National Argon Map: an AuScope initiative

Data Acquisition Project Proposal

Project Proponent

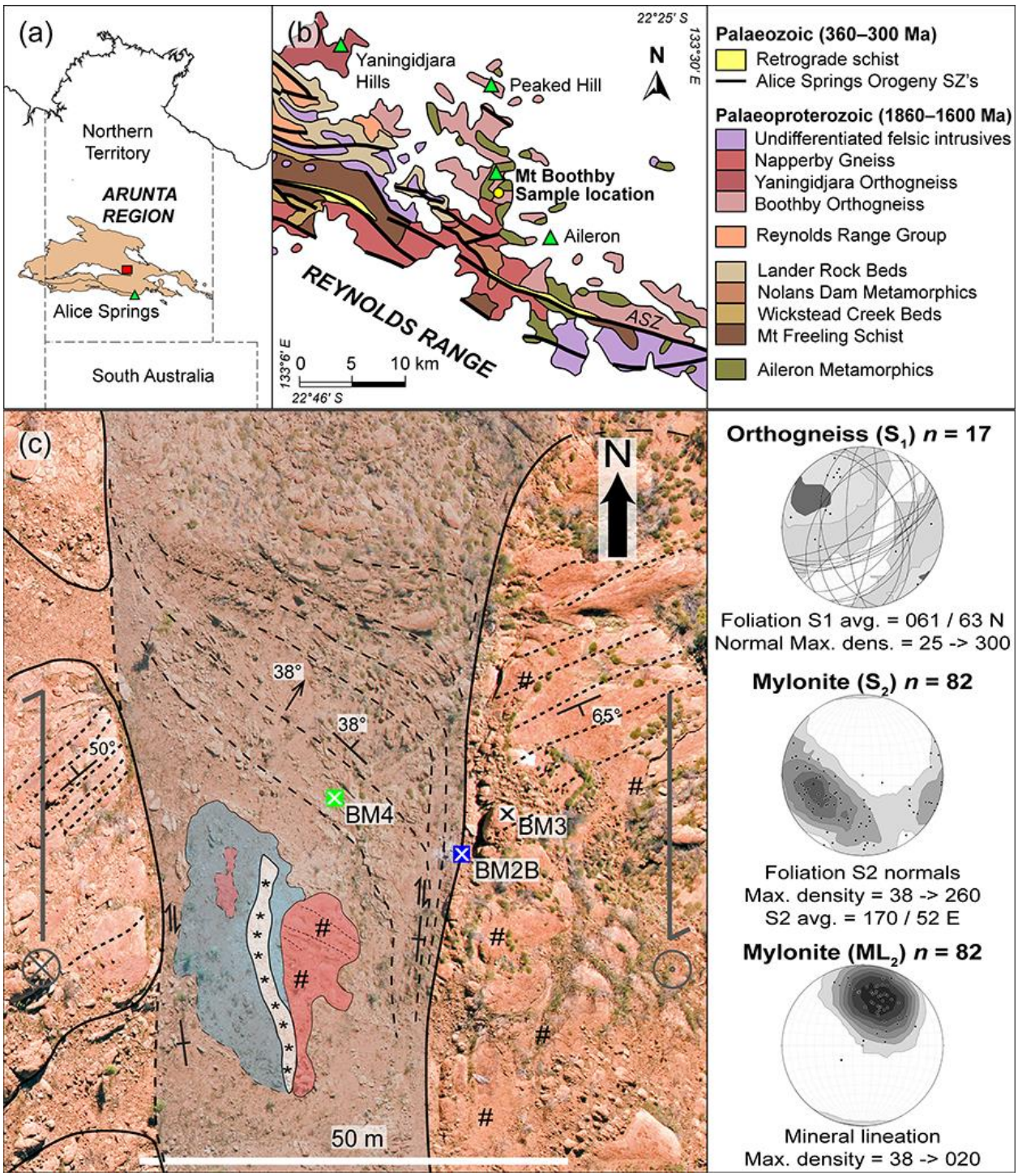
Name: Alexander Martin Prent
Affiliation and position: John de Laeter Centre, Research Associate
Collaborators: Bryant Ware, Tom Raimondo, Chris Kirkland, Fred Jourdan
Project Title: Quadruple dating of a shear zone, comparing techniques and analytical efficiencies
Geographic Region: Reynolds Range, central Australia
Geological Province or Tectonic Unit: Mt Boothby Orthogneiss and mylonite

Brief Project Description:
Targeted drilling of biotite, muscovite and K-feldspar is proposed to approach 'in situ' $^{40}Ar/^{39}Ar$ dating of a shear zone and its wall rock in central Australia. The new $^{40}Ar/^{39}Ar$ information of the shear zone activity and alteration will be compared with existing in situ apatite and monazite U-Pb analyses (Prent et al. in review with Lithos) from the same shear zone at Mt Boothby, the Reynolds Range. Based on these results the shear zone was interpreted to have formed during the Chewings Orogeny (c. 1550 Ma) and subsequently reactivated during the Alice Springs Orogeny (c. 350 Ma). The $^{40}Ar/^{39}Ar$ analyses aim to provide more information on timing of the shear zone activity, its rate of cooling and the isotopic contrast between wall-rock and mylonite geochronometers. This approach will provide textural control on the analysed material which places it in the context of metamorphic processes.

With this study we aim to test if micro sampling of mica's for single grain $^{40}Ar/^{39}Ar$ analysis using the Argus VI can approach an 'in situ like' contextualization for Ar-dating. The goal is to drill out specific locations from thin sections that have been previously interpreted through petrographical study and constrained via other dating techniques (in situ apatite and monazite U-Pb analyses) for single grain $^{40}Ar/^{39}Ar$ analysis. This novel approach utilises the analytical sensitivity and precision of the Argus VI. Due to low sample volumes and the fine-scale ages and textural difference that will be targeted, such an approach is only possible with the significantly improved analytical precision of a multi-collector noble gas mass spectrometer.

The shear zone and wall rock of interest for this research are not much studied and are thought to be of a different nature to the regional geological context, for example, the orientation of the shear zone is at high angle to the regional structural grain. The area has seen some activity in terms of $^{40}Ar/^{39}Ar$ dating but with complications of argon reservoir contamination, a good study with the constraints of apatite ages will contribute to our understanding of the area and geological significance. Rb-Sr dating has been done on metapelites from Mt Boothby by Cartwright et al. (1999), Read (2002, PhD Thesis) has analysed (with $^{40}Ar/^{39}Ar$) a variety of major shear zone structures 30 km south of the proposed locality. All ages obtained are within the period of the Alice Springs Orogeny.

A detailed petrographical study combined with U-Pb dating of monazite and apatite on the samples selected for $^{40}Ar/^{39}Ar$ analyses (Figure 1; BM3 and BM4) is currently under review. $^{40}Ar/^{39}Ar$ analyses would be a great addition to this work to evaluate the monazite and apatite U-Pb ages precision and the techniques can be compared when applied to dating shear zones. This can also form the basis of a cost benefit analysis of using the various techniques (U/Pb LA-MC-ICP-MS on accessory minerals versus $^{40}Ar/^{39}Ar$ ARGUS VI on single grain mica) for a given hypothesis. Adding Ar-analyses to the equation will help our understanding of timing of shearing, cooling, fluid flow, fluid fluxing and elemental transport/deposition into wall rock that is potentially explaining the Nolans Bore mineralisation close by.



Approximate number of samples proposed for $^{40}Ar/^{39}Ar$ analyses:
5

Lithologies and minerals proposed for $^{40}Ar/^{39}Ar$ analyses:
Orthogneiss 2 aliquots = 2 (biotite C- and S-fabrics)
Mylonite 3 aliquots = 3 (biotite, muscovite, recrystallised K-feldspar)

Do you have a preferred ^{40}Ar-^{39}Ar laboratory? (ANU, Curtin, UQ, UMelb):
The Curtin University, Western Australian Argon Isotope Facility of the John de Laeter Centre for Isotope Research is preferred to be able to work closely with Fred Jourdan in the process of analysis and writing of the manuscript.

Guidelines and Criteria

Project Proposals for funding support as part of the AuScope National Argon Map initiative will be assessed on the following criteria.

Australian: Samples must come from Australia (this may include Australian offshore regions)

Non-confidential: $^{40}Ar/^{39}Ar$ data must be made publicly-available (ie non-confidential)

Impact: to what extent new $^{40}Ar/^{39}Ar$ data from the proposed samples will contribute to geographic data coverage, or address key geological questions

Feasibility: whether the nature of the work is tractable via $^{40}Ar/^{39}Ar$ geochronology and the scale of the proposal is realistic within the time frame of the National Argon Map initiative (January 2020 – June 2021)?

Appropriate sample material: whether the proposed samples are (i) appropriate for $^{40}Ar/^{39}Ar$ analyses, and (ii) available within the time-frames of the National Argon Map initiative?

Oversight Panel

Dr Geoff Fraser, Geoscience Australia
Professor Zheng-Xiang Li,
Dr Anthony Reid, Geological Survey of South Australia
Peter Rea, MIM/Glencore
Dr Catherine Spaggiari, Geological Survey of Western Australia
Dr David Giles, MinEx CRC
Dr Marnie Forster (observer role as Project Coordinator)

Expectations

AuScope funding will cover the costs of sample irradiation and isotopic analyses.

Project Proponents will be responsible for:

- Provision of appropriate sample material. This includes mineral separation, which can be arranged at the relevant $^{40}Ar/^{39}Ar$ laboratories (in many cases this is preferred), but costs of mineral separation will be borne by the project proponent. The relevant laboratory reserves the right not to analyse material if it is deemed unsuitable for $^{40}Ar/^{39}Ar$ analysis.
- Provision of appropriate sample information. A sample submission template will be provided. Information in these sample submission sheets will form the basis of data delivery/publication, and the oversight committee or relevant laboratory reserves the right not to proceed with analyses unless and until appropriate sample details are provided. This includes description and geological context for each sample.
- Leading the preparation of reports and/or publications to deliver $^{40}Ar/^{39}Ar$ results into the public domain within the duration of the National Argon Map initiative (January 2020 – June 2021).
- Project Proponents will be expected to communicate directly with the relevant $^{40}Ar/^{39}Ar$ laboratory once a project has been accepted by the Oversight Committee, in order to clarify project expectations, arrange sample delivery, discuss results, collaborate on reporting and data delivery etc.

Participating Ar Laboratories will be responsible for:

- Providing advice to project proponents regarding suitable sample material and feasibility of proposed work
- Irradiation of sample material
- $^{40}Ar/^{39}Ar$ isotopic analyses
- Delivery of data tables, and analytical metadata to project proponents

Queries regarding possible projects as part of the National Argon Map initiative can be directed to Marnie Forster (Marnie.Forster@anu.edu.au) or Geoff Fraser (Geoff.Fraser@ga.gov.au)