
Arbroath to Auchmithie Geodiversity Trail

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Figures

Note: Not all figures are shown in this web page — to view all see the above PDF

(Figure 1) Location map.

(Front cover)

Geodiversity is the rich variety of rocks, minerals, fossils, landforms, soils and natural processes that form our planet.'
Code for geodiversity walks:

- Visitors should observe, photograph and record the rocks and landscape.
- Do not hammer or otherwise break the rocks.
- Keep collecting to a minimum and only from loose materials; never from walls etc.'

Please

- Take your litter home.
- Keep your dog under close control. Remove Dog dirt and dispose of it safely.
- Be aware that cattle can be dangerous.
- Don't take your dog into fields where there are calves or other young animals. Never let your dog worry or attack livestock.
- Expect to meet other people. Let farm traffic pass safely. Cycle or ride at a safe speed.

Responsible Access: Enjoy Scotland's outdoors responsibly!

Know the Code before you go... Everyone has the right to be on most land and inland water providing they act responsibly. Your access rights and responsibilities are explained fully in the Scottish Outdoor Access Code.

Whether you're in the outdoors or managing the outdoors, the key things are to:

- take responsibility for your own actions;
- respect the interests of other people;
- care for the environment

Findout more by visiting <https://www.outdooraccess-scotland.scot/> or phoning Scottish Natural Heritage on (01738) 458545 for a copy of the full Code or a leaflet.

Traveline (Public Transport information): Tel: 0871 200 22 33 <https://www.travelinescotland.com/> Design: Print & Design Unit, Angus Council.

How to get there

The trail starts at the east end of the King's Drive in Victoria Park at the northeast side of Arbroath where there are toilets and ample parking. The walk follows the coastal path from the end of the promenade northeast through the Scottish Wildlife Trust's Seaton Cliffs Wildlife Reserve along recently improved surfaced paths for about 9 km to Auchmithie, where there are toilets and there is parking at the village hall. There is an infrequent bus service back. It is recommended

that anyone intending to use the bus, travels out to Auchmithie and then walks the trail in reverse order to Arbroath. Allow at least three hours for the full one way walk.

You can see some of the localities only by leaving the coastal path and descending to the shore. Care must be exercised at all times especially on rocky and boulder beaches where there is a high risk of slipping, tripping and falling. Avoid all cliff edges especially potentially slippery, sloping grassy fringes. Keep away from cliff bases to reduce any risk from falling rocks and other loose materials. The walk is best made on a falling tide if you intend to leave the path. Tide times are available from the Harbour Office or Tourist Information Centre in Arbroath. Sturdy footwear with good tread is strongly recommended and outdoor clothing suited to the likely weather on the day. You follow the route at your own risk.

Safety advice in relation to the coast:

- Do not approach cliff edges.
- Do not climb the cliffs. The cliff face is very unstable and can collapse with little warning.
- Do not allow your dog to roam freely on cliff paths, they do tend to chase rabbits over the cliff edge and become a casualty. Should this happen never try and climb down to rescue your pet but call the Coastguard on 01333 450666 who will endeavour to assist you with their cliff rescue equipment.
- Beaches can be fun, but do get local advice as to any dangerous currents, weather and the tide times. Entering caves, and there are quite a few, can be dangerous if the tide is coming in. Don't get cut off.
- Never use inflatable beach toys on the sea, they can so easily be carried away on the tide or blown offshore in an offshore wind.
- Always dial 999 and ask for the Coastguard for all Sea and Coastal Emergencies.

Further safety advice is available at <https://www.facebook.com/HMCGAngusDundee/> Tidal information is available at <https://easytide.admiralty.co.uk/>

Introduction

The erosive power of the sea and wind has dominated the development of the features of the rocky coast between Arbroath and Auchmithie. These powerful forces have influenced the development of the cliffs, the rocky shore platform beneath and the presence of narrow, boulder and gravel rather than broader sandy beaches. The cliffs are not particularly high often only 6 to 15 metres, but reach a maximum height of about 40 m north of Carlingheugh Bay.

The Rocks

The local coastal landscape features are mainly controlled by the nature of the sedimentary rocks - sandstone and conglomerate (formerly sand and gravel) — into which the coastline has been carved. The physical characteristics of these rock layers, or strata, determine how erosion affects them. Such characteristics include; the dip of the strata imposed by Earth movements (mountain building and plate tectonics); the hardness of the rocks and their resistance to physical and chemical weathering; the patterns and spacing of vertical joints (fractures); occurrence of faults; the thickness of the beds and the presence of cross bedding. The rocks along the trail are sandstones and conglomerates of two different ages - 410 million year old Lower Devonian (Lower Old Red Sandstone) and 370 million year old Upper Devonian (Upper Old Red Sandstone) rocks respectively. The Devonian is the name given to the time period between 416 and 354 million years ago. A brief description of the rocks and also the formal geological names given to the units are presented below.

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| Upper Devonian | Burnside Sandstone Formation | Red, orange or yellow sandstones and conglomerates & breccias mainly of Lower Devonian rock fragments. |
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| | | |
|----------------|---|--|
| Lower Devonian | Scone Sandstone Formation including: Arbroath Sandstone Member | Cross bedded, pebbly red sandstones, with large white mica flakes and conglomerates with limestone & mudstone-pellets. |
| | Auchmithie Conglomerate Member | Conglomerates of well rounded, fine to coarse (up to 15 cm) mainly quartzite stones with beds of sandstone also containing limestone pellets. |

Geological history

During Devonian time, Scotland was located south of the Equator, probably in the desert belt. The climate was most likely hot and dry but with seasonal floods. Huge rivers flowed across the arid landscape during the Devonian. These rivers left masses of sand, gravel and boulders that now form the Devonian rocks. The rocks at Arbroath tell the story of two ancient rivers and a fossil landscape. The older river, about 410 million years old, was southwesterly flowing and drained eroding mountains well to the northeast of Arbroath. The sands it transported and deposited are now preserved as rock — the sand as the red sandstones of the Arbroath Sandstone Member; the gravels as the Auchmithie Conglomerate Member.

This river may have been the same size as the Mississippi River (USA). Subsequent Earth movements resulted in the originally horizontal beds of sandstone being tilted towards the southeast at 25°. Erosion by wind and water sculpted the rocks into a landscape with hollows and hills. This ancient land surface is now preserved as an angular unconformity that is clearly visible in the cliffs for more than 250 metres north of Whiting Ness. Indeed, this part of the trail is a nationally protected Special Site of Scientific Interest for this reason. Detailed observation suggests that there were hills 100 metres high on this ancient land surface.

The younger river flowed towards the southeast about 370 million years ago and drained an uplifted, much eroded highland to the northwest of Arbroath. The sands, gravels and boulders transported by this river are now preserved as the Upper Devonian age Burnside Sandstone Formation. This consists of red or yellow sandstones, conglomerates and breccias — rock containing broken angular fragments of older rock. Most of the gravels and boulders incorporated in the conglomerates and breccias are eroded from the underlying red Lower Devonian sandstones. In places the coarsest boulders rest on the former land surface (unconformity) and have not been moved far, by erosion or river transport, from where the parent rock was once exposed to the elements. After these younger rocks were laid down, a further period of Earth movements tilted these once horizontal rock layers to the east-southeast.

Whiting Ness has long been recognised as a place to see in three dimensions a geological feature known as an angular unconformity. An unconformity is where older rock has been weathered and eroded before more sediment (now also converted to rock) was laid down on top of it; so there is a 'time gap' between the two different rocks. An angular unconformity is where the older rock has been tilted or otherwise deformed so that the older rock layers are not parallel to the younger.

Coastal landscape

Modern coastal processes are subjecting the cliffs to erosion by waves, wind abrasion and rock fall by gravity, with faults and joints being exploited by these dynamic forces to form sea caves, natural arches and stacks. The Lower Devonian rocks are generally harder and more resistant to erosion than the Upper Devonian rocks, that weather and erode back more easily and rapidly. The Lower Devonian rocks, however, contain many 'joints' - parallel sets of fractures in the rock — and these, along with geological faults, form lines of weakness which the sea has eroded to form spectacular coastal features.

The different stages in the evolution of cliff coastlines can be seen at Arbroath Cliffs. Faults and joints erode to form everything from minor gashes to large caves. Phases of cave collapse form blowholes, collapsed cave roofs (gloups)

to natural arches are developed, and finally there are good examples of complete roof collapse that has formed elongate inlets, called 'geos', and secluded coves. The power of the sea and wind during storms is demonstrated by the presence of fresh sand and gravel on rock surfaces well above normal high tide. Changes in relative sea levels, generally downwards from about 30 metres above present level, have occurred during the last 17,000 years and have added a further degree of complexity to the coastal features.

The Trail

The Arbroath to Auchmithie Trail is part of the Whiting Ness to Ethie Haven Site of Special Scientific Interest (SSSI). It was selected as a SSSI for its geological interest, but also because it contains important areas of coastal grassland and cliff vegetation, and several different bird, plant and insect species. Eight figure National Grid References are provided for the key features on the trail.

1. Victoria Park

A very obvious feature is the relatively flat rock shelf, known as a 'wave-cut platform', which forms the intertidal platform in front of Victoria Park. The sea has cut this into the local Upper Devonian bedrock. It illustrates the relative ease with which soft sedimentary rocks, mainly sandstone are eroded over time.

2. Whiting Ness

On the promenade end [NO 6590 4109], the facing cliff (2a) shows the Upper Devonian conglomerates and sandstones resting slightly irregularly on the Lower Devonian sandstones. This is a rather unspectacular view of the unconformity but safely accessible by all visitors. By descending to the beach and passing northwards around the Ness (2b) the unconformity may be more clearly seen [NO 6590 4107]. However the underfoot conditions are both rough and slippery and for those who follow the next part of the walk, care is required in taking access. This part of the walk is not possible from half to high tide. If this part of the walk is omitted, continue to 2e but look down on the shore below for the wheel marks, like tramways, made when the monks quarried building stone to construct Arbroath Abbey from 1178 onwards.

On the seaward side of the Ness you can see the angular unconformity, a surface of erosion that separates younger strata from older with a time 'gap' between the two. The rock layers above the unconformity are not parallel to those below. There was a significant period of non-deposition and erosion between the two sequences. About 40 million years separates deposition of the two sets of rocks. The Lower Devonian strata have been tilted to dip 15° to 25° to the southeast, the Upper Devonian strata to about 10° to the east-southeast. At this locality and later at [NO 6601 4106], we see the wheel marks, like tramways, made by the monks quarrying building stone to construct Arbroath Abbey from 1178 onwards. Farther on (2c) at [NO 6605 4110], we see angular blocks of Lower Devonian sandstone incorporated into the lowest layer of the Upper Devonian as a breccia.

Just short of the first cave (2d) at [NO 6610 4108], an exposure of the unconformity shows marked topography cut into the Lower Devonian rock landscape — a former valley side can be seen.

From this point return to the promenade and join the cliff top path.

! Caution: Access to this locality involves crossing inter-tidal areas which can be difficult underfoot. Take care not to get cut off by the tide.

East of Whiting Ness to the Deil's Head, the seaward dipping beds of the Lower Devonian sandstones form a gentle cliff behind the present beach. Before reaching the Needle E'e, a conspicuous inlet (geo) (2e) [NO 6634 4125] is seen with two levels of floor erosion. To the north is a perched level above present high water and cut thousands of years ago when sea level was higher. The associated cliff base has been undercut (notched) by wave erosion. To the south the sea is exploiting a much narrower, box-shape cut.

3. Needle E'e

[NO 6647 4132] This well loved landform marks the position of a collapsed sea cave. The arch is located above normal high water mark although the funnel (at the base of the arch) is occasionally flooded by the sea during storms as is shown by the shingle flooring the hollow on the landward side of the arch. The area of the hollow may mark the dimensions of the original cave. The arch forms part of a beach landscape, about 7 metres above the present beach, associated with a period of higher sea-level about 6000 years ago.

4. The Mermaid's Kirk

This is a cove [NO 6650 4135] with a long history. When sea level was rather higher than today the now dry remnants of a high level arch (like the Needle E'e) was then part of a collapsed cave. Fall of the sea to today's level was associated with erosion of a shoreparallel cave, currently about 75 m in length, along a northeast trending fault so that seawater now enters the cove from the southwest. There are at least three floor levels within the cove, the lowest being the most northerly. These levels reflect falling sea levels through time.

5. The Crusie

Here [NO 6662 4152], the sea has taken advantage of joints (parallel sets of cracks) in the Lower Devonian sandstones to excavate two caves which have largely or totally fallen in to form a blowhole to the right and a geo to the left (north). The cave has fallen in to landwards leaving part of the roof as a blowhole, whereas in the case of the elongate geo, it has collapsed all the way.

6. The Blowhole

Here [NO 6670 4157] a cave has been cut along a joint in Lower Devonian sandstone with partial roof collapse forming the blowhole adjacent to the path. Although about 15 m above the sea, during storms the surf still rushes up the funnel, and continues to widen the hole as shown by the abrasion and rounding of the sandstone at path level.

7. Dickmont's Den

[NO 6670 4168] At almost 200 metres long and 100 metres wide, this is the most impressive of the fault-controlled geos. Cut largely in the Lower Devonian age Arbroath Sandstone Member, an 'island' of Upper Devonian conglomerate and sandstone is perched high up on the north-east wall. The unconformity between Lower and Upper Devonian rocks appears to be highly irregular with significant ancient topography indicated.

8. The Deil's Heid

This sea stack [NO 6701 1477] is formed of Lower Devonian sandstone, by marine erosion working along the joint-planes. The erosive forces at work include the power of the waves driven by the wind and tides, and also the debris the water transports to abrade the rocks. In addition, the waves impinging on the cliffs trap and compress air that releases explosively to increase erosion of the rocks.

9.

This feature [NO 6698 1475] is not visible from the path. You need to look southwest back to Arbroath from beside the Deil's Heid (locality 8) to see an open cleft cut in the cliffs. The shoreparallel gash is erosion along a line of weakness formed by a small, seaward-dipping, fault plane. If the landward part of this feature were to erode and collapse faster than the seaward part, another stack like the Deil's Heid would be formed.

!Caution: Access to this locality involves descending grassy slopes which can be slippery.

10. Mason's Cave

At this cave [NO 6695 4206] which can only be seen from the shore, the cliffs are cut along the line of a fault in the The rocks have been sculpted by weathering and erosion into shapes such as The Sphinx [NO 6694 4218] and the Camel's Humps (or Three Sisters) at 10a. These can easily be seen without leaving the path.

10a softer, less well-jointed Upper Devonian sandstones and conglomerates. This cave can only be reached via several poor tracks down to the beach from Maiden Castle or through the Castle Gate Arch.

!Caution: Access to this locality involves descending grassy slopes which can be slippery and crossing inter-tidal areas which can be difficult underfoot. Take care not to be cut off by the tide. Tidal information is available at

<https://easytide.admiralty.co.uk/>

11. Castle Gate

This arch [NO 6698 4222] just north of the Mason's Cave has formed along the line of a small fault which defines the south side of the narrow, elongate headland here.

The wave-cut platform(see Locality 1 for explanation) is conspicuous on the broad foreshore from the Mason's Cave northwards to the Dark and Light Caves at the north end of Caution: Access to this locality involves descending grassy slopes which can be slippery and crossing inter-tidal areas which can be difficult underfoot. Take care not to be cut off by the tide.

Tidal information is available at <https://easytide.admiralty.co.uk/> Carlingheugh Bay, where it is cut in flat-lying Upper Devonian rocks. There is an extensive flat area of raised beach forming the vegetated area above high water mark. This deposit of sand and gravel formed about 6000 years ago when sea level was higher than today.

To visit localities 12 & 13, leave the coastal path and walk northwards along the shore. Binoculars will help you make more of these two localities if you do not wish to detour from the main path to visit them.

12. Dark Cave

In the cliffs at the north end of Carlingheugh Bay, the Lower Devonian rocks (LD) are separated from the Upper Devonian rocks (UD) by a fault. The line of the seaward dipping fault plane can be seen at the Dark Cave. The Lower Devonian rocks are to the left and the Upper Devonian rocks to the right. The southern entrance to the Dark Cave [NO 6713 4280] is cut along the line of the fault with a vein of pale coloured barite (Barium Sulphate) up to 1.8 metres thick marking the main fracture. The northern mouth of this cave [NO 6721 4289] emerges above the present beach where it also partly cuts into the barite vein. Fissures in the Lower Devonian (Arbroath Sandstone Member) are in-filled with Upper Devonian material that encloses shattered barite from the vein. This implies that the fault was active before as well as after Upper Devonian times.

!Caution: Access to this locality involves descending grassy slopes which can be slippery and crossing inter-tidal areas which can be difficult underfoot.

13. Light Cave

This cave [NO 6721 4279] is cut along a small fault within the Upper Devonian rocks. This cave does not require lighting to negotiate it because it is quite shallow. The unconformity between the Upper and Lower Devonian rocks can be seen at the extreme seaward point of the cliff. The Lower Devonian rocks are cut by many more joints and more closely spaced joints than the Upper Devonian rocks. The flat-lying land immediately above the cliffs forms part of a raised beach, possibly 17 000 years old that was occupied by the sea towards the end of the last Ice Age. Return to the coastal path at the west end of the bay to continue to Locality 14.

!Caution: Access to this locality involves descending grassy slopes which can be slippery and crossing inter-tidal areas which can be difficult underfoot. Take care not to be cut off by the tide. Tidal information is available at

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14. Gaylet Pot

The most famous local example of a collapsed cave (gloup) is the Gaylet Pot [NO 6788 4333] which is 100 m long by 60 m wide and about 30 m deep. It is cut along joints in the Lower Devonian rocks, is approximately 150 m inland from the foot of the sea-cliff and the resulting hole is located in the middle of a field south of Laverock Den. This feature is best safely viewed from its north end, near but east of the pole marking its location in the field. Access to this locality may not be available when fields are in crop.

Caution: Gaylet Pot has cliffs and steep slopes. Approach with care.

Nearby (14a) at Lud Castle headland [NO 6800 4335], another example of the angular unconformity between Lower and Upper Devonian rocks is well seen, by partially descending its south side by the keen and careful visitor. From here follow the path into Auchmithie to reach its harbour (Conglomerate Member) with beds of sandstone. You can see these in cliffs sections [NO 6823 4415] both on the beach and along the path down to the harbour.

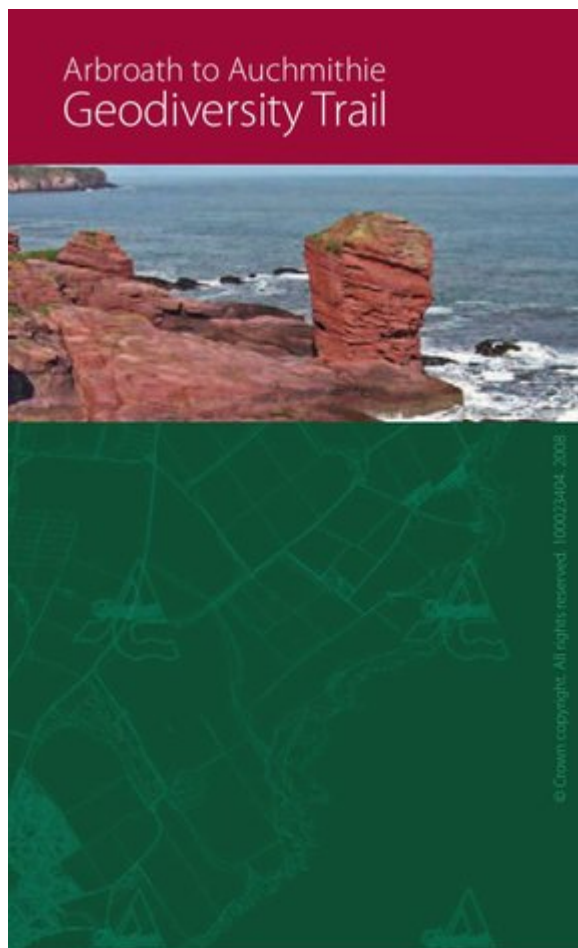
The cave (15a) and a sea stack called The Rock, (15b) are visible on the shore which also has superb gravel stormbeach ridges.

!Caution Gaylet Pot has cliffs and steep slopes. Approach with care.

15. Auchmithie Harbour.

Below the village of Auchmithie, for the only time, you can see Lower Devonian conglomerates (Auchmithie Conglomerate Member) with beds of sandstone. You can see these in cliffs sections [NO 6823 4415] both on the beach and along the path down to the harbour.

The cave (15a) and a sea stack called The Rock, (15b) are visible on the shore which also has superb gravel stormbeach ridges.



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