PETROLOGY AND GEOCHEMISTRY OF DONEGAL GRANITES IRELAND.

BY

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CHAPTER SIX

MODELLING OF THE DONEGAL GRANITES

6.1 INTRODUCTION

The geochemistry of the Donegal granites (Chapter 5) shows that the granites consist of individual melts which later make up specific granitic plutons. In general, the variation in granitic rocks can be produced by one of several processes. These include fractional crystallisation, effect of a vapour phase, restite unmixing, magma mixing, crustal assimilation and thermo gravitational diffusion. In the Donegal granites crystal fractionation appears to be the dominant process that produced the variation of the rocks. The variation in the Thorr pluton is regarded as due to accretion from the margin of the pluton (Oglethorpe 1987). The variation of Barnesmore resulted from fractional crystallisation of a granodioritic magma (G1 type ; Dempsey 1987). In the Rosses pluton, the decrease of biotite from margin to the centre of the pluton suggests the effects of fractional crystallisation. However the exception is probably shown by the Ardara granite, where the three units (the outer, intermediate and inner units) are not related by simple fractionation. A process that may be important is the effect of vapour phase fractionation (Whalen 1983) in producing the muscovite granite in the Trawnagh Bay pluton.

This chapter attempts to model the geochemistry of the individual plutons of the Donegal granites as seen at the present erosion level. The modelling has been carried out in three stages. Firstly, the granites will be modelled using the large ion lithophile elements (LILE) Ba, Sr and Rb. These elements have been used to determine the crystallising proportions of biotite, plagioclase, alkali feldspar and hornblende. Secondly the major elements have been used to determine the crystallising proportion of the major phases such as plagioclase, alkali feldspar, hornblende and biotite and some of the accessory phases such as apatite, ore phases and sphene (Atherton et al. 1992). Thirdly, REEs have been used to evaluate the roles of the various accessory phases.

6.2 INTRODUCTION TO MODELLING USED IN THIS CHAPTER.

6.2.1 LILE Modelling

The LIL elements Ba, Sr and Rb are of considerable value in determining the type and amount of major phase fractionation in intermediate and acid rocks because :

(a) they are held predominantly in the major phases,

(b) Kd's for commonly occurring major phases are available,

(c) each element behaves somewhat differently ; thus Rb is taken up preferentially by biotite, Ba by biotite and alkali feldspar and Sr by plagioclase and alkali feldspar.

The arrow in the log Sr vs Ba, Ba vs Rb and Rb vs Sr diagrams indicates the net change in composition of the liquid for 20% Rayleigh fractionation of the named phase. This was calculated using (Rayleigh) fractional crystallisation :

$$C_l/C_o = F^{Da-1} \quad \text{where}$$

C_o = concentration of element 'a' in the original melt

C_l = concentration of element 'a' in residual melt

Da = bulk distribution coefficient for element a

F = weight fraction of melt remaining.

The ranges of Kds used are listed in **Table 6.1.**

6.2.2 Major element modelling

The next step is to use a more sophisticated approach to model the effect of fractional crystallisation. For this purpose an arbitrary start and target using 8 major element oxides is used to model the precipitated phases. The calculation of the major element modelling is determined by the following simple mass balance equation (Sanderson and Atherton 1985).

$$M_k^{melt} = (M_k^{o} - S_k)/(1 - F)$$

	Hb	Bi	Plag	K-felds
Ba	0.044	6.36	0.36	6.12
Sr	0.022	0.12	4.4	3.87
Rb	0.014	3.26	0.048	0.34

Table 6.1 : Partition coefficients of Ba,Sr and Rb used in the LILE modelling. After Arth (1976). All values are for rhyolitic rocks.

	K-felds			Plagioclase			Bi	Qu	Hb	Ap	Zr	All	Mag	Sp
La	0.08	0.072	0.08	0.38	0.3	0.3	0.03	0.015	1	30	7	2594 -820	1.2	15
Ce	0.044	0.046	0.037	0.24	0.27	0.27	0.04	0.014	1.5	35	10	2278 -635	1.6	25
Nd	0.025	0.038	0.035	0.17	0.21	0.21	0.04	0.016	4.3	57	5	1620 -463	2.3	78
Sm	0.018	0.025	0.025	0.13	0.13	0.013	0.05	0.014	7.8	63	11	866 - 205	2.8	107
Eu	1.13	2.6	4.45	2.1	5.42	2.15	0.015	0.06	5.1	30	20	111 - 81	1	94
Gd	0.011	0.01	0.01	0.9	0.125	0.097	0.08	0.015	10	56	29	250 - 130	3	113
Tb	0.025	0.033	0.025	0.02	0.033	0.033	0.09	0.017	12	53	38	273 - 71	3.3	112
Dy	0.006	0.052	0.055	0.086	0.112	0.064	0.1	0.014	13	51	108	136 - 45	2.6	111
Er	0.006	0.006	0.006	0.084	0.084	0.055	0.12	0.015	12	37	336	50 - 20	2	107
Yb	0.012	0.015	0.03	0.077	0.09	0.049	0.18	0.017	8.4	24	564	30 - 8.9	1.5	83
Lu	0.006	0.031	0.033	0.062	0.092	0.046	0.19	0.015	5.5	20	648	33 - 7.7	1.2	62

References :

K-Feldspar : Arth (1976) , Nash and Crecraft (1985) , Mahood & Hildreth (1983)
Plagioclase : Arth (1976) , Nash and Crecraft (1985) , Mahood & Hildreth (1983)
Biotite : Arth (1976)
Hornblende : Arth (1976)
Quartz : Nash and Crecraft (1985)
Magnetite : Petford (1990)
Zircon : Micheal (1983)
Apatite : Petford (1990)
Allanite : Mahood and Hildreth (1985) , Brooks at al. (1981)
Sphene : Hellman and Green (1979)

Arth (1976) : Rhyolites
Nash and Crecraft (1985): Rhyolites
Mahood and Hildreth (1983): High silica rhyolites
Micheal (1983): High silica tuff/rhyolites
Brooks et al. (1981): Obsidian
Hellman and Green (1979): Hydrous mafic composition

Table 6.2 : Partition coefficients used in REE modelling.

where

M_k^{melt} = weight % of element oxide k in final melt after fractionation

M_k^{o} = weight % of element oxide k in the initial melt

F = fraction (0 - 1) of the melt crystallised

S_k = sum of k-th element oxide in the crystallised fraction.

6.2.3 REE modelling.

The third stage is modelling using REEs. The influence of accessory minerals, notably apatite, zircon, sphene and allanite has been shown to be crucial in determining the REE pattern in silicic rocks (Gromet and Silver 1983 ; Atherton et al.1992). The mixture of minerals predicted from the major element modelling which includes apatite, sphene, magnetite, zircon and allanite was used to calculate the REE profiles of the evolved liquids. The partition coefficients for the major phases and the accessory minerals are given in **Table 6.2.**

6.3 THORR PLUTON

Field and chemical evidence show that the Thorr pluton is normally but asymmetrically zoned ; the central part of the pluton consists of granite (s.s.) and grades outwards to granodiorite, then to diorite, mainly in the south and southwest **(Map 2.5).** No contacts have been found between these rocks (Pitcher and Berger 1972). Oglethorpe (1987) suggested that the accretion from the margin to the centre of the pluton is the important process in producing the observed chemical zonation of the Thorr pluton. Thus in this section, the Thorr granite will be modelled from the margin (hornblende bearing Normal facies) to the centre (hornblende free Normal facies) of the pluton.

6.3.1 LILE modelling

Inter elements variation diagrams for the pairs Rb-Sr, Ba-Sr and Ba -Rb for both hornblende bearing and hornblende free normal facies are shown in **Fig 6.1.** In all three plots, the hornblende free granite has low Ba and Sr and high Rb compared to the hornblende bearing granite. On a Sr vs Ba plot **(Fig 6.1a)**, the trend shown by the granite from both facies is consistent with the crystallisation of some combination of alkali feldspar, biotite and plagioclase. Thus the crystallisation options are plagioclase + alkali feldspar and plagioclase + alkali feldspar + biotite.

On a Ba vs Rb plot **(Fig 6.1a)**, indicates that the plagioclase and hornblende are important in the early magmatic evolution of the rocks from the hornblende bearing facies. As the granite evolved to the hornblende free facies, alkali feldspar and biotite became more important.

On a Rb vs Sr plot **(Fig 6.1c)** calculated Rayleigh fractionation vectors for single mineral phases imply that the crystallisation of alkali feldspar + plagioclase + hornblende is responsible for evolving the liquid from hornblende-bearing to hornblende-free granites, with feldspars becoming more important at acid compositions.

The conclusions that can be drawn from LILE modelling of the Thorr pluton are : (1) Plagioclase, hornblende and minor biotite are important in the evolution of the hornblende bearing normal facies and (2) Plagioclase, alkali feldspar and perhaps biotite are important in the hornblende free normal facies.

6.3.2 Major element modelling

In this section the normal facies will be modelled from the margin to the centre of the pluton in two stages ; (1) quartz diorite to granodiorite (hornblende bearing normal facies) and (2) granodiorite to granite (hornblende free normal facies). The results of both stages and the difference between the target composition and the target model are shown in **Tables 6.3 and 6.4** respectively. The mineral compositions used in this modelling are taken from the microprobe analyses of the starting sample (Oglethorpe 1987). The mineral mix in the first stage is plagioclase, alkali feldspar, biotite, hornblende, magnetite, apatite and sphene at 50% fractionation **(Table 6.3)**.

The mineral mix of the second stage is plagioclase, alkali feldspar, biotite, hornblende, quartz, magnetite, apatite and sphene at 24% fractionation **(Table 6.4)**. The results indicate that the plagioclase, alkali feldspar, biotite and hornblende precipitation are important in the first stage whereas in the second stage alkali feldspar become more important and hornblende and plagioclase less so.

6.3.3 REE modelling

As with the major elements, the REE modelling of the Thorr pluton has been done in the same two stages. The REE profiles of the observed start and target compositions used in the modelling, together with the calculated melt profile are shown the **Fig 6.2** and **Fig 6.3** respectively. The mineral mixtures of both stages are very similar to the major element modelling **(Table 6.5)**.

6.3.4 Discussion

Summary of the major and REE modelling is given in **Table 6.5**. The results show that in the first stage (hornblende bearing normal facies) plagioclase, biotite, alkali feldspar and hornblende are dominant while in the second stage plagioclase, alkali feldspar and biotite are dominant. Oglethorpe (1987) modelled the Thorr granite in five stages from the margin to the centre of the pluton. He showed that the biotite is important in the late stage of the hornblende bearing normal facies and that the proportion of hornblende decreases with fractionation.

Since all the Thorr granites have > 75% normative An+ Ab+ Or+ Qz, their bulk compositions can be represented reasonably accurately on a tetrahedral An-Ab-Or-Qz plot **(Fig 6.4)**. Calculated normative composition of rocks from hornblende bearing and hornblende free normal facies were plotted on this diagram. It shows that the bulk of Thorr crystallised high in the plagioclase volume. Later crystallisation drove the liquid towards the plagioclase-alkali feldspar surface. At this stage alkali feldspar started to crystallised.

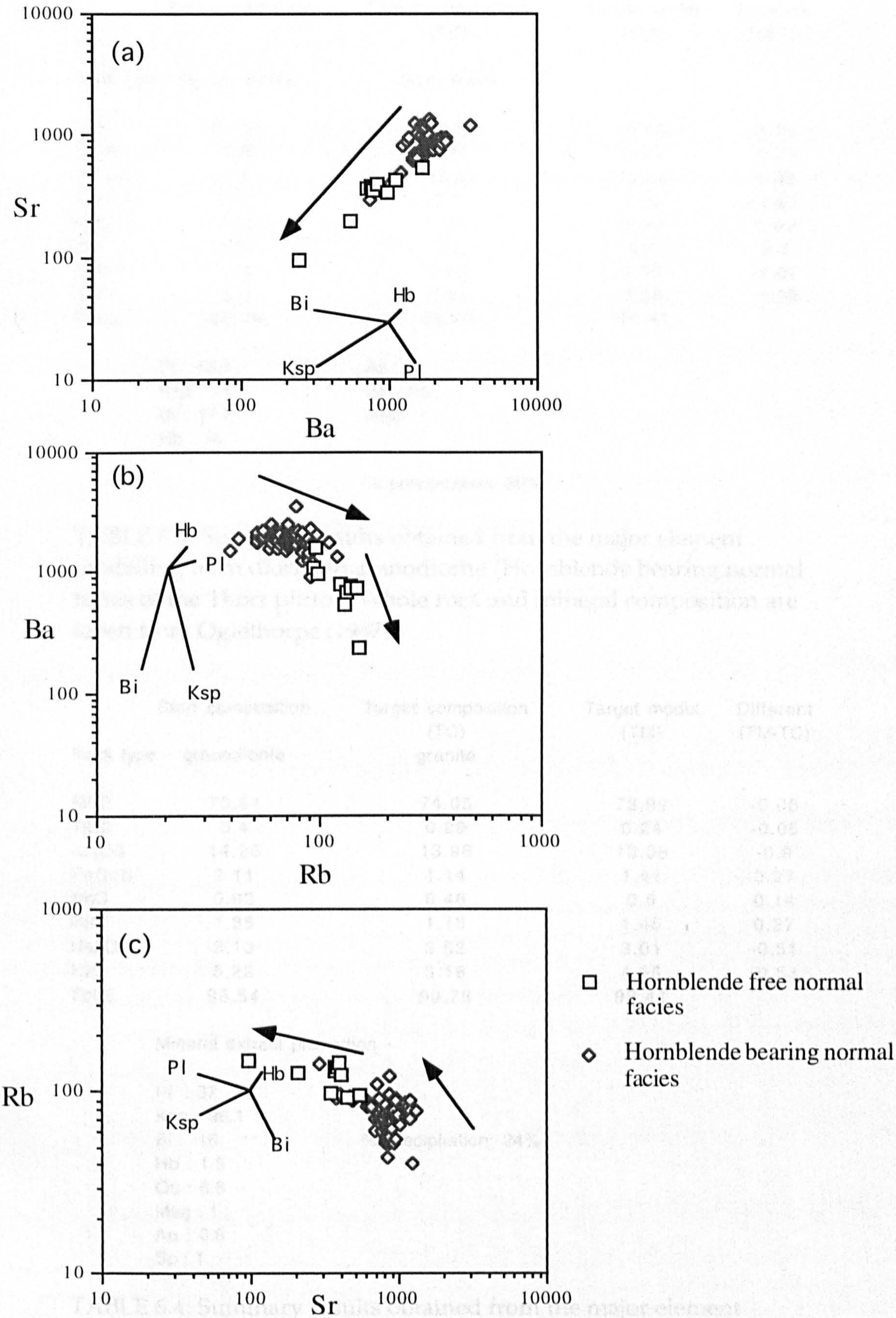


FIGURE 6.1 : Inter element variation diagrams for LIL elements Ba,Rb and Sr of the normal facies of Thorr pluton. Mineral vectors indicate the net change in composition of the initial liquid after 20% Rayleigh fractionation of the named phase.

	Start composition	Target composition (TC)	Target model (TM)	Different (TM-TC)
Rock type	Quartz diorite	granodiorite		
SiO2	61.97	69.54	69.68	0.14
TiO2	0.76	0.46	0.21	-0.25
Al2O3	17.51	15.2	16.29	1.09
Fe(tot)	4.32	2.2	1.52	-0.68
MgO	2.76	1.06	2.09	1.03
CaO	4.17	2.1	2.8	0.7
Na2O	3.5	3.62	2.55	-1.07
K2O	3.8	4.31	3.28	-1.03
Total	98.79	98.49	98.42	

Pl : 48.7
Ksp : 16
Bi : 17.8
Hb : 14
Ap : 1
Sp : 1.5
Mag : 1

% precipitation: 50%

TABLE 6.3: Summary results obtained from the major element modelling from diorite to granodiorite (Hornblende bearing normal facies of the Thorr pluton. Whole rock and mineral composition are taken from Oglethorpe (1987).

	Start composition	Target composition (TC)	Target model (TM)	Different (TM-TC)
Rock type	granodiorite	granite		
SiO2	70.64	74.05	73.99	-0.06
TiO2	0.4	0.29	0.24	-0.05
Al2O3	14.26	13.96	13.06	-0.9
Fe(tot)	2.11	1.14	1.41	0.27
MgO	0.93	0.46	0.6	0.14
CaO	1.85	1.18	1.45	0.27
Na2O	3.13	3.52	3.01	-0.51
K2O	5.22	5.18	4.65	-0.53
Total	98.54	99.78	98.41	

Mineral extract proportion

Pl : 37
Ksp : 36.1
Bi : 16
Hb : 1.5
Qu : 6.6
Mag : 1
Ap : 0.8
Sp : 1

% precipitation: 24%

TABLE 6.4: Summary results obtained from the major element modelling from granodiorite to granite (hornblende free normal facies) of the Thorr pluton. Whole rock and mineral composition are taken from Oglethorpe (1987).

	Start TH36I quartz diorite	Target TH9 Granodiorite	Target model	Bulk Kd	Min Prop	
La	28.4	17.47	16.26	4.4	Pl	47.38
Ce	64.8	41.66	41.31	4.26	Kf	16.10
Nd	8.4	14	18.47	4.35	Bi	18.57
Sm	31.6	2.68	2.58	4.19	Hb	12
Eu	1.62	0.56	0.54	5.4	Zr	0.22
Gd	4.3	2.05	2.05	3.75	All	0.03
Dy	3.51	1.48	1.55	4.24	Sp	2
Er	2.19	0.83	0.87	4.26	Ap	2.6
Yb	1.59	0.8	0.93	3.71	Mag	1.1
Lu	0.25	0.1	0.14	3.07		

% precipitation : 21%

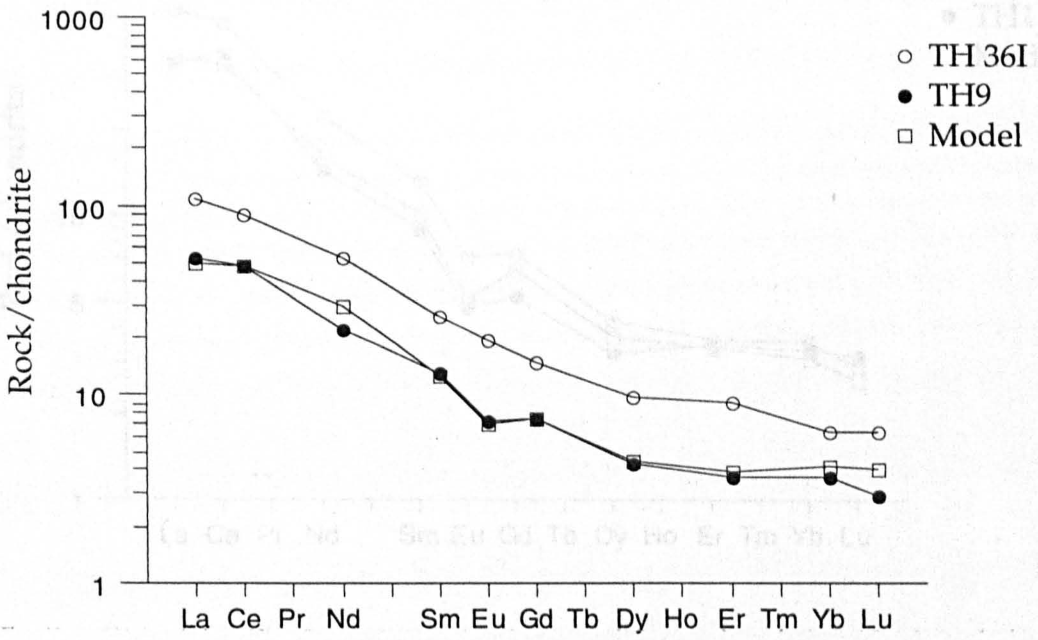


FIGURE 6.2 : Summary of the REE modelling of the quartz diorite to granodiorite of the Thorr pluton. At the top is the summary of start and target compositions, target model, amount of mineral precipitate (%) and bulk Kd of the REE used in the modelling . % precipitation is the percentage precipitated to move the start composition to the target model. Below is the graphical presentation of the modelling.

	Start TH9 granodiorite	Target TH1 granite	Target model	Bulk Kd	Min Prop	
La	17.47	11.67	11.93	3.99	Pl	37
Ce	41.66	32.87	29.55	3.7	Kf	36.2
Nd	14	9.2	10.12	3.56	Bi	16.32
Sm	2.68	1.84	2.09	2.96	Hb	1.5
Eu	0.56	0.37	0.39	3.87	Zr	0.15
Gd	2.05	1.44	1.8	2.05	All	0.13
Dy	1.48	1.13	1.28	2.18	Sp	1
Er	0.83	0.8	0.77	2.22	Ap	0.8
Yb	0.8	0.75	0.69	2.16	Mg	0.9
Lu	0.1	0.11	0.09	1.98		

% precipitation : 12%

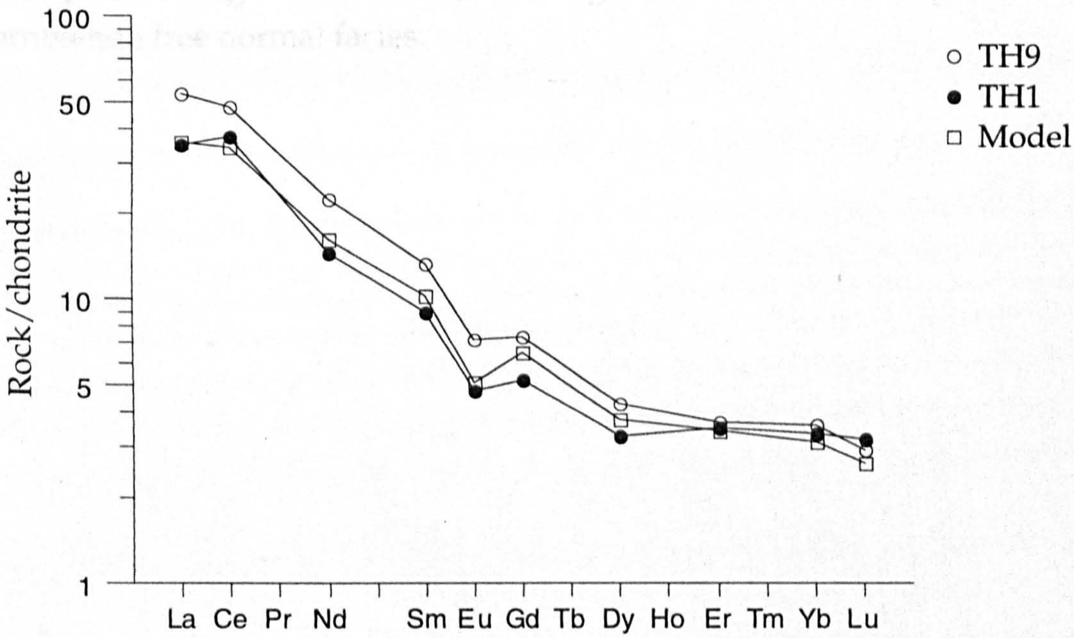


FIGURE 6.3 : Summary of the REE modelling of the granodiorite to granite of the Thorr pluton. At the top is the summary of start and target compositions, target model, amount mineral precipitate (%) and bulk Kd of the REE used in the modelling . % precipitation is the percentage precipitated to move the start composition to the target model. Below is the graphical presentation of the modelling.

Major element modelling

	Pl	KF	Bi	Hbl	Qtz	Mag	Ap	Sp	% ppt
Stage 1	48.7	16	17.8	14	0	1	1	1.5	50%
Stage 2	37	36.1	16	1.5	6.6	1	0.8	1	24%

REE modelling

	Pl	KF	Bi	Hbl	Qtz	Zr	All	Sp	Ap	Mag	% ppt
Stage 1	47.4	16.1	18.6	12	0	0.22	0.03	2	2.6	1.1	21%
Stage 2	37	36.2	16.3	1.5	6	0.15	0.13	1	0.8	0.9	12%

TABLE 6.5: Summary of (a) major elements and (b) REE modelling of the Thorr pluton. Stage 1 : hornblende bearing normal facies and stage 2 : hornblende free normal facies.

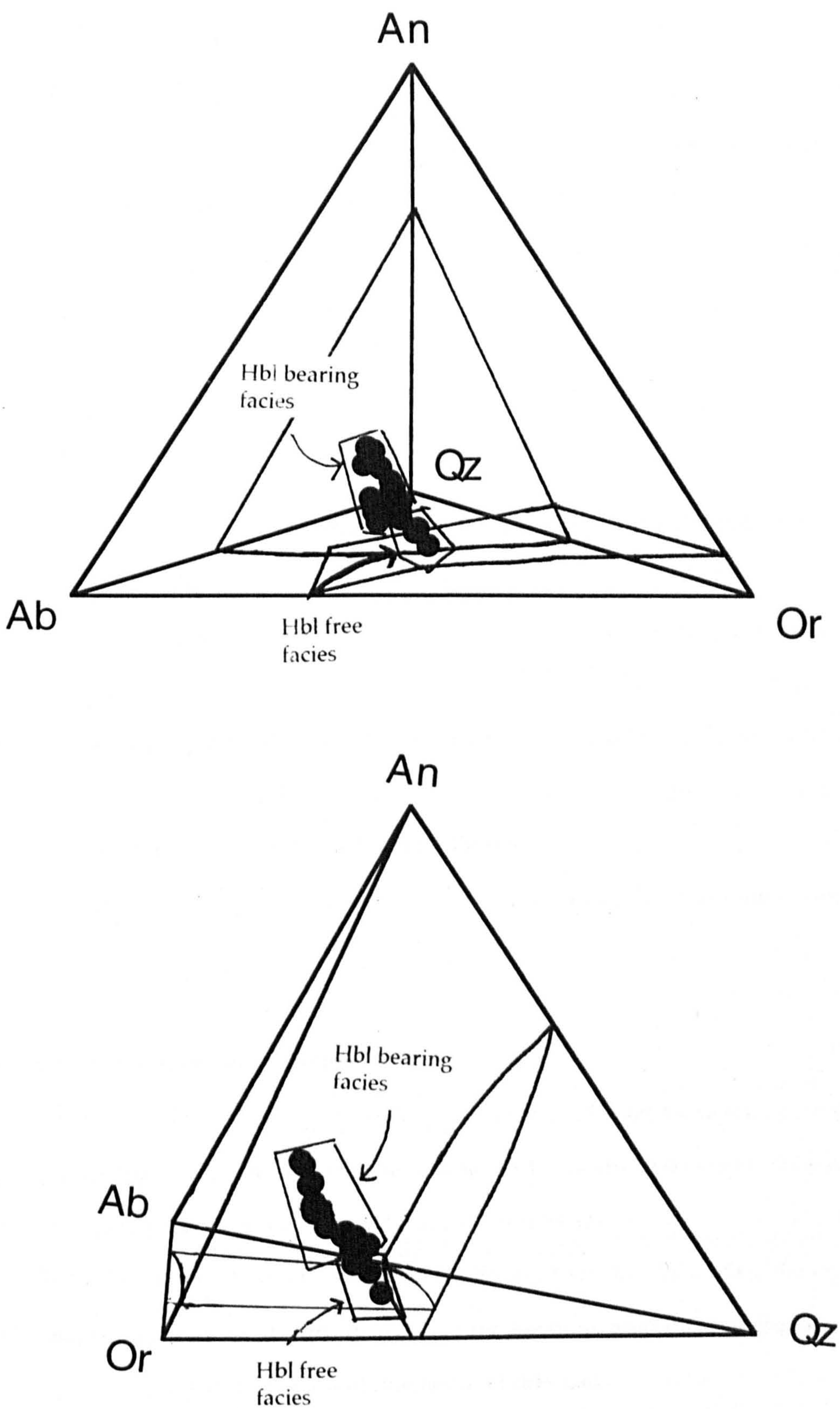


FIGURE 6.4: Normative Ab-Or-An-Qz tetrahedral diagram for the Thorr granite. Phase boundaries from Presnall and Bateman (1973).

6.4 ROSSES PLUTON

The geochemistry of the Rosses granites indicates that there is a distinct chemical break at the G2 - G3 contact. It also appears that G3 is more basic than G2 which does not support the idea of continuous evolution from G1 to G4. The Harker plots show that each of the units of the Rosses granite overlap in SiO_2 content. Rosses granites will be modelled in two parts (1) Intra units (each unit separately), (2) Inter units.

6.4.1 Intra unit modelling

6.4.1.1 LILE modelling

Inter element variation diagrams for the pairs Rb-Sr, Ba-Sr and Ba-Rb are shown in **Fig 6.5**. All the units show a similar trend on all plots. On a Sr vs Ba plot **(Fig 6.5a)** there is a good positive correlation. The sequence of decreasing Ba and Sr values is microgranite - porphyry dykes - G1- G3 - G2 and G4. Rayleigh fractionation vectors for single mineral phases imply that the crystallisation of alkali feldspar, plagioclase and biotite may have controlled the trends in all units. The same minerals may have controlled the trends shown on a Ba vs Rb **(Fig 6.5b)** plot.

On a Rb vs Sr **(Fig 6.5c)** plot, plagioclase and alkali feldspar are important in controlling the trends in all units.

6.4.1.2 Major element modelling

The results of major element modelling are shown in **Tables 6.6 to 6.11.** Each unit has been modelled from its most basic to most felsic rock. The mineral compositions used are from the microprobe analyses (Appendix 4) . The results are :

(1) The microgranite sheet has been modelled from 69.92% to 75.4% SiO_2. The model target composition can be achieved at 72% fractionation and the mineral mix is plagioclase, biotite, alkali feldspar and magnetite **(Table 6.6)**.

(2) G1 has been modelled from 70.2 % to 74.3% SiO_2. The model target composition can be achieved at 27% fractionation and the mineral extract is plagioclase, alkali feldspar, biotite. quartz and magnetite **(Table 6.7)**.

(3) G2 has been modelled from 71.4% to 76.5% SiO_2. The model target composition can be achieved at 36% fractionation and the mineral extract is plagioclase, alkali feldspar , biotite, quartz, and magnetite **(Table 6.8).**

(4) The porphyries have been modelled from 70.1% to 72.82% SiO_2 The model target composition can be achieved at 15% fractionation and the mineral extract is plagioclase, alkali feldspar , biotite and magnetite **(Table 6.9).**

(5) G3 has been modelled from 72.8 % to 75.6 % SiO_2. The model target composition can be achieved at 16% fractionation and the mineral extract is plagioclase, alkali feldspar , biotite, quartz and magnetite **(Table 6.10).**

(6) G4 has been modelled from 73.7 % to 76.6 % SiO_2. The model target composition can be achieved at 21% fractionation and the mineral extract is plagioclase, alkali feldspar, biotite and quartz **(Table 6.11).**

6.4.1.3 REE modelling

The REE in the Rosses pluton have been modelled in three stages, from the basic to the most felsic rocks of G1, G2 and G3. The REE profiles of the start and target compositions used in the modelling, together with the calculated melt profile are shown graphically in **Fig 6.6, Fig 6.7, Fig 6.8** and are summarised in **Table 6.12a .**

G1 has been modelled from ROS11 (SiO_2= 70.05%) to ROS12 (SiO_2 = 71.66%). The mineral mix plagioclase, alkali feldspar, biotite, quartz and magnetite, allanite, apatite and zircon at 23% fractionation is required to produce the calculated REE profile **(Fig 6.6).**

G2 has been modelled from ROS5 (SiO_2 = 72.29%) to ROS15 (SiO_2 = 75.26%). The mineral mix plagioclase, alkali feldspar, biotite, quartz, magnetite, allanite, apatite and zircon at 45 % fractionation is required to produce the calculated REE profiles **(Fig 6.7).**

G3 has been modelled from ROS18 (72.83%) to ROS20 (73.34%). The mineral mix of the REE modelling of the G3 namely plagioclase, alkali feldspar, biotite, quartz, magnetite, allanite, apatite, and zircon at 16% fractionation is required to produce the calculated REE profile **(Fig 6.8).**

6.4.2 Inter units modelling

Inter unit modelling of the Rosses granite are divided into two paths, (1) Microgranite to G1 to G2 and (2) Porphyry dyke to G3 to G4. The samples for both paths were selected using the Ba vs Sr plot **(see Fig 5.11)** and are shown in **Figure 6.9**. The location of the samples is shown in a small map in **Fig 6.9**. Note that in the first path (microgranite to G1 to G2), sample ROS7 is not in line with other samples. However, it was included in the modelling because it has the highest Ba and Sr contents compared to other G2 samples. Each path was modelled using the major elements and the results are:

The first path is modelled in three stages :

Stage 1 has been modelled from 69.9% (microgranite sheet) to 72.6% SiO_2 (G1). The model target composition can be achieved at 22% fractionation and the mineral mix is plagioclase (50%), alkali feldspar (30.4%), biotite (17%), quartz (2%) and magnetite (0.6%).

Stage 2 has been modelled from 72.6% (G1) to 73.3%(G2) SiO_2. The model target composition can be achieved at 7% fractionation and the mineral mix is plagioclase (47%), alkali feldspar (33.2%), biotite (15%), quartz (4%) and magnetite (0.8%).

Stage 3 has been modelled from 73.3%(G2) to 74.02% (G2) SiO_2. The model target composition can be achieved at 6% fractionation and the mineral mix is plagioclase (45.9%), alkali feldspar (35.7%), biotite (13%), quartz (5%) and magnetite (0.4%).

The second path is modelled in four stages :

Stage 1 has been modelled from 71.6% (porphyry dyke) to 72.8% (G3) SiO_2. The model target composition can be achieved at 9% fractionation and the mineral mix is plagioclase (44.5%), alkali feldspar (36.7%), biotite (18%) and magnetite (0.4%).

Stage 2 has been modelled from 72.8% (G3) to 73.3% (G3) SiO_2. The model target composition can be achieved at 5% fractionation and the mineral mix is plagioclase (46%), alkali feldspar (35.7%), biotite (15%), quartz (3%) and magnetite (0.3%).

Stage 3 has been modelled from 73.3% (G3) to 73.4% (G3) SiO_2. The model target composition can be achieved at 1% fractionation and the mineral mix is plagioclase (46.3%), alkali feldspar (35.4%), biotite (15%), quartz (3.8%) and magnetite (0.3%).

Stage 4 has been modelled from 73.4% (G3) to 74.9% (G4) SiO_2. The model target composition can be achieved at 9% fractionation and the mineral mix is plagioclase (41%), alkali feldspar (41.1%), biotite (11%), quartz (6%) and magnetite (0.9%).

6.4.3 Discussion

Major, LILE and REE modelling of the Rosses granites indicate that the evolution of each unit is controlled by the same minerals viz plagioclase, alkali feldspar and biotite but in different proportions. A summary of the major element modelling is given in **Table 6.12a**. In general, it shows no systematic decrease or increase the role of a given mineral through the whole sequence microgranite - G1 -G2 - porphyry - G3 and G4. However, biotite and quartz proportions show two separates but similar trends. Thus the role of biotite decreases in importance through the sequence microgranite (19%) to G1 (18%) to G2 (14%). It then becomes more important in the porphyry dykes (19%) but again less so in G3 (15.5%) and in G4 (12%). On the other hand, the role of quartz is important in controlling the rock composition through the sequence of microgranite (0%) to G1 (2%) to G2 (6%). It then becomes unimportant in the porphyry (0%) but increases in importance in G3 (2%) and finally in G4 (5%).

A summary of the inter unit modelling is shown in **Table 6.12b**. Two paths have been modelled namely (1) microgranite to G1 to G2 and (2) porphyry to G3 to G4. The modelling is divided into two paths because 'G2' cannot fractionate to 'G3' type magmas as the latter is more basic (see section 5.2.2.1 and 5.2.2.2). In the first path plagioclase and biotite decrease whereas alkali feldspar and quartz increase from stage 1 to 2 to 3. In the second stage plagioclase and alkali feldspar do not show any trend whereas quartz increases and biotite decreases from stage 1 to 2 to 3 to 4.

The results seem to support Mercy's suggestion (1960b) that the evolution of the Rosses pluton involved two cycles i.e. microgranite to G1 to G2 and porphyry/G3 to G4.

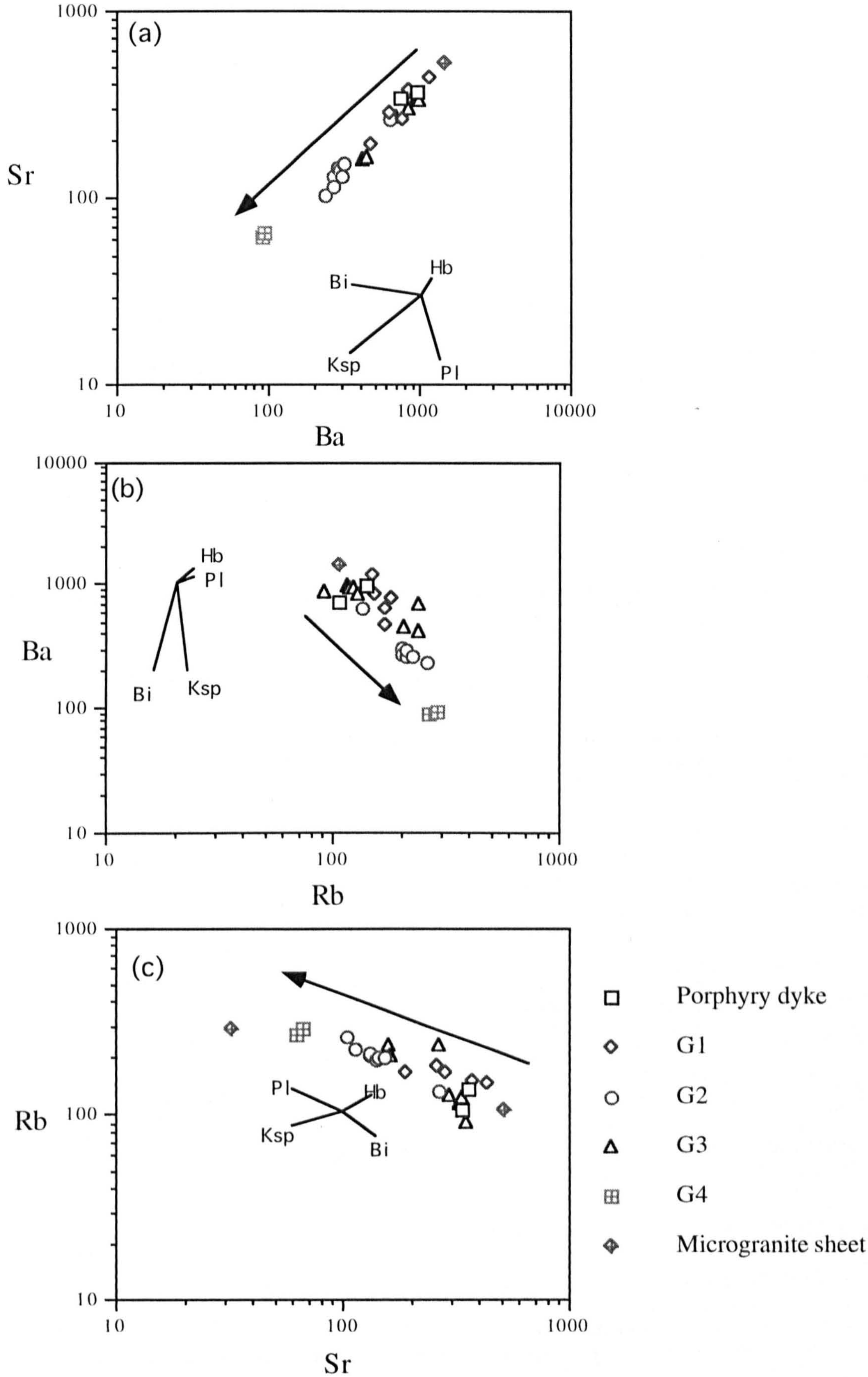


FIGURE 6.5: Inter element variation diagrams for LIL elements Ba, Rb and Sr of the Rosses pluton. Mineral vectors indicate the net change in composition of the initial liquid after 20% Rayleigh fractionation of the named phase.

	Start composition	Target composition (TC)	Target model (TM)	Different (TM-TC)
Rock type	Granite	Granite		
SiO2	69.92	75.4	75.39	-0.01
TiO2	0.27	0.08	0.14	0.06
Al2O3	15.36	13.24	12.97	-0.27
Fe(tot)	2.02	0.64	1.19	0.55
MgO	1.38	0.16	1.09	0.93
CaO	1.88	0.56	1.17	0.61
Na2O	4.56	4.4	4.78	0.38
K2O	4.23	5.1	3.49	-1.61
Total	99.62	99.58	100.22	

Mineral extract proportion

Bi : 19 % precipitation: 72%
Pl : 50.9
Ksp : 30
Qu : 0
Mag : 0.1

TABLE 6.6 : Summary results obtained from the major element modelling of the microgranite sheets of Rosses pluton. Mineral data from G1 rock (Appendix 4).

	Start composition	Target composition (TC)	Target model (TM)	Different (TM-TC)
Rock type	Granite	Granite		
SiO2	70.2	74.3	74.4	0.1
TiO2	0.3	0.14	0.17	0.03
Al2O3	15	13	13.36	0.36
Fe(tot)	2.2	1.2	0.93	-0.27
MgO	0.71	0.39	0.43	0.04
CaO	1.1	0.89	0.81	-0.08
Na2O	4	4	4.18	0.18
K2O	5.1	4.6	4.07	-0.53
Total	98.61	98.52	98.35	

Mineral extract proportion

Bi : 18 % precipitation: 27%
Pl : 39
Ksp : 39
Qu : 2
Mag : 2

TABLE 6.7 : Summary results obtained from the major element modelling of G1 of the Rosses pluton. Mineral data from G1 rock (Appendix 4).

	Start composition	Target composition (TC)	Target model (TM)	Different (TM-TC)
Rock type	Granite	Granite		
SiO2	71.4	76.5	76.43	-0.07
TiO2	0.25	0.17	0.15	-0.02
Al2O3	14.6	12.3	12.3	0
Fe(tot)	1.8	1.1	0.87	-0.23
MgO	0.76	0.35	0.57	0.22
CaO	1.4	1.1	1.32	0.22
Na2O	4.2	4.2	4.13	-0.07
K2O	4.3	4.6	3.45	-1.15
Total	98.71	100.32	99.22	

Mineral extract proportion

Bi : 14
Pl : 44.6 % precipitation: 36%
Ksp : 35
Qu : 6
Mag : 0.4

TABLE 6.8: Summary results obtained from the major element modelling of G2 of the Rosses pluton. Mineral data from G2 of the Rosses granite (Appendix 4).

	Start composition	Target composition (TC)	Target model (TM)	Different (TM-TC)
Rock type	Granite	Granite		
SiO2	70.10	72.82	72.61	-0.21
TiO2	0.35	0.16	0.29	0.13
Al2O3	15.00	13.50	13.98	0.48
Fe(tot)	2.50	1.90	1.89	-0.01
MgO	1.00	0.75	0.82	0.07
CaO	1.70	2.00	1.52	-0.48
Na2O	4.20	4.40	4.28	-0.12
K2O	4.50	4.00	3.90	-0.1
Total	99.35	99.53	99.29	

Mineral extract proportion

Bi : 19
Pl : 39 % precipitation: 15%
Ksp : 38
Mag : 2

TABLE 6.9 : Summary results obtained from the major element modelling of the porphyry dykes of the Rosses pluton. Mineral data from the porphyry of the Rosses granite (Appendix 4).

	Start composition	Target composition (TC)	Target model (TM)	Different (TM-TC)
Rosk type	granite	granite		
SiO2	72.82	75.6	75.52	-0.08
TiO2	0.17	0.05	0.1	0.05
Al2O3	14.21	14.1	13.09	-1.01
Fe(tot)	1.32	0.54	0.65	0.11
MgO	1	0.1	0.94	0.84
CaO	0.97	0.4	0.68	0.28
Na2O	3.98	4.1	4.45	0.35
K2O	4.55	4.4	4.09	-0.31
Total	99.02	99.29	99.52	

Mineral extract proportion

Bi : 15.5 — % precipitation : 16%
Pl : 45
Ksp : 32
Qu : 2
Mag : 0.5

TABLE 6.10 : Summary results obtained from the major element modelling of G3 of the Rosses pluton. Mineral data from G3 rock (Appendix 4).

	Start composition	Target composition (TC)	Target model (TM)	Different (TM-TC)
Rosk type	granite	granite		
SiO2	73.7	76.6	76.58	-0.02
TiO2	0.11	0.1	0.04	-0.06
Al2O3	14.6	13.7	13.41	-0.29
Fe(tot)	0.97	0.39	0.57	0.18
MgO	0.26	0.3	0.07	-0.23
CaO	0.51	0.46	0.14	-0.32
Na2O	3.9	3.4	3.88	0.48
K2O	4.6	4.6	3.76	-0.84
Total	98.65	99.55	98.45	

Mineral extract proportion

Bi : 12
Pl : 40 — % precipitation : 21%
Ksp : 43
Qu : 5

TABLE 6.11: Summary results obtained from the major element modelling of G4 of the Rosses pluton. Mineral data from G4 rock (Appendix 4).

	Start ROS11 granite	Target ROS12 granite	Target model	Bulk Kd	Min prop	
La	30.18	23.58	18.99	2.77	Pl	38.03
Ce	60.52	44.69	40.79	2.51	Kf	39
Nd	23.09	16.7	17.58	2.04	Bi	19
Sm	3.81	3.04	3.49	1.33	Qu	1.76
Eu	0.72	0.55	0.53	2.23	All	0.09
Gd	2.55	2.3	2.78	0.68	Ap	0.7
Dy	1.68	1.66	1.80	0.74	Zr	0.12
Er	0.73	0.78	0.77	0.82	Mag	1.3
Yb	0.72	0.7	0.72	1.01		
Lu	0.1	0.09	0.10	1.05		

% precipitation : 23%

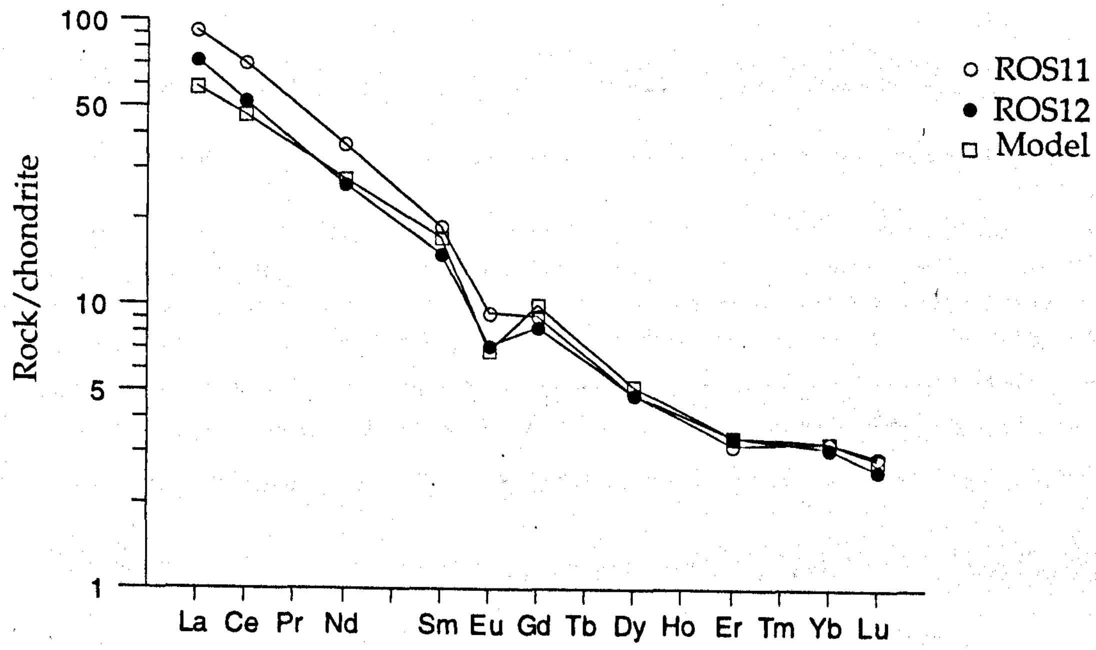


FIGURE 6.6 : Summary of the REE modelling of G1 from Rosses pluton.
At the top is the summary of start and target compositions, target model, amount of mineral precipitate (%) and bulk Kd of the REE used in the modelling.
% precipitation is the percentage precipitated to move the start composition to the target model. Below is the graphical presentation of the modelling.

	Start ROS5 Granite	Target ROS15 Granite	Target model	Bulk Kd	Min Prop	
La	16.17	7.12	6.55	2.51	Pl	44.03
Ce	32.27	17.1	15.9	2.18	Kf	33.2
Nd	14.45	6.1	7.13	2.18	Bi	14
Sm	3.61	1.99	2.08	1.92	Qu	5.8
Eu	0.46	0.28	0.25	2.01	All	0.05
Gd	3.3	2.08	2.4	1.53	Ap	2.4
Dy	2.91	2.45	2.34	1.37	Zr	0.08
Er	1.62	1.49	1.43	1.22	Mag	0.44
Yb	1.45	1.6	1.39	1.07		
Lu	0.2	0.2	0.2	1.04		

% precipitation : 45%

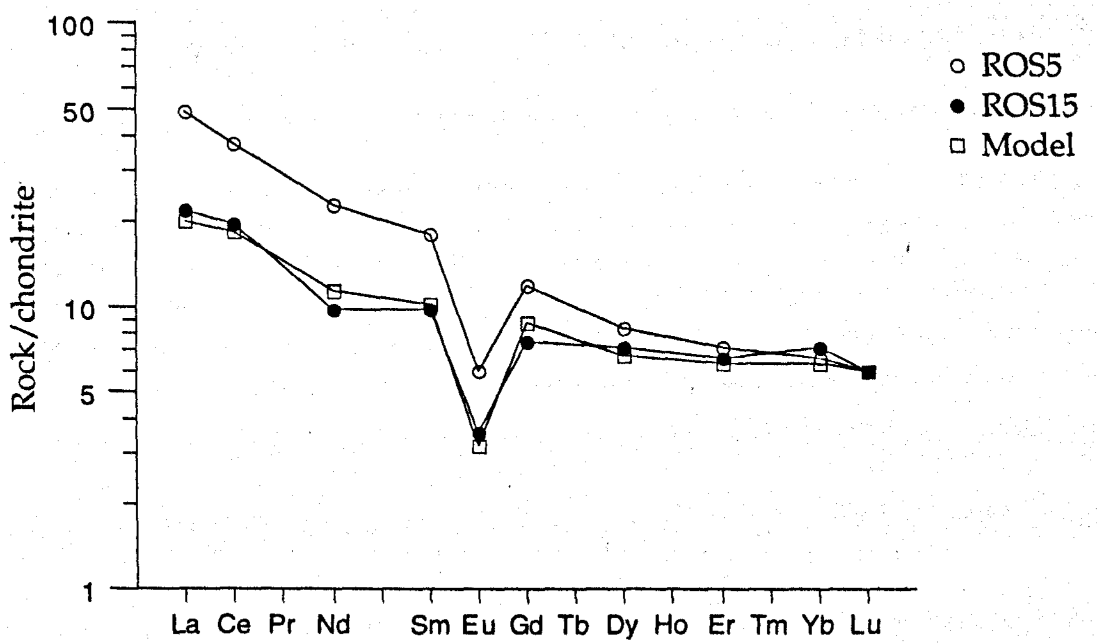


FIGURE 6.7 : Summary of the REE modelling of G2 from Rosses pluton. At the top is the summary of start and target compositions, target model, amount of mineral precipitate (%) and bulk Kd of the REE used in the modelling. % precipitation is the percentage precipitated to move the start composition to the target model. Below is the graphical presentation of the modelling.

	Start ROS18 granite	Target ROS20 granite	Target model	Bulk Kd	Min Prop	
La	25.16	17.8	19.32	2.51	Pl	44.47
Ce	45.1	39.1	36.69	2.18	Kf	31
Nd	17.3	14.97	14.07	2.18	Bi	14.5
Sm	3.04	2.8	2.58	1.93	Qu	7
Eu	0.6	0.51	0.5	2.01	All	0.05
Gd	2.1	2	1.91	1.53	Ap	1.4
Dy	1.66	1.62	1.56	1.37	Zr	0.08
Er	0.87	0.92	0.84	1.22	Mag	0.5
Yb	0.85	0.92	0.84	1.07		
Lu	0.07	0.13	0.07	1.05		

% precipitation : 16%

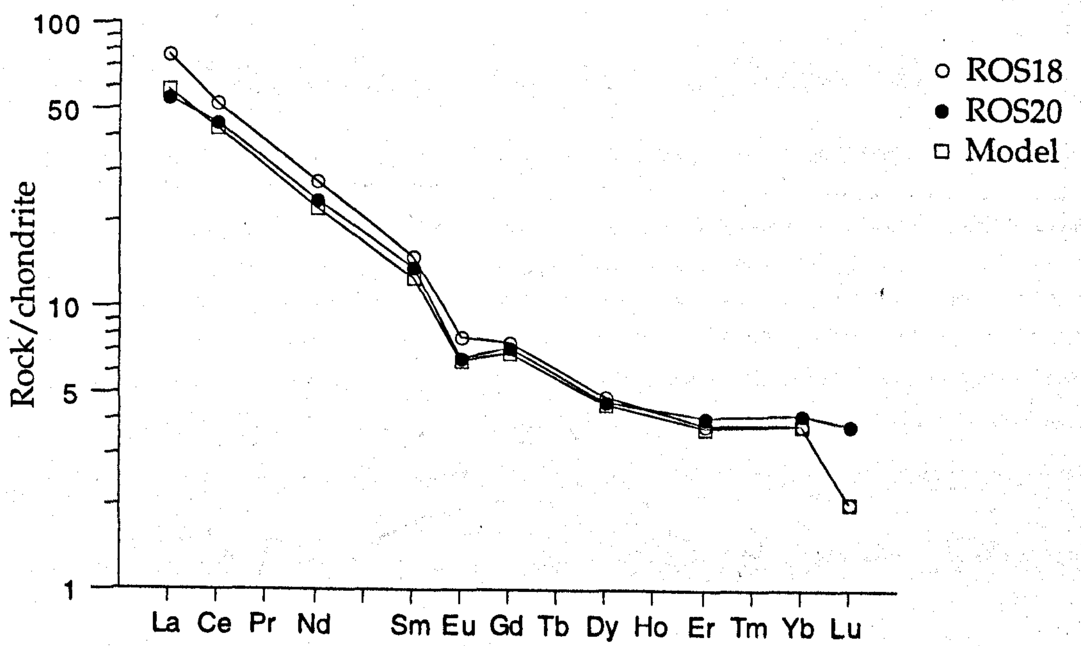
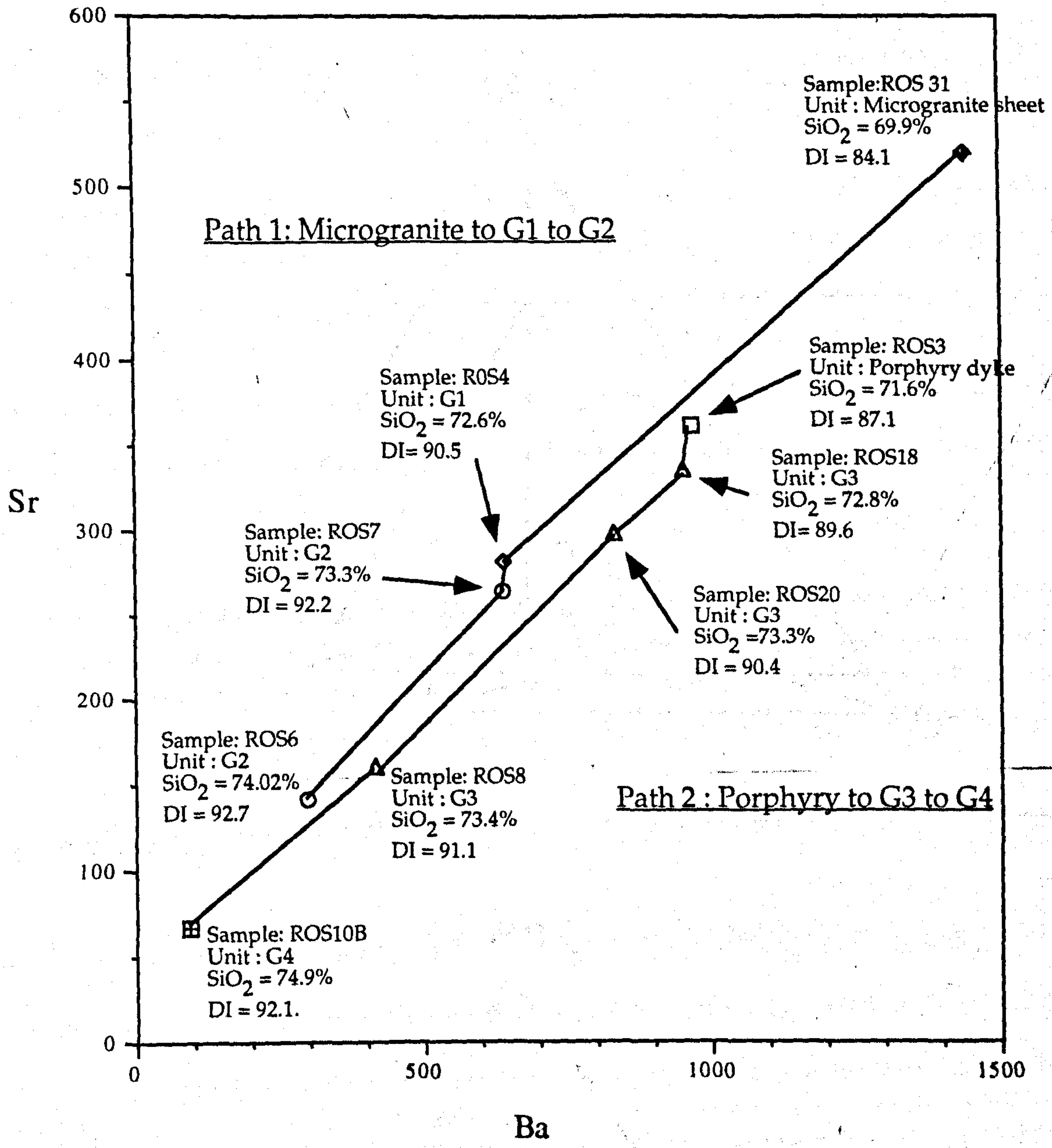


FIGURE 6.8 : Summary of the REE modelling of G3 from Rosses pluton. At the top is the summary of start and target compositions, target model, amount of mineral precipitate (%) and bulk Kd of the REE used in the modelling. % precipitation is the percentage precipitated to move the start composition to the target model. Below is the graphical presentation of the modelling.



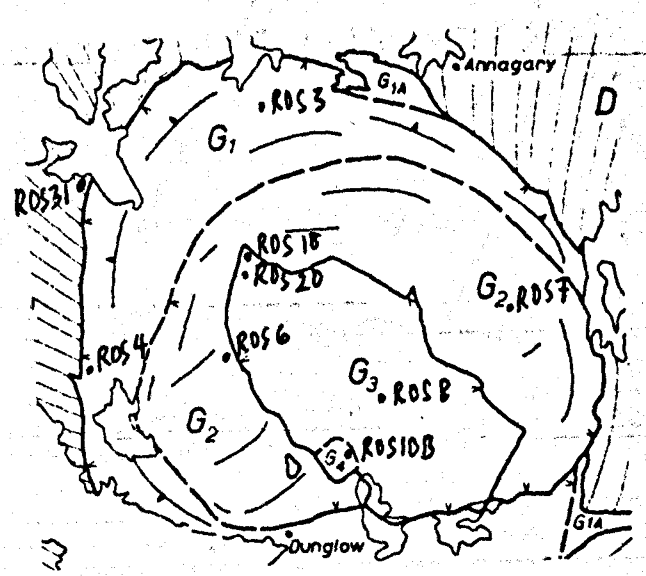


FIGURE 6.9 : Samples used in the inter units modelling of the Rosses granite. The modelling is divided into two paths i.e. (1) microgranite to G1 to G3 and (2) porphyry dyke to G3 to G4. Location of the samples shown in the small map. Result of the modelling is shown in Table 6.12b.

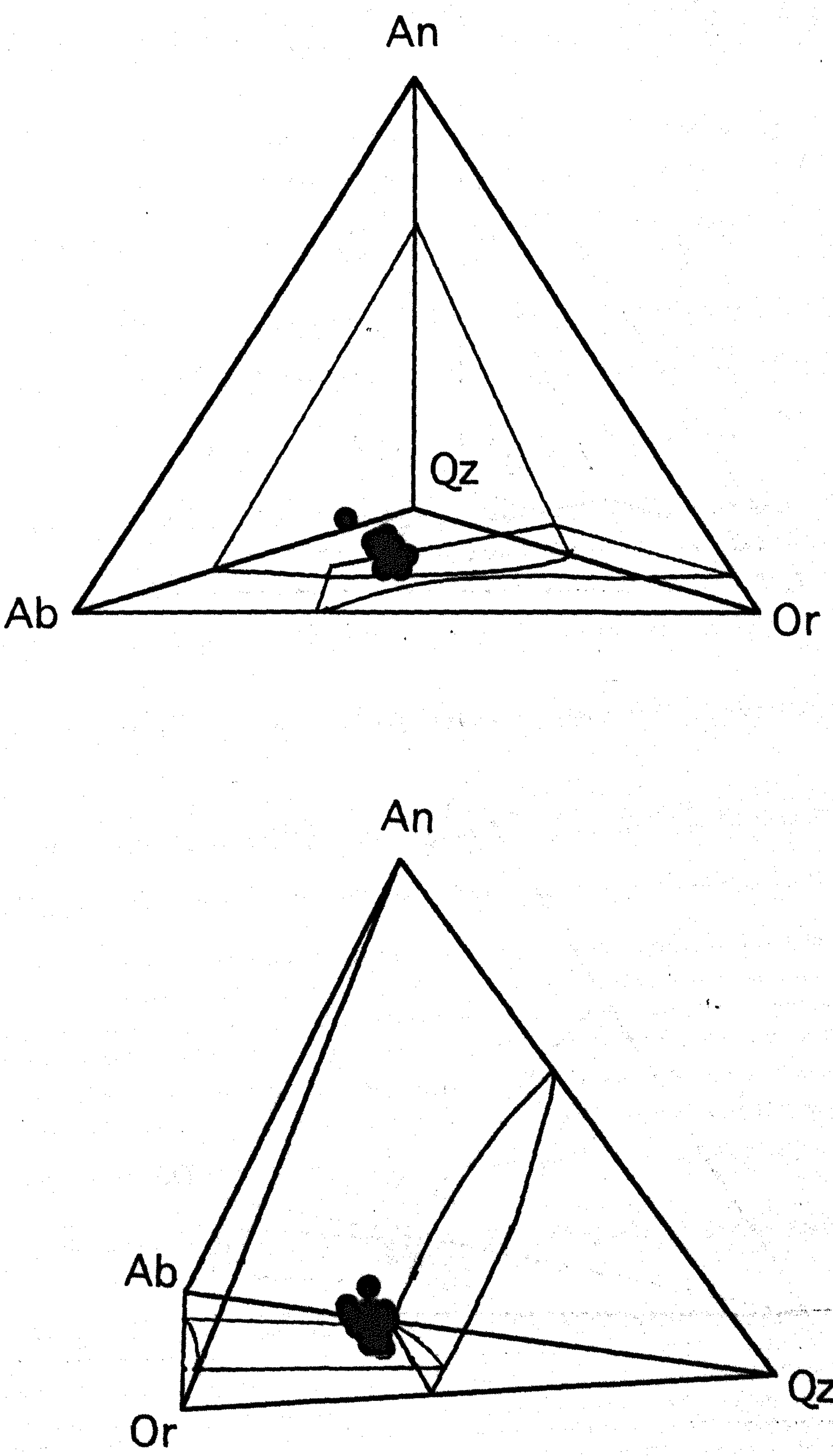


FIGURE 6.10a: Normative Ab-Or-An-Qz tetrahedral diagram for the Rosses granite (Microgranite - G1 - G2). Phase boundaries from Presnall and Bateman (1973).

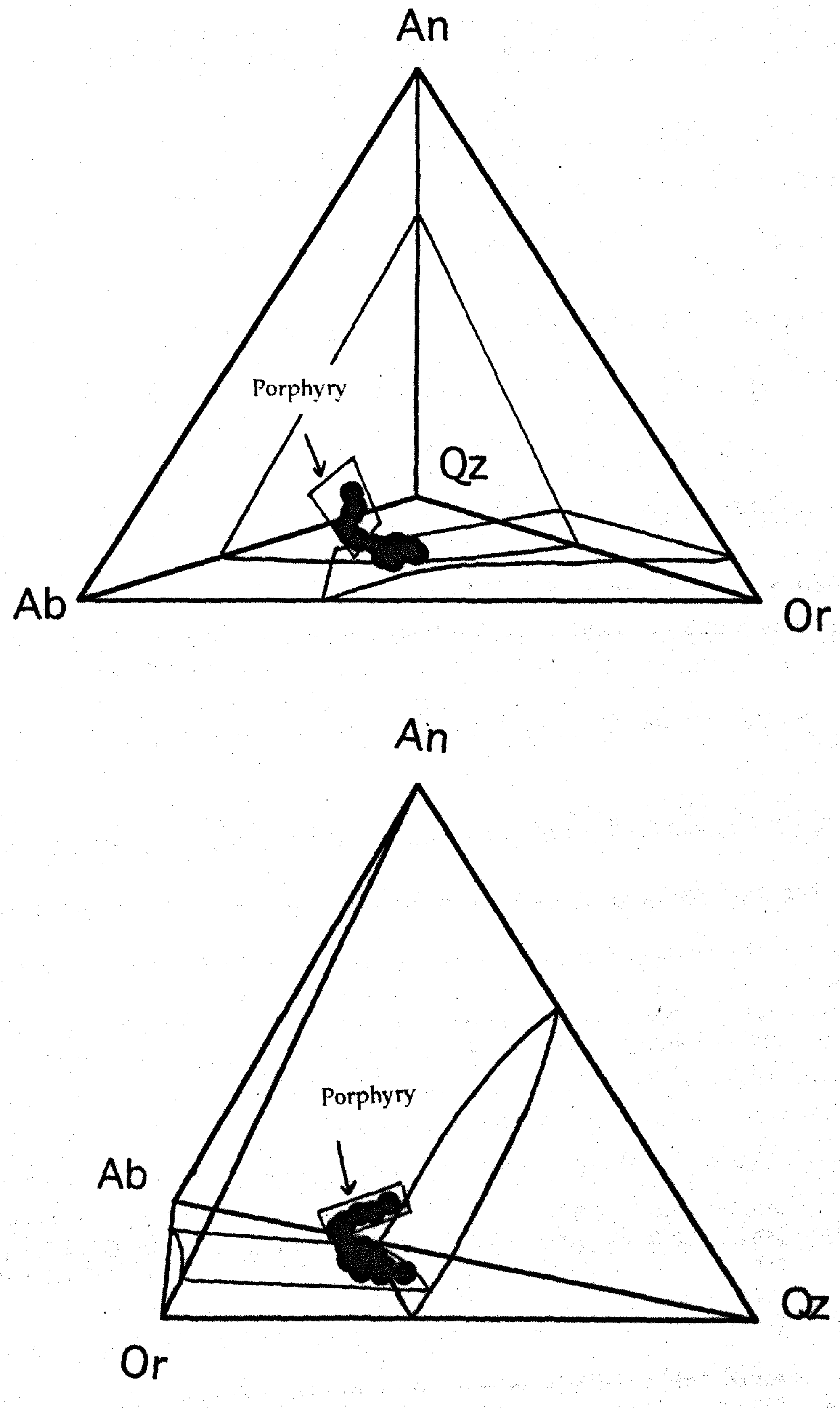


FIGURE 6.10b: Normative Ab-Or-An-Qz tetrahedral diagram for the Rosses granite (porphyry - G3 - G4). Phase boundaries from Presnall and Bateman (1973).

Major elements modelling

Units	Pl	Ksp	Bi	Qu	Mag	%ppt
Microgranite	50.9	30	19	0	0.1	72%
G1	39	39	18	2	2	27%
G2	44.6	35	14	6	0.4	36%
Porphyry	39	38	19	0	2	15%
G3	45	32	15.5	2	0.5	16%
G4	40	43	12	5	0	21%

REE modelling

Units	Pl	Ksp	Bi	Qu	Mag	All	Ap	Zr	%ppt
G1	38.3	39	19	1.76	1.3	0.09	0.7	0.12	23%
G2	44.03	33.2	14	5.8	0.55	0.05	2.4	0.08	45%
G3	44.47	31	14.5	7	0.5	0.05	1.4	0.08	16%

TABLE 6.12a: Summary results of major and RE element modelling of the Rosses pluton. Note that in the major element modelling, biotite and quartz show decreasing and increasing trend respectively from microgranite to G1 to G3 and from porphyry to G3 to G4 (arrows).

STEPS	Plag	K-Felds	Quartz	Biotite	Magnetite	% ppt
PATH 1						
M'granite (ROS31) to G1(ROS4)	50	30.4	2	17	0.6	22%
G1 (ROS4) to G2 (ROS7)	47	33.2	4	15	0.8	7%
G2(ROS7) to G2 (ROS6)	45.9	35.7	5	13	0.4	6%
PATH 2						
Porphyry (ROS3) to G3(ROS18)	44.9	36.7	0	18	0.4	9%
G3(ROS18) to G3 (ROS20)	46	35.7	3	15	0.3	5%
G3(ROS20) to G3 (ROS8)	46.3	35.4	3.8	14.5	0.3	1%
G3(ROS8) to G4 (ROS10B)	41	41.1	6	11	0.9	9%

Table 6.12b : Summary results of the inter unit . modelling of the Rosses granite.

Mercy (1960b) suggested two cycles of differentiation at depth from magmas with compositions of the average microgranite and porphyry. The first cycle involved the differentiation of a biotite microgranite to form G1 and then G2 .The second cycle of differentiation involved the porphyries to G3 and G4. This radically different to Hall's model (1966c) in which he suggested that the changes in composition required to produce the Rosses G1 to G4 series resulted from *continuous assimilation* of the Thorr granodiorite at a depth of 30 km unlikely.

On a tetrahedral An-Ab-Or-Qz plot of the Rosses granites, two paths can be distinguished i.e. (i) microgranite-G1 and G2 **(Fig 6.10a)** and (ii) G3-porphyry-G4 **(Fig 6.10b)**. The microgranite of (i) started precipitation in the plagioclase volume, but quickly included alkali feldspar as the plagioclase-alkali feldspar surface was reached. The porphyry dykes of the second path plot higher in the plagioclase volume compared to those of the first path. The crystallisation started at the plagioclase-quartz surface and at this time both plagioclase, minor quartz and alkali feldspar crystallised as phenocrysts. Further crystallisation would have moved the liquid away from the plagioclase-quartz surface towards the plagioclase-alkali feldspar surface. At this stage plagioclase precipitated along with alkali feldspar and final crystallisation involved quartz.

6.5 ARDARA PLUTON

The geochemistry of the Ardara pluton (see section 5.2.3) indicates that the outer, intermediate and inner units are not related by simple crystal fractionation. Thus, each unit of the Ardara granite will be modelled separately.

6.5.1 LILE modelling

Inter element variation diagrams for the pairs Rb-Sr, Ba-Sr and Ba-Rb are shown in **Fig 6.11**. The Sr vs Ba **(Fig 6.11a)** diagram shows that all units in Ardara pluton have restricted Sr and Ba contents compared to the other Donegal granites. The general trend shown by the Ardara rocks in this plot is consistent with minor fractionation of hornblende and biotite. On a Ba vs Rb plot **(Fig 6.11b)**, the outer unit has higher Rb value than the intermediate and inner units. This is odd considering that the outer unit of the Ardara pluton is the most basic of the Ardara rocks. On a Rb vs Sr plot **(Fig 6.11c)**, the general trend of the Ardara granites is consistent with fractionation of alkali feldspar and biotite.

6.5.2 Major element modelling

The Outer, intermediate and inner units have been modelled separately. The results are shown in **Tables 6.13 to 6.15**. Each unit has been modelled from its most basic to most felsic rock. The results are :

(1) Outer unit. This stage has been modelled from 60.6% to 63.2 % SiO_2. The target composition can be achieved by 22% fractionation and the mineral mix is plagioclase, biotite, hornblende, alkali feldspar, apatite, magnetite and sphene **(Table 6.13)**.

(2) Intermediate unit. This stage has been modelled from 62.6 % to 68.6 % SiO_2. The target composition can be achieved by 36% fractionation and the mineral mix is plagioclase, biotite, alkali feldspar, hornblende, magnetite, apatite and sphene **(Table 6.14)**.

(3) Inner unit. This stage has been modelled from 68.6 % to 72.18 % SiO_2. The target composition can be achieved by 24% fractionation and the mineral mix is plagioclase, biotite, alkali feldspar, hornblende, magnetite, apatite and sphene **(Table 6.15)**.

6.5.3 REE modelling

As in major elements modelling, the REEs have been modelled in the outer, intermediate and inner units.

In the outer unit, the start sample (ARD1F) is taken from the outer margin and the target sample (ARD 1E) is from the inner margin. The mineral mixes from major element modelling plus 0.14% allanite and 0.19% zircon at 16% fractionation are required to produce the calculated REE profiles shown in **Fig 6.12.**

In the intermediate unit, the start sample is ARD2 (69.18 % SiO_2) and the target sample is ARD4 (69.47 % SiO_2). The mineral mixes from major element modelling plus 0.14% allanite and 0.19% zircon at 3% fractionation are required to produce the calculated REE profiles shown in **Fig 6.13**. The amount of magnetite is less in the REE modelling compared to the major element modelling.

In the inner unit, the start sample is ARD13 (69.3 SiO_2) and the target sample is ARD 11 (72.18 SiO_2). The mineral mixes from major elements modelling plus 0.05% allanite and 0.24% zircon at 22% fractionation are required to produce the calculated REE profiles shown in **Fig 6.14**

To further investigate the relationship between each unit, the differentiation index **(Fig 6.15)** and Rb/Sr **(Fig 6.16)** values of the traverse samples of each unit were plotted against the distance from the margin to the centre of the pluton (see Fig 5.21). The mineral proportion and remaining liquid proportion (F) results obtained from the REE modelling (see Fig 6.12, 6.13 and 6.14) were used to model Rb/Sr value of the target sample. These were compared to the actual values in **Fig 6.16**. The results are summarised below .

Outer unit

The changes observed from the outer margin (contact with the country rocks) to the inner margin (contact with the intermediate unit) of the outer unit are :

(1) SiO_2 and DI decrease from the outer margin to the inner margin ; 61.85% to 61.68% and 70.6 to 67.1 respectively. Thus the outer unit of Ardara granite is finely reversely zoned.

(2) Rb/Sr ratio decreases from the outer margin to the inner margin ; 0.39 to 0.17.

(3) Modelled Rb/Sr value is 0.17.

Intermediate unit

The changes observed from the outer margin (contact with the outer unit) to the inner margin (contact with the inner unit) of the intermediate unit are :

(1) Rb/Sr decreases and SiO_2 and DI increase from the outer to inner margin. Thus in terms of SiO_2 and DI, the intermediate unit of the Ardara granite is normally zoned.

(2) The gap observed in the intermediate unit is marked by the sudden increase of DI

and SiO_2 (see also Fig 5.21 ; section 5.2.3.3.).

(3) Modelled Rb/Sr values are 0.08 (before the gap) and 0.04 (after the gap).

Inner unit.

The change observed from the outer margin (contact with the intermediate unit) to the centre of the inner unit are :

(1) SiO_2, DI and Rb/Sr increase to the centre of the unit. Thus the inner unit is normally zoned which is in contrast to the outer unit.

(2) Modelled Rb/Sr value is 0.04.

6.5.4 Discussion

The summary of the major and REE modelling within the units is given in **Table 6.16.** Although all the units show a similar trend in the LILE plots, the mineral precipitates from the major element modelling are significantly different in the three units. The difference is obvious when comparing the inner unit to both the outer and intermediate units. Thus the amount of plagioclase (62%) precipitated in the inner unit is higher compared to both outer and intermediate units (53 and 50% respectively). The amount of hornblende precipitated is high in the outer and low in the intermediate to inner units. The amount of alkali feldspar precipitated in the inner unit (14.5%) is lower than that in the intermediate unit (15.5%). These results are opposite to what would be expected in a simple closed evolving granite system.

By using mass balance Yarr (1991), showed that the outer and intermediate units are closely related and that it is possible to generate an intermediate composition from an outer unit type parent magma. Yarr's results give an average of 65% plagioclase precipitated in order to move the liquid from the composition of the outer unit magma to that of the intermediate unit type magma. However, tests of Yarr's model using an average Sr for the outer unit of 513 ppm and Kd_{Sr} Plag = 4.4 (Arth 1976), if 65% plagioclase was precipitated by fractional crystallisation, the average of Sr in the intermediate unit would be 156 ppm. It is 591 ppm. Furthermore the Rb/Sr ratio for the outer unit is higher than the intermediate unit, the opposite of what would be expected if

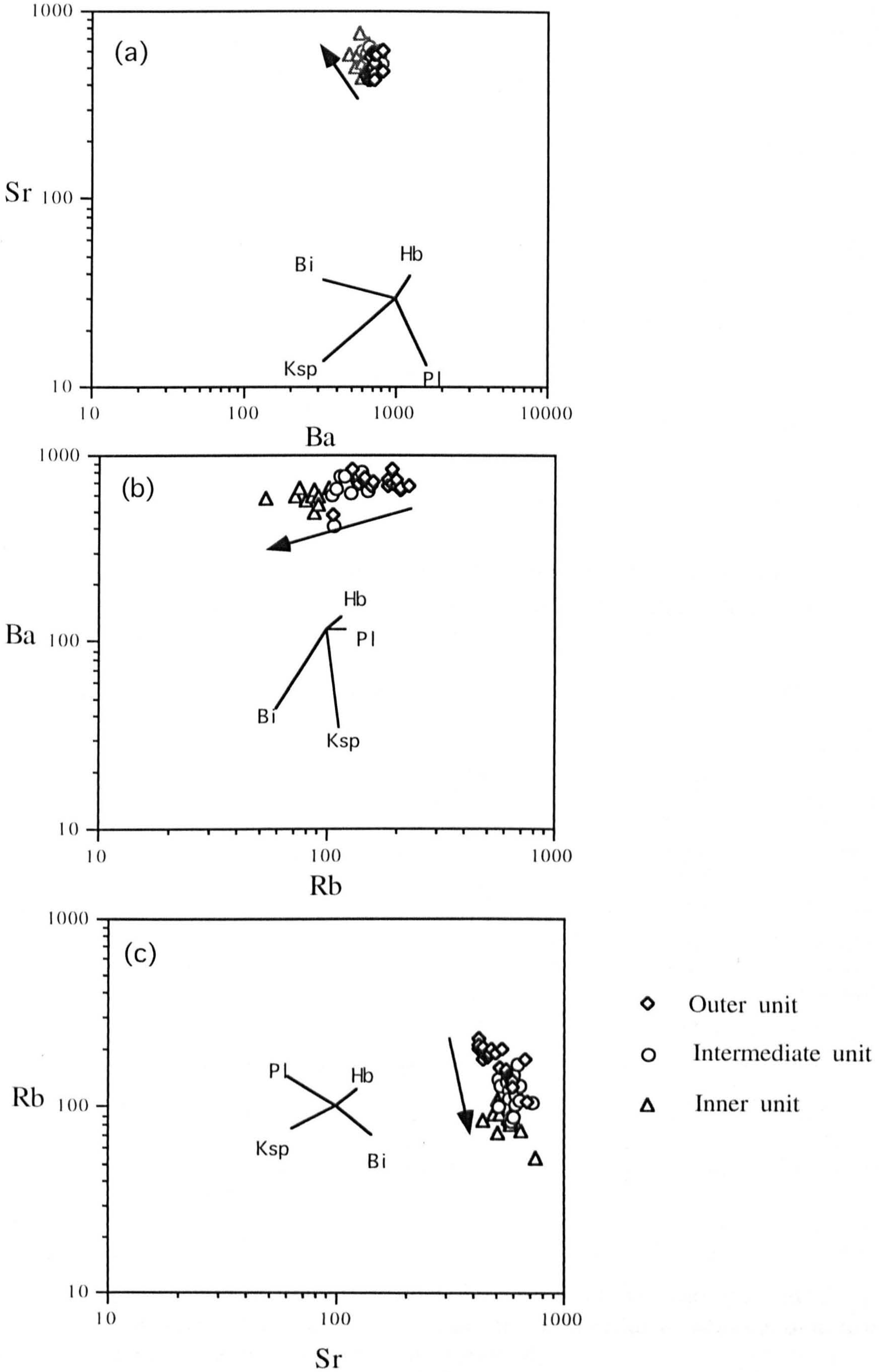


FIGURE 6.11: Inter element variation diagrams for LIL elements Ba, Rb and Sr of the Ardara granite. Mineral vectors indicate the net change in composition of the initial liquid after 20% Rayleigh fractionation of the named phase.

	Start composition	Target composition (TC)	Target model (TM)	Different (TM-TC)
Rock type	QMZD	QMZD		
SiO2	60.57	63.22	63.23	0.01
TiO2	0.91	0.84	0.77	-0.07
Al2O3	17.82	16.65	17.44	0.79
Fe(tot)	4.84	4.35	3.87	-0.48
MgO	3.28	2.76	3.19	0.43
CaO	4.06	2.97	3.51	0.54
Na2O	4.52	4.1	4.53	0.43
K2O	3.47	4.15	3.48	0.67
Total	99.47	99.04	100.02	

Mineral extract proportion

Pl : 52.5
Bi : 20.5
Hbl :14
Ksp : 9

Ap : 0.5
Mag : 1.5
Sph : 2

% precipitation : 22%

TABLE 6.13 : Summary results obtained from the major element modelling of the outer unit of Ardara pluton. Mineral data from the outer unit rock (Appendix 4).

	Start composition	Target composition (TC)	Target model (TM)	Different (TM-TC)
Rock type	QMZD	Granodiorite		
SiO2	62.6	68.55	68.52	-0.03
TiO2	0.7	0.38	0.33	-0.05
Al2O3	16.8	15.58	15.34	-0.24
Fe(tot)	4.2	2.62	2.33	-0.29
MgO	2.6	1.85	2.27	0.42
CaO	3.6	2.09	2.54	0.45
Na2O	4.3	4.51	4.29	-0.22
K2O	3.4	3.75	2.92	-0.83
Total	98.2	99.33	98.54	

Mineral extract proportion

Pl : 50
Bi : 19.5
Ksp : 15.5
Mag : 1.5

Hb : 11
Ap : 0.5
Sp : 2

% precipitation : 36%

TABLE 6.14 : Summary results obtained from the major element modelling of intermediate unit of the Ardara pluton. Mineral data from the intermediate unit rock (Appendix 4).

	Start composition	Target composition (TC)	Target model (TM)	Different (TM-TC)
Rock type	Granodiorite	Granodiorite		
SiO2	68.6	72.18	72.26	0.08
TiO2	0.3	0.13	0.15	0.02
Al2O3	16.2	14.79	14.93	0.14
Fe(tot)	2	0.9	1.1	0.2
MgO	1	0.86	0.69	-0.17
CaO	2.5	1.2	1.92	0.72
Na2O	5.5	5.61	5.6	-0.01
K2O	2.9	3.45	2.62	-0.83
Total	99	99.12	99.27	

Mineral extract proportion

Pl : 62.4
Bi : 19.5
Ksp : 14.5
Mag : 1.5
Hb : 1
Ap : 0.4
Sp : 1

% precipitation : 24 %

TABLE 6.15 : Summary results obtained from the major element modelling of the inner unit of the Ardara pluton. Mineral data from the inner unit rock (Appendix 4).

	Start ARD1F QMZD	Target ARD1E QMZD	Target model	Bulk Kd	Min Prop	
La	67.58	38.28	37.43	4.39	Pl	52.75
Ce	156	71.9	86.97	4.35	Kf	9.22
Nd	59.5	28.8	29.53	5.02	Bi	20.5
Sm	9.66	5.16	4.74	5.08	Hbl	13
Eu	1.69	1.21	0.94	4.35	Mag	1.5
Gd	6.28	3.75	3.1	5.05	All	0.14
Dy	4.65	2.56	2.35	4.93	Sp	2.2
Er	2.53	1.14	1.27	4.95	Ap	0.5
Yb	2.19	1.23	1.23	4.31	Zr	0.19
Lu	0.26	0.15	0.17	3.57		

% precipitation : 16%

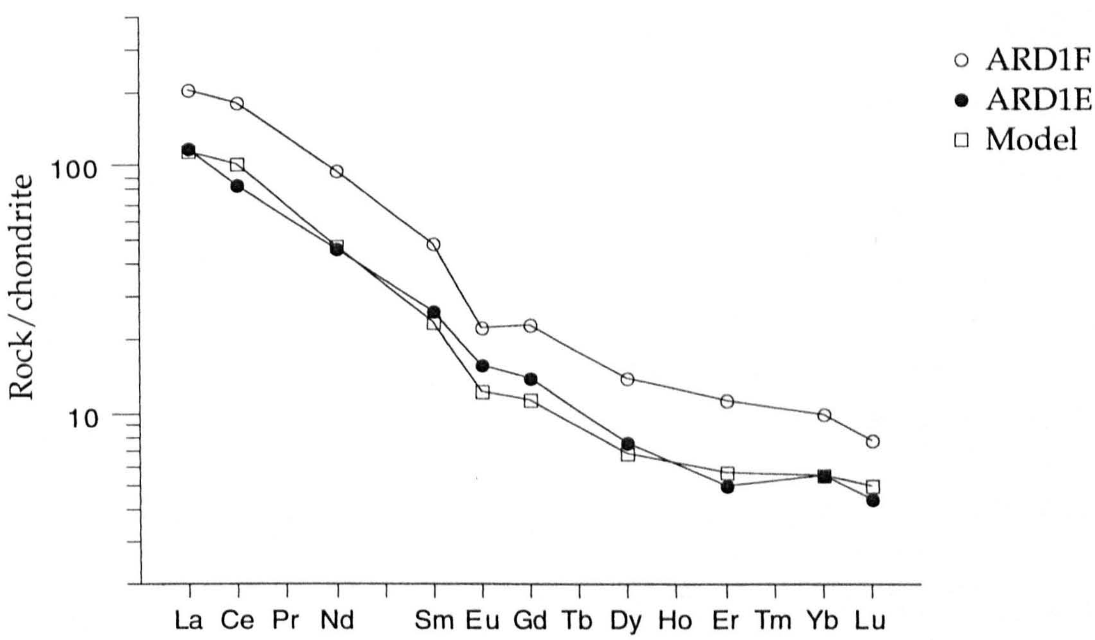


FIGURE 6.12 : Summary of the REE modelling of the Outer unit, of the Ardara pluton. At the top is the summary of start and target compositions, target model amount of mineral precipitate (%) and bulk Kd of the REE used in the modelling. % precipitation is the percentage precipitated to move the start composition to the target model. Below is the graphical presentation of the modelling.

	Start ARD2 granodiorite	Target ARD4 granodiorite	Target model	Bulk Kd	Min Prop	
La	15.37	15.17	13.89	4.33	Pl	49.68
Ce	34.8	32.3	31.55	4.22	Kf	18
Nd	15	15.66	13.42	4.65	Bi	18.09
Sm	3.36	3.17	3.02	4.52	Hbl	10
Eu	0.69	0.75	0.63	3.95	Mag	0.5
Gd	2.05	2.38	1.85	4.38	All	0.14
Dy	1.69	1.53	1.53	4.19	Sp	1.9
Er	1.14	0.8	1.03	4.26	Ap	0.5
Yb	0.72	0.72	0.66	3.76	Zr	0.19
Lu	0.1	0.1	0.09	3.21		

% precipitation : 3%

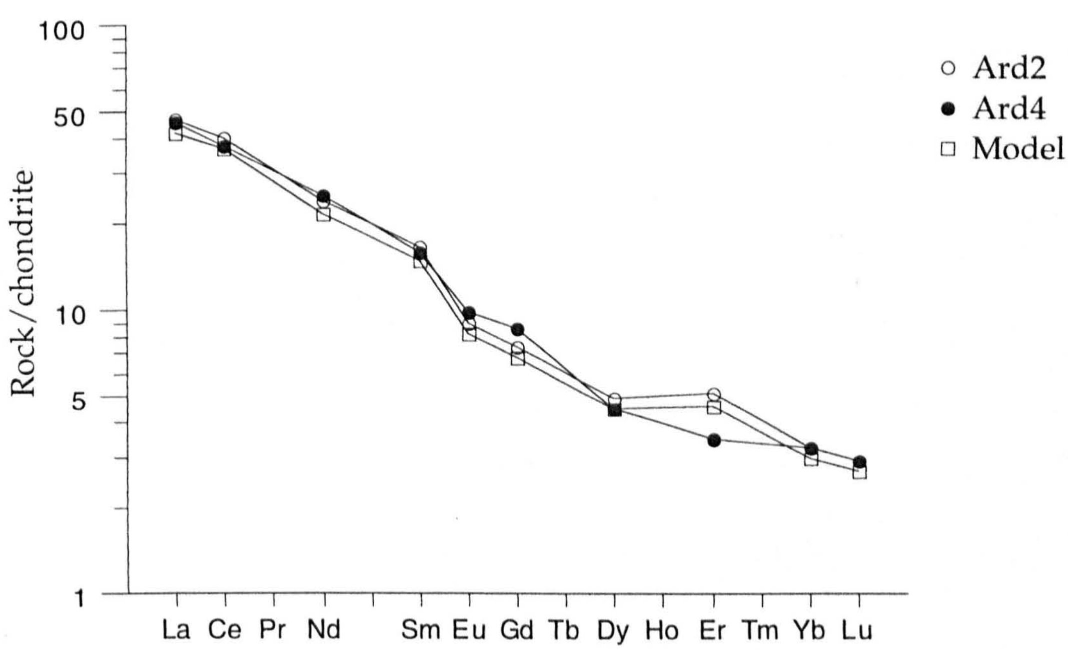


FIGURE 6.13 : Summary of the REE modelling of the intermediate unit, of the Ardara pluton. At the top is the summary of start and target compositions, target model, amount of mineral precipitate (%) and bulk Kd of the REE used in the modelling . % precipitation is the percentage precipitated to move the start composition to the target model.Below is the graphical presentation of the modelling.

	Start ARD13 granodiorite	Target ARD11 granite	Target model	Bulk Kd	Min Prop	
La	15.36	14.98	12.52	1.82	Pl	62.51
Ce	33.2	28.1	27.7	1.73	Kf	14.5
Nd	14.6	10.8	11.88	1.83	Bi	19.5
Sm	2.48	1.78	2.08	1.7	Hbl	1
Eu	0.66	0.51	0.46	2.5	Mag	1.1
Gd	1.8	1.48	1.42	1.96	All	0.05
Dy	1.47	0.65	1.27	1.58	Sp	0.7
Er	0.89	0.13	0.69	1.99	Ap	0.4
Yb	0.61	0.4	0.44	2.28	Zr	0.24
Lu	0.06	0.04	0.04	2.56		

% precipitation : 22%

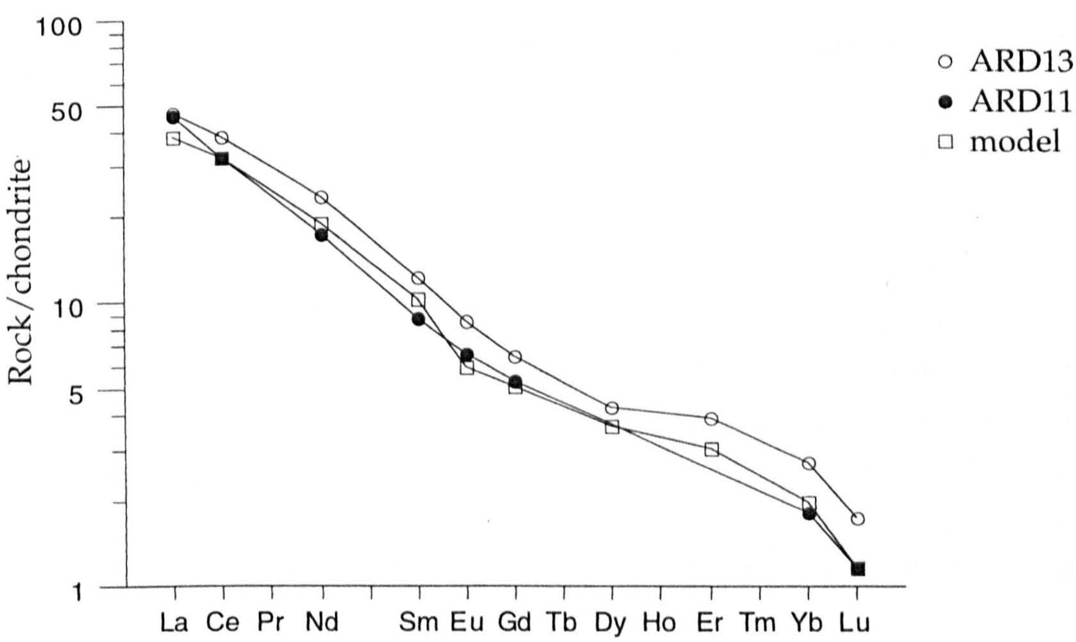


FIGURE 6.14 : Summary of the REE modelling of the inner unit of the Ardara pluton. At the top is the summary of start and target compositions, target model, amount of mineral precipitate (%) and bulk Kd of the REE used in the modelling % precipitation is the percentage precipitated to move the start composition to the target model. Below is the graphical presentation of the modelling.

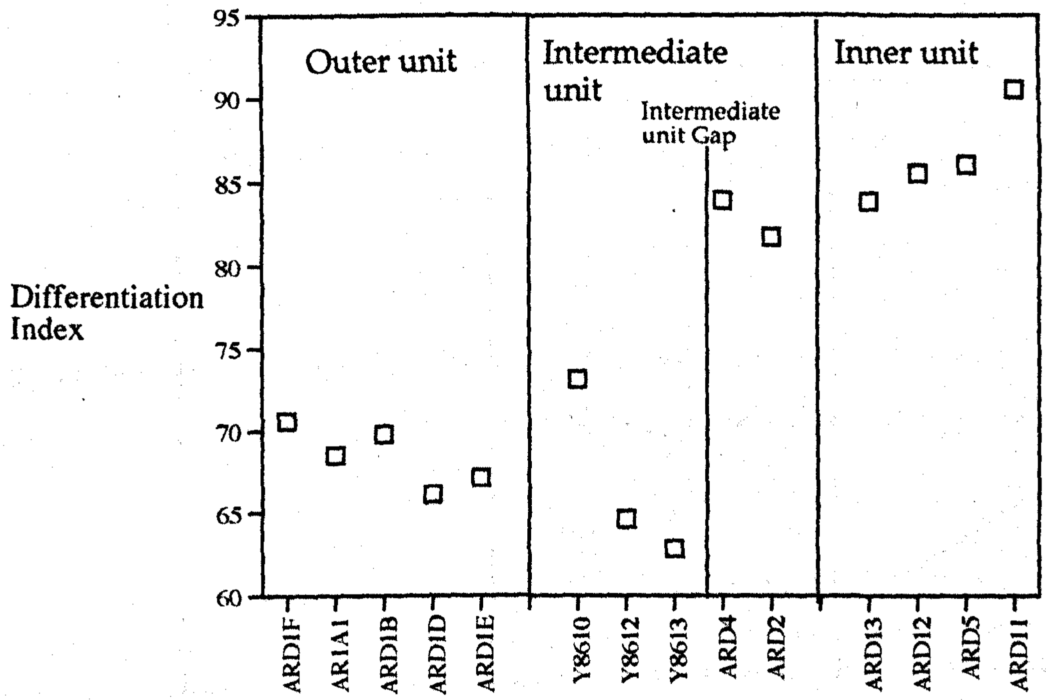


FIGURE 6.15: Differentiation index (DI) accross the Ardara traverse (see Fig 5.21).

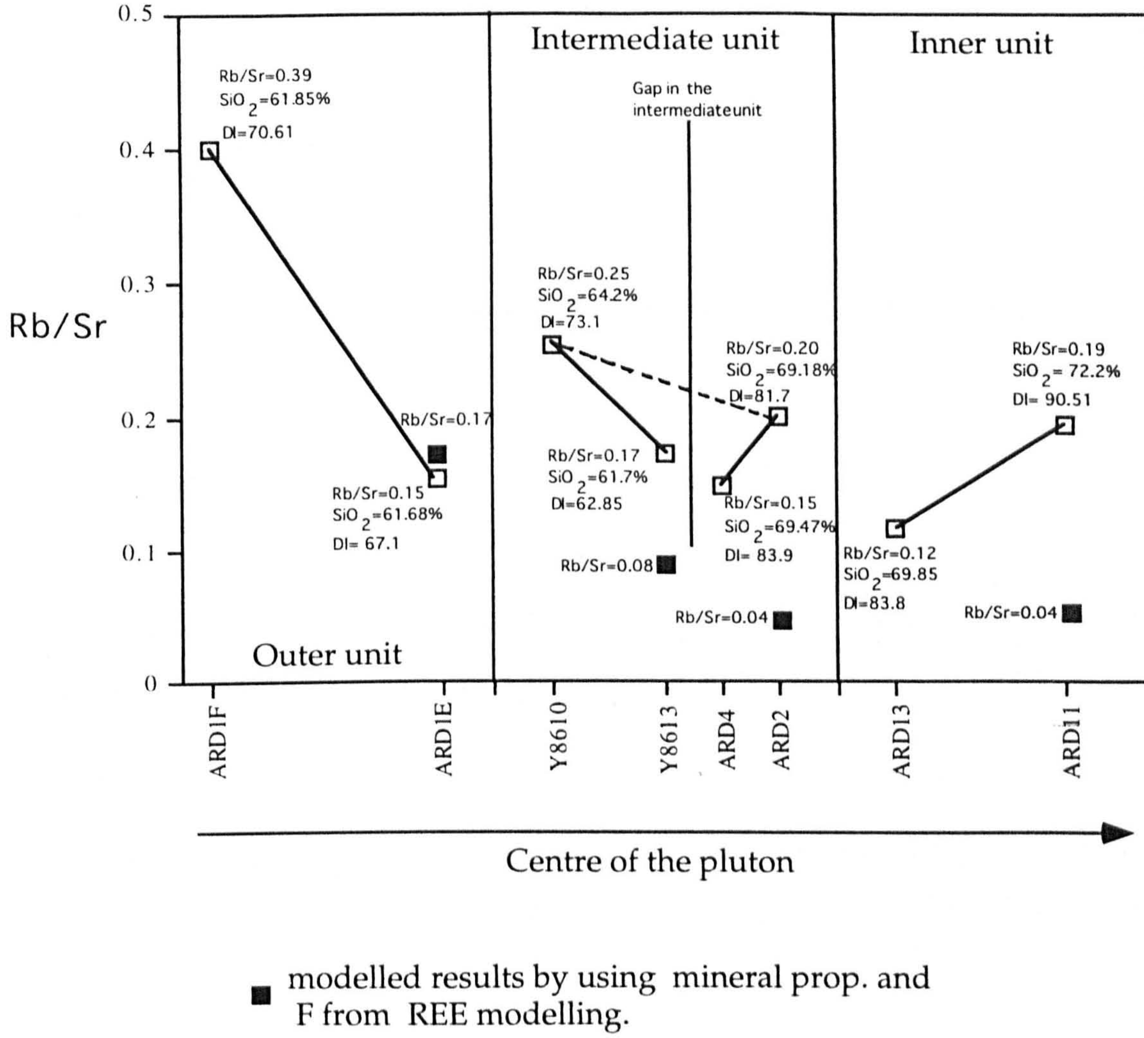


FIGURE 6.16: Rb/Sr ratios vs the relative distance from the margin to the centre of the Ardara pluton. Dotted line in the intermediate unit indicate the general trend of Rb/Sr ratio across the unit.

Major elements modelling

	Pl	Ksp	Bi	Hbl	Ap	Mag	Sph	% ppt
Outer	52.5	9	20.5	14	0.5	1.5	2	22%
Intermediate	50	15.5	19.5	11	0.5	1.5	2	36%
Inner	62.4	14.5	19.5	1	0.4	1.5	1	24%

REE modelling

	Pl	Ksp	Bi	Hbl	Ap	Mag	Sph	All	Zr	% ppt
Outer	52.75	9.22	20.5	13	0.5	1.5	2.2	0.14	0.19	16%
Intermediate	49.68	18	18.09	11	0.5	0.5	1.9	0.14	0.19	3%
Inner	62.51	14.5	19.5	1	0.4	1.1	0.7	0.05	0.24	22%

Table 6.16: Summary results of major and RE element modelling of the Ardara pluton.

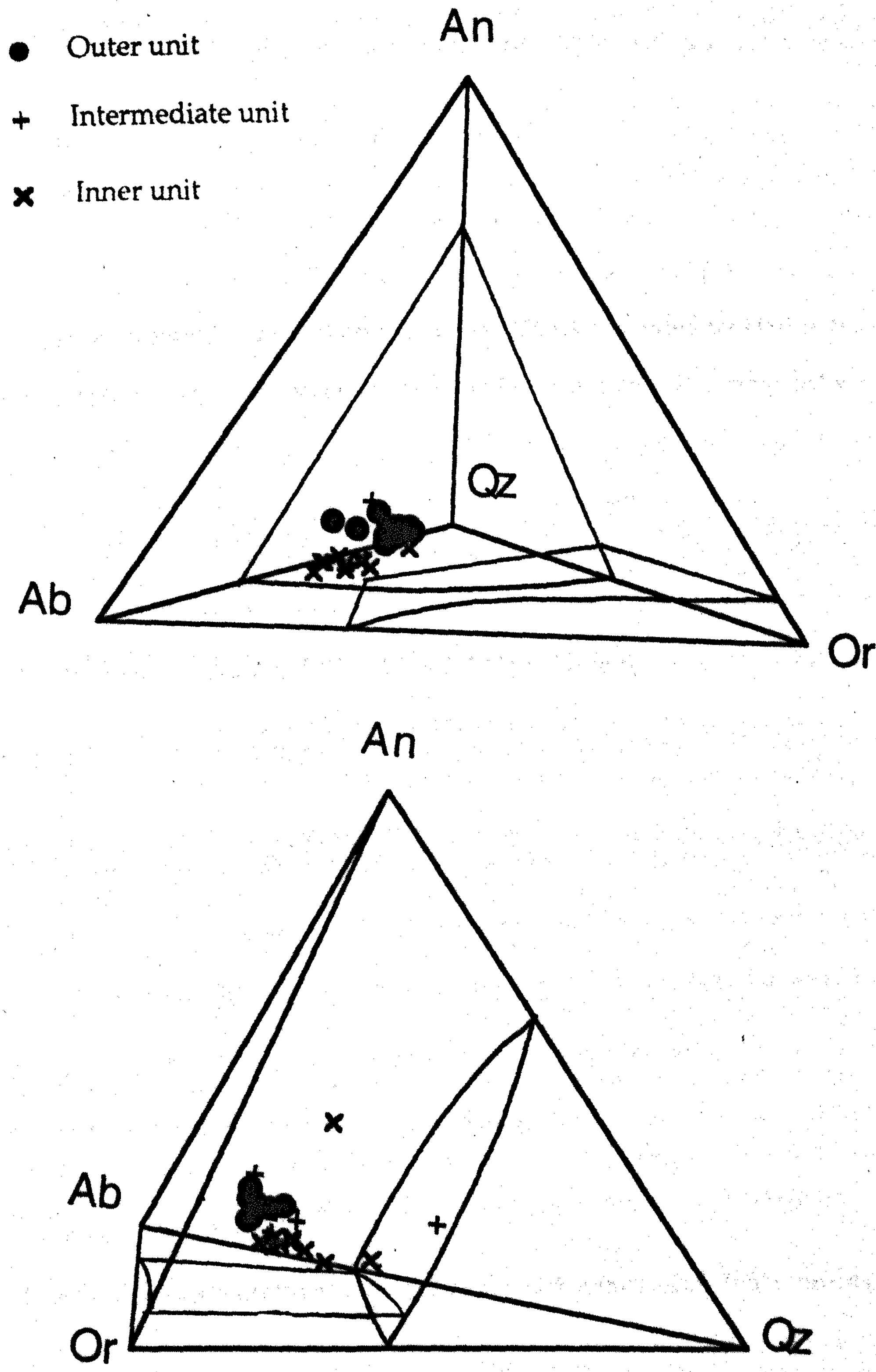


FIGURE 6.17: Normative Ab-Or-An-Qz tetrahedral diagram for the Ardara granite . Phase boundaries from Presnall and Bateman (1973).

both units are related by a simple fractionation involving plagioclase.

On a Rb/Sr vs SiO_2 plot (see Fig 5.19a ; section 5.2.3.2), Rb/Sr ratios generally decrease from the outer to intermediate and inner units i.e it does not show the systematic increase that would be expected in a normally zoned pluton where zoning is related to a in situ fractional crystallisation inwards from the walls (e.g. Tindle and Pearce 1981 ; Tindle 1982). Thus modelling and Rb/Sr data indicate that the units of Ardara granite are not related by a simple fractional crystallisation. This is supported by Harker trace element plots, where most of the data is scattered and does not show any trend, between units (see Fig 5.18). The style of zoning within the three units is also different, thus the outer unit is reversely zoned and the inner and intermediate units are normally zoned. Such difference in zoning style would have not occurred if each unit was related by simple in situ fractional crystallisation.

The traverse profiles (Fig 5.21, 6.15 and 6.16) indicate that a gap occurs in the intermediate unit. The gap is also obvious in the Harker major and trace element plots (see Fig 5.16 and 5.18) and occurs at SiO_2 rocks between 65 % to 67%. It may be a true gap and not related to undersampling as Hall (1966d) analyses also indicate a similar gap.

On a tetrahedral An-Ab-Or-Qz plot **(Fig 6.17)** the outer and intermediate unit magmas started to crystallise in the plagioclase volume whereas the inner unit magma crystallised lower, nearer to the alkali feldspar-plagioclase surface. This reflects the higher An of plagioclase in the outer and intermediate units but the plots do not indicate a single coherent liquid lineage.

6.6 FANAD PLUTON

Major and trace elements geochemistry indicates that the Fanad pluton consists of three separate units or facies namely Rosguill quartz monzodiorite to granodiorite, Melmore quartz monzodiorite and Fanad peninsula quartz monzodiorite. The latter can be divided according to the Ba content into low Ba Fanad peninsula and high Ba Fanad peninsula (Map 5.1). Thus the Fanad granites will be modelled separately viz. (1) Rosguill, (b) Melmore, (c) Low Ba Fanad peninsula and (d) high Ba Fanad peninsula.

6.6.1 LILE modelling

Inter elements variation diagrams for the pairs Rb-Sr, Ba-Sr and Ba-Rb are shown in **Fig 6.18**. On a Sr vs Ba plot **(Fig 6.18a)** the Melmore, low Ba Fanad Peninsula and Rosguill rocks have a similar trend. The fractionation vectors indicate that the trend is strongly controlled by hornblende and plagioclase. A different trend is shown by the rocks from the high Ba Fanad peninsula and this trend is strongly controlled by plagioclase. On a Ba vs Rb plot **(Fig 6.18b)**, rocks from the high and low Ba Fanad Peninsula have a similar trend which is strongly controlled by plagioclase. The trend from the Rosguill rocks is controlled by hornblende and plagioclase. On a Rb vs Sr plot **(Fig 6.18c)**, a similar trend is shown by the rocks from Melmore, high and low Ba Fanad Peninsula which appear to be controlled by the crystallisation of the plagioclase and minor hornblende. On the other hand the minor trend of the Rosguill rocks is controlled by hornblende and minor biotite. In conclusion, the LILE modelling shows that the evolution of the Fanad granite is strongly controlled by hornblende and plagioclase.

6.6.2 Major element modelling

The results of major element modelling are shown in **Tables 6.17 to 6.20**. They are .

(1) High Ba Fanad peninsula. This unit has been modelled from a sample with 58.4% SiO_2 to one with 61.93 % SiO_2. The target can be achieved by 34% fractionation and a mineral mix of plagioclase, biotite, alkali feldspar, hornblende, magnetite and sphene **(Table 6.17)**.

(2) Low Ba Fanad peninsula This unit has been modelled from a sample with 57.3 % SiO_2 to one with 64.37 % SiO_2. The target can be achieved by 24 % fractionation and a mineral mix of plagioclase, biotite, alkali feldspar, hornblende, magnetite and sphene **(Table 6.18)**.

(3) Rosguill quartz monzodiorite-granodiorite. This unit has been modelled from a sample with 58.6 % SiO_2 to one with 62.04 % SiO_2. The target can be achieved by 29% fractionation and a mineral mix of plagioclase, biotite, alkali feldspar, hornblende,

apatite and sphene **(Table 6.19).**

(4) Melmore quartz monzodiorite . This unit has been modelled from a sample with 55.44 % SiO_2 to one with 56.85 % SiO_2. The target can be achieved by 11% fractionation and a mineral mix of plagioclase, biotite, alkali feldspar, hornblende, apatite and magnetite **Table 6.20.**

6.6.3 REE modelling

The REE modelling of the Fanad granite is restricted to two units, namely low Ba Fanad peninsula and Rosguill.

Low Ba Fanad peninsula. The Low Ba Fanad peninsula rocks have been modelled from a sample with 57.3% SiO_2 to one with 64.86% SiO_2 , cf major element modelling. The mineral mixes from the major element modelling plus 0.16 % allanite, 0.18% apatite and 0.16% zircon at 11 % fractionation are required to produce the calculated REE profiles shown in **Fig 6.19.**

Rosguill .The Rosguill rocks have been modelled from a sample with 60.42% SiO_2 to one with 64.86% SiO_2. The mineral mixes from major element modelling plus 0.09% allanite and 0.4% zircon at 27% fractionation are required to produce the calculated REE profiles shown in **Fig 6.20.**

6.6.4 Discussion

The summary of the major and REE element modelling of the Fanad pluton is given in **Table 6.21.** Major, LIL and RE elements modelling shows the importance of precipitation of plagioclase and hornblende in each unit of the Fanad granite. The high Ba Fanad peninsula requires the highest amount of plagioclase and hornblende precipitation compared to the other units. The low Ba Fanad peninsula modelling indicates low plagioclase and high alkali feldspar precipitation. The modelling results of the high and low Ba Fanad peninsula suggest that the former may represent a cumulate; this is supported by high positive Eu anomalies shown by the rocks from this unit (see section 5.3.4.3). The modelling results of the Fanad granite suggest that the

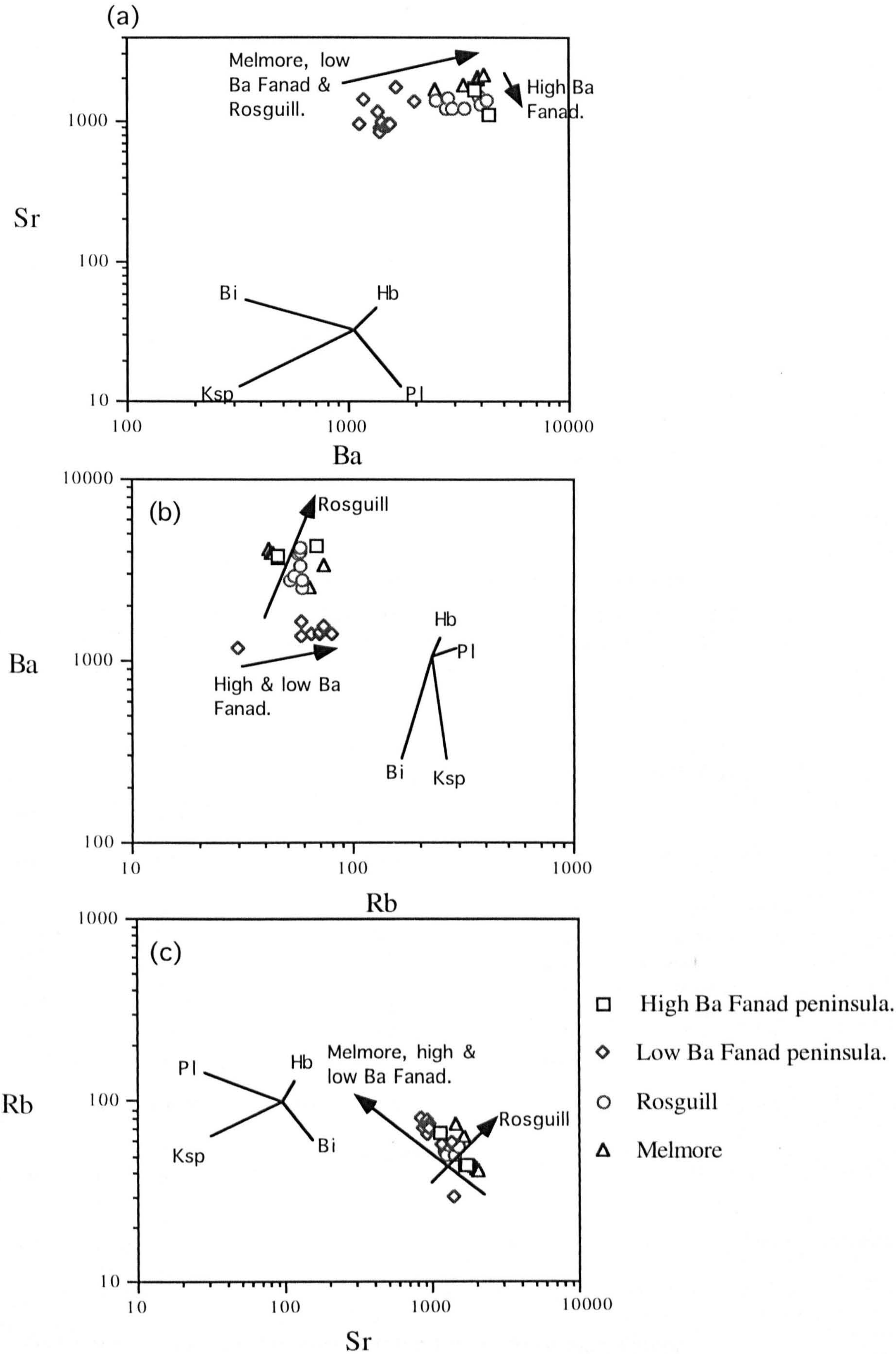


FIGURE 6.18: Inter element variation diagrams for LIL elements Ba, Rb and Sr of the Fanad granite. Mineral vectors indicate the net change in composition of the initial liquid after 20% Rayleigh fractionation of the named phase.

	Start composition	Target composition (TC)	Target model (TM)	Different (TM-TC)
Rock type	QMZD	QMZD		
SiO2	58.4	61.93	61.96	0.12
TiO2	0.8	0.64	0.74	-0.17
Al2O3	19.01	17.78	18.86	0.11
Fe(tot)	5.55	4.23	4.32	0.7
MgO	3.33	2.72	2.88	0.73
CaO	4.22	2.58	2.89	0.7
Na2O	4.55	4.25	4.65	-0.3
K2O	3.05	4.27	3.26	-1.28
Total	98.91	98.4	99.56	

Mineral extract proportion

Bi : 15	Hbl : 25	% precipitation: 34%
Pl : 52.8	Mag : 0.1	
Ksp : 7	Sph : 0.1	

TABLE 6.17 : Summary results obtained from the major element modelling of the rocks from high Ba Fanad peninsula , Fanad pluton. Mineral data from the Fanad peninsula rock (Appendix 4). QMZD : quartz monzodiorite , GDR : Granodiorite.

	Start composition	Target composition (TC)	Target model (TM)	Different (TM - TC)
Rock type	QMZD	QMZD		
SiO2	57.3	64.37	64.31	-0.06
TiO2	0.98	0.57	0.45	-0.12
Al2O3	17.49	15.23	16.71	1.48
Fe(tot)	6.29	3.92	3.36	-0.56
MgO	3.38	3.49	2.68	-0.81
CaO	4.47	3.74	3.02	-0.72
Na2O	3.95	4.09	3.87	-0.22
K2O	3	3.37	1.87	-1.5
Total	96.86	98.78	96.27	

Mineral extract proportion

Bi : 14.3	% precipitation : 45%
Pl : 43.5	
Ksp : 17	
Qu : 0.1	
Mag : 3	
Hbl : 21.1	
Sph : 1	

TABLE 6.18 : Summary results obtained from the major element modelling of the rocks from low Ba Fanad peninsula , Fanad pluton. Mineral data from the Fanad peninsula rock (Appendix 4). QMZD Quartz monzodiorite .

	Start composition	Target composition (TC)	Target model (TM)	Different (TM-TC)
Rock type	QMZD	granodiorite		
SiO2	58.61	62.04	62.16	0.03
TiO2	0.91	0.67	0.6	0.1
Al2O3	18.2	18.11	18	1.08
Fe(tot)	5.63	4.24	4.94	0.09
MgO	3.34	2.26	2.99	0.16
CaO	4.75	3.21	3.91	0.31
Na2O	4.37	4.67	4.37	0.4
K2O	2.83	3.83	2.55	-1.01
Total	98.64	99.03	99.52	

Mineral extract proportion

Bi : 18	Hbl : 19
Pl : 49	Ap : 1
Ksp : 9	Sph : 1

% precipitation: 29%

TABLE 6.19: Summary results obtained from the major element modelling of the quartz monzodiorite (QMZD) to granodiorite of Rosguill, Fanad pluton.Mineral data from the Rosguill rock (Appendix 4).

	Start composition	Target composition (TC)	Target model (TM)	Different TM -TC
Rock type	QMZD	QMZD		
SiO2	55.44	56.85	56.77	-0.06
TiO2	0.87	0.88	0.81	-0.12
Al2O3	20.09	19.17	20.48	1.48
Fe(tot)	6.09	5.6	5.38	-0.56
MgO	3.23	3.04	2.9	-0.81
CaO	5.02	3.87	4.66	-0.72
Na2O	4.82	4.45	4.99	-0.22
K2O	2.8	3.52	2.79	-1.5
Total	98.36	97.38	98.78	

Mineral extract proportion

Pl : 51
Bi : 16
Hbl :23
Ksp: 9.5
Ap: 0.5
Mag :0.8

% precipitation : 11%

TABLE 6.20: Summary results obtained from the major element modelling of the rocks from Melmore , Fanad pluton. QMZD : Quartz monzodiorite. Mineral data from the Melmore rock (Appendix 4).

	Start FAN13 QMZD	Target FAN10 QMZD	Target model	Bulk kd	Min Prop	
La	41.68	26.56	31.6	4.87	Pl	43.18
Ce	89.8	58.9	68.31	4.62	Kf	16.92
Nd	41	25.91	26.7	4.94	Bi	14.9
Sm	6.36	4.05	4.06	4.88	Hb	20
Eu	1.79	1.07	1.19	5.42	Mag	3
Gd	4.35	2.98	2.68	4.24	All	0.16
Dy	2.79	1.77	1.69	4.93	Sp	1.5
Er	1.06	0.68	0.66	4.84	Ap	0.18
Yb	1.07	0.75	0.75	4.07	Zr	0.16
Lu	0.11	0.08	0.08	3.29		

% precipitation : 11%

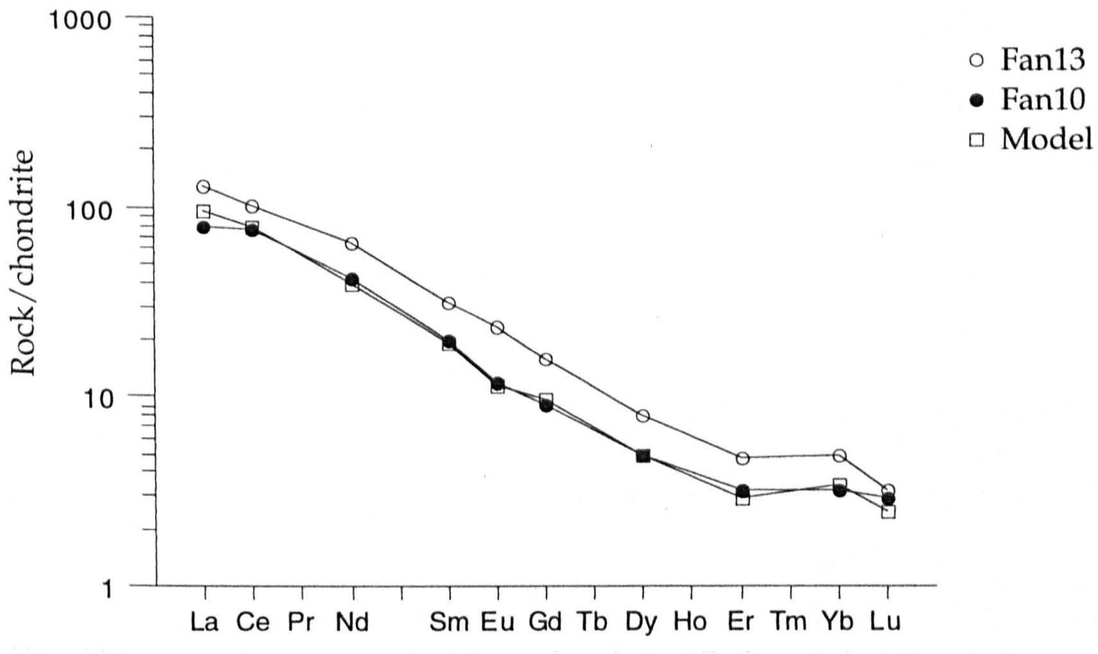


FIGURE 6.19 : Summary of the REE modelling of the low Ba Fanad peninsula, Fanad pluton. At the top is the summary of start and target compositions, target model, amount of mineral precipitate (%) and bulk Kd of the REE used in the modelling . % precipitation is the percentage precipitated to move the start composition to the target model.Below is the graphical presentation of the modelling.

	Start FAN 23 QMZD	Target FAN 29 Granodiorite	Target model	Bulk kd	Min Prop	
La	76.07	50.6	49.96	4.87	Pl	48.01
Ce	137	97.5	88.07	4.52	Kf	10.79
Nd	49.1	29.9	29.38	4.94	Bi	18.1
Sm	6.65	3.43	3.72	4.00	Hb	20
Eu	2.1	1.21	1.34	5.42	Mag	0.5
Gd	3.64	1.95	2.01	4.32	All	0.09
Dy	2.38	0.95	1.02	4.93	Sp	0.6
Er	1.83	0.52	0.59	4.71	Ap	0.8
Yb	0.96	0.29	0.24	4.07	Zr	0.4
Lu	0.13	0.05	0.04	3.6		

% precipitation : 27%

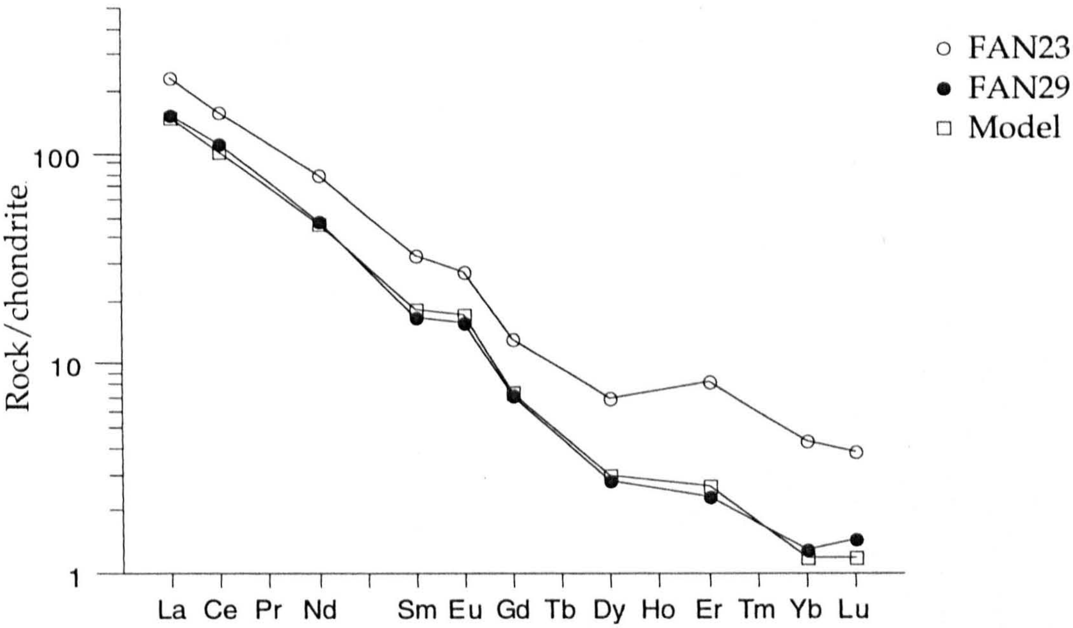


FIGURE 6.20 : Summary of the REE modelling of the rocks from the Rosguill of the Fanad pluton. At the top is the summary of start and target compositions, target model, amount of mineral precipitate (%) and bulk Kd of the REE used in the modelling . % precipitation is the percentage precipitated to move the start composition to the target model. Below is the graphical presentation of the modelling.

Major element modelling

	Pl	Bi	Ksp	Hbl	Mag	Ap	Sp	% ppt
High BaFanad	52.8	15	7	25	0.1	0	0.1	34%
Low Ba Fanad	43.5	14.3	17	21.1	3	0	1	45%
Rosguill	49	18	9	19	0	1	1	29%
Melmore	51	16	9.5	23	0.8	0.5	0	11%

REE modelling

	Pl	Bi	Ksp	Hbl	Mag	Ap	Sp	All	Zr	% ppt
Low Ba Fanad	43.14	14.9	16.92	20	3	0.18	1.5	0.16	0.16	11%
Rosguill	48.01	21	10.79	17	0.5	0.8	0.6	0.09	0.4	27%

TABLE 6.21 : Summary of major element and REE modelling of the Fanad pluton.

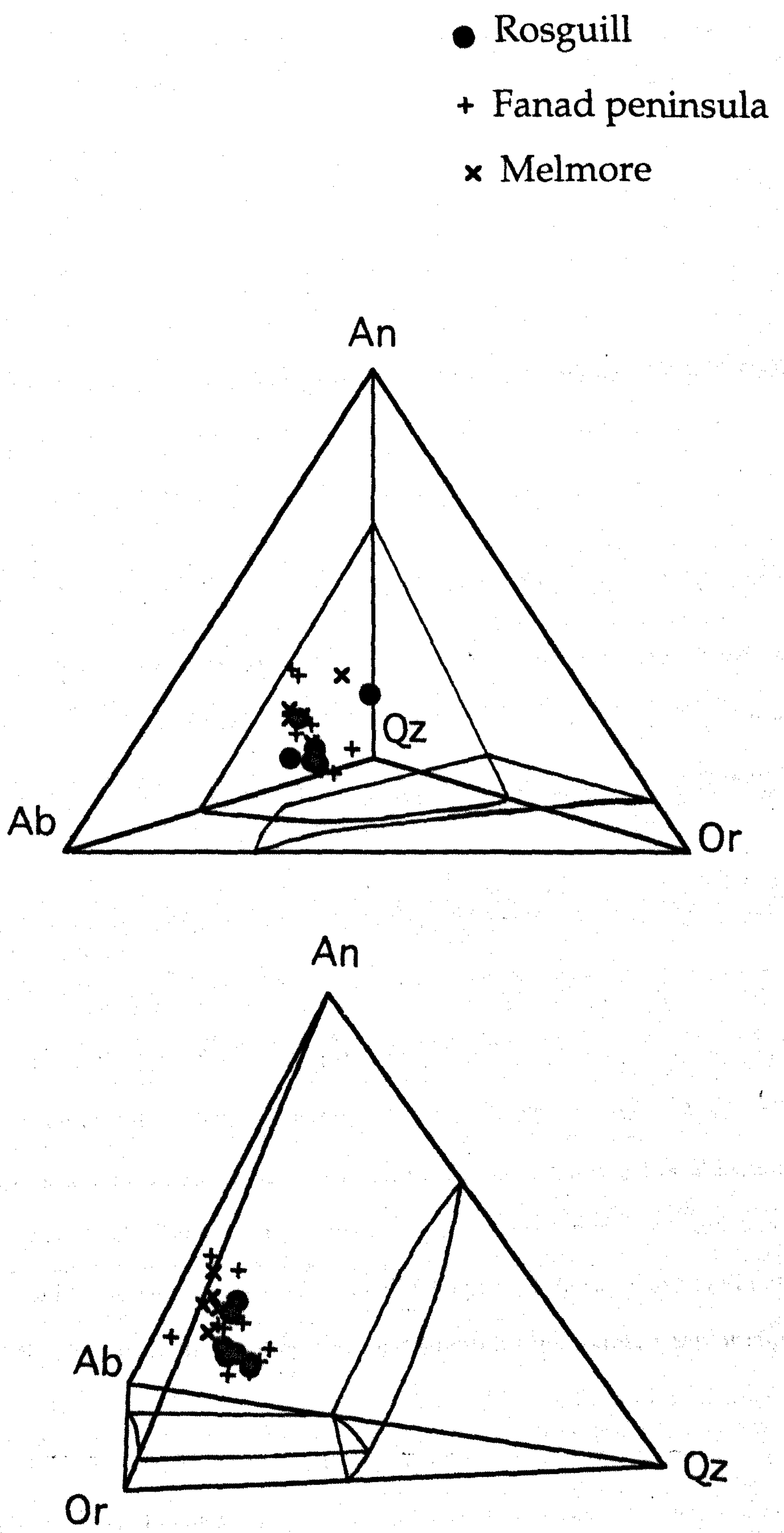


FIGURE 6.21: Normative Ab-Or-An-Qz tetrahedral diagram for the Fanad granite . Phase boundaries from Presnall and Bateman (1973).

different units of this granite (Melmore, Fanad peninsula and Rosguill) represent separate magma batches.

Plots of samples representative of Rosguill, Melmore and Fanad peninsula on a tetrahedral An-Ab-Or-Qz plot are shown in **Fig 6.21.** All three units overlap. Precipitation starts in the high plagioclase volume and it would appear that extensive plagioclase crystallisation occurred. Hornblende and magnetite also crystallised at this stage. Further crystallisation moved the liquid towards the quartz liquid surface.

6.7 MAIN DONEGAL PLUTON.

The Main Donegal granite consists of two main lithologies namely dark bands (trondhjemite) and light bands (granodiorite-granite), which may have a different origin (chapter 5). The latter probably represent a continental trondhjemite that has tholeiitic to calc alkali affinities while the light bands magma which are similar to the other Donegal granite magmas (high-K calc alkali). Thus in this section, trondhjemite (dark bands) and granodiorite - granite (light bands) will be modelled separately .

6.7.1 LIL modelling

Inter elements variation diagrams for the pairs Rb-Sr, Ba-Sr and Ba-Rb are shown in **Fig 6.22.** On a Sr vs Ba plot **(Fig 6.22a)**, the trondhjemite has lower Ba than the granodiorite-granite. Both trondhjemite and granodiorite-granite evolved on a different path in this diagram and the fractionation vector indicates that trondhjemite evolution is strongly controlled by the plagioclase whereas the evolution of granodiorite to granite is controlled by some combination of alkali feldspar, plagioclase and biotite. On a Ba vs Rb plot **(Fig 6.22b)**, both trondhjemite and granodiorite-granite show a similar trend. Both trends are controlled by plagioclase with hornblende. On a Rb vs Sr plot **(Fig 6.22c)**, both trondhjemite and granodiorite-granite show a similar trend controlled by plagioclase and hornblende.

In conclusion the LILE modelling shows that the plagioclase (+ hornblende) are the most important phases in the evolution of the trondhjemite whereas plagioclase, biotite and perhaps alkali feldspar contolled the trend shown by the granodiorite - granite.

6.7.2 Major element modelling

The results of major element modelling are shown in **Table 6.22** and **6.23** respectively. The mineral mix of the major element modelling of the dark bands is plagioclase, alkali feldspar, biotite and quartz and the light bands is plagioclase, alkali feldspar, biotite, magnetite and quartz. The model target of the dark band can be achieved by 20% fractionation whereas the light band requires 47% fractionation.

6.8.3 REE modelling

The REE modelling of the Main Donegal granite has been modelled from the granodiorite to the granite of the light bands. The REE profiles of the observed start and target compositions used in the modelling, together with the calculated melt profile are shown in **Fig 6.23.** The mineral mix isthe same as in the major element modelling plus 0.75% apatite, 0.12 allanite and 0.2% zircon and 47% precipitation is required to produce the calculated REE profiles.

6.8.4 Discussion

The results of the major and REE modelling of the Main Donegal granite are given in **Table 6.24**. The results of major elements modelling show that the amount of plagioclase (56%) is relatively low in the light band model compared to the dark band (77%). On the other hand the amount of alkali feldspar precipitation in the dark band model is low compared to the light band granodiorite-granite (1 to 24.9%). This is consistent with the modal composition of the dark band trondhjemite which has <1% alkali feldspar. Modal biotite and quartz are higher in the dark band trondhjemite. The major elements modelling supports the LILE modelling which shows that the plagioclase is the most important phase in the evolution of the dark band trondhjemite whereas plagioclase and alkali feldspar are important in controlling the evolution of the light

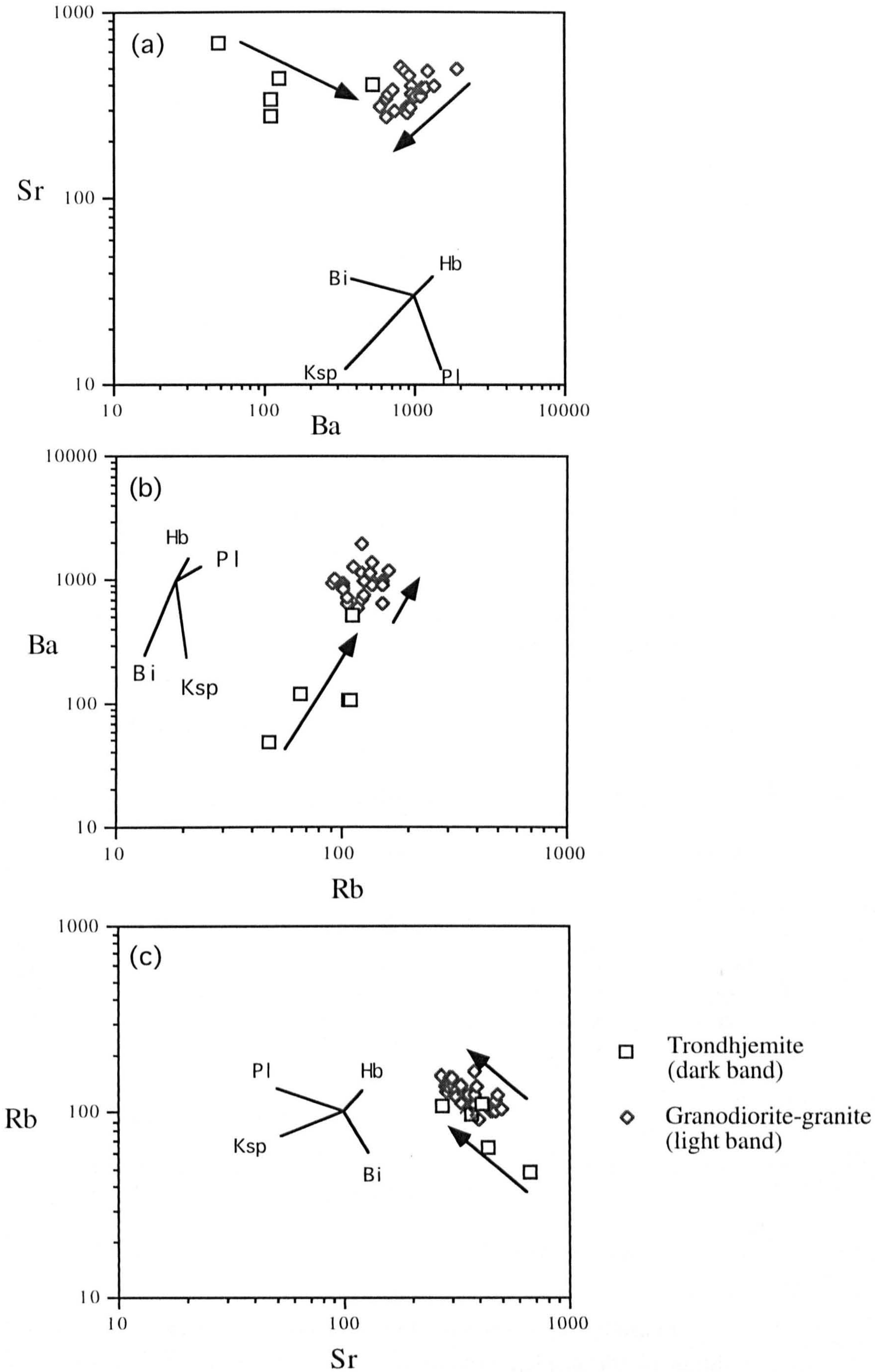


FIGURE 6.22: Inter element variation diagrams for LIL elements Ba, Rb and Sr of the Main Donegal granite. Mineral vectors indicate the net change in composition of the initial liquid after 20% Rayleigh fractionation of the named phase.

	Start composition	Target composition (TC)	Target model (TM)	TM-TC
Rock type	granodiorite	granite		
SiO2	67.76	74.65	74.23	-0.42
TiO2	0.27	0.12	0.01	-0.11
Al2O3	15.83	12.94	12.03	-0.91
Fe(tot)	2.24	0.88	0.84	-0.04
MgO	0.76	0.72	0.33	-0.39
CaO	1.74	0.96	1.05	0.09
Na2O	4.5	3.43	3.89	0.46
K2O	4.05	5.12	2.72	-2.4
Total	97.15	98.82	95.1	

Mineral extract proportion

Pl : 56
Kf : 24.9 — % precipitation : 47%
Bi : 16
Qu : 3
Mag : 0.1

Table 6.22: Summary results obtained from the major element modelling of the light band of the Main Donegal granite. Mineral data from the granodiorite of the light band (Appendix 4).

	Start composition DON25	Target composition (TC)	Target model (TM)	(TM - TC)
Rock type	trondhjemite	trondhjemite		
SiO2	68.99	71.24	71.19	-0.05
TiO2	0.32	0.25	0.26	0.01
Al2O3	15.83	14.93	14.58	-0.35
Fe(tot)	2.8	2.02	2.47	0.45
MgO	1.32	1.19	1.29	0.1
CaO	2.62	2.85	2.48	-0.37
Na2O	5.64	5.58	5.33	-0.25
K2O	2.4	1.17	2.48	1.31
Total	99.92	99.23	100.08	

Mineral extract proportion

Pl : 77
Bi : 20 — % precipitation : 20%
Qu : 5
Ksp: 1

Table 6.23: Summary results obtained from the major element modelling of the dark band of the Main Donegal granite. Mineral data from the trondhjemite rock of the Main Donegal (Appendix 4).

	Start DON1 granodiorite	Target DON5 granite	Target model	Bulk Kd	Min Prop	
La	49.07	14.27	11.45	3.43	Pl	55
Ce	93.4	28.2	26.73	3.09	Kf	24.6
Nd	28.2	10.3	11.84	2.45	Bi	16.21
Sm	4.66	2.28	3.26	1.59	Zr	0.2
Eu	0.78	0.34	0.37	2.24	All	0.12
Gd	2.58	1.52	2.01	0.69	Qu	3
Dy	1.84	1.5	2.04	0.83	Ap	0.75
Er	1.46	1.07	1.395	1.08	Mag	0.12
Yb	0.84	0.69	0.65	1.43		
Lu	0.11	0.09	0.08	1.55		

% precipitation : 45%

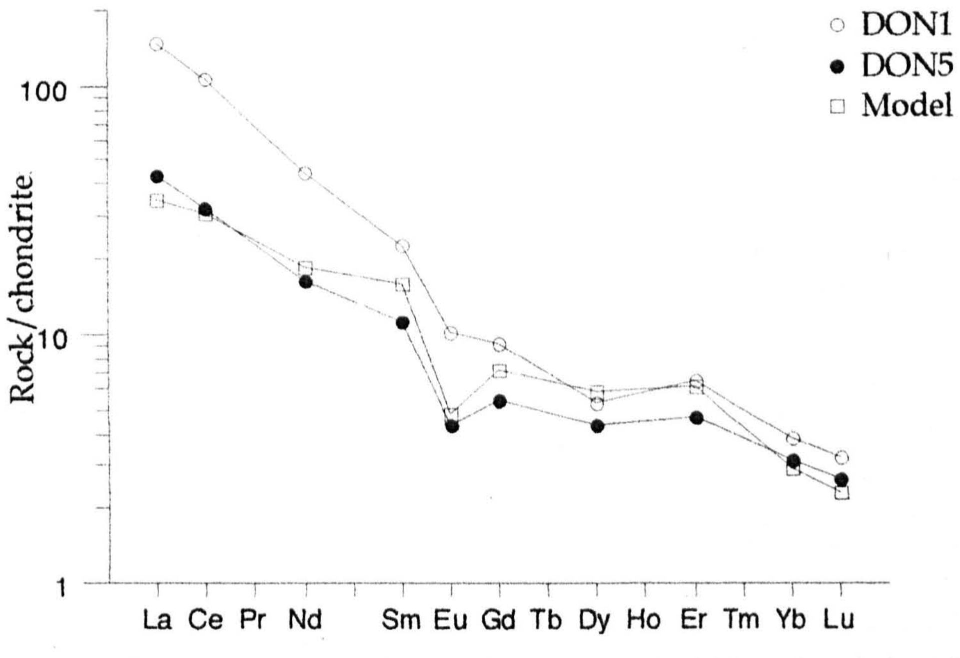


FIGURE 6.23 : Summary of the REE modelling of the light band of the Main Donegal pluton. At the top is the summary of start and target compositions, target model, amount of mineral precipitate (%) and bulk Kd of the REE used in the modelling. % precipitation is the percentage precipitated to move the start composition to the target model.Below is the graphical presentation of the modelling.

Major elements modelling

	Pl	Ksp	Bi	Qu	Mag	% ppt
Light band	56	24.9	16	3	0.1	47%
Dark band	77	1	20	5	0	20%

REE modelling

	Pl	Ksp	Bi	Qu	Ap	Mag	All	Zr	% ppt
Light band	55	24.6	16.21	3	0.75	0.12	0.12	0.2	45%

TABLE 6.24: Summary results of major and RE element modelling of the Main Donegal granite.

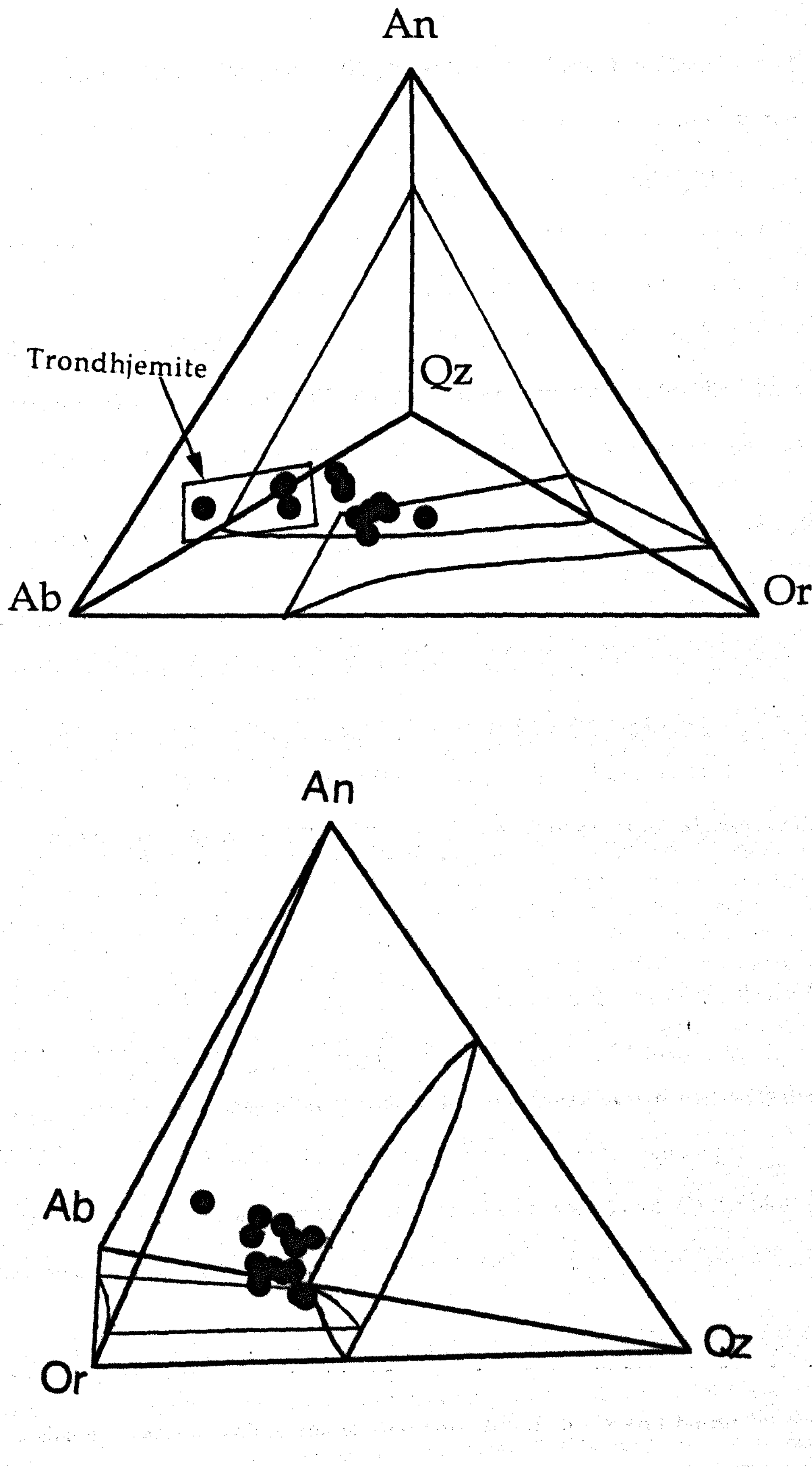


FIGURE 6.24: Normative Ab-Or-An-Qz tetrahedral diagram for the Main Donegal granite . Phase boundaries from Presnall and Bateman (1973).

band rocks.

On a tetrahedral An-Ab-Or-Qz plot **(Fig 6.24)** the dark band trondhjemite and the light band granodiorite-granite plot in different fields. The trondhjemite plots in the plagioclase volume nearer to the Ab apex and extends towards the plagioclase-quartz surface. The granodiorite-granite lies in the lower plagioclase volume, and presumably crystallised to eventually reach the plagioclase-alkali feldspar surface. Quartz is also involved in the final crystallisation.

The results of the modelling of the Main Donegal granites confirm the difference between the light and the dark bands which likely originated from a different sources from that of the light band.

6.8 TRAWENAGH BAY PLUTON.

The major and trace element geochemistry suggests that the biotite granite from the Trawenagh Bay and granodiorite and granite from Main Donegal plutons have a common origin, supporting Pitcher and Read's (1959) suggestion that the Trawenagh Bay biotite granite represents a magma displaced from Main Donegal (granodiorite and granite or light band) and which was intruded in the final stage of the emplacement of the Main Donegal granite. The Trawenagh Bay pluton consists of two main types of granite i.e. biotite granite and muscovite granite. The latter is more felsic and has crystallised as the final magmatic stage of the parental biotite granite magma.

In this section the Trawenagh Bay granite will be modelled in two stages (1) the most basic rock from the light bands of the Main Donegal granite to the biotite granite of the Trawenagh Bay (to confirm or reject the Pitcher and Read model) and (2) the biotite granite to the muscovite granite.

6.8.1 LILE Modelling

Inter element variation diagrams for the pairs Rb-Sr, Ba-Sr and Ba-Rb for the Trawenagh Bay granite and the granodiorite-granite (light bands) of the Main Donegal granite are shown in **Fig 6.25**. The muscovite granite of the Trawenagh Bay has very low

Ba (below detection limit), thus no Ba data points for the granite are shown **(Fig 6.25a & b).**

In general, in all three plots (Fig 6.23) both biotite granite and the rocks from the light bands plot in the same field which suggests that they have common a origin. On a Rb vs Sr plot **(Fig 6.25c)**, the muscovite granite has lower Sr but slightly higher Rb compared to the biotite granite. On a Sr vs Ba plot **(Fig 6.25a)**, the trend shown by the biotite granite and the rocks from the light bands of the Main Donegal granites is consistent with the removal of biotite and alkali feldspar with perhaps minor plagioclase whereas on a Ba vs Rb plot **(Fig 6.25b)**, the trend can be produced by the removal of alkali feldspar and plagioclase.

On a Rb vs Sr plot **(Fig 6.25c)** plot, The evolution of biotite granite to muscovite granite is strongly controlled by fractionation of plagioclase and alkali feldspar. This is supported by the major and REE modelling. The limited trend of the biotite granite and the rocks from the light bands of the Main Donegal granites is consistent with the removal of plagioclase.

In conclusion, the LILE modelling of the Trawenagh Bay granite shows that the plagioclase, alkali feldspar and biotite are important phases in the evolution of the granite.

6.8.2 Major element modelling

In the first stage for modelling the granodiorite of the Main Donegal granite to the biotite granite of Trawenagh Bay, granodiorite (DON1) with SiO_2 = 67.76%, was selected from the light bands of the Main Donegal granite as a start composition for the modelling. This is the most basic rock of the light band and is more likely to represent the source composition. The target is the biotite granite sample (TRA 5) with SiO_2 = 71.87%. The results are shown in **Table 6.25.** The target composition can be achieved by 25% fractionation and the mineral mix is plagioclase, alkali feldspar, biotite and magnetite.

The second stage involves modelling from the evolution of the Trawenagh Bay biotite granite to muscovite granite. The results are shown in **Table 6.26.** The target composition can be achieved by 23% fractionation with a mineral mix of plagioclase, alkali feldspar, biotite, quartz and magnetite.

6.8.3 REE modelling

The same start and the target samples used in the major element modelling were also used in the REE modelling . The results for the modelling of granodiorite of the Main Donegal granite to the biotite granite of the Trawenagh Bay are shown in **Fig 6.26.** The mineral mix is plagioclase, alkali feldspar, biotite, zircon, allanite, apatite and magnetite .

Results of the modelling of the biotite granite to the muscovite granite of the Trawenagh Bay are shown in the **Fig 6.27.** The mineral mixes are similar to the major element modelling plus 0.35% allanite, and 0.4% apatite with 48% fractionation.

6.8.4 Discussion

On all three LILE plots, the biotite granite of the Trawenagh Bay and the light band rocks from the Main Donegal granite plot in the same field and with the trend which is controlled by the same mineral proportions of plagioclase, alkali feldspar and biotite. This may suggest that the granites are co-genetic. This is supported by the fact that both granites plot in the same field in all major and trace element Harker diagrams (see section 5.2.6). A summary of the major and REE modelling of the Trawenagh Bay pluton and the light band of the Main Donegal granite are shown in **Table 6.27.** The results are consistent with the LILE modelling where plagioclase, alkali feldspar and biotite are mportant.

The chemical data (section 5.2.6) indicates that the muscovite granite is highly evolved granite. Modelling indicates that the crystallisation of plagioclase and alkali feldspar **(Fig 6.25c)** plus apatite, allanite and zircon for the fractionation of the muscovite granite magma from the biotite granite.

On a tetrahedral An-Ab-Or-Qz plot **(Fig 6.28)**, biotite granite magma

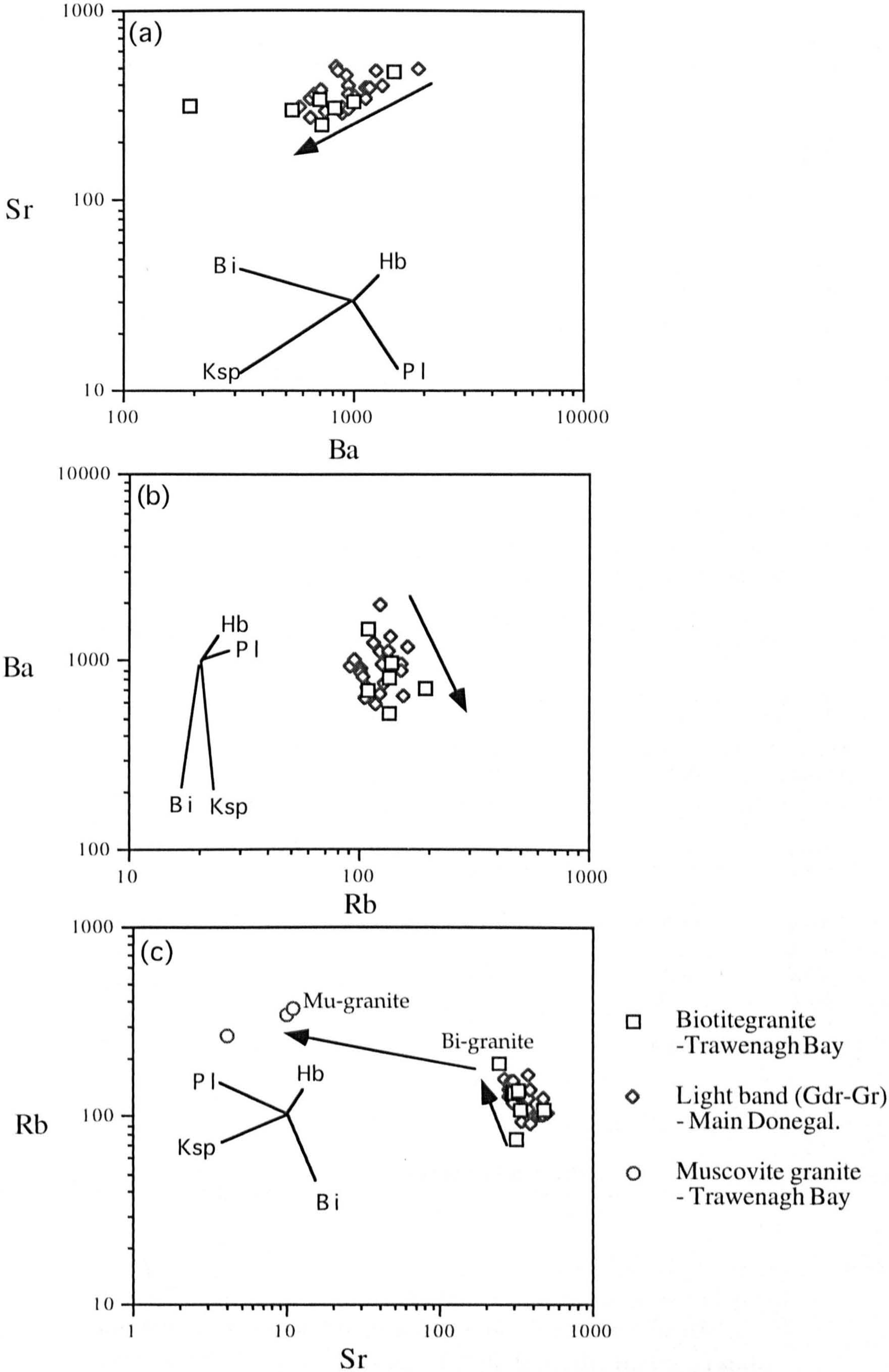


FIGURE 6.25 : Inter element variation diagram for LIL elements Ba, Rb and Sr of the biotite and muscovite granites of the Trawenagh Bay pluton and the granodiorite-granite (light bands) of the Main Donegal granite. Mineral vector indicates the net chance in composition of the initial liquid after 20% Rayleigh fractionation of the named phase.

	Start composition	Target composition (TC)	Target model (TM)	Different (TM-TC)
Rock type	Granodiorite	granite		
SiO2	67.76	71.87	71.75	-0.12
TiO2	0.27	0.18	0.16	-0.02
Al2O3	15.83	14.37	13.9	-0.47
Fe(tot)	2.24	1.48	1.6	0.12
MgO	0.76	0.76	0.3	-0.46
CaO	1.74	1.32	1.03	-0.29
Na2O	4.5	4.4	4.63	0.23
K2O	4.05	4.5	3.45	-1.05
Total	97.15	98.88	96.82	

Mineral extract proportion

Pl : 52.9
Bi : 19 — % precipitation : 25%
Ksp : 28
Mag : 0.1

TABLE 6.25: Summary results obtained from the major element modelling of the granodiorite (light band) of the Main Donegal granite to the biotite granite of the Trawenagh Bay granite. Mineral data from the granodiorite of the Main Donegal granite. (Appendix 4).

	Start composition	Target composition (TC)	Target model (TM)	Different (TM-TC)
Rock type	granite	granite		
SiO2	71.78	75.46	75.42	-0.04
TiO2	0.18	0.04	0.12	0.08
Al2O3	14.37	13.35	12.23	-1.12
Fe(tot)	1.48	0.29	0.9	0.61
MgO	0.76	0.26	0.74	0.48
CaO	1.32	0.39	0.98	0.59
Na2O	4.4	5.44	4.11	-1.33
K2O	4.5	3.87	3.66	-0.12
Total	98.79	99.1	98.16	

Mineral extract proportion

Pl : 51
Bi : 10 — % precipitation : 23%
Ksp : 37.4
Qu : 0.8
Mag : 0.8

TABLE 6.26: Summary result obtained from the major element modelling of the biotite granite to muscovite granite of the Trawenagh Bay pluton. Mineral data from the biotite granite Appendix 4)

	Start DON1 granodiorite	Target TRA5 Bi granite	Target model	Bulk Kd	Min Prop	
La	49.07	22	20.19	4.98	Pl	51.79
Ce	93.4	47.86	43.29	4.45	Kf	28
Nd	28.2	16.39	16.56	3.39	Bi	19
Sm	4.66	2.78	3.67	2.08	Zr	0.3
Eu	0.78	0.59	0.58	2.32	All	0.18
Gd	2.58	1.78	2.72	0.78	Ap	0.66
Dy	1.84	1.58	1.85	0.98	Mag	0.07
Er	1.46	0.78	1.33	1.42		
Yb	0.84	0.64	0.67	1.99		
Lu	0.11	0.09	0.08	2.21		

% precipitation : 20%

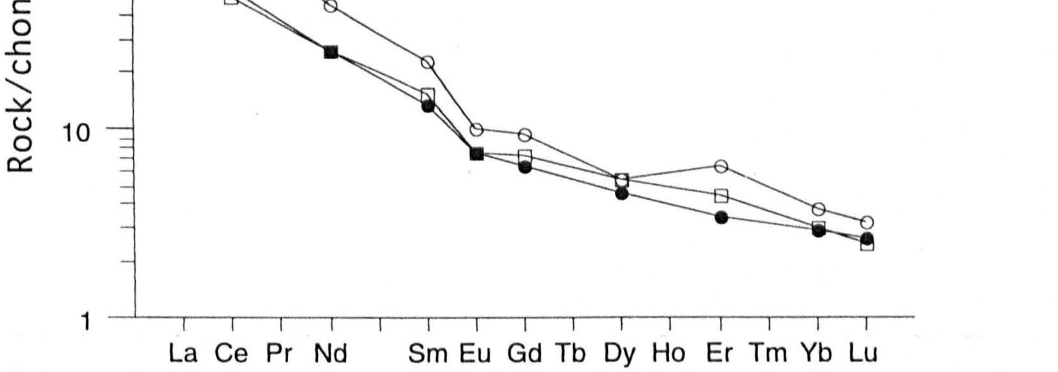


FIGURE 6.26: Summary of the REE modelling of the granodiorite (DON1) from the Main Donegal granite to the biotite granite (TRA 5) of the Trawenagh Bay granite. At the top is the summary of start and target compositions, target model, amount of mineral precipitate (%) and bulk Kd of the REE used in the modelling. % precipitation is the percentage precipitated to move the start composition to the target model. Below is the graphical presentation of the modelling.

	Start TRA6 granite	Target TRA3 granite	Target model	Bulk Kd	Min Prop	
La	20.76	6.97	3.97	3.25	Pl	51.6
Ce	39.76	11.6	12.65	2.56	Kf	37.5
Nd	14.79	5.48	6.92	20.4	Bi	10.00
Sm	2.56	2.86	2.3	1.15	All	0.35
Eu	0.55	0.03	0.031	4.9	Ap	0.40
Gd	1.99	2.74	2.7	0.82	Mag	0.50
Dy	1.48	3.25	2.11	0.52		
Er	0.89	1.3	1.47	0.32		
Yb	0.87	2.14	1.53	0.23		
Lu	0.12	0.24	0.21	0.21		

% precipitation : 48%

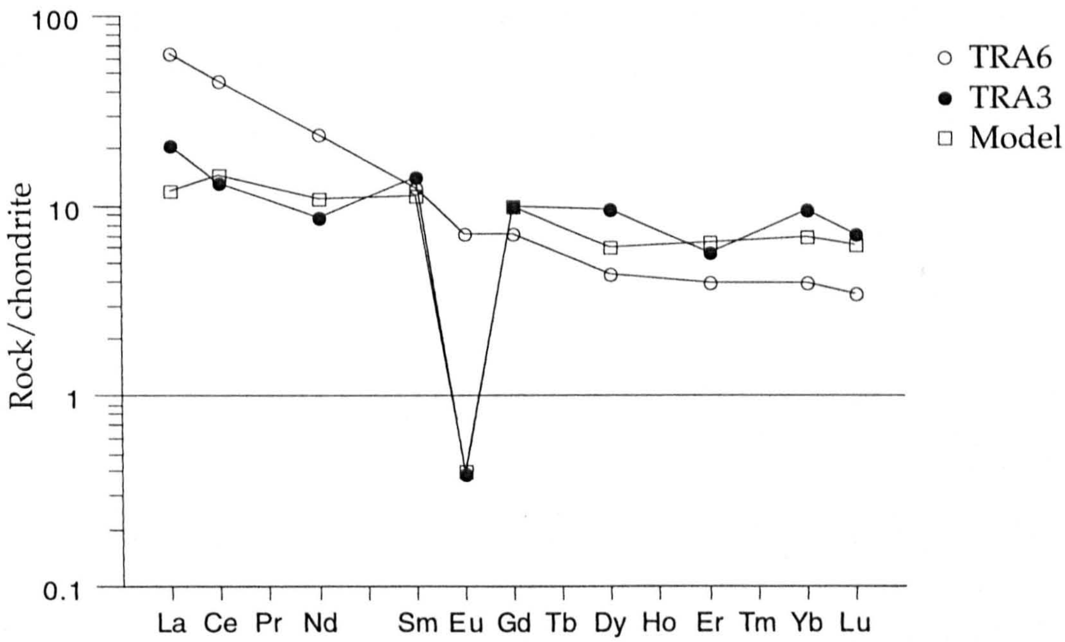


FIGURE 6.27 : Summary of the REE modelling of biotite granite to muscovite granite of the Trawenagh Bay pluton. At the top is the summary of start and target compositions, target model , amount mineral precipitate (%) and bulk Kd of the REE used in the modelling . % precipitation is the percentage precipitated to move the start composition to the target model. Below is the graphical presentation of the modelling.

Major elements modelling

Units	Pl	Ksp	Bi	Qu	Mag	% ppt
Granodiorite to Bi granite	52.9	28	19	0	0.1	25%
Bi granite to Mu granite	51	37.4	10	0.8	0.8	23%

REE modelling

Units	Pl	Ksp	Bi	Qu	Ap	Mag	All	Zr	% ppt
Granodiorite to Bi granite	51.79	28	19	0	0.66	0.07	0.18	0.3	20%
Bi granite to Mu granite	51.6	37.5	10	0	0.4	0.5	0.35	0	48%

TABLE 6.27: Summary results of major and RE element modelling of the Trawenagh Bay granite.Granodiorite samples are from the light band of the Main Donegal granite.

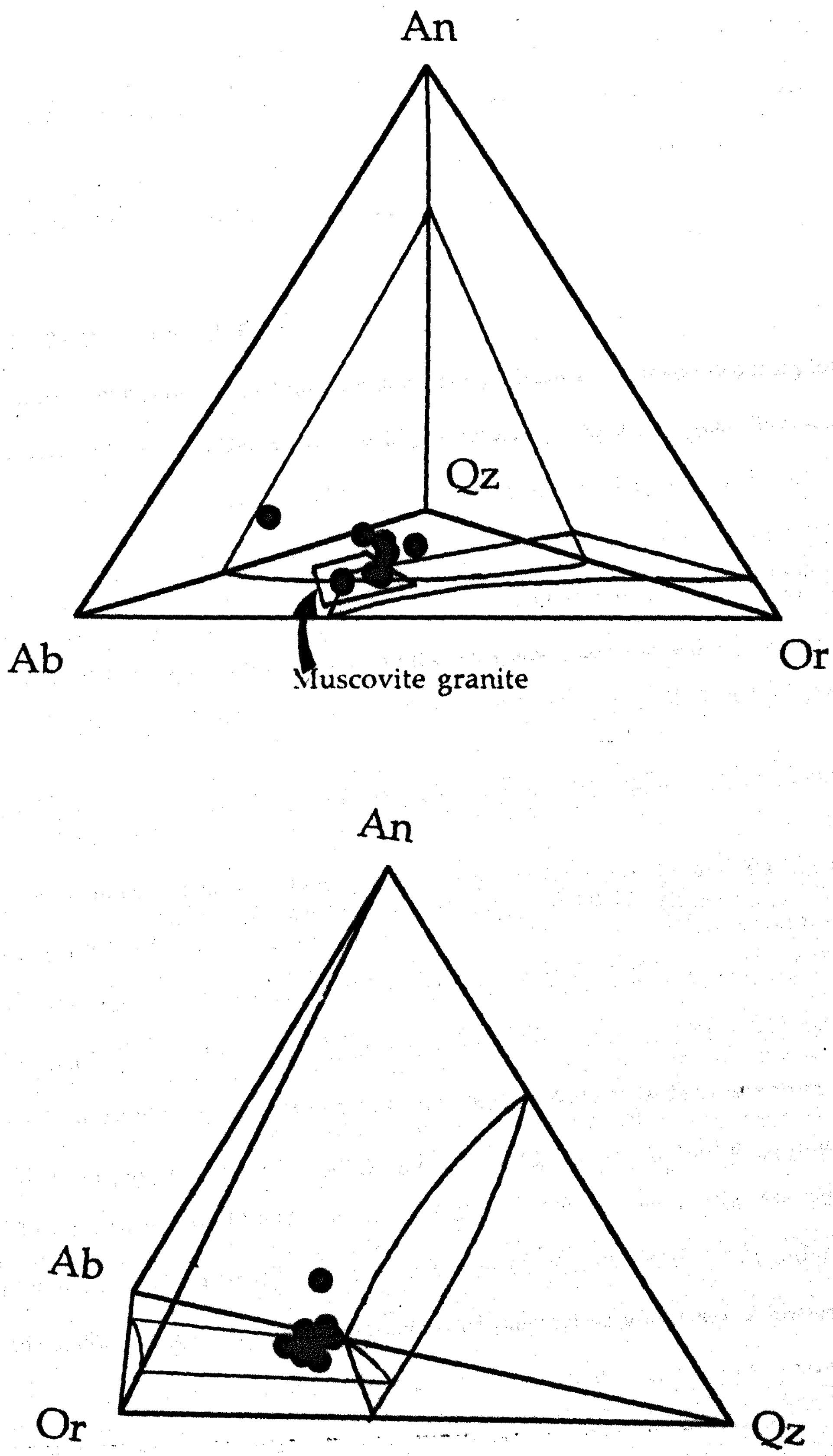


FIGURE 6.28 : Normative Ab-Or-An-Qz tetrahedral diagram for the Trawenagh Bay granite . Phase boundaries from Presnall and Bateman (1973).

precipitation started in the lower plagioclase volume, and later reached the plagioclase-alkali feldspar surface. Final crystallisation also involved quartz. Precipitation of muscovite granite took place near/at the cotectic where plagioclase, quartz and alkali feldspar crystallised simultaneously.

6.9 BARNESMORE PLUTON

The Barnesmore granites generally define a single linear trend on a bivariate plot (major and trace elements ; see section 5.2.7) supporting the suggestion that the Barnesmore granites are comagmatic and that the magmas have undergone fractionation. Dempsey (1987) suggested that fractional crystallisation of a granodioritic magma (G1 type) was the dominant process in the production of the geochemical variation in the Barnesmore complex. In this section the units of the Barnesmore granite will be modelled separately.

6.9.1 LILE modelling

Inter elements variation diagrams for the pairs Rb-Sr, Ba-Sr and Ba-Rb are shown in **Fig 6.29**. All three plots of Barnesmore granite show a clear evolution trend from G1 to G2 to G3. On a Sr vs Ba plot **(Fig 6.29a)**, the Barnesmore rocks show a good trend of decreasing Ba and Sr which is strongly controlled by alkali feldspar, perhaps with minor biotite and plagioclase. On a Ba vs Rb plot **(Fig 6.29b)**, Ba decreases from 763 ppm in G1 to 6 ppm in G3 over Rb range of 159 to 416 ppm. The trend for all units is controlled by fractionation of biotite and alkali feldspar. On a Rb vs Sr plot **(Fig 6.29c)**, Rb slightly increases and Sr decreases from G1 to G3. The trends for all units are compatible with liquid evolution by extraction of plagioclase and alkali feldspar. In conclusion, the LILE modelling shows that plagioclase, alkali feldspar and biotite are important in determining the overall trend of the units of the Barnesmore granite.

6.9.2 Major element modelling

The three main units of the pluton have been modelled separately namely : (1)

G1, (2) G2 and (3) G3. The results are shown in **Tables 6.28 to 6.30**. All analyses for the modelling (whole rock and mineral compositions) are taken from Dempsey (1987). The results are :

(1) G1 has been modelled from a sample containing 71.79 SiO_2 to one with 75.79 % SiO_2. The target composition can be achieved by 20 % fractionation with a mineral mix of plagioclase, alkali feldspar, biotite, quartz, and magnetite **(Table 6.28).**

(2) G2 has been modelled from G2 basic facies (72.23 % SiO_2) to G2 porphyritic facies (76.49 % SiO_2). The target composition can be achieved by 23 % fractionation with a mineral mix of plagioclase, alkali feldspar, biotite, quartz, and magnetite **(Table 6.29).**

(3) G3 has been modelled from the most basic (75 % SiO_2) to the most felsic (76.8 % SiO_2) sample in the unit. The target composition can be achieved by 9 % fractionation with a mineral mix of plagioclase, alkali feldspar, biotite, quartz, and magnetite **(Table 6.30).**

6.9.3 REE modelling

The REE of the Barnesmore granite has been modelled for two units i.e (1) G2 and (2) G3. All REE analyses are taken from Dempsey (1987). For the evolution of G2 the mineral mixes are similar to the major element modelling plus 1.23% apatite, 0.14% allanite and 0.13% zircon and 36% fractionation is required to produce the calculated REE profiles shown in **Fig 6.30.** For the evolution of G3, mineral mixes are similar to the major element modelling plus 0.2% apatite, 0.12 allanite and 0.13% zircon and 24% fractionation is required to produce the calculated REE profiles as shown in **Fig 6.31.**

6.9.4 Discussion.

A summary of the major and REE modelling is given in **Table 6.31.** In the major element modelling, a clear decrease in biotite and increases in alkali feldspar and quartz precipitated from G1 to G2 to G3 suggest that they are comagmatic and have undergone fractionation. The good correlation and sequential variation in the LILE plots supports the fact that the Barnesmore rocks are comagmatic.

On a tetrahedral An-Ab-Or-Qz plot **(Fig 6.32)**, precipitation of the Barnesmore magma started in the lower plagioclase volume, and later reached the plagioclase-alkali feldspar surface. Final crystallisation also involved quartz, probably on the cotectic.

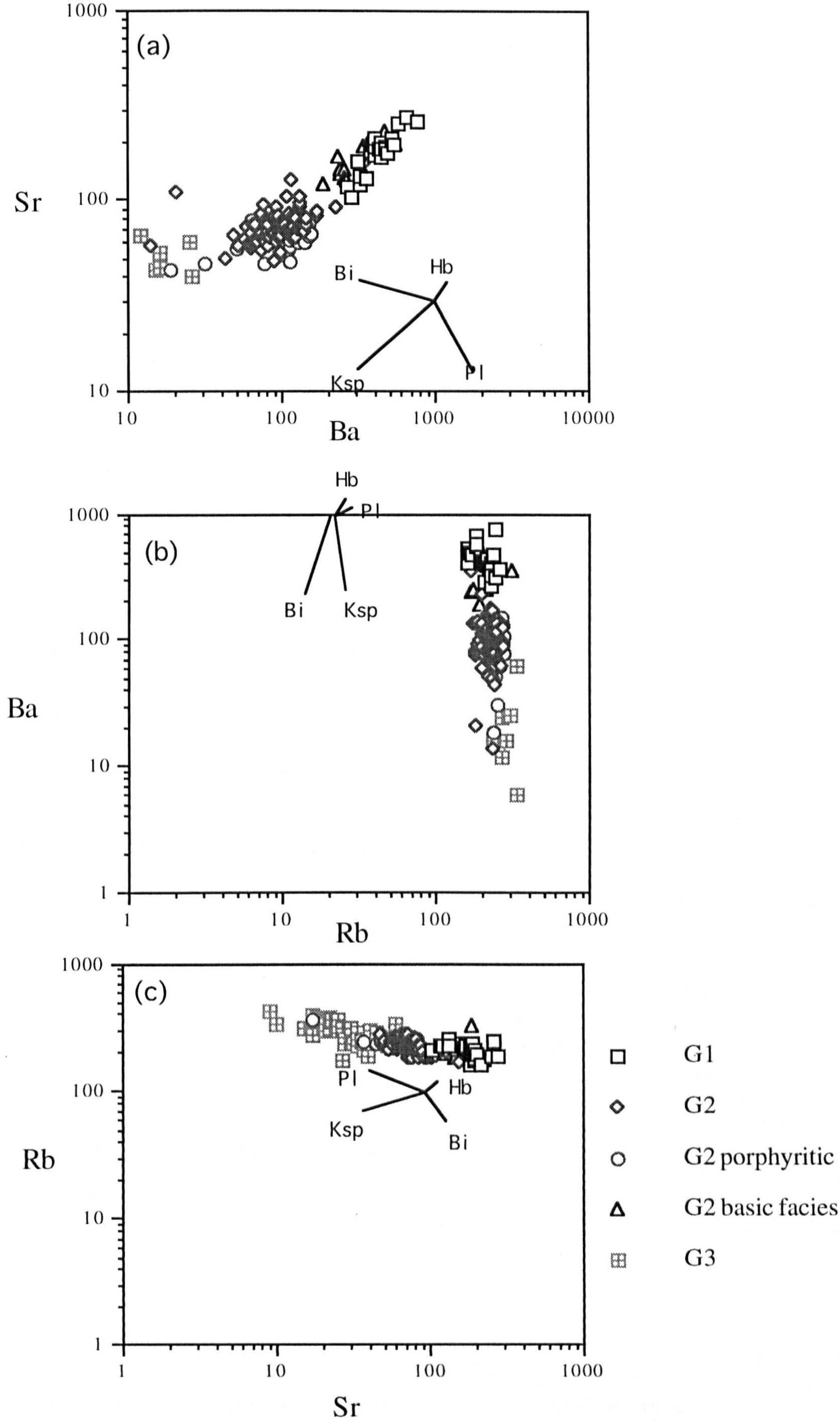


FIGURE 6.29: Inter element variation diagrams for LIL elements Ba, Rb and Sr of the Barnesmore granite. Mineral vectors indicates the net change in composition of the initial liquid after 20% Rayleigh fractionation of the named phase.

	Start composition	Target composition (TC)	Target model (TM)	Different (TM-TC)
Rock type	Granite	Granite		
SiO2	71.79	75.79	75.25	-0.54
TiO2	0.28	0.16	0.16	0
Al2O3	14.59	13.44	13.59	0.15
Fe(tot)	1.8	0.88	1.05	0.17
MgO	0.83	0.5	0.56	0.06
CaO	1.27	0.33	1.06	0.73
Na2O	4.05	4.4	4.36	-0.04
K2O	4.52	4.05	3.92	-0.13
Total	99.13	99.55	99.95	

Mineral extract proportion

Pl : 40
Bi : 20 % precipitation : 20 %
Qu : 10
Mag : 1
Ksp: 29

TABLE 6.28 : Summary results obtained from the major element modelling of the G1, Barnesmore pluton.Whole rock and mineral data are taken from Dempsey (1987).

	Start composition	Target composition (TC)	Target model (TM)	Different (TM-TC)
Rock type	Granite	Granite		
SiO2	72.23	76.49	76.35	-0.14
TiO2	0.27	0.12	0.18	0.06
Al2O3	14.75	13.13	13.25	0.12
Fe(tot)	1.85	0.87	1.25	0.38
MgO	0.59	0.2	0.34	0.14
CaO	1.08	0.52	0.57	0.05
Na2O	4.16	4.06	4.32	0.26
K2O	4.45	4.83	4.17	-0.66
Total	99.38	100.22	100.43	

Mineral extract proportion

Pl : 53.1
Bi : 15 % precipitation : 23 %
Qu : 10
Mag : 0.9
Ksp: 21

TABLE 6.29 : Summary results obtained from the major element modelling of the G2, Barnesmore pluton. Whole rock and mineral analyses are taken from Dempsey (1987).

	Start composition	Target composition (TC)	Target model (TM)	Different (TM-TC)
Rock type	granite	granite		
SiO2	75	76.78	76.74	-0.04
TiO2	0.07	0.04	0.04	0
Al2O3	14.17	13.38	13.5	0.12
Fe(tot)	0.57	0.59	0.37	-0.22
MgO	0.11	0.13	0.04	0.09
CaO	0.56	0.37	0.34	-0.03
Na2O	4.42	4.48	4.49	0.01
K2O	4.98	4.51	4.82	0.31
Total	99.88	100.28	100.34	

Mineral extract proportion

Pl : 53.1
Bi : 9
Qu : 7
Mag : 0.7
Ksp : 32.2

% precipitation : 9%

TABLE 6.30 : Summary results obtained from the major element modelling of the G3, Barnesmore pluton. Whole rock and mineral are taken from Dempsey (1987).

	Start G2/52 granite	Target G2/90 granite	Target model	Bulk Kd	Min Prop
La	15.4	11.48	13.15	2.37	Pl 42
Ce	26	21.43	24.13	2.2	Ksp 30.1
Nd	10.7	5.53	6.13	2.64	Bi 17
Sm	2	1.03	1.11	2.46	Qu 10
Eu	0.36	0.21	0.21	2.83	Mag 1.5
Gd	1.7	0.9	0.86	2.58	Ap 1.23
Dy	1.43	0.86	0.95	1.96	All 0.14
Er	0.92	0.56	0.67	1.75	Zr 0.13
Yb	1.32	0.99	1.04	1.61	
Lu	0.22	0.19	0.2	1.58	

% precipitation : 36%

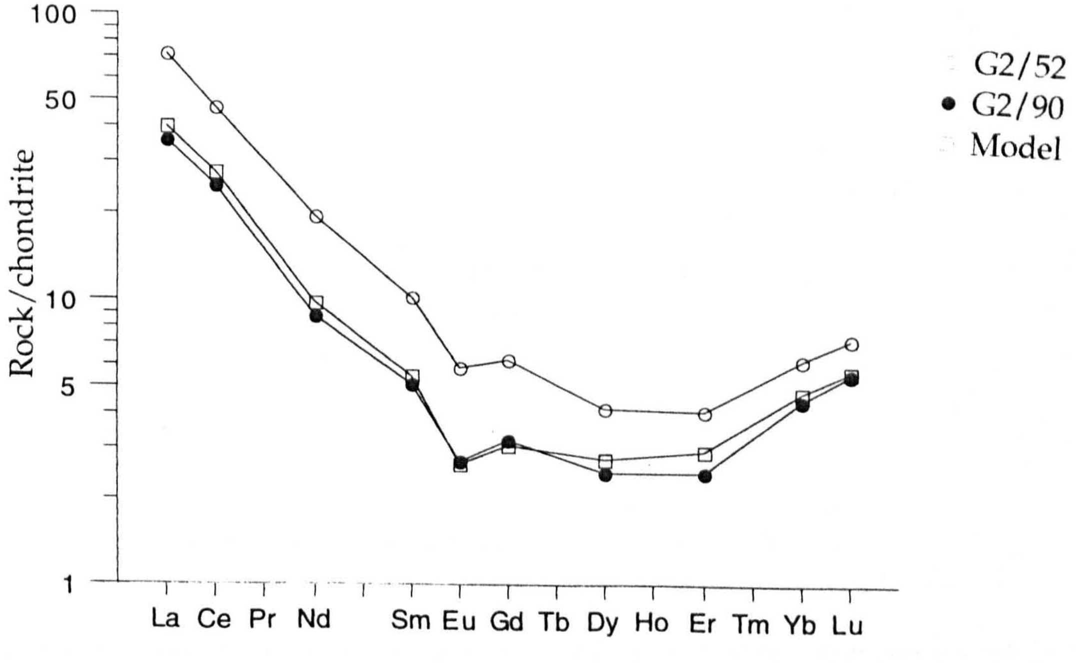


FIGURE 6.30 : Summary of the REE modelling of G2 of the Barnesmore pluton. At the top is the summary of start and target compositions, target model, amount of mineral precipitate (%) and bulk Kd of the REE used in the modelling. % precipitation is the percentage precipitated to move the start composition to the target model.Below is the graphical presentation of the modelling.

	Start G3/215 granite	Target G3/186 granite	Target model	Bulk Kd	Min Prop	
La	7.50	6.57	8.66	1.65	Pl	45
Ce	11.53	11.76	10.39	1.43	Ksp	32
Nd	3.50	3.08	3.4	1.49	Bi	11.23
Sm	0.68	0.59	0.64	1.25	Qu	12
Eu	0.07	0.06	0.072	2.53	Mag	0.2
Gd	0.55	0.53	0.56	1.49	Ap	1.03
Dy	0.69	0.57	0.62	1.004	All	0.12
Er	0.41	0.47	0.404	1.05	Zr	0.13
Yb	0.90	1.24	0.85	1.156		
Lu	0.20	0.26	0.161	1.21		

% precipitation : 24%

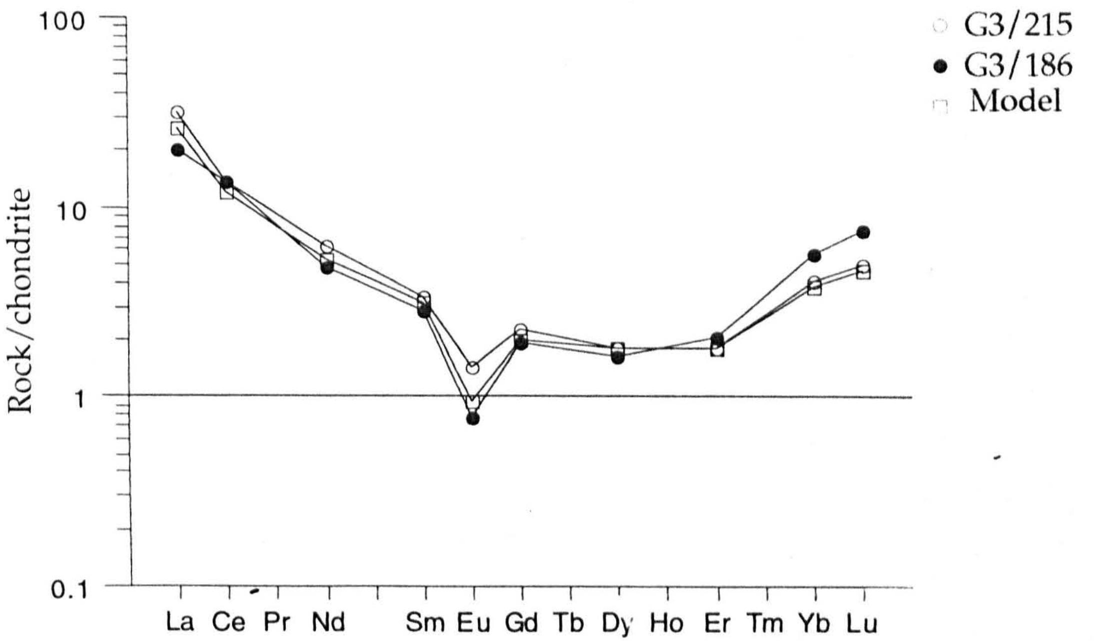


FIGURE 6.31 : Summary of the REE modelling of G3 of the Barnesmore pluton At the top is the summary of start and target compositions, target model, amount of mineral precipitate (%) and bulk Kd of the REE used in the modelling. % precipitation is the percentage precipitated to move the start composition to the target model. Below is the graphical presentation of the modelling.

Major element modelling

	Pl	Ksp	Bi	Qu	Mag	% ppt
G1	43	29	20	7	1	20%
G2	42	30	15	12	0.9	23%
G3	45.1	32.2	9	13	0.7	9%

REE modelling

	Pl	Ksp	Bi	Qu	Mag	Ap	All	Zr	% ppt
G2	42	30.1	17	10	1.5	1.23	0.14	0.13	36%
G3	45	32	11.23	12	0.2	1.03	0.12	0.13	24%

TABLE 6.31 : Summary results of major and RE element modelling of the Barnesmore pluton.

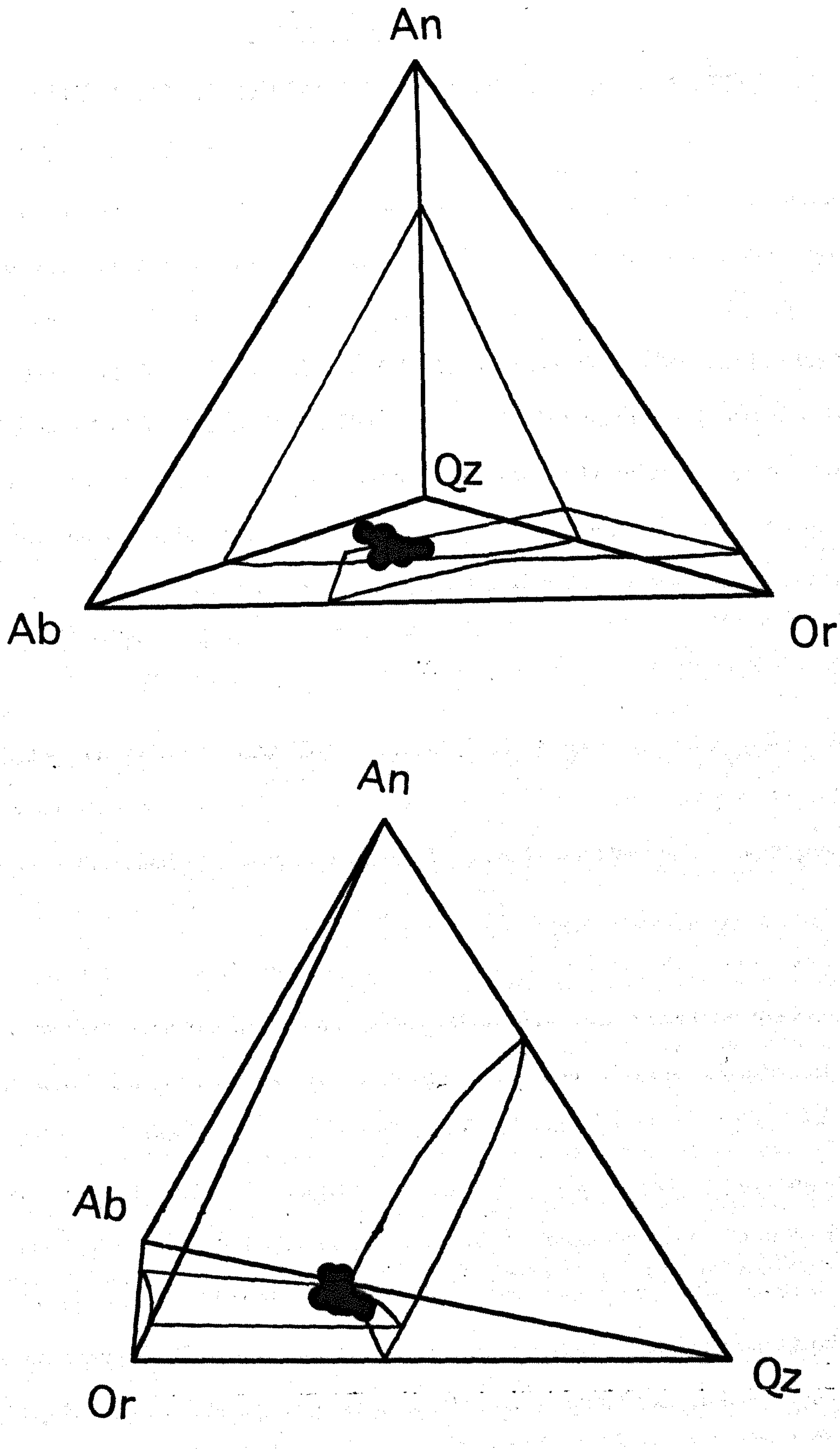


FIGURE 6.32 : Normative Ab-Or-An-Qz tetrahedral diagram for the Barnesmore granite . Phase boundaries from Presnall and Bateman (1973).

CHAPTER SEVEN

AGE AND TECTONIC SETTING OF THE DONEGAL GRANITES.

7.1 INTRODUCTION.

During the Caledonian orogeny, the British Isles was intruded by abundant granitic bodies. These are known as Caledonian granites and include those studied here. Several models have been suggested to explain the tectonic setting of the Caledonian granites, these include subduction (Thirwall 1981) , post-collision uplift (Pitcher 1983) and strike slip faulting (Leake 1990). The main aim of this chapter is to discuss the tectonic setting of the Donegal granites. However because the Donegal granites are part of the Caledonian granites, any suggestion on the tectonic setting of the latter must be taken into account when studying the Donegal granites. This chapter will also discuss the isotopic age of the Donegal granites .

7.2 AN OUTLINE OF CALEDONIAN OROGENY

Major Paleozoic orogenies are recorded along both coasts of the North Atlantic. Among them, the Caledonian orogeny (Upper Silurian to Lower Devonian) is widespread in the British Isles, Scandinavia and eastern Greenland.

During the Early Ordovician, a major early Paleozoic ocean, Iapetus was bordered by the Baltica and Laurentia continents **(Map 7.1)**. During this time, the British Isles was divided into two parts. The southern part together with the adjacent part of continental Europe formed the eastern Avalonia microcontinent whereas the northern part was associated with the Laurentia craton **(Map 7.1)**. The Iapetus ocean eventually closed in Ordovician and early Silurian times and the position of the Iapetus suture can be traced along the Solway line **(Map 7.2)**. Collision occurred between two continental masses, Laurentia and Baltica on one hand and a microcontinent, Avalonia on the other hand **(Map 7.1)**. By considering the published data from Britain, Greenland, Scandinavia and Newfoundland, Soper et al.(1992) showed that western and eastern Avalonia and Baltica docked sinistrally against Laurentia in Silurian times.

The evidence of the closure of Iapetus ocean is given by McKerrow and Soper (1989) , viz :

(1) The presence of distinct Ordovician faunas on either side of the orogen.

(2) The occurrence of early Paleozoic ophiolitic rocks at Ballantrae, southwest Scotland (Stone 1984) and Tyrone, Ireland (Hutton et al. 1985).

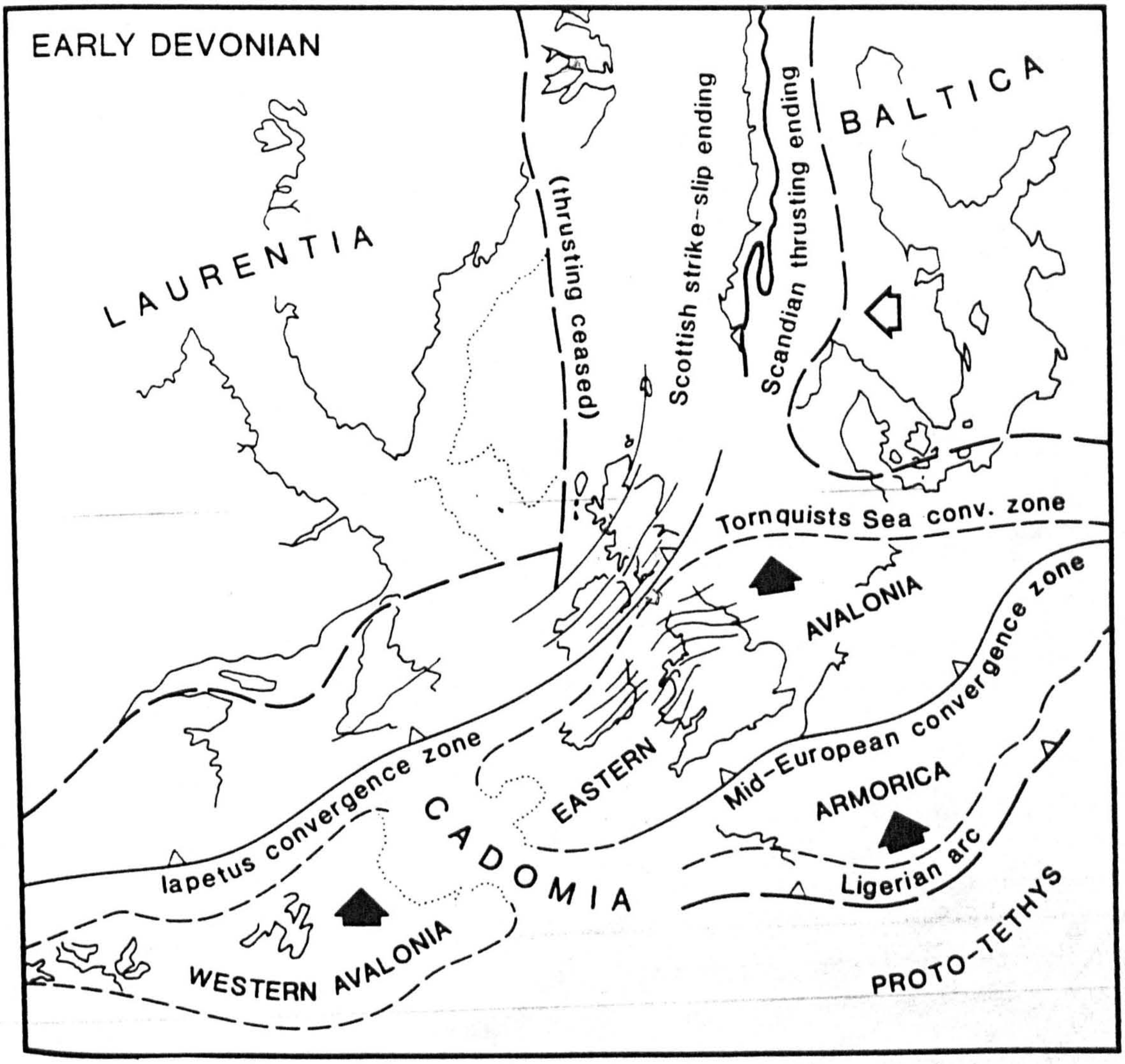
A chart summarizing the chronology of Late Caledonian events including the formation of the Iapetus suture in the British Isles is shown in **Figure 7.1** (after Watson 1984).

7.3 AGE OF THE DONEGAL GRANITES

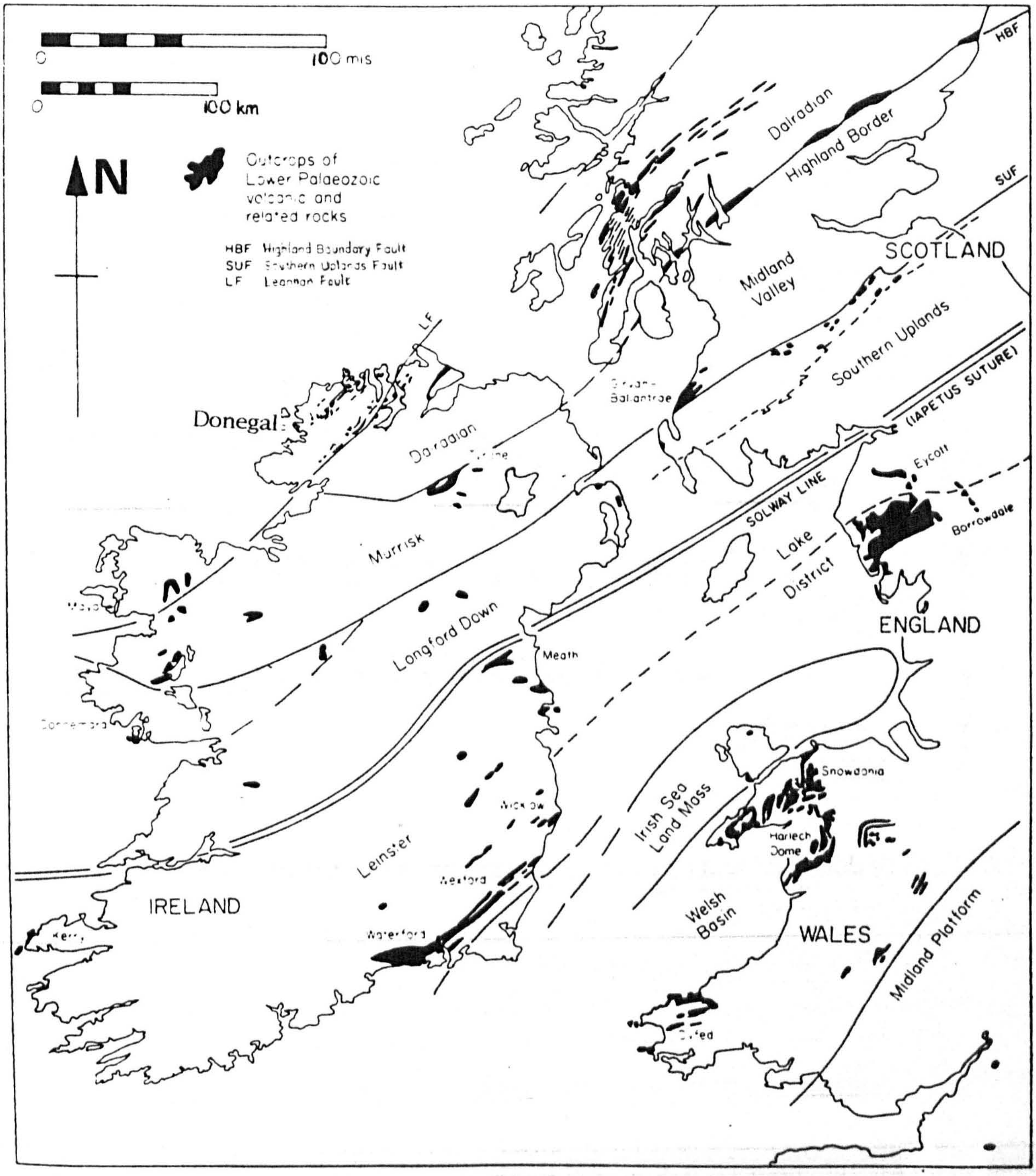
The work on the geochronology of the Donegal granites began when Brown (1968) reported K-Ar mineral ages for mica and hornblende separates from Thorr, Ardara, Rosses and Main Donegal granites in the range 365 ± 8 Myr to 412 ± 8 Myr. These dates indicate that the granites belong to the 'Younger' granites of Read (1961). Leggo et al.(1969) published the first whole rock Rb-Sr isochron on rocks from Thorr, Main Donegal, Trawenagh Bay and Rosses plutons. A single isochron was drawn through the granite data set which defined an age of 470 ± 1 Myr, suggesting that Donegal granites are intermediate between the 'Older' and 'Younger' granites of Read (1961).

In contrast to Leggo et al. (1969), Long (1978) reported a reconnaissance Rb-Sr date on the Donegal batholith of 405 ± 7 Myr. This result was supported by the work of Fitch and Miller (1980) who published an ^{40}Ar - ^{39}Ar muscovite age from the Main Donegal granite of 400 ± 2 Myr. Subsequently Halliday et al. (1980) presented individual Rb-Sr isochrons for Ardara, Rosses, Trawenagh Bay and Main Donegal granites (405 ± 5 , 404 ± 3, 405 ± 3 and 388 ± 3 respectively). The later works of Long (1978), Fitch and Miller (1980), Halliday et al. (1980) showed that the Donegal granites are related to the 'Younger' granites of Read (1961), and that the previous date determined by Leggo et al. (1969) was in error.

The work of O'Connor et al.(1982) using the Rb-Sr method suggested that the Thorr granite was emplaced around 418 ± 26 Myr and the Main Donegal granite has an emplacement age of 407 ± 23 Myr. More recent work by O'Connor et al. (1987) suggests that



MAP 7.1 : Geotectonic model for the early devonian, after collision between Baltica and Laurentia with Cadomian terranes (after Soper and Hutton 1984 ; Soper 1987).



MAP 7.2 : Outcrops of Lower Paleozoic volcanic and related rocks in the British Isles and some of the major lineaments. Note the location of the Iapetus suture (Solway line) (after Moseley 1982).

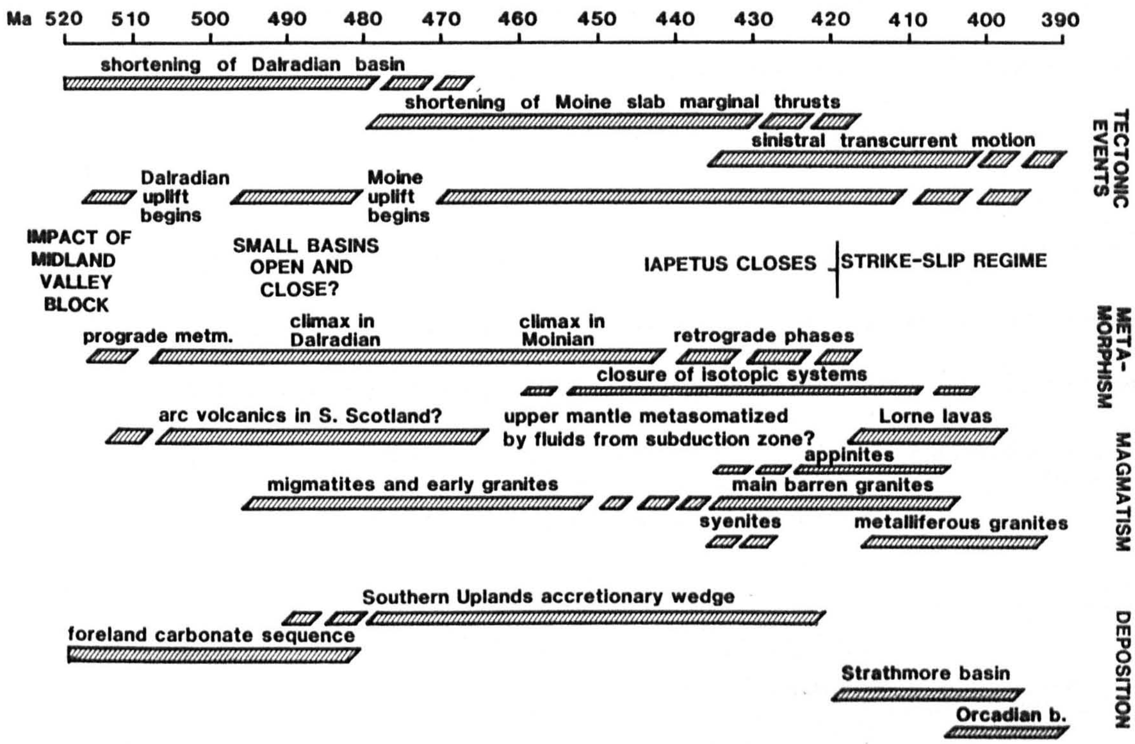


FIGURE 7.1 : Chart summarizing the chronology of the late Caledonian events (after Watson 1984).

the Barnesmore granite was emplaced around 397 ± 7 Myr and Fanad around 402 ± 10 Myr. Dempsey (1987) gives slightly an older age for Barnesmore (417 ± 6 Myr) compared to that of O'Connor et al. (1987). The various isotopic ages from the Donegal granites are summarised in **Table 7.1.**

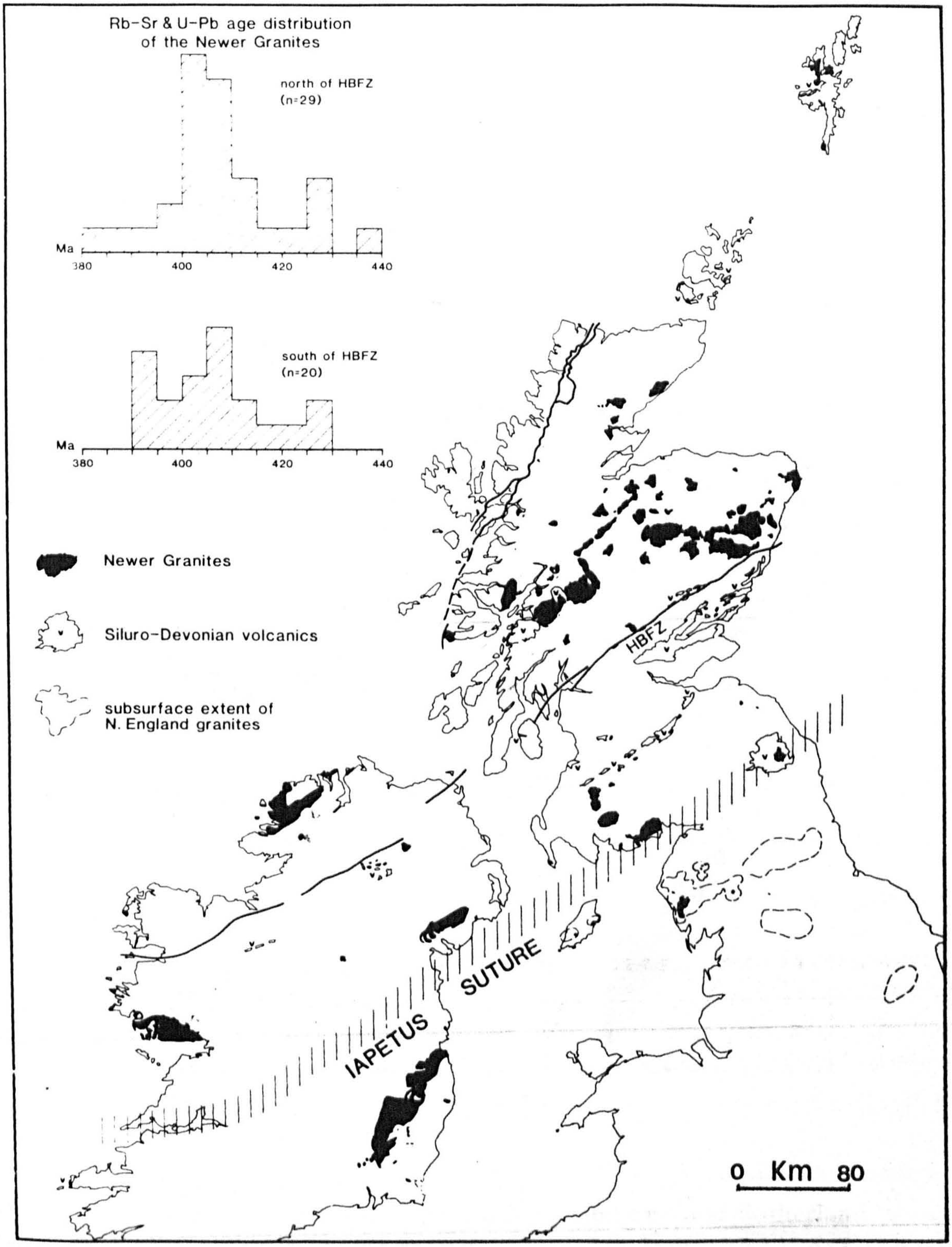
The isotopic ages from the Donegal granites indicate that they are part of the Caledonian granites, emplaced in a relatively short time span between 392 to 418 Ma and can be classified as 'Newer' granites according to Read's classification. Moreover, the results do not show a real difference in intrusion age as shown by the field relations of the granites (see Chapter 2). Pankhurst and Sutherland (1982) suggested that long cooling, reheating and contamination processes are factors which may have complicated the radiometric dating of the Donegal granites. However, Oglethorpe (1987) has shown that factors such as contamination did not play an important role in granite petrogenesis in Donegal. On the other hand, Atherton and Boyle (1994) concluded the tight age grouping with no real difference in age was probably because the granites were formed at more or less at the same depth and there was no time for differential uplift.

7.4 OCCURRENCE OF THE CALEDONIAN GRANITES

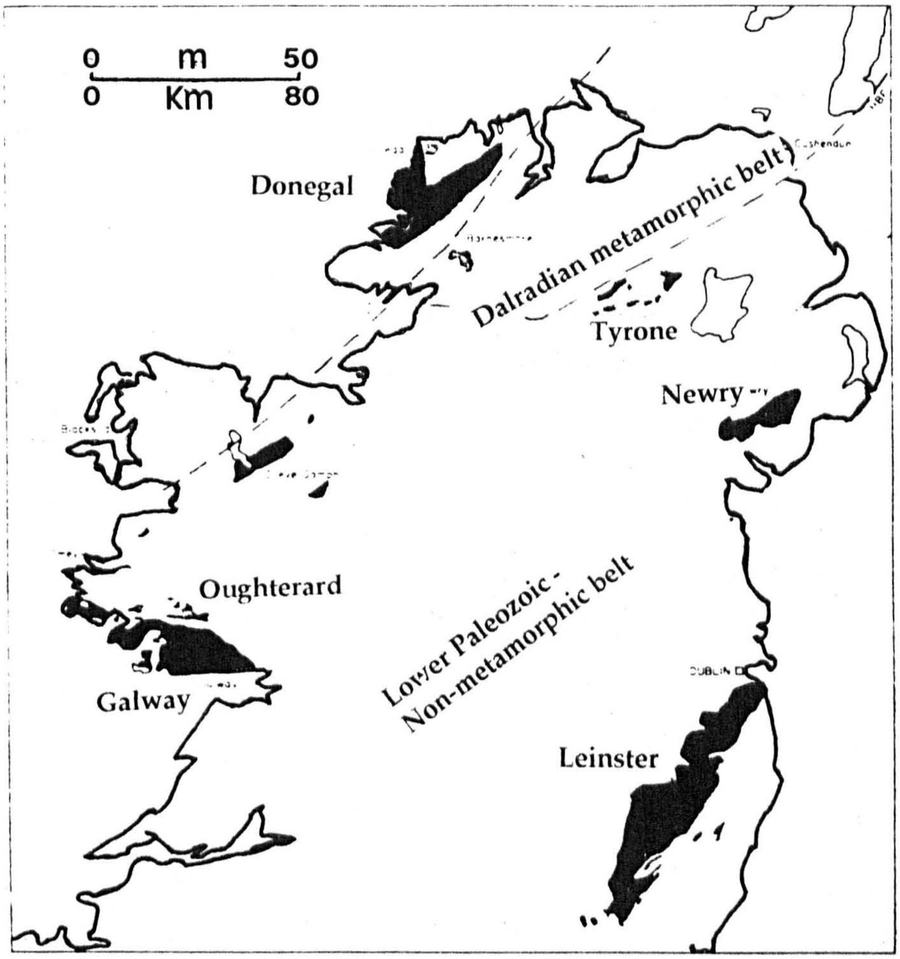
The distribution of the Caledonian granites in the British Isles is shown in **Map 7.3.** In Ireland, the Caledonian granites occur north and south of the Iapetus suture. Pankhurst and Sutherland (1982) have divided the granites into 2 groups according to whether they occur in the metamorphic or non-metamorphic belt **(Map 7.4).** The first group occurs in the Dalradian metamorphic belt. These are comparable to those in the Scottish Highlands and include Donegal, Mayo and Galway granites. The second group occurs in the non-metamorphic belt and includes the Newry, Tyrone and Leinster granites.

In Scotland, the Caledonian granites occur widely in the Grampian Highlands, north of the Highland Boundary Fault **(Map 7.5).** Here, the granites can be divided into three groups.

(1) The granites from the NE Highlands: These include Cairngorm, Monadliath, Ben Rinnes, Peterhead and Ardclach plutons. They are mainly peraluminous, dominated by a



MAP 7.3 : Distributions of Newer granites in the British Isles. INSET : Rb/Sr and U-Pb ages of Newer granite from north and south of the Highland Border Fault Zone (HBFZ) (after Soper 1987).



MAP 7.4 : Granitic intrusions in Ireland (after Pankhurst and Sutherland 1982)

INTRUSIONS	LOCATION	METHOD	AGE	SOURCE
Donegal Complex	Thorr, Main Granite, Trawenagh Bay & Rosses	Rb-Sr (WR)	487 ± 5	3
Donegal Complex		Rb-Sr (WR)	405 ± 7	4
Thorr	650 yds E of Gweebarra Bridge	K-Ar (Mu)	391 ± 8	1
Thorr	Owenator river , near Lough Agher	K-Ar (Bi)	390 ± 7	2
		K-Ar (Hbl)	392 ± 8	2
Thorr	Tonalite, aplite, granite	Rb-Sr (WR)	418 ± 8	7
Ardara	Ardara-Clooney road (Hornfels at contact)	K-Ar (Bi)	414 ± 8	1
Ardara	Outer monzodiorite, Clooney	K-Ar (Bi)	394 ± 8	2
		K-Ar (Hbl)	392 ± 7	2
Ardara		Rb-Sr (WR)	405 ± 5	5
Rosses	Greisen, Sheskinarone	K-Ar (Mu)	404 ± 8	1
Rosses	Greisen, Lough Nabrack	K-Ar (Mu)	384 ± 8	2
Rosses	Garnetiferous MG, south of Dungloe	K-Ar (Mu)	382 ± 6	2
Rosses	G3, G4 & aplite	Rb-Sr (WR)	404 ± 3	5
Main Donegal	Pelitic raft, Barnesbeg gap.	K-Ar (Bi)	357 ± 8	1
		K-Ar (Mu)	382 ± 8	1
Main Donegal	Mica hornfels , N of Losset.	K-Ar (Mu)	384 ± 7	1
Main Donegal	Granite, 1 mile SSE of New Bridge	K-Ar (Mu)	378 ± 7	2
Main Donegal	Pegmatitic granite, NE of Sand Lough	K-Ar (Mu)	372 ± 6	2
Main Donegal	Pegmatitic granite, NE of Sand Lough	$^{40}Ar-^{39}Ar$ (Mu)	400 ± 2	6
Main Donegal		Rb-Sr (WR, Bi, Mu, Ksp, Plg, Apa)	388 ± 3	5
Main Donegal	Light main granite, dark main granite & aplite.	Rb-Sr (WR)	407 ± 23	7
Trawenagh Bay	Aplite phase	Rb-Sr (WR)	405 ± 3	5
Fanad		Rb-Sr (WR)	403 ± 10	8
Fanad		Rb-Sr (WR)	402 ± 10	9
Barnesmore		Rb-Sr (WR)	394 ± 8	8
Barnesmore	G1, G2, G3 & aplite	Rb-Sr (WR)	397 ± 7	9
Barnesmore	G1, G2, G2 porphyritic & G3	Rb-Sr (WR)	412 ± 6	10

List of Source :

1. R.S.J.Lambert (in Pitcher and Berger 1972 , p91)
2. Brown et al.(1968)
3. Leggo et al.(1969)
4. Long (1978)
5. Halliday et al.(1980)
6. Fitch and Miller (1980)
7. O'Connor et al.(1982)
8. O'Connor et al.(1985)
9. O'Connor et al.(1987)
10. Dempsey (1987)

WR - Whole Rock
Mu - Muscovite
Bi - Biotite
Ksp - K-Feldspar
Plg - Plagioclase
Apa - Apatite
MG - Microgranite

TABLE 7.1 : Table showing the geochronological work that has been done on the Donegal granites.

pink biotite granite facies' rarely associated with appinitic bodies and have tendency to 'A' type characteristics (Harrison and Hutchison 1987; Stephen and Halliday 1984).

(2) The granites from SW Highlands region consist of Etive, Strath Ossian, Ballachulish, Glen Coe, Ben Nevis, Rannoch Moor and Kilmelford. These are mainly made up of granodioritic to dioritic rocks.

(3) The granites from S Highlands and the Midland Valley : these include the plutons of Garabal Hill, Arrochar and Distinkhorn.

Caledonian granites of Scotland also occur in the Lower Paleozoic rocks of the Southern Uplands. They include Loch Doon, Mull of Galloway, Cairnsmore of Fleet and Criffell plutons. Most of the plutons here tend to be concentrically zoned from diorite at the margin to granite at the centre.

7.4.1 Division of the Caledonian granites

Several authors have attempted to subdivide the Caledonian granites (Stephens and Haliday 1984 ; Brown et al. 1981). Stephens and Halliday (1984) divided the late Caledonian granites of Scotland into 3 suites, each of which has distinctive chemical characteristics. They are the Cairngorm, Argyll and south of Scotland suites. The essential characteristics of these suites are given in **Table 7.2.**

(1) The Cairngorm suite lies in the eastern Grampian region and has been divided by Harrison and Hutchison (1987) into an early group which includes the Monadliath, Lochnagar, Hill of Fare and Kincardine plutons. This group is often associated with relatively abundant diorites. A slightly later group not associated with diorites includes Ben Rinnes, Moy, Cairngorm and Bennachie. This suite is characterised by highly silicic metaluminous compositions and has high Nb, Rb, Th and low Ba and Sr contents.

(2) The Argyll suite is typically represented by granodiorite and diorite. An appinite suite is well developed in this region (SW Highlands), principally occurring as small satellite pipes (Wright and Bowes 1979). The granitic plutons in this suite include Etive, Ballachulish, Garabal Hill,Ben Nevis and Glen Coe. This suite is calc alkalic

	Cairngorm suite	*Argyll suite*	*S of Scotland suite*
Rock types	Mainly red biotite granites; intermediate types rare; few appinites	Common grandiorites and diorites; appinites abundant; hornblende characteristic of diorites	Commonly diorites and granodiorites; pyroxene typical of diorites; appinites in the N only.
Major oxides	Highly silicic metaluminous compositions	Calc-alkalic high Na_2O compositions	Calc-alkalic
Trace-elements	High Nb, Rb and Th; low Ba, Sr	Very high Sr and Ba; low Nb, Th, Rb	Low La, Ce, Ba, Sr
Age (Ma)	408–415	410–415	390–408
εSr	+24–+33	−7–+58	+1–+54
εNd	−8–−1	−10–+3	−4–+1
$\delta^{18}O$	8·2–11·1	7·2–10·7	7·9–10·4

TABLE 7.2 : Characteristics of late granitic suites of Scotland (after Stephens and Halliday 1984)

with high Na_2O and very high Sr, Ba and low Nb,Th and Rb contents.

(3) The south of Scotland suite consists of several plutons ranging from diorite to granite in composition, usually zoned in a concentric manner. The main plutons of this suite are Loch Doon, Criffell and Mull of Galloway. This suite is characterised by calc alkalic affinity and low La,Ce,Ba and Sr contents.

Brown et al.(1981) divided the Caledonian granites of the British Isles into three groups based on the ages of the granites and their tectonic setting.

1. A pre-tectonic group mainly dioritic plutons with associated migmatites and with isotopic ages exceeding 460Ma.

2. A post-tectonic , mainly forcefully emplaced group of zoned granodiorites with ages ranging from 410 to 460 Ma (pre-mid Silurian).

3. A post-tectonic , mainly discordant groups of granites and granodiorites with ages ranging from 390 to 410 Ma.

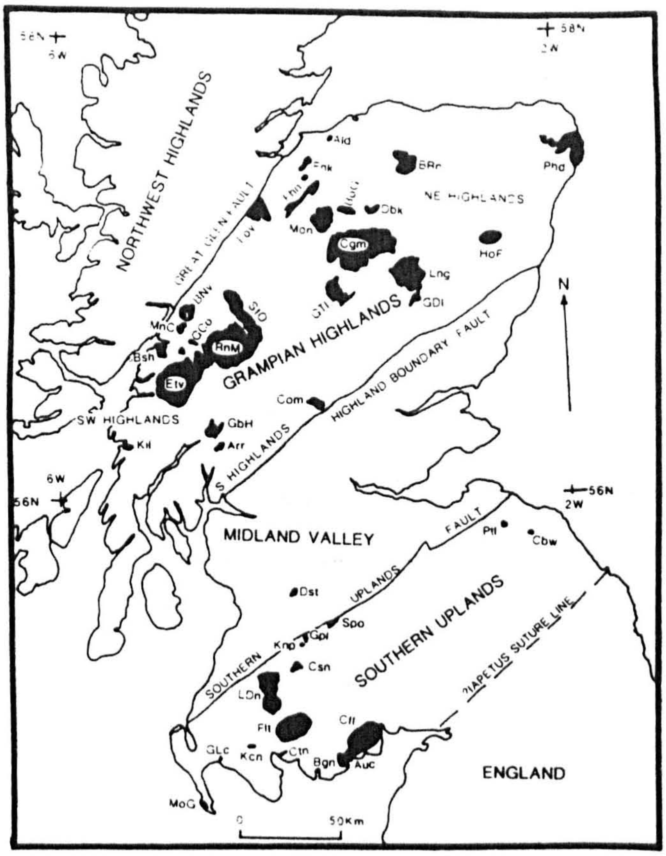
They also showed that the first two groups have many features in common. These include lack of prominent gravity anomalies, probably indicating small volumes of magma ; generally low LIL trace elements abundances which are reminiscent of average crustals rocks in the region and variable isotopic characteristics which nevertheless, generally include some evidence of a partly crustal derivation.

In terms of rock type and major and trace elements, the Donegal granites are comparable to the Argyll suite of Stephens and Halliday (1984). Thus

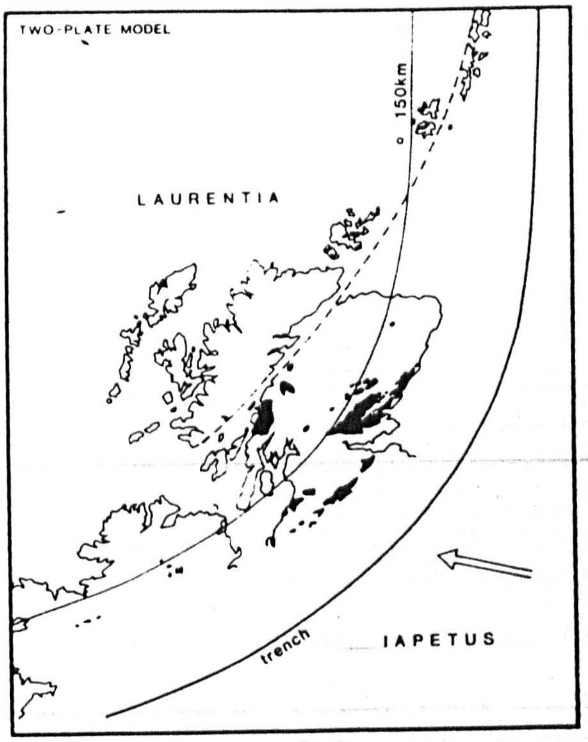
(1) The most common rock type in Donegal is granodiorite with diorite and granite occurring in lesser amount. Appinite is mainly associated with Ardara pluton and hornblende is characteristic of the dioritic rocks.

(2) Major oxides show that the Donegal granites are calc-alkali with high Na_2O (3.9 - 6.2%). The Argyll suite is also characterised by being calc alkalic with high Na_2O.

(3) The Donegal granites have high Sr and very high Ba (up to 4500 ppm). **Fig 7.2(a)** shows that the Donegal granites have the widest range of Ba content, greater than the



MAP 7.5 : Location map showing the granitic plutons in the Scotland (after Stephens and Halliday 1984)



MAP 7.6 : Two plate model for the generation of the Scottish Old Red Sandstone volcanics by subduction of Iapetus lithosphere (Thirwall 1981). This model account for Newer Granite magmatism northwest of the Highland Border but not in the south.

three late granites suites of Scotland. The highest Ba is from Fanad pluton which is higher than Argyll suite rocks. **Fig 7.2(b)** shows that the Sr content of the Donegal granites is comparable to Argyll suite whereas Cairngorm and South of Scotland suites have much lower Sr contents. **Fig 7.2(c)** shows that the Donegal granites have higher Rb compared to the Argyll and S of Scotland suite. The concentration of Rb in Donegal granites is very similar to that in the Cairngorm suite.

(4) Epsilon Nd of Donegal granites ranges from -8.3 to -1.2 Although the range is similar to the Cairngorm suite (-8 to -1) it still lies within the range of the Argyll suite (-10 to +3).

In terms of the Brown et al. (1981) classification of Caledonian granites, the Donegal granites fall into group three i.e. post tectonic with ages ranging from 390 - 410Ma.

7.5 TECTONIC SETTING

In this section the three models describing the tectonic setting of the Caledonian granites will be summarised and a tentative alternative model will be provided. The three models are (a) subduction related (Thirlwall 1981) (b) adiabatic decompression during rapid post orogenic uplift (Pitcher 1983,1993) (c) strike slip faulting accompanied by uplift (Leake 1990). In addition to these models, a mantle plume model has been proposed by Hill et al. (1990).

7.5.1 Caledonian granites and subduction related models

The Iapetus ocean was believed to have closed by the subduction of ocean crust (e.g Phillips et al.1976) during the Caledonian Orogeny. Several models have been proposed to explain the occurrence of the Caledonian granites of the British Isles in relation to Iapetus subduction. One is a two plate model (e.g.Phillips et al.1976 ; Thirlwall 1981) and the other a three plate model (Soper 1986).

The two plate model assumes the convergence of two continental plates i.e. Eastern Avalonia (which later formed southern Britain and the eastern part of Europe)

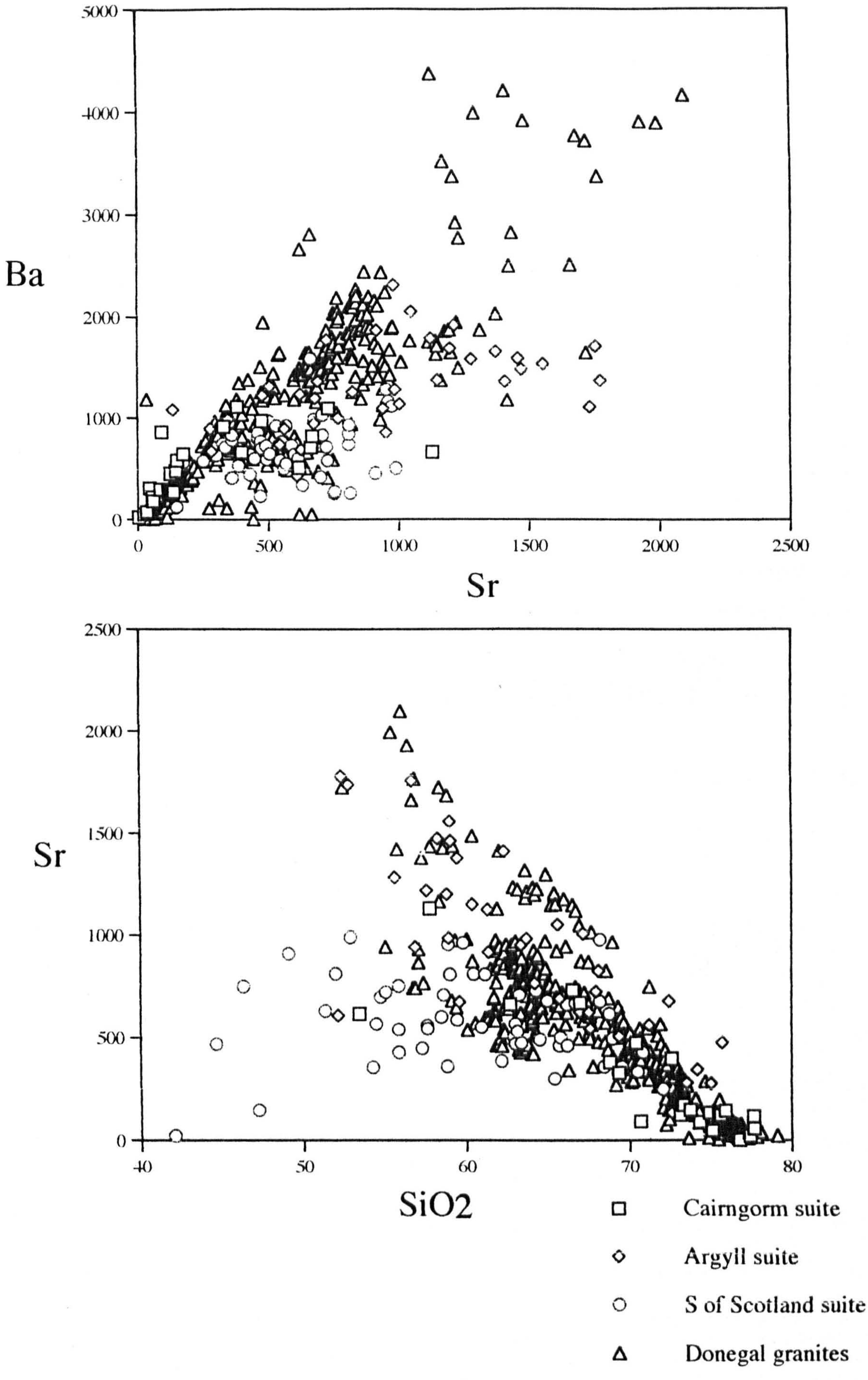


FIGURE 7.2: Plots of (a) Sr vs Ba and (b) Sr vs SiO2 for the Cairngorm,Argyll, South of Scotland suites and the Donegal granites. Data for the Cairngorm, Argyll and South of Scotland suites are from Stephen and Halliday (1984).

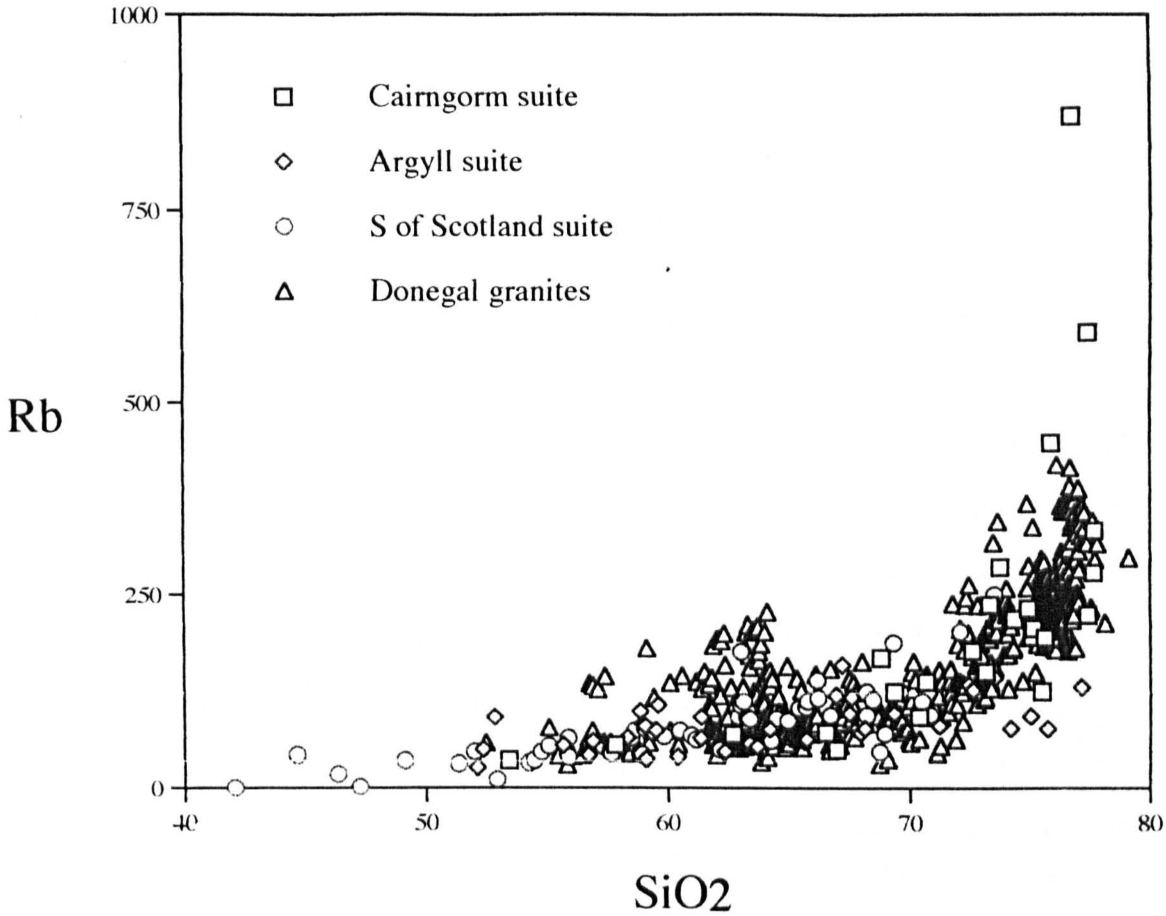


FIGURE 7.2: Continued, (c) plot of Rb vs SiO2 for the Cairngorm,Argyll, South of Scotland suites and the Donegal granites.

and Laurentia plate (e.g.Thirlwall 1981) **(Map 7.6)** in Ordovician or mid-Silurian times (Watson 1984). The Caledonian granites and associated volcanic rocks are thought to be related to this subduction. Thirlwall (1983) showed that the volcanism in the Scottish Highlands and Midland Valley occurred close to 410 Ma. The recognition of tholeiitic, calc alkaline and alkaline volcanics together with ophiolitic rocks near Girvan and along the Highland Border is interpreted as evidence for the existence of a volcanic arc related to the subducted margin.

The alternative three plate model (Soper and Hutton 1984 ; Soper 1986) involves Laurentia, Baltica and Armorica plates **(Map 7.1).** According to this model, Laurentia and Baltica converged during Ordovician time so by late Silurian time, Laurentia and Baltica were sutured together to form part of the Laurentian supercontinent. This part later formed the northern part of the British Isles. Subsequently the Eastern Avalonia which formed southern Britain, was accreted on to the southern margin of Laurasia in the Devonian. This model involves three late Caledonian magmatic arcs.

(1) Laurentia - Baltica convergence with westward subduction beneath the Scottish sector of the Laurentian margin in the Ordovician and Early Silurian, which generated the early members of the late Caledonian granite suite in the Highlands.

(2) Northward Silurian to Early Devonian subduction at the Solway line which produced the younger late Caledonian granites and volcanic rocks north of the Highland Border.

(3) Northward accretion of the Armorica terrane in the Early Devonian which produced intrusive and extrusive magmatism in southern Ireland and the English Midlands.

However the two models above raise some interpretative problems when compared to the other known subduction related granites batholiths e.g. Peninsular Range (Silver and Chappell 1988). Among the problems are :

(1) The distance between the trench and arc in modern examples is normally greater than 90 km and is often 150 km or more. The approximate distance of the Scottish Highland granite plutons from the Iapetus suture is about 150 to 200 km whereas the granite plutons from Southern Uplands are less than 50 km. Thus the two plate model may explain the occurrence of the granites in the Scottish Highland but not those in the

Southern Uplands. The same difficulty is seen in Ireland where the distance of the Galway and Newry plutons is less than 50 km from the Iapetus suture.

(2) Brown (1991) has pointed out that the plutons also fail to show the progressive space-time changes in chemistry which are characteristic of magmatism at a plate margin. Marked isotopic, age and trace elements vriations within the subduction related granite batholiths, e.g. Peninsular Ranges batholith (Gromet and Silver 1987) are not found in the Caledonian granites.

(3) Another characteristic of Caledonian granites which is different from the subduction related batholiths such as the Peninsular Ranges batholith, is the presence within the latter of continuous magmatism over a period of at least 45 Ma (85 Ma if the extension of the magmatic arc across the Gulf of California is considered). This is in contrast with the magmatic history of the Caledonian plutonism which is characterised by short periods of intense activity separated by periods of relative quiescence.

(4) The peninsular Ranges batholith that developed in a subduction environment is elongated over a distance of more than 1000 km and is parallel to subducting oceanic crust. Such batholiths in this environment usually comprise hundreds of cross cutting plutons variable in diameter from 1 to 50 km. whereas the Caledonian granites usually occur as separate small plutons, which are not elongated.

(5) The rock types present in the Caledonian batholith vary from quartz monzodiorite to granite (s.s) and do not form a gabbro-granite continuum, typical of the subduction environment.

7.5.2 Adiabatic decompression during post orogenic uplift model.

In this model, the late Caledonian granitic complexes (440 to 390 Ma) have been regarded as post-collision and magma genesis was suggested to be induced by adiabatic decompression during rapid post orogenic uplift (e.g.Pitcher 1983). However, the problem with this model is that the Highland metamorphic terrain was already deeply eroded before the emplacement of Newer granites and the crust was never sufficiently thickened enough to induce the rapid uplift and decompression required to produce widespread melting (Soper 1986).

7.5.3 Srike slip faulting

The main period of intrusion of Late Caledonian granites (440 to 390 Ma) coincided with major strike-slip faulting (e.g. Soper and Hutton 1984) during the closing of the Iapetus ocean. Such long continued strike-slip faulting is invariably accompanied by uplift, depression and rotation of blocks (Nur and Boccaletti 1989 in Leake 1990), compression (Soper et al.1987), extension (Pankhurst and Sutherland 1982) at different locations and times during this episode.

Leake (1990) postulated that the result of compression would be to depress and uplift crustal blocks. Those pushed down into the mantle would provoke partial melting of the lower crust while those uplifted would initiate isothermal melting of the mantle and lower crust (Leake 1990)**(Fig 7.3)**. Thus both mantle and crustally derived magmas would be produced. The existence of active fractures cutting right through the crust would serve to channel the intrusive and extrusive magmas up through the crust to active sites of extension where granite batholiths would fill the opening spaces (Leake 1990) **(Fig. 7.3)**.

The strong correlation between Caledonian granites and strike slip faulting is shown by many of the granites. In Ireland, the Leinster batholith was emplaced along a sinistral shear zone (Copper and Bruck 1983) .The Galway granite also occurs along the Skird Rock fault, a splay extension of the Southern Uplands fault (Leake 1963). In Scotland, Watson (1984) has correlated many of the Caledonian granites (e.g. Helmsdale granites) with the Great Glen fault. The emplacement of the Cairngorm granite has been suggested to reflect a tensional block fault system conjugate to the Great Glen fault set (Watson 1984). Potts et al (1995), showed that the Sound of Iona fault is one of many late Caledonian faults and postdates the Ross of Mull granite which strongly suggests the possibility of the granite being intruded through the fault (Potts , pers. comm). Leake (1990) concluded that the faulting and the crustal movements are not coincidently temporally related to the Caledonian granites but they are genetically related .

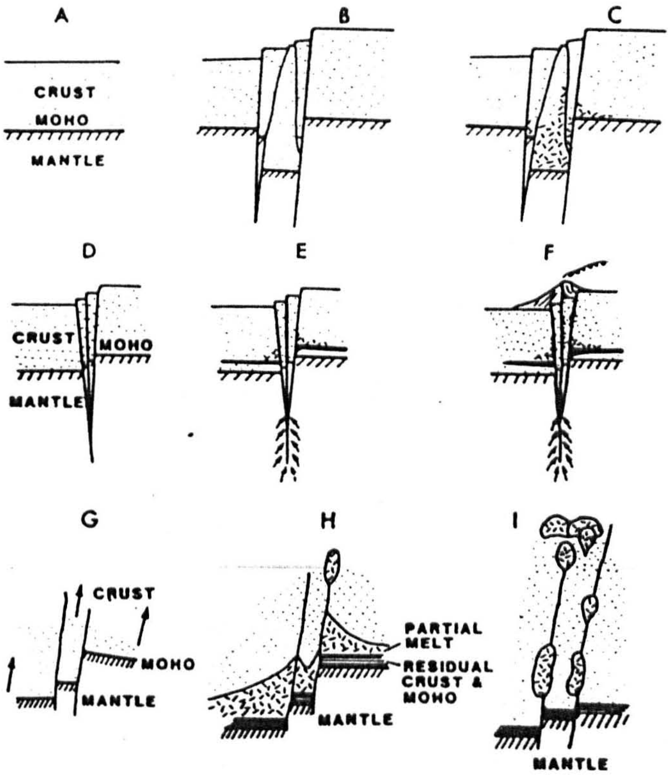
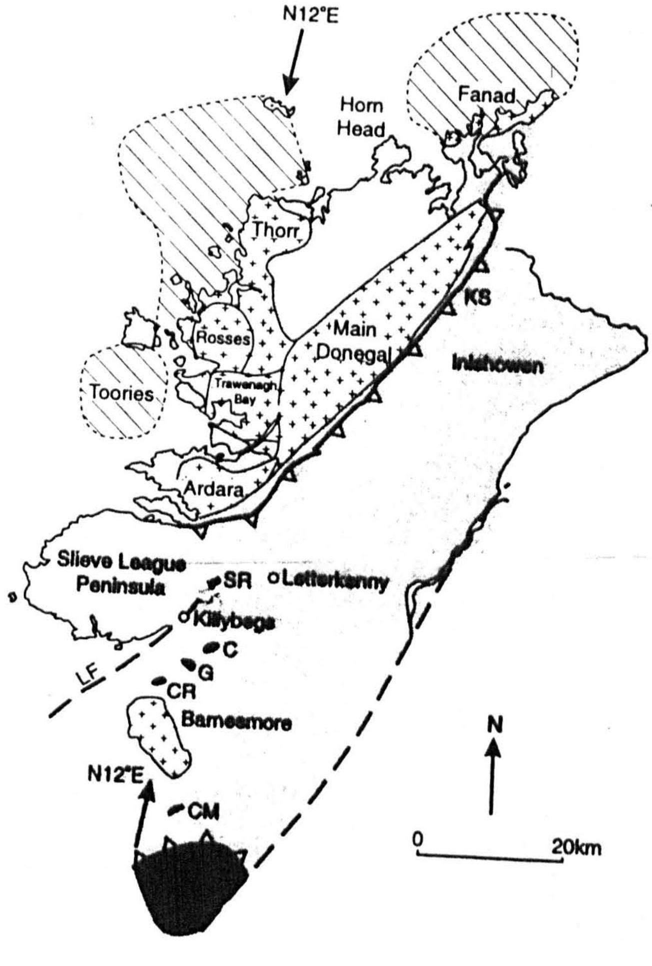


FIGURE 7.3 : Postulates of the influence of faulting on granite formation and emplacement (after Leake 1990). (A) Initial pre-fracture state. (B) Faulting with depression of a crustals block and some uplift. (C) Crustal melting due to depression into the mantle and isothermal melting due to uplift. Granite magma concentrates along fractures and begin to move upwards. (D) Deep fracturing of the crust and mantle . (E) Basic magma aggregates along the faults and intrudes the crust causing partial melting ; some basic magma injects as dykes. (F) Granite produced by partial melting moves sideways and upwards into the fractured zone; volcanic rocks are largely mantle derived but with some crustal contamination. (G) Differential uplift brings hot mantle blocks against the lower crust by upward and sideways motion thus provoking isothermal and other melting. (H) Granite magma gathers at fractures. (I) Granite plutons form and move upward, leaving restite.



MAP 7.7 : The Donegal granites and other Devonian acid intrusions after restoration of the Leannan fault system. Note that the alignment of Thorr,Rosses,Trawenagh Bay, Ardara and Barnesmore approximately along the direction of N12^{o}E (Hutton and Alsop 1996)

Recently Hutton and Alsop (1996) showed that the Caledonian strike swing and related lineaments, including faults **(Fig 7.3)** controlled the sedimentation, deformation and igneous intrusion pattern in Donegal. They also showed that after restoration of the 34 km sinistral displacement on the Leannan fault system five out of the eight Donegal granites would align remarkably along a direction approximately N12^{O}E **(Map 7.7)**. The five plutons are Thorr, Rosses, Ardara, Trawenagh Bay and Barnesmore. They suggested that the lineament (N12^{O}E) may represent a deep fault, reaching down into the granite source regions and which preferentially allowed magmas to be channelled up to the level of emplacement.

7.5.4. The mantle plume model

A mantle plume model appears to explain successfully a wide range of observations relating to both ocean island and flood basalt provinces (e.g. Griffiths and Campbell 1990). A plume ascending from the core-mantle boundary consists of a large volume head followed by a narrow and possibly long lived conduit. The conduits keep supplying mantle material to the ascending head. Upon reaching the upper crust, the head will spread and give rise to a disc of hot material predicted to be 1500 to 2500 km across and 100 to 200 km thick (Griffiths and Campbell 1990).

The volume of basaltic material in the plume head (probable temperature of 1300^{O}C to 1550^{O}C) may initiate partial melting of overlying continental crust (Hill et al.1992a). Conductive heat transfer into overlying mantle and crust may play an important role in the development of continental crust. The relationship between mantle plumes and continental tectonics has been reviewed by Hill et al. (1992a). They suggested that probable candidates for a plume head province include Late Caledonian granites terrains of Scotland and southeastern Australia.

Hill et al. (1992a) reviewed the magmatic history of two inferred plume head provinces ; Karoo and Yilgarn provinces. They showed that both areas have a rather similar magmatic history which is summarised below.

1. Partial melting of the bulk of a rising and spreading mantle plume head resulted

in an early period of basaltic volcanism and melting of much hotter material that ascended in the axial conduit and produced komatiites. Conduction of heat upwards - after a delay time of 25 Ma - resulted in the production of crustally derived melts. Heat transport by conduction will usually involve a time gap (of a few Ma to several tens of Ma) between mafic and felsic magmatism, as heat is conducted from the hot mantle source into the overlying crust (Hill et al.1992b). Thus the time gap between the start of mantle derived mafic magmatism (gabbroic rocks) and crustally derived felsic magmatism can be explained as being the time taken to conduct sufficient heat from plume head into the crust in order to initiate melting (Hill et al.1992b).

2. The first anatectic episode in the plume related area produced the early granites and volcanic rocks which were voluminous but of brief duration (several million years) as a consequence of conduction of heat into the crust.

3. Continued conduction of heat into the crust resulted in the production of second set of anatectic melts having high SiO_2, K_2O and Na_2O contents and low mafic mineral abundances. This second anatectic melts have been interpreted (Hill et al. 1992a) as indicating derivation from originally structurally higher material that underwent partial melting at lower temperature and pressures than during the first melting episode.

4. The youngest granites of the plume related area (High T-felsic magmatism) are alkali rich, water poor and may contain fluoride and alkali pyroxene.

Hill et al.(1992a) constructed the stratigraphies of the inferred plume related areas (Yilgarn and Karoo province), magmatic arcs (Sierra Nevada batholith) and igneous rocks from Lachlan fold belt **(Fig 7.4)**. In the present study , I have constructed the stratigraphy of the igneous rocks from the Caledonian orogeny in the British Isles for comparison **(Fig 7.4)**. The 'stratigraphy' of the Caledonian granites is more similar to a plume related area rather than subduction related area e.g. Sierra Nevada batholiths. This suggests that the Caledonian granites may not be related to subduction rather to some form of plume magmatism.

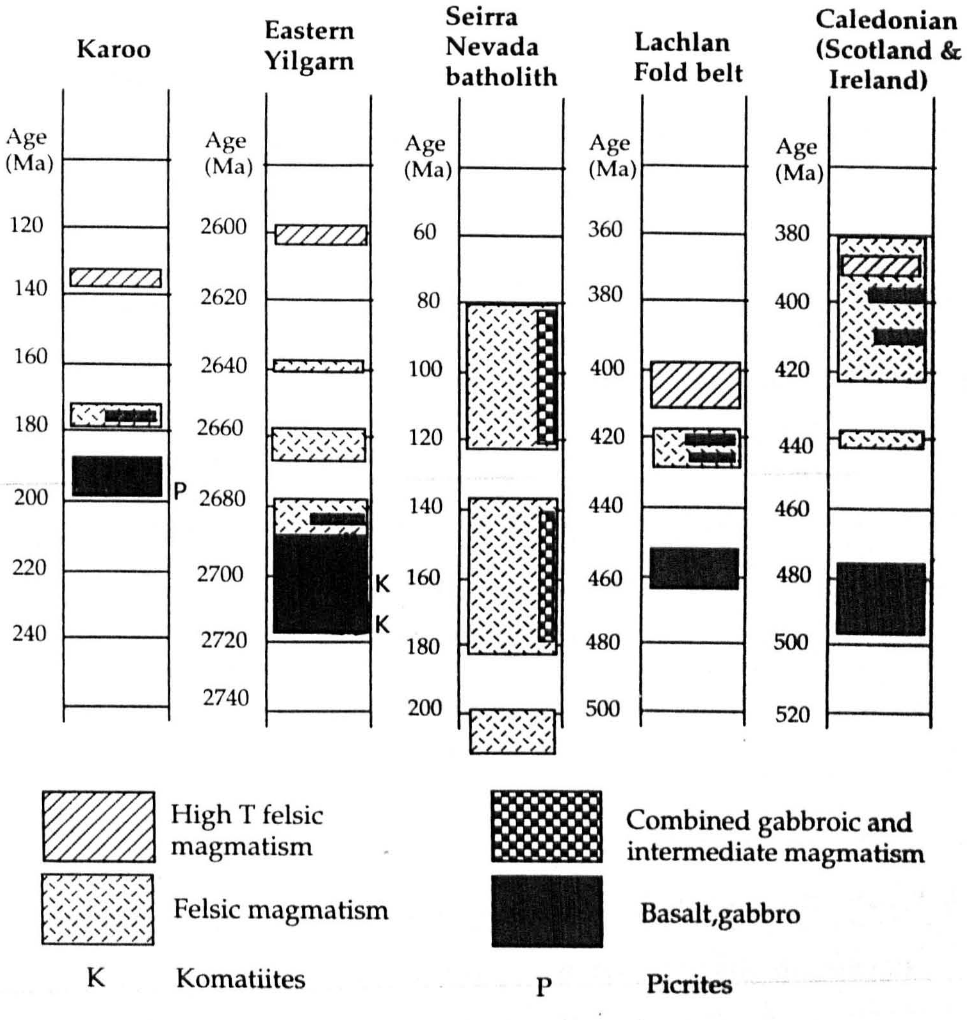


FIGURE 7.4 : Stratigraphic columns summarizing the magmatic history of, the Yilgarn and Karoo province, two inferred plume head provinces, a continental magmatics arc, e.g. Sierra Nevada batholith of western North America and the Lachlan fold belt of the southeastern Australia (after Hill 1992). The Caledonian granite (Ireland and Scotland) complexes are in many respects similar to Karoo and Eastern Yilgarn.

7.5.4.1 Problems with the plume model

Although the plume model seems to explain the occurrence of the Caledonian granites much better than the subduction model, it also has some problems .

1. There are no picrites and komatiites in the British Isles : No such rocks were found in the British Isles at the beginning of the Caledonian orogeny which can be related to plume activity.

2. Magmatic provinces associated with mantle plumes are predicted to be equant and have a diameter of 2000 km whereas the Caledonian granites province of the British Isles mainly consists of separate plutons and rarely formed a big batholith.

7.5.5 Discussion

In this chapter I have reviewed the occurrence and the tectonic setting of the Caledonian granites. I also reviewed the isotopic ages of the Donegal granites which showed them to belong to the late Caledonian granites (440 - 390 Ma) which are post plate closure and are usually associated with fault or fault uplift according to Pitcher (1993,p 280).

Stephens and Halliday (1984) have divided the late Caledonian granites of Scotland into three suites namely Argyll, Cairngorm and South of Scotland suites (Table 7.2). The Donegal granites have characteristics similar to the Argyll suite. These features include : predominantly granodiorite and diorite rocks with abundant associated appinitic bodies ; they are calc alkali with high Na_2O, Sr and Ba contents.

The association of the Caledonian granites with strike slip faulting or crustal movements is confined only to the late Caledonian plutons (less than 450Ma). Watson (1984) showed that crustal movement during this time coincided with the post collisional regime of strike-slip motion after Iapetus closed. Thus the crustal movement discussed in section 7.5.3 was clearly the crucial factor in the onset of the magmatism during the late Caledonian orogeny. In Donegal, intrusions of the granites coincided with major strike slip movements (Hutton 1982 ; Hutton and Alsop 1996). Hutton and Alsop (1996) also showed that these movements and associated lineaments controlled the

Dalradian stratigraphy and sedimentation pattern in the Donegal area.

The relation between mantle plume and uplift (e.g Griffiths and Campbell 1990 ; Nadin et al.1995) and extension (Houseman and England 1986 ; Hill 1991) of the crustal lithosphere has long been recognised . Surface uplift due to the positive buoyancy of the hot plume material has been quantified at as much as ~ 1000 m (Hill et al.1992a) . The amount of uplift can lead to extension of the overlying crust (Houseman and England 1986). Thus, if one accepts the importance of the plume model in the Caledonian orogeny, the crustal movements during this time probably related to the early stage rising of the plume head.

7.6 Summary

(1) Donegal granites are part of the late Caledonian granites and have similar characteristics to the Argyll suite of mainland Scotland.

(2) Faulting and the crustal movements are important factors in the emplacement of the late Caledonian granites.

(3) Conductive heat transfer by mantle plume into overlying mantle and crust may have been an important heat source in the formation of Caledonian granites.

CHAPTER EIGHT

CLASSIFICATION OF THE DONEGAL GRANITES

8.1 INTRODUCTION

At least 20 schemes of granite classification have been proposed. Among the criteria that have been used in classifying rocks of granitic composition are petrography (e.g. Orsini 1976 ; Tischendorf and Palchen 1985), mineralogy (e.g. Lameyre and Bowden 1982), peraluminosity (Shand 1943), zircon morphology (Pupin 1980), major elements chemistry (e.g Chappell and White 1974; Debon and Lefort, 1983) and tectonic environment (e.g.Pitcher 1983 , 1987).

This chapter is divided into two main parts. The first part is a brief review of the main schemes of granite classification, the second part is the application of some of these classifications to the Donegal granites.

8.2 CLASSIFICATION OF GRANITIC ROCKS.

8.2.1 Classification based on mineralogy

The main minerals of granitic rocks are quartz, plagioclase, alkali feldspar and mafics (mainly biotite & hornblende). Pitcher (1987) noted that the mineralogy and mode are important in the classification of the granitic rocks. One of the most widely used mineralogical classifications in igneous rocks is the quartz - alkali feldspar - plagioclase diagram (QAP) (Streckeisen 1967,1976). In this diagram, granitic rocks show considerable variation in the relative proportion of alkali feldspar (albite, orthoclase and microcline) and plagioclase (An>5) and contain between 20 - 60% quartz **(Fig 8.1)**. In this diagram, granitic rocks are subdivided into alkali feldspar granite, syenogranite, monzogranite, granodiorite and tonalite. It not only classifies rocks of granitic type but also more basic rocks such as diorite, monzonite, syenite and gabbro. Thus, the QAP classification is valuable in classifying the rocks of granitic series and their related intermediate and basic counterparts (Lameyre & Bowden 1982).

The QAP diagram discriminates three characteristic series among the large variety of granitic rocks associated in intrusions.The series are **(Fig 8.2)** (1) Calc-

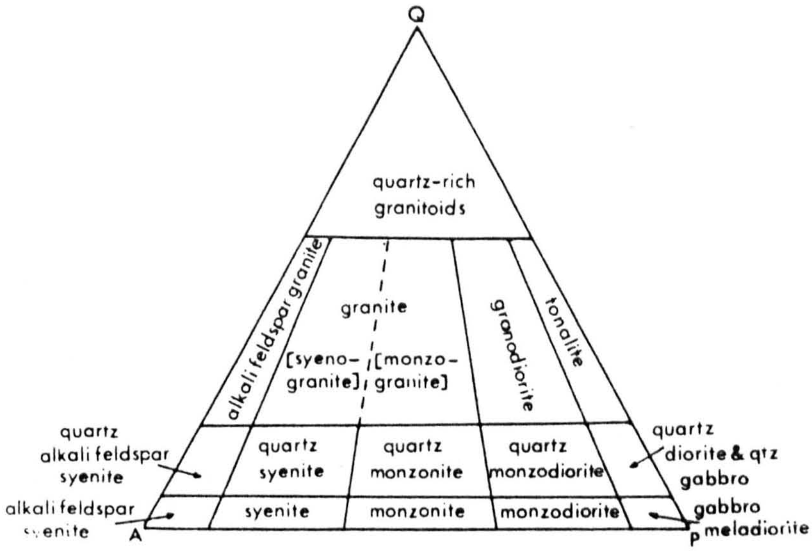


FIGURE 8.1 : Modal classification of granitic rocks (Streckeisen 1973).

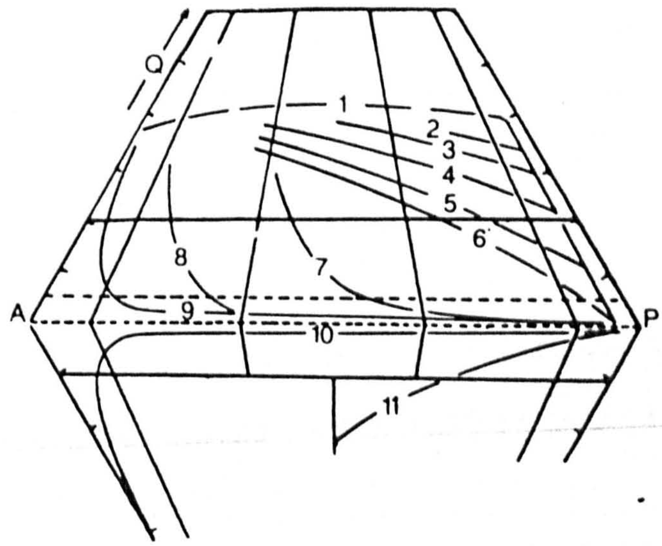


FIGURE 8.2: Main trends of some plutonic type series (modal composition). 1. tholeiitic series COLEMAN and PETERMAN (1975) ; WAGER and BROWN (1967) , 2 . Calc alkaline -trondhjemite series ARTH et al. (1978) , 3. Calc alkaline-granodiorite series ORSINI (1976) 4. ISHIHARA and ULRIKSEN (1980) , 5. ATHERTON et al.(1979) , 6. BATEMAN et al. (1963) , 7 . Monzonitic series ORSINI (1976) and PAGEL (1980) , 8,9,10,11. Alkaline series STRECKEISEN (1967),BOWDEN and TURNER (1974), BONIN (1980), GIRET and LAMEYRE (1980) , GIRET (1979)

alkaline series and its variants (2) Tholeiitic series (3) Alkaline series. The calc alkaline series can be further divided into calc- alkaline trondhjemite (Arth et al. 1978), calc-alkaline granodiorite (Atherton et al.1979 ; Bateman et al. 1963) and calc-alkaline monzonite (Orsini 1976 ; Pagel and Leterrier 1980) . Bowden et al.(1984) showed that each of the series has its own chemical characteristics and some are different in source material.

8.2.2 Classification based on the peraluminosity

This classification was introduced by Shand (1943) and is based on the molar proportion of Al_2O_3 to CaO, Na_2O and K_2O (e.g mol $Al_2O_3/CaO + Na_2O + K_2O$ (ACNK)). Thus granitic rocks have been divided into three groups, namely peraluminous granites : A > CNK, metaluminous granites : CNK > A > NK and peralkaline granites : A < NK (Clarke 1981).

Each of the subdivisions above can be recognised by the minerals present in the rock. Peraluminous granite is characterised by muscovite, garnet, cordierite and alumino-silicate and biotite (high $ACNK_{biotite}$) as well as normative corundum. Metaluminous granite can be recognised by the presence of hornblende, diopside and sphene and peralkaline granite by minerals such as riebickite, fluorite and acmite .

Peraluminosity in granitic rocks can be achieved through a number of diverse mechanisms: (1) melting of diopside normative basaltic and andesitic compositions to leave amphibole as a significant component in residues has been found by Heltz (1976) to produce corundum normative peraluminous melt, (2) crustal anatexis of peraluminous material such as pelite can also generate the peraluminous 'S' type granitic magmas (Chappell and White 1974), (3) fractional crystallisation of amphibole with appropriate Fe/Mg ratios (Cawthorn and O'Hara 1976) and (4) assimilation either by material or fluid contamination of metaluminous magmas by aluminous sediments during ascent and emplacement or post emplacement hydrothermal interactions between granitic rock and country rock (Atherton and Sanderson 1987).

8.2.3 Classification using opaque minerals.

This classification was suggested by Ishihara (1977) and is based on the occurrence of opaque oxides in granitic rocks. The opaque minerals used in this classification are ilmenite and magnetite. In this classification, *magnetite* and *ilmenite* series rocks can be distinguished by their different magnetic susceptibilities ; rocks of the magnetite series showing high values (more than 100 X 10 emu/g) while those of the ilmenite series have lower than 100 X 10 emu/g. Ishihara (1977) emphasized the role of crustal carbon in the generation of the ilmenite - series magmas while deep seated carbon free material and a tensional tectonic setting favoured the generation of magnetite series magmas. He suggested that oxygen fugacity was the most important variable controlling the formation of magnetite and ilmenite series. This suggests that the ilmenite series was generated in the middle to lower continental crust where pelitic rocks containing carbonaceous material may occur and that the magnetite series originated at greater depth i.e. upper mantle or lower crust. Although there were attempts to correlate this classification with the I/S type classification (Chappell and White 1974), the two classifications are not exactly equivalent (Takahashi et al. 1980). Comparison between the characteristic features of the two types of classification is given by Beckinsale (1979) and is shown in **Table 8.1.**

8.2.4. Classification using normative mineralogy

O'Connor (1965) introduced a normative An-Ab-Or classification of granitic rock which was modified by Barker (1979) **(Fig 8.3)**. In this diagram granitic rocks were divided into 5 main fields i.e. tonalite, granodiorite, quartz monzonite, trondhjemite and granite (s.s). The disadvantage of this diagram is probably the lack of the fields for more basic rocks such as monzodiorite, monzonite and diorite, often associated with granites.

Streckeisen and Le Maitre (1979) proposed a classification based on the normative minerals which is intended to mirror the Streckeisen QAP classification (Streckeisen 1967,1975). This rectangular diagram has two axes which reflect the silica saturation (y-axis , QU) and changing feldspar composition (x-axis , ANOR) **(Fig 8.4).**

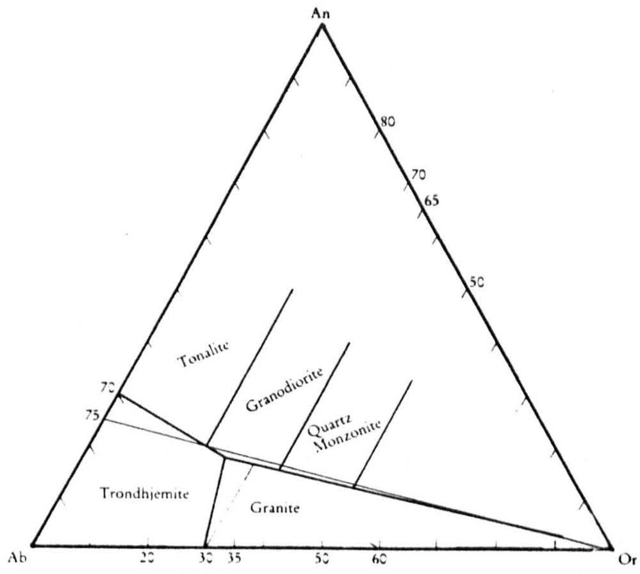
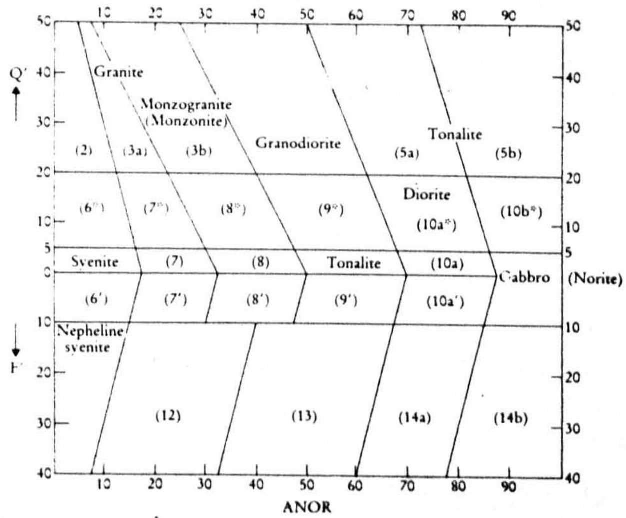


FIGURE 8.3 : The classification of 'granitic' rock according to their normative An-Ab-Or composition (Barker 1979)- heavy lines. The original fields of O'Connor (1965) are shown in faint lines.



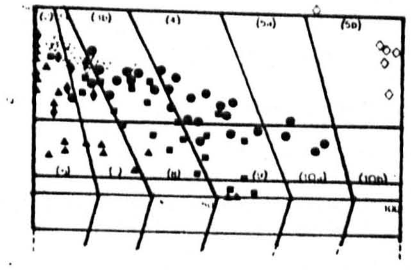


FIGURE 8.4 : The Q'-ANOR (normative) classification of plutonic rocks (Streckeisen and LeMaitre 1979). The small diagram is Q'-ANOR plot of rocks from various tectonic environment (Bowden et al.1984).

Open diamond : Plagiogranites from Cyprus and Oman
Closed circle : Cordilleran granitic rocks.
Closed square : Caledonian granitic, post orogenic rocks.
Closed diamond: 2-mica cordierite granites, Strathbogie, Australia.
Closed triangle : 'A' type granite - anorogenic rocks, Nigeria.
Open inverted triangle : 'A' type granite from Lachlan fold Belt.

I-type or magnetite-series granites	S-type or ilmenite-series granites
Tend to be the acid end of a broad compositional spectrum from basic to acid	Tend to occur in restricted ranges of only acidic compositions
Relatively high sodium contents	Relatively low sodium contents ($<3.2\%$ Na_2O in rocks with $\sim 5\%$ K_2O)
Low initial $^{87}Sr/^{86}Sr$ ratios (<0.708)	High initial $^{87}Sr/^{86}Sr$ ratios (>0.708)
Normal range of $\delta^{18}O$ values (approx. 6–10 ‰, SMOW)	Enriched in ^{18}O ($\delta^{18}O$ values $\geqslant$ about 10‰, SMOW)
Magmas with relatively high oxygen fugacity; relatively high ferric/ferrous ratios; characterized by magnetite	Magmas with relatively low oxygen fugacity; relatively low ferric/ferrous ratios; characterized by ilmenite
Hornblende and sphene commonly present	Muscovite, monazite, cordierite and garnet commonly present

TABLE 8.1 : Characteristic features of 'I' type /magnetite series and 'S' type/ Ilmenite series (after Beckinsale 1979).

	I-types	*S-types*
(i)	Metaluminous mineralogy; hornblende common and more abundant than biotite in mafic samples; accessory sphene common	Peraluminous mineralogy: biotite and muscovite predominate; no hornblende; some cordierite and/or aluminosilicates; monazite may be accessory
(ii)	Hornblende-rich igneous-appearing xenoliths	Pelitic or quartzose metasedimentary xenoliths
(iii)	Relatively high Na_2O	Relatively low Na_2O
(iv)	Molecular $Al_2O_3/(Na_2O + K_2O + CaO) < 1.1$	Molecular $Al_2O_3/(Na_2O + K_2O + CaO) > 1.1$
(v)	Normative diopside or small amounts of normative corundum	Normative corundum >1%
(vi)	Broad spectrum of compositions from mafic to felsic	Narrow range of more felsic rocks
(vii)	Regular inter-element variations within plutons; linear or near linear variation diagrams	More irregular variation diagrams
(viii)	Mafic hornblende-bearing enclaves	Metasedimentary enclaves
(ix)	Initial $^{87}Sr/^{86}Sr$ 0.704–0.706	Initial $^{87}Sr/^{86}Sr$ >0.708
(x)	Usually unfoliated; contacts strongly discordant· well developed contact aureoles	Often foliated; sometimes surrounded by high grade metamorphic rocks

TABLE 8.2 : Summary of distinctive features of the 'S' and 'I' type granites of Lachlan Fold Belt as originally proposed by Chappell and White (1974).

Bowden et al. (1984) plotted granites from different environments on this diagram (oceanic plagiogranite, Cordilleran granite, Caledonian granite, Australia 'S' type granite and Nigerian anorogenic granite , **Fig 8.4)** and recommended that the diagram should be used more widely in future studies as all of the series can be separated.

8.2.5 Classification based on zircon morphology

The idea of using zircon in the characterisation of granitic rocks was developed by Poldervart (1950,1956). Later, Pupin (1980) divided granitic rocks into three main groups based on the morphology of zircon populations found in rocks. They are:

(a) crustal origin (autochthonous and aluminous granites),

(b) mantle origin (alkaline and tholeiite granites),

(c) mixed origin (calc alkaline and sub-alkaline granites).

Varva (1994) studied the internal morphology of zircon crystals from different types of granites. He observed that the morphological evolution of zircon varies systematically between the different granitic types. He concluded that important factors controlling the zircon morphology in the different types of granitic rocks are high cooling rates, magma mixing, enrichment of H_2O and trace elements in residual liquids and the major element chemistry of the magma (Na and K to Al).

8.2.6 Alphabet classification

The concept of alphabet classification (adopted from Clarke 1992) in granitic rocks was introduced by Chappell and White (1974). This classification was developed by these authors in a series of papers on the Lachlan Fold Belt, Australia (e.g. Chappell and White 1984, 1991 ; White and Chappell, 1983, 1988).

The first subdivision of this classification was between those granites derived from a sedimentary or igneous source rock. The distinction between 'I' and 'S' type granitic rocks is largely genetic. 'I' type granites are considered to have been generated from igneous source materials and 'S' types granite from a sedimentary source (White and Chappell 1974). Relative to 'I' type granites, 'S' type granites are low in Na, Ca and Sr, three elements which are lost during conversion of feldspar to clay minerals by weathering of sedimentary rock and are higher in Pb, Cr and Ni. As a result 'S' type granite is always corundum normative or peraluminous and becomes more strongly so as the rocks become more mafic (Chappell 1984). Felsic 'I' types are mildly peraluminous and overlap 'S' types, but more mafic 'I' types are metaluminous .

'I' and 'S' type rocks also show different characteristic minerals; 'S' types contain Al-rich minerals such as muscovite, andalusite, cordierite or sillimanite etc. and 'I' type rocks are characteristically hornblende bearing with accessory sphene. $^{87}Sr/^{86}Sr$ ratios for 'S' type granite is more than 0.707 whereas for 'I' type it is less than 0.705. The summary of distinctive features of both types as originally proposed by Chappell and White (1974) are given in **Table 8.2.** **Table 8.3 a and b** show the specific geochemical characteristics of 'I' and 'S' types granites (White and Chappell 1983)

'A'-type granite was introduced by Loiselle and Wones (1979) for granites found in anorogenic areas. The letter 'A' also indicates the alkaline and anhydrous nature of 'A'-type granite. Collins et al. (1982) found that the chemical characteristics of 'A'-type granites from Lachlan Fold Belt, Australia include low MgO and CaO and high Na_2O+ K_2O **(Table 8.5).** They can be peraluminous and metaluminous. The geochemical characteristics of 'A' type granitic rocks are shown in **Table 8.3 c.**

'M'-type granite (White,1979 ; Pitcher 1983) was introduced for granite that originates in the mantle. This type of granite is usually associated with ophiolite. Among the characteristics of the 'M'-type granite are A/CNK < 1, strontium ratio < 0.705 and $\partial^{18}O$ < 9‰, implying a mantle source (Clarke 1992) .The origin of these granites can either be indirectly through partial melting of subducted oceanic crust or directly by extended fractional crystallisation of basalt.

Castro et al. (1991) introduced a new alphabet classification of granitic rocks. They reviewed the 'I'/'S' classification of Chappell and White (1974) and introduced hybridization as a new element in the granite typology particularly in orogenic environments. A new term - hybrid ('H' type) has been suggested to replace the 'I' type

TABLE 8.3 : Characteristic of (a) I type (b) S type (c) A type granite. (After White and Chappell 1983)

PARAMETER	CHARACTERISTIC VALUE	EXPLANATIONS
SiO_2	Wide range (53 - 76 %)	Relatively mafic source rocks
K_2O/Na_2O	Low	Na has not been removed by weathering.
K_2O/SiO_2	Variable	Derived from source rocks of moderate and variable content
Ca	High in mafic rocks	High Ca in source ; not removed by weathering.
A/CNK	Normally low	Only minimum tempreture melts or fractionated I type may be peraluminous
Fe^{3+}/Fe^{2+}	Moderate	
Cr and Ni	Low	Source rocks relatively low in Cr and Ni , indicating prior fractionation
$\partial^{18}O$	Low	Primary igneous source rocks
$^{87}Sr/^{86}Sr$	Generally Low	Mantle derived igneous source rocks.Some high value for granitoids derived from old source with high Rb/Sr

a

PARAMETER	CHARACTERISTIC VALUE	EXPLANATIONS
SiO_2	Within range 65 - 74%	Derived from SiO_2 rich source
K_2O/Na_2O	High	K adsorbed by clays on weathering,whereas Na is removed
Ca and Sr	Low	Removed in weathering cycle
A/CNK	High (> 1.05) and increase as the rocks becomes more mafic.	Weathering increase Al relative to Na + K + Ca
Fe^{3+}/Fe^{2+}	Low	Carbon common in sedimentary source rocks
Cr and Ni	High relative to I types	Cr and Ni incorporated into clays during weathering
$\partial^{18}O$	High	Oxygen isotopes fractionates during production of clays during low temp.weathering
$^{87}Sr/^{86}Sr$	High (normally > 0.708)	Rb concentrated relative to Sr during weathering and sedimentation

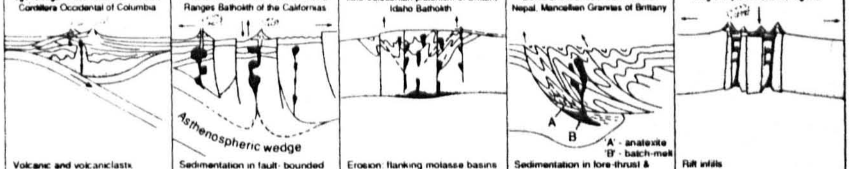
b

PARAMETER	CHARACTERISTIC VALUE	EXPLANATIONS
SiO_2	Usually high , often near 77%	Small degree of partial melting
Na_2O	High	Small degree of partial melting
CaO	Low	Small degree of partial melting,Ca not compatible with melt structure.
Ga/Al	High	Ca complexed in melt , plagioclase in residue.
Y and REE	high except Eu	Complexed in melt , with much Eu remaining in anorthite
Nb and Sn	High	Complexed in melt
Zr	Normally high , particularly in more mafic varieties	Complexed in melt
F and Cl	High	Source rock is a residue from an earlier melt and rich in F and Cl.

c

Granitoid types				
S-type	H_s-type	H_{ss}-type	H_m-type	M-type
Leucogranites (2 mica) sienogranites to monzo-granites	monzogranites to granodiorites	granodiorites and tonalites	tonalites (fine grained mostly)	quartzdiorites and tonalites
Metamorphic restites (biot., sill., cord., etc.)	metamprohic restites, mafic enclaves scarce	mafic enclaves predominate	poor in enclaves scarce or no restites	only cumulate-like enclaves
Residual phases from the melting reaction (K-feld, cord, sill, etc.) biot.-sill. clots	K-felds. megacrysts and cord. from the melting reaction, biotite clots	K-felds. megacrysts resorbed. reaction cord → bi frequent, hb-bi clots	hb clots characteristics from px → hb reaction bi. → hb reaction	stable ferromagnesian phases, only peritectic reactions
Simple zoning in plag., no resorbtion zones	complexely zoned plagioclases with conspicuous resorbtion zones			oscillatory, simple zoning in plag.
No xenocrysts	scarce or no xenocrysts (acicular apatite?)	hornblende clots xenocrysts	plag., K-felds. and q. xenocrysts	no xenocrysts
Major association with regional, high-grade metamorphism	generally associated with M-type and S-type granitoids in large batholiths with transitional contacts; at epizonal levels, each type can appear in isolated, single plutons			generally associated with minor bodies of ultramafic rocks
Crustal isotopic ratios $\delta^{18}O \geq 10‰$ Sr initial ratio > 0.708 $\epsilon_{Nd} \ll 0$	isotopic ratios very variable; isotopic ratios are generally intermediate between mantelic and crustal ratios; mixing lines are characteristic			Sr initial ratio < 0.704 $\epsilon_{Nd} > 0$ generally (depleted mantle)
$K_2O/Na_2O > 1$		K_2O/Na_2O close to 1	$K_2O/Na_2O < 1$	
Saturation alumina index (SAI) > 1		SAI close to 1	SAI < 1	tholeiitic affinities
Partial melting of metasedimentary rocks compositional variations explained by restite unmixing	developed by magma mixing (hybridization) between mantle-derived mafic magmas (M-type) and supracrustal anatectic (S-type) magmas			fractionation of mantle-derived, basaltic magmas

TABLE 8.4 : Alphabet classification by using hybridation as a new element (After Castro et al.1991)



OROGENIC				ANOROGENIC
Oceanic Island arc	Continent margin arc, liminal basin	Post-closure uplift	Oblique continental collision (Transpression)	Major rifting
egs. Bougainville, Solomon Islands, Cordillera Occidental of Columbia	Coastal Batholith of Peru, Peninsular Ranges Batholith of the Californias	Late Caledonian plutonism of Britain, Idaho Batholith	Liotse and Manaslu Batholiths of Nepal, Mancellian Granites of Brittany	Ring complexes of Jos, Nigeria
Volcanic and volcaniclastic aprons	Sedimentation in fault-bounded marginal basins	Erosion: flanking molasse basins	Sedimentation in fore-thrust & pull-apart basins	Rift infills
Island arc basalts	Andesites & dacites in great volume	Plateau-type basaltic volcanicity	Often lacking volcanism esp. felsic	Alkali lavas, tuffs, as caldera infill
Burial metamorphism	Burial metamorphism	Strongly discordant aureoles	Regional, low-pressure metamorphism	
Gabbro, 'M'-type quartz diorite in mature arcs	'I'-type tonalite & granodiorite dominate, lesser granite & gabbro	'I' & 'S'-type granodiorite in contrasted association with diorite & gabbro	Migmatites, the Granite Series, largely 'S'-type granites	Biotite granite, alkali granite and syenite, A-type
Small zoned plutons	Discordant, linear batholiths feeding volcanoes	Dispersed plutons taking advantage of range of tectonic accidents	Concordant, 'diapir' batholiths & sheets in active shear zones	Resurgent subsidence cauldrons
Open folding	Spreading-minimal shortening	Strike-slip & normal faulting, uplift	Shortening & thrust thickening	Rifting
Au-bearing porphyry-Cu	Mo-bearing porphyry-Cu	Metals rarely concentrated	Sn & W skarn, vein & replacements	Sn, Nb, U, Th minerals in vugs and pegmatites
Ocean-ocean subduction	Ocean-continental subduction	Rapid, post-closure uplift	Inter-continental 'subduction	Encratonic or post-orogenic rifting
Short-lived, though sustained	Long-lived, episodic	Relatively short-lived 'bursts'	Episodic recycling over long periods	Relatively short-lived
Partial melting of mantle-derived, metamorphosed, mafic underplate	Partial melting of mantle-derived underplate' plus crustal contribution within continental lip	Partial melting of old, tonalitic lower crust plus mantle & mid-crustal contributions	Partial melting of recycled crustal material by ultrametamorphic anatexis: reworking as batch-melts	Partial melting of old mantle, or exhausted lower crust under anhydrous but F,B-rich conditions
Hot, 'dry', quartz-diorite magma rising high into new crust	Hot, 'dry' tonalitic magma rising high into the new & old crust	Moderately hot and 'dry', evolved, crystal-bearing magma rising to various levels	Relatively warm, 'wet', granitic mush freezing at depth, with autometamorphic recrystalization	Relatively hot, fluidal magma, rising to near surface with subsolidus crystalization
Subduction energy – transfer of heat by mafic magmas		Adiabatic decompression, plus heat transfer by mafic magmas	Blanketing by tectonic thickening of radiogenic crust, plus slab transfer of heat	Decompression on fast release from deep crustal trap

TABLE 8.5 : Granite classification according to their tectonic occurrence (after Pitcher 1993).

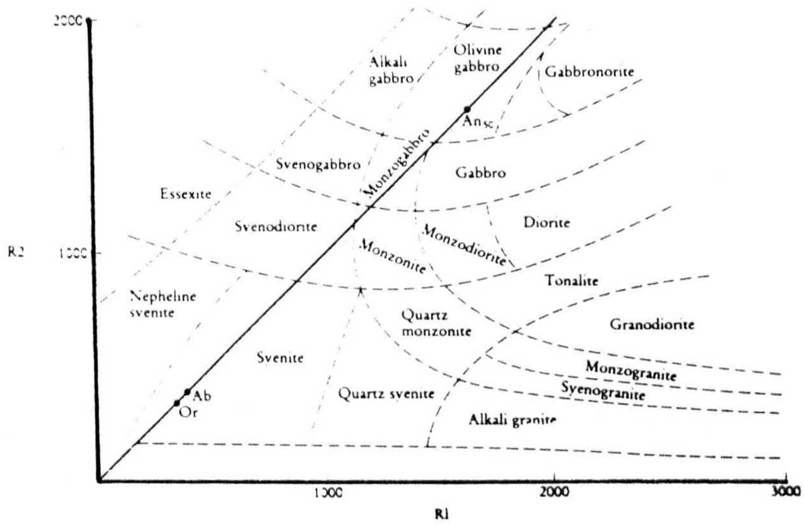


FIGURE 8.5 : The classification of plutonic rock using parameter R1 and R2 (after de la Roche et al.1980).
R1= 4Si - 11(Na+K) - 2(Fe+Ti) ; R2=6Ca + 2Mg + Al.

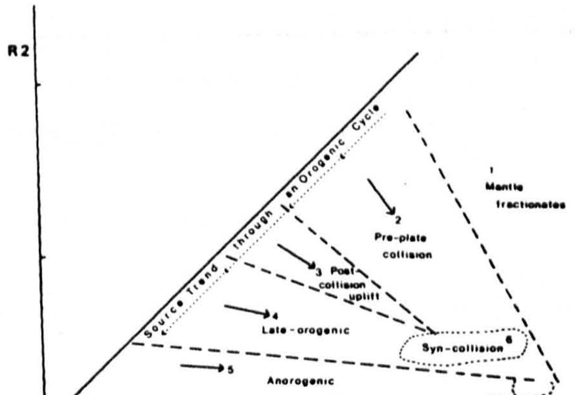


FIGURE 8.6 : Summary diagram of the major granitic association, base on Pitcher (1979,1983) and Harris et al. (1983) (after Batchelor and Bowden 1985).

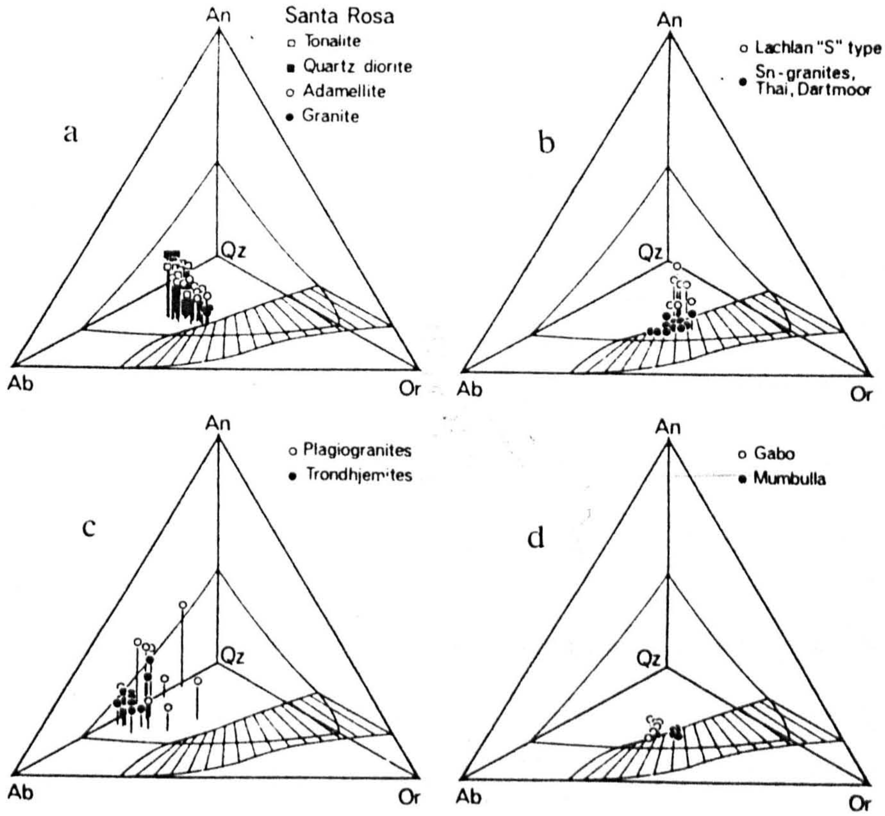


FIGURE 8.7 : Various granitic rocks plotted in the An-Ab-Or-Qz tetrahedron (a) Santa Rosa-major super unit from the Coastal Batholith Peru (Atherton 1984) ; (b) Lachlan'S' types granites (Chappell 1984) , and Thai granites (Ishihara et al. 1980) and Dartmoor (Watson et al.1984) ; (c) Plagiogranite and trondhjemites (Malpas 1979) ; (d) `A' type granites (Collins et al. 1982).

(after Atherton 1988)

granite. They suggested that in orogenic environments, 'H'-type granite may be developed from the mixing of mantle derived magmas ('M'-type) and anatectic, supracrustal melts (S-type). The 'M' and 'S' types magmas were regarded as the end members of the 'H' type. By mixing these two end members, they suggested that three 'H' types magmas can be produced. These are H_S ('S'-type predominates), 'H_m' ('M' type predominates) and H_{SS} ('S' and 'M' equal). The distinctive features of these types are given in **Table 8.4.**

8.2.7 Classification based on the major element cation proportions.

De La Roche et al.(1980) proposed a classification scheme for volcanic and plutonic rocks based upon their cationic proportions of major elements, expressed as millications. The diagram is a X - Y bivariate graph using the plotting parameters R1 and R2 where :

$R1 = 4Si - 11(Na + K) -2(Fe + Ti)$

$R2 = Al + 2Mg + 6Ca)$

The diagram is important in classifying granitic and associated rocks **(Fig 8.5).** Among the advantages of using this diagram are (1) the entire major element chemistry of the rock is used in the classification, (2) the scheme is sufficiently general to apply to all types of igneous rock and (3) the degree of silica saturation and changing feldspar compositions can be shown. Batchelor and Bowden (1985) showed that the diagram can discriminate five granitic groups related to the tectonomagmatic divisions proposed by Pitcher (1979,1983 , **Fig 8.6)** .

8.2.8 Lineages and granitic series.

Atherton (1988) suggested that granitic rocks should be considered in terms of the lineage which produced the major variation at the exposed level. A large number of parameters have to be considered to complete the definition of the lineage among which are ascent modification and fractionation, mixing, final crystallisation and tectonic regime (Atherton 1990).

The lineage character of a granitic series can be expressed using the QAP modal diagram (Streikeisen 1967) and the system An-Ab-Or-Qz-H_2O. The importance of the latter lies in the fact that most granitic batholith rocks contain more than 80% normative An-Ab-Or-Qz, so their evolution can be readily shown in the granite system. Different lineages and mineral paragenesis can be plotted in the An-Ab-Or-Qz diagram (Atherton 1988,1989) **(Fig 8.7).**

8.2.9 Tectonic classification of granitic rocks.

This classification has been proposed by Pitcher (1983,1987,1993). He suggested a five fold classification of the granites depending on their tectonic setting **(Table 8.5).** According to Pitcher (1983) "the close relationship between granite type and geological context is because granite in the widest sense, arises at the end stage of several generative processes involving different source rocks, each process and source being appropriate to a particular environment". The survey is mainly based on granites of Phanerozoic age (Pitcher 1983). Granitic rocks were first divided into two main types, Orogenic and Anorogenic. The Orogenic granites have been further subdivided into four types according to their tectonic setting namely oceanic island arc, continental margin arc, post closure uplift and continental collision **(Table 8.5).**

8.2.10 Synthetic classification

Barbarin (1990) summarised many of the previous granitic classifications, then offered yet another classification. He compared some twenty previous granite classifications **(Table 8.6).** In almost all classifications, alkaline and peralkaline granites are separated from calc-alkaline, peraluminous and metaluminous granites. Most of the classifications distinguished three groups of granites corresponding to their sources i.e. crustal, mantle-derived or mixed.

Barbarin (1990) noted that the majority of orogenic granites originate at the crust-mantle interface and involve crust and mantle components. He later suggested that granites can be broadly divided into three main petrogenetic groups (1) almost

Classification Basis	Authors	Origin						
		Crustal			Mixed		Mantle	
First chemical Nomenclatures	Shand (1943)	PERALUMINOUS rocks			METALUMINOUS rocks			PERALKALINE rocks
	Lacroix (1933)	Roches Calco-ALC. HYPERALUMINEUSES		Roches CALCO-ALCALINES				Roches ALCALINES
Petrography	Capdevila and Floor (1970) Capdevila *et al.* (1973)	Granites MESOCRUSTAUX		Granites MIXTES	Granites BASICRUSTAUX			
	Orsini (1976 and 1979)			A.M. SUB-ALC. ALUMINEUX	A.M. SUB-ALC. HYPOALUM.	A.M. CALCO-ALC		
	Yang Chaoqun (1982)		MM-TYPE	CR-TYPE	MS-TYPE			MD-TYPE
	Tischendorf and Palchen (1985)	S_I	S_S	S_I	I_{KK}	I_{OK}	I_{MT}	I_{MA}
Enclaves	Didier and Lameyre (1969) Didier *et al.* (1982)	C-TYPE (Crustal) ("Leucogranites")			M-TYPE (Mixed or mantle) ("Monzogranites & Granodiorites")			
Mineralogy (QAP system)	Lameyre (1980) Lameyre and Bowden (1982)	"LEUCOGRANITES" (Crustal fusion)		CALC-ALKALINE Series (High K, Medium K or Low K)			THOLEITIC Series	(PER) ALKALINE Series
Mafic Minerals	Rossi and Chevremont (1987)	A.M. ALUMINOPOTASSIQUE (s.s. ou composites)			A.M. MONZONITIQUE	A.M. CAL-COALCALINE	A.M. THO-LEITIQUE	A.M. (PER) ALCALINE
Biotite Composition	Nachit *et al.* (1985)	Lignées ALUMINO-POTASSIQUES			Lignées CALCOALCALINES et SUBALCALINES			Lignées ALCALINES et HYPERALCALINES
Zircon Morpology	Pupin (1980 and 1985)	TYPE 1	TYPE 2	TYPE 3	TYPE 4 & 5		TYPE 7	TYPE 6
Opaque Oxides	Ishihara (1977) Czamanske *et al.* (1981)	ILMENITE Series				MAGNETITE Series		
Geochemistry (Major Elements)	Chappell and White (1974 and 1983) Collins *et al.* (1982), Whalen *et al.* (1987)		S-TYPE		(I-TYPE)*		M-TYPE	(A-TYPE)*
	La Roche (1986) La Roche *et al.* (1980)	AK-L M.A.	AK-G M.A.		SA M.A.	CA M.A.	TH M.A.	A-PA M.A.
	Debon and Lefort (1983 and 1988)	ALUMINOUS M.A.			ALUMINO—CAFEMIC and CAFEMIC M.A. (Subalkaline, calc-alkaline, tholeiitic, and (per)alkaline)			
	Maniar and Piccoli (1989)	CCG			POG	CAG	IAG / OP	RRG / CEUG
Geochemistry (Trace Elements)	Tauson and Kozlov (1973)	PLUMASITIC LEUCOGR	ULTRA-MM GRANITES	PALINGENIC GRANITES (Normal and Subalkalines)			PLACIO-GRANITES	AGPAITIC LEUCOGRANITES
	Pearce *et al.* (1984)	C O L G - Collision Granites (Syntectonic) (Post-tectonic)				VAG Volcanic Arc Granites	ORG	WPG Within Plate Granites
Associated Mineralizations	Xu Keqin *et al.* (1982)	TRANSFORMATION TYPE (Continental crust)			SYNTEXIS TYPE (Transitional crust)		MANTLE—DERIVED TYPE	
Tectonic Environment	Pitcher (1983 and 1987)	HERCYNOTYPE		CALEDONIAN TYPE		ANDINOTYPE	W.PACIFIC TYPE	NIGERIA TYPE
Suggested classification		C_{ST}	C_{CA}	C_{CI}	H_{LO}	H_{CA}	T	A

TABLE 8.6 : Comparison of the main petrogenetic classification of granitic rocks (after Barbarin 1990)

(BARBARIN, 1990)

<table>
<tr><th>- ORIGIN -</th><th colspan="2">- GRANITOID TYPES -</th><th colspan="2">- TECTONIC SETTING -</th></tr>
<tr><td rowspan="3">CRUSTAL ORIGIN

PERALUMINOUS ROCKS</td><td>Intrusive Two-mica Leucogranites</td><td>C_{ST}</td><td rowspan="4">COLLISION
OR
POST-COLLISION
ZONES</td><td rowspan="6">OROGENIC GRANITOIDS</td></tr>
<tr><td>Peraluminous Autochtonous Granitoids</td><td>C_{CA}</td></tr>
<tr><td>Peraluminous Intrusive Granitoids</td><td>C_{CI}</td></tr>
<tr><td rowspan="2">MIXED ORIGIN (Crust + Mantle)

METALUMINOUS
OR CALC-ALKALINE ROCKS</td><td>Potassic Calc-Alkaline granitoids
(High K - Low Ca)</td><td>H_{LO}</td></tr>
<tr><td>Calc-Alkaline Granitoids
(Low K - High Ca)</td><td>H_{CA}</td><td rowspan="2">SUBDUCTION
ZONES</td></tr>
<tr><td rowspan="3">MANTLE ORIGIN

THOLEIITIC, ALKALINE
OR PERALKALINE ROCKS</td><td>Island Arc Tholeiitic Granitoids</td><td>T_{IA}</td></tr>
<tr><td>Midocean Ridge Tholeiitic Granitoids</td><td>T_{OR}</td><td rowspan="2">RIFTING OR DOMING
ZONES</td><td rowspan="2">ANOROGENIC GRANITOIDS</td></tr>
<tr><td>Alkaline and Peralkaline Granitoids</td><td>A</td></tr>
</table>

TABLE 8.7 : Proposed classification obtained from the comparison of the main petrogenetic classification of the granitic rocks and the relationships to the origin of the magmas and tectonic settings (After Barbarin 1990)

exclusively crustal orogenic group (C-group) (2) hybrid orogenic granites with mixed origin, both crustal and mantle derived (H-group) and (3) mantle derived anorogenic granites (T-or A-group).

In this synthetic classification, eight types of granitic rocks fit into the three main categories of rocks of crustal, mantle and hybrid (crust + mantle) origin **(Table 8.7).** This classification underlines the close relationship between the origin of granitic rocks and their tectonic setting.

8.3 CLASSIFICATION OF THE DONEGAL GRANITES

In this part the Donegal granites will be classified using some of the classifications that have been surveyed in the first part of this chapter. Pitcher (1983) has classified the granites together with other Caledonian granites of the British Isles as Caledonian `I' type that occur in a post closure uplift tectonic regime. Dempsey (1987) studied the geochemical aspects of Barnesmore pluton and said that the pluton is subalkaline and generally peraluminous. Barbarin (1990) has grouped the granites as calc-alkaline type with high-K and low-Ca.

8.3.1 Classification by mineralogy

Modes of the quartz, alkali feldspar and plagioclase of the 120 samples from the Donegal granites are given in Appendix 2. They were plotted on a QAP diagram (Streckeisen 1967; **Fig 8.8 , Fig 8.9**). In terms of the granite series (Lameyre and Bowden 1982 ; Bowden et al. 1984), the Donegal granites fall in the calc-alkaline granodioritic series, similar to the subduction related granitic rocks from Cordilleran granites (Bateman 1963). However, the geological evidence (see chapter 7 for discussion) does not support this conclusion. In general the Rosses, Trawenagh Bay, Ardara, Thorr, Fanad and Barnesmore plutons belong to the calc-alkaline granodioritic series. The Main Donegal granite however show a trend similar to the calc-alkaline trondhjemite series (Arth et al.1978 and **Fig 8.9**).

The granitic rocks from Rosses, Barnesmore, Trawenagh Bay and some of the rocks

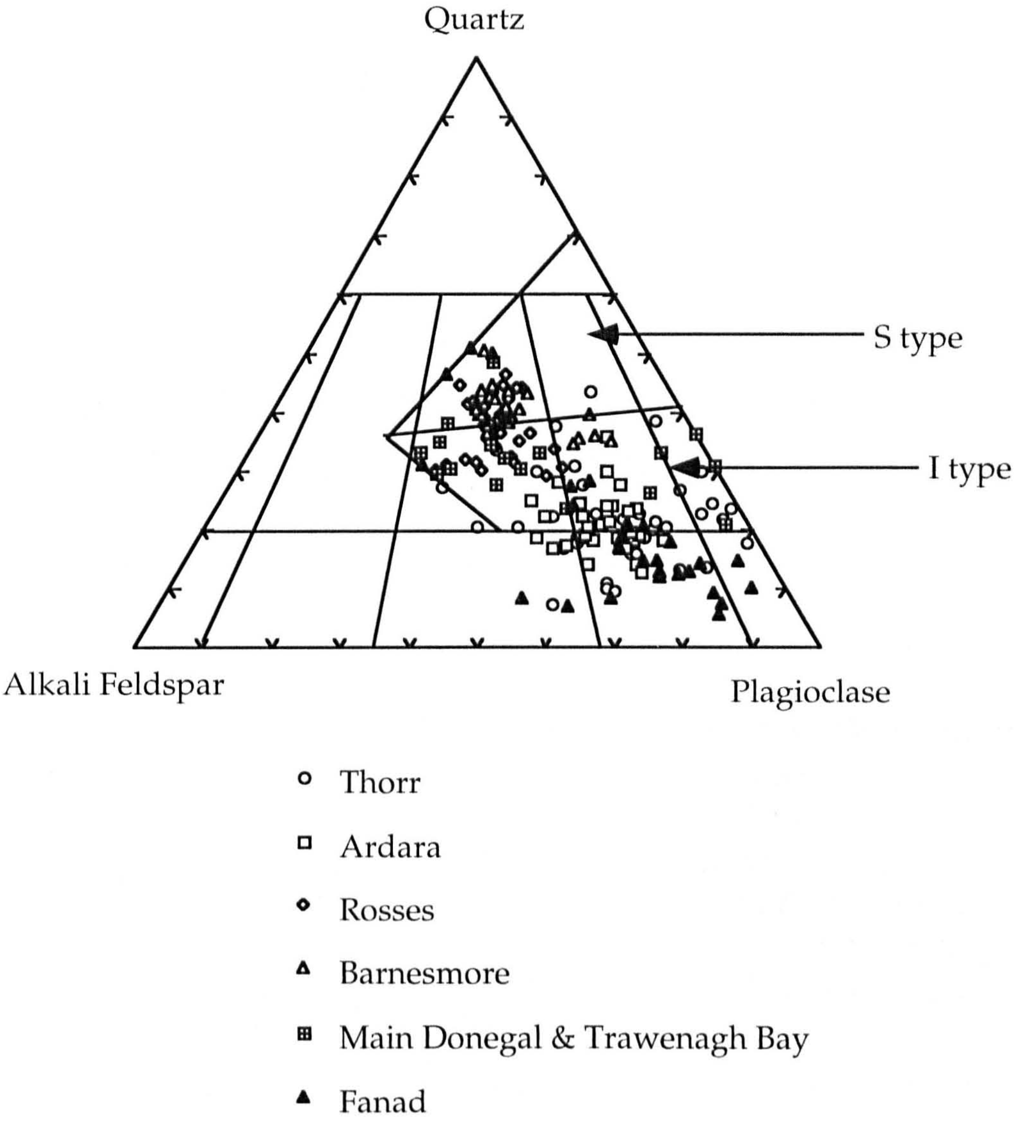


FIGURE 8.8 : Modal Q-A-P plot for the Donegal granites. The field of 'S'-type and 'I'-type granitic rocks from Lachlan fold belt, Australia (Bowden et al. 1984) is also shown. It shows that the general trend is similar to calc alkaline granodiorite series (Atherton et al. 1979 ; Bateman et al. 1963).

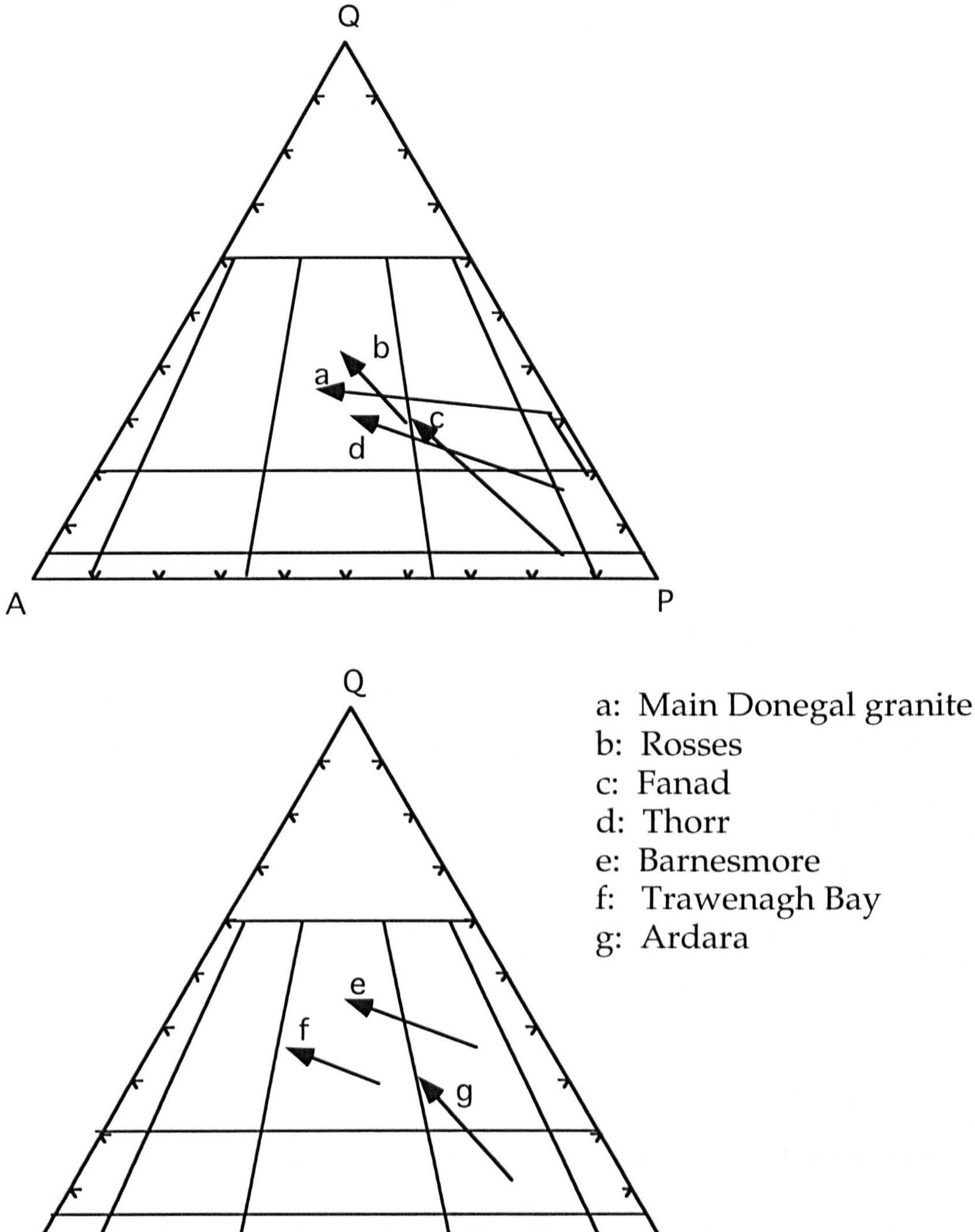


FIGURE 8.9 : Lineages of individual plutons of the Donegal granites plotted in the Q-A-P diagram (Streckeisen 1967).

from the Main Donegal granite (granite-granodiorite) occupy a central area of the diagram **(Fig 8.8)**. Granites plotting in this area have been regarded as crustal melts (Bowden et al.1984) and this suggests the importance of crustal material in the source rocks of those plutons. Furthermore many of the rocks from Rosses and Barnesmore plutons plot in the 'S'-type field of Lachlan fold Belt (Bowden et al. 1984) **(Fig 8.8)**.

8.3.2 Classification based on the peraluminosity

A plot of aluminium saturation index (ACNK) versus SiO_2 for the Donegal granites is shown in **Fig 8.10**. In general the ACNK value for the Donegal granites range from metaluminous to peraluminous. Quartz monzodiorite from the Fanad pluton has the lowest ACNK value (0.8) and the highest ACNK values are from 'contact' facies rocks of Thorr pluton (1.32). The range of ACNK for individual plutons are given in **Table 8.8**.

The plots of ACNK versus SiO_2 for the individual plutons are shown in **Fig 8.11.** The ACNK value for the Ardara and Rosses plutons increases and the Main Donegal and Barnesmore decreases with SiO_2. There are no clear trends for the Thorr, Fanad and Trawenagh Bay plutons.

(1) Trawenagh Bay : all Trawenagh Bay rocks plot in the 'I' type field (Chappell and White 1974) with the majority of the rocks being slightly peraluminous.

(2) Main Donegal : the samples from the Main Donegal granite plot in both metaluminous to peraluminous fields with considerable grouping of data points near the line of ACNK = 1. All samples plot in the 'I' type field.

(3) Ardara : The majority of the samples from the outer unit plot in the 'I' type field and are metaluminous. The samples from the inner unit show a wider range of ACNK from metaluminous to peraluminous, only 2 samples from this unit fall in the 'S' type field. These samples were collected from the inner unit of the Ardara pluton.

(4) Fanad : The samples are mainly metaluminous with some slightly peraluminous. All samples from Fanad plot in the I type field

(5) Rosses : Samples from Rosses show consistent variation of increasing ACNK (metaluminous to peraluminous) from porphyry dykes to G4. The majority of the samples

Pluton	Range ACNK
Trawenagh Bay	0.85 to 1.09 (1.01)
Main Donegal granite	0.95 to 1.14 (1.01)
Fanad	0.86 to 1.09 (0.94)
Ardara Outer Unit	0.86 to 1.03 (.94)
Ardara Inner Unit	0.92 to 1.12 (1.02)
Rosses G1	0.95 to 1.12 (1.03)
Rosses G2	0.89 to 1.12 (1.04)
Rosses G3	0.94 to 1.16 (1.03)
Rosses G4	0.99 to 1.2 (1.08)
Thorr normal facies	0.92 to 1.07 (1.0)
Thorr contact facies	1.03 to 1.32 (1.13)
Barnesmore G1	1.01 to 1.12
Barnesmore G2	1.02 to 1.11
Barnesmore G2pf	1.01 to 1.05
Barnesmore G3	0.95 to 1.04

TABLE 8.8 : Range of ACNK values of different plutons of the Donegal granites.

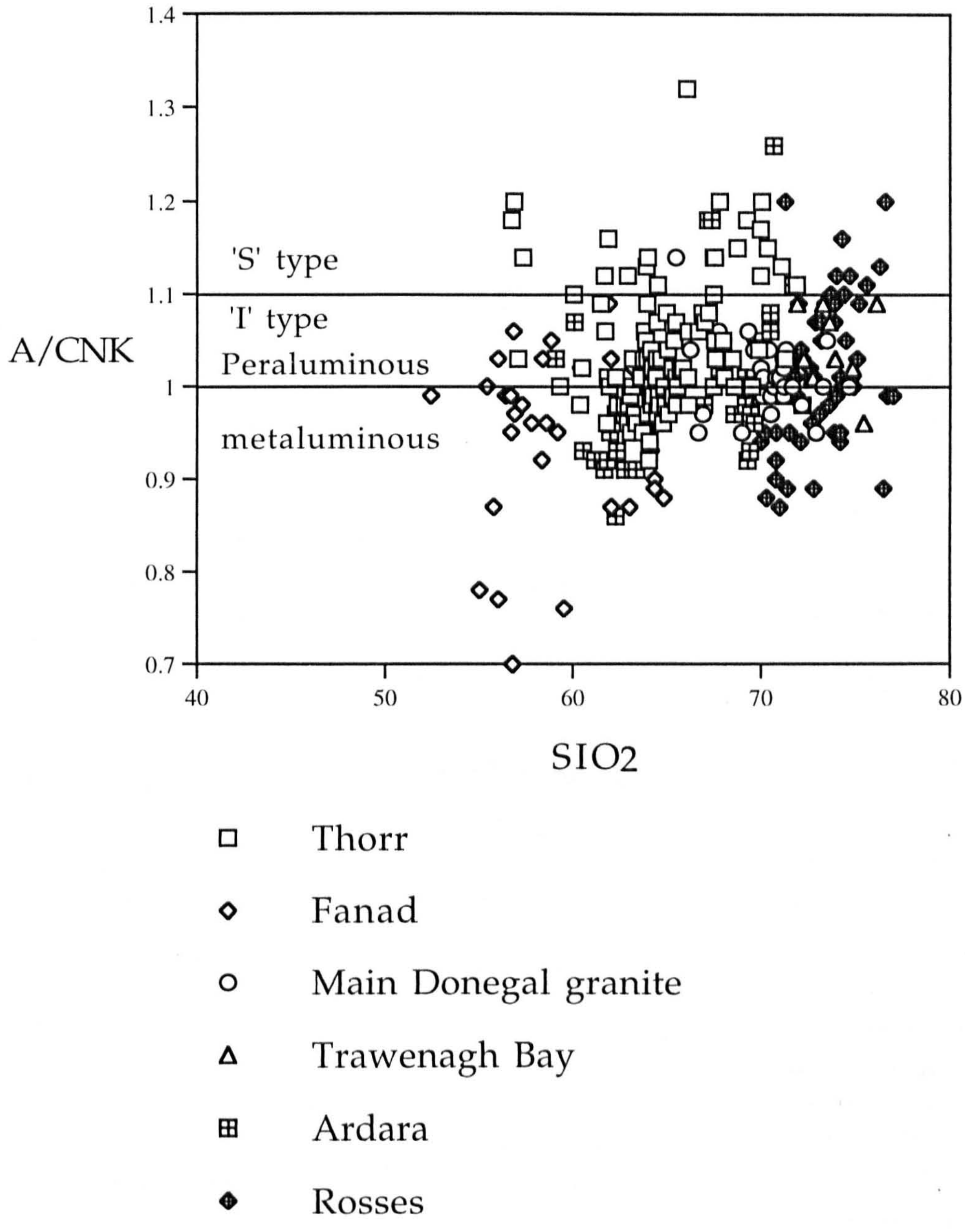


FIGURE 8.10 : Al2O3/CaO+Na2O+K2O vs SiO2 diagram for Donegal granites. Line at ACNK=1 divided between peraluminous and metaluminous (Shand 1927) and line at ACNK=1.1 divided between I type and S type granite (Chappell and White 1974)

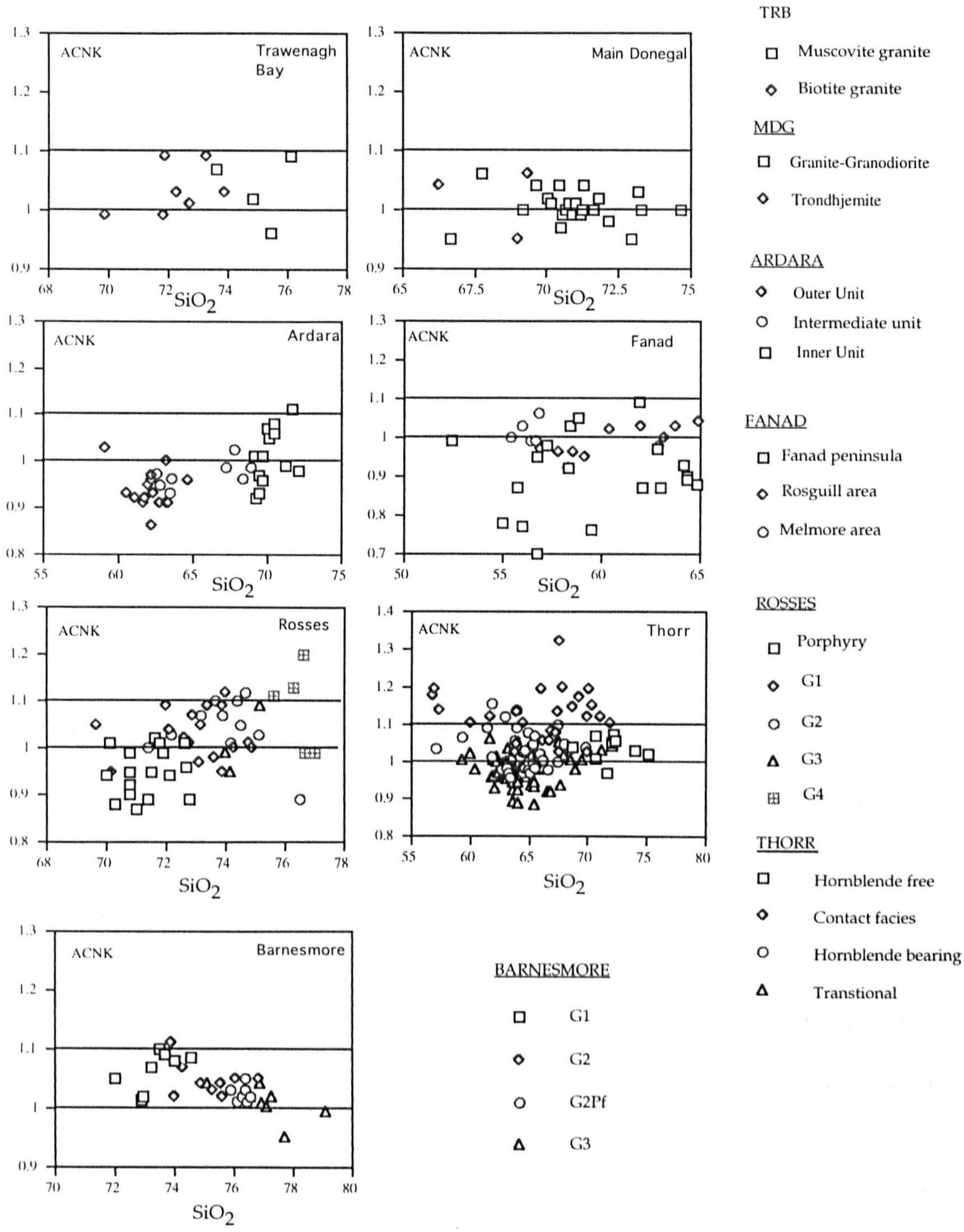


FIGURE 8.11 : ACNK vs SiO_2 for individual plutons of the Donegal granites. Line ACNK=1 divides peraluminous and metaluminous field and line ACNK = 1.1 divides the 'I' and 'S' type granite (Chappell and White 1974).

plot in the 'I' type field. Three samples from G4 and one each from G1 and G2 plotted in the 'S' type field.

(6) Thorr : In Thorr, the samples from the contact facies plot in the 'S' type field and all are peraluminous. Hornblende free, hornblende bearing and transitional facies rocks are metaluminous to slightly peraluminous and plot mainly in the 'I' type field

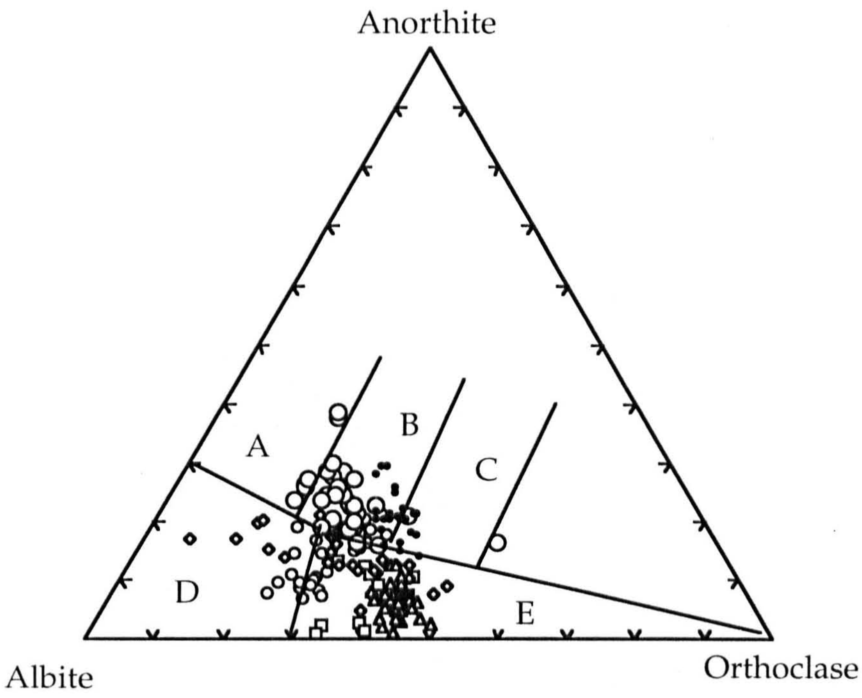
(7) Barnesmore : In contrast to the Rosses, the Barnesmore samples show slight decrease of ACNK with increasing SiO_2 from G1 to G3. The majority of the samples are peraluminous and plot in the 'I' type field.

The diagrams **(Fig 8.11)** show that most of the Donegal granites (except the contact facies from Thorr and the G4 of the Rosses plutons) are 'I' type and are metaluminous to slightly peraluminous. Both G4 from Rosses and contact facies rocks from Thorr gained peraluminosity by high level interaction with fluid and pelites respectively.

8.3.3 Normative classification.

The normative data for rocks of the Donegal granites were plotted on an An-Ab-Or triangular diagram (Barker (1979), **Fig 8.12**). All Rosses samples plot in the granite(s.s) field. This is similar to the Rosses rocks in a Q-A-P diagram and in the major element plots (de La Roche 1980 ; Batchelor and Bowden 1985). 20% of the rocks of the Main Donegal granite plot in the trondhjemite field and grade into the granite field. Fanad rocks plot mainly in the granodiorite and tonalite fields. Thorr rocks plot in the granodiorite to the granite field.

The other normative plot , the Q' vs ANOR (Streckeisen and Le Maitre 1979) is shown in **Fig 8.13**. The rocks trend from granite to monzogranite to granodiorite to tonalite. This general trend follows the Caledonian post orogenic trend of Bowden (1984). All Rosses, Trawenagh Bay and Barnesmore samples plot in the granite and monzogranite fields whereas Ardara, Main Donegal, Fanad and Thorr samples grade from granodiorite to tonalite.



- o Ardara
- □ Trawenagh Bay
- ◇ Main Donegal
- △ Rosses
- O Fanad
- • Thorr

A= Tonalite
B= Granodiorite
C= Quartz Monzonite
D= Trondhjemite
E= Granite

FIGURE 8.12 : Classification of the Donegal granites by using normative anorthite, albite and orthoclase (after Barker, 1979)

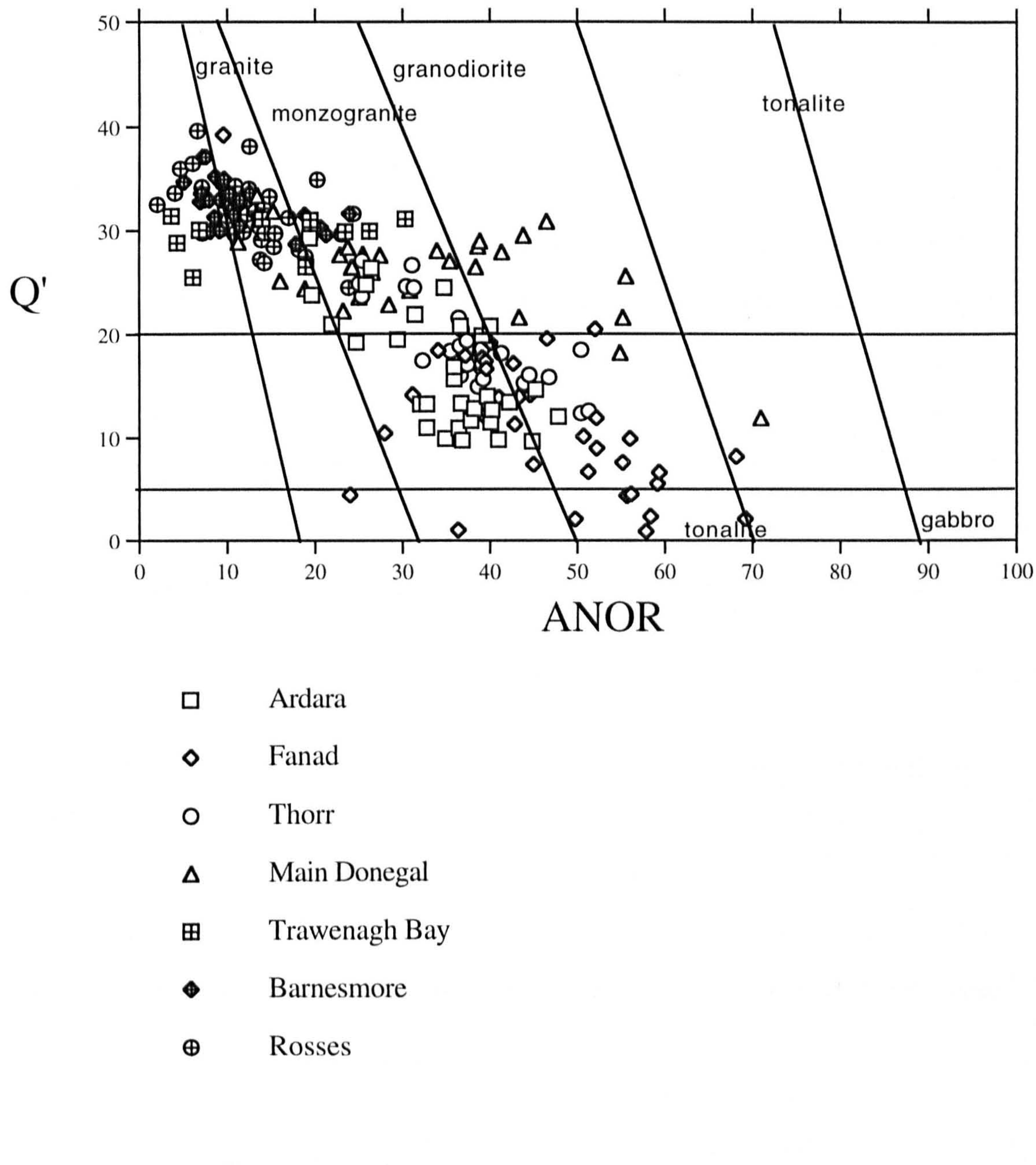


FIGURE 8.13 : Q'-ANOR plot for the Donegal granites. The main trend of the plot follows the Caledonian post orogenic trend of Bowden et al. (1984)

8.3.4 Alphabet classification

On a plot of Na_2O vs K_2O **(Fig 8.14)**, 99% of the samples of Donegal granites plot in the 'I' type field of White & Chappell (1983); only two rock samples fall into the 'S' type field. They are from the 'contact' facies of the Thorr pluton.

Comparison of the Donegal granites with the original 'I'/'S' type classification (Chappell and White 1974) is shown in **Table 8.9.** In terms of their mineralogy, the Donegal granites show both metaluminous and peraluminous characteristics. Metaluminous mineralogy is evident in the basic plutons such as Fanad, Ardara and Thorr which contain hornblende and accessory sphene. The more felsic plutons such as Rosses, Trawenagh Bay, Main Donegal and Barnesmore show peraluminous mineralogy including muscovite and garnet. They do not contain hornblende. The Donegal granites also have a wide range of SiO_2 between 52% to 77%. This is comparable to the SiO_2 range of the original 'I' type (White and Chappell 1983) between 53% to 76% **(Table 8.3a)**.

8.3.5 Major element classification.

Major element data from Donegal granites have been plotted in R1-R2 diagram of De La Roche et al.(1980) **(Fig 8.15)**. This diagram shows that, in terms of rock types the Donegal granites range from monzodiorite to tonalite to granodiorite to monzogranite and syenogranite (cf. **Fig 8.5)**. Fig 8.15 also shows the tectonic setting of the granites. The general trend of the Donegal granites coincides with the trends defined by the post collision uplift and late orogenic granitic trends.

8.3.6 Tectonic classification

It has been shown (section 8.3.5) that the Donegal granites are 'I' type according to the Chappell and White (1974) classification. Pitcher (1983) has divided the 'I' type granites into two types according to their tectonic environment i.e.'I' (Cordilleran) and 'I' (Caledonian) type granite. Comparison of the characteristics of these two types to the Donegal granites **(Table 8.10)** shows that the Donegal granites have both 'I'type (Caledonian) and 'I' type (Cordelleran) characteristics.

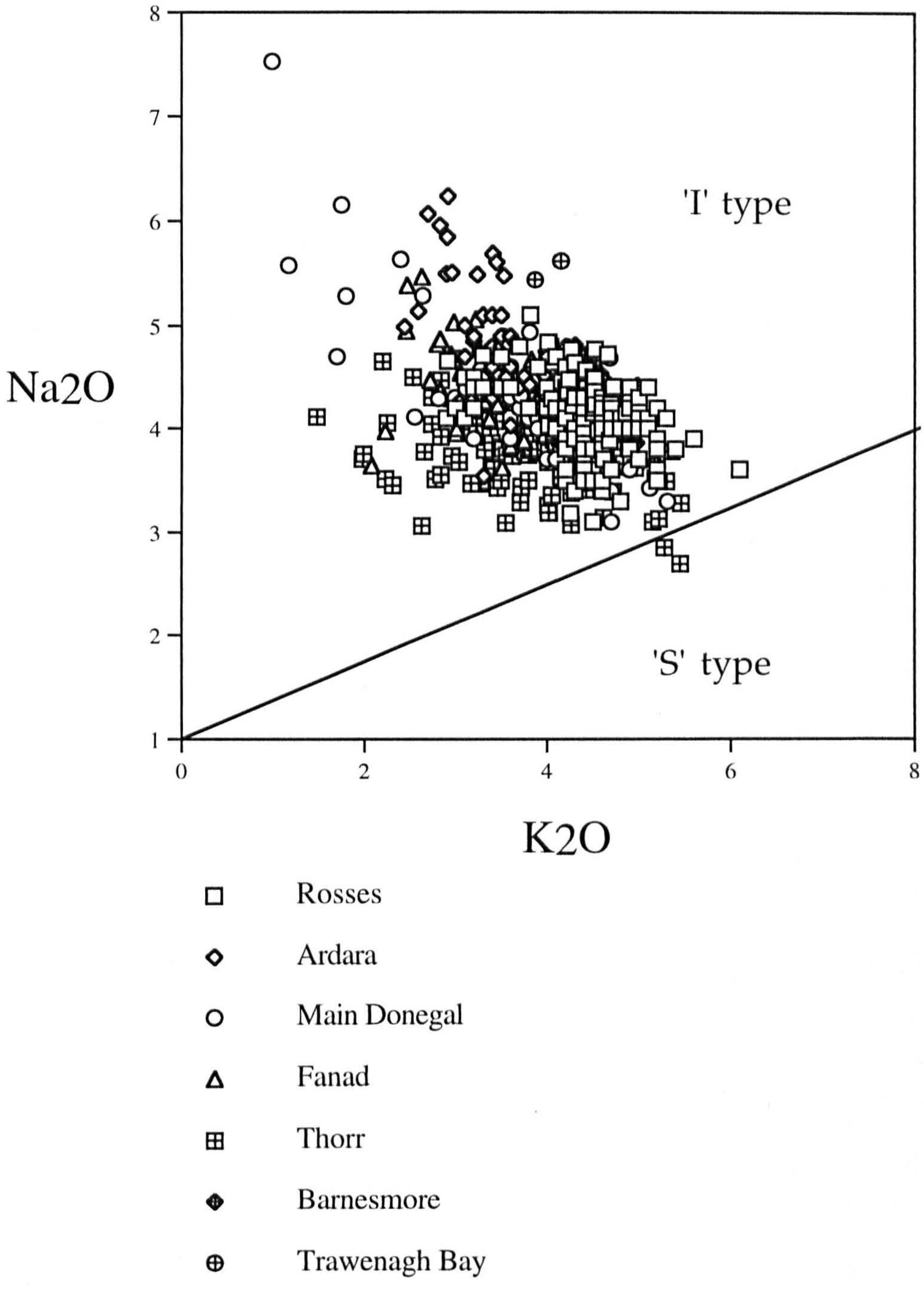
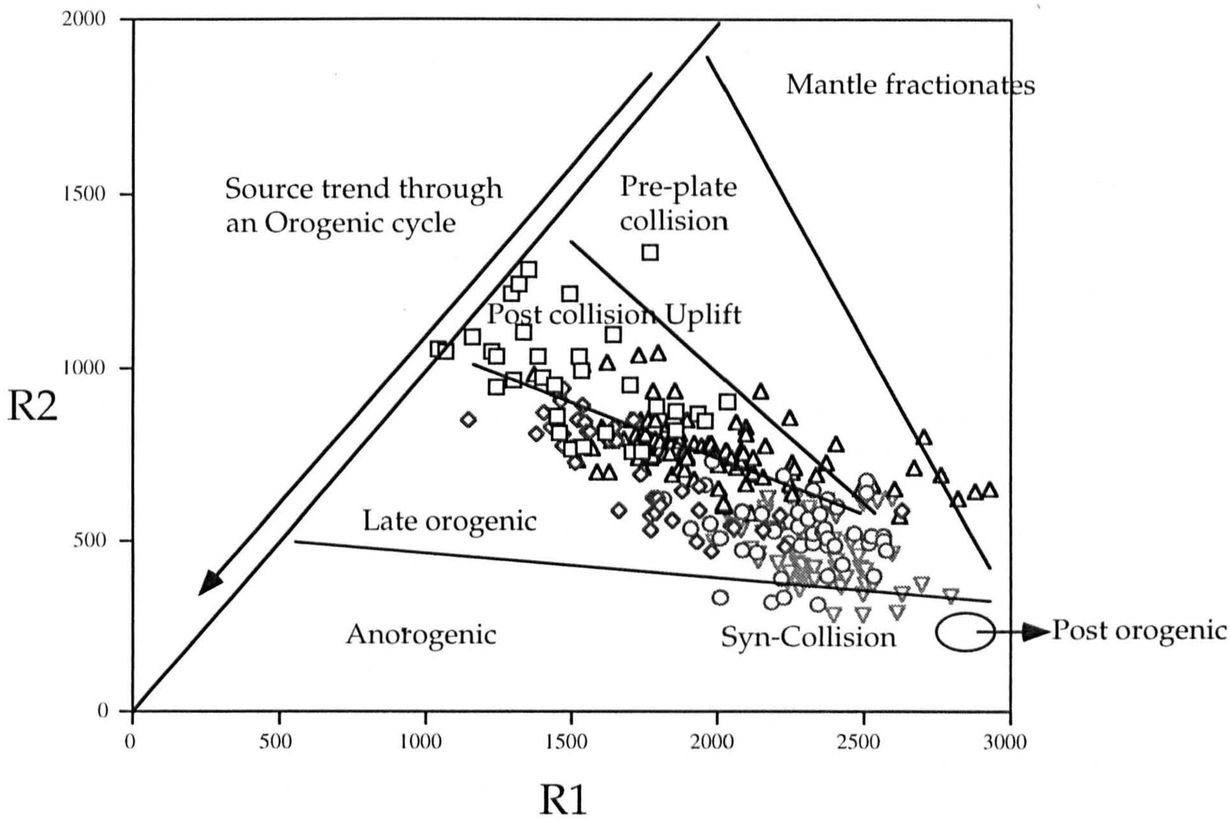


FIGURE 8.14: Plot of Na2O vs K2O for the Donegal granites. The 'I' and 'S' type field is after Chappell and White (1983). (n = 705)

'I' Type	'S' Type	Donegal granites
Metaluminous mineralogy, hornblende and accessory sphene common. hornblende exceed biotite in mafic samples	Peraluminous mineralogy : no hornblende, biotite and muscovite predominate, with cordierite,aluminosilicate ,monazite and garnet.	Metaluminous and peraluminous mineralogy present. Hornblende and sphene occur in more basic plutons (Fanad,Thorr and Ardara). Muscovite, garnet occur in more felsic pluton (Rosses, Trawenagh Bay, Main Donegal and Barnesmore
Hornblende rich igneous appearing xenoliths	Pelitic or quartzose metasedimentary xenoliths	Both igneous and sedimentary xenoliths to rafts size occur (Thorr, Fanad, Main Donegal and Ardara)
Relatively high Na_2O	Relatively low Na_2O	Relatively high Na_2O
ACNK < 1.1 , normative diopside or small amount of normative corundum	ACNK > 1.1 and normative corundum > 1%	ACNK : 0.86 to 1.32
Broad spectrum of composition mafic to felsic	Narrow range of more felsic rocks	Generally broad range of composition from mafic (diorite,quartz monzodiorite) to granodiorite and trondhjemite to felsic composition (granite (s.s.))
Regular interelement variations within plutons;linear or near linear variation diagrams	More irregular variation diagrams	Regular inter-element variation within plutons.
Initial 87Sr/86Sr - 0.704 - 0.706	Initial 87Sr/86Sr >0.708.	Initial 87Sr/86Sr - < 0.707

TABLE 8.9 : Comparison of 'I'/'S' types (Chappell and White 1974) with the Donegal granites.



□ Fanad

◇ Ardara

○ Main Donegal & Trawenagh Bay

△ Thorr

▽ Rosses

R1 = 4 Si - 11(Na+K) - 2 (Fe + Ti)

R2 = 6Ca + 2 Mg +Al

FIGURE 8.15 : R1-R2 diagram (De La Roche et al. 1980) and major tectonic association (Pitcher 1979,1983) of the Donegal granites.

'I' TYPE CORDILLERAN	'I' TYPE CALEDONIAN	DONEGAL GRANITE COMPLEX
Tonalite dominant but broad compositional spectrum	Granodiorite-granite contrasted association with minor bodies of hornblende diorite & gabbro	Quartz monzodiorite-granite association with minor appinite bodies
Hornblende ,biotite,magnetite and sphene	Biotite predominated,ilmenites and magnetite	Biotite predominate(Brown > green > reddish), hornblende magnetite, sphene
K-feldspar interstitial and xenomorphic	K-feldspar interstitial and invasive	K-feldspar interstitial and invasive
Dioritic xenoliths ; may represent restitic material	Mixed xenolith populations	Mixed xenoliths populations
ACNK - 1.1	ACNK - 1	ACNK 0.7 - 1.32
$^{87}Sr/^{86}Sr < 0.706$	$^{87}Sr/^{86}Sr > 0.705 < 0.709$	$^{87}Sr/^{86}Sr$ 0.705 - 0.707
Great multiple,linear batholiths with arrays of composite cauldrons	Dispersed,isolated complexes of multiple plutons and sheets	Isolated batholith with distinct plutons , multiple & sheets
Associated with great volumes andesites and dacite	Sometimes associated basalt-andesites lave plateaux	Lacking of voluminous volcanic equivalent

TABLE 8.10 : Comparison of the Donegal granites to the 'I' type Caledonian and 'I' type Cordilleran. Both I type classifications after Pitcher (1983).

8.3.7 Summary

The Donegal granites are metaluminous to slightly peraluminous (ACNK : 0.86 - 1.2) and generally belong to the calc-alkaline granodiorite series. The granites are 'I' type according to the Chappell and White (1974) classification except the contact facies of the Thorr and the G4 of the Rosses plutons which show apparent 'S' type characteristics. In terms of tectonic classification the Donegal granite is 'I' (Caledonian) type which is late orogenic granite. A summary of the classification of the Donegal granites is shown in **Table 8.11.**

CLASSIFICATION	DONEGAL GRANITE	REFRENCES
1) Q-A-P		Streckeisen (1967)
Rock type	Quartz monzodiorite to granodiorite to granite with minor trondhjemite.	
Trend	Calc -alkaline granodiorite	Atherton et al.(1979) Bateman et al.(1963)
2) ACNK	Metaluminous to peraluminous	Shand (1943)
4) Normative An-Ab-Or	Tonalite to granodiorite to granite with minor trondhjemite	Baker (1979)
5) R1-R2 classification		
Trend	Subalkaline (similar to Ploumanac'h granite)	De La Roche (1980)
Tectonic	Post collision uplift to late orogenic.	Bowden & Batchelor(1985)
6) I/S Classification	'I' type to felsic 'I' type. S type only occurs in contact facies of Thorr and the G4 of Rosses	Chappell & White (1974)
7)Tectonic Classification	The Donegal granites show both characteristics of 'I' type Caledonian and Cordilleran.	Pitcher (1983)

TABLE 8.11 : Summary of classification of the Donegal granites.

CHAPTER NINE

CONCLUSIONS AND FUTURE WORK

9.1 Introduction

This study has been concerned with the petrological, mineralogical and geochemistry of the Donegal granites. The Donegal granites are located in the north west of Ireland , in County Donegal **(Map 2.1)**. They are part of the Caledonian granites of the British Isles and cover an area of approximately 1150 km^2. They are intruded into Late Precambrian to Cambrian Dalradian metasediments ranging from pelites, quartzites to marls.The granites plutons are : Thorr, Rosses, Ardara, Fanad, Barnesmore, Main Donegal and Trawenagh Bay plutons **(Map 2.2)**

In the terminology of Peacock (1931) the Donegal granites have a calc-alkali chemistry. This is supported by the AFM plot which also shows that the granites follow the calc alkaline trend. More specifically the granites show that they belong to the high-K calc alkaline series of Peccerillo and Taylor (1976 ; Na_2O + K_2O ranges from 5.9 to 9.8%). The rocks are metaluminous to slightly peraluminous (ACNK : 0.8 - 1.15). Higher ACNK values are shown by the rocks from the contact facies of the Thorr pluton and the G4 from the Rosses granite.

The granites are generally 'I' type according to Chappell and White (1977) classification. Specifically the Donegal granites can be classified as 'I' type Caledonian. An apparently 'S' type characteristic granite is from the contact facies of the Thorr granite where the granitic magma interacts with the pelitic rafts or xenoliths. This 'S' type rocks however do not suggest the sedimentary origin of the contact facies magma, but it is the result of interaction between the Thorr magma with the pelitic rafts or xenoliths. It represent a modified 'I' type.

The essential mineralogy of the Donegal granites are plagioclase, alkali feldspar, quartz and biotite. Hornblende is only present in the mafic plutons (Ardara, Thorr, Fanad and Toories). Muscovite occurs as a secondary mineral in the felsic plutons (Rosses, Barnesmore, Main Donegal and Trawenagh Bay) and in the contact facies rock of the Thorr granites. According to the Quartz - Alkali feldspar - Plagioclase classification

(Streckeisen 1967) the rock types of the Donegal granites grade from diorite to quartz monzodiorite to tonalite to granodiorite to granite (Thorr), granite (Rosses and Trawenagh Bay), granodiorite to granite (Barnesmore), trondhjemite to granodiorite to granite (Main Donegal), quartz monzodiorite to granodiorite (Fanad and Ardara). Mineralogical (Q-A-P) lineages show that the rocks belong to the calc alkaline granodiorite series similar to those formed near a plate edge (Bateman et al. 1963, Atherton et al. 1979). The accessory minerals of the Donegal granites are apatite, sphene, zircon, allanite, magnetite, garnet, ilmenite, pyrite and epidote. Magnetite is the main opaque phase (up to 2 % in the mafic Fanad and Thorr rocks). This suggests that the Donegal granites belong to the magnetite series (Ishihara 1977) which is comparable with the 'I' type classification of the Donegal granites (e.g. Beckinsale 1979).

Correlation with the Caledonian granites of the British Isles gives the following conclusions:

(1) The Donegal and late Caledonian granites are calc alkali.

(2) The Donegal granites show characteristics similar to the late Argyll suite granites of the Mainland Scotland. They are high-K calc alkali, and have high Ba and Sr contents.

9.2 Subdivision of the Donegal granites.

Based on the petrology and geochemistry the Donegal granites were divided into three groups

(1) The most felsic group - Rosses and Barnesmore plutons.

(2) The felsic group - Main Donegal granite and Trawenagh Bay plutons.

(3) The mafic group - Ardara, Thorr and Fanad plutons.

9.2.1 The most felsic group.

This group consists of the Barnesmore and Rosses plutons. The mineralogy of this group is alkali feldspar, plagioclase, biotite, quartz, magnetite, sphene, allanite, zircon and garnet. This group has high SiO_2 contents (70 - 79%), Rb, Th (Barnesmore only) and

Rb/Sr ; and has low Ba, Sr, Zr, Sr/Y and total REE.

9.2.2 The felsic group.

This group consists of the Trawenagh Bay and Main Donegal granites. It is characterised by intermediate to high SiO_2 (65 - 75%) and Rb (Trawenagh Bay) ; intermediate Sr/Y ; and low Sr, V, Ba and Rb/Sr. The mineralogy of this group is similar to the most felsic group.

9.2.3 The mafic group

This group consists of the Ardara, Thorr and Fanad granites and is characterised by a wide range of SiO_2 contents (52 - 72%) with the majority of the rocks between 52 - 65 % SiO_2. Rocks of this group contain hornblende (up to 15%) and the modal amount of the accessory minerals such as allanite, apatite, sphene and magnetite are higher than those from the two previous groups. This group has high Ba (Fanad and Thorr), Ce, Sr, V, Zn, Zr, Sr/Y, and total REE ; intermediate to low Rb (Fanad and Thorr) ; and low Co, Rb/Zr, Rb/Ba and Rb/Sr compared to the other groups. It is interesting to note that among these three mafic plutons, Ardara shows a slight difference in geochemical characteristics. Compared to the Fanad and Thorr plutons, the Ardara pluton has :

(1) low Ba and Sr - the Ba content is similar to the felsic and the most felsic groups,

(2) high Rb especially in the rocks from the outer and intermediate units,

(3) high Th and Pb.

9.3 Individual plutons

9.3.1 Thorr pluton

(1) The Thorr pluton is normally but asymmetrically zoned and varies from quartz diorite (~55% SiO2) to true granite (75 % SiO2).

(2) The pluton can be divided into the hornblende-bearing normal facies and the hornblende-free normal facies. The latter facies, also known as the Gola facies (Whitten 1966), occurs in the NW of the pluton. This facies grades continously into a more basic one

(granodiorite to diorite) towards the south and south-east viz hornblende-bearing normal facies. The rocks of the hornblende-bearing normal facies adjacent for to the pelitic xenoliths/rafts in the south and south-east change gradationally into the transitional facies and then to a contact facies (10 m wide).

Apart from the Bloody Foreland rocks the modal properties and the whole rock major and trace elements chemistry vary continuously from margin to core and there are no major internal contacts.

(3) In the normal facies the mineral phases present are alkali feldspar, plagioclase, quartz, biotite, hornblende, sphene, apatite, allanite, epidote, zircon, magnetite, pyrite and ilmenite. The dominant minerals in the contact facies are plagioclase, microcline, quartz, biotite, muscovite, apatite, zircon and rutile.

(4) The Thorr granite has the widest range of SiO_2 (from 56.75 to 75.19%) of all the Donegal granites. It also has the widest range of most of the major and trace elements and is exceptionally high in P_2O_5 ; high in Zr, Zn, Sr, V and has low Rb/Sr, Rb/Ba, Rb/Zr and Ni.

(5) The marginal accretion models of Oglethorpe (1987) may explain the compositional variation of the Thorr granite. Combined major and trace element modelling indicates that the compositional variation in the Thorr granites was produced by plagioclase, hornblende and biotite fractionation and alkali feldspar and quartz fractionation may have been important in the end-stage melt (= hornblende free facies)

9.3.2 Rosses pluton

(1) The pluton forms a ring complex which was intruded into the older Thorr pluton. The main body of the granite consists of 4 units, G1 to G4 and is generally medium to coarse grained biotite to muscovite granite. There is a peripheral group of arcuate, steeply inclined microgranite sheets and a north-south trending porphyry dyke swarm which intruded G1 and G2.

(2) The main rock type of the Rosses complex is granite (s.s.) consisting of plagioclase, microcline microperthite, quartz, biotite, apatite, magnetite, allanite ,

zircon and hematite, sphene (secondary) epidote (secondary).

(3) The rocks have SiO_2 contents ranging from 69 to 77 %, low Ba, Ce, La, Nd, Sc, Sr, Th, V, Zr, Sr/Ba and Sr/Y and high Rb (G2 and G4), Ni, Co (G4 and G2), Rb/Sr, Rb/Ba, Y/Zr (G2 and G4) and Rb/Zr. ACNK increases with SiO_2.

(4) A distinct chemical break occurs within the pluton at the G2 - G3 contact where G3 is more basic than G2. This indicates that the continuous evolution of the Rosses granites from G1 to G2 to G3 to G4 at the present level is unlikely. The primitive nature of G3 may be explained by the influx of basic magma into a magma chamber at depth after the emplacement of the G2.

(5) Combined major, LILE and REE element modelling indicates that the compositional variation in the pluton at the present level involved the precipitation of plagioclase, biotite and alkali feldspar. The variation of the Rosses granites can be explained by 2 cycles of magma evolution namely (1) microgranite to G1 to G2 and (2) porphyry/G3 to G4. The porphyry dykes may represent a basic quench of the G3 magma.

9.3.3 Ardara pluton

(1) The Ardara pluton is normally zoned and consists of three units, an outer, intermediate and inner unit.

(2) The essential minerals of the rocks from this pluton are plagioclase, alkali feldspar, hornblende, biotite and quartz. The accessory minerals in decreasing abundance are epidote, sphene, apatite, magnetite, hemo-ilmenite and pyrite.

(3) The Ardara granitic rocks have SiO_2 contents ranging from 59.1 to 72 %. The rocks have high V, Th, Pb, Ce and low Co, Ba, Y/Zr, Rb/Zr, Rb/Sr, Rb/Ba compared to the other Donegal granites.

(4) The modelling showed that the units of the Ardara granite are not related by a simple in situ fractionation from the wall inwards. Each unit may represent three magmas, each has is fractionated separately (cf Yarr 1991).

9.3.4 Fanad pluton

(1) The Fanad granite is located in the most northerly part of Donegal and consists of three separate units namely Rosguill, Melmore and Fanad peninsula. Using the geochemical data, the Fanad peninsula rocks are subdivided into 2 sub-units namely high Ba Fanad peninsula, low Ba Fanad peninsula.

(2) The dominant minerals in decreasing abundance are plagioclase, biotite, alkali feldspar, quartz, hornblende, sphene, magnetite, apatite, allanite and zircon, pyrite and ilmenite.

(3) The rocks are characterised by low SiO_2 contents ranging from 52 to 64% i.e it is the most basic of the Donegal granites and has high Ba, Nd, Sr, Sc, V, Zn, Zn, Zr, Sr/Y, total REE and low Co, Pb, Rb, Th, Y, Rb/Zr, Rb/Ba, Rb/Sr.

(4) Combined major, LILE and REE element modelling indicates that the compositional variation in the pluton is due mainly to the fractionation of hornblende and plagioclase. The geochemical evidence indicates that the separate units of the Fanad granites are not related at the present exposure level and may represent separate magma batches from different sources.

9.3.5 Main Donegal pluton

(1) The Main Donegal granite is the largest intrusion of the Donegal granites. It is characterised by a broad, sheeted contact zone and internally by lithological banding of light (graniodiorite-granite) and dark (trondhjemite) bands.

(2) The dominant minerals in the light bands (in decreasing abundance) are plagioclase, alkali feldspar, biotite, quartz, sphene, magnetite, apatite, allanite, zircon, epidote, pyrite, hematite, ilmeno-hematite, chalcopyrite and geothite. The dark bands also have a similar mineral assemblages but with very low modal alkali feldspar and very high modal plagioclase.

(3) The dark bands have SiO_2 contents ranging from 66.2 to 71.2 % whereas the light bands range from 67.8 to 74.7%. The trondhjemite can be distinguished from the granodiorite-granite as it has lower K_2O, Rb, Ba, Sr/Rb and and higher Na_2O, Nb and

Rb/Ba values.

(3) The geochemical data suggests that the dark band trondhjemite from the Main Donegal granite is different to the granodiorite-granite and likely to have a different origin from other Donegal granite magmas.

9.3.6 Trawenagh Bay pluton

(1) The Trawenagh Bay granite is located at south-west end of the Main Donegal granite. No contacts have been observed between the two plutons.

(2) 90 % of the Trawenagh Bay pluton is made up of homogeneous, equigranular, medium to coarse grained biotite granite with diffuse areas of finer grain size in the centre and south of the pluton. The remaining 10 % is garnetiferous muscovite granite occurring as scattered patches at the centre and margins of the pluton.The contact between the two granites is gradational, the normal biotite granite grades into marginal muscovite granite by the disappeareance of biotite accompanied by the incoming first of muscovite and then of garnet.

(2) The biotite granite consists of alkali feldspar, plagioclase, quartz, biotite, muscovite, epidote, apatite, magnetite and allanite, whereas the muscovite granite consists of plagioclase, alkali feldspar, quartz, muscovite and accessory garnet.

(3) The muscovite granite of the Trawenagh Bay pluton is among the most evolved granites of Donegal (73.6 - 75.6% SiO_2). It has low concentrations of TiO_2, FeO, MgO, CaO, P_2O_5, Ba, Ce, La, Nd, Pb, Sr, V, Zn, Zr and Sr/Y and high Nb, Y/Zr, Rb/Zr and Sr/Ba compared to the other Donegal granites. The biotite granite has SiO_2 contents ranging from 69.9 to 73.28%. The rocks have high Ni and low Pb, Th, Zr, Ce, Ba, Rb/Ba, Rb/Zr, Rb/Sr compared to the other Donegal granites.

(4) Geochemical data show that the biotite granite of the Trawenagh Bay pluton is similar to the light band granodiorite - granite from the Main Donegal granite. This suggests that both granites may be cogenetic (cf. Pitcher and Berger 1972). The presence of pegmatite pods and aplites in the muscovite granite provides strong evidence for the presence and exsolution of a vapour phase from the Trawenagh Bay magma, probably at

the final stages of solidification.

9.3.7 Barnesmore pluton

(1) The Barnesmore pluton consists of several distinct granite members, three of which were sufficiently separated in time of intrusion to be demarcated by sharp contacts. The G2 granite comprises three facies namely the main G2, G2 porphyritic facies and G2 basic facies and the main G2 is the most abundant component of the pluton.

(2) The rocks are made up of plagioclase, K-feldspar, quartz, muscovite, biotite, sphene, apatite, allanite, zircon, magnetite and ilmenite.

(3) The Barnesmore granite is the most felsic of the Donegal plutons with SiO_2 values ranging from 71.9 to 79.1%. It has low Ba, Sr, Zn, Zr, Sr/Ba, Sr/Y, Zr/Rb, total REE and high Nb, Pb, Rb, Th, Rb/Sr, Rb/Zr, Y/Zr and Rb/Ba

(4) Modelling indicates that fractional crystallisation of a granodioritic magma (G1 type) was the dominant process in the production of the geochemical variation in the Barnesmore complex.

9.4 Tectonism and heat source.

Although previous chemical studies have credibly interpreted some of the British Isles Caledonian granitic and volcanic rocks as part of a continental margin magmatic arc generated by subduction of Iapetus oceanic lithosphere, problems of distribution and timing arise when attempts are made to relate the magmatic activity as a whole to the subduction model. The problems of the subduction model for the Caledonian granites are as follow :

(1) The distance between the trench and arc in subduction examples is normally greater than 90 km and is often 150 km or more. The approximate distance of the Scottish Highland granite plutons from the Iapetus is about 150 to 200 km whereas the granite plutons from Southern Uplands are less than 50 km

(2) The Caledonian granitic plutons fail to show the progressive space-time changes in chemistry which are characteristic of magmatism at a plate margin.

(3) The presence of a continuous magmatism over a period of at least 45 Ma in a subduction related batholiths. This is in contrast with the magmatic history of the Caledonian plutonism which is characterised by short periods of intense activity separated by periods of relative quiescence.

(4) The rock types present in the Caledonian batholith vary from quartz monzodiorite to granite (s.s) and do not form a gabbro-granite continuum, typical of subduction environment.

(5) Batholiths that developed in a subduction environment are elongated over a distance of more than 1000 km and parallel to the trench. Such batholiths in this environment usually comprise hundreds of plutons of variable diameter, from 1 to 50 km, whereas the Caledonian granites usually occur as separate small plutons, which are not elongated .

The mantle plume model (Hill et al. 1992) has been suggested as an alternative to the subduction models. This model is preferred here since :

(1) There is similarity in the 'stratigraphy' of the Caledonian magmatism in Donegal compared to that in a mantle plume area such as Karoo province.

(2) The occurrence of high Ba granitic rocks in the Fanad pluton and the plutons of the Argyll suite and associated appinites can best be explained by melting in response to a deep heat supply and underplated mafic magmas (Stephens and Halliday 1984 ; Yarr 1991 ; Tarney and Jones 1994).

The basic magma formed in the plume can provide heat into the crust resulting in the production of the anatectic melts which gave rise to the Caledonian granites.

9.5 Future work.

(1) A detailed study of geochemistry and mineralogy of the individual plutons with more carefull, controlled sampling using a greater number of samples has to be done in order to understand more fully the petrochemistry of each of the plutons. Individual study is recomended for the Rosses, Fanad, Ardara,Trawenagh Bay and Main Donegal

plutons because the other two plutons (Thorr and Barnesmore) already have a substantial amount of chemical data and the modelling is good.

(2) Detailed study of radiogenic isotope especially Sr, Nd, Sm and Pb should be undertaken to determine the source region and other processes such as mixing and high level interaction.

(3) The various types of enclaves that occur in the Donegal granites (Pitcher and Berger 1972) should be studied in more detail because they may provide information (Barbarin and Didier 1991) on the mode of emplacement, the origin of the granitic magma and the dynamics of magma chambers including magma interaction.

APPENDIX 1
ANALYTICAL METHODS.

A. MODAL ANALYSIS.

Modes were determined for medium and coarse grained rocks by point counting (Appendix 2). The data were collected using a Swift Model E point counter fitted with an automated stage. Samples were either normal thin sections (area of rock approximately 30 by 40 mm) or polished thin section that had been prepared for microprobe analyses. Usually the total counts were between 1500 - 2000 on each specimen in such way that the whole surface of the thin section was covered.

Minerals counted were alkali feldspar, plagioclase, quartz, biotite, hornblende, muscovite, sphene, allanite, zircon, epidote, Fe-Ti oxide and apatite. Where 'tr' (trace) appears in the table it implies that the mineral was observed , but not point counted.

B. SAMPLE PREPARATION.

Wherever possible, 2 kg samples of the freshest available material were collected; however, certain samples such as some of the aplites and dykes were considerably smaller. The samples were firstly trimmed in order to remove any altered/wethered material. Some of the removed sawn slabs were used for photograph. The clean and freshest samples were split into 1 cm cubes using a hydraulic jaw-splitter and an automatic jaw-crusher, washed to remove dust, and dried (at room temperature) overnight.

The chips were then reduced to powder by grinding in a "Tema" laboratory disc mill using a tungsten-carbide barrel. W, Co and Ta are known contaminants that could be introduced at this stage. Milling time was 30 seconds (150 micron) and another 15 seconds to reduce the size to 53 microns. The sample powder was not sieved as it is believed that this procedure introduces unnecessary inhomogeneity into the sample. The samples powder was then shaken and dried at 110 C for 12 hours.

C. WHOLE ROCK MAJOR AND TRACE ELEMENTS ANALYSIS.

X-Ray Fluorescence Analysis

Glass fusion disc were used in the analysis of major elements. Each disc was prepared by using a mixture of approximately 0.62 g (weighed to 4 decimal places) of 153 microns of rock powder with 3.3 g of lithium borate flux in a ratio of 5.4321 : 1 , flux : rock, at 1000^{o}C and casting the melt onto 4 cm diameter aluminium platterns. The resultant glass disc was then mounted on a backing disc for analysis. Powder pellets used in trace elements analysis , were prepared by mixing 7 g of 53 microns powder with 12 to 15 drops moviol binder solution (4 g Moviol + 10ml ethanol + 50 ml distilled water) . The resultant mixture was pressed into a 4 cm disc under 5 tons pressure and left dried before analysis.

Major oxide elements (SiO_2, TiO_2, Al_2O_3, Fe_2O_3 (expressed as Fetot in data tables), MgO, MnO, CaO, Na_2O, K_2O, P_2O_5) and trace elements (Ba, Ce, La, Cr, Nd, Nb, Ni, Pb, Rb, Sc, Sr, Th, V, Y, Zn and Zr) were analysed by X-Ray fluorescence at the Department of Earth Sciences, University of Liverpool; analyses are presented in Appendix 5. The equipment used was Siemens sequential X-Ray spectrometer. The major oxides were determined using Cr primary beam radiation generated at 50 kV and 40mA and trace elements using W beam radiation generated at 45kV and 60mA. Accuracy in major element analysis was checked by routine analysis of the USGS standard G2. Major element precision is given in Table 1.c.1. Trace elements precision and detection limit values is given in Table 1.c.2.

Ferrous and Ferric iron analyses.

Ferrous iron was determined by wet chemical analysis. This involved attacking ~0.5 g of rock powder with a mixture of HF and H_2SO_4 and titrating with potassium dichromate solution using a sodium diphenylamine sulphonate indicator. The titration was undertaken in the presence of boric acid to complex flouride, and phosphoric acid to suppress ferric iron. The Fe_2O_3 concentration in the rock sample was calculated from the XRF total iron value and the wet chemical FeO analysis using the following relationship : Fe_2O_3 = Fe(XRF) - 1.111 FeO (wet).

D. WHOLE ROCK REE ANALYSIS.

The REE concentration was determined by using Inductive Couple Plasma (ICP) in the Department of Earth Sciences, Liverpool University.

Sample preparation.

1 g of powdered rock is weighted accurately into a Pt crucible and 3 g lithium metaborate added. The mixture was heated at 1000^{o}C for about 1 hour. The metaborate disc (sample + lithium metaborate) was dissolved in complexing solution (10g oxalic acid + 50 ml conc. HCl + 5 ml H_2O_2 + deionised water to 1 litre). The fusion solution was loaded into the chromatographic glass column (2 g resin loaded onto the column). The resin was then washed with 50 ml 1 N HCl to discard of the major elements. At this stage, the REEs are held quantitatively on the resin (together with Ba,Sr,Zr and Hf). The REEs were stripped off the resin by using 7.5N HCl and boiled down using conc. HNO3. Prior to ICP analyses the dry precipitated sample was dissollved in 10 ml 10% HNO3.

D. MINERAL CHEMISTRY ANALYSIS.

Electron probe microanalysis (EPMA) Energy Dispersive system (EDS).

Analysis of plagioclase, hornblende and biotite were carried out at the Department of Earth Sciences, University of Manchester on a modified Cambridge Instruments Geoscan EPMA equiped with a Link analytical 8.60 EDS and ZAF 4 software. All samples used were highly polished thin sections coated with a 20 nm carbon film.

The operating conditions were: 15kV Electron beam accelerating voltage, 75 X-Ray take-off angle, 3nA specimen current on Cobalt metal with a count time of 40 liveseconds, 2.5 KCPS output count rate from cobalt metal with 18% detection system dead time. The nominal beam width was 1 micron.

Element	x	$sigma_{n-1}$	c%
SiO_2	72.60	0.24	0.33
TiO_2	0.30	0.0041	1.36
Al_2O_3	14.27	0.094	0.66
Fe_2O_3	1.76	0.015	0.86
MnO	0.16	0.0040	2.46
MgO	1.46	0.046	3.15
CaO	1.86	0.0063	0.34
Na_2O	5.81	0.101	1.74
K_2O	4.10	0.011	0.27
P_2O_5	0.08	0.012	15.1

Table 1.c.1: XRF major element precision.

Element	Detection limit	Precission c%
Ba	41	0.0436
Ce	21	0.0045
La	10	0.073
Nd	6	0.0372
Ni	5	0.01617
Pb	7	0.1132
Rb	5	0.1005
Sc	3	0.0583
Sr	3	0.1233
Th	8	0.0685
V	4	0.01227
Y	4	0.0083
Zn	5	0.0907
Zr	3	0.0192

Table 1.c.2: Trace elements precision and detection limit of the trace element analysis.

APPENDIX 2

MODAL DATA

2.1 Thorr pluton.

2.2 Rosses pluton .

Sampel 1 to 32 from the Geology Department , University of Liverpool.

2.3 Ardara pluton .

Sample AR1 to AR8 (inner unit) from the Geology Department , University of Liverpool.

2.4 Fanad pluton.

2.5 Main Donegal pluton .

2.6 Trawenagh Bay pluton.

Notes.

All modes determined by the author unless otherwise stated (Source).

APPENDIX 2.1

THORR PLUTON.

Sample No.	686	42671	42677	590	42681	43937	43908	43944	42660	42709	42701	43896
Unit	Hbl-bear	Hbl-bear	Hbl-bear	Hbl-bear	Hbl-bear	Hbl-bear	Hbl-bear	Hbl-bear	Hbl-bear	Contact	Contact	Contact
Source												
Plagioclase	56.7	41.1	39.3	45.4	44.6	43.4	28.2	34.6	32.7	54.4	39.2	42.7
Quartz	18	18.3	17.5	14.2	14	23.4	26.6	23.7	16.7	18.7	25	37.5
K-feldspar	4.8	23	tr	21.5	24.1	17.5	23.9	20.8	32.7	2.5	16.6	19.7
Biotite	16.5	12.1	9.3	12.9	13.6	12.8	20.4	15.3	12.3	17.9	15.6	12.1
Hornblende	2.2	4.1	1.7	2.8	1.8	0.9	tr	2.9	2.4	0	0	0
Apatite	0.1	0.2	0.1	0.4	0.1	0.1	0.3	0.4	0.2	0.4	0	0
Sphene	1.4	0.6	1.2	1.2	0.4	0.3	tr	0.8	0.8	0.1	0	0
Epidote	0.1	0.2	0.5	0.5	1	0.3	0.2	0.2	1.7	0	0	0
Opaque	tr	1	1	0.4	0.3	0.7	tr	0.3	tr	0	0.5	0.1
Allanite.	0.1	0.1	tr	0.2	tr	tr	tr	tr	tr	0	0	0
Zircon	tr	0.1	tr	tr	tr	tr	tr	0.2	tr	0	0.1	0
Muscovite	0	0	0	0	0	0	0	0	0	5.8	2.7	2.3

Sample No.	TH6	31/4	33	35A	35B	36	37	38	39A	39B	40	42
Unit	Contact	Contact	Contact	Trans	Contact	Hbl-bear	Contact	Hbl-bear	Hbl-bear	Hbl-bear	Hbl-bear	Contact
Source	Oglethorpe	Oglethorpe	Oglethorpe	Oglethorpe	Oglethorpe	Oglethorpe	Oglethorpe	Oglethorpe	Oglethorpe	Oglethorpe	Oglethorpe	Oglethorpe
Plagioclase	51.5	47.9	54.2	54	59.1	50.4	58.3	51	57.2	60.8	49.4	52.3
K-feldspar	6.6	19.5	1.9	5.7	1	11.1	2.5	9.3	10.8	1.3	14.9	12.6
Quartz	9.2	8.1	23.9	21.9	18.8	15.4	16.9	15.6	10.4	13.4	12.3	19.3
Biotite	24.9	17.2	16.6	16.7	20.4	16.3	21.2	20.1	14.8	16.9	20.3	14
Hornblende	0	0	0	0	0	4.4	0	2.6	4.3	4.6	1.5	0
Muscovite	6.1	5.6	2.9	0.3	0.3	0	0.2	0	0	0.1	0	1.2
Sphene	0	0	0	0.2	0	1.6	0	0.8	1.6	1.5	0.8	0
Epidote	0	0	0	0.2	0	0.1	0	0.4	0.7	1.1	0.2	0
Apatite	1.5	1.2	0.4	0.1	0.2	0.3	0.6	0.2	0.1	0.2	0.5	0.3
Opaque	0	0.4	0	0.8	0	0.4	0.2	0	0.1	0	0	0.3
Zircon	0.2	0.1	0.1	0.1	0.2	0	0.1	0	0	0.1	0.1	0
Tourmaline	0	0	0	0	0	0	0	0	0	0	0	0

Sample No.	48	50A	52	53	54	59	253	98	246	198	45	47
Unit	Hbl-bear	Contact	Contact	Hbl-bear	Hbl-bear	Trans	Contact	Hbl-bear	Hbl-bear	Hbl-bear	Hbl-bear	Hbl-bear
Source	Oglethorpe	Oglethorpe	Oglethorpe	Oglethorpe	Oglethorpe	Oglethorpe	Oglethorpe	Oglethorpe	Oglethorpe	Oglethorpe	Oglethorpe	Oglethorpe
Plagioclase	47.5	48.7	49.9	46.6	50.1	53.2	38.8	47.4	43.3	43.9	46.1	54
K-feldspar	18.3	18.7	12.5	21.9	15	10.7	10.1	29.3	36.7	21.1	21.7	15.5
Quartz	19.4	7.3	14.5	15.7	18	17.3	37.6	6.1	1.8	20	15.7	13.3
Biotite	11.7	21.5	19.8	11	12.2	17	12.5	14.3	0.3	7.5	14.6	12.5
Hornblende	1.4	0	0	1.7	2.1	0	0	0.3	16.2	6.7	0.4	2
Muscovite	0	2.8	2.8	0	0.1	0.5	0.4	0	0	0	0	0
Sphene	0.7	0	0	0.9	0.9	0.3	0	0.3	0.9	0.1	0.5	1.4
Epidote	0.7	0	0	0.9	1.3	0.8	0	1.8	0.1	0.1	0.4	0.8
Apatite	0.2	0.9	0.5	0.7	0	0.1	0.5	0.2	0.6	0.4	0.3	0.3
Opaque	0.1	0.1	0	0.5	0.3	0.1	0.1	0.3	0	0.2	0.3	0.2
Zircon	0	0	0	0	0	0	0	0	0.1	0	0	0
Tourmaline	0	0	0	0.1	0	0	0	0	0	0	0	0

APPENDIX 2.2

ROSSES PLUTON

Sample No.	1	2	3	4	5	6	7	8	9	ROS11	ROS12	ROS4
Unit	G1	G1	G1	G1	G1	G1	G1	G1	G1	G1	G1	G1
Source												
Plagioclase	34	29.2	33	33.3	32.5	31.5	28.3	29.4	30.2	31.2	33.2	33.5
Quartz	43.1	29.4	34.7	34.3	34.1	30.8	28.9	39.3	35.5	34	35.2	29.5
K-feldspar	21.1	37.2	28.1	26.7	29.2	34.7	39.5	27.4	28.2	36	36.5	32.5
Biotite	3.4	2.2	2.9	3.8	3.2	2.3	2.6	3.2	4.2	3.2	2	3
Muscovite	0.3	1.4	0.4	1.3	0.6	0.3	0.2	0.4	0.9	0.6	0.1	0.6
Apatite	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr
Epidote	0.1	0.3	0.4	0.1	0.1	0.2	0.2	tr	0.4	tr	tr	tr
Opaque	tr	0.1	tr	tr	tr	tr	tr	tr	0.1	tr	tr	tr

Sample No.	10	11	12	13	14	15	16	17	18	19	20	ROS6
Unit	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2
Source												
Plagioclase	30.1	28.7	27.3	34.9	37.7	30.8	43	31.9	37.1	36	34	32.4
Quartz	45.1	40.1	40.3	33.1	31.3	37.7	27.2	36.7	29.6	32.8	28.8	34.3
K-feldspar	21.9	21.5	29.8	29.3	27.5	28.2	23.9	26.2	27.1	24.6	32.4	27.8
Biotite	2.3	8.5	2.2	2	2.9	2.9	4.5	4.4	4	4.2	3.6	3.4
Muscovite	0.3	0.6	0.1	0.2	tr	tr	0.9	0.5	1	1.5	0.5	1.3
Apatite	0	tr	0	0	0	tr	tr	tr	0.1	tr	tr	tr
Epidote	tr	0	0	0	0.1	tr	tr	tr	0.1	tr	0.3	tr
Opaque	tr	0.2	tr	0.1	tr	0.1	tr	tr	0.1	tr	0.1	0.5

Sample No.	21	22	23	24	25	26	27	28	29	30	31	32
Unit	G3	G3	G3	G3	G3	G3	G3	G3	G3	G3	G3	G3
Source												
Plagioclase	24.3	27.03	44.7	32.1	32.8	29.1	32.4	31.9	42.8	32.5	34	37.7
Quartz	42.7	39.4	28.7	41.8	30.2	41.1	40.7	35.7	32.1	37.7	36.5	34.7
K-feldspar	29.1	27.9	20.7	21.1	32.7	25.2	23	28.7	21.1	25.5	24.1	22.6
Biotite	2.7	3.1	4.5	3.7	2.5	3.5	3	2.5	3.4	3.1	3.8	3.4
Muscovite	0.5	1.8	1	0.4	1	0.4	0.7	0.6	0.2	0.6	1	1
Apatite	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr
Epidote	0.5	0.1	tr	0.6	0.4	tr	tr	0.3	0.1	0.3	0.2	0.3
Opaque	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr

Sample No.	ROS10A	ROS10B	ROS10C
Unit	G4	G4	G4
Source			
Plagioclase	29.44	30.1	29.3
Quartz	39.6	40.2	42
K-feldspar	24.3	25.2	21
Biotite	tr	0.4	2
Muscovite	6.3	5	5
Apatite	tr	tr	tr
Sphene	tr	0	tr
Epidote	tr	0	tr

APPENDIX 2.3

ARDARA PLUTON

Sample No.	224	249	250	251	254	256	261	302	AR1	AR2	AR3	AR4
Unit	Outer	Outer	Outer	Outer	Outer	Outer	Outer	Outer	Outer	Outer	Outer	Outer
Source	Akaad	Akaad	Akaad	Akaad	Akaad	Akaad	Akaad	Akaad				
Plagioclase	53.8	44.6	49.7	54.1	39.3	40.2	41.2	45	45.70	43.30	49.20	43.60
Quartz	11.6	14.4	11.7	10.2	14.9	18.3	13.1	14.7	14.20	20.10	14.10	16.00
K-feldspar	16	25.8	22.4	15.5	25.7	24.1	21.6	20	19.00	18.70	14.10	16.20
Biotite	16.6	11.8	10.2	13.7	15.7	14.5	17.4	11.5	11.60	9.10	13.20	13.50
Hornblende	0.4	1.1	3.4	2.9	1.7	1.4	3.4	6.3	6.00	6.70	6.10	7.40
Apatite	0.4	0.4	0.4	0.3	0.7	tr	1	0.6	tr	tr	0.40	0.30
Sphene	0.6	0.6	1.2	0.8	0.8	1	1.3	1.3	0.30	0.30	0.20	0.50
Epidote	0.6	1.1	0.8	2.3	1.2	0.4	1	0.6	2.20	0.80	1.70	1.10
Opaque	tr	0.1	tr	0.1	tr	tr	tr	tr	tr	0.10	0.30	0.70

Sample No.	AR5	AR6	AR7	AR8
Unit	Outer	Outer	Outer	Outer
Source				
Plagioclase	44.10	43.40	45.50	47.50
Quartz	17.80	18.00	15.60	19.90
K-feldspar	14.90	18.80	19.80	15.20
Biotite	14.50	11.20	11.10	12.00
Hornblende	5.60	6.60	5.30	3.70
Apatite	0.30	0.10	0.10	tr
Sphene	0.50	0.20	0.30	tr
Epidote	1.10	0.60	1.40	0.60
Opaque	0.50	0.20	0.30	0.30

Sample No.	196	209	213	22	222	224	233	281	ARD4	ARD2
Unit	Intmdte	Intmdte	Intmdte	Intmdte	Intmdte	Intmdte	Intmdte	Intmdte	Intmdte	Intmdte
Source	Akaad	Akaad	Akaad	Akaad	Akaad	Akaad	Akaad	Akaad		
Plagioclase	46.8	48.1	46.4	44.6	46.9	46.5	55.6	47.5	51.4	49.7
Quartz	12.5	15	14.3	16.4	12.3	16.9	14.7	14.1	30.2	25.5
K-feldspar	15.7	15	15.5	18.8	14.8	16	11.1	12.5	10.6	14.8
Biotite	14.7	12.4	13.7	10.4	11.3	14	11.2	15.4	6.5	7.1
Hornblende	3.3	6	6.8	6.3	11.2	5	5.4	5.6	0.7	1
Apatite	0.1	tr	tr	tr	tr	tr	tr	tr	0.4	0.3
Sphene	1	1	1.2	0.7	1.4	tr	tr	tr	0.4	0.2
Epidote	4.8	2.5	2.1	2.7	1.9	1.6	1.9	4.9	0.3	1
Opaque	1	tr	tr	tr	tr	tr	tr	tr	0.5	tr

Sample No.	544	552	558	561	565	603	605	608	609	ARD11	ARD10	ARD13
Unit	Inner	Inner	Inner	Inner	Inner	Inner	Inner	Inner	Inner	Inner	Inner	Inner
Source	Akaad	Akaad	Akaad	Akaad	Akaad	Akaad	Akaad	Akaad	Akaad			
Plagioclase	45.3	50	56	53	42.2	56.7	47.8	49.2	47.6	43.2	40	42
Quartz	26.6	27.5	21.6	20.2	23.1	17.6	33.6	20.9	23.1	22.3	25.7	23.1
K-feldspar	22.7	14.8	13.6	14.6	27.4	16	12.6	16.6	13	28.3	25.6	21
Biotite	4.7	7.5	8	8.8	7	9	4	10.7	9.5	9	9	8.5
Hornblende	0	0	0.1	0	0	0	0	0	0	0	0	0
Apatite	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr
Sphene	tr	0.2	tr	0.1	0.1	tr	tr	0.5	0.1	0.2	tr	0.1
Epidote	0.7	tr	0.8	3.4	0.2	0.7	tr	2.1	1.7	0.6	0.7	0.2
Opaque	tr	tr	tr	tr	0.1	tr	tr	tr	tr	tr	tr	0.1

APPENDIX 2.4

FANAD PLUTON

Sample No.	FAN 18	FAN2	FAN23	FAN43	FAN41	FAN29	FAN46
Unit	Fan Pen	Fan Pen	Rosguill	Melmore	Fan Pen	Rosguill	Rosguill
Source							
Plagioclase	57.9	50	50.6	70	56	45.4	53
K-feldspar	11.9	15.7	14.3	2	10	16.6	15.1
Quartz	6	15	17.2	5	11	24.5	13.3
Biotite	18.1	13.7	15.8	14	12	11.1	12.1
Hornblende	4.9	1.4	0.6	7	10	0	4
Muscovite	0	0	0	0	0	0	0
Sphene	0.1	1	0.3	0.6	0.4	0.3	0.8
Epidote	0	0	0	0	0	0	0
Apatite	0.4	0.5	0.2	0.4	0.1	0.7	0.4
Opaque	0.1	1.2	0.9	0.6	0.5	0.6	1
Zircon	0.1	tr	0.2	tr	tr	0	tr
Allanite	0.1	tr	0	tr	0	0.7	0.2

APPENDIX 2.5

MAIN DONEGAL PLUTON

Sample No.	1a	1b	2a	2b	3a	3b	3c	4a	4b	4c
Unit	Dark	Dark	Dark	Dark	Dark	Light	Light	Light	Light	Light
Source	Berger	Berger	Berger	Berger	Berger	Berger	Berger	Berger	Berger	Berger
Plagioclase	64.4	60.2	55.3	51.4	58.9	36	38.6	28.3	56.8	25.9
K-feldspar	2.8	0	0	5.7	0	28.2	26.8	35.3	10.5	21.8
Quartz	18	27.1	31.7	28.2	26.5	30.9	28.5	27.9	24.1	45.1
Biotite	13	11.6	10.5	12	13	4.8	3.8	4.2	6.2	4.1
Muscovite	1.9	1	2.2	2.5	1.3	0.6	2.1	3.7	2.4	2.9
Apatite	0.1	0.1	0.2	0.2	0.1	0.2	0.1	tr	0.1	0.1
Opaque	0.1	0.1	0.2	0.3	tr	0.3	0.2	0.1	tr	tr
Epidote	tr	tr	0.2	0.1	tr	0.1	tr	tr	0.1	0.1
Epidote	tr	tr	0.2	0.1	tr	0.1	tr	tr	0.1	0.1

APPENDIX 2.6

TRAWENAGH BAY PLUTON.

Sample No.	TRA4	TRA7	TRA3	TRA2	TRA1	TRA5	TRA6
Unit	Mu gra	Mu gra	Mu gra	Bi gra	Bi gra	Bi gra	Bi gra
Source							
Plagioclase	25.5	23	27.6	39.9	25.5	36.9	36.5
K-feldspar	34	38.4	38.4	22.9	34	31.9	32.5
Quartz	36.5	30.6	27.7	31.2	36.5	26.6	24.6
Biotite	0	0	0	4.8	3.9	5.1	4.7
Muscovite	3.9	7.8	4.6	0.4	0.6	0.4	0.6
Apatite	0	0	tr	0.3	0.1	0.1	tr
Opaque	0	0	0	tr	tr	tr	tr
Garnet	tr	tr	0.9	0	0	0	0
Epidote	0	0	0	0.5	0.2	0.3	tr
Allanite	0	0	0	tr	tr	tr	tr

APPENDIX 3

PREVIOUS WHOLE ROCK MAJOR AND TRACE ELEMENT ANALYSES

3.1 Thorr pluton (Oglethorpe 1987).

Hb bear : Hornblende bearing normal facies.

Hb free : Hornblende free normal facies.

Contact : Contact facies.

Trans : Transitional facies.

3.2 Rosses pluton (Mercy 1957)

Porp : Porphyry dykes.

Mg : Microgranite.

3.3 Ardara pluton (Yarr 1991).

3.4 Appinitic rocks associated with Ardara granite (Yarr 1991).

3.5 Barnesmore pluton (Dempsey 1987).

G2BF : G2 basic facies.

G2PF : G2 porphyritic facies.

3.6 Main Donegal pluton (Curtis,in Atkin 1977).

Light : Light band.

Dark : Dark band.

APPENDIX 3.1 : THORR (OGLETHORPE 1987)

Sample	T5H	T7H	T9H	T10H	T10BH	T11H	T21H	T75H	T78H	T82H
Unit	Hb-free	Hb-free	Hb-free	Hb-free	Hb-free	Hb-free	Hb-free	Hb-free	Hb-free	Hb-free
SiO2	74.05	72.00	70.68	72.01	72.27	72.15	68.68	75.19	71.57	70.64
TiO2	0.29	0.33	0.37	0.30	0.30	0.30	0.49	0.15	0.38	0.39
A12O3	13.96	15.03	15.25	14.76	14.70	15.24	15.43	12.44	13.77	14.26
Fe2O3	0.60	0.79	0.83	0.68	0.61	0.72	1.16	0.65	1.19	0.90
FeO	0.54	0.92	0.96	0.92	0.99	0.78	1.36	0.08	0.78	1.21
MgO	0.46	0.94	0.95	0.85	0.89	0.96	1.14	0.20	0.76	0.93
CaO	1.18	1.82	2.06	1.86	1.87	1.79	2.30	0.49	1.51	1.85
Na2O	3.52	4.00	3.86	3.96	3.88	4.08	3.39	3.28	3.49	3.13
K2O	5.18	4.17	3.87	3.83	3.81	3.89	4.72	5.46	5.30	5.22
P2O5	0.05	0.11	0.11	0.09	0.21	0.09	0.11	0.04	0.11	0.13
MnO	0.04	0.05	0.05	0.05	0.05	0.05	0.01	0.05	0.04	0.05

Ba	1212	766	740	753	703	816	1091	244	964	1646
Ce	64	29	57	36	30	30	76	47	88	86
Cr	15	18	22	18	16	17	16	20	30	28
La	41	14	26	12	16	16	49	29	56	63
Nd	24	12	23	14	14	14	30	n.d	n.d	n.d
Ni	10	10	9	8	8	8	6	12	19	22
Pb	22	27	30	29	27	27	21	n.d	n.d	n.d
Rb	90	137	146	137	132	124	93	149	98	96
Sc	4	3	2	1	2	1	2	2	4	3
Sr	494	366	392	377	369	400	440	97	349	544
Th	7	10	13	10	11	8	9	n.d	n.d	n.d
V	45	28	30	27	26	26	40	10	27	33
Y	12	10	13	7	5	6	14	11	41	11
Zn	60	38	44	38	38	39	41	21	41	39
Zr	213	100	117	101	98	102	211	58	46	50
Cu	n.d	n.d	n.d	n.d	n.d	n.d	n.d	106	79	316
Li	n.d	n.d	n.d	n.d	n.d	n.d	n.d	18	34	22

Sample	T31S	T31S	T42S	T50AS	T52S	T65S	T69S	T72S	T73S	T85S	T91S	T96S
Unit	Contact	Contact	Contact	Contact	Contact	Contact	Contact	Contact	Contact	Contact	Contact	Contact
SiO2	56.89	57.37	67.57	63.94	61.71	70.06	60.07	69.26	67.51	67.24	66.16	70.37
TiO2	0.86	0.79	0.57	0.65	0.69	0.39	0.77	0.49	0.59	0.57	0.55	0.48
A12O3	20.10	19.39	16.60	17.76	18.08	15.81	18.20	15.95	16.75	16.38	16.31	14.55
Fe2O3	0.62	0.84	0.44	0.28	0.76	0.19	1.04	0.50	0.20	0.90	0.81	0.79
FeO	4.10	3.49	2.68	3.76	3.67	1.22	3.55	2.57	2.37	2.69	3.03	2.41
MgO	3.58	3.33	1.72	2.19	2.23	0.83	2.25	1.76	1.15	1.91	1.61	1.40
CaO	4.12	3.68	2.88	3.43	3.44	1.40	3.35	2.31	2.83	3.37	2.84	2.45
Na2O	2.97	2.69	3.49	3.29	3.36	3.10	2.85	3.43	3.19	3.77	3.78	3.45
K2O	4.11	5.45	3.36	3.71	4.05	5.15	5.28	3.46	4.02	2.66	3.76	2.31
P2O5	0.81	0.79	0.43	0.45	0.56	0.05	0.94	0.32	0.36	0.21	0.27	0.05
MnO	0.05	0.04	0.07	0.06	0.06	0.03	0.08	0.06	0.04	0.07	0.05	0.04

Ba	1354	2051	1431	1223	1537	1378	1627	1195	1203	1090	1454	363
Ce	19	17	42	47	23	66	90	16	54	52	35	40
Cr	64	47	28	32	34	16	32	23	54	50	45	50
La	4	10	21	25	11	37	50	6	26	34	19	25
Nd	16	15	17	24	15	31	47	10	24	n.d	n.d	n.d
Ni	23	18	9	11	12	8	12	9	8	33	26	32
Pb	33	41	22	20	22	39	30	23	28	n.d	n.d	n.d
Rb	132	144	127	110	107	114	136	100	103	92	94	63
Sc	18	16	5	8	4	4	9	5	7	10	8	8
Sr	741	766	603	666	698	424	538	526	522	717	683	446
Th	1	1	6	10	2	18	18	4	11	n.d	n.d	n.d
V	98	86	51	63	64	30	69	46	45	64	57	56
Y	66	66	18	24	35	15	59	4	26	5	31	4
Zn	95	85	60	76	82	24	79	55	54	60	60	58
Zr	196	186	250	272	280	126	312	223	242	55	52	42
Cu	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	125	97	108
Li	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	25	35	51

APPENDIX 3.1 : CONTINUED - THORR.

Sample	T33S	T37S	T113S	T116S	T118S	T121S	T126S	T127S	T213S	T222S	T224S	T234S
Unit	Contact	Contact	Contact	Contact	Contact	Contact	Contact	Contact	Contact	Contact	Contact	Contact
SiO2	67.82	56.75	66.10	63.88	71.89	68.75	64.53	70.01	66.89	71.11	67.61	69.98
TiO2	0.67	0.88	0.83	0.69	0.44	0.56	0.68	0.65	0.55	0.40	0.55	0.44
Al2O3	16.44	20.16	16.67	16.59	14.53	15.81	16.96	14.20	16.15	14.75	15.91	15.90
Fe2O3	0.61	0.80	1.27	1.26	0.74	0.77	1.11	0.93	1.16	0.74	0.81	0.80
FeO	2.68	4.04	2.88	3.32	2.08	2.67	3.31	2.55	2.66	1.79	2.35	2.15
MgO	1.72	3.56	1.35	1.86	1.34	1.49	1.77	1.41	1.60	1.18	1.38	1.32
CaO	3.19	4.08	2.33	3.59	2.73	3.01	3.14	2.05	2.92	2.69	2.78	2.89
Na2O	3.06	3.07	3.26	3.67	3.51	3.75	3.62	3.09	4.04	3.70	3.81	4.11
K2O	2.63	4.26	4.01	3.04	2.23	1.99	3.39	3.55	2.74	1.98	3.84	1.48
P2O5	0.18	0.81	0.01	0.25	0.08	0.12	0.12	0.07	0.09	0.13	0.24	0.08
MnO	0.04	0.05	0.03	0.06	0.03	0.05	0.05	0.05	0.05	0.04	0.06	0.04

Ba	506	1352	1225	1440	497	724	1364	1304	836	693	1494	336
Ce	47	19	166	37	39	86	102	132	163	62	36	47
Cr	50	67	41	47	38	39	44	36	42	38	36	39
La	24	9	109	20	24	61	62	88	92	44	24	30
Nd	21	13	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Ni	15	24	27	32	30	27	32	28	29	25	25	27
Pb	22	35	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Rb	85	135	147	72	62	31	62	58	90	45	110	63
Sc	12	17	14	8	8	6	10	8	10	5	4	8
Sr	642	741	563	745	564	689	657	521	494	543	620	468
Th	8	3	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
V	62	96	51	72	49	64	65	53	57	45	50	52
Y	20	65	18	22	7	20	17	10	23	10	10	6
Zn	64	98	71	70	52	48	66	46	64	44	56	49
Zr	205	190	49	46	72	52	53	47	49	38	41	42
Cu	n.d	n.d	107	92	169	92	113	99	264	392	126	122
Li	n.d	n.d	36	36	26	35	30	30	81	46	113	75

Sample	T113S	T116S	T118S	T121S	T126S	T127S	T213S	T222S	T224S	T234S	T249S	T253S
Unit	Contact	Contact	Contact	Contact	Contact	Contact	Contact	Contact	Contact	Contact	Contact	Contact
SiO2	66.10	63.88	71.89	68.75	64.53	70.01	66.89	71.11	67.61	69.98	66.70	63.76
TiO2	0.83	0.69	0.44	0.56	0.68	0.65	0.55	0.40	0.55	0.44	0.49	0.60
Al2O3	16.67	16.59	14.53	15.81	16.96	14.20	16.15	14.75	15.91	15.90	16.27	16.87
Fe2O3	1.27	1.26	0.74	0.77	1.11	0.93	1.16	0.74	0.81	0.80	0.71	0.59
FeO	2.88	3.32	2.08	2.67	3.31	2.55	2.66	1.79	2.35	2.15	2.73	2.96
MgO	1.35	1.86	1.34	1.49	1.77	1.41	1.60	1.18	1.38	1.32	1.41	1.74
CaO	2.33	3.59	2.73	3.01	3.14	2.05	2.92	2.69	2.78	2.89	2.84	3.02
Na2O	3.26	3.67	3.51	3.75	3.62	3.09	4.04	3.70	3.81	4.11	3.85	3.79
K2O	4.01	3.04	2.23	1.99	3.39	3.55	2.74	1.98	3.84	1.48	3.63	4.33
P2O5	0.01	0.25	0.08	0.12	0.12	0.07	0.09	0.13	0.24	0.08	0.21	0.29
MnO	0.03	0.06	0.03	0.05	0.05	0.05	0.05	0.04	0.06	0.04	0.04	0.05

Ba	1225	1440	497	724	1364	1304	836	693	1494	336	1800	2210
Ce	166	37	39	86	102	132	163	62	36	47	24	28
Cr	41	47	38	39	44	36	42	38	36	39	39	44
La	109	20	24	61	62	88	92	44	24	30	14	15
Nd	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Ni	27	32	30	27	32	28	29	25	25	27	27	29
Pb	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Rb	147	72	62	31	62	58	90	45	110	63	154	165
Sc	14	8	8	6	10	8	10	5	4	8	6	6
Sr	563	745	564	689	657	521	494	543	620	468	744	838
Th	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
V	51	72	49	64	65	53	57	45	50	52	51	57
Y	18	22	7	20	17	10	23	10	10	6	26	19
Zn	71	70	52	48	66	46	64	44	56	49	61	59
Zr	49	46	72	52	53	47	49	38	41	42	40	51
Cu	107	92	169	92	113	99	264	392	126	122	140	110
Li	36	36	26	35	30	30	81	46	113	75	39	40

APPENDIX 3.1 : CONTINUED - THORR.

Sample	T35AT	T35BT	T44T	T59T	T92T	T93T	T94T	T95T	T97T	T102T	T103T	T278T
Unit	Trans	Trans	Trans	Trans	Trans	Trans	Trans	Trans	Trans	Trans	Trans	Trans
SiO2	63.98	62.93	61.50	63.97	64.93	69.88	65.10	64.86	67.49	63.38	62.75	57.09
TiO2	0.66	0.68	0.65	0.59	0.63	0.50	0.66	0.70	0.59	0.77	0.78	0.94
Al2O3	17.47	18.28	17.96	17.12	16.16	14.71	16.44	16.59	15.41	16.78	17.10	18.73
Fe2O3	0.79	0.67	0.57	0.79	1.06	0.58	1.06	0.89	0.94	1.05	1.68	1.73
FeO	2.97	3.11	3.92	3.00	2.98	1.97	2.53	2.92	2.13	3.18	2.87	4.01
MgO	2.49	2.74	2.48	2.11	1.67	1.18	1.65	1.65	1.39	1.81	1.99	3.13
CaO	3.61	4.05	3.48	3.12	3.19	2.77	2.72	3.38	3.03	3.39	3.53	4.23
Na2O	3.51	3.55	3.14	3.74	4.00	4.05	4.06	4.17	3.95	4.36	4.21	4.47
K2O	2.78	2.84	4.61	3.56	3.79	2.25	4.93	3.30	3.16	3.86	3.84	2.84
P2O5	0.32	0.30	0.52	0.27	0.32	0.15	0.30	0.26	0.17	0.28	0.28	0.34
MnO	0.07	0.07	0.06	0.09	0.10	0.03	0.06	0.07	0.05	0.09	0.07	0.09
Ba	1051	938	2212	1591	1601	705	2030	1546	1375	1990	1560	983
Ce	51	20	20	18	26	56	46	55	130	71	61	68
Cr	50	52	36	30	26	34	43	41	43	42	44	65
La	33	8	11	9	17	36	31	36	96	45	37	39
Nd	22	9	13	12	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Ni	16	17	14	14	29	25	27	29	91	32	30	47
Pb	19	19	17	16	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Rb	87	91	150	110	157	37	86	95	67	108	111	128
Sc	6	6	6	7	6	7	6	7	6	9	8	14
Sr	762	917	833	656	716	556	756	736	665	769	726	928
Th	6	4	2	3	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
V	68	73	70	58	60	46	58	61	54	64	72	105
Y	8	8	19	24	4	9	14	14	17	31	12	26
Zn	66	66	90	68	69	41	58	66	52	69	72	94
Zr	179	200	295	268	53	43	42	50	42	49	51	54
Cu	n.d	n.d	n.d	n.d	121	109	137	85	94	81	87	225
Li	n.d	n.d	n.d	n.d	61	58	85	111	91	115	123	53

Sample	T110T	T111T	T114T	T115T	T122T	T123T	T125T	T128T	T129T	T133T	T135T	T180T
Unit	Trans	Trans	Trans	Trans	Trans	Trans	Trans	Trans	Trans	Trans	Trans	Trans
SiO2	64.99	63.84	64.18	64.50	59.39	65.29	68.01	64.12	61.91	64.21	65.72	67.51
TiO2	0.64	0.67	0.58	0.59	0.76	0.62	0.50	0.62	0.92	0.63	0.70	0.35
Al2O3	16.61	17.33	16.33	17.01	18.25	16.09	15.74	16.05	17.22	15.67	16.14	15.87
Fe2O3	1.22	1.23	1.34	1.35	1.59	1.35	0.76	1.58	1.59	1.45	1.27	0.85
FeO	3.64	3.04	2.50	2.87	3.46	2.48	2.24	2.96	3.14	3.02	2.61	1.67
MgO	1.75	1.90	1.66	1.69	2.01	1.61	1.34	1.83	1.89	1.89	1.81	1.77
CaO	3.34	3.76	2.87	2.92	2.87	3.15	2.67	3.42	3.41	3.41	2.59	1.83
Na2O	3.73	3.92	4.22	4.80	4.21	3.93	4.50	3.95	3.96	3.96	3.84	3.81
K2O	2.96	2.84	3.89	4.03	4.58	3.38	2.53	3.23	4.33	4.33	4.47	4.48
P2O5	0.27	0.28	0.25	0.28	0.39	0.23	0.20	0.27	0.37	0.37	0.32	0.19
MnO	0.05	0.07	0.06	0.07	0.09	0.06	0.09	0.07	0.08	0.08	0.05	0.06
Ba	1156	1585	1599	1181	1492	1436	1427	1506	1187	1633	1467	1566
Ce	54	54	39	38	40	30	24	45	40	29	30	58
Cr	42	51	41	37	46	41	36	43	40	40	48	45
La	31	30	24	22	21	17	15	28	26	16	17	40
Nd	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Ni	29	32	28	28	31	29	24	30	33	31	29	44
Pb	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Rb	57	34	99	87	117	100	163	54	70	151	85	141
Sc	8	11	5	7	8	5	11	12	6	8	5	10
Sr	684	822	766	600	648	719	629	764	854	817	655	865
Th	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
V	65	72	59	59	66	59	48	68	102	65	66	49
Y	18	20	11	15	25	11	19	16	10	14	20	14
Zn	56	70	66	84	83	57	51	67	68	75	63	48
Zr	59	58	54	43	51	52	64	68	56	45	52	49
Cu	102	79	97	99	59	83	104	99	87	114	72	47
Li	41	43	27	60	63	28	26	42	45	54	36	25

APPENDIX 3.1 : CONTINUED - THORR.

Sample	T193T	T215T	T216T	T217T	T218T	T223T	T226T	T228T	T229T	T230T	T231T	T232T
Unit	Trans	Trans	Trans	Trans	Trans	Trans	Trans	Trans	Trans	Trans	Trans	Trans
SiO2	66.12	64.55	65.51	65.87	64.45	65.38	64.60	65.32	66.65	63.29	63.63	64.15
TiO2	0.75	0.63	0.66	0.66	0.66	0.67	0.66	0.66	0.68	0.69	0.76	0.67
Al2O3	14.46	16.08	16.57	16.25	16.06	16.30	15.71	16.18	15.64	15.96	16.97	16.78
Fe2O3	1.11	1.26	1.09	1.44	1.11	0.85	1.03	1.18	1.00	1.65	1.03	1.26
FeO	2.99	2.69	2.70	2.63	2.83	2.60	3.22	2.68	2.28	2.51	2.85	2.69
MgO	2.63	1.68	1.57	1.68	1.65	1.58	1.55	1.56	1.59	1.68	1.73	1.74
CaO	2.12	3.15	3.13	3.21	2.80	3.05	3.27	3.25	3.20	3.17	3.24	3.12
Na2O	3.56	3.79	3.79	3.73	3.99	4.65	3.86	4.08	4.18	4.05	4.68	3.87
K2O	4.31	3.98	3.32	3.62	3.17	2.20	3.40	3.37	3.04	3.76	2.97	3.82
P2O5	0.24	0.28	0.26	0.26	0.25	0.11	0.39	0.26	0.23	0.26	0.27	0.24
MnO	0.07	0.06	0.06	0.06	0.06	0.06	0.06	0.08	0.06	0.07	0.05	0.06

Ba	1288	1649	1579	1557	1488	1870	664	1216	1644	1589	1308	1717
Ce	72	32	41	31	65	41	127	47	49	38	69	102
Cr	67	42	42	40	42	44	38	40	39	44	42	47
La	49	20	24	20	43	23	85	31	29	18	44	71
Nd	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Ni	58	30	30	30	29	32	28	30	30	30	28	30
Pb	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Rb	92	119	127	89	84	77	64	55	99	141	56	86
Sc	3	8	5	4	4	7	10	5	8	14	6	6
Sr	940	657	677	720	661	724	538	645	645	709	686	729
Th	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
V	70	59	62	65	55	64	52	53	54	58	58	63
Y	9	12	12	8	11	14	11	10	19	50	13	13
Zn	67	62	59	72	66	68	57	54	67	64	53	68
Zr	73	43	45	45	46	51	39	43	45	47	47	43
Cu	225	110	97	278	315	368	528	446	109	246	98	162
Li	35	77	89	93	83	90	74	72	122	94	98	40

Sample	T233T	T234T	T235T	T245T	T247T	T471	T481	T531	T541	T791	T811
Unit	Trans	Trans	Trans	Trans	Trans	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear
SiO2	65.52	63.76	63.05	61.85	64.69	62.31	63.77	63.96	64.42	66.16	67.04
TiO2	0.58	0.73	0.69	0.75	0.67	0.72	0.70	0.73	0.68	0.58	0.57
Al2O3	15.74	17.26	16.60	17.45	16.42	17.26	17.22	17.44	16.52	15.72	16.31
Fe2O3	1.12	1.03	1.52	1.79	0.77	1.47	1.24	1.47	1.16	1.38	1.06
FeO	2.29	2.91	2.51	2.70	2.73	2.71	2.64	2.83	2.57	1.89	2.24
MgO	1.47	1.56	1.66	1.94	1.53	2.26	2.04	2.28	2.20	1.38	1.60
CaO	3.10	3.45	3.50	3.78	2.86	3.70	3.43	3.66	3.23	2.74	2.66
Na2O	4.07	4.14	3.80	3.79	3.92	3.53	3.51	3.54	3.56	3.79	3.41
K2O	3.43	3.44	3.91	3.82	3.97	4.16	4.32	4.15	4.23	4.43	4.42
P2O5	0.23	0.28	0.27	0.28	0.26	0.41	0.36	0.38	0.30	0.20	0.20
MnO	0.06	0.07	0.07	0.07	0.05	0.07	0.06	0.07	0.06	0.06	0.06

Ba	1430	1708	1739	1707	1378	2271	2103	1842	1809	1480	2442
Ce	67	53	67	63	37	41	54	51	48	77	73
Cr	40	42	44	51	41	32	27	29	31	39	42
La	47	31	41	40	22	28	36	32	37	52	53
Nd	n.d	n.d	n.d	n.d	n.d	19	25	24	23	n.d	n.d
Ni	28	31	34	34	29	12	11	13	13	28	28
Pb	n.d	n.d	n.d	n.d	n.d	18	21	21	21	n.d	n.d
Rb	62	176	88	75	73	72	76	71	73	83	61
Sc	6	6	6	8	7	5	5	6	5	6	5
Sr	696	745	751	769	599	836	812	803	743	620	868
Th	n.d	n.d	n.d	n.d	n.d	5	8	8	7	n.d	n.d
V	52	65	64	72	55	68	60	67	59	49	55
Y	11	13	12	17	14	14	13	14	14	12	14
Zn	52	59	65	71	58	67	61	74	83	56	49
Zr	40	55	46	46	43	306	292	305	294	56	43
Cu	257	203	238	177	209	n.d	n.d	n.d	n.d	155	110
Li	73	104	69	116	80	n.d	n.d	n.d	n.d	35	27

APPENDIX 3.1 : CONTINUED - THORR.

Sample	T831	T861	T881	T891	T901	T981	T991	T1001	T1041	T1051	T1061	T21
Unit	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear
SiO2	64.05	61.83	65.56	63.20	63.08	63.98	64.08	63.72	62.95	64.78	62.93	64.21
TiO2	0.69	0.81	0.70	0.73	0.66	0.76	0.87	0.71	0.67	0.73	0.73	0.54
Al2O3	15.92	16.71	16.63	16.68	16.23	16.47	17.18	15.99	17.10	16.24	16.54	16.55
Fe2O3	1.26	1.76	1.44	1.73	1.58	1.54	1.41	1.59	1.62	1.82	1.81	0.93
FeO	2.79	3.07	2.83	2.38	2.29	2.62	2.25	2.42	2.32	2.33	2.41	2.37
MgO	2.05	2.49	1.82	1.98	1.58	1.83	1.99	1.71	1.63	1.71	1.75	2.52
CaO	3.51	4.06	3.08	2.53	3.43	3.53	3.81	3.40	3.52	3.07	3.50	3.42
Na2O	3.82	3.82	4.06	3.98	3.94	3.96	4.04	4.00	4.00	3.80	3.83	3.74
K2O	4.27	3.50	4.09	4.61	4.00	3.79	4.31	3.83	4.14	4.72	4.15	4.25
P2O5	0.25	0.28	0.28	0.26	0.24	0.27	0.28	0.26	0.26	0.25	0.25	0.30
MnO	0.07	0.07	0.06	0.07	0.06	0.07	0.08	0.07	0.07	0.07	0.07	0.07
Ba	2142	1889	2111	2093	1921	1680	2189	1538	1976	2113	1974	1879
Ce	72	57	59	67	62	59	79	63	66	64	72	69
Cr	51	60	42	44	48	44	49	46	45	41	44	73
La	46	33	39	45	40	39	52	39	44	40	44	36
Nd	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Ni	35	40	29	28	28	31	31	31	29	30	30	40
Pb	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Rb	53	55	52	84	60	91	80	60	52	66	61	89
Sc	9	9	8	8	7	8	11	7	7	7	7	5
Sr	836	972	919	823	860	742	763	702	876	819	836	1192
Th	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
V	70	85	68	64	62	65	69	63	63	66	69	63
Y	16	18	12	16	13	15	16	13	13	15	16	16
Zn	66	74	65	58	60	59	54	64	56	66	65	57
Zr	51	57	54	60	53	52	57	55	55	63	48	200
Cu	124	101	124	90	133	113	141	99	90	85	125	n.d
Li	28	36	24	53	20	108	64	80	42	30	31	n.d

Sample	T41	T61	T121	T161	T191	T201	T26A	T231	T24AI	T36I	T38I	T39AI
Unit	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear
SiO2	68.58	67.57	65.49	69.54	64.27	71.28	64.22	62.39	68.07	60.4	61.97	60.05
TiO2	0.35	0.55	0.69	0.46	0.65	0.46	0.72	0.72	0.52	0.81	0.76	0.8
Al2O3	14.77	16.08	16.78	15.2	16.36	15.4	16.74	16.18	15.33	16.9	17.51	18.46
Fe2O3	0.36	1.09	1.61	0.75	1.28	0.7	1.53	1.57	1.06	1.3	0.99	1.38
FeO	1.47	1.64	2.31	1.45	2.23	1.52	2.4	2.32	1.59	3.46	3.33	3.41
MgO	1.74	1.47	1.85	1.06	1.92	1.11	2.11	2	1.43	3.12	2.76	3.41
CaO	2.36	2.51	3.32	2.1	3.09	2.1	3.25	3.29	2.16	4.17	4.17	4.71
Na2O	3.77	3.68	3.48	3.62	3.77	3.63	3.77	3.67	3.66	3.44	3.5	3.61
K2O	3.9	4.31	4.42	4.96	4.31	4.77	4.02	4.21	4.83	3.72	3.8	3.42
P2O5	0.2	0.2	0.21	0.11	0.21	0.14	0.3	0.27	0.16	0.54	0.42	0.32
MnO	0.04	0.06	0.06	0.05	0.08	0.05	0.07	0.07	0.06	0.07	0.07	0.08
Ba	1255	1212	2036	1034	1437	923	1437	1543	1173	1179	2440	1907
Ce	53	64	54	77	67	73	52	57	73	66	61	62
Cr	46	15	26	17	24	18	23	19	20	59	55	58
La	26	41	34	45	40	43	36	31	43	37	37	37
Nd	22	24	23	31	26	27	23	25	29	30	25	27
Ni	24	10	12	8	10	8	10	10	7	20	21	21
Pb	18	22	20	23	21	22	20	19	23	18	18	19
Rb	83	90	76	96	90	92	84	83	93	74	73	74
Sc	2	4	5	2	4	3	5	4	1	8	5	9
Sr	822	494	749	400	621	383	634	654	478	871	934	977
Th	9	7	6	7	6	8	4	5	9	9	7	7
V	42	45	66	35	60	33	65	67	42	86	76	87
Y	9	12	8	12	11	8	10	12	13	21	17	19
Zn	26	60	59	38	56	39	66	62	44	77	69	77
Zr	139	213	288	178	251	204	278	258	220	288	255	276
Cu	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Li	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d

APPENDIX 3.1 : CONTINUED - THORR.

Sample	T39BI	T40I	T256I	T45I	T107I	T108I	T109I	T112I	T117I	T119I	T120I	T124I
Unit	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear
SiO2	59.32	61.72	63.01	65.05	64.36	62.84	64.34	64.64	64.1	62.14	62.75	63.09
TiO2	0.86	0.72	0.73	0.6	0.74	0.71	0.75	0.55	0.77	0.78	0.77	0.71
Al2O3	18.26	17.86	17.11	16.59	16.86	17	16.55	16.76	16.73	16.45	16.94	17.18
Fe2O3	1.72	1.5	1.69	0.86	1.82	1.84	1.75	1.28	1.8	1.76	1.88	1.67
FeO	3.34	3.27	2.66	2.43	2.47	2.36	2.45	3.07	2.63	2.79	2.71	2.55
MgO	3.32	2.92	1.82	1.89	1.8	1.77	1.77	1.67	1.85	1.97	2	1.82
CaO	4.76	4.23	3.62	3.17	3.55	3.37	3.44	3.28	3.51	3.63	3.75	3.49
Na2O	3.5	3.47	3.93	3.38	3.79	3.9	3.91	4.09	3.95	4.14	4.06	4.35
K2O	3.5	3.17	4.14	4.26	4.1	4.18	4.14	3.89	3.67	4	3.92	3.89
P2O5	0.41	0.3	0.27	0.21	0.27	0.25	0.26	0.26	0.26	0.27	0.28	0.25
MnO	0.08	0.07	0.07	0.06	0.07	0.07	0.07	0.06	0.06	0.07	0.07	0.07
Ba	1890	1697	2017	1958	1836	1938	1870	1756	1742	2024	1895	2027
Ce	45	46	67	48	77	69	67	40	65	66	64	41
Cr	61	56	43	34	44	44	47	43	49	49	46	42
La	28	30	41	35	50	44	42	23	41	40	40	24
Nd	23	18	n.d	19	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Ni	21	17	31	13	31	29	30	29	30	31	31	30
Pb	17	18	n.d	20	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Rb	73	79	66	72	53	56	64	71	69	79	65	97
Sc	7	6	7	4	8	7	7	11	6	8	8	8
Sr	971	921	880	764	811	832	834	703	909	881	892	860
Th	8	8	n.d	9	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
V	91	80	71	54	70	68	68	62	75	73	74	67
Y	20	13	16	9	16	15	15	19	13	16	9	11
Zn	81	78	66	59	65	55	64	65	62	64	63	62
Zr	309	297	52	263	53	60	66	56	58	55	48	52
Cu	n.d	n.d	119	n.d	82	64	86	111	70	79	74	104
Li	n.d	n.d	41	n.d	50	35	31	42	29	58	38	26

Sample	T130I	T131I	T132I	T134I	T279I	T179I	T183I	T184I	T185I	T186I	T188I	T190I
Unit	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear
SiO2	62.32	62.00	62.78	62.39	62.16	66.74	64.36	63.66	66.95	66.01	68.98	65.22
TiO2	0.72	0.78	0.73	0.80	0.87	0.50	0.51	0.56	0.50	0.47	0.44	0.52
Al2O3	16.84	16.87	17.61	17.01	17.72	15.23	16.43	16.11	14.94	15.66	14.65	15.16
Fe2O3	1.82	1.61	1.61	1.81	1.49	1.38	1.31	1.40	1.20	1.14	1.20	1.21
FeO	2.43	3.00	2.77	3.04	3.70	1.80	2.11	2.36	2.02	1.94	1.60	2.09
MgO	1.93	1.98	1.92	2.10	2.86	2.03	2.24	2.44	2.04	2.07	1.74	2.28
CaO	2.89	3.77	3.76	3.65	4.26	2.75	3.05	3.40	2.80	2.65	2.31	2.72
Na2O	4.07	4.01	4.26	4.08	4.30	4.07	3.91	4.13	3.98	3.96	3.95	4.17
K2O	4.51	3.80	4.24	3.91	2.74	4.53	4.24	4.17	4.29	4.31	3.97	4.07
P2O5	0.25	0.28	0.28	0.29	0.32	0.23	0.24	0.26	0.22	0.21	0.19	0.24
MnO	0.07	0.07	0.07	0.08	0.08	0.06	0.07	0.08	0.07	0.07	0.05	0.07
Ba	2160	1866	1906	1881	1331	1756	1949	1870	1768	3510	1378	1634
Ce	60	73	64	57	80	87	83	85	81	83	69	81
Cr	41	44	43	48	58	52	58	61	55	59	51	64
La	38	49	40	35	50	55	50	49	52	49	39	47
Nd	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Ni	30	32	31	32	45	49	53	58	51	50	48	53
Pb	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Rb	63	43	64	62	120	83	71	78	83	78	89	73
Sc	7	8	8	8	15	7	8	9	8	7	6	7
Sr	909	848	878	859	864	1114	1220	1311	1043	1170	962	1143
Th	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
V	66	73	71	79	95	60	66	73	60	59	53	65
Y	14	14	16	14	28	20	22	23	20	19	11	22
Zn	63	70	64	74	89	53	58	63	47	61	54	55
Zr	54	53	54	53	54	73	65	65	70	57	68	66
Cu	105	109	142	70	267	126	56	81	162	109	184	199
Li	51	56	44	49	58	18	20	22	20	17	21	20

APPENDIX 3.1 : CONTINUED - THORR.

Sample	T191I	T192I	T194I	T198I	T199I	T204I	T205I	T206I	T214I	T220I	T221I	T227I
Unit	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear
SiO2	64.86	64.11	65.43	63.66	65.43	66.54	67.71	65.50	64.05	63.29	65.98	64.55
TiO2	0.51	0.60	0.54	0.54	0.58	0.51	0.44	0.52	0.72	0.71	0.76	0.70
Al2O3	15.73	15.25	15.84	15.73	15.62	15.54	14.54	15.65	16.72	16.34	15.61	16.00
Fe2O3	1.09	1.35	1.42	1.26	1.08	1.12	1.08	1.25	1.61	1.77	1.50	1.26
FeO	2.19	2.56	2.16	2.20	2.55	2.04	1.77	2.14	2.49	2.33	2.58	2.70
MgO	2.22	2.57	2.34	2.40	2.53	2.12	1.83	2.20	1.69	1.77	1.71	1.68
CaO	2.86	3.49	3.67	3.06	3.18	2.89	2.62	3.18	3.73	3.22	3.15	3.26
Na2O	3.83	4.26	3.67	4.47	4.50	4.12	3.89	3.96	3.77	3.74	3.80	3.74
K2O	3.82	3.54	4.01	4.34	4.14	4.49	4.07	3.93	3.76	4.19	3.51	3.80
P2O5	0.24	0.27	0.26	0.24	0.25	0.22	0.20	0.25	0.28	0.28	0.23	0.29
MnO	0.07	0.07	0.08	0.07	0.07	0.06	0.06	0.07	0.07	0.07	0.06	0.07
Ba	1677	1497	1875	1864	1649	1769	1158	1716	1707	1787	1486	1730
Ce	77	78	80	72	75	74	65	77	73	58	100	72
Cr	64	70	61	63	71	59	59	67	46	47	47	46
La	44	48	44	45	46	45	39	43	43	37	69	46
Nd	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Ni	55	65	61	57	60	54	50	58	32	32	31	31
Pb	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Rb	73	40	77	82	78	87	65	73	67	71	71	110
Sc	8	8	8	8	8	7	6	7	8	8	6	7
Sr	966	1228	1194	1177	1200	1142	1009	1146	768	745	705	727
Th	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
V	66	74	69	67	71	61	54	65	66	62	65	64
Y	19	18	24	18	20	17	15	18	15	13	16	16
Zn	52	64	65	56	60	53	46	56	62	65	70	62
Zr	64	65	65	60	67	69	64	63	44	52	60	50
Cu	142	180	218	239	126	230	287	315	264	359	126	539
Li	21	18	16	20	25	19	17	17	81	70	88	98

Sample	T236I	T237I	T250I	T251I	T252I	T254I	T255I
Unit	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear	Hb-bear
SiO2	64.29	63.62	64.82	62.79	70.22	62.37	63.40
TiO2	0.69	0.66	0.69	0.73	0.33	0.68	0.69
Al2O3	16.58	16.09	15.57	16.68	13.41	17.67	16.45
Fe2O3	1.31	1.33	1.61	1.65	0.38	1.32	1.44
FeO	2.46	2.51	2.51	2.63	1.20	2.82	2.66
MgO	1.67	1.66	2.05	1.78	0.72	1.85	1.86
CaO	3.26	3.27	3.87	3.75	1.25	3.64	3.27
Na2O	4.18	4.17	3.47	4.13	3.78	4.22	3.91
K2O	4.03	4.19	3.34	4.14	5.36	4.18	4.38
P2O5	0.25	0.25	0.24	0.27	0.12	0.24	0.25
MnO	0.06	0.07	0.07	0.07	0.05	0.07	0.07
Ba	1717	1795	1744	2123	736	2246	2202
Ce	70	66	63	65	56	54	58
Cr	38	43	52	45	24	46	49
La	48	42	36	40	39	37	36
Nd	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Ni	29	31	37	30	18	31	31
Pb	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Rb	61	65	52	65	140	92	56
Sc	7	7	8	8	4	7	7
Sr	771	779	812	865	293	949	885
Th	n.d	n.d	n.d	n.d	n.d	n.d	n.d
V	62	62	72	66	23	66	68
Y	14	14	17	14	14	12	12
Zn	62	63	66	63	36	63	61
Zr	51	45	54	50	49	48	53
Cu	196	174	197	249	243	69	120
Li	90	80	28	21	30	57	37

APPENDIX 3.2 : ROSSES PLUTON (MERCY 1957)

Sample	87P	82P	26P	9(1)	9(2)	95	96	98P	104P	99P	108P	18P
Unit	Porp	Porp	Porp	Porp	Porp	Porp	Porp	Porp	Porp	Porp	Porp	Porp
SiO2	70.10	70.80	70.00	72.80	71.40	71.80	72.60	71.50	71.40	72.10	70.80	70.80
TiO2	0.35	0.27	0.33	0.16	0.13	0.25	0.34	0.19	0.30	0.29	0.32	0.30
Al2O3	15.00	15.30	16.80	13.50	12.80	14.90	14.30	14.70	13.70	14.20	14.30	14.50
Fe2O3	0.72	0.83	0.82	0.46	0.75	0.78	0.88	0.75	1.00	0.42	1.20	0.96
FeO	1.60	1.50	1.60	1.90	1.40	1.10	1.10	1.40	0.86	1.60	0.97	1.30
Fe(tot)	2.50	2.50	2.60	1.30	2.30	2.00	2.10	2.30	2.00	2.20	2.30	2.40
MnO	0.03	0.04	0.04	0.02	0.03	0.03	0.02	0.03	0.03	0.04	0.04	0.04
MgO	1.00	0.98	1.20	0.75	0.98	0.86	0.78	0.92	0.70	0.89	0.82	0.73
CaO	1.70	1.90	1.30	2.00	1.80	2.60	1.70	2.60	2.00	2.60	2.20	2.50
Na2O	4.20	4.30	4.30	4.40	4.40	4.10	4.20	4.50	4.60	4.20	4.80	4.40
K2O	4.50	4.60	4.20	4.00	4.90	3.10	3.80	3.10	3.90	3.20	3.70	3.30
P2O5	0.16	0.14	0.16	0.13	0.12	0.09	0.10	0.10	0.10	0.08	0.11	0.11
Total	99.54	100.83	100.93	99.06	98.86	99.73	99.94	99.94	98.73	99.80	99.39	99.08

Sample	15P	16P	106P	25P	159P	2P	37P	38P	39P	40P	28P
Unit	Porp	Porp	Porp	Porp	Porp	Porp	Porp	Porp	Porp	Porp	Porp
SiO2	71.90	71.00	70.80	70.30	71.60	71.30	72.60	72.60	73.10	71.60	72.70
TiO2	0.31	0.60	0.28	0.55	0.31	0.28	0.26	0.20	0.18	0.28	0.41
Al2O3	14.60	14.30	14.40	14.20	15.40	15.30	14.50	14.50	15.30	15.30	14.60
Fe2O3	0.77	0.87	0.66	0.80	0.87	0.56	0.58	0.68	0.72	0.56	0.25
FeO	1.20	1.20	1.30	1.80	1.20	1.30	1.10	1.10	0.88	1.30	1.40
Fe(tot)	2.10	2.20	2.10	2.80	2.20	2.00	1.80	1.90	1.70	2.00	1.80
MnO	0.04	0.07	0.04	0.05	0.02	0.03	0.03	0.03	0.02	0.04	0.03
MgO	0.77	0.89	0.90	0.76	0.88	0.86	0.69	0.66	0.52	0.82	0.74
CaO	2.70	2.70	2.30	2.90	2.70	1.90	1.80	1.90	1.70	1.90	2.30
Na2O	4.10	4.70	4.70	4.50	4.20	4.10	4.30	4.20	3.90	4.10	4.40
K2O	2.90	3.50	3.50	3.20	3.00	4.60	4.30	4.00	4.20	4.40	3.50
P2O5	0.09	0.10	0.10	0.19	0.12	0.12	0.10	0.10	0.09	0.13	0.11
Total	99.51	100.06	98.98	99.25	100.30	100.35	100.26	99.97	100.61	100.43	100.44

Sample	258G1A	150G1A	153G1A	141G1A	147G1A	22G1A	126G1	68G1	10G1	9G1	74G1	17
Unit	G1	G1	G1	G1	G1	G1	G1	G1	G1	G1	G1	G1
SiO2	69.70	74.90	74.80	73.90	72.10	73.60	72.90	73.90	72.80	74.00	74.30	73.20
TiO2	0.26	0.14	0.14	0.15	0.33	0.19	0.22	0.19	0.24	0.20	0.14	0.20
Al2O3	15.80	13.90	13.90	14.20	14.80	13.50	14.30	13.30	14.50	14.40	13.00	13.70
Fe2O3	0.52	0.15	0.28	0.26	0.44	0.37	0.57	0.54	0.59	0.59	0.52	0.62
FeO	1.60	0.77	0.74	0.76	1.50	0.93	0.84	0.87	1.00	0.64	0.61	0.70
Fetot	2.30	1.00	1.10	1.10	2.10	1.40	1.50	1.50	1.70	1.20	1.20	1.40
MnO	0.04	0.03	0.01	0.02	0.06	0.02	0.04	0.05	0.03	0.05	0.02	0.03
MgO	0.84	0.41	0.34	0.36	0.91	0.47	0.67	0.52	0.79	0.63	0.39	0.57
CaO	2.40	0.91	0.82	0.82	1.60	1.50	0.84	1.40	1.40	0.97	0.82	0.78
Na2O	4.40	4.10	4.20	4.00	4.20	4.00	4.00	4.20	4.00	3.80	4.00	4.00
K2O	3.20	5.10	5.00	5.10	4.10	4.10	4.90	4.20	4.80	4.50	4.60	4.70
P2O5	0.12	0.07	0.08	0.08	0.12	0.07	0.10	0.05	0.10	0.05	0.05	0.07
Total	98.88	100.48	100.31	99.65	100.16	98.75	99.38	99.22	100.25	99.83	98.45	98.57

Sample	23G1	110G1	116G1	256G1	256G1	149G1	261G1	26G1	123G1	67G2	121G2	8G2
Unit	G1	G1	G1	G1	G1	G1	G1	G1	G1	G2	G2	G2
SiO2	73.10	74.80	72.60	72.60	72.70	73.40	72.00	70.20	73.70	74.40	74.50	74.70
TiO2	0.18	0.19	0.26	0.20	0.24	0.21	0.30	0.30	0.22	0.21	0.20	0.20
Al2O3	13.60	13.60	14.40	14.10	14.30	14.20	15.40	15.00	14.30	13.50	14.10	13.10
Fe2O3	0.50	0.40	0.59	0.48	0.48	0.55	0.60	0.98	0.49	0.69	0.50	0.77
FeO	0.63	0.72	1.00	1.10	1.10	0.94	0.90	1.10	1.00	1.00	0.81	0.75
Fetot	1.20	1.20	1.70	1.70	1.70	1.60	1.60	2.20	1.60	1.80	1.40	1.60
MnO	0.02	0.03	0.02	0.02	0.03	0.04	0.04	0.04	0.04	0.10	0.02	0.03
MgO	0.64	0.56	0.68	0.70	0.69	0.80	0.71	0.63	0.66	0.65	0.57	0.56
CaO	1.20	0.79	1.10	1.70	1.70	0.94	1.10	2.20	1.00	0.63	0.71	0.79
Na2O	4.00	4.00	4.10	3.80	3.90	4.10	4.00	4.10	4.20	3.80	4.10	3.40
K2O	4.90	5.10	5.10	4.20	4.40	4.20	5.10	4.70	4.50	4.50	5.00	4.30
P2O5	0.06	0.08	0.08	0.08	0.10	0.09	0.11	0.13	0.09	0.07	0.08	0.05
Total	98.83	100.27	99.93	98.98	99.64	99.47	100.26	99.38	100.20	99.55	100.59	98.65

Sample	7G2	13G2	24G2	111G2	145G2	128G2	146G2	122G2	118G3	6G3	14G3	290G3
Unit	G2	G2	G2	G2	G2	G2	G2	G2	G3	G3	G3	G3
SiO2	73.70	75.10	76.50	74.20	71.40	73.20	72.20	73.90	74.20	74.30	74.00	74.20
TiO2	0.16	0.13	0.17	0.20	0.25	0.24	0.22	0.13	0.20	0.21	0.19	0.25
Al2O3	14.80	13.70	12.30	13.30	14.60	13.80	14.20	14.60	12.70	14.70	13.70	13.10
Fe2O3	0.47	0.36	0.43	0.64	0.58	0.68	0.66	0.41	0.45	0.55	0.55	0.54
FeO	0.66	0.52	0.60	0.78	1.10	1.10	0.94	0.39	0.77	0.68	0.77	0.69
Fetot	1.20	0.94	1.10	1.50	1.80	1.90	1.70	0.84	1.30	1.30	1.40	1.30
MnO	0.04	0.05	0.04	0.03	0.03	0.03	0.04	0.03	0.03	0.04	0.03	0.04
MgO	0.54	0.47	0.35	0.58	0.76	0.69	0.69	0.37	0.50	0.61	0.57	0.52
CaO	0.94	0.89	1.10	0.84	1.40	1.40	1.10	0.87	1.10	0.84	1.10	0.82
Na2O	4.00	4.10	4.20	4.00	4.20	3.50	4.10	3.90	3.80	3.80	4.20	4.40
K2O	4.80	4.60	4.60	4.70	4.70	4.20	4.70	5.20	4.90	4.50	4.60	4.70
P2O5	0.05	0.05	0.05	0.05	0.08	0.10	0.08	0.04	0.10	0.06	0.05	0.10
Total	100.16	99.97	100.34	99.32	99.1	98.94	98.93	99.84	100.05	100.29	99.76	99.36

APPENDIX 3.2 : CONTINUED - ROSSES PLUTON

Sample	273G3	5(1)G4	5(2)G4	5(3)G4	12G4	29G4	1MG	2MG	47MG	53MG	65MG	45MG
Unit	G3	G4	G4	G4	G4	G4	Mg	Mg	Mg	Mg	Mg	Mg
SiO2	75.20	76.30	76.60	77.00	75.60	76.70	75.60	75.00	73.80	73.70	76.90	70.70
TiO2	0.15	0.11	0.10	0.04	0.10	0.11	0.09	0.08	0.15	0.15	0.05	0.24
Al2O3	13.70	13.60	13.70	12.10	13.90	12.70	14.30	13.90	14.20	13.90	12.40	14.20
Fe2O3	0.42	0.51	0.51	0.23	0.51	0.33	0.28	0.27	0.61	0.31	0.27	0.56
FeO	0.61	0.36	0.14	0.14	0.28	0.16	0.45	0.40	0.53	0.58	0.22	1.30
Fetot	1.10	0.91	0.67	0.39	0.82	0.51	0.78	0.71	1.20	0.95	0.51	2.00
MnO	0.03	0.05	0.01	0.01	0.04	0.11	0.01	0.04	0.01	0.01	0.07	0.03
MgO	0.40	0.46	0.30	0.18	0.30	0.16	0.30	0.26	0.32	0.32	0.19	0.84
CaO	0.70	0.47	0.46	0.38	0.47	0.19	0.47	0.59	0.40	0.51	0.52	1.50
Na2O	4.00	3.80	3.40	3.60	4.00	4.30	3.50	3.70	3.90	3.60	4.00	4.00
K2O	4.40	4.60	4.60	5.20	4.70	5.00	5.20	5.00	5.60	6.80	5.00	4.60
P2O5	0.05	0.09	0.07	0.04	0.04	0.02	0.10	0.08	0.11	0.12	0.01	0.13
Total	99.66	100.35	99.89	98.92	99.94	99.78	101.00	100.00	100.50	100.70	100.20	98.90

Sample	43MG	60MG	51MG	59MG	59(1)	61MG	102MG	103MG	19MG	103MG	21MG	100MG
Unit	Mg	Mg	Mg	Mg	Mg	Mg	Mg	Mg	Mg	Mg	Mg	Mg
SiO2	74.10	74.20	72.80	72.40	73.70	73.70	72.00	74.20	74.70	73.70	75.50	75.40
TiO2	0.11	0.18	0.22	0.15	0.21	0.18	0.23	0.11	0.10	0.18	0.05	0.05
Al2O3	13.50	13.10	14.30	14.10	13.70	13.60	14.00	15.30	13.00	13.40	15.00	13.00
Fe2O3	0.34	0.40	0.50	0.34	0.48	0.40	0.27	0.48	0.36	0.34	0.34	0.24
FeO	0.69	0.67	0.90	0.87	1.10	0.90	1.20	0.32	0.41	0.87	0.18	0.22
Fetot	1.10	1.20	1.50	1.30	1.70	1.40	1.60	0.84	0.82	1.30	0.54	0.48
MnO	0.02	0.04	0.05	0.03	0.04	0.02	0.04	0.02	0.02	0.03	0.01	0.03
MgO	0.32	0.47	0.52	0.48	0.64	0.55	0.71	0.25	0.23	0.73	0.17	0.16
CaO	0.66	1.00	0.88	0.79	1.30	0.96	1.40	0.39	0.72	0.90	0.45	0.44
Na2O	4.10	4.20	3.60	4.00	4.20	3.80	4.30	4.20	4.00	4.10	3.80	4.00
K2O	5.30	4.60	4.70	4.80	4.40	5.20	4.40	4.20	4.80	4.20	4.40	4.90
P2O5	0.02	0.06	0.06	0.08	0.12	0.08	0.04	0.07	0.05	0.08	0.03	0.02
Total	99.80	99.60	99.10	98.80	100.60	99.90	99.30	101.00	98.70	99.10	100.40	99.70

Sample	73MG	84MG	85MG	89MG	131MG	160MG	164MG
Unit	Mg	Mg	Mg	Mg	Mg	Mg	Mg
SiO2	75.30	71.50	75.40	74.10	75.40	72.40	75.60
TiO2	0.09	0.18	0.08	0.32	0.11	0.24	0.10
Al2O3	13.30	15.00	13.40	15.00	14.10	14.30	13.50
Fe2O3	0.41	0.59	0.42	0.46	0.76	0.37	0.19
FeO	0.39	1.00	0.20	0.58	0.19	1.20	0.41
Fetot	0.84	1.70	0.64	1.10	0.97	1.70	0.65
MnO	0.01	0.02	0.02	0.03	0.02	0.02	0.02
MgO	0.33	0.69	0.16	0.40	0.23	0.71	0.23
CaO	0.50	1.20	0.56	0.57	0.55	0.59	0.49
Na2O	4.50	4.10	4.40	3.80	4.00	4.20	3.60
K2O	4.80	4.80	5.10	5.40	4.80	4.90	6.10
P2O5	0.05	0.14	0.04	0.07	0.06	0.16	0.02
Total	100.40	99.90	100.30	101.40	100.90	100.20	100.80

APPENDIX 3.3 : ARDARA PLUTON (YARR 1991)

Sample	Y43	Y861	Y862	Y863	Y864	Y866	Y1262	Y1265	Y1266
Unit	Outer	Outer	Outer	Outer	Outer	Outer	Outer	Outer	Outer
SiO2	63.50	64.00	63.30	64.10	62.10	63.70	61.80	61.40	63.40
TiO2	0.79	0.80	0.78	0.82	0.79	0.80	0.80	0.90	0.84
Al2O3	16.59	17.00	16.69	16.56	16.48	16.70	17.33	17.51	17.31
Fe(tot)	4.46	4.10	4.24	4.30	4.57	5.46	4.96	5.31	4.91
MnO	0.06	0.10	0.07	0.07	0.07	0.06	0.08	0.09	0.07
MgO	1.88	1.60	1.63	1.83	2.12	1.83	2.20	2.59	2.27
CaO	3.44	3.40	3.45	3.03	3.26	3.38	4.09	4.16	3.84
Na2O	4.30	4.10	4.10	4.10	4.20	4.10	4.80	4.50	4.40
K2O	3.93	4.00	4.28	4.54	4.17	4.04	3.50	3.55	3.69
P2O5	0.29	0.30	0.30	0.31	0.31	0.28	0.30	0.29	0.30
LOI	0.80	0.20	1.40	1.00	2.20	0.80	0.80	0.60	0.00
Total	100.04	99.60	100.44	100.87	100.46	100.14	100.93	101.18	101.02

Nb	17	22	24	21	18	21	13	15	15
Zr	287	408	360	360	313	304	188	200	221
Y	24	27	28	31	29	26	22	24	23
Sr	441	423	428	420	498	446	582	600	556
Rb	204	202	211	227	193	208	142	129	156
Th	23	31	35	34	31	27	21	20	19
Pb	35	30	40	39	36	36	38	27	35
Zn	62	52	55	58	59	61	63	69	66
Cu	<2	24	34	46	25	39	24	52	41
Ni	24	19	22	20	22	24	28	30	29
Cr	<2	22	29	25	34	27	41	43	40
V	106	103	98	97	105	102	109	124	112
Ba	<5	724	659	667	696	642	728	819	680
Hf	<5	9	8	9	8	8	5	5	6
Ce	112	70	113	137	122	100	55	88	94
La	<5	15	44	64	55	39	30	36	43

Sample	Y1364	Y8610	Y49	Y8611/	Y8612	Y8613	Y1264	Y1365	Y1367	Y965	Y2153
Unit	Int'mde	Int'mde	Int'mde	Int'mde	Int'mde	Int'mde	Int'mde	Int'mde	Int'mde	Int'mde	Int'mde
SiO2	64.72	64.23	63.91	61.68	61.79	61.72	64.05	67.67	64.31	68.55	66.91
TiO2	0.86	0.66	0.61	0.65	0.71	0.71	0.75	0.45	0.56	0.38	0.53
Al2O3	13.63	15.87	16.28	17.07	17.04	16.35	16.97	16.45	16.16	15.58	15.91
Fe(tot)	3.90	4.14	4.20	4.77	4.75	5.14	4.59	3.09	4.15	2.61	3.64
MnO	0.06	0.06	0.08	0.08	0.82	0.09	0.07	0.05	0.07	0.05	0.08
MgO	2.16	1.80	2.54	3.26	2.57	3.37	2.30	1.69	2.31	1.85	2.22
CaO	3.20	3.37	3.45	3.27	3.81	4.17	3.68	2.74	2.79	2.09	3.04
Na2O	4.42	4.21	4.69	4.03	4.27	4.26	4.37	4.35	4.31	4.51	4.99
K2O	3.66	3.93	3.39	3.60	3.17	3.04	3.46	3.95	4.05	3.75	2.44
P2O5	0.20	0.24	0.24	0.23	0.24	0.22	0.26	0.16	0.2	0.13	0.17
LOI	0.80	1.60	0.60	1.00	1.60	1.00	0.80	0.2	1.6	0.6	0.2
Total	99.93	100.22	100.18	99.85	100.96	100.27	101.50	100.8	100.5	100.3	100.3

Nb	9	15	10	0	14	14	14	7	10	12	6
Zr	150	205	170	157	144	125	171	124	158	104	120
Y	18	19	22	17	13	13	20	16	20	17	19
Sr	579	520	611	593	615	632	594	562	515	571	619
Rb	120	132	118	134	104	109	148	136	141	113	106
Th	9	30	22	5	18	11	16	10	15	14	7
Pb	31	36	41	25	35	23	33	31	30	17	24
Zn	50	53	62	61	59	67	65	41	48	38	73
Cu	35	19	33	29	27	35	23	10	52	10	53
Ni	30	24	35	39	18	45	29	26	29	25	31
Cr	59	30	70	89	42	102	44	48	63	56	74
V	88	n.d	96	101	109	121	104	63	97	49	57
Ba	736	n.d	761	732	601	651	633	760	800	761	409
Hf	5	n.d	6	4	5	5	5	5	5	4	4
Ce	76	n.d	53	64	68	62	72	30	57	45	48
La	33	n.d	33	31	31	30	29	18	29	27	25

APPENDIX 3.3 : CONTINUED - ARDARA

Sample	Y37/	Y90	Y94	Y961	Y962	Y963	Y8615	Y8616
Unit	Inner	Inner	Inner	Inner	Inner	Inner	Inner	Inner
SiO2	71.88	69.37	70.66	75.86	67.37	68.43	69.25	66.89
TiO2	0.26	0.33	0.23	0.05	0.26	0.34	0.26	0.35
Al2O3	15.62	15.23	15.4	13.43	15.19	15.59	16.14	15.56
Fe(tot)	1.89	2.55	1.76	0.7	2.09	1.47	2.08	2.57
MnO	0.04	0.06	0.06	0.02	0.05	0.05	0.05	0.05
MgO	1.07	1.48	0.94	0.25	1.57	1.57	1.14	1.8
CaO	1.2	1.67	1.22	0.66	1.6	2.45	1.79	2.1
Na2O	5.41	5.08	4.91	4.01	4.87	4.61	4.45	4.78
K2O	3.08	3.04	3.57	4.53	3	3.59	3	3
P2O5	0.06	0.1	0.09	0	0.1	0.13	0.1	0.11
LOI	1.4	1	0.8	0.2	3.6	0.8	1	2.8
Total	101.77	99.9	99.81	99.82	99.85	99.21	99.4	100.18

Nb	7	7	7	4	5	9	10	11
Zr	90	91	79	57	87	120	108	101
Y	6	10	8	9	10	15	6	7
Sr	431	527	499	206	536	548	505	554
Rb	68	95	103	125	94	123	92	98
Th	13	15	13	7	9	15	14	6
Pb	17	32	32	42	23	33	38	38
Zn	41	54	39	5	45	45	39	40
Cu	12	42	16	20	19	14	21	46
Ni	20	19	16	5	18	25	17	23
Cr	27	40	19	<2	32	55	30	47
V	36	57	30	11	36	53	34	44
Ba	514	567	830	594	536	623	449	616
Hf	5	4	4	2	4	4	4	4
Ce	35	32	30	0	40	47	43	40
La	16	14	24	6	21	32	22	20

APPENDIX 3.4 - APPINITE (YARR 1991)

Sample	M10	Y25518	Y25511	Y453	Y1851	Y1	Y1452	Y4	Y2557	76C	Y2657	AP2
SiO2	52.80	56.10	56.30	54.90	52.00	48.90	56.90	48.10	46.00	44.70	43.00	42.60
TiO2	0.48	0.30	0.74	0.32	0.50	1.65	0.88	2.41	3.85	1.61	1.82	1.56
Al2O3	19.73	12.79	11.30	13.36	15.17	15.51	18.91	13.35	12.37	10.87	12.30	16.60
Fe(tot)	4.87	5.48	8.64	6.51	4.60	9.18	8.00	13.83	17.50	11.32	12.01	11.01
MnO	0.07	0.12	0.15	0.14	0.09	0.13	0.09	0.24	0.28	0.15	0.15	0.11
MgO	5.91	8.51	8.77	9.90	7.63	9.10	2.78	7.22	5.36	12.58	11.30	10.34
CaO	8.04	8.38	8.82	9.31	15.38	9.96	5.45	11.86	9.69	11.49	11.41	12.41
Na2O	4.80	2.80	2.10	3.10	2.60	2.60	3.60	2.10	2.10	2.20	2.50	1.70
K2O	1.59	1.53	1.40	1.25	0.62	1.20	3.09	0.23	0.64	1.21	1.04	0.97
P2O5	0.15	0.07	0.12	0.04	0.13	0.37	0.25	0.27	0.47	0.06	0.10	0.02
LOI	1.80	3.80	1.00	1.20	1.20	2.20	0.60	0.00	1.00	3.80	3.60	2.40
Total	100.16	100.35	99.52	100.40	100.10	100.10	100.80	99.69	99.44	100.03	99.37	99.72
Nb	0	4	6	1	0	4	11	3	15	4	3	2
Zr	54	26	79	59	26	76	123	96	262	65	52	73
Y	9	15	33	12	14	30	23	29	44	33	30	31
Sr	1420	651	359	831	820	813	772	217	244	236	305	735
Rb	76	72	54	48	14	37	50	0	11	31	18	20
Th	2	10	5	6	1	1	4	14	3	2	8	1
Pb	9	14	19	11	15	0	12	21	6	9	11	106
Zn	41	60	93	62	40	69	83	109	155	82	92	82
Cu	0	31	35	46	6	0	28	165	162	0	118	n.d
Ni	56	104	123	145	18	95	63	65	43	67	42	55
Cr	0	276	341	341	5	0	99	177	50	0	385	n.d
V	89	103	175	96	139	271	183	517	705	408	455	355
Ba	0	321	120	15	167	336	584	72	174	0	217	n.d
Hf	0	2	2	3	2	3	3	2	3	1	1	n.d
Ce	50	28	28	14	14	9	50	0	44	42	19	60
La	16	13	12	12	96	27	n.d.	5	n.d	n.d.	9	n.d

Sample	AP1	Y2652	Y27517	Y30517	Y77	Y55	Y80	Y71	Y31515	Y26523	Y31512	Y31511
SiO2	41.50	48.70	56.60	47.00	50.70	62.60	53.40	55.10	48.80	55.10	50.20	52.60
TiO2	1.96	0.85	0.91	0.58	0.67	0.70	1.14	1.03	0.90	1.02	1.00	0.71
Al2O3	12.43	8.69	16.27	15.52	7.37	17.68	16.98	17.05	19.43	17.41	14.30	10.63
Fe(tot)	11.23	8.27	9.09	5.38	10.77	6.12	7.05	7.78	7.42	7.51	7.70	6.78
MnO	0.12	0.15	0.09	0.08	0.18	0.07	0.10	0.10	0.08	0.14	0.10	0.14
MgO	11.31	9.68	4.20	4.52	13.82	4.52	5.79	3.90	5.14	4.64	7.90	8.72
CaO	10.53	15.77	6.51	15.50	11.88	0.63	8.01	6.78	9.23	6.12	11.80	13.59
Na2O	2.00	1.70	3.50	1.80	1.30	1.20	3.10	3.50	3.10	3.70	2.80	2.20
K2O	1.20	0.39	2.51	0.79	0.56	3.20	1.80	3.04	2.42	2.00	1.00	1.33
P2O5	0.05	0.08	0.29	0.11	0.05	0.13	0.22	0.00	0.54	0.19	0.30	0.11
LOI	2.40	4.60	1.40	8.00	2.00	3.40	1.80	0.60	1.80	1.60	2.40	3.60
Total	94.71	98.90	101.42	99.39	99.32	100.49	99.43	99.10	98.84	99.56	100.50	100.56
Nb	2	n.d	4	6	2	20	5	11	2	8	4	7
Zr	73	n.d	98	54	58	265	82	186	144	126	62	46
Y	31	n.d	21	16	19	65	22	31	44	25	18	19
Sr	735	n.d	328	606	116	152	864	497	861	521	415	316
Rb	20	n.d	72	19	7	144	70	100	130	83	31	46
Th	1	n.d	6	4	18	25	3	16	7	6	4	8
Pb	106	n.d	11	10		25	9	20	16	14	11	12
Zn	82	n.d	n.d	44	81	115	62	136	54	78	75	64
Cu	n.d	n.d	n.d	21	123	25	n.d	62	n.d	17	n.d	26
Ni	55	n.d	n.d	8	14	51	48	62	10	20	35	32
Cr	n.d	n.d	n.d	64	370	174	n.d	56	n.d	83	n.d	163
V	355	n.d	265	267	242	136	191	162	192	223	230	198
Ba	n.d	n.d	459	179	68	595	n.d	606	n.d	577	n.d	209
Hf	n.d	n.d	3	2	2	5	n.d	5	n.d	3	n.d	1
Ce	60	n.d	25	32	12	107	60	84	88	50	45	29
La	n.d	n.d	21	17	7	55	140	27	n.d	20	94	11

APPENDIX 3.4 - CONTINUED - APPINITE

Sample	Y2554	Y2554	Y1854	Y2552	Y458	Y2556	Y1856	Y2159	M14	M11	Y2559	M5
SiO2	52.70	53.00	52.20	52.30	52.80	47.10	50.90	53.70	50.00	53.40	46.95	48.65
TiO2	0.71	0.73	0.49	1.44	1.19	3.40	1.00	1.16	2.10	0.53	1.60	1.58
Al2O3	13.24	12.89	12.33	16.34	8.69	17.39	13.36	15.58	17.37	16.20	13.79	14.66
Fe2O3	1.90	4.21	2.49	2.20	0.70	5.36	5.34	4.41	1.60	0.50	0.47	2.06
FeO	5.80	3.73	4.52	5.73	6.00	6.00	2.55	5.00	6.98	5.04	9.79	7.00
MnO	0.15	0.14	0.14	0.15	0.12	0.14	0.15	0.13	0.09	0.11	0.15	0.13
MgO	10.16	9.62	11.99	6.77	11.74	4.69	10.26	7.34	7.54	8.21	11.36	9.50
CaO	10.6	10.31	9.95	9.04	13.97	8.06	10.20	6.78	8.87	9.13	9.51	9.67
Na2O	2.1	2.20	2.20	3.00	2.30	4.00	2.30	2.40	3.40	3.10	2.56	3.04
K2O	1.01	1.00	1.16	0.88	1.35	1.27	1.28	2.31	1.92	1.93	1.77	1.37
P2O5	0.11	0.09	0.12	0.15	0.20	0.44	0.16	0.14	0.14	0.26	0.32	0.11
LOI	1.40	1.40	1.60	1.00	2.00	1.60	1.80	1.20	0.00	2.20	0.80	3.00
Total	100.00	99.30	99.42	99.14	101.28	99.58	99.57	100.17	99.99	100.57	99.28	100.78
Nb	4	4	3	4	8	30	4	8	5	0	18	9
Zr	38	38	24	19	81	151	58	113	107	108	128	98
Y	23	23	14	10	21	26	19	24	27	15	18	29
Sr	621	621	841	973	396	975	686	792	1057	1854	536	840
Rb	40	40	63	25	41	38	42	84	82	79	37	39
Th	3	3	7	9	3	9	0	3	4	6	0	6
Pb	10	10	8	7	6	7	9	16	11	15	0	7
Zn	67	67	64	77	57	81	64	59	68	43	70	74
Cu	35	35	39	26	10	0	44	27	0	0	44	0
Ni	81	81	138	51	119	18	155	44	41	97	197	140
Cr	173	173	355	77	535	0	211	143	0	0	642	0
V	154	154	137	135	218	367	201	112	296	114	219	264
Ba	250	251	226	256	411	0	321	714	0	0	192	0
Hf	1	2	2	2	2	0	2	4	0	0	3	0
Ce	23	21	6	14	39	60	25	30	0	0	10	53
La	16	18	9	4	16	152	12	15	0	0	10	19

Sample	Y13	Y1859	Y1858	Y22159	Y1751	Y1751/
SiO2	53.46	52.92	51.48	48.59	50.54	49.34
TiO2	0.73	0.72	1.10	1.04	1.50	1.49
Al2O3	14.10	14.57	16.81	14.01	18.26	17.47
Fe2O3	1.40	0.01	2.90	2.87	3.08	7.76
FeO	5.30	7.34	4.95	6.14	4.70	n.d.
MnO	0.14	0.13	0.14	0.15	0.11	0.10
MgO	9.25	9.30	7.69	7.80	6.56	6.21
CaO	8.98	9.38	9.84	12.26	10.10	10.17
Na2O	2.86	2.57	3.27	2.83	3.07	3.49
K2O	1.47	1.25	1.28	0.96	1.42	1.36
P2O5	0.12	0.13	0.23	0.33	0.23	0.22
LOI	1.60	1.60	0.40	1.80	1.60	2.20
Total	99.59	99.93	100.24	99.31	101.93	99.81
Nb	4	5	1	16	12	13
Zr	110	55	70	95	96	91
Y	34	16	20	16	16	17
Sr	634	797	414	664	49	813
Rb	60	44	46	33	49	49
Th	18	2	9	5	1	1
Pb	9	7	9	4	49	8
Zn	76	61	65	71	52	52
Cu	56	38	45	25	0	0
Ni	140	98	207	23	50	52
Cr	0	119	267	61	0	0
V	264	162	191	436	188	198
Ba	0	292	157	236	0	0
Hf	0	3	2	3	0	0
Ce	53	34	6	16	0	55
La	19	9	4	0	12	0

APPENDIX 3.5 : BARNESMORE PLUTON (DEMPSEY 1987).

Sample No	1	2	3	4	5	6	7	8	9	10	11	12
Unit	G1	G1	G1	G1	G1	G1	G1	G1	G1	G1	G1	G1
SiO2	73.51	72.33	72.82	73.23	75.79	74.03	73.19	73.32	71.96	73.97	73.21	73.63
TiO2	0.20	0.24	0.22	0.18	0.16	0.17	0.20	0.20	0.28	0.18	0.18	0.19
Al2O3	14.52	14.79	14.50	14.24	13.44	14.22	14.36	14.31	14.59	14.22	14.51	14.41
Fe(tot)	1.38	1.67	1.56	1.30	0.88	0.94	1.47	1.44	1.80	1.31	1.34	1.39
Fe2O3	0.59	0.59	0.67	0.62	0.28	0.29	0.68	0.65	0.63	0.62	0.63	0.66
FeO	0.71	0.97	0.80	0.61	0.54	0.59	0.71	0.71	1.06	0.62	0.64	0.66
MnO	0.04	0.07	0.05	0.03	0.03	0.04	0.05	0.05	0.05	0.05	0.04	0.04
MgO	0.44	0.57	0.59	0.45	0.50	0.38	0.52	0.51	0.83	0.46	0.41	0.55
CaO	1.39	1.40	1.18	1.07	0.33	0.73	1.09	1.47	1.27	1.09	1.36	0.80
Na2O	4.49	4.29	4.20	4.06	4.40	4.43	4.21	4.48	4.05	4.38	4.23	4.34
K2O	3.51	4.02	4.01	4.20	4.05	4.28	4.02	3.53	4.52	4.06	4.18	4.23
P2O5	0.06	0.08	0.08	0.06	0.06	0.05	0.06	0.06	0.08	0.04	0.05	0.06
Total	99.45	99.34	99.12	98.75	99.56	99.21	99.09	99.28	99.32	99.68	99.43	99.57
Rb	198	245	235	237	209	231	206	161	185	241	195	225
Sr	187	259	185	186	103	122	193	211	278	162	200	172
Ba	428	763	452	480	284	319	409	410	662	312	449	401
Zr	136	139	129	111	100	102	116	121	103	101	109	111
Y	21	23	26	21	18	16	16	18	19	18	16	16
Nb	22	19	18	14	20	18	17	16	16	16	12	14
Th	15	12	13	14	20	21	20	28	11	21	18	20
U	11	b.d.l	4	4	21	5	4	4	b.d.l	8	4	b.d.l
Zn	23	37	31	25	33	20	31	31	37	30	33	33
Ni	bdl	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	3	b.d.l	b.d.l	b.d.l
Pb	33	33	34	36	21	28	28	31	30	32	38	36

Sample No	13	14	15	16	17	18	19	20	21	22	23	24
Unit	G1	G1	G1	G1	G1	G1	G1	G1	G1	G1	G1	G2BF
SiO2	73.99	72.73	74.08	72.88	72.64	72.52	74.95	72.95	73.34	73.50	73.64	73.98
TiO2	0.17	0.23	0.17	0.22	0.22	0.22	0.15	0.24	0.20	0.18	0.18	0.19
Al2O3	14.34	14.71	14.18	14.72	14.76	14.78	13.92	14.85	14.47	14.37	14.36	13.71
Fe(tot)	1.16	1.68	1.12	1.60	1.82	1.60	1.05	1.58	1.46	1.39	1.31	1.35
Fe2O3	0.47	0.99	0.48	0.71	0.93	0.72	0.45	0.61	0.67	0.67	0.62	0.59
FeO	0.62	0.84	0.58	0.80	0.80	0.80	0.52	0.87	0.71	0.65	0.62	0.68
MnO	0.04	0.04	0.04	0.04	0.06	0.04	0.03	0.04	0.05	0.05	0.05	0.04
MgO	0.44	0.58	0.38	0.64	0.66	0.73	0.39	0.65	0.47	0.45	0.41	0.43
CaO	0.73	1.30	0.87	1.12	1.15	1.17	0.73	0.98	1.34	1.21	1.14	0.75
Na2O	4.30	4.41	4.27	4.35	4.27	4.19	4.23	4.26	4.30	4.26	4.28	3.97
K2O	4.36	3.64	4.33	3.81	3.87	3.90	4.33	3.73	3.89	4.08	4.26	4.80
P2O5	0.06	0.08	0.05	0.07	0.06	0.07	0.05	0.07	0.07	0.05	0.05	0.05
Total	99.52	99.53	99.42	99.36	99.41	99.13	99.78	99.25	99.50	99.47	99.60	99.19
Rb	257	159	227	172	185	183	227	163	211	219	217	224
Sr	132	215	133	193	252	197	117	180	196	162	168	132
Ba	357	523	322	472	568	564	266	496	390	376	444	262
Zr	103	131	101	135	122	123	96	127	121	107	103	103
Y	20	21	14	17	15	18	16	16	16	16	24	20
Nb	20	15	14	14	14	15	15	13	17	17	20	18
Th	24	21	21	21	16	13	20	14	22	21	18	24
U	b.d.l	3	5	2	b.d.l	2	8	2	b.d.l	b.d.l	b.d.l	b.d.l
Zn	32	35	27	33	39	35	25	32	33	31	31	22
Ni	b.d.l	b.d.l	b.d.l	b.d.l	26	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l
Pb	32	28	33	31	21	25	31	17	30	37	31	32

Sample No	25	26	27	28	29	30	31	32	33	34	35	36
Unit	G2BF	G2BF	G2BF	G2BF	G2BF	G2BF	G2BF	G2BF	G2BF	G2BF	G2BF	G2BF
SiO2	75.28	73.45	74.13	74.26	72.90	74.05	72.69	74.88	72.23	72.86	76.12	75.13
TiO2	0.17	0.23	0.16	0.12	0.24	0.22	0.20	0.20	0.27	0.22	0.14	0.16
Al2O3	13.37	14.07	14.24	14.55	14.55	13.87	14.72	13.82	14.75	14.66	13.60	13.76
Fe(tot)	1.20	1.53	1.14	0.92	1.52	1.57	1.31	1.33	1.85	1.45	0.97	1.14
Fe2O3	0.53	0.60	0.52	0.51	0.55	0.68	0.50	0.53	0.72	0.56	0.46	0.53
FeO	0.60	0.84	0.56	0.37	0.88	0.80	0.73	0.72	1.02	0.80	0.46	0.55
MnO	0.04	0.05	0.04	0.02	0.04	0.05	0.04	0.05	0.06	0.05	0.03	0.04
MgO	0.42	0.55	0.40	0.32	0.68	0.55	0.48	0.42	0.59	0.53	0.33	0.31
CaO	0.80	0.87	0.79	0.56	0.82	1.05	1.12	0.88	1.08	1.01	0.62	0.75
Na2O	4.06	4.11	4.11	4.52	4.01	4.15	4.25	4.11	4.16	4.03	3.92	3.97
K2O	4.39	4.51	4.82	4.47	4.74	4.22	4.66	4.54	4.45	4.89	4.58	4.74
P2O5	0.04	0.06	0.04	0.03	0.06	0.06	0.05	0.05	0.08	0.06	0.03	0.04
Total	99.71	99.34	99.80	99.73	99.46	99.69	99.44	100.19	99.42	99.67	100.28	99.96
Rb	210	317	216	179	187	172	178	194	178	174	194	213
Sr	128	190	139	145	199	168	207	121	205	230	122	145
Ba	269	344	242	246	564	237	396	186	384	475	191	259
Zr	99	125	92	62	97	110	89	91	112	93	78	90
Y	20	27	11	11	18	17	17	19	20	17	13	13
Nb	19	19	14	9	17	15	15	15	16	13	12	15
Th	20	17	22	21	24	21	23	39	19	10	28	27
U	b.d.l	b.d.l	b.d.l	b.d.l	26	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l
Zn	21	26	27	18	30	32	27	28	35	30	23	23
Ni	b.d.l	b.d.l	b.d.l	b.d.l	26	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l
Pb	39	37	34	29	28	25	24	27	26	29	24	30

APPENDIX 3.5 : CONTINUED - BARNESMORE PLUTON.

Sample No	37	38	39	40	41	42	43	44	45	46	47	48
Unit	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2
SiO2	75.25	75.45	75.97	75.95	76.52	75.51	76.23	74.26	75.50	75.24	76.20	75.76
TiO2	0.11	0.13	0.13	0.11	0.12	0.14	0.11	0.12	0.12	0.14	0.12	0.13
Al2O3	13.80	13.60	13.07	13.28	13.20	13.31	13.26	13.82	13.65	13.65	13.28	13.56
Fe(tot)	0.83	1.03	0.99	0.88	0.86	0.97	0.74	0.81	0.91	1.04	0.96	0.93
Fe2O3	0.44	0.55	0.53	0.49	0.43	0.44	0.25	0.38	0.40	0.44	0.53	0.45
FeO	0.35	0.43	0.41	0.35	0.39	0.48	0.44	0.39	0.46	0.54	0.39	0.43
MnO	0.03	0.04	0.03	0.04	0.04	0.03	0.03	0.04	0.03	0.04	0.04	0.03
MgO	0.26	0.24	0.34	0.24	0.27	0.28	0.23	0.23	0.23	0.26	0.23	0.22
CaO	0.57	0.67	0.48	0.57	0.56	0.59	0.58	0.72	0.66	0.70	0.59	0.72
Na2O	4.32	4.30	3.84	3.86	3.91	3.98	4.18	4.44	4.07	4.27	4.15	4.25
K2O	4.71	4.54	4.81	4.97	4.70	4.64	4.50	4.22	4.86	4.55	4.55	4.54
P2O5	0.02	0.03	0.03	0.02	0.02	0.03	0.02	0.02	0.03	0.03	0.03	0.03
Total	99.87	99.63	99.63	99.88	100.16	99.42	99.84	99.64	100.00	99.85	100.11	100.12
Rb	236	277	192	205	201	226	237	185	251	238	246	233
Sr	74	73	76	79	81	87	58	110	76	82	55	72
Ba	83	122	99	79	87	173	14	21	105	169	74	101
Zr	80	96	93	84	82	100	81	72	77	89	93	96
Y	22	28	18	18	20	21	19	16	22	21	22	22
Nb	18	25	13	13	15	22	15	13	13	16	18	19
Th	22	27	24	42	25	29	25	23	21	22	25	27
U	b.d.l	7	7	7	b.d.l	b.d.l	2	b.d.l	b.d.l	b.d.l	3	b.d.l
Zn	14	18	17	16	16	19	13	19	16	17	17	15
Ni	b.d.l	b.d.l	b.d.l	b.d.l	26	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l
Pb	29	49	26	39	24	29	34	43	39	30	35	32

Sample No	49	50	51	52	53	54	55	56	57	58	59	60
Unit	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2
SiO2	75.59	75.51	75.14	75.61	75.76	75.40	75.66	76.48	75.73	76.46	74.87	76.52
TiO2	0.13	0.12	0.12	0.12	0.13	0.13	0.14	0.13	0.12	0.13	0.11	0.12
Al2O3	13.54	13.61	13.42	13.45	13.50	13.72	13.40	13.16	13.51	13.21	14.13	13.34
Fe(tot)	0.98	0.89	0.95	0.82	1.00	0.86	1.00	0.87	0.94	0.93	0.91	0.88
Fe2O3	0.50	0.46	0.52	0.39	0.60	0.38	0.47	0.41	0.48	0.44	0.54	0.46
FeO	0.43	0.39	0.39	0.39	0.36	0.43	0.48	0.42	0.41	0.44	0.34	0.38
MnO	0.03	0.03	0.04	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.02
MgO	0.25	0.21	0.27	0.24	0.22	0.24	0.28	0.25	0.22	0.28	0.21	0.22
CaO	0.75	0.62	0.57	0.53	0.66	0.64	0.68	0.60	0.54	0.50	0.66	0.60
Na2O	4.06	4.34	4.24	4.19	4.19	4.17	4.05	4.09	4.16	4.04	4.48	4.15
K2O	4.65	4.59	4.74	4.73	4.75	4.70	4.74	4.62	4.79	4.57	4.61	4.66
P2O5	0.03	0.03	0.03	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Total	99.96	99.90	99.48	99.69	100.23	99.86	99.60	100.22	100.03	100.13	100.01	100.50
Rb	273	273	275	252	250	241	252	242	274	250	258	245
Sr	70	66	65	69	81	73	70	69	71	63	83	58
Ba	129	96	89	113	115	122	116	82	95	67	89	83
Zr	91	89	90	78	89	85	95	90	97	83	76	83
Y	25	23	24	22	21	24	25	23	22	14	16	15
Nb	25	23	19	19	21	20	21	18	27	23	20	22
Th	27	27	30	27	27	22	26	32	26	28	23	25
U	b.d.l	b.d.l	b.d.l	4	b.d.l	5	b.d.l	3	b.d.l	2	b.d.l	b.d.l
Zn	17	14	18	15	20	15	14	24	24	22	23	17
Ni	b.d.l	b.d.l	b.d.l	b.d.l	26	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l
Pb	35	33	39	33	33	35	35	38	33	28	40	31

Sample No	61	62	63	64	65	66	67	68	69	70	71	72
Unit	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2
SiO2	76.06	76.07	75.65	75.88	75.90	75.16	76.25	75.76	75.76	76.80	76.72	75.96
TiO2	0.14	0.12	0.12	0.10	0.10	0.17	0.13	0.12	0.14	0.13	0.12	0.13
Al2O3	13.35	13.63	13.71	13.67	13.44	13.56	13.24	13.87	13.40	12.98	13.03	13.42
Fe(tot)	0.98	0.87	0.87	0.80	0.86	1.15	0.91	0.88	1.02	0.90	0.87	0.95
Fe2O3	0.46	0.45	0.45	0.47	0.50	0.49	0.42	0.47	0.49	0.43	0.42	0.49
FeO	0.47	0.38	0.38	0.30	0.32	0.60	0.44	0.38	0.48	0.42	0.41	0.42
MnO	0.02	0.02	0.03	0.03	0.05	0.03	0.02	0.02	0.03	0.03	0.03	0.03
MgO	0.25	0.21	0.23	0.18	0.20	0.41	0.28	0.25	0.32	0.27	0.21	0.32
CaO	0.65	0.65	0.60	0.62	0.72	0.59	0.80	0.50	0.54	0.47	0.66	0.50
Na2O	4.16	4.19	4.21	4.21	4.13	4.05	3.98	4.35	3.87	3.89	3.89	3.90
K2O	4.50	4.75	4.77	4.77	4.70	4.67	4.78	4.63	5.17	4.67	4.68	4.91
P2O5	0.03	0.03	0.03	0.03	0.03	0.05	0.04	0.03	0.04	0.03	0.03	0.04
Total	100.08	100.49	100.07	100.25	100.09	99.76	100.19	100.17	100.03	100.11	100.20	100.10
Rb	217	245	264	247	238	224	231	224	187	223	181	207
Sr	69	69	64	60	65	81	64	58	91	64	72	127
Ba	107	124	85	70	49	147	81	52	92	96	80	116
Zr	87	84	83	82	78	103	90	92	108	78	84	76
Y	15	13	14	15	13	16	13	15	13	15	13	13
Nb	20	17	20	25	13	22	14	23	9	15	11	11
Th	26	27	27	27	29	27	28	27	29	28	22	27
U	b.d.l	b.d.l	2	13	26	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l
Zn	15	20	21	20	22	24	19	20	18	21	21	21
Ni	b.d.l	b.d.l	b.d.l	b.d.l	26	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l
Pb	29	38	35	37	40	28	33	26	30	29	31	21

APPENDIX 3.5 : CONTINUED - BARNESMORE PLUTON.

Sample No	73	74	75	76	77	78	79	80	81	82	83	84
Unit	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2
SiO2	75.48	75.75	75.83	75.88	76.52	76.34	75.76	76.59	75.55	75.98	76.43	75.84
TiO2	0.10	0.11	0.12	0.13	0.13	0.14	0.13	0.12	0.13	0.13	0.12	0.12
Al2O3	13.74	13.46	13.29	13.64	13.23	13.19	13.60	13.38	13.55	13.55	13.26	13.61
Fe(tot)	0.67	0.77	0.77	0.83	0.95	0.95	0.95	0.83	0.98	0.98	0.91	0.90
Fe2O3	0.34	0.37	0.36	0.37	0.48	0.40	0.46	0.41	0.49	0.50	0.46	0.45
FeO	0.30	0.36	0.37	0.42	0.42	0.50	0.44	0.38	0.44	0.44	0.41	0.41
MnO	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.02	0.04	0.04	0.03	0.05
MgO	0.15	0.21	0.17	0.23	0.22	0.31	0.24	0.21	0.26	0.30	0.29	0.23
CaO	0.55	0.57	0.58	0.57	0.47	0.32	0.49	0.21	0.80	0.70	0.57	0.77
Na2O	4.22	4.17	4.06	4.15	4.12	4.04	4.03	4.37	4.01	3.95	3.85	4.06
K2O	4.98	4.85	4.78	4.80	4.82	4.72	4.97	4.79	4.78	4.79	4.81	4.57
P2O5	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.03	0.03	0.03	0.03
Total	99.89	99.89	99.61	100.23	100.48	100.02	100.17	100.50	100.07	100.39	100.25	100.14
Rb	234	215	246	247	242	203	220	196	205	180	192	182
Sr	56	54	59	68	50	91	81	74	82	103	74	93
Ba	63	100	63	110	43	131	123	83	112	134	79	77
Zr	69	81	86	80	81	84	76	76	86	82	75	87
Y	11	11	14	11	17	16	13	13	14	13	15	13
Nb	10	14	22	24	28	18	14	14	14	10	11	13
Th	28	26	25	24	32	29	31	29	30	27	26	32
U	b.d.l	b.d.l	5	2	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l
Zn	16	15	18	19	20	22	23	21	29	19	19	24
Ni	b.d.l	b.d.l	b.d.l	b.d.l	26	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l
Pb	25	32	32	27	29	18	32	22	34	36	36	39

Sample No	85	86	87	88	89	90	91	92	93	94	95	96
Unit	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2
SiO2	75.65	75.91	76.22	75.73	75.85	75.91	76.28	75.93	76.09	76.47	75.95	75.70
TiO2	0.11	0.12	0.11	0.13	0.11	0.12	0.13	0.13	0.12	0.12	0.15	0.15
Al2O3	13.85	13.62	13.45	13.66	13.57	13.51	13.45	13.53	13.42	13.22	13.31	13.62
Fe(tot)	0.91	0.92	0.85	0.99	0.81	0.89	0.86	0.96	0.87	0.87	1.08	1.03
Fe2O3	0.53	0.48	0.47	0.50	0.43	0.47	0.37	0.50	0.45	0.45	0.50	0.46
FeO	0.34	0.40	0.34	0.44	0.34	0.38	0.44	0.42	0.38	0.38	0.52	0.51
MnO	0.03	0.04	0.04	0.05	0.06	0.04	0.03	0.03	0.04	0.04	0.04	0.03
MgO	0.19	0.23	0.23	0.28	0.20	0.23	0.24	0.25	0.28	0.20	0.29	0.24
CaO	0.73	0.60	0.57	0.60	0.72	0.58	0.58	0.58	0.55	0.63	0.54	0.64
Na2O	4.30	4.17	4.08	4.07	4.35	3.98	3.96	4.14	4.19	4.15	4.01	4.08
K2O	4.58	4.68	4.67	4.77	4.60	4.87	4.85	4.68	4.67	4.58	4.82	4.78
P2O5	0.03	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Total	100.34	100.26	100.19	100.25	100.24	100.10	100.35	100.20	100.20	100.25	100.15	100.25
Rb	200	243	238	233	265	223	221	236	259	246	247	247
Sr	72	62	68	82	59	78	74	75	68	62	74	76
Ba	59	58	86	96	61	95	97	66	64	79	134	142
Zr	78	91	75	94	85	91	84	91	90	83	101	94
Y	13	15	14	16	14	13	13	14	14	15	15	14
Nb	14	20	16	19	22	11	13	21	18	19	16	16
Th	39	37	40	44	34	31	34	35	32	31	32	30
U	b.d.l	b.d.l	b.d.l	b.d.l	2	b.d.l	b.d.l	5	b.d.l	b.d.l	b.d.l	4
Zn	22	22	26	27	25	23	26	26	28	24	25	25
Ni	b.d.l	b.d.l	b.d.l	b.d.l	26	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l
Pb	33	39	39	41	47	41	30	39	41	37	35	34

Sample No	97	98	99	100	101	102	103	104	105	106	107	108
Unit	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2
SiO2	76.20	76.22	76.39	76.16	75.79	75.81	75.57	76.87	76.29	76.04	75.56	75.95
TiO2	0.14	0.15	0.14	0.13	0.13	0.12	0.12	0.14	0.11	0.14	0.13	0.12
Al2O3	13.27	13.16	13.28	13.50	13.50	13.49	13.66	13.12	13.38	13.48	13.63	13.50
Fe(tot)	0.96	1.00	0.83	0.97	0.95	0.79	0.87	0.89	0.85	0.91	0.94	0.87
Fe2O3	0.42	0.44	0.34	0.50	0.48	0.38	0.42	0.38	0.46	0.37	0.45	0.43
FeO	0.48	0.51	0.44	0.42	0.42	0.36	0.40	0.46	0.36	0.48	0.44	0.40
MnO	0.03	0.03	0.03	0.03	0.03	0.02	0.03	0.02	0.03	0.04	0.03	0.03
MgO	0.28	0.30	0.26	0.26	0.32	0.45	0.32	0.35	0.15	0.16	0.22	0.21
CaO	0.46	0.51	0.51	0.57	0.50	0.31	0.39	0.53	0.71	0.70	0.62	0.59
Na2O	4.12	4.05	4.15	4.21	4.14	4.26	4.07	4.01	4.01	4.04	4.10	4.05
K2O	4.70	4.81	4.55	4.64	4.77	4.62	4.15	4.45	4.87	4.67	4.86	4.87
P2O5	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Total	100.13	100.20	100.11	100.44	100.11	99.87	100.15	100.37	100.40	100.14	100.07	100.16
Rb	238	249	218	229	255	240	201	180	243	229	248	255
Sr	64	70	65	70	60	61	91	78	66	75	65	70
Ba	126	131	79	98	93	68	229	81	100	144	123	93
Zr	93	96	86	89	93	90	71	88	84	91	92	85
Y	15	16	13	14	17	16	12	12	13	17	14	12
Nb	22	21	17	17	22	15	12	15	16	17	18	20
Th	30	28	28	31	28	33	32	32	31	29	34	29
U	b.d.l	b.d.l	b.d.l	b.d.l	3	4	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	2
Zn	21	25	20	24	21	24	21	21	23	23	24	24
Ni	b.d.l	b.d.l	b.d.l	b.d.l	26	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l
Pb	31	43	29	33	28	23	28	31	38	41	34	34

APPENDIX 3.5 : CONTINUED - BARNESMORE PLUTON.

Sample No	109	110	111	112	113	114	115	116	117	118	119	120
Unit	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2PF
SiO2	76.43	75.75	75.65	76.62	75.81	75.94	75.94	75.68	75.52	75.64	75.92	76.23
TiO2	0.12	0.122	0.134	0.132	0.11	0.119	0.112	0.127	0.122	0.142	0.136	0.125
Al2O3	13.39	13.52	13.36	13.46	13.59	13.61	13.81	13.71	13.62	13.83	13.46	13.32
Fe(tot)	0.7	0.92	0.93	0.82	0.91	0.85	0.76	0.94	0.94	0.84	0.96	0.89
Fe2O3	0.26	0.47	0.43	0.33	0.53	0.43	0.36	0.47	0.54	0.31	0.45	0.44
FeO	0.4	0.4	0.45	0.44	0.34	0.38	0.36	0.42	0.36	0.48	0.46	0.41
MnO	0.02	0.037	0.031	0.017	0.031	0.025	0.018	0.031	0.036	0.023	0.042	0.032
MgO	0.19	0.22	0.2	0.16	0.2	0.18	0.2	0.22	0.26	0.22	0.27	0.25
CaO	0.44	0.58	0.68	0.74	0.68	0.56	0.64	0.61	0.75	0.58	0.65	0.56
Na2O	4.24	4.03	4.11	4.13	4.11	4.12	4.13	4.14	3.97	4.04	3.93	3.87
K2O	4.75	4.81	0.66	4.55	4.66	4.77	4.83	4.91	4.94	5	4.89	4.85
P2O5	0.027	0.03	0.034	0.027	0.034	0.025	0.022	0.025	0.03	0.029	0.029	0.028
Total	100.26	99.967	99.726	100.6	99.726	100.16	100.42	100.34	100.15	100.29	100.23	100.11
Rb	274	228	237	241	237	212	205	219	214	186	213	215
Sr	48	84	74	67	71	61	69	70	80	77	84	75
Ba	91	111	119	90	95	80	75	99	119	137	113	102
Zr	106	76	95	88	83	80	75	88	87	84	79	86
Y	14	14	15	15	14	12	14	14	14	14	16	14
Nb	22	12	15	19	19	19	14	15	10	11	14	14
Th	28	25	26	36	33	31	25	33	36	33	29	41
U	5	b.d.l	b.d.l	b.d.l	3	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l
Zn	23	24	23	22	22	19	20	19	22	21	25	22
Ni	b.d.l	b.d.l	b.d.l	b.d.l	26	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l
Pb	31	34	36	38	35	32	29	35	40	30	35	32

Sample No	121	122	123	124	125	126	127	128	129	130	131	132
Unit	G2PF	G2PF	G2PF	G2PF	G2PF	G2PF	G2PF	G2PF	G2PF	G2PF	G2PF	G2PF
SiO2	76.22	76.04	73.89	74.28	76.18	75.57	75.89	75.98	75.83	75.78	76.43	76.10
TiO2	0.12	0.14	0.16	0.15	0.15	0.15	0.13	0.13	0.13	0.12	0.12	0.12
Al2O3	13.60	13.42	14.70	14.36	13.30	14.36	13.69	13.53	13.71	13.60	13.30	13.39
Fe(tot)	0.85	1.01	1.12	0.98	0.99	0.98	1.01	0.97	0.88	0.85	0.73	0.89
Fe2O3	0.44	0.47	0.50	0.41	0.41	0.41	0.52	0.48	0.41	0.40	0.31	0.44
FeO	0.38	0.48	0.56	0.52	0.52	0.52	0.44	0.44	0.42	0.41	0.38	0.40
MnO	0.05	0.03	0.03	0.03	0.04	0.03	0.04	0.03	0.03	0.03	0.02	0.04
MgO	0.23	0.34	0.38	0.37	0.22	0.37	0.27	0.23	0.25	0.19	0.19	0.20
CaO	0.68	0.74	0.64	0.74	0.61	0.74	0.60	0.67	0.47	0.68	0.62	0.64
Na2O	4.17	3.98	4.12	4.31	4.22	4.31	4.12	4.13	4.29	4.16	4.10	3.88
K2O	4.72	4.51	4.99	4.60	4.40	4.60	4.67	4.61	4.73	4.74	4.54	4.76
P2O5	0.02	0.04	0.03	0.04	0.03	0.04	0.03	0.03	0.03	0.03	0.03	0.02
Total	100.62	100.18	100.00	99.79	100.09	99.79	100.40	100.27	100.29	100.15	100.04	100.00
Rb	241	178	171	181	229	230	199	218	237	235	243	192
Sr	75	96	155	84	73	68	103	74	70	67	69	77
Ba	67	132	346	74	105	71	109	105	102	75	142	82
Zr	71	86	108	81	99	85	91	91	90	89	81	80
Y	14	16	16	16	14	12	14	15	12	13	13	16
Nb	15	10	12	14	21	15	12	16	16	15	18	11
Th	25	28	10	35	33	34	38	32	30	33	28	32
U	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	3	3	2	b.d.l	4	b.d.l	b.d.l
Zn	23	22	25	23	25	25	24	20	24	25	21	25
Ni	b.d.l	b.d.l	b.d.l	b.d.l	26	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l
Pb	40	34	30	22	32	30	34	35	29	36	32	35

Sample No	133	134	135	136	137	138	139	140	141	142	143	144
Unit	G2PF	G2PF	G2PF	G2PF	G2PF	G2PF	G2PF	G2PF	G2PF	G2PF	G2PF	G2PF
SiO2	75.88	76.45	76.38	76.37	76.24	76.46	76.91	76.49	76.56	76.50	76.07	76.17
TiO2	0.15	0.14	0.13	0.15	0.10	0.09	0.07	0.12	0.13	0.13	0.10	0.13
Al2O3	13.35	12.98	13.17	13.09	12.98	13.34	13.29	13.13	13.13	13.19	13.61	13.27
Fe(tot)	0.99	1.01	0.96	1.07	0.79	0.85	0.53	0.87	0.94	0.90	0.80	0.98
Fe2O3	0.48	0.48	0.48	0.47	0.39	0.55	0.29	0.38	0.46	0.42	0.46	0.50
FeO	0.46	0.48	0.48	0.54	0.36	0.27	0.22	0.44	0.43	0.43	0.31	0.43
MnO	0.03	0.03	0.03	0.03	0.03	0.03	0.01	0.02	0.03	0.03	0.02	0.04
MgO	0.24	0.22	0.23	0.29	0.18	0.20	0.08	0.20	0.22	0.22	0.17	0.23
CaO	0.59	0.50	0.57	0.55	0.48	0.55	0.34	0.52	0.69	0.47	0.70	0.61
Na2O	4.16	4.10	4.03	3.96	4.11	4.39	4.56	4.06	4.11	4.12	4.15	4.07
K2O	4.65	4.76	4.72	4.77	4.70	4.47	4.51	4.83	4.60	4.75	4.66	4.66
P2O5	0.03	0.02	0.02	0.03	0.02	0.02	0.01	0.03	0.03	0.03	0.02	0.03
Total	100.02	100.16	100.19	100.25	99.58	100.36	100.29	100.22	100.39	100.28	100.16	100.14
Rb	219	246	256	248	236	242	369	241	237	250	245	265
Sr	69	64	62	66	44	37	17	53	69	55	56	75
Ba	139	121	112	150	19	b.d.l	b.d.l	96	112	108	51	136
Zr	99	107	99	98	80	44	90	80	88	99	84	92
Y	22	22	29	21	21	18	29	19	22	19	20	27
Nb	20	22	20	20	21	19	31	17	23	14	20	29
Th	26	27	26	28	27	25	27	29	25	31	27	26
U	b.d.l	b.d.l	2	b.d.l	4	b.d.l	4	b.d.l	2	2	b.d.l	4
Zn	16	16	14	15	13	10	6	11	17	14	10	19
Ni	b.d.l	b.d.l	b.d.l	b.d.l	26	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l
Pb	36	33	36	34	42	43	28	40	39	39	32	42

APPENDIX 3.5 : CONTINUED - BARNESMORE PLUTON.

Sample No	145	146	147	148	149	150	151	152	153	154	155	156
Unit	G2PF	G2PF	G2PF	G2PF	G2PF	G2PF	G2PF	G2PF	G2PF	G2PF	G2PF	G2PF
SiO2	76.67	76.02	76.22	76.22	75.88	76.22	76.71	76.08	75.80	75.90	76.06	76.71
TiO2	0.13	0.15	0.13	0.12	0.15	0.14	0.15	0.12	0.14	0.13	0.16	0.15
Al2O3	12.99	13.39	13.30	13.18	13.24	13.15	12.90	13.31	13.39	13.32	13.37	13.17
Fe(tot)	1.00	1.03	0.98	0.94	1.08	1.04	1.02	0.91	1.03	1.00	1.02	1.03
Fe2O3	0.52	0.45	0.50	0.54	0.50	0.51	0.64	0.48	0.50	0.52	0.42	0.45
FeO	0.43	0.52	0.43	0.36	0.52	0.48	0.34	0.39	0.48	0.43	0.54	0.52
MnO	0.03	0.03	0.04	0.03	0.04	0.04	0.02	0.02	0.03	0.03	0.02	0.03
MgO	0.21	0.25	0.22	0.20	0.26	0.21	0.24	0.25	0.27	0.25	0.26	0.27
CaO	0.51	0.69	0.57	0.57	0.62	0.59	0.44	0.50	0.69	0.54	0.50	0.49
Na2O	3.89	4.03	4.15	4.03	4.13	4.13	3.97	4.33	4.11	4.15	4.03	4.05
K2O	4.86	4.75	4.66	4.77	4.69	4.63	4.75	4.55	4.66	4.71	4.89	4.75
P2O5	0.03	0.04	0.03	0.03	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Total	100.27	100.32	100.25	100.05	100.06	100.12	100.20	100.06	100.11	100.01	100.26	100.62
Rb	261	265	274	248	246	247	255	280	264	261	217	223
Sr	58	77	65	63	72	67	61	47	68	65	67	60
Ba	111	151	104	99	118	123	130	77	139	105	155	143
Zr	105	99	92	88	99	95	102	99	106	85	101	102
Y	24	24	24	21	23	23	25	27	26	24	15	16
Nb	22	22	20	16	21	21	24	28	28	20	19	20
Th	35	29	28	29	31	29	25	31	35	27	33	30
U	b.d.l	2	2	b.d.l	2	b.d.l	3	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l
Zn	12	21	17	16	20	15	15	12	16	11	24	22
Ni	b.d.l	b.d.l	b.d.l	b.d.l	26	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l
Pb	41	44	42	37	37	37	27	32	35	33	37	30

Sample No	157	158	159	160	161	162	163	164	165	166	167	168
Unit	G2PF	G2PF	G2PF	G2PF	G2PF	G2PF	G2PF	G2PF	G2PF	G2PF	G2PF	G2PF
SiO2	76.27	76.15	76.21	75.56	75.80	75.93	75.32	76.21	76.94	76.89	76.23	75.66
TiO2	0.17	0.15	0.14	0.14	0.16	0.17	0.13	0.17	0.13	0.12	0.13	0.17
Al2O3	13.08	13.38	13.39	13.72	13.49	13.36	12.70	13.31	13.09	13.24	13.37	13.60
Fe(tot)	1.12	1.06	0.99	1.06	1.07	1.18	0.86	1.04	0.87	0.88	0.97	1.15
Fe2O3	0.46	0.48	0.45	0.52	0.47	0.49	0.37	0.39	0.40	0.42	0.48	0.49
FeO	0.60	0.52	0.49	0.49	0.54	0.62	0.44	0.59	0.42	0.41	0.45	0.60
MnO	0.02	0.05	0.03	0.04	0.03	0.04	0.02	0.05	0.03	0.03	0.04	0.03
MgO	0.33	0.24	0.26	0.30	0.26	0.29	0.27	0.22	0.22	0.17	0.19	0.30
CaO	0.37	0.74	0.64	0.74	0.62	0.68	0.49	0.66	0.36	0.53	0.64	0.58
Na2O	4.31	4.24	4.10	4.24	4.18	4.09	4.09	4.17	4.09	3.97	4.11	4.19
K2O	4.53	4.37	4.60	4.53	4.66	4.50	4.43	4.34	4.79	4.86	4.72	4.69
P2O5	0.04	0.03	0.03	0.03	0.04	0.04	0.03	0.04	0.03	0.03	0.04	0.05
Total	100.17	100.35	100.33	100.30	100.33	100.20	98.28	100.14	100.50	100.67	100.40	100.35
Rb	240	241	233	225	241	253	247	244	253	253	245	262
Sr	62	76	70	78	69	81	47	76	48	52	68	68
Ba	139	130	110	63	109	125	31	99	114	96	114	142
Zr	106	105	90	86	103	110	104	99	90	90	85	113
Y	18	18	15	13	16	15	13	19	18	19	16	19
Nb	22	26	19	20	19	21	22	30	24	20	20	25
Th	27	28	24	24	27	29	31	32	29	32	32	32
U	b.d.l	4	10	3	2	b.d.l	2	b.d.l	2	3	2	4
Zn	23	26	24	27	26	29	21	26	18	17	25	29
Ni	b.d.l	b.d.l	b.d.l	b.d.l	26	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l
Pb	26	41	33	39	40	33	34	36	40	42	35	38

Sample No	169	170	171	172	173	174	175	176	177	178	179	180
Unit	G2PF	G2PF	G2PF	G2PF	G2PF	G2PF	G3	G3	G3	G3	G3	G3
SiO2	76.46	77.73	79.75	78.44	75.62	65.33	76.54	76.91	76.59	76.92	77.27	76.88
TiO2	0.12	0.11	0.07	0.11	0.13	0.16	0.08	0.07	0.08	0.07	0.07	0.08
Al2O3	13.96	13.65	11.64	12.33	13.56	18.99	13.11	13.29	13.27	13.34	13.28	13.23
Fe(tot)	0.88	0.62	0.44	0.70	0.96	1.00	0.65	0.56	0.64	0.66	0.47	0.58
Fe2O3	0.39	0.25	0.24	0.33	0.48	0.37	0.39	0.34	0.38	0.47	0.39	0.32
FeO	0.44	0.34	0.18	0.34	0.44	0.57	0.23	0.19	0.23	0.17	0.07	0.23
MnO	0.03	0.02	0.02	0.04	0.04	0.03	0.02	0.02	0.01	0.01	0.02	0.03
MgO	0.23	0.22	0.09	0.21	0.24	0.31	0.16	0.09	0.11	0.08	0.10	0.09
CaO	0.29	0.16	0.42	0.22	0.42	0.10	0.51	0.49	0.56	0.42	0.38	0.40
Na2O	4.13	4.15	4.75	3.97	4.04	5.97	4.42	4.59	4.42	4.48	4.56	4.45
K2O	4.68	4.74	3.45	4.50	4.88	7.32	4.40	4.34	4.51	4.39	4.38	4.42
P2O5	0.03	0.02	0.02	0.02	0.03	0.03	0.01	0.01	0.02	0.01	0.01	0.01
Total	99.78	100.39	100.62	100.50	99.87	99.16	99.87	100.34	100.18	100.37	100.54	100.14
Rb	193	198	130	180	195	257	177	344	310	331	358	343
Sr	80	72	52	56	89	85	27	25	30	24	20	19
Ba	106	86	34	28	103	285	b.d.l	b.d.l	b.d.l	6	b.d.l	b.d.l
Zr	85	78	59	73	86	108	75	71	76	75	80	92
Y	18	14	14	12	18	15	26	25	26	26	31	25
Nb	15	15	13	13	13	21	33	27	30	26	29	27
Th	26	27	31	34	35	36	24	27	28	28	28	27
U	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	28	7	8	b.d.l	18	5
Zn	16	14	8	18	29	25	12	7	9	11	12	13
Ni	b.d.l	b.d.l	b.d.l	b.d.l	26	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l
Pb	25	25	12	13	6	14	46	42	43	34	22	28

APPENDIX 3.5 : CONTINUED - BARNESMORE PLUTON.

Sample No	181	182	183	184	185	186	187	188	189	190	191	192
Unit	G3	G3	G3	G3	G3	G3	G3	G3	G3	G3	G3	G3
SiO2	76.36	76.30	76.28	76.68	75.10	76.67	76.89	76.83	76.63	76.88	76.55	76.73
TiO2	0.07	0.10	0.07	0.06	0.07	0.06	0.07	0.07	0.07	0.07	0.07	0.08
Al2O3	13.50	13.20	13.54	13.19	14.17	13.34	13.23	13.30	13.22	13.21	13.28	13.25
Fe(tot)	0.69	0.84	0.58	0.58	0.57	0.57	0.56	0.70	0.63	0.46	0.66	0.66
Fe2O3	0.48	0.50	0.45	0.40	0.36	0.39	0.35	0.40	0.42	0.25	0.47	0.40
FeO	0.19	0.31	0.12	0.16	0.19	0.16	0.19	0.27	0.19	0.19	0.17	0.23
MnO	0.03	0.03	0.03	0.02	0.02	0.03	0.04	0.02	0.03	0.01	0.01	0.02
MgO	0.12	0.22	0.11	0.07	0.11	0.12	0.14	0.14	0.09	0.08	0.10	0.12
CaO	0.47	0.50	0.42	0.39	0.56	0.38	0.42	0.39	0.38	0.27	0.34	0.38
Na2O	4.68	4.45	4.66	4.81	4.42	4.66	4.61	4.50	4.56	4.67	4.52	4.49
K2O	4.39	4.42	4.53	4.30	4.98	4.45	4.37	4.58	4.49	4.37	4.49	4.42
P2O5	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Total	100.31	100.31	100.22	100.10	99.99	100.29	100.31	100.52	100.09	100.01	100.02	100.13

Rb	359	306	366	416	338	392	351	374	370	342	360	338
Sr	24	27	23	9	60	17	21	19	18	19	23	24
Ba	b.d.l	b.d.l	b.d.l	b.d.l	62	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l
Zr	75	75	79	88	77	68	69	77	73	70	72	70
Y	27	25	28	32	27	29	29	30	28	27	27	27
Nb	27	25	30	35	26	20	29	28	27	28	29	32
Th	23	20	24	26	24	23	29	30	28	23	23	23
U	8	11	15	7	8	7	14	7	4	4	5	3
Zn	14	18	14	11	13	12	15	12	14	10	20	11
Ni	b.d.l	b.d.l	b.d.l	b.d.l	26	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l
Pb	37	41	29	36	40	43	40	36	39	18	22	33

Sample No	193	194	195	196	197	198	199	200	201	202	203	204
Unit	G3	G3	G3	G3	G3	G3	G3	G3	G3	G3	G3	G3
SiO2	76.95	76.90	76.55	77.10	77.10	76.91	76.57	76.63	76.27	77.23	77.70	77.24
TiO2	0.08	0.08	0.09	0.07	0.07	0.08	0.09	0.09	0.10	0.06	0.07	0.07
Al2O3	13.30	13.55	13.49	13.44	13.27	13.42	13.46	13.42	13.67	13.22	13.17	13.22
Fe(tot)	0.53	0.63	0.65	0.43	0.62	0.62	0.70	0.70	0.65	0.53	0.60	0.53
Fe2O3	0.29	0.39	0.38	0.23	0.41	0.38	0.41	0.41	0.32	0.38	0.40	0.32
FeO	0.22	0.22	0.24	0.18	0.19	0.22	0.26	0.26	0.30	0.14	0.18	0.19
MnO	0.02	0.01	0.03	0.02	0.02	0.03	0.03	0.02	0.02	0.01	0.02	0.02
MgO	0.12	0.10	0.11	0.07	0.09	0.11	0.13	0.15	0.15	0.10	0.09	0.11
CaO	0.38	0.38	0.48	0.49	0.47	0.43	0.53	0.61	0.63	0.40	0.48	0.33
Na2O	4.49	4.56	4.66	4.77	4.53	4.55	4.11	4.36	4.62	4.29	4.35	4.62
K2O	4.42	4.41	4.44	4.29	4.58	4.48	4.91	4.44	4.27	4.72	4.51	4.45
P2O5	0.01	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.01	0.01	0.02
Total	100.13	100.60	100.48	100.66	100.75	100.60	100.50	100.41	100.36	100.97	100.97	100.58

Rb	331	297	374	327	342	339	233	265	269	321	296	319
Sr	21	25	22	25	20	25	56	66	60	20	24	22
Ba	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	12	25	b.d.l	b.d.l	b.d.l
Zr	90	80	81	71	74	73	55	55	68	67	80	70
Y	13	14	17	13	16	15	14	12	13	12	12	13
Nb	24	26	32	21	29	20	15	19	20	18	22	24
Th	32	24	31	25	29	31	30	28	26	29	20	26
U	7	5	4	7	5	4	b.d.l	10	6	b.d.l	7	12
Zn	17	18	19	13	16	20	18	19	22	16	18	17
Ni	b.d.l	b.d.l	b.d.l	b.d.l	26	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l
Pb	34	24	53	39	43	33	34	34	36	35	38	27

Sample No	205	206	207	208	209	210	211	212	213	214	215	216
Unit	G3	G3	G3	G3	G3	G3	G3	G3	G3	G3	G3	G3
SiO2	76.70	77.01	76.94	76.76	76.33	77.27	76.94	77.02	76.62	79.10	76.78	76.74
TiO2	0.07	0.07	0.07	0.07	0.10	0.06	0.07	0.08	0.07	0.06	0.07	0.07
Al2O3	13.27	13.35	13.35	13.45	13.68	13.29	13.46	13.33	13.41	12.33	13.38	13.37
Fe(tot)	0.62	0.53	0.48	0.65	0.81	0.44	0.59	0.65	0.61	0.45	0.59	0.65
Fe2O3	0.41	0.33	0.28	0.43	0.47	0.29	0.38	0.41	0.39	0.32	0.37	0.43
FeO	0.19	0.18	0.18	0.20	0.30	0.13	0.19	0.22	0.20	0.12	0.20	0.20
MnO	0.03	0.02	0.01	0.03	0.03	0.01	0.03	0.02	0.02	0.01	0.03	0.02
MgO	0.10	0.09	0.08	0.13	0.16	0.04	0.09	0.14	0.09	0.05	0.13	0.09
CaO	0.40	0.31	0.34	0.42	0.51	0.45	0.44	0.46	0.45	0.43	0.37	0.43
Na2O	4.70	4.72	4.48	4.57	4.46	4.70	4.60	4.75	4.79	4.15	4.48	4.34
K2O	4.28	4.41	4.43	4.49	4.60	4.39	4.44	4.19	4.23	4.40	4.51	4.73
P2O5	0.02	0.01	0.01	0.02	0.04	0.01	0.01	0.02	0.01	0.01	0.02	0.02
Total	100.16	100.49	100.17	100.56	100.68	100.65	100.64	100.64	100.28	100.98	100.33	100.44

Rb	360	389	385	345	300	337	345	240	280	298	343	320
Sr	17	17	17	24	40	10	20	31	17	21	20	20
Ba	b.d.l	b.d.l	b.d.l	b.d.l	26	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l
Zr	76	73	79	81	85	64	77	62	84	72	82	63
Y	15	14	15	14	13	13	13	17	12	14	12	12
Nb	28	26	26	34	21	21	23	16	21	30	24	18
Th	27	26	28	29	25	23	25	20	31	20	30	29
U	7	2	4	b.d.l	b.d.l	b.d.l	4	7	b.d.l	5	5	b.d.l
Zn	20	14	16	17	22	16	19	15	14	12	18	20
Ni	b.d.l	b.d.l	b.d.l	b.d.l	26	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l
Pb	31	27	31	41	43	35	41	34	34	36	26	35

APPENDIX 3.5 : CONTINUED - BARNESMORE PLUTON.

Sample No	217	218	219	220	221	222	223	224	225	226	227	228
Unit	G3	G3	G3	G3	G3	G3	G3	G3	G3	G3	G3	G3
SiO2	76.90	77.02	76.95	77.03	76.74	77.37	77.82	77.62	77.17	76.59	77.45	78.10
TiO2	0.08	0.07	0.08	0.08	0.06	0.08	0.05	0.07	0.07	0.08	0.08	0.06
Al2O3	13.31	13.27	13.32	13.47	13.61	13.31	13.02	13.27	13.28	13.29	12.87	12.48
Fe(tot)	0.67	0.66	0.68	0.65	0.50	0.61	0.48	0.32	0.61	0.66	0.68	0.52
Fe2O3	0.40	0.44	0.44	0.41	0.33	0.38	0.37	0.10	0.40	0.40	0.36	0.34
FeO	0.24	0.20	0.22	0.22	0.16	0.21	0.10	0.20	0.19	0.23	0.29	0.16
MnO	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.04	0.03	0.03	0.02
MgO	0.14	0.09	0.11	0.13	0.07	0.09	0.06	0.04	0.08	0.14	0.14	0.12
CaO	0.43	0.44	0.50	0.47	0.56	0.41	0.46	0.44	0.42	0.71	0.50	0.50
Na2O	4.41	4.48	4.42	4.41	4.54	4.60	4.52	4.58	4.51	4.28	3.92	3.62
K2O	4.47	4.42	4.47	4.61	4.56	4.42	4.36	4.46	4.38	4.35	4.84	4.97
P2O5	0.02	0.02	0.02	0.02	0.01	0.02	0.01	0.01	0.02	0.01	0.01	0.01
Total	100.43	100.47	100.53	100.87	100.66	100.90	100.79	100.79	100.55	100.11	100.49	100.37
Rb	270	307	248	283	256	317	316	347	366	185	228	213
Sr	41	22	36	33	28	25	15	22	25	39	33	37
Ba	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l
Zr	77	74	71	72	42	76	39	72	73	57	62	33
Y	13	13	14	12	9	12	11	15	12	16	18	15
Nb	18	24	17	17	15	25	21	27	27	13	16	15
Th	34	32	31	27	23	25	18	28	26	31	32	14
U	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	10	8	6	b.d.l	b.d.l
Zn	21	17	17	20	14	17	11	10	21	14	14	4
Ni	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l
Pb	31	34	40	30	35	31	36	39	33	34	35	31

Sample No	229	230	231	232	233
Unit	G3	G3	G3	G3	G3
SiO2	76.77	76.72	76.40	77.52	76.68
TiO2	0.10	0.09	0.09	0.12	0.09
Al2O3	13.18	13.38	13.60	12.72	13.37
Fe(tot)	0.84	0.71	0.74	0.89	0.67
Fe2O3	0.50	0.44	0.43	0.47	0.39
FeO	0.30	0.24	0.28	0.38	0.26
MnO	0.01	0.02	0.02	0.03	0.03
MgO	0.13	0.16	0.16	0.27	0.19
CaO	0.47	0.64	0.49	0.52	0.52
Na2O	4.22	4.12	4.39	4.10	4.30
K2O	4.69	4.72	4.64	4.38	4.55
P2O5	0.02	0.02	0.02	0.02	0.02
Total	100.38	100.55	100.50	100.52	100.38
Rb	237	217	287	232	254
Sr	28	56	45	53	44
Ba	b.d.l	b.d.l	16	16	15
Zr	89	61	81	88	72
Y	17	13	12	14	11
Nb	29	12	20	18	17
Th	36	26	28	33	27
U	3	b.d.l	b.d.l	2	b.d.l
Zn	13	15	24	28	18
Ni	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l
Pb	23	34	34	32	31

APPENDIX 3.6 : MAIN DONEGAL GRANITE (CURTIS, IN ATKIN 1977)

Sample	2NF	5NF	6NF	7NF	16NF	19NF	37NF	38NF	39NF	3/4NF	17/18NF	4SF
Unit	light	light	light	light	light	light	light	light	light	light	light	light
SiO2	72.50	71.50	70.10	71.40	72.60	72.10	70.10	72.70	72.40	73.10	71.70	71.50
TiO2	0.22	0.29	0.37	0.29	0.18	0.30	0.37	0.24	0.25	0.21	0.30	0.30
Al2O3	15.60	14.70	15.50	15.50	15.40	15.00	15.30	14.80	14.60	14.50	15.10	15.40
Fe2O3	0.06	0.61	0.67	0.46	0.00	0.56	0.90	0.69	0.60	0.41	0.43	0.45
FeO	1.30	1.30	1.70	1.30	1.30	1.20	1.30	1.00	1.00	0.96	1.60	1.30
Fe(tot)	1.36	1.33	1.73	1.33	1.32	1.23	1.33	1.04	1.03	0.98	1.64	1.33
MnO	0.03	0.03	0.03	0.03	0.02	0.03	0.03	0.04	0.03	0.02	0.04	0.03
MgO	0.48	0.65	0.87	0.67	0.56	0.63	0.70	0.56	0.51	0.50	0.68	0.67
CaO	1.90	2.00	2.20	2.20	1.70	1.80	1.90	1.80	1.50	1.80	2.20	2.10
Na2O	3.80	3.70	4.00	4.20	3.70	3.60	3.60	3.90	3.10	3.60	4.60	4.30
K2O	4.20	4.40	3.90	3.70	4.10	4.90	4.50	3.60	4.70	4.20	3.60	3.60
P2O5	0.33	0.45	0.64	0.49	0.64	0.53	0.61	0.58	0.44	0.45	0.53	0.50
Total	100.42	99.05	99.34	99.81	100.22	100.12	98.44	99.26	98.56	99.36	100.39	99.73

Sample	8SF	11SF	12SF	21SF	15SF	20SF	13SF
Unit	light	light	light	light	light	light	dark
SiO2	71.00	71.80	70.00	74.00	73.80	71.10	69.00
TiO2	0.30	0.26	0.37	0.27	0.23	0.43	0.41
Al2O3	15.00	15.40	15.60	13.40	14.40	15.40	16.20
Fe2O3	0.49	0.55	0.44	0.52	0.26	0.67	0.69
FeO	1.40	1.30	1.60	1.00	0.75	1.60	2.10
Fe(tot)	1.44	1.33	1.63	1.02	0.76	1.63	2.15
MnO	0.04	0.03	0.03	0.02	0.01	0.03	0.05
MgO	0.58	0.72	0.73	0.39	0.32	0.73	0.89
CaO	1.90	2.40	2.50	1.50	1.40	2.30	3.30
Na2O	3.80	3.90	4.10	3.40	3.30	3.70	4.70
K2O	4.20	3.20	3.10	4.70	4.80	4.00	1.70
P2O5	0.54	0.48	0.64	0.52	0.60	0.72	0.75
Total	98.80	99.52	98.70	99.22	99.62	100.04	99.15

APPENDIX 4

MINERAL CHEMISTRY DATA

4.1 Plagioclase (Normalised to 8 oxygen).

4.2 Alkali feldspar (Normalised to 8 oxygen).

4.3 Biotite (Normalised to 22 oxygen).

4.4 Hornblende (Normalised to 23 oxygen).

4.5 Muscovite (Normalised to 22 oxygen).

4.6 Apatite (Normalised to 12.5 oxygen).

4.7 Epidote (Normalised to 25 oxygen).

4.8 Magnetite (Normalised to 3 oxygen).

4.9 Garnet (Normalised to 12 oxygen).

APPENDIX 4.1
PLAGIOCLASE ARDARA

Sample	ARD4	ARD4	ARD4	ARD4	ARD4	ARD4	ARD4	ARD4	ARD4	ARD4	ARD4	ARD4
Location	Core/1	Rim/1	Half/2	Half/2	Core/2	Rim/2	Core/3	Core/4	Rim/4	Core/5	Core/6	Core/7
SiO2	64.73	63.73	64.69	64.72	65.57	64.15	65.42	63.78	65.18	64.11	65.03	65.21
TiO2	0.11	0.01	0.00	0.02	0.00	0.01	0.01	0.00	0.00	0.03	0.00	0.06
Al2O3	22.25	22.20	21.95	21.65	21.74	22.07	21.35	22.76	21.71	21.69	21.58	21.74
Cr2O3	0.00	0.12	0.00	0.11	0.00	0.07	0.00	0.08	0.08	0.00	0.16	0.05
FeO	0.13	0.13	0.16	0.08	0.16	0.11	0.00	0.35	0.19	0.05	0.06	0.05
MnO	0.05	0.00	0.00	0.06	0.05	0.00	0.00	0.00	0.00	0.14	0.00	0.04
MgO	0.00	0.02	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00
CaO	3.43	1.56	3.26	2.87	1.75	3.05	2.37	3.86	2.52	2.94	2.94	2.67
NiO	0.09	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.06	0.00	0.09
Na2O	9.62	9.40	9.65	10.01	9.96	10.06	10.37	9.50	10.26	10.02	9.89	9.99
K2O	0.21	1.31	0.16	0.08	0.62	0.06	0.06	0.15	0.11	0.10	0.15	0.08
BaO	0.00	0.16	0.07	0.06	0.21	0.00	0.00	0.02	0.26	0.02	0.00	0.00
P2O5	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	100.46	98.63	99.94	99.66	100.12	99.58	99.59	100.24	100.19	99.13	99.81	99.99
Si	2.84	2.86	2.86	2.87	2.89	2.85	2.89	2.82	2.88	2.89	2.88	2.88
Ti	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Al	1.15	1.18	1.15	1.13	1.13	1.16	1.11	1.18	1.13	1.14	1.13	1.13
Cr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Fe	0.01	0.01	0.01	0.00	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.00
Mn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Mg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ca	0.16	0.08	0.15	0.14	0.08	0.15	0.11	0.18	0.12	0.14	0.14	0.13
Ni	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Na	0.82	0.82	0.83	0.86	0.85	0.87	0.89	0.81	0.88	0.87	0.85	0.86
K	0.01	0.08	0.01	0.00	0.04	0.00	0.00	0.01	0.01	0.01	0.01	0.00
Ba	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Sample	ARD4	ARD4	ARD4	ARD4	ARD10	ARD10	ARD10	ARD10	ARD3	ARD3	ARD3
Location	Core/8	Core/9	Half/9	Rim/9	Core/1	Rim/1	Core/2	Rim/2	Core/1	Rim/1	Core/2
SiO2	66.36	64.54	64.27	65.03	64.44	65.56	64.84	65.93	62.32	62.81	63.53
TiO2	0.03	0.02	0.00	0.00	0.02	0.00	0.00	0.00	0.05	0.00	0.10
Al2O3	22.06	23.32	23.08	22.61	22.36	21.21	22.31	21.79	23.97	23.20	23.64
Cr2O3	0.02	0.06	0.84	0.00	0.00	0.06	0.02	0.01	0.00	0.00	0.04
FeO	0.00	0.12	0.12	0.19	0.16	0.17	0.17	0.11	0.06	0.06	0.30
MnO	0.00	0.00	0.00	0.12	0.07	0.00	0.00	0.17	0.02	0.00	0.02
MgO	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CaO	2.63	4.09	3.88	3.49	3.52	2.43	3.49	2.89	5.33	4.56	4.65
NiO	0.00	0.03	0.01	0.00	n.d	n.d	n.d	n.d	0.00	0.00	0.09
Na2O	10.27	9.48	9.39	9.63	9.60	10.15	9.95	10.32	8.54	8.41	8.68
K2O	0.03	0.14	0.16	0.21	0.14	0.08	0.16	0.17	0.14	0.30	0.19
BaO	0.00	0.02	0.23	0.00	0.00	0.00	0.08	0.04	0.07	0.09	0.06
P2O5	0.06	0.00	0.00	0.00	0.13	0.17	0.10	0.32	0.00	0.00	0.03
Total	101.14	101.60	100.83	101.05	99.97	99.43	100.65	101.42	100.21	99.21	101.18
Si	2.88	2.81	2.82	2.84	2.84	2.90	2.84	2.87	2.76	2.80	2.78
Ti	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Al	1.13	1.20	1.19	1.16	1.16	1.10	1.15	1.12	1.25	1.22	1.22
Cr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fe	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.01
Mn	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00
Mg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ca	0.12	0.19	0.18	0.16	0.17	0.12	0.16	0.14	0.25	0.22	0.22
Ni	0.00	0.00	0.00	0.00	n.d	n.d	n.d	n.d	0.00	0.00	0.00
Na	0.86	0.80	0.80	0.82	0.82	0.87	0.85	0.87	0.73	0.73	0.74
K	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01
Ba	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.00	0.00	0.00

APPENDIX 4.1 : CONTINUED

PLAGIOCLASE ARDARA

Sample	ARD3	ARD3	ARD3	ARD3	ARD3	ARD3	ARD3
Location	Rim/2	Core/3 Pheno	Rim/3 Pheno	Core/4	Rim/4	Core/5	Rim/5
SiO2	62.89	60.71	61.68	60.01	61.87	62.11	63.89
TiO2	0.00	0.04	0.00	0.07	0.00	0.01	0.00
Al2O3	23.43	24.09	23.57	24.85	23.85	23.81	22.77
Cr2O3	0.01	0.02	0.00	0.11	0.00	0.16	0.06
FeO	0.13	0.00	0.00	0.00	0.02	0.13	0.10
MnO	0.04	0.03	0.09	0.00	0.01	0.00	0.00
MgO	0.00	0.01	0.00	0.00	0.00	0.00	0.00
CaO	4.78	5.66	5.18	6.55	5.29	5.05	3.82
NiO	0.00	0.08	0.10	0.02	0.02	0.00	0.00
Na2O	9.07	8.22	8.49	7.84	8.55	8.63	9.55
K2O	0.12	0.07	0.10	0.11	0.11	0.12	0.16
BaO	0.30	0.00	0.00	0.00	0.00	0.00	0.02
Total	100.52	98.93	99.20	99.46	99.73	100.00	100.15
Si	2.78	2.28	2.77	2.69	2.75	2.76	2.82
Ti	0.00	0.00	0.00	0.00	0.00	0.00	1.18
Al	1.22	1.28	1.25	1.31	1.25	1.25	0.00
Cr	0.00	0.00	0.00	0.00	0.00	0.01	1.18
Fe	0.01	0.00	0.00	0.00	0.00	0.01	0.00
Mn	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mg	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ca	0.23	0.27	0.25	0.32	0.25	0.24	0.18
Ni	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Na	0.78	0.72	0.74	0.68	0.74	0.74	0.82
K	0.01	0.00	0.01	0.01	0.01	0.01	0.01
Ba	0.01	0.00	0.00	0.00	0.00	0.00	0.00

PLAGIOCLASE FANAD

Sample	FAN19	FAN19	FAN19
Location	Core/1	Rim/1	COre/2
SiO2	60.73	61.66	59.35
TiO2	0.00	0.00	0.00
Al2O3	24.55	23.86	25.32
Cr2O3	0.00	0.03	0.02
FeO	0.23	0.18	0.27
MnO	0.07	0.00	0.04
MgO	0.00	0.00	0.00
CaO	6.41	5.59	7.30
Na2O	7.80	8.00	7.11
K2O	0.41	0.35	0.27
BaO	0.20	0.01	0.16
P2O5	0.00	0.04	0.07
Total	100.00	99.67	99.83
Si	2.71	2.75	2.67
Ti	0.00	0.00	0.00
Al	1.29	1.26	1.34
Cr	0.00	0.00	0.00
Fe	0.01	0.01	0.01
Mn	0.00	0.00	0.00
Mg	0.00	0.00	0.00
Ca	0.31	0.27	0.35
Na	0.68	0.69	0.62
K	0.02	0.02	0.02
Ba	0.00	0.00	0.00
P	0.00	0.01	0.03

CONTINUED -PLAGIOCLASE FANAD

Sample	FAN19	FAN19	FAN19	FAN19	FAN19	FAN19	FAN19	FAN19	FAN19	FAN23	FAN23	FAN23	FAN23
Location	Half/2	Rim/2	Core/3	Rim/3	core/4 small	Half/5	Core/6 small	Core/7 small	Core/8	Core/1	Rim/1	Core/2	Half/2
SiO2	59.59	60.49	59.63	60.05	60.92	60.59	61.58	59.59	59.81	59.80	61.57	59.24	59.18
TiO2	0.00	0.04	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.03
Al2O3	25.05	24.60	24.45	24.97	24.87	24.54	23.70	24.83	24.77	24.70	23.53	25.22	24.95
Cr2O3	0.00	0.02	0.02	0.05	0.02	0.12	0.00	0.02	0.03	0.00	0.02	0.11	0.10
FeO	0.19	0.21	0.23	0.12	0.11	0.10	0.18	0.22	0.10	0.10	0.13	0.30	0.27
MnO	0.00	0.03	0.02	0.00	0.11	0.03	0.04	0.00	0.05	0.02	0.00	0.00	0.04
MgO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CaO	7.07	6.53	6.66	6.82	6.69	6.47	5.30	6.72	6.52	6.62	5.50	7.12	7.10
NiO	7.44	7.78	7.64	7.71	7.67	7.83	8.56	7.50	7.71	7.47	8.24	7.49	7.17
Na2O	0.36	0.32	0.30	0.22	0.16	0.33	0.20	0.29	0.17	0.34	0.35	0.25	0.27
K2O	0.14	0.12	0.09	0.12	0.11	0.36	0.15	0.00	0.02	0.25	0.07	0.31	0.15
BaO	0.00	0.00	0.00	0.02	0.03	0.07	0.01	0.00	0.13	0.00	0.09	0.00	0.00
Total	99.84	100.13	99.02	99.74	100.46	100.36	99.71	99.14	99.18	99.29	99.61	100.05	99.27
Si	2.68	2.71	2.70	2.69	2.70	2.71	2.75	2.69	2.69	2.70	2.75	2.66	2.67
Ti	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Al	1.33	1.30	1.30	1.32	1.30	1.29	1.25	1.32	1.31	1.32	1.24	1.34	1.33
Cr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fe	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.01
Mn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ca	0.34	0.31	0.32	0.33	0.32	0.31	0.25	0.33	0.31	0.32	0.26	0.34	0.34
Ni	0.68	0.68	0.67	0.67	0.66	0.68	0.74	0.66	0.67	0.65	0.72	0.65	0.63
Na	0.02	0.02	0.02	0.01	0.01	0.02	0.01	0.02	0.01	0.02	0.02	0.01	0.02
K	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Ba	0.00	0.00	0.00	0.01	0.01	0.02	0.00	0.00	0.04	0.00	0.00	0.00	0.00

APPENDIX 4.1 : CONTINUED
PLAGIOCLASE FANAD

Sample	FAN46	FAN 46	FAN46	FAN 46	FAN46	FAN 46	FAN46	FAN 46	FAN46	FAN 46	FAN46	FAN 46	FAN46
Location	Core/1	Rim/1	Half/1	Core/2	Rim/2	Core/3	rim/3	Core/4	Half/4	Rim/4	Core/5	Half/5	Rim/5
SiO2	61.07	62.03	61.17	60.45	59.25	59.62	67.60	61.44	60.48	63.27	60.90	60.10	62.29
TiO2	0.02	0.00	0.01	0.02	0.06	0.09	0.00	0.00	0.00	0.04	0.00	0.07	0.06
Al2O3	24.06	24.45	24.75	24.76	25.49	25.65	20.10	23.57	24.90	22.80	25.82	26.02	24.47
Cr2O3	0.05	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.07	0.05	0.00	0.07	0.04
FeO	0.20	0.17	0.18	0.38	0.10	0.24	0.09	0.06	0.25	0.15	0.02	0.26	0.29
MnO	0.02	0.00	0.00	0.03	0.04	0.08	0.00	0.02	0.00	0.00	0.06	0.07	0.00
MgO	0.00	0.02	0.03	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.01	0.01
CaO	5.77	5.62	6.04	6.28	7.26	7.26	4.03	5.03	6.62	4.22	6.87	7.63	5.79
NiO	0.00	0.15	0.02	0.00	0.11	0.00	0.00	0.03	0.00	0.05	0.06	0.02	0.19
Na2O	8.46	8.33	8.20	7.95	7.42	7.44	7.77	8.63	7.49	8.89	7.65	7.25	8.17
K2O	0.04	0.15	0.28	0.33	0.14	0.07	0.04	0.06	0.32	0.45	0.23	0.21	0.41
BaO	0.06	0.13	0.17	0.00	0.00	0.00	0.08	0.00	0.05	0.00	0.24	0.01	0.00
Total	99.75	100.80	100.63	100.08	99.61	100.08	99.70	98.84	99.86	99.53	101.82	101.71	101.60

Si	2.73	2.74	2.71	2.70	2.66	2.66	2.97	2.76	2.69	2.81	2.67	2.64	2.73
Ti	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Al	1.27	1.27	1.29	1.30	1.35	1.35	1.04	1.25	1.31	1.19	1.33	1.35	1.26
Cr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fe	0.01	0.01	0.01	0.01	0.00	0.01	0.00	0.00	0.01	0.01	0.00	0.01	0.01
Mn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Ca	0.28	0.40	0.29	0.30	0.35	0.35	0.19	0.24	0.32	0.20	0.32	0.36	0.27
Ni	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Na	0.73	0.71	0.70	0.69	0.64	0.64	0.33	0.75	0.65	0.77	0.65	0.62	0.69
K	0.00	0.01	0.02	0.02	0.01	0.00	0.00	0.00	0.02	0.03	0.01	0.01	0.02
Ba	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

APPENDIX 4.1 : CONTINUED
PLAGIOCLASE ROSSES

Sample	G4	G4	G4	G4	G4	G4	G4	G4	G3	G3	G3	G3
Location	Core/1	Rim/1	Core/2	Rim/2	Core/3	Core/4	Core/4	Rim/4	Core/1	Rim/1	Core/2	Rim/2
SiO2	66.57	66.79	65.74	66.02	66.40	67.14	66.14	67.74	65.12	64.74	61.64	64.16
TiO2	0.03	0.04	0.00	0.00	0.00	0.01	0.00	0.00	0.11	0.07	0.00	0.00
Al2O3	20.41	21.32	20.28	20.32	20.11	20.53	20.47	20.54	22.70	22.14	24.30	22.90
Cr2O3	0.02	0.02	0.02	0.09	0.00	0.09	0.06	0.00	0.00	0.02	0.17	0.06
FeO	0.01	0.03	0.09	0.07	0.03	0.00	0.08	0.03	0.09	0.17	0.12	0.14
MnO	0.07	0.00	0.02	0.02	0.05	0.00	0.00	0.00	0.07	0.00	0.00	0.00
MgO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CaO	1.01	1.98	1.48	1.21	1.14	1.37	1.43	0.97	3.56	3.16	6.02	4.01
NiO	0.02	0.00	0.00	0.06	0.12	0.03	0.00	0.10	9.46	9.80	8.37	9.54
Na2O	11.03	10.57	10.48	10.64	10.70	10.98	10.88	11.12	0.06	0.14	0.10	0.12
K2O	0.09	0.04	0.02	0.09	0.37	0.03	0.03	0.07	0.00	0.00	0.15	0.06
BaO	0.00	0.00	0.31	0.01	0.10	0.02	0.05	0.09	0.11	0.00	0.15	0.13
Total	99.26	100.40	98.44	98.53	99.04	100.12	99.08	100.30	100.85	99.76	100.58	100.69
Si	2.95	2.91	2.94	2.94	2.95	2.94	2.94	2.96	2.84	2.86	2.73	2.82
Ti	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Al	1.06	1.10	1.07	1.07	1.05	1.06	1.07	1.06	1.17	1.15	1.27	1.18
Cr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Fe	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01
Mn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ca	0.05	0.09	0.07	0.06	0.05	0.06	0.07	0.05	0.17	0.15	0.29	0.19
Ni	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.80	0.84	0.72	0.81
Na	0.95	0.89	0.91	0.92	0.92	0.93	0.94	0.94	0.00	0.01	0.01	0.01
K	0.01	0.00	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ba	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01

Sample	G3	G3	G3	G3	G3	Porphyry	Porphyry	Porphyry	Porphyry	Porphyry	Porphyry	Porphyry
Location	Core/3	Rim/3	Core/4	Half/4	Rim/4	Core/6 inc	Rim/6 inc	Core/7 inc	Rim/7 inc	Core/8 pheno	Core/1 inc	Core/2 pheno
SiO2	61.33	59.88	60.60	61.70	63.56	63.74	64.19	63.92	62.88	63.55	61.17	58.38
TiO2	0.00	0.00	0.02	0.00	0.01	0.00	0.08	0.00	0.03	0.00	0.00	0.09
Al2O3	24.85	26.12	25.04	24.72	23.29	23.50	23.15	23.85	23.95	23.54	23.83	26.64
Cr2O3	0.12	0.05	0.07	0.08	0.02	0.00	0.12	0.00	0.03	0.07	0.07	0.00
FeO	0.04	0.03	0.06	0.01	0.04	0.09	0.10	0.26	0.13	0.03	0.10	0.19
MnO	0.00	0.00	0.02	0.00	0.00	0.03	0.00	0.00	0.05	0.09	0.00	0.00
MgO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CaO	6.46	7.75	6.78	6.18	4.71	4.47	4.21	4.82	5.26	4.68	5.69	8.63
NiO	7.96	7.23	7.81	8.17	9.07	8.99	9.41	8.91	8.81	8.86	8.40	6.63
Na2O	0.11	0.17	0.13	0.09	0.15	0.15	0.30	0.19	0.38	0.30	0.05	0.13
K2O	0.06	0.15	0.06	0.19	0.04	0.11	0.06	0.11	0.05	0.00	0.01	0.00
BaO	0.18	0.05	0.10	0.07	0.18	0.17	0.00	0.02	0.00	0.00	0.00	0.00
Total	100.68	101.14	100.55	100.79	100.68	100.92	101.40	101.88	101.44	100.71	99.29	100.35
Si	2.71	2.64	2.68	2.72	2.79	2.80	2.80	2.78	2.76	2.79	2.74	2.61
Ti	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.00	0.00	0.00	0.00	0.00
Al	1.29	1.36	1.31	1.21	1.21	1.22	1.19	1.22	1.24	1.22	1.26	1.14
Cr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fe	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01
Mn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ca	0.31	0.37	0.32	0.29	0.22	0.21	0.20	0.23	0.25	0.22	0.27	0.41
Ni	0.68	0.62	0.67	0.70	0.77	0.77	0.80	0.76	0.75	0.76	0.73	0.57
Na	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.02	0.02	0.00	0.01
K	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ba	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00

APPENDIX 4.1 : CONTINUED
PLAGIOCLASE ROSSES

Sample	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2
Location	Core/2	Core/3	Core/4	Rim/4	Core/5	Rim/5	Core/6	Rim/6	Rim/6	Core/7	Rim/7	Core/8
SiO2	63.73	64.66	64.09	64.33	63.71	64.09	64.99	64.67	68.55	65.20	64.38	62.85
TiO2	0.07	0.07	0.00	0.00	0.07	0.06	0.03	0.00	0.03	0.01	0.04	0.00
Al2O3	22.18	21.87	22.29	21.71	22.74	22.60	21.88	21.58	19.51	21.20	21.57	23.20
Cr2O3	0.08	0.08	0.10	0.07	0.04	0.00	0.00	0.00	0.07	0.00	0.02	0.02
FeO	0.00	0.01	0.02	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MnO	0.00	0.01	0.00	0.13	0.00	0.07	0.00	0.00	0.00	0.08	0.00	0.00
MgO	0.03	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00
CaO	3.44	2.82	3.48	2.89	3.59	3.55	3.03	2.59	0.10	2.25	2.84	4.50
NiO	0.04	0.14	0.08	0.17	0.18	0.04	0.00	0.00	0.00	0.00	0.00	0.00
Na2O	9.50	9.91	7.59	9.95	9.51	9.52	9.89	10.07	11.64	10.41	9.94	9.07
K2O	0.19	0.14	0.20	0.17	0.27	0.19	0.09	0.13	0.06	0.05	0.11	0.19
BaO	0.00	0.01	0.06	0.17	0.01	0.02	0.00	0.02	0.00	0.00	0.02	0.00
Total	99.25	99.46	99.69	99.36	99.93	100.19	99.54	99.06	99.69	99.21	98.93	99.83
Si	2.84	2.87	2.84	2.86	2.82	2.82	2.87	2.88	3.00	2.90	2.87	2.78
Ti	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Al	1.16	1.14	1.16	1.14	1.19	1.17	1.14	1.13	1.01	1.11	1.13	1.22
Cr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fe	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mn	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ca	0.16	0.13	0.17	0.14	0.17	0.17	0.14	0.12	0.01	0.11	0.14	0.31
Ni	0.00	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Na	0.82	0.85	0.82	0.86	0.82	0.81	0.85	0.87	0.99	0.90	0.86	0.78
K	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.00	0.00	0.01	0.00
Ba	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Sample	G2	G2	G2	G2	G1	G1	G1	G1	G1	G1
Location	Half/8	Rim/8	Core/9	Rim/9	Core/1	Half/1	Rim/1	Core/2	Rim/2	Core/3
SiO2	64.30	66.05	64.64	65.60	64.58	64.62	66.85	64.19	67.47	64.92
TiO2	0.00	0.10	0.00	0.00	0.08	0.00	0.01	0.01	0.00	0.00
Al2O3	22.37	21.53	22.42	21.91	22.42	22.06	21.14	23.73	21.26	22.48
Cr2O3	0.04	0.00	0.03	0.82	0.11	0.13	0.00	0.09	0.00	0.00
FeO	0.05	0.00	0.05	0.00	0.11	0.05	0.15	0.00	0.03	0.00
MnO	0.05	0.10	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.01
MgO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CaO	3.63	2.46	3.45	2.81	4.02	3.51	2.01	4.84	2.07	3.84
NiO	0.00	0.00	0.08	0.22	n.d	n.d	n.d	n.d	n.d	n.d
Na2O	9.60	10.32	9.46	10.15	9.38	9.52	10.87	9.13	10.65	9.65
K2O	0.17	0.07	0.16	0.06	0.29	0.29	0.31	0.10	0.10	0.23
BaO	0.01	0.00	0.06	0.12	0.00	0.03	0.00	0.06	0.10	0.00
Total	100.24	100.36	100.12	100.66	100.61	99.83	101.15	101.97	101.38	100.70
Si	2.84	2.89	2.85	2.87	2.83	2.86	2.91	2.79	2.92	2.85
Ti	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Al	1.16	1.11	1.16	1.13	1.16	1.15	1.09	1.22	1.09	1.16
Cr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fe	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
Mn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ca	0.17	0.12	0.16	0.13	0.19	0.17	0.09	0.23	0.10	0.18
Ni	0.00	0.00	0.00	0.01	n.d	n.d	n.d	n.d	n.d	n.d
Na	0.82	0.88	0.81	0.86	0.80	0.82	0.92	0.77	0.90	0.82
K	0.01	0.00	0.01	0.00	0.02	0.02	0.02	0.01	0.01	0.01
Ba	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

APPENDIX 4.1 : CONTINUED
PLAGIOCLASE TRAWENAGH BAY

Sample	TRA4	TRA4	TRA4	TRA4	TRA4	TRA4	TRA4	TRA4	TRA4	TRA4	TRA4	TRA4
Location	Rim/1	Core/1	Rim/2	Core/2	Core/3	Half/4	Rim/4	Core/4	Half/5	Core/6	Rim/7	Core/7
SiO2	68.27	67.21	67.51	67.04	67.34	67.74	67.44	67.35	67.76	68.15	67.92	68.72
TiO2	0.00	0.09	0.05	0.04	0.05	0.03	0.00	0.07	0.01	0.00	0.03	0.00
Al2O3	19.77	20.72	20.08	21.02	20.16	21.03	20.78	20.74	20.11	19.69	19.66	20.32
Cr2O3	0.03	0.00	0.00	0.03	0.00	0.02	0.05	0.07	0.00	0.00	0.00	0.00
FeO	0.00	0.04	0.06	0.03	0.13	0.00	0.00	0.00	0.00	0.03	0.07	0.20
MnO	0.00	0.00	0.02	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MgO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CaO	0.30	1.54	0.66	1.59	1.00	1.41	1.24	1.52	0.65	0.44	0.46	0.56
NiO	0.07	0.05	0.01	0.00	0.15	0.09	0.14	0.07	0.00	0.01	0.09	0.10
Na2O	11.72	10.88	11.33	10.94	11.02	10.99	11.15	10.82	11.33	11.39	11.21	11.42
K2O	0.07	0.03	0.08	0.09	0.03	0.08	0.02	0.13	0.05	0.00	0.04	0.02
BaO	0.18	0.00	0.00	0.00	0.18	0.00	0.12	0.00	0.07	0.00	0.03	0.00
P2O5	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.05	0.00	0.00
Total	100.34	100.07	99.79	100.65	100.04	101.04	100.82	100.19	100.16	99.76	99.54	101.00
Si	2.99	2.94	2.97	2.92	2.96	2.94	2.93	2.94	2.98	2.99	2.99	2.97
Ti	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Al	1.02	0.01	1.04	1.08	1.05	1.07	1.07	1.07	1.04	1.09	1.02	1.04
Cr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fe	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Mn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ca	0.01	0.07	0.03	0.07	0.05	0.07	0.06	0.07	0.03	0.02	0.02	0.03
Ni	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Na	1.00	0.92	0.97	0.92	0.94	0.92	0.94	0.92	0.96	0.97	0.96	0.96
K	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00
Ba	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Sample	TRA4	TRA4	TRA4	TRA2	TRA2	TRA2	TRA5	TRA5	TRA5	TRA5	TRA3
Location	Rim/8	Half/8	Core/8	Rim/1	Core/2	Rim/2	Core/1	Rim/1	Core/2	Rim/2	Rim/3
SiO2	68.10	66.03	67.37	62.86	64.03	64.28	66.63	64.60	63.74	65.61	67.70
TiO2	0.00	0.00	0.09	0.00	0.00	0.00	0.02	0.07	0.04	0.01	0.06
Al2O3	20.12	20.55	20.79	24.08	23.55	23.84	22.00	22.52	22.47	21.82	20.51
Cr2O3	0.04	0.07	0.00	0.00	0.00	0.00	0.05	0.05	0.00	0.08	0.00
FeO	0.04	0.00	0.15	0.02	0.11	0.31	0.00	0.12	0.08	0.11	0.06
MnO	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.00	0.00	0.06	0.00
MgO	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00
CaO	0.60	1.55	1.06	5.37	4.43	4.42	2.83	3.43	4.25	3.27	1.44
NiO	0.12	0.06	0.07	0.04	0.00	0.23	n.d	n.d	n.d	n.d	n.d
Na2O	11.32	10.84	11.02	8.70	9.33	9.32	10.25	9.93	9.20	10.20	10.76
K2O	0.06	0.08	0.02	0.20	0.17	0.15	0.26	0.17	0.15	0.16	0.13
BaO	0.17	0.14	0.00	0.00	0.07	0.17	0.00	0.00	0.00	0.00	0.00
P2O5	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.17	0.09	0.27	0.00
Total	100.34	99.31	100.23	100.93	101.29	102.72	102.08	100.36	99.99	101.16	100.42
Si	2.97	2.93	2.94	2.76	2.77	2.78	2.87	2.84	2.83	2.86	2.95
Ti	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Al	1.04	1.08	1.07	1.25	1.21	1.22	1.12	1.17	1.17	1.12	1.05
Cr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fe	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Mn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mg	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Ca	0.03	0.07	0.05	0.25	0.21	0.21	0.13	0.16	0.20	0.15	0.07
Ni	0.00	0.00	0.00	0.00	0.00	0.01	0.86	0.83	0.79	0.86	0.00
Na	0.96	0.93	0.93	0.74	0.79	0.78	0.01	0.01	0.01	0.01	0.91
K	0.00	0.01	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.01
Ba	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.00

APPENDIX 4.1 : CONTINUED
PLAGIOCLASE TRAWENAGH BAY

Sample	TRA2	TRA2	TRA2	TRA2	TRA2	TRA2	TRA2	TRA2	TRA3	TRA3	TRA3	TRA3
Location	Core/3	Rim/3	Core/4	Rim/4	Core/5	Rim/5	Core/6	Rim/6	Core/1	Rim/1	Core/2	Rim/2
SiO2	62.49	61.86	62.78	61.19	63.93	63.21	62.80	63.07	69.14	68.80	68.23	68.32
TiO2	0.00	0.03	0.00	0.07	0.00	0.08	0.00	0.00	0.04	0.00	0.00	0.08
Al2O3	23.79	23.36	22.58	23.55	22.90	24.27	23.87	23.96	19.76	19.97	19.85	19.73
Cr2O3	0.04	0.00	0.01	0.02	0.04	0.03	0.00	0.00	0.01	0.00	0.00	0.07
FeO	0.01	0.08	0.00	0.00	0.04	0.12	0.03	0.00	0.00	0.08	0.02	0.00
MnO	0.00	0.04	0.00	0.05	0.00	0.00	0.02	0.06	0.03	0.03	0.06	0.04
MgO	0.00	0.00	0.00	0.06	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
CaO	4.93	4.94	3.99	5.03	3.91	5.12	5.16	4.92	0.26	0.42	0.82	0.71
NiO	0.00	0.11	0.00	0.04	0.00	0.03	0.17	0.00	n.d	n.d	n.d	n.d
Na2O	8.71	8.61	9.30	8.56	9.42	8.75	8.81	8.76	11.68	11.80	11.18	11.37
K2O	0.14	0.08	0.11	0.09	0.23	0.11	0.13	0.13	0.09	0.08	0.41	0.09
BaO	0.00	0.00	0.10	0.00	0.16	0.00	0.17	0.00	0.00	0.22	0.00	0.00
Total	100.11	99.11	98.87	98.66	100.28	101.47	100.90	100.41	100.84	100.90	100.32	100.15
Si	2.77	2.77	2.81	2.75	2.82	2.76	2.76	2.78	2.99	2.99	2.98	2.98
Ti	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Al	1.24	1.23	1.19	1.25	1.19	1.25	1.24	1.24	1.01	1.01	1.02	1.01
Cr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fe	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ca	0.23	0.24	0.19	0.24	0.19	0.24	0.24	0.23	0.01	0.02	0.04	0.03
Ni	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Na	0.75	0.75	0.81	0.75	0.81	0.74	0.75	0.75	0.98	0.99	0.95	0.96
K	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.02	0.01
Ba	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

PLAGIOCLASE MAIN DONEGAL

Sample	DON4	DON4	DON4	DON4	DON4	DON4	DON4	267MDG	267MDG	267MDG	267MDG	267MDG
Location	Core/1	Rim/1	Core/2	Rim/2	Rim/2	Core/3	Core/3	Core/1	Half/1	Rim/1	Core/2	Rim/2
SiO2	61.99	62.77	63.46	63.19	62.50	62.59	62.77	62.88	62.88	63.54	62.36	64.07
TiO2	0.11	0.03	0.12	0.01	0.00	0.00	0.00	0.06	0.00	0.00	0.02	0.10
Al2O3	23.66	22.78	23.14	23.45	23.53	23.82	23.54	23.76	23.33	22.55	23.86	23.11
Cr2O3	0.04	0.00	0.00	0.02	0.00	0.06	0.00	0.10	0.08	0.02	0.15	0.14
FeO	0.05	0.03	0.00	0.09	0.01	0.04	0.07	0.00	0.00	0.09	0.05	0.01
MnO	0.07	0.00	0.06	0.06	0.00	0.00	0.00	0.11	0.00	0.01	0.00	0.00
MgO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CaO	5.20	4.49	4.53	4.84	5.06	5.43	5.01	5.31	5.03	4.33	5.45	4.33
Na2O	8.61	9.03	8.68	8.90	8.64	8.85	8.90	7.77	8.73	9.44	8.67	9.24
K2O	0.17	0.15	0.39	0.21	0.33	0.22	0.09	0.17	0.17	0.18	0.13	0.13
BaO	0.00	0.07	0.00	0.05	0.20	0.32	0.18	0.01	0.18	0.13	0.01	0.00
P2O5	0.07	0.00	0.08	0.08	0.18	0.00	0.00	0.06	0.07	0.08	0.00	0.07
Total	99.87	99.34	100.38	100.55	100.28	101.03	100.15	100.93	100.42	100.29	100.40	100.87
Si	2.76	2.81	2.81	2.79	2.78	2.76	2.78	2.76	2.79	2.82	2.76	2.81
Ti	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Al	1.24	1.20	1.21	1.22	1.23	1.24	1.23	1.23	1.22	1.18	1.24	1.19
Cr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
Fe	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00
Mn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ca	0.25	0.22	0.21	0.23	0.24	0.26	0.24	0.25	0.24	0.21	0.26	0.20
Na	0.74	0.78	0.74	0.76	0.74	0.76	0.76	0.75	0.75	0.81	0.72	0.75
K	0.01	0.01	0.02	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Ba	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
P	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00

APPENDIX 4.1 : CONTINUED
PLAGIOCLASE MAIN DONEGAL

Sample	267MDG	267MDG	267MDG	267MDG	267MDG	267MDG	DON16	DON16	DON16	DON16	DON16	DON16
Location	Core/3	Rim/3	Core/4	Rim/4	Core/5	Rim/5	Rim/1	Rim/2	Core/3	Rim/3	Core/4	Rim/4
SiO2	63.79	69.43	63.01	64.63	63.36	65.00	63.39	63.33	63.18	64.86	63.07	62.82
TiO2	0.00	0.08	0.07	0.01	0.03	0.00	0.00	0.00	0.00	0.00	0.03	0.00
Al2O3	22.76	19.73	23.07	23.39	23.75	22.58	23.16	22.98	23.21	22.81	22.83	23.13
Cr2O3	0.02	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.10	0.01	0.00	0.04
FeO	0.00	0.05	0.12	0.00	0.05	0.03	0.12	0.00	0.05	0.07	0.00	0.02
MnO	0.00	0.09	0.01	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.07	0.00
MgO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CaO	4.20	3.29	4.93	4.35	5.12	3.80	4.54	4.50	4.58	3.69	4.57	4.71
Na2O	9.08	8.54	8.72	9.36	9.25	9.46	9.04	8.91	8.86	9.59	9.03	8.85
K2O	0.22	0.06	0.25	0.16	0.17	0.18	0.18	0.22	0.20	0.26	0.07	0.25
BaO	0.02	0.00	0.00	0.00	0.00	0.09	0.24	0.00	0.00	0.14	0.03	0.10
P2O5	0.02	0.06	0.10	0.36	0.11	0.12	0.09	0.10	0.18	0.15	0.12	0.00
Total	99.79	100.96	100.10	102.16	101.78	100.77	100.35	99.75	100.09	101.12	99.83	99.90
Si	2.83	3.00	2.80	2.80	2.76	2.84	2.80	2.80	2.79	2.83	2.81	2.79
Ti	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Al	1.19	1.00	1.21	1.19	1.22	1.16	1.21	1.20	1.21	1.17	1.20	1.21
Cr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fe	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ca	0.20	0.15	0.23	0.20	0.24	0.18	0.22	0.21	0.22	0.17	0.22	0.22
Na	0.78	0.72	0.75	0.78	0.78	0.80	0.77	0.77	0.76	0.81	0.78	0.76
K	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.00	0.01
Ba	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00

APPENDIX 4.2.
K FELDSPAR ARDARA

Sample	ARD4	ARD3	ARD3	ARD3	ARD3	ARD3	ARD3	ARD3	ARD3	ARD3	ARD3	ARD1D
Location							Core	Rim		Core	Rim	
SiO2	65.22	65.35	65.28	63.21	64.93	64.68	63.30	64.88	64.75	65.18	65.23	64.27
TiO2	0.00	0.00	0.00	0.02	0.00	0.00	0.08	0.10	0.02	0.04	0.06	0.00
Al2O3	18.46	18.75	18.50	18.89	18.45	18.49	18.35	18.50	18.72	18.51	18.25	18.18
Cr2O3	0.00	0.04	0.17	0.00	0.10	0.00	0.20	0.00	0.00	0.06	0.04	0.00
FeO	0.00	0.01	0.01	0.10	0.01	0.09	0.10	0.08	0.00	0.00	0.09	0.00
MnO	0.00	0.00	0.00	0.10	0.01	0.09	0.00	0.08	0.04	0.05	0.00	0.00
MgO	0.00	0.18	0.14	0.01	0.00	0.06	0.02	0.11	0.18	0.15	0.00	0.00
CaO	0.00	0.10	0.05	0.01	0.02	0.13	0.00	0.06	0.13	0.02	0.08	0.00
NiO	0.03	0.05	0.15	0.00	0.11	0.16	0.00	0.00	0.00	0.05	0.00	n.d
Na2O	0.53	0.97	0.99	0.70	0.73	0.70	0.92	0.70	0.83	0.90	0.81	0.66
K2O	15.79	15.42	15.50	15.10	15.60	15.33	15.23	15.43	15.50	15.47	15.15	15.23
BaO	0.48	0.46	0.40	0.46	0.53	0.31	0.12	0.29	0.35	0.57	0.39	0.68
P2O5	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14
Total	100.49	101.25	101.04	98.44	100.34	99.87	99.32	99.96	100.28	100.91	99.90	99.16
Si	3.00	2.99	2.99	2.97	3.00	2.99	2.99	3.00	2.99	2.99	3.01	3.01
Ti	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Al	1.00	1.01	1.00	1.05	1.00	1.01	1.01	1.01	1.02	1.00	0.99	1.00
Cr	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Fe	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mg	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00
Ca	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00
Ni	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	n.d
Na	0.05	0.09	0.09	0.06	0.07	0.06	0.08	0.06	0.07	0.08	0.07	0.23
K	0.93	0.90	0.91	0.91	0.92	0.91	0.91	0.91	0.91	0.91	0.89	0.91
Ba	0.01	0.01	0.01	0.01	0.01	0.91	0.00	0.01	0.01	0.01	0.01	0.01
P	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
Total	4.99	5.01	5.02	5.01	5.00	5.90	5.01	5.00	5.02	5.00	4.98	5.21

Sample	ARD1D	ARD1D	ARD1D	ARD10	ARD10	ARD4	ARD4	ARD4	ARD4	ARD4	ARD4	ARD4
Location				Core/2	Rim/2	Rim/1	Rim/1	?/2 thin strip	Core/3	Rim/3	Core/4	Rim/4
SiO2	64.84	63.09	64.04	64.89	65.01	65.04	65.04	65.33	65.11	64.88	66.33	65.50
TiO2	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.06	0.07	0.08
Al2O3	18.31	19.46	18.12	18.01	18.15	18.25	18.25	18.41	18.24	18.52	18.86	18.34
Cr2O3	0.00	0.06	0.06	0.00	0.00	0.05	0.05	0.00	0.00	0.04	0.02	0.06
FeO	0.00	0.05	0.10	0.00	0.03	0.11	0.11	0.01	0.02	0.07	0.00	0.16
MnO	0.12	0.00	0.02	0.03	0.11	0.05	0.05	0.00	0.06	0.01	0.00	0.06
MgO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
CaO	0.00	0.01	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00
NiO	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Na2O	0.78	1.03	0.69	1.07	0.78	0.77	0.77	0.63	0.64	0.62	4.89	0.90
K2O	15.18	14.77	15.26	15.20	15.70	15.74	15.74	15.79	15.46	15.88	9.57	15.38
BaO	0.55	0.58	0.65	0.28	0.51	0.24	0.24	0.56	0.88	0.46	0.69	0.56
P2O5	0.05	0.16	0.10	0.10	0.04	0.09	0.09	0.18	0.08	0.20	0.19	0.15
Total	99.92	99.22	99.00	99.58	99.94	100.10	100.10	100.59	100.15	100.58	100.32	101.07
Si	3.01	2.95	3.00	3.02	3.01	3.00	3.00	3.00	3.01	2.99	2.99	3.00
Ti	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Al	1.00	1.07	1.00	0.99	0.99	0.99	0.99	1.00	0.99	1.00	1.00	0.99
Cr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fe	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Mn	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ca	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ni	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Na	0.07	0.09	0.06	0.10	0.07	0.07	0.07	0.06	0.06	0.06	0.43	0.08
K	0.90	0.88	0.91	0.90	0.93	0.93	0.93	0.93	0.91	0.93	0.55	0.90
Ba	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.02	0.01	0.01	0.01
P	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01

APPENDIX 4.2 : CONTINUED

K FELDSPAR ARDARA / K FELDSPAR FANAD

Sample	ARD10	ARD10	ARD10	FAN23	FAN23	FAN23	FAN23	FAN23	FAN23	FAN23	FAN23
Location	Core/1	Rim/1	Rim/1	Core/1	Rim/1	Core/2	Rim/2	?/3 Late	?/4 Late	Core/5	Half/5
SiO2	63.99	65.38	64.96	62.72	65.30	61.75	64.24	65.33	65.74	62.39	63.65
TiO2	0.01	0.00	0.01	0.03	0.06	0.00	0.00	0.00	0.00	0.00	0.00
Al2O3	18.09	18.22	18.20	18.92	18.46	19.52	18.90	18.83	18.46	19.35	18.92
Cr2O3	0.02	0.02	0.07	0.11	0.00	0.00	0.12	0.00	0.04	0.03	0.00
FeO	0.11	0.12	0.09	0.11	0.04	0.21	0.07	0.19	0.16	0.15	0.21
MnO	0.00	0.11	0.03	0.00	0.05	0.00	0.08	0.00	0.01	0.00	0.00
MgO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CaO	0.00	0.00	0.00	0.00	0.00	0.09	0.07	0.00	0.00	0.07	0.01
Na2O	0.73	0.62	0.70	1.72	1.29	1.94	1.56	3.50	2.69	2.45	2.21
K2O	15.27	15.91	15.73	13.01	14.73	12.34	13.62	11.43	13.10	11.41	12.23
BaO	0.78	0.15	0.16	3.11	0.49	4.27	2.59	1.07	0.45	4.74	3.30
P2O5	0.05	0.05	0.19	0.01	0.12	0.10	0.04	0.00	0.15	0.05	0.16
Total	99.05	100.25	99.86	99.73	100.39	99.98	100.94	99.94	100.56	100.31	100.11
Si	3.00	3.01	3.00	2.95	3.00	2.91	2.97	2.99	3.00	2.93	2.97
Ti	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Al	1.00	0.99	0.99	1.05	1.00	1.09	1.03	1.02	0.99	1.07	1.04
Cr	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Fe	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.01
Mn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ca	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Na	0.07	0.06	0.06	0.16	0.12	0.18	0.14	0.31	0.24	0.22	0.20
K	0.91	0.94	0.93	0.78	0.86	0.74	0.80	0.67	0.76	0.68	0.73
Ba	0.01	0.00	0.00	0.06	0.01	0.08	0.05	0.02	0.01	0.09	0.06
P	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.01

CONTINUED - K FELDSPAR FANAD

Sample	FAN7	FAN11	FAN11	F270	F270	F270	FAN7	FAN7	FAN23
Location	Rim/2	Core/1	Rim/1				Rim/1	Core/1	Rim/5
SiO2	65.88	64.82	64.92	64.26	64.09	64.88	66.34	65.50	63.67
TiO2	0.00	0.00	0.00	0.09	0.14	0.00	0.05	0.09	0.00
Al2O3	17.82	17.94	17.71	18.95	18.54	18.31	17.88	17.46	19.15
Cr2O3	0.03	0.06	0.01	0.05	0.00	0.04	0.00	0.01	0.02
FeO	0.10	0.04	0.02	0.16	0.09	0.10	0.15	0.03	0.02
MnO	0.00	0.00	0.00	0.02	0.06	0.00	0.09	0.12	0.00
MgO	0.00	0.00	0.00	0.16	0.03	0.11	0.00	0.00	0.00
CaO	0.00	0.00	0.00	0.08	0.10	0.11	0.00	0.00	0.06
Na2O	1.61	0.63	1.45	1.19	0.77	0.76	1.63	1.71	2.14
K2O	14.76	15.54	14.33	14.08	15.02	15.21	14.64	14.46	12.72
BaO	0.37	0.93	0.92	1.74	1.00	0.67	0.14	0.20	2.72
P2O5	0.38	0.37	0.22	0.00	0.00	0.00	0.33	0.48	0.06
Total	99.97	100.21	99.57	100.69	99.68	100.11	100.42	100.06	100.32
Si	3.03	3.02	3.04	2.97	2.98	3.00	3.03	3.03	2.96
Ti	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Al	0.97	0.99	0.98	1.03	1.02	1.00	0.96	0.95	1.05
Cr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fe	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00
Mn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mg	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00
Ca	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00
Na	0.14	0.06	0.13	0.11	0.07	0.07	0.14	0.15	0.19
K	0.87	0.92	0.86	0.83	0.89	0.90	0.85	0.85	0.75
Ba	0.01	0.02	0.02	0.03	0.02	0.01	0.00	0.00	0.05
P	0.02	0.02	0.01	0.00	0.00	0.00	0.01	0.02	0.00

APPENDIX 4.2 : CONTINUED
K FELDSPAR ROSSES

Sample	G4	G4	G4	G4	G4	G4	G4	G4	G4	G4	G4	G4
Location		core/1	rim/2	core/2	core/2	Rim/2	core/3	core/4	rim/5	core/6	core/7	rim/7
SiO2	65.07	64.18	64.39	64.37	64.03	64.22	64.93	64.44	64.94	64.51	64.19	64.10
TiO2	0.04	0.00	0.06	0.03	0.00	0.02	0.00	0.00	0.00	0.00	0.02	0.00
Al2O3	18.42	18.36	18.08	18.37	18.42	18.36	18.51	19.25	18.43	18.68	18.41	18.15
Cr2O3	0.00	0.01	0.00	0.13	0.00	0.00	0.07	0.02	0.42	0.00	0.00	0.00
FeO	0.00	0.00	0.00	0.01	0.07	0.07	0.00	0.09	0.10	0.16	0.03	0.00
MnO	0.02	0.12	0.04	0.00	0.00	0.09	0.00	0.03	0.04	0.00	0.12	0.03
MgO	0.09	0.16	0.10	0.05	0.07	0.15	0.10	0.03	0.02	0.13	0.04	0.07
CaO	0.05	0.94	0.09	0.00	0.10	0.00	0.18	0.00	0.09	0.13	0.07	0.06
NiO	0.00	0.00	0.10	0.13	0.05	0.18	0.01	0.23	0.15	0.19	0.12	0.00
Na2O	0.71	0.98	0.71	0.72	0.67	0.71	0.53	0.65	1.04	0.69	0.53	0.74
K2O	15.91	14.90	15.52	15.17	15.37	15.47	15.64	15.47	15.36	15.45	15.62	15.38
BaO	0.00	0.00	0.06	0.00	0.00	0.04	0.21	0.00	0.04	0.07	0.00	0.01
P2O5	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Total	100.04	98.80	99.16	98.99	98.79	99.29	99.92	100.13	100.20	99.83	99.16	98.53
Si	3.00	2.99	3.00	3.00	2.99	2.99	3.00	2.97	2.99	2.98	2.99	3.00
Ti	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Al	1.00	1.01	0.99	1.01	1.01	1.01	1.01	1.05	1.00	1.02	1.01	1.00
Cr	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fe	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Mn	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Mg	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.00	0.00	0.01	0.00	0.01
Ca	0.00	0.01	0.01	0.00	0.01	0.00	0.01	0.00	0.00	0.01	0.00	0.00
Ni	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.01	0.01	0.01	0.01	0.00
Na	0.06	0.09	0.06	0.07	0.06	0.06	0.05	0.06	0.09	0.06	0.05	0.07
K	0.94	0.89	0.92	0.90	0.92	0.92	0.92	0.91	0.90	0.91	0.93	0.92
Ba	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d

Sample	G3	G3	G3	G3	G3	G3	G3	G1	G1	G1	G1
Location	Core/1	Half/1	Rim/1	Core/2	Rim/2	Core/3	Rim/3	Core/1	Rim/1	Core/2	Rim/2
SiO2	65.05	65.36	64.40	65.31	65.00	65.48	65.51	65.90	65.57	66.49	65.94
TiO2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.03
Al2O3	18.32	18.19	18.34	18.28	18.28	18.51	18.49	18.67	18.33	18.62	18.17
Cr2O3	0.10	0.00	0.00	0.00	0.11	0.04	0.00	0.01	0.00	0.02	0.02
FeO	0.09	0.02	0.14	0.00	0.04	0.00	0.20	0.03	0.00	0.06	0.10
MnO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.05	0.00
MgO	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00
CaO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NiO	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Na2O	0.77	0.87	0.68	0.65	0.53	0.97	1.11	0.70	0.72	3.44	0.76
K2O	15.24	15.53	15.58	15.67	15.81	14.95	15.44	15.78	15.86	11.95	15.93
BaO	0.71	0.37	0.94	0.02	0.39	0.77	0.18	0.30	0.35	0.19	0.16
P2O5	0.16	0.14	0.17	0.18	0.13	0.12	0.16	0.13	0.23	0.22	0.20
Total	100.23	100.08	99.88	99.74	99.88	100.59	100.90	101.20	100.61	100.96	101.01
Si	3.00	3.01	2.99	3.01	3.01	3.00	2.99	3.00	3.01	3.00	3.01
Ti	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Al	1.00	0.99	1.00	0.99	1.00	1.00	1.00	1.00	0.99	0.99	0.98
Cr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fe	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Mn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mg	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Ca	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ni	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Na	0.07	0.08	0.06	0.06	0.05	0.09	0.10	0.06	0.06	0.30	0.07
K	0.90	0.91	0.92	0.92	0.93	0.88	0.90	0.92	0.93	0.69	0.93
Ba	0.01	0.01	0.02	0.00	0.01	0.01	0.00	0.01	0.01	0.00	0.00
P	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

APPENDIX 4.2

K FELDSPAR ROSSES

Sample Location	G1 Rim/2	G1 Core/3	G1 Core/4	G1 Core/5	G1 Rim/5
SiO2	65.94	66.17	65.65	65.85	65.47
TiO2	0.03	0.00	0.00	0.01	0.00
Al2O3	18.17	18.12	18.28	18.35	18.27
Cr2O3	0.02	0.00	0.03	0.00	0.00
FeO	0.10	0.00	0.04	0.09	0.07
MnO	0.00	0.15	0.05	0.01	0.00
MgO	0.00	0.00	0.00	0.00	0.00
CaO	0.00	0.00	0.00	0.00	0.00
NiO	n.d	n.d	n.d	n.d	n.d
Na2O	0.76	0.50	0.64	0.65	0.92
K2O	15.93	16.14	16.28	15.84	15.36
BaO	0.16	0.40	0.15	0.16	0.01
P2O5	0.20	0.18	0.10	0.23	0.16
Total	101.01	101.18	100.97	100.77	99.84
Si	3.01	3.03	3.01	3.01	3.01
Ti	0.00	0.00	0.00	0.00	0.00
Al	0.98	0.98	0.99	0.99	0.99
Cr	0.00	0.00	0.00	0.00	0.00
Fe	0.00	0.00	0.00	0.00	0.00
Mn	0.00	0.01	0.00	0.00	0.00
Mg	0.00	0.00	0.00	0.00	0.00
Ca	0.00	0.00	0.00	0.00	0.00
Ni	n.d	n.d	n.d	n.d	n.d
Na	0.07	0.04	0.06	0.06	0.08
K	0.93	0.94	0.95	0.93	0.90
Ba	0.00	0.01	0.00	0.00	0.00
P	0.01	0.01	0.00	0.01	0.01

K FELDSPAR TRAWENAGH BAY

Sample Location	TRA3 Core/1	TRA3 Rim/1	TRA3 Core/2	TRA3 Rim/2	TRA4 Core/1	TRA4 Core/2	TRA4 Core/3
SiO2	65.28	65.46	65.38	65.77	65.20	64.93	64.93
TiO2	0.04	0.00	0.03	0.00	0.07	0.02	0.00
Al2O3	18.30	18.60	18.31	18.03	18.46	18.32	18.48
Cr2O3	0.00	0.00	0.00	0.05	0.06	0.00	0.00
FeO	0.00	0.08	0.07	0.00	0.00	0.00	0.12
MnO	0.09	0.00	0.01	0.00	0.02	0.00	0.00
MgO	0.00	0.00	0.00	0.00	0.04	0.07	0.09
CaO	0.00	0.00	0.00	0.00	0.10	0.05	0.03
NiO	n.d	n.d	n.d	n.d	0.01	0.10	0.00
Na2O	0.74	0.91	0.90	1.00	0.87	0.77	0.60
K2O	15.73	15.68	15.65	15.48	15.59	15.32	15.71
BaO	0.00	0.07	0.00	0.04	0.02	0.00	0.00
P2O5	0.28	0.19	0.20	0.31	0.00	0.00	0.05
Total	100.03	100.74	100.28	100.30	100.30	99.56	100.02
Si	3.00	2.99	3.00	3.01	3.00	3.01	3.00
Ti	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Al	0.99	1.00	0.99	0.97	1.00	1.00	1.01
Cr	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fe	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Mn	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mg	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Ca	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Ni	n.d	n.d.	n.d	n.d	0.00	0.00	0.00
Na	0.07	0.08	0.08	0.09	0.08	0.07	0.05
K	0.92	0.91	0.92	0.91	0.92	0.91	0.93
Ba	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P	0.01	0.01	0.01	0.01	0.00	0.00	0.00

CONTINUED - K FELDSPAR TRAWENAGH BAY

Sample Location	TRA4 ?/4	TRA4 Core/5	TRA4 Rim/5	TRA4 Core/6	TRA4 Rim/6	TRA2 Core/1	TRA2 Rim/1	TRA2 Core/2	TRA2 Rim/2	TRA2 Rim/3
SiO2	65.14	65.16	64.78	64.88	65.18	65.83	65.69	66.00	65.57	65.62
TiO2	0.08	0.00	0.00	0.00	0.03	0.04	0.00	0.00	0.09	0.15
Al2O3	18.44	18.42	18.49	18.24	18.25	18.65	18.70	18.86	18.96	18.96
Cr2O3	0.04	0.06	0.02	0.09	0.00	0.00	0.04	0.06	0.00	0.08
FeO	0.02	0.14	0.00	0.00	0.00	0.11	0.02	0.19	0.08	0.00
MnO	0.00	0.00	0.08	0.05	0.00	0.02	0.02	0.00	0.00	0.00
MgO	0.18	0.09	0.12	0.09	0.03	0.07	0.08	0.14	0.06	0.07
CaO	0.08	0.06	0.07	0.05	0.13	0.50	0.00	0.14	0.11	0.02
NiO	0.05	0.00	0.10	0.00	0.02	0.16	0.05	0.07	0.02	0.16
Na2O	0.77	1.04	0.90	1.07	0.71	0.84	1.03	1.22	1.32	1.02
K2O	15.47	15.38	15.26	15.13	15.51	15.82	15.56	15.28	14.62	15.30
BaO	0.02	0.12	0.13	0.12	0.05	0.06	0.20	0.20	0.38	0.25
P2O5	0.02	0.00	0.00	0.00	0.15	0.00	0.00	0.01	0.00	0.00
Total	100.28	100.27	99.94	99.72	100.01	101.56	101.19	102.09	101.00	101.41
Si	3.03	3.00	3.00	3.01	3.00	3.00	3.00	2.99	2.99	2.99
Ti	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Al	1.00	1.00	1.01	1.00	0.99	1.00	1.01	1.01	1.02	1.02
Cr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fe	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Mn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mg	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.00	0.00
Ca	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.00
Ni	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01
Na	0.07	0.09	0.08	0.10	0.06	0.07	0.09	0.11	0.12	0.09
K	0.91	0.90	0.90	0.89	0.91	0.92	0.91	0.88	0.85	0.89
Ba	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
P	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00

APPENDIX 4.2 : CONTINUED
K FELDSPAR MAIN DONEGAL

Sample	MDG276	MDG276	MDG276	MDG276	MDG276	DON4	DON4	DON4	DON4	DON4	DON4	DON4
Location	Rim/1	Half/1	Core/1	Rim/1	Rim/1	Core/1	Half/1	Rim/1	Core/2	Rim/2	Core/3	Core/4
SiO2	65.52	65.32	65.98	65.66	65.72	64.95	64.26	64.87	64.89	64.98	65.42	65.17
TiO2	0.00	0.11	0.00	0.11	0.04	0.00	0.00	0.10	0.05	0.18	0.02	0.00
Al2O3	18.23	18.18	18.23	18.17	18.38	18.77	18.26	18.40	18.30	18.34	18.67	18.60
Cr2O3	0.05	0.07	0.07	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.08
FeO	0.13	0.00	0.01	0.10	0.00	0.00	0.08	0.00	0.00	0.14	0.02	0.15
MnO	0.00	0.00	0.02	0.00	0.02	0.07	0.00	0.41	0.02	0.05	0.00	0.00
MgO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.03
CaO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00
Na2O	0.84	0.97	0.88	1.00	0.94	2.02	0.94	1.23	1.04	1.17	0.80	0.98
K2O	15.52	15.25	15.15	15.37	15.56	13.50	15.04	14.76	14.75	15.17	15.46	15.31
BaO	0.50	0.14	0.24	0.22	0.12	0.58	0.44	0.22	0.50	0.20	0.65	0.37
P2O5	0.00	0.00	0.10	0.19	0.05	0.09	0.04	0.38	0.00	0.14	0.17	0.12
Total	100.47	100.04	100.48	100.53	100.79	99.97	99.07	99.71	99.61	100.24	101.13	100.68
Si	3.01	3.02	3.02	3.01	3.01	3.00	3.00	2.99	3.01	2.99	2.99	2.99
Ti	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Al	0.99	0.99	0.98	0.98	0.99	1.02	1.01	1.00	1.00	1.00	1.01	1.01
Cr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fe	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01
Mn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ca	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Na	0.08	0.09	0.08	0.09	0.08	0.18	0.09	0.11	0.09	0.10	0.07	0.09
K	0.91	0.90	0.88	0.90	0.91	0.79	0.90	0.87	0.87	0.89	0.90	0.90
Ba	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.00	0.01	0.01
P	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.15	0.00	0.01	0.01	0.00

Sample	DON4	DON16	DON16	DON16	DON16
Location	Core/5	Core/1	Rim/1	Rim/1	Rim/2
SiO2	65.25	65.17	65.23	64.60	63.99
TiO2	0.04	0.00	0.12	0.00	0.00
Al2O3	18.38	18.59	18.54	18.20	18.22
Cr2O3	0.00	0.17	0.00	0.00	0.05
FeO	0.01	0.00	0.03	0.07	0.00
MnO	0.00	0.10	0.04	0.06	0.00
MgO	0.00	0.01	0.00	0.00	0.00
CaO	0.01	0.00	0.00	0.00	0.00
Na2O	1.08	1.37	1.08	0.92	0.99
K2O	15.01	14.60	14.76	14.82	15.00
BaO	0.28	0.47	0.20	0.27	0.55
P2O5	0.11	0.12	0.12	0.23	0.00
Total	100.06	100.36	100.01	99.18	98.79
Si	3.01	2.99	3.00	3.01	3.00
Ti	0.00	0.00	0.00	0.00	0.00
Al	1.00	1.01	1.00	1.00	1.01
Cr	0.00	0.01	0.00	0.00	0.00
Fe	0.00	0.00	0.00	0.00	0.00
Mn	0.00	0.00	0.00	0.00	0.00
Mg	0.00	0.00	0.00	0.00	0.00
Ca	0.00	0.00	0.00	0.00	0.00
Na	0.10	0.12	0.10	0.08	0.09
K	0.88	0.86	0.87	0.88	0.90
Ba	0.01	0.01	0.00	0.01	0.01
P	0.00	0.01	0.01	0.01	0.00

APPENDIX 4.3
BIOTITE ROSSES

Sample	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2
Location	Core/1	Rim/1	Core/2	Core/3	Rim/3	Core/4	Rim/4	Core/5	Rim/5	Core/6	Core/7	Core/8
SiO2	35.51	35.29	34.63	35.53	36.10	35.46	35.44	35.71	35.90	35.19	35.82	35.58
TiO2	2.83	3.38	2.77	2.99	3.18	3.05	2.96	2.94	3.36	3.11	3.09	3.21
Al2O3	16.12	15.85	16.10	16.44	16.50	16.30	16.27	16.75	16.61	16.69	16.71	16.09
Cr2O3	0.05	0.01	0.01	0.03	0.00	0.15	0.12	0.05	0.01	0.05	0.04	0.02
FeO	22.00	21.47	21.15	21.87	21.43	22.31	21.91	21.43	21.39	22.07	21.69	22.26
MnO	0.54	0.49	0.46	0.59	0.52	0.40	0.50	0.52	0.55	0.65	0.52	0.52
MgO	7.71	7.98	7.65	7.46	7.77	7.97	7.74	7.83	8.05	7.97	7.93	7.71
CaO	0.10	0.16	0.73	0.08	0.17	0.06	0.04	0.14	0.08	0.14	0.01	0.01
Na2O	0.54	0.36	0.32	0.32	0.49	0.46	0.45	0.36	0.42	0.27	0.43	0.42
K2O	9.38	9.18	9.22	9.51	9.54	9.60	9.42	9.37	9.36	8.74	9.59	9.46
BaO	0.14	0.00	0.00	0.16	0.00	0.00	0.09	0.00	0.00	0.00	0.34	0.00
P2O5	0.01	0.00	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00
Total	94.95	94.19	93.53	94.99	95.87	95.76	94.93	95.01	95.74	94.92	96.17	95.28

Si	5.56	5.55	5.48	5.57	5.57	5.52	5.54	5.55	5.54	5.49	5.53	5.56
Ti	0.33	0.40	0.33	0.35	0.34	0.36	0.35	0.34	0.39	0.36	0.36	0.34
Al	2.98	2.94	3.00	3.04	3.00	2.99	3.00	3.07	3.02	3.07	3.04	2.96
Aliv	2.44	2.45	2.52	2.43	2.43	2.48	2.46	2.45	2.46	2.51	2.47	2.44
Alvi	0.54	0.49	0.48	0.61	0.57	0.51	0.54	0.67	0.56	0.55	0.57	0.52
Cr	0.01	0.00	0.00	0.00	0.00	0.02	0.02	0.01	0.00	0.01	0.01	0.00
Fe3+	0.32	0.31	0.31	0.32	0.30	0.32	0.32	0.31	0.30	0.32	0.31	0.32
Fe2+	2.57	2.51	2.49	2.55	2.46	2.59	2.55	2.48	2.46	2.56	2.49	2.59
Mn	0.07	0.07	0.06	0.08	0.07	0.05	0.07	0.07	0.07	0.09	0.07	0.07
Mg	1.80	1.87	1.80	1.74	1.83	1.85	1.80	1.82	1.85	1.85	1.83	1.80
Ca	0.02	0.03	0.12	0.01	0.03	0.01	0.01	0.02	0.01	0.02	0.00	0.00
Na	0.16	0.11	0.10	0.10	0.00	0.00	0.14	0.11	0.13	0.08	0.13	0.13
K	1.88	1.84	1.86	1.90	0.15	0.14	1.88	1.86	1.84	1.74	1.89	1.88
Ba	0.01	0.00	0.00	0.01	1.88	1.91	0.01	0.00	0.00	0.00	0.02	0.00
P	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00

Sample	G2	G2	G2	278POR	278POR	278POR	278POR	278POR	278POR	278POR	278POR
Location	Rim/8	Core/9	Rim/9	Core/1 Pheno	Rim/1 Pheno	Core/2 G'mass	Core/3 G'mass	Core/4 Pheno	Half/5 Pheno	Rim/5 Pheno	Core/6 Pheno
SiO2	35.79	36.62	35.58	36.30	35.65	35.71	36.60	35.43	35.60	35.46	35.87
TiO2	2.99	3.05	3.08	3.26	3.19	2.81	2.53	2.55	3.06	2.95	3.07
Al2O3	16.26	16.42	16.48	15.35	15.97	15.92	16.17	17.18	15.92	15.98	15.91
Cr2O3	0.00	0.00	0.01	0.17	0.13	0.00	0.08	0.05	0.00	0.02	0.07
FeO	22.64	21.75	21.72	21.53	21.51	21.31	20.62	21.27	22.17	21.58	21.20
MnO	0.73	0.66	0.79	0.16	0.21	0.18	0.04	0.11	0.26	0.16	0.17
MgO	7.70	7.86	8.02	8.68	8.57	8.80	9.26	8.18	8.64	8.66	8.99
CaO	0.05	0.06	0.20	0.00	0.00	0.00	0.08	0.04	0.00	0.00	0.00
Na2O	0.28	0.42	0.53	0.35	0.30	0.21	0.29	0.36	0.38	0.46	0.36
K2O	9.51	9.28	9.21	9.70	9.66	9.47	9.57	9.17	9.65	9.58	9.44
BaO	0.00	0.00	0.00	0.80	0.23	0.95	0.00	0.20	0.11	0.18	0.93
P2O5	0.00	0.00	0.00	0.02	0.07	0.07	0.16	0.03	0.06	0.09	0.00
Total	95.95	95.12	95.06	96.33	95.48	95.41	95.41	94.56	95.85	95.13	96.00

Si	5.55	5.55	5.51	5.59	5.52	5.55	5.61	5.51	5.51	5.51	5.54
Ti	0.35	0.36	0.36	0.38	0.37	0.33	0.29	0.30	0.36	0.35	0.36
Al	2.97	3.01	3.01	2.79	2.91	2.92	2.92	3.15	2.90	2.93	2.89
Aliv	2.45	2.45	2.49	2.41	2.48	2.45	2.39	2.50	2.49	2.49	2.46
Alvi	0.53	0.56	0.52	0.38	0.43	0.46	0.53	0.65	0.41	0.44	0.43
Cr	0.00	0.00	0.00	0.02	0.02	0.00	0.01	0.01	0.00	0.00	0.01
Fe3+	0.32	0.31	0.31	0.31	0.31	0.31	0.29	0.30	0.32	0.31	0.30
Fe2+	2.62	2.52	2.51	2.47	2.48	2.46	2.35	2.46	2.55	2.50	2.44
Mn	0.10	0.09	0.10	0.02	0.03	0.02	0.01	0.01	0.04	0.02	0.02
Mg	1.78	1.83	1.85	1.99	1.98	2.04	2.12	1.90	1.99	2.01	2.07
Ca	0.01	0.01	0.03	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00
Na	0.09	0.13	0.16	0.11	0.09	0.06	0.09	0.11	0.11	0.14	0.11
K	1.88	1.84	1.82	1.91	1.91	1.88	1.87	1.82	1.91	1.90	1.86
Ba	0.00	0.00	0.00	0.05	0.01	0.06	0.00	0.01	0.01	0.01	0.06
P	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.00	0.01	0.01	0.00

APPENDIX 4.3 - CONTINUED
BIOTITE ROSSES

Sample	G1	G1	G1	G1	G1	G1	G1	G1	G1	G3	G3	G3
Location	Core/1	Rim/1	Core/2	Rim/2	Core/3	Rim/3	Core/4	Core/5	Rim/5	Core/1	Rim/1	Core/2
SiO2	35.94	36.25	35.95	36.24	36.10	36.78	36.04	35.88	35.38	37.10	37.08	37.04
TiO2	3.35	3.22	3.06	2.96	3.28	2.80	3.34	3.05	2.43	3.02	2.47	3.16
Al2O3	16.21	15.79	15.95	15.76	16.07	15.95	15.49	16.17	15.82	16.33	16.84	16.02
Cr2O3	0.00	0.03	0.07	0.06	0.17	0.03	0.00	0.16	0.14	0.00	0.00	0.00
FeO	20.74	21.13	21.92	22.00	21.87	22.10	21.18	21.78	22.03	20.87	19.60	20.79
MnO	0.33	0.21	0.28	0.23	0.18	0.22	0.17	0.14	0.18	0.06	0.14	0.01
MgO	8.08	8.33	8.11	8.12	7.87	8.12	8.37	8.18	8.30	8.22	8.16	8.40
CaO	0.00	0.02	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Na2O	0.37	0.35	0.55	0.41	0.29	0.40	0.21	0.22	0.35	0.24	0.36	0.32
K2O	9.25	9.51	9.48	9.62	9.37	9.74	9.49	9.53	9.03	9.74	9.33	9.67
BaO	1.04	0.51	0.78	0.71	1.08	0.09	1.03	0.92	0.24	0.36	0.29	0.44
P2O5	0.17	0.05	0.11	0.15	0.02	0.09	0.09	0.04	0.00	0.18	0.09	0.02
Total	95.49	95.40	96.24	96.24	96.37	96.45	95.36	96.07	93.89	96.12	94.37	95.94
Si	5.56	5.60	5.55	5.59	5.57	5.63	5.60	5.55	5.58	5.66	5.71	5.67
Ti	0.39	0.38	0.36	0.34	0.38	0.34	0.39	0.35	0.29	0.35	0.29	0.36
Al	2.96	2.88	2.90	2.87	2.92	2.88	2.84	2.95	2.94	2.94	3.06	2.91
Aliv	2.44	2.40	2.45	2.41	2.44	2.37	2.40	2.46	2.42	2.34	2.29	2.33
Alvi	0.51	0.48	0.46	0.46	0.49	0.51	0.44	0.49	0.52	0.60	0.76	0.57
Cr	0.00	0.00	0.01	0.01	0.02	0.00	0.00	0.02	0.02	0.00	0.00	0.00
Fe3+	0.30	0.30	0.31	0.31	0.31	0.31	0.30	0.31	0.32	0.29	0.25	0.29
Fe2+	2.39	2.43	2.52	2.53	2.51	2.52	2.45	2.51	2.59	2.37	2.01	2.37
Mn	0.04	0.03	0.04	0.03	0.02	0.03	0.02	0.02	0.02	0.01	0.02	0.00
Mg	1.86	1.92	1.87	1.87	1.81	1.85	1.94	1.89	1.95	1.87	1.87	1.92
Ca	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Na	0.11	0.10	0.16	0.12	0.09	0.12	0.06	0.07	0.11	0.07	0.11	0.09
K	1.83	1.88	1.87	1.89	1.84	1.90	1.88	1.88	1.82	1.90	1.83	1.88
Ba	0.06	0.03	0.05	0.04	0.07	0.01	0.06	0.06	0.01	0.02	0.02	0.03
P	0.02	0.01	0.01	0.02	0.00	0.09	0.01	0.01	0.00	0.02	0.01	0.00

Sample	G3	G3	G3	G3	G3	G2	G2	G2	G2
Location	Rim/2	Core/3	Rim/3	Core/4	Rim/4	Core/1	Rim/1	Core/2	Rim/2
SiO2	37.21	36.32	36.33	36.80	36.96	36.15	36.17	36.26	36.52
TiO2	3.07	3.19	3.14	3.18	3.34	2.46	2.65	2.60	2.28
Al2O3	15.65	15.98	16.00	16.40	16.41	17.02	16.72	16.94	16.41
Cr2O3	0.00	0.06	0.07	0.04	0.06	0.14	0.06	0.00	0.11
FeO	20.27	21.11	20.75	21.39	20.31	20.79	20.73	20.44	20.24
MnO	0.10	0.05	0.12	0.09	0.00	0.84	0.77	0.77	0.61
MgO	8.27	8.10	7.71	7.95	7.92	6.99	7.32	7.75	7.89
CaO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
Na2O	0.21	0.31	0.27	0.34	0.39	0.29	0.38	0.31	0.39
K2O	9.66	9.46	9.51	9.41	9.50	9.59	9.32	9.57	9.19
BaO	0.22	1.05	0.83	0.50	0.87	0.49	0.60	0.14	0.15
P2O5	0.01	0.00	0.00	0.11	0.03	0.03	0.00	0.02	0.01
Total	94.68	95.64	94.71	96.20	95.80	94.85	94.71	94.79	93.82
Si	5.75	5.62	5.67	5.63	5.66	5.62	5.63	5.62	5.69
Ti	0.36	0.37	0.37	0.37	0.39	0.29	0.31	0.30	0.27
Al	2.85	2.91	2.94	2.96	2.96	3.12	3.07	3.09	3.02
Aliv	2.25	2.38	2.33	2.37	2.34	2.38	2.37	2.38	2.31
Alvi	0.60	0.53	0.61	0.58	0.62	0.75	0.70	0.71	0.71
Cr	0.00	0.01	0.01	0.01	0.01	0.02	0.01	0.00	0.01
Fe3+	0.29	0.30	0.32	0.30	0.29	0.30	0.30	0.29	0.29
Fe2+	2.04	2.43	2.62	2.44	2.32	2.41	2.40	2.36	2.35
Mn	0.01	0.01	0.02	0.01	0.00	0.11	0.10	0.10	0.08
Mg	1.91	1.87	1.79	1.81	1.81	1.62	1.70	1.79	1.83
Ca	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Na	0.06	0.09	0.08	0.10	0.12	0.09	0.11	0.09	0.12
K	1.90	1.87	1.89	1.84	1.86	1.91	1.85	1.89	1.83
Ba	0.01	0.06	0.05	0.03	0.05	0.03	0.04	0.01	0.01
P	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

APPENDIX 4.3 : CONTINUED.
BIOTITE ARDARA

Sampel	ARD4	ARD4	ARD4	ARD4	ARD4	ARD4	ARD4	ARD4	ARD4	ARD1D	ARD1D	ARD1D
Location	Core/1	Core/2	Core/3	Rim/3	Core/11	Core/12	Core/13	Core/14	Core/15	Core/1	Rim/1	Core/2
SiO2	37.32	37.19	37.21	37.01	37.27	37.49	37.30	37.28	37.22	36.81	36.71	35.98
TiO2	1.87	1.89	1.88	1.54	2.34	1.77	1.81	1.95	2.02	2.47	2.83	2.93
Al2O3	15.72	15.46	15.38	15.71	15.33	15.19	15.40	15.63	15.59	14.93	14.53	14.67
Cr2O3	0.03	0.01	0.06	0.00	0.08	0.00	0.03	0.00	0.11	0.08	0.14	0.09
FeO	17.97	18.29	18.14	18.05	19.18	19.26	18.79	18.89	18.65	20.56	20.11	20.49
MnO	0.06	0.05	0.16	0.16	0.11	0.21	0.12	0.08	0.16	0.00	0.00	0.00
MgO	11.88	11.90	11.42	12.14	11.80	11.42	11.44	11.86	11.72	10.34	10.01	10.12
CaO	0.12	0.13	0.13	0.05	0.13	0.09	0.05	0.11	0.17	0.00	0.00	0.07
Na2O	0.42	0.37	0.67	0.33	0.41	0.27	0.41	0.46	0.47	0.34	0.41	0.49
K2O	8.87	9.48	9.56	9.16	9.53	9.79	9.51	9.38	9.52	9.55	9.52	9.47
BaO	0.00	0.00	0.00	0.00	0.01	0.17	0.00	0.00	0.13	0.10	0.09	0.12
P2O5	0.02	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.11	0.06
Total	94.28	94.77	94.68	93.44	96.20	95.66	94.86	95.62	95.74	95.34	94.45	94.49
Si	5.70	5.70	5.71	5.69	5.64	5.72	5.71	5.66	5.66	5.66	5.70	5.60
Ti	0.22	0.22	0.22	0.18	0.27	0.20	0.21	0.22	0.23	0.29	0.33	0.34
Al	2.83	2.79	2.78	2.85	2.73	2.73	2.78	2.80	2.79	2.70	2.66	2.69
Aliv	2.30	2.30	2.29	2.31	2.36	2.29	2.29	2.34	2.35	2.34	2.30	2.40
Alvi	0.53	0.49	0.49	0.54	0.37	0.44	0.49	0.46	0.45	0.36	0.36	0.30
Cr	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.01	0.01	0.02	0.01
Fe3+	0.25	0.26	0.26	0.26	0.27	0.27	0.27	0.26	0.26	0.29	0.29	0.29
Fe2+	2.04	2.09	2.07	2.07	2.16	2.19	2.14	2.14	2.11	2.35	2.32	2.38
Mn	0.01	0.01	0.02	0.02	0.01	0.27	0.02	0.01	0.02	0.00	0.00	0.00
Mg	2.71	2.72	2.61	2.79	2.66	2.60	2.61	2.69	2.65	2.37	2.32	2.35
Ca	0.02	0.02	0.02	0.01	0.02	0.02	0.01	0.02	0.03	0.00	0.00	0.01
Na	0.12	0.01	0.20	0.10	0.12	0.08	0.12	0.14	0.14	0.10	0.12	0.15
K	1.73	1.85	1.87	1.80	1.84	1.91	1.86	1.82	1.85	1.87	1.88	1.88
Ba	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01
P	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.02	0.01	0.01

Sampel	ARD1D	ARD3A	ARD3A	ARD3A	ARD3A	ARD3A	ARD3A	ARD3A	ARD3A	ARD3A	ARD3A	ARD3A
Location	Rim/2	Core/1	Rim/1	Core/2	Rim/3	Core/3	Rim/3	Core/4	Rim/4	Core/5	Core/6	Rim/6
SiO2	36.58	36.63	36.08	36.57	36.54	36.64	36.93	37.01	37.18	37.19	36.72	37.06
TiO2	2.31	1.91	2.06	1.94	1.96	1.76	1.96	2.39	2.24	1.71	1.96	1.96
Al2O3	14.74	15.46	14.72	15.13	15.17	15.06	15.01	15.00	15.01	14.73	14.98	15.50
Cr2O3	0.01	0.08	0.05	0.00	0.02	0.03	0.11	0.00	0.04	0.05	0.11	0.04
FeO	19.51	20.97	20.56	21.00	20.60	21.22	21.48	21.02	20.49	19.99	20.86	20.91
MnO	0.02	0.00	0.00	0.05	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MgO	10.45	10.79	10.72	10.64	10.66	10.81	10.68	10.70	10.72	11.52	10.75	10.82
CaO	0.00	0.26	0.03	0.10	0.21	0.06	0.01	0.00	0.08	0.19	0.06	0.14
Na2O	0.22	0.44	0.48	0.32	0.43	0.34	0.55	0.50	0.34	0.37	0.32	0.25
K2O	9.41	9.10	9.23	9.37	9.17	9.49	9.59	9.57	9.40	9.32	9.59	9.00
BaO	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00
P2O5	0.09	0.10	0.06	0.00	0.00	0.00	0.00	0.00	0.04	0.07	0.04	0.00
Total	93.58	95.74	94.93	95.12	94.87	95.39	96.32	95.71	95.53	95.15	95.42	95.68
Si	5.71	5.62	5.70	5.66	5.66	5.67	5.66	5.67	5.71	5.72	5.66	5.67
Ti	0.27	0.22	0.24	0.23	0.23	0.20	0.23	0.28	0.26	0.20	0.23	0.23
Al	2.71	2.80	2.66	2.76	2.77	2.75	2.71	2.71	2.72	2.67	2.72	2.80
Aliv	2.29	2.38	2.30	2.34	2.35	2.33	2.34	2.33	2.29	2.28	2.34	2.33
Alvi	0.42	0.42	0.36	0.43	0.42	0.41	0.37	0.39	0.42	0.39	0.39	0.47
Cr	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.01
Fe3+	0.28	0.30	0.29	0.30	0.29	0.30	0.30	0.30	0.29	0.28	0.30	0.30
Fe2+	2.26	2.40	2.37	2.42	2.37	2.44	2.45	2.40	2.34	2.29	2.40	2.38
Mn	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mg	2.43	2.47	2.47	2.46	2.46	2.49	2.44	2.44	2.45	2.64	2.47	2.47
Ca	0.00	0.04	0.03	0.02	0.04	0.01	0.00	0.00	0.01	0.03	0.01	0.02
Na	0.07	0.13	0.15	0.10	0.13	0.10	0.16	0.15	0.10	0.11	0.09	0.07
K	1.87	1.78	1.82	1.85	1.81	1.87	1.87	1.87	1.84	1.83	1.89	1.76
Ba	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00

APPENDIX 4.3 - CONTINUED
BIOTITE ARDARA

Sampel	ARD3A	ARD3A	ARD3A	ARD10	ARD10	ARD10	ARD10	ARD10	ARD10
Location	Core/7	Core/8	Rim/8	Core/1	Rim/1	Core/2	Rim/2	Core/3	Rim/3
SiO2	37.13	36.57	36.92	37.87	37.61	38.06	37.26	37.81	38.23
TiO2	1.88	2.41	1.82	1.90	1.91	1.77	1.73	1.75	1.89
Al2O3	15.10	14.87	15.11	15.87	15.89	15.64	15.43	15.63	15.35
Cr2O3	0.00	0.13	0.05	0.10	0.05	0.08	0.06	0.03	0.07
FeO	20.16	20.95	20.32	17.28	17.51	17.47	17.26	16.96	16.86
MnO	0.01	0.06	0.00	0.19	0.21	0.25	0.21	0.17	0.09
MgO	11.52	10.43	10.83	11.64	11.65	12.20	12.43	11.69	11.55
CaO	0.11	0.12	0.10	0.07	0.02	0.03	0.06	0.00	0.00
Na2O	0.45	0.51	0.56	0.44	0.45	0.31	0.42	0.23	0.18
K2O	9.24	9.42	9.19	9.29	9.65	9.70	8.86	9.56	9.65
BaO	0.00	0.00	0.00	0.36	0.20	0.19	0.22	0.66	0.34
P2O5	0.00	0.00	0.03	0.09	0.22	0.15	0.09	0.06	0.18
Total	95.55	95.48	94.92	95.09	95.36	95.85	94.02	94.55	94.40
Si	5.68	6.06	5.70	5.73	5.68	5.72	5.69	5.76	5.51
Ti	0.22	0.28	0.21	0.22	0.22	0.20	0.20	0.20	0.22
Al	2.72	2.71	2.75	2.83	2.83	2.77	2.78	2.81	2.75
Aliv	2.32	1.94	2.30	2.27	2.32	2.28	2.31	2.24	2.49
Alvi	0.40	0.77	0.45	0.56	0.51	0.49	0.47	0.57	0.26
Cr	0.00	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.01
Fe3+	0.28	0.30	0.29	0.24	0.24	0.24	0.24	0.24	0.24
Fe2+	2.29	2.41	2.34	1.95	1.97	1.95	1.96	1.92	1.91
Mn	0.00	0.01	0.00	0.02	0.03	0.03	0.03	0.02	0.01
Mg	2.63	2.40	2.49	2.62	2.62	2.73	2.83	2.66	2.62
Ca	0.02	0.02	0.02	0.01	0.00	0.01	0.01	0.00	0.00
Na	0.13	0.15	0.17	0.13	0.13	0.09	0.12	0.07	0.05
K	1.80	1.89	1.81	1.79	1.86	1.86	1.73	1.86	1.87
Ba	0.00	0.00	0.00	0.02	0.01	0.01	0.01	0.04	0.02
P	0.00	0.00	0.00	0.01	0.03	0.02	0.01	0.01	0.02

APPENDIX 4.3 : CONTINUED
BIOTITE FANAD

Sampel	FAN23	FAN23	FAN23	FAN23	FAN23	FAN23	FAN23	FAN23	FAN19	FAN19	FAN19	FAN19
Location	Core/1	Rim/1	Core/2	Rim/2	Core/3	Rim/3	Core/4	Rim/4	Core/1	Half/1	Rim/1	Core/2
SiO2	35.83	36.22	36.43	36.50	35.70	36.52	36.61	36.56	35.17	36.40	36.33	35.37
TiO2	4.05	4.07	3.97	3.29	4.18	3.71	3.36	3.66	4.02	3.80	3.95	3.14
Al2O3	13.39	14.23	13.82	13.01	14.76	14.21	14.26	14.22	14.44	14.20	14.45	14.56
Cr2O3	0.02	0.06	0.20	0.01	0.01	0.06	0.08	0.08	0.02	0.12	0.17	0.00
FeO	18.86	18.50	19.20	19.47	19.95	18.66	19.53	19.08	20.85	19.96	20.27	20.70
MnO	0.00	0.00	0.00	0.02	0.00	0.02	0.03	0.02	0.00	0.00	0.00	0.00
MgO	11.25	11.35	11.43	12.17	10.69	11.89	11.26	10.89	9.95	10.17	10.34	11.17
CaO	0.07	0.11	0.00	0.01	0.00	0.20	0.00	0.00	0.00	0.10	0.10	0.00
Na2O	0.43	0.43	0.42	0.11	0.34	0.10	0.37	0.29	0.35	0.49	0.32	0.33
K2O	8.93	9.10	8.80	9.17	8.98	8.47	9.43	9.30	8.62	8.92	9.23	8.33
BaO	1.37	0.87	1.95	0.61	2.22	0.66	1.00	0.75	2.35	1.76	1.17	0.85
P2O5	0.07	0.10	0.10	0.08	0.02	0.11	0.13	0.07	0.10	0.11	0.15	0.75
Total	94.26	95.04	96.32	94.44	96.87	94.61	96.06	94.98	95.81	96.03	96.48	94.51
Si	5.60	5.58	5.59	5.67	5.49	5.61	5.61	5.64	5.48	5.61	5.57	5.51
Ti	0.48	0.47	0.46	0.38	0.48	0.43	0.39	0.43	0.47	0.44	0.46	0.37
Al	2.47	2.58	2.50	2.38	2.68	2.57	2.57	2.59	2.66	2.58	2.61	2.68
Aliv	2.40	2.43	2.41	2.33	2.51	2.39	2.39	2.36	2.52	2.39	2.43	2.49
Alvi	0.07	0.16	0.09	0.05	0.17	0.18	0.18	0.22	0.14	0.20	0.18	0.19
Cr	0.00	0.01	0.02	0.00	0.00	0.01	0.01	0.01	0.00	0.01	0.02	0.00
Fe3+	0.27	0.26	0.27	0.28	0.28	0.26	0.28	0.27	0.30	0.28	0.29	0.30
Fe2+	2.19	2.12	2.19	2.25	2.28	2.13	2.23	2.19	2.42	2.29	2.31	2.40
Mn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mg	2.62	2.61	2.61	2.82	2.45	2.72	2.57	2.50	2.32	2.34	2.36	2.60
Ca	0.01	0.02	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.02	0.02	0.00
Na	0.13	0.13	0.13	0.03	0.10	0.03	0.11	0.09	0.11	0.14	0.10	0.10
K	1.78	1.79	1.72	1.82	1.76	1.66	1.84	1.83	1.72	1.75	1.81	1.66
Ba	0.08	0.05	0.12	0.04	0.13	0.04	0.06	0.05	0.14	0.11	0.07	0.05
P	0.01	0.01	0.01	0.01	0.00	0.02	0.02	0.01	0.01	0.01	0.02	0.01

Sampel	FAN19	FAN19	FAN19	FAN19	F582	F582	F582	FAN11	FAN11	FAN11	FAN11	FAN11
Location	Rim/2	Core/3	Rim/3	Core/4	Core/3	Core/2	Rim/2	Core/1	Rim/1	Core/2	Rim/2	Core/3
SiO2	35.83	35.06	36.12	35.79	35.83	37.31	36.93	38.81	38.99	38.49	38.22	38.79
TiO2	4.17	3.98	3.06	3.74	4.46	4.38	4.62	3.10	2.66	2.70	2.83	3.73
Al2O3	14.34	14.52	14.94	14.27	14.84	14.42	14.26	13.85	14.36	13.90	14.07	13.60
Cr2O3	0.00	0.11	0.06	0.02	0.01	0.05	0.00	0.09	0.14	0.19	0.04	0.12
FeO	19.96	21.09	20.42	20.28	19.37	19.14	18.89	17.32	16.83	17.54	17.31	18.24
MnO	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.12	0.00
MgO	10.05	10.02	10.72	10.09	11.55	12.03	11.94	12.18	12.84	12.11	12.73	12.13
CaO	0.00	0.01	0.05	0.04	0.03	0.10	0.05	0.00	0.00	0.00	0.00	0.00
Na2O	0.29	0.54	0.47	0.36	0.45	0.57	0.00	0.00	0.00	0.00	0.00	0.00
K2O	8.85	8.75	9.12	9.08	9.15	9.26	9.44	9.58	9.42	9.52	9.25	9.88
BaO	1.98	2.36	1.23	1.34	1.09	0.57	0.71	0.95	0.77	1.34	1.05	1.30
P2O5	0.06	0.10	0.05	0.00	n.d	n.d	n.d	0.26	0.38	0.19	0.37	0.34
Total	95.52	96.56	96.22	95.01	96.81	97.82	97.45	96.14	96.38	95.97	95.98	98.13
Si	5.57	5.45	5.55	5.59	5.46	5.58	5.56	5.84	5.81	5.84	5.75	5.77
Ti	0.49	0.45	0.35	0.44	0.51	0.49	0.52	0.35	0.30	0.31	0.32	0.42
Al	2.63	2.66	2.71	2.63	2.67	2.54	2.53	2.46	2.52	2.49	2.50	2.38
Aliv	2.43	2.55	2.45	2.41	2.54	2.42	2.45	2.16	2.20	2.16	2.25	2.23
Alvi	0.20	0.11	0.26	0.22	0.13	0.12	0.08	0.29	0.33	0.32	0.25	0.15
Cr	0.00	0.01	0.01	0.00	0.00	0.01	0.00	0.01	0.02	0.02	0.01	0.02
Fe3+	0.29	0.30	0.29	0.29	0.27	0.26	0.26	0.24	0.23	0.25	0.24	0.25
Fe2+	2.31	2.44	2.34	2.36	2.20	2.13	2.12	1.94	1.87	1.98	1.94	2.02
Mn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00
Mg	2.33	2.32	2.46	2.35	2.62	2.68	2.68	2.73	2.85	2.74	2.86	2.69
Ca	0.00	0.00	0.01	0.01	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.00
Na	0.09	0.16	0.14	0.11	0.13	0.16	0.18	0.00	0.00	0.00	0.00	0.00
K	1.76	1.73	1.79	1.81	1.78	1.77	1.81	1.84	1.79	1.84	1.77	1.87
Ba	0.12	0.14	0.01	0.08	0.07	0.03	0.04	0.06	0.05	0.08	0.06	0.08
P	0.01	0.01	0.01	0.00	n.d	n.d	n.d	0.03	0.05	0.03	0.05	0.04

APPENDIX 4.3 : CONTINUED
BIOTITE MAIN DONEGAL GRANITE

Sampel	DON4	DON4	DON4	DON4	DON4	DON4	DON4	DON4	DON4	DON4	DON4	DON4
Location	Core/1	Rim/1	Core/2	Rim/2	Core/3	Half/3	Rim/3	Core/4	Core/5	Core/6	Rim/6	Core/7
			small	small				small	inc.			small
SiO2	35.43	35.52	35.13	34.56	35.37	35.37	35.48	35.06	35.24	35.44	37.02	35.23
TiO2	2.98	2.89	3.21	2.75	3.12	3.09	2.87	2.51	3.69	2.82	2.48	3.19
Al2O3	15.90	16.10	15.93	16.11	15.94	16.13	15.93	15.81	16.25	15.96	16.02	15.77
Cr2O3	0.08	0.00	0.07	0.08	0.04	0.09	0.00	0.01	0.05	0.12	0.00	0.02
FeO	23.10	23.22	22.59	22.62	23.05	23.27	23.40	23.60	22.88	23.64	22.50	23.00
MnO	0.00	0.05	0.03	0.00	0.00	0.09	0.07	0.00	0.10	0.01	0.09	0.07
MgO	7.92	8.03	7.68	7.88	7.81	8.25	7.85	7.86	7.41	7.97	7.52	7.93
CaO	0.00	0.00	0.00	0.10	0.08	0.05	0.01	0.10	0.01	0.00	0.05	0.00
Na2O	0.38	0.44	0.00	0.33	0.45	0.23	0.32	0.31	0.27	0.49	0.38	0.44
K2O	9.69	9.58	9.39	8.77	9.47	9.04	9.61	9.54	9.63	9.64	8.93	9.46
BaO	0.31	0.18	0.00	0.14	0.34	0.00	0.26	0.26	0.35	0.28	0.16	0.26
P2O5	0.00	0.11	0.00	0.12	0.12	0.19	0.06	0.00	0.01	0.06	0.04	0.08
Total	95.77	96.11	94.42	93.45	95.82	95.80	95.86	95.05	95.88	96.42	95.18	95.45

Si	5.52	5.50	5.52	5.48	5.50	5.47	5.52	5.52	5.47	5.49	5.72	5.50
Ti	0.35	0.34	0.38	0.33	0.37	0.36	0.34	0.30	0.43	0.33	0.29	0.38
Al	2.92	2.94	2.95	3.01	2.92	2.94	2.92	2.94	2.97	2.92	2.92	2.90
Aliv	2.48	2.50	2.48	2.52	2.50	2.53	2.48	2.48	2.53	2.51	2.28	2.50
Alvi	0.44	0.44	0.47	0.49	0.43	0.41	0.44	0.46	0.45	0.41	0.64	0.40
Cr	0.01	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.00	0.00
Fe3+	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.34	0.33	0.34	0.32	0.33
Fe2+	2.68	2.68	2.64	2.67	2.67	2.68	2.67	2.77	2.65	2.73	2.59	2.67
Mn	0.00	0.01	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.00	0.01	0.01
Mg	1.84	1.85	1.01	1.86	1.81	1.90	1.82	1.85	1.72	1.84	1.73	1.85
Ca	0.00	0.00	0.00	0.02	0.01	0.01	0.00	0.02	0.00	0.00	0.01	0.00
Na	0.11	0.13	0.12	0.10	0.14	0.07	0.10	0.10	0.08	0.15	0.11	0.13
K	1.93	1.89	1.88	1.77	1.88	1.78	1.91	1.92	1.91	1.91	1.76	1.88
Ba	0.02	0.01	0.00	0.01	0.02	0.00	0.01	0.02	0.02	0.02	0.01	0.02
P	0.00	0.01	0.00	0.02	0.02	0.02	0.02	0.00	0.00	0.01	0.01	0.01

Sampel	MDG267	MDG267	MDG267	MDG267	MDG267	MDG267	MDG267	MDG267	DON17	DON17	DON17
Location	Core/1	Rim/1	Core/2	Rim/2	Core/3	Rim/3	Core/4	Rim/4	Rim/2	Core/3	Rim/3
SiO2	35.28	35.13	35.58	35.53	35.31	35.62	35.51	35.72	36.01	36.07	36.25
TiO2	3.06	2.71	2.41	2.33	2.45	2.61	2.40	2.47	3.08	3.35	3.13
Al2O3	17.17	16.51	17.80	17.54	17.55	17.38	17.72	17.91	15.84	16.37	16.37
Cr2O3	0.01	0.00	0.10	0.03	0.00	0.02	0.03	0.13	0.17	0.00	0.06
FeO	22.93	22.29	21.94	22.57	22.39	22.06	22.04	22.76	22.40	22.20	21.92
MnO	0.25	0.32	0.20	0.02	0.18	0.10	0.21	0.05	0.00	0.00	0.10
MgO	7.20	7.11	7.25	7.39	7.28	7.40	7.35	7.76	8.65	8.41	8.42
CaO	0.00	0.10	0.00	0.00	0.03	0.00	0.03	0.00	0.00	0.00	0.01
Na2O	0.41	0.21	0.25	0.22	0.22	0.21	0.28	0.43	0.49	0.37	0.40
K2O	9.15	9.05	9.22	9.46	9.42	9.30	9.43	9.18	9.62	9.76	9.48
BaO	0.46	0.34	0.39	0.10	0.25	0.28	0.33	0.24	0.43	0.08	0.43
P2O5	0.14	0.04	0.16	0.02	0.03	0.08	0.03	0.10	0.16	0.09	0.04
Total	96.07	93.81	95.29	95.20	95.11	95.06	95.35	96.75	96.84	96.70	96.61

Si	5.45	5.55	5.50	5.51	5.49	5.52	5.50	5.45	5.53	5.51	5.54
Ti	0.36	0.32	0.28	0.27	0.29	0.30	0.28	0.28	0.36	0.39	0.36
Al	3.13	3.07	3.24	3.21	3.22	3.18	3.23	3.22	2.87	2.95	2.95
Aliv	2.55	2.45	2.50	2.49	2.51	2.48	2.50	2.55	2.47	2.49	2.46
Alvi	0.58	0.62	0.75	0.72	0.71	0.70	0.73	0.67	0.39	0.46	0.49
Cr	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.01
Fe3+	0.33	0.32	0.31	0.32	0.32	0.32	0.31	0.32	0.32	0.31	0.31
Fe2+	2.64	2.62	2.53	2.61	2.59	2.55	2.54	2.59	2.56	2.53	2.50
Mn	0.03	0.04	0.03	0.00	0.02	0.01	0.03	0.01	0.00	0.00	0.01
Mg	1.66	1.67	1.67	1.71	1.69	1.71	1.70	1.77	1.98	1.92	1.92
Ca	0.00	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Na	0.12	0.07	0.07	0.07	0.07	0.06	0.08	0.13	0.15	0.11	0.12
K	1.80	1.82	1.82	1.87	1.87	1.84	1.86	1.79	1.88	1.90	1.85
Ba	0.03	0.02	0.02	0.01	0.02	0.02	0.02	0.01	0.03	0.01	0.03
P	0.02	0.01	0.02	0.00	0.00	0.01	0.00	0.01	0.02	0.01	0.01

APPENDIX 4.3 : CONTINUED
BIOTITE MAIN DONEGAL GRANITE

Sampel	DON16	DON16	DON16	DON16	DON16	DON16	DON16	DON17	DON17	DON17
Location	Core/1	Rim/1	Core/2	Core/3	Rim/3	Core/4	Rim/4	Core/1	Rim/1	Core/2
SiO2	35.52	35.96	35.32	34.85	35.58	35.35	35.47	35.48	35.91	35.83
TiO2	3.18	3.24	3.13	2.69	2.96	3.03	3.20	2.63	3.10	3.21
Al2O3	15.93	15.76	15.84	15.57	15.86	16.18	16.14	16.26	16.70	16.10
Cr2O3	0.13	0.11	0.02	0.07	0.00	0.07	0.03	0.00	0.05	0.00
FeO	22.75	22.81	22.70	23.52	22.53	22.66	22.31	20.51	21.59	22.27
MnO	0.09	0.11	0.19	0.30	0.12	0.16	0.22	0.04	0.01	0.05
MgO	7.94	7.64	7.76	8.54	7.91	7.64	7.45	10.64	8.81	8.47
CaO	0.00	0.06	0.01	0.05	0.00	0.03	0.02	0.00	0.02	0.02
Na2O	0.38	0.43	0.36	0.36	0.56	0.42	0.33	0.45	0.36	0.51
K2O	9.55	9.49	9.41	8.07	9.55	9.22	9.54	8.22	9.11	9.67
BaO	0.56	0.13	0.11	0.58	0.54	0.22	0.25	0.45	0.54	0.19
P2O5	0.06	0.05	0.00	0.06	0.04	0.04	0.05	0.07	0.08	0.09
Total	96.04	95.77	94.82	94.65	95.65	95.08	94.98	94.76	96.27	96.41
Si	5.51	5.57	5.53	5.51	5.54	5.52	5.54	5.47	5.49	5.51
Ti	0.37	0.38	0.37	0.32	0.35	0.36	0.38	0.31	0.36	0.37
Al	2.91	2.88	2.93	2.90	2.91	2.98	2.97	2.96	3.01	2.92
Aliv	2.49	2.43	2.47	2.49	2.46	2.48	2.46	2.53	2.51	2.50
Alvi	0.42	0.45	0.46	0.41	0.46	0.49	0.51	0.42	0.51	0.42
Cr	0.02	0.01	0.00	0.01	0.00	0.01	0.03	0.00	0.01	0.00
Fe3+	0.33	0.33	0.33	0.34	0.32	0.33	0.32	0.29	0.30	0.32
Fe2+	2.63	2.63	2.65	2.77	2.61	2.63	2.59	2.35	2.46	2.55
Mn	0.01	0.01	0.03	0.04	0.02	0.02	0.03	0.01	0.00	0.01
Mg	1.84	1.76	1.80	2.03	1.84	1.79	1.73	2.44	2.01	1.94
Ca	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00
Na	0.11	0.13	0.11	0.11	0.17	0.13	0.10	0.13	0.11	0.15
K	1.89	1.88	1.88	1.63	1.90	1.84	1.90	1.62	1.78	1.90
Ba	0.03	0.01	0.01	0.04	0.03	0.01	0.02	0.03	0.03	0.01
P	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01

APPENDIX 4.3 : CONTINUED
BIOTITE TRAWENAGH BAY

Sampel	TRA2	TRA2	TRA2	TRA2	TRA2	TRA2	TRA2	TRA2	TRA2	TRA2	TRA2	TRA2
Location	Core/1	Rim/1	Core/2	Core/3	Rim/3	Core/4	Core/5	Rim/5	Core/6	Core/7	Rim/7	Core/8
SiO2	36.01	36.71	35.97	35.99	35.57	36.13	36.16	36.09	35.71	36.08	36.31	35.92
TiO2	3.04	3.02	3.13	3.05	2.94	3.03	3.29	3.39	3.10	3.18	3.05	2.62
Al2O3	16.17	16.66	16.42	16.19	16.51	16.73	16.31	16.24	16.12	16.37	16.79	16.27
Cr2O3	0.00	0.00	0.04	0.00	0.04	0.06	0.07	0.07	0.00	0.03	0.00	0.08
FeO	22.89	21.81	22.20	22.08	22.44	21.85	22.74	22.17	21.60	22.56	21.55	23.47
MnO	0.25	0.21	0.13	0.30	0.12	0.32	0.20	0.13	0.16	0.29	0.31	0.16
MgO	8.35	8.70	8.22	8.56	8.55	8.44	8.07	7.97	7.94	7.90	7.70	7.72
CaO	0.02	0.11	0.07	0.05	0.07	0.09	0.00	0.08	0.82	0.07	0.03	0.12
Na2O	0.27	0.44	0.44	0.39	0.40	0.33	0.46	0.26	0.49	0.37	0.37	0.45
K2O	9.46	9.49	9.62	9.34	8.89	9.77	9.48	9.49	9.18	9.65	9.59	9.57
BaO	0.06	0.00	0.04	0.00	0.00	0.10	0.00	0.10	0.14	0.00	0.04	0.10
P2O5	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.01	0.48	0.00	0.00	0.00
Total	96.52	97.14	96.27	95.92	95.54	96.84	96.78	96.01	95.73	96.51	95.74	96.46
Si	5.56	5.58	5.54	5.56	5.51	5.52	5.56	5.56	5.51	5.56	5.60	5.56
Ti	0.35	0.35	0.36	0.35	0.34	0.35	0.38	0.39	0.36	0.37	0.35	0.31
Al	2.94	2.98	2.98	2.95	3.02	3.01	2.96	2.95	2.93	2.97	3.05	2.97
Aliv	2.41	2.43	2.46	2.41	2.49	2.48	2.44	2.44	2.49	2.44	2.40	2.44
Alvi	0.50	0.56	0.53	0.54	0.53	0.53	0.52	0.52	0.45	0.53	0.65	0.53
Cr	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.01
Fe3+	0.33	0.31	0.32	0.31	0.32	0.31	0.32	0.31	0.31	0.32	0.31	0.34
Fe2+	2.63	2.47	2.55	2.54	2.59	2.48	2.60	2.55	2.48	2.59	2.47	2.70
Mn	0.03	0.03	0.02	0.04	0.02	0.04	0.03	0.02	0.02	0.04	0.04	0.02
Mg	1.92	1.97	1.19	1.97	1.97	1.92	1.85	1.83	1.83	1.82	1.77	1.78
Ca	0.00	0.02	0.01	0.01	0.01	0.02	0.00	0.01	0.14	0.01	0.05	0.02
Na	0.08	0.13	0.13	0.12	0.12	0.10	0.14	0.08	0.15	0.11	0.11	0.14
K	1.86	1.84	1.89	1.84	1.76	1.90	1.86	1.87	1.81	1.90	1.89	1.89
Ba	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.00	0.00	0.01
P	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00

APPENDIX 4.4
HORNBLENDE ARDARA

Sample	ARD3	ARD3	ARD3	ARD3	ARD3	ARD3	ARD3	ARD3	ARD3	ARD3	ARD1D	ARD1D
Location	Core/1	Core/2	Rim/2	Core/3	Rim/3	Core/4	Core/5	Rim/5	Core/6	Core/7	Core/1	Rim/1
SiO2	43.53	43.77	43.54	43.56	42.08	43.52	43.43	44.04	43.32	43.18	43.16	43.34
TiO2	1.73	1.62	1.40	1.76	1.33	1.18	1.36	1.14	1.42	1.50	1.59	0.74
Al2O3	9.09	9.51	9.18	8.98	9.43	9.64	9.12	9.80	9.36	9.17	8.65	9.07
Cr2O3	0.02	0.01	0.15	0.14	0.02	0.00	0.12	0.01	0.05	0.12	0.05	0.10
FeO	19.73	20.00	19.77	19.06	20.37	20.24	18.87	19.32	19.01	19.08	18.26	18.56
MnO	0.10	0.14	0.15	0.16	0.30	0.23	0.13	0.35	0.10	0.18	0.08	0.02
MgO	9.33	9.48	9.28	9.67	8.92	8.85	9.79	9.59	9.81	9.92	9.57	9.36
CaO	11.23	11.91	11.33	11.26	11.06	11.41	11.32	11.37	11.24	11.56	11.12	10.83
Na2O	1.74	1.84	1.77	2.04	1.68	1.78	2.03	1.77	2.02	1.90	1.85	1.83
K2O	1.12	1.20	1.12	1.17	1.08	1.21	1.14	1.14	1.07	1.11	1.10	1.05
BaO	0.03	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.03	0.00	0.08	0.31
P2O5	0.11	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.09
Total	97.45	98.17	97.54	97.79	96.26	97.96	97.36	98.51	97.40	97.73	95.58	95.29
Si	6.64	6.63	6.65	6.65	6.57	6.65	6.65	6.67	6.64	6.61	6.69	6.75
Ti	0.20	0.18	0.16	0.20	0.16	0.14	0.16	0.13	0.16	0.17	0.19	0.09
Al	1.64	1.70	1.65	1.62	1.74	1.74	1.65	1.75	1.69	1.66	1.58	1.66
AlIV	1.36	1.37	1.35	1.35	1.43	1.35	1.35	1.33	1.36	1.39	1.31	1.25
AlVI	0.28	0.33	0.30	0.27	0.31	0.39	0.29	0.42	0.33	0.27	0.28	0.42
Cr	0.00	0.00	0.02	0.02	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.01
Fe	2.52	2.53	2.52	2.44	2.66	2.86	2.42	2.45	2.44	2.44	2.37	2.42
Mn	0.01	0.02	0.02	0.02	0.04	0.03	0.02	0.05	0.01	0.02	0.01	0.02
Mg	2.21	2.14	2.11	2.20	2.08	2.02	2.23	2.17	2.24	2.27	2.21	2.17
Ca	1.84	1.82	1.85	1.84	1.85	1.87	1.86	1.89	1.86	1.90	1.85	1.81
Na	0.52	0.54	0.52	0.60	0.51	0.53	0.60	0.52	0.60	0.56	0.56	0.55
K	0.22	0.23	0.22	0.23	0.22	0.53	0.22	0.22	0.21	0.22	0.22	0.21
Ba	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02
P	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01

Sample	ARD1D	ARD1D	ARD1D	ARD1D	ARD1D	ARD1D	ARD1D	ARD1D
Location	Core/2	Core/3	Core/4	Core/5	Core/6	Core/7	Core/8	Core/9
SiO2	43.51	43.57	43.15	43.49	43.51	42.16	44.15	43.89
TiO2	0.98	1.17	1.33	1.56	1.56	0.95	1.39	1.04
Al2O3	8.86	8.77	8.40	8.51	8.85	9.61	8.91	9.18
Cr2O3	0.16	0.10	0.06	0.11	0.09	0.00	0.08	0.06
FeO	19.08	19.14	18.76	18.29	17.92	19.40	19.29	18.95
MnO	0.10	0.13	0.18	0.23	0.12	0.09	0.06	0.09
MgO	9.53	9.43	9.22	9.75	10.17	9.18	9.68	9.62
CaO	11.23	11.46	11.35	10.95	11.22	11.38	11.39	11.67
Na2O	1.56	1.72	1.57	1.87	1.17	1.46	1.54	1.45
K2O	1.14	1.12	1.11	1.00	1.14	1.14	1.12	1.20
BaO	0.24	0.00	0.02	0.14	0.11	0.00	0.29	0.00
P2O5	0.05	0.03	0.16	0.29	0.07	0.16	0.04	0.18
Total	96.43	96.64	95.32	96.19	96.53	96.53	97.95	97.32
Si	6.71	6.71	6.73	6.71	6.67	6.65	6.70	6.69
Ti	0.11	0.14	0.16	0.18	0.18	0.11	0.16	0.12
Al	1.61	1.59	1.54	1.55	1.60	1.74	1.60	1.65
AlIV	1.29	1.29	1.25	1.29	1.33	1.35	1.30	1.31
AlVI	0.33	0.30	0.27	0.25	0.27	0.39	0.30	0.34
Cr	0.02	0.01	0.01	0.01	0.01	0.00	0.01	0.01
Fe	2.46	2.46	2.45	2.36	2.30	2.50	2.45	2.41
Mn	0.01	0.02	0.02	0.03	0.02	0.01	0.01	0.01
Mg	2.19	2.16	2.14	2.24	2.32	2.11	2.19	2.19
Ca	1.86	1.89	1.90	1.81	1.84	1.88	1.85	11.67
Na	0.47	0.51	0.48	0.56	0.53	0.44	0.46	0.43
K	0.22	0.22	0.22	0.20	0.22	0.23	0.22	0.23
Ba	0.01	0.00	0.00	0.02	0.01	0.00	0.02	0.00
P	0.01	0.00	0.02	0.02	0.01	0.02	0.01	0.02

APPENDIX 4.4 : CONTINUED
HORNBLENDE - FANAD

Sample	FAN 46	FAN 46	FAN 46	FAN 46	FAN 46	FAN 46	FAN 46	FAN 46	FAN 46	FAN23	FAN23	FAN23
Location	Core/1	rim/1	core/2	rim2		Core/3	rim/3			Core/1	Rim/1	Core/2
SiO2	46.71	49.04	44.86	46.39	47.46	42.72	45.59	44.38	46.95	43.22	45.93	44.35
TiO2	1.68	1.12	1.79	1.43	1.34	2.95	1.71	1.81	1.28	1.38	1.27	1.84
Al2O3	7.41	6.19	8.68	7.34	8.02	10.96	8.13	8.81	7.68	9.46	7.50	8.65
Cr2O3	0.14	0.07	0.23	0.04	0.07	0.07	0.17	0.19	0.00	0.07	0.08	0.11
FeO	16.28	15.45	17.47	16.10	16.54	15.35	16.01	16.61	17.12	17.18	16.69	17.42
MnO	0.19	0.16	0.07	0.10	0.12	0.18	0.07	0.19	0.11	0.22	0.17	0.22
MgO	12.26	13.39	11.29	12.46	12.44	11.49	12.06	10.96	11.84	11.41	11.57	10.66
CaO	11.22	12.10	11.86	11.71	11.86	11.14	11.44	12.18	11.73	10.50	11.46	11.37
Na2O	1.77	1.16	1.57	1.74	1.56	2.00	1.96	1.69	1.59	1.56	1.42	1.96
K2O	0.71	0.50	0.75	0.66	0.71	1.24	0.59	0.90	0.71	0.68	0.76	0.74
BaO	0.02	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.00	0.26	0.00	0.17
P2O5	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	0.14	0.09	0.07
Total	98.02	98.63	98.20	97.96	99.69	98.07	97.50	97.72	98.71	96.05	96.93	97.56

Si	6.92	7.15	6.70	6.91	6.91	6.39	6.81	6.69	6.93	6.61	6.91	6.70
Ti	0.19	0.12	0.20	0.16	0.15	0.33	0.19	0.21	0.14	0.16	0.14	0.21
Al	1.30	1.06	1.53	1.29	1.38	1.93	1.43	1.57	1.34	1.70	1.33	1.54
AlIV	1.08	0.85	1.30	1.09	1.09	1.61	1.19	1.31	1.07	1.39	1.09	1.30
AlVI	0.22	0.21	0.23	0.20	0.28	0.32	0.24	0.25	0.27	0.31	0.24	0.24
Cr	0.02	0.01	0.03	0.01	0.01	0.01	0.02	0.02	0.00	0.01	0.01	0.01
Fe	2.02	1.88	2.19	2.01	2.01	1.92	2.00	2.09	2.11	2.20	2.10	2.20
Mn	0.02	0.02	0.01	0.01	0.01	0.02	0.01	0.03	0.01	0.03	0.02	0.03
Mg	2.71	2.91	2.51	2.77	2.70	2.56	2.68	2.46	2.61	2.60	2.60	2.40
Ca	1.78	1.89	1.90	1.87	1.85	1.79	1.83	1.97	1.86	1.72	1.85	1.84
Na	0.51	0.33	0.46	0.50	0.44	0.58	0.57	0.05	0.45	0.46	0.42	0.57
K	0.13	0.09	0.14	0.13	0.13	0.24	0.11	0.17	0.13	0.13	0.15	0.14
Ba	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.02	0.00	0.01
P2O5	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	0.02	0.01	0.01

Sample	FAN7	FAN7	FAN11	FAN11	FAN11	FAN11	FAN11	FAN11	FAN11	FAN19	FAN19	FAN19
Location	Core/1	Core/2	Core/3	Rim/3	Rim/1	Core/2	Rim/2	Core/3	Rim/3	Core/1	Rim/1	Core/2
SiO2	46.25	46.29	47.49	50.56	50.60	47.51	47.36	48.13	47.50	43.16	45.33	45.28
TiO2	1.15	1.26	1.07	0.33	0.15	1.30	1.17	1.08	1.20	1.64	1.57	1.39
Al2O3	7.13	7.06	6.53	4.87	4.20	6.71	6.71	6.30	6.98	9.49	8.24	7.88
Cr2O3	0.21	0.09	0.16	0.08	0.06	0.02	0.11	0.02	0.19	0.14	0.03	0.11
FeO	17.41	16.77	15.26	14.22	13.75	15.17	15.46	14.74	15.63	18.37	16.93	17.13
MnO	0.32	0.16	0.00	0.09	0.19	0.27	0.10	0.27	0.18	0.02	0.03	0.03
MgO	11.08	11.18	12.65	13.95	14.40	12.51	12.43	12.92	12.57	10.07	11.28	11.23
CaO	11.72	11.56	11.83	12.13	12.35	11.56	11.81	11.71	11.48	11.69	11.65	11.57
Na2O	1.39	1.30	1.06	0.78	0.69	1.31	1.10	1.10	1.45	1.86	1.58	1.60
K2O	0.97	1.08	0.83	0.48	0.33	0.88	0.81	0.78	0.92	0.89	0.83	0.77
BaO	0.58	0.44	0.25	0.00	0.32	0.09	0.11	0.47	0.36	0.35	0.08	0.22
P2O5,	0.53	0.37	0.27	0.32	0.33	0.34	0.37	0.37	0.40	0.11	0.20	0.12
Total	98.73	97.56	97.38	97.80	97.35	97.66	97.53	97.88	98.85	97.77	97.74	97.33

Si	6.90	6.95	7.06	7.37	7.41	7.03	7.02	7.10	6.98	6.56	6.79	6.83
Ti	0.12	0.14	0.12	0.04	0.02	0.14	0.13	0.12	0.13	0.19	0.18	0.16
Al	1.25	1.25	1.14	0.84	0.73	1.17	1.17	1.10	1.21	1.70	1.45	1.40
AlIV	1.11	1.05	0.94	0.63	0.59	0.97	0.98	0.90	1.02	1.44	1.21	1.18
AlVI	0.15	0.20	0.20	0.20	0.14	0.20	0.20	0.19	0.18	0.26	0.24	0.23
Cr	0.02	0.01	0.02	0.01	0.01	0.00	0.01	0.00	0.02	0.02	0.00	0.01
Fe	2.17	2.11	1.99	1.73	1.69	1.88	1.92	1.82	1.92	2.33	2.12	2.16
Mn	0.04	0.02	0.00	0.01	0.02	0.03	0.01	0.03	0.41	0.00	0.00	0.00
Mg	2.46	2.50	2.80	3.01	3.15	2.76	2.75	2.84	2.75	2.28	2.52	2.52
Ca	1.87	1.86	1.88	1.89	1.94	1.83	1.88	1.85	1.81	1.90	1.87	1.87
Na	0.40	0.38	0.30	0.22	0.19	0.38	0.32	0.32	0.41	0.55	0.46	0.47
K	0.19	0.21	0.16	0.09	0.06	0.17	0.15	0.15	0.17	0.17	0.16	0.15
Ba	0.04	0.03	0.02	0.00	0.02	0.01	0.01	0.03	0.02	0.02	0.01	0.01
P	0.07	0.05	0.03	0.04	0.04	0.04	0.05	0.05	0.05	0.01	0.03	0.02

APPENDIX 4.4 : CONTINUED.
HORNBLENDE FANAD

sample	FAN19	FAN19	FAN19	FAN19	FAN19
location	Rim/2	Core/3	Rim/3	Core/3	Rim/3
SiO2	45.81	41.49	44.15	45.52	45.36
TiO2	1.25	2.52	1.45	1.62	1.35
Al2O3	8.24	11.30	8.31	8.43	8.02
Cr2O3	0.00	0.02	0.03	0.02	0.02
FeO	17.42	14.27	17.25	15.47	16.65
MnO	0.07	0.06	0.00	0.11	0.01
MgO	11.28	11.09	11.09	11.99	11.40
CaO	11.77	11.60	11.47	11.32	11.58
Na2O	1.40	2.12	1.48	1.42	1.44
K2O	0.86	0.83	0.93	0.83	0.80
BaO	0.23	0.05	0.23	0.00	0.00
P2O5	0.00	0.11	0.14	0.10	0.05
Total	98.32	95.44	96.56	96.79	96.68
Si	6.84	6.34	6.73	6.82	6.85
Ti	0.14	0.29	0.17	0.18	0.15
Al	1.45	2.04	1.49	1.49	1.43
AlIV	1.16	1.66	1.27	1.18	1.15
AlVI	0.29	0.37	0.23	0.31	0.28
Cr	0.00	0.00	0.00	0.00	0.00
Fe	2.18	1.82	2.20	1.94	2.10
Mn	0.01	0.01	0.00	0.01	0.00
Mg	2.51	2.53	2.52	2.68	2.57
Ca	1.88	1.90	1.87	1.82	1.87
Na	0.40	0.63	0.44	0.41	0.42
K	0.16	0.16	0.18	0.16	0.15
Ba	0.01	0.00	0.01	0.00	0.00
P	0.00	0.01	0.02	0.01	0.01

TOORIES HORNBLENDE

sample	TO3	TO3	TO3	TO3	TO3	TO3	TO3	TO3	TO3
location	Core/1	Rim/1	Core/2	Core/2	Rim/2	Core/3	Rim/3	Core/4	Rim/4
SiO2	47.07	47.31	48.97	46.40	46.85	47.62	47.63	46.89	47.31
TiO2	1.28	0.90	1.03	1.38	1.18	0.81	0.66	1.26	1.48
Al2O3	7.20	7.37	5.55	7.39	7.26	6.60	6.79	7.47	6.66
Cr2O3	0.04	0.14	0.22	0.06	0.19	0.21	0.15	0.14	0.20
FeO	15.78	15.49	14.84	15.86	15.55	15.43	15.79	15.76	14.86
MnO	0.12	0.00	0.09	0.00	0.05	0.24	0.14	0.11	0.26
MgO	12.75	12.66	13.38	12.23	12.33	12.84	12.91	12.47	13.08
CaO	11.73	11.76	12.14	11.64	11.66	11.74	11.98	11.61	11.99
Na2O	1.52	1.49	1.06	1.29	1.56	1.49	1.37	1.75	1.48
K2O	0.79	0.80	0.62	0.85	0.81	0.68	0.75	0.77	0.79
BaO	0.05	0.15	0.17	0.00	0.07	0.00	0.17	0.00	0.09
P2O5	0.10	0.03	0.12	0.05	0.11	0.15	0.15	0.07	0.15
Total	98.42	98.04	98.17	97.09	97.61	97.68	98.48	98.21	98.35
Si	6.94	6.99	7.19	6.94	6.96	7.05	7.02	6.93	6.97
Ti	0.14	0.10	0.11	0.16	0.13	0.09	0.07	0.14	0.16
Al	1.25	1.28	0.96	1.30	1.27	1.15	1.18	1.30	1.16
AlIV	1.06	1.01	0.81	1.06	1.04	0.95	0.98	1.07	1.03
AlVI	0.20	0.28	0.15	0.24	0.24	0.20	0.20	0.23	0.12
Cr	0.00	0.02	0.03	0.01	0.02	0.03	0.02	0.02	0.02
Fe	1.95	1.91	1.82	1.98	1.93	1.91	1.95	1.95	1.83
Mn	0.02	0.00	0.01	0.00	0.01	0.03	0.02	0.02	0.03
Mg	2.80	2.79	2.93	2.72	2.73	2.83	2.84	2.75	2.87
Ca	1.85	1.86	1.91	1.87	1.86	1.86	1.89	1.84	1.98
Na	0.44	0.43	0.30	0.37	0.45	0.43	0.39	0.50	0.44
K	0.15	0.15	0.12	0.16	0.15	0.13	0.14	0.15	0.15
Ba	0.00	0.01	0.01	0.00	0.00	0.00	0.01	0.00	0.01
P	0.01	0.00	0.02	0.01	0.01	0.02	0.02	0.01	0.01

APPENDIX 4.5.
MUSCOVITE ROSSES

Sample	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2	G2
Location	Core/1	Rim/1	Core/2	Rim/2	Core/3	Core/4	Rim/4	Core/5	Rim/5	Core / 6	Core/7	Core/8
SiO2	44.87	43.26	44.47	45.40	46.47	44.85	45.20	45.06	46.12	45.16	44.99	45.49
TiO2	1.34	1.42	1.03	0.75	1.85	0.85	0.72	1.40	1.92	1.28	0.80	0.88
Al2O3	29.32	29.29	29.27	28.29	29.01	30.06	30.11	30.28	27.65	29.98	29.33	30.32
Cr2O3	0.00	0.05	0.14	0.07	0.00	0.00	0.00	0.01	0.13	0.04	0.00	0.00
FeO	4.78	5.31	5.24	5.81	5.06	5.56	5.36	5.03	5.50	4.79	5.81	4.50
MnO	0.00	0.00	0.00	0.01	0.00	0.00	0.11	0.00	0.06	0.00	0.00	0.00
MgO	1.21	1.20	1.26	1.78	1.68	1.32	1.26	1.34	2.04	1.48	1.64	1.22
CaO	0.08	0.00	0.06	0.05	0.08	0.13	0.00	0.14	0.00	0.11	0.09	0.04
Na2O	0.54	0.37	0.68	0.51	0.39	0.52	0.00	0.53	0.20	0.56	0.50	0.61
K2O	10.27	10.50	10.40	10.53	10.66	10.22	10.47	10.27	10.76	10.45	10.37	10.44
BaO	0.02	0.00	0.06	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00
P2O5	0.00	0.00	0.00	0.00	0.00	0.06	0.04	0.00	0.01	0.00	0.01	0.00
Total	92.48	93.40	92.66	93.90	95.19	93.58	93.62	94.07	94.39	93.88	93.52	93.52
Si	6.31	6.33	6.29	6.34	6.36	6.26	6.29	6.24	6.39	6.27	6.29	6.32
Ti	0.14	0.15	0.11	0.08	0.19	0.09	0.08	0.15	0.20	0.13	0.08	0.09
Al	4.86	4.83	4.88	4.77	4.68	4.94	4.94	4.95	4.51	4.91	4.83	4.96
Cr	0.00	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00
Fe	0.56	0.62	0.62	0.68	0.58	0.65	0.62	0.58	0.64	0.56	0.68	0.52
Mn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
Mg	0.25	0.25	0.26	0.37	0.34	0.27	0.26	0.28	0.42	0.31	0.34	0.25
Ca	0.01	0.00	0.01	0.01	0.01	0.02	0.00	0.02	0.00	0.02	0.01	0.01
Na	0.15	0.10	0.19	0.14	0.11	0.14	0.11	0.14	0.06	0.15	0.13	0.17
K	1.84	1.87	1.88	1.88	1.86	1.82	1.86	1.82	1.90	1.85	1.85	1.85
Ba	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00

Sample	G2	G2	G2	G2	G2	G2	G3	G3	G3	G3
Location	Core/9	Core/10	Core/1	Rim/1	Core/2	Rim/2	Core/1	Rim/1	Core/2	Rim/2
SiO2	45.70	46.10	45.94	45.65	45.30	45.47	46.77	50.50	46.42	46.01
TiO2	0.81	0.24	0.28	0.69	0.89	1.21	1.31	0.43	0.86	0.70
Al2O3	30.59	29.75	27.85	26.00	30.99	29.91	27.63	25.38	28.30	28.11
Cr2O3	0.01	0.00	0.10	0.00	0.00	0.00	0.00	0.03	0.03	0.00
FeO	4.68	4.83	6.09	6.68	4.05	4.61	5.87	6.55	5.46	5.30
MnO	0.06	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.04
MgO	1.44	1.68	1.89	2.38	0.97	0.97	1.85	2.27	1.90	1.69
CaO	0.09	0.09	0.00	0.04	0.00	0.00	0.00	0.08	0.00	0.00
Na2O	0.64	0.44	0.32	0.30	0.82	0.39	0.27	0.32	0.21	0.28
K2O	10.26	10.83	10.62	10.82	10.21	10.26	10.89	9.25	10.79	10.95
BaO	0.00	0.16	0.08	0.00	0.20	0.00	0.26	0.21	0.27	0.17
P2O5	0.00	0.00	0.14	0.03	0.08	0.12	0.07	0.05	0.08	0.14
Total	94.28	94.12	93.27	92.66	93.40	92.82	94.91	95.07	94.31	93.39
Si	6.29	6.38	6.44	6.49	6.27	6.34	6.46	6.87	6.43	6.44
Ti	0.08	0.03	0.03	0.07	0.09	0.13	0.14	0.04	0.09	0.07
Al	4.97	4.85	4.60	4.36	5.05	4.91	4.50	4.07	4.62	4.64
Cr	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fe	0.54	0.56	0.71	0.79	0.47	0.54	0.68	0.74	0.63	0.62
Mn	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01
Mg	0.30	0.35	0.40	0.50	0.20	0.20	0.38	0.46	0.39	0.35
Ca	0.01	0.01	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00
Na	0.17	0.12	0.09	0.08	0.22	0.11	0.07	0.09	0.06	0.08
K	1.80	1.91	1.90	1.96	1.80	1.82	1.92	1.61	1.91	1.95
Ba	0.00	0.01	0.01	0.00	0.01	0.00	0.01	0.01	0.02	0.01
P	0.00	0.00	0.02	0.00	0.01	0.01	0.01	0.01	0.01	0.02

APPENDIX 4.5 : CONTINUED
MUSCOVITE TRAWENAGH BAY

Sample	TRA4	TRA4	TRA4	TRA4	TRA4	TRA4	TRA4	TRA4	TRA4	TRA4	TRA4	TRA4
Location	Core/1	Core/2	Core/3	Core/4	Core/5	Rim/5	Core/6	Rim/6	Core/7	Rim/7	Rim/8	Core/9
SiO2	45.28	45.34	45.58	45.38	45.32	45.48	45.56	45.70	44.98	44.98	44.84	45.63
TiO2	0.73	0.72	0.79	0.77	0.77	0.92	0.80	0.70	0.72	0.79	0.91	0.91
Al2O3	29.64	29.58	29.51	30.12	30.39	29.84	29.70	29.57	31.19	31.25	30.83	10.35
Cr2O3	0.10	0.00	0.01	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00
FeO	5.10	5.30	5.69	5.32	4.91	5.19	5.84	6.17	4.47	4.81	4.44	5.12
MnO	0.00	0.01	0.04	0.02	0.01	0.04	0.05	0.06	0.16	0.00	0.19	0.09
MgO	1.45	1.30	1.40	1.18	1.44	1.17	1.19	1.19	1.00	1.18	0.87	1.35
CaO	0.05	0.04	0.06	0.06	0.10	0.04	0.10	0.23	0.06	0.10	0.04	0.05
Na2O	0.42	0.46	0.41	0.37	0.47	0.35	0.27	0.39	0.52	0.46	0.47	0.46
K2O	10.42	10.39	10.65	10.42	10.13	10.05	10.67	9.98	10.54	10.60	10.46	10.44
BaO	0.10	0.00	0.21	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00
P2O5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.00
Total	93.28	93.15	94.40	93.64	93.54	93.01	94.24	94.10	93.65	94.13	93.10	94.41
Si	6.33	6.34	6.32	6.31	6.29	6.36	6.34	6.32	6.24	6.22	6.25	6.30
Ti	0.08	0.08	0.08	0.08	0.08	0.10	0.08	0.07	0.08	0.08	0.10	0.10
Al	4.88	4.87	4.82	4.94	4.97	4.72	4.87	4.82	5.10	5.09	5.07	4.94
Cr	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00
Fe	0.60	0.62	0.66	0.62	0.57	0.61	0.68	0.71	0.52	0.56	0.52	0.59
Mn	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.01	0.02	0.00	0.02	0.01
Mg	0.30	0.27	0.29	0.25	0.30	0.24	0.25	0.24	0.21	0.24	0.18	0.28
Ca	0.01	0.01	0.01	0.01	0.02	0.01	0.02	0.04	0.01	0.02	0.01	0.01
Na	0.11	0.13	0.11	0.10	0.13	0.10	0.07	0.11	0.14	0.12	0.13	0.12
K	1.86	1.85	1.89	1.85	1.79	1.79	1.89	1.76	1.87	1.87	1.86	1.84
Ba	0.01	0.19	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Total	14.17	14.36	14.20	14.15	14.14	13.92	14.21	14.11	14.18	14.19	14.13	14.18

Sample	TRA2	TRA2	TRA2	TRA2	TRA2	TRA2	TRA2	TRA2	TRA2	TRA3	TRA3	TRA3
Location	Core/10	Core/11	Core/12	Rim/12	Core/13	Core/14	Rim/14	Core/15	Rim/15	Core/1	Rim/1	Core/2
SiO2	45.78	45.60	45.82	45.81	46.89	44.36	45.00	45.68	46.09	45.50	45.93	45.38
TiO2	0.88	0.83	0.82	1.02	0.55	1.32	0.59	1.29	1.30	0.21	0.64	0.28
Al2O3	29.83	30.26	28.84	28.85	29.68	28.26	28.37	28.87	28.29	31.93	31.75	33.12
Cr2O3	0.00	0.11	0.05	0.00	0.02	0.04	0.02	0.00	0.07	0.04	0.00	0.00
FeO	5.24	5.14	6.40	6.47	5.90	5.23	5.41	5.53	5.88	4.62	4.39	3.68
MnO	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00
MgO	1.39	1.23	1.65	1.97	1.69	1.43	1.53	1.55	1.72	0.46	0.52	0.49
CaO	0.05	0.07	0.09	0.03	0.01	0.14	0.10	0.03	0.11	0.00	0.00	0.00
Na2O	0.38	0.35	0.26	0.45	0.35	0.44	0.35	0.43	0.35	0.37	0.52	0.74
K2O	10.62	10.68	10.41	10.89	11.04	10.36	10.56	10.84	10.82	10.89	10.39	10.48
BaO	0.00	0.01	0.05	0.00	0.10	0.00	0.00	0.00	0.00	0.25	0.13	0.18
P2O5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.08	0.13
Total	94.17	94.30	94.38	95.51	96.10	91.60	91.93	94.22	94.63	94.21	94.19	94.29
Si	6.35	6.30	6.37	6.32	6.38	6.33	6.40	6.35	6.39	6.26	6.29	6.20
Ti	0.91	0.09	0.09	0.11	0.06	0.14	0.06	0.14	0.14	0.02	0.07	0.03
Al	4.87	4.93	4.72	4.69	4.76	4.76	4.75	4.73	4.62	5.18	5.13	5.33
Cr	0.00	0.01	0.01	0.00	0.02	0.01	0.00	0.00	0.01	0.00	0.00	0.00
Fe	0.61	0.59	0.74	0.75	0.67	0.63	0.64	0.64	0.68	0.53	0.50	0.42
Mn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mg	0.29	0.25	0.34	0.40	0.34	0.31	0.33	0.32	0.36	0.09	0.11	0.10
Ca	0.01	0.00	0.01	0.01	0.00	0.02	0.02	0.01	0.02	0.00	0.00	0.00
Na	0.10	0.10	0.01	0.12	0.09	0.12	0.10	0.12	0.09	0.34	0.14	0.20
K	1.88	1.88	1.84	1.92	1.92	1.89	1.92	1.92	1.91	1.91	1.82	1.83
Ba	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01
P	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02

APPENDIX 4 : CONTINUED

MUSCOVITE
TRAWENAGH BAY

Sample	TRA3	TRA3	TRA3	TRA5	TRA5
Location	Rim/2	Core/3	Rim/3	Core/1	Core/2
SiO2	46.18	45.94	45.83	46.19	46.06
TiO2	0.44	0.37	0.21	0.95	0.25
Al2O3	32.33	32.66	32.36	29.17	30.96
Cr2O3	0.00	0.00	0.20	0.00	0.00
FeO	4.21	4.10	4.00	5.64	5.07
MnO	0.01	0.00	0.00	0.00	0.00
MgO	0.44	0.56	0.50	1.20	0.87
CaO	0.00	0.00	0.00	0.00	0.00
Na2O	0.51	0.54	0.56	0.38	0.44
K2O	10.50	10.72	10.82	10.95	11.05
BaO	0.00	0.00	0.03	0.12	0.01
P2O5	0.24	0.02	0.00	0.09	0.01
Total	94.65	94.59	94.29	94.66	94.72
Si	6.28	6.26	6.27	6.39	6.33
Ti	0.05	0.04	0.02	0.10	0.03
Al	5.18	5.24	5.22	4.79	5.01
Cr	0.00	0.00	0.02	0.00	0.00
Fe	0.48	0.47	0.46	0.65	0.58
Mn	0.00	0.00	0.00	0.00	0.00
Mg	0.09	0.12	0.10	0.25	0.18
Ca	0.00	0.00	0.00	0.00	0.00
Na	0.14	0.14	0.15	0.10	0.12
K	1.82	1.86	1.89	1.93	1.94
Ba	0.00	0.00	0.00	0.01	0.00
P	0.03	0.00	0.00	0.01	0.00
Total	14.06	14.13	14.14	14.15	14.17

MUSCOVITE
MAIN DONEGAL

Sample	DON4	DON4	DON4	DON4	DON4	DON4
Location	Core/1	Rim/1	Core/2	Core/3	Core/4	Core/5
SiO2	45.85	45.72	45.45	45.51	46.01	46.14
TiO2	0.60	0.53	0.67	1.40	1.13	0.81
Al2O3	29.77	28.70	29.30	30.00	28.17	29.33
Cr2O3	0.00	0.00	0.03	0.05	0.00	0.00
FeO	5.11	5.28	5.85	4.98	5.60	5.54
MnO	0.00	0.00	0.00	0.00	0.00	0.00
MgO	1.14	1.27	1.26	1.09	1.49	1.19
CaO	0.00	0.00	0.02	0.00	0.02	0.04
Na2O	0.32	0.25	0.22	0.49	0.42	0.31
K2O	10.62	10.98	10.74	10.92	10.79	10.78
BaO	0.13	0.22	0.26	0.13	0.18	0.12
P2O5	0.02	0.09	0.02	0.00	0.03	0.02
Total	93.45	93.04	93.82	94.56	93.82	94.28
Si	6.37	6.42	6.34	6.29	6.41	6.39
Ti	0.06	0.06	0.07	0.15	0.12	0.08
Al	4.88	4.75	4.82	4.89	4.63	4.79
Cr	0.00	0.00	0.00	0.01	0.00	0.00
Fe	0.59	0.62	0.68	0.58	0.65	0.64
Mn	0.00	0.00	0.00	0.00	0.00	0.00
Mg	0.24	0.27	0.26	0.22	0.31	0.25
Ca	0.00	0.00	0.00	0.00	0.00	0.01
Na	0.86	0.07	0.06	0.13	0.11	0.08
K	1.88	1.97	1.91	1.92	1.92	1.90
Ba	0.01	0.01	0.01	0.01	0.01	0.01
P	0.00	0.01	0.00	0.00	0.00	0.00
Total	14.11	14.16	14.16	14.15	14.17	14.13

APPENDIX 4.6 : DONEGAL GRANITES - APATITES

Sample	FAN270	FAN3	FAN23	FAN23	FAN23	FAN19	ARD4	ARD4	ARD4	ARD4	ARD3A	ARD3A
Loaction			Core	Core	Core		Core	Core	Core			
SiO2	0.44	0.69	0.43	0.37	0.45	0.21	0.13	0.28	0.24	0.31	0.40	0.79
TiO2	0.20	0.07	0.08	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.05
Al2O3	0.11	0.00	0.15	0.09	0.06	0.11	0.06	0.10	0.09	0.05	0.10	0.76
Cr2O3	0.00	0.00	0.01	0.00	0.04	0.00	0.00	0.09	0.00	0.00	0.00	0.00
FeO	0.03	0.03	0.00	0.00	0.17	0.13	0.08	0.08	0.00	0.19	0.18	0.10
MnO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MgO	0.14	0.01	0.16	0.02	0.05	0.00	0.07	0.10	0.00	0.00	0.10	0.06
CaO	55.13	54.67	54.83	54.61	54.70	54.38	55.85	54.77	54.75	55.77	54.11	54.27
NiO	0.10	n.d	n.d	n.d	n.d	n.d	n.d	0.27	0.13	0.23	0.20	0.07
Na2O	0.31	0.21	0.20	0.14	0.07	0.20	0.18	0.17	0.15	0.19	0.18	0.00
K2O	0.02	0.12	0.15	0.09	0.09	0.14	0.08	0.01	0.01	0.02	0.00	0.01
BaO	0.00	0.00	0.00	0.00	0.11	0.20	0.05	0.00	0.12	0.00	0.00	0.17
P2O5	43.47	41.93	42.99	43.43	43.12	42.73	43.77	43.45	43.16	43.74	42.94	42.93
Total	99.54	97.64	98.99	98.83	98.89	98.09	100.19	99.03	98.65	100.31	98.31	99.22
Si	0.08	0.12	0.07	0.06	0.08	0.04	0.02	0.05	0.04	0.05	0.07	0.14
Ti	0.03	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01
Al	0.02	0.00	0.03	0.02	0.07	0.02	0.01	0.02	0.02	0.01	0.02	0.15
Cr	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Fe	0.00	0.00	0.00	0.00	0.03	0.02	0.01	0.01	0.00	0.03	0.03	0.02
Mn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mg	0.04	0.00	0.04	0.01	0.01	0.00	0.02	0.03	0.00	0.00	0.03	0.02
Ca	10.04	10.25	10.09	10.05	10.08	10.13	10.16	10.05	10.12	10.13	10.02	9.95
Ni	0.01	n.d	n.d	n.d	n.d	n.d	n.d	0.04	0.02	0.03	0.03	0.01
Na	0.10	0.07	0.07	0.00	0.02	0.07	0.06	0.06	0.05	0.06	0.06	0.00
K	0.00	0.03	0.03	0.02	0.02	0.03	0.02	0.00	0.01	0.00	0.00	0.00
Ba	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.00	0.00	0.01
P	6.26	6.21	6.25	6.31	6.28	6.29	6.29	6.30	6.30	6.28	6.28	6.22

Sample	ARD3A	ROS21	ROS21	ROS21	ROS6	ROS6	ROS6	TRA5	TRA5	DON4	DON4
Location		Core	Rim					Core	Rim	Core	Rim
SiO2	0.57	0.19	0.16	0.16	0.19	0.29	0.11	0.00	0.07	0.21	0.15
TiO2	0.00	0.05	0.00	0.05	0.00	0.02	0.00	0.02	0.04	0.00	0.00
Al2O3	0.11	0.05	0.08	0.17	0.06	0.11	0.04	0.03	0.11	0.06	0.00
Cr2O3	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO	0.23	0.27	0.20	0.33	0.12	0.59	0.25	0.12	0.18	0.12	0.15
MnO	0.00	0.00	0.00	0.00	0.70	0.60	0.66	0.00	0.22	0.00	0.13
MgO	0.11	0.01	0.07	0.14	0.07	0.02	0.08	0.04	0.11	0.00	0.02
CaO	54.92	55.29	55.42	55.04	53.28	52.74	53.23	55.48	54.86	54.48	54.45
NiO	0.14	n.d	n.d	n.d	0.21	0.03	0.00	n.d	n.d	n.d	n.d
Na2O	0.20	0.22	0.28	0.15	0.14	0.20	0.22	0.18	0.32	0.26	0.21
K2O	0.01	0.05	0.10	0.08	0.03	0.04	0.00	0.04	0.17	0.02	0.09
BaO	0.00	0.00	0.22	0.00	0.22	0.00	0.17	0.00	0.00	0.00	0.00
P2O5	43.15	43.82	43.46	43.73	42.92	42.25	43.04	44.27	44.29	43.74	43.91
Total	99.44	99.93	99.81	99.91	97.94	96.89	97.80	100.14	100.15	98.88	99.11
Si	0.01	0.03	0.03	0.03	0.03	0.05	0.02	0.00	0.01	0.04	0.03
Ti	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Al	0.02	0.01	0.02	0.03	0.01	0.02	0.01	0.01	0.02	0.01	0.00
Cr	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fe	0.03	0.04	0.03	0.05	0.02	0.09	0.04	0.02	0.03	0.02	0.02
Mn	0.00	0.00	0.00	0.00	0.10	0.09	0.10	0.00	0.03	0.00	0.02
Mg	0.03	0.00	0.02	0.04	0.02	0.00	0.02	0.01	0.03	0.00	0.01
Ca	10.08	10.08	10.14	10.03	9.93	9.93	9.93	10.07	9.94	10.01	9.99
Ni	0.02	n.d	n.d	n.d	0.03	0.00	0.00	n.d	n.d	n.d	n.d
Na	0.07	0.07	0.09	0.05	0.05	0.07	0.07	0.06	0.10	0.09	0.07
K	0.00	0.01	0.02	0.02	0.01	0.01	0.00	0.01	0.04	0.01	0.02
Ba	0.00	0.00	0.01	0.00	0.02	0.00	0.01	0.00	0.00	0.00	0.00
P	6.26	6.31	6.28	6.29	6.32	6.29	6.34	6.35	6.34	6.35	6.36

APPENDIX 4.7
EPIDOTE - DONEGAL GRANITES.

Sample	ARD3A	ARD3A	ARD3A	ARD3A	ARD3A	TRA2	TRA2	ARD4	ARD4	ARD4	ARD4	ARD4
Location	Small											
SiO2	37.34	37.64	37.49	37.27	37.30	38.25	37.33	39.27	37.36	37.81	37.74	37.72
TiO2	0.12	0.06	0.27	0.18	0.18	0.08	0.00	0.00	0.00	0.20	0.20	0.00
Al2O3	22.08	22.54	21.70	21.72	21.60	23.16	21.91	21.86	22.84	22.25	21.87	21.87
Cr2O3	0.15	0.42	0.06	0.07	0.10	0.15	0.12	0.06	0.11	0.05	0.08	0.17
FeO	13.22	13.16	13.89	13.77	13.94	12.93	13.08	12.61	12.55	13.73	13.89	14.05
MnO	0.00	0.01	0.00	0.07	0.11	0.19	0.08	0.04	0.00	0.15	0.20	0.00
MgO	0.17	0.13	0.31	0.09	0.24	0.12	0.14	0.00	0.13	0.21	0.10	0.15
CaO	22.76	23.14	23.01	22.76	22.95	23.07	22.78	22.24	23.13	22.95	22.74	22.74
Na2O	0.12	0.11	0.14	0.08	0.21	0.08	0.14	0.08	0.15	0.13	0.23	0.08
K2O	0.00	0.00	0.02	0.00	0.03	0.00	0.00	0.00	0.00	0.03	0.04	0.00
BaO	0.00	0.06	0.00	0.05	0.00	0.10	0.09	0.15	0.00	0.00	0.00	0.18
Total	95.97	97.16	96.88	96.06	96.45	98.00	95.65	96.33	96.56	97.50	97.07	96.95
Si	6.25	6.21	6.24	6.25	6.23	6.24	6.27	6.49	6.23	6.23	6.28	6.29
Ti	0.02	0.01	0.03	0.02	0.02	0.01	0.00	0.00	0.00	0.03	0.02	0.00
Al	4.35	4.39	4.26	4.30	4.26	4.45	4.33	4.26	4.49	4.32	4.29	4.30
Cr	0.02	0.06	0.01	0.01	0.01	0.02	0.02	0.01	0.02	0.01	0.01	0.02
Fe	1.85	1.82	1.93	1.93	1.95	1.76	1.85	1.74	1.75	1.89	1.93	1.96
Mn	0.00	0.00	0.00	0.01	0.02	0.03	0.01	0.01	0.00	0.02	0.03	0.00
Mg	0.04	0.03	0.08	0.02	0.06	0.03	0.03	0.00	0.03	0.05	0.03	0.04
Ca	4.08	4.09	4.10	4.09	4.11	4.03	4.10	3.94	4.13	4.05	4.05	4.06
Na	0.04	0.04	0.05	0.03	0.07	0.03	0.05	0.02	0.05	0.04	0.07	0.02
K	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.00
Ba	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.01
Total	16.65	16.64	16.69	16.66	16.73	16.59	16.66	16.48	16.69	16.66	16.72	16.71
%Ps	29.80%	29.90%	31.20%	30.99%	31.40%	28.38%	29.95%	29%	28%	30.46%	31.06%	31.32%

Sample	FAN30	FAN30	FAN30	FAN30	ARD1D	ROS21	ROS21	ROS21	ROS21
Location									
SiO2	37.33	37.33	37.50	37.77	37.46	37.34	37.94	38.41	37.45
TiO2	0.84	0.22	0.05	0.51	0.10	0.11	0.29	0.08	0.21
Al2O3	17.57	19.63	19.55	19.27	21.48	21.92	22.64	23.41	21.85
Cr2O3	0.07	0.14	0.14	0.11	0.11	0.08	0.00	0.08	0.00
FeO	18.79	17.06	17.14	17.73	14.33	13.00	12.74	11.83	13.49
MnO	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.16	0.12
MgO	0.44	0.17	0.12	0.24	0.00	0.00	0.00	0.00	0.00
CaO	22.44	20.25	22.22	22.72	22.75	22.62	22.79	23.37	22.81
Na2O	0.26	0.19	0.04	0.18	0.04	0.10	0.08	0.07	0.07
K2O	0.00	0.02	0.00	0.04	0.03	0.02	0.05	0.04	0.00
BaO	0.00	0.00	0.00	0.00	0.06	0.05	0.01	0.03	0.00
Total	97.35	95.01	96.32	98.57	96.35	95.24	96.96	97.47	95.99
Si	6.35	6.39	6.35	6.31	6.27	6.29	6.25	6.27	6.27
Ti	0.11	0.03	0.01	0.07	0.01	0.01	0.04	0.01	0.03
Al	3.52	3.96	3.90	3.80	4.24	4.35	4.40	4.50	4.31
Cr	0.01	0.02	0.02	0.02	0.02	0.01	0.00	0.01	0.00
Fe	2.67	2.44	2.43	2.48	2.01	1.80	1.76	1.61	1.89
Mn	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.02	0.02
Mg	0.11	0.04	0.03	0.06	0.00	0.00	0.00	0.00	0.00
Ca	4.09	3.38	4.03	4.07	4.08	4.08	4.02	4.09	4.09
Na	0.09	0.06	0.01	0.06	0.01	0.03	0.02	0.02	0.02
K	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.01	0.00
Ba	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	16.94	16.33	16.78	16.86	16.65	16.58	16.55	16.54	16.62
%Ps	43.14%	38.16%	38.34%	39.50%	32.13%	29.25%	28.54%	26.39%	30.47%

APPENDIX 4.8

OPAQUE MINERAL - DONEGAL GRANITES

Sample	TRA5	FAN7	FAN7	FAN270	FAN270	ROS6	FAN23	FAN23	FAN23
Location				inc hbl		inc bio			
SiO2	0.64	0.41	0.40	0.39	0.31	0.30	0.43	0.48	0.41
TiO2	0.13	0.11	0.25	0.20	0.32	0.19	0.17	0.34	0.20
Al2O3	0.66	0.23	0.26	0.22	0.22	0.10	0.10	0.14	0.35
Cr2O3	0.24	0.25	0.16	0.06	0.01	0.11	0.44	0.18	0.06
FeO	92.25	91.65	92.35	90.33	91.44	92.01	90.83	90.71	91.51
MgO	0.09	0.11	0.08	0.09	0.00	0.06	0.00	0.05	0.16
CaO	0.03	0.05	0.00	0.08	0.00	0.21	0.03	0.00	0.00
Na2O	0.46	0.52	0.47	0.60	0.53	0.55	0.43	0.09	0.44
K2O	0.00	0.02	0.02	0.00	0.01	0.04	0.02	0.46	0.07
P2O5	0.09	0.01	0.00	0.09	0.00	0.03	0.00	0.00	0.01
Total	94.57	93.44	93.99	92.06	92.85	93.61	92.44	92.47	93.21
Si	0.26	0.17	0.16	0.17	0.13	0.13	0.18	0.20	0.17
Ti	0.04	0.04	0.22	0.07	0.10	0.06	0.05	0.11	0.06
Al	0.31	0.11	0.12	0.11	0.11	0.05	0.05	0.07	0.17
Cr	0.75	0.08	0.05	0.02	0.00	0.04	0.15	0.06	0.02
Fe	30.90	31.41	31.43	32.10	32.44	32.13	31.63	31.51	31.50
Mg	0.05	0.07	0.05	0.06	0.00	0.04	0.00	0.03	0.10
Ca	0.02	0.05	0.00	0.04	0.00	0.09	0.01	0.00	0.00
Na	0.35	0.41	0.37	0.49	0.43	0.45	0.35	0.37	0.35
K	0.00	0.01	0.01	0.00	0.01	0.02	0.01	0.05	0.04
P	0.03	0.00	0.00	0.03	0.00	0.01	0.00	0.00	0.00

APPENDIX 4.9

GARNET - TRAWENAGH BAY

Sample	TRA3	TRA3	TRA3	TRA3	TRA3	TRA3	TRA3	TRA3
Location	Core/1	Rim/1	Core/2	Rim/2	Core/3	Rim/3	Core/4	Rim/4
SiO2	36.66	36.56	36.50	36.46	36.37	36.60	36.08	36.78
TiO2	0.11	0.05	0.00	0.11	0.00	0.11	0.00	0.00
Al2O3	20.37	20.21	20.13	19.96	20.23	20.17	19.95	20.12
Cr2O3	0.00	0.04	0.02	0.00	0.01	0.00	0.00	0.00
FeO	23.20	22.82	23.28	21.33	23.14	22.40	23.77	23.18
MnO	20.36	19.70	20.56	20.74	19.79	20.24	20.05	20.27
MgO	0.61	0.77	0.49	0.54	0.71	0.80	0.48	0.55
CaO	0.36	0.43	0.51	0.59	0.47	0.43	0.51	0.03
Na2O	0.33	0.31	0.12	0.19	0.20	0.15	0.19	0.04
K2O	0.02	0.04	0.00	0.00	0.00	0.00	0.06	0.00
BaO	0.08	0.04	0.00	0.04	0.00	0.00	0.23	0.00
P2O5	0.12	0.15	0.07	0.19	0.31	0.11	0.09	0.01
Total	102.21	101.11	101.61	100.09	101.53	100.88	101.31	101.66
Si	2.97	2.99	2.98	3.00	2.98	2.99	2.97	2.99
Ti	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Al	1.95	1.95	1.94	1.94	1.94	1.94	1.93	1.93
Cr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fe	1.57	1.56	1.59	1.47	1.57	1.53	1.64	1.58
Mn	1.39	1.36	1.42	1.45	1.86	1.40	1.40	1.40
Mg	0.74	0.09	0.06	0.07	0.09	0.10	0.06	0.07
Ca	0.03	0.04	0.05	0.05	0.04	0.04	0.05	0.03
Na	0.52	0.31	0.02	0.03	0.03	0.03	0.03	0.04
K	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Ba	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
P	0.01	0.01	0.01	0.01	0.02	0.04	0.01	0.01

APPENDIX 5

WHOLE ROCK MAJOR AND TRACE ELEMENT ANALYSES

5.1 Thorr pluton.

5.2 Rosses pluton.

5.3 Ardara pluton.

5.4 Fanad pluton.

5.5 Main Donegal pluton.

5.6 Trawenagh Bay pluton.

APPENDIX 5.1

THORR PLUTON

Major element (wt%)

Sample	TH1	TH9	TH5	TH6	TH4	TH7	TH8	TH2	TH3
Units	Hbl-free	Hbl-free	Contact	Hbl-bear	Hbl-bear	Hbl-bear	Hbl-bear	Hbl-bear	Hbl-bear
SiO2	76.39	71.75	64.28	63.39	62.73	64.45	64.09	65.24	59.33
TiO2	0.18	0.27	0.63	0.72	0.74	0.70	0.56	0.64	0.73
Al2O3	12.12	14.62	16.97	16.78	16.84	16.66	16.28	15.94	19.11
Fe2O3	0.38	0.86	0.67	1.31	1.79	1.62	1.46	1.21	1.06
FeO	0.49	0.68	2.60	2.84	2.39	2.10	2.18	2.10	3.48
Fetot	0.88	1.70	3.56	4.47	4.44	3.95	3.88	3.54	4.93
MnO	0.01	0.03	0.04	0.05	0.05	0.06	0.06	0.05	0.06
MgO	0.42	1.28	2.15	2.50	2.58	2.30	3.20	2.04	2.88
CaO	0.66	1.25	2.61	2.98	3.40	2.72	3.02	2.82	3.73
Na2O	3.78	4.57	4.38	4.06	4.17	4.01	4.63	4.10	4.18
K2O	4.73	4.18	3.86	4.08	3.90	4.68	4.22	4.08	3.70
P2O5	0.01	0.08	0.28	0.19	0.16	0.21	0.21	0.20	0.37
LOI	0.24	0.49	0.51	0.61	0.69	0.57	0.52	0.57	0.62
Total	99.42	100.22	99.27	99.83	99.70	100.30	100.67	99.23	99.64

Trace element (ppm)

Ba	650	894	1467	1930	1852	1462	1948	1304	1358
Ce	b.d.l.	b.d.l.	47	52	61	66	90	60	97
La	20	25	32	39	50	53	59	45	77
Nb	n.d.	n.d.	n.d.	11	9	n.d.	9	n.d.	n.d.
Nd	b.d.l.	b.d.l.	32	23	24	33	54	32	43
Pb	18	28	13	21	19	18	22	20	21
Rb	111	154	183	78	91	100	94	82	145
Sc	b.d.l.	3	11	3	4	6	6	5	7
Sr	84	399	667	808	787	642	1235	613	637
Th	14	15	5	10	4	10	11	7	8
V	8	21	55	65	64	59	68	63	85
Y	7	12	37	13	9	17	20	15	24
Zn	21	41	80	70	64	62	60	59	89
Zr	85	101	221	304	310	289	232	259	196

Norm

Qu	34.37	23.38	11.89	16.00	11.86	11.06	9.78	13.46	3.80
Cor	0.00	0.50	1.51	0.72	0.00	0.55	0.00	0.13	2.33
Or	27.95	24.70	22.81	24.11	23.05	27.66	24.94	24.11	21.87
Ab	31.99	38.67	37.06	34.36	35.29	33.93	39.18	34.69	35.37
An	2.13	5.68	11.12	13.54	15.71	12.12	11.18	12.68	16.09
Di	0.86	4.48	9.10	11.01	0.09	9.71	1.95	10.24	13.17
Hy	0.96	1.52	4.69	4.49	8.64	2.97	9.46	2.45	5.86
Mt	0.55	1.25	0.97	1.90	2.60	2.35	2.12	1.75	1.54
Im	0.34	0.51	1.20	1.37	1.41	1.33	1.06	1.22	1.39
Ap	0.02	0.19	0.66	0.45	0.38	0.50	0.50	0.47	0.88

APPENDIX 5.2

ROSSES PLUTON

Major element (wt%)

Sample	ROS3	ROS29	ROS28	ROS2	ROS4	ROS11	ROS12	ROS4AP	ROS5	ROS6	ROS7	ROS14
Unit	Porp	Porp	Porp	G1	G1	G1	G1	G1	G2	G2	G2	G2
SiO2	71.63	70.39	70.23	72.65	72.55	70.05	71.66	72.98	72.39	74.02	73.30	74.18
Al2O3	14.74	14.29	15.22	14.39	14.15	14.65	14.53	13.83	13.66	13.25	14.24	13.37
TiO2	0.20	0.27	0.29	0.13	0.18	0.31	0.21	0.20	0.25	0.16	0.19	0.16
FeO	0.81	1.13	1.07	0.59	0.64	1.41	0.96	0.78	1.17	0.71	0.75	0.63
Fe2O3	0.64	0.76	1.05	0.36	0.56	0.74	0.52	0.61	0.67	0.53	0.59	0.58
Fetot	1.54	2.02	2.24	1.02	1.27	2.31	1.59	1.48	1.97	1.32	1.42	1.28
MnO	0.02	0.03	0.04	0.03	0.03	0.04	0.03	0.03	0.04	0.03	0.02	0.04
MgO	0.79	0.96	1.18	0.55	0.86	1.31	1.10	0.78	1.06	0.72	0.90	0.75
CaO	1.69	2.53	2.21	1.20	0.72	1.93	1.05	0.85	0.89	0.91	0.97	1.00
Na2O	4.46	4.66	4.71	4.57	4.72	4.03	4.22	4.15	4.48	4.41	4.77	4.48
K2O	4.16	2.91	3.30	4.42	4.66	4.02	4.28	4.86	4.50	4.72	4.52	4.23
P2O5	0.04	0.05	0.07	0.05	0.03	0.10	0.05	0.04	0.04	0.05	0.06	0.05
LOI	0.37	0.30	0.65	0.29	0.71	0.44	0.74	0.50	0.64	0.32	0.62	0.49
Total	99.64	99.59	100.14	99.30	99.87	99.20	99.46	99.69	100.70	99.45	101.02	100.14

Trace element (ppm)

Ba	967	734	887	775	644	1167	849	476	311	298	637	265
Ce	30	45	32	24	25	41	26	23	20	30	33	23
La	31	28	35	14	17	35	21	19	17	17	17	13
Nb	9	n.d.	7	10	n.d.	n.d.	n.d.	14	n.d.	n.d.	n.d.	n.d.
Nd	16	27	16	11	12	23	16	10	17	19	16	10
Ni	b.d.l.	117	b.d.l.	b.d.l.	b.d.l.	178	40	b.d.l.	b.d.l.	b.d.l.	b.d.l	119
Pb	24	17	21	31	20	24	30	30	30	24	23	33
Rb	139	106	92	182	170	150	153	171	200	199	134	209
Sc	2	3	1	b.d.l.	1	4	3	1	4	1	2	2
Sr	361	335	348	260	280	432	375	190	151	141	264	131
Th	12	7	13	9	11	11	11	15	15	7	8	16
V	15	24	25	7	12	29	20	15	19	11	16	11
Y	10	21	10	9	11	10	12	10	21	21	11	25
Zn	40	49	51	34	35	59	45	29	61	40	40	41
Zr	110	157	142	74	99	157	104	104	103	75	97	68

Norm

Qu	24.76	26.03	21.22	24.34	23.52	25.68	27.18	27.56	25.95	27.43	24.73	28.98
Cor	0.00	0.00	0.05	0.03	0.10	0.84	1.49	0.61	0.26	0.00	0.00	0.00
Or	24.58	17.20	19.50	26.12	27.54	23.76	25.29	28.72	26.59	27.89	26.71	25.00
Ab	37.74	39.43	39.86	38.67	39.94	34.10	35.70	35.11	37.90	37.32	40.36	37.90
An	7.83	9.48	10.51	5.63	3.38	7.72	3.99	3.10	3.16	2.42	4.10	3.88
Di	0.23	1.28	8.06	4.38	2.70	3.09	2.05	1.45	1.60	1.43	0.26	0.06
Hy	2.69	1.80	0.00	0.00	1.46	3.26	2.74	1.94	2.64	1.91	2.88	1.84
Mt	0.93	1.30	1.52	0.52	0.81	1.40	0.80	0.75	1.30	0.77	0.86	0.70
Im	0.38	0.70	0.55	0.25	0.34	0.60	0.40	0.43	0.50	0.30	0.36	0.46
Ap	0.09	0.12	0.17	0.12	0.07	0.23	0.12	0.09	0.09	0.12	0.14	0.12

APPENDIX 5.2

ROSSES PLUTON

Major element (wt%)

Sample	ROS15	ROS16	ROS17	ROS19	ROS9	ROS13	ROS18	ROS20	ROS21	ROS26	ROS8	ROS24
Unit	G2	G2	G2	G2	G3	G3	G3	G3	G3	G3	G3	G3
SiO2	75.26	72.44	73.57	74.13	72.07	73.06	72.83	73.34	73.11	71.75	73.44	75.46
Al2O3	13.54	14.30	13.7	13.55	14.33	14.31	14.21	13.73	14.21	14.37	13.96	13.57
TiO2	0.07	0.30	0.16	0.15	0.18	0.17	0.17	0.17	0.17	0.21	0.17	0.08
FeO	0.16	1.18	0.62	0.49	0.43	0.59	0.45	0.62	0.64	0.86	0.6	0.13
Fe2O3	0.24	0.94	0.62	0.65	0.68	0.67	0.88	0.6	0.64	0.62	0.45	0.69
Fetot	0.42	2.25	1.31	1.19	1.16	1.33	1.38	1.29	1.35	1.52	1.12	0.83
MnO	0.01	0.07	0.04	0.04	0.02	0.03	0.02	0.03	0.03	0.04	0.03	0.01
MgO	0.34	1.13	0.67	0.7	0.62	0.7	1	0.88	0.79	1.03	0.71	0.37
CaO	0.66	0.77	0.88	0.64	1.2	1.05	0.97	1.06	1.03	0.99	0.76	0.34
Na2O	4.24	5.10	4.77	4.49	4.84	4.36	3.98	4.29	4.36	3.88	4.64	3.65
K2O	4.69	3.82	4.26	4.51	4.01	4.51	4.55	4.05	4.22	4.68	4.3	4.25
P2O5	0.02	0.03	0.01	0.02	0.07	0.03	0.06	0.05	0.04	0.07	0.04	0.01
LOI	0.33	0.55	0.48	0.59	0.65	0.6	0.63	0.64	0.71	0.76	0.61	0.9
Total	99.57	100.76	99.84	99.75	99.14	99.22	99.79	99.53	100	98.95	99.77	99.47

Trace element (ppm)

	ROS15	ROS16	ROS17	ROS19	ROS9	ROS13	ROS18	ROS20	ROS21	ROS26	ROS8	ROS24
Ba	265	236	281	300	453	979	953	834	961	692	419	5
Ce	5	27	23	20	31	25	27	34	33	42	20	13
La	10	22	17	14	14	23	20	19	21	25	13	4
Nb	n.d.	37	19	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Nd	8	11	16	11	19	8	12	18	15	18	12	12
Ni	b.d.l.	b.d.l.	b.d.l	b.d.l.	157	65	71	84	b.d.l.	258	134	246
Pb	30	27		21	21	27	27	19	25	24	23	19
Rb	224	262	201	212	205	115	124	129	118	237	237	296
Sc	1	6	1	3	2	1	3	3	2	3	4	2
Sr	114	103	144	132	163	326	335	297	327	266	160	57
Th	10	20	8	9	12	8	10	7	11	12	11	3
V	3	22	12	10	10	13	14	b.d.l.	14	13	12	12
Y	19	31	26	21	21	11	12	12	20	12	16	35
Zn	12	74	41	36	33	42	15	37	33	63	37	38
Zr	43	98	71	71	69	84	89	92	94	116	79	55

Norm

	ROS15	ROS16	ROS17	ROS19	ROS9	ROS13	ROS18	ROS20	ROS21	ROS26	ROS8	ROS24
Qu	30.89	25.13	26.86	27.61	24.05	27.39	29.04	29.61	28.49	26.45	26.37	36.36
Cor	0.51	0.83	0.00	0.17	0.01	0.70	1.41	0.76	0.97	1.29	0.39	2.37
Or	27.72	22.58	25.18	26.65	23.70	26.65	26.89	23.93	24.94	27.66	25.41	25.12
Ab	35.87	43.15	40.36	37.99	40.96	36.89	33.67	36.30	36.89	32.83	39.26	30.89
An	2.66	2.58	3.39	3.04	5.50	4.26	3.63	4.18	4.10	4.45	3.51	1.62
Di	1.97	1.67	0.18	2.41	3.44	1.40	1.03	1.90	2.00	3.57	2.82	1.26
Hy	0.85	2.81	1.59	0.89	0.00	1.74	2.49	2.19	1.97	1.72	1.05	0.34
Mt	0.30	1.70	0.80	0.94	0.99	0.75	0.76	0.90	0.97	0.90	0.65	0.25
Im	0.12	0.53	0.54	0.28	0.34	0.65	0.65	0.30	0.40	0.40	0.32	0.15
Ap	0.05	0.07	0.02	0.05	0.17	0.07	0.14	0.12	0.09	0.17	0.09	0.02

APPENDIX 5.2 - CONTINUED

ROSSES PLUTON

Major element (wt%)

Sample	ROS8AP	ROS10A	ROS10B	ROS31
Unit	G3	G4	G4	MG
SiO2	75.57	74.93	75.50	69.92
Al2O3	13.59	13.39	13.51	15.36
TiO2	0.06	0.12	0.09	0.27
FeO	0.10	0.28	0.31	1.16
Fe2O3	0.30	0.65	0.18	0.86
Fetot	0.40	0.93	0.49	2.02
MnO	0.01	0.01	0.01	0.02
MgO	0.30	0.50	0.44	1.38
CaO	0.34	0.48	0.38	1.88
Na2O	4.82	3.70	4.23	4.56
K2O	4.57	4.61	4.52	4.23
P2O5	0.02	0.04	0.00	0.05
LOI	0.56	0.90	0.69	0.50
Total	100.24	100.15	99.88	100.18

Trace element (ppm)

Ba	b.d.l	93	91	1443
Ce	1	4	17	27
La	2	8	12	20
Nb	33	29	16	7
Nd	b.d.l.	2	12	7
Ni	b.d.l	b.d.l	b.d.l.	b.d.l.
Pb	20	b.d.l.	24	27
Rb	292	288	267	106
Sc	1	3	b.d.l.	1
Sr	32	66	62	519
Th	2	b.d.l.	10	16
V	9	16	12	26
Y	11	15	15	7
Zn	6	14	7	44
Zr	19	45	41	112

Norm

Qu	27.90	33.64	32.25	20.81
Cor	0.14	1.54	1.17	0.00
Or	27.01	27.24	26.71	25.00
Ab	40.79	31.31	35.79	38.59
An	1.56	2.12	1.33	8.95
Di	1.32	1.65	2.08	0.04
Hy	1.59	0.48	1.10	4.43
Mt	0.43	0.59	0.30	1.25
Im	0.11	0.23	0.12	0.51
Ap	0.05	0.09	0.00	0.12

APPENDIX 5.3

ARDARA PLUTON.

Major element (wt%)

Sample	ARD1	ARD1F	ARD1A1	ARD1B	ARD1C	ARD1D	ARD1E	ARD3A	ARD4	ARD2	ARD5	ARD6
Unit	Outer	Outer	Outer	Outer	Outer	Outer	Outer	Outer	Int'mde	Int'mde	Inner	Inner
SiO2	62.01	61.85	63.22	62.36	61.18	62.57	61.68	63.83	69.47	69.18	69.65	70.69
Al2O3	17.42	16.96	16.65	16.51	16.23	17.28	16.36	16.20	15.73	15.34	15.20	15.22
TiO2	0.85	0.85	0.84	0.82	0.66	0.90	0.75	0.76	0.33	0.32	0.27	0.25
FeO	2.60	2.79	2.65	3.11	2.97	2.75	2.89	2.39	1.16	1.24	1.10	1.06
Fe2O3	1.68	1.34	1.48	1.50	1.88	1.94	1.55	1.58	1.09	0.69	0.69	0.54
Fetot	4.57	4.55	4.35	4.71	4.88	4.84	4.76	4.24	2.38	2.07	1.91	1.72
MnO	0.05	0.05	0.05	0.06	0.08	0.06	0.06	0.05	0.05	0.04	0.04	0.06
MgO	2.00	2.13	2.76	2.76	4.40	3.28	3.57	2.35	2.11	2.17	1.54	2.50
CaO	3.41	3.74	2.97	3.53	3.41	4.06	3.67	3.15	1.87	1.52	1.95	1.46
Na2O	4.51	4.52	4.10	4.43	4.85	4.52	5.14	4.75	5.96	5.48	5.51	3.54
K2O	4.31	3.97	4.15	3.81	3.20	3.47	2.59	3.99	2.83	3.53	2.96	3.31
P2O5	0.19	0.27	0.17	0.17	0.16	0.20	0.19	0.15	0.05	0.11	0.03	0.03
LOI	0.45	0.26	0.58	0.49	0.65	0.39	0.72	0.51	0.77	0.66	0.49	0.49
Total	99.12	99.16	100.11	100.79	99.70	99.12	100.80	100.28	101.56	100.41	99.27	99.30

Trace element (ppm)

Ba	819	723	666	713	697	737	470	679	640	650	488	532
Ce	91	117	73	60	42	61	44	86	23	26	25	22
La	44	63	50	40	36	41	33	40	24	24	19	21
Nb	20	n.d	n.d	n.d	n.d	n.d	n.d	17	n.d	n.d	n.d	5
Nd	46	59	44	29	18	31	23	39	14	11	9	11
Ni	b.d.l	b.d.l	61	66	7	87	43	b.d.l	167	151	b.d.l	b.d.l
Pb	43	40	34	30	23	26	26	41	22	25	30	35
Rb	193	184	202	159	137	145	106	186	88	102	87	91
Sc	8	7	8	7	10	8	9	5	3	2	4	3
Sr	473	461	482	525	596	571	690	463	600	513	574	495
Th	29	29	29	23	13	13	10	24	8	12	6	6
V	95	106	105	102	109	111	106	93	41	35	33	29
Y	32	23	24	23	15	17	13	24	9	9	9	7
Zn	71	62	69	73	71	77	69	67	61	45	43	38
Zr	442	337	283	238	201	232	167	292	100	105	91	94

Norm

Qu	8.58	8.90	9.29	9.79	6.53	7.38	8.29	10.76	16.74	14.45	19.61	28.49
Cor	0.00	0.00	0.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.25
Or	25.47	23.46	24.53	22.52	18.91	20.51	15.31	23.58	16.72	20.86	17.49	19.56
An	14.56	14.26	13.62	13.91	13.06	16.61	13.92	11.10	7.81	6.82	8.00	7.05
Ab	38.16	38.25	34.69	37.49	41.04	38.25	43.50	40.19	50.43	46.37	46.63	29.96
Di	0.91	2.06	10.97	2.02	2.24	1.78	2.45	2.86	0.90	5.45	1.18	5.60
Hy	7.15	7.77	4.35	9.31	12.92	9.67	11.20	6.89	5.84	4.32	4.57	4.98
Mt	2.44	1.94	2.15	2.17	2.73	2.81	2.25	2.29	1.58	1.00	1.00	0.78
Ilm	1.61	1.61	1.60	1.56	1.25	1.71	1.42	1.44	0.63	0.61	0.51	0.47
Ap	0.45	0.64	0.40	0.40	0.38	0.47	0.45	0.36	0.12	0.26	0.07	0.07

APPENDIX 5.3 - CONTINUED

ARDARA PLUTON.

Major element (wt%)

Sample	ARD7	ARD3B	ARD10	ARD11	ARD12	ARD13
Unit	Inner	Inner	Inner	Inner	Inner	Inner
SiO2	69.66	71.24	69.19	72.18	69.42	69.30
Al2O3	15.63	15.44	15.20	14.79	15.54	15.38
TiO2	0.27	0.18	0.29	0.13	0.29	0.30
FeO	1.03	0.59	0.80	0.37	1.32	1.19
Fe2O3	0.52	0.38	1.14	0.49	0.65	0.71
Fetot	1.66	1.04	2.03	0.90	2.12	2.03
MnO	0.02	0.01	0.04	0.01	0.03	0.04
MgO	1.64	0.69	2.11	0.86	1.74	1.73
CaO	1.32	1.45	1.43	1.20	1.79	2.15
Na2O	5.69	6.07	5.49	5.61	6.24	5.85
K2O	3.41	2.70	3.24	3.45	2.92	2.91
P2O5	0.03	0.02	0.04	0.03	0.05	0.05
LOI	0.37	0.45	0.58	0.61	0.63	0.47
Total	99.70	99.29	99.65	99.76	100.78	100.21

Trace element (ppm)

Ba	598	584	590	594	560	655
Ce	27	b.d.l	25	20	27	18
La	17	12	18	17	14	17
Nb	4	n.d	n.d	n.d	n.d	7
Nd	15	5	16	8	11	12
Ni	b.d.l	b.d.l	171	b.d.l	b.d.l	b.d.l
Pb	27	31	27	30	25	25
Rb	72	54	91	85	80	75
Sc	1	3	2	1	1	4
Sr	518	747	525	440	578	684
Th	2	7	8	11	4	6
V	29	16	36	11	34	33
Y	5	6	11	7	9	9
Zn	74	31	48	20	45	45
Zr	98	73	100	71	106	95

Norm

Qu	16.38	21.27	17.15	22.65	15.39	17.14
Cor	0.25	0.00	0.16	0.00	0.00	0.00
Or	20.15	15.96	19.15	20.39	17.26	17.20
An	6.35	6.91	6.83	4.99	5.77	7.11
Ab	48.15	51.36	46.46	47.47	52.80	49.50
Di	5.08	0.12	5.35	0.61	2.25	2.58
Hy	2.91	2.28	3.05	2.06	5.15	4.49
Mt	0.75	0.55	1.65	0.71	0.94	1.03
Ilm	0.51	0.34	0.55	0.25	0.55	0.57
Ap	0.07	0.05	0.09	0.07	0.12	0.12

APPENDIX 5.4

FANAD PLUTON

Major element (wt%)

Sample	FAN15A	FAN17	FAN11	FAN1	FAN12	FAN41	FAN2	FAN7	FAN13	FAN10
Unit	Fanad Pen	Fanad Pen	Fanad Pen	Fanad Pen	Fanad Pen	Fanad Pen	Fanad Pen	Fanad Pen	Fanad Pen	Fanad Pen
SiO2	55.81	61.93	64.37	64.37	64.15	62.82	63.03	62.07	57.30	64.86
Al2O3	17.84	17.78	15.46	15.23	15.50	15.99	15.29	15.90	17.49	14.99
TiO2	0.80	0.64	0.54	0.57	0.58	0.64	0.59	0.64	0.98	0.53
FeO	3.90	2.75	22.10	2.20	2.50	2.06	2.47	2.57	3.62	2.24
Fe2O3	1.87	1.17	1.41	1.48	1.42	2.25	1.47	1.58	2.27	1.18
Fetot	6.13	4.23	3.74	3.92	4.20	4.54	4.21	4.44	6.29	3.67
MnO	0.07	0.04	0.05	0.05	0.05	0.06	0.05	0.06	0.07	0.04
MgO	5.24	2.72	3.34	3.49	3.97	3.76	3.56	3.81	3.38	3.35
CaO	6.78	2.58	3.54	3.70	3.74	3.50	3.81	4.21	4.47	3.36
Na2O	3.64	4.25	4.34	4.09	4.00	3.83	4.27	4.23	3.59	4.25
K2O	2.08	4.27	3.37	3.37	3.01	3.60	3.31	3.46	3.00	3.64
P2O5	0.14	0.22	0.13	0.14	0.14	0.24	0.17	0.23	0.45	0.13
LOI	1.09	0.71	0.52	0.57	1.24	0.76	0.56	0.60	1.74	0.53
Total	99.61	99.38	99.40	99.51	100.58	99.67	99.47	99.65	99.11	99.36

Trace element (ppm)

Ba	1181	4367	1390	1519	1415	1517	1429	1561	2029	1409
Ce	34	28	53	52	43	58	66	61	68	44
La	25	36	32	34	31	30	35	46	40	28
Nb	9	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	7
Nd	21	15	28	23	27	40	45	38	50	27
Ni	b.d.l	b.d.l	72	89	66	58	109	196	b.d.l	5
Pb	13	9	20	20	23	22	15	16	12	23
Rb	30	67	70	74	65	74	71	74	59	80
Sc	22	4	7	7	10	9	7	9	8	7
Sr	1416	1124	884	899	921	949	966	940	1372	835
Th	3	b.d.l	10	8	13	8	4	8	8	10
V	110	68	67	76	76	86	74	77	108	65
Y	17	17	11	12	3	12	15	18	14	13
Zn	70	53	52	55	59	28	56	63	77	52
Zr	111	361	133	135	160	141	146	163	125	148

Norm

Qu	6.16	11.92	14.91	16.04	16.31	14.33	13.64	11.32	9.49	15.43
Cor	0.00	1.99	0.00	0.00	0.00	0.00	0.00	0.00	0.68	0.00
Or	12.25	25.22	19.87	19.87	17.76	21.27	19.54	20.43	17.70	21.49
An	26.21	11.41	12.77	13.27	15.47	15.83	12.80	14.49	19.30	11.10
Ab	30.79	35.93	36.71	34.56	33.83	32.36	36.08	35.77	33.41	35.93
Di	5.30	9.20	3.20	3.40	1.75	12.50	4.02	4.17	14.90	3.80
Hy	11.50	6.77	7.49	7.56	9.74	9.35	7.70	8.34	8.41	7.25
Mt	2.71	1.70	2.04	2.15	2.06	3.30	2.13	2.30	4.70	1.71
Ilm	1.52	1.20	1.03	1.10	1.10	1.22	1.12	1.22	1.86	1.01
Ap	0.30	0.50	0.30	0.30	0.30	0.54	0.37	0.54	1.04	0.30
Ru	0.00	0.60	0.00	0.00	0.00	0.56	0.00	0.00	0.90	0.00

APPENDIX 5.4

FANAD PLUTON

Major element (wt%)

Sample	FAN16A	FAN16B	FAN13A	FAN46	FAN30	FAN46D	FAN29	FAN28	FAN23	FAN24
Unit	Fanad Pen	Fanad Pen	Fanad Pen	Rosguill	Rosguill	Rosguill	Rosguill	Rosguill	Rosguill	Rosguill
SiO2	58.40	58.86	52.46	58.61	57.82	59.20	64.92	62.91	60.42	63.17
Al2O3	19.01	18.90	20.10	18.20	18.57	18.27	17.43	17.05	18.13	17.45
TiO2	0.80	0.79	1.00	0.91	0.92	0.88	0.57	0.69	0.71	0.60
FeO	3.33	3.67	5.56	3.23	2.92	3.11	1.86	2.05	2.58	2.07
Fe2O3	2.22	1.77	1.99	2.02	2.46	1.98	1.93	1.85	1.87	1.72
Fetot	5.55	5.44	7.55	5.63	5.70	5.44	4.00	4.16	4.74	4.02
MnO	0.04	0.04	0.06	0.05	0.05	0.04	0.03	0.04	0.04	0.05
MgO	2.90	2.95	4.36	3.34	3.15	2.94	1.97	2.41	2.55	1.86
CaO	4.22	4.03	6.30	4.75	4.71	4.28	2.97	3.35	3.55	3.13
Na2O	4.55	4.54	3.97	4.37	4.95	5.03	4.47	4.78	4.45	5.06
K2O	3.05	3.05	2.23	2.83	2.46	2.98	3.76	3.25	3.69	3.22
P2O5	0.20	0.24	0.28	0.36	0.24	0.22	0.25	0.18	0.20	0.17
LOI	0.50	0.71	1.24	0.56	1.47	0.54	0.48	0.44	0.57	0.44
Total	99.22	99.55	99.55	99.61	100.03	99.82	100.85	99.26	99.05	99.17

Trace element (ppm)

Ba	3709	3761	1643	2499	2546	2824	3988	2770	3909	2924
Ce	43	67	46	50	55	68	79	64	79	53
La	42	51	33	43	50	43	65	54	70	40
Nb	6	3	6	n.d.	n.d.	7	n.d.	n.d.	n.d.	11
Nd	20	35	27	35	28	35	34	31	38	27
Ni	b.d.l	b.d.l	b.d.l	149	b.d.l.	b.d.l.	31	117	53	b.d.l.
Pb	16	12	17	17	15	13	18	15	16	19
Rb	45	45	58	58	51	58	57	51	56	53
Sc	5	4	10	8	b.d.l.	8	2	5	4	3
Sr	1717	1678	1717	1422	1430	1433	1292	1230	1481	1218
Th	2	4	2	6	3	1	11	5	4	6
V	62	68	102	89	95	89	44	66	62	50
Y	5	4	12	14	13	9	11	9	8	24
Zn	74	73	96	78	82	75	63	64	68	69
Zr	439	443	285	295	306	332	349	293	392	353

Norm

Qu	6.49	5.43	1.64	8.22	5.50	5.61	15.93	12.38	9.62	12.37
Cor	1.04	1.36	0.36	0.17	0.00	0.00	1.19	0.00	0.85	0.33
Or	17.98	17.98	13.14	16.70	14.53	17.59	22.21	19.21	21.77	18.98
An	19.63	18.49	29.48	21.25	21.20	18.47	13.14	15.47	16.31	14.51
Ab	38.50	38.39	33.57	36.98	41.85	42.54	37.82	40.44	37.61	42.80
Di	6.26	8.90	10.15	7.30	0.51	1.06	10.50	12.30	13.00	12.00
Hy	5.22	4.35	7.23	8.31	7.60	6.83	4.90	5.99	6.34	4.63
Mt	3.22	2.57	2.89	2.90	3.57	2.87	2.80	2.70	2.80	2.50
Ilm	1.52	1.50	1.90	1.73	1.75	1.67	1.08	1.30	1.40	1.14
Ap	0.47	0.54	0.64	0.84	0.54	0.50	0.57	0.40	0.47	0.37
Ru	0.76	0.74	0.93	0.85	0.67	0.45	0.54	0.64	0.66	0.54

APPENDIX 5.4 - CONTINUED

FANAD PLUTON

Major element (wt%)

Sample	FAN25	FAN27	FAN21	FAN22	FAN43	FAN18	FAN 19
Unit	Rosguill	Rosguill	Melmore	Melmore	Melmore	Melmore	Melmore
SiO2	63.74	62.04	56.04	56.71	56.85	56.43	55.44
Al2O3	16.99	18.11	20.09	18.55	19.17	19.44	20.09
TiO2	0.63	0.67	0.88	0.95	0.88	0.85	0.87
FeO	2.54	2.18	3.60	3.43	3.04	3.50	3.66
Fe2O3	1.51	1.82	2.15	2.39	2.22	1.93	2.02
Fetot	4.33	4.24	6.15	6.20	5.60	5.83	6.09
MnO	0.04	0.03	0.04	0.06	0.05	0.04	0.05
MgO	2.16	2.26	3.44	3.38	3.04	3.13	3.23
CaO	2.95	3.21	5.05	4.68	3.87	4.80	5.02
Na2O	4.49	4.67	4.47	4.29	4.40	4.72	4.82
K2O	3.51	3.83	2.72	2.95	3.52	2.95	2.80
P2O5	0.18	0.21	0.29	0.27	0.35	0.30	0.27
LOI	0.18	0.39	0.52	0.96	1.35	0.42	0.60
Total	99.65	99.66	99.66	99.00	99.08	98.91	99.28

Trace element (ppm)

Ba	3363	4199	4157	2504	3362	3897	3888
Ce	86	102	61	47	56	71	42
La	74	81	45	28	53	52	46
Nb	n.d.	n.d.	n.d.	11	5	3	3
Nd	43	47	30	44	31	35	23
Ni	b.d.l.	185	b.d.l.	b.d.l.	b.d.l.	b.d.l.	b.d.l.
Pb	16	15	16	21	13	15	14
Rb	57	57	41	64	74	43	42
Sc	4	4	5	12	b.d.l.	5	4
Sr	1207	1408	2094	1657	1760	1925	1991
Th	10	6		4	6	9	3
V	56	58	93	103	76	123	75
Y	13	13	8	37	11	7	7
Zn	72	60	79	76	73	73	76
Zr	357	376	446	237	309	424	338

Norm

Qu	15.17	10.57	4.52	6.17	5.97	3.60	2.60
Cor	0.86	0.93	1.30	0.44	1.92	0.48	0.70
Or	20.71	22.60	16.03	17.42	20.76	17.42	16.60
An	13.52	14.62	23.19	21.44	16.97	21.84	23.00
Ab	37.97	39.49	37.82	36.29	37.19	39.91	31.70
Di	10.00	11.00	15.00	17.00	13.00	17.00	18.00
Hy	5.37	5.62	8.56	8.41	7.57	7.79	2.00
Mt	2.20	2.64	3.21	3.50	3.22	2.80	2.90
Ilm	1.20	1.27	1.67	1.80	1.67	1.52	1.71
Ap	0.40	0.47	0.67	0.64	0.81	0.71	0.64
Ru	0.58	0.63	0.84	0.88	0.82	0.81	0.20

APPENDIX 5.5

MAIN DONEGAL PLUTON

Major element (wt%)

Sample	DON17	DON25	DON26	DON12	DON7B	DON7A	DON38	DON33	DON35	DON27	DON16	DON40
Unit	Dark	Dark	Dark	Dark	Dark	light	light	light	light	light	light	light
SiO2	66.26	68.99	66.68	69.15	71.24	70.53	70.52	74.65	72.16	71.65	73.19	70.78
TiO2	0.44	0.38	0.16	0.41	0.25	0.29	0.27	0.12	0.17	0.21	0.13	0.26
Al2O3	16.72	15.83	18.68	15.83	14.93	14.87	15.25	12.94	14.45	15.12	13.76	15.22
FeO	2.32	1.61	0.57	2.03	1.21	1.21	1.20	0.55	0.83	0.89	0.65	1.10
Fe2O3	0.79	1.01	0.47	0.86	0.68	1.07	0.44	0.27	0.45	0.41	0.62	0.60
Fetot	3.37	2.80	1.10	3.12	2.02	2.15	1.76	0.88	1.37	1.40	1.34	1.82
MnO	0.02	0.04	0.02	0.05	0.03	0.02	0.03	0.02	0.03	0.04	0.01	0.03
MgO	0.72	1.32	0.73	1.50	1.19	1.09	1.02	0.72	0.66	0.88	0.67	1.06
CaO	0.96	2.62	3.46	2.83	2.85	2.74	2.14	0.96	1.65	2.00	1.19	2.50
Na2O	5.43	5.64	7.53	5.28	5.58	4.29	4.90	3.43	4.27	5.29	3.30	4.39
K2O	3.12	2.40	0.99	1.80	1.17	2.81	3.52	5.12	4.32	2.64	5.31	3.11
P2O5	0.02	0.06	0.06	0.12	0.10	0.10	0.08	0.02	0.02	0.04	0.05	0.13
LOI	0.60	0.56	0.62	0.12	0.54	0.58	0.08	0.67	0.36	0.51	0.37	0.54
Total	98.66	100.64	100.03	100.25	100.02	99.47	99.89	99.44	99.47	99.78	99.33	99.84

Trace element (ppm)

Ba	110	529	49	108	124	1009	925	890	1126	1126	894	860
Ce	33	33	57	41	23	42	40	29	30	b.d.l	271	36
La	23	21	37	34	10	34	35	20	31	22	36	24
Nb	n.d.	15	56	19	n.d.	n.d	9	6	7	10	n.d.	n.d.
Nd	20	22	33	15	16	21	12	10	7	b.d.l.	73	17
Ni	b.d.l.	b.d.l.	b.d.l.	b.d.l.	228	b.d.l.	b.d.l.	b.d.l.	b.d.l.	b.d.l.	113	146
Pb	17	18	25	12	17	19	20	22	24	22	29	21
Rb	110	112	48	108	65	95	102	138	135	124	153	102
Sc	7	5	2	6	4	2	1	b.d.l.	b.d.l.	2	2	1
Sr	341	403	665	272	433	346	449	288	339	382	304	468
Th	5	13	23	14	4	13	12	15	18	12	14	10
V	24	36	12	36	20	b.d.l.	21	11	13	15	14	22
Y	12	12	14	18	11	7	9	2	10	9	6	8
Zn	89	67	32	82	53	53	42	22	29	44	28	50
Zr	174	213	88	166	140	144	131	57	107	93	99	120

Norm

Qu	19.35	20.03	11.33	23.61	25.20	24.51	22.88	32.05	26.48	25.29	28.80	23.70
Cor	0.82	0.00	0.00	0.33	0.16	0.00	0.00	0.05	0.00	0.00	0.54	0.40
Or	11.25	14.14	5.85	10.63	27.17	16.60	20.76	30.23	25.50	15.59	31.40	18.40
An	13.87	10.82	14.27	13.28	8.70	12.90	9.24	4.66	7.54	9.71	5.60	11.60
Ab	45.00	47.68	63.67	44.63	33.99	36.30	41.43	29.00	36.08	44.74	27.90	37.20
Di	3.61	1.14	2.02	10.80	1.10	0.06	2.00	3.73	0.45	7.00	4.48	8.27
Hy	4.51	3.06	1.10	3.73	2.21	0.00	2.51	1.79	1.61	2.19	0.13	0.00
Mt	1.34	2.30	0.70	1.30	0.99	1.55	0.60	0.40	0.65	0.59	0.90	0.87
Ilm	0.84	0.72	0.30	0.80	0.50	0.60	0.40	0.23	0.32	0.40	0.25	0.49
Ru	0.38	0.00	0.00	0.35	0.22	0.00	0.00	0.10	0.00	0.17	0.00	0.00
Ap	0.24	0.13	0.13	0.27	0.13	0.24	0.17	0.03	0.03	0.07	0.12	0.31

APPENDIX 5.5 - CONTINUED

MAIN DONEGAL PLUTON

Major element (wt%)

Sample	DON8D	DON30	DON8A	DON28	DON13	DON1	DON4	DON31	DON11	DON42	DON3	DON39
Unit	light	light	light	light	light	light	light	light	light	light	light	light
SiO2	69.64	67.76	70.09	72.94	71.18	69.32	70.13	70.68	73.30	71.19	70.43	70.01
TiO2	0.38	0.27	0.24	0.09	0.25	0.30	0.23	0.24	0.17	0.22	0.21	0.30
Al2O3	15.26	15.83	15.54	14.70	15.16	15.89	15.06	15.13	14.56	14.76	14.88	15.34
FeO	1.60	0.99	1.10	0.46	1.19	1.69	0.93	1.08	0.72	1.06	1.58	1.46
Fe2O3	1.09	1.14	0.60	0.19	0.59	0.45	0.68	0.37	0.45	0.52	0.41	0.63
Fetot	2.74	2.24	1.82	0.70	1.76	2.33	1.71	1.57	1.24	1.70	1.62	2.25
MnO	0.02	0.02	0.02	0.01	0.03	0.03	0.02	0.03	0.01	0.03	0.04	0.02
MgO	1.50	0.76	0.84	0.51	0.87	1.18	0.99	0.95	0.68	0.89	1.47	1.16
CaO	2.80	1.74	1.86	1.50	2.06	2.58	1.52	2.22	1.59	1.83	1.78	3.01
Na2O	4.11	4.50	4.94	4.69	4.57	4.30	4.01	4.52	4.30	4.02	4.32	4.10
K2O	2.55	4.05	3.81	4.68	3.27	2.99	5.09	3.34	4.27	4.60	3.71	4.27
P2O5	0.14	0.10	0.05	0.04	0.05	0.07	0.09	0.04	0.01	0.07	0.09	0.13
LOI	0.84	0.32	0.36	0.43	0.42	0.65	0.47	0.11	0.60	0.42	0.80	0.50
Total	99.99	97.60	99.56	100.29	99.61	99.64	99.32	98.81	100.72	99.40	99.36	100.08

Trace element (ppm)

Ba	949	675	755	954	588	832	1183	726	894	963	1256	1945
Ce	71	24	25	15	47	44	30	26	59	52	43	92
La	60	21	19	16	33	35	29	18	37	41	26	74
Nb	n.d.	n.d.	9	4	11	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Nd	31	11	18	14	19	18	13	12	35	27	24	42
Ni	183	b.d.l.	b.d.l.	b.d.l.	b.d.l.	b.d.l.	251	b.d.l.	b.d.l.	b.d.l.	226	b.d.l.
Pb	12	21	26	26	21	22	32	19	26	27	17	19
Rb	92	124	128	127	119	103	163	108	137	152	115	123
Sc	5	2	b.d.l.	b.d.l.	2	b.d.l.	2	b.d.l.	b.d.l.	2	3	2
Sr	396	358	286	353	306	500	380	378	283	296	474	481
Th	16	14	1	7	10	16	9	8	18	16	6	17
V	44	19	18	9	27	33	19	22	15	17	22	26
Y	8	15	11	6	9	9	12	8	11	10	9	12
Zn	63	39	54	15	53	55	48	43	29	46	50	50
Zr	185	98	125	59	139	161	141	96	102	128	134	200

Norm

Qu	23.50	19.47	21.68	24.34	26.51	25.78	22.88	25.55	27.57	25.15	25.41	24.17
Cor	0.60	1.12	0.02	0.00	0.46	1.03	0.41	0.12	0.00	0.00	0.74	0.63
Or	21.60	23.90	22.49	27.61	19.32	17.65	30.06	19.71	25.22	27.17	21.88	25.22
An	5.89	7.98	8.93	5.26	9.93	12.43	6.98	10.80	7.85	8.65	8.26	9.13
Ab	34.30	38.10	41.80	39.65	38.65	36.35	33.88	38.23	36.35	33.99	36.50	34.67
Di	3.00	5.34	0.03	1.33	7.07	10.30	5.60	8.03	5.20	7.00	6.70	2.70
Hy	2.10	0.00	3.50	1.20	0.00	0.60	0.80	0.00	0.00	0.21	2.10	3.60
Mt	1.30	1.65	0.90	0.30	0.86	0.65	1.00	0.50	0.70	0.80	0.60	0.91
Ilm	0.40	0.51	0.50	0.20	0.57	0.57	0.40	0.50	0.32	0.40	0.40	0.60
Ru	0.00	0.00	0.22	0.00	0.22	0.26	0.21	0.21	0.15	0.17	0.17	0.28
Ap	0.30	0.24	0.10	0.07	0.10	0.13	0.20	0.07	0.00	0.13	0.20	0.30

APPENDIX 5.5 - CONTINUED

MAIN DONEGAL PLUTON

Major element (wt%)

Sample	DON39	DON6B	DON5	DON8BT
Unit	light	light	light	light
SiO2	70.01	71.32	73.50	70.99
TiO2	0.30	0.20	0.13	0.22
Al2O3	15.34	14.65	14.29	15.04
FeO	1.46	0.97	0.82	2.24
Fe2O3	0.63	0.53	0.10	0.40
Fetot	2.25	1.61	0.98	1.63
MnO	0.02	0.02	0.03	0.03
MgO	1.16	0.94	0.64	0.92
CaO	3.01	1.79	0.69	2.39
Na2O	4.10	3.87	4.63	4.36
K2O	4.27	4.18	4.33	3.11
P2O5	0.13	0.08	0.03	0.04
LOI	0.50	0.40	0.29	0.34
Total	100.08	99.04	99.76	99.07

Trace element (ppm)

Ba	1945	1349	649	647
Ce	92	32	19	34
La	74	26	19	27
Nb	n.d.	11	n.d.	n.d.
Nd	42	20	8	26
Ni	b.d.l.	b.d.l.	b.d.l.	b.d.l.
Pb	19	19	22	18
Rb	123	138	155	106
Sc	2	b.d.l.	1	3
Sr	481	389	270	341
Th	17	4	7	8
V	26	21	15	24
Y	12	13	9	10
Zn	50	41	40	43
Zr	200	89	71	94

Norm

Qu	24.17	27.81	27.67	25.20
Cor	0.63	0.68	0.80	0.00
Or	25.22	24.66	25.55	18.40
An	9.13	8.41	3.24	11.10
Ab	34.67	32.73	39.18	39.20
Di	2.70	6.78	2.66	0.43
Hy	3.60	2.34	1.59	3.70
Mt	0.91	0.77	0.14	0.58
Ilm	0.60	0.38	0.25	0.42
Ru	0.28	0.18	0.10	0.01
Ap	0.30	0.17	0.07	0.09

APPENDIX 5.6

TRAWENAGH BAY PLUTON

Major element (wt%)

Sample	TRA1	TRA2	TRA5	TRA6	TRA8B	TRA3	TRA4	TRA7
Unit	Bi gra	Bi gra	Bi gra	Bi gra	Bi gra	Mu gra	Mu gra	Mu gra
SiO2	72.27	72.75	71.87	72.76	69.89	73.63	75.46	74.86
Al2O3	14.33	14.11	14.37	14.44	15.56	14.03	13.35	14.59
TiO2	0.18	0.18	0.18	0.19	0.29	0.03	0.04	0.03
FeO	1.12	0.79	0.83	0.80	1.59	0.13	0.12	0.12
Fe2O3	0.13	0.55	0.56	0.55	0.71	0.31	0.16	0.24
Fetot	1.37	1.43	1.48	1.44	2.48	0.45	0.29	0.37
MnO	0.04	0.03	0.02	0.03	0.05	0.10	0.04	0.04
MgO	1.04	0.91	0.76	0.77	1.13	0.29	0.26	0.27
CaO	1.75	1.51	1.32	1.70	2.58	0.42	0.39	0.32
Na2O	4.33	4.20	4.40	4.25	5.83	4.65	5.44	5.62
K2O	3.31	4.04	4.50	3.93	1.27	4.35	3.87	4.15
P2O5	0.04	0.04	0.03	0.03	0.09	0.04	0.00	0.01
LOI	0.75	0.63	0.69	0.43	0.48	0.50	0.41	0.59
Total	99.39	99.82	99.61	99.87	100.69	98.49	99.54	100.40

Trace element (ppm)

Ba	539	708	990	828	191	b.d.l	b.d.l	b.d.l
Ce	34	15	32	30	28	9	15	2
La	17	4	26	20	19	6	4	4
Nb	n.d	n.d	n.d	n.d	15	n.d	40	40
Nd	21	12	18	12	13	9	9	n.d
Ni	139	b.d.l	b.d.l	209	b.d.l	133	b.d.l	b.d.l
Pb	22	23	23	29	16	16	25	13
Rb	133	109	136	133	77	345	266	369
Sc	2	b.d.l	1	3	5	2	1	b.d.l
Sr	298	338	328	307	310	10	4	11
Th	7	4	7	12	10	6	9	2
V	15	15	9	20	21		2	3
Y	10	9	17	12	13	19	29	9
Zn	37	33	41	41	75	22	18	22
Zr	87	87	105	99	138	30	27	13

Norm

Qu	26.52	26.40	24.77	26.04	12.54	28.26	28.02	24.87
Cor	0.54	0.18	0.00	0.18	0.00	1.00	0.00	0.30
Or	19.56	23.88	26.59	23.23	26.59	25.71	22.87	24.53
An	8.42	7.23	6.17	8.24	3.00	1.82	0.58	1.52
Ab	36.64	35.54	37.23	35.96	49.33	39.35	46.03	47.56
Di	6.90	5.82	0.15	5.87	7.62	1.44	1.07	1.20
Hy	1.15	0.38	2.79	0.00	1.77	0.18	0.25	0.18
Mt	0.19	0.80	0.81	0.80	0.25	0.45	0.23	0.35
Ilm	0.34	0.34	0.34	0.36	0.55	0.06	0.08	0.06
Ap	0.09	0.09	0.07	0.07	0.21	0.09	0.00	0.02

APPENDIX 6.

RARE EARTH ELEMENT ANALYSES.

Notes.

(1) All Barnesmore analyses are taken from Dempsey (1987).

(2) All Thorr analyses are taken from Oglethorpe (1987) except TH1, TH5, TH6B andTH4.

Outer : Outer unit of Ardara.
I'mediate : Intermediate unit of Ardara.
Inner: Inner unit of Ardara.
Fan penin: Fanad peninsula.
Bi-granite : Biotite granite of Trawenagh Bay.
Mu-granite: Muscovite granite of Trawenagh Bay.
Contact : Contact facies of Thorr.
Trans : Transitional facies of Thorr.
Hbl bear : Hornblende bearing Normal facies of Thorr.
Hbl free : Hornblende free Normal facies of Thorr.
Qz Mzd : Quartz monzodiorite.
Gdr : Granodiorite.

APPENDIX 6 - RARE EARTH ELEMENT (DONEGAL GRANITES)

Pluton	Ardara	Ardara	Ardara	Ardara	Ardara	Ardara	Ardara	Ardara	Ardara	Ardara	Fanad	Fanad
Unit	Outer	Outer	Outer	Outer	Outer	Outer	I'mediate	I'mediate	Inner	Inner	Fan penin	Fan penin
Rock type	Qz Mzd	Qz Mzd	Qz Mzd	Qz Mzd	Qz Mzd	Qz Mzd	Gdr	Gdr	Granite	Granite	Qz Mzd	Qz Mzd
Sample	ARD1F	ARD1A1	ARD1B	ARD1C	ARD1D	ARD1E	ARD2	ARD4	ARD11	ARD13	FAN11	FAN16
La	67.58	59.87	38.28	27.56	36.66	38.28	15.37	15.17	14.98	15.36	29.68	33.7
Ce	156	120	87.8	56.2	79.2	71.9	34.8	32.3	28.1	33.2	59.6	60.2
Pr	13.4	14.5	7.85	5.78	7.03	6.54	4.18	3.91	2.61	3.34	5.67	6.16
Nd	59.5	51.9	36.7	24.8	31.4	28.8	15	15.66	10.8	14.6	27.3	24.1
Sm	9.66	9.65	7.24	4.16	4.87	5.16	3.36	3.17	1.78	2.48	4.59	3.36
Eu	1.69	1.59	1.39	1.07	0.97	1.21	0.69	0.75	0.51	0.66	1.19	1.55
Gd	6.28	6.35	4.9	3.06	3.39	3.75	2.05	2.38	1.48	1.8	4.46	2.21
Ho	0.85	1.00	0.67	0.48	0.49	0.41	0.39	0.27	0.01	0.27	0.43	0.29
Er	2.53	2.83	2.12	1.67	1.46	1.14	1.14	0.8	0.13	0.89	1.34	0.63
Dy	4.65	4.63	3.76	2.48	2.59	2.56	1.69	1.53	0.65	1.47	2.9	1.1
Yb	2.19	1.92	2.04	0.91	0.99	1.23	0.72	0.72	0.4	0.61	1.07	0.58
Lu	0.26	0.22	0.25	0.12	0.12	0.15	0.1	0.1	0.04	0.06	0.12	0.08
Total	324.59	274.46	193	128.29	169.17	161.13	79.49	76.76	61.49	74.74	138.35	133.96

Pluton	Fanad	Fanad	Fanad	Fanad	Fanad	Fanad	Fanad	Main Don	Main Don	Main Don	Main Don	Main Don
Unit	Fan penin	Fan penin	Fan penin	Melmore	Rosguill	Rosguill	Rosguill	Dark band	Dark Band	Light band	Light band	Light band
Rock type	Qz Mzd	Qz Mzd	Qz Mzd	Qz Mzd	Qz Mzd	Qz Mzd	Qz Mzd	Trondhj	Trondhj	Gdr	Gdr	Granite
Sample	FAN17	FAN1	FAN10	FAN46	FAN23	FAN25	FAN29	DON17	DON26	DON30	DON1	DON16
La	31.48	41.28	26.06	27.28	76.07	68.04	50.6	20.03	53.7	27.48	49.07	50.42
Ce	51.66	71.8	65.99	67.8	137	108.2	97.5	43.44	94	54.4	93.4	98
Pr	5.17	6.83	6.75	6.84	14.07	10.35	8.35	4.42	9.75	4.85	9.06	9.92
Nd	19.1	30.7	26.32	32.84	49.1	38.13	29.8	16.48	33.9	20.2	28.2	32.7
Sm	3.02	5.06	4.06	5.33	6.65	4.91	3.43	3.73	6.85	4.07	4.66	5.6
Eu	1.44	1.27	0.92	1.81	2.1	1.48	1.21	0.61	0.76	0.68	0.79	0.71
Gd	2.63	3.33	2.55	3.61	3.64	3.12	1.95	3.1	4.4	3.12	2.58	3.15
Ho	0.59	0.35	0.29	0.3	0.54	0.48	0.17	0.39	0.58	0.33	0.42	0.42
Er	1.43	1.21	0.73	0.84	1.83	1.05	0.52	0.95	1.68	0.99	1.46	1.26
Dy	2.44	2.26	1.68	2.14	2.38	1.98	0.95	2.31	2.83	2.31	1.84	1.9
Yb	0.7	1.14	0.72	0.72	0.96	0.8	0.29	0.72	0.75	1.13	0.84	0.54
Lu	0.09	0.13	0.1	0.09	0.13	0.08	0.05	0.1	0.1	0.12	0.11	0.09
Total	119.75	165.36	136.17	149.16	294.47	238.62	194.82	96.28	209.3	119.7	192.4	204.71

Pluton	Main Don	Main Don	Rosses	Rosses	Rosses	Rosses	Rosses	Rosses	Rosses	Rosses	Rosses	Rosses
Unit	Light band	Light band	porphyry	porphyry	G1	G1	G1	G2	G2	G2	G2	G2
Rock type	Granite	Granite	Granite	Granite	Granite	Granite	Granite	Granite	Granite	Granite	Granite	Granite
Sample	DON5	DON3	ROS29	ROS3	ROS11	ROS12	ROS4AP	ROS17	ROS14	ROS15	ROS5	ROS16
La	14.27	41.37	26.66	34.17	30.18	23.58	13.7	14.66	17.17	7.12	16.17	18.2
Ce	28.2	72.1	53.2	63.5	60.52	44.69	32.68	29.1	32.2	17.1	32.27	38.8
Pr	3.23	7.2	5.16	6.81	6.34	4.46	3.46	2.92	3.21	1.87	3.4	3.96
Nd	10.3	25.2	21	22.6	23.09	16.7	13.3	12.6	13.2	6.1	14.45	15.9
Sm	2.28	4.53	3.04	4.63	3.81	3.04	2.99	3.37	3.88	1.99	3.61	4.36
Eu	0.34	0.92	0.63	0.67	0.72	0.55	0.42	0.37	0.73	0.28	0.46	0.35
Gd	1.52	2.56	2.04	2.71	2.55	2.3	2.32	3.43	2.98	2.08	3.3	3.98
Ho	0.35	0.42	0.33	0.48	0.29	0.39	0.29	1.05	0.7	0.5	0.59	0.79
Er	1.07	1.28	1.09	1.37	0.73	0.78	0.75	2.81	1.83	1.49	1.62	1.99
Dy	0.15	1.82	1.62	2.23	1.68	1.66	1.79	4.65	3.6	2.45	2.91	4.17
Yb	0.69	0.77	0.72	0.88	0.72	0.7	0.66	2.54	1.68	1.6	1.45	1.87
Lu	0.09	0.1	0.08	0.08	0.1	0.09	0.09	0.29	0.16	0.2	0.2	0.25
Total	62.49	158.3	115.57	140.13	130.73	98.94	72.45	77.79	81.34	42.78	80.43	94.62

APPENDIX 6 : CONTINUED.

Pluton	Rosses	Rosses	Rosses	Rosses	Rosses	Trawenagh	Trawenagh	Trawenagh	Trawenagh	Trawenagh	Thorr	Thorr
Unit	G3	G3	G3	G3	G4	Bi-gra	Bi-gra	Bi-gra	Mu-gra	Mu-gra	Hbl free	Hbl free
Rock type	Granite	Granite	Granite	Granite	Granite	Granite	Granite	Granite	Granite	Granite	granite	granite
Sample	ROS18	ROS13	ROS20	ROS21	ROS10B	TRA5	TRA6	TRA1	TRA4	TRA3	5H	TH1
La	25.16	31.37	17.8	18.02	17.87	22	20.76	17.33	7.55	6.97	28.3	11.67
Ce	45.1	56.1	39.1	37.77	24.88	47.86	39.7	32.68	15.5	11.6	69.8	32.87
Pr	4.55	5.2	4.08	3.9	2.37	4.81	4.00	3.46	1.32	1.13	7.5	2.94
Nd	17.3	20.4	14.97	14.4	8.1	16.39	14.7	13.3	7.56	5.48	28.6	9.2
Sm	3.04	3.82	2.8	2.62	1.95	2.78	2.56	2.99	3.76	2.86	4.83	1.84
Eu	0.6	0.75	0.51	0.53	0.22	0.59	0.55	0.42	0.06	0.03	0.77	0.37
Gd	2.1	2.26	2	1.96	1.91	1.78	1.99	2.32	4.64	2.74	3.7	1.44
Ho	0.32	0.4	0.29	0.25	0.5	0.28	0.35	0.29	1.27	0.46	0.67	0.19
Er	0.87	0.92	0.92	0.68	1.25	0.78	0.89	0.75	3.38	1.30	1.98	0.8
Dy	1.66	1.91	1.62	1.45	2.13	1.58	1.48	1.79	6.13	3.25	3.29	1.13
Yb	0.85	0.58	0.92	0.67	1.5	0.64	0.87	0.66	3.15	2.14	1.5	0.75
Lu	0.07	0.06	0.13	0.1	0.2	0.09	0.12	0.11	0.37	0.24	0.22	0.11
Total	101.62	123.77	85.14	82.35	62.88	99.59	87.97	76.1	54.69	38.2	151.2	63.31

Pluton	Thorr	Thorr	Thorr	Thorr	Thorr	Thorr	Thorr	Thorr	Thorr	Thorr	Thorr	Thorr
Unit	Contact	Contact	Contact	Contact	Contact	Contact	Trans	Trans	Hbl bear	Hbl bear	Hbl bear	Hbl bear
Rock type	Qz Mzd	Gdr	Gdr	Qz Mzd	Qz Dio	Qz Mzd	Qz Mzd	Qz Mzd	Qz Mzd	Qz Mzd	Qz dio	Qz dio
Sample	31/3S	33S	42S	50AS	52S	253S	35BT	44BT	TH5	TH6B	TH4	36I
La	12.2	41.1	34.7	42.6	16.2	11.6	10.4	11.4	28.3	11.67	12.2	41.1
Ce	29.1	77.2	62.2	89.8	35.2	25.5	23	23.8	69.8	32.87	29.1	77.2
Pr	4.5	8.5	6.3	10.3	4.9	3.4	3.2	3.5	7.5	2.94	4.5	8.5
Nd	19.5	29.2	21.6	37.2	20.2	13.2	11.5	11.9	28.6	9.2	19.5	29.2
Sm	5.96	4.21	3.12	6.57	5.16	2.51	1.9	2.34	4.83	1.84	5.96	4.21
Eu	2.46	1.58	1.07	1.37	1.46	1.35	1.18	1.15	0.77	0.37	2.46	1.58
Gd	6.9	3.3	2.4	5.1	5.4	2.1	1.1	2.2	3.7	1.44	6.9	3.3
Ho	2.28	0.84	0.66	1	1.31	0.64	0.39	0.85	0.67	0.19	2.28	0.84
Er	6.51	1.96	1.85	2.51	3.49	1.7	1.2	1.99	1.98	0.8	6.51	1.96
Dy	10.18	3.12	2.7	4.16	6.14	2.25	1.16	2.78	3.29	1.13	10.18	3.12
Yb	5.3	1.31	1.43	1.67	2.59	1.74	1.04	1.37	1.5	0.75	5.3	1.31
Lu	0.7	0.19	0.22	0.25	0.37	0.28	0.18	0.21	0.22	0.11	0.7	0.19
Total	105.6	172.5	138.3	202.5	102.4	66.3	56.3	63.5	151.2	63.31	105.6	172.5

Pluton	Thorr	Thorr	Thorr	Thorr	Thorr	Thorr	Thorr	B'more	B'more	B'more	B'more	B'more
Unit	Hbl bear	Hbl bear	Hbl bear	Hbl bear	Hbl bear	Hbl bear	Hbl bear	G1	G1	G2	G2	G2
Rock type	Qz Mzd	Qz Mzd	Qz Mzd	Qz Dio	Qz Mzd	Qz Mzd	Diorite	Granite	Granite	Granite	Granite	Granite
Sample	48I	53I	38I	39BI	40I	47I	277I	G1/2	G1/21	G2'/39	G2'/52	G2'/90
La	10.4	11.4	34.7	42.6	16.2	11.6	28.4	20.7	23.72	15.7	15.4	11.48
Ce	23	23.8	62.2	89.8	35.2	25.5	64.8	42.5	40.49	26.3	26	21.43
Pr	3.2	3.5	6.3	10.3	4.9	3.4	8.4	n.d.	3.72	n.d.	n.d.	1.75
Nd	11.5	11.9	21.6	37.2	20.2	13.2	31.6	15	12.4	9.1	10.7	5.53
Sm	1.9	2.34	3.12	6.57	5.16	2.51	5.31	2.24	2.09	1.3	2	1.03
Eu	1.18	1.15	1.07	1.37	1.46	1.35	1.62	0.57	0.45	0.27	0.36	0.21
Gd	1.1	2.2	2.4	5.1	5.4	2.1	4.3	n.d.	1.7	n.d.	1.7	0.9
Ho	0.39	0.85	0.66	1	1.31	0.64	0.97	n.d.	0.3	n.d.	n.d.	0.2
Er	1.2	1.99	1.85	2.51	3.49	1.7	2.19	n.d.	0.92	n.d.	0.92	0.56
Dy	1.16	2.78	2.7	4.16	6.14	2.25	3.51	n.d.	1.43	n.d.	1.43	0.86
Yb	1.04	1.37	1.43	1.67	2.59	1.74	1.59	1.15	1.35	0.9	0.32	0.99
Lu	0.18	0.21	0.22	0.25	0.37	0.28	0.25	0.19	0.25	0.16	0.22	0.19
Total	56.3	63.5	138.3	202.5	102.4	66.3	152.9	82.35	80.75	53.73	49.13	40.86

APPENDIX 6 : CONTINUED.

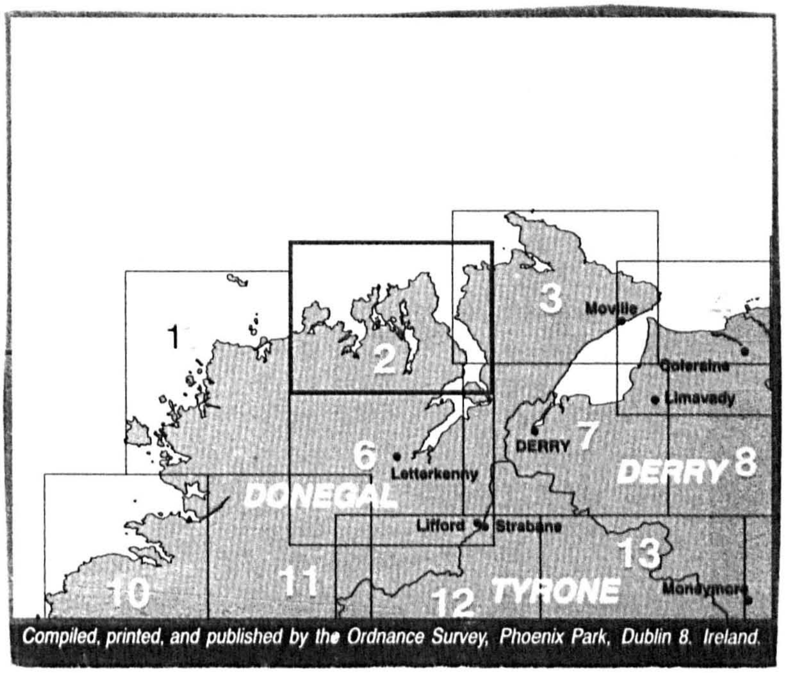
Pluton	B'more	B'more	B'more	B'more
Unit	G2	G2 porp.	G3	G3
Rock type	Granite	Granite	Granite	Granite
Sample	G2'/131	G2PF/138	G3/186	G3/215
La	6.06	10.38	6.57	7.5
Ce	20.14	11.68	11.76	11.53
Pr	1.16	1.24	1.03	0.97
Nd	3.72	3.89	3.08	3.5
Sm	0.78	0.69	0.59	0.68
Eu	0.18	0.11	0.06	0.07
Gd	0.7	0.64	0.53	0.55
Ho	0.18	0.14	0.15	0.18
Er	0.53	0.41	0.47	0.41
Dy	0.78	0.62	0.57	0.69
Yb	1.03	0.89	1.24	0.9
Lu	0.2	0.17	0.26	0.2
Total	32.11	30.86	23.56	23.27

APPENDIX 7.

SAMPLE LOCATION.

Notes.

(1) The sample locations are given using the 1:50000 map by Ordnance Survey of Ireland (Sheet No: 1, 2, 6 and 10 - Map App. 7)



Map App. 7 : Map (1 : 50000) of the northwestern Ireland showing sheets 1, 2, 6 and 10 used in this study.

SAMPLE NUMBER	PLUTON	UNIT	ROCK TYPE	SHEET	GRID REF
ROS2	Rosses	G1A	Granite	1	824120
ROS4	Rosses	G1	Granite	1	734147
ROS4AP	Rosses	G1A	microgranite	1	735146
ROS5	Rosses	G2	Granite	1	745139
ROS6	Rosses	G2	Granite	1	758152
ROS7	Rosses	G2	Granite	1	799158
ROS8	Rosses	G3	Granite	1	773148
ROS8AP	Rosses	G3	microgranite	1	774148
ROS9	Rosses	G3	Granite	1	780155
ROS10A	Rosses	G4	Granite	1	776126
ROS10B	Rosses	G4	Granite	1	777126
ROS11	Rosses	G1	Granite	1	763109
ROS12	Rosses	G1	Granite	1	786114
ROS13	Rosses	G3	Granite	1	764163
ROS14	Rosses	G2	Granite	1	765167
ROS15	Rosses	G2	Granite	1	761168
ROS16	Rosses	G2	Granite	1	762168
ROS17	Rosses	G2	Granite	1	767166
ROS18	Rosses	G3	Granite	1	762164
ROS19	Rosses	G2	Granite	1	763165
ROS20	Rosses	G3	Granite	1	764161
ROS21	Rosses	G3	Granite	1	763162
ROS24	Rosses	G3	Granite	1	778124
ROS26	Rosses	G3	Granite	1	777126
ROS27	Rosses	G3	Granite	1	778127
ROS31	Rosses	Microgranite	Granite	1	734178
ROS28	Rosses	Porphyry	Porphyry gr	1	754210
ROS3	Rosses	Porphyry	Porphyry gr	1	775185
ROS29	Rosses	Porphyry	Porphyry gr	1	763109
ARD1A1	Ardara	Outer	Qtz monzodiorite	10	734987
ARD1B	Ardara	Outer	Qtz monzodiorite	10	734986
ARD1C	Ardara	Outer	Qtz monzodiorite	10	733985
ARD1D	Ardara	Outer	Qtz monzodiorite	10	732984
ARD1E	Ardara	Outer	Qtz monzodiorite	10	733983
ARD1F	Ardara	Outer	Qtz monzodiorite	10	733989
ARD1	Ardara	Outer	Qtz monzodiorite	10	730988
ARD3	Ardara	Outer	Qtz monzodiorite	10	764975
ARD2	Ardara	Intermediate	Granodiorite	10	750972
ARD4	Ardara	Intermediate	Granodiorite	10	760973
ARD3B	Ardara	Inner	Granite	10	765976
ARD5	Ardara	Inner	Granodiorite	10	755952
ARD6	Ardara	Inner	Granite	10	745937
ARD7	Ardara	Inner	Granodiorite	10	736933
ARD12	Ardara	Inner	Granodiorite	10	755954
ARD10	Ardara	Inner	Granite	10	744942
ARD11	Ardara	Inner	Granite	10	748945

ARD13	Ardara	Inner	Granodiorite	10	757956
TRA1	Trawenagh Bay	Bi granite	Granite	1	802074
TRA2	Trawenagh Bay	Bi granite	Granite	1	786052
TRA3	Trawenagh Bay	Musc granite	Granite	1	781072
TRA4	Trawenagh Bay	Musc granite	Granite	1	772092
TRA5	Trawenagh Bay	Bi granite	Granite	10	768033
TRA6	Trawenagh Bay	Bi granite	Granite	1	780075
TRA7	Trawenagh Bay	Musc granite	Granite	1	778077
TRA8	Trawenagh Bay	Bi granite	Granite	1	805046
TH1	Thorr	Hbl free	Granite	1	725228
TH2	Thorr	Hbl bearing	Granodiorite	1	724153
TH3	Thorr	Hbl bearing	Diorite	6	975224
TH4	Thorr	Hbl bearing	Quartz diorite	1	814097
TH5	Thorr	Contact	Quartz monzodiorite	1	827141
TH6	Thorr	Hbl bearing	Quartz monzodiorite	1	828207
TH7	Thorr	Hbl bearing	Granodiorite	1	815225
TH8	Thorr	Hbl bearing	Granodiorite	1	811338
TH9	Thorr	Hbl free	Granodiorite	1	806300
DON1	Main Donegal	Light band	Granodiorite	6	O65223
DON3	Main Donegal	Light band	Granodiorite	6	O49225
DON4	Main Donegal	Light band	Granodiorite	6	O43230
DON5	Main Donegal	Light band	Granite	1	O55225
DON6B	Main Donegal	Light band	Granite	1	852093
DON7A	Main Donegal	Light band	Granite	1	856083
DON8A	Main Donegal	Light band	Granodiorite	1	863074
DON8BT	Main Donegal	Light band	Granite	1	863074
DON7B	Main Donegal	Dark band	Trondhjemite	1	856083
DON8D	Main Donegal	Light band	Granodiorite	1	863074
DON11	Main Donegal	Light band	Granite	1	876065
DON12	Main Donegal	Trondhjemite	Trondhjemite	1	876065
DON13	Main Donegal	Light band	Granite	1	O61886
DON16	Main Donegal	Light band	Granite	1	868065
D0N17	Main Donegal	Trondhjemite	Trondhjemite	1	868065
DON25	Main Donegal	Trondhjemite	Trondhjemite	6	O55225
DON26	Main Donegal	Trondhjemite	Trondhjemite	6	O55225
DON27	Main Donegal	Light band	Granite	6	O55225
DON42	Main Donegal	Light band	Granite	1	880065
DON30	Main Donegal	Light band	Granodiorite	6	O61226
DON31	Main Donegal	Light band	Granite	6	O61266
DON33	Main Donegal	Light band	Granite	2	O94242
DON35	Main Donegal	Light band	Granite	2	O94242
DON38	Main Donegal	Light band	Granodiorite	2	O85261
DON39	Main Donegal	Light band	Granodiorite	2	O81264
DON40	Main Donegal	Light band	Granite	2	O81264

FAN1	Fanad	Fanad peninsula	Qtz monzodiorite	2	173448
FAN2	Fanad	Fanad peninsula	Qtz monzodiorite	2	173449
FAN7	Fanad	Fanad peninsula	Qtz monzodiorite	2	172450
FAN8	Fanad	Fanad peninsula	Qtz monzodiorite	2	172450
FAN10	Fanad	Fanad peninsula	Qtz monzodiorite	2	161450
FAN11	Fanad	Fanad peninsula	Qtz monzodiorite	2	161444
FAN12	Fanad	Fanad peninsula	Qtz monzodiorite	2	154441
FAN13	Fanad	Fanad peninsula	Qtz monzodiorite	2	164429
FAN14	Fanad	Fanad peninsula	Qtz monzodiorite	2	196444
FAN15	Fanad	Fanad peninsula	Qtz monzodiorite	2	217467
FAN16	Fanad	Fanad peninsula	Qtz monzodiorite	2	155427
FAN16A	Fanad	Fanad peninsula	Qtz monzodiorite	2	154426
FAN17	Fanad	Fanad peninsula	Qtz monzodiorite	2	166422
FAN18	Fanad	Melmore	Qtz monzodiorite	2	125445
FAN19	Fanad	Melmore	Qtz monzodiorite	2	125445
FAN21	Fanad	Melmore	Qtz monzodiorite	2	126442
FAN22	Fanad	Melmore	Qtz monzodiorite	2	130438
FAN23	Fanad	Rosguill	Granodiorite	2	107415
FAN24	Fanad	Rosguill	Granodiorite	2	106413
FAN25	Fanad	Rosguill	Qtz monzodiorite	2	106411
FAN27	Fanad	Rosguill	Granodiorite	2	106412
FAN28	Fanad	Rosguill	Qtz monzodiorite	2	102421
FAN29	Fanad	Rosguill	Qtz monzodiorite	2	101423
FAN30	Fanad	Rosguill	Qtz monzodiorite	2	O96421
FAN41	Fanad	Fanad peninsula	Qtz monzodiorite	2	231479
FAN43	Fanad	Melmore	Qtz monzodiorite	2	135436
FAN46	Fanad	Rosguill	Qtz monzodiorite	2	O95422

REFRENCES

Abdel Rahman, A. M. 1994. Nature of biotites from Alkaline, Calc-alkaline and peraluminous magmas. Jour. Petrol.,35 (2), 525 - 541

Abdel Rahman, A. M. 1995. Chlorites in a spectrum of igneous rocks: mineral chemistry and paragenesis. Min.Mag.,59 , 129 - 141.

Akaad, M. K. 1954. The Geology of Narin area,Country Donegal. Unpubl. PhD thesis,Imperial College,London.

Akaad, M. K. 1956. The Ardara granitic diapir of County Donegal, Ireland. Q.J.Geol.Soc.Lond.112, 263-88

Allan, B. D. and Clarke, D. B. 1981. Occurrence and origin of garnet in the South Mountains batholith, Nova Scotia. Can. Mineral., 19, 19 - 24.

Anderson, J. L. and Rowley, M. L. 1981. Synkinemetic intrusion of peraluminous and associated metaluminous granitic magmas, Whipple mountains, California. Can. Mineral.,19 , 83 - 101.

Aspden, J. A., Fortey, N., Litherland, M., Viteri, F. and Harrison, S. M. 1992. Regional S type granites in the Equadorian Andes:Possible remnants of the breakup of western Gondwana. Jour. South American Earth Sci.,6(3), 123 - 132.

Arth, J. G. 1976. Behaviour of trace elements during magmatic processes - a summary of theoretical models and their applications . J. Res. U. S. Geol. Surv. 4, 41 - 47.

Arth, J. G., Barker, F., Peterman, Z. E. and Friedman, I. 1978. Geochemistry of the Gabbro - diorite - tonalite - trondhjemite suite of southwest Findland and its implication for the origin of tonalitic and trondhjemitic magmas. Jour.Petrol., 19 , 289 -316.

Atherton, M. P.1988. On the lineage character of evolving granite. Fifth International Symposium on Tin/Tungsten granites in Southeast Asia and the Western Pacific. Shimane Uni. Matsue, Japan, 1 - 6.

Atherton, M. P. 1989. Analysing and modelling geochemical data from granitoids. Per. Mineral., 58. 167 - 168.

Atherton, M. P. 1990. Granites and tectonic environment. IV summer school on petrological and structural analysis of plutonic complex. 1 -11.

Atherton, M. P. and Boyle, A. P. 1994. Field guide to the metamorphic rocks around the Donegal granites. Conf. Control of Metamorphism. University of Liverpool .

Atherton, M.P. and Petford, N. 1996. Plutonism and the growth of Andean crust at 9°S from 100 to 3 Ma. Jour. South American Earth Sciences, 9 (1/2), 1-9.

Atherton, M. P. and Sanderson, L. M. 1987. The Cordillera Blanca Batholith: a study of granite intrusion and the relation of crustals thickening to peraluminosity. Geol. Rundsch., 76, 213 - 232.

Atherton, M. P., Mc Court, W. J., Sanderson, L. M. and Taylor, W. P. 1979. The geochemical character of the segmented Peruvian Coastal Batholith and associated volcanics. In. M.P. Atherton and J. Tarney (eds) : Origin of granite batholiths - geochemical evidence. Shiva. 45 - 64.

Atherton, M. P., Mahawat, C. and Brotherton, M. S. 1992. Intergrated chemistry, textures,phase relations and modelling of a composite granodioritic - monzonitic batholith, Tak, Thailand. Jour. Southeast Asian Earth Science, 7 (2/3) , 89 - 112

Atherton, M. P., Sanderson, L. M. and Taylor, W. P. 1979. The geochemical character of the segmented Peruvian batholith and associated volcanic . In M.P.Atherton and J.Tarney (eds) : Origin of granite batholiths : geochemical evidence . Shiva

Atkin, B. P. 1977 . A mineralogical and chemical study of the paragenesis of opaque mineral in the Donegal granites and their aureole rocks,Eire. Unpubl. PhD thesis , Univ. of Liverpool.

Barbarin, B. 1990. Granitoids:main petrogenetic classifications in relation to origin and tectonic setting. Geol. Jour.,25 , 227 - 238.

Bea, F., Pereira, M. D., Corretge, L. G. and Freshtater, G. B. 1994. Differentiation of strongly peraluminous, perphosphorous granites: The Pedrobernardo pluton, central Spain. Geochim.Cosmochim.Acta., 58 , 2609 - 2627.

Barker, F. 1979. Trondhjemite : definition, environment and hyphothesis of origin. In F.Barker (ed.) : Trondhjemite, dacites and related rocks. Elsevier , Amsterdam , 1 - 12

Barnes, C. G. 1987. Mineralogy of the Wooley Creek batholith, Slinkard pluton, and related dikes, Klamath Mountains, northern California. Am. Mineral., 72. 879 - 901.

Batchelor, R. A. and Bowden, P. 1985. Petrogenetic interpretation of granitoid rock series using multicationic parameters. Chem. Geol., 48 , 43 - 55.

Bateman, P . C . , Clarke, L . D., Huber, N . D., Moore, J . G ., Rinehart, C. D. 1963. The Sierra Nevada batholith, a synthesis of recent work across the central part. Geol. Surv.Prof.paper 414D , 46 p.

Barth. A. P. 1990. Mid crustals emplacement of Mesozoic plutons, San Gabriel Mountains, California, and implications for the geologic history of the San Gabriel terrane. In J.L. Anderson (ed) The nature and origin of Cordilleran magmatism . Geol. Soc. Am. Memoir 174. 33 - 45.

Beckinsale, R.D. 1979. Granite magmatism in the tin belt of South -East Asia. In M.P.Atherton and J.Tarney (eds).Origin of granite batholiths : Geochemical evidence. Shiva . 34 - 44.

Berger, A. R. 1967 . The Main Donegal granites and its regional setting. Unpubl.PhD thesis , Univ. of Liverpool.

Berger, A. R. 1971. The origin of banding in the Main Donegal granite, N.W. Ireland. Geol.Jour., 7, 347 - 358.

Berger, A. R. 1980. The structural setting of the Main Donegal granites,comment on recent interpretation. Geol.Jour.,15 , 3 - 6.

Bettison, L. A. and Schiffman, P. 1988. Compositional and structural variation of phyllosilicates from the Point Sal ophiolite, California. Am.Mineral., 73, 62 - 76.

Bigi, S., Brigatti, M. F., Mazzucchelli, M . and Rivalenti , G . 1993. Crystal chemistry variation in Ba rich biotites from Gabbroic rocks of lower crust (Ivrea Zone,NW Italy). Contrib.Mineral.Petrol.,113, 87 - 99.

Bowden , P., Batchelor, R. A., Chappell, B. W., Didier, J. and Lameyre, J. 1984.

Petrological, geochemical and source criteria for the classification of granitic rocks: a discussion. Phy. Earth Planet. Int., 35. 1 - 11.

Bradshaw, R., Plant, A. C., Burke, K. C. and Leake. B. E. 1969. The Oughterard granite, Connemara, Co.Galway. Proc. R . Ir. Acad., 68B , 39 - 65.

Brandon, A. D., Creaser, R. A. and Chacko, T. 1996. Constraints on rates of granitic magma transport from epidote dissolution kinetics. Science, 271, 1845 - 1848.

Brooks, C. K. , Henderson, P. and Ronsbo, J. G. 1981. Rare earth element partitioning between allanite and glass in the obsidian of Sandy Braes, northern Ireland. Mineral. Mag., 44 , 157 - 160.

Brown, G. C., Cassidy, J., Locke, C. A., Plant, J. A. and Simpson, P. R. 1981. Caledonian plutonism in Britain : A summary. Jour. of Geophysical Res., 86 (B11) , 10502 - 10514.

Brown , P. E. 1991 . Caledonian and earlier magmatism. In G.Y. Craig (ed) , Geology of Scotland. Geol.Soc.Lond. 229 - 295.

Brown. P. E., Miller, J. A. and Grasty, R. L. 1968. Isotopic ages of late Caledonian granitic intrusions in the British Isles. Proc. Yorks. Geol. Soc. , 36, 251 - 276.

Bruck, P. M. and O'Connor, P. J. 1977. The Leinster Batholith: geology and geochemistry of the northern unit . Geol.Surv.Ireland Bull.2 , 107 - 141.

Brindley, J. C. 1973. The structural setting of the Leinster granite,Ireland- a review. Scient.Proc. R. Dubl. Soc., 5A , 27 - 36.

Bryon, D. N. 1992. Textural development in granitoid rocks: A case study from the zoned Linga Superunit of the Coastal batholith, Peru. Unpubl.PhD thesis. Univ. of Liverpool.

Bryon, D. N., Atherton, M. P. and Hunter, R. H. 1994. The description of the primary textures of Cordilleran granitic rocks. Contrib. Mineral. Petrol.,117, 66 - 75.

Bryon, D. N. ,Atherton, M. P. and Hunter, R. H. 1995 . The interpretation of granitic textures from serial thin sectioning,image analysis and three dimensional reconstruction. Min.Mag.,59 , 203 - 211

Bryon, D. N., Atherton, M. P., Cheadle, M. J. and Hunter, R. H. 1996. Melt movement and the occlusion of porosity in the crystallizing granitic systems. Min.Mag., 60. 163 - 171.

Cambray, F. W. 1969a. The Kilmacrenan succession east of Glenties, Country Donegal. Proc.R. Irish Acad., 67B, 291 - 302.

Cambray, F. W. 1969b. The Dalradian of Donegal. In M. Kay (ed) , North Atlantic - Geology and Continental drift . Mem.Am. Assoc. Petrol.Geol.,12, 181 - 193.

Campbell, I. H., Griffith, R. W. and Hill, R. I. 1989. Melting in the Archean mantle plume: heads it's basalt, tails it's komatiites . Nature, 339 , 697 - 699.

Carey, M. 1994. Some new aspect of Fanad granite,Country Donegal, Ireland.(abst). 4th.ann.thematic and research in progress meeting, V.S.G. Univ.of Liverpool.

Castro, A., Moreno-Ventas, I. and De La Rosa, J. D. 1991. H type (hybrid) granitoids : a proposed revision of the granite type classification and nomenclature. Earth Sci.Rev.,31 , 237 - 253.

Cawthorn, R. G. and Brown, P. A. 1976. A model for the formation and crystallisation of corundum-normative calc-alkaline magmas through amphibole fractionation. Jour.Geol., 84. 467 - 476.

Cawthorn. R. G. and O' Hara, M. J. 1976. Amphibole fractionation in calc-alkaline magma genesis. Am. Jour. Sci.,276 , 309 - 329.

Chappell, B. W. and Stephens, W. E. 1988. Origin of infracrustal (I-type) granite magmas. Trans. Roy. Soc. Edibn: Earth Sciences , 79 , 71 - 86.

Chappell, B. W. and White, A. J. R. 1974. Two contrasting granite types. Pacific Geol.,8. 173 - 174.

Chappell, B. W and White, A. J. R. 1984. I and S type granites in the Lachlan Fold Belt , southern Australia. In Xu Keqin and Tu Guangchi (eds): Geology of granites and their metallogenic relation, 87 - 101. Beijing Sci. Press.

Chappell, B. W. and White, A. J. R. 1992. I- and S- type granites in the Lachlan fold belt. Trans. Roy.Soc.Edibn:Earth Sciences,83, 1- 26.

Clarke. D. B. 1981. The mineralogy of peraluminous granites: A review. Can. Mineral.,19 . 3 - 17 .

Clarke, D. B. 1992. Granitoid Rocks. Chapman and Hall . 283 pp.

Cobbing, E. J., Pitfield, P. E. J., Darbyshire, D. P. F., and Mallick, D. I. J. 1992. The granites of the South-East Asian tin belt. Overseas Memoir 10, B.G.S.

Coleman, R. G. and Paterman, Z. E. 1975. Oceanic plagiogranite. Jour. Geophys. Res., 80 , 1099 - 1108.

Coleman, R. G. and Donato, M. M. 1979. Oceanic plagiogranite revisited. In F.Barker (ed.) : Trondhjemite, dacites and related rocks. Elsevier, Amsterdam , 149 - 165.

Collins, W.J., Beams, S.D., White, A.J.R. and Chappell, B.W. 1982. Nature and origin of A type granites with particular reference to south eastern Australia. Contrib.Mineral.Petrol., 80, 189 - 200.

Collins, W. J. and Vernon, R. H. 1992. Paleozoic arc growth , deformation and migration across the Lachlan fold belt, southeastern Australia. Tectonophys., 214 , 381 - 400.

Condie, K. C. 1989. Plate tectonics and Crustal evolution. 3rd ed. Pergamon Press. 476pp.

Cooper, A and Bruck, P. M. 1983. Tectonic relationship of the Leinster granite, Ireland. Geol. Jour., 18 . 351 - 360.

Cox, K. G., Bell, J. D. and Pankhurst, R. J. 1979. The interpretation of igneous rocks. George Allen and Unwin, London. 450 pp.

Dawes, R. L. and Evans, B. W. 1991. Mineralogy and geothermobarometry of magmatic epidote-bearing dikes, Front Range , Colorado. Geol. Soc. Am. Bull., 103., 1017 - 1031.

Debon, F. and LeFort, P . 1983. A chemical - mineralogical classification of common plutonic rocks and association. Trans. Royal Soc. Edinb. : Earth Sci., 73 ,135 - 149.

De la Roche, H., Leterrier, J., Grande Claude, P. and Marchal, M. 1980. A classification of volcanic and plutonic rocks using R1-R2 diagrams and major elements analyses - its relationship and current nomenclature. Chem. Geol., 29, 183 - 210.

Dempsey, C. S. 1987. The petrology and geochemistry of the Caledonian granitoids of the Barnsmore Complex, Country Donegal. Unpubl.PhD thesis , The Queen's Univ. of Belfast.

Dempsey, C. S., Halliday, A. N. and Meighan, I. G. 1990. Combined Sm-Nd and Rb-Sr isotope systematics in the Donegal granitoids and their petrogenetic implications. Geol. Mag., 127(1). 75 - 80.

Didier, J., Duthou, J.L and Lameyre, J. 1982. Mantle and crustal granites : genetic classification of orogenic granites and the nature of their enclaves. Jour. Volc. Geotherm.Res., 14. 125 - 132.

Dodge, F. C. W., Smith, V. C., and Mays, R. E.1969. Biotite from granitic rocks of the central Sierra Nevada batholith, California. Jour. Petrol., 10. 250 - 271.

Drummond , M.S. and Defant, M.J. 1990. A model for trondhjemite-tonalite-dacite genesis and crustal growth via slab melting: Archean to modern comparisons. Jour. Geophys.Res., 96 , 21503 - 21521.

Edmunds, W. M. 1969. A chemical and mineralogical study of pelitic hornfelses associated with certain granites of Co.Donegal with particular refrences to the paragenesis of garnet and biotite . Unpubl. PhD thesis, Univ. of Liverpool.

Eggleton, R. A. and Banfield, J. F. 1985. The alteration of granitic biotite to chlorite. Am.Mineral.,70. 902 - 910.

Evans, B.W. and Vance, J.A. 1987. Epidote phenocrysts in dacitic dykes, Boulder County, Colorado. Contrib.Mineral.Petrol., 96. 178 - 185.

Evans,D. and Whittington, R. J. 1976. The submarine extensions of the Thorr and Fanad plutons, County Donegal. Proc.R.Ir.Acad. 76B, 111 - 120.

Farrow, C. E. G. and Barr, S. M. 1992. Petrology of high Al hornblende and magmatic epidote bearing plutons in the southeastern Cape Breton Highlands, Nova Scotia. Can. Mineral., 30. 377 - 392.

Fernandez Davila, M. 1969. The petrology and mode of emplacement of the Rosguill pluton, Co. Donegal, Eire. Unpubl. MSc thesis, Univ.of Liverpool.

Fitch, F. J. and Miller, J. A. 1980. On the age of Donegal granite. Scot.Jour.Geol., 16.(4) , 315 - 320.

Foster ,M. D. 1960. Interpretation of the composition of trioctahedral micas. Prof.Pap. U.U. Geol. Surv., 354B,11 - 49

French, W. J. 1966. Appinitic intrusions clustered around the Ardara pluton,County Donegal. Proc.R.Ir.Acad., 64B, 303 - 322.

Gamil, A. S. 1991. Petrology and geochemistry of Shetland granites. Unpubl. PhD. thesis , Univ. of Liverpool.

Gaspar, J. C. and Wyllie, P. J. 1982. Barium phlogopite from the Jacupiranga carbonatite,Brazil. Am.Mineral., 67. 997 - 1000.

Gindy, A. R. 1951. The country rock and associated granites northeast of Gweebarra Bay,Country Donegal. Unpubl. PhD thesis ,Imperial College London.

Gindy, A. R. 1953. The plutonic history of the district around Trawenagh Bay ,Country Donegal. Q.Jour.Geol.Soc.Lond., 108 , 377 - 411.

Griffiths , R. W. and Campbell, I. H. 1990. Stirring and structure in mantle plumes. Earth Planet. Sci. Lett., 99, 66 - 78.

Green, D. H., Nicholas, I. A., Viljoen, M. and Viljoen, R. 1975. Experimental demonstration of the existence of peridotitic liquids in the earliest Archean magmatism. Geology, 3 , 11 - 14.

Green, D. H. and Wallace, M. E. 1988. Mantle metasomatism by ephemeral carbonatites melts. Nature, 336 , 459 - 462.

Gromet, L. P. and Silver , L. T. 1983. Rare earth element distributions among accessory minerals in a granodiorite and their petrogenetic implications. Geochim.Cosmochim. Acta 47, 925 - 939.

Hall, A. 1965a. The occurrence of prehnite in appinitic rocks from Donegal,Ireland. Min.Mag., 35 , 234 - 236.

Hall, A. 1965b. On a granite-metadolerite contact at Curran Hill, Co. Donegal, Ireland. Geol. Mag., 102, 531 - 537.

Hall, A. 1966a The alkali feldspar of the Ardara pluton, Donegal. Min. Mag., 35, 693 - 703.

Hall, A. 1966b. The petrogenetic study of the Rosses granite complex, Donegal. Jour.Petrol.,7 , 202 - 220

Hall, A. 1966c. The feldspar of the Rosses granite complex, Donegal. Min.Mag.,35, 975 - 982.

Hall, A. 1966d. The Ardara pluton: A study of the chemistry and crystallization of a contaminated granite intrusion. Proc. R. Irish Acad., 65B , 203 -235

Hall, A. 1967a. The variation of some trace elements in the Rosses granite complex, Donegal. Geol.Mag.,104, 99 - 109.

Hall, A. 1967b. The distribution of some major and trace element in feldspar from Rosses and Ardara granitic complex. Geochim. Cosmochim. Acta,31, 835 - 848

Hall, A. 1967c. The chemistry of appinitic rocks associated with the Ardara pluton, Donegal, Ireland. Contrib.Mineral.Petrol.,16, 156 - 171.

Hall, A. 1969. The mica of the Rosses granite complex. Sci. Proc. R. Dubl. Soc.,3, 209 - 217.

Hall, A. 1987. Igneous petrology. Longman. 573 pp.

Hall, A. 1993. The influence of secondary alteration on the ammonium content of granites, exemplified by the Rosses complex of Donegal. Min.Mag., 57, 591 - 598.

Hall, A. J. 1941. The relation between chemical composition and refractive index in the biotite. Am. Mineral., 26, 34 - 41.

Halliday, A. N. and Stephens, W. E. 1984. Crustal controls on the genesis of the 400 Ma old Caledonian granites. Phys.Earth.Planet.Interiors, 35 , 84 - 104.

Halliday, A. N., Aftalion, M. and Leake, B. E. 1980. A revised age of Donegal granites. Nature, 284 , 542 - 543.

Hanson, G.N. 1978 . The application of trace elements to the petrogenesis of igneous rocks of granitic composition. Earth Planet. Sci. Lett., 38, 26 - 43.

Hammarstrom, J. M. and Zen, E. A. 1986. Aluminium in hornblende: An empirical igneous geobarometer. Am. Mineral., 71, 1297 - 1313.

Harris, A. L. and Pitcher,W. S. 1975. The Dalradian supergroup. In A.L. Harris et al. (eds) ; A correlation of Precambrian rocks in the British Isles. Spec. Rep. Geol. Soc. Lond., 6, 52 - 75.

Harrison, T. N. and Hutchison. J. 1987. The age and origin of the Grampians Newer granites. Scot.Jour.Geol.,23 (3) , 269-282.

Harvey, J. T. T. 1969. Postmagmatic alteration in the Rosses granite complex, Donegal. Unpubl.PhD thesis, King's College London.

Haughton, S. 1862. Experimental researches on the granites of Ireland : Part III. On the granites of Donegal. Q. Jour. Geol. Soc. Lond., 18, 403 -420.

Hayama, Y. 1959. Some consideration of the colour of biotite and its relation to metamorphism. Jour. Geol. Soc. Japan, 65, 21 - 30.

Hellman, P. L . and Green, T. H. 1979.The role of sphene as an accessory phase in the high pressure partial melting of hydrous mafic composition. Earth planet. Sci.Lett., 42 , 191 - 201.

Heltz, R. T. 1976. Phase relations of basalt in their melting ranges at PH_2O = 5 kbar , Part 2, melt composition. Jour.Petrol.,17, 139 - 193.

Henderson, P. 1988. Inorganic geochemistry. Oxford, Pergamon , 312 pp.

Henderson, P. and Pankhurst, R. J. 1984. Analytical chemistry. In P. Henderson (ed) ; Rare earth element geochemistry. Elsevier, Amsterdam.

Hibbard, M. J. 1987. Deformation of incompletely crystallized magma system: granite gneisses and and their tectonic implications. Jour.Geol., 95 , 543 - 561.

Hill, R. I. 1991. Starting plumes and continental breakup. Earth planet. Sci. Lett., 104 , 398 - 416.

Hill, R. I., Campbell, I. H., Davies, G. F. and Griffiths, R. W. 1992a . Mantle plumes and continental tectonics. Science, 256 . 186 - 193.

Hill, R. I., Chappell, B. W. and Campbell, I. H. 1992b. Late Archean granites of the Southern Yilgarn Block, Western Australia: age, geochemistry and origin. Trans. Roy. Soc. Edinb: Earth Sciences, 83 , 211 - 226.

Holder, M. T, 1979. An emplacement mechanism for the post tectonic granites and its implication for their geochemical features. In M.P.Atherton and J.Tarney (eds) ; Origin of Granite batholith geochemical evidence. Shiva. 116 - 128.

Hollister, L. S., Grissom, G. C., Peters, E. K., Stowell, H. H. and Sisson, V. B. 1987. Conformation of the empirical correlation of Al in hornblende with pressure of solidification of calc-alkaline plutons. Am. Mineral., 72, 231 - 239.

Houseman, G. and England, P . 1986. A dynamical model of lithospheric extension and sedimentary basin formation. Jour. Geophys. Res., 91 , 719 - 726.

Hutton, D. H. W. 1979. Metadolerite age relationship in the Dalradian of Northwest Donegal,Ireland and their orogenic significance. Geol.Jour., 14, 171 - 177

Hutton, D. H. W. 1981. The structural setting of the main Donegal granites; a reply to comments on a recent interpretations . Geol. Jour.,16, 149 - 151.

Hutton, D. H. W. and Alsop, G. I. 1996. The Caledonian strike-swing and associated lineaments in the NW Ireland and adjacent areas: sedimentation, deformation and igneous intrusion patterns. Jour. Geol. Soc. Lond., 153 , 345 - 360.

Hutton, D. H. W., Aftalion, M. and Halliday, A. N. 1985. An Ordovician ophiolite in County Tyrone, Ireland. Nature, 315, 210 - 212.

Ingerson. E. 1952. Twinning fequency in feldspar phenocrysts from a quartz latite sill at Sierra Balanca, Texas. Am. Jour. Sci., (Bowen volume), 189 - 202

Ishihara, S. 1977. The magnetite series and ilmenite series granitic rocks. Mining Geol.,27, 293 - 305.

Jahns, R. H. and Burnham, C.W. 1969. Experimental studies of pegmatite genesis. I. A model for the derivation and crystallisation of granitic pegmatites. Econ.Geol., 64. 843 - 864.

Jahn, B. and Zhang, Z. 1984. Archean granulite gneisses from eastern Hebei Province, China: rare earth geochemistryand tectonic implication. Contrib. Mineral. Petrol., 85, 224 - 243.

Johnson, M. C. and Rutherford, M. J. 1989. Experimental calibration of the aluminium in hornblende geobarometer with application to Long valley Caldera,California volcanic rocks. Geology, 17, 837 - 841.

Kerrick. D. M. 1987. Fibrolite in the contacts aureoles of Donegal , Ireland: Am. Mineral., 72 , 240 - 254.

Kontak, D. J. 1991. The east Kemptville topaz-muscovite leucogranite, Nova Scotia. II . Mineral chemistry. Can.Mineral., 29, 37 - 60.

Knill, P. C. and Knill, J. L. 1961. Time relation between folding, metamorphism and emplacement of granite in Rosguill, Co.Donegal. Q.Jour.Geol.Soc.Lond.,117 , 273 - 302.

Khostova, V. A. 1961. On the isomorphism of epidote and allanite. Dokl. Acad. Sci. U.S.S.R. Earth Sci.,141, 1307 - 1309.

Lalonde, A. E. and Bernard, P. 1993. Composition and color of biotite from granites : two useful properties in the characterization of plutonic suites from the Hepburn internal zone of Wopmay orogen, Northwest Territories. Can. Mineral., 31 , 203 - 217.

Lameyre, J. and Bowden, P. 1982. Plutonic rock types series: discrimination of various granitoid series and related rocks. Jour. Volc. and Geotherm. Res.,14 , 169 - 186.

Lameyre, J., Black, R., Bonin, B., Bowden, P. and Giret, A. 1982. The granitic terms of converging plutonic type series and associated mineralization. In Xu Keqin and Tu Guangchi (eds) : Geology of Granites and Their Metallogenic Relations. Nanjing Uni. Sci. press Beijing, 241 - 253.

Leake, B. E. 1963. The location of the Southern Uplands fault in central Ireland. Geol.Mag., 100, 420 - 423.

Leake, B. E. 1974. The crystallisation history and mechanism of emplacement of the western part of the Galway granite, Connemara, western Ireland. Min.Mag., 39, 498 - 513

Leake, B. E. 1978. Nomenclature of amphiboles. Can. Mineral.,16. 501 - 520.

Leake, B. E. 1990. Granite magmas: their sources, initiation and consequences of emplacement. Jour. Geol. Soc. Lond.147. 579 - 589.

Le Bas, M. J. 1982. The Caledonian granites and dioritesof England and Wales. In D. S. Sutherland (ed) : Caledonian granites and diorites of Scotland and Ireland : Igneous rocks of the British Isles. John Wiley & Sons. 191 - 202

Leggo, P. J., Tanner, P. W. G., and Leake, B. E. 1969. Isochron study of Donegal granite and certain Dalradian rocks of Britain. In M. Kay (ed), North Atlantic - Geology and Continental drift. Mem. Am. Assoc. Petrol. Geol. 12. 354-362

Loiselle, M. C. and Wones, D.R. 1979. Characteristics and origin of anorogenic granites. Geol. Soc.Am.Abstr.with Progr.,11., 468.

Long, L. E. 1978. Rb-sr isotope systems in Caledonian granites, County Donegal, Ireland. In abstr. conf. The Caledonian of the British Isles-reviewed. 41-42.

Ludington, S. 1981. The Redskin granite: evidence for thermogravitational diffusion in a Precambrian granite batholith. Jour. Geophy. Res., 86 (B11), 10423 - 10430.

MaCall, G. J. H. 1954. The Dalradian geology of the Creeslough area, County Donegal. Q. Jour. Geol. Soc. Lond. 110, 153-73.

Mahawat, C., Atherton, M. P. and Brotherton, M. S. 1989 . The Tak Batholith: contrasting granites types and implication for tectonic setting. Jour. Southeast. Asian Earth Sci., 4, 11 - 27.

Mahood, G.A. and Hildreth, W . 1983. Large partition coeffients for trace elements in high silica rhyolites. Geochim. Cosmochim. Acta. 47 . 2537 - 2545.

Mahood, G. A., Nibler, G. E. and Halliday, A. N. 1996. Zoning patterns and petrologic processes in peraluminous magma chambers: Hall canyon pluton, Panamint Mountains, California. Geol.Soc.Am.Bull. 108(4) , 437 - 453.

Mansker, W. L., Ewing, R. C., and Keil ,Klaus. 1979. Barian-titanian biotites in nephelinites from Oahu, Hawaii. Am. Mineral.,64, 156 - 159.

Mason, G. H. 1982.The mineralogy and textural history of the Coastal Batholith , Peru. Unpubl.PhD thesis , Univ.Of Liverpool

Mason, G. H. 1985. The mineralogy and textures of the Coastal batholith, Peru. In W. S. Pitcher., M. P. Atherton., E. J. Cobbing and R. D. Beckinsale (eds). Magmatism at a plate edge : the Peruvian Andes. Blackie Glasgow , 156 - 166

Masuda, A., Nakamura, N. and Tanaka, T. 1973. Fine structures of mutually normalized rare-earth patterns of chondrites. Geochim. Cosmochim. Acta. 38. 239 - 248.

McKerrow, W. S. and Soper, N. J. 1989. The Iapetus suture in the British Isles. Geol. Mag.,126(1) , 1 - 8

Mercy, E. L. P. 1956. The geochemistry of part of the Donegal granite, Co.Donegal, Eire. Unpubl.PhD thesis , Imperial College, London

Mercy, E. L. P. 1960a. The geochemistry of the Older Granodiorite, Co. Donegal. Trans. R. Soc. Edinb.,64, 101- 127

Mercy, E. L. P. 1960b. The geochemistry of the Rosses ring complex Co. Donegal, Ireland. Trans. R. Soc. Edinb.,64, 128 - 138

Mercy, E. L. P. 1963. The geochemistry of some Caledonian granitic and metasedimentary rocks. In M. R. W. Johnson and F.H. Stewart (eds) : The British Caledonides. Oliver and Boyd. London.188 - 215.

Mercy, E. L. P. 1962 . The Mullaghduff porphyry dykes. Trans. Edinb. Geol. Soc., 19, 65-82.

Micheal, P. J. 1983 . Chemical differentiation of the Bishop tuff and other high silica magmas through crystallisation processes . Geology , 11, 31- 34.

Miller, C. F., Stoddard, E. F., Bradfish, L. J. and Dollase, W. A. 1981. Composition of plutonic muscovite: genetic implications. Can. Mineral., 19(1) , 25 - 34.

Molyneux, S. J. and Hutton, D. H. W. 1995. The Ardara pluton, Co. Donegal. NW Ireland : A straightfoward example of ballooning pluton. Abstr. Third Hutton symposium , The origin of granites and related rocks . Univ of Maryland

Moseley, F. 1982. Introduction to part 2 : Lower Paleozoic volcanic environments in the British Isles. In D. S. Sutherland (ed) , Igneous rocks of the British Isles. John Wiley . 39 - 44.

Muecke, G. K. and Clarke, D. B. 1980. Rare earth element geochemistry of the South Mountain Batholith, Nova Scotia. Geol. Soc. Can. Abstr. Prog. 5, 72

Muecke, G. K. and Clarke, D. B. 1981b. Geochemical evidence of the South Mountain Batholith, Nova Scotia: Rare earth element evidence. Can. Mineral. 19, 133 - 145.

Murphy, F. C. 1987. Late Caledonian granitoids and timing of deformation in the Iapetus suture zone of eastern Ireland. Geol. Mag., 124 (2), 135 - 142.

Nabelek, C. R. and Lindlsley, D. H. 1985. Tetrahedral Al in amphibole: a potential thermometer for some mafic rocks. Geol. Soc. Am. Abstr with Prog. 17, 673.

Nadin, P. A., Kusznir, N. J. and Toth, J . 1995. Transient regional uplift in the early Tertiary of the northern North Sea and the develpoment of the Iceland Plume. J. Geol. Soc. Lond., 152 . 953 - 958.

Naggar, M. H. and Atherton, M. P. 1970. The composition and metamorphic history of some aluminium silicate-bearing rocks from the aureoles of the Donegal granites. Jour.Petrol.,11 , 549-589.

Naney. M. T. 1983. Phase equilibria of rock-forming ferromagnesian silicates in granitic systems. Am.Jour.Sci., 283. 993 - 1033

Nash,W. P. and Crecraft, H.R. 1985. Partition coefficients for the trace elements in silicic magmas. Geochim. Cosmochim. Acta, 49. 2309 - 2322,

Nishimoto, S., Suzuki, Y. and Miyano, T. 1991. Texture and zonal structure of K-feldspar phenocryst from granitic rocks in the Tsukuba district. Ann. Rep. Inst. Geosci. Univ. Tsukuba, 17., 79 - 84.

Nur, A. and Boccaletti, M. 1989. Active and recent strike-slip tectonics. EOS, Transect. Am. Geophys. Union, 70. 806.

Obaid, T.M.S. 1967. Certain minor intrusions in County Donegal. Unpubl. PhD thesis, Univ. of Liverpool.

O'Brien, C.,Plant, J. A.,Simpson, P. R. and Tarney, J. 1985. The geochemistry, metasomatism and petrogenesis of the granites of the English Lake district. J. Geol. Soc. Lond., 142 , 1139 - 1157.

O'Connor, J.T. 1965. A classification of quartz rich igneous rock based on feldspar ratios. U. S. Geol. Surv. Prof. Paper., 525B, **B79-B84.**

O'Connor,P.J. 1990. Geochemical aspect of desilication in the Barnesmore complex,Co.Donegal. Geol. Surv. Ire. Bull., 4(3)., 211 - 215.

O Connor, P. J., Long, C. B. and Evans, J. A. 1987. Rb-Sr whole rock isochron studies of the Barnesmore and Fanad plutons, Donegal, Ireland. Geol. Jour., 22, 11 - 23.

O'Connor, P.J., Long, C. B., Kennan, P. S., Halliday, A. N., Max, M. D. and Roddick, .J. C. 1982. Rb-Sr isochrons study of the Thorr and Main Donegal granites,Ireland. Geol.Jour., 17, 279 - 295.

Oglethorpe, R. D. J. 1987. A mineralogical and chemical study of the interaction between granite magma and pelitic country rock, Thorr pluton, Co. Donegal, Eire. Unpubl. PhD thesis, Univ. of Liverpool.

Oliver,H.W.1980. Interpretation of the gravity map of the California and its continental margin . Cal. Div. Mines and Geol. Bull., 205.

Orsini.B.1976. Les granitoides hercyniens corso-sardes: mise en evidence de deux associations magmatiques. Bulletin de la Societe Geologique de France, 18 ,1203 - 1206.

Pagel,M and Leterrier, J. 1980. The subalkaline potassic magmatism of the Ballons massif (Southern Vosges,France): shoshonitic affinity. Lithos., 13, 1 - 10.

Pankhurst, R.J. 1979. Isotope and trace element evidence for the origin and evolution of Caledonian granites in the Scottish Highlands . In M.P. Atherton and J.Tarney (eds) : Origin of granite batholiths : Geochemical evidence. Shiva. 18 - 33.

Pankhurst, R. J. and Sutherland, D. S. 1982. Caledonian granites and diorites of Scotland and Ireland. Caledonian granites and diorites of Scotland and Ireland. In D.S.Sutherland (ed) : Igneous rocks of the British Isles . John Wiley & Sons. 149 - 190.

Peacock, M.A. 1931. Classification of igneous rock series. Jour. Geol.,39, 54 - 67

Pearce, J. A., Harris, N. B. W. and Tindle, A. G. 1984. Trace elements discrimination diagrams for the tectonic interpretations of granitic rocks. Jour. Petrol.,25(4) ,956 - 983.

Peccerillo, A. and Taylor, S. R. 1976. Geochemistry of Eocene calc-alkaline volcanic rocks from the Kastamona area, northern Turkey. Contrib. Mineral. Petrol., 58, 63 - 81.

Phillips, W. E. A., Stillman, C. J. and Murphy, T. 1976 . A Caledonian plate tectonic model. J. Geol. Soc. Lond., 132, 579 - 609.

Pitfield, P. E. J., Teoh, L. H. and Cobbing, E. J. 1990. Textural variation and tin mineralization in granites from the Main Range province of the southeast Asia tin belt. Geol. Jour.,25 , 419 - 430.

Pitcher, W. S. 1953a. The migmatitic older granodiorite of Thorr district, County Donegal .Q. Jour. Soc. Lond.,108. 413 - 446.

Pitcher, W. S. 1953b . The Rosses granitic ring-complex , County Donegal , Eire. Proc.Geol.Assoc., 64. 153- 182.

Pitcher, W. S. 1970 . Ghost stratigraphy in intrusive granite: a review. G.Newall and N.Rast (eds) : In Mechanism of Igneous Intrusion . Geol.Jour. Spec. Issue (2) , Gallery Press , 123 - 140.

Pitcher. W. S. 1979. The nature, ascent and emplacement of granitic magmas. J.Geol. Soc.Lond.,136., 627 - 662

Pitcher, W. S 1983. Granite type and tectonic environment. In K. Hsu (ed): Mountain building processes. Academic Press, London. 19 - 40.

Pitcher. W. S. 1987. Granites and yet more granite forty years on. Geol. Rundsch., 76. 51 - 79.

Pitcher, W. S. 1991. Synplutonic dykes and mafic enclaves. In J. Didier and B. Barbarin (eds) : Enclaves and granite petrology. Elsevier , 383 - 391.

Pitcher, W. S. 1993. The nature and origin of granite. Blackie Academic. 321 pp

Pitcher, W. S . and Berger, A. R. 1972. The geology of Donegal: A study of granite emplacement and unroofing. Wiley Interscience, London. 435 pp

Pitcher. W. S. and Bussell, M. A.1985. Andean dyke swarms: andesite in synplutonic relationship with tonalite : In W. S. Pitcher, M. P. Atherton., E. J. Cobbing and R. D. Beckinsale (eds) : Magmatism at a plate edge : the Peruvian Andes. Blackie Glasgow , 93-101.

Pitcher ,W. S. and Read, H. H. 1959. The Main Donegal granite. Q.Jour. Geol. Soc. Lond., 114, 259 - 305.

Pitcher, W. S. and Read, H. H. 1960. Early tranverse dykes in the Main Donegal granite. Geol. Mag. 97. 53 - 61.

Poldervaart, A. 1950. Statistical studies of zircon as a criterion in granitization, Nature 165 , 574 - 575.

Poldervaart, A. 1956. Zircon in rocks. 2. - Igneous rocks. Am. Jour. Sci., 254. 521 - 554.

Potts, G. J., Hunter, R. H., Harris, A. L. and Fraser, F. M. 1995 . Late orogenic extensional tectonics at the NW margin of the Caledonides in Scotland. J.Geol.Soc.London. 152, 907 - 910.

Pulvertaft, T. C. R. 1961. The Dalradian successions and their relationship in the Churchill district of county Donegal. Proc.R.Irish Acad. 61B , 255 - 273.

Pupin, J. P. 1980. Zircon and granite petrology. Contrib. Mineral. Petrol., 73. 207 - 220.

Read, H. H. 1961 Aspect of Caledonion magmatism in Britain. Liverpool Manchester. Geol. Jour., 2, 653 - 683.

Rickwood, P. C. 1989. Boundary lines within petrologic diagrams which use oxides of major and minor elements. Lithos., 22, 247 - 263.

Roberts, M. P. and Clemens, J. D. 1993. Origin of high-potassium, calc alkaline , I type granitoids. Geology, 21, 825 -828.

Roberts, M. P. and Clemens, J. D. 1994. Low pressure stability of magmatic epidote in granitoid plutons : field and experimental evidence. (abstr). 4th.ann.thematic and research in progress meeting. V.S.G. Univ.of Liverpool.

Rollinson, H. R. 1993. Using geochemical data : evaluation, presentation and interpretation. Longman. 352 pp.

Rudnick, R. L. and Taylor, S. R. 1986. Geochemical constraints on the origin of Archean tonalitic-trondhjemitic rocks and implications for lower crustal composition. In , J.B. Dawson, D.A.Carswell, J.Hall, and K.H. Wedepohl (eds) ; The nature of the lower continental crust. Geol. Soc. Spec. Publ.,24, 179 - 191.

Sawka, W. N., Chappell, B. W. and Norrish, K .1984. Light-rare-earth-element zoning in sphene and allanite during granitoid fractionation. Geology, 12, 131-134

Sawka, W. N., Heizler, M. T., Kistler, R. W. and Chappell, B. W. 1990. Geochemistry of highly fractionated I and S type granites from the tin- tungsten province of western Tasmania : In H.J. Stein and J.L. Hannah (eds) ; Ore bearing granite systems : Petrogenesis and mineralizing processes , Geol. Soc. Am. Special paper 246, 161 -179.

Schmidt, M.W. 1992. Amphibole composition in tonalite as a function of pressure : an experimental calibration of the Al in hornblende barometer. Contrib.Mineral.Petrol., 110. 304 - 310.

Scott, P. 1974 .The Thorr Granodiorite,Co.Donegal, Eire: A study of a contaminated pluton. Unpubl. MSc thesis, Univ. of Liverpool.

Shand, S. J. 1943. Eruptive rocks. T Murby and Co., London, 2nd edn., 444 pp.

Shelley, D. 1992. Igneous and metamorphic rocks under microscope: Classification, textures, microstructures and mineral preferred orientations. Chapman and Hall. 445 pp.

Sheraton, J. W. and Black, L. P .1983. Geochemisrty of Precambrian gneisses : relevance for the evolution of the east Antartica sheild. Lithos., 16 , 273 - 296.

Silver, L. T. and Chappell, B. W. 1988. The Peninsular Ranges batholith: an insight into the evolution of the Cordilleran batholiths of the southwestern North America. Trans. Roy. Soc. Edibn. : Earth Sciences , 79, 105 - 121.

Simpson, C . and Wintsch, R. P. 1989. Evidence of deformation induced K-feldspar replacement by mymerkite. Jour. Metamorph. Geol.,7, 261 - 275.

Smethurst, M. A. and Briden, J. C. 1988. Paleomagnetism of Silurian sediments in W. Ireland : evidence for block rotation in the Caledonides. Geophysical Jour., 95 , 327 - 346.

Soper, N. J. 1986. The Newer granite problem : a geotectonic view. Geol.Mag.,123(3) , 227 - 236.

Soper, N. J. and Hutton, D. H. W. 1984. Late Caledonian sinistral displacement in Britain.: implication for a three plate collision model. Tectonics, 3, 175 - 192.

Soper, N. J., Webb, B. C. and Woodcock, N. H. 1987. Late Caledonian (Acadian) transpression in NW England: timing, geometry and geotectonic significance. Proc. Yorkshire. Geol. Soc., 46 , 175 - 192.

Soper, N. J., Strachan, R. A., Holdsworth, R. E., Gayer, R. A. and Greiling, R. O. 1992. Sinistral transpression and Silurian closure of Iapetus. Jour. Geol. Soc. Lond., 149 , 871 - 880.

Speer, J. A.1984. Micas in igneous rocks. Mineralogy Soc. of America Rev. in Mineralogy, 13, 229 - 356.

Streckeisen, A.L. 1967. Classification and nomenclature of igneous rocks. Neues. Jahrb. Mineral. Abh.,107 , 144 - 240.

Streckeisen, A. L. 1976. To each plutonic rock its proper name. Earth Sci. Rev.,12 , 1 - 33.

Streckeisen. A. L. and Le Maitre, R. W. 1979. A chemical approximation to the modal QAPF classification of igneous rocks. Neues. Jahrb. Mineral. Abh., 136 , 169 - 209.

Stephens, W. E. and Halliday, A. N. 1984. Geochemical contrasts between late Caledonian granitoid plutons of northern, central and southern Scotland. Tran. Roy. Soc. Edibn. : Earth Sciences , 75 , 259 - 273.

Stephens, W. E., Whitley, J. E., Thirwall, M. F. and Halliday , A. N. 1985. The Criffell zoned pluton. : correlated behaviour of rare earth element abundances with isotopic systems. Contrib. Mineral. Petrol., 89 , 226 - 238.

Stone, P. 1984. Constraints for genetic models for the Ballantrae complex, SW Scotland. Trans. Roy. Soc. Edibn. : Earth Sciences 75, 189 -191.

Stone, M., Exley, C. S. and George. M. C. 1988. Compositions of tri- octahedral micas in the Cornubian batholith. Min.Mag., 52, 175 - 192.

Sweetman, T. M. 1987. The geochemistry of the Blackstairs Unit of the Leinster granite, Ireland. Jour. Geol. Soc. Lond., 144 , 971 - 984.

Takahashi, M., Aramaki, S. and Ishihara, S. 1980. Magnetite-series/ Ilmenite-series vs I-type/S-type granitoids. Mining Geol. Spec. Issue, 8 , 13 - 28.

Tarney, J. and Jones, C.E. 1994. Trace element geochemistry of orogenic igneous rocks and crustal growth models. Jour. Geol. Soc. Lond., 151, 855 - 868.

Thirlwall,M. F. 1981. Implications for Caledonian plate tectonic models of chemical data from volcanic rocks of the British Old Red Sandstone. Jour. Geol. Soc. Lond.,138 , 123 - 138.

Thirlwall,M. F. 1983. Isotope geochemistry and origin of calc alkaline lavas from a Caledonian continental margin volcanic arc. Jour. Volc. Geotherm. Res., 18, 589 - 631.

Thompson, R. N. 1982. Magmatism of the British Tertiary province. Scot. Jour. Geol.,18, 49 - 107.

Tindle,A.G. 1981. Petrogenesis of the Loch Doon granitic intrusion, Southern Uplands of Scotland. Unpubl. PhD thesis , Open University.

Tindle,A.G. and Pearce,J.A. 1981. Petrogenetic modelling of in situ fractional crystallisation in the zoned Loch Doon pluton, Scotland. Contrib.Mineral.Petrol.,78, 196 - 207.

Tischendorf, G. and Palchen, W. 1985. Zur klassifikation von granitoiden. Z. Geol. Wiss. Berlin, 13 , 615 - 627

Tulloch. A. J. 1979. Secondary Ca-Al silicates as low grade alteration products of granitoid biotite. Contrib. Mineral. Petrol. 69. 105-117.

Twist, D. and Jock Harmer, R. E. 1987. Geochemistry of contrasting siliceous magmatic suites in the Bushveld Complex : genetic aspects and implications for tectonic discrimination diagrams. Jour.Volc. Geotherm. Res., 32 , 83 - 98

Vance,J.A. 1961. Zoned granitic intrusions - an alternative hypothesis of origin. Geol.Soc.Am.Bull.,72, 1723 - 1728.

Vance.J.A. 1969. On synneusis. Contrib. Mineral. Petrol., 24. 7 - 29.

Varva, G. 1994. Systematic of internal zircon morphology in major Variscan granitoids types. Contrib. Mineral. Petrol., 117, 331 - 344.

Vernon, R. H. 1986. K feldspar megacrysts in granites - phenocrysts , not porphyroblasts. Earth Sci. Rev., 23, 1 - 63.

Vernon, R. H. 1991. Question about mymerkite in deformed rocks. Jour. Struct. Geol., 13 (9) , 979 - 985.

Vollbrecht, A. Rust, S. and Weber, K. 1991. Development of microcracks in granites during cooling and uplift: examples from the Variscan basement in NE Bavaria, Germany. Jour. Struct. Geol.,13 , 787 - 799.

Wadsworth, W.J. 1982. The basic plutons. In D.S.Sutherland (ed) ; Igneous rocks of the British Isles , John Wiley & Sons, 135 - 148.

Walker, G. P. L and Leedal, G. P. 1954. The Barnesmore granite complex, Co. Donegal. Sci. Proc. R. Dubl. Soc., 26, 207 - 243.

Warren, R, G. and Ellis, D. J. 1996. Mantle underplating , granite tectonics and metamorphic P-T-t paths. Geology , 24(7) , 663-666.

Watson, J. V . 1984. The ending of the Caledonian orogeny in Scotland. J. Geol. Soc. Lond.,141, 193-214.

Watson, E. B. and Harrison, T. M. 1983. Zircon saturation revisited: temperature and compositional effects in a variety of crustals magma types. Earth Planet Sci.Lett., 64 , 295 - 304.

Weaver, B.L. and Tarney, J. 1980. Rare earth geochemistry of Lewisian granulite facies gneisses, northwest Scotland : implication for the petrogenesis of the Archean lower continental crust. Earth Planet. Sci. Lett., 51, 279 - 296.

Weiss, S. and Troll, G. 1989. The Ballachulish igneous complex, Scotland. Petrography, mineral chemistry and order of crystallisation in the monzodiorite-quartz diorite suite and in the granite. Jour. Petrol. 30 (5), 1069-1115.

Whalen, J. B. 1983. The Ackley City batholith, southeastern Newfound- land : evidence for crystal versus liquid state fractionation. Geochim. Cosmochim. Acta, 47, 1443 - 1457.

White, A. J. R. 1979. Sources of granite magmas. Geol. Soc. Am. Abs. with Prog. 11, 539.

White, A. J. R. and Chappell, B. W. 1983. Granitoid types and their distributions in the Lachlan Fold Belts; southeastern Australia. In J.A.Roddick (ed) ; Circum Pacific plutonic Terranes, Geol.Soc. Am. Mem., 159, 21 - 34.

White, A. J. R. and Chappell, B. W. 1988. Some supracrustal (S-type) granites of the Lachlan Fold Belt. Trans. Roy. Soc. Edinb., 79 , 169 - 181.

Whitten,E.H.T. 1953. The geology of the metamorphic and plutonic rocks of the Gweedore area, Co. Donegal ,Eire. Unpubl.PhD thesis, Queens Mary ,London.

Whitten,E.H.T. 1955. Metasediments of Bunbeg (country Donegal) and their relationship to the surrounding granite. Proc. Geol. Assoc., 66 , 51 - 67.

Whitten,E.H.T. 1957. The Gola granite (country Donegal) and its regional setting. Proc.R.Irish Acad. 58B , 245 - 292.

Whitten,E.H.T. 1959. Compositional trends in a granite: modal variation and ghost stratigraphy in part of the Donegal granite Eire. Jour. Geophys. Res., 64 , 835 - 848.

Whitten,E.H.T. 1961. Quantitative areal modal analysis of granitic complexes. Bull. Geol. Soc. Am., 72. 1331- 1360.

Whitten,E.H.T. 1966. Quantitative models in the economic evaluation of rocks unts : illustrated with the Donegal granite and gold bearing Witwatersrand conglomerates. Trans. Inst. Min. Metal. 75B. 181 - 198.

Wright, A. E. and Bowes, D. R. 1979. Geochemistry of appinite suite. In Harris,A.L., Holland , C.H. and Leake,B.E. (eds) The Caledonides of the British Isles - Reviewed. Spec. Publ. Geol.Soc. Lond. 8 , 699 - 703

Wyllie, P . J., Cox, K. G. and Biggar, G. M. 1962. The habit of apatite in synthetic systems and igneous rocks. Jour. Petrol., 3 , 238 - 243.

Yarr. T. R. 1991. A petrological study of the appinite suite associated with the Ardara pluton, Co. Donegal, Ireland. PhD thesis, Univ. St Andrews, Scotland.

Young. D. G. G. 1969. The gravity anomaly map of county Donegal. Geophys. Bull. Dubl. Inst. Adv. Stud., 26 , 6 p.

Zen, E. 1988. Phase relations of peraluminous granitic rocks and their petrogenetic implications : Ann.Rev.Earth and Planet. Sci., 16 , 21 - 51.

Zen, E., and Hammarstrom,J.M. 1984. Magmatic epidote and its petrologic significance. Geology, 12, 515-518.