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): ERIVSJT1289.01B and ERIVSJT1289.01C
Mineral separation required? Yes
Date submitted: 27/05/2020

GEOGRAPHIC AREA/ PROVINCE/ BASIN: Eastern Riverina district, southern central NSW/ Central Lachlan Orogen.	
1:250k SHEET NAME: Jerilderie	**NUMBER:** SI 55-14
1:100k SHEET NAME: Lockhart	**NUMBER:** 8227
LOCATION METHOD: GPS (GDA94)	
ZONE: 55	
EASTING: 479415.84109457	**NORTHING:** 6113659.3693126
LATITUDE: -35.119698333333	**LONGITUDE:** 146.774095

STRATIGRAPHIC UNIT FORMAL NAME *: Gillenbah Granite
STRATIGRAPHIC UNIT INFORMAL NAME:
LITHOLOGY: mylonitic, medium- to coarse-grained, muscovite-granite (protomylonite)

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 submitted samples comprise granitic protomylonite from the Galore Hill Shear Zone, a dextral strike-slip shear zone overprinting the northeast margin of the mid-Silurian Gillenbah Granite in the Central Lachlan Orogen. $^{40}Ar/^{39}Ar$ dating of fabric forming white mica will determine the age of shear zone development. $^{40}Ar/^{39}Ar$ dating of relict primary (porphyroclastic) muscovite will examine the isotope systematics of this inherited component and assist interpreting of the results from analysis of the fabric-forming white mica.
Two samples have been supplied (from the same exposure) to run duplicate analyses that will assess the consistency and reproducibility of $^{40}Ar/^{39}Ar$ ages between samples.

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

Sericite defining C-planes in the mylonite are expected to yield a deformation age. Coarser grained muscovite porphyroclasts inherited from the granite protolith are likely to yield a magmatic cooling age. Alternatively, deformation of the granite may have caused isotopic disturbance in the igneous muscovite, in which case an age intermediate between the magmatic age and the deformation age is expected.

Mineral target(s) for dating:

There are two proposed targets for dating in this sample. The priority is to date fine-grained white-mica (sericite) that defines distinct C-planes in the mylonite to date deformation of the granite protolith. The second target is medium- to coarse-grained muscovite porphyroclasts (mica fish) in order to understand the $^{40}Ar/^{39}Ar$ isotope

systematics of this inherited muscovite component. These mica fish are typically 0.6–4.4 mm long, rarely down to 0.25 mm long.

Estimated $^{40}Ar/^{39}Ar$ age (e.g. Cenozoic, Mesozoic, Paleozoic, Proterozoic, Archean – provide estimated numerical age range if possible):
Overprinting relationships restrict fabric development to a period in the late-Silurian to Middle-Devonian (c. 427–380 Ma); although, an Early Devonian age is considered likely based on the known deformation history of the region.

Sample Information

Location description (e.g. a sample of x was collected from y, z km from abc town):
Samples collected from relatively fresh rock exposed at the southern end of Godens Pit, on the southern side of Galore Hill, c. 12.4 km north-northeast of Lockhart township.

Lithological characteristics (rock description):
The sample is a light-grey granitic protomylonite featuring medium- to coarse-grained feldspar porphyroclasts enveloped by well-developed S–C fabrics. The penetrative S-plane is defined by lenses of recrystalised quartz and elongated medium- to coarse-grained feldspar porphyroclasts up to 20 mm long. Distinct C-planes are defined by very fine-grained white-mica (sericite) and recrystallised quartz contain a strong aggregate lineation. Abundant relict igneous muscovite occurs as randomly-oriented medium-grained porphyroclasts.
The protolith rock type is interpreted as medium- to coarse-grained muscovite-granite with trace tourmaline.

Relative age constraints (pertinent geological relationships with surrounding rock units and any previous geochronology):
The maximum age of fabric development is constrained by the 427.3 ± 2.3 Ma magmatic crystallisation age of the Gillenbah Granite (zircon U–Pb SHRIMP, Bodorkos et al. in prep.). A minimum age is provided by the Galore Hill Formation (inferred Late Devonian), which non-conformably overlies the sheared granite.

Thin section description (if available):
The sample predominately comprises K-feldspar, plagioclase and muscovite porphyroclasts enveloped by a mylonitic foliation with distinct S–C fabric elements. Igneous accessory minerals include apatite, tourmaline and zircon.
The mylonitic fabric is defined by bands of fine-grained dynamically recrystallised quartz alternating with bands of fine-grained white-mica (sericite). S-planes are locally emphasized by lens shaped aggregates of interlobate quartz crystals, which undergo considerable grainsize reduction as they are drawn into C-plane shears. These may represent relicts of primary quartz crystals.
Deformation related sericite occurs as aligned acicular crystals typically 0.03–0.05 mm long and some slightly larger laths c. 0.07 mm long that form relatively continuous folia c. 0.1 mm wide (locally up to 0.5 mm wide) mainly defining C-planes but also wrapping into the S-plane orientations.
Primary (igneous) muscovite form mica fish typically 0.6–4.4 mm long (rarely down to 0.25 mm long) that are commonly localised within the sericite-rich shear fabric. Most show undulose extinction and kink-bands locally and some are shredded along the foliation plane.
Blocky plagioclase porphyroclasts display undulose extinction as well as wrapped twin planes and many have quartz-filled brittle fractures/boundinage structures. The interiors of some plagioclase porphyroclasts have a light dusting of secondary sericite that is typically finer grained than the deformation related sericite.
Simply-twinned K-feldspar porphyroclasts have dynamically recrystallised margins commonly with sodic-plagioclase replacements; although, these are not typically associated with wormy quartz as in a classic myrmekite replacement.
S–C fabric geometry, mica fish and σ-type strain shadows on K-feldspar are consistent with dextral shear-sense.

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

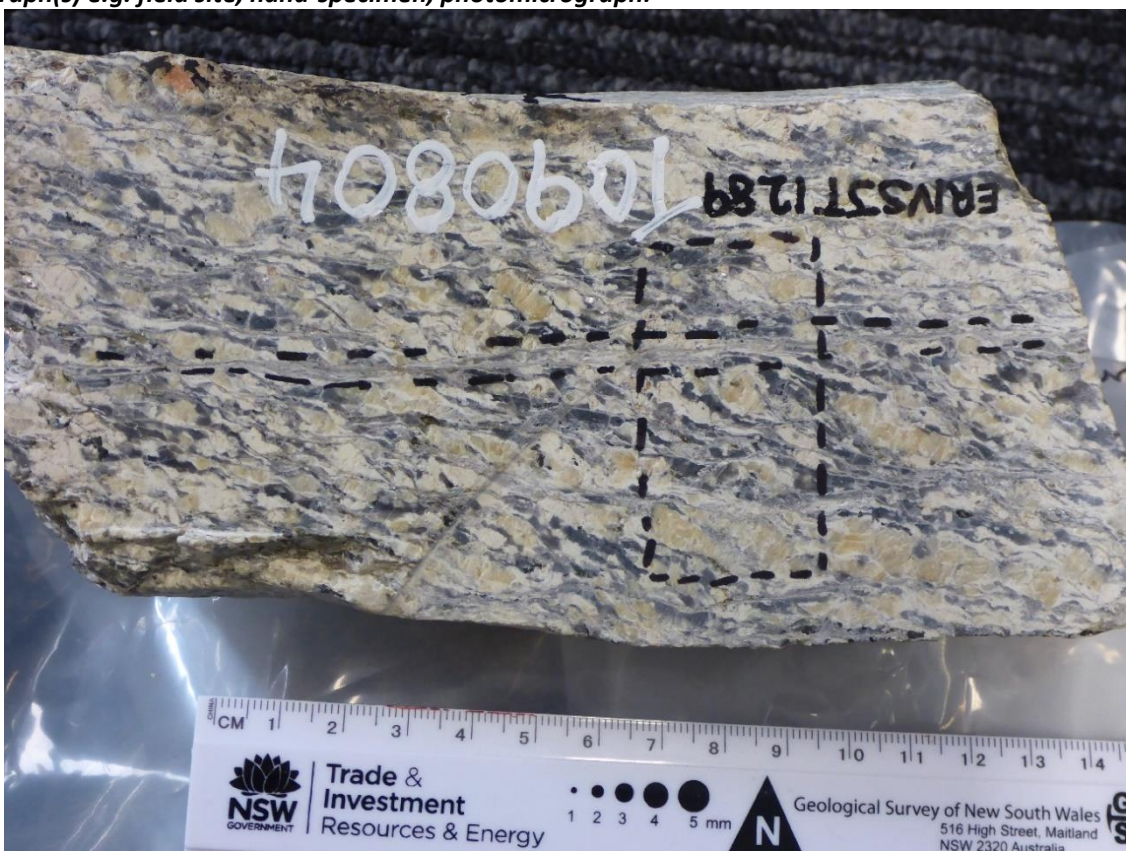

Figure 1 View onto cut surface oriented perpendicular to foliation and parallel to lineation. The penetrative S-fabric (oriented bottom-right to top-left) wraps around pale-greenish-yellow feldspar porphyroclasts. C-planes (oriented left-to-right and highlighted by parallel dashed lines) are defined by secondary sericite.

Figure 2 Photomicrograph in cross-polarised light showing C-planes (oriented top-left to bottom-right) in mylonitic foliation that are defined by secondary sericite. Note the relict igneous muscovite forming mica fish within the foliation (right-of-centre). The plagioclase porphyroclasts at base and top-right of the image have near vertical quartz filled fractures consistent with brittle fragmentation behaviour. By contrast the K-feldspar crystal right-of-centre is dynamically recrystallised into a strain shadow that trails into the C-plane.

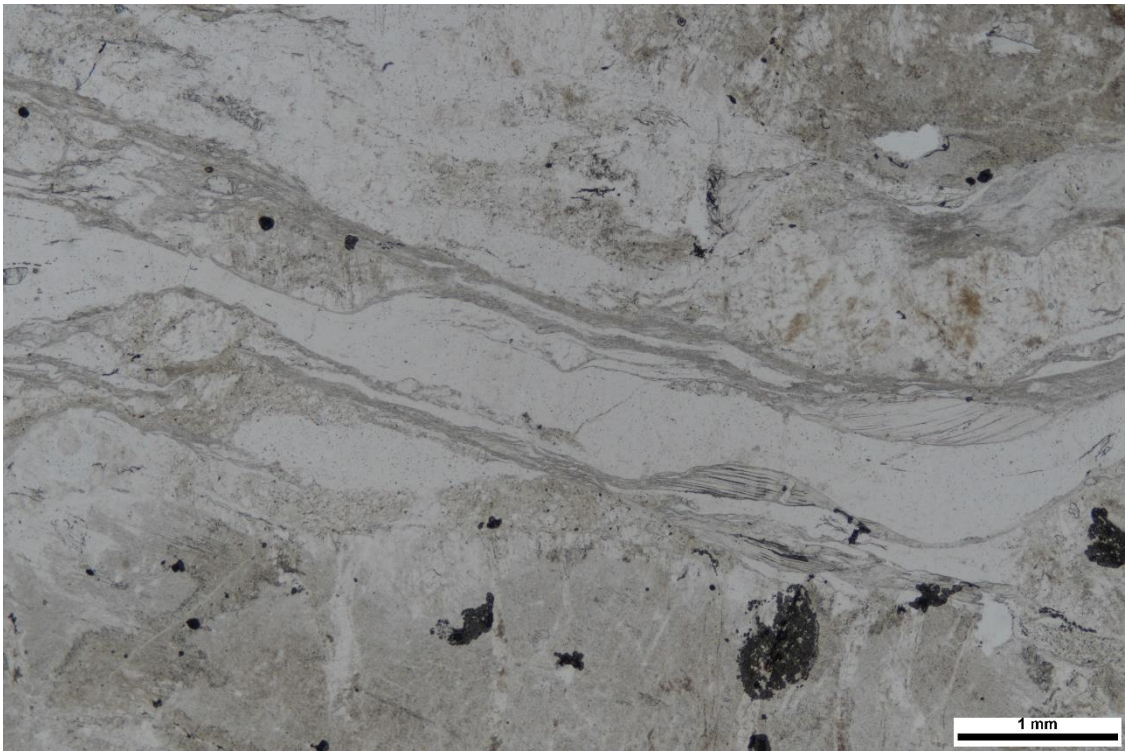

Figure 3 Field of view as for Figure 2 in plane-polarised light.

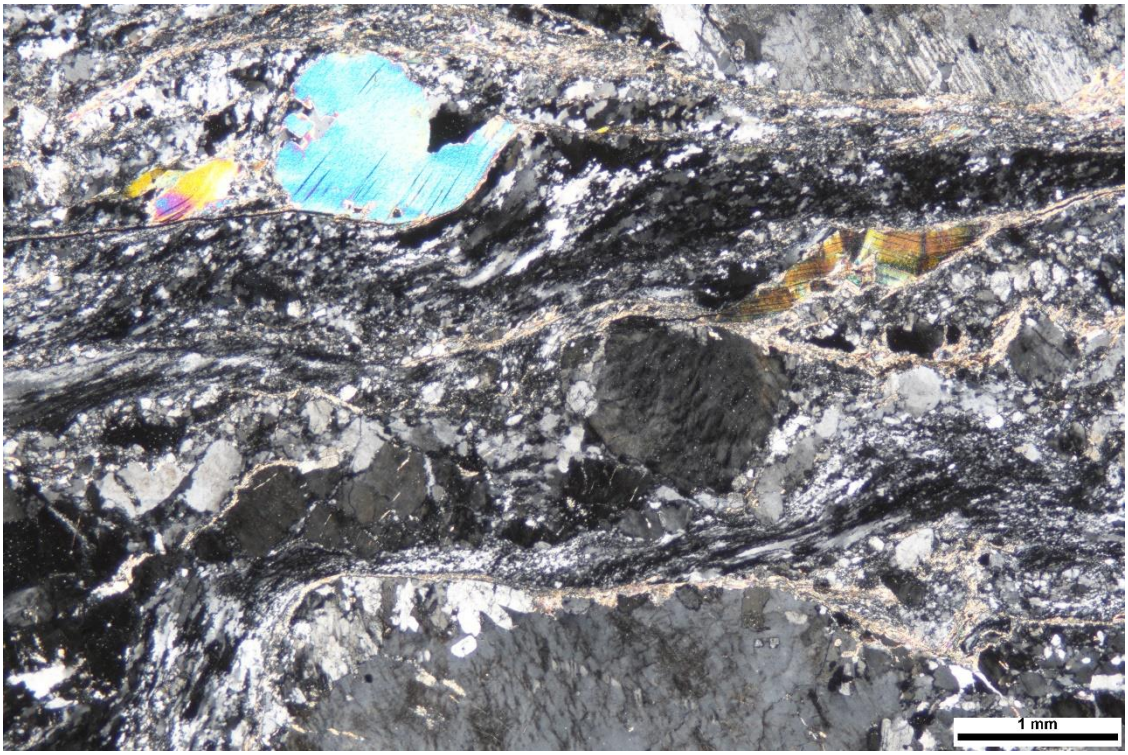

Figure 4 Photomicrograph in cross-polarised light showing a K-feldspar porphyroclast (bottom-centre) with albite replacements along the upper left margin, which is wrapped by a fine-grained aggregate of dynamically recrystallised quartz defining a C-plane shear band (oriented left-to-right). There is also muscovite fish (upper-left and right-of-centre) localised along the foliation with distinct kinks locally (e.g. right-of-centre).

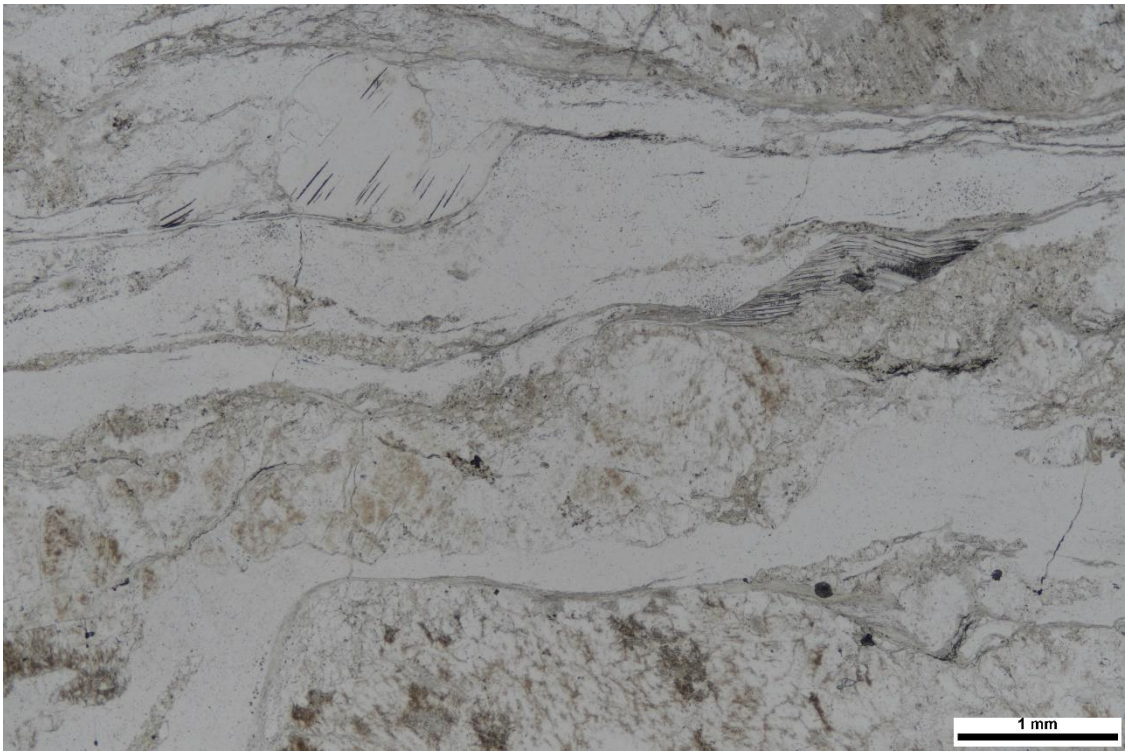

Figure 5 Field of view as for Figure 4 in plane-polarised light.

Relevant bibliographic references:

Bodorkos S., Waltenberg K., Bull K.F., Eastlake M.A.S., Gilmore P.J., Campbell L.M., Trigg S.J., Blevin P.L., Deyssing L.J. and Williams B.J. in prep. New SHRIMP U–Pb ages from the Lachlan Orogen, New South Wales: East Riverina Project, July 2016–June 2019. Geoscience Australia Records; Geological Survey of New South Wales Report **GS2019/1089**.