The Geological Society of Zimbabwe

Structural constraints on the evolution of the south-eastern Mwanesi Greenstone Belt and adjacent granitoids, central Zimbabwe Craton: implications for gold mineralisation

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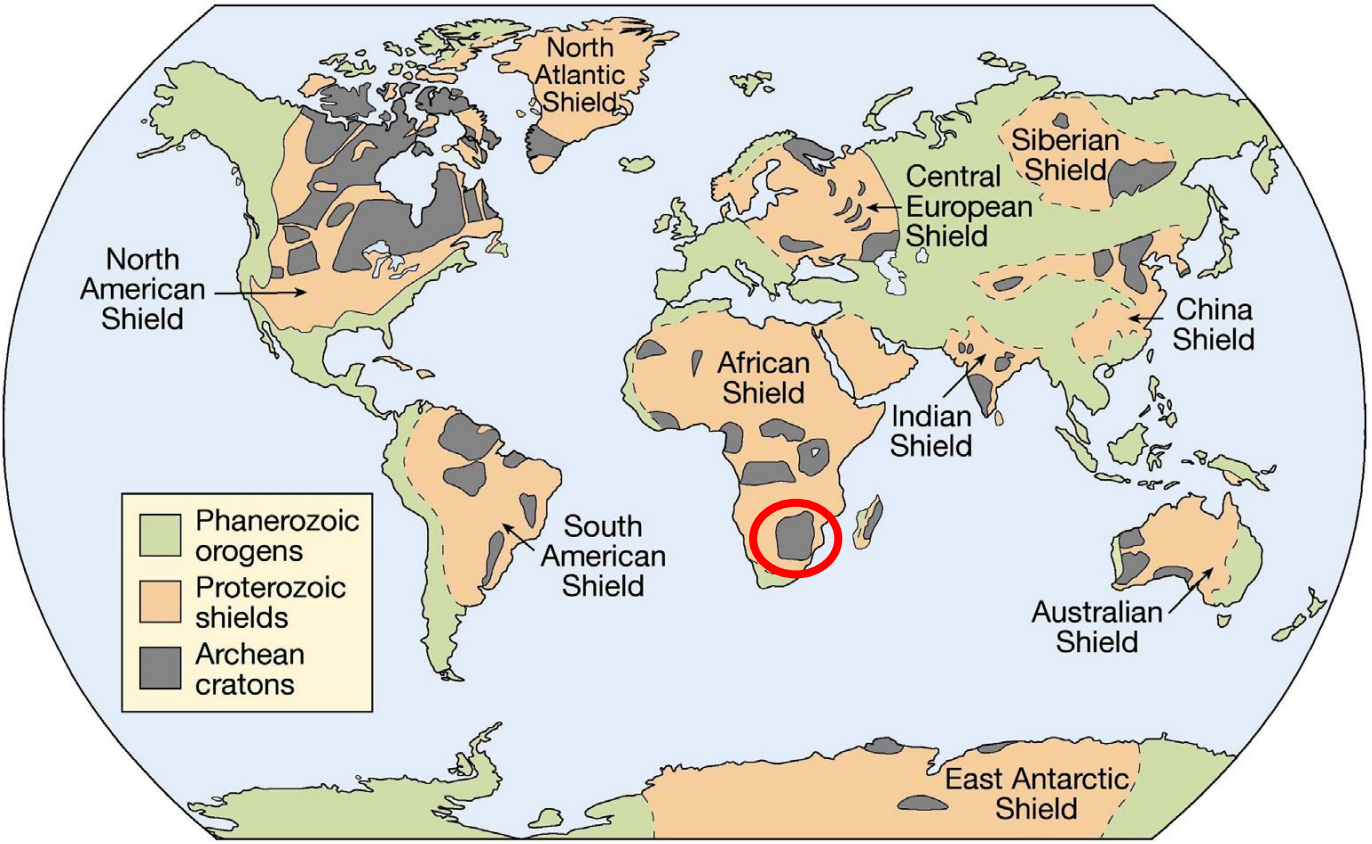
IRP BuCoMO

Building Continents - From Mantle to Ore

National Research Foundation

Archaean greenstone belts



Furnes *et al*. (2013)

- Common in Archaean cratons
- Tectonic evolution still debatable (e.g. Cawood et al. 2018; Gapais, 2018; Brown et al. 2020)
- Host orogenic gold deposits (Groves and Foster, 1991)
- Mineralising fluids source still controversial (Goldfarb and Groves, 2015; Groves et al. 2019a, 2019b)

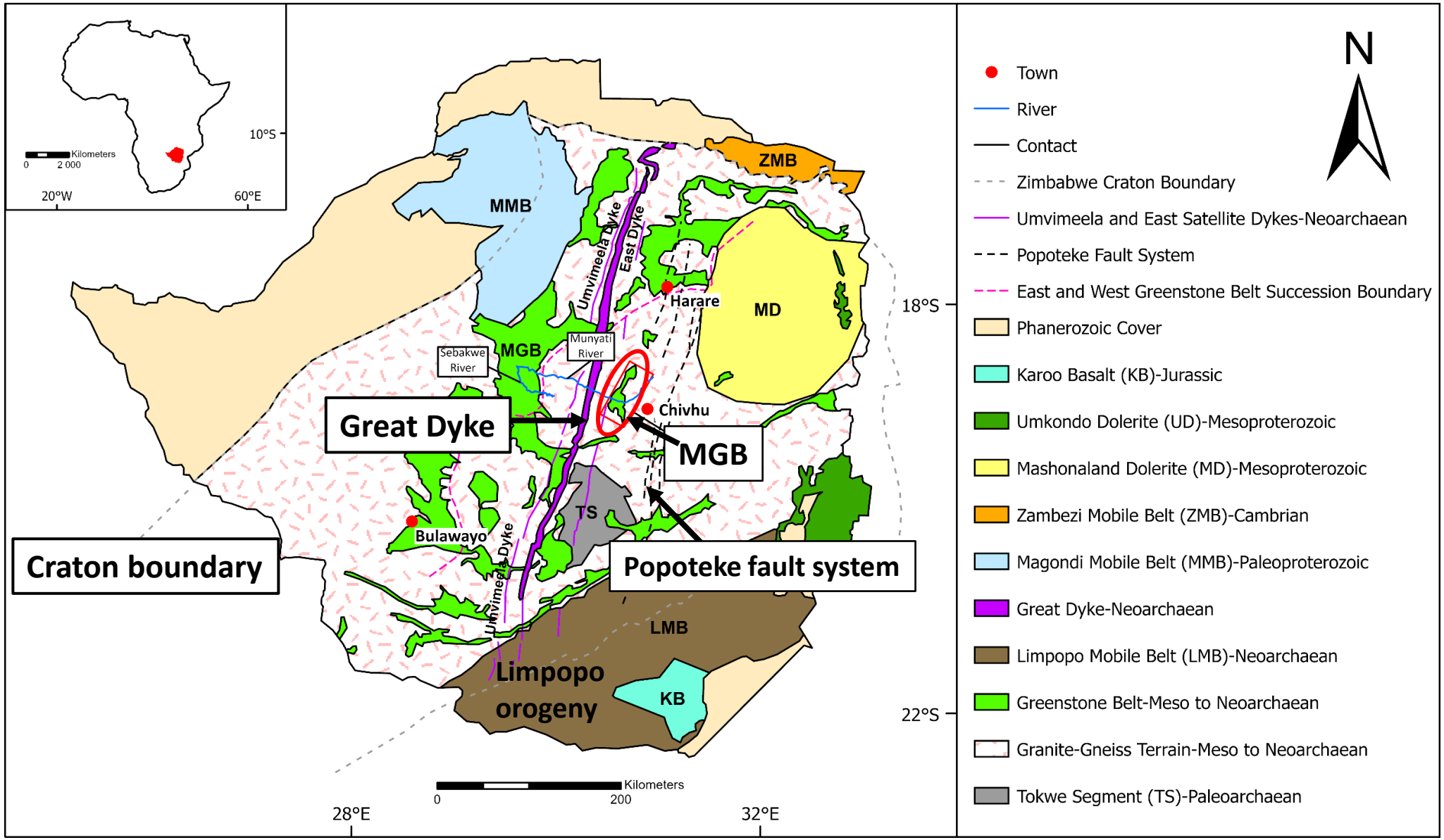
Aims of this study

1. Deformation of the Mwanesi Greenstone Belt (MGB) and the surrounding granitoids
2. The link between deformation and gold mineralisation (controls and timing)
3. Suggest a unified tectonic model for the evolution of the MGB

Why the MGB?

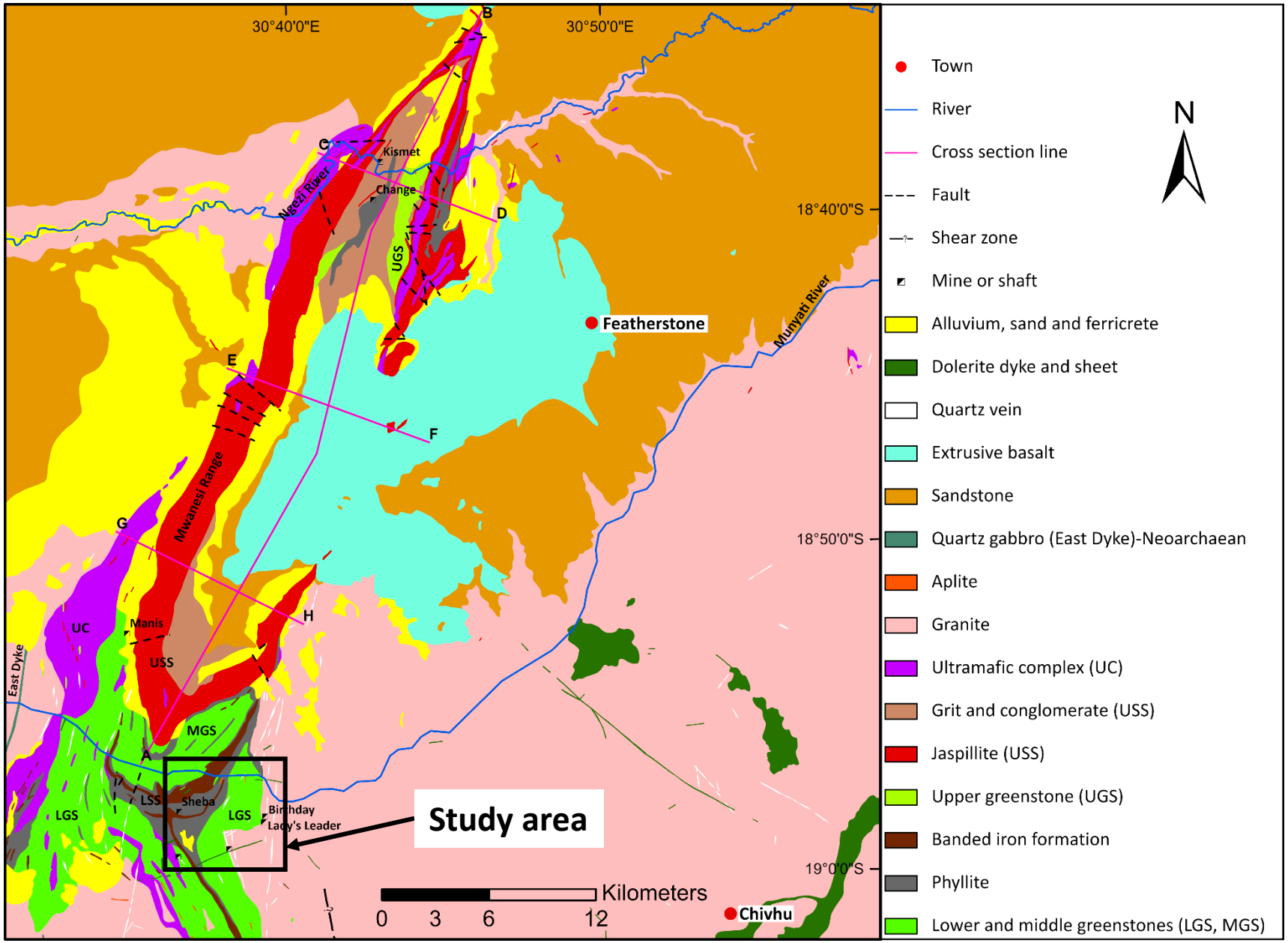
- One of the least studied greenstone belts in the Zimbabwe Craton (ZC)
- Its low gold endowment compared to other greenstone belts of the ZC

Geology of the Zimbabwe Craton



Modified after Markwitz et al. (2010), Western and eastern succession greenstone belts division is after Wilson (1979).

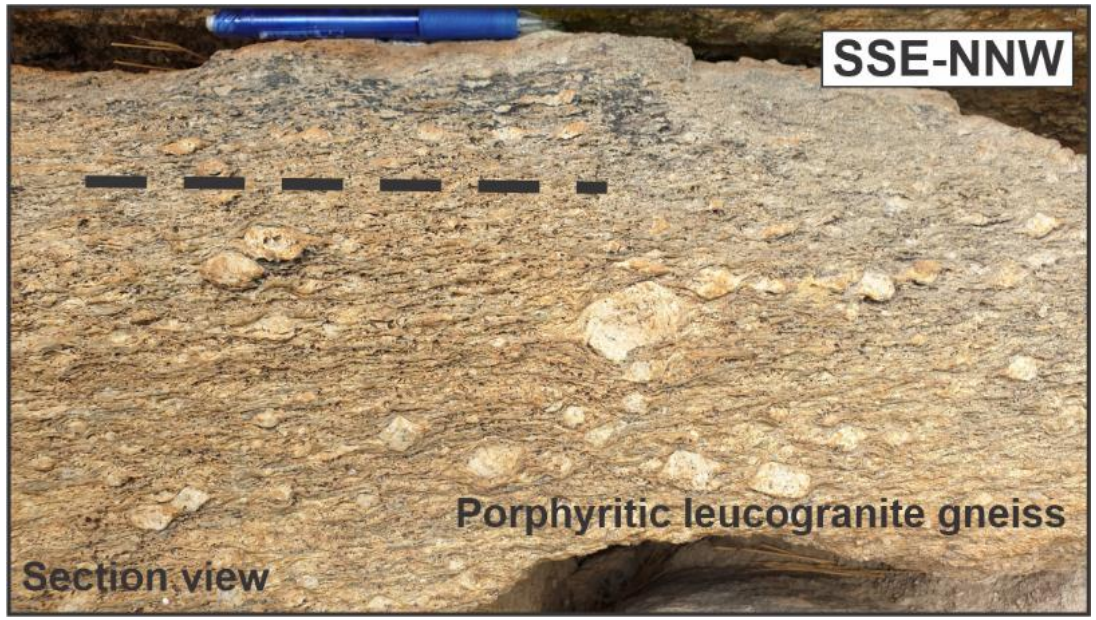
Geology of the Mwanesi Greenstone Belt



Modified after Worst (1962)

Lithostratigraphy – Adjacent granitoids

- Gneissic granites and minor isotropic granite
- Medium to coarse-grained, porphyritic, largely leucocratic
- Grey gneiss intruded by leucogranite gneisses
- Granite gneiss bands, and crosscutting dikes

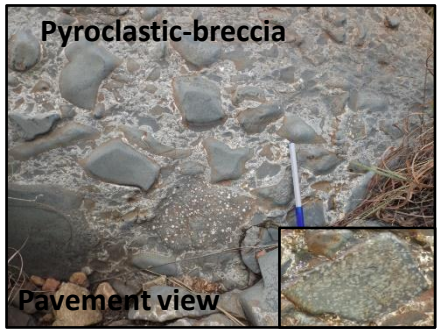


Lithostratigraphy – Lower Greenstone Series

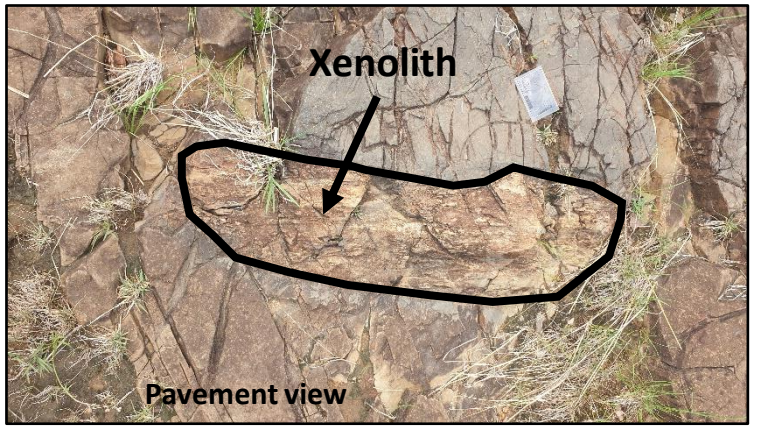
- **Metasedimentary rocks** – pelitic schists
- **Volcanic rocks** - pillow and amygdaloidal basalts, pyroclastic-breccia, felsic volcanic rocks
- **Intrusive rocks** – mafic rocks, and dikes

Metasedimentary rocks

Volcanic rocks

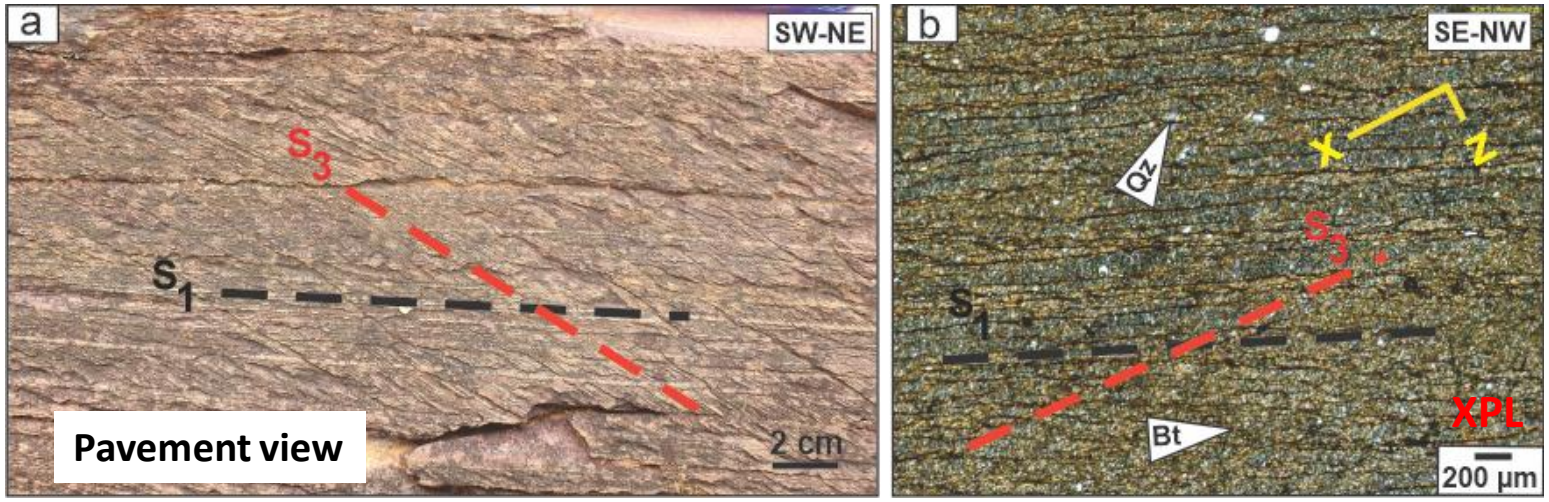


Intrusive rocks



Lithostratigraphy - Lower Sedimentary Series

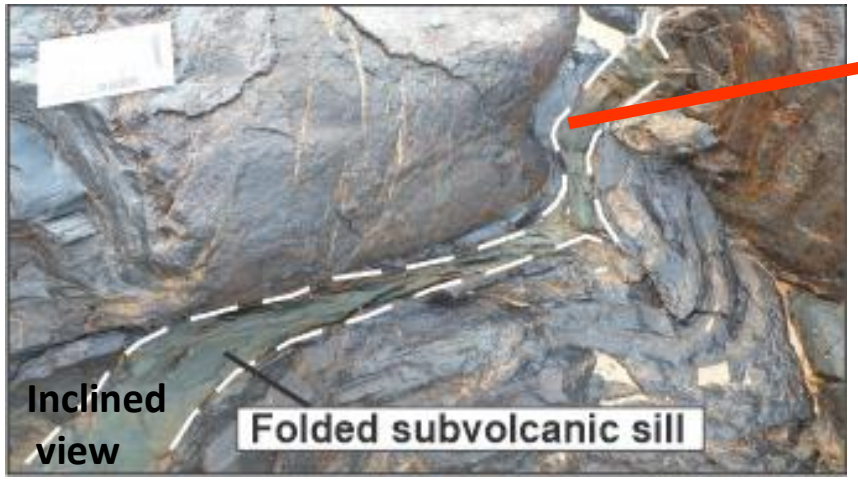
Phyllite



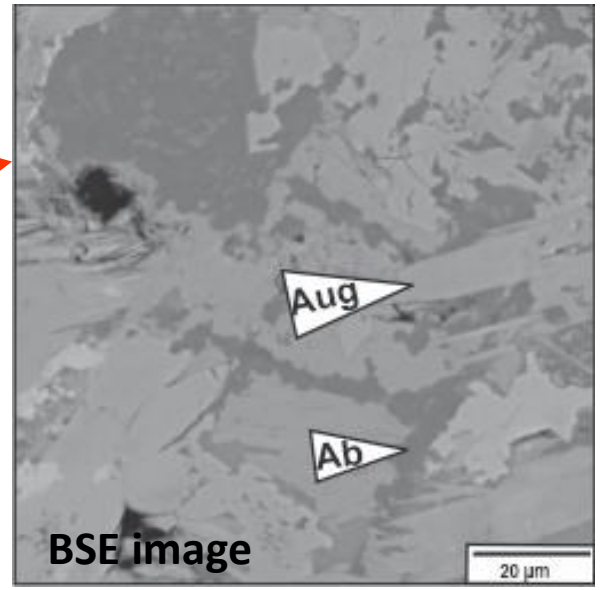
- Phyllite and BIF
- BIF intruded by subvolcanic basalts
- Intrusive greenstones (Worst, 1962)

Banded iron formation

Banded iron formation

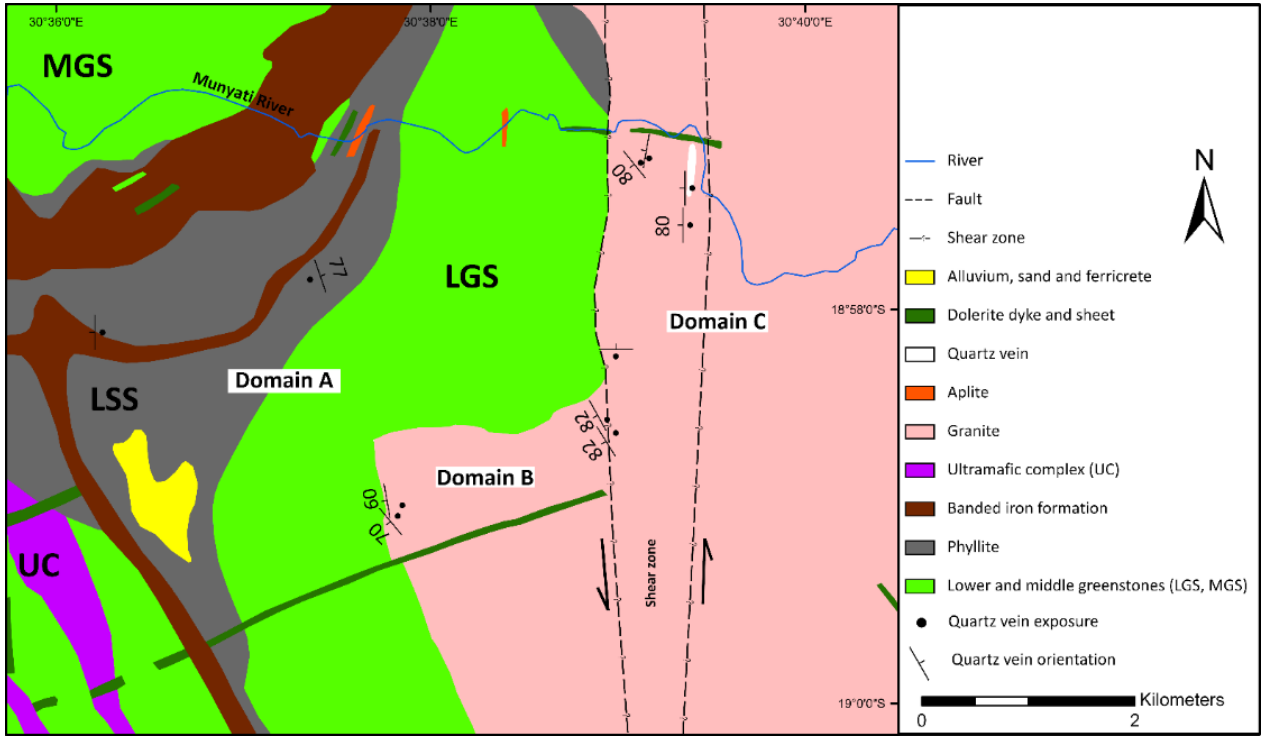


Subvolcanic sill



Lithostratigraphy - Middle greenstone Series

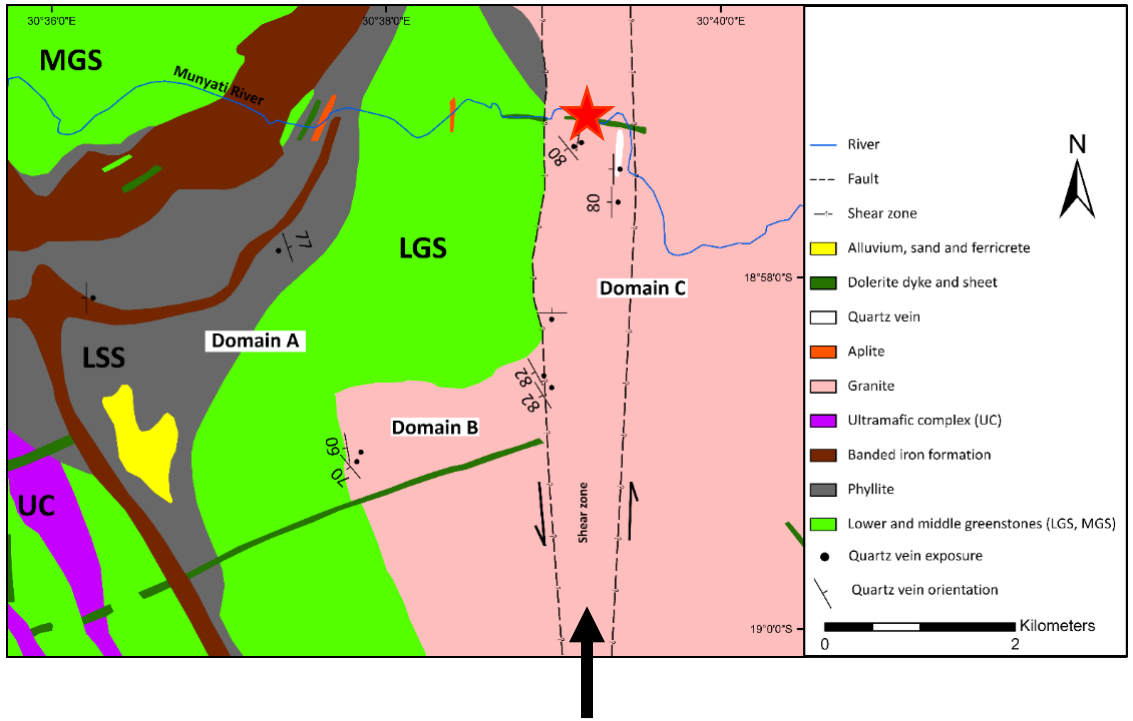
- Characterised by basaltic rocks, locally pillowed
- MGS and LGS pillow basalts are lithologically similar
- Minor textural differences



Modified after Worst (1962)

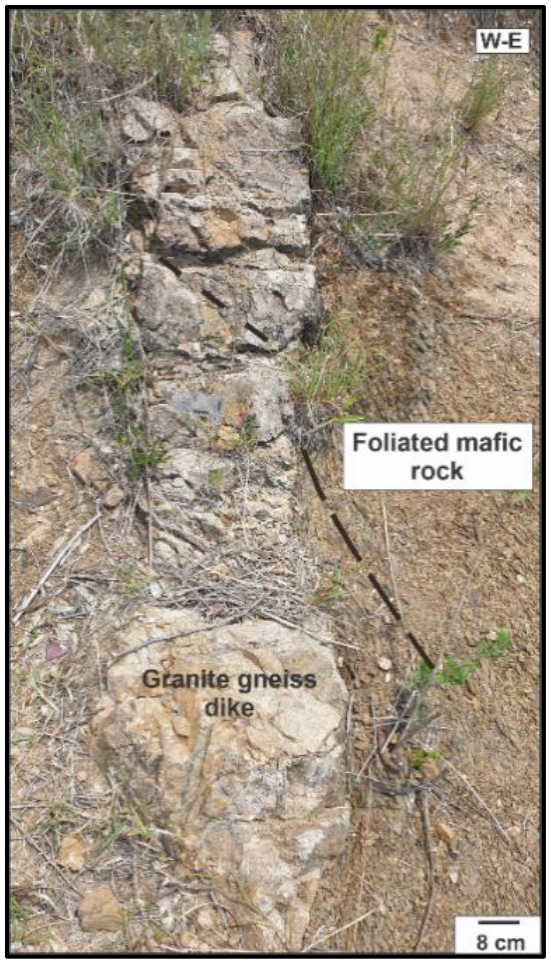
Granite-greenstone age relationship

- All granitoids younger than the MGB Worst (1962)
- Not all granitoids are younger (this study)

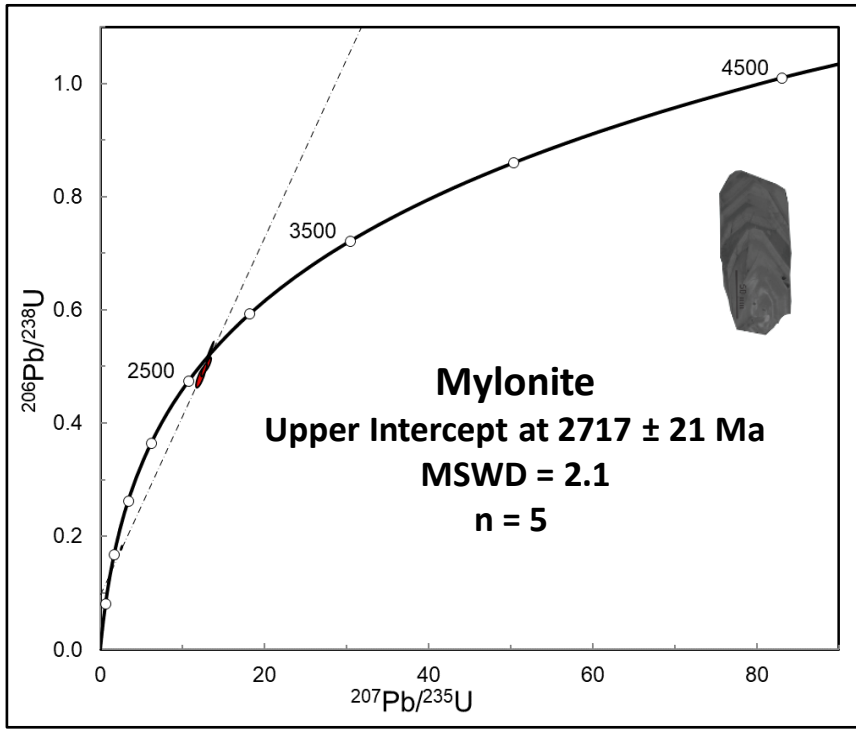


Mhou Shear Zone (MSZ)

Granite gneiss dike

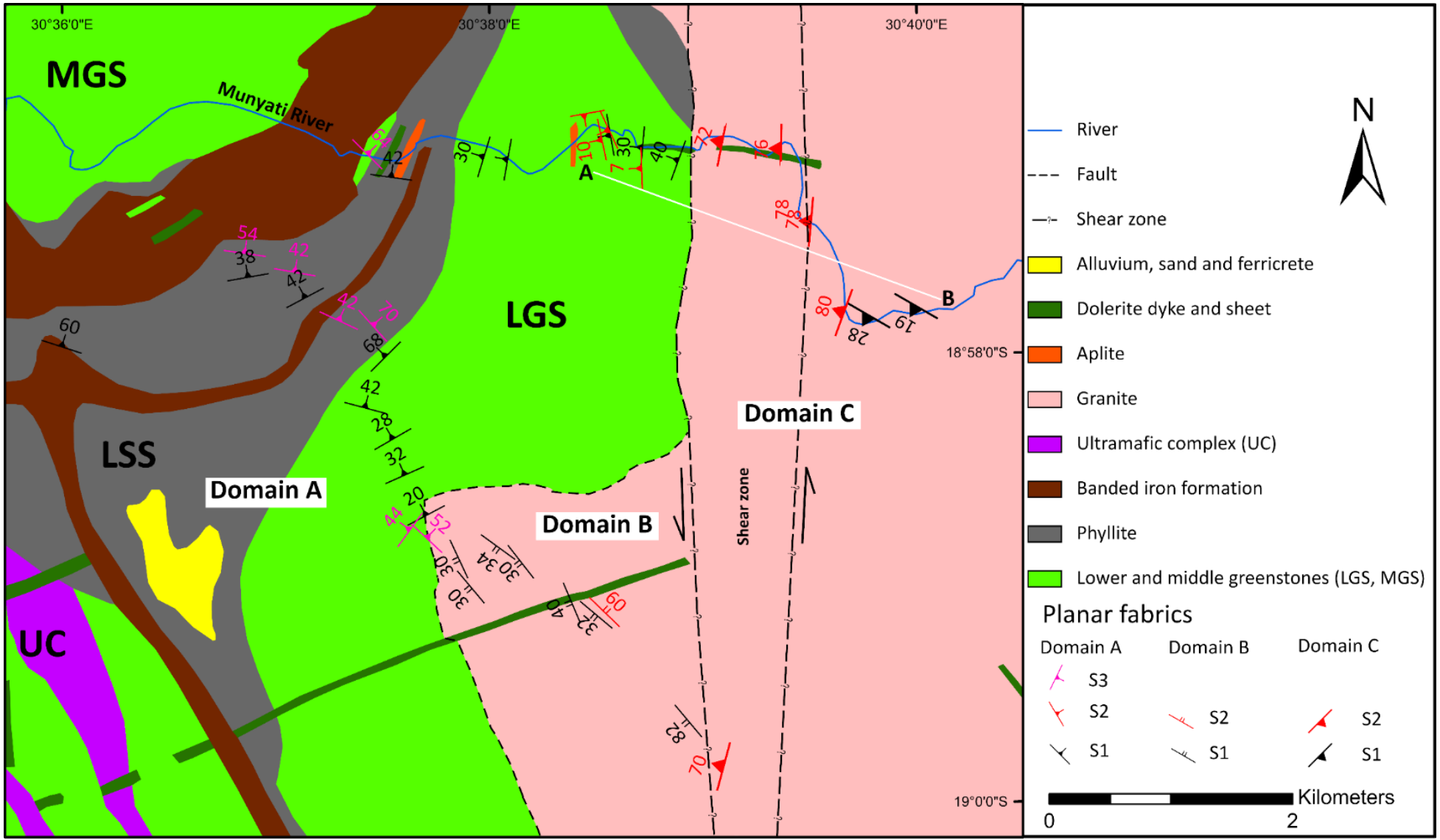


Mylonite sample



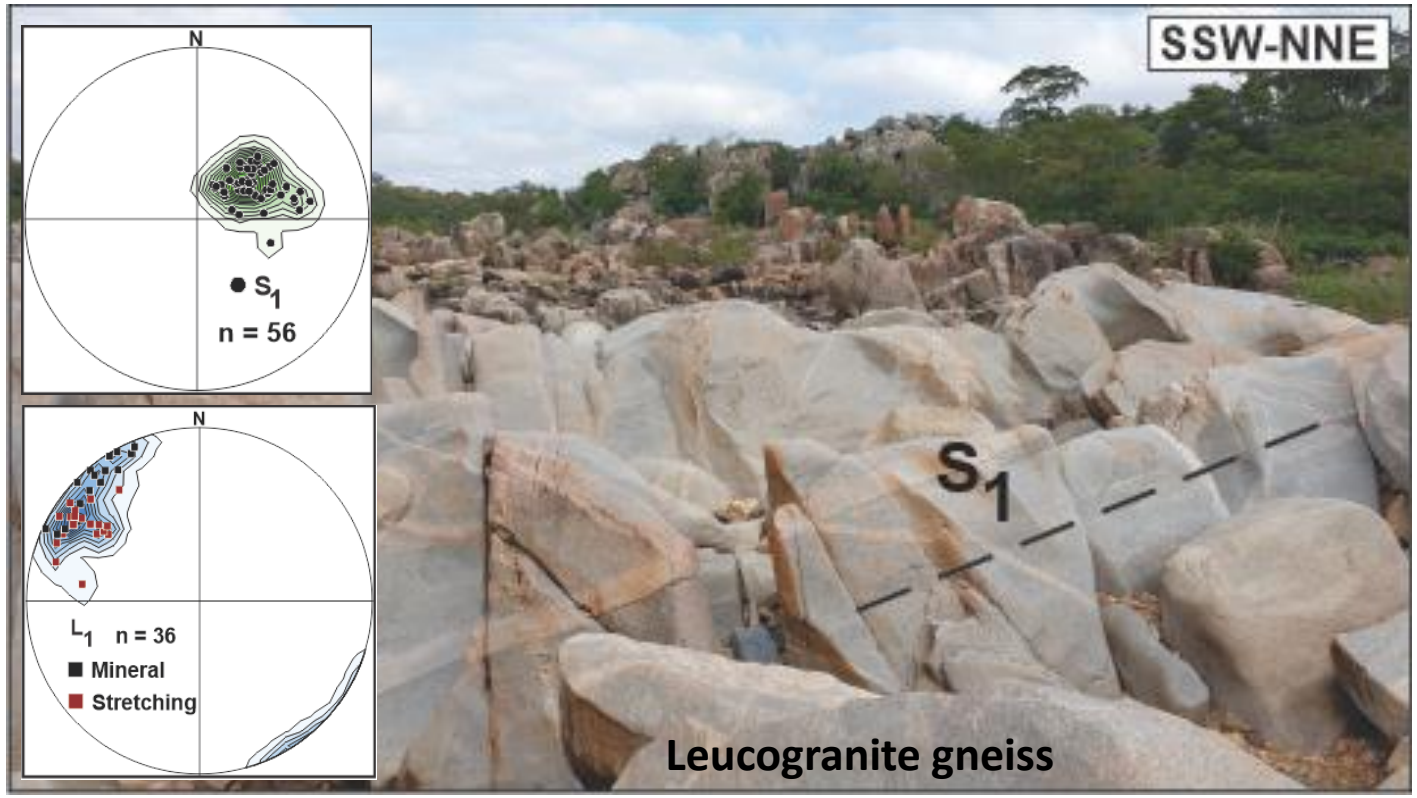
Deformation

- 3 deformation events recorded

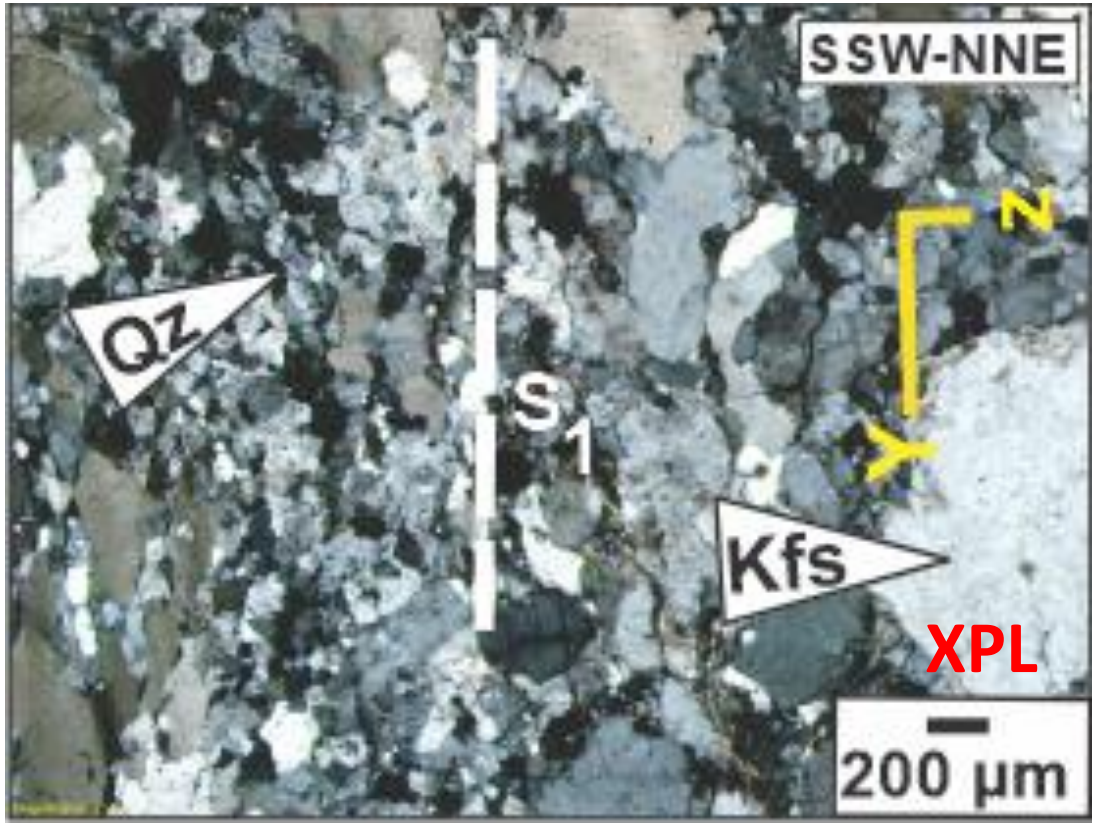


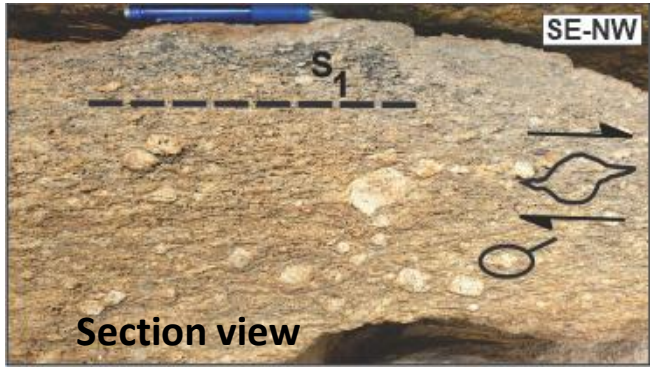
Modified after Worst (1962)

D_1 event – granite gneisses



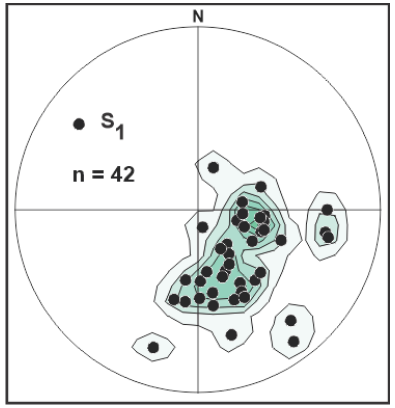
- Ductile deformation (300-450°C)

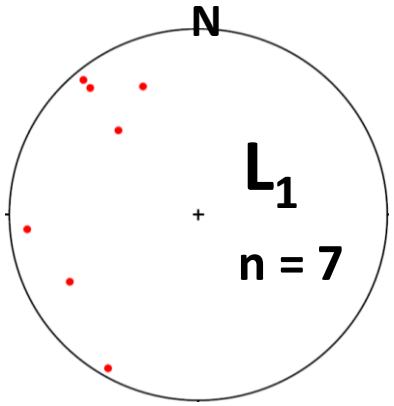


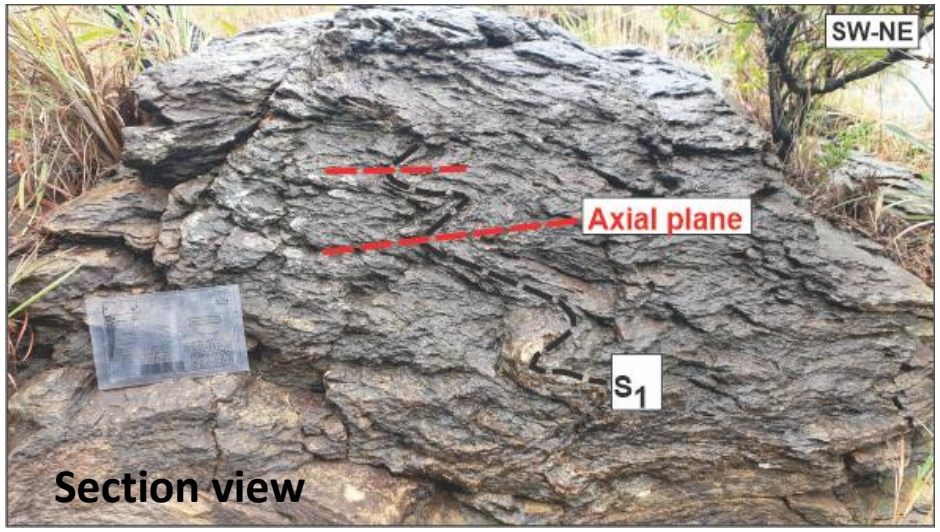


Porphyritic leucogranite gneiss

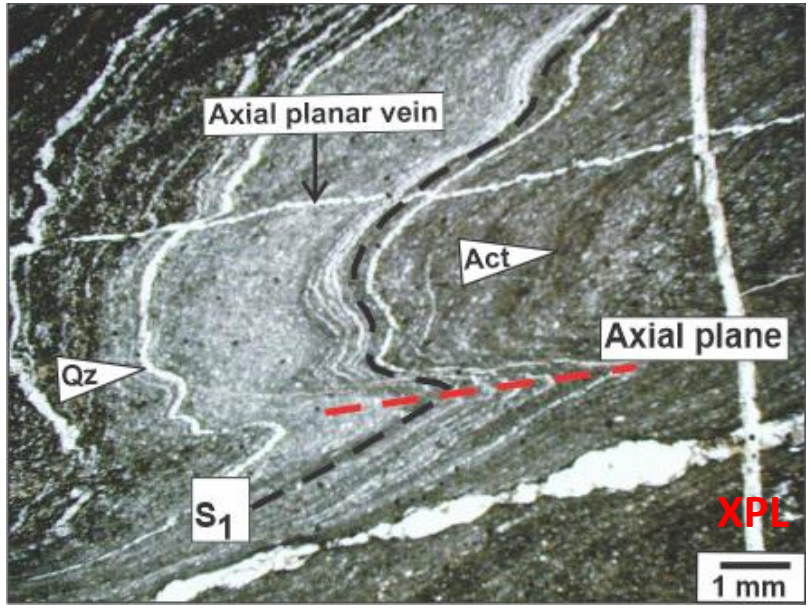
D_1 event – supracrustal rocks

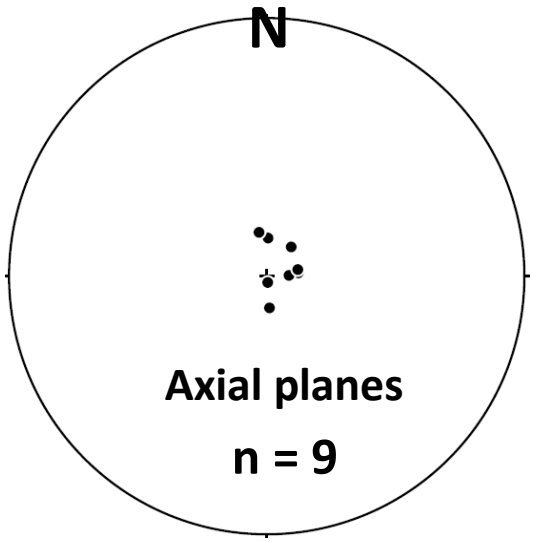


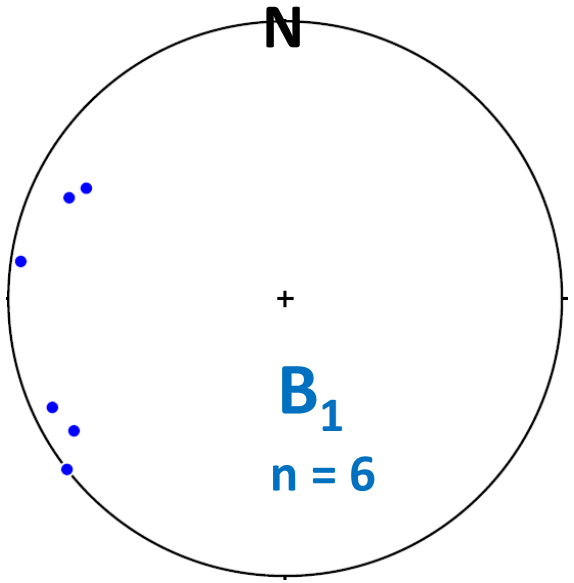




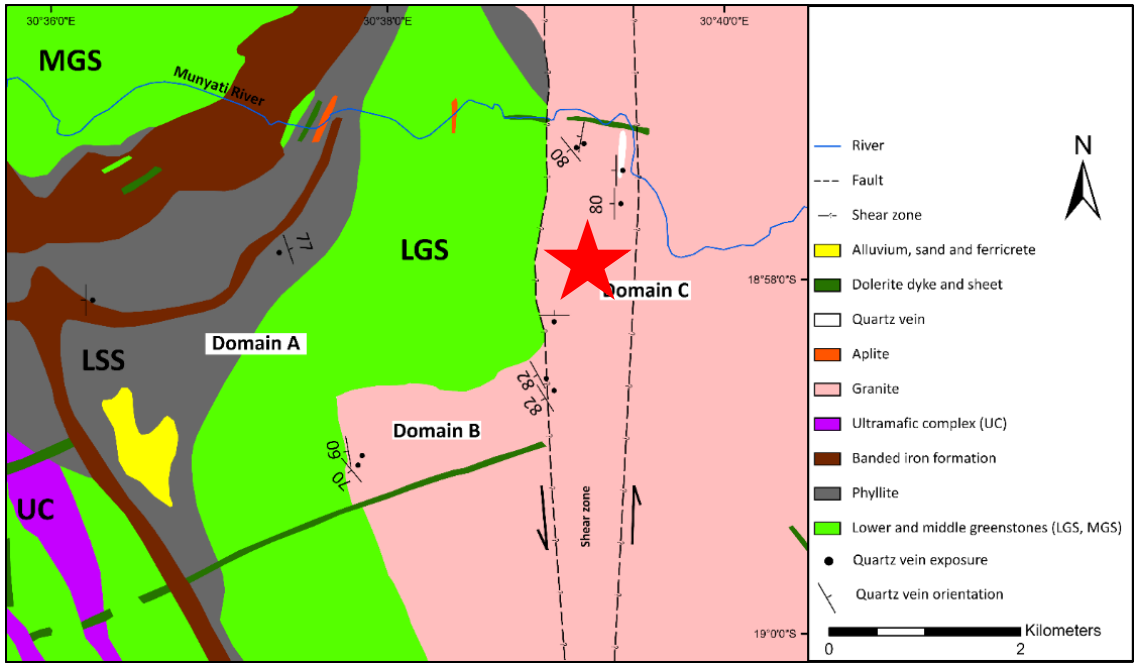
Medium-laminated pelitic schist







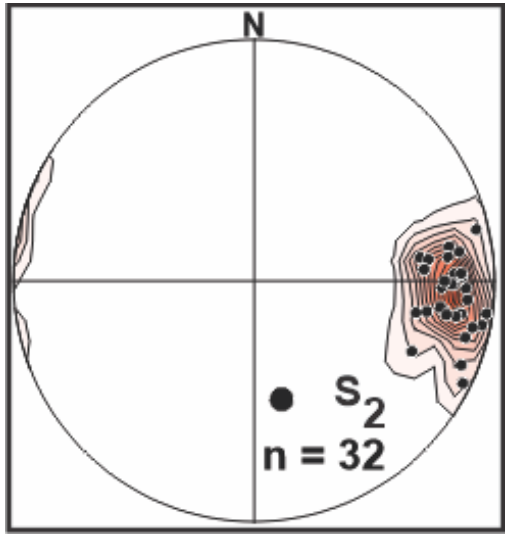
D_2 event - Mhou Shear Zone (MSZ)

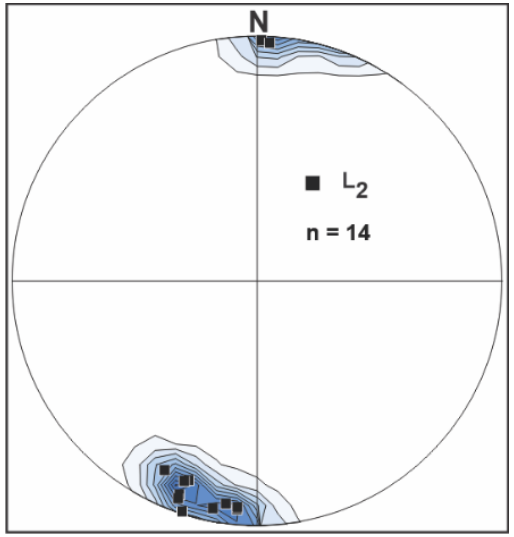


Ultramylonite

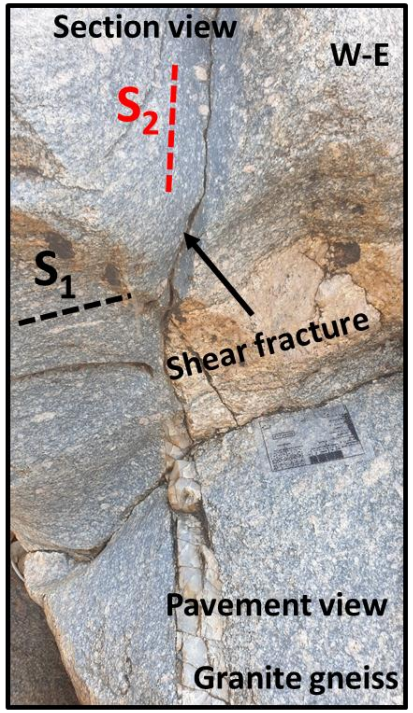
Protomylonite

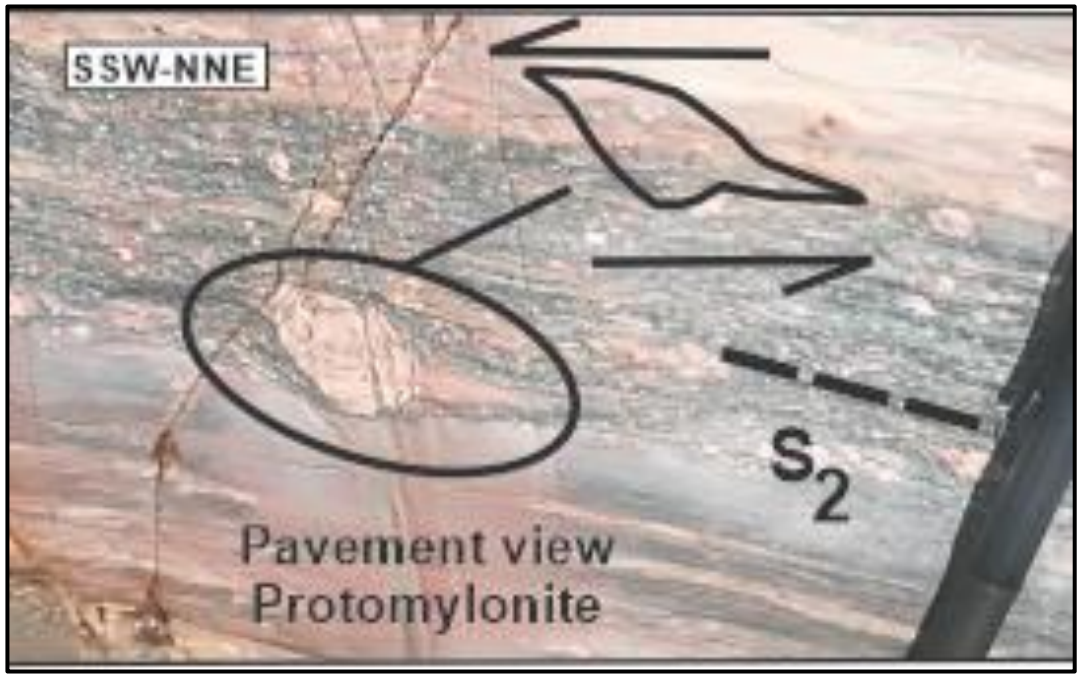
D_2 event

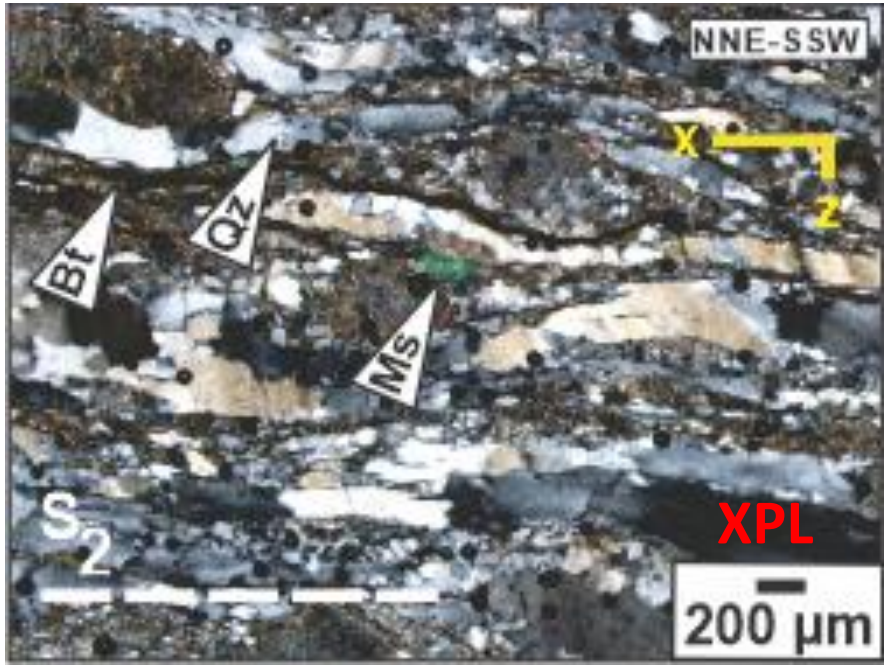




- Crystal plastic deformation in quartz, quartz ribbons
- Ductile deformation (400-550 °C)
- Between NW-SE and NNW-SSE directed shortening



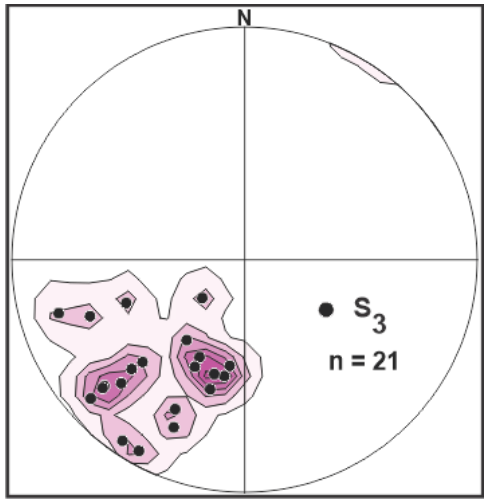


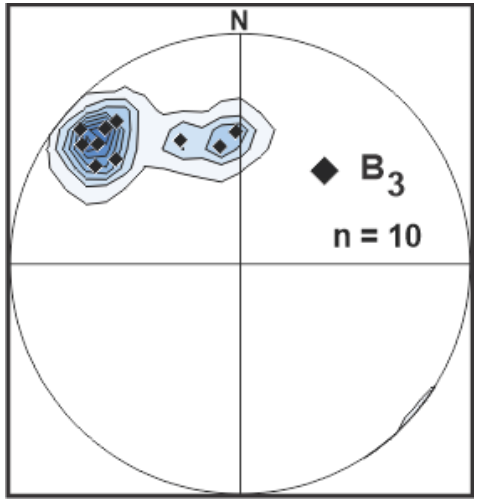


D_3 event

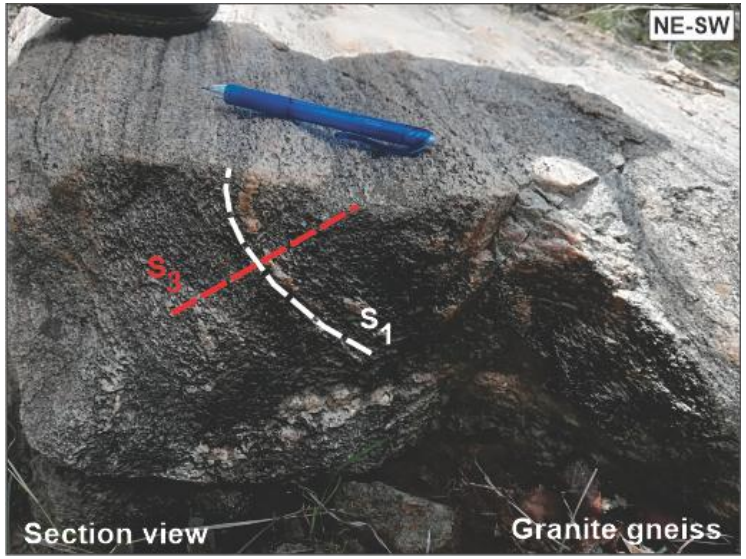
- Cm-dm-scale box, open and inclined F_3 folds
- Moderately NE-dipping axial planes and axial planar cleavage S_3
- NE-SW shortening

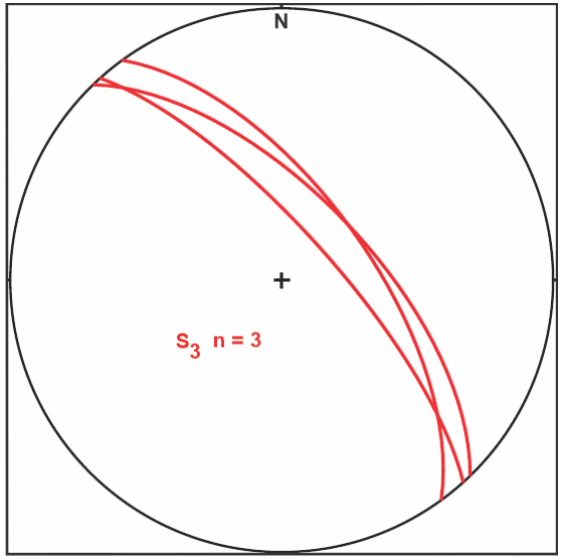
Supracrustal rocks

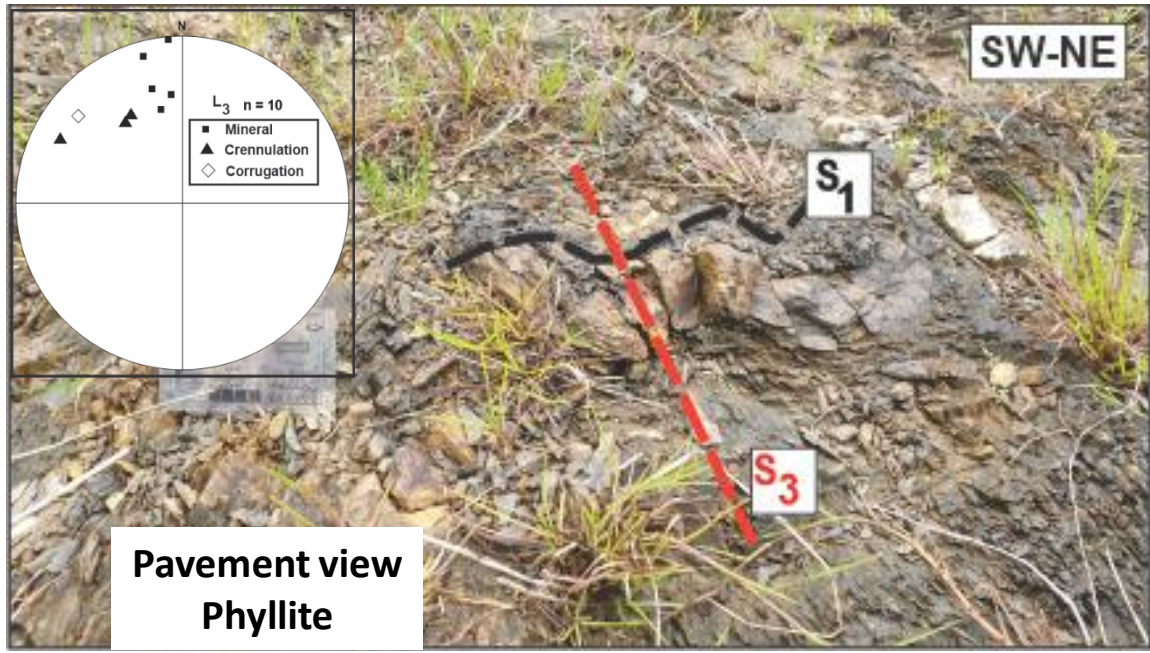




Granite gneisses W of the MSZ

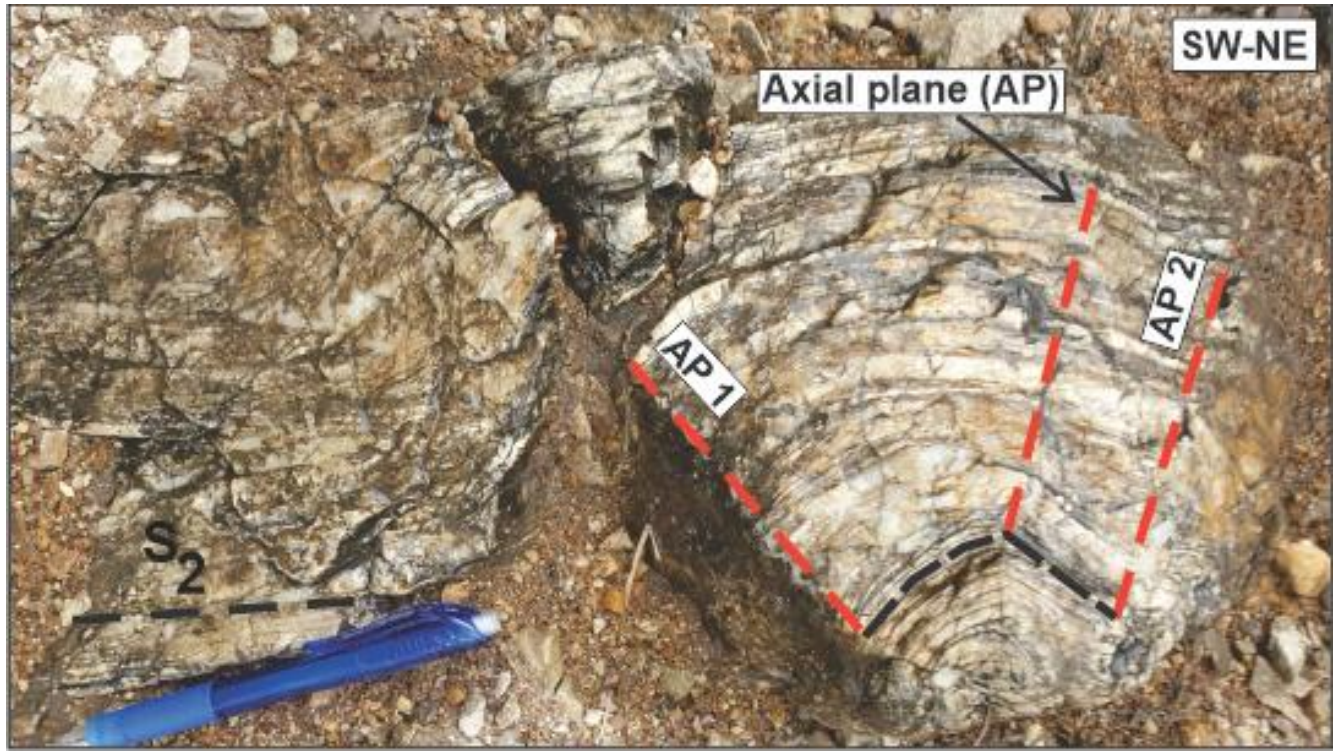


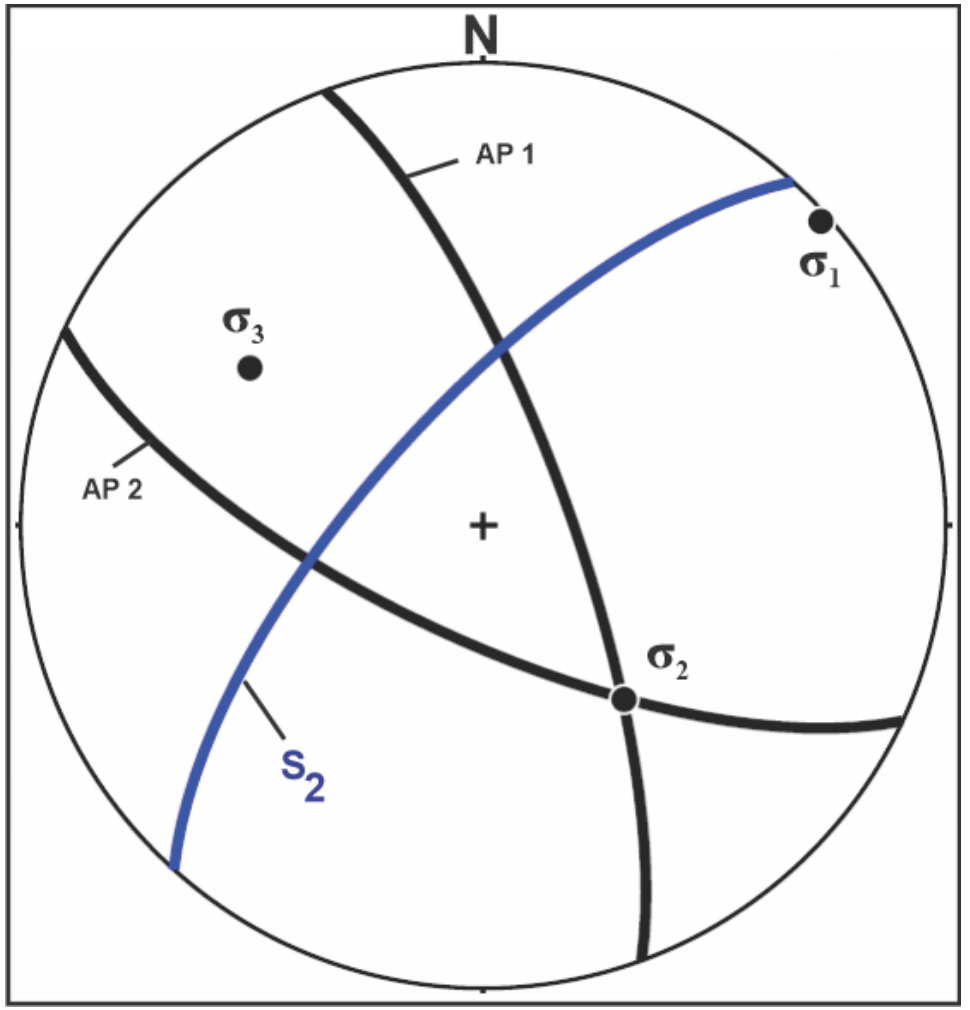




D_3 event

- Paleostress direction reconstruction after Ramsay and Huber (1987) – box folds
- NE-SW shortening inferred from **F_3** box folds





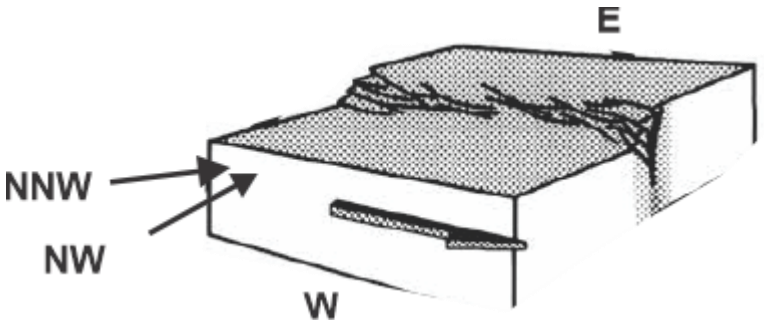
Interpretation of deformation events

D_1

- Contractional regime with a top to the NW simple shear component
- Ductile deformation

D_2

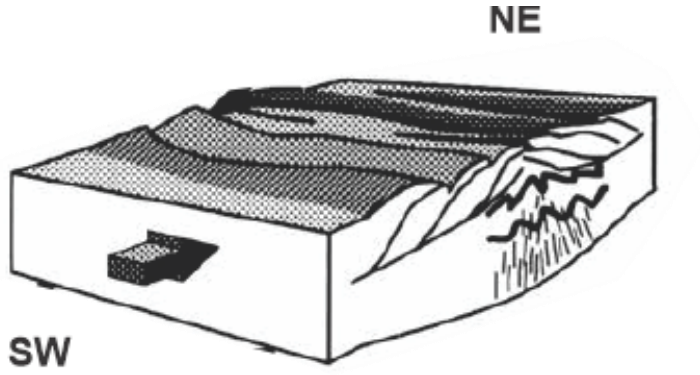
Wrench dominated transpression



- Medium grade mylonites
- Ductile deformation

D_3

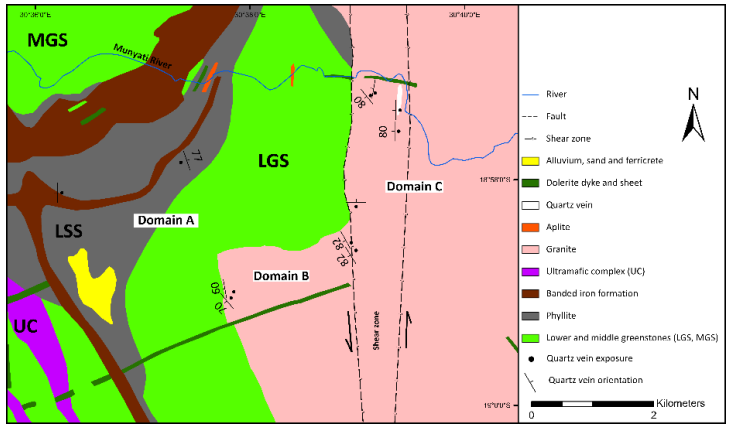
Contractional regime



- Brittle-ductile deformation

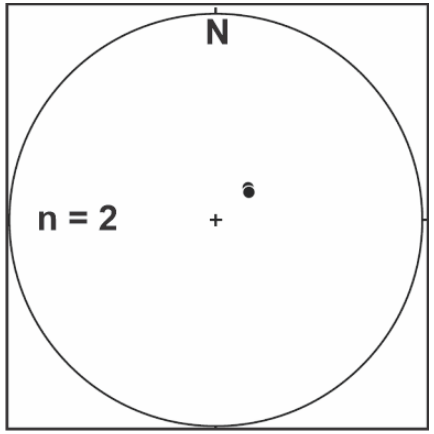
Sketches modified after Fossen et al (1994)

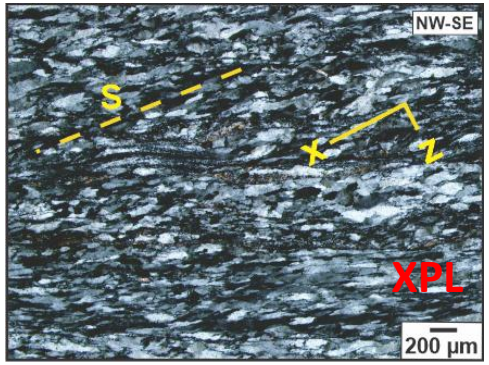
Quartz veins



Veins W of the MSZ

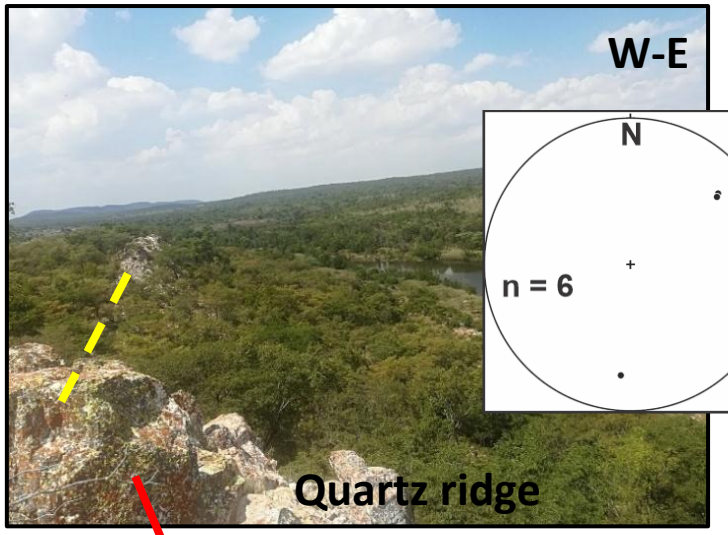
- M-thick, shallowly SW-dipping
- Pre- or early syn-**D_1**

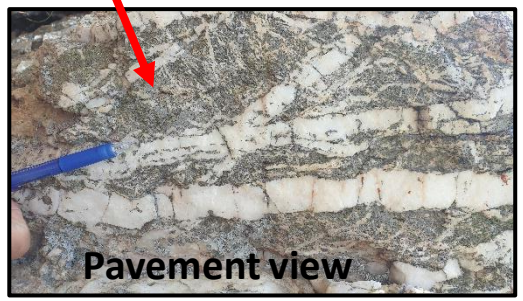


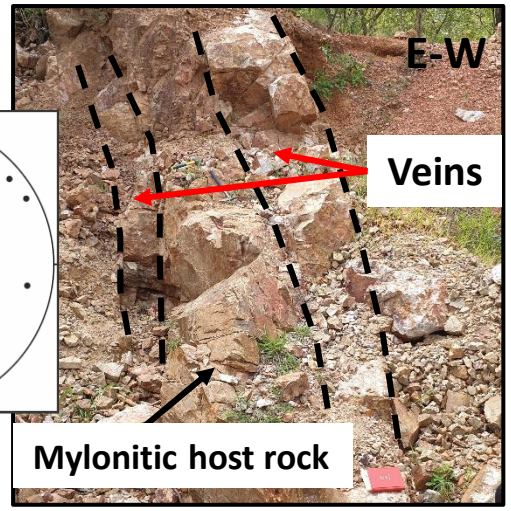


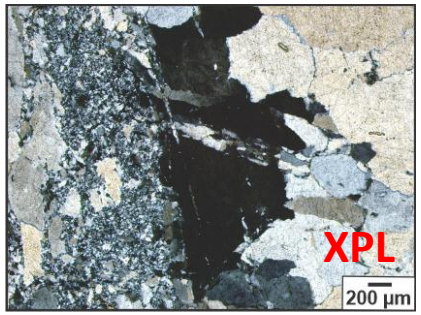
Veins in the MSZ

- Steeply SW-W- and N dipping
- Dm-thick; m-thick up to ~40 m thick
- Post-**D_2** veins
- More than one fluid injection event



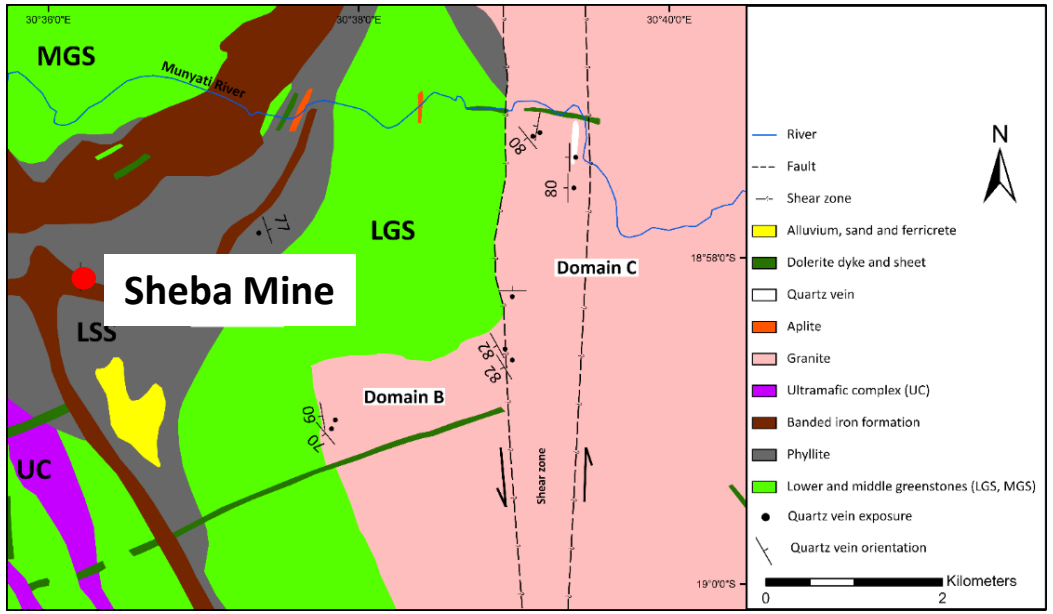






Gold mineralisation

- Gold mineralisation occurs in both the MGB and adjacent granitoids
- Gold mineralisation hosted by quartz veins
- Not enough information about mineralisation in the MGB
- In the MSZ, post D_2 veins mineralized (this study)
- Mineralised veins generally SW-dipping (this study)
- Very low grades, averaging 5g/t (From small scale miners)



Au assay results

MGB – Sheba Mine

3 g/t

Veins W of MSZ

0.01 g/t

MSZ veins

W-dipping veins

Average – 0.01 g/t

SW-dipping veins

0.03 g/t & 0.13 g/t

Take home messages

- Polyphase deformation in the MGB - 3 deformation events lower-upper greenschist facies
- **D_1** – recumbent folding in the supracrustal rocks and top to the NW-shearing in the underlying granite gneisses, **D_2** - wrench dominated transpression and **D_3** - contractional tectonic regime
- Two generations of quartz veins recognized i.e. pre- or early syn-**D_1** and post **D_2**
- Gold mineralisation hosted in post **D_2** quartz veins, grades generally low

Acknowledgements

- GSZ is thanked for the opportunity to present
- Prof K.S. (Fanus) Viljoen (SARChI Geometallurgy) is thanked for funding the project. Prof K.S. (Fanus) Viljoen acknowledges funding from the South African Department of Science and Innovation through their Research Chairs initiative, as administered by the National Research Foundation (NRF)

Thank you

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