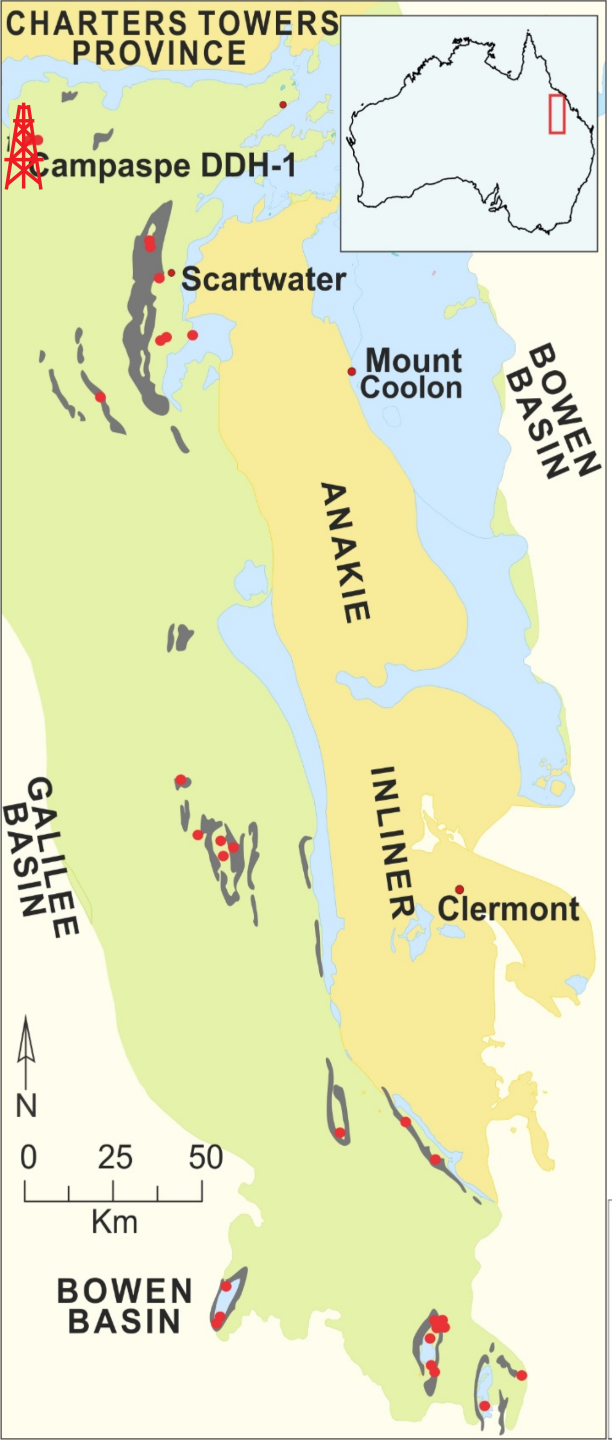
Detrital geochronology constraints on sediment provenance and transport distance in the Drummond Basin (central Queensland)

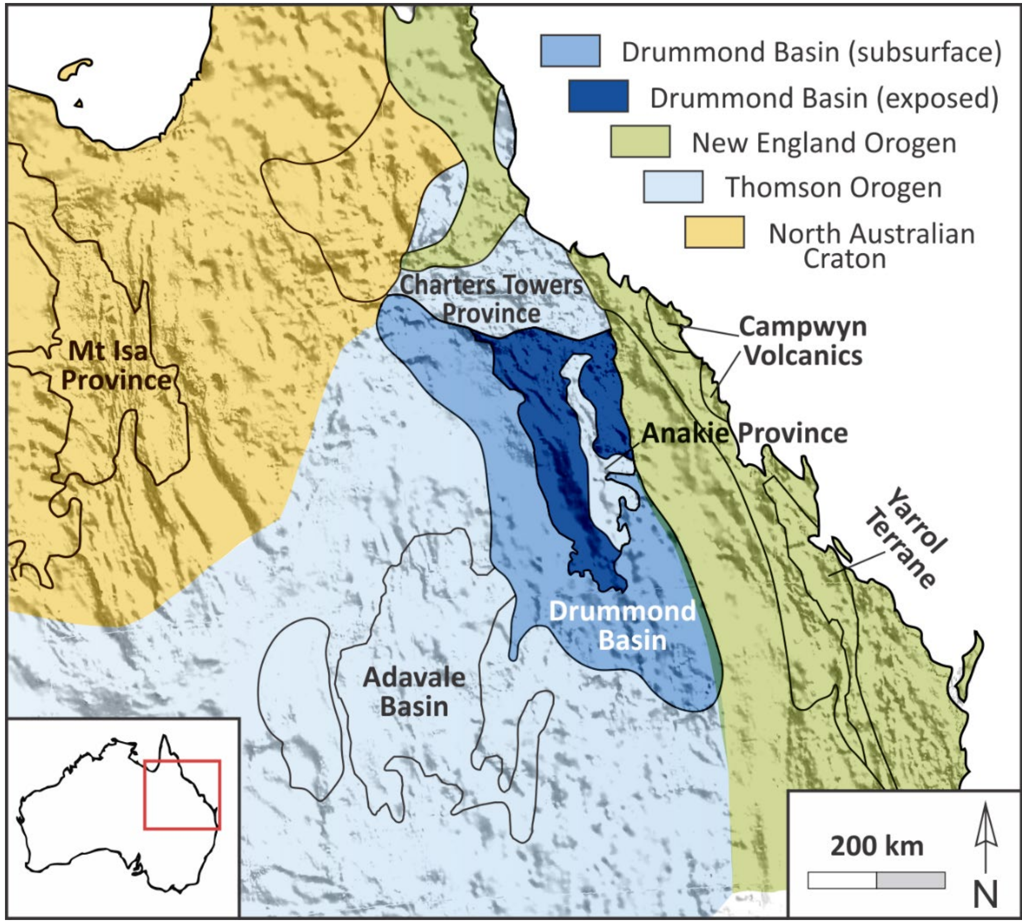
Kasia Sobczak



Drummond Basin

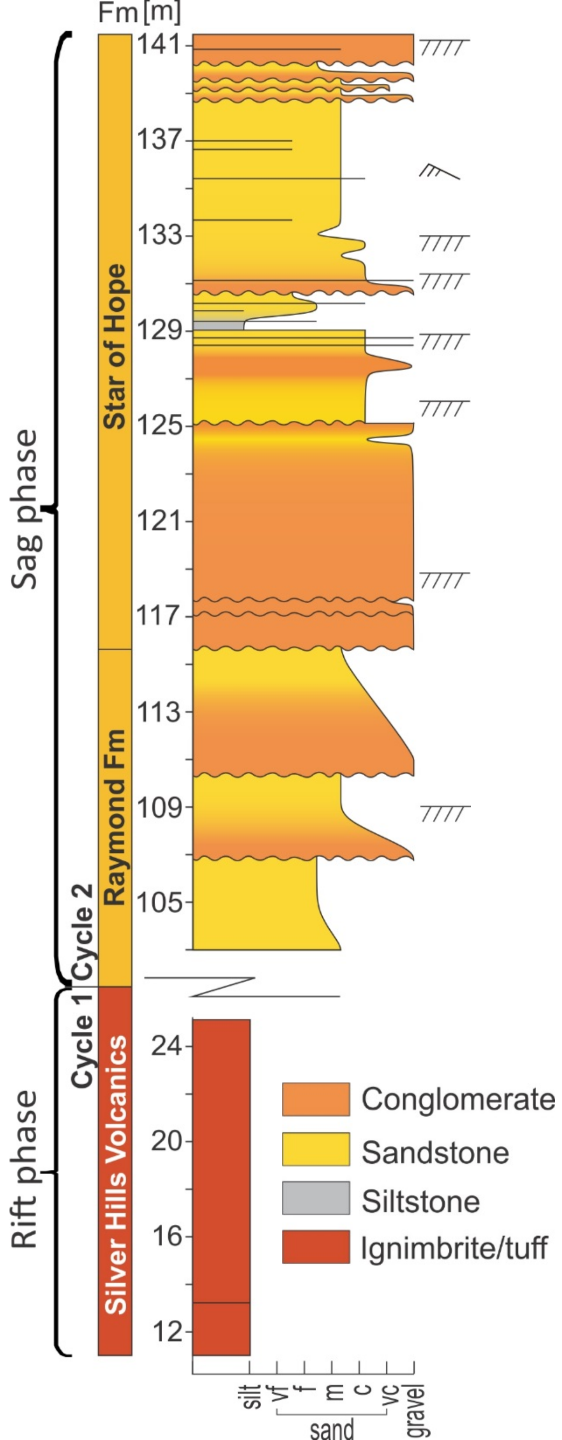
- Sedimentation: Late Devonian – mid Carboniferous, non-marine
- Sequence thickness: 7.6 km
- Basin dimensions: 470 km (N-S) x 100 km (E-W)
- Natural resources:
  - Epithermal (Au and Cu)
  - Coal
  - Poor reservoir-quality hydrocarbons

	Post-Drummond Basins
	Drummond Cycle 2 & 3
	Mount Hall Fm exposures
	Drummond Cycle 1
	Pre-Drummond Basement



Modified after Henderson

Provenance change in Drummond Basin

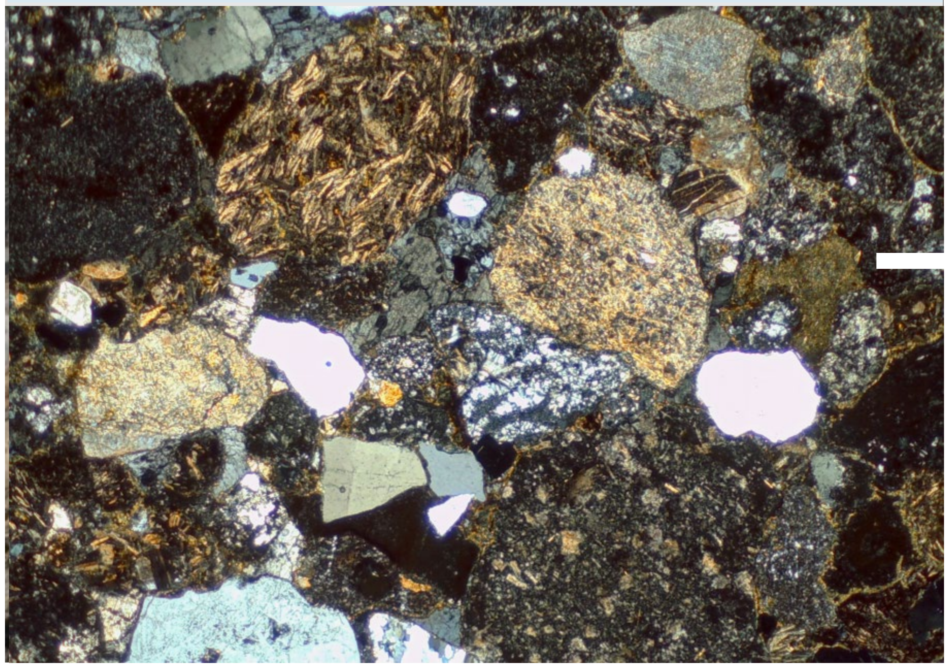


Drummond Basin evolution deviates from a typical rift basin model

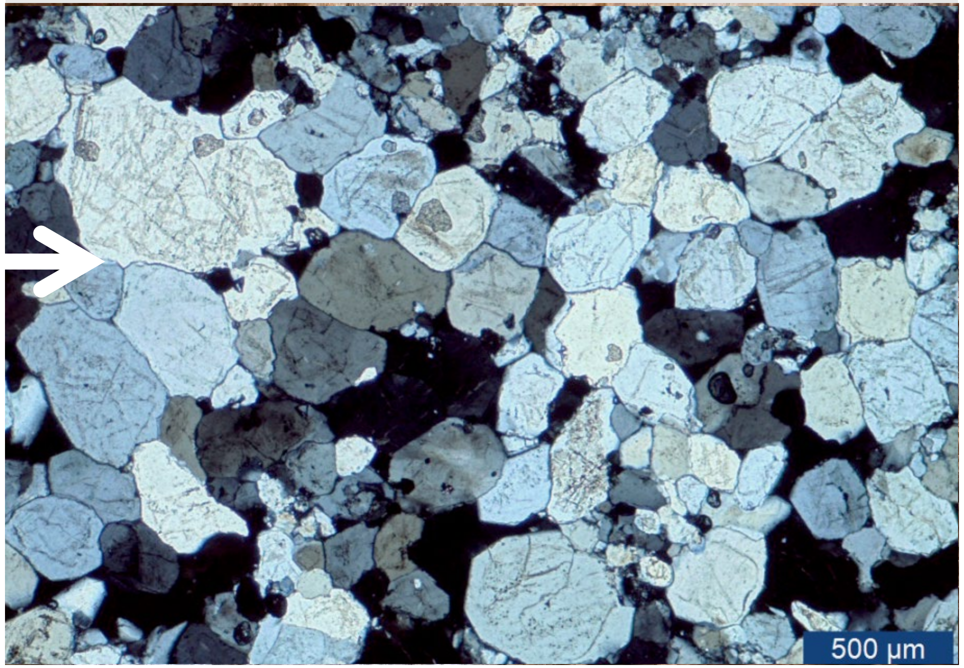
A pronounced sedimentary provenance shift is recorded at Cycle 1/Cycle 2 boundary:

Volcanic and volcano-sedimentary rocks → qtz-rich cratonic-derived rocks

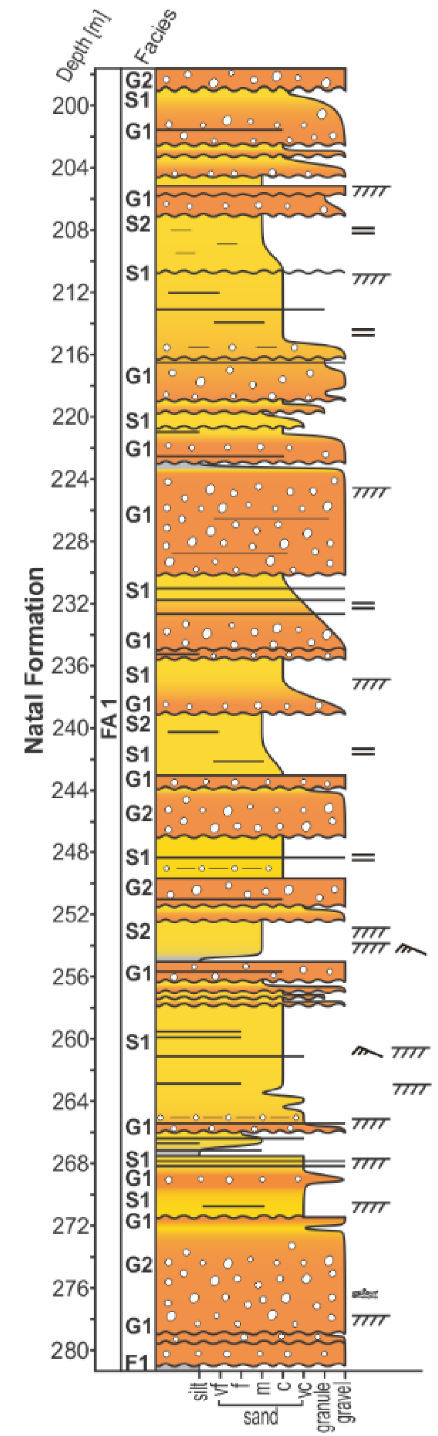
Cycle 1 Lithic-rich sandstone



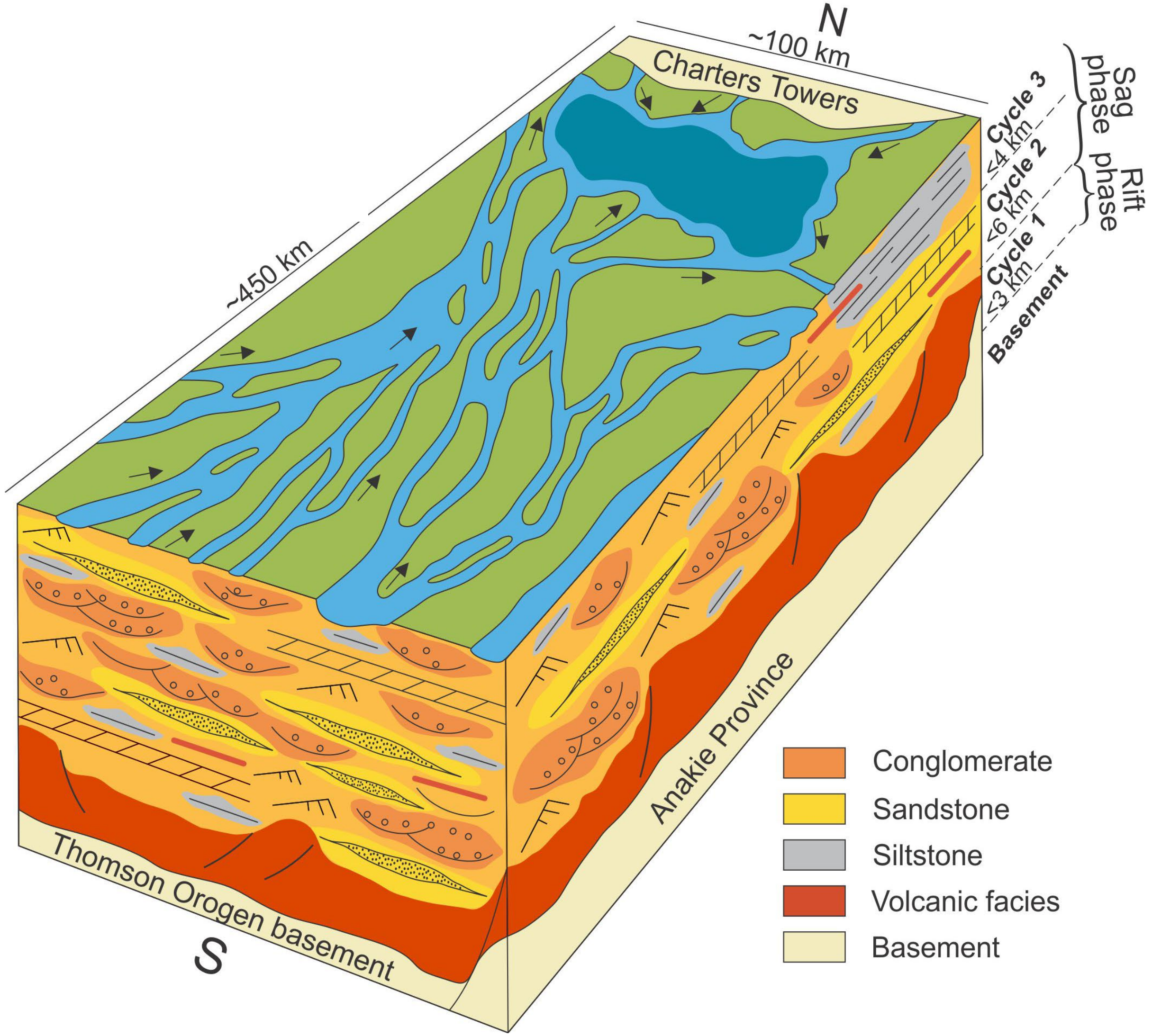
Cycle 2 Quartz sandstone



Depositional environment and facies architecture



- Sediment sourcing from outside S-SW margin of the basin
    - Northward sediment transport along the basin axis

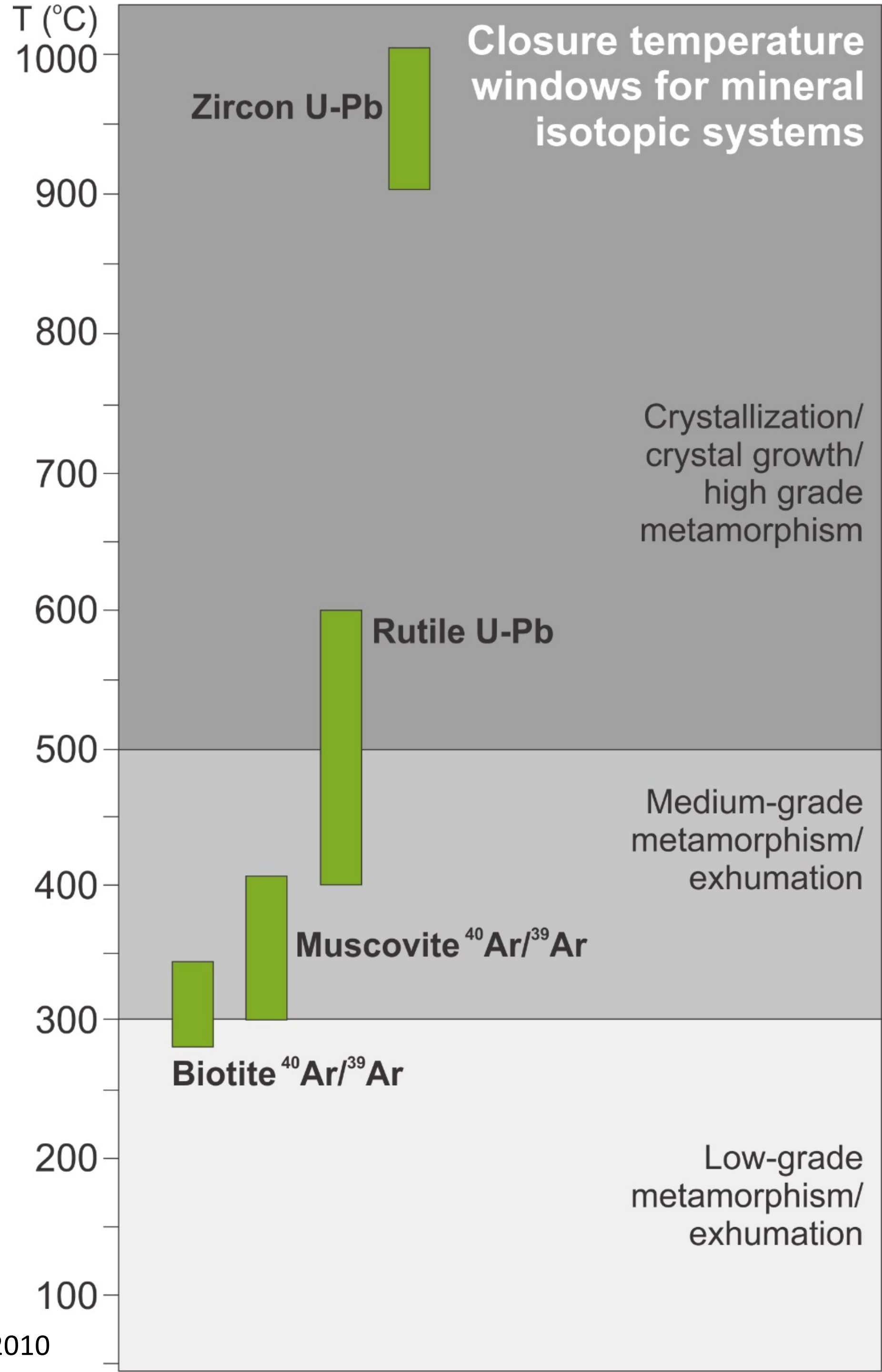


Canterbury Plains
South Island, NZ
(New Zealand Geographic)

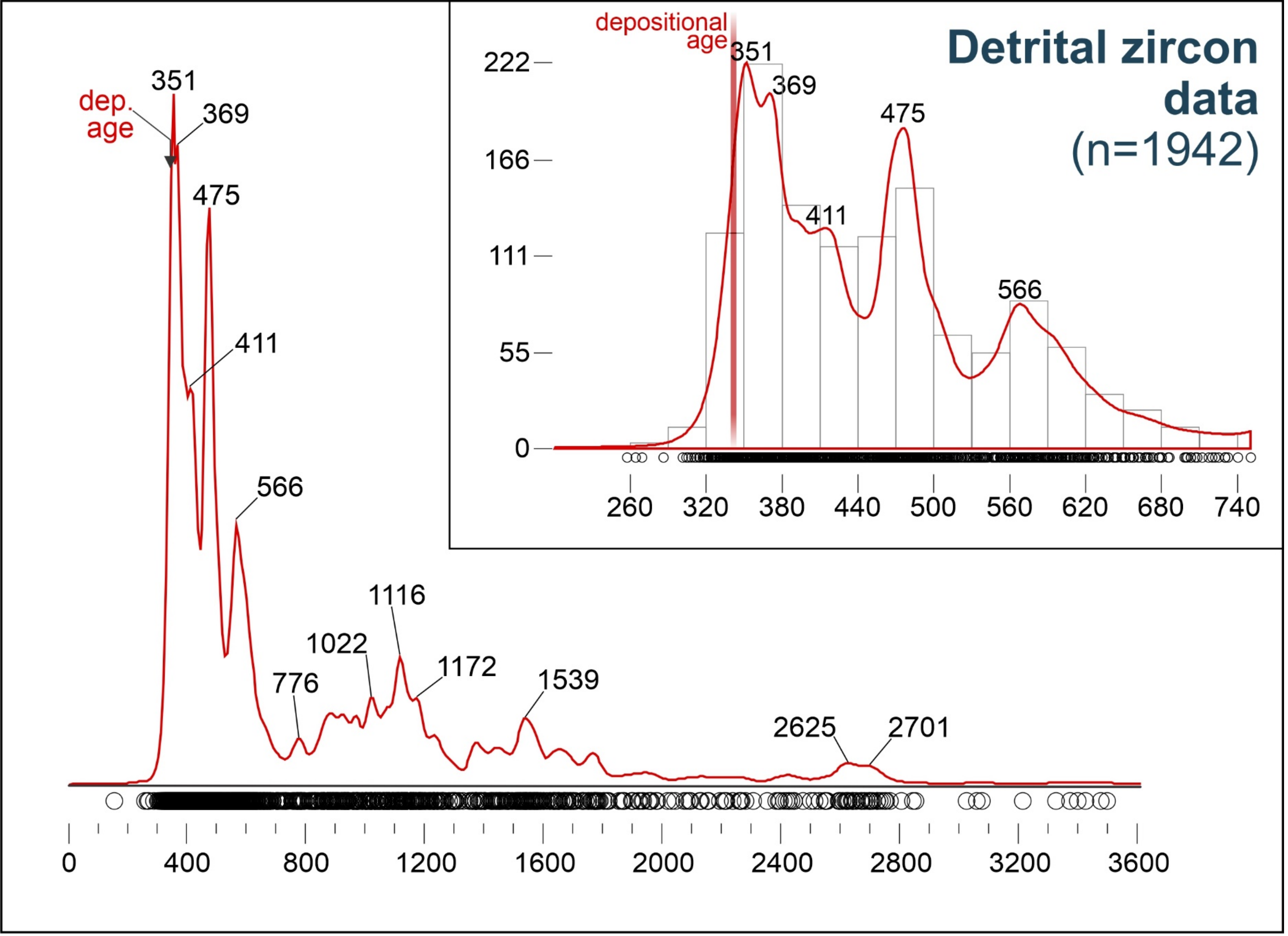
Multi-method detrital geochronology

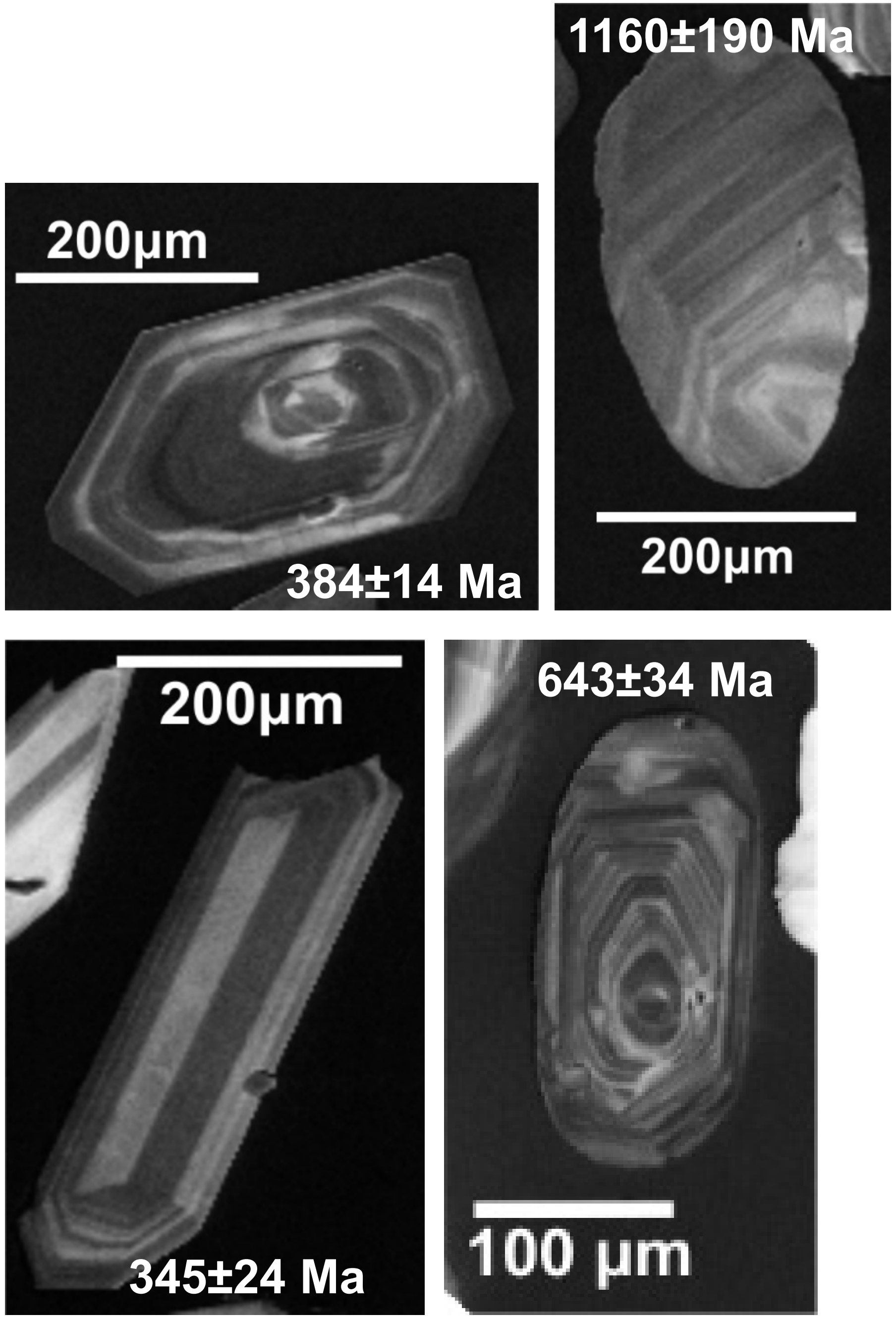
- U-Pb zircon dating of interbedded tuffs (depositional ages)
- U-Pb dating of detrital zircon (LA-ICP-MS)
- U-Pb dating of detrital rutile (LA-ICP-MS)
- $^{40}Ar/^{39}Ar$ dating of detrital mica (single grain total fusion ages)

Zircon: 27 samples (total of 2,544 analyses)
Rutile: 18 samples (1,431 analyses)
Muscovite: 2 samples
Biotite: 1 sample



Modified after Carrapa, 2010

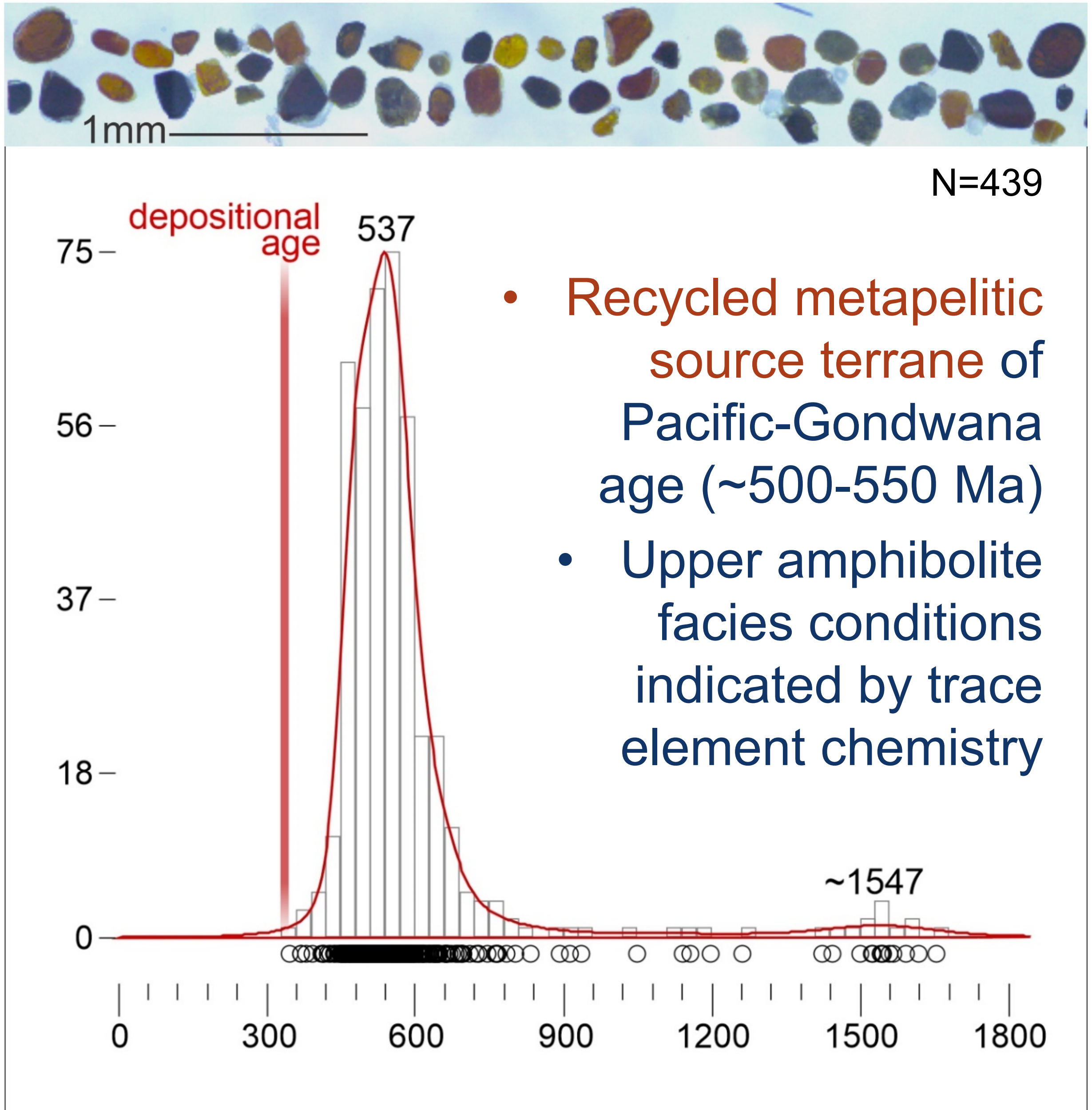




Local, syn-depositional volcanic sources: 16% of the dataset.

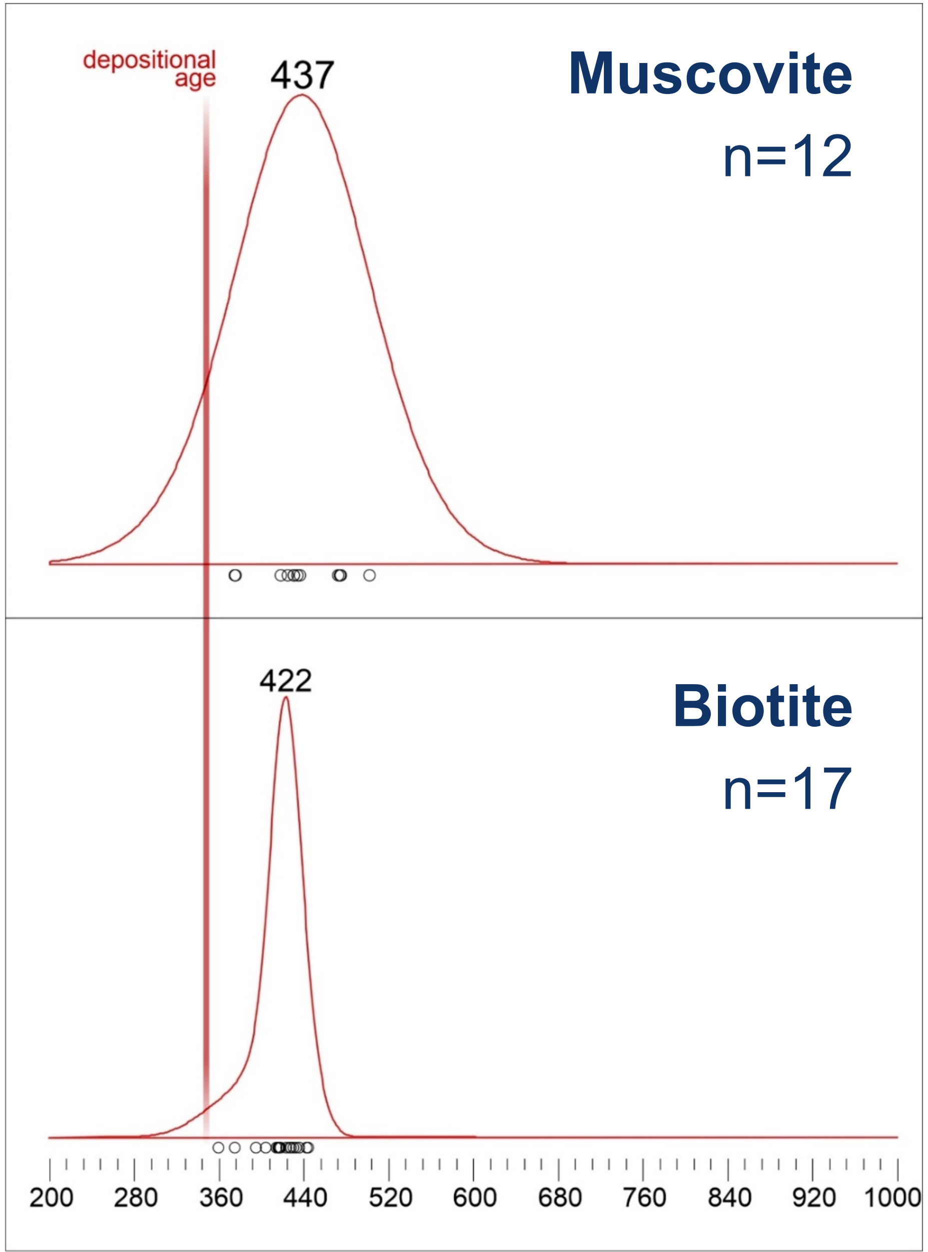
Drummond Basin age signature dominated by older sources.

Detrital rutile ages



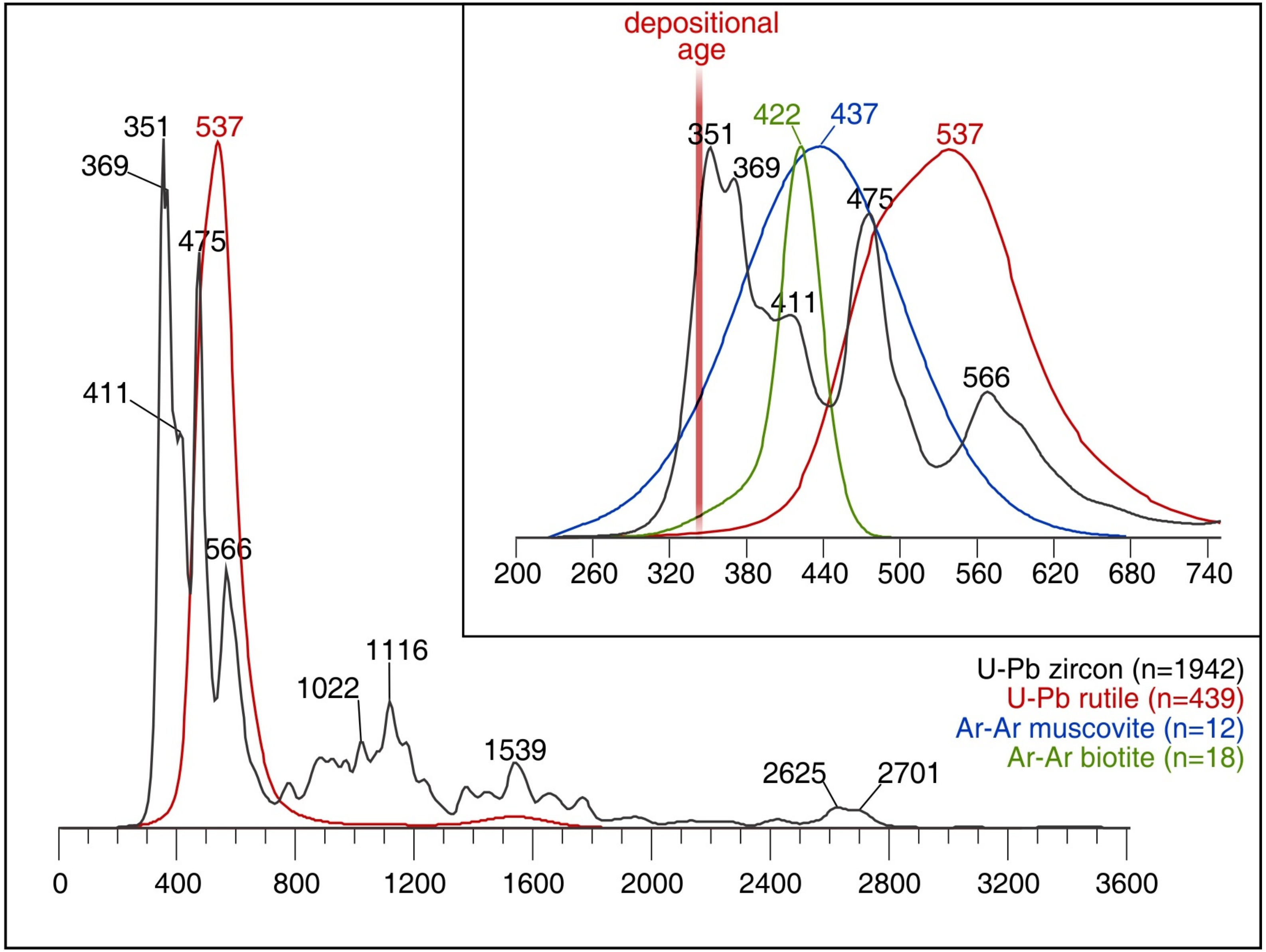
- Recycled metapelitic source terrane of Pacific-Gondwana age (~500-550 Ma)
- Upper amphibolite facies conditions indicated by trace element chemistry

Detrital mica ages

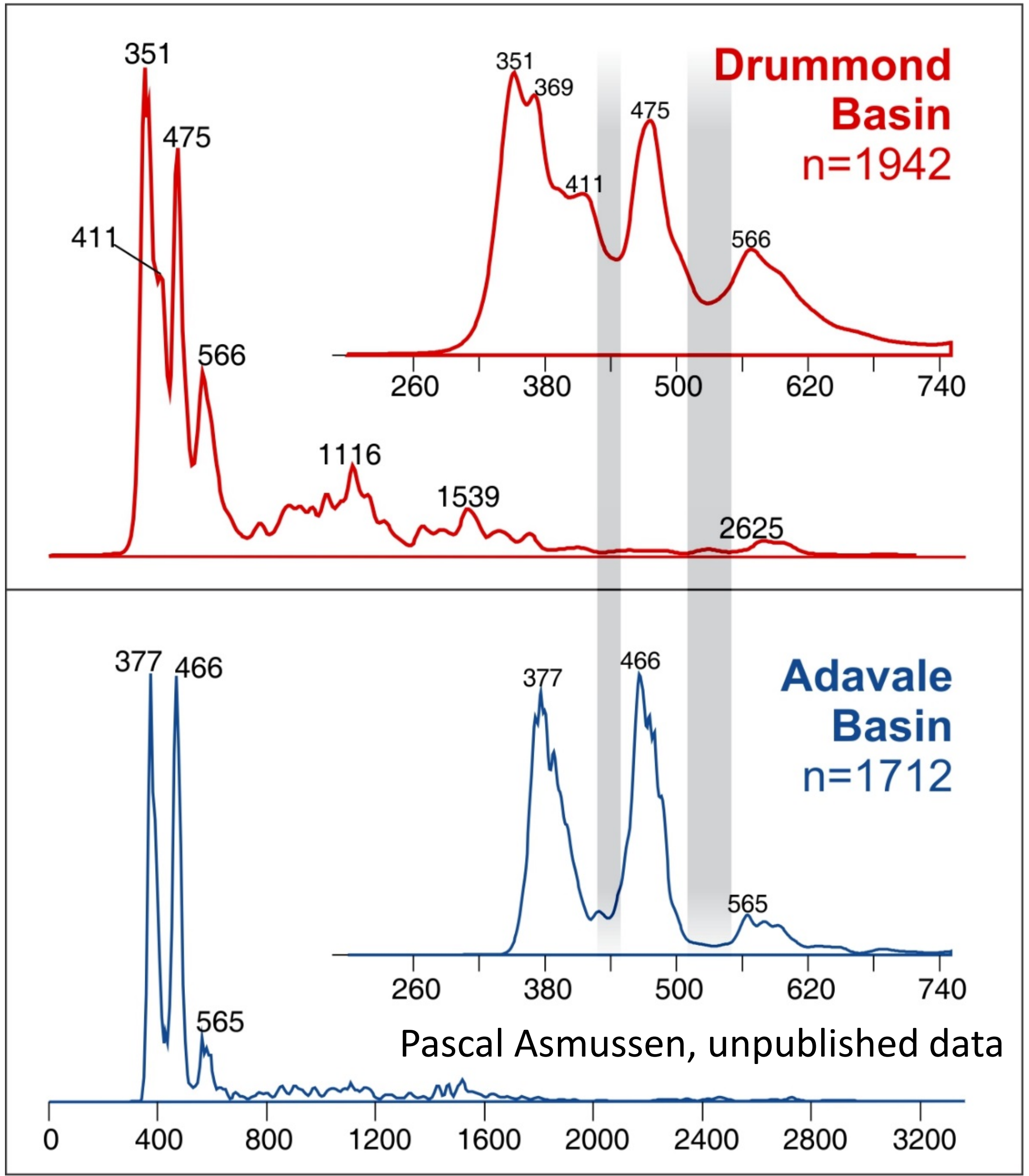


Contributions to Cycle 2 and 3 Sedimentation in the Drummond Basin

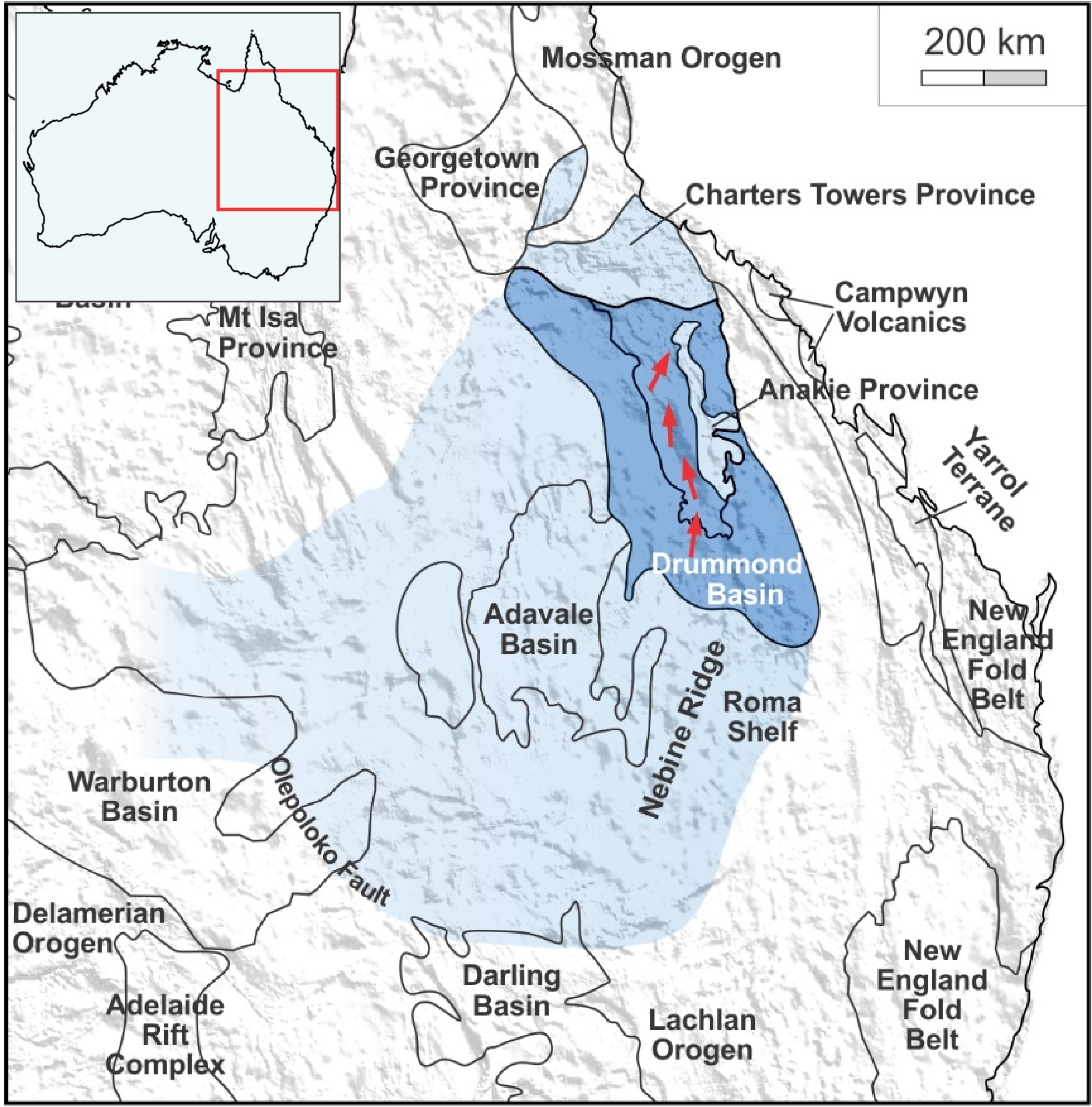
1. Contemporary volcanism (<350 Ma detrital zircons)
2. Remobilised local Cycle 1 volcanics (~350-360 Ma detrital zircons)
3. Basement igneous rocks (~360-500 Ma zircons, detrital mica)
4. Recycled metapelitic rocks (>500 Ma detrital zircons, detrital rutile)



Source region for the Cycle 2 and 3 succession



Pascal Asmussen, unpublished data



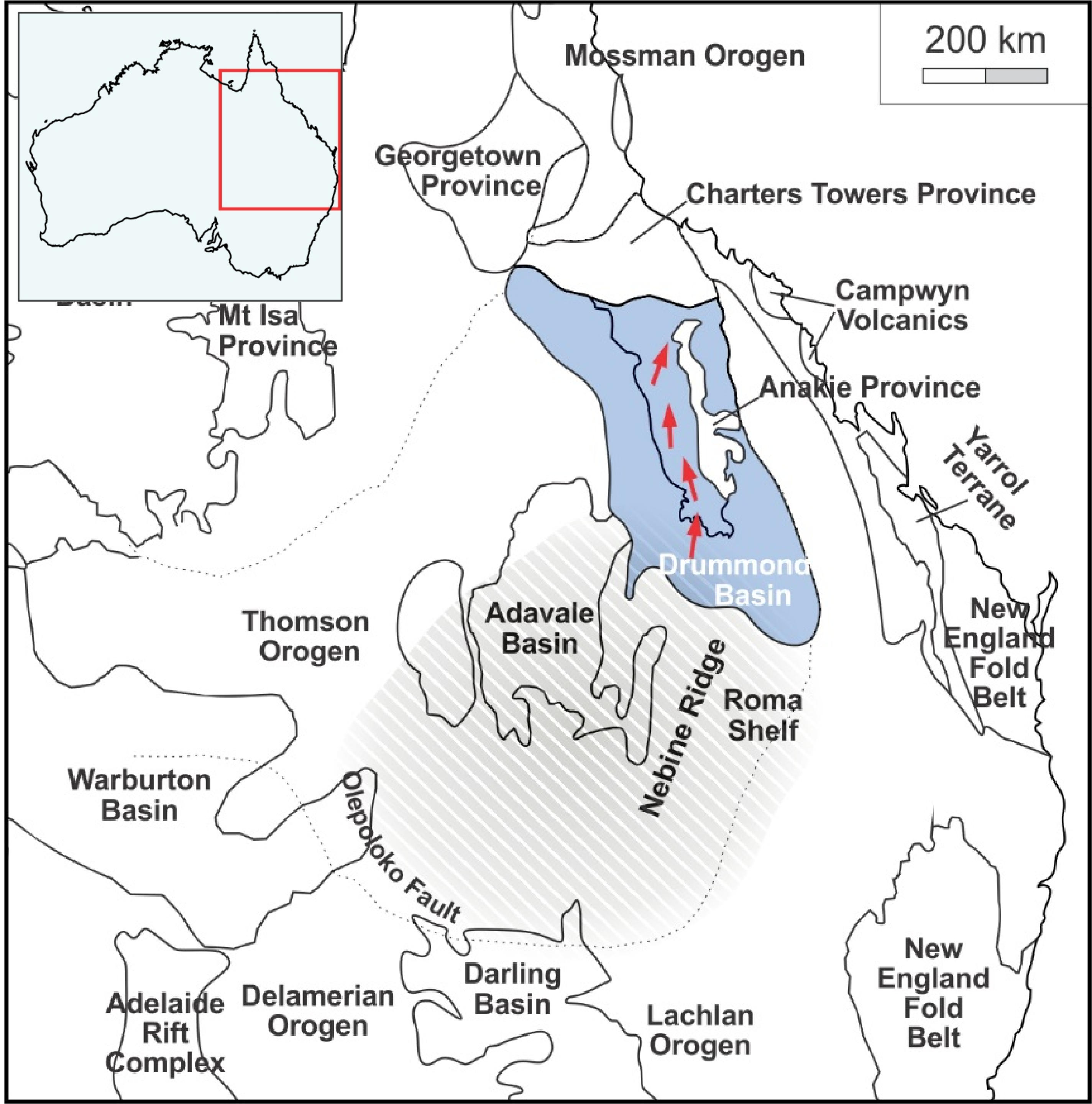
Source region for the Cycle 2 and 3 succession

Proposed source region located in central, S and E Thomson Orogen

Thomson Orogen is largely concealed under a thick Permo-Mesozoic sedimentary cover,

but

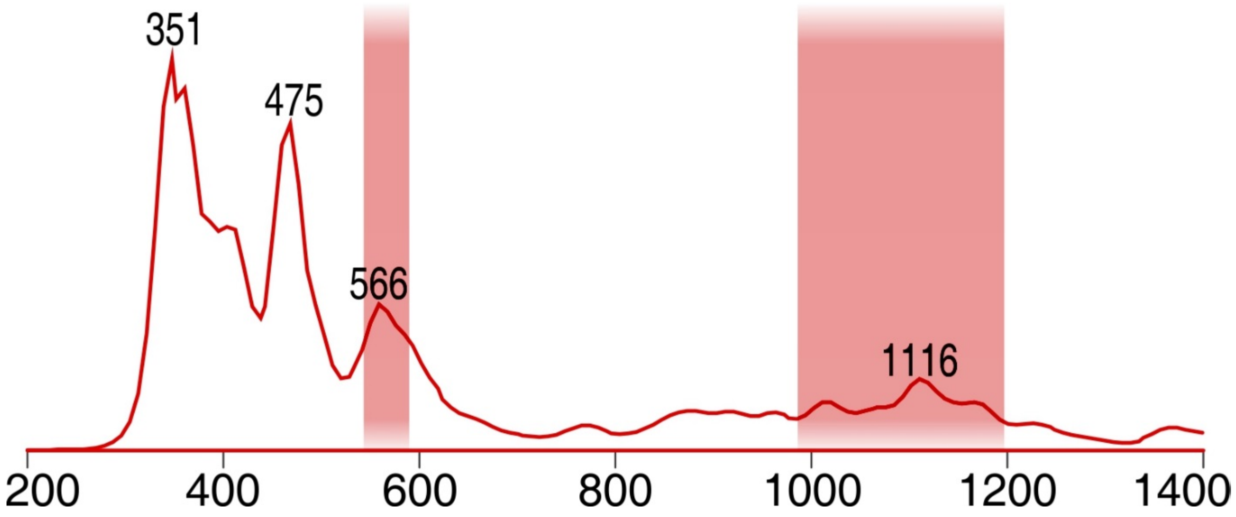
A growing drill core database of primary and detrital U-Pb zircon ages exists

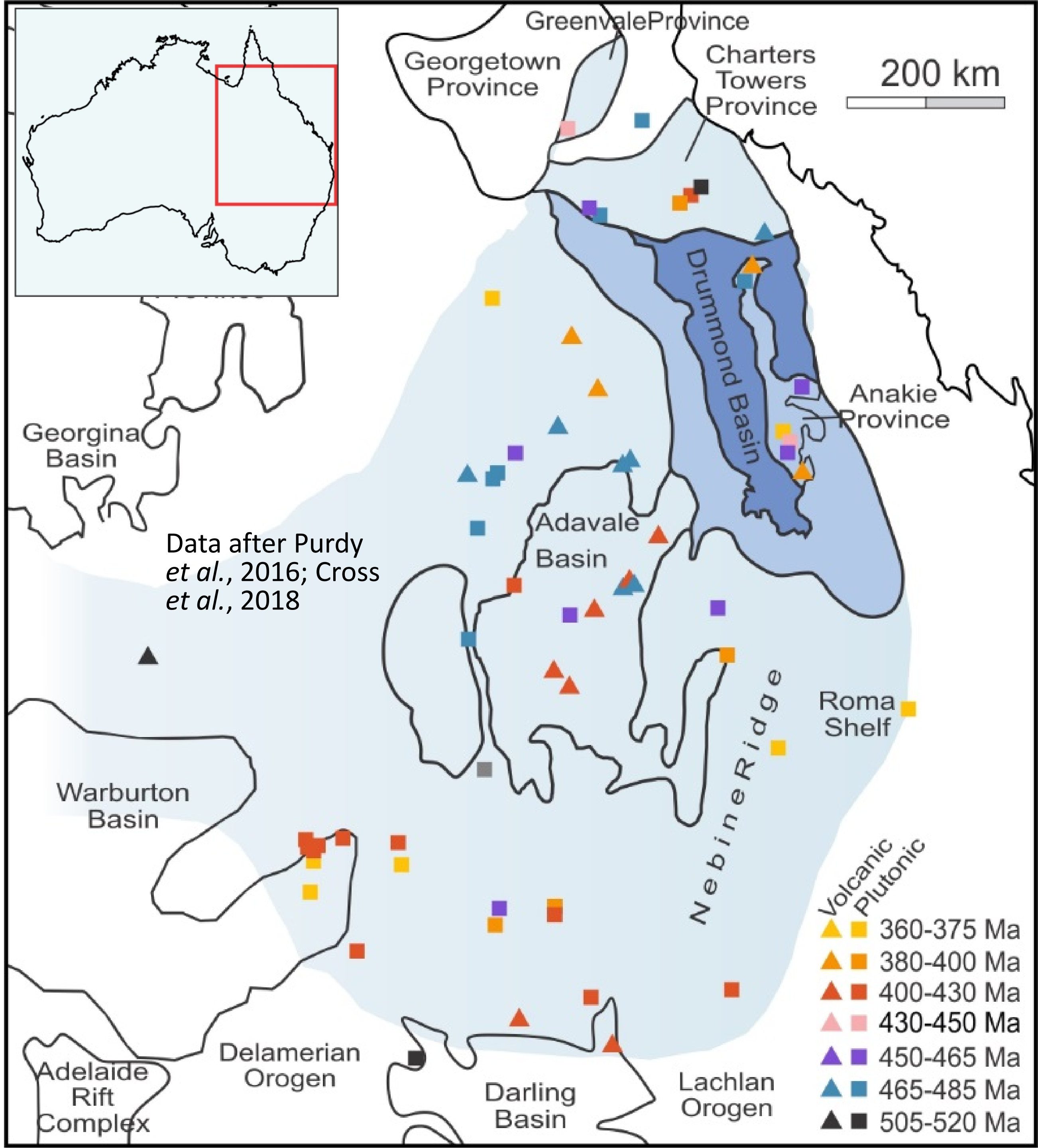


Thomson Orogen basement igneous sources

Early Ordovician and Devonian S-type granites and volcanics present in the source area

Absence of ~430-450 and ~500-550 Ma ages in both the Drummond Basin and the source region

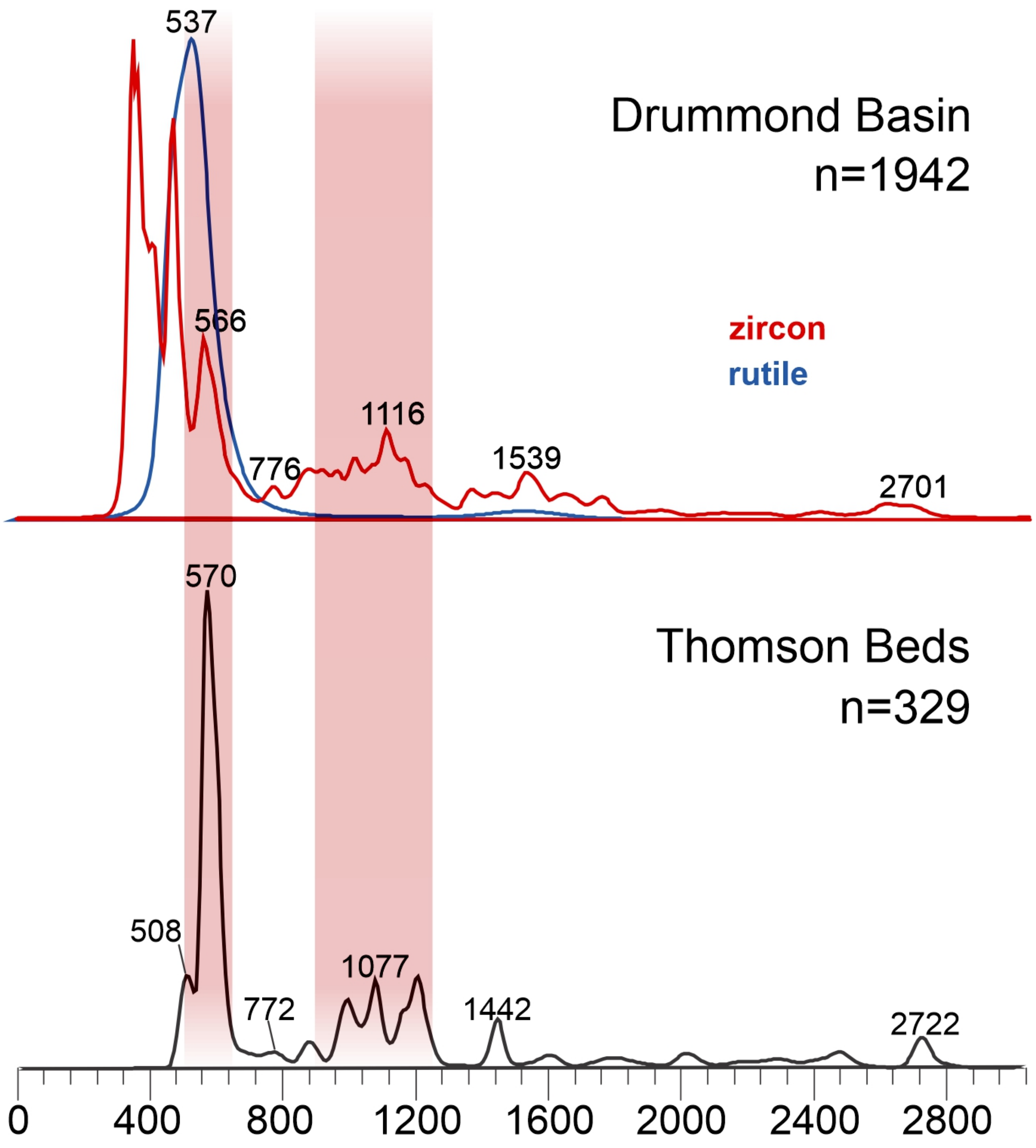




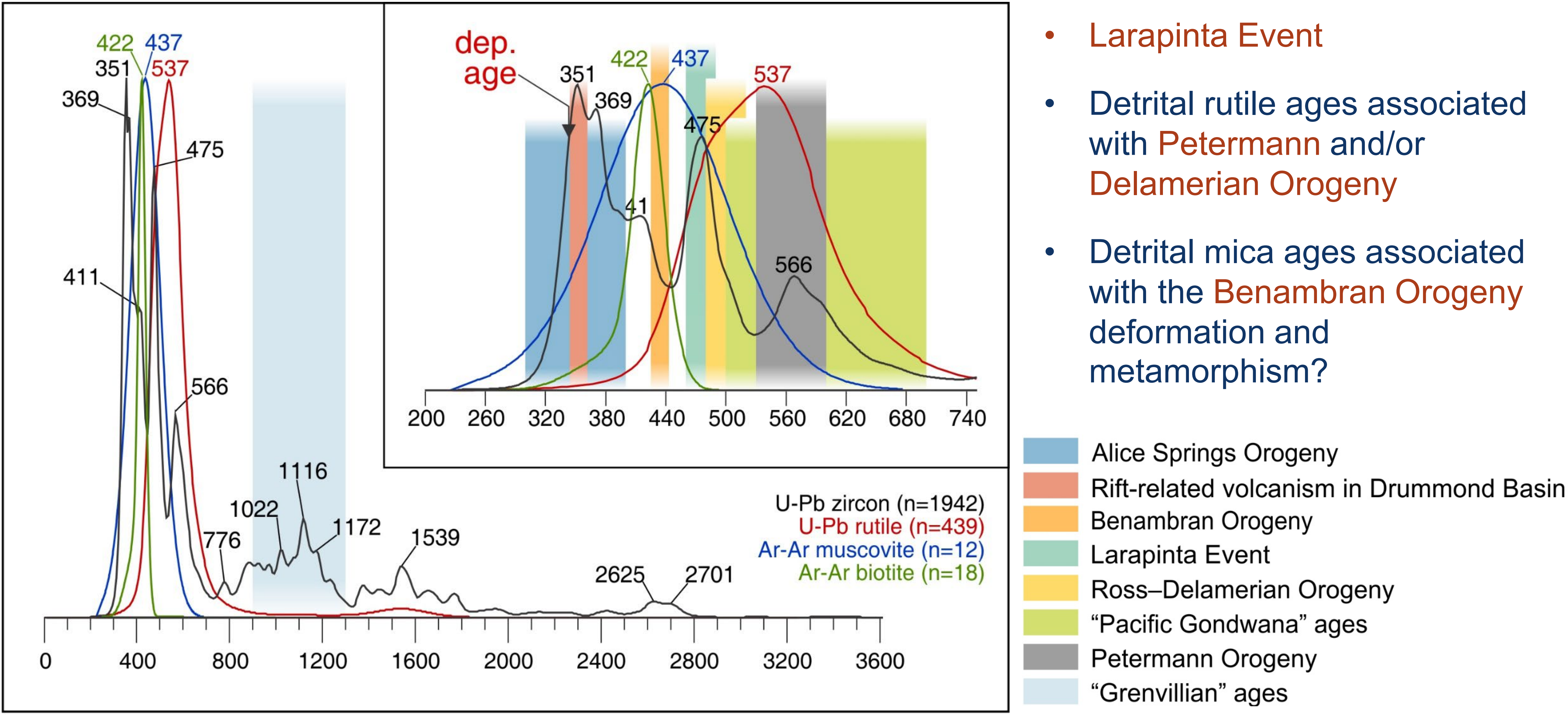
Recycled sedimentary sources

- Pacific-Gondwana, Grenvillean and older ages in the Drummond Basin – sourcing from the Thomson metasediments in the E and S Thomson Orogen
- No major contribution from the N Thomson, Lachlan or Delamerian orogens.

Data after Purdy *et al.*, 2016



Source region possibly influenced by several tectonic events:



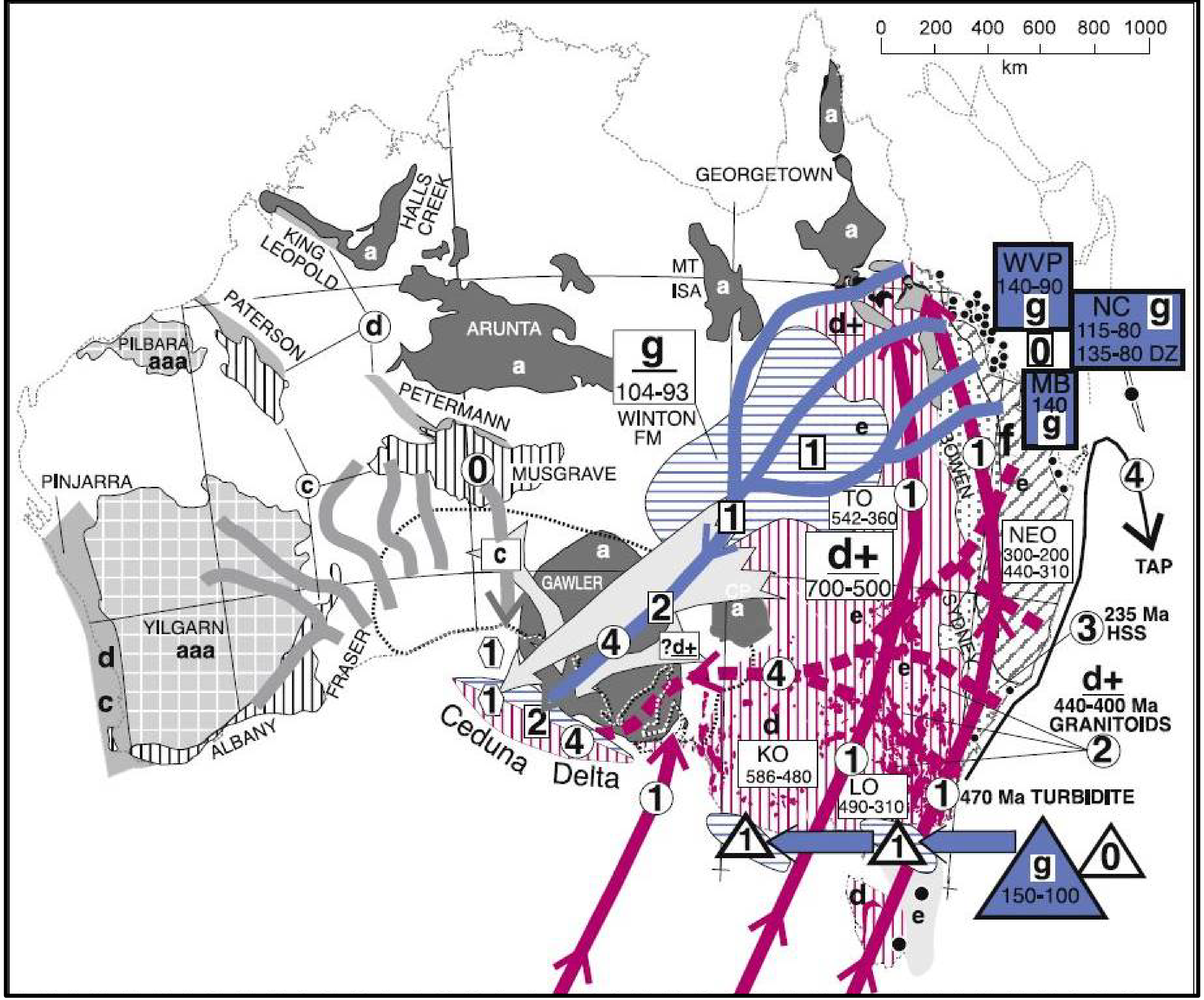
- Larapinta Event
- Detrital rutile ages associated with Petermann and/or Delamerian Orogeny
- Detrital mica ages associated with the Benambran Orogeny deformation and metamorphism?

Key Conclusions

- Long-distance transport (>>470 km) of high loads of coarse-grained sediment.
- Cycle 2 and 3 succession sourced mainly from central, E and S Thomson Orogen basement.
- Source region possibly affected by several tectonic events: Benambran Orogeny, Larapinta Event, Petermann and/or Delamerian Orogeny.
- Major provenance shift recorded between Cycle 1 and Cycle 2 in the Drummond Basin, caused by a sudden influx of extrabasinal, basement-derived material.
- Basin evolution altered by an external tectonic event, causing it to deviate from a typical rift basin model → deposition in sedimentary basins is not only controlled by host basin dynamics, but can be overwhelmed by extrabasinal sediment supply if favourable sedimentary pathways exist.

References

- Carrapa, B. (2010). Resolving tectonic problems by dating detrital minerals. Geology 38(2): 191-192.
- Henderson, R. A. & P. R. Blake (2013). Drummond Basin. Geology of Queensland. Jell, P. A., Geological Survey of Queensland: 189-196.
- Purdy, D. J., Cross, A. J., Brown, D. D., Carr, P. A. & Armstrong, R. A. (2016). New constraints on the origin and evolution of the Thomson Orogen and links with central Australia from isotopic studies of detrital zircons. Gondwana Research 39: 41-56.
- Sobczak, K., Bryan, S. E., Fielding, C. R. & Corkeron, M. (2019). From intrabasinal volcanism to far-field tectonics: causes of abrupt shifts in sediment provenance in the Devonian–Carboniferous Drummond Basin, Queensland. Australian Journal of Earth Sciences 66(4): 497-518.



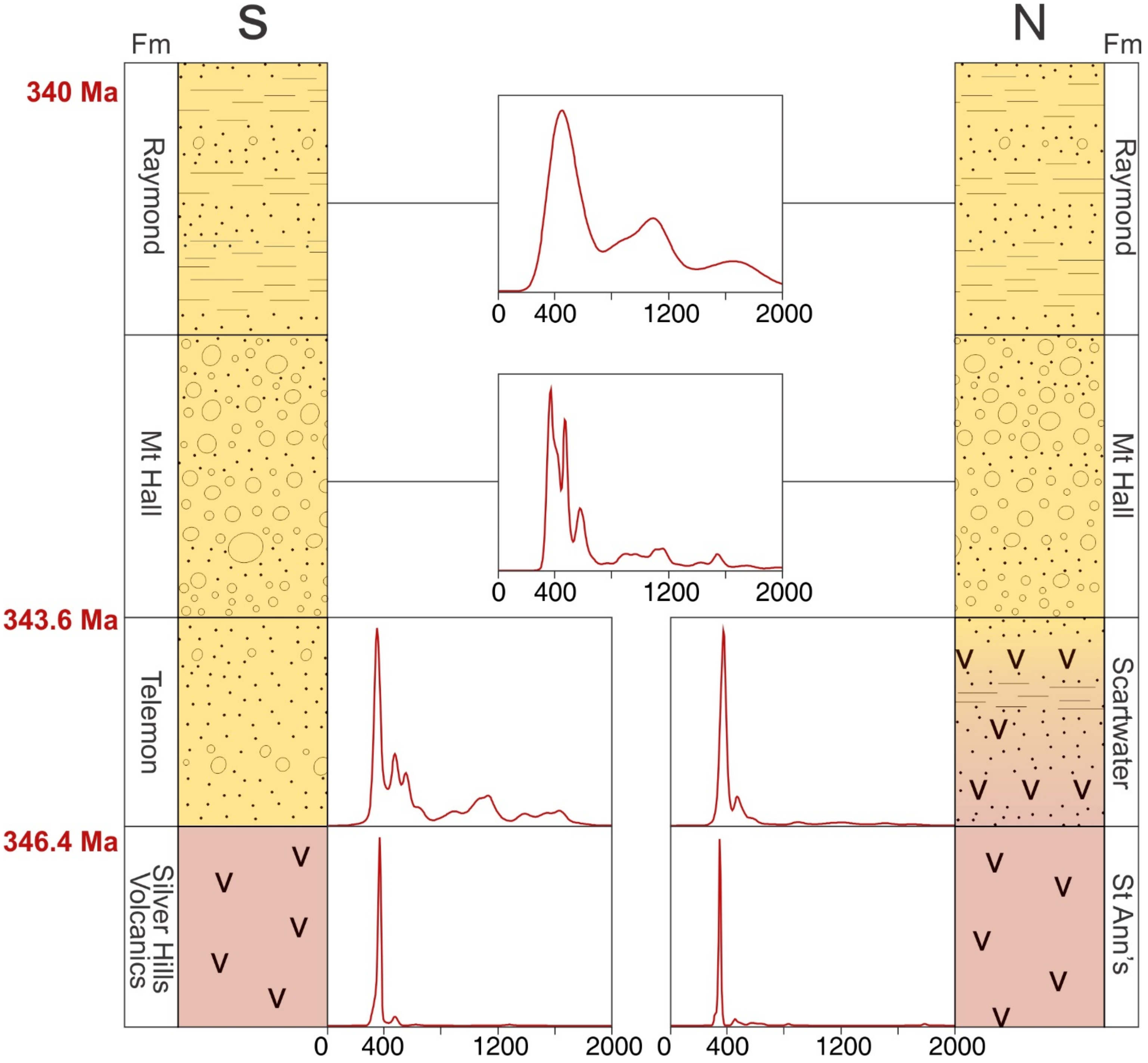
Veevers *et al.*, 2016

Antarctica, Transgondwanan Supermountains

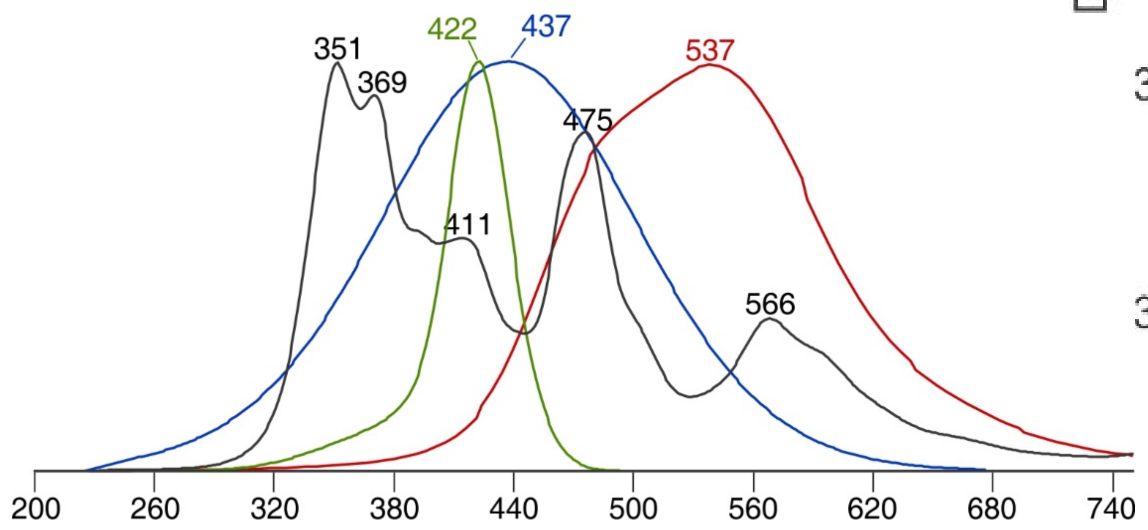
Cycle 1/Cycle 2 transition

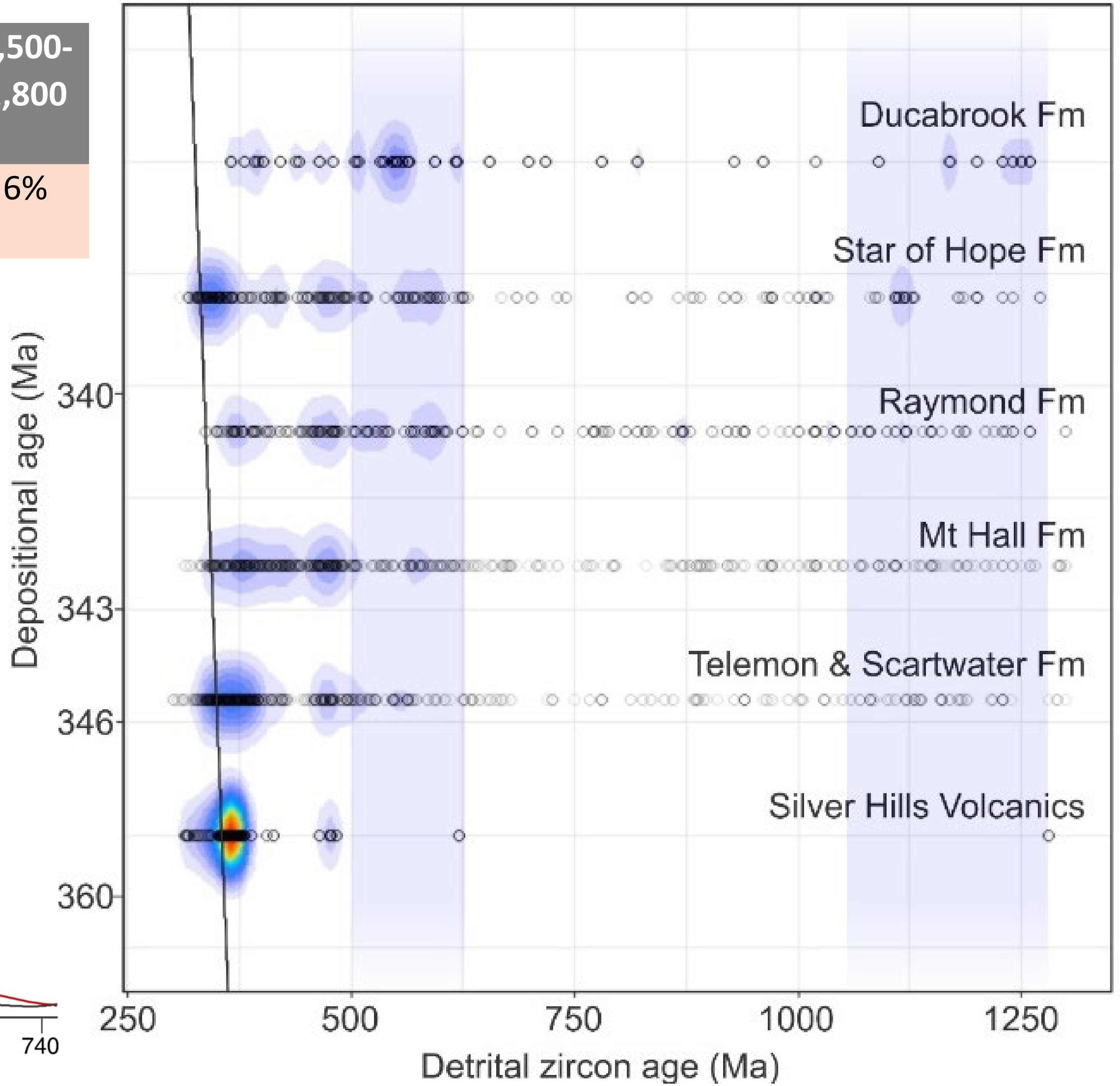
- Telemon Fm (S basin) dominated by older ages
- Scartwater Fm (N basin) dominated by younger ages (recycled Cycle 1 sourcing)

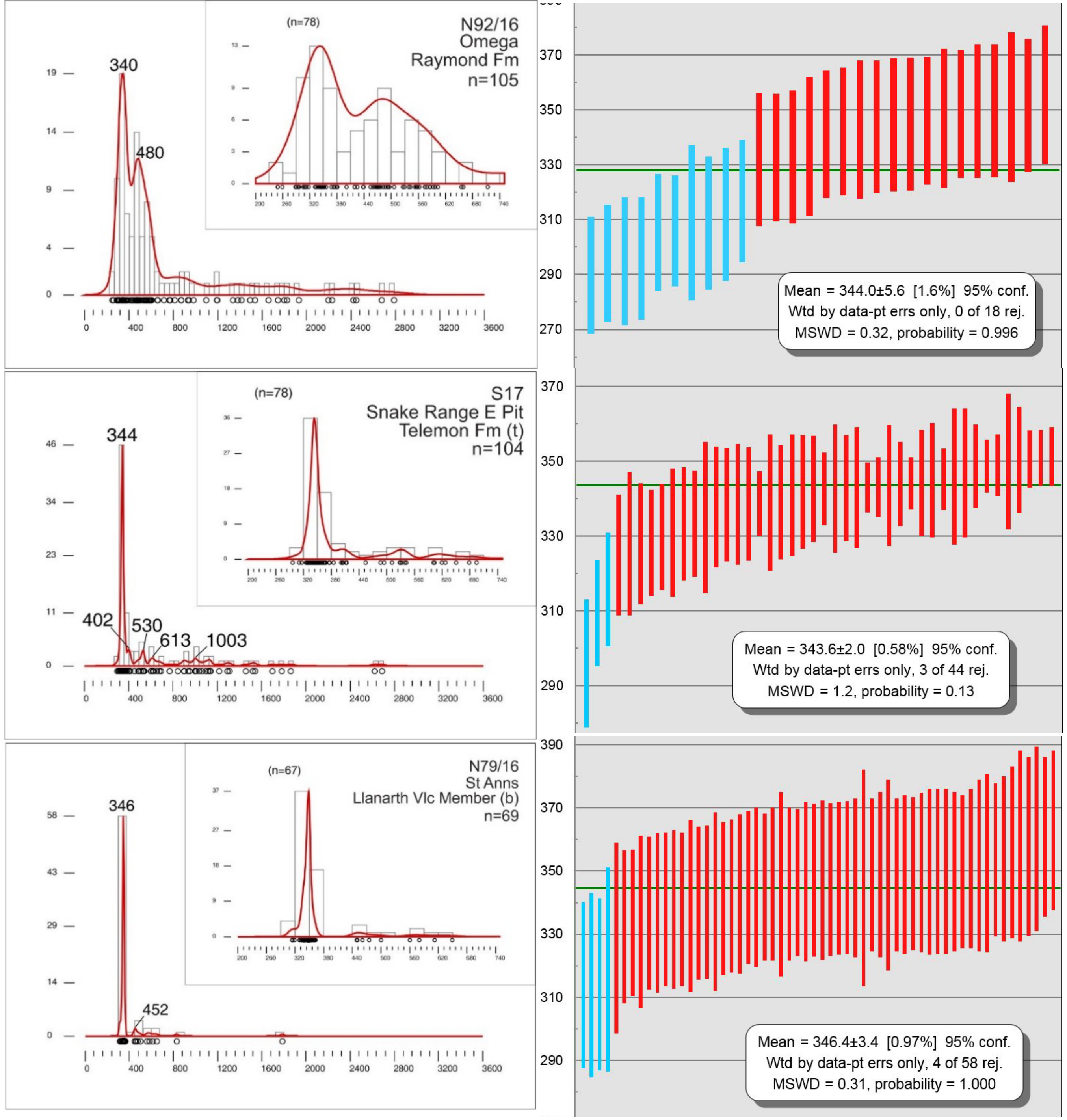
Cycle	Th [ppm]	U [ppm]	Th/U
3	185	333	0.56
2	184	285	0.65
1	390	421	0.93



Age population [Ma]	<355	365-375	468-482	500-650	900-1,250	1,500-1,800
% of all ages	10%	6%	5%	14%	15%	6%







U-Pb zircon dating of interbedded tuffs

- Depositional age constraints: 346.4 – 340 Ma
- Syn-depositional volcanic input: <350 Ma

Detrital rutile data