summarised in the box on the following page.

Geodiversity Action Plan: Aim and Objectives

GAP aim:

To provide both a strategic framework for geodiversity in Cornwall and the Isles of Scilly and to identify projects and actions which take the development or conservation of geodiversity forward in a sustainable manner.

GAP objectives:

1. Undertake an audit of the geodiversity of Cornwall and the Isles of Scilly (Geodiversity Audit), in order to identify and summarise the current status of our geological assets (covering the range of geological, geomorphological and soil and landscape features present and also the physical and human resources available).
2. Develop targets and action plans which provide for the future geoconservation and sustainable development of Cornwall and the Isles of Scilly's geodiversity and ensure the conservation of at least adequate representative examples of the geodiversity identified in the Audit.
3. Improve recognition of the economic and amenity value of Cornwall and the Isles of Scilly's natural resources, in particular its geology and landscapes, and promote the sustainable development of these resources.
4. Promote awareness, at all levels from government policy makers through to school children and the wider public, of the following factors:
 - a. The exceptional scientific and cultural value of Cornwall and the Isles of Scilly's geological heritage.
 - b. The wider significance of rocks, soils and physical processes as a key part of our natural heritage, landscapes and scenery.
5. Encourage greater involvement in geoconservation issues from local communities and businesses.
6. Encourage wider collaboration between the earth science community and the biodiversity and historic environment communities.

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Chapter 2 Geodiversity Audit

2.1 Scope of Audit

The purpose of this Audit is to identify, summarise and classify the principal geological, geomorphological, soil and landscape features and natural resources that together make up Cornwall and the Isles of Scilly's geodiversity. By reviewing the number, location and features of exposure and integrity sites currently identified and designated as conservation sites within Cornwall and the Isles of Scilly, an assessment can be made of the current status of the protection being afforded to these principal features. Sites of Special Scientific Interest (SSSI) and Regionally Important Geological/geomorphological Sites (RIGS) are the most frequent designations used to protect geological features.

The Audit has, however, reviewed all aspects of geodiversity and not just those under current conservation designations. Many features of Cornwall and the Isles of Scilly's geodiversity achieve regional, national or indeed international status in their own right without falling within the RIGS or SSSI systems of designation. For example, many of the current or historic mineral extraction areas provide extensive additional exposure sites of considerable geodiversity and economic value. Sustainable development and/or sympathetic management of these features is required, which relies on the owner or operator being aware of the geodiversity value of the site (or specimens in the case of collections).

International schemes for nominating and designating areas or sites of outstanding geodiversity include European Geoparks, which are endorsed as part of UNESCO's Global Geopark Network, and the Geosites scheme. Similarly there are a number of organisations such as the European Association for the Protection of the Geological Heritage which exist to promote dialogue on geological conservation and good practice among member countries. Consideration of these broader international frameworks is, however, beyond the scope of this 1st edition of the GAP.

2.1.1 Approach

It should be acknowledged that the sort of comprehensive audit achieved by the Cornwall Biodiversity Initiative (CBI) in Cornwall's Biodiversity Action Plan (BAP) is beyond the scope and resources of the current Exploring the Geodiversity of Cornwall Project. A synthesis of the conservation status of every individual rock type, mineral, fossil, stratigraphic unit etc. within Cornwall and the Isles of Scilly has not been attempted to the same depth achieved in the BAP, which addressed all taxonomic groups and individual species of conservation concern within them. It is hoped, however, that in itself this Audit provides an initial framework within which further detail can be added and refinements made on an ongoing basis.

The detailed findings of the Geodiversity Audit present a very technical account of all aspects of Cornwall and the Isles of Scilly's geology and geomorphology, at a level which is inappropriate for inclusion in the main text of the Geodiversity Action Plan (GAP). The geological overview and the key findings from each section are therefore presented here; ultimately the detailed technical report on the Audit will be made

available through the websites of the Environmental Records Centre for Cornwall and the Isles of Scilly (ERCCIS) and the Cornwall RIGS Group.

Section 2.2 provides a brief history of the tectonic and geological evolution of Cornwall and the Isles of Scilly and sections 2.3 to 2.8 then group the Audit's key findings into sensible geological blocks. These sections should be read in conjunction with the conservation sites list in Table 1 and the brief descriptions of each site contained in Appendices 3 and 4.

Section 2.9 includes a very limited review of the organisations with geological/geomorphological skills and resources, as well as assessing the status of the collection and storage of data within the current conservation framework in Cornwall and the Isles of Scilly.

In addition to reviewing specific exposure and integrity sites in Cornwall and the Isles of Scilly, consideration has also been given to the public (and private) collections of minerals, rocks and fossils which have an important role to play in conserving Cornwall and the Isles of Scilly's geodiversity. Existing public collections have immense value as repositories of representative and/or rare samples of this geodiversity; and as a gateway for raising public awareness of our geological heritage.

Key data sources used in the compilation of this Audit are given in Appendix 1 and there is also a full list of References.

2.1.2 Geological SSSIs and GCR sites

The Nature Conservancy Council (NCC) began a review of earth science conservation in the late 1970s which subsequently led to the Geological Conservation Review (GCR), a national programme to identify earth science sites of **national** scientific importance for their geology or geomorphology. The NCC subsequently split into separate statutory agencies by country; English Nature is the statutory body with responsibility for England; with the Joint Nature Conservancy Council (JNCC) retaining responsibility for the management and publication of GCR information.

The GCR site series recognised sites on the basis of three, overlapping criteria: sites of international importance, sites that are nationally important because they show exceptional (rare or 'classic') features and sites that are nationally important because they are representative of a key earth science feature, event or process in Britain.

Although minor amendments continue to be made to the GCR, the majority of GCR sites were identified by 1990 and have now been designated as geological, or combined biological and geological, Sites of Special Scientific Interest (SSSI) by the statutory nature conservation agencies (i.e. English Nature for sites in England, including Cornwall and the Isles of Scilly).

The term Site of Special Scientific Interest (SSSI) applies to areas of land that have been notified under the provisions of the Wildlife and Countryside Act 1981, as being of 'special interest by reason of any of its flora, fauna, geological or physiographical features'. The SSSI system is the main nature conservation designation in Great

Britain, designating sites of **national** importance. SSSI sites are either biological SSSIs, geological SSSIs or a combination of both.

Designation as a SSSI provides a mechanism which ensures that English Nature must, legally, be consulted about any development or activity that would damage the scientific interest for which the site is notified. A potentially damaging operation can only be carried out on a SSSI if English Nature has given its consent or if the operation is undertaken in accordance with a management agreement. For some geological SSSIs in England, a Site Management Brief is also available.

Table 1 provides a list of the SSSI sites (geological and geological/biological) in Cornwall and the Isles of Scilly which contain geodiversity features of national importance, sub-divided into various aspects of geology/geomorphology. Sites may be important exposure or integrity sites for more than one aspect and therefore appear in several sections. Brief descriptions of each of these SSSIs are given in Appendix 3.

Table 1: Conservation sites list for selected aspects of Cornwall and the Isles of Scilly's geodiversity (as at 31/12/04).

Geodiversity Audit heading	SSSI sites (statutory)	County Geology Sites (RIGS, non-statutory)
Pre-Devonian Basement	Aire Point to Carrick Du* Caerthillian to Kennack Cuckoo Rock to Turbot Point *exposures of basement material occur but are not specifically cited	Carne Quarries
Looe Basin	Kingsand to Sandway Point Rame Head and Whitsand Bay Polyne Quarry	Black Head-Ropehaven Carlyon Bay East Carlyon Bay West Cawsand Bay Duporth Gamas Point Lantic Bay Sandheap Point Seaton Beach St Germans Quay Whipsiderry
Gramscatho Basin	Aire Point to Carrick Du Baulk Head to Mullion Cuckoo Rock to Turbot Point Cudden Point to Prussia Cove Gerrans Bay to Camels Cove Godrevy Head to St Agnes Meneage Coastal Section Mullion Cliff to Predannack Cliff Penhale Dunes Penlee Point Penlee Quarry Porthleven Cliffs East Rosemullion Tater-Du	Black Cliff Caragloose Point Carne Quarries Fishing Cove Great and Little Hogus Jacka Point Porthcadjack Cove Tubb's Mill Quarry
Trevone-South Devon Basin	Bedruthan Steps and Park Head Clicker Tor Quarry Harbour Cove Pentire Peninsula Rock Dunes	Cant Hill Lowhill Quarry & Forder Quarries Port Arthur Port Quin Stepper Point

Geodiversity Audit heading	SSSI sites (statutory)	County Geology Sites (RIGS, non-statutory)
	Rosenun Lane Stepper Point Trebetherick Point Trevone Bay Trevose Head and Constantine Bay	Wearde Area Wearde Quay
Tavy Basin	Crocadon Quarry Greystone Quarry Polyphant Stourscombe Quarry Tintagel Cliffs Viverdon Quarry Yeolmbridge Quarry	Lanterdan Oldwit Lane Penfoot Quarry South Petherwin Underwood
Culm Basin (north of Rusey Fault Zone)	Boscastle to Widemouth Bude Coast Duckpool to Furzey Cove	Upton Coast
Variscan Structures (key sites)	Boscastle to Widemouth Bude Coast Cuckoo Rock to Turbot Point Godrevy Head to St Agnes Greystone Quarry Penhale Dunes Pentire Peninsula Porthleven Cliffs East Rosemullion Stepper Point Tintagel Cliffs Trevone Bay Trevose Head and Constantine Bay	Carlyon Bay East Carne Quarries Fishing Cove Lantic Bay Porthcadjack Cove Portnadler Bay Trebrown Upton Coast
Lizard Complex	Baulk Head to Mullion Caerthillian to Kennack Coverack Cove & Dolor Point Coverack to Porthoustock Kennack to Coverack Meneage Coastal Section Mullion Cliff to Predannick Cliff West Lizard	Countybridge Quarry Downas Cove to Pedn Boar Enys Head
Granites and associated rocks (elvans, contact metamorphism)	Aire Point to Carrick Du Belowda Beacon Carn Grey Rock & Quarry Cameron Quarry Cligga Head De Lank Quarries Folly Rocks Luxulyan Quarry Penlee Point Porthcew Porthgwarra to Pordenack Point Roche Rock St Mewan Beacon St Michael's Mount Tregargus Quarries Trelavour Downs Tremearne Par Wheal Martyn	Beacon Hill Carn Brea Flat Marsh Cutting Goonbarrow Helman Tor Newgate Cutting Shallow Water Hill Cutting The Cheese-wring Tremore Quarry East Tremore Quarry West Tresayes Venton Cove Wheal Hazard Wheal Remfry Wicca Pool
Other associated rocks (rhyolite, lamprophyres)	Kingsand to Sandway Point	The Gannel Quarry Withnoe
	Aire Point to Carrick Du Cameron Quarry	Countybridge Quarry Croft Gothal

Geodiversity Audit heading	SSSI sites (statutory)	County Geology Sites (RIGS, non-statutory)
Mineralisation and alteration	Cligga Head Godrevy Head to St Agnes Great Wheal Fortune Hingston Down Quarry & Consols Lidcott Mine Mulberry Downs Quarry Penberthy Croft Mine Penhale Dunes Penlee Quarry Porthgarra to Pordenack St Michael's Mount South Terras Mine Tremearne Par Trevaunance Cove Wheal Alfred Wheal Gorland Wheal Penrose	Geevor Mine Ore Stockpile Gilson's Cove Mine Great Wheal Fortune Gryll's Bunny Harrowbarrow Mine Hobb's Hill Kerriack Cove Kit Hill Lambriggan Mine New Mexico Shaft, Geevor Redmoor Mine Stowe's Section, Wheal Phoenix Trewavas Mine Tye Rocks Wheal Basset Wheal Carpenter Wheal Cock Wheal Drea Wheal Edward Wheal Hazard Wheal Jane East Wheal Johnny Wheal Rose Wheal Uny
Tertiary	St Agnes Beacon Pits St Erth Sand Pits	Crousa Common Luxulyan Valley
Quaternary sediments	Aire Point to Carrick Du Boscawen Castle Down (Tresco), Isles of Scilly Chapel Down (St Martin's), Isles of Scilly Dozmary Pool Gerrans Bay to Camel Cove Godrevy Head to St Agnes Gugh, Isles of Scilly Hawkstor Pit Higher Moors & Porth Hellick Pool (St Mary's), Isles of Scilly Porth Seal (St Martin's), Isles of Scilly Porthleven Cliffs Porthloo, Isles of Scilly Tean, Isles of Scilly. Trebetherick Point Watermill Cove, Isles of Scilly. White Island (off St Martin's), Isles of Scilly	Carlyon Bay East Carlyon Bay West Countybridge Quarry Crowstone Cliff Fistral Bay Praa Sands The Hutches Upton Coast
Geomorphology	Boscawen Eastern Isles, Isles of Scilly Gwithian to Mexico Towans Higher Moors & Porth Hellick Pool (St Mary's), Isles of Scilly Loe Pool Peninnis Head (St Mary's), Isles of Scilly Rame Head and Whitsand Bay Tintagel Cliffs	Bog Inn Duckpool Valley Fowey Estuary Helman Tor Lowland Point to Trevalsoe Luxulyan Valley Maindale The Cheesewring Trebarwith Stream West Lizard Cliffs

2.1.3 County Geology Sites (RIGS)

The Nature Conservancy Council's strategy for earth science conservation also formalised the concept of Regionally Important Geological/Geomorphological Sites (RIGS); "*sites within a county that are considered worthy of protection for their Earth Science importance but are not as protected as SSSIs.*"

RIGS are currently considered the most important places for recognising and thereby protecting important earth science and landscape features outside statutorily protected areas. The term has been widely adopted to describe **locally** and **regionally** important earth science sites.

RIGS are not statutorily designated. If sites are notified to the local planning authority they can be registered as conservation sites and listed in local authorities' development plans, thereby affording a degree of protection through the planning process. This is the system currently operated in Cornwall and the Isles of Scilly.

RIGS are broadly equivalent to County Wildlife Sites and other non-statutory wildlife designations in their level of protection through the planning system. As such, RIGS sites are also commonly referred to as **County Geology Sites** within Cornwall; and this terminology is adopted throughout this Plan.

Although the selection criteria for designating County Geology Sites (or RIGS) are developed locally they follow national guidelines from organisations such as UKRIGS and English Nature. The criteria for selection are based on a site's value in one (or more) of four key areas:

- Educational fieldwork in primary and secondary schools, at undergraduate level and in adult education courses
- Study by both professional and amateur earth scientists. Such sites demonstrate, alone or as part of a network, the geology or geomorphology of an area
- Historical significance in terms of important advances in earth science knowledge
- Aesthetic qualities in the landscape, particularly in relation to promoting public awareness and appreciation of earth sciences

The County Geology Sites (RIGS) system is usually operated at county or unitary authority level, or where regions or metropolitan councils have distinct identities. The various RIGS groups define their own selection criteria and then aim to select representative sites and a variety of other sites (exposure and integrity) which reflect the geodiversity of a region. County Geology Sites (RIGS) may also be identified as areas important for their educational value, research potential and for the wider appreciation of Earth heritage. The Cornwall RIGS Group represents Cornwall and the Isles of Scilly.

Table 1 provides a list of the County Geology Sites (RIGS) designated in Cornwall and the Isles of Scilly, sub-divided into various aspects of geology/geomorphology. Brief descriptions of each of these sites are given in Appendix 4.

2.1.4 Other Nature Conservation Sites

A network of statutory and non-statutory sites, identified or designated for their conservation value, also offer varying degrees of protection for any features of geodiversity interest; although these sites often imply protection rather than providing explicitly for geoconservation in their citations. Landscape features in Cornwall and the Isles of Scilly have, in particular, a raft of conservation designations.

Conservation sites that may potentially contain geodiversity interest include: Areas of Outstanding Natural Beauty (AONB), which include Heritage Coasts; National Nature Reserves (NNR); Special Areas of Conservation and Special Protection Areas (SAC/SPA); biological SSSIs and Areas of Great Landscape Value (AGLV).

The coverage in Cornwall and the Isles of Scilly of many of the different site designations and nature reserves is shown in Table 2, although it should be noted that many of these designations overlap. Figures 1A and 1B, on the following pages, illustrate the location and extent of these designated sites and reserves.

Table 2: Type and coverage of designated sites and nature reserves in Cornwall and the Isles of Scilly.

Designation		Number	Area (ha)
Designated Sites (Statutory):			
International:			
SPA*		3 sites	3,391 ha
SAC*		17 sites	45,668 ha
Ramsar		1 site	401 ha
National:			
National Nature Reserve		3 reserves	2,053 ha
SSSI (total - all sites)		166 sites	21,070 ha
of which	SSSI (geological)	53 sites	914 ha
	SSSI (geological and biological)	34 sites	5235 ha
AONB		14 sites	105,608 ha
Local Nature Reserve		11 sites	426 ha
Conservation Areas		138 areas	3,912 ha
Designated Sites (Non-statutory)			
County Wildlife Sites		627 sites	55,106 ha
County Geology Sites (RIGS)		91 sites	1,621 ha
AGLV		26 sites	87,585 ha
Nature Reserves/Ownership			
The National Trust ownership		49 property units	9,924 ha
CWT Reserves		54 reserves	1,919 ha
Woodland Trust Reserves		25 reserves	264 ha
RSPB Reserves		2 reserves	181 ha

* Tamar SPA/SAC area has been adjusted to exclude the part of it that is in Devon. Former AGSV and AGHV designations have been replaced by AGLV and other key site and area designations. Planning implications of the various designations are discussed in Chapter 4.

Figure 1A: Location of geological or geomorphological related designated sites in Cornwall and the Isles of Scilly.

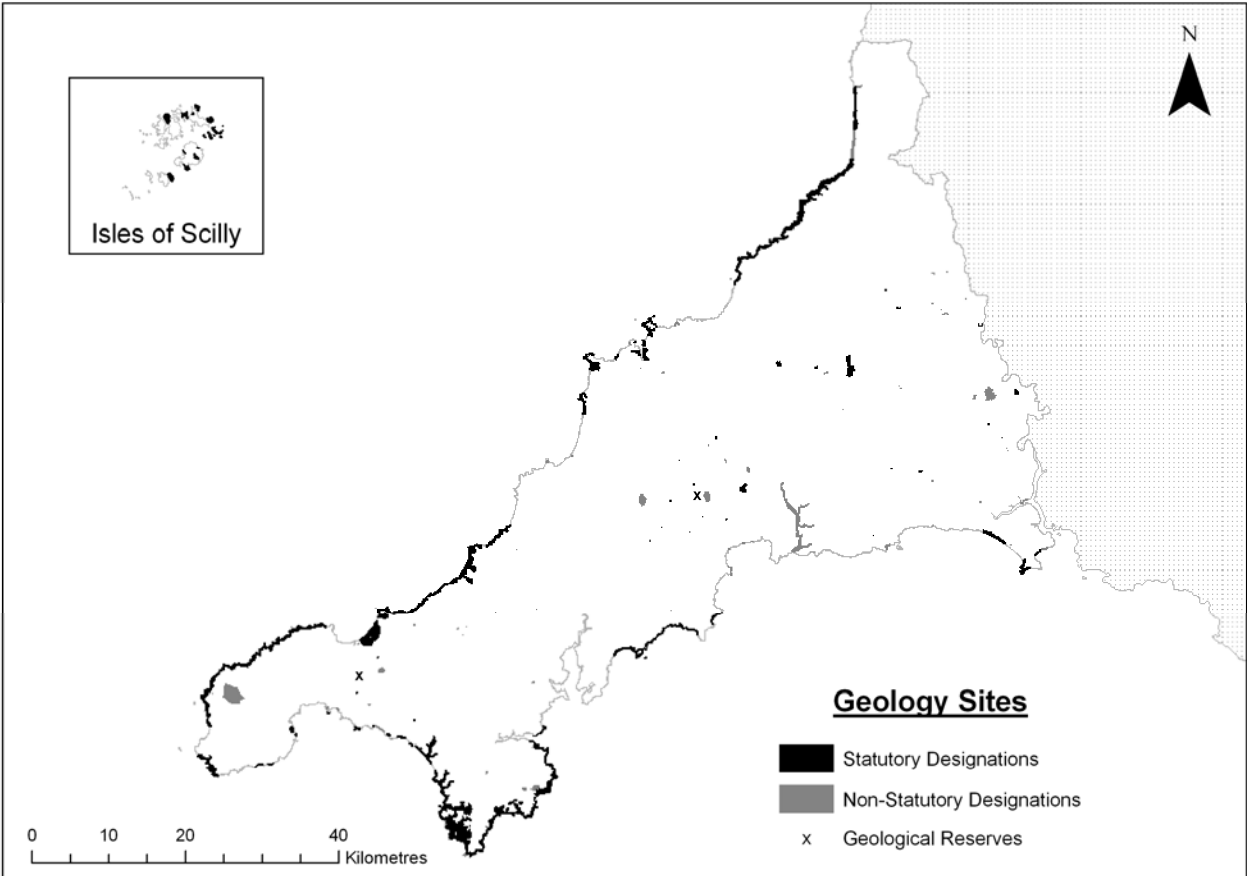


Figure 1B: Location of other (non-geological) nature or landscape conservation sites in Cornwall and the Isles of Scilly.

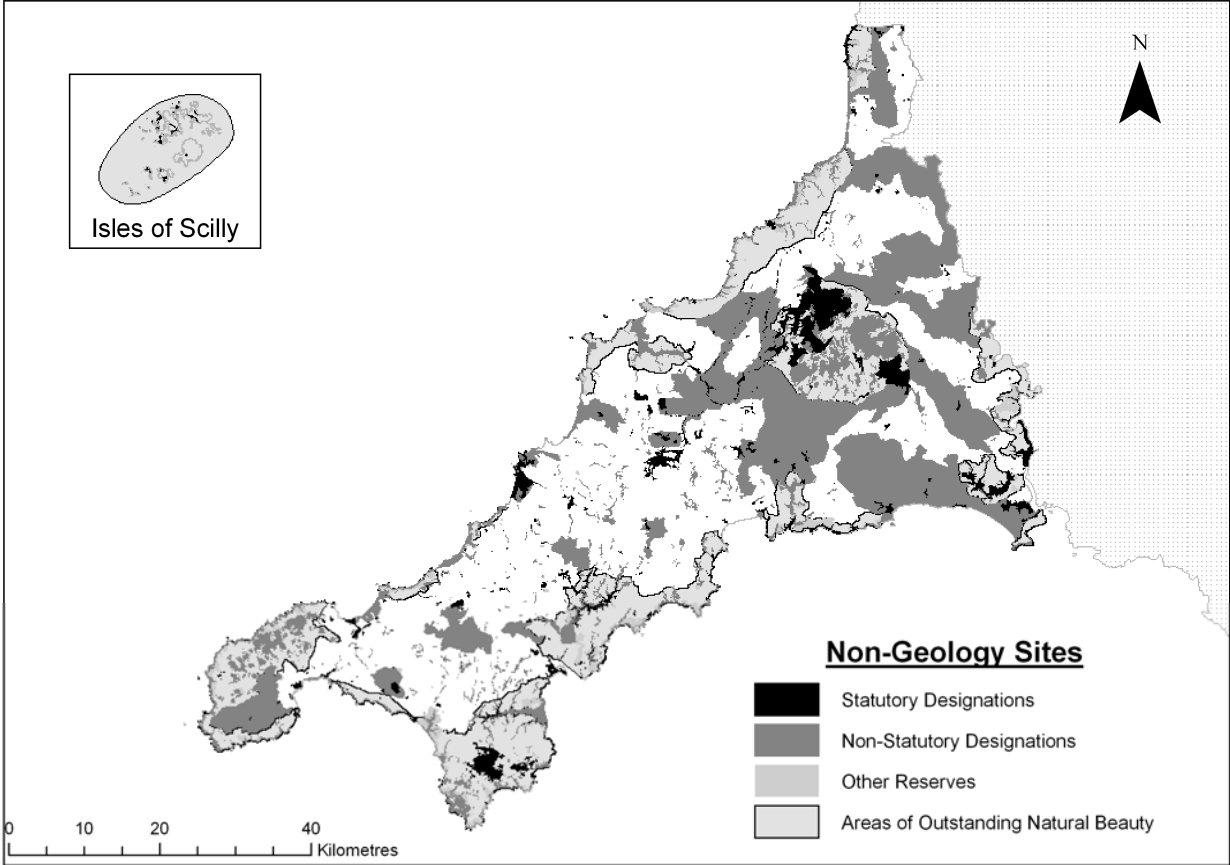


Figure 1A maps out the locations of all the geologically related designated sites in Cornwall and the Isles of Scilly; both statutory (SSSIs) and non-statutory (County Geology Sites); together with the locations of the two Geological Nature Reserves in Cornwall (refer to section 4.4).

Figure 1B maps out the locations of all non-geology related nature conservation sites in Cornwall and the Isles of Scilly (statutory and non-statutory) together with other nature reserves. Also shown on this map are the boundaries of the Cornwall AONB and the Isles of Scilly AONB and Areas of Great Landscape Value (AGLV). These designations afford protection to the overall character of the landscape rather than to any individual geodiversity features.

The extensive coverage of land designated for some form of nature or landscape conservation (Figure 1B) emphasises the high quality and value afforded to the natural environment in both Cornwall and the Isles of Scilly. In comparison, however, the coverage of geology-related conservation sites is substantially smaller in its extent (Figure 1A).

Whilst non-geology site designations imply safe ownership in terms of, for example, gross changes through built development, they do not imply that there will be appropriate management to conserve or protect any geodiversity interest(s) that may be present. Where these designations refer to protection of the general character of an area rather than individual features, the attitudes and policies of landowners and local planning authorities become particularly important.

There is a need to increase geology-related site designations and/or to ensure policies for nature conservation sites and reserves take account of the geodiversity interest.

2.2 Geological History

Cornwall and the Isles of Scilly's geology is related to plate tectonic movements over the last 500 million years, which have changed the geographical position of Cornwall from some 60° south of the equator to its present location in the northern hemisphere (50°N). From around 400 million years ago, for a period of some 130 million years, the geology in Cornwall, located on the margins of an ocean, evolved in a completely different manner to the rest of Britain.

Many of the distinctive rocks of Cornwall and the Isles of Scilly were formed in a zone where the movement of tectonic plates progressively opened and then closed sedimentary basins, as the Earth's crust was firstly pulled apart (rifted) to form a new ocean and then pushed back again. While open, these sedimentary basins were the site of large scale deposition of sediments and volcanic material; their closure piled up these pre-existing rocks, compressing and deforming them as part of a mountain-building event.

The oldest and most extensive sedimentary rocks in Cornwall were deposited in five major east-west trending basins, defined by major fault boundaries. The most southerly basin, known as the Gramscatho Basin, was on the margin of a major oceanic region. Remnants of the ocean floor were later thrust up and onto the sedimentary rocks of this basin to form the Lizard Complex. Four other basins; known from south to north as the Looe Basin, Trevone-South Devon Basin, Tavy Basin and Culm Basin; developed in a series of northwards extensions. Figure 2 is a simplified geological map of Cornwall which illustrates the relative position of these sedimentary basins.

The rifting of the crust also allowed the generation of volcanic magmas, which erupted or were emplaced at shallow depths, within the sedimentary sequences. Variations in the locations and types of sediment supplied to each of the major basins, and differences in their environment of deposition, account for the variations seen in these sedimentary rocks in Cornwall.

As the tectonic regime changed to one of compression (closure of the ocean), collision-related deformation progressed northward as part of a relatively slow and continuous sequence. In each basin in turn, the sediments were piled up, thrust over each other and deformed (folded and faulted) until movement on major faults was no longer possible and the pressure could be transmitted to the next basin. This was known as the Variscan orogeny. Sedimentation therefore continued in basins to the north while basins to the south were being deformed.

During these deformation events, the large scale action of both heat and pressure caused the rocks in these former basins to change to their metamorphic equivalents (a process known as regional metamorphism), creating new minerals within them and generating new textures. Regional metamorphism in Cornwall and the Isles of Scilly was under conditions of relatively moderate temperature, low pressure and high stress; giving rise to a relatively low grade of metamorphism and leaving many rocks seemingly unchanged when observed in the field. More obvious signs of the deformation events come from structures such as faults and folds which dislocate and disrupt the rock mass. One distinctive characteristic of Cornwall's metamorphic legacy is, however, the widespread presence of slates formed from the original mudstone rocks.

Subsequent relaxation of these tectonic forces released pressures deep in the Earth's crust and triggered melting of rocks and the generation of granite magmas. These magmas were then emplaced at higher levels in the crust to form the Cornubian batholith. Subsequent erosion of the overlying rocks has exposed a series of granite plutons; the locations of the major plutons in Cornwall are shown on Figure 2. Granite also forms the bedrock to the Isles of Scilly.

Prominent fracture systems were developed and/or reactivated in both the granite and the surrounding country rocks and provided structural pathways for the migration of hydrothermal fluids. These fluids contained tin (Sn), copper (Cu) and other metal species which were deposited in the fractures and wall-rocks to form mineral bearing lodes.

This mineralisation formed around 270 million years ago and for most of the rest of its geological history, Cornwall and the Isles of Scilly formed a major land mass that was subjected to uplift, deep weathering and erosion under desert to sub-tropical conditions as the continent drifted northwards. Deep chemical weathering of some upper parts of the granite batholith further altered many of the feldspar minerals in the granite, creating extensive areas of china clay alteration (kaolinisation).

Conditions onshore eventually became more temperate and minor marine incursions led to localised deposition of some shallow-water sediments. Weathering and erosion continued to dominate, however, and almost all the rocks formed in the last 270 million years have been lost from Cornwall and the Isles of Scilly's geological record (at least onshore).

The last two million years (called the Quaternary) has seen major climate fluctuations and associated changes in sea-levels. These changes have had a marked effect on the sub-surface deposits and landforms in Cornwall and the Isles of Scilly but the Quaternary sequences found are very fragmentary. At least one of the major cold periods produced ice sheets close enough to the mainland to produce periglacial (tundra-like) conditions in Cornwall and may have brought glacial activity to the Isles of Scilly.

The major sea-level rise after the last glacial period had a profound effect on the geomorphology and landscape seen today; controlling development of Cornwall's rias (flooded valleys), the Isles of Scilly archipelago, associated coastal geomorphological features (sand dunes, marshes) and the current rates of erosion and sedimentation.

Footnote

Strictly speaking, the majority of Devonian rocks we see in Cornwall today are meta-sediments i.e. sedimentary rocks that have been metamorphosed, or meta-basites, metamorphosed basic igneous rocks. The metamorphism experienced, however, is generally of low grade and many rock types retain their internal structures. These rocks are commonly referred to in the literature and in this report by their sedimentary and igneous names, (sandstones, conglomerates, dolerites etc.). The exception is where mudstones have been altered and new minerals grown in alignment to give a well-defined, slaty cleavage. In this report these rocks are referred to as slates.

To add further to the confusion there are a plethora of local terms for some rock types and these are explained where first encountered in the text. The terminology Ma is used to indicate the age of rocks in millions of years before present i.e. most of our Devonian age sediments are 345-395 million years old, shown here as 345-395Ma. Definitions for many of the geological terms can be found in the Glossary.

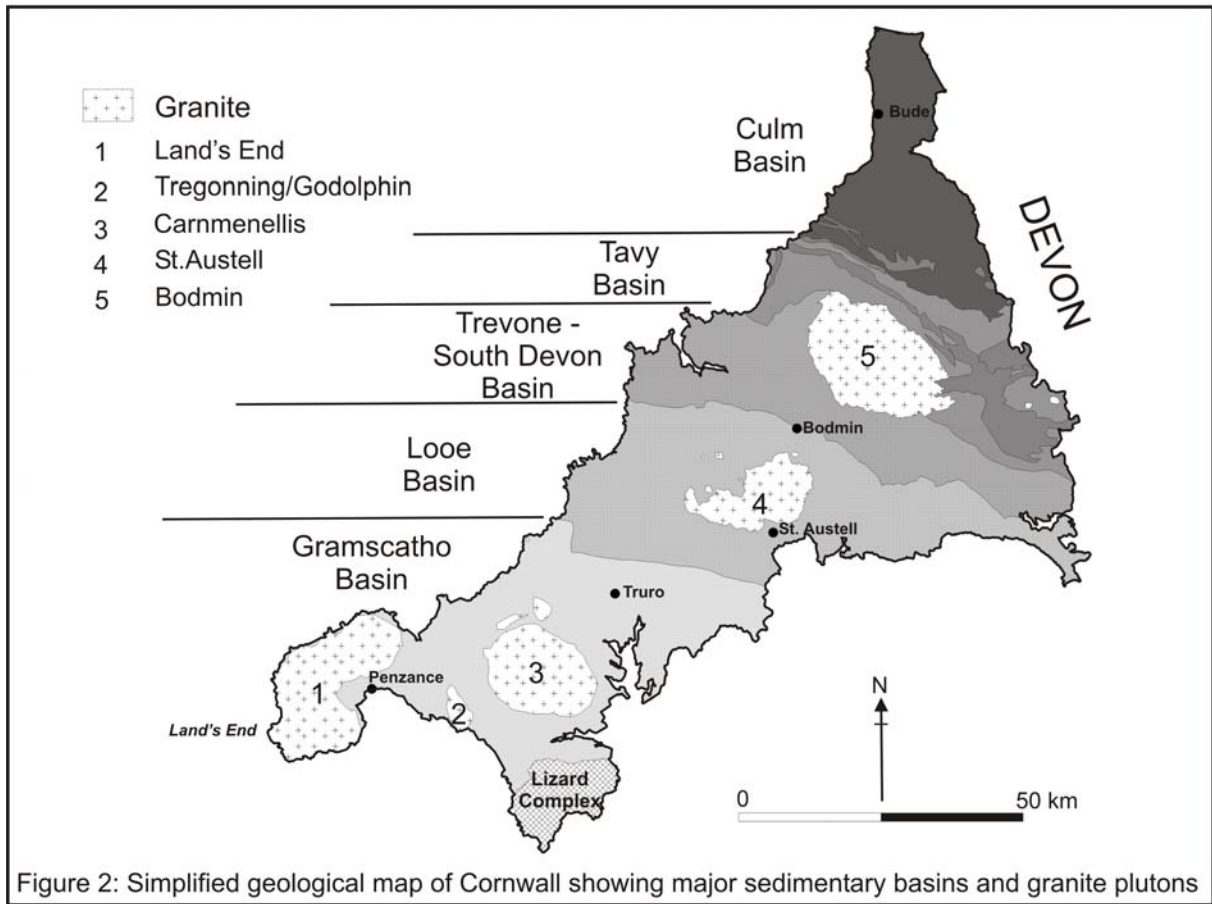


Figure 2: Simplified geological map of Cornwall showing major sedimentary basins and granite plutons

2.3 Sedimentary Basins

2.3.1 Pre-Devonian Basement

Most of the rocks in Cornwall are deposited on top of crystalline basement, a fragment of continental crust that formed 500Ma. Cornwall today contains only very limited or indirect evidence for this crystalline basement.

Three SSSIs and one County Geology Site contain exposures where evidence of these basement rocks can be seen.

No major omissions occur in the coverage of Cornwall and the Isles of Scilly's basement rocks by existing conservation designations.

2.3.2 Looe Basin

The Lower Devonian rocks (up to 395Ma) of the Looe Basin are the oldest sedimentary rocks exposed in Cornwall. The sediments occur in successions of mudstones, siltstones and sandstones with occasional thin limestone beds. Sedimentation was accompanied by volcanic and intrusive igneous activity of basic composition, giving rise to the greenstones found today. Greenstone is the local term for metamorphosed igneous rocks (dolerites and basalts).

Three SSSIs and eleven County Geology Sites have been designated as important exposure and/or integrity sites for the geology of the Looe Basin.

No major omissions occur in the coverage of designated exposure and integrity sites for Cornwall's Lower Devonian rocks (refer also to section 2.3.7).

2.3.3 Gramscatho Basin

The Gramscatho Basin represents one of the most complex regions in Cornwall and the Isles of Scilly's hard-rock geodiversity. Evidence suggests it represents an oceanic basin which received thick deposits of mudrocks, sandstones and conglomerates from the erosion of rocks to the south; as well as some carbonate rock fragments, turbidites and cherts. Submarine volcanism was extensive with lavas and intrusive sills and dykes, now metamorphosed to greenstones. There is considerable structural complexity within the basin.

Fourteen SSSIs and eight County Geology Sites have been designated as important exposure and/or integrity sites for the geology of the Gramscatho Basin.

There would appear to be no major omissions in the coverage of designated exposure and integrity sites for the main lithologies and structural units found within the Gramscatho Basin.

The complexity of the stratigraphy and structural history of the Gramscatho Basin has made it difficult, however, to identify and audit the status of all key units within this initial GAP. Further consultation and review is required to ensure that key aspects have indeed been recognised and afforded some degree of geoconservation designation.

2.3.4 Trevone-South Devon Basin

The Trevone-South Devon basin was mainly filled in East Cornwall with mudstones and siltstones, together with some sandstone units and basalt lavas and tuffs (now greenstones). In West Cornwall, dark grey to black slates with interlaminated siltstones dominate the succession but there are also important formations of sandstones, slaty mudstones and siltstones; fossil-rich limestone beds and conglomerates. Dolerite (greenstone) lavas, sills and dykes also occur, as does a later generation of volcanic rocks (the Pentire Volcanic Formation), which is a spectacular series of basic tuffs, volcanic sediments and basalt lava flows and pillow lavas.

Ten SSSIs and seven County Geology Sites have been designated as important exposure and/or integrity sites for the geology of the Trevone-South Devon Basin.

No major omissions occur in the coverage of designated exposure and integrity sites for the Trevone-South Devon Basin, although sites in East Cornwall are less well represented compared to the exposures on the North Cornwall coast.

2.3.5 Tavy Basin

The sediments found in the south-eastern part of the Tavy basin are largely slaty mudstones and siltstone, with thin sandstone beds. Similar slaty mudstone-dominated formations continue westwards and flank the north-east side of Bodmin Moor. Complex limestone and slate sequences associated with shallowing depths (rises) in the basin give rise to a number of Devonian age (c. 350Ma) formations which are only locally developed. Many of the limestone dominated successions are rich in fossils.

Slightly younger (300-345Ma) rocks (Carboniferous) that appear in the Tavy Basin have a wide variety of types: black shales and slaty mudstones, turbidite sandstones, cherts and limestones together with volcanic tuffs and lavas. The tectonic and structural setting of these rocks in east Cornwall is extremely complex.

In the western half of the Tavy basin the succession is less complicated, with extensive exposures and thicknesses of slates (including Delabole Slate) and basic tuffs, volcanic-derived sediments and lavas (Tintagel Volcanic Formation).

Seven SSSIs and five County Geology Sites have been designated as important exposure and/or integrity sites for the geology of the Tavy Basin.

Outside of coastal exposures on the north coast, many of the sediments and formations found in the Tavy Basin are not well represented in terms of conservation sites, especially those to the east of the county. Coverage is particularly patchy in the Devonian and Lower Carboniferous rocks of the basinal and rise facies found between the east and north-eastern flanks of Bodmin Moor and the River Tamar.

A number of the geological features under-represented in Cornwall appear to have been identified in the recent Geodiversity Audit for the Tamar and Tavy

rivers (Page, 2004) in West Devon. A further review of these, in collaboration with the Devon RIGS Group, may indicate that some of the best sites for conservation in this basin lie geographically in Devon.

Further west, in the area from Camelford to Boscastle, the situation is greatly improved and no major omissions are apparent in the coverage of exposure and integrity sites for the key sedimentary and volcanic formations.

2.3.6 Culm Basin

The Culm Basin developed in the Carboniferous period (280-345Ma) and for the purposes of this Audit, the sedimentary succession in the Culm Basin is taken to be those sediments found predominantly northwards of the Rusey Fault Zone, from Boscastle to Bude in North Cornwall. The oldest of these rocks are slates with minor siltstone, limestone and sandstone beds; and well bedded cherts and mudstones. The younger sediments consist almost entirely of interbedded sandstones and shales in which spectacular folds have developed, now exposed to dramatic effect along the North Cornwall coast.

Three SSSIs and one County Geology Site provide almost continuous coverage of the Carboniferous succession exposed along the North Cornwall coast. There are no designated sites inland.

No major omissions occur in the coverage of designated exposure and integrity sites for the Culm Basin successions and Rusey Fault Zone in Cornwall, although these are dominated by coastal sites as inland exposure is poor.

2.3.7 Additional Findings

The descriptions used in many of the SSSI and County Geology Site (RIGS) citation sheets do not reflect changes to lithostratigraphic and tectonic unit names and interpretations. This is a recurrent theme throughout all sections of the Audit.

The major faults and lineaments defining the boundaries and sub-divisions of a number of the sedimentary basins in Cornwall are not specifically covered in site designations. For example, there is no provision for conservation of the coastal exposures of the Start-Perranporth Line, which defines the boundary between the Looe and Gramscatho Basins. These features often represent reactivation of much earlier lineaments and are important features controlling Cornwall's geological evolution. Further review and assessment is required to ensure that key aspects of these early structural features have been recognised and afforded some degree of protection.

For all of Cornwall's sedimentary successions, it has not yet been determined if representative integrity sites and/or publicly accessible collections exist for the fossil assemblages present in some of the formations.

Aspects of the geology of East Cornwall which are poorly or under-represented in terms of conservation sites should be reviewed in co-operation with the Devon RIGS Group. Collaboration on the identification of target

features would allow the best sites to be nominated from a geodiversity point of view, irrespective of their geographical location.

2.4 Variscan Structures, Metamorphism and the Lizard Complex

2.4.1 Variscan Structures

The characteristics of the various sedimentary basins established in the Devonian-Carboniferous controlled the subsequent patterns of deformation experienced during the Variscan orogeny. The structures seen throughout Cornwall are therefore as complex and diverse as the basins themselves, although on the broad scale there are similarities in their major structural elements.

Each basin shows evidence of (several phases of) folding and thrust faulting relating to the Variscan orogeny, followed by folds and reverse faults relating to later extension, often accompanied by reactivation of the major thrust faults. A further phase of extensional structures appears to have accompanied granite emplacement. Extensional movement (largely faulting) continued in the Mesozoic and adds to the complexity of structures seen in Cornwall, but these are unrelated to the Variscan orogeny.

Thirteen SSSIs and eight County Geology Sites have been specifically designated as important exposure and/or integrity sites for the study and interpretation of structures relating to the Variscan orogeny.

In addition Variscan structures are present throughout many of the remaining sites listed in Table 1 for the various Devonian-Carboniferous sedimentary basins.

No major omissions have been identified by a preliminary assessment of the designated sites covering the structural geology of the Variscan orogeny. The sheer complexity of the range of structures and deformation chronology within each basin has, however, made it difficult to identify and audit the status of all key units within this GAP.

Further consultation and review is required to ensure that all key aspects of the Variscan structural geology have been recognised and afforded some degree of geoconservation designation.

2.4.2 Regional Metamorphism

During these deformation events, the large scale action of both heat and pressure caused the rocks in these former basins to change to their metamorphic equivalents creating new minerals within them and generating new textures. The relatively low grade of metamorphism left many rocks seemingly unchanged when observed in the field, although one distinctive feature of the regional metamorphism is the widespread presence of slates formed from former mudstone rocks.

The descriptions within site designations for exposure and integrity sites in Devonian-Carboniferous basins are not consistent in their reference to specific lithological changes during regional metamorphism; but a review of all these

sites found no major omissions in terms of representative examples of the regional metamorphic effects on sediments and igneous rocks in Cornwall.

2.4.3 Lizard Complex

Much of the Lizard Complex is thought to have formed as part of the floor to the Gramscatho ocean basin, and during closure of the Gramscatho Basin, part of the ocean floor of the basin became detached and was thrust up and over the sediments lying to the north to form the Lizard Complex.

The Lizard Complex consists of two main tectonic units. The eastern unit consists of an ophiolite sequence of intrusive to extrusive, basic–ultrabasic, igneous rocks (peridotite, gabbro and a sheeted dolerite dyke complex). The peridotite has been variably altered to give rise to the rich play of colours associated with Lizard serpentine. The boundary between the peridotite and gabbro provides exposure of the Mohorovicic Discontinuity, more commonly known as the base of the Earth's crust i.e. the contact between crustal rocks and mantle rocks. In the western unit the peridotite is thrust over amphibolites and metasediments (schists) and a series of mixed acid to basic igneous rocks intrude the peridotite, and have now been metamorphosed to gneiss.

The Lizard Complex is one of considerable national significance for its geodiversity and this has been recognised in the designation of eight SSSIs and three County Geology Sites; which either lie within the complex itself and/or explore its geological relationship with, and emplacement into, the Devonian metasediments of the Gramscatho Basin.

Excellent protection of the geodiversity of the Lizard Complex is afforded by the existing SSSI and County Geology Site (RIGS) designations (both exposure and integrity sites).

Many of the SSSIs are designated for both geological and biological significance and the Lizard Complex could therefore provide an excellent case study to further explore and promote the links between geodiversity and biodiversity.

2.5 Granites and Mineralisation

2.5.1 Granites

The Cornubian granite batholith extends from Dartmoor to the Isles of Scilly, a distance of some 200 km. Five of the six major plutons outcrop in Cornwall and the Isles of Scilly: Bodmin Moor, St Austell, Carnmenellis (which includes the Carn Marth and Carn Brea exposures), Land's End and the Isles of Scilly. There are numerous smaller and contemporaneous satellite stocks.

The thickness of the batholith has been estimated at 10 km and is the result of multiple intrusions over a period from 295-270Ma. The granites are not uniform in composition, texture, or grain size and show considerable variability even within a single pluton. Petrographically three main granite types are recognized: biotite granites, tourmaline granites and topaz granites. Biotite granites predominate,

forming all or part of every pluton, the St Austell pluton is unique in exhibiting all three granite types.

Pegmatites and aplites were formed in the roof zones of the various granite intrusions and the intrusions themselves often contain xenoliths of igneous rocks and metasediments.

The Cornubian Batholith is one of considerable national significance for its geodiversity and this has been recognised in the designation of eighteen SSSIs, which either lie within the various granite plutons and smaller stocks themselves and/or explore their contact relationships with, and emplacement into, the various sediments and greenstones in Cornwall. These sites are well supported and complemented by fifteen County Geology Sites.

Identification and designation of a representative selection of exposure and integrity sites for granites in Cornwall has largely been achieved, with no major omissions. The Carnmenellis granite pluton is the only exception and is considered to be under-represented in conservation terms.

The solid geology of the Isles of Scilly is dominated by coarse-grained, biotite granite and although the nine SSSIs designated on the islands are recognised for their value to the Quaternary of South-West England, there is no specific recognition, in conservation terms, of the geodiversity value of the Isles of Scilly granite(s). Designated sites are therefore required for the Isles of Scilly pluton.

2.5.2 Associated Rocks

Rhyolite dykes and sheets (known locally as elvans), postdate the main granite intrusions but are of similar composition and are believed to be genetically related. Evidence of volcanic activity associated with the granites is limited to the Kingsand rhyolite.

Contacts between the granite and country rocks are often sharp and a contact metamorphic aureole extends for some 0.5-3 km from the major plutons and stocks. Various hornfels, calc-flintas and spotted slate units are reported. Chemical alteration involving extensive fluid-rock interactions is also common in the aureoles, most notably with the development of tourmaline.

A number of minette-type lamprophyre dykes and sills are found in Cornwall; they were emplaced either just before or at the onset of granite magmatism; but are not genetically related.

The associated igneous and contact metamorphic features of the granite batholith (pegmatite and aplite development, contact metamorphism, elvan dykes) are covered by many of the same sites discussed in section 2.5.1 and there are no major omissions in the coverage provided by designated sites.

Intrusions and volcanic activity associated with the Kingsand rhyolite are covered by the designations of one SSSI and one County Geology Site; no further conservation sites are considered necessary.

There is only a single County Geology Site providing a designated exposure site for lamprophyres and these rocks are under-represented in terms of conservation sites.

2.5.3 Mineralisation and Alteration

The Cornubian Orefield represents an extensive, complex system of hydrothermal mineralisation in several, world-class metalliferous mining districts. Mineralisation and alteration is one of the pre-eminent features of Cornwall and the Isles of Scilly's geodiversity, not least because of the cultural heritage and industrial archaeology associated with its commercial exploitation.

The extent and styles of mineralisation, and of mineral species and textures, found across the Cornubian Orefield are of **international significance**. The majority, but not all, of the mineral deposits and mineralisation found in Cornwall and the Isles of Scilly are related to the movement of hydrothermal fluids (hot, aqueous fluids) through fracture systems and are associated with the emplacement of the granite batholith. The timing of this mineralisation is 286-260Ma (Late Carboniferous to Permian) i.e. within some 10Ma of the emplacement of the various granite batholiths in the upper crust.

Examples of pre-granite mineralisation include metal-enriched horizons, bedded manganese ores and iron-rich veins in some of the sedimentary basins. The Wadebridge district in North Cornwall contains numerous veins that were exploited by small mines for lead and antimony, with some veins also carrying gold.

Greisen-related mineralisation gives rise to a highly distinctive style of mineralisation. Sheeted vein complexes and zones of quartz veining (floors) occur with wolframite and cassiterite, the main tin (Sn) ore. Wall-rock alteration in sheeted veins hosted by granite is particularly distinctive and produces an alteration halo of quartz and muscovite. Pegmatite bodies are largely devoid of economic mineralisation with only traces of ore minerals. Development of tourmaline veinlets, veins and associated brecciation occurs in many phases in and around all the granite plutons in South-West England.

The main stage of mineralisation in Cornwall is structurally controlled, forming veins and lodes (zones of veins and wall-rock alteration), dominantly east-north-east in trend and steeply dipping. *Tourmaline breccias/veins* contain brecciated assemblages of tourmaline, quartz and wall-rock fragments; cassiterite is usually the only economic phase present. *Chlorite-bearing, polymetallic lodes* contain complex assemblages of Sn-Cu-Zn-As (+/- Fe, Pb, F) minerals, mainly sulphides. Styles of mineralisation are highly variable, with evidence of repeated reactivation/remobilisation.

Lodes exposed near surface are often extensively weathered to leave a gossan (a mass of various iron oxides/ hydroxides plus quartz) at surface and an oxide zone beneath this, where the original sulphide minerals were oxidised. An immense range of secondary oxides, sulphates, arsenates, carbonates and native metals have been reported, some of them unique to Cornwall. The eroded remnants of those mineral deposits containing cassiterite formed alluvial (or placer) deposits which were the most important sources of tin ore for centuries.

Cross-course mineralisation is significantly later in age (c.200Ma) than main stage mineralisation and is largely restricted to quartz, Fe-oxides and clay filled, north-south fractures and faults. Economically significant assemblages occur in some regions, for example the Pb-Ag-Zn mineralisation in east Cornwall.

Nineteen SSSIs and twenty-six County Geology Site designations relate to the principal elements of mineralisation and alteration seen in the Cornubian batholith. It would appear that a representative selection of exposure and integrity sites has been designated for conservation purposes, but there are omissions.

Designated sites are particularly focused on mineral species rather than styles of mineralisation, although mineral type localities are highly important as reference sites. Consequently, examples of all the various styles of mineralisation and alteration seen in the Cornubian orefield appear to be under-represented in current conservation terms. Most notably, there is no specific coverage of alluvial (placer) tin deposits or in-situ gossan and oxide zones. Further work is required to complete the assessment of this aspect of geodiversity in Cornwall.

Additional coverage of Cornwall's mineralisation and alteration is also provided by the exposure sites seen in many of the active quarries in the county. Furthermore, although there is little surface expression, many styles of mineralisation and mineral species are associated with the Metalliferous Mineral Consultation Areas in the Local Minerals Plan (see chapter 4).

South Crofty would make an excellent County Geology Site (RIGS) for its mining geology and educational value.

2.5.4 Mineral Specimens

Over 470 mineral species have been recorded in Cornwall and the Isles of Scilly of which 37 were first recorded in Cornwall and are type localities where a new mineral species was first discovered and recorded. Ten mineral species are believed to be unique to the county.

As indicated in section 2.5.3, numerous SSSIs and County Geology Sites have been designated on the basis of their rare and distinct mineralogy, often now only seen in material left on mine dumps.

The mineral collections of the Royal Cornwall Museum, Camborne School of Mines and Royal Geological Society of Cornwall provide a superb reference and educational resource in support of the key mineral species from Cornwall and the Isles of Scilly. This Audit has not established, however, whether the various museum and academic collections contain a comprehensive record of all the key (unique and/or rare) mineral species in Cornwall.

2.6 More Recent Sediments

2.6.1 Offshore Geology

The record of geological events for an immense period of time in Cornwall and the Isles of Scilly's natural history (from 260-65Ma, the whole of the Mesozoic era) is now only found offshore, in the remnants of major sedimentary basins and extremely limited island exposures such as the Wolf Rock (a volcanic rock).

There is little precedent for conserving offshore geology in the UK and no action is considered necessary at this stage. Previous attempts to designate the Wolf Rock ran into objections from the landowners (Trinity House).

2.6.2 Tertiary

There are no major exposures or large basins of Tertiary age (from 2-65Ma) rocks in Cornwall. Tertiary sediments occur only in small basins or as isolated outliers of very limited extent. The latter appear to be erosional relics of sedimentary sheets that were once more widespread. Deep weathering and erosion processes are thought to have continued from the late Mesozoic period and probably covered much of Cornwall in a Tertiary weathering mantle (now eroded away).

The Dutson Basin contains clays, silts and lignite-rich clays; the St Agnes outlier contains clays and sands with iron-cemented horizons and the sands and clays of the St Erth Beds contain a prolific and diverse fossil fauna that provide information on palaeoclimates just before the onset of the Ice Age. Important outliers of gravels, sands and clays also occur on the Lizard peninsula (Crousa Gravels and Polcrebo Gravels – although the latter are very poorly exposed).

The known and dated exposures of Tertiary sediments in Cornwall provide important information on palaeoclimates and landscape evolution and are all of such rarity and limited extent for each to be considered as an integrity site for conservation. SSSI designations cover the St Agnes outlier and St Erth Beds, the latter is also the site of one of the first Geological Nature Reserves in Cornwall. There is one County Geology Site designation for the Crousa Gravels.

The SSSI boundaries at St Erth do not, however, cover all the important geodiversity features and the Dutson Formation and Polcrebo Gravels are not afforded any conservation status at present. These and other documented Tertiary sediments are of regional (county) significance and consideration should be given to their designation as County Geology Sites.

2.6.3 Quaternary Sediments

Throughout Britain the last two million years (Quaternary) has seen major climate fluctuations and associated changes in sea-levels. The Quaternary sequences found are very fragmentary and successions are difficult to tie together, the most complete succession has been identified in the Isles of Scilly. Raised beach deposits are abundant and submerged forests are preserved in a number of intertidal zones around Cornwall.

Slope deposits formed from periglacial processes are widespread in Cornwall and the Isles of Scilly and have been given the generic term Head. The exact nature of the Head found in any one location depends on the underlying bedrock, regolith and topography. Loess, or wind blown silt, is much less extensively preserved, the principal deposit being the Lizard Loess, although the original coverage would have been widespread and may have made a significant contribution to the development of the region's soils.

The maximum glacial limit reached as far south as the north coast of the Isles of Scilly, eroding the rocks over which it passed and depositing glacial tills (sand, gravel and clay) at its limits. The result of granite weathering, erosion and periglacial activity on the islands formed angular Head material and sand which is often blown up into small ridges and dunes.

There are nine SSSIs designated on the Isles of Scilly for their value to the geological conservation of the Pleistocene (Quaternary) of South-West England; and there are no major omissions in the designation of exposure or integrity sites on the Isles.

In Cornwall there are eight SSSIs and eight County Geology Sites designated as important exposure and/or integrity sites for their Quaternary sediments. As such, identification and recognition of at least a representative selection of sites has been achieved in conservation terms.

Although a sufficient number of representative exposure sites of many features of the Quaternary such as raised beach and Head deposits have been designated for geoconservation purposes, it is less clear if all the particularly rare or scientifically important integrity sites have been similarly recognised. In particular it is not clear if the conservation of features is keeping pace with the high level of research into the Quaternary that is currently being undertaken throughout the South-West, and which continues to identify new successions.

In addition other features, such as submerged forests and frost structures in the Head, provide important information on the development of climatic conditions and changes in sea-level throughout the Quaternary. Consideration should be given to the designation of the best examples of these as County Geology Sites, while the recording and notification of other sites to Cornwall RIGS Group or ERCCIS is to be encouraged.

Further assessment of the conservation status of the Quaternary sediments and related features in Cornwall is therefore required.

2.7 Soils, Landscape and Geomorphology

2.7.1 Soils

Soil classification runs on a hierarchal structure of soil series, soil sub-groups, soil groups and major soil groups.

The soil groups of Cornwall and the Isles of Scilly are dominated by brown podzolic soils (which form on granitic regolith) and brown earths (slaty regolith and regolith from basic igneous rocks-greenstones). There are also extensive areas of rankers in the lower parts of major drainage catchments, stagnopodzols (peaty topsoil, common in upland areas of main granite plutons), stagnogley soils (peridotite-serpentinite of Lizard Complex) and of stagnohumic gley soils and non-calcareous pelosols (on sandstones and shales of North Cornwall).

Soil groups of more limited distribution include sand pararendzinas and brown calcareous earths (developed on calcareous dune sand substrates), argillic and paleo-argillic brown earths (Lizard Complex), podzols and raw peat soils (granite regolith) and man-made humus and disturbed soils. These are of importance in localised areas because of the highly specialised habitats and wildlife they support.

Although bedrock or regolith composition has clearly influenced soil development in Cornwall and the Isles of Scilly, many soils may not have been derived directly from the underlying bedrock. There is evidence to suggest that soils have also been derived from a significant input of loess material in the closing stages of the last glacial period of the Ice Age.

The number and distribution of individual soil series and soil sub-groups is extremely diverse and, due to time constraints, this Audit has concentrated on the soil groups.

A representative number of exposure sites for the various soil groups found in Cornwall and the Isles of Scilly do currently lie within the boundaries of designated conservation sites (SSSIs and County Geology Sites). A preliminary analysis also suggests that this is true for the common soil sub-groups.

The actual conservation status of soils within these areas is, however, less clear. A large number of SSSI citations (particularly for biological sites) mention specific soil groups and sub-groups in their descriptions but the actual level of protection this affords them remains to be clarified.

It has not been possible to assess whether integrity sites for rare soil sub-groups and soil series have been adequately recognised; nor is it clear what mechanisms are in place for designating soils for geological conservation, either nationally or regionally. No soils are covered by County Geology Site (RIGS) designations in Cornwall and the Isles of Scilly.

Future conservation work in relation to soils should be informed by the findings of The First Soil Action Plan for England (DEFRA, 2004).

2.7.2 Landscape and Geomorphology

Compared with regions of a similar size, Cornwall and the Isles of Scilly has a high number of nationally defined character areas; indicative of the rich diversity of landscapes evident in the region. Landscape character areas are The Culm, Bodmin Moor, Cornish Killas, Hensbarrow, Carnmenellis, West Penwith, The Lizard, Isles of Scilly and the coastal sections Start Point to Land's End and Land's End to Minehead.

Within these character areas there are a diverse range of landforms and processes present, dominated inland by fluvial (river) geomorphology, weathering and erosion of the granite tors and periglacial landforms and structures. Spectacular examples of coastal geomorphological features exist throughout Cornwall and the Isles of Scilly and the coastal regions are also notable for evidence of mass movement (landslide) processes.

Blown sand deposits of Holocene age occur in numerous locations and are of considerable, in some cases national, biodiversity importance because of the habitats they provide.

The coastal geomorphology and landforms of the Isles of Scilly, are of national and international scientific value. The archipelago of over 200 low-lying granite islands and rocks, often tied together with sand and gravel bars, is the only archipelago in England.

Many geomorphological processes and their associated landforms and deposits, such as those found in rivers (fluvial) and on coasts, are by their nature dynamic and relatively short-lived, and their conservation may need to be limited in timescale if surface processes are to be allowed to develop naturally.

Geomorphological processes have an intrinsic value in dynamically shaping the landscape and there is a need to conserve this dynamism and to view any potential loss of individual features or sites within the context of larger, landscape-scale conservation. Dynamic systems of eroding and building features should be conserved as far as possible through the operation of natural processes. This links with the concepts of process-led and landscape-scale conservation which are being actively developed for biodiversity conservation. Considerable synergy exists, for example, between geodiversity and biodiversity conservation in the conservation of landscapes dominated by wetlands, river systems and fluvial processes.

Eight SSSIs and ten County Geology Sites are designated as important exposure and/or integrity sites for the geomorphology of Cornwall and the Isles of Scilly.

Individual landforms and even some processes, receive clear designations in many of these SSSIs and County Geology Sites, particularly in relation to coastal geomorphology, periglacial landforms and weathering and erosion of the granite tors. Existing designations provide a representative selection of exposure sites covering these aspects of geomorphology and landforms.

This initial audit has not achieved a comprehensive review of all elements of Cornwall and the Isles of Scilly's geomorphology, however, and further work and consultation is required in some areas. The preliminary findings suggest that specific fluvial systems and mass movement/landslip features are particularly under-represented, although the overall character they impart to the landscape is covered in many areas by other conservation designations.

Many important landforms and geomorphic processes (e.g. sand dunes and fluvial (river) features), are by their nature, dynamic and ephemeral and often occur on a small scale. While the vulnerability of such features makes their recognition more significant in the short-term, broader scale landscape

conservation strategies need to recognise that some change, and ultimately loss, is inevitable over time if surface processes are to be allowed to develop naturally. Conservation of some features may therefore need to be limited in timescale and responsive to the dynamics of systems.

2.8 Economic Geology

Cornwall contains extensive deposits of locally and nationally important minerals. The extraction of minerals in the County makes an important and vital contribution to the local economy and ensures that essential raw materials are produced to meet local building and manufacturing needs.

Exposures of metalliferous mineralisation and industrial rocks and minerals in coastal situations, quarries and china clay pits provide a valuable resource for teaching and research, notably at the higher education level.

2.8.1 Aggregates and Building Stone

A wide variety of rock types are quarried for use in the construction industries as roadstone, in the manufacture of concrete, or as general aggregate. In Cornwall, the bulk of the production is of granite, which is worked locally in many of the larger outcrops. Metabasites (known locally as greenstones), meta-dolerites and gabbro are quarried in West Cornwall and on the Lizard. There is also some production of crushed sandstone from the Carboniferous sediments in North Cornwall.

About 50% of Cornwall's aggregate production is made up of secondary mineral sources, mainly waste materials from china clay and slate production. Waste tips of sand and gravel form a major secondary source in the St Austell china clay area. Recycled construction and demolition materials are also used to meet construction demand although this is difficult to quantify.

Cornwall has very limited primary resources of sand and gravel and even historic production has been limited. Small outcrops of Tertiary sediments, such as those around St Agnes Head, are worked for speciality uses and there is limited extraction of beach and dune sand on Cornwall's north coast.

Cornwall has a long tradition of the production of building stones. Many of the granite and slate/sandstone quarries presently active have some production of stone for walling and building purposes. More specialist production includes roofing slate and slate materials from Delabole in north Cornwall; dimension stone, for example from the De Lank granite quarry on Bodmin Moor; or rock armourstone from the West of England quarry on the Lizard.

Building stone and slate are important for maintaining and restoring the existing building stock and ensuring distinctive character and local variation is retained in new buildings. Similarly, there is a need for local sources of hedging stone for the repair and creation of Cornish hedges, which are an important and distinctive part of the region's landscape. Cornwall's building stone is also valued for architectural and decorative use in prestige buildings, both within Cornwall and outside of the county.

Reserves of the various building stones and aggregates are, in most instances, considerable. Permitted reserves of aggregates are sufficient to meet anticipated needs over the next few decades.

*For building stone, reserves are more difficult to quantify, but they appear to be sufficient to maintain existing levels of production through to at least 2016 (the Plan period for the Minerals Development Framework). Some of Cornwall's building stones (including dimension and armour-stone) are of **national significance**.*

Minerals Local Plan Policy BS1 gives a positive approach to applications to re-open dormant or disused building stone and slate quarries, to extract special stone required for building restoration and heritage projects, except where there are detrimental effects on the environment, local amenities or communities. Where granted, the re-opening of such quarries will provide further opportunities to enhance this aspect of Cornwall and the Isles of Scilly's geodiversity.

2.8.2 China Clay

China clay or kaolin is a product of the alteration (kaolinisation) of feldspar minerals in granite to the clay mineral kaolinite. Economic deposits of china clay are particularly prevalent in the St Austell granite pluton, although there are known deposits in the Land's End, Tregonning-Godolphin and Bodmin Moor plutons. China clay has a multitude of uses in the production of ceramics, paper manufacture, in all kinds of paints and polymers, as a pigment extender and filler.

The primary kaolin deposits of Cornwall are of international significance for their size and quality and have yielded over 160 million tonnes of marketable clay since production began in the middle of the 18th Century.

*The primary kaolin deposits of Cornwall are world class and make a major contribution to the **international significance** of Cornwall and the Isles of Scilly's geodiversity. The widespread nature and large size of the china clay deposits will ensure continuing extraction over a long period. No reserve figures are published, but long-term operational plans allow for continuous production for at least 50 years. The majority of planning permissions currently have a time limit set at 2042.*

2.8.3 Metals and Other Resources

At present, the one remaining deep tin mine, South Crofty Mine is on care and maintenance and the resumption of metal production is uncertain. Future operation of the site is further complicated by its prominent location within the Camborne-Pool-Redruth Urban Regeneration area.

Specialist ornamental and monumental stones such as serpentine and Polyphant stone are quarried intermittently in small quantities.

Mineral Consultation Areas exist to safeguard the future potential reserves of ore minerals, hard rock and china clay, through ensuring that development does not lead to the sterilisation of workable minerals.

2.9 Available Skills and Resources

2.9.1 Skills

Key Organisations and Groups involved in the Conservation of Geodiversity

- English Nature
- Joint Nature Conservation Committee (JNCC)
- Cornwall RIGS Group
- Cornwall Wildlife Trust (including ERCCIS)
- Cornwall County Council (Historic Environment Service and Natural Environment Service)
- The National Trust
- Local conservation consultants including Spalding Associates, Cornwall Countryside & Environmental Agency.
- Local geological consultants, including Earthwords, David Roche Geoconsulting, Pendeen Heritage Trust, IGL Ltd
- Local companies, including Imerys, Goonvean Ltd
- Quarry Products Association
- Devon RIGS Group
- Museums, including Royal Cornwall Museum, Helston Folk Museum, Geevor Mine Heritage Centre, Camborne School of Mines Geological Museum (including the web-hosted GeoMinCentre) and Plymouth Museum.

Key Organisations involved in Geodiversity Research

- British Geological Survey
- Universities and other educational establishments, including University of Exeter (incorporating Camborne School of Mines), University of Plymouth, Combined Universities in Cornwall.
- Quaternary Research Association
- British Geomorphological Research Group
- Ussher Society
- South-West Regional Group of the Geological Society
- Cornwall Archaeological Society
- English Nature/JNCC

Other

- Local or regional branches of geological societies and related groups, including Open University Geological Society, Russell Society, China Clay History Society, Royal Geological Society of Cornwall.

A detailed skills audit has been beyond the scope of this GAP. There is a need to audit and review the resources and skills available within existing partners, potential partners and other organisations or individuals in order to assess how these resources and skills could be integrated into the overall strategy for geodiversity and geological conservation in Cornwall and the Isles of Scilly.

Subject to complying with Data Protection Act legislation, a database of the organisations and individuals, along with their relevant skills and knowledge would be a useful tool to have for the County.

As identified in previous sections of this Audit chapter, there is also a need to undertake an audit of public and major private collections of minerals, rocks and fossils (refer also to section 3.6.3), many of which are held by the organisations or institutions identified above.

2.9.2 Data Collection and Storage

Information relating to the geology and geomorphology of Cornwall and the Isles of Scilly is collected and collated by a number of organisations and individuals, including the Cornwall RIGS Group, University of Exeter (incorporating Camborne School of Mines), University of Plymouth and the British Geological Survey.

Much of this information remains with the collecting organisation/individual and is not made more widely available. The exception to this is where data is collected about the designated earth science sites – SSSIs and County Geology Sites (RIGS). Data concerning these are collated by English Nature and by the Environmental Records Centre for Cornwall and the Isles of Scilly (ERCCIS). ERCCIS acts as the focal point in the County for the collection, management and dissemination of earth science and wildlife information for Cornwall and the Isles of Scilly.

Designated sites

Designated site boundaries are held and managed on the Environmental Records Centre's (ERCCIS's) Geographical Information System (GIS – a computerised mapping system). The citation sheets relating to the geological SSSIs are linked to the site boundaries on computer; however for County Geology Sites only the boundaries are available electronically, all other site information is paper-based.

SSSI details such as boundary maps, reasons for designation, Operations Likely to Damage (OLD) lists, and site conditions are publicly available from English Nature's website and local team offices, together with statements on the views about management (VAM) as they become available. Information on GCR sites is being published in the Geological Conservation Review as a series of 42 volumes.

The descriptions used in much of the existing SSSI and County Geology Sites (RIGS) information does not reflect more recent changes to lithostratigraphic and tectonic unit names and interpretations. SSSI citations are based on the information available at the date of designation and may be based on GCR descriptions from the late 1970s-early 1980s that are now out of date – nomenclature and interpretation having moved on.

A review of the descriptions and reasons for designations within SSSIs and County Geology Sites would be worthwhile to identify any additional features of geodiversity significance that are not included in current citations. Updating SSSI details would not be appropriate as any changes to the SSSI citation, reasons for designation or OLD list or VAM would require a lengthy and expensive procedure of de-notification, consultation and re-notification. It would, however, be practical to revise County Geology Site citations or, indeed, to nominate new County Geology Sites within the

boundaries of SSSIs if additional geodiversity features of regional significance were recognised.

An overhaul of the current County Geology Site proposal forms and selection criteria is needed to update and standardise the information collected and reported. This would also provide an opportunity to computerise the whole system, introduce database-driven collation and analysis of data and achieve closer integration with GIS systems used by ERCCIS, the Cornwall Wildlife Trust, local authorities, English Nature etc. Terminology used across all platforms (proposal forms, databases and GIS software) must be standardised to ensure compatibility. Database design should be future-proofed to allow for easy additions, format changes etc. Development of these systems is one area where business/community sponsorship could be sought.

Beyond designated sites

There is a need to maintain a watching brief on current research, mapping work and new exposures in Cornwall and the Isles of Scilly. At present, this is a role that the Cornwall RIGS Group tries to fulfil (in partnership with other organisations). The help provided by all partners should increase as geodiversity awareness begins to permeate through organisations.

Opportunities for new potential County Geology Sites may be created or recognised in a number of ways, for example:

- Mapping work by the British Geological Survey may redefine a number of the sedimentary basins and create new stratigraphic units (as seen with the recent Plymouth Sheet and Memoir). These revised interpretations should be reflected in the identification of potential representative sites;
- New exposures developed in quarries, road cuttings or major development works (even if temporary, their geodiversity features could still be recorded, as is done with archaeological remains);
- The research into the Quaternary that is currently being undertaken throughout the South-West continues to identify new successions; recording and conservation of Quaternary features is probably not keeping pace with this activity.

Even if features exposed and reported do not merit, or are not appropriate for, designation of County Geology Site status, they could still be recorded in a computerised database to help build up a repository of knowledge on a wide range of geodiversity features.

2.9.3 Site Management

Geological Site Management Briefs have been produced for internal use by English Nature's geological specialist team, covering many, but not all, geological SSSIs. They include a site description, details of scientific interest and references, GCR information, a section on the principles of conservation and photos of the geological interest of the site. There is also an indication of any potential threats to the site, suggested enhancements and actions. English Nature is also required by the Countryside and Rights of Way Act 2000 to notify all SSSI owners/occupiers of its

views about the management of SSSIs (known as VAMs). The VAM is a statement explaining the basic management that is needed to conserve and enhance the wildlife or geological features of the SSSI. The process of producing VAMs for all SSSI sites in Cornwall and the Isles of Scilly is on-going.

There is a lack of similar data for County Geology Sites, many of which have not been re-visited or surveyed since designation. Nor are there similar agreed plans for site management which assess and address the level of impact of threats such as erosion, overgrowth or fly-tipping, on these sites.

2.10 Summary

Summary: Geodiversity Audit

1. Good designated site coverage for:
 - i. South Devon and Trevone Basin in west Cornwall
 - ii. Tavy Basin along north coast
 - iii. Culm Basin
 - iv. regional metamorphic effects on Devonian and Carboniferous sediments
 - v. Lizard Complex
 - vi. Cornubian granite batholith and associated rocks (exceptions shown in 2.iii)
 - vii. Key mineral species locations
2. Under-represented or poor designated site coverage for:
 - i. South Devon and Trevone Basin in east Cornwall
 - ii. Tavy Basin away from the north coast
 - iii. Carnmenellis and Isles of Scilly granite pluton; lamprophyres
 - iv. styles of mineralization and alteration
 - v. Tertiary sediments
3. Insufficient work carried out to date to confirm coverage for:
 - i. Gramscatho Basin
 - ii. Variscan and sedimentary basin structural geology
 - iii. integrity sites of the Quaternary
 - iv. soil sites (particularly rare sub-soils or soil series); the status of soil conservation within SSSIs needs clarification.
 - v. geomorphological sites
 - vi. fossil fauna and assemblages
4. Revise and update County Geology Site (RIGS) descriptions. Review descriptions on SSSI citation sheets to identify any additional features of geodiversity interest that could be designated at regional (RIGS) level.
5. There are a number of issues relating to the collection and management of County Geology Sites (RIGS) data:
 - i. lack of standardised information collected
 - ii. lack of up-to-date survey and photographic information for each site
 - iii. lack of adequate computerised information for each site
 - iv. lack of management plans/recommendations for each site
6. Systems for the recording and wider reporting of temporary exposures of geological significance are not well developed. Formal watching briefs, such as those required for archaeological interests, could be established.
7. There is currently insufficient information pertaining to sites outside of the designated sites system i.e. sites in the wider landscape.
8. This audit has not established whether the museum and academic collections contain a comprehensive record of all the key mineral, rock and fossil specimens or species in Cornwall.
9. A detailed skills audit has been beyond the scope of this GAP. There is a need to audit and review the resources and skills available within existing partners, potential partners and other organisations or individuals.

Chapter 3 Issues Affecting Geodiversity

3.1 Introduction

The following issues have been identified as having significant influence on the geodiversity of Cornwall and the Isles of Scilly.

- Planning and conservation policies
- Public awareness and appreciation
- Minerals extraction and restoration
- Agriculture and forestry
- Waste disposal and derelict land
- Built development
- Tourism, amenity use and access
- Climate and sea-level change

Consideration of the first two issues is particularly important to the objectives of this GAP and they have therefore been given separate chapters (Chapters 4 and 5) to highlight their significance.

The remaining issues are discussed in sections 3.2 to 3.8 in this chapter. The order of discussion is not meant to imply any ranking to, or the relative magnitude of, their effect(s) on geodiversity. The major points relating to each of these issues are summarised in the table in section 3.9.

3.2 Mineral Extraction and Restoration

3.2.1 Review

Minerals represent an important natural resource in Cornwall and the Isles of Scilly and mining and quarrying is a traditional industry, which benefits both the national and local economy. Over 6700ha of land are covered by planning permissions for minerals extraction, although production is now restricted to industrial rocks and minerals (china clay, aggregates, building stone and slate), following the demise of metalliferous mining operations (tin).

Mining and quarrying in Cornwall accounts for some 2,500 direct employees and the local economy also benefits from indirect employment (suppliers etc.) and induced employment (from the re-spending of income generated by direct and indirect employment). Typical multipliers in the mining industry are 3-5 indirect jobs for every direct employee.

The natural resources available within Cornwall and the Isles of Scilly are summarised in section 2.8. The legacy of the minerals industry in Cornwall extends beyond geodiversity and is reflected in the county's industrial archaeology, cultural heritage and even its biodiversity.

Annually some 2.5-3 million tonnes of china clay is produced in Cornwall and Devon, with the majority coming from the St Austell region, and almost all exclusively for export. China clay exports are valued at over £200million per annum, making china clay the UK's second most valuable minerals export after oil.

Sufficient aggregates production is maintained for most of the County's needs, supplemented by the processing of waste materials from china clay extraction. In 2002, approximately 50% of Cornwall's demand for aggregates was serviced from this secondary source. In 2002 production of primary aggregates was around 1.6 million tonnes, as yet it is not clear if there is a downward trend in production as a result of the introduction of the Aggregates Levy.

Other minerals production includes: building and cut stone such as granite, specialised sands, slate for roofing and decorative use and ornamental serpentine. Building stone production currently is from around 20 operational quarries producing mainly sandstone (gritstone), slate and granite with around 30,000 tonnes being produced during 2002. There are also a number of sites which although not operational currently, have valid planning consents and therefore could be brought back into production in the future.

Minerals companies are among the largest landowners in Cornwall and the Isles of Scilly and their activities therefore have a major role to play in geoconservation. They have the opportunity to record, and where possible protect and manage, features of geological and geomorphological interest exposed in their operations. Many of their landholdings hold significant landscape value in their own right. Quarrying activity repeatedly creates new geological exposures and the study and recording of these features adds considerably to the breadth and depth of our geological knowledge.

Historically, and continuing through to the present day, a substantial volume of published data of regional, national and international significance has been generated through research based on extractive industry locations in Cornwall and the Isles of Scilly. The scientific significance of former mining and quarrying areas is reflected in the abundance of geological SSSI and County Geology Sites (RIGS) designations in such areas.

Central Government generates national policy for minerals issues and Cornwall County Council (CCC) are the Mineral Planning Authority, acting through the production of the Cornwall Minerals Local Plan which was adopted in 1997. They also co-ordinate the China Clay Area Tipping and Restoration Strategy. Cornwall County Council has commenced the production of a Minerals Development Framework to replace the Minerals Local Plan with a policy framework to:

“guide decisions about planning applications related to mining and quarrying in Cornwall and provide a spatial plan or geographic blueprint for the development of Cornwall's mineral resources which is sensitive to the needs of people and the environment”.

The role played by the Mineral Planning Authority is considered in more detail in Chapter 4. Other important parties include: China Clay Association, Cornish Chamber of Mines, Cornwall Wildlife Trust/Cornwall RIGS Group, District Councils, Environment Agency, English Nature, Imerys and the other mine and quarry owners and operators.

China clay production is set to continue for the foreseeable future and will produce a significant amount of waste rock material. Hard rock production for aggregate and other building materials is likely to continue. The resumption of metalliferous mining is uncertain at this time but retention of access to the underground workings at South Crofty would be of significant educational value for its mining geology.

3.2.2 *Key Issues*

It should be recognised that mineral resources and their exploitation are an important and valid element of the geodiversity of Cornwall and the Isles of Scilly. The minerals industry's exploitation of our natural resources has played a very significant role in establishing the cultural identity of Cornwall; and continues to play an important role in the conservation of our geological heritage.

The importance of the mineral industry to the economy of Cornwall and the Isles of Scilly is considerable and the impact of mineral extraction on geodiversity is usually positive, in that it leads to the creation of geological exposures in areas that would otherwise be covered.

Many mineral deposits and Mineral Consultation Areas lie within areas valued for their biodiversity or landscape character, however, and the potential benefits of the minerals extracted and the geological exposure sites created have to be balanced against the potential negative environmental impacts of such operations.

The visual impacts of quarrying and china-clay extraction are generally perceived to be negative and operators attempt to minimise these through landscaping during and after extraction. The complete restoration of some quarrying landscapes may, however, be inappropriate if examples of the cultural, historical and industrial archaeological significance of mineral extraction are to be retained.

Wherever possible, mineral extraction should be managed in such a way that damage to integrity sites for geodiversity is avoided and rare features exposed during production are reported or recorded. This highlights a need to raise awareness with operators about the potential for geological conservation within sites and how it might be incorporated within schemes of working and restoration.

Sites previously used for mineral extraction often provide valuable inland exposure of bedrock geology, exposure of which is limited inland in Cornwall. Former sites therefore offer very significant restoration and educational potential. The feasibility of highlighting geodiversity needs full consideration when land ceases to be used for mineral extraction and should be included as part of restoration conditions set by Local Planning Authorities (LPAs).

A considerable amount of waste sand and rock (about nine tonnes) is produced per tonne of china clay. This waste material is either sold for use as an aggregate, backfilled or tipped above ground. Use of (processed) stent or waste rock from the

china clay industry is an important aspect of reducing the impact of waste tipping operations, as is the planned backfilling of abandoned pits.

3.3 Agriculture and Forestry

3.3.1 Review

Some 74% of the land cover in Cornwall is directly related to agriculture and horticulture, with an additional 7.5% represented by woodland cover. The agriculture and forestry industries therefore have a vital role in the management of landforms, landscape and visual amenity throughout Cornwall and the Isles of Scilly. Maintenance of soil quality and the prevention of soil erosion are other vital areas where farmers, foresters and land managers have an important role to play in conservation.

Agricultural and forestry activities contribute strongly to Cornwall's economy and levels of employment, as well as providing important areas for recreational and amenity activities.

The farming community in Cornwall and the Isles of Scilly comprises a broad range of smallholders, large farm owners, tenant farmers and large landowners and estates, such as The National Trust, Duchy of Cornwall and County Farms (Cornwall County Council). Key organisations representing the views and interests of the farming community are the National Farmers Union and Country Landowners Association.

The Forestry Commission is the lead organisation providing advice, grants and felling licences for woodland; whether it is controlled by local authorities, major landowners or private woodland owners. The largest areas of woodland are owned and managed by traditional estates, investment companies or Forest Enterprise. Most small woods are unmanaged. Cornish Woodmeet is a leading forum for those in Cornwall's woodland, forestry and wood processing sectors.

Policy and funding for agriculture, horticulture and forestry is particularly influenced by European legislation, such as the Common Agricultural Policy, while the Forestry Commission is responsible for forestry policy throughout Great Britain. The Secretary of State in the Department for Environment, Food and Rural Affairs (DEFRA) has responsibility for forestry in England. The national organisation charged with conserving and enhancing England's countryside for landscape and recreational purposes is the Countryside Agency (funded by DEFRA).

Advice on issues relating to conservation is available to the agricultural and forestry sectors in Cornwall and the Isles of Scilly through a range of local authority departments and non-governmental organisations. Key players here are various advisory groups within or supported by Cornwall County Council, such as the Farming Wildlife Advisory Group (FWAG), Cornwall Wildlife Trust and the Rural Development Service (DEFRA). Advice is also provided nationally by English Nature, Environment Agency etc.

Various schemes are now available to farmers and land managers who actively seek to manage their land in an environmentally beneficial way. Payments may be awarded to farmers who agree to manage their land in order to enhance, restore or

create wildlife habitat, resources, historic features and public access. In 2000 slightly over 3.0% of farm land in Cornwall was managed under the Countryside Stewardship Scheme (DEFRA) and Cornwall also has one designated Environmentally Sensitive Area (ESA), located in West Penwith. The West Penwith ESA spans an area of 7,800 hectares of which over 90% is covered by management agreements which encourage the use traditional practices and materials to enhance both the historic landscape and the conditions for wildlife.

The new Environmental Stewardship (Agri-Environment) scheme, being brought in to replace the Countryside Stewardship Scheme, will be important in further enhancing the broader nature conservation role of farmers.

3.3.2 *Key Issues*

Good agricultural and land management practices work towards the retention of soil fertility, reduction in soil erosion and, overall, make a positive contribution to soil conservation and landform/landscape geodiversity in Cornwall and the Isles of Scilly. Well managed woodland planting and maintenance protects and enhances soils by reducing soil compaction and increasing water infiltration, which in turn reduces surface water run-off and subsequent soil erosion.

Many farmers are already following the principles outlined in the Code of Good Agricultural Practice for the Protection of Soil (produced by MAFF, now DEFRA); foresters follow similar guidance laid out in the UK Forestry Standard.

Farmers, foresters and landowners, although increasingly aware of the importance of their land for biodiversity, are often unaware of the importance of geodiversity.

Intensification of farming has a potentially negative impact on geodiversity of soils and landscape. Land previously farmed at low intensity or not at all has been brought into use and the intensity of farming on existing land is increasing. In combination with extensive use of fertilisers and/or commercial waste the quality and structure of soils in some areas is likely to be adversely affected. The switch to larger scale production and removal of many field boundaries is leading to increased surface run-off and erosion/loss of soils. Persistent ploughing on steep slopes may affect the physical stability of slopes and increase soil losses.

Farming practices sympathetic to nature conservation are becoming more widespread and many farmers are increasingly involved in positive management of their land for wildlife benefits, aided by schemes such as the Countryside Stewardship Scheme and Environmentally Sensitive Areas. Raising awareness of geodiversity issues during the implementation of these schemes would be a relatively straightforward task, potentially leading to some payments tied in part to geo-conservation tasks or management activities.

Many of the tasks already funded to aid wildlife conservation (e.g. capital grants for hedge laying and planting, repairing Cornish hedges with existing stones or other similar local stone etc.) are enhancing geodiversity but go largely unrecognised.

Some existing woodlands are not managed and their contribution to geodiversity could be investigated and enhanced should they be returned to management.

The development of large scale plantations can render the location, mapping and interpretation of geological outcrops very difficult. Raising awareness and informing

developers/landowners of geodiversity issues could lead to greater opportunities for conservation, through sympathetic planning and restructuring.

3.4 Waste Disposal and Derelict Land

3.4.1 Review

Cornwall and the Isles of Scilly's annual waste production is dominated by wastes from mineral extraction and agriculture. The disposal of mineral wastes is controlled by conditions attached to individual mineral permissions (also see section 3.2) and the majority of agricultural wastes are applied to land.

Landfill provision within Cornwall is made for the residual waste (after recycling, composting or recovery) from domestic, industrial and construction streams. Sewage waste is treated and discharged to rivers or the sea. In total some 500,000 tonnes of waste was sent for landfill disposal in 2003.

The landtake required for landfill operations is not seen as a major threat to Cornwall's geodiversity. Future waste disposal options on the Isles of Scilly are potentially more problematic. At present all waste is incinerated or returned to the mainland. Fly tipping in many areas of Cornwall and the Isles of Scilly is a major problem.

The Environment Agency is the key organisation responsible for controlling and regulating potentially polluting processes and regulating the treatment, storage and disposal of controlled wastes. In Cornwall, the District Councils are the waste collection authorities and the County Council the waste planning and disposal authority (these roles are also fulfilled by Council of the Isles of Scilly).

Contaminated/Derelict Land

The long history of metalliferous mining in Cornwall has led to an abundance of former mining areas. The spoil and bare ground on many sites contains high levels of tin, copper and other base-metals but also potentially provides important geodiversity sites for mineralogical and mining geology interests, as well as adding to biodiversity.

In addition to rab pits and openworks on metal-rich outcrops there is a much larger number of disused pits and quarries which historically provided much of Cornwall and the Isles of Scilly's building or hedging material. It has been estimated that there may be up to 5000 abandoned pits and quarries in Cornwall alone.

The conservation of geodiversity in these settings has been discussed in two key reports: *The Conservation Value of Abandoned Pits and Quarries in Cornwall* (Spalding *et al*, 1999) and *A Manual for the Nature Conservation Management of Metalliferous Mine Sites in Cornwall* (CEC, 2001).

3.4.2 Key Issues

National policy has led to all the local authorities in Cornwall (and the Urban Regeneration Company in Camborne-Pool-Redruth) being under pressure to reclaim or redevelop contaminated land holdings in Cornwall. This could potentially have an effect on many former mining sites which could be significant from a geodiversity standpoint, and are known to be important for biodiversity.

Restoration schemes for abandoned former metalliferous mine sites need to assess the potential benefits for nature conservation, industrial heritage and amenity (usually visual) against the potential losses of exposures or waste dumps of geodiversity interest and losses of specialised biodiversity habitats.

A further consideration in some old quarry sites, is the need to avoid sterilisation of potential resources of distinctive building materials which may be required for future repair or restoration projects. Retention of access to sources of local hedging stone for Cornish hedges also needs to be considered.

Abandoned quarry sites can be the location for unauthorised activities and anecdotal evidence suggests that the introduction of the Landfill Tax in 1996 has encouraged an increase in fly-tipping. Even partial infill of quarries can prevent access to or obscure geological exposures.

Shipping activities are highly concentrated around Cornwall and the Isles of Scilly's coast and the extensive coastline is vulnerable to oil pollution incidents. Much of the Cornish coast has been notified as geological SSSIs and is therefore especially sensitive to pollution incidents.

Litter is also a significant problem on Cornish shores, largely originating from amenity use, fishing and shipping.

3.5 Built Development

3.5.1 Review

In recent decades, there has been increasing pressure on the countryside from built development. New construction development can have large impacts on geodiversity by removing or damaging soils and Quaternary or alluvial sediments, removing landforms and altering land profiles, and obscuring underlying bedrock. Water run off from large areas of impermeable surfaces causes erosional problems in streams and rivers if directed to these rather than being allowed to soak into the ground.

The Cornwall Biodiversity Initiative (CBI) Biodiversity Audit identified a clear trend in Cornwall and the Isles of Scilly for a progressive shift in land status, initially from semi-natural habitat to agricultural use and then from agriculture to built development. While the first stage has some potential landscape character impacts, it is the second stage which presents the greater threat to geodiversity.

Piecemeal development may encroach into areas of geodiversity sensitivity although the notification of County Geology Sites (RIGS) to LPAs and the consideration of location in respect to other conservation areas goes some way to alleviating this. The loss of more subtle aspects of Cornwall and the Isles of Scilly's geodiversity such as

Cornish hedges, or the use of non-locally sourced building materials has a small but cumulative effect on the landscape of Cornwall.

The role of local authorities, through the planning process and with advice/guidance, in both conserving geodiversity and promoting use of local building materials, is an important theme in this GAP and is considered in more depth in Chapter 4.

Economic Development

Significant recent and future trends include the provision in the Structure Plan for about 30,500 new dwellings in 2001-2016, redevelopment schemes proposed by the Camborne-Pool-Redruth Urban Regeneration Company, and the economic development activity being driven by the designation of Objective One status under the European Union's Structural Fund Regulations.

An increase and improvement in the overall economic activity in the county can have both positive and negative impacts on geodiversity. The use of most sources of grant funds (Urban Regeneration Fund, Objective One) is now tied to recognition of the importance of the environment to economic development. The environment is one of the most important factors in attracting or retaining investment in Cornwall and the Isles of Scilly and highlights the need for a balance between economic development and the maintenance of environmental quality, which should include geodiversity.

Transport

Traffic levels in Cornwall may almost double by 2025 according to Department of Transport (DoT) forecasts, while the Countryside Agency has predicted a possible three-fold increase in rural areas.

Although traffic movements themselves have no discernible impact on geodiversity; the road building and maintenance programmes required to support this level of usage will make demands on the supply of aggregates. Road development may encroach on sensitive landscapes and the run off of surface water can cause changes in fluvial conditions. Predictions of increased journeys also imply that demands for access to the countryside for recreation and tourism will continue to increase.

Increased demand for road-building materials could have a positive impact on geodiversity by extending the available geological exposures in local quarries.

3.5.2 Temporary Exposures

There is an opportunity for studying temporary exposures of geological interest revealed in the course of engineering works such as new road construction, major pipe-laying and site clearing/foundation work on major construction projects. Consideration is currently given to archaeological interests but ignores the wider potential for recording features of geodiversity interest, despite the fact that these can potentially be recorded more quickly and less disruptively than the archaeological features.

Archaeologists have a watching brief for many major and temporary excavations and an opportunity exists to extend this to the more formal recording of geology and

geodiversity features. Geological advice could be made available to support excavations and watching briefs on a regular basis throughout construction projects.

The site investigation of geological features in foundation excavations is already standard practice in many locations in Cornwall as a means of assessing the risk of from abandoned mine workings on the stability of new built development. While acknowledging the commercial sensitivities involved, the recording and reporting to the wider geological community of features uncovered during these excavations is strongly encouraged.

Road cuttings, embankments and similar excavations in Cornwall and the Isles of Scilly with stable soil profiles or solid rock and safe access could be left uncovered i.e. only to vegetate naturally, if at all.

3.5.3 Key Issues

Any decline in environmental quality threatens the economy of Cornwall and the potential for economic development strategies and programmes to have an impact on geodiversity needs to be recognised by all parties involved.

Loss of geodiversity can be experienced through all types of built development, although clearly development on greenfield sites has more of an impact, particularly on landscape character than redevelopment of brownfield sites. In all instances exposures and landforms will be obscured or obliterated. Landscaping which is sympathetic to, and integrated with, the surrounding countryside can minimise the visual impact of developments.

Promoting the use of specific stone for renovation/conservation projects can highlight historic and architectural heritage as well as providing economic growth. The Design Statement for Cornwall (Achieving Quality in the Built Environment) adopted in the Structure Plan, sets a benchmark for future development by actively promoting the role of Cornish context and local distinctiveness in design. A Supplementary Planning Statement on the uses and sources of local building stones is in preparation as part of the county's Minerals Development Framework.

The contribution of local stone to landscape and Cornish architecture is a vital component of local distinctiveness. The poor availability of local stone for hedging has recently been identified by the National Trust and Cornwall AONB Partnership, who wish to see if small quarry sites can be identified to meet this need.

Considerable potential exists to increase the recording and reporting of information on geodiversity revealed in temporary excavations.

3.6 Tourism, Amenity Use and Access

3.6.1 Review

Tourism is Cornwall's largest single industry and employer, and the quality of the environment remains by far its greatest single attraction. The Isles of Scilly's outstanding environment brings in over 120,000 visitors a year, sustaining the tourism industry that makes up 85% of the islands' economy. Tourism generates an

annual five million visitor trips and a spend of over £1.1 billion (UK Tourism Survey, 2004). Recreational and amenity use of the natural environment by residents is also high.

Although the coastal landscape is the primary attraction, countryside walking and visits to heritage or nature conservation sites (such as the Eden Project and National Trust properties) are also significant. The maintenance of the quality of the natural environment throughout Cornwall and the Isles of Scilly is therefore of vital importance to the future of tourism and recreational use. Although successive Governments have recommended that the tourism industry should contribute to the conservation and management of the natural environment, little has been achieved in terms of either national or local policies or initiatives.

As the largest driver of the Cornish economy, and one which relies for its long term future on its landscape and beaches, the tourism and recreational industry needs to be more engaged in all stages of the conservation of geodiversity. Establishing how best tourism can contribute to the maintenance of the local environment is one of the key areas in which synergy between this GAP and Cornwall Biodiversity Initiative's biodiversity targets can be achieved.

There are a wide range of organisations and projects currently involved in the tourism industry in Cornwall, many of which are actively promoting 'greener tourism' in the county. These include: Cornwall Tourist Board, Cornwall Association of Tourist Attractions and other local tourism associations, South-West Coast Path Strategy, Eden Trust.

3.6.2 Access

New rights of access (known as 'Right to Roam') to mapped areas of open, uncultivated countryside will come into effect in Cornwall and the Isles of Scilly in August 2005 through the Countryside and Rights of Way Act, 2000. The Countryside Agency is responsible for mapping new access land, which will give walkers the right to explore off-track on moors, heathland and common land. Restrictions on access may be granted in areas of wildlife or historic interest, or for reasons of land management or safety. No decision has yet been taken as to whether access land will be extended to foreshore areas and adjacent coastal slopes, which provide the largest exposures of geological features in Cornwall and the Isles of Scilly.

The management and maintenance of routes for access to the countryside is largely in the hands of landowners although Cornwall County Council has a duty to protect public rights of way. Parishes are now being encouraged and supported in the management and reopening of footpaths. The County Council has taken the lead in the development of new opportunities for access such as cycle routes and the Mineral Tramways Project.

Access and safety issues are not criteria used to judge the designation of many conservation areas (especially SSSIs). Landowner approval is always sought before the formal notification of County Geology Sites (RIGS) in Cornwall, but does not necessarily confer any rights of access.

Landowners are vital stakeholders in geodiversity, not least in terms of granting permission to gain access to sites and in their management (for conservation or other purposes). Major landowners, organisations and their representatives need to be fully engaged and aware of the development of this GAP and of the broader issues surrounding geoconservation. These include Cornwall County Council, The National Trust, Duchy of Cornwall, Country Land and Business Association, and large estate owners such as the Tregothan Estate.

3.6.3 Museums and Collections

Nationally or internationally significant Cornish ore mineral collections can be found in three of the county's museums. The Rashleigh collection at the Royal Cornwall Museum (RCM) in Truro is of international significance and is currently the only major collection on display in Cornwall. Material from the Camborne School of Mines (CSM) Geological Museum is currently being re-organised and displayed in new premises on the university campus at Tremough, supplemented by development of a substantial virtual (web-based) resource, the GeoMinCentre.

The Royal Geological Society of Cornwall's (RGSC) various collections are no longer on public display due to funding and access difficulties. The RGSC is the second oldest geological society in the world, and its collections include material of great historical value. The Peach collection of Devonian fossils is of at least national importance.

Collections in the RCM are well maintained and displayed, display of the various geological collections of CSM is limited but trials of digital recording and web-based display are allowing access to a wider potential audience. The future of the RGSC collections needs to be secured.

Other local museums have a range of smaller displays on the geodiversity of Cornwall and the Isles of Scilly, for example the Isles of Scilly Museum on St Mary's. Important collections containing Cornish minerals are also held in the Natural History Museum in London and Plymouth Museum. The role of all museums in raising public awareness is significant.

Some private collections, particularly of mineralogical specimens, are known to be extensive and comprehensive in their coverage and represent a largely untapped source of conservation potential for geodiversity. Although more problematic to audit and access, these private collections (including those under the control of societies/organisations) have an important role in preserving rare specimens and those from now inaccessible locations.

3.6.4 Key Issues

Any decline in the quality of the natural environment, including geodiversity, threatens the tourism economy of Cornwall.

Tourism has a strong role to play in learning and personal development and could be very valuable in raising awareness of Cornwall's geodiversity and in explaining less well understood subjects such as geology and geomorphology to visitors and residents.

Cornwall is one of the most important counties in Britain for its geological heritage but the potential for building tourism around this geodiversity (geotourism) has not been fully developed, although the Cornish Tourist Board do not expect the demand for specific geotourism packages to be high.

Increased awareness, appreciation and use of the natural environment can be both an asset and a liability to conservation efforts. Closer links are required with the tourism industry to raise awareness of conservation issues and minimise the potential impacts of tourism (e.g. increased waste disposal, higher rates of human erosion) whilst maximising the benefits to the environment. Visitors can provide much needed additional resources but can also create the need for additional site management. Gaining support from the industry for geoconservation projects and initiatives is an important target for this Geodiversity Action Plan.

If successfully granted, World Heritage Site (WHS) status for the Cornwall and West Devon Mining Landscape is likely to enhance visitor numbers in some areas. Although the WHS status may offer further protection, conservation and promotion for geodiversity in some regions, the pattern and number of visitors to some sites will change and will need to be carefully managed to avoid site degradation. It is acknowledged by the World Heritage Site Office, however, that not all areas are suitable for increased footfall and the Cornwall Tourist Board does not expect the number of visitors to cause undue concern. Overall, the WHS bid is seen as a positive opportunity for geoconservation in Cornwall and the Isles of Scilly.

The impact of Right to Roam, promotion of the South-West Coast Path and further development and usage of the network of footpaths and cycle routes will increase access to sites and regions of geodiversity and make the creation of effective partnerships with landowners even more important for geoconservation.

A higher level of funding is needed to fully develop the geodiversity related museum collections in Cornwall and the Isles of Scilly and make better use of their potential for scientific and educational purposes. The potential conservation benefits of private collections are largely unknown.

3.7 Coastal Erosion and Climate Change

3.7.1 Review

There is mounting evidence to show that climatic conditions are changing at an increasing rate and that noticeable effects are already being experienced on our environment. The United Kingdom Climate Impacts Programme (UKCIP) predicted that by 2050 Cornwall can expect, among other changes: wetter, more stormy winters; drier, more droughty summers; more intense winter rainfall, increasing the risk of flooding; higher storm surges around the coast and total sea-level rises of around 0.2-0.8m.

Fluvial systems will be particularly affected by the anticipated climatic changes, for example higher flow rates in streams can cause erosional problems and siltation further downstream. There has been a noticeable increase in flooding events in recent years and there are currently 27 Environment Agency designated flood warning areas in Cornwall.

The Environment Agency aims to address the issue of increased risk of flooding through issuing effective flood warnings and sustainable defences. Through their flood defence roles, the Environment Agency and DEFRA actively promotes the idea of not siting new developments within floodplains, although the ultimate decision on development lies with the planning authorities.

Rises in sea level could have a major impact upon Cornwall and the Isles of Scilly's geodiversity in coastal and estuarine areas. In Cornwall, taking into account natural rates of subsidence of the land, there is still an unexplained net sea-level rise amounting to between 3 and 10cm per century.

The supporting objectives for the development of the county's Shoreline Management Plans include objectives aimed at conserving geodiversity. The relevant objectives are that coastal defence provision should not adversely affect areas of known geological significance unless physical circumstances do not permit reasonable alternative options; and that coastal defences should not detract from the aesthetic quality of the coastline, especially those designated for landscape quality.

Climate change is likely to modify the key soil processes that maintain the quality of soils; soil ecology and organic matter will be influenced by changes in temperature, atmospheric carbon dioxide and rainfall. Soil erosion rates will be affected by changes in rainfall intensity, duration and amount. DEFRA's First Soil Action Plan for England highlights the need for research into the impacts of climate change on English soils. Given the vital agricultural and biodiversity (and hence amenity) role played by soils in Cornwall and the Isles of Scilly, it is important that, from the outset, such research investigates impacts on soils particular to the Cornwall and the Isles of Scilly region.

3.7.2 *Key Issues*

Hard engineering of river flood prevention schemes can impede natural fluvial processes and impact on the diversity of geomorphological features present in Cornwall and the Isles of Scilly. Although in many cases this impact is over-ridden by the need to protect lives and communities, the potential conservation importance of integrity sites for fluvial processes needs to be given more consideration.

Sea level rise is likely to result in some loss of geodiversity, either by direct inundation or by accelerating the rate of natural erosion in coastal areas. Areas which have been identified as more susceptible include the Tamar Estuary, parts of the coast at Mount's Bay and Perranporth and the Isles of Scilly. Other estuaries, such as the Fal, Fowey and Camel may also be at risk, particularly if sea-level rise combines with substantial changes to fluvial conditions and flow rates.

Coastal defence works need careful planning to minimise the loss of access to exposure and integrity sites and to minimise impacts on active coastal geomorphological processes. In areas of soft rocks (which are limited in Cornwall) a balance needs to be maintained between allowing natural erosion to renew exposures and preventing excessive erosion which threatens slope stability and property.

In preparing this GAP, a preliminary review of the Shoreline Management Plans for Cornwall's coastline has been undertaken. There does not appear to be any immediate conflict between the preferred strategies outlined in the various SMPs and conservation of the majority of integrity sites (geological SSSIs) in coastal areas, but the impact on general coastal exposure sites has not been fully assessed. Shoreline Management Plans for the Isles of Scilly have not been reviewed.

Soil types and diversity are likely to alter due to changes in hydrology and soil composition.

Tourism and recreation activities may change, potentially increasing pressures on the coastal environment in particular.

Assessing the affect on geodiversity of changes to the groundwater (hydrogeological) regime in Cornwall and the Isles of Scilly is beyond the scope of this report.

3.8 Mineral and Specimen Collecting

Cornwall has a long tradition of academic mineral research and of collecting by dedicated amateur mineralogists; but with the cessation of most metalliferous hardrock mining and centuries of previous collecting in Cornwall, mineral specimens are a diminishing resource. Good quality fossil specimens are more rarely found in the county.

Excessive hammering, coring and collecting can damage geological exposures in areas frequently used by amateur, professional and academic individuals and groups. On some sites however, such as mine spoil dumps, a responsible level of collecting may be required to generate fresh exposures. Unscrupulous collecting by commercial and a few individual collectors has caused irreparable damage to some integrity sites in Cornwall, despite their protected status.

Conservation of this resource is a matter of considerable disagreement within the geological community in Cornwall but it is apparent that the two extreme, opposite views of either a completely unregulated approach or a total ban are not practical or sustainable.

In all geological fieldwork and/or collecting activities the landowner's permission to both gain access to sites and to collect specimens is a fundamental, and in most cases legal, requirement.

3.8.1 Key Issues

Excessive hammering, coring and collecting can damage geological exposures in heavily used areas. These activities should be moderated in exposure sites and actively discouraged in most integrity sites. On some sites, such as mine spoil dumps, a responsible level of collecting may be required to generate fresh exposures. Landowner's permission is a fundamental pre-requisite for any collecting.

There is no county-wide policy, nor a code of practice, relating to specimen collection; although there are national policy statements issued by a number of

organisations, most notably English Nature and the Geologist's Association, which could be applied to Cornwall and the Isles of Scilly.

This issue may become more important if World Heritage Site (WHS) status is obtained and attracts increased numbers of visitors to Cornwall's Mining Landscape, many areas of which contain rock dumps. The English Nature policy statement has been used as a model for developing guidance and codes within the Dorset and East Devon Coast WHS.

3.9 Summary

The following table (Table 3) summarises the key issues presented in this chapter; note that significant issues will also arise from consideration of the issues relating to planning and conservation policies (Chapter 4) and public awareness and appreciation (Chapter 5).

Consideration of these key issues has underpinned the development of all of the Action Plans presented in Chapter 7.

Discussion of the issues presented here has been guided in part by the findings of the Cornwall Biodiversity Initiative and many of the findings mirror those reported in Cornwall's Biodiversity Volume 1: Audit and Priorities. This emphasises the link between geodiversity and biodiversity and the opportunity for better integration of these two strands of nature conservation. Similarly there is considerable overlap with historic environment interests in a number of issues (e.g. derelict land, built development).

Table 3: Summary of Geodiversity Issues in Cornwall and the Isles of Scilly

Issue	Positive aspects	Negative aspects	Opportunities	Threats
Minerals extraction and restoration	Geodiversity value of Cornwall's resources is of national/international significance. Quarries provide valuable exposure sites.	Loss of landscape features in areas of high sensitivity. Perception that all mining damages the environment.	Conservation, research and educational potential can be recognised as part of restoration plans.	Waste rock disposal impacts on land take. Poor management practices damage/neglect integrity sites.
Agriculture and forestry	Good land management practices promote soil conservation and landscape geodiversity.	Intensification of farming impacts on soil quality and structure.	Agri-environmental schemes to assist conservation	Poor working practices lead to soil erosion. Large plantations reduce geological exposure.
Waste disposal and derelict land	Many abandoned mine sites are significant for biodiversity as well as geological and industrial heritage.	Visual impact of derelict sites increases pressure for redevelopment.	Survey of old quarries may provide valuable geodiversity data and highlight sources of stone for building or hedging projects.	Unregulated waste disposal in abandoned quarries.
Built development	Use of local, distinctive building materials encouraged.	Loss of exposures and landforms, impact on soils and landscape.	Recording of geological features during temporary exposures.	Any decline in environmental quality threatens economy.
Tourism, amenity use and access	Key promoters of Cornwall and the Isles of Scilly's natural environment. Many landowners have positive attitude towards geodiversity.	Concept of geodiversity not widely understood. Little direct involvement in geoconservation.	Potential to develop geotourism. WHS bid raises awareness of mining landscape.	Increased visits to geodiversity sites cause damage or exceed management capacity.
Coastal erosion and climate change	Cornwall and the Isles of Scilly's geodiversity is valuable for research into sea-level changes.	Increased rates of erosion in coastal areas. Changes to fluvial systems.	May change range of geomorphology features and processes available for study.	Flood and coastal defence plans in conflict with protection of geodiversity.
Mineral and specimen collecting	Public collections provide excellent educational resource to introduce geodiversity.	Excessive hammering and collection damages exposures.	Private collections may provide untapped source of conservation potential.	Lack of policy or code of practice to regulate collection.
Biodiversity and Historic Environment Links	Conservation bodies placing increased emphasis on linking geology to biodiversity. Protection of historic environment has a high profile in Cornwall and Isles of Scilly.	Some landowners, businesses respond poorly to nature and heritage conservation approach.	Develop geodiversity aspects to the watching brief archaeologists have for major and temporary excavations. Collaborative projects broaden potential funding sources. GAP could be linked with the Cornwall BAP process through the Biodiversity Initiative.	Geodiversity does not develop separate identity

Chapter 4 Planning and Conservation Policies

4.1 Introduction

A significant proportion of Cornwall and the Isles of Scilly's land surface is subject to some form of nature conservation designation or protection. All land areas are influenced by the advice, policies and laws generated at various levels within local and national government, government funded bodies (such as English Nature and the Environment Agency) and, increasingly from European directives.

Planning policy at the local level is contained in Local Development Frameworks (replacing Local Plans) and Minerals/Waste Development Frameworks for minerals and waste development, guided by regional and national guidance and, for the short-term, the Cornwall County Council Structure Plan. These documents inform decision making by District Councils regarding the control of built development.

The policies and working practices of major businesses, non-governmental organisations and landowners such as Imerys, The National Trust and the Duchy of Cornwall also have a great influence on nature conservation issues.

Policies and working practices therefore have a key role to play in conserving and enhancing geodiversity in Cornwall and the Isles of Scilly and it is important that geodiversity is recognised and/or remains on the agenda of policy and decision makers.

Similarly, geodiversity conservation needs to respond to, as well as influence, changing advice and policies. For example, conservation work in relation to soils can now be informed by the First Soil Action Plan for England (DEFRA, 2004).

4.2 Land Use Planning

The planning system in England and Wales was reformed in 2004, replacing the three tier system of Regional Planning Guidance, Structure Plans and Local Plans with a two tier system of a Regional Spatial Strategy (RSS) and Local Development Frameworks (LDF). Replacement Development Frameworks should be in place by 2007 although recently adopted Local Plans or parts thereof may be saved for a three year period.

Strategic policy is now the responsibility of the Regional Planning Body. Cornwall County Council is, however, still the planning authority for minerals and waste development and other "county matter" applications. Cornwall County Council is the authority with statutory control of land use, the disposal of waste, and programmes for the conservation and enhancement of the historic and natural environment. For the Isles of Scilly, effectively the same functions are performed by the Council of the Isles of Scilly. The Secretary of State at DEFRA plays an important part in dealing with planning appeals.

Development plans frameworks are informed and guided by Planning Policy Statements (PPS) which replace the former Planning Policy Guidance (PPG). A consultation draft of PPS9 *Biodiversity and Geological Conservation* has been issued which, together with a new Circular covering legislative provisions and good practice

guidance, will ultimately replace PPG9 *Nature Conservation* which provides the current national framework.

Once adopted, PPS9 is expected to raise the profile of geological conservation as it draws more specific attention, not least in its title, to geological issues. The importance of regional and local sites is strongly highlighted in PPS9:

“Regional and local sites of biodiversity and geological interest (such as Regionally Important Geological Sites and Local Nature Reserves) have a fundamental role to play in meeting overall national biodiversity targets, contributing to the quality of life and the well being of the community and in supporting research and education.”

Adoption of PPS9 will require increased attention to be focused on geodiversity, as it contains statements such as:

“Criteria-based policies should be established in local development documents against which proposals for any development on or affecting such sites will be judged.”

“policy and decision making to be based upon surveys and information about the relevant biodiversity and geological resources, and assessments of the potential to sustain and enhance them.”

This will lead to additional costs for developers, who are likely to be the ones to provide the relevant information and undertake surveys in support of an application, and may lead to additional costs for local authorities in reviewing and assessing such documentation.

4.3 Cornwall Structure Plan

A revised Cornwall Structure Plan was adopted in September 2004 and the policy for Character Areas, Design and Environmental Protection states that:

“The conservation and enhancement of sites, areas, or interests of recognised international or national importance for their landscape, nature conservation, archaeological or historic importance, including the proposed World Heritage Site, should be given priority in the consideration of development proposals.”

Specific areas afforded protection include the Areas of Great Landscape Value, identified on the basis of the Cornwall Landscape Assessment and now incorporated into District-wide Local Plans. The landscape character area approach is complemented by the protection of key sites of regional (County) importance as environmental resources; including Cornwall Wildlife Sites and County Geology Sites (RIGS). (The former designations of Areas of Great Historic Value and Areas of Great Scientific Value are no longer applied)

“Within Areas of Great Landscape Value and other areas or sites of county-wide significance for their biodiversity, geodiversity or historic interest, development proposals will be required to respect those interests.”

There is also a network of statutory and non-statutory sites identified or designated for their conservation value. Sites of national or international significance in Cornwall and the Isles of Scilly are afforded the strongest protection under specific legislation. Adverse impacts on these areas are normally only considered acceptable where the importance of the public need, in the national interest, outweighs the reasons leading to the designation. Decisions concerning development in these areas are almost inevitably the subject of a (Public) Planning Inquiry process. Cornwall Structure Plan sustainable development principles require that development must be compatible with the prudent use of resources and the conservation of natural and historic assets and that environmental values are integrated with land use.

4.4 Geodiversity and Conservation Designations

Geodiversity receives specific conservation protection from the designation of geological SSSIs (by English Nature) and County Geology Sites (RIGS) by Cornwall RIGS Group; these have previously been discussed in section 2.1.

Guidance from English Nature is that RIGS sites can be designated within existing geological SSSIs where they do not duplicate the features of geological interest but constitute an additional geological/geomorphological interest (i.e. features may be identified as being significant regionally which are not significant nationally). Some County Geology Sites in Cornwall have therefore been designated within SSSI boundaries because they recognise additional features.

Local authorities in Cornwall and the Isles of Scilly have been supportive of the establishment of County Geology Sites (RIGS) and there is an expectation that, when formally adopted, the guidance from PPS9 *Biodiversity and Geological Conservation* will enable the broader concepts of geodiversity and its conservation to become further embedded in policy and practice.

Two Geological Nature Reserves exist within Cornwall. These are sites that have been acquired by the Cornwall Wildlife Trust, in consultation with the Cornwall RIGS Group, that are important for both geological and biological reasons. They illustrate the close links that exist between the geology of an area and its wildlife habitats.

A number of other conservation areas and sites may potentially contain geodiversity interest and these include: Areas of Outstanding Natural Beauty (AONB), National Nature Reserves (NNR), Special Areas of Conservation and Areas of Great Landscape Value (AGLV). In Cornwall and the Isles of Scilly, numerous representative exposure sites of landscape, geomorphological features and soils fall within these various conservation designations.

The Cornwall AONB includes 10 stretches of coastline, the Camel Estuary and Bodmin Moor. The purpose of the designation is to conserve the natural beauty of these separate areas. Part of the Tamar AONB also lies within Cornwall. Natural beauty is taken to mean not just the look of the landscape, but includes geology and landscape features, although individual features are not protected.

The Countryside and Rights of Way Act (2000) strengthened the AONB designation and made the production of a management plan statutory. In broad landscape terms, AONBs enjoy equal status with National Parks and development proposals must have due regard to the conservation of natural beauty and character of AONBs.

The specific protection afforded to features of geodiversity interest in these areas is less well defined, however, as citations tend to refer to protection of the general character of an area rather than individual features. In this respect the attitude and policy of the local planning authorities becomes particularly important.

It should be noted, however, that there are features of Cornwall and the Isles of Scilly's geodiversity that may achieve regional, national or indeed international status in their own right, without falling within any conservation areas or sites; nor is there a presumption that these features should all be under designation. Many of the current or historic mineral extraction areas, for example provide considerable geodiversity value without requiring specific conservation.

4.5 Isles of Scilly

The entire Isles of Scilly archipelago is only 1600ha and is designated as a Conservation Area, Area of Outstanding Natural Beauty (AONB) and Heritage Coast. There are 26 Sites of Special Scientific Interest, a Special Area of Conservation under the EU Habitats Directive, a Special Protection Area under the EU Birds Directive, a Ramsar site (international designation for bird life) and a non-statutory Marine Park.

A revised Isles of Scilly Local Plan is currently at the Deposit Draft stage and will ultimately replace the Local Plan (1991) and provide a framework for guiding the development and use of land; in conjunction with existing strategies such as the Integrated Area Plan, the Area of Outstanding Natural Beauty Management Plan and the forthcoming tourism strategy.

4.6 Minerals Planning

The minerals industry makes a significant contribution to both the Cornish economy and to its geodiversity. The exploitation of Cornwall's mineral resource is considered in more detail in sections 2.8 and 3.2.

The development of minerals resources is explicitly supported by Policy 5 of the Cornwall Structure Plan, subject to consideration of environmental and social factors.

The Cornwall Structure Plan and the Minerals Local Plan support the continued development of the minerals industry in Cornwall to meet society's need for minerals, within the context of applying sustainable development to the sector as a whole. The detailed policy framework is set out in the Cornwall Minerals Local Plan which sets out a strategic approach to balancing the need for minerals, their economic importance and environmental impact.

Consideration is given to the conservation of the mineral resource whilst enabling a steady supply of minerals (where compatible with the need to protect the environment); encouraging greater efficiency and effectiveness of mineral usage; continuing to promote the reuse and recycling of waste materials; improving standards of operation of mineral working and ensuring high and consistent standards of restoration. Exploitation of Cornwall's significant resource of secondary aggregates, a by-product of the china clay industry, is encouraged. Supplementary Planning Guidance exists to provide a Tipping and Restoration Strategy for the St Austell China Clay Area.

As well as controlling development, operation and restoration of existing extractive industry sites, a key aim of the Minerals Local Plan is to see that a minerals industry in Cornwall continues and develops in future years and that long term production is sustained. Mineral Consultation Areas have therefore been established which indicate locations containing potential reserves of key minerals (china clay, metalliferous minerals, hard rock/aggregates) that should, in most circumstances, be safeguarded from sterilisation by other forms of development.

There is no presumption in favour of mineral development within Mineral Consultation Areas; applications within such areas are determined in accordance with policies in the Minerals Local Plan/ Development Framework.

4.7 World Heritage Site Bid

A bid for World Heritage Site (WHS) status for the Cornwall and West Devon Mining Landscape is being prepared by Cornwall County Council on behalf of a partnership of local and national organisations and individual experts. World Heritage Sites are examples of cultural and natural heritage that are designated as being of international importance by the United Nations Educational, Scientific and Cultural Organisation (UNESCO).

The Cornwall and West Devon Mining Landscape comprises ten areas across the region which display the best physical remains, in terms of buildings, mining landscapes and related urban areas, of the hard-rock mining industry in Cornwall and West Devon.

Although primarily aimed at facilitating the conservation, management and promotion of the region's mining heritage there is an inextricable link with the geological heritage of the selected areas. Enhanced opportunities for sustainable heritage tourism resulting from a successful bid will have implications for the region's geodiversity.

A number of the issues and targets raised in this Action Plan are shared with the World Heritage Site Management Plan and provide opportunities for a co-ordinated approach across several scientific and cultural sectors. There could, for example, be a joint initiative to further develop and enhance the accessibility, promotion and curation of public and private collections of minerals and rocks.

4.8 Working Practices

Outside of legislation and national or local government development policies, use of the land in Cornwall and the Isles of Scilly, and hence its geodiversity, is greatly influenced by the advice, schemes, and day to day practices employed at all levels by the trade organisations, businesses and individual operators involved in working with the land and its natural resources. These working practices therefore play an equally important role in conserving and enhancing geodiversity.

In various industry and development sectors there are areas where changes to working practices or design criteria can be sufficient to enhance and/or conserve geodiversity; without the need to resort to formal policies. For example, hard engineering of river flood prevention schemes can impede natural fluvial processes

and impact on the diversity of geomorphological features; while (often quite small) adjustments to planned designs can protect important integrity sites for fluvial processes while retaining the ability to protect communities and property.

Working practices in the construction and engineering sectors could be adjusted to allow the more formal recording of geology and geodiversity features; in a similar manner to the watching brief held by archaeologists for many major and temporary excavations. Further discussion of temporary excavations is given in section 3.5.2.

Many farmers are becoming increasingly involved in positive management of their land for conservation, aided by schemes such as the Countryside Stewardship Scheme and Environmentally Sensitive Areas (Environmental Stewardship will replace these in 2005). Many conservation techniques and activities that assist biodiversity (such as replacing hedgerows) also assist in boosting or retaining geodiversity and providing advice during the implementation of these schemes would be a relatively straightforward way to aid geological conservation.

Conservation and management of designated sites depends upon agreements and cooperation with landowners. The Cornwall RIGS Group maintain a position that sites will not be designated without the agreement of the landowner and that the landowner and/or manager should be involved as early as possible in developing proposals for sites.

Outcrops in inland areas and abandoned quarries etc. can quickly become overgrown by scrub vegetation which then obscures geological exposures. Weathering and erosion of rock faces creates stability/safety problems and similar stability, together with flooding, problems may develop in abandoned underground mines (and some quarries).

In most cases natural erosion and overgrowth are unavoidable and for many exposure sites present no significant threat to geodiversity. There is a lack of recent survey data for County Geology Sites, nor are there agreed plans for site management, so it is not possible to assess the level of impact of erosion and overgrowth on these sites.

Consideration of the health and safety aspects of geological conservation and the study of geodiversity in the field (or laboratory) is beyond the scope of this GAP. Good working practices have been developed across all industry and education sectors to comply with relevant legislation. Individual geologists, geological societies and informal or recreational visitors to sites of geodiversity interest need to be equally aware of safe working practices, health and safety obligations and the potential need for insurance to cover fieldwork.

4.9 Summary

A significant proportion of Cornwall and the Isles of Scilly's land surface is subject to some form of nature conservation designation or protection. All land areas are influenced by the advice, policies and laws generated at various levels within local and national government, statutory bodies and European directives. The policies and working practices of major businesses, non-governmental organisations and landowners also have a great influence on nature conservation issues.

Summary: Planning and Conservation Policies

1. Policies and working practices have a key role to play in conserving and enhancing geodiversity in Cornwall and the Isles of Scilly and it is important that geodiversity is recognised and/or remains on the agenda of policy and decision makers.
2. In general, the current designation system works well and for most scenarios is an appropriate conservation framework within which to protect Cornwall and the Isles of Scilly's geodiversity.
3. There are features of Cornwall and the Isles of Scilly's geodiversity (e.g. mineral extraction areas) that may achieve regional, national or indeed international status in their own right, without falling within any conservation areas or sites; nor is there a presumption that these features should all be under designation.
4. In various industry and development sectors there are areas where changes to working practices or design criteria can be sufficient to enhance and/or conserve geodiversity; without the need to resort to formal policies
5. PPS9 *Biodiversity and Geological Conservation*, once adopted, will give much clearer guidance on the need to conserve regional and local sites of geological interest; and require specific criteria-based policies for assessing development proposals on or affecting such sites. Additional understanding, data collection and analysis of geodiversity issues may be required by local authorities in Cornwall and the Isles of Scilly.
6. A number of conservation designations (e.g. AONB, AGLV) cover exposure sites of geodiversity interest but the specific protection afforded to these features is less well defined. In this respect the attitude and policy of the local planning authorities becomes particularly important.
7. The minerals industry makes a significant contribution to both the Cornish economy and to its geodiversity. The continued development of minerals resources is explicitly supported in the Cornwall Structure Plan, subject to consideration of environmental and social factors. Cornwall's Minerals Local Plan and the Waste Local Plan are currently under review and will be replaced by the Cornwall Minerals and Waste Development Framework.
8. Although the World Heritage Site bid is primarily aimed at facilitating the conservation, management and promotion of the region's mining heritage there is an inextricable link with the geological heritage of the selected areas and a successful bid will have implications for the region's geodiversity.

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Chapter 5 Public Awareness and Appreciation

5.1 Introduction

Geodiversity finds itself in the same position as biodiversity 15 years ago, before the 1992 Earth Summit in Rio de Janeiro successfully highlighted the concepts of biological conservation and sustainable development. These concepts have been increasingly incorporated into all levels of national and local policy making, industrial and economic development and education/lifelong learning; gaining a recognition and momentum that geological conservation needs to recreate.

It is unlikely that a similar groundbreaking event will drive geodiversity to the forefront of people's agendas or catch the media's interest in the same way (although on a regional level a successful World Heritage Site Bid could boost geoconservation as well as mining heritage). Promoting geodiversity and the importance of geoconservation is therefore going to be much harder, but no less important, in Cornwall and the Isles of Scilly.

The key priority will be to raise awareness of the wider significance of rocks, soils and physical processes in our daily lives and as a key part of our natural heritage, landscapes and scenery.

The science and issues affecting geodiversity can be difficult concepts to explain. In most circumstances the language used should be as understandable as possible, taking the target audience into consideration; demonstrating how geodiversity affects everyday life, the community and the economy, while keeping the message imaginative and exciting.

5.2 Understanding of Conservation and Science

In recent years there has been a shift away from the simple promotion of conservation and other science-based subjects to an attempt to improve public understanding through a process of engagement and dialogue, which better recognises that the public's awareness and involvement with these issues is complex and dynamic.

In the science sector a leading report, "*Science and Society*" was published in 2000 by the House of Lords Select Committee on Science and Technology; which identified concerns about the science world's ability to communicate effectively and interactively with the wider public, and has been the impetus behind a number of subsequent reports and guidelines on communicating scientific issues.

Similarly there have been numerous reports and initiatives at all levels in the conservation and sustainable development sectors since the publication of the UK Biodiversity Action Plan (BAP) in 1994, which itself included over 80 proposals to increase public awareness and foster education and training in biodiversity.

Sustainable development promotion has been driven by the UK Government's (DfES and DEFRA) Strategy for Education for Sustainable Development in England and the Sustainable Development Action Plan (both published in 2003). The Action Plan aims

to encourage wider participation in sustainable development in all education and skills sectors (schools, further and higher education bodies, and education in work, recreation and the home).

Key strands and themes emerge from a consideration of these initiatives in public awareness and understanding that can be applied to geodiversity and geoconservation in Cornwall and the Isles of Scilly:

- There remains a role for straightforward information dissemination (simply giving out information) by a variety of techniques. Information helps to inform debate about the real issues and also to allay concerns or correct misconceptions. All of the other processes of public involvement will be supported to some extent by the provision of information on geodiversity.
- Engagement is the first step in stimulating people's interest in geodiversity or conservation issues and in generally raising public awareness of the subjects and the issues surrounding them.
- Dialogue involves generating discussions and interaction between individuals and groups. This informal discussion might not feed directly into decision-making, but is crucial if the ultimate goal of making geodiversity and geoconservation one of the everyday topics of conservation is to be achieved.
- The three previous processes lead into consultation; consulting the public on issues in a process which actively contributes to decision-making. Better decisions emerge if an exchange of views, with a wide range of people, is used to inform decisions. Non-experts often raise questions experts overlook and contribute ideas drawn from different backgrounds and experiences.
- The degree of background knowledge that people bring with them can have profound effects on their views or indeed whether they have a view at all. People need access to the relevant technical information so that they can construct arguments that reflect their own views and concerns.
- A significant proportion of the public are likely to have little (initial) interest in and therefore be harder to engage in geodiversity and geoconservation, they may understand that they are important but will not see it as relevant to them personally.
- Many potential audiences will have low incomes, and their interests are likely to be much more closely related to things that impact directly and visibly on their lives. (This is of particular relevance to Cornwall and the Isles of Scilly). It is very likely that any message will have to be taken to these audiences and any events targeting these groups will need to be affordable and locally based.
- Research has shown that it is extremely unlikely that any one individual activity will have a noticeable, long-term impact on general public attitudes and that a programme of events is required to substantially improve public awareness and understanding of an issue.

5.3 Current Status

General appreciation of the recreational and amenity benefits of Cornwall and the Isles of Scilly's natural heritage and environment is widespread and for many is seen as one of the defining characteristics of living, working or visiting in the region.

The concept of geodiversity i.e. making the link between our natural heritage, landscapes and scenery and the rocks, soils and processes which shape and support them is poorly understood by the general public.

Local authorities, the minerals industry and some other business sectors have a better understanding of geodiversity because of the links between mineral resources and society's demand for economic and built development. There appears to be less awareness of issues surrounding geodiversity in the tourism sector, although there is an implicit understanding that the quality of the natural environment will be crucial to future growth prospects.

The natural environment is now acknowledged as one of Cornwall and the Isles of Scilly's main economic assets, particularly in relation to tourism but also serving as a key factor attracting inward investment in other business sectors. The challenge for promoters of geo-conservation (in combination with the industries themselves) is to complete the link back from appreciation of our natural heritage to an understanding of geodiversity and involvement with geoconservation.

Currently, events promoting awareness of geodiversity, or involvement in geological conservation are aimed primarily at (and largely attended by) those people with an interest in or already engaged with geology, mining heritage or mineral collection. Important activities are promoted by Cornwall RIGS Group, Ussher Society and the Geological Society (SW Regional Group) and include a range of talks, events and guided walks. Interpretative material and displays is used at various events such as agricultural shows, in/with schools and at conferences.

Geological and earth science related courses (AS, A2 and BSc level) are strongly promoted at a small number of Further Education and Higher Education centres in Cornwall, Plymouth and through the Open University. Here again, however, students and prospective students have already engaged with the subject and shown an interest in learning, although promotional activity from these institutions does serve, in a limited way, to disseminate information about geology into the wider public. Within these courses, specific mention of the broader concepts of geodiversity or geoconservation is more restricted. There appears to be little provision in the lifelong learning sector.

There is also some cross-collaboration with the activities of other organisations involved in the broader aspects of nature conservation, such as the Cornwall Wildlife Trust and The National Trust. English Nature and various mineral industry companies actively support a number of these initiatives. There are relatively few specific publicity campaigns or press releases.

Over the last decade a series of excellent geological guides, brochures and leaflets have been produced in Cornwall and the Isles of Scilly, as well as site interpretation boards. Their production provides noteworthy examples of how highly readable media can be produced by cooperation between private individuals and businesses

(e.g. Earthwords), voluntary groups (Cornwall RIGS Group), non-government organisations (The National Trust), education providers (Cornwall College), English Nature and the District and County Councils.

5.4 Target Sectors

As well as activities specifically designed to raise awareness in the general public; other activities aimed at particular sectors will also generate a broader dissemination of the concept of geodiversity and the issues surrounding it. Local government, landowners or managers, businesses and community groups, the tourism industry, and the education and lifelong learning sector will be key target groups, to whom the message will need to be specifically addressed, and in a different format for each.

As indicated in Chapter 4, a significant proportion of Cornwall and the Isles of Scilly's land surface is subject to some form of nature conservation designation or protection and development control rests with the local planning authorities. The policies and working practices of major businesses, non-governmental organisations and landowners such as Imerys, The National Trust, English Nature and the Duchy of Cornwall also have key role to play in conserving and enhancing geodiversity in Cornwall and the Isles of Scilly.

It is important that geodiversity is recognised and/or remains on the agenda of policy and decision makers. Specific action plans have therefore been produced which targets decision makers and the business community (see Chapter 7).

As the largest driver of the Cornish economy and one which relies so heavily on its landscape and beaches, the tourism industry needs to be more engaged in all stages of the promotion and conservation of geodiversity, on which its long-term future depends. Both the tourism sector, and those landowners and managers whose land provides recreational amenity use for residents and visitors alike, have particular significance for the promotion and conservation of geodiversity and are the subject of their own action plan (see Chapter 7).

There is a high degree of cross-over between promotional activities in the education and life-long learning sectors and the general raising of public awareness. Environmental and conservation organisations are currently very active in promoting and supporting a wide range of activities including: life-long learning (adult education) events and courses; projects and materials tied to both the National Curriculum and the non-core curriculum within schools; running clubs for children (e.g. Cornwall Wildlife Trust's Fox Club) and informal recreational activities for all age groups.

The current range of geodiversity activities is not nearly as extensive or as well integrated with educational providers, and could benefit by plugging into this much wider network of contacts and promotional events. As well as the direct provision of input, this implies that further effort will be needed to inform, engage and train information providers within the schools and lifelong learning sectors. Establishing a good working dialogue with providers will inform the development of new education and training materials.

Similarly, the interest and demand for environmental and conservation based activities from community groups has seen considerable growth in recent years. It

should be possible to highlight the role of geodiversity within nature conservation and thereby stimulate an interest and appreciation of geoconservation within the same target groups. Community projects are very effective in involving local people in learning about, and conserving, their own environment.

Geodiversity could be promoted to community groups through the contribution of articles to newsletters and poster displays, attending local shows or sending speakers to relevant meetings and events. A range of activities could be developed that could be undertaken/co-sponsored with different groups e.g. gardening clubs to help with site clearances or maintenance.

Most of the activities discussed in this section are already happening on a small scale through the (largely voluntary) efforts of dedicated individuals and organisations. It is unlikely that funding will become available to substantially increase the level of activities. Promotion of geodiversity in Cornwall and the Isles of Scilly will continue to rely, for the most part, on the support of its current practitioners and enthusiasts.

There could, however, be benefits in seeking a loose co-operative approach from those involved, whereby common logos, phrases or tag-lines are consistently used at some point in the advertising, information leaflets, display materials and publicity/press releases. Even a small level of informal branding will subconsciously reinforce the geodiversity message and promote greater awareness.

5.5 Further Opportunities

Geodiversity demonstration sites could be established and promoted using existing Sites of Special Scientific Interest (SSSIs) where geological or geomorphological criteria have been the sole or major rationale for designation. Alternatively, there are other sites which lend themselves as excellent examples of geology, landforms or processes and, in consultation and agreement with the landowner could be promoted as “type” or exemplar localities.

Raising awareness of the fundamental links between geodiversity and biodiversity would be a very simple and effective way of increasing appreciation and involvement in geoconservation, for example by increasing the number of geological nature reserves. Cornwall Wildlife Trust and the Isles of Scilly Wildlife Trust have an important role to play in this respect and should be encouraged to increase their efforts through the production of articles and information leaflets on geodiversity, organising training events and promoting geodiversity at events which the Trusts host or attend.

Opportunities will also exist to promote geodiversity and to raise awareness of Cornwall and the Isles of Scilly’s natural resources through and alongside the activities of other organisations and initiatives. This may include working with mineral extraction companies for example but, equally well, it could be to provide an additional geodiversity theme to perceived “non-geology” projects. Projects or sites where geodiversity could be included as one of the themes might include Neighbourhood Gardens, sculpture parks, amenity areas created by local authority reclamation schemes etc.

The biggest individual opportunity of this kind at present is the World Heritage Site bid for the Cornwall and West Devon Mining Landscape. Carefully managed, World Heritage Site status may offer further protection, conservation and promotion for geodiversity in some regions of Cornwall, to the advantage of the whole county.

5.6 Summary

Summary: Public Awareness and Appreciation

1. The key priority for promoting geodiversity must be to raise awareness of the wider significance of rocks, soils and physical processes as a key part of our natural heritage, landscapes and scenery, and as a vital ingredient in our leisure and economic activities. Simply put, the message must be that geodiversity is important in Cornwall and the Isles of Scilly.
2. As well as activities specifically designed to raise awareness in the general public; other activities aimed at particular sectors (e.g. businesses, community groups, education and lifelong learning) will also encourage broader dissemination of geodiversity and the issues surrounding it.
3. It is extremely unlikely that any one individual activity will have a noticeable, long-term impact on general attitudes. Promotion of geodiversity will require a more co-ordinated approach, using action plans to help guide development of a whole series of activities.
4. General appreciation of the recreational and amenity benefits of our natural heritage and environment is widespread and for many is seen as one of the defining characteristics of living and working in Cornwall and the Isles of Scilly. The natural environment is also acknowledged as a major economic asset, attracting inward investment in all business sectors.
5. Many excellent geological guides, brochures and leaflets have been produced in Cornwall and the Isles of Scilly, as well as site interpretation boards.
6. Making the link between our natural heritage, landscapes and scenery and the rocks, soils and processes which shape and support them is less well understood by most businesses and the wider community. Greater effort is needed to move attitudes from a simple appreciation of our natural heritage to an understanding of and involvement with conservation or sustainable development of those natural resources.
7. The tourism sector has particular significance for the promotion and conservation of geodiversity. As the largest driver of the Cornish economy and one which relies so heavily on its landscape and beaches, the tourism industry needs to be more engaged in all stages of the conservation of geodiversity, on which its long-term future depends.
8. Geodiversity can be a difficult concept to explain. In most circumstances the activities undertaken should use non-scientific language, demonstrating how geodiversity affects everyday life, our communities and the economy, while keeping the message imaginative and exciting.

Chapter 6 Recommendations

6.1 Introduction

The Geodiversity Audit presented in Chapter 2 and review of the issues affecting geodiversity given in Chapters 3, 4 and 5 has allowed:

- an analysis of whether the range and number of exposure and integrity sites that have been identified are a representative reflection of the geodiversity in Cornwall and the Isles of Scilly;
- identification of geodiversity features that are not adequately represented or recognised in current conservation strategies;
- exposure of gaps in the existing data coverage which prevent a full assessment being made;
- a qualitative assessment of the main issues, opportunities and threats facing geodiversity in Cornwall and the Isles of Scilly.

This chapter seeks to identify the targets for future work, taking into account the key issues identified in the preceding chapters, whilst the following chapter (Chapter 7) addresses the actions required to enable these targets to be delivered.

6.2 Recommendations Arising from the Key Issues

- Recommendation 1: Set-up infrastructure to deliver the GAP
- Recommendation 2: Complete resources and skills audit
- Recommendation 3: Improve data coverage
- Recommendation 4: Improve policy and working practices
- Recommendation 5: Raise public awareness
- Recommendation 6: Promote sustainable geotourism and amenity use
- Recommendation 7: Increase corporate awareness
- Recommendation 8: Improve links with the biodiversity and historic environment sectors

6.2.1 Recommendations, Action Plans and Targets

An explanation of the main objectives of each of these recommendations is given below.

In order to meet the objectives, an action plan has been developed for each of the recommendations. The action plan sets out the targets, and within each target there is a series of action points, which together provide a programme of work towards achievement of the recommendation.

The individual actions plans and targets are presented in Chapter 7.

Recommendation 1 SET-UP INFRASTRUCTURE TO DELIVER THE GAP

Whilst this Geodiversity Action Plan (GAP) will provide the framework for taking forward work related to geodiversity conservation in Cornwall and the Isles of Scilly, a robust infrastructure needs to be established if the GAP is to be delivered.

It is recommended that implementation of the GAP should be overseen by a small steering group representing the key partners, similar to the set up of the Cornwall Biodiversity Initiative (CBI). Indeed it would seem sensible if this group were linked to the CBI, or even a sub-group of it. It is believed that the delivery of the GAP would be easier if it were led by a full-time appointee (nominally designated the Geodiversity Officer). The absence of such an appointee should NOT, however, invalidate attempts to pursue the targets and actions outline in this Geodiversity Action Plan.

Recommendation 2 COMPLETE RESOURCES AND SKILLS AUDIT

Audit and review the resources and skills available from existing partners, potential partners and other organisations or individuals and provide feedback to demonstrate how these resources and skills could be integrated into the overall strategy for geoconservation in Cornwall and the Isles of Scilly. This should also include identifying areas (both topic-based and geographical) for future research.

Recommendation 3 IMPROVE DATA COVERAGE

Improve and extend data collection, analysis and designation of County Geology Sites in the following areas:

- a) Where there are clear gaps in data coverage or types of sites identified by the Audit.
- b) Where only a preliminary assessment of status has been made in the Audit, pending further data and consultation.

Further assessment work should include an audit of collections, to determine the coverage of mineral, rock and fossil specimens afforded by collections in public/society museums and the private sectors.

- c) Where modifications can be made to the collection and storage of data for existing and new County Geology Sites.

Improve and extend data collection and analysis relating to non-designated sites, including temporary exposures.

Recommendation 4 IMPROVE POLICY AND WORKING PRACTICES

Ensure that organisations, both statutory and non-statutory, working locally incorporate geodiversity conservation into policy documents, management plans, business plans and strategic documents. Enable these organisations to make sound

decisions concerning the geodiversity of Cornwall and the Isles of Scilly, and influence their working practices.

There is a need to capitalise on Planning Policy Statement 9 *Biodiversity and Geological Conservation* once this has been adopted.

Recommendation 5 RAISE PUBLIC AWARENESS

The key priority for promoting geodiversity must be to raise awareness of the wider significance of rocks, soils and physical processes as a key part of our natural heritage, landscapes and scenery. It is extremely unlikely that any one activity will have a noticeable, long-term impact on general attitudes. Promotion of geodiversity will require a more co-ordinated approach, using an action plan to help guide development of a whole series of activities. Efforts to raise public awareness and appreciation of geodiversity will also be aided by implementing Recommendation 8.

Recommendation 6 PROMOTE SUSTAINABLE GEOTOURISM AND AMENITY USE

Work with the tourism sector to promote sustainable geotourism and a greater understanding of the landscape and geodiversity issues. Coastal landscapes, countryside walking and visits to heritage or nature conservation sites are the main attractions bringing visitors to the region, and maintenance of the quality of the natural environment in Cornwall and the Isles of Scilly is vital. Geotourism would allow the shoulder months of the tourist season to be extended.

Recommendation 7 INCREASE CORPORATE AWARENESS

Develop links with companies and businesses, highlight where their activities can impact on geological conservation and work towards increasing their awareness of geodiversity. This has already begun with the quarrying industry.

Recommendation 8 IMPROVE LINKS WITH THE BIODIVERSITY AND HISTORIC ENVIRONMENT SECTORS

Highlight areas where links exist between the conservation of biodiversity, geodiversity and the historic environment, as a means of promoting closer working relations and collaboration between the organisations and agencies involved.

Biodiversity is inextricably linked to maintaining and managing the geological features and geomorphological processes that provide the physical settings for habitats and species and it is recommended that these links are driven in partnership with the Cornwall Biodiversity Initiative. Many sites of geodiversity (and biodiversity) interest also have historic and archaeological value and would benefit from a multidisciplinary approach to their assessment and conservation.

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Chapter 7 Action Plans

7.1 Introduction

Action plans, targets and action points have been drawn up as a result of the recommendations identified in Chapter 6.

Each recommendation has its own action plan and within each plan a simplified sense of priority for each target has been identified. Similarly costs have only been assessed on an approximate order of magnitude; they reflect anticipated levels of expenditure *per annum* and exclude the costs of staff involved.

1= highest priority	(£)	= minimal cost
2= medium priority	(££)	= £100s, low cost
3= lowest priority	(£££)	= £1,000s, moderate cost
	(££££)	= £10,000s, high cost

7.1.1 Priority targets

Action Plan 1, targets 1.1 to 1.3 and Action Plan 2, target 2.1 represent the priority tasks which need to be addressed with immediate effect.

The most critical action required from this Geodiversity Action Plan is to establish a network of partners willing to support the aims and objectives of the GAP, with a shared and agreed view on how the action plans will be delivered and funded. The positive feedback received at the consultation stage suggests that establishing a steering group of key partners will be achievable.

The remaining Action Plans make the assumption that there is an individual (nominally called the Geodiversity Officer) tasked with overseeing their implementation and acting as a leading contact for geodiversity issues in Cornwall and the Isles of Scilly. Clearly, the nature of that role/appointment, and the level of support funding attached, will define what is achievable in all other action plans.

Funding a full-time Geodiversity Officer is likely to require an additional commitment of £25-35,000 per annum (salary and on-costs). Pro-rata funding needs to be found to formally underwrite the cost of any appointment/secondment that falls short of a full-time commitment. However, the absence of such an appointment should not invalidate attempts to pursue the targets and actions outlined in this GAP.

The strategy and infrastructure developed for geodiversity in Cornwall and the Isles of Scilly will also need to address the issue of on-going funding; ensuring that sufficient resources are available to meet the recurrent or maintenance costs of projects over the medium to long term. Any process which raises public awareness also raises expectations and will place increasing demands on both the geodiversity itself and the staff charged with its conservation and management. The infrastructure developed must be suitably robust and flexible to meet this demand without compromising other action plan activities.

Whether future funding to support the implementation of the Geodiversity Action Plan comes from a single, or a variety of sources, it is important that no one organisation should be seen to have ownership of the GAP and that responsibility for promoting, enhancing and conserving geodiversity in Cornwall and the Isles of Scilly is shared by all partners.

Considerable progress on geological conservation in Cornwall and the Isles of Scilly has already been made through the dedicated efforts of part-time, largely voluntary, groups and individuals over the last few decades. This provides both an excellent base on which to build the required infrastructure and a pool of resources, skills and knowledge to help drive forward progress. Work towards the aims and objectives of this GAP will continue through these efforts, even in the absence of substantial additional resources.

Action Plan 1: SET-UP INFRASTRUCTURE TO DELIVER THE GAP

Action Plan 1: SET-UP INFRASTRUCTURE TO DELIVER THE GAP				
Target	Action(s)	Potential partners/contacts	Timescale	Priority (Cost)
1.1 Identify and approach additional partners.	Follow up responses to Consultation Draft. Invite potential partners to round-table discussions on GAP infrastructure.	All potential partners: Local Authorities, statutory bodies, Non-Governmental Organisations (NGOs), companies and individuals.	Ongoing. Main partners approached in the short term - by June 2005.	1 (£)
1.2 Establish steering group to oversee GAP implementation.	Select representative partners from key sectors. Formalise role and responsibilities of steering group. Identify lead partners for specific geodiversity action plans. Seek to link the GAP with the Cornwall Biodiversity Initiative Steering Group.	All potential partners.	Short term - complete by end of 2005.	1 (£)
1.3 Agree role of Geodiversity Officer and seek funding for post, (also see target 7.3).	Generate job description, person specification and terms of appointment. Agree and obtain secure funding route. Fund and appoint Geodiversity Officer.	All potential partners.	Short term - no later than start of 2006-07 financial year. (dependent on funding route)	1 (££££)
1.4 Initiate Monitoring and Evaluation Plan.	Establish systems for monitoring and reviewing GAP indicators (see Chapter 8).	GAP Steering Group.	Short-long term.	1-2 (££)
1.5 Seek funding for development and maintenance of all action plans to ensure long-term viability, (also see target 7.3).	Identify potential funding routes. Open dialogue with funding bodies and potential sponsors. Submit grant applications.	All partners, Funding bodies (government and industry).	Short-long term.	1-2 (£££)

Action Plan 2: COMPLETE RESOURCES AND SKILLS AUDIT

Action Plan 2 COMPLETE RESOURCES AND SKILLS AUDIT				
Target	Action(s)	Potential partners/contacts	Timescale	Priority (Cost)
2.1 Audit and review the resources and skills possessed by partners and other organisations or individuals.	<p>Identify additional consultees.</p> <p>Consult with bodies undertaking similar initiatives to avoid duplication of effort (e.g. Enviroskills).</p> <p>Design a survey to assess and record the available resources, skills and on-going projects within partner organisations and individuals.</p> <p>Generate and maintain database of resources and skills relating to geodiversity and geoconservation in region. (Note requirements of Data Protection Act).</p> <p>Analyse responses and feedback into discussions on development of infrastructure.</p>	All potential partners: (Local Authorities, organisations, companies, educational establishments and individuals)	Ongoing. Short-long term.	1 (£££)
2.2 Identify areas for research into geodiversity conservation.	<p>Identify current status of research into conservation of geodiversity in terms of:</p> <ul style="list-style-type: none"> (a) national/international good practice (b) research within Cornwall and the Isles of Scilly. <p>Develop and/or maintain links with research organisations or individuals to foster two-way dialogue on issues of importance to Cornwall and the Isles of Scilly.</p> <p>Provide input into research projects as and when requested.</p> <p>Identify potential sources of research funding, formulate grant proposals and/or commission research into specific issues/geodiversity problems.</p>	Academic departments, institutes (e.g. British Geological Survey, National Soils Resources Institute), industry or sector funding bodies (e.g. Aggregates Levy Sustainability Fund, Local Intelligence Network Cornwall, Environmental Research and Intelligence Network) and individual researchers.	Medium-long term.	2-3 (££)

Action Plan 3: IMPROVE DATA COVERAGE (Plans 3A, 3B and 3C)

Action Plan 3A DATA COVERAGE: CLOSE GAPS IN DATA COVERAGE				
Target	Action	Potential partners/contacts	Timescale	Priority (Cost)
3A.1 Devonian sites in East Cornwall (South Devon–Trevone Basin).	Desk review of potential sites; followed by site survey and assessment against County Geology Site criteria.	British Geological Survey (BGS) - Sheet 348 mapping team, Academics/researchers, Cornwall RIGS Group, Devon RIGS Group.	Short term.	1 (£-££)
3A.2 Basinal and rise facies lithologies in East Cornwall (Tavy Basin, Culm Basin).	Desk review of potential sites; followed by site survey and assessment against County Geology Site criteria.	BGS, Academics/researchers, Cornwall RIGS Group, Devon RIGS Group.	Short term.	1 (£-££)
3A.3 Tertiary (esp. Dutson Formation).	Site survey and assessment against County Geology Site criteria.	Cornwall RIGS Group.	Short term.	1 (£-££)
3A.4 Granites and associated rocks (Carnmenellis, Isles of Scilly plutons; lamprophyres).	Desk review of potential sites; followed by site survey and assessment against County Geology Site criteria.	Quarry companies, Academics/researchers, Cornwall RIGS Group, Isles of Scilly Wildlife Trust.	Short-medium term.	1-2 (£-££)

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Action Plan 3B DATA COVERAGE: COMPLETE ASSESSMENT OF STATUS				
Target	Action(s)	Potential partners/contacts	Timescale	Priority (Cost)
3B.1 Variscan and other key structural features.	Further desk review and consultation (particularly for Gramscatho and Tavy Basins, pre-Devonian structural features and basin-defining faults). Re-assess sufficiency of sites afforded conservation status.	British Geological Survey (BGS), Academics/researchers, Cornwall RIGS Group, Geological societies.	Short-medium term.	1-2 (££)
3B.2 Quaternary sediments and features (integrity sites).	Further desk review and consultation. Re-assess sufficiency of sites afforded conservation status.	Academics/researchers, Cornwall RIGS Group, Geological societies, BGS.	Short-medium term.	1-2 (££)
3B.3 Geomorphological sites (Fluvial, mass movement).	Further desk review and consultation. Re-assess sufficiency of sites afforded conservation status.	Academics/researchers, Cornwall RIGS Group, Geomorphological societies.	Short-medium term.	1-2 (££)
3B.4 Economic geology: audit of local stone quarries.	Contribute to survey of abandoned pits and quarries. Develop a project team to analyse building stone types and potential sources.	Historic Environment Service - Cornwall County Council (CCC), The National Trust, Cornwall AONB Partnership, Minerals Policy Team (CCC), Cornwall Hedge Group, Cornwall RIGS Group.	Ongoing (by HES). Short-long term.	2 (£££)
3B.5 Audit of collections (Minerals species, rocks and fossils).	Audit and assess coverage afforded by collections in public/society museums. Initiate dialogue with private collectors.	Academics/researchers, Cornwall RIGS Group, Geological societies, Museums, Private collectors.	Medium-long term.	2 (£££)
3B.6 Styles of mineralisation and mineral species.	Further desk review and consultation (linked to 3B.5). Re-assess sufficiency of sites afforded conservation status.	BGS, Academics/researchers, Cornwall RIGS Group, Geological societies.	Medium-long term.	2-3 (££)
3B.7 Fossil sites.	Further desk review and consultation (linked to 3B.4). Re-assess sufficiency of sites afforded conservation status.	Academics/researchers, Cornwall RIGS Group, Geological societies, BGS.	Medium-long term.	2-3 (££)

Action Plan 3B DATA COVERAGE: COMPLETE ASSESSMENT OF STATUS				
Target	Action(s)	Potential partners/contacts	Timescale	Priority (Cost)
3B.8 Soils (rare sub-groups and individual soil series).	Further desk review and consultation. Access/interrogate Geographical Information Systems (GIS) versions of soil survey data. Re-assess conservation status and practices of soils.	National Soil Resources Institute, BGS, DEFRA, Farming and Wildlife Advisory Group, Environment Agency, Academics/researchers.	Medium-long term.	2-3 (£££)
3B.9 Target identification and closure of data. coverage gaps	Where further gaps in data coverage identified, move to site survey and assessment against County Geology Site criteria.	Cornwall RIGS Group.	Follows on from other 3B actions.	1-2 (£-££)

Action Plan 3C DATA COVERAGE: IMPROVE COLLECTION AND STORAGE OF DATA				
Target	Action(s)	Potential partners/contacts	Timescale	Priority (Cost)
3C.1 Develop electronic database of County Geology Sites to improve data storage.	Design and create database system to replace current paper-based filing system and to improve links with Cornwall Wildlife Trust's and other potential partners' Geographical Information Systems (GIS) systems. Link this with work on updating site proposal forms, site descriptions, threats etc. in order to standardise terminology (see targets above). Future-proof design to allow for development of related databases/GIS based tasks. Consider later use of open-access versions of database.	Cornwall RIGS Group, Environmental Records Centre for Cornwall and the Isles of Scilly (ERCCIS), Cornwall Wildlife Trust (CWT).	Short-medium term	1 (££-£££)
3C.2 Review and re-survey County Geology Sites to assess level of threat, sites at risk.	Further desk review and consultation. Standardise assessment and reporting of threats. Physical survey of sites to assess status of sites and level of threat. Flag up sites at risk and consult with landowners and interested parties to agreed suitable mitigation strategy.	Cornwall RIGS Group, English Nature, CWT, Landowners and site managers.	Ongoing. Short-medium term.	1-2 (££-£££)
3C.3 Clear backlog of County Geology Sites on hold.	Prioritise County Geology Sites currently awaiting registration or deferred against findings of Audit. Assess potential for progressing these sites in short-term. De-select non-priority sites on which progress is likely to remain stalled. Fast-track designation of priority sites.	Cornwall RIGS Group, ERCCIS, Landowners, Local Authorities.	Ongoing. Complete in 2005.	1-2 (£)
3C.4 Revise, standardise and update County Geology Site descriptions.	Desk review and consultation. Update and revise descriptions held. Identify and remove designation from any sites not reaching appropriate standard.	Cornwall RIGS Group, ERCCIS.	Short-medium term.	1-2 (£)
3C.5	Desk review and consultation of	Cornwall RIGS Group,	Short-	2

Action Plan 3C DATA COVERAGE: IMPROVE COLLECTION AND STORAGE OF DATA				
Target	Action(s)	Potential partners/contacts	Timescale	Priority (Cost)
Review and update County Geology Site proposal forms and site selection criteria.	current practice. Modify proposal forms. Revise and agree assessment, designation and notification criteria to be applied to sites.	UKRIGS, English Nature, ERCCIS, CWT, Local Authorities.	medium term.	(£)
3C.6 Increase the use made of temporary exposures.	Improve mechanisms for the recording and wider reporting of temporary exposures of geological significance. Develop system for reporting features to the wider geological community (also see target 3C.8). Encourage use of watching brief for temporary exposures (in a similar way to archaeological practices).	Cornwall RIGS Group, ERCCIS, Developers, Civil engineers and utility companies, Local Authorities (Building Control, County Highways etc.).	Short-long term.	2 (£-££)
3C.7 Identify new potential sites as geodiversity related work progresses.	Maintain watching brief (with help through partners) on current research, mapping work and mine/quarry exposures. Identify new potential sites and feed into County Geology Site system. Record features of geodiversity interest from new exposures.	Academic journals and conferences, Ussher Society, Cornwall RIGS Group, ERCCIS, Quarry operators, Developers and civil engineers, British Geological Survey, CWT.	Short-long term.	2 (£-££)
3C.8 Encourage wider sharing of earth science data.	Establish network and methods of dissemination of data, including site-based information.	All potential partners.	Medium-long term.	2-3 (£-££)

Action Plan 4: IMPROVE POLICY AND WORKING PRACTICES

Action Plan 4: IMPROVE POLICY AND WORKING PRACTICES				
Target	Action(s)	Potential partners/contacts	Timescale	Priority (Cost)
4.1 Continue and expand review of policy documents and method statements from local authorities and key organisations.	<p>Regularly meet and maintain good working relationships with all key partners.</p> <p>Encourage pro-active inclusion of geodiversity input into draft stages of plans or proposals.</p> <p>Obtain documentary versions of relevant policies or schemes or verbally consult with partners.</p> <p>Work to ensure views on conserving geodiversity and best practice (e.g. as outlined in recent EN brochures for the Minerals Industry) are included in the Minerals Development Framework.</p>	Local Authorities, English Nature, Imerys, Institute of Quarrying, The National Trust, Cornwall Wildlife Trust, Duchy of Cornwall, Government Office South West, DEFRA, Country Landowners Association, National Farmers Union, Environment Agency.	Ongoing. Short-long term.	1-2 (£-££)
4.2 Provide advice and support to enable decision makers to include or enhance policies/practices which safeguard geodiversity.	<p>Regularly invite representatives of key partners to attend geodiversity based events and discussions.</p> <p>Produce factsheets, position papers and dedicated workshop sessions targeted at specific user groups e.g. planners, quarry owners, forestry managers etc.</p> <p>Seek representation on appropriate focus groups.</p>	All potential partners.	Ongoing. Short-long term.	1-2 (££-£££)
4.3 Look to embed good working practices into management plans and business activities.	<p>Use factsheets, position papers and newsletters as a means of disseminating latest knowledge on good/best conservation practice to all partners.</p> <p>Work with representative industry bodies to encourage uptake of conservation-based initiatives and best practice advice (from whichever source).</p>	All potential partners.	Medium-long term.	2-3 (£-££)

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Action Plan 5: RAISE PUBLIC AWARENESS

Action Plan 5: RAISE PUBLIC AWARENESS				
Target	Action(s)	Potential partners/contacts	Timescale	Priority (Cost)
5.1 Raise general levels of awareness.	<p>Actively promote geodiversity through newsletters and articles/posters distributed by partner organisations, and through the promotion of Cornwall RIGS Group and other related websites.</p> <p>Send regular press releases on action plan progress, new County Geology sites, major finds etc. to local media.</p> <p>Contribute to and/or lead at least 1 event a year specifically aimed at raising geodiversity awareness.</p> <p>Attend local shows, send speakers or give poster displays at relevant meetings and events.</p> <p>Seek permission to devise text and questionnaire for inclusion in local authorities' focus group surveys (e.g. Kerrier Matters Citizens Panel).</p>	<p>Local and regional media, All potential partners, Community groups, Schools, Museums, Geo-conservation specialists and writers, Local Authorities, Cornwall Wildlife Trust (CWT).</p>	Ongoing. Short-long term.	1 (££-£££)
5.2 Use a range of media to more widely disseminate information on geodiversity and conservation.	<p>Continue support for production of high quality geological guides, brochures and leaflets for public use.</p> <p>Seek approval to embed hyperlinks to RIGS Group web pages within a range of partner's websites.</p> <p>Encourage further on-line access to information.</p> <p>Prepare display materials for museum exhibitions and/or for innovative displays in art galleries, garden centres etc.</p>	<p>Cornwall RIGS Group Geo-conservation specialists and writers Partner organisations Local Authorities Geological societies Museums CWT Environmental Records Centre for Cornwall and the Isles of Scilly (ERCCIS).</p>	Short-long term.	2 (££-£££)
5.3 Increase community involvement in geodiversity conservation.	<p>Identify community groups that can contribute to conservation activities.</p> <p>Devise a range of activities that can be undertaken/co-sponsored by different groups e.g. gardening clubs to help with site clearances or maintenance.</p> <p>Offer assistance, or provide materials, to community projects exploring geodiversity themes.</p>	<p>All potential community partners Parish councils, regeneration groups and Integrated Area Plan (IAP) teams.</p>	Short-long term.	2-3 (££-£££)

Action Plan 5: RAISE PUBLIC AWARENESS				
Target	Action(s)	Potential partners/contacts	Timescale	Priority (Cost)
5.4 Create Geodiversity Demonstration or Exemplar sites.	<p>Identify key earth science sites in the county that exhibit excellent, easily understandable examples of geology, landforms or processes.</p> <p>Consult with landowners and interested parties to agree access to and wider use of site as for demonstration purposes.</p> <p>Develop specific materials for both on-site and virtual use (interpretation boards, digital images etc.).</p> <p>Develop fieldcourses, guided trips around exemplar sites.</p> <p>Provide way-marked trails with information boards in regions where good geodiversity sites occur in close proximity (e.g. Lizard).</p>	<p>Landowners</p> <p>English Nature</p> <p>Geo-conservation specialists and writers</p> <p>Cornwall RIGS Group</p> <p>Local interest groups</p> <p>Education and lifelong learning partners</p> <p>Local Authorities</p> <p>Cornish Tourist Board.</p>	Short-long term.	2-3 (££-£££)
5.5 Build on partnerships with Education and Lifelong Learning providers.	<p>Develop a targeted education programme that complements existing curriculum (e.g. National Curriculum, Sense of Place project, FE/HE modules etc.).</p> <p>Create stronger links with science-based colleges and departments.</p> <p>Link into out of school projects and clubs. Get kids involved!</p> <p>Develop relationships with lifelong learning organisations.</p>	<p>Local Education Authorities (Science Advisors)</p> <p>Primary and Secondary Head Associations</p> <p>Further Education and Higher Education institutions (inc.UoTA)</p> <p>Open University</p> <p>Education Otherwise</p> <p>Geo-conservation writers.</p>	Ongoing. Short-long term.	2 (£-££)
5.6 Use other initiatives as a springboard for geodiversity publicity.	<p>Identify existing and forthcoming initiatives.</p> <p>Tailor geodiversity publicity to slot into current vogues (e.g. urban trails highlighting use of local stones).</p> <p>Actively seek partnerships and involvement in schemes.</p> <p>Provide the geodiversity slant to perceived “non-geology” projects/sites (e.g. Neighbourhood Gardens, sculpture parks etc.).</p>	<p>Local Authorities</p> <p>Minerals companies</p> <p>Environment Agency</p> <p>DEFRA</p> <p>World Heritage Bid Partnership</p>	Short-long term.	2-3 (££)
5.7 Rename Cornwall RIGS Group?	<p>Cornwall RIGS Group to discuss name change at an Executive Committee meeting.</p> <p>Consider adopting more recognisable name e.g. Cornwall Geology Group.</p>	<p>Cornwall RIGS Group</p> <p>CWT</p> <p>ERCCIS</p>	Short term	1 (£)

Action Plan 6: PROMOTE SUSTAINABLE GEOTOURISM AND AMENITY USE

Action Plan 6: PROMOTE SUSTAINABLE GEOTOURISM AND AMENITY USE				
Target	Action(s)	Potential partners/contacts	Timescale	Priority (Cost)
6.1 Include tourism representatives on GAP steering group.	Invite active representation from Cornish Tourist Board and/or other key tourism players on Steering Group for geodiversity.	Cornish Tourist Board (CTB), English Nature, The National Trust, Country Landowners Association (CLA) National Farmers Union.	Short-long term.	1 (£)
6.2 Develop a voice within appropriate industry bodies and focus groups.	Gain representation on appropriate industry bodies. Produce factsheets, position papers and dedicated workshop sessions targeted at tourism and amenity use sectors.	All tourism/amenity partners, Cornwall RIGS Group.	Short-long term	1-2 (££-£££)
6.3 Increase awareness and understanding of geodiversity. (also see Action Plan 5)	Actively promote geodiversity through newsletters and articles/posters distributed by partner organisations. Contribute to and/or lead at least 1 event a year specifically aimed at raising geodiversity awareness in tourism/amenity use sector. Attend local shows, send speakers or give poster displays at relevant meetings and events. Provide link for tourism providers/promoters to check suitability of proposed destinations or activities against geodiversity sensitivity.	Tourism partner organisations, Landowners and representative groups (e.g.CLA), Cornwall RIGS Group, Geo-conservation specialists and writers, Cornwall County Council, Educational establishments.	Short-long term	1-2 (££)
6.4 World Heritage Status.	Support WHS Bid for Cornwall and West Devon Mining Landscape. Ensure management plans for bid sites include recognition and protection of geodiversity.	WHS Bid Partnership	Short term	1 (£)
6.5 Promote sustainable geotourism.	Work with Tourist Boards to ensure that geodiversity is included as a selling point for tourism in Cornwall and the Isles of Scilly. Continue support for production of high quality geological guides, brochures, leaflets and trails for public use.	Tourism partner organisations, Geo-conservation specialists and writers, English Nature, Cornwall RIGS Group, Educational establishments.	Medium-long term	2-3 (££-£££)

Action Plan 6: PROMOTE SUSTAINABLE GEOTOURISM AND AMENITY USE				
Target	Action(s)	Potential partners/contacts	Timescale	Priority (Cost)
6.5 [cont.]	<p>Draw up code of conduct for marketing of geotourism so that sensitive sites or those at risk are not adversely targeted.</p> <p>Develop partnerships providing geodiversity conservation holidays (e.g. as in The National Trust schemes).</p>			
<p>6.6</p> <p>Look to embed good working practices into management plans and business activities.</p>	<p>Use factsheets, position papers and newsletters as a means of disseminating latest knowledge on good/best conservation practice to all partners.</p> <p>Work with representative industry bodies to encourage uptake of conservation-based initiatives and best practice advice.</p>	All tourism/amenity partners, Landowners.	Medium-long term	2-3 (£-££)

Action Plan 7: INCREASE CORPORATE AWARENESS

Action Plan 7: INCREASE CORPORATE AWARENESS				
Target	Action(s)	Potential partners/contacts	Timescale	Priority (Cost)
7.1 Develop a voice within appropriate industry bodies and focus groups.	Gain representation on appropriate industry bodies and/or invite representation from these sectors on Steering Group for geodiversity. Produce factsheets, position papers and dedicated workshop sessions targeted at community and business sectors.	Chambers of Commerce, Country Land and Business Association, Cornwall RIGS Group, Minerals and extraction industries.	Short-long term.	1-2 (££-£££)
7.2 Increase awareness and understanding of geodiversity (also see Action Plan 5).	Actively promote geodiversity through newsletters and articles/posters distributed by partner organisations. Contribute to and/or lead at least one event a year specifically aimed at raising geodiversity awareness in the business community. Attend local shows, send speakers or give poster displays at relevant meetings and events.	All potential partners.	Short-long term.	1-2 (££)
7.3 Seek partners for funding action plans (see also targets 1.3 and 1.5).	Identify and approach business partners to fund site specific conservation or specific initiatives/activities.	All potential business partners.	Short-long term.	1-2 (£-££)
7.4 Increase business involvement in geodiversity conservation.	Identify business groups that can contribute to conservation activities. Devise a range of activities that can be undertaken/co-sponsored by different companies e.g. engineering firms to help with site clearances, design firms to help with information boards, web-design etc. Develop opportunities for joint publicity or promotion by association. Provide the geodiversity slant to perceived "non-geology" projects/sites.	All potential business partners.	Medium-long term.	2-3 (££-£££)

Action Plan 8: IMPROVE LINKS WITH BIODIVERSITY AND HISTORIC ENVIRONMENT SECTORS

Action Plan 8: IMPROVE LINKS WITH BIODIVERSITY AND HISTORIC ENVIRONMENT SECTORS				
Target	Action(s)	Potential partners/contacts	Timescale	Priority (Cost)
8.1 Raise awareness of geodiversity among nature conservation and historic environment staff.	Circulate GAP widely. Organise workshop on geodiversity for Cornwall Biodiversity Initiative partners and Historic Environment practitioners.	Cornwall Wildlife Trust (CWT) staff and volunteers, Cornwall Biodiversity Initiative (CBI), Historic Environment Services- Cornwall County Council (CCC), Cornwall Archaeological Society, Geo-conservation experts/training providers.	Ongoing. Short-medium term.	1-2 (££-£££)
8.2 Disseminate information on examples of multi-disciplinary projects in Cornwall and the Isles of Scilly.	Develop and distribute fact sheets or newsletter items. Write articles for trade magazines or journals.	CWT, CBI, Cornwall RIGS Group, Historic Environment Services (CCC), Cornwall Archaeological Society.	Short-long term.	2 (£-££)
8.3 Train and support archaeological and conservation site staff to audit own sites for geodiversity potential.	Desk review of potential sites. Develop a pro-forma sheet to enable (5-10?) site-based staff to undertake own preliminary geodiversity site surveys. Offer workshop support to survey teams to integrate results into site information boards, management plans etc.	Archaeological societies and organisations, Historic Environment Services (CCC), CWT staff and volunteers, Other conservation bodies (The National Trust, RSPB etc.), Cornwall RIGS Group, Geo-conservation experts/training providers.	Medium-long term.	2 (££-£££)
8.4 Participate in high-profile projects which could establish best practice linking all aspects of environmental management and conservation.	Establish dialogue with suitable project teams and organisations. Provide skills and knowledge on geodiversity issues.	Environment Agency, Environment and Heritage Service (CCC), Cycleau Project team, GeoValue Forum, English Nature, WHS Bid, Penlee Quarry re-development.	Ongoing. Short-long term.	1-2 (££-£££)
8.5 Broaden the multi-disciplinary approach.	Combine activities on geodiversity action plans with current projects run by Historic Environment Services (CCC), English Heritage etc.	Cornwall County Council, English Heritage, Cornwall RIGS Group.	Short-long term.	2-3 (£)

Chapter 8 Monitoring and Evaluation

8.1 Introduction

The overall success of the Geodiversity Action Plan will be judged by measuring progress against the main objectives presented in Chapter 1. These objectives are in turn subject to a series of Action Plans (Chapter 7) which have evolved from the Geodiversity Audit and consideration of the various issues affecting geodiversity.

Monitoring progress and evaluating the success of the various targets and actions proposed in the individual Action Plans requires a system of measurement against indicators which can be used to assess changes to the status of geodiversity in Cornwall and the Isles of Scilly. Many of the individual Action Plans are inter-related and rather than develop a whole raft of indicators for each one, it is suggested that a generic set of indicators be used to measure progress as a whole. These indicators, and the objectives they measure progress against, are discussed in section 8.2.

8.2 Geodiversity Action Plan Monitoring

8.2.1 GAP Indicators

A set of indicators have been selected which are measurable, rather than subjective, and which can be easily applied to the objectives of the Geodiversity Action Plan. A draft Monitoring Action Plan is given below; this sets out the indicators and the mechanisms that could be used to collect data on them.

The indicators should be measured annually and reported as one of the key items in any progress reports or annual review of the Geodiversity Action Plan.

It is likely that these indicators will evolve over time, and with further consultation, and it is suggested that any annual review includes an evaluation of the usefulness of individual indicators and allows for their refinement.

8.2.2 Monitoring of Sites

One of the findings of the Geodiversity Audit, is that currently there is insufficient data on County Geology Sites to quantify the number that may be under threat, the significance or nature of those threats or to prioritise sites in order to target mitigation measures. Development of an appropriate monitoring system is highlighted as a target in Action Plan 3C. Detailed guidance is also available from the Common Standards Monitoring Guidance for Earth Science Sites (JNCC, 2004).

Not all features of geodiversity significance fall under various conservation designations, nor is it appropriate for them to do so, and monitoring of these is often afforded less significance. Informal monitoring of sites tends to occur as a result of the dialogue generated by the network of contacts and working relationships established between landowners, mineral operators, geologists and conservation workers. It is difficult to see how this informal approach, relying on goodwill and good working practices, could be improved upon with anything more practical.

8.3 MONITORING AND EVALUATION PLAN

MONITORING AND EVALUATION PLAN			
GAP Objective	Indicators	Mechanism/source of data	Action Plans monitored
1. Undertake an audit of the geodiversity of Cornwall and the Isles of Scilly, to identify and summarise the status of our geological assets.	Completion of Geodiversity Audit; (Progress on targets in Action Plan 2 and 3B). Development of database of resources and skills.	Progress reports (by Geodiversity Officer).	2, 3B
2. Develop targets and action plans which provide for the future conservation and sustainable development of Cornwall and the Isle of Scilly's geodiversity.	Increase in number of designated geodiversity sites.	English Nature, Cornwall RIGS Group and Local Planning Authority records.	3A, 3B, 3C
	Increase in % of SSSI sites meeting favourable management status (national Public Service Agreement target).	English Nature records.	
	Completed review of County Geology Sites.	Progress reports (Geodiversity Officer).	
	Reduction in number of proposed County Geology Sites on hold.	Cornwall RIGS Group records.	
	Increase in % of County Geology Sites meeting favourable management status (or similar).	Cornwall RIGS Group records.	
	Changes in land uses and landscape character.	Environmental Records Centre for Cornwall and the Isles of Scilly (ERCCIS), Cornwall County Council and AONB Team records.	
3. Improve recognition of the economic and amenity value of Cornwall and the Isles of Scilly's natural resources and promote the sustainable development of these resources.	Recognition/awareness improved by 10% (per annum) across all target audiences and general public.	Surveys, questionnaires, informal polls. Feedback from industry representatives.	4, 5, 6 and 7
	Attendance at training events/workshops on geoconservation.	Training course records.	
	Reduction in the number of sites lost/impacted by development schemes.	Local Planning Authority records.	

MONITORING AND EVALUATION PLAN			
GAP Objective	Indicators	Mechanism/source of data	Action Plans monitored
4. Promote awareness of the geodiversity and geological heritage of Cornwall and the Isles of Scilly, at all levels from government policy makers through to school children.	Recognition/awareness improved by 10% (per annum) across all target audiences and general public.	Surveys, questionnaires, informal polls.	4, 5, 6 and 7
	Attendance at training events/workshops on geoconservation.	Training course records.	
	Increase in promotional events hosted/attended.	Geodiversity Officer records, feedback from other organisations.	
	Increase in requests for information on geodiversity related subjects.	Geodiversity Officer records, feedback from other organisations, website hits.	
5. Encourage greater involvement in geoconservation issues from local communities and businesses.	Increase in demand for assistance with projects.	Geodiversity Officer records, feedback from other organisations.	5 and 7
	Increase in number of conservation volunteers, geological society members etc.	Geodiversity Officer records, feedback from other organisations.	
	Increase in level of funding/business support.	Financial records (Geodiversity Officer).	
6. Encourage wider collaboration between the earth science and the biodiversity and historic environment communities.	Recognition/awareness improved by 10% (per annum).	Surveys, questionnaires, informal polls.	8
	Increase in collaborative projects undertaken.	Geodiversity Officer records.	
	Attendance at training events/workshops on geoconservation.	Training course records.	

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Appendix 1: Key Sources of Information

The following data sources provided key information for the preparation of this Geodiversity Action Plan:

- Cornwall RIGS Group archives
- Volumes 1-11 of the Proceedings of the Ussher Society (Geoscience in south-west England)
- District Council Local Plans and Deposit Drafts
- Memoirs and Sheets of the British Geological Survey
- English Nature Research Reports, Natural Area Profiles, Shoreline Management Plans

Websites and on-line databases from the following organisations were also important sources of information:

- UK RIGS (www.ukrigs.org.uk)
- Cornwall RIGS Group (www.cornwallwildlifetrust.org.uk/rigs)
- Cornwall County Council (www.cornwall.gov.uk)
- English Nature (www.english-nature.org.uk)
- GeoMinCentre, Camborne School of Mines (www.ex.ac.uk/geomincentre)

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The following key references were extensively used as sources of information; the complete list of references can be found towards the end of this document.

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Appendix 2: List of Consultees

List of consultees for the Geodiversity Action Plan

The organisations and individuals consulted whilst producing the GAP are listed below; they all had the opportunity to comment on an external Consultation Draft of the GAP. Those individuals who responded with comments are indicated and their input acknowledged with thanks.

Organisation	Individual
Local authorities:	
Cornwall County Council: Historic Environment Service	Steve Hartgroves
Cornwall County Council: Natural Environment Service	Andrew Goodman, Scott Sharples,
Cornwall County Council: Minerals Policy Team	Adrian Lea, Carol Foster
World Heritage Site Office	Simon Thorpe, Deborah Boden.
Carrick District Council: Community Planning Service	Martin Woodley
Penwith District Council: Museums & Heritage	Tamsin Daniel
Cornwall County Council: Spatial Planning Cornwall County Council: ANOB Team Cornwall County Council: Cycleau Project Caradon District Council Kerrier District Council North Cornwall District Council Restormel Borough Council	
Statutory agencies:	
Defra	Pat Lehain
Environment Agency	Martin Rule
English Nature: Cornwall and Isles of Scilly Team	Beth Tonkin
English Nature: National	Jonathan Larwood
NGOs/local groups (non-geology):	
Cornwall Wildlife Trust: ERCCIS	Sarah Board, Sue Hocking
Cornwall Tourist Board	Deborah Smith
Cornwall Archaeological Society	Henrietta Quinnell
Cornwall Coastal & Environmental Agency	Pat Sargeant
The National Trust	Janet Lister
Royal Cornwall Museum	Sara Chambers

Organisation	Individual
Campaign for the Protection of Rural England Cornwall Sustainable Tourism Project Country Landowners Association Farming and Wildlife Advisory Group (CCC) Institute of Quarrying – Devon & Cornwall Branch Isles of Scilly Wildlife Trust North Cornwall Heritage Coast & Countryside Service RSPB	
Geology groups/consultants:	
Cornwall RIGS Group	Peter Ealey, Simon Camm, Colin Bristow
Devon RIGS Group	Kevin Page
David Roche Geoconsulting	Clive Nicholas
Earthwords	John Macadam
Geological consultant	Eric Robinson
Spalding Associates (Environmental Ltd.) British Geological Survey Geological Society (South West Regional Group) Royal Geological Society of Cornwall Russell Society Ussher Society	
Academic institutions:	
Open University	Linda Fowler
University of Exeter in Cornwall	Robin Shail, Prof. Peter Scott
University of Plymouth	Prof. Malcolm Hart, Jim Griffiths
Cornwall College Group (Geology) Living Earth Centre, Saltash Community School	
Businesses, organisations:	
Duchy of Cornwall Eden Project Goonvean Ltd. Imerys	

Appendix 3: Geological SSSI designations

Geological SSSI designations in Cornwall and Isles of Scilly

SSSI name	Area (ha)	Interest	Grid reference	Geological description	Geological Conservation Review Sites
Aire Point to Carrick Du	597.22	Biological/ Geological	SW392360	Intrusion of Land's End granite into Gramscatho Basin (Mylor Slate Formation) metasediments and volcanics. Some basic lavas contain granitoid (basement) xenoliths. Low-grade contact metamorphism of basic sills and pillow lavas within the aureole. Contact between the granite and metasediments shows pods of pegmatites and aplite, tourmalinisation and evidence of K metasomatism. Two small outlying granite stocks at Portmeor Cove show pegmatite and granite veins in the roof zone. Botallack Mine and Wheal Owles yielded important suites of secondary Cu minerals, together with some Pb and U secondaries and skarn mineralisation. Raised boulder beach overlain by head at Porth Nanven.	Gurnard's Head Carrick Du to Clodgy Point Botallack Head to Porth Ledden Porth Nanven Cape Cornwall Porthmeor Cove Priest's Cove Botallack Mine to Wheal Owles
Baulk Head to Mullion	151.77	Biological/ Geological	SW664200	Gramscatho Beds (turbidites) and Roseland Breccia Formation (olistostrome). Coastal section through the Meneage mélange including faulted contact with the Lizard Complex.	Baulk Head to Gunwalloe Church Loe Bar Poldhu Cove to Polurrian Cove
Bedruthan Steps & Park Head	80.98	Biological/ Geological	SW847702	Bedruthen and Trevoze Slate formations (Lower Middle Devonian). Fossiliferous slates with primitive fish.	Bedruthan Steps Bedruthan Steps
Belowda Beacon	0.47	Geological	SW972627	Former mine workings expose topaz-tourmaline quartz rock with large euhedral topaz crystals.	Belowda Beacon
Boscastle to Widemouth	641.4	Biological/ Geological	SX146976	Type area for the Crackington Formation (Upper Carboniferous); shales and turbiditic sandstones with fossiliferous horizons containing ammonoids. Exposure of Rusey Fault Zone and strongly folded and faulted slates and sandstones of Crackington and Bude formations.	Widemouth to Saltstone Strand Widemouth to Crackington Boscastle Millook to Foxhole Point Rusey Cliff to Buckator
Boscawen	5.6	Geological	SW422230	Granitic shore platform with facies variations in raised beach and head deposits. Fossil cliff notches.	Boscawen

SSSI name	Area (ha)	Interest	Grid reference	Geological description	Geological Conservation Review Sites
Bude Coast	60.24	Biological/ Geological	SS201068	Bude Formation (Upper Carboniferous); folded and faulted sandstone and shales with occasional fossiliferous bands containing ammonoids.	Bude Coast
Caerthillian to Kennack	139.65	Biological/ Geological	SW720142	Exposures of Old Lizard Head metasediments and metabasalts, and the Kennack Gneiss. Thrust contact between the Lizard peridotite and the Landewednack Hornblende Schists. Man of War Gneiss (basement) is located within the SSSI boundaries.	Polbarrow to the Balk Lizard Point
Cameron Quarry	0.49	Geological	SW703506	Only surface exposure of St. Agnes granite stock. Sequence of pervasive greisenisation, silicification and Sn-W mineralisation.	Cameron Quarry Cameron Quarry
Carn Grey Rock & Quarry	1.94	Geological	SX033550	Granite of an intermediate character between the eastern and western parts of the St Austell granite.	Carn Grey Rock & Quarry
Castle Down (Tresco)	57.57	Biological/ Geological	SV884161	Glacial outwash gravels with abundant erratic pebbles. Small cave in raised beach deposits.	Castle Porth, Tresco Battery (Castle Down), Tresco
Chapel Down (St. Martin's)	33.32	Biological/ Geological	SV942158	Glacial till and outwash gravel, with abundant erratic pebbles.	Bread & Cheese Cove, St Martin's Northward Bight, St Martins
Clicker Tor Quarry	3.83	Geological	SX285614	Ultramafic intrusion into Middle Devonian slates of Trevone Basin.	Clicker Tor Quarry
Cligga Head	106.85	Biological/ Geological	SW738533	Greisen-bordered sheeted-vein mineralisation in a small granite stock. Veins contain cassiterite, wolframite, topaz, chalcopyrite and arsenopyrite.	Cligga Head Cligga Head Mine
Coverack Cove & Dolor Point	5.6	Geological	SW782185	Contact between peridotite and gabbro.	Coverack
Coverack to Porthoustock	173.04	Biological/ Geological	SW801198	Dean Quarry actively working in gabbro of the Lizard Complex. Sheeted dolerite dyke swarm.	Porthoustock Point Dean Quarry
Crocadon Quarry	0.15	Geological	SX392657	Type locality for Crocadon Formation; turbidites, siltstones and shales in a nappe structure. Provides evidence of way-up and structural facing in otherwise poorly exposed flysch deposits in Tavy Basin.	Crocadon Quarry

SSSI name	Area (ha)	Interest	Grid reference	Geological description	Geological Conservation Review Sites
Cuckoo Rock to Turbot Point	101.6	Geological	SW983405	Roseland Breccia Formation, including pillow lavas at Great Perhaver Point. Ordovician quartzite olistoliths (blocks) in formation give evidence of basement rocks.	Perhaver East Portholland to Cadythew Rock Cuckoo Rock to Turbot Point
Cudden Point to Prussia Cove	15.69	Geological	SW550277	Metamorphosed dolerite-gabbro sill of tholeiitic composition.	Cudden Point to Prussia Cove
De Lank Quarries	21.96	Geological	SX100752	Coarse-grained biotite granite, with a strong, sub-vertical tectonic foliation emphasised by orthoclase megacrysts and irregular bands of strained quartz. Bodmin Moor pluton.	De Lank Quarries
Dozmary Pool	104.14	Biological/ Geological	SX192755	Palynological record of the Flandrian vegetational history of Bodmin Moor.	Dozmary Pool
Duckpool to Furzey Cove	86.89	Biological/ Geological	SS200098	Part of type section for Bude Formation (Upper Carboniferous); alternating shales, mudstones, siltstones with interbedded sandstones rich in sedimentary structures. Shale beds have rich fossil fauna.	Bude Coast
Eastern Isles	36.07	Biological/ Geological	SV948142	Numerous islands and smaller islets and rocks with small areas of wind blown sand and linking cobble beaches.	Isles Of Scilly
Folly Rocks	2.43	Geological	SW573280	Praa Sands elvan dyke showing evidence of multiple intrusion, possibly in a fluidised state.	Folly Rocks
Gerrans Bay to Camels Cove	132.4	Biological/ Geological	SW912378	Middle and Upper Devonian sediments of the Gramscatho Basin, including basic pillow lavas and other igneous rocks contained within the Roseland Breccia Formation. Raised beach deposit at Pendower beach.	Nare Head to the Straythe Pendower Gerrans Bay Nare Head to the Blouth Pendower to Shannick Point
Godrevy Head to St Agnes	624.61	Biological/ Geological	SW652453	Folding and faulting in Mylor Slate Formation. Towanrath lode in the cliffs at Wheal Coates shows brecciated hornfels and an elvan dyke with a matrix of quartz, hematite and minor sulphides; perfect pseudomorphs of cassiterite after feldspar were formerly obtained. Raised beach at Godrevy composed of cemented sandrock overlain by head; dating suggests penultimate interglacial.	Wheal Coates Godrevy Godrevy Point & Strap Rocks
Great Wheal Fortune	0.56	Geological	SW627288	Main stage mineralisation with cassiterite crystals.	Great Wheal Fortune

SSSI name	Area (ha)	Interest	Grid reference	Geological description	Geological Conservation Review Sites
Greystone Quarry	4.42	Geological	SX363803	Working quarry showing Greystone Formation overthrust by Lezant Slate Formation. Normal faulting with Pb/Ag/Cu mineralization.	Greystone Quarry Greystone Quarry
Gugh	36.7	Biological/ Geological	SV890081	A small island connected to St.Agnes by The Bar, a sandy tombolo.	Old Man, St Agnes
Gwithian to Mexico Towans	373.38	Biological/ Geological	SW574403	Wind-formed dunes composed of sand with a high shell content.	Godrevy Point & Strap Rocks Upton & Gwithian Towans
Harbour Cove	28.89	Geological	SW914769	Type locality for the Harbour Cove Slate Formation (Upper Devonian).	Harbour Cove
Hawkstor Pit	5.94	Geological	SX150748	Organic sediments and solifluction gravels. Palynomorphs provide detailed stratigraphic and chronological record of vegetation and climate changes during the late-glacial Devensian and Holocene.	Hawk's Tor
Higher Moors & Porth Hellick Pool (St. Mary's)	15.77	Biological/ Geological	SV922108	Area of open water separated from the open sea by sand and shingle bar. Developed on peat and alluvium.	Higher Moors
Hingston Down Quarry & Consols	24.2	Geological	SX410716	Type locality for arthurite (Cu-Fe arsenate). Native Bi, molybdenite, scheelite, wolframite, arsenopyrite, opal and bertrandite (beryllium silicate) have also been found.	Hingston Down Consols Hingston Down Quarry
Kennack to Coverack	265.45	Biological/ Geological	SW762169	Kennack gneiss and 'primary' peridotite. Sheared gabbro associated with a transform fault.	Lankidden Kennack Sands
Kingsand to Sandway Point	6.13	Geological	SX439508	Early Permian/Late Carboniferous red breccias and sandstones with trace fossils. Rhyolitic lava indicating volcanism contemporaneous with granite intrusion.	Kingsand, Cawsand Beach
Lidcott Mine	0.11	Geological	SX240850	Small Mn mine which yielded rhodonite, pyrolusite, wad and rhodochrosite.	Lidcott Mine
Loe Pool	124.1	Biological/ Geological	SW646248	Beach and bar formed of shingle and sand with a high flint content.	Porthleven Loe Bar
Luxulyan Quarry	50.14	Geological	SX053590	Exposure of eastern biotite granite of the St Austell pluton and luxullianite, a tourmaline-orthoclase granite variety.	Luxulyan Quarry

SSSI name	Area (ha)	Interest	Grid reference	Geological description	Geological Conservation Review Sites
Meneage Coastal Section	79.35	Geological	SW792252	Meneage Formation (Middle! Upper Devonian) of the Gramscatho Group. Transition from laminated sediments to chaotic mélanges. Boundary fault of Lizard Complex at Porthallow, with highly deformed mafic and ultramafic rocks of the Traboe cumulate complex to the south.	Porthallow Cove to Porthkerris Cove Little Dennis to Porthallow
Mulberry Downs Quarry	3.56	Geological	SX019657	Openwork exploited stockwork of veins containing cassiterite, together with small amounts of arsenopyrite, Cu ores and W minerals.	Mulberry Down
Mullion Cliff to Predannack Cliff	108.5	Biological/ Geological	SW665174	Volcanic suite of the Upper Meneage Formation (Gramscatho Group) exhibiting pillow lavas interbedded with cherts and limestones with Upper Devonian fossils. This and overlying metabasalts of the Roseland Breccia Formation comprise the basement over which the ophiolites of the Lizard Complex have been obducted.	Mullion Island Mullion Island
Penberthy Croft Mine	2.35	Geological	SW552324	Source of rare and unusual Cu and Pb arsenates and phosphates.	Penberthy Croft Mine
Penhale Dunes	1070.4	Biological	SW769570	Variscan folding in middle Devonian Gramscatho Group. Two lead-bearing cross-course lodes demonstrate the structure and mineralogy of late, low temperature lead mineralization. Exposure of the Perran Iron Lode shows the paragenesis of pyrite-sphalerite-siderite mineralization.	Cotty' Point, Perranporth Perran Beach to Holywell Bay Gravel Hill Mine (information on GCRs was not available when designated for biological interest)
Peninnis Head (St. Mary's)	16.24	Biological/ Geological	SV910094	Granite cliffs and tors of Isles of Scilly pluton. Quaternary coastal geomorphology includes weathering landforms and head deposits providing comparison with glaciated sites in the north of the archipelago.	Peninnis Head
Penlee Point	2.73	Geological	SW473268	Contact metamorphism of a dolerite sill by the Land's End granite.	Penlee Point
Penlee Quarry	24.99	Geological	SW467276	Mixed sequence of metasediments and metavolcanics. Diverse range of mineralisation styles, including metasomatic sulphide mineralisation in meta-basic igneous rocks.	Penlee Quarry

SSSI name	Area (ha)	Interest	Grid reference	Geological description	Geological Conservation Review Sites
Pentire Peninsula	108.51	Biological/ Geological	SW930800	Complex succession of slates, siltstones, tuffs and pillow lavas in the Trevone Basin (Middle-Upper Devonian). Gravel Caverns Conglomerate contains ammonoid fauna. Structures associated with the Padstow Confrontation.	Pentire Point to Rumps Point Polzeath to Pentire Point Pentire Head
Polyne Quarry	0.11	Geological	SX225530	Fossiliferous slates of the Meadfoot Group (Lower Devonian).	Polyne Quarry
Polyphant	3.49	Geological	SX256826	Ultrabasic picrite in a thrust slice which has been altered to a talc-carbonate-chlorite rock.	Polyphant
Porth Seal (St. Martin's)	1.17	Geological	SV919166	Quaternary deposits of raised beach, interbedded organic and inorganic silts and sands and head. Organic layers provide Late Devonian dates and indicate tundra conditions.	Porth Seal, St Martins
Porthcew	9.78	Geological	SW593269	Contact zone of the Tregonning-Godolphin granite at Rinsey Cove, with a pelitic roof pendant and evidence of metasomatism.	Porthcew
Porthgwarra to Pordenack Point	158.01	Biological (NB. information on GCR interest not available at time of notification)	SW361229	Land's End granite pluton exposed in high cliffs. Pinnacles exhibit prominent columnar jointing. Sn mineralization in granite at Nanjizal Cove.	Nanjizal Cove
Porthleven Cliffs	7.27	Geological	SW623257	A large glacial erratic block of garnetiferous gneiss (Giant's Rock) resting on intertidal shore platform.	Porthleven
Porthleven Cliffs East	14.21	Geological	SW634248	Dolerite intrusions into Mylor Slate Formation.	Porthleven Porthleven Loe Bar
Porthloo	0.66	Geological	SV905118	Important lithostratigraphy of raised beach, interbedded organic and inorganic silts and sands, head deposits and a capping layer of loess. Type locality for Porthloo Breccia.	Porthloo
Rame Head & Whitsand Bay	160.11	Biological/ Geological	SX379530	Fossiliferous beds near the top of the Dartmouth Group (Lower Devonian). The earliest marine Devonian fauna in Britain. Cliff line at Whitsand Bay little affected by coastal retreat, small beach volume with negligible sediment input.	Whitsand Bay Bull Cove

SSSI name	Area (ha)	Interest	Grid reference	Geological description	Geological Conservation Review Sites
Roche Rock	2.21	Geological	SW991596	Tor-like mass of schorl composed of tourmaline and quartz, probably representing an accumulation of fluids in an outlying cusp of the St Austell granite.	Roche Rock
Rock Dunes	68.1	Biological/ Geological	SW926765	Exposures of the Harbour Cove Slates and Polzeath Slates with rich faunas and useful palaeoenvironmental indicators	Daymer Bay
Rosemullion	16.73	Biological/ Geological	SW792272	Complex folding in Gramscatho Group.	Rosemullion Head
Rosenun Lane	0.37	Geological	SX248617	Middle Devonian slates with trilobites.	Rosenun Lane
South Terras Mine	0.59	Geological	SW933523	Former U mine with secondary U minerals, and Ni-Co arsenides in old dumps.	South Terras Mine
St Agnes Beacon Pits	7.72	Geological	SW705509	Sands and clays exposed in working sand pits, with Miocene palynomorphs.	St Agnes Beacon
St. Erth Sand Pits	3.8	Geological	SW556350	Disused sand pits with gastropods and microfossils of late-Pliocene age.	St Erth
St. Mewan Beacon	0.71	Geological	SW985534	Quartz topaz tourmaline rock forming a small tor-like mass at the southern contact of the St Austell granite with the adjoining Lower Devonian metasediments.	St Mewan Beacon
St. Michael's Mount	2.42	Geological	SW513297	Granite stock occupies the southern part of the island. Greisen-bordered sheeted veins on the southern wave-cut platform show cassiterite, wolframite, stannite and secondary Cu minerals.	St Michael's Mount
Stepper Point	1.83	Geological	SW914781	Complex thrust structures lying south of the Padstow Confrontation.	Stepper Point
Stourscombe Quarry	0.36	Geological	SX344838	Stourscombe Formation (Upper Devonian). Slates with a rich fossil fauna.	Stourscombe Quarry
Tater-Du	4.78	Geological	SW439230	Metamorphism of basic lavas within the aureole of the Land's End granite.	Tater-Du
Tean	18.63	Biological/ Geological	SV908164	Granite tors separated by land overlain with glacial till and outwash gravels.	Isles of Scilly

SSSI name	Area (ha)	Interest	Grid reference	Geological description	Geological Conservation Review Sites
Tintagel Cliffs	195.41	Biological/ Geological	SX062895	Low-angle faults repeat Upper Devonian and Lower Carboniferous sequences. Basaltic lavas and volcanoclastic rocks of the Tintagel Volcanic Formation. Assemblage of coastal geomorphological features (rock-coast) displaying relationship between landforms and bedrock structure.	Trebarwith Strand Tintagel Smith's Cliff to Tintagel Island Tintagel Head to Bossiney Haven
Trebetherick Point	20.24	Biological/ Geological	SW925780	(Daymer Bay GCR site also covers the Rock Dunes SSSI). Fossiliferous Polzeath Slate Formation (Upper Devonian). Raised beach overlain by boulder gravel of possible glacial origin.	Trebetherick Point Daymer Bay
Tregargus Quarries	1.66	Geological	SW948540	Quarries in non-megacrystic lithium-mica - topaz granite and fluorite granite of the St Austell pluton.	Tregargus Quarries
Trelavour Downs	0.33	Geological	SW960575	Coarsely crystalline pegmatite containing large sheaves of Li-rich biotite.	Trelavour Downs
Tremearne Par	14.55	Geological	SW609266	Megilligar Rocks: pegmatite-aplite-granite sheets cutting Mylor Slate Formation in the roof of the Tregonning-Godolphin granite pluton. Pegmatites contain apatite and unusual phosphate minerals.	Megilligar Rocks Tremearne Par
Trevaunance Cove	6.85	Geological	SW722517	Sn-Cu mineralisation with fluorite in lodes exposed in coastal section. Wood tin specimens on the beach.	Trevaunance Cove
Trevone Bay	9.32	Geological	SW889763	Trevose Slate Formation with rich fauna of late Middle Devonian ammonoids. Marble Cliff Limestone provides an alternating sequence of limestones and slates yielding conodonts of Upper Devonian age. Parasitic folding in Upper Devonian slates and limestones. Meta-dolerite shows pumpellyite facies regional metamorphism.	Porthmissen Bridge Trevone Bay Pentonwarra Point Marble Cliff
Trevose Head & Constantine Bay	155.45	Biological/ Geological	SW857753	Complex folding and faulting in Middle-Upper Devonian slates, limestones and volcanic rocks.	Dinas Head to Trevose Head Booby's Bay to Trevose Head
Viverdon Quarry	0.37	Geological	SX374675	Lower Carboniferous sediments overlying Upper Devonian slates, due to thrusting.	Viverdon Down Quarry Viverdon Down Quarry
Watermill Cove	0.48	Geological	SV925121	Quaternary deposits of raised beach, interbedded organic and inorganic silts and sands and head. Organic layers provide Late Devonian dates and indicate arctic tundra conditions.	Watermill Quarry
West Lizard	775.19	Biological/ Geological	SW682147	Two types of serpentinised peridotite at Kynance Cove.	Kynance Cove

SSSI name	Area (ha)	Interest	Grid reference	Geological description	Geological Conservation Review Sites
Wheal Alfred	1.13	Geological	SW579369	Complex Sn-Cu-Zn-Pb mineralisation with important suite of secondary minerals.	Wheal Alfred
Wheal Gorland	0.19	Geological	SW732429	Old Cu-Sn-W mine with many rare minerals, including Cu-Pb phosphates and arsenates and other secondaries (including cornwallite!).	Wheal Gorland & Wheal Unity
Wheal Martyn	0.14	Geological	SX002554	A small exposure of the St Austell pluton shows relatively fresh lithium-mica granite, representative of the parent rock from which china clay formed.	Wheal Martyn
Wheal Penrose	0.89	Geological	SW635251	Old Pb-Zn mine with unusual secondary minerals.	Wheal Penrose
White Island (off St. Martin's)	15.57	Biological/ Geological	SV923176	Suite of Late Pleistocene deposits in Chad Grit. Raised beach, Porthloo Breccia, solifluction deposits and head.	Chad Girt, St Martins
Yeolmbridge Quarry	0.73	Geological	SX321874	Type locality for the Yeolmbridge Formation, slates with thin limestones.	Yeolmbridge
					The entire Isles of Scilly archipelago is designated as a GCR site for its coastal geomorphology.
Compiled in part from English Nature on-line database (May 2004 version) and Selwood <i>et al</i> (1998) – updated and revised by Paul Wheeler.					

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Appendix 4: Designated County Geology Sites

FULL LIST OF APPROVED & REGISTERED COUNTY GEOLOGY SITES (RIGS), arranged by district as at 31/12/04.

County Geology Site	No.	Grid Reference	Description
CARADON			
Redmoor Mine	CN1	SX 356711	Underground workings and surface mine dumps.
Lantic Bay	CN2	SX 146507	Sedimentary structures & folding in Meadfoot Group sediments (Lower Devonian).
Harrowbarrow Mine	CN3	SX 401701	Underground lead/silver workings.
Stowe's Section, Wheal Phoenix	CN4	SX 262722	Surface mine dumps & underground workings on Cu-Sn lodes.
The Cheesewring	CN5	SX 257724	Bodmin Moor granite, tor weathering & quarry with some mineralisation.
Withnoe	CN6	SX 404517	Circular rhyolite intrusion exhibiting vertical flow banding & cut by inclined dykes. Evidence of volcanic activity.
Hobb's Hill	CN8	SX 185694	Tourmalinised elvan with cassiterite.
Trebrown	CN9	SX 302601	Only inland exposure of the Portwrinkle Fault, a major NNW-SSE fault. Evidence of movement is seen in small scale structures.
Portnadler Bay	CN10	SX 243515	An exposure of the Portnadler Fault – a major wrench fault which divides the rocks of the Looe area into two zones.
Crowstone Cliff	CN11	SX 390522	Quaternary head & raised beach deposits of possible Pleistocene age, indicating a previous fall in sea level.
St Germans Quay	CN12	SX 363574	Exposure of Jennycliff Slate Formation (Middle Devonian) - grey slates with sporadic limestone beds and some tuff.
Sandheap Point	CN13	SX 163512	Deformed sun-cracks in the Dartmouth Slates (Lower Devonian) - evidence of drying out in shallow deposition environments.
Lowhill Quarry & Forder Quarries	CN14	SX 415578	Disused quarries in hornblende dolerite, showing its relationship with the Wearde Sandstone Member (Upper Devonian).
Wearde Quay	CN15	SX 424 577	Exposure showing volcanic rocks adjacent to an exposure of the Wearde Sandstone Formation. Contrast in structural styles.
Wearde Area	CN16	SX 417 572	Exposure of the Wearde Sandstone Member yielding abundant fossils. Contact with adjacent igneous intrusion can be seen.
Cawsand Bay	CN17	SX 449513	A multi-phased dyke intrusion and the BGS reference section of the Staddon Grits.
Seaton Beach	CN18	SX 301543	Exposure of shallow water facies of the Dartmouth Group (Lower Devonian).
CARRICK			
Tubb's Mill Quarry	CK1	SW 962432	Greenstones with a geochemistry indicative of a rift origin.
Carne Quarries	CK2	SW 913381	Ordovician age quartzite blocks found in Upper Devonian mudstones. Evidence of earlier basement rocks.

County Geology Site	No.	Grid Reference	Description
Caragloose Point	CK3	SW 947399	Conglomerate with dominantly granite clasts in Upper Devonian Roseland Breccia Formation, Gramscatho Basin.
Jacka Point	CK4	SW 939393	Upper Devonian conglomerates in Roseland Breccia Formation.
Wheal Jane East	CK6	SW 786433	Unusual lode structure and open stopes for Cornwall. Underground workings with an extensive exposure of the elvan hanging-wall.
Lambriggan Mine	CK7	SW 760511	An example of a mine ore (Pb-Zn) pile left standing at surface. One of very few sites of its kind in Cornwall.
KERRIER			
Wheal Basset	K1	SW 690398	Mine dumps with Cu-U mineralization.
Wheal Uny	K2	SW 695410	Only known access to the Great Flat Lode. Classic main-stage mineralisation.
Fishing Cove	K3	SW 599428	Exposures of a 60m thick debris slump within the Porthtowan Formation.
Carn Brea	K4	SW 684407	Exposures of biotite-muscovite granite of Carn Brea. Geomorphological weathering of granites.
Porthcadjack Cove	K5	SW 641447	Exposures of contractional fault systems & The Great Cross-Course.
Great Wheal Fortune	K6	SW 626288	Mineralisation in the Mylor metasediments.
The Hutches	K7	SW 791286	Uplifted wave-cut platform & raised beach deposits.
Crousa Common	K9	SW 771198	Pit exposures in the Tertiary Crousa Gravels.
Wheal Johnny	K11	SW 627412	Dumps with ore material. Good educational site.
Praa Sands	K12	SW573281	A composite raised beach and Head sequence overlain by Holocene peat and coastal dunes.
Kerriack Cove	K13	SW678470	Mineralisation in Devonian sandstones.
Beacon Hill	K14	SW782337	Road-cutting with varied granites, structural foliation, jointing, shear zones, variable weathering and kaolinisation.
Countybridge Quarry	K15	SW 722220	Serpentinite quarry.
West Lizard Cliffs	K17	SW 670160	10Km cliff section through serpentinite and hornblende schist, showing cliff topography, landslips, caves, stacks & islands.
Wheal Rose	K18	SW 637247	Lead 'stringer' vein running across beach and underground workings.
Tye Rocks	K19	SW 634250	Lead vein exposed in cliff and on beach below.
Lowland Point to Trevalsoe	K20	SW 797195	Coastal gabbroic tors, head, loess, gabbro blocks & clitter, illustrating periglacial processes.
Enys Head	K22	SW 728149	Probably the best locality on the Lizard to view rodingites - veinstones within the serpentinite. Also altered basic dykes.
Downas Cove to Pedn Boar	K23	SW 766165	Unique primary features preserved in peridotite of upper mantle derivation. Also excellent examples of early copper mining.
Trewavas Mine	K24	SW 598265	Mine dumps with sulphide mineralisation.

County Geology Site	No.	Grid Reference	Description
Maindale	K25	SW 784199	Best remaining site to observe numerous gabbroic blocks of problematic origin, littering the landscape.
NORTH CORNWALL			
Stepper Point	NC1	SW 908780	Dolerite sill intruded into Upper Devonian slates, showing later deformation.
Underwood	NC2	SX 302872	Exposure of the Stourscombe Beds.
Port Quin	NC3	SW 970806	Devonian slates with some fossils and vein mineralisation.
Penfoot Quarry	NC4	SX 301832	Exposure of the Yeolmbridge Beds.
Oldwit Lane	NC5	SX 318819	Road cutting exhibiting important Upper Devonian fossil fauna.
Kit Hill	NC7	SX 376713	Mine dumps with lode material.
Port Arthur	NC10	SW 922747	Faulted, fossiliferous Devonian slate/tuff succession.
Gilson's Cove Mine	NC11	SW 967804	Mine dumps with Pb, Zn, Cu mineralization.
Cant Hill	NC12	SW 951742	Middle Devonian slates with diverse, shallow-marine fauna.
Upton Coast	NC13	SS 190040	Upper Carboniferous Bude Formation sediments and structures, Quaternary sections at Widemouth.
Tremore Quarry West	NC14	SX 010649	Quarry in Tremore elvan.
Lanterdan	NC18	SX 051870	Disused quarry in Upper Devonian, Upper Delabole Slate. Good locality for minerals & fossils. Quarrying methods of interest.
Flat Marsh Cutting	NC19	SX 163741	Artificial exposure of porphyritic granite with variable kaolinisation, overlain by a thin regolith.
Shallow Water Hill Cutting	NC20	SX 163741	Granite cutting showing abundant kaolinisation features & variable weathering. Exposure a mix of sub-vertical faces & regolith.
South Petherwin	NC21	SX 313823	Exposure of basal Lower Carboniferous, West Petherwin Conglomerate.
Tremore Quarry East	NC22	SX 011648	Former elvan quarry, primarily of interest for exposures of calc-flinta.
Duckpool Valley	NC23	SS 215118	Suite of fluvial geomorphological features, including meanders & ox-bow lakes, in the lower reaches of the Coombe Valley
Trebarwith Stream	NC24	SX 048 864	Site exhibiting erosion by a rejuvenated, downcutting river. The processes of corrasion (giving rise to potholes), corrosion, attrition and hydraulic action can be observed.
PENWITH			
Gryll's Bunny	P1	SW 364335	Opencast & underground tin workings including visible "tin floor" deposits.
Venton Cove	P2	SW 527303	Volatile-derived (hot gases) breccia intrusion.
Wheal Cock	P3	SW 364340	Mine dumps.
Wheal Hazard	P4	SW 363334	Mine workings exhibiting granite contact & mineralisation. Contact metamorphism and hornfels evident.
Black Cliff	P5	SW 553387	Sandstone dominated turbidites in the Porthtowan Formation.

County Geology Site	No.	Grid Reference	Description
Great and Little Hogus	P6	SW 512306	Volcaniclastic debris flows within the Mylor Slate Formation.
Bog Inn	P7	SW 393319	Large depression sculpted by glacial/periglacial action.
Wheal Drea	P8	SW 365322	Large mine dump.
Wheal Carpenter	P9	SW 584353	Mine dumps.
Wicca Pool	P10	SW463398	Granite veining in slate, includes roof pendants and tourmalinisation.
Geevor Mine Ore Stockpile	P11	SW 373346	Recently constructed "finger-dump" of original Geevor ore.
New Mexico Shaft, Geevor	P12	SW 368344	18 th Century mine workings exhibiting fissure veins, hand-worked stopes and an exposure of the granite/killas contact.
Wheal Edward	P13	SW361327	Mining waste in a killas and hornfels matrix.
Croft Gothal	P14	SW 569309	Mine dumps demonstrating two distinctive mineralogical assemblages.
RESTORMEL			
Duporth	R1	SX 036512	An altered intrusion of ultrabasic lava.
Black Head-Ropehaven	R2	SX 039484	Fossiliferous slates and volcanics in contact with limestone and minor intrusive rocks.
Wheal Remfry	R3	SW 924575	Sheeted vein system with tourmaline hydrothermal breccia, elvan & contact with the metamorphic aureole rocks.
Goonbarrow	R4	SX 007583	Active china clay pit exhibiting intrusive relationships & hydrothermal features.
Helman Tor	R5	SX 062615	St Austell granite. Excellent educational site to study tor formation and clitter (sharp edged material) slopes from periglacial activity.
Whipsiderry	R6	SW 832635	Conformable transition between sediments of Dartmouth & Meadfoot Groups, Lower Devonian.
The Gannel Quarry	R7	SW 795612	20m exposure of minette lamprophyre (igneous intrusion).
Carlyon Bay East	R8	SX 067522	Lower Devonian slates containing volcanoclastic material. Also a dolerite sill, folding & raised beach/Head deposits.
Fistral Bay	R9	SW 799625	Raised beach. Cemented Quaternary interglacial beach sand.
Gamas Point	R10	SX 023472	Locality demonstrating important stratigraphic relationship between Meadfoot Group and Gramscatho Group sediments.
Luxulyan Valley	R12	SX 056571	Granite core-stones formed by deep Tertiary weathering of St Austell granite.
Fowey Estuary	R13	SX 130540	An example of a drowned river valley, showing the characteristic features of a ria.
Newgate Cutting	R14	SX 032626	Exposure of granite contacts and quartz-mica rock, hornfels, spotted slates & alteration in a road cutting.
Tresayes	R15	SW 996588	Old workings in a rare, feldspar-rich pegmatite vein, in the metamorphic aureole of the St Austell granite.
Carlyon Bay West	R16	SX 055520	Fossiliferous Lower Devonian slates with volcanoclastic material, cut by Cu/Pb veins. A raised beach caps Crinnis Island.

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Glossary

Acid: A descriptive term applied to igneous rocks with more than 60% silica (SiO₂). Acid rocks usually contain abundant light-coloured minerals, such as quartz.

Aggregates: Crushed rock used for construction purposes.

Alluvial: Relating to movement by a river and/or deposition in a river or floodplain. Alluvial material is usually silt and clay, but may be sand and gravel, where this material contains economic minerals it is called a **placer** deposit.

Aplite: A light-coloured igneous rock with the same mineral composition as granite: quartz, plagioclase feldspar, and potassium feldspar, but with a fine-grained, almost sugary texture.

Archaeology: Study of past human activities usually by excavation of remains lying below the present surface.

Basalt: A basic volcanic rock (or lava) that characteristically is fine grained, dark in colour, contains around 50% silica, and generally is rich in iron and magnesium.

Basement: The undifferentiated rocks that underlie the rocks of interest in an area.

Basic: A descriptive term applied to igneous rocks (basalt and gabbro) with silica (SiO₂) contents around 50%. These basic rocks are usually dark in colour.

Basin and range: A large region of the surface that is dropped down between fault systems (the basin) while the rocks on either side have been relatively uplifted (the range).

Batholith: Very large (100s km scale) mass of intrusive igneous rock that forms when magma solidifies at depth.

Biodiversity - biological diversity, literally meaning the variety of life found within a particular region. Biodiversity therefore encompasses all organisms, plant and animal species as well as the habitats and areas in which they are found.

Breccia: Rock made up of angular fragments of other rocks held together by mineral cement or a fine-grained matrix.

Carboniferous: A period in geological history that extended from 360 to 286 million years ago.

Chert: A sedimentary rock made of very fine grained (microscopic) quartz.

China clay: A deposit of a white clay mineral (**kaolinite**), formed from altered granite, which can be extracted for numerous uses.

Cleavage (slaty): Parallel fracture planes which allow a rock to break into slices. Formed by alignment of new minerals during metamorphism.

Conglomerate: A sedimentary rock made of rounded rock fragments, such as pebbles, cobbles, and boulders, in a finer-grained matrix.

Contact metamorphism: Metamorphism caused by heat from an igneous intrusion.

Country rock: The rock intruded by and surrounding an igneous intrusion.

Cretaceous: A period in geological history between 136 and 64 million years ago.

Devonian: A period of geological history, between 410 and 360 million years ago. Most of Cornwall's sedimentary rocks were deposited during this period.

Dolerite: A medium-grained, basic igneous rock of similar composition to basalt, usually occurring in dykes or sills.

Dyke: A sheet-like body of igneous rock that cuts across layering or contacts in the rock into which it intrudes.

Exposure sites - these are sites whose scientific or educational value lies in providing current exposures of a geological feature(s) which is laterally and vertically extensive or widespread below the surface.

Fault: A crack or fracture in a rock or group of rocks, along which there has been movement. A **thrust fault** is a shallow dipping plane along which one block of rock has been pushed up over another.

Fauna: Animals of a given region or period of geologic time.

Fluvial: Relating to rivers and streams.

Formation: A body of rock which can be identified by specific characteristics and stratigraphic position and which can be mapped or traced on the surface.

Fossil: Fossils are the recognizable remains, such as bones, shells, or leaves, or other evidence, such as tracks, burrows, or impressions, of past life on Earth. The study of fossils is called palaeontology.

Gabbro: A dark, coarse-grained intrusive igneous rock, chemically equivalent to basalt.

Geoconservation - the conservation of geodiversity for its intrinsic, ecological and heritage value as a natural phenomena.

Geodiversity: The variety of rocks, minerals, fossils (i.e. the geology), together with the variety of soils, natural processes and landforms (the geomorphology) found within a particular region.

Geodiversity Action Plan (GAP) - a document with objectives, targets, action plans and indicators to measure success; which highlights priorities for, and focuses resources on, the conservation and promotion of geodiversity in a region.

Geology: The study of the Earth as a whole; its origin, structure, composition and history (including the evolution of life) plus the natural processes which affect it.

Geomorphology: The study, description and identification of processes which affect the Earth's surface (*geomorphic processes*) and the features, such as rivers, beaches, granite tors etc. that result (*landforms*).

Glacial: A cold interval characterised by the expansion of glaciers and an Arctic type climate into areas that presently enjoy a temperate climate.

Gneiss: A coarse-grained metamorphic rock that commonly has alternating bands of light and dark-coloured minerals.

Grain size: Refers to the size of individual mineral crystals or grains (**clasts**) within a rock or sediment. Sedimentary and igneous rocks both range from fine-grained (very small grains or crystals) to coarse-grained (very large grains or crystals).

Granite: A coarse-grained intrusive igneous rock with at least 65% silica. Quartz, feldspar and mica minerals make up most of the rock and give it a fairly light colour.

Greenstone: A metamorphic rock derived from basalt or chemically equivalent rock such as gabbro or dolerite.

Greisen: A hard, grey-coloured form of wall-rock alteration caused by hydrothermal fluids altering rocks to a mass of quartz and mica minerals.

Head: An earthy, often chaotic mass of sediments containing angular fragments produced as a result of the slow, downslope movement of material by repeated freezing and thawing processes in periglacial regions.

Holocene: The most recent division of geological time, dating back to 10,000 years ago from the present.

Hornfels: A dark, very fine-grained metamorphic rock produced by the recrystallisation of rocks by heat from a nearby igneous intrusion. If the recrystallising rock was originally a limestone, or had a high carbonate content, then a **calc-flinta** may develop.

Hydrogeology: The science that deals with subsurface waters and geologic aspects of surface waters.

Hydrothermal fluids: Hot, watery fluids containing minerals which precipitate out into veins or lodes, and/or chemicals which react with the rocks that the fluids are passing through (**host rocks**) to form **wall-rock alteration**.

Ice Age: A period of time during which ice sheets and glaciers cover regions that are normally ice-free.

Igneous rock: Rock formed when magma has cooled and solidified (crystallized). **Intrusive** (plutonic) rocks cool and solidify beneath the Earth's surface; **extrusive** (volcanic) rocks solidify rapidly at or very near the surface.

Integrity sites - these are sites whose scientific or educational value lies in the fact that they contain scarce deposits, features or landforms that cannot be recreated if damaged or destroyed.

Intrusion: The process of emplacement of magma in pre-existing rock.

Lamprophyre: A type of intrusive igneous rock whose composition is intermediate between acid and basic.

Lava: Magma which has reached the surface through a volcanic eruption. The term also refers to cooled and solidified rock.

Limestone: A sedimentary rock of calcium carbonate often formed of shell fragments or spheres of calcium carbonate or crystals of calcite.

Lithostratigraphic unit: A body of rock that is consistently dominated by a certain **lithology** (rock type) or similar colour, mineral composition and grain size. It may be igneous, sedimentary, or metamorphic.

Lode: A zone of veining and wall-rock alteration containing economic mineralisation.

Loess: A wind-blown deposit of sediment made mostly of silt-sized grains.

Magma: Molten rock beneath the surface of the earth.

Mesozoic: A group of several geological periods of geologic time, whose ages range between 248 and 65 million years ago.

Metamorphic aureole: Zone of rock around an igneous intrusion that has been altered or baked by heat from the hot magma.

Metamorphic rock: A rock that has undergone chemical or structural changes produced by increase in heat or pressure.

Mineralisation: The formation of minerals. New minerals may be added to fractures and empty spaces in a rock or by replacing pre-existing minerals with different ones. Economically important minerals are called **ores**.

Moho: Also called the Mohorovicic discontinuity. The surface or discontinuity that separates the Earth's crust from its mantle.

Mudstone: A very fine-grained sedimentary rock formed from clay and silt.

Ophiolite: A succession of basic and ultrabasic lavas and minor intrusions which form oceanic crust. Most commonly applied to a section of this ocean crust which has been thrust up onto a continent and metamorphosed.

Orogeny: An episode of mountain building and/or intense rock deformation.

Pegmatite: A very coarse-grained igneous rock, commonly with a granitic composition. Usually forms from molten rock rich in water or other volatiles that facilitate the growth of large crystals.

Periglacial: Tundra-like climatic and environmental conditions in a region adjacent to glaciers. Characteristic landforms and sediments may form in periglacial areas.

Permian: A period of geological time between 286 and 248 million years ago.

Pillow lava: Interconnected, pillow-like bodies of lava that originally formed underwater.

Plate Tectonics: The theory that the earth's crust is broken into about 10 fragments (plates,) which move in relation to one another, shifting continents, forming new ocean crust, and stimulating volcanic eruptions and earthquakes.

Pleistocene: A period of time lasting from about 2 million to 10,000 years ago and denoted by the alternation between glacial and interglacial stages; equated with the Ice Age.

Pluton: A large igneous intrusion, originally formed at great depth in the crust but may be exposed by uplift and erosion of the country rocks above it.

Quaternary: The latest period in geological history, beginning about 2 million years ago, which is divided into two smaller periods of time: the Pleistocene and the Holocene.

Raised beach: A platform formed by wave action that is now raised above present sea-level. Often contains sediments that represent former beach deposits.

Reclamation: To bring waste or derelict land into new and often more appropriate use ("restoration" is the return land to its original use).

Regional metamorphism: Metamorphism affecting a large region that is associated with mountain building events.

Regolith: Loose broken mass of material that rests on solid rock, from which a soil may develop.

Rhyolite: Volcanic rock (or lava) that is equivalent to granite.

Sandstone: Sedimentary rock made mostly of sand-sized grains.

Schist: Metamorphic rock usually derived from fine-grained sedimentary rocks. Individual minerals in schist often develop to a size visible to the naked eye.

Sedimentary basin: A large, underwater depression, often bounded by faults, into which sediments are deposited and consolidate to form rocks.

Sedimentary rock: A rock that is the result of consolidation of sediments, often forming distinct beds or layers. Sediment is unconsolidated grains of rock and mineral fragments that comes from the weathering of rocks and is transported by water, air, or ice to form layers on the Earth's surface. Sediments can also result from chemical precipitation or secretion by organisms. Sedimentary rocks are often classified on the basis of the size of the grains.

Shale: Sedimentary rock derived from mud. Commonly finely layered (or **laminated**).

Sill: A tabular body of intrusive igneous rock, parallel to the layering of the rocks into which it intrudes.

Slate: A metamorphic rock formed from mudstones, in which a cleavage is developed

Stock: Relatively small globular or columnar-shaped igneous pluton.

Stratigraphy: The branch of geology concerned with the formation, composition, ordering in time, and arrangement in space of sedimentary rocks.

Sustainable development: Development which meets the needs of the present without compromising the abilities of future generations to meet their own needs. (e.g. by minimising the environmental impact of operations)

Tectonic: Relating to the major structural features of the Earth's crust or the overall structure of a region. A **tectonic unit** is a group of structural features (folds, faults etc.) formed in one deformation (tectonic) event or region.

Tertiary: A period of geological history after the Mesozoic era and before the Quaternary period, spanning the time between 65 and 1.8 million years ago.

Triassic: A geological period extending from 225 to 195 million years ago.

Tuff: Rock consisting of fragmented material and ash formed by a volcanic explosion or ejection from a volcano.

Turbidite: A sedimentary rock of variable grain-size, formed from the massive flow of sediments down slopes within a sedimentary basin.

Ultrabasic (i.e.very basic): Igneous rocks made mostly of the dark-coloured minerals rich in iron and/or magnesium, with a relatively low silica content. **Peridotite** is an ultrabasic rock consisting predominantly of the mineral olivine.

Unconformity: A break in a sedimentary sequence, or a period of no deposition that represents a gap in geological time.

Vein: A mineral-filled fracture or fault in a rock.

Volcanic: Rocks formed from the activity of a volcano.