National Argon Map: an AuScope Initiative
$^{40}Ar/^{39}Ar$ Geochronology Laboratory Sample Submission Form

This form must be completed and returned to Marnie Forster (Marnie.Forster@anu.edu.au) before any work can be commenced in the Argon Laboratories.

Person submitting samples: Mark Eastlake
Affiliation: Geological Survey of NSW
Project Title: New $^{40}Ar/^{39}Ar$ age constraints on the timing of deformation on major faults in the Lachlan Orogen, NSW
Sample Number(s) (including IGSN if one exists): ERIVMAE0229.01E
Mineral separation required? Yes
Date submitted: 27/05/2020

GEOGRAPHIC AREA/ PROVINCE/ BASIN : Eastern Riverina district, southern central NSW/ boundary between Central and Eastern Lachlan Orogen.	
1:250k SHEET NAME: Cootamundra	**NUMBER:** SI/55-11
1:100k SHEET NAME: Barmedman	**NUMBER:** 8329
LOCATION METHOD: GPS (GDA94)	
ZONE: 55	
EASTING:	**NORTHING:**
LATITUDE: -34.053395	**LONGITUDE:** 147.33614666667

STRATIGRAPHIC UNIT FORMAL NAME *: Faulted boundary between the Gidginbung Volcanics and the Yiddah Formation
STRATIGRAPHIC UNIT INFORMAL NAME:
LITHOLOGY: Fine-grained quartz-muscovite schist

DRILLHOLE ID (if applicable):
PROSPECT (if applicable):
DEPTH FROM (metres):
DEPTH TO (metres):

* Stratigraphic Unit names can be searched and checked within the Australian Stratigraphic Units Database via the following link: https://asud.ga.gov.au/

Dating Objective

What is the geological question $^{40}Ar/^{39}Ar$ analysis will address?

The sample is a kinematically constrained muscovite schist from part of the Gilmore Fault Zone, a long lived tectonic boundary that defines the boundary between the Central and Eastern subprovinces of the Lachlan Orogen (Stuart-Smith 1991; Foster et al. 1999; Gray & Foster 2004). An $^{40}Ar/^{39}Ar$ age of fabric forming minerals will constrain the timing of reverse movement on this part of the Gilmore Fault Zone.

What type of age(s) are expected? (e.g. magmatic crystallisation, metamorphism, fluid alteration/mineralisation, cooling, shearing etc):

$^{40}Ar/^{39}Ar$ dating of fabric forming micas is expected to yield a deformation age.

Mineral target(s) for dating:

There are potentially two targets for dating in this sample (see petrographic description and photomicrographs). The first is syn-kinematic muscovite flakes (0.1–0.35 mm) that are intergrown with quartz defining fringe structures developed on pyrite porphyroclasts. The second is finer-grained muscovite needles defining foliation in the sample. Both muscovite populations are interpreted to have grown during the same deformation event.

Estimated $^{40}Ar/^{39}Ar$ age (e.g. Cenozoic, Mesozoic, Paleozoic, Proterozoic, Archean – provide estimated numerical age range if possible):

An initial attempt to date this rock by $^{40}Ar/^{39}Ar$ geochronology returned a weighted mean age of 353.6 ± 14.1 Ma (Matchan & Phillips 2017). A similar age is anticipated here.

Sample Information

Location description (e.g. a sample of x was collected from y, z km from abc town):

Sample collected in situ from low tabular outcrops c. 600m east of Goldfields Way, c.11.3 km NNW of Barmedman township.

Lithological characteristics (rock description):

Light silvery-grey, fine-grained muscovite-rich schist with blotchy purply-brown staining variably developed along the foliation likely related to the breakdown of pyrite (now evident as fine-grained cubic pits in the foliation plane; Figure 2). At the outcrop the foliation dips steeply ENE and contains a down-dip lineation. Quartz fringe structures observed in thin section indicate reverse sense of movement during fabric development.

Relative age constraints (pertinent geological relationships with surrounding rock units and any previous geochronology):

Sample is from the faulted boundary between the Gidginbung Volcanics (Late Ordovician to Earliest Silurian) and the Yiddah Formation (Latest Silurian; Bodorkos et al. 2018). An initial attempt to date this rock by $^{40}Ar/^{39}Ar$ geochronology returned a weighted mean age of 353.6 ± 14.1 Ma (Matchan & Phillips 2017). This age is broadly consistent with the Kanimblan Orogeny (Fergusson 2017).

Thin section description (if available):

Fine-grained quartz-muscovite schist displaying broad zones defined by highly elongate discontinuous mats of essentially pure very fine-grained (ca. 0.02 mm long) acicular muscovite, which pass into quartz-dominant domains with minor muscovite. The foliation contains abundant rigid pyrite porphyroclasts with distinct quartz fringe structures. Consistency in the geometry of these fringe structures translates to a reverse sense of movement on this structure during fabric development. In many examples, coarser flakes of muscovite 0.1–0.35 mm at the long axis are intergrown with quartz in the fringe structure (Figure 3).

Photograph(s) e.g. field site, hand-specimen, photomicrograph:

Figure 1 View onto foliation surface of muscovite-schist showing lineation (aligned top-to-bottom).

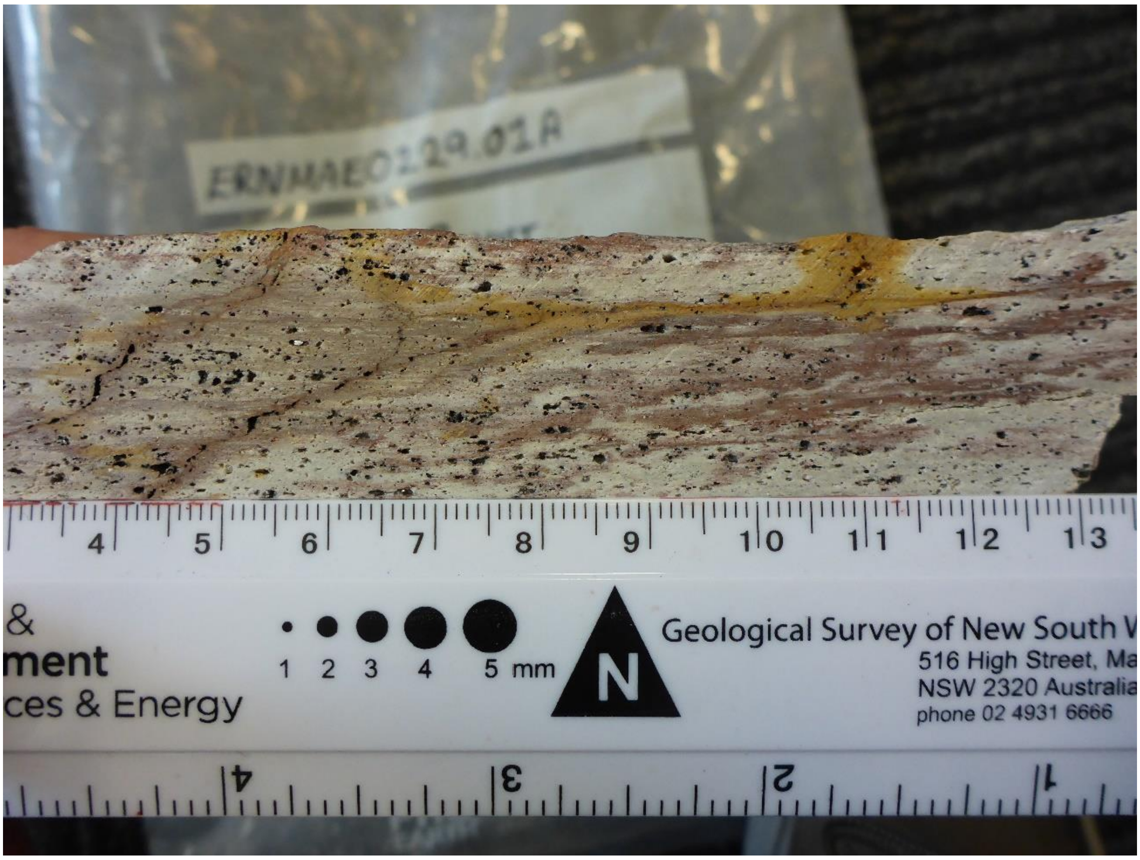

Figure 2 View onto cut surface oriented perpendicular to foliation and parallel to lineation. Note the cubic pits after pyrite that acted as ridged objects during deformation to produce quartz fringe structures shown in Figure 3 below.

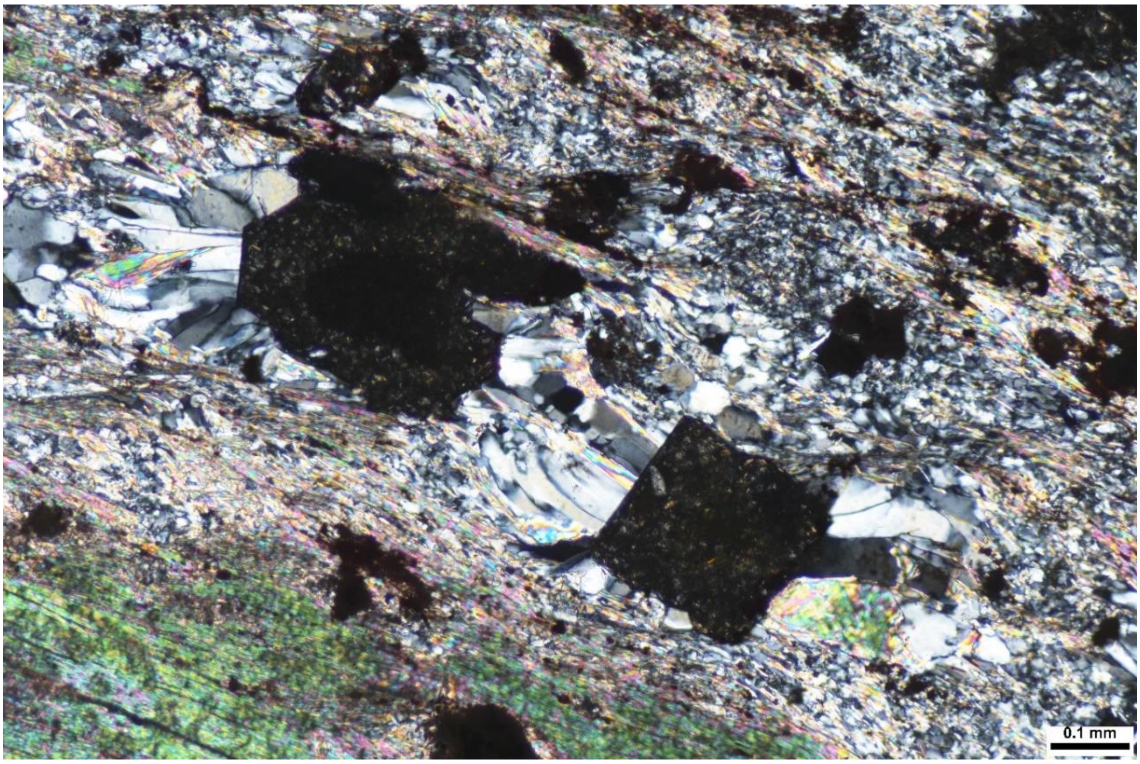

Figure 3 Photomicrograph in cross-polarised light showing quartz + muscovite fringe structures on former pyrite porphyroclasts. The lower left of the image comprises a dense mat of essentially pure muscovite needles in optical continuity.

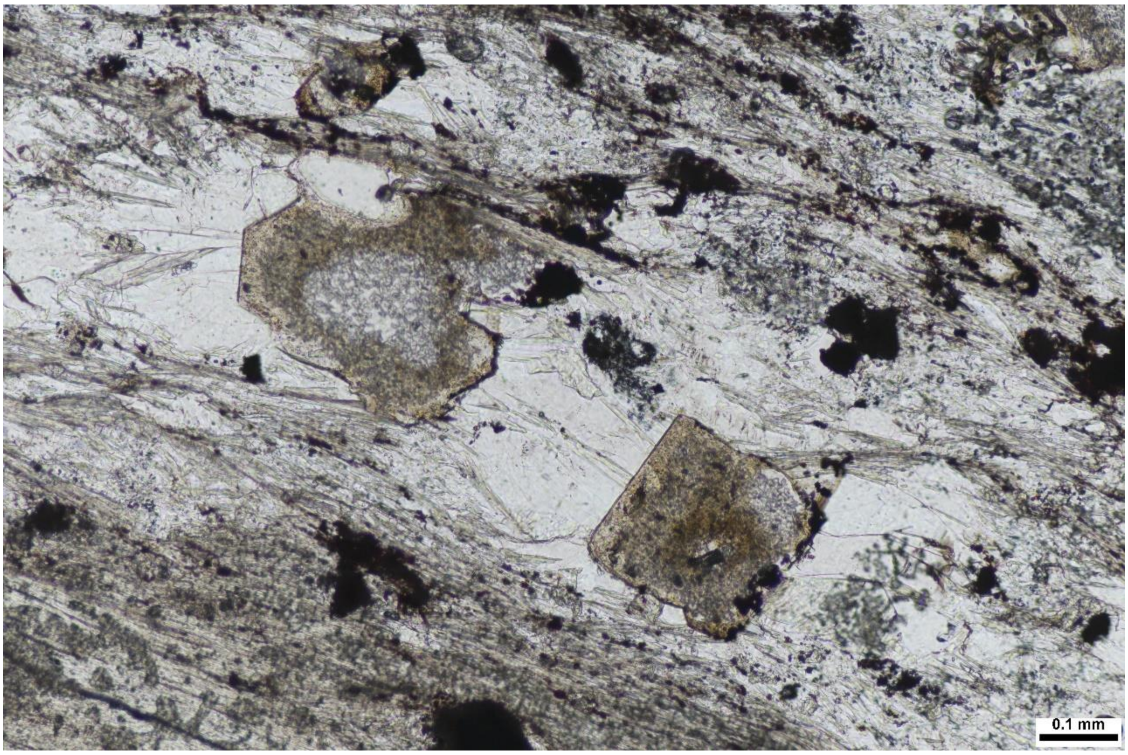

Figure 4 View as for Figure 3 in plane-polarised light.

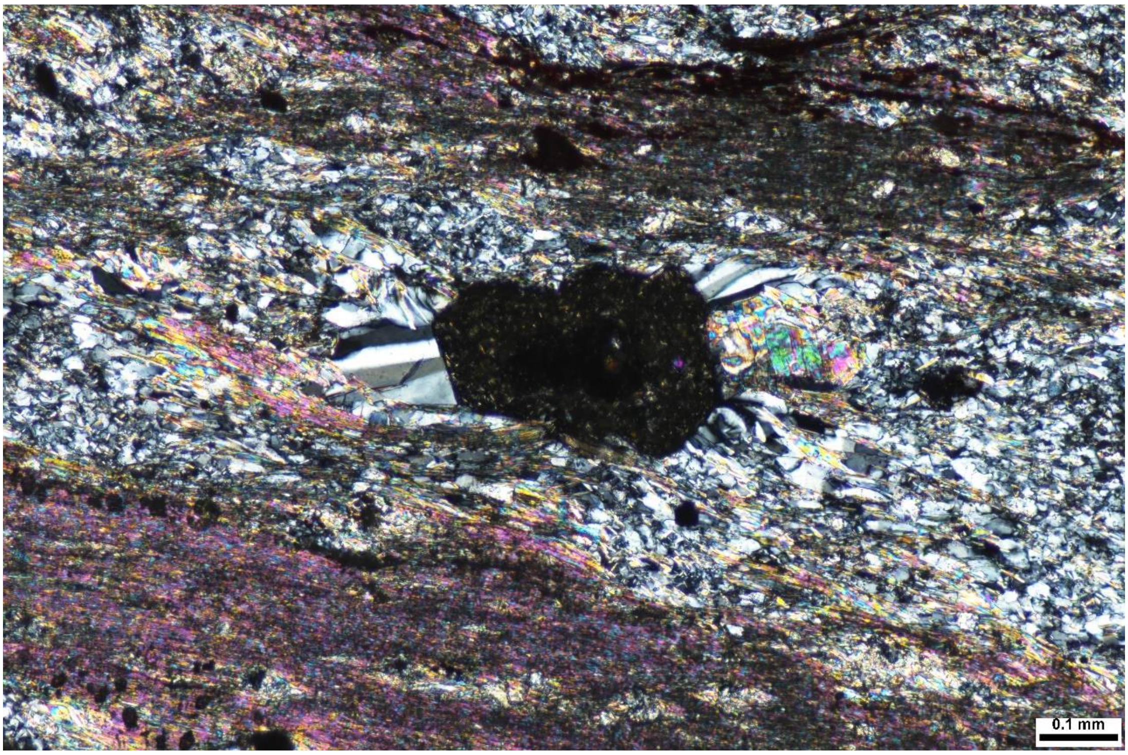

Figure 5 Photomicrograph in cross-polarised light showing a quartz + muscovite fringe structure on former pyrite. This specimen shows distinct muscovite-rich domains (bottom and top) and muscovite-poor (quartz-rich) domains (middle).

Figure 6 Field of view as for Figure 5 in plane-polarised light.

Relevant bibliographic references:

Bodorkos S., Main P.T., Bull K.F., Campbell L.M., Eastlake M.A., Gilmore P.J., Trigg S.J. & Waltenberg K. 2018. New SHRIMP U-Pb zircon ages from the central Lachlan Orogen, New South Wales. Geoscience Australia Record 2018/17. Geological Survey of New South Wales, Report GS2018/0313.

Fergusson C. L. (2017). Mid to late Paleozoic shortening pulses in the Lachlan Orogen, southeastern Australia: a review. *Australian Journal of Earth Sciences*. **64 (1)**, 1–39.

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.

Gray D.R. & Foster D.A. 2004. Tectonic evolution of the Lachlan Orogen, southeast Australia: historical review, data synthesis and modern perspectives. *Australian Journal of Earth Sciences*. **51**, 773–817.

Matchan E. & Phillips D. 2017. $^{40}Ar/^{39}Ar$ step-heating analysis of muscovite from East Riverina samples ERIVMAE0003.01B, ERIVMAE0052.01B and ERIVMAE0229.01D (Wagga Omeo Belt). Report UM17-0601, School of Earth Sciences, University of Melbourne.

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