



Geopark Shetland Application

June 2008

Shetland Amenity Trust
Garthspool
Lerwick
Shetland, ZE1 0DU
United Kingdom

CONTENTS

INTRODUCTION	1
SECTION A. DESCRIPTION OF THE GEOPARK TERRITORY	
A1 Geographical and Cultural Background to the Geopark	3
A1.1 Name of the area applying to become a European Geopark	
A1.2 Location	
A1.3 Geography and demography	
A1.3.1 <i>Surface area, geography and geo-diversity</i>	
A1.3.2 <i>Population and economic situation</i>	
A1.4 History and culture	
A1.4.1 <i>The archaeological landscape</i>	
A1.4.2 <i>Mesolithic c7000BC to 3600BC: The first settlers</i>	
A1.4.3 <i>Neolithic & Bronze Age c3600BC to 600BC: The first farmers</i>	
A1.4.4 <i>Iron Age c 600BC to 800AD: The broch builders and Picts</i>	
A1.4.5 <i>Viking and Norse settlement c800AD to 1469AD</i>	
A1.4.6 <i>The Scots Period 1469 to 2006</i>	
A1.4.7 <i>Language</i>	
A1.4.8 <i>Music and dance</i>	
A2 General Description and Importance of Shetland Geology	7
A2.1 Global and Regional setting	
A2.1.1 <i>Introduction</i>	
A2.1.2 <i>The European and Scottish connection</i>	
A2.2 Geological Units	
A2.2.1 <i>Basement (Precambrian)</i>	
A2.2.2 <i>Metamorphic Cover (Precambrian, Cambrian, Ordovician)</i>	
A2.2.2.1 <i>Moine</i>	
A2.2.2.2 <i>The Boundary Zone</i>	
A2.2.2.3 <i>Dalradian</i>	
A2.2.2.4 <i>The Shetland Ophiolite</i>	
A2.2.3 <i>Old Red Sandstone Cover (Devonian and Carboniferous)</i>	
A2.2.4 <i>Major Thrusts and Faults (Silurian to Jurassic)</i>	
A2.2.5 <i>Post Old Red Sandstone erosion (Jurassic to present)</i>	
A3 General Description and Importance of Shetland Geomorphology	11
A3.1 Introduction	
A3.2 Pre-glacial landscapes	
A3.3 Glacial landscapes	
A3.4 Periglacial landscapes	
A3.5 Coastal landscapes	
A3.6 Postglacial landscapes	
A4 Economic geology	13
A4.1 Early exploitation	
A4.2 Mines and miners	
A4.3 Fossil fuels	
A5 Climate, Flora and Fauna	14
A5.1 Climate	
A5.2 Flora and Fauna	
SECTION B STRUCTURE AND MANAGEMENT OF THE GEOPARK	
B1 Organisation in charge of the European Geopark	16
B1.1 Introduction	
B1.2 The role of the Shetland Amenity Trust and Geopark Shetland	
B1.2.1 <i>Background</i>	
B1.2.2 <i>Funding</i>	
B1.2.3 <i>Geopark Shetland and the SAT</i>	
B1.2.4 <i>The Heritage Hub Concept</i>	

- B1.3 The Geopark Shetland Mission**
- B1.4 Local Framework for Development – Shetland Islands Council**
- B1.5 Geopark Shetland Management Structure**
 - B1.5.1 SAT Key Specialist Staff*
 - B1.5.1.1 Geology Project Officer*
 - B1.5.2 Geopark Shetland Working Group*
 - B1.5.2.1 Shetland Islands Council*
 - B1.5.2.2 Scottish Natural Heritage*
 - B1.5.2.3 Highlands and Islands Enterprise (HIE)*
 - B1.5.2.4 VisitShetland*
 - B1.5.2.5 Community Involvement*
- B1.6 Financial Sustainability – budget & other resources**
- B1.7 Geopark Shetland Identity**
- B1.8 Disabled Access - 'Access for All'**
- B1.9 Geopark Shetland Ethics Policy**
- B1.10 Monitoring & Evaluation of the Geopark Shetland and its Benefits**

SECTION C GEOSITES, INTERPRETATION AND PROJECTS

- C1 Geosites and geo-conservation within the Geopark** **23**
 - C1.1 Introduction**
 - C1.2 Geosites**
 - C1.2.1 Existing Scientifically Designated Areas*
 - C1.2.2 Audit of geo-diversity*
 - C1.2.3 Active Geosites*
 - C1.2.4 Active interpretation*
 - C1.2.4.1 Geology walls and trails*
 - C1.2.4.2 Restoration of Hagdale Chromate Crushing Mill*
 - C1.2.4.3 Interpretation panels and leaflets*
 - C1.2.4.4 Guided tours*
 - C1.2.4.5 Community activities – Northmavine*
 - C1.2.5 Access, monitoring and maintenance of Geosites*
 - C1.2.6 Protection of Geosites*
- C2 Interpretation within the Geopark** **25**
 - C2.1 Heritage Hub and Spoke**
 - C2.2 Action Plan and Current Projects**
 - C2.2.1 Geology course*
 - C2.2.2 Education*
 - C2.2.3 Geology tours*
 - C2.2.4 Art Exhibition*
 - C2.2.5 Northmavine Community Exhibition*
 - C2.2.6 Geotextiles*
 - C2.3 Web Presence**

SECTION D GEOTOURISM AND MARKETING

- D1 Sustainable Tourism** **28**
 - D1.1 Introduction**
 - D1.2 Shetland Tourist Information Network**
 - D1.3 Training**
 - D1.4 Travel to Shetland**
 - D1.5 Travel within Shetland**
 - D1.6 Accommodation**
- D2 Marketing and Promoting a Geopark Shetland** **30**
 - D2.1 Adoption of the Ideals and Ethics of the EGN**
 - D2.2 Marketing**
 - D2.3 Corporate Identity and Logo – an integrated approach**
 - D2.4 Product development**

SECTION E ENVIRONMENTAL EDUCATION

E1 Educational facilities within proposed Geopark area	32
E1.1 Universities, Colleges and Schools	
<i>E1.1.1 Letters of Support from Educational Establishments</i>	
<i>E1.1.2 The University of the Highlands and Islands (UHI)</i>	
<i>E1.1.3 Primary and Secondary Education</i>	
<i>E1.1.4 Shetland Library Service and Learning Centre</i>	
E1.2 Educational provision by Geopark Shetland	
<i>E1.2.1 Shetland Amenity Trust (SAT)</i>	
<i>E1.2.2 Scottish Natural Heritage (SNH)</i>	
<i>E1.2.3 The Shetland Field Studies Group (SFSG)</i>	
<i>E1.2.4 Shetland Landscapes</i>	
E1.3 Other providers	
<i>E1.3.1 Shetland Geotours</i>	
<i>E1.3.2 Seabirds-and-Seals</i>	
<i>E1.3.3 Shetland Nature Cruises</i>	
<i>E1.3.4 Shetland Wildlife</i>	
<i>E1.3.5 Burland Croft Trail</i>	
<i>E1.3.6 Scottish Geology Festival</i>	
<i>E1.3.7 Shetland Nature Festival</i>	
<i>E1.3.8 Earl Viking Tour</i>	
E2 Scientific Research & Academic Institutions working within the area	35
E2.1 Quaternary stratigraphy	
E2.2 Storm waves and Cliff Top Storm Deposits	
E2.3 The Shetland Ophiolite	
E2.4 Tsunami	
E2.5 Glaciation	
E2.6 Walls Boundary Fault	
E2.7 Undergraduate and post graduate work within the area	
E2.8 Proposed International Study Centre	
 INDEX OF APPENDICES	 38
 INDEX OF ENCLOSURES	 39

Introduction

Shetland is an archipelago of over 100 islands lying 170km north-east of the Scottish Mainland. Before the opening of the North Atlantic 55 million years ago Shetland lay roughly mid-way between Norway, Scotland and Greenland and its rocks are central to understanding the geological evolution of this region. Earlier still, Shetland like the rest of Scotland was separated from Europe by the Iapetus Ocean. The legacy of the opening and closing of this ancient ocean, and the associated mountain building and volcanism, makes Shetland's geology more diverse than any similar sized area in Europe.

Ancient gneisses dating back almost 3 billion years which are related to those of Greenland and the Laurentian Shield, are overlain by the eroded roots of the Caledonian mountain chain, formed in a continental collision 500 million years ago as the Iapetus Ocean closed. The Shetland ophiolite, a section of former ocean crust and upper mantle, is the most complete and accessible example in Europe and represents the end of the ocean itself. More remarkable still is Europe's only komatiite lava – possibly the youngest of its kind in the world, which may mark the ocean's birth. Shetland's youngest rocks include volcanic rocks and sandstones and mudstones deposited by rivers and in lakes in the interior of the "Old Red Sandstone" continent. Some of these lake sediments contain unique fish fossils that are crucial in understanding the evolution of vertebrates and, ultimately, ourselves.



At the Eshaness coast one can walk through the flank of a volcano

Yet more than this, in the open, wildlife-rich Shetland landscape, geology or its effects, are apparent all around you. Nowhere in Shetland is further than 5 kilometres from the sea. The exposed west coast is subject to the full force of the Atlantic and eroding rapidly producing awe-inspiring seascapes. High cliffs drop sharply into the sea and spectacular stacks, arches and caves are commonplace whilst at Eshaness the sea has carved a breathtaking section through the flank of an ancient volcano. More sheltered coasts tell a



St. Ninian's Isle has one of Europe's best sand tombolos

different story – here a rising sea level has reworked sediments to produce stunning sandy beaches, bars and tombolos including that at St. Ninian's Isle – one of the finest sand tombolos in Europe. Inland, the landscape shows to an extraordinary degree the relationship between topography and the underlying geology, not least in the remarkable parallel valleys that run along the length of the central Mainland. Ronas Hill is the highest point in Shetland, yet here at just 450 metres the climate is as extreme as any British mountain and a full suite of peri-glacial features can be found.

Over a million seabirds breed on Shetland, many of their nesting ledges the product of differential weathering. Offshore, kelp forests provide a haven for marine life. Otters are as easy to observe as anywhere in Europe and Killer Whales are often spotted hunting seals. Blanket bogs, formed on poorly draining soils derived from acidic rocks, support internationally important populations of moorland birds and a lack of intensive agriculture

allows many wild flowers to brighten up the landscape. Shetland's most famous flower – the endemic Edmondston's Chickweed – is a product of geology, found on the serpentinite at the Keen of Hamar whose barren slopes have changed little since the last glaciation.

The oil industry that has brought Shetland so much wealth since the 1970s is now in decline as are the traditional industries of fishing, agriculture and knitwear. Tourism however, is becoming a bigger contributor to the economy. Shetland's strength has been its appeal to those interested in wildlife, wild places and spectacular scenery, but now archaeology, culture, history and recently geology, are added to the mix, or attract visitors in their own right. Among the many high quality products on offer, one can cruise aboard Dunter III under the seabird-packed cliffs of Noss

A school party enjoying some living history at Old Scatness



and hear how they formed from ancient desert sandstones by millions of years of erosion by wind and ice. Or one can visit the Shetland Amenity Trust's award-winning archaeological site at Old Scatness, where you can watch (and help!) picts and Vikings manufacture and trade contemporary goods including objects fashioned from local stone. Meanwhile the Viking Unst project is currently undertaking excavations of three Viking longhouses in Unst and bringing to life Viking Heritage through living history interpretation at the Skidbladner longship. Future plans include the construction of a full-size Viking longhouse, which will provide a long term visitor attraction. In addition, Shetland Geotours majors on trips to sites of geological significance but encompasses wildlife and culture along the way, while the new Shetland Museum and Archives devotes a whole section to the story of Shetland from nearly three billion years ago, until humans arrived in the islands.

Recent geological products include the refurbishment and interpretation of the horse-drawn minerals crushing circle at Hagdale on Unst, the last of its kind in the British Isles; the



The Shetland Museum & Archives, which opened in May 2007

production of 50 new panels to interpret aspects of Shetland's heritage, including geology; the development of a 'Volcano Trail' in the north Mainland, and the construction of two geology exhibits in Northmavine and Fetlar – these being the first two of a family of similar structures throughout the Isles.

All these projects are managed by the Shetland Amenity Trust, which works closely with the Geopark Shetland Working Group. Shetland's Geopark application enjoys political support from the Shetland Islands Council,

and all the key bodies and community interests are represented on the Geopark Shetland Working Group. This group drives the implementation of geology 'products' and Geopark activities through the Geopark Shetland Action Plan, which is reviewed on an annual basis. The management structure serves the Geopark well, and when successful, it will continue to build upon the efforts already being made in Shetland to utilise our rich geological heritage in a sustainable way to contribute towards the economic and social well being of one of Europe's most peripheral communities.

SECTION A. DESCRIPTION OF THE GEOPARK TERRITORY

Section A1. Geographical and Cultural Background to the Geopark

"Shetland is a spectacular group of islands with a varied geology, a wonderful landscape and a special flora and fauna, peopled by a culture distinct within the British Isles. Shetland remains one of Britain's natural treasures."

(From: *A Naturalist's Shetland*, J. Laughton Johnston. Poyser, 1999)

A1.1 Name of the area applying to become a European Geopark

The name for the proposed Geopark will be **Geopark Shetland**. This name is an appropriate reflection of the territory, which encompasses the Shetland Islands as a whole rather than a smaller area within the territory. The area also represents the geological, historical and cultural links between Scotland, Scandinavia, Iceland and Greenland.

A1.2 Location

The proposed European Geopark comprises the entire Shetland archipelago, which lies 170km north east of the Scottish mainland, at the same latitude as St Petersburg and southern Greenland and roughly mid way between Norway and Faeroe. Politically Shetland has been part of Scotland since 1469 so now is the most northerly group of the British Isles.



Figure A1.1 The relative position of the Shetland Islands

A1.3. Geography and demography

A1.3.1 Surface area, geography and geo-diversity

Shetland consists of a group of over 100 islands, 15 of which are inhabited. The islands extend 110km from north to south with Fair Isle lying a further 35km to the south. The total land area is 1468 square kilometres, but their tortuous coastline, over 1500km in length, means that no point is more than 5km from the sea.



Figure A1.2 The Shetland Islands

The landmasses of the larger islands are generally in the form of roughly north-south ridges of hills forming the 'spine' of Shetland. The hills, mainly composed of acidic granite, schists and gneisses, are treeless and generally covered by peat or blanket bog. The valleys of the central Mainland are underlain by crystalline limestone and are generally more fertile and, together with sandy coastal areas, form the best agricultural land.

Shetland displays some of the most complex and varied geo-diversity to be found anywhere within such a small area. The islands consist for the most part of metamorphic rocks, mainly of sedimentary origin but altered by heat and pressure during the Caledonian mountain building period around 500 million years ago, overlain by sedimentary and volcanic rocks, which formed towards the end of that orogeny. In places the underlying basement of Precambrian gneiss (some of Scotland's oldest rocks at almost 3 billion years in age) protrudes from beneath this pile. These rocks link the Norwegian, Scottish and East Greenland parts of the former Caledonian terranes of Pangaea that pre-dates the opening of the North Atlantic, whilst the north east of Shetland contains an ophiolite; a sliver of ocean crust that was caught up in the continental collisions, which formed that supercontinent.

The landscape of Shetland has been sculpted from this diverse geology by rivers, glaciers and the sea over the last few million years. Major landforms survive from before the Ice Age, notably the great granite whaleback of Ronas Hill (450m) and the remarkable parallel valleys that run north-south through central Mainland. Hundreds of lochans and the firths that separate and penetrate the islands attest to glacial erosion, yet in a few places peat deposits survive from the last interglacial warm period.

Unlike Scotland and Scandinavia, the landmass of Shetland is sinking and now shows all the classic geomorphological features of a recently drowned coastline. The islands' exposed "outer" coast has cliffs up to 370 metres high often dropping sheer into deep water where attack by waves has excavated innumerable caves, including one of the world's longest sea caves on Papa Stour. This contrasts markedly with the gentler "inner" coast formed by flooded valleys running far inland, where the slowly rising sea level has created numerous sand and shingle beaches, bars and tombolos.

The richness of the geology and geomorphology is the foundation for the many layers of natural habitat and human history that make Shetland so special.

A1.3.2 Population and economic situation

Land suitable for agriculture is restricted to small areas of fertile soil derived from limestone or blown sand and to sheltered coastal areas where soil could be augmented by addition of shell-sand and seaweed as fertiliser. With land so scarce and crops limited by the climate, Shetlanders have always looked to the sea as much as the land for food, so a safe beach or inlet for landing boats was vitally important to the crofter (subsistence farmer). These two factors have combined to produce the characteristic Shetland landscape of small, coastal crofting settlements set against the backdrop of the islands' moorland interior. Thus the 22,000 population of Shetland is unevenly distributed across the islands with the majority living in and around the capital Lerwick.

Traditional crofting was never more than a subsistence economy and had to be combined with other activities such as fishing or whaling or production of the distinctive Shetland knitwear with its Fair Isle pattern. Sheep and wool production, fishing and knitwear were the mainstays of the Shetland economy, however each saw periods of boom and bust leading to emigration of Shetlanders to many parts of the world and New Zealand in particular.

Economic circumstances changed with the discovery of North Sea Oil in the early 1970s. Europe's largest oil terminal was built in the islands at Sullom Voe, bringing previously undreamed of prosperity. Oil production is now in decline, but aquaculture has joined fishing as a major industry and Shetland is looking to utilise its vast resources of wind and waves for renewable power generation.

After generations of population decline Shetland saw an increase then stabilisation in population during the last quarter of the 20th Century. This is attributed mainly to economic activity generated by the North Sea oil industry. Since the beginning of the 21st Century the North Sea oil industry has been in decline as are the traditional industries of agriculture, fishing and knitwear with a resultant decline in population.

Some communities in Shetland have been, and will be, more severely affected by this economic decline and depopulation than others. In order to arrest economic decline and maintain their structure and viability, these communities in particular, and Shetland as a whole, will have to develop new community-based initiatives. Tourism has long been

regarded as playing only a small part in the Shetland economy, constrained by the cost of getting here, the short season and the rather unpredictable weather. Its strength has always been its special attraction for those interested in history, wildlife, island scenery and wild places. Now it is waking up to the fascinating geological resource beneath our feet. Refer to Appendix A1 and Section A “Geopark Territory” Enclosures for more detail on Shetland’s current economic situation.

A1.4 History and culture

A1.4.1 The archaeological landscape

Shetland's archaeology is to a large extent a result of the underlying geology. Shetland's geo-diversity is rivalled by its archaeological heritage with close to 8000-recorded sites on the islands. These range from the Neolithic complex at Stanydale to the 17th century Fort Charlotte in Lerwick. The extraordinary sites at Old Scatness and Jarlshof allow the visitor to explore 6000 years of human settlement in Shetland and are ranked among the premier archaeological sites in Europe.

The most remarkable aspect of Shetland archaeology is that these sites are situated within landscapes that have been relatively untouched in more recent times. Shetland boasts some of the most complete Neolithic and Bronze Age farming landscapes anywhere in Europe. The West Mainland of Shetland, for example, contains many square kilometres of prehistoric landscape still awaiting systematic study.

A1.4.2 Mesolithic c7000BC to 3600BC: The first settlers

The first settlers in Shetland were probably seasonal Mesolithic hunter-gatherers, living on the coast where they fished and gathered seabirds and their eggs but left little evidence of their presence. A shell midden from about 3800BC is currently being excavated at Sumburgh at the south of the islands and is Shetland's oldest known archaeological site.

A1.4.3 Neolithic & Bronze Age c3600BC to 600BC: The first farmers

Later Neolithic and Bronze Age people were farmers who enjoyed a milder climate than of today, allowing them to establish permanent farms on what is now moorland. Lower sea level at the time gave more fertile ground around the shores and inland low forests of alder, willow and birch covered the hills. Grazing of animals and woodland clearance gradually created a more open landscape. When all the larger trees had been used stone became the building material of necessity for houses and field boundaries. This practice of building in stone and the later lack of intensive use of the upland areas have resulted in the preservation of the Neolithic farming landscape.

A1.4.4 Iron Age c 600BC to 800AD: The broch builders and Picts

Climatic deterioration and poor agricultural practice in the Iron Age forced agriculture down from the high ground. The resulting land shortage, which was worsened by rising sea levels flooding the coastal margins, is thought to have led to the construction of brochs. Brochs are remarkable defensive towers whose remains can be found throughout northern Scotland but nowhere in such large numbers as in Shetland. The 13 metre high broch on the island of Mousa, still almost perfect after 2000 years, is the most complete Iron Age fortification in Scotland.

In the 7th century, missionaries converted the Iron Age Pictish people of Shetland to Christianity, while priests seem to have settled in the heart of communities as well as establishing remote cliff-top retreats. There is more information on these people in the “Landscape Mysteries” DVD in Section A enclosures.

A1.4.5 Viking and Norse settlement c800AD to 1469AD

The improvement of the climatic conditions in northern Europe saw a Norse expansion westward during the 9th century. Pagan Vikings from Norway may have rapidly overrun Shetland in the 9th century or there may have been gradual settlement. The state of Pictish Shetland and its population by this time is still an open question. Norse place names incorporating “papa” (priest) and “pet” (Pict) suggest that there was some population that may have been assimilated rather than eradicated. By 900AD Shetland was an important province

of the Norwegian crown, sitting as it did at a crossroads for sea-going trade, exploration and invasion.

A1.4.6 The Scots Period 1469 to 2008

Norse rule came to an end in 1469 when the Danish King, short of cash for a dowry for his daughter's marriage to a Scottish prince, offered the islands of Orkney and Shetland as security, to be redeemed later when he could find the money. The Scots reneged on the deal and held on to the islands, placing them under the control of unscrupulous lowland Scots Earls who set about reducing the Norse occupants and their descendants to poverty and serfdom by depriving them of their land which had previously been held under Norse (Udal) law.

Fishing has long been a commercial activity and the mainstay of Shetland economy until the discovery of North Sea oil in the 1970's. Trade in line-caught cod and ling, air-dried on shingle beaches to preserve them for export, was started in the 15th century by merchants from Bremen and Hamburg and later operated by Scots and Shetland lairds. The last of the "Haaf" fishing stations, still catching fish on longlines set from small, open boats continued in operation until 1913, by which time the first steam trawlers were already showing which way fishing would develop in the new century.

The Dutch were first to exploit the vast shoals of herring in Shetland waters and, by choosing Bressay Sound as a harbour, indirectly gave birth to the town of Lerwick as a rival to Shetland's old Norse capital, Scalloway. By the late 19th century, herring fishing had become a major British industry, with boats and herring "gutters" from ports all along the east coast of Britain following the herring's migration from Shetland down the North Sea to Lowestoft in England. At the industry's peak, Lerwick and Baltasound in Unst were two of the busiest ports in Britain and it was claimed that a man could walk across Bressay Sound on the decks of the herring boats moored there.

A1.4.7 Language

Throughout the middle ages, Shetland had its own language, Norn, which had evolved from the Old Norse (*Norroena*) language brought by Viking settlers in about AD 800. With the imposition of Scots Earls in the 16th century and gradual change from the Norse Udal Laws to the Scottish Feudal system, together with the arrival of increasing numbers of Scottish settlers, Lowland Scots replaced Norn as the language of court and business.

In one form, Norn survived the change to Scots and then English. The place-names of Shetland, recorded by Ordnance Survey cartographers in the mid 19th Century (albeit not always accurately, so that spellings may not reflect the Shetland pronunciation) are almost exclusively Norse in origin. This is a matter of pride to Shetlanders, many of whom still consider themselves more Scandinavian than Scottish, or for that matter British.

Although Norn continued to be spoken in Shetland until the mid 1700s it fell into decline, being replaced by the development of a uniquely Shetland dialect based on Lowland Scots but with grammatical structures and many words derived from Norn. This has continued to evolve, incorporating new words coined locally or drawn from languages spoken by visiting traders and seafarers. Since the mid 19th century however, the dialect has become diluted by English, particularly since education authorities considered it inferior to English and banned its use in schools. This trend is now being reversed with the dialect being promoted in schools, evening classes, dialect societies, local media and through a project to record and interpret surviving place-names.

A1.4.8 Music and dance

Shetland has a world-wide reputation for music, particularly that of the fiddle (violin), which was probably introduced to Shetland about 1700, perhaps by Hanseatic traders. Initially there were three basic rituals that required the use of the fiddle: the playing to the townspeople on the morning of Yule Day; accompanying ancient Norwegian sword dances and playing at weddings, but the last of these soon became the most important. As with language, the Norse character of Shetland music and dance declined with the rise of Scots influence, but was never entirely lost and combined with styles drawn from elsewhere to produce a

distinctive Shetland genre. Early circle dances, accompanied by Norse verse, gave way to line dances and reels of Scottish origin accompanied by just the fiddle, playing music composed locally or brought back by seafarers.

Shetland tunes are often categorised by their origins, for example "Greenland" or "Whaling Tunes", "Yakki Tunes" learned by Shetland whaling men from Inuit in the Hudson Bay area and "Wedding Tunes" associated with the wedding ritual. Perhaps unique to Shetland, and proof that Shetlanders' love of a good party is not a modern phenomenon, are the 'Trowie Tunes', supposedly inspired by the music of 'Hill Folk' or 'Trows' (akin to fairies) which could often be heard by a fiddler if he fell asleep by the roadside whilst walking home after a long night of playing and drinking.

Today traditional music and dance is taught in schools and evening classes and music and dance festivals have become a regular part of the Shetland calendar.

Section A2 General Description and Importance of Shetland Geology

Refer to Section A Enclosures and Shetland Landscapes (www.fettes.com/shetland) website for further geological information to complement sections A2 to A5.

A2.1 Global and Regional setting

A2.1.1 Introduction

For a small geographical area of just 1468 square kilometres Shetland has probably the most complex and diverse geology and geomorphology to be found anywhere. This is reflected in the astonishing number of national designations afforded to Shetland.

Shetland has many fascinating geological localities that show most of the pages of Earth History stretching back nearly 3 billion years. These illustrate the opening and closing of oceans, mountain building and erosion, volcanism, ice ages, sea level rise, climate change and land use.

Virtually every type of rock ranging from ancient igneous to recent sedimentary is exposed in a large number of easily accessible localities, often in a dramatic coastal setting. Shetland's unique geological heritage includes an almost complete ophiolite sequence and a remarkable section through the flank of a volcano.

A2.1.2 The European and Scottish connection

Shetland is Britain's most northerly remnant of the Caledonian Mountain belt that was thrown up between 600 Ma and 400 Ma as the Iapetus Ocean closed and the continents of Gondwana, Laurentia and Baltica collided. Other remnants of the Caledonian Mountains are found in mainland Britain, Ireland, Scandinavia, Spitsbergen, Greenland and North America. The rocks formed in the roots of these mountains are exposed by erosion so that Shetland now forms an important pre-Atlantic 'in situ' link between the East Greenland, Scottish and Norwegian parts of the Caledonian Orogenic belt.

Today Shetland can be said to mirror the geology of northern Scotland but confined within a remarkably much smaller area. Revealed within close proximity on Shetland are suites of Precambrian basement rocks of Lewisian Gneisses (2500-1700 Ma) that support cover rocks of the Moine Group (1000-700 Ma) in tectonic contact with Dalradian Supergroup rocks (700-600 Ma). Overlapping the metamorphic cover are the sandstones and contemporaneous volcanic rocks of the Scottish 'Old Red Sandstone'.

A2.2 Geological Units

A2.2.1 Basement (Precambrian)

In Shetland, the main outcrops of Lewisian basement gneisses of the Hebridean Terrane is on north-west Mainland (Fig A2.1) and are cut in places by foliated pegmatites. These gneisses are acid, banded, high-grade orthogneiss and once were granites that had been intruded by smaller bodies of gabbro. Subsequent burial to extreme depths by mountain building events re-crystallised and deformed the granites and gabbros. Since their uplift to higher crustal levels these rocks have been relatively undisturbed and represent the Caledonian foreland in Shetland.

Inliers of basement gneiss also outcrop within the Caledonian cover rocks and are believed to represent the ancient ‘Laurentian’ continental basement onto which the cover sediments were deposited. Included in the Shetland basement are paragneisses that make up the south coast of St Magnus Bay. These formed from the reworking of the continental basement during the Grenville Orogeny (1100-1000 Ma) when continental convergence formed the Rodinia supercontinent.

Little research has been published with regard to the relationships between basement and cover in Shetland and between Moine and Dalradian sequences. Shetland offers much scope for future investigations into these relationships to increase understanding of Scottish and European regional geology.

A2.2.2 Metamorphic Cover (Precambrian, Cambrian, Ordovician)

Exposures of both Moine and Dalradian metamorphic cover rocks show deformations formed during the Grampian and Caledonian orogenies that occurred during the late Cambrian, Ordovician and Silurian periods.

A2.2.2.1 Moine

Moine Group metamorphic rocks make up most of the island of Yell and parts of the North Mainland (Fig. A2.1). These rocks were originally sediments laid down in a deep trough and metamorphosed on the edge of the eroding Lewisian continent (Laurentia). Later these were caught up in the Caledonian Orogeny and thrust north-west over the Lewisian basement.

A2.2.2.2 The Boundary Zone

The ‘Boundary Zone’ (base of Scatsta Division) between the Moine and Dalradian rocks is a series of near vertical tectonic slices of kyanite grade metasediments and high-grade gneisses. Narrow bands of distinctive microcline-augen-gneiss mark the upper and lower edges of the Boundary Zone. The most spectacular of these is the Valayre gneiss that delineates the base of the boundary zone. This is microcline-megacryst-porphyroblastic gneiss in which the megacrysts have formed in a matrix of similar composition to that of the adjacent rocks even although the composition of the adjacent rocks varies over an 80 km distance.

A2.2.2.3 Dalradian

Overlying the Moine rocks and in tectonic contact with them via a ‘boundary zone’ is the Dalradian rocks of the Scatsta, Whiteness and Clift Hills Divisions, (Fig. A2.1). Dalradian Supergroup rocks make up much of Mainland, Whalsay and the western parts of Unst and Fetlar.

In the main the original Dalradian sediments were deposited under marine conditions within fault controlled basins. Formation of these basins was due to crustal extension that created a new plate margin as a new ocean, the Iapetus Ocean, began to open. A suite of marginal basin volcanic rocks, partially serpentinised, is exposed at the top of the Clift hills Division. Part of this suite has been identified as komatiite lavas, believed to have been sourced in the mantle; the only known exposure of this rock type in Europe.

Much later crustal extension changed to compression as the Iapetus Ocean began to close these sediments experienced metamorphism, deformation and uplift to develop the Grampian Highlands, this was followed by further metamorphism and deformation as the continents on either side of Iapetus Ocean collided.

Overall the Dalradian rocks have been folded on a regional scale so that now the sequence is exposed lying on its side to give the rocks an almost vertical dip and a north-northeast strike with the succession younging from west to east. With a thickness of about 12 km these form the largest group of metamorphic rocks in Shetland.

A2.2.2.4 The Shetland Ophiolite

The Shetland Ophiolite, which forms much of the islands of Unst and Fetlar, is a remarkable and outstanding feature within Shetland's extraordinary geological diversity.

An ophiolite is a slice of upper mantle and oceanic crust that has been thrust onto continental crust during the final stages of the closure of an ocean. In Scotland there are three such ophiolites; the Ballantrae complex, the Highland Border Complex and Shetland. The Shetland ophiolite is by far the largest and most complete of the three and includes a classic exposure of the transition between mantle and crust.

Obduction of the Shetland ophiolite occurred during the Grampian phase of the Caledonian orogeny approximately 500 million years ago. Two tectonic units have been identified: the Upper and Lower Nappes, each underlain by imbricate zones comprising metasediments and metavolcanics. The Upper Nappe is composed mostly of metaharzburgite of mantle origin, while the Lower Nappe includes much of the classic ophiolite sequence: metaharzburgite, metadunite, metagabbro, wehrlite and the lower parts of the sheeted dyke complex.

Professor Derek Flinn (The University of Liverpool), who has spent 50 years working on the Shetland Ophiolite, considers this *'the most compact, best exposed, complete and accessible in the world'*, whilst Dr Hazel Prichard (Cardiff University) describes the island of Unst as *'an open air museum of oceanic rocks'*.

A2.2.3 Old Red Sandstone Cover (Devonian and Carboniferous)

Through the Devonian to the Early Carboniferous (410-360 Ma) the Caledonian Mountains were being eroded extremely quickly, the resulting sediments being redeposited to form the Old Red Sandstone (ORS) of Scotland. At least three of the intermontane sedimentary basins into which these erosion products poured are now exposed on Shetland. Fish and plant fossils occur in the Devonian sandstones. The Devonian geology of Shetland has been extremely important in studies of the early evolution of fishes.

Contemporaneous igneous intrusion and vulcanism during these periods is now represented by the Northmaven Igneous Complex, seen in fine exposures of suites of both plutonic and extrusive volcanic rocks. The late W. Mykura has described the Eshaness peninsula on Shetland as *'the best section through the flank of a volcano in the British Isles'*.

A2.2.4 Major Thrusts and Faults (Silurian to Jurassic)

Collision of Baltica with Laurentia caused the Moine rocks to be thrust north-westwards over the Lewisian basement, along a number of low-angle faults represented in Scotland by the Moine Thrust Zone. In Shetland the Moine Thrust manifests itself as an imbricate stack of interleaved basement and cover rocks in the northern tip of Mainland (Fig. A2.1).

After the Caledonian Orogeny reached its peak large relative plate movements continued along a series of strike-slip fault planes. These deep-seated faults were a major control on both sedimentation and igneous intrusion.

The Walls Boundary Fault (Fig. A2.1) has a long and complex history and is linked to the Great Glen Fault, the major transcurrent fault that cuts Scotland. This fault was active at various times from the Devonian (170km sinistral movement) through until the Jurassic (65km dextral movement). Major movements along this fault and its splays brought the 'jigsaw pieces' of Shetland's various rock units ever closer to their present day juxtaposition. Shetland has the best 'hands on' exposure of the Great Glen Fault, one of Europe's major tectonic features.

A2.2.5 Post Old Red Sandstone erosion (Jurassic to present)

Shetland today is an inlier of Caledonian rocks that stands above a platform of Lewisian basement rocks and is surrounded by younger sediments that make up the seabed. Subaerial erosion was the dominant mechanism in the exhumation of Shetland through until the Jurassic when cliff erosion due to rise and fall of sea level became the dominant mechanism.

Apart from recent glacial deposits no rocks laid down since ORS times are found on Shetland today. By the Early Carboniferous metamorphic and igneous rocks were probably buried under several thousand feet of ORS which itself was being eroded and carried away to the south by rivers. Erosion continued through the Permian and Triassic into basins to the east and west of Shetland, which stood as a range of steep sided hills above a tropical desert

plain. During the Triassic, extension of the crust developed rift valleys to the east (the Viking Graben) and west of Shetland into which hundreds of metres of sediment accumulated.

The extensional forces continued through the Jurassic and Cretaceous so the grabens continued to develop and were periodically transgressed and flooded by the sea - Shetland may have become an island for the first time and a lush tropical one at that! By the end of the Cretaceous the tensional forces in the crust had split the continental plate to the west of Shetland and the Atlantic Ocean began to open between the European Plate, carrying Shetland, and the plate carrying Greenland and America.

Organic material in shale deposited in the grabens during periods of high Jurassic sea level became buried under kilometres of sediment to become oil. Over time the oil migrated into and was trapped within porous sandstone to form the oil provinces of the present day East and West Shetland Basins.

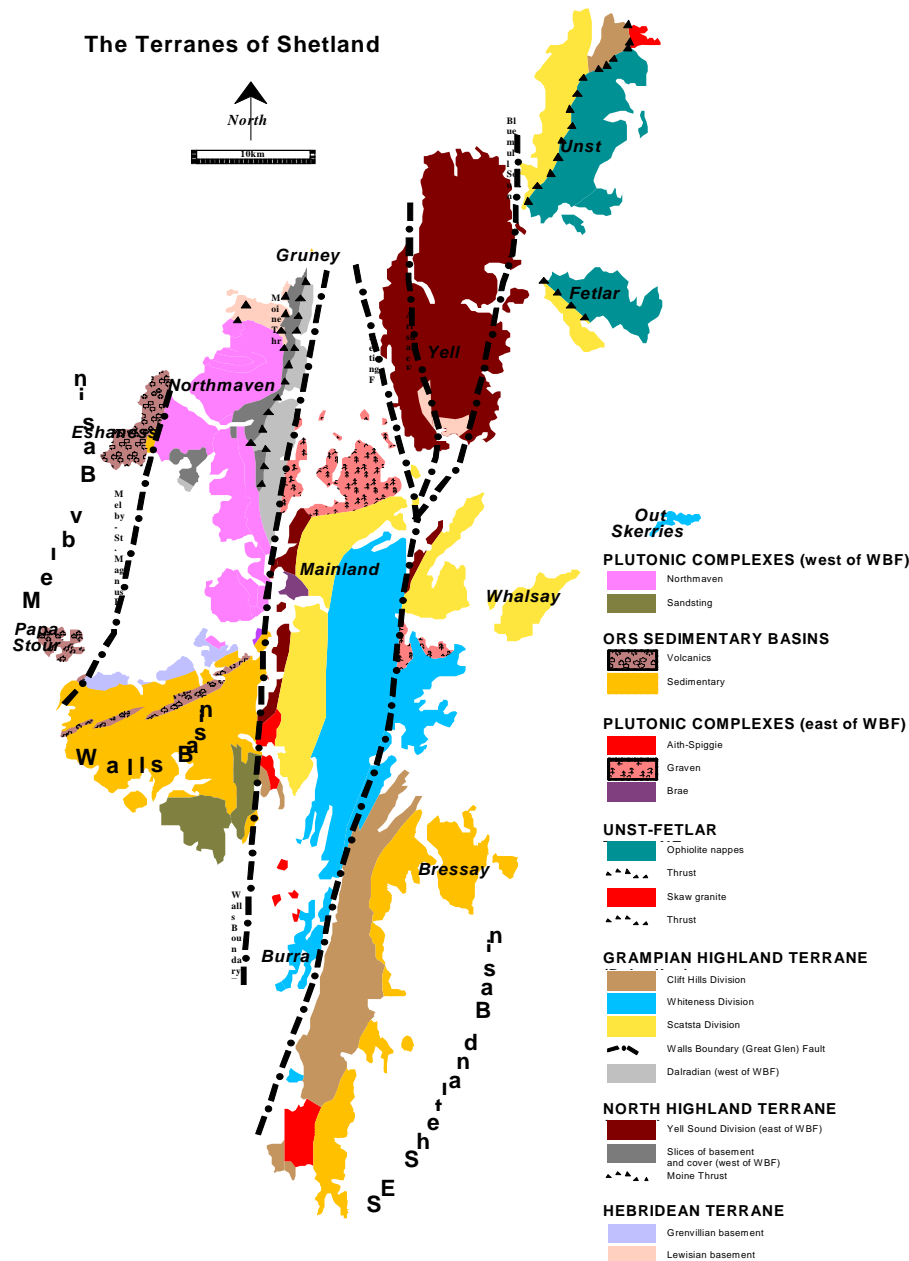


Figure A2.1. The Geology of Shetland

Section A3. General Description and Importance of Shetland Geomorphology

A3.1 Introduction

Rivers, glaciers and the sea have sculpted the landscape of Shetland over the last few million years. The coastline is remarkable in its variety with an outer coast showing spectacular cliff scenery and an inner coast adorned by sandy beaches and tombolos.

During the ice age, Shetland supported an independent ice cap - one of only a small number in the British Isles - however this was much thinner than the major ice sheets covering mainland Britain and Norway and the impact of glaciation on Shetland was less severe. Many of the major landforms of Shetland date from a prolonged period of sub-aerial weathering and erosion long before the ice age and were merely modified by the ice, whilst in a few places peat deposits have even survived from the last interglacial warm period.

The immediate consequence of the melting of the ice sheets at the end of the glaciation was a rapid rise in sea level, followed by a slower isostatic readjustment of landmasses, which had been depressed by their load of ice. Scotland and Scandinavia have risen many metres as a result of this readjustment, but Shetland, having been much less heavily loaded, has been slowly sinking in compensation. The present day coastline of Shetland is the result of this rapid inundation followed by slower subsidence, creating a classic example of a drowned coastline.

A3.2 Pre-glacial landscapes

The reconstruction of the pre-glacial relief of Shetland is made difficult by the ubiquity of glacial erosion and by the limited extent of the land area above sea level. Remnants of little-modified pre-glacial topography can be identified widely where they have been incised by, and so predate, glacial valleys. More generally, there is a strong association between lithology and relief on Shetland, often revealing a pronounced NNE-SSW grain derived from major structural trends, a situation best explained by long-term differential weathering and erosion.

The relationship between geology and landform is most clearly seen in the parallel valleys, which run north-south through central Mainland along trending vertical limestone bands, contrary to the predominantly east-west direction of ice flow. By contrast, the ground west of the Walls Boundary Fault has fewer linear features and the grain of the landscape is more varied, reflecting numerous igneous intrusions and tight folds in the Devonian rocks, and the rounded hills of eastern Unst and Fetlar are developed on large masses of serpentinite and gabbro separated by phyllites and schists.

The sheer variety of geology on Shetland makes it an excellent location to study the links between rock and relief.

A3.3 Glacial landscapes

Shetland supported independent ice caps and local glaciers of various sizes during the Pleistocene. Not surprisingly, Shetland displays many classic glacial landforms, often described first by the great Victorian geologists, Peach and Horne. These include roches moutonnées and over-deepened valleys, now drowned by the sea. Glacial details, such as erratics and striae, are exceptional, well exposed and accessible. Glacial moraines occur on a number of valley floors and meltwater has formed some significant channels.

Figure A2.2 Shetland from space



As associations or groups, the landforms create distinctive landscapes. The extensive glacial erosion on Shetland has created classic landscapes of areal scouring with a character that varies markedly over different rock types.

Shetland provides the best records in Scotland of terrestrial environments around the period of the last interglacial between 130 and 80 thousand years ago. Well-exposed organic deposits also provide detailed records of environmental change over the last 15 thousand years. These records are of great importance for reconstructions of the history of the Gulf Stream.

A3.4 Periglacial landscapes

Three generations of periglacial features exist on Shetland:

- Features active today or earlier in the Holocene
- Features formed under intensely cold conditions during the Loch Lomond Stadial and the early phases of deglaciation
- Features inherited from phases of periglacial activity prior to the last ice sheet

Together these point to the importance of the action of frost and wind in the shaping of both contemporary and Ice Age landscapes of Shetland. Ronas Hill, the highest point on Shetland, carries an exceptional range of periglacial forms usually found only within the Arctic Circle.

A3.5 Coastal landscapes

Shetland has approximately 1500 kilometres of indented coastline consisting partly of exposed cliffs and shores bordering both the Atlantic Ocean and the North Sea. No part of Shetland is more than 5 km from the coast; the sea and the coastline are central to life in the islands.

Two almost land-locked bays, St. Magnus Bay and The Firth contain possible meteorite impact craters formed between Devonian and Pleistocene times. Steep-sided basins in the rock, several kilometres wide, are found in the sea floor in the centre of each, plunging to 165m in St Magnus Bay and 147m in The Firth. It has been argued that since ice has not excavated formations of this magnitude elsewhere in Shetland, then these basins had another mode of formation. It is suggested that they formed by meteorite impact sometime before a glaciation episode that removed impact debris from the basins. Following the meteorite impact the retreating coastline would have intersected and radiated outward to form the present day bays.

Unlike much of Scotland, Shetland has a 'drowned' coastline, progressively flooded (by up to 120m) since the end of the last glaciation. This provided material for the outstanding diversity of sand and shingle bars, spits and tombolos found in the islands. The submarine topography is extraordinarily varied over short distances, creating rich habitats for inshore sea life, particularly in the kelp forest, which may cover an area of over 250 square miles.

The submergence of the archipelago has had a profound effect on coastal processes. The outer coast displays spectacular cliff scenery, reflecting rapid erosion along one of the highest energy coastlines in the world. It is littered with awe-inspiring stacks, arches and caves, including some of the longest sea caves and geos (clefts in sea cliffs) in the world. The middle coast is much more sheltered and includes the anchorages of Sullom Voe and Bressay Sound, where deep-water fills drowned glacial valleys. The sands and gravels along the inner coast are highly mobile, with beaches, spits and bars adapting to sea level rise and being reworked during major storms.

Shetland experiences one of the highest wave energy environments in the world. The west coast is exposed to the full force of the Atlantic waves, with hundreds of kilometres of fetch, hurricane-force wind speeds and deep-water close inshore allowing huge waves to arrive at the cliffs unbroken. The rocks of Shetland are highly varied, allowing the effects of lithology and structure on cliff form to be identified. The cliff-top storm deposits found at a few localities can be matched at only a handful of sites elsewhere around the coasts of Western Europe. Rates and styles of marine erosion and cliff retreat can be assessed on Shetland, unlike many other coasts where change is usually regarded as very slow.

A3.6 Postglacial landscapes

Around 14,000 years ago, the last ice sheet disappeared from Shetland to leave a barren, scoured terrain. As temperatures rose rapidly, pioneer plants arrived from the south and the low ground was soon carpeted with a rich herbaceous cover. For a bleak thousand years, there was a reversion to Ice Age conditions; only Arctic species clung on and small glaciers probably reformed in north-facing hollows.

With the melting of the last glaciers and the amelioration of climate at the start of the Holocene, around 10000 years ago, the pace of environmental change on Shetland slackened. The present interglacial has seen many slow changes in the landscape, with the development of soils, the succession of vegetation types and the rise of sea level drowning the major valleys. The steady pace of change has been interrupted by a sequence of natural disasters, including at least three tsunami events, heavy falls of volcanic ash and extreme storms.

The Shetland coast also preserves sediments left by the Storegga tsunami of 7300 years ago and the tsunami record in Shetland is so well preserved that researchers intend to bring South Asian geologists to Shetland as part of a training programme in defining such hazards.

Man has been the main agent of landscape change in the last 7000 years, initially causing the loss of trees through cutting and grazing by domestic animals but later affecting the landscape through farming. In modern history, we have begun to physically reshape the land, opening quarries, reclaiming land, opening cuttings and creating building sites.

Section A4. Economic Geology

A4.1 Early exploitation

When the first settlers appeared on Shetland's shores somewhere between 7000 and 5500 years ago it must have been their 'New Rock', a land of opportunity. Rocks were a fundamental resource for those early settlers and all who came after. They have been used as a building material since the earliest times with many examples of the stonemason's art evident throughout Shetland, especially on archaeological sites. Rocks were also the raw material for essential tools (or weapons); flint is not found in Shetland so quartz was a substitute used to make arrowheads and scrapers, and coarse sandstones and schists for querns and millstones. Some rocks seem to have had aesthetic appeal or even ceremonial function. In Neolithic times highly polished axes, knives and mace heads were fashioned from the unique flow banded and spherulic felsite dykes of North Roe.

Neolithic potters also ground down talc-magnesite rock (steatite or soapstone, *clebber* in Shetland) to be used as an ingredient in pottery along with glacial clay but the greatest exploitation of this material occurred in Norse times. Steatite was extensively quarried by the Norse settlers to produce a whole range of functional and decorative objects from fishing weights to cooking utensils to personal ornaments. Objects of Shetland steatite have been found in association with Norse settlements throughout Britain and Ireland suggesting a thriving export trade. In more recent times talc has been quarried in Unst and exported intermittently for industrial use.

A4.2 Mines and miners

Shetland does not have an abundance of economically exploitable ores but some have been exploited in the past. Archaeological evidence of smelting of bronze and iron has been uncovered in Shetland; both copper ore and iron ore (bog iron) would have been known to the early smiths. Obtaining tin for the bronze would have been a problem; the nearest source is in Cornwall, and so by the time the Bronze Age reached Shetland iron working was well underway in the rest of Britain.

Copper and iron ores, may have been worked in several localities in Shetland in prehistoric times, but industrial-scale mining did not take place until the start of the 19th century when mine shafts were sunk at Sandlodge in Sandwick to win chalcopyrite, malachite and hematite. This proved to be an economic failure, as did successive attempts in the 1870's and 1920's, and a second mine at Garths Ness near Quendale. More recently, magnetite

was briefly mined during and just after World War II from a remarkable scarn-magnetite mass near Sullom.

The most extensive mineral workings in Shetland are the numerous pits around Baltasound in Unst, dug to extract chromite (iron chromate), which occurs as pods and veins in the ophiolite rocks. Chromite was mined between 1820 and 1944, initially for use as a pigment and later for steel manufacture and as a refractory material for lining furnaces. The ophiolite rocks are also the source of talc, which has been exploited intermittently over the past half century. They also contain platinum and other rare earth elements, but like the gold, which can be found in several parts of Shetland, these do not occur in commercial concentrations.

A4.3 Fossil fuels

Blanket bog is almost ubiquitous in Shetland and has provided fuel in the form of peat since earliest times. The Island of Yell is particularly well endowed with peat, reaching depths of 6 metres in places, and during the 1970s was proposed as the location for a peat-burning power station. The crystalline limestone bands of central and east mainland, and the ophiolite suite in Unst and Fetlar, where the mineral composition of the underlying rocks prevents the growth of Sphagnum mosses, are the only districts where peat is virtually absent. Historically, all crofters had the right to cut peat for fuel on nearby open moorland, but the peat rights for townships in eastern Unst and Fetlar were more distant on the hills to the west or even on other islands, entailing long journeys by pony or boat to bring home the essential fuel.

Exploration during the early 1970's discovered the oil and gas trapped in the grabens east and west of Shetland. By 1978 Europe's largest oil terminal had been built at Sullom Voe in Shetland to receive oil piped from the fields in the Northern North Sea for onward shipment by tanker. During the late 1990's, with the North Sea province in decline, the oil industry began to exploit the technologically more challenging West of Shetland province.

Section A5. Climate, Flora and Fauna

A5.1 Climate

The establishment of the North Atlantic Current (an extension of the Gulf Stream), which probably occurred soon after the last glaciation, would have been critical in allowing many plants and animals to colonise Shetland. This brings warmer water into the north Atlantic, which warms the overlying atmosphere. Prevailing winds then carry this heat towards Europe and Shetland. As a result annual-mean air temperatures over the northern North Atlantic and Western Europe are 5-10 degrees warmer than elsewhere at the same latitude. Just compare Shetland in winter to St Petersburg in Russia, Cape Farewell in Greenland or Anchorage in Alaska, all of which lie at the same latitude as Shetland. The relatively warm seas around the islands also result in a high humidity so that although rainfall in Shetland is not high (at only 1200 mm today) the climate is damp. Refer to Appendix A2 for more detailed information on Shetland's climate.

A5.2 Flora and Fauna

Much of the present land surface of Shetland is covered with blanket peat and plant communities dominated by heather, grasses and sedges. The flora is restricted, with only some 400 native vascular plant species. This is primarily due to a combination of Shetland's geography, being an isolated group of islands at 60 degrees north, and the limited range of environmental niches available on the islands. Although more recently man's activities, especially grazing by sheep, have also played a part.

Isolation also prevented colonisation by land mammals. The few species that now occur here (perhaps even the otter), have been introduced accidentally or deliberately by man. By contrast, a combination of productive seas, excellent cliff-nesting sites and an absence of native mammalian predators provide a haven for seabirds whose numbers and diversity are equalled in few other parts of the world. The rich and diverse marine ecosystem also supports a variety of sea-mammals, seals are abundant and Shetland is one of the best locations in the British Isles to see whales, dolphins and porpoises.

An unusual feature of Shetland's flora and fauna is the occurrence of sub-arctic species alongside those from temperate zones, a consequence of Shetland's northern location and the ameliorating effects of the Gulf Stream. As well as limiting the colonisation of the islands,

Shetland's isolation has contributed to its biodiversity by allowing the evolution of distinct island forms. These include races of several moths, field mice and the wren. Some have even evolved into new species, endemic to the islands, including Edmondston's Chickweed and a remarkable group of 18 micro-species of hawkweeds (*Hieracia*).

The importance of Shetland's biodiversity and its habitats is recognised through a number of international designations. The islands host 12 Special Protection Areas and 12 Special Areas of Conservation, as well as 3 National Nature Reserves and over 80 Sites of Special Scientific Interest. The island of Fair Isle is also a European Diploma site.

An audit of Shetland's biodiversity was produced by Shetland Amenity Trust, in partnership with a range of other organisations, in 1999. This has since been maintained, and where possible updated, by the Shetland Biological Records Centre. A Local Biodiversity Action Plan (LBAP) project officer was appointed in October 2001, with funding from a range of sources. The LBAP officer produced a range of Action Plans including five community plans, one sectoral plan (agriculture) and a range of species and habitat plans. These are all available to the public as well as those bodies who make decisions regarding Shetland's biodiversity. A new officer was appointed by Shetland Islands Council in 2007 to continue partnership working and implement these plans.

Refer to Appendix A3 for further information on Shetland's biodiversity.

SECTION B. STRUCTURE AND MANAGEMENT OF THE GEOPARK

B1 Organisation in charge of Geopark Shetland

B1.1 Introduction

Geopark Shetland is in a fortunate position regarding the way its structure and management is organised. Rather than being an independently managed body, Geopark Shetland integrates into and utilises resources within an established organisation – the Shetland Amenity Trust (SAT). This trust has over 25 years of experience in project design, management and service delivery within the heritage sector, and is fully committed to the long-term success of Geopark Shetland.

Whilst SAT is responsible for the management of the Geopark along with other aspects of Shetland's heritage, the key group is the Geopark Shetland Working Group (GSWG). This group, which includes representatives of organisations committed to the long-term future of Geopark Shetland, such as Shetland Islands Council (SIC), Scottish Natural Heritage (SNH), community groups, tourism operators and geology advisors, drives Geopark activities under the guidance of the Geopark Shetland Action Plan (Appendix B5). The Action Plan, consistent with SAT objectives and the Geopark Shetland mission statement, is reviewed and agreed on an annual basis, by the GSWG and the Shetland Amenity Trust.

B1.2 The role of Shetland Amenity Trust and Geopark Shetland

B1.2.1 Background

Shetland Amenity Trust is a heritage trust with an overarching responsibility for Shetland's natural and cultural heritage and is the lead partner for Geopark Shetland. The trust is highly experienced in the development, delivery and subsequent management of a wide range projects. These projects range from small-scale access improvements to complex archaeological excavations and the delivery and management of large-scale construction projects such as the new Shetland Museum and Archives. SAT is committed to the long-term sustainability of Geopark Shetland. This is evident in the Trust's Strategic Plan 2007-2010 (Appendix B1), in which the development of Geopark Shetland is a key strategic objective.

B1.2.2 Funding

The Shetland Amenity Trust receives its income from a variety of sources. In 2007/08 this amounted to approximately £4.3 million of which approximately £3.8 million was grant funding, with £0.5 million coming from interest receivable, donations and other income (note that these are draft figures at the time of writing).

Income of 28% in 2007/08 was core funding provided by the Shetland Charitable Trust and covers the Administration, Management and the main strands of SAT's operation. Shetland Islands Council provided 36% of the overall revenue in 2007/08. Primarily this went towards the Museum and Archives Services, which is core funded under a Service Level Agreement (24.5% of overall income).

The remainder of funding in 2007/08 (27% of total income) came from various other funders, including Heritage Lottery Fund, Historic Scotland, Scottish Natural Heritage and Highlands and Islands Enterprise. This funding was utilised mainly on capital projects but also revenue projects such as Geopark Shetland. Finally, SAT also generates approximately 12% of its total turnover from the following - sales of merchandise and publications; income from external (construction and woodland-related) works; consultancy work; letting income for heritage accommodation; donations and interest receivable.

B1.2.3 Geopark Shetland and the Shetland Amenity Trust

Geopark Shetland fits well with the core objectives of SAT's founding deed and in particular the promotion of access (both physical and intellectual), to cultural and natural heritage. It also provides the opportunity for SAT to focus on another aspect of natural heritage in its activities, linking geology into other work within the Trust, for example archaeology, place

names and biodiversity. At the same time, Geopark Shetland is able to integrate into a well-established organisation with significant staff, knowledge and financial resources at its disposal. It is important to emphasise that while Geopark Shetland forms an integral part of SAT, it also operates as a distinct project in terms of identity and project funding.

B1.2.4 The Heritage Hub concept

Whilst SAT does not manage all of the natural and cultural heritage sites in Shetland, it does help and support those heritage organisations to deliver quality products. This approach is being strengthened through the development of the ‘Heritage Hub’ concept, which seeks to better integrate heritage sites and local museums. The new Museum and Archives serves as a ‘Hub’, introducing visitors and residents to Shetland’s heritage, and promoting the exploration of other sites and centres throughout Shetland. This is done via websites, leaflets and trails aimed at different audiences and interests. Geological interpretation features strongly in the Shetland Museum and Archives and in several of the sites and local museums. The Hub concept therefore forms an integral part of Geopark Shetland’s work. Appendix B2 outlines the remit of the Heritage Hub.

In association with the Heritage Hub, and its work over the years, the Shetland Amenity Trust works very closely with a range of statutory and voluntary groups throughout Shetland and within Europe. SAT has established good working relationships with these groups and individuals, and partnership working is commonplace. Geopark Shetland has only served to enhance these relationships, with those representatives on the GSWG fully committed to the success of the Geopark over the longer term.

B1.3 The Geopark Shetland Mission

The Geopark Shetland Mission is to:

"Safeguard and increase the awareness and understanding of Shetland’s rich geological heritage and to use this as a driver for sustainable development."

It does this by fulfilling its aims:

1. Conserving Shetland’s rich geological heritage and demonstrating its clear links with natural and cultural heritage.
2. Raising awareness and increasing understanding of Shetland’s geological heritage.
3. Enhancing the image of Shetland and promoting sustainable development linked to geological heritage and Geotourism.

B1.4 Local Framework for development – Shetland Islands Council

Shetland has the advantage of having a single local authority (Shetland Islands Council) with many of the policies and structures for the Geopark already in place (Table B.1).

Table B.1 <i>Copies of all of these policies are available online</i> www.shetland.gov.uk	Policies	Consistent with Geopark Aims
	Shetland Development Plan 2001-2016, Shetland Islands Council	1,2 & 3
	Shetland Corporate Plan 2004-2008, Shetland Islands Council	1, 2 & 3
	Cultural Strategy, Shetland Community Planning Board	1, 2 & 3
	Together Shetland, Shetland Community Planning Board	3
	2012 Shetland Economic Development Strategy, Shetland Economic Development Forum	3
	Shetland Environmental Strategy	1
	Shetland Interpretative Plan	1,2 & 3
	Shetland Tourism Plan 2006-2009	2 & 3
	Shetland Heritage Tourism Investment Programme	1,2 & 3

For example the Shetland Islands Council Corporate Plan sets out the authority’s objectives from 2004-2008. It stated aim is “to support Geopark status”. Meanwhile, the Shetland Structure Plan sets out policies and procedures to guide development throughout Shetland from 2001-2016. Its stated aim is to ‘Protect, sustain and enhance Shetland’s natural

resources and cultural heritage for future generations to enjoy and ensure that new development contributes to environmental quality’. Partnership working and liaison between local agencies, the local community and other European countries are also common practice.

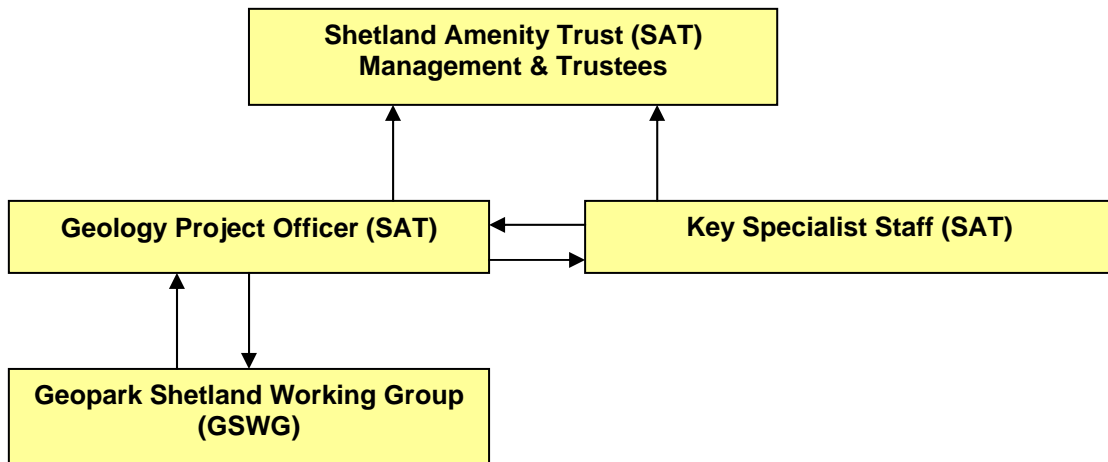
It has been established that there is political will and community support to use Shetland’s geology as a driver for developing sustainable geotourism. In January 2008, the local authority, which has continued to support Geopark Shetland, unanimously agreed to fund the Geology Project Officer post full-time for three years from April 2008 as recognition of the commitment required to progress the work undertaken to date. Geopark Shetland has also received letters of support from various internal and external organisations. These are included within the Enclosures.

B1.5 Geopark Shetland Management Structure

Geopark Shetland is a distinct project in terms of its identity and resource allocation, within the overarching management of the SAT. Fig B.1 outlines the management structure of Geopark Shetland, a model similar to other initiatives that SAT manages within the heritage sector.

The Geopark Shetland Working Group (GSWG) consists of a range of external organisations, advisors and specialists committed to the promotion of geological heritage as an economic driver and to the long-term success of Geopark Shetland. While the Geology Project Officer coordinates project delivery alongside this group and key specialist staff within SAT, the SAT manages the allocation of resources through its board of Trustees, and Senior Management Team.

Fig. B.1: Management structure for the Geopark Shetland



B1.5.1 SAT Key Specialist Staff

This group provides delivery of the projects within Geopark Shetland, namely through the Geology Project Officer and the Natural Heritage Project Officer. SAT possesses a wide range of skills, which are utilised as appropriate in providing support for project delivery. For example, key staff members such as the Trust’s Marketing and Communication Officers, Finance and Administrative Support, Lifelong Learning Officers, Archaeologists and Rangers contribute valuable resources to the Geopark. These vital resources are available on a long-term basis as a consequence of the SAT’s involvement, without which additional funding would be required. Consequently, Geopark Shetland is in a strong position regarding long-term sustainability.

B1.5.1.1 Geology Project Officer

Since October 2006 SAT has employed a Geology Project Officer. Shetland Islands Council demonstrated their full support to the Geopark by agreeing to fund this post, full-time for three years between April 2008 and March 2011. After this SAT has pledged to incorporate

Geopark Shetland, and therefore this post, into its core activities. This role is primarily focuses upon facilitating geological projects and the promotion of the conservation, understanding and enjoyment of Shetland’s geodiversity. They are the primary contact for all EGN communications and initiatives, and attend the EGN conferences and meetings on behalf of Geopark Shetland (Appendix B3 details their job description).

B1.5.2 Geopark Shetland Working Group (GSWG)

The GSWG consists of representatives from a range of statutory bodies, agencies and local groups including Shetland Amenity Trust, Shetland Islands Council (Economic Development, Infrastructure and Education Services), Scottish Natural Heritage, Highlands and Islands Enterprise, Visit Shetland, Association of Community Councils, a Specialist Geology Advisor, and commercial tourism operators. The Shetland Amenity Trust’s Vice-Chairman chairs the group. This maintains the strong link between SAT and Geopark Shetland. A nominated Councillor for Shetland Islands Council is also a member of this group, and acts as a champion for Geopark Shetland within the Shetland Islands Council. Table B.2 outlines the respective roles of the GSWG members. Meetings of this group are held a minimum of every three months.

Table B2: Membership of the Geopark Shetland Working Group (GSWG)		
Organisation	Representatives	Role within GSWG
Shetland Amenity Trust Vice Chairman (Chair)	1	Representing Shetland Amenity Trust Trustees
Shetland Amenity Trust – Geology Project Officer	1	Coordination of Geopark Shetland projects
Shetland Amenity Trust – Natural Heritage Project Officer	1	Overseeing & working closely with Geology Project Officer
Shetland Islands Council – Elected Member	1	Representative and champion for Geopark Shetland within the Council
Shetland Islands Council – Economic Development	1	Tourism, Regeneration, Product Development & Funding
Shetland Islands Council – Infrastructure Services	1	Access, Conservation, Development Planning/ Control
Shetland Islands Council – Education	1	Geological, natural & cultural heritage in schools
Scottish Natural Heritage	1	Access, Interpretation, Monitoring & Protection of SNH sites, Geology advice
Specialist Geology Advisor	1	Geology advice
Highlands and Islands Enterprise (HIE)	1	Economic, Community & Environmental Development, Funding
Shetland Tourism Association (STA) (representing tourism operators)	1	Industry Association representing all tourism sectors throughout Shetland
Visit Shetland	1	Tourism & Marketing
Association of Community Councils	1	Association representing all 18 communities in Shetland
TOTAL	13	

The Geology Project Officer works in close cooperation with members of the GSWG who possess specialist knowledge in this field and are able to advise on all matters pertaining to the development and growth of Geopark Shetland. Specialist support from this group is an invaluable component in guaranteeing the long-term success of the Geopark.

Together with the Geology Project Officer and relevant SAT staff, the GSWG progress Geopark activities in accordance with the Geopark Action Plan. This prioritises projects for the next three years with the current Action Plan (Appendix B5) focussing upon the Geopark’s “development phase” between 2008-2011. This current document is reviewed and agreed annually to ensure that the proposed activities complement the objectives of

Geopark Shetland and the Shetland Amenity Trust. Additional projects for beyond 2011 are also included in the Plan. These will be added to and prioritised as appropriate to ensure that the Geopark continues to look ahead and remain focussed in its activities.

The Geology Project Officer is responsible for obtaining funding for individual projects on a project-by-project basis. To date this has proved to be a successful approach, and it will continue into the future. Beyond 2011, SAT will manage Geopark Shetland as a core activity and therefore the only funding required will be that relating to individual projects. This enhances Geopark Shetland's long-term financial sustainability.

B1.5.2.1 Shetland Islands Council (SIC)

SIC is the local authority for the entire territory of Shetland and therefore Geopark Shetland. It provides a number of services including economic development, education, access, planning control. SIC has several different and important roles within Geopark Shetland. This is illustrated by the number of SIC representatives present in the GSWG. An elected member of the Council acts as a champion for Geopark Shetland in all discussions with the Council; a representative of SIC's Economic Development Unit provides guidance regarding rural development and regeneration, tourism and funding matters; an Infrastructure Services representative assists on matters relating to access and planning control, and the Education Department provides an avenue to enhancing geological interpretation within schools and clubs (www.shetland.gov.uk).

B1.5.2.2 Scottish Natural Heritage (SNH)

SNH is a national organisation, responsible to the Scottish Government, and has a statutory role in protecting the natural heritage of Scotland. Their main responsibilities are to advise central and local government on the natural heritage, including earth heritage; protect designated sites; encourage public understanding and engagement through grants, advice, publications and information; undertake research and support heritage interpretation. With regard to Geopark Shetland the SNH representative provides geological and natural heritage assistance and project funding (www.snh.org.uk).

B1.5.2.3 Highlands and Islands Enterprise (HIE)

HIE is the Scottish Government's economic and community development agency for a diverse region which covers more than half of Scotland. HIE aims to build sustainable economic growth in all parts of the Highlands and Islands, and delivers its services through area teams located from Lerwick to Lochgilphead. Particular focus is given to a number of key sectors, and tourism is one of these sectors. HIE also has a remit to create stronger, more dynamic and sustainable communities, with a particular focus on the fragile areas, and these are the main focus for geological developments in Shetland. HIE can support the group through providing assistance to social enterprises, business development and transformational projects in the area, as well as advice and signposting to funding (www.hie.co.uk).

B1.5.2.4 Visit Shetland

Visit Shetland is a subsidiary of Visit Scotland – Scotland's national tourist board – and is therefore the official tourism body for Shetland. Through their website, publications and tourist offices, Visit Shetland provide advice, information and bookings for visitors, and are significantly involved in the marketing of tourism attractions, facilities and events in Shetland, including those relating to the Geopark. In addition, they manage the network of tourist information points throughout Shetland, providing advice and training to those within the community who liaise with visitors (www.visitshetland.com).

B1.5.2.5 Community Involvement

Shetland has 18 Community Councils, and these are the first point of contact for all local consultation and decision-making. All the Community Councils are represented through the Association of Community Councils (ACC), who has a representative serving on the GSWG. In turn, the representative of ACC feeds back Geopark information to the Shetland's Community Councils as part of the regular ACC meetings.

SAT employs two Rangers who work closely with local communities throughout Shetland to progress access and interpretation at heritage sites. The GSWG, the ACC and the Rangers encourage and support local community groups to develop projects directly or indirectly linked to geological heritage, in accordance with the Shetland Interpretive Plan and the Geopark Shetland Action Plan. When such practical projects are proposed the relevant community groups are invited to join GSWG for the duration of delivery of those specific projects. Community involvement is also encouraged in strategic projects, through on-going consultation and membership of working groups and project teams.

B.1.6 Financial Sustainability – budget and other resources

Geopark Shetland has the advantage of being a distinct project in terms of its identity and resource allocation while operating within the established management of SAT. Consequently many of the skills and resources required for a successful Geopark such as administrative, financial and marketing services, office accommodation, and experienced colleagues within related fields of natural and cultural heritage, are available without the requirement for additional funding to be sought. This therefore reduces the total amount of funding required, meaning that Geopark Shetland can focus its efforts towards sourcing for individual projects, and subsequently enabling the Geopark to be financially stable over the years and decades ahead.

Geopark Shetland has secured a budget of approximately £125,656 required for the next three years (2008-2011). This will:

- Develop Geopark Shetland as a core element of SAT activities and identify funding streams for future projects beyond 2011.
- Continue to employ a Geology Project Officer for a 3-year period between 2008-2011
- Promote Geopark Shetland (Appendix B6)
- Fulfil Geopark Shetland core activities, including contributing fully to the EGN

Geopark Shetland has identified a further £134,500 to:

- Fulfil projects identified in the next three years of the Geopark Shetland Action Plan.
- Of this, £30,000 has already been secured while sources for the additional amount have been identified and will be secured on a project-by-project basis.

Funding is in place to support the Geology Project Officer post for a further 3-years (2008-2011) on a full-time basis. Following completion of this 3-year programme, the ongoing development of Shetland's geological heritage and involvement within the EGN, will be carried out as a core part of SAT's wider natural and cultural heritage responsibilities. With the commitment from SAT and GSWG partners, and the integration into a well-established, resourced structure, Geopark Shetland can look forward to a future and longevity, which would otherwise be difficult to achieve.

B1.7 Geopark Shetland Identity

Geopark Shetland, unlike some Geoparks, has the advantage of operating as a distinct body while forming an integral part of an established organisation. This is of real benefit to Geopark Shetland as it can utilise (as well as contribute to) the experience, expertise and contacts that the SAT has developed over the years. In addition, the Geopark is able to access resources such as administration, financial services and office accommodation provided by SAT. Geopark Shetland has a distinct identity and brand within Shetland's wider heritage brand (Section D Enclosures).

In addition to its own identity, as a European Geopark, Shetland will be able to utilise the EGN branding and identity within its own marketing. This will instantly allow visitors and residents to recognise the Geopark as a place, which is not only geologically significant, but one which is adhering to the standards and practices of an established and respected international organisation. Consequently, EGN membership will improve Shetland's profile, and increase its recognition within international circles, while contributing to the economic development of this region, over the longer term.

B1.8 Disabled Access - 'Access for All'

In line with Shetland's Countryside Access Strategy (refer to Section C Enclosures or online at www.shetland.gov.uk/) all projects generated by Geopark Shetland takes into account the needs of people with disability and existing provision will be reassessed to identify ways in which it can be improved to cater for the needs of the disabled.

B.1.9 Geopark Shetland Ethics Policy

Geopark Shetland has developed an Ethics Policy in line with current legislation, partner organisation policies and the EGN charter (Appendix B4).

B.1.10 Monitoring and Evaluation of Geopark Shetland and its Benefits.

Geopark Shetland recognises the importance of monitoring and evaluating its activities, not only to avoid adverse impacts through methods such as regular monitoring of sites (Appendix C5) and implementing the Ethics policy, but also to continually improve and develop its operations and measure sustainable benefits to the community. Some methods used to monitor and evaluate Geopark Shetland's activities are detailed in Appendix B7.

A SWOT analysis of Shetland's current activities has also been carried out (Appendix B8). This highlights Shetland's strengths, weaknesses and opportunities it has for development and the possible threats that may need to be overcome if it is to be successful. The Geopark Shetland Action Plan draws on this analysis to prioritise Geopark related activities and ensure its sustainability over the longer term.

SECTION C. GEOSITES, INTERPRETATION AND PROJECTS

Section C1. Geosites and geo-conservation within Geopark Shetland

C1.1 Introduction

The Geopark recognises that there needs to be a balance between the irreplaceable nature of much of our geo-heritage and the improved prosperity of our human population. This is being achieved in three ways:

- By documenting, monitoring and safeguarding Shetland's geological heritage through a combination of designated sites and locally important sites i.e. Geosites.
- By raising awareness of Shetland's geological heritage among visitors and islanders through interpretation of Shetland's geology and its Geosites, and directed access to Geosites.
- By continuing responsible development of Geosites and geological trails, and links to other aspects of Shetland's natural heritage, archaeology, history and culture.

In 1997 Shetland Amenity Trust carried out a comprehensive interpretive review of Shetland in partnership with Scottish Natural Heritage, Shetland Islands Council, Shetland Enterprise Company, Visit Shetland, Community Groups in every Community Council area and other organisations with an interest in interpretative provision. This resulted in the Shetland Interpretative Plan 2001, which has since been the key reference document for all those involved in interpreting sites of cultural or heritage significance.

Within the plan, sites throughout Shetland are organised into key themes i.e. Archaeology, History, Cultural Heritage, Maritime Heritage, Agriculture, Sea Birds, Wildlife, Botany, Mineral Extraction, Wilderness, Landscape, Recreation, Angling, Amenity, Knitwear, Musical Heritage and Crafts; and then rated from 1 to 3 in order of importance. Sites ranked as Tier 1 are considered a priority in terms of developing appropriate access and interpretation.

Several strategic partnership projects have been generated from the recommendations in this plan, including the Shetland Museum and Archives, a suite of high quality geographic and thematic leaflets www.shetland-heritage.co.uk, and the signposting of all Tier 1 Sites that met the Visit Scotland quality assurance standards for access and amenity. One of Shetland's most popular outdoor tourist attractions - Old Scatness - is already indelibly linked with geology through its Living History interpretation, which graphically illustrates how natural resources were used and traded by early peoples.

Geopark Shetland believes that becoming a European Geopark will make a major contribution to promoting and celebrating Shetland's rich geological heritage and give it the prominence it deserves when enhancing the awareness and understanding of Shetland's natural and cultural heritage to a global audience. We also believe that Shetland is unique, not just in terms of its geological resources, but also in terms of its wider heritage and culture. To this end there is no existing Geopark like it, it will simply be unique within the Geopark Network.

C1.2 Geosites

C1.2.1. Existing Scientifically Designated Areas

Shetland is seen to be extremely important in environmental terms both nationally and internationally and this is reflected in the high number of designations within the proposed Geopark area, (Appendix C1).

Shetland has 81 Sites of Special Scientific Interest (SSSI), 40 of which are geological. There are 43 Geological Conservation Review sites (GCR) listed for Shetland (Appendix C2), an unusually high density, which reflects the special character of the Shetland landscape. The Joint Nature Conservation Committee's (JNCC) principal domestic geological function is the (GCR), a major initiative to identify and describe the most important Earth science sites in Britain. GCR sites are often SSSI. Each has been thoroughly documented by Scottish Natural Heritage.

SSSIs are afforded legal protection and each site has a summary document (Site Management Statement) that is available to the general public. Scottish Natural Heritage carries out detailed monitoring of notified features on SSSI on a six-yearly cycle and reports the overall condition to government. For geological sites this means that the features identified in the Geological Conservation Review (GCR) report are checked for integrity (i.e. are they still there and intact) accessibility/visibility and, for active geomorphological sites, continued functioning of natural processes.

C1.2.2 Audit of geo-diversity

Shetland Amenity Trust, Scottish Natural Heritage and the Shetland Field Studies Group compiled an audit of geological and geomorphological sites relevant to Shetland's Earth Heritage, in 2005. A total of 269 sites were recorded in the audit, which included all existing designated sites. A comprehensive Geo-register is being compiled which will include all sites identified in the audit (Geosite record sheet Appendix C3).

C1.2.3 Active Geosites

A range of sites were selected as 'active' Geopark sites based on the audit and community aspirations. Taken together these sites have been identified as giving the best integrated, or 'holistic' experience for both visitors and residents alike.

These active sites are not just restricted to geological or geomorphological sites, trails or areas, but also include 'gateway' sites to and within the Geopark, and museums or heritage centres where Earth Science is often related to archaeology, history and culture. A total of 67 such sites have been identified which have existing interpretation or are included in the Geopark Shetland Action Plan (Appendix B5).

C1.2.4 Active interpretation

The Shetland Museum and Archives serves as the Heritage Hub in Shetland, which directs visitors to a series of satellite sites and smaller sites where more of the heritage story can be told (See section C2.1). The 'Active Geosites' and the network of community museums, heritage centres, tourist information points and gateways throughout Shetland all form part of the Heritage Hub vision.

The European Geoparks Network state that:

"A European Geopark must comprise a certain number of geological sites of particular importance in terms of their scientific quality, rarity, aesthetic appeal or educational value." (www.europeangeoparks.org).

Appendix C4 provides a map to indicate the locations of Shetland's national and international geosites. In addition, this Appendix describes these sites through (i) a comprehensive list of the existing and proposed interpretation at each of those sites, (ii) sites incorporated into tours and trails, and (iii) sites such as visitor centres, transport terminals and others, which do not specifically relate to a geosite or trail.

C1.2.4.1 Geology walls & trails

A geological 'wall' constructed out of locally sourced stone complements a self-guided 'Volcano Trail' through Northmavine's Igneous Complex. This gateway exhibit represents a cross-section through Northmavine and introduces visitors to the types of rocks they may encounter during their visit. The Volcano Trail itself incorporates the innovative use of sculptures within its interpretation. A second geology wall has been constructed in Fetlar for the same purpose as that in Northmavine. Geopark Shetland intends to produce a series of similar exhibits in Unst and Yell, and eventually throughout other parts of Shetland, creating a family of interpretation for visitors to identify with.

C.1.2.4.2 Restoration of Hagdale Chromate Crushing Mill

The renovation of, and improved access to an early 19th century horse powered chromate crushing mill on Unst has been completed along with the installation of three interpretation panels.

C1.2.4.3 Interpretation panels & leaflets

Shetland Amenity Trust in conjunction with local statutory and community bodies has produced a series of 50 interpretation panels, which will collectively interpret Shetland's varied geological, archaeological, natural and cultural heritage. Many of Shetland's important geological sites have been included within these on-site panels. The Trust has also reproduced a range of geographical and thematic leaflets within which a geology leaflet has been added.

C1.2.4.4 Guided Tours

Guided tours, run by several operators remain popular for those wishing to find out in more detail about Shetland's geological heritage. Education groups such as Open University and students from Shetland and Orkney high schools have also undertaken tours recently. In addition, scheduled boat trips using one of Shetland's inter-island ferries allow visitors to appreciate the geology, wildlife and archaeology around Shetland's coastline.

C1.2.4.5 Community activities - Northmavine

To further promote and interpret the geosites within their area, the Northmavine community commissioned a 'Virtual Field Trip' linked to their website (<http://www.northmavine.com>).

In addition to the suite of Shetland webcams organised by Visit Shetland (www.visitshetland.com), a webcam has been installed at the Braewick café, Northmavine – the view from which is a key geosite included within the Volcano Trail.

C1.2.5 Access, monitoring and maintenance of Geosites

The Shetland Islands Council Infrastructure Services Department (a member of the Geopark Shetland Liaison Group), take the lead in access, monitoring and maintenance matters with assistance from the Shetland Amenity Trust Ranger Service, Scottish Natural Heritage and other organisations as required (Appendix C5). Before developing access to any geosite, or geotrail, Geopark Shetland ensures that they have the landowner and land manager's agreement. A risk assessment is undertaken to ensure that the route is free from unforeseen dangers and appropriate action taken as necessary. All promoted sites and trails are inspected on an annual basis to ensure that they are suitable for public use.

C1.2.6 Protection of Geosites

As well as the statutory protection afforded to Sites of Special Scientific Interest and Geological Conservation Review sites, any site or trail promoted by Geopark Shetland will be protected through Shetland Islands Council Infrastructure Services procedures with help from other members of the Geopark Shetland Working Group as required. Any breaches of legislation brought to the attention of Geopark Shetland will be referred to the appropriate statutory bodies (Shetland Islands Council and/or Scottish Natural Heritage) to avoid any further damage or risk to geological, biological or archaeological heritage sites. It is hoped that through raising awareness of the importance of Shetland's geology, and in particular these sites, that the community will assist in protecting these sites through increased vigilance.

There is one site in Shetland, which contains Komatiite. This rock is unique within the European context and so this site requires special protection. At the moment, it is protected by a policy of non-promotion and no access. However, Geopark Shetland is considering a way forward in an effort to ensure that this site is afforded greater protection in the future.

For more information on Interpretation, access, monitoring, maintenance and protection of sites refer to section C enclosures.

Section C2. Interpretation within the Geopark

C2.1 Heritage Hub and Spoke

The Shetland Museum and Archives, which opened in 2007, is a five star visitor attraction for Scotland and has seen almost 90,000 visitors during its first 12 months. It therefore plays a huge role within Shetland's tourism industry. A feature in the heart of the community, the Museum is a popular local meeting place as well as a venue for events such as meetings,

conferences, book launches, exhibitions, films, plays and weddings. The Shetland Museum and Archives in Lerwick serves as the Heritage Hub in Shetland directing people to a series of heritage sites located throughout the islands to discover more about the various facets of Shetland's heritage.

The museum itself is split into 12 zones, with full disabled access. The first zone 'The Beginnings' tells the story of Shetland up until the first people arrived in the islands. This zone centres on Shetland's geology, setting the scene for the rest of the museum, essentially showing how everything is linked to geology.

Geological interpretation, both within the museum and at other sites around the islands, is a mix of the traditional, e.g. geological exhibits and graphic panels, and the innovative, e.g. interactive displays and artistic use of geological resources. The GSWG, the SAT and partners are always looking for more original and exciting ways to interpret geology.

C2.2 Action Plan and Current Projects

The Geopark Shetland Action Plan (Appendix B5) includes a range of innovative interpretation planned for the next three years and beyond. High priorities include two more geological walls and a quartzite xylophone in the islands of Unst and Yell. Three more geological trails will also be developed, with all important in terms of scientific quality, rarity, aesthetic appeal and educational value. They represent key features of Shetland's geology (i) Beneath an Ancient Ocean – Ophiolite Trail; (ii) Humans and Resources and (iii) Soft rock – post-glacial/sea-level rise features and coastal geomorphology. Other planned interpretation projects include for example, a geology garden/timeline and a geology field guide of Shetland.

C2.2.1 Geology course

Following a raised profile of Geopark Shetland and in response to an increasing number of requests, the Shetland Amenity Trust is organising an 'Introduction to Geology' course in 2008 as part of its annual training provision. Two similar courses have been undertaken in previous years, both of which were full, and therefore this course is also being held in recognition of the level of public interest in Shetland. The two-day field-based excursion led by Allen Fraser, aims to introduce members of the public to the rocks and landscapes that have shaped the Shetland we see today by visiting some of Shetland's key Geosites.

C2.2.2 Education

Geopark Shetland is increasingly being involved in geology field trips for both primary and secondary schools, and this looks set to continue in 2008. Many schools have expressed an interest in participating in the Volcano Trail and the geology walls, with Geopark Shetland aiming to enhance this involvement through these and future planned interpretation projects.

Peter Craig (Earth Sciences Education Services) travelled to Shetland in April 2008 to carry out a series of workshops in many of Shetland's primary schools. Workshop subjects included: *Shetland's Amazing Technicolour Rocks*, *How are Beaches Formed?*, *Oil, Gas & Rocks*, *So What is Shetland's Geological Story?*.

C2.2.3 Geology Tours

Several organised groups will be undertaking guided geology tours during 2008, including repeat visits by Open University students and the Shetland and Orkney high schools, and a number of geology groups from the UK and overseas. In addition, a series of scheduled tours around the northern isles on one of Shetland's inter-island ferries allow visitors and residents to explore the islands' geology, wildlife and archaeology around Shetland's coastline, as well as undertaking guided walks onshore.

C2.2.4 Art Exhibition

Shetland Museum and Archives is currently hosting (24th May – 29th June 2008) an art exhibition entitled 'Along the Edges' displaying works from different Scottish artists influenced by the landscapes of Shetland.

C2.2.5 Northmavine Community Exhibition

For the summer of 2008, a temporary exhibition is being planned in Northmavine, to promote the natural and cultural heritage of the area and encourage visitors to spend time in the more remote parts of Shetland. Displays will include local geology and landscape interpretation, which is being organised by local geologists, and information promoting Geopark Shetland.

C2.2.6 Geotextiles

Linked to the Volcano Trail is an exhibition at the Braewick café that has been inspired by different volcanic rocks found in Northmavine. Using close up images of rock specimens (themselves adapted into postcards for sale), a variety of geotextiles, each including a description of the rock type and how it formed, are on display (www.spindrift-shetland.com)



Geotextile exhibit inspired by rock patterns



Postcards of local rocks & textiles

C2.3 Web Presence

GeoparkShetland.org has been set up as a domain name and funding is in place for a Geopark website. It is intended that the site will contain a wealth of information specifically related to Geopark Shetland activities to which all existing web sites dealing with interpretation of Shetland and any other relevant information will be linked (Refer to Appendix B6 for an outline of the website content).

Geopark Shetland currently has a presence on the VisitShetland website (www.visitshetland.com). Once it becomes a member of the European Geopark Network a stand-alone website will be produced which links into the Shetland Amenity Trust and Shetland Museum and Archives websites.

Shetland Landscapes is a website dedicated to a comprehensive interpretation of Shetland's geology and geomorphology and ongoing research in the area. Shetland Landscapes www.fettes.com/shetland will continue to be authored by Dr Adrian Hall of Fettes College, Edinburgh who is a partner on the Shetland Geology Working Group.

Another independently run website www.nature-shetland.co.uk provides up to date information on Shetland's wildlife.

For details of other Shetland websites refer to the application enclosures, where websites of interest are listed by application section.

SECTION D. GEOTOURISM AND MARKETING

Section D1. Sustainable Tourism

Section D1.1 Introduction

Although Shetland is well known for wildlife and archaeology, visitors are much less aware of its geological heritage. This is changing, however, as the profile of geology in the islands is raised and further geological attractions are developed. Geopark status will help ensure that this process continues and that Shetland's geological heritage is given the prominence it deserves, becoming an integral part of the heritage package used as a driver for sustainable economic development.

The key findings of the 2005/06 Shetland Visitor Survey, carried out by AB Associates, were that 25,000 visitors came to Shetland on holiday, an increase of 40% compared to 2000. Business visitors meanwhile totalled just over 22,000, a 7% increase on 2000. Holiday visitors generated £7.3m in revenue, business visitors £5.4m in revenue. A reduction in business visitors and increase in holiday visitors reflects the recent downturns in Shetland's oil and fishing industries and an increase in the value of tourism as a whole. For example, eight visitor attractions at strategic locations throughout Shetland recorded a 42% overall increase in visitor numbers between 2003 and 2005. When asked about their motivation for coming to Shetland, visitors highlighted Shetland's beautiful scenery, the ability to get away from it all, natural and historic attractions and experiencing local culture.

Shetland recognises that it will never be a mass-market destination and that it will always have particular challenges in terms of location, capacity and short summer season. Its aim as described in The Shetland Tourism Plan 2006 - 2009 (Section D Enclosures) is "To become a year round destination offering a high quality product and experience". It also targets the growing number of visitors prepared to pay a premium for a quality experience, turning Shetland's challenges into selling points. Actions identified in support of this aim include "Supporting Shetland's application to become a European Geopark", "Encouraging the use of local products", "Supporting Shetland's ambition to become a National Marine Park", "Improving signposting of tourism facilities" and "Investigating the development of heritage sites as a niche tourism product". Appendix C6 outlines some of the current projects, which intend to promote Shetland's natural and cultural heritage.

D1.2 Shetland Tourist Information Network

Visit Shetland, part of the Visit Scotland network, which is a member of the Geopark Shetland Liaison Group has a comprehensive web presence www.visitshetland.com promoting Shetland as a high quality visitor destination. The site includes information on Shetland's location, geography, climate, nature, history, culture and economy as well as attractions and activities, events, area guides, accommodation and transport provision. The Visit Shetland website is controlled locally and its web management team is committed to promoting Shetland's rich Heritage.

Visit Shetland also manage Shetland's visitor information service, which serves to direct visitors to areas of interest. The network consists of:

- A Tourist Information Centre in Lerwick,
- Gateway Information Centres at the ferry and airport terminals,
- Visitor information services within 12 existing visitor attractions at strategic locations throughout Shetland,
- Free standing all-weather information boards at ferry terminals to the smaller Shetland Islands.

As well as production and distribution of Shetland's annual Tourism Guide, Visit Shetland makes available maps, leaflets etc. from other parts of the tourism and education sectors. For a sample of these leaflets and websites of interest to visitors refer to Section D enclosures.

Geopark Shetland works with VisitShetland to enhance the displays and visitor information available on Shetland's rich cultural heritage throughout the visitor information network (Appendix D1). One such publication was a Shetland geology leaflet, which was printed in May 2007. Once a member of the EGN, the Geopark Shetland logo will appear prominently

at each of these locations explaining to visitors that they are in Geopark Shetland and promoting the aims and activities of Geopark Shetland and the wider European Geopark Network.

The Shetland Tourism Association is also represented in the Geopark Shetland Liaison Group. It is a voluntary association representing all sectors of the Shetland Tourism Industry. Its committee acts as an advisor to the Council and other agencies, on tourism related issues, and directs Visit Shetland in its marketing efforts.

D1.3 Training

Training over the past three years to those providing Shetland tourist information services has included presentations on Shetland's Ranger Service, geology, archaeology, genealogy and flora and fauna (Appendix D1). It has been agreed that this training programme will continue to develop understanding and awareness of Shetland's rich and interconnected geological heritage with particular reference to the aims, objectives and activities of the Geopark Shetland. The Shetland Ranger service also offers a summer programme of guided walks in various parts of Shetland.

Shetland Islands Tourist Guide Association (S.I.T.G.A.) is the Association of the Tourist Guides working within Shetland. Every guide is trained to a nationally accredited Green Badge standard, with the training provided locally through the Shetland College (part of the University of Highlands and Islands). This year 9 people are participating on the course, with an introduction to Shetland's geology forming one of the learning modules. Once qualified, individuals specialise in different areas of guiding - for example archaeology, geology, history, wildlife, flowers etc.

Shetland College is currently looking at extending these courses to include a Yellow Badge accreditation, aimed at those working at specific sites or routes. In addition, in the autumn of 2008, the Shetland Heritage Association is intending on holding a heritage seminar, for all those involved in local heritage activities. This forms part of the Heritage Hub concept and will allow people to swap ideas and experience with each other. It is hoped that this will become an annual event.

D1.4 Travel to Shetland

Although geographically remote, Shetland is surprisingly easy to reach from both Britain and Europe. There are seven daily flights from the UK mainland: Aberdeen (55 mins), Edinburgh (85 mins) and Glasgow (90 mins), all connecting with London and other major European cities. In summer you can fly direct to Shetland from London Stansted and Bergen, Norway. Car ferries sail from Aberdeen seven nights a week, year-round, arriving in Lerwick early the following morning. In addition to this, Shetland is one of Scotland's top cruise ship destinations, with around 50 ships a year, and also hosts many visiting yachts throughout the year at its network of 23 marinas.

D1.5 Travel within Shetland

There are regular air services within Shetland to the outer islands of Fair Isle, Foula, Out Skerries and Papa Stour, while regular ferry services run to all the inhabited islands. Roll on/ Roll off ferries carry passengers and vehicles to the islands of Yell, Unst, Fetlar, Whalsay, Bressay and Papa Stour. Freight and limited passenger services operate to Skerries, Fair Isle, and Foula.

The Viking Bus Station in Lerwick is the terminus and departure point for all local bus services. It offers waiting and left luggage facilities, timetable information, baby changing area and toilets.

A number of hire car companies offer a range of vehicles. Touring is straightforward, roads are of an excellent quality, well signposted and traffic is low. There are a number of taxi firms operating throughout Shetland. Visitors can hire bicycles to use both on and off the road. Shetland is also part of the North Sea Cycle Route, a developing network of international links that encircles the North Sea.

D1.6 Accommodation

In 2007 Shetland's leading authorities commissioned a study of Shetland's visitor accommodation requirements in the 21st century. The prime purpose of the study was to

assess Shetland's accommodation supply against current and future visitor requirements, with a focus on the tourism market. Within this, various types of visitor accommodation were identified available throughout Shetland, summarised in Table D1.

Accommodation Type	Number in Shetland	Visit Scotland Star Rating (1-5)	Future developments
Hotels	14	2 to 4 Star	Despite Shetland's extensive accommodation infrastructure, some areas have been highlighted for improvement, for example caravan and camping sites. The SIC have developed a caravan and camping strategy to develop sites all over the isles.
Guest Houses	11	2 to 4 Star	
Bed & Breakfast	24	2 to 4 Star	
Self Catering	84	2 to 4 Star	
Bod (<i>basic, economic, self-catering accommodation</i>)	10	All Approved - No rating as different inspection scheme	
Youth Hostel	2	3 and 5 Star	At Braewick campsite, four wigwams will be in place by late 2008. These form part of the national 'Wigwam Holidays' scheme and further serve to diversify the visitor accommodation available in Shetland.
Caravan & Camping	6 sites	Lerwick site - 4 Star Others awaiting inspection	

Refer to section D enclosures for more information on travel to/from and within Shetland, and accommodation provision in Shetland.

Section D2. Marketing and Promoting Geopark Shetland

D2.1 Adoption of the Ideals and Ethics of the EGN

The policies for sustainable economic development already in place in Shetland fit well with the European Geopark Network mission. Geopark Shetland, through its partners, is inclusive in all its activities and actively engages with educational organisations and tourism providers both within and outside the Geopark.

Once an EGN member, Geopark Shetland will make recommendations to the annual Shetland Environmental Award Scheme judging panel for an award in '*Geopark Best Practice*' in connection with sustainable economic development related to Shetland's geological heritage. The aim of this award scheme will be to encourage community involvement and raise the profile of the Geopark.

D2.2 Marketing

The marketing and media function is seen as a critical component in the Geopark achieving its stated objectives. Marketing and communications strategies as well as a Public Relations remit have been developed (Appendices D2, D3 and B6). The Shetland Amenity Trust will carry out marketing for the Geopark.

D2.3 Corporate Identity and Logo - an integrated approach

We recognise the need for standardised and recognisable elements specific to the Geopark that will become associated with its public image. This branding will also integrate with the existing Shetland Museum and Archive Heritage Hub and spoke marketing model.

Within this model the Shetland Museum and Archive is the gateway for all Shetland's culture and heritage, directing people to key sites, including geosites, visitor centres and collections. This it does under key themes e.g. Geology, Archaeology, Architecture, Birds, Crofting, Fishing, Flora and Fauna, Shetland at War etc. This effectively forms a network of heritage resources through which visitors are directed to areas of local interest the length and breadth of Shetland.

The Geopark Shetland logo is designed to symbolise Shetland's rich and interconnected geological, natural and cultural heritage. It is similar in shape to the boat shed of the Museum and could be said to represent a sail, thus Shetland's maritime culture. Alternatively others consider it depicts Mousa Broch, the finest surviving example of a 2,000-year-old Iron Age tower built from the Old Red Sandstone rock of the south east of the islands.

Geopark Shetland logo and branding will be reflected in everything associated with the Geopark including letters, website, leaflets and interpretative panels. Refer to section D enclosures for details of the Heritage Hub branding and the use of the Geopark logo within this context.

Local accommodation providers and visitor attractions may apply to the Shetland Amenity Trust to use the Geopark Shetland logo to promote their business. It will be made clear that the logo denotes that the business is either within the Geopark Shetland or, in the case of the attractions, part of the Geopark's physical interpretation. Local businesses that use the Geopark Shetland logo must be quality assured to an approved industry standard and must not be involved in the sale or unsupervised collection of geological material.

D2.4 Product development

Local craft producers already produce commissioned items for Shetland Amenity Trust for sale at the Scatness Visitor Centre. Similar local craft products being sold on behalf of Visit Shetland at the main tourism office in Lerwick, alone generated revenue of over £85,000 in 2007. In 2005, Shetland Amenity Trust commissioned a product designer and developer to design a range of contemporary products, which are sold commercially at the Shetland Museum and Archives shop. This will result in a range of prototypes and product specifications in a number of materials for manufacture by local craft workers. Geopark Shetland will adopt a similar approach to generate new products for sale in the new Museum and Archives, and at visitor attractions.

Already craft producers are being inspired by the work of Geopark Shetland. For example, section C2.2.6 above describes the Volcano Trail-related geotextiles being exhibited and commercially sold by local producers. It is considered that these products alone will encourage other producers to come forward with their products.

In addition to products commissioned by the Shetland Amenity Trust, any local producer requesting endorsement from the Geopark would be quality assured under an existing Shetland Quality Assurance Scheme, which is funded and administered by SIC Economic Development Unit, Shetland College and the Shetland Arts and Crafts Association (Appendix D4). This is a voluntary body, which represents and promotes quality assured craft producers in Shetland, (www.shetlandartsandcrafts.co.uk). It will be a condition of endorsement by Geopark Shetland that all products have been quality assured under this existing scheme as well as meeting the additional requirement that the product is not the result of the destruction or sale of geological material or objects.

SECTION E. ENVIRONMENTAL EDUCATION

Section E1. Educational facilities within the proposed Geopark area.

E1.1 Universities, Colleges and Schools

E1.1.1 Letters of Support from Educational Establishments

Geopark Shetland has received letters of support from several universities, showing Shetland's geodiversity as a special resource for education (refer to letters of support enclosure).

E1.1.2 The University of the Highlands and Islands (UHI Millennium Institute)

The UHI Millennium Institute is a higher education institution providing university-level courses and research opportunities throughout the Highlands & Islands of Scotland and beyond. Partner Colleges on Shetland are the Shetland College of Further Education and The North Atlantic Fisheries College.

Shetland College provides full-time and part-time courses in a wide range of subjects relevant to the needs of Shetland, including courses on the island's unique culture and environment. For example the BSc (Hons) Environment and Heritage Studies degree has a special appeal and relevance to members of rural communities, both within and beyond the Highlands and Islands of Scotland. It is designed for students wishing to help their communities to take charge of their own environment and heritage resources. It equips graduates to work

- For Tourist boards, and government agencies dealing with the environment
- In heritage management
- In a consultancy capacity to private developers, corporate organisations, heritage and wildlife trusts, and country estates

The North Atlantic Fisheries College carries out a wide range of activities related to the fisheries and maritime industries, including training and education, research and development, environmental and quality monitoring, and advice and management. It lies at the heart of the northern European fishing grounds and is ideally placed for fisheries training. Shetland has one of the most modern fisheries industries in Europe, with which the college has close ties.

E1.1.3 Primary and Secondary Education

There are 26 Primary Schools, 6 Junior High Schools and 2 High Schools within the proposed Geopark area. As in the rest of Scotland, Earth Science teaching in Shetland is confined to the National Curriculum. In Shetland two educational trusts, The Voxter Outdoor Centre and The Shetland Field Studies Trust (SFST), supplement environmental education and natural history teaching within the National Curriculum. The Field Studies Trust in particular covers geology with most Shetland primary schools. They look at the origins of the earth, the structure of the earth, the three different rock types and plate tectonics. All this is taught through some imaginative hands-on experiments.

Every school in Shetland has a box of geological samples collected in Shetland and this is utilised by SFST, and at least one geological field trip is undertaken. In addition, every two years or so sees Peter Craig (Earth Science Education Services) undertaking workshops in many of Shetland's primary schools. For example, in 2008 the following workshops were undertaken: *Shetland's Amazing Technicolour Rocks*, *How are Beaches Formed?*, *Oil, Gas & Rocks*, *So What is Shetland's Geological Story?*. Mr Craig works closely with the Geology Project Officer regarding this and future geological education activities.

Some schools have Earth Science or Natural History projects outside the National Curriculum. Nine schools in Shetland have been awarded Eco School status, one of which, Lunnasting Primary, became the first school in Scotland to receive Eco School status in 1995.

Eco Schools is a Europe-wide project designed to encourage and acknowledge whole school action for the Environment. The project offers schools:

- An opportunity to make environmental issues influence the life of the school and its impact on the environment
- An opportunity to help develop children's decision-making skills
- Curriculum materials and ideas for projects and events
- Links with other schools in the UK and Europe

The Geopark website will have an education section (refer to Appendix B6 for remit), and the Education Department are supportive of building up additional geological resources for teaching purposes. We also plan to develop some geological activities for summer play-schemes.

Geopark Shetland is increasingly being involved in geology field trips for both primary and secondary schools. For example, in 2007 Shetland Geotours undertook a joint trip for Orkney and Shetland high school students, and it is intended this will become an annual event.

Inspired by a teacher-training session in November 2007, undertaken by the Earth Sciences Education Unit and focussing on the Geology of Scotland's Landscapes, Anderson High School in particular has incorporated a geology module into its curriculum using local Shetland case studies. These studies will link appropriately with the Geology Trails and other interpretation being implemented by Geopark Shetland.

E1.1.4 Shetland Library Service and Learning Centre

The Library houses an extensive local collection including natural history, and also two donated collections of old and rare Shetland books. The local collection is kept up to date, as new publications become available. The service supports two community libraries and a mobile library service that serves most other parts of Shetland.

The Learning Centre is part of the Shetland Library service, providing access to the People's Network. This is a national initiative, bringing computer access to everyone via a network of public libraries.

E1.2 Educational provision by Geopark Shetland

E1.2.1 Shetland Amenity Trust (SAT)

Shetland Amenity Trust is a charitable trust set up to protect, develop, improve, promote access to, and enhance understanding of various aspects of Shetland's heritage. The Trust is responsible for the Shetland Museum and Archives complex, which opened in May 2007. The environment is prominent in the Museum and the opening zone, known as 'The Beginnings', tells the story of Shetland from nearly 3 billion years ago until just before man arrived in the islands. The Museum serves as the hub for all heritage interpretation in the islands including the proposed Geopark and aims to direct visitors to a network of community museums and heritage centres, and heritage sites throughout the islands. The Museum and several of the heritage centres possess a virtual geology field trip comprising a series of digitised images provided by Professor Derek Flinn. The Museum and Archives houses a reference library of Shetland books, journals and research papers. As part of the Geopark action plan, additional resources will be allocated to the library to build its stock of material relevant to the Geopark. The Museum has, as part of its staff, a Lifelong Learning Officer whose role is to develop and deliver a structured and sustainable learning service.

Shetland Amenity Trust, working in co-operation with its colleagues in the Shetland Islands Council Infrastructure Services Department, secured substantial European Funding of around £250,000 to implement the Shetland Interpretative Plan during 2007/08. This project adds value to the Shetland Museum and Archives by developing site interpretation and visitor access to around 50 heritage sites in Shetland, many with geological interest. The Trust has also revised and expanded its popular suite of interpretative leaflets, with place-names, geology, history and folklore being added to the series. In addition a set of trail leaflets are currently in production focussing on a number of subjects, including Landscapes and Rocks.

Shetland Amenity Trust also manages the Shetland Ranger Service, comprising two rangers that cover the whole of Shetland, other than Foula and Fair Isle, each of which has its own Ranger Service under a different management mechanism. All four rangers work closely together and assist with monitoring and maintaining existing access routes and infrastructure provision, as well as facilitating the provision of interpretative information relating to the natural heritage. This includes guided walks; open days, publications and other interpretative media.

Finally the Trust, through its Biological Records Centre, organises an annual programme of training courses for professionals and amateurs alike. In 2008 there will be three courses, covering geology, invertebrates and seabirds.

E1.2.2 Scottish Natural Heritage (SNH)

SNH has a duty to encourage understanding of the natural heritage. It achieves this by working with schools, voluntary groups, and bodies such as the Shetland Amenity Trust, the Shetland Islands Council and others. SNH manages 3 National Nature Reserves and operates visitor centres on the islands of Noss and at Hermaness on Unst. SNH and its partners also organise an annual schools week which provides a range of activities for Shetland's primary schools.

Section E SNH enclosures include a copy of a letter to invite schools to participate in the schools week and details of some of the educational resources provided by SNH.

E1.2.3 The Shetland Field Studies Group (SFSG)

The SFSG is a voluntary group founded 27 years ago to raise awareness of all aspects of Shetland's natural history, archaeology, history and environment. Each summer the Group organises a series of 13 guided walks that are available to local residents and visitors to Shetland, while during the winter a programme of indoor events is held. At least one such event is a workshop or presentation relating to Shetland's geology. Group members lead the walks along with volunteer guides from the local community in which the walk takes place. Walks cover various interests including geology, archaeology, botany, community history etc. The SFSG own and publish, on an occasional basis, *The Shetland Naturalist*. This is a recognised scientific journal that presents original refereed and reviewed scientific papers on Shetland's environment (Appendix E1).

E1.2.4 Shetland Landscapes

Shetland Landscapes is an Internet site concerned with the geology and landscapes of Shetland. This is a voluntary site hosted by Fettes College, Edinburgh and maintained and authored by geo-scientist Dr Adrian Hall and co-authored by geologist Allen Fraser. The site aims to summarise, highlight and record as well as be a platform for research and knowledge into the geology and geomorphology of Shetland.

Shetland Landscapes recognises that Shetland is exceptionally well documented, with a larger literature compiled on natural sciences than for any similar sized area in rural Scotland. Well over 1000 books and papers have been documented and the website carries an extensive bibliography of these. A selected bibliography on the geology and geomorphology of Shetland is given in Appendix E2.

The Shetland Amenity Trust gave its annual Environmental Award to this site in December 2004. The panel of judges *"was very impressed by this web site. The huge amount of information is extremely well presented with some stunning imagery. It is a site which is invaluable to any student but also is very easy to read for the casual browser"*

E1.3 Other providers

E1.3.1 Shetland Geotours

This company offers guided tours or walks with an emphasis on the diverse geology, landscapes and archaeology of Shetland. Shetland Geotours specialises in geological field trips within the proposed Geopark area and has provided detailed field excursions for the Geologists' Association, the Open University Geological Society and the Edinburgh Geological Society. Shetland Geotours also gives lectures on Shetland geology and

landscapes to The Shetland Tour Guides Association whose membership are qualified freelance local tour guides.

Refer to section E enclosures for a copy of their 2006 field excursion for the Edinburgh Geological Society.

E1.3.2 Seabirds-and-Seals

Seabirds-and-Seals offers daily cruises around the islands of Bressay and Noss. Millions of years of wind and ice eroded these ancient desert sandstones into 2km of cliffs, up to 181m high, with thousands of ledges and balconies making perfect nest sites for the seabirds. As well as wild life cruises around seabird colonies on what has been described as a "*World-class cliff!*" (Franz Lanting, *National Geographic* photographer) these cruises also explore in some detail the geology and caves of the area. The company won the Scottish Thistle Award for Tourism in 2001.

E1.3.3 Shetland Nature Cruises

This is a new company, established in 2007, offers one-day wildlife tours throughout Shetland on land as well as by boat. Although these day trips focus mainly on wildlife, links are made between the surrounding landscapes and the flora and fauna they influence.

E1.3.4 Shetland Wildlife

This very successful Shetland-based company runs three and seven-day wildlife tours around the islands. Although tours major on wildlife the links between botany, soils and geology are frequently explained to clients. The company won the Scottish Thistle Award for Tourism in 1999.

E1.3.5 Burland Croft Trail

Traditional Shetland agriculture '*crofting*' (subsistence farming) was due entirely to the underlying geology. The Burland Croft Trail is on a working croft that is still run in the traditional manner and aims to preserve native breeds of animals and crops some of which have changed little since the Iron Age. This guided trail is open during summer months and is popular with tourists of all ages but particularly school parties from Shetland and abroad.

E1.3.6 Scottish Geology Festival

Supported by the British Geological Survey and Scottish Natural Heritage the annual 'Rock On' Scottish Geology Festival aims to make geology, and Earth Science in general, available to everyone. Through the auspices of local geologists Shetland has supported the annual Scottish Geology Festival since its inception. This, through the provision of geological field trips for the general public, will raise awareness of the special aspects of Shetland's geology and landscape (www.scottishgeology.com).

E1.3.7 Shetland Nature Festival

This annual event, being held for the first time in 2008 is organised by the Royal Society for the Protection of Birds (RSPB), Scottish Natural Heritage and Visit Shetland. This eight-day event at the start of the school holidays aims to involve local businesses to raise awareness of the islands' wildlife, geology and landscapes through a variety of activities (<http://www.visitshetland.com/major-events/shetland-nature-festival>).

E1.3.8 Earl Viking Tour

This series of tours around the northern isles of Shetland on one of the inter-island ferries was trialled in 2007 with another trial scheduled for summer 2008. These trips allow members of the public to explore the islands' coastlines from the sea as well as undertaking guided walks onshore. All the while they are able to find out more regarding the geology, archaeology, and wildlife in these areas.

Section E2 Scientific Research and Academic Institutions working within the area

E2.1 Quaternary stratigraphy

Recent work on Quaternary stratigraphy and palaeo-environments by Dr Adrian Hall (Honorary Lecturer at the University of St Andrews) and Dr Hamish Ross (University of St Andrews). This work was sponsored by The Carnegie Trust for the Universities of Scotland and by Natural Environment Research Council.

E2.2 Storm waves and Cliff Top Storm Deposits

The Carnegie Trust has also supported the storm waves research on Shetland for the Universities of Scotland. One paper on the patterns and rates of erosion at the Grind of the Navir has recently been published in *Marine Geology*. Another on the characteristics of cliff-top storm deposits is in press. The collaborators here are Dr Adrian Hall (St Andrews), Dr Jim Hansom (Glasgow), Dr D Williams (National University, Galway) and Dr Jack Jarvis (St Andrews).

E2.3 The Shetland Ophiolite

Prof. Derek Flinn (University of Liverpool) has recently published a series of papers on the Shetland Ophiolite (Appendix E2). Dr Hazel Prichard (Cardiff University) has also published recent papers on the mineralisation of the Shetland Ophiolite, (Appendix E2). The British Geological Survey has recently published new maps of the islands of Unst and Fetlar that include the Shetland Ophiolite area and Professor Flinn's Memoir for the area (in press).

E2.4 Tsunami

Mapping and dating tsunami deposits caused by submarine slides in the Norwegian Seas. This project is funded by Norsk Hydro and is a continuation of the work that has been done mapping and dating the Storegga tsunami along the Norwegian coast. The project will search for tsunami deposits in coastal settings around the Norwegian Seas with focus on events younger than the Storegga tsunami. One of its aims is to describe, ¹⁴C date, and map two sand beds in Shetland, most likely deposited by tsunamis younger than the Storegga tsunami. Participants: Stein Bondevik (University of Tromsø), John Inge Svendsen and Jan Mangerud (University of Bergen), Sue Dawson (University of Coventry), Alastair Dawson (University of Coventry) and Oystein Lohne (University of Bergen).

E2.5 Glaciation

Recent publication in *British Geological Survey* by N. Golledge, A. Finlayson, T Bradwell and J Everest. This paper appraises previous studies of Shetland's glacial history and compares them to new evidence.

E2.6 Walls Boundary Fault

This recent publication in the *Journal of the Geological Society* by L. M. Watts, R. E. Holdsworth, J. A. Sleight, R. A. Strachan and S. A. F. Smith presents the first detailed account of the kinematic history and fault rock assemblages associated with the onshore evolution of the Walls Boundary Fault Zone.

E2.7 Undergraduate and post graduate work within the area

There is at least one undergraduate mapping report completed by British University students working on Shetland each year. In 2006 Eleanor Ridley, a third year Geology student at Aberdeen University undertook geological mapping at Sandness. In 2007 Findlay Craig (Department of Geology and Petroleum Geology, University of Aberdeen) for a Senior Honours Mapping Project, undertook a geological survey around the Quarff area.

Regarding PhD studies L.M Watts in 2001, focused on the Walls Boundary and Møre-Trøndelag Fault Complexes. Two PhD's have studied plant adaptation to serpentine rocks. Currently, Liz Bourne is studying rock-creep adaptation in areas of serpentine in Unst. . Published PhD theses are included in the bibliography (Appendix E2). There have been at least three Ornithological PhDs undertaken/completed in Shetland in the last five years.

E2.8 Proposed International Study Centre

Shetland Islands Council is currently investigating the feasibility of establishing an International Study Centre on the island of Unst. The Centre would be based in an existing

Ministry of Defence Camp, which was decommissioned on 31 March 06 and has the potential to provide high quality conference, research and accommodation facilities.

The proposition is to base a number of high profile complementary projects in one location and add value to them, building on local expertise and existing academic relationships and contacts to establish a Study Centre with an international reputation for research and learning in the areas of archaeology, geology, natural history and renewable energy.

It is envisaged that Shetland's Geology Project Officer could utilise this Study Centre alongside staff progressing:

- Viking Unst, an SAT project to excavate and interpret Viking Heritage in Unst
- Living Shetland, a joint agency led project designed to promote the conservation of biodiversity in Shetland
- The Pure Project, which is leading the way in the demonstration of hydrogen energy storage technology for off grid applications and
- The Viking Energy Project, which is in the process of developing a massive 600MW part community, owned wind farm development

Unst is an ideal location for all these activities, particularly geology related field research, and the centre would offer a considerable boost to an island community that has lost 144 of its 720 residents as a direct result of the Royal Air Force leaving the Island.

INDEX OF APPENDICES

- Appendix A1 Shetland's Economy
- Appendix A2 Climate of Shetland
- Appendix A3 Biodiversity
- Appendix B1 Shetland Amenity Trust Strategic Plan
- Appendix B2 Heritage Hub Development Team
- Appendix B3 Geology Project Officer Job Description
- Appendix B4 Geopark Shetland Ethics Policy
- Appendix B5 Geopark Shetland Action Plan
- Appendix B6 Remit for Public Relations Function
- Appendix B7 Methods to monitor and evaluate the Geopark Shetland and its Benefits
- Appendix B8 SWOT Analysis of Shetland's Current Position
- Appendix C1 Definitions of Existing Scientifically Designated Areas
- Appendix C2 Geological Conservation Review Sites
- Appendix C3 Geosite Record Sheet
- Appendix C4 Index of Active Geosites
- Appendix C5 Management of Access, Protection, Monitoring & Maintenance and Associated Forms
- Appendix C6 Examples of Current Projects
- Appendix D1 Visitor Information Network
- Appendix D2 Geopark Marketing Strategy
- Appendix D3 Geopark Communications Strategy
- Appendix D4 Shetland Amenity Trust Quality Assurance Scheme
- Appendix E1 Index of papers published by Shetland Naturalist
- Appendix E2 Bibliography

INDEX OF ENCLOSURES

Letters of Support

- Geopark Shetland Partners
- National Trust
- Local Organisations
- Educational Establishments

Section A Enclosures

- Description of Territory
- History and culture
- Geology

Section B Enclosures

- Press releases

Section C Enclosures

- Sites of Special Scientific Interest
- Access, Monitoring, Maintenance & Protection of Geosites & Resources

Section D Enclosures

- The Shetland Tourism Plan 2006 - 2009
- VisitShetland/Tourism Portal/Shetland Visitor
- Leaflets and Websites
 - Cultural Heritage/Archaeology
 - Natural Heritage
 - Information on Individual Islands
 - Land Based Tours
 - Water Based Tours
 - Events/Attractions
 - Travel to, from and within Shetland
 - Accommodation
 - Arts & Crafts
 - Music
 - Food & Drink
- Shetland Heritage Hub Branding and use of Geopark Logo

Section E Enclosures

- Geopark Shetland activities: Field excursions & geology course
- Scottish Natural Heritage (SNH)
- Field Excursions for the Expert Market