

# The Fife Coastal Path from Kinghorn to Kircaldy, 5<sup>th</sup> July 2014

Leader- Dr Colin Braithwaite.  
Report *Barbara Balfour*.

We started on the coastal path at Kinghorn, overlooking a sandy bay and the Firth of Forth. After a short walk in a north easterly direction, we made our way down to the shore to study volcanic rocks of the Lower Carboniferous. Geikie referred to the lavas we examined on the shore, as 'pillow structures' suggesting that they had formed under water, but they were not as the classical pillow lavas at Girvan. These 'pillow structures' looked as though they had tumbled into the muddy ash and cooled. The lava was rich in vesicles, suggesting that they formed in shallow water where the gas could have escaped which wouldn't happen at depth. Some of these vesicles were infilled with calcite, originating from hot ground water, forming amygdalae. Nearby we saw the effect of cooling and contraction of the lava which had superimposed a pattern of polygonal fractures on the pillows. The volcanism in this area probably happened following the Caledonian orogeny when the area was in tension.



*Pillow structures with vesicles, and ash below it*



*Polygonal fractures marked by calcite veins*

As we moved along the shore of the bay, we observed large blocks of limestone with shell fossils and also ones with crinoids indicating a marine environment. Although we could not be sure these were in situ, we could see the source ahead, the First Abden Limestone. This is an excellent cross section, as the beds are dipping 22° NE, allowing us to see that underneath the limestone lay shelly grey shale, and below that, grey green tuffs showing graded bedding. Above the limestone, there was calcareous shale contorted under the lava flow with basaltic lava on top. However this was not the same lava flow as we had seen previously.



*Shelly grey shale and grey green tuffs with the First Abden Limestone and lavas on top*



On the foreshore, solitary cup corals and brachiopods were found, which again suggests shallow, oxygenated water, probably relatively warm in the Lower Carboniferous.

*Cross sections (2-3cms diameter) of solitary cup corals*

We also saw recent weathering of the limestone which exhibited “lapié”. This looked as though grooves had been cut in a downwards direction in the limestone. Colin explained that this had happened in the recent past, caused by exposure to rain water reacting with the limestone in the presence of carbonic acid i.e. possibly formed from emissions of carbon dioxide from earlier industries in the area.

Continuing a short distance along the footpath, another large basalt flow was observed on the shore below. Colin pointed out that the undercut was a wave-cut notch in the old sea cliff. In the notch was fossilised, red, lateritic soil, called bole, which has formed on tuff. This red bole or laterite is indicative of weathering and soil formation under tropical conditions in the Early Carboniferous, and, as the lava flow lies on the bole it must have erupted on dry land. Down on the shore again, we could clearly see the exposed succession – from the path, going seawards, roughly west to east, basalt lavas with pillow structure, tuffs passing into red laterite, dark grey fossiliferous calcareous shale and the Second Abden Limestone dipping about 22°E, a series of limestone beds separated by irregular muddy parting.



*The Second Abden Limestone in background, then shales, and red laterite covered in green seaweed.*

The laterite had taken at least 10,000 years to form in dry conditions before there was a marine incursion forming the shales and limestone on top of it. This marine area gave rise to many fossils including bivalves, brachiopods, crinoids, corals and bryozoan.



*Solitary coral*



*Naiadites crassa*



*Crinoid 'debris'*

We prised ourselves away from fossil hunting to have lunch in the sunshine with a beautiful view of the Forth.

Back onto the path north and then down to the shore again to see some ‘lumpy’ limestone. This was a result of limestone forming which is not all cemented, so there is some limestone of muddy consistency present. When this mixture is overburdened the ‘muddy’ part is squeezed out from the more cemented yielding the ‘lumpy’ limestone or ‘discontinuous cementation nodular rocks’.

Digenesis is common near the Carbonate Compensation Depth (CCD), usually about 4 kilometres depth, as below this depth calcium carbonate will dissolve, thus limestone will not form.

*Discontinuous cementation nodular rocks*



Still moving north-east along the shore, we came upon a fault which had caused the ridge of the limestone, which runs along the shore, to be breached. The affected limestone has been turned at right angles to the dip. It was best viewed from the path.



*Faulted area of limestone ridge.*

It is worth mentioning that this photograph shows the exposures of the rocks of the Lower Carboniferous dipping approximately  $20^{\circ}$ NE, caused by the Burntisland Anticline which disappears under the Forth and becomes the Fife Coalfield Syncline.

Although we missed the way back up to the path we quickly retraced our steps along the shore and made our way to the Seafield Tower via the footpath, where we were able to look down on some seals basking in the sunshine.

By the shore at the Tower, Colin showed us very good examples of burrows of Zoophytes 'Coda di Gallo', so named as it resembles the plumes of a (Italian?) cockerel's tail. We also saw lots of crinoid 'debris'. However the main attraction here was a wonderful example of current bedded sandstone, reddish in colour. A discussion ensued as to the source of the quartz. The grains, although fine, were angular and not rounded. It was thought to have been a high energy river system flowing north to south with braided streams or a deltaic system.



*Seafield Tower and sandstone outcrop*



*Cross- bedded sandstone*

*Photo courtesy of S.Leishman*



*Zoophytes 'Coda di Gallo'*

Our last stop of the day was next to the Tyrie breakwater. Here we saw a quartz-dolerite sill that is exposed further south, but in this area it has been buried in sand for about 25 metres until it makes a reappearance. This sill, which has a dip of 20-25° eastward, intruded into the Limestone Coal Formation. The sill margins are fine grained and bleached. It contains a large raft of sandstone, now baked to quartzite and with its bedding perpendicular to the sill margins.



*Quartz-dolerite sill*

As we walked along the shore to the car park at Kircaldy to rendezvous with the bus, we came across examples of *Stigmaria*, root stocks of lycopod trees. It is hardly surprising to find evidence of these trees, which grew in deltaic swamp conditions and finally became the Limestone Coal Formation, 259 metres in thickness (including 15 metres of coal) at Kircaldy.

*Stigmaria*



It was a splendid day, both weather and geology. What a treat it was to easily follow successions, to see volcanics contemporaneous with sediments *and* a plethora of fossils. Colin was clear with his explanations, patiently answered questions and was still smiling at the end of the excursion!

*References: Fife and Angus Geology by A.R. MacGregor 1996  
Teachers' Guide: Higher & Intermediate 2 Kinghorn, Fife.*

