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## Chapter 23 IV. The Southern Belt. Wenlock and Ludlow

Along the southern margin of the Silurian Tableland a narrow belt of territory is occupied by rocks of Wenlock and Ludlow age, which rest conformably on the underlying Tarannon sediments to the north, and pass underneath the Upper Old Red Sandstone and Carboniferous strata to the south. A small development of these rocks is to be found on the promontory of Burrow Head, Jest of Wigtown Bay, their extreme south-westerly limit. From where they reappear on the shores of Kirkcudbright Bay, eastwards to the granite mass of Bengairn, they occupy a strip of ground about two miles and a half broad. From the margin of the Red Sandstone basin at Dumfries, they can be traced as stn irregular belt, about five miles wide, north-eastwards by Gockerbie to MossPaul, and thence to the Slitrig Water, which joins the Teviot at Hawick. Beyond these limits they appear on the northern slopes, and even on the crest of the Cheviots as inliers among younger Palaeozoic rocks, ranging from the Lower Old Red Sandstone to the Carboniferous systems.

**Burrow Head, Wigtownshire.** — [NX 45767 34023] The exposures on this rocky headland, though difficult of access, are of considerable interest, because at one or two localities the finest specimens of *Cyrtograptus Murchisoni*, the zonal graptolite of the Lower Wenlock beds, have been collected by the Geological Survey from this horizon. A further attractive feature of this coast is the evidence supplied by the range of sea-cliffs of the perfect passage from the underlying Tarannon rocks to the base of the Wenlock formation.

The shore section from the Isle of Whithorn southwards, affords a typical development of the Hawick Rocks, which there consist of alternations of greenish greywackes, mudstones, and green and grey shales, with zones of purple shales. The greywackes become more massive, till near. Morrach Farmhouse flaggy greywackes alternate with zones of mudstones and shales, the whole series being repeated by normal and isoclinal folds. The general dip of the strata and of the tidal planes of the flexures is towards the south-east.

Immediately to the south of Morrach Farmhouse [NX 46756 34798] this series is succeeded by green and grey greywackes and shales with bands of dark graptolite shales, similar to those which are so well developed on the shores of Kirkcudbright Bay, to be referred to presently. At a point on the coast, named "The Thieves' Hole" on the six-inch map [NX 46439 34430], half a mile north-east of Burrow Head, the graptolite shales appear at the base of the cliff, interbedded with grey shales and greywackes, and dipping towards the south-east at an angle of about 70°. Traced along the strike towards Burrow Head, these shales are seen at the "Devil's Bridge" [NX 46208 34139] and one or two other accessible points, where they yield a similar assemblage of graptolites.

The best place for collecting graptolites will be found on the shore about 400 yards west from Burrow Head, and about 100 yards west from an old fort, now in ruins [NX 45440 34153], where the fossiliferous band dips towards the south-east at high angles, and is associated with greywackes and grey argillaceous shales. Here fine specimens of *Cyrtograptus Murchisoni* can be obtained. The fossils given in the annexed list have been collected from this exposure by the Geological Survey:

*Cyrtograptus Murchisoni* (Carr.)

*Cyrtograptus Carruthersi* (Lapw.)

*Monograptus Flemingi* (Salter.)

*Monograptus priodon* (Bronn.)

*Monograptus vomerinus* (Nich.)

*Monograptus* sp.

*Retiolites geinitzianus* (Barr.)

*Heliolites* (?)

Crinoid stems.

*Aptychopsis elongata* (Jones.)

*Ceratiocaris* sp.

*Orthoceras* sp.

**District between the Dee and the Nith.** — From the Geological Map of the Silurian Tableland, which accompanies this volume, it will be seen that the representatives of the Wenlock and Ludlow rocks of the Silurian system occur on both sides of Kirkcudbright Bay, whence they stretch eastwards by Dundrennan [NX 74977 47761] to the granite of Bengairn [NX 77023 54612]. A strip of altered strata belonging to the same series is traceable along the shores of the Solway Firth to the hill slopes south-east of Criffel. The character of the rocks is admirably seen on the coast sections, specially on the east side of Kirkcudbright Bay, and onwards to White Port, where they are unconformably overlain by the basement breccias of the Lower Carboniferous series.

The strata may be grouped in two sub-divisions, given here in descending order:

(b) Green and olive shales with limestone nodules, grey sandy flags, and thin-bedded greywackes, with occasional bands of fossiliferous grit and conglomerate.

(a) Yellow and brown-crustured greywackes and grits, with flags and shales. The chief characteristic of this group is the constant occurrence in it of dark shales charged with graptolites.

The members of the lower group (a) occur on both sides of Kirkcudbright Bay. On the eastern shore they extend from the base-line at Long Robin [NX 67228 45865] to near the mouth of Balmae Burn [NX 68347 43821], presenting a constant repetition of well-bedded greywackes, grits, and flags with pale and dark coloured shales. On weathered surfaces, the greywackes have a brown tint; in fresh fracture they are grey and blue. The average thickness of each bed varies from one to two and sometimes to three feet. The pale-coloured shales are argillaceous, and are frequently cleaved, the cleavage-planes trending in the same general direction as those of the Hawick type of the Llandoverly group already described. The graptolite bands differ lithologically from the black shales of the Moffat series. Weathering with a dark brown crust, they have a dark colour on fresh fracture, and also a fibrous texture. They sometimes occur in zones from ten to twelve feet in breadth; and, on the other hand, it occasionally happens that thin leaf-like seams, charged with graptolites, alternate with the barren pale-coloured shales and flags of the group. At one locality, on the shore near Witchwife's Haven, about half a mile south of Long Robin, limestone nodules occur in one of these graptolite bands.

This lower sub-division of the Wenlock beds is repeated by rapid folds, as was long ago pointed out by Professor Harkness. <ref>Quart. Jour. Geol. Soc., vol. ix., p. 183.</ref> The plications are so numerous that no well-marked axis can be traced inland from the shore. Indeed, from the frequent changes of dip, it is evident that the various outcrops of graptolite-shale are merely repetitions of a few bands. Towards the south, in the broader synclinal folds, the members of the overlying subdivision are to be found. The exposures of the graptolite-shale group on the cliff at Clinking Cove, west of Raeberry Castle [NX 69794 43732], and again, still further to the south-east, in Mulloch Bay [NX 71422 43661], are evidently due to anticlinal folds, the intervening areas being occupied by younger strata.

Few species of graptolites occur in the graptolitic bands. They include *Monograptus vomerinus*, *M. priodon*, *M. riccartonensis*, *M. colonus* (?), *M. Flemingi*, *Cyrtograptus Murchisoni*, and *Retiolites geinitzianus*. Fragments of crustaceans and orthoceratites are associated with the graptolites. The carapace of a crustacean — *Aptychopsis oblata* (Jones) — was found in one of the graptolite-bands immediately to the south of Torr's Cove Bay. Many of the orthoceratite remains are so fragmentary that the species are hardly determinable. The best specimens have been obtained near the Witchwife's Haven, Torr's Point, and Balmae Haven. The strata associated with the graptolite-bands have hitherto yielded no organic remains.

The members of the lower sub-division also occur on the west side of Kirkcudbright Bay, round the shores of Balmangan [NX 65577 45603] and Falbogue Bays [NX 64238 44408], in the peninsular tract of Meikle Ross and in the island of Little

Ross [NX 65946 43263]. Here, also, they present the same features as those already indicated, and they have yielded similar organic remains. Near the base, on the shore, one-third of a mile north of Balmangan Bay, *Cyrtograptus Murchisoni* is one of the characteristic forms.

The graptolite-bearing group has been traced from the east shore of Kirkcudbright Bay to the contact zone round the granite of Bengairn. At various places throughout this belt of ground, graptolites have been obtained from the dark bands. No fossils have been exhumed from the strip of altered Upper Silurian strata along the Colvend shore; but graptolites and orthoceratites have been found in the Wenlock beds in the Kirkbean Burn to the south-east of Criffel.

The members of the higher group (b) are admirably seen on the shore between the mouth of Balmae Burn and Howell Bay, along the Raeberry cliffs, and between Mulloch Bay and White Port. The most prominent among them are green and olive shales, with fossiliferous limestone-nodules and ripple-marked sandy flags. These are occasionally associated with sandstones, grits, and bands of fossiliferous conglomerate. They seem to have been deposited in shallow water on a shelving platform, subject to gentle earth-movements. The fossiliferous brecciated conglomerates, intercalated with the olive shales, are evidently old beach-deposits. The gradual thinning out of the sandstones and grits, and the overlapping of the flags and shales, point to repeated changes in the distribution of the materials by currents along the shore.

From the small trough north of Gipsy Point [NX 68360 43683], the following is the arrangement of the strata, between the Balmae Burn and the reappearance of the graptolite-bearing bands in Howell Bay. Immediately to the north of the mouth of Balmae Burn [NX 68361 43835], a fault occurs with a down-throw to the west. On the east side of this fault, the strata consist of brown-crustured greywackes, shales, flags, and graptolite-bands, dipping to the south-east at 70°. These are succeeded by green fissile shales, with bands of flaggy shale from two to three inches thick. For a short distance the beds are inclined to the north at high angles, being here inverted, but they soon dip to the south-east at an angle of 80° till at the mouth of Balmae Burn they pass underneath a lenticular band of fine conglomerate, which may be the attenuated representative of the fossiliferous conglomerate at Gipsy Point, on the south side of the trough.

Southwards, this conglomerate is overlain by olive shales and flags, intersected with veins of calcite, which, within a short distance, have a return dip to the north-west at high angles. Here a zone of finely laminated olive shales, with limestone-nodules, is exposed on the shore, succeeded by ripple-marked greywackes, flags, and shales, graduating into the coarse grits and conglomerates at Gipsy Point. At this locality some excellent examples of the gradual thinning out of bands of grit are visible on the beach and on the cliff. Two outcrops of conglomerate at this headland lie about 70 yards distant from each other. The matrix of the rock is a grey grit, in which are embedded pebbles of greywacke and grit, with angular pieces of shale and rounded grains of quartz. The north band of conglomerate has yielded casts of *Pterinea* and *Petraia*; and the south band *Petraia elongata*, *Favosites*, casts of *Heliolites*, *Spirifera*, *Ptilodictya*, *Cornulites*, and a fragment of a trilobite.

Between these outcrops of fossiliferous conglomerate lies a zone of gnarled green shales containing lenticular patches of coarse grit and numerous nodules of limestone, which measure from a few inches to a foot across, and have yielded some of the best-preserved fossils. Similar shales reappear on the south side of the southern outcrop of conglomerate at Gipsy Head, veined abundantly with carbonate of lime. They dip to the north-west at angles of from 83° to 88°, and can be traced along the shore to the centre of Howell Bay. Among the fossils obtained from the limestone-nodules may be mentioned *Orthonota*, *Murchisonia obscura*, *Ctenodonta*, *Cucullella*, and *Bellerophon trilobatus*.

In the centre of Howell Bay this group of olive shales, with limestone-nodules and fossiliferous conglomerates, is brought into conjunction with the underlying graptolite-bearing group by means of a fault with a down-throw to the west. Here the strata are traversed by several small faults which have interfered with the natural stratigraphical sequence. On the cliff on the east side of the bay, the graptolite-bearing beds are inclined to the north-west; while east of the headland, towards Clinking Cove [NX 69057 43595], the prevalent dip is to the south-east. These beds are apparently brought to the surface along an anticlinal fold traceable eastwards to the centre of the bay west of Raeberry Castle [NX 69772 43739]. The strata consist of brown-crustured greywackes with shaly partings, and the characteristic graptolite-shales. The latter are best seen at Brandy Craig on the east side of Howell Bay, where they have yielded specimens of *Monograptus vomerinus* and *Dictyocaris*. The occurrence of *Monograptus vomerinus* close to the olive mudstones and shales with limestone nodules is worthy of note, as it is one of the forms that occur in the higher graptolite-bands in the Wenlock

group of the South of Scotland.

In the centre of the bay, west of Raeberry, the graptolite-bearing group is much disturbed by faults, and has been thrown into a series of sharp folds. It is traversed by a number of intrusive dykes, of which only a few could be engraved on the one-inch map. On the east side of the bay, the strata have a persistent dip to the south-east, in the direction of Raeberry Point, where they consist of ripple-marked micaceous sandstones, flags, and olive shales. The thinning out of the gritty sandstones is well displayed on the beach at this locality, and occasionally small seams and pockets of sand may be observed in the shales. At Raeberry Point a beautiful specimen of *Orthoceras Etheridgei* (Blake) was found in the flaggy shales with limestone-nodules; indeed, upwards of fourteen examples of this species were here obtained. Professor Harkness also found specimens of *Terebratula lacunosa* and *T. semisulcata*.

From Raeberry Point eastwards to the mouth of Dunrod Burn [NX 70693 43569], the shore affords a continuous section of grey flaggy sandstones, in beds averaging from six to twelve inches in thickness, flaggy shales, and green fissile shales. A zone of olive shales with small limestone nodules occurs immediately to the west of Robb's Craigs, in the centre of which a band of coarse grit forms a prominent feature on the beach. A striking characteristic of the sandstones and flags on the beach at Raeberry is the prevalence of ripple marks. The cliffs display excellent examples of rapid folds and inversions, and of variations in direction of dip along the same line of strike.

The strata just referred to are not prolonged eastwards into Mulloch Bay [NX 71418 43666], in the centre of which the graptolite-bearing strata appear, forming skerries on the beach. Well preserved graptolites have here been obtained from the dark bands associated with the greywackes. It is evident, therefore, that a fault intervenes with a downthrow to the west, separating the graptolite shales from the Raeberry Castle beds.

The section exposed on the beach from the mouth of the Quartercake Burn on the side of Mulloch Bay, south to Nether-law Point and onwards to White Port, closely resembles that between the mouth of the Balmae Burn and Howell Bay already described. The beds are inclined to the west of north, and there is a similar descending series from the olive shales with limestone-nodules at the mouth of the Quartercake Burn [NX 71612 43761] to the fossiliferous conglomerate and associated shales at Netherlaw Point [NX 71792 43369]. At the White Port [NX 72265 43393] the green shales have been reddened by the infiltration of iron oxide from the overlying red breccias at the base of the Carboniferous system.

The members of the upper sub-division are also exposed at Abbey Burnfoot [NX 74368 44430], in the lower reaches of the Abbey and Netherlaw Burns [NX 73974 44808], and also in the Dunrod Burn north of Burnside. A band of fine brecciated conglomerate, exposed at the farmhouse of Little Balmae, has yielded the following organic remains:

*Petraia elongata*

*Petraia bina* (Lons.)

*Favosites* sp.

*Stenopora (Favosites) fibrosa* (Goldf.)

*Syringopora*.

*Heliolites* sp.

*Encrinite* stems.

*Cornulites* sp.

*Ptilodictya* sp.

*Phacops caudatus* (Brun.)

*Spirifera* sp.

*Leptaena sericea* (Sow.)

*Orthis calligramma* (Dalm.)

*Orthis Bouchardi* (Dav.)

*Pterinea* sp.

*Murchisonia* sp.

In a review of the palaeontological evidence obtained from the strata overlying the Tarannon Rocks in Kirkcudbright Bay, it is clear that the graptolites, though numbering few species, are of great service for purposes of correlation. The fossils collected by Mr. Fleming and the Rev. Mr. Underwood, and forwarded to the Geological Society of London by the Earl of Selkirk, led Mr. Salter to the conclusion that the strata are of Wenlock age — a view which was confirmed by the evidence obtained by Professor Harkness. There can be no doubt that the graptolite-bearing group belongs to this division of the Silurian system. As already indicated, the lowest graptolite-band on the west side of Kirkcudbright Bay yields *Cyrtograptus Murchisoni*, and the highest bands in contact with the olive shales with limestone-nodules, *Monograptus vomerinus*. But from some of the fossils obtained from the limestone-nodules, it is probable that the upper group (b), comprising the olive shales, may be of Ludlow age.

**District between Dumfries and Langholm.** — Throughout the area which stretches from the Red Sandstone basin of Dumfries north-eastwards by Lockerbie to the pastoral district north of Langholm, a zone of massive grits has been traced at the base of the Wenlock formation that indicate a slight change in physical conditions from those which prevailed during the deposition of the Hawick type of rocks. The dominant members of this zone are brown-crustured greywackes, flags, and shales with dark-brown graptolitic shales. Indeed, the presence of these constantly recurring fossiliferous shales is the characteristic feature of the group.

The lowest band of graptolite shale above the base of the formation, about a foot in thickness, has been traced for several miles along the southern slope of the valley of the Stennies Water [NY 32045 93208], which joins the Esk about six miles north-west of Langholm (Sheet 10, of the Survey Map), where it is highly fossiliferous, the characteristic graptolite being *Cyrtograptus Murchisoni*. In a streamlet east of Nether Stennies Water [NY 32738 94356], 6½ miles N.N.W. of Langholm, the following fossils were collected from this band:

*Cyrtograptus Muirchisoni* (Carr.)

*Monograptus vomerinus* (Nich.)

*Aptychopsis Wilsoni* (Woodw.)

*Orthis reversa* (Salter.)

*Hyolithes (Theca) reversus?* (Salter.)

*Orthoceras Nicholianum* (Blake.)

*Heliolites interstinctus* (Linn.)

Owing to the plication of the strata this fossiliferous band is again brought to the surface upwards of a mile to the south-east of the outcrop just referred to, near the head of Rig Burn [NY 34111 92056], about five miles N.N.W. of Langholm, where it has yielded:

*Cyrtograptus Murchisoni* (Carr.)

*Monograptus vomerinus* (Nich.)

*Monograptus priodon* (Bronn.)

*Monograptus Barrandei* (TuUb.)

*Monograptus exiguus* (Nich.)

*Retiolites geinitzianus* (Barr.)

*Aptychopsis ovata* (Jones & Woodward.)

*Ceratiocaris* sp.

*Orthis reversa* (Salter.)

Again, near the head of Woolfhope Burn, [NY 34271 93389], Ewes Water, the following species were obtained from the same band of graptolitic shale:

*Cyrtograptus Murchisoni* (Carr.)

*Cyrtograptus* sp.

*Monograptus vomerinus* (Nich.)

*Retiolites geinitzianus* (Barr.)

*Orthis reversa* (Salter.)

*Aptychopsis ovata* (Jones & Woodward.)

*Orthoceras annulatum* (Sow.)

*Orthoceras* sp.

Far to the south-west, on the west bank of the Corrie Water [NY 18355 82509], a tributary of the Water of Milk, near South Corriellaw, this band has been detected, as indicated in Sheet 10. It has there yielded *Monograptus vomerinus*, *M. galaensis*, *M. priodon*, *Orthoceras annulatum* and *Orthoceras* sp.

Higher up in the series, other bands of graptolite-shale occur, which individually sometimes reach a thickness of 50 feet, but they are not so fossiliferous as the band just referred to. From an exposure of one of these higher bands in the course of the Annan, at Linkmill [NY 10982 76127], Dormant House, four miles south of Lockerbie, the fossils given in the annexed list were obtained:

*Monograptus priodon* (Bronn.)

*Monograptus riccartonensis* (Lapw.)

*Ceratiocaris inaequalis?* (Barr.)

*Orthis (Dinorthis) flabellulum* (Sow.)

*Orthoceras* sp.

Yet again, another exposure, in the Gimmenbie Burn, Milk Water, near Gimmenbie Mains [NY 16275 78597], three miles south-east of Lockerbie, furnished:

*Cyrtograptus* sp.

*Monograptus priodon* (Bronn.)

*Monograptus riccartonensis* (Lapw.)

*Ceratiocaris papilio* (Salter.)

*Orthoceras* with central siphuncle.

*Orthoceras* sp.

Owing to the intense folding of the strata, it has not been possible to fix the exact number of the bands of graptolitic shale in the district now under description. As yet the fine olive shales with limestone nodules overlying this series in the share section south of Kirkcudbright have not been detected between Dumfries and the valley of the Esk. On the hill slope, however, above Langholm Lodge [NY 35642 85370] at Wrae Hill, and also in the Ewes Water, a bed of fossiliferous grit has been found to contain fragments of crinoids, corals, and brachiopods in an imperfect state of preservation, like the band at Gipsy Point, Kirkcudbright. Throughout the region, between Dumfries and Langholm, isoclinal folding prevails, giving rise to constant reduplication of the strata, with a general south-easterly dip. One of the best examples of this phenomenon occurs at Langholm Lodge, in the bend of the Esk opposite the ancestral domain, where the graptolitic shales have been rudely cleaved.

**District between Langholm and the River Jed.** — The Wenlock and Ludlow Rocks of the Border territory naturally fall into three sub-divisions, which are here given in descending order.

(c) Green mudstones and marly beds, with nodular calcareous bands, similar to the Raeberry Castle group on the Kirkcudbright shore.

(b) Grey, green, and brown, often purple-stained mudstones and shales, frequently occurring in thick zones, with greywackes and grit bands, some of which are massive and pebbly. The characteristic feature of this sub-division is the occurrence of dark-brown flaggy shales charged with graptolites, orthoceratites, phyllopod crustaceans, and sometimes *Eurypterids*. These brown bands vary in thickness from seams interleaved in grey shales to zones fifty feet in thickness. The pebbly grits usually contain fragments of brachiopods, corals, crinoids, &c.

(a) Greenish grey flaggy grits, separated by grey shale bands, some of which are crowded with *Crossopodia*, *Nemertites*, and other tracks, resembling those found in the Hawick Rocks. The members of this group pass conformably downwards into the Tarannon strata of Hawick.

Beginning with the lowest sub-division (a), we find the grits along the northern margin of the Wenlock area, where they form a belt of high ground about a mile broad, rising to a height of upwards of 1950 feet. They probably reappear as inliers on the crests of the anticlines among the members of the overlying subdivision (b) as, for instance, along the northern slopes of Cauldcleuch Head [NT 45737 00690], by Langtae Hill, Anton Heights [NY 41743 97905], to Frodaw Height [NY 37711 97372], which is indeed the most prominent mass of elevated ground on the south-west part of Sheet 17, of the Survey Map, and the north-west corner of Sheet 11. At one locality on the Slitrig Water, immediately below Stobs Castle [NT 50616 08597], the shales and the surfaces of the greywackes of this sub-division are crowded with tracks.

With the exception of the tracts just referred to, nearly the whole of the remainder of the Wenlock and Ludlow areas between Langholm and Oxnam is floored by the members of the middle sub-division (b). The graptolitic shales constantly reappear throughout this region and yield some, if not all, of the characteristic forms. Though the localities from which the fossils have been obtained are now many miles distant from each other across the strike of the beds, yet it is highly probable that the various outcrops are merely repetitions by folding of two or three bands. There is abundant evidence of isoclinal folding. Along the northern edge of the Wenlock series the members of the lowest sub-division (a), together with the underlying Tarannon strata, are isoclinally folded, the dip of the axial planes being towards the south-east at angles varying from 30°–80° South of this belt lies a broad area where the axial planes of the flexures are nearly vertical, while still further south, as, for instance, near Langholm, they have a persistent dip to the south-east.

Of the numerous fossiliferous localities between Langholm and Oxnam, a few may suffice for special reference, in order to show the persistent similarity of the assemblage of organic remains. One of the best is certainly that at Stobs Castle Gate, at the junction of a small tributary with the Slitrig Water, four miles south of Hawick, where the graptolitic shale has yielded the following forms:

*Cyrtograptus Murchisoni* (Carr.)

*Cyrtograptus Carruthersi* (Lapw.)

*Monograptus priodon* (Bronn.)

*Monograptus vomerinus* (Nich.)

*Monograptus* sp.

*Retiolites geinitzianus* (Barr.)

*Aptychopsis ovata* (Jones & Woodward.)

*Ceratiocaris papilio* (Salt.)

*Eurypterus* sp.

About a mile south of Stobs Castle, the Slitrig Water is joined from the west by the Penchrise Burn [NT 50850 06776], in which the graptolitic shale has furnished the following fossils:

*Cyrtograptus Murchisoni* (Carr.)

*Cyrtograptus Carruthersi* (Lapw.)

*Monograptus priodon* (Bronn.)

*Monograptus riccartonensis* (Lapw.)

*Monograptus vomerinus* (Nich.)

*Aptychopsis ovata* (Jones & Woodw.)

*Orthoceras annulatum* (Sow.)

*Orthoceras* smooth variety.

*Orthoceras* sp. (1)

*Orthoceras* sp. (2)

In a streamlet at the head of Skelfhill Burn [NT 44497 01115], a tributary of the Allan Water, about nine miles S.S.W. of Hawick, the graptolitic shale has yielded the following forms:

Plant remains.

*Cyrtograptus Murchisoni* (Carr.)

*Cyrtograptus Carruthersi* (Lapw.)

*Monograptus priodon* (Bronn.)

*Monograptus riccartonensis* (Lapw.)

*Monograptus vomerinus* (Nich.)

*Dictyonema* sp.

*Aptychopsis* sp.

*Ceratiocaris* sp.

*Discinocaris* sp.

*Orthoceras* sp.

Again, from an exposure of graptolitic shale in the Priestthaugh Burn [NT 46474 04768], which joins the Allan Water below Skelfhill, about eight and a half miles S.S.W. of Hawick, the fossils given in the annexed list have been obtained:

*Cyrtograptus Murchisoni* (Carr.)

*Cyrtograptus* sp.

*Monograptus priodon* (Bronn.)

*Monograptus riccartonensis* (Lapw.)

*Monograptus* sp.

*Aptychopsis ovata* (Jones & Woodw.)

Crustacean.

Linguloid shell.

*Cyrtoceras* sp.

*Orthoceras* sp.

Similar lists might be quoted from many other localities over this belt of country.

Reference has already been made to the occasional presence of fossiliferous grits in this sub-division, of which the band near Langholm Lodge is an example. Another instance occurs at a waterfall at Caulkerton Grain [NY 44953 95246], five miles N.N.W. of Newcastleton, where the following fossils were obtained: *Favosites gothlandicus*, *Glyptocrinus basalis*, *Heliolites*, and a crinoid stem.

**Inlier of Riccarton and Wolfelee**, — The strata included in this inlier (Sheet 17), form a belt rather more than two miles in width, extending from Doorpool, about a mile and a half east of Hobkirk on the Rule Water to Arnton Fell two miles south-west of Riccarton. Junction. In the north, the strata are bounded by the unconformable Upper Old Red Sandstone, with which they form a most irregular junction. Their south-east and north-west boundaries are defined chiefly by two large faults, between which and the Silurian strata patches of Old Red Sandstone rocks make their appearance as overlying masses.<ref>The Silurian inliers on the slopes of the Cheviots were mainly surveyed by Professor James Geikie, whose descriptive notes are incorporated in the account here given of the strata.</ref> The best exposures occur in Wolfelee Burn and Peden's Cleuch. In the former they consist chiefly of thin bedded blue and grey greywackes and grey shales; in the latter similar beds are laid open, some of the finer-grained shales and greywackes showing obscure cleavage. Some of the greywackes are coarse-grained, and pass into conglomerates. The coarse grits contain rounded pebbles of white and brown quartz, many of which measure three and six inches across, and they likewise pass into conglomerates with water-worn fragments of quartz, mudstone, shale. Here and there the greywackes are purplish in

colour, while the shales are now and again green. The beds are frequently vertical, but have a general inclination to south and south-east.

Various bands of graptolitic shale appear in several burns to the south of Hyndlee, where they yield fossils similar to those in the graptolitic shale to the north. One example may here be quoted, from the Kirn Cleuch, Hyndlee Burn, about four miles south of Hobkirk, where *Cyrtograptus Carruthersi*, *Monograptus riccartonensis*, *Retiolites geinitzianus*, and *Orthoceras subundulatum* were obtained,

In the south-western portion of this inlier near Riccarton Junction, similar evidence is obtained of the intercalation of graptolitic shales with greenish greywacke, grits, and mudstones, which are isoclinally folded, the general inclination of the axial planes being to the south-east. From a band of graptolitic shale in the railway cutting at Riccarton Junction the following forms were collected, viz.: *Cyrtograptus*, *Monograptus vomerinus*, *M. riccartonensis*, *M. priodon*, *Dictyocaris Ramsayi*, and *Orthoceras*. From an exposure in the burn at Riccarton Junction, *Monograptus vomerinus*, *M. Riccartonensis*, *M. priodon*, and *Orthoceras* were gathered, and in the Riccarton Burn, a little below where the railway crosses the stream, *Monograptus riccartonensis*, *M. vomerinus*, and *Orthoceras* were obtained.

Nearly the whole of the Wolfelee and Riccarton inlier is occupied by strata belonging to subdivision (b) (p. 558). There is one small patch, however, of the overlying group (c). It consists of green mudstones and manly beds with calcareous nodular bands, similar to the beds near Raeberry Castle, on the Kirkcudbright shore. These strata are exposed in the railway cutting about half a mile W.N.W. of Riccarton Station, where they form a strip about 100 yards broad. Their actual thickness probably does not exceed from 30 to 40 feet, for they are repeated by gently undulating folds.

**Inliers on the northern slopes of the Cheviot Hills.** — The Upper Silurian strata included within these limits occur in more or less interrupted patches. One of the largest is that traversed by the Jed Water and the Edgerston Burn [NT 68487 11314]. It is everywhere bounded by rocks of Old Red Sandstone age, underneath which the Silurian strata are frequently seen to pass, the boundary lines being, as is usual in such cases, very irregular.

Another large area occurs high up on the slopes of the Cheviots, stretching eastwards to the Hindhope Burn [NT 77460 09363] and the river Coquet [NT 77683 07676]. The Silurian strata are here again overlain unconformably by rocks of much more recent age. Towards the north they are covered by the Old Red Sandstone volcanic series, their southern boundary being defined by overlying beds of white sandstone belonging to the Carboniferous series. Insignificant patches of Silurian strata appear here and there beyond the limits of these larger areas, in ravines and stream-cuttings, where the superincumbent strata of Old Red Sandstone have been removed by the denuding action of running water. They may be seen at Willowford Burn [NT 65685 15616] and Woodfield Burn [NT 65767 15325], which enter the Jed opposite Molsburnford, and in Richards Cleuch [NT 68747 14202], near Doresford, two miles further up the Jed valley. Two small patches are likewise exposed in the bed of the Jed, a mile or two below Chesters, another is traversed by the Carter Burn at Southdeanrig [NT 64857 08233], and again two similar exposures appear in the headwaters of the Jed near Dun Knowe [NT 62808 04848], [NT 62498 04178]. Most of these sections present admirable examples of unconformability.

The strata in the various areas now mentioned are evidently prolongations of the beds which occupy the districts already described. They show a pretty constant dip towards the southeast, although now and again the beds roll over and dip in the opposite direction. In many places the strata are on end or nearly so, but more commonly the dip does not exceed 50° or 60°, the inclination being occasionally as low as 15° or 20°. The strata consist generally of thin-bedded blue and grey greywackes and shales, with occasional thicker zones of shale, in which bands and ribs of greywacke are intercalated. The greywackes sometimes become coarse-grained and pebbly, and now and again display ripple-marks on their surfaces. Frequently the greywackes weather with an ochreous crust. Here and there thin seams and zones of graptolite-shale are intercalated in the other sediments, thus linking these strata with the members of subdivision (b). Approaching the crest of the Cheviots, the observer finds that the beds continue as usual to show more or less rapid alternations of greywacke and shale; the latter, however, become more common, and the associated greywackes more fine-grained, as the strata, are traversed towards the south-east.

In order to show that the graptolitic shale of these inliers yields forms identical with those found in the regions already described, we may quote the following examples. From an exposure on the Jed Water at Doresford [NT 67954 13766],

Camptown, five miles S.S.E. of Jedburgh, the following forms were collected:

*Monograptus Flemingi* (Salt.)

*Monograptus priodon* (Bronn.)

*Monograptus riccartonensis* (Lapw.)

*Monograptus vomerinus* (Nich.)

*Retiolites geinitzianus* (Barr.)

*Ceratiocaris ludensis* (Woodw.)

At the road-side at Camphouse [NT 68022 13454], six miles S.S.E., a band of this material yielded *Monograptus priodon*, *M. vomerinus*, together with fragments of *Monograptidae*.

Still another instance is to be found about ten miles south of Morebattle, near the crest of the Cheviots, in the Hindhope Burn [NT 77417 08658], which drains the northern slopes at Coquet Head and the surrounding heights, where the graptolitic shale furnished the fossils in the annexed list:

*Monograptus priodon* (Bronn.)

*Monograptus riccartonensis* (Lapw.)

*Monograptus* sp.

*Retiolites geinitzianus* (Barr.)

*Cyrtograptus* sp.

*Orthoceras* sp.

*Aptychopsis Wilsoni* (Woodw.)