Pink Felsite dykes cutting through Lewisian rocks at Grut Ness, North Roe

Shetland's origins

Our continents are not static but drift slowly over the Earth's surface, occasionally splitting apart or colliding as new oceans form or old ones shrink or vanish. 600 million years ago, Shetland was joined to Laurentia (proto America) and separated from Norway by an ocean called Iapetus. Shetland's rocks tell the story of how this ocean disappeared when Shetland and Laurentia collided with Norway and Europe.

The heart of the Laurentian continent was made up of 2.5 billion year old gneiss rocks, some of which can be seen in Shetland today. As the continent eroded, thick layers of sediment - sand and mud - accumulated on the sea bed around its edge. When the two continents collided these sediments, now turned into rock, were crumpled and forced upwards to form a range of mountains like the present-day Himalaya. Most of Shetland is made up of rocks that once formed the roots of this mountain range.

The continental collision between 500-430 million years ago, created a super-continent whose desert interior occasionally held short-lived lakes. Heat from deep in the planet melted rocks deep in the crust and the molten magma forced its way up to the surface, creating volcanoes that spewed lava and ash onto the desert plains.

Folded rocks at Ollaberry

About 300 million years ago, Laurentia and Scandinavia tried to drift apart again. A first attempt east of Shetland failed, but led to the deposition of several kilometers of sediments forming the North Sea basin, which now contains the oil fields. 60 million years ago the rift opening the Atlantic Ocean occurred west of Shetland leaving Shetland attached to Scotland as part of Scandinavia and Europe.

Geology

Introduction

Shetland's rocks tell a fascinating story of drifting continents and vanishing oceans, of ice ages and tropical seas, mountain building, deserts and volcanoes. This story spans more than half of the Earth's 4.5 billion year history.

Shetland's landscape has been shaped over millions of years by rain, wind, ice and waves. Weathering created soils that reflect the underlying geology and in turn influenced biodiversity, human settlement and agricultural practices. Archaeology reveals how our ancestors used different rocks for sustaining themselves, building and making tools and weapons. Today, Shetland's rocks are economic assets, providing us with building materials, minerals, oil and gas.

Geology is more than just rocks and history: It affects our landscape, wildlife, history, culture, and economy. This leaflet gives a taste of how geology has contributed to the Shetland we see today.

The Walls Boundary Fault cuts through the cliffs at Ollaberry and is part of one of Europe's major tectonic features, the Great Glen Fault. Rocks on either side of the fault have slid more than 100 km past each other.

Geology

Access Code

Shetland is famed for its natural beauty and wildlife. By following these simple guidelines you will respect the needs for those who rely on the countryside for their living whilst preserving the natural environment.

1. Use stiles and gates to cross fences and walls. Fasten all gates that you have opened.
2. Do not walk through fields of cultivated grass, as this is an important crop in Shetland.
3. If you have to cross cultivated land, do so by the edge of the field.
4. Avoid livestock and do not disturb them, especially during lambing time (mid April-mid June).
5. Whilst you may walk your dog you should keep it on a lead in the countryside, avoid livestock and be a responsible owner and pick up after your dog. Obey any notice forbidding dogs.
6. Do not leave litter or start fires.
7. Do not disturb nesting birds, especially those which nest on the ground.
8. Respect wildlife and refrain from picking flowers.
9. When parking on country roads, do not obstruct access roads or access to fields.
10. Take care when walking near cliff tops as the edges can be crumbly and dangerous.
11. Leave rocks as you find them, do not take geological specimens.

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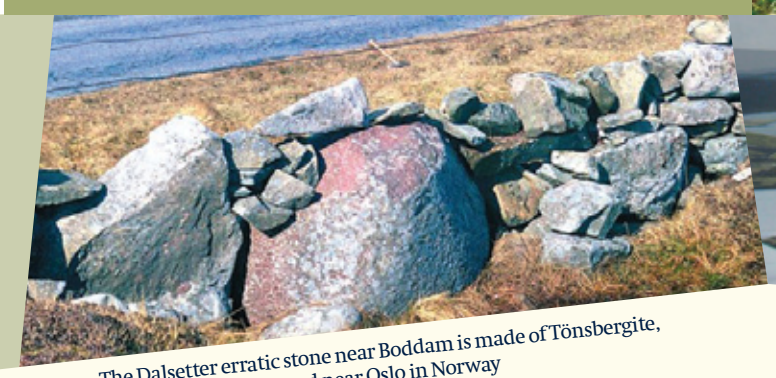


The Dalsetter erratic stone near Boddam is made of Tönsbergite, a type of rock only found near Oslo in Norway

Shaped by geology

Shetland's landscape reflects the varying nature of the rocks beneath. The hard granite of North Roe resisted erosion better than the neighbouring rocks. Today it stands above its surroundings as a plateau capped by Shetland's highest point – Ronas Hill.

Thick vertical bands of limestone running through the central Mainland were etched away by water millions of years ago to form the remarkable parallel valleys of Pettadale and Weisdale. Throughout Shetland the grain of the underlying geology can be seen in the North - South pattern of hills and valleys.

Only older valleys, carved by ancient rivers at a time when Shetland was part of a much larger land mass, run east and west across the grain of rocks. Perhaps the oldest of these cuts through the Clift Hills at Quarff. First formed 400 million years ago, it was filled in with desert sands, and then re-excavated more recently by ice.

The tombolo at St. Ninian's Isle

Da Auld Rock

The drowned valleys of Weisdale are typical of Shetland's Inner Coast

A glacial landscape

Over the past million years, ice has covered Scotland several times. Shetland's ice cap was never as thick as that on mainland Scotland and rather than carving deep trenches, like the glens of the Scottish highlands, it scoured a landscape of low hills and shallow lochs. On at least one occasion, ice from Scandinavia pushed across what is now the North Sea to Shetland, bringing with it rocks - *glacial erratic boulders* - that can be traced back to Norway.

The influence of the sea

With huge amounts of water locked up in ice caps, sea level was much lower during glacial periods. As the sea rose again at the end of the last glaciation, 10,000 years ago, it drowned the lower ends of valleys to form Shetland's characteristic voes (Inner Coast). In these sheltered waters you will find shingle bars,tombolos and even drowned peat.

This gentle coastline contrasts dramatically with the Outer Coast with its spectacular high cliffs plunging steeply beneath the sea.

Cliffs of Clibberswick, Unst plunging steeply beneath the sea. Shetland's Outer coastline

Banded Lewisian Gneiss at Grut Ness, North Roe

Examples of folded rocks – Dalradian schists at Ollaberry

The fertile limestone grassland at Whiteness

1 2.5 billion year old *Lewisian gneiss*, found in Northmavine, is Shetland's oldest rock - half the age of the Earth itself. Since it first formed it has been *metamorphosed* - heated, folded and recrystallised - many times by massive earth movements. Lewisian gneiss also occurs on the north west coast of Scotland and in the Outer Hebrides, including the Isle of Lewis from which it takes its name.

2 The island of Yell and parts of central Mainland are composed of *Moine* rocks. Originally laid down 1000 million years ago as thick layers of sand and mud in the sea on the edge of the American continent, they were metamorphosed when Scandinavia, Europe and America collided. Heat and pressure welded the grains of sand together to form *quartzite* and changed the mud to *schist* containing new minerals such as shiny flakes of *mica* and deep red grains of *garnet*.

3 By 800 million years ago when the Dalradian rocks began to be laid down sea animals with calcium carbonate shells had not evolved. The limestones in central Shetland were formed by bacteria and calcium combining with carbon dioxide from the atmosphere. This led to Global Cooling and ice ages. The limestones produce Shetland's most fertile soils in the Tingwall and Weisdale valleys and were burnt to make fertiliser and lime for the building trade.

12 The rift that initially opened along the North Sea 300 million years ago is of major importance for Shetland. Marine sediment that slowly filled the rift contained remains of billions of tiny creatures that would eventually give rise to North Sea oil. Today, this oil travels by pipe under the sea to Sullom Voe - Europe's largest oil terminal - where it is loaded onto ships for export. This terminal began operating in 1978, and remains a large source of employment for Shetland.

Sullom Voe Oil Terminal

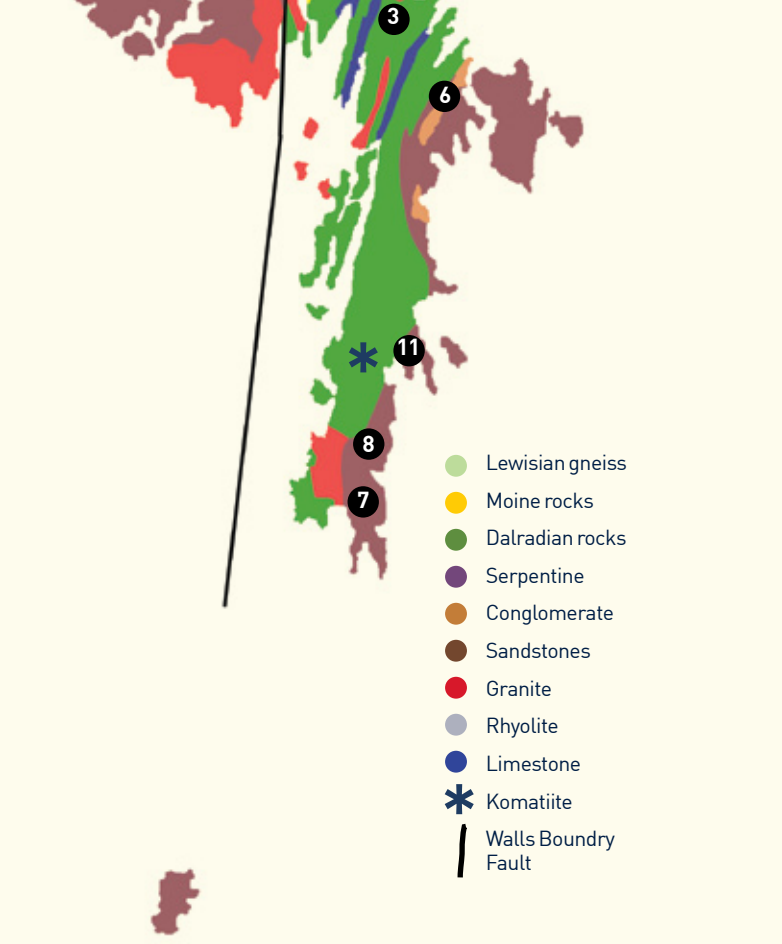
11 Hot water trapped in the earth's crust dissolved minerals from the rock. Escaping through fractures, the water cooled again and the minerals crystallised out to form *hydrothermal veins* which criss-cross Shetland's rocks. Many contain interesting minerals and metal ores, but only one, at Sand Lodge, proved rich enough to be mined commercially for iron and copper ores.

Sand Lodge mine, Sandwick, which operated sporadically between 1790 and 1929

10 Where magma found its way to the earth's surface, it erupted to form volcanoes. At Eshaness, the sea has carved away the flank of an ancient volcano exposing layer upon layer of lava and volcanic ash in the cliffs. Papa Stour too is formed of volcanic rock, but it is mainly pink *rhyolite* lava, rather than the dark purple *andesite* of Eshaness.

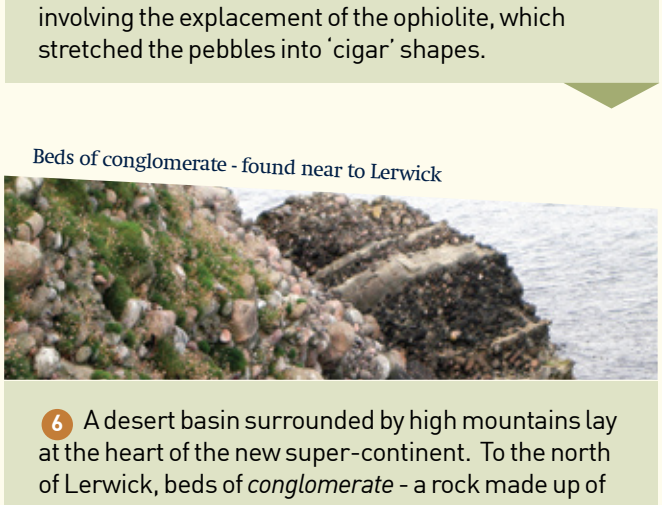
Layers of lava & volcanic ash along the Eshaness coastline

9 Meanwhile, deep in the crust, molten magma melted during the continental collision forced its way upwards. Some cooled and solidified before it could reach the Earth's surface to form coarse crystalline rocks such as the *granite* of Ronas Hill.



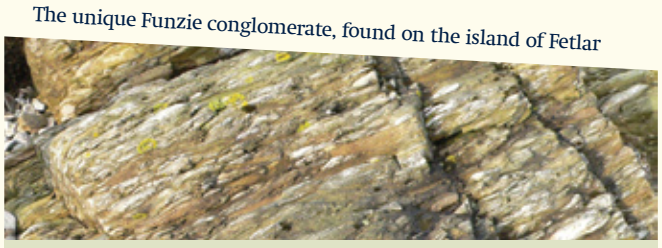
8 Beyond the mountains, the streams merged into slow-moving rivers that laid down thick beds of red, brown, and grey *sandstone* that now make up the southeast Mainland and Walls peninsula. A few primitive plants grew along riversides, but otherwise the land was barren and, with no roots to bind it, the sand was blown into dunes by the wind.

Serpentinite hillside, Clibberswick, Unst



4 As America drifted towards Scandinavia, most of the floor of the Iapetus Ocean sank into the Earth's interior, but a fragment was trapped between the colliding continents (An ophiolite). The unusual *serpentinite* rocks of Unst and Fetlar are a relic of this vanished ocean floor, giving rise to a strange landscape of peat free rusty-brown crags, flower-rich heathland and bare gravel that supports rare plants. They also contain rare minerals such as *chromite* - a chromium ore, which was mined in Unst for over a century.

The unique Funzie conglomerate, found on the island of Fetlar



5 The deformed conglomerate rocks at Funzie, in Fetlar were distorted by massive earth movements involving the explacement of the ophiolite, which stretched the pebbles into 'cigar' shapes.

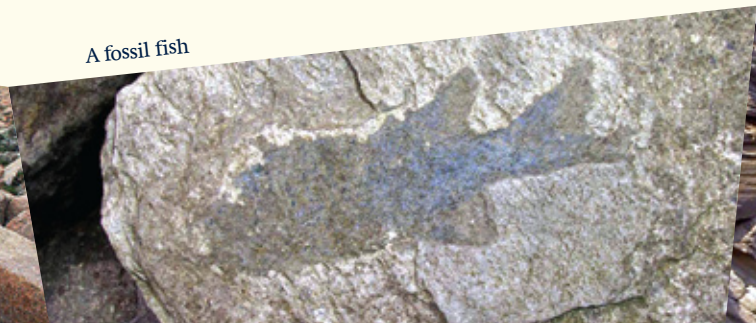
Beds of conglomerate - found near to Lerwick

6 A desert basin surrounded by high mountains lay at the heart of the new super-continent. To the north of Lerwick, beds of *conglomerate* - a rock made up of water-worn pebbles - show where mountain streams spilled onto the desert plain. Further south between Brindister and Quarff, similar rocks made of angular fragments, known as *breccia*, were once banks of scree that cloaked the mountainsides.

7 At several places around the coast, fine sediments containing fossil fish mark periods when the climate became wetter and for a few thousand years the desert basin became a lake, populated with aquatic life.

The granite upland of Shetland's highest point - Ronas Hill

A fossil fish



Sloping sandstone beds at Exnaboe, an indication of ancient sand dunes