

Insights into the origin of the Lachlan Orogen with applications for exploration

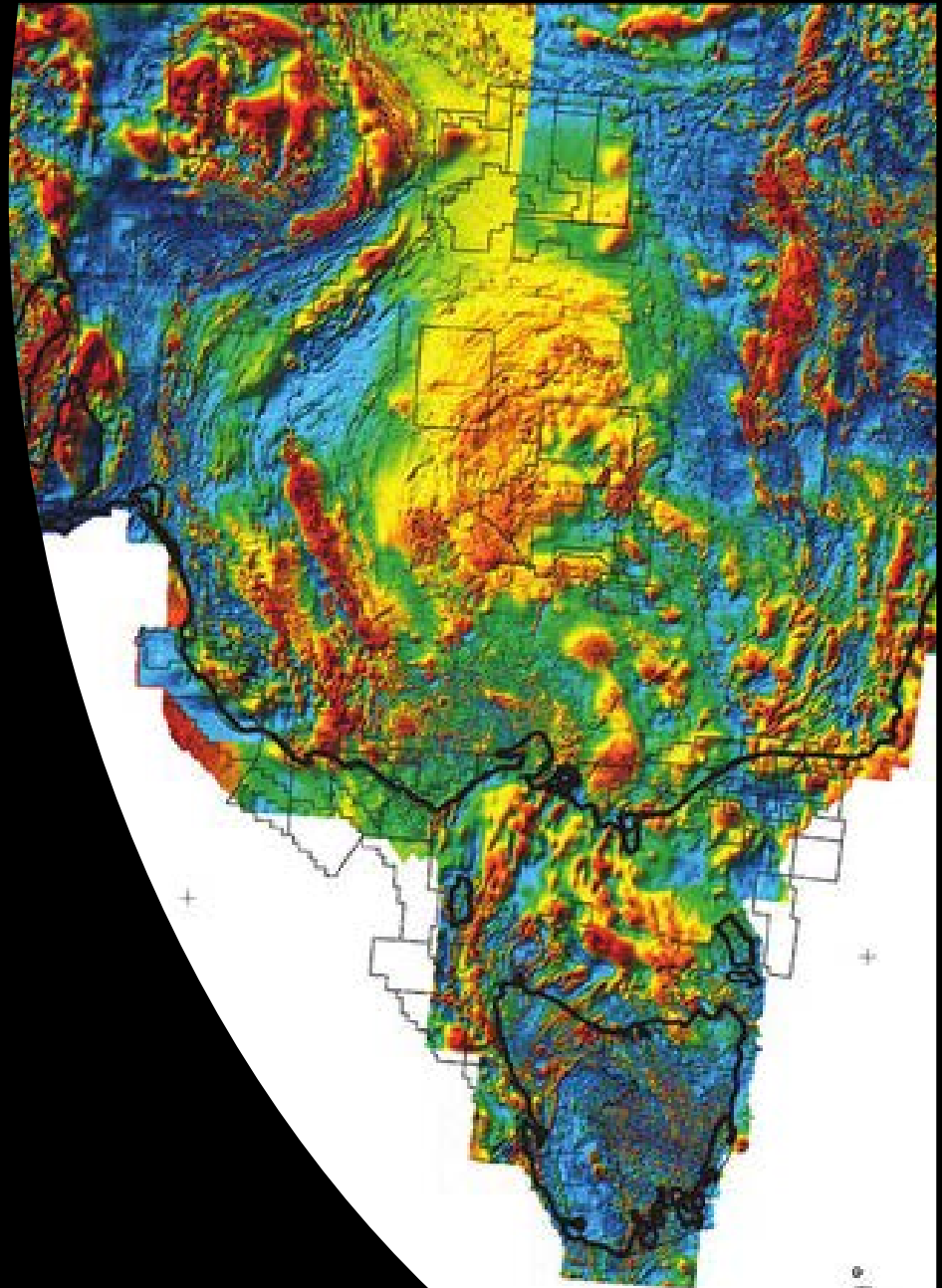
*Sebastien Meffre, Chris Leslie, Tristan Wells, Umer Habib,
Thomas Schaap*



UNIVERSITY of
TASMANIA

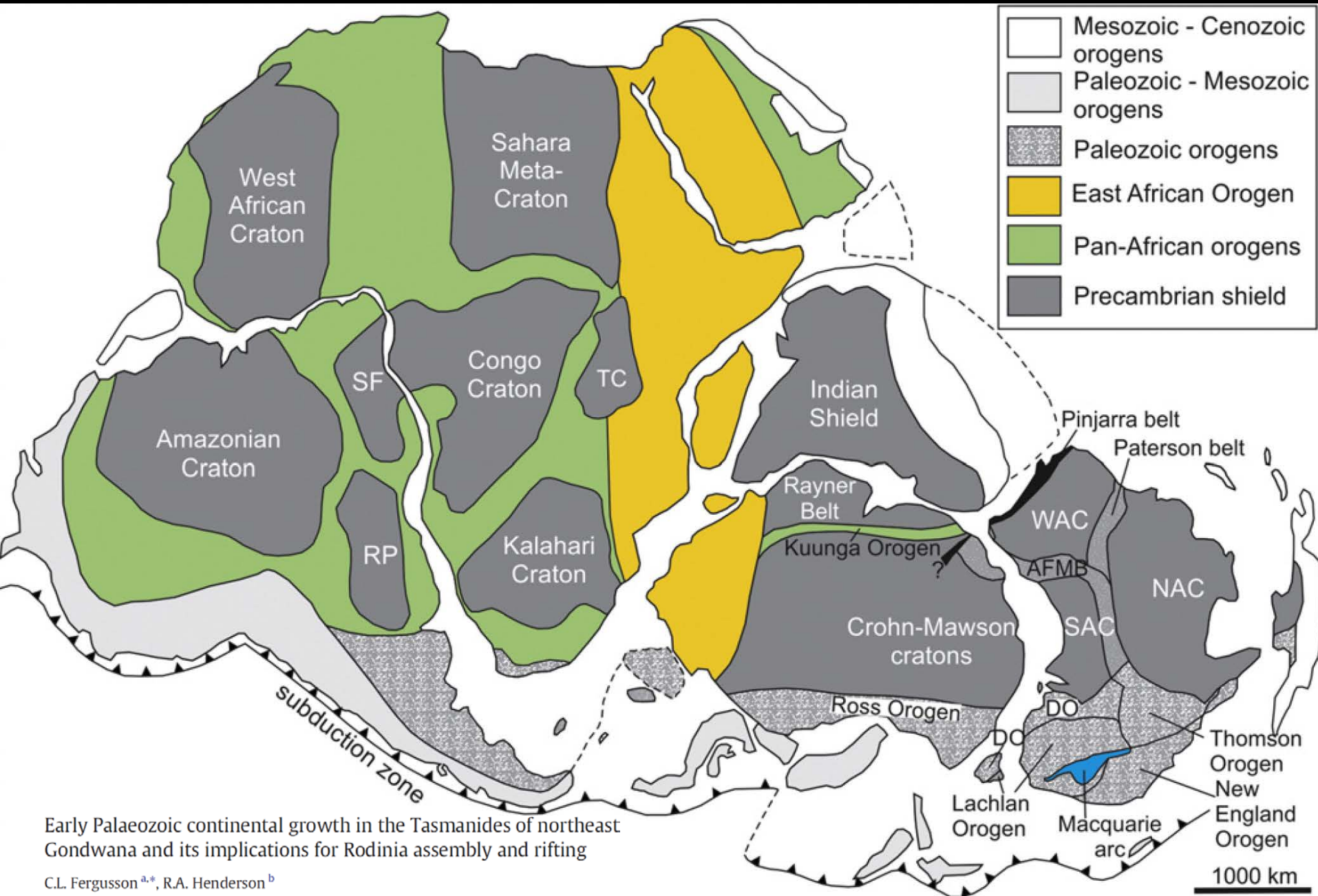
Why investigate the tectonics of SE Australia?

- Make predictions about prospectivity
- Scientific understanding of
 - Local environment
 - Global tectonic processes
 - Tectonic evolution of the Earth



Teasdale 2003

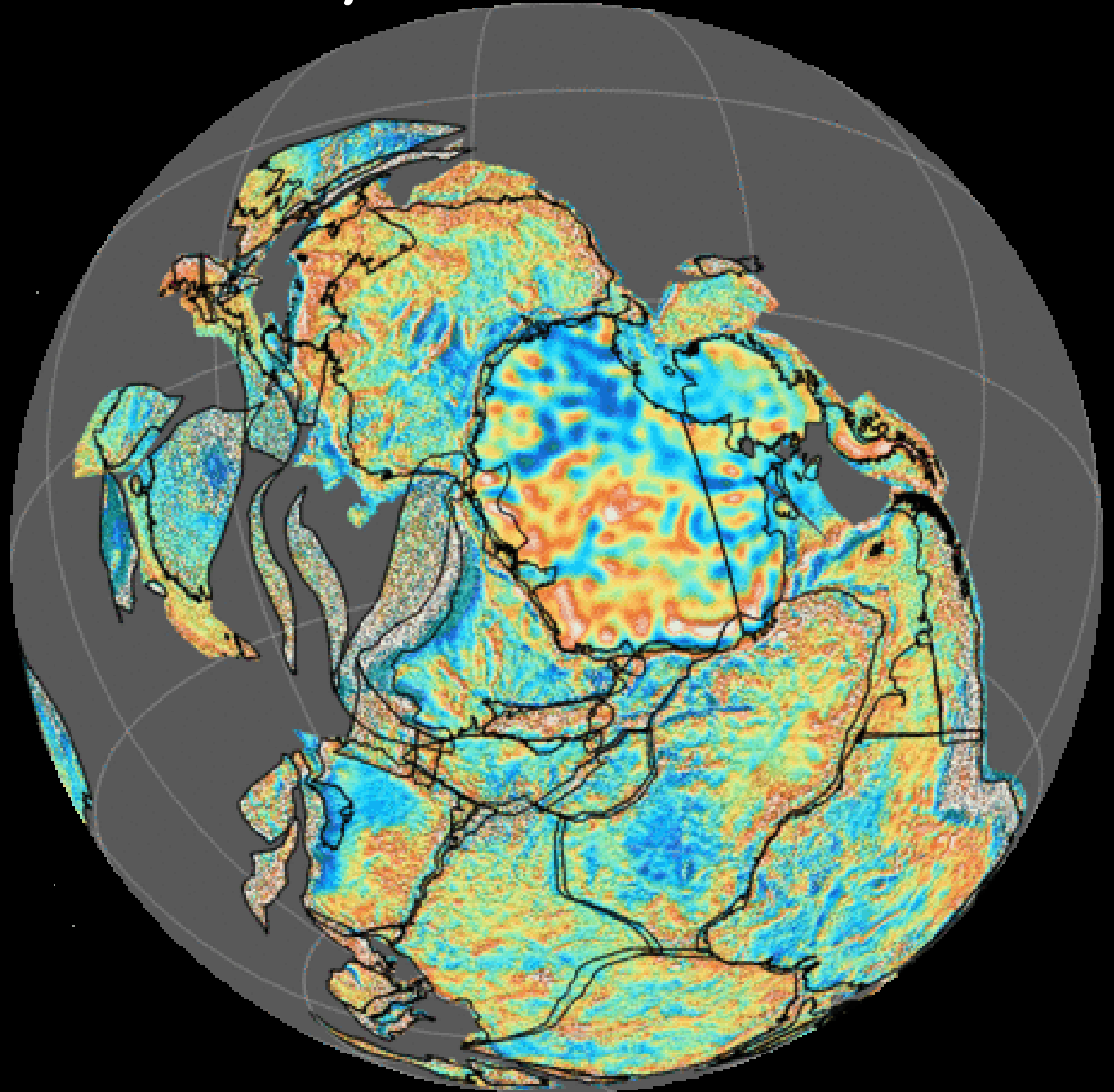
The Big Picture: Early Paleozoic Gondwana



Early Palaeozoic continental growth in the Tasmanides of northeast Gondwana and its implications for Rodinia assembly and rifting

C.L. Fergusson ^{a,*}, R.A. Henderson ^b

The Big Picture: Early Paleozoic Gondwana



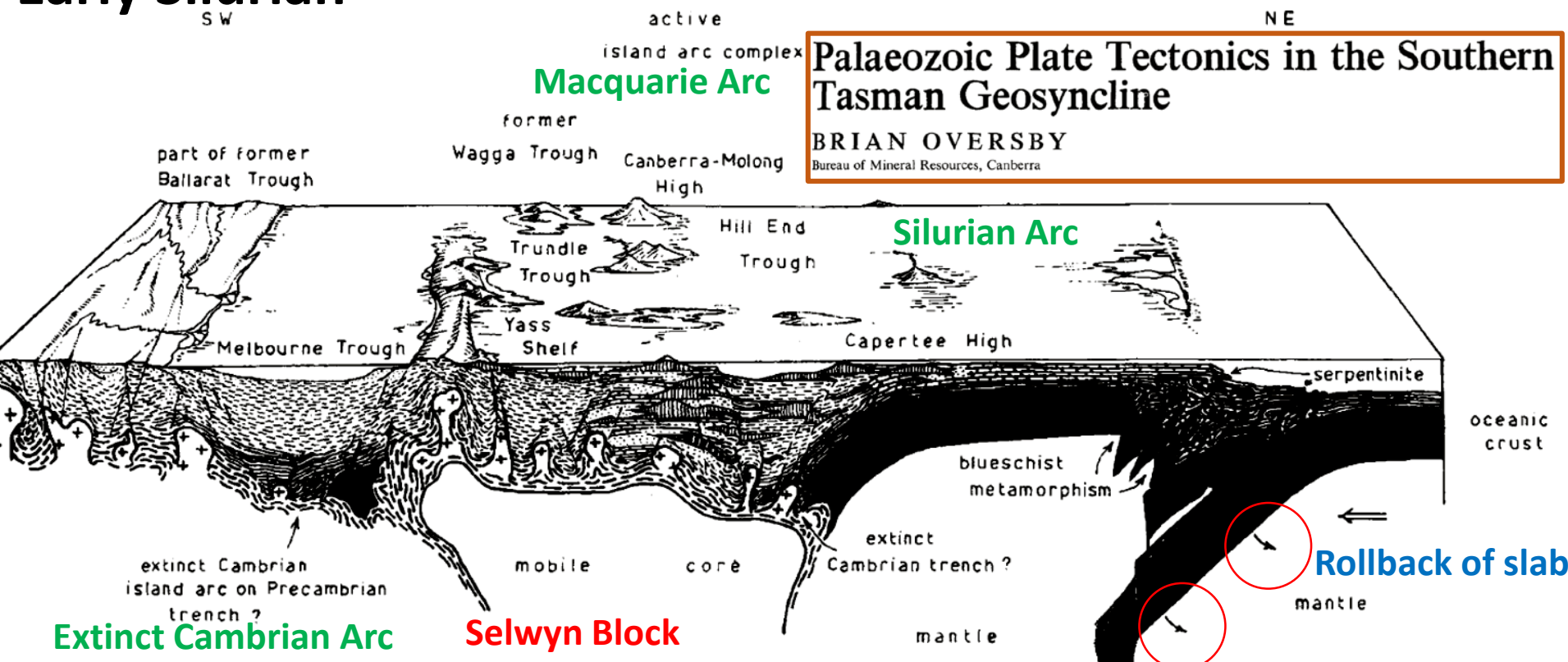
Our understanding of the really big picture has not changed much in 40 years

- 1971 Lachlan Orogen tectonic reconstruction very similar to that from 2019

Early Silurian

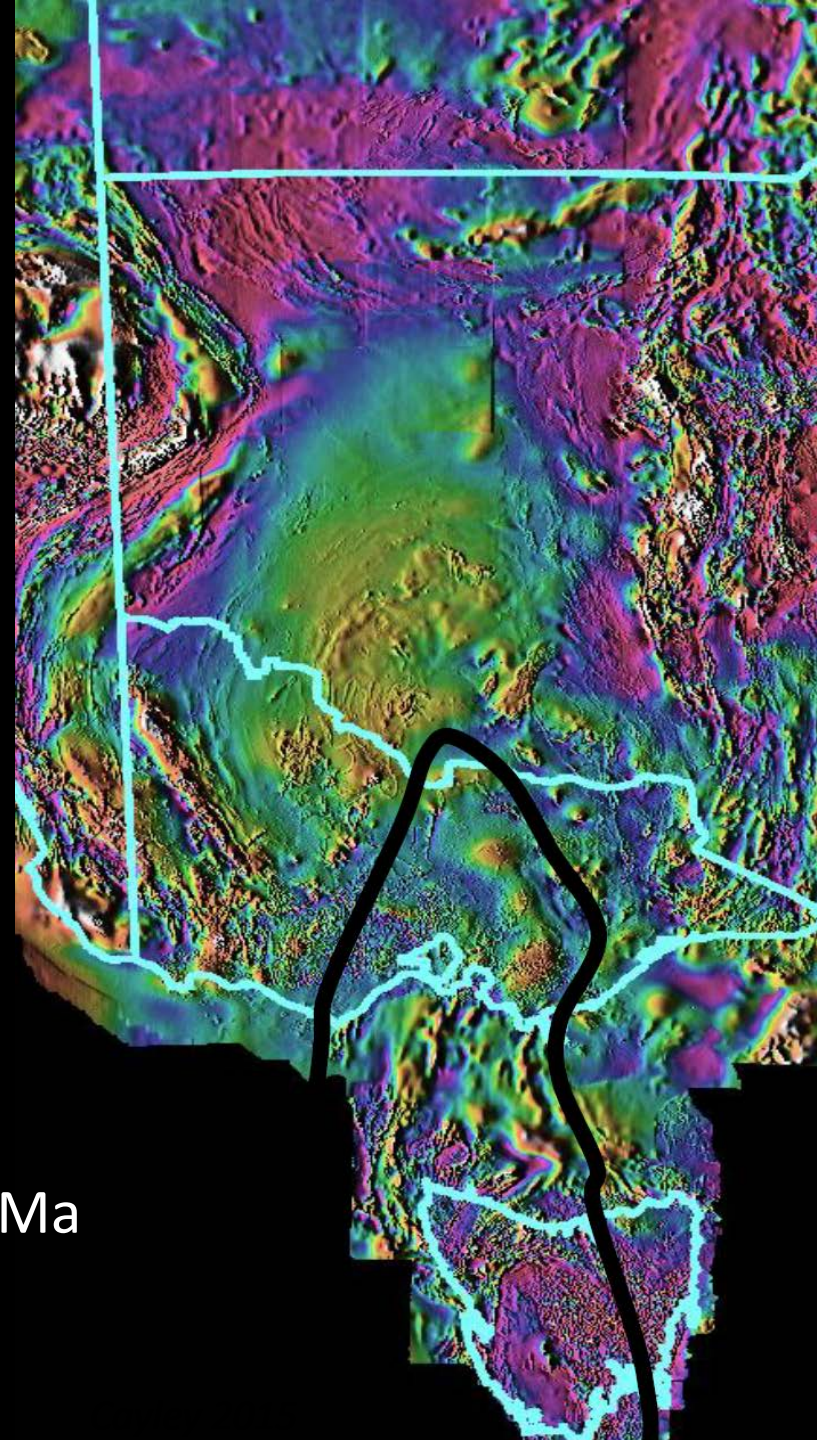
NATURE PHYSICAL SCIENCE VOL. 234 NOVEMBER 15 1971

Palaeozoic Plate Tectonics in the Southern Tasman Geosyncline
BRIAN OVERSBY
Bureau of Mineral Resources, Canberra



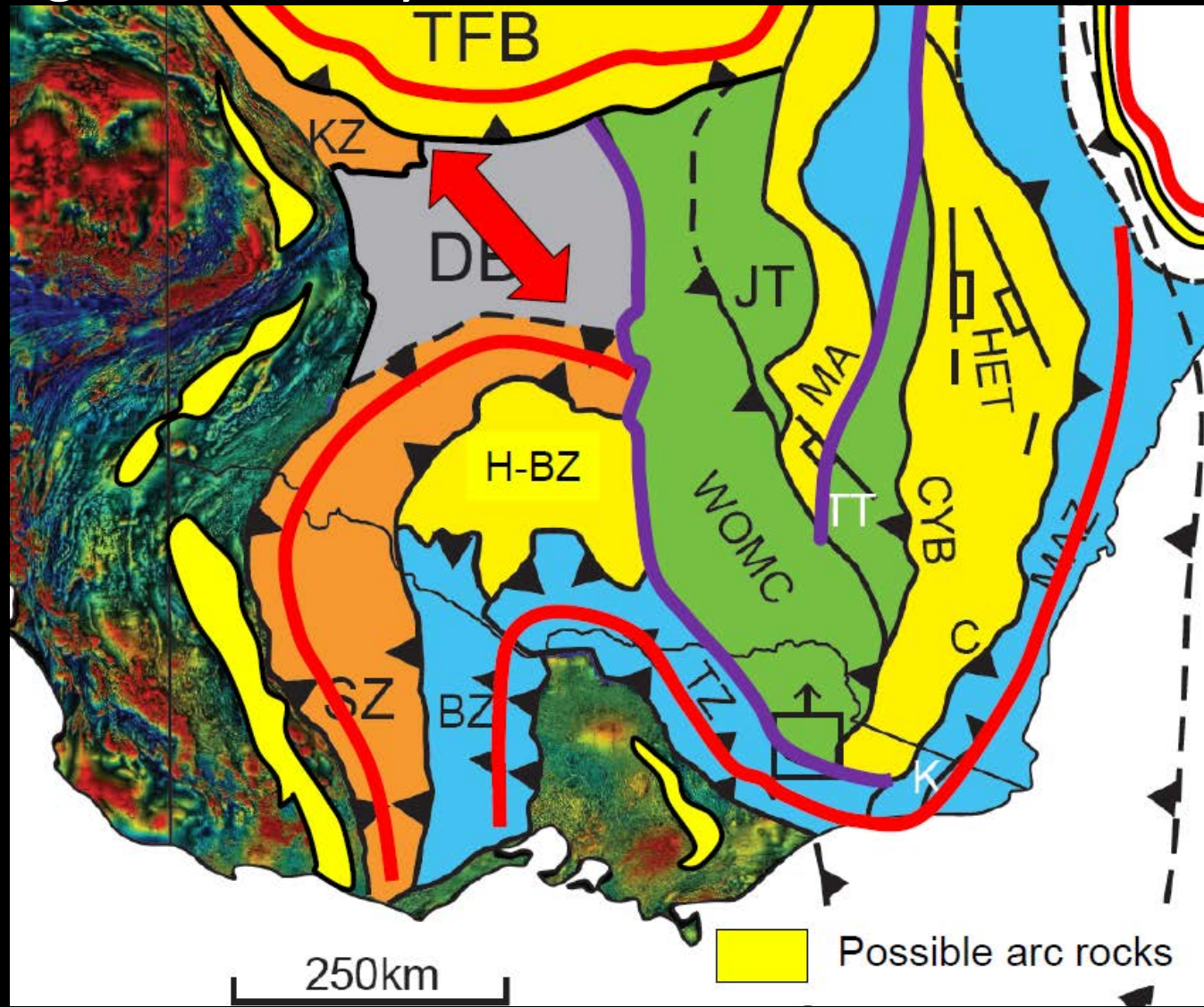
Major events in the history of SE Australia

- Neoproterozoic rifts 585-520 Ma
- Cambrian subduction 520-510 Ma
- Cambrian orogenesis 510-490 Ma
- Ordovician subduction 490-445 Ma
- Early Silurian Orogenesis 445-440 Ma
- Silurian-Early Devonian rifts 440-415 Ma
- Devonian orogenesis 415-360 Ma



The Lachlan Orocline

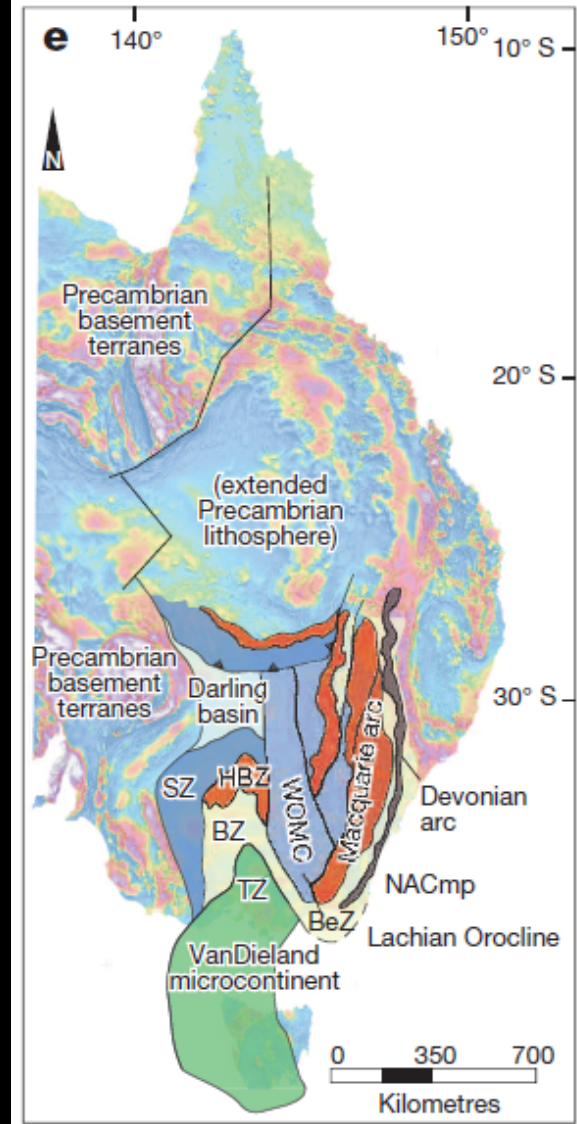
- A great hypothesis but it's a model and it must not get in the way of the facts



Important constraints on the Lachlan Orogen

- At least 2 subduction zones operated between 516-495 Ma
- Tasmania docked between 510-490 Ma
- Tasmania \neq central Victoria
- No subduction zone between NW and central Tasmania
- Both the Lachlan and the Dundas Fossey orocline models need fine tuning

SZ: Stawell Zone
 BZ: Bendigo Zone
 TZ: Tabberabberan Zone
 BeZ: Bega Zone
 HBZ: Hay-Booligal Zone
 NACmp: Narooma Accretionary Complex
 WOMC: Wagga-Omeo Metamorphic Complex



■ Devonian arc	■ Ordovician sediment
■ Silurian sediment	■ Cambrian
■ Ordovician metamorphic	■ Proterozoic basement
■ Ordovician arc	

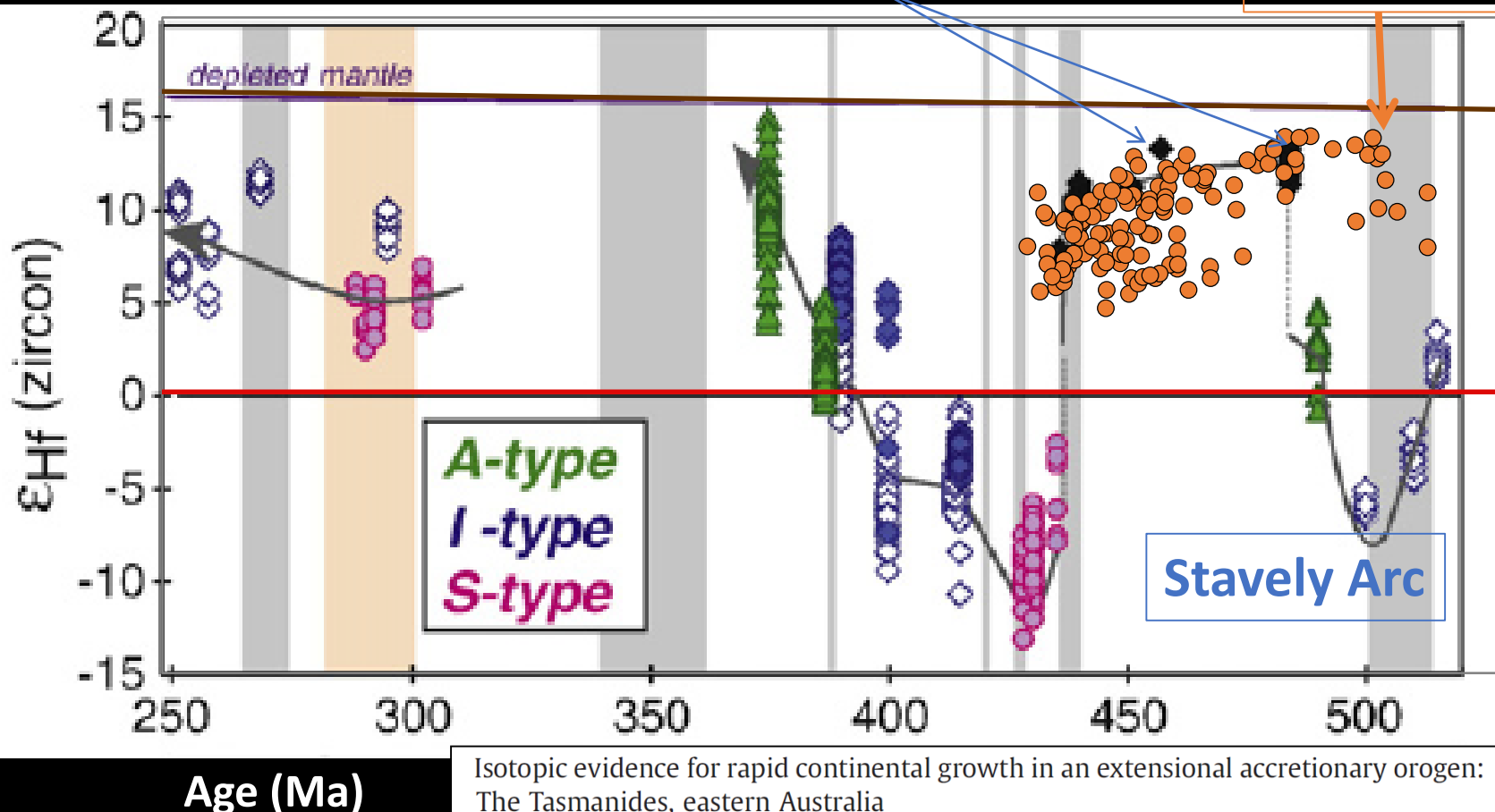
Two subduction zones in the Cambrian

- The Macquarie arc is built on Cambrian island arc crust
- Stavelly Arc-Mt Wright Arc is on continental crust

New results from Macquarie Arc

Cambrian Zircons

MANTLE
EARTH
OLD CRUST

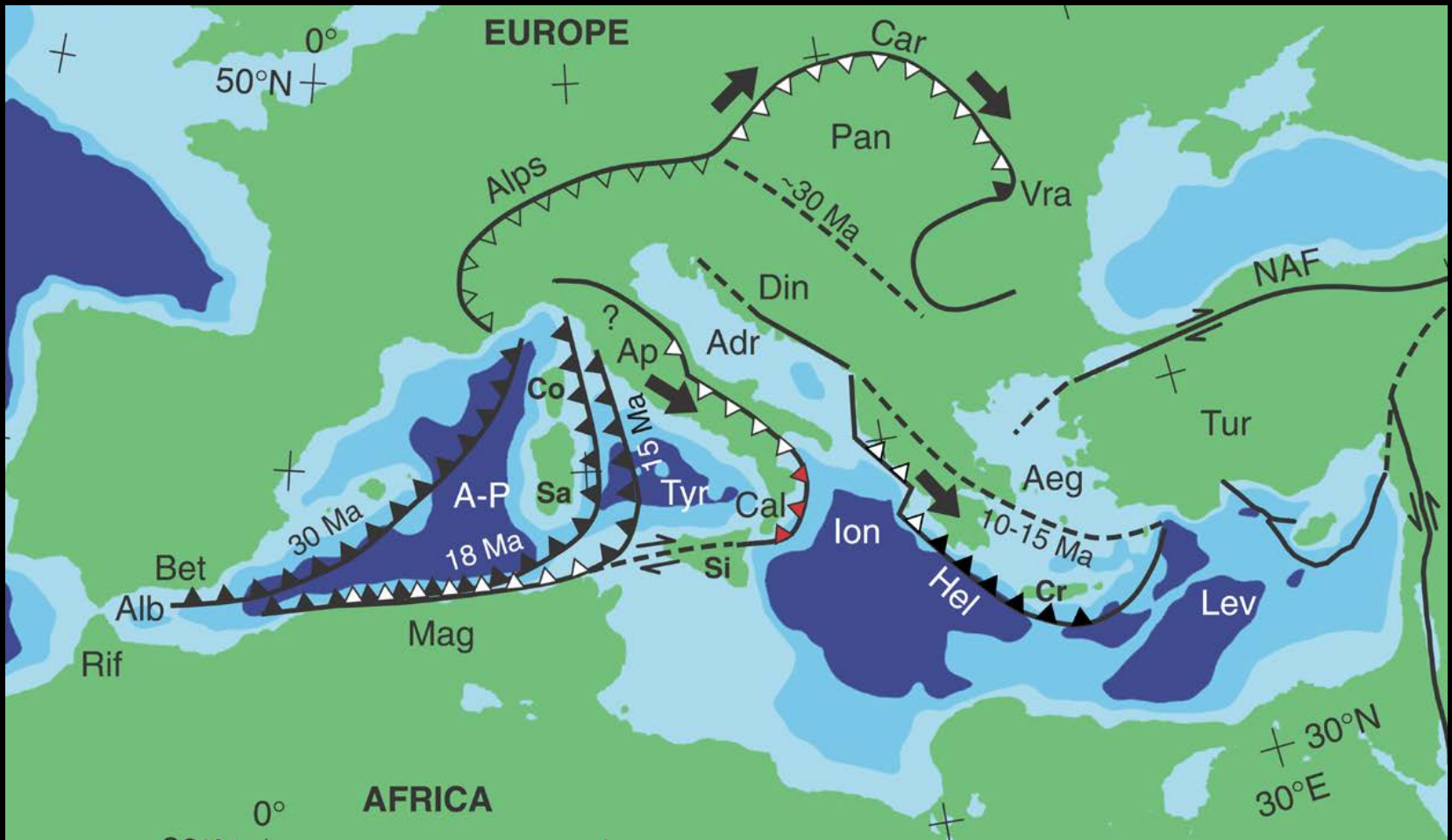


Isotopic evidence for rapid continental growth in an extensional accretionary orogen: The Tasmanides, eastern Australia

A.I.S. Kemp^{a,*}, C.J. Hawkesworth^b, W.J. Collins^a, C.M. Gray^a, P.L. Blevin^c, EIMF^d

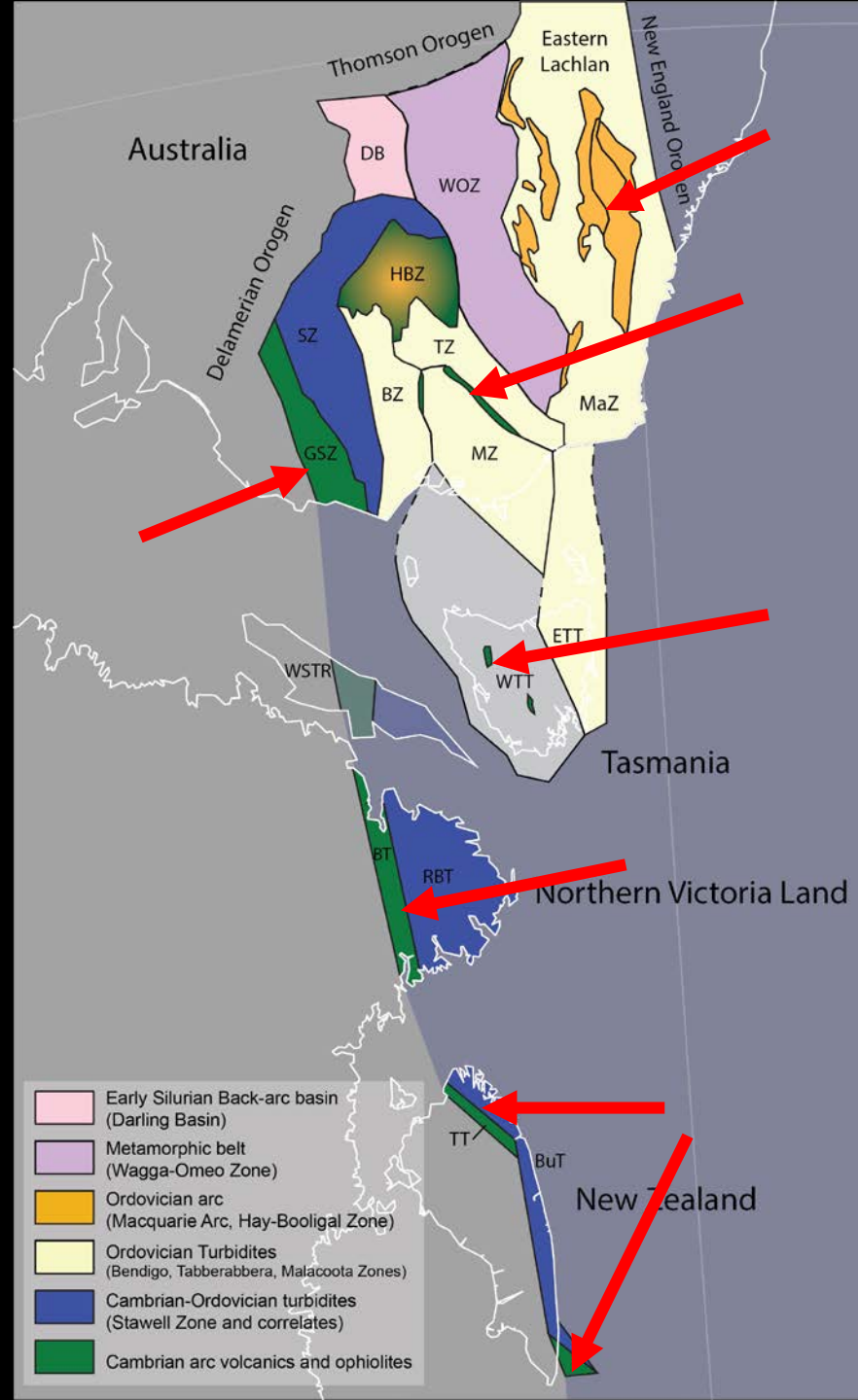
Two subduction zones in the Cambrian

- Is this surprising?:
 - Subduction zones are complicated



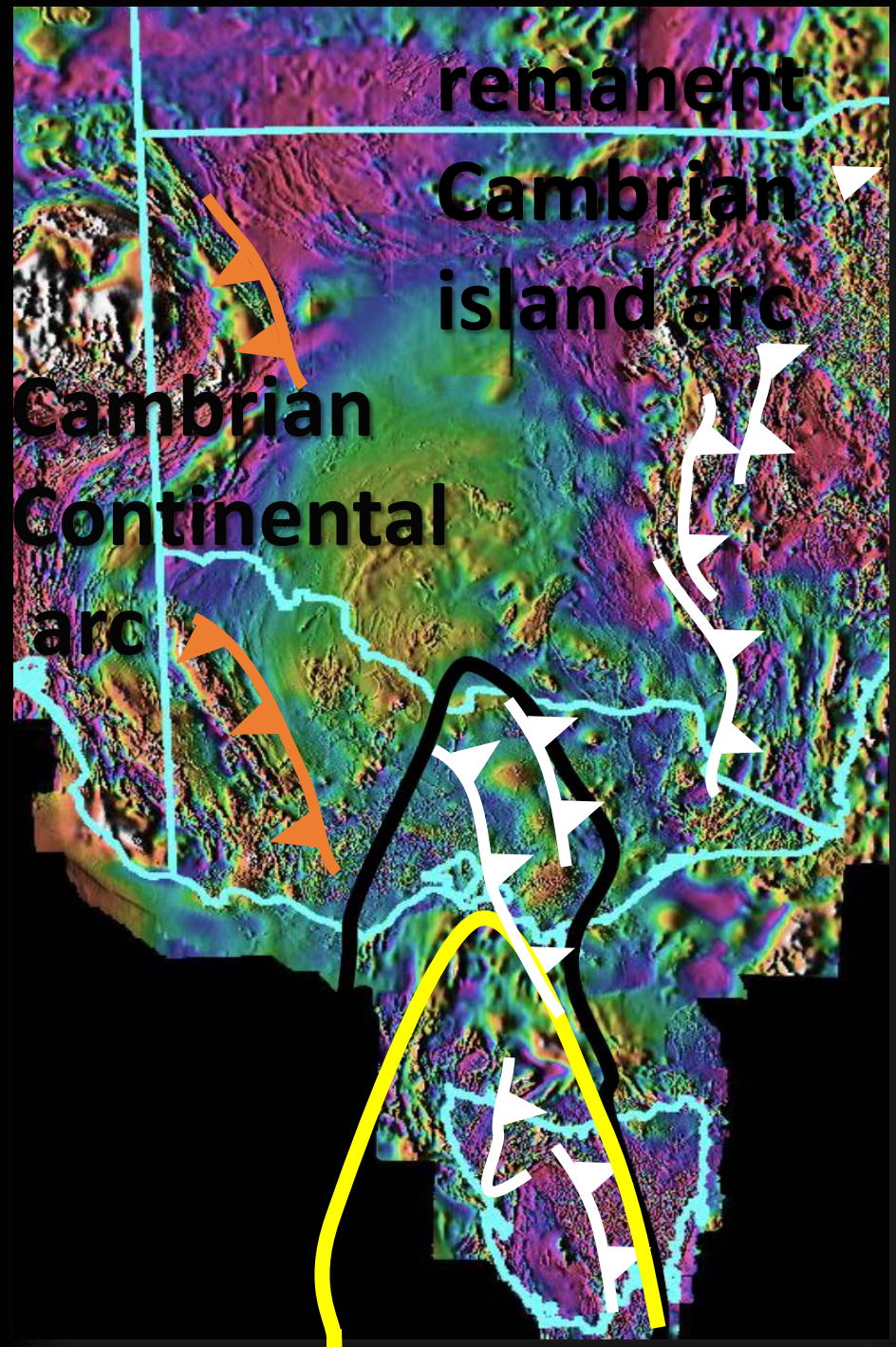
Cambrian arcs

- NSW
- Central Vic
- West Vic
- West Tas
- North Victoria Land
- New Zealand



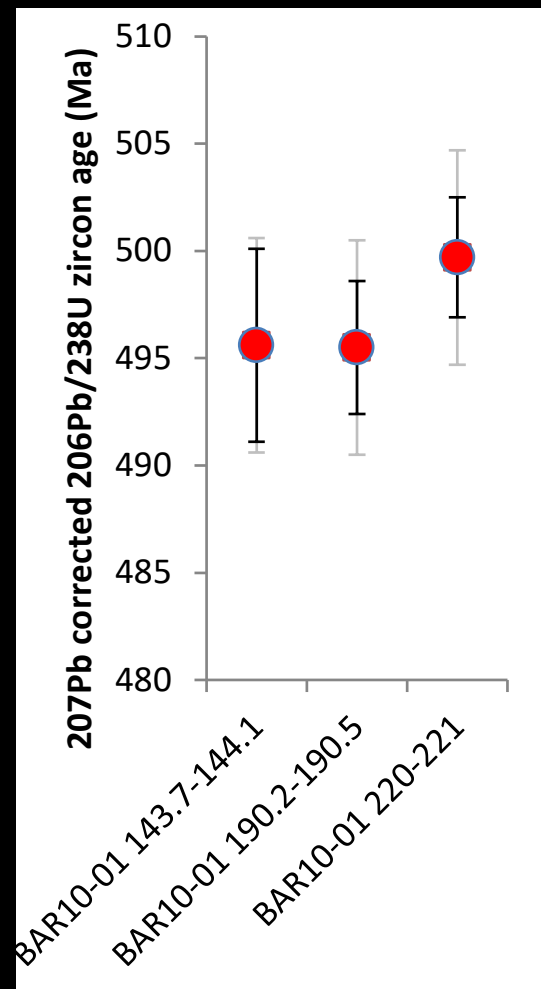
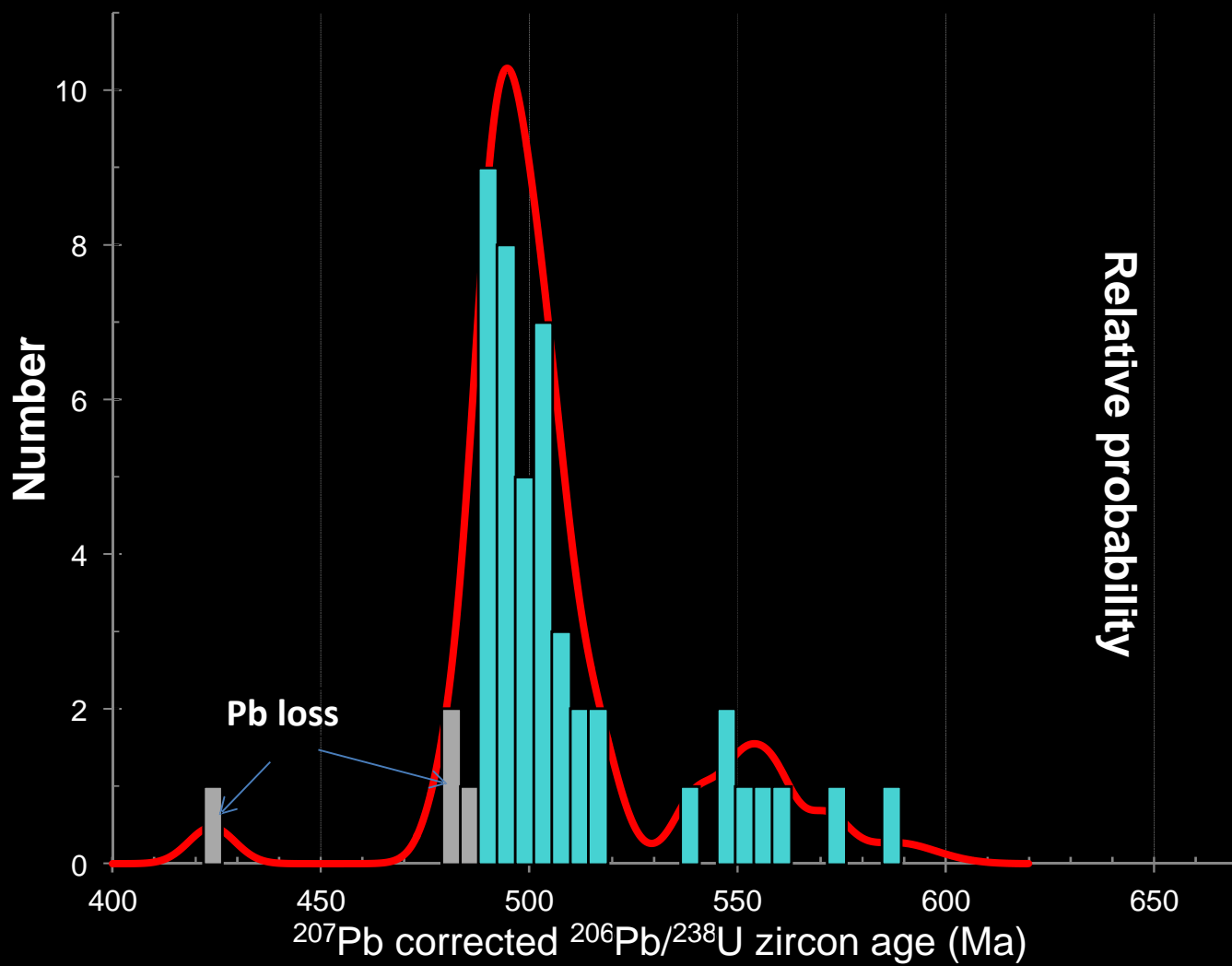
Two subduction zones in the Cambrian

- One continental
- The other intra-oceanic



The Macquarie arc is built on Cambrian island arc crust

New results: U-Pb zircon diorite from Barmedman

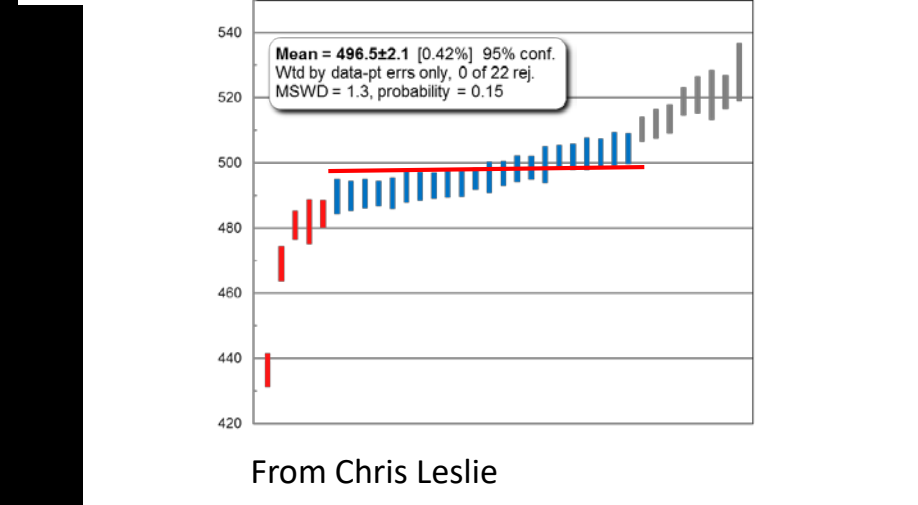
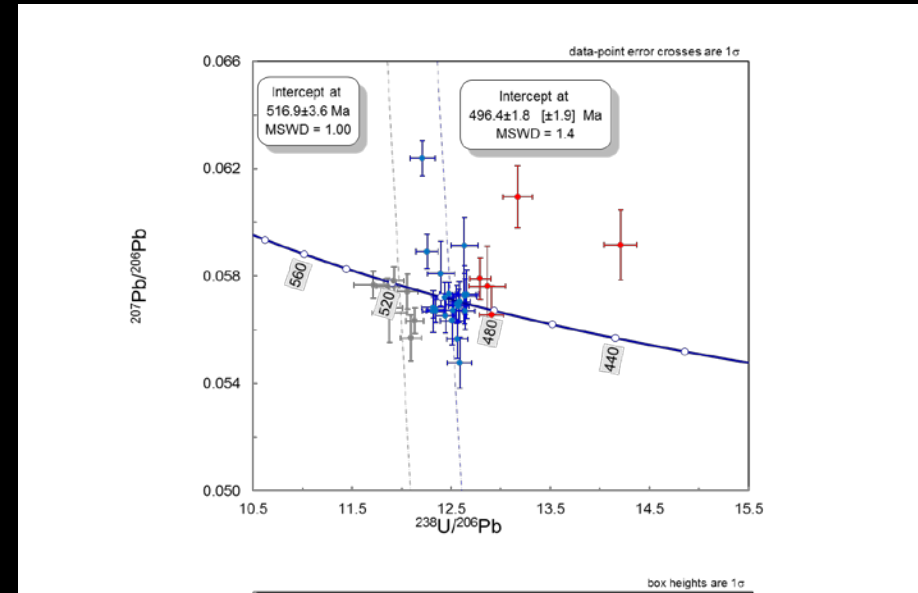
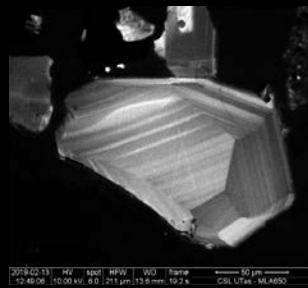
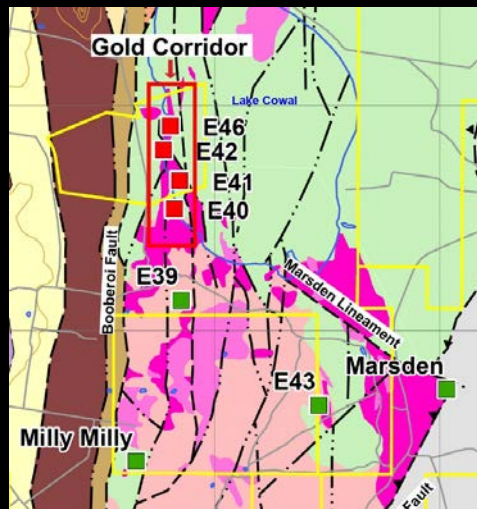


The Macquarie arc is built on Cambrian island arc crust



New Cambrian intrusive

- **Marsden Monzodiorite**



From Chris Leslie

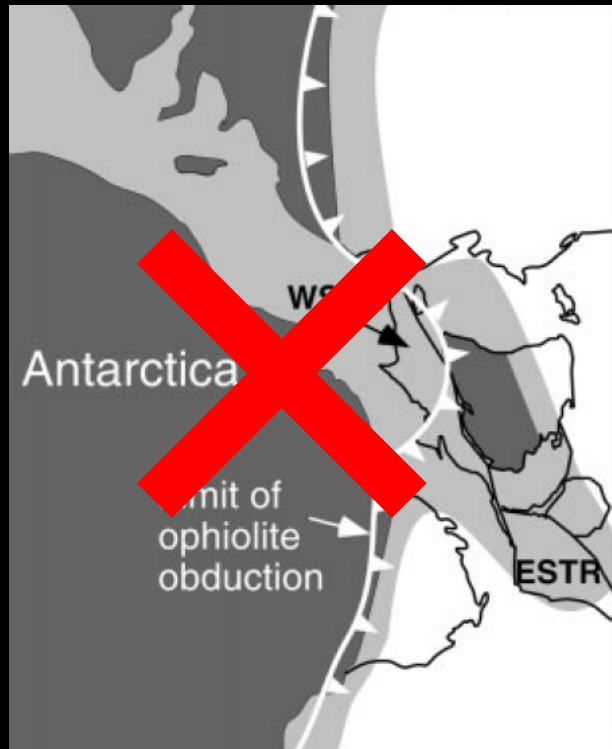
Two subduction zones in the Cambrian

Applications for explorers:

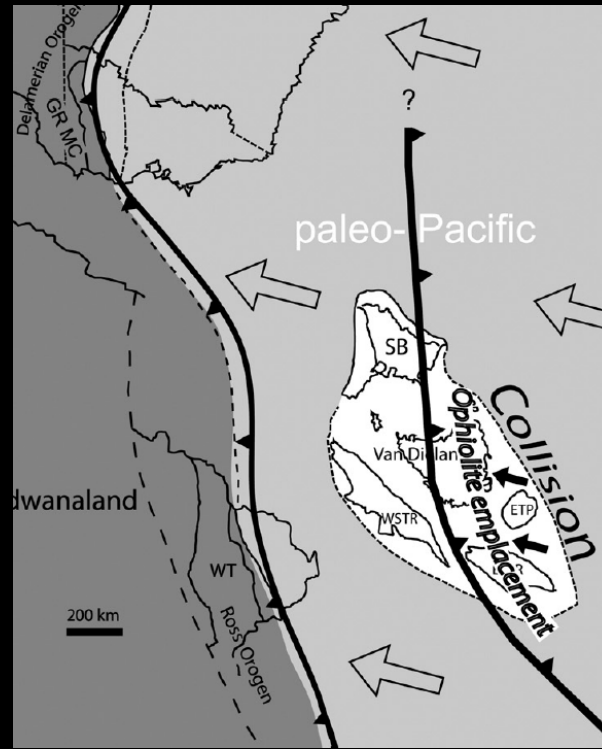
Prospectivity of the Stavelly Arc \neq west Tasmania

At 500 Ma

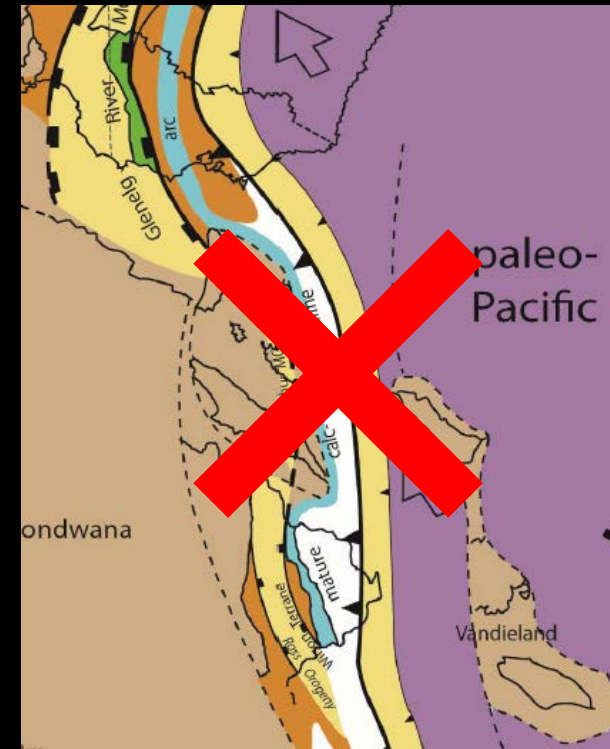
East-dipping
Meffre et al. 2000



East and west dipping
Cayley 2011

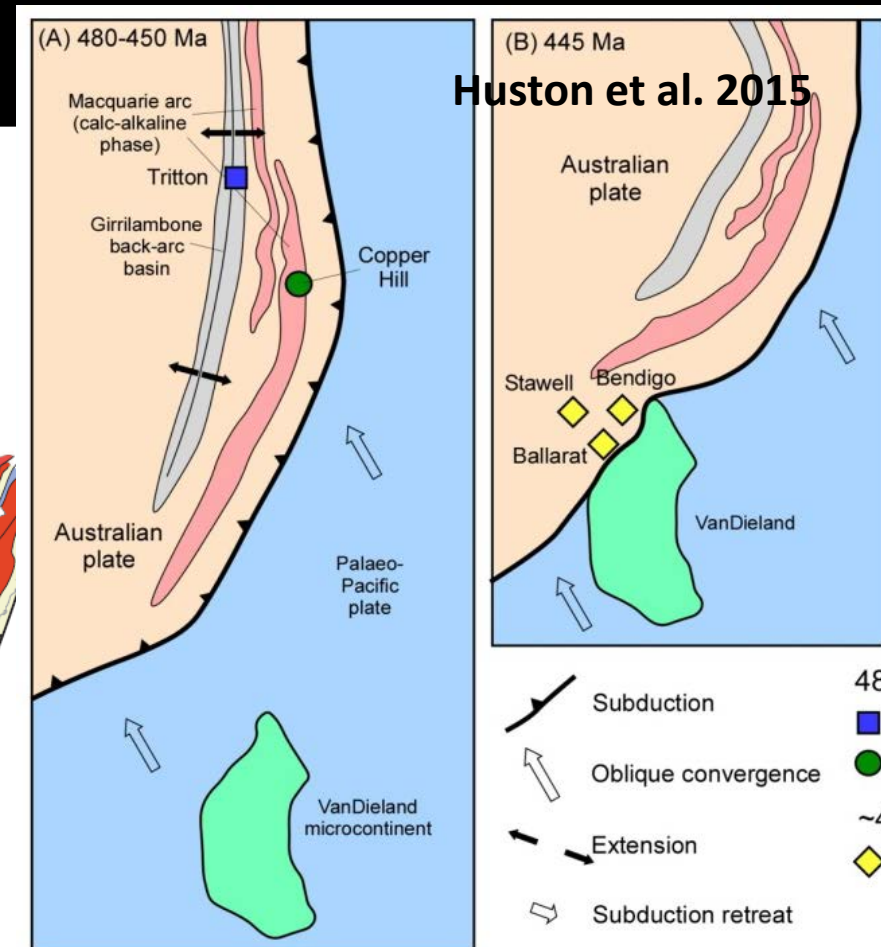
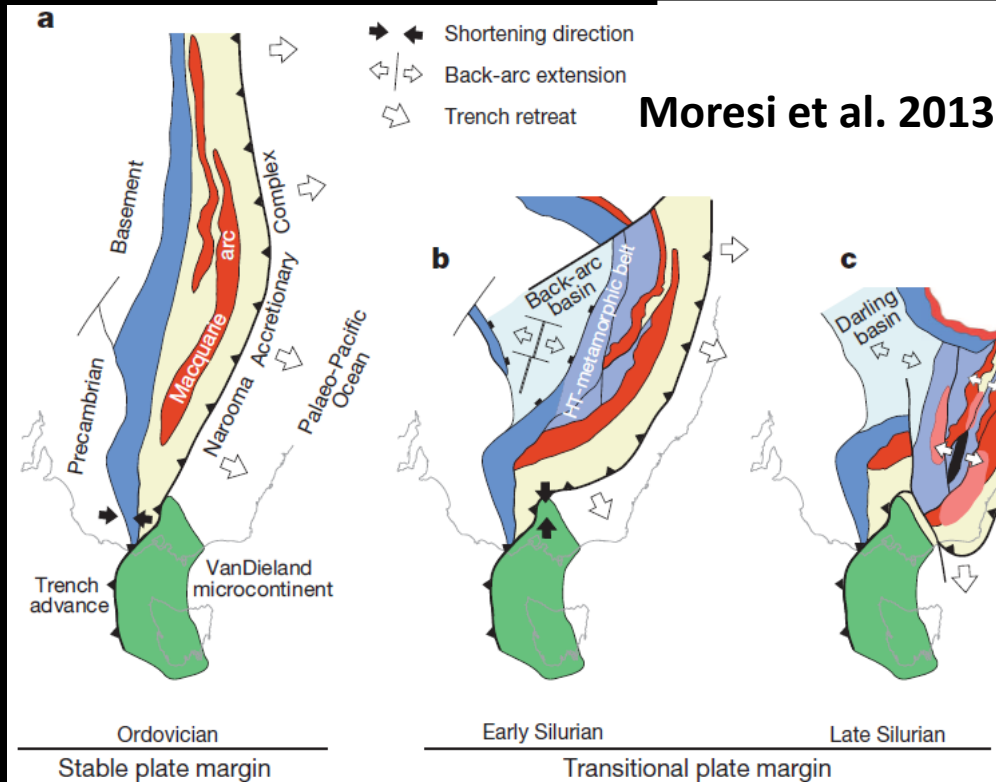


West-dipping
Cayley et al. 2018



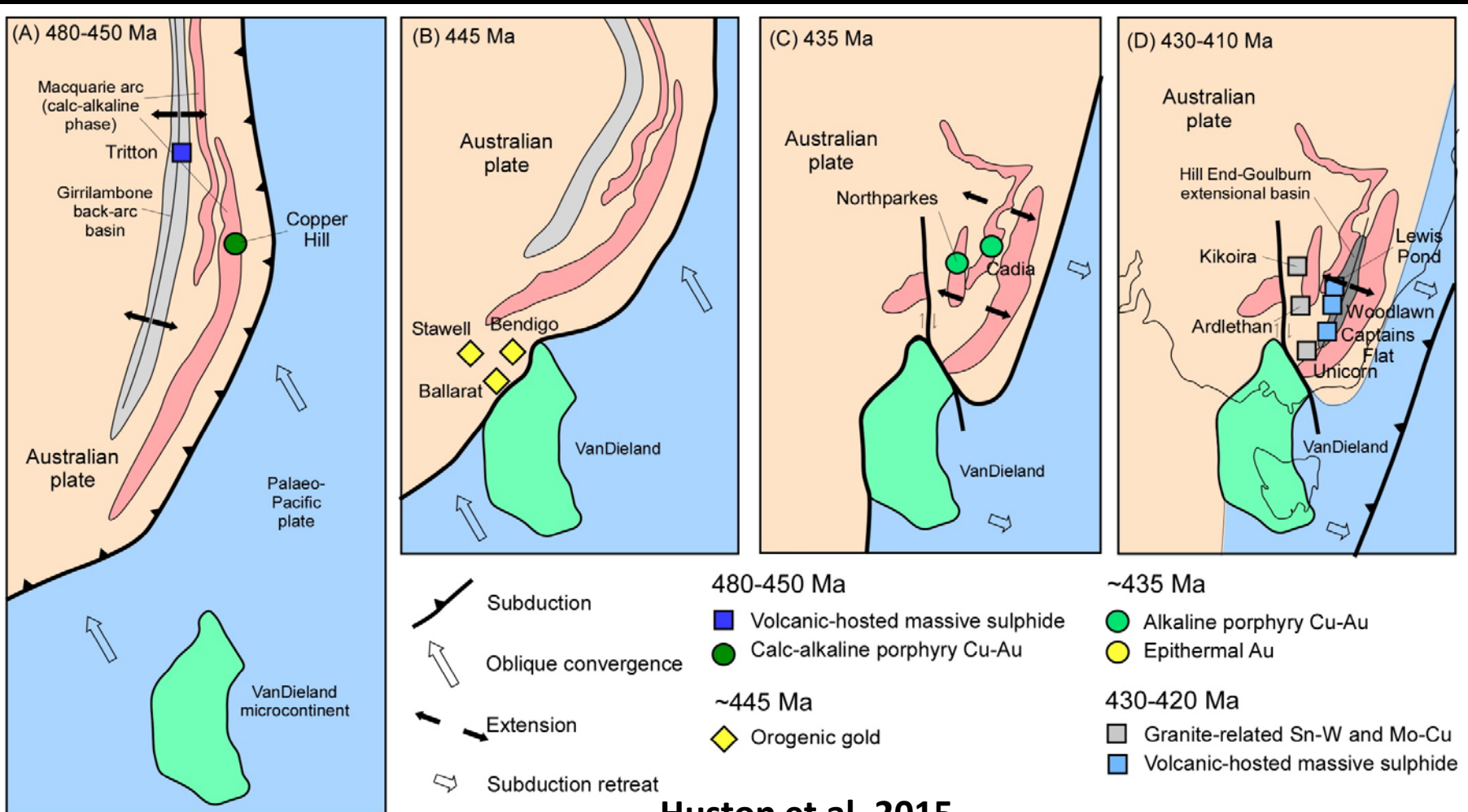
Tasmania docked between 510-490 Ma

- Different models have different docking times



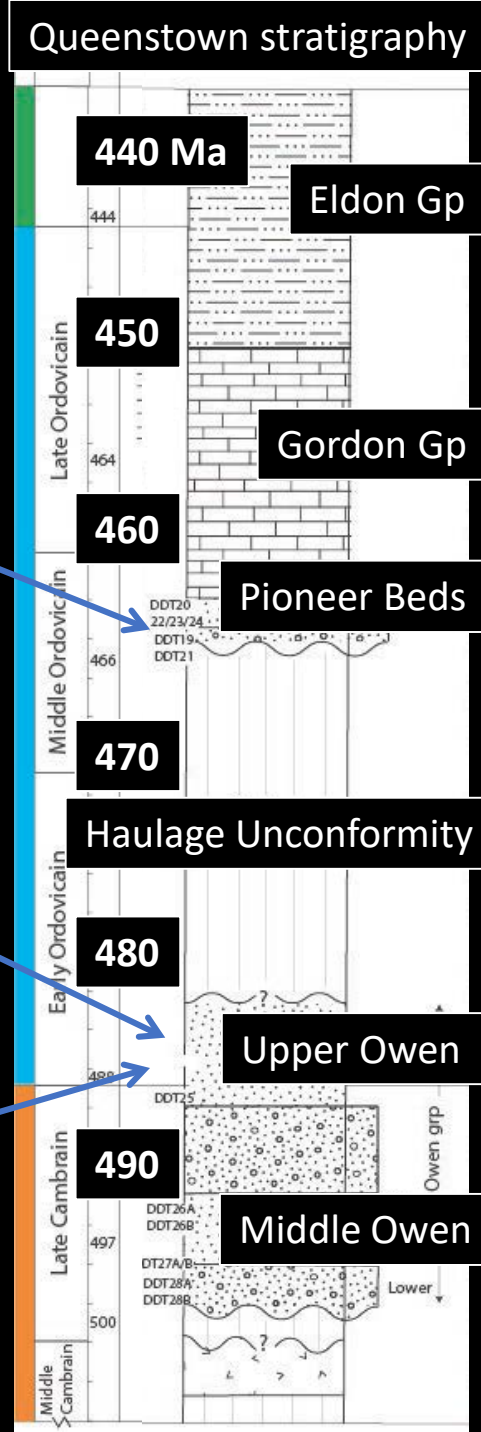
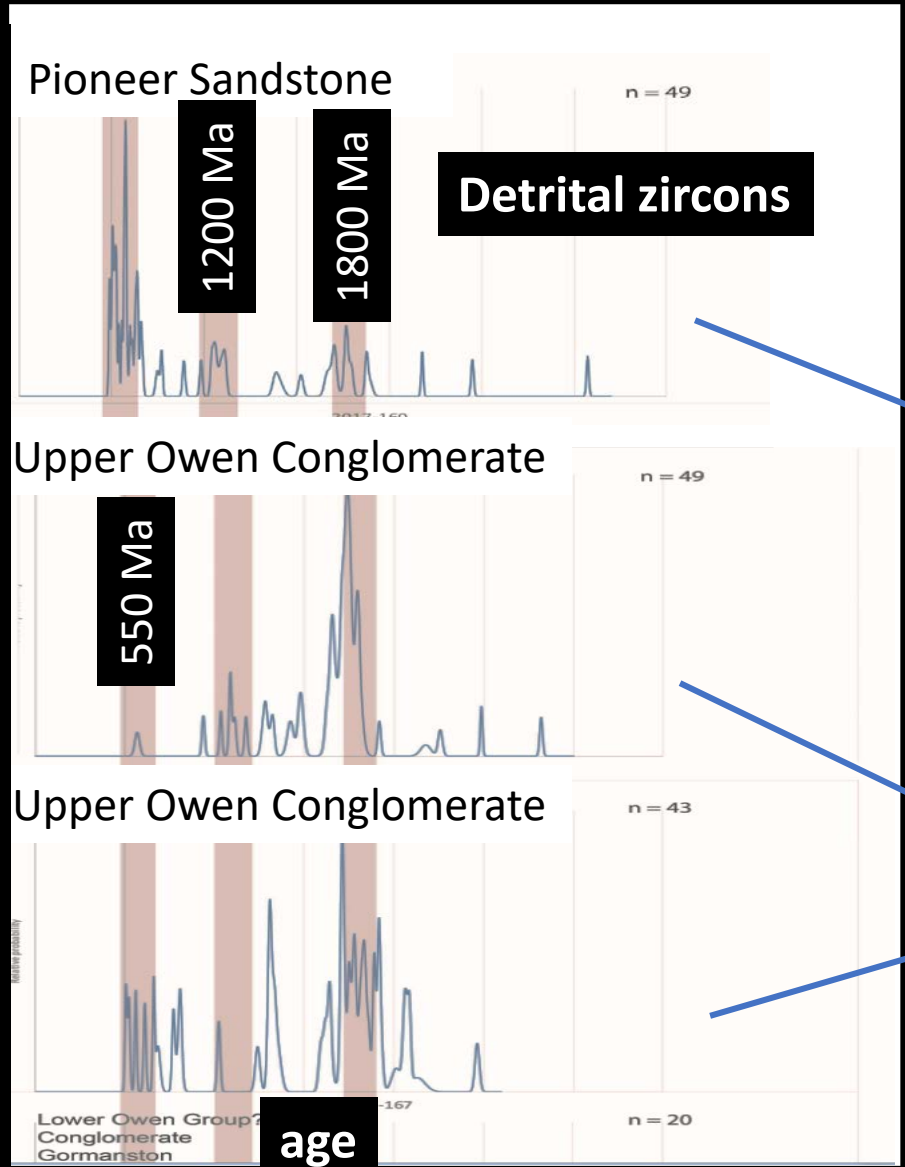
Tasmania docked between 510-490 Ma

- Applications for Explorers:
 - Late collision could be the cause of the gold in Bendigo and the NSW Porphyries



Tasmanian Early Paleozoic

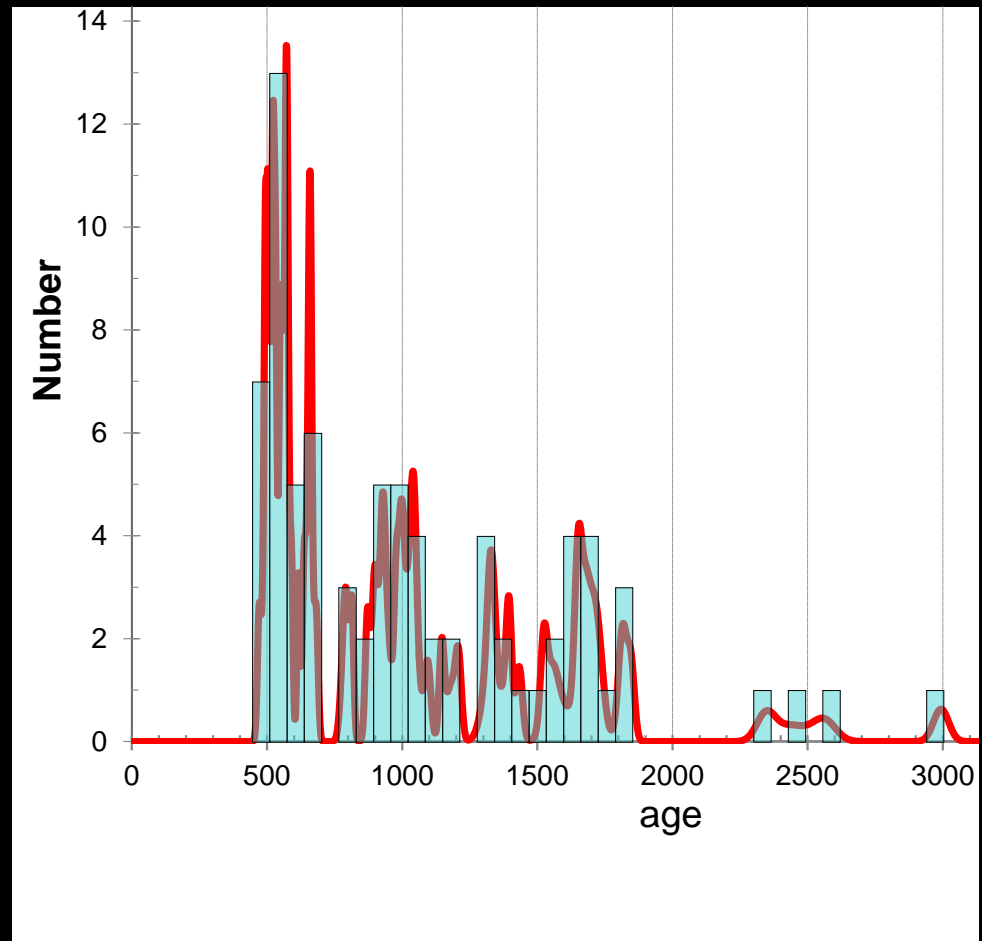
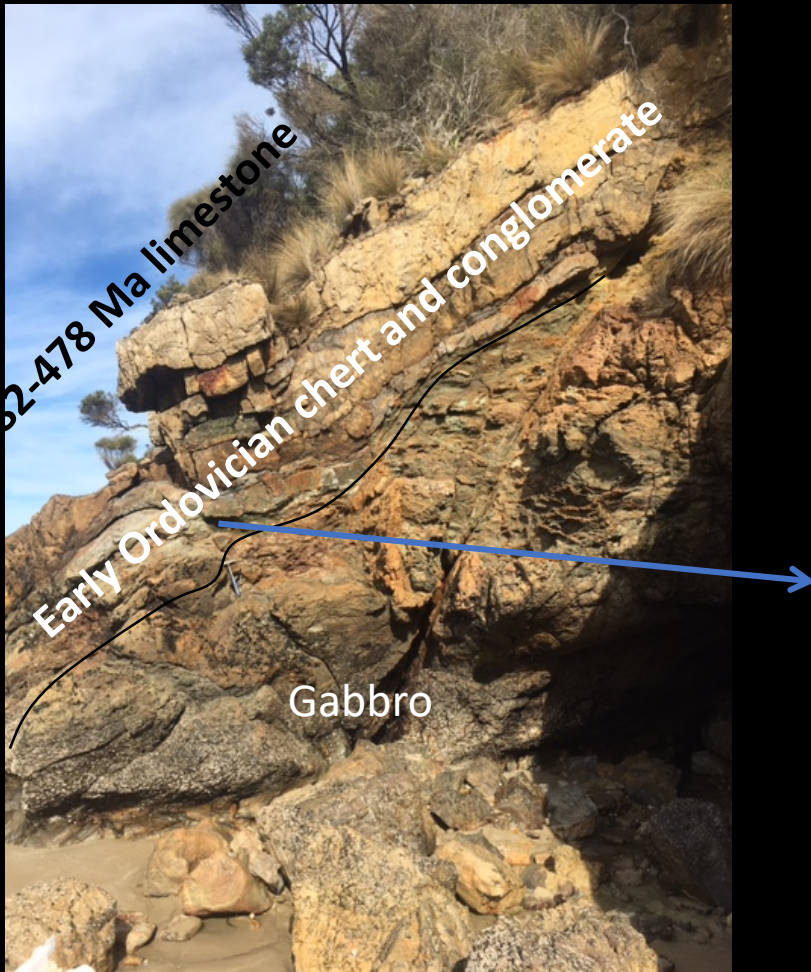
- Major change in zircon provenance
- In Early to Middle Ordovician



Tasmania \neq central Victoria

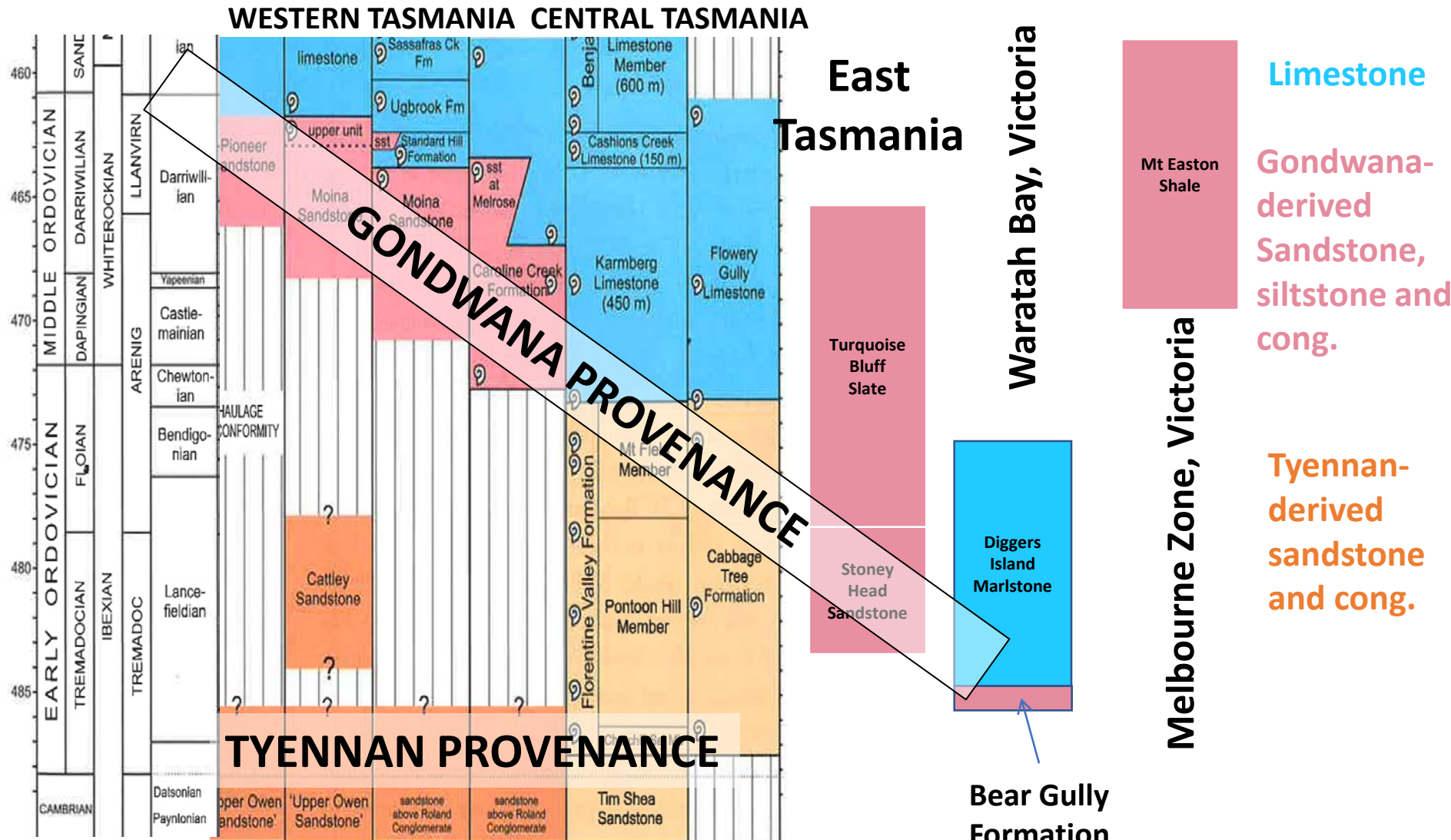
Earliest Ordovician Waratah Bay Victoria

- **NOT** correlate for Owen conglomerate
- Not a sourced from Tasmanian zircons



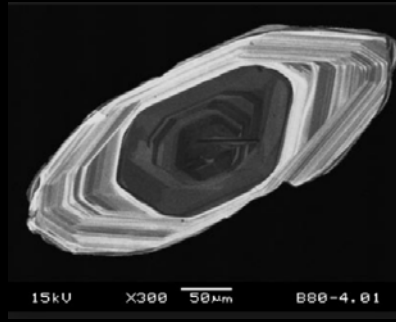
Comparison of sedimentary rocks

- Detrital zircons and sedimentary rock chemistry highlight key differences between Tasmania and Victoria

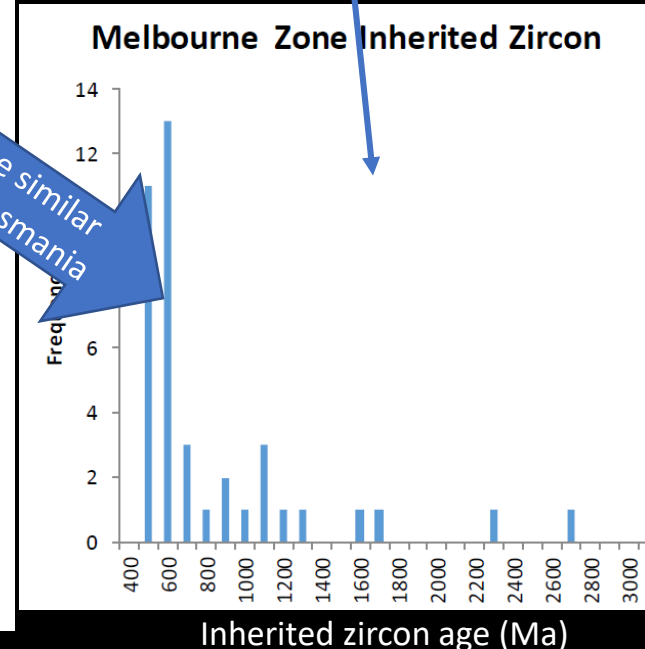
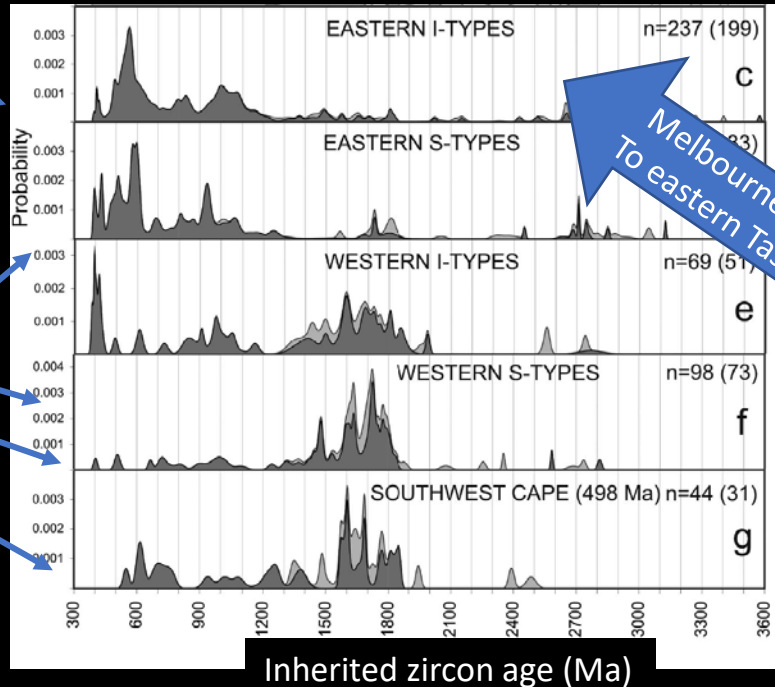
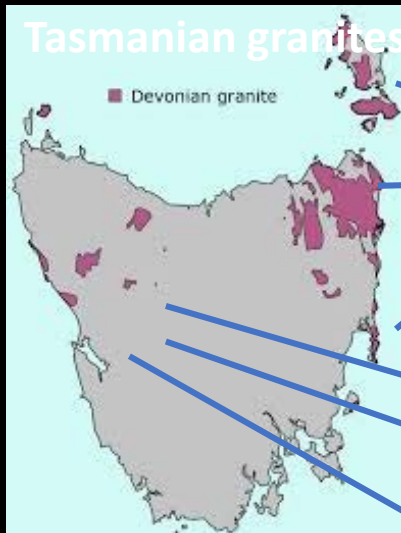
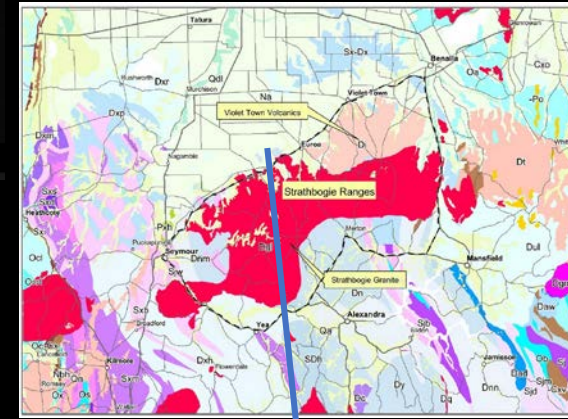


Evidence against a direct western Tasmania correlation with the Melbourne zone

- Inherited zircons in granites

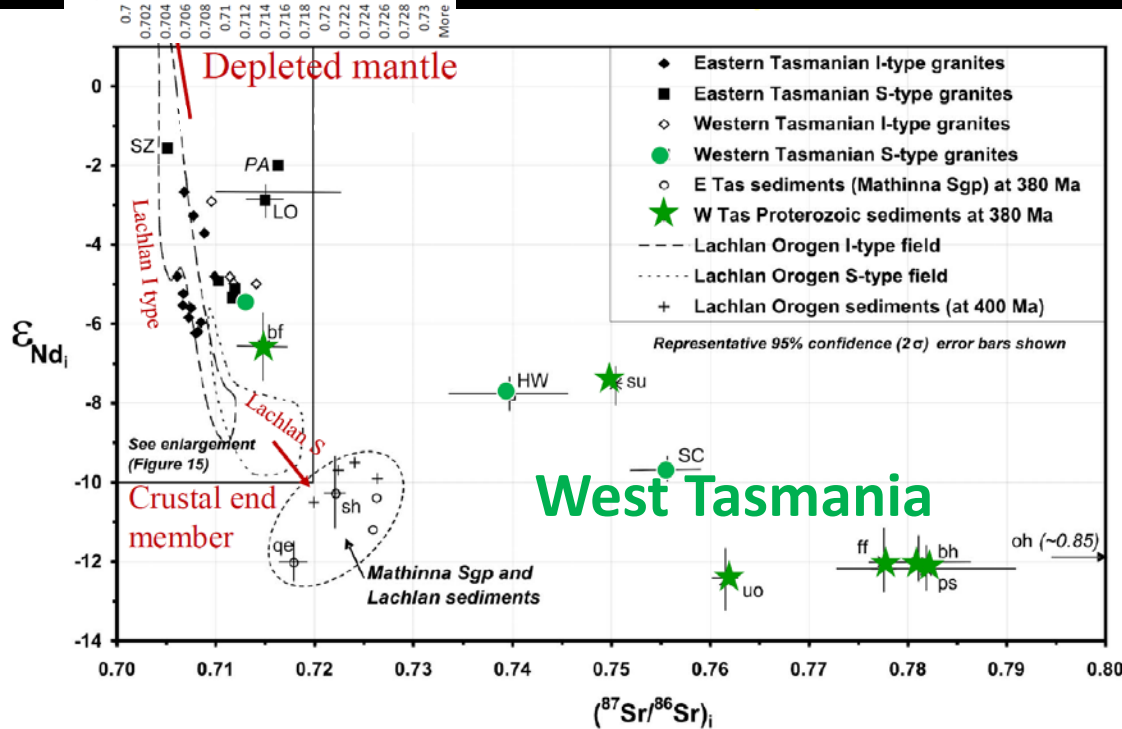
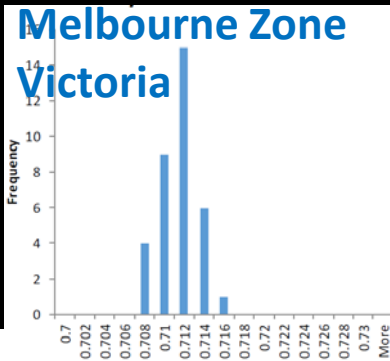


Strathbogrie Granite Central Victoria



Evidence against ad western Tasmania correlation with the Melbourne zone

- Sr isotopes in granite



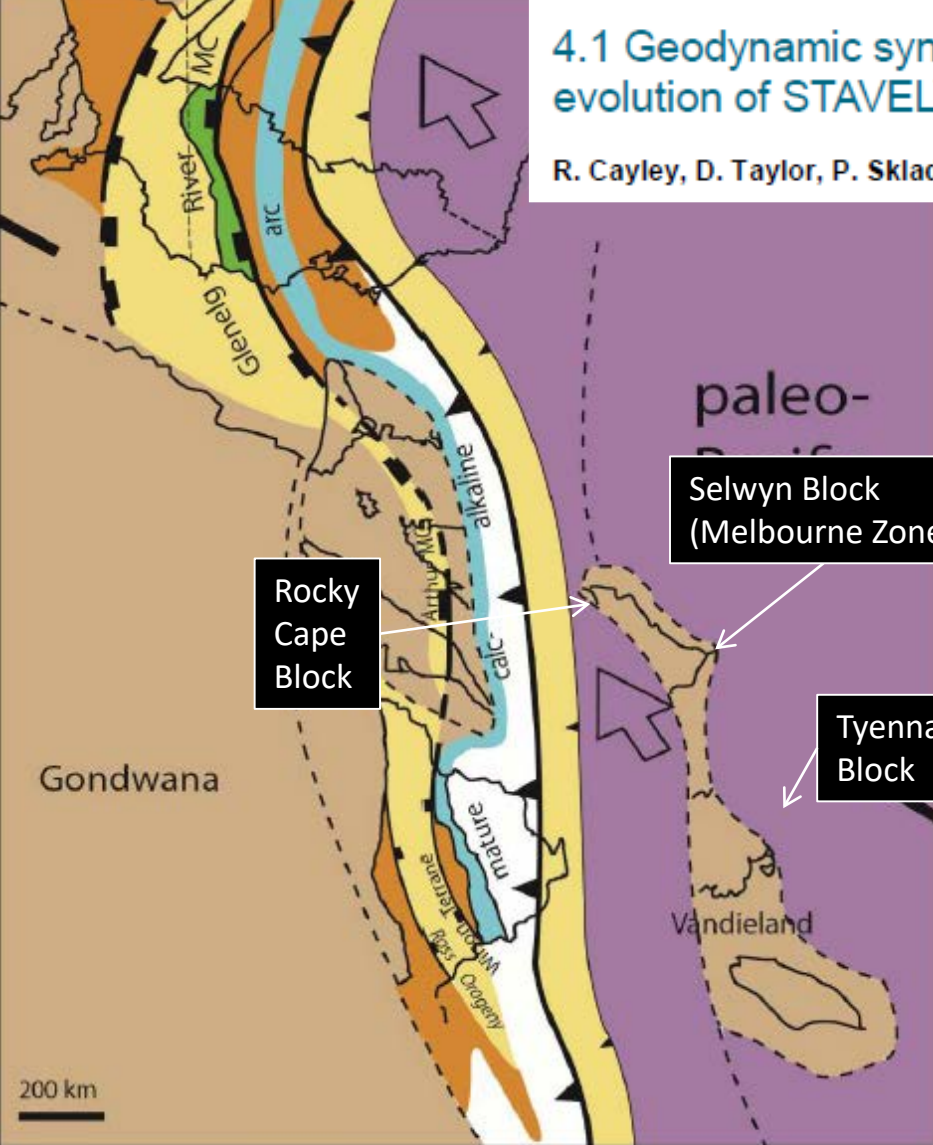
Heemskirk Granite, Granville Harbour



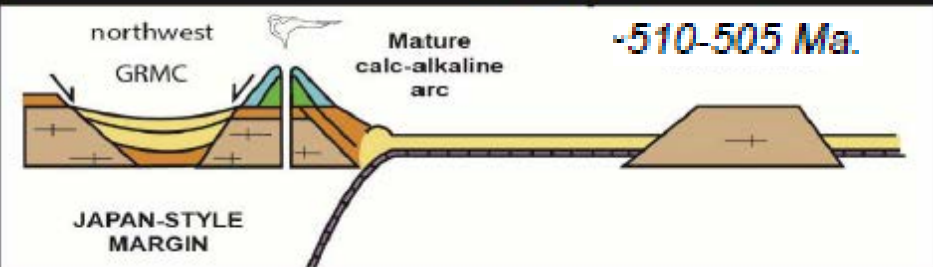
4.1 Geodynamic synthesis and implications for the geological evolution of STAVELY

R. Cayley, D. Taylor, P. Skladzien, C. Cairns, R. Duncan, D. Huston, A. Schofield and C. Lewis

Geoscience Australia Record 2018/02



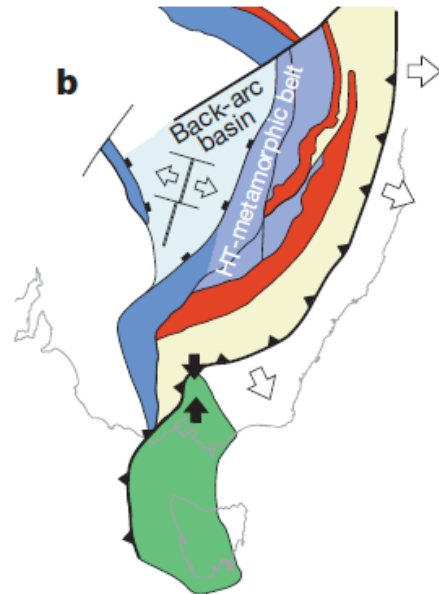
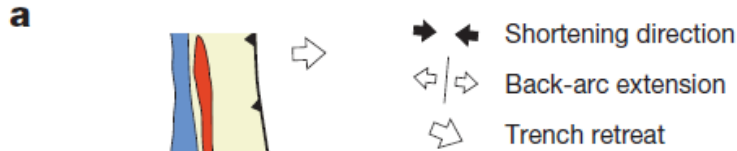
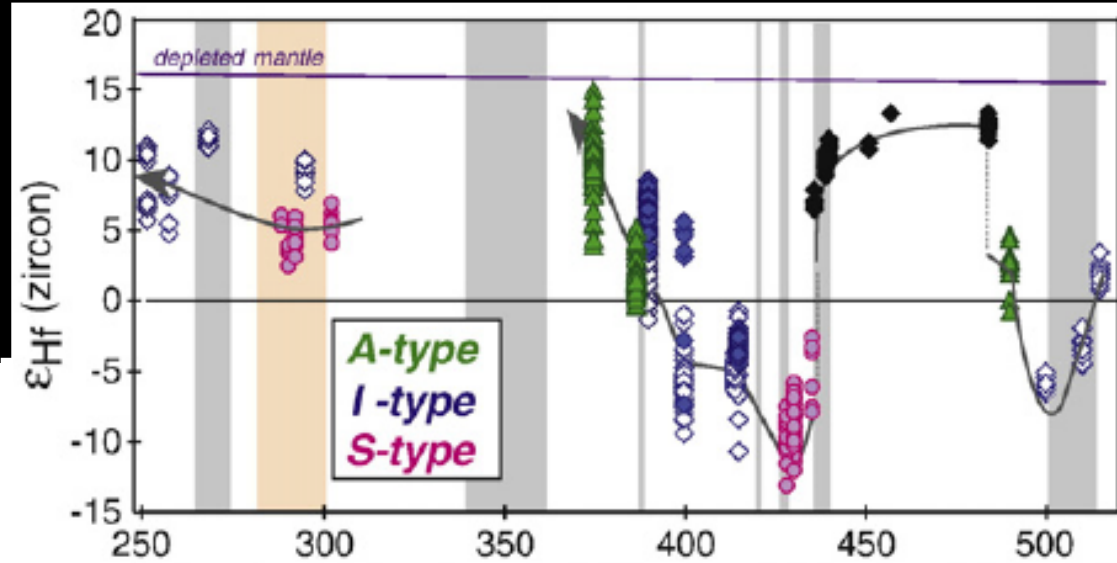
This is wrong for Tasmania!



Issues with the Lachlan Orogen

Fails to explain

- Changes Macquarie Arc chemistry
- Major Benambran unconformity



Ordovician

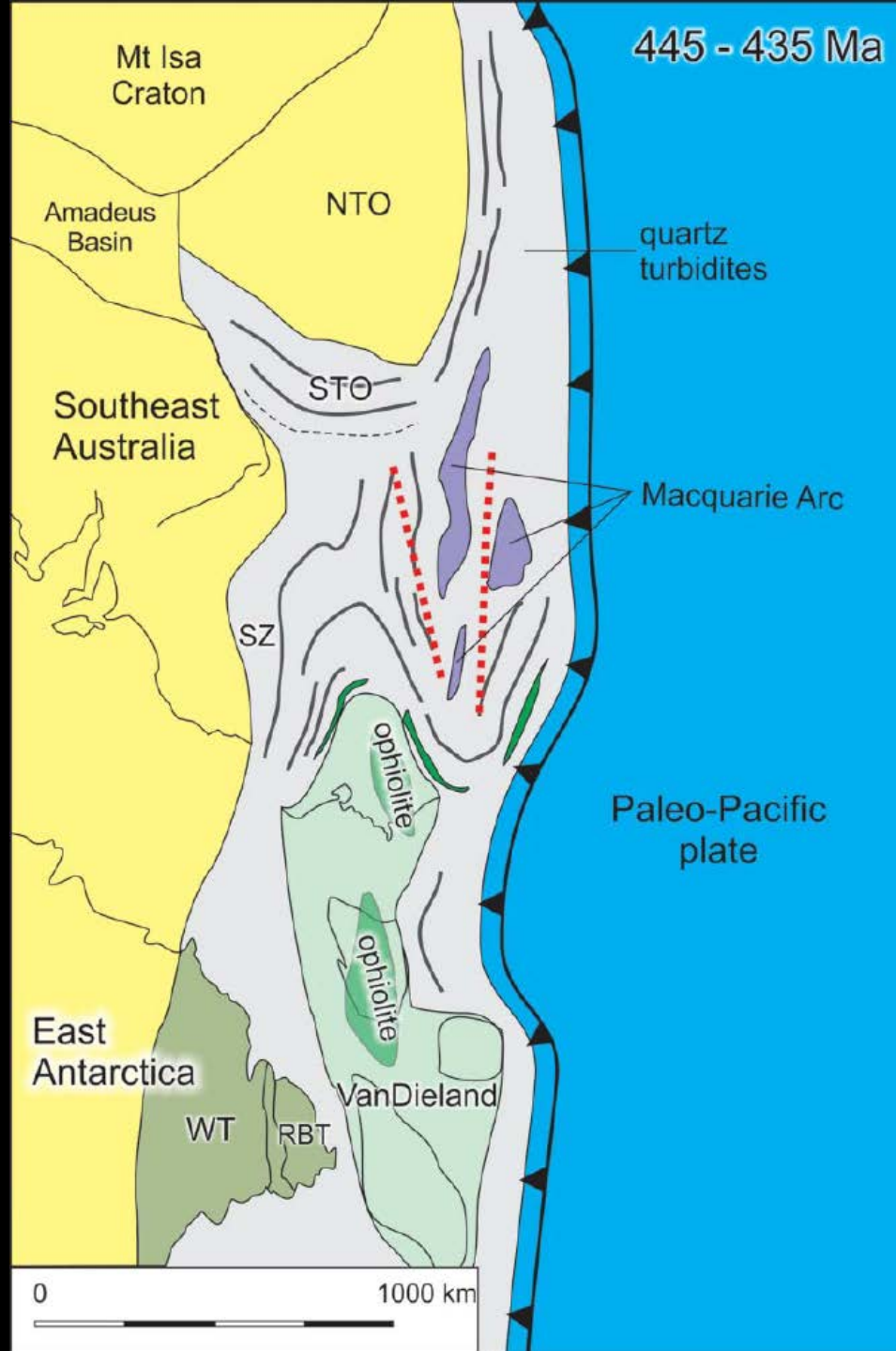
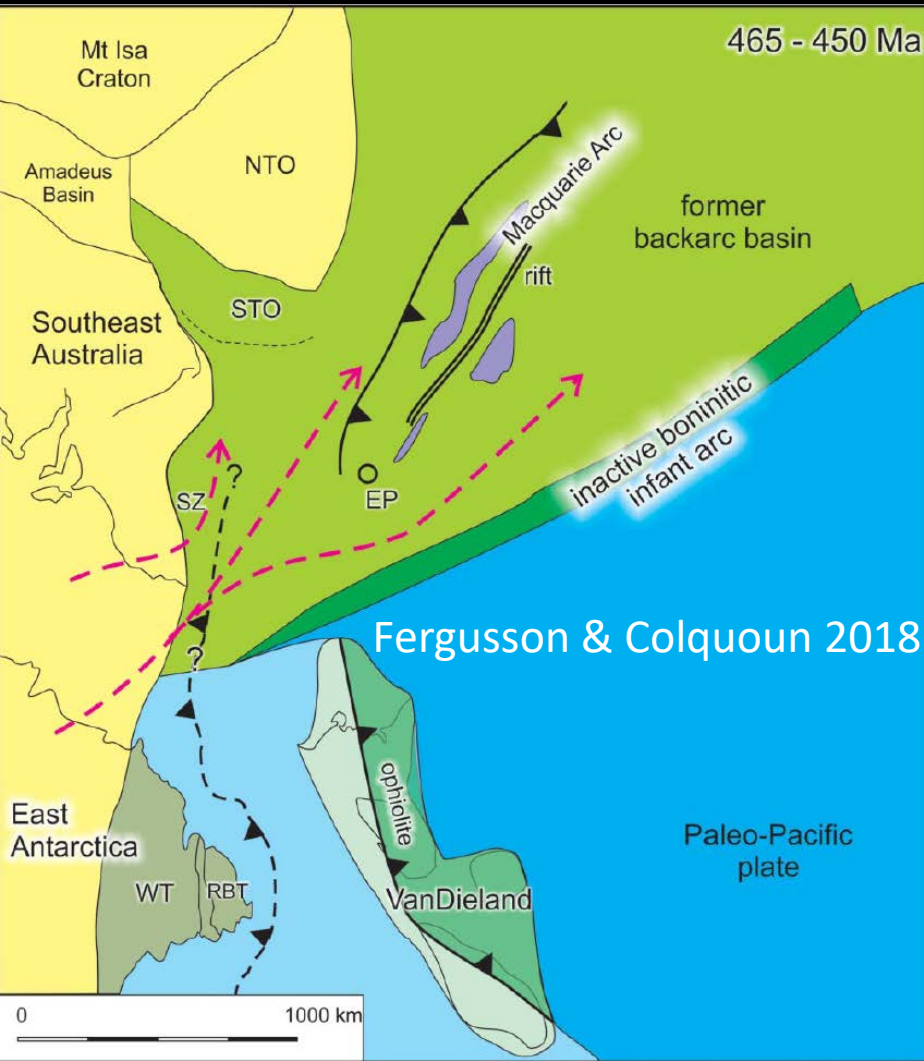
Early Silurian

Late Silurian

Stable plate margin

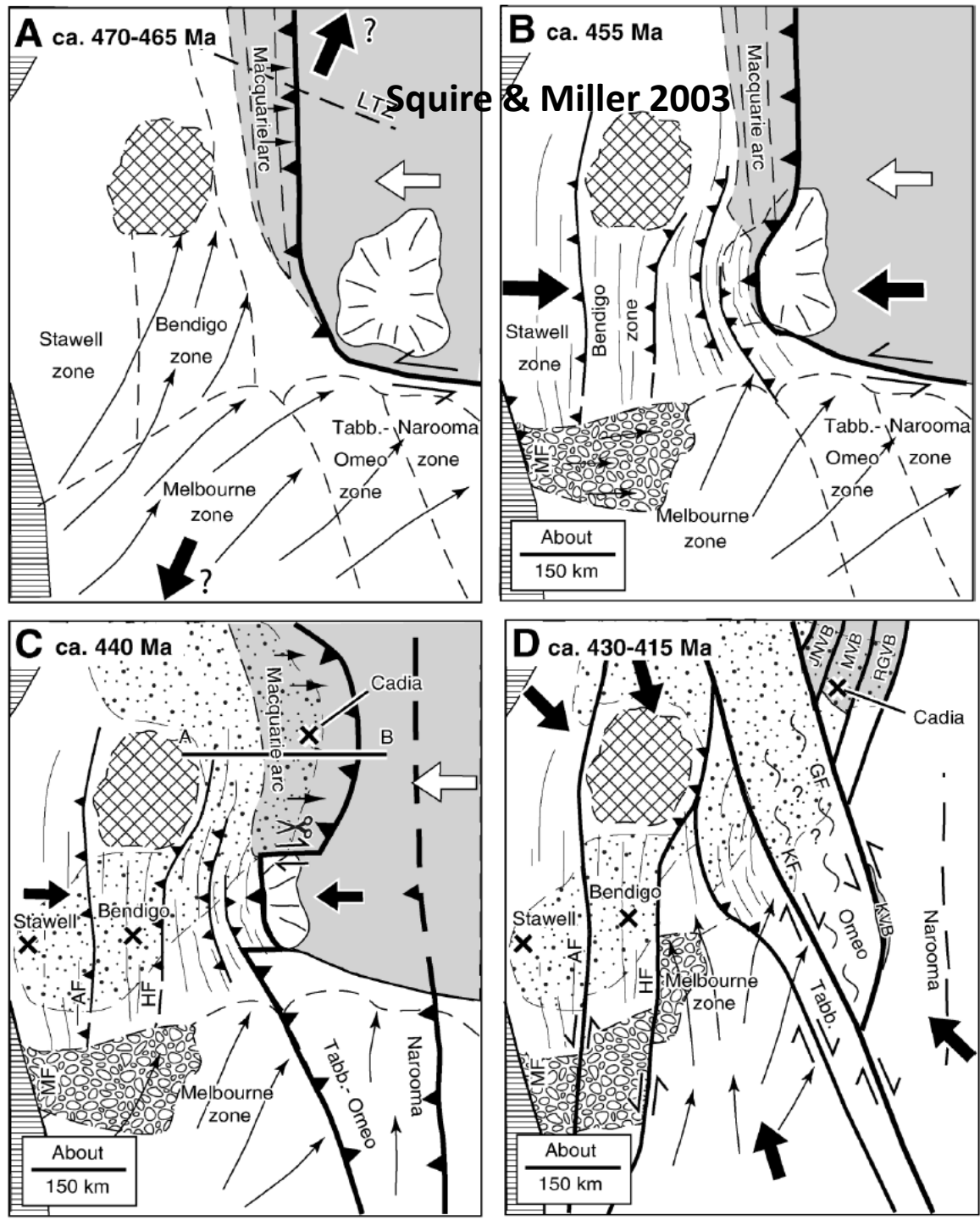
Transitional plate margin

What happened during the Benambran?

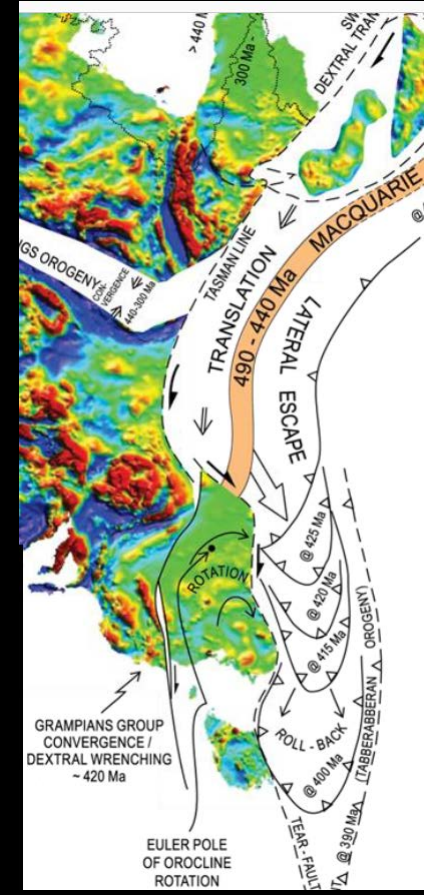
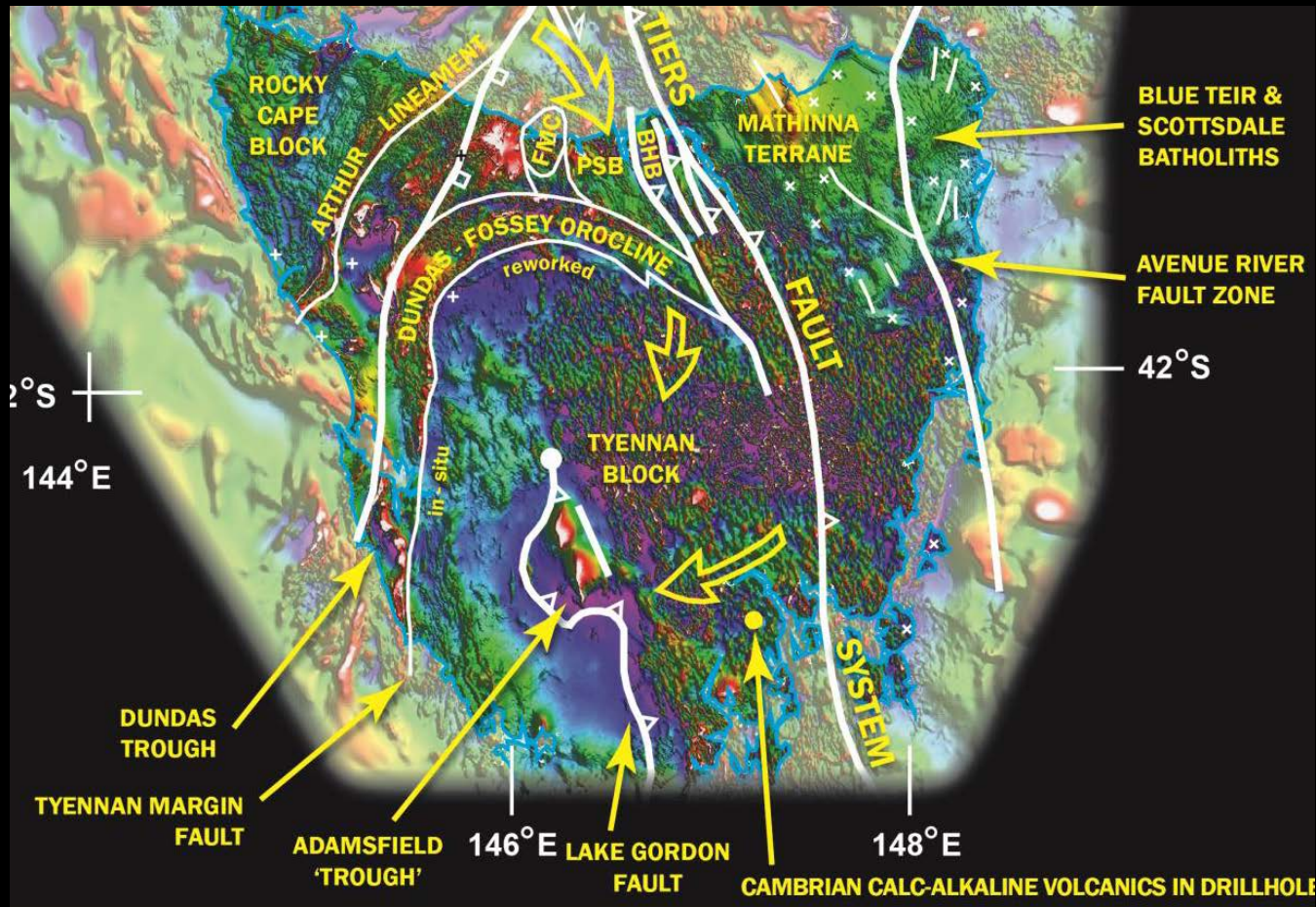


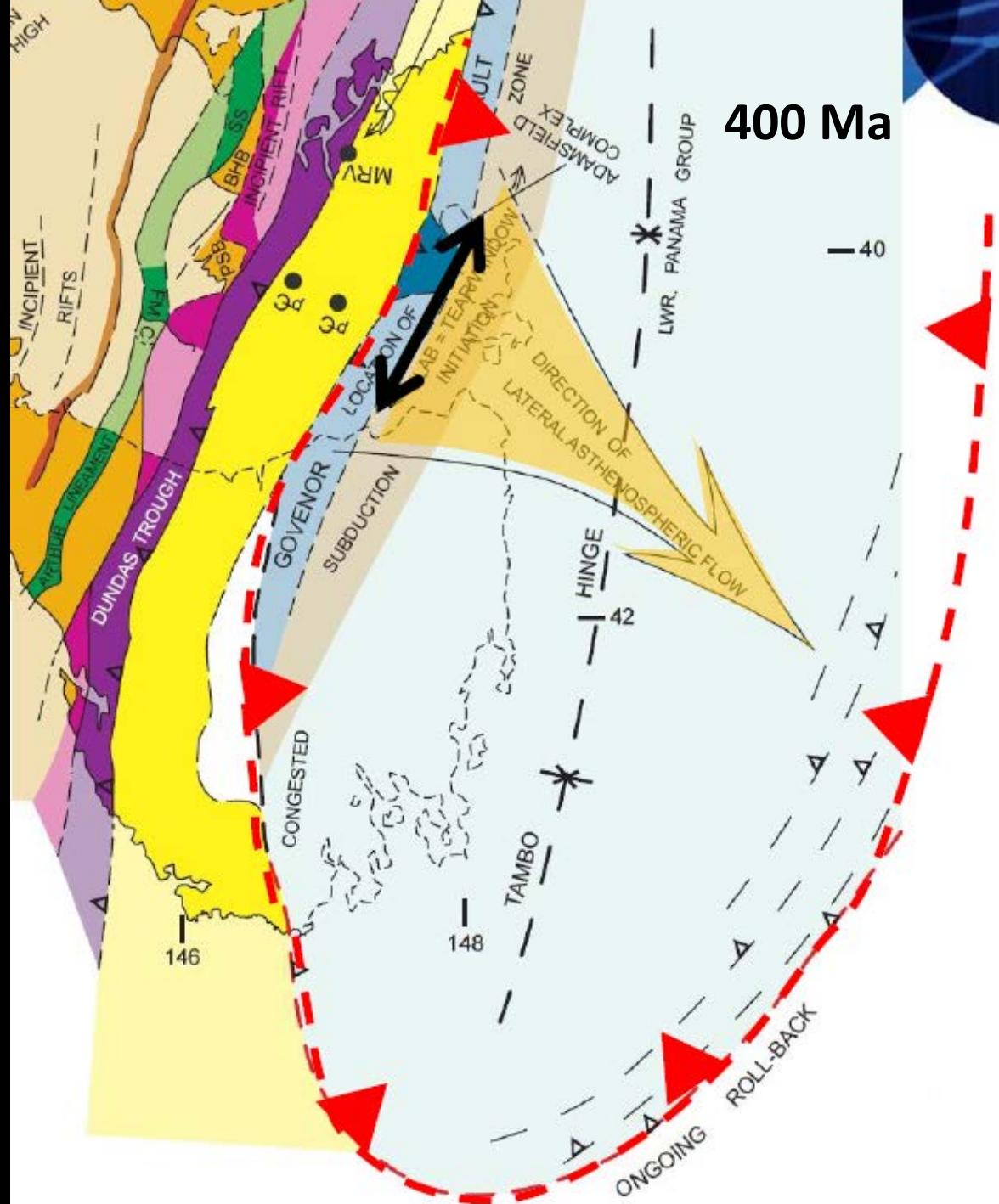
What happened during the Benambran?

Seamount or microcontinent collision?

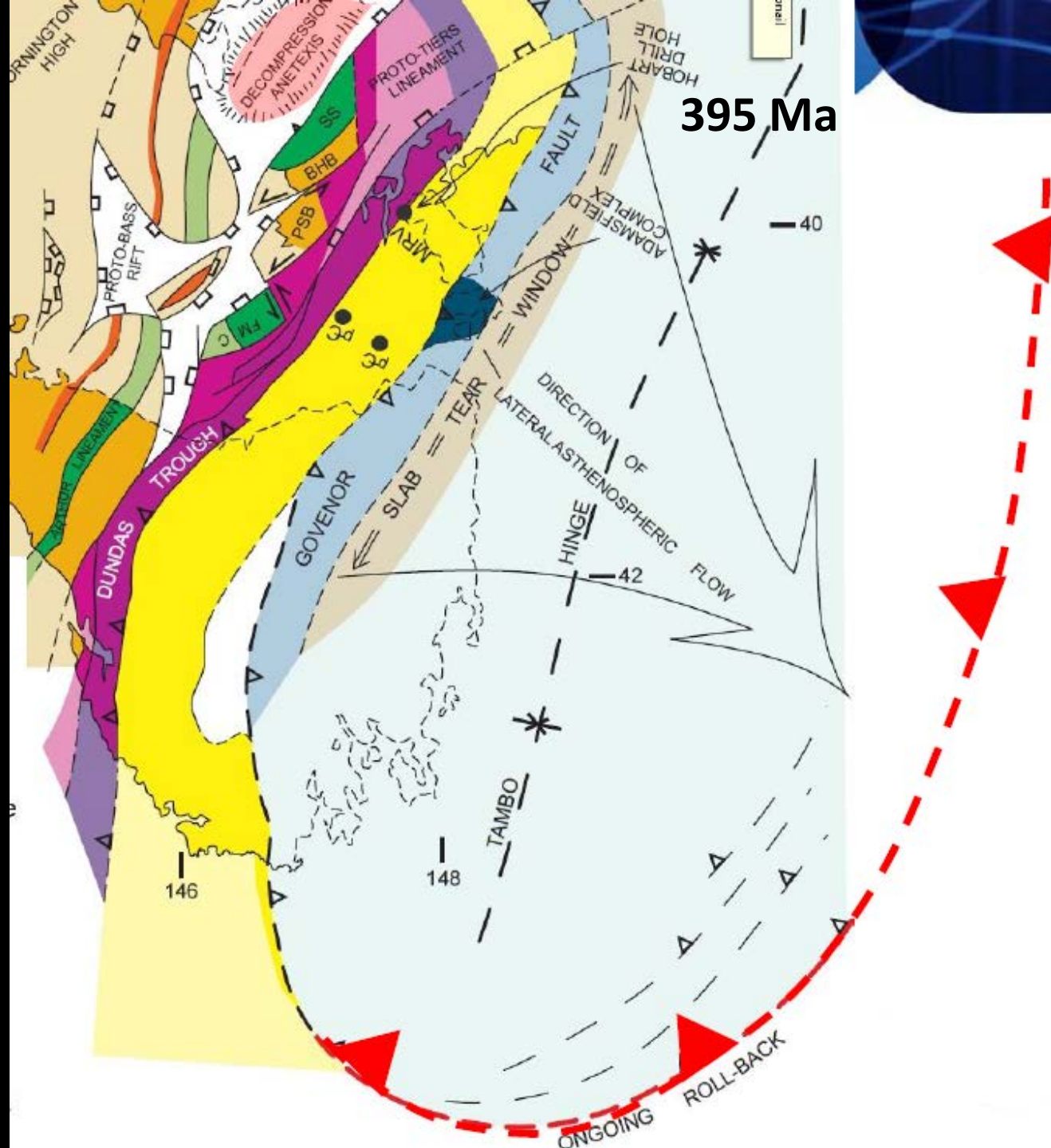


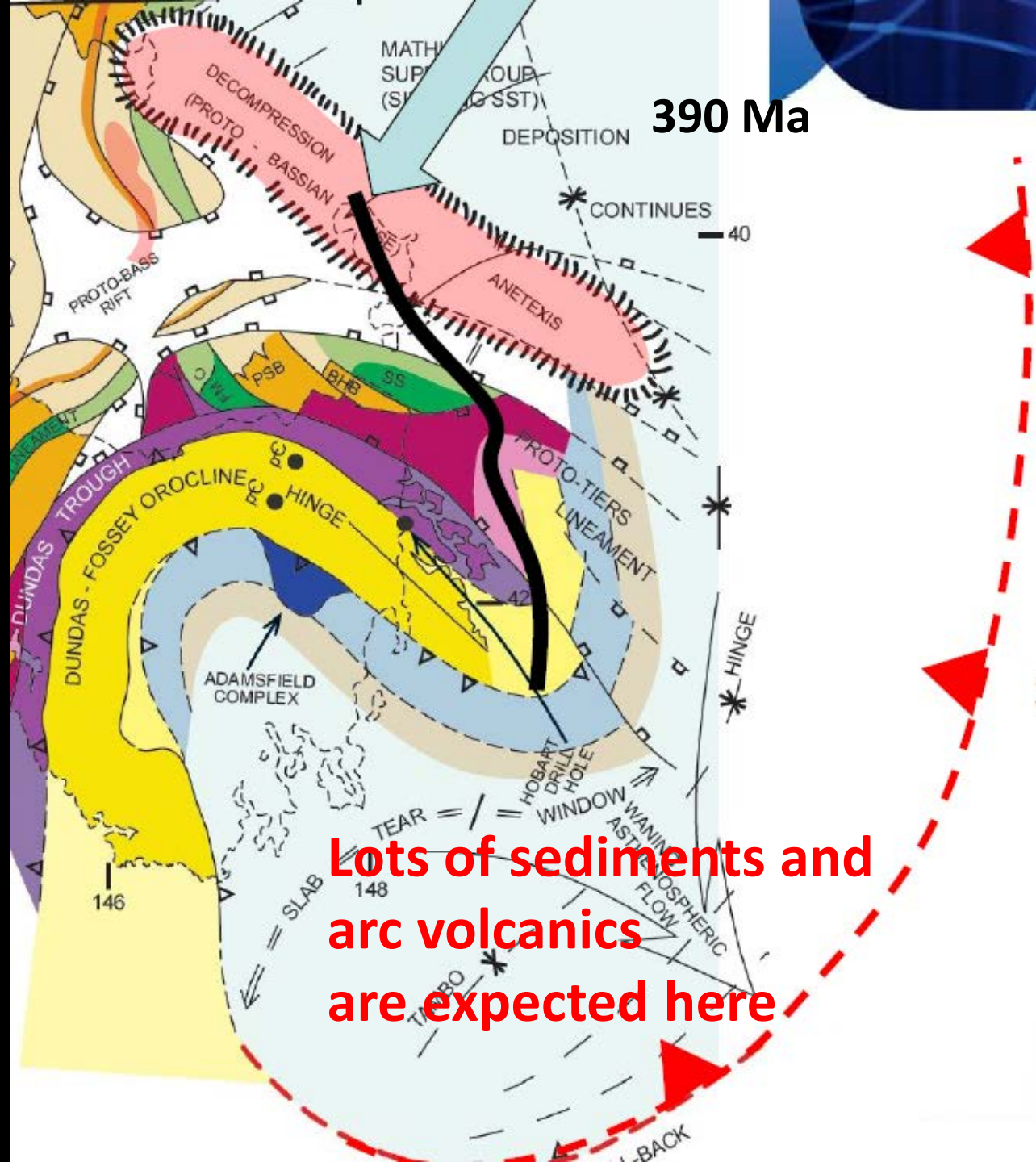
What about the The Dundas Fossey Orocline?





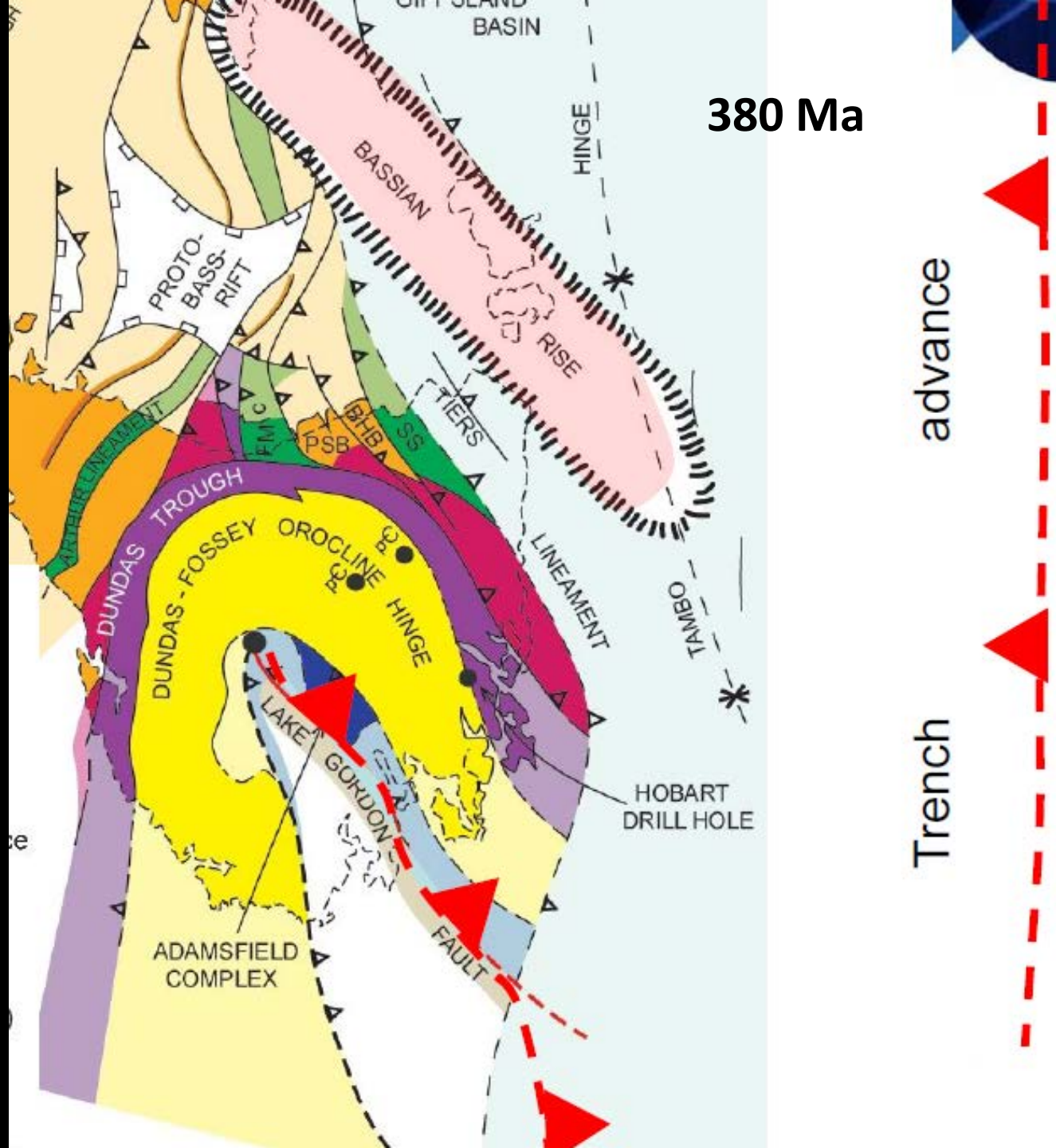
400 Ma





390 Ma

Lots of sediments and arc volcanics are expected here

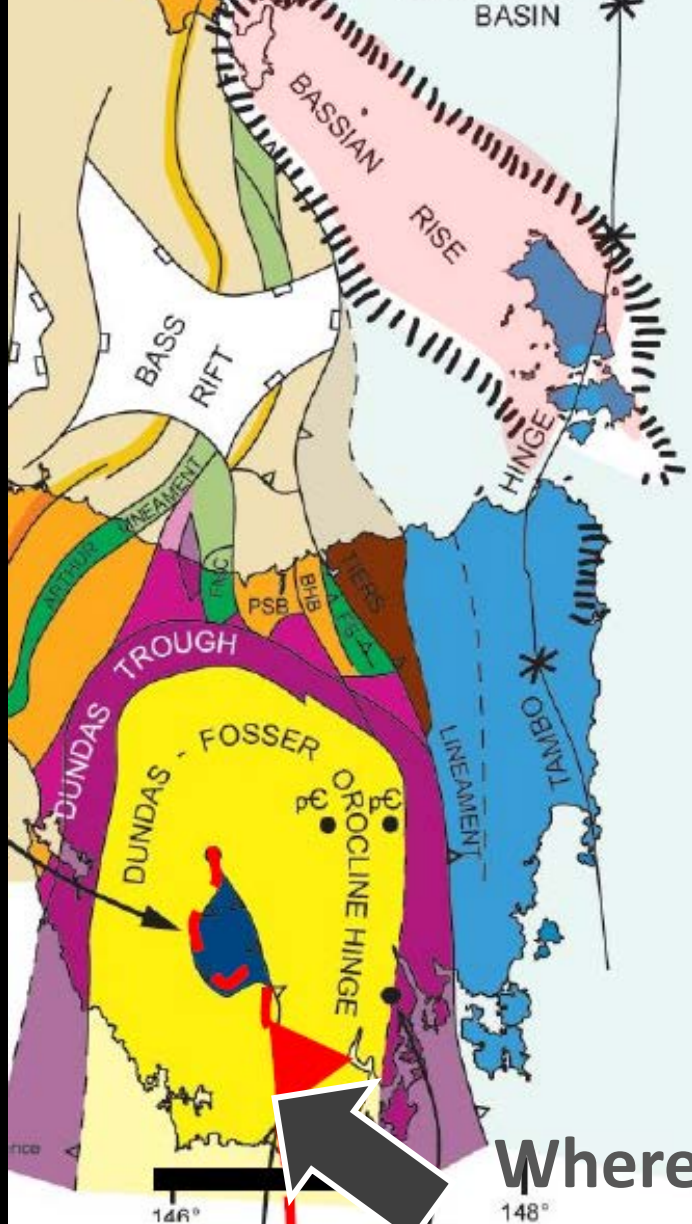


380 Ma

advance

Trench





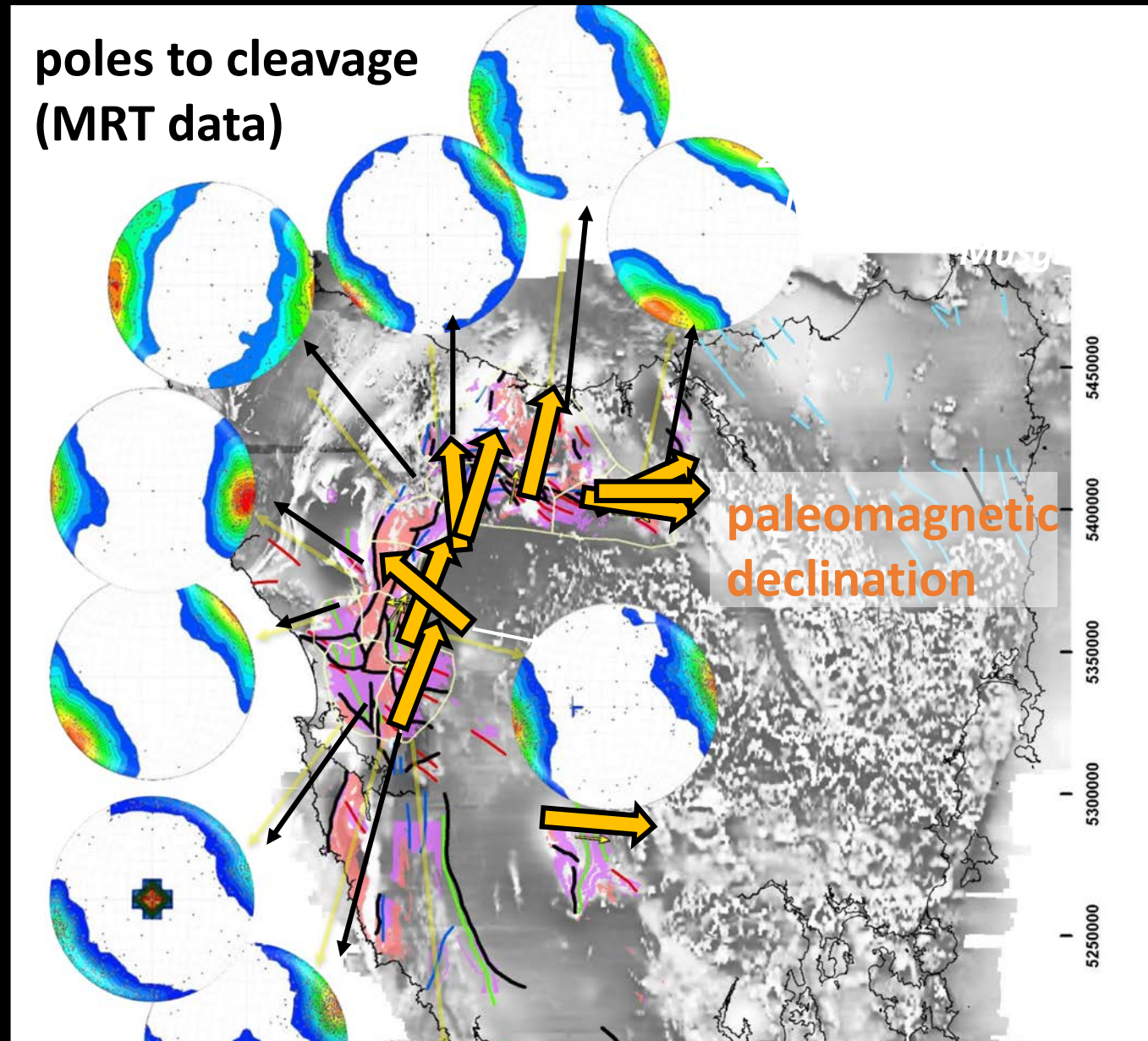
375 Ma



Where did the
sediments
go???

The Dundas Fosse Orocline

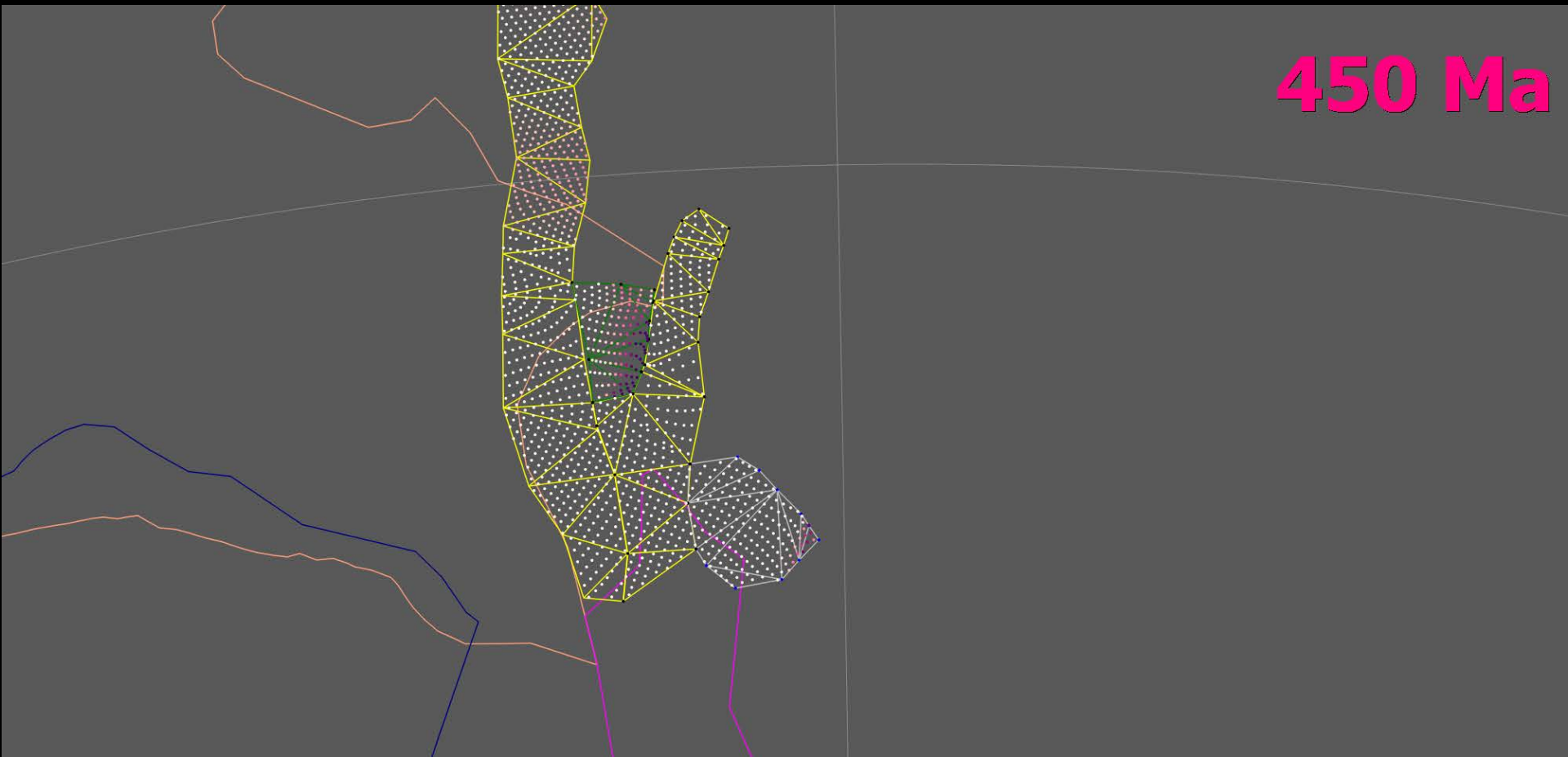
- Geometrically implausible as drawn by Ross
- But interesting paleopoles in Ordovician sedimentary rocks



New G-Plates (deforming plates) model

- To try and put these new data in model

in progress from University of Tasmania PhD student Thomas Schaap



New G-Plates (deforming plates) model

New G-Plates (deforming plates) model in progress from University of Tasmania PhD student



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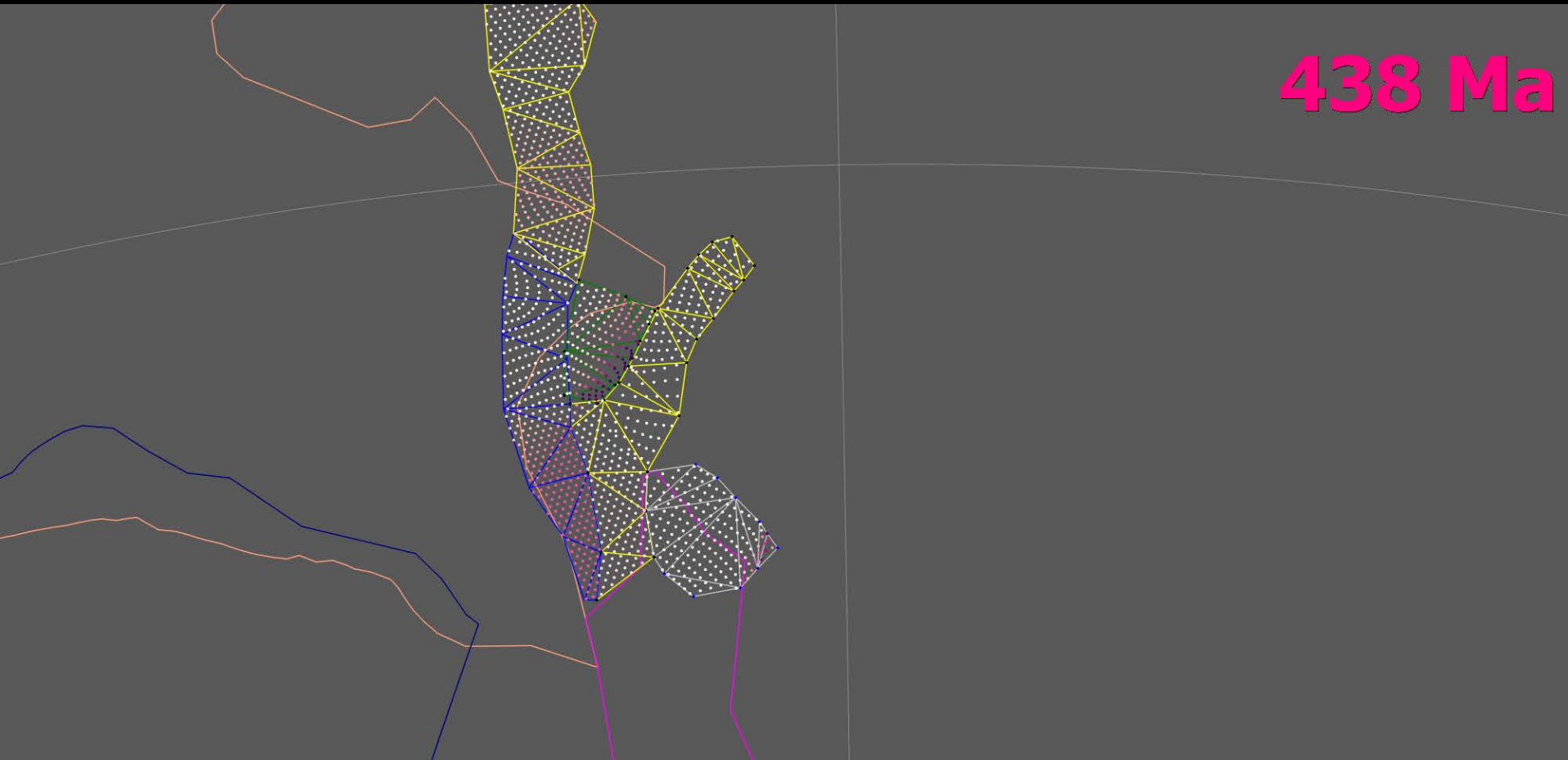
New G-Plates (deforming plates) model

New G-Plates (deforming plates) model in progress from University of Tasmania PhD student



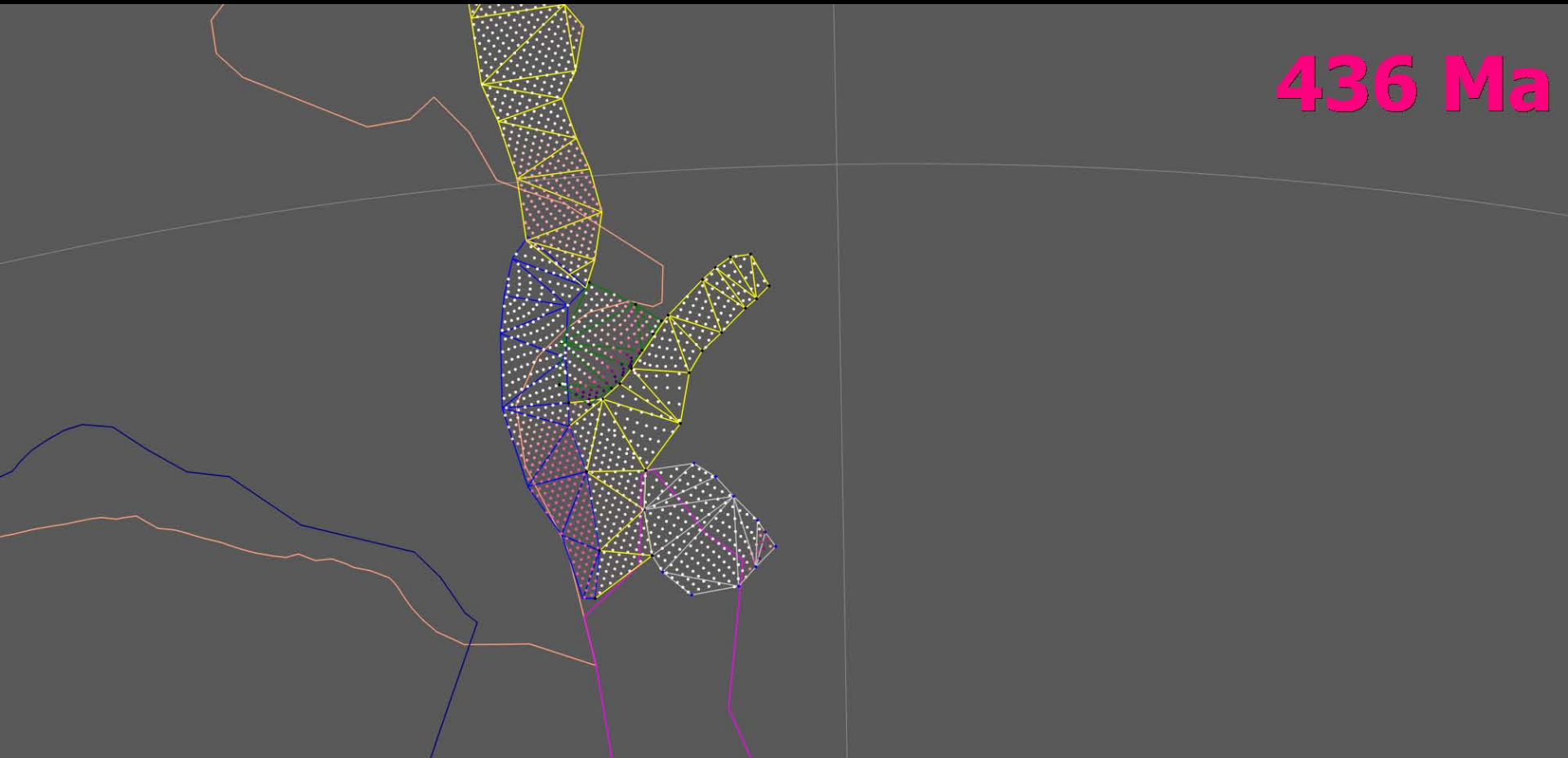
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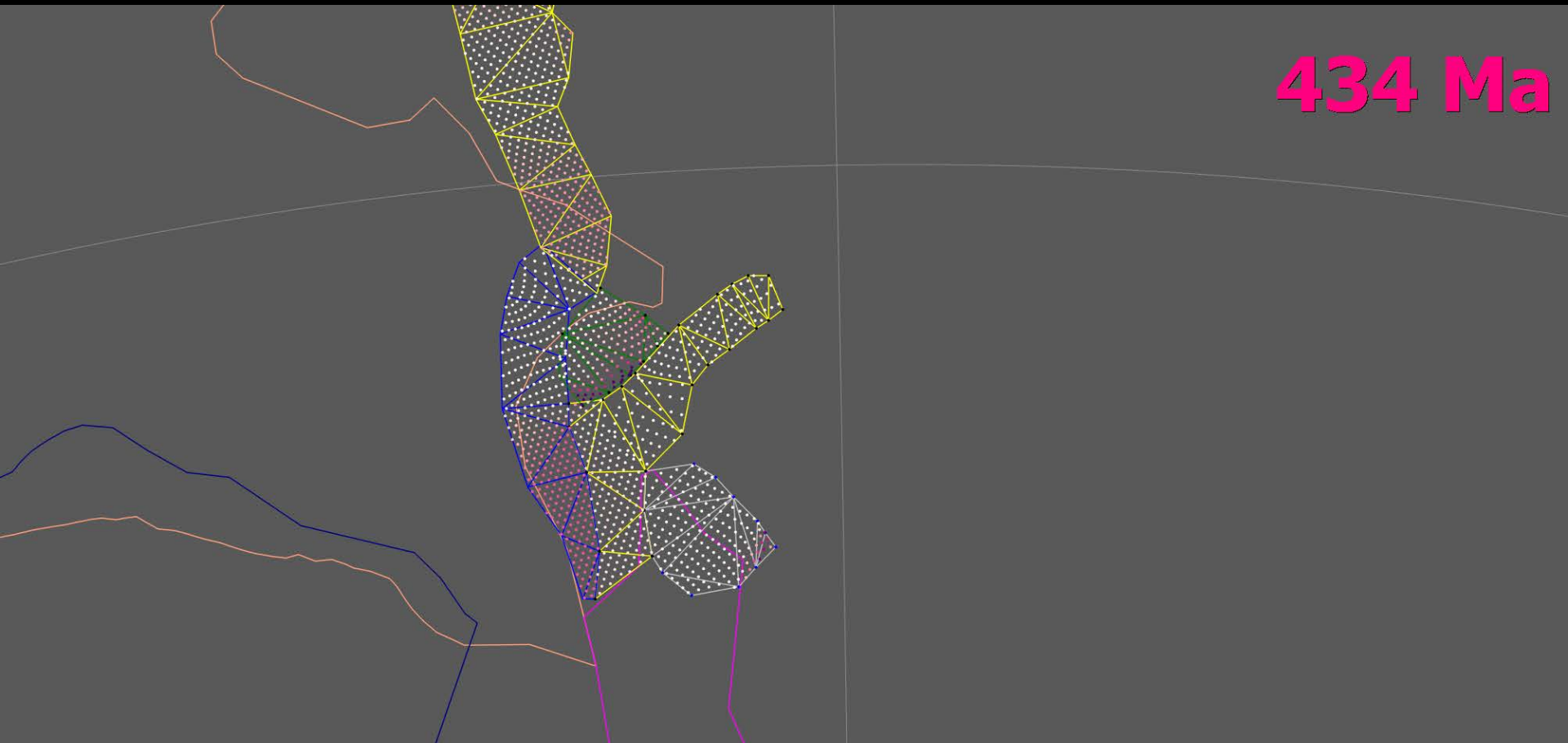
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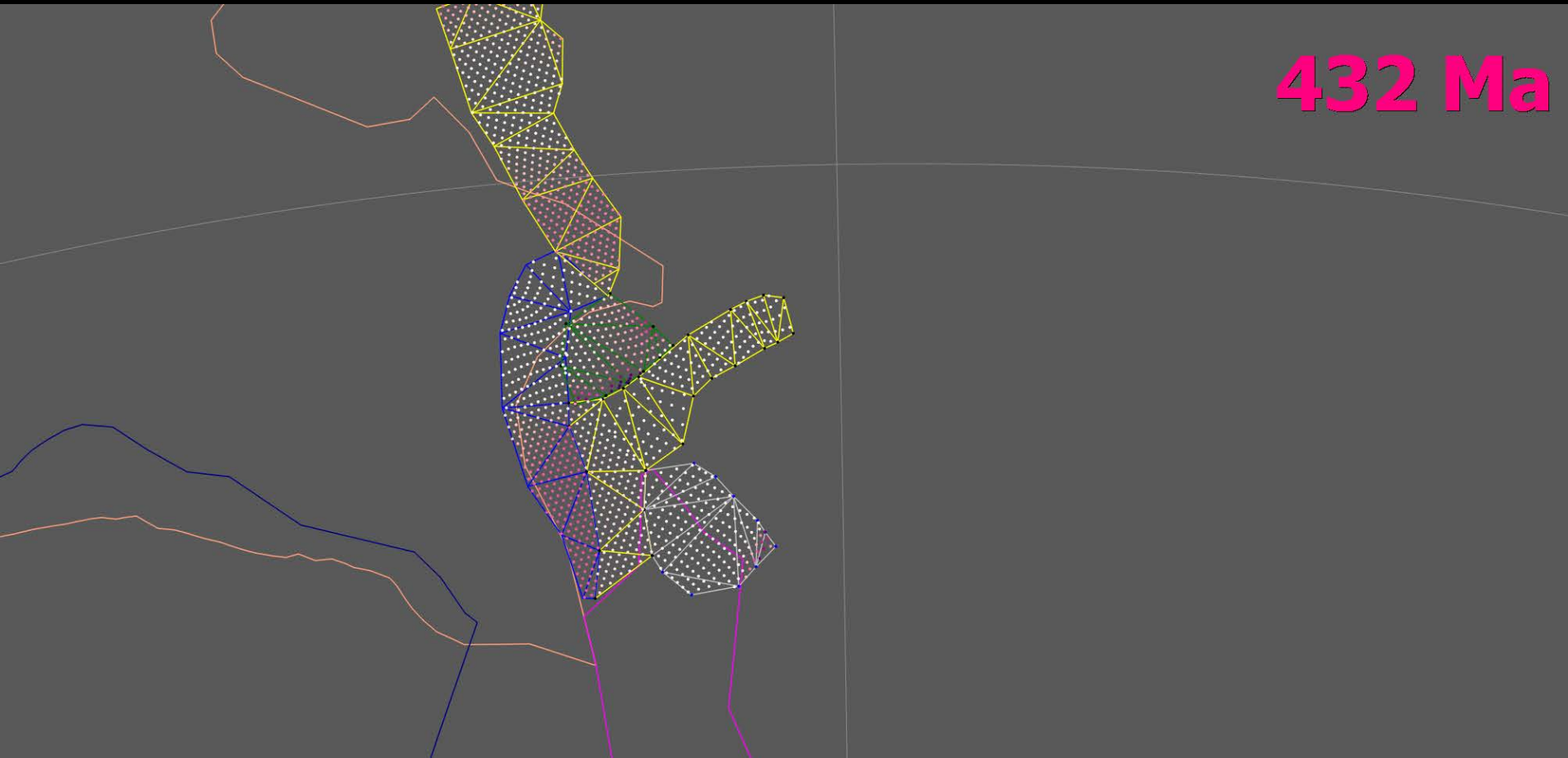
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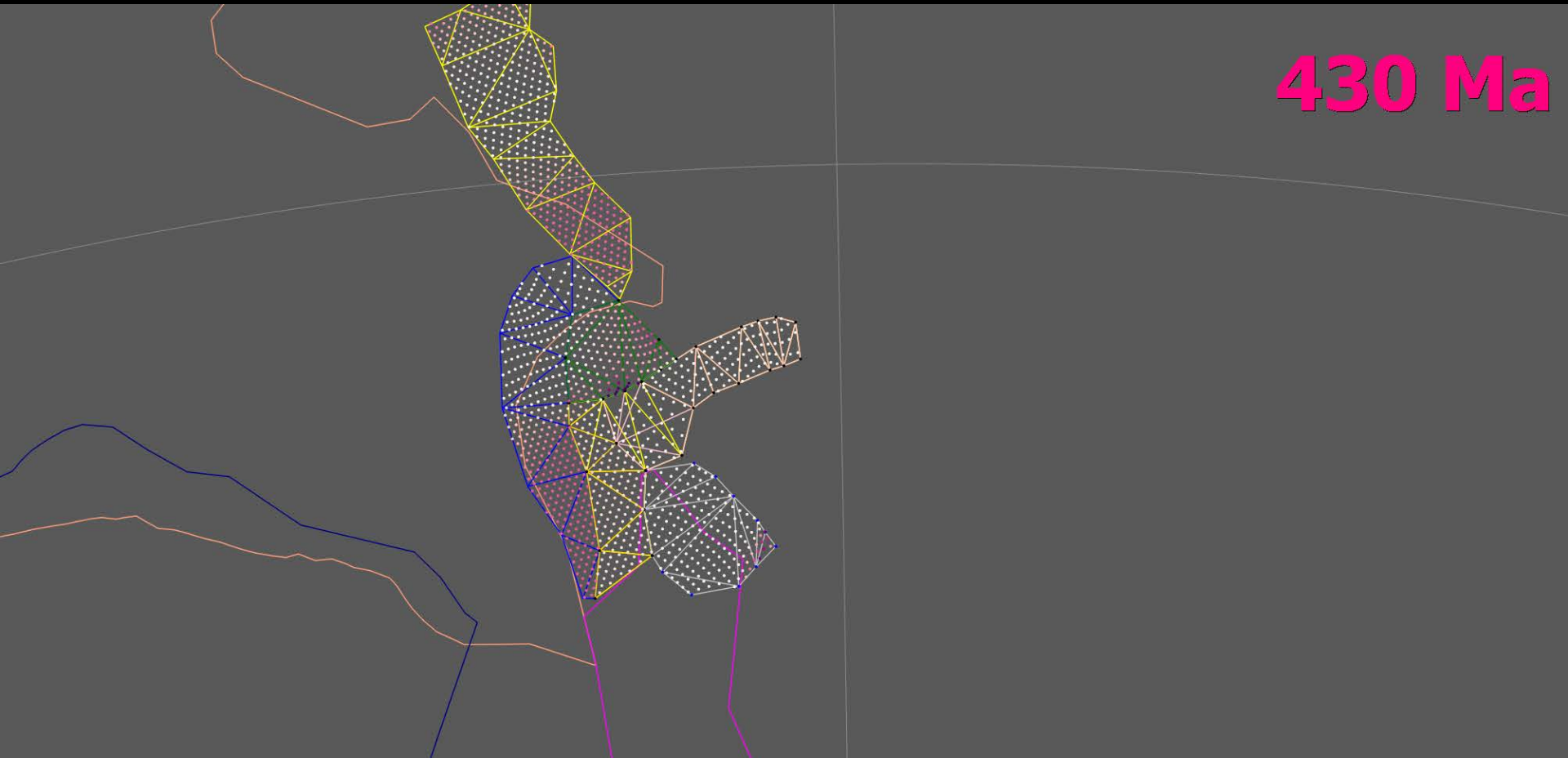
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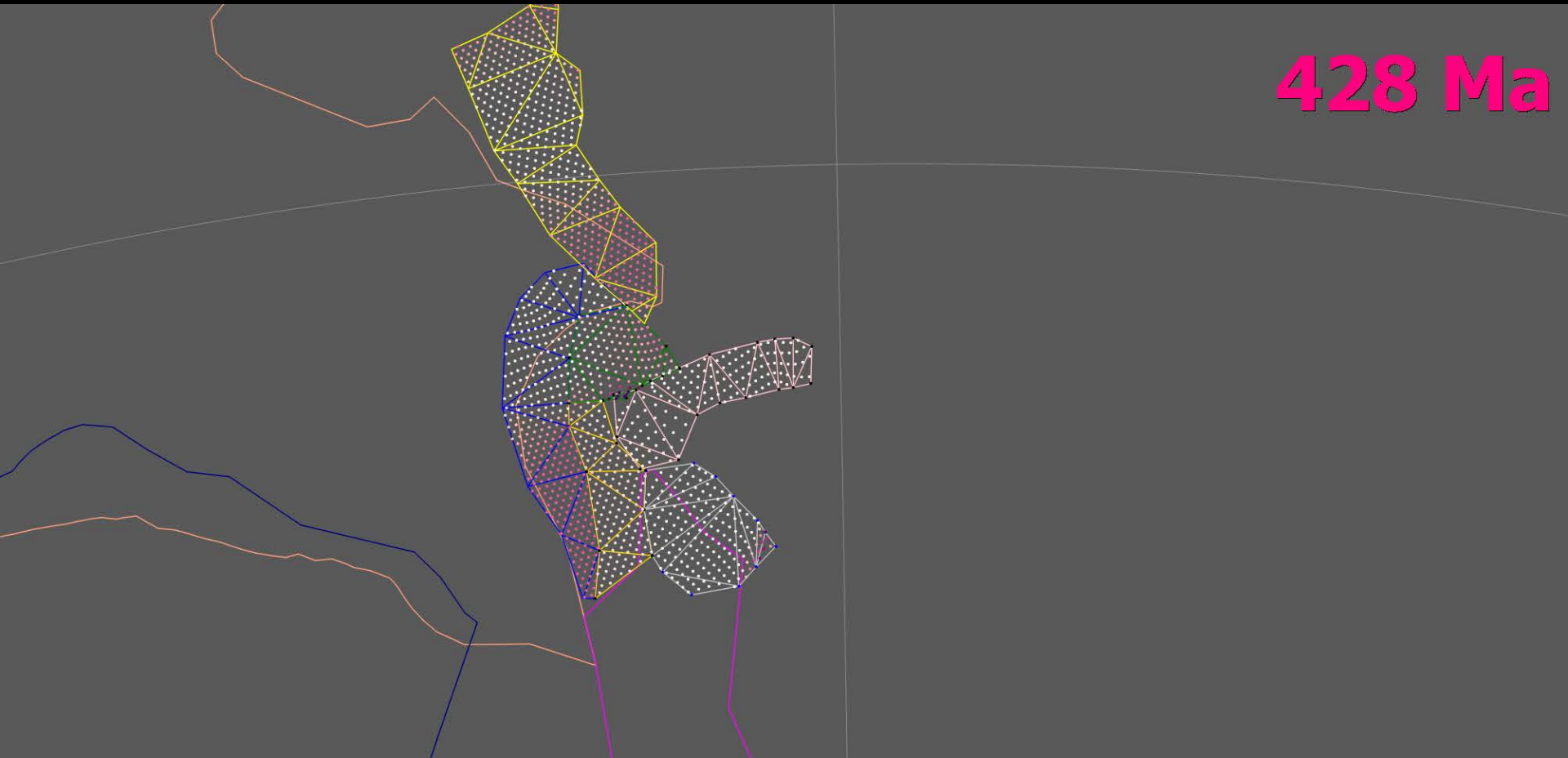
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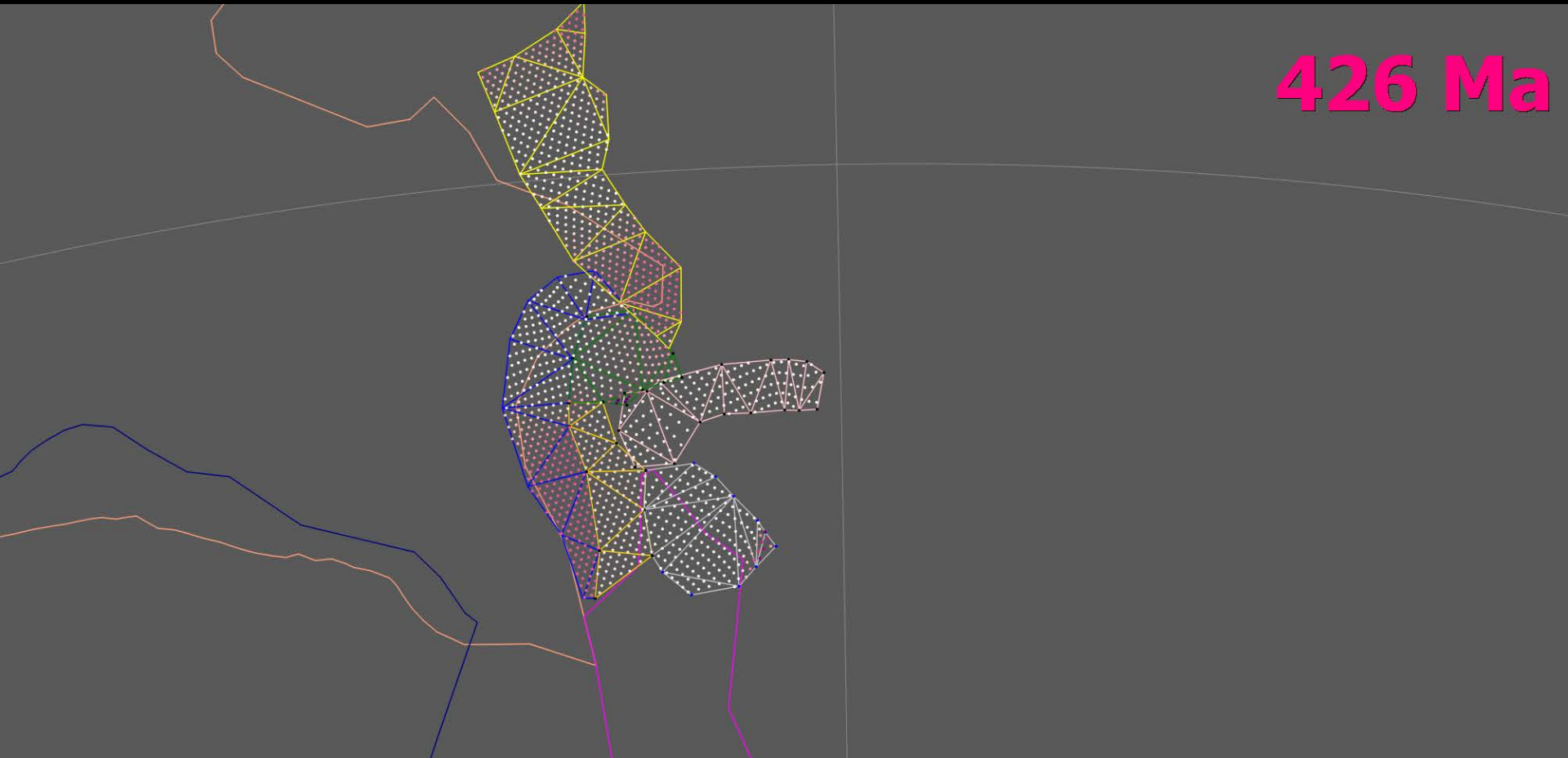
New G-Plates (deforming plates) model

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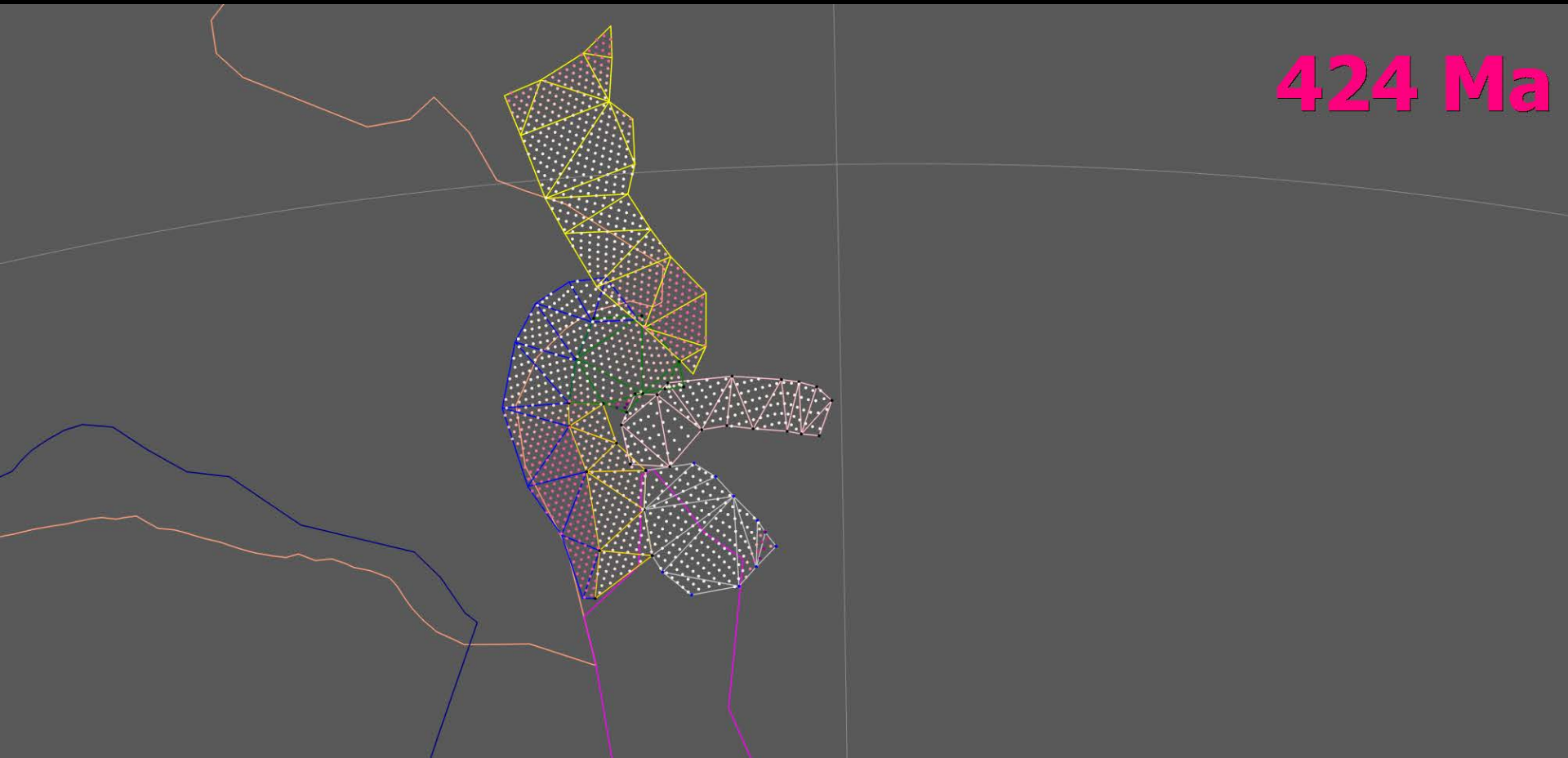
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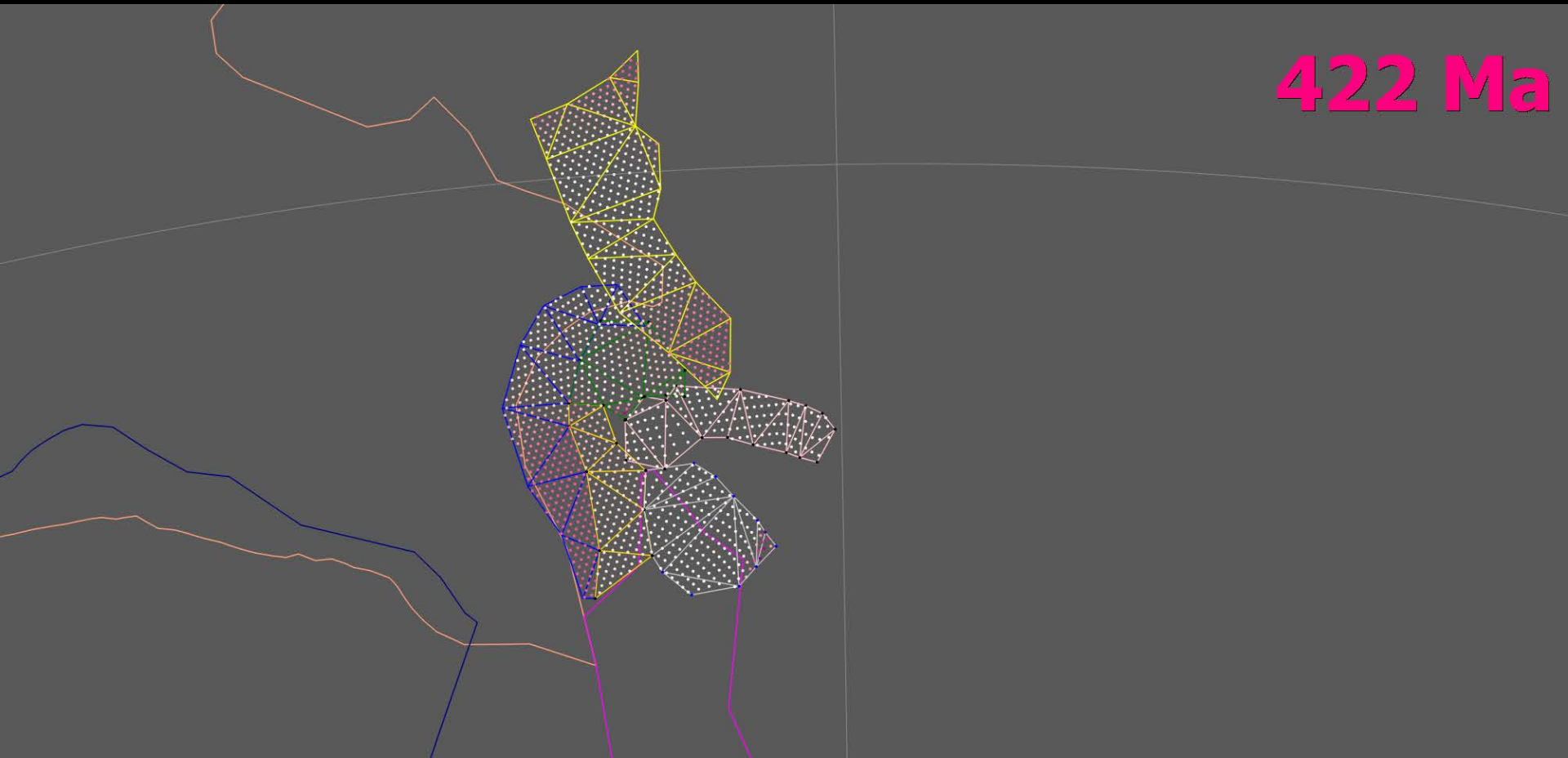
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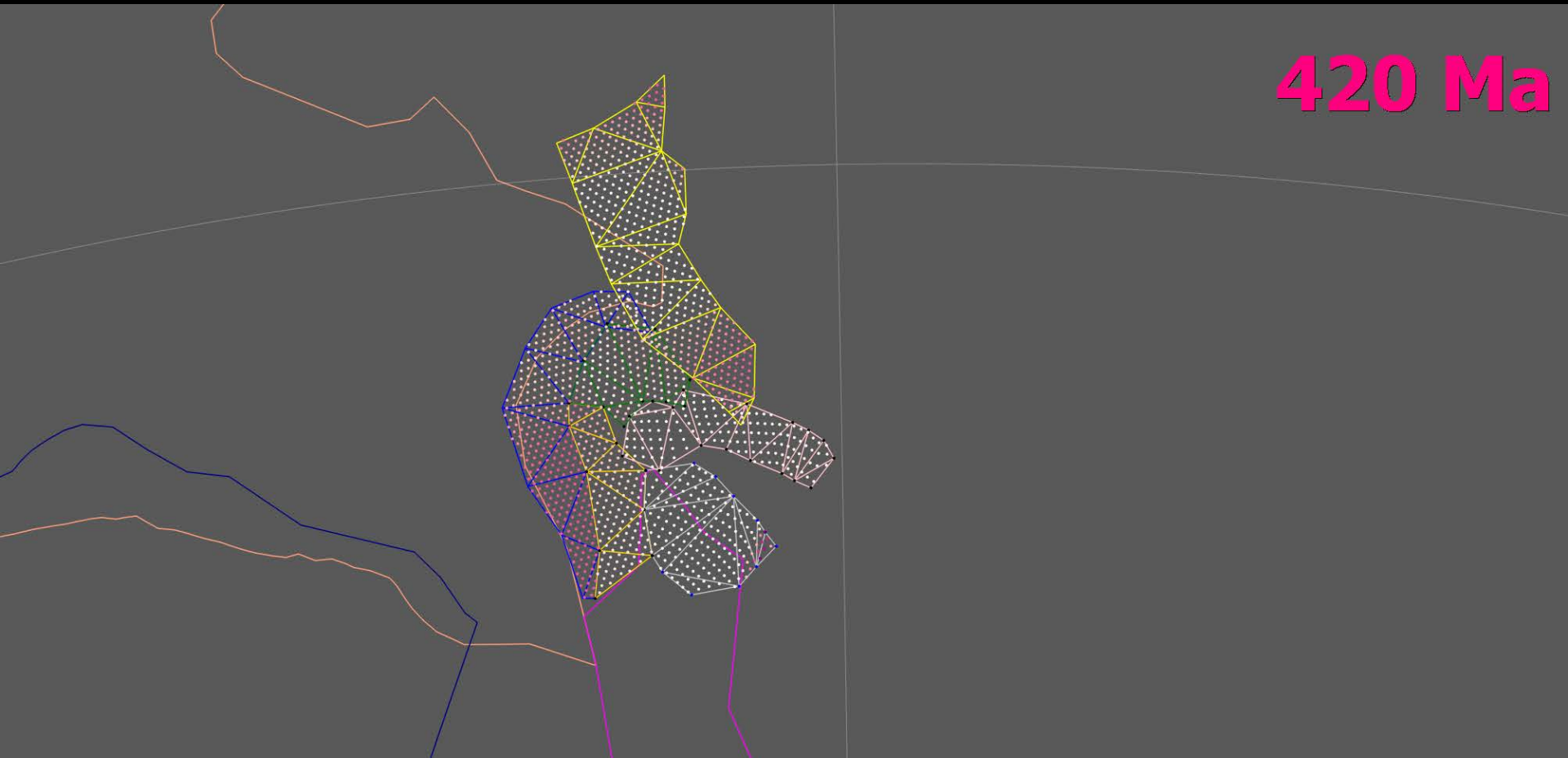
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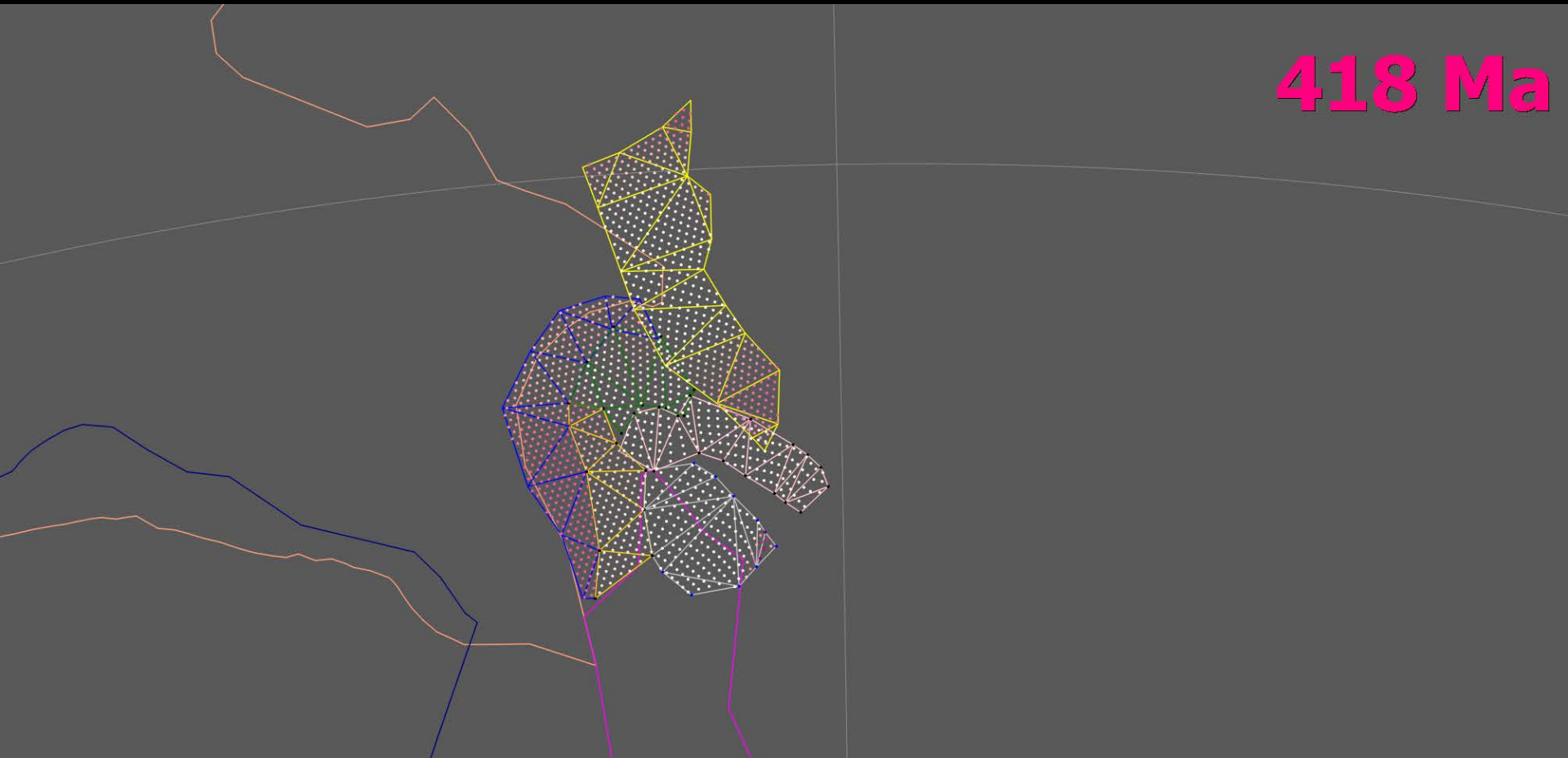
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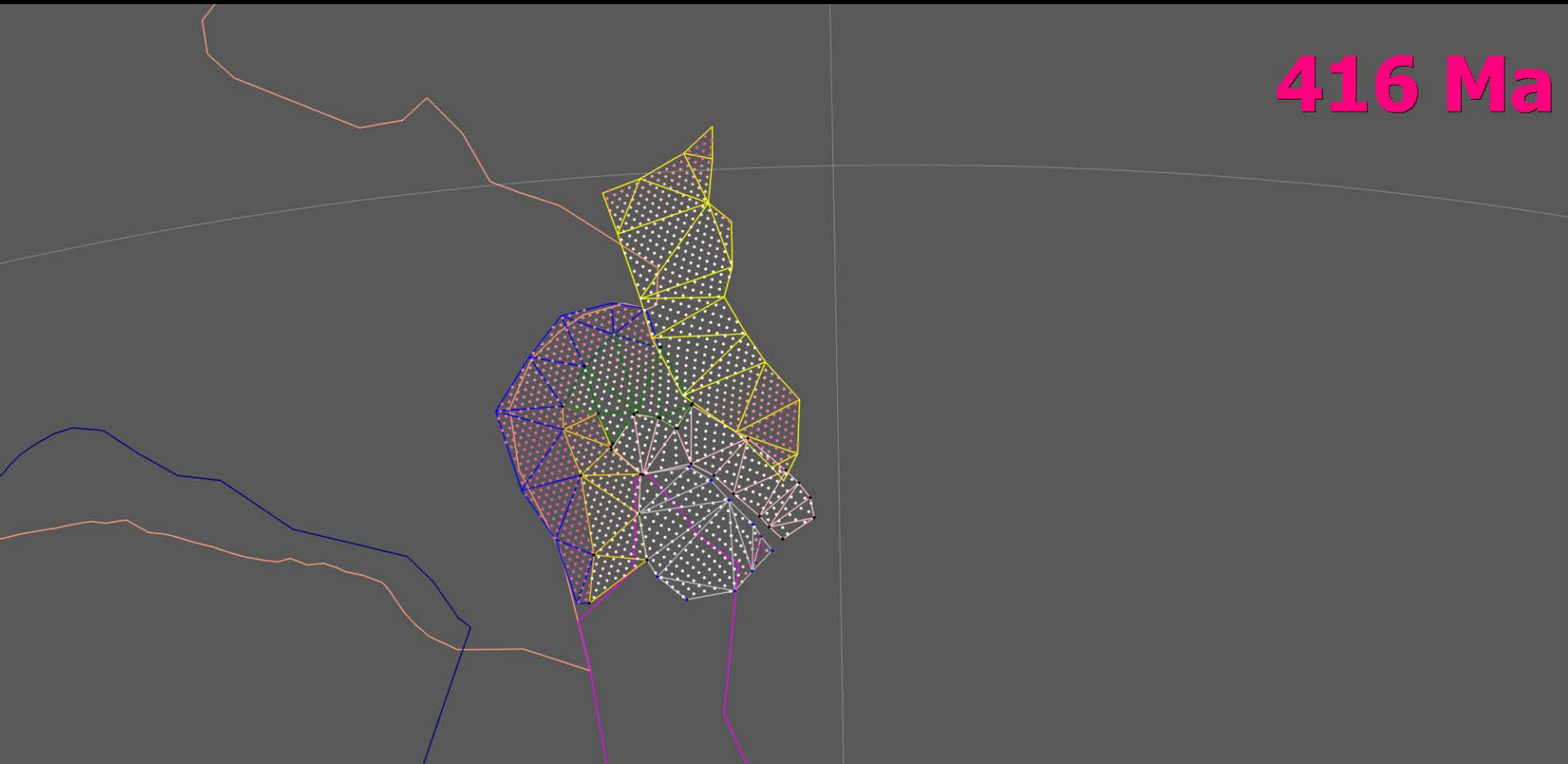
What happened during the Benambran?

New G-Plates (deforming plates) model in progress from University of Tasmania PhD student



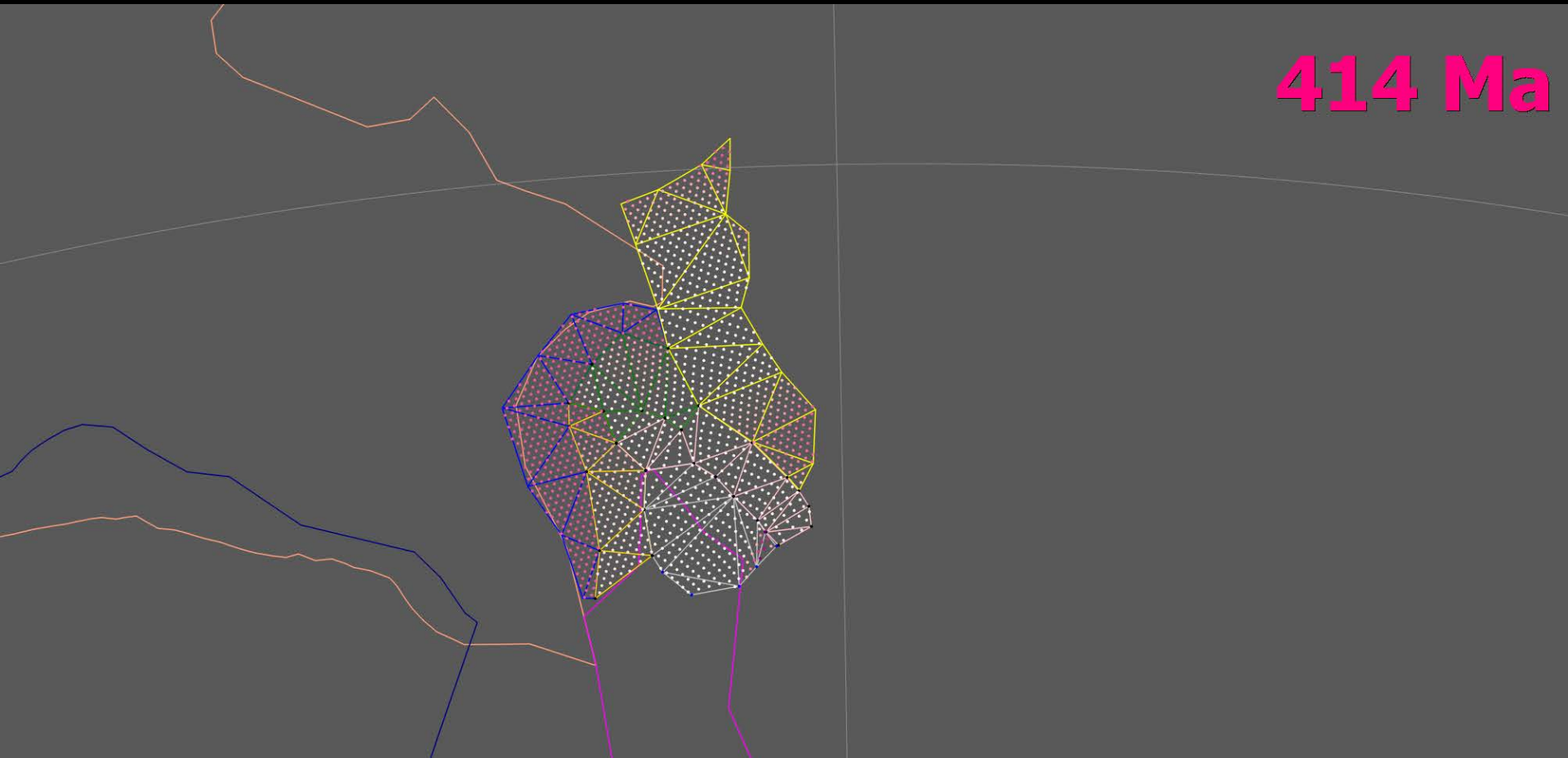
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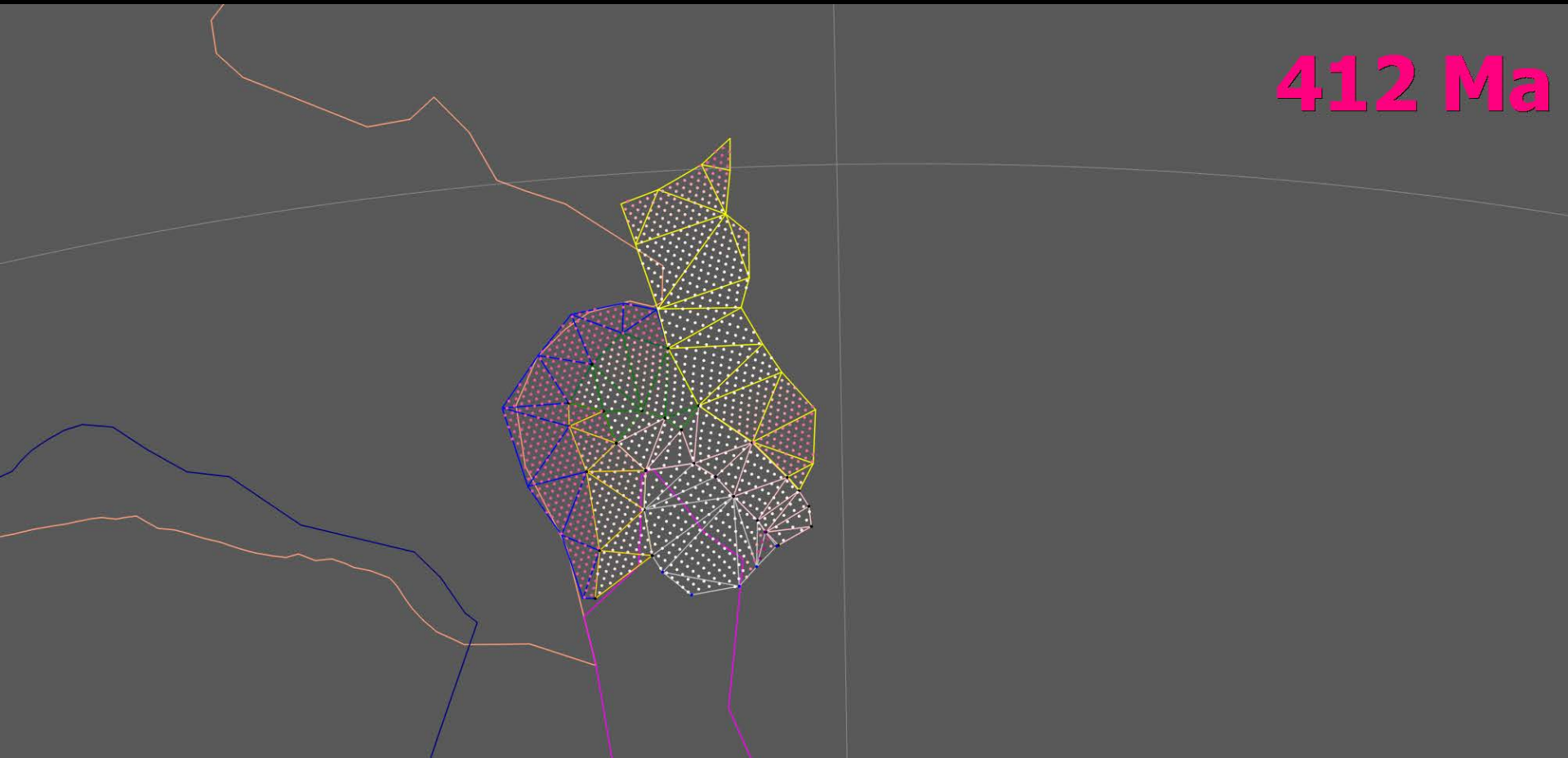
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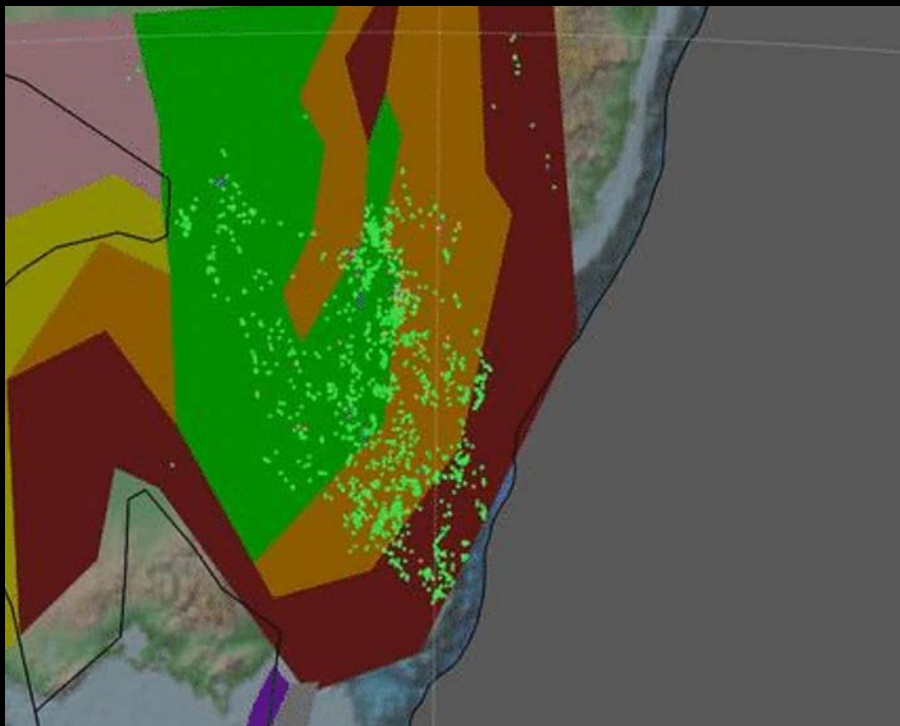
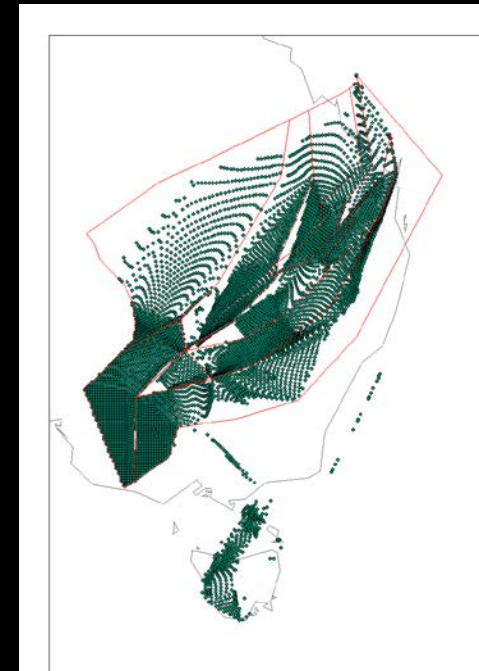
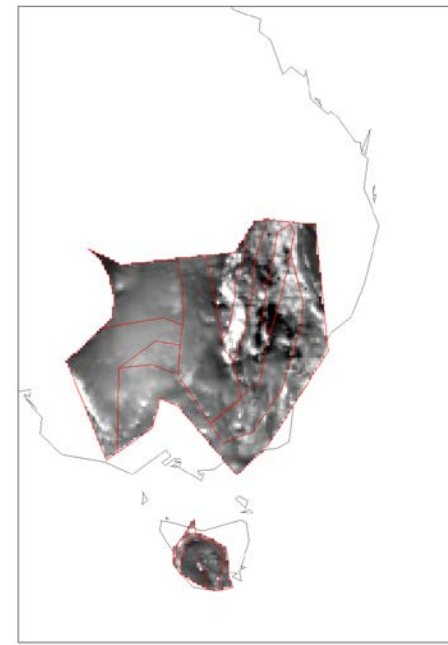
New G-Plates (deforming plates) model

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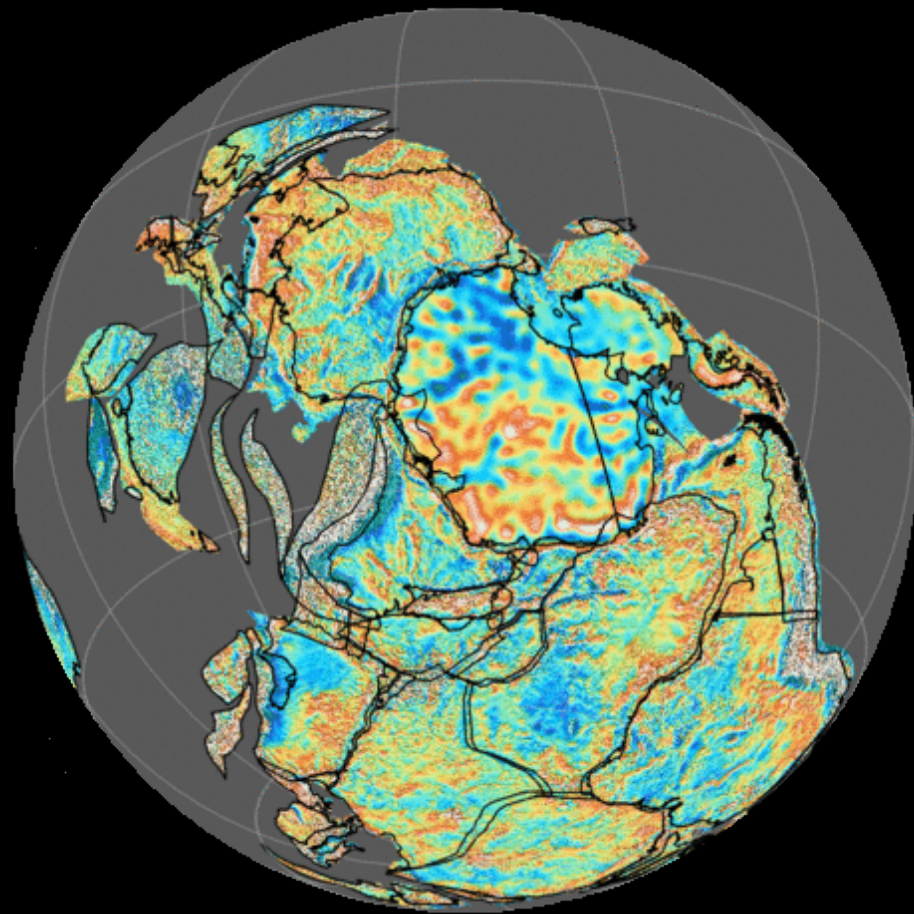
Application for Explorers

- Tom's PhD project aim is to use G-Plates to rotate geochemical data back in time
 - to investigate how porphyry fertility indicators are distributed in the various reconstructions



Conclusion

- Current tectonic reconstruction need significant improvement and refinement
- detailed prediction can be used about ore forming processes
- New development in models and software



Thanks to ARC Linkage project “Ore deposits and tectonics of SE Australia” partners:

