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: Ian Terence Graham
Affiliation and position: UNSW Sydney, Senior Lecturer
Collaborators: Khalid Schellen (UNSW Hons student), Adam McKinnon (Aurelia Metals), Angela Lay (ANPM, Timor Leste)
Project Title: Hera intrusive events
Geographic Region: Central NSW
Geological Province or Tectonic Unit: Lachlan Fold Belt, Cobar Basin

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 which showing the spatial distribution of samples in their geological context (with scale).

The Hera mine is located within the southern Cobar Basin of central NSW (see attached image). Previous geochronological investigations by Waltenberg et al (2019) on hydrothermal titanite which occurs in veins that clearly cross-cut the main stage of mineralisation and main foliation gave indistinguishable ages (when errors are taken into account) of 383.4 ± 2.9 Ma (from 460 level) and 382.5 ± 2.6 Ma (from 435 vent access). Importantly, these ages are significantly older than an Ar-Ar mica age of 372 Ma from the Girilambone District (Fergusson et al., 2005), suggesting that the main foliation, main mineralisation and quartz vein forming events all pre-date the Benambran Orogeny. Also, one of my former Honours students, Liepa (2019), showed that besides these quartz veins, there are also cross-cutting granitic pegmatites. More of these pegmatites were further analysed by Khalid Schellen (2019) in a pre-Honours research project.

Some of the underground workings have exposed relatively wide (up to 2 metres across) coarse-grained pegmatite dykes that are dominantly composed of quartz and were previously thought to be veins of hydrothermal origin. These contain relatively coarse-grained remobilised sulphides, in particular, pyrrhotite, chalcopyrite, sphalerite and galena. However, recent investigations by us (petrographic analysis, laboratory XRD, SEM) have shown that along with quartz, some portions of these contain significant coarse-grained microcline, and importantly, intermediate phases of the plagioclase group (i.e. labradorite, andesine), showing that they are in fact granitic pegmatites. They are thus of magmatic origin and not products of lower temperature hydrothermal activity. Importantly, a number of studies (Fitzherbert et al., 2017; Burrows, 2017, Liepa 2019) have shown that many of the alteration assemblages (in particular, the widespread occurrence of tremolite, less common occurrences of garnet and calc-silicates) are of skarn origin although the source of this has yet to be found. These granite pegmatites could well be related to the source of skarnification. Importantly, as these dykes clearly cross-cut the host sequence, main foliation and mineralised lenses, they represent the youngest geological event exposed to date and will help to constrain the geological evolution of the southern Cobar Basin. It will also provide a more robust geochronological framework for the Hera deposit which will then help to inform a genetic model for Hera and importantly, exploration models

to help discover additional deposits of this type (i.e. Federation) within the southern half of the Cobar Basin.

For this proposal, we plan to attempt to acquire Ar-Ar dates on the ages of crystallisation of two of these pegmatite dykes, one from 285SC and one from 310SA. We have already conducted petrographic analysis, XRD analysis, pXRF analysis, some SEM analysis and additionally plan to undertake wholerock laboratory XRF and ICP-MS analysis and EMPA work. We plan to use K-feldspar separates (microcline) for the analysis and these will be hand-picked from the same crushed samples used for the laboratory XRF and ICP-MS analyses. Petrographic analysis clearly shows mutual grain boundaries between the microcline, orthoclase and plagioclase grains.

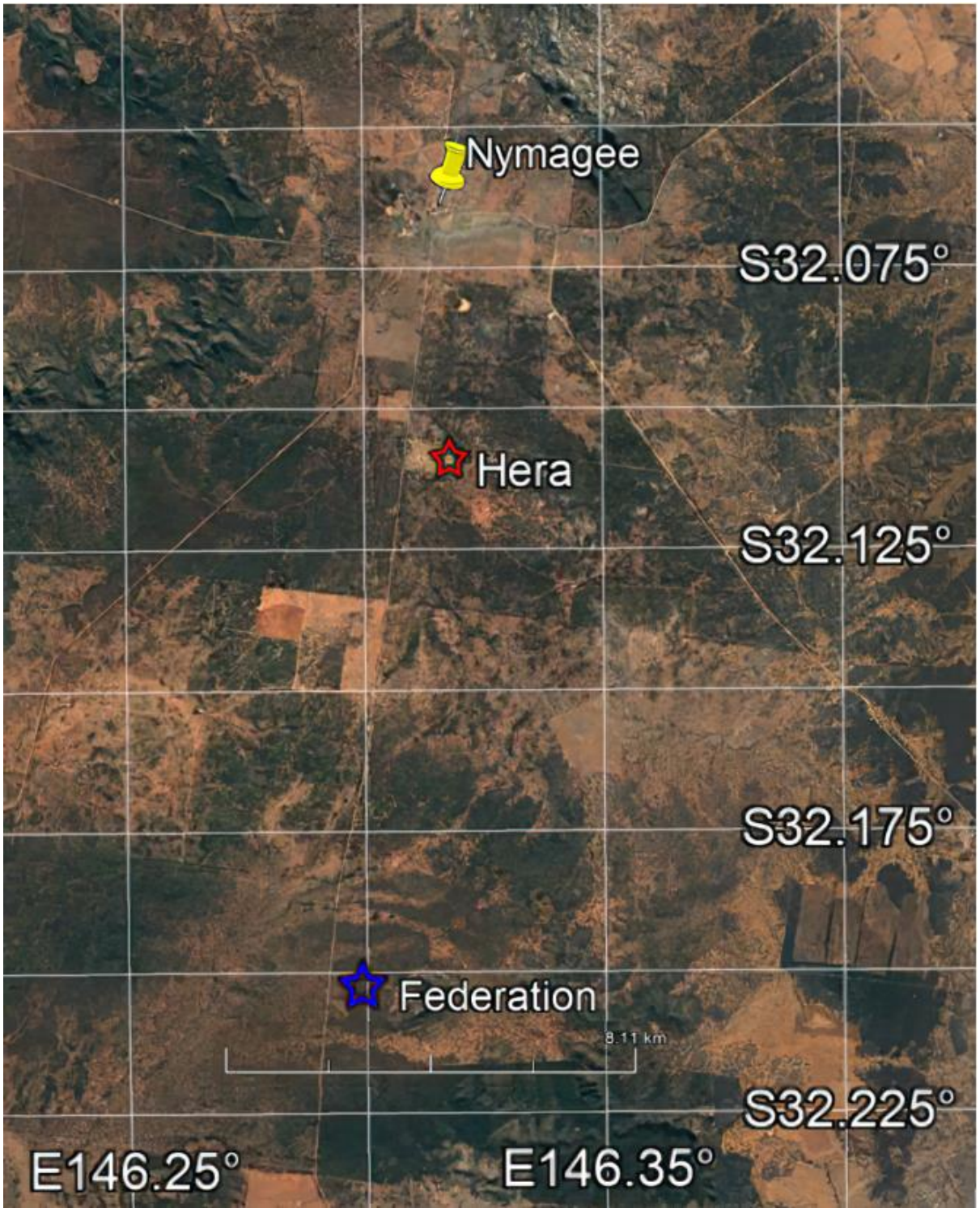
Approximate number of samples proposed for $^{40}Ar/^{39}Ar$ analyses: 2

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

Microcline separates from granite pegmatite dykes.

Do you have a preferred ^{40}Ar-^{39}Ar laboratory? (ANU, Curtin, UQ, UMelb):
While undertaking a Postdoctoral Fellowship at the University of Pretoria in South Africa, I undertook Ar-Ar age-dating of amphibole separates with the help of Prof David Phillips (see de Waal et al., 2002 on Marble Hall breccia) and would therefore prefer to use his facilities at the University of Melbourne for this proposed project.

A BIGGER PICTURE MAP IS NEEDED ALSO


Nymagee
S32.075°
Hera
S32.125°
S32.175°
Federation
8.11 km
S32.225°
E146.25°
E146.35°

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)