Kentallen

[NN 0091 5766]–[NN 0135 5822]

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Introduction

The Kentallen intrusion is a member of the Duror of Appin cluster of appinitic diorite intrusions (see the Ardsheal Hill and Peninsula GCR site report) and is the type locality of 'kentallenite', a melanocratic olivine monzonite with unusually high MgO (15%) and K_2O (2.5%). The rocks post-date deformation and metamorphism of the Dalradian country rocks but pre-date emplacement of the Ballachulish granite pluton (Bowes, 1962). The rock lentallenite' was described by Teall (1888, 1897) and its occurrence was described by Hill and Kynaston (1900), Bailey and Maufe (1916) and Bailey (1960). More recently the field relationships have been described by Bowes (1962), Bowes and Wright (1967) and Platten (1966) and the petrology by Weston (1968), Wright and Bowes (1979) and Hamidullah and Bowes (1987). The area lies within the aureole of the Ballachulish pluton which has been described by Pattison and Harte (1985). The site was revisited for this review and new data were obtained about the Kentallen intrusion margin and the sequence of igneous, hydrothermal and structural events. The name 'kentallenite' has been formally replaced by olivine monzonite and should now only be used in the strictly local context.

Description

The Kentallen intrusion is about 0.6 x 0.3 km (Figure 8.39), typical of many of the Appinite Suite plugs. Short sections of near-vertical contact can be seen at two places and the general topographical relationships suggest that the entire northern contact must be steep. The northern and southern contacts are grossly discordant to the strike of the host rocks while the eastern margin is broadly concordant. The body is thus a steeply plunging pipe. The bulk of the observed intrusion is emplaced in semipelite and quartzite of the Appin Phyllite and Limestone Formation but the eastern margin is in contact with a dolomitic member. The intrusion exhibits a relatively uniform interior but varied marginal rocks and structures.

The interior of the intrusion is composed of a uniform melanocratic olivine monzonite ('kentallenite') (Figure 8.39) which is well exposed in the railway and road cuttings. The rock is composed of olivine, diopside, plagioclase, orthoclase, anorthoclase, phlogopite, magnetite and apatite. The olivine and diopside are coarse grained, most being 2–8 mm, but rare elongate olivine crystals may reach 20 mm. The crystals are euhedral to subhedral and are densely packed, approaching a grain-supported fabric. Plagioclase occurs as small interstitial tablets. Phlogopite crystals are large, 10 to 30 mm, and poikilitically enclose the plagioclase and mafic minerals. Alkali feldspar either overgrows plagioclase or forms poikilitic crystals. Rare examples of rootless veins and patches of coarse, leucocratic feldspar-biotite rock, superficially similar to the interstitial minerals of the olivine mon-zonite, are seen in displaced blocks on the coast. Xenoliths and enclaves are generally absent.

Changes occur in the main olivine monzonite towards the contacts. The phlogopite shows a marked decrease in grain size (from >10 mm to <1 mm) and a change from poikilitic to interstitial texture. The olivine is much less abundant and the large (>10 mm) olivine crystals are absent. Colour index is reduced and olivine and pyroxene crystals are well separated from each other. Some enclaves of a porphyritic facies with very fine-grained matrix are present locally, close to the outer margin. This finer-grained margin abuts directly against country rock in the east but in the north and south is separated from the country rocks by sheets of diverse, earlier contact facies rocks.

The early contact fades is best exposed on the coast just south of Sron Garbh (Figure 8.39). The earliest rock is a very fine-grained porphyritic 'kentallenite' with pyroxene and olivine phenocrysts in a very fine-grained matrix, the 'large lamprophyre body' of Bowes (1962). Traced south this shows a rapidly gradational, near-vertical contact with pyroxenite. The pyroxenite is a clinopyroxene-phlogopite-plagioclase rock that is coarser grained (5–10 mm pyroxene) than most other rocks in the intrusion. Olivine appears abruptly to the south and the rock becomes a phlogopite–clinopyroxene-bearing peridotite. The phlogopite crystals in these ultramafic rocks form a subpoikilitic framework and show evidence of cataclasis and kinking. This is succeeded southwards by pyroxene-olivine meladiorite and then the slightly chilled margin of the main 'kentallenite'. The meladiorite shows fine, millimetre-scale, vertical layering at and near the contact.

Two marginal intrusions are emplaced between the country rock and the early contact facies rocks in the Sron Garbh section. The first is a medium-grained pyroxe ne-hornblende-biotite diorite that carries conspicuous xenoliths of the Appin Quartzite. This diorite locally carries small numbers of pyroxene phenocrysts. The second is a pyroxene-biotite diorite with large (5 mm) pyroxenes that carries a rounded xenolith of chilled porphyritic 'kentallenite'.

The country rocks at the northern margin (Figure 8.39), (Figure 8.40) and (Figure 8.41) show a conspicuous antiform with an axial trace parallel to the contact. The fold style is concentric with multiple, angular hinges, local decollement planes, changes in profile along the fold axial surface and minor box folds. Domains of breccia consist of plate-like fragments of siliceous metasedimentary rock in a white microgranite matrix. Major and minor fold hinges ,show bedding-normal, wedge-shaped, gaping tensile fractures filled by microgranite. These veins are rootless. The southern limb of the antiform is the most disturbed with an extensive breccia of pelite and quartzite clasts. These breccias contain 4–8 mm-diameter altered pyroxenes, olivines and hornblendes similar to those found in the adjacent marginal intrusion.

Four dyke sets cut the Kentallen intrusion (Figure 8.39). Microdiorite dykes, Set Dk1, trending NNE and ENE and white feldsparphyric microgranodiorite dykes, Set Dk2, are cut by granite veins and show fine-grained biotite and amphibole of hornfels origin in their matrix. An ENE-trending, hornblende microdiorite dyke, Set Dk3, with fresh, wholly igneous texture, cuts the hornfelsed microdiorites of Set Dkl and one granite vein in the Sron Garbh section. A pink porphyritic microgranodiorite, Set Dk4, lacks secondary, hornfels-generated biotite and has a turbid altered appearance. It is cut by fracturing on the south side of Kentallen Bay that also affects the Kentallen intrusion. Relationships between Dk3 and Dk4 are not seen.

Four hydrothermal events have been recognized at Kentallen. (H1) Granular textured calcite veins occur as en echelon, concordant and discordant sheets in Dalradian rocks south of Sron Garbh. (H2) An early phase of hydrous alteration, with development of disseminated iron sulphides, is thought to have affected both the marginal rocks of the Kentallen intrusion and the early dykes of sets Dk1 and Dk2. These altered rocks have been extensively recrystallized by later contact metamorphism due to the Ballachulish pluton. (H3) The Kentallen intrusion contact in the Sron Garbh section is displaced by faults containing quartz veins. These lack an obvious drusy texture and contain <1% of pyrite and chalcopyrite. They are cut by granite veins and dykes of sets Dk3 and Dk4. (H4) The exposures on the south side of Kentallen Bay are cut by drusy-textured quartz-calcite-chal-copyrite veins associated with crushing and chlorite growth in the igneous rocks.

Two episodes of faulting are indicated at the site. NNE-trending faults lined with quartz (H3, above) cut the Kentallen intrusion and some Dkl microdiorites in the Sron Garbh section. One is seen to be cut by a granite vein. These faults dip east at low to steep angles and have oblique-slip, normal and reversed movements. The second faulting event produced a sinistral offset of the margin of the Kentallen intrusion across Kentallen Bay (Figure 8.39) and some dextral and sinistral, oblique-slip, small faults dissecting the igneous rocks in the bay.

The Kentallen area lies within the inner aureole of the Ballachulish pluton (Pattison and Harte, 1985) and the northern part of the site shows good exposures of pelitic, semipelitic and calcareous hornfels. Calc-silicate rocks and granular calcite rocks are present, but poorly exposed, all along the eastern margin of the area. The pelitic rocks are coarse-grained cordierite hornfels with 2–10 mm poikiloblastic cordierite and local rootless veins of mobilized granitic material. Leucocratic biotite granodiorite dykes (trending NNE and ESE) with traces of yellow sulphides and lacking chilled margins cut the entire area. Contact metamorphic effects on fresh olivine monzonite are negligible, but hydrothermally altered igneous rocks develop contact metamorphic pyroxene, amphibole and biotite. The aureole obliterates most metamorphic effects associated with emplacement of the Kentallen intrusion.

Interpretation

The olivine monzonite ('kentallenite') is considered to be derived from magma represented by the porphyritic chill facies, which are similar to other chilled rocks in the Appinite Suite. Following the interpetation of similar rocks by Platten (1991), in-situ wall crystallization from a convecting magma formed the pyroxenite and peridotite cumulates of the marginal zones. Cataclasis of phlogopite in the pyroxenite and peridotite reflects the internal, gravitational deformation of these rocks while they formed weak layers with interstitial fluid that were only supported on one side. Temporary cessation of convection allowed crystallization of meladiorite at the walls. New, more mafic, magma was introduced into the pipe, displacing the existing magmas and triggering partial collapse and removal of the wall cumulates and initial chilled facies. This new magma quenched on the walls, trapping enclaves of penecontemporaneous fine-grained porphyritic rock and forming the relatively fine-grained outer facies of the main intrusion. Settlement and accumulation of olivine and pyroxene phenocrysts in the centre of the pipe led to the formation of the typical olivine monzonite ('kentallenite) with its densely packed olivine and pyroxene crystals. Compaction of this mass then expelled some interstitial residual liquid to form the leucocrat-ic biotite monzonite segregations. The marginal intrusions at Sron Garbh may have been emplaced during collapse of the early contact facies rocks (Platten, 1983).

The time relationships of some events are reinterpreted here. The marginal fold at Sron Garbh is considered by Bowes and Wright (1967) to pre-date the Kentallen intrusion and to control its site of emplacement. The presence in the associated breccias of igneous material derived from the Kentallen intrusion and the rootless microgranite veins and patches in the fold hinges point to the fold forming in hot country rocks during emplacement of the Kentallen intrusion. The extensive fracturing south of Kentallen Bay was interpreted by Bowes and Wright (1967) as an important initial stage in the emplacement of the Kentallen intrusion. However, the recognition here that this fracturing affects the intrusion, and even later rocks, removes any link with emplacement. The fracturing is considered to be related to movements in the nearby Great Glen Fault-zone.

An extended sequence of late Caledonian magmatic, hydrothermal and structural events established at the site, can be summarized as follows.

1. Calcite veins (H1) are considered to pre-date the Kentallen intrusion; their texture results from contact metamorphism by the Ballachulish granite.
2. Kentallen intrusion emplaced in at least two stages and marginal fold formed.
3. Emplacement of Set Dkl microdiorite and Set Dk2 leucocratic porphyritic microgranodiorite dykes.
4. Faulting and quartz vein emplacement (H3), post-dating microdiorite. Early Great Glen Fault movement.
5. Ballachulish granite emplacement and associated contact metamorphism of the products of events 1, 2 and 3 above.
6. Emplacement of Set Dk4 pink porphyritic microgranodiorite dykes.
7. Faulting, extensive shattering, chloritization and quartz-chalcopyrite-calcite vein emplacement (H4). The low temperature assemblages are considered to indicate that the fractures post-date hornfelsing due to the Ballachulsh granite. Late Great Glen Fault movement.

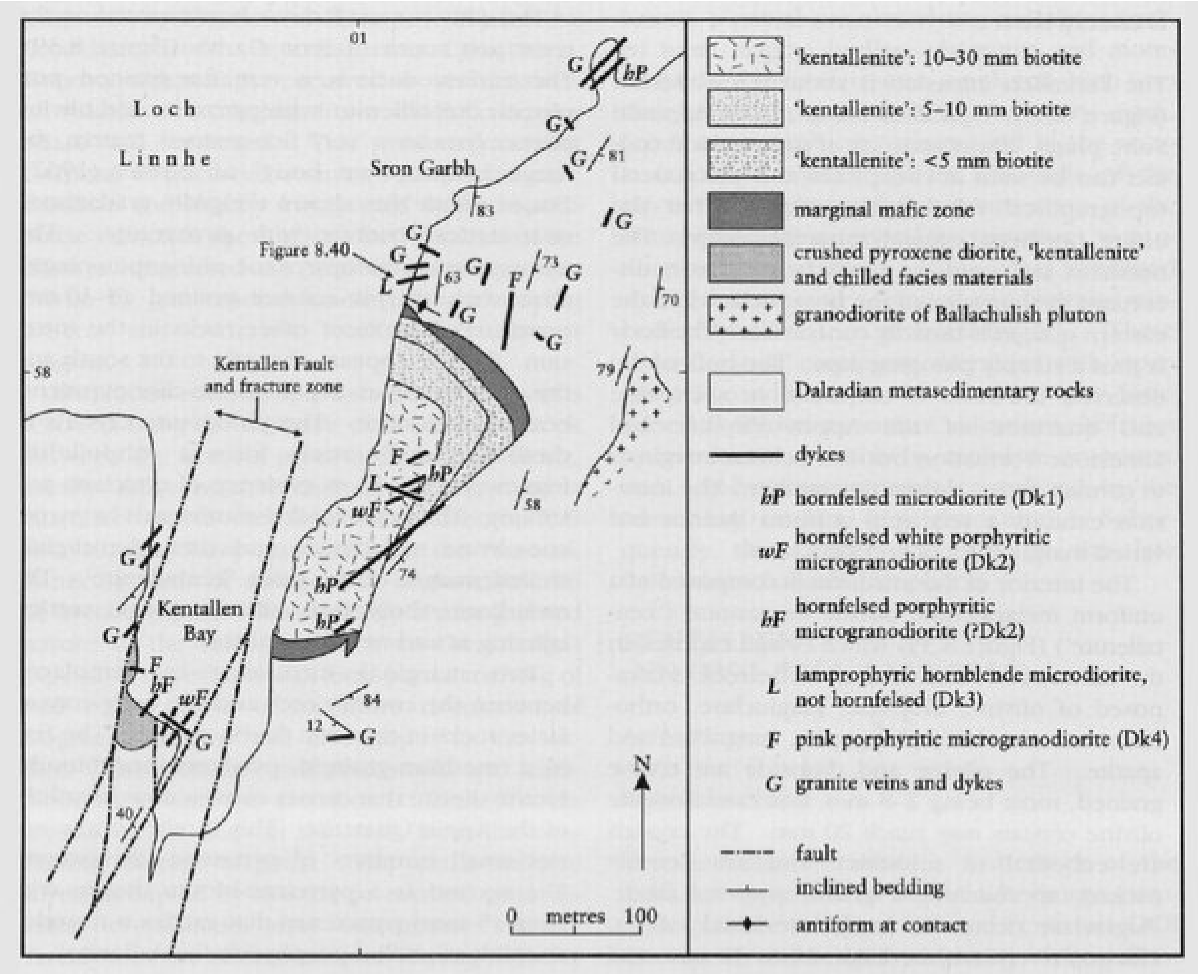
Certain events are only partly dated relative to this sequence. The extensive recrystallization of the Kentallen intrusion marginal zones and of the early Dk1 and Dk2 (event 3) dykes indicates that they had been reduced to a hydrous mineralogy that was unstable under prograde contact metamorphism during emplacement of the Ballachulish granite. This implied alteration (collectively termed H2) is most closely related in time to the emplacement of the Kentallen intrusion but is likely to post-date the main intrusive phases. It clearly pre-dates event 5 but time relationships with event 4 are unknown. Hornblende microdiorite dykes of Set Dk3 postdate event 5 but relationships with events 6 and 7 are unknown.

Conclusions

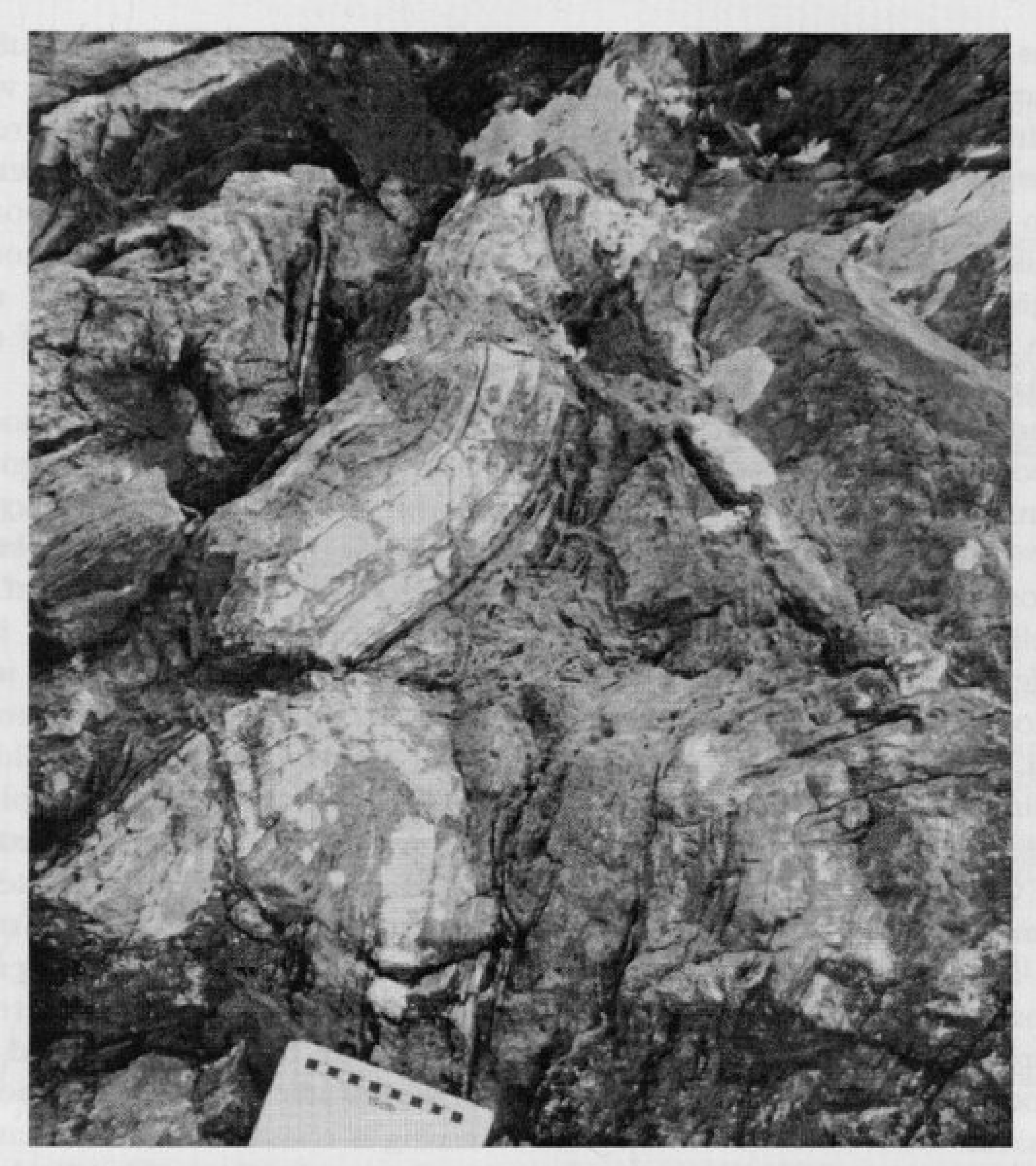
The Kentallen GCR site exposes a small intrusion of olivine monzonite, which is part of a large cluster of intrusions and breccia pipes in the type area of the Appinite Suite (see the Ardsheal Hill and Peninsula GCR site report). The olivine monzonite, which is unusually MgO and K_2O rich, is a distinctive lithology that was formerly termed 'kentallenite' after this, the type locality. The contact facies are particularly well exposed and the location, within the aureole of the Ballachulish pluton and close to the Great Glen Fault-zone, together with the wide range of igneous, hydrothermal and structural events that can be recognized, enable a complex sequence of time relationships to be determined.

The intrusion was emplaced in at least two stages, after the main deformation and metamorphism of the Dalradian country rocks, but prior to two sets of dykes, hydrothermal alteration, early movement on the Great Glen Fault and subsequent emplacement of the Ballachulish pluton. This was followed by the intrusion of two further sets of dykes, extensive shattering, hydrothermal alteration and veining and later movements on the Great Glen Fault.

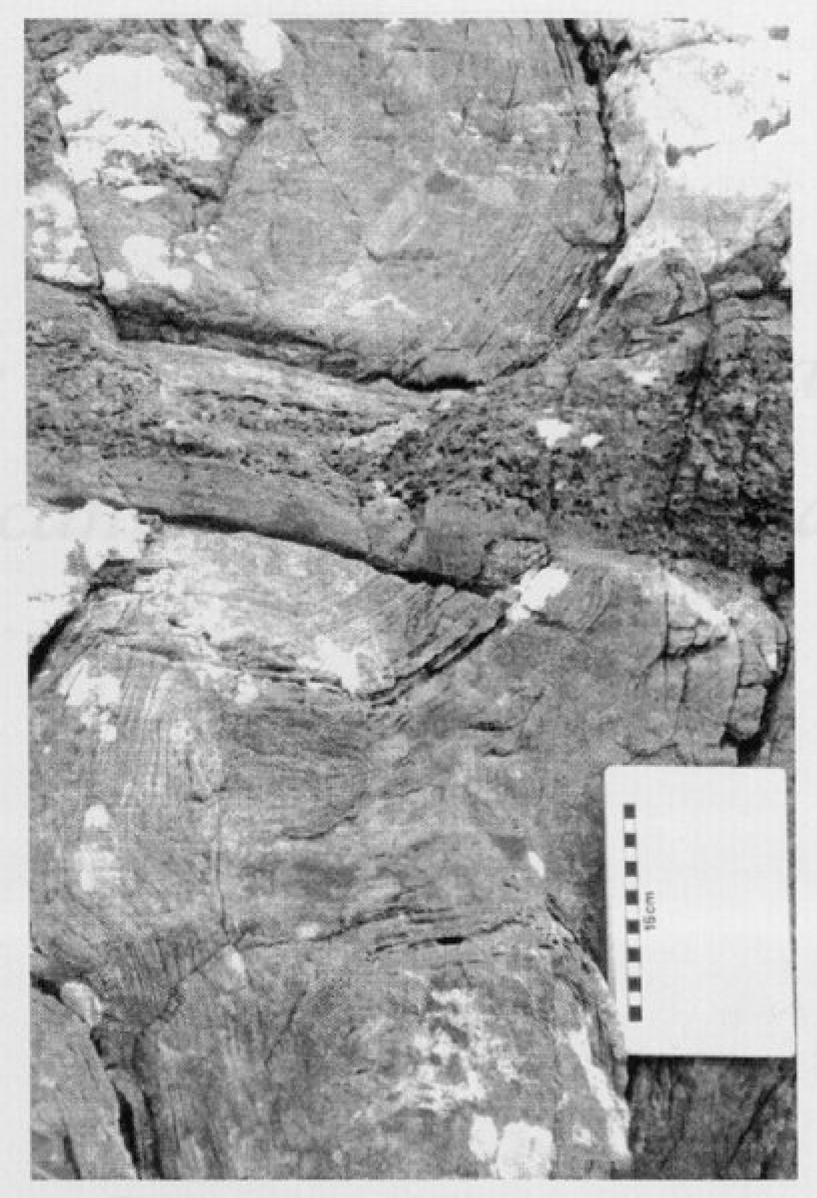
[References](#)



(Figure 8.39) Map of the Kentallen appinitic intrusion.



(Figure 8.40) Disharmonic minor folds at the margin of the Kentallen intrusion in the Sron Garbh section; view looking east. A 0.15 m-thick layer of quartzite on the left shows concentric folding (bottom) and fracture and pull-apart (top). A patch of breccia composed of 10 to 30 mm-long plates in a matrix of fine-grained micro-granite occupies the space between differently folded adjacent layers (centre). A set Dk1 dyke cuts the structures at the top of the photograph.



(Figure 8.41) Microdiorite dyke of set Dk1 cutting minor folds at the northern margin of the Kentallen intrusion; view looking east. The dyke shows axial concentration of mafic phenocrysts. The folded layer shows radial granitic veins forming a fan around the hinge (top). Traced downwards, this layer forms a box fold with few veins, but its core (centre) is mobilized and the bedding has been destroyed. The mobilized area forms a detachment surface isolating another fold closure (beside the scale), which shows an irregular mass of granite veins in the hinge and abrupt truncation of bedding on the upper limb. (Photos: I.M. Platten.)