

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

ALISON L. WOODGET B.Sc.

Thesis submitted as partial fulfilment for the
Honours Degree of Bachelor of Science

NOVEMBER 1987

Department of Geology and Geophysics
The University of Adelaide



Supervisor: J D Foden

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

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 recrystallised 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.

TABLE OF CONTENTS

ABSTRACT	i
TABLE OF CONTENTS.....	iii
Chapter 1 INTRODUCTION	1
1.1 GEOLOGICAL BACKGROUND	1
1.2 STATEMENT OF THE PROBLEM.....	1
1.3 METHODS.....	2
1.4 AIM.....	2
Chapter 2 GEOLOGY	3
2.1 REGIONAL GEOLOGY.....	3
2.1.1 INTRODUCTION.....	3
2.1.2 ADELAIDE GEOSYNCLINE STRATIGRAPHY	3
2.1.2.1 The Callanna Group.....	3
2.1.2.2 The Burra Group.....	3
2.1.3 STUART SHELF STRATIGRAPHY	4
2.1.3.1 The Pandurra Formation.....	4
2.1.3.2 The Callanna Group.....	4
2.1.3.3 The Burra Group.....	5
2.2 LOCAL GEOLOGY	5
2.2.1 MOONABIE FORMATION - BACKY POINT	5
2.2.1 BACKY POINT BEDS - BACKY POINT.....	5
Chapter 3 PETROLOGY.....	7
3.1 PETROLOGY OF THE BEDA VOLCANICS	7
3.1.1 INTRODUCTION.....	7
3.1.2 OUTCROP PETROLOGY	7
3.1.3 DRILL CORE PETROLOGY.....	8
3.2 PETROLOGY OF THE DEPOT CREEK VOLCANICS	9
3.2.1 INTRODUCTION.....	9
3.2.2 PETROLOGY	9
3.3 PETROLOGY OF THE PORT PIRIE VOLCANICS	10
3.3.1 INTRODUCTION.....	10
3.3.2 PETROLOGY.....	10
3.4 PETROLOGY OF THE GAIRDNER DYKE SWARM.....	12
3.4.1 INTRODUCTION.....	12
3.4.2 PETROLOGY.....	12

Chapter 4 GEOCHEMISTRY - Major and Trace Elements.....	14
4.1 GEOCHEMISTRY OF THE SUITES.....	14
4.1.1 INTRODUCTION.....	14
4.1.2 GEOCHEMISTRY OF THE BEDA VOLCANICS.....	14
4.1.3 GEOCHEMISTRY OF THE GAIRDNER DYKE SWARM.....	14
4.1.4 GEOCHEMISTRY OF THE DEPOT CREEK AND WOOLTANA VOLCANICS.....	15
4.1.5 GEOCHEMISTRY OF THE PORT PIRIE VOLCANICS.....	15
4.2 MAJOR MINERAL CRYSTALLISATION PATTERNS.....	15
4.2.1 PYROXENE-OLIVINE CRYSTALLISATION.....	15
4.2.2 MAGNETITE CRYSTALLISATION.....	16
4.3 ALTERATION AND CRUSTAL CONTAMINATION AFFECTS.....	16
4.4 MODELLING OF FRACTIONAL CRYSTALLISATION.....	17
4.4.1 INTRODUCTION.....	17
4.4.2 BEDA VOLCANICS MODELLING.....	17
4.4.3 GAIRDNER DYKE SWARM MODELLING.....	18
Chapter 5 GEOCHEMISTRY - Discrimination Diagrams	19
5.1 INTRODUCTION	19
5.2 FLOYD AND WINCHESTER Nb/Y - Zr/P2O5 PLOT.....	19
5.3 SHERVAIS V - Ti PLOT	19
5.4 PEARCE AND CANN Ti - Zr - Y PLOT.....	19
5.5 PEARCE AND NORRY Zr - Y PLOT	20
5.6 CLINOPYROXENE DISCRIMINATION DIAGRAM.....	20
5.7 PEARCE'S SPIDERGRAMS.....	20
5.7.1 INTRODUCTION.....	20
5.7.2 ADELAIDE GEOSYNCLINE AND STUART SHELF VOLCANICS.....	21
5.7.3 KAROO VOLCANICS	21
5.7.3. NORTHERN UTAH AND SOUTHEASTERN IDAHO VOLCANICS.....	21
Chapter 6 DISCUSSION AND CONCLUSION.....	22
6.1 PETROLOGY AND GEOCHEMISTRY.....	22
6.2 COMPARISON WITH OTHER RIFT VOLCANICS.....	23
6.3 CONCLUSION	23
ACKNOWLEDGEMENTS	25
REFERENCES	26

LIST OF APPENDICES

Appendix 1	Analytical Procedures, Major and Trace Element Analysis
Appendix 2	Pertography
Appendix 3	Drill Core Logs
Appendix 4	Geochemical Graphs - Major and Trace Elements Versus Zr
Appendix 5	Major and Trace Element Geochemical Data
Appendix 6	Microprobe Major and Trace Element Geochemical Data
Appendix 7	Geochemical Results of Magmodel

LIST OF FIGURES

Figure 1	Location map of Selected Stuart Shelf and Adelaide Geosyncline Volcanics.
Figure 2	Stratigraphic Column for the Stuart Shelf and the Adelaide Geosyncline.
Figure 3	Ni and Cr Versus Zr Graphs
Figure 4	Graphs Showing the Alteration of the Beda Volcanics
Figure 5	Graphs Showing the Alteration of the Gairdner Dyke Swarm
Figure 6	Mg# Versus Major Element Graphs of the Beda Volcanics, Including the Results of Magmodel.
Figure 7	Mg# Versus Major Element Graphs of the Gairdner Dyke Swarm, Including the Results of Magmodel.
Figure 8	Floyd and Winchester Nb/Y - Zr/P ₂ O ₅ Plots.
Figure 9	Shervais V- Ti Plot.
Figure 10	Pearce and Cann Ti - Zr - Y Plot.
Figure 11	Pearce and Norry Zr - Y Plot.
Figure 12	Clinopyroxene Discrimination Plot Ti - SiO ₂ .
Figure 13	Pearce's Spidergrams

LIST OF TABLES

Table 1	Comparison Table of an Average Tholeiitic Basalt, a Central Karoo Province Basalt and Basalts of the Stuart Shelf and Adelaide Geosyncline.
Table 2	Least Squares Mixing Programme Results for Selected Beda Volcanics.
Table 3	Magmodel Results for Selected Beda Volcanics.
Table 4	Least Squares Mixing Programme Results for Selected Gairdner Dyke Swarm Samples.
Table 5	Magmodel Results for Selected Gairdner Dyke Swarm Samples.

LIST OF PLATES

- Plate 1 Photomicrographs and photographs of the Beda and Depot Creek Volcanics
Plate 2 Photomicrographs and photographs of the Depot Creek and Port Pirie
Volcanics and the Gairdner Dyke Swarm.

LIST OF MAPS

- Map 1 Geology of the Backy Point Area, South Australia.
Map 2 Geology of the Douglas Point Area, South Australia.