
Excursion 9 Gargunnoch Burn

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Purpose: To demonstrate changing environments in the Stratheden and Inverclyde groups, from braided rivers of the Stockiemuir Sandstone Formation to meandering rivers of the Kinnesswood Formation and the Downie's Loup Sandstone Member (Clyde Sandstone Formation); the low-energy, dominantly coastal alluvial, hypersaline Ballagan Formation; and to examine the Downie's Loup Sill.

Logistics: This half-day excursion is on private land, and the lower part of the Gargunnoch Burn (Locality 9.1), **can be dangerous**, particularly because of replanting, with much remaining felled timber and brash left to rot, and navigating around waterfalls. Care should also be taken whilst scrambling out of the valley around Downie's Loup (Locality 9.5).

Travel westwards on the Dumbarton Road (A811) from Stirling and turn left at Dasherhead Farm [NS 7104 9516] into Gargunnoch village, where cars may be parked with care near the T-junction [NS 7066 9436] west of Gargunnoch Kirk. Walk eastwards from the junction to the end of the village along a minor road for 370 m before turning right (south) at [NS 7108 9420] up a track forming part of the local path network. This passes a cottage on the right. Cross two stiles, follow the track uphill to a left-hand bend at the village water supply reservoir and enter by a gate (on the right) into Dinnin Wood [NS 7082 9362]. From the gate, head upstream to reach the burn at a somewhat less than perpendicular angle to the fence.

Maps: OS 1:50,000 Sheet 57 Stirling & the Trossachs; OS 1:25,000 Sheet 348 Campsie Fells; BGS 1:50,000 Sheet 39W Stirling; locality map (Figure 9.1).

This excursion demonstrates the sedimentology of typical sandy fluvial environments of the Stockiemuir Sandstone and Kinnesswood formations. The overlying Ballagan Formation was laid down in low-energy, dominantly coastal alluvial, hypersaline environments, with its characteristic mud-dominated succession, with thin dolostone (cementstone) beds and nodules. Renewed fluvial activity is seen in the Downie's Loup Sandstone Member above. A volcanic period with the eruption of basaltic lavas concludes this sequence (Clyde Plateau Volcanic Formation), but only the base is seen here. The major ENE–WSW Abbey Craig Fault cuts out part of the Lower Carboniferous succession. Downie's Loup and Dinnin Quarry expose the Downie's Loup Sill, with some indication of changes in thickness and stratigraphical level of intrusion. This excursion description has been updated by the editors for modern concepts and terminology.

Locality 9.1 [NS 7073 9364] to [NS 7063 9340] Stockiemuir Sandstone and Kinnesswood formations

At the northern end of the locality, beds high in the Stockiemuir Sandstone Formation are displaced up to the east by a small WNW-trending fault to lie against strata of the overlying Kinnesswood Formation. The Stockiemuir Sandstone consists of brick-red sandstones that were probably laid down by braided rivers. However, they also contain wind-rounded grains; farther west, aeolian dunes have been identified in the upper part of the formation, suggesting an arid climate (Hall & Chisholm, 1987).

On the downthrow side of the fault are Kinnesswood Formation strata. Farther upstream [NS 7072 9351] to [NS 7065 9343], mostly in a series of small waterfalls, upward-fining cycles deposited by meandering rivers may be seen. These consist typically of an erosive-based, upward-fining, channel-fill sandstone, capped by argillaceous flood plain (overbank) deposits containing calcretes. Rounded, eroded pebbles of calcrete and mudstone are seen incorporated into the pebbly bases of channel-fill sandstones. Irregular concretions were produced *in situ* by soil-forming processes under semi-arid conditions in the upper parts of these sandstones, as well as in the overbank deposits, where they are best developed. At a waterfall [NS 7065 9344] is a creamy-white calcrete over 1 m thick. Cross bedding indicates that the rivers flowed in from the NW.

Very determined visitors may wish to continue upstream to the south end of the locality near the northern boundary of Dinnin Wood to see a gradual colour change take place up succession. The sandstones change from dull red to white, whereas the mudstones change from brick red to purplish grey and pale green. At [NS 7065 9343], the erosive base of a channel-fill sandstone, which forms the lip of a waterfall, cuts down into the overbank deposits at the top of the preceding cycle (Plate 9.1). Whichever option is followed, return to the track at the gate and continue SW into open ground to the ford across the Gargunnock Burn at Locality 9.2.

Locality 9.2 [NS 7077 9332] and [NS 7067 9331] Junction of Kinnesswood and Ballagan formations

This locality consists of two exposures: one in a small disused sandstone quarry (Plate 9.2); the other at a waterfall, which lies immediately upstream from where the track from Dinnin Wood crosses the burn beside a large pipe. They show a series of lenticular sandstones interleaved with overbank mudstone, which contain irregular calcrete lenses and nodules. The quarry is the best and most easily accessed exposure of calcrete. The cross-bedded sandstones probably represent short-lived, sinuous, laterally accreting channels, which were formed on the floodplain during seasonal floods (Read & Johnson, 1967, fig. 2a). Immediately upstream from the waterfall there is a small gap in the stream section, which means that the junction is not exposed between the Kinnesswood Formation and the overlying dolostones and mudstones of the Ballagan Formation.

Locality 9.3 [NS 7068 9328] to [NS 7072 9316] Marginal facies of Ballagan Formation

Typically, this formation consists of alternating thin beds of grey mudstone and pale, fine-grained dolostone. Some of the dolostones are laminated and others are probably diagenetic (nodular). Pseudomorphs after salt in the mudstones suggest periodic hypersaline conditions; nodular gypsum is found elsewhere. Thus, arid periods still occurred. In this section, a supposed marginal facies in the lower part of the formation is overlain by a lower energy basinal facies (Locality 9.4). The top of the formation is faulted out (see below). The marginal facies includes sporadic beds of brownish grey, fine- and very fine-grained, flaggy sandstone, two of which are exposed in the west bank [NS 7068 9326]. They are generally less than 0.3 m thick, and may represent sand brought in by small meandering streams. Some of the mudstones are brown or dull red. The reddened horizons are soils which, together with mudstone breccias and polygonal cracks in the dolostones (e.g. at [NS 7070 9324]), indicate periods of lowered water level when the surface sediments were exposed to desiccation and partial oxidation. In the east bank at [NS 7070 9324] there is a 2 m-wide wall-like NE–SW basaltic dyke. From here, walk upstream about 30 m to Locality 9.4.

Locality 9.4 [NS 7072 9314] to [NS 7073 9309] Basinal facies of Ballagan Formation

Supposed basinal facies deposits are exposed in the east bank, with grey and greenish grey mudstones, showing only rare brown and dull-red mottling (soil horizons), alternating with numerous thin beds of pale-grey dolostone. Here, sandstones are absent and traces of desiccation and oxidation are rare.

The upstream end of the section is truncated by the major ENE–WSW Abbey Craig Fault, with displacement down to the south. The southerly dip of the strata steepens from $<10^\circ$ to $>18^\circ$ towards the fault. The displacement increases progressively towards the ENE, so that within 3 km it throws lavas of the Clyde Plateau Volcanic Formation down against the Stockiemuir Sandstone Formation.

Locality 9.5 [NS 7074 9309] Downie's Loup Sill, Downie's Loup Sandstone and Abbey Craig Fault

This locality includes the spectacular Downie's Loup waterfall, which is more than 20 m high and is the type locality for the Downie's Loup Sandstone Member. The lip of the waterfall is formed by the mafic, columnar-jointed, Downie's Loup Sill, which is here about 6 m thick. The Downie's Loup Sandstone Member represents a return to meandering river deposits, like those of the Kinnesswood Formation, the upper part of which it closely resembles. It consists of a series of

upward-fining cycles, with white or pale-greenish grey, erosive-based, channel-fill sandstones, some of which are coarse grained and pebbly, grading up into purplish grey overbank mudstones containing sporadic calcrete nodules. Some of the pebbles in the sandstones are also of calcrete. Cross-stratification dip directions indicate rivers flowing from the NW.

The base of the Downie's Loup Sandstone, which is faulted out in the Gargunnoch Burn section, is exposed farther west. It seems to be sharp and erosive in some localities, but in others there seems to be a passage by alternation. Francis *et al.* (1970, p. 124) correlated this sandstone with the Spout of Ballagan Sandstone of the Campsie Fells. The section below is in rather inaccessible exposures either side of the waterfall, and **considerable caution** must be exercised when examining even the lowest beds. Polygonal, sand-filled, desiccation cracks and poorly preserved trace fossils may be observed in some parts of the section.

	Thickness (m)
Sandstone, white, calcareous, mostly coarse- and very coarse-grained, with rare layers of calcareous pebbles and greenish grey mudstone clasts. Top baked hard by sill above	3.04
Sandstone greenish white, calcareous, silty, mostly very fine-grained	1.52
Mudstone, purplish grey, with calcareous nodules	0.23
Sandstone, mostly white, calcareous, mostly fine- and very fine-grained, but medium-grained at the base, which contains greenish grey mudstone clasts	3.05
Mudstone, purplish grey, silty and sandy, with indefinite calcareous concretions. Bed split by a lens of white, fine-grained sandstone, which includes a 5-cm bed of calcareous granules towards its top	1.46
Sandstone, greenish white, micaceous, very fine-grained, with thin, greenish grey, muddy siltstone laminae. Dip steepens to 70° against plane of Abbey Craig Fault	2.23

A landslide in till on the east bank currently provides the most acceptable route out of the gorge from the waterfall. Walk uphill on the more gentle slope to the east of the burn, by-passing the waterfall, and continue to where the burn crosses the foot of the escarpment formed by the lavas. Here there is a spectacular view northwards over the Holocene tidal flats and overlying raised peat-mires of the Carse of Stirling and over the steeply upturned Lower Devonian sedimentary rocks on the north flank of the Strathmore Syncline. Beyond the Highland Boundary Fault the peaks of the Southern Highlands are composed of Dalradian metamorphic rocks. At least some of the clastic detritus that formed the sedimentary succession that has just been examined was derived from those Dalradian rocks. The view to the east is almost equally impressive and includes the escarpment of Abbey Craig, capped by the Wallace Monument, and that below Stirling Castle, both formed by components of the Midland Valley Sill-complex. Beyond lies the steep scarp where the Early Devonian volcanic pile of the Ochil Hills is abruptly truncated by the West Ochil Fault, with softer, younger Carboniferous rocks preserved on the southern, downthrown side.

Locality 9.6 [NS 7073 9295] Base of the Clyde Plateau Volcanic Formation

Here the irregular slaggy base of a mugearite or albitised trachybasalt, which locally forms the lowest flow of the formation, is underlain by a soft, reddish brown, bole-like, clayey material, which may be a highly decomposed tuff. Similar rocks have been considered by Craig (see Excursion 10) to be typical of his proximal volcanic facies, which is closely associated with lines of vents and major dyke feeders. This exposure indicates the close proximity to the south of the ENE–WSW North Campsie Linear Vent System, which was the source of the overlying lavas. The junction between this bole-like material and the Downie's Loup Sandstone below is here obscured by talus. It is exposed in the Fintry area some 10 km to the WSW, where there are indications of an upward gradation from the sandstone into highly decomposed tuff or volcanoclastic detritus immediately below the lava pile. From here walk about 250 m NE, below the

foot of the lava escarpment to the entrance to Dinnin Quarry.

Locality 9.7 [NS 7085 9310] Dinnin Quarry: Downie's Loup Sill

The sill is an unusual trachybasaltic rock that has been albitised and chloritised. In the quarry the sill has thickened to more than 18 m and has transgressed upwards to a higher stratigraphical horizon within the Downie's Loup Sandstone. The lower half of the sill contains large feldspar phenocrysts, but these are absent from the upper half, which is also finer grained. The rough columnar jointing remains perpendicular to the chilled top of the sill as the latter curves downwards on the west side of the quarry face, indicating that the sill transgresses downwards in that direction. From the quarry, walk NNW down the slope to the gate on the north side of Dinnin Wood [NS 7079 9338] and return by the track to rejoin the road back to Gargunnock.

(Table 10.1) Characteristics of proximal and distal basaltic sequences

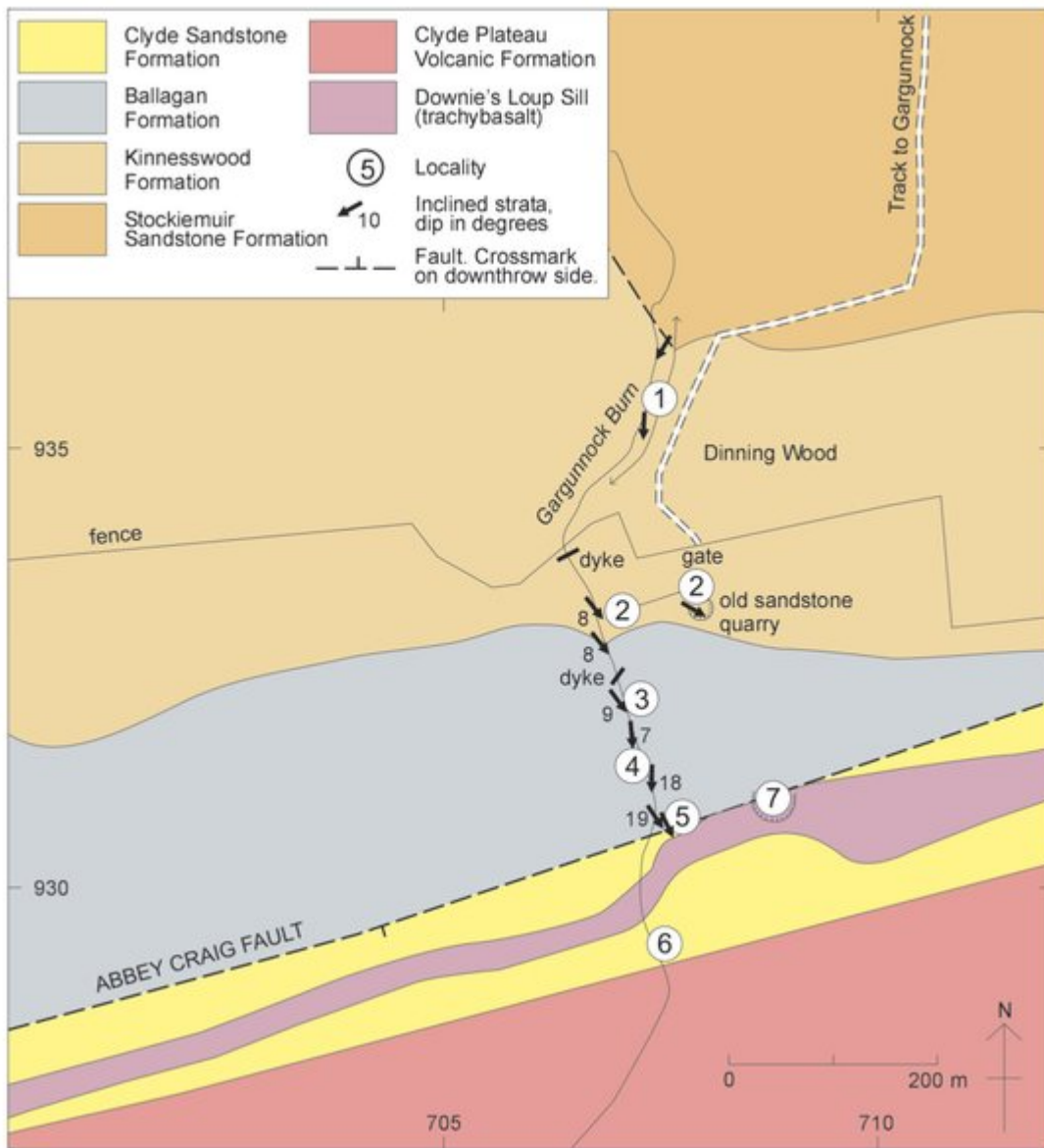
Proximal

- fragmental rocks form high proportion of sequence
- blocks, scoria bombs and spatter usually present
- thick units of chaotic, coarsely fragmental rock common
- thickly stratified sequences of tuffaceous material common, usually incorporating blocks and bombs
- lava flows commonly compound and highly vesicular
- lava texture relatively coarse grained with ophitic clinopyroxene
- extensive bright red steam oxidation common in fragmental deposits close to conduit
- irregular minor basaltic intrusions common in sequences close to vents
- major columnar jointed basaltic intrusions commonly associated with conduit systems
- veins of intrusive tuffisite occasionally present in sequences adjacent to conduits
- sills commonly intruded in sedimentary strata beneath base of volcanic pile

Distal

- lava flows form high proportion of sequence
- blocks, scoria bombs and spatter always absent
- coarse fragmental deposits only thinly developed on upper flow surfaces
- tuffaceous material present only in thinly stratified sequences between flows
- lava flows commonly in form of simple, uniform sheets of predominantly massive character
- lava texture generally fine grained with granular clinopyroxene
- red-brown bole commonly restricted to interflow fragmental deposits
- intrusions rare and always in form of dykes

[References](#)



(Figure 9.1) Geological map of the area around the Gargunnoch Burn, showing localities for Excursion 9.



(Plate 9.1) Locality 9.1. Sandstone resting erosively on red mudstone, Kinnesswod Formation, Gargunnock Burn.



(Plate 9.2) Locality 9.2. Quarry exposure of nodular bed of calcrete, Kinnesswod Formation.

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