Excursion 8 Ardmore Point and Auchensail

Key details

Author	B.J.Bluck
Themes	The stratigraphy and sedimentation of the Lower and Upper Old Red Sandstone rocks; the angular unconformity which separates them.
Features	Lower Devonian plants and trace fossils; various alluvial facies; structure, including possible faulting in unconsolidated sediments.
Maps	O.S. 1:50 000 Sheet 63 Firth of Clyde B.G.S. 1:50 000 Sheet 30 W Greenock
Terrain	Muddy coastal path and foreshore: quarry exposures.
Distance and Time	The circuit of Ardmore Point is about 3 km (1.8 miles): allow two hours at least.
Access	Avoid high tides, most localities accessible at mid-tidal range. Parties visiting Locality 1 should obtain permission from Mr. Semple Findlay, Carniedrouth Farm, Barrs Road, Cardross G82 5EY. Ardmore Point is an SSSI but no permit is required at this time.

Locality 1. Auchensail Quarry [NS 342 798]: Devonian plants

Approaching this locality from Glasgow, follow the A814 to the NW end of Cardross village (just before Geilston Burn crosses the A814) and take a minor road to the north which leads to Auchensail Farm and Darlieth House. It is important to take the left fork at Auchensail and travel north to cross Geilston Burn. The quarry is behind Auchensail Cottage.

Auchensail Quarry exposes gently dipping Lower Old Red Sandstone rocks cut by an E–W Carboniferous dyke. These Lower Old Red Sandstone rocks are in the axial zone of the Strathmore syncline where they form the youngest beds in the regional Old Red Sandstone sequence. On the basis of the plant identification they belong to the uppermost unit of the Lower Old Red Sandstone (Emsian).

There are two important lithologies in the quarry: grey-green lithic sandstones alternating with red irregular beds of siltstones and shales (Scott et al 1976). The sandstones are in upward fining sediment units about 2 m thick, beginning with intraformational conglomerates of red mudstone clasts, followed by cross stratified sandstones and terminating with beds rich in aligned spiny carbonaceous plants. The commonest plant is *Sawdonia ornata*, but it is in a fairly poor state of preservation. Patient collecting, however, should yield identifiable specimens of the two main spiny bush-like plants (Figure 8.1). *Sawdonia ornata* has fertile tips with lateral sporangia and sterile branch tips with circinnate vernation: also branching styles with stem spines. The less common *Drepanophycus* (*Arthrostigma*) *spinaeformis* has less sterile branches and branch tips with typical spine-leaves. These plants were well adapted to the arid, semi-arid climatic conditions of the Devonian where they grew to a height of 0.5–0.7 m (Rayner 1983). Good collecting can be made from sandstone blocks on the quarry floor and particularly in the eastern end of the quarry.

Each of the upward-fining cycles is produced by the lateral migration of a river, so that the thickness of a cycle is approximately equivalent to the depth of the river. On this basis the sandstones were laid down by rivers which were no more than 2–3 m deep.

Red siltstone interstratified with these sandstones have yielded Beaconites, burrows produced by an organism of uncertain type. One view is that they are the resting burrows of amphibians or reptiles which may have lived within the muds of temporary pools in ephemeral streams. The red siltstones either infill channels or spread laterally as sheets and often have very well developed mudcracks which are vertically infilled with sandstone. Some mudcracked beds have roughly circular depressions 3–5 mm in diameter: these are rain imprints. The siltstones with the sheet-like form are produced by deposition on the floodplains of the rivers which deposited the sandstones. Their periodic drying out caused the formation of mudcracks and subsequent floods washed sands over the flood plain to fill the cracks with sandstone.

An E–W, Carboniferous quartz dolerite dyke, c. 0.8 m thick runs the length of the quarry and is exposed in the far (eastern) wall. It has a good chilled margin and the sandstones adjacent to the dyke are slightly metamorphosed .

Ardmore Peninsula [NS 325 878] (Figure 8.2) is reached by returning to the A814 and following it NW to Lyleston Cottage: turn left onto a small road to cross the railway line and park cars at Ardmore Peninsula. The main outcrops are to the west of this car park and are reached by a track which follows the coastline (Figure 8.2).

Ardmore Point exposes two sequences of rocks which are divided by an unconformity. The first, encountered at Locality 2, is Lower Old Red sandstone in age, on the basis that when the sequence at Ardmore is traced towards the NNE, it is seen to conformably underlie the sandstones of Auchensail Quarry which are known to be at the top of the Lower Old Red Sandstone. The second sequence (Locality 6), which unconformably overlies the first, has generally been regarded as Upper Old Red Sandstone because elsewhere the Upper is seen to rest unconformably on the Lower and also the Upper is generally bright red in colour in contrast to the dark red of the Lower. Current thinking in the B.G.S believes these lighter red rocks to be Lower Old Red Sandstone in age and the unconformity a local event within the Lower Old Red Sandstone sequence.

Locality 2. [NS 3145 7824]: Conglomerates and sandstones

The main part of the foreshore is made up of alternating conglomerates and sandstones, dipping to the SE. Most of the conglomerates have a sheet-like form, but some are infilling channels: each contains well rounded pebbles and cobbles mainly of quartzite, vein quartz and andesite, plus other lithologies. The size of the clasts, up to 300 nun in diameter, suggests that they were deposited near their source. The high degree of rounding, particularly of the tough quartzite clasts, implies long distances of transportation, which is not consistent with their being close to source. This paradox is resolved if the clasts are assumed to have been derived from a nearby source which included a pre-existing conglomerate in which the clasts were already partly or largely in a rounded condition.

The composition of the clasts may be used to determine the provenance of the sediment. The provenance comprised metamorphic, igneous and, if the rounded quartzite is from a pre-existing conglomerate, sedimentary rocks.

Sandstones interstratified amongst the conglomerate have abundant small scale cross-stratification 10–20 cm thick. This is produced by the migration of small sand-bars and megaripples the height of which are, in a complex way, related to the flow depth: deeper flows produce thicker bars and larger megaripples which in turn may yield thicker cross strata. Lineations seen on the bedding surfaces are normally produced in shallow, fast flowing streams, and these structures together with the thin cross strata suggest deposition by flows which were probably less than a metre deep.

The conglomerates and sandstones, being red in colour were laid down in conditions where there was an abundant supply of oxygen to convert iron-bearing minerals to haematite, the red iron oxide grain-coating which gives these rocks their colour. This, together with the presence of mudcracks elsewhere within the sequence implies deposition in a terrestrial environment, and these deposits are considered to be alluvium laid down by ephemeral streams in an arid or semi-arid climate.

The directions in which these sediments were dispersed vary considerably within the region of Ardmore as well as in the Old Red Sandstone along strike towards the Balmaha. Because of this variability in the directions of sediment transport a cautious view is taken of the direction in which the source lay: sometimes it was in the south, SE, SW and north. The clear implication is, however, that the present Highlands were not so dominant in Old Red Sandstone times that they controlled the dispersal of sediment. Indeed they may have lain a little further to the north or were so flat that they were not the main source of the sediment (Bluck 1984). Some of these points are made in Excursion 9 (Balinaha).

Locality 3. Faulted anticline

This structure is easily recognised by a sudden change in the dip of the beds. The low foreshore to the SE comprises a SE dipping sequence of coarse conglomerates and dark red sandstones terminated at this point by a series of fractures with fault-breccias which locally mark the path of a fault running SW towards the Clyde. On the NW of the fault the beds dip to the NW so the structure of this ground is a faulted anticline.

Locality 4. Plunging syncline

Follow the path northwards, noting that the beds which form the faulted anticline change dip to form a plunging syncline on the foreshore. This syncline has a steep limb to the south with a shallow limb to the north , and in walking from one limb to the other it is possible to stop at the axis and look down the plunge of the fold which extends out into the Clyde.

Locality 5. Slickensides and raised beach

The plunging syncline is terminated NW by a fault the plane of which forms the low cliff at the NW side of this Bay. This cliff face shows almost horizontal slickensides suggesting that there was a horizonal movement along it for at least part of its history. A small burn reaches the shore near the cliff and raised beach gravels are exposed along its banks. This raised beach sediment, or the erosion surface upon which it was laid is now covered with peat and forms the low ground up to the old sea cliffs which surround Ardmore House. This beach and the cliff behind it was abandoned c. 7000 years B.P. (Before Present).

Locality 6. Unconformity between the Lower and Upper Old Red Sandstone

This unconformity is not well displayed, and to see it requires a careful examination of the ground. The purple-dark red rocks of the Lower Old Red Sandstone strike almost N–S , and as they are traced in a northerly direction they are truncated by the, brighter red, Upper Old Red Sandstones which dip to the NW. The irregular contact between the two rock groups can be traced across the foreshore, and is particularly well seen at the low cliff on the upper part of the shore. In places along and sometimes above the unconformable surface there are faults above which the Upper Old Red Sandstone has been slightly rotated, and the unconformable surface has, in places been used as a plane of detachment—a fault along the surface of the unconformity.

There is not only a contrast in the colours of the two red sandstone units but the compositions of the clasts in the conglomerates are also different. The Lower Old Red Sandstone contains quartzite, vein quartz and volcanic rock fragments; but the Upper is particularly rich in vein quartz and greenschist.

This unconformable relationship is clearly not the sharp break seen in many other unconformities. One possible reason for this is that the Lower Old Red Sandstone was not fully indurated at the time the Upper was laid on top of it. If, as seems likely these Lower Old Red Sandstone rocks occur towards the top of the Lower Old Red Sandstone sequence, then they may not have been buried to a great depth before the Upper was laid over them. Pebbles and the dark-red sand from the Lower have been incorporated into the basal beds of the Upper and this, as well as the nature of the exposure, makes it difficult to clearly see the contact between them.

The sequence of events which must have taken place in order for this unconformable relationship to be established are as follows: after deposition of the Lower Old Red Sandstone the beds were tilted and those which were at the top of the pile, such as at Ardmore, may not have been fully consolidated. Either as they were tilted or after tilting they were eroded, probably by river action. New beds, the Upper Old Red Sandstone, were then laid on top this surface of erosion. These new beds, along with the underlying Lower Old Red Sandstone strata were then folded. It follows that before this second folding event the Lower Old Red Sandstone of Locality 2 had a very diffent dip than it now has: some of the beds there were dipping in the opposite direction.

Recently the B.G.S. have indicated that the beds which are referred to as Upper in this account are indeed Lower, and this unconformity is a local one within the Lower Old Red Sandstone sequence.

Locality 7. Upper Old Red Sandstone and soft sediment faulting

Rocks of the Upper Old Red Sandstone comprise an alternation of light red, cross-stratified sandstones and whitish conglomerates. The sandstones are cross-stratified, with larger scale cross strata than at Locality 2, and the conglomerates are finer grained than in the Lower Old Red Sandstone and have abundant vein quartz. The conglomerate beds are often channelled into the underlying sandstones with the relief on the channels being up to 1 metre.

These rocks, like the Lower Old Red Sandstone, were probably laid down by shallow braided streams which spread sediment in sheets over the alluvial plain surface. Cross-stratification indicates a southerly palaeoflow for these rivers, so a source from the north is indicated. The location and nature of that source is difficult to establish, but the abundant vein quartz and the associated greenschist and phyllite clasts suggest a source in low grade metamorphic rocks where there were abundant quartz veins. When metamorphic rocks of this kind weather in a source region, the phyllites and schists are usually broken down by chemical or physical action quite quickly, but the quartz veins are very resistant and remain intact. This results in a high concentration of the vein quartz and a loss of the host rock so that the gravels produced are greatly enriched in what may be the minor lithology of the source. The Dalradian Highlands to the north could well be the source of this Upper Old Red Sandstone sequence.

Particularly fine examples of faulting can be seen at this locality, most of which appears to be normal. A series of fractures oriented N–S displace the conglomerates and sandstones by c. 0.5 m. A more detailed examination of these fractures reveals that screens of conglomerate have been dragged down into the interleaved sandstone; the sandstone has been folded and deformed adjacent to the fracture and some of the elongate clasts have been re-orientated during the faulting so that they lie flat in the plane of the fracture. Some faults have sandstone sheets which have been injected up them. These observations suggest rather than prove that the sediment was poorly consolidated at the time of fracturing. Faults cutting Recent or unconsolidated Tertiary sediments are certainly accompanied by similar features.

Locality 8. Sandstone dykes

This locality is near the far northern end of the Ardmore Peninsula. The outcrop on the headland comprises alternations of sandstone and fine conglomerate. Some of the thin sandstones (c. 20 cm thick) cut across the bedding for short distances. These features are sandstone dykes which are formed when waterlogged sands liquefy and intrude upwards.

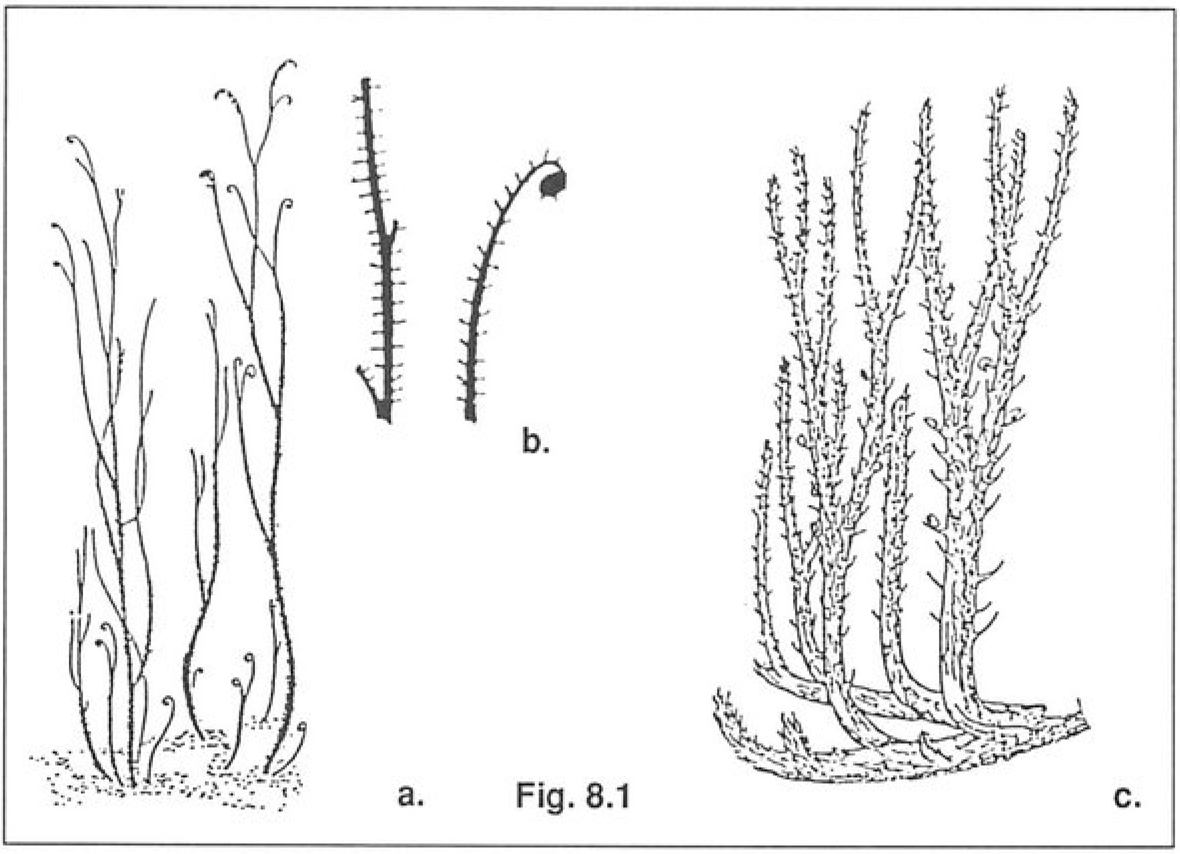
Follow the path adjacent to the fence and return to the road on the track indicated (Figure 8.2).

References

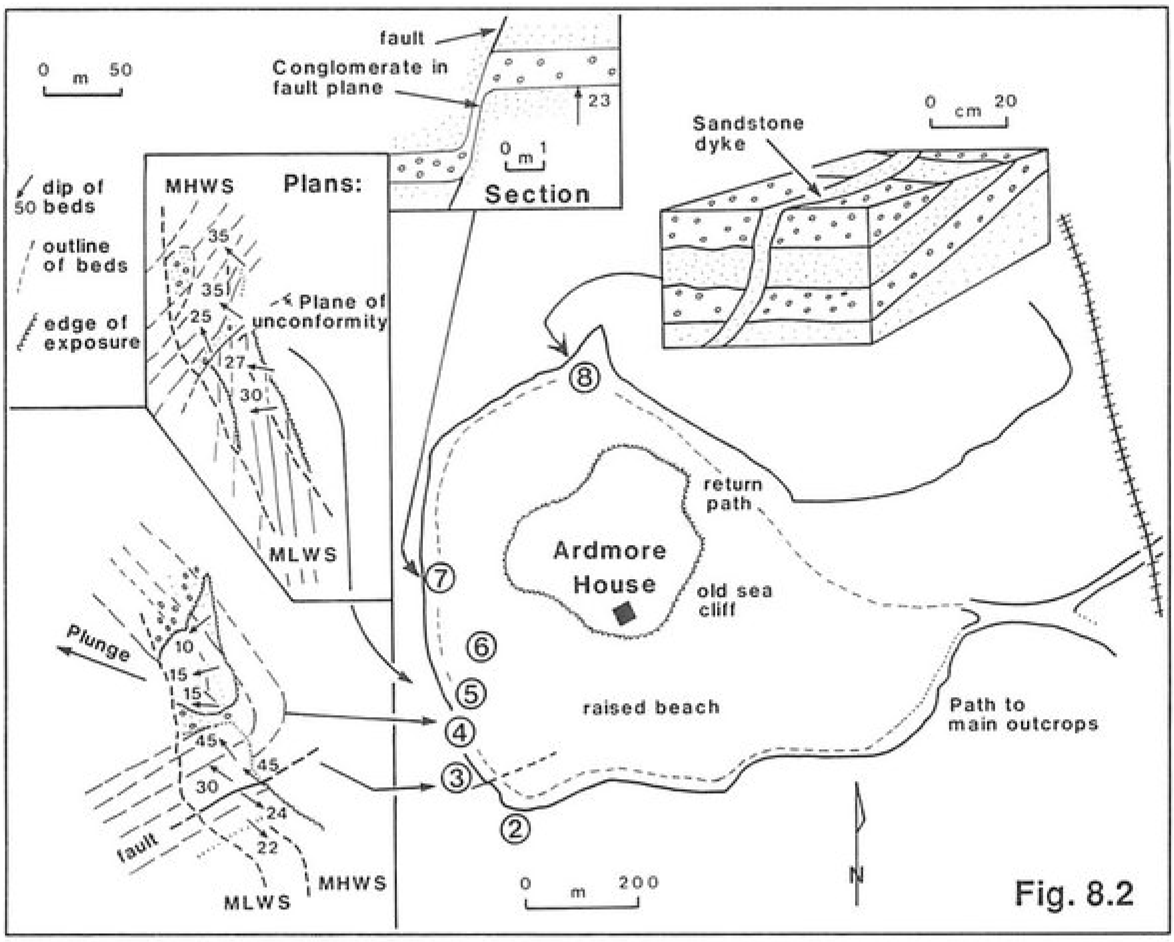
BLUCK, B.J. 1984. Pre-Carboniferous history of the Midland Valley of Scotland. Trans. Roy. Soc. Edinb. Earth Science. 75, 274–295.

RAYNER, R.J. 1983. New observations on Sawdonia ornata from Scotland Trans. Roy. Soc. Edinb. Earth Science. 74, 79–94.

SCOTT, A.C., EDWARDS, D and ROLFE, W.D.I. 1976. Fossiliferous Lower Old Red Sandstone near Cardross, Dunbartonshire. Proc. Geol. Soc. Glasgow. 117, 4–5.



(Figure 8.1) Plants from the Lower Old Red Sandstone of Auchensail Quarry. a. Sawdonia ornata (reconstruction, × 0.1), b. Sawdonia ornata (stems, × 0.05), c. Drepanophycus spinæformis (reconstruction, × 0.15) [Redrawn after Rolfe, 1976]



(Figure 8.2) Map, with illustrative sections and plans, of Ardmore Point.