Lower Devonian, Midland Valley of Scotland

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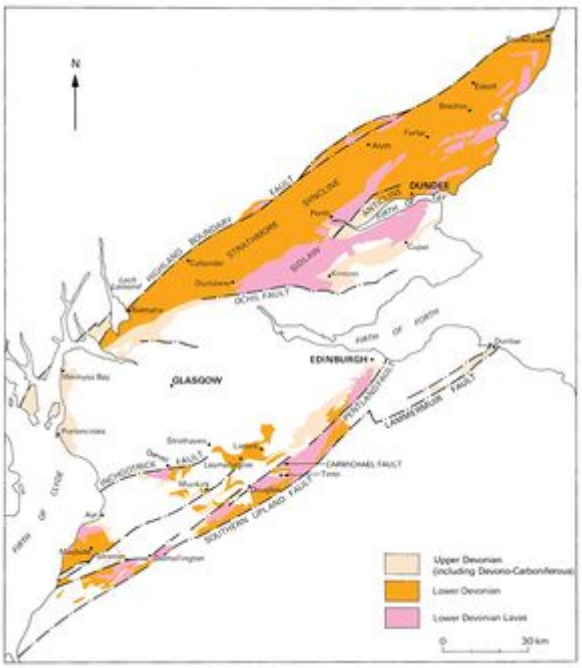

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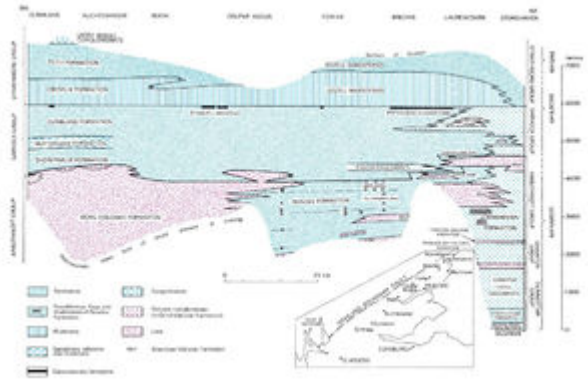

Lateral variation in the Lower Devonian on the SE limb of the Strathmore Syncline. P915521.

The Lower Devonian sediments were laid down in most areas on a surface of folded and eroded Lower Palaeozoic sediments and are molasse deposits which resulted from rapid erosion in the upland regions north and south of the main depositional area. The eroded material was washed down into the valleys, transported and deposited in the first instance as coarse valley-fill deposits within the mountains. The lighter fractions were carried farther and laid down in coalescing alluvial fans at the mountain front and more distally on the flood plains of braided and meandering rivers and in shallow lakes.

Andesitic, basaltic and more rarely rhyolitic lavas are intercalated with the sedimentary succession in many places. These are described in the next chapter. Contemporaneous erosion of the lavas provided a considerable proportion of the detritus incorporated into the sediments, especially in the southern part of the area.

One possible model of Lower Devonian sedimentation consists of two south-westerly flowing river systems, one in the northern part of the region and the other in the south, separated by volcanic uplands in the central part of the Midland Valley. Drainage from the mountains resulted in the formation of coarse piedmont fans in belts at the margins of the Midland Valley with a system of braided streams and flood plains draining the area towards the south-west (P915519). In

Kincardineshire there is evidence that the sediment was derived from the north-east and possibly the basin closed to the north-east. It has also been suggested that the main centre of deposition migrated towards the south-west with time, controlled by hinge movements on the Highland Boundary Fault (Bluck, 1978).

The outcrop distribution of the Lower Devonian rocks is shown in P915520. The major controls on the outcrop, but not on the original extent of deposition, are the Highland Boundary Fault and the Ochil Fault in the north, and the Southern Upland Fault and its associated faults in the south.

Fossils are not common in the Lower Devonian rocks but interesting material has been found in several fish-beds, notably in the Forfar–Letham–Brechin area. The fauna includes the arthropods *Kampecaris* and *Pterygotus* and the fish *Cephalaspis, Climatius, Mesacanthus* and *Pteraspis.* The plants include *Arthrostigma, Parka, Psilophyton* and *Zosterophyllum.* Spore assemblages from various horizons have given some indication of the ages of the beds sampled.

Northern part of the Midland Valley

The Devonian strata in the northern part of the Midland Valley are folded into a broad syncline and anticline with their axes roughly parallel to the Highland Boundary Fault. The Strathmore Syncline, which lies to the north-west of the Sidlaw Anticline is asymmetrical. The north-west limb of the syncline is steep and locally overturned in the vicinity of the Highland Boundary Fault, but the south-east limb is gently inclined. The axis of the syncline extends from Stonehaven south-westwards to Loch Lomond and the Clyde Estuary.

The Sidlaw Anticline is almost symmetrical and its axis runs from Montrose south-westwards to meet the Ochil Fault near Tillicoultry.

The subdivisions of the Lower Devonian in the Strathmore area are given in P915521, the total sequence being about 7500m thick. This figure is reduced to about 4000m in the Callander–Dunblane area where the lowest two subdivisions have been cut out by overlap. The lateral extent of the basal two subdivisions along the axis of the basin is unknown.

Dunnottar Group

The Dunnottar Group is the oldest of the Lower Devonian subdivisions and is well exposed on the coast south of Downie Point, near Stonehaven.

Dunnottar Group subdivisions		
Tremuda Bay Volcanic Formation	Olivine-basalt lavas	60 m
Dunnottar Castle Conglomerate	Coarse conglomerate mainly of metamorphic rocks	1035 m
Strathlethan Formation	Grey sandstone with andesitic lava and agglomerate	350 m
Downie Point Conglomerate	Coarse conglomerate mainly of metamorphic rocks	170 m

The basal formation, the Downie Point Conglomerate, rests with an erosive base, but without apparent angular discordance on the Stonehaven Group of the Silurian. The conglomerate consists of well-rounded boulders, up to 0.6 m across, mainly of metamorphic rocks including quartzite and schistose grit. This contrasts with the content of the conglomerates in the underlying Stonehaven Group which are predominantly acid volcanic rocks.

The remainder of the Dunnottar Group is mainly very coarse conglomerate with boulders up to 1m

across of quartzite and schist. The top part of the group consists of olivine-basalt lavas, but the full thickness of these is not known.

Crawton Group

The Crawton Group rocks are best exposed in coastal sections north and south of Inverbervie.

The rocks consist principally of conglomerates of metamorphic rocks and locally of volcanic detritus. The maximum development is seen on the coast south of Stonehaven where the following subdivisions can be seen:

Crawton Group, south of Stonehaven		
Crawton Volcanic Formation	Distinctive olivine-basalt or basaltic andesite lavas	0–30 m
Whitehouse Conglomerate	Mainly coarse conglomerate of metamorphic rocks	60–300 m
Gourdon Formation	Mainly coarse dull and pebbly sandstones	150–365 m
Rouen Formation	Mainly coarse conglomerate of metamorphic rocks	185–215 m

The Crawton Volcanic Formation is known only in the north-eastern part of the area, but an approximate correlation has been made with a ‘quartz porphyry’ at Glenbervie and the ‘Lintrathen Porphyry’ near Alyth which have been shown to consist of ignimbrite. The Lintrathen Porphyry has given a radiometric age (411 ±6 Ma) which places it close to the Silurian/Devonian boundary on the current radiometric time scale. Near Dunkeld the ignimbrite rests directly on Dalradian rocks indicating that the Dunnottar Group and most of the Crawton Group as seen to the north-east have been overlapped in this part of the Highland border area by the uppermost part of the Crawton Group.

Arbuthnott Group

The Arbuthnott Group occurs on the north side of the Strathmore Syncline between Stonehaven and Loch Lomond, on the south side of the syncline from Stonehaven south-eastwards to the Ochil Fault at Tillicoultry and on the south-east limb of the Sidlaw Anticline.

The group is subdivided into four strikingly diachronous formations including coarse conglomerates at the Highland Border which are considered to be the lateral equivalents of the volcanic formations of the Ochil and Sidlaw Hills. The relationships are shown on P915521.

The Johnshaven Formation, in the north-east of the area, consists of conglomerates made up of metamorphic and igneous rocks. At its maximum it is about 1800 m thick. Its lateral equivalent further to the southwest is the Dundee Formation which is up to 1500 m thick. It consists of medium- and coarse-grained, cross-bedded sandstones with intercalations of flaggy lacustrine sandstones which were formerly an important source of paving stones and roofing tiles.

The Montrose Volcanic Formation consists of several lenticular masses of olivine-basalt and andesitic lava interbedded with the Johnshaven and Dundee formations.

In the Ochil Hills the Arbuthnott Group consists almost entirely of andesitic and basaltic lavas with beds of volcanic detritus comprising the Ochil Volcanic Formation which may be up to 3000 m thick.

There are a number of important fish-bearing horizons within the lacustrine flagstones particularly in the Forfar, Letham and Brechin area. These include the Aberlemno, Tillywhandland, Canterland Den and Den of Dun fish-beds.

Garvock Group

The outcrop of the Garvock Group occurs on both limbs of the Strathmore Syncline from near Edzell to Loch Lomond on the north side, and from Stonehaven to Bridge of Allan on the southern limb. It also forms an outcrop on the south limb of the Sidlaw Anticline on the coast north and south of the Tay estuary.

Around Laurencekirk the strata consist of conglomerates of both metamorphic and volcanic rocks, and lava flows of basalt and andesite occur at several horizons. In the Forfar–Brechin area, the conglomerate is largely replaced by brown, cross-bedded sandstones. Calcareous detritus of intra-formational origin occurs in the sandstones and there is a thin but persistent concretionary limestone near the top of the group in the Brechin area which is possibly equivalent to similar limestone occurrences at Stanley, near Perth, and at Dunblane. The limestone is a caliche type of deposit which is sufficiently persistent laterally to be of value as a stratigraphical marker.

Strathmore Group

The Strathmore Group occupies the core of the Strathmore Syncline and its outcrop extends from Laurencekirk to the Firth of Clyde.

In the north-east, around Edzell, the group consists of a lower formation called the Edzell Mudstones and an upper formation, the Edzell Sandstones. The mudstone formation is estimated to be about 1200 m thick and consists of red and green mottled, poorly bedded mudstone with beds of sandstone and siltstone. The sandstone formation consists of pale red sandstone, pebbly in places and up to 600 m thick.

On the north-west side of the syncline a thick group of coarse conglomeratic sediments called the Gannochy Formation intervenes between the Edzell Sandstone and the Edzell Mudstones and largely replaces them.

In the Dunblane and Callander area the stratigraphy is broadly similar. A lower mudstone and siltstone formation called the Cromlix Formation represents the Edzell Mudstones and is overlain by the Teith Formation which is predominantly arenaceous.

On the north-west of the syncline, around Callander, the sediments are predominantly arenaceous, but at Uamh Bheag, north-east of Callander, the sandstones are overlain by conglomerates containing clasts of both metamorphic and volcanic rocks.

Western Midland Valley

In the Loch Lomond area, the Lower Devonian rocks have been correlated with the Strathmore, Garvock and Arbuthnott groups of Strathmore and are believed to be about 800m thick (Morton, 1979). However an interpretation of the gravity measurements suggests a thickness in the range 1500 to 1800m (Qureshi, 1970).

The oldest Lower Devonian rocks seen in the area belong to the Balmaha Conglomerate which consists of cobbles and pebbles of quartzite in the lower part and pebbles of quartzite and lava higher up. The conglomerates are overlain by sandstone with beds of conglomerate.

At Portencross, on the north Ayrshire coast, the oldest sediments are the Sandy’s Creek Beds which are tectonically disturbed grey sandstones and siltstones. Spores from these beds indicate a Lower Devonian age but the beds could be older.

The younger Portencross Beds, which are about 450 m thick, consist of brownish sandstones with lenticular, irregular intercalations of conglomerate containing pebbles of quartzite mainly, with lesser quantities of chert, sandstone and lava.

Southern part of the Midland Valley

In the much faulted tract in the south of the region, Lower Devonian rocks occur in a number of outcrops which extend from the Pentland Hills in the east to Dalmellington and Maybole in the south-west. The detailed stratigraphy of the rocks is not well known.

In the Pentland Hills the Lower Devonian strata rest with angular unconformity on Silurian rocks. The sediments consist of about 600 m of coarse greenish grey conglomerates and coarse pebbly sandstones. The content of the conglomerate consists of pebbles of greywacke, chert and jasperised lava and they tend to be coarser towards the base of the succession. The sediments thin towards the north-east where they interdigitate with and are replaced by a sequence of lavas and tuffs up to 1800 m thick, varying in composition from basalt to rhyolite. The lavas are probably equivalent in age to part of the sedimentary sequence, but there is no palaeontological evidence for the age of these rocks.

The outcrop continues to the south-west in a strip between the Southern Upland Fault and the Carmichael Fault. The Lower Devonian rocks in this area can be subdivided into three groups. The Greywacke Conglomerate at the base is overlain by a group of lavas which in turn is succeeded by another group of sandstones and conglomerates.

The Greywacke Conglomerate is exposed north and south of Tinto Hill where it is very coarse. In addition to greywacke it contains pebbles of quartz, jasper and chert.

The lavas consist mainly of basalts and andesites with some trachytes, but a rhyolite breccia occurs near West Linton. Lavas are present in the succession along the entire length of the outcrop from West Linton to Corsencon Hill, near New Cumnock.

The strata overlying the lavas consist of purplish and green micaceous feldspathic sandstones and conglomerates containing clasts of volcanic rock. The youngest preserved component of the sequence is a very coarse volcanic conglomerate called the Dungavel Conglomerate. The sandstones and conglomerates occur in two outcrops contained in a syncline parallel to the Southern Upland Fault.

In the Lanark area to the north-west of the Carmichael Fault, the Greywacke Conglomerate rests without apparent discordance on the Silurian rocks. It is about 450 m thick in the southern part of the area and it thins rapidly north-westwards to about 8 m west of Lesmahagow. The conglomerate passes up into medium- and coarse-grained sandstones with sporadic pebbly horizons. There are no lavas in the Lower Devonian outcrop in the Lanark area, north-west of the Carmichael Fault. The Greywacke Conglomerate and the overlying sandstones are probably equivalent to the sediments below the lavas elsewhere and the lavas have either been completely eroded or were never present in this area.

Lavas reappear in the sequence south of Darvel. The sediments below the lavas form an outcrop around Distinkhorn where they consist of red and purplish, cross-bedded feldspathic sandstone with a conglomerate at the base and are about 670 m thick. The content of the conglomerate is mainly greywacke, but there are also pebbles of quartz, quartzite, chert, jasper and acid igneous rocks. The conglomerate rests on Silurian rocks with apparent conformity.

In south-west Ayrshire there are two main areas of outcrop of Lower Devonian rocks. The Maybole outcrop extends from the Carrick Hills south-westwards to Girvan, and the Dalmellington outcrop extends south-westwards from Dalmellington in a zone parallel to the Southern Upland Fault.

In the Dalmellington outcrop the Lower Devonian strata are seen to rest unconformably on folded and eroded Ordovician and Silurian strata and are themselves folded and faulted. In the Maybole outcrop the base of the sequence is not seen and the strata dip fairly gently to the north-west.

The succession consists of a lower sedimentary group overlain by lavas. The sediments at Maybole are at least 420 m thick but could be as much as 1200 m thick. They consist principally of reddish, purple or brown micaceous and feldspathic sandstones with conglomerates developed in the lower and upper parts of the exposed sequence. The lower conglomerate contains pebbles, mainly of greywacke, chert, jasper and felsitic porphyry, and the upper conglomerate has a content of chert, acid igneous rocks, sandstone and quartzite with only subordinate amounts of greywacke.

In the Dalmellington area the sedimentary group is 515 to 665m thick. It consists of a basal conglomerate, 150 to 180 m thick, sandstones with subordinate beds of conglomerate and mudstone, 335 to 425 m thick and an upper conglomerate, 30 to 60 m thick. The conglomerates consist mainly of greywacke pebbles with chert, jasper and acid igneous rocks. The basal conglomerate at Dalmellington may be the lateral equivalent of the lower conglomerate at Maybole.

The lava sequence at Dalmellington is estimated to be about 600m thick and in the Carrick Hills it is 300 to 450 m thick.

Bibliography

Armstrong, M. and Paterson, I. B. 1970. The Lower Old Red Sandstone of the Strathmore region. Rep. Inst. Geol. Sci., No. 70/12.

Bluck, B. J. 1978. Sedimentation in a late orogenic basin: the Old Red Sandstone of the Midland Valley of Scotland. In Bowes, D. R. and Leake, B. E. (editors). 1978. Crustal evolution in northwestern Britain and adjacent regions. Spec. Issue Geol. J., No. 10.

Bluck, B. J. 1980. Evolution of a strike-slip fault-controlled basin, Upper Old Red Sandstone, Scotland. In Sedimentation in oblique slip mobile zones, pp. 63–78. Reading, H. G. and Ballance, P. F. (editors). Spec. Publ. Int. Assoc. Sedimentol., No. 4.

Bluck, B. J. 1983. Role of the Midland Valley of Scotland in the Caledonian orogeny. Trans. R. Soc. Edinburgh: Earth Sci., Vol. 74, pp. 119–136.

Chisholm, J. I. and Dean, J. M. 1974. The Upper Old Red Sandstone of Fife and Kinross; a fluviatile sequence with evidence of marine incursion. Scott. J. Geol., Vol. 10, pp. 1–30.

Downie, C. and Lister, T. R. 1969. The Sandy’s Creek Beds (Devonian) of Farland Head, Ayrshire. Scott. J. Geol., Vol. 5, pp. 193–206.

House, M. R., Richardson, J. B., Chaloner, W. G., Allen, J. R. L., Holland, C. H. and Westoll, T. S. 1977. A correlation of Devonian rocks of the British Isles. Spec. Rep. Geol. Soc. London, No. 7, 110 pp.

Lumsden, G. I. 1982. Devonian strata in Scotland. Rep. Inst. Geol. Sci., No. 82/1. Miles, R. S. 1968. The Old Red Sandstone antiarchs of Scotland: Family Bothriolepididae. Palaeontogr. Soc. (Monogr.),

No. 552, (Vol. 122).

Morton, D. J. 1979. Palaeogeographical evolution of the Lower Old Red Sandstone basin in the western Midland Valley. Scott. J. Geol., Vol. 15, pp. 97–116.

Mykura, W. 1960. The Lower Old Red Sandstone igneous rocks of the Pentland Hills. Bull. Geol. Surv. G.B., No. 16, pp. 131–155.

Qureshi, I. R. 1970. A gravity survey in the region of the Highland Boundary Fault in Scotland. Q.J. Geol. Soc. London, Vol. 125, pp. 481–502.

Read, W. A. and Johnson, S. R. H. 1967. The sedimentology of sandstone formations within the Upper Old Red Sandstone and lowest Calciferous Sandstone Measures west of Stirling. Scott. J. Geol., Vol. 3, pp. 242–267.

Richardson, J. B. 1967. Some British Lower Devonian spore assemblages and their stratigraphical significance. Rev. Palaeobot. Palynol., Vol. 1, pp. 111–129.

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