

# Remote Mapping in the Northern Gawler Craton

## *Ooldea to Oolgelima*

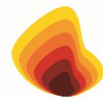
Jack Percival | November 2025

*Claire Wade, Dillon Brown, Mark Pawley,  
Frank Rarity, Rashed Abdullah*



**GEOLOGICAL  
SURVEY OF**  
South Australia

**DISCOVERY DAY**



**MinEx CRC**

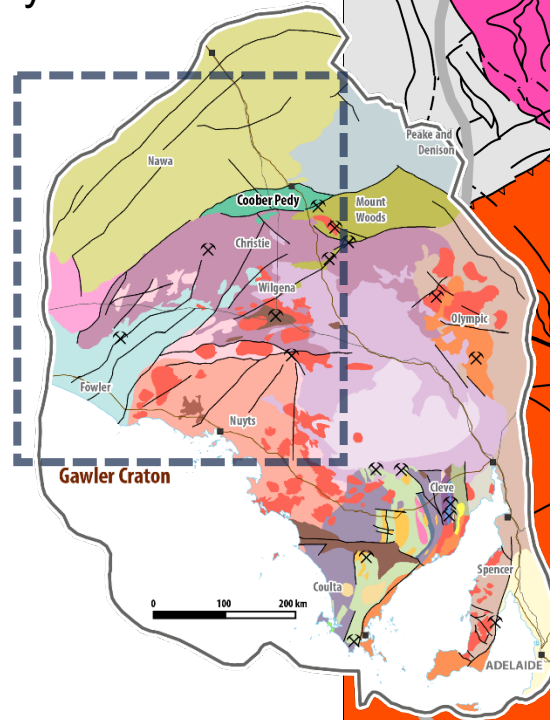


# Aims

- South Australia Discovery Mapping:
  - Update published geological interpretations and solid geology maps of the Gawler Craton
  - Incorporate solid geology into a machine-readable statewide digital map and data delivery system
- The published data, **SA Geology**, includes recompilation of the western half of the Gawler Craton

## Solid Geology of South Australia

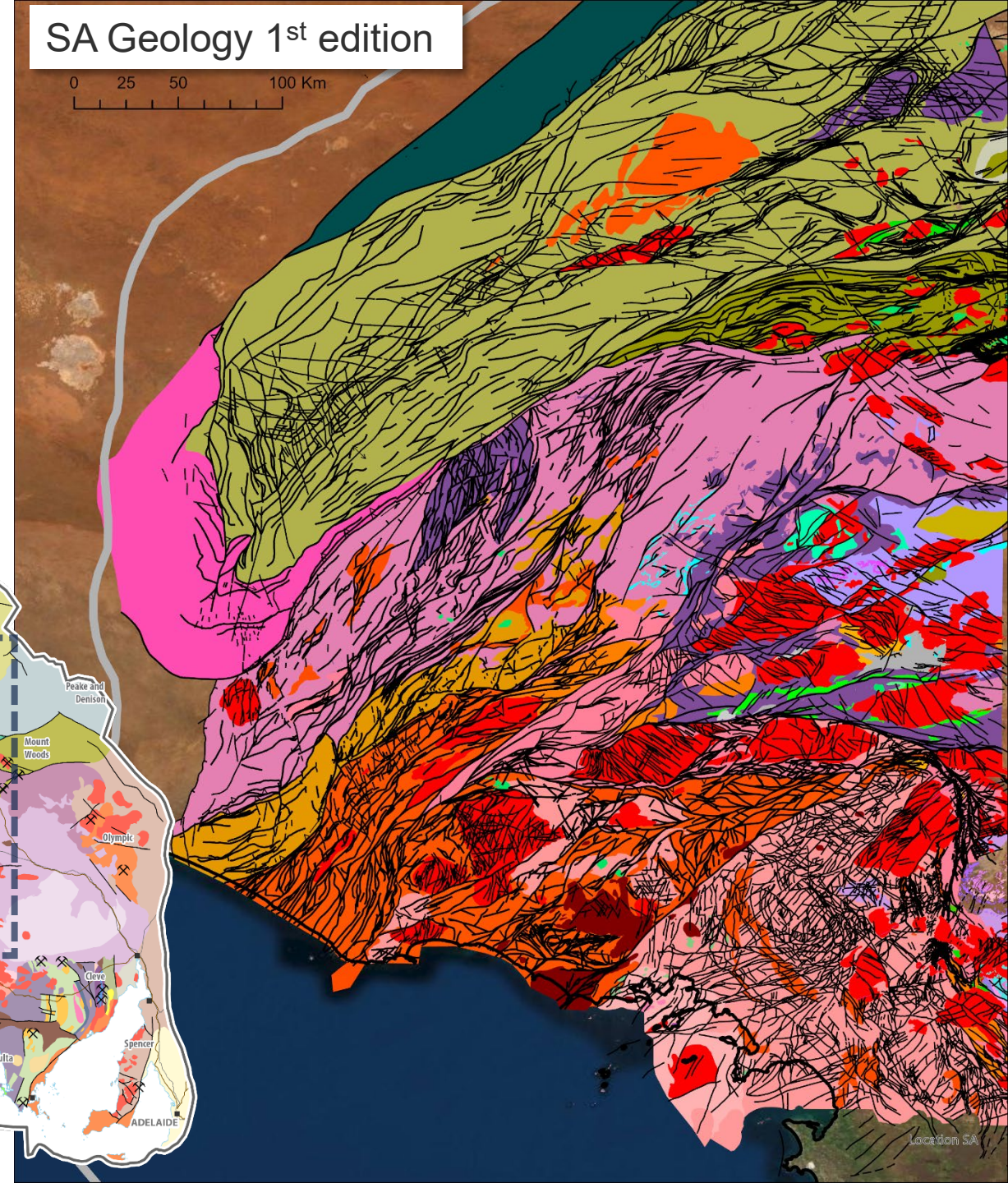
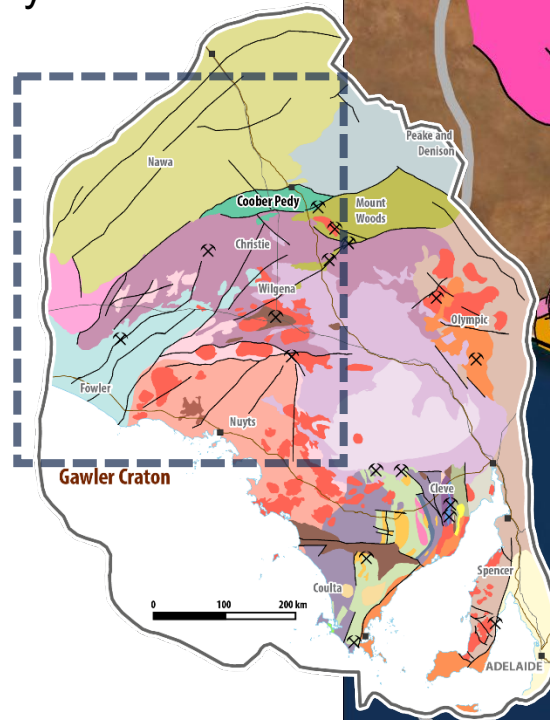
0 25 50 100 Km



**GSSA**  
**DISCOVERY DAY**

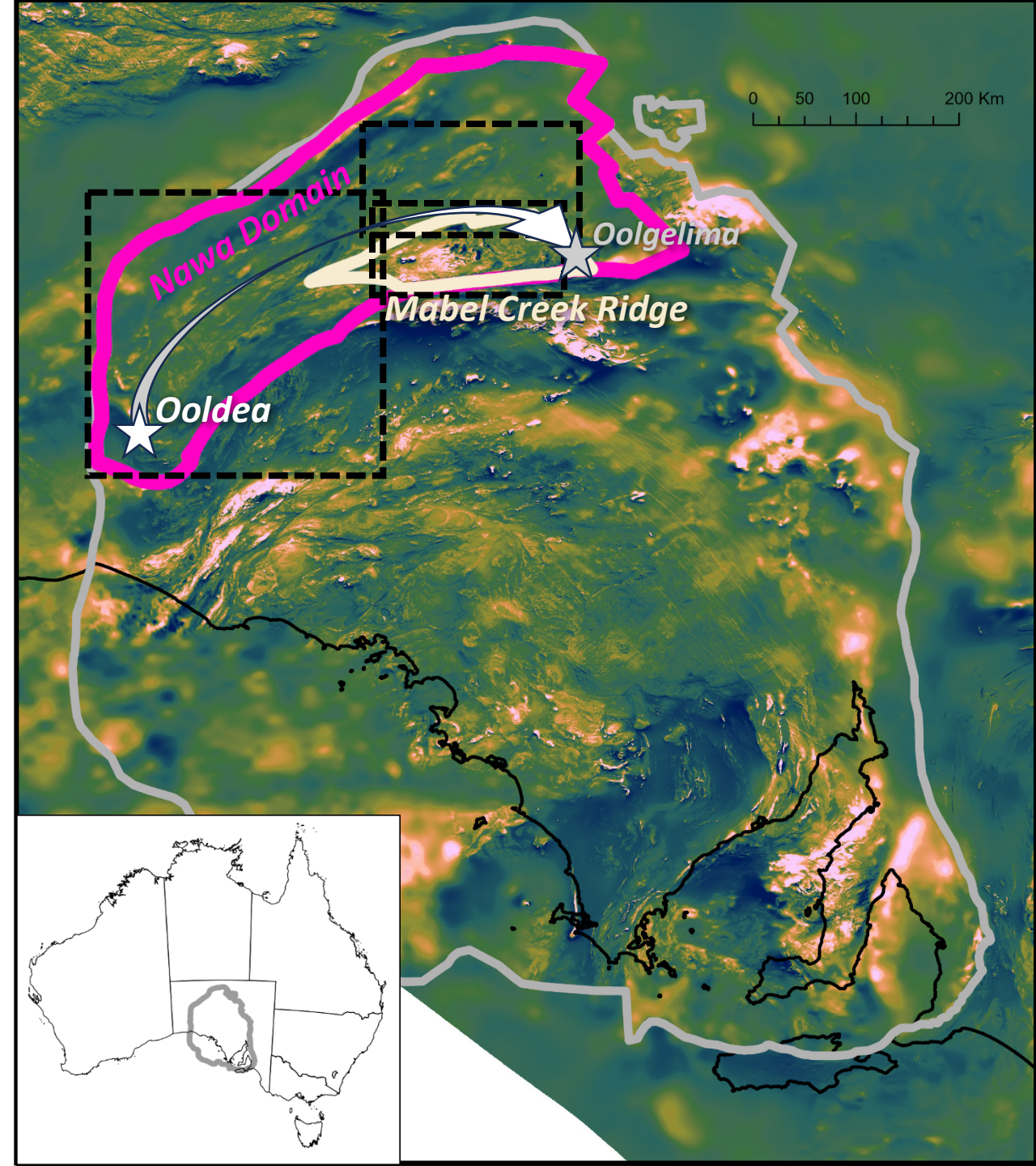
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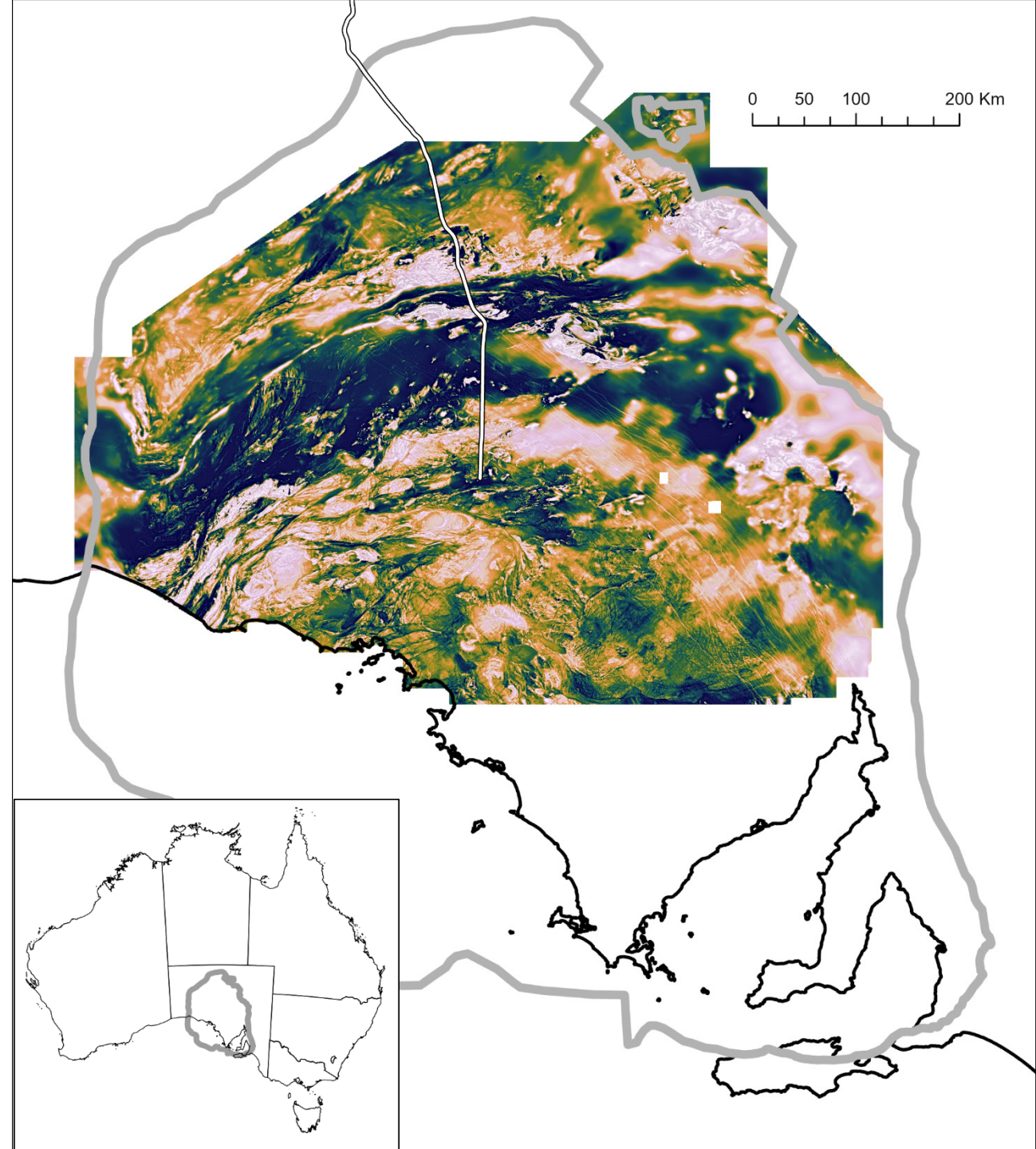
# Aims

- Interpretation of covered basement geology in the **Nawa Domain** of the *northern Gawler Craton*
  - *Ooldea to Oolgelima*
- Comparison of structural/metamorphic evolutions of:
  - **Western Nawa Domain**
  - **Northern Nawa Domain**
  - **Mabel Creek Ridge subdomain**

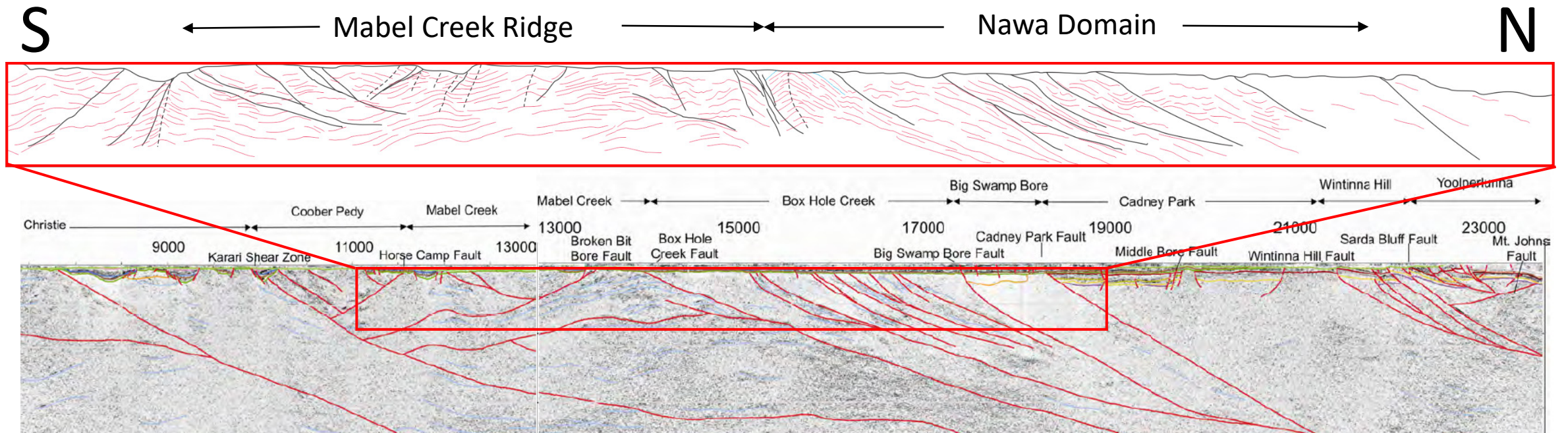


# Methods

- Aeromagnetics
  - *Gawler Craton Airborne Survey (GCAS)*
  - Identify structures, boundaries, lithologies, and anomalies
- Drillcore
  - Constrain lithologies
- Seismics
  - *08GA-OM1 (GOMA) Seismic Line*
  - Estimate steepness and depth of major structures and fabrics



# Seismics – GOMA Seismic Line (08GA-OM1)



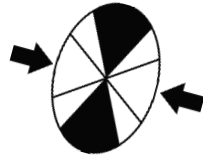
Korsch et al. (2010)



# Background – Tectonic events

Paleoproterozoic

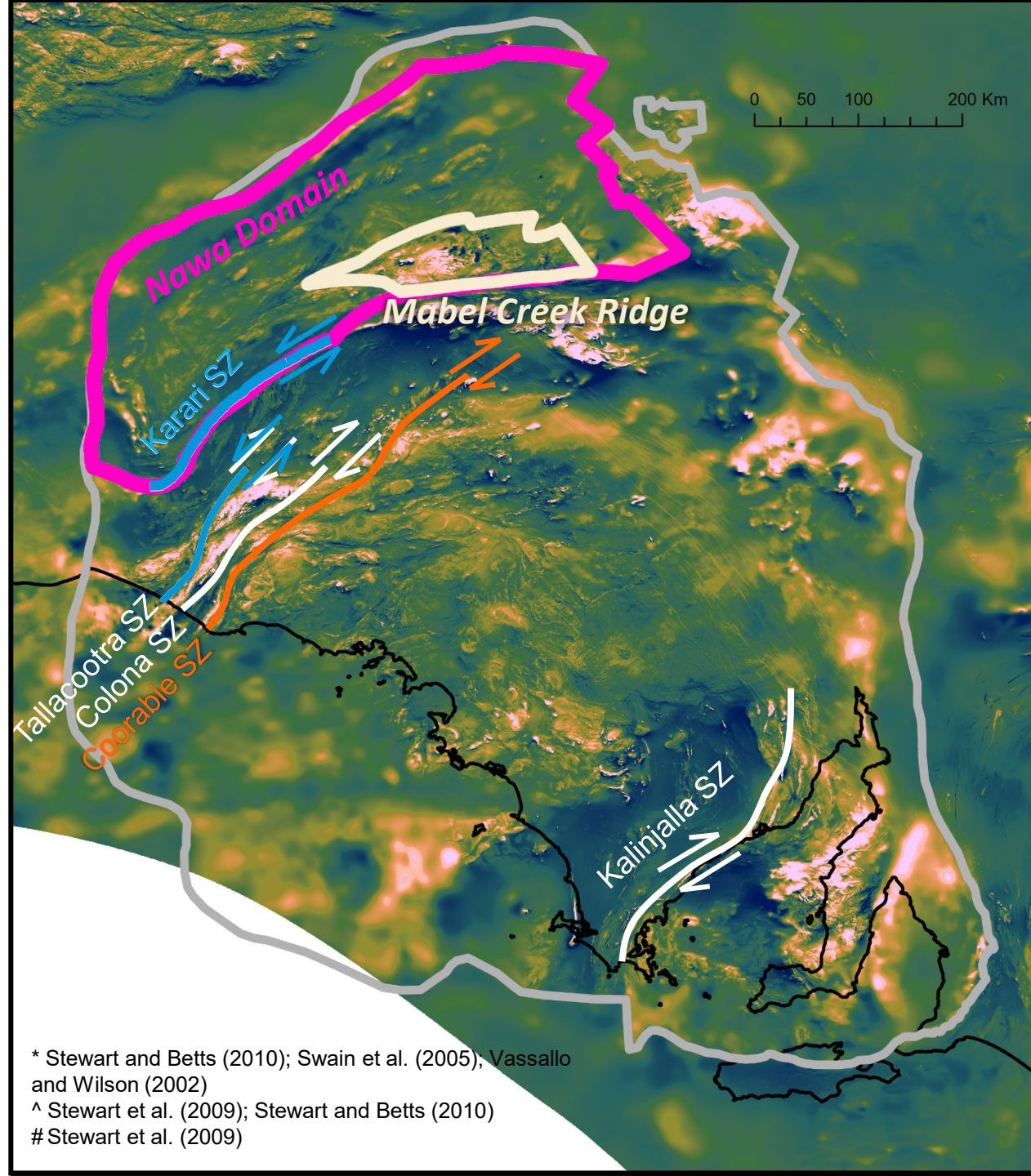
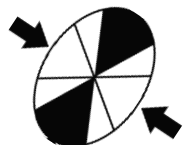
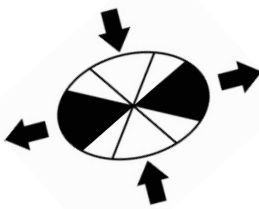
- **Kimban Orogeny** (ca. 1730–1690 Ma)
  - Dextral transpression\*
  - W–E to NW–SE directed shortening
- **Ooldean Event** (ca. 1660–1650 Ma)
  - Kinematics – ?
  - Shortening/stretching direction – ?



?

Mesoproterozoic

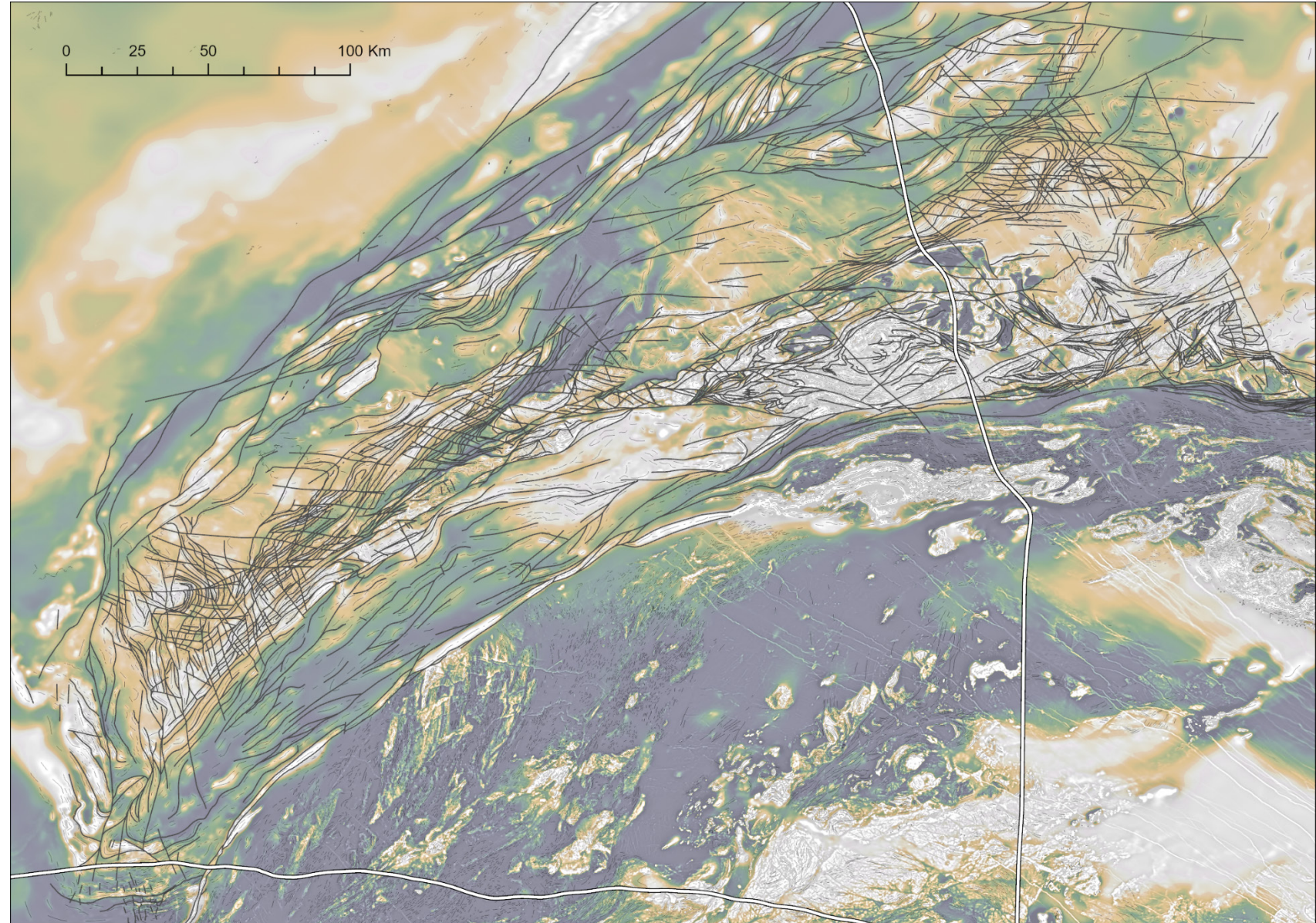
- **Olarian Orogeny** (ca. 1620–1550 Ma)
  - Sinistral strike slip^
  - N–S to NE–SW directed shortening?
  - NE – SW directed extension?
- **Coorabie Event** (ca. 1500–1450 Ma)
  - Dextral transpression#
  - NW–SE directed shortening



\* Stewart and Betts (2010); Swain et al. (2005); Vassallo and Wilson (2002)  
 ^ Stewart et al. (2009); Stewart and Betts (2010)  
 # Stewart et al. (2009)

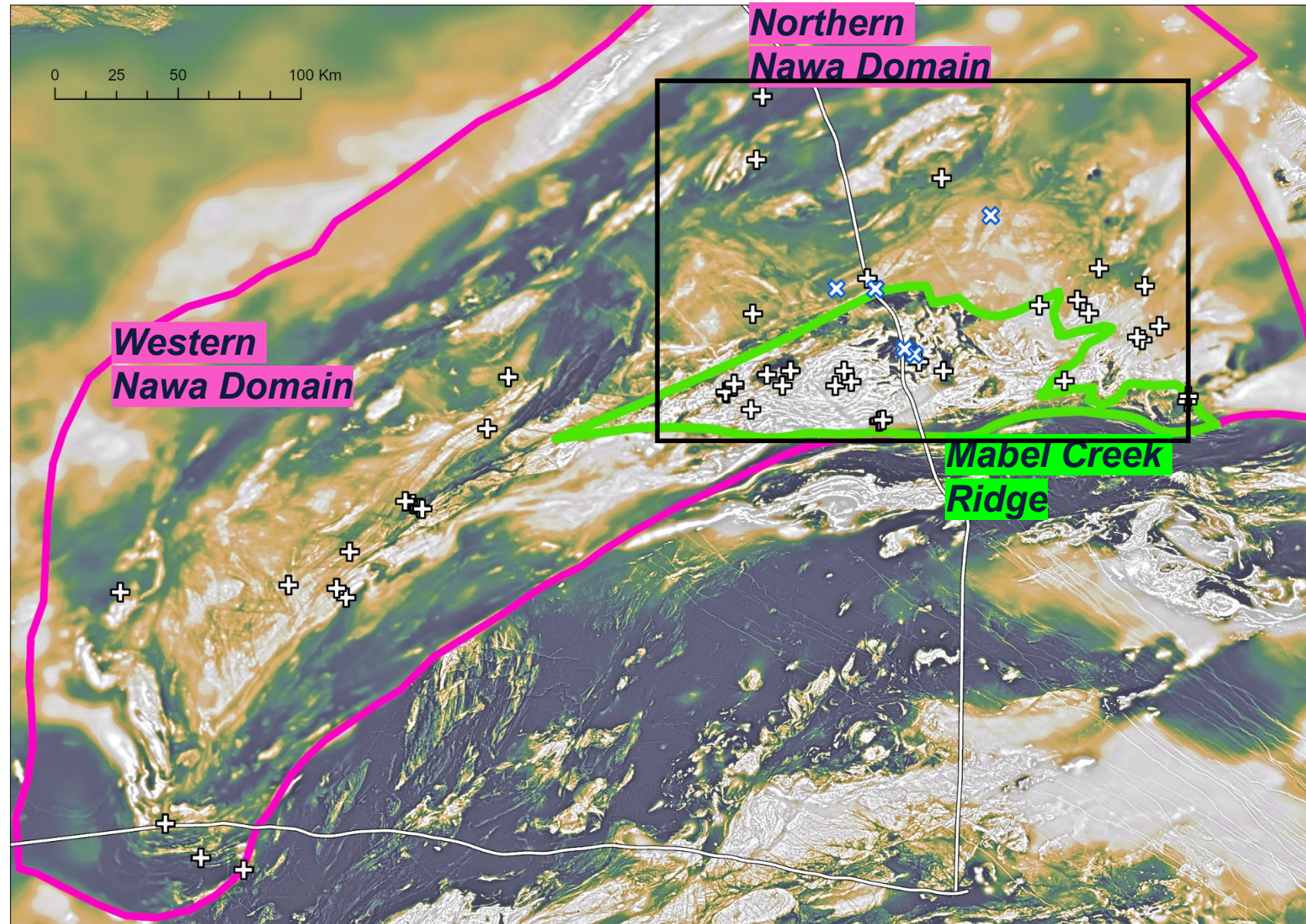
# Structural Interpretation

- Determine kinematics and orientations of structures
- Determine cross-cutting relationships
- Tie back to known geochronological constraints
- Develop structural model through time



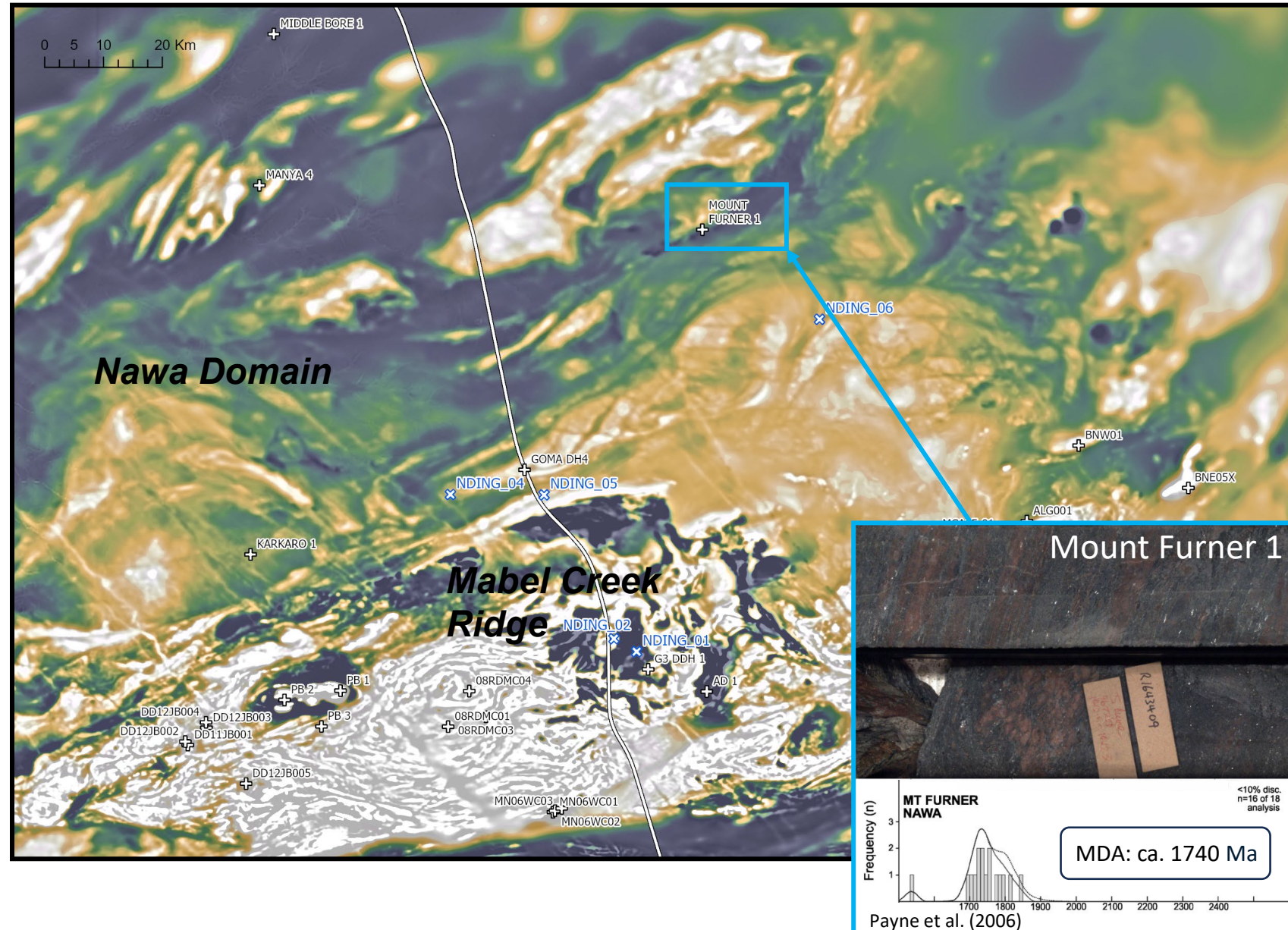
# Northern Nawa Domain

- Northern Nawa Domain
- Five drillholes intersect basement in the northern Nawa Domain
- Minor (?) mafic and felsic orthogneisses



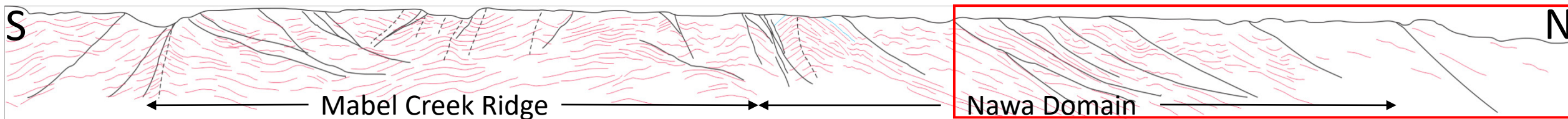
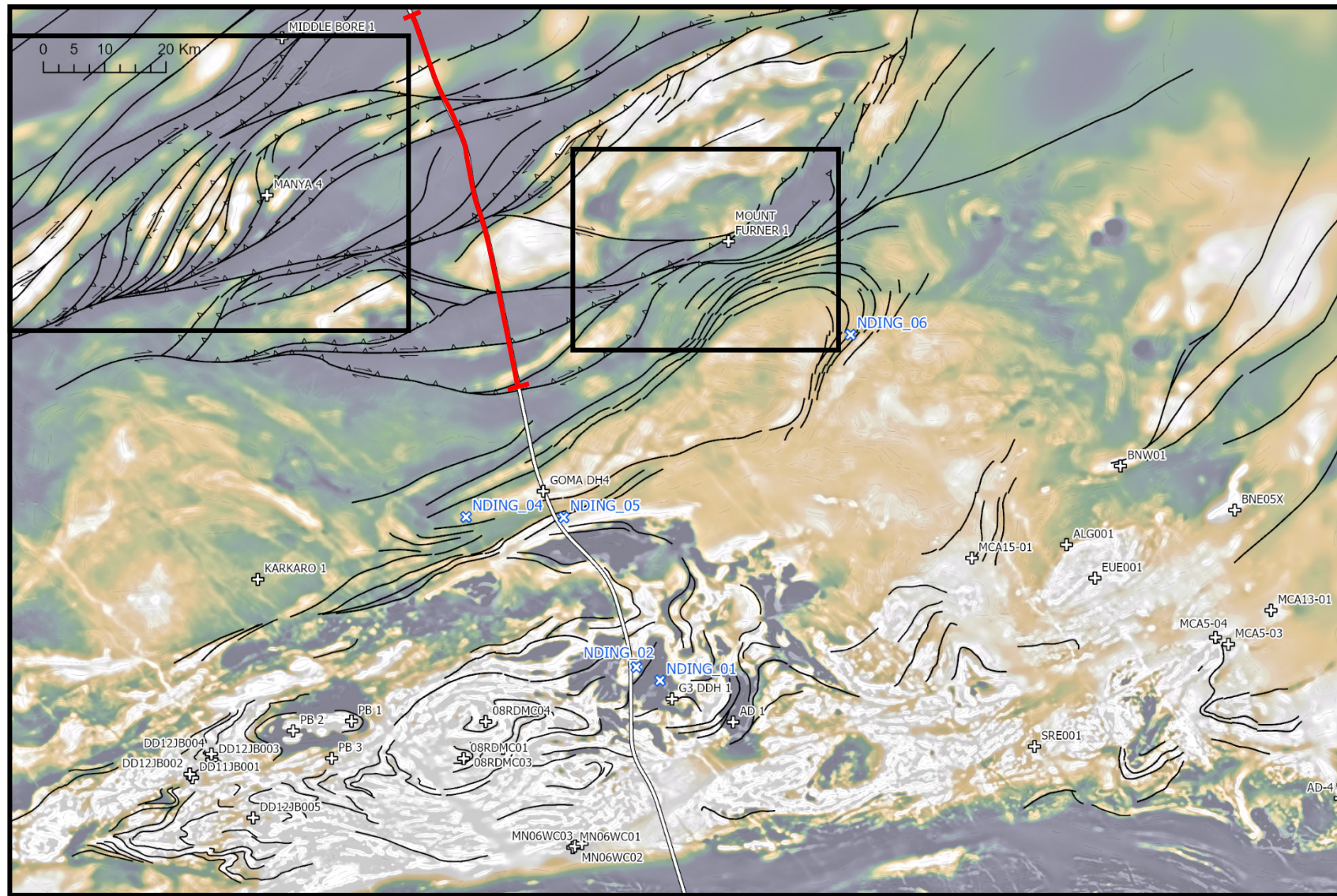
# Northern Nawa Domain

- Northern Nawa Domain
- Five drillholes intersect basement in the northern Nawa Domain
- Minor (?) mafic and felsic orthogneisses
- Metasedimentary gneisses
  - Max. Dep. Age ca. 1740 Ma



# Northern Nawa Domain

- ENE-trending structures
- Northward dipping structures
- Anastomosing, connected demagnetised shear zones



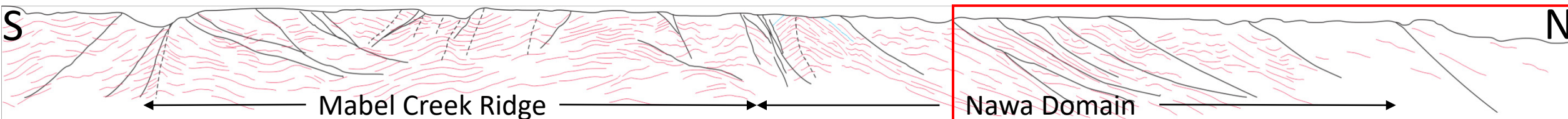
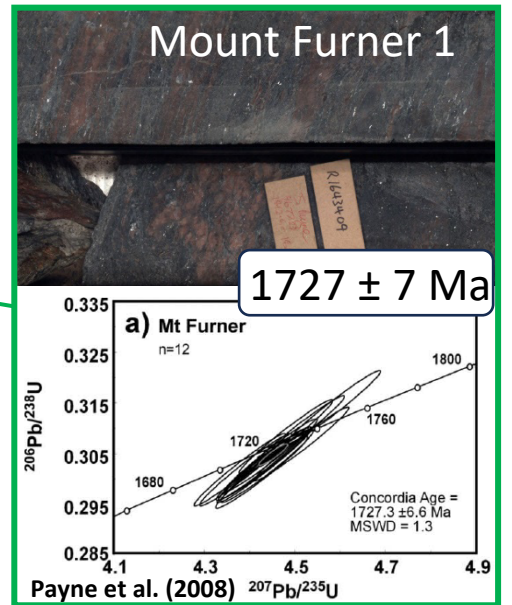
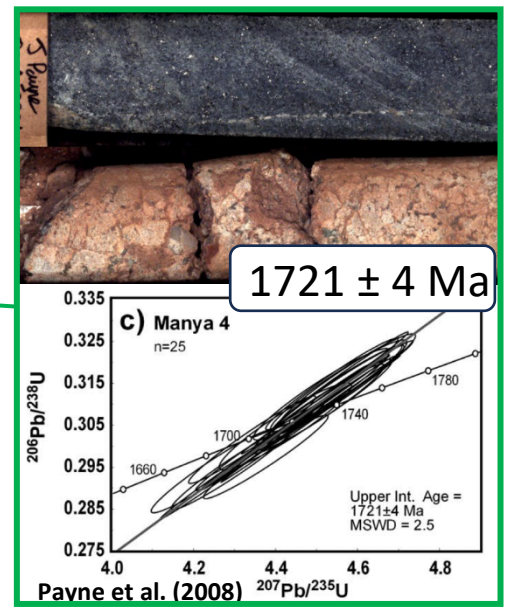
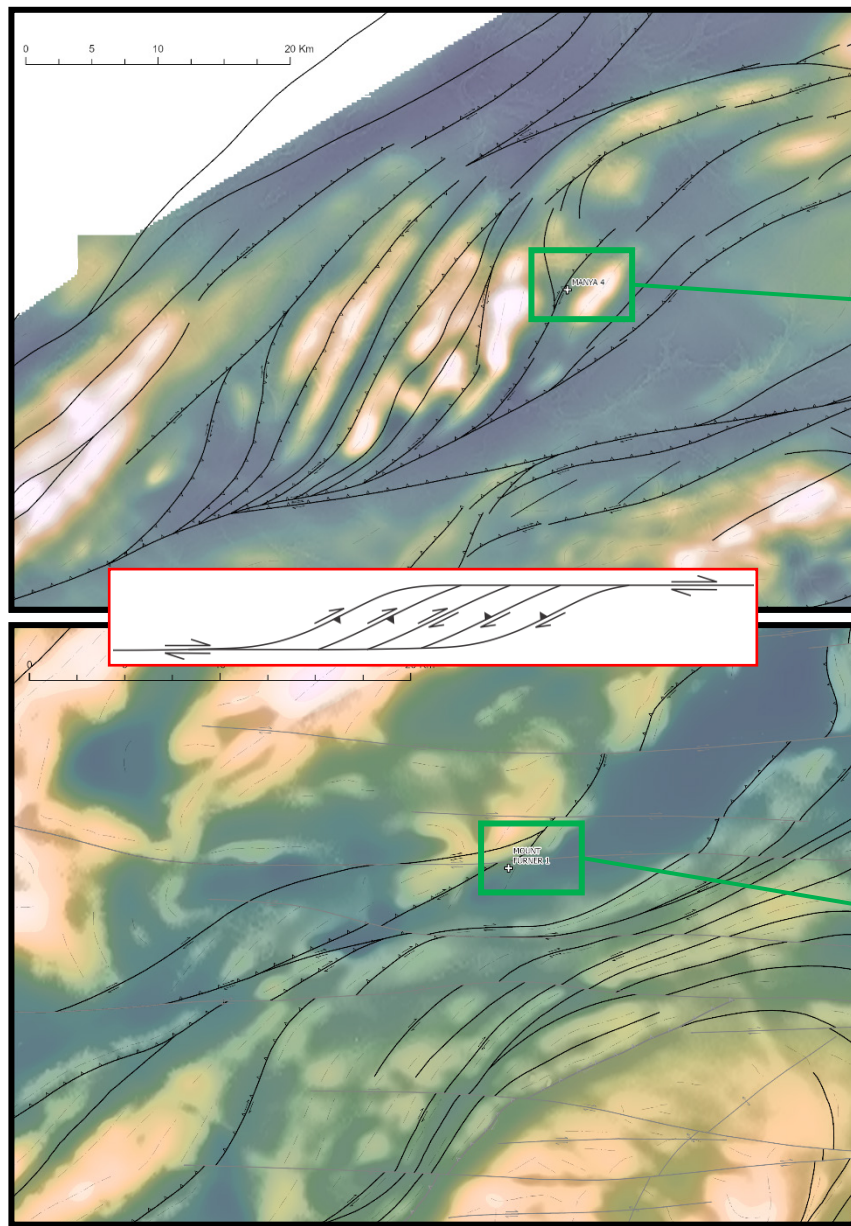
# Northern Nawa Domain

- Dextral strike-slip duplex structures and  $\sigma$ -shaped domains
- Northward dipping structures

Metamorphism and deformation:

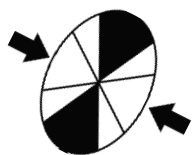
**ca. 1725 Ma**

*Early Kimban Orogeny*

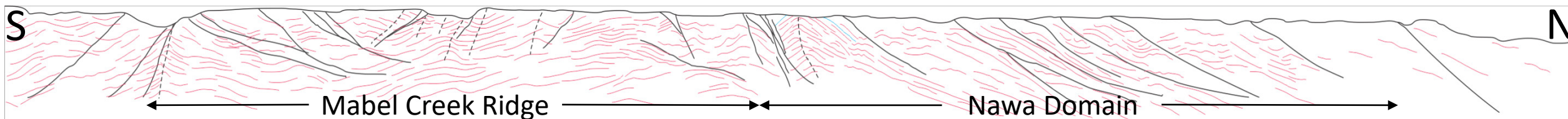
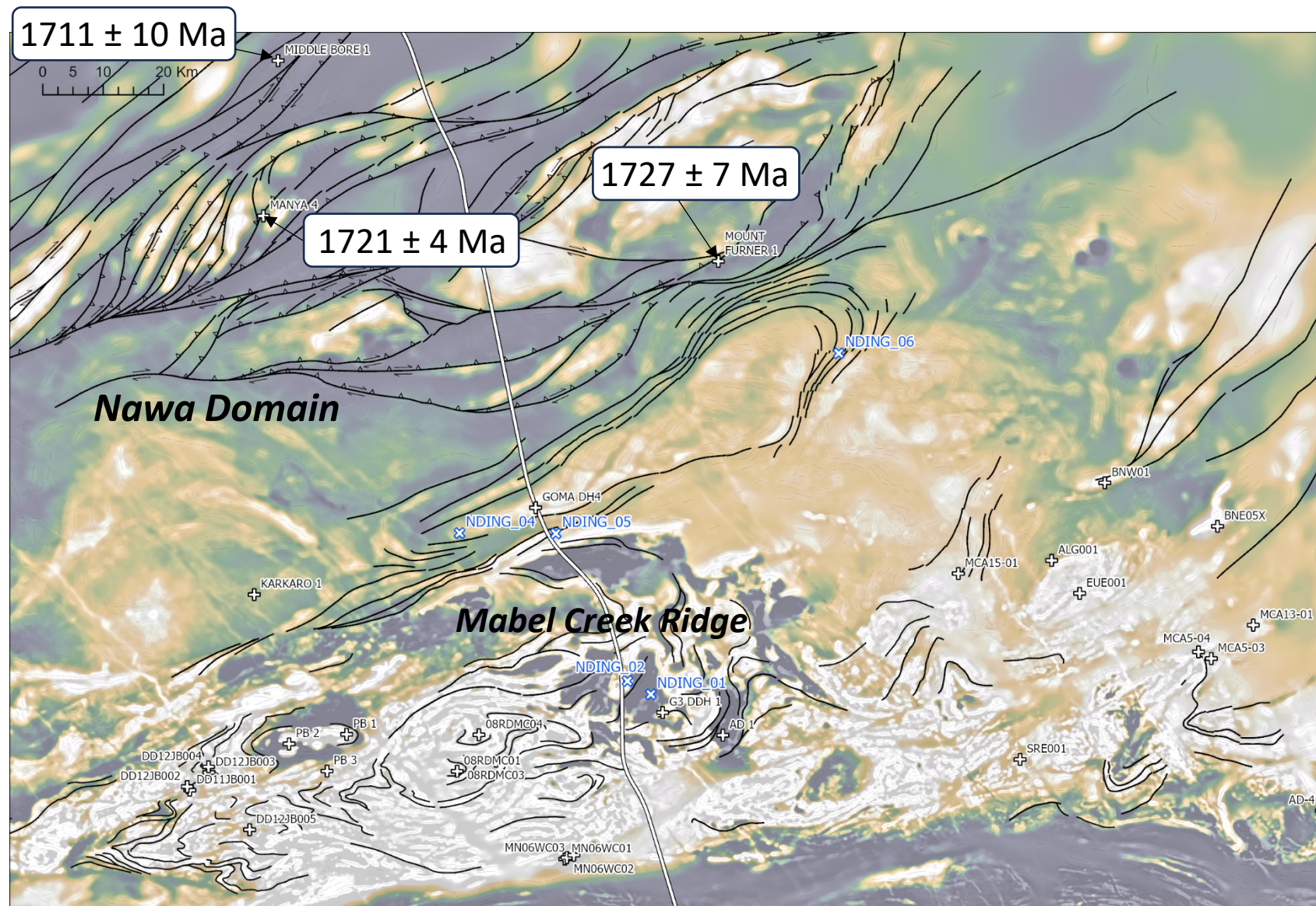


# Northern Nawa Domain

- Dextral transpression
- Top to ESE
- **WNW – ESE directed shortening\* during Kimban Orogeny from ca. 1725 Ma**

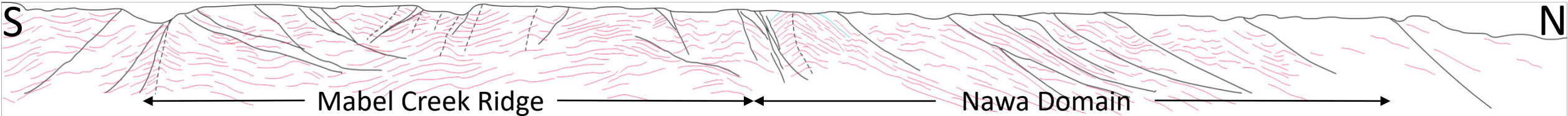
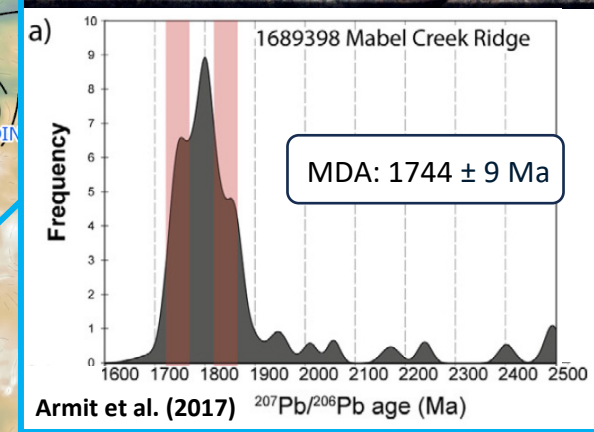
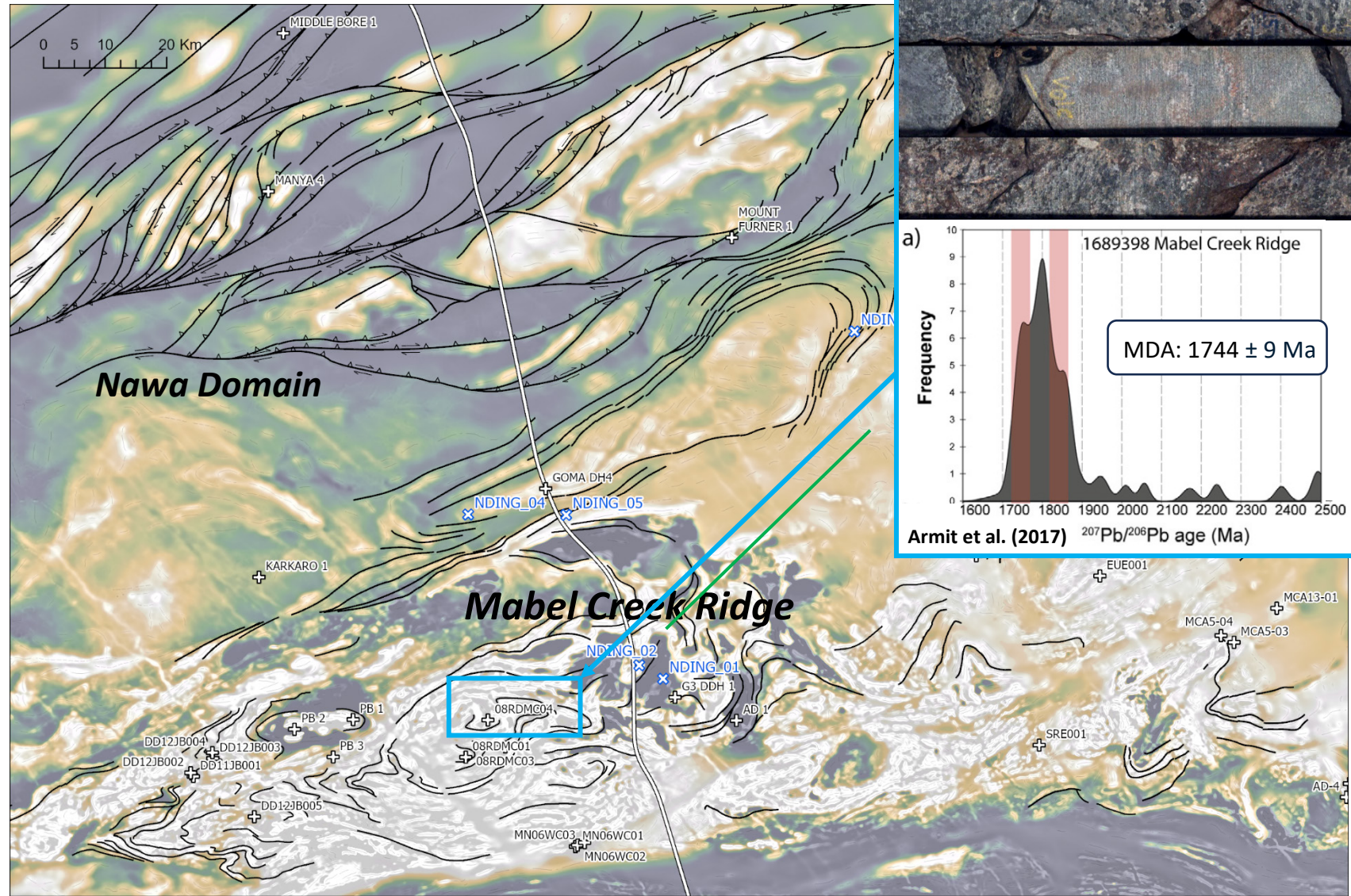


\*See: Baines et al. (2011); Payne et al. (2008)



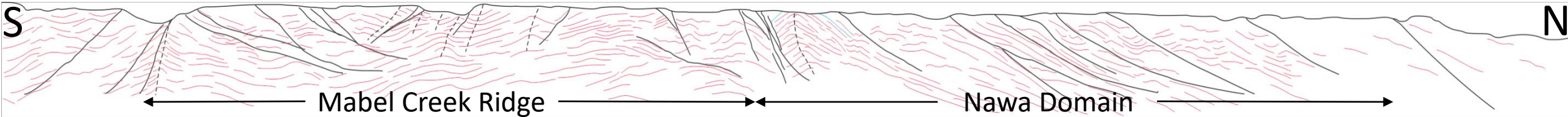
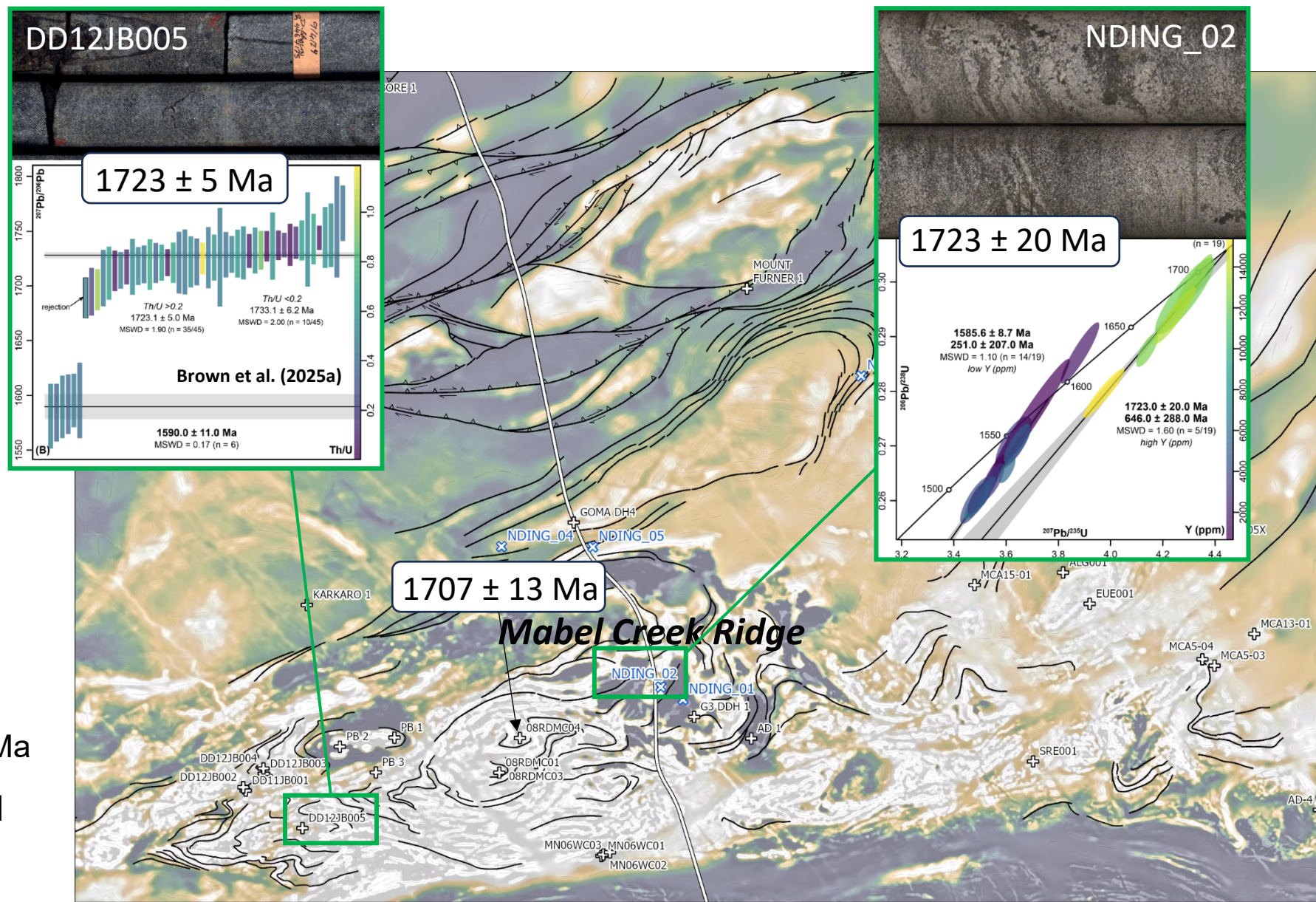
# Mabel Creek Ridge

- Mabel Creek Ridge
- A dozen or so drillholes intersecting basement
- Minor mafic and felsic orthogneisses
- Iron-rich metasedimentary gneisses
  - Max. Dep. Age ca. 1744 Ma



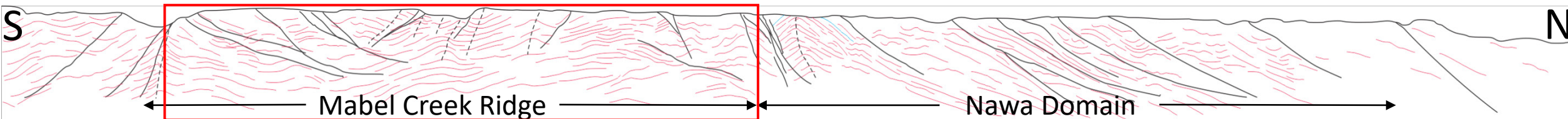
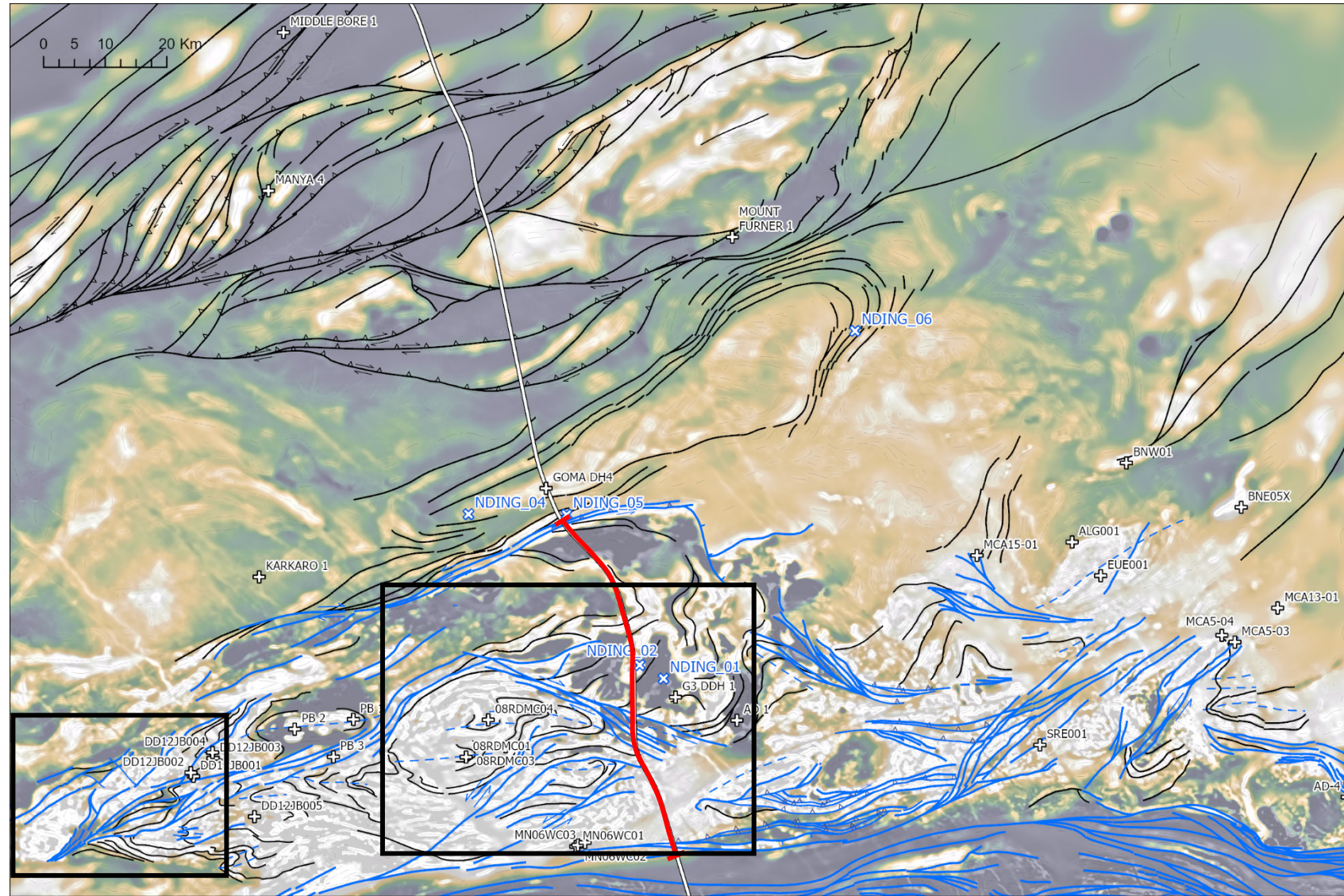
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  - Max. Dep. Age ca. 1744 Ma
- Kimban metamorphism and magmatism



# Mabel Creek Ridge

- Complexly deformed
- SE and SW trending shear structures
- E – W trending folds evident in magnetics and seismics



# Mabel Creek Ridge

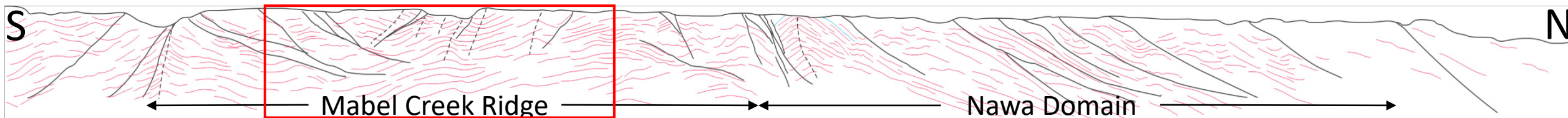
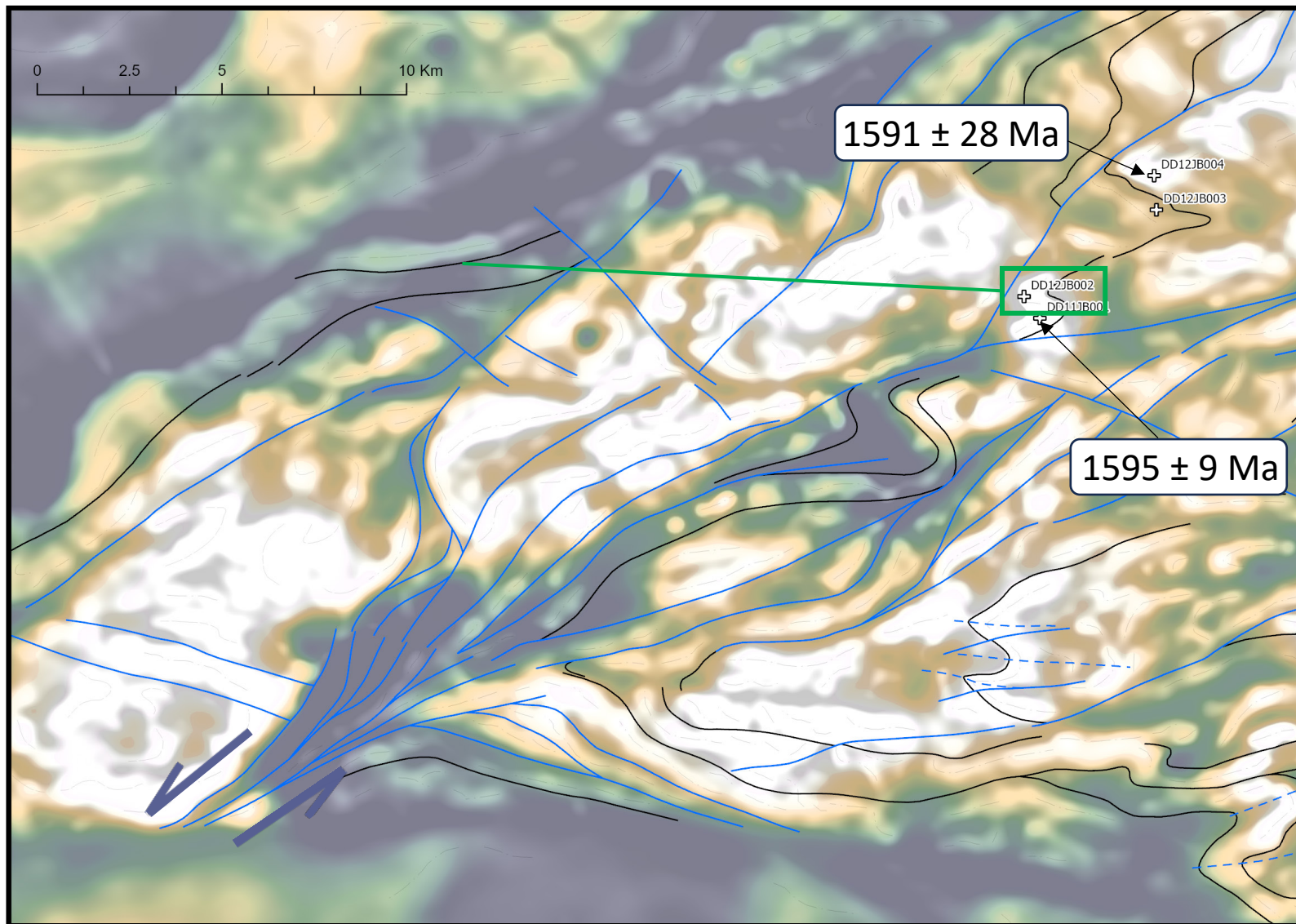
- Multiple generations of sinistral shearing
- Shear zones overprinting folds
- Granulite facies metamorphism\*

Metamorphism and deformation:

**ca. 1600 – 1560 Ma**

**Olarian Orogeny**

\*See: Cutts et al. (2011); Yu et al. (2024)



# Mabel Creek Ridge

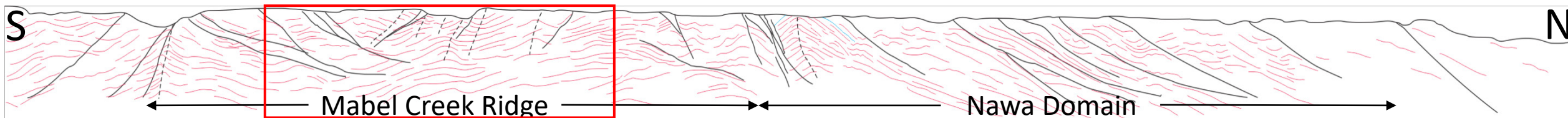
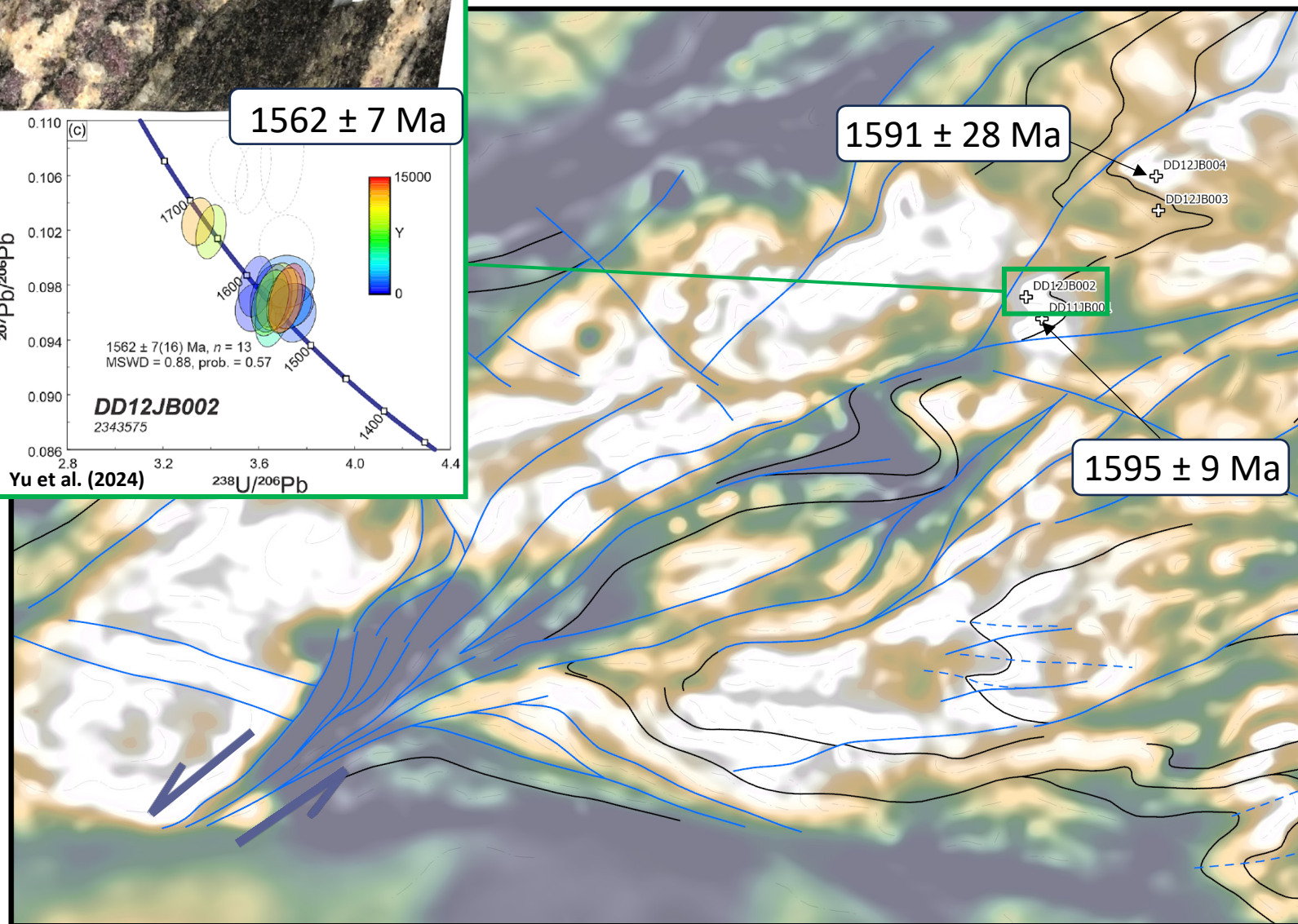
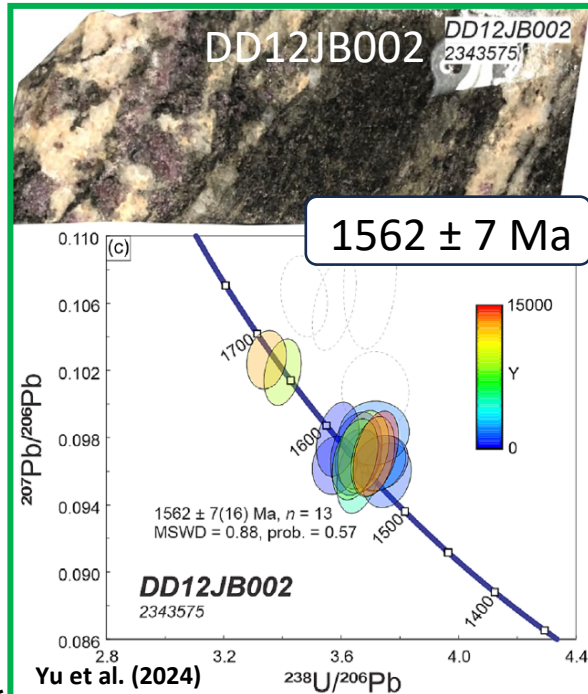
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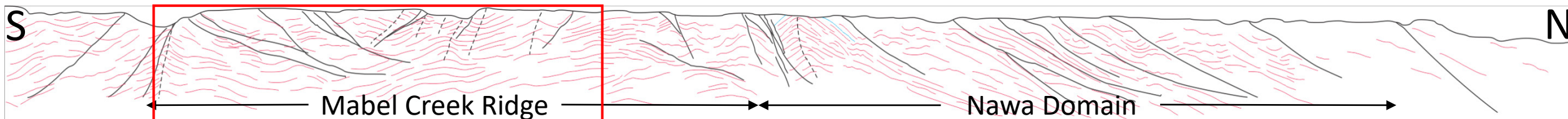
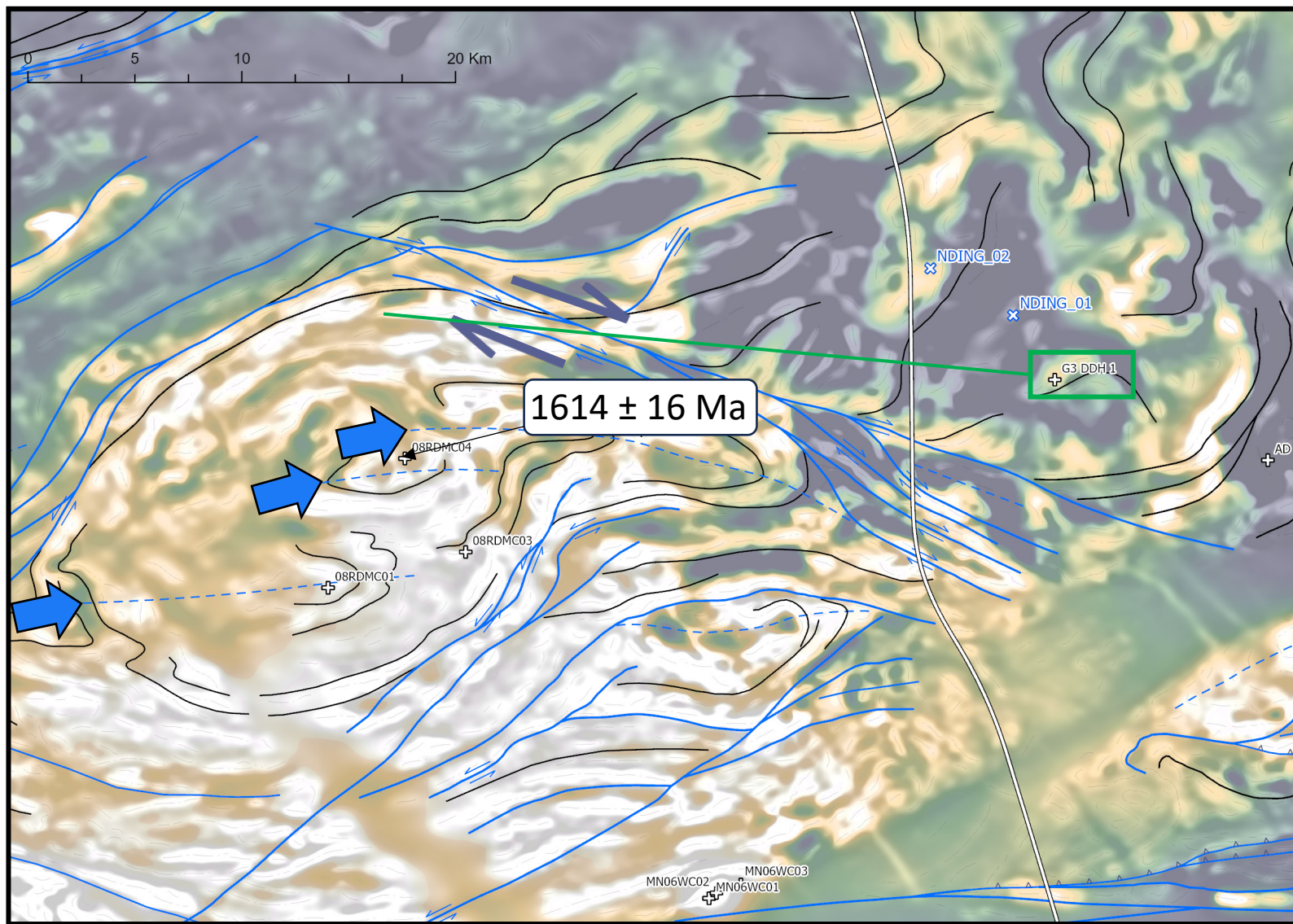
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- Multiple generations of sinistral and dextral shearing
- E – W trending folds
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**Olarian Orogeny**



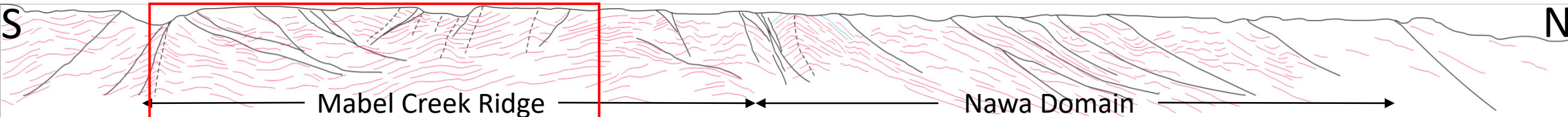
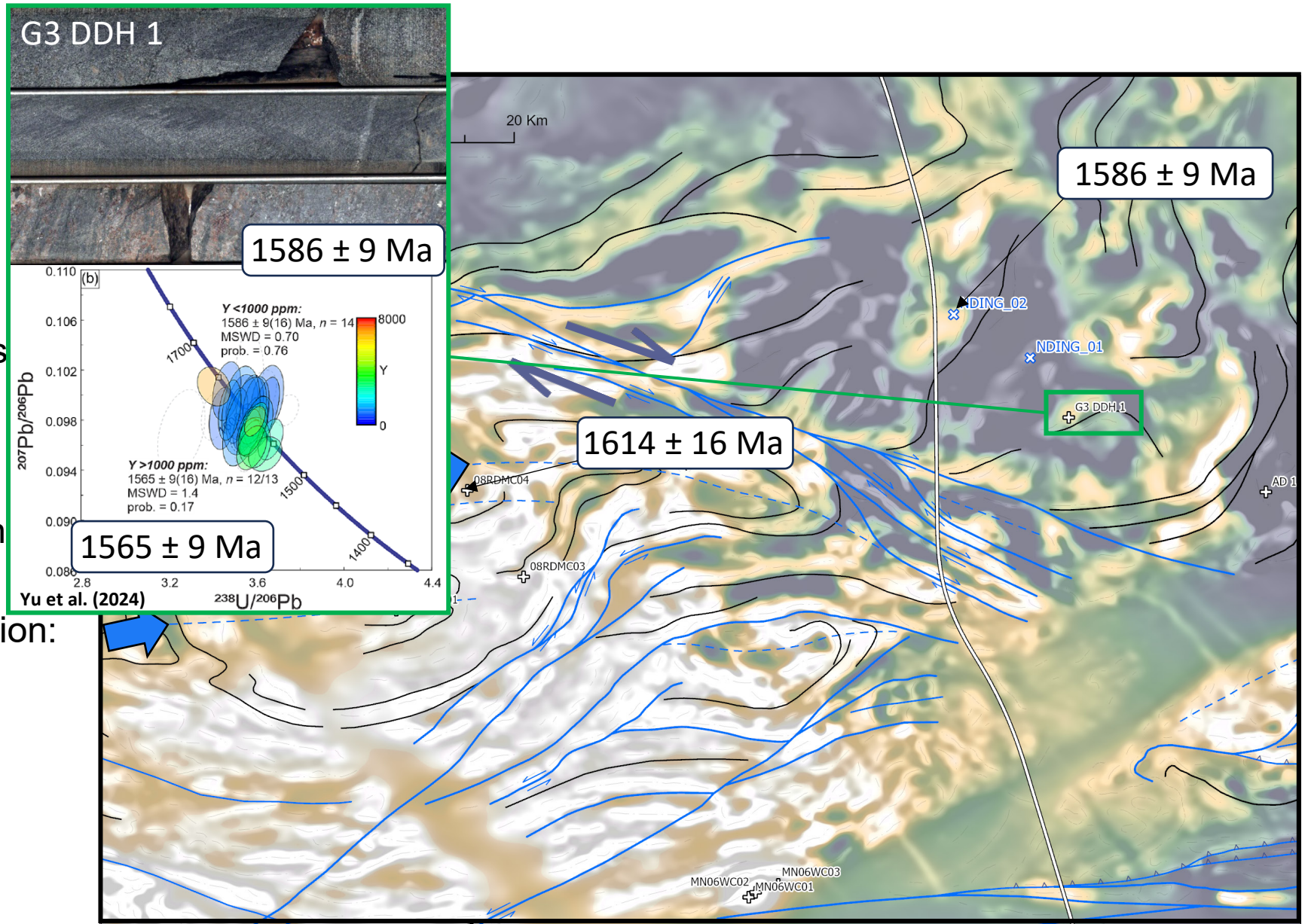
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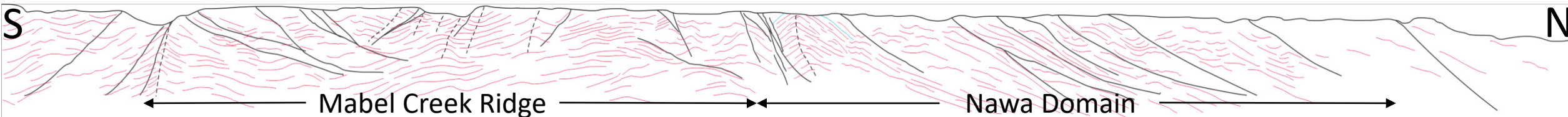
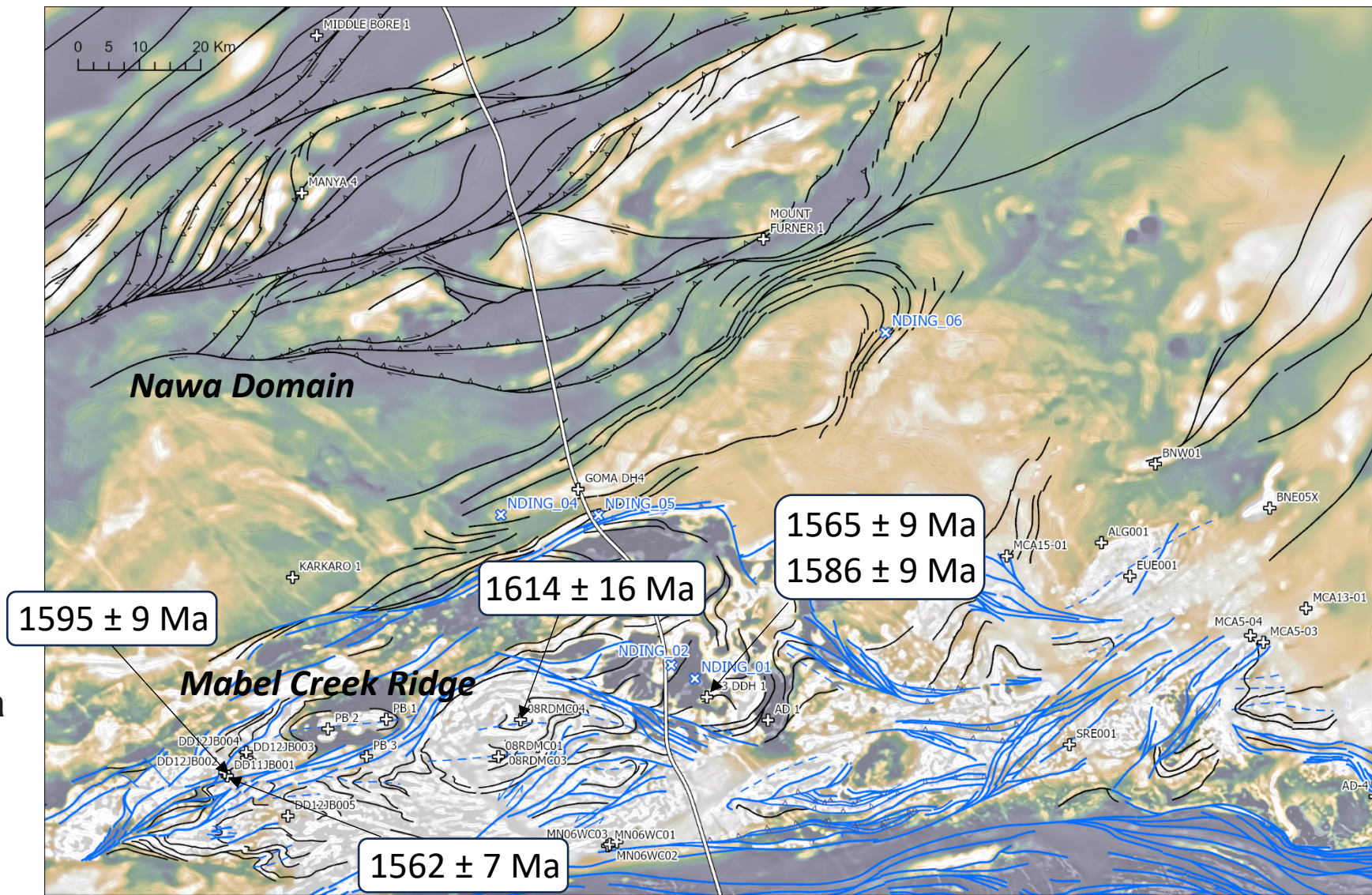
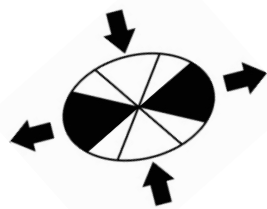
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Olarian Orogeny



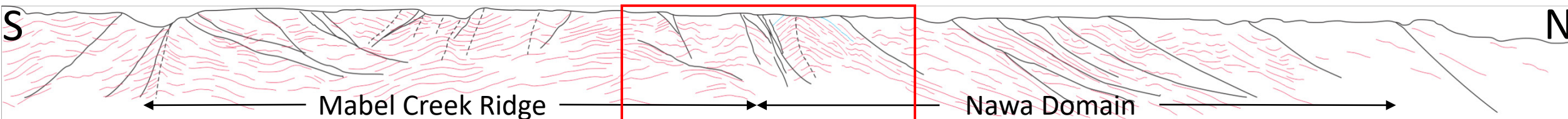
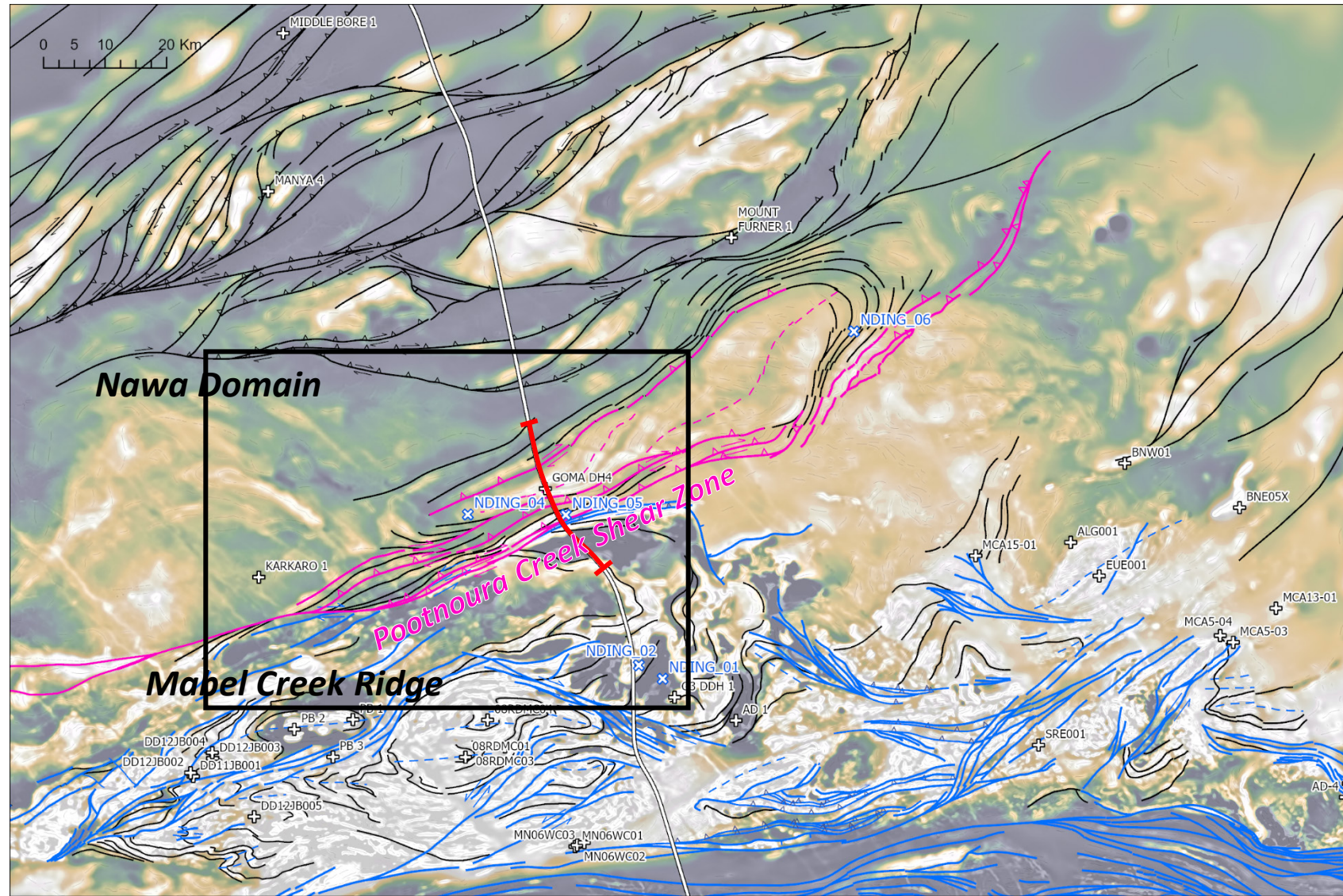
# Mabel Creek Ridge

- Complexly deformed
- ENE trending sinistral shearing *and* ESE trending dextral shearing
- E–W trending folding
- **N–S** directed shortening during **Olarian Orogeny** between ca. 1600 – 1560 Ma



# Pootnoura Creek Shear Zone

- Domain bounding shear zone between Mabel Creek Ridge and northern Nawa Domain
- Folding of Nawa Domain basement rocks against shear zone



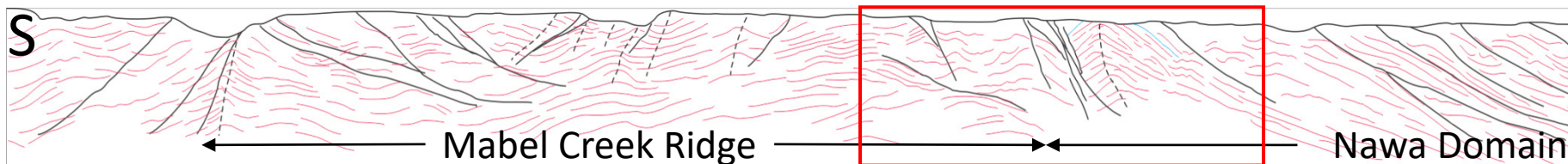
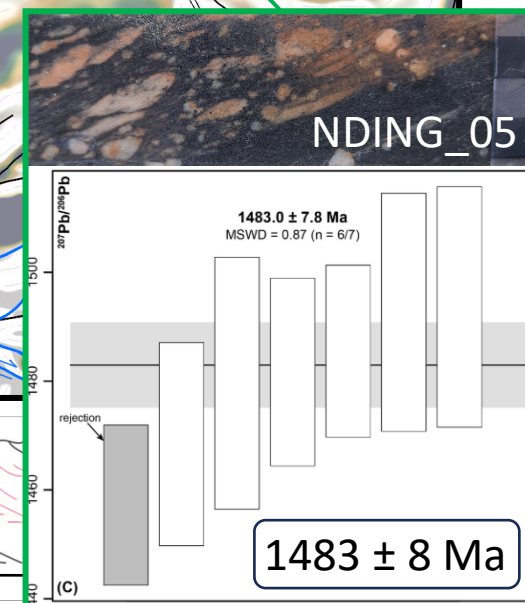
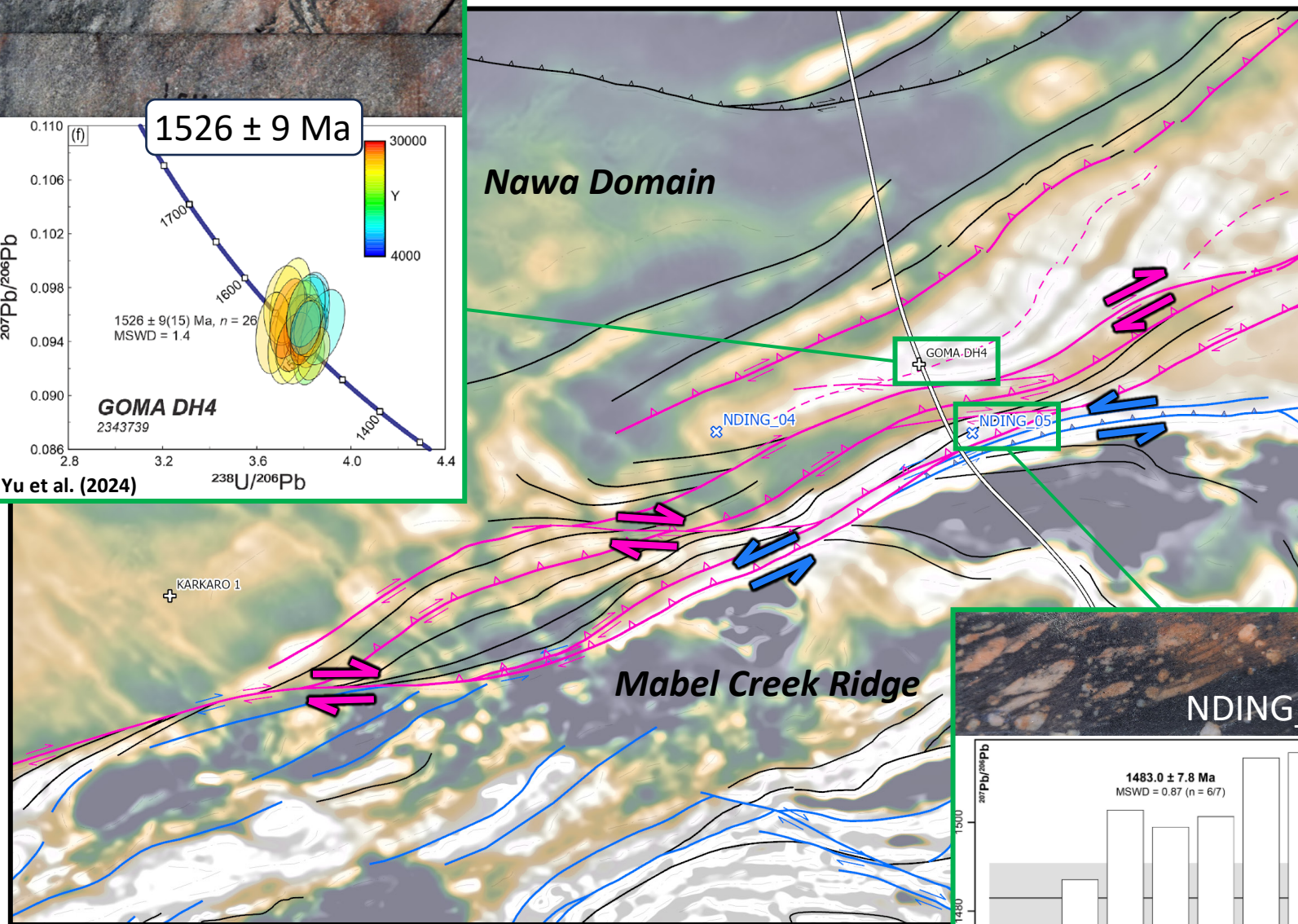
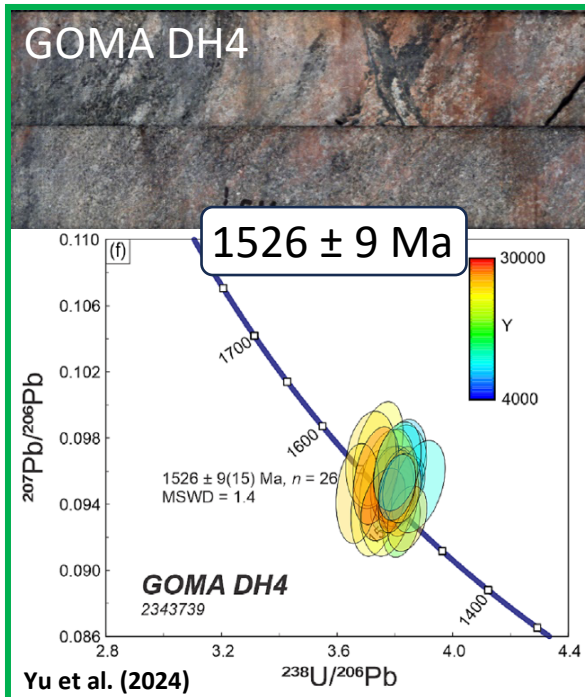
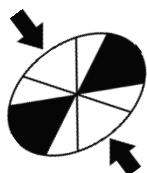
# Pootnoura Creek Shear Zone

- Apparent dextral deflection of Nawa Domain fabric, and dextral shear bands within shear zone
- Apparent sinistral deflection of magnetic fabric in MCR
- Multiple generations of reactivated faults and shears

Metamorphism and deformation:

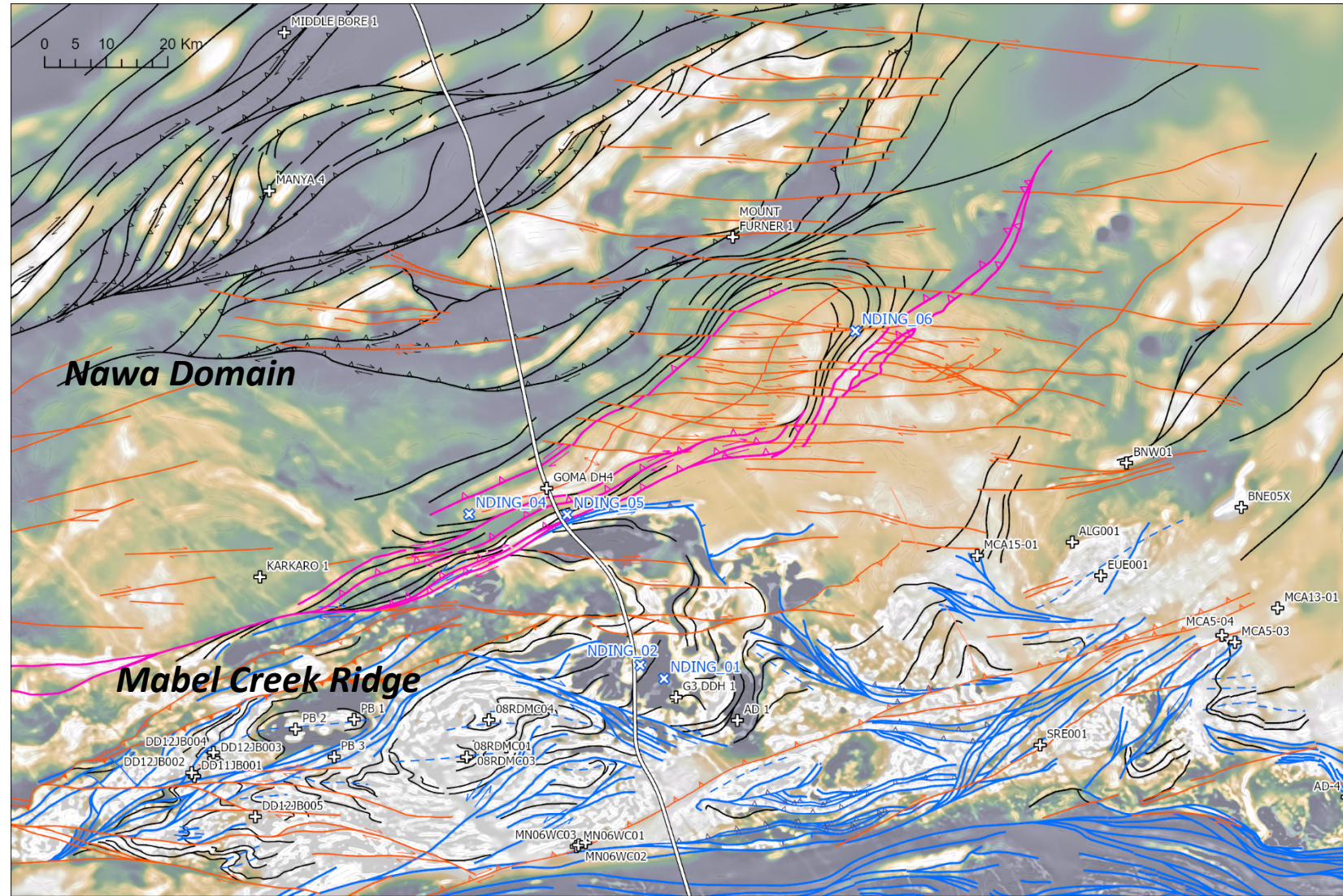
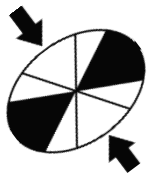
ca. 1520 – 1480 Ma

Early **Coorabie Event** (?)



# Coorabie Event

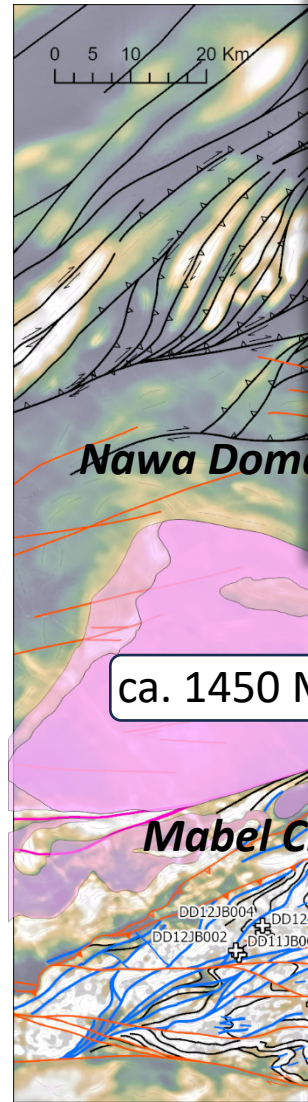
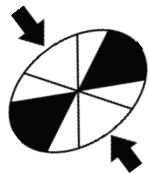
- Extensive E–W-trending dextral faults
- ENE-trending dextral reverse faults
- Post-metamorphic cooling from ca. 1460 Ma\*
- Granite emplacement ca. 1450 Ma<sup>^</sup>
- **NW–SE directed shortening (?) during the Coorabie Event between ca. 1520 – 1450 Ma**




\* Reid and Forster (2021); <sup>^</sup> Morrissey et al. (2019)

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Research Paper  
Magmatism and metamorphism at ca. 145 Ga in the northern Gawler Craton: The Australian record of rifting within Nuna (Columbia)

Laura J. Morrissey<sup>a,b,\*</sup>, Karin M. Barovich<sup>b</sup>, Martin Hand<sup>b</sup>, Katherine E. Howard<sup>b</sup>, Justin L. Payne<sup>a</sup>

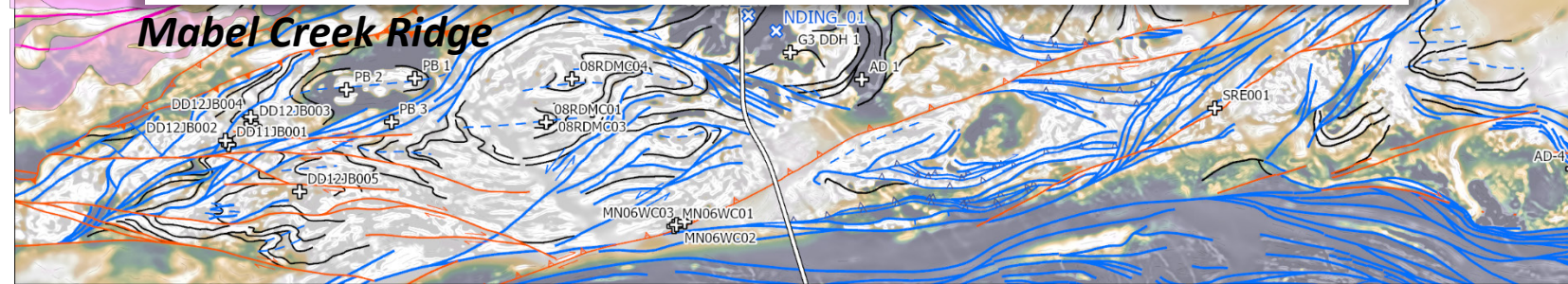
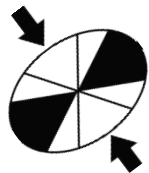
<sup>a</sup>School of Natural and Built Environments, University of South Australia, Adelaide, Australia  
<sup>b</sup>Department of Earth Sciences, School of Physical Sciences, University of Adelaide, Adelaide, SA, 5005, Australia



\* Reid and Forster (2021); <sup>^</sup> Morrissey et al. (2019)

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Research Paper

Linking the Gawler Craton and Mount Isa Province through hydrothermal systems in the Peake and Denison Domain, northeastern Gawler Craton

Mitchell J. Bockmann <sup>a,b,\*</sup>, Justin L. Payne <sup>c,d</sup>, Martin Hand <sup>a,b</sup>, Laura J. Morrissey <sup>a,d</sup>, Antonio P. Belperio <sup>e</sup>

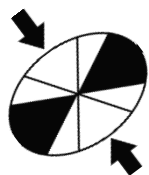
<sup>a</sup>Department of Earth Sciences, University of Adelaide, Adelaide, SA, Australia  
<sup>b</sup>Mineral Exploration Cooperative Research Centre, University of Adelaide, Adelaide, SA, Australia  
<sup>c</sup>UniSA STEM, University of South Australia, Adelaide, SA, Australia  
<sup>d</sup>Mineral Exploration Cooperative Research Centre, Future Industries Institute, University of South Australia, Adelaide, SA, Australia  
<sup>e</sup>Demetallica Ltd, Norwood, SA, Australia

Check for updates

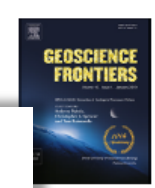
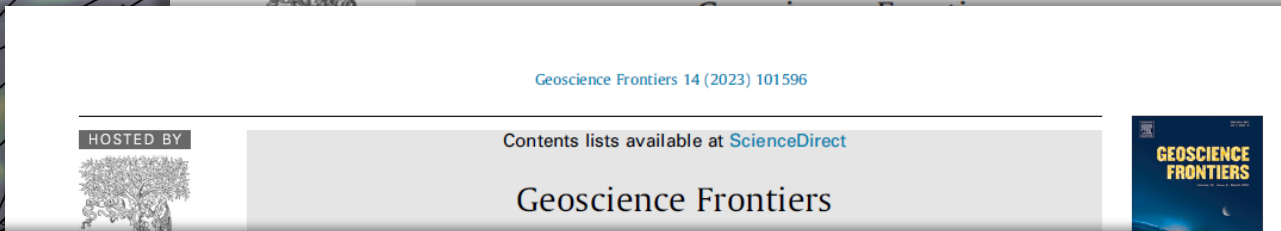
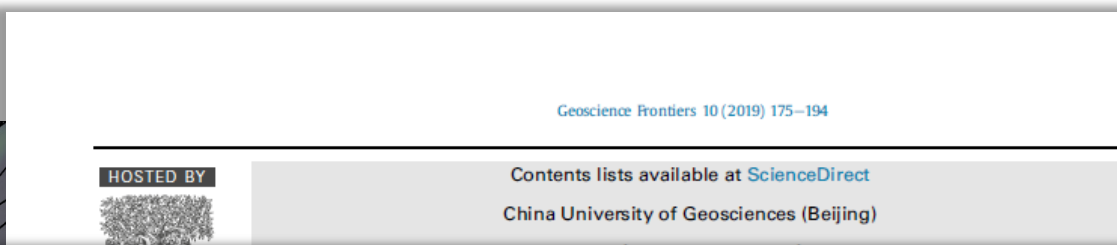
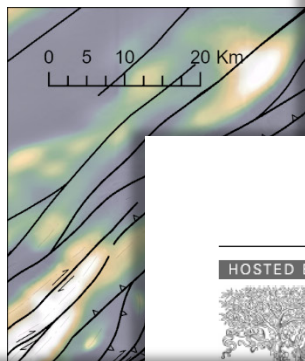
\* Reid and Forster (2021); <sup>^</sup> Morrissey et al. (2019)

# Coorabie Event

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*Economic Geology*, v. XXX, no. XX, pp. X–X



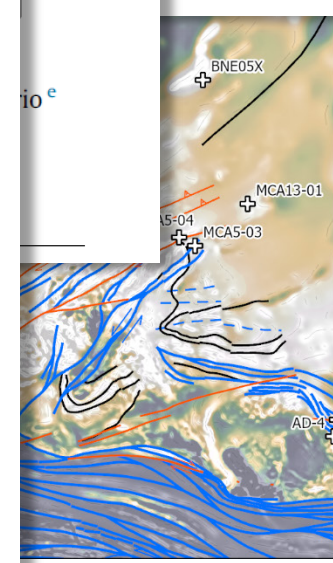
## A New Cu Province in Southern Australia? Geochronological Framework of Potential Iron Oxide Copper-Gold Systems in Northeastern Gawler Craton

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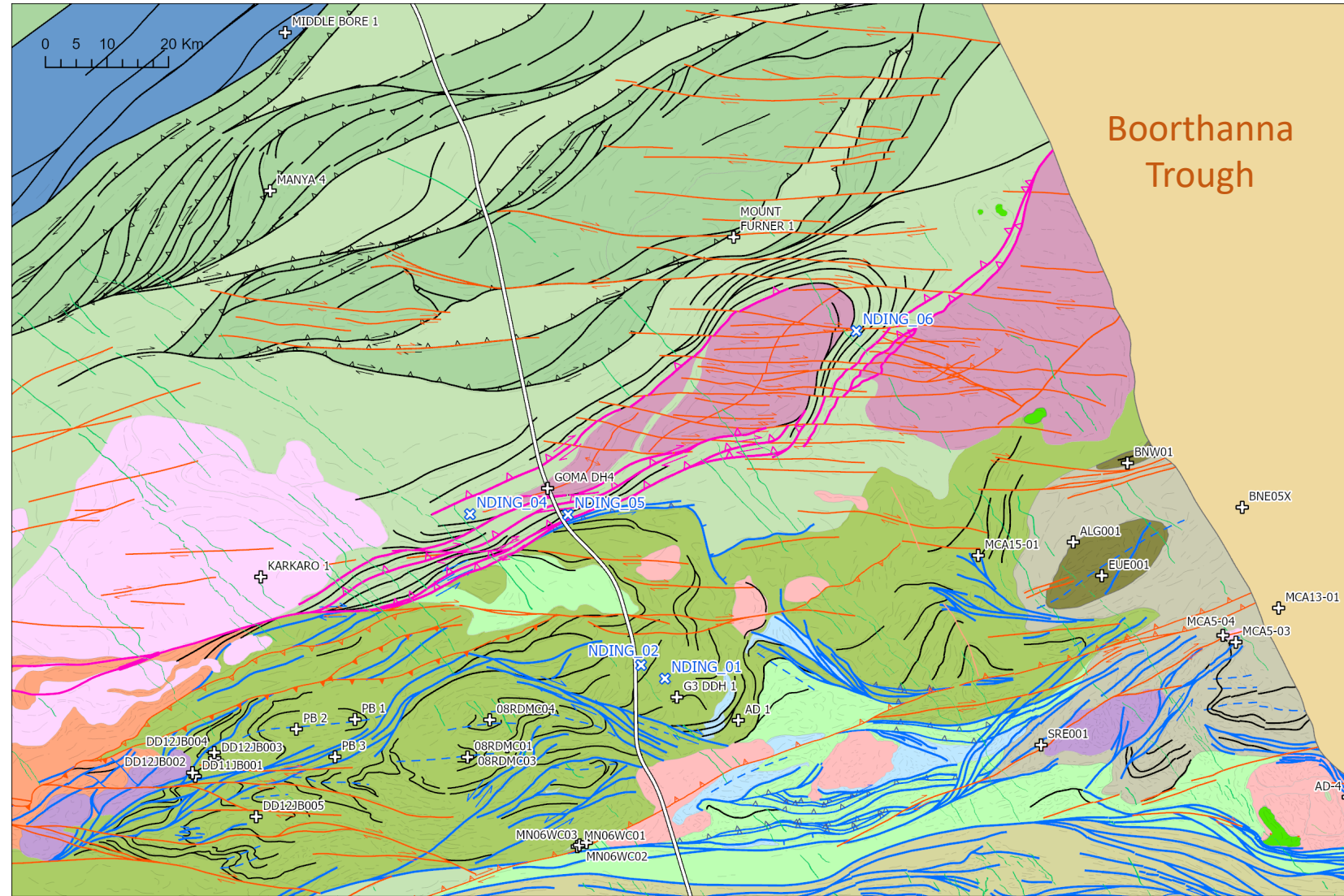
### Abstract

Breccia-hosted and magnetite-dominated Cu mineralization has been recently discovered in the Peake and Denison Domain, northeastern Gawler craton, Australia. The iron oxide copper-gold (IOCG)-style alteration and mineralization and proximity to the world-class Olympic and Cloncurry IOCG provinces highlight the prospectivity potential for IOCG and affiliated deposits in the Peake and Denison Domain. New zircon-titanite-apatite U-Pb and apatite Lu-Hf age data from the Wills and Mawson prospects in the Peake and Denison region are presented to construct a geochronological framework for the new Cu district in southern Australia. Zircons from the host quartzfeldspathic gneiss define a major peak at ca. 1780 Ma, two shoulder peaks at ca. 1740 and ca. 1710 Ma, and minor peaks at ca. 1850 and ca. 1900 Ma. Titanite U-Pb and apatite Lu-Hf geochronology reveals an early-stage magnetite-actinolite-titanite-apatite alteration at ca. 1530 Ma for the Wills prospect, coincident with the coeval mineralization in the Cloncurry and Mary Kathleen IOCG districts of the Mount Isa inlier. The Wills prospect subsequently underwent ca. 1500 Ma ductile deformation. Apatite Lu-Hf and U-Pb geochronology from both prospects constrain vein-type and breccia-type Cu mineralization at ca. 1465 Ma, broadly coeval with regional barren Na-Ca alteration in the Peake and Denison Domain and barren potassic alteration in the Cloncurry IOCG District. The ca. 1465 Ma Cu mineralization is equivalent to the recently discovered later-stage Cu mineralization in the northern Olympic Cu-Au Province and potentially coincided with the rifting of Proto-Australia and the supercontinent Nuna in the early Mesoproterozoic.



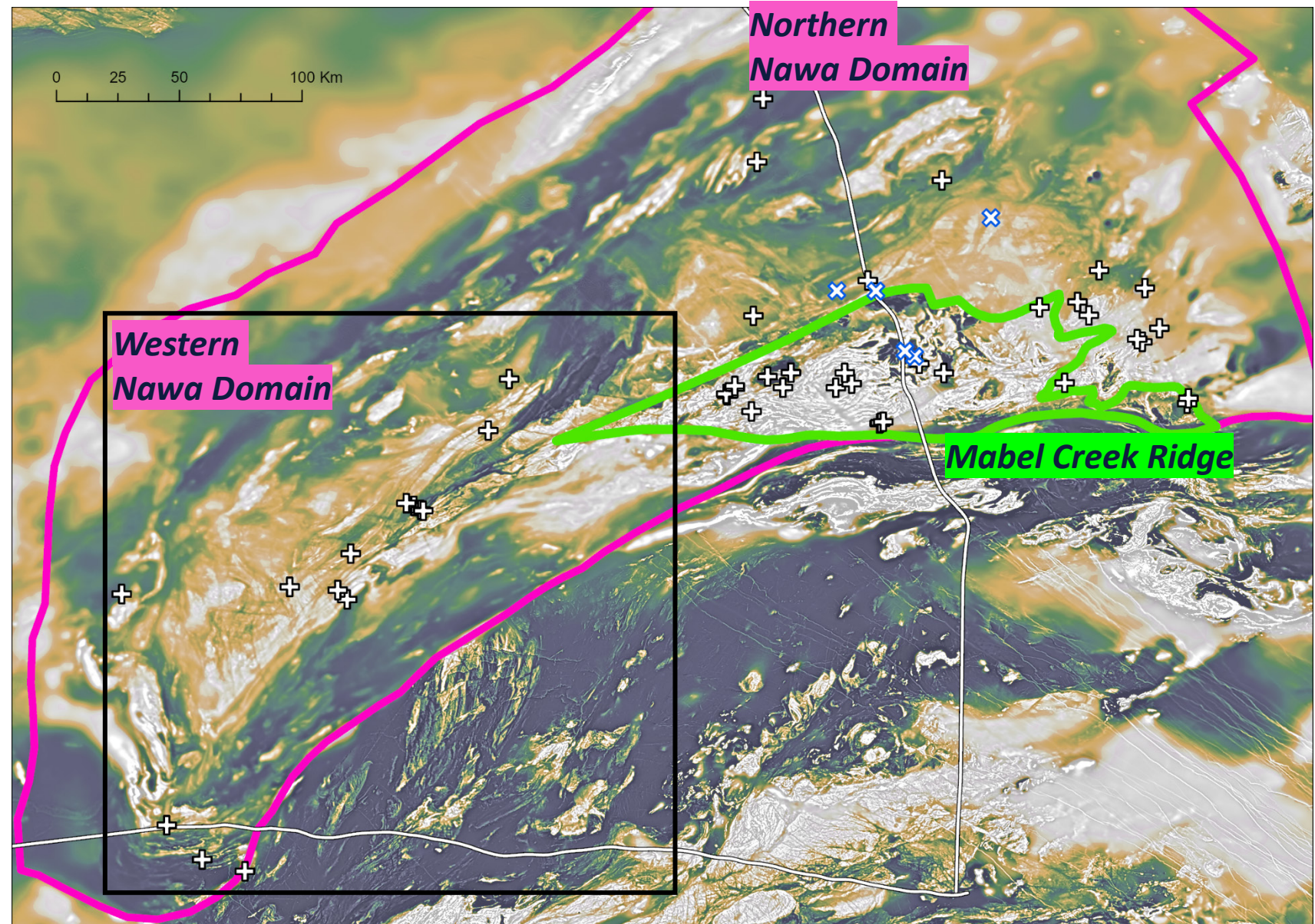
# Structural Interpretation

- Northern Nawa Domain and Mabel Creek Ridge affected by dextral transpression during the **Kimban Orogeny**
- Only the Mabel Creek Ridge affected by N–S shortening (?) during the **Olarian Orogeny**
- **Pootnoura Creek Shear Zone** reactivated during the Coorabie Event as a dextral transpressional shear zone
- Entire northern Gawler Craton affected by late **Coorabie Event** dextral faulting



# Western Nawa Domain

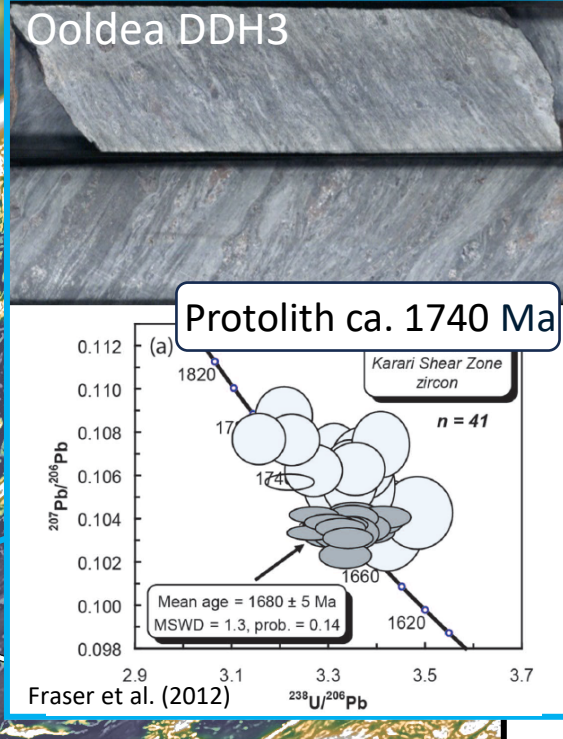
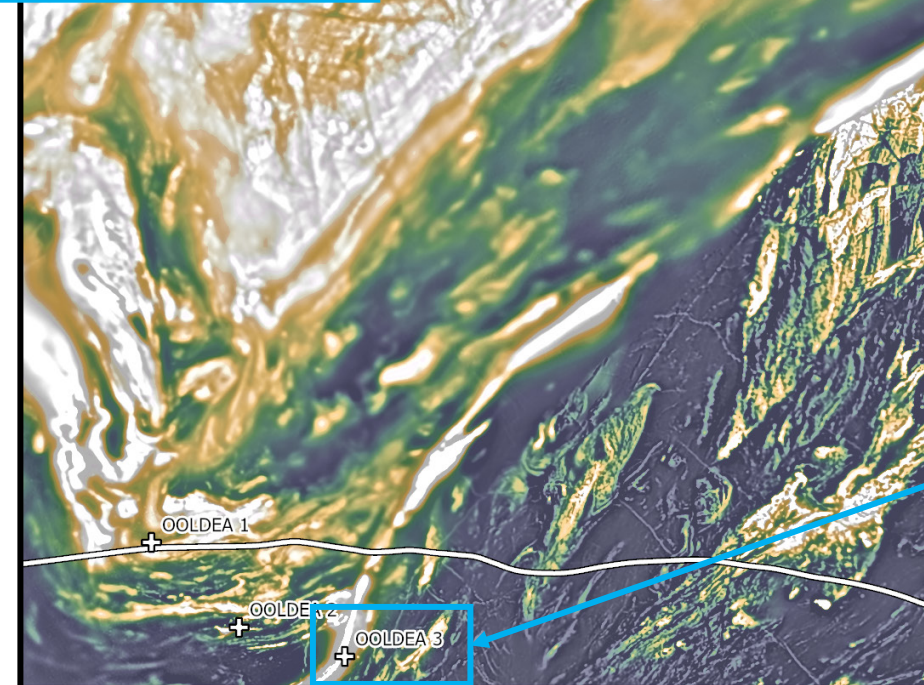
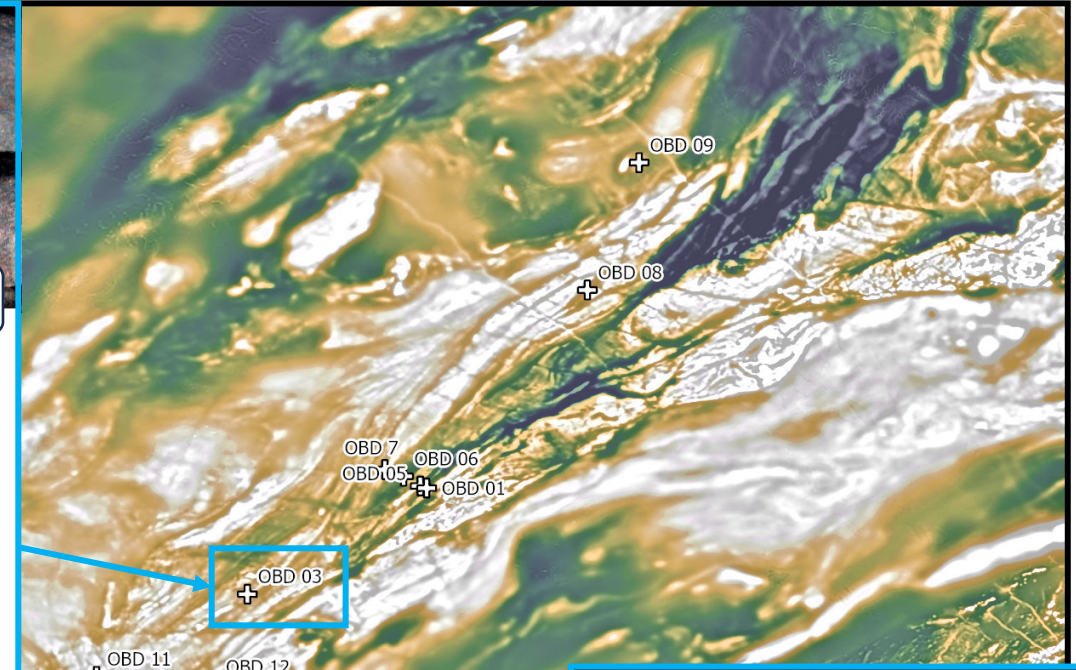
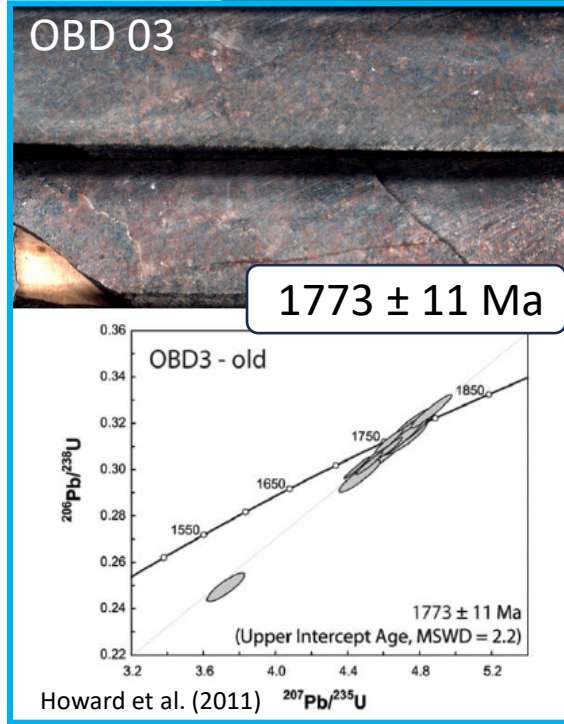
- Western Nawa Domain
- A dozen or so drillholes intersect basement



# Western Nawa Domain

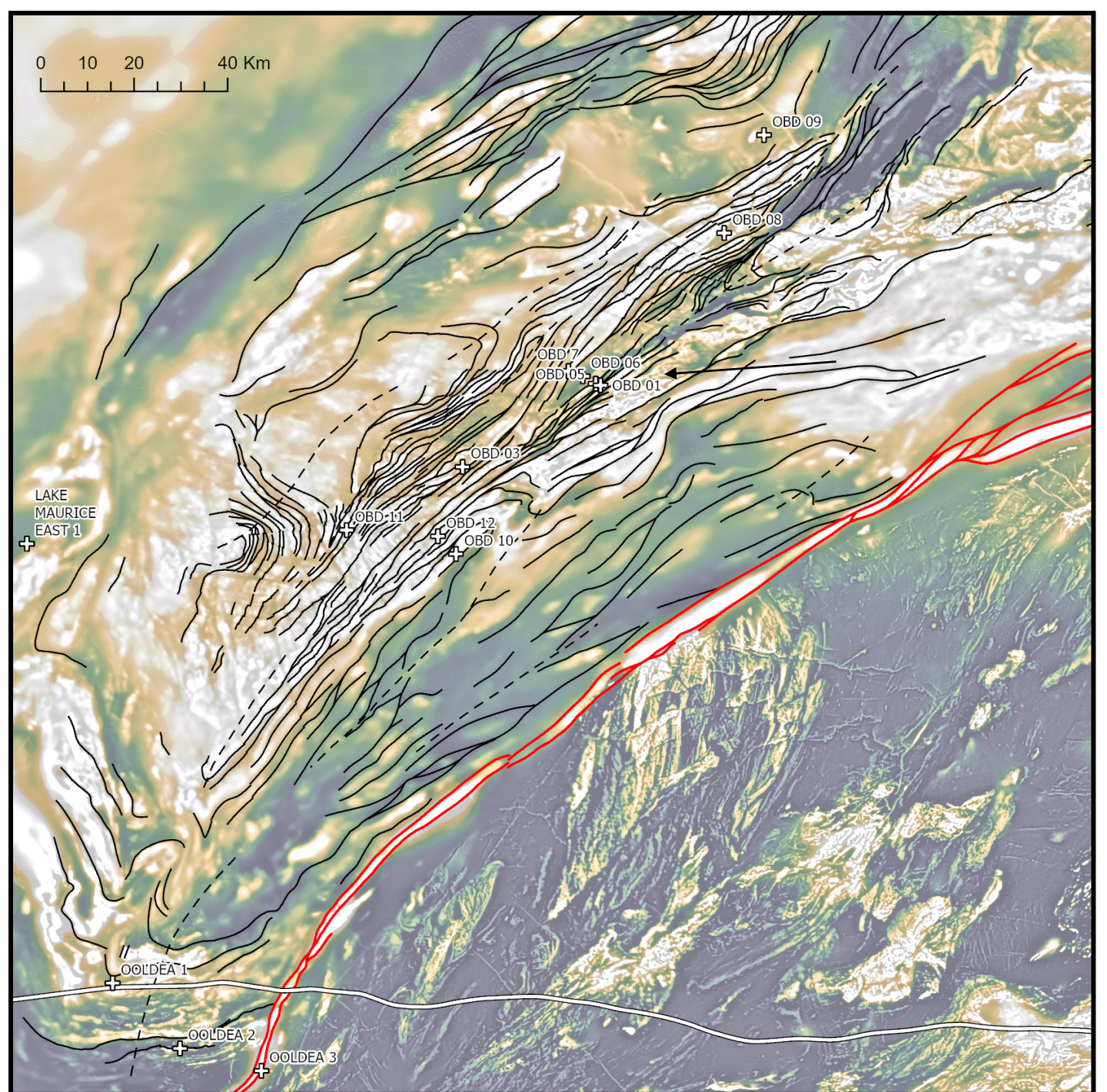
- Granitic orthogneisses
  - Magmatic crystallisation ca. 1770 – 1750 Ma
  - Basement to metasedimentary rocks\*
- Metasedimentary gneisses
  - Max. Dep.(?) ca. 1740 Ma (?)

\*See: Howard et al. (2011)



# Western Nawa Domain

- NE-trending structures
- NE-trending folds



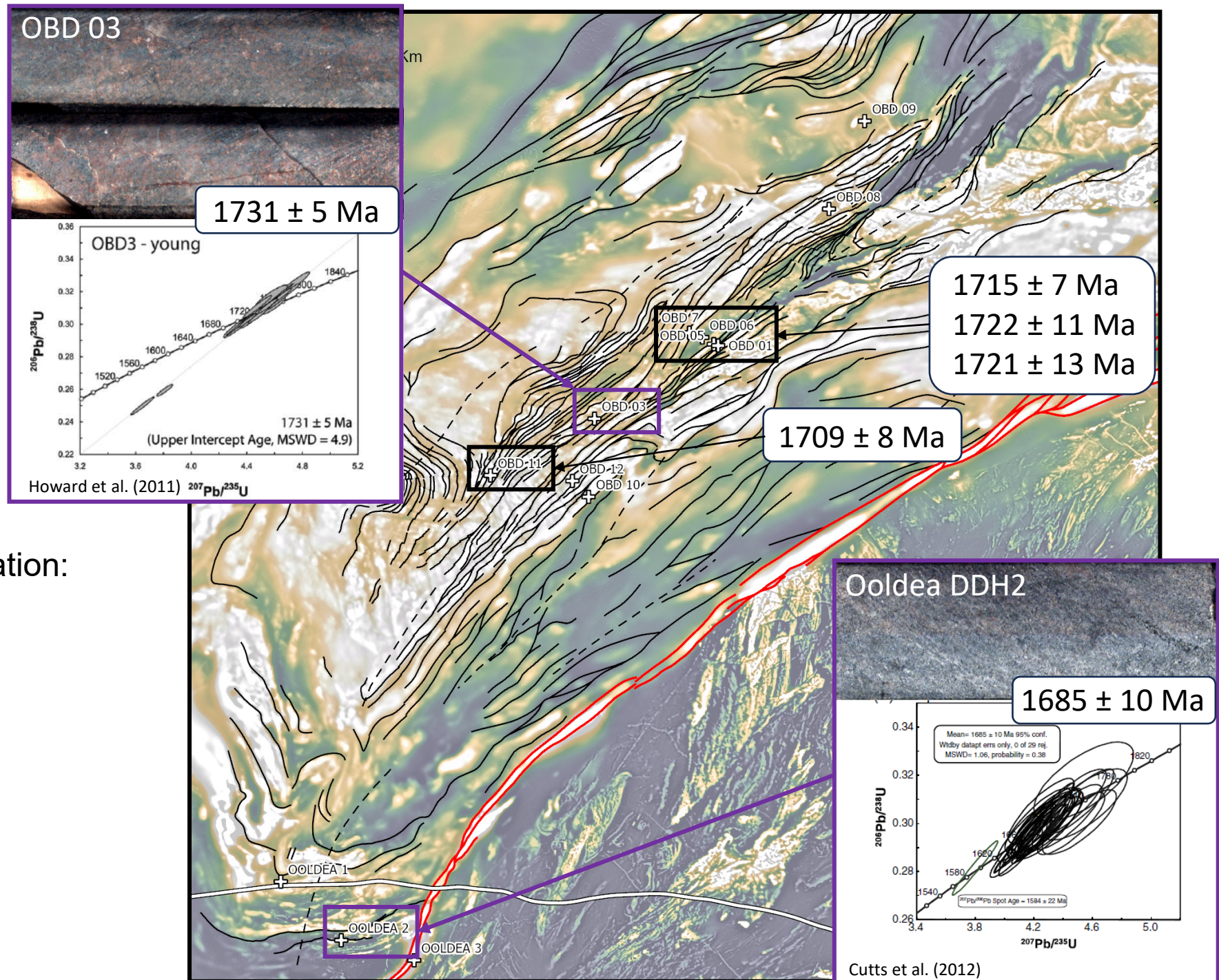
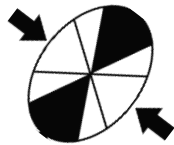
# Western Nawa Domain

- NE-trending structures
- NE-trending folds

Metamorphism and deformation:

**ca. 1730 – 1690 Ma**

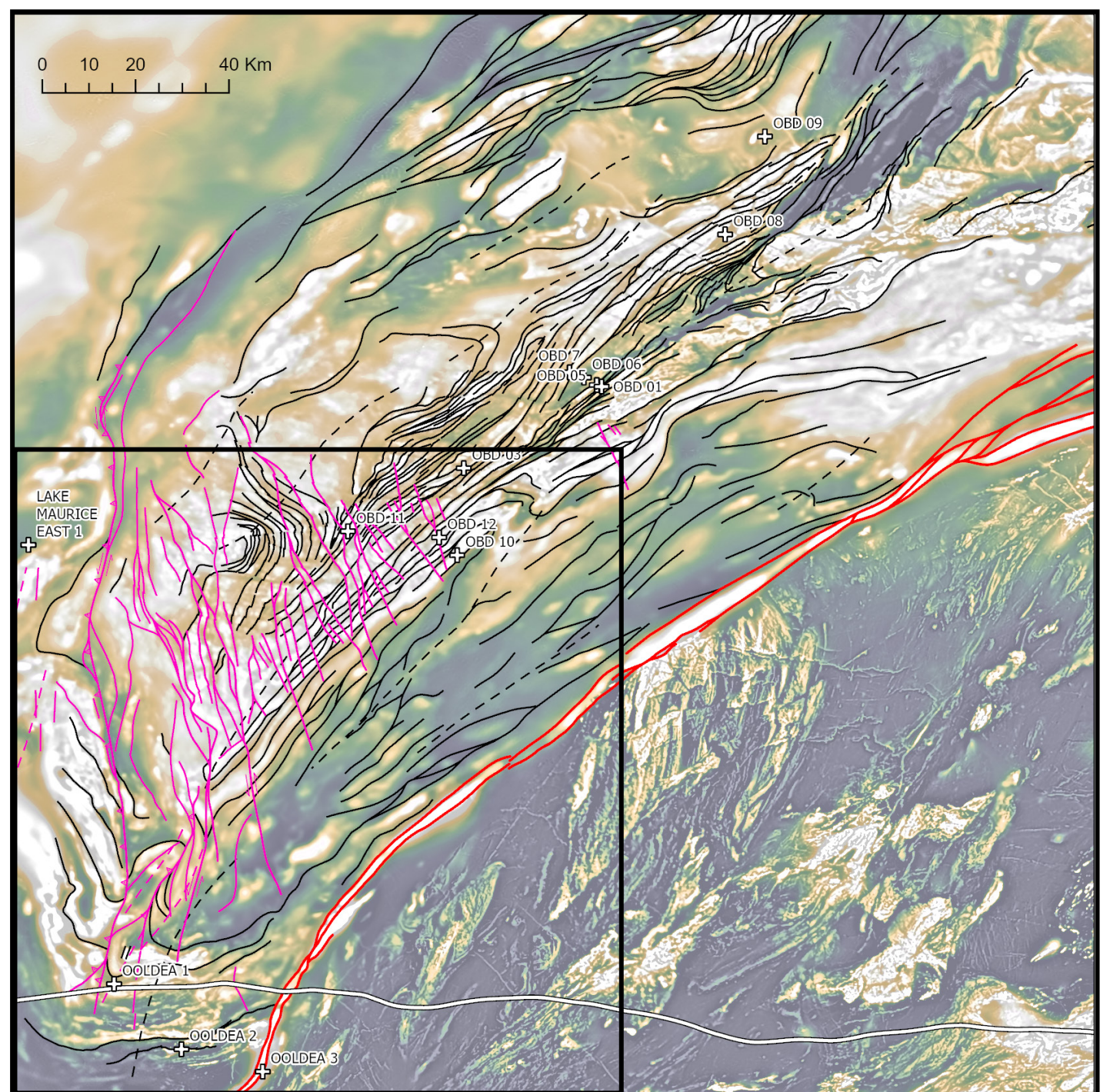
Kimban Orogeny



# Western Nawa Domain

- North-trending structures
- West-dipping shear
- Sinistral kinematics
- Granulite facies metamorphism\*

\*See: Cutts et al. (2012)



# Western Nawa Domain

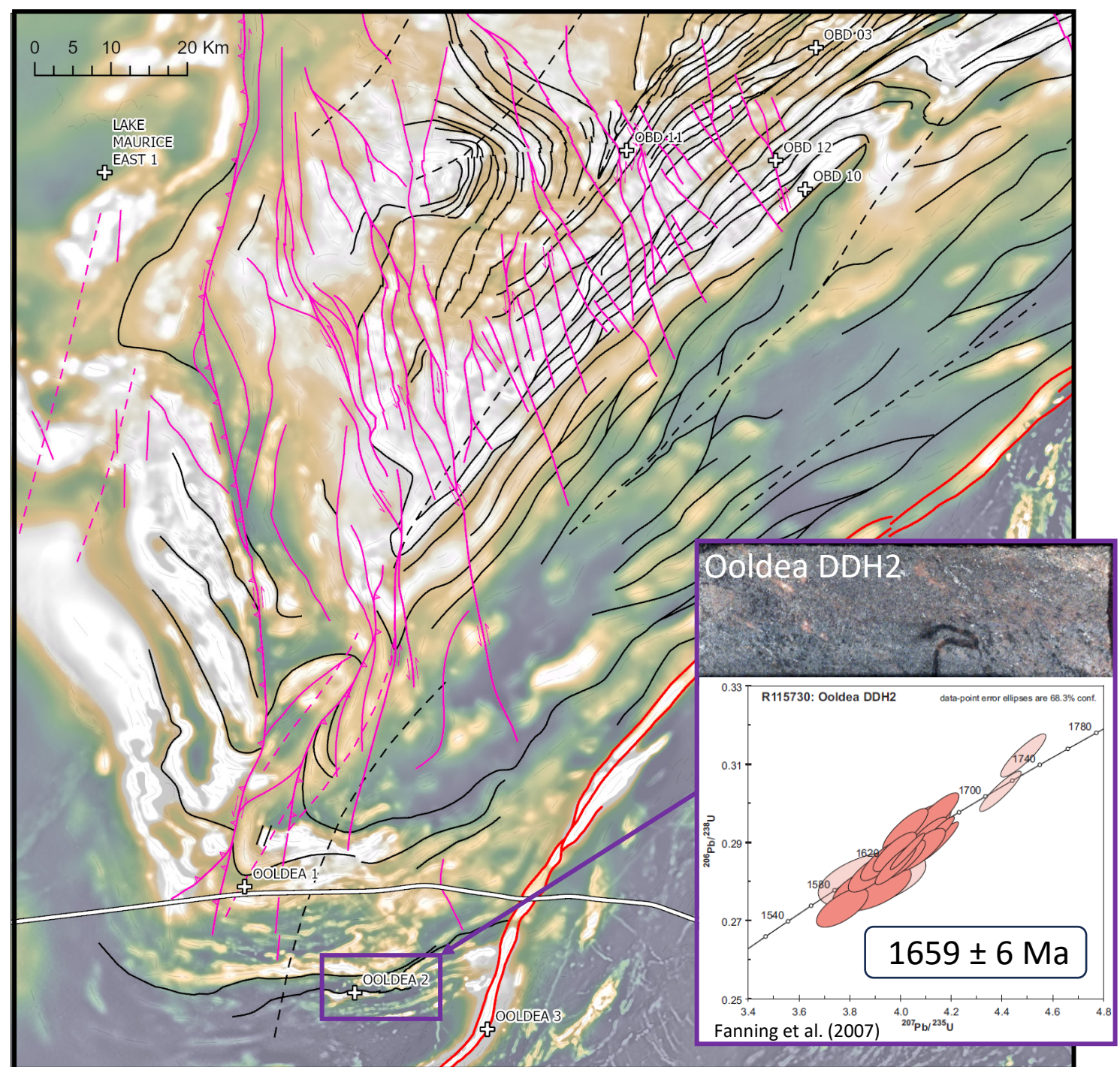
- North-trending structures
- West-dipping shear
- Sinistral kinematics
- Granulite facies metamorphism\*

Metamorphism and deformation:

**ca. 1660 – 1650 Ma (?)**

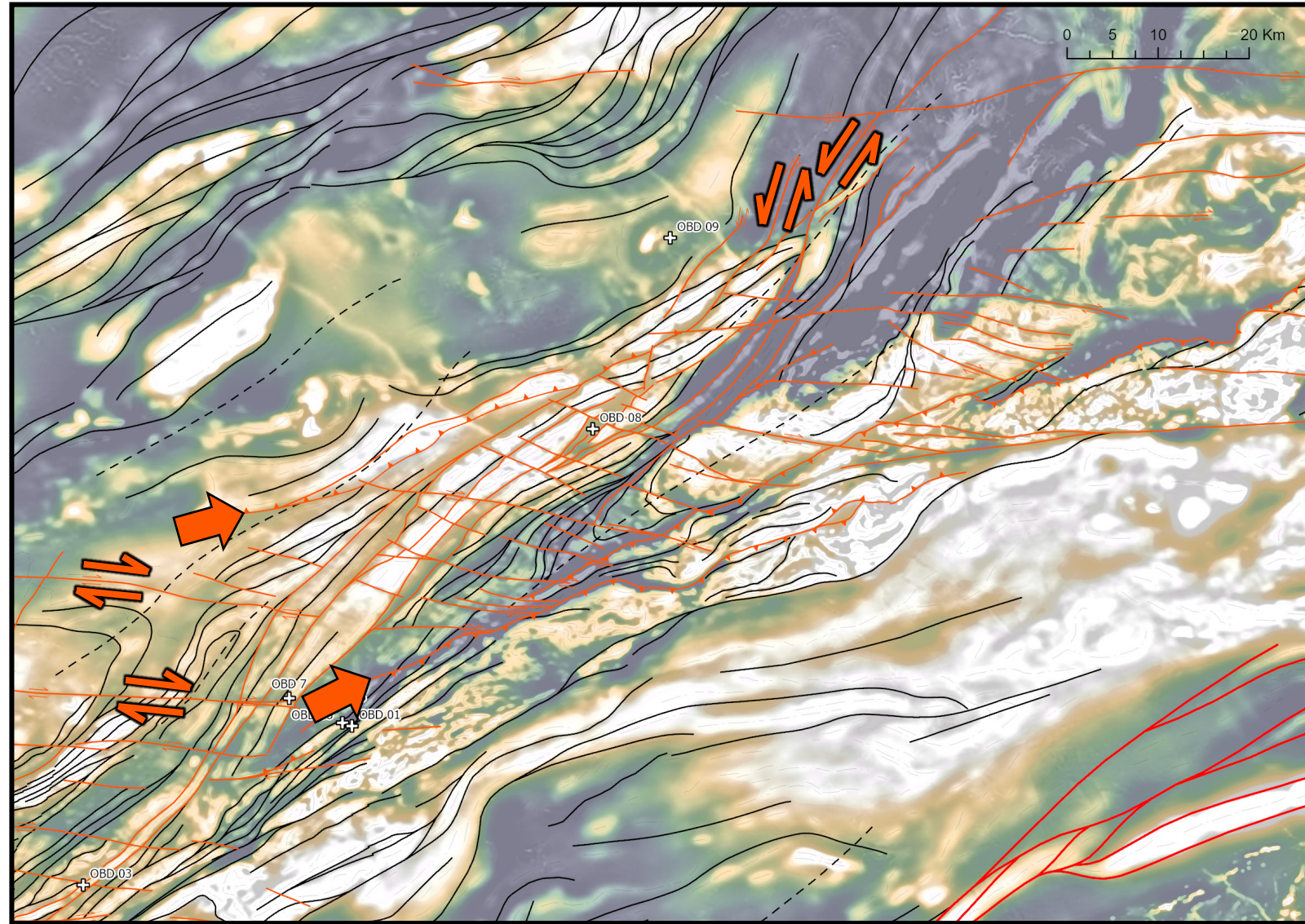
Ooldean Event (?)

\*See: Cutts et al. (2012)



# Western Nawa Domain

- Reactivation of NE-trending Kimban structures
  - Thrust faults
  - Sinistral faults
- Dextral E–W-trending faults



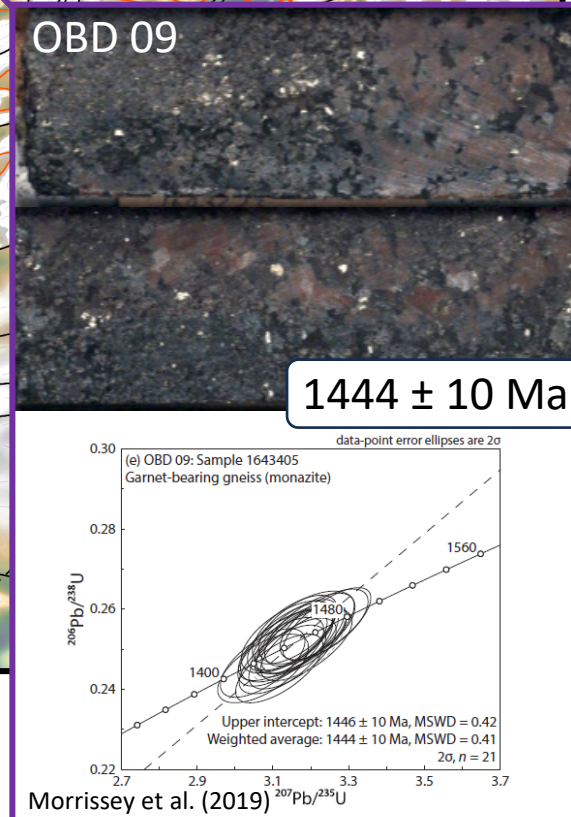
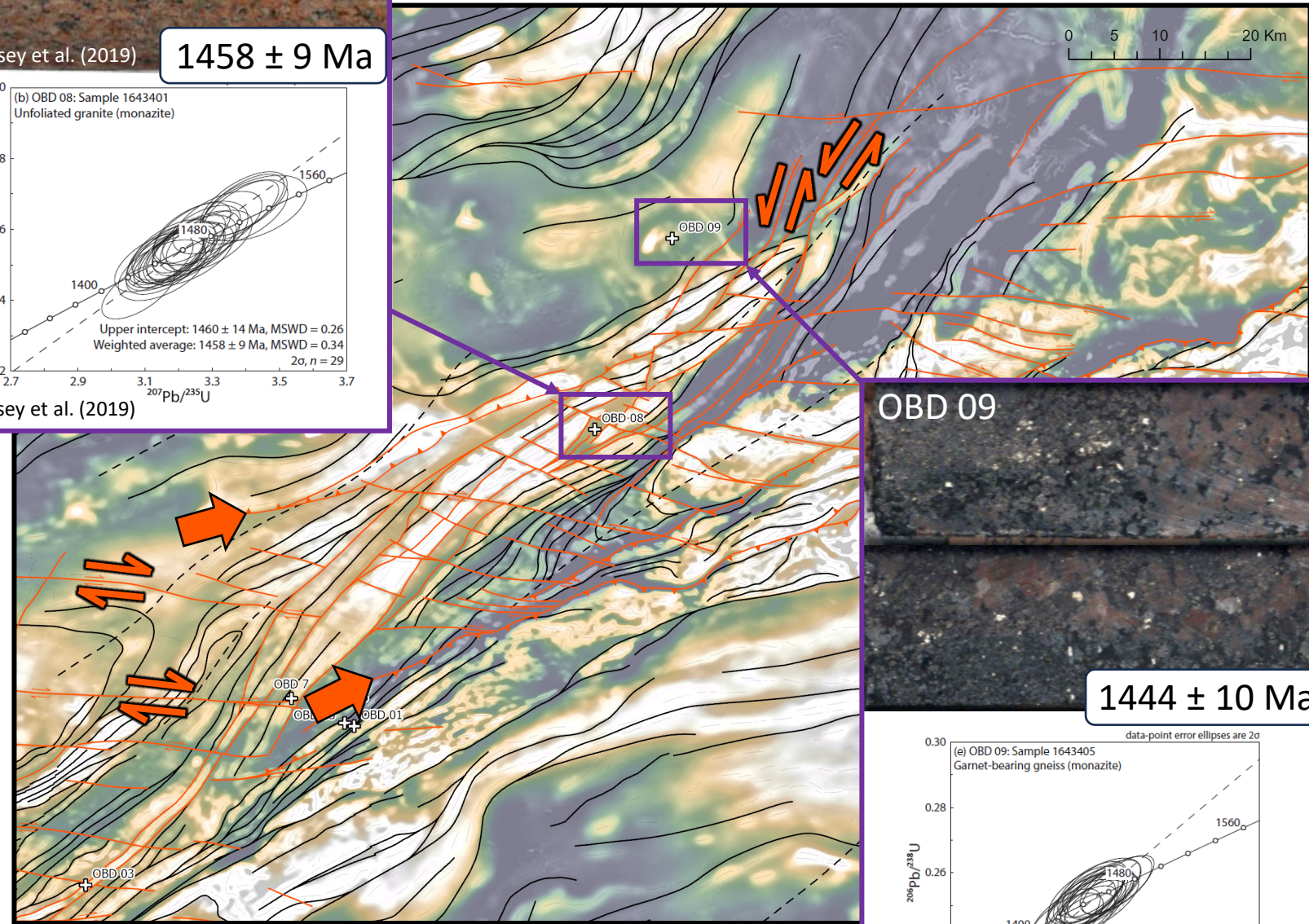
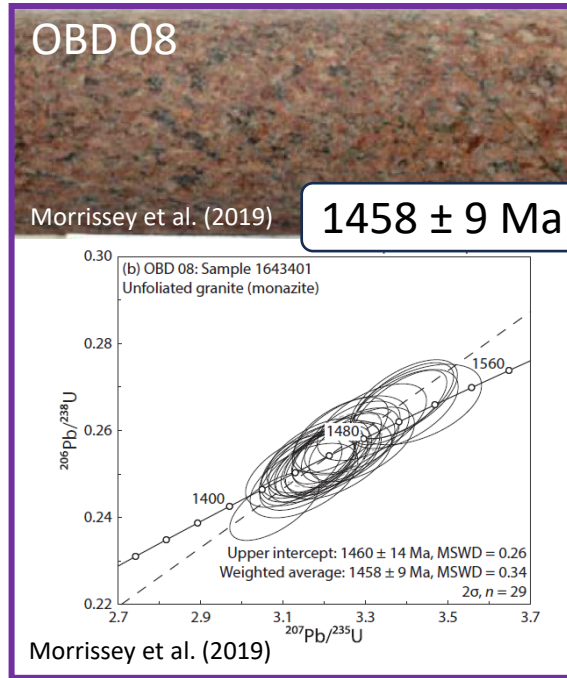
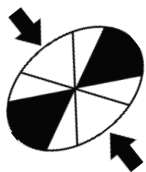
# Western Nawa Domain

- Reactivation of NE-trending Kimban structures
  - Thrust faults
  - Sinistral faults
- Dextral E–W-trending faults

Metamorphism, magmatism and deformation:

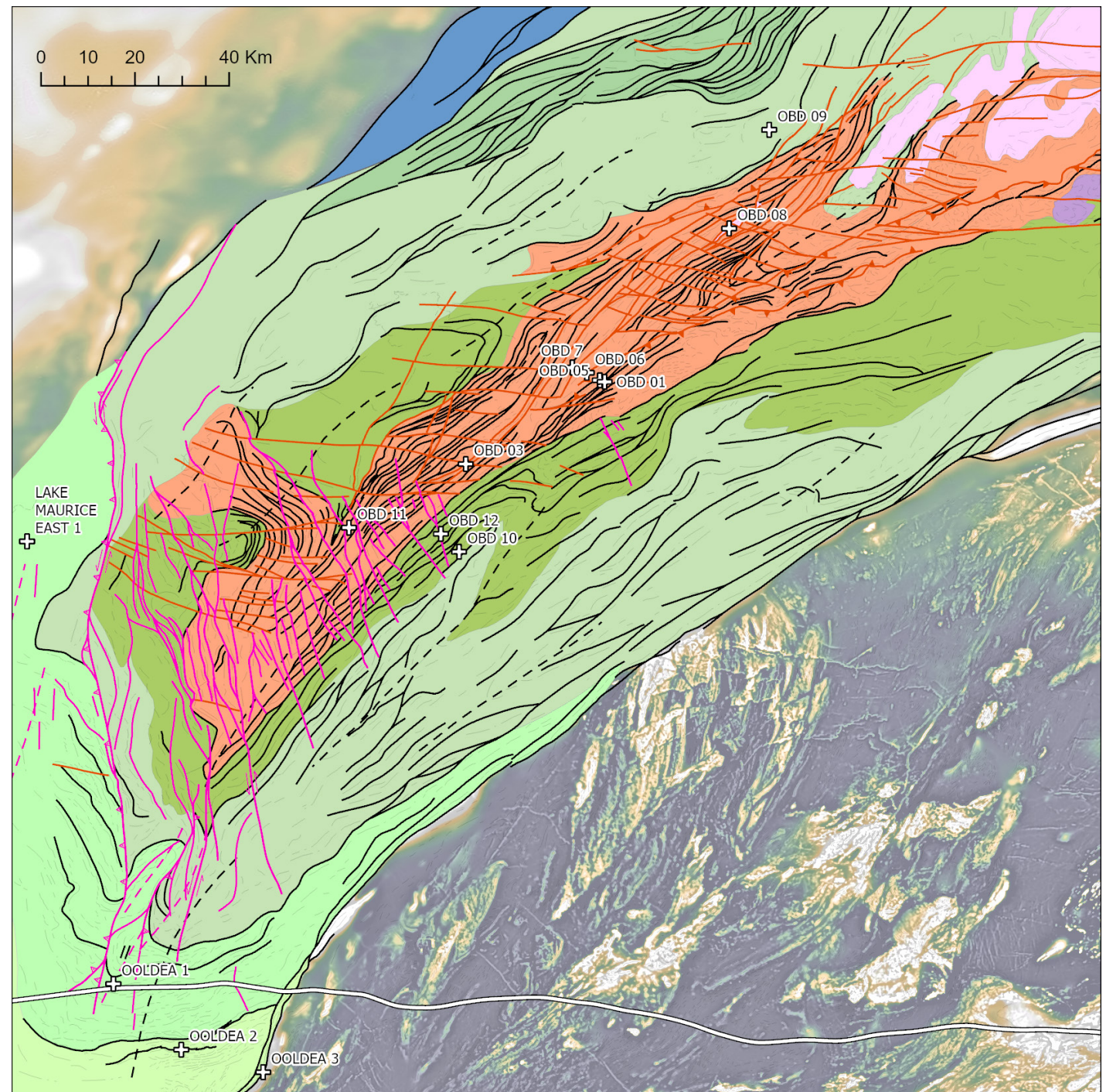
**ca. 1460 – 1440 Ma**

Coorabie Event



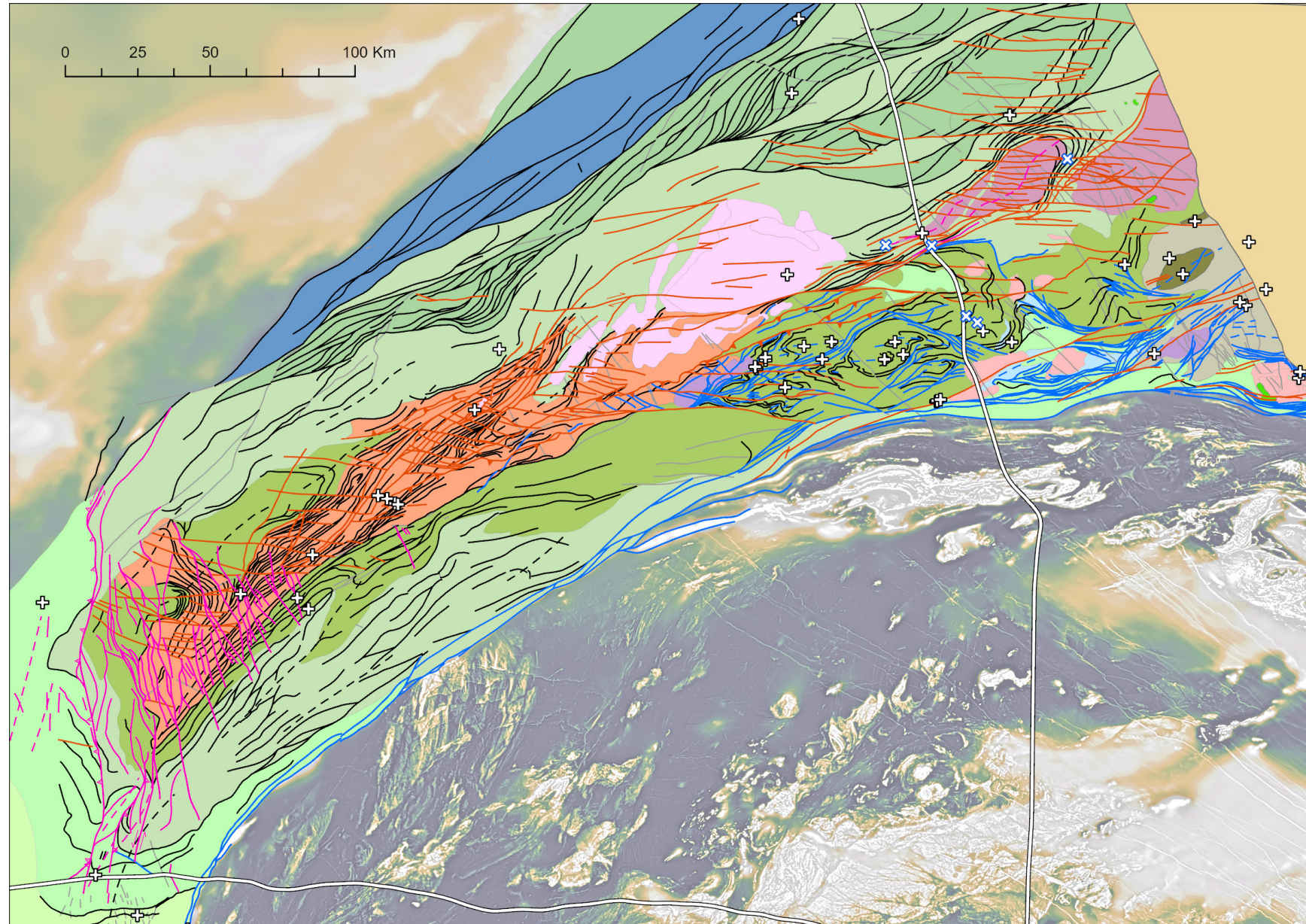
# Structural Interpretation

- Western Nawa Domain affected by the **Kimban Orogeny**
- Westernmost Nawa Domain later affected by sinistral shearing and faulting, possibly during the **Ooldean Event**
- Nawa Domain affected by reactivation of Kimban shears and overprinting faulting likely during the **Coorabie Event**



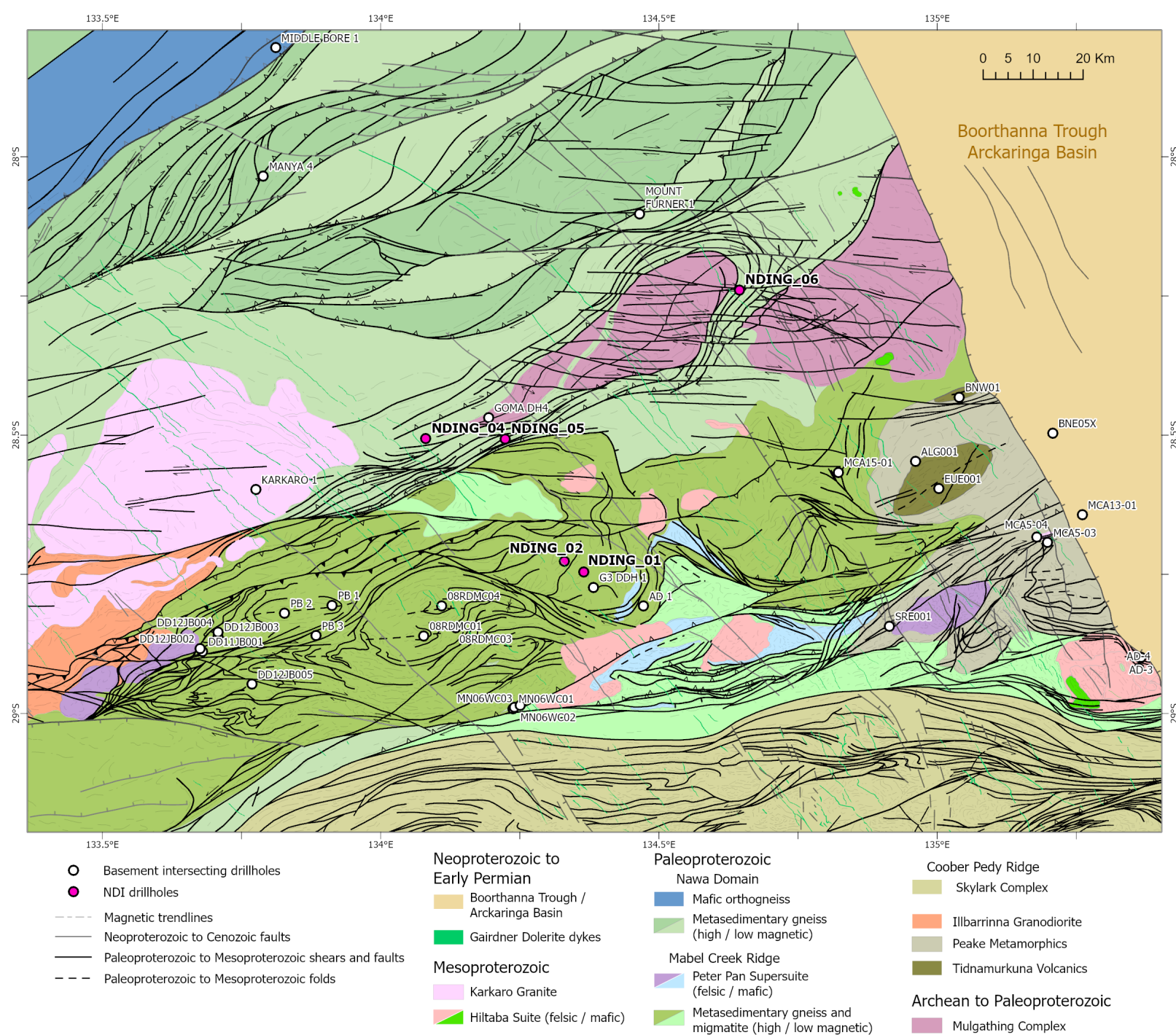
# Structural Interpretation

- Domain-wide ductile deformation during the **Kimban Orogeny**
- Cryptic reworking in the westernmost Nawa Domain during the **Ooldean Event**
- High-grade reworking in the Mabel Creek Ridge subdomain during the **Olarian Orogeny**
- Reactivation of older structures, dextral faulting, and hydrothermal activity during the **Coorabie Event**



# Summary

- Revised interpretation of the northern Gawler Craton solid geology
- Structural framework correlates structures with specific tectonic events across the Gawler Craton
- SA Geology allows for ongoing updates and refinements of maps and models



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# References

Armit, R., Betts, P. G., Schaefer, B. F., Yi, K., Kim, Y., Dutch, R. A., Reid, A., Jagodzinski, L., Giles, D., & Ailleres, L. (2017). Late Palaeoproterozoic evolution of the buried northern Gawler Craton. *Precambrian Research*, 291, 178–201. <https://doi.org/10.1016/j.precamres.2017.01.023>

Baines, G., Giles, D., Betts, P. G., & Backé, G. (2011). Locating a major Proterozoic crustal boundary beneath the Eastern Officer Basin, Australia. *Precambrian Research*, 191(3), 120–140. <https://doi.org/10.1016/j.precamres.2011.09.001>

Brown D, Percival J, Wise T, and Abdullah R, 2025. Geochronology on the buried northern Gawler craton. Part 1: Multi-mineral laser-ablation U–Pb–Lu–Hf dating, Report Book 2025/00006. Department for Energy and Mining, South Australia, Adelaide.

Cutts, K., Hand, M., & Kelsey, D. E. (2011). Evidence for early Mesoproterozoic (ca. 1590 Ma) ultrahigh-temperature metamorphism in southern Australia. *Lithos*, 124(1), 1–16. <https://doi.org/10.1016/j.lithos.2010.10.014>

Cutts, K. A., Kelsey, D. E., & Hand, M. (2013). Evidence for late Paleoproterozoic (ca 1690–1665 Ma) high- to ultrahigh-temperature metamorphism in southern Australia: Implications for Proterozoic supercontinent models. *Gondwana Research*, 23(2), 617–640. <https://doi.org/10.1016/j.gr.2012.04.009>

Fanning, C., Reid, A., & Teale, G. (2007). A geochronological framework for the Gawler Craton, South Australia. In *Bull. Geol. Surv. S. Aust.* (Vol. 55).

Fraser, G., Reid, A., & Stern, R. (2012). Timing of deformation and exhumation across the Karari Shear Zone, north-western Gawler Craton, South Australia. *Australian Journal of Earth Sciences*, 59(4), 547–570. <https://doi.org/10.1080/08120099.2012.678586>

Howard, K. E., Hand, M., Barovich, K. M., Payne, J. L., Cutts, K. A., & Belousova, E. A. (2011). U–Pb zircon, zircon Hf and whole-rock Sm–Nd isotopic constraints on the evolution of Paleoproterozoic rocks in the northern Gawler Craton. *Australian Journal of Earth Sciences*, 58(6), 615–638. <https://doi.org/10.1080/08120099.2011.594905>

Korsch, R., Blewett, R., Giles, D., Reid, A., Neumann, N., Fraser, G., Holzshuh, J., Costelloe, R. D., Roy, I. G., Kennett, B., Cowley, W., Baines, G., Carr, L., Duan, J., Milligan, P., Armit, R., Betts, P., Preiss, W., & Bendall, B. (2010). *Geological interpretation of the deep seismic reflection and magnetotelluric line 08GA-OM1: Gawler Craton-Officer Basin-Musgrave Province-Amadeus Basin (GOMA), South Australia and Northern Territory* (p. 86).

Morrissey, L. J., Barovich, K. M., Hand, M., Howard, K. E., & Payne, J. L. (2019). Magmatism and metamorphism at ca. 1.45 Ga in the northern Gawler Craton: The Australian record of rifting within Nuna (Columbia). *Geoscience Frontiers*, 10(1), 175–194. <https://doi.org/10.1016/j.gsf.2018.07.006>

Payne, J. L., Hand, M., Barovich, K. M., & Wade, B. P. (2008). Temporal constraints on the timing of high-grade metamorphism in the northern Gawler Craton: Implications for assembly of the Australian Proterozoic. *Australian Journal of Earth Sciences*, 55(5), 623–640. <https://doi.org/10.1080/08120090801982595>

Payne, J. L., Barovich, K. M., & Hand, M. (2006). Provenance of metasedimentary rocks in the northern Gawler Craton, Australia: Implications for Palaeoproterozoic reconstructions. *Precambrian Research*, 148(3), 275–291. <https://doi.org/10.1016/j.precamres.2006.05.002>

Reid, A., & Forster, M. (2021). Mesoproterozoic thermal evolution of the northern Gawler Craton from 40Ar/39Ar geochronology. *Precambrian Research*, 358, 106180. <https://doi.org/10.1016/j.precamres.2021.106180>

Stewart, J. R., Betts, P. G., Collins, A. S., & Schaefer, B. F. (2009). Multi-scale analysis of Proterozoic shear zones: An integrated structural and geophysical study. *Journal of Structural Geology*, 31(10), 1238–1254. <https://doi.org/10.1016/j.jsg.2009.07.002>

Stewart, J. R., & Betts, P. G. (2010). Implications for Proterozoic plate margin evolution from geophysical analysis and crustal-scale modeling within the western Gawler Craton, Australia. *Convergent Plate Margin Dynamics: New Perspectives from Structural Geology, Geophysics and Geodynamic Modelling*, 483(1), 151–177. <https://doi.org/10.1016/j.tecto.2009.11.016>

Yu, J., Hand, M., Morrissey, L. J., & Payne, J. L. (2024). A buried gneiss dome in the northern Gawler Craton: The record of early Mesoproterozoic (ca. 1600–1560 Ma) extension in southern Proterozoic Australia. *Journal of Metamorphic Geology*, 42(4), 497–527. <https://doi.org/10.1111/jmg.12762>



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