Excursion 2 Thornhill: a small Permo-Carboniferous basin

By A.A. McMillan

OS 1:50 000 Sheet 78 Nithsdale 6- Annandale

BGS 1:50 000 sheets 9E Thornhill, 15E Leadhills

Route map: (Figure 13)

Main points of interest Permian and Carboniferous stratigraphy; desert sandstones and breccias; Coal Measures and Lower Carboniferous strata; sandstones, siltstones and mudstones; marine fossils; Permian basalt lavas.

Logistics A whole day should be assigned to this excursion if all the localities are visited. Alternatively it may be possible to combine part of the excursion with some localities around Dumfries (Excursion 9). A good starting point is the town of Thornhill where there are shops and public conveniences. A coach can be driven to all the localities mentioned but some roads are single track and turning space is limited. Most localities involve relatively easy walks of 2–3 km on tracks. Locality 4 involves a steep valley side descent and re-ascent. Wellingtons or boots are advised since some of the best exposures are stream sections.

Introduction At Thornhill (Figure 13) rocks of Permian and Carboniferous age occupy a fault-bounded basin orientated north–south and 18 km long (Pringle and Richey, 1931). Smaller outliers, which once formed part of a larger basin, are present to the east. The highest of these (presumed to be Coal Measures) lies some 350 m above sea level. The basin forms an important link between the Solway and Midland Valley basins (Figure 8). A particularly interesting transition is seen within the Lower Carboniferous sequence, where lithological variation at the northern and southern margins of the Thornhill basin may indicate differences in sedimentation imposed by local barriers to marine transgression. Other interesting features include a recognizable Coal Measures sequence, comparable with that in the adjacent Sanquhar Basin to the north, but thinner and without the coals. Excellent examples of Permian desert dune sandstones, basalt lavas and alluvial channel deposits can also be seen.

1 Park Quarry, Croalchapel: Closeburn Limestone Formation

From Closeburn take the Loch Ettrick road as far as Croalchapel and park at the entrance to the old Park Quarry [NX 907 913] (Figure 14). There is room here for several cars or a coach. The quarry is one of several in the area which formerly worked the Closeburn Limestone. Sir James Kirkpatrick established the Closeburn Lime-works in 1772 for the purpose of providing lime for land improvement, and for some years he had to overcome a widely held prejudice that liming was actually bad for the ground. As described many years later (1828) by James Stuart Menteath:

'... so general was the opinion of the injurious consequences of lime laid on the ground for agricultural purposes, that the proprietor, in order to introduce its use, obliged his tenants in their leases, to lime a certain quantity of land yearly, he furnishing the lime, and even paying for the carriage; and the tenants for their parts, were bound to pay 5s. additional rent for every 80 measures of lime, the quantity considered sufficient for an acre.'

Unfortunately the limestones are no longer visible but the upper part of the Closeburn Limestone Formation, of Lower Carboniferous (Brigantian) age, can be examined in Park Quarry. On accessing the quarry, **proceed carefully** to the degraded quarry faces near the remains of the old water wheel. Note also that the deep, **steep-sided quarry hole is water-filled so** stay well clear. The exposed strata comprise thinly bedded micaceous sandstone and siltstone overlying red and fossiliferous, micaceous silty mudstone. The strata dip gently east into the quarry face.

The mudstone has yielded the following marine fauna (after Brand, 1990): brachiopods: *Buxtonia* sp., *Pleuropugnoides* sp., *Productus* sp. *Schellwienella* sp. bivalves: *Donaldina* sp. *Retispira?, Leiopteria thomsoni, Modiolus* sp., *Polidevcia attenuata, Schizodus* sp., *Wilkingia* cf. *elliptica* echinoid: *Archaeocidaris* spines and fragments.

The underlying strata, no longer exposed, include two limestones originally worked. These appear to be present only at the south margin of the Thornhill Basin. The upper limestone was magnesian and poorly fossiliferous; the lower was so compact that it could only be worked with the aid of gunpowder. It was this limestone which yielded spectacular large fossils, several specimens of which are curated in the Royal Museum of Scotland. The fauna includes nautiloids, orthocones, gastropods, brachiopods and corals indicating a marine environment in which the sea was relatively free of terrigenous material. These rocks represent an incursion of the Lower Carboniferous sea across the Southern Uplands and perhaps indicate the first occasion when the Midland Valley was linked by a seaway with the Solway Basin.

The limestone was worked at both Croalchapel and Park Quarries and also at Barjarg and Porterstown, west of the River Nith. When the thickness of overburden became too great for quarry development, underground mining took place. Menteath (1828) reported that at the Closeburn mine:

'... strong pillars of nearly 6 square yards are left standing, as supports for the roof of the mine, which is high enough to admit the miner to stand erect at his work; and between the pillars the space of 30 feet is excavated.'

The remains of the great water wheel can still be seen at Park Quarry. Waggons laden with limestone were raised by the water wheel up an inclined iron railway from the excavation to the top of the kiln. The water was then channelled down a clay bed to a lower level where it fell on another wheel that put in motion the pump which drained the mine and at the same time drove a mill for sawing timber. Menteath noted:

'... The water after these useful applications, is next conveyed away for irrigation.'

Coal had to be brought for the kilns from Sanquhar or further afield for, although the Thornhill Basin contains Coal Measures, no coal is present.

2 Crichope Linn: Coal Measures and Permian strata

Crichope Linn lies 3 km east of Thornhill and about 4 km north of Croalchapel. The Linn is approached by a well-marked path from the narrow road linking Gatelawbridge with Closeburnmill. An area nearby at the back of Newton Quarry [NX 907 955] (Figure 15), one of several old sandstone quarries at Gatelawbridge, serves as a parking place for several cars. It is also possible to take a coach to this locality but note that the roads are narrow and single tracked.

Situated near the eastern margin of the Thornhill Basin, Crichope Linn is a narrowgorge cut by the Crichope Burn in the Thornhill Sandstone Formation of Permian age. The Permian strata rest unconformably upon Coal Measures rocks which are seen downstream of the gorge.

Follow the path upstream on the north bank of Crichope Burn. Several stream sections in Coal Measures strata demonstrate some of the lithological characteristics of the sequence, which is best known from the core of the Crichope Linn Borehole put down by the BGS in 1962 (Davies, 1964; McMillan and Brand, 1995).

Biostratigraphical evidence from fossil nonmarine 'mussels' identifies most of the exposed sequence as Middle Coal Measures. The top few metres may be Upper Coal Measures if a *Lingula*-bearing mudstone discovered in a tributary burn is equivalent to the *Aegiranum* Marine Band.

The strata consist of interbedded reddened mudstone, seatearth, siltstone and fine-grained sandstone. The mudstones are reddish purple to lilac with green-grey reduction spots. They contain plant stems, layers of nodular ironstone and occasional ribs of gypsum. Listric surfaces are common. The siltstones are also lilac or greenish grey and are commonly micaceous. They contain sandy laminae and plant fragments. Seat-earths are typically mottled lilac, green and red and, despite alteration, contain roots. Former coal seams may now be represented by thin deep red, iron-rich mudstones above the seatearths. The sandstones are mostly greyish white with red staining; they are fine grained, thinly bedded and micaceous with small-scale ripple lamination. The deep weathering which has affected these strata (and possibly caused alteration of original thin coals) may be attributed to circulating groundwaters beneath an arid early Permian land surface (see Bailey, 1926; Mykura, 1960).

Continuing upstream, Permian red sandstone is best seen beside the path leading to the narrow Crichope Linn gorge. The unconformity between Coal Measures and Permian strata is not currently exposed but was proved in the nearby borehole, where the lowest Permian bed was a coarse-grained sandstone 1.4 m thick, with rounded pebbles of quartz and flakes of red mudstone indicating fluviatile origin. This was overlain by brick-red, medium-grained, cross-bedded aeolian sandstone. The walls of the 30 m deep gorge are cut in the sandstone; Brookfield (1978, pp.132–134) used this locality as his type section for the Thornhill Sandstone Formation, which he interpreted as a desert dune deposit. The formation is characterised by well-sorted, well-rounded, fine- to coarse-grained quartz sandstone in tabular to wedge-shaped cross-stratified sets. Visitors may **proceed with care** further upstream past the spectacular narrow gorge; **the path can be wet and slippery** in places. The gorge has a number of historical associations, in particular with the Covenanters, and was the scene of the famous confrontation between Burley and Morton in Sir Walter Scott's Waverley Novel *Old Mortality.* The theme of Scott's novel was influenced by the career of Robert Paterson (1715–1801), 'Old Mortality', a stonemason and stone carver who held a lease on one of the Gatelawbridge red sandstone quarries which were worked for building stone from the 17th century until after the First World War. Gatelawbridge stone was used extensively both locally and in cities including Glasgow and Edinburgh. Recently Scottish Natural Stones Ltd extracted stone from the same lithological unit in Newton Quarry for use in Edinburgh at the new Financial Centre, Castle Terrace and the Edinburgh Solicitors Property Centre, 81 George Street.

Retrace the path to the Gatelawbridge–Closeburnmill road.

3 Jenny Hair's Bridge, Durisdeer: Permian lavas, breccias and sandstones

Some 7 km north of Thornhill near the north margin of the Thornhill Basin, sections at Jenny Hair's Bridge provide a good opportunity to see some of the basal Permian sedimentary rocks and lavas. Limited car parking is possible at Jenny Hair's Bridge [NS 886 024] on the road leading from the A702 to Durisdeer (Figure 16). From the bridge a short round trip of 0.5 km downstream along the Carron Water enables the principal lithologies to be examined. This and several other localities are described in a field guide by Brookfield (1981). In this northern part of the basin and in the small outlier of Locherben to the east (Figure 13) the basal Permian strata comprise stream-flood breccias interbedded with thin olivine-basalt lava flows of the Carron Basalt Formation. The overlying breccias, fluviatile sandstones and siltstones of the Durisdeer and Locherben Breccia formations (Brookfield, 1978, pp.132–134; 1980, p.191, figs. 5 and 7) are interpreted as sheetflood desert floor deposits. These pass up into aeolian dune sandstones, the Thornhill Sandstone Formation, as seen previously at Locality 2.

Under Jenny Hair's Bridge, when the water is low, it is possible to examine flat-lying coarse- and fine-grained red sandstones with fragments of basalt lava. Sand grain shapes vary from subangular to subrounded; rare rounded grains are present. The strata are interpreted as shallow-water stream channel deposits derived from local sources.

Some 250 m downstream on the east bank, stream channel deposits and interbedded sand dune deposits overlie lavas. The deposits comprise mainly coarse-grained, subangular to angular, red-stained quartz sand interbedded with sandy breccia, and include a few well-rounded grains. They also incorporate large blocks of amygdaloidal basalt which have been picked up locally. A few metres downstream, a small gorge is cut in the underlying amygdaloidal basalt. The lavas were erupted during small-scale rifting which took place in late Carboniferous to early Permian times. Similar volcanic rocks are present in the Permian basins at Mauchline (Mykura, 1967), Ballantrae and Loch Ryan (Stone, 1988) and in the Lochmaben basin.

At the junction of a small tributary, some 50 m farther downstream, there is a well-exposed, thin sequence of gently dipping breccia interbedded with coarse-grained red sandstone. The clasts in the breccia appear to be dominantly angular greywacke with a small proportion of basalt.

Evidence from all these localities indicates a local source for the sediment. At that stage there was only limited input from the desert dune sands which later came to dominate the sequence.

4 Enterkin Burn: early Namurian marine mudstone

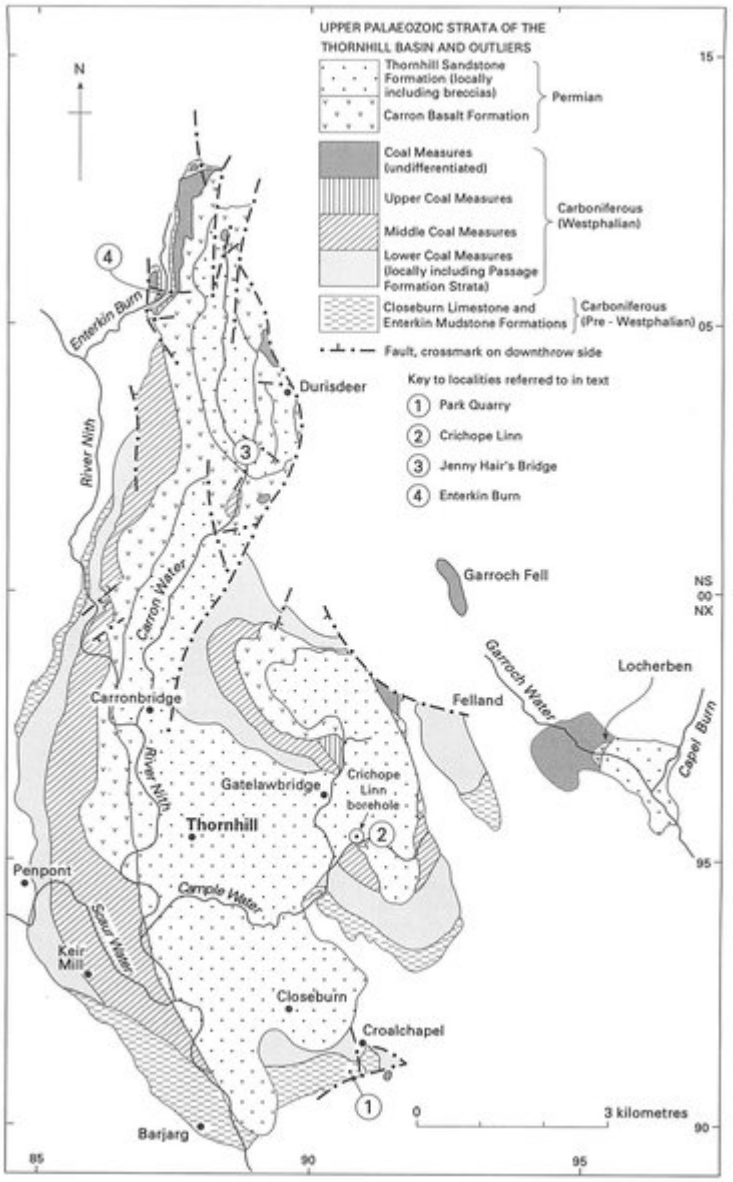
Enterkin Burn, about 3 km NNW of Jenny Hair's Bridge, exposes fossiliferous Carboniferous strata resting unconformably on Ordovician turbidites at the northern extremity of the Thornhill Basin. Limited car parking is available at the junction [NS 874 046] between the farm track to Inglestone and the footpath to Wanlockhead (Figure 17). From here visitors should proceed north on the Wanlockhead track for about 0.5 km before descending westwards down the steep valley side of the Enterkin Burn.

The valley side comprises a scarp of weathered basalt lava flows resting on poorly exposed Coal Measures. The base of the Coal Measures is best seen on the SE bank of the Enterkin Burn [NS 8726 0542] where it is marked by a coarse-grained sandstone with quartz pebbles. This lies unconformably on about 2.5 m of sandstone, which rests on fossiliferous mudstone (Simpson and Richey, 1936). The beds below the unconformity belong to the Enterkin Mudstone Formation, which is exposed in several places in the Enterkin Burn. This formation consists of a thin, gently dipping sequence of purplish red sandstone and seatearth interbedded with deep purple-red, fossiliferous siltstone and mudstone. On biostratigraphical grounds, these strata could be as young as early Namurian, although a Brigantian age is also possible. A few metres downstream, sandstone underlying the fossiliferous beds rests unconformably upon steeply dipping Ordovician greywacke turbidites and shales.

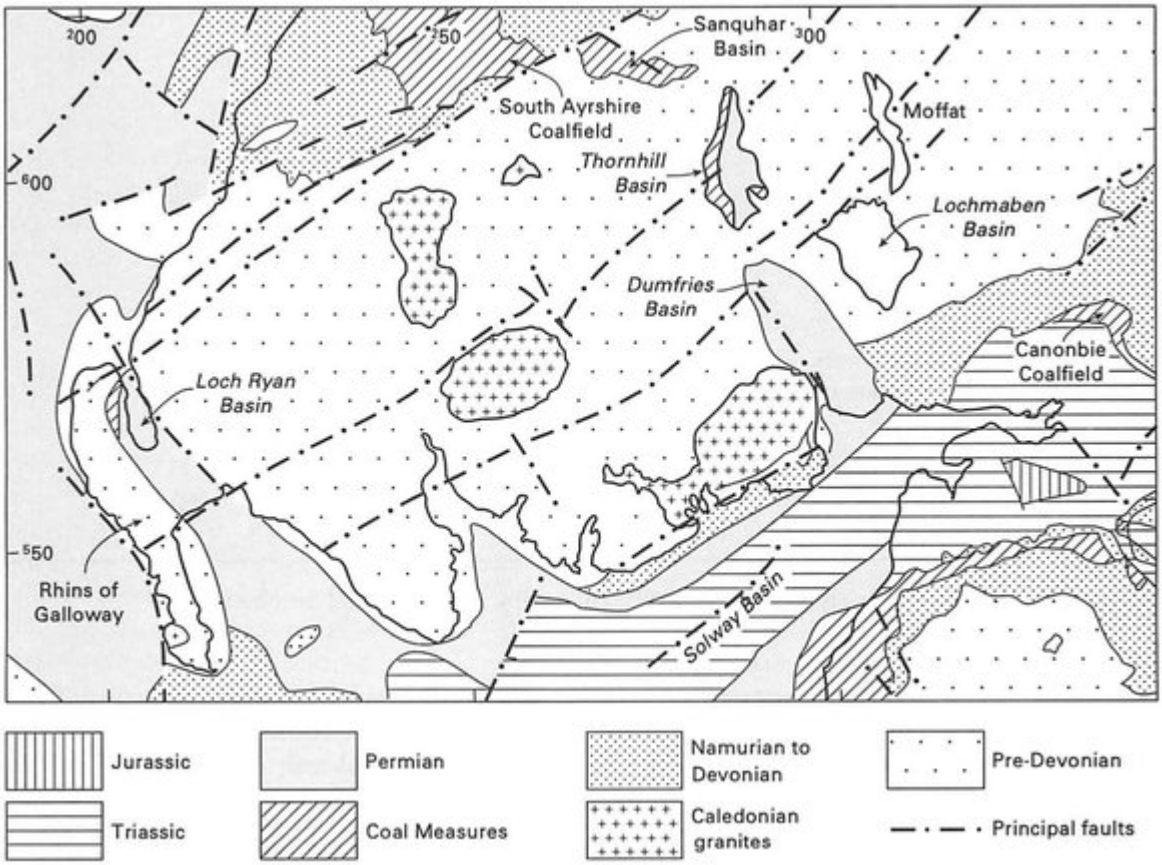
The fossiliferous Enterkin Mudstone Formation beds contain a rich and varied fauna (Brand, 1990) including: brachiopods: *Buxtonia* sp., *Composita* sp., latissimoid productoids, *Pleuropugnoides* sp., *Productus* sp., *Pugilis* sp., *Retispira decussata* bivalves: *Aviculopecten* cf. *interstitialis, Edmondia* sp., *Leiopteria* cf. *thompsoni, Limipecten* sp., *Parallelodon* cf. *semicostatus, Pernopecten* sp., *Polidevcia attenuata, Schizodus?, Wilkingia?* Nautiloids, orthocones and trilobite pygidia have also been found.

Aspects of the fauna are common to the north margin of the Thornhill Basin and the Sanquhar Basin to the north (Davies, 1970), suggesting that in the late Carboniferous the marine influence of the Midland Valley was being felt as far south as Thornhill.

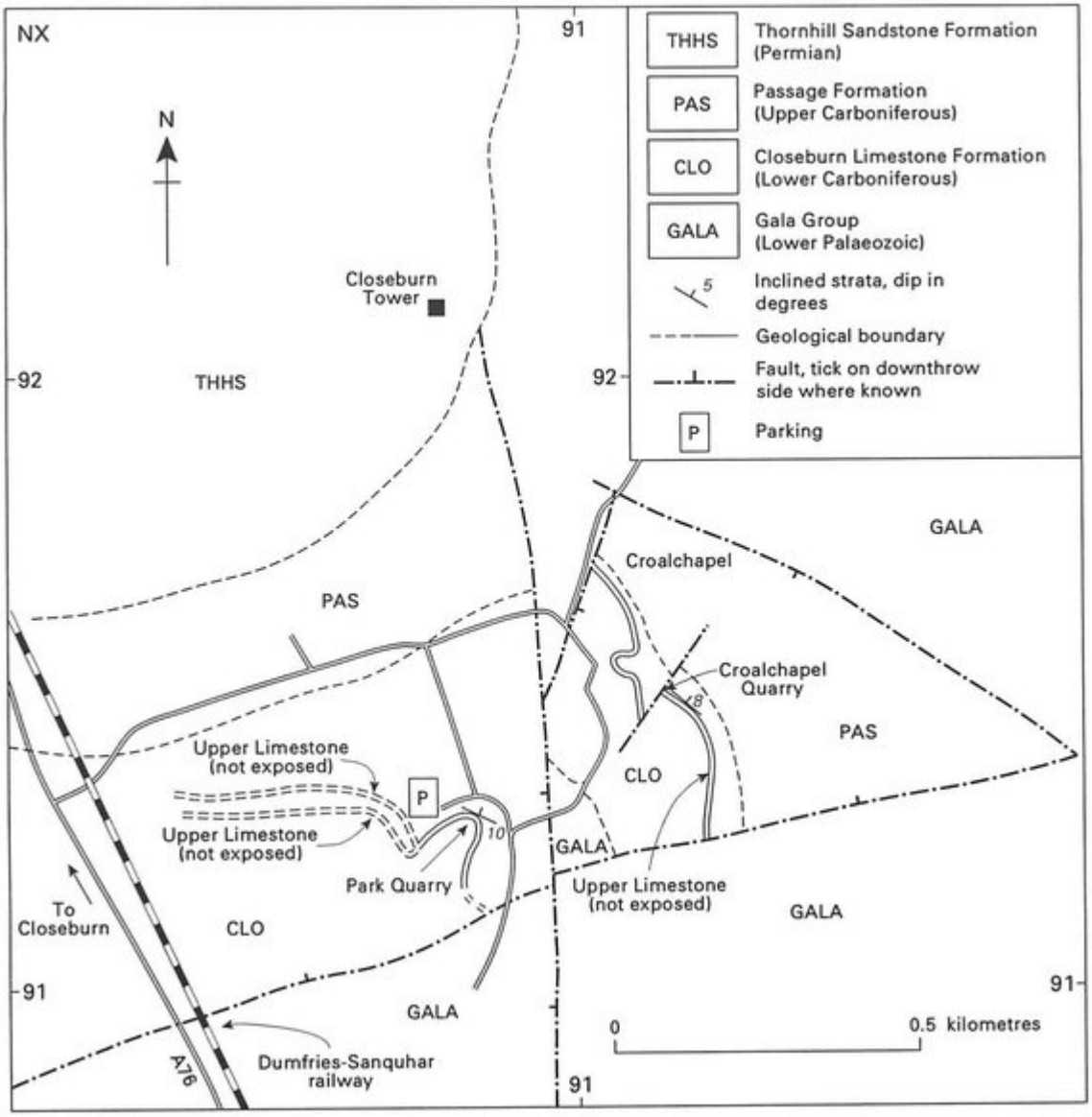
References



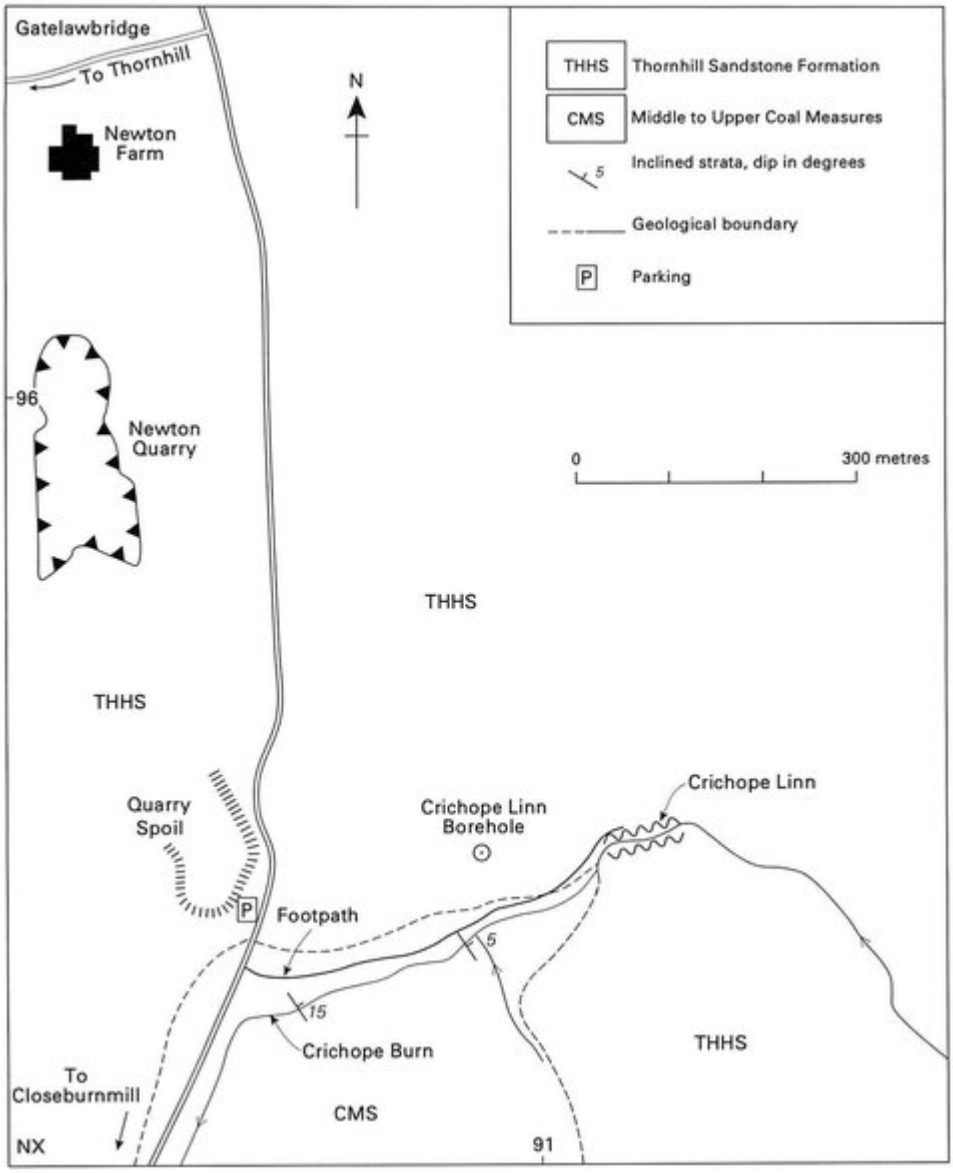
(Figure 13) Locality map and outline geology for the Upper Palaeozoic succession of the Thornhill basin



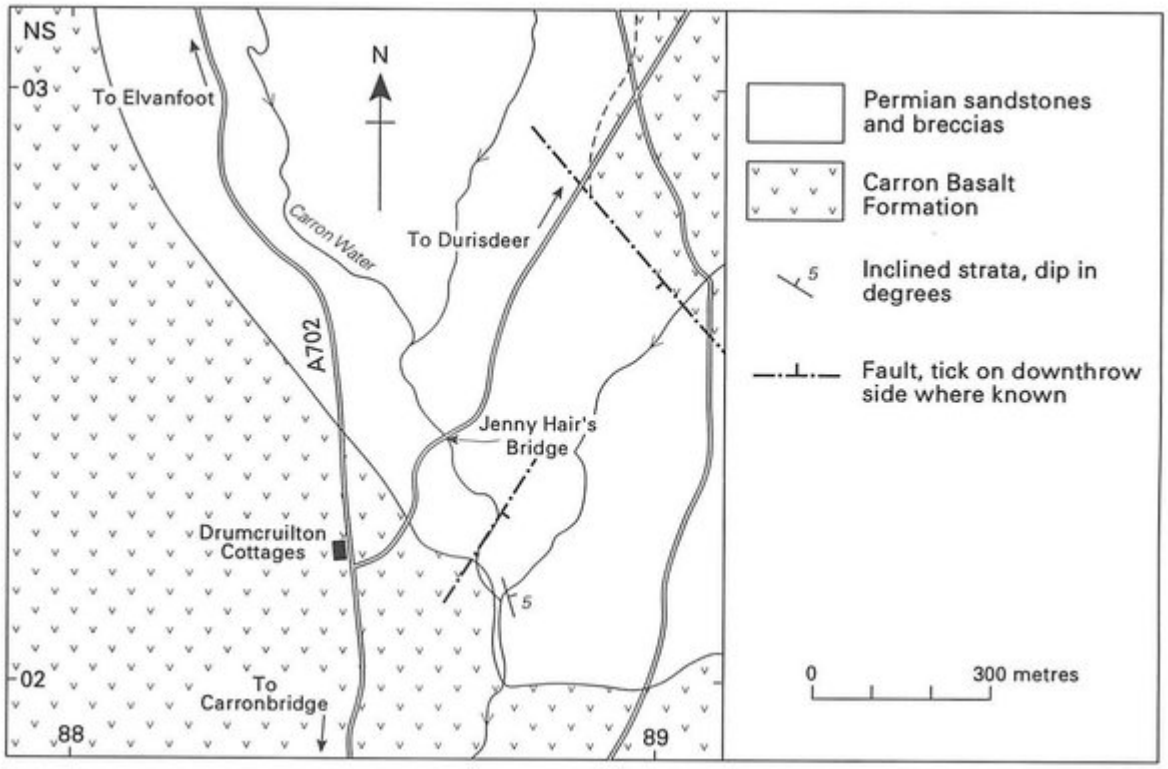
(Figure 8) Upper Palaeozoic geology in south-west Scotland.



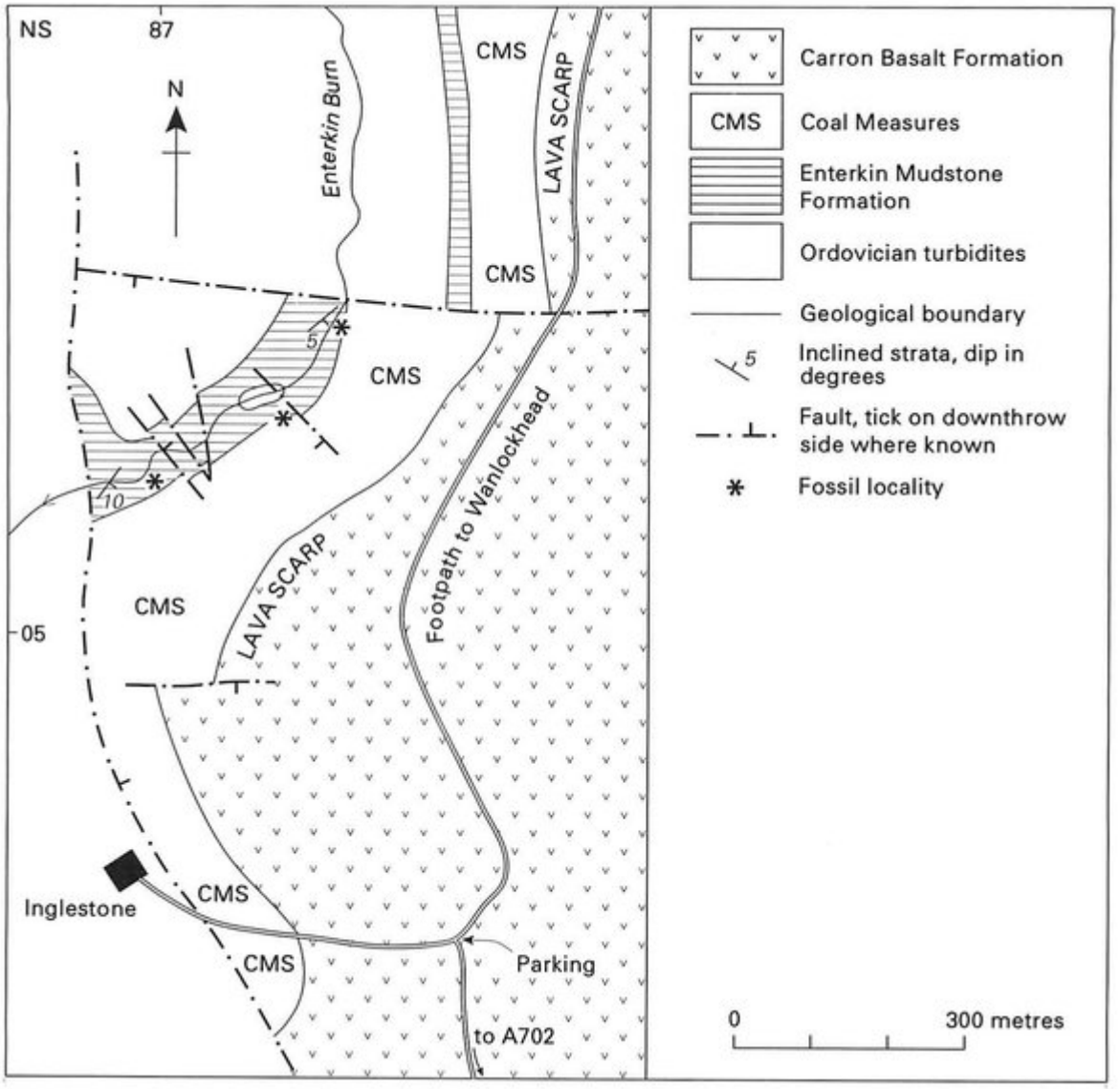
(Figure 14) Park Quarry (Locality 1: Closeburn Limestone Formation).



(Figure 15) Crichope Linn (Locality 2: Coal Measures and Thornhill Sandsrone Formation).



(Figure 16) Jenny Hair's Bridge (Locality 3: Permian sandstone, breccia and basalt).



(Figure 17) Enterkin Burn (Locality 4: Enterkin Mudstone Formation).