Dow Hill, Byne Hill and Ardmillan Braes - an excursion

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From: Lawson, J.D. and Weedon, D.S. (editors). 1992. Geological excursions around Glasgow & Girvan. Glasgow : Geological Society of Glasgow.

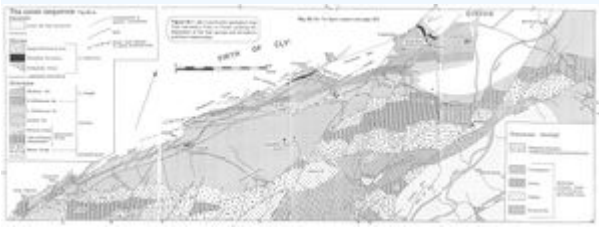

Figure 28.1. a,b A panoramic geological map from Kennedy's Pass to Girvan showing the disposition of the main groups and formations and their re lationships.

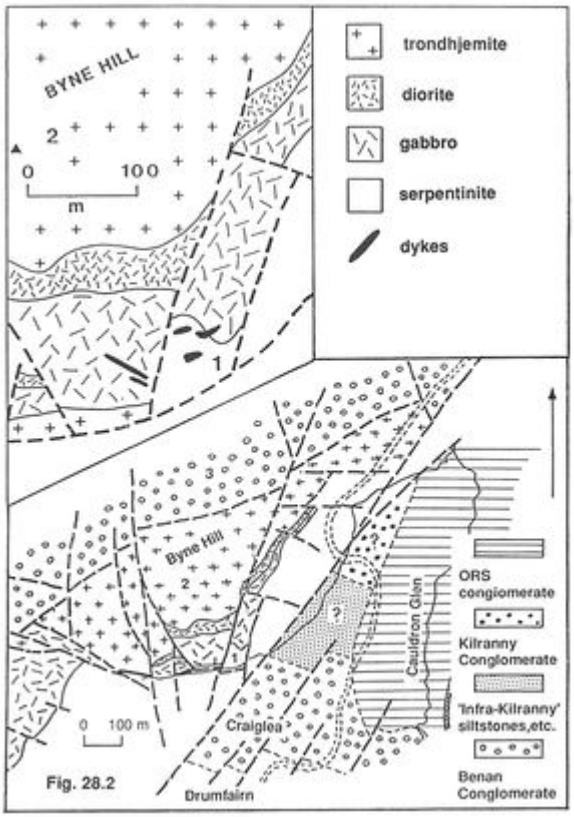

Figure 28.2. A detailed geological map of the southern end of Byne Hill (see also (Figure 28.1).
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Key details

Author	B. J. Bluck and J. Keith Ingham
Themes	To examine intrusive rocks and their relationships within the Ballantrae Volcanic Complex; in particular to examine the contact between the intrusive gabbroic rocks and the serpentinite; to trace the transition between gabbro and trondhjemite and to examine the conglomerates (Benan Conglomerate) which form part of the summit of Byne Hill and the summit of Dow Hill; to examine part of the fossiliferous cover sequence above the Benan Conglomerate–the 'Infra-Kilranny greywackes and mudstones (Balclatchie Group) of the western flanks of Byne Hill and on Dow Hill and to examine the fossiliferous lowest Ardwell Flags at Ardmillan Braes.
Features	Serpentinite, rodingite, trondhjemite, diorite, chilled margins, conglomerates, mass flows, greywackes, mud-stones, trilobites, brachiopods, deep water faunules.
Maps	O.S. 1:25 000 Sheet 490 (NS10 NX19) Girvan 1:50 000 Sheet 76 Girvan B.G.S. 1:50 000 Sheet 7 Girvan
Terrain	Rough walking, steep hillside, scrambling in places.
Distance and Time	About 9 km , 5.6 miles (maximum), 4–5 hours, depending on time spent at each locality.
Access	Cars and buses should be parked alongside Girvan Cemetery, just off the Newton Stewart road (A714) to the south of Girvan.

Locality 1. Dow Hill [NX 192 960]: Benan Conglomerate, fossiliferous Balclatchie mudstones (Figure 28.1)b

From Girvan Cemetery, the isolated, near conical Dow Hill can be seen a short distance to the east. Access is obtained by crossing the main road, negotiating a field gate beyond which can be seen an underpass beneath the railway line leading down into Girvan. Beyond this a short climb will lead you to the exposures around the summit of the hill.

Dow Hill is composed largely of Middle Ordovician Benan Conglomerate (essentially Llandeilo in age) which has been offset by sinistral wrench faulting from the main outcrop of Byne Hill ((Figure 28.1)b). Exposures are extensive on and around the summit and detailed mapping shows the outcrop to be traversed by a number of small sinistral wrench faults. The succession youngs towards the NW and the beds dip quite steeply in this direction. The Benan Conglomerate here is thought to rest unconformably on serpentinite (Ballantrae Complex) but no exposures are available between the summit of the hill and the major Craiglea Fault which follows the line of the sharp valley immediately to the SE.

In a number of places along the NW face of the summit the conglomerate can be seen passing into

the finer-grained sandy beds at the base of the so-called 'Infra-Kilranny' unit (part of the Balclatchie Group of early Caradoc age) but a rather larger than usual sinistral wrench fault brings back muds tones a little higher in this unit to crop out in a well marked excavation by the fence on the southern side of the summit. The Benan Conglomerate is described and characterized under Locality 4. The overlying mudstones seen in the exposure mentioned above have been excavated over many years and there are extensive samples from this classical locality in a number of museum collections. The fauna is a relatively low diversity one and reflects an offshore environment in which the sea bed had foundered somewhat. Inarticulate brachiopods are relatively common but the well preserved trilobites are what usually attract collectors to this locality. The most common species by far is the blind raphiophorid *Lonchodornas maccalltoni* (Figure 30.9) but other forms can usually be found with a little diligence. This is the type locality for the strange trinucleid *Reedolithus subradiatus*, the genus being known from rocks of almost the same age in eastern Canada and Norway. The bizarre remopleuridid *Teratorhynchus bicornis* can also be found, together with two or three other, largely pelagic forms (see Tripp 1980a).

Locality 2. Byne Hill: Benan Conglomerate, serpentinised harzburgite. (Figure 28.1b)

From Dow Hill, return to Girvan Cemetery and follow the track down to Daltippan farmyard. From this track a splendid view of the Benan Conglomerate outcrop forming the steep NW face of Byne Hill can be seen. The beds are dipping steeply seawards and the outcrop is cut by a number of small sinistral and dextral wrench faults. Follow the track through the farmyard beyond which it climbs and twists towards the north-eastern bluff of Byne Hill where Benan Conglomerate can be seen at outcrop for some distance. The stream below Byne Hill here, immediately to the east and draining north from Cauldron Glen, contains a number of exposures of sheared serpentinite (Ballantrae Complex), caught up along the large Craiglea Fault ((Figure 28.1)b). Continue following the path leading to Drumfairn Farm at Craiglea along the steep flank of Byne Hill above Balaclava Wood. Part way along this path, on the bank to the right and opposite a row of trees above the Craiglea Fault negative feature, is an exposure of serpentinised harzburgite. This represents upper mantle material, originally beneath oceanic crust, and now caught up within the Ballantrae Complex. Its significance in terms of the large scale crustal movements which must have been taking place in Early Ordovician, and perhaps earlier, times, is very important.

At the point where this path curves sharply SE to cross a small stream (at [NX1833 9466]), leave the track, climbing up somewhat to continue along and above the wall alongside the foot of Byne Hill. This wall follows approximately the boundary between serpentinite and gabbro, which is about 20–30 m to the west. Continue until the wall turns sharply WSW.

Locality 3. [NX 181 944]. Junction between the gabbro-trondhjemite intrusion and the serpentinite (Figure 28.1)b, (Figure 28.2)

The low ground here and in the burn immediately to the east is made up of serpentinite and the main gabbro mass of this part of Byne Hill has chilled against the serpentinite to give a vertical wall of doleritic rock at (a). Tracing away from this margin up the hill the rock becomes coarser grained and gabbro ic. Cutting this vertical wall, and also cutting the serpentinite within this outcrop are white dykes a few tens of centimetres thick. These are dykes of hydrogrossular garnet (rodingite), which are fairly abundant along the coast (Excursion 25) and in the main mass of the northern serpentinite inland. This vertical contact between gabbro and serpentinite is displaced by a vertical

NNE-SSW trending fracture immediately to the west and makes a clear feature. A similar and parallel fracture truncates the outcrop to the east and brings in serpentinite in the lower ground.

Ascend to the summit of Byne Hill and as one ascends examine the rocks with care for the presence of incoming quartz. They show a fairly gradual transition between gabbro-diorite-trondhjemite. The trondhjemite is distinctive; it is pale pink in colour, rich in quartz and foliated.

Locality 4. Byne Hill summit [NX 178 945]: Trondhjemite; a spectacular view of the Firth of Clyde and the local geology (Figure 28.1)b

There are abundant exposures at and around the summit of Byne Hill and it is from this locality that zircons have been extracted from the rock which date it at 482±5 Ma, this being an Early Ordovician (Arenig) age. Trondhjemites and associated gabbros and diorites are thought to have formed either in the magma chamber beneath ocean ridges or by some fractionation process which takes place after the plate has moved off the ridge. In any case, the trondhjemite, being silica rich, normally accumulates at the top of the magmatic sequence so that here it is associated with the sheeted dyke complex and the lava pile (Figure 25.1). With respect to these outcrops (Localities 3 & 4) a number of points are worth making:

1. The gabbroic rocks associated with the trondhjemite are chilled against serpentinite, and are therefore associated with mantle rocks deeper in the magmatic pile than rocks towards the top.

2. Although there is much evidence for structural jumbling within the serpentinite, discussions in Excursion 26 conclude that the protolith to the serpentinite crystallised at depths greater than 25 km. The trondhjemite on the other hand is a high level intrusion, so it is clear that the serpentinite was uplifted prior to the intrusion of the gabbrotrondhjemite complex. However, the timing of the intrusion of this complex in relation to the timing of obduction is unclear. The ages (and their errors) of both the trondhjemite at 482 ±5 Ma and of the amphibolite in the metamorphic zone beneath the serpentinite at 476±14 Ma overlap so much that they are of no help. However it is clear from the chemistry of the trondhjemite mass that during its generation it saw no continental crust, so a genesis in a fully oceanic realm is evident.

3. Although the contact between serpentinite and gabbro is now almost vertical, if the gabbro-trondhjemite sequence was intruded before the folding of the obduction zone (?post cover sequence folding) then it would need to be untilted by the amount of dip of the metamorphic sole. This sole dips towards the NW at c. 45 ° so that the Byne Hill-Grey Hill intrusion, when untilted around the pole to this dip would then turn out to be a northerly dipping sheet rather than a small, vertical pluton. Similar rotation of the folded cover sequence at Byne Hill, to which the intrusions form a monoclinal core, produces similar results.

From the summit of Byne Hill a good deal of the local geology together with its regional context can be seen. To the west, in the Firth of Clyde, lies the Tertiary volcanic plug of Ailsa Craig. This is an arfvedsonite microgranite which has been used extensively in the past for the manufacture of curling stones. Beyond this, on a fine day, it is possible to see Kintyre (Late Proterozoic Dalradian metamorphic rocks of the Grampian terrane) and to the NW the Isle of Arran. Along the coast to the SW lies Kennedy's Pass which exposes, among other things, the Kilrarmy Conglomerate of the Lower Palaeozoic cover sequence (beginning of Excursion 30) and beyond that the coast of Antrim. Almost due west on the foreshore is Woodland Point, where the Lower Silurian rests unconformably on the Ordovician. To the left of it lie the long, straight sectors of the Whitehouse and beyond that the Ardwell foreshores with their spectacular and varied Mid-Late Ordovician sequences. To the right of

Woodland Point lies the Myoch foreshore, also a particularly important Late Ordovician site: beyond that to the north lies the upstanding Craigskelly rock and the adjacent foreshore, mostly Silurian. The entire cover sequence seen along the foreshore from this vantage point has near vertical dips and youngs seawards, thus emphasising the essentially monoclinal structure of this entire coastal tract. To the north and NE lies the Upper Palaeozoic cover of the Midland Valley of Scotland, the long, low hill immediately to the north of the Girvan Valley (Craighead Inlier–Excursion 31) being the most northerly place where the Ordovician cover sequence overlaps the obducted Ballantrae Complex 'basement'.

Locality 5. Benan Conglomerate with a variety of igneous clasts (Figure 28.1)b

The Benan Conglomerate is well exposed along the northwesterly ridge of Byne Hill. It is a massive, boulder-bearing conglomerate of Llandeilo-earliest Caradoc age, with clasts of various granites and porphyries, together with a variety of basic igneous rocks which are thought to have their provenance in the underlying Ballantrae Complex. There are only a small number of clasts of metamorphic rock and these are mainly quartz rich. The composition and ages of the granite boulders have been studied in detail. Most of the granites are hornblende-bearing, high level intrusions and have Rb-Sr whole rock mineral ages which range from 559±20–466±13 Ma: one has a Pb-Pb age of 475 ±3 Ma (Longman et al. 1979). Some of these dates are only a little older than the chronometric age assigned to the chronostratigraphical date of the conglomerate itself. This conglomerate was probably deposited on a foundering sea floor as part of a fan-delta complex (Ince 1984) which drained a major plutonic-volcanic arc. As many of the clasts are boulder sized, the immediate source was not distal; and as the palaeoflow for the conglomerate is from the north, then a plutonic-volcanic arc within the Midland Valley is suggested as being present at this time. It was evidently an uplifted area in which the plutons were being unroofed rapidly by erosion. The Benan Conglomerate in the Byne Hill area is estimated to be less than 200 m in thickness. This contrasts strongly with areas to the SE, just north of the Stinchar Valley (Excursion 26), where it is substantially thicker.

Locality 6. SW side of Byne Hill: Benan Conglomerate and 'Infra-Kilranny' greywackes (Figure 28.1)b

Descend the hill along strike to the SW to the wall. Following it around the foot of the hill toward the NW the outcrop of the Benan Conglomerate, striking over from the western crest of Byne Hill, is traversed and a number of exposures of the typical lithology are visible on the lower flanks. Further along, as one progressively descends, still following the wall, a number of exposures of fine, weathered sandstone or greywacke is seen above it. These constitute basal beds of the 'Infra-Kilranny' greywackes (Balclatchie Group) which overlie the Benan Conglomerate and form the lower slopes to Byne Hill on the seaward side. A search through this material for only a few minutes will yield trilobite debris belonging largely to the genera *Remopleurides* and *Calyptaulax* , together with a variety of brachiopods. Complete trilobites are not unknown.

Locality 7. Ardmillan Braes [NX169 938]

Basal Ardwell Flags, trilobites, brachiopods, thrust, Benan Conglomerate ((Figure 28.1)a). From the SW side of Byne Hill the itinerary is optional. Either, one can proceed down the hill towards the foreshore at Woodland Farm (Black Neuk) and pick up Excursion 30 at Locality 11, or one can proceed southwards for a brisk moorland walk of about 1.5 km, aiming for the small streams

surrounded by extensive gorse bushes beyond Ardmillan Burn above the wall behind Ardwell Farm. This gorse covered moorland site is known as Ardmillan Braes and was, at the beginning of this century, a favourite picnic and collecting spot for members of the famous Gray family from Edinburgh whose world famous collections are now largely housed in the Natural History Museum in London.

There are three small streams at this site. The middle one has the critical section: it is now deeply embedded in gorse bushes but perseverance will be rewarding. A small 'waterfall', usually dry, identifies the locality and there is abundant evidence of collecting activities. The most profitable rock is the weathered kind from the top of the section on the south side of the stream from which with diligence and a small, deftly used hammer a wide variety of brachiopods, including *Rostricellula ardmillanensis*, and trilobites, many complete, can be obtained. Again, as on Byne Hill, *Remopleurides* and *Calyptaulax* predominate but otherwise quite rare forms such as *Hemiarges* and *Isoteltis* can be found (see Williams 1962; Tripp 1980a).

The locality can further be identified by an exposure above the north bank a short distance above the 'waterfall'. Here a small bluff of Benan Conglomerate has been thrust over strongly sheared shale.

From this locality proceed down the slope, negotiate the wall and then follow the track down to the coastal road at Ardwell Farm. A number of exposures of steeply dipping, typical Ardwell Flags will be seen on the way. At Ardwell Farm, Excursion 30 can be picked up at Locality 3 and if all, or part, of this excursion is followed it is only a short walk along the lane from Shalloch Mill, near Myoch Bridge (Locality 11) to where cars may previously have been parked by Girvan cemetery near Daltippen Farm.

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