

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: Anthony Reid
Affiliation and position: Senior Principal Geoscientist, Geological Survey of South Australia
Collaborators: Dr Marnie Forster
Project Title: Dating of mineralisation-related alteration at the Cairn Hill Mine, and regional thermal history of the northern Mt Woods Region, Gawler Craton
Geographic Region: Mt Woods Region
Geological Province or Tectonic Unit: Gawler Craton

Brief Project Description:

Approximately 500 word maximum. Include what geological process/problem will be addressed, and how new $^{40}\text{Ar}/^{39}\text{Ar}$ 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 which showing the spatial distribution of samples in their geological context (with scale).

The Cairn Hill Fe-Cu deposit is an example of magnetite-dominant iron oxide copper gold (IOCG) mineralisation in the Gawler Craton. Hematite-dominant IOCG deposits are well represented within the Olympic Cu-Au Province, including Olympic Dam, Prominent Hill and Carapateena (Skirrow et al. 2007; Skirrow 2009). Magnetite IOCG's are less common, with Cairn Hill the only deposit of economic viability in South Australia.

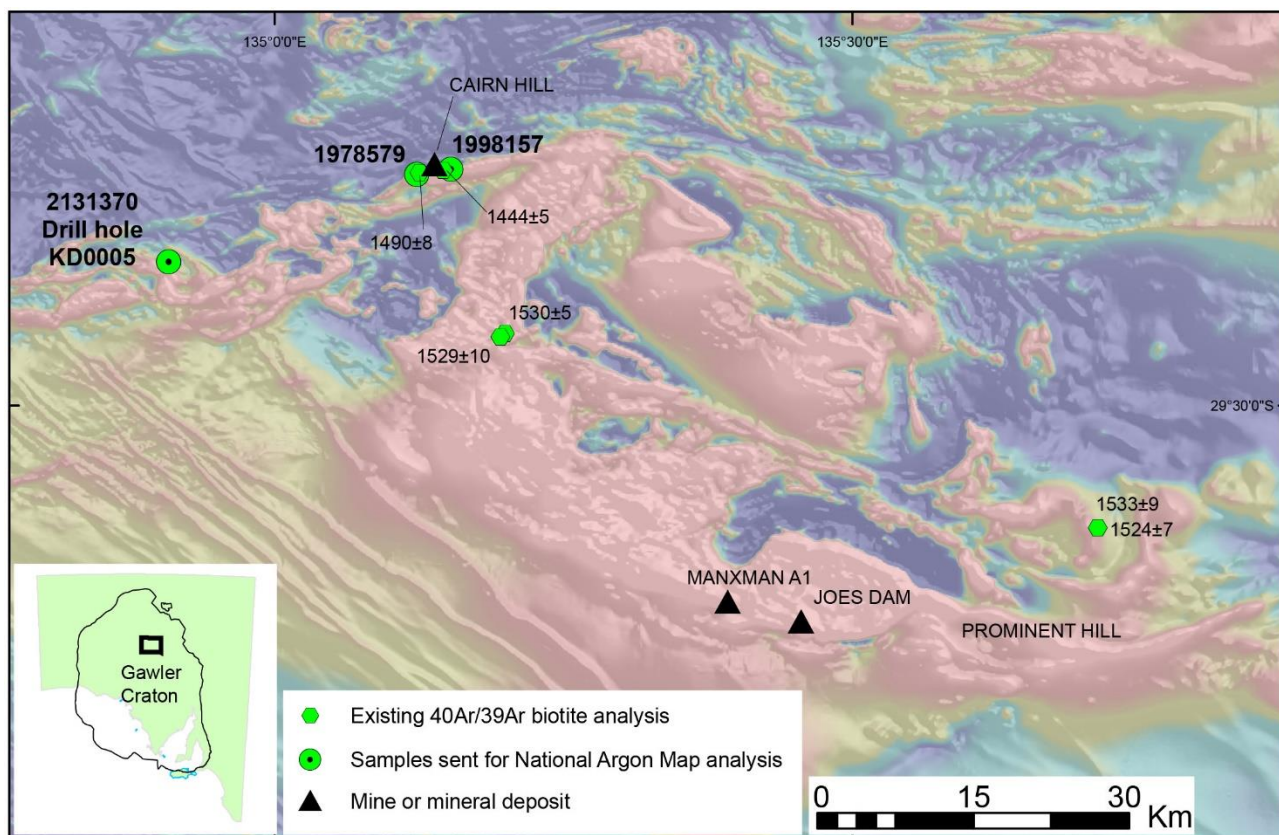
Previous work at Cairn Hill has dated two rock types by zircon U-Pb (Jagodzinski and Reid, 2015). The host monzogranite has a tectonic fabric defined by elongate quartz ribbons and the alignment of the minor biotite. This rock was emplaced at 1572 ± 6 Ma. A second sample of unmineralised and weakly deformed microgranite was emplaced at 1514 ± 8 Ma.

The mineralisation is magnetite-rich and is associated with apatite-amphibole-phlogopite alteration. A previous attempt to date the amphibole (hornblende) and phlogopite was made via laser ablation $^{40}\text{Ar}/^{39}\text{Ar}$ methods (Jagodzinski and Reid, 2015). However, due to rapid outgassing of both the hornblende and phlogopite, both age spectra is dominated by single steps, which yielded ages c. 1490 Ma and c. 1460 Ma respectively. The current proposal is to date the hornblende and phlogopite in the alteration mineralogy via furnace step heating methods to refine this age and our understanding of magnetite-rich IOCG mineral systems in the northern Gawler Craton.

In addition we also submit a second sample of biotite gneiss from drill hole KDD005. This sample is an example of the regional host rock in the vicinity of the Cairn Hill mine and will enable the further characterisation of the cooling history of the region that can be compared with the analysis of hornblende from the mineralisation itself.

These new samples compliment two samples of biotite analysed by Fraser et al. (2012) which are in the vicinity of the Cairn Hill mine, and yielded ages of 1490 ± 8 Ma (sample 2007371062, Biotite gneiss CD93 2 175.7–176.0m) and 1444 ± 5 Ma (sample 2007371063, Granitic gneiss, DD86EN33

85.1–85.3m). In addition, there are also four samples of biotite analysed by Forbes et al. (2012) from elsewhere in the Mt Woods region. These ages are older than the biotite dated by Fraser et al. (2012). This suggests that movement along some of the major shear zones in the region, evident in the magnetic intensity image, could be responsible for the younger ages for the biotite in the vicinity of Cairn Hill.



Location map of samples submitted for this National Argon Map application. Note the samples of biotite in the vicinity of Cairn Hill Mine are from Fraser et al. (2012); other samples are those of Forbes et al. (2012).

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

Three samples are submitted, detailed in the below table.

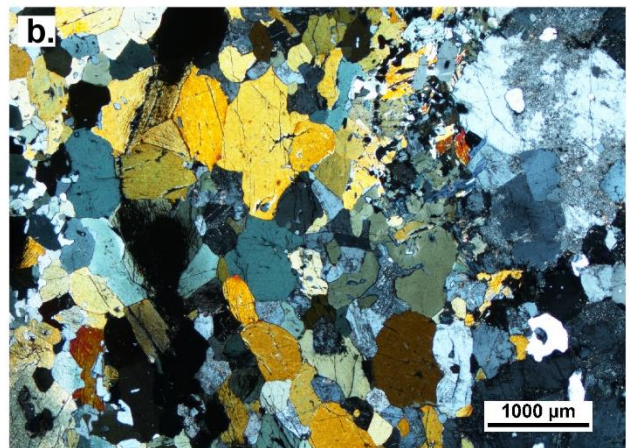
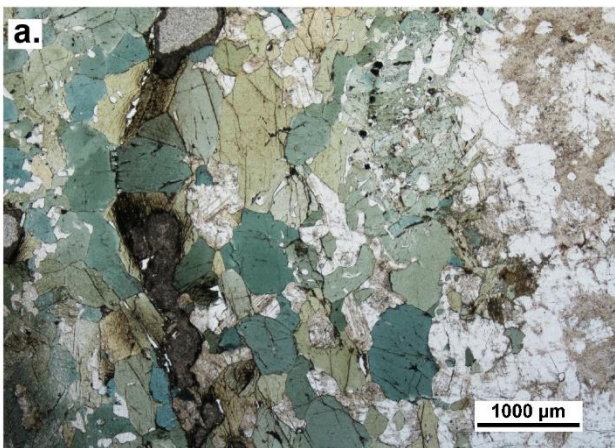
Sample number	Location	MGA East	MGA North	Zone	Target mineral	Lithology
1978579	Cairn Hill mine	511919	6758775	53	hornblende	altered granite
1998157	Cairn Hill mine	515330	6759520	53	phlogopite	magnetite ore
2131370	Drill hole KDD005, 130.5-131.9m	491100	6750371	53	biotite	quartzofeldspathic gneiss

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

Sample 1978579 is a quartzofeldspathic gneiss with an emplacement age of 1572 ± 6 Ma with a vein of magnetite-amphibole (hornblende) alteration that cuts the main fabric. Thin section reveals the coarse grained nature of the hornblende suitable for dating.

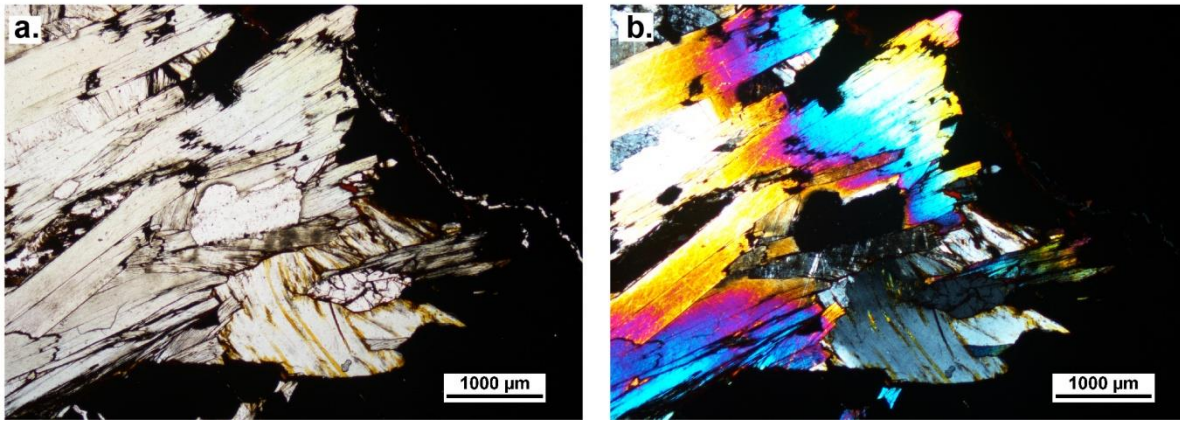


Photograph of sample 1978579. The coarse-grained dark alteration cuts the pre-existing granitic fabric and is also associated with sericitisation of the feldspar.



Photomicrographs of sample 1978579. a. Plain polarised light. b. Cross polars. Photographs show the transition from the hornblende-rich magnetite-bearing alteration on the left of the field of view to the quartz and sericite altered feldspar that represents the granite on the right.

Sample 1998157 is a sample of coarse magnetite ore from Pit 1 of the Cairn Hill Mine. The sample contains very coarse magnetite crystals intergrown with phlogopite forming coarse mica books.



Photomicrographs of sample 1998157. a. Plain polarised light. b. Cross polars. Opaque mineral is massive magnetite.

Sample 2131370 is a biotite-bearing granitic gneiss. The sample is from the upper portion of drill hole KDD005, located to the west of Cairn Hill (Garsed et al., 2006). The drill hole intersected dark grey to black, and pink mafic and felsic gneisses in the upper part of the hole, with the lower unit (from about 250m) being dominated by pale grey quartz rich garnet gneiss. From around 230m to 252m is a dark grey to green, overprinting pyroxene-amphibole alteration. There is only minor sulphide mineralisation present in this hole.

Further samples could be taken from the amphibole alteration in this hole, or from others in the KDD series (Kangaroo Dam) pending results from the current round of analysis.



Photograph of sample 2131370.

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

ANU as the furnace methodology is vital for T-t modelling with diffusion parameters.

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

Impact: to what extent new $^{40}\text{Ar}/^{39}\text{Ar}$ 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 $^{40}\text{Ar}/^{39}\text{Ar}$ 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 $^{40}\text{Ar}/^{39}\text{Ar}$ 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 $^{40}\text{Ar}/^{39}\text{Ar}$ 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 $^{40}\text{Ar}/^{39}\text{Ar}$ 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 $^{40}\text{Ar}/^{39}\text{Ar}$ 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 $^{40}\text{Ar}/^{39}\text{Ar}$ 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
- $^{40}\text{Ar}/^{39}\text{Ar}$ 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)

Forbes, C.J., Giles, D., Jourdan, F., Sato, K., Omori, S., Bunch, M., 2012. Cooling and exhumation history of the northeastern Gawler Craton, South Australia. *Precambrian Research* 200–203, 209-238.

Fraser, G., Reid, A., Stern, R., 2012. Timing of deformation and exhumation across the Karari Shear Zone, north-western Gawler Craton, South Australia. *Australian Journal of Earth Sciences* 59, 547-570.

Garsed, I.R., Manzi, B., Purvis, A.C., 2006 Unlocking South Australia's Mineral and Energy Potential - A Plan for Accelerating Exploration. Theme 2 (drilling partnerships with PIRSA and industry) : Year 2 partnership no. DPY2-35, Mount Woods Inlier, Kangaroo Dam platinoid metals mineral prospect. Project final report. South Australia. Department of Primary Industries and Resources. Open file Envelope, 11161.

Jagodzinski, E.A., Reid, A.J., 2015. PACE Geochronology: Results of collaborative geochronology projects, 2013-2015. Government of South Australia. Department of the Premier and Cabinet. Report Book, 2015/00003.