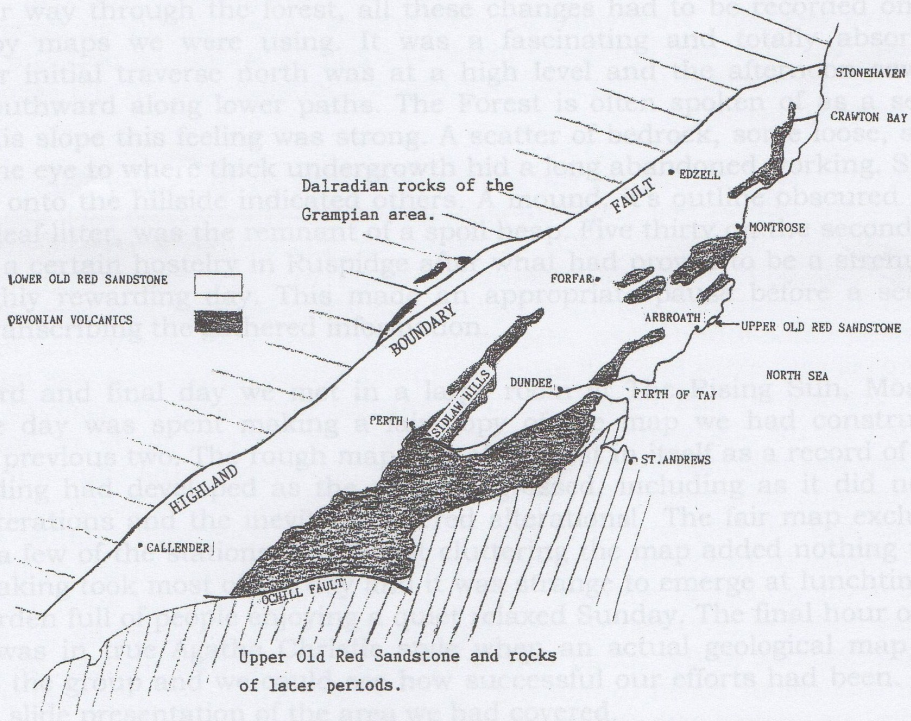
North and South of the Highland Boundary Fault

Some holiday observations

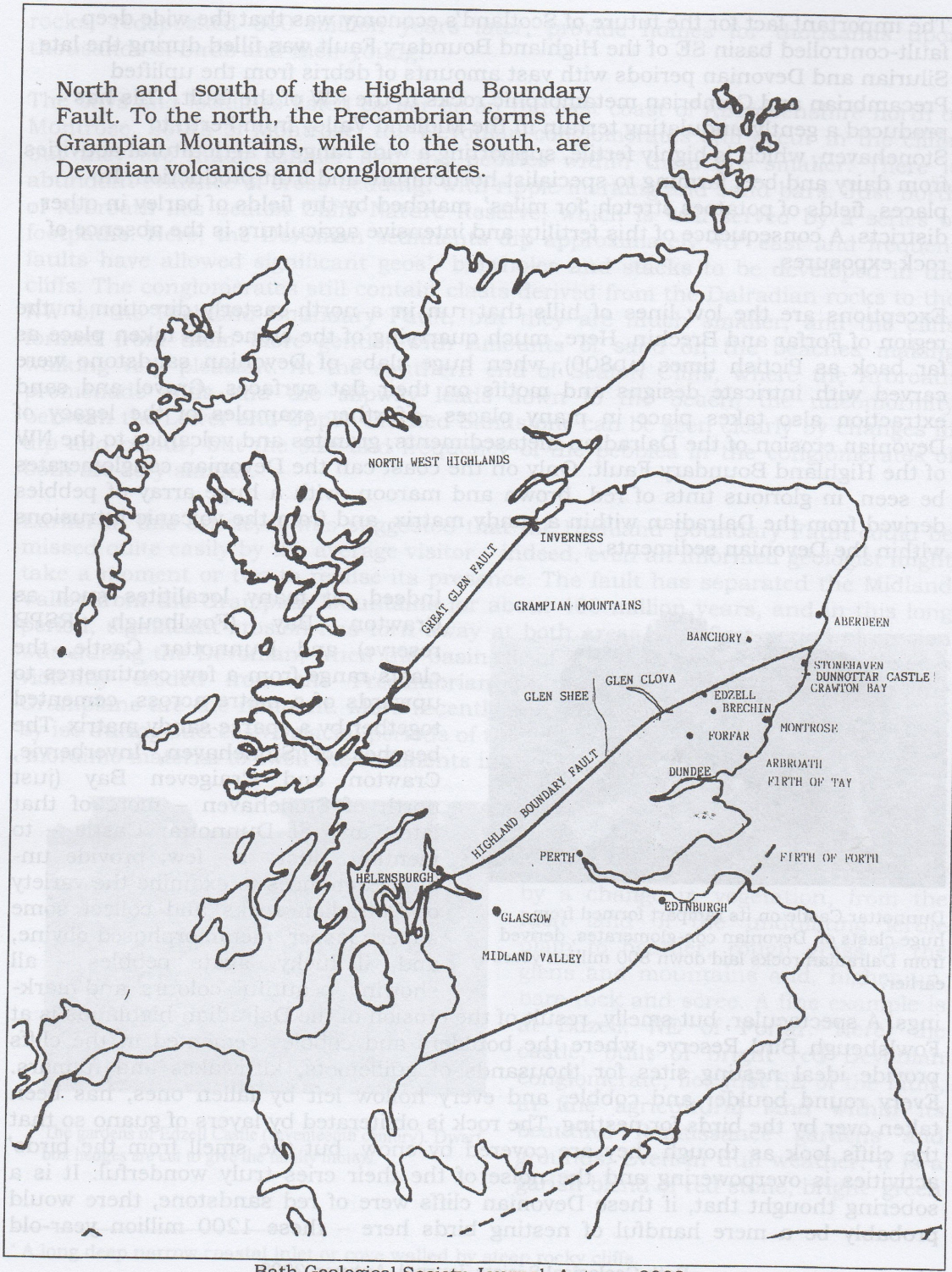
Charles Hiscock

Visitors to Scotland, particularly those in the NW who travel the roads from Fort William to Inverness, will be aware of the Great Glen Fault, so dramatic is its effect on the scenery, even though they may never consider the underlying geological history. Visitors to the Midland Valley and Grampian Mountain regions can, however, be forgiven if they overlook another of the important faults in Scotland's geological past, in spite of the fact that it has had a far greater effect on the economy of country than its northern counterpart. This fault is the Highland Boundary Fault, which runs from Stonehaven, a few miles south of Aberdeen, south-westerly to Helensburgh on the Firth of Clyde. Active at the same time as the Great Glen Fault, during late Silurian and Devonian times, the land to the SE dropped, forming fault bounded and controlled extensional basins. During the Carboniferous, volcanism occurred, which can now be seen as lines of hills (Ochill and Sidlaw Hills) and intrusions (King Arthur's Seat and Salisbury Crags, Edinburgh) to the SE of the



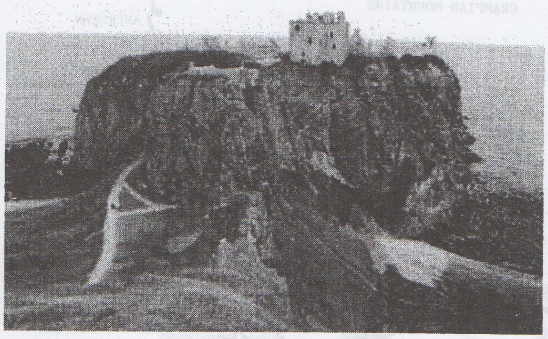
Distribution of rock types in the Midland Valley, SE of the Highland Boundary Fault.

North and south of the Highland Boundary Fault. To the north, the Precambrian forms the Grampian Mountains, while to the south, are Devonian volcanics and conglomerates.



The important fact for the future of Scotland's economy was that the wide deep fault-controlled basin SE of the Highland Boundary Fault was filled during the late Silurian and Devonian periods with vast amounts of debris from the uplifted Precambrian and Cambrian metamorphic rocks to the NW of the fault. This has produced a gently undulating terrain in the Midland Valley from Perth to Stonehaven, which is highly fertile, supporting a wide range of agricultural activities from dairy and beef farming to specialist horticulture and fruit production. In places, fields of potatoes stretch 'for miles', matched by the fields of barley in other districts. A consequence of this fertility and intensive agriculture is the absence of rock exposures.

Exceptions are the low lines of hills that run in a north-easterly direction in the region of Forfar and Brechin. Here, much quarrying of the stone has taken place as far back as Pictish times (AD800), when huge slabs of Devonian sandstone were carved with intricate designs and motifs on their flat surfaces. Gravel and sand extraction also takes place in many places – further examples of the legacy of Devonian erosion of the Dalradian metasediments, granites and volcanics to the NW of the Highland Boundary Fault. Only on the coast can the Devonian conglomerates be seen, in glorious tints of red, brown and maroon, with a huge array of pebbles derived from the Dalradian within a sandy matrix, and from the volcanic intrusions within the Devonian sediments.



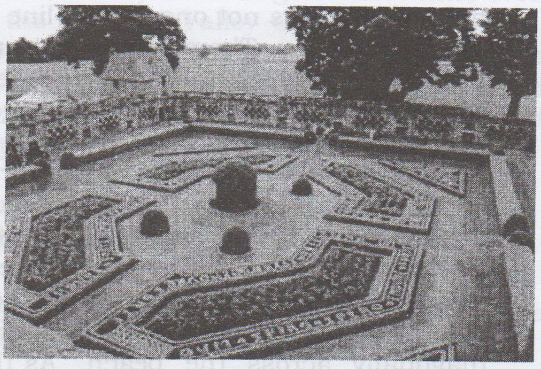
Dunnottar Castle on its rampart formed from huge clasts of Devonian con-glomerates, derived from Dalradian rocks laid down 800 million years earlier.

Indeed, at many localitites such as Crawton Bay (Fowlheugh RSPB reserve) and Dunnottar Castle, the clasts range from a few centimetres to upwards of a metre across, cemented together by a sparse sandy matrix. The beaches of Stonehaven, Inverbervie, Crawton and Craigeven Bay (just north of Stonehaven – more of that later) and at Dunnottar Castle – to mention just a few, provide unlimited chances to examine the variety of Dalradian rocks and collect some superb jasper, metamorphosed olivine, and, if lucky, agate pebbles – all showing beautiful colours and markings. A spectacular, but smelly, result of the erosion of the Dalradian highlands is at Fowlsheugh Bird Reserve, where the boulders and cobbles cemented in the cliffs provide ideal nesting sites for thousands of guillemots, kittiwakes and fulmars. Every round boulder and cobble, and every hollow left by fallen ones, has been taken over by the birds for nesting. The rock is obliterated by layers of guano so that the cliffs look as though they are covered by snow, but the smell from the birds' activities is overpowering and the noise of the their cries truly wonderful. It is a sobering thought that, if these Devonian cliffs were of red sandstone, there would probably be a mere handful of nesting birds here – these 1200 million year-old

rocks, redeposited 800 million years later, provide homes for thousands upon thousands of birds and their young.

The bays and localities listed earlier lie on the east coast of Aberdeenshire north of Montrose. South of Montrose, the Devonian conglomerates still occur in the cliffs, but they are much sandier and the pebbles within them are smaller. There is abundant evidence of cross-bedding, with ripple marking and sand bars. Just north of Arbroath lies Seaton Cliffs Nature Reserve, which is well served by a series of footpaths. Here, the Devonian sediments dip approximately 45° east and frequent faults have allowed significant geos*, blowholes and stacks to be developed in the cliffs. The conglomerates still contain clasts derived from the Dalradian rocks to the NW of the Highland Boundary Fault, but they are much smaller, and the cliffs formed from them more gentle, with amounts of sand on the beaches making walking very pleasant. At the southern end of Seaton Cliffs, where the Arbroath promenade ends and the slipway leads down to the beach, the unconformity between the Lower and Upper Old Red Sandstone can be seen clearly by changes in dip and colour, but the size and frequency of the pebbles in the conglomerates of both are very similar.

Earlier in this article, it was suggested that the Highland Boundary Fault could be missed quite easily by the average visitor – indeed, even an informed geologist might take a moment or two to realise its presence. The fault has separated the Midland Valley from the Grampian Mountains for about 400 million years, and in this long period, significant erosion has torn away at both areas. The first period of erosion was during the Devonian, when the basin SE of the fault was filled with sediments violently eroded from the Precambrian Dalradian mountains, of which the Grampians are the remnant. More recently, smoothing of the mountains and glens by ice during successive glacial periods of the Pleistocene produced large amounts of morainic material to swell the sediments in the Midland Valley and shaped the mountain, valleys and wide glens that we see today. These violent erosive force have disguised the path of the fault and its presence is marked only by a change in vegetation, from the lush land of the undulating fertile plain to heather, rough grass of the glens and mountains and, higher up, bare rock and scree. A fine example is at Edzell, NE of Forfar. Here, the castle, built of bright red Devonian conglomerate, lies just SE of the fault, in fine agricultural land within its beautiful Renaissance gardens and grounds. Even in dull weather, it is a garish blend of red stone, bright green



The gardens of Edzell Castle (seventeenth century). Dwarf box hedges are cut to give the family mottos.

* A long deep narrow coastal inlet or cove walled by steep rocky cliffs.

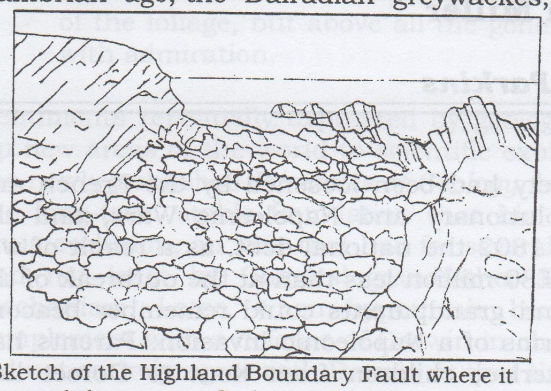
lawns and hedges with vivid displays of flowers. Yet, a quarter of a mile to the NW, one enters Glen Esk, with smooth rounded hillocks leading up to rolling mountain tops. The only trees lie in the wide open glen along the riverside and on the huge sandy moraines that line the glenside and fill the mouth of the glen. Indeed, it is on one of these moraines that the now vanished medieval village of Edzell was built. Higher up the glen, alpine conditions start to appear, and on the mountain tops in the distance, June snowfall picked out the upper edges of corries and leesides of the Grampians.

To the NW of the Highland Boundary Fault, the landscape is noticeably different, and the change can be seen by exploring the Angus glens – Glen Isla, Glen Esk and longest, Glen Clova. All are characterised by extensive sandy and gravely terminal moraines, wide valley bottoms with sinuous rivers surrounded by high rounded hills, which, as they get higher, become rougher as the central Grampian area is approached. From the end of the road in Glen Clova, smaller glens branch off into the mountains, which can be explored on foot. One such walk is to Corrie Fee at the head of Glen Doll, where the corrie is now a nature reserve containing many species of alpine plants. At its back, the burn pours over the cliff edge, falling down over the scree of Dalradian rocks and boulders. A huge variety of rock types, all metamorphosed sedimentary and volcanic rocks, can be found on the surface – evidence of the violence of the processes that have affected the Grampians over time. At the junction of Glen Doll and Glen Clova, high up on the side of the mountain, a glacial sandbank shows cross-bedding. These remote areas provide ideal habitats for wildlife – red squirrels, red and roe deer and, if one is lucky, golden eagles can be spotted soaring in the updrafts. These high mountain glens provide a nesting habitat for our only migrant blackbird, the ring ouzel, in the vertical rock faces and piles of scree.

Fowlsheugh RSPB Reserve: a geo formed by one of the branches of the Highland Boundary Fault.

To see the Highland Boundary Fault, one has to return to the coast. Like most faults, it is not one simple line of displacement. There are many branches, of which the easiest to see, and the most spectacular, is the geo that has been formed by the sea at Fowlheugh RSPB Reserve, just north of Crawton Bay. However, the main fault passes out to sea at Craigeven Bay, about 2 km north of Stonehaven. Here, the path of the fault can be seen clearly as it passes from the cliff, diagonally across the beach. As the fault is approached from Stonehaven, the beds of the late Silurian sediments of mainly yellow and brown fine sandstones strike across the beach, dipping slightly north of vertical. At the SE edge of the fault, the beds stop and a morass of jumbled rocks of the fault breccia form a lower

channel across the foreshore. On the NW side of the channel, jagged rocks of Cambrian age, the Dalradian greywackes, shales and volcanics of the Highland Boundary Series dip SE of vertical. These beds form a small headland from which the expanse of Craigeven Bay can be seen with the cliffs formed from brecciated and deformed strata, marking the main path of the fault. In the sketch of the Highland Boundary Fault where it crosses the coast at Craigeven Bay, the Dalradian beds (top left) are slightly overturned, dipping to the NW, while on the right, late Silurian rocks dip SE, and are separated by the fault breccia through the centre.



Sketch of the Highland Boundary Fault where it crossed the coast at Craigeven Bay, near Stonehaven.

Returning to Stonehaven from the bay, the fault path is crossed as it cuts into the cliff. On the south-eastern side, the late Silurian mudstones and sandstones are again reached and, in the cliff, the almost vertical beds show excellent ripple features while, nearby, another bed is covered with fossil sun cracks and rain spots – evidence of very shallow lacustrine waters that dried out on a regular basis. The locality, know as Cowie Harbour, has yielded fish remains in the past, as have other localities in the Old Red Sandstone from Stonehaven to Dundee. To the south of Stonehaven, the sandy Silurian beds are followed by the Devonian conglomerates, containing boulders up to a metre in diameter. Clearly, the quiet conditions of the late Silurian were very quickly superseded by the violence of the Devonian erosion as the Highland Boundary Fault continued its long epoch of movement. Later periods made their sedimentary and volcanic contributions, and followed much, much later by the ice ages. These later events were minor stages in the development of the Midland Valley compared with the movements of the fault in Silurian and Devonian times, and the violent erosion, particularly NW of the fault, that occurred at the same time and during the Carboniferous Period. In these quiet geological times and with the lush fertility that typifies the Midland Valley, it is difficult to appreciate its early history.

Bibliography

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