National Argon Map: an AuScope initiative

Data Acquisition Project Proposal

This form should be completed and returned to Geoff Fraser (Geoff.Fraser@ga.gov.au) for consideration by the National Argon Map Oversight Panel

Project Proponent

Name: Barry Reno
Affiliation and position: NTGS Senior Geologist
Collaborators: Eloise Beyer, Anett Weisheit, Jo Whelan
Project Title: Tectonic and Thermal Events in the Northeastern Aileron Province
Geographic Region: Arunta Region
Geological Province or Tectonic Unit: Aileron Province

Brief Project Description:

Approximately 500 word maximum. Include what geological process/problem will be addressed, and how new $^{40}Ar/^{39}Ar$ data from the specific samples to be dated will contribute. Please include reference to pre-existing geochronological constraints, if any exist. Please include a simple location map showing the spatial distribution of samples in their geological context (with scale).

The nature of the Palaeozoic Larapinta Event and Alice Springs Orogeny, and the degree to which they affected the Palaeoproterozoic Aileron Province (**Figure 1a**), is of fundamental importance to understanding the tectonic framework of the southern margin of the North Australian Craton. Previous studies (eg Scrimgeour and Raith 2001a, b), have indicated the Alice Springs Orogeny had a strong effect over a geographically large area of the Aileron Province, including the development of terrain-scale shear zones, and an extensive area of ductile deformation and metamorphism.

Recent studies (eg Reno *et al* 2017, Weisheit *et al* 2017, Weisheit *et al* 2019, Reno *et al* 2020a, b; **Figure 1b**) of a series of structural domains bound by the Delny and Entire Point shear zones in the northeastern Aileron Province indicate that the metamorphism and ductile deformation in some of these shear zones and terrains is actually Palaeoproterozoic in age, and may have only experienced minor brittle reactivation during the Palaeozoic.

An argon thermochronologic study of the Delny and Entire Point shear zones by Scrimgeour and Raith (2001b) interpreted these shear zones to have formed during the Palaeozoic, and Scrimgeour and Raith (2001a) interpreted rocks in one of the tectonic domains, the Kanandra Domain, to have been extensively reworked at amphibolite facies during the Palaeozoic. Conversely, Reno *et al* (2017), Weisheit *et al* (2017), Weisheit *et al* (2019), and Reno *et al* (2020a, b) presented in situ LA–ICP–MS U–Pb and EPMA (U-Th)–Pb monazite ages indicating the Delny and Entire Point shear zones were mainly active during the Palaeoproterozoic, and only record minor brittle Palaeozoic reactivation. Furthermore, Reno *et al* (2017, 2020a) interpreted the Kanandra Domain to only have a Palaeo–Mesoproterozoic deformational and metamorphic history.

Scrimgeour and Raith (2001) and Reno and Fraser (in prep) argon data indicate that the shear zone system and some domains cooled below ~500°C at ca 1.70–1.65 Ga, and that the Delny Shear Zone was reheated above ~400°C and locally reworked during the Palaeozoic by fluid being driven off the Irindina Province during high-grade metamorphism.

There is currently no argon data from within the Kanandra Domain; this forms a key gap in the chronologic dataset for the northeastern Aileron Province. Fully constraining the thermal history of the Kanandra Domain will allow for an assessment of the effects of the Larapinta Event and Alice Springs Orogeny on this part of the Aileron Province, including the degree of thermal overprint or reworking. Accordingly, we propose to collect argon data from hornblende from a sample of Carmencita Metadolerite, and biotite from an adjacent sample of Kanandra Metamorphics that also has SHRIMP and LA–ICP–MS zircon and monazite age data (HU15BLR979 in Kositcin *et al* 2018, Reno *et al* 2018, Reno *et al* 2020a). With these data, we hope to constrain a temperature–time history for the Kanandra Domain, including the currently ambiguous Palaeozoic history.

Kositcin N, Reno BL and Beyer EE, 2018. Summary of results. Joint NTGS–GA geochronology project: Aileron Province, July 2015–June 2016. *Northern Territory Geological Survey, Record* 2018-005.

Reno BL, Beyer EE, Thompson JM and Meffre S, 2018. NTGS laser ablation ICP–MS zircon petrochronology project: Aileron Province, Jinka and Dneiper 1:100 000 mapsheets. *Northern Territory Geological Survey, Record* 2018-003.

Reno BL, Beyer EE and Weisheit A, in prep. Jinka, Northern Territory (First Edition). *1:100 000 geological map series, explanatory notes 6052*. Northern Territory Geological Survey, Darwin.

Reno BL and Fraser G, in prep. Summary of results. Joint NTGS–GA geochronology project: Constraining the cooling history of the Aileron Province through $^{40}Ar/^{39}Ar$ step-heating of hornblende, muscovite, and biotite, *Northern Territory Geological Survey, Record*.

Reno BL, Weisheit A, Beyer EE, McGloin MV and Kositcin N, 2017. Proterozoic tectonothermal evolution of the northeastern sector of the Aileron Province: in '*Annual Geoscience Exploration Seminar (AGES) Proceedings, Alice Springs, Northern Territory, 28–29 March 2017'.* Northern Territory Geological Survey, Darwin, 36–41.

Reno BL, Weisheit A, Beyer EE, Thompson J and Meffre S, 2020a. Summary of results. NTGS laser ablation ICP–MS in situ monazite petrochronology project: Constraining the chronologic history of the Delny and Entire Point shear zones, and the timing of metamorphism in the Aileron and Irindina provinces, HUCKITTA. *Northern Territory Geological Survey, Record*.

Reno BL, Weisheit A and Goemann K, 2020b. Summary of results. NTGS EPMA in situ monazite geochronology project: Constraining the chronologic history of the Aileron Province in the Delny Shear Zone, DNEIPER 1:100 000 map sheet. *Northern Territory Geological Survey, Record* 2020-004.

Scrimgeour IR and Raith, J, 2001a. High-grade reworking of Proterozoic granulites during Ordovician intraplate transpression, eastern Arunta Inlier, central Australia. *Geological Society, London, Special Publications* 184, 261–287.

Scrimgeour IR and Raith J, 2001b. Tectonic and thermal events in the Northeastern Arunta Province. *Northern Territory Geological Survey, Report* 12.

Weisheit A, Reno BL and Beyer EE, 2017, Proterozoic and Palaeozoic evolution of a crustal-scale shear zone system in the northeastern Aileron and Irindina provinces, central Australia: in 'SGTSG Denmark 2017 abstract volume'. *Geological Survey of Western Australia, Record* 2017/17.

Weisheit A, Reno BL and Beyer EE, 2019. Jervois Range Special, Northern Territory (First Edition). *1:100 000 geological map series, explanatory notes 6152 and part 6252*. Northern Territory Geological Survey, Darwin.

Approximate number of samples proposed for $^{40}Ar/^{39}Ar$ analyses: 2

Lithologies and minerals proposed for $^{40}Ar/^{39}Ar$ analyses:

1. Carmencita Metadolerite: mafic granulite – hornblende
2. Kanandra Metamorphics: migmatitic metamudstone gneiss – biotite

Do you have a preferred ^{40}Ar-^{39}Ar laboratory? (ANU, Curtin, UQ, UMelb):

If so, why you prefer this laboratory (e.g. student affiliation, ongoing relationship, sample type etc):

We are happy to send the samples to any of these laboratories, and would prefer to use the laboratory with the next available capacity.

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, Curtin University

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)

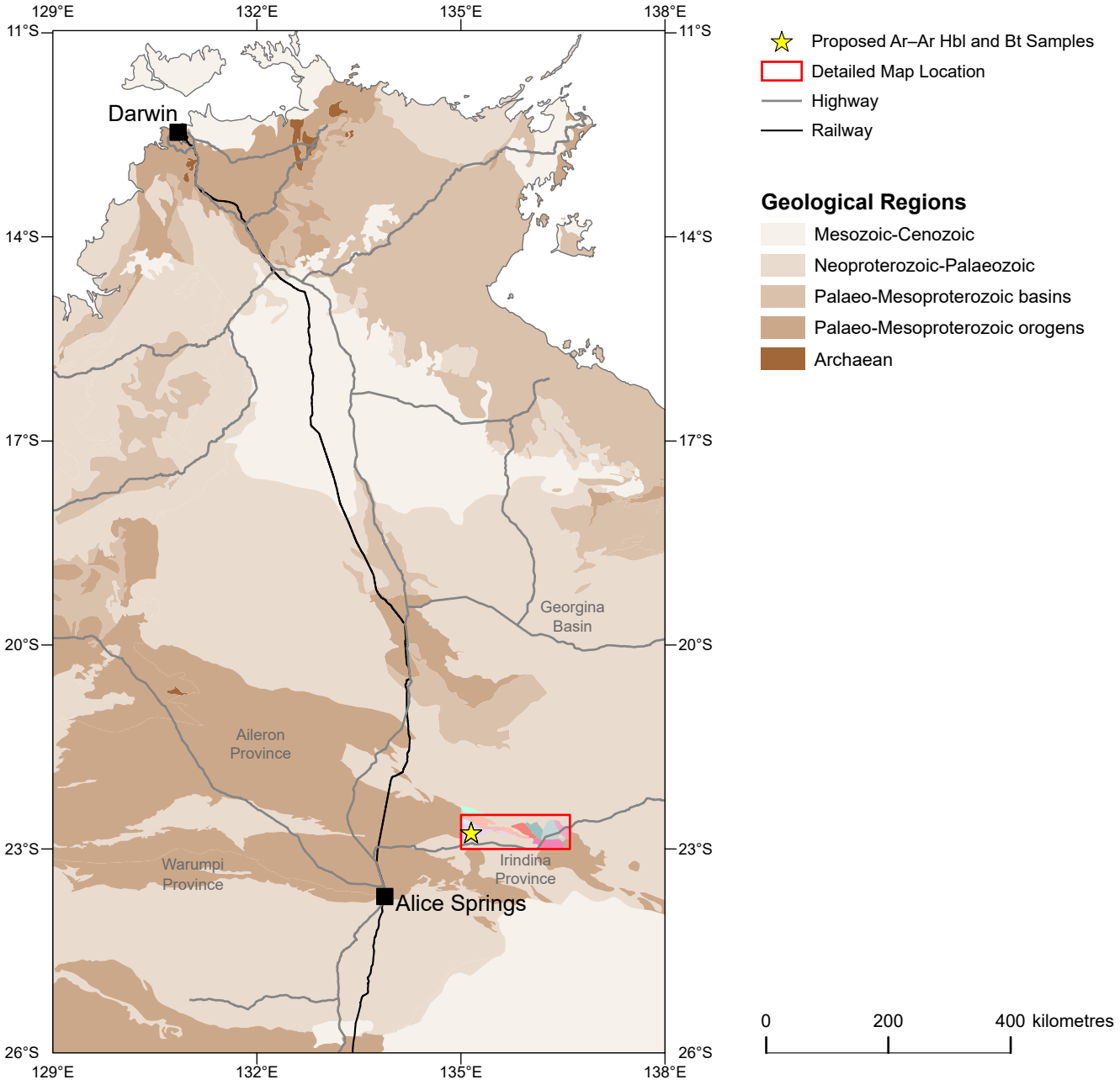

Figure 1a. Location of the proposed samples within the Northern Territory

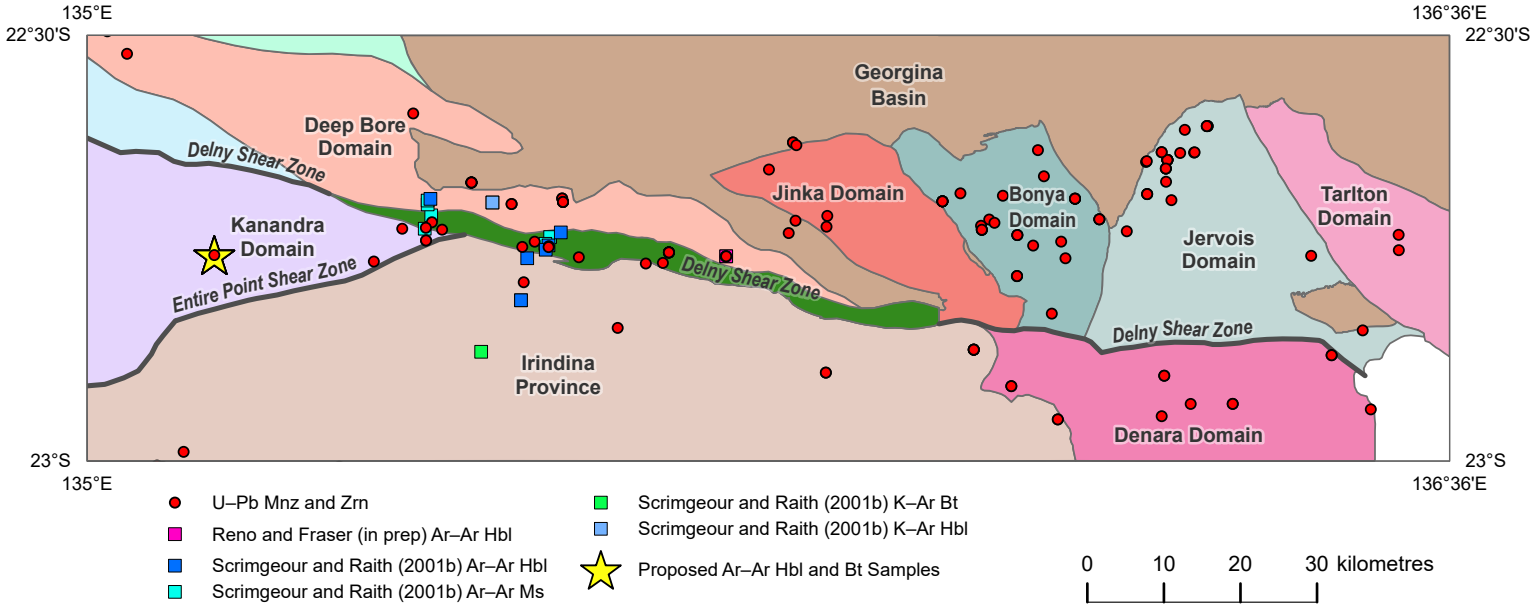

Figure 1b. Detailed map of the northeastern Aileron Province and adjacent Irindina Province and Georgina Basin, depicting the structural domains of the Aileron Province, the location of geochronologic data, and the site of the proposed samples. Modified from Reno *et al* 2017, Weisheit *et al* 2017, Weisheit *et al* 2019, Reno *et al* (2020a), and Reno *et al* (in prep).