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: Mark Eastlake
Affiliation and position: Geoscientist (Geoscience, Acquisition & Synthesis unit), Geological Survey of New South Wales
Collaborators: Marnie Forster (ANU)
Project Title: New $^{40}Ar/^{39}Ar$ age constraints on the timing of deformation on bounding structures of the Mount Foster–Tumut Zone, Eastern Lachlan Orogen, NSW.
Geographic Region: Central NSW.
Geological Province or Tectonic Unit: Mount Foster–Tumut Zone, Eastern Lachlan Orogen, NSW

Brief Project Description:

Faults and fault zones mark major strato-tectonic divisions in the crustal architecture of the Palaeozoic Lachlan Orogen in eastern Australia (Leitch & Scheibner 1987). In the eastern sub-province of the Lachlan Orogen, the boundaries of the Mt Foster–Tumut Zone are defined by the Gilmore and Coolac–Narromine fault zones as well as the Parkes Thrust (Scheibner 1993; Figure 1).

The Gilmore and Coolac–Narromine fault zones have complex kinematic histories with inferred movements in the Late Silurian to mid-Devonian and/or Carboniferous (e.g. Stuart-Smith 1991, Warner et al. 1992). The Parkes Thrust records similar early Devonian and Carboniferous movements and may have formed as a major linking structure between the Gilmore and Coolac–Narromine fault zones (Lyons 2000). Despite their complex kinematic histories, published studies into the absolute timing of deformation associated with these structures are scarce (Foster et al. 1999).

We propose using the $^{40}Ar/^{39}Ar$ dating technique to analyse kinematically constrained tectonite samples from multiple locations along each of the abovementioned structures (potentially incorporating splays or associated fault networks) to clarify their deformation histories. As part of this approach we aim to collect samples of deformed igneous rock types where the emplacement/eruption age of the protolith is well characterised by robust isotopic means (namely U–Pb dating of magmatic zircon), thus providing maximum ages for deformation and removing a degree of uncertainty in the interpretation of $^{40}Ar/^{39}Ar$ data.

The samples analysed in this study will contribute to an ongoing systematic approach by the GSNSW to date the deformation history of major faults in the Lachlan Orogen and greater Tasmanides in NSW, with implications extending into Queensland and Victoria. We aim to build on the abovementioned studies, the recent SLACT seismic acquisition across the NSW–Victorian border, the East Riverina Mapping Project, ongoing mineral-systems work in the Cobar Basin and the Lachlan ARC project, other MinEx NDI areas (e.g. Cobar and in Victoria). This study will complement the existing NAM project in the Central Lachlan Orogen, which is focussed on faults linking the Gilmore Fault Zone with the South and North Cobar NDI areas.

Importantly, these structures link the geology between the Forbes, North Cobar and Dubbo MinEx NDI areas in NSW and characterising their deformation histories has implications for mineral-systems studies as well as geodynamic reconstructions in these areas.

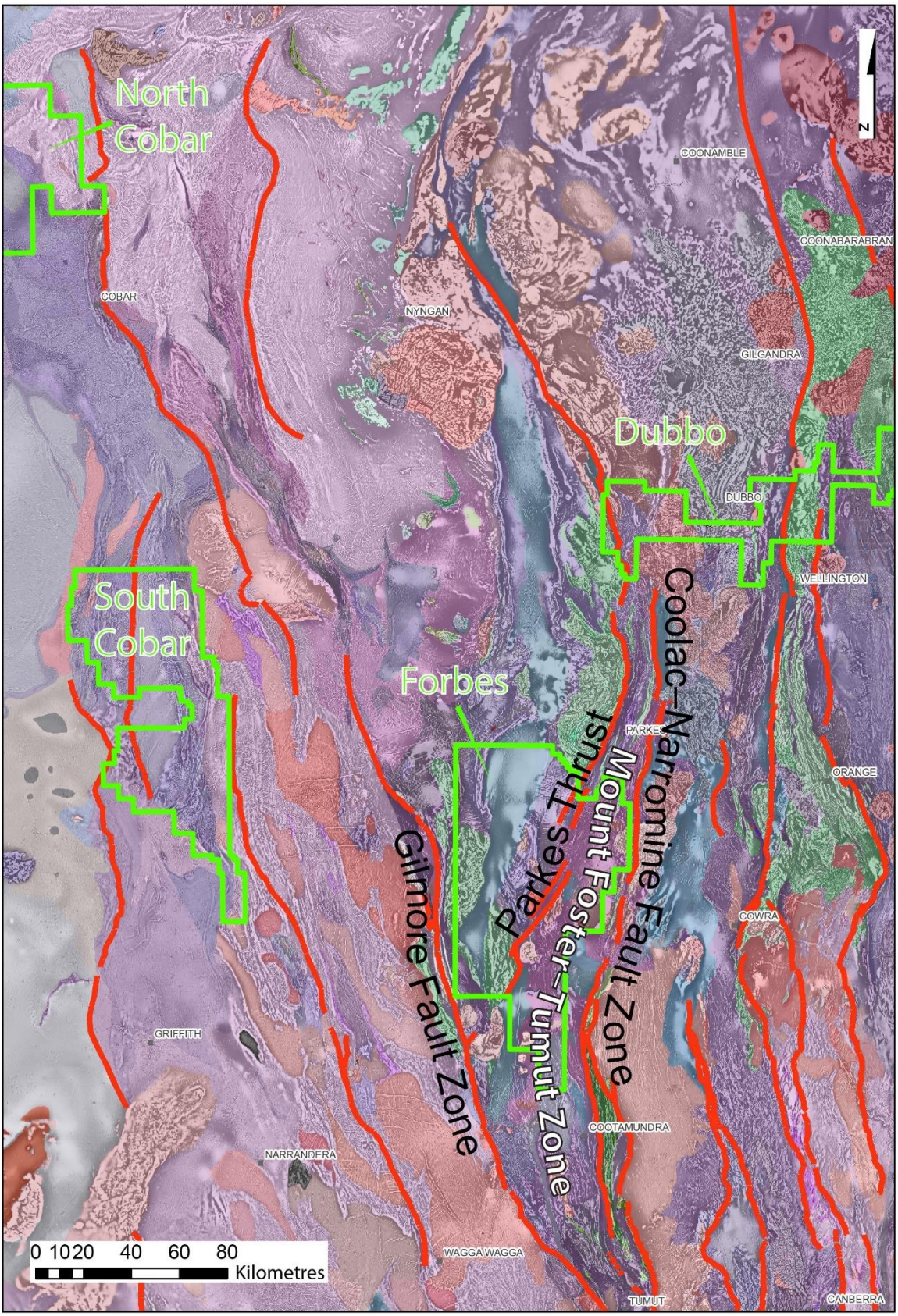

Figure 1. Map showing the distribution of first-order faults and fault zones (red lines) transecting the Palaeozoic Lachlan Orogen in central NSW including the bounding structures of the Mount Foster–Tumut Zone that will be targeted in the proposed study. MinEx NDI areas are shown with a green outline. Base layer is the Lachlan Orogen province of the NSW Seamless Geology at 40% transparency overlain onto 1VD aeromagnetic imagery.

References:

Foster D.A., Gray D.R. & Bucher M. 1999. Chronology of deformation within the turbidite-dominated, Lachlan orogen: Implications for the tectonic evolution of eastern Australia and Gondwana. *Tectonics*. **18 (3)**, 452–485.

Lietch E.C. & Scheibner E. 1987. Stratotectonic terranes of the eastern Australian Tasmanides. In: E.C. Leitch & E. Scheibner (eds). *Terrane Accretion and Orogenic Belts*. pp. 1–20. Geodynamic Series 19. American Geophysical Union, Washington DC.

Lyons P. 2000. Structural Geology. In: P. Lyons, O.L. Raymond & Duggan M.B. (compiling editors) *Forbes 1:250 000 Geological Sheet SI55-7, 2nd editions, Explanatory Notes*. AGSO Record 2000/20, pp. 156–158.

Scheibner E. 1993. Structural framework of New South Wales. *Quarterly Notes of the Geological Survey of New South Wales*, **93**.

Stuart-Smith P.G. 1991. The Gilmore Fault Zone—the deformation history of a possible terrane boundary within the Lachlan Fold Belt, New South Wales. *BMR Journal of Australian Geology & Geophysics*. **12**, 35–50.

Warner P.J., Marshall B. & Franklin B.J. The Mooney Mooney Fault System and Coolac ophiolite suite in the tectonics of the Tumut Trough, southeastern Australia. *Australian Journal of Earth Science*s. **39**, 127–140.

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

Up to 15 samples.

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

Target rock types are deformed intermediate to felsic igneous rocks (primarily granitoids) where the emplacement/eruption age of the protolith is constrained by robust isotopic means (namely U–Pb dating of magmatic zircon). Target minerals for $^{40}Ar/^{39}Ar$ analyses will include deformation-related micas (sericite, muscovite, biotite) defining shear fabrics. Relict primary (i.e. igneous) potassium-bearing phases such as K-feldspar or micas may also be targeted to elucidate the thermal history of individual shear zones.

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

ANU due to successful recent collaborations with Dr. Marnie Foster on similar materials with complex deformation histories.

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)