Investigating the metamorphic evolution of reworked terrains

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This thesis is submitted in fulfilment of the requirements for the degree of Doctor of Philosophy in the Faculty of Science, University of Adelaide

December 2010
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Abstract

This project is an integrated monazite and zircon LA-ICPMS geochronology and metamorphic phase equilibria study of regions which have experienced multiple metamorphic events. The aim of using this combination of techniques is to construct $P-T-t$ evolution histories of both older and younger overprinting events in a terrane. The data presented in this thesis can be used as constraints for models of supercontinent evolution.

Two different regions are targeted in this study. The first region is the Palaeo- to Mesoproterozoic rocks of the Gawler Craton. These rocks have experienced extensive granulite facies metamorphism at $c.$ 1690 - 1665 and 1590 Ma and are poorly exposed. An understanding of the tectonothermal history of this region is important for resolving the evolution of the supercontinent Columbia, which was proposed to have amalgamated from 2.1-1.8 Ga and broken up from 1.6-1.2 Ga. Based on arguments that link the formation of UHT belts to supercontinental cycles, UHT granulite facies rocks from the Gawler Craton indicate that Columbia amalgamation may still have been ongoing at $c.$ 1700 to 1500 Ma or breakup started earlier at $c.$ 1700 Ma.

The second region investigated in this study is the Neoproterozoic rocks of the north Atlantic region. The metapelitic rocks of the Moine Supergroup in Scotland and equivalents on the Shetland Islands have been found to have experienced several amphibolite facies metamorphic events at $c.$ 930 Ma (Shetland), 830 Ma, 780 Ma and 725 Ma (Scotland). All of these regions have been extensively reworked by the Ordovician to Silurian Caledonian orogeny such that all the preserved structures and in many cases the metamorphic mineral assemblages are Caledonian in age. Fortunately, large garnet porphyroblasts have preserved the older events and in situ geochronology allows us to target monazite grains within these garnets providing the age of the older metamorphic events. The garnets can also be used to determine the $P-T$ evolution of each event. The results of this study provide age and $P-T$ constraints for each of the Neoproterozoic events. The data suggest that these events were part of an accretionary orogenic system termed the Valhalla orogeny which existed on a margin of the supercontinent Rodinia. As an additional result of this study, the $P-T$ evolution of the Grampian event ($c.$ 460 Ma) of the Caledonian Orogeny in both Shetland and Scotland has been well constrained.
Declaration

I, Kathryn Cutts, certify that this work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution, and to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

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Kathryn A. Cutts
Publications and Selected Conference Abstracts

Journal Articles


Selected Conference Abstracts


Statement of authorship

The research described in this thesis has been published or submitted for publication in scientific journals. The publication details of each journal article are listed at the beginning of each chapter and include the names of all co-authors involved in their production. The contribution of each author in the conceptualisation, realisation and documentation of these publications is outlined below.

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I certify that the above statement is accurate.

Signed: Date:

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Chapters 2, 3, 6-9: Conceptualisation, fieldwork assistance, guidance with data interpretation, manuscript review.
I certify that the above statement is accurate and give permission for the relevant manuscripts to be included in this thesis.

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Acknowledgements

A large amount of people made my PhD an enjoyable and rewarding experience. It will be impossible to thank them all but I will endeavor to cover the main ones. First of all I would like to thank my supervisors: Martin Hand, Dave Kelsey, Rob Strachan and Karin Barovich. The huge amount of work I conducted and the high quality of it (if I do say so myself) was only possible because of support and advice from them. In particular, I thank Martin for encouraging my ideas, putting me in situations that helped me to grow as an individual and as a young researcher, and for saying, ‘why don’t you do this too Kathryn, it won’t take too long’. If I become half as good a scientist as Martin is, I will be pretty pleased with myself. I would like to thank Dave for putting up with my endless questions with infinite patience and for the huge amount of help he gave me in putting everything together.

I would like to thank Rob for assistance in all things to do with Scotland from field work, to beer and whisky selection. Rob has an encyclopedic knowledge of Scottish geology which is extremely useful and is also probably the nicest person I have ever met.

Thanks to Karin for being there when I needed a chat and for reading through abstracts for me.

I would also like to thank Angus Netting, Ben Wade and John Terlet at Adelaide Microscopy for the huge amount of assistance they gave me with the collection of data. I think there were several weeks during my PhD where I actually spent more time at Adelaide Microscopy than at home!

My PhD was made a much more enjoyable experience by Katie Howard, who started her PhD the same time as I started mine. It was awesome having someone to share the experience with, whether it was work or procrastination. The friends I had before and those I made during my PhD also deserve thanks. In particular the Cerg tank crew: Ailsa, Rachael, Diana, Yee, Tom and Spuz; and also my Hamstervan compatriots: Hilary Coleman and Christine Sealing.

Most importantly I would like to thank my family for putting up with me. Thanks to my brother Ryan for the birthday text messages (wherever I happened to be) and my sister Erin for being awesome (if it wasn’t for you I never would have known what a phage was). I dedicate this thesis to my mum. She has done a brilliant job of bringing up my brother, my sister and me completely on her own. I cannot appreciate how much of a difficult and stressful position this must have been and I hope that I prove to be as strong a person as you are.

‘What’s comin’ will come an’ we’ll meet it when it does’ – J.K. Rowling