

Longniddry Bents to Aberlady Point

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The shoreline from Longniddry Bents to Aberlady Point exposes the top of the Aberlady Formation and the overlying Lower Limestone Formation, into which is intruded the Gosford Bay Sill. Cyclic sedimentation is well demonstrated, a typical cycle has an upward sequence of marine limestone, shale, sandstone, seat-earth, coal, marine limestone. Occasionally individual units may be very thin or absent. The cycles are considered to represent the normal sequence of events in a subsiding delta. Periodically, the trees growing on the muds and sands of the deltas died and were covered by the sea, in which limestone was formed, before the next influx of mud and sand shallowed the water sufficiently for another forest to establish itself. The seat-earths in which traces of rootlets can be seen are fossil soils. The structure is dominated by shallowly plunging open synclines and anticlines.

Logistics

The shoreline is tidal, with many of the key exposures below the high tide mark. Most are available from mid-tide to low tide. The risk of getting cut off by a rising tide is generally very low as there is a coastal path to walk back to, but care should be exercised around Aberlady Point where the wave-cut platform is backed by a steep cliff for a few hundred metres.

The excursion is described from southwest to northeast, however, the exposures, or selected areas, can be accessed from several starting points. All require at least some walking on trackless terrain. The East Lothian Ranger service do not encourage large numbers of visitors along this section of coast due to the diverse bird life along this stretch of shore (Earthwise, ELC 14).

Possible starting points are:

Option 1: From Seton Sands Holiday Village or either of Longniddry Bents #1 or #2 car parks, walk eastwards along the beach to locality 1. From Seton Sands the return trip to Aberlady Point is around 12 km of walking, with some off-track sections.

Option 2: From Longniddry Bents car park number 3 on the headland of Ferny Ness, walk SW to get to location 1, then return through the car park and head N. This reduces the walking distance to less than 10km.

Option 3: From the west end of Aberlady village (car parking on the main road) walk west along a path in the woods that runs parallel to the main road (A198) on the north side and join the gated, metalled track that leads into the woods and hence the shore as described below.

Option 4: From the east end of Aberlady village, walk up the metalled access road to Craigielaw Golf Club (parking down here is discouraged). Join the excursion by walking along the shore westwards, and join at the last locality.

The Lower Limestone Formation has few natural exposures in central Scotland, so that this section is a regionally important lithostratigraphic site (BGS Earthwise ELC 14). The description of the geology of this section is built upon that in Duff (1986) and the limestone names are taken from the [BGS Geology Viewer](#).

Most of the excursion is in the shallowly westwards-plunging Gosford Bay syncline and an anticline to the north. However, the orientation of the sediments can be irregular and are possibly controlled by variations in thickness of the underlying Gosford Bay sill and by local faulting.

W	Coal Measures	Upper Coal Measures
		Middle Coal Measures
		Lower Coal Measures
N	Clackmannan Gp	Passage F ^m
		Upper Limestone F ^m
		Middle Limestone F ^m
		Lower Limestone F ^m
V	Strathclyde Gp	Aberlady F ^m
		Gullane F ^m
T	Inverclyde Gp	Clyde Sandstone F ^m
		Ballagan F ^m
		Kinneswood F ^m

Table 1: Carboniferous stratigraphy of East Lothian; Gp = Group; F^m = Formation. The red bar indicates the approximate position of the exposures. From Browne et al. (1999). W = Westphalian; N = Namurian; V = Visean and T = Tournasian.

1: Foreshore S of Ferny Ness

The wave-cut platform to the south of the headland of Ferny Ness (on which the Longniddry Bents #3 carpark is built) exposes the top of the Gosford Bay sill. This is an olivine-analcime-dolerite sill (Duff, 1986) with alteration at the top surface to 'white trap', i.e. replacement of the original mineralogy by calcite or dolomite plus amorphous silica. The igneous texture is sometimes preserved in thin section as pseudomorphs.

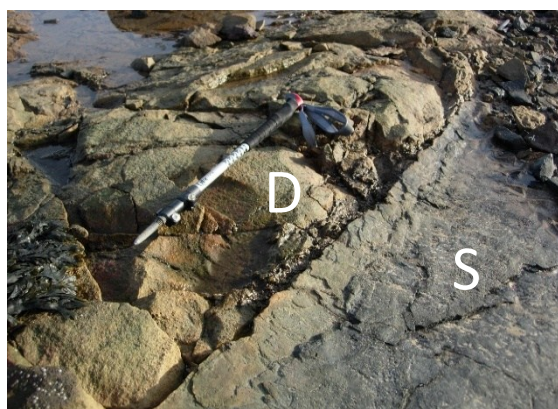


Fig 1: Contact of altered dolerite (yellow; D) against sediment (S) at the top of the Gosford Bay sill.

The contact between the sill and the overlying sediments is gently undulating, with arcuate features on a scale of 10m or more visible. Considerable time could be spent examining or even mapping the contact in detail.

2: Gosford Bay south: Lower Limestone Formation

Walk north from Longniddry Bents #3 car park along a path on the edge of the shore. The path dies out, leading to a short section on boulders where the coastline swings to the east. Around this corner, an exposure faces north (NT 444 778). It is partly obscured by sea buckthorn bushes but offers an excellent section of a c. 10m coarsening and thickening clastic sequence with some evidence of either shallow (c. 1 m deep) channels, or bars (Fig. 2). The basal beds are dark grey silty shales, the upmost beds are well sorted fine-grained sandstones with beds of c. 0.5 m thickness. The exposure would make an excellent exercise as an introduction to sedimentary logging for a small party. The lack of body fossils and a general lack of bioturbation suggests a non-marine environment. The coarsening and thickening sequence is developed by the progradation of a delta into a non-marine lagoon, with the thickness of the sequence corresponding to the approximate paleo-depth of the water in the lagoon.

The top of the Gosford Bay sill is sometimes exposed at the seawards end of the exposure, but can be covered by cobbles and boulders. The top of the sill is altered to white trap (actually yellow / pale orange) for a few decimetres, and can be tricky to distinguish from the baked sandstone which immediately overlies it. Duff (1986) describes glacial sediments on top of the cliff exposure, but these are not now visible.

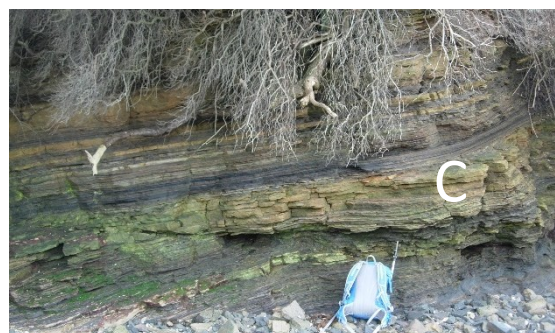


Fig 2: A possible shallow channel feature (C) that thins to the left.

There is evidence of bedding-parallel shear, as mm – cm thick layers of micro-breccia within some of the laminated shale-sandstone intervals. A challenge is to determine the sense of motion.

The sequence dip at c. 10° to the East, which is the opposite sense to that expected from the more regional structure: the Gosford Bay syncline plunges to the west, and here on the southern limb a dip towards the W or NW might be expected. Presumably the local dip reflects the effects of the immediately underlying sill. Dolomite concretions are occasionally exposed in the overlying sediments on the wave-cut platform to the N of the cliff. These are 10 – 20 cm diameter but only 3 – 5cm thickness, so quite oblate. They are set in a laminated sandstone-siltstone bed. The dolomitic mineralogy is unusual in a non-marine clastic sequence, where siderite is the norm.



Fig 3: Oblate dolomite concretion

3: Gosford Bay, north: fault with dyke

Walk along the seawall, until the wall has a bend with a conspicuous change in the style of stonework. The Gosford Bay sill is exposed here again, but immediately to the south is a fault marked by steeply dipping beds on the SW side (NT 444 778). Both a 0.5 – 1m wide ‘neptunian’ dyke (sandstone) and a similar width dolerite dyke, now partly altered to (orange) white trap, are intruded along the fault plane.



Fig 4: Neptunian dyke (sandstone; S) and the dolerite dyke (D)

Depending upon the state of the beach cover, the landwards end of the dyke can be seen to split and surround a block of bedrock of c. 50 cm dimensions.

In the centre of Gosford Bay are 2 ‘cryptovents’ which are sometimes visible under shifting sands and gravels (Howells, 1969). Although in the field the matrix to the cryptovents appears to be a dark grey / black shale or siltstone, Howells records a significant igneous component, including brown vesicular glass and fragments of kaolinitised tuff in thin-section. Howells interpreted the structures to have formed by sub-surface volcanic activity, i.e. with no evidence that the activity reached the contemporary land surface. This seems a debatable basis for classification, given that the contemporary land surface has eroded away. A possible origin is as steam-driven explosion breccias associated with the intrusion of the Gosford Bay sill, which presumably underlies the bay. See [location 6](#) for a more easily located and well exposed vent.

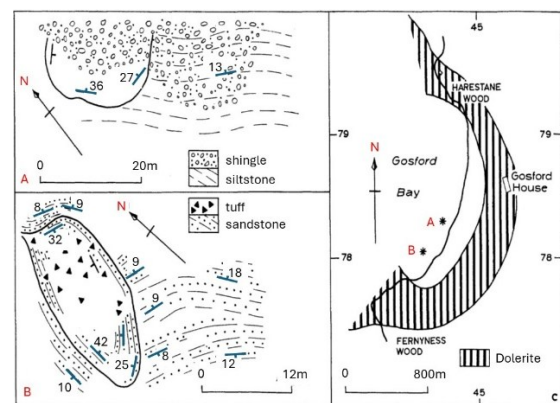


Fig 5: Details of the Gosford Bay cryptovents, redrawn from Howells (1969)

To continue northwards, walk along the path on the seawards side of the A198 until the path enters a wooded area. Either continue along the trackless coast, with sporadic exposures (both in the sense of geographical separation and the beach cover). This is rough walking, and many will prefer to follow the path into the trees, until it crosses a private tarmac road with a gate that may be locked. Walk along this road for c. 350m and immediately after a small (and inconspicuous) bridge with low stone parapets, take a narrow track to the left (west). This almost immediately crosses a shallow ditch, which can be slippery in wet weather. The track leads to the shore, here turn right and head northwards along the coast,

and past the sandy bay that surrounds the tidal islet of Green Craig.

4: Craigie Law Point to Aberlady Point

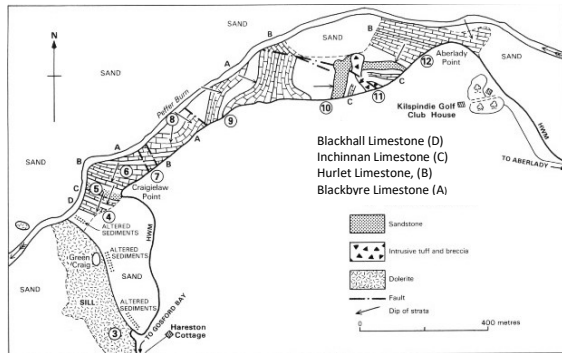


Fig. 6 – Location map redrawn from Duff (1986)

The section between Craigie Law Point and Aberlady Point has virtually continuous exposure, with 4 well exposed limestones and less well-exposed intervening sediments. Initially, the sediments are low in the Lower limestone Formation.

4.1. The first limestone encountered is the stratigraphically highest, the Blackhall Limestone (D on Fig 6), previously the Middle Skateraw Limestone, dipping at about 15° to the SSW. The limestone is a hard massive dark-grey unit about 8 m in thickness. It contains crinoid fragments and productid brachiopods. A dark-grey mudstone is visible under the overhang of the more resistant limestone, otherwise the underlying beds are poorly exposed.

4.2 The second limestone is the Inchinnan Limestone (C on Fig. 6), previously the Lower Skateraw Limestone. This well-jointed limestone is about 1 metre in thickness, is hard and grey rock and also contains crinoids and brachiopods. A thin coal and seat earth below the limestone may be found depending on the state of the beach boulders.

4.3 The 3rd limestone is the Hurlet Limestone, previously the Upper Longcraig Limestone (B on Fig. 6). This is a bedded limestone on top of pale-brown limestone with a nodular or 'rubby' top surface. This lower part is dolomitic and contains many crinoid fragments. The base of Hurlet Limestone marks base of the Lower Limestone Formation (Clackmannan Group) and the top of the Aberlady Formation (Strathclyde Group).

Around 15 - 25 cm of coal is well exposed under the overhang beneath the limestone, and this lies on a seat earth of indeterminate thickness. A c. 30 cm thick brown mudstone separates the coal from the limestone. The contact between the limestone and underlying mudstone is sharp though nodular, although as with all such contacts, the extent to which this is a primary feature, rather than due to diagenetic 'un-mixing', is open for debate.

Although reconstructions of the coal-forming environment during the Carboniferous invariably show forests, neither the coal nor the underlying seat earth hold evidence for the past existence of trees. The rootlets in the seat earth are mm-scale and fossils such as *Stigmaria* are mostly absent. The coal is hence interpreted to have formed as peat, from small plants commensurate with the size of the preserved plant rootlets.



Fig 7: The coal (C) below the Hurlet Limestone (L) and the underlying seat earth (SE)

4.4 The final limestone is seen is the Blackbyre Limestone, previously the Middle Longcraig Limestone (A on Fig. 6). This is easily recognized as it is yellow-brown in colour and made up largely of colonies of the compound corals *Lithostrotion junceum* and *L. pauciradiale*. These give rise to the field names 'spaghetti-rock' and 'macaroni-rock', respectively. The limestone is extremely fossiliferous containing the solitary rugose corals *Caninia* and *Zaphrentis*, and the brachiopods *Eomarginifera*, *Spirifer*, *Avonia*, *Pustula*, *Composita* and *Pugnoides* (Duff, 1986).



Fig 8: *Lithostroton junceum* (top and left) and *L. pauciradiale* (lower right)

The Blackbyre Limestone is cut by 2 thin (5 to 10 cm) 'Neptunian' sandstone dykes which are approximately parallel to the axis of the anticline (c. 300°). Fractures that run in the same orientation conspicuously control the shape of the exposures at the NE end of this section of coast.



Fig 9: A thin sandstone dyke

It is worthwhile searching the pebble and cobble beaches of this section of the coast for fossils. One peculiar feature are brachiopod fossils (identified as *Dictyoclostus*; E. Clarkson, pers. comm.) with a single, approximately circular indentation that is not obviously a feature of stress during burial: the shells are robust and unlikely to break, and in any case are not comprehensively crushed. A speculative explanation is that the indentations are from a strongly toothed fish, which was presumably intent on eating the animal inside the shell. Rare fish teeth of a suitable size have been found here (T. Challands, pers. comm.), though have not been described in the scientific literature.



Fig 10: *Dictyoclostus* with crushed upper surface (arrow)

5 Glacial erratic boulders

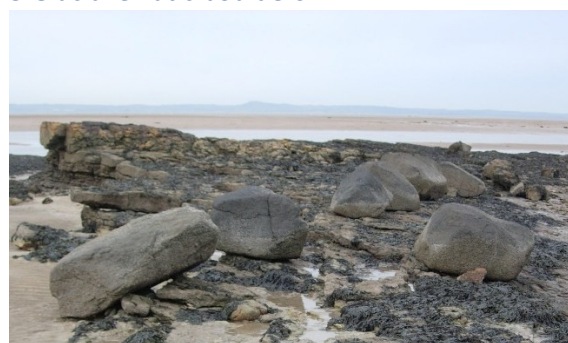


Fig 11: Seven of the eight erratic boulders

On the scarp of the Blackbyre Limestone there is a line of 8 conspicuous glacial erratic boulders of micro-gabbro (dolerite). The shorewards one is the largest at approximately 3m in maximum dimension, (not shown in the figure). While glacial erratics are common in the area, why there is a concentration here isn't clear.

6 West of Aberlady Point

The geometry of the coastline changes dramatically past the bend in the coastline at NT 450 804, where Aberlady Bay comes into view. The rugged limestone scenery is replaced by a what appears to be wave-cut platform backed by a c. 5m sheer cliff. This topography is unlikely to be natural, as History Tomorrow (n.d.) conclude, from the study of historical records, that 'probably considerable' quantities of rock were removed over centuries of quarrying activity, largely in the Middle Ages. Many of the local towns, including Haddington, were built from stone sourced here. The 'King's Kist', a small square-cut outlier that lies c. 100m from the present-day cliff is an important historical boundary marker (History Tomorrow, n.d.) and is possibly a relic of quarrying. Kist is a Scot's word for a chest or container. King's Kist is mentioned in a report from 1799.



Fig 12: Overturned bedding due to slumping.

The wavecut platform (or relic quarry surface, as above) here is formed of an open southwards plunging syncline. The west limb of the syncline is well exposed in the c. 5m high cliff that forms the shoreline to the west part of the shore. A dark grey laminated siltstone is overlain by a pale yellow / orange sandstone with parallel and trough cross bedding. The same sandstone-siltstone boundary can be inspected on the wave-cut platform, immediately to the east of the stone-built building that sits above the east end of the cliff. Clear trough crossbedding and some slumping can be seen in the sandstone. The same sandstone-siltstone boundary can be seen in King's Kist.

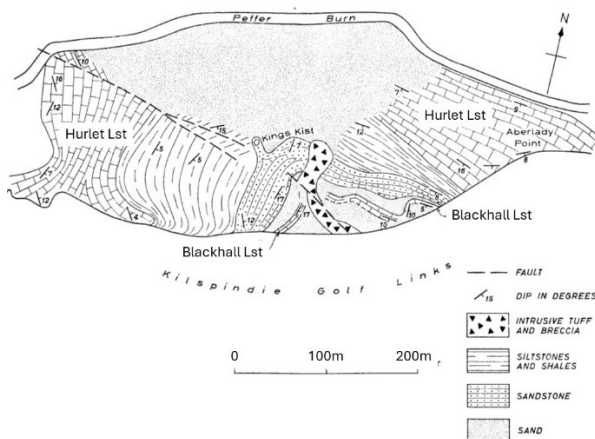


Fig 13: Map of the wave-cut platform east of Aberlady Point, redrawn from Howells (1969).

On the wave-cut / quarried platform is another cryptovent described by Howells (1969), see [section 3](#). This is easily located at a few metres due west of an old drainage pipe that runs out to sea. The cryptovent is a N-S oriented area of approximately 100m by 10 - 20m, with blocks of

limestone and other lithologies of up to m-scale, arranged chaotically. Howells identifies the limestone as the Blackhall Limestone (then the Middle Skateraw Limestone), into which the cryptovent was intruded. The dark grey shale matrix is surprisingly well laminated for the supposed product of an explosive event.



Fig 14: Blocks in the cryptovent – note the random orientation (orange arrows) and the almost horizontal block in the foreground.

Acknowledgements

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