
Excursion 2 Bannock Burn

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Purpose: To view the deeply weathered top of the basaltic lava pile of the Clyde Plateau Volcanic Formation (Strathclyde Group); to examine the overlying Kirkwood Formation derived from the reworking of weathered lava, and its relationship to the marine sedimentary rocks in the cyclically deposited Lawmuir Formation above; to inspect the Lower Limestone Formation (Clackmannan Group) including the Hurllet, Inchinnan and Blackhall limestone cycles.

Logistics: This excursion is on land belonging to Sauchie Estates Ltd, Cultenhove Farm, Sauchieburn Estate, Stirlingshire and Todholes Farm. Care should be taken whilst traversing round the numerous small waterfalls in the burn and whilst crossing fences. **A 3-tonne maximum load limit applies to the local access roads, so that this excursion is not suitable for coach parties.** Leave the centre of Stirling, drive south to the Bannockburn Heritage Centre and turn right at [NS 798 905] onto the road to Howietoun Fishery. Turn right at the junction at [NS 7862 8790] and then at the junction with the Carronbridge road at [NS 7694 8744]. The car park is at [NS 7600 8782].

Maps: OS 1:50,000 Sheet 57 Stirling & the Trossachs; OS 1:25,000 Stirling & Ochil Hills West; BGS 1:50,000 Sheet 39W Stirling; locality map (Figure 2.1).

(Figure 2.1) is a geological map of the Bannock Burn near Todholes Farm. The stream section displays the deeply weathered top of the basaltic lava pile of the Clyde Plateau Volcanic Formation overlain by the diachronous Kirkwood Formation. This consists of bedded and cross-stratified volcanoclastic detritus derived from the lavas, which were progressively buried by younger deltaic and marine sediments during the late Viséan. Repeated marine transgressions gradually deposited sediments that covered the old lava landmass.

The overlying cyclically deposited Lawmuir Formation (Paterson & Hall, 1986) also has a diachronous base, but this formation contains marine limestones and broadly resembles the overlying Lower Limestone Formation (Clackmannan Group). In the thicker basinal sequences of the Clackmannan Syncline to the east, quartzose fluviodeltaic sands represent regressive intervals with lowered sea levels, which alternated with the transgressive intervals represented by the marine limestones. However, these sandstones are absent from the basin-margin Todholes and Touchadam sections. (Figure 2.2) illustrates two vertical sections down from the Hurllet Limestone through the Lawmuir and Kirkwood formations at Todholes (A) and farther downstream around Touchadam Quarry (B) [NS 7600 9055], 4 km NNE along strike. The two basin-margin sections show considerable changes in thickness and lithology.

Limestones in the Lawmuir Formation, formerly designated alphabetically in downward order (Dinham & Haldane, 1932, pp. 14–16), have been renamed the Bannock Burn White (E), the Touchadam (F) and the Todholes (G) limestones. The Hurllet Limestone (formerly Murrayshall Limestone or D) marks the base of the Lower Limestone Formation. It was deposited during a major marine transgression that finally submerged almost all of the old subaerial lava pile. Both it and the overlying Inchinnan Limestone (C) were extensively quarried locally for lime and are generally seen only as loose blocks.

Locality 2.1 [NS 7532 8779] to [NS 7501 8768] Kirkwood Formation and lateral attenuation of the Todholes Limestone

From the car park, walk NW to the ford at [NS 7574 8810], 700 m east of Todholes Farm, where the minor road to North Third Reservoir crosses the Bannock Burn. Pass through the gate immediately south of the ford on the left (SW) side of the road and walk south-westwards, parallel to the burn, keeping on the south side of a high drystone wall, to join the stream at [NS 7542 8778]. Walk upstream, noting on the way a landslide on the path at [NS 7542 8781]. This is the type locality of the Todholes Limestone, which crops out in the burn at the downstream end of the locality. Here it is a continuous bed, 0.7 m thick, of dark-grey, crystalline limestone containing a varied marine fauna, including simple corals, the compound coral *Siphonodendron* (Plate 2.1) and the large brachiopod *Gigantoproductus*. This fauna resembles that

of the Hollybush Limestone of the Paisley district, with which the Todholes Limestone has been correlated (Francis *et al.*, 1970, p. 181). Farther upstream, in a rather inaccessible exposure about 300 m to the west [NS 7503 8773], the Todholes Limestone is reduced to a discontinuous bed of nodules, which is underlain by the following succession:

LAWMUIR FORMATION	Thickness (m)
Mudstone, dark-grey, poorly bedded at top; articulate brachiopods	0.15
Siltstone, dark-grey, ferruginous	0.15
Ironstone, sideritic, silty	0.01
Mudstone, pale-grey, grading down into greenish-grey volcanoclastic detritus of silt and sand grade, which contains a nodular, sideritic bed 0.4 m thick (Erosional unconformity, truncating beds below)	1.58
KIRKWOOD FORMATION	
Volcanoclastic detritus, grey, greenish-grey and dull purple, generally upward-fining, cross-stratified with easterly-dipping foresets; contains rounded pebbles of decomposed basalt in lenses and towards base	5.50

The unconformity between these two formations is well seen between [NS 7505 8772] and [NS 7503 8773] (Plate S.6). The Todholes Limestone, 45–55cm thick, crops out in the burn and rises above the volcanoclastic beds at [NS 7521 8771]. Its surface is slightly karstified and weathers black. Mudstone can be seen above and below. The basal bed is definitely not an ash-fall tuff but a water-sorted deposit derived from the reworking of decomposed bole-like material on top of the lava pile. The beds in the Lawmuir Formation above the now-discontinuous nodular Todholes Limestone are more accessible in the south bank at [NS 7501 8768], where the following section is exposed:

	Thickness (m)
Sandstone, greenish-grey, chloritic, mostly fine-grained, upward-coarsening, with argillaceous siltstone laminae towards base; root traces at top	0.84
Siltstone, greenish-grey, argillaceous, with sandy laminae towards top	1.40
Mudstone, olive-green with grains of volcanoclastic detritus, grading down into dark-grey mudstone with silty, micaceous laminae	1.75
Mudstone, dark-grey, mostly fissile, with harder silty and sideritic beds towards top; articulate brachiopods at base	1.02
TODHOLES LIMESTONE, dark-grey, fine-grained, in nodules	0.15

The limestone cannot be recognised farther upstream and it presumably dies out less than 200 m to the west. On the south side of the last exposure, the overlying Touchadam and Bannock Burn White limestones are exposed intermittently. Above them lie extensive opencast workings in the Hurllet Limestone, which continue upstream for the rest of the section, appearing initially on the south side of the stream and then extending to both sides farther west. Talus from these old workings obscures the beds immediately below the Hurllet Limestone over most of the section. Several primitive, horseshoe-shaped clamp kilns show that at least some of the limestone was burnt on site.

Locality 2.2 [NS 7495 8765] to [NS 7493 8766] Bannock Burn White and Touchadam limestones.

The two limestones lie very close together, but are of markedly different lithology (see below). They crop out in, and immediately upstream from, a waterfall [NS 7494 8765], which is the type section of the former limestone. Here the

following section is exposed:

Mudstone, blackish-grey, locally carbonaceous, fissile, silty towards top, with thin beds and nodules of pyritous, sideritic, ironstone	2.62
Limestone, dark-grey, fine-grained, pyritous	0.10
Mudstone, dark-grey	0.15
BANNOCK BURN WHITE LIMESTONE, mottled pale- and dark-grey yellowish-weathering and dolomitised at the top, which locally contains carbonaceous root traces; pale-grey and crystalline below, locally pseudobrecciated; abundant crinoid columnals, articulate brachiopods, bryozoa, etc. (junction at [NS 7492 8764], above small waterfall)	1.03
TOUCHADAM LIMESTONE, dark-grey, fine-grained, argillaceous, flaggy; divided into five layers by thin beds of dark-grey, calcareous mudstone; crinoid ossicles and abundant articulate brachiopods. (Cut by small NW–SE fault)	1.88
Mudstone, mostly dark-grey, fissile; paler and more silty towards base, which contains a thin sideritic limestone up to 0.07 m thick, with shell fragments	1.01
Sandstone, grey, mostly fine-grained, sideritic	0.10
Mudstone, pale-grey, silty and sandy, poorly bedded, with sideritic concretions	1.83

The Touchadam Limestone contains fragments of goniatites in exposures farther west and probably correlates with the lower part of the Blackbyre Limestone of the Paisley district. The overlying Bannock Burn White Limestone almost certainly correlates with the upper part of the Blackbyre Limestone (Wilson, 1989) and with the combined White Nodular Limestone and Coral Limestone of the Corrie Burn section some 11 km to the SW (Robertson & Haldane, 1937, p. 18). The non-marine Baldernock Limestone lies at this stratigraphical horizon on the south side of the Campsie Fells (Dinham & Haldane, 1932, pp. 14–16). A widespread fall in sea level took place shortly after the Bannock Burn White Limestone had been deposited, so that its top was exposed, dolomitised and locally colonised by vegetation. The roots at the top of this limestone mark the horizon of the Hurllet Coal of the Central Coalfield. Walk upstream, noting in passing the excellent exposures of Touchadam Limestone and its capping of dark-grey, fissile mudstone.

Locality 2.3 [NS 7483 8761] Lower Limestone Formation and Midland Valley Sill-complex

Cross the burn and the old opencast workings in the Hurllet Limestone to the south and climb to the foot of the cliff. This locality lies on the SW (upthrow) side of a small NW–SE fault, which also truncates a broad platform of the Touchadam Limestone at water level. The exposure detailed below shows strata in the lower part of the Lower Limestone Formation, between the Hurllet Limestone and the ochreous bed that marks the horizon of the Blackhall Limestone, immediately below the quartz-dolerite sill. This limestone has been metamorphosed locally. The strata between the Hurllet and Blackhall limestones are much thinner in this section than they are farther east in the Clackmannan Syncline (Francis *et al.*, 1970, figs. 15 & 16), indicating that the area above the old lava pile continued to be an area of reduced subsidence (basin margin), even towards the end of the Viséan Epoch.

	Thickness (m)
Dolerite, medium-grained and columnar-jointed at top, but finer grained, platy and amygdaloidal at chilled base	3.20

Horizon of BLACKHALL LIMESTONE. Soft, yellowish-brown, ochreous bed containing a thin intercalation of hard-baked, pale-grey mudstone with shell fragments	1.12
Wedge of fine-grained dolerite (basalt), which thins to west	0.76
Mudstone, pale-grey, baked hard and bleached	0.30
Alternating beds of pale whitish-grey and brownish-grey sandstone, mostly fine-grained and ripple-laminated, in upward-coarsening sequences, and dark-grey, micaceous siltstone and silty mudstone, containing drifted plant scraps	8.66
Mudstone, dark-grey, silty, micaceous	0.15
Gap, obscured by talus. Trenching revealed collapsed workings in the INCHINNAN LIMESTONE (which was originally about 1 m thick) underlain by a 0.10 m-thick coal and 0.25 m of seatclay (mudstone reworked by roots)	1.65
Sandstone, whitish-grey and brownish-grey, mostly fine-grained, with silty micaceous laminae; roots at top	0.69
Gap, obscured by talus, down to approximate level of the worked-out	
HURLET LIMESTONE. (Outcrops about 12 m to the west along the strike suggest that most of this gap is occupied by alternating beds of sandstone and siltstone, similar to those seen above the Inchinnan Limestone)	10.00

The limestone beds in the above section represent widespread marine transgressions, which may be traced over the greater part of the Midland Valley of Scotland and into the north of England. The repeated upward-coarsening sequences of sandy strata between the limestone beds probably represent minor, local delta-lobes that were built out during periods of lowered sea level and occasionally colonised by vegetation. These sandy beds die out south-westwards, towards Glasgow. Return downhill and cross the burn to Locality 2.4, just beyond a substantial fence at [NS 7482 8765].

Locality 2.4 [NS 7481 8766] to [NS 7458 8769] Kirkwood Formation and shoreward facies of basal Lawmuir Formation.

Within this locality the deeply weathered top of the Clyde Plateau Volcanic Formation is exposed, together with the overlying Kirkwood Formation and the basal Lawmuir Formation, in a small inlier. At the east end of the inlier, strata just below the horizon of the Todholes Limestone are exposed dipping SSE at 14°, but there is no trace of that limestone anywhere within the inlier and it has probably died out. The cross-stratified, decomposed, reworked, volcanoclastic detritus of the Kirkwood Formation is well exposed in the stream bed and in both banks (Plate 2.2). It is mostly yellowish-green in colour and tends to become coarser towards the base, ranging from a silty mudstone to a conglomerate containing rounded pebbles of weathered lava. The basal Kirkwood Formation is difficult to distinguish in some places from the in-situ bole-like material produced by the deep tropical weathering of the topmost lavas. However, the Kirkwood Formation is here obviously much thinner than in the exposures farther downstream. Tuff, containing blocks, may be seen above the lava at [NS 7465 8768], where another fence crosses the stream. The following section in the Bannock Burn White and Touchadam limestones can be seen at [NS 7457 8766]:

	Thickness (m)
Mudstone	2.40
Limestone	0.15
Mudstone	0.10
Limestone, fossiliferous, nodular	1.10
Nodular limestone, shelly	0.10

Limestone	0.65
Calcareous mudstone	0.35
Mudstone	0.50
Limestone	0.30
Mudstone	0.50
Limestone	0.10
Mudstone	0.30

Continue upstream, past a good exposure of the Bannock Burn White and Touchadam limestones in the north bank where fossils may be collected from loose material, and cross a small NNE–SSW fault with an easterly down-throw which brings up strata close to the horizon of the Todholes Limestone, to reach Locality 2.5 at a prominent waterfall at [NS 7448 8767].

Locality 2.5 [NS 7447 8763] to [NS 7443 8767] Hurlet Limestone and shoreward facies of the Bannock Burn White and Touchadam limestones

The Bannock Burn White and Touchadam limestones form the prominent waterfall at this locality (Plate 2.3). Here the Touchadam Limestone has thinned to 0.49 m and is separated from the overlying Bannock Burn White Limestone by some 0.75 m of calcareous mudstone containing abundant brachiopods. The Bannock Burn White Limestone has not thinned perceptibly and remains more than 1 m thick. Its weathered, decalcified and dolomitised top contrasts with its unweathered, highly fossiliferous, lower portion. The beds below the Touchadam Limestone are exposed below the waterfall and are similar to those already described in Localities 2.1 and 2.2. The chief interest lies in the beds above the Bannock Burn White Limestone, which are better exposed upstream from the waterfall than anywhere else in the Todholes section. The following section through these beds is exposed in the north bank, between [NS 7445 8766] and [NS 7443 8763]:

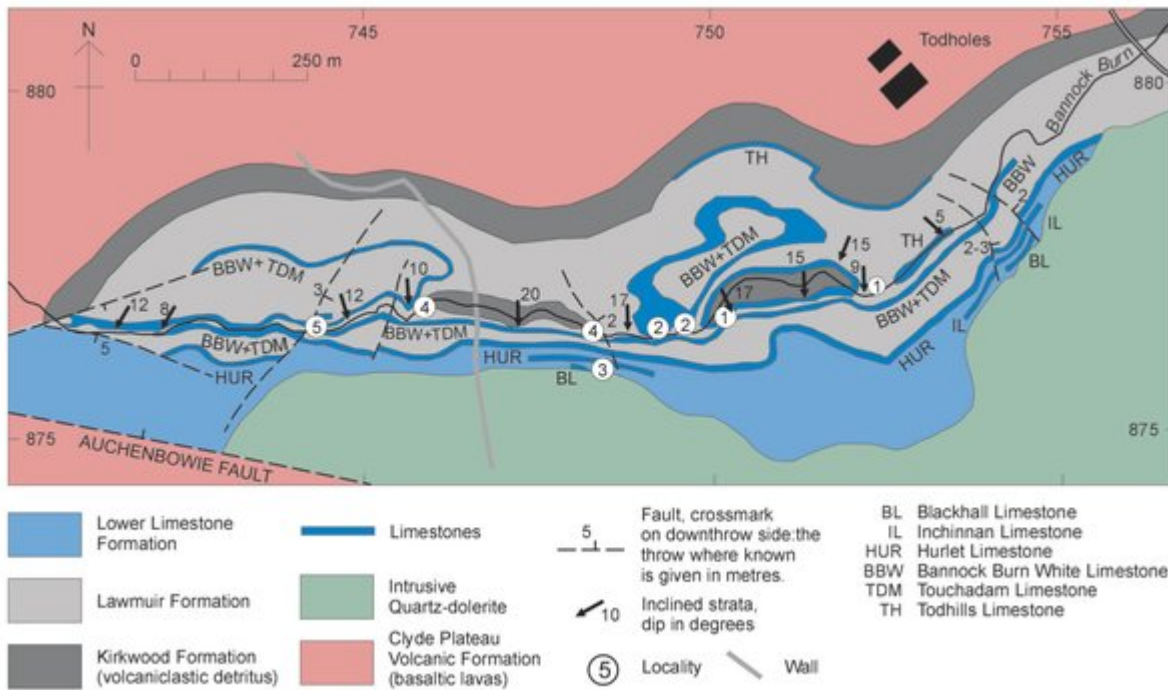
	Thickness (m)
HURLET LIMESTONE, dark-grey, crinoidal; argillaceous towards base, which is decomposed locally to an ochreous bed	0.37
Mudstone, dark-grey, fissile; top calcareous with abundant articulate brachiopods, but base ferruginous with <i>Lingula</i>	0.61
Mudstone, dark-grey, fissile and ferruginous with silty, sideritic ironstone beds up to 0.03 m thick; decomposed pyrite concretions and selenite crystals; basal 0.10 m is contorted, whereas the beds immediately above and below are unaffected	1.58
Mudstone, dark-grey, fissile, with sideritic nodules and beds of dark-grey, argillaceous limestone up to 0.10 m thick; fragmental marine shells at base (Irregular top of BANNOCK BURN WHITE LIMESTONE)	1.83

Only the base of the Hurlet Limestone is preserved at the top of this section, but a loose block of similar limestone that lies in the stream indicates that the Hurlet Limestone was at least 1 m thick. There is no trace of the Hurlet Coal. Upstream the section is truncated by a NE–SW fault with a throw of about 3 m down to the SE.

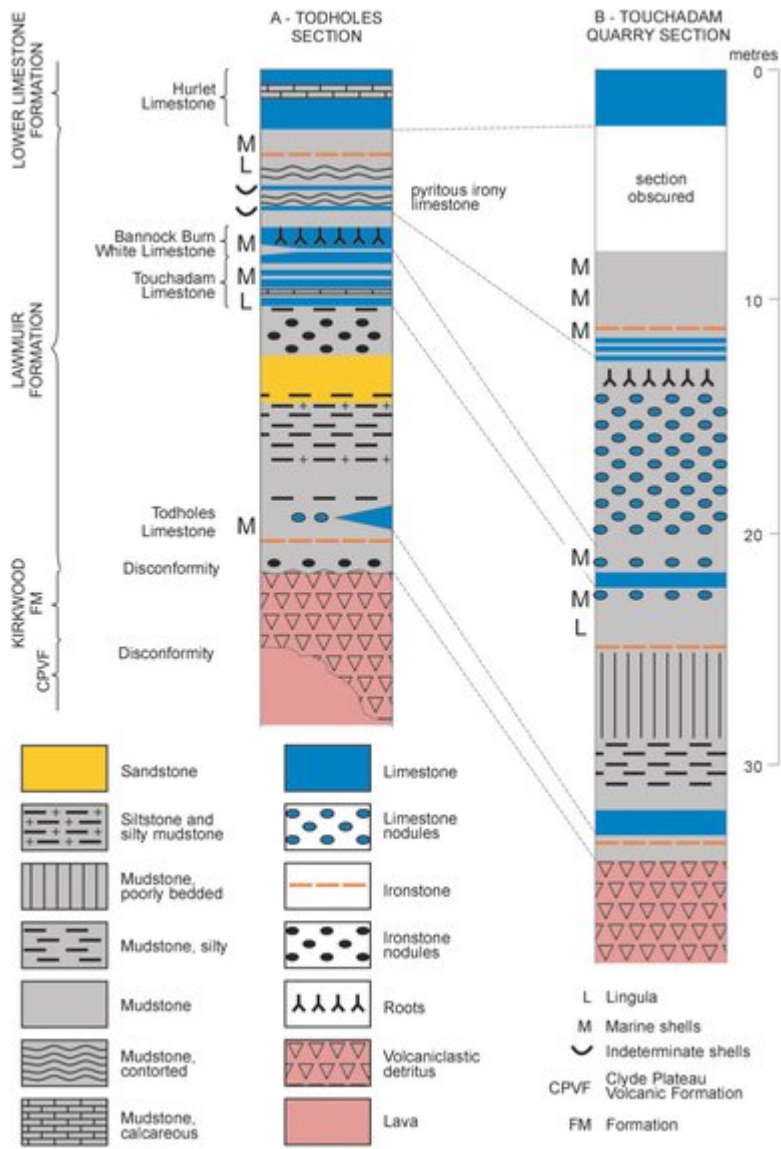
If time is still available, visitors have two choices. They may either examine a set of faulted exposures, mostly in the Bannock Burn White and Touchadam limestones, farther upstream, or they may return to their cars, drive north past the North Third Reservoir, and visit the Touchadam section, illustrated in (Figure 2.2). In the Touchadam section, the Bannock Burn White Limestone has been almost entirely replaced by a pale-grey mudstone, locally derived from volcanoclastic detritus ((Figure 2.2); Francis *et al.*, 1970, pp. 170–2, fig. 14). Before leaving the west end of the Todholes section, the visitor should climb out of the immediate valley of the upper Bannock Burn in order to see the view to the NE.

Here a component of the Midland Valley Sill-complex (intruded into the marine mudstones above the Blackhall Limestone) is seen forming the impressive cliffs of Sauchie Craig. North of the prominent gap in these cliffs at Windy Yet, the sill transgresses down into sedimentary rocks below the Inchinnan Limestone, before rising upwards in a dyke-like body along the plane of the Wallstale Fault. This proves that the fault was formed before the dolerite was intruded.

References



(Figure 2.1) Map of late Viséan rocks exposed in the upper Bannock Burn near Todholes, showing localities for Excursion 2. Adapted from Francis et al. (1970, fig. 13).



(Figure 2.2) Vertical sections of late Viséan rocks exposed in the Bannock Burn, (A) near Todholes and (B) near Touchadam Quarry. Adapted from Francis et al. (1970, fig. 15).



(Plate 2.1) Locality 2.1. Colonial coral (*Siphonodendron* sp.) in Todholes Limestone, Lawmuir Formation.



(Plate S.6) Disconformity between Kirkwood Formation and the overlying Lawmuir Formation. Outlines of clamp kilns in foreground; Lewis Hill Quartz-dolerite Sill forms crags in background. See Excursion 2.



(Plate 2.2) Locality 2.4. Coarse-grained volcaniclastic detritus in Kirkwood Formation.



(Plate 2.3) Locality 2.5. Waterfalls in the Bannock Burn, formed by the Bannock Burn White and Touchadam limestones, Lawmuir Formation.