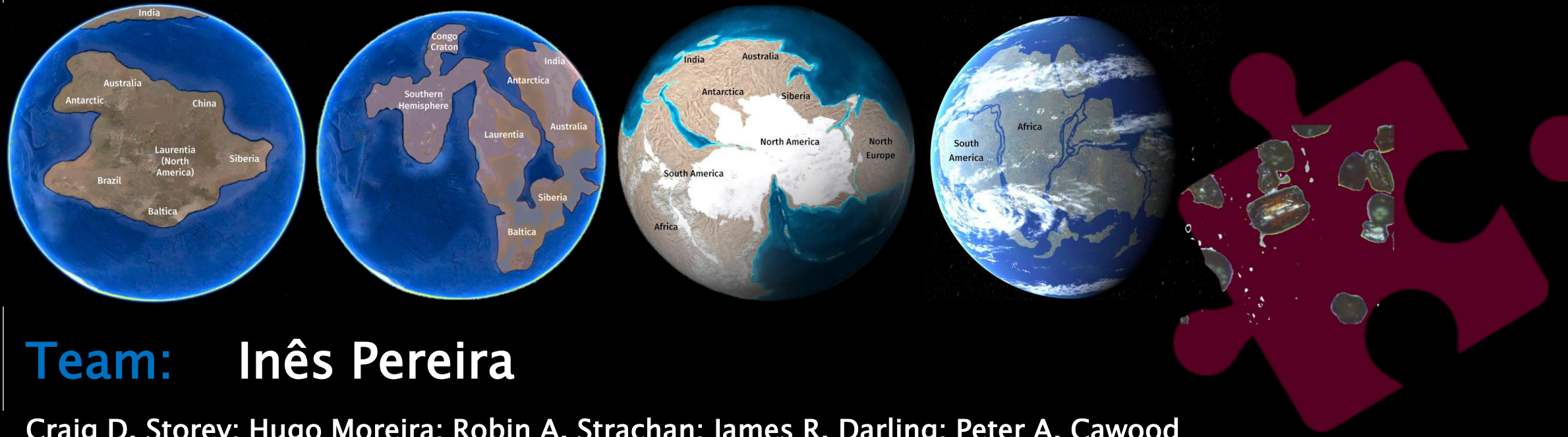
Laboratoire Magmas & Volcans

UNIVERSITY OF PORTSMOUTH

Fitting a new piece into the Precambrian puzzle: the detrital rutile record and its links to *modern plate tectonics*



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Craig D. Storey; Hugo Moreira; Robin A. Strachan; James R. Darling; Peter A. Cawood

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Geoscience Frontiers 9 (2018) 51–60

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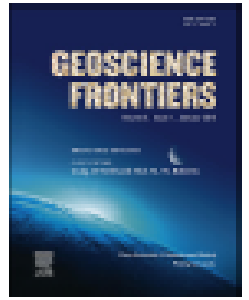
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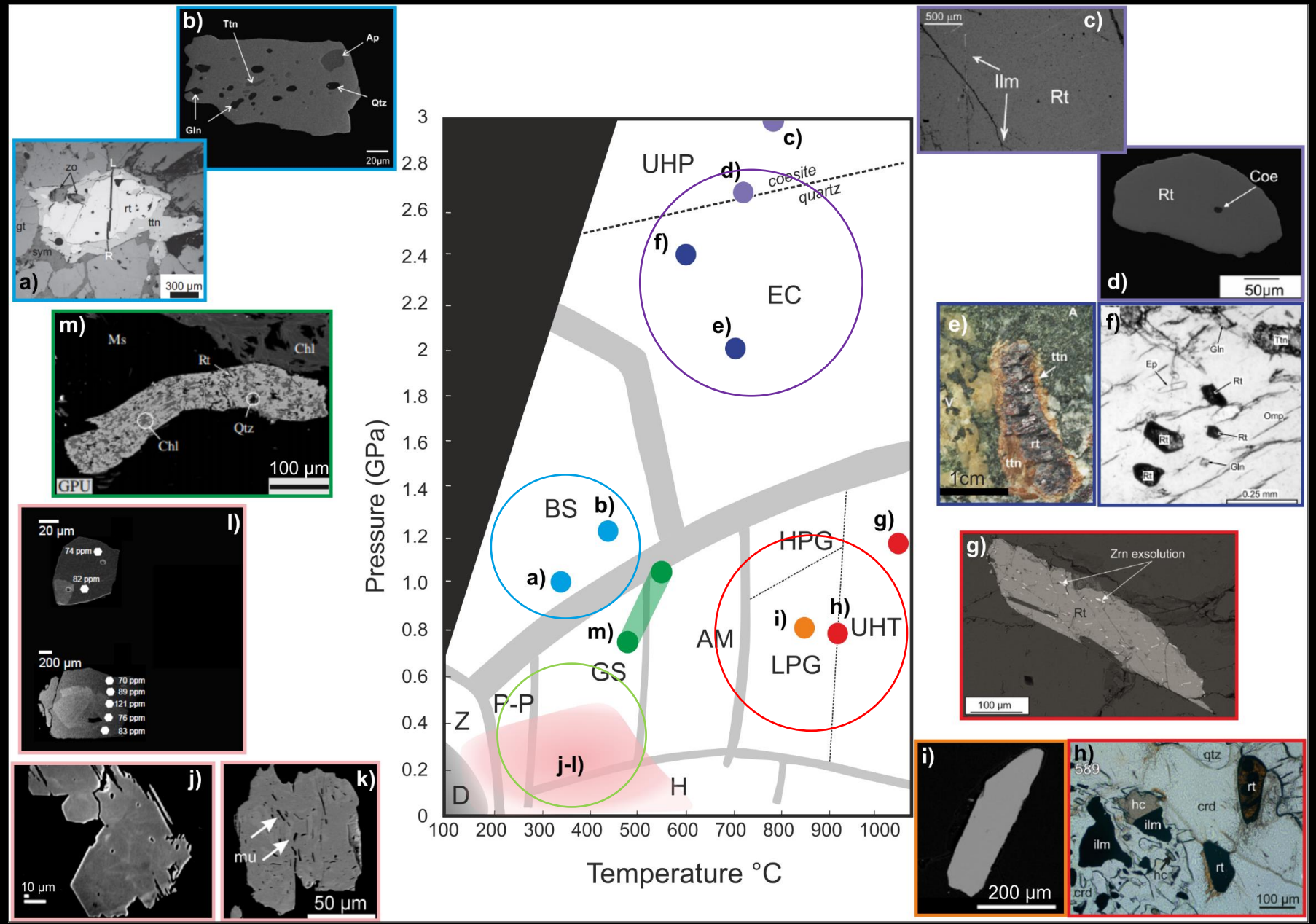
A planet in transition: The onset of plate tectonics on Earth between 3 and 2 Ga?

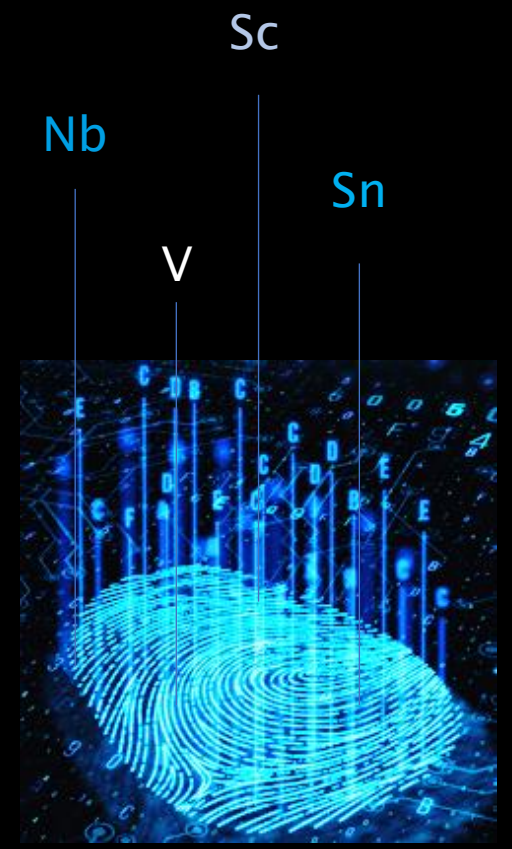
Kent C. Condie

Department of Earth and Environmental Science, New Mexico Tech, Socorro, NM 87801, USA

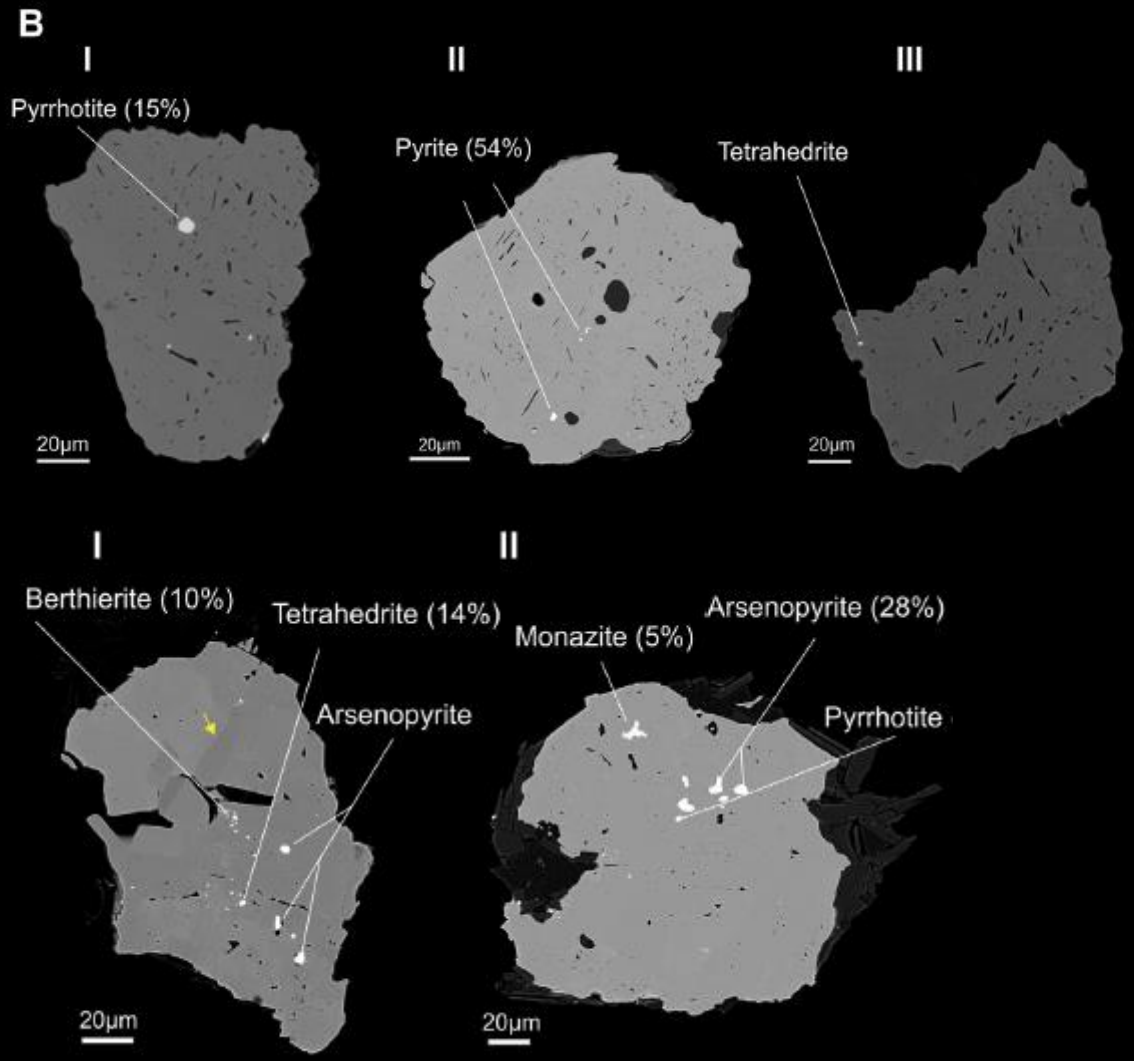
There are many changes in the geological record, but do they represent the onset of modern plate tectonics? and when exactly?

Using rutile as the “metamorphic zircon”: still some things we don’t know



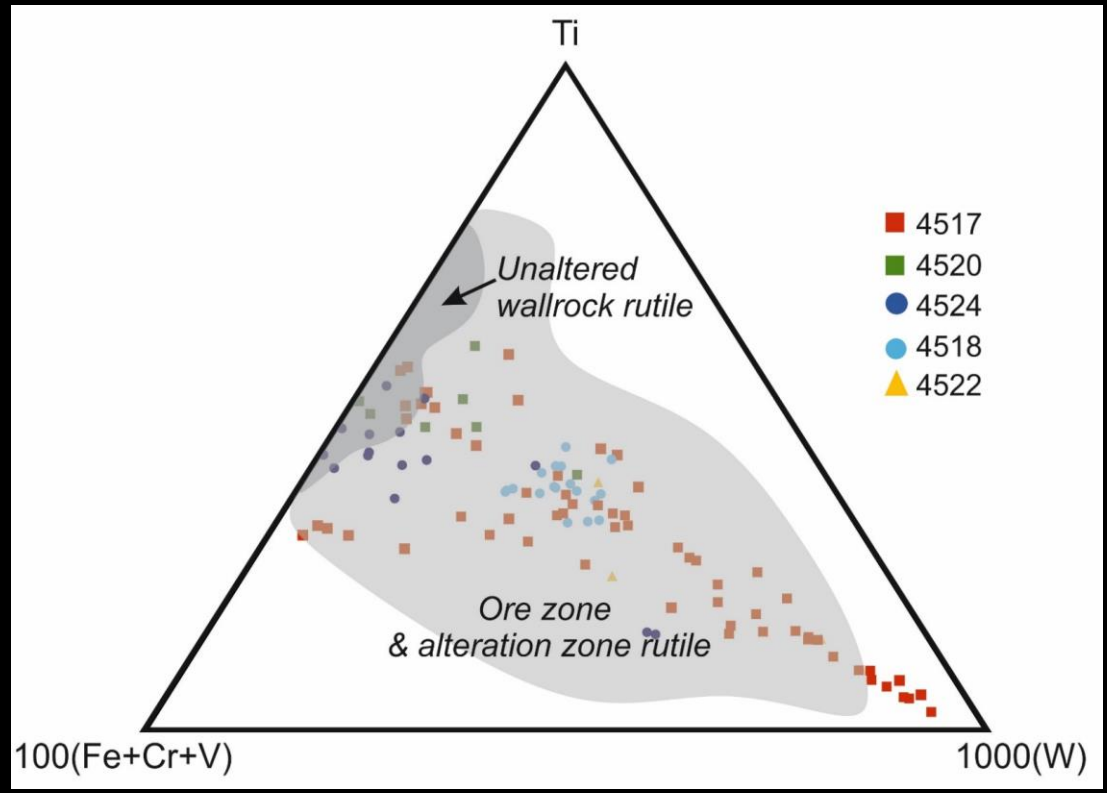


Crustal processes ::: links with mineralising fluids



Rutile grains retrieved from a Paleoproterozoic Siliciclastic unit from SSFC (Brazil) – complex history but related to fluid precipitation phenomena

- Rutile is known to form in ore mineralised rocks, such as in orogenic gold settings;
- W in rutile has been used as a vector in such cases

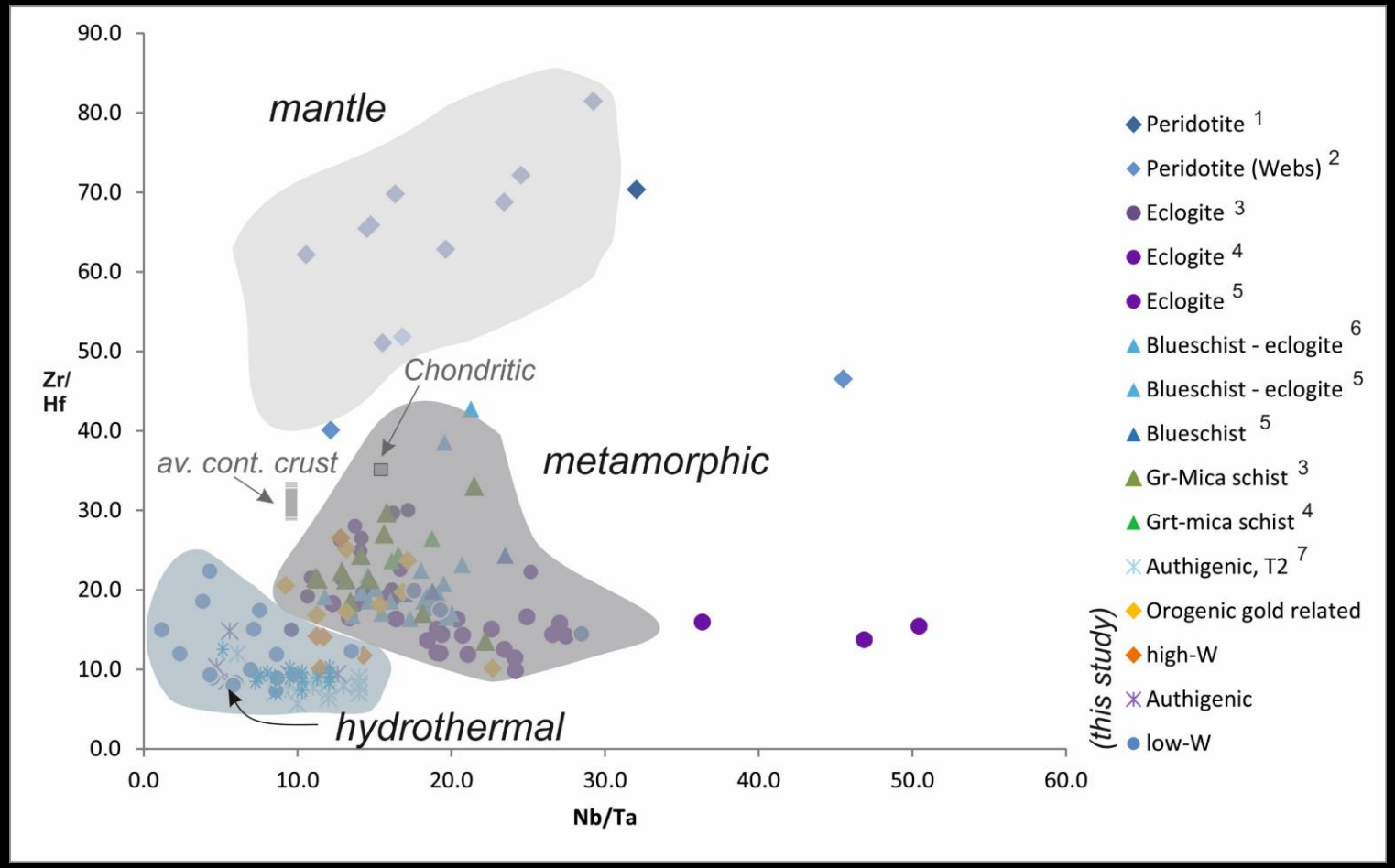


Clark and Williams-Jones (2004)

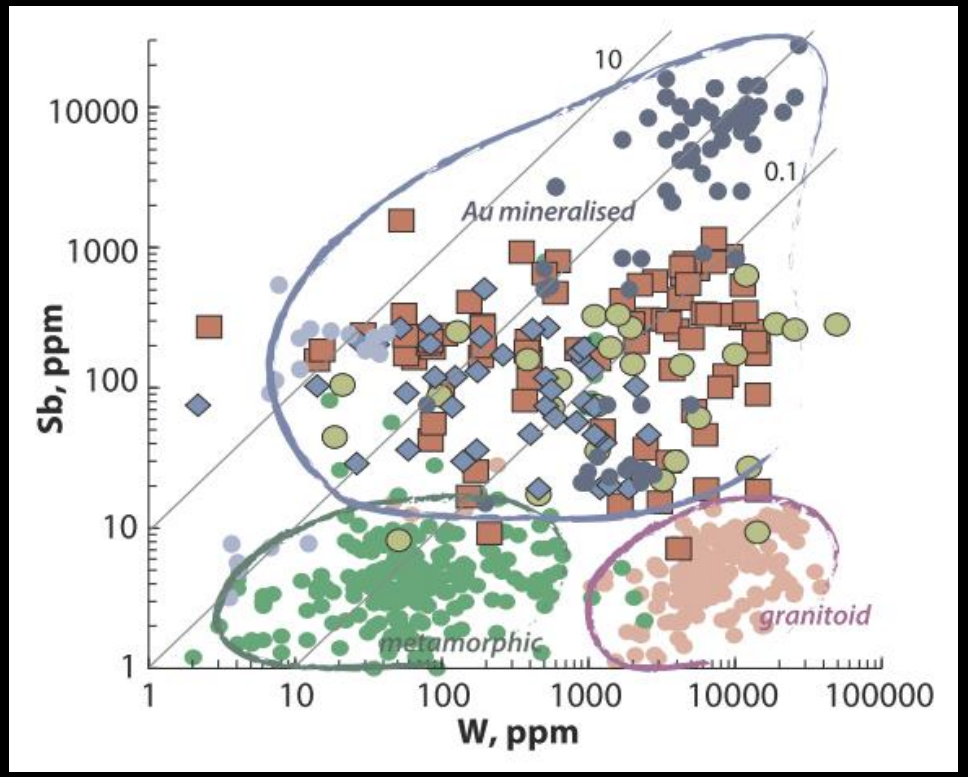
- look at other potential vectors and compare these rutiles with metamorphic rutiles (HP and HT).

Trace element geochemistry to fingerprint processes and sources: Work in progress…

- Efforts are being made to fingerprint metamorphic rutile (s.s.) …



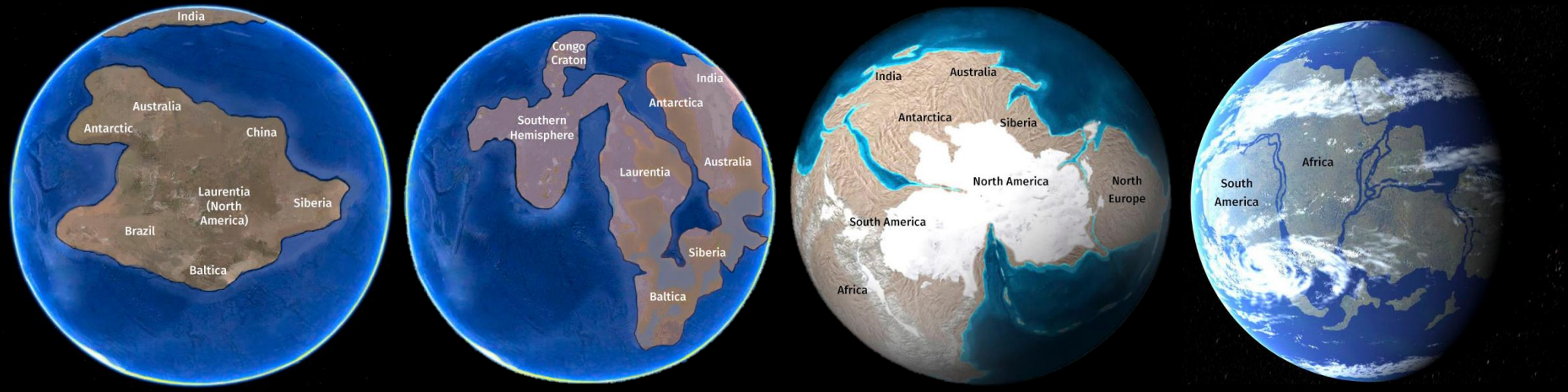
Pereira et al. (2019) GR



Agangi et al. (2019) OGR

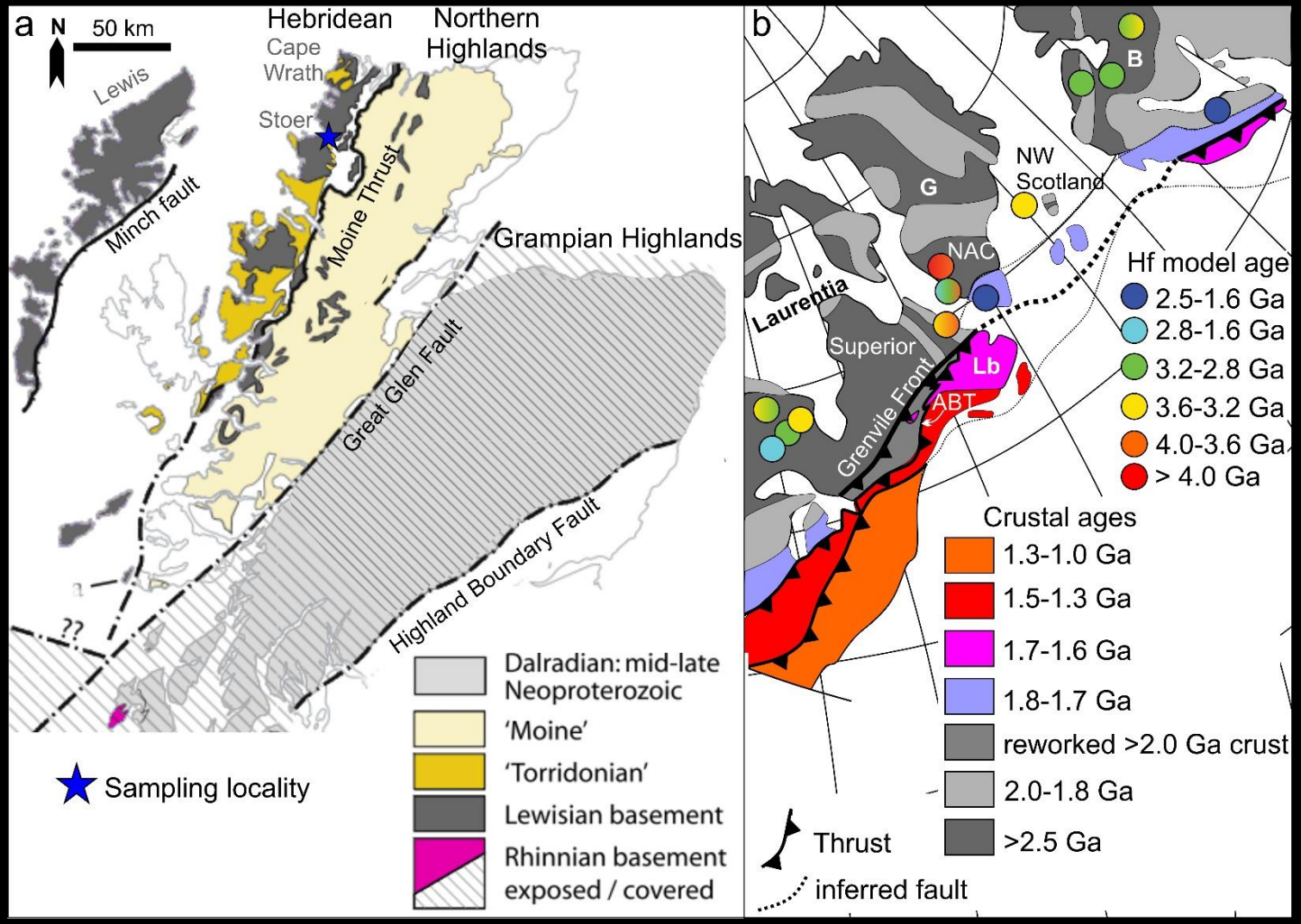
- rutiles formed by fluid-mediated processes yield low, but variable Zr/Hf and low Nb/Ta
- Ta is more compatible with rutile in the presence of saline fluids

Tectonic processes



Strategy: sampling NW Scotland siliciclastic units

- Not affected by significant metamorphism or fluid circulation
- Detrital zircon ages range from the Archean to the Neorproterozoic



Cambrian

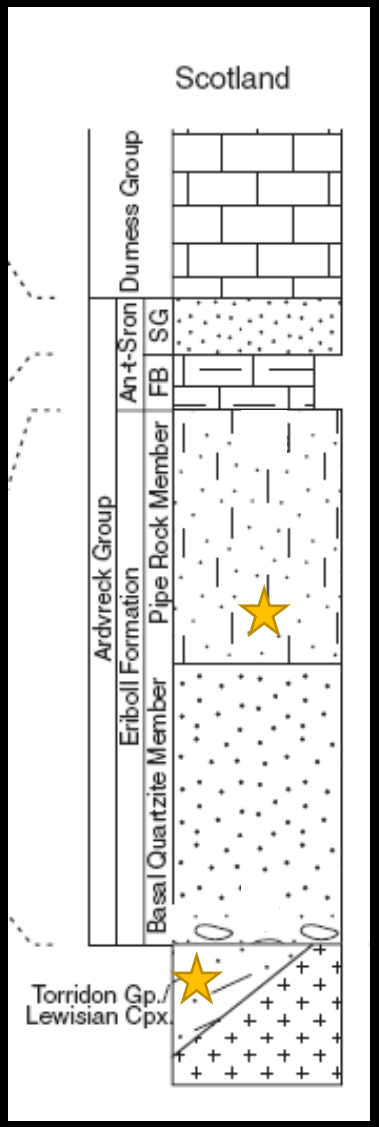
Neoproterozoic

Passive margin basin



Foreland basin

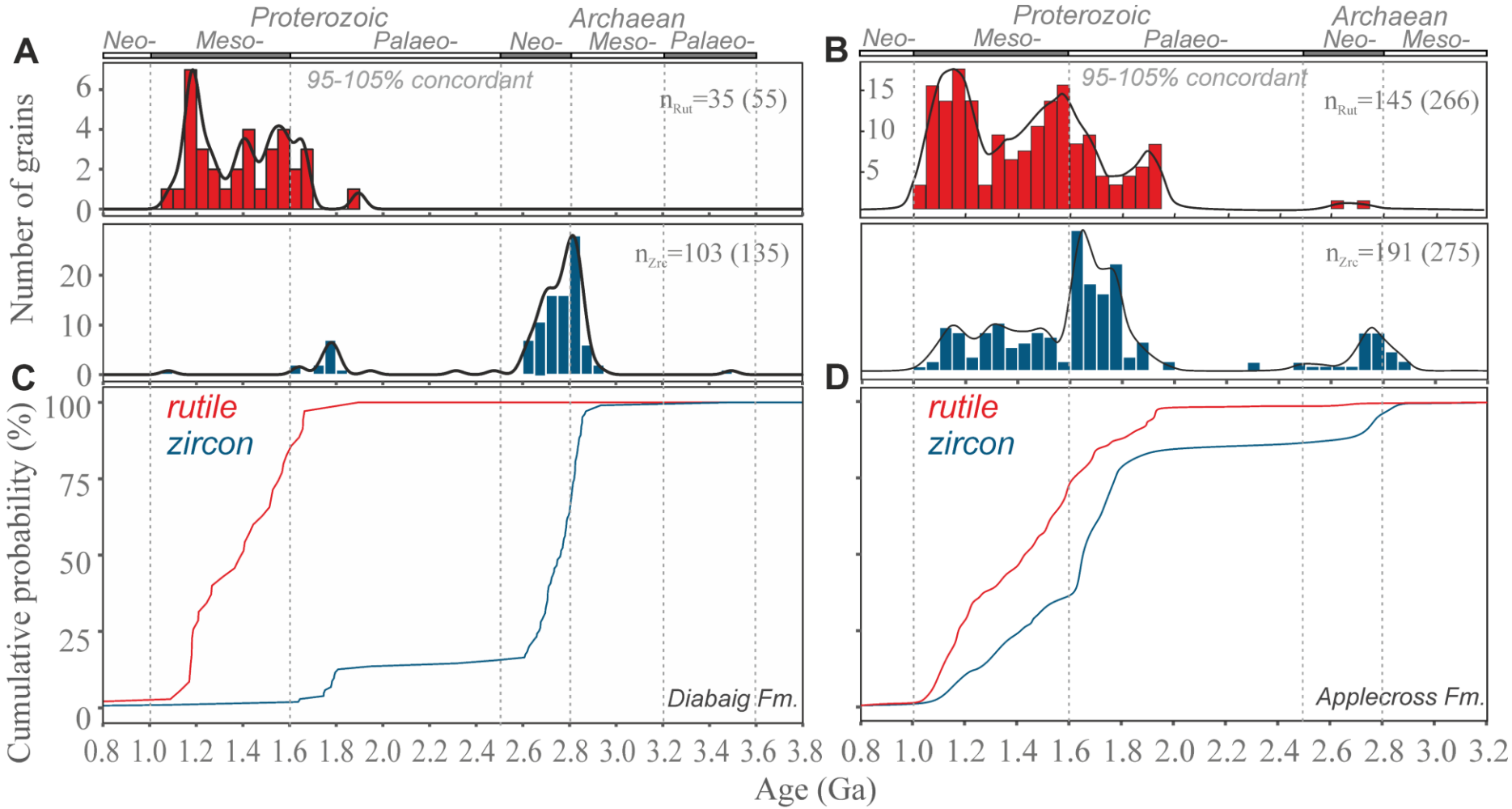




Cawood et al. (2007)

Rutile KDE (Kernel density estimate) and cumulative probability

- Torridon Group (Meso-Neoproterozoic age) : Diabaig Fm. and Applecross Fm.

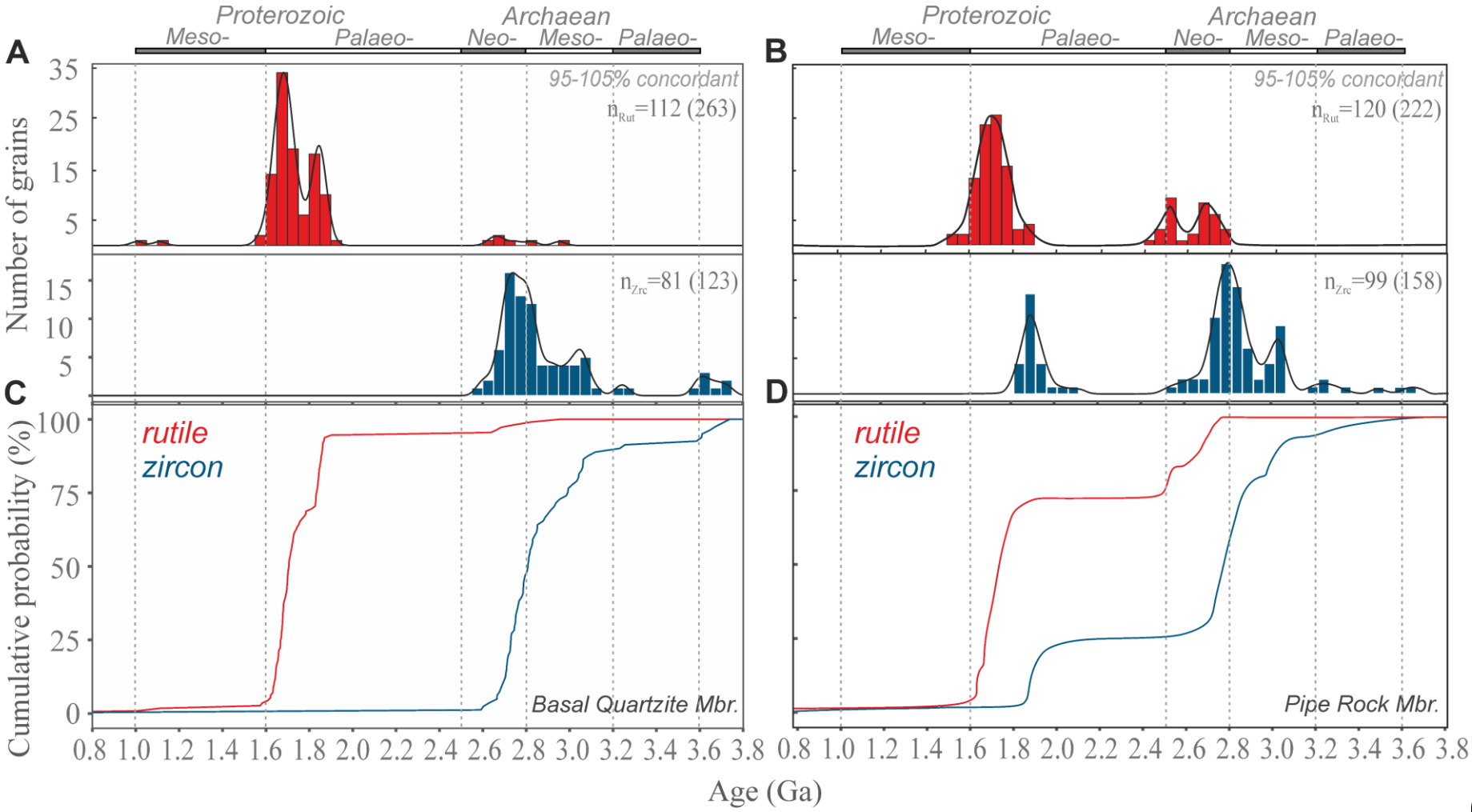


Pereira et al. (2020) EPSL

- main detrital rutile population is constrained from the late Palaeo- to the late Mesoproterozoic

Rutile KDE (Kernel density estimate) and cumulative probability

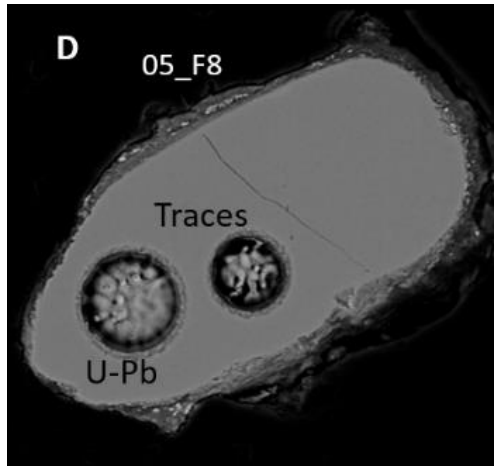
- Ardvreck Group (Cambrian age) : Basal Quartzite Mbr. and Pipe Rock Mbr.

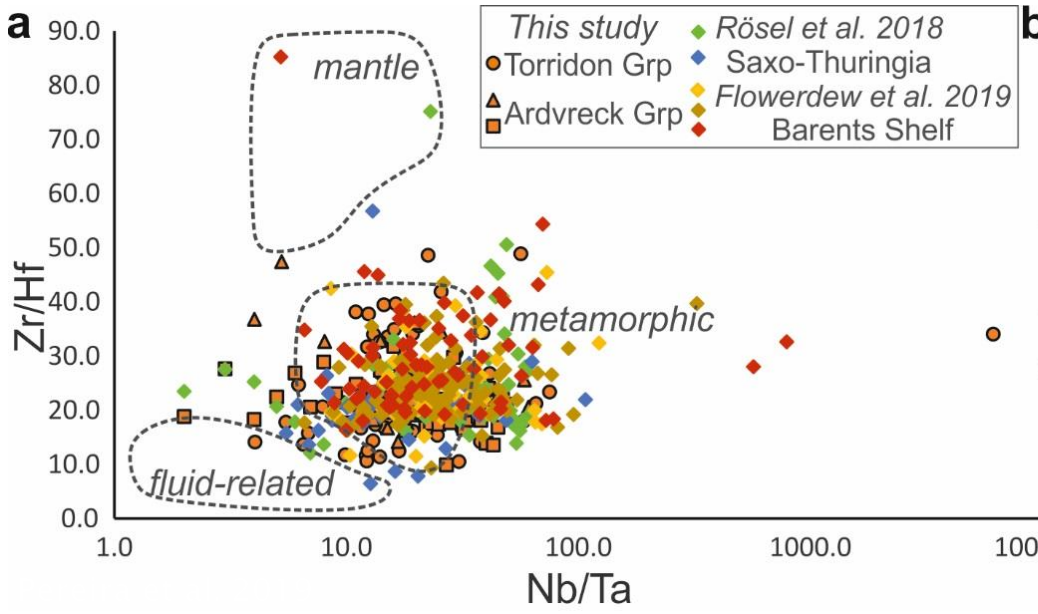


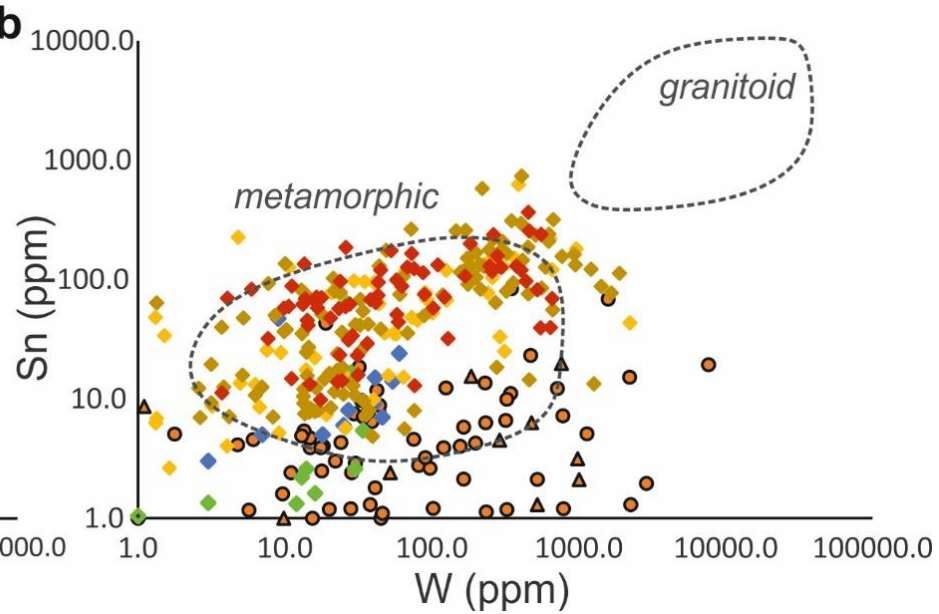
Pereira et al. (2020) EPSL

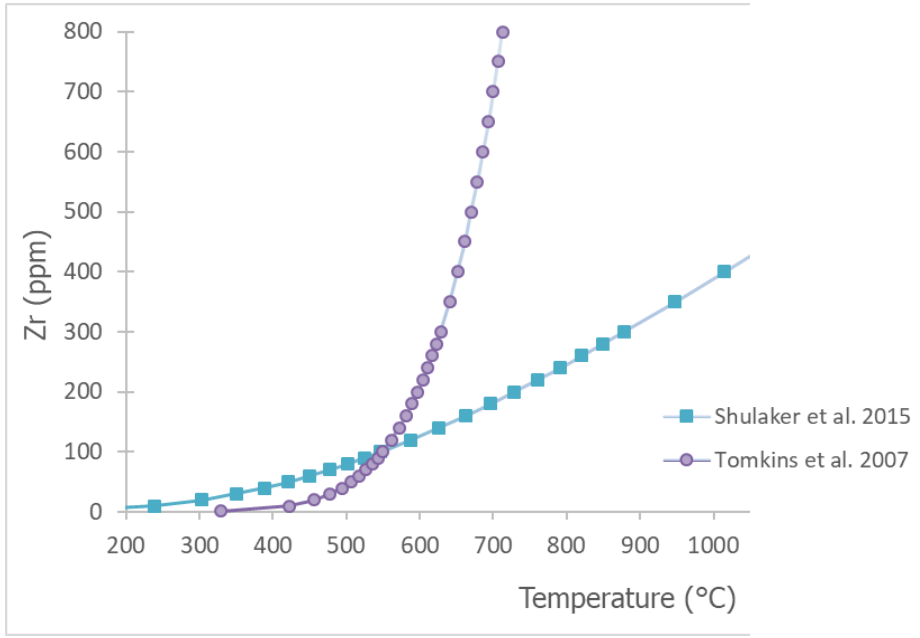
- Detrital rutile population form two clusters; sourced from eastern Greenland terranes

Trace element chemistry and Zr-in-rutile thermometry







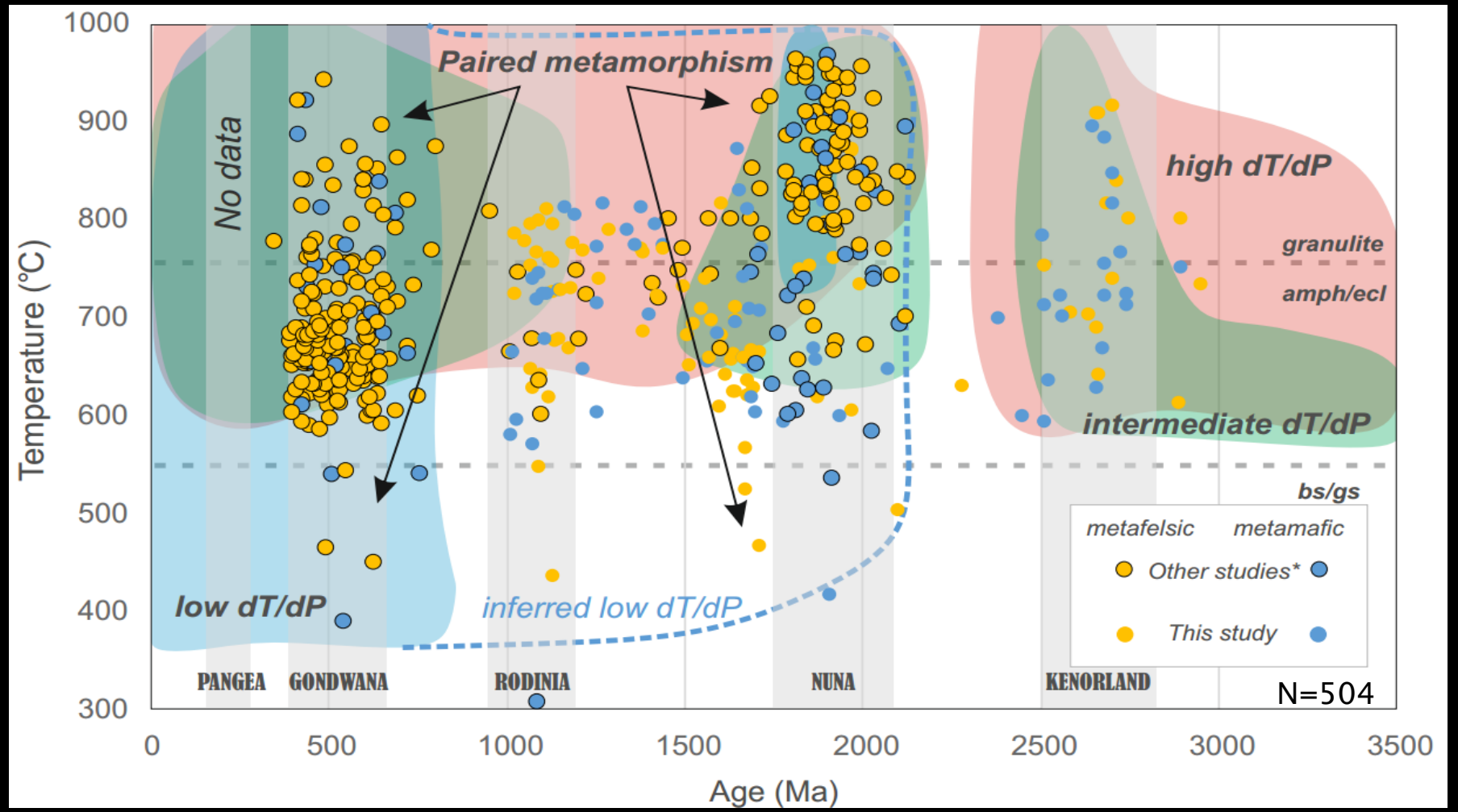


Zr >130 ppm	Zr <130 ppm
- Tomkins et al. (2007) - @ 10kbar	- Shulaker et al. (2015) - 2s ± 50 °C

$$T(^{\circ}\mathrm{C}) = \frac{83.9 + 0.410P}{0.1428 - \mathrm{R}\ln\phi} - 273$$

$$T(^{\circ}\mathrm{C}) = \frac{26(\pm 9)}{0.07(\pm 0.01) - \mathrm{R}\ln x} - 273$$

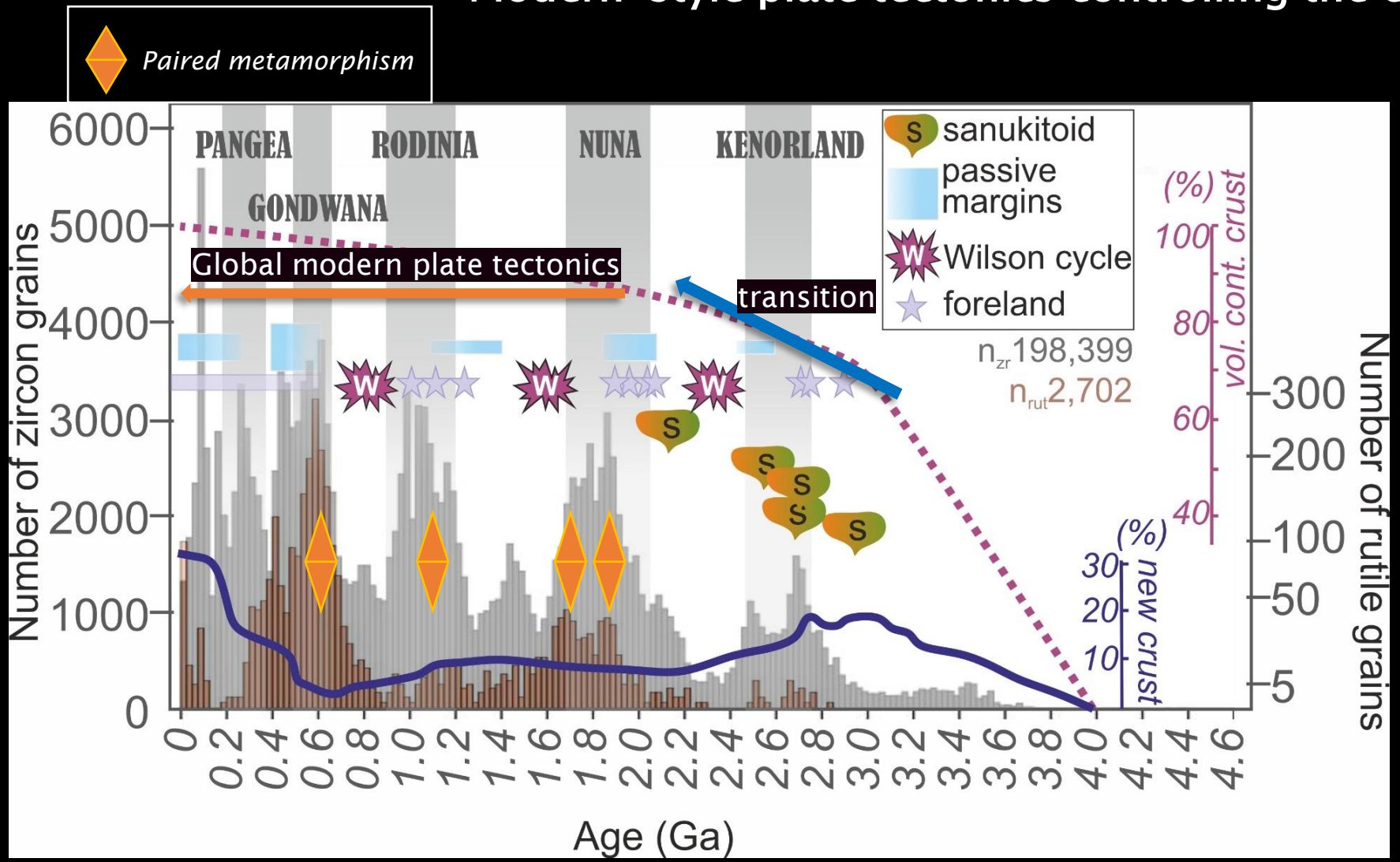
Contrasting thermal regimes – paired metamorphism?

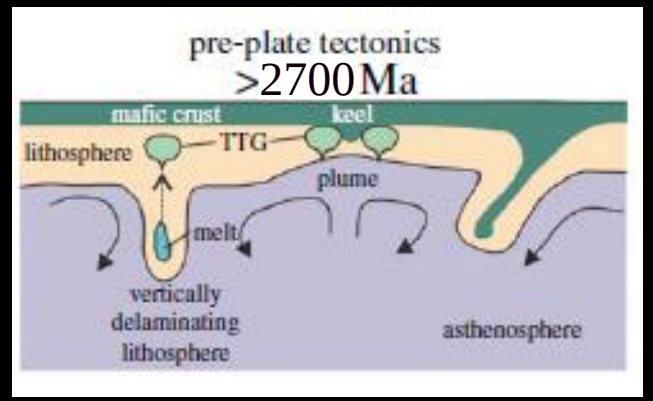


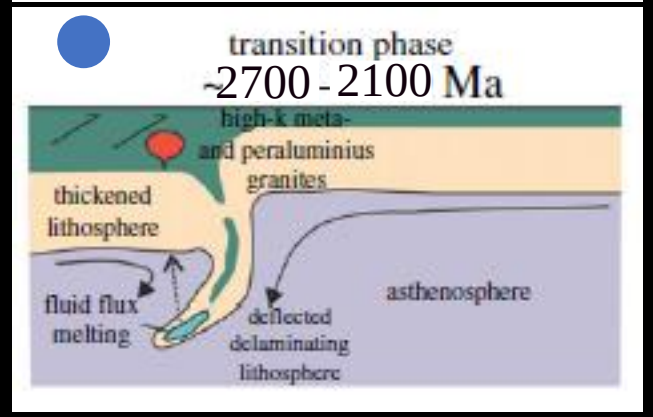
Rutile grains preserving the lowest temperatures (T < 550 ºC; n = 14)

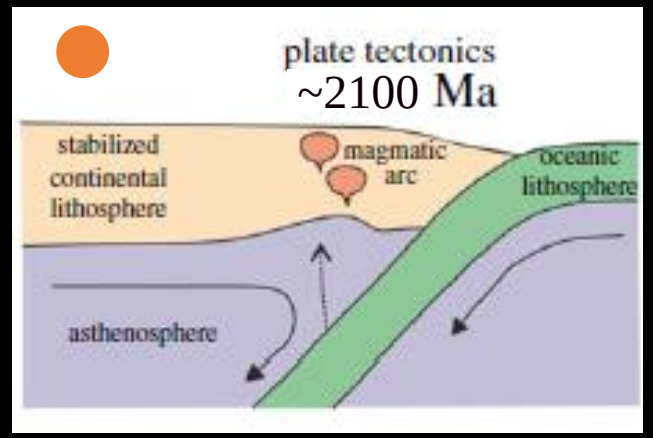
- No low dt/dP in the late Archean
- U-Pb recording exhumation/cooling?

Modern-style plate tectonics controlling the continental crust preservation









Integrated data from:

continental crustal growth (purple dashed curve) and juvenile additions (blue curve) from Dhuime et al. (2012)

TTG-Sanukitoids from Laurent et al. (2014) and Moreira et al. (2018)

Passive margins and Wilson cycle: Bradley, 2008; Alkmim and Marshak, 1998; Alkmim and Martins-Neto, 2012; Nicoli et al., 2018)

Foreland basins data from multiple sources

Modified from Cawood et al. (2018)

HAPPY TO HAVE YOUR QUESTIONS

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Find the extended version of this presentation in:
https://www.youtube.com/watch?v=JrGXTzF59CA