



THE GEOLOGY OF THE ADELAIDEAN-KANMANTOO GROUP
SEQUENCES IN THE EASTERN MOUNT LOFTY RANGES

by

Stephen Toteff

B.Sc. (Hons.), University of Adelaide

Department of Geology and Mineralogy,
University of Adelaide.

November, 1977.

Awarded December 1978

CONTENTS (cont'd)

	<u>Page</u>
3. NAIRNE-MT. BARKER CREEK AREA .	35
3.1 Introduction	35
3.2 Sturt Group	35
3.2.1 Tapley Hill Formation	35
3.2.2 Brighton Limestone Equivalent	37
3.3 Marino Group	37
3.3.1 Unit 1	37
3.3.2 Unit 2	40
3.3.3 Unit 3	41
3.3.4 Unit 4	46
3.3.5 Mt. Barker Quartzite	47
3.3.5.1 Stratigraphic position of the Mt. Barker Quartzite	50
3.3.6 Comparison with the Marino Group Stratotype	50
3.4 Normanville Group	51
3.5 Kanmantoo Group	52
3.5.1 Carrickalinga Head Formation	52
3.5.2 Backstairs Passage Formation	53
3.5.3 Talisker Calc-siltstone Equivalent	56
3.5.4 Tapanappa Formation	58
3.6 Conclusions	59
4. BIRDWOOD-BRUKUNGA AREA	60
4.1 Introduction	60
4.2 Precambrian	60
4.2.1 Torrens Group	60
4.2.1.1 Stoneyfell Quartzite	60
4.2.1.2 Saddleworth Formation	61
4.2.2 Sturt Group	63
4.2.2.1 Belair Sub-group	63
4.2.2.2 Tapley Hill Formation	64
4.2.2.3 Brighton Limestone	65
4.2.3 Marino Group	65
4.3 Cambrian	67
4.3.1 Carrickalinga Head Formation	68
4.3.2 Backstairs Passage Formation	70
4.4 Structure	73
4.5 Conclusions	74

CONTENTS (cont'd)

	<u>Page</u>
5. NATURE OF THE PRECAMBRIAN-KANMANTOO GROUP BOUNDARY	75
5.1 A comparison with previous work advocating an unconformity	77
 <u>PART II FOLDING AND METAMORPHISM IN THE NAIRNE-MT. BARKER CREEK AREA</u>	
A: FOLDING	83
B: METAMORPHISM	86
1. INTRODUCTION	86
2. MINERAL ASSEMBLAGES AND INTERPRETATION OF TEXTURES	88
2.1 Metasiltstones	89
2.2 Metasandstones	92
2.3 Metashales	95
2.3.1 The less alluminous metashales	95
2.3.2 Peraluminous metashales	96
2.3.2.1 Phase rule considerations	97
2.3.2.2 Origin of andalusite and staurolite	99
2.3.2.3 The sillimanite problem	100
2.3.2.4 Textures in peraluminous schists	105
2.3.2.4.1 General	105
2.3.2.4.2 Textures involving andalusite and staurolite	106
2.3.2.4.3 Pressure shadows	110
2.3.2.4.4 Textures involving garnet	112
2.3.2.4.5 Textures related to the formation of fibrolite	113
2.3.2.4.5.1 Polymorphic inversion	113
2.3.2.4.5.2 The association of fibro- lite, biotite and quartz	114
2.3.2.4.5.3 The role of muscovite	117
2.3.2.4.5.4 Conclusions	122
2.3.2.4.6 Staurolite-fibrolite relations	122
2.3.2.4.7 Post-F ₃ features	124
2.4 Calc-silicates	124
2.4.1 Group one	125
2.4.2 Group two	127
2.4.3 Other assemblages	128
2.5 Marbles	129
2.6 Meta-Calcsiltstones and Calcshales	130
2.7 Quartz-Biotite Segregations	132
2.8 Basic Dykes (Meta-Dolerites)	135

CONTENTS (cont'd)

	<u>Page</u>
4. CHEMICAL COMPARISON OF TYPE MARINO GROUP SEDIMENTS AND THEIR METAMORPHOSED EQUIVALENTS.	175
5. SUMMARY AND CONCLUSIONS	177
PART III <u>CONCLUSIONS</u>	180
TABLES A - 0	
Figure 1	Preceding page 1
APPENDIX I. DESCRIPTION OF THE SEQUENCE ALONG PART OF MT. BARKER CREEK.	
APPENDIX II. STRUCTURAL MAPS OF THE MOUNT LOFTY RANGES IN THE VICINITY OF THE STUDY AREA (after Fleming, 1971).	
APPENDIX III. AFM PLOTS OF ROCKS IN THE DAWESLEY-KANMANTOO AREA (after Fleming, 1971).	
APPENDIX IV. SUMMARY OF TEXTURES RELATED TO THE FORMATION OF FIBROLITE (after Fleming, 1971).	
APPENDIX V. MAGNETIC SURVEY OVER METADOLERITE DYKES	

REFERENCES

Volume 2

Figures 2 - 35

Plates 1 - 46

Maps 1 and 2

SUMMARY

The metamorphosed sedimentary sequence of the Precambrian Adelaide Supergroup in the eastern Mt. Lofty Ranges closely resembles its lower grade stratotype in the western Mt. Lofty Ranges. Although rocks have been metamorphosed from biotite to high andalusite grade, the nature of the original succession can still be deduced. Stratigraphic thicknesses in the eastern and western sequences differ, however. The thickness of the Torrens Group metasediments in the eastern sequence above the Stoneyfell Quartzite equivalent is over four times that found in its type area. In contrast, the overlying Sturt Group is less than half the thickness of the stratotype whilst the Marino Group is only slightly thinner in the eastern sequence.

In the region between Birdwood and Mt. Barker Creek, the Lower Cambrian Kanmantoo Group is in fault contact with the Adelaide Supergroup, the lower levels of the basal unit of the Kanmantoo Group (the Carrickalinga Head Formation) being absent. A conformable succession of Kanmantoo Group strata, closely resembling the lithologies in the type area on the south coast of Fleurieu Peninsula, occurs to the east of this contact. Evidence for a fault contact disproves earlier interpretations that the Kanmantoo Group unconformably overlies older strata in parts of this region and confirms the existence of the Nairne Fault. Furthermore, it is doubtful whether the Kanmantoo Group unconformably overlies older strata elsewhere in the eastern Mt. Lofty Ranges. Where there is a break in the normal Kanmantoo Group succession (which exhibits a remarkable constancy of facies), faulting is probably the cause.

A well developed penetrative schistosity (S_2) occurs throughout the Nairne-Mt. Barker Creek area, being related to a deformation phase F_2 which produced tight asymmetric folds with easterly-dipping axial planes (paralleled by S_2) during the Early Palaeozoic Delemarian Orogeny. An earlier deformation (F_1) with accompanying metamorphism, earlier than generally recog-

nized in the Mt. Lofty Ranges is evident in the schists. Metadolerite dykes in the area were probably emplaced pre-S₂ to early syn-S₂.

Petrological examination of the metasediments in the Nairne-Mt. Barker Creek area revealed that critical minerals present in metashales of appropriate bulk composition are andalusite, staurolite and almandine whereas cordierite is absent. The origin of andalusite and staurolite is unresolved. Fibrolite ([±] minor coarse sillimanite) is present in all andalusite-bearing rocks. The sillimanite problem is examined through the well developed textures in peraluminous schists.

Green hornblende, diopside and scapolite occur in calc-silicates. Green hornblende, high-An plagioclase and minor epidote are present in the metadolerite dykes.

P-T conditions at the peak of metamorphism (based on mineral assemblages and metamorphic textures) were probably around 3.5 to 3.75 kb and 500 to 550°C (close to the andalusite-sillimanite phase boundary and near the Al₂SiO₅ triple-point). Temperatures of metamorphism deduced from the garnet-biotite geothermometer and more generally from muscovite compositions are compatible with this range. Fibrolite probably formed just within the upper limits of the andalusite stability field. It is uncertain, however, if fibrolite formed as a stable mineral under these P-T conditions or whether it formed metastably, perhaps as a result of rapid reactions induced by sudden temperature increases.

ACKNOWLEDGEMENTS

The author is indebted to Dr. B. Daily and Dr. R.L. Oliver for their supervision of this project and their invaluable criticisms of the first draft of the thesis. Special thanks to Dr. S.K. Sen who most willingly gave his time to read a portion of the thesis, and offered most constructive criticisms. Thanks go also to Dr. K. Turnbull for his guidance in the analytical work, to Miss A.M. Swan for helpful suggestions with regard to the drafting of maps and diagrams, and to Mr. R. Barrett for his dedication in reproducing my photographs. The ESSO Scholarship which covered part of the study period was most gratefully received. The use of the electron probe equipment at the Department of Earth Sciences, Melbourne University under the initial guidance of Dr. D. Sewell is gratefully acknowledged. Finally, the writer would like to thank Mrs. J. Brumby for her fastidiousness in typing the thesis.