Hawick Group, Silurian, Southern Uplands

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Hawick Group

Variable bed thickness in Hawick Group turbidite strata exposed on the north-east coast of Wigtown Bay at Low Auchenlarie. P008453.

Rippled bedding surface in steeply inclined turbidite strata from the Kirkmaiden
Formation (Hawick Group) exposed at Carrick Point. P220405.

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Steeply inclined, thinly bedded turbidite strata of the Carghidown Formation (Hawick Group) exposed at Brighouse Bay. P220426.

The Hawick Group comprises the upper Llandovery to lower Wenlock, sandstone-dominated turbidite strata that crop out between the Ettrick Group to the north and the Riccarton Group to the south. The steeply-dipping fault-bounded tracts that characterise the structural pattern in the older Southern Uplands divisions are clearly present only in the oldest part of the Hawick Group in south-west Scotland, where narrow slivers of the underlying Moffat Shale Group are locally preserved. Elsewhere, whilst it is possible that a cryptic tract structure is present, it is evident only that the
succession is much folded.

All of the formations in the Hawick Group are composed of alternating turbidite lithofacies (P008453). The succession is dominated by well-bedded turbidite sandstone (bed thickness most commonly in the 20-60 cm range) with interbeds of silty mudstone up to about 30 cm thick. Interspersed with this dominant facies are units of thinly interbedded sandstone and silty mudstone up to a few metres thick, and thickly bedded, massive sandstone either in single beds or forming units up to 10 m thick. Even the thinner sandstone beds have marked lateral continuity. Thin red mudstone beds are common in the Llandovery part of the succession, but are replaced in the upper part by beds of hemipelagic, laminated and carbonaceous siltstone that are characteristic of the Wenlock. The siltstone beds are commonly fossiliferous, with graptolite faunas proving the centrifugus to riccartonensis biozones. In the earlier, Llandovery part of the succession, graptolite faunas are very sparse, ranging through the guerichi, crenulata and insectus biozones.

The sandstone is usually fine- to medium-grained although locally includes coarse-grained detritus and mudstone intraclasts. Beds are usually massive through much of their thickness, grading only in the upper part to siltstone that may be cross-laminated, though thinner beds may be laminated or cross-laminated throughout. Sandstone beds have parallel, sharply defined tops and bases, the latter commonly carrying sole marks; these are typically linear grooves and flute casts that generally indicate axial sediment transport towards the southwest. Rippled top surfaces of beds (P220405) are also widely seen and the palaeocurrent orientations determined from them are commonly oblique or perpendicular to those derived from sole marks. Trace fossils, usually small burrows or feeding traces, are abundant in places.

Petrographically, the sandstone is a lithic wacke, with angular to subrounded sand grains and up to 40 per cent silt-grade matrix. The sand fraction is dominated by quartz with significant amounts of feldspar (c.10 per cent, mainly plagioclase) and mica (3-15 per cent depending on grain size) with reddened, haematite-coated mica grains conspicuous in younger parts of the group. Carbonate is a significant component, forming up to 15 per cent of the rock, and though now extensively recrystallised it probably originated largely as detrital material. The high carbonate content of the rocks is shown by the whole-rock geochemistry (P912332), which also demonstrates the relatively homogeneous compositional character of the group, and its contrast with sandstones from both the Gala and Ettrick groups. The lithic grain assemblage in the sandstone (variable around 15 per cent) consists mainly of mafic-volcanic and sedimentary rocks, polycrystalline quartz and granitic material. Accessory minerals include green tourmaline, zircon and garnet.

**Stratigraphical framework**

The difficulties that beset stratigraphical definition in the more northerly parts of the Southern Uplands are less of an impediment in the Hawick Group, which is divided into conventional formations based on subtle variations in the lithological character of the turbidite succession and the presence within it of interbedded red mudstone or laminated hemipelagite. Four formations are identified in the south-west of the Southern Uplands — Cairnharrow, Kirkmaiden, Carghidown and Ross — but only the Carghidown and Ross formations can be recognised north-east of Dumfries.

The Cairnharrow Formation (up to 1000 m) forms the northern part of the Hawick Group in south-west Scotland. Poorly preserved slivers of Moffat Shale Group strata thought to underlie the formation indicate that it forms at least two fault-bounded tracts. The northern tract is best exposed in the hills north-west of Gatehouse of Fleet, the southern tract is well exposed in coastal sections on either side of the Wigtown peninsula and the eastern side of Wigtown Bay. In both tracts, the Cairnharrow Formation is composed mostly of thickly bedded sandstone characterised by a rough, parallel lamination throughout most of the bed thickness, grading to a thin cross-laminated layer.
near the top; there is very little interbedded mudstone. Sporadic thinly bedded units range up to 40 m in thickness, whilst very thick-bedded, massive sandstone units occur locally. Despite the paucity of mudstone interbeds, sparse graptolite faunas have been recovered from several of them and all indicate the guerichi Biozone. The Cairnharrow Formation is, therefore, contemporaneous with the older part of the Ettrick Group.

The Kirkmaiden Formation (1000–1500 m) is well exposed in coastal sections in Luce Bay and Wigtown Bay whence it is transitional — north-easterwards, laterally along strike; south-easterwards, in stratigraphical sequence across strike — with the Carghidown Formation as that unit’s characteristic red mudstone beds appear in the succession. It is dominated by medium to thickly bedded sandstone with thin silty mudstone interbeds that together form units up to tens of metres in thickness, separated by more thinly bedded sandstone units less than 2 m thick. Very thick sandstone beds occur sporadically and may amalgamate into units up to 10 m thick. Biostratigraphical evidence is not good, with only sparse and ill-preserved graptolite faunas in a few mudstone beds, but does confirm a crenulata Biozone age. Hence the Kirkmaiden Formation may be in part coeval with the Glendearg Formation of the Ettrick Group, from which it can be distinguished by the carbonate-rich nature of its sandstone.

The Carghidown Formation (1000–1500 m) is well exposed in long coastal sections: in south-west Scotland, on the east side of Luce Bay and around Wigtown Bay and in Berwickshire, in the north-east of the Southern Uplands, to the south of Eyemouth. Like the Kirkmaiden Formation, much of the Carghidown Formation is composed of strata displaying classical turbidite facies features (P220426). Mudstone interbeds are a little more abundant than in other formations, particularly in the area north-west of Hawick where mudstone, commonly well laminated, locally forms up to 40 per cent of the succession. The Carghidown Formation is characterised by red mudstone interbedded with the ubiquitous grey-green silty mudstone, and by the common presence of distinctive red, haematite-coated mica flakes in the sandstone. The red mudstone beds are thin and rare in the northern part of the outcrop, but they become more common southwards with their maximum thickness increasing up to several metres. A primary origin for the red colouration is indicated by the occurrence of patches of red mudstone mixed with green mudstone in the matrix of slumped units.

Evidence for soft sediment deformation is widespread in the southern part of the Carghidown Formation, where disrupted sequences up to several tens of metres thick are common. Disruption varies from incipient pinch and swell of otherwise continuous bedding to mélangé zones, in which bedding has completely disaggregated into lenses and irregular blocks of sandstone of varying size and density in a silty mudstone matrix. Small slump folds in the mélangé zones characteristically have a wide range of axial orientations. The deformation in many of the disrupted zones has been accentuated by tectonic effects, but early, soft sediment disruption is favoured by gradational boundaries with coherent strata, blocks lying across the matrix foliation, and variations in matrix lithology.

Much of the outcrop of the Carghidown Formation is devoid of macrofossils. None are known from the south-west of the Southern Uplands, where the formation’s age at the northern margin of its outcrop is constrained to crenulata Biozone or older by its stratigraphical position beneath the Kirkmaiden Formation, whilst to the south the junction between the Carghidown and Ross formations (see below) also appears to be a stratigraphical transition in which the Carghidown Formation passes up into the lower Wenlock Ross Formation. However, in the central part of the Southern Uplands, several sparse graptolite faunas recovered close to the northern boundary of the outcrop suggest a range from the crenulata Biozone, through the upper Llandovery, and into the murchisoni Biozone of the lower Wenlock. The lower part of the Carghidown Formation overlaps in age with the Kirkmaiden Formation (in which there is no red mudstone). The upper part of the
formation was deposited contemporaneously with the Ross Formation (see below) but lacks the latter’s defining interbeds of pelagic laminated siltstone. There was also a depositional overlap with the upper part of the Ettrick Group, demonstrating the contemporaneous deposition of distinctive carbonate-poor and carbonate-rich wacke sandstones. The implication of these relationships is that the late Llandovery and early Wenlock was a period during which several distinct lithofacies were deposited with interfingering relationships, whilst the accretionary process that had previously dominated development of the terrane was relatively inactive.

The youngest division of the Hawick Group, the Ross Formation (up to 2000 m) is best exposed in coastal sections at Burrow Head and south of Kirkcudbright. The formation is dominated by sequences up to 50 m thick comprising turbidite sandstone units with sporadic mudstone interbeds, which alternate with sequences up to 4 m thick with more thinly bedded sandstone. The formation is characterised by distinctive dark grey, finely laminated carbonaceous siltstone in beds ranging from a few millimetres up to 1.5 m in thickness, which forms up to 10 per cent of the succession. Red mudstone beds, varying from a few centimetres to 1.2 m in thickness, occur together with the laminated siltstone in a transitional zone from the Carghidown Formation. In south-west Scotland, the transition is a few tens of metres in thickness, but south of Hawick it forms an outcrop about 2 km in width and has been separately named the Stobbs Castle Beds. Also in the Hawick area, the Ross Formation includes a unit comprising thick beds of very coarse-grained, pebbly sandstone (known as the Penchrise Burn Beds and best exposed south-east of Berryfell Farm (NT 524 074)) that is lithologically very similar to the Gypsy Point Member of the Raeberry Castle Formation (see below). Some of these coarse-grained sandstone beds contain small shelly fossils such as crinoid ossicles, brachiopods and solitary corals. Graptolites are relatively common in the carbonaceous laminated siltstone, with faunas ranging from the insectus Biozone, near the top of the Llandovery, up to the riccartonensis Biozone of the lower Wenlock. The distribution of the graptolites allows four biostratigraphically distinct structural tracts to be identified (P912334), albeit they show much internal imbrication.

The Coldingham-Linkim inlier

A small inlier of Silurian strata crops out on the North Sea coast of the Southern Uplands between Eyemouth and St Abbs (P912333). The inlier contains two distinct divisions, separated by a fault. These have been widely described as the Coldingham and Linkim formations, either with no group assignation or with an implied association with the Hawick Group, but have also been reduced to member status within the Carghidown Formation.

The northern division, the Coldingham Formation/Member, is a sequence of thinly bedded, quartzose sandstone and siltstone with a high proportion of carbonate in the matrix (hence the association with the Hawick Group). The sequence has been thoroughly and chaotically deformed by slumping. The southern division, the Linkim Formation/Member, is a well-bedded succession of turbidite sandstone and mudstone that has been pervasively reddened; but despite a low dip and apparent lack of deformation, it is inverted. The only biostratigraphical control is provided by a poor graptolite fauna and a microflora assemblage from Linkim Kip (NT 928 654). The graptolite fauna is either late Llandovery or early Wenlock in age. The microfloral assemblage is probably early Wenlock in age and shows similarity with a microflora obtained from the Carghidown Formation in Brighouse Bay, southwest Scotland. This floral comparison, and the pervasive reddening, encourages the association of the Linkim succession with the Carghidown Formation.

There is no evidence for a tectonic cause of the disturbances seen in the Coldingham– Linkim inlier. Soft-sediment deformation is widespread in the Carghidown Formation and it may be that Coldingham–Linkim examples are exceptionally extensive manifestations of this common phenomenon. Alternatively, it has been proposed that the two divisions originated separately as the
fill of small, isolated trench-slope basins that formed on the flank of the accretionary thrust complex. Deformation and inversion might then have been caused by large-scale, gravity-induced sliding soon after deposition. Such an origin would weaken the direct association with the Carghidown Formation.

Bibliography


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