

**ISOTOPIC AND GEOCHEMICAL CONSTRAINTS ON
PROTEROZOIC CRUSTAL GROWTH FROM THE MT
PAINTER INLIER.**

By

Bruce F. Schaefer B.Sc.

**This thesis is submitted as partial fulfillment for the
Honours Degree of Bachelor of Science**

**Department of Geology and Geophysics
University of Adelaide
November 1993**

National Grid Reference (SH - 54) 6737, 6837 1:100 000

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

KEY TO ABBREVIATIONS USED IN TEXT AND DIAGRAMS

ABSTRACT

CHAPTER 1 -INTRODUCTION	1
1.1 Introduction	1
1.2 Aims and methods	1
CHAPTER 2 -REGIONAL GEOLOGY	3
2.1 Previous Investigations	3
2.2 Geology of the Paralana Hot Springs - Hidden Valley Area	3
2.2.1 Lithological Descriptions	3
2.2.2 Structure	9
CHAPTER 3 -GEOCHEMISTRY	12
3.1 Geochemical Characteristics of the Granite Suites	12
3.1.1 Orthogneisses	12
3.1.2 Mt Neill Granite	13
3.1.3 British Empire Granite	14
3.2 Geochemical Characteristics of the Metasedimentary Sequences	15
3.2.1 Paragneisses	15
3.2.2 Radium Creek Metamorphics	15
CHAPTER 4 -ISOTOPE GEOLOGY	17
4.1 The Rb-Sr and Sm-Nd Isotope Systems	17
4.2 Rb-Sr data and interpretations	18
4.3 Sm-Nd data and interpretations	19
CHAPTER 5 -INTERREGIONAL CORRELATIONS FROM ISOTOPIC AND GEOCHEMICAL DATA	22
CHAPTER 6 -IMPLICATIONS FOR PROTEROZOIC CRUSTAL GROWTH	24
6.1 Overview	24
6.2 Application of Data from Hidden Valley to Crustal Growth Mechanisms	24

6.3 Discussion	25
6.4 Conclusions and Recommendations	28

ACKNOWLEDGEMENTS

REFERENCES

APPENDIX A

Selected thin section descriptions

APPENDIX B

Summary of geochemical data and graphs

APPENDIX C

Isotope systematics

APPENDIX D

Summary of isotopic data

APPENDIX E

Analytical procedures

APPENDIX F

Geological map and block diagrams of the Paralana Hot Springs - Hidden Valley Area

LIST OF TABLES AND FIGURES

Figure:	Following Page:
1: Location of the Mt Painter Inlier in South Australia.	1
2: Location of the study area within the Mt Painter Inlier.	2
3: Location of the Mt Painter Inlier with respect to other Australian Precambrian provinces.	2
4: Simplified stratigraphic column for the map area.	4
5: Summary of the major deformational events and their resultant structures in the Paralana Hot Springs - Hidden Valley area.	9
6: Ternary plots of the three igneous suites.	12
7: Comparative trace element geochemistry of the igneous suites.	12
8: Spidergram contrasting variations within the orthogneisses.	13
9: Discrimination diagrams for the Mt Neill and British Empire Granites.	13
10: Tectonic discrimination diagrams.	14
11: Discrimination diagrams of granite suites within the map area.	14
12: Variation diagrams comparing the metasedimentary sequences and British Empire Granite.	15
13: Al index vs K_2O/Na_2O for major lithologies.	15
14: Rb-Sr Whole Rock isochrons.	18
15: Schematic representation of the variation between real and calculated model ages assuming simple linear crustal evolution.	19
16: Histograms of frequency of model ages determined in the Paralana Hot Springs - Hidden Valley area.	20
17: Isotopic discrimination diagrams for samples from the Hidden Valley - Paralana Hot Springs area.	21
Tables:	
1: Comparison of lithological names used in the Hidden Valley - Paralana Hot Springs area.	5
2a: Comparison of average granite compositions within the Mt Painter and Babbage Inliers.	12
2b: Selected Whole Rock Analyses for the orthogneissic sequence.	12
3a: Summary of Whole Rock Analyses carried out on the Mt Neill Granite.	13
3b: Summary of Whole Rock Analyses carried out on the British Empire Granite.	13
4: Summary of isotopic data for major lithologies in the Hidden Valley - Paralana Hot Springs area.	19

5: Average Whole Rock Analyses comparing the Gawler Craton, Adelaide Geosyncline and Lachlan Fold Belt S-type granites with granites from the study area. 22

Plates:

Plate 1: Hand specimens and photomicrograph. 7

Key to abbreviations used in text and diagrams.

Although abbreviations are defined where appropriate throughout the thesis, in the interests of completeness and easy referencing a summary of all abbreviations is presented below:

BEG	British Empire Granite
bt	biotite
cd	cordierite
CHUR	Chondritic Undifferentiated Reservoir
COLG	Collisional Granites
cor	corundum
FHQ	Freeling Heights Quartzite
fspar	feldspar
Ga	Giga-anna, = billions of years before present.
GRV	Gawler Range Volcanics
gt	garnet
HREE	Heavy Rare Earth Elements
KI	Kangaroo Island
kspar	Potassium feldspar
LBF	Lady Buxton Fault
LFB	Lachlan Fold Belt
LREE	Light Rare Earth Elements
MAQ	Mount Adams Quartzite
Ma	Mega-anna, = Millions of years before present.
micro	microcline
MNG	Mount Neill Granite
mu	muscovite
OIA	Ocean Island Arc
- ORG	Ocean Ridge Granites
phlog	phlogopite
plag	plagioclase
qtz	quartz
RCM	Radium Creek Metamorphics
REE	Rare Earth Elements
TCHUR	Model age from CHUR
TDM	Model age from depleted mantle
tour	tourmaline
- VAG	Volcanic Arc Granites
- WPG	Within Plate Granites
YP	Yagdlin Phyllite

ABSTRACT

The Mt Painter Inlier comprises sequences of Palaeo- Mesoproterozoic metasediments, granitoids and granites. The igneous suites are geochemically similar to penecontemporaneous Australian I- and A-type granites, and contain elevated immobile element concentrations relative to Phanerozoic analogues. The metasedimentary sequences indicate shallow water, intracontinental depositional environments and isotope studies suggest short transport distance and local provenance. Nd depleted mantle model ages for the oldest granitoids and metasediments are clustered around 2.1-2.4 Ga, with the *younger* granitic units returning *older* model ages of 2.9-3.3 Ga. The 2.1-2.4 Ga event is correlated with events of similar age from other Australian terrains, and interpreted to represent a period of major continental crustal growth in Australia. The Archaean model ages for the younger granite suites are older than those of the neighbouring Gawler Craton, and may represent the juxtaposition of a hitherto undocumented Archaean terrain prior to ~1700 Ma. Proterozoic tectonic processes must therefore be responsible for the relative movement of stable cratonic nuclei on large scales in order to produce allochthonous juxtaposition. The Mt Painter Inlier therefore records an active tectonic evolution throughout the Proterozoic, incorporating continental crustal growth periods between 2.1-2.4 and at ~3 Ga. Tectonic activity continues to the present day, with both the Delamerian Orogeny and ongoing Tertiary thrusting processes being responsible for the current morphology of the inlier.