IAPETUS2
Doctoral Training Partnership

General Information	
Project Title:	
The Shackleton Range of East Antarctica: unravelling a complex geological history via an integrated geochronological, geochemical and geophysical approach	
Lead Institution:	BAS
Department / School / Institute	Geology & Geophysics
CASE Partner Organisations [OPTIONAL] Leave blank if not applicable	CASP, West Building, Madingley Road, Cambridge, CB3 0UD.
End-user Collaborations [OPTIONAL] Leave blank if not applicable	

Project Team The first supervisor should be from the lead institution. The Second Supervisor should be from a second IAPETUS2 organisation	
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CASE Partners If applicable, add any CASE Partners here	
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End-user Collaborations If applicable, add any End-user Collaborations here	
Name [optional]	
Organisation	
Email	
Biography URL	
In Collaboration with Add any non-IAPETUS University collaboration partners here. [OPTIONAL] Leave blank if not applicable	
Name	
Organisation	
Email	
Biography URL	

Project Details The information provided here will be used to create the project advertisement online and in pdf format. The overall project description should not normally be longer than 1,200 words in total, including references. Please note that the boxes below are plain-text only, formatting & links will be stripped from the text.	
Keywords Add up to 5 comma separated keywords that best describe the project.	Antarctica, crustal evolution, geochronology, tectonics, geophysics
Overview	

The proposed project is a multidisciplinary geochemical, geochronological and geophysical study on rock collections and aeromagnetic data from the remote Shackleton Range of East Antarctica. This detailed analysis will substantially improve the geological understanding of the region and allow us to evaluate its role in the assembly of Antarctica.

A multi-national effort to determine the geological evolution of the Shackleton Range in East Antarctica was conducted over 25 years ago during two summer expeditions involving several teams of European geologists (Euroshack Expedition). The result was impressive: a unified geology map and an exhaustive collection of rocks and fossils from across the mountainous region, and an analytical programme highlighting its complex history (Tessensohn and Thomson, 1999).

Geological investigations since the Euroshack expedition have been limited, with the most comprehensive studies carried out by Will et al. (2009, 2010). This work has highlighted that the Shackleton Range is situated at a geological crossroads: traces of former mountain building events, many responsible for the suturing of crustal units and the assembly of the East Antarctic continent, either cross the Range or trend toward it (Figure) and have demonstrated that it and East Antarctica form key components in global paleogeographic reconstructions (Liu et al., 2018).

Remote sensing and geophysical surveys conducted since the Euroshack expedition have highlighted evidence that the tectonic history for the Range is incomplete. Some areas have distinct magnetic responses yet rock exposures from these regions are largely unstudied, whereas other areas indicate a greater complexity than current tectonic models suggest. Importantly these unique geophysical signatures apparently continue into the interior of East Antarctic, indicating that an improved geophysical understanding of the Shackleton Range would help underpin a more comprehensive tectonic framework for East Antarctica within the context of supercontinent reconstruction.

The student will use the 1990's rock collection of the geophysically distinctive units held at the British Antarctic Survey. Using the state of the art geochemistry and geochronology facilities at St Andrews University, a diverse set of isotopic compositions will be measured on grains, portions of grains for a variety of different minerals (e.g. U-Pb and Hf isotopes in zircon) and supplemented by whole-rock major and trace elements geochemistry. The student will use these data to update the geological evolution of the Shackleton Range, focussing on constraining the age and conditions of metamorphism and magmatism associated with the former mountain building events. The student will develop a high level of expertise in the use of mass spectrometry for isotopic and elemental analysis. This work will be carried out in close collaboration with the supervisors Gardiner (St Andrews), Riley (BAS) and Flowerdew (CASP) and the student will be embedded in research teams at both BAS (Cambridge) and St Andrews University.

The improved understanding of how the various geophysical signatures developed and what they represent, contextualised into a comprehensive geological and tectonic history for East Antarctica and formerly adjacent regions, by the extrapolation of the geophysical anomalies away from the Range. In close collaboration with Ferraccioli (BAS), the student will be provided with enhanced training in the processing and interpretation of airborne geophysical data to evaluate the broader tectonic setting of the Shackleton Range. To assist with this process, comparative fieldwork in either the Gawler carton (Australia) or Kalahari craton (southern Africa) (Figure), where sample collections are less comprehensive than for the Shackleton Range.

Overall the proposed project will determine a geological and tectono-metamorphic history of the Shackleton Range and evaluate its place in the assembly of East Antarctica.

Methodology

Analytical work will be carried out at the University of St Andrews Isotope Geochemistry Laboratory (StAIG), which is equipped with a variety of solution-based and laser ablation MC-ICP-MS facilities to undertake *in-situ* trace element and isotopic analyses of mineral phases, including zircon U-Pb geochronology and Hf isotope analysis, as well as whole-rock geochemical and isotopic analysis. A range of other facilities including a new electron microprobe and SEM are also available.
CASE partner CASP (Flowerdew) will provide guidance in aspects of geochronology and geochemistry and training in mineral separation techniques.

Timeline - Year 1

Literature review; Initial selection of geological samples from the BAS archive collection and close evaluation of field reports, maps and notebooks as well as geophysical data. Sample preparation and initial geochemical and isotopic work at St Andrews.

Timeline - Year 2

Lab-based at St Andrews, to collect full geochemical and geochronological datasets. Geophysical data processing and interpretation. CASP internship.

Timeline - Year 3

Complete data collection by second half of reporting year. Manuscript writing. Present work at Antarctic Earth Sciences or other overseas conference.

Timeline - Year 3.5 (6 months only)

Complete thesis. 2/3 further manuscripts. Present work at EGU, AGU.

Training & Skills

The student will join the Planetary Geodynamics Research Group at the University of St Andrews. Full training in sample preparation and analytical geochemistry and isotope analysis will be provided, as well as data reduction and interpretation. It is anticipated a number of publications will arise from this study, and training in scientific manuscript preparation will be given.

Training and development in the processing and interpretation of geophysical data will be provided at BAS.
Fieldwork training will be supported by BAS and St Andrews during the field campaign in Australia or southern Africa.

References & Further Reading

Liu et al. 2018. First Precambrian palaeomagnetic data from the Mawson Craton (East Antarctica) and tectonic implications. Nature Scientific Reports, 8, 16403.

Riley, T.R. et al., 2020. U-Pb zircon geochronology from Haag Nunataks, Coats Land and Shackleton Range (Antarctica): constraining the extent of juvenile Late Mesoproterozoic arc terranes. Precambrian Research, 340, 105646.

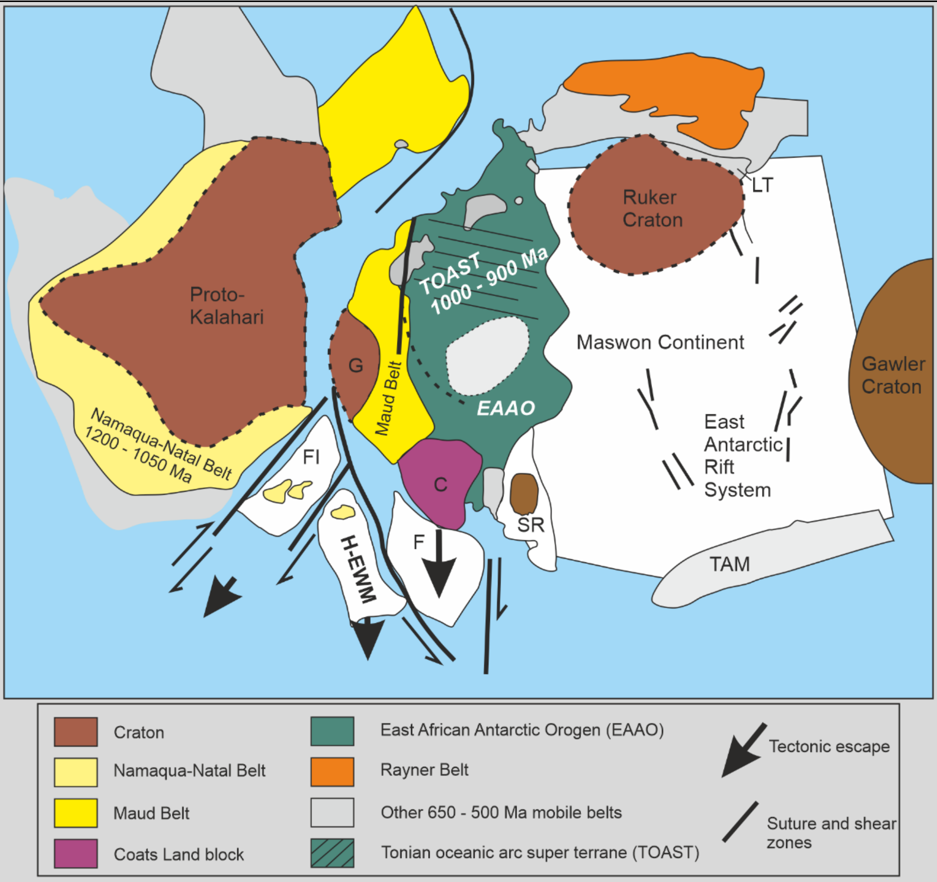
Tessensohn, F.; Thomson, M.R.A., 1999 The EUROSHACK Project: a brief outline. Terra Antarctica, 6, 175-182.

Will, T.M., et al. 2009. Palaeoproterozoic to Palaeozoic magmatic and metamorphic events in the Shackleton Range, East Antarctica: Constraints from zircon and monazite dating, and implications for the amalgamation of Gondwana. Precambrian Research 172, 25-45.

Will, T.M. et al.., 2010. Geochemical and isotopic constraints on the tectonic and crustal evolution of the Shackleton Range, East Antarctica, and correlation with other Gondwana crustal segments. Precambrian Research 180, 85-112.

Further Information

Add contact information including name, email and phone numbers.



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Gondwana reconstruction at approximately 500 Ma illustrating the location of the key continental units and the extent of the East African Antarctic Orogen (EAAO) and the Tonian oceanic arc superterrane (TOAST). C: Coats Land; F: Filchner block; G: Grunehogna; LT: Lambert terrane; SR: Shackleton Range; TAM: Transantarctic Mountains; Z: Zambesi belt. H-EWM: Haag-Ellsworth Whitmore Mountains block; FI: Falkland Islands (Riley et al., 2020). During the Archean, East Antarctica originated with a small cratonic nucleus in the Terre Adelie region, associated with the Gawler Craton of Australia. East Antarctica grew during the Paleoproterozoic by incorporating Precambrian portions of Australia and Laurentia. This was succeeded by the Neoproterozoic supercontinent, Rodinia and the Palaeozoic supercontinent, Gondwana.