Tweedsmuir - an excursion

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By J. D. Floyd and P. Stone. From Scottish Borders geology: an excursion guide edited by A.D. McAdam, E.N.K. Clarkson, P. Stone. Edinburgh : Scottish Academic Press (for Edinburgh Geological Society), 1992.

O.S. 1:50000 Sheets 72 Upper Clyde Valley, 73 Galashiels and Ettrick Forest and 79 Hawick and Eskdale

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Route: Figure 35

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Introduction

This excursion traverses across strike through the Northern (late Ordovician) and Central (early Silurian) belts of the Southern Uplands (Figure 1). A variety of turbidite lithological assemblages and structural styles can be observed as the route is followed through some of the finest scenery In the south of Scotland. Several of the minor roads used are narrow, serpentine and unsuitable for vehicles larger than private cars or perhaps a minibus.

1.Coulter Quarry: Marchburn Formation Greywacke, Haggis Rock

The excursion commences at Coulter on the A702 between Biggar and Abington. At the sharp bend of the main road over the Coulter Water bridge (NT 024 340) take the minor road to the south-east marked "No through road". This leads past Coulter Primary School and straight on for 1 km; Coulter Quarry is on the left (NT 028 334) with parking available either opposite the quarry or a little further on, across the bridge, on the left. The main quarry section exposes well-bedded greywackes and siltstones of the Marchburn Formation (Llandeilo-Caradoc) which strike NE-SW with a steep, normal dip to the NW. The greywackes show all of the characteristics of deposition from turbidity flows with well-developed graded bedding and a variety of erosional bottom structure casts on bed bases. These indicate a variable current regime with flow from either the NE or the NW. In the central part

of the quarry section are exposed the most massive greywacke beds, ranging up to several metres in thickness and commonly showing bulbous load casts and associated flame structures at their bases. These beds may also have a very coarse, granular basal greywacke unit colloquially known as "Haggis Rock". This distinctive lithology contains a wide range of clast types including jasper, felsite granite, gabbro and dolerite, which impart a speckled, multicoloured appearance to the rock reminiscent of the traditional Scottish dish from which it takes its name. Toward the northern and southern margins of the quarry the proportion of thin-bedded greywacke and siltstone in the sequence increases but, curiously, the best example of "Haggis Rock" occurs at the base of the thin-bedded unit on the north side of the quarry. Slightly farther north, in the roadside outcrops just beyond the quarry, the thin-bedded greywackes are folded into a large, upright anticline-syncline pair. This fold pair is south verging, typically so for the northern part of the Southern Uplands, with hinges (slightly faulted in the anticline) plunging gently north-east. An associated cleavage is only very weakly developed as a rather irregular spaced fracture in the finer-grained lithologies. Elsewhere in the quarry small fold pairs, only 2-3 m in wave length and amplitude, are incongruous with the larger, upright fold pair and may represent a different deformational event. The quarry section can be followed intermittently southwards for about 250 m towards Coulter Craigs. Thin to medium-bedded greywackes dominate at first but near the southern limit of exposure the greywacke horizons appear to be interbedded with red siliceous mudstone an, chert. Such assemblages are generally regarded as amongst the earliest sedimentary deposits in the Southern Upland succession and here arc probably of Llanvirn or Llandeilo age. The overlying greywackes in the quarry section are generally assigned to the Llandeilo to Caradoc *N. gracilis* graptolite zone.

2. Stobo Quarry: Lowther Shales

South-east from Coulter Quarry, across the strike trend of the Southern Uplands, the Stobo and Wrae areas lie within the outcrop of a succession of particularly well-laminated siltstones and mudstones known as the Lowther Shales. These form part of the Shinnel Formation (Caradoc) and have been worked in numerous quarries between Stobo and Moniaive (50 km along strike to the south-west) as an inferior roofing slate. From Coulter Quarry return to the A702 and thence to Biggar; at the eastern end of the town turn right on to the minor road signposted for Broughton. In this village turn right on to the A701 (towards Moffat) but after only a short distance turn left on to a minor road following signs for "Peebles via Dreva." From the road there is a good view north-eastward towards the Stobo quarry complex which is reached by a left turn on to a rough track at Altarstone (NT 156 359). The various quarry sections at Stobo jointly expose a continuous section of at least 150 m, across a greywacke, siltstone and shale sequence. The darker variety of the shales, which have a pervasive bedding-parallel fissility, are known as the Stobo slates and have yielded Caradocian graptolite fauna of D. clingani zone age (Eckford and Ritchie 1931; Leggett 1980). Bedding strikes about 060 degrees and is vertical to steeply inclined with a consistent sense of younging towards the NW. In the lowest (farthest south-east) part of the Stobo section thin, fine-grained greywacke beds occur sporadically with the generally pale grey shale: Darker shale horizons are associated with thin nodular chert bands containing radiolarian remains. Upwards through the succession there is a tendency for the greywacke beds to become thicker and more numerous. However, the fine grained shales remain dominant across the quarry until, if its north face, the proportion of greywacke increases abruptly with only thin mudstone interbeds. The greywackes are thickly-bedded and are usually fine to medium-grained. They are often massive, possibly due to amalgamation. Bottom structures are very common on the bases of the greywacke beds with load-casts being the most abundant. Where a current direction can be deduced from flute-casts it is invariably indicative of flow approximately along strike from the north-east. Some of the thicker greywacke beds contain large numbers of shale rip-up clasts.

3. Wrae Hill: Caradoc Limestone Breccia and Lava

A different aspect of the Lowther Shales can be seen in the various disused quarries at Wrae, about 6 km along strike to the south-west from Stobo (Figure 36). These quarries are reached by rejoining the A701 at Broughton and proceeding south-west towards Moffat for about 3 km. Roadside parking space at the foot of Wrae Hill, beneath the quarries, is very limited (NT 119 326). On the eastern slope of Wrae Hill the Wrae Limestone is interbedded with the Lowther Shales and was formerly worked in a number of small quarries. These exposures are of historical significance for geology since it was here, in 1792, that Sir James Hall discovered fossil shells in the limestone. This led his friend James Hutton to conclude, in Theory of the Earth (Hutton 1795), that the "schistus" of the Southern Uplands were once water-lain sediments which had been elevated from the bottom of the sea. The country-rock in the Wrae area is a succession of particularly veil-cleaved laminated siltstones and mudstones, the Lowther Shales. These have been worked as an inferior slate is in the North Quarry at Wrae which has a large scree of broken shaly debris creeping downslope below the workings. The regional strike of bedding is 070 degrees and dip is about 75 towards the NW. Sedimentary structures indicate that the beds are right-way-up. The Upper Quarry, 200 m farther south, probably worked the limestone which consisted entirely of resedimented blocks, some many metres in size, set in a pebbly mudstone matrix. Although now mostly quarried-out, a few scattered blocks of the limestone can still be found lying around on the floor of the quarry, some with recognisable shelly fragments on weathered surfaces. The limestone is very hard and recrystallised so that it is almost impossible to extract fossils without destroying them. The fauna of brachiopods, trilobites and gastropods is of shallow water (reefal) aspect and has been transported into deeper water by some sort of mass-flow mechanism. Its age was originally described as Upper Caradoc by Peach & Horne (1899), but Bergstrom (1971) has assigned it to the Llandeilo based on conodonts recovered from the limestone. The gap in exposure represented by the worked-out limestone is about 8 m wide. Traversing southwards and down the succession, 17 m of pebbly mudstone with gritty patches and pebbles of mudstone, limestone and quartz is seen. This is underlain in turn by 5 m of greenish-grey calcareous tuff containing pebbles of fine-grained porphyritic lava. The tuff rests on a wedge of pale grey fine-grained non-porphyritic alkaline lava (quartz-keratophyre) which forms a prominent 5 m thick feature just above the fence. From its apparently conformable and intimate contact with the underlying Lowther Shales, this unit has been interpreted by Eckford & Ritchie (1931) and Leggett (1980) as a lava flow rather than a slab-like olistolith. The whole succession of lava, tuff, pebbly mudstone and limestone breccia is about 35 m thick and is underlain and succeeded by Lowther Shales of uniform appearance. It was considered by Leggett (1980) to be a submarine slide deposit derived from a volcanic island fringed with a limestone reef. In the Lower Quarry, 150 m downslope from the Upper Quarry, a mudflake breccia horizon is interbedded with greywackes. Greywackes are more abundant than siltstones in this quarry and the stone was probably used for building dry-stone dykes. This quarry is now in the middle of a thick forest and access is difficult.

4. Tweedsmuir: Greywackes "Pyroxenous Group"

Continue towards Moffat on the A701 for a further 10 km as far as the village of Tweedsmuir. Turn south across the River Tweed on the unclassifed road signposted to St Mary's Loch. NOTE: This road is not suitable for caravans or vehicles larger than a minibus. Park near the crossroads a few metres south of the bridge. In the gorge of the River Tweed both upstream and downstream from the bridge, thick-bedded pebbly greywackes of the Llandovery "Pyroxenous group" are well displayed with a strike trend of 035 degrees and dipping 65 degrees towards the NW. Close inspection of bedding planes a few metres upstream from the bridge will reveal, from the evidence of such characteristic greywacke features as graded-bedding and flame-structures, that the beds are in fact overturned and young towards the southeast. These beds form part of a zone, about 2 km wide

across strike, along the northern edge of the Central Belt in the Tweedsmuir area, where the dominant direction of younging is towards the south-east in contradiction of the regional pattern. At this locality and others in the Tweed and its tributaries a short distance along strike to the south-west, Peach and Horne (1899) record scarce graptolites indicative of the zone of P. acuminatus, the basal zone of the Llandovery. The graptolites are not easily found and occur in thin bands within a grey and dark grey shale and greywacke succession. The paucity of graptolites, together with the grey shale and greywacke lithology, contrasts sharply with the beds of similar age at Dob's Linn, only some 14 km across strike to the south-east, where graptolites are abundant in a black shale lithology (see Dob's Linn Excursion).

5. Cramalt Road Section, Megget: Greywacke, Gala Group

Continue eastwards on the unclassified road from Tweedsmuir towards St Mary's Loch. This road traverses the valley of the Talla Water and along the side of the Talla Reservoir, built in 1895-1905 as the first major water supply scheme for the City of Edinburgh. The road at the head of the valley is particularly steep, winding and narrow where it climbs over the watershed to the valley of the Megget Water. The view from the top of the hill, from the bridge over Talla Linn northwest along the glacially gouged Talla valley, must be one of the most magnificent in the south of Scotland and is worth a brief stop to appreciate. Glacial moraine deposits are liberally scattered on the eastern side of the watershed. Proceed eastwards along the road for a further 7 km to a lay-by near Cramalt (NT 200 229) beside the new Megget Reservoir (filled in 1983). This carefully landscaped gravity dam forms the latest and largest addition to Edinburgh's water resources. View points with explanatory display boards are situated overlooking the dam and it is possible to walk out along the top of the latter the better to appreciate its construction. A new road has replaced the old route now flooded by the reservoir, and this affords excellent exposures in the greywackes and siltstones of the Queensberry Formation (Gala Group) along the north side of the reservoir. On the north side of the road a few hundred metres to the west of the Cramalt Burn a roadside crag shows a fine array of bottom structures, mainly linear grooves, on the bases of the greywacke beds. However, a more complete section may be inspected further east, beyond the Cramalt Burn and close to the large lay-by (NT 200 229) on the reservoir side of the road. At this locality (Figure 37), thick-bedded pebbly greywackes strike 040 degrees and dip 80 degrees to the NW. These massive greywackes occupy a large channel cut into the underlying dark-grey laminated siltstones, and contain numerous irregular ripped-up fragments of dark mudstone and siltstone. Large flute-casts visible at the eastern end of the section demonstrate that the beds young towards the north-west. Examination of the beds near the west end of the section reveals an excellent example of channelling by a greywacke unit. The channel infill cuts down into the underlying laminated siltstones and thin greywackes for over 3 m in a relatively short distance, with flutes on the base of this and several other adjacent beds showing that currents were generally flowing from south-east to northwest. Very coarse-grained breccias of sedimentary clasts fill likely de-watering pipes which cut through the massive channel-fill greywackes. The laminated siltstone at the western end of the section is locally deformed by tight, small-scale anticline-syncline pairs plunging about 20° to the NE. The greywackes and laminated siltstones at Cramalt are the equivalent of the greywackes which succeed the Moffat Shales at Hartfell (Hartfell Score excursion) and are thus probably of M. gregarius zone (Llandovery) age or younger. Trace fossils such as Megagrapton and Planolites are visible on the bases of some of the bedding surfaces at the western end of the section (Benton 1982).

6. Cappercleugh Quarry: Gala Group

Follow the unclassified road eastward from the Megget Dam

towards St Mary's Loch. About 0.5 km east of Henderland Farm a small quarry is located on the north side of the road, adjacent to a large unpaved lay-by and partially obscured by trees (NT 235

232). This small quarry affords an interesting example of the use of sedimentary structures in deducing the presence of a fold. At first sight the greywackes exposed seem to have a fairly consistent NE-SW strike, the beds being either vertical in attitude or dipping steeply to the NW. However, on closer inspection, the bases of beds on the eastern side of the quarry are marked by load-accentuated grooves which show that the sequence youngs to the SE. In contrast, on the western side of the quarry the bases of the beds are marked by very small bottom-structures which, together with welldeveloped grading within the beds, show that there the sequence youngs to the NW. An anticlinal structure is required within the quarry to explain these relationships but, where exposure is more or less complete along the back of the quarry the greywackes consistently young to the NW. One possible solution is shown in Figure 38 where a low-angle fault or thrust separates the upper and lower quarry sections. The younging evidence in this area is ambiguous. Is there additional structural complication? What do you think?

FIG 38. Structural problem, Cappercleuch Quarry.

From St Mary's Loch the excursion may be continued in one of three ways. If the A708 is followed south-westward towards Moffat a visit can be made to the classic section through the Moffat Shale Group described in the Dob's Linn Excursion. Alternatively the A708 may be followed north eastwards to the Gordon Arms where a left turn towards Innerleithen will link with the Heriot and Peebles Excursion. The third possibility involves a right turn at the Cordon Arms on to the B709 towards the Tushielaw Inn.

7. Tushielaw: Hawick Group

Hawick road section, 2 km. SE of Tushielaw, Ettrick. Looking E. Folded greywackes. Southern half of Hawick road section showing folds 3 (anticline), 4 (syncline) and 5 (imbricated) in greywacke sandstones of the Gala Group. P220053

From Cappercleugh Quarry continue along the unclassified road to St Mary's Loch and thence by the A708 (via the Gordon Arms) and B709 to the Tushielaw Inn. About 2 km farther south-east, on the B711 towards Hawick, a fine section in tightly folded Hawick Group (upper Llandovery) greywackes and siltstones is exposed on the north side of the road (318 164). This section (Figure 39), described in detail by Webb (1983), consists of a series of anticlines and synclines plunging at 40° towards the NE. A well-developed axial-planar slaty cleavage can be seen in places. Although the fold hinges are not always obvious, due to the fusion or amalgamation of beds in the cores of the folds, plentiful sole

structures on beds within the limbs of the folds allow the structure to be easily demonstrated. Directional evidence from flutes indicates a predominance of currents flowing from east to west with a few flowing from south to north.

Continuing south-east on the B711 will join the A7, Hawick. Alternatively retrace the route to the Gordon Arms crossroads whence the A708 leads to Moffat (turn left), Selkirk (turn right) whilst the B709 (straight on) is the beginning of a scenic route to Edinburgh via Innerleithen an Peebles.

References

> At all times follow: The Scottish Access Codeand Code of conduct for geological field work

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