Bittern Countryside

Community Interest Company

An Atlas and Guide to the Rocks and Soils of the Arnside & Silverdale AONB

Supporting the **Arnside & Silverdale Area of Outstanding Natural Beauty**

Bittern Countryside Community Interest Company
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Rocks and Soils of the Arnside & Silverdale AONB

Text and photos by Peter Standing - April 2014

Geobasics

The **hard geology or bedrock** of the AONB consists almost entirely of limestones from the early Carboniferous. These are only exposed on the surface as outcrops of bare rock across less than 15% of the 4445 hectares of the land based AONB. Elsewhere the limestone is covered by **soft geology** of soils and sediments.

Other non-native, erratic rocks have been transported here by glacial ice. The AONB has many examples of these glacial erratics, notably rocks of the Borrowdale Volcanic Group, Shap Granite and the ubiquitous Silurian greywacke.

Identifying Rocks

Successful rock Identification is rather like bird watching 'giz'. There are many clues such as typical landforms, bed structures, texture, colour and microscopic appearance. Different limestones can even have distinctive smells and sounds.

The surface appearances of rocks can be misleading because many develop weathering features and coatings of algae, lichens and mosses which disguise the true colour and texture within. This inner appearance can be exposed by breaking the rock but geological hammering is generally discouraged now and it is better practice to try and inspect naturally fractured specimens. Although local limestones have some characteristic distinguishing features it must be remembered that not all beds display these.

Some AONB geological sites with public access

Storth Geotrail— This 3 mile circular walk starts at the Ship Inn at Sandside. Highlights include Sandside Cutting, Throughs Lane and Haverbrack Fell—PDF guide at www.arnsidesilverdaleaonb.org.uk/images/stories/pdfs/lt_storthgeotrailsept13.pdf

Arnside — This walk from Arnside Promenade follows the coast to Far Arnside coral beds and returns over Arnside Knott. Full description by Michael Dewey in ***Exploring Lakeland Rocks and Landforms*** Cumberland Geological Society 2008.

Trowbarrow Quarry — Dramatic views of the Silverdale Disturbance. Guide from www.arnsidesilverdaleaonb.org.uk/images/stories/pdfs/trowbarrowleaflet_web.pdf

Gait Barrows NNR Limestone Pavement— many consider this to be the UK's finest lowland pavement. Walk guide at www.limestone-pavements.org.uk/pdf/gaitbarrowleaf%20.pdf

Safety: Although looking at rocks is reasonably safe, it is sensible to observe health and safety basics and to remember that you are responsible for any loss, injury or inconvenience you might suffer. Take care on slippery rocks, avoid quarry faces, mines and caves and watch out for tides around the estuary.

Where to Start

The best places to observe AONB rocks are Trowbarrow Quarry, Sandside Cutting, the limestone pavements at Hale and Gait Barrows and the coastal cliffs between Arnside and Jenny Brown's Point. Many of the area's other geological treasures are hidden in woodland and the rapid growth of vegetation can be a nuisance, making winter a good time for rocky rambles. Access to geological sites on private land is another problem. The map on the back cover locates some of the major sites mentioned in this guide.

Limestones

Our limestones are sedimentary rocks laid down in beds from particles deposited in warm, marine environments. The local Early Carboniferous (Dinantian) limestones were deposited around 340 million years ago when 'Britain' was located in the tropics 5°-10° south of the equator. During their journey to their present latitude of 54° N, beds have been folded and fractured by tectonic plate movements and land surfaces have been subjected to much weathering and erosion.

Local Formations

Our four limestones all have local names that originate in Furness—three from villages and Park from Park Sop mine. Dalton Limestone (DLB) is the oldest formation and is overlain by beds of Park Limestone (PKL) and Urswick Limestone (UL). All three are widespread and easily seen. The AONB's youngest formation, the Gleaston Limestone (GL), is much less common and only found in a small area just east of Trowbarrow Quarry. AONB limestones are perhaps more interesting in the context of the landforms they have helped to create rather than in close up view.

Local Names	Age (million years)	Rough Thickness	Appearance
GLEASTON	**333-325Ma**	**200m**	**dark grey-black**
URSWICK	**339-336Ma**	**120m-160m**	**grey**
PARK	**343-339Ma**	**120m**	**cream or pale grey**
DALTON	**345-343Ma**	**120m**	**dark grey**

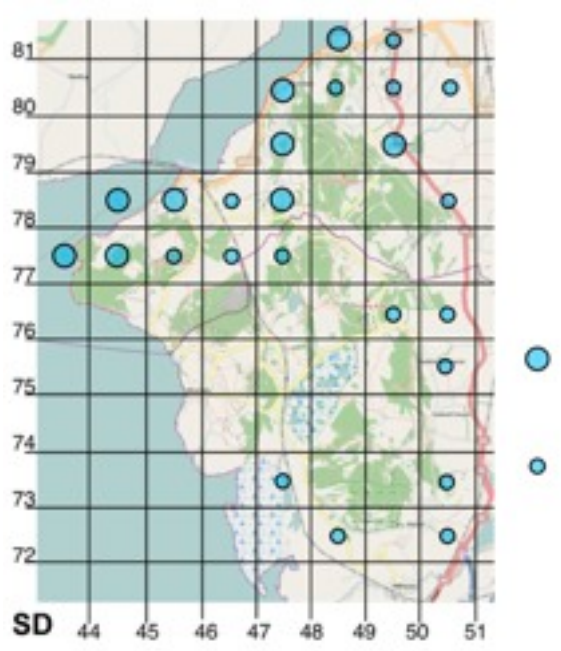
Non-calcareous rocks — the Pendleton Formation (PENDL)

Warton Crag is composed of limestones but to the south are younger beds of sandstones (Pendleton Formation) raised by a major fault. Small surface exposures near Ings Point are difficult to find but examples can be seen in the walls just east of Cotestones Farm (SD 488715).

Dalton Limestone (DLB)

Dalton rocks are medium grained limestones and typically dark grey in colour with a characteristic bituminous odour when fractured. The formation is usually well bedded and can make good building stone. Fossils and interbeds of calcareous shale are both common in the middle part of the formation.

Blackstone Point This cliff, southwest of Arnside, is a fine place to see beds of Dalton Limestone, shale partings and fossils (SD 437776).



Where to find Dalton Limestone

Dalton Limestone crops out along the NW coast from the Bela Estuary to Blackstone Point. It forms the ridges of western Storth exposed in the Sandside Cutting.

Grid squares where DLB crops out with prominent exposures.

Grid squares where DLB bedrock may only crop out in small areas or be hidden by overlying sediments and soils.

Dalton Limestone (DLB)

Summerhouse Point

SD 485815

DLB beds dip 20° down to the west and can be seen continuing underwater at the Bela Estuary.

Heron Corn Mill, Beetham

SD 496799

The ancient corn mill dates back to early Norman times and owes it's existence to the AONB's only waterfall. This fall and the cave and mill foundations nearby are all formed in Dalton Limestone.

Sandside Cutting

Stop 3 of the Storth Geotrail at SD 474804 has fine examples of Dalton corals. This location and the nearby Stop 4 demonstrate structural change whereby the Dalton beds have been tilted by tectonic forces from horizontal to near vertical. The Geotrail PDF guide and display boards give more information.

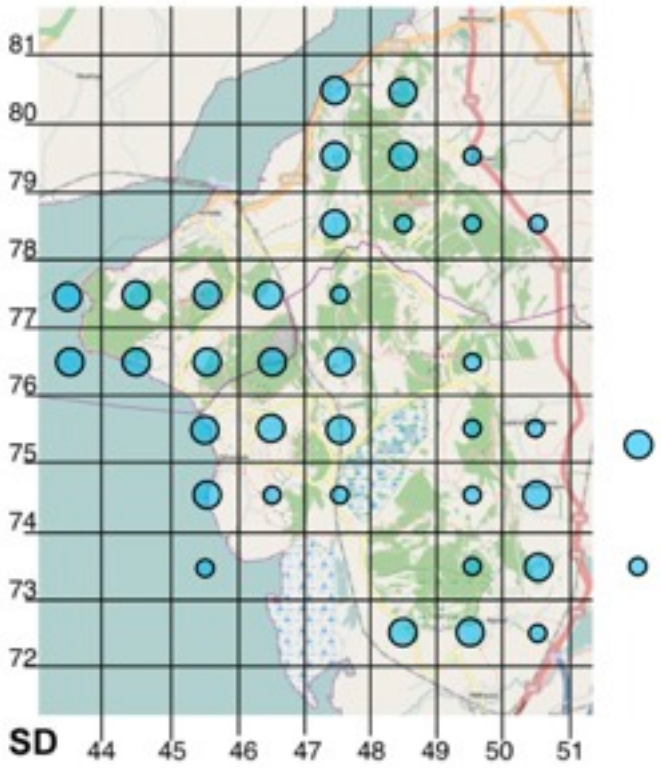
Park Limestone (PKL)

Park rocks are usually coloured pale grey or cream and have a distinctive ringtone when tapped with a hammer. PKL was laid down in shallow tropical seas and the bedding is generally weaker than Dalton and Urswick limestone making it more susceptible to erosion.

Sandside Quarry

(SD 482810)

The new quarry entrance offers a fine PKL exposure with a prominent mudstone layer. The faces are unstable so heed the warning signs and observe from a distance!



Where to find Park Limestone

Park Limestone is most easily seen in the lower sections of Sandside and Warton Main quarries, on Arnside Knott, in the southern cliffs of White Creek Bay and at Silverdale, south of Shore Road.

Grid squares where PKL crops out with prominent exposures.

Grid squares where PKL bedrock may only crop out in small areas or be hidden by soils and sediments.

Park Limestone (PKL)

Arnside Knott Shiloe Screes

(SD 457772)

PKL's susceptibility to erosion makes it ideal for scree formation from periglacial weathering. The Knott screes or 'shiloe beds' have been harvested in the past.

Storth Playing Fields

(SD 476802)

A north-south corridor of gentle terrain traverses central Storth marking the passage of glaciers which have smoothed the easily eroded PKL.

Silverdale Coast

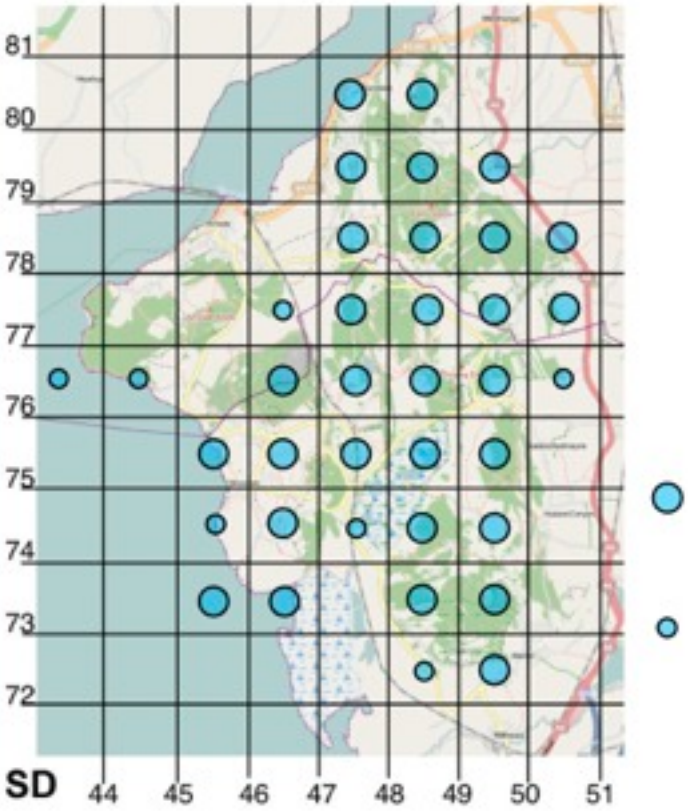
(SD 456744)

The coastal cliffs south of Shore Road around Know End Point are Park Limestone. The terrain in the fields above is typical of PKL.

Urswick Limestone (UL)

Urswick Limestone is a hard, pale grey, well bedded grainstone deposited in shallow seas. It resists mechanical erosion better than Park and forms some of the AONB's most dramatic rocky landscapes including all the limestone pavements, many cliffs and the best rock climbing sites.

Two iconic AONB Urswick sites — ***Left,*** Fairy Steps near Beetham at SD 487789 and ***Right*** Jack Scout, Silverdale at SD 459737.
Both cliffs feature massive Urswick beds which at Jack Scout are 11m thick.



Where to find Urswick Limestone

Urswick Limestone is found over much of the central AONB from the top of Haverbrack Fell to Fairy Steps, Gait Barrows, Trowbarrow, Cringlebarrow and Warton Crag. It is also seen intermittently along the Silverdale coast especially around Jack Scout.

Grid squares where UL crops out with prominent exposures.

Grid squares where UL bedrock may only crop out in small areas or be completely hidden by overlying soils and sediments.

Urswick Limestone Pavements

Pavements are formed on level or gently inclined limestone beds and show a variety of characteristic solutional sculpturing effects known as **karren**. The four commonest local karren landforms are **clints** (solid rocky platforms), **grikes** (the linear clefts bordering clints), **runnels** (drainage channels on clints) and **kamenitzas** (shallow hollows or pans on clints). The AONB's limestone pavements are of national importance and all are in conservation zones with legal protection.

Above—runnels, clints and grikes at Hale Pavement (SD 497786)

Below—Gait Barrows (SD 481774) **(*left*)** kamenitza with orange colouring caused by the cyanobacteria Schizothrix **(*right*)** a meandering runnel.

Shale

Shale is a common sedimentary rock composed of compacted fine mineral particles of silt or clay. The resulting laminated layers are fissile, split easily into thin layers and are easily eroded. In the AONB shale is often seen in the Dalton Limestone especially the middle Dalton. Small shale bands can also be found in Park Limestone but perhaps the best known local shale is Woodbine Shale which is found in Urswick Limestone.

Shale beds at Coastguard Station SD 45177846

Arnside Coastguard Station Slipway

These shale beds are near horizontal but a few metres further south the DLB limestone and shale beds become very folded. Another good site is Blackstone Point where the DLB shale beds have eroded differentially (see photo on page 4).

Woodbine Shale (WBSH)

This band, 4m-5m thick, is found about 30m above the UL base. It crops out along the Silverdale Disturbance monocline where the Urswick beds have been folded from horizontal to vertical and back to horizontal. Because of surface erosion it is easier to see where the WBSH used to be rather than where it is now. Striking shale eroded troughs are found at Throughs Lane and near the Karabiner Gate (SD 480755). There is a small exposure of Woodbine Shale at Trowbarrow (SD 480757).

The dramatic trough at **Throughs Lane, Storth** (SD 478800) has been formed by erosion of the soft WBSH leaving tougher, near vertical, beds of Urswick Limestone on either side of the road.

Throughs Lane, Storth

Some Other Geological Features

Hematite

Hematite (iron oxide Fe_2O_3) is thought to have been deposited in the joints and bedding planes of some AONB limestones from hot hypersaline fluids. Ore deposits were rich enough to launch an iron industry mainly around Warton and Carnforth. Evidence of hematite deposits can be seen in the fault at Red Rake and the nearby cliffs and in short mine adits at White Creek Bay.

Iron Mines near White Creek Bay SD 439772

Red Rake, Silverdale SD 457754

Keer Estuary SD 482710

The former Carnforth ironworks has left a legacy of extraordinary manmade geology along the Keer Estuary. These furnace waste deposits can be followed down to Morecambe Bay and provide some bizarre physical landscapes.

Silurian Rocks

Silurian rocks crop out across an east-west band about 20 km north of the AONB in locations like Old Hutton and Lambrigg Fell. At the height of the last (Devensian) ice age, glaciers flowing southwards from the Lake District ice dome plucked rocks from this band and transported them to the AONB where they were deposited when the ice melted about 19,000 years ago. Silurian greywackes are by far our commonest glacial erratic and are found everywhere - in paths, walls, fields and as isolated erratic boulders.

Where to see them

A good example can be found at the bottom of the Arnside Sailing Club slipway (SD 44807821). Once you get your eye in you will find several more along the coast near here. There is another splendid greywacke erratic at Blackstone Point (SD 43717765).

Arnside Sailing Club

Storth Geotrail - Stop15 - SD 48508075

Wall greywacke, Haverbrack Fell

Glacial erratics were often cleared from fields and used to build walls. This example, on the Storth Geotrail, shows both the weathering mantle and cut surface of a greywacke.

Greywackes were formed during submarine landslides or turbidity flows that lasted just a few hours. Thin sections show a poorly sorted arrangement of angular grains consistent with rapid formation. Greywackes contain more than 50% of quartz but also feldspar and muscovite (common mica).

Borrowdale Volcanic Group (BVG) Rocks

Many of the Lake District's distinctive peaks such as the Langdale Pikes and Scafell are composed of Borrowdale Volcanic Group rocks from the late Ordovician. The BVG includes basaltic and andesitic lavas together with lithified rhyolitic lithified ash from explosive volcanism. A variety of BVG rocks followed glacial flow lines from Kentmere, Longsleddale and adjoining valleys towards the AONB where they form about 5% of our glacial erratics.

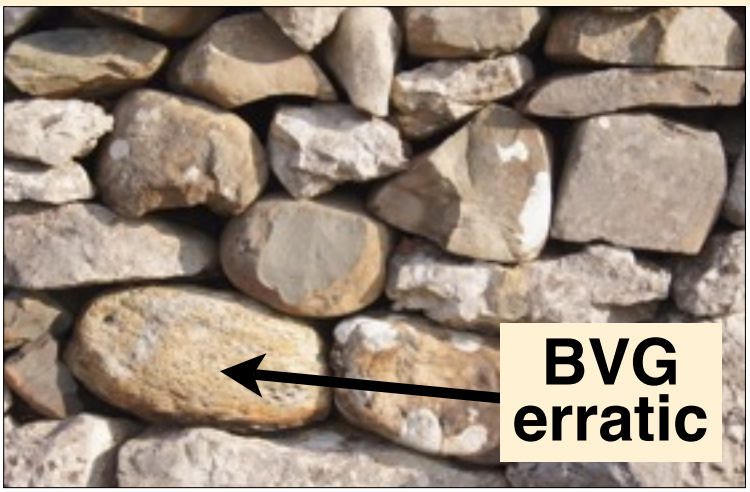
BVG at Dallam Park

Left—Brecciated BVG boulder by public footpath gate at the southern border of Dallam Park at SD 49458026 with 30cm ruler.

Right— The AONB's largest BVG erratic at the Landscape Trust reserve of Coldwell Parrock (SD 480777). This site also has a fine ancient lime kiln.

Coldwell Parrock Reserve BVG

Storth Geotrail - Stop15 - SD 48508075

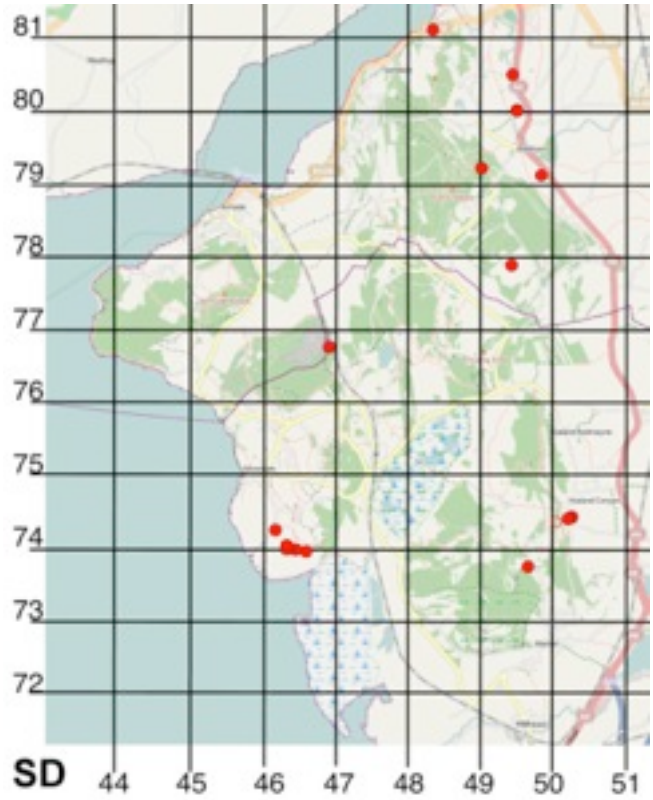


Left —Just below the greywacke in the photo on page 12 there is a rock that looks quite different with a much rougher texture. This is a BVG erratic.

Shap Granite

The Devonian granite batholith at Shap has a small surface exposure area of less than 5.5km^2 but the ease of identification of its beautifully pink phenochrysts makes it one of Cumbria's most distinctive rocks. Trains of Shap erratics provide excellent surface markers for tracing glacial flow lines. Shap Granite erratics are uncommon in the AONB and only 25 have so far been recorded. There are a few smaller examples in walls.

(***left***) The Beetham Rent Stone (***right***) close up showing pink phenocrysts



Where to see Shap Granite

The best AONB example is the 'Rent Stone' near Beetham Hall at SD 49857913. Other fine boulders can be found by Yealand Conyers pump (SD 50227442) and at Storth Geotrail Stop 16 (SD 48368113).

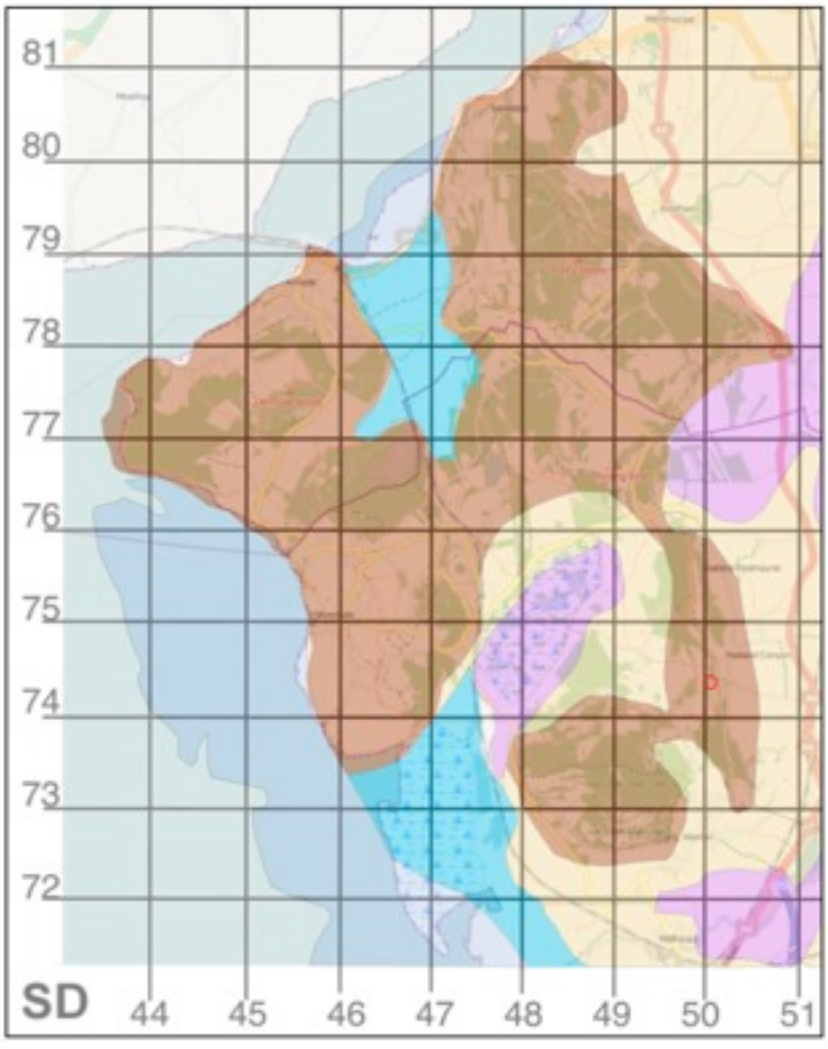
Shap granite erratic locations are useful for improving our knowledge of glaciology. Please help by reporting unrecorded finds to the author via the Bittern Countryside CIC at the email address on the back cover (page 20).

Soils and Sediments

Producing a grid square based atlas of 'soft geology' is not easy. The soils and sediments that cover much of the AONB's bedrock are themselves often hidden beneath vegetation and usually only visible when exposed by erosion or quarrying, in road or rail cuttings or by the action of moles or rabbits. Ecological communities such as those of calcareous grasslands, reflect the underlying soil types. There are several ways of classifying soils. The one shown below is based on the freely accessible website **Soilscapes** at www.landis.org.uk/soilscapes. This gives a rough idea of local soils dividing them into five broad groups.

Freely draining slightly acid but base rich soils are the commonest group in the AONB and include our calcareous grasslands. The name sounds contradictory but reflects the underlying neutral or alkaline limestone bedrock with overlying soils that can be slightly acidic because of the influences of till, loess and soil CO_2

Loamy and sand soils with naturally high groundwater and peaty surfaces— e.g. Arnside Moss, Silverdale Moss

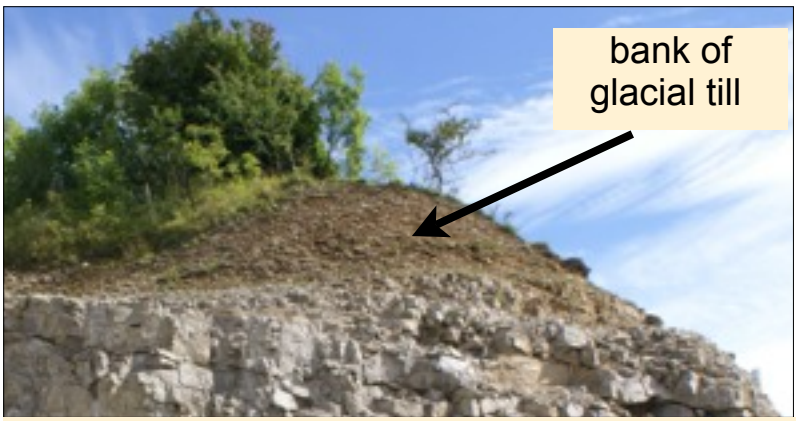


Freely draining slightly acid loamy soils e.g. fields at Beetham both sides of the A6

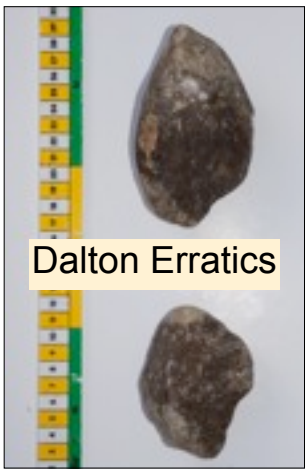
Raised bog peat soils e.g. Hale Moss & Leighton Moss

Saltmarsh — Much of the Silverdale sector disappeared in 2007 due to estuary channel changes. White Creek Bay is one of best remaining sites

Glacial Till



Park Limestone Bedrock



Till is the unsorted sedimentary debris left after glacial retreat.
Although glacial till is widespread across the AONB, easily viewed exposures are uncommon and the best is found at the new entrance to Sandside Quarry (Storth Geotrail Stop 17 at SD 48168102). Many of the erratics at this particular till site are not Lakeland rocks but Dalton and Urswick limestones transported here from a little further north.

Loess

Loess is fine glaciogenic silt which blew over the AONB when Morecambe Bay ice melted around 19,000 years ago. Loessic soil is common locally and on Summerhouse Hill at SD 500744 moles have done a fine job uncovering it. Elsewhere loess can be mixed with till. Its widespread distribution partly explains our rich biodiversity.

Loess molehill

Regolith

Weathering of surface bedrock contributes to new soil formation in a transitional zone called regolith. Good exposures occur just south of White Creek Bay (SD 437771) together with fine examples of biological weathering.

Marl

Marl is a mixture of calcium carbonate and clay and in the AONB is associated with small postglacial lakes such as Hawes Water and Hale Moss. ***Chara*** green algae, which has a plant-like structure, utilizes bicarbonate and becomes encrusted with calcium carbonate which aids marl formation.

At Guard Hill in Storth (SD 473798) excavations uncovered a striking, pale bed of marl, since submerged in a new lake.

Marl bed at Guard Hill

Hawes Water SD 478766

Hawes Water is our largest lake with an area of 8 hectares. The main interest for the casual visitor is the assortment of tiny shell fragments around the eastern shore. These are the remains of fresh water molluscs.

Hawes Water is an important post-glacial palaeoclimate research site. Coring has revealed sediments of clays, marl, micrite and peat.

Peat

Peat contains at least 20-30% by weight of the undecomposed or partly decomposed remains of plant material. It is frequently waterlogged and marl can provide an impermeable base on which peat can form. This has happened at Hale Moss (SD 504776). Peat occurring in the AONB is usually well hidden. This Leighton Moss soil pit found peat about 1 metre below the surface.

Peat

Estuarine Deposits

Out of the AONB's 75km^2 about 40% lies in the Kent Estuary which can be crossed by walks from Arnside to Kents Bank. With tidal ranges up to 10 metres the sediments and channels here are constantly changing and straying onto the sands without a guide is dangerous.

Cedric Robinson: Queen's Guide

Muddy channel, New Barns SD 443779

Mud

Mud refers to sediments of silt and clay with fine particles less than 62.5 microns. In macrotidal wide estuaries mud trends to be deposited higher than larger grained sand, unlike maritime beaches.

Sand

Sand particles range between 62.5 microns and 2mm. Any walker who has traversed below the cliffs from Arnside to Silverdale at low tide will know that sand generally offers a firmer surface than mud!

Firm sand Arnside Point SD 436770

White Creek Bay SD 437774

Saltmarsh

Saltmarshes are vegetated portions of intertidal mudflats colonised by halophytic plants that can tolerate intermittent seawater immersion. Saltpans form where seawater focuses in hollows of high salinity rendering plant life impossible.

Further information

The Landscape Trust, a charity of 900 members who support the AONB, runs guided landscape walks on geology, ecology and local history. Check the AONB website www.arnsidesilverdaleaonb.org.uk for event details.

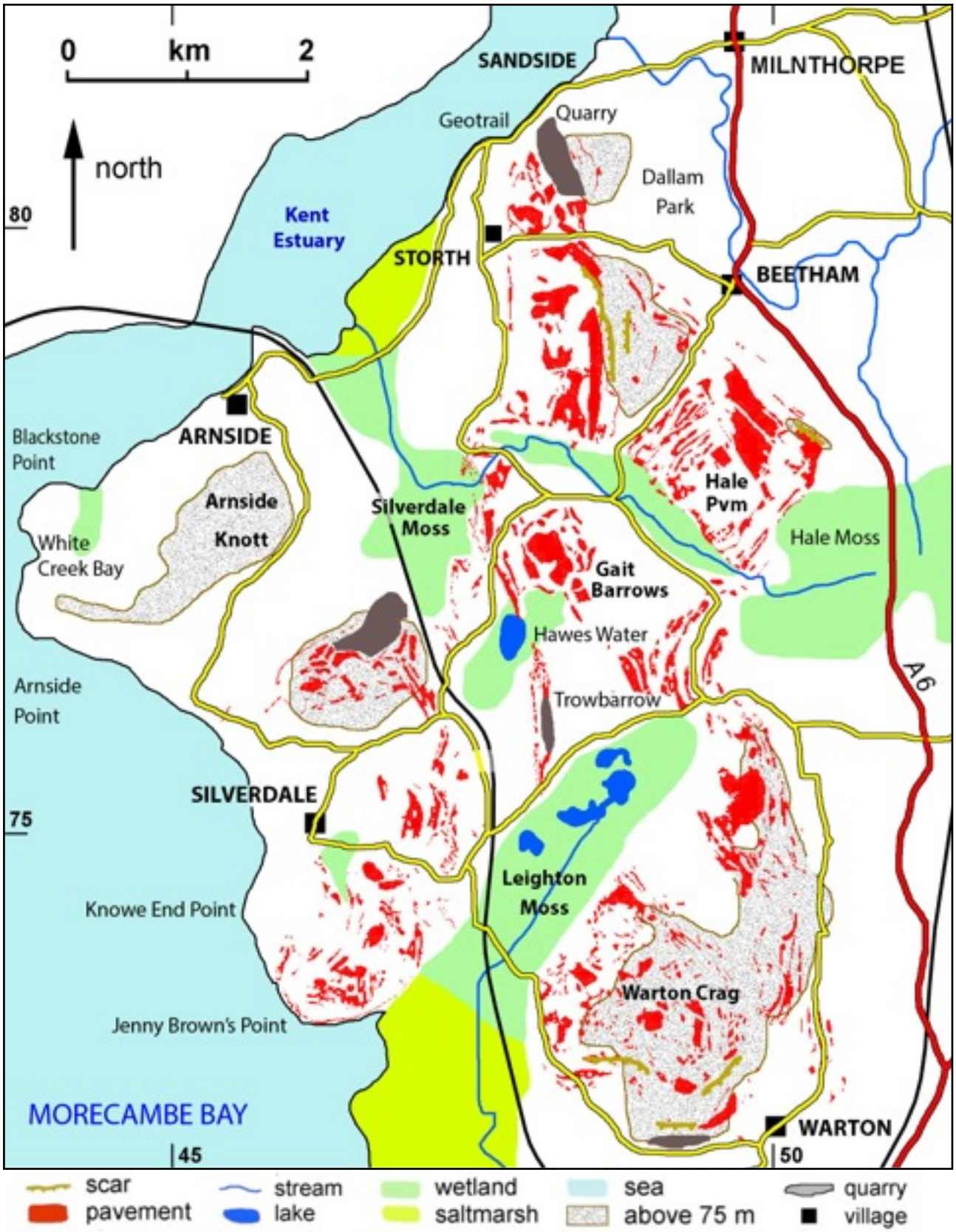
The AONB Office at the old Arnside Station is a treasure trove of information and holds leaflets on Trowbarrow Quarry, Warton Crag and Limestone Pavements.

Cumbria GeoConservation (formerly Cumbria RIGS) See www.cumbriarigs.co.uk for information on Cumbrian geology, free downloads and leaflets.

The British Geological Survey (BGS) has a superb website www.bgs.ac.uk with a free app on UK geology. This site also provides the definitive guide to local and national classifications for the complex nomenclature of our sedimentary rocks. The BGS publish 1:50,000 scale geological maps but the currently available sheet covering the AONB (Sheet 49 Kirkby Lonsdale) dates back to 1892. Publication of a revised electronic format edition is imminent and will offer a good picture of overall geology within the limitations of its scale. Producing a very detailed, wholly accurate map of the AONB geology would be a huge undertaking and the maps in this atlas of rocks and soils must be viewed within the limitations of current knowledge.

The Westmorland Geological Society holds winter lectures and summer field trips and welcomes visitors and new members. Details www.westmorlandgeolsoc.co.uk

Index



Acknowledgements:

The map above is modified from one by Tony Waltham in his excellent book 'Caves and Karst of the Yorkshire Dales'. Artist Jane Brady contributed the drawings of Throughs Lane and Storth Playing Fields and David Mower photographed the soil pit at Leighton Moss. Maps on pages 4, 6, 8 and 14 are based on openstreetmap.org under Open Database License. Ann Kitchen encouraged me to compile this atlas.
Please send any feedback to the author via bitterncic@arnsidesilverdaleaonb.org.uk