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THE PETROLOGY AND GEOCHEMISTRY
OF THE REEDY CREEK GRANITOIDS
AND MAGMATITES.

BY

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THE PETROLOGY AND GEOCHEMISTRY OF
THE REEDY CREEK GRANITOIDS AND MIGMATITES

by
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Abstract

The composite, regionally concordant Reedy Creek Pluton comprises three major rock units: (a) the relatively voluminous Reedy Creek Granodiorite, (b) a mafic, commonly foliated diorite and (c) a pink granite occurring in the upper parts of the pluton. Surrounding this complex are migmatites and gneisses belonging to the Cambrian Kanmantoo Group metamorphics. Also intruding these metamorphics, but probably predating the members of the Reedy Creek Pluton, is the Summerfield Granodiorite. This small, concordant dyke-like intrusion displays petrological and chemical features which differ markedly from those of the granitoids belonging to the Reedy Creek Pluton.

^{white}
~~granite~~ Chemical, mineralogical, petrological and field criteria suggest that the granitoids belonging to the Reedy Creek Pluton may be genetically related. Although the gross appearance of these granitoids is consistent with their derivation from igneous source material, i.e. I-type, a derivation invoking two stages of partial melting of a metasedimentary sequence is proposed. The first stage of partial melting, which may have been initiated by the intrusion of the Cambrian-Ordovician? Black Hill Norite (a large mafic intrusion 40km N.E. of Reedy Creek) produced a magma with a composition approaching a minimum melt (this may be represented by the Palmer Granite). Further non minimum melting of this metasedimentary source produced the majority of granitoids in this region. Compositional variation within these granitoids is ascribed to varying degrees of separation of restite from melt during ascent. Since this separation may be very effective at higher temperatures, the refractory minerals may concentrate and so form dioritic rocks. This close genetic relationship between the granodiorites and diorites of the complex is supported by field evidence which suggests that the two rock units are essentially contemporaneous.

In contrast to the I-type granitoids of the Reedy Creek Pluton, the S-type Summerfield Granodiorite displays chemical and mineralogical features which suggest that it may be derived by partial melting of pelitic metasediments which have undergone only a small amount of surface weathering.

Biotite crystallization temperatures of the migmatites (790-810°C) are similar to those of the Reedy Creek granitoids. In addition, migmatite biotites are compositionally similar to biotites of granitic rocks in comparison to those of gneisses and migmatites of the Palmer region (White, 1966). This implies a greater degree of heating for the Reedy Creek migmatites in comparison to those of Palmer and points to an origin involving partial melting.

1. Introduction and Previous Work

The mapped area is situated approximately 60km east of Adelaide within an extensive belt of Lower Cambrian rocks of the Kanmantoo Group (Daily, 1976). The rocks of the Kanmantoo Group consist chiefly of quartzo-feldspathic schists (meta-greywackes and meta-arkoses) with intercalations of pelitic schists, marbles and calc-silicates (Kleeman and White, 1956).

The Reedy Creek Pluton which comprises several different granitoid types is enveloped by migmatites and gneisses derived from the Kanmantoo Group sediments. The pluton is flanked by the Palmer Granite to the northwest and Mannum Granite to the northeast (Fig. 1). The emplacement of these and other granitoids in southeastern South Australia is considered by Milnes et al. (1977) to either predate or coincide with the main phase of orogenesis which produced a history of elevated temperatures and structural events encompassing a period of at least 50 m.y.

Major works on the Reedy Creek area include an M.Sc. thesis (Sando, 1957) and Honours thesis (Whitehead, 1975). Comprehensive petrographic descriptions of the gneisses and migmatites and less detailed descriptions of the granitic rocks were compiled by Sando whereas Whitehead covered the structural aspects of the area in addition to minor geochemical consideration of the migmatites, gneisses and granites. Feldspars from Reedy Creek granitoids and migmatites were examined by Virgo (1966) in order to determine the applicability of distribution coefficients and Barth thermometers to feldspar pairs in metamorphic rocks. The metamorphism and folding history of the Mount Lofty Ranges examined by Offler and Fleming (1968) also included the Reedy Creek area within its bounds.

The Reedy Creek granitoids have not been documented hitherto in terms of Chappell and White's S- and I-type granitoid classification. This project outlines the chemistry and mineralogy of the Reedy Creek granitoids (i.e. Reedy Creek Granodiorite, Diorite, Pink Granite, Summerfield Granodiorite and Microgranite) and migmatites and attempts to:

- (a) determine the applicability of the S- and I-type granitoid classification to the Reedy Creek granitoids,
- (b) establish whether fundamental and systematic chemical differences exist between the granitoids and hence whether they constitute a single comagmatic series,
- (c) determine if any similarities between the Reedy Creek granitoids and Palmer and Mannum Granites occur, possibly indicating petrogenetic relationships between them, and
- (d) determine if differences in chemistry and mineralogy of the Reedy Creek migmatites in comparison to the Palmer migmatites (White, 1966) indicate contrasting mechanisms of formation.

2. Field relationships and general characteristics

2.1 Variation within granitoids

An indication of range of composition of each of the major granitoids is listed in table 1(% SiO₂). Three of the granitoids are relatively homogeneous i.e. Pink Granite, Microgranite and Summerfield Granodiorite, and variation in composition cannot be discerned in the field. A granitic phase of the latter outcrops near Summerfield (Sando, 1957) but is not present within the mapped area.

The Reedy Creek Granodiorite is sufficiently heterogeneous for this to be apparent in the field. The variation is unsystematic. It is not zoned; both relatively mafic and felsic varieties may occur near the margin or the centre of the pluton. The most mafic rock analysed (779/53) occurs within only 5m of the most felsic variety (779/66).

The Diorite is also noticeably heterogeneous. There is no pattern in the variation except for the increase of interstitial quartz at the contacts with Reedy Creek Granodiorite. This is restricted to the immediate vicinity of the contacts.

Table 1. Variation within the granitoids of the Reedy Creek area.

<u>Granitoid</u>	<u>Rock types</u>	<u>% SiO₂ Range</u>
Diorite	diorite	46.8 - 55.7
	quartz diorite	
Reedy Creek Granodiorite	diorite	49.7 - 67.8
	quartz monzodiorite	
	granodiorite	
	tonalite	
Summerfield Granodiorite	granodiorite	69.3 - 71.7
Pink Granite	adamellite	*74.6
	granite	
Microgranite	granite	72.2 - 76.8

*only 1 sample analysed.

2.2 Contact relations

The Reedy Creek Granodiorite comprises a major part of the concordant elongate pluton, parallel north-south to the strike of the surrounding gneiss. Contacts between Reedy Creek Granodiorite and gneiss are sharp and steeply dipping to the west. Thermal effects are evident in the gneiss indicated by the presence of migmatites in close vicinity of the pluton. Chilled margins are not observed in the Reedy Creek Granodiorite.

Diorite intrusives generally outcrop as small, irregularly shaped elongate bodies roughly paralleling the pluton-gneiss contact. Sharp contacts occur between the Reedy Creek Granodiorite and fine grained diorite, however loose clusters of plagioclase phenocrysts resulting from disaggregation of Reedy Creek Granodiorite commonly manifest a more diffuse relationship (plate 1A). Diorite intrusives occur also west of the pluton contact with the migmatites but no further than 700m from the pluton. A chilled margin comprising a narrow microtonalite rim surrounds the Diorite at the Diorite-gneiss contact.

Pink medium to coarse grained granites occupy the topographically higher parts of the pluton approximately 500m east of the pluton-gneiss contact. Diffuse contacts between the Pink Granite and Reedy Creek Granodiorite are observed in contrast to sharp contacts between Pink Granite and Diorite.

Roughly parallel microgranite dyke-like intrusions, often several hundred metres long and up to 50m wide transect the Reedy Creek Pluton, striking slightly oblique to the pluton-gneiss contact. Microgranites transect all the major granitoids within the pluton and are probably of late stage development in the pluton history. Intrusives of Microgranite are observed in the gneiss but to a far lesser extent.

The Summerfield Granodiorite outcrops as a concordant dyke-like body. The 200m wide intrusion outcrops only within the gneiss, several hundred metres west of the pluton-gneiss contact. Intimate mixing is evident at the Summerfield Granodiorite-gneiss contact.

A rare occurrence of orbiculite (orbicular granitoid) is encompassed by the Reedy Creek Granodiorite. The tonalitic matrix and dioritic cores of the orbicules are texturally indistinguishable from the surrounding granodiorite. Contacts between the granite rims of the orbicules and matrix are relatively sharp.

A narrow lamprophyre dyke striking east-west transects the Reedy Creek Pluton. Contacts between Reedy Creek Granodiorite and lamprophyre are sharp, however the granodiorite either side of the contact has been altered considerably, pertaining to intrusion of the lamprophyre.

2.3 Structural aspects

A foliation defined by the preferred orientation of ferromagnesian minerals is well developed within the Reedy Creek Granodiorite and Pink Granite. The foliation normally strikes north-south and dips steeply west, parallel to the foliation in the adjacent gneiss and broadly parallel to the pluton-gneiss contact. This foliation is manifested in outcrop by fairly distinct banding. A weak foliation parallel to that of the Reedy Creek Granodiorite is observed in the Diorite bodies defined by the preferred orientation of plagioclase and

ferromagnesian minerals. Rotated blocks of Reedy Creek Granodiorite occur within the Diorite; the foliation within the block striking oblique to the regional foliation.

The foliation within the Summerfield Granodiorite appears to be warped. Whitehead (1975) observed two major stages of deformation within the migmatites and gneisses. The Summerfield Granodiorite was probably subject to a similar deformation history as was the migmatites and gneisses.

Analysis of joint planes within the pluton (Sando, 1957) indicate a prominent joint direction normal to the pluton-gneiss contact. Faulting parallel to these joint planes has produced small displacements noticeable at the pluton-gneiss contact. The faults have provided the pathway for intrusion of the lampprophyre.

2.4 Xenoliths and inclusions

Mafic inclusions (mafic diorites) of varying colour index are conspicuous although comparatively rare in the Diorite bodies. Ellipsoid shaped mafic inclusions occur to a limited extent in the vicinity of and parallel to the margins of the Diorite intrusives. In addition, Diorite inclusions are present within the Reedy Creek Granodiorite (plate 1B) which contrasts the presence of Reedy Creek Granodiorite inclusions in the Diorite bodies.

Xenoliths of Diorite and Reedy Creek Granodiorite within the Microgranites substantiate evidence from contact relationships for the late stage development of the Microgranites. Xenoliths are absent in both the Pink Granite and Summerfield Granodiorite.

3. Petrography

3.1 Reedy Creek Granodiorite

(a) granodiorites and quartz monzodiorites.

These rocks are typically coarse grained (4-7mm), hypidiomorphic inequigranular, mildly porphyritic and consist predominantly of large (up to 20mm) pink, tabular to equant crystals of alkali feldspar (Or_{85-92}), strained anhedral quartz, small to large, stumpy crystals of polysynthetically twinned and oscillatory zoned, subhedral to euhedral antiperthitic plagioclase (An_{26-30}).

Straw yellow (x) to dark brown (Y=Z) biotite (mg_{49-55}) is the most common ferromagnesian mineral. It occurs as either small ragged or large euhedral crystals, concentrated in layers occurring at regular intervals resulting in the banded appearance of the granitoid. The common amphibole (mg_{50-54}) in these rocks is green, generally subhedral and has a tendency to occur in patches, generally in close association with biotite. Rare clinopyroxene ($mg \sim 76$) is included within calcic plagioclase as discrete ovoid, pale coloured grains, 0.1-0.2mm in length.

A feature of these rocks is the ubiquitous presence of co-existing magnetite and ilmenite. Magnetite frequently occurs as solitary octahedra whereas manganese ilmenite forms ragged crystals containing exsolved hematite (plate 2A). Sphene is a major accessory mineral occurring as small to large euhedral crystals (plate 2B). Additional accessory minerals include apatite, zircon, epidote, piemontite, pyrite and chalcopyrite.

(b) tonalites and diorites

These rocks are coarse grained (5-6mm) with a hypidiomorphic equigranular texture. In addition to the major variation in modal plagioclase, quartz and alkali feldspar, amphibole is absent and a marked decrease in accessory mineral abundance is detected in comparison with the granodiorites and quartz monzodiorites.

3.2 Diorite (diorites and quartz diorites)

Textures of these melanocratic rock types vary from hypidiomorphic equigranular to hypidiomorphic inequigranular. These fine to medium grained rocks with average grain size ranging from 1mm to 2mm are characterized by an assemblage consisting of plagioclase (An_{35-52}), biotite (mg_{50-55}), amphibole (mg_{55-57}) and interstitial quartz. They may best be described as an accumulation of decussate subhedral to euhedral ferromagnesian minerals and strongly preferred to randomly orientated laths of twinned, oscillatory zoned and sometimes porphyritic plagioclase.

Ilmenite is the dominant iron oxide occurring as (a) discrete subhedral crystals and (b) ragged cigar shaped grains enclosed by biotite and amphibole. Octahedra of magnetite occur rarely. Euhedral sphene crystals are common along biotite cleavages. Ubiquitous anhedral and subhedral sphene occurs interstitially (plate 2c) and commonly contains ilmenite inclusions.

In addition, stocky apatite which is particularly abundant in the more mafic diorites, zircon and epidote are also common accessories.

3.3 Pink Granite

This rock type is medium to coarse grained (3-7mm) hypidiomorphic granular, mildly porphyritic and relatively homogeneous. Distinctively pink, clouded, tabular to equant alkali feldspar crystals ($Or \sim 90$) are characteristic of this group. Plagioclase (An_{16-20}) up to 4mm in length is usually polysynthetically twinned and zoned. Plagioclase cores are commonly clear, pale grey and antiperthitic. Colourless quartz occurs interstitially to the feldspars.

Biotite (mg ~55) is the dominant ferromagnesian mineral which is concentrated in clots, similarly to the Reedy Creek Granodiorite. Euhedral sphene, zircon and apatite are common accessories. Ilmenite forming as ragged crystals is the major oxide mineral and contains exsolution lamellae of hematite.

3.4 Microgranite

The fine to medium grained (1-3mm) hypidiomorphic inequigranular microgranites contain a mineral assemblage resembling that of the Pink Granite. Anhedral clouded pinkish alkali feldspar (Or ~89), polysynthetically twinned and oscillatory zoned subhedral plagioclase (An₉₋₂₄) and strained anhedral quartz comprise the bulk of the rock. Scattered biotite (mg ~51) is the most common ferromagnesian mineral. Accessory minerals are comparatively rare comprising sphene, apatite and zircon.

3.5 Summerfield Granodiorite

This rock type is fine to medium grained (1-3mm) hypidiomorphic inequigranular and characterized by the occurrence of pale coloured euhedral muscovite and straw yellow (x) to dark brown (Y=Z) ragged crystals of biotite (mg ~52) defining a foliation. Plagioclase generally occurs as subhedral, polysynthetically twinned, subequant, pale grey crystals varying from An₂₅ to An₃₅. Zoning in plagioclase is generally normal with rare minor oscillations. Alkali feldspar is present as anhedral, simply twinned grains up to 1mm in length, commonly as interstitial grains occurring in close association with strained anhedral quartz.

Accessory minerals include acicular apatite, subrounded zircon and ilmenite which is enclosed by biotite.

3.6 Orbiculite

Spherical orbicules with diameters up to 50mm enclosed by a tonalitic matrix are single shelled corresponding to type II proto-orbicules or single shell orbicules (Leveson, 1966). The dioritic orbicule cores with diameters varying from 10 to 30mm dominantly comprise plagioclase, biotite, amphibole, sphene and ilmenite. The orbicule rims consist of large, wedge shaped alkali feldspar crystals up to 20mm in length which are radially orientated around the core. Graphically intergrown, relatively parallel worm-like quartz inclusions occur within the alkali feldspar crystals.

3.7 Lamprophyre

Textures of this medium to coarse (3-7mm) grained rock type vary from hypidiomorphic to panidiomorphic granular. The texture is also porphyritic; phenocrysts of plagioclase and amphibole are set in a finer grained groundmass of plagioclase and ferromagnesian minerals.

Plagioclase (An_{25-32}) phenocrysts, up to 8mm in length, are polysynthetically twinned and have oscillatory zoning. Inclusions of amphibole and biotite are common in the equant plagioclase crystals. In contrast, lath-shaped plagioclase crystals in the groundmass up to 1mm in length are relatively free of inclusions. Interstitial quartz and rare alkali feldspar are restricted to the groundmass.

Amphibole is the most abundant ferromagnesian mineral; it forms phenocrysts up to 6mm in length. The euhedral, simply twinned amphibole crystals commonly contain inclusions of biotite. Disseminated euhedral biotite flakes are generally restricted to the groundmass. Ilmenite and acicular apatite are frequent inclusions in the ferromagnesian minerals. Additional accessories in this mafic rock include sphene, zircon and epidote.

3.8 Migmatites

The veined gneisses of the migmatite zone are typically heterogeneous and medium grained. The neosome of the compositionally layered migmatites are generally narrow averaging 5mm thickness and consist predominantly of quartz, feldspar, biotite, muscovite and magnetite. Polysynthetically twinned plagioclase is the sold feldspar in the paleosome whereas both alkali feldspar and plagioclase are present in the neosome. Smooth curving interlocking boundaries and patches of myrmekite along plagioclase-microcline junctions in the neosome resemble similar textures observed in the Palmer migmatites (White, 1966).

Biotite (mg44-55) is the most abundant ferromagnesian mineral which occurs as selvages to the compositional layering and cross cutting granitic veins and as clots (plate 1c) and disseminated crystals within both the neosome and paleosome. Scattered porphoroblastic muscovite is common in both the neosome and paleosome, however it occurs rarely in the selvages. Accessory minerals which are associated with biotite comprise rounded zircons displaying pleochroic haloes, acicular apatite and less commonly magnetite.

4. Mineralogy

4.1 Biotite

4.1.1 Occurrence and chemistry

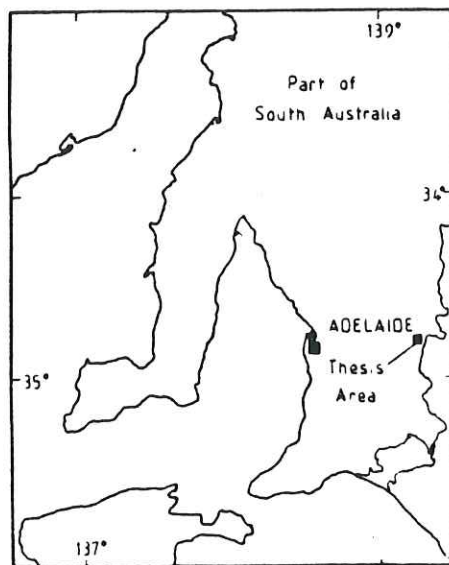
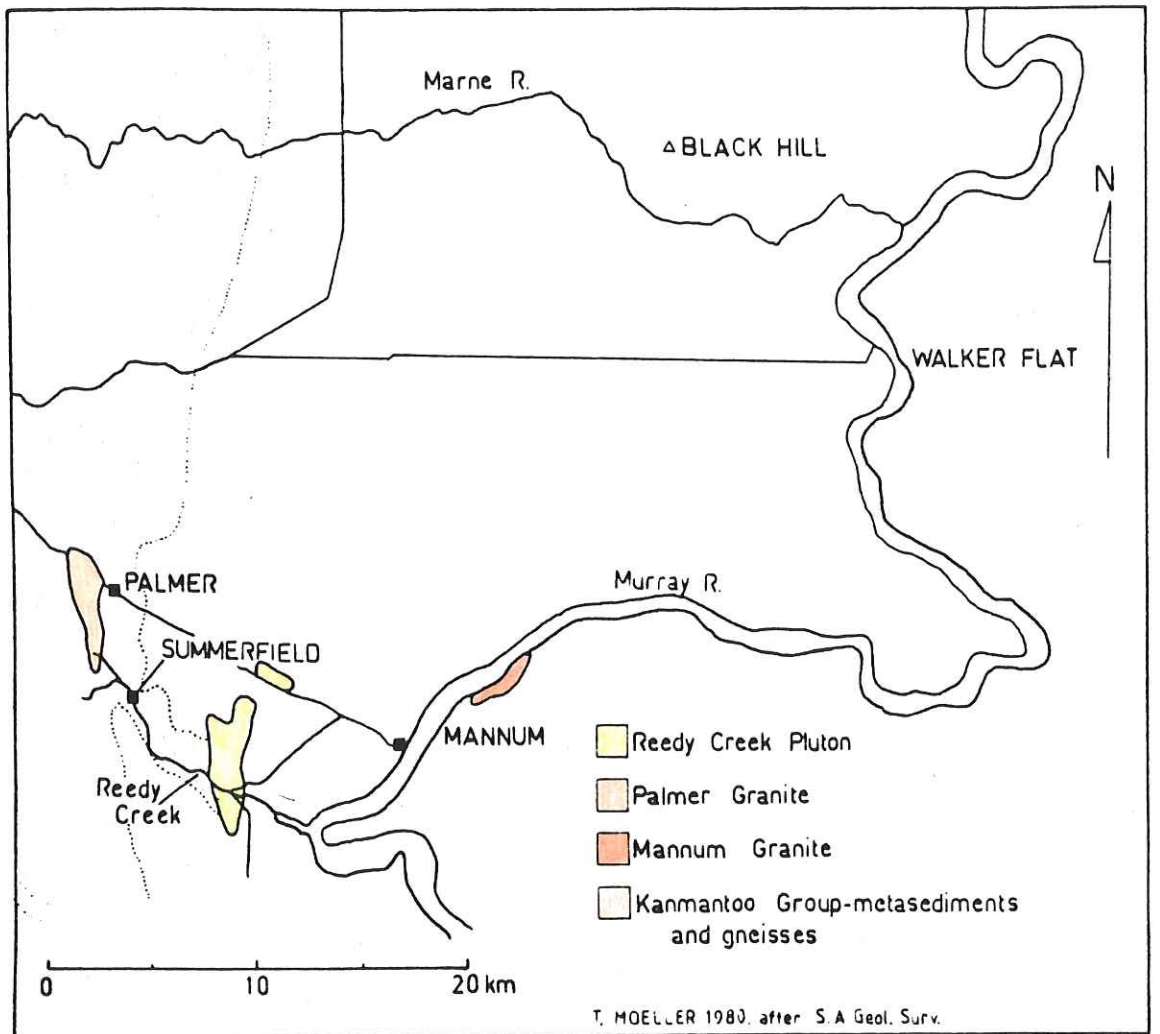
Biotite occurs in all rock types and in most is the dominant ferromagnesian mineral. It generally occurs as the sole ferromagnesian silicate in rocks with SiO_2 greater than 65 weight percent. Throughout the granitoids, irrespective of textural type, the optical properties of biotite are uniform ($x = \text{straw yellow}$, $Y = Z = \text{dark brown}$). Within the granitoids biotite occurs as:

- (a) decussate aggregates in which amphibole and ilmenite are closely associated,
- (b) aligned ragged and euhedral crystals with which amphibole and ilmenite are also closely associated,
- (c) discrete disseminated crystals.

The analyses of biotites from granitoids occurring within the Reedy Creek Pluton are listed in table 2 (col. 1-7) in order of approximately increasing bulk rock SiO_2 . Slight major element variation is observed between the biotites of the various granitoids vis. FeO , CaO and TiO_2 decrease with increasing SiO_2 . Trace element variations are more marked with decreasing Ba and increasing Rb as the host rocks become more felsic. This contrasts with large significant variations of major and trace elements occurring between biotites of fractionated granitic rocks (e.g. Albuquerque, 1973; Dodge et al, 1969). However, the slight elemental variation in biotites of the Reedy Creek granitoids reflects the variation in chemistry of the host rock which parallels observed variations between the biotites of fractionated granitic rocks (e.g. Albuquerque, 1973). Zoning in biotite is rare but where it occurs Al_2O_3 , TiO_2 , FeO and MgO generally increase in the rims and SiO_2 and K_2O decrease.

The analyses of biotites from three migmatites are also presented in table 2 (col. 9-11). The migmatites in which these biotites occur contain feldspar assemblages consisting of plagioclase, plagioclase and alkali feldspar in equal proportions, and alkali feldspar and minor plagioclase respectively (i.e. the migmatites become more granitic). Increasing Al_2O_3 , FeO and TiO_2 and decreasing MgO are observed within the increasingly "granitic" migmatites. This parallels the variation observed for biotites in granitic rocks (e.g. Albuquerque, 1973) and may indicate that greater degrees of partial melting were involved in the formation of the increasingly "granitic" migmatites.

On the Al_2O_3 - MnO_2 - FeO triangular plot (Fig. 2), four distinct fields indicate biotite paragenesis in relation to compositional variation within the biotites (Nockolds, 1947). Biotites of the granitoids within the Reedy Creek Pluton plot closely together in their respective fields. The biotite from the Summerfield Granodiorite is clearly distinguished from these, occupying



LOCATION OF THE
 REEDY CREEK AND
 SURROUNDING PLUTONS

Fig. 1

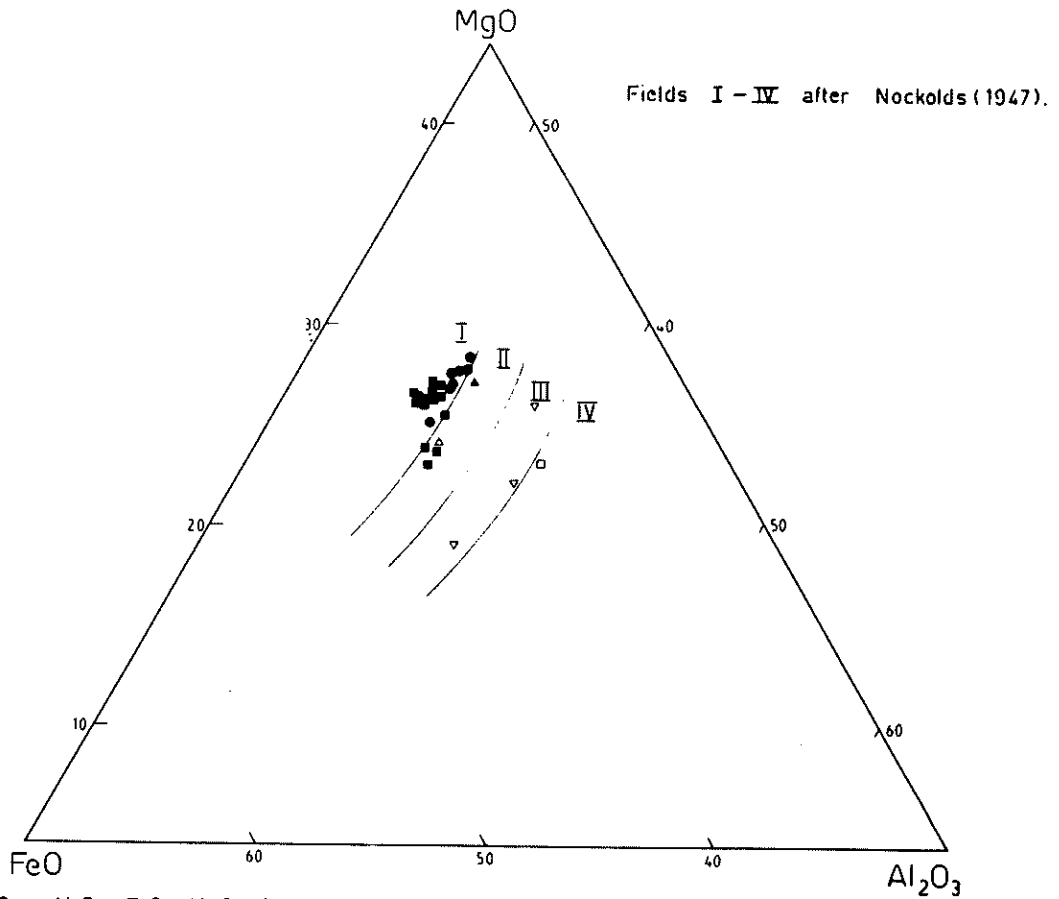


Fig. 2. Al_2O_3 - FeO - MgO diagram of the Reedy Creek biotites. I - Field of biotites co-existing with amphibole. II - Field of biotites unaccompanied by other ferromagnesian minerals. III - Field of biotites co-existing with muscovite. IV - Field of biotites co-existing with aluminosilicates.

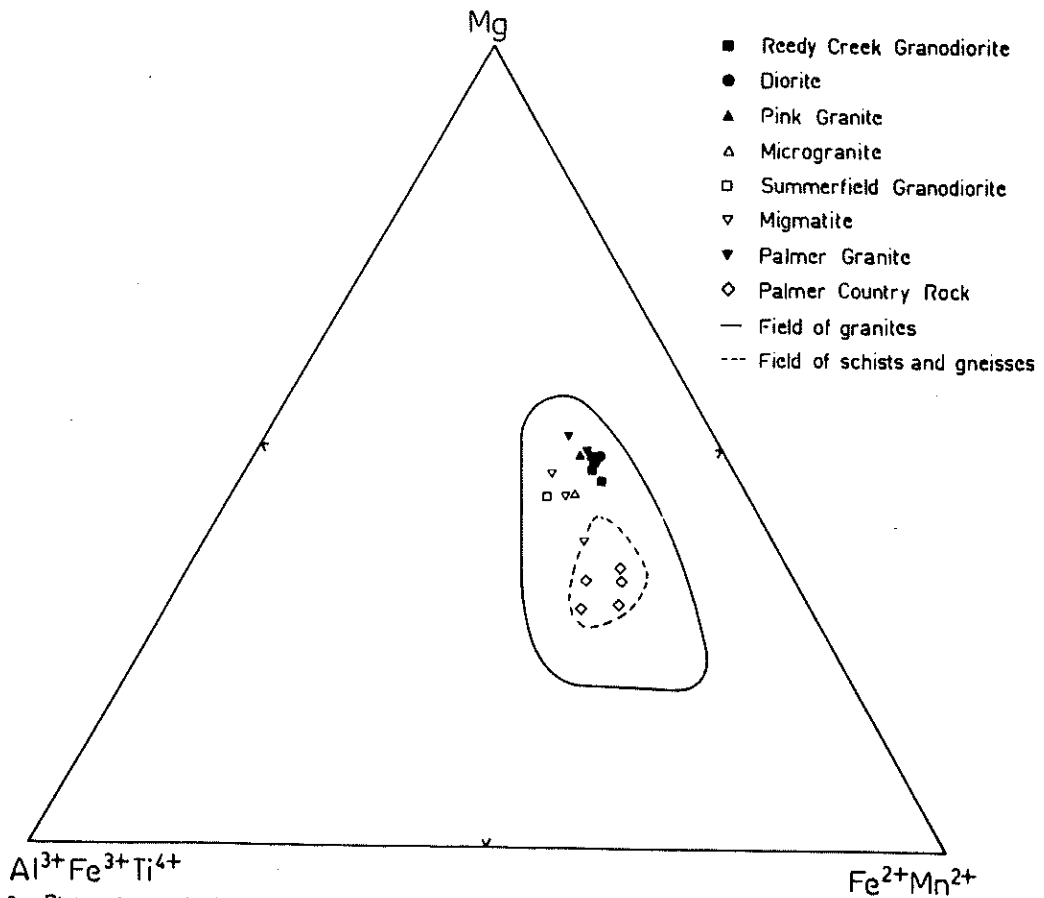


Fig. 3. Plot of octahedrally co-ordinated elements of biotites from the Reedy Creek and Palmer granitoids and migmatites. Field of (1) granites, and (2) schists and gneisses after Foster (1960).

the field in which biotite co-exists with aluminosilicates (after Nockolds, 1947) although aluminosilicates were not observed in this rock type. Migmatite biotites plot in the field of biotite co-existing with muscovite (after Nockolds, 1947); the spread of points resulting from differing Fe/Mg ratios. The increased Al_2O_3 contents of biotites in both the migmatites and Summerfield Granodiorite in comparison to the biotites from granitoids occurring within the Reedy Creek Pluton is reflected in the total rock compositions and is probably a reflection of their source rocks.

The $(Al + Fe^{3+} + Ti)-(Fe^{2+} + Mn)-Mg$ triangular diagram of octahedrally co-ordinated atoms (Fig. 3) similarly indicates biotite paragenesis. The biotites of the Reedy Creek granitoids plot within the field of biotites occurring in granitic rocks (after Foster, 1960). Again the Summerfield Granodiorite biotites are clearly distinct from the biotites of granitoids occurring within the Reedy Creek Pluton, comparing more closely to the migmatite biotites. Similarly, Microgranite biotites also differ from biotites of granitoids occurring within the Reedy Creek Pluton.

4.1.2 Chemical comparison between biotites from Reedy Creek and Palmer granitoids and migmatites

Biotites of the Palmer Granite (table 2, col. 12; White et al, 1967), Reedy Creek Granodiorite, Diorite and Pink Granite are compositionally similar. However, in contrast to the granitoids, specific chemical features which readily distinguish biotites of the Reedy Creek migmatites from those of the Palmer migmatites (table 2, col. 13; White, 1966) include:

- (a) higher Al_2O_3 , MgO and K_2O , and
- (b) lower FeO and TiO_2 .

On the $(Al + Fe^{3+} + Ti)-(Fe^{2+} + Mn)-Mg$ triangular diagram (Fig. 3) the biotites from the Palmer migmatites and gneisses plot well within the field of schists and gneisses (after Foster, 1960) whereas biotites from the Reedy Creek migmatites plot within the field of granites (after Foster, 1960). This is possibly a reflection of greater degrees of heating involved in the formation of the Reedy Creek migmatites in comparison to the Palmer migmatites. In addition, the more "granitic" migmatites (4.1.1) which occur at Reedy Creek plot further away from the field of schists and gneisses (after Foster, 1960) which may likewise, be a reflection of the degree of partial melting within the gneisses.

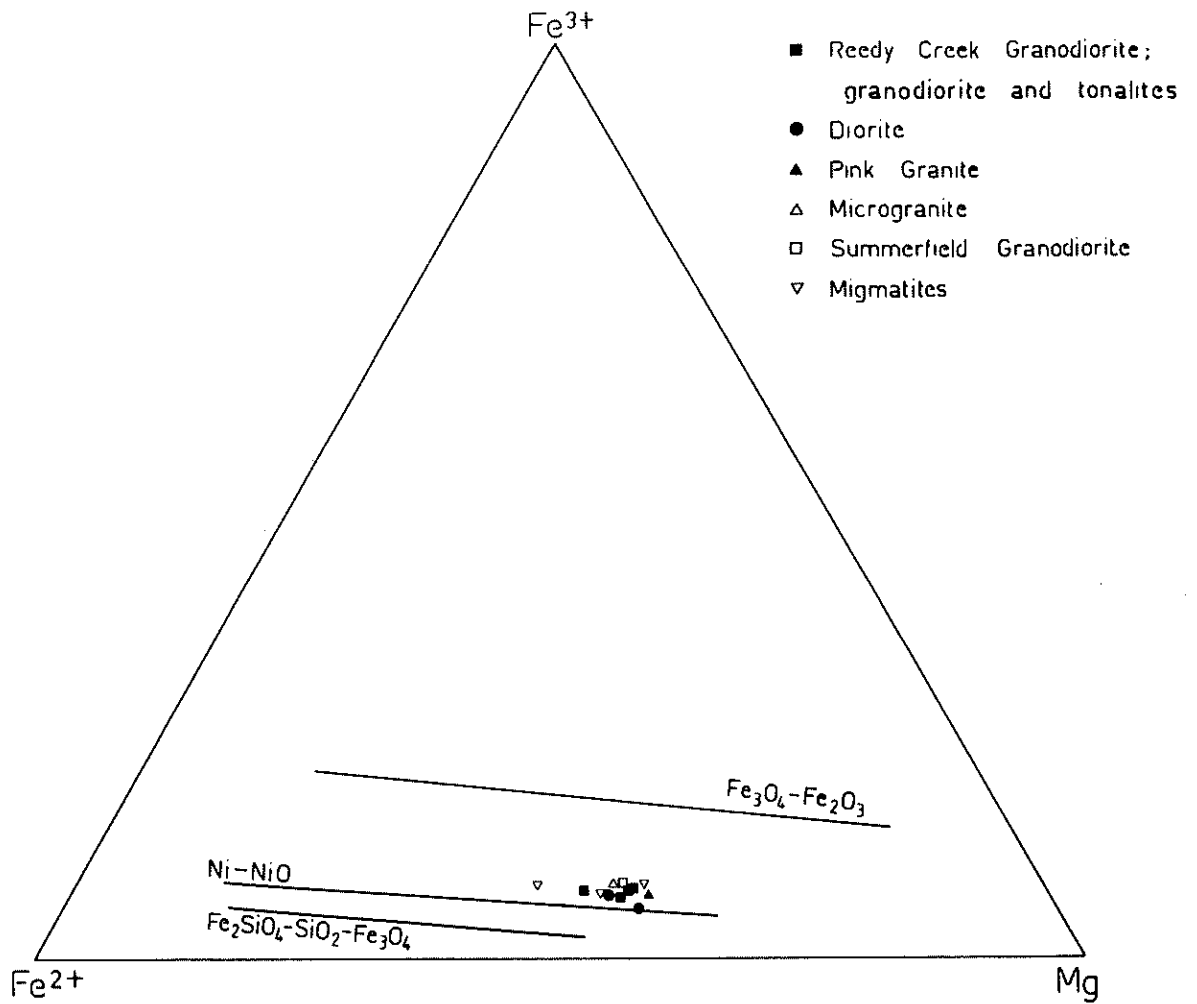


Fig. 4. Fe^{3+} - Fe^{2+} -Mn diagram of the Reedy Creek biotites.

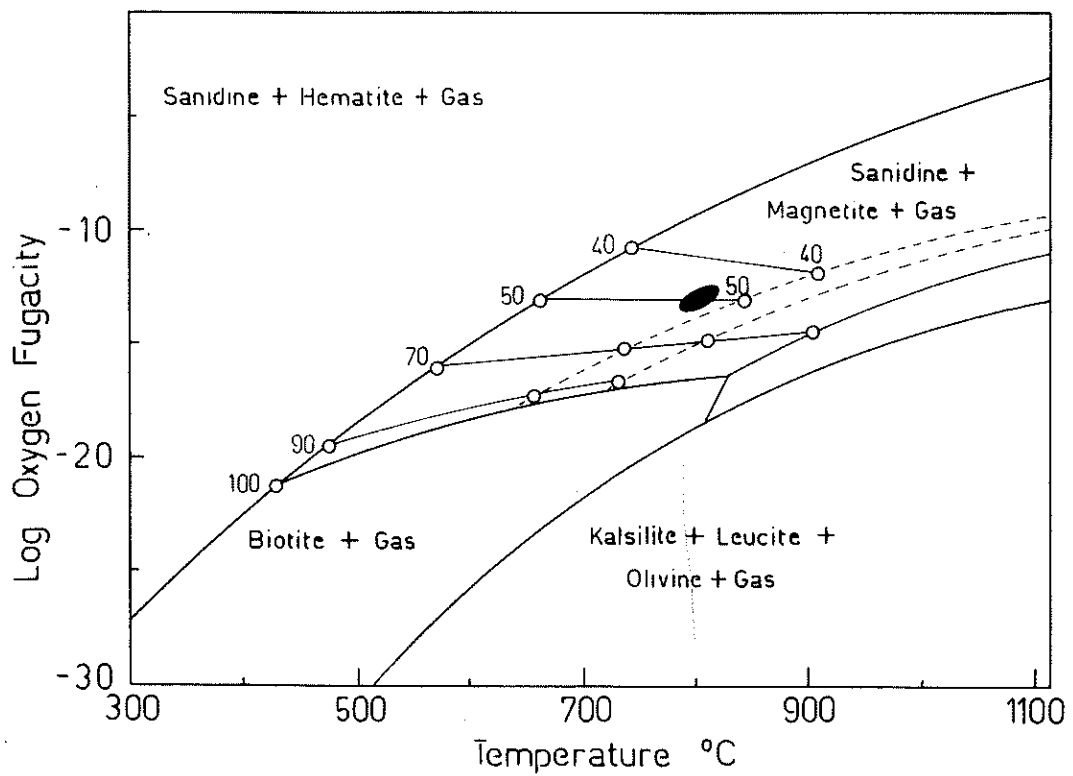


Fig. 5. Stability of biotite as a function of oxygen fugacity and temperature at 2070 bars total pressure (after Wones and Eugster, 1965). ● — Reedy Creek biotites (granitoids and migmatites).

4.1.3 Conditions of crystallization of biotite

The biotites from Reedy Creek granitoids and migmatites co-exist with magnetite and alkali feldspar in the majority of rock types or with magnetite in the dioritic rocks. When plotted on a Fe^{3+} - Fe^{2+} -Mg diagram (Fig. 4), using the experimental data from Wones and Eugster (1965) the biotites of the Reedy Creek granitoids and migmatites are grouped together occurring slightly above the trend of the Ni-NiO buffer and well below the Fe_3O_4 - Fe_2O_3 buffer.

$\text{Fe}/(\text{Fe}+\text{Mg})\times 100$ for the Reedy Creek biotites varies from 45.1 to 56.0. Plotted according to experimentally determined biotite stability relations at $P_{\text{Total}} = 2070$ bars (Fig. 5; Wones and Eugster, 1965), Reedy Creek biotite compositions indicate that $f\text{O}_2$ conditions were oxidizing. Extrapolation of the biotite data indicates biotite temperatures ranging from 790° to 810°C at $f\text{O}_2$ of 10^{-12} to 10^{-13} bars.

4.2 Amphibole

4.2.1 Occurrence and chemistry

The presence of calciferous amphiboles is characteristic of the Reedy Creek granitoids with SiO_2 content of less than 65 weight percent. Amphibole is totally absent in the Microgranite, Pink Granite, Summerfield Granodiorite and some tonalites.

Texturally the amphiboles of the granitoids display the same features as outlined for the biotites i.e. they occur as decussate aggregates, discrete and often well-formed twinned crystals. A feature of these amphiboles is the high proportion of accessory minerals enclosed within them consisting predominantly of prismatic apatite and ilmenite.

The amphiboles belong to the hornblende series. Representative analyses of hornblendes from the Diorite and Reedy Creek Granodiorite (quartz monzodiorite and granodiorite) are listed in table 3 (col. 1-3). At least two varieties of hornblende may be distinguished. In the Diorite, Si cations range from 6.69 to 6.73 where $\Sigma\text{Ca}+\text{Na}+\text{K}$ is less than 2.5 cations. In contrast to these magnesio hornblendes, Si cations range from 6.61 to 6.69 and $\Sigma\text{Ca}+\text{Na}+\text{K}$ is greater than 2.5 cations in the hornblendes from the quartz monzodiorites and granodiorites. This edenitic substitution is not commonly observed in calc-alkaline rocks (Leake, 1968).

K_2O and Na_2O generally increase and SiO_2 , CaO and mg decrease in hornblendes from mafic to felsic host rock compositions. The slight variations in major element abundance are similar to those observed for amphiboles in other calc-alkaline plutonic sequences (e.g. Rhodes, 1968).

Table 2. Representative major and trace element analyses of biotites from the Reedy Creek and Palmer granitoids and migmatites

	diorite	diorite	quartz diorite	tonalite	grano- diorite	Micro- granite	Pink Granite	Summer- field Granodiorite	Mig- matite	Mig- matite	Mig- matite	Palmer Granite	Palmer Migmatite
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Sample No.	779/3	779/5	779/47	779/46	779/51	779/4	779/19	779/55	779/49	779/48	779/50	P5	191
SiO ₂	36.0	36.1	36.3	36.9	36.6	36.6	36.7	35.4	36.0	35.4	35.1	37.3	35.1
Al ₂ O ₃	15.4	15.5	16.0	15.0	15.1	15.7	15.4	18.3	17.9	18.0	18.1	14.8	17.5
Fe ₂ O ₃	3.04	2.30	3.12	3.30	3.08	3.74	3.26	3.57	3.41	2.91	3.25	2.56	3.10
FeO	17.24	16.43	17.13	16.48	16.60	16.05	15.15	15.00	14.80	16.16	18.25	16.58	20.24
MnO	0.33	0.18	0.22	0.35	0.37	0.37	0.42	0.29	0.20	0.19	0.21	0.12	0.14
MgO	11.70	12.63	10.85	12.08	12.12	11.21	12.39	10.96	12.02	10.98	9.34	12.51	7.52
CaO	0.23	0.27	0.06	0.15	0.08	0.20	0.10	0.07	0.02	0.02	0.02	0.09	0.07
Na ₂ O	0.15	0.17	0.16	0.17	0.15	0.16	0.16	0.13	0.15	0.14	0.16	0.09	0.24
K ₂ O	9.31	9.24	9.85	9.64	9.64	9.67	9.60	9.98	9.98	9.97	9.88	9.36	9.68
TiO ₂	3.33	3.03	3.43	2.80	2.66	3.28	2.84	3.09	2.12	2.56	3.02	2.90	3.63
P ₂ O ₅	0.05	0.05	0.04	0.03	0.01	0.10	0.02	0.06	0.02	0.03	0.03	0.00	0.01
TOTAL	96.8	95.9	97.2	96.9	96.4	97.1	96.0	96.9	96.6	96.4	97.4	95.9	97.7
mg	51.1	54.9	49.4	52.5	52.2	50.6	54.9	51.8	54.5	51.0	44.0	54.1	36.8

Structural formulae (based on 22 oxygens per formula unit)

Si	5.421	5.449	5.439	5.527	5.522	5.480	5.511	5.277	5.364	5.320	5.278	5.592	5.327
Al ⁴	2.579	2.551	2.561	2.473	2.478	2.520	2.489	2.723	2.636	2.680	2.722	2.408	2.673
Al ⁶	0.155	0.207	0.266	0.175	0.208	0.251	0.237	0.493	0.508	0.509	0.487	0.201	0.461
Ti	0.377	0.344	0.387	0.321	0.302	0.369	0.321	0.346	0.238	0.289	0.342	0.327	0.414
Fe ³⁺	0.344	0.261	0.352	0.372	0.350	0.422	0.368	0.401	0.383	0.329	0.368	0.298	0.354
Fe ²⁺	2.166	2.070	2.143	2.070	2.094	2.016	1.909	1.870	1.844	2.036	2.301	2.077	2.570
Mn	0.043	0.023	0.028	0.044	0.047	0.047	0.053	0.036	0.025	0.024	0.027	0.015	0.018
Mg	2.626	2.835	2.434	2.701	2.720	2.499	2.774	2.444	2.664	2.464	2.093	2.792	1.702
Ca	0.037	0.044	0.010	0.024	0.013	0.004	0.016	0.011	0.004	0.004	0.004	0.014	0.012
Na	0.043	0.049	0.047	0.049	0.044	0.047	0.047	0.038	0.043	0.042	0.047	0.026	0.070
K	1.788	1.780	1.884	1.841	1.857	1.848	1.839	1.897	1.896	1.911	1.896	1.788	1.875

Trace elements (ppm)

Rb	361	353	449	491	463	631	553	458	516	472	574
Sr	7	13	8	9	9	10	9	9	4	-	3
Ba	3877	2807	2725	1557	1248	693	440	2546	1490	573	507
Ni	71	78	67	77	94	45	80	106	94	140	117

(1),(2) - Diorite

(3),(4),(5) - Reedy Creek Granodiorite

Palmer Granite from White et al (1967)

Palmer Migmatite from White (1966)

Table 3. Representative major and trace element analyses of amphibole, clinopyroxene, alkali feldspar and sphene from selected granitoids within the Reedy Creek Pluton.

Sample No.	Amphiboles			Clino- pyroxene	Alkali Feldspars			Sphenes	
	(1) 779/5	(2) 779/7	(3) 779/51	(4) 779/7	(5) 779/51	(6) 779/19	(7) 779/4	(8) 779/5	(9) 779/51
SiO ₂	44.7	43.6	43.6	52.1	63.9	64.9	64.3	30.4	29.9
Al ₂ O ₃	9.36	9.52	9.26	1.81	19.2	18.9	18.9	1.30	1.65
Fe ₂ O ₃	-	-	-	2.42	0.10	0.10	0.08	-	-
FeO	16.74	17.91	17.81	7.07	-	-	-	1.05	1.68
MnO	0.26	-	0.32	0.44	-	0.01	0.01	-	-
MgO	11.85	10.69	10.66	12.27	-	0.09	0.04	0.19	-
CaO	11.81	11.48	11.48	22.7	0.34	0.11	0.17	28.3	27.5
Na ₂ O	1.21	1.55	1.53	0.85	1.69	1.35	1.36	-	-
K ₂ O	0.71	1.08	1.02	-	13.6	15.0	14.80	-	-
TiO ₂	1.00	1.00	0.90	0.15	0.02	0.01	0.02	35.9	34.5
P ₂ O ₅	-	-	-	-	0.01	0.02	0.01	-	-
Cl	0.18	0.18	0.13	-	-	-	-	-	-
TOTAL	97.9	97.0	95.3	99.8	99.7	100.5	99.7	97.1	95.5
mg	55.8	51.9	51.6	75.6					

Structural Formulae (oxygen per formula unit)

	23			6	32			19	
Si	6.695	6.643	6.669	1.952	11.821	11.894	11.875	3.909	3.897
Al	1.651	1.709	1.668	0.080	4.187	4.083	4.115	0.196	0.253
Fe ³⁺	-	-	-	0.068	0.013	0.013	0.011	-	-
Fe ²⁺	2.096	2.288	2.276	0.222	-	-	-	0.112	0.184
Mn	0.033	-	0.042	0.014	-	-	-	-	-
Mg	2.644	2.428	2.429	0.686	-	0.024	0.011	0.036	-
Ca	1.894	1.874	1.880	0.912	0.068	0.022	0.033	3.873	3.838
Na	0.350	0.458	0.454	0.061	0.606	0.480	0.486	-	-
K	0.135	0.210	0.199	-	3.210	3.506	3.480	-	-
Ti	0.113	0.115	0.104	0.004	-	-	-	3.456	3.382
Ba	-	-	-	-	0.080	0.026	0.031	-	-
Cl	0.047	0.046	0.032	-	-	-	-	-	-
Cr								0.13	0.27

Trace Elements (ppm)

Rb		161	252	253		
Sr		576	551	438	41	31
Ba		9854	3325	3863		
Zr					568	678
Nb					938	2071
Ce					2440	6424
Nd					1255	3241
Y					1029	1718
Cr					98	177

779/5 - Diorite

779/7 - quartz monzodiorite)

779/51- granodiorite) Reedy Creek Granodiorite

4.3 Clinopyroxene

4.3.1 Occurrence and chemistry

Clinopyroxene is observed in the hornblende bearing rocks of the Reedy Creek Granodiorite. It generally occurs as very small anhedral, colourless "globules" enclosed by plagioclase. The clinopyroxene analysis (table 3, col. 4) occupies the salite field which is typical for calc-alkaline suite clinopyroxenes. A feature of the clinopyroxene is the high CaO content.

Yoder and Tilley (1962) demonstrated experimentally that during crystallization of basaltic liquids, the presence of amphibole is clearly pressure related. Therefore at higher pressures the stability of clinopyroxene in the granitoids which crystallized amphibole is directly related to a H_2O (Hensel, 1980). It follows that the small clinopyroxene inclusions within the Reedy Creek Granodiorite were shielded by plagioclase from the influence of water which would otherwise result in the breakdown of the clinopyroxene to amphibole.

4.4 Alkali feldspar

4.4.1 Occurrence and chemistry

Colourless to pink alkali feldspar is common in the majority of felsic granitoids and frequently displays microcline cross hatched twinning. Three textural varieties of alkali feldspar are readily recognised as:

- (a) discrete tabular to equant phenocrysts,
- (b) as part of equant crystals of antiperthite, and
- (c) anhedral, interstitial crystals.

Comparison between alkali feldspars of the Reedy Creek granodiorite and Pink Granite (table 3, col. 5,6) indicates increasing K_2O and SiO_2 and decreasing Al_2O_3 and CaO which correlates closely with variation observed in whole rock compositions. The trace element contents also reflect the host rock compositions i.e. as the host rock becomes more felsic, Ba and Sr decrease and Rb increases. Higher Rb and lower Sr content in the Microgranite alkali feldspar distinguishes it from the alkali feldspars of both the Reedy Creek granodiorite and Pink Granite.

A characteristic feature of these alkali feldspars is the high Ba (0.33-1.15%) and low Rb (~ 200 ppm) contents compared with values obtained by other authors for similar rock types (e.g. Hall, 1967; Joyce, 1973). Ba and Rb compete for similar structural sites in alkali feldspars (Heier, 1962); the abundant Ba is preferentially captured in the early stages of alkali feldspar crystallization i.e. during quartz monzodiorite and granodiorite crystallization. Rb substitution is therefore inhibited because of occupancy by the larger Ba atoms. This results in a marked decrease in K/Rb in the alkali feldspars

which usually varies only under extreme conditions of fractionation (Heier, 1962; Taylor, 1962). These unusual trace element abundance are also reflected in the host rocks.

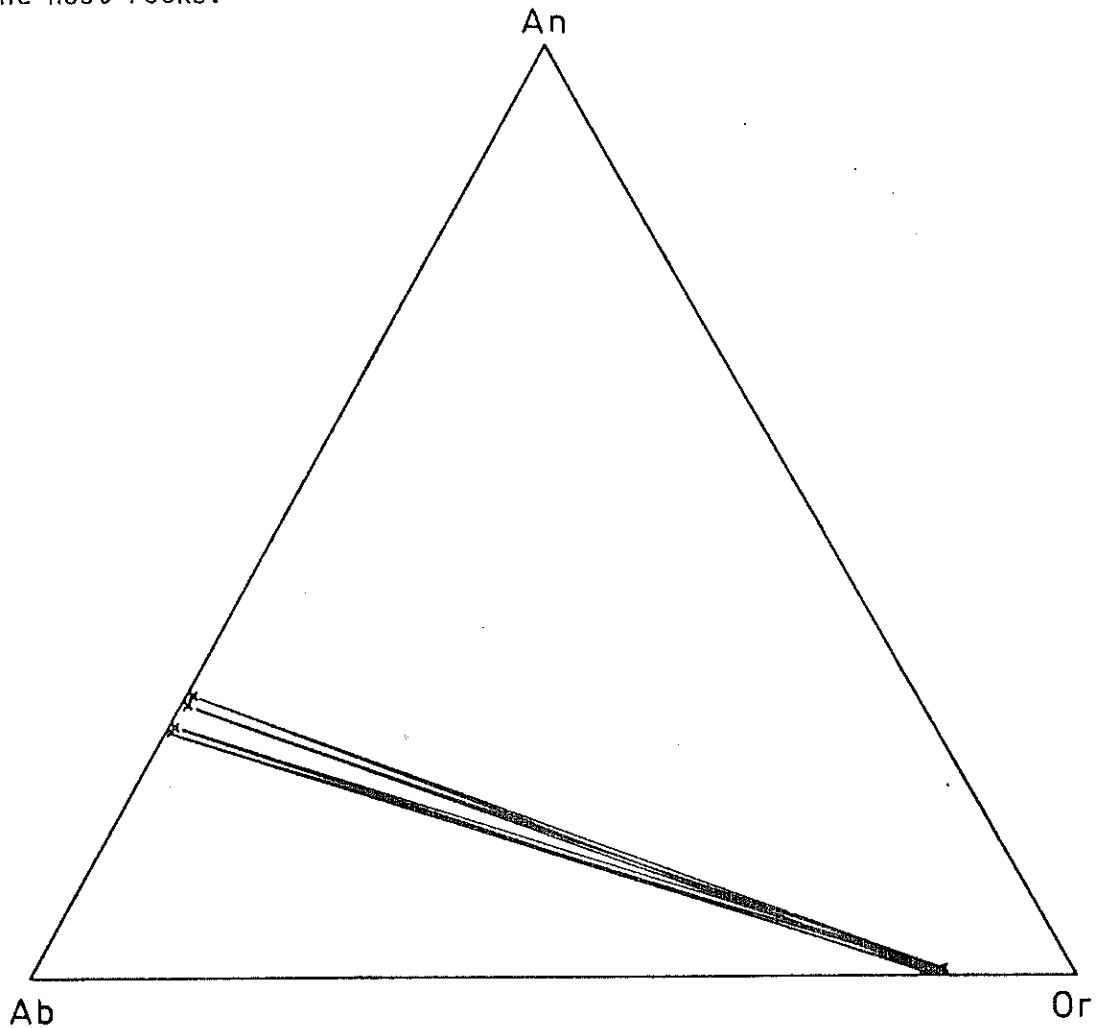


Fig. 6. Ab-An-Or diagram indicating the range of feldspar compositions in the Reedy Creek granodiorite (sample 779/51).

4.4.2 Feldspar crystallization temperatures

The range of co-existing plagioclase and alkali feldspar compositions in the Reedy Creek granodiorite is narrow (Fig. 6). Crystallization temperatures determined for the Reedy Creek granodiorite based on albite distribution between co-existing plagioclase and alkali feldspar (Stormer, 1975) range between 525^o and 540^oC utilizing plagioclase rims and cores respectively at 2kb pressure. Hall (1967) has suggested that the low feldspar crystallization temperatures derived may have resulted from recrystallization during cooling.

4.5 Iron-titanium oxides

4.5.1 Occurrence and chemistry

Iron-titanium oxides occur in all rock types, decreasing in abundance from mafic to felsic rocks. Ilmenite is the dominant opaque oxide occurring as (a) discrete ragged crystals commonly enveloped by sphene, (b) small cigar shaped inclusions within ferromagnesian minerals and (c) rare exsolution blebs within magnetite. Magnetite occurs less abundantly as discrete octahedra.

Recalculation of iron-titanium oxide analyses into molecular proportions (Carmichael, 1967, Buddington and Lindsley, 1964) results in co-existing $Il_{89.7-91.4} Hm_{10.3-8.6}$ and $Mt_{99}Ulv_1$ in the Diorite and co-existing $Il_{93.8-94.5} Hm_{6.2-5.5}$ and $Mt_{99}Ulv_1$ in the Reedy Creek granodiorite. Differences in the recalculated ilmenite molecular proportions for these rocks may be attributed to MnO content which increases sharply in the granodiorite in comparison to the diorite.

Plotted accordingly to experimentally determined compositions of magnetite-ulvospinel and ilmenite-hematite solid solutions as functions of temperature and oxygen fugacity (Buddington and Lindsley, 1964), the iron-titanium oxide pairs correspond to different conditions of crystallization. Subsolidus re-equilibrium pertaining to secondary oxidation is favoured as the mechanism resulting in the contrasting crystallization conditions (Elsdon, 1975; Buddington and Lindsley, 1964) with extensive exsolution within the opaque oxides being evident (plate 2A).

4.6 Sphene

4.6.1 Occurrence and chemistry

Sphene, ubiquitous in occurrence, is a common accessory mineral in the majority of granitoids. Textural varieties of sphene readily observed are:

- (a) interstitial anhedral to subhedral crystals commonly containing ilmenite inclusions (plate 2C),
- (b) euhedral, inclusion free crystals frequently associated with ferromagnesian mineral aggregates (Plate 2B), and
- (c) small euhedral crystals occurring along biotite cleavages.

Selected sphene analyses are listed in table 3 (col. 8,9). Decreases in CaO and TiO_2 content with increasing host rock SiO_2 reflects host rock compositions. Rare earth and some trace element contents of the sphenes are extremely high. However, they are consistent with values obtained by other authors (e.g. Lee et al, 1969). Increased concentrations of rare earth elements are observed in sphene from the Reedy Creek granodiorite in comparison to that of the Diorite. The majority of these elements present in the respective rocks are probably concentrated in the sphenes. It therefore follows that concentration of these elements in most rocks is probably a function of sphene abundance.

5. Geochemistry

5.1 Igneous rocks

5.1.1 Major element chemistry

Representative analyses of the Reedy Creek granitoids, mesonorms, mg numbers and selected ratios are presented in table 4. The chemical variations are illustrated in Harker diagrams (Fig. 7).

In terms of SiO_2 the granitoids of the Reedy Creek Pluton cover a wide range of compositions (46.8-76.8%) with gaps occurring between 55.7% and 61.6% SiO_2 and between 67.8% and 72.2% SiO_2 . The most mafic members of the Reedy Creek granitoids are melanocratic diorites. Their high ferromagnesian mineral content is reflected in the low SiO_2 contents (~46.8%) and C.I.P.W. nepheline normative chemistry. The most felsic granitoids are the microgranites (72.2-76.8% SiO_2) and Pink Granite (~74.6% SiO_2).

The major element variation trends (Fig. 7) of the Reedy Creek granitoids are all essentially linear with the exception of Al_2O_3 which is curvilinear, deviating slightly in the felsic granitoids. TiO_2 , Fe_2O_3 , FeO , MnO , MgO , CaO and P_2O_5 define negative straight line correlations with SiO_2 . K_2O displays a relatively less-well defined positive correlation with SiO_2 whereas Na_2O content essentially remains constant throughout the SiO_2 range. The Summerfield Granodiorite plots away from the trend on most of the Harker diagrams.

5.1.2 Trace element chemistry

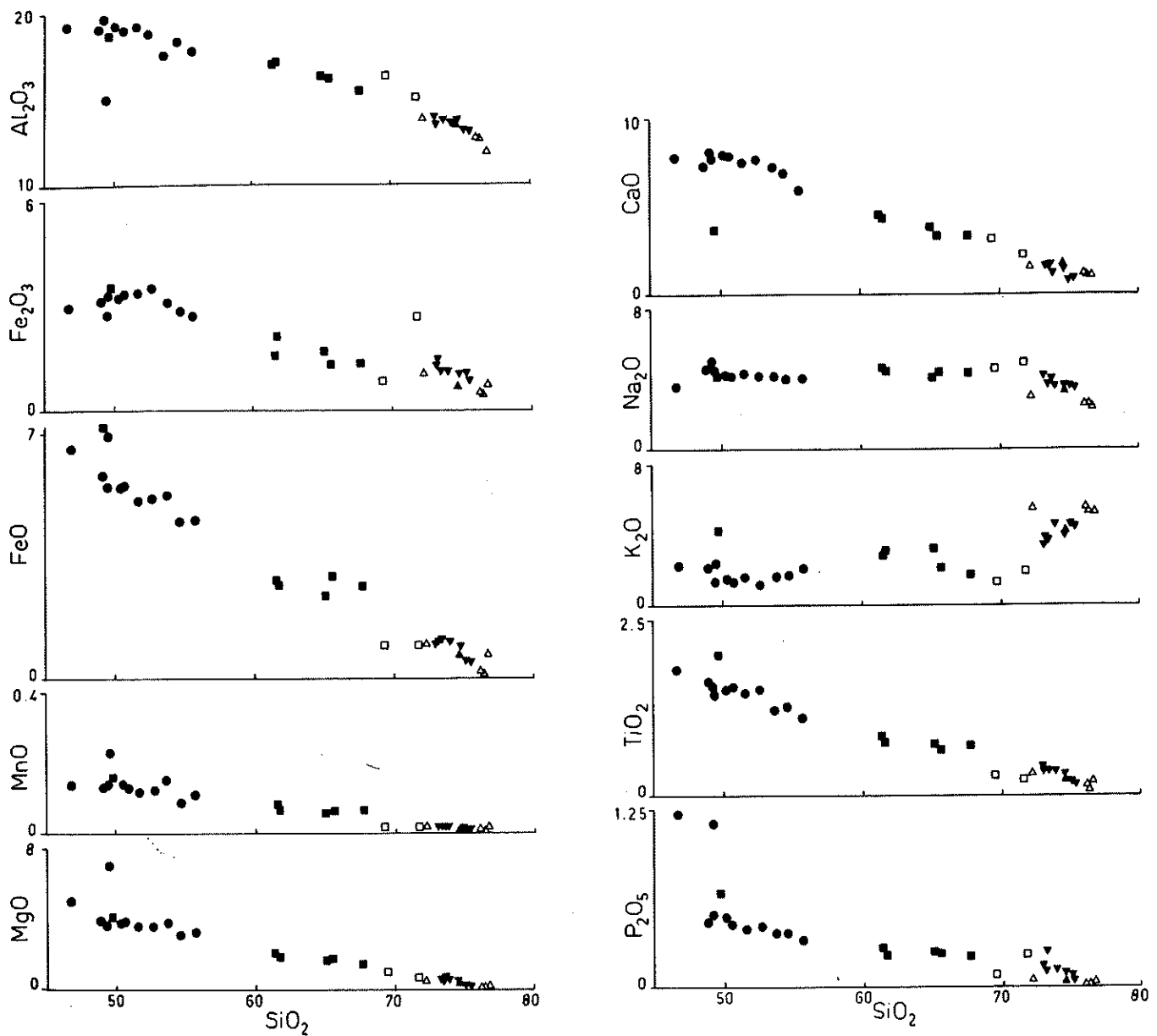
The trace element variation trends (Fig. 8) of the Reedy Creek granitoids are also linear but with less-well defined correlations against SiO_2 . Sr, Nb, Sc, V, Ni, Li, Zn and Y tend to decrease with increasing SiO_2 . Rb, Ce and Nd exhibit positive correlations with increasing SiO_2 content although somewhat more scattered. The data points for Cu are scattered, but show a weak negative correlation with SiO_2 . The trend for Ba differs from that of other trace elements showing increases against SiO_2 until the intermediate SiO_2 range i.e. 60-65% and then decreases in the felsic granitoid variants. This trend is commonly observed with respect to Ba content for differentiated granitic magmas (Nockolds and Allen, 1959; Taylor, 1962). The high Ba concentrations of the Microgranites in comparison to granitoids of similar SiO_2 content within the Reedy Creek Pluton suggests that the microgranites do not constitute part of a differentiated comagmatic series for this suite of rocks. This is well supported by field and mineralogical evidence. The trend for Zr is similar to that of Ba.

Table 4. Representative major and trace element analyses of granitoids from the Reedy Creek area

	diorite (1)	quartz diorite (2)	quartz monzo- diorite (3)	grano- diorite (4)	ton- alite (5)	Pink Granite (6)	Micro- granite (7)	Summerfield Granodiorite (8)
Sample No.	779/3	779/30	779/7	779/51	779/66	779/19	779/18	779/35
SiO ₂	49.0	53.7	61.8	65.0	67.8	74.6	76.8	69.3
Al ₂ O ₃	19.2	17.4	16.9	16.3	15.3	13.4	11.7	16.1
Fe ₂ O ₃	3.14	3.07	1.55	1.67	1.36	0.62	0.73	0.81
FeO	5.74	5.23	2.67	2.38	2.63	0.64	0.67	0.94
MnO	0.13	0.15	0.07	0.06	0.07	0.00	0.02	0.02
MgO	3.95	3.89	1.91	1.63	1.49	0.46	0.37	0.96
CaO	7.30	7.18	4.37	3.78	3.26	1.66	1.05	3.12
Na ₂ O	4.55	4.13	4.51	4.06	4.38	3.31	2.31	4.96
K ₂ O	2.03	1.61	2.88	3.29	1.63	4.19	5.30	1.95
TiO ₂	1.62	1.24	0.85	0.74	0.71	0.21	0.22	0.21
P ₂ O ₅	0.46	0.38	0.27	0.25	0.22	0.04	0.04	0.07
H ₂ O	2.0	1.3	1.4	1.0	1.1	0.7	0.6	1.0
TOTAL	99.1	99.3	99.2	100.2	100.0	99.8	99.8	99.4
Barth Mesonorms								
Quartz	0.05	7.23	15.39	20.15	27.49	33.62	38.86	26.23
Orthoclase	-	-	11.04	14.32	4.40	23.95	31.15	6.13
Albite	41.90	37.84	41.02	36.85	40.01	30.33	21.36	45.26
Anorthite	25.80	24.68	17.46	16.72	15.00	8.14	5.10	15.14
Sillimanite	-	-	-	-	1.55	0.83	0.59	1.49
Actinolite	3.72	7.09	-	-	-	-	-	-
Hypersthene	1.03	0.91	-	-	-	-	-	-
Biotite	19.68	15.53	11.36	8.52	8.63	2.09	1.75	4.31
Apatite	0.99	0.81	0.49	0.53	0.47	0.09	0.09	0.19
Sphene	3.47	2.64	1.51	0.35	-	-	-	-
Magnetite	3.37	3.27	1.65	1.76	1.45	0.66	0.79	0.86
Ilmenite	-	-	0.09	0.81	1.01	0.30	0.32	0.40
Trace Elements (ppm)								
Rb	69	46	70	76	71	75	115	49
Sr	698	639	514	450	513	341	269	662
Ba	1000	901	1796	1853	811	942	1496	906
Zr	241	174	316	318	305	73	123	121
Nb	19	29	26	25	15	11	17	21
Sc	34	23	14	12	12	2	2	5
Ni	27	35	21	21	16	11	10	18
V	191	194	80	81	79	18	16	37
Zn	94	76	40	35	47	14	14	46
Cu	61	44	14	3	36	0	0	36
Li	11	9	7	6	6	6	5	9
Ce	53	78	103	98	102	68	151	42
Nd	22	34	33	30	35	19	30	11
Y	23	41	28	26	17	11	14	5
Ratios								
mg	45	46	46	43	41	41	33	51
mol Al/Ca+Na+K	0.82	0.81	0.95	0.95	1.03	1.03	1.02	1.08
Fe ³⁺ /Fe ²⁺ + Fe ³⁺	0.33	0.35	0.35	0.39	0.32	0.46	0.50	0.44
(diopside								
%CIPW norm (corundum	D(3.36)	(D)3.74)	D(1.03)	D(0.24)	C(0.93)	C(0.50)	C(0.35)	C(1.34)
K/Rb	244	290	342	359	190	464	382	330
Ba/Kx10 ³	59	67	75	68	60	27	34	56
Ba/Sr	1.43	1.41	3.49	4.12	1.57	2.76	5.56	1.37
Ba/Rb	14.5	19.6	25.7	24.4	11.4	12.6	13.0	18.5

(1),(2) - Diorite

(3),(4),(5) - Reedy Creek Granodiorite



- Reedy Creek Granodiorite
- Diorite
- ▲ Pink Granite
- △ Microgranite
- Summerfield Granodiorite
- ▼ Palmer Granite

Fig. 7. Major element variation diagrams for the Reedy Creek and Palmer granitoids plotted against SiO₂. (Data for Reedy Creek granitoids compiled by Moeller, 1980. Data for Palmer Granites from White, 1967.)

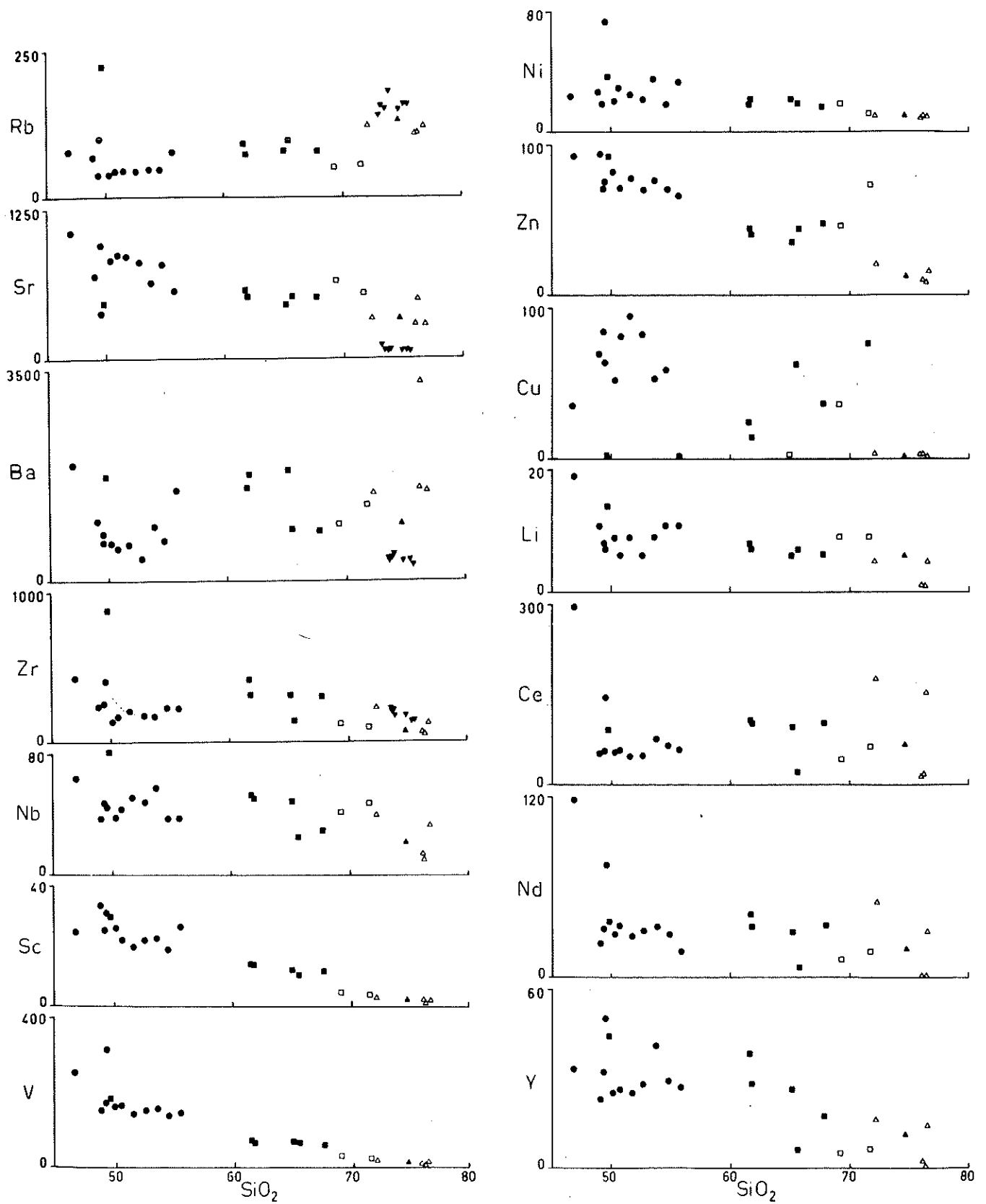


Fig. 8. Trace element variation diagrams for the Reedy Creek and Palmer granitoids plotted against SiO_2 (symbols as for Fig. 7.)

K/Rb, Ba/K, Ba/Sr and Ba/Rb ratios for calc-alkaline rocks have been shown to decrease with fractionation (Taylor, 1965), however, marked increases in these ratios occur in the granitoids of the Reedy Creek Pluton, especially in granitoids of the melanocratic to intermediate SiO_2 range. This is probably a reflection of the high Ba concentrations in the alkali feldspars with which Rb competes for similar lattice sites affecting all of the above ratios.

Chondrite normalized incompatible element abundance patterns show close similarities for the Reedy Creek granodiorite, Diorite and Pink Granite (Fig. 9). Arranged in order of decreasing incompatibility, a steady decrease of normalized values of the elements is observed, with marked depletions of Nb and Ti. Slight enrichments of normalized Ba values also occurs, with concentrations ranging up to 470 times chondrite abundance.

5.1.3 Chemical comparison between the Reedy Creek granitoids and S- and I-type granitoids of the Lachlan and New England Suites

The concept of S- and I-type granitoids introduced by Chappell and White (1974) was based initially on contrasting granitoid types in the Lachlan Fold Belt of southeastern Australia which reflect the nature and composition of their source. I-type granitoids derived by partial melting of pre-existing igneous source rocks should possess characteristics which distinguish them from S-type granitoids derived from source rocks which have experienced surface weathering processes.

Criteria used to successfully distinguish the two granitoid types include high Na_2O which is reflected in low molecular $\text{Al}/\text{Ca}+\text{Na}+\text{K} < 1.1$ and $\text{Fe}^{3+}/\text{Fe}^{2+} + \text{Fe}^{3+} > 0.1$ for I-type granitoids in comparison to molecular $\text{Al}/\text{Ca}+\text{Na}+\text{K} > 1.1$ and $\text{Fe}^{3+}/\text{Fe}^{2+} + \text{Fe}^{3+} < 0.1$ for S-types. Differences in chemical criteria are reflected by the mineralogy of the granitoids; I-types characteristically contain biotite + hornblende + sphene + magnetite whereas S-types contain biotite + muscovite + aluminosilicates + ilmenite. Additional features which distinguish S- and I-type granitoids include C.I.P.W. normative diopside and corundum values and spectrum of composition with respect to SiO_2 content for the granitoid suite.

SiO_2 contents for the major granitoid types within the Reedy Creek Pluton (i.e. Diorite, Reedy Creek Granodiorite and Pink Granite) range from 46.8% to 74.6% corresponding to an I-type granitoid suite. In contrast, the Summerfield Granodiorite SiO_2 values are relatively restricted (69.3-71.7%). Although the latter range may be widened if the Summerfield Granite variants were included, the range is well within Chappell and White's range of SiO_2 values for S-type granitoids and compare favourably with the S-type granitoids of the Moonbi District, eastern Australia (Chappell, 1978).

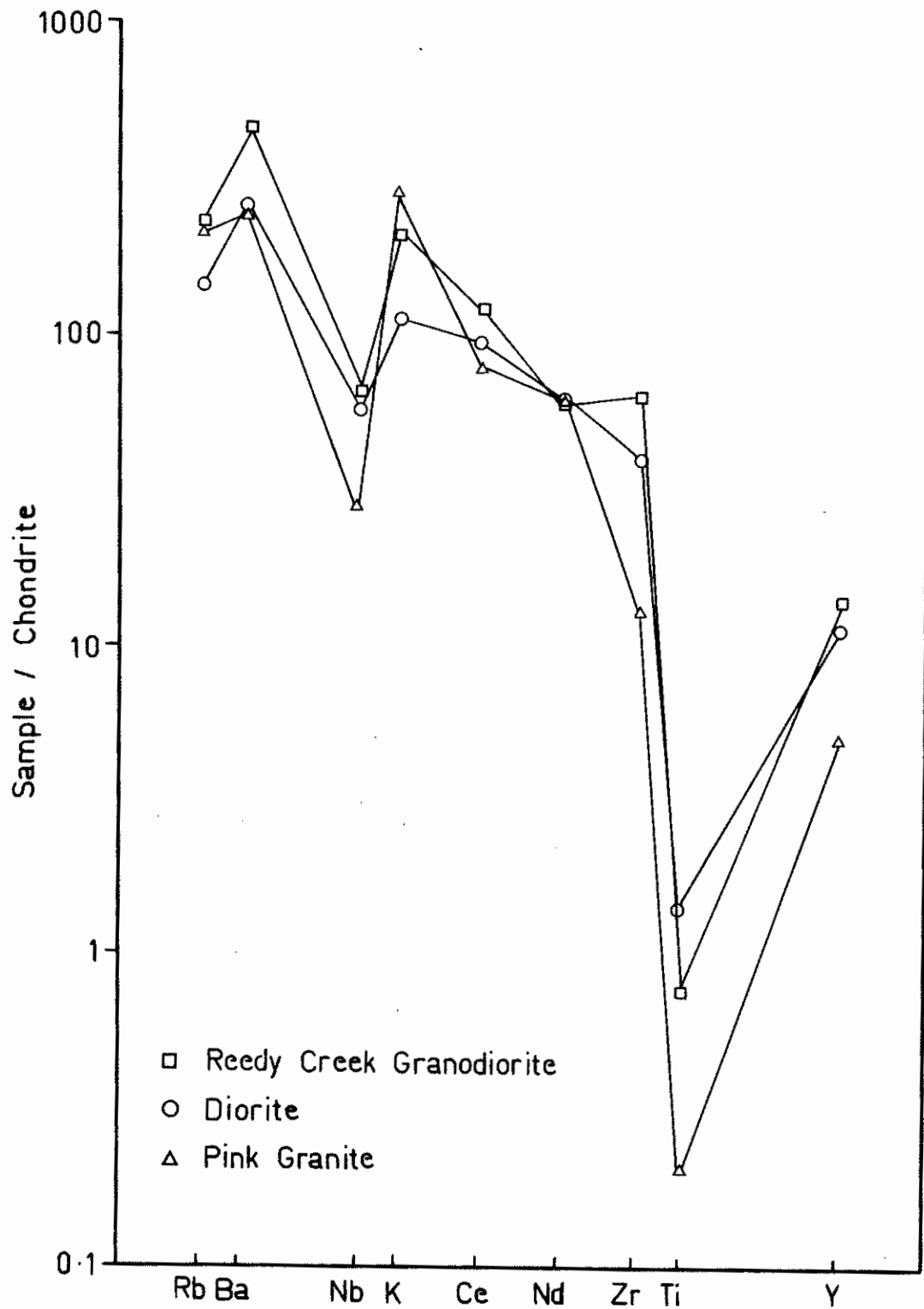


Fig. 9. Comparison of normalized incompatible element abundance patterns for selected representative granitoids from the Reedy Creek Pluton. Abundances of Ce, Nd, Ba, Nb, Zr, Ti, Y and K, Rb are normalized using chondrite abundances from Sun and Nesbitt, 1977 and 1979.

Although Na_2O contents are relatively consistent throughout the granitoid range ($\sim 4\%$), a subdivision on the basis of molecular $\text{Al}/\text{Ca}+\text{Na}+\text{K}$ between granitoids of the Reedy Creek Pluton (0.71-1.03) and Summerfield Granodiorite (1.05-1.08) can be made. S-type granitoids of the Moonbi District (Chappell, 1978) contain similarly high Na_2O contents. The high Na_2O content of the Summerfield Granodiorite implies a derivation from a sodium rich source, a source which would have been subjected to less chemical weathering than that involved in the generation of the S-type granitoids of the Lachlan Suite.

High $\text{Fe}^{3+}/\text{Fe}^{3+} + \text{Fe}^{2+}$ (0.28-0.46) are observed in the granitoids of the Reedy Creek area including the Summerfield Granodiorite and are probably the result of the highly oxidizing conditions at the time of crystallization, evident from the biotite compositions. However $\text{Fe}^{3+}/\text{Fe}^{3+} + \text{Fe}^{2+}$ ratios are generally low (0.1) for S-type granitoids (Chappell and White, 1974). Hensel (1980) reported similarly high $\text{Fe}^{3+}/\text{Fe}^{3+} + \text{Fe}^{2+}$ ratios for the S-type granitoids of the Hillgrove Suite, New England, indicating the inconsistency of this ratio as a source rock indicator.

The I- and S-type character of the granitoids constituting the Reedy Creek Pluton and Summerfield Granodiorite respectively is expressed mineralogically; the pluton granitoids containing an indicative assemblage of biotite + sphene + hornblende which contrasts with the Summerfield Granodiorite which is characterized by an assemblage of biotite + muscovite. This is also reflected in the generally diopside and high corundum C.I.P.W. normative values respectively for these contrasting granitoid types.

An interesting feature of the granitoids which may have petrogenetic significance is the tendency for the ratios indicating source rock composition (i.e. mol $\text{Al}/\text{Ca}+\text{Na}+\text{K}$ and $\text{Fe}^{3+}/\text{Fe}^{2+} + \text{Fe}^{3+}$) and C.I.P.W. normative corundum and diopside values to vary systematically as the rocks become more felsic.

5.1.4 Chemical comparison between the Reedy Creek, Palmer and Mannum granitoids

The Palmer and Mannum Granites outcrop in close vicinity to the Reedy Creek Pluton (Fig. 1) and have similar mineral assemblages to the granitoids of the pluton. Both the Palmer and Mannum Granites are I-type granitoids on the basis of Chappell and White's S- and I-type granitoid classification.

(a) Mannum Granite

Analyses of the Mannum Granite (Goode, 1927; Mancktelow, 1979) and five dioritic inclusions are listed in appendix 1. The inclusions have a similar appearance to the Diorite of Reedy Creek, however, marked differences in major and trace element concentrations clearly distinguish these rocks. In addition, comparison of chemical compositions between the Mannum Granite and Reedy Creek granitoids also indicates marked differences which is suggestive of different petrogenetic histories for the respective granitoid bodies.

(b) Palmer Granite

On Harker diagrams both major and trace elements (Figs. 7 and 8) of the Palmer Granite (analyses listed in appendix 1) plot as extension of the trends containing the I-type granitoids of the Reedy Creek Pluton. The adamellites and granites constituting the Palmer Granite similarly contain sparsely distributed dioritic inclusions (White et al, 1967). Concordancy with the country rocks and a lineation in the same orientation as the foliation within the Reedy Creek Pluton is also observed.

5.2 Metamorphic rocks

5.2.1 Major and trace element chemistry of selected migmatites

Migmatites (total rock) in close vicinity to the pluton (listed in appendix 1) show little systematic elemental variation. Any systematic variation which does occur can be attributed to modal biotite and feldspar probably resulting from variation within the source material and the varying degrees of migmatitization of these rocks. Similarly, analyses of migmatites and gneisses collected at increasing distance from the pluton also show little systematic variation.

6. Petrogenetic aspects of the Reedy Creek area

6.1 Igneous rocks

6.1.1 Introduction

Classic theories on the origin of the calc-alkaline rock association include partial or wholesale melting of a variety of source rocks, differentiation of basaltic magma and modification of magma by mafic or sialic material. More recently, White and Chappell (1977) presented a model to explain the geochemical and mineralogical characteristics of granitoids and their inclusions. At the source, the product of partial melting is a mixture of melt and solid refractory material (restite) which behave essentially as two separate components and resultant rock compositions consist of varying proportions of these components.

6.1.2 Origin of the Reedy Creek granitoids

6.1.2.1 Application of experimental phase relationships

Compared with the 4-7kb, P_{H_2O} thermal trough in the Q-Ab-An-Or- H_2O system for Ab/An ratios of 2.9 (von Platen and Holler, 1966), mesonormative Q-Ab-Or proportions for the majority of Reedy Creek granitoids plot outside of the respective cotectics and closer to the Ab apex (Fig. 10). This field is occupied by the Reedy Creek and Summerfield Granodiorites. In contrast, the Pink Granite plots within the thermal trough and close to the 4kb cotectic. The Microgranites contain a higher Or component in comparison to the other granitoids within the Reedy Creek Pluton and occupy a narrow elongate field plotting within the Q-rich side of the 4-7kb thermal trough.

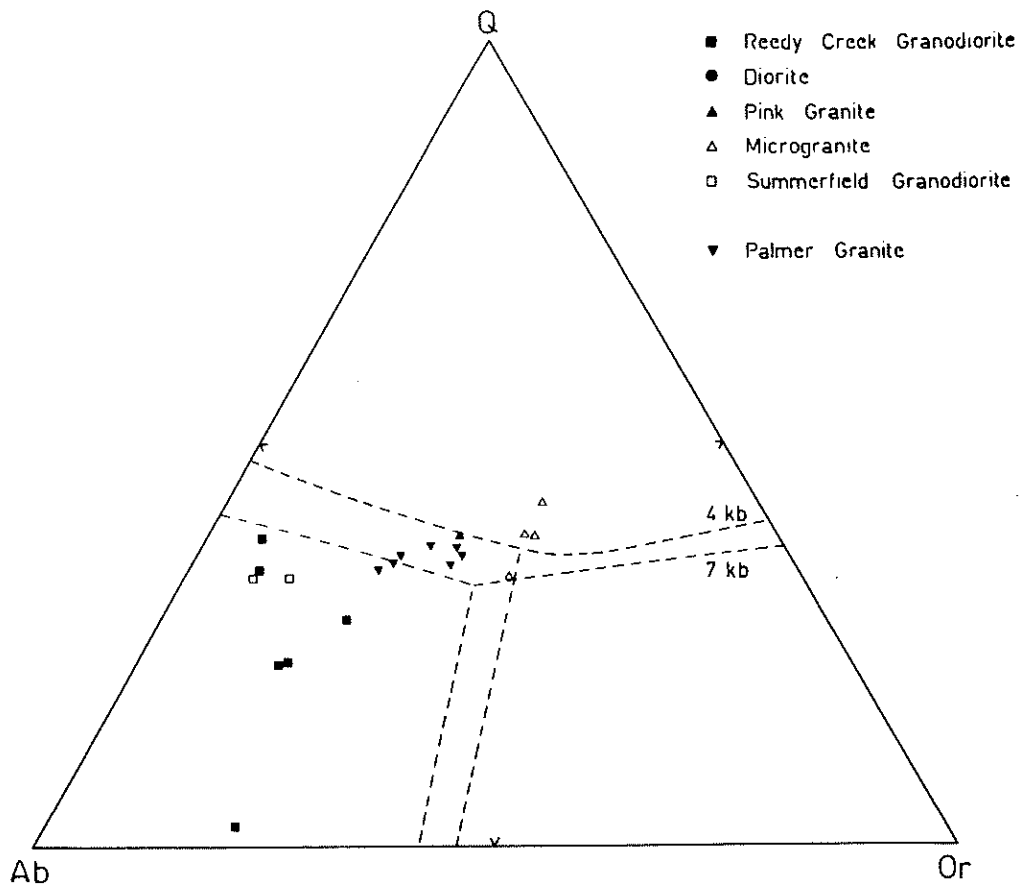


Fig. 10. Mesonormative Q-Ab-Or proportions of the Reedy Creek and Palmer granitoids compared with the cotectic lines for water vapour pressures of 4 and 7 kb and $Ab/An=2.9$ (after von Platen and Höller, 1966).

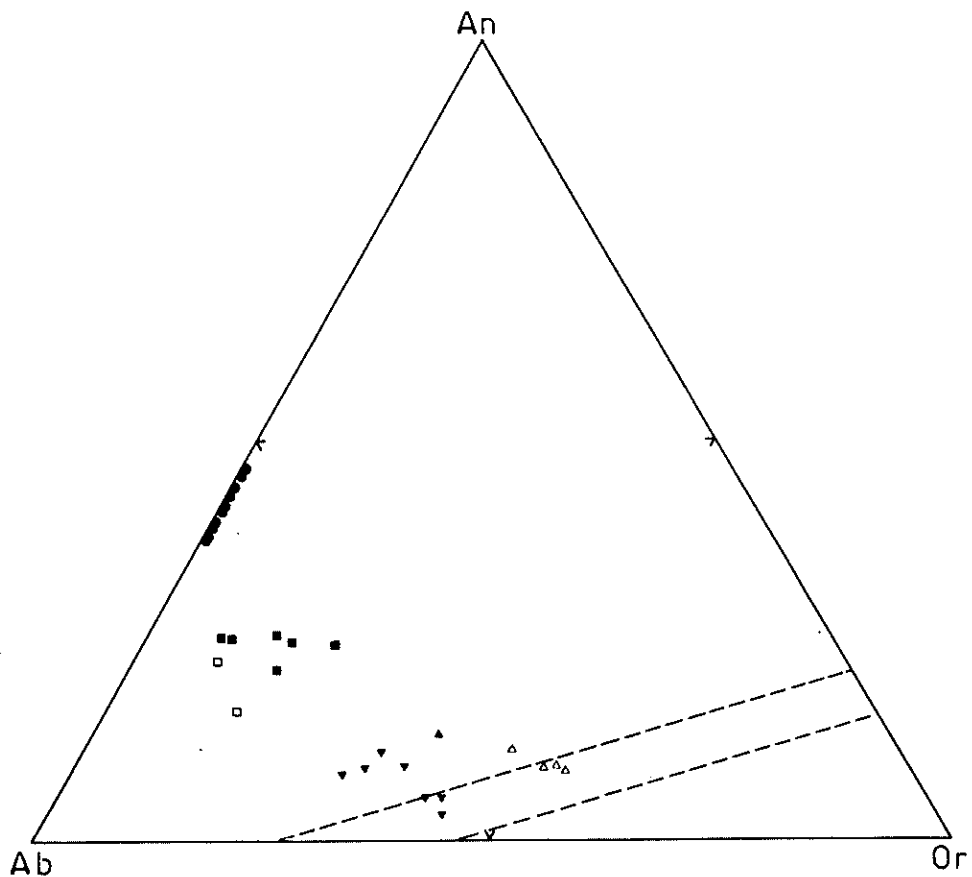


Fig. 11. Mesonormative An-Ab-Or proportions of the Reedy Creek and Palmer granitoids compared with the thermal trough in the system An-Ab-Or-Q (after Kleeman, 1965).

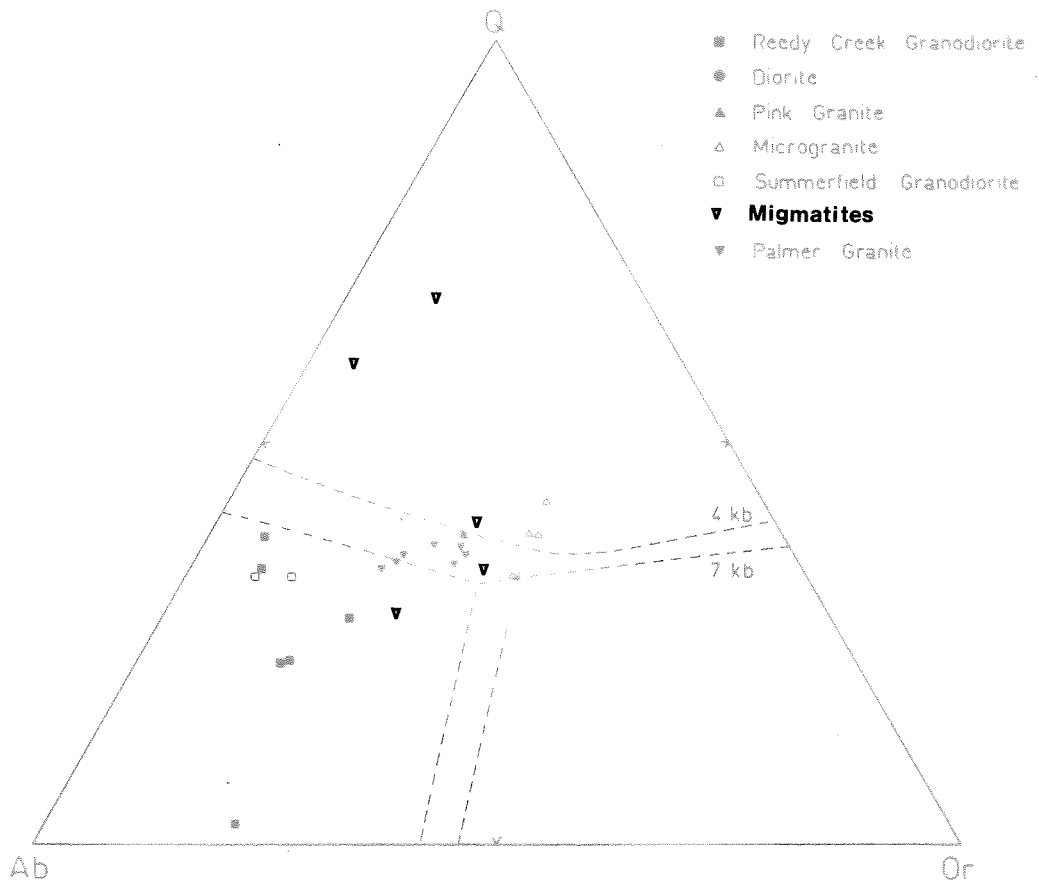


Fig. 10. Mesonormative Q-Ab-Or proportions of the Reedy Creek and Palmer granitoids compared with the cotectic lines for water vapour pressures of 4 and 7 kb and $Ab/An=2.9$ (after von Platen and Höller, 1966).

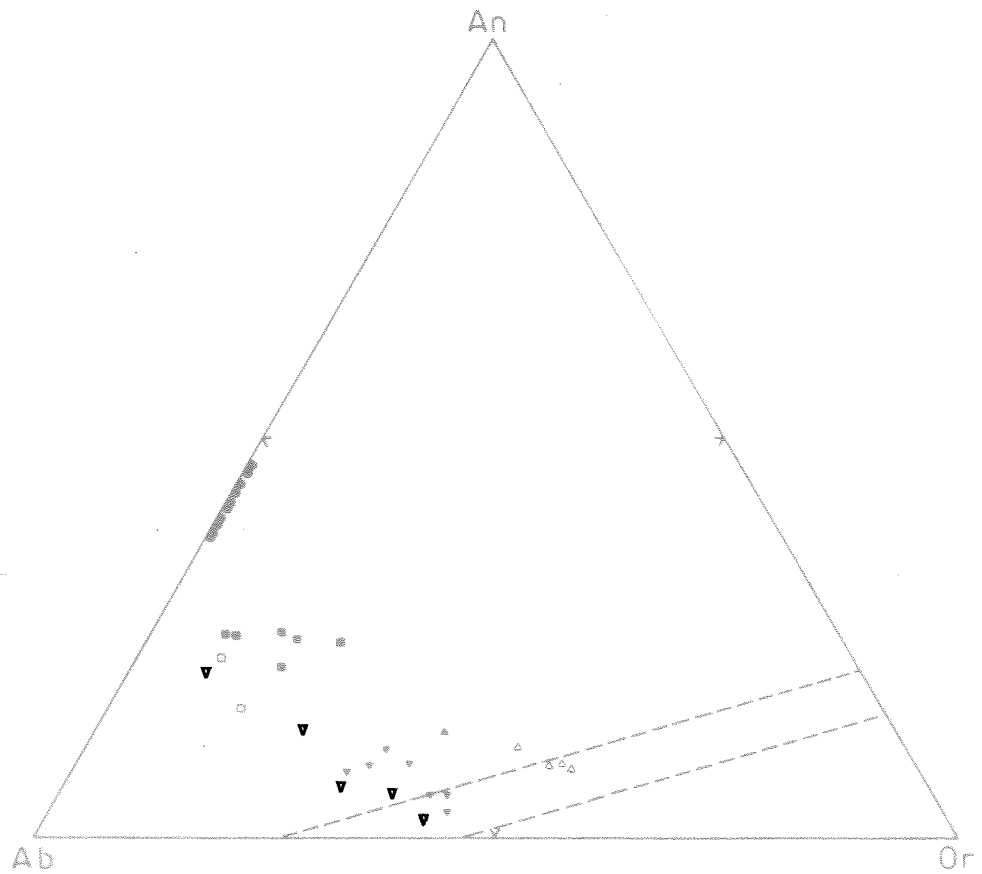


Fig. 11. Mesonormative An-Ab-Or proportions of the Reedy Creek and Palmer granitoids compared with the thermal trough in the system An-Ab-Or-Q (after Kleeman, 1965).

On the An-Ab-Or diagram (Fig. 11) the Diorite which probably represents an accumulation of refractory crystals plot along the Ab-An edge nearer the Ab apex. The Reedy Creek Granodiorite and Pink Granite plot in a continuous elongate field extending from the Ab-An edge (Diorite) toward the thermal trough (Kleeman, 1965). The trend is consistent with an origin where melt and restite are mixed in different proportions however the nature of the trend curving toward the Or corner may possibly imply a certain degree of fractional crystallization occurring concurrently.

6.1.2.2 Application of theories for origin of granitic magma to the granitoids of the Reedy Creek Pluton

Application of the classic theories for origin of granitic magma alone cannot adequately explain the field, petrographical, mineralogical and chemical characteristics of the Reedy Creek granitoids. Although the presence of the tonalitic phase of the Reedy Creek Granodiorite in the Black Hill Gabbroic Complex (Wegmann, 1980) is suggestive of genetic association between the gabbros and granitoids, the granitoids of the Reedy Creek area outcrop more than 40km from Black Hill. If produced by fractional crystallization of basaltic magma, huge reservoirs of basaltic magma are required.

Major short-comings of assimilation of basaltic magma by granitic magma for the formation of the Diorite include:

- (a) restriction of assimilation to magma contacts; chilling at the magma contacts is generally observed, and
- (b) granophyres generally occur in the hybrid rocks (Gamble, 1979).

Similarly, contamination of felsic magma by mafic materials is relatively restricted as felsic magmas have only limited capacity to assimilate mafic material (McBirney, 1979).

An origin involving various mixtures of restite and melt for the formation of the major granitoids within the Reedy Creek Pluton is supported by the chemical, mineralogical, textural and field criteria. In addition, this is the only model which adequately explains the occurrence of inclusions of Diorite in the Reedy Creek Granodiorite (plate 1B) and vice versa (plate 1A).

6.1.2.3 Source rocks

The chemical features displayed by the granitoids of the Reedy Creek Pluton generally accord well with the criteria of Chappell and White (1974) for granitoids presumed to have been derived from pre-existing igneous source material. However, granitoids derived by partial melting of source material comprising mainly volcanic detritus e.g. greywackes would display all of the characteristics of I-type granitoids. Metagreywacke horizons compositionally similar to dacites and rhyodacites are common in the Kanmantoo Group meta-sediments (Kleeman and White, 1956; Mancktelow, 1979). The relatively

high initial $^{87}\text{Sr}/^{86}\text{Sr}$ ratio of 0.706 (Hensel, pers. comm.) for I-type granitoids and the systematic change in $\text{Fe}^{3+}/\text{Fe}^{2+} + \text{Fe}^{3+}$, molecular Al/Ca+Na+K and C.I.P.W. normative corundum content as the granitoid suite becomes more felsic, may be a reflection of sedimentary character acquired by partial melting of the metagreywackes. Alternatively, the source for the granitoids of the Reedy Creek Pluton may have been a pre-existing granodiorite body ($\text{SiO}_2 \sim 60-65\%$) occurring at depth.

The S-type Summerfield Granodiorite was probably also the result of partial melting of one of the many pelitic horizons occurring at depth within the Kanmantoo Group metasediments as the source material in which surface weathering had not been very extensive.

6.1.2.4 Mechanisms of granitoid formation and timing of emplacement

Following partial melting of the proposed metagreywacke source and separation of non minimum melt and restite, fractional crystallization of the melt probably occurred during its emplacement into its present position. A significant restite component within the melt is evident from the similar biotite compositions occurring in the respective granitoids. Intrusion of the Diorite (restite) as a crystal mush occurred subsequently.

The volume of Pink Granite in comparison to Reedy Creek Granodiorite is small. This may be a reflection of source composition however a previous melting history involving the extraction of magma of minimum melt composition from the source is more likely.

The Palmer Granite is a likely result of initial partial melting of the source having comparable mineralogical and chemical compositions to the granitoids of the Reedy Creek Pluton. The Palmer Granite plots in or near the thermal troughs (von Platen and Holler, 1966; Kleeman, 1965) of both Q-Ab-Or and An-Ab-Or diagrams respectively indicating minimum or near minimum melt compositions. The "straight" line trends which occur on these diagrams between Palmer Granite, Reedy Creek Granodiorite and Diorite lends support to a close genetic association between the Palmer Granite and the granitoids of the Reedy Creek Pluton.

Both the Palmer Granite and Reedy Creek Pluton were emplaced concordantly within the country rock during periods of deformation and metamorphism which probably occurred for 50-60 m.y. until 449-459 m.y. ago (Milnes et al, 1977). White et al (1967) determined the age of the Palmer Granite to be 489 ± 15 m.y. The intrusion of the Black Hill Norite, indicating an age of 487 ± 5 m.y. (Milnes et al, 1977) may have initiated partial melting in the source resulting in formation of the Palmer Granite. The age of the Reedy Creek Granodiorite is approximately 471 m.y. (Hensel, pers. comm.) and is supportative of the earlier partial melting history for the Palmer Granite.

6.2 Metamorphic Rocks

6.2.1 Introduction

Whitehead (1975) cited evidence involving specific trace element ratios for the origin of the contact migmatites within the Reedy Creek area in accordance with either partial melting or metamorphic differentiation. Similar conclusions were derived by White (1966) for the Palmer migmatites however, in the Q-Ab-An-Or-H₂O system, non minimum melt compositions indicated by the migmatites suggested an origin involving metamorphic differentiation.

6.2.2 Origin of the Reedy Creek migmatites

6.2.2.1 Application of experimental phase relationships

Mesonormative proportions for migmatites (total rock) occurring within close vicinity of the pluton, containing alkali feldspar as a major constituent plot in or near the thermal troughs (von Platen and Holler, 1966; Kleeman, 1965) of the Q-Ab-Or (Fig. 10) and An-Ab-Or diagrams (Fig. 11) respectively indicating minimum or near minimum melt compositions. In contrast, the migmatites containing plagioclase as the sole feldspar plot well away from the thermal troughs (von Platen and Holler, 1966; Kleeman, 1965).

The migmatites occurring at greater distances from the pluton similarly plot well away from the thermal troughs (von Platen and Holler, 1966; Kleeman, 1965).

6.2.2.2 Mechanism for formation of the Reedy Creek migmatites

The "granitic" character of the migmatite biotites and the high biotite crystallization temperatures (790-810°C) are suggestive of an origin involving partial melting for the migmatites, at least within close vicinity of the pluton. A higher degree of partial melting is suggested in the migmatites which are of minimum melt composition; the migmatites containing alkali feldspar as a major constituent of the mineralogy.

Metamorphic differentiation is a possible alternative mechanism for migmatite formation and may have occurred in conjunction with partial melting (e.g. Yardley, 1978).

PLATE 1

A: Loose clusters of plagioclase phenocrysts within the diorites resulting from disaggregation of Reedy Creek Granodiorite.

B: Inclusions of diorite within the Reedy Creek Granodiorite.

C: Migmatite consisting of layered paleosome (biotite gneiss) and felsic neosome.



A



B



C

PLATE 2

A: Extensive exsolution lamellae of hematite in ilmenite crystals
(sample 779/51).

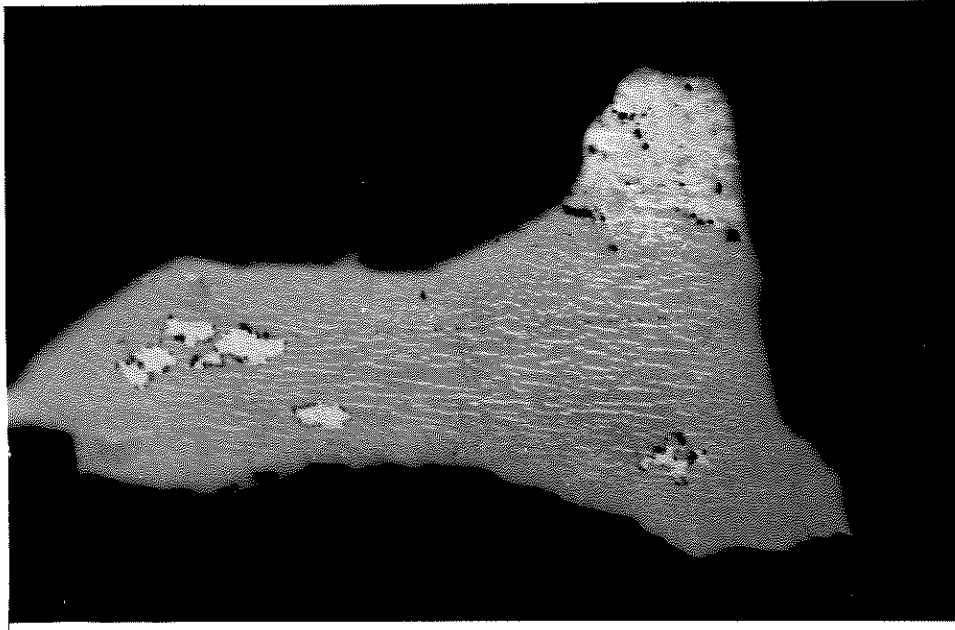
(x40)

B: Anhedral sphene occurring interstitially to plagioclase
in the diorites (sample 779/3).

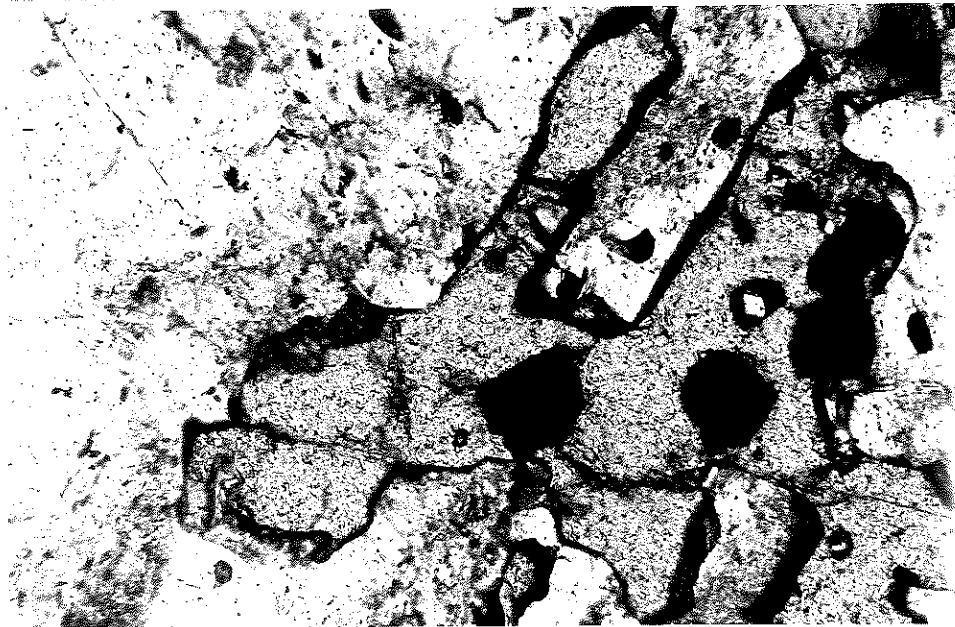
(x40)

C: Euhedral "rhombic" sphene occurring in the Reedy Creek
Granodiorite (sample 779/51).

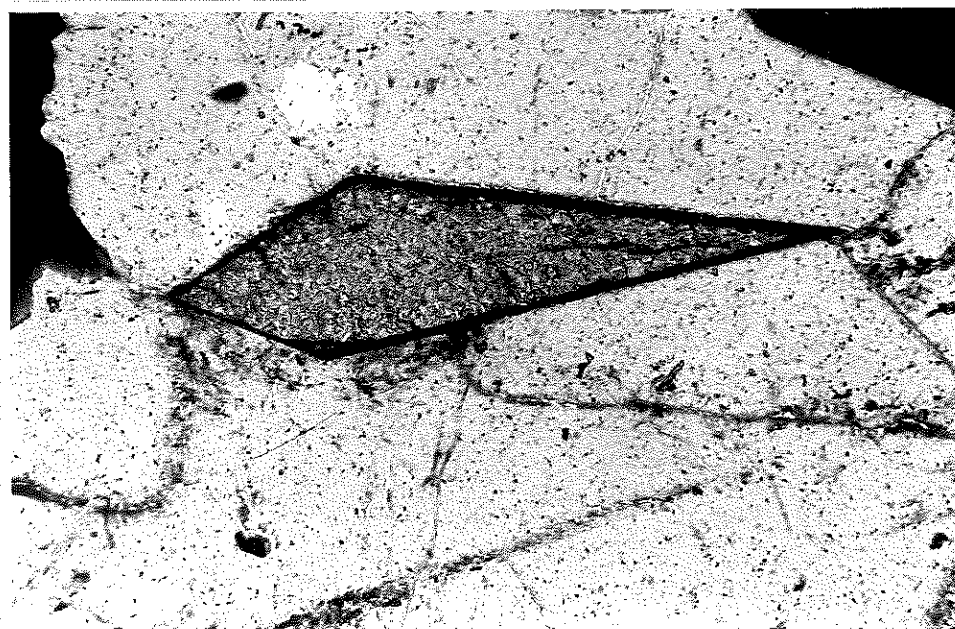
(x40)



A



B



C

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APPENDIX 1

WHOLE ROCK AND TRACE ELEMENT ANALYSES

(A) Modes, major and trace elements of the Reedy Creek granitoids and migmatites

	<u>Diorite</u>										
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Sample No.	779/23	779/3	779/32	779/36	779/5	779/25	779/31	779/31	779/30	779/21	779/43
Rock Type	diorite	diorite	diorite	quartz diorite	diorite	diorite	diorite	diorite	quartz diorite	quartz diorite	quartz diorite

Modes (estimated)

Quartz	-	-	-	5	2	2	3	4	8	10	15
Plagioclase	52	60	55	40	70	65	70	70	70	65	65
Biotite	26	20	25	28	10	10	12	15	10	10	12
Amphibole	14	15	15	22	15	20	10	8	10	10	10
Sphene	3	2	2	1	1	tr.	2	1	1	2	1
Apatite	3	1	1	3	1	tr.	1	1	tr.	1	tr.
Zircon	tr.	1	tr.	tr.	tr.	tr.	tr.	tr.	tr.	1	tr.
Epidote	tr.	1	tr.	tr.	1	tr.	tr.	tr.	tr.	tr.	tr.
Opaques	2	1	1	1	2	3	1	1	1	2	1

Reedy Creek Granodiorite

Pink Granite

	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Sample No.	779/53	779/54	779/7	779/51	779/52	779/66	779/19
Rock Type	diorite	quartz monzo- diorite	quartz monzo- diorite	grano- diorite	tonalite	tonalite	granite

Modes

Quartz	3	17	15	25	20	25	32
Plagioclase	65	50	55	45	65	60	22
Alkali Feldspar	-	15	13	15	-	1	37
Biotite	30	10	10	9	15	12	6
Amphibole	-	6	5	4	-	-	-
Sphene	-	tr.	1	1	-	-	1
Apatite	tr.	1	tr.	tr.	tr.	tr.	tr.
Zircon	tr.	1	tr.	tr.	tr.	-	1
Epidote	-	tr.	tr.	-	-	-	-
Opaques	1	tr.	1	1	tr.	2	tr.

	<u>Microgranite</u>				<u>Summerfield Granodiorite</u>		<u>Lamprophyre</u>	
	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)
Sample No.	779/4	779/9	779/10	779/18	779/35	779/6	779/14	779/8
Rock Type	granite	granite	granite	granite	grano- diorite	grano- diorite	quartz diorite	quartz diorite
<u>Modes</u>								
Quartz	35	40	40	37	28	30	10	15
Plagioclase	20	12	12	20	11	12	62	60
Alkali Feldspar	40	45	47	40	55	53	-	1
Biotite	5	3	1	3	6	5	8	5
Amphibole	-	-	-	-	-	-	18	15
Muscovite	-	-	-	-	tr.	tr.	-	-
Sphene	tr.	tr.	-	tr.	-	-	1	1
Apatite	tr.	-	-	-	-	-	tr.	1
Zircon	-	-	-	-	-	-	-	tr.
Opaques	tr.	tr.	-	tr.	tr.	tr.	1	1
<u>Migmatites and country rock</u>							<u>Chilled margin Diorite-gneiss contact</u>	
	(27)	(28)	(29)	(30)	(31)	(32)	(33)	(34)
Sample No.	779/48	779/49	779/50	779/45	779/34	779/33	779/28	779/29
Rock Type	migma- tite	migma- tite	migma- tite	migma- tite	country rock	leucosome	tonalite	tonalite
<u>Modes</u>								
Quartz	35	49	35	48	27	45	40	45
Plagioclase	15	15	12	47	68	45	54	50
Alkali Feldspar	23	-	38	-	5	-	-	1
Biotite	25	35	10	3	-	10	5	2
Amphibole	-	-	-	-	-	-	1	-
Muscovite	1	tr.	1	tr.	-	tr.	-	1
Apatite	-	-	-	-	tr.	tr.	tr.	tr.
Zircon	1	1	tr.	-	-	-	-	-
Epidote	-	-	-	-	-	-	tr.	-
Opaques	tr.	tr.	tr.	-	tr.	tr.	tr.	tr.

Note: granitoid classification after Streckeisen, 1973.

Sample No.	Reedy Creek Granodiorite						Pink Granite		Microgranite		
	(12) 779/53	(13) 779/54	(14) 779/7	(15) 779/51	(16) 779/52	(17) 779/66	(18) 779/19	(19) 779/4	(20) 779/9	(21) 779/10	(22) 779/18
SiO ₂	49.7	61.6	61.8	65.0	65.6	67.8	74.6	72.2	76.2	76.3	76.8
Al ₂ O ₃	18.6	17.0	16.9	16.3	16.2	15.3	13.4	13.7	12.8	12.7	11.7
Fe ₂ O ₃	3.51	2.05	1.55	1.67	1.29	1.36	0.62	1.04	0.50	0.44	0.73
FeO	7.18	2.73	2.67	2.38	2.95	2.63	0.64	0.97	0.19	0.12	0.67
MnO	0.16	0.08	0.07	0.06	0.06	0.07	0.00	0.02	0.01	0.00	0.02
MgO	4.20	1.97	1.91	1.63	1.77	1.49	0.46	0.58	0.10	0.01	0.37
CaO	3.60	4.37	4.25	3.78	3.38	3.26	1.66	1.51	1.17	1.14	1.05
Na ₂ O	4.29	4.51	4.48	4.06	4.36	4.38	3.31	2.98	2.59	2.67	2.31
K ₂ O	4.26	2.88	3.01	3.29	2.00	1.63	4.19	5.49	5.52	5.35	5.30
TiO ₂	2.10	0.85	0.77	0.74	0.67	0.71	0.21	0.30	0.12	0.08	0.22
P ₂ O ₅	0.67	0.27	0.23	0.25	0.24	0.22	0.04	0.05	0.00	0.00	0.04
H ₂ O	1.2	1.4	1.5	1.0	1.2	1.1	0.7	0.8	0.7	0.8	0.6
TOTAL	99.5	99.7	99.1	100.2	99.7	100.0	99.8	99.6	99.9	99.6	99.8

Barth Mesonorms

Quartz	1.36	15.25	15.39	20.15	23.79	27.49	33.62	29.03	35.34	35.80	38.86
Orthoclase	10.65	10.42	11.04	14.32	5.48	4.40	23.95	31.50	33.18	32.48	31.15
Albite	39.08	41.08	41.02	36.85	39.82	40.01	30.33	27.39	23.83	24.65	21.36
Anorthite	13.68	17.89	17.46	16.72	15.46	15.00	8.14	7.33	5.95	5.82	5.10
Sillimanite	3.31	-	-	-	2.15	1.55	0.83	0.39	0.73	0.75	0.59
Biotite	23.81	10.95	11.36	8.52	10.47	8.63	2.09	2.72	0.38	0.04	1.75
Apatite	1.42	0.57	0.49	0.53	0.51	0.47	0.09	0.11	-	-	0.09
Sphene	-	1.39	1.51	0.35	-	-	-	-	-	-	-
Magnetite	3.72	2.17	1.65	1.76	1.37	1.45	0.66	1.11	0.22	0.11	0.79
Ilmenite	2.97	0.28	0.09	0.81	0.95	1.01	0.30	0.43	0.17	0.11	0.32
Haematite	-	-	-	-	-	-	-	-	0.21	0.24	-

Trace Elements (ppm)

Rb	219	87	70	76	92	71	75	117	104	103	115
Sr	474	574	514	450	518	513	341	333	291	497	269
Ba	1747	1518	1796	1853	857	811	942	1461	1564	3303	1496
Zr	882	415	316	318	143	305	73	232	69	65	123
Nb	41	27	26	25	13	15	11	20	7	5	17
Sc	30	14	14	12	10	12	2	3	2	1	2
Ni	36	18	21	21	19	16	11	10	8	10	10
V	229	86	80	81	81	79	18	20	10	8	16
Zn	93	44	40	35	44	47	14	20	7	5	14
Cu	3	25	14	3	63	36	0	3	3	3	0
Li	14	8	7	6	7	6	6	5	1	1	5
Ce	92	108	103	98	21	102	68	179	17	15	151
Nd	37	42	33	30	7	35	19	49	0	0	30
Y	44	38	28	26	6	17	11	16	2	0	14

DIORITE

Sample No.	(1) 779/23	(2) 779/3	(3) 779/20	(4) 779/32	(5) 779/36	(6) 779/5	(7) 779/25	(8) 779/31	(9) 779/30	(10) 779/21	(11) 779/43
SiO ₂	46.8	49.0	49.4	49.5	50.3	50.7	51.6	52.7	53.7	54.6	55.7
Al ₂ O ₃	19.2	18.9	19.7	14.9	19.3	18.9	19.1	18.7	17.4	18.2	17.7
Fe ₂ O ₃	2.94	3.14	3.29	2.71	3.21	3.33	3.35	3.48	3.07	2.86	2.73
FeO	6.57	5.74	5.49	6.93	5.44	5.52	5.04	5.19	5.23	4.44	4.53
MnO	0.14	0.13	0.14	0.23	0.14	0.13	0.12	0.13	0.15	0.09	0.11
MgO	5.02	3.95	3.65	7.09	3.72	3.88	3.59	3.64	3.89	3.08	3.37
CaO	7.84	7.30	8.12	7.72	7.95	7.82	7.52	7.64	7.18	6.83	5.88
Na ₂ O	3.59	4.55	4.96	2.72	4.15	4.22	4.32	4.24	4.13	3.99	4.06
K ₂ O	2.39	2.03	1.41	2.40	1.55	1.32	1.64	1.10	1.61	1.68	2.00
TiO ₂	1.80	1.62	1.57	1.45	1.51	1.56	1.48	1.52	1.24	1.27	1.12
P ₂ O ₅	1.23	0.46	0.51	1.17	0.49	0.44	0.41	0.43	0.38	0.39	0.34
H ₂ O	1.8	2.0	1.5	2.1	1.2	1.5	1.4	1.1	1.3	1.6	1.5
TOTAL	99.3	98.8	99.7	98.9	99.0	99.3	99.6	99.9	99.3	99.0	99.1

Barth Mesonoms

Quartz	1.85	0.05	-	6.18	2.65	2.59	4.13	5.22	7.23	10.96	12.70
Orthoclase	-	-	-	-	-	-	-	-	-	-	0.03
Albite	32.98	41.90	42.23	25.27	38.04	38.68	39.40	38.58	37.84	36.82	37.35
Anorthite	29.89	25.80	27.59	22.10	30.08	29.33	28.33	29.13	24.68	27.54	24.77
Nepheline	-	-	0.37	-	-	-	-	-	-	-	-
Sillimanite	-	-	-	-	-	-	-	-	-	-	-
Actinolite	-	3.72	-	6.59	2.33	2.69	2.43	1.60	7.09	0.19	-
Hypersthene	3.49	1.03	-	7.78	4.26	6.16	2.39	7.11	0.91	1.54	-
Edenite	-	-	6.72	-	-	-	-	-	-	-	-
Biotite	23.11	19.68	13.45	23.47	14.96	12.74	15.75	10.54	15.53	16.32	19.33
Apatite	2.63	0.99	1.08	2.53	1.05	0.94	0.87	0.91	0.81	0.84	0.73
Sphene	1.01	3.47	3.31	3.14	3.22	3.33	3.14	3.22	2.64	2.73	1.71
Magnetite	3.14	3.37	3.47	2.93	3.43	3.55	3.56	3.69	3.27	3.07	2.92
Ilmenite	1.89	-	-	-	-	-	-	-	-	-	0.46
Olivine	-	-	1.78	-	-	-	-	-	-	-	-

Trace Elements (ppm)

Rb	76	69	37	97	38	43	44	41	44	44	76
Sr	1066	698	950	386	823	882	856	824	639	793	561
Ba	1913	1000	616	796	620	504	555	381	901	696	1489
Zr	431	241	257	412	145	171	212	189	174	236	230
Nb	32	19	24	23	19	22	26	25	29	19	19
Sc	25	34	25	31	26	22	26	22	23	19	27
Ni	23	27	19	73	20	29	25	21	35	18	32
V	315	191	218	396	200	206	177	188	194	173	167
Zn	93	94	71	75	82	71	78	70	76	71	66
Cu	27	61	76	55	43	73	86	74	44	50	2
Li	19	11	8	7	9	6	9	6	9	11	11
Ce	299	53	58	148	54	58	48	49	78	65	59
Nd	118	22	32	75	28	34	27	31	34	28	17
Y	33	23	32	50	25	26	25	28	41	29	27

	<u>Summerfield Granodiorite</u>		<u>Lamprophyre</u>		<u>Migmatites and country rock</u>					<u>Chilled margin Diorite-gneiss contact</u>		
	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)	(33)	(34)
Sample No.	779/35	779/6	779/14	779/8	779/48	779/49	779/50	779/45	779/34	779/33	779/28	779/29
SiO ₂	69.3	71.7	54.4	58.7	69.5	70.9	71.7	77.0	74.4	76.2	71.0	76.3
Al ₂ O ₃	16.1	15.0	17.7	16.9	12.9	10.4	12.5	10.4	14.4	11.5	15.1	12.9
Fe ₂ O ₃	0.81	0.43	2.73	1.96	1.09	1.35	1.17	1.57	0.18	0.79	0.98	0.71
FeO	0.94	0.96	4.82	3.99	3.51	4.94	3.21	1.76	0.30	1.80	1.73	0.61
MnO	0.02	0.02	0.14	0.11	0.07	0.07	0.06	0.02	0.00	0.00	0.03	0.01
MgO	0.96	0.68	4.03	3.29	2.44	4.16	1.71	0.92	0.28	1.30	0.97	0.24
CaO	3.12	2.21	7.24	5.89	0.37	0.78	0.64	1.91	0.60	0.42	3.42	3.08
Na ₂ O	4.96	4.96	4.09	4.17	3.13	1.65	3.07	3.21	6.67	4.43	4.07	3.86
K ₂ O	1.47	1.95	1.67	1.54	5.10	3.45	4.25	1.03	1.39	1.69	1.15	0.47
TiO ₂	0.28	0.21	1.11	0.92	0.61	0.71	0.70	0.39	0.08	0.39	0.44	0.18
P ₂ O ₅	0.09	0.07	0.37	0.28	0.13	0.07	0.21	0.04	0.25	0.12	0.07	0.01
H ₂ O	0.9	1.0	1.4	1.3	1.1	1.5	0.8	0.6	0.6	0.9	0.8	0.7
TOTAL	99.0	99.2	99.7	99.0	100.0	100.0	100.0	98.9	99.2	99.6	99.8	99.1

Barth Mesonorms

Quartz	26.23	28.55	7.84	14.99	28.61	43.47	33.70	48.48	26.77	40.12	38.13	43.28
Orthoclase	6.13	9.33	-	-	21.69	6.20	18.90	3.17	7.39	5.72	3.44	2.11
Albite	45.26	45.27	37.25	38.24	28.71	15.44	28.25	30.15	59.99	40.76	37.31	35.83
Anorthite	15.14	10.68	25.37	23.34	1.01	3.56	1.85	9.64	1.35	1.33	16.86	15.73
Sillimanite	1.49	1.46	-	-	3.13	4.61	3.67	1.08	2.35	3.20	1.85	0.79
Actinolite	-	-	7.05	2.05	-	-	-	-	-	-	-	-
Hypersthene	-	-	0.45	1.85	-	-	-	-	-	-	-	-
Biotite	4.31	3.80	16.01	14.87	14.54	24.07	10.93	5.11	1.34	7.22	5.59	1.21
Apatite	0.19	0.15	0.78	0.60	0.28	0.15	0.45	0.09	0.52	0.26	0.15	0.02
Sphene	-	-	2.35	1.96	-	-	-	-	-	-	-	-
Magnetite	0.86	0.46	2.90	2.09	1.16	1.47	1.25	1.72	0.19	0.85	1.05	0.77
Ilmenite	0.40	0.30	-	-	0.87	1.03	1.00	0.57	0.11	0.56	0.63	0.26

Trace Elements (ppm)

Rb	49	51	36	50	125	177	135	45	16	54	48	12
Sr	662	553	732	1018	116	87	116	256	93	67	562	534
Ba	906	1276	384	714	785	658	893	462	224	178	478	225
Zr	121	101	203	208	176	361	411	184	13	185	78	70
Nb	21	24	23	19	12	16	13	10	2	9	11	5
Sc	5	4	19	23	10	11	10	5	2	8	4	2
Ni	18	12	36	43	33	35	26	18	8	22	14	11
V	37	25	156	197	72	106	70	45	9	44	50	25
Zn	46	73	67	85	20	16	12	21	3	5	27	11
Cu	36	76	24	109	0	0	13	0	0	0	14	36
Li	9	9	13	14	10	14	7	2	1	4	0	6
Ce	42	67	43	75	42	104	105	86	12	41	58	102
Nd	11	17	19	32	21	47	47	36	3	19	25	35
Y	5	6	47	27	30	33	42	9	10	24	20	17

(B) Major and trace element analyses of investigated rocks outside of the Reedy Creek Area.

- | | | |
|------|--------|--|
| (1) | 779/63 | dioritic xenolith - Mannum Quarry. |
| (2) | 779/60 | " " " |
| (3) | 779/62 | " " " |
| (4) | 779/64 | " " " |
| (5) | 779/61 | " " " |
| (6) | 156 | Mannum Granite (Goode, 1927) |
| (7) | 2903 | Mannum Granite (Mancktelow, 1979) |
| (8) | P2 | Palmer Granite (White et al., 1967) |
| (9) | SA23 | " " " |
| (10) | P5 | " " " |
| (11) | SA22 | " " " |
| (12) | P4 | " " " |
| (13) | P6 | " " " |
| (14) | P7 | " " " |
| (15) | 775/51 | Tonalitic phase of the Reedy Creek Granodiorite, Black Hill
(Wegmann, 1980) |
| (16) | 775/70 | " " " " |
| (17) | 779/67 | Leucosome from migmatites, west of Palmer. |

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Sample No.	779/63	779/60	779/62	779/64	779/61	156	2903	P2	SA23	P5	SA22	P4	P6	P7
SiO ₂	49.9	52.9	53.6	57.8	58.2	70.8	73.8	73.1	73.1	73.4	74.0	74.5	75.3	75.5
Al ₂ O ₃	15.2	15.1	15.0	15.0	14.9	13.7	13.0	13.8	13.5	13.8	13.4	13.6	13.2	13.1
Fe ₂ O ₃	5.96	4.46	4.71	3.76	4.46	1.97	1.89*	1.31	1.50	1.12	1.10	1.04	1.03	0.86
FeO	5.66	5.24	4.78	3.62	3.62	0.97		1.04	1.05	1.13	1.02	0.97	0.48	0.44
MnO	0.28	0.38	0.28	0.24	0.26	0.28	0.04	0.02	0.02	0.02	0.02	0.02	0.01	0.01
MgO	5.15	4.44	4.08	2.53	2.71	0.34	0.22	0.58	0.58	0.46	0.56	0.47	0.32	0.21
CaO	6.77	6.71	6.21	4.90	4.35	0.94	0.74	1.60	1.78	1.79	1.22	1.58	0.87	0.94
Na ₂ O	4.66	4.48	5.47	5.09	5.64	3.70	3.81	4.31	3.87	4.00	3.62	3.69	3.60	3.55
K ₂ O	1.85	1.41	1.98	3.55	1.78	5.68	5.57	3.46	3.87	3.61	4.58	4.03	4.62	4.50
TiO ₂	2.54	1.93	1.79	1.53	1.52	0.72	0.30	0.37	0.41	0.34	0.33	0.32	0.21	0.19
P ₂ O ₅	0.68	0.52	0.45	0.69	0.73	0.11	0.04	0.15	0.12	0.27	0.13	0.12	0.10	0.06
H ₂ O	1.7	1.8	1.1	1.1	1.5	0.81	-	-	-	-	-	-	-	-
TOTAL	99.3	99.4	99.5	99.8	99.7	100.15	99.85	99.75	99.83	99.94	99.98	100.32	99.77	99.34
<u>Trace Elements (ppm)</u>														
Rb	149	58	54	88	112		190	138	151	144	179	142	153	151
Sr	435	220	225	378	159		88	103	77	70	82	74	78	52
Ba	571	108	319	623	159		386	259	360	338	419	391	365	388
Zr	324	294	284	549	522		257	229	203	213	181	177	152	154
Nb	30	34	34	58	69		57							
Sc	32	27	29	20	19		4							
Ni	52	32	33	15	21									
V	314	225	226	150	143									
Zn	269	203	170	187	202									
Cu	20	8	17	16	13									
Li	59	41	25	15	51									
Ce	601	112	115	205	275		126							
Nd	202	45	48	86	91		36							
Y	139	57	71	78	90		39							

*Fe as Fe₂O₃

	(15)	(16)	(17)
	775/51	775/70	779/67
SiO ₂	63.3	63.8	74.6
Al ₂ O ₃	16.3	16.8	13.9
Fe ₂ O ₃	5.13*	4.64*	0.40
FeO			0.58
MnO	0.10	0.07	0.01
MgO	2.52	2.05	0.34
CaO	4.60	4.80	1.03
Na ₂ O	3.90	4.35	4.94
K ₂ O	2.42	1.52	4.13
TiO ₂	0.77	0.66	0.11
P ₂ O ₅	0.30	0.19	0.21
H ₂ O	0.85	0.85	0.1
TOTAL	100.2	99.7	100.4

Trace Elements

Rb	94	51	91
Sr	659	760	295
Ba	1140	598	1357
Zr	193	153	31
Nb	18	14	3
Sc	13	13	3
Ni	23	20	12
V	110	97	10
Zn	63	42	5
Cu			0
Li			0
Ce	58	41	27
Nd	21	11	6
Y	21	14	19

*Fe as Fe₂O₃

APPENDIX 2

MICROPROBE ANALYSES.

<u>Sample</u>	<u>Rock type</u>
779/5	Diorite
779/7	Reedy Creek Granodiorite-quartz monzodiorite
779/51	Reedy Creek Granodiorite - granodiorite

BIOTITE

Sample	779/5 BT core	779/5 BT rim	779/5	779/5	779/7	779/7	779/7	779/7	779/51 BT core	779/51 BT rim	779/51
SiO ₂	36.3	36.2	36.5	36.6	36.3	36.5	36.6	36.6	36.9	37.2	36.4
TiO ₂	3.24	3.21	3.14	2.93	2.29	2.75	2.10	2.32	2.93	2.90	3.09
Al ₂ O ₃	15.1	15.2	15.4	15.2	14.9	15.0	14.8	14.9	15.2	15.1	15.2
FeO	18.2	18.4	18.0	17.8	18.8	19.0	19.0	18.5	18.7	18.1	18.3
MnO	0.00	0.00	0.00	0.00	0.15	0.00	0.17	0.00	0.21	0.20	0.16
MgO	12.6	12.7	12.5	12.8	12.6	12.3	12.7	12.6	12.1	12.0	12.2
CaO	0.12	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09
K ₂ O	9.36	9.20	9.51	9.56	9.69	9.73	9.61	9.40	9.85	9.80	9.73
Na ₂ O	0.17	0.13	0.20	0.00	0.14	0.00	0.21	0.25	0.00	0.17	0.00
Cl	0.26	0.24	0.25	0.18	0.17	0.18	0.20	0.18	0.11	0.10	0.12
TOTAL	95.32	95.45	95.45	95.09	95.05	95.46	95.29	94.69	96.00	95.56	95.26
Mg	55	55	55	56	55	54	54	55	55	54	54

Structural formulae (based on 22 oxygens per formula unit)

Si	5.532	5.502	5.547	5.573	5.573	5.572	5.609	5.606	5.593	5.642	5.554
Ti	0.371	0.367	0.359	0.335	0.264	0.316	0.241	0.268	0.344	0.330	0.354
Al	2.708	2.728	2.752	2.726	2.693	2.698	2.663	2.701	2.714	2.700	2.737
Fe	2.324	2.340	2.284	2.261	2.408	2.421	2.425	2.370	2.368	2.288	2.329
Mn	0.000	0.000	0.000	0.000	0.020	0.000	0.022	0.000	0.027	0.025	0.021
Mg	2.853	2.890	2.825	2.905	2.889	2.809	2.889	2.874	2.727	2.718	2.767
Ca	0.020	0.029	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.014
K	1.819	1.786	1.842	1.855	1.897	1.896	1.876	1.838	1.903	1.896	1.893
Na	0.051	0.037	0.059	0.000	0.042	0.000	0.061	0.074	0.000	0.049	0.000
Cl	0.067	0.062	0.064	0.047	0.045	0.047	0.053	0.046	0.028	0.025	0.030

AMPHIBOLE

Sample	779/5	779/5	779/5	779/7	779/7	779/7 HB core	779/7 HB Rim	779/51	779/51 HB core	779/51 HB rim	779/51
SiO ₂	44.8	44.6	44.7	43.6	43.1	43.5	43.4	42.6	44.0	43.6	44.0
TiO ₂	1.10	0.85	1.00	1.00	0.94	1.13	0.73	0.79	0.91	0.90	0.87
Al ₂ O ₃	9.26	9.56	9.36	9.52	9.04	9.53	9.42	9.41	9.37	9.26	9.19
FeO	16.2	16.5	16.7	17.9	17.4	17.7	17.8	17.9	18.0	17.8	17.3
MnO	0.16	0.12	0.26	0.26	0.31	0.35	0.32	0.31	0.35	0.32	0.33
MgO	11.8	11.8	11.9	10.7	10.9	10.9	10.5	10.4	11.0	10.7	11.3
CaO	11.8	11.9	11.8	11.5	11.5	11.6	11.4	11.4	11.7	11.5	11.9
K ₂ O	0.64	0.77	0.71	1.08	1.01	1.11	0.84	1.06	1.02	1.02	1.00
Na ₂ O	1.32	1.14	1.21	1.55	1.42	1.61	1.53	1.38	1.41	1.53	1.45
Cl	0.20	0.23	0.18	0.18	0.11	0.18	0.15	0.09	0.14	0.13	0.13
TOTAL	97.31	97.46	97.85	96.99	95.24	97.26	95.78	95.26	97.9	96.76	97.44
Mg -	56.6	56.1	55.8	51.9	53.2	52.8	51.6	50.8	52.0	51.6	53.9

Structural formulae (based on 23 oxygens per formula unit)

Si	6.724	6.691	6.695	6.643	6.668	6.611	6.688	6.626	6.647	6.669	6.659
Ti	0.124	0.096	0.113	0.115	0.110	0.129	0.084	0.092	0.103	0.104	0.099
Al	1.637	1.691	1.651	1.709	1.650	1.708	1.710	1.724	1.669	1.668	1.639
Fe	2.031	2.073	2.096	2.289	2.201	2.268	2.277	2.327	2.277	2.276	2.188
Mn	0.021	0.016	0.033	0.033	0.040	0.046	0.042	0.041	0.045	0.042	0.042
Mg	2.645	2.644	2.644	2.428	2.505	2.475	2.405	2.398	2.471	2.429	2.560
Ca	1.898	1.916	1.894	1.874	1.899	1.882	1.887	1.898	1.896	1.880	1.925
K	0.122	0.148	0.135	0.210	0.200	0.215	0.165	0.211	0.197	0.199	0.193
Na	0.385	0.332	0.350	0.458	0.427	0.474	0.457	0.416	0.414	0.454	0.426
Cl	0.050	0.058	0.047	0.046	0.028	0.047	0.039	0.025	0.035	0.032	0.034

PLAGIOCLASE

Sample	779/5 PL1 Core	779/5	779/5	779/5 PL1 Rim	779/5 PL2 Core	779/5	779/5	779/5 PL2Rim	779/7 PL1 Core	779/7 PL1Rim	779/7 PL2 Core	779/7 PL2 Rim	779/7 PL3 Core	779/7 PL3Rim
SiO ₂	55.8	57.4	54.5	59.0	54.0	58.5	54.0	58.0	61.3	61.1	64.6	62.6	59.3	59.3
Al ₂ O ₃	28.6	27.2	28.9	26.5	28.9	25.6	29.2	26.7	24.4	24.9	18.8	23.8	24.8	24.5
FeO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.24
CaO	9.62	8.36	10.3	7.38	10.5	6.79	10.7	7.72	5.00	5.19	5.52	4.29	5.91	5.57
K ₂ O	0.08	0.10	0.10	0.08	0.0	0.17	0.0	0.08	0.14	0.0	0.19	0.27	0.36	0.27
Na ₂ O	6.04	6.87	5.57	7.50	5.51	7.64	5.40	7.21	8.81	8.94	8.50	9.07	7.82	8.14
TOTAL	100.17	99.87	99.36	100.42	98.80	98.72	99.34	99.84	99.66	100.15	100.69	100.04	98.20	97.99
An	47	40	50	35	51	33	52	37	24	24	26	20	29	27

Structural formulae (based on 32 oxygens per formula unit)

Si	10.009	10.288	9.872	10.486	9.837	10.576	9.802	10.386	10.909	10.840	10.837	11.073	10.748	10.776
Al	6.049	5.741	6.178	5.548	6.205	5.450	6.243	5.641	5.129	5.198	5.205	4.969	5.294	5.241
Fe	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.022	0.000	0.000	0.000	0.000	0.000	0.036
Ca	1.849	1.606	1.999	1.405	2.045	1.315	2.083	1.482	0.953	0.986	1.043	0.814	1.147	1.084
Na	0.018	0.023	0.022	0.017	0.000	0.038	0.000	0.018	0.031	0.000	0.043	0.062	0.083	0.062
K	2.100	2.390	1.957	2.585	1.947	2.676	1.898	2.506	3.041	3.075	2.907	3.111	2.747	2.869

Sample	779/51 PL1 Core	779/51 PL1Rim	779/51 PL2 Core	779/51 PL2Rim
SiO ₂	56.0	60.1	61.0	61.1
Al ₂ O ₃	25.5	25.0	24.9	25.0
FeO	0.17	0.22	0.00	0.00
CaO	6.27	5.89	5.73	5.73
K ₂ O	0.29	0.17	0.17	0.27
Na ₂ O	7.95	8.40	8.36	8.27
TOTAL	100.15	99.82	100.09	100.35
An	30	28	27	27

Structural formulae (based on 32 oxygens per formula unit)

Si	10.671	10.738	10.823	10.822
Al	5.356	5.260	5.204	5.213
Fe	0.025	0.033	0.000	0.000
Ca	1.195	1.128	1.089	1.087
Na	0.066	0.040	0.039	0.06
K	2.742	2.908	2.878	2.839

ALKALI FELDSPAR

Sample	779/7	779/7	779/7	779/7	779/7	779/7 Antiperthite	779/51	779/51	779/51	779/51	779/51	779/51
SiO ₂	63.1	64.1	63.7	63.7	64.9	64.3	63.2	63.8	64.2	64.3	64.1	64.1
TiO ₂	0.00	0.00	0.00	0.00	0.00	0.00	0.73	0.40	0.00	0.00	0.00	0.00
Al ₂ O ₃	19.1	19.0	19.5	19.1	18.7	18.8	19.2	19.1	19.4	19.4	19.5	19.2
CaO	0.00	0.12	0.18	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00
K ₂ O	14.7	14.5	15.7	15.1	15.2	15.6	14.9	14.9	14.8	14.4	14.8	15.0
Na ₂ O	1.15	1.43	0.60	0.91	0.85	0.68	1.20	1.24	1.26	1.63	1.36	1.36
BaO	1.20	1.01	0.99	1.16	0.86	0.34	1.39	0.76				
TOTAL	99.20	100.14	100.66	99.97	100.53	99.78	100.63	100.20	99.55	99.76	99.76	99.61
Or	89.4	86.5	93.6	91.7	92.1	93.3	89.0	88.8	88.5	85.3	87.8	87.9

Structural formulae (based on 32 oxygens per formula unit)

Si	11.845	11.881	11.803	11.869	11.976	11.922	11.752	11.822	11.854	11.851	11.826	11.854
Ti	0.000	0.000	0.000	0.000	0.000	0.000	0.102	0.056	0.000	0.000	0.000	0.000
Al	4.229	4.162	4.262	4.199	4.073	4.111	4.209	4.175	4.217	4.212	4.239	4.190
Ca	0.000	0.023	0.036	0.000	0.000	0.019	0.000	0.000	0.000	0.000	0.000	0.000
K	3.514	3.432	3.714	3.598	3.572	3.696	3.520	3.520	3.481	3.380	3.493	3.529
Na	0.418	0.513	0.216	0.327	0.304	0.244	0.433	0.444	0.452	0.582	0.486	0.486

SPHENE

Sample	779/5	779/5	779/7	779/51 Rim	779/51 Core
SiO ₂	30.4	30.7	29.6	29.7	29.9
TiO ₂	35.9	36.2	34.4	34.5	34.5
Al ₂ O ₃	1.30	1.39	1.57	1.47	1.65
FeO	1.05	1.01	1.78	1.87	1.68
CaO	28.3	29.1	26.8	27.5	27.5
MgO	0.19	0.17	0.00	0.00	0.00
Cr ₂ O ₃	0.00	0.00	0.24	0.32	0.26
TOTAL	97.13	98.52	94.64	95.33	95.48

Structural Formulae (based on 19 oxygens per formula unit)

Si	3.909	3.875	3.878	3.882	3.897
Ti	3.456	3.434	3.388	3.395	3.382
Al	0.196	0.207	0.243	0.226	0.253
Fe	0.112	0.106	0.194	0.204	0.184
Ca	3.873	3.911	3.764	3.852	3.838
Mg	0.036	0.042	0.000	0.000	0.000
Cr	0.000	0.000	0.025	0.034	0.027

APPENDIX 3

Analytical Methods

Sample Preparation

Samples were initially crushed using a jaw crusher and then ground in a Siebtechnik tungsten carbide mill. 280 mg of sample was added to 20 mg of sodium nitrate and 1.5g of flux 17, which was then fused for whole rock analysis. Pressed pellets were produced for trace element determination containing approximately 5g of rock powder.

Major Element Analyses

- (a) SiO_2 , Al_2O_3 , Fe_2O_3 , MnO , MgO , CaO , K_2O , TiO_2 and P_2O_5 concentrations were determined using the programmable Siemens S.R.S.
- (b) Na_2O - approximately 30 mg of rock powder was digested in a teflon beaker using 10 mls of HF and 2 mls of H_2SO_4 at 110°C for a minimum of six hours. The solution was made up to 100 mls and then Na_2O was measured on the Corning - E.E.L. flame photometer.
- (c) FeO - 50g of sample was digested using 10 mls of 50% fresh H_2SO_4 and 5 mls of HF in a platinum crucible at approximately 325°C for five minutes after commencement of boiling. The crucibles were quickly plunged into a 600 ml beaker containing 300 mls distilled water, 20 mls 50% H_2SO_4 , 30 mls saturated H_3BO_3 and 2 mls N-phenol anthranilic acid indicator and then titrated against ceric ammonium sulphate.

Trace Element Analyses

- (a) Ba, Sc, Zr and Nb measurements were obtained using the programmable Siemens S.R.S.
- (b) Rb, Sr, Y, Ni, V, Zn, Ce, Nd and V concentrations were determined on the Philips X.R.F. machine using the operating conditions listed in table 5.
- (c) Li, Cu, Zn - approximately 1g of rock powder was digested with 5 mls of HClO_4 and 10 mls of HF in a teflon beaker at 110°C until boiled dry. 5 mls of HCl and 10 mls of 20,000 ppm K were then added and the solutions were made up to 100 mls. The solutions were then analysed using the Varian Techtron A.A.7. for Li, Cu and Zn using the following operating conditions:

Element	Lamp(nm)	Lamp(mA)	Slit Width	λ (nm)	Flame	H_2 Lamp(mA)
Li	670.9	5	0.2	282.2	Air- C_2H_2	-
Cu	324.8	3	0.5	387.7	Air- C_2H_2	3.4
Zn	213.9	6	1.0	416.9	Air- C_2H_2	1.6

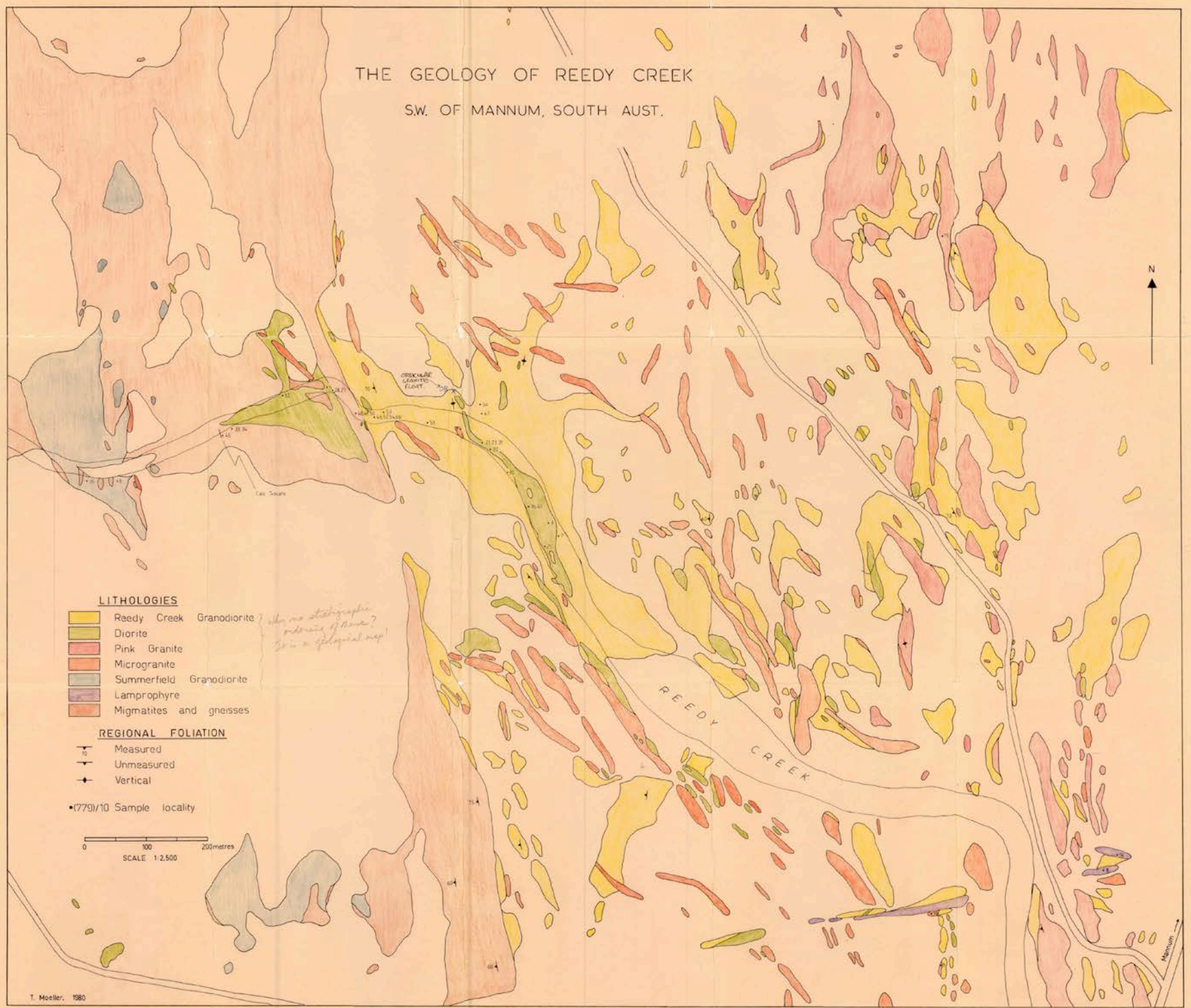
Table 5. Operating conditions for trace element determinations

Element	Tube	KV	mA	Crystal	Collimator	Counter	Peak	Background
V	Tungsten	60	40	LiF ₂₂₀	coarse	Flow proportional	K α 93.29	91.29
Ni	Gold	50	40	LiF ₂₂₀	coarse	scintillation	K α 71.27	70.27
Ce	Tungsten	60	40	LiF ₂₂₀	coarse	flow proportional	L β 111.85	110.85
Nd	Tungsten	60	40	LiF ₂₂₀	coarse	flow proportional	L α 112.93	113.93
Rb	Molybdenum	60	40	LiF ₂₂₀	Fine	scintillation	K α 37.93	38.68
Sr	Molybdenum	60	40	LiF ₂₂₀	Fine	scintillation	K α 35.79	36.54
Y	Molybdenum	60	40	LiF ₂₂₀	Fine	scintillation	K α 33.83	34.83

Mineral Separations

Approximately 2-3 kg of sample was crushed in the disc crusher, washed, dried and then sieved, the 120-170[#] size fraction used in the separation. Alkali feldspar, biotite and sphene were separated initially using the Frantz Isodynamic Magnetic Separator followed by further separation using tetrabromoethane and methylene iodide until a concentration of at least 99% was achieved. The mineral separates were then analysed for major and trace elements.

THE GEOLOGY OF REEDY CREEK
SW. OF MANNUM, SOUTH AUST.



LITHOLOGIES

- Reedy Creek Granodiorite
- Diorite
- Pink Granite
- Microgranite
- Summerfield Granodiorite
- Lamprophyre
- Migmatites and gneisses

REGIONAL FOLIATION

- Measured
 - Unmeasured
 - Vertical
- (779)/10 Sample locality

0 100 200 metres
SCALE 1:2,500