CHAPTER 4: INTRUSIVE IGNEOUS ROCKS

Three categories of acid intrusive rocks have been recognised in the New England area (Browne 1929; Binns 1966; Flood 1971). Two of these groups, termed the New England Batholith and the Hillgrove Plutonic Suite have been described by Binns *and others* (1967), and Flood (1971) presented evidence to show that the western part of the New England Batholith is a separate suite, termed the Bundarra Suite. The main differences between the three suites are listed in Table 16.

Field and petrographic data reported here show that the plutons of the Rockvale - Coffs Harbour region can be placed into either the Hillgrove Plutonic Suite or the New England Batholith, even though several plutons in the eastern part of the area are not, physically, a part of the main batholith. Only those plutons occurring wholly within the field area and previously undescribed have been examined in this study. The aim has been to provide brief descriptions of the plutons as a background for describing the tectonic evolution of the area in Section II. The rock classification is based on that of Chayes (1957), as modified by Flood (1971). Methods used in modal analysis are discussed in Appendix III.

Plutons of the Hillgrove Plutonic Suite

As seen on Map 1, the boundaries of all intrusions are either discordant with, or faulted against, the country rocks, with the exception of the Dundurrabin Granodiorite which has northern and southern boundaries parallel to the strike of bedding in the sediments, possibly making it a concordant intrusion.

Dundurrabin Granodiorite

The Dundurrabin Granodiorite (Binns *and others*, 1967) is a west-north-west trending body of about 45 sq. km occurring 10 km northwest of Dorrigo. Neuss (1965) mapped the western portion and provided a brief petrological description of the intrusive rocks around Dundurrabin. This body has been emplaced into the Brooklana Beds and Moombil Beds producing biotite-cordierite hornfels adjacent to the contacts. Two small granitic

TABLE 16: A comparison of salient features of the three suites of granitic rocks in New England (based on Flood 1971, with additional information from Binns 1966, Binns *and others* 1967, and Gunthorpe 1970)

Feature	Bundarra Suite	Hillgrove Suite	New England Batholith
Location	A narrow north-south trending belt extending from Bendemeer to the Queensland border.	A north-east trending belt extending from Walcha to east of Guyra.	Adamellites occupy central portion of New England between other two suites. Leuco-adamellites scattered over a wide area.
Main Rock Types	Biotite muscovite Leucoadamellites; biotite adamellites.	Biotite and biotite-hornblende granodiorites.	Hornblende-biotite and biotite adamellites; Leucoadamellites and granodiorites.
Texture	Coarse-grainsize; phenocrysts of K-feldspar; massive in outcrop.	Medium to coarse-grained; weak to strongly developed foliation.	Coarse-grained; some K-feldspar phenocrysts; massive in outcrop.
Mineralogy: Quartz		Abundant, at least 30%; blue colour.	Less than 30 modal percent.
Mineralogy: K-feldspar	Dominantly microcline.	Well-twinned microcline.	Perthitic orthoclase.
Mineralogy: Biotite	Red-brown colour.	Red-brown, strongly pleochroic.	Drab-brown colour.
Mineralogy: Horn-blende	Rare to absent.	Rare; pale to colourless if present.	Common, deep-green colour.
Mineralogy: Muscovite	Present.	Absent.	Absent.
Mineralogy: Opaque Oxide	Ilmenite	Ilmenite	Magnetite
Mineralogy: Other	Cordierite	Accessory garnet	
Geo-chemistry	Low Fe_2O_3/FeO ratio Low CaO High Sr^{87}/Sr^{86}: .708 to .709	Low Fe_2O_3/FeO ratio Low CaO High Sr^{87}/Sr^{86}	High Fe_2O_3/FeO ratio High CaO Low Sr^{87}/Sr^{86}: .704 to .705
Age	294 m.y. ("granite" north of Bundarra) to 270 m.y. (Bannalasta Adamellite). From Leitch (1973) and Chappell (1973).	269 m.y. (Hillgrove Adamellite, Cooper *et al.* 1963) to 252 m.y. (Abroi Granodiorite, Binns & Richards 1965).	244 m.y. (Wards Mistake Adamellite, Binns & Richards 1965) to 224 m.y. (Round Mountain Leucoadamellite, Binns & Richards *op. cit.*)
Other	Bent biotites and other microscopic deformation; sedimentary origin for xenoliths.	Syntectonic; two intrusions associated with regional metamorphics; other intrusions have poorly developed contact aureoles. Sedimentary origin for xenoliths.	Post tectonic; pronounced contact aureoles. Xenoliths igneous in origin.

inliers, which emerge from beneath the basalt, occur 2 km north and 2 km east of Dorrigo, and because of their petrological affinities, are allied with the Dundurrabin pluton.

The pluton is composed predominantly of coarse to medium-grained granodiorite and adamellite and is frequently porphyritic in K-feldspar with minor hornblende-bearing phases. Some dykes occur, associated with the pluton, but are not common, and are found mainly in the western portion.

The typical coarse-grained granodiorites and adamellites show a wide modal variation but consist of large phenocrysts of microcline (up to 10 mm x 10 mm) set in a medium-grained groundmass (2-5 mm) which is a hypidiomorphic-granular aggregate of stout plagioclase laths, biotite flakes and anhedra of quartz. Xenoliths are abundant and the coarser rocks have a weakly developed foliation in places, due to the alignment of biotite.

Most K-feldspar grains occur as irregularly-bounded phenocrysts up to 10 mm x 10 mm that often poikolitically enclose grains of all other phases. Microcline, showing cross-hatched twinning is common, and orthoclase is minor in comparison with microcline. The K-feldspars are commonly perthitic. Plagioclase laths average between 1 mm and 3 mm in length and are generally subhedral. They show only minor normal zoning and are of oligoclase composition (average of 5 determinations of β_{Na} = 1.543 corresponding to An_{19}, range β_{Na} = 1.540 - 1.547, An_{14} - An_{29}). Neuss (1965) reported a zoned plagioclase with a core of β_{Na} = 1.549 (An_{33}) and a rim of β_{Na} = 1.537 (An_8). Quartz is always anhedral and occurs as irregular masses up to 5 mm long.

Euhedral to subhedral plates of biotite (α - straw-yellow; $\beta\gamma$ - deep red-brown) up to 3 mm across tend to occur as clusters and occasionally show a preferred orientation. Opaque oxides, probably ilmenite, are an accessory phase. Apatite crystals occur as small inclusions within quartz masses. Secondary alteration is minor with chlorite and sphene being the main products.

Associated with the coarse-grained phase, which lacks hornblende, is a series of small finer-grained phases which contain hornblende ranging in abundance from 7 to 40%. Neuss (1965) mapped two dioritic phases in the western part near Dundurrabin. Other, more acidic phases, occur in the east towards Bostobrick. These phases are characterised by the presence of hornblende and a feldspar ratio where plagioclase dominates over K-feldspar (P/F = 0.95 to 0.98). Plagioclase, commonly zoned, occurs as equant subhedral laths 0.3 - 1 mm in size. K-feldspar is anhedral, being moulded around plagioclase grains. Quartz (0.2 - 0.5 mm) is anhedral and very irregular in outline. Biotite exhibits a similar pleochroic scheme to that in the coarse granodioritic phase (α- straw-yellow; $\beta\gamma$- deep red-brown) and occurs as subhedral to anhedral aggregates up to 0.5 mm in size. Hornblende (α- colourless to pale green; β- pale green to brown-green; γ- green) occurs as subhedral prismatic crystals up to 0.5 mm long and also forms large (up to 4 mm) clusters of anhedral crystals. Opaque oxides are rare. Secondary alteration has resulted in the production of chlorite, sericite and sphene.

Xenoliths are abundant in the coarse granodiorite and adamellite phases. Those observed range from 2 cm to 10 cm in diameter and are mafic-rich compared to the host rock. The xenoliths show a diffuse contact with the host and have a similar mineralogy but enriched in mafic minerals, possibly indicating that the xenoliths and host may have a close genetic relationship.

In some specimens (e.g. S32852, S32850) the xenoliths are fine-grained equivalents of the host, the only difference being an increase in biotite in the xenoliths. All minerals exhibit the same characteristics as the minerals in the host. In S32848 sphene and hornblende (α- pale yellow; β- pale green; γ- green) occur away from the edge of the xenolith at a distance of about 10 mm from the host. In S32849 the xenolith appears to contain three distinct zones each with a different mineralogy. Moving away from the host these zones are:

1. quartz-feldspars-biotite-rare hornblende
2. quartz-feldspars-hornblende
3. quartz-feldspars-clinopyroxene-orthopyroxene

These zones occur at 0 - 8 mm, 8 - 15 mm and $\geqslant$15 mm from the host, which has a very diffuse contact with the xenolith. The origin of the xenoliths is obscure but some appear to be hornfelsic (e.g. S32847) and are possibly of sedimentary derivation. The diffuse margins suggest contamination of the host rock.

Evidence of strain occurs on a microscopic scale in all rocks although there is little evidence of deformation on the scale of the outcrop. Biotite flakes are bent and kinked, the twin lamellae in plagioclase are distorted, and occasionally feldspar crystals have been fractured. Quartz has undulose extinction and deformation bands occur. A sutured-granoblastic texture is common in the quartz.

Modal analyses for representative specimens from the Dundurrabin

Granodiorite are listed in Table 17 and QPKf and MFQ diagrams are shown in Fig. 18. The data of Neuss (1965) are also plotted for comparison. The following points emerge:

1. The coarse-grained rocks occupy a unified field on the MFQ diagram and show little variation in the ratios of plagioclase to total feldspar (P/F = 0.52 to 0.66). These rocks resemble other members of the Hillgrove Suite in their relatively high contents of quartz and biotite.
2. The hornblende-bearing phase varies from a trondhjemite (29% quartz) to a diorite (7% quartz). Proportions of K-feldspar, plagioclase and biotite remain relatively constant. There is an inverse relationship in the proportion of quartz to hornblende.
3. The xenoliths differ markedly in proportions of quartz (6% and 30%) and feldspar (P/F = 0.67 and 0.90). The mafic constituents are more abundant than in their coarse-grained host rocks.

Two small intrusions to the east of the Dorrigo basalts are very similar to the Dundurrabin Granodiorite. The intrusion to the north of Dorrigo township is a coarse-grained, xenolithic, porphyritic granodiorite (S32843) strongly related in mineralogical composition to the coarse phases of the Dundurrabin mass. The intrusion to the east of Dorrigo is a leucoadamellite (S32845) which is thought to be an acidic phase related to the Dundurrabin Granodiorite. Neuss (1965) also reported a leucocratic phase from the western part of the pluton.

Sheep Station Creek Complex

The Sheep Station Creek Complex (Binns *and others* 1967) crops out over 30 sq. km approximately 5 km northwest of Dundurrabin. A small portion of the southern part has been mapped by Cronk (1973) who described five separate intrusions in approximately 7 sq. km. In order of decreasing age these are: a gabbro with a tonalite component; granodiorite; microadamellite with a chilled border; coarse-grained adamellite; leucoadamellite. This Complex has intruded the Moombil Beds and Brooklana Beds producing a biotite-cordierite zone approximately 500 m wide along its southern edge. Garnet in the hornfels adjacent to the contact is very localised in occurrence and samples in which it occurs have probably suffered thermal effects from both the Sheep Station Creek Complex and the Dundurrabin Granodiorite.

Only the coarse-grained adamellite phase of Cronk (1973) has been

Table 17: Modal Analyses of Hillgrove Suite Batholiths

Specimen	Quartz	K-feld-spar	Plagio-clase	Biotite	Horn-blende	Opaques	Secondary Minerals	Chlorite pseudo-morphs
				Dunburrabin Granodiorite				
32842[1]	28.4	24.7	32.7	13.2	-	0.2	0.2	0.6
32846[1]	34.9	16.8	32.7	15.3	-	0.3	-	-
32851[1]	32.0	26.6	29.9	11.1	0.2	0.1	0.2	-
32853[1]	36.6	20.1	30.2	12.8	-	-	-	0.3
Average	33.0	22.1	31.4	13.1	-	0.1	0.1	0.2
32843[2]	29.5	11.3	43.1	16.0	0.1	0.1	-	-
32845[2]	32.5	39.8	24.8	2.9	-	0.1	-	-
32854[3]	29.0	2.2	51.4	9.2	6.7	-	0.3	1.1
32844[3]	15.5	0.7	61.0	10.8	11.2	-	0.5	0.4
32855[3]	7.1	1.1	43.7	10.0	37.0	1.1	-	-
32852[4]	6.2	19.3	39.4	34.3	-	0.4	-	0.5
32848[4]	29.9	4.2	38.0	22.2	2.9	2.2	0.7	-

[1] Coarse-grained porphyritic granodiorite or adamellite.

[2] Small intrusions north and east of Dorrigo.

[3] Hornblende-bearing phases with P/F $>$ 0.95.

[4] Xenoliths from coarse-grained phase.

				Sheep Station Creek Complex				
32856[5]	26.3	19.9	39.5	12.6	0.2	0.1	1.3	-

[5] Coarse-grained adamellite phase.

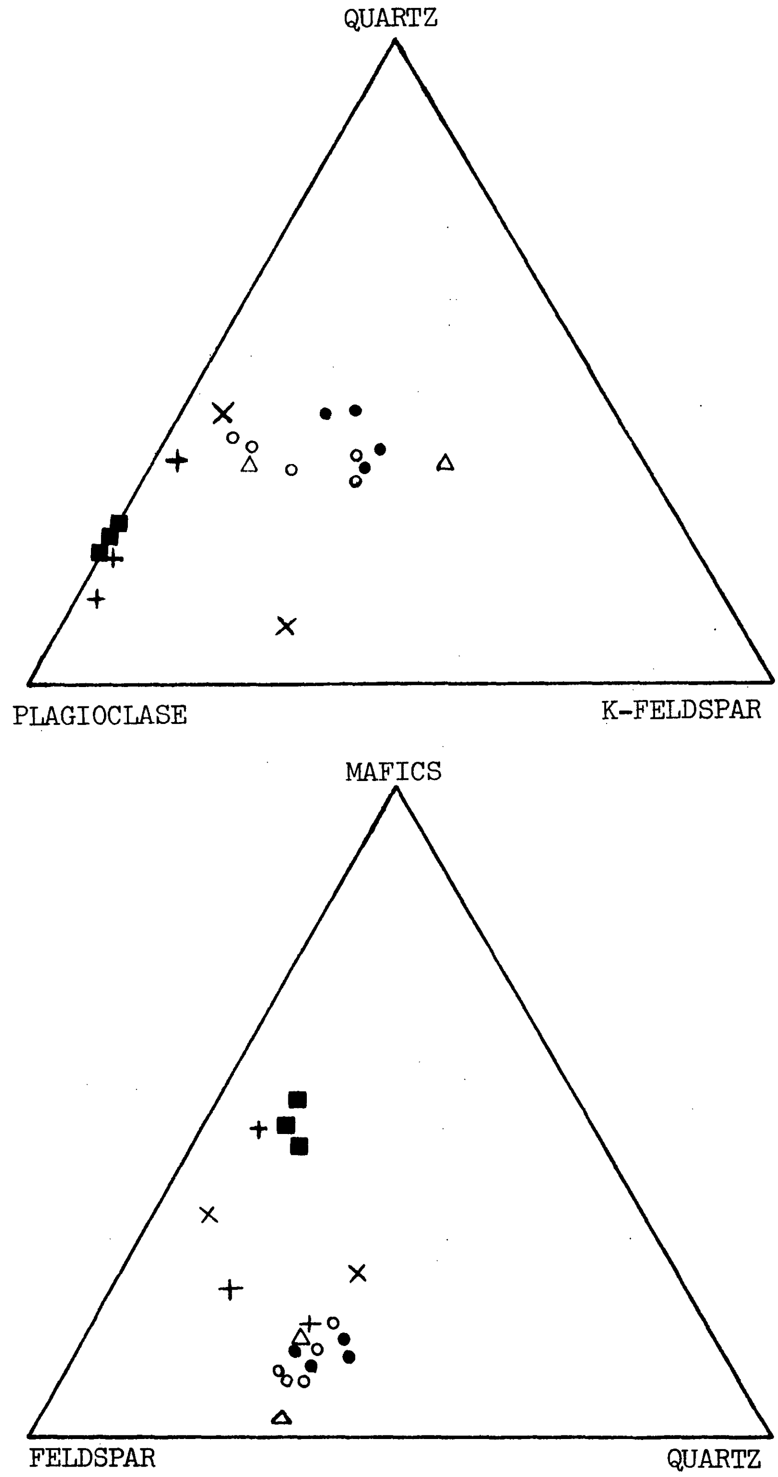


Fig. 18: QPkf and MFQ diagrams for phases associated with the Dundurrabin Granodiorite.

Key: • - coarse porphyritic phase, ▲ - small intrusions east and north of Dorrigo, ✚ - hornblende-bearing plagioclase rich phase, ✖ - xenoliths, o - granodiorites from Neuss (1965), ■ - diorites from Neuss (1965).

examined here. The alignment of biotite flakes has produced a weak foliation. Petrographically it has an hypidiomorphic-granular texture with phenocrysts of microcline set in a coarse-grained groundmass. Quartz shows undulose extinction and biotite (α- straw-yellow; $\beta\gamma$ - dark red-brown) is bent and kinked. A modal analysis (Table 17) indicates that this phase is an adamellite occurring close to the adamellite-granodiorite boundary (P/F = 0.66). Cronk (1973), who described in detail the petrography, modal analyses and geochemistry for the five phases she identified, considered that the pluton is syntectonic.

Other Plutons from the Hillgrove Suite

The Dorrigo Mountain Complex and Glenifer Adamellite have been described previously by Leitch (1972). The Dorrigo Mountain Complex consists of a microdiorite intruded by a later microadamellite and is considered by Leitch (*op. cit.*) to be a pre-tectonic or syn-tectonic intrusion. The Glenifer Adamellite has been emplaced across the faulted boundary between the Coffs Harbour Block and the Nambucca Fold Belt and is considered by Leitch to be a late-tectonic pluton.

The northern portion of the Hillgrove adamellite occurs in the field area and is thought to be a composite body in which the intrusion previously known as the Bakers Creek Diorite (Binns *and others* 1967) is possibly a marginal phase (M.G. Farrand, pers. comm.). A K/Ar radiometric age of 269 m.y. has been reported by Cooper *et al.* (1963).

The Tobermory Adamellite, described in detail by Neilson (1965) and Binns (1966), invades the Girrakool Beds and is disrupted by the Glen Bluff Fault, east of which it intrudes the Wongwibinda Complex. A K/Ar date of 259 m.y. has been reported by Binns and Richards (1965).

The Abroi Granodiorite has been described in detail by Binns (1966) and Collerson (1967). Binns and Richards (1965) reported a K/Ar age of 252 m.y. for this intrusion which, according to Binns (1966), has been emplaced at a relatively late stage during the evolution of the Wongwibinda Complex. The granodiorite has a well developed gneissic foliation, resulting mainly from the preferred orientation of biotite flakes, and it appears to be a primary igneous flow structure (Binns 1966, Leitch 1972). The pluton intrudes the Early Permian Girrakool Beds and is itself intruded by the Round Mountain Leucoadamellite.

The Rockvale Adamellite-Granodiorite has been described by Greaves (1960) and Ransley (1964), and varies from massive adamellite in the north-west to foliated granodiorite elsewhere. It has intruded the Girrakool Beds producing only a small contact aureole of biotite-cordierite hornfels.

The Kookabookra Adamellite (Binns 1966) transgresses the northern part of the Wongwibinda Complex but is displaced by the Wongwibinda Fault which occurs through the intrusion as a prominent shear zone. The pluton is later intruded by the Wards Mistake Adamellite. It is a stressed intrusion with only limited mineralogical affinity with the Hillgrove Suite.

The Mornington Diorite (Binns 1966, Mason 1968) has been cut by the Wongwibinda Fault producing a shear zone, and is a composite intrusion varying from pyroxene-biotite diorite to biotite granite and aplite. Mason (1968) considers the Mornington Diorite postdates the Abroi Granodiorite and intruded into the high grade metamorphic rocks at a time between the cessation of the intrusion of the Hillgrove Suite and commencement of intrusion of the New England Batholith. Hence this pluton exhibits characteristics of both suites of plutonic igneous rocks.

The Camperdown Complex is a small (0.6 sq. km) composite body possibly related to the Hillgrove Suite. It intrudes both the Girrakool Beds and Abroi Granodiorite and has been described by Collerson (1967).

Igneous dykes varying in composition from porphyritic acid rocks to hornblende-lamprophyre occur in the Rockvale area to the north of the Rockvale Adamellite-Granodiorite. Here over 50 different dykes have been recorded and exhibit a preferred orientation of approximately 045° strike. Another dyke swarm occurs between the Chandler and Glen View Faults south of Wollomombi. Dykes and pods of tourmaline pegmatite occur within the Wongwibinda Complex around "Lynoch" Station. No petrographic study of these minor intrusions has been undertaken.

Plutons of the New England Batholith

There are almost no data available concerning the relative ages of the New England Batholith plutons of the Rockvale - Coffs Harbour region. All boundaries of the intrusions are either faulted against or are discordant with the country rocks.

Emerald Beach Adamellite

The Emerald Beach Adamellite derives its name from the coastal resort of Emerald Beach, occurs at the headland between Bare Bluff and Signal Hill, and has been described by Korsch (1971). It has intruded the Coramba Beds producing biotite-grade hornfels, and is a slightly porphyritic medium-grained adamellite. Modal data (Table 18) indicate a close mineralogical relationship between xenolith and host rock; the host being adamellite and the xenolith a tonalite (Fig. 19).

Randomly-oriented plagioclase laths have a composition of An_{17} (β_{Na} = 1.542) and are abundant over K-feldspar (P/F = 0.59 to 0.67) with which they have an inverse relationship (Fig. 20). Chlorite (penninite pseudomorphs after biotite) is common and, together with unaltered biotite, makes up about 10% of the total rock. In the xenolith mafic minerals are slightly more abundant (17%).

This stock is post-tectonic and has formed from a relatively quickly cooled, comparatively low-temperature magma. It has been intruded into the highest levels of the crust by permissive emplacement.

Tallawudjah Leucoadamellite

The Tallawudjah Leucoadamellite derives its name from Tallawudjah Creek, west of Glenreagh Village, and is a previously undescribed pluton that crops out over some 0.7 sq. km, 5 km south-west of Glenreagh. It has been emplaced into the Coramba Beds and its western boundary is covered by Mesozoic sediments. The intrusion is composed of phenocrysts of white feldspar (2 mm - 10 mm) set in a fine groundmass of feldspar, quartz and mafics, which have a grainsize usually less than 1 mm.

The rock has a porphyritic-granitoid texture. Tabular plagioclase crystals (0.55 mm to 5 mm) are common and are oligoclase in composition (β_{Na} = 1.545, An_{25}). Some zoned crystals are present. Orthoclase occurs in irregular, anhedral patches interlocking with quartz and frequently moulded around plagioclase and mafic constituents. Quartz is also anhedral and forms irregular masses that attain a longest dimension of 2 mm. There is no evidence of strain. Mafic minerals are not abundant (4%) and both biotite and hornblende are present. Biotite (α- pale yellow-brown; $\beta\gamma$ - dark drab brown) forms small descussate aggregates up to 1 mm across, while hornblende (α- pale yellow-green; β- olive green; γ - green) forms subhedral prismatic crystals up to 0.5 mm long. Accessory minerals are

Table 18: Modal Analyses of New England Batholith Intrusions

Specimen	Quartz	K-feld-spar	Plagio-clase	Biotite	Horn-blende	Opaques	Secondary Minerals	Chlorite pseudo-morphs
				Emerald Beach Adamellite				
17176	21.0	27.3	39.9	2.4	-	1.0	0.3	8.2
17177	21.4	23.3	43.2	8.1	0.1	0.9	0.0	3.1
17178	24.8	20.7	41.7	2.3	-	0.8	0.4	9.2
Average	22.4	23.8	41.6	4.3	0.03	0.9	0.2	6.8
Xenolith	15.3	10.1	54.4	0.1	0.1	2.6	0.8	16.7
				Tallawudjah Leucoadamellite				
32826	31.3	39.2	23.7	1.6	0.8	0.4	1.3	1.7
				Kellys Creek Leucoadamellite				
32827	29.4	40.8	25.0	4.2	0.2	0.4	-	-
32828	37.1	38.8	18.8	4.5	0.7	-	0.1	0.1
32831	33.3	37.7	22.1	4.3	2.1	0.4	0.1	-
32830	20.7	47.0	27.0	3.1	-	1.8	0.4	-
32832	31.8	41.2	21.7	5.3	-	-	-	-
Average	30.5	41.1	22.9	4.3	0.6	0.5	0.1	-
				Chaelundi Complex				
32837	27.9	14.5	47.6	-	-	-	-	10.0
32838	26.1	19.0	42.5	2.7	2.8	0.1	5.0	1.7
32839	34.9	27.5	27.7	5.7	0.9	0.2	0.4	2.6
32834	28.3	18.7	43.1	9.6	-	-	-	0.3
Average	29.3	19.9	40.2	4.5	0.9	0.1	1.4	3.7
				Unnamed Diorite				
32833	5.3	6.8	25.6	0.1	42.5	-	5.0	14.7

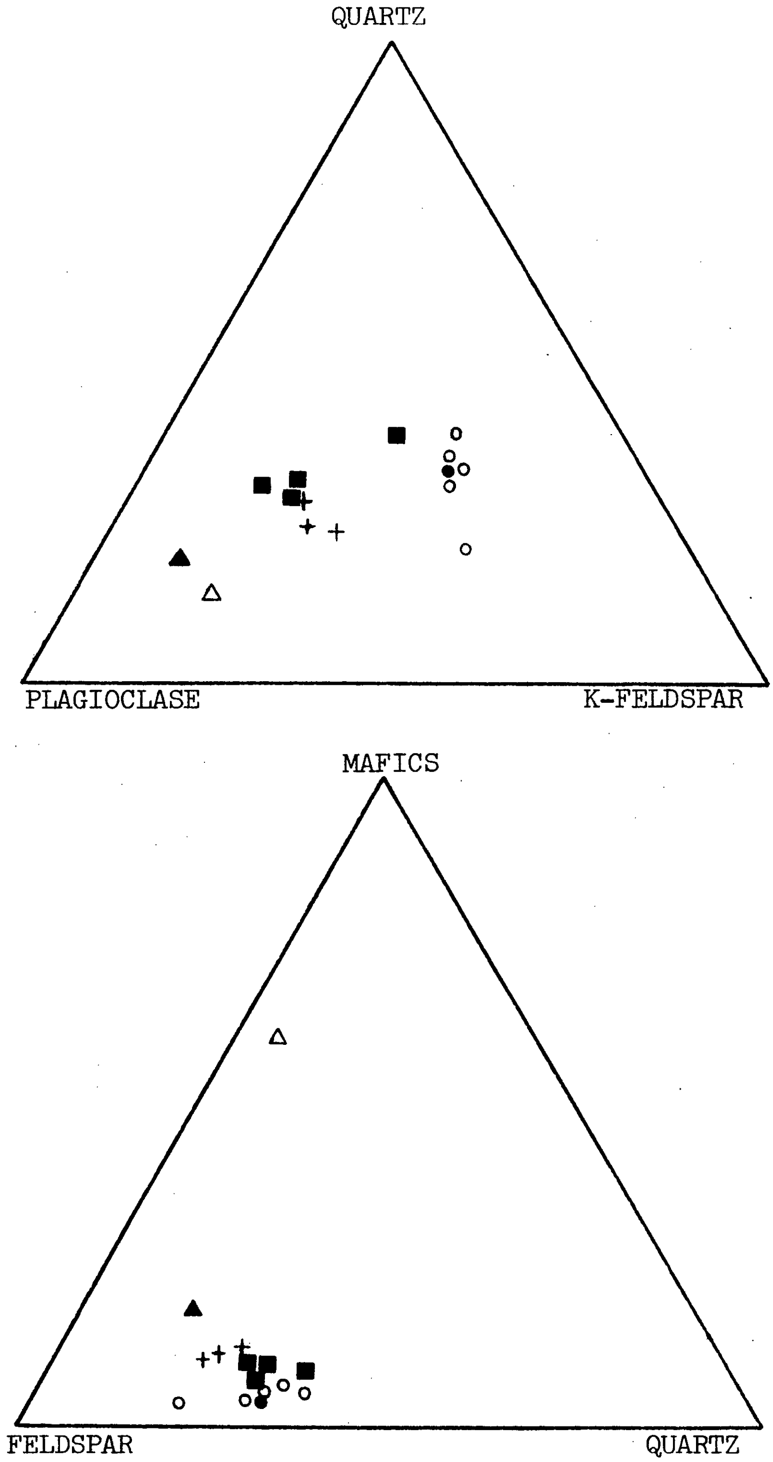


Fig. 19: QPKf and MFQ diagrams for intrusions from the New England Batholith.

Key: + - Emerald Beach Adamellite, ▲ - xenolith from Emerald Beach Adamellite, ● - Tallawudjah Leucoadamellite, o - Kellys Creek Leucoadamellite, ■ - Chaelundi Complex, △ - unnamed diorite.

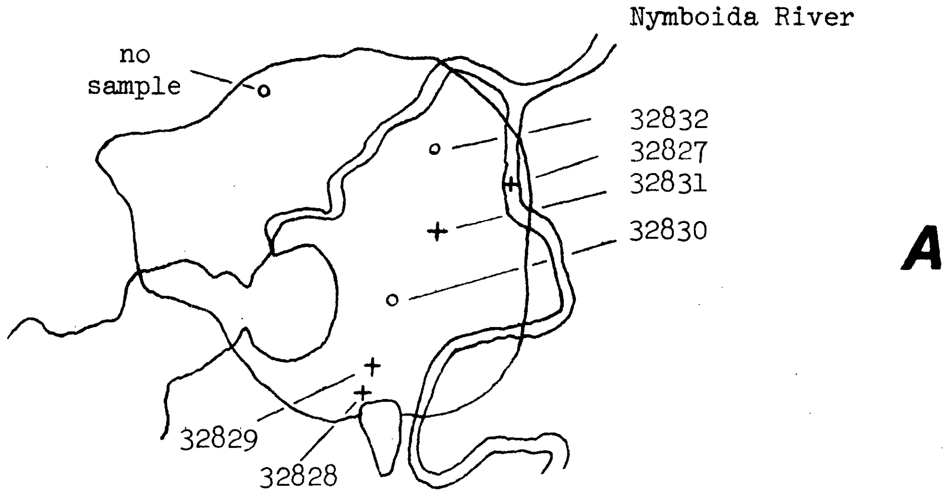
uncommon, with the opaque oxide being magnetite. Minor secondary alteration has resulted in chloritisation of biotite. Sericite, calcite and epidote have been produced by incipient alteration of plagioclase.

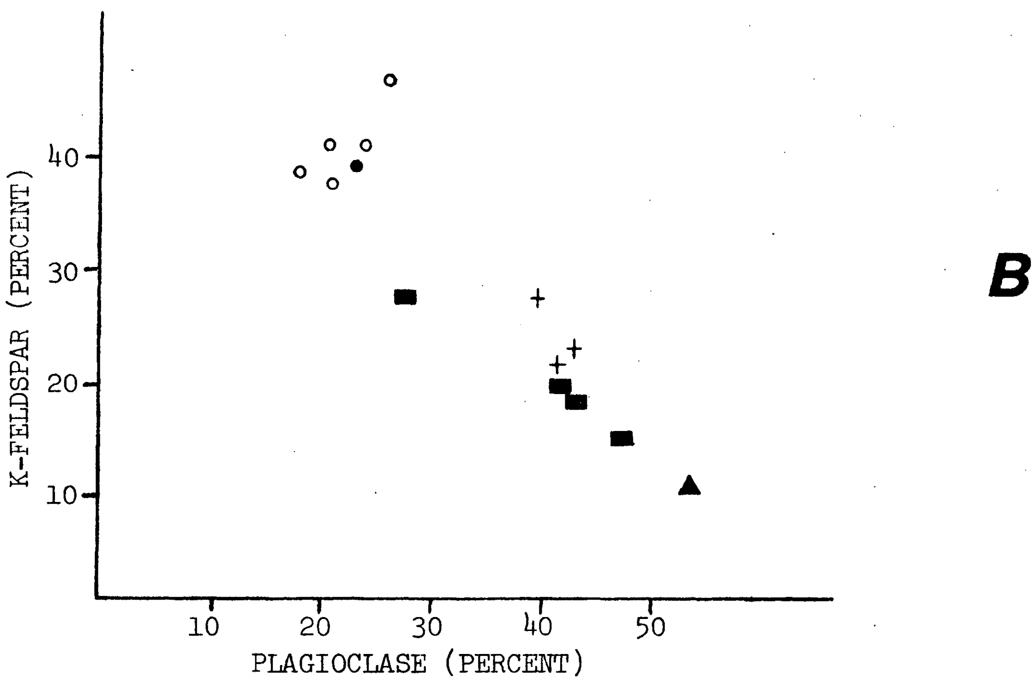
A modal analysis (Table 18) shows the dominance of orthoclase over plagioclase (P/F = 0.37) and this intrusion shows a strong similarity to the Kellys Creek Leucoadamellite which occurs approximately 20 km to the west.

<u>Kellys Creek Leucoadamellite</u>

This intrusion derives its name from Kellys Creek, which enters the Nymboida River near the western margin of the intrusion. It is a previously undescribed subcircular intrusion cropping out over an area of about 35 sq. km approximately 30 km south of Nymboida, and has intruded into the Coramba Beds producing biotite-cordierite hornfels. The pluton consists of two textural variants of leucoadamellite. One is a coarse-grained porphyritic rock with phenocrysts of K-feldspar (5 - 10 mm), quartz (1 - 5 mm), and minor biotite (0.5 - 2 mm) in a fine-grained groundmass ranging in size from about 0.05 mm to 0.2 mm. The other variety is a coarse (5 - 8 mm) to fine (0.5 - 1 mm) even-grained leucoadamellite. The spatial relationships of the two types (Fig. 20) are not certain due to limited sampling, but the even-grained rocks tend to occur in the northern part of the intrusion and the porphyritic phase in the southwest. No distinct contact between the two types were observed, but this does not preclude its existence. No xenoliths were observed in the intrusion.

The porphyritic phase contains randomly-oriented laths of plagioclase up to 5 mm long with a composition of An_{23} (β_{Na} = 1.544). The plagioclases are rarely zoned but often contain small intergrowths of anhedral quartz. K-feldspars are the most abundant phenocrysts ranging in size from 3 mm to 10 mm and consist of simple-twinned perthitic orthoclase laths. Quartz phenocrysts are subhedral in outline and rarely exhibit a slight undulose extinction. Biotite (about 0.55 mm long, α - straw-yellow; $\beta\gamma$ - dark brown-black) consists of both euhedral crystals and ragged outlines. Hornblende (α - pale green; β - olive-green; γ - sea green) occurs in some thin sections as phenocrysts (e.g. S32831) and consists of euhedral to subhedral simple-twinned crystals. Opaques, presumably magnetite, are an accessory phase. The groundmass consists of fine-grained anhedral aggregates of quartz, K-feldspar, plagioclase and minor biotite.





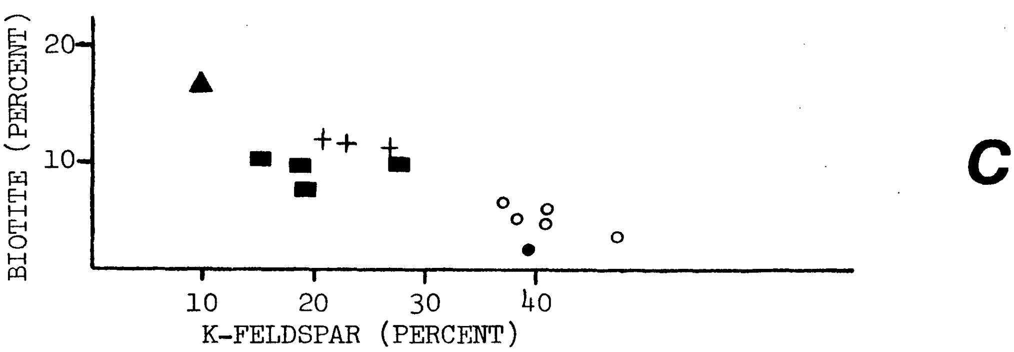


Fig. 20 A: Location of textural types in the Kellys Creek Leucoadamellite, o - even-grained, + - porphyritic.

B: Comparison of K-feldspar with plagioclase for rocks of the New England Batholith.

C: Comparison of biotite and K-feldspar for rocks of the New England Batholith.

Key for B and C is same as for Fig. 19.

The even-grained specimens have an hypidiomorphic-granular texture consisting of laths of plagioclase (An_{19}, β_{Na} = 1.543) surrounded by anhedral aggregates of quartz and perthitic orthoclase. Biotite (α- yellow-brown; $\beta\gamma$ - brown-black) is euhedral to ragged in outline. Anhedral magnetite is an accessory mineral.

Modal analyses (Table 18) and triangular diagrams (Fig. 19) indicate that the two textural types have very similar mineralogical compositions and hence have been possibly derived from the same magma but represent different cooling histories. A direct relationship between the proportions of K-feldspar and plagioclase exists (Fig. 20) and this contrasts with that for all other intrusions of the New England Batholith described in this thesis. An inverse relationship of K-feldspar to biotite exists and is consistent with other intrusions (Fig. 20). Modally, the Kellys Creek Leucoadamellite is very similar to the Tallawudjah Leucoadamellite. However the latter is only slightly porphyritic and is finer grained, which may be a reflection of the extremely small size of that intrusion.

Chaelundi Complex

The Chaelundi Complex, originally named the Chaelundi Adamellite by Binns *and others* (1967), is a large composite body of approximately 200 sq. km and occurs about 30 km north of Ebor. It is previously undescribed and has intruded the Moombil Beds and Brooklana Beds to the east, producing biotite-cordierite hornfels near the contact. The western boundary has been truncated by the Demon Fault. This fault has produced a mylonite zone approximately 20 m wide but further east the granitic rocks appear to be undisturbed by movement on the fault.

To the north at Newton Boyd, Brunker *et al.* (1969) mapped the Mt. Mitchell Adamellite on the eastern side of the Demon Fault. Work for this thesis has shown that no sediment occurs to the east of the Demon Fault between the Mt. Mitchell Adamellite and the Chaelundi Complex, and these plutons are coincident. Further work may prove that the Mt. Mitchell Adamellite west of the Demon Fault is the same as the Chaelundi Complex, with the Complex being displaced to the south by movement along the fault. This would require a dextral movement of approximately 29 km along the fault. Shaw (1964) considers that in the Tenterfield area, the Demon Fault has displaced the Stanthorpe Adamellite and the Bungulla Porphyritic-Adamellite with a transcurrent movement of the east block towards the south for a distance of 30 km. This agrees with the proposed distance of movement in the Chaelundi area. There has possibly been also a vertical component of movement with the east block rising relative to the western block.

At least three phases of intrusion are evident in outcrops of the Chaelundi Complex along the Guy Fawkes River. A "normal" biotite-hornblende adamellite occurs with approximately 10 -12% mafic minerals, and in places is porphyritic in K-feldspar. Xenoliths are abundant with two main types occurring: a very dark fine-grained type, and a lighter coarse-grained type. These are intimately associated with each other. Sometimes the xenoliths contain large porphyritic K-feldspars, and occasionally large blocks of hornfelsic sediments occur, some of which have retained their bedding planes. The xenolithic adamellite is cut by several aplitic dykes often up to 100 m wide. These dykes are massive and are dominantly non-xenolithic but occasionally contain fragments of the adamellite. The adamellite varies in places to granodiorite.

Near Kellys Creek (GR 5380 2970) a fine-grained leucocratic phase occurs. Almost no mafic minerals are present and the phase contains xenoliths of coarse-grained K-feldspar-bearing porphyritic-adamellite which suggest that the leucocratic rock is a later phase. Aplitic dykes occur but are very thin (usually less than 10 cm wide).

The specimens examined from the Chaelundi Complex have an hypidiomorphic-granular texture dominated by stout euhedral to subhedral laths of plagioclase that average about 5 mm in length. Some of the feldspar crystals are zoned but others are unzoned and have refractive indices of β_{Na} = 1.540 (S32834) and 1.541 (S32839) indicating compositions of An_{14} and An_{15}. K-feldspar, in the form of perthitic orthoclase, occurs both as euhedral phenocrysts up to 15 mm long and as anhedral aggregates moulded around other phases. Anhedral quartz occupies patches up to 5 mm in diameter, but graphic intergrowths with quartz are uncommon.

Biotite is the main mafic mineral and hornblende occurs in some specimens. Biotite (α- pale yellow; $\beta\gamma$- dark brown) occurs in plates up to 2 mm across, is typically subhedral and frequently exhibits ragged outlines. Hornblende (α - pale yellow green; β - olive green; γ - green) forms prismatic crystals up to 1 mm long with euhedral cross sections. Opaque oxides are a minor accessory.

The shearing produced by movement along the Demon Fault has had noticeable effects on the granitic rocks. Close to the fault the rocks are severely brecciated and a rock flour produced. Further to the east, quartz and feldspar show undulose extinction and are often fractured. Biotite, frequently replaced by chlorite, is severely kinked and deformed. Veins of epidote, calcite and sphene occur and become more abundant close to the fault. Specimen S32834 occurs 3 km east of the fault and appears to suffer no effects due to the fault movement. Micas are not kinked, and quartz only occasionally exhibits undulose extinction. There is no fracturing and veins do not occur.

Modal analyses (Table 18) and triangular diagrams (Fig. 19) indicate that three of the specimens micrometrically examined are granodiorites with P/F = 0.69 to 0.76. The other specimen is an adamellite with P/F = 0.50. The percentage of plagioclase is inversely proportional to K-feldspar (Fig. 20) while the biotite percentage appears to remain relatively constant with increasing K-feldspar (Fig. 20).

Other Intrusions of the New England Batholith

The Round Mountain Leucoadamellite is a typical post-tectonic member of the New England Batholith and has been described in detail by Binns (1966) and Collerson (1967). A radiometric age (K/Ar) of 224 m.y. has been reported by Binns and Richards (1965). The pluton intrudes the Dyamberin Beds and the Abroi Granodiorite, and there is no evidence of a later deformation after the intrusion of this late-stage pluton (Leitch 1972).

The Wards Mistake Adamellite (Binns 1966) has been the subject of an intense study by Neilson (1965, 1970). A radiometric age (K/Ar) of 244 m.y. has been reported by Binns and Richards (1965) making this massive intrusion one of the oldest in the New England Batholith. The intrusion has a wide modal variation and xenoliths are extremely abundant with dioritic xenoliths predominating over sedimentary and basic igneous types. The Wards Mistake Adamellite intrudes into the Tobermory Adamellite and Days Creek Gabbro.

The Days Creek Gabbro consists of two separate bodies believed to be younger than the Tobermory Adamellite and older than the Wards Mistake Adamellite (Neilson 1965). No work was attempted on this intrusion because of the detailed study by Neilson (1970).

The Aberfoyle River Adamellite-Porphyrite has been described by Neilson (1965, 1970) who considered it to be younger than the Wards Mistake Adamellite. No evidence of chilling at its margins was observed.

The Billy Goat Hill Monzonite (Ransley 1964) is a group of very small intrusions occurring to the west of the Rockvale Adamellite-Granodiorite. One body intrudes the Rockvale pluton indicating that the monzonite is younger than the larger mass.

The Oban River Leucoadamellite intrudes the Kookabookra Adamellite and the Wards Mistake Adamellite and has been described in detail by Neilson (1965, 1970). It is a coarse-grained massive intrusion containing no xenoliths. This pluton is considered to be one of the youngest intrusions in the field area.

The Henry River Granite was mapped by Brunker *et al.* (1969) and to date no petrological examination of it has been attempted. Part of the intrusion occurs in the north-west corner of the field area where it intrudes the Sara Beds. It is medium-grained porphyritic hornblende-biotite granite.

The Mt. Mitchell Adamellite was mapped by Brunker *et al.* (1969). It has been described by Mikulski (1973) to the north of the field area. Previous mapping indicated that a mass to the east of the Demon Fault was a faulted part of the Mt. Mitchell Adamellite. This pluton is here included in the Chaelundi Complex.

A very small unnamed dioritic mass occurs to the west of the Demon Fault about 5 km south-west of Newton Boyd School. It has an hypidiomorphic-granular texture and consists dominantly of mafic minerals (57%). Hornblende with three main pleochroic schemes (α- yellow-green, greenish-brown, yellow; β- green, brown, brown; γ - blue-green, brown, dark brown) occurs as euhedral to subhedral crystals 0.3 mm to 2 mm long. Plagioclase is dominant over othoclase (P/F = 0.79) and quartz occurs as anhedral blebs. There has been some secondary alteration with the development of actinolite, chlorite, zoisite, sericite and calcite. A modal analysis (Table 18) indicates that the rock is a monzo-diorite and, as can be seen on the MFQ diagram (Fig. 19), differs from other rocks described from the New England Batholith.

Igneous dykes occur in the Sara Beds west of the Demon Fault and in the Coramba Beds at Laytons Range (south of the Clarence - Moreton Basin) and north of Nana Glen, and are porphyritic acid types.

Comments

Modal compositions of a selection of rocks from the New England Batholith are presented in Table 18. The same data are used for construction of quartz-plagioclase-K-feldspar (QPKF) and quartz-feldspar-mafic (QFM) diagrams (Fig.19), and K-feldspar versus plagioclase (Fig. 20) and biotite versus K-feldspar graphs (Fig. 20). The following points emerge from a consideration of the data:

1. The Tallawudjah Leucoadamellite has a very similar composition to the Kellys Creek Leucoadamellite, and the Emerald Beach Adamellite is similar to rocks from the Chaelundi Complex. The unnamed diorite has a mineralogical composition very different from all other New England Batholith intrusions in the area.
2. An inverse relationship exists between the presence of biotite and K-feldspar for all intrusions and an inverse relationship between K-feldspar and plagioclase also exists for all intrusions with the exception of the Kellys Creek Leucoadamellite which appears to have a direct relationship.
3. Intrusions of the New England Batholith in the Rockvale - Coffs Harbour area are very similar to intrusions of the batholith in the rest of the New England area as reported by numerous workers in Wilkinson (1969), and Ransley (1970), Neilson (1970), Flood (1971) and Leitch (1972).