THE PETROLOGY, GEOCHEMISTRY AND TECTONIC SETTING OF BASIC VOLCANICS ON THE STUART SHELF AND IN THE ADELAIDE GEOSYNCLINE, SOUTH AUSTRALIA.

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ABSTRACT

In 1980, Von der Borch suggested that the Adelaide Geosyncline formed as a result of a rift initiated in the late Proterozoic. In 1984, Gunn added further to the idea, and proposed that the Roopena Volcanics represented alkaline igneous activity associated with the initial doming phase. The basaltic lavas of Depot Creek, Port Pirie, Wooltana, the Adelaide Geosyncline, and the Beda Volcanics represent tholeiitic flood basalts from a later rifting stage, with the Gairdner Dyke Swarm acting as feeder dykes to the basalts.

In hand specimen the volcanics look very similar, i.e. red-brown to green-grey fine grained vesicular basalts, but in thin section they are quite different. The Beda Volcanics are merocrystalline with an intersertal texture, the main mineral being plagioclase with small patches of subophitic augite (maximum 10%). The Gairdner Dyke Swarm rocks consist of either fine grained, curved branching augite with coarse laths of plagioclase and phenocrysts of olivine set in an iron rich glass, or coarser grained holocrystalline ophitic rocks. The Depot Creek volcanics have a fine grained intersertal texture, consisting of potassium feldspar and recrystalised glass. The Port Pirie Volcanics are interbedded with both Callanna Group and Emeroo Subgroup sediments. The Emeroo Volcanics are intersertal fine grained rocks containing potassium feldspar and minor pyroxene set in an iron rich glassy ground mass. The Callanna Volcanics are subophitic in texture.

Geochemically all the volcanics except the Port Pirie Volcanics are very similar, with the Beda Volcanics and Gairdner Dyke Swarm being the most fractionated. Magma chamber fractionation simulation studies suggest that the Gairdner Dykes were extruded from a crustal magma chamber of much greater depth, but the similar geochemistry suggests they may have stemmed from the same mantle magma chamber as the other volcanics. Geochemical discrimination diagrams indicate the volcanics are tholeiitic continental flood basalts, and this is reinforced by using a spidergram plot developed by Pearce (1979). Comparison of these volcanics with volcanics from the Central Karoo Province and northern Utah and southeastern Idaho on spidergrams show very similar trace element patterns.

The basic volcanics of Depot Creek, Wooltana, and the Beda Volcanics, along with the Gairdner Dyke Swarm represent co-magmatic tholeiitic igneous activity associated with the Spencer Gulf rift. The more enriched Port Pirie volcanics were extruded at a later stage of the reactivation of the rift.

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Chapter 1 INTRODUCTION

1.1 GEOLOGICAL BACKGROUND

Sedimentation was initiated on the Stuart Shelf and in the Adelaide Geosyncline between 1200 and 1100 Ma. The sedimentary sequence derived from a series of marine regressions and transgressions over a period of 500 - 600 million years. During this period there were several episodes of basic volcanism.

The Stuart Shelf overlies the Gawler Craton, the crystalline basement that became stabilized in the late Precambrian prior to 1400 ma (Thompson, 1975). The shelf consists of gently folded, relatively thin Adelaidean and Cambrian cover. A north trending belt of fractures, the Torrens Hinge Zone, divides the Stuart Shelf to the west from the Adelaide Geosyncline to the east. The geosyncline contains a thick sequence of Adelaidean and Cambrian cover, the stratotype of the Adelaidean time period, which underwent intense folding in the Delamarian orogeny (Ordovician time) (Thompson *et al..*, 1976).

1.2 STATEMENT OF THE PROBLEM

Major mapping and geophysical surveys of the Adelaide Geosyncline have shown that its floor is shattered by a series of intersecting fractures and shears (Thompson, 1965). In 1980, Von der Borch suggested the Adelaide geosyncline was formed as a result of a rift instigated in the late Proterozoic. Bouger gravity maps show a three arm gravity ridge extending along the Muloorinna Ridge to the northwest, and paralleling the Willyama Domain to the east. The main axis of the rift extends north-south through the Adelaide Geosyncline. Such gravity anomalies have been interpreted by Halls (1978) in the North American Rift System as zones of dense mafic intrusive rocks (axial dykes) emplaced through thinned continental crust in the central graben of the rift system. Von der Borch (1980) interpreted a similar situation in South Australia. The Adelaide Geosyncline was the main depositional basin of the rift, with a minor basin forming to the west - the Stuart Shelf.

The Roopena Volcanics are the upper-most basement sequence underlying the Stuart Shelf, and are composed of basic and rhyolitic volcanics. It has been proposed that the earliest sequence deposited in the rift environment is the Callanna group, defined as evaporitic, dolomitic, carbonated, black shales and quartzarenites interbedded with basic volcanics (Von der Borch, 1980).

In 1984, Gunn summarized the above suggestion. He then proposed that the Roopena Volcanics represented the alkaline igneous activity associated with the initial doming phase of the rift. He also suggested that the basaltic lavas of Depot Creek, Wooltana, the Adelaide Geosyncline and the Beda Volcanics represented tholeiitic flood basalts from the later rifting stage, with the Gairdner Dyke Swarm acting as feeder dykes to these basalts (see Figure 1 for location). However, at that stage no work had been done on these volcanics to determine their igneous nature and their possible tectonic origin. The objective, therefore, is to determine if the volcanics did form as a result of the proposed rift.

1.3 METHODS

Study of the upper Proterozoic volcanics of the Stuart Shelf and Adelaide Geosyncline has been conducted via:-

1. Geological mapping of Backy Point and Douglas Point on Eyre Peninsular, South Australia on a scale of 1:3500.
2. Sampling and logging of drill core over most of the Stuart Shelf.
3. Collection of all known geochemical data on the volcanics in question.
4. The use of various geochemical comparison graphs to determine the tectonic setting of the volcanics, and to make comparisons within suite, between suite, and between the volcanics and other known rift related volcanics.

1.4 AIM

The aim of this thesis is to compare and contrast the geochemistry of the late Proterozoic volcanics of the Stuart Shelf and Adelaide Geosyncline to determine if they have similar characteristics and suggest their tectonic setting.

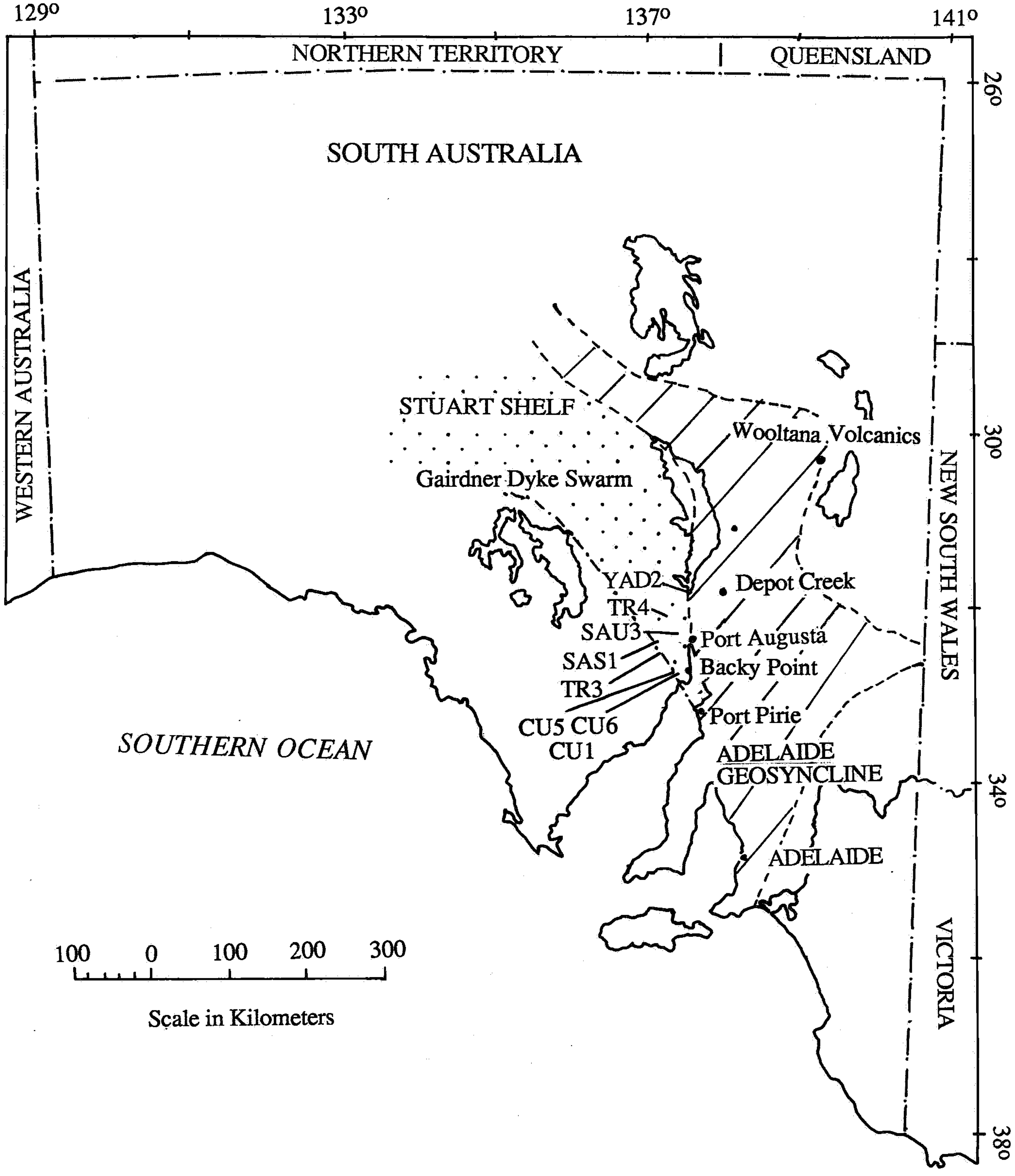


FIGURE 1 Location Map

Chapter 2 GEOLOGY

2.1 REGIONAL GEOLOGY

2.1.1 INTRODUCTION

The Adelaide Geosyncline is the stratotype for the Adelaidean period, in which the Precambrian sediments of the geosyncline and Stuart Shelf were deposited. The Adelaide system has been divided chronostratigraphically into the Torrensian, Sturtian and Marinoan ages by Mawson and Sprigg (1950), and the older Willouran age by Sprigg (1952). As the above ages were thought to be inadequate, the system has since been divided into four lithostratigraphic units: the Callanna Group of Willouran age; the Burra Group, which includes rocks of Torrensian, Torrensian/Sturtian boundary and the earliest Sturtian age; the Umberatana Group follows this with Sturtian to early Marinoan age rocks, and includes all the glaciogenic sediments of the Adelaidean succession; and the Wilpena Group of the late Marinoan age, which includes all the later sediments until the beginning of the Cambrian.

This work concentrates on the volcanics and sediments of Willouran and Torrensian age on the Stuart Shelf and in the Adelaide Geosyncline.

2.1.2 ADELAIDE GEOSYNCLINE STRATIGRAPHY

The Adelaide Geosyncline has a near continuous stratigraphic record during the Adelaidean period with only minor hiatuses (Figure 2).

2.1.2.1 The Callanna Group

The Mount Painter region was chosen as the stratotype of the lower Callanna Group. The basal member is the Paralana Quartzite which is a clean, cross bedded, pebbly quartzite, heavily laminated in parts with minor siltstones. It has been suggested that it formed under shallow marine conditions (Rutland *et al.*, 1981).

The overlying conformable Wywana formation consists of calcite and dolomite marble, calcsilicates and minor siltstones. They are overlain by the Wooltana Volcanics (Rutland *et al.*, 1981). In the late Willouran age, sedimentation was restricted to the Adelaide Geosyncline and consisted of carbonaceous and laminated pyritic siltstones and shales, which suggests a low energy evaporitic or tidal flat to subtidal basin.

2.1.2.2 The Burra Group

The Torrensian sedimentation commenced with the Aldgate Sandstone in the Adelaide region, which is a widespread transgressive clastic deposit. The equivalent in the

Flinders Ranges is called the Emeroo Quartzite, which overlies the Depot Creek Volcanics and is interbedded with the Port Pirie Volcanics. It consists of a lower heavily banded conglomeratic feldspathic siltstone overlain by a more mature feldspathic quartzite. These two units are separated by a silty micaceous sandstone with salt casts.

2.1.3 STUART SHELF STRATIGRAPHY

The record of sedimentation on the Stuart Shelf is not nearly as complete as that of the Adelaide Geosyncline (Figure 2).

2.1.3.1 The Pandurra Formation

The Pandurra Formation consists of cross bedded lithic sandstones and quartzites, with minor siltstones, mostly derived from the erosion of the Gawler Range Volcanics on the Gawler Craton (Mason *et al.*, 1978). It has been suggested that it was deposited in a fluvial environment on down faulted older Precambrian rocks. The Gairdner Dyke Swarm intrudes the Pandurra Formation.

The age of the Pandurra Formation has provided some controversy. It was interpreted by Thompson (1980) as basal Adelaidean. The Pandurra Formation overlies the Roopena Volcanics dated by Compston (in Compston *et al.*, 1966) to be 1345 +/- 30ma, but Webb (in Webb *et al.*, 1982) dated them at 1256 +/- 120 ma. The Beda Volcanics unconformably overlie the Pandurra formation, and have been dated by Webb and Coates in 1980 to be 1076 +/- 34 ma. This gives an inferred age of formation between 1345 and 1076 ma. Fanning, Flint and Preiss (1983) dated the Pandurra Formation by Rb-Sr at 1425 +/- 51 ma which is outside the possible time of deposition. The date arouses two possibilities:- the Roopena Volcanics were extruded at the same time as the Gawler Range Volcanics (about 1500 ma), and the Pandurra Formation is a result of erosion of the Gawler Ranges, or the date represents the age of the original rock that produced the clastic sediment. It is now considered by many authors (Preiss, 1983) to be a pre-Adelaidean sequence.

2.1.3.2 The Callanna Group

The Callanna Group is represented on the Stuart Shelf by the Backy Point Beds, which unconformably overlie the Pandurra Formation. They consist of buff and pink litharenites and conglomerates, with clasts of granite and acid volcanics. Some of the beds have been tourmalinized and haematised. The Backy Point Beds intertongue with the Beda Volcanics.

2.1.3.3 The Burra Group

The Burra Group is not represented on the Stuart Shelf, but during the period of deposition of the Burra Group in the Adelaide Geosyncline the Stuart Shelf acted as a source of clastic sediments for the geosyncline sedimentation.

2.2 LOCAL GEOLOGY

2.2.1 MOONABIE FORMATION - BACKY POINT

The Moonabie Formation type area is at Moonabie Range, 40 kms south of Whyalla, where they are described as volcaniclastic grits. It is mid-Proterozoic in age and underlies the Pandurra Formation. The Moonabie Formation outcrop in the Backy Point field area represents a distal deposit, hence the sediments are far more mature and well rounded than those of Moonabie Hill.

The Moonabie Formation defines most of the hills in the Backy Point field area. It consists of greenish grey mature quartzarenites, which are predominantly composed of fragments of acid McGregor Volcanics (quartz and sericite) with minor potassium feldspar, plagioclase and tourmaline. The sediments are well sorted, with layering defined by fine heavy mineral lamination. Many of the sediments are bisected by fine iron rich veins which have spread out as alteration halos. The haematite veins are the latest addition to the system, as they occurred after the intrusion of the volcanics.

2.2.1 BACKY POINT BEDS - BACKY POINT

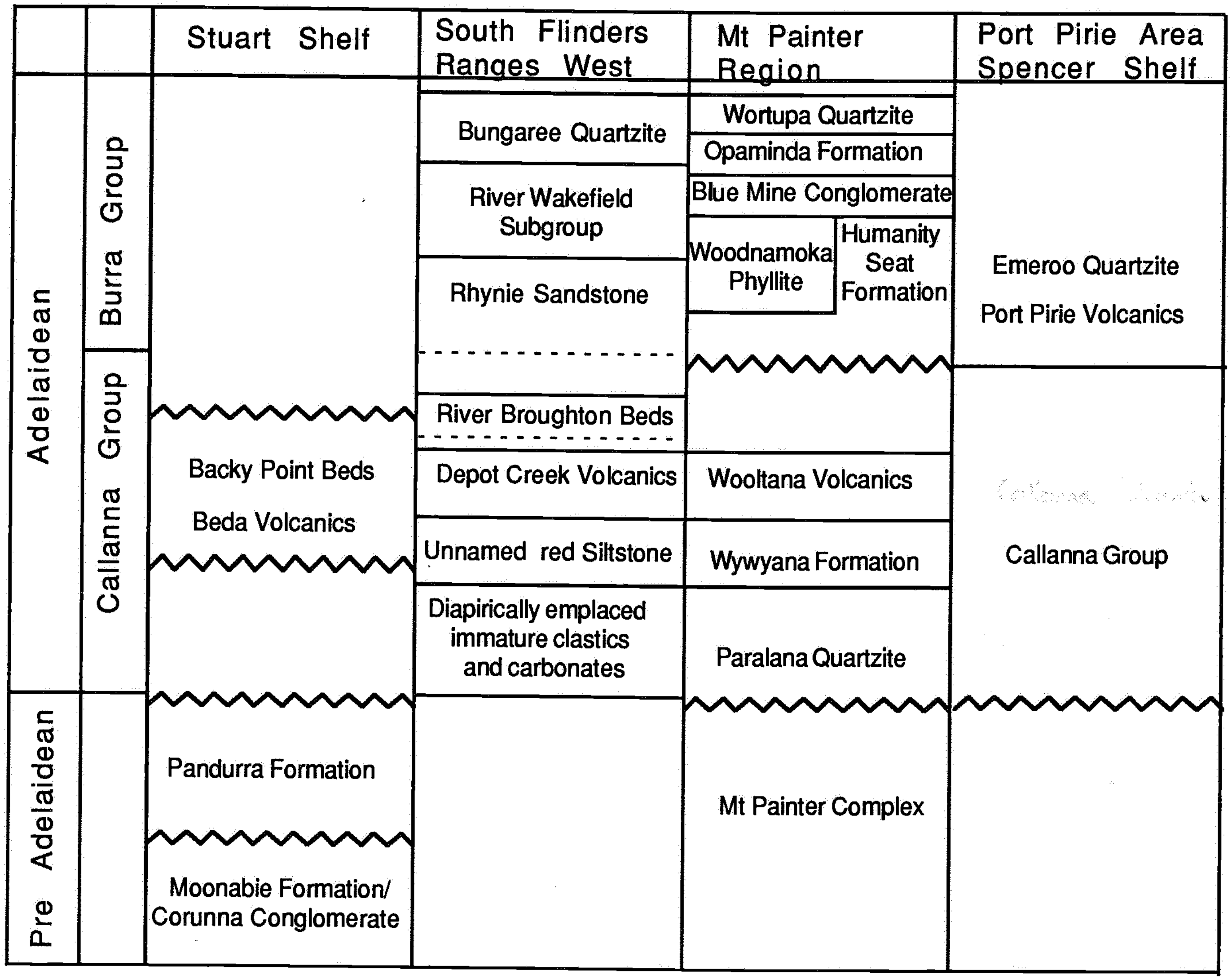
The type area for the Backy Point Beds is at Backy Point (Map 1). The sediments outcrop along the beach of Backy Point and Douglas Point (Map 2).

The Backy Point Beds are represented by the talus breccia on slopes directly surrounding the Beda Volcanics and coarse grained red quartzarenites on the beach at Backy Point and Douglas Point. The talus breccia formed as a result of the rapid movement and incorporation of the clasts in the down moving lava.

The arenites are coarse grained, quartz rich, highly mature and have been iron stained. The talus Backy Point Formation consists of brecciated pieces of reworked Moonabie Formation, mostly consisting of acid volcanic, quartz rich clasts. The breccia is well sorted, with rough layering defined by the coarser sediment.

The finer grained quartzarenites crop out in small areas at Backy Point and totally cover the Douglas Point region. At Backy Point they are well sorted and coarse grained, and mainly consist of reworked Moonabie Formation. At Douglas Point they are far more extensive and consist of 10 cm layers of fining upward sequences. The coarsest sediments consist of clasts of Cultana Granite, amphibolite and Moonabie Formation which grade into finer grained, well sorted quartz rich sediments. Parts of the rock have undergone tourmalinization, with resulting recrystallisation of quartz. Overall, this suggests that the sediments were deposited in a fluvial environment.

Figure 2 Stratigraphic Correlation of Volcanics and Sediments in the Adelaide Geosyncline and on the Stuart Shelf



		Stuart Shelf	South Flinders Ranges West	Mt Painter Region	Port Pirie Area Spencer Shelf
Adelaidean	Burra Group		Bungaree Quartzite	Wortupa Quartzite	Emeroo Quartzite Port Pirie Volcanics
				Opaminda Formation	
			River Wakefield Subgroup	Blue Mine Conglomerate	
			Rhynie Sandstone	Woodnamoka Phyllite Humanity Seat Formation	
	Callanna Group	Backy Point Beds Beda Volcanics	River Broughton Beds		Callanna Beds Callanna Group
			Depot Creek Volcanics	Wooltana Volcanics	
			Unnamed red Siltstone	Wywyana Formation	
			Diapirically emplaced immature clastics and carbonates	Paralana Quartzite	
Pre Adelaidean		Pandurra Formation		Mt Painter Complex	
		Moonabie Formation/ Corunna Conglomerate			

Chapter 3 PETROLOGY

3.1 PETROLOGY OF THE BEDA VOLCANICS

3.1.1 INTRODUCTION

The Beda Volcanics outcrop in three places; Backy Point, Douglas Point and Two Hummock Point on north eastern Eyre Peninsula. They are interbedded with the Backy Point Beds and overlie the Pandurra Formation. At both Backy Point and Douglas Point they outcrop on the beach over an area of a few metres.

In drill core they are far more extensive, up to 200m in thickness. Examination of drill core TR3 and TR4 drilled in the Tregolana-Sugar Loaf Hill area by North Broken Hill for the Dampier Mining Company in 1981, CU1, CU5 and CU6 drilled in the Cultana area by North Broken Hill for the Dampier Mining Company in 1982, SAS1 near Tent Hill South and SAU3 west of Port Augusta drilled by Seltrust for Australian Sections in 1977 and YAD2 was drilled for C.R.A. in 1986 at the southern tip of Lake Torrens. (See Appendix 3 for log descriptions and Figure 1 for location.)

Stratigraphically, the drill cores are all very similar. The lowest member is the Pandurra Formation, which is unconformably overlain by the Backy Point Beds/Beda Volcanics, which in turn are unconformably overlain by the Tapley Hill Formation (Plate 1.1). The drill core shows that the Beda Volcanics extend over most of the Stuart Shelf north of Backy Point. There are no tuffs associated with the volcanics, which suggests they were extruded sub-aereally.

3.1.2 OUTCROP PETROLOGY

The volcanics that outcrop at Backy Point and Douglas Point are highly vesicular, fine grained, red-maroon basalts (Plates 1.2 and 1.3). The highly vesicular nature of the basalts (up to 70% vesicles) suggests they were extrusive, hot and had a low viscosity. The vesicles are filled with calcite, chlorite, quartz and specular haematite.

The Beda Volcanics consist predominantly of plagioclase and an iron-rich fine grained recrystalised glassy ground mass. In thin section the volcanics are merocrystalline, highly altered basalts. Plagioclase constitutes up to 60% of each specimen and occurs as laths up to 0.1 mm in length. The laths have been partially altered to chlorite and sericite. Any pyroxenes that were originally present have been totally altered and incorporated into the ground mass. The vesicles are filled with chlorite, consertal quartz and specular haematite (Plate 1.4). The vesicle filling and iron-rich alteration of the glassy ground mass occurred as a result of later infiltration of hydrothermal fluids.

3.1.3 DRILL CORE PETROLOGY

The volcanic rocks in drill core are much less altered than the surface specimens. They can be divided into flows and, within flows, pulses. A number of fissures were involved in the genesis of the suite rendering it impossible to correlate the flows between the drill cores. The volcanics extend to a maximum depth of two hundred metres and contain up to twenty five flows.

The flows are maroon brown towards the top due to an increase in ilmenite/magnetite crystals and the oxidation of iron in the ground mass (which occurred when the magmas came in contact with the cold air), and green brown towards the base as a result of increased chlorite. The flow tops are highly vesicular (up to 70%) and brecciated. The vesicles are filled with chlorite, epidote and calcite. The brecciated veins are filled with calcite.

The volcanics originally consisted of plagioclase laths set in a ground mass of iron rich glass, with small patches of subophitic pyroxene (Plate 1.5) and plagioclase. The pyroxene has been partially altered to sericite, iron rich opaques and chlorite, while the plagioclase has been altered to chlorite and sericite in both regions. The rocks have also undergone low grade greenschist metamorphism and subsequent albitization. The calcium released in this reaction combined with the iron released from the ground mass when it was converted to chlorite, to produce epidote (Plate 1.6). The vesicles are filled with chlorite, epidote, calcite, minor quartz and chalcodonic quartz.

	Before Alteration	After Alteration
Pyroxene	up to 10%	0
Plagioclase	40%	10%
Sericite/Chlorite	0	30%
Iron Rich Opaques	0	up to 10%
Iron Rich groundmass	40%	40-50%
Vesicles	10%	10%

Microprobe analyses of samples 533-009 and -013 (Hörr, 1977) on crystals of plagioclase, pyroxene, chlorite and epidote revealed the actual composition of the minerals in the specimen, and the total analyses are presented in Appendix 6. During analyses of the pyroxene laths particular attention was paid to the variation between the core and the rim of individual phenocrysts. The cores are more MgO rich than the rim of individual phenocrysts. The pyroxene is mainly augite in composition with a structural formula of $[Ca_{0.7}Mg_{0.9}Fe^{2+}{}_{0.2}Ti_{0.01}Al_{0.08}][Si_2O_6]$. Most of the plagioclase has been altered to albite with a structural formula of $[K_{0.16}Na_{0.92}][Al_{1.1}Si_{2.9}O_8]$. A few samples have the composition of $Ca_{1.2}[Al_{1.3}Si_2O_8]$ whch is close to clinozozisite.

Epidote is present within the vesicles and has a fairly consistent structural formula of $[Ca_{1.8}Mg_{0.15}][Fe_{1.0}Al_2O_3OH][Si_2O_7][SiO_4]$. Titaniferous magnetite exsolved into exsolution lamelli forming the phases magnetite and ilmenite. Magnetite has a structural formula varying between $[Si_{0.5}Ti_{0.2}Al_{0.3}][Fe^{3+}{}_{14}Fe^{2+}{}_{8.3}]Mg_{0.32}O_{24}$ and $[Si_{0.2}Ti_{1.0}Al_{0.1}][Fe^{3+}{}_{13.4}Fe^{2+}{}_{9.2}]O_{24}$. Ilmenite shows a small variation of structural formula, with the average being $Si_{1.0}Ti_{8.9}Al_{0.27}Fe^{2+}{}_{8.3}Ca_{0.1}Mn_{0.16}O_{20}$.

3.2 PETROLOGY OF THE DEPOT CREEK VOLCANICS

3.2.1 INTRODUCTION

The Depot Creek Volcanics outcrop along Depot Creek. The volcanics are unconformably underlain by early red bed Callanna Group sediments that consist of reddish laminated medium bedded dolomitic siltstone and sandstone with small lenses of dolomite (Thompson *et al.*, 1976). The red bed sediments form most of the creek bed and show ripple marks. The volcanics are unconformably overlain by the Emeroo Subgroup. In outcrop, individual flows can be distinguished by vesicular flow tops and are up to one metre in thickness.

3.2.2 PETROLOGY

In hand specimens the Depot Creek Volcanics appear very similar to the Beda Volcanics, being red maroon fine grained vesicular basalts. The volcanics below the flow top are greenish grey, as they were not subject to oxidation on extrusion The vesicles are filled with quartz and clasts of sediment, which have been incorporated towards the contact with the surrounding sediments (Plate 1.7). In thin section the volcanics consist of laths of potassium feldspar set in a chlorite and iron rich recrystalised glassy ground mass (Plate 1.8 and 2.1). The feldspar originally may have been plagioclase which was altered to potassium feldspar due to excess potassium introduced into the system. The rocks have been highly sericitized and less chloritized. All the pyroxene phenocrysts have undergone pseudomorphous replacement by iron rich opaques. There is no evidence for any olivine existing in the unaltered rock. The vesicles are filled with consertal quartz and calcite. The modal compositions on extrusion and after alteration are:

	Before Alteration	After Alteration
Pyroxene	50%	5%
Pyroxene	up to 10%	0
Sericite/Chlorite	0	45%
Iron Rich Opaques	0	up to 10%
Iron Rich groundmass	40%	50-60%
Vesicles	10%	10%

3.3 PETROLOGY OF THE PORT PIRIE VOLCANICS

3.3.1 INTRODUCTION

The Port Pirie volcanics have only been located in drill core PP2, -5, -6, -10, -12, -13, -17 and -19, drilled by North Broken Hill between April and September 1977. All the volcanic flows except the lowest in PP12 (specimens 6431RS79, -80, -81 and -82) are interbedded with the Emeroo Subgroup. The lower PP12 volcanics are interbedded with Callanna Group sediments. In hand specimen the volcanics appear to be very similar. For convenience, I shall call the volcanics interbedded with the Emeroo Subgroup Emeroo Volcanics, and the volcanics interbedded with the Callanna Group, Callanna Volcanics.

3.3.2 PETROLOGY

The Emeroo Volcanics are merocrystalline basalts with an intergranular texture. Small patches of the specimens exhibit a subophitic texture.

The dominant minerals in the Emeroo Volcanics are potassium feldspars set in an iron-rich recrystalised glassy groundmass. Potassium feldspar is visible in hand specimen after staining with sodium cobaltinitrite (Plate 2.2). It occurs as subhedral to euhedral laths up to 2mm in length in the coarser varieties. The feldspars have been partially sericitized and chloritized (Plate 2.3).

Fresh augite is absent from most of the specimens. It has been mostly altered to chlorite with minor alteration to sericite and iron-rich opaques. The calcium liberated from the reaction combined with oxygen and carbon to form the calcite filling of the vesicles (Plate 2.4). The pyroxene occurs as subhedral to anhedral crystals with laths of feldspar radiating from them. Only sample 6431RS65 contains iron rich opaques that are possibly pseudomorphs of olivine.

	Before Alteration	After Alteration
Potassium Feldspar	45%	20%
Pyroxene	up to 10%	1%
Sericite/Chlorite	0%	40%
Iron Rich groundmass	40%	30%
Vesicles	5%	5%

The glassy ground mass has been enriched by iron-rich hydrothermal fluids. The vesicles range from spherical to irregular in shape and are filled with calcite, chlorite and some quartz.

The Callanna Volcanics are dissimilar to the Emeroo Volcanics in thin section and hand specimen (Plate 2.5). The specimens have a ubiquitous ophitic texture, and are holocrystalline (Plate 2.6). The dominant minerals are plagioclase and pyroxene.

The plagioclase laths are subhedral to euhedral and have been altered to chlorite and sericite. The pyroxene is more dominant in these specimens than in the Emeroo Volcanics and constitutes up to 50% of each specimen. Their crystals are subhedral to euhedal.

	Before Alteration	After Alteration
Plagioclase	50%	5%
Pyroxene	up to 50%	30%
Sericite/Chlorite	0	45%
Iron Rich groundmass	5%	5%

The pyroxene is present as augite with an average composition $[Ca_{0.6}Mg_{0.9}Fe^{2+}{}_{0.4}Ti_{0.03}Al_{0.12}][Si_2O_6]$. There is no overall variation between the composition of the core and rim for individual augite phenocrysts, but in sample 6431RS79 there is increased Al_2O_3 and decreased FeO in the core relative to the rim, and sample 6431RS81 has an increase in TiO_2 in the core relative to the rim. The plagioclase has all been albitized and varies in composition between Ab_{50} and Ab_{90}.

The Callanna Volcanics exhibit pseudomorphism of olivine, especially in specimen 6431RS81. Chlorite is also present as small vesicle filling.

The most obvious difference between these two volcanics is the degree of alteration. The Emeroo basalts consist primarily of feldspar, and the majority of pyroxenes have been altered. The Callanna Volcanics consists of equal amounts of plagioclase and pyroxene with the plagioclase showing greater alteration than the pyroxene as they have undergone greater infiltration by potassium rich liquid. The potassium feldspar in the

Emeroo Volcanics is a primary feature, as is the plagioclase in the Callanna Volcanics. As differentiation proceeds the rocks change from calcic to potassic rich, indicating that the feldspar composition is simply a function of fractionation. Pyroxene formed early in the system, and decreased with fractionation. This implies that the Callanna Volcanics are a less evolved member of the same magma chamber as the Emeroo Volcanics.

3.4 PETROLOGY OF THE GAIRDNER DYKE SWARM

3.4.1 INTRODUCTION

The Gairdner Dyke Swarm can be traced for 1,000 km from the southern Gawler Craton to the northwest Musgrave Block, and within the Stuart Shelf-Gawler Craton for at least 100 kms on magnetic maps (Parker et.al., 1985). The dykes have been intersected in drill core at Reedy Lagoon RL1, Aquitane SSR1001 and CRS-LY3 and are shown to intrude the Pandurra Formation (Blissett, 1985).

Preliminary age dating of the swarm from RL1 suggests an age of formation of 1050 ma using Rb-Sr (Blissett, 1985) and 700ma using K-Ar dating (Parker et. al, 1985). It has been suggested that these dykes are feeders for the volcanics in the Stuart Shelf and possibly the Adelaide Geosyncline.

3.4.2 PETROLOGY

The Gairdner Dyke Swarm has two distinctly different dominant textures. One is fine grained and one is much coarser grained. The dominant minerals in the Gairdner Dyke Swarm are feldspars, predominantly plagioclase. The percentage compositions are shown below. The finer grained specimens are merocrystalline, with fine curved branching augite which crystalised when the magma was emplaced (Plate 2.7). The majority of pyroxene has been altered to chloritic clays. In small areas, coarse laths of plagioclase and occasionally olivine crystals are set in the recrystalised glassy ground mass. This indicates that plagioclase and olivine crystals started to crystalise in the magma chamber before extrusion. There are also very fine laths of plagioclase intergrown with the augite as not all the plagioclase had been crystalised from the magma before extrusion.

	Before Alteration	After Alteration
Potassium Feldspar	20%	20%
Pyroxene	60%	10%
Olivine	1%	0%
Sericite/Chlorite	0%	50%
Iron Rich groundmass	20%	20%

The coarser grained specimens (Plate 2.8) have an ophitic texture, the dominant mineral being plagioclase ranging in composition from Ab_0 - Ab_{100}. The plagioclase is totally enclosed by augite. The plagioclase formed as subhedral to euhedral laths and in some specimens such as 6137RS26 shows inclusions of fine laths of plagioclase in potassium feldspar and vice versa. This is a result of two simultaneous exsolving phases from the melt due to simultaneous crystallisation temperatures.

	Before Alteration	After Alteration
Plagioclase	50%	40%
Pyroxene	up to 50%	40%
Sericite/Chlorite	0	15%
Iron Rich groundmass	5%	5%

The Gairdner Dyke Swarm is much less altered than the other volcanic suites. Apart from the alteration of the augite in the fine grained specimens, the samples have remained fresh, and thus suggest any contamination affects seen in their geochemistry is due to crystal contamination and assimilation rather than surface and hydrothermal alteration effects.

PLATE 1

1.1 Section of drill core CU1 which starts at a depth of 181.8 m. The grey/white core is the lowest member of the Tapley Hill Formation and consists of light grey dolomitic siltstones. The underlying Beda Volcanics are present as a volcanic flow top, which is highly vesicular and veined.

1.2 Hand specimen of brecciated Beda Volcanics from a flow top. The specimen comes from Douglas Point (scale in cm).

1.3 Hand specimen of vesicular Beda Volcanics from Backy Point (scale in cm). The vesicles are filled with quartz and haematite

1.4 Photomicrograph of a vesicle from specimen 882-4 showing quartz (Q) and specular haematite (red).

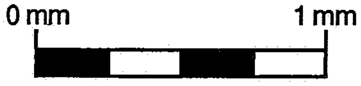
1.5 Photomicrograph of specimen 533-001 showing a subophitic grain of augite and plagioclase from the Beda Volcanics.

1.6 Photomicrograph of specimen 533-011 showing a vesicle filled with epidote(E) and chlorite from the Beda Volcanics. The vesicle is surrounded by plagioclase laths.

1.7 Hand specimen of basalt and sediment from Depot Creek (specimen 882-104). The basalt (dark red) is overlain by red sediment (Callanna Group) which has been partially incorporated in the volcanic. (Scale in cm).

1.8 Photomicrograph of the previous specimen 882-104. The section shows laths of plagioclase set in a recrystalised glassy ground mass. The vesicle is rimmed by quartz and filled with laminated sediment.

Scale for photomicrographs:



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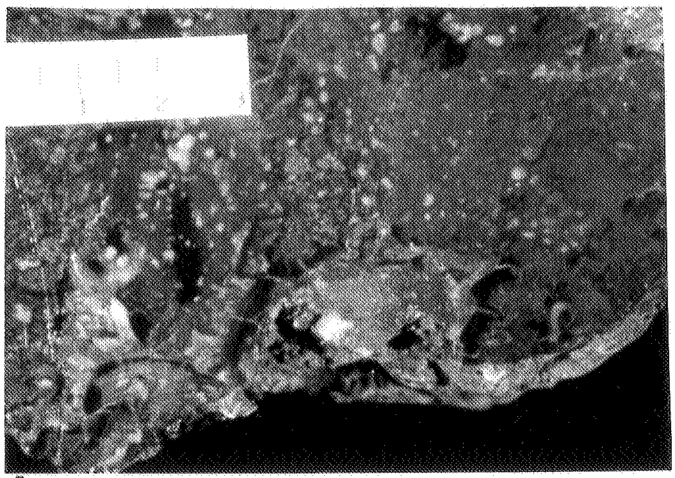

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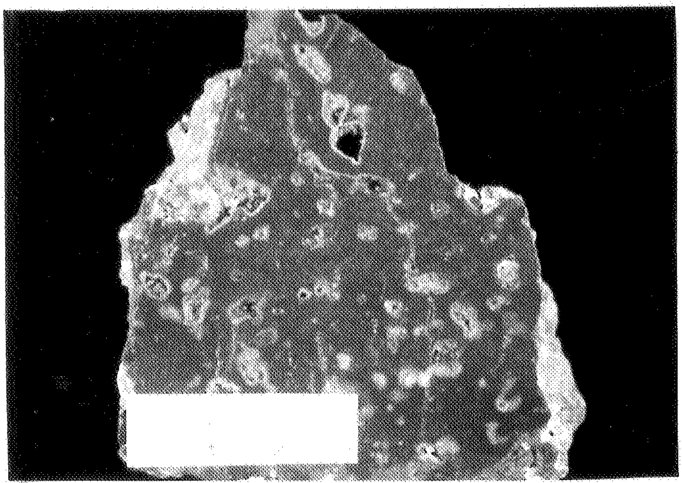

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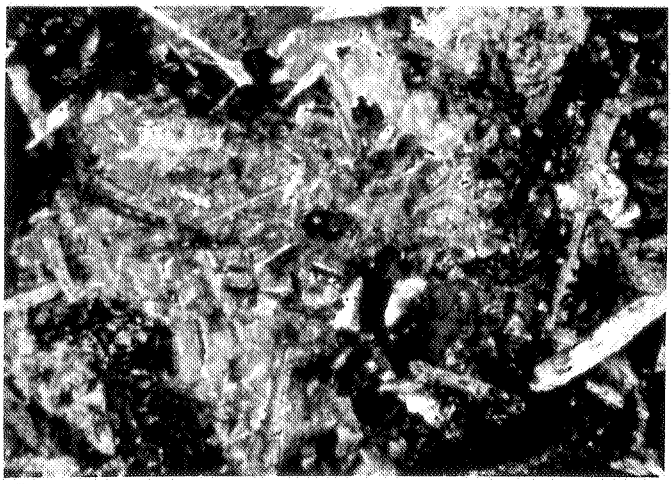

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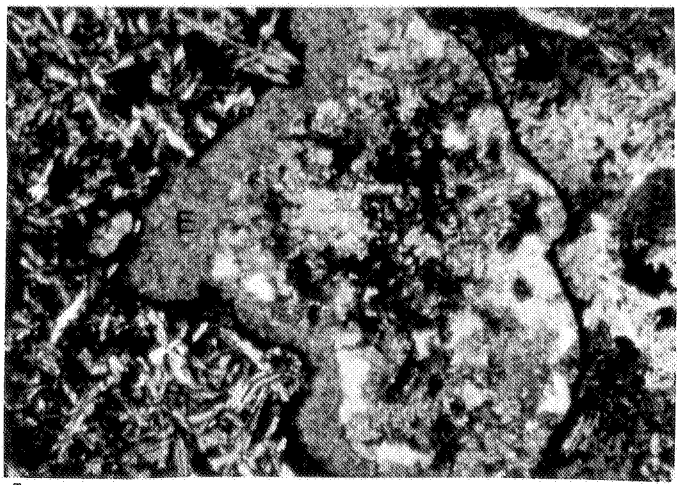

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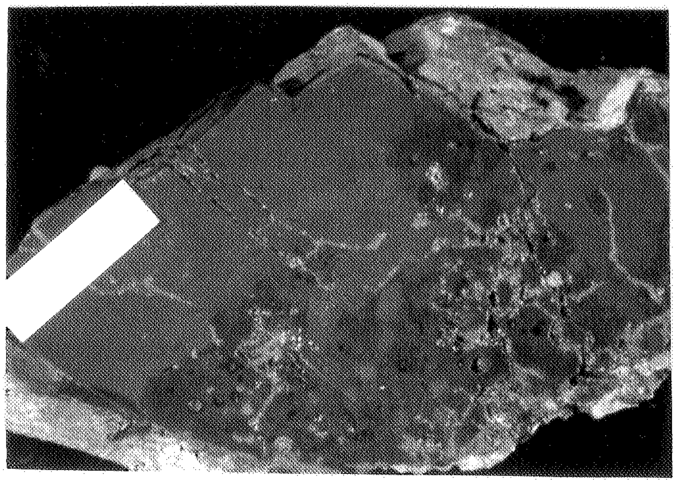

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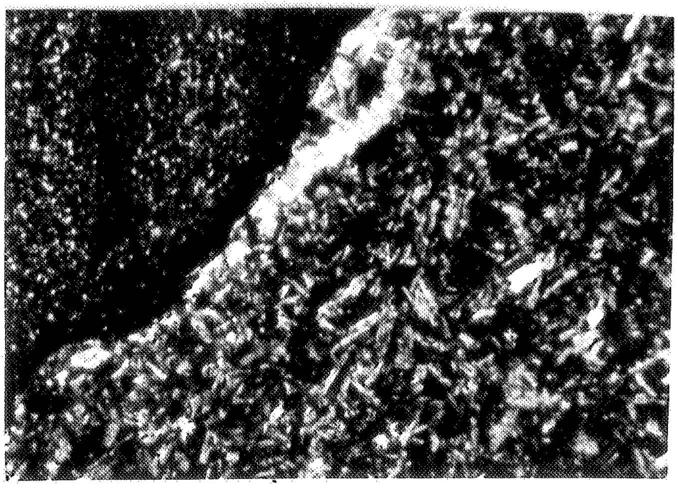


1.8

PLATE 2

2.1 Photomicrograph of specimen 882-6 from Depot Creek, showing a chlorite filled vesicle surrounded by potassium feldspar laths set in an iron rich recrystallised glassy groundmass.

2.2 Hand specimen from the Emeroo member of the Port Pirie Volcanics. The yellow colour is due to staining by sodium cobaltrinitrite which highlights the potassium feldspar content. (Scale in cm)

2.3 Photomicrograph of specimen 6431RS0065 from the Emeroo member of the Port Pirie Volcanics. The specimen consists of potassium feldspar laths and intersertal augite set in a recrystallised ground mass. The vesicles are filled with calcite(C).

2.4 Photomicrograph of specimen 6431RS0066 from the Emeroo member of the Port Pirie Volcanics. The section shows a large vesicle filled with calcite(C) and quartz(Q).

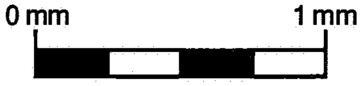
2.5 Hand specimen of sample 6431RS0080 from the Callanna Volcanics. The sample has also been stained by sodium cobaltrinitrite, highlighting its lack of potassium feldspar.

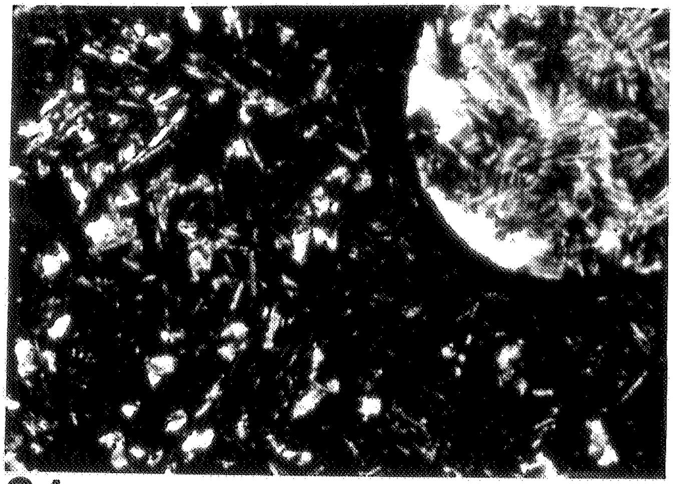
2.6 Photomicrograph of sample 6431RS0081 from the Callanna Volcanics. The specimen has a subophitic texture consiting of plagioclase(P) and augite set in a glassy ground mass.

2.7 Photomicrograph of sample 6335RS21 from the Gairdner Dyke Swarm. The specimen consists of fine branching augite, with coarser laths of plagioclase(P).

2.8 Photomicrograph of sample 6137RS0027 from the Gairdner Dyke Swarm. The sample has an ophitic texture.

Scale for photomicrographs:





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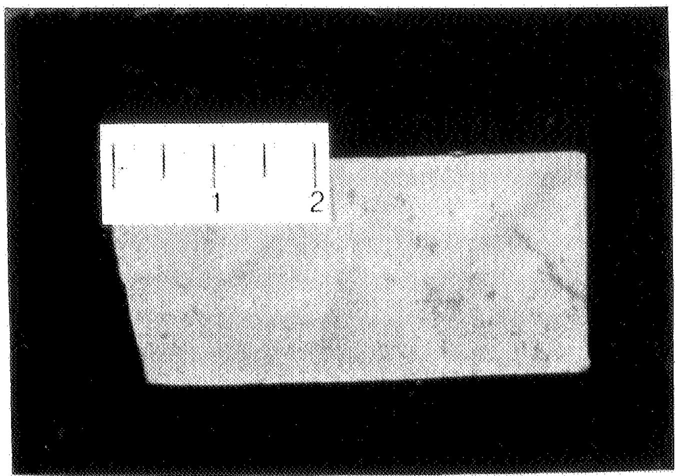

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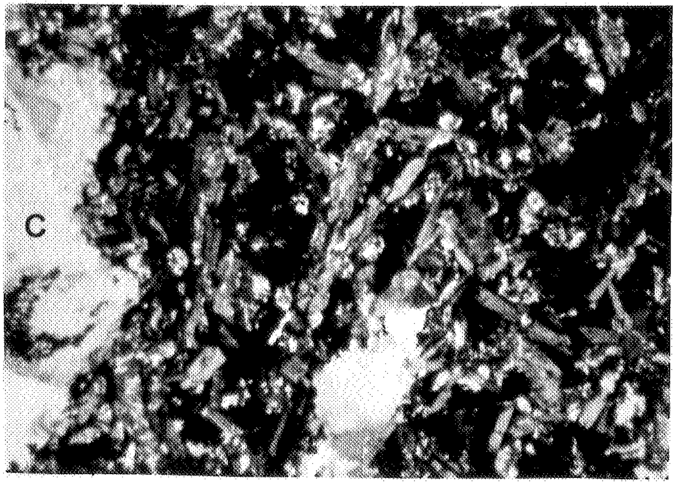

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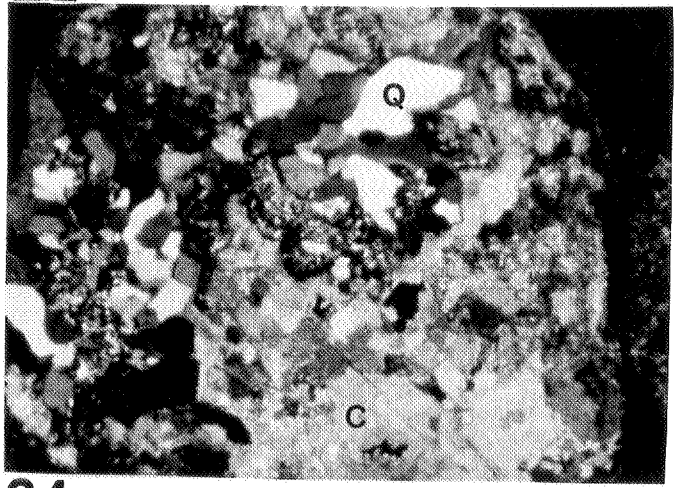

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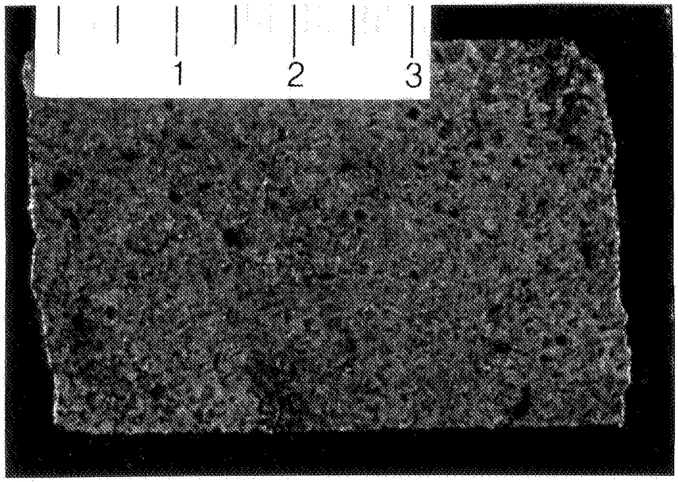

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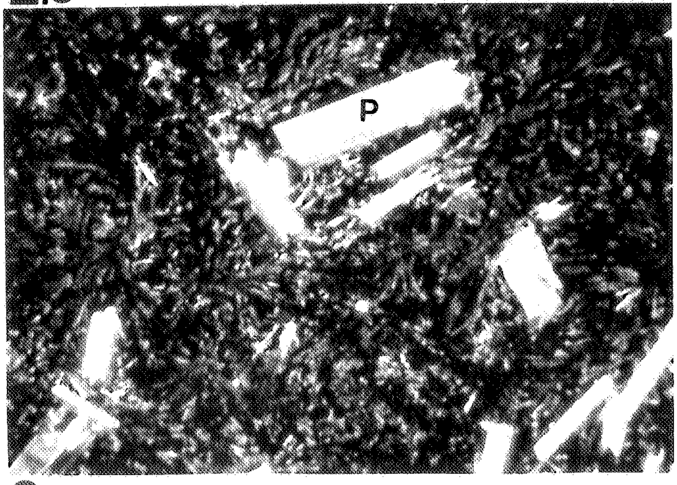

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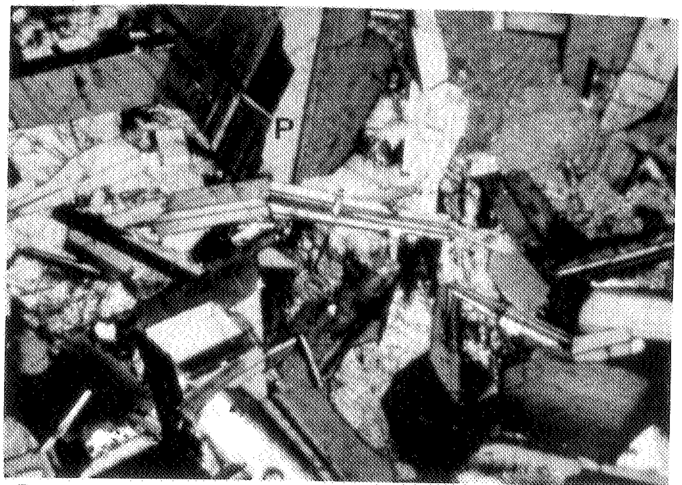


2.8

Chapter 4 GEOCHEMISTRY - Major and Trace Elements

4.1 GEOCHEMISTRY OF THE SUITES

4.1.1 INTRODUCTION

The trace and major element chemistry of the Beda, Wooltana, Port Pirie and Depot Creek Volcanics and the Gairdner Dyke Swarm are presented in Appendix 5. There is significant scatter of some major and trace elements due to more than one fissure and possibly more than one magma chamber feeding the suites. Intense alteration of some of the samples has also contributed to the scatter. All the elements are plotted against Zr as it exhibits a better overall fractionation trend than SiO_2 for the particular suites (the graphs are presented in Appendix 4).

4.1.2 GEOCHEMISTRY OF THE BEDA VOLCANICS

Compared to the average tholeiite basalt and the average Central Karoo basalt presented in Table 1, the Beda Volcanics show slight enrichment in MnO, Na_2O and Rb, and major enrichment in MgO, Ba, Ni and Cr. They are depleted in Al_2O_3, CaO, P_2O_5, Sr and Y.

With decreasing Mg# or increasing Zr content, the Beda Volcanics show trends of slight Al_2O_3 and CaO depletion, major Ni, Cr, MgO and MnO depletion and enrichment of FeO*, P_2O_5, Y and TiO_2. The alkalies and the large ion lithophile elements, i.e. K_2O, Na_2O, Sc, Ba and Rb, all show very scattered trends, some of which appear to be due to alteration.

4.1.3 GEOCHEMISTRY OF THE GAIRDNER DYKE SWARM

Compared to the average tholeiitic basalt and the Central Karoo basalt presented in Table 1, the Gairdner Dyke Swarm is depleted in Na_2O, K_2O, Ba, Sr, Rb and Y, slightly enriched in TiO_2, MgO and CaO and shows major enrichment of MnO.

With increasing Zr or decreasing Mg$^{\#}$, the Gairdner Dyke Swarm exhibits very similar trends to the Beda Volcanics. There is a slight depletion of Al_2O_3, MnO and CaO, major Ni, Cr, and MgO depletion and enrichment of FeO*, P_2O_5, Ce and Y. Again the alkalies and the large ion lithophiles show a scattered trend. The three main arms of TiO_2 and V trends suggest there are three different magma sources responsible for the formation of the dyke swarm.

4.1.4 GEOCHEMISTRY OF THE DEPOT CREEK AND WOOLTANA VOLCANICS

On comparing the Wooltana and Depot Creek Volcanics with the average basalt (Table 1) there are some differences between the two suites and between them and the average values. The more mafic Wooltana Volcanics are more primitive, with a much higher MgO than the Depot Creek Volcanics and the average tholeiitic basalt value. This is also reflected in the low TiO_2 and Zr content, and the high Cr. The Depot Creek Volcanics are enriched in MgO, Na_2O, and TiO_2 relative to the average tholeiite, indicating that they are also more primitive than the average basalt.

The Depot Creek and Wooltana Volcanics show very similar trends with decreased $Mg^\#$ and increased Zr, i.e. SiO_2, TiO_2, Nb, Ce and Y increase, Al_2O_3 decreases slightly and MgO, MnO, Cr and Ni decreases to a greater extent. The most scattered trends consist of the mobile elements; CaO, K_2O, Na_2O, Ba, Rb, Sc and Sr.

4.1.5 GEOCHEMISTRY OF THE PORT PIRIE VOLCANICS

The Emeroo and Callanna Volcanics show quite different geochemistry. The Callanna Volcanics are quite similar to the average tholeiitic basalt, except for enrichment in TiO_2 and Ba and depletion of Sr. The Emeroo Volcanics show a much more fractionated geochemistry than the Callanna Volcanics, with depletion of MgO and Ni. They also have ten times the averge K_2O and fifteen times the averge Rb relative to the average tholeiitic basalt.

With increased fractionation the Port Pirie Volcanics show different fractionation trends than the other suites. They are enriched in TiO_2, FeO^*, P_2O_5, Ce, Ba, Nb, V, Sc, Nd and Y, with a slight depletion in MnO and a major depletion in MgO, Cr and Ni. A few of the low ion lithophile elements have highly scattered trends that of Rb, Na_2O and K_2O.

4.2 MAJOR MINERAL CRYSTALLISATION PATTERNS

4.2.1 PYROXENE-OLIVINE CRYSTALLISATION

The major trends illustrated in the graphs presented in Appendix 4, apart from the increased concentration of the immobile incompatible elements (P_2O_5, TiO2, Nb, V, Y, and La), are due to the crystallisation of olivine and pyroxene and, to an minor extent, chromium spinel in the magma chamber. The trends of Ni, Cr (Figure 3) and MgO best illustrate the crystallisation trend.

The initial rapid depletion of Ni in all but the Gairdner Dyke Swarm is due to the crystallisation of olivine. The subsequent flattening of the Ni curve is due to pyroxene and feldspar becoming the dominant minerals crystalising in the chamber. The Gairdner Dyke Swarm graphs suggest that crystallisation of olivine and clinopyroxene took place simultaneously rather than as individual phases, resulting in a shallower curve. A similar trend is seen with Cr, but this is due to initial crystallisation of chromium spinel. Pyroxene crystallisation leads to the flattening out of the curve. The Harker diagrams suggest the main controls on fractionation in the magma chamber is the crystallisation of pyroxene, olivine and chromium spinel.

4.2.2 MAGNETITE CRYSTALLISATION

The crystallisation of magnetite is illustrated by the trends of TiO_2 and V. The introduction of magnetite is illustrated by a reduction in the increasing slope of these elements. None of the volcanic suites show any variation of the slope of TiO_2 or V, which suggests that little magnetite has crystalised in the magma chamber and does not play a major part in the fractionation history of the suites.

4.3 ALTERATION AND CRUSTAL CONTAMINATION AFFECTS

Plots of the more mobile elements from the system (K_2O, Ba, Rb and Sr) against $Mg^{\#}$ show the degree of alteration that the system has undergone and the samples which are the most altered. Plots of $Mg^{\#}$ versus K_2O/Zr, Rb/Zr, and Sr/Zr have all illustrated that the Beda Volcanics have undergone a considerable amount more alteration than the Gairdner Dyke Swarm. With a system that has not undergone surface alteration, the ratio of the alkalies and large ion lithophiles to Zr should remain constant with fractionation, as both increase during fractionation. Therefore, we would expect the data to plot in a vertical line.

The plots for the Beda Volcanics and Gairdner Dyke Swarm are shown in Figures 4 and 5. The least differentiated specimens, i.e. those with the highest $Mg^{\#,}$ have the greatest horizontal spread, showing that the earliest samples are the least altered. This indicates that the hydrothermal fluids were only able to penetrate the lowest members of the suite. The spread of the data is also a function of the amount of glass and olivine in the earliest samples.

The alteration of only the lowest members of the volcanics is shown especially well with the Port Pirie Volcanics (see Appendix 4), where the oldest Port Pirie Volcanics have undergone a lot of alteration by potassic rich fluids and the younger upper layers have not.

According to Pearce (1983), crustal contamination is implicated when there is enrichment in Ba and Th. A plot of Mg# versus Ba/Zr for the Beda Volcanics shows a similar pattern to the other alkalies mentioned above. The least fractionated basalts show the highest variation in Ba/Zr ratio, implying enrichment in Ba. As the least fractionated basalts are the first to leave the magma chamber, and are the hottest, it is reasonable to assume they underwent the most assimilation with the plagioclase rich members of the wall rock, enriching these volcanics in Ba.

4.4 MODELLING OF FRACTIONAL CRYSTALLISATION

4.4.1 INTRODUCTION

Two models have been used to determine the theoretical fractional crystallisation in the magma chamber. The first is the least squares mixing programme, where the amount of each set mineral composition which must crystalise between a parent and daughter basalt is determined. The second model is a computer simulated fractional crystallisation model at 1 Kb pressure, which traces the mineral assemblage and mineral composition that are in equilibrium with a series of liquids approaching the chemical complexity of the magma. The model is called Magmodel and was developed by Nathan and Van Kirk in 1978.

4.4.2 BEDA VOLCANICS MODELLING

Both simulation models have been used on selected Beda Volcanic data. Sample 533-095 is the most mafic and unaltered specimen of the available data. The least squares mixing programme was carried out between samples 533-095 (parent) and 533-122 (daughter). The minerals crystalising out were clinopyroxene (the composition derived from probing the samples), An_{61} and $foresterite_{86}$ (Table 2). The mixing error, R squared, is 0.303 - less than one is assumed near perfect. The error was caused by a mismatch of the mobile K_2O.

33.2% of the parent liquid crystalised, with the dominant phases being plagioclase and near equal amounts of clinopyroxene and olivine. This assemblage, according to Green and Ringwood (1967) assumes a crystalising pressure of greater than 9 kb.

When Magmodel was applied to the data quite different minerals abundances were produced. Table 3 shows the data for samples 533-095 and 533-122. This time the dominant phase crystalising out is olivine, with later crystallisation of plagioclase and augite. Note that although the minerals and their abundances crystalising out are dissimilar, the overall composition of the liquid phases are not. This model assumes crystallisation takes place at a one atmosphere pressure, hence the results should be incorrect. However, as shown in Figure 6, the compositions crystalising are a perfect fit, with the exception of TiO_2. Although the least squares mixing model is independent of pressure and should therefore give an accurate estimation of the pressure at which the phases crystalised, any errors in the initial parent composition due to alteration and contamination factors will lead to inaccurate results. As this system is highly altered, it is likely to be the less correct of the two methods.

According to Green and Ringwood (1967) the dominant phase to crystalise at 1 Kb is olivine, with minor amounts of plagioclase. Sample 533-122 crystalises with the dominant phase again predominantly olivine, but this time the second phase is orthoclase. Green and Ringwood regard this as indicative of crystallisation at a greater pressure - about 9 Kb. As sample 533-122 has a lower Mg#, it is more fractionated than the 533-095, and it follows that it originated from lower depths and at a greater pressure in the crust. This explains the pressures calculated above.

4.4.3 GAIRDNER DYKE SWARM MODELLING

Both simulation models were also used with Gairdner Dyke Swarm samples 6136RS001 and 6136RS002. The least squares mixing programme operated between the samples as shown in Table 4, and had a perfect correlation (error 0.038). This time the crystallisation involved clinopyroxene and plagioclase, with olivine only playing a minor part. According to Green and Ringwood (1967), this suggests greater pressures and hence greater depths of crystallisation. The Magmodel showed the simultaneous crystallisation of augite and plagioclase and later crystallisation of Ca poor pyroxene and magnetite. Again the theoretical data fit very well with actual geochemical data (Figure 7). Both samples showed a similar sequence (Table 5). Although both models show good correlations, the minerals crystalised out are different due to the different pressures used. For the reasons given above, the Magmodel results are more likely to be representative of this system. The chemical composition is controlled by low pressure - liquid equilibrium which implies that the eruptive basalts have evolved chemically in crustal magma chambers, irrespective of any affects produced by fractionation at great depths.

Table 1. Tabulation of Volcanics of the Stuart Shelf and Adelaide Geosyncline Compared to an Average Tholeiitic Basalt and a Karoo Basalt

	A	Beda Volcanics Most Mafic	Gairdner Dyke Swarm Most Mafic	Depot Creek Volcanics Most Mafic	Wooltana Volcanics Most Mafic	Callanna Volcanics Most Mafic	Emeroo Volcanics Most Mafic	Central Karoo Basalts
%								
SiO_2	51.50	50.24	51.55	50.92	46.90	47.40	45.20	52.46
TiO_2	1.20	1.27	1.51	1.91	1.11	2.40	2.12	1.04
Al_2O_3	16.30	13.48	14.54	14.78	12.98	13.20	17.50	15.25
Fe_2O_3	11.60					16.10	15.70	10.67
FeO		11.27	11.23	10.84	14.22	10.90	0.92	
MnO	0.17	0.24	0.36	0.21	0.40	0.22	0.16	0.16
MgO	5.90	10.40	7.42	9.16	14.71	7.60	2.76	6.37
CaO	9.80	7.91	11.14	7.49	6.06	7.65	1.54	9.81
Na_2O	2.50	3.68	1.89	4.07	2.18	2.72	0.42	2.78
K_2O	0.86	1.40	0.15	0.46	0.80	1.40	9.10	1.24
P_2O_5	0.21	0.12	0.21	0.16	0.11	0.22	0.22	0.21
ppm								
Ba	244.00	573.00	67.00			123.00	153.00	258.00
Sr	450.00	22.00	160.00	320.00		139.00	14.40	287.00
Rb	30.00	50.00	8.00	10.00		57.00	438.00	21.30
Zr	108.00	79.00	90.00	104.00	57.09	144.00	123.00	154.00
Nb		5.00	8.00	12.00		8.60	8.10	16.50
Co	39.00					80.00	40.00	40.40
V	251.00	243.00		426.00	208.00	399.00	356.00	227.00
Ni	85.00	237.00	134.00	116.00		148.00	60.00	67.00
Cr	162.00	214.00	149.00	210.00	290.00	74.00	221.00	299.00
Y	32.00	22.00	20.00	29.00	17.00	36.00	23.40	26.70
La		4.00				18.00	13.00	17.30
Ce		26.00	20.00	29.00	20.00	39.00	20.00	39.00

A - average tholeiitic basalt, major elements from Mason (1967), trace elements from Prinz (1967)

Beda Volcanic - Sample 533-095, Gairdner Dyke Swarm - Sample 6136RS001, Depot Creek Volcanic - Sample 6433RS0136, Wooltana Volcanic - Sample A171, Callanna Volcanic - Sample 6431RS0081, Emeroo Volcanic - Sample 6431RS0078

Central Karoo Basalt - Moshesh's Ford from Duncan *et al.*,1984.

Table 2 Least Squares Mixing Programme Results from Selected Beda Volcanic Samples

Parent 533-095
Daughter 533-122

	Solution	% Cumulate
533-095	1.000	
Clinopyroxene	-0.095	28.568
Plagioclase (An61)	-0.148	44.619
Olivine (Fo86)	-0.089	26.812
533-122	0.668	
33.8% Fractionated		

Parent 533-122
Daughter 533-136

	Solution	% Cumulate
533-122	1.000	
Clinopyroxene	-0.054	40.538
Plagioclase (An60)	-0.042	31.804
Olivine (Fo86)	-0.037	27.658
533-136	0.866	
13.4% Fractionated		

Table 3 Magmodel Mixing Model Results for Selected Beda Volcanic Samples

Parent 533-095

Percentage Crystallised	Olivine	Plagioclase	Augite	Magnetite
5.07	100.00			
10.06	100.00			
15.05	96.60	3.30		
20.08	79.80	20.20		
25.04	69.85	30.15		
30.04	61.60	35.80	1.40	1.20
35.03	54.59	38.18	5.26	1.97
40.03	49.01	40.00	8.20	2.80

Parent 533-122

Percentage Crystallised	Olivine	Orthoclase	Magnetite	Plagioclase	Augite
5.07	100.00				
10.06	100.00				
15.05	73.90	26.00			
20.08	55.43	44.57			
25.04	48.58	49.18	4.24		
30.04	41.03	48.40	6.70	3.87	
35.03	36.99	49.87	7.32	5.82	
40.00	32.27	51.25	7.48	8.08	0.93

Table 4 Least Squares Mixing Programme Results from Selected Gairdner Dyke Swarm Samples

Parent 6136RS001
Daughter 6136RS002

	Solution	% Cumulate
6136RS001	1.000	
Clinopyroxene	-0.027	38.249
Plagioclase (An61)	-0.038	53.760
Olivine (Fo86)	-0.006	7.991
6136RS002	0.929	

7.01% Fractionated

Table 5 Magmodel Mixing Model Results for Selected Gairdner Dyke Swarm Samples

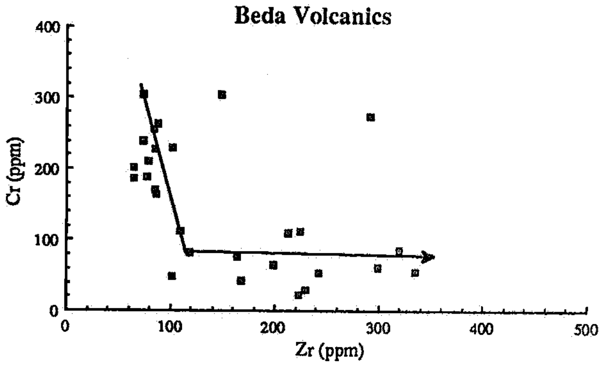
Parent 6136RS001

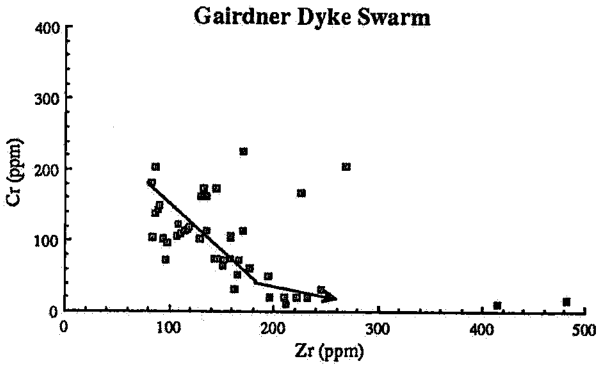
Percentage Crystallised	Augite	Plagioclase	Ca Poor Pyr.	Magnetite
5.07	53.75	46.25		
10.06	57.40	42.59		
15.05	38.41	48.39	13.19	
20.08	34.55	49.55	15.90	
25.04	27.71	51.82	20.47	
30.04	23.10	53.33	23.57	
35.03	19.80	54.03	24.83	1.34
40.03	18.23	53.90	25.34	2.58

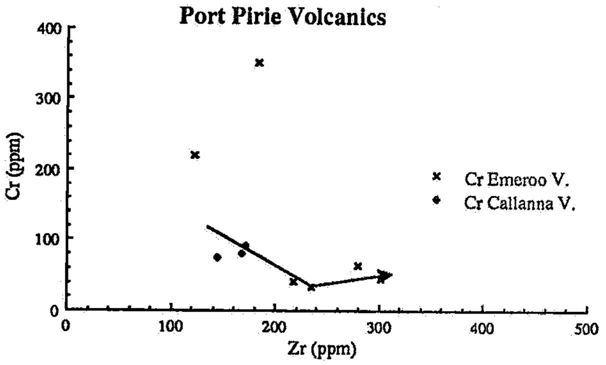
Parent 6136RS002

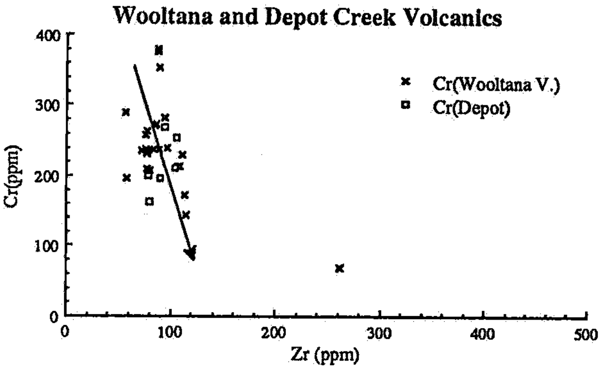
Percentage Crystallised	Augite	Plagioclase	Ca Poor Pyx	Magnetite
5.07	55.70	44.26		
10.06	58.41	41.59		
15.05	48.50	44.64	6.85	
20.08	36.34	48.65	15.01	
25.04	29.14	51.08	19.46	0.01
30.04	24.30	52.00	21.53	2.17
35.03	21.98	52.30	22.32	3.40
40.00	20.48	52.31	22.81	4.40

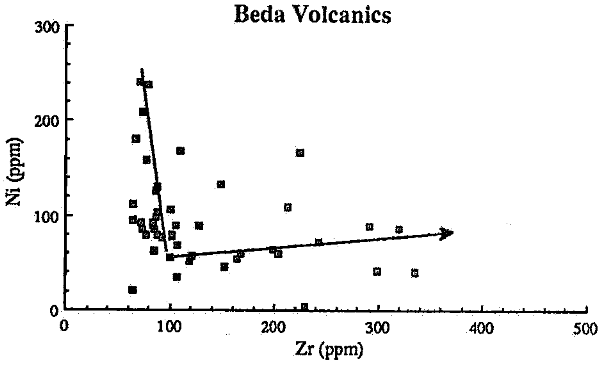
Figure 3   Ni and Cr versus Zr Graphs

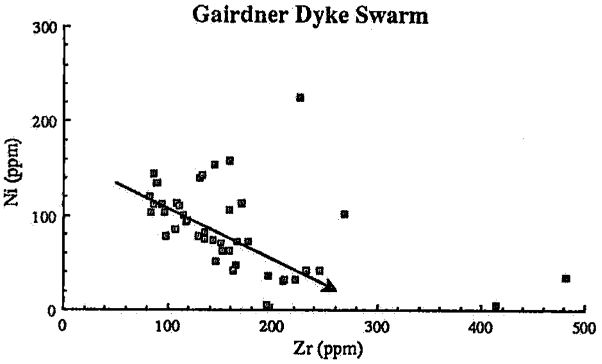

Beda Volcanics
Cr (ppm)
400
300
200
100
0
0
100
200
300
400
500
Zr (ppm)

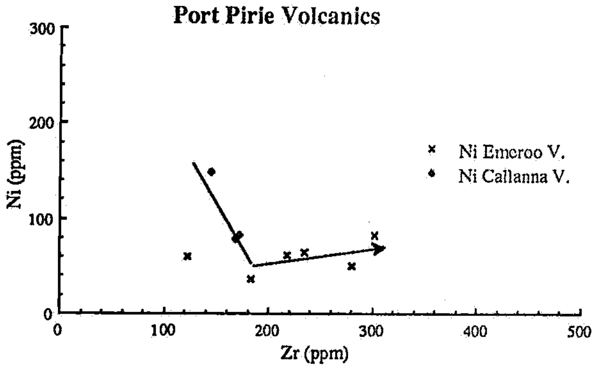

Gairdner Dyke Swarm
Cr (ppm)
400
300
200
100
0
0
100
200
300
400
500
Zr (ppm)


Port Pirie Volcanics
Cr (ppm)
400
300
200
100
0
0
100
200
300
400
500
Zr (ppm)
× Cr Emeroo V.
◆ Cr Callanna V.


Wooltana and Depot Creek Volcanics
Cr(ppm)
400
300
200
100
0
0
100
200
300
400
500
Zr (ppm)
× Cr(Wooltana V.)
□ Cr(Depot)


Beda Volcanics
Ni (ppm)
300
200
100
0
0
100
200
300
400
500
Zr (ppm)


Gairdner Dyke Swarm
Ni (ppm)
300
200
100
0
0
100
200
300
400
500
Zr (ppm)


Port Pirie Volcanics
Ni (ppm)
300
200
100
0
0
100
200
300
400
500
Zr (ppm)
× Ni Emeroo V.
◆ Ni Callanna V.

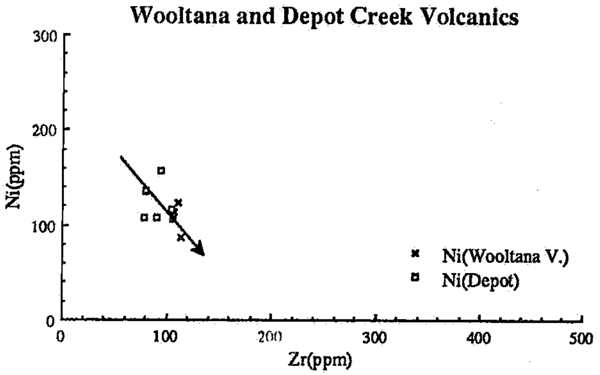
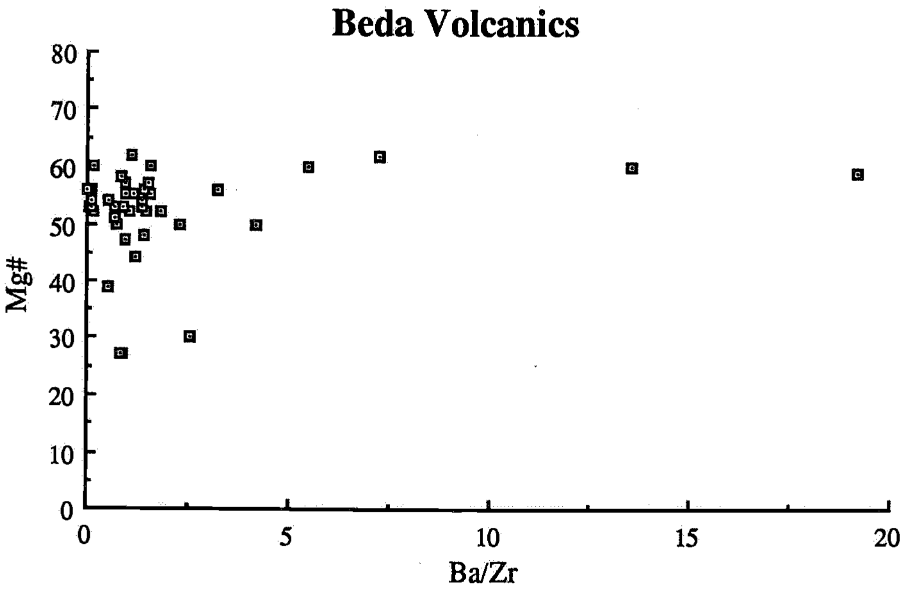
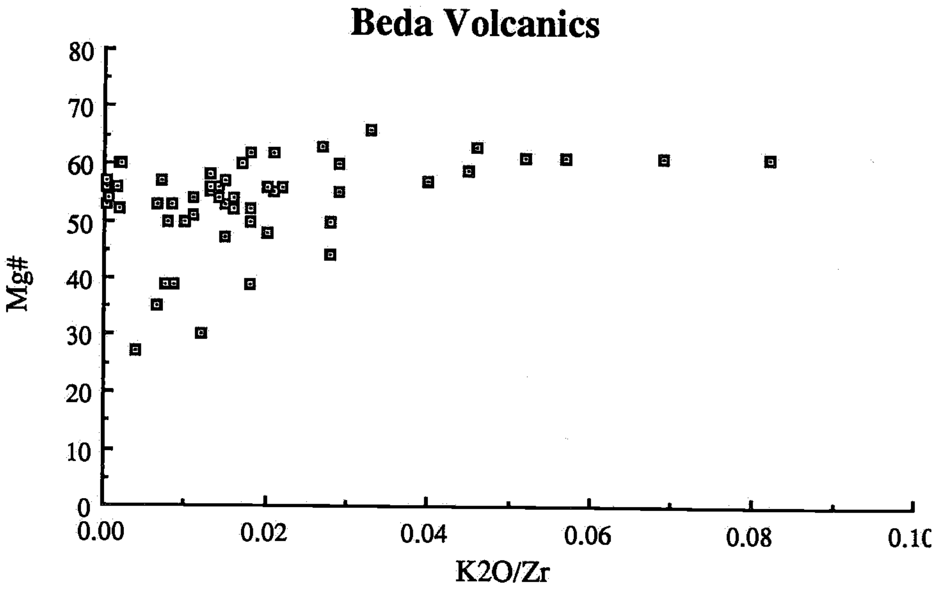

Wooltana and Depot Creek Volcanics
Ni(ppm)
300
200
100
0
0
100
200
300
400
500
Zr(ppm)
× Ni(Wooltana V.)
□ Ni(Depot)

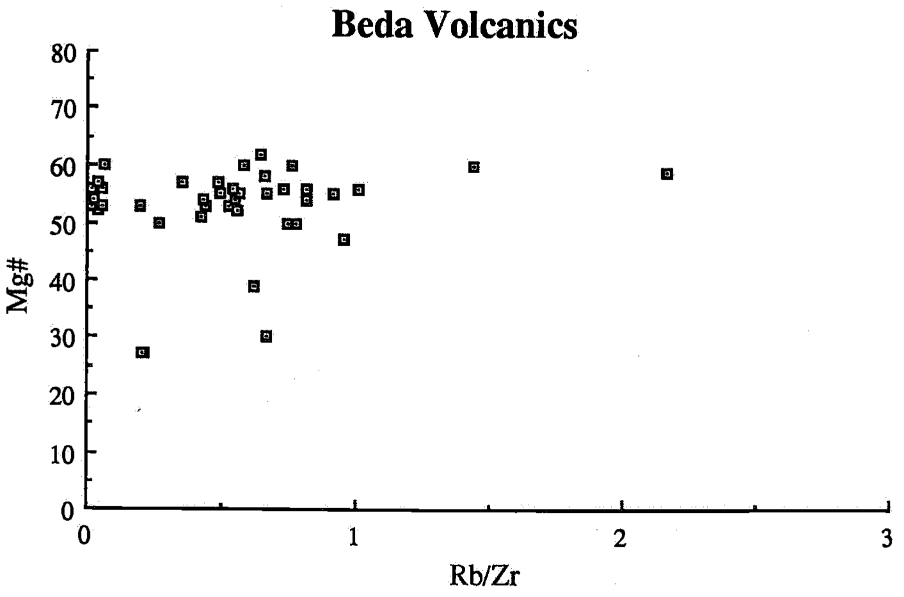
Figure 4 Graphs of Rb/Zr, Sr/Zr, Ba/Zr and K2O/Zr Versus Mg# for the Beda Volcanics (see text for explanation)



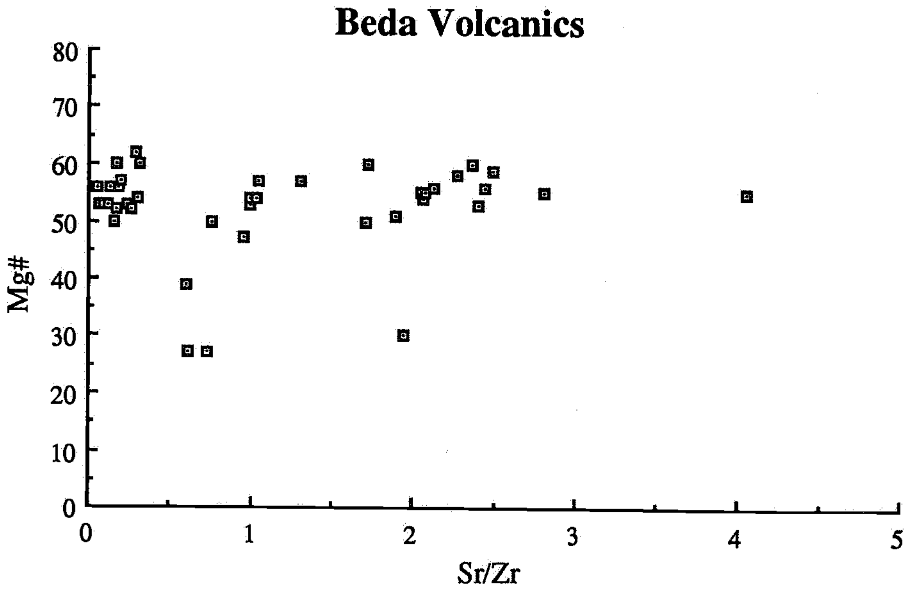
Beda Volcanics



Beda Volcanics

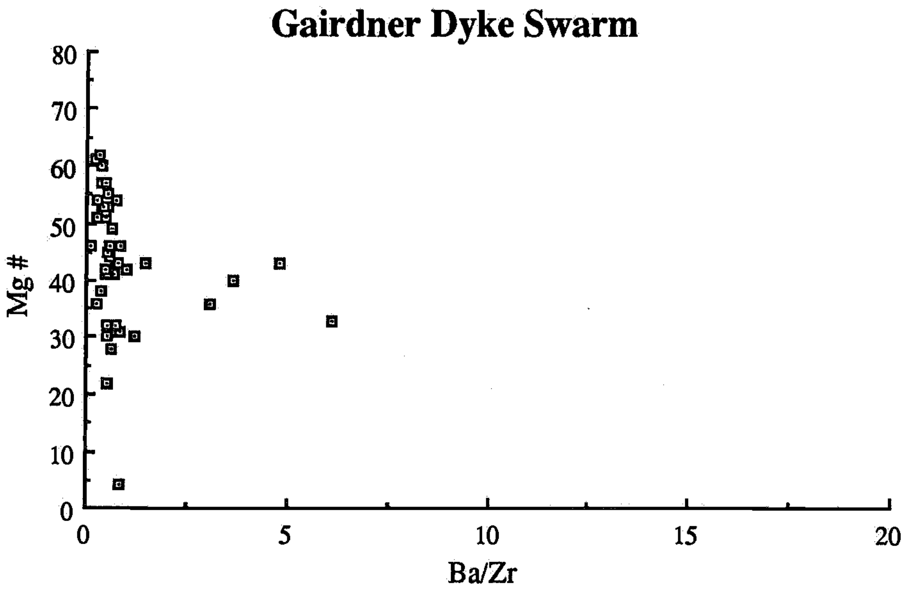


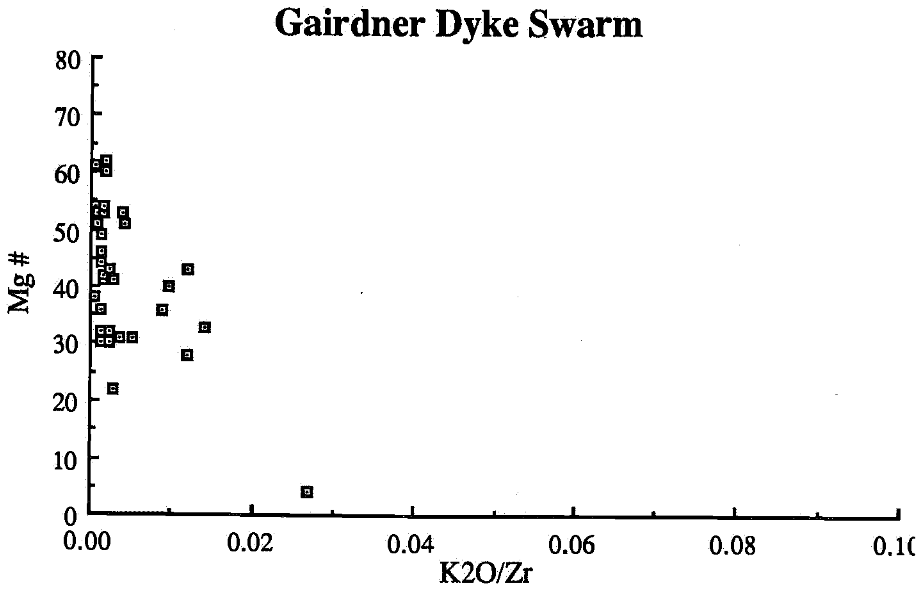
Beda Volcanics

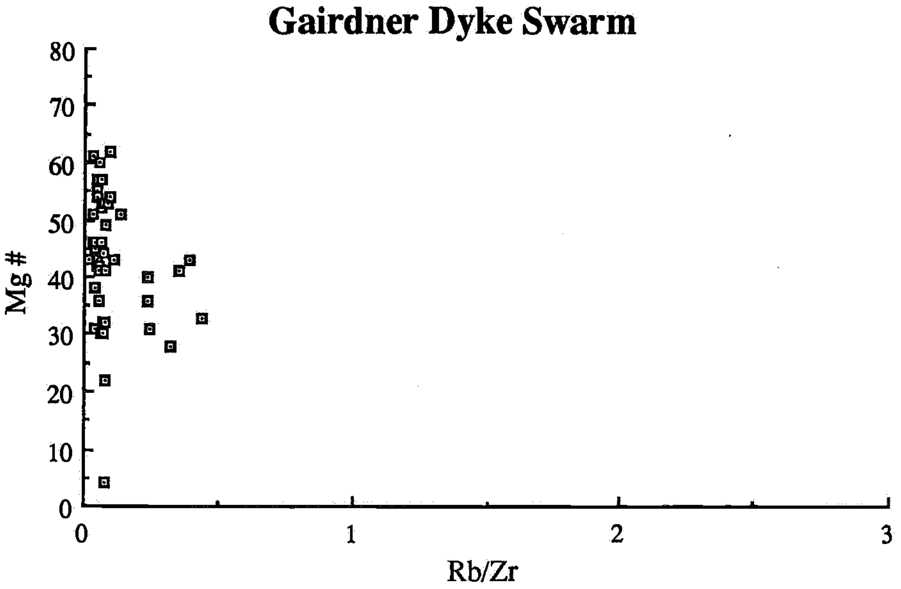


Beda Volcanics

Figure 5 Graphs of Rb/Zr, Sr/Zr, Ba/Zr and K2O/Zr Versus Mg# for the Gairdner Dyke Swarm (see text for explanation)


Gairdner Dyke Swarm


Gairdner Dyke Swarm


Gairdner Dyke Swarm

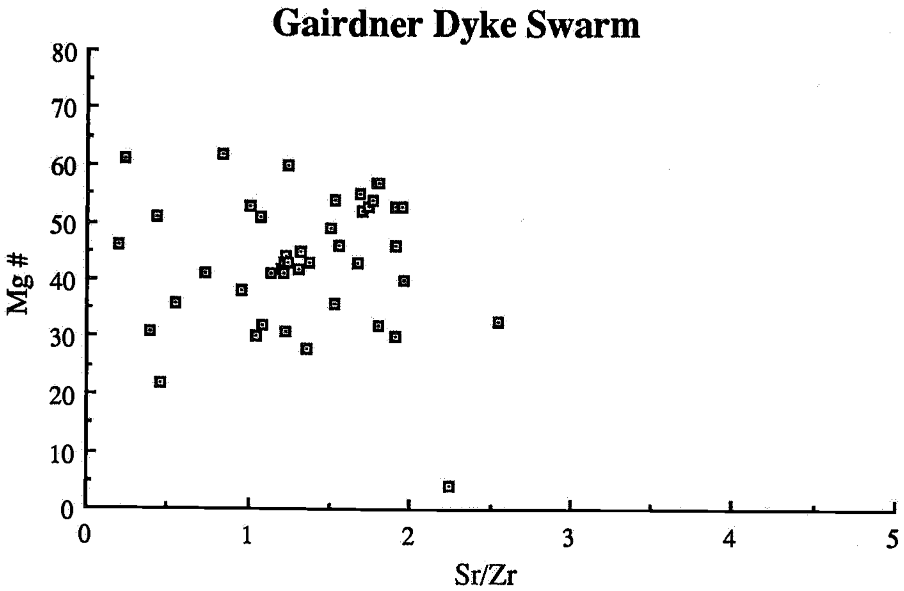
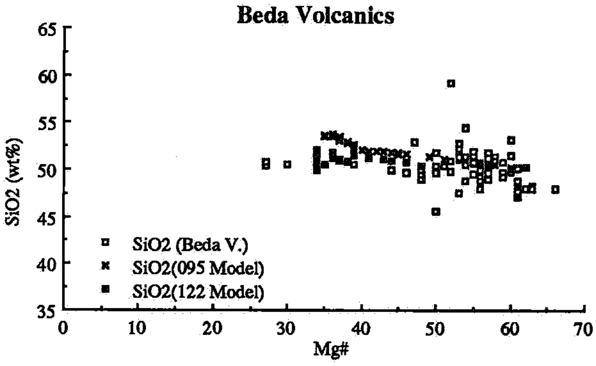
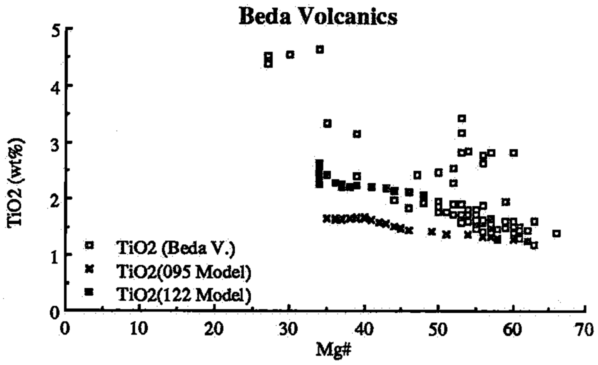
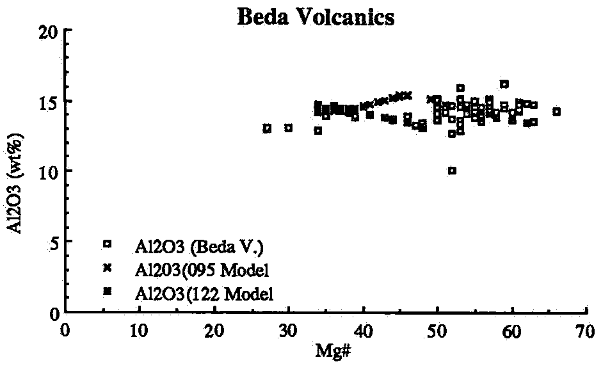
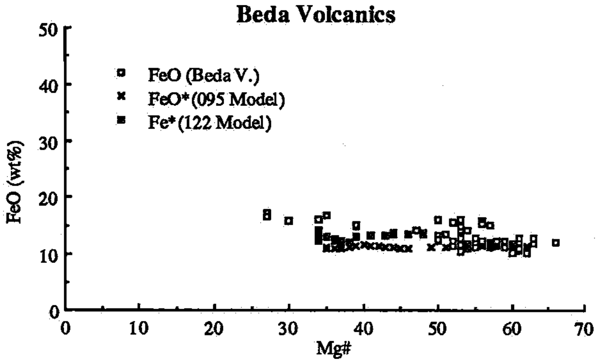

Gairdner Dyke Swarm

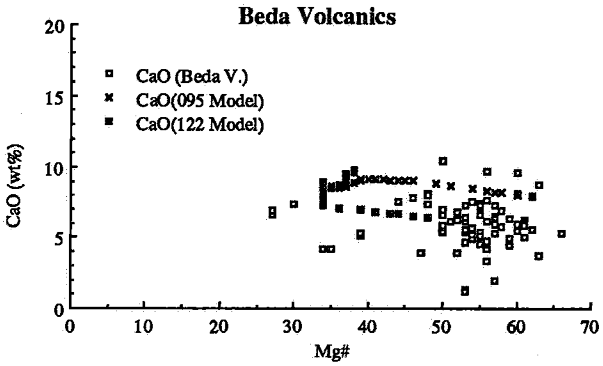
Figure 6 Graphs of Major Elements Versus Mg# for the Beda Volcanics Including the Theoretical Results Generated by Magmodel

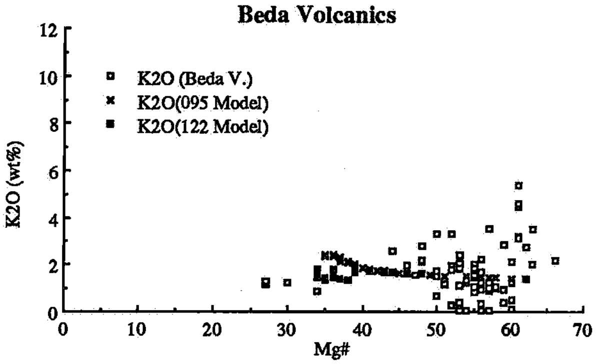

Beda Volcanics


Beda Volcanics


Beda Volcanics


Beda Volcanics


Beda Volcanics


Beda Volcanics

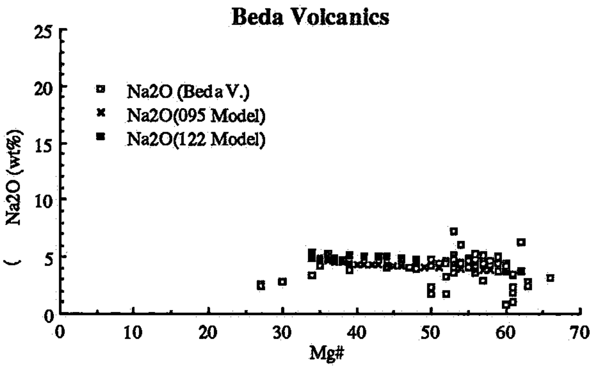
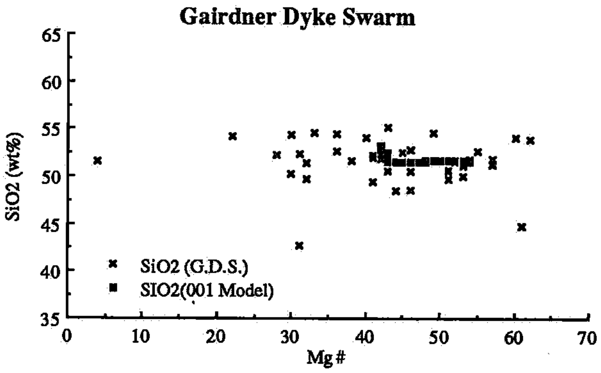
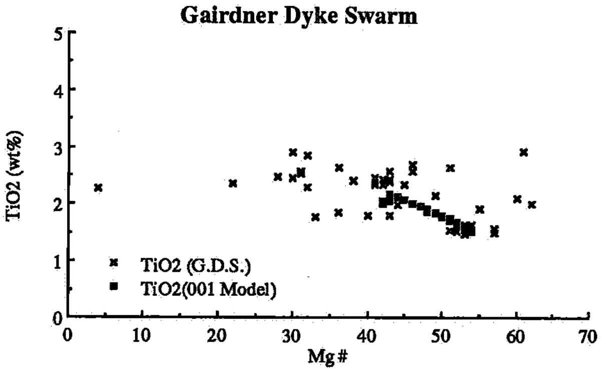
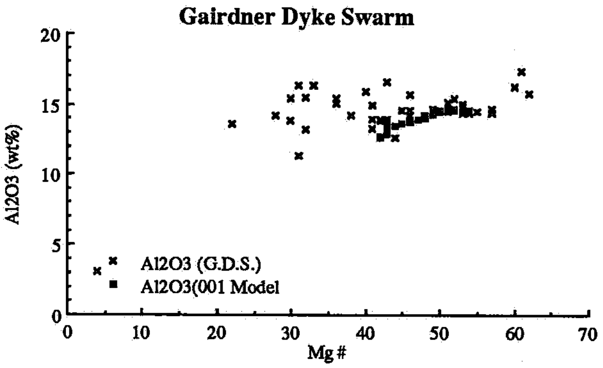
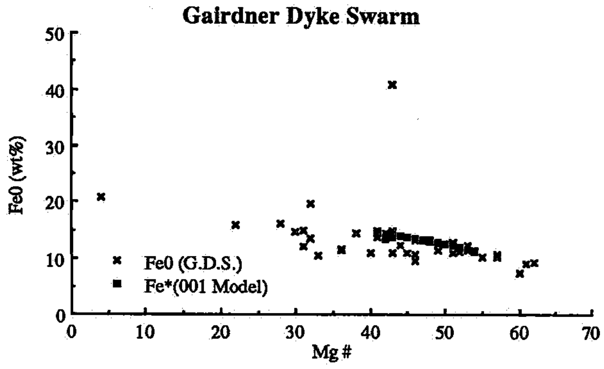

Beda Volcanics

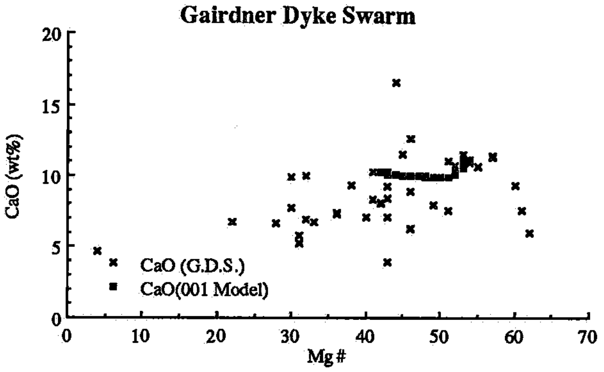
Figure 7 Graphs of Major Elements Versus Mg# for the Gairdner Dyke Swarm Including the Theoretical Results Generated by Magmodel

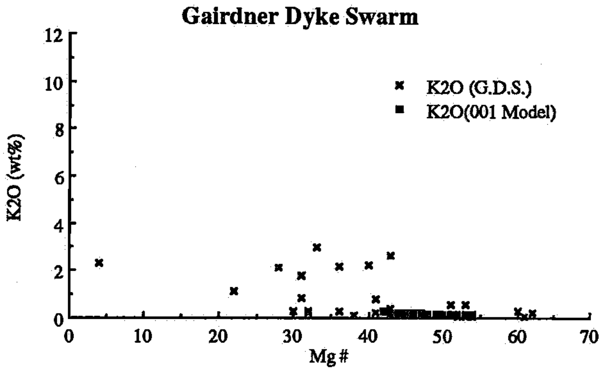

Gairdner Dyke Swarm
SiO2 (wt%)
65
60
55
50
45
40
35
0
10
20
30
40
50
60
70
Mg #
SiO2 (G.D.S.)
SIO2(001 Model)

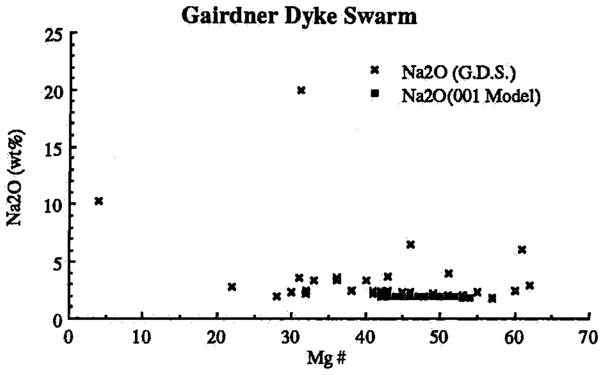

Gairdner Dyke Swarm
TiO2 (wt%)
5
4
3
2
1
0
0
10
20
30
40
50
60
70
Mg #
TiO2 (G.D.S.)
TiO2(001 Model)


Gairdner Dyke Swarm
Al2O3 (wt%)
20
15
10
5
0
0
10
20
30
40
50
60
70
Mg #
Al2O3 (G.D.S.)
Al2O3(001 Model)


Gairdner Dyke Swarm
Fe0 (wt%)
50
40
30
20
10
0
0
10
20
30
40
50
60
70
Mg #
Fe0 (G.D.S.)
Fe*(001 Model)


Gairdner Dyke Swarm
CaO (wt%)
20
15
10
5
0
0
10
20
30
40
50
60
70
Mg #
CaO (G.D.S.)
CaO(001 Model)


Gairdner Dyke Swarm
K2O (wt%)
12
10
8
6
4
2
0
0
10
20
30
40
50
60
70
Mg #
K2O (G.D.S.)
K2O(001 Model)


Gairdner Dyke Swarm
Na2O (wt%)
25
20
15
10
5
0
0
10
20
30
40
50
60
70
Mg #
Na2O (G.D.S.)
Na2O(001 Model)

Chapter 5 GEOCHEMISTRY - Discrimination Diagrams

5.1 INTRODUCTION

A number of discrimination diagrams have been presented over the years to determine the tectonic setting of basic volcanics. For the purpose of this investigation, I will use graphs developed by Pearce and Cann (1973), Floyd and Winchester (1974), Shervais (1982), Nisbet and Pearce (1977), Pearce *et al..* (1977) and Pearce and Norry (1979) to determine the tectonic setting of the basic volcanics.

5.2 FLOYD AND WINCHESTER Nb/Y - Zr/P_2O_5 PLOT

Floyd and Winchester (1975) have developed a number of discrimination diagrams to determine the tectonic setting of the basic volcanics. Their best diagram involves the system Nb/Y - Zr/P_2O_5. Tholeiitic basalts plot in a horizontal field, whilst alkali basalts plot in a vertical field. All the volcanic suites plot in the tholeiitic field (figure 8), with sufficient spread to suggest they are continental, not oceanic basalts.

5.3 SHERVAIS V - Ti PLOT

Shervais (1982) suggested the use of Ti and V in determining the tectonic setting of basalts. Tholeiitic flood basalts are confined between the Ti/V ratios of 20 and 50. All the volcanic suites plot in the tholeiitic flood basalt field, covering the same area as basalts from the Columbia River Plateau (Shervais, 1982) (Figure 9). The Beda Volcanics and Gairdner Dyke Swarm scatter into the ocean floor basalts field due to the anomalous high Ti values.

5.4 PEARCE AND CANN Ti - Zr - Y PLOT

In 1973, Pearce and Cann introduced a number of discrimination diagrams for basic igneous rocks. Their best diagram involved the most immobile elements; Ti, Zr and Y. The diagram discriminates between ocean floor basalts (O.F.B.), low potassium tholeiites (L.K.T.), calk-alkaline basalts (C.A.B.) and within plate basalts (W.P.B.) (Figure 10). The fractionated Beda Volcanics plot in the W.P.B. field and the least fractionated specimens from SAS-1 and SAU-3 plot on the boundary of the L.K.T. and W.P.B. fields. The same is true for the Wooltana Volcanics. The majority of the Gairdner Dyke Swarm and Port Pirie Volcanic samples plot in the W.P.B. field. In general all the suites except the Port Pirie Volcanics plot in the upper more enriched Ti field of the W.P.B. field. The Port Pirie Volcanics plot in the lower Ti field.

5.5 PEARCE AND NORRY Zr - Y PLOT

Pearce and Norry (1979) suggested the use of Zr and Y to discriminate between (W.P.B.), island arc basalts (I.A.B.) and mid-ocean ridge basalts (M.O.R.B.). All the volcanic suites plot in the W.P.B. field, except for the Wooltana Volcanics and the early fractionates from the Beda Volcanic suite which plot in the M.O.R.B. field, since they are not as enriched in Ti as a typical within plate basalt (Figure 11).

5.6 CLINOPYROXENE DISCRIMINATION DIAGRAM

Nisbet and Pearce (1977) suggested that microprobe analysis of relict clinopyroxene crystals can be used to identify the magma of the host lava. They suggest that the geochemical differences between clinopyroxenes of different magma types can be explained by : the chemical composition and structure of the melt, partitioning into the pyroxene lattice, temperature controls, and the crystallisation history of the melt. A graph of TiO_2 versus SiO_2 best discriminates between O.F.B., W.P.T., W.P.A. and V.A.B. (volcanic arc basalts). The clinopyroxenes from both the Port Pirie and Beda Volcanics plot in the W.P.T. and the V.A.B. field (Figure 12). The W.P.T. discrimination field relies heavily on the low TiO2 content in tholeiitic basalts, originally noted by Pearce and Cann (1973). The samples that plot in the volcanic arc are depleted in SiO_2, as a result of the mobilization and alteration that has taken place in the system.

5.7 PEARCE'S SPIDERGRAMS

5.7.1 INTRODUCTION

The extrusion of magma through a 35-40 km thickness of continental crust provides great potential for contamination. However, the compositional uniformity of large volumes of continental magma from all over the world can be explained by the buffering of major trace element abundances during fractional crystallisation (Weaver and Tarney, 1983). It is known that when basalts erupt in within plate settings they are enriched in incompatible elements compared to MORB's. The least incompatible Y and Yb are the least enriched and Ba, Th and Ta show the most enrichment, giving the characteristic humped pattern on Peace's MORB normalized spidergrams (Pearce *et al..*, 1983).

In 1982 Pearce suggested the use of MORB normalized spidergrams to compare the composition of trace elements between different continental suites. Within plate basalts are enriched in low ion lithophile elements, but not in immobile elements relative to MORB's.

5.7.2 ADELAIDE GEOSYNCLINE AND STUART SHELF VOLCANICS

A plot of the Depot Creek, Beda, Wooltana and Port Pirie Volcanics, and the Gairdner Dyke Swarm all show the characteristic within plate pattern (figure 13a). The only variation between the suites exists between the mobile elements Sr, K, Rb and Ba. As I have shown, a lot of alteration has taken place in the system with considerable movement of the mobile elements. The immobile elements show a near perfect correlation.

5.7.3 KAROO VOLCANICS

Figure 13a also shows the comparison of the Adelaide Geosyncline and Stuart Shelf Volcanics with volcanics from the Central Karoo Province, South Africa. The Central Karoo Province is described as a typical rift setting with accompanying tholeiitic flood basalts instigated in the Jurassic during the initial break up of Gondwana (Marsh and Eales, 1984). With the exception of the mobile elements, the trace element composition of the Karoo Volcanics is very similar to the South Australian volcanics.

When the Stuart Shelf and Adelaide Geosyncline basalts are normalized with the average Central Karoo basalt, as shown in figure (13b) , a wider variation is more apparent. The South Australian suites are depleted in Sr and Cr and enriched in K, Rb, Ba and Ti relative to the Karoo basalts, but no suite varies greatly from the main trend. The Gairdner Dyke Swarm has the most similar trace element signature.

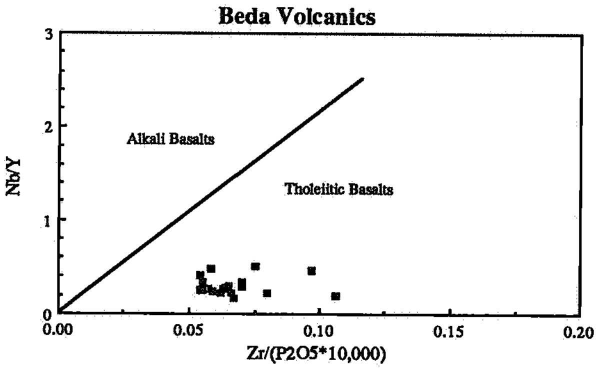
5.7.3. NORTHERN UTAH AND SOUTHEASTERN IDAHO VOLCANICS

The norhtern Utah and southeastern Idah Volcanics are Upper Proterozoic in age. They are thought to be associated with the rifting in the Cordilleran miogeocyncline. Using an adaptation of Pearce's MORB normalized plot (Figure 13c), the Adelaide Geosyncline and Stuart Shelf Volcanics have similar trace element signatures to the Idaho and Utah Volcanics. The Utah and Idaho Volcanics are not as enriched in the mobile elements as the South Australian volcanics, but as with the Karoo Volcanics they have very similar immobile elements.

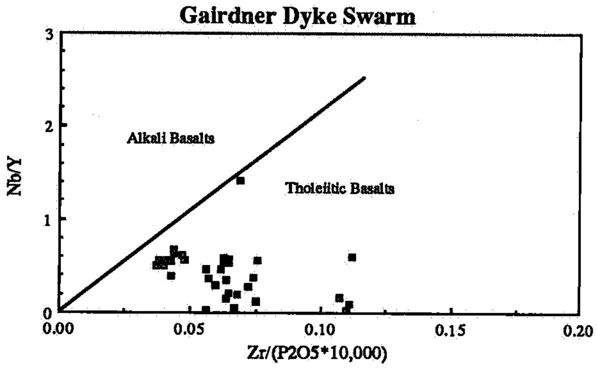
When the South Australian Volcanics are normalized by the averaged Utah and Idaho Volcanics (Figure 13d), the South Australian volcanics are enriched in K, Rb and Ba and depleted in Sr and Nb. The enrichment of the mobile elements is due to the high mobility of the system.

Figure 8 Floyd and Winchester Nb/Y - Zr/P_2O_5 Plots
(after Floyd and Winchester, 1975)

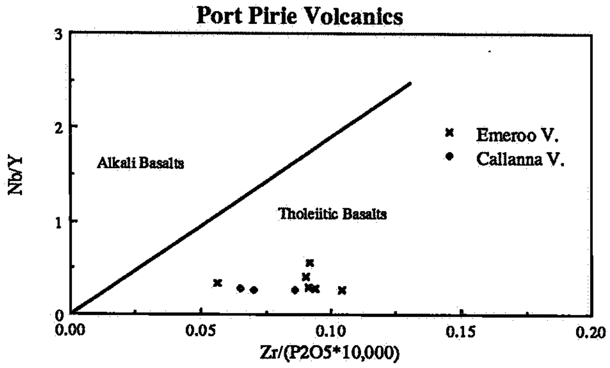
Figure 9 Shervais V - Ti Plots
(adapted from Shervais, 1982)



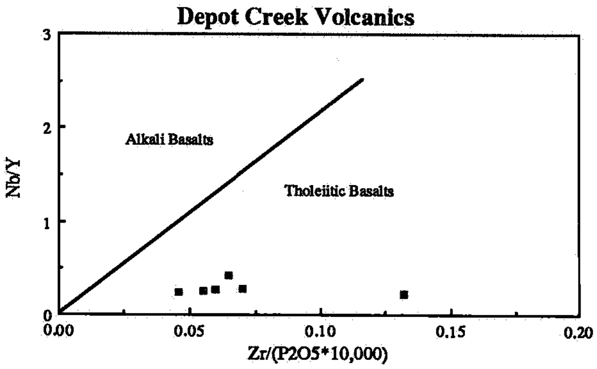
Beda Volcanics



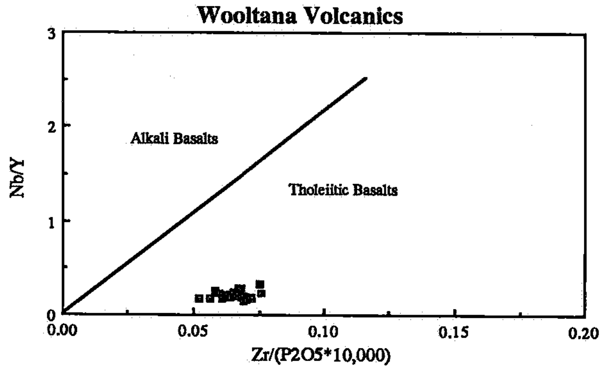
Gairdner Dyke Swarm



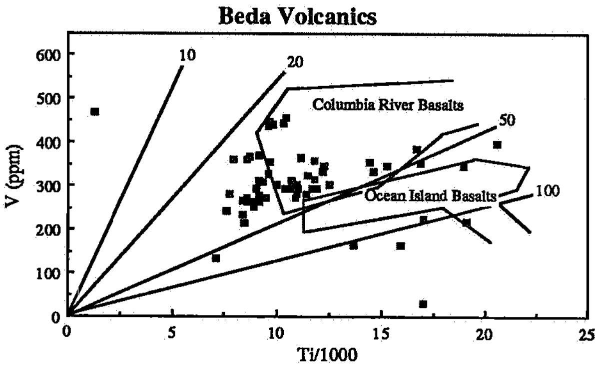
Port Pirie Volcanics



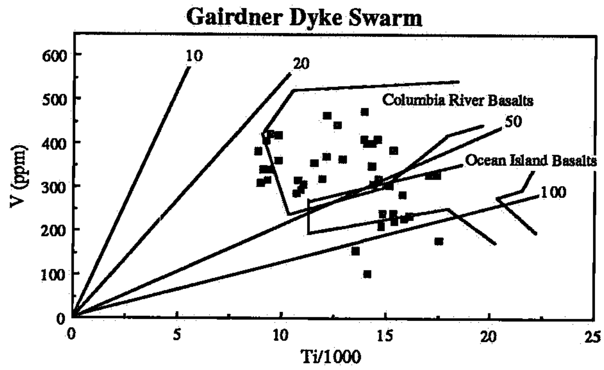
Depot Creek Volcanics



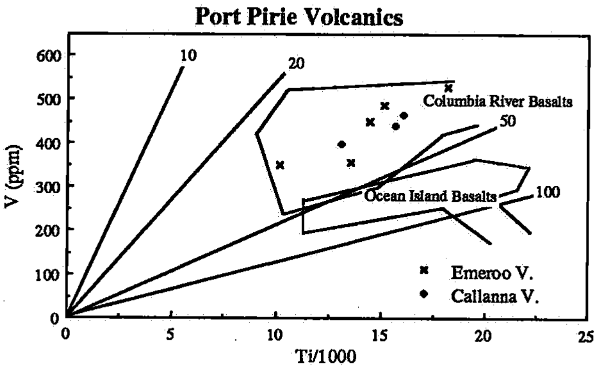
Wooltana Volcanics



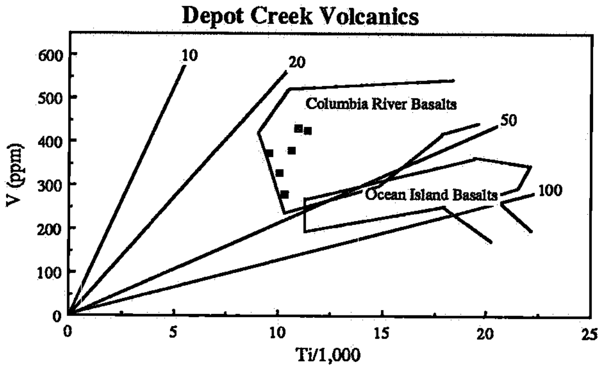
Beda Volcanics



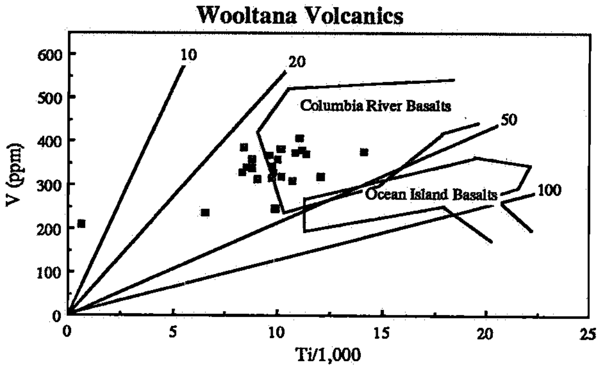
Gairdner Dyke Swarm



Port Pirie Volcanics

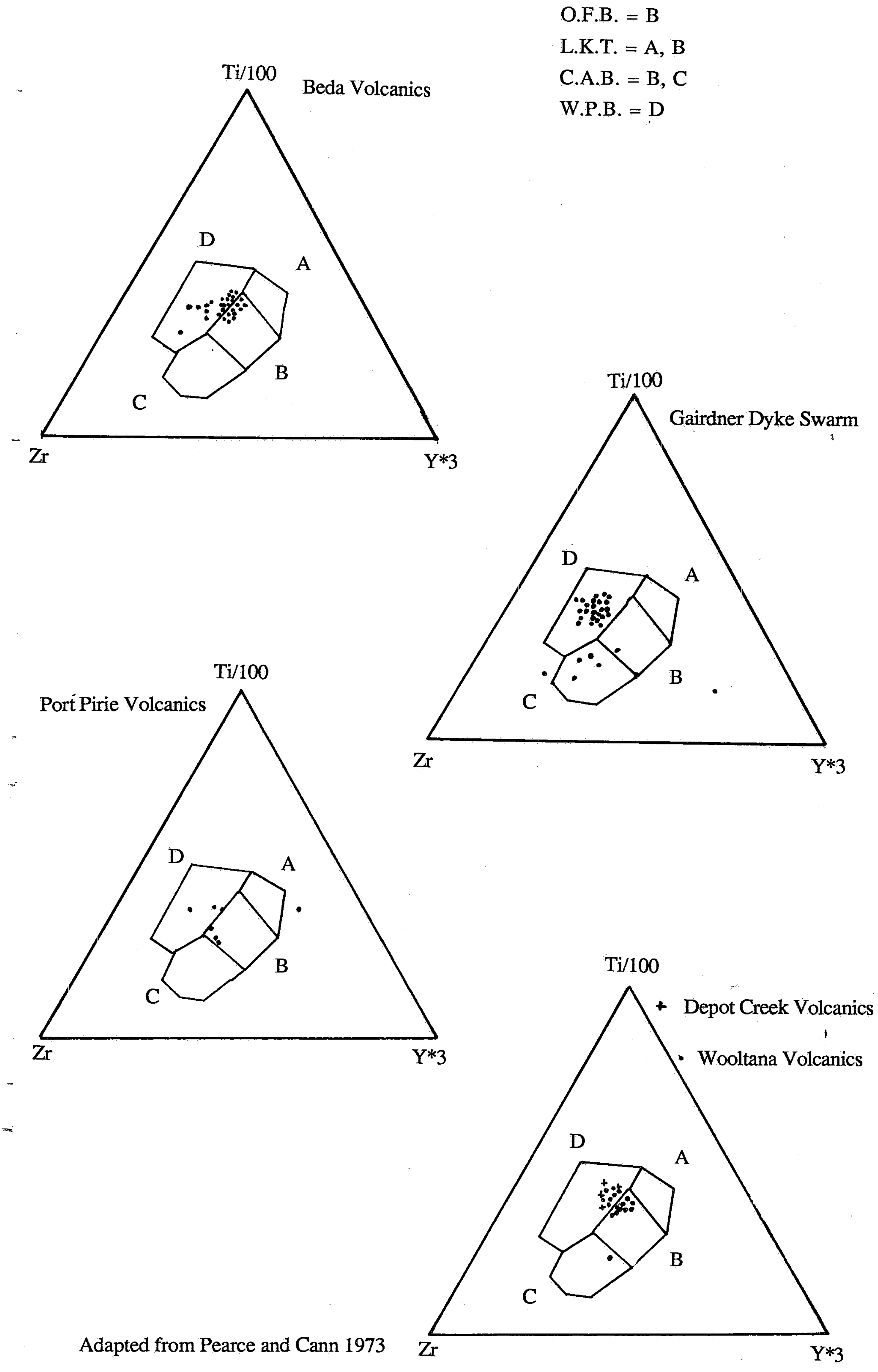


Depot Creek Volcanics



Wooltana Volcanics

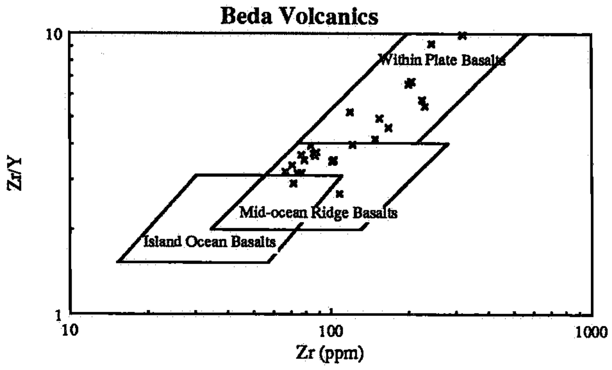
Figure 10 Pearce and Cann Ti - Zr - Y Plots
(adapted from Pearce and Cann, 1973)

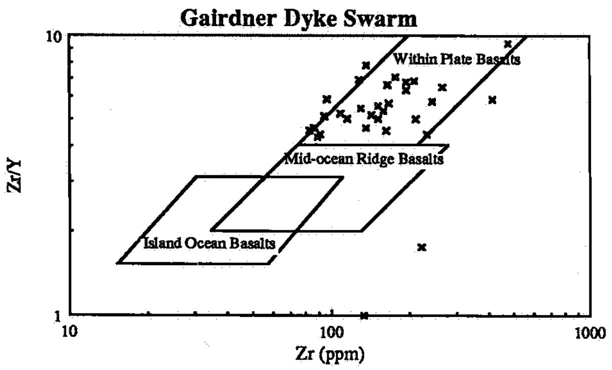


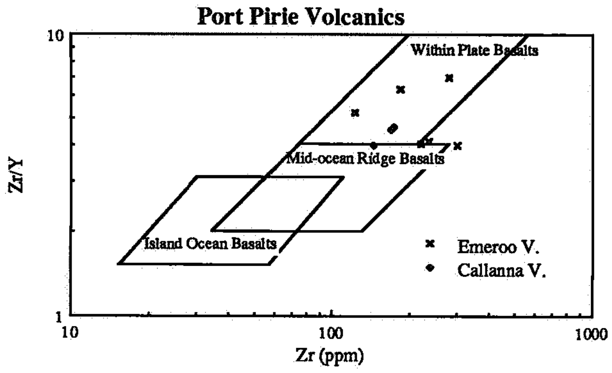
Adapted from Pearce and Cann 1973

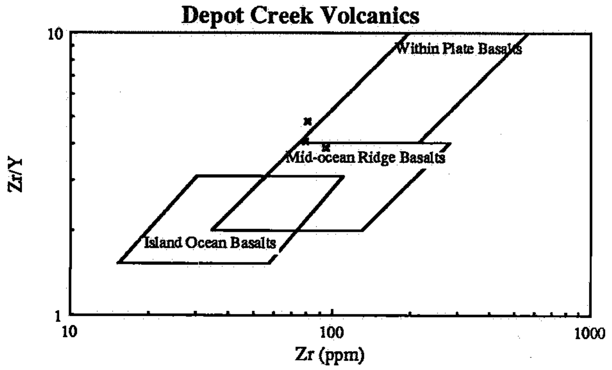
Figure 11 Pearce and Norry Zr - Y Plots
(adapted from Pearce and Norry, 1979)

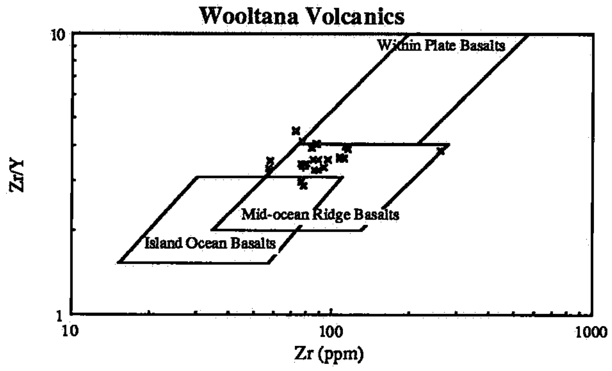
Figure 12 Clinopyroxene Discrimination Plots
(adapted from Nisbet and Pearce, 1977)

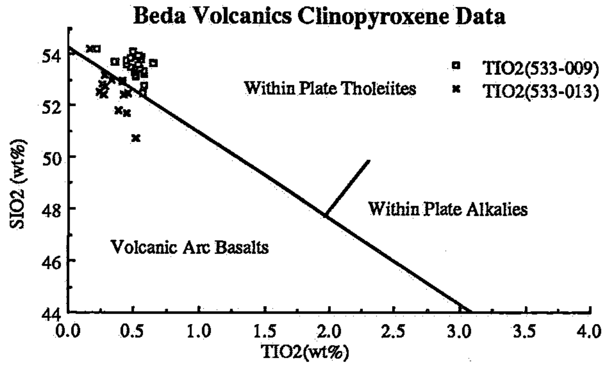

Beda Volcanics


Gairdner Dyke Swarm


Port Pirie Volcanics


Depot Creek Volcanics


Wooltana Volcanics


Beda Volcanics Clinopyroxene Data

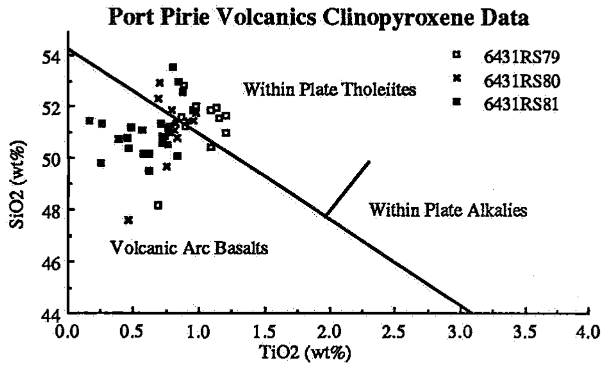
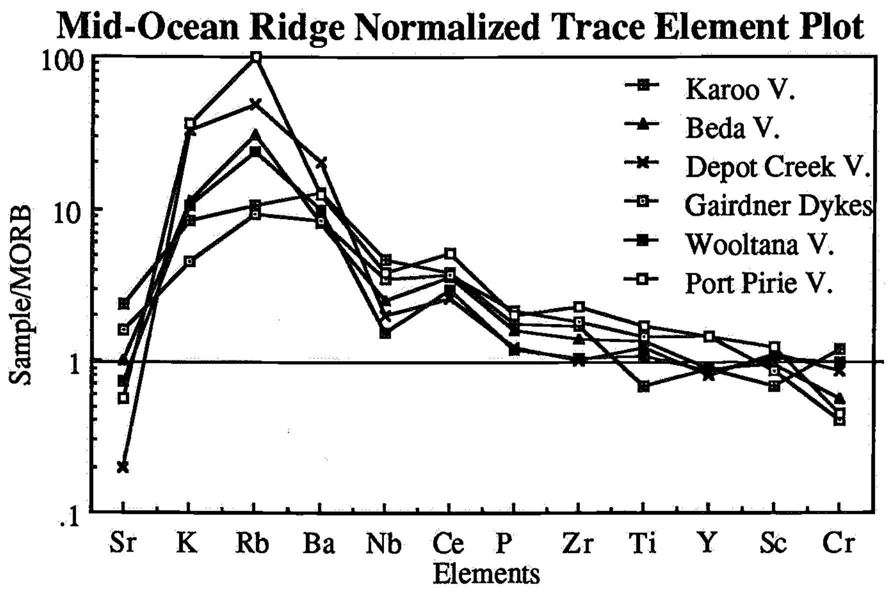

Port Pirie Volcanics Clinopyroxene Data

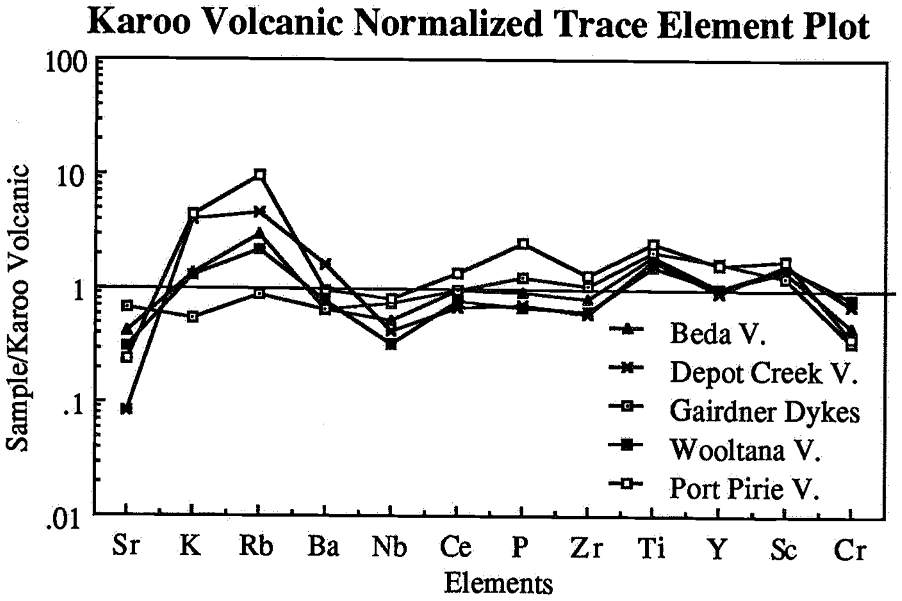
Figure 13a Stuart Shelf, Adelaide Geosyncline and Karoo Basalts Normalized by an Average Mid-Ocean Ridge Basalt
(adapted from Pearce, 1983)

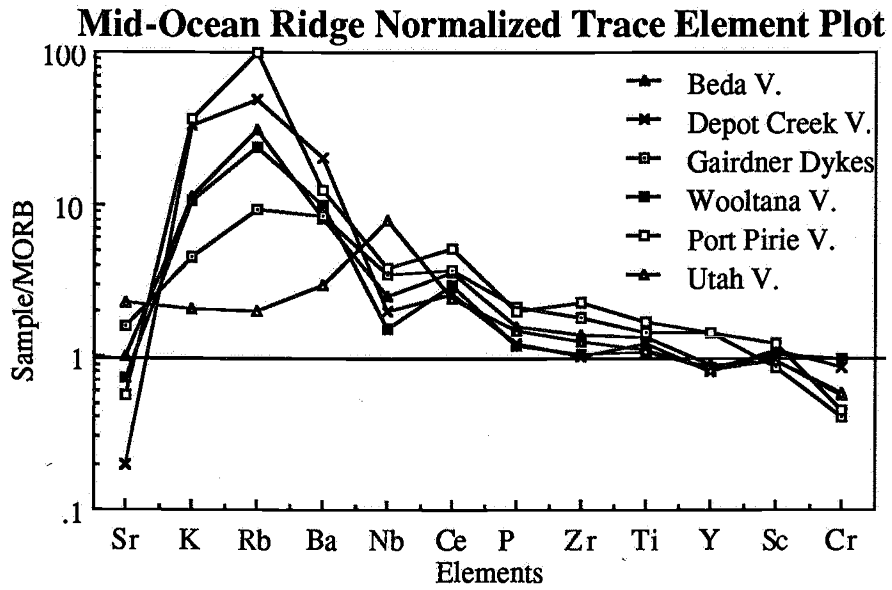
Figure 13b Stuart Shelf and Adelaide Geosyncline Basalts Normalized by an Average Karoo Basalt
(adapted from Pearce, 1983)

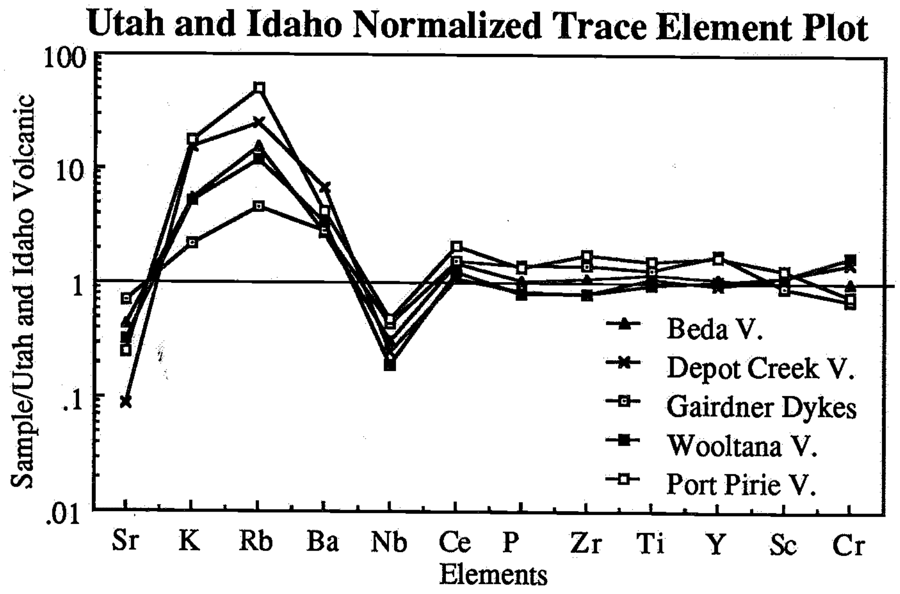
Figure 13c Stuart Shelf, Adelaide Geosyncline and Northern Utah and Southeastern Idaho Basalts Normalized by an Average Mid-Ocean Ridge Basalt
(adapted from Pearce, 1983)

Figure 13d Stuart Shelf and Adelaide Geosyncline Basalt Normalized by an average Northern Utah and Southeastern Idaho Basalts
(adapted from Pearce, 1983)


Mid-Ocean Ridge Normalized Trace Element Plot


Karoo Volcanic Normalized Trace Element Plot


Mid-Ocean Ridge Normalized Trace Element Plot


Utah and Idaho Normalized Trace Element Plot

Chapter 6 DISCUSSION AND CONCLUSION

6.1 PETROLOGY AND GEOCHEMISRTY

Initially, the petrology and geochemistry of the volcanics of the Stuart Shelf and the Adelaide Geosyncline appear similar, with the exception of the Port Pirie Volcanics.

The similar geochemical trends suggest the Beda, Depot Creek and Wooltana Volcanics originated from the same or a closely related system of crustal magma chambers at approximately the same time. Initially they were quite primitive, with a Zr concentration between 60 - 100 ppm. The Depot Creek and Wooltana Volcanics are the least fractionated members of the system, their highest Zr content reaching approximately 120 ppm. The Beda Volcanics and Gairdner Dyke Swarm were extruded over a much longer period of time, with the final extrusions being highly fractionated.

Closed analysis of the MgO, Ni and Cr suggest different paths of fractional crystallisation for the Beda, Wooltana and Depot Creek Volcanics and the Gairdner Dyke Swarm. The Volcanics are controlled by low pressure fractionation minerals, mainly olivine and later plagioclase and augite. The Gairdner Dyke Swarm is controlled by greater pressure fractionation minerals, i.e. olivine, plagioclase and augite simultaneously.

Computer simulation of the fractional crystallisation of the Beda Volcanics also implies that the main control of the magma chamber is olivine, and those of the Gairdner Dyke Swarm are plagioclase, augite and low calcium pyroxene. This would therefore suggest that the volcanics originated from a magma chamber that is higher in the crust than the Gairdner chamber. This would also explain why the Gairdner Dykes Swarms are so augite rich compared with the volcanics, they simply formed under different conditions. The main crystalising mineral in the dykes is augite and plagioclase, and thus they are more likely to crystalise.

If the Gairdner Dyke Swarm originated from three separate crustal magma chambers (Ti and V data suggest this), which are distinct from the volcanic magma chambers, it is incorrect to suggest they are feeder dykes to the volcanics, as they simply would have been co-magmatic events. Due to the close proximity of the volcanic magma chambers to the rift, they developed at higher levels in the crust as a result of a highly tensional regime. The Gairdner Dyke Swarms developed at a lower depth as a result of their greater distance from the rift and concomitant reduced tension. All the igneous activity in the Willouran Age stemmed from the same mantle magma chamber as the most mafic members of each suite are geochemically similar, and the magma chamber tapped off into the crust to form many smaller magma chambers in the crust. The fractionated geochemistry was controlled by their depth in the crust.

Stratigraphically and geochemically the Port Pirie Volcanics do not appear to have been extruded at the same time as the other volcanics. Harker diagrams of the Port Pirie Volcanics indicate that the Emeroo Volcanics are later fractionates from the same source as the Callanna Volcanics. Trends involving both occur with FeO, P_2O_5, TiO_2, Y, V, Sc, Nd, MgO, Ni and Cr. The Callanna Volcanics are enriched in MgO, Ni, and Cr relative to the Emeroo Volcanics, which suggests that the presence of pyroxene is simply a function of the Callanna Volcanics being the least fractionated member of the same suite. The Emeroo Volcanics are interbedded with Burra Group sediments, which implies they, and hence the Callanna Volcanics, are stratigraphically younger than the other suites studied.

6.2 COMPARISON WITH OTHER RIFT VOLCANICS

The basic volcanics of the Adelaide Geosyncline and Stuart Shelf compare favourably with the rift volcanics of the Central Karoo Province and of northern Utah and southeastern Idaho. The South Australian volcanics are enriched in K, Rb, and B and depleted in Sr and Nb due to the higher degree of alteration the suites have undergone. However, the immobile elements are neither enriched nor depleted relative to the other rift volcanics of the world and thus suggest a similar origin and tectonic setting.

There is a favourable comparison of the rift volcanics of different ages, i.e. the South Australian and North American Volcanics of the Late Proterozoic, and the Karoo Volcanics of the Jurassic. This suggests that the mantle has not altered greatly from the Proterozoic through to the Jurassic, a time difference of some seven hundred million years. We would expect the older volcanics to be slightly enriched in incompatible elements relative to the younger volcanics. The South Australian and Utah and Idaho Volcanics are indeed enriched slightly in P, Ti and Sc relative to the Karoo Basalts.

6.3 CONCLUSION

Using data presented from petrological and geochemical study, the Beda, Depot Creek and Wooltana Volcanics and the Gairdner Dyke Swarm represent tholeiitic volcanic activity associated with the doming phase of the Spencer Gulf rift in the Willouran age, i.e. tholeiitic basalts erupted in a within plate setting. All the volcanics originally came from the same mantle magma chamber, but their crustal magma chambers developed at different depths and pressures as a function of their distance from the rift, resulting in different fractional crystallisation processes.

Using the data presented, the Gairdner Dykes are not feeder dykes to the Beda Volcanics but are simply a co-magmatic event. The Port Pirie Volcanics are younger than the other volcanics mentioned, and represent flood basalts associated with the reactivation of the rift in the Torrensian age.

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REFERENCES

Blisset, A.H., 1985. EXPLANATORY NOTES FOR THE GAIRDNER 1:250,000 GEOLOGICAL MAP SHEET AH/53-15. Geological Survey of South Australia.

Compston,W., Crawford, A.R. and Bofinger, V.M., 1966. A RADIOMETRIC ESTIMATE OF THE DURATION OF SEDIMENTATION IN THE ADELAIDE GEOSYNCLINE, SOUTH AUSTRALIA. Journal of the Geological Society of Australia, 13, pp. 229-276.

C.S.R., 1986. FINAL TECHNICAL REPORT ON EXPLORATION LICENCE 973, LAKE TORRENS AREA, S.A.. EMR 177/86

Dalgarno, C.R., Johnson, J.E., Forbes, B.G. and Thompson, B.P., 1968. PORT AUGUSTA MAP SHEET, GEOLOGICAL ATLAS OF SOUTH AUSTRALIA, 1:250,000 SERIES. Geology Survey of South Australia.

Dampier Mining Company, 1981. EXPLORATION LICENCE 654. TREGOLANA - SUGARLOAF HILL, SOUTH AUSTRALIA. Report for the quarter ending 30th June, 1981. EL 3915.

Dampier Mining Company, 1982. EXPLORATION LICENCE 645. CULTANA, SOUTH AUSTRALIA. El 3917.

Duncan, A.R., Erlank, A.J. and Marsh, J.S., 1984. REGIONAL GEOCHEMISTRY OF THE KAROO IGNEOUS PROVINCE. In the Petrogenesis of the Volcanic Rocks of the Karoo Province - Eds. Erlank, A.J.. Special Publication of the Geology Society of South Africa No 13 pp. 355-388.

Fanning, G.M., Flint, R.B. and Preiss, W.V., 1983. GEOCHRONOLOGY OF THE PANDURRA FORMATION. Geological Society of South Australia Quarterly Geological notes, No 88.

Floyd, P.A. and Winchester, J.A., 1975. MAGMA TYPE AND TECTONIC SETTING DISCRIMINATION USING IMMOBILE ELEMENTS. Earth and Planetary Science Letters, 27 pp. 211-218.

Green, D.H. and Ringwood, A.E., 1967. THE GENESIS OF BASALTIC MAGMAS. Contributions to Mineralogy and Petrology, 15 pp. 103-190.

Gunn, P.J., 1984. RECOGNITION OF ANCIENT RIFT SYSTEMS: EXAMPLES FROM THE PROTEROZOIC OF SOUTH AUSTRALIA. Exploration Geophysics 15, pp. 85-97.

Harper, G.D. and Link, P.K., 1986. GEOCHEMISTRY OF UPPER PROTEROZOIC RIFT-RELATED VOLCANICS, NORTHERN UTAH AND SOUTHEASTERN IDAHO. Geology, vol. 14, pp. 864-867.

Hörr, G.M., 1977. PRECAMBRIAN SPILLITES AND THE PANDURRA FORMATION OF THE STUART SHELF, NEAR PORT AUGUSTA, SOUTH AUSTRALIA. University of Adelaide Honours thesis (unpublished).

Mason, B. and Moore, C.B., 1982. PRINCIPLES OF GEOCHEMISTRY. John Wiley and Sons, U.S.A..

Mason, M.G., Thompson, B.P. and Tonkin, D.G., 1978. REGIONAL STRATIGRAPHY OF THE BEDA VOLCANICS, BACKY POINT BEDS AND PANDURRA FORMATION ON THE SOUTHERN STUART SHELF, SOUTH AUSTRALIA. Quarterly Geological Notes, Geological Survey of South Australia, No 66, pp. 2-9.

Mason, V., 1967. GEOCHEMISTRY OF BASALTIC ROCKS: MAJOR ELEMENTS. 271-324 in Hess, H.H. and Poldervaart, A. - Eds., Basalts, vol. 1 Interscience, New York 482 pp.

Marsh, J.S. and Eales, H.V., 1984. THE CHEMISTRY AND PETROGENESIS OF IGNEOUS ROCKS OF THE KAROO CENTRAL AREA, SOUTHERN AFRICA. Special Publication of the Geological Society of South Africa, 13 pp. 27-67.

Mawson, D. and Sprigg, R. 1950. SUBDIVISION OF THE ADELAIDE SYSTEM. Australian Journal of Science vol 13 (3), pp. 69-72.

Nathan , H.D. and Van Kirk, C.K., (1978). A MODEL OF MAGMATIC CRYSTALLIZATION. Journal of Petrology vol 19, pp. 66-94.

Nisbet, E.G. and Pearce, J.A. (1977). CLINPYROXENE COMPOSITION IN MAFIC LAVAS FROM DIFFERENT TECTONIC SETTINGS. Contributions to Mineralogy and Petrology, vol 63, pp. 149-160.

Parker, A.J., Rickwood, P.C., Baillie, P.W., Boyd, D.M., Freeman, M.J., McClenaghan, M.P., Murray, C.G., Myers J.S. and Pietsch, B.A., 1985. MAFIC DYKE SWARMS OF AUSTRALIA. Geological Association of Canada Special Publication on Mafic Dyke Swarms, Proceedings of the International Dyke Conference, Toronto.

Pearce, J.A., 1982. TRACE ELEMENT CHARACTERISTICS OF LAVAS FROM DESTRUCTIVE PLATE BOUNDARIES. In Andesites Ed Thorpe, R.S., John Wiley and Sons.

Pearce, J.A., 1983. ROLE OF THE SUB-CONTINENTAL LITHOSPHERE IN MAGMA GENESIS AT ACTIVE CONTINENTAL MARGINS. In Continental Basalts and Mantle Xenoliths - Eds. Hawkesworth, C.J., and Norry, M.J., pp. 230-249.

Pearce, J.A. and Cann, J.A., 1973. TECTONIC SETTING OF BASIC VOLCANIC ROCKS DETERMINED USING TRACE ELEMENT ANALYSES. Earth and Planetary Science Letters 19, pp. 290-300.

Pearce, J.A. and Norry, M.J., 1979. PETROGENETIC IMPLICATIONS OF Ti, Zr, Y AND Nb VARIATIONS IN VOLCANIC ROCKS. Contributions to Mineralogy and Petrology, vol 69, pp. 33-47.

Preiss, W.V. and Sweet I.P., 1966. THE GEOLOGY OF THE DEPOT CREEK AREA, FLINDERS RANGES, SOUTH AUSTRALIA. University of Adelaide Honours thesis (unpublished).

Preiss, W., 1983. GEOLOGICAL MAP OF THE ADELAIDE GEOSYNCLINE SCALE 1:1,000,00. South Australian Department of Mines and Energy.

Prinz, M., 1967. GEOCHEMISTRY OF BASALTIC ROCKS: TRACE ELEMENTS. In Hes, H.H. and Poldervaart, A. - Eds., Basalts vol 1, pp. 271-324, Interscience, New York.

Rutland, R.W.R., Parker, A.J., Pitt, G.M., Preiss, W.V. and Murrell B., 1981. PRECAMBRIAN OF THE SOUTHER HEMSPHERE. Edited by D.R. Hunter. Elsevier Scientific Publishing Company, New York.

Shervais, J.W., (1982). Ti - V PLOTS AND PETROGENESIS OF MODERN AND OPHITIC LAVAS. Earth and Planetary Sceince Letters, vol. 59, pp. 101-118.

Sprigg, 1952. SEDIMENTATION IN THE ADELAIDE GEOSYNCLINE AND THE FORMATION OF THE CONTINENTAL TERRACE. Sir Douglas Mawson Anniversary Volume, editors Glassner, M.F. and Rudd, E.A., University of Adelaide, pp. 153-159.

Thompson B.P., 1965. GEOLOGY AND MINERALIZATION OF SOUTH AUSTRALIA. 8th Commonwealth Mining and Metalurgy Congress of Auatralia and New Zealand, vol 1, pp. 270-284.

Thompson B.P., 1975. GAWLER CRATON - REGIONAL GEOLOGY. Australasian Insitute of Mining and Metalurgy Monographs, No 5, pp. 461 - 466.

Thompson B.P., (compiler), 1980. GEOLOGICAL MAP OF SOUTH AUSTRALIA 1:1,000,000 scale. Department of Mines and Energy, Adelaide.

Thompsom, B.P., Daily, B., Coats, R.P. and Forbes, B.G., 1976. LATE PRECAMBRIAN GEOLOGY OF THE ADELAIDE 'GEOSYNCLINE' AND STUART SHELF, SOUTH AUSTRALIA. 25th International Geological Congress, Excursion Guide No 33A.

Von der Borch, C.C., 1980. EVOLUTION OF LATE PROTEROZOIC TO EARLY PALEOZOIC ADELAIDE FOLD BELT, AUSTRALIA: COMPARISONS WITH POST-PERMIAN RIFTS AND PASSIVE MARGINS. Tectonophysics 70, pp. 115-134.

Webb, A.W., and Coats, R.P., 1980. A REASSESSMENT OF THE AGE OF THE BEDA VOLCANICS ON THE STUART SHELF, SOUTH AUSTRALIA. Department of Mines and Energy report book no 80/6 (unpublished).

Webb, A.W., and Hörr, G., 1978. THE RB-SR AGE AND PETROLOGY OF A FLOW FROM THE BEDA VOLCANICS. Quarterly Geological Notes, Geological Survey of South Australia, No 66, pp. 10-13.

Webb, A.W., Thompson, B.P., Blissett, A.H., Daly, S.J., Flint, R.B. and Parker, A.J., 1982. GEOCHRONOLOGY OF THE GAWLER CRATON. South Australian Department of Mines and Energy Report 82/86 (Unpublished).

APPENDIX 1

ANALYTICAL PROCEDURES, MAJOR AND TRACE ELEMENT ANALYSIS

Method of Whole Rock Analysis

Sample Preparation

1. The samples were trimmed of weathered edges using a rock saw.
2. Samples were crushed to a fine powder using a Siebtechnic tungsten carbide mill.
3. Powder for whole rock analysis was ignited overnight at 960^{o}c, and the loss of ignition was recorded.
4. 280 mg of each sample was combined with 1.5 g of flux and 20 mg of $NaNO_3$, then fused into discs for major element analysis on the Siemens XRF.
5. Approximately 5 g of each sample was used to produce pressed pellets for trace element analysis, which was carried out on the Siemens XRF.

Sodium Determination

The samples were prepared for sodium determination using the following steps:

1. Approximately 50 mg of each ignited sample were digested overnight at 150^o C in a teflon beaker containing 2 ml of H_2SO_4 and 10 ml of 50% HF.
2. Sample solutions were diluted to 100 ml in an A^+ volumetric flask using distilled water.
3. Na concentration were then determined using the Varian Techron Atomic Absorption Spectrophotometer by calibrating the unknown sample concentration against a series of known standards.

APPENDIX 2

PETROGRAPHY

PETROGRAPHY

2.1 PORT PIRIE VOLCANICS

Specimen 6431RS0065
Slide C48447.
Rock Name Basalt
Location and Depth PP2, 1246 ft, 379.8 m.
Hand Specimen

A fine grained brown volcanic, with small (1 mm) and medium (5 mm) vesicles filled with calcite and minor chlorite. Fine veins of calcite connect some of the larger vesicles. This specimen represents the upper section of a lava flow.

Thin section

The main texture of this specimen is intergranular, consisting of plagioclase, potassium feldspar and pyroxene. Minor patches of the specimen have a of subophitic texture, with laths of plagioclase radiating away from the central pyroxene mass. Both minerals have been partially altered to chloritic clays. The phenocrysts are set in an iron rich recrystalised red glassy ground massy ground mass. Minor red subhedral hexagonal opaques occur as pseudomorphous replacement of olivine or pyroxene.

The vesicles are filled with calcite and some are rimmed with chlorite.

Specimen 6431RS0066
Slide C48448
Rock name Basalt
Location and Depth PP2, 1294 ft, 394.4 m
Hand Specimen

This specimen is a very fine grained haematite rich red-brown basalt. 60% of the basalt consists of calcite and chlorite filled vesicles, the larger ones containing shards of the ground mass. Many of the vesicles are connected by veins filled with calcite and/or clay.

This specimen represents the flow top of a lava flow. The lava is covered by a 1 cm vein of calcite containing many shards of the volcanic material.

Thin Section

The specimen consists of vesicles within an iron rich glassy ground mass. The ground mass is a primary feature and contains no remnant textures from feldspar or pyroxene crystals. This indicates that the rock has been quenched.

The vesicles are filled with calcite, quartz and shards of volcanic glass. The quartz has a consertal texture and normally surrounds the shards of glass. The vesicles have a bimodal distribution. The large ones are up to 10 mm in diameter, the smaller ones about 1 mm in diameter.

Specimen 6431RS0067
Slide C48449
Rock Name Basalt
Location and Depth PP2, 1307 ft, 398 m
Hand Specimen
This specimen is a fine grained haematite rich red-brown basalt, with visible blebs of haematite. 5% of the specimen consist of vesicles filled with chlorite.

Thin Section
Much of the original texture of the rock has been removed. The specimen consists of potassium feldspar, chlorite after feldspar, pyroxene, and an iron rich opaque after pyroxene set in an iron rich glassy ground mass. The rock has a predominantly intergranular texture, but small areas of subophitic texture are present.

The vesicles are filled with calcite and chlorite, and the veins are filled with calcite and consertal quartz.

Specimen 6431RS0068
Slide C48450
Rock Name Basalt
Location and Depth PP5, 898 ft, 273.7 m
Hand Specimen
This specimen is a massive medium grained brown purple basalt, with chlorite and calcite filled vesicles making up 15 - 20% of the sample. There is also minor horizontal calcite veining.

Thin Section
In thin section small areas the specimen shows a subophitic texture, with the potassium feldspars radiating away from the sericite (or some sort of clay or smectite) which replaced the pyroxenes. The iron rich red glassy ground mass is an original feature of the rock, and the overgrown opaques have formed due to the replacement of pyroxenes.

The vesicles are filled with calcite, chlorite and sericite, and are iron stained.

Specimen 6431RS0069
Slide C48451
Rock Name Basalt
Location and Depth PP5, 1025 ft, 6 in. 312.6 m
Hand Specimen

This specimen is a medium grained brown maroon basalt. It is highly altered and shows replacement of pyroxene by chlorite and clay minerals. The specimen also contains fine horizontal clay and calcite filled veins.

Thin Section

Unlike all previous specimens, the texture of this specimen is intergranular with no subophitic patches. The sample consists of potassium feldspar and pyroxene with the feldspars altered to sericite and chlorite, but much of the original crystal shape remains. Many of the pyroxenes have become fractured, the fractures being rimmed by opaques. They have also been partially altered to chlorite and sericite. The pyroxenes are quite fresh compared with many of the other specimens.

The vesicles and veins are filled with an iron rich clay mineral, chlorite and sericite.

Specimen 6431RS0070
Slide C48452
Rock Name Basalt flow top and silt
Location and Depth PP5, 1138 ft, 9 in 348.9 m
Hand Specimen

The hand specimen shows the upper contact between the volcanic and the silt interbed, with the silt overlying the basalt. The chocolate brown sediment is fine to medium grained, massive, with fine calcite veins running through it.

The red brown basalt is fine grained, with veins of calcite, and calcite or chlorite filled vesicles.

Thin Section

This specimen is very fine grained and altered so the original texture of the rock is hard to determine. It consists of feldspar, which has mostly been altered to sericite and chlorite, set in an iron rich glassy ground mass. Any pyroxene that was present has been or is in the process of being altered to sericite, or an iron rich opaque.

The vesicles are filled with calcite, clay and, around the perimeter, fine grained quartz. The contact between the siltstone and the basalt consist of bands of clay and calcite.

The sediments consist of fine grains of clay and possibly volcanic fragments with the layering defined by alternating fine and coarse grains.

Specimen 6431RS0071
Slide C48453
Rock Name Basalt
Location and Depth PP 6, 873 ft, 266.1 m
Hand Specimen
This specimen is a grey brown non-vesicular, medium to fine grained massive basalt. The distribution of grain sizes is bimodal, with a very fine brown ground mass and medium white clay laths rimmed in chlorite.

Thin Section
The thin section consists of very fine grains of feldspar and pyroxene which have been highly altered to sericite, chlorite and other clay materials, set in an iron rich glassy ground mass. No remnant texture remains except for a few altered feldspar laths, resulting in a massive homogeneous fine grained rock.

Specimen 6431RS0072
Slide C48454
Rock Name Basalt
Location and Depth PP 6, 1049 ft, 319.7 m
Hand Specimen
This specimen is a fine grained non-vesicular grey black basalt, with blebs of haematite and very fine veins filled with calcite.

Thin Section
The thin section shows this is a highly altered rock, with the original texture impossible to determine. Approximately 90% of the potassium feldspar has been altered to chlorite and sericite. Any pyroxene that was present has been altered to either iron rich opaques or chlorite and sericite. The chlorite is present as two species, bright green pennine or prochlorite and lighter green clinochlore.

Specimen 6432RS0073
Slide C48455
Rock Name Basalt
Location and Depth PP6, 1092 ft, 332.8 m
Hand Specimen

A brown fine grained massive basalt. 10% of the rock consists of vesicles filled with calcite or clay and rimmed in iron rich red clays.

Thin Section

The section is again highly altered, but not as much as the previous slide. The feldspar laths have been altered to chlorite and sericite which have grown as very fine strings. Most of the texture of the laths remains, but not many have the original mineralogy. Some of the feldspars appear to be showing minor multiple twinning suggesting that they have formed from plagioclase. The pyroxenes have altered to iron rich opaques or sericite.

Specimen 6431RS0074
Slide C48456
Rock Name Basalt
Location and Depth PP 6, 1093 ft, 333.3 m
Hand Specimen

This specimen is a fine grained brown maroon basalt with a 1 cm wide vertical vein. The vein has been fractured and continues after a break in the same direction. It is filled in vertical strips by calcite, chlorite and an iron rich clay.

Thin Section

This basalt is similar to the previous slide. It is altered with sericite and chlorite altered from feldspar, and opaques and sericite altered from pyroxene. The fracture is filled with parallel layers of consertal quartz, calcite, sericite and chlorite, mainly pennine or prochlorite.

Specimen 6431RS0075
Slide C48457
Rock Name Dolerite
Location and Depth PP 10, 1129 ft 6 in, 344.3 m
Hand Specimen

This specimen is brick red in colour, with yellow clay and white calcite streaks all orientated at 45° to the horizontal. The volcanics have traces of chalcopyrite disseminated through them.

Thin Section

The section has a intergranular texture and is less altered than the previous specimens. The feldspar laths (70%) are iron stained around the edges, with some altered to chlorite and sericite and the remaining ones surrounded by clay. The opaques (20%) consist of an iron rich glassy ground mass, with the vesicles and veins (10%) filled with clay.

Specimen 6431RS0076
Slide C48458
Rock Name Basalt
Location and Depth PP 10, 1163 ft 6 in, 354.6 m
Hand Specimen

This specimen is a massive homogeneous fine grained pink red rock, with disseminated chalcopyrite.

Thin Section

This specimen consists entirely of of potassium feldspar. The feldspar laths are corroded around the edges and are replaced by opaques. The feldspar laths and pyroxenes are moderately altered to an iron rich clay and chlorite.

Specimen 6431RS0077
Slide C48457
Rock Name Basalt
Location and Depth PP 10, 1171 ft, 356.9 m
Hand Specimen

This specimen is a medium to coarse grained red brown non-vesicular massive volcanic with pink laths of feldspar and chalcopyrite disseminated in thin veins.

Thin Section

The slide has relict subophitic texture in small areas, with potassium feldspar laths radiating away from pyroxene, which has been altered to sericite. The ground mass mainly consists of iron rich red recrystalised glass with chlorite, sericite, weathered feldspars and possibly pyroxene.

Specimen 6431RS0078
Slide C48460
Rock Name Basalt
Location and Depth PP 12,1047 ft 9 in 319.4 m
Hand Specimen
This specimen is a fine grained massive purple basalt, with 1 mm blebs of clay.

Thin Section
The slide is of a fine grained quenched mass with an intergranular texture. The feldspar laths (60%) have been replaced to some extent by sericite and chlorite. The pyroxenes are partially altered to clay and some are totally altered to opaques which are subhedral. The vesicles (10%) are filled with calcite or clay, but the centres of many have been lost during slide preparation.

Specimen 6431RS0079
Slide C48461
Rock Name Basalt
Location and Depth PP 12, 1393 ft, 424.6 m
Hand Specimen
A grey green massive medium grained non-vesicular basalt, the colouration being characteristic of chlorite alteration.

Thin Section
The sample shows a totally subophitic coarse grained basalt containing partially altered laths of plagioclase to chlorite and a small amount sericite, with the pyroxene sericitized around the edge. The opaques are iron rich and are a later addition. Fine veins of calcite, sericite and chlorite crosscut the slide.

Specimen 6431RS0080
Slide C48462
Rock Name Basalt
Location and Depth PP 12, 1425 ft 6 in, 434.5 m
Hand Specimen
A grey green massive non-vesicular basalt, with blebs of haematite and chlorite. The specimen appears more altered than the previous one (6431RS0079) with more black chlorite alteration.

Thin Section

The texture of this specimen is very similar to the previous sample. However, the plagioclase laths (50%) have been altered to chlorite and sericite to a greater degree. The pyroxenes are mainly augite (40%) and are present as laths and phenocrysts. The specimen is set in chlorite (10%), rather than a glassy ground mass. The slide is again overgrown with haematite blebs.

Specimen 6431RS0081
Slide C48462
Rock Name Basalt
Location and Depth PP 12, 1476 ft 6 in, 450 m
Hand Specimen

A medium grained grey green chlorite rich basalt. The grains are bimodally distributed, with medium grained black and green chlorite and phenocrysts of pyrite set in the fine grained green grey ground mass.

Thin Section

This slide is the third in the series of ophitic rocks and is more altered than the previous two. The plagioclase laths (40%) are altered to sericite and chlorite, and the pyroxene phenocrysts (50%) have become iron stained and altered to chloritic clays. The feldspars appear to be more highly altered than the pyroxenes. The opaques (10%), haematite or pyrite, again appear to have joined the assemblage later as some are pseudomorphs of olivine phenocrysts.

Specimen 6431RS0082
Slide C48464
Rock Name Basalt
Location and Depth PP 12, 1496 ft 3 in, 455.1m
Hand Specimen

A dark grey green massive homogeneous basalt, with dominant phenocrysts of black chlorite.

Thin Section

This slide is the fourth in the series with increasing alteration of the pyroxenes and plagioclase. This slide is a finer grained version of the previous specimen, with small intersertal patches of granopheric liquid consisting of quartz and feldspar.

Specimen 6431RS0083
Slide C48465
Rock Name Basalt
Location and Depth PP 17, 554 ft 9 in, 169.1 m
Hand Specimen
A medium grained brown maroon basalt with small (2 mm) and large (10 cm) vesicles, peripherally filled with clay and carbonate and centrally filled with epidote or chlorite. The basalt is massive with no flow directions indicated.

Thin Section
A partially subophitic altered basalt with laths of feldspar, which is mainly potassium rich (50%) radially pointing out from the central pyroxene (25%) which is now mostly altered to sericite and brown clay. The feldspars are altered to chlorite and sericite along the central twin axis. The vesicles (10%) are filled with epidote, and rimmed with chlorite. The ground mass (15%) consists of iron rich recrystalised glass.

Specimen 6431RS0084
Slide C48466
Rock Name Basalt
Location and Depth PP 17, 595 ft , 181.4 m
Hand Specimen
This specimen is a brown maroon medium grained basalt, with small and large calcite vesicles. It also contains blebs of greenish chlorite.

Thin Section
The thin section has a subophitic texture, with the laths of mostly potassium feldspar (60%) radiating away from the altered pyroxenes (30%), some of which are now altered to chlorite and sericite with a fractured iron rich rim. The feldspars are only partially altered to sericite, but much of the original mineralogy remains. The vesicles are mainly calcite filled, and some are rimmed with chlorite. The ground mass consists of altered pyroxenes in the form of opaques.

Specimen 6431RS0085
Slide C48467
Rock Name Basalt
Location and Depth PP 19, 966 ft 3 in, 294.5 m
Hand Specimen
This specimen is a red grey medium grained massive haematite rich basalt, with very fine disseminated pyrite throughout the specimen.

Thin Section

The thin section shows a highly altered fine grained quenched rock. Many of the original feldspar laths remain, but many have been altered to sericite and chlorite. The pyroxenes are few and far between, most are altered to chlorite and opaques. Many of the minerals are iron stained around the edges, with a ground mass of opaques. Fine vesicles are filled with blebs of sericite and quartz.

Specimen 6431RS0086
Slide C48468
Rock Name Basalt
Location and Depth PP 19, 1050 ft, 320 m
Hand Specimen

This specimen is a haematite rich medium to fine grained non-vesicular basalt. It is massive and homogeneous.

Thin Section

This again is a highly altered quenched, fine grained specimen mainly consisting of feldspar laths, with few opaques and no coarse material. Many of the feldspar laths have been altered to chlorite.

Specimen 6431RS0087A
Slide C48469
Rock Name Sandstone
Location and Depth PP 19, 1194 ft 6 in, 363.9 m
Hand Specimen

This specimen is a haematitic red brown sandstone which varies upward in grain size from fine to coarse. The clasts consists of quartz, calcite, and volcanics. The sandstone represents interflow sediments.

Thin Section

The section consists of subround to round poorly sorted clasts of feldspar, quartz and plagioclase in an iron rich very fine grained matrix of calcite and chlorite. Some of the clasts have been altered to chlorite or iron stained, but most remain in their original condition. As the clast size decreases, the amount of iron increases in the matrix to give a dark red brown staining.

Specimen 6431RS0087B

Slide C48470

Rock Name Sandstone/Basalt contact

Location and Depth PP 19, 1194 ft, 363.9m

Hand Specimen

This specimen is the contact between the red brown fine grained sandstone and the flow top of the maroon fine grained basalt with 50% calcite filled vesicles. The contact is at 50° to the horizontal.

Thin Section

The section exhibits the contact between the overlying sandstone and the volcanic. The contact is very sharp, and is defined by about 5 mm of breccia with a calcite cement. The sandstone is the same as in specimen 6431RS0069. The basalt is highly altered to chlorite, with a remnant texture of feldspar laths still present. The vesicles are filled with fine grained calcite and rimmed with consertal quartz.

2.2 Beda Volcanics from Drill Core SAS 1

Specimen 533/010
Rock Name Basalt
Flow Number and Depth Flow 13, 280.26-280.3m
Thin Section

The thin section shows a green brown fine grained basalt. The majority of the slide consists of plagioclase as phenocrysts (5%) and laths (40%). The phenocrysts are altered to albite, sericite and chlorite, and the laths are altered chlorite and are iron stained. The opaques constitute 10% of the specimen and red brown haematite ground mass after volcanic glassy ground mass (10%). The vesicles (15%) are filled with calcite and chlorite, which occur as both irregular blebs and large vesicles. The larger vesicles contain fine grained quartz aggregates. The rest of the chlorite in the slide is formed as an alteration from pyroxene.

Specimen 533/009
Rock Name Basalt
Flow Number and Depth Flow 13, 296.18-296.22 m
Thin Section
The thin section shows a non-vesicular coarse grained basalt, consisting of plagioclase laths and fresh feldspar in a recrystalised glassy ground mass.

The feldspar (50%) laths have been partially altered to epidote along the central twin axis. The pyroxenes (30%) occur as rhombohedral crystals (only slightly fractured), and a few have been altered to epidote. The opaques and red brown glassy ground mass constitute about 5% of the slide. The specimen appears to have undergone a later influx of hydrothermal fluid which has altered the ground mass to very fine chlorite.

Specimen 533/001
Rock Name Basalt
Flow Number and Depth Flow 13, 298.04 - 298.13 m
Thin Section
This specimen is a subophitic textured basalt. The 10% of the specimen consists of vesicles which are filled with calcite and chlorite. The specimen has a subophitic texture, with partially altered clinopyroxene (15%) forming the ground mass from which fine altered laths of feldspar radiate out. The feldspar laths (60%) are all partially altered to chlorite. The opaques and red brown glassy ground mass constitute 15% of the slide.

Specimen 533/107
Rock Name Interflow sediment
Flow Number and Depth Flow 12, 301.6 - 301.67 m
Thin Section

This specimen consist of sediment at the top of basalt flow 12. It consist of fine grained opaques, and well rounded clasts of feldspar, plagioclase and quartz. Fine calcite veins run through the slide with random orientation.

Specimen 533/103
Rock Name Basalt
Flow Number and Depth Flow 12, 308.24 - 380.31 m
Thin Section

This specimen is less altered than the previous basalt (as a result of alteration increasing down the flow). The remaining pyroxene (15%) is present as rhombohedrals forming an intersertal texture. The plagioclase laths have been altered to chlorite. Chlorite is also present in the slide filling vesicles (15%). The slide also contains highly altered blebs of epidote (5%) and opaques and iron stained glassy ground mass (5%). The overall texture of the slide is massive.

Specimen 533/011
Rock Name
Flow Number and Depth Flow 12, 310.14-310.17 m
Thin Section

The slide shows the basal contact of the basalt with the interbedded siltstone. The siltstone is fine grained and consists of mainly opaques, with fine laths of feldspar and quartz. The basalt along the contact is highly altered, and is iron stained consisting of opaques with plagioclase laths and blebs of chlorite.

The basalt away from the contact has vesicles filled with chalcodeny around the perimeter, the smaller ones only contain chalcodonic quartz. The glassy ground mass ground mass consists of chlorite tuffs and laths of plagioclase altered to albite. The specimen contains blebs of red opaques, which are probably due to a later influx of iron rich material. The specimen is again pyroxene absent.

Specimen 533/109
Rock Name
Flow Number and Depth Flow 11, 310.46 - 310.54 m
Thin Section

A fine grained highly altered rock with laths of altered feldspar (30%) and an iron rich glassy ground mass (40%). Small chlorite vugs or vesicles make up 30% of the slide. The vesicles are filled with calcite and quartz and have an epidote rim.

Specimen 533/012
Rock Name
Flow Number and Depth Flow 10, 319.14-319.07 m
Thin Section

The slide consist of feldspar laths altered to chlorite, opaques, a red brown glassy ground mass and chlorite after pyroxene. The vesicles are filled with calcite, and the larger ones calcite rimmed with chalcedonic quartz or chlorite.

Specimen 533/085
Rock Name
Flow Number and Depth Flow 10, 319.92-320.0 m
Thin Section

The slide consists of laths of plagioclase partially altered to sericite, and pyroxene altered to chlorite and iron rich opaques.

The vesicles are filled with epidote and the smaller ones are filled with biotite and chlorite and rimmed in quartz.

Specimen 533/101
Rock Name
Flow Number and Depth Flow 10, 320.14-320.14 m
Thin Section

The thin section contains plagioclase partially altered to sericite, opaques and a red brown glassy ground mass. It also contains chlorite after pyroxene.

The large vesicles are filled with epidote, calcite and quartz and the smaller ones are filled with epidote.

The texture of the rock is subophitic to interstitial. The pyroxenes have been altered to chlorite and iron rich clay.

Specimen 533/086

Rock Name

Flow Number and Depth Flow 10, 321.87-321.98 m

Thin Section

A medium grained basalt consisting of laths of feldspar (70%) in a subophitic texture of plagioclase laths altered to sericite and chlorite. The laths are set in iron rich glassy ground mass (10%). The vesicles consist of 20% of the specimen and are filled mainly with chlorite and minor amounts of epidote.

Specimen 533/087

Rock Name

Flow Number and Depth Flow 10, 323.97-324.10 m

Thin Section

This slide is similar to the previous one. The medium feldspar laths (50%) are partially altered to sericite and chlorite and are in part iron stained. The original pyroxenes formed a subophitic texture, which is common throughout the whole slide. The pyroxene has been altered to chlorite and has also become iron stained. The vesicles (5%) are filed with chlorite, calcite and epidote which is surrounded by a fine grained possibly quartz rich glassy ground mass.

The glassy ground massy ground mass is not well represented in this slide (5%).

Specimen 533/088

Rock Name

Flow Number and Depth Flow 10, 325.87-325.98 m

Thin Section

A medium grained sample with laths of feldspar (60%) altered to sericite and chlorite and the pyroxene (20%) is altered to chlorite defining a subophitic texture. The vesicles are filled with epidote and chlorite (15%). The opaques (5%) are sparse in this slide and tend to be angular.

Specimen 533/089

Rock Name

Flow Number and Depth Flow 10, 327.92-328.06 m

Thin Section

A finer grained version of the previous slide with most of the vesicles filled with a very fine chlorite. The feldspar constitutes 60% and pyroxene 30% of the specimen. The pyroxene is much less altered than in previous slides.

Specimen 533/090
Rock Name
Flow Number and Depth Flow 10, 329.98-330.06 m
Thin Section

A medium to coarse grained basalt with feldspar laths (50%) altered to sericite and chlorite. The intersertal iron and chlorite after pyroxene (35%) has removed all traces of the original pyroxene. The vesicles are filled with chlorite and epidote with the opaques occurring as a later overgrowth of the whole specimen.

Specimen 533/091
Rock Name
Flow Number and Depth Flow 10, 331.91-332.07 m
Thin Section

This slide appears much less altered than the previous ones. Much of the pyroxene (30%) still remains and has only been iron stained around the edge due to a later hydrothermal iron rich fluid. The pyroxene forms an intersertal texture. The feldspars constitute 50% of the rock and overall are iron stained and altered in part to sericite.

Specimen 533/092
Rock Name
Flow Number and Depth Flow 10, 335.92-336.03 m
Thin Section

A finer grained basalt than the previous two slides. It contains laths of feldspar (60%) altered to sericite in part and pyroxene (15%), which have been iron stained around the edges. The centres of some of the vesicles contain chlorite, quartz and epidote, and the rims contain chlorite. The opaques again appear to be a later addition to the system.

Specimen 533/005
Rock Name
Flow Number and Depth Flow 9, 352.40-352.48 m
Thin Section

The slide shows the alternation between a fine-coarse-fine grained volcanic, with a very sharp contact between the volcanics. The volcanics consist of fine laths of feldspar and iron altered intersertal pyroxenes set in an iron rich glassy ground mass. The vesicles are filled with epidote, calcite and chlorite. The variation between the fine and coarse grained regions is due to later influxes of the volcanic, but neither layer has a cooked margin.

Specimen 533/004

Rock Name

Flow Number and Depth Flow 9, 358.3-358.35 m

Thin Section

A very fine grained basalt with laths of feldspar (40%) radiating away from chlorite altered from pyroxene (40%) defining a remnant subophitic texture. The vesicles are oval in shape and appear to be orientated in a horizontal flow direction. The vesicles are filled with chlorite and constitute 20% of the rock.

Specimen 533/007

Rock Name

Flow Number and Depth Flow 9, 370.24-370.30 m

Thin Section

Again a fine grained basalt, but this time the pyroxenes (30%) is not as altered. Some have been altered to an iron opaques, but most remain fresh.

There are a few small vesicles (10%) filled with chlorite and opaques (10%) which have formed as a result of alteration of the pyroxenes. The plagioclase has been altered to sericite (to a greater extent than the previous specimens).

Specimen 533/014

Rock Name

Flow Number and Depth Flow 9, 379.29-379.36 m

Thin Section

A finer grained version of the previous slide with laths of feldspar(50%) altered to sericite and intersertal pyroxenes (30%) forming very fine blebs.

The vesicles are filled with chlorite (10%) and the larger ones are also filled with calcite. The opaques (10%) are a later addition, possibly a hydrothermal alteration.

Specimen 533/008

Rock Name

Flow Number and Depth Flow 9, 375.78-375.84 m

Thin Section

A very fine grained basalt consisting of subophitic feldspars (45%) altered to sericite, radiating out of pyroxene (45%) which are quite fresh.

The opaques (10%) are skeletal like and occur as pseudmorphs of pyroxene.

2.3 Backy Point Field Area:- Beda Volcanics, and Backy Point Beds

Specimen 882-1
Formation Backy Point Beds
Rock Name Matrix Supported Breccia
Location:- On the beach of Backy Point directly to the east of the volcanic outcrop in front of the shacks.

Hand Specimen

The rock is a matrix supported breccia, containing angular clasts up to 2 cm in diameter mainly consisting of quartz. The clasts are rectangular in shape, and orientated to provide a rough bedding plane.

The matrix consists of fine grained quartz in a very fine grained haematite and clay supporting mass. Only the breccia clasts define the bedding, no bedding is suggested by the matrix.

Thin Section

The section is poorly sorted compositionally mature rock consisting of subangular clasts of acid volcanic (10% of total rock), and semi-constertial quartz (60% of the total rock) surrounded by haematite. The acid volcanics consist of epidote (60% of the clasts) and quartz (40% of the clasts). The quartz gains have a constertial texture and are highly etched. The volcanic quartz has a bimodal distribution with medium grained quartz grains 0.5 mm in diameter, and very fine quartz grains. Epidote totally surrounds the quartz.

The quartz in the ground mass is subangular and highly etched. The iron staining has affected the epidote in the groundmass most of all.

Interpretation

The breccia was rapidly deposited in a talus slope underlying the Beda Volcanics, with the sediment forming the rock being derived from the Moonabie Formation, to the east of Backy Point. The sediment has undergone low grade metamorphism, partially welding the quart grains, and hydrothermal fluids have passed through the system enriching the sediment in iron.

Specimen 882-3
Formation Beda Volcanics
Rock Name Basalt
Location:- On the beach of Backy Point in front of the shacks facing south.

Hand Specimen

A highly vesicular brick red volcanic. The larger vesicles are up to 5 mm in diameter and have been filled with specular haematite. The smaller vesicles average 1 mm in diameter and have been filled with clay and squashed flat. The large vesicles also tend to be slightly elongated in the plane of flattening.

Thin section

This vesicular holocrystaline basalt consists of iron enriched volcanic glassy ground mass. The small flattened vesicles are filled with illite or a smectite mineral too fine to determine. The coarser vesicles are filled with quartz and haematite laths but do not appear to be squashed.

Specimen 882-4
Formation Beda Volcanics
Rock Name Basalt
Location:- On the beach of Backy Point directly to the east of the volcanic outcrop just by the shacks.

Hand Specimen

A highly vesicular red brown basalt with large (up to 3 cm) and small vesicles (average size 1 mm) filled with calcite, quartz, and specular haematite. The rock is also bisected by large veins filled with quartz.

Thin Section

The thin section displays sericite after feldspar set in a glassy ground mass. The vesicles are filled with quartz, chlorite and specular haematite laths which are acicular. Some of the quartz displays a radial zeolite texture on the rim of the vesicle, whereas centrally the crystals are more angular and show no undulose extinction which suggests they formed over a longer period than the outer ones.

Specimen 882-5
Formation Beda Volcanics
Rock Name Basalt
Location:- Douglas Point

Hand Specimen

This specimen is a flow top which includes both the breccia and sediment. The volcanic is a vesicular basalt, with most of the vesicles filled with quartz. The overlying breccia consists of angular silt and coarse clay clasts.

Thin Section

A quenched holocrystaline volcanic, consisting of iron rich volcanic glassy ground mass. The vesicles (70%) are filled with radiating zeolite textured quartz and are rimmed with epidote and minor biotite.

Specimen 882-107
Formation Backy Point Formation
Rock Name Quartzarentite
Location:- On the beach of Backy Point directly to the east of the volcanic outcrop in front of the shacks.

Hand Specimen

A pinkish medium grained rock with heavy mineral layering which is continuous throughout the rock. The specimen has several dark spherical stains at the base up to 3 cm in diameter which contain angular clasts of quartz.

Thin Section

A compositionally mature, poorly sorted subrounded quartzarenite. In the unaltered section of the rock, the quartz grains have all formed as overgrowths so their margins are indistinguishable.

The haematite alteration fluids have provided a haematite rich ground mass. The quartz crystals are more angular and show no overgrowths.

Interpretation

The rock was deposited in a fairly low energy environment. Hydrothermal iron rich fluids infiltrated the area along joints and veins. The fluid spread out at the base of the veins forming spherical alteration haloes. The fluids acted as a ground mass for the quartz, separating the grains. When the rock underwent metamorphism and the quartz not imbedded in matrix fused, the quartz within the iron rich matrix could not fuse as the matrix separated the grains.

Specimen 882-111
Formation Moonabie Formation
Rock Name Quartzarenite
Location:- 150 m west of Backy Point.

Hand Specimen

A coarse grained, poorly sorted, massive grey green rock mainly consisting of quartz. The rock is dissected by iron rich veins which have spread, staining the surrounding material. The stain is maroon red in colour.

Thin Section

A poorly sorted, subrounded quartzarenite with haematite veins running through it. The quartz has a bimodal distribution. The coarser grains of quartz are subrounded and etched. The ground mass consists of fine grained quartz in sericite. Some of the larger quartz grains are of volcanic origin.

The slide is bisected by iron rich veins which overlie the quartz grains.

Specimen 882-122
Formation Backy Point Beds
Rock Name Matrix Supported Breccia
Location:- On the north eastern high tide mark of Fitzgerald Bay.

Hand Specimen

A dark brown rock with angular clasts of quartz rich material and clay. The clasts vary between 1 mm and 3 cm in diameter. The rock has layering defined by the smaller clasts. The rock weathers to a dark brown with the quartzite rich clasts turning yellow.

Thin Section

The specimen exhibits layering between the coarse and fine grained quartz. The individual quartz grains are free and subrounded to subangular in shape. The finer grained layers consist of fine consertal quartz and coarser quartz grains which have been eaten their way into the finer grains.

The quartz is pitted with only minor scratching. The ground mass consists of epidote and opaques which are either haematite or magnetite.

Specimen 882-124
Formation Backy Point Beds
Rock Name Matrix Supported Breccia
Location:- On the north eastern high tide mark of Fitzgerald Bay.

Hand Specimen

A poorly sorted matrix supported breccia with angular clasts up to 4 cm in diameter. The clasts consist of quartz, granite and clay rich clasts which were originally acid volcanics from McGregor Volcanics. The rock has bedding defined by alternating coarse and fine breccia units, i.e. it is not a massive breccia.

Thin Section

The slide is a quartz rich rock, very similar to specimen 882-125, i.e. a poorly sorted quartz coarse grained rock. However, the rock has undergone tourmilinization, and the ground mass has become very iron rich due to hydrothermal fluid interaction. As seen in other rocks, the tourmalinization process causes the quartz to recrystalise. The coarse grained quartz is partially surrounded by tourmaline which in turn is surrounded by an iron rich matrix.

The titanium rich opaques have also undergone alteration due to the tourmaline interaction, altering to rutile. The breccia, on the other hand, cannot be entirely of hydrothermal origin as some of the clasts have no interaction with the tourmaline or iron, but are still broken up. The rock also contains andesitic pebbles consisting of quartz and sericite, which are possible derived from the Roopena Volcanics

Specimen 882-125
Formation Moonabie Formation
Rock Name Matrix Supported Breccia
Location:- On the tip of Backy Point.

Hand Specimen

A heavy mineral laminated quartzite. The fresh surface is grey brown and it weathers to a black maroon colour, with veins of iron staining. The veins are narrow, but the staining has spread to form a large halo surrounding each vein.

Thin Section

The heavy mineral banding is defined by alternating opaques and sericite in the ground mass. The quartz grains are subangular, poorly sorted, with the large ones up to 1 mm in diameter.

The lighter coloured ground mass consists of fine and coarse grained quartz, with the fine quartz has an overgrowth texture.

Specimen 882-131a
Formation Backy Point Beds
Rock Name Conglomerate.
Location:- Douglas Point

Hand Specimen

A coarsely layered fine grained quartz rich brown sandstone. A rock shows a fining upward sequence with a sharp contact of fine material overlain by coarse material. The overlying conglomerate is poorly sorted and consists of subangular clasts of orthoclase and quartz (Cultana granite) and quartz.

Thin Section

A fine grained quartz rich rock, with minor plagioclase and potassium feldspar grains set in a ground mass of sericite and chlorite. The grain size of the minerals increases towards the top of the thin section, with more rounded anhedral grains of quartz and sericite. Overall the quartz has overgrown around the margins of the individual grains.

Minor tourmilinization has taken place around some of the quartz grains. The opaques appear as later additions to the specimen and are euhedral in shape, perfect diamonds, which is the crystal structure for iron oxide.

Specimen 882-133
Formation Backy Point Beds
Rock Name Conglomerate
Location:- Douglas Point

Hand Specimen

A poorly sorted conglomerate consisting of clasts of Cultana granite (orthoclase and quartz) and quartz in a pink quartz rich ground mass. The specimen has no particular bedding orientation. The specimen also contains a large pebble of tourmaline and quartz. The large clasts in the conglomerate are subrounded and the smaller ones (1–2 mm) are subangular.

Thin Section

The large pebble in the hand specimen consists of tourmaline and quartz, which is a later alteration to the conglomerate. The tourmaline is probably schorl. The alteration sphere occurred in a vein along which the fluids traveled and then flooded out at the end. The quartz associated with the tourmaline is recrystalised to form coarse euhedral grains.

The ground mass of the rock consists of a fine grained rounded and poorly sorted quartz surrounded by clay and illite. The opaques are angular and appear to be later overgrowths.

2.4 Gairdner Dyke Swarm

Specimen 6137RS0023
Slide Number C39598
Rock Name Basalt
Location and Depth Reedy Lagoon RL1, 655.0 m
Thin Section

A fine grained merocrystaline subophitic basalt. The plagioclase laths (50%) are too fine to determine their composition. The laths of plagioclase do not radiate from the chlorite (35%) which was altered from pyroxene, but are partially enclosed by it. The opaques (15%) are rounded blebs of iron rich material associated with both the plagioclase and pyroxene.

A quartz veins bisects the specimen, but it formed as the latest addition to the slide as no opaques have overgrown it.

Specimen 6137RS0024
Slide Number C39595
Rock Name Basalt
Location and Depth Reedy Lagoon, RL1, 616.65 m
Thin Section

A very similar specimen to the previous rock, with much finer laths of plagioclase, which in this case are radiating from the chlorite.

A calcite vein bisects the slide, but it formed as the latest addition to the slide as no opaques have overgrown it.

Specimen 6137RS0025
Slide Number C39596
Rock Name Dolerite
Location and Depth Reedy Lagoon RL1, 624.7 m
Thin Section

This specimen is a holocrystaline fine grained massive homogeneous specimen, containing plagioclase, alkali feldspar, pyroxene, chlorite and sericite.

The plagioclase and potassium feldspar (60%) form inclusions in each other. Both types of inclusions have definite boundaries and are orientated with a particular phenocryst in one general direction and do not interfinger like intergrowth structures.

The pyroxene (35%) is altered to chlorite to a greater extent than in the previous specimens. The opaques (5%) are a later addition and are skeletal in structure, mainly overgrowing the pyroxene.

Interpretation
The integrowths of alkali feldspar and plagioclase is as a result of exsolution during the original solidification of the melt.

Specimen 6137RS0026
Slide Number C39597
Rock Name Dolerite
Location and Depth Reedy Lagoon RL1, 631.6 m
Thin Section
This specimen is identical to 6137RS27 but the specimen contains coarser opaques.

Specimen 6137RS0027
Slide Number C39598
Rock Name Dolerite
Location and Depth Reedy Lagoon RL1, 655.0 m
Thin Section
A subophitic fine grained holocrystaline textured basalt with laths of plagioclase (60%) exhibiting very clear Carlsband and albite twinning which radiates out of pyroxene (35%). These pyroxenes mainly consist of augite which has been partially altered to chlorite and sericite, while the plagioclase varies between Ab_{40} and Ab_{12}. The plagioclase is of primary origin and has not undergone any alteration to albite. The augite boundaries are not very distinguishable due to plagioclase disguising many of them. The opaques (5%) are a later addition to the specimen. They appear as overgrowths over the pyroxene and avoid the plagioclase growing around it in contorted shapes.

Specimen 6137RS0028
Slide Number C39598
Rock Name Dolerite
Location and Depth Reedy Lagoon RL1, 655.0 m
Thin Section
A holocrystaline fine grained massive dolerite containing laths of plagioclase (60%) with their compositions ranging between Ab_{90} and Ab_{50}. The plagioclase exhibits both albite and percline twinning, with most of the plagioclase present as laths. The plagioclase phenocrysts show the specimen has undergone stress, resulting in undulose

and percline extinction. The plagioclase has a bimodal distribution. The fine grained laths have an ophitic texture within the larger pyroxene grains. The larger plagioclase laths have overgrown the margins of most of the pyroxene crystals.

The pyroxene (35%) has been partially altered to chlorite and sericite, whilst the opaques (5%) show a skeletal structure and have only overgrown the pyroxene.

Specimen 6335RS0020
Slide C41778
Rock Name Basalt
Location and Depth CSR-LY3, 176.2 m
Thin Section
A subophitic vesicular basalt with very fine laths and phenocrysts of plagioclase (50%). The fine laths are orientated in a flow direction, the phenocrysts are zoned and have no particular orientation. They are set in pyroxene (30%) which has been partially altered to chlorite.

The vesicles (10%) are filled with chlorite, quartz and calcite (stained pink). The iron rich opaques (10%) are original.

Specimen 6335RS0021
Slide C41779
Rock Name Dolerite
Location and Depth CSR-LY3, 186.3 m
Thin Section
A merocrystaline basalt with fine curved branched pyroxene (60%) altered to chloritic clays set in a ground mass of iron rich recrystalised glass (35%). The specimen also contains patches of coarse laths of plagioclase and iron rich opaques and chlorite pseudomorphs after olivine.

Interpretation

The bimodal distribution of grains formed as a result of the crystallisation history of the magma. The coarse plagioclase and olivine phenocrysts started to crystalise while the magma was still in the magma chamber. When the magma was extruded, it was rapidly quenched resulting in the very fine branching pyroxene and a glassy ground mass, with the coarser phenocrysts in the basalt and dolerite.

Specimen 6335RS0022
Slide Number C41780
Rock Name Dolerite
Location and Depth CSR-LY3, 193.2 m
Thin Section

This specimen is a subophitic textured rock with plagioclase (50%) and pyroxene (40%), which has been altered to calcite and other calcium rich minerals and are set in a glassy ground mass (10%). Veins of iron rich matrix bisect the specimen and are filled with laths of plagioclase and phenocrysts of calcium rich pyroxene.

Specimen 6335RS0023
Slide Number C41781
Rock Name Dolerite
Location and Depth CSR-LY3, 196.5 m
Thin Section

The specimen is a fine grained merocrystaline basalt with two distinctly different compositions in its upper and lower sections. The upper section of the slide consists of very fine laths of plagioclase (50%) set in a glassy ground mass (40%). The plagioclase has been sericitized. As in specimen 6333RS21 coarse phenocryst laths of plagioclase are present in patches as a result of prolonged crystallisation. The laths of plagioclase have compositions between Ab_{100} and Ab_{60}. The laths exhibit Carlsband and percline twinning and are very rarely euhedral. The boundary between this an the lower composition is very sharp, but curved.

The lower texture consists of a glassy ground mass (20%) with fine curved branching pyroxene (70%). They have been nearly all altered to chlorite but the texture still remains. It too contains areas of plagioclase laths (10%) which have been partially eaten away around the edges and sericitized in veins of the plagioclase.

Specimen 6335RS0024
Slide Number C41782
Rock Name Dolerite
Location and Depth CSR-LY3, 216.0 m
Thin Section

This specimen is a merocrystaline rock consisting of a glassy ground mass (20%) and curved branching pyroxenes (70%). The branches are longer than in the previous specimen and the plagioclase and olivine phenocrysts (10%) are coarser, suggesting this specimen cooled more slowly.

Specimen 6335RS0025
Slide Number C41783
Rock Name Dolerite
Location and Depth CSR-LY3, 240.0 m
Thin Section

A subophitic coarse grained basalt, consisting of laths of plagioclase radiating from pyroxene. The specimen also contains both idiomorphic olivine, up to 1 mm in diameter, and very fine olivine blebs. The olivine has mainly been altered to calcite (AMDEL pink staining) and have become highly fractured.

Specimen 6136RS008
Slide Number C41778
Rock Name Dolerite
Location and Depth Aquitaine SSR 1001, 405.7 m
Thin Section

A fine grained merocrystaline basalt with two different textures separated by a wide vein of copper and calcite rich material and laths of plagioclase. The upper section of the specimen consists of phenocrysts of plagioclase (10%), some of which are zoned, and very fine laths of plagioclase (20%) in a glassy ground mass (70%).

The lower section is a coarser grained subophitic textured basalt with laths and phenocrysts of plagioclase half enclosed by pyroxene that has been highly chloritized and is copper rich.

2.5 Depot Creek Volcanics

Specimen 882-6
Formation Depot Creek Volcanics
Rock Name Basalt
Location:- Depot Creek, in the cliff by the bend in the creek at the base of the first range of hills.

Hand Specimen

A pink maroon massive vesicular basalt. The vesicles are filled with quartz, chlorite, and siltstone, and are up to 1 cm in diameter.

Thin Section

A highly altered vesicular merocrystaline basalt. The dominant mineral in the sample is feldspar, which has been altered to sericite and chlorite and is set in an iron rich glassy ground mass. The smaller vesicles are filled with quartz and the larger ones are rimmed in quartz and filled with chlorite.

Specimen 882-7
Formation Depot Creek Basalt
Rock Name Basalt
Location:- Depot Creek, in the cliff by the bend in the creek, at the base of the first range of hills.

Hand Specimen

A purple homogeneous fine grained basalt with black blebs of haematite, chlorite and clay.

Thin section

The dominant mineral in this specimen is potassium feldspar (80%) which has been partially altered to sericite, and in some cases occurs as radial masses. The laths are euhedral to anhedral set in an iron rich glassy ground mass (10%). The vesicles (10%) are filled with quartz.

Specimen 882-8
Formation Backy Point Beds
Rock Name Basalt
Location:- Depot Creek, in the cliff by the bend in the creek, at the base of the first range of hills.

Hand Specimen

A flow top purple vesicular basalt, with vesicles (50%) only rimmed with quartz. The quartz is obviously a later addition to the specimen as the Depot Creek basalts are basic and quartz undersaturated.

Thin Section

A very fine grained highly vesicular merocrystaline basalt. The main constituent of this specimen is feldspar (50%) (type indistinguishable due to high degree of alteration), set in an iron rich glassy ground mass (25%). The vesicles (25%) are filled with quartz, chlorite and sericite.

Specimen 882-104
Formation Depot Creek Volcanic/Emeroo Subgroup
Rock Name Basalt/Siltstone
Location:- Depot Creek, in the cliff by the bend in the creek, at the base of the first range of hills.

Hand Specimen

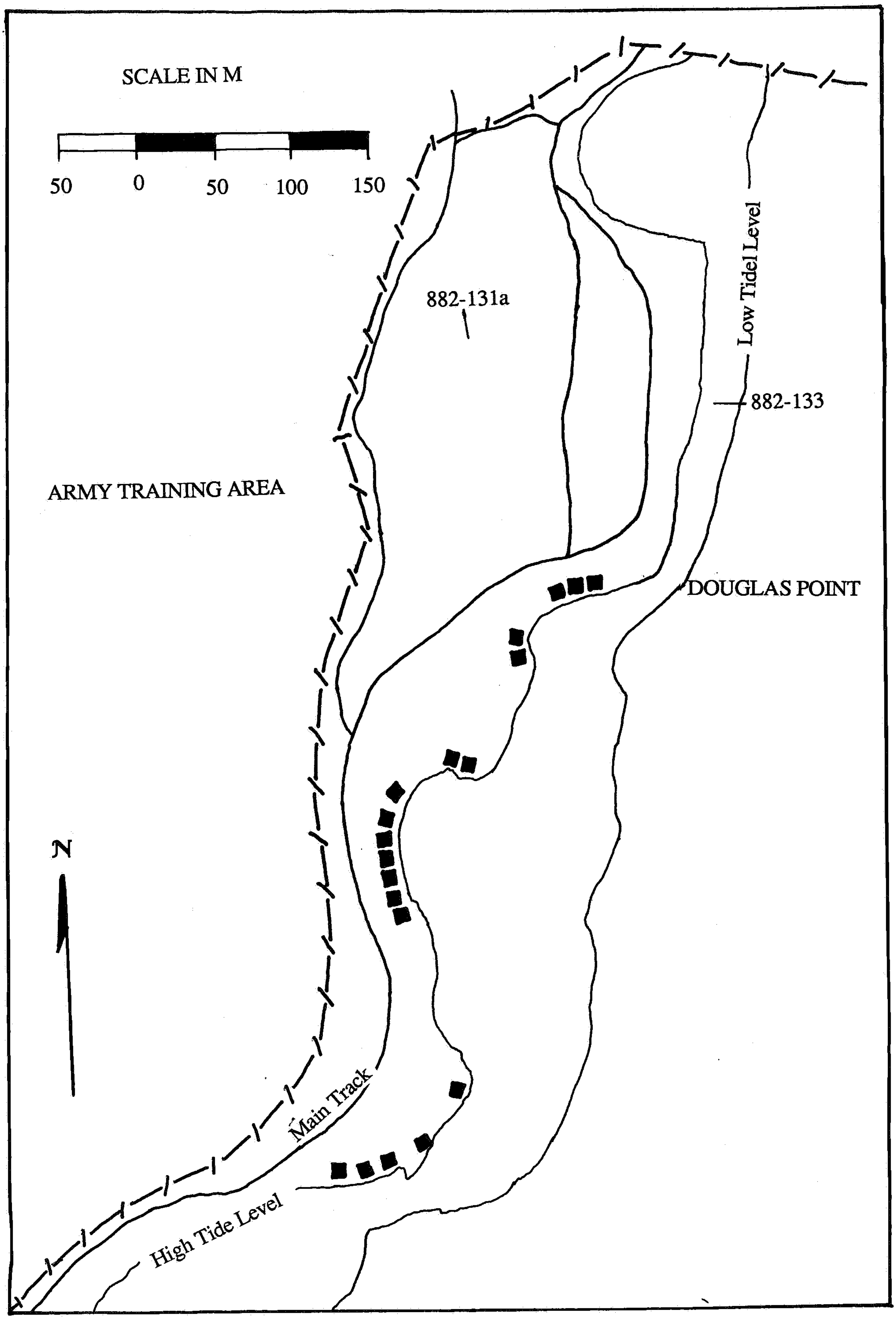
This specimen shows the contact between the Depot Creek Volcanics and a fine grained siltstone which overlies it.. The volcanic is a very fine grained maroon brown vesicular basalt, the vesicles being filled with quartz, haematite and, near the contact, sediment.

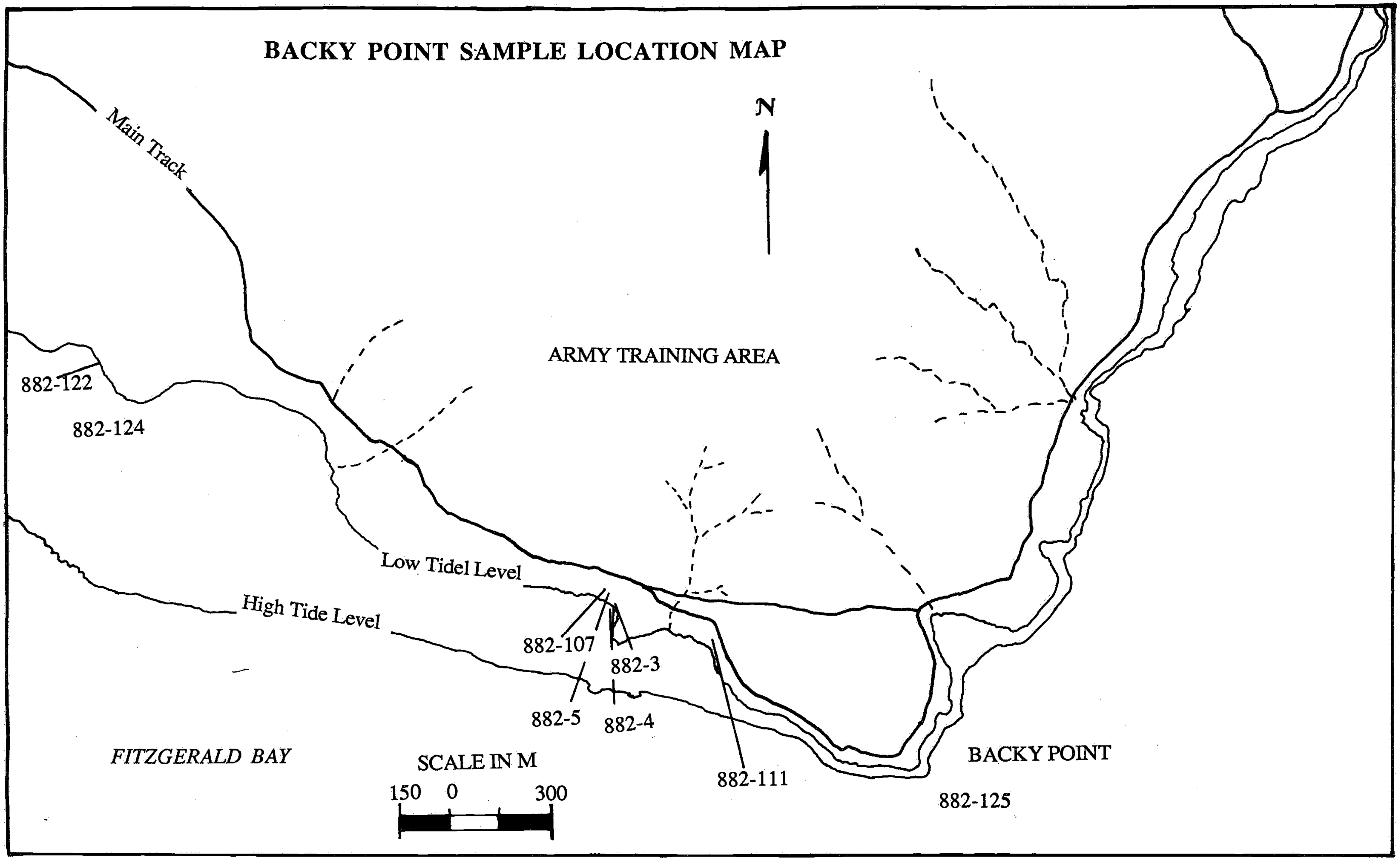
Thin Section

The volcanic is a very fine grained quenched rock consisting of altered laths of feldspar in a iron rich glassy ground mass. The vesicles are filled with quartz and chlorite. Siltstones from the surrounding sediment has been incorporated in the volcanic. They still show their original layering, but have been highly iron stained around the edge. This suggests the volcanics are shallow intrusives.

The incorporated siltstones are very finely bedded, with the layering defined by alternating coarse and fine layers.

DOUGLAS POINT SAMPLE LOCATION MAP




BACKY POINT SAMPLE LOCATION MAP
N
Main Track
ARMY TRAINING AREA
882-122
882-124
Low Tidel Level
High Tide Level
882-107
882-3
882-5
882-4
882-111
BACKY POINT
882-125
FITZGERALD BAY
SCALE IN M
150
0
300

APPENDIX 3

DRILL CORE LOGS

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

TR3

B.H.P. TREGALANA - SUGARLOAF HILL

CORE DESCRIPTION

DEPTH 400·9 m

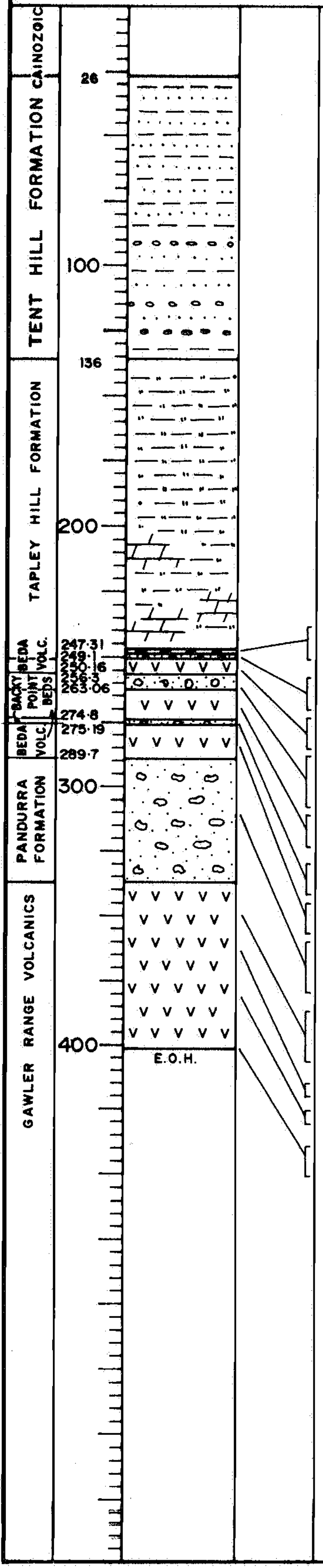
INCLINATION Vertical

LOGGED BY A. Woodget

DATE DRILLED

REFERENCE Env. 3915

DEPTH (m) | GRAPHIC LOG | DESCRIPTION



Brown fine-grained sand, silt and sludge.

Interbedded brown silts and shales, with micaceous fine-grained grey-green sands. Sand shows minor structure of mudcracks, cross bedding, and slump structures.

Grit horizon developed with clasts of G.R.V., chert, and grey silt.

Massive non-calcareous white sand with grit bands. Sands poorly sorted, non-calcareous, with herringbone crossbedding.

Mottled green-purple sands, with minor grit/pebble horizon.

Conformable contact.
Grey flat laminated siltstone.

30% carbonate: 70% grey siltstone. Carbonate interbeds have cryptic algae laminae.

40% carbonate: 60% silt. Carbonate interbeds much thicker.

Alternate layers of laminated shale and carbonate. 60% carbonate, increasing down section.

Conglomerate with boulders of Beda Volcanics, fine-grained matrix of grey sand, blebs of hematite and albite.

Basalt flow, maroon basalt with calcite veining, and blebs of hematite.

Conglomerate interbeds of G.R.V. clasts and gneiss. Pebbles up to 3 cm. Poorly sorted matrix, with conglomerate horizon increasing in thickness towards the base.

Basalt flow. Dark red basalt with 30% calcite rimmed chlorite amygdules.

Medium grained calcic sand containing clasts of Beda Volcanics and Gawler Range Volcanics. Poorly sorted.

Basalt flow. Maroon basalt, possibly 2 flows. 20% vesicles filled with calcite.

Very sharp contact.
Poorly sorted conglomerate horizon, with clasts up to 5 cm. Clasts are G.R.V. and gneiss in very coarse sandy matrix.

Sharp contact.
Basalt Flow. Fine-grained non-calcareous dark red-chocolate brown basalt with orange bleach spots.

No evidence for individual flows.

Increased brecciation.

Brecciated red-orange-yellow-green infilling between volcanic fragments which are variable in size.

SHEET 1 OF 1

PLAN Nº

4329

MF 179

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

TR3

B.H.P. TREGALANA - SUGARLOAF HILL

CORE DESCRIPTION

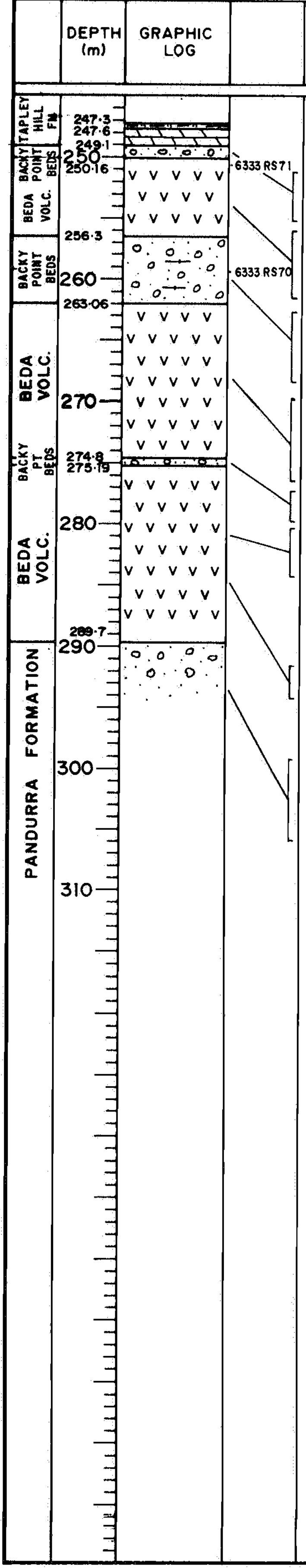
DEPTH 400·4 m

INCLINATION Vertical

LOGGED BY A. Woodget

DATE DRILLED

REFERENCE Env. 3915



DESCRIPTION

Alternate layers of laminated dolomite and silt. 60% carbonate, 40% silt.

Massive carbonate horizon with dark wavy heavy mineral bands.

Conglomerate, with boulders of Beda Volcanics, which are subangular. The matrix is fine-grained grey sands, with blebs of hematite and albite.

Basalt flow 4. Very sharp contact between grey conglomerate and maroon volcanic defined by calcite veining. Uniform maroon basalt with blebs of hematite. Minor calcite veining at the base of the unit.

Conglomeratic interbeds of G.R.V. clasts and gneiss. Mainly red ironstained pebbles up to 3 cm, subangular in shape. The matrix is poorly sorted, with conglomerate horizons increasing in thickness towards the base of the unit.

Basalt flow 3. Dark red basalt with 30% calcite rimmed chlorite amygdules, many joined by calcite veining.
264 m - 20% hematite and calcite amygdules.

non-vesicular uniform maroon basalt.

Medium grained calcic sand containing clasts of Beda Volcanics and Gawler Range Volcanic, poorly sorted.

Basalt flow 2. Maroon basalt. Top 1 m contains 60% amygdules, mainly calcite connected by fine veins, vesicles large up to a few cm.

277.2 m maroon basalt 20% vesicles filled with calcite rimmed by hematite. Few coarse green crystals.

281.31 m 15% fine vesicles filled with calcite and chlorite.

Near vertical cross cutting of calcite veins, and some horizontal veins.

289.46 m-Basalt flow 1? Maroon basalt with 20% vesicles filled with calcite.

Very sharp contact.

Very poorly sorted conglomerate horizon. Clasts up to 5 cm. Clasts are Gawler Range Volcanics, gneiss and ironstone Very coarse sandy matrix.

SHEET 1 OF 1

PLAN N°

43.29

DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA

TR4

B.H.P. TREGALANA

CORE DESCRIPTION

DEPTH 401·25 m

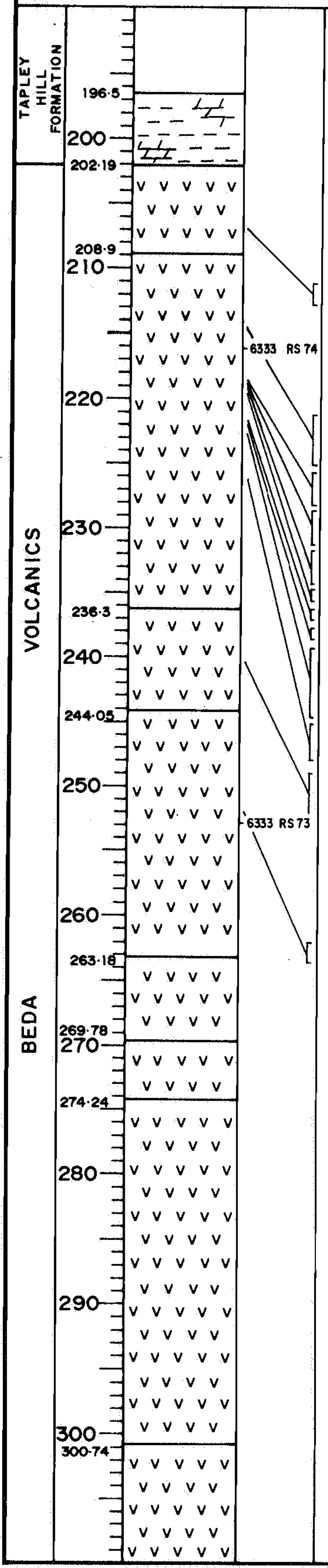
INCLINATION Vertical

LOGGED BY A. Woodget

DATE DRILLED

REFERENCE Env. 3915

DEPTH (m) | GRAPHIC LOG | DESCRIPTION



Dark and light grey interbeds of silts (80%) and carbonates (20%). Carbonate beds show traces of chalcopyrite, and chalcocite.

Carbonate content increased.

Basalt flow 14. Convoluted contact between the Tapley Hill Formation and Beda Volcanics with no conglomerates at the contact. The flow top is represented by white possibly calcic and chlorite <10% amygdules. The basalt is dark green, with heavy mineral and carbonate veining.

206.65 - pure calcite infill fracture about 4 cm wide.

Basalt flow 13D. Red basalt, flow top represented by 50% vesicles filled with calcite.

Reducing to 30% filled with chlorite (black), rimmed with hematite. Basalt gradually turns chocolate brown/maroon.

214.6 - amygdules increase in size, mainly chlorite, rimmed with calcite. About 30% vesicles.
finer grained black light green basalt.
218.5 Basalt flow 13C. 30% white calcite and hematite filled vesicles. Basalt has a higher hematite content.
218.8 - 10 cm of pure hematite clasts. Each clast is surrounded by carbonate veining.
218.9 - Reintroduction of black amygdules, 10% in a fine-grained grey/chocolate brown basalt.
219.5 - flow 13B. Grey-brown basalt, with 40% large white amygdules.
221.77 - Bright green brecciated volcanic with calcite infill
221.97 - non-vesicular green basalt.
222.74 - Basalt flow 13A. Alternate vesicular/non-vesicular volcanics. Possibly 3 pulses. Vesicular sections contain 15% amygdules of chlorite and carbonate, and chlorite hematized veins and fractures.
226.2 - amygdules <5%. Green-grey volcanic, with vesicles filled with chlorite, or pink albite. Volcanic looked mottled.

Basalt flow 12. Red-maroon basalt with alternating vesicular and non-vesicular horizons. Vesicular horizon contains 30-40% calcite and chlorite filled amygdules.

Basalt flow 11. No flow top present (intrusive?). Green-grey volcanic with 30% vesicles filled with carbonate and chlorite. Intermittent chlorite ribbons are present, with hematite red staining around the edge of some.

252.0 - massive green-grey non-vesicular, non-calcareous basalt.

Basalt flow 10. Purple-green basalt. Vesicles < 10% are large, and filled with chlorite, and minor pink albite increasing towards the base.

Basalt flow 9, as flow 10.

Basalt flow 8 - as flow 10. Vesicles mostly chlorite <10%.

Massive green-grey basalt.

Basalt flow 7. Maroon-red basalt, with hematite streaking. <10% white amygdules, rimmed with hematite. Possible to distinguish between 3 or 4 pulses.

SHEET 1 OF 2

PLAN N°

4329

MF 179

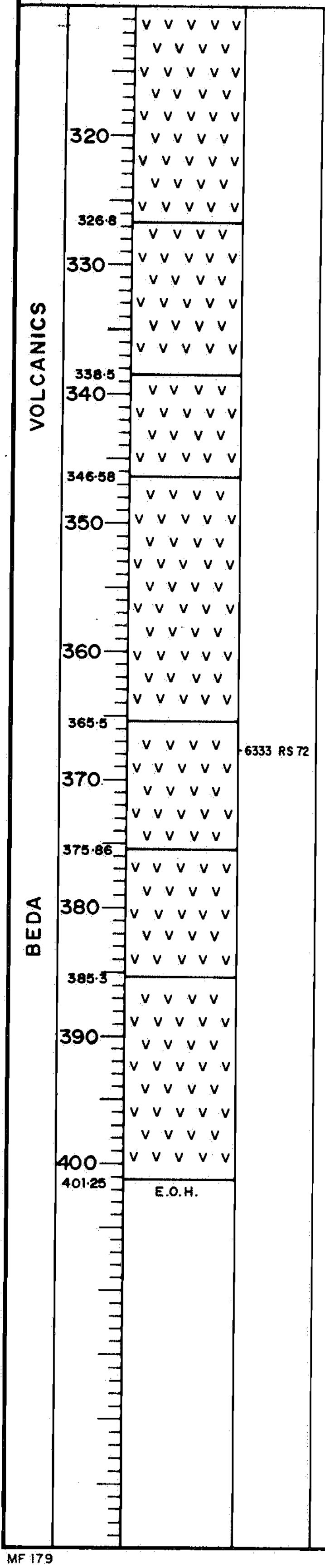
DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

TR4

B.H.P. TREGALANA
CORE DESCRIPTION

DEPTH 401·25 m
INCLINATION Vertical
LOGGED BY A. Woodget
DATE DRILLED
REFERENCE Env. 3915

DEPTH (m)	GRAPHIC LOG		DESCRIPTION



313.35 Non-vesicular green-brown basalt.

Basalt flow 6. Hematite-rich red-brown basalt. Vesicles < 10% large filled with carbonate and chlorite.

Hematite content decreased down core, and volcanic becomes more green grey in colour.

Basalt flow 5. Hematite rich red-maroon flow, with alternating vesicular and non-vesicular horizons, representing 9 pulses. 50% amygdules with calcite fill.

Basalt flow 4. Black-purple basalt, with 60% vesicles filled with calcite and pink albite.

348.22 Non-vesicular green basalt, with porphyritic laths of feldspar. Minor hematite horizons.

Basalt flow 3. Maroon hematite-rich basalt, 40% vesicles. Some very large filled with chlorite, hematite, calcite and albite.

Basalt flow 2. Grey-green basalt, with < 5% vesicles filled with chlorite, some have minor iron staining.

Basalt flow 1. Fine-grained red basalt, with 25% amygdules of chlorite, albite and calcite.

392.93 massive grey-green basalt, with minor hematite ribbons.

SHEET 2 OF 2

PLAN Nº

4329

MF 179

DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA

TR4

B.H.P. TREGOLANA

CORE DESCRIPTION

DEPTH 401·25m

INCLINATION Vertical

LOGGED BY A. Woodget

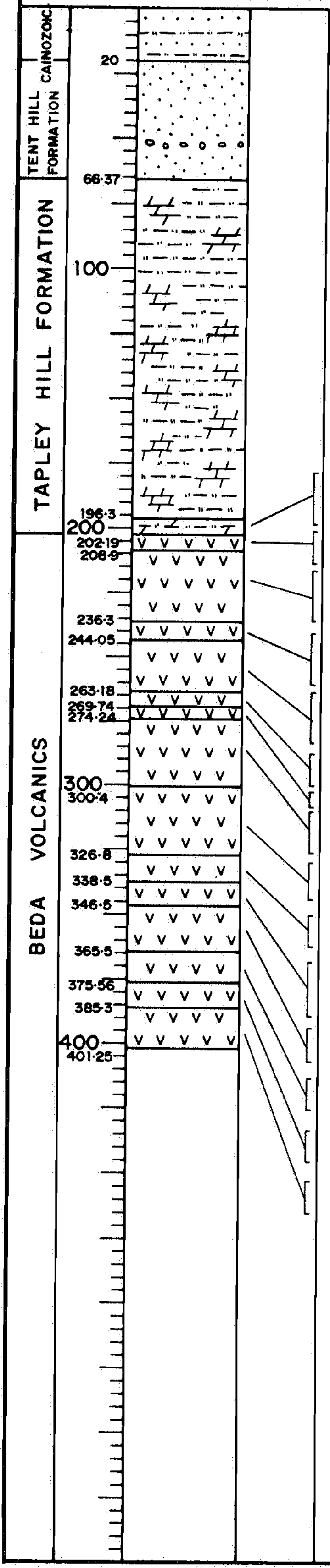
DATE DRILLED

REFERENCE Env. 3915.

DEPTH (m)

GRAPHIC LOG

DESCRIPTION



Sludge. Brown sand and silt.

Massive fine-grained grey-green sandstone with grit bands.

Pebbly horizon - Pebbles of G.R.V. and flat carbonates in fine-grained green sandstone matrix.

Fine grey sandstone with few G.R.V., and dolomitic clasts.
Fine grained laminated grey silts with flat dolomitic pebbles.
30% dolomite: 70% grey silt.

50% carbonate; 50% dark silt. Carbonates show sedimentary structures of x bedding, ripples, slumps and wavy bedding.

Dark and light grey interbeds of silts and carbonates. Carbonate: silt 20%:80%. Carbonate beds show traces of chalcopyrite and chalcocite.

Basalt flow. Convoluted contact. Dark green basalt with 10% vesicles filled with calcite and chlorite.

Basalt flow. Possibly 4 pulses. Green-grey-red basalt. Flow tops represented by 30-50% vesicles filled with calcite and chlorite. Between flow tops: green-grey basalt with minor vesicles.

Basalt flow. Red-maroon basalt, with alternating vesicular and non-vesicular horizons. Vesicular horizons 30-40% calcite and chlorite filled.

Basalt flow. Grey-green volcanic with 30% vesicles filled with carbonate and chlorite. Intermittent chlorite ribbons.
No flow top.

Basalt flow. Purple-green basalt with <10% large chlorite filled vesicles. Minor pink albite increasing towards the base.

Basalt flow - as above.

Basalt flow - as above.

Massive green-grey basalt.

Basalt flow. Maroon-red basalt, with hematite streaking. <10% white amygdules rimmed with hematite.

Basalt flow. Hematite rich red-brown basalt. Vesicles <10% filled with carbonate and chlorite.

Basalt flow. Hematite rich red-maroon basalt, with alternating vesicular, and non-vesicular horizons representing 9 pulses. 50% amygdules with calcite fill.

Basalt flow. Purple-black basalt with laths of feldspar and minor hematite horizons.

Basalt flow. Maroon hematite rich basalt, 40% vesicles filled with chlorite, carbonate and albite.

Basalt flow. Green-grey basalt with <5% vesicles filled with chlorite. Some have iron staining.

Fine-grained red basalt with 25% amygdules filled with chlorite, albite and calcite.

SHEET 1 OF 1

PLAN Nº

4329

MF 179

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

CU1

B.H.P. CULTANA AREA

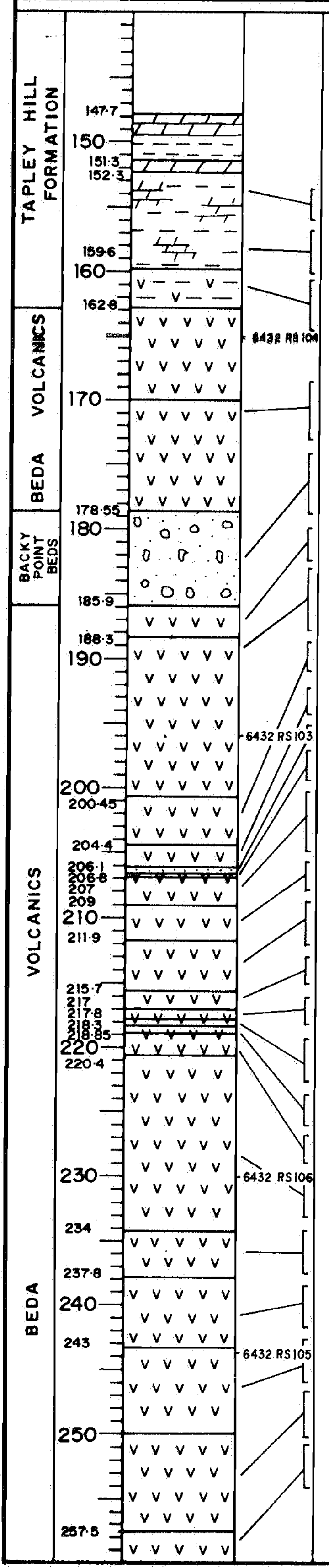
CORE DESCRIPTION

DEPTH 305·2 m. INCLINATION Vertical

LOGGED BY A. Woodget DATE DRILLED

REFERENCE Env. 3917

DEPTH (m) | GRAPHIC LOG | DESCRIPTION



Interbedded laminated dark grey shales and light grey dolomitic siltstone. Minor calcite veining 50% shale and 50% calcite. Minor hematite.

Alternate 5-10 cm bands of pure siltstone and dolomite. Dolomite contains only minor layers of siltstone.

90% dolomite and 10% siltstone. Minor disruption of bedding by calcite veining.

Sharp contact between well laminated overlying dolomite and grey pyritized volcanics. The pyrite is disseminated <5%. 50% altered to carbonate.

Conglomeratic 80% greenish basaltic pebbles, well rounded, contains minor hematite about 1% pyrite disseminated in pebbles. Matrix-pink feldspar/quartz medium-coarse grained sandstone.

Basalt flow 25.20% amygdules, mostly green, some have hematitic margins.

Basalt flow 24. Flow top reddish brown-green basalt. 50% amygdules mainly green. 10% carbonate veining 5 mm - 5 cm wide veins surrounded by hematite. Last 50 cm of flow amygdules white, and much finer.

Alternate layers of sandstone and conglomerate grey-black. Some pebbles are well rounded, some subangular 1 mm-5 cm in size. Pebbles are pink, mainly feldspar and quartz. Remnants of perthitic granite.

Basalt flow 23. brown-green basalt flow, 50% amygdules mostly >5 mm decreasing to 10% amygdules mainly white, calcium veining.

Basalt flow 22. Flow top brown-green basalt 15% carbonate fractures up to 5 cm wide reddish brown hematite streaking.

Flow - green-brown-red basalt. 10% and pale green and hematitic amygdules.

Basalt flow 21. Brown-green basalt flow 50% amygdules decreasing down to 10% large amygdules. Generally a dense brown-red volcanic.

Basalt flow 20. Flow top coarse amygdules 20% white hematitie and dark green, minor light green.

Sediment. Red-brown sandstone. Fine to medium grained.

Basalt flow top 19. Reddish brown. 30% amygdules of calcite and hematite.

Basalt flow top 18. Red-brown basalt 70% amygdules mainly pink/red (albite?) and white-green. Pink amygdules joined by fine threads. The green filled ones are surrounded by the pink or white material.

Basalt flow 17. Purple-brown basalt containing 70% amygdules pink and white decreasing down to 20% mainly white and green.

Basalt flow 16. Purple-dark brown basalt. 60% amygdules white with pink rims up to 5 cm wide. Fine grains amygdules dark green-black in colour (chlorite?).

Basalt flow 15. 70% amygdules pink with white centres, decreasing down to fine-grained white amygdules about 20%.

Basalt flow 14. Purplish brown. 50% amygdules, coarse grained pink with white centres. Small ones only pink.

Basalt flow 13. Purplish black basalt. 40% large pink amygdules some have white centres, grading down to 15% white small amygdules.

Basalt flow 12. Purple-grey rock, mainly white coarse amygdules initially 60% reducing.

Basalt flow 11. Purple-grey basalt. 60% amygdules mainly white. Some have pink rims.

Basalt flow 10. Up to 14 pulses. Purple/brown basalt with olive green amygdules. Each flow top is expressed by up to 40% amygdules.

Basalt flow 9. 5 pulses. Purple-brown green. Mostly white and green amygdules. 234.5 m 8 cm thick green epidote layer. Epidote also is dispersed in other flow tops.

Basalt flow 8. 8 pulses. Green-brown basalt. Flow tops 2-10 cm of fine amygdules of chlorite, carbonate and hematite. Interlayers of fine-grained green/brown basalt.

Basalt flow 7. 3 or 4 pulses of green-brown basalt, coarser grained than above. Flow tops represented by 60% green amygdules 10-40 cm thick.

Basalt flow 6. 3 pulses brown medium grained basalt. Much more hematite rich than above layer. Indistinct flow top 40% amygdules, mainly chlorite.

Basalt flow 5. 3 to 4 pulses of very fine even grained brown-red basalt with very thin flow tops, all less than 10 cm and contain about 50% green amygdules.

SHEET 1 OF 2

PLAN N°

4329

MF 179

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

CU1

B.H.P. CULTANA AREA

CORE DESCRIPTION

DEPTH 305·2 m

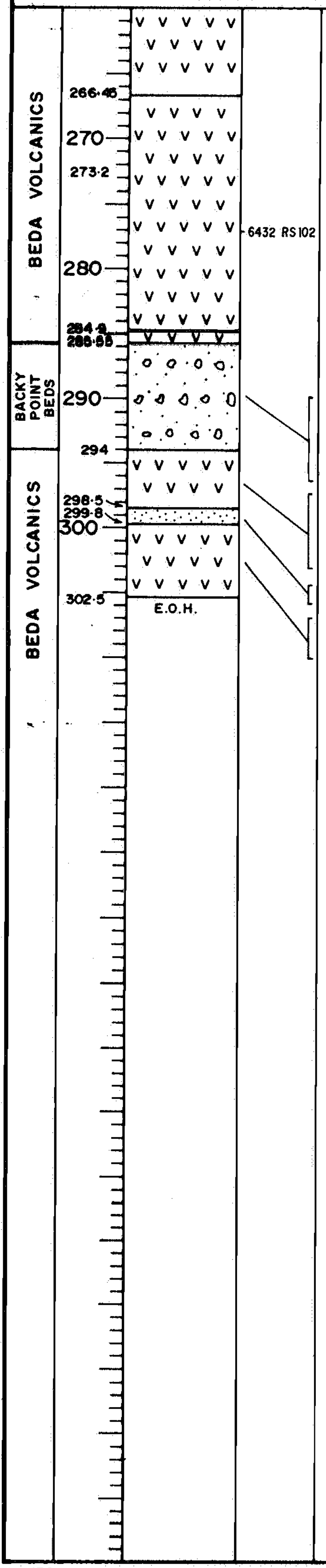
INCLINATION Vertical

LOGGED BY A. Woodget

DATE DRILLED

REFERENCE Env. 3917.

DEPTH (m)	GRAPHIC LOG		DESCRIPTION



Basalt flow 4. Flow top. Very thick basalt flow top, brown/purple basalt containing 15% amygdules of calcite and green (chlorite) calcite veining flow top.

Basalt flow 4. Purple brown basalt, finely mottled green and even grained no amygdules.

Basalt flow 3. Brown/red basalt. Amygdules yellow/white carbonate. Some olive green 30%.
10% horizontal carbonate veining.
Basal carbonate forms contact between Backy/Beda.

Red bed sandstone conglomerates and minor brown shales, with interlayer conglomerate bands up to 20 cm containing pink feldspar and granitic gneiss - up to 3 cm subangular. Also heavy mineral bands.

Basalt flow 2. 11 pulses, 9 of which are separated by sand. Flows from 5 cm to 80 cm in thickness, and sand from ½ cm - 30 cm.
Lava pulses mainly amygdaloidal 30% with large white calcite.

Sandstone, medium-grained mainly pink feldspar.

Basalt flow 1. Purple brown basalt with 20% large vesicles mostly green and white.

SHEET 2 OF 2

PLAN N°

4329

MF 179

DEPARTMENT OF MINES AND ENERGY — SOUTH AUSTRALIA

CU 1

B.H.P. CULTANA AREA

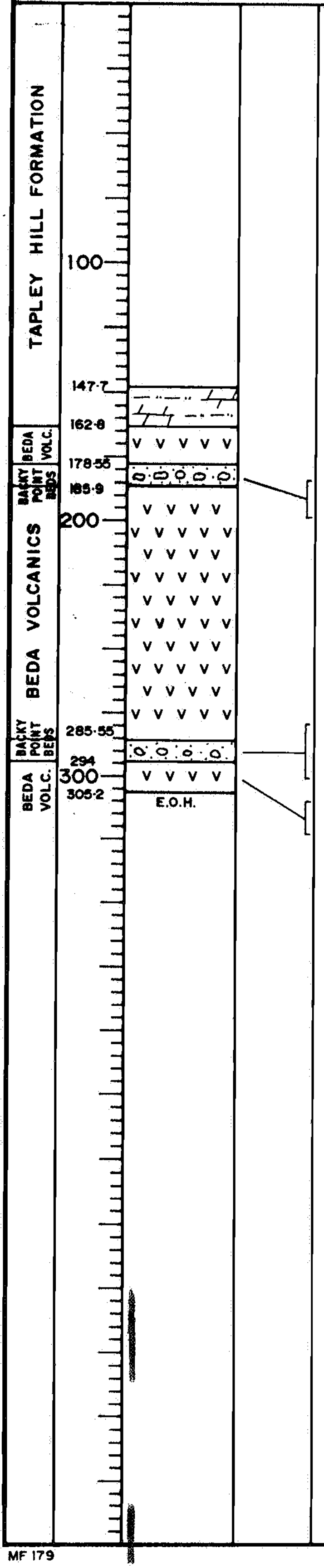
CORE DESCRIPTION

DEPTH 305·2m **INCLINATION** Vertical

LOGGED BY A. Woodget **DATE DRILLED**

REFERENCE Env. 3917

	DEPTH (m)	GRAPHIC LOG		DESCRIPTION



Alternate layers laminated dark grey shales and light grey dolomitic siltstone.

Basalt flow 24, 25 green/brown basalt with vesicular flow top mainly green amygdules.

Grey-black sandstone and conglomerate. Conglomerate pebbles are pink, mainly feldspar. Remnants of perthitic granite.

Basalt flows 3-23. Brown red-green iron enriched basalts. Flow tops contain between 30-70% amygdules of carbonate, chlorite (black and dark green) and pink material, either iron stained carbonate, or albite.

Red bed sandstone and conglomerate. 4 minor brown shales with interlayered conglomeratic bands up to 20 cm thick. Conglomerates are composed of pink feldspar and granitic gneiss up to 3 cm in size.

Basalt flow 1, 2 purple/brown basalt containing a number of pulses. 20-30% vesicles mostly calcite and chlorite fill.

SHEET 1 **OF** 1

PLAN N°

4329

MF 179

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

CU5

B.H.P. CULTANA AREA

CORE DESCRIPTION

DEPTH 456·7 m

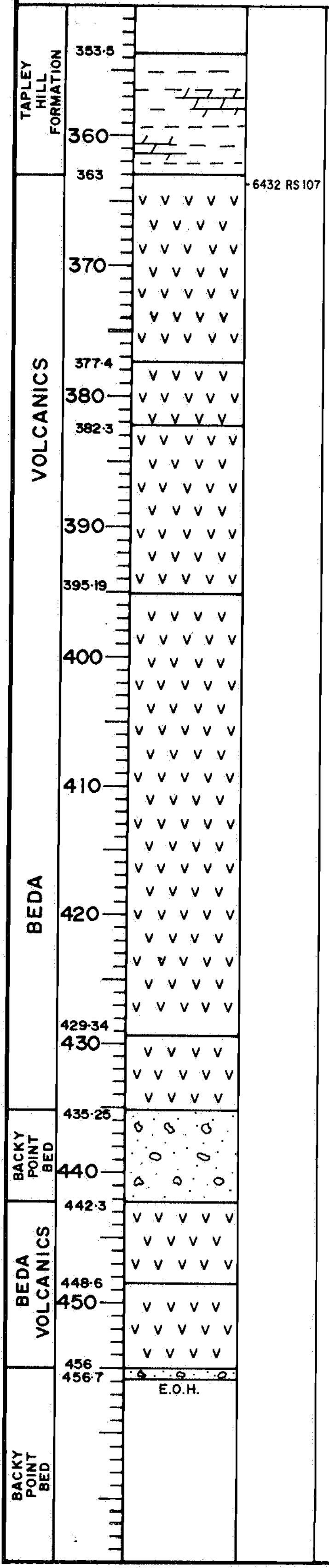
INCLINATION Vertical

LOGGED BY A. Woodget

DATE DRILLED

REFERENCE Env. 3917

DEPTH (m)	GRAPHIC LOG		DESCRIPTION



Alternate layers of dolomite and siltstone, with cross cutting calcite veins. Disseminated pyrite.

"Cooked up" basalt. Grey rock with calcite filled vesicles. 40% vesicles decreasing down to 15%.

366.08 - Basalt flow 6. Basalt is medium-grained vesicular red-brown volcanic. 20% vesicles filled with calcite, and black chlorite. It consists of a number of pulses, but their boundaries are not distinguishable.

Large bands of calcite veining with hematite outer rim, and chalcopyrite mineralization in large crystals.

Basalt flow 5. Interlayered vesicular/non vesicular red-brown magnetic basalt. Vesicles filled with calcite, black chlorite. Contains a number of pulses, but boundaries not distinguishable.

Basalt flow 4. Interbedded vesicular and non vesicular maroon-green basalt. 15% amygdules filled with chlorite. Very iron rich basalt, with wavy laminations between 391.3-391.5 m.

Basalt flow 3. Flow top breccia, with carbonaceous infill. Dark brown-green basalt, with 30% carbonate vesicles up to 1.5 cm. 395.86 - fine-grained brown vesicular basalt. 10% vesicles filled with green-black chlorite. Increased iron staining down core.

408.65 - non-vesicular red/green medium grained basalt. It has blocky ironstaining with chlorite alteration, and traces of disseminated fine pyrite. In sections it is more green due to increased chlorite alteration.

Basalt flow 2. Fine-grained dark brown-maroon basalt. 15% vesicles filled with calcite, chlorite and iron stained orange material. Vesicles decrease in number, but increase in size down core.

Interbedded conglomerate and pink/orange sandstone. Conglomerate clasts are up to 4 cm, poorly sorted, consisting of Beda Volcanics (some completely chloritized), Gawler Range Volcanics and gneiss. Minor disseminated chalcopyrite at base.

Basalt flow 1. Red-brown vesicular basalt. 10% vesicles filled with calcite and chlorite. Vesicles are more abundant at the top of the flow. Minor calcite veining.

Volcanics very broken up and weathered.

Flat laminated sediments, fine-grained, polymitic pink/red. Heavy mineral bands. Highly calcareous matrix.

SHEET 1 OF 1

PLAN Nº

4329

MF 179

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

CU5

B.H.P. CULTANA AREA

CORE DESCRIPTION

DEPTH 456·7m.

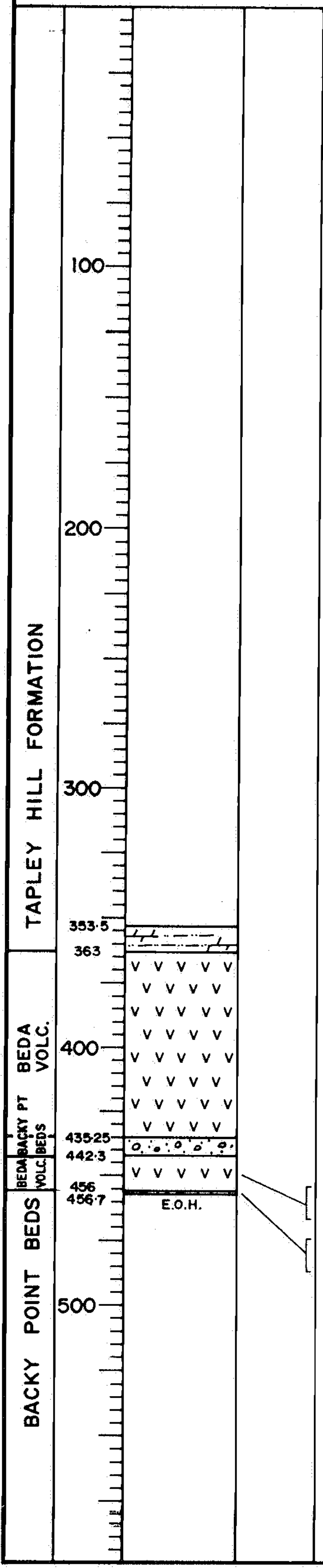
INCLINATION Vertical

LOGGED BY A. Woodget

DATE DRILLED

REFERENCE Env. 3917

DEPTH (m) | GRAPHIC LOG | DESCRIPTION



Alternate layers of dolomite and siltstone, with cross cutting calcite veins. Disseminated pyrite.

Basalt flow. Five flows of red-green-brown basalts, with 10-30% vesicles filled with green-black chlorite, calcite, and iron rich material. Below flow tops basalt becomes finer grained, with a reduction in the amount of vesicles.

Interbedded conglomerate and pink-orange sandstone. Conglomerate clasts up to 4 cm, poorly sorted, consisting of Beda Volcanics, G.R.V., and gneiss. Minor chalcopyrite at base.

Basalt flow. Red-brown vesicular basalt. 10% vesicles filled with calcite and chlorite. Very broken up weathered volcanic.

Fine grained flat laminated sediments polymictic pink/red. Heavy mineral bands, with highly calcareous matrix.

SHEET 1 OF 1

PLAN Nº

4329

MF 179

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

CU6

B.H.P.

CORE DESCRIPTION

DEPTH 400·4 m

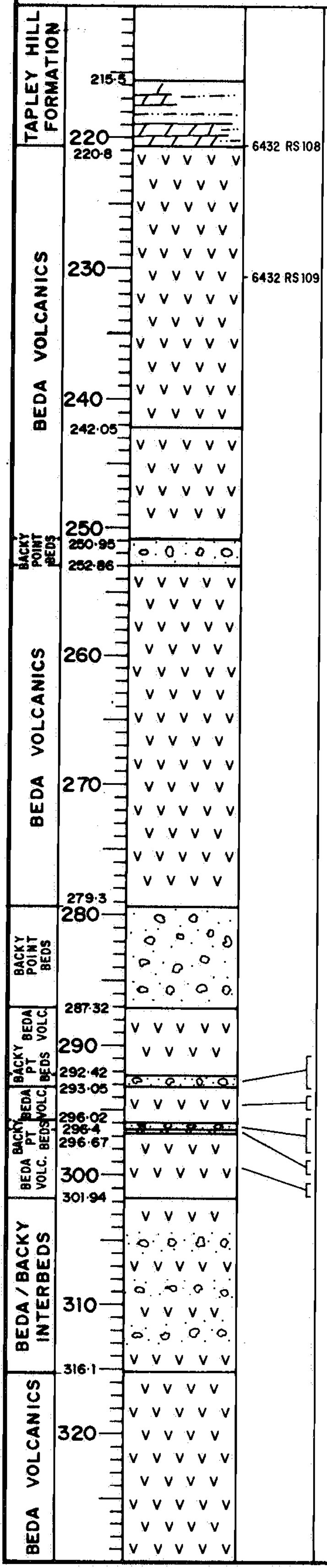
INCLINATION Vertical

LOGGED BY A. Woodget

DATE DRILLED

REFERENCE Env. 3917

DEPTH (m) | GRAPHIC LOG | DESCRIPTION



Alternate layers of silt and carbonate (dolomite), with heavy mineral streaking. Increase in carbonate down core.

Nearly pure dolomite 80% carbonate 20% silt. Still heavy mineral streaking.

Basalt flow 15. Grey/green felted textured basalt, contains traces of chalcopyrite. Minor green and pink amygdules <5% and fine hematite amygdules.

Basalt flow 14. Maroon basalt. Top of flow fracture infilled with siliceous/calcic white material. Amygdules in top 40 cm about 20%, mainly white and green fine-grained.

Minor carbonate veining.

Interbedded sandstone and conglomerate. Conglomerate is poorly sorted subangular feldspar (albite?) and quartz. Few large pebbles up to 3 cm with pink/orange overall colour. Few heavy mineral laminae. Cement mainly calcite.

Basalt flow 13. Brown/maroon volcanics. 15% vesicles, small and irregular filled with calcite (white) and chlorite (green). Hematite content increases towards the base, with red iron staining increasing.

Homogeneous green/red basalt, massive.

Interbedded sandstone and conglomerate 70:30. Conglomerate horizon: Poorly sorted subangular clasts of quartzite and red gneiss, also subrounded sandstone grains, with heavy mineral laminae.

Basalt flow 12. Brown/maroon basalt iron stained fine grained. 40% amygdules filled with albite, and calcite.

Sand supported conglomerate horizon. Poorly sorted clasts of G.R.V., gneiss, amphibolite, up to 2 cm subangular.

Basalt flow 11. As above in flow 12.

Hematized conglomerate interbed. Iron stained calcareous matrix. Hematized clasts of Beda Volcanics.

Flow top breccia. Angular volcanic clasts, with matrix of calcite.

Basalt flow 10. As above in flow 12.

Mixed horizon of Beds Volcanics and Backy Point Beds. The volcanics can be divided into 15 pulses.

Flow 9. 40% amygdules filled with calcite. Red/brown basalt.

Conglomerate horizon. Poorly sorted subangular clasts up to 3 cm, but most are <1 cm. Clasts are mainly granitic material, with calcareous hematized sandy matrix. Minor pyrite along grains.

Basalt flow 8. Maroon/dark brown beds, with 15% calcite and hematite rim, and chlorite amygdules. Carbonate veins also have hematite rims.

SHEET 1 OF 2

PLAN No.

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

CU6

B.H.P.

CORE DESCRIPTION

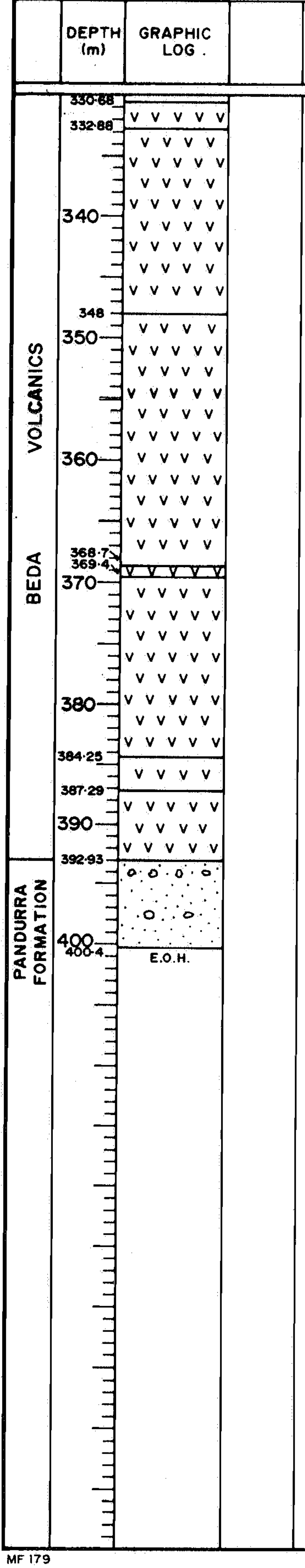
DEPTH 400·4 m

INCLINATION Vertical

LOGGED BY A. Woodget

DATE DRILLED

REFERENCE Env. 3917



DESCRIPTION

Basalt flow 7. Dark grey/black, fine grained vesicular basalt, with 2 or 3 pulses identified.

Flow top is represented by 40% calcite and hematite stained amygdules, up to 1 cm, also albite?

Basalt flow 6. Massive red/brown volcanic fine grained, with minor layers of amygdules of 8-10% filled with chlorite and calcite. Minor hematite staining.

Basalt flow 5. Flow top brecciated with calcite cement. Green/red/brown volcanic, with patches of iron staining - wavy streaks. Mainly chlorite green amygdules < 5%.

Much iron alteration.

Basalt flow 4. Dark brown vesicular basalt, with vesicles up to 3 cm. 30% amygdules with albite-carbonate-chlorite.

Rim - centre.

Basalt flow 3. Fine grained brown-maroon basalt, non vesicular flow, with patches of chlorite alteration and minor calcite veining.

Uniform non-vesicular brown/red volcanic, with hematite alteration/colouration.

Fine grained brown volcanic.Sparse vesicles, but large up to 1 cm filled with chlorite, or carbonate.

Basalt flow 2. Brown vesicular volcanic, with near vertical iron stained calcite veins.

Basalt flow 1. Homogeneous non-vesicular fine grained brown basalt.

Non calcareous sandy beds, with minor conglomerate interbeds. Sands are medium-coarse grained, with heavy mineral laminae. They are finer grained than the Backy Point Beds.

SHEET 2 OF 2

PLAN Nº

4329

MF 179

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

CU6

B.H.P.

CORE DESCRIPTION

DEPTH 400·4m

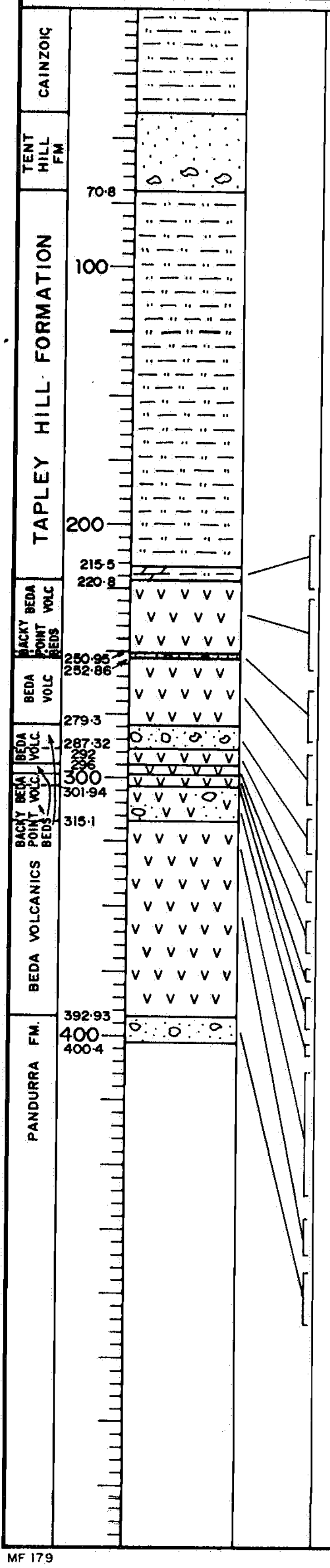
INCLINATION Vertical

LOGGED BY A. Woodget

DATE DRILLED

REFERENCE Env. 3917

DEPTH (m) | GRAPHIC LOG | DESCRIPTION



Silts and sludge.

Red sandstone medium to coarse grained, mottled in parts.

Very fine grained red calcareous sand with pyrite along fractures.

Poorly sorted polymict conglomerate. Clasts subangular-subrounded of G.R.V., quartzite, ironstone, chert, carbonate.

Conformable contact, with grey laminated siltstone.

Alternate layers of silt (grey) and dolomite (light grey), with heavy mineral streaking. Increase in carbonate content down section.

Basalt flow 14, 15. Flow 15 - grey-green, felted textured with <5% green and pink amygdules. Flow 14 - maroon basalt. Flow top fracture calcite fill. Amygdules for 40 cm about 20% mainly white and green fine-grained.

Interbedded sandstone and conglomerate. Conglomerate poorly sorted feldspar (albite). Large pebbles up to 3 cm pink/orange colour. Calcite cement.

Basalt flow 13. Brown/maroon volcanic 15% vesicles small and irregular filled with calcite and chlorite. Hematite content increases towards the base.

Interbedded sandstone and conglomerate. Conglomerate horizon poorly sorted, subangular clasts of quartzite and red gneiss.

Basalt flow 12. Brown/maroon basalt ironstained fine-grained. 40% amygdules filled with albite and calcite.

Sand supported conglomerate horizon. Poorly sorted clasts of G.R.V.,gneiss, amphibolite, up to 2 cm in size.

Basalt flow 11 as flow 12.

Hematized conglomerate interbeds. Iron stained calcareous matrix. Hematized clasts of Beda volcanics.

Basalt flow 10, as flow 12.

Mixed horizon of Backy Point Beds and Beda volcanics. Volcanics can be divided into 15 pulses. 40% amygdules filled with calcite. Red/brown basalt. Basalt flow 9.

Conglomerate horizon: poorly sorted subangular clasts up to 3 cm, but most are<1 cm. Clasts mainly granitic, with calcareous hematized sandy matrix, minor pyrite.

Basalt flow 1-8 maroon-dark grey-brown basalts. 15-40% amygdules, mainly calcite, chlorite and hematite.

Non-calcareous sandy beds, with minor conglomerate interbeds. Sands are medium-coarse grained, with heavy mineral laminae. Finer grained than Backy Point Beds.

SHEET 1 OF 1

PLAN No

4329

MF 179

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

SAS 1

SELTRUST TREGALANA - SUGARLOAF HILL

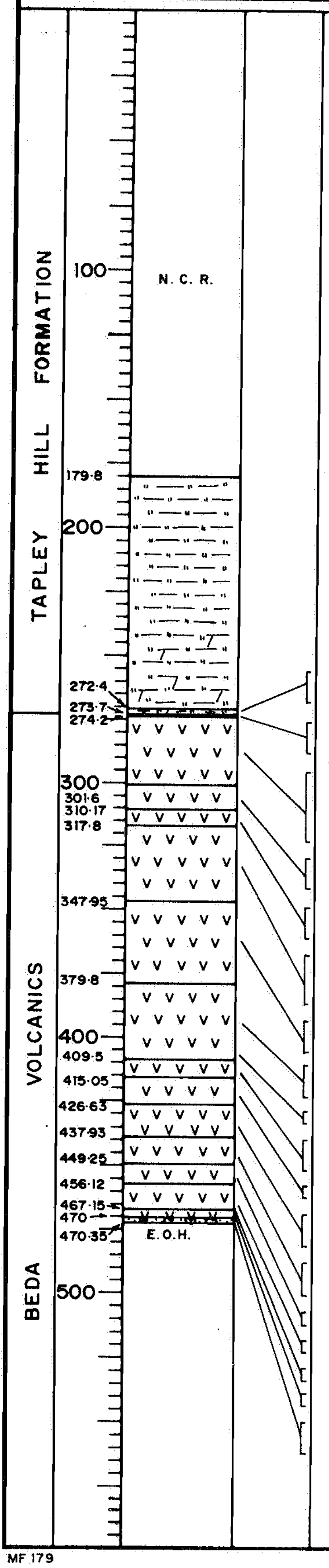
CORE DESCRIPTION

DEPTH . 470·35 . . . . . . INCLINATION . Vertical . .

LOGGED BY . A. Woodget . . DATE DRILLED . . . .

REFERENCE . Hörr University of Adelaide Honours Thesis 1977

DEPTH (m) GRAPHIC LOG DESCRIPTION



Siltstone. Dark very fine grained, with indistinct laminations.

5% white dolomite and graded dol. siltstone layers.

Interlayers of dolomite and siltstone. 30% dolomite. Parting occurs along layers of very fine black material.

Breccia-reworked subangular clasts of purple-brown Beda volcanics with a fine grained matrix. Clasts up to 4 cm.

Basalt flow 13. Purple-maroon hematite-rich basalt with 20% vesicles filled with chlorite, carbonate and yellow material. Further down the flow, the vesicles become finer and mainly calcite filled.

Basalt flow 12. Chocolate brown basalt, with up to 10% large amygdules, mainly calcite filled.

Basalt flow 11. Very sharp contact between flows. Purple basalt with medium to large white amygdules rimmed with red iron staining.

Basalt flow 10. Above flow top 1 cm of horizontal siltstone. Purple-maroon medium to fine grained basalt, with 20% amygdules filled with carbonate and chlorite.

Basalt flow 9. Dark brown-red basalt, with 20% white and pink filled amygdules. Possibly 5 pulses.

Basalt flow 8. Dark brown-red basalt with 10% amygdules and calcite veining. 3 or 4 main flow horizons.

Very fine grained basalt with green amygdules.

Basalt flow 7. Brown fine grained basalt, flow top 80% chlorite and carbonate amygdules.

Basalt flow 6. 50-60% vesicular maroon v.fine grained basalt.

Basalt flow 5. Brown fine-grained basalt - 4 pulses, with flow tops represented by small vesicles filled with carbonate.

Basalt flow 4. Brown-maroon basalt, 10% vesicles filled with calcite with pink rims and chlorite.

Basalt flow 3. Same as flow 4 with up to 3 cm wide calcite horizons.

Basalt flow 2. Same as flow 4.

Sandy layer, white-brown in colour.

Basalt flow 1. Same as flow 4.

Poorly sorted horizon, with conglomerate clasts up to 3 cm. Clasts are G.R.V. and gneiss in coarse sandy matrix.

SHEET . 1 . OF . 1 . .

PLAN Nº

4329

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

SAU3

AUSTRALIAN SECTION URO BLUFF

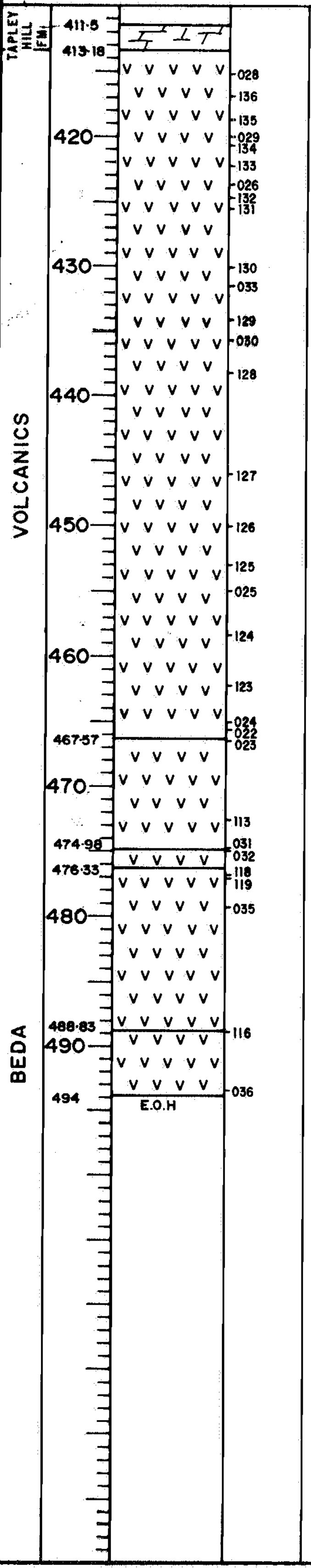
CORE DESCRIPTION

DEPTH 494 m. INCLINATION Vertical

LOGGED BY A. Woodget DATE DRILLED

REFERENCE Hörr University of Adelaide Honours Thesis 1977

DEPTH (m)	GRAPHIC LOG	SAMPLE No. prefix 533/	DESCRIPTION



Light grey laminated beds containing 20% shale and 80% carbonate. Base section has calcite veining.

Basalt flow 10. Thin band of calcite forming contact. Green-brown-purple basalt, with felted texture of chlorite and hematite, with fine laths of heavy minerals. Disseminated chalcopyrite throughout. No vesicular flow top (intrusion?).

Alternating every few m between coarse and fine grained.

Basalt flow 9. 20% vesicular maroon basalt. Vesicles filled with green chlorite. Some are either weathered out or were never filled in the first place. Mainly large vesicles.

Basalt flow 8. Brick red hematite rich basalt, with 60% white calcite amygdules reducing down the flow to 30%. Some pink amygdules also.

Basalt flow 2. Green/buff volcanic with < 5% white and green amygdules, medium to coarse grain size. Some red hematite iron staining.

Basalt flow 1. As above in flow 2, with thick calcite veining.

SHEET 1 OF 1

PLAN Nº

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

SAU3

AUSTRALIAN SECTIONS URO BLUFF

CORE DESCRIPTION

DEPTH 494m

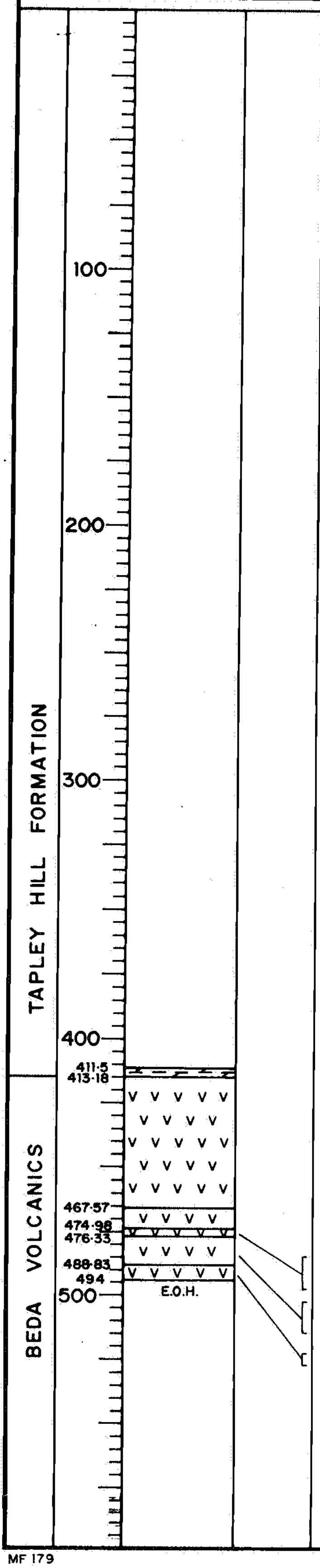
INCLINATION Vertical

LOGGED BY A. Woodget

DATE DRILLED

REFERENCE Hörr, University of Adelaide Honours Thesis, 1977

DEPTH (m)	GRAPHIC LOG		DESCRIPTION



Light grey laminated beds containing 20% shale, and 80% carbonate. Base has carbonate veining.

Basalt flow. Thin band of calcite forming contact. Green-brown-purple basalt, with laths of chlorite, hematite and heavy minerals. Disseminated chalcopyrite throughout. No vesicular flow top.

Basalt flow. 20% vesicular maroon basalt. Vesicles filled with chlorite, but some have been weathered or never originally filled.

Basalt flow. Brick red hematite rich basalt, with 60% white filled amygdules, reducing to 30% downflow.

Basalt flow, green-buff basalt with < 5% white amygdules. Some hematite staining.

Basalt flow as in above flow, but with thick calcite veining.

SHEET 1 OF 1

PLAN Nº

4329

MF 179

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

YAD2

C.S.R.

CORE DESCRIPTION

DEPTH 221·3 m

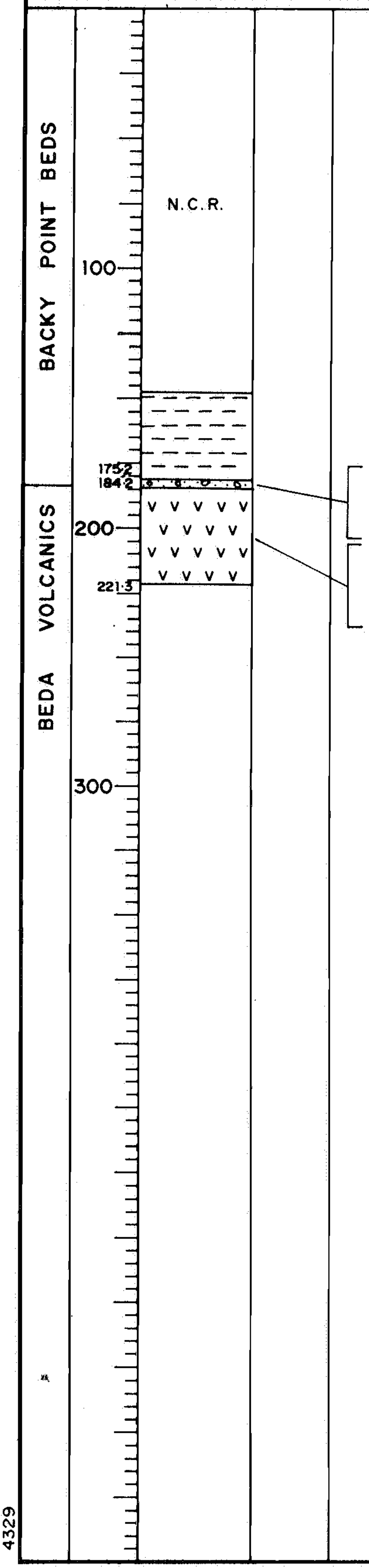
INCLINATION Vertical

LOGGED BY A. Woodget

DATE DRILLED

REFERENCE Env.

DEPTH (m)	GRAPHIC LOG		DESCRIPTION



Puggy clay.

Silty clay.

Dark brown laminated siltstone, with pink hematite throughout. Light coloured sandy laminae with up to 10% fine subangular quartz.

Conglomeratic subangular clasts of pink feldspar and quartz. Well rounded medium-grained dark green and Beda volcanic pebbles. Most of the volcanic pebbles are surrounded by a hematite red 'halo'.

Basalt flow, no flow top obvious (intrusion or sill?). Green-grey vesicular basalt with 10% amygdules filled with chlorite. Some large ones have carbonate in the centre. Minor hematite streaking.

There is no distinction between individual flows. Possibly minor bands of vesicles, but no definite distinction.

SHEET 1 OF 1

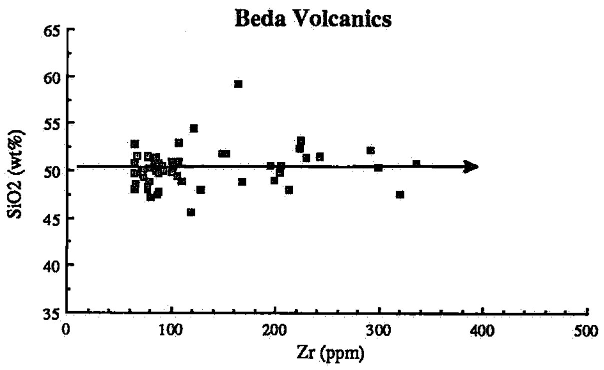
PLAN Nº

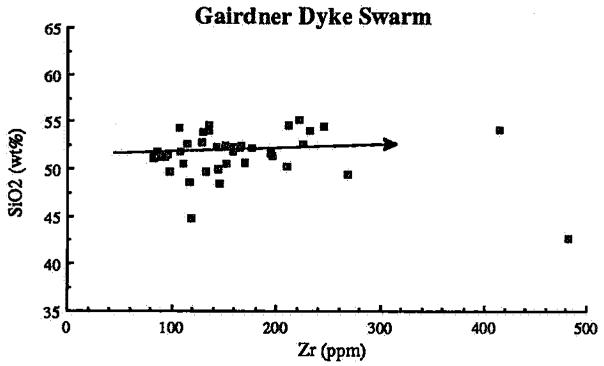
4329

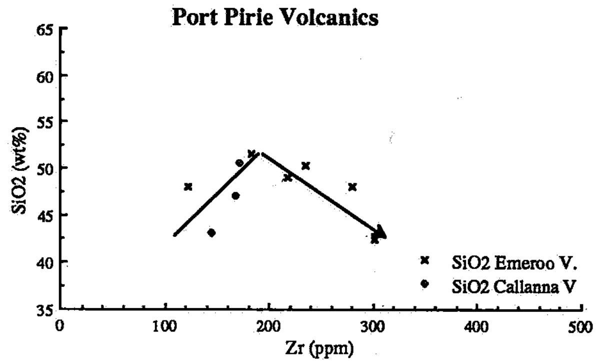
MF 179

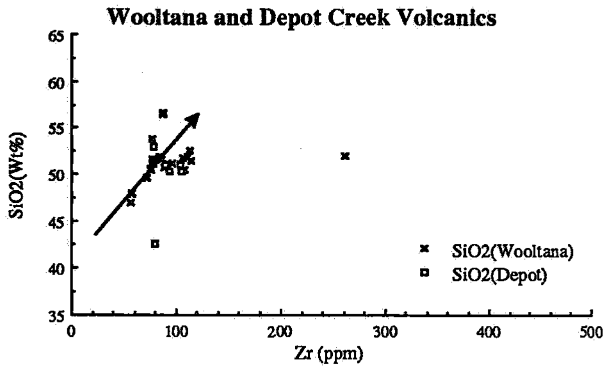
APPENDIX 4

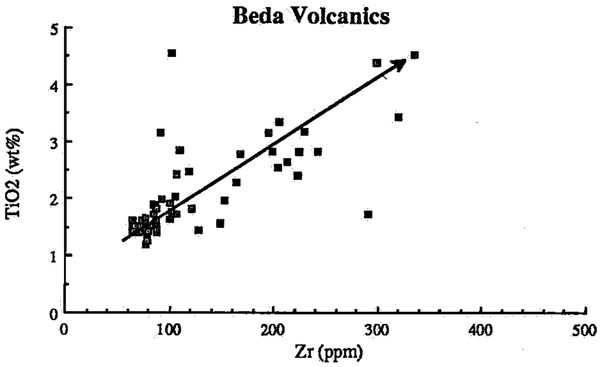
GEOCHEMICAL GRAPHS
Zr VERSUS MAJOR AND TRACE ELEMENTS

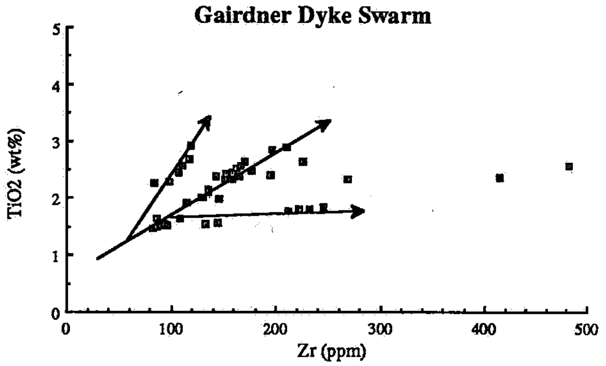

Beda Volcanics
SiO2 (wt%)
65
60
55
50
45
40
35
0
100
200
300
400
500
Zr (ppm)

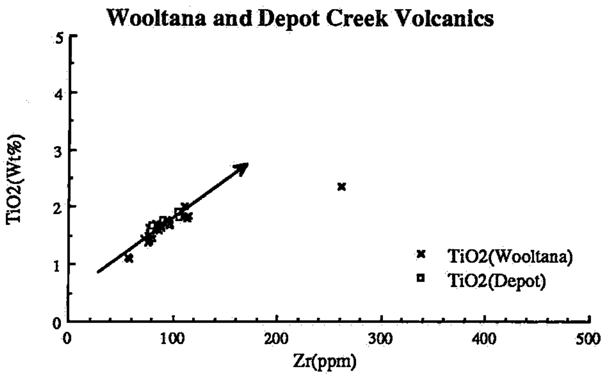

Gairdner Dyke Swarm
SiO2 (wt%)
65
60
55
50
45
40
35
0
100
200
300
400
500
Zr (ppm)

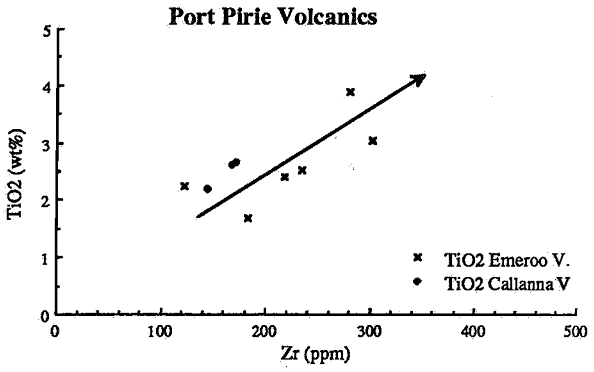

Port Pirie Volcanics
SiO2 (wt%)
65
60
55
50
45
40
35
0
100
200
300
400
500
Zr (ppm)
SiO2 Emeroo V.
SiO2 Callanna V

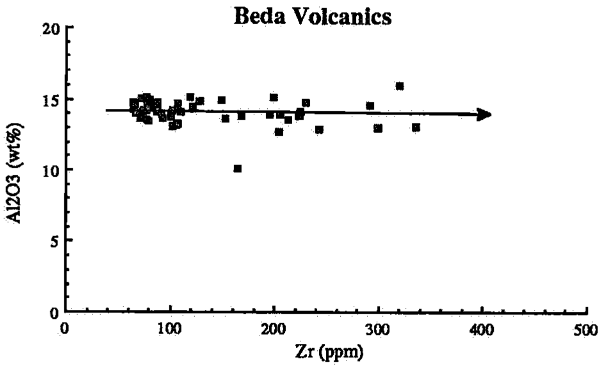

Wooltana and Depot Creek Volcanics
SiO2(Wt%)
65
60
55
50
45
40
35
0
100
200
300
400
500
Zr (ppm)
SiO2(Wooltana)
SiO2(Depot)

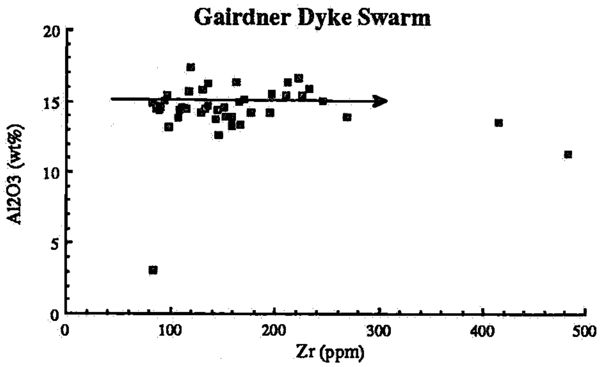

Beda Volcanics
TiO2 (wt%)
5
4
3
2
1
0
0
100
200
300
400
500
Zr (ppm)

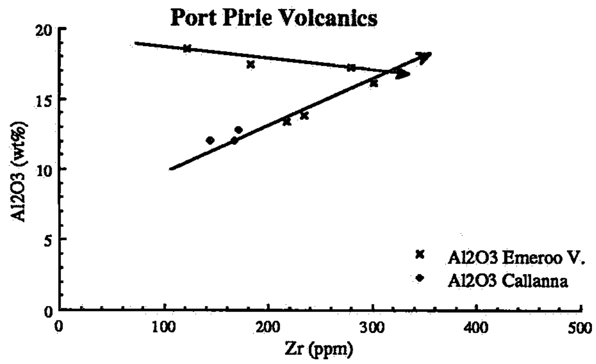

Gairdner Dyke Swarm
TiO2 (wt%)
5
4
3
2
1
0
0
100
200
300
400
500
Zr (ppm)

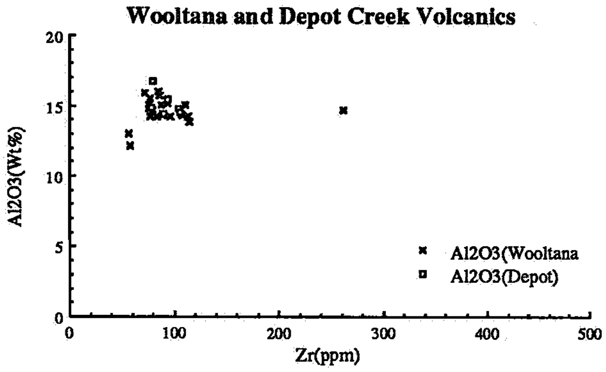

Wooltana and Depot Creek Volcanics
TiO2(Wt%)
5
4
3
2
1
0
0
100
200
300
400
500
Zr(ppm)
TiO2(Wooltana)
TiO2(Depot)

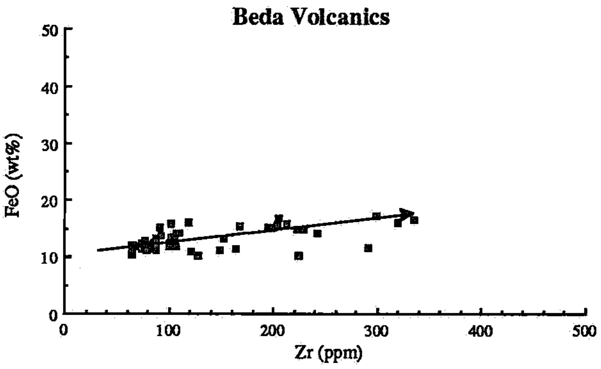

Port Pirie Volcanics
TiO2 (wt%)
5
4
3
2
1
0
0
100
200
300
400
500
Zr (ppm)
TiO2 Emeroo V.
TiO2 Callanna V

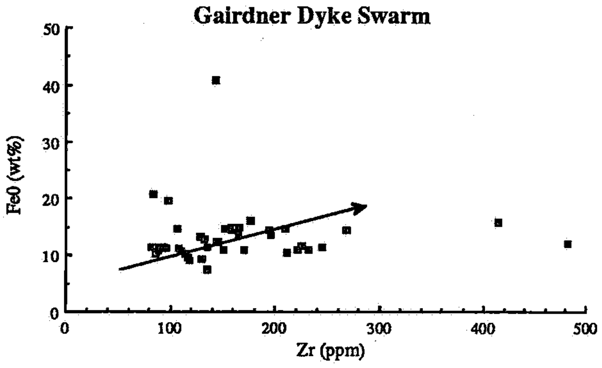

Beda Volcanics
Al2O3 (wt%)
0
5
10
15
20
0
100
200
300
400
500
Zr (ppm)

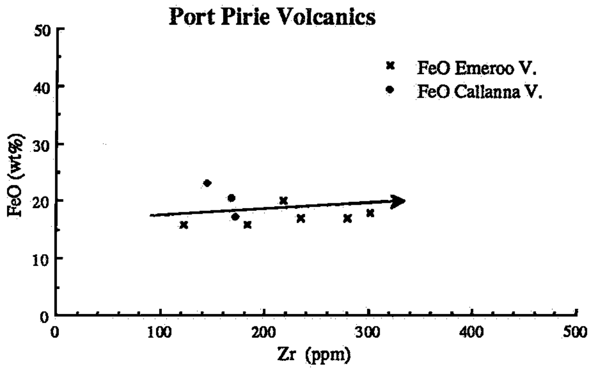

Gairdner Dyke Swarm
Al2O3 (wt%)
0
5
10
15
20
0
100
200
300
400
500
Zr (ppm)

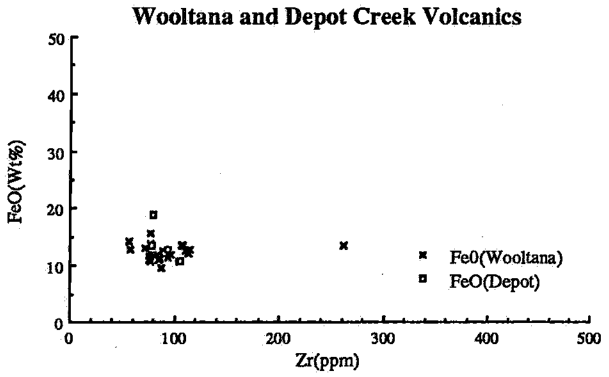

Port Pirie Volcanics
A12O3 (wt%)
0
5
10
15
20
0
100
200
300
400
500
Zr (ppm)
A12O3 Emeroo V.
A12O3 Callanna

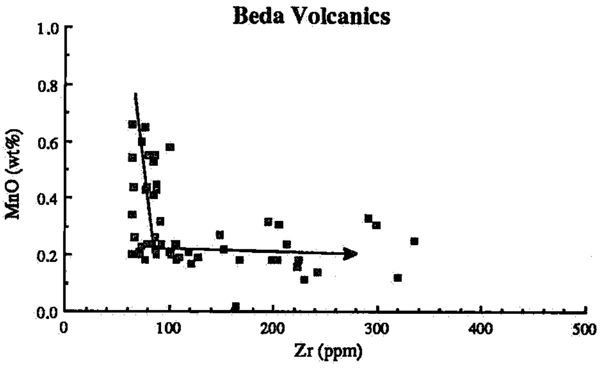

Wooltana and Depot Creek Volcanics
A12O3(Wt%)
0
5
10
15
20
0
100
200
300
400
500
Zr(ppm)
A12O3(Wooltana
A12O3(Depot)

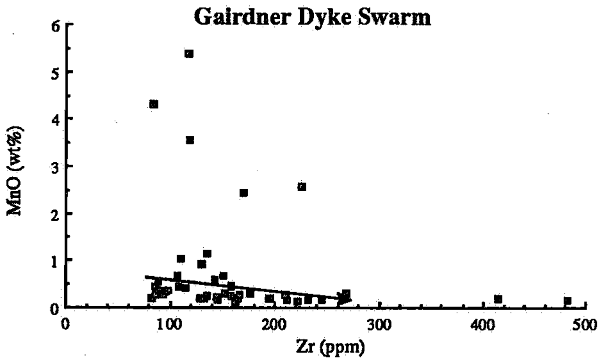

Beda Volcanics
FeO (wt%)
0
10
20
30
40
50
0
100
200
300
400
500
Zr (ppm)

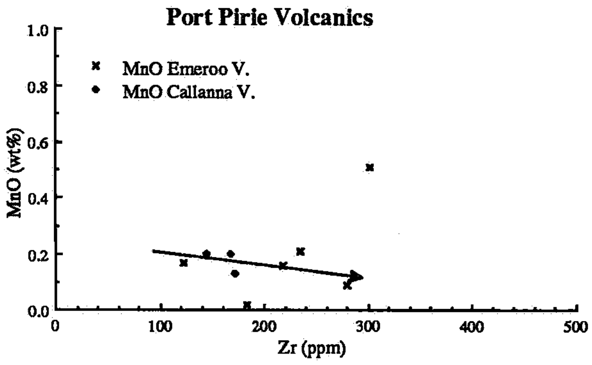

Gairdner Dyke Swarm
Fe0 (wt%)
0
10
20
30
40
50
0
100
200
300
400
500
Zr (ppm)


Port Pirie Volcanics
FeO (wt%)
0
10
20
30
40
50
0
100
200
300
400
500
Zr (ppm)
FeO Emeroo V.
FeO Callanna V.


Wooltana and Depot Creek Volcanics
FeO(Wt%)
0
10
20
30
40
50
0
100
200
300
400
500
Zr(ppm)
Fe0(Wooltana)
FeO(Depot)


Beda Volcanics


Gairdner Dyke Swarm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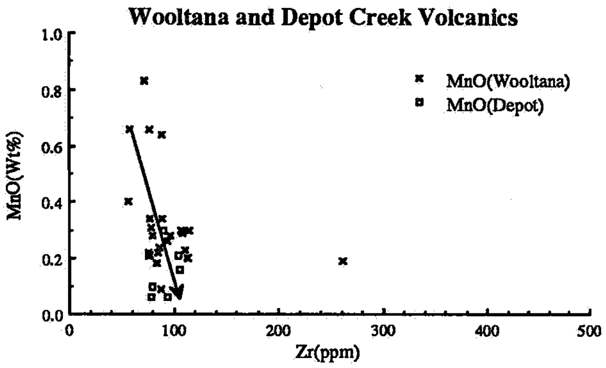
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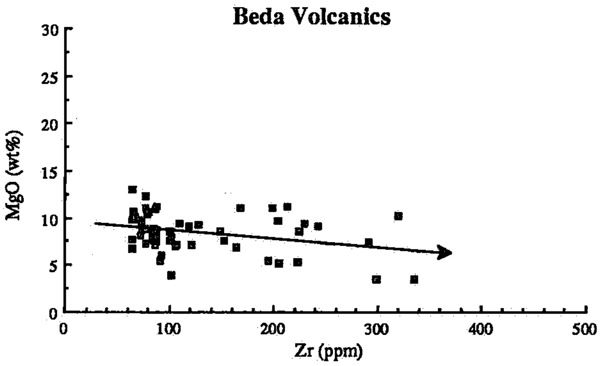
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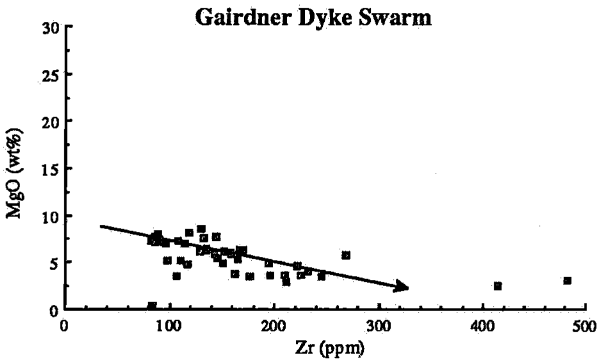
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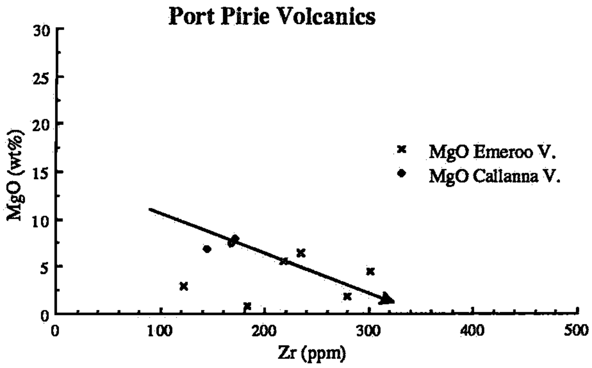
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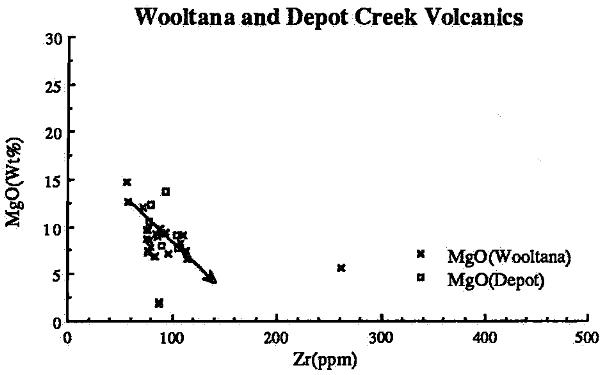
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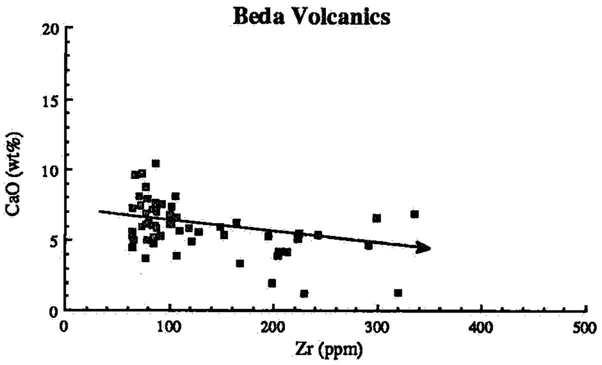

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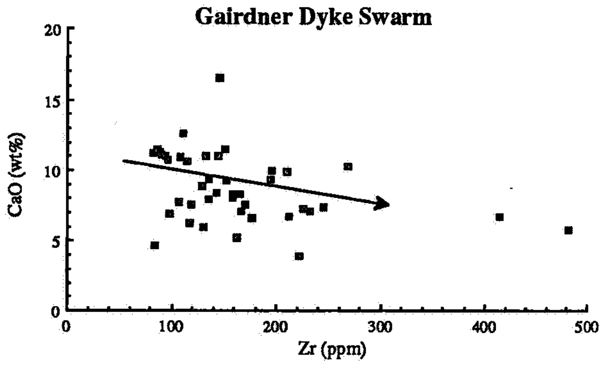

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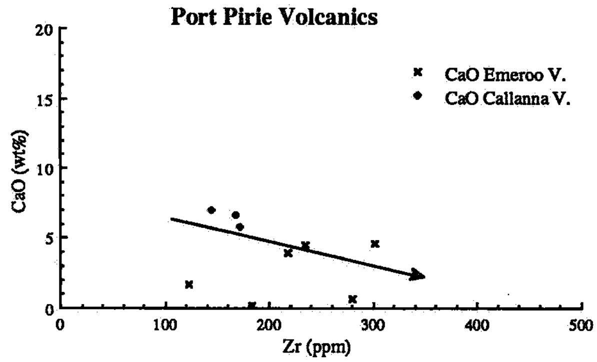

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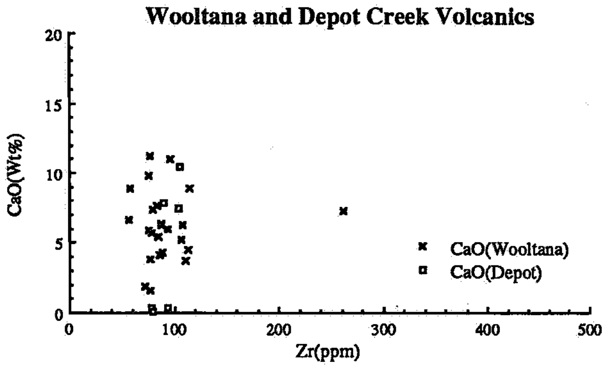
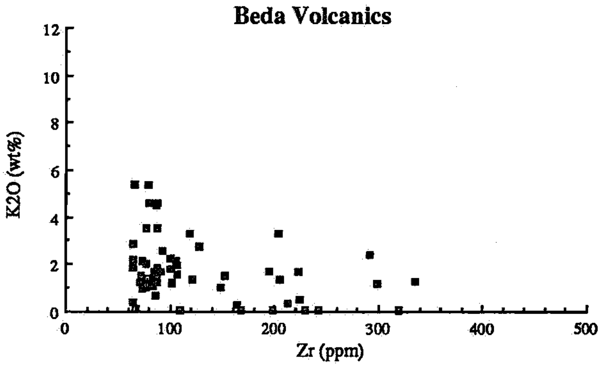


Wooltana and Depot Creek Volcanics



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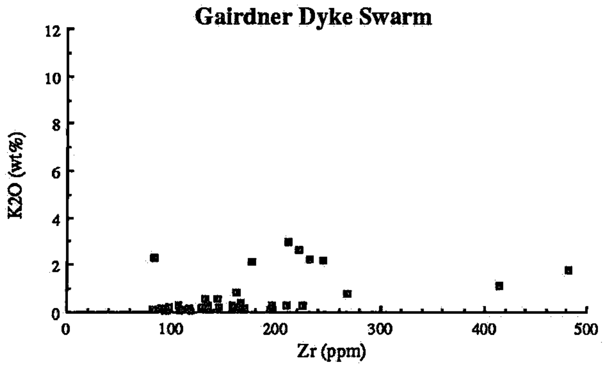

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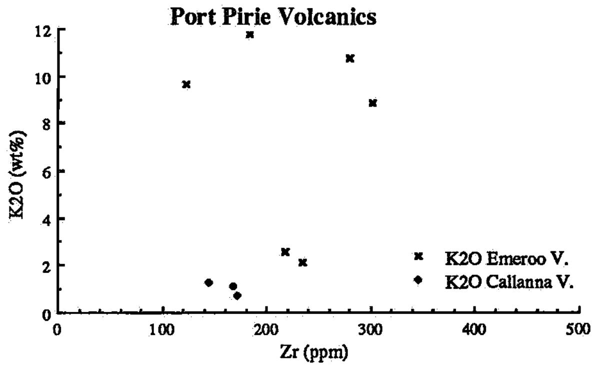

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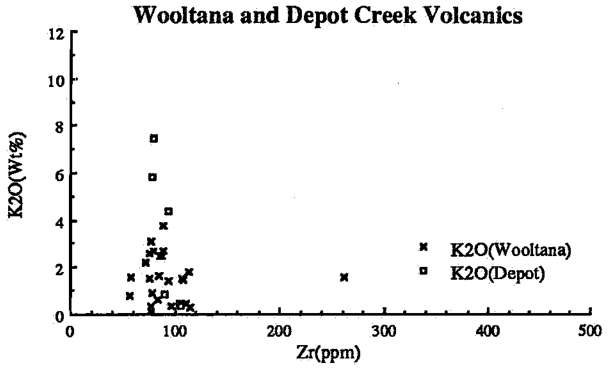
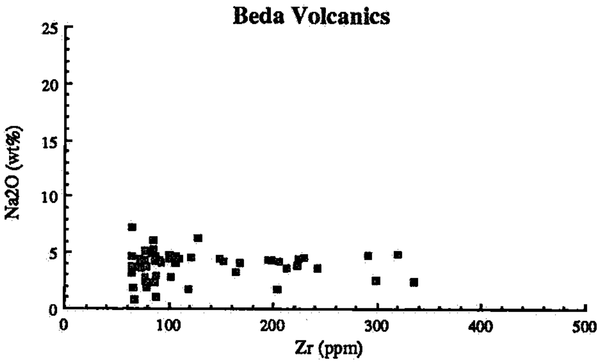


Wooltana and Depot Creek Volcanics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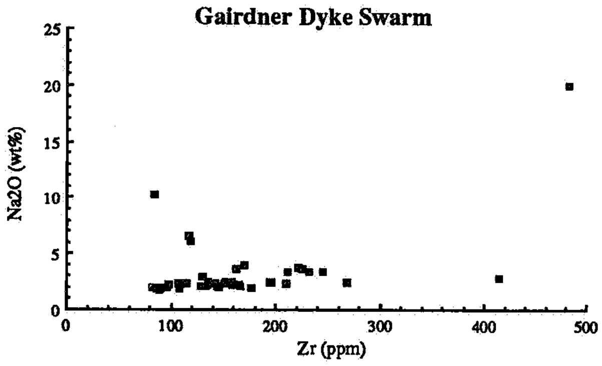
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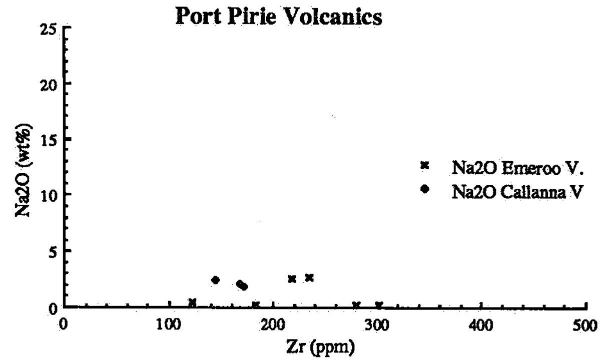
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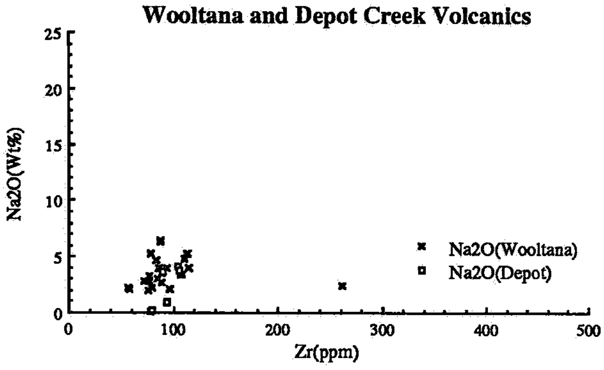
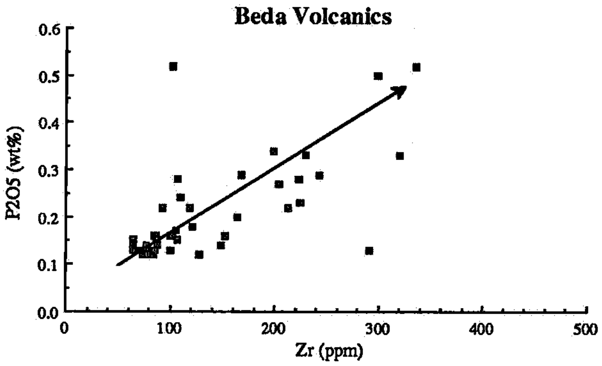

Wooltana and Depot Creek Volcanics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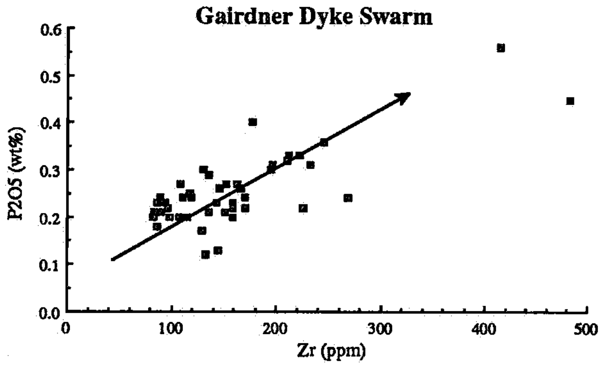
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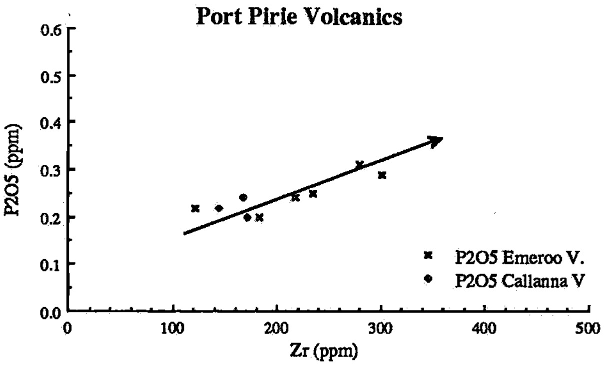
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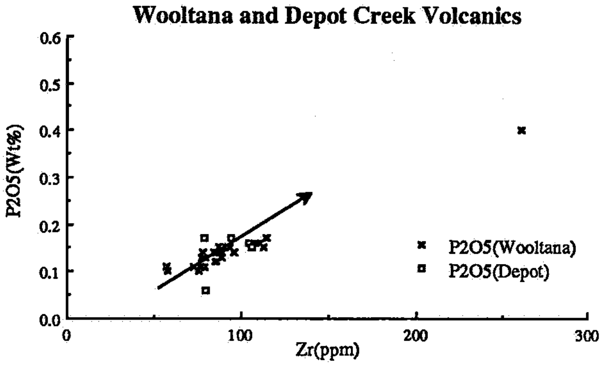
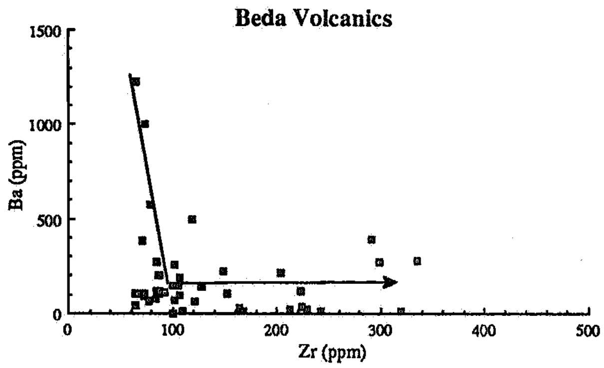

Wooltana and Depot Creek Volcanics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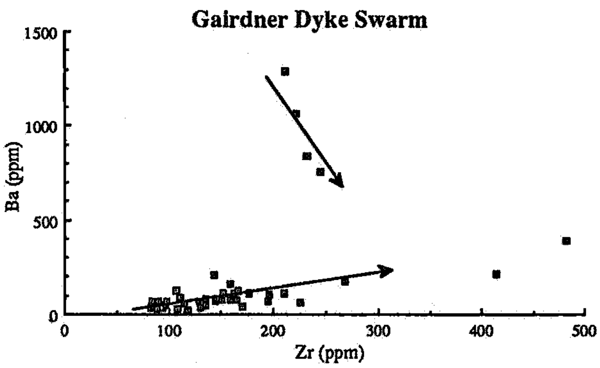
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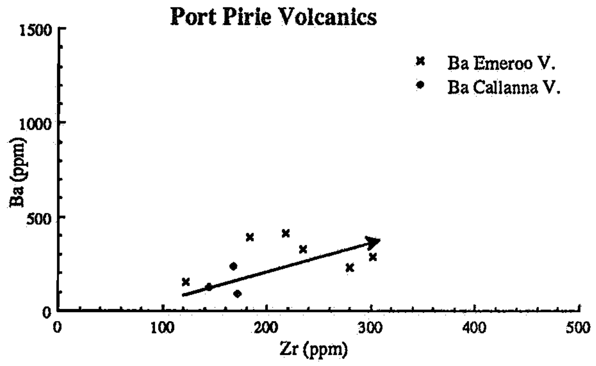
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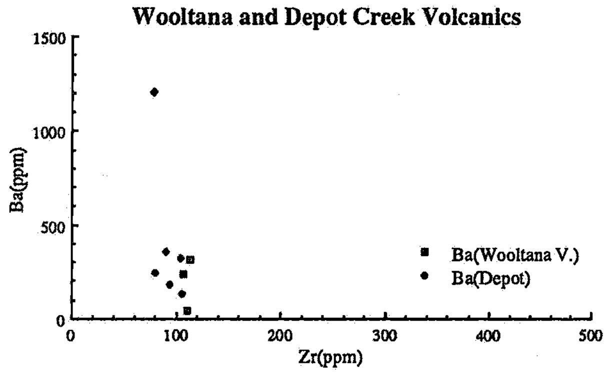
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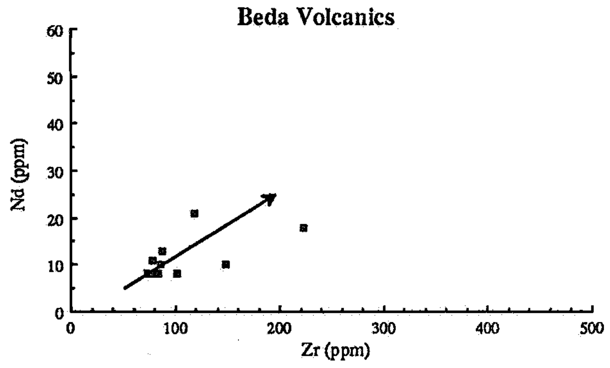
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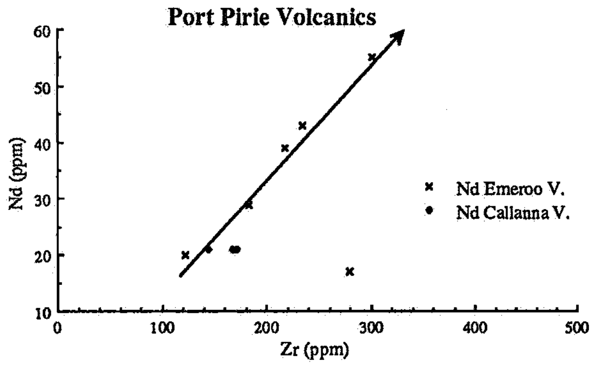
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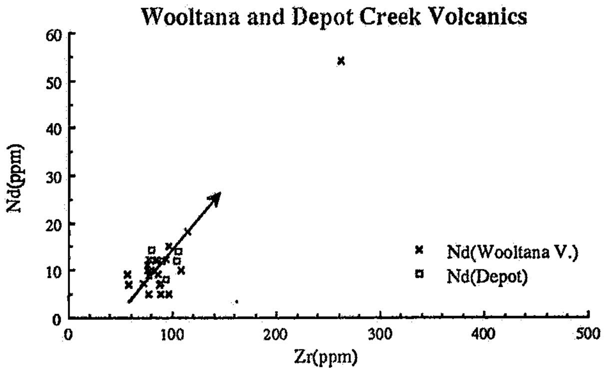
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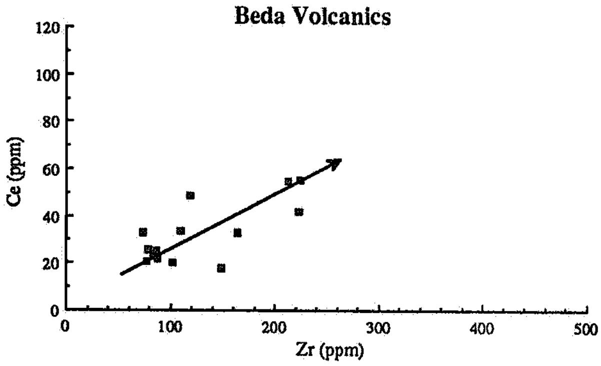
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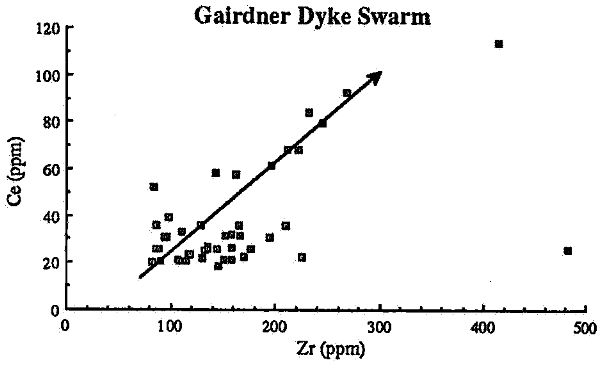
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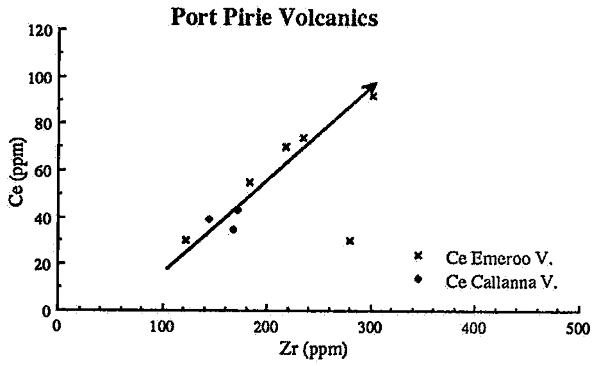
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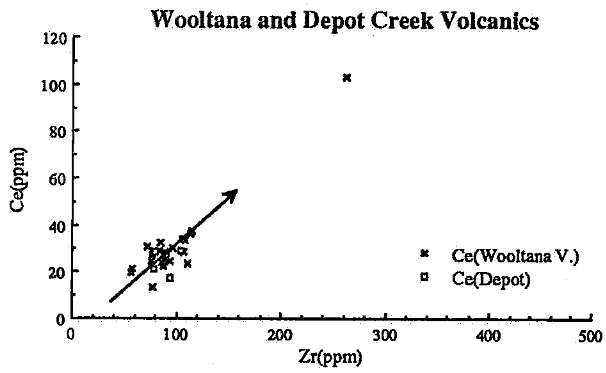
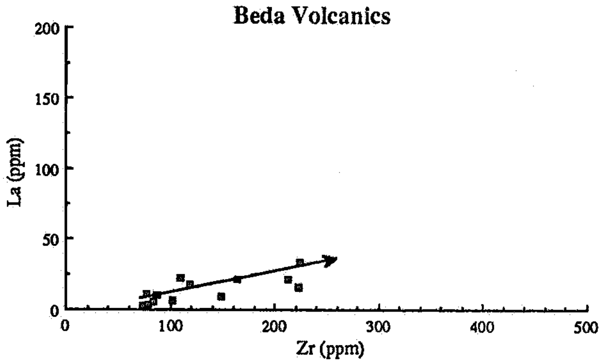

Wooltana and Depot Creek Volcanics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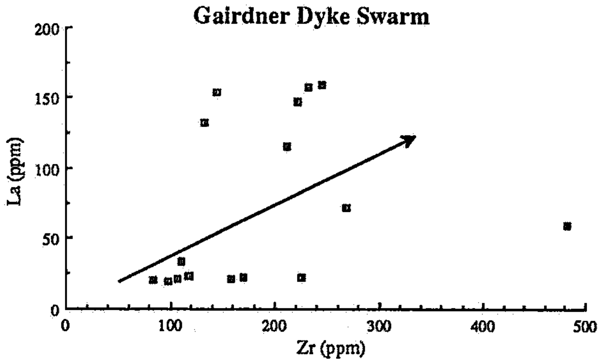
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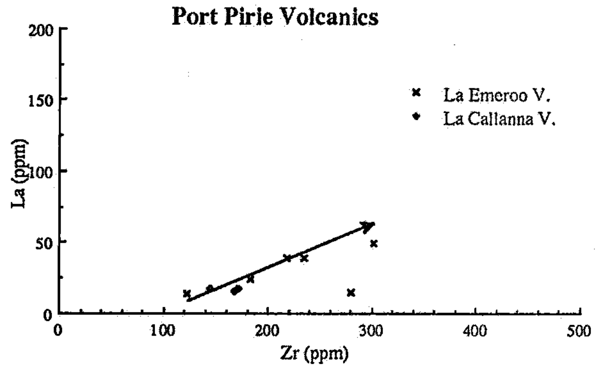
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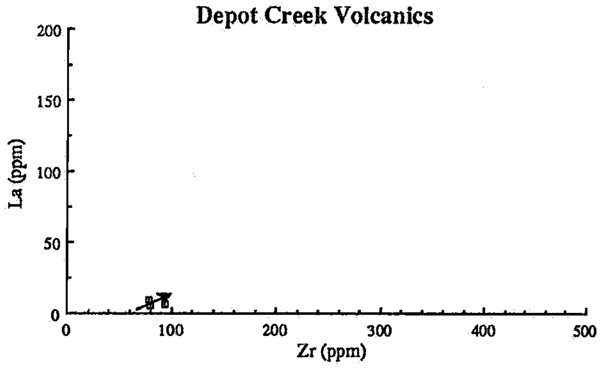
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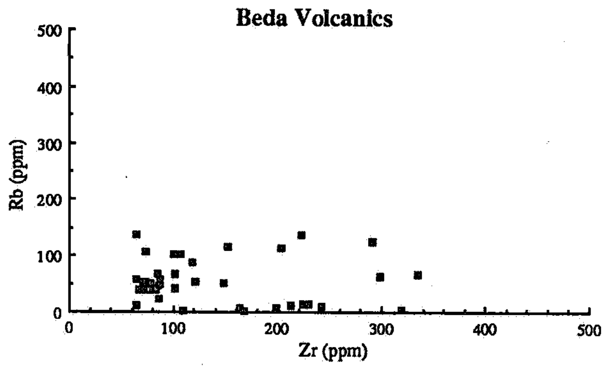
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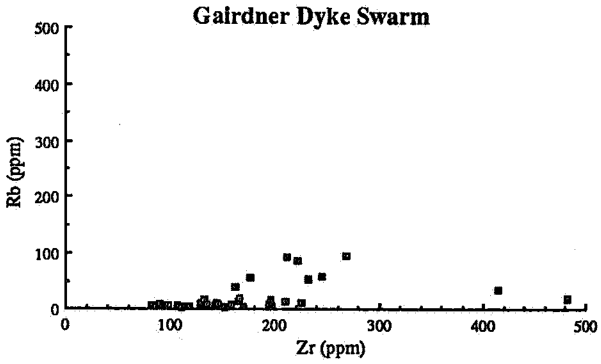
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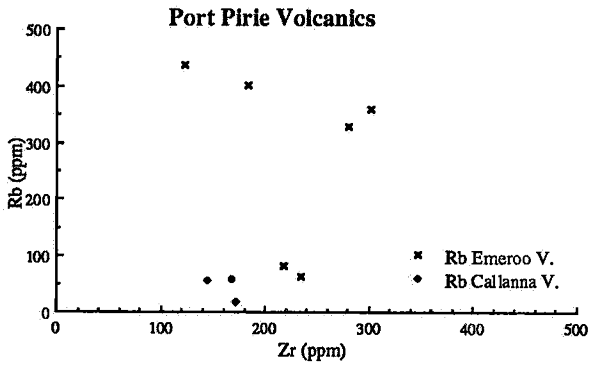
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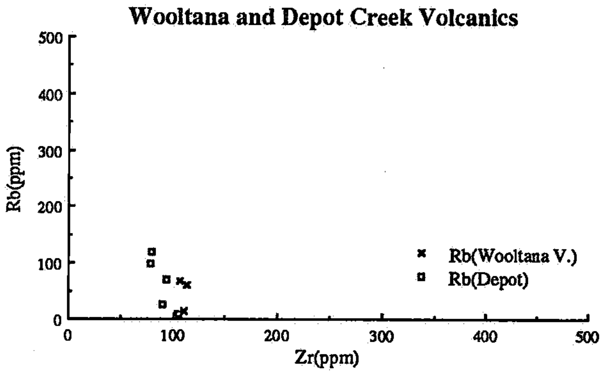
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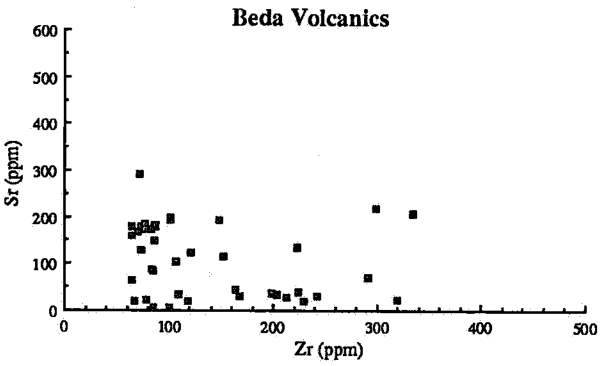
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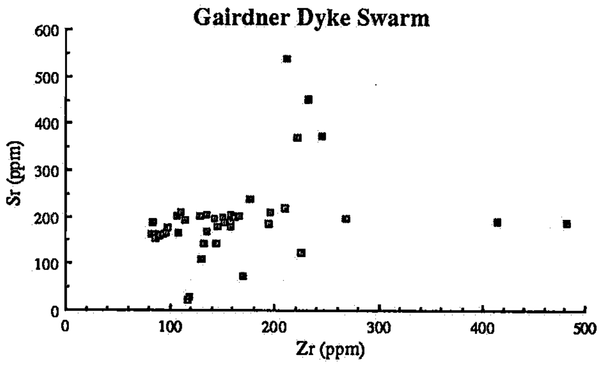
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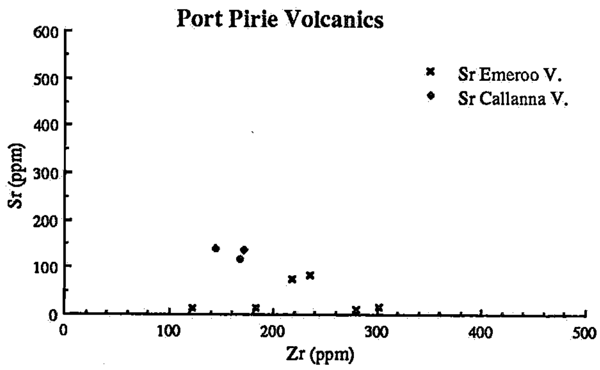
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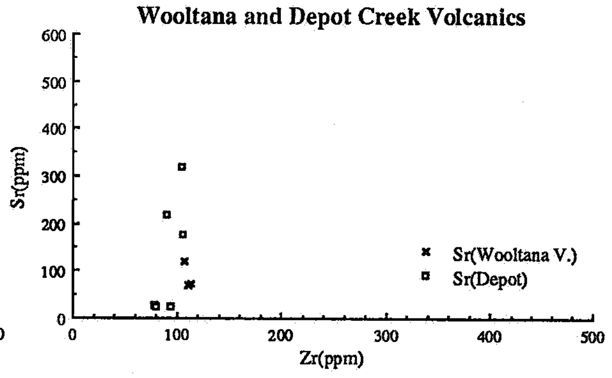
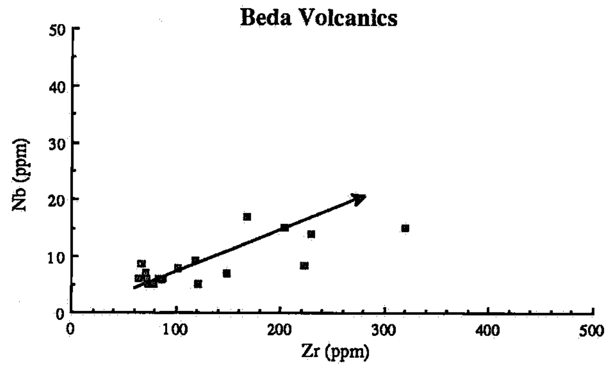

Wooltana and Depot Creek Volcanics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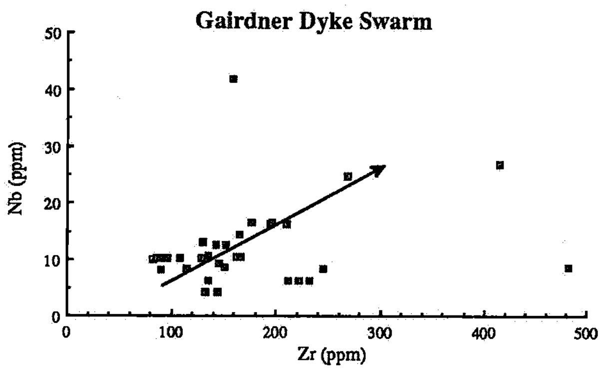
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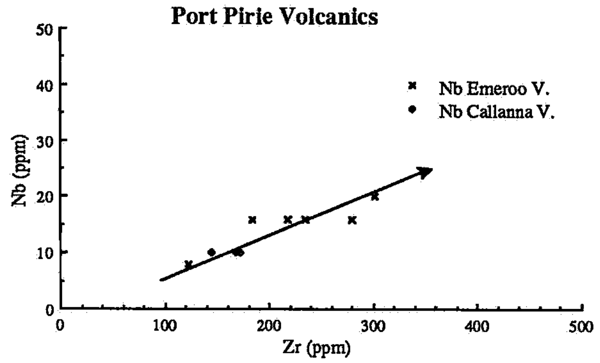
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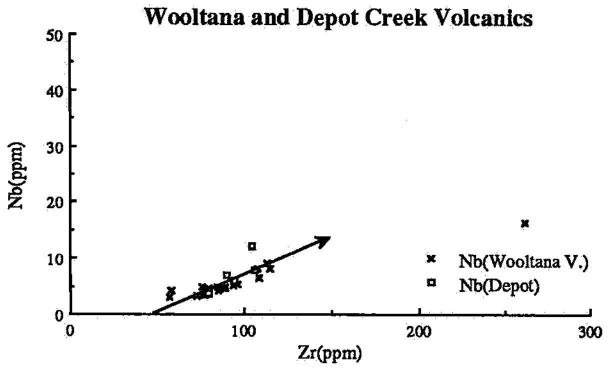
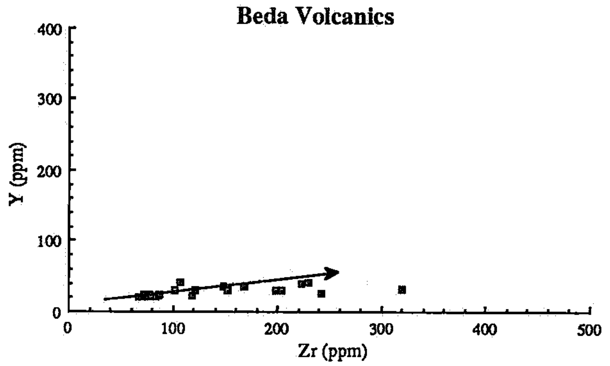

Wooltana and Depot Creek Volcanics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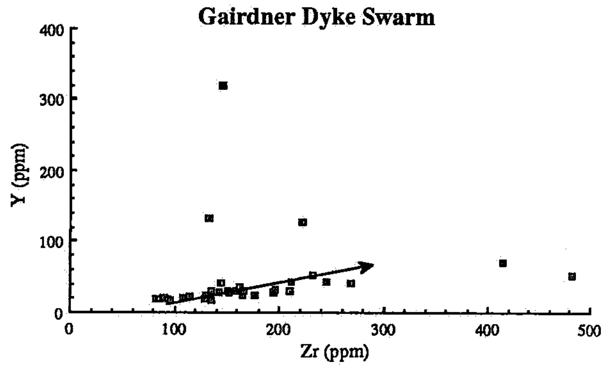
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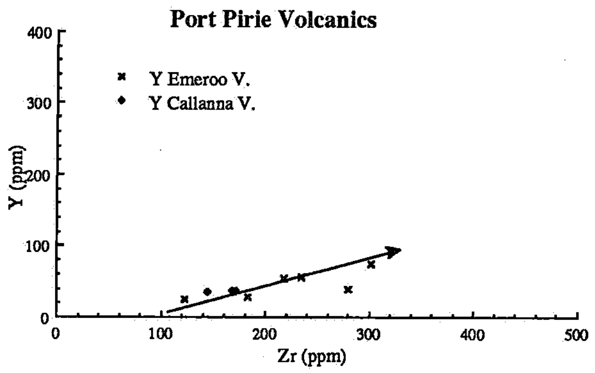
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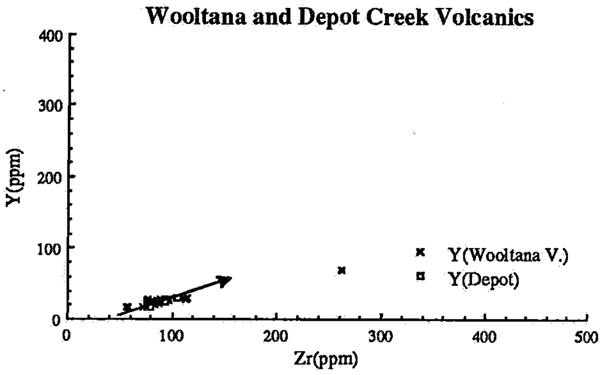
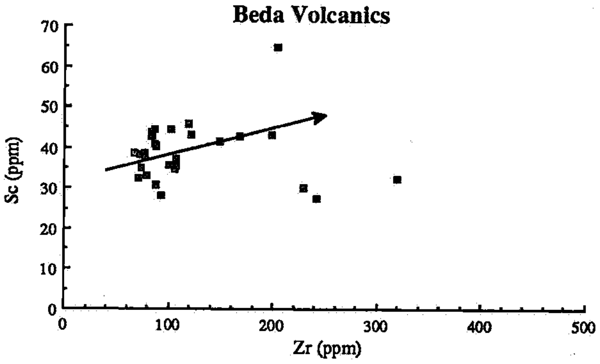

Wooltana and Depot Creek Volcanics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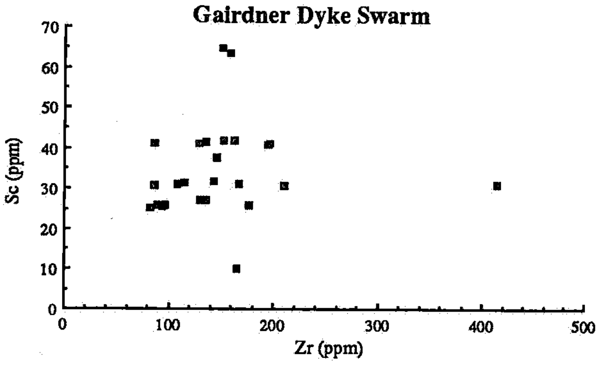
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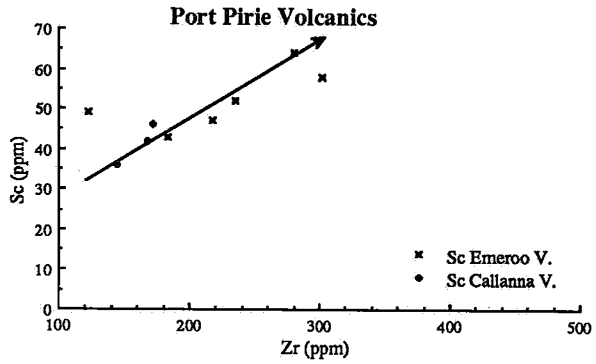
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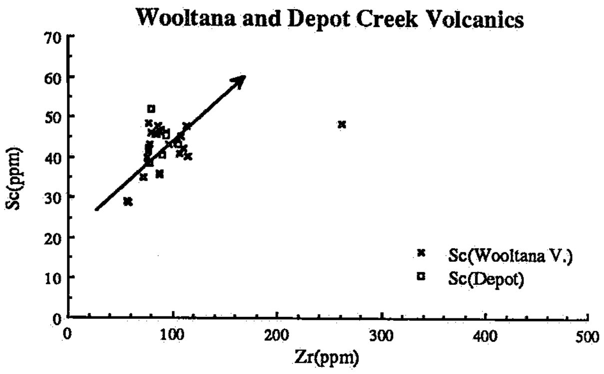
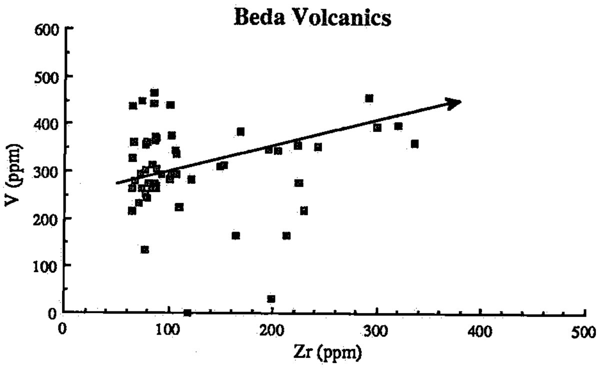

Wooltana and Depot Creek Volcanics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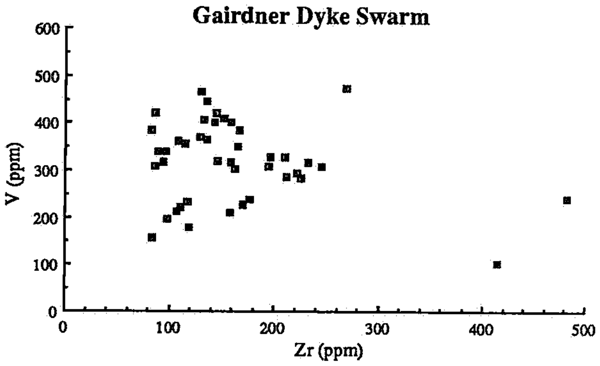
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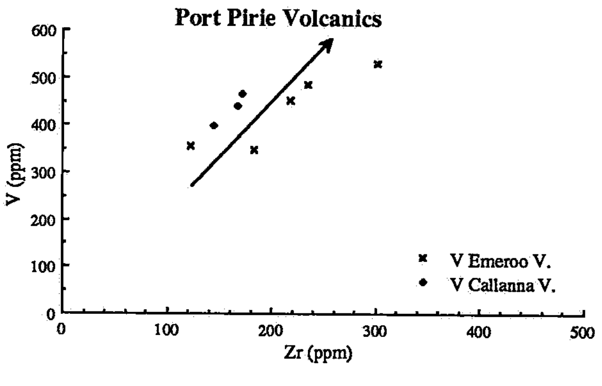
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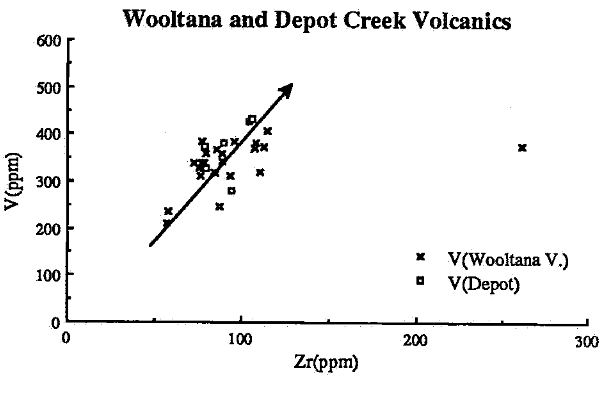
Wooltana and Depot Creek Volcanics

APPENDIX 5

MAJOR AND TRACE ELEMENT DATA

BEDA VOLCANICS GEOCHEMICAL DATA

SAMPLE:	533-073	533-074	533-075	533-076	533-077	533-078	533-079	533-080	533-085	533-086	533-087
SiO2	50.47	50.64	50.88	50.58	50.25	50.14	51.46	50.96	50.39	51.42	50.81
TiO2	1.65	1.66	1.58	1.62	1.42	1.44	1.74	1.64	1.77	1.53	1.53
Al2O3	14.31	14.42	14.23	14.22	14.99	14.70	14.26	14.85	14.16	14.48	14.67
Fe0	12.06	12.08	11.69	12.01	10.78	11.04	12.18	12.06	13.62	11.47	11.56
MnO	0.23	0.22	0.22	0.21	0.22	0.22	0.21	0.24	0.21	0.24	0.24
MgO	8.95	8.85	8.24	8.04	9.62	9.70	8.36	8.41	7.97	8.58	7.90
CaO	6.54	6.35	7.63	7.55	5.97	6.03	5.39	5.14	6.13	6.04	7.18
Na2O	4.67	4.67	4.17	4.41	3.42	3.49	4.75	4.51	4.43	4.85	4.91
K2O	0.98	0.96	1.21	1.22	3.21	3.12	1.48	2.04	1.15	1.26	1.08
P2O5	0.13	0.13	0.15	0.14	0.12	0.12	0.15	0.15	0.16	0.13	0.12
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
LOI	3.90	3.70	4.20	3.40	4.10	4.10	3.50	3.60	3.00	4.40	3.30
Mg #	57.00	57.00	56.00	54.00	61.00	61.00	55.00	55.00	51.00	57.00	55.00
Cr									230.00		256.00
Ni	115.54	113.53	125.62	130.74	130.55	131.59	111.48	119.05	88.00	92.16	89.13
Sc	40.74	40.24	40.93	40.54	44.63	43.32	42.97	45.00	44.54	43.75	42.95
V			273.53						294.93	263.32	313.99
Rb	32.43	32.44	46.60	48.65	59.71	59.72	44.59	57.51	42.71	40.51	41.53
Ba	81.08	81.09	119.54	119.59	132.58	130.58	86.14	66.59	67.12	76.97	76.98
Sr	132.77	134.82	183.37	181.41	292.48	276.34	107.42	86.76	192.21	88.11	174.21
Nb			6.10	6.10					8.10	6.10	6.10
Zr			86.11	88.17					101.70	84.06	84.07
Y	25.24	25.95	23.20	23.41	23.18	22.27	26.55	25.93	29.09	21.17	21.17
La									7.00		6.00
Ce									20.00		23.00
Nd									8.00		8.00

BEDA VOLCANICS GEOCHEMICAL DATA

SAMPLE:	533-088	533-089	533-090	533-091	533-091	533-092	533-093	533-094	533-095	533-096	533-097
SiO2	49.55	51.58	54.42	50.87	51.34	49.34	49.79	50.24	51.57	50.77	51.24
TiO2	1.51	1.66	1.82	1.47	1.48	1.43	1.40	1.27	1.53	1.72	1.61
Al2O3	15.07	15.15	14.46	14.62	14.22	13.67	13.69	13.48	13.99	14.27	14.60
Fe0	11.87	11.59	10.95	11.20	11.40	12.28	11.89	11.27	12.00	12.19	11.91
MnO	0.20	0.18	0.17	0.20	0.18	0.23	0.21	0.24	0.26	0.22	0.20
MgO	8.20	7.29	7.18	7.71	8.90	8.67	9.81	10.40	10.12	8.31	8.93
CaO	7.48	6.13	4.99	7.28	6.93	9.69	8.16	7.91	9.63	6.68	5.34
Na2O	4.47	5.15	4.50	4.65	4.38	3.59	3.71	3.68	0.77	4.84	5.16
K2O	1.52	1.12	1.32	1.86	1.03	0.97	1.22	1.40	0.13	0.84	0.87
P2O5	0.13	0.14	0.18	0.14	0.13	0.12	0.13	0.12	0.00	0.14	0.14
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
LOI	3.50	3.00	2.80	3.00	3.00	4.10	2.90	3.20	3.40	2.90	3.10
Mg #	55.00	53.00	54.00	55.00	58.00	56.00	60.00	62.00	60.00	55.00	57.00
Cr		188.00		264.00		305.00		212.00			
Ni	92.20	80.01	57.69	103.28	157.97	208.80	241.18	237.97	180.51	99.33	127.80
Sc	38.40	37.67	43.12	40.10	38.48	34.87	32.23	32.91	38.47		
V	293.82	303.83	283.40	263.26	253.16	263.53	233.08	243.04	279.36		
Rb	40.66	40.51	52.63	58.73	50.63	53.72	53.71	50.63	38.68		
Ba	93.21	66.84	62.75	102.27	64.81	105.41	388.12	573.16	103.15	93.25	42.60
Sr	290.78	185.34	124.49	180.23	175.19	180.42	167.21	22.38	20.95		
Nb	6.10		5.10	6.10	5.10	5.10	7.10	5.10	8.60		
Zr	71.94	76.97	121.46	88.09	76.96	73.99	70.94	78.99	66.62		
Y	24.82	24.41	30.47	23.39	20.86	23.41	20.98	22.38	20.95		
La		11.00		10.00		3.00		4.00			
Ce		21.00		22.00		33.00		26.00			
Nd		8.00		13.00		8.00		11.00			

BEDA VOLCANICS GEOCHEMICAL DATA

SAMPLE	533-099	533-100	533-122	533-119	533-123	533-124	533-125	533-126	533-127	533-128	533-129
SiO2	50.89	48.03	50.48	50.98	49.43	50.02	49.97	49.73	49.74	50.43	51.05
TiO2	1.49	1.45	2.08	1.29	2.04	1.95	1.99	1.84	1.83	1.78	1.73
Al2O3	14.50	14.87	13.20	13.84	13.21	13.48	13.63	13.91	14.11	14.59	14.66
Fe0	11.30	10.24	13.74	12.49	13.63	13.47	13.68	13.55	13.37	12.47	11.80
MnO	0.29	0.19	0.27	0.26	0.24	0.24	0.24	0.23	0.22	0.25	0.24
MgO	9.07	9.32	7.17	9.51	6.98	6.92	5.98	6.49	7.47	7.13	7.16
CaO	6.31	5.58	6.44	5.75	8.10	7.40	7.57	7.81	6.99	6.65	6.64
Na2O	5.04	6.33	4.78	4.70	4.04	4.17	4.10	4.35	4.60	4.83	4.63
K2O	0.97	2.73	1.62	1.05	2.15	2.18	2.60	1.96	1.53	1.72	1.94
P2O5	0.13	0.12	0.20	0.11	0.17	0.16	0.22	0.14	0.15	0.14	0.15
Total	100.00	98.87	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
LOI	3.10	3.80	2.20	3.20	1.90	2.00	1.30	2.10	2.20	2.80	2.40
Mg #	59.00	62.00	48.00	58.00	48.00	48.00	44.00	46.00	50.00	50.00	52.00
Cr			100.00			103.00		156.00		145.00	
Ni	128.61	90.30	79.21	105.46	90.35	77.15	77.15	792.89	80.17	74.01	68.19
Sc			31.89		34.72	28.22	28.22	30.15	30.85	30.62	35.42
V			304.66	283.92	344.99	294.39	294.39	294.42	304.44	314.31	295.17
Rb			93.43		0.00	186.78		171.57	0.00	102.40	0.00
Ba	49.62	140.79	102.57	102.41	148.21	112.68	109.63	102.54	199.92	259.56	192.37
Sr			149.28			185.77		197.97		216.97	
Nb			8.70			7.60		5.90		5.40	
Zr			127.96			105.57		92.39		87.19	
Y			32.50			27.10				23.73	
La			10.00			14.00		8.00		12.00	
Ce			37.00			29.00		30.00		28.00	
Nd			17.00			15.00		16.00		11.00	

BEDA VOLCANICS GEOCHEMICAL DATA

SAMPLE	533-130	533-131	533-132	533-133	533-134	533-135	533-136	74420021G	74420021H	74420021J	74420021K
SiO2	51.15	50.97	51.23	52.96	51.99	51.89	52.34	53.23	48.84	59.27	48.03
TiO2	1.73	1.91	1.92	2.44	1.82	1.97	2.41	2.82	2.84	2.28	2.65
Al2O3	13.61	13.70	13.39	13.27	13.86	13.64	13.82	14.11	14.08	10.13	13.54
Fe0	12.11	12.33	12.75	14.21	12.87	13.35	14.97	10.36	14.22	11.40	15.93
MnO	0.22	0.21	0.23	0.18	0.21	0.22	0.16	0.18	0.19	0.02	0.24
MgO	7.53	7.64	8.02	7.09	8.81	7.61	5.27	8.59	9.39	6.85	11.17
CaO	7.32	6.84	6.44	3.91	4.59	5.41	5.16	5.49	5.69	6.30	4.20
Na2O	4.11	4.42	4.02	4.06	4.13	4.21	3.89	4.46	4.42	3.23	3.67
K2O	2.05	1.81	1.85	1.59	1.56	1.53	1.70	0.49	0.07	0.30	0.32
P2O5	0.16	0.16	0.16	0.28	0.15	0.16	0.28	0.23	0.24	0.20	0.22
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.97	99.97	99.98	99.98
LOI	2.10	2.20	3.20	2.70	3.80	2.10	3.80	4.40	4.50	3.40	5.00
Mg #	53.00	52.00	53.00	47.00	55.00	50.00	39.00	60.00	54.00	52.00	56.00
Cr	103.00		76.00		54.00		22.00	111.57	111.81	76.69	109.49
Ni	68.92	55.76	50.70	34.54	46.66	46.69		167.35	167.71	54.78	109.49
Sc	35.27	35.69	36.71	37.18							
V	293.91	283.89	324.51	335.20	273.86	314.62	355.57	278.92	223.61	164.33	164.24
Rb	129.73		122.71	102.59	100.42	117.73	137.28	13.39	2.24	6.57	12.04
Ba	135.81	148.03	153.13	100.56	87.23	108.60	116.94	33.47	11.18	27.39	21.90
Sr	122.63		118.65	102.59	98.39	114.69	134.23	37.93	33.54	43.82	28.47
Nb	7.50		6.60		6.60		8.50				
Zr	106.42		100.40		107.52		152.53	223.14	223.61	109.55	164.24
Y	27.36		24.74	40.53	26.17	30.75	38.64				
La	11.00		9.00		16.00		16.00	33.47	22.36	21.91	21.90
Ce	34.00		34.00		41.00		42.00	55.78	33.54	32.87	54.75
Nd	13.00		15.00		12.00		18.00				

BEDA VOLCANICS GEOCHEMICAL DATA

SAMPLE	78420023J	6333RS0088	6334RS0021	6334RS0094	6334RS0095	6334RS0096	6334RS0097	6334RS0098	6334RS0099	6334RS0217	6334RS0218
SiO2	52.08	49.08	50.58	48.99	48.93	49.82	51.58	47.65	51.42	50.57	50.58
TiO2	4.66	2.03	3.15	2.83	2.78	2.55	2.82	3.43	3.18	3.34	3.15
Al2O3	12.91	13.11	13.88	15.14	13.81	12.75	12.87	15.96	14.81	13.90	13.88
Fe0	16.15	13.54	15.24	15.09	15.51	15.66	14.16	16.11	14.95	16.93	15.24
MnO	0.48	0.24	0.32	0.18	0.18	0.18	0.14	0.12	0.11	0.31	0.32
MgO	4.67	6.94	5.47	11.14	11.03	9.67	9.07	10.19	9.45	5.22	5.47
CaO	4.21	8.04	5.36	1.92	3.32	3.96	5.39	1.29	1.20	4.18	5.36
Na2O	3.38	4.01	4.31	4.28	4.07	1.79	3.59	4.85	4.50	4.18	4.31
K2O	0.90	2.83	1.68	0.05	0.05	3.33	0.07	0.05	0.05	1.36	1.68
P2O5	0.54	0.17	0.00	0.34	0.29	0.27	0.29	0.33	0.33		0.00
Total	99.97	100.00	100.00	99.97	99.98	99.98	99.97	99.97	100.00	100.00	100.00
LOI	3.10		2.70	6.30	5.70	5.80	8.10	5.50	5.50	2.40	2.70
Mg #	34.00	48.00	39.00	57.00	56.00	52.00	53.00	53.00	53.00	35.00	39.00
Cr	53.15			64.89	42.83		54.99	86.24	30.01		
Ni	212.61	89.72		64.89	59.96	60.51	72.59	86.24	4.00		
Sc	0.00	34.48		43.26	42.83	64.84	27.50	32.34	30.01		
V	106.30	332.66	347.04	30.28	385.44	345.80	351.96	398.88	220.09		
Rb	42.52	0.00		7.57	2.28	113.46	8.80	4.31	13.01		
Ba	159.46	147.18			10.71	216.12	16.50	16.17	20.01		
Sr	100.99			37.85	29.98	33.50	29.70	21.56	20.01		
Nb					17.10	15.10	0.00	15.10	14.00		
Zr	212.61			194.66	198.07	167.50	203.48	242.56	320.13	229.89	205.07
Y				30.28	36.40	30.26	26.40	32.34	42.02		
La	31.89										
Ce	116.93										
Nd											

BEDA VOLCANICS GEOCHEMICAL DATA

SAMPLE	6334RS0219	6334RS0220	6334RS0221	6334RS0222	6334RS0223	6334RS0224	6334RS0225	6334RS0226	6334RS0227	633RS60	6434RS0001
SiO2	48.08	48.29	47.21	49.69	47.46	48.07	48.59	48.86	47.75	50.87	49.82
TiO2	1.40	1.18	1.43	1.40	1.53	1.62	1.43	1.32	1.45	1.47	1.64
Al2O3	14.26	13.55	14.93	14.27	14.32	14.77	14.59	14.38	14.76	14.62	14.02
Fe0	12.16	11.81	12.06	11.78	12.30	12.80	12.04	12.06	12.88	11.20	11.90
MnO	0.54	0.43	0.55	0.43	0.55	0.65	0.44	0.44	0.45	0.20	0.58
MgO	12.97	11.08	10.65	8.69	10.93	12.29	10.64	10.65	11.18	7.71	8.60
CaO	5.29	8.82	6.26	7.30	6.12	3.77	5.04	5.05	5.93	7.28	6.21
Na2O	3.13	2.80	2.31	2.90	2.30	2.48	1.86	1.87	1.01	4.65	4.84
K2O	2.16	2.04	4.61	3.54	4.48	3.56	5.37	5.38	4.59	1.86	2.25
P2O5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.13
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.99
LOI	6.60	5.70	7.20	4.80	6.80	5.50	7.00	7.00	9.00	0.00	0.00
Mg #	66.00	63.00	61.00	57.00	61.00	63.00	61.00	61.00	61.00	55.00	56.00
Cr											
Ni										21.26	107.10
Sc											
V	216.10	134.44	274.48	268.30	371.79	355.68	361.92	362.32	369.04	263.26	439.11
Rb										58.73	101.75
Ba										102.27	0.11
Sr										180.23	4.28
Nb										6.10	
Zr	91.84	64.53	76.86	80.49	87.48	86.23	76.77	65.88	78.28	88.09	64.26
Y										23.39	
La											
Ce											
Nd											

DEPOT CREEK GEOCHEMICAL DATA

SAMPLE :	6433A1246/	633A1731/	6433RS0002	6433RS0003	6433RS0005	6433RS0006	6433RS0007	6433RS0008	6433RS0009
SiO2	51.02	49.67	55.80	45.50	56.29	49.21	55.01	48.13	56.22
TiO2	1.12	1.80	2.09	1.71	1.75	1.67	1.58	2.80	1.94
Al2O3	13.77	17.14	12.06	14.83	11.59	13.29	12.49	20.55	14.59
Fe0	17.98	11.20	12.58	20.53	12.94	18.85	15.79	6.89	13.03
MnO	0.05	0.01	0.05	0.04	0.04	0.06	0.02	0.02	0.02
MgO	10.09	13.21	12.63	11.35	12.37	10.25	11.52	11.74	7.24
CaO	0.29	0.44	0.42	0.45	0.42	0.18	0.57	0.26	0.39
Na2O	0.19	1.47	0.81	0.10	0.08	0.39	0.11	0.15	0.05
K2O	5.39	4.86	3.49	5.39	4.35	5.97	2.69	9.33	6.28
P2O5	0.09	0.18	0.07	0.09	0.14	0.12	0.21	0.12	0.21
Total	99.99	99.98	99.99	99.99	99.98	99.98	99.98	99.99	99.99
LOI		5.50	5.40	5.20	5.40	4.90	4.50	5.00	4.10
Mg #	50.00	68.00	64.00	50.00	63.00	49.00	57.00	75.00	50.00
Cr									
Ni									
Sc									
V									
Rb			56.36	123.58	61.31	112.61	53.82	209.71	106.48
Ba									
Sr			16.91	11.23	11.15	11.26	10.76	10.49	10.65
Nb									
Zr									
Y									
La									
Ce									
Nd									

BEDA VOLCANICS GEOCHEMICAL DATA

SAMPLE	6434RS0002	6434RS0003	6434RS0004	6434RS0005	6434RS0006	6434RS0007	6434RS0008	6434RS0009	6434RS0010	6333RS71	6333RS78
SiO2	50.00	52.79	49.78	50.15	51.41	52.20	50.39	50.80	50.50	50.45	51.83
TiO2	1.89	1.60	1.61	1.61	1.72	1.74	4.39	4.53	4.55	1.86	1.56
Al2O3	14.55	14.57	14.72	14.17	14.80	14.60	13.01	13.12	13.05	14.11	14.96
Fe0	12.30	10.52	12.17	11.48	11.41	11.65	17.33	16.70	15.85	12.58	11.21
MnO	0.53	0.34	0.66	0.60	0.41	0.33	0.31	0.25	0.20	0.26	0.27
MgO	8.87	6.74	9.85	9.59	7.52	7.49	3.57	3.50	3.86	7.10	8.50
CaO	4.72	5.62	4.49	5.98	5.20	4.64	6.68	6.88	7.38	10.51	6.02
Na2O	5.29	7.23	3.72	4.18	6.03	4.79	2.61	2.41	2.81	2.31	4.47
K2O	1.69	0.42	2.86	2.11	1.35	2.42	1.19	1.28	1.26	0.67	1.03
P2O5	0.16	0.15	0.13	0.13	0.13	0.13	0.50	0.52	0.52	0.16	0.14
Total	99.99	99.99	99.99	99.99	99.99	99.99	99.98	99.98	99.98	100.00	100.00
LOI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.30	2.60
Mg #	56.00	53.00	59.00	60.00	54.00	53.00	27.00	27.00	30.00	50.00	57.00
Cr	227.95	201.38	186.21	239.74	169.22	275.54	62.30	56.79	49.12	165.00	304.00
Ni	84.82	95.39	111.73	85.24	63.46	90.08	41.53	41.31	78.38	98.18	133.43
Sc										44.53	41.44
V	466.50	328.56	436.26	447.52	444.21	455.70	394.56	361.42	376.21	365.38	311.33
Rb	68.91	12.72	138.33	106.55	68.75	127.17	62.30	67.12	67.93	23.08	52.56
Ba	275.66	42.40	1223.66	1001.60	116.34	392.12	269.96	278.81	261.26	200.40	222.38
Sr	4.24	63.59	159.61	127.86	84.61	68.89	218.05	206.53	198.56	148.79	194.08
Nb										5.90	6.90
Zr	100.72	84.79	63.84	63.93	74.03	84.78	290.73	299.46	334.41	102.23	86.93
Y										29.05	23.96
La										10.00	9.00
Ce										25.00	18.00
Nd										10.00	10.00

BEDA VOLCANICS GEOCHEMICAL DATA

SAMPLE	6432RS104	6333RS108
SiO2	45.69	49.23
TiO2	2.47	1.96
Al2O3	15.13	16.29
Fe0	16.20	12.31
MnO	0.21	0.10
MgO	9.07	10.14
CaO	5.88	4.98
Na2O	1.80	4.39
K2O	3.33	0.42
P2O5	0.22	0.17
Total	100.00	100.00
LOI	8.30	7.50
Mg #	50.00	59.00
Cr	82.00	178.00
Ni	51.78	85.85
Sc	45.69	41.90
V		359.73
Rb	88.33	9.30
Ba	496.50	39.86
Sr	19.29	30.56
Nb	9.30	7.10
Zr	148.24	118.55
Y	35.54	22.69
La	18.00	10.00
Ce	49.00	35.00
Nd	21.00	12.00

GAIRDNER DYKE SWARM GEOCHEMISTRY

SAMPLE :	6035RS0029	6035RS0030	6030RS0031	6035RS0032	6134RS0035	6134RS0036	6136RS0001	6136RS0002	6136RS0003
SiO2	54.53	54.11	55.13	54.68	49.65	50.01	51.55	51.85	51.33
TiO2	1.84	1.79	1.81	1.78	1.54	1.57	1.51	1.63	1.57
Al2O3	15.09	15.90	16.66	16.36	14.48	14.38	14.54	14.36	14.43
Fe0	11.48	10.90	11.01	10.54	12.75	12.29	11.23	11.25	10.85
MnO	0.17	0.17	0.14	0.18	0.20	0.23	0.36	0.45	0.55
MgO	3.55	4.04	4.60	2.98	7.54	7.70	7.42	7.28	7.94
CaO	7.39	7.11	3.94	6.76	11.01	10.99	11.14	10.95	11.34
Na2O	3.40	3.41	3.73	3.40	2.14	2.14	1.89	1.88	1.75
K2O	2.17	2.25	2.64	2.98	0.56	0.56	0.15	0.07	
P2O5	0.36	0.31	0.33	0.33	0.12	0.13	0.21	0.27	0.24
Total	99.98	99.98	99.98	99.98	100.00	100.00	99.99	99.99	99.99
LOI	3.60	4.00	4.50	3.90	1.50	1.20	2.20	2.00	2.50
Mg #	36.00	40.00	43.00	33.00	51.00	53.00	54.00	54.00	57.00
Cr	31.89	21.05	21.08	10.56	173.31	174.57	149.50	123.94	144.30
Ni	42.52	42.11	31.63	31.67	142.73	154.04	134.03	113.61	133.99
Sc							25.78	30.99	25.77
V	308.25	315.82	295.17	284.99	407.79	421.03		361.50	340.14
Rb	57.40	54.74	86.44	92.89	17.33	12.32	8.25	5.16	4.12
Ba	755.94	844.30	1064.73	1287.73	61.17	71.88	67.02	30.99	30.92
Sr	372.02	452.68	368.96	538.32	142.73	143.77	159.81	165.26	159.76
Nb	8.50	6.30	6.30	6.30	4.10	4.10	8.20	10.30	10.30
Zr	244.47	231.60	221.38	211.10	132.53	143.77	90.73	108.45	88.64
Y	42.52	52.64	126.50	42.22	132.53	41.08	20.62	20.66	20.61
La	159.44	157.91	147.59	116.11	132.53	154.04			
Ce	79.72	84.22	68.52	68.61	25.49	25.67	20.62	20.66	25.77
Nd									

GAIRDNER DYKE SWARM GEOCHEMISTRY

SAMPLE :	6136RS0004	6136RS0005	6136RS0006	6136RS0007	6137RS0023	6137RS0024	6137RS0027	6137RS0028	6237RS0015
SiO2	51.50	51.28	51.83	52.30	53.95	54.10	51.09	51.23	52.51
TiO2	1.52	1.55	1.49	2.47	2.02	2.10	1.47	1.64	2.56
Al2O3	15.38	15.09	14.63	14.22	15.78	16.26	14.84	14.52	13.41
Fe0	11.33	11.38	10.29	16.06	9.34	7.56	11.54	11.50	15.07
MnO	0.33	0.29	0.46	0.30	0.92	1.14	0.21	0.28	0.29
MgO	6.97	7.14	7.78	3.47	8.54	6.45	7.32	7.16	6.34
CaO	10.73	11.01	11.44	6.64	5.95	9.32	11.21	11.45	7.07
Na2O	1.94	1.96	1.83	1.99	2.94	2.49	1.99	2.03	2.10
K2O	0.07	0.08		2.14	0.24	0.26	0.12		0.38
P2O5	0.22	0.23	0.23	0.40	0.30	0.29	0.20	0.18	0.26
Total	99.99	100.00	99.99	99.98	99.98	99.98	100.00	100.00	99.99
LOI	1.60	1.30	1.50	1.80	7.30	7.90	0.40	0.90	2.00
Mg #	52.00	53.00	57.00	28.00	62.00	60.00	53.00	53.00	43.00
Cr	72.25	101.95	139.10	62.26	162.16	162.62	181.74	204.52	72.78
Ni	103.21	112.14	144.26	72.64	140.54	75.89	121.16	112.49	72.78
Sc	25.80	25.49	41.22	25.94	27.03	27.10	25.24	30.68	31.19
V	340.59	316.04	309.12	238.66	464.86	444.49	383.68	419.27	384.70
Rb	6.19	6.12	5.15	56.03	11.89	7.59	7.07	6.14	17.68
Ba	46.44	35.68	41.22	114.14	37.84	48.79	35.34	35.79	124.77
Sr	165.14	163.12	154.56	238.66	108.11	168.04	161.55	163.62	202.74
Nb	10.30	10.20	10.30	16.60	13.00	10.80	10.10	10.20	10.40
Zr	97.02	93.79	86.55	176.40	129.73	135.52	82.79	85.90	166.35
Y	16.51	18.35	18.55	24.90	23.78	17.35	18.17	18.41	29.11
La									
Ce	30.96	30.58	36.06	25.94	21.62	27.10	20.19	25.57	31.19
Nd									

GAIRDNER DYKE SWARM GEOCHEMISTRY

SAMPLE :	6327RS0016	6237RS0017	6237RS0018	6237RS0019	6237RS0020	6237RS0021	6237RS0022	6237RS0023	6237RS0024
SiO2	54.63	52.82	48.49	52.23	52.39	50.60	51.34	50.28	54.17
TiO2	2.15	2.02	1.99	2.39	2.53	2.43	2.84	2.90	2.36
Al2O3	14.70	14.21	12.66	14.94	16.31	13.93	15.54	15.43	13.54
Fe0	11.54	13.25	12.32	13.81	14.87	14.61	13.52	14.62	16.00
MnO	0.25	0.20	0.17	0.20	0.12	0.31	0.21	0.28	0.20
MgO	6.26	6.23	5.49	5.31	3.81	6.18	3.58	3.60	2.46
CaO	7.92	8.86	16.51	8.34	5.21	9.22	9.98	9.91	6.77
Na2O	2.17	2.08	1.93	2.27	3.64	2.43	2.41	2.37	2.79
K2O	0.17	0.16	0.20	0.25	0.84		0.27	0.29	1.14
P2O5	0.21	0.17	0.26	0.26	0.27	0.27	0.31	0.32	0.56
Total	99.99	99.99	100.02	99.99	99.99	99.99	99.99	99.99	99.98
LOI	2.80	0.30	1.90	1.50	3.20	3.60	2.20	1.00	2.00
Mg #	49.00	46.00	44.00	41.00	31.00	43.00	32.00	30.00	22.00
Cr	114.68	102.97	75.03	51.51	31.37	73.33	20.58	20.44	10.34
Ni	83.40	78.25	52.52	47.39	41.83	62.85	37.04	30.66	6.20
Sc	41.70	41.19	37.52	10.30	41.83	41.90	41.16	30.66	31.01
V	364.89	370.68	318.89	350.26	303.28	408.55	329.25	327.00	103.37
Rb	10.43	8.24	10.32	13.39	39.74	2.10	15.43	13.28	34.11
Ba	83.40	72.08	84.41	77.26	115.04	115.23	102.89	112.41	217.08
Sr	203.29	200.78	178.20	200.89	198.70	188.56	210.93	219.70	191.23
Nb	6.30	10.30	9.40	14.40	10.50	12.60	16.50	16.30	26.90
Zr	135.53	128.71	145.38	164.83	162.10	151.90	195.49	209.48	413.48
Y	29.19	18.53	318.89	24.72	35.56	27.24	30.87	30.66	70.29
La									
Ce	26.06	36.04	18.76	36.06	57.52	31.43	61.73	35.77	113.71
Nd									

GAIRDNER DYKE SWARM GEOCHEMISTRY

SAMPLE :	6332RS0513	6332RS0514	6335RS0020	6335RS0021	6335RS0023	6335RS0024	6335RS0025	6335RS0031	6335RS0037
SiO2	42.74	49.40	52.73	51.70	52.44	52.37	52.55	50.64	51.52
TiO2	2.56	2.33	1.92	2.40	2.34	2.39	2.33	2.64	2.26
Al2O3	11.35	13.89	14.51	14.16	13.82	13.75	14.54	15.11	3.13
Fe0	12.15	14.54	10.24	14.40	14.53	41.00	10.95	10.90	20.77
MnO	0.18	0.31	0.42	0.19	0.45	0.60	0.68	2.44	4.33
MgO	3.06	5.76	7.00	4.94	5.96	5.92	4.93	6.36	0.47
CaO	5.76	10.29	10.65	9.34	8.02	8.41	11.52	7.60	4.69
Na2O	20.00	2.45	2.32	2.46	2.19	2.31	2.28	3.92	10.32
K2O	1.81	0.77		0.09				0.15	2.29
P2O5	0.45	0.24	0.20	0.30	0.23	0.23	0.21	0.22	0.21
Total	100.06	99.99	99.99	99.99	99.99	99.99	99.98	99.97	99.99
LOI	0.90	2.30	3.60	1.60	3.80	4.10	5.30	1.50	2.10
Mg #	31.00	41.00	55.00	38.00	42.00	43.00	45.00	51.00	4.00
Cr	17.20	205.85	114.86	51.29	73.86	74.06	64.61	113.51	104.25
Ni	34.40	102.92	100.24	6.16	63.30	74.06	71.07	113.51	104.25
Sc			31.33	41.03	63.30	31.74	64.61		
V	240.78	473.45	355.02	307.76	400.93	402.03	409.17	227.01	156.38
Rb	18.92	94.69	5.22	8.21	8.44	6.35	5.38	5.68	6.26
Ba	395.56	174.97	57.43	71.81	73.86	211.60	75.37	45.40	67.76
Sr	189.18	195.55	193.17	184.65	205.74	195.73	199.20	73.78	187.66
Nb	8.60	24.70	8.40	16.40	41.80	12.70	8.60		
Zr	481.55	267.60	114.86	194.91	158.26	142.83	150.75	170.26	83.40
Y	51.60	41.17	22.97	28.72	29.54	27.51	30.15		
La	60.19	72.05						22.70	20.85
Ce	25.80	92.63	20.88	30.78	26.38	58.19	21.54	22.70	52.13
Nd									

GAIRDNER DYKE SWARM GEOCHEMISTRY

SAMPLE :	77420022A	77420022B	77420022C
SiO2	44.88	52.60	48.55
TiO2	2.92	2.64	2.68
Al2O3	17.36	15.45	15.72
Fe0	9.11	11.64	9.69
MnO	3.57	2.59	5.37
MgO	8.14	3.61	4.72
CaO	7.53	7.27	6.26
Na2O	6.12	3.66	6.55
K2O	0.07	0.29	0.15
P2O5	0.24	0.22	0.25
Total	99.95	99.97	99.96
LOI	0.60	0.40	0.30
Mg #	61.00	36.00	46.00
Cr	118.84	169.13	116.63
Ni	95.07	225.50	93.31
Sc			
V	178.25	281.88	233.26
Rb	3.57	12.40	4.67
Ba	23.77	62.01	11.66
Sr	28.52	124.03	23.33
Nb			
Zr	118.84	225.50	116.63
Y			
La	23.77	22.55	23.33
Ce	23.77	22.55	23.33
Nd			

PORT PIRIE VOLCANICS GEOCHEMICAL DATA

	Emeroo Subgroup				Callanna Group			Emeroo Subgroup	
	PP2 378m	PP6 266.1 m	PP10 344.3m	PP12 319.4	PP12 424.6m	PP12 450m	PP12 455.1	PP19 294.5	PP19 320 m
SAMPLE:	6431RS67	6432RS71	6431RS75	6431RS78	6431RS79	6431RS81	6431RS82	6431RS85	6431RS86
SiO2	51.58	42.44	47.99	48.05	50.58	43.17	47.12	48.95	50.31
TiO2	1.69	3.04	3.88	2.25	2.67	2.19	2.61	2.41	2.52
Al2O3	17.43	16.21	17.30	18.60	12.79	12.02	12.09	13.37	13.81
FeO	15.91	17.93	16.97	16.00	17.25	23.12	20.46	20.12	17.07
MnO	0.02	0.51	0.09	0.17	0.13	0.20	0.20	0.16	0.21
MgO	0.88	4.42	1.78	2.93	7.93	6.92	7.41	5.66	6.50
CaO	0.22	4.56	0.70	1.64	5.82	6.97	6.61	3.95	4.52
Na2O	0.27	0.19	0.20	0.45	1.89	2.48	2.13	2.57	2.68
K2O	11.79	8.88	10.76	9.67	0.74	1.27	1.13	2.57	2.12
P2O5	0.20	0.29	0.31	0.22	0.20	0.22	0.24	0.24	0.25
Total	99.99	98.46	100.00	99.99	100.01	98.55	100.01	99.99	100.00
LOI	1.70	8.40	4.50	5.30	3.30	2.20	2.30	3.30	4.30
Mg #	9.00	31.00	16.00	25.00	45.00	35.00	39.00	33.00	40.00
Cr	352.00	45.00	63.00	221.00	92.00	74.00	80.00	42.00	34.00
Ni	36.00	83.00	51.00	60.00	83.00	148.00	79.00	61.00	65.00
Co	60.00	30.00	50.00	40.00	80.00	80.00	70.00	70.00	80.00
Sc	43.00	58.00	64.00	49.00	46.00	36.00	42.00	47.00	52.00
V	349.00	530.00	1151.00	356.00	466.00	399.00	440.00	451.00	485.00
Cu	140.00	120.00	540.00	170.00	555.00	400.00	250.00	180.00	161.00
Pb	50.00	50.00	50.00	70.00	70.00	60.00	50.00	80.00	80.00
Zn	50.00	140.00	90.00	40.00	130.00	120.00	310.00	220.00	210.00
Rb	401.00	360.00	330.00	438.00	18.90	57.00	58.00	81.00	62.00
Cs	20.00	35.00	20.00	50.00	20.00	20.00	20.00	20.00	20.00
Ba	390.00	287.00	232.00	153.00	90.00	123.00	240.00	415.00	327.00
Sr	13.20	16.60	12.30	14.40	136.00	139.00	117.00	77.00	83.00
Nb	16.00	20.00	16.00	8.00	10.00	10.00	10.00	16.00	16.00

DEPOT CREEK GEOCHEMICAL DATA

SAMPLE :	6433RS0010	6433RS0135	6433RS0136	6433RS1013	882-007	882-009	882-010
SiO2	57.87	50.28	50.92	50.98	50.30	42.50	52.98
TiO2	2.51	1.83	1.91	1.78	1.72	1.68	1.59
Al2O3	21.22	14.52	14.78	14.37	15.44	16.71	14.87
Fe0	2.46	10.86	10.84	12.06	12.82	18.89	13.46
MnO	0.02	0.16	0.21	0.30	0.06	0.10	0.06
MgO	3.36	7.70	9.16	8.04	13.77	12.33	10.58
CaO	0.49	10.44	7.49	7.83	0.41	0.09	0.33
Na2O	0.21	3.71	4.07	3.64	0.90	0.18	0.12
K2O	11.55	0.35	0.46	0.85	4.40	7.45	5.84
P2O5	0.29	0.15	0.16	0.15	0.17	0.06	0.17
Total	99.99	100.00	100.00	100.00	100.00	100.00	100.00
LOI	3.20	1.50	2.80	2.10	5.20	4.70	4.50
Mg #	71.00	56.00	60.00	54.00	66.00	54.00	58.00
Cr		254.40	210.78	196.99	269.05	162.02	200.00
Ni		106.59	116.54	108.09	156.90	135.41	107.42
Sc		43.24	43.58	40.41	45.55	51.93	38.51
V		432.38	426.63	380.85	280.40	327.83	373.94
Rb	325.60	10.06	10.13	25.26	70.85	119.12	97.28
Ba		133.74	321.24	358.62	182.21	244.34	1208.96
Sr	10.50	175.97	320.23	218.20	24.29	25.35	27.56
Nb		8.00	12.20	7.10	6.00	3.80	4.50
Zr		105.58	104.38	89.91	94.14	79.42	79.04
Y		29.16	29.39	26.27	24.29	16.59	19.36
La					7.00	6.00	9.00
Ce		34.19	29.39	27.28	17.20	28.50	21.28
Nd		14.08	12.16	12.12	8.10	14.25	

WOOLTANA VOLCANICS GEOCHEMISTRY DATA

SAMPLE:	6737RS1167	6737RS1168	6737RS0011	A42A	A67	A740	A100B	A165(1)	A165(2)	A171	A175
SiO2	51.81	51.74	52.54	50.68	51.48	50.65	53.79	56.48	56.53	46.90	50.27
TiO2	2.01	1.89	1.80	1.66	1.46	1.63	1.42	1.65	1.66	1.11	1.78
Al2O3	15.05	14.42	14.18	14.38	14.63	14.31	15.56	15.01	15.01	12.98	15.18
Fe0	12.69	13.62	12.20	12.53	11.91	12.60	13.72	9.55	9.59	14.22	11.56
MnO	0.23	0.30	0.20	0.64	0.28	0.34	0.21	0.09	0.09	0.40	0.26
MgO	9.12	7.75	7.46	9.21	7.82	9.77	7.26	1.92	1.88	14.71	9.40
CaO	3.70	5.27	4.45	4.29	7.41	4.33	1.56	6.31	6.29	6.60	5.96
Na2O	4.77	3.33	5.20	2.70	2.21	3.54	3.28	6.37	6.34	2.18	4.02
K2O	0.46	1.51	1.81	3.77	2.67	2.70	3.06	2.46	2.46	0.80	1.40
P2O5	0.16	0.16	0.15	0.14	0.13	0.13	0.13	0.14	0.15	0.11	0.15
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
LOI		2.90	3.60								
Mg #	56.00	50.00	52.00	57.00	54.00	58.00	49.00	26.00	26.00	65.00	59.00
Cr	229.07	213.64	171.96	238.17	207.55	354.11	264.07	378.78	376.56	290.55	282.89
Ni	123.27	113.46	86.49								
Sc	42.12	40.89	47.82	46.11	46.07	46.77	41.54	35.94	35.73	29.05	46.18
V	319.47	370.03	373.42	359.79	359.42	341.83	340.24	247.43	245.98	208.99	310.37
Rb	14.38	67.46	60.03								
Ba	42.12	240.21	313.39								
Sr	70.88	121.64	74.28								
Nb		8.20	9.20	4.60	4.60	5.00	4.20	4.70	4.70	3.00	5.10
Zr	110.94	107.33	112.94	89.19	79.98	89.04	77.19	87.57	87.05	57.09	93.62
Y	30.82	29.64	28.49	25.13	23.29	27.33	18.69	21.69	21.56	17.33	28.19
La											
Ce	23.63	28.62	36.63	25.34	28.35	28.66	27.42	22.40	22.27	19.37	24.42
Nd				5.07	10.12	7.16	5.08	7.13	7.09	9.18	12.21

WOOLTANA VOLCANICS GEOCHEMISTRY DATA

SAMPLE:	A190C	A197	A216	A219B	A235	A236	A237(1)	A237(2)	A238	A239	A241B
SiO2	50.39	51.43	51.48	51.12	51.88	51.83	51.58	51.52	49.61	47.87	50.58
TiO2	1.85	1.84	1.63	1.46	1.70	1.62	1.59	1.60	1.46	1.10	1.38
Al2O3	14.32	13.87	14.21	14.86	14.23	15.96	15.67	15.70	15.87	12.14	14.72
Fe0	13.63	12.79	15.77	11.89	11.96	10.96	11.22	11.23	13.11	12.88	11.05
MnO	0.29	0.30	0.34	0.31	0.18	0.22	0.24	0.24	0.83	0.66	0.21
MgO	8.23	6.52	9.71	8.49	6.92	9.19	9.01	8.97	12.11	12.65	8.73
CaO	6.26	8.84	3.81	5.67	7.65	5.38	4.11	4.12	1.89	8.88	9.77
Na2O	3.42	3.94	2.79	5.21	4.70	3.08	3.98	3.98	2.84	2.14	1.94
K2O	1.45	0.30	0.11	0.88	0.62	1.62	2.46	2.48	2.16	1.58	1.52
P2O5	0.16	0.17	0.14	0.11	0.14	0.12	0.12	0.14	0.11	0.10	0.10
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
LOI											
Mg #	52.00	48.00	52.00	56.00	51.00	60.00	59.00	59.00	62.00	64.00	58.00
Cr	212.92	143.19	231.72	235.97	237.20	270.60	273.78	273.47	236.39	195.84	257.78
Ni											
Sc	45.23	40.32	48.40	43.04	45.72	45.75	47.86	47.81	35.00	28.82	38.52
V	381.01	407.23	329.13	338.26	318.30	316.55	367.07	366.66	338.72	235.41	328.55
Rb											
Ba											
Sr											
Nb	6.50	8.10	4.50	4.40	4.90	4.30	4.50	4.50	3.20	4.10	4.80
Zr	107.99	114.76	77.92	79.00	84.14	84.75	86.19	86.09	72.66	57.84	75.82
Y	30.05	29.55	27.27	23.39	21.49	23.69	26.36	26.33	16.07	16.44	22.04
La											
Ce	33.62	37.57	13.33	29.37	29.40	32.68	24.34	24.31	30.70	21.31	23.25
Nd	10.19	18.28	12.30	10.13	12.16	12.25	9.13	9.12	7.16	7.10	10.11

WOOLTANA VOLCANICS GEOCHEMISTRY DATA

SAMPLE:	A242	A244B	A260B	A278(1)	A278(2)
SiO2	50.46	51.09	51.94	51.13	51.19
TiO2	1.50	1.40	2.35	1.70	1.69
Al2O3	15.08	14.18	14.63	14.18	14.23
Fe0	11.70	10.84	13.48	11.93	11.89
MnO	0.22	0.66	0.19	0.28	0.28
MgO	9.61	7.39	5.65	7.20	7.12
CaO	5.89	11.19	7.32	11.00	10.99
Na2O	2.83	2.84	2.47	2.13	2.14
K2O	2.59	0.31	1.56	0.32	0.32
P2O5	0.11	0.11	0.40	0.14	0.14
Total	100.00	100.00	99.99	100.00	100.00
LOI					
Mg #	59.00	55.00	43.00	52.00	52.00
Cr	236.91	209.62	68.30	238.50	239.04
Ni					
Sc	40.06	42.13	48.32	43.05	43.15
V	312.15	384.81	375.17	383.02	383.88
Rb					
Ba					
Sr					
Nb	3.60	3.50	16.40	5.40	5.40
Zr	76.26	76.96	260.98	96.01	96.22
Y	25.83	22.89	68.30	27.08	27.14
La					
Ce	24.40	28.35	102.97	30.32	30.39
Nd	11.18	9.11	54.03	15.16	5.06

APPENDIX 6

MICROPROBE MAJOR AND TRACE ELEMENT DATA

Microprobe Clinopyroxene Data Sample 533-009

	CPX OO1		CPX OO2	
	weight %	atomic fraction	weight %	atomic fraction
SiO2	53.30	1.96	52.20	1.96
TiO2	0.52	0.01	0.57	0.02
Al2O3	2.55	0.11	2.75	0.12
FeO	8.12	0.25	7.95	0.25
MnO	0.17	0.01	0.22	0.01
MgO	16.41	0.90	15.65	0.87
CaO	18.26	0.72	17.93	0.72
Na2O				
Total	99.91	3.97	97.75	3.96

	CPX OO3		CPX004 Rim	
	weight %	atomic fraction	weight %	atomic fraction
SiO2	53.27	1.96	53.73	1.99
TiO2	0.58	0.02	0.35	0.01
Al2O3	2.80	0.12	1.57	0.06
FeO	8.11	0.25	9.96	0.30
MnO	0.22	0.01	0.16	0.01
MgO	15.94	0.87	16.26	0.90
CaO	18.29	0.72	17.62	0.70
Na2O				
Total	99.72	3.96	99.65	3.97

	CPXOO5 Rim		CPXOO6 Rim	
	weight %	atomic fraction	Weight %	atomic fraction
SiO2	53.46	1.99	53.90	1.98
TiO2	0.55	0.02	0.53	0.10
Al2O3	1.49	0.07	2.01	0.09
FeO	10.35	0.32	8.64	0.27
MnO				
MgO	16.24	0.90	16.04	0.88
CaO	17.05	0.68	18.65	0.73
Na2O				
Total	99.14	3.97	99.90	3.97

	CPXOO7 Core		CPXOO8 Rim	
	weight %	atomic fraction	weight %	atomic fraction
SiO2	53.20	1.95	53.93	1.97
TiO2	0.52	0.01	0.56	0.02
Al2O3	2.74	0.12	2.25	0.10
FeO	7.90	0.24	8.47	0.26
MnO				
MgO	16.27	0.89	16.28	0.88
CaO	18.24	0.72	18.76	0.73
Na2O				
Total	99.71	3.96	100.57	3.96

Microprobe Clinopyroxene Data Sample 533-009

	CPXOO9 Rim		CPXO1O Rim	
	weight %	atomic fraction	weight %	atomic fraction
SiO2	53.36	1.97	53.65	1.96
TiO2	0.58	0.02	0.65	0.02
Al2O3	2.10	0.09	2.16	0.09
FeO	10.38	0.32	8.94	0.27
MnO			0.17	
MgO	16.06	0.88	16.12	0.88
CaO	17.18	0.68	18.62	0.73
Na2O				
Total	99.66	3.97	100.61	3.96

	CPXO11 Core		CPX012 Core	
	weight %	atomic fraction	weight %	atomic fraction
SiO2	53.60	1.97	53.43	1.95
TiO2	0.44	0.01	0.52	0.01
Al2O3	2.28	0.10	2.37	0.10
FeO	7.52	0.23	7.89	0.24
MnO	0.01			
MgO	16.26	0.89	16.39	0.89
CaO	18.95	0.74	18.88	0.74
Na2O				
Total	99.52	3.96	100.11	3.80

	CPXO13 Core		CPXO14 Core	
	weight %	atomic fraction	weight %	atomic fraction
SiO2	53.97	1.98	53.75	1.96
TiO2	0.54	0.01	0.44	0.01
Al2O3	1.62	0.07	1.59	0.07
FeO	9.38	0.29	9.66	0.30
MnO	0.12	0.01	0.12	0.01
MgO	16.43	0.90	16.31	0.89
CaO	17.97	0.71	17.78	0.70
Na2O				
Total	100.28	3.97	99.90	3.97

	CPXO15 Rim		CPXO16 Phenocryst	
	weight %	atomic fraction	weight %	atomic fraction
SiO2	53.61	1.98	53.15	1.96
TiO2	0.54	0.02	0.52	0.01
Al2O3	1.50	0.07	2.61	0.11
FeO	10.90	0.34	7.77	0.24
MnO	0.16	0.01	0.17	0.01
MgO	16.26	0.90	16.04	0.88
CaO	16.76	0.66	18.72	0.74
Na2O				
Total	99.90	3.97	99.65	3.96

Microprobe Clinopyroxene Data Sample 533-009

	CPXO17 Rim		CPXO18 Rim	
	weight %	atomic fraction	weight %	atomic fraction
SiO2	53.72	1.98	53.72	1.97
TiO2	0.35	0.01	0.36	0.01
Al2O3	1.91	0.08	1.92	0.08
FeO	7.87	0.24	8.38	0.26
MnO	0.15	0.93	0.19	0.01
MgO	16.88	0.71	17.27	0.94
CaO	17.85	0.70	17.29	0.68
Na2O				
Total	99.14	3.96	99.71	3.97

	CPXO19 Core		CPX020 Core	
	weight %	atomic fraction	weight %	atomic fraction
SiO2	53.44	1.96	52.77	1.94
TiO2	0.53	0.01	0.58	0.02
Al2O3	2.41	0.10	2.67	0.12
FeO	7.66	0.24	7.80	0.24
MnO	0.14	0.01		
MgO	15.95	0.87	16.07	0.88
CaO	19.13	0.75	19.10	0.75
Na2O				
Total	99.91	3.96	99.80	3.97

	CPXO21 Core		CPXO22 Core	
	weight %	atomic fraction	weight %	atomic fraction
SiO2	54.13	1.96	53.88	1.96
TiO2	0.50	0.01	0.47	0.01
Al2O3	1.98	0.08	2.58	0.11
FeO	8.25	0.25	8.56	0.26
MnO	0.20	0.01	0.26	0.01
MgO	16.91	0.91	17.01	0.92
CaO	18.88	0.73	17.33	0.67
Na2O				
Total	101.23	3.98	100.78	3.96

	CPXO23 Rim		CPXO24 Rim	
	weight %	atomic fraction	weight %	atomic fraction
SiO2	53.80	1.96	54.22	1.99
TiO2	0.56	0.01	0.22	0.01
Al2O3	2.44	0.10	1.55	0.07
FeO	7.51	0.23	8.74	0.27
MnO				
MgO	16.12	0.87	17.26	0.94
CaO	19.70	0.77	17.56	0.69
Na2O				
Total	100.67	3.97	99.91	3.97

Microprobe Clinopyroxene Data Sample 533-009

	CPXO25 Rim		CPX026 Rim	
	weight %	atomic fraction	weight %	atomic fraction
SiO2	53.30	1.97	52.96	1.98
TiO2	0.15	0.01	0.41	0.01
Al2O3	1.99	0.09	1.30	0.06
FeO	10.13	0.31	11.69	0.37
MnO			0.61	0.02
MgO	16.35	0.90	12.85	0.72
CaO	17.45	0.69	20.06	0.81
Na2O			0.34	
Total	99.89	3.97	100.22	3.99

	CPX O27	
	weight %	atomic fraction
SiO2	53.52	1.97
TiO2	0.47	0.01
Al2O3	2.18	0.09
FeO	8.10	0.01
MnO		
MgO	16.32	0.89
CaO	18.85	0.74
Na2O		
Total	99.82	3.97

Microprobe Clinopyroxene Data Sample 533-013

	CPX401 Core		CPX402 Rim	
	weight %	atomic fraction	weight %	atomic fraction
SiO2	51.82	1.94	54.21	2.05
TiO2	0.38	0.01	0.16	0.01
Al2O3	2.86	0.13	8.08	0.36
FeO	7.85	0.25	9.47	0.30
MnO			0.41	0.01
MgO	15.91	0.89	7.54	0.87
CaO	18.35	0.74	11.48	0.72
Na2O				
Total	97.17	3.97	95.24	3.96

	CPX403 Core		CPX404 Rim	
	weight %	atomic fraction	weight %	atomic fraction
SiO2	53.01	1.98	56.69	2.05
TiO2	0.41	0.01	0.24	0.01
Al2O3	2.02	0.09	8.63	0.37
FeO	7.88	0.25	7.24	0.22
MnO			0.16	0.01
MgO	16.73	0.93	10.18	0.55
CaO	17.58	0.70	11.17	0.43
Na2O			3.46	0.24
Total	97.63	3.96	67.84	3.88

	CPX407 Core		CPX408 Core	
	weight %	atomic fraction	weight %	atomic fraction
SiO2	52.43	1.97	52.43	1.96
TiO2	0.27	0.01	0.42	0.01
Al2O3	2.26	0.10	2.22	0.10
FeO	7.76	0.24	7.52	0.24
MnO				
MgO	16.94	0.95	16.67	0.93
CaO	17.27	0.69	17.82	0.71
Na2O				
Total	96.93	3.97	97.08	3.97

	CPX409 Core		CPX410 Core	
	weight %	atomic fraction	weight %	atomic fraction
SiO2	53.19	1.99	51.69	1.94
TiO2	0.28	0.01	0.44	0.01
Al2O3	1.49	0.07	2.79	0.12
FeO	7.92	0.25	8.38	0.26
MnO	0.13	0.01		
MgO	17.16	0.96	17.28	0.97
CaO	17.24	0.69	16.21	0.65
Na2O				
Total	97.41	3.97	96.79	3.98

Microprobe Clinopyroxene Data Sample 533-013

	CPX411 Rim		CPX412 Core	
	weight %	atomic fraction	weight %	atomic fraction
SiO2	52.47	1.96	53.02	1.96
TiO2	0.45	0.01	0.33	0.01
Al2O3	2.00	0.09	2.26	0.10
FeO	10.30	0.32	7.42	0.23
MnO			0.14	0.01
MgO	17.09	0.95	16.59	0.92
CaO	16.14	0.65	18.57	0.74
Na2O				
Total	98.45	3.98	98.33	3.97

	CPX413 Rim		CPX414 Core	
	weight %	atomic fraction	weight %	atomic fraction
SiO2	50.73	1.97	52.86	1.97
TiO2	0.52	0.01	0.26	0.01
Al2O3	1.86	0.09	2.22	0.10
FeO	11.69	0.38	7.78	0.24
MnO	0.42	0.01		
MgO	12.19	0.71	16.85	0.94
CaO	18.86	0.78	17.78	0.71
Na2O	0.56	0.04		
Total	96.83	4.00	97.75	3.97

	CPX415 Rim		CPX416 Core	
	weight %	atomic fraction	weight %	atomic fraction
SiO2	52.52	1.99	52.74	1.97
TiO2	0.24	0.01	0.28	0.01
Al2O3	1.44	0.06	2.33	0.10
FeO	9.00	0.29	7.57	0.24
MnO	0.17	0.01	0.16	0.01
MgO	15.37	0.87	16.97	0.94
CaO	18.48	0.75	17.48	0.70
Na2O				
Total	97.22	3.99	97.53	3.97

Microprobe Clinopyroxene Geochemistry Sample 6431RS0079

	CPX201 Core		CPX202 Core	
	weight %	atomic fraction	weight %	atomic fraction
SiO2	50.40	1.95	50.98	1.92
TiO2	1.09	0.03	1.21	0.03
Al2O3	2.81	0.13	2.75	0.12
FeO	11.52	0.37	14.36	0.45
MnO	0.21	0.01	0.15	0.01
MgO	13.38	0.77	13.35	0.75
CaO	17.80	0.73	16.77	0.68
Na2O			0.27	
Total	97.21	3.97	99.90	3.99

	CPX203 Core		CPX204 Core	
	weight %	atomic fraction	weight %	atomic fraction
SiO2	52.03	1.93	51.88	1.93
TiO2	0.98	0.03	1.09	0.03
Al2O3	2.83	0.12	2.68	0.12
FeO	13.15	0.41	13.42	0.42
MnO	0.19	0.01	0.26	0.01
MgO	15.58	0.86	15.77	0.89
CaO	15.50	0.62	15.21	0.61
Na2O	0.17	0.01		
Total	100.43	3.97	100.31	3.98

	CPX2O5 Rim		CPX2O6 Rim	
	weight %	atomic fraction	Weight %	atomic fraction
SiO2	51.27	1.95	51.59	1.95
TiO2	0.90	0.03	0.87	0.03
Al2O3	1.94	0.09	1.91	0.09
FeO	18.19	0.58	18.85	0.59
MnO	0.20	0.01	0.37	0.01
MgO	14.22	0.81	15.03	0.85
CaO	12.57	0.51	11.63	0.47
Na2O				
Total	99.29	3.98	100.25	3.98

	CPX2O7 Core		CPX2O8 Core	
	weight %	atomic fraction	weight %	atomic fraction
SiO2	51.57	1.93	51.85	1.94
TiO2	1.15	0.03	0.96	0.03
Al2O3	2.50	0.11	2.46	0.12
FeO	13.65	0.43	12.97	0.41
MnO	0.21	0.01	0.27	
MgO	13.62	0.76	14.32	0.80
CaO	17.91	0.69	16.70	0.67
Na2O	0.22	0.02	0.18	0.01
Total	100.11	3.98	99.71	3.98

Microprobe Clinopyroxene Geochemistry Sample 6431RS0079

	CPX2O9 Rim		CPX210 Rim	
	weight %	atomic fraction	Weight %	atomic fraction
SiO2	50.67	1.94	50.95	1.94
TiO2	1.21	0.03	1.13	0.03
Al2O3	2.30	0.10	2.10	0.09
FeO	15.34	0.49	8.64	0.51
MnO	0.24	0.01	0.20	0.01
MgO	12.46	0.71	12.01	0.68
CaO	16.65	0.68	17.13	0.70
Na2O	0.19	0.01	0.19	0.01
Total	99.12	3.99	99.72	3.98

Micrprobe Clinopyroxene Geochemistry Samples 6431RS080

	CPX301 Core		CPX302 Rim	
	weight %	atomic fraction	weight %	atomic fraction
SiO2	49.64	1.94	50.74	1.96
TiO2	0.75	0.02	0.38	0.10
Al2O3	2.41	0.11	20.80	0.09
FeO	12.96	0.42	17.26	0.56
MnO			0.37	0.01
MgO	14.64	0.85	13.31	0.77
CaO	14.82	0.62	13.63	0.56
Na2O				
Total	99.91	3.98	98.15	3.99

	CPX303 Core		CPX304 Inclusion	
	weight %	atomic fraction	weight %	atomic fraction
SiO2	51.86	1.97	51.43	1.95
TiO2	0.79	0.02	0.96	0.27
Al2O3	1.78	0.08	1.83	0.08
FeO	16.96	0.54	16.38	0.52
MnO	0.22	0.01	0.27	0.01
MgO	13.07	0.74	13.00	0.73
CaO	14.92	0.61	15.94	0.65
Na2O				
Total	99.79	3.98	100.07	3.99

	CPX 305		CPX 306	
	weight %	atomic fraction	Weight %	atomic fraction
SiO2	51.44	1.95	47.61	1.85
TiO2	0.92	0.02	0.46	0.01
Al2O3	1.81	0.08	4.68	0.21
FeO	17.61	0.56	17.66	0.57
MnO	0.28	0.01	0.17	0.01
MgO	14.42	0.81	13.71	0.79
CaO	12.96	0.53	13.25	0.55
Na2O	0.32	0.02		
Total	99.75	3.97	98.03	4.05

	CPX3O7 Core		CPX3O8 Core	
	weight %	atomic fraction	weight %	atomic fraction
SiO2	51.34	1.96	52.93	1.97
TiO2	0.82	0.02	0.70	0.02
Al2O3	1.96	0.09	1.81	0.08
FeO	15.04	0.48	10.92	0.34
MnO	0.22	0.01		
MgO	14.70	0.84	16.17	0.89
CaO	14.36	0.59	16.57	0.66
Na2O				
Total	98.44	3.98	99.34	3.98

Micrprobe Clinopyroxene Geochemistry Samples 6431RS080

	CPX3O9 Rim		CPX31O Core	
	weight %	atomic fraction	weight %	atomic fraction
SiO2	52.34	1.96	51.75	1.93
TiO2	0.69	0.02	0.98	0.03
Al2O3	2.10	0.09	2.53	0.11
FeO	12.32	0.39	12.63	0.39
MnO	0.22	0.01	0.18	0.01
MgO	15.42	0.86	15.82	0.88
CaO	16.05	0.64	15.41	0.62
Na2O				
Total	99.14	3.97	99.54	3.99

	CPX311 Core	
	weight %	atomic fraction
SiO2	51.08	1.97
TiO2	0.81	0.02
Al2O3	1.46	0.07
FeO	19.94	0.64
MnO	0.35	0.01
MgO	11.66	0.67
CaO	14.04	0.58
Na2O		
Total	99.34	3.97

Microprobe Clinopyroxene Analysis Sample 6431RS081

	CPX101 Core		CPX102 Rim	
	weight %	atomic fraction	weight %	atomic fraction
SiO2	50.83	1.96	51.33	1.98
TiO2	0.73	0.02	0.26	0.01
Al2O3	2.21	0.10	1.64	0.07
FeO	11.32	0.36	12.82	0.41
MnO	0.15	0.01	0.28	0.01
MgO	14.72	0.85	12.75	0.73
CaO	16.19	0.67	17.95	0.74
Na2O			0.23	0.02
Total	96.15	3.97	97.26	3.98

	CPX103 Core		CPX104 Rim	
	weight %	atomic fraction	weight %	atomic fraction
SiO2	50.55	1.96	50.07	1.98
TiO2	0.76	0.02	0.84	0.03
Al2O3	1.65	0.08	1.28	0.60
FeO	15.12	0.49	17.70	0.58
MnO	0.15	0.01	0.14	0.01
MgO	13.00	0.75	11.37	0.67
CaO	15.90	0.66	15.39	0.65
Na2O				
Total	97.13	3.97	96.79	3.97

	CPX1O5 Core		CPX1O6 Rim	
	weight %	atomic fraction	Weight %	atomic fraction
SiO2	41.87	1.76	50.79	1.99
TiO2	0.41	0.01	0.45	0.01
Al2O3	6.25	0.31	0.79	0.04
FeO	17.28	0.61	15.65	0.51
MnO	0.16	0.01	0.32	0.01
MgO	13.04	0.82	8.60	0.50
CaO	11.78	0.53	20.62	0.87
Na2O	0.41	0.03	0.62	0.05
Total	91.31	4.09	98.02	4.00

	CPX1O7 Core		CPX1O8 Rim	
	weight %	atomic fraction	weight %	atomic fraction
SiO2	51.27	1.94	51.46	2.02
TiO2	0.77	0.02	0.17	0.01
Al2O3	2.57	0.11	0.62	0.03
FeO	10.17	0.32	15.89	0.52
MnO	0.17	0.01	0.35	0.01
MgO	14.66	0.83	8.48	0.49
CaO	17.88	0.73	20.43	0.86
Na2O	0.21	0.02	0.47	0.04
Total	98.01	3.98	97.87	3.98

Microprobe Clinopyroxene Analysis Sample 6431RS081

	CPX1O9 Core		CPX11O Rim	
	weight %	atomic fraction	weight %	atomic fraction
SiO2	51.34	1.95	50.38	1.99
TiO2	0.71	0.02	0.46	0.01
Al2O3	2.37	0.11	1.00	0.05
FeO	10.28	0.01	19.21	0.63
MnO		0.33	0.26	0.01
MgO	15.00	0.85	11.15	0.66
CaO	17.30	0.70	14.92	0.63
Na2O				
Total	97.00	3.97	97.38	3.98

	CPX111 Core		CPX112 Rim	
	weight %	atomic fraction	weight %	atomic fraction
SiO2	51.12	1.94	50.82	1.94
TiO2	0.76	0.02	0.72	0.02
Al2O3	2.50	0.11	2.50	0.11
FeO	10.80	0.34	10.49	0.33
MnO	0.13	0.01	0.16	0.01
MgO	15.19	0.86	15.27	0.87
CaO	16.59	0.67	16.54	0.68
Na2O	0.15	0.01		
Total	97.24	3.98	96.50	3.98

	CPX113 Core		CPX114 Core	
	weight %	atomic fraction	weight %	atomic fraction
SiO2	53.02	1.96	52.59	1.96
TiO2	0.85	0.02	0.88	0.03
Al2O3	2.15	0.09	1.61	0.07
FeO	12.58	0.39	16.03	0.50
MnO	0.18	0.01	0.20	0.01
MgO	14.98	0.82	12.72	0.71
CaO	16.90	0.67	17.51	0.71
Na2O				
Total	100.66	3.97	101.54	3.97

	CPX115 Rim		CPX116 Core	
	weight %	atomic fraction	weight %	atomic fraction
SiO2	51.18	1.98	53.55	1.94
TiO2	0.48	0.01	0.80	0.02
Al2O3	1.46	0.07	2.31	0.10
FeO	17.28	0.56	10.86	0.33
MnO	0.22	0.01	0.18	0.01
MgO	10.64	0.61	15.35	0.83
CaO	17.24	0.71	18.63	0.73
Na2O	0.32	0.02		
Total	98.82	3.98	101.68	3.98

Microprobe Clinopyroxene Analysis Sample 6431RS081

	CPX117 Core		CPX118 Rim	
	weight %	atomic fraction	weight %	atomic fraction
SiO2	50.99	1.95	51.10	1.97
TiO2	0.78	0.02	0.57	0.02
Al2O3	2.10	0.09	1.78	0.08
FeO	12.22	0.39	11.16	0.36
MnO	0.17	0.01	0.32	0.01
MgO	14.09	0.80	12.37	0.71
CaO	17.31	0.71	19.56	0.81
Na2O			0.27	0.02
Total	97.66	3.98	97.13	3.99

	CPX 119		CPX120 Core	
	weight %	atomic fraction	weight %	atomic fraction
SiO2	50.15	1.98	49.50	1.96
TiO2	0.62	0.02	0.62	0.02
Al2O3	1.16	0.05	1.16	0.06
FeO	14.38	0.47	14.38	0.67
MnO	0.22	0.01	0.22	0.01
MgO	9.52	0.56	9.52	0.62
CaO	20.32	0.86	20.32	0.62
Na2O	0.31	0.02	0.31	0.01
Total	96.68	3.99	96.68	3.99

	CPX121 Core		CPX122 Rim	
	weight %	atomic fraction	weight %	atomic fraction
SiO2	50.85	1.95	49.79	2.01
TiO2	0.74	0.02	0.25	0.01
Al2O3	2.20	0.10	0.51	0.02
FeO	11.73	0.37	17.10	0.58
MnO	0.24	0.01	0.40	0.01
MgO	14.82	0.85	7.21	0.43
CaO	16.18	0.67	20.43	0.88
Na2O			0.40	0.03
Total	96.76	3.97	96.09	4.00

	CPX124 Rim		CPX 125	
	weight %	atomic fraction	weight %	atomic fraction
SiO2	50.72	1.98	50.56	1.96
TiO2	0.39	0.01	0.72	0.02
Al2O3	1.70	0.07	2.13	0.09
FeO	11.04	0.36	11.87	0.38
MnO	0.19	0.01	0.14	0.01
MgO	12.96	0.75	14.10	0.81
CaO	18.54	0.77	16.79	0.69
Na2O	0.34	0.03		
Total	95.97	3.99	96.31	3.97

Microprobe Clinopyroxene Analysis Sample 6431RS081

	CPX126 Rim	
	weight %	atomic fraction
SiO2	50.19	1.98
TiO2	0.58	0.02
Al2O3	1.09	0.05
FeO	18.52	0.61
MnO	0.38	0.01
MgO	11.76	0.69
CaO	14.23	0.60
Na2O		
Total	96.75	3.97

APPENDIX 7

GEOCHEMICAL RESULTS OF MAGMODEL

Magmodel Theoretical Results for Selected Beda Volcanics Samples

Liquid Compositions

	Parent 533-095	5% Crystallised	10% Crystallised	15% Crystallised	20% Crystallised
SiO2	50.24	50.61	51.15	51.72	51.90
TiO2	1.27	1.33	1.39	1.47	1.56
Al2O3	13.48	14.09	14.80	15.42	15.09
Fe203	2.50	2.61	2.74	2.89	3.07
FeO	9.30	9.15	8.85	8.41	8.51
MgO	10.40	8.64	6.81	5.16	4.75
CaO	7.91	8.27	8.68	9.08	9.11
Na2O	3.68	3.85	4.04	4.23	4.29
K2O	1.40	1.46	1.54	1.62	1.72

	25% Crystallised	30% Crystallised	35% Crystallised	40% Crystallised
SiO2	52.05	52.52	52.92	53.47
TiO2	1.66	1.66	1.66	1.63
Al2O3	14.68	14.46	14.44	14.45
Fe203	3.26	3.23	3.18	3.05
FeO	8.63	8.50	8.41	8.24
MgO	4.40	4.09	3.82	3.57
CaO	9.14	9.15	8.90	8.63
Na2O	4.34	4.43	4.54	4.67
K2O	1.83	1.96	2.11	2.29

Magmodel Theoretical Results for Selected Beda Volcanics Samples

Liquid Compositions

	Parent 533-122	5% Crystallised	10% Crystallised	15% Crystallised	20% Crystallised
SiO2	50.48	51.16	51.85	51.37	51.39
TiO2	2.08	2.19	2.30	2.43	2.57
Al2O3	13.20	13.87	14.60	14.59	14.32
Fe203	3.50	3.68	3.87	4.09	4.33
FeO	11.50	10.05	9.25	9.38	9.94
MgO	7.17	5.56	3.93	3.71	3.93
CaO	6.44	6.77	7.12	7.52	7.97
Na2O	4.78	5.02	5.29	5.21	5.00
K2O	1.62	1.70	1.79	1.70	1.54

	25% Crystallised	30% Crystallised	35% Crystallised	40% Crystallised
SiO2	50.62	51.18	51.01	50.87
TiO2	2.44	2.27	2.24	2.22
Al2O3	14.46	14.52	14.33	14.20
Fe203	3.99	3.59	3.48	3.41
FeO	9.58	9.09	9.11	9.16
MgO	3.97	3.96	4.09	4.21
CaO	8.51	8.97	9.49	9.82
Na2O	4.95	4.97	4.86	4.78
K2O	1.46	1.45	1.38	1.33

Magmodel Theoretical Results for Selected Gairdner Dyke Swarm Samples

Liquid Compositions

	Parent 6136RS001	5% Crystallised	10% Crystallised	15% Crystallised	20% Crystallised
SiO2	51.55	51.70	51.69	51.65	51.62
TiO2	1.51	1.59	1.71	1.77	1.88
Al2O3	14.54	14.57	14.71	14.54	14.18
Fe203	2.50	2.61	2.76	2.86	3.03
FeO	9.00	9.34	9.81	9.98	10.31
MgO	7.42	7.41	7.30	7.13	6.87
CaO	11.14	10.69	9.90	9.92	9.94
Na2O	1.89	1.96	1.97	1.98	1.99
K2O	0.15	0.16	0.17	0.18	0.19

	25% Crystallised	30% Crystallised	35% Crystallised	40% Crystallised
SiO2	51.58	51.52	51.96	52.56
TiO2	2.00	2.13	2.11	2.05
Al2O3	13.83	13.44	13.13	12.86
Fe203	3.22	3.44	3.39	3.26
FeO	10.63	10.98	10.97	10.89
MgO	6.57	6.24	6.00	5.81
CaO	9.98	10.05	10.21	10.30
Na2O	1.99	2.00	2.01	2.02
K2O	0.20	0.21	0.23	0.25

Magmodel Theoretical Results for Selected Gairdner Dyke Swarm Samples

Liquid Compositions

	Parent 6136RS002	5% Crystallised	10% Crystallised	15% Crystallised	20% Crystallised
SiO2	51.85	51.84	51.82	51.79	51.77
TiO2	1.63	1.71	1.81	1.91	2.02
Al2O3	14.36	14.37	14.44	14.35	14.00
Fe203	3.00	3.12	3.25	3.42	3.62
FeO	9.00	9.30	9.63	9.94	10.25
MgO	7.28	7.22	7.15	6.95	6.68
CaO	10.95	10.45	9.89	9.61	9.62
Na2O	1.88	1.90	1.93	1.95	1.96
K2O	0.07	0.07	0.08	0.08	0.09

	25% Crystallised	30% Crystallised	35% Crystallised	40% Crystallised
SiO2	51.80	52.33	52.90	53.58
TiO2	2.12	2.08	2.04	1.99
Al2O3	13.65	13.41	13.18	12.92
Fe203	3.80	3.69	3.59	3.45
FeO	10.51	10.42	10.36	10.27
MgO	6.41	6.20	6.02	5.83
CaO	9.65	9.79	9.82	9.85
Na2O	1.96	1.97	1.99	2.00
K2O	0.09	0.10	0.11	0.12

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