APPEA 2021

Sediment provenance analysis of the Permian from the Perth Basin using an automated Raman heavy mineral technique

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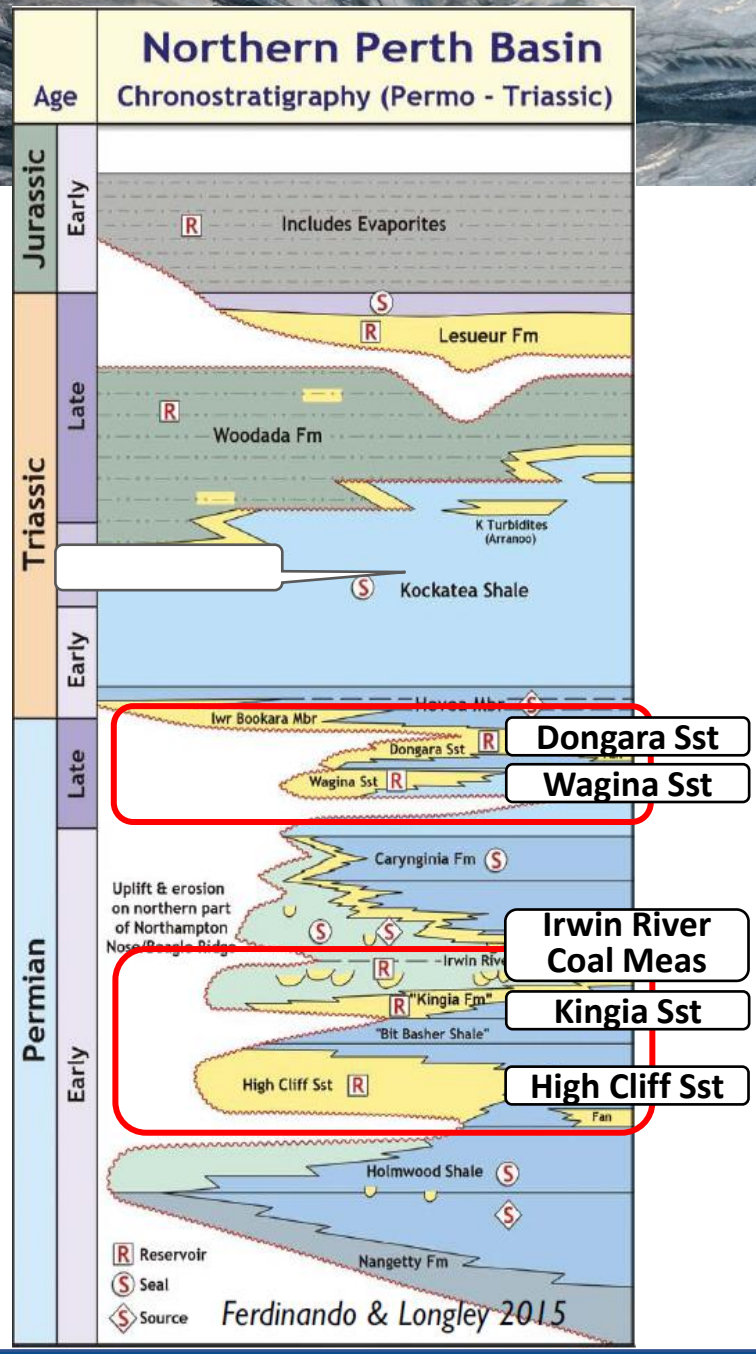
Objectives

Project Background

- Provenance history of North Perth Basin Permian sediments poorly understood
- Abundance of opaque material and variable HM returns made identification and obtaining viable sample numbers problematic

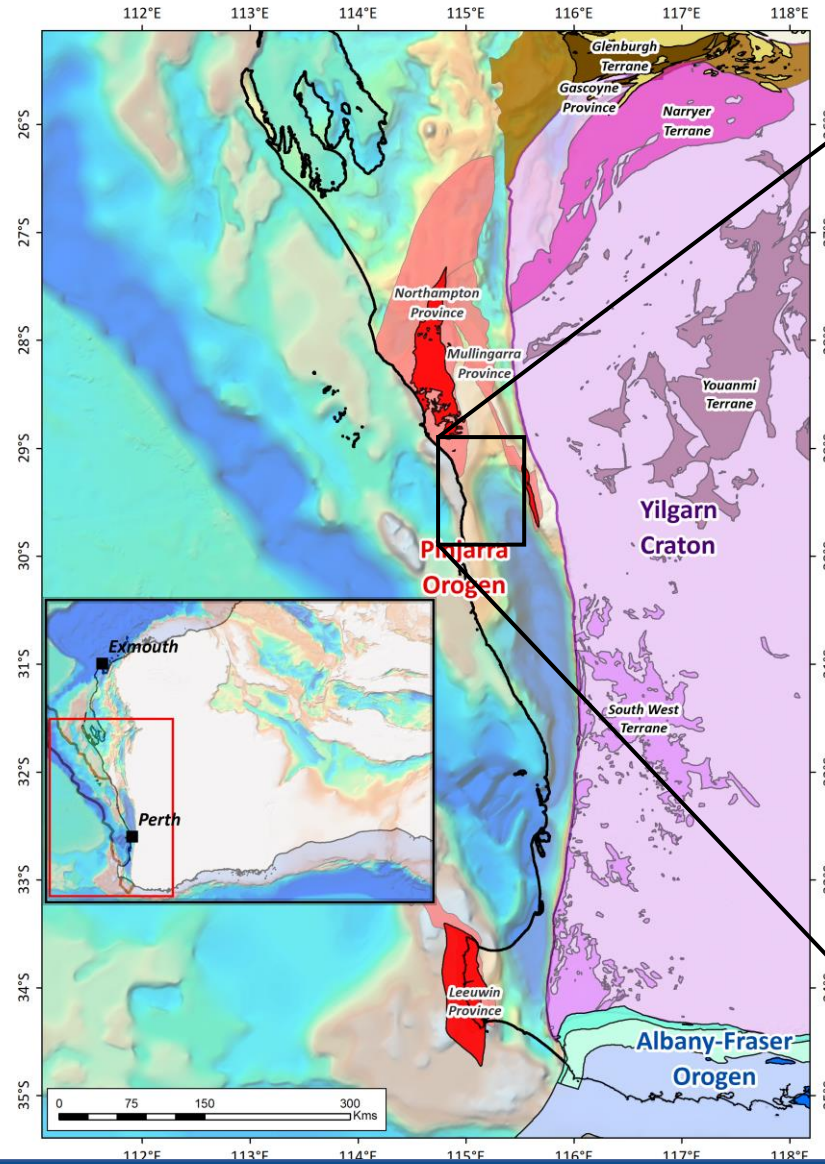
Objectives

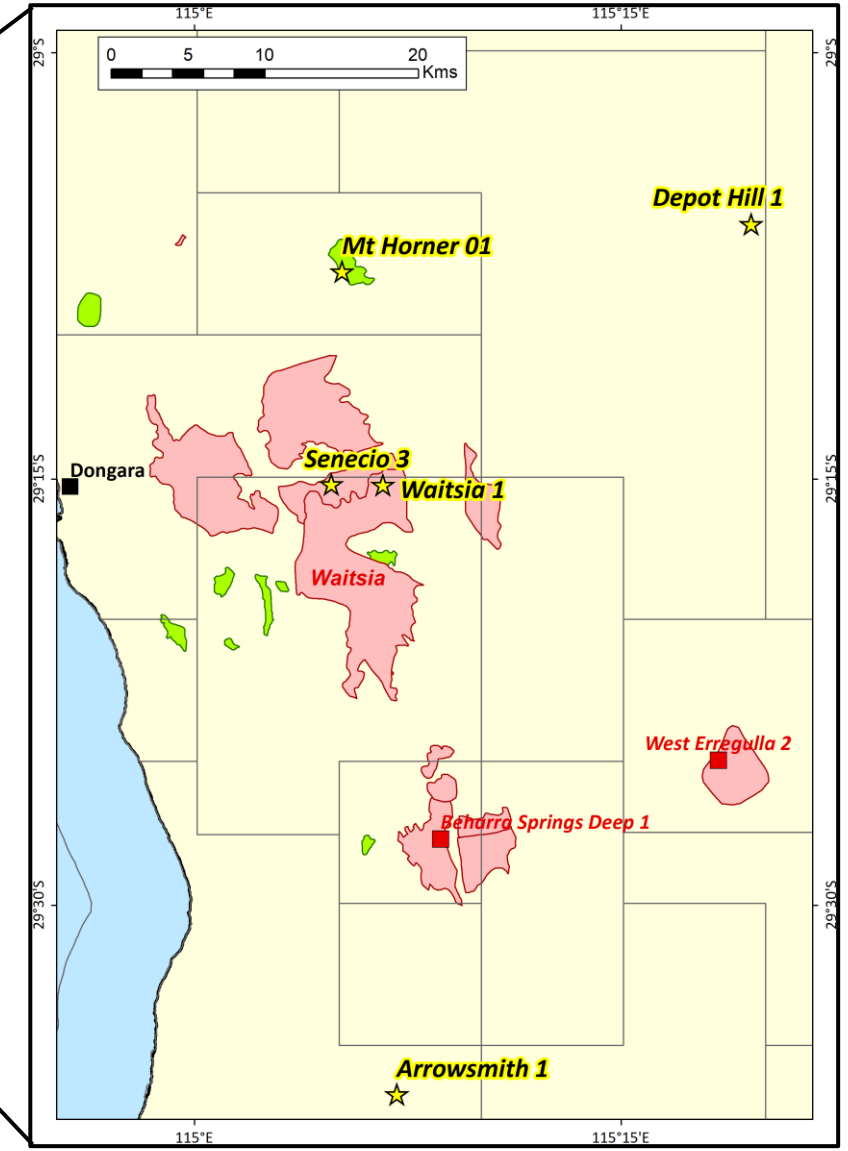
- Trial Raman spectroscopy heavy mineral identification
- Integrate with ICP-OES/MS elemental and detrital zircon data to elucidate stratigraphic and spatial changes in Permian reservoirs



Study Area

- Onshore North Perth Basin, Early Permian play fairway
- Northern end of Dandaragan Trough
- Surrounded by Archean and Proterozoic terranes
- Underlain by highly segmented Mesoproterozoic basement





(OZ SEEBASE® 2021)

In-house Raman Spectroscopy

- A molecule scatters incident light from a high intensity laser light source
- A small amount of light is scattered at different wavelengths to the source – termed Raman Scatter
- Based on chemistry and structure of HM, thus Raman can differentiate:

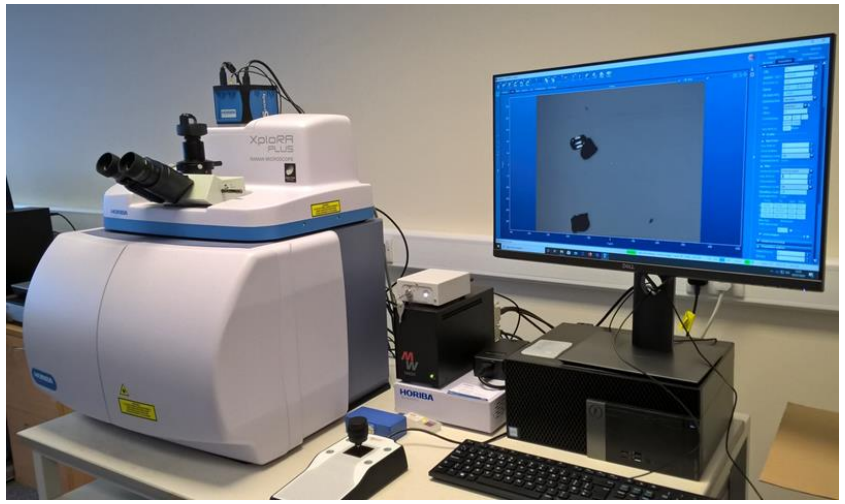
  Solid solutions (e.g., garnet end-members)

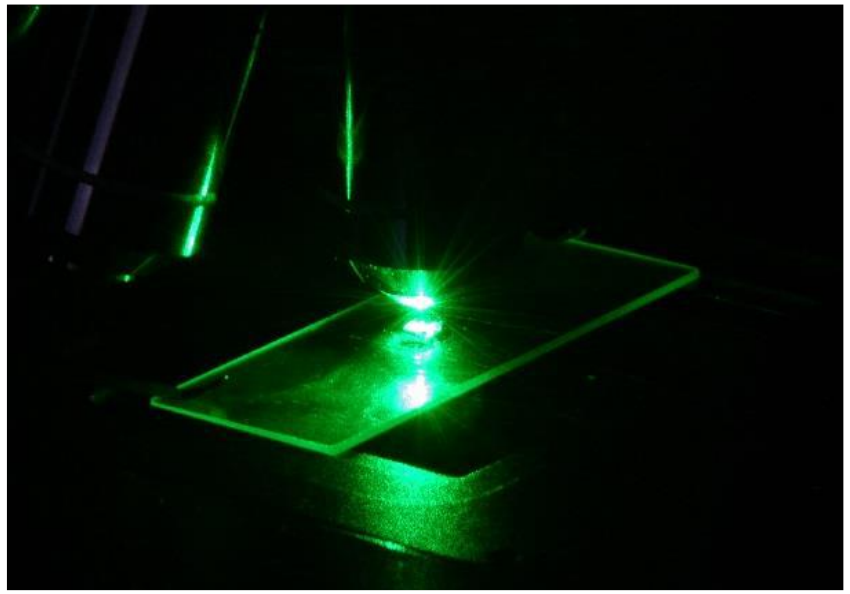
  Polymorphs (e.g., TiO_2 HMs)

  Translucent HMs with similar optical properties (e.g., apatite vs. baryte)

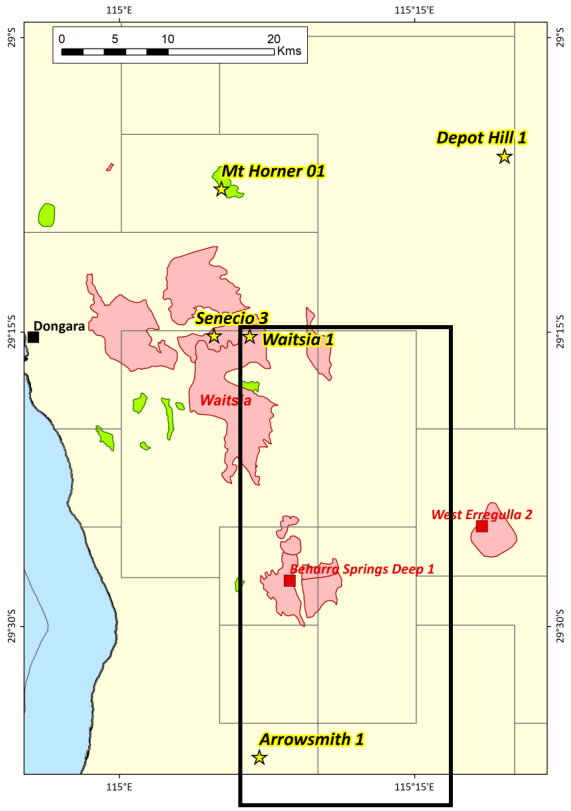
  Opaque grains (e.g., chrome spinel, altered rutile)

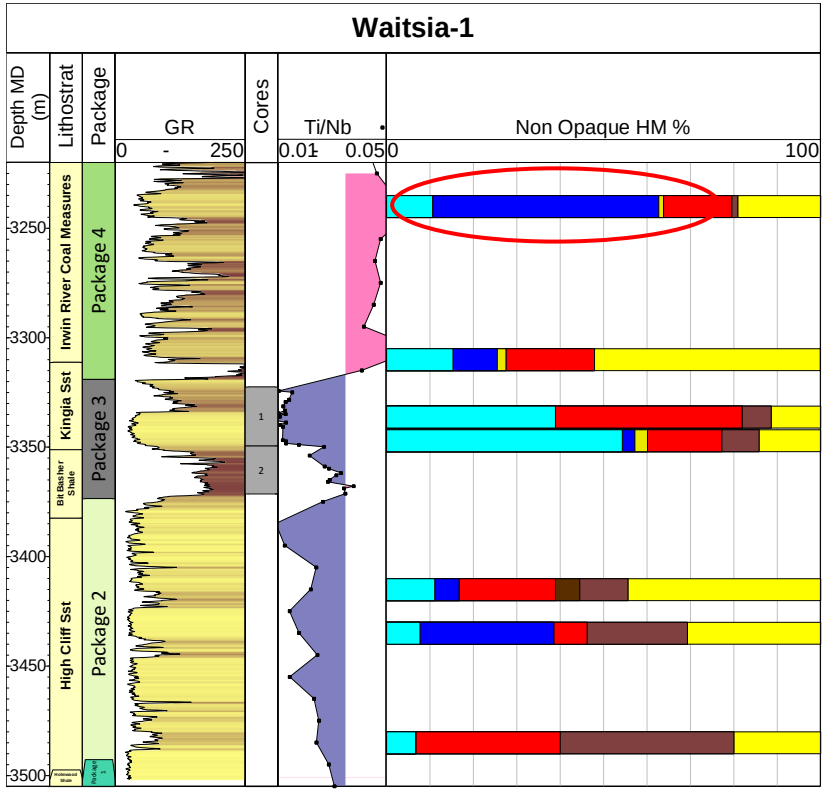
- Cost and time effective as fully automated (both spectra acquisition and spectra matching)
- Analysis of sands and silts, removes operator bias

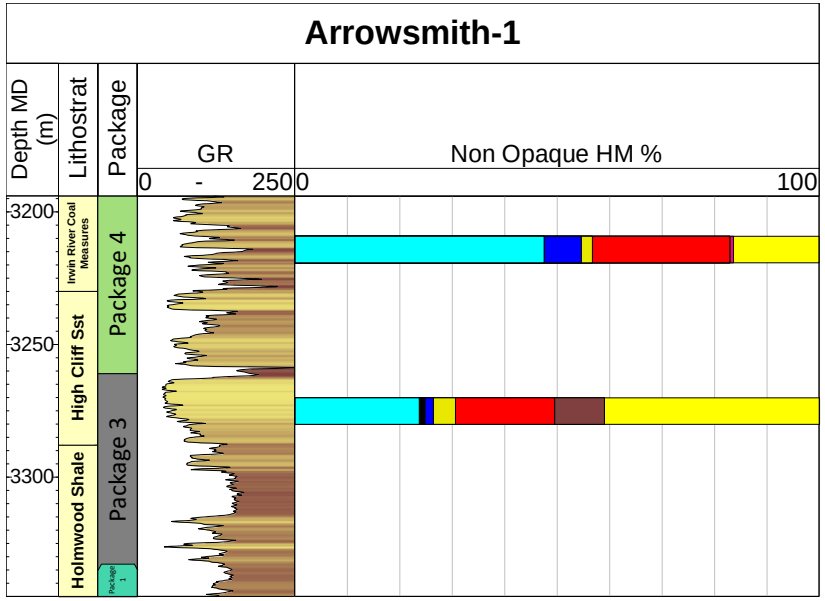


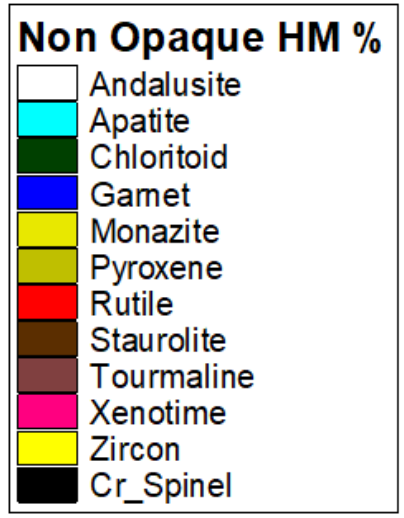


Raman Results
Kingia / High Cliff Sst (South)



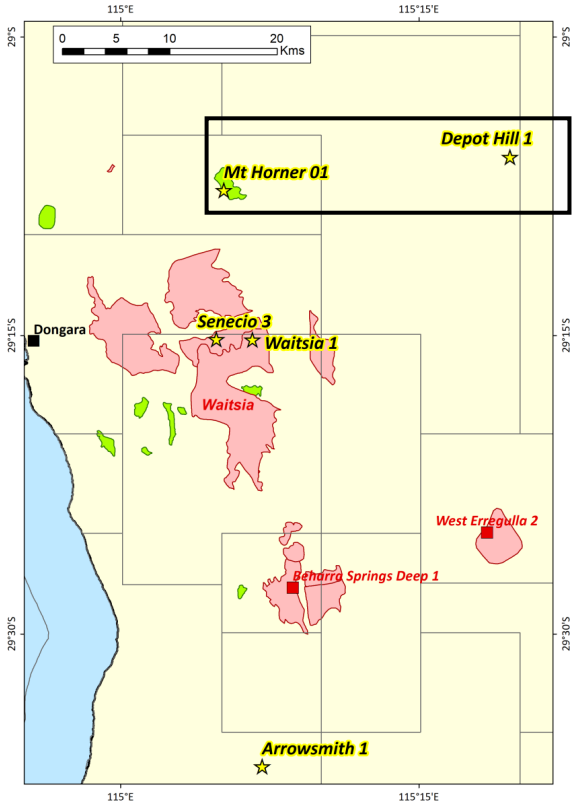


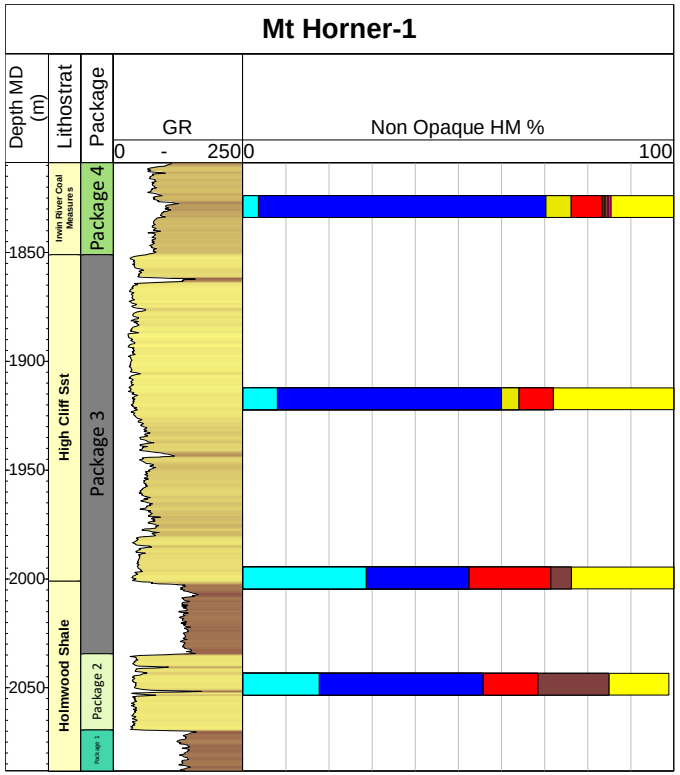


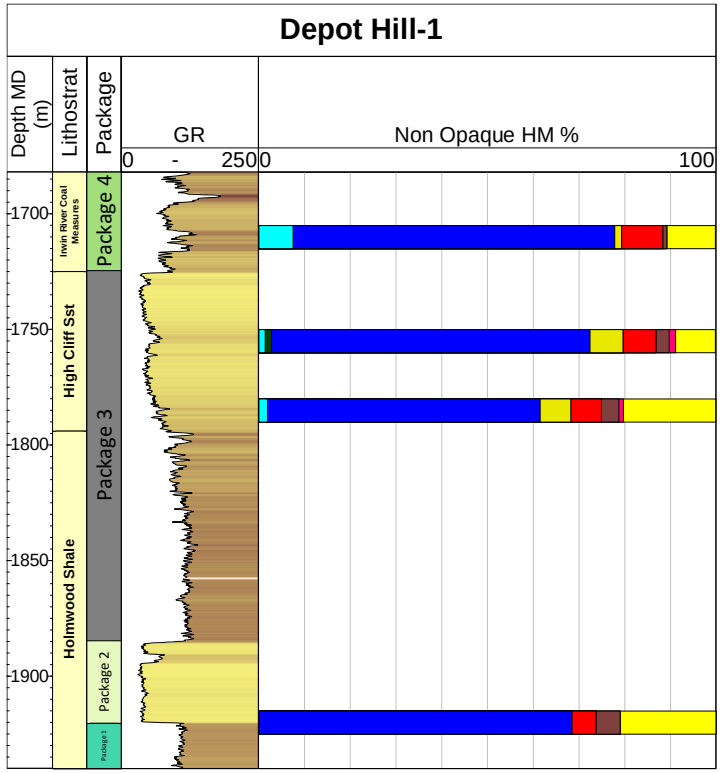


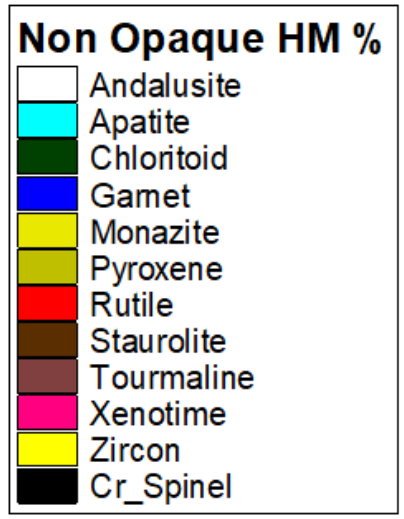
- High rutile and zircon, decreasing tourmaline in High Cliff Sst
- High apatite (relative low zircon) in Kingia Sst
- The apatite rich Kingia Sst would suggest a granitoid source with input from ?recycled metamorphics (high rutile)

Raman Results
Kingia / High Cliff Sst (North)



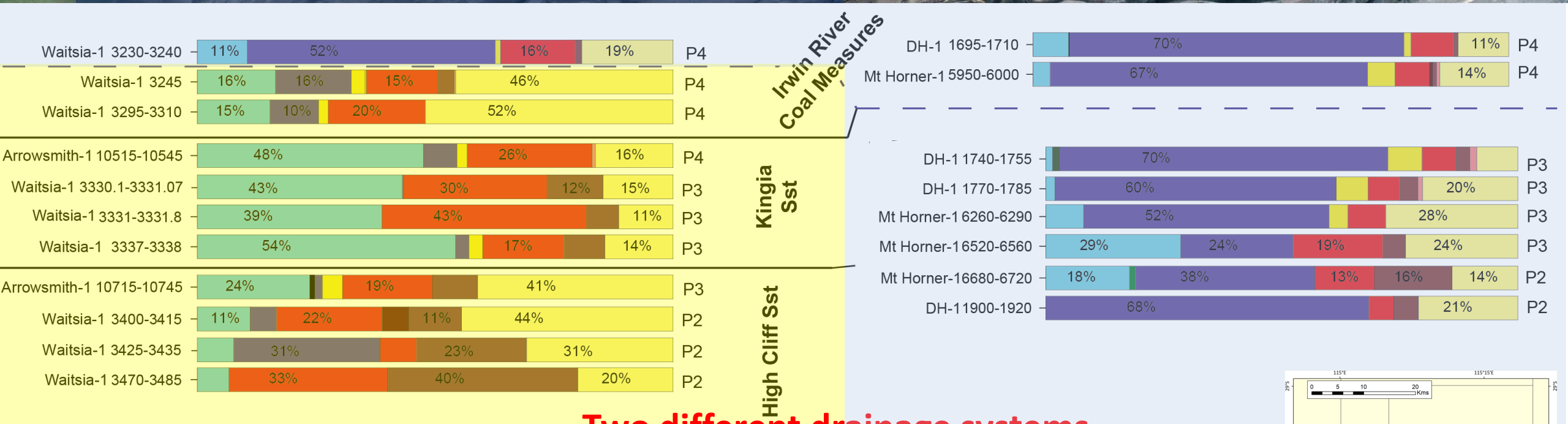






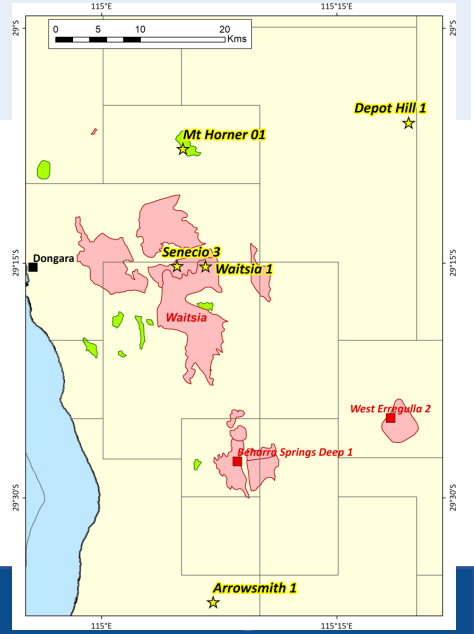
- Dominated by garnet
- Subordinate apatite and ultrastable HMs (ZTR)
- The garnet-rich nature would suggest metamorphic source

Early Permian Heavy Mineral Synthesis

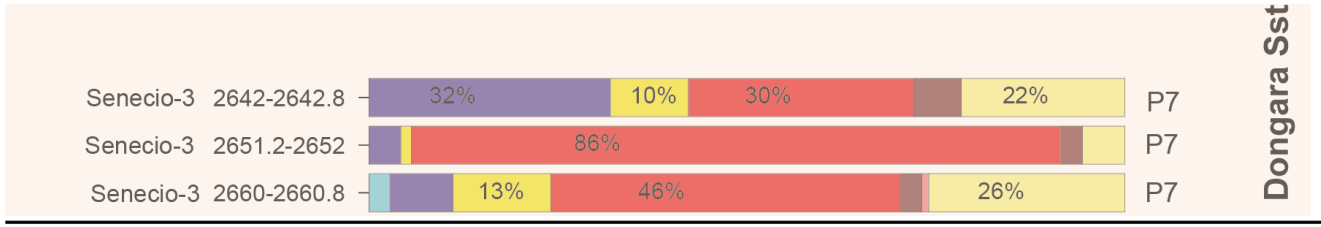


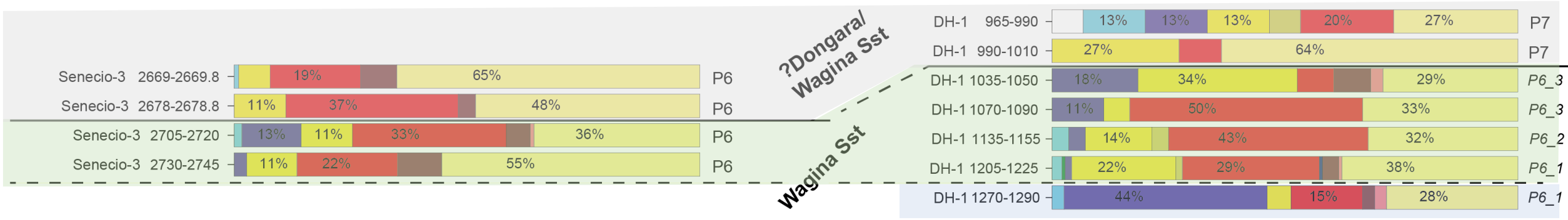
Two different drainage systems

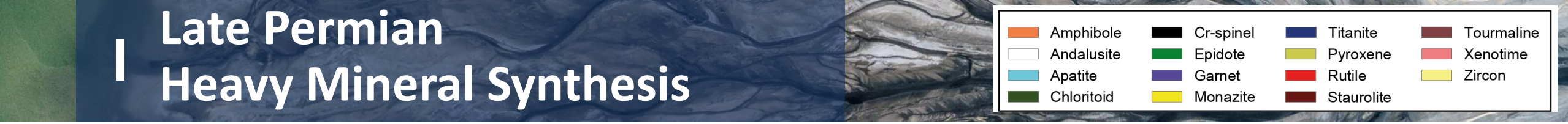
- Clear distinction in dominant provenance between south and north/northeast wells in Kingia & High Cliff Ssts
- Garnet-rich source active over all of the study area during early deposition of Irwin River Coal Measures



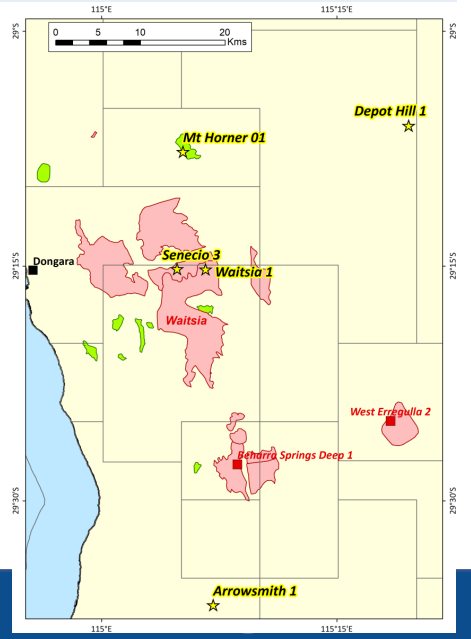
Late Permian Heavy Mineral Synthesis



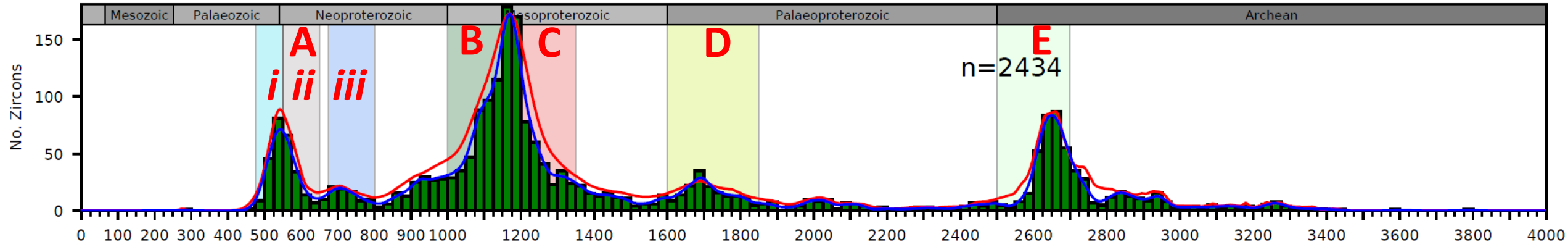




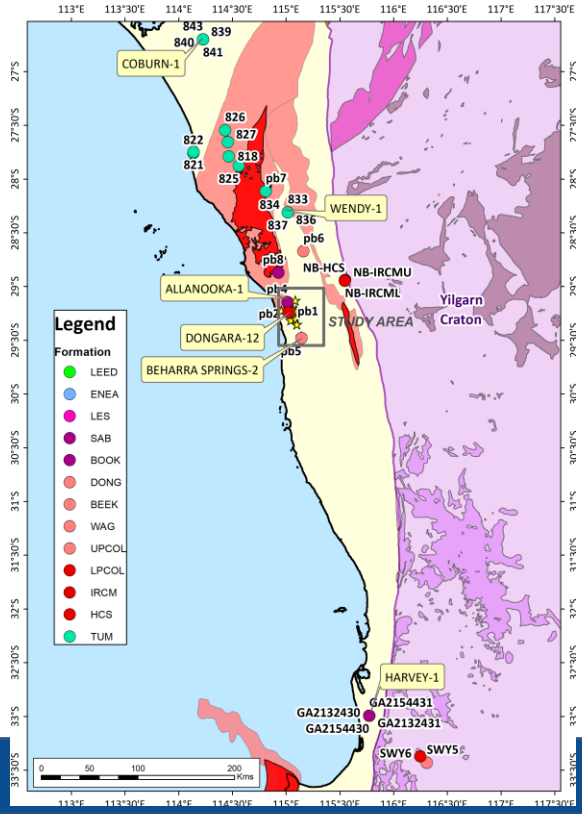
- Evolving Wagina Sst low – mod high garnet content, abundant monazite (and xenotime) rare earth phosphates
- Increasing zircon content in upper Wagina Sst
- Senecio-3 (Dongara Sst) rutile dominated



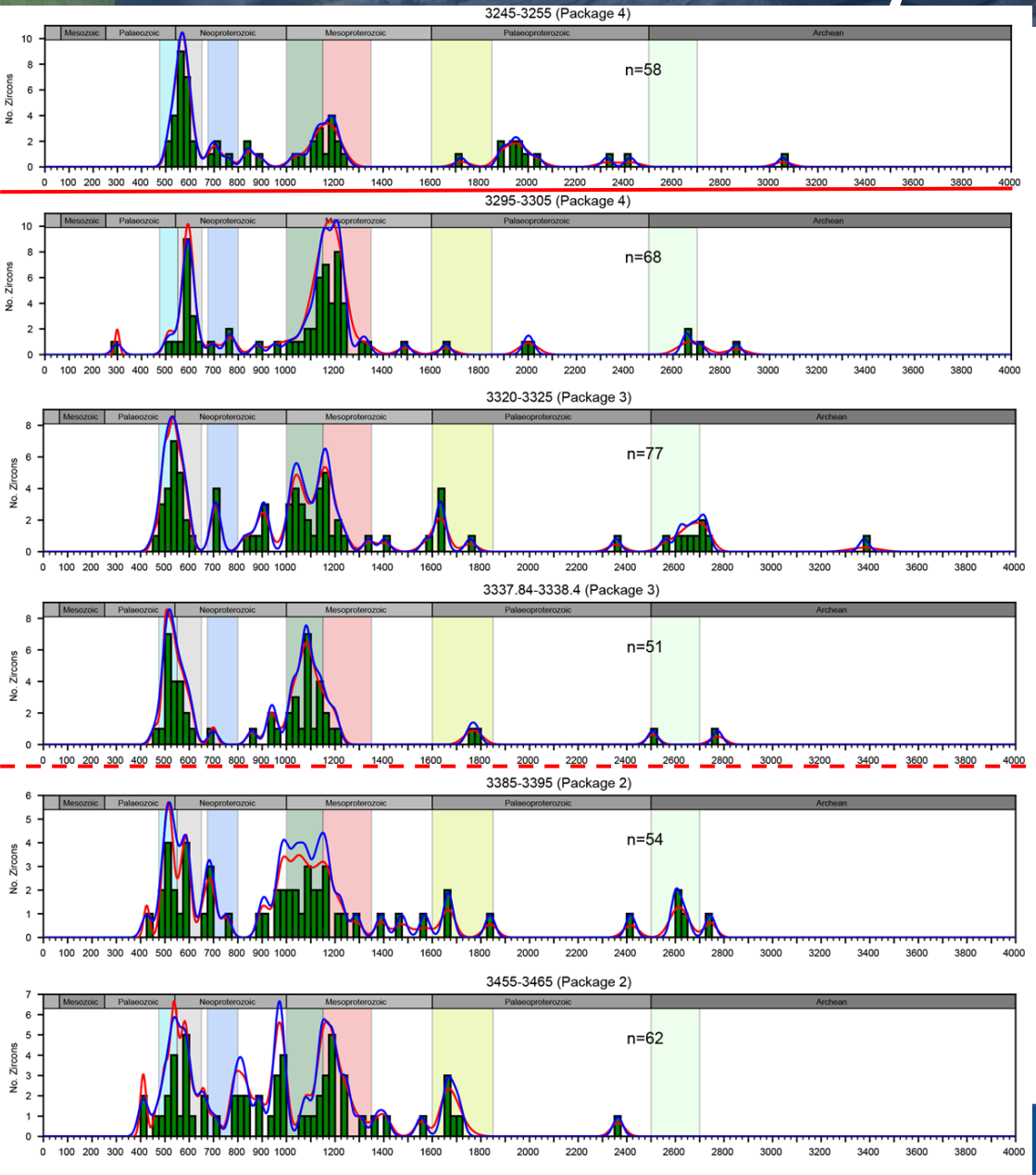
Perth Basin Detrital Zircon
All Published Data



- All published detrital zircon data (Olierook, 2019)
- Indicates contribution ultimately sourced from multiple Archean – Early Proterozoic terranes that surround and underly N Perth Basin
- Early Permian ‘rift axis’ sediments not represented



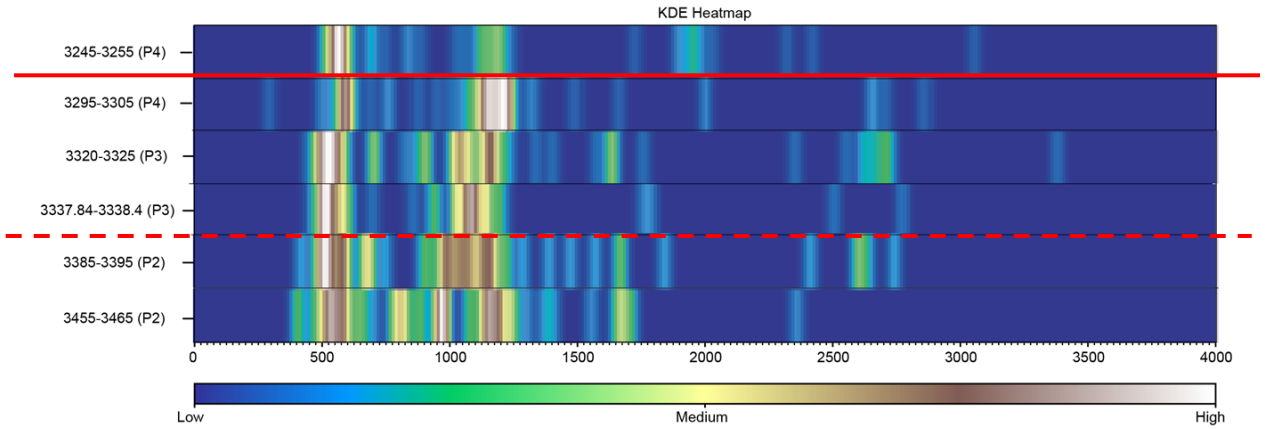
Waitsia-1
Detrital Zircon Analysis



IRCM

KINGIA

HIGH CLIFF



Kingia-High Cliff Sst

- Early Paleozoic population
- Mixed Late Meso-Early Neoproterozoic
- Minor Archean component only
- More scatter in the High Cliff Sst

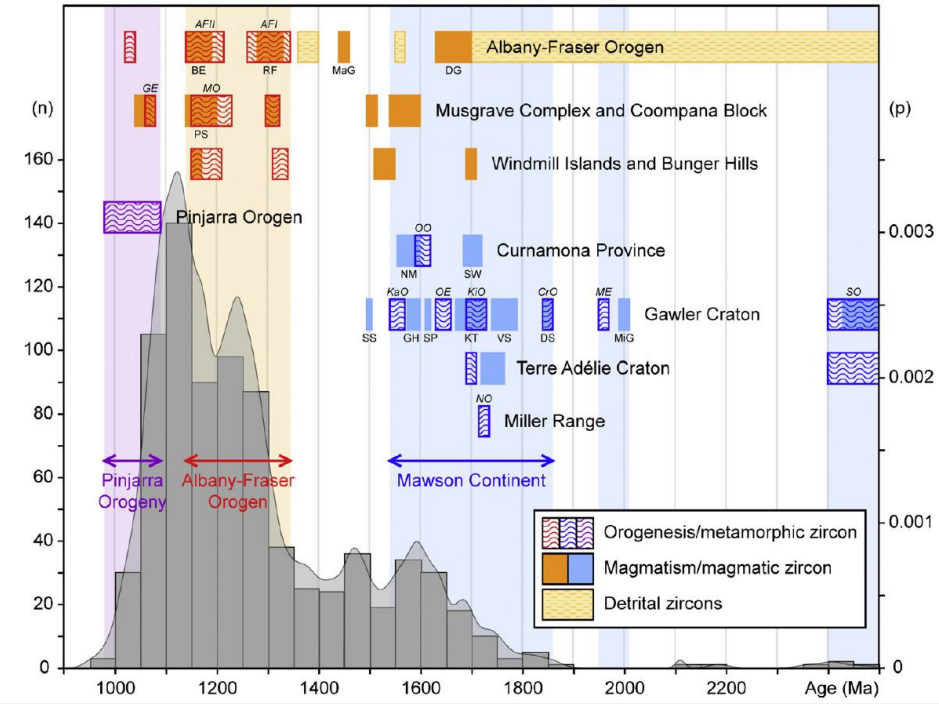
Irwin River Coal Measures

- Shift to Late Neoproterozoic dominant population at the top → coinciding with the significant increase in garnet

Perth Basin Basement

PINJARRA BASEMENT

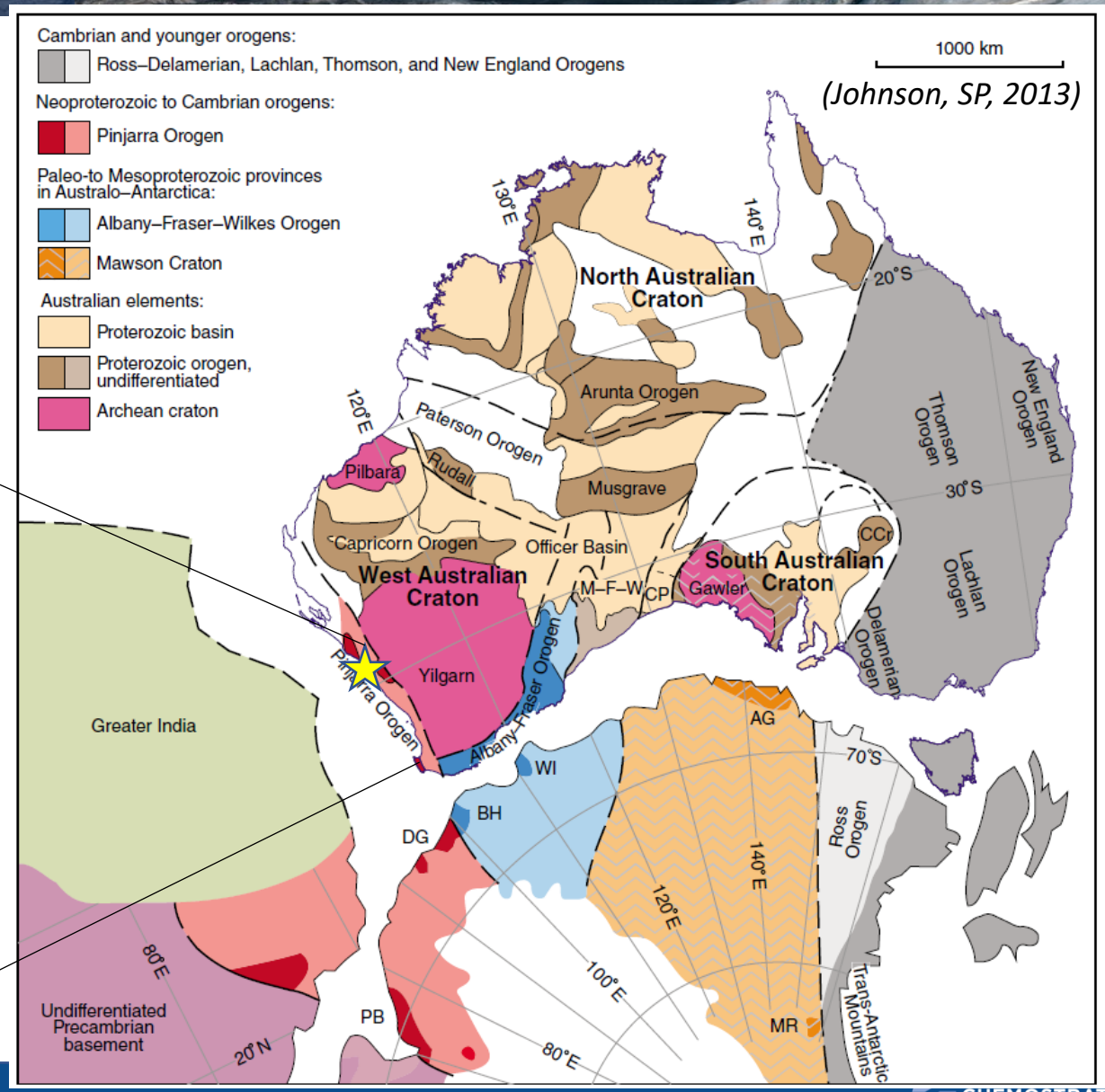
Isotopically consistent ortho /paragneiss basement. Detrital zircon data indicates Albany-Fraser inherited grains, eg Northampton Complex:



(Ksienzyk et al., 2012)

LEEUWIN COMPLEX

Activity resumed at c. 755 Ma with the intrusion of the voluminous granites. Late Neoproterozoic – Early Paleozoic high-grade metamorphic events record late stage amalgamation of Gondwana



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Summary

Conclusions

- Geochemical evidence for changes in provenance defining top Kingia Sst
- New Raman data successful in demonstrating multiple drainage systems sourcing Kingia-High Cliff Sst reservoirs
- Apatite dominated Kingia Sst to the south but garnet-rich facies in northern study wells that's observed in Waitsia in the Irwin River Coal Measures
- Waitsia-1 detrital zircon data dominated by Mesoproterozoic – Paleozoic populations that can be tied back to Pinjarra basement
- Late Permian has minor apatite and garnet, but abundant rutile, zircon and RE phosphates

Ongoing Work

- Part of ongoing multidisciplinary program to refine the sedimentary depositional systems of Late & Early Permian reservoirs

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