The complexity of sediment recycling as revealed by common Pb isotopes in K-feldspar

Presented by

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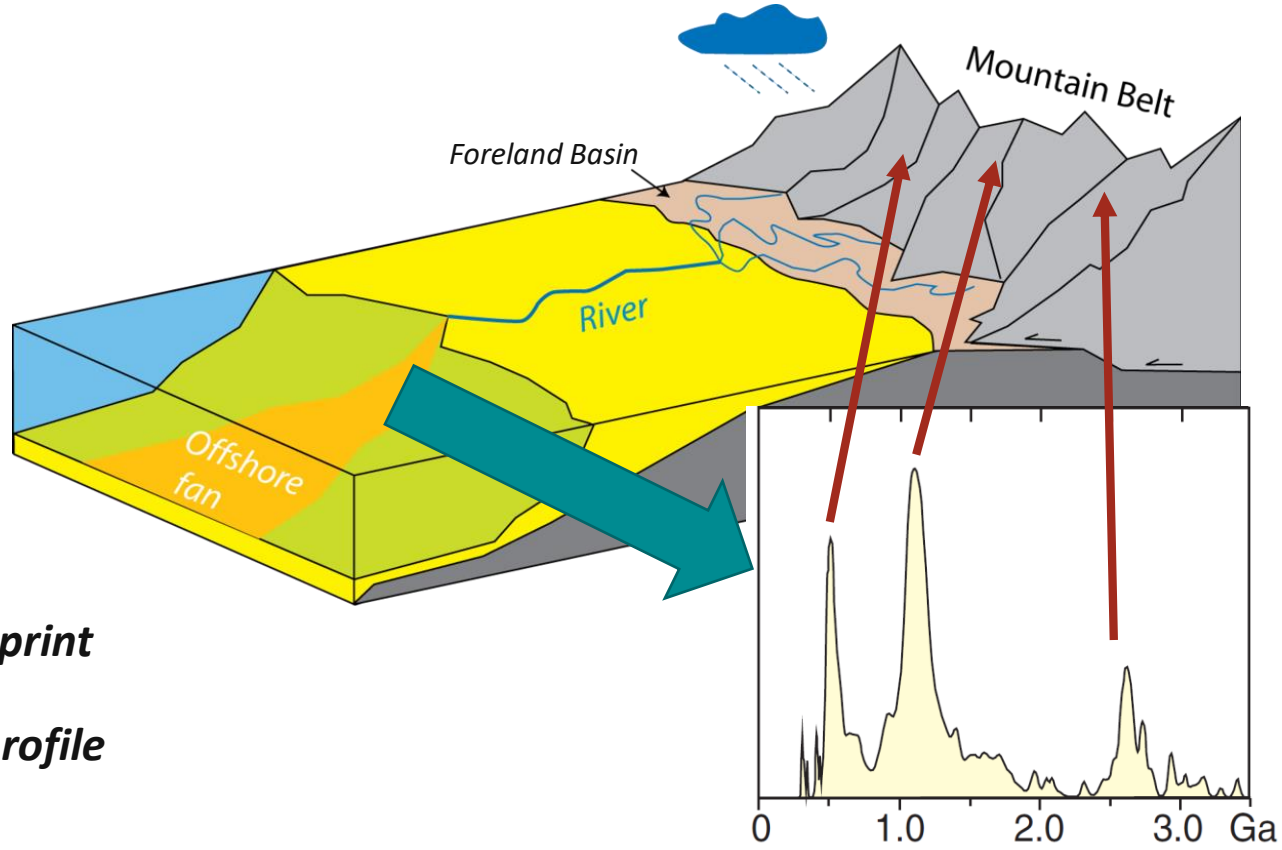
Sediment provenance

Provenance – determine the source region for the sediments = area of uplift and erosion (active tectonics)

- Zircon has become the provenance tool of choice
- Chemically and physically robust
- Match U–Pb ages to that in the source region (comparative technique)
  - Lu–Hf and O isotopic compositions
  - trace elements

– Fingerprint

DNA profile

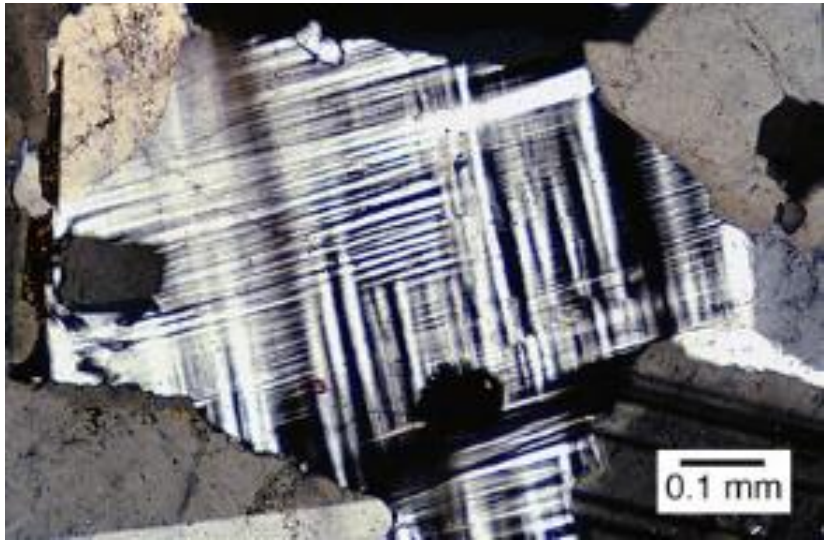


The chemical and physical robustness of zircon is its strength, but is also its weakness.

Once zircon is in the system it is ALWAYS in the system and is difficult to remove (multicycle).

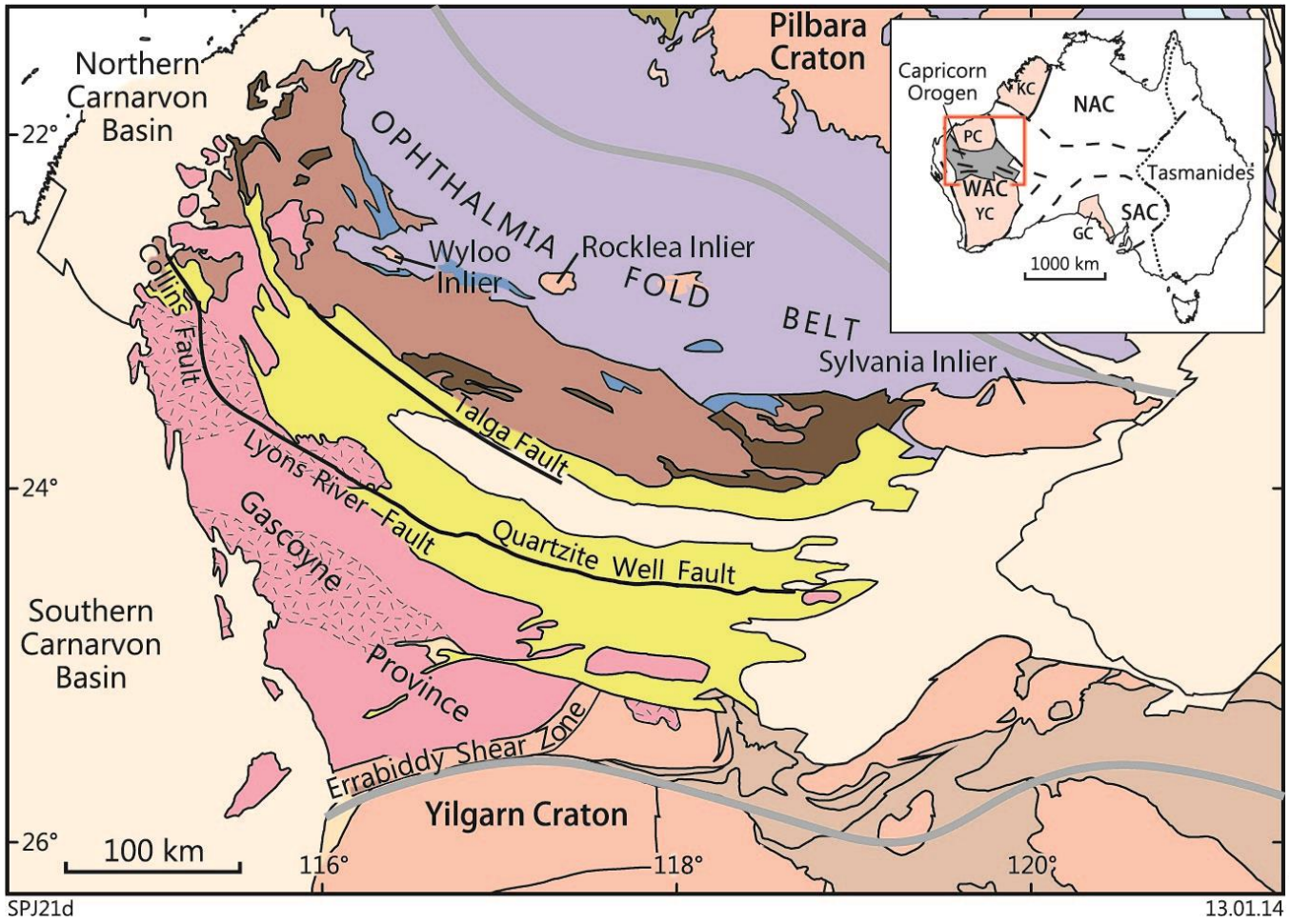
Pb isotopes of K-feldspar

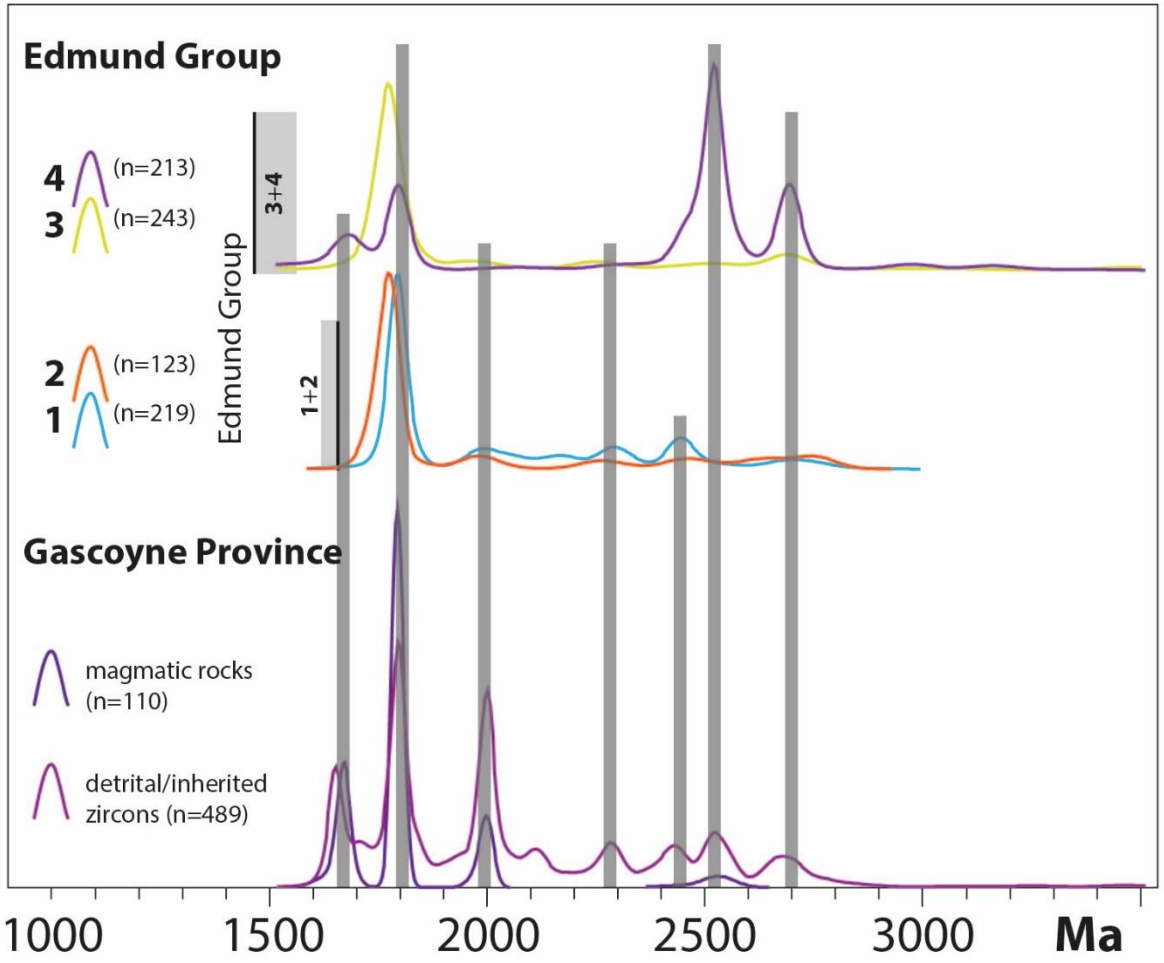
- K-feldspar is a common mineral in clastic rocks, particularly arkosic sandstones and in felsic igneous rocks
- Unlikely to survive more than one erosion–transport–depositional cycle
- Appreciable concentrations of Pb (10–40 ppm)
  - little to no U or Th (no radiogenic ingrowth)
- Can precisely measure ^{208}Pb, ^{207}Pb, ^{206}Pb and ^{204}Pb by laser ablation



- Pb isotope signature of detrital K-feldspar is retained through diagenesis and recrystallization
- Compare the $^{208}Pb/^{204}Pb$, $^{207}Pb/^{204}Pb$ and $^{206}Pb/^{204}Pb$ ratios to those of magmatic K-feldspar in the potential source basement terranes (comparative technique)

Provenance of the Edmund Group (zircon)





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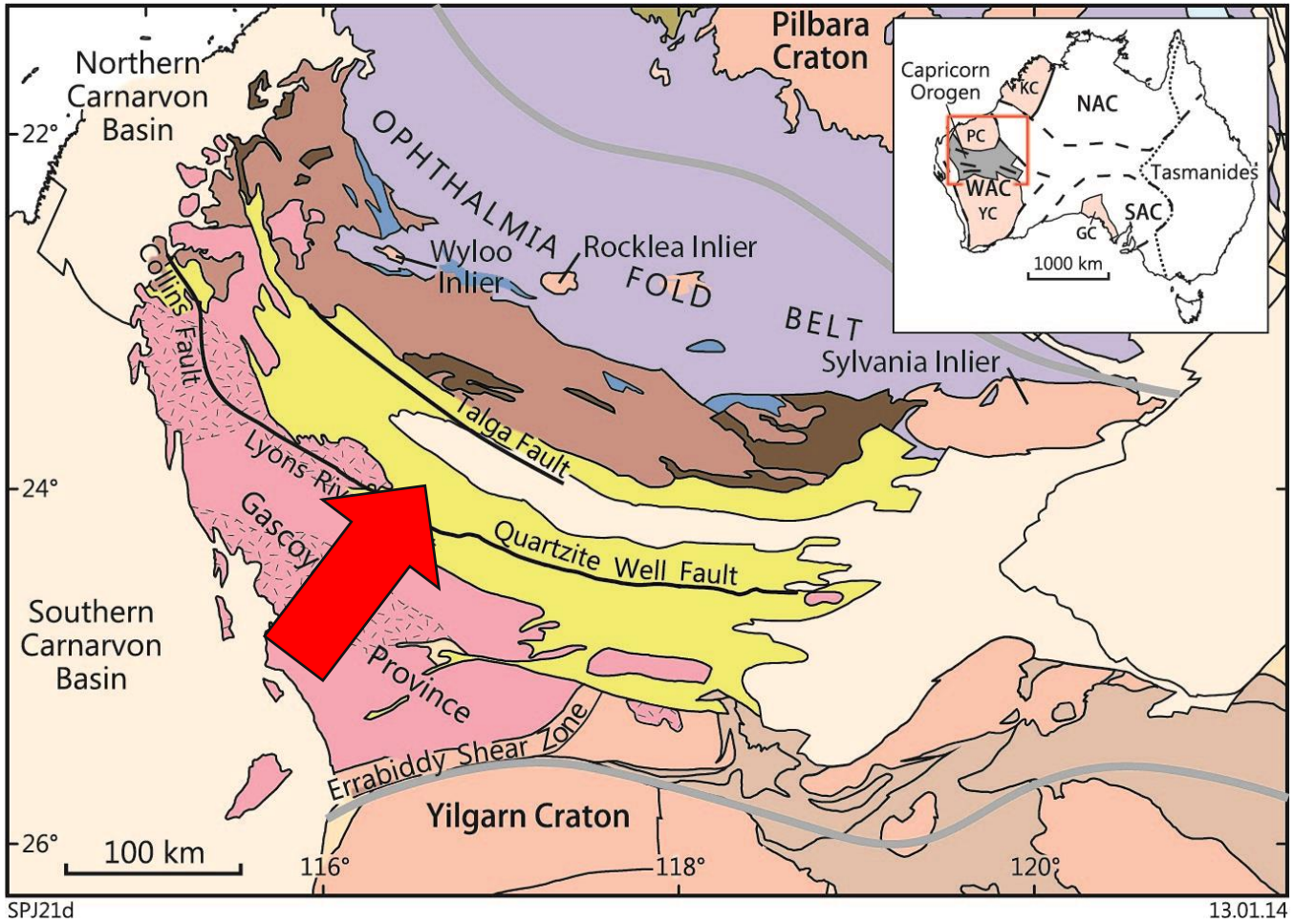

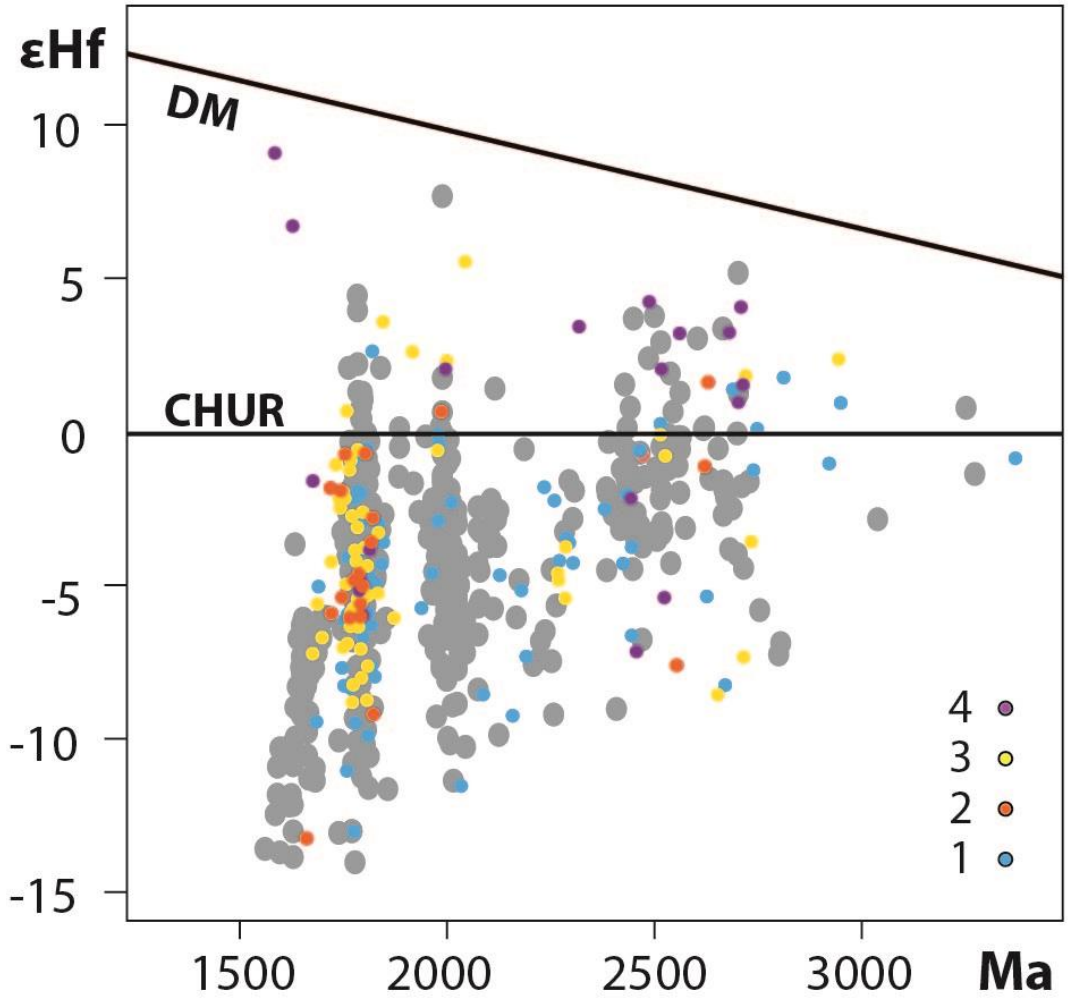

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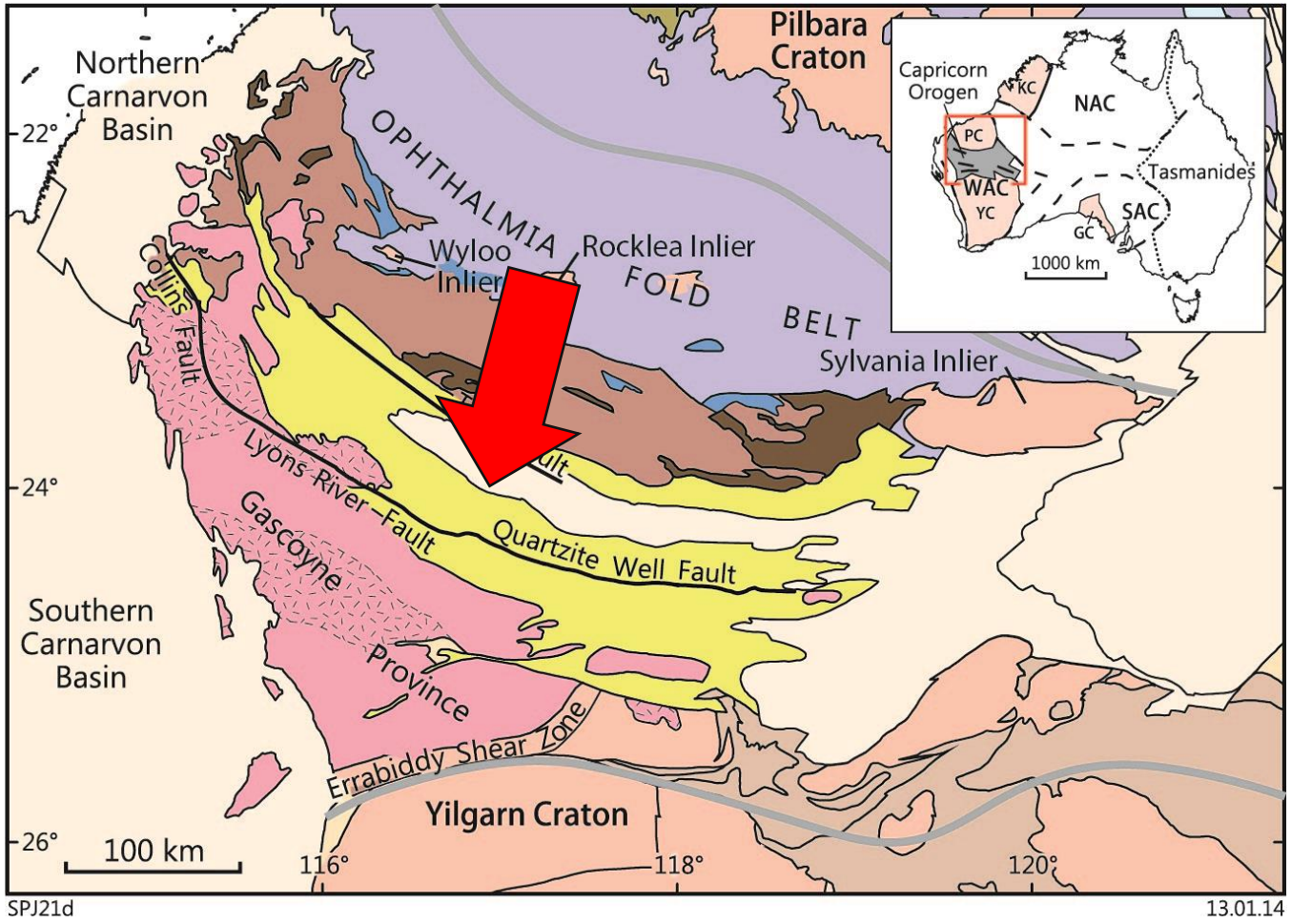
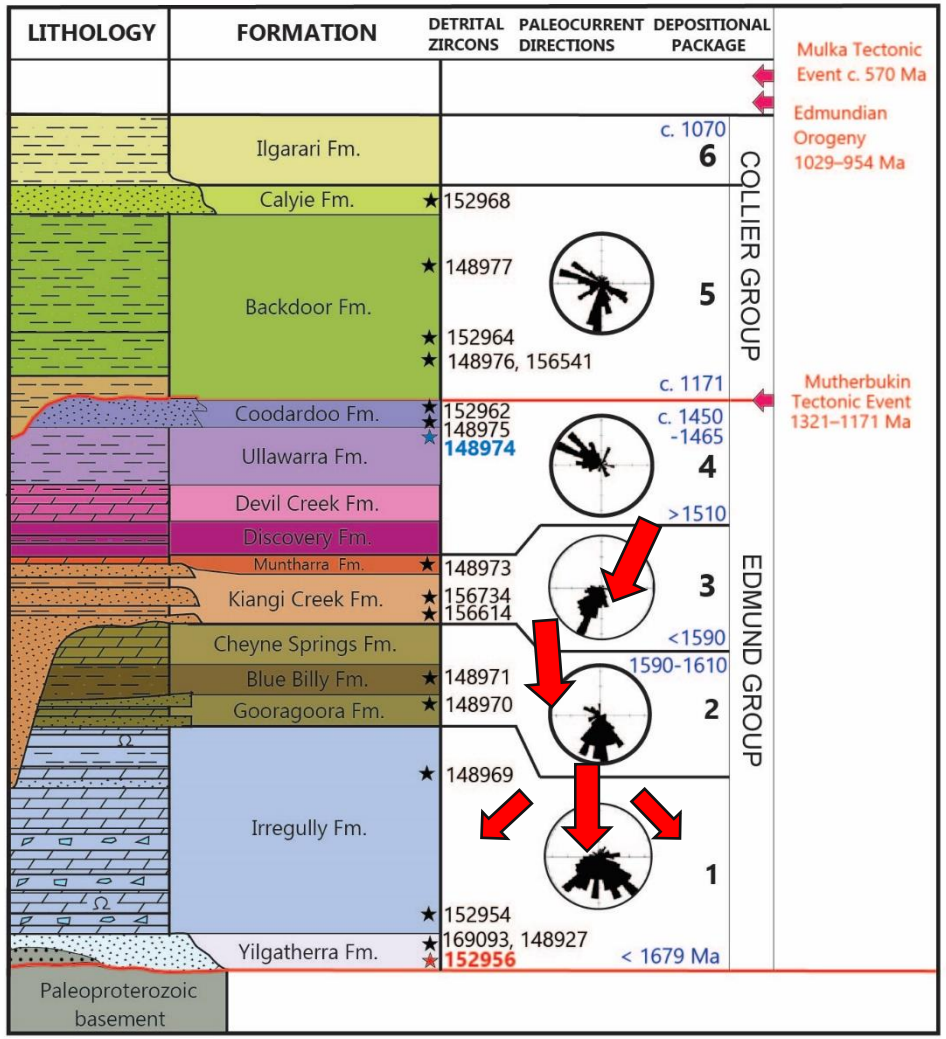
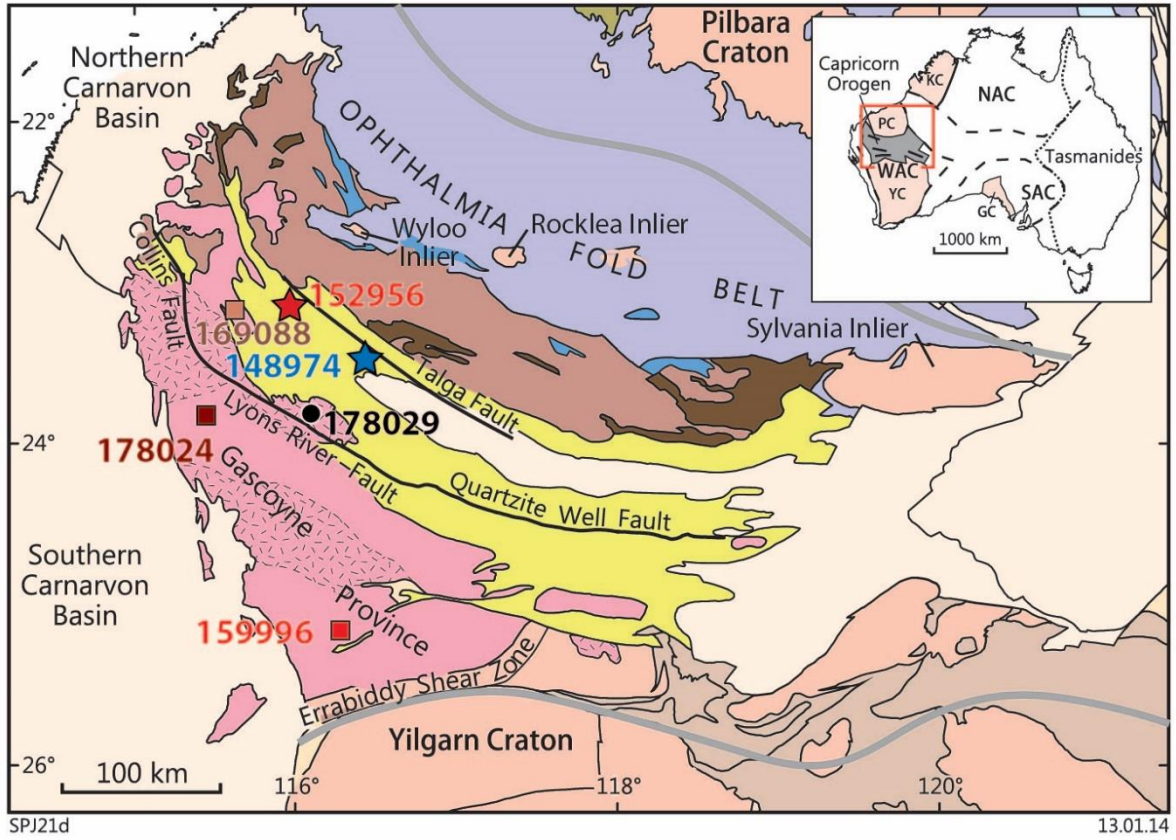




Detrital and magmatic K-feldspar in the Capricorn Orogen

Test the hypothesis that: *'the detrital zircon cargo of the Edmund Group was sourced directly from the Gascoyne Province – first cycle zircon detritus'*



- Measure and compare the Pb isotope ratios of detrital K-feldspar with magmatic K-feldspar from the major granitic sources
  - isotopic information from zircon and K-feldspar should be coupled
- Largest detrital zircon U–Pb age mode:
  - 1820–1775 Ma Moorarie Supersuite
  - 3 samples from across the Gascoyne Province
- Minor contribution from:
  - 1680–1620 Ma Durlacher Supersuite
  - 1 sample close to the depositional centre

Detrital K-feldspar from the Edmund Group

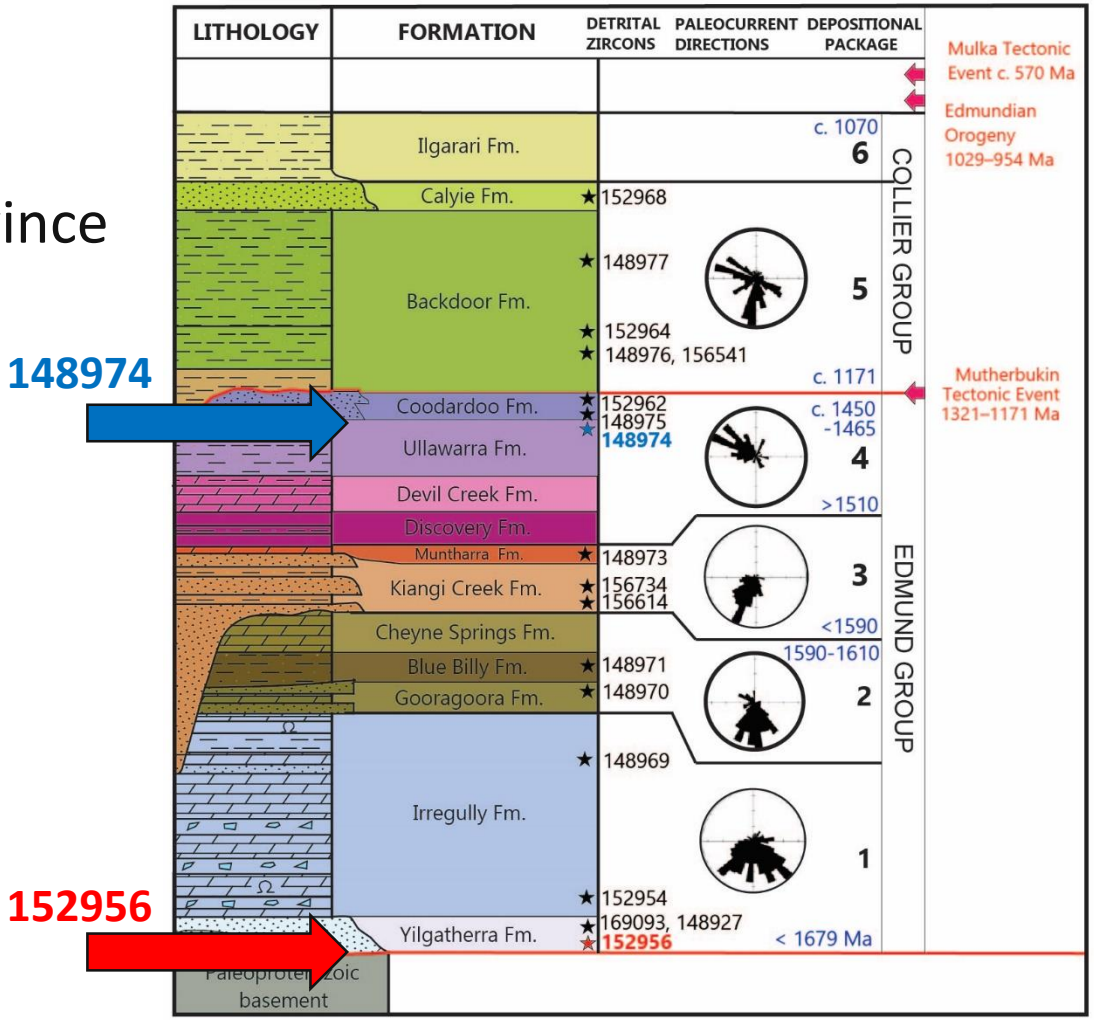
Two samples of arkosic sandstone

152956

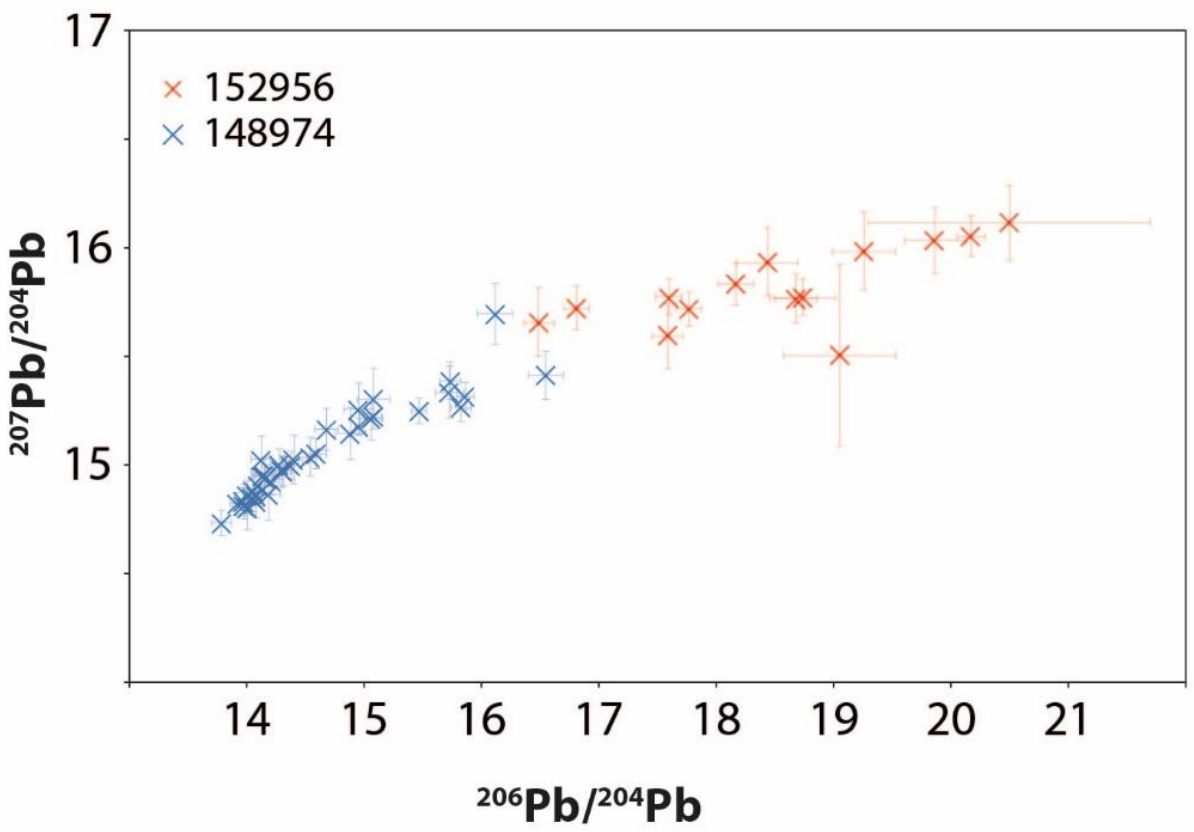
- 2 m above basal contact with the Gascoyne Province
- Fluvial — braided river setting
- Paleoflow from the northwest
- Detrital zircons major age mode at c. 1805 Ma

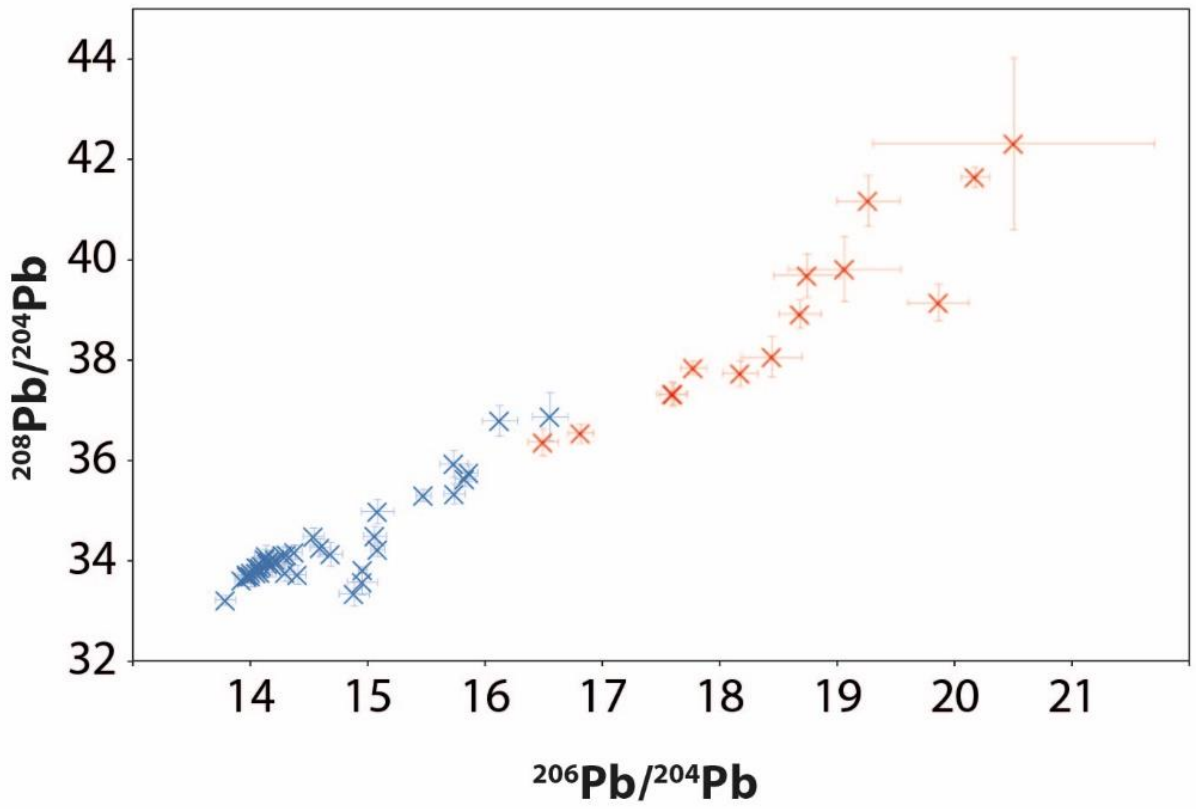
148974

- Curran Member towards the top of the Ullawarra Formation
- Deep-marine to shelf setting
- Paleoflow from the southeast – axial flow
- Detrital zircons at c. 1798 and 1680 Ma

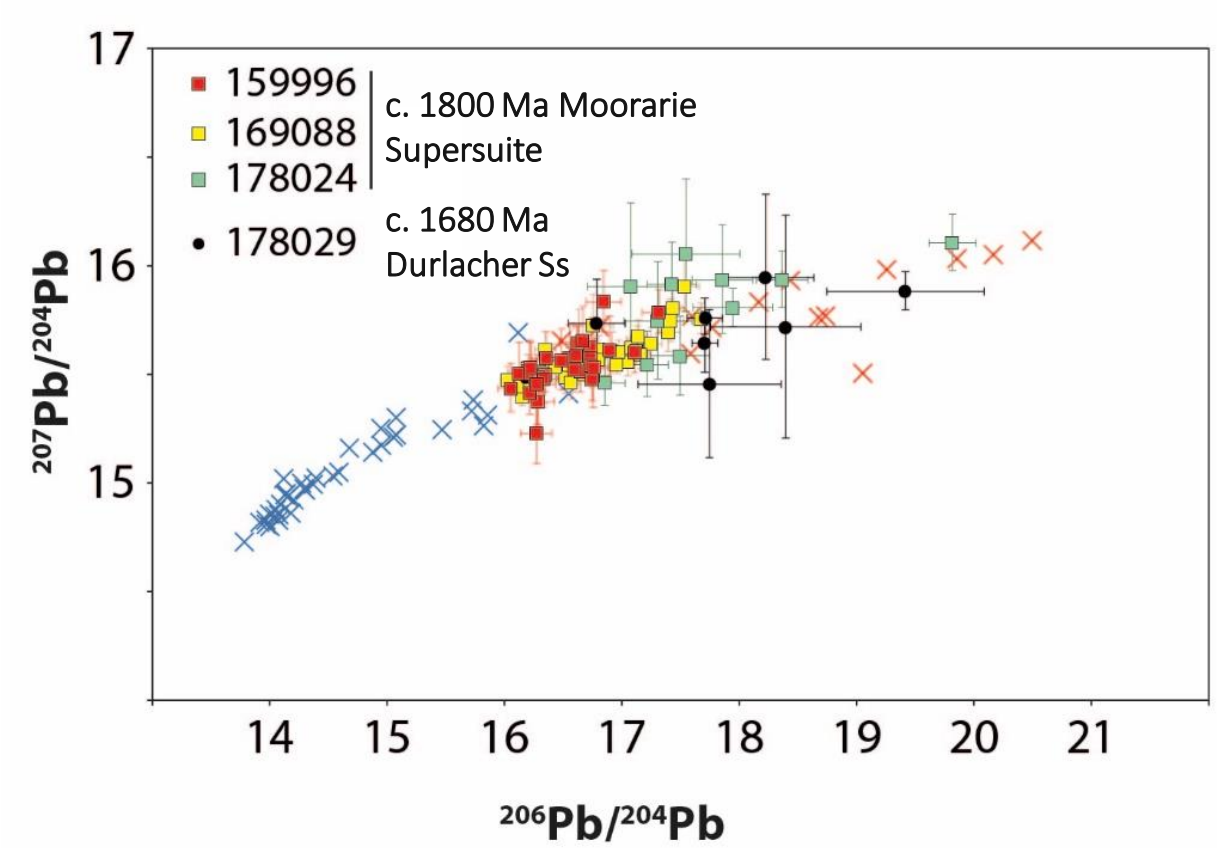


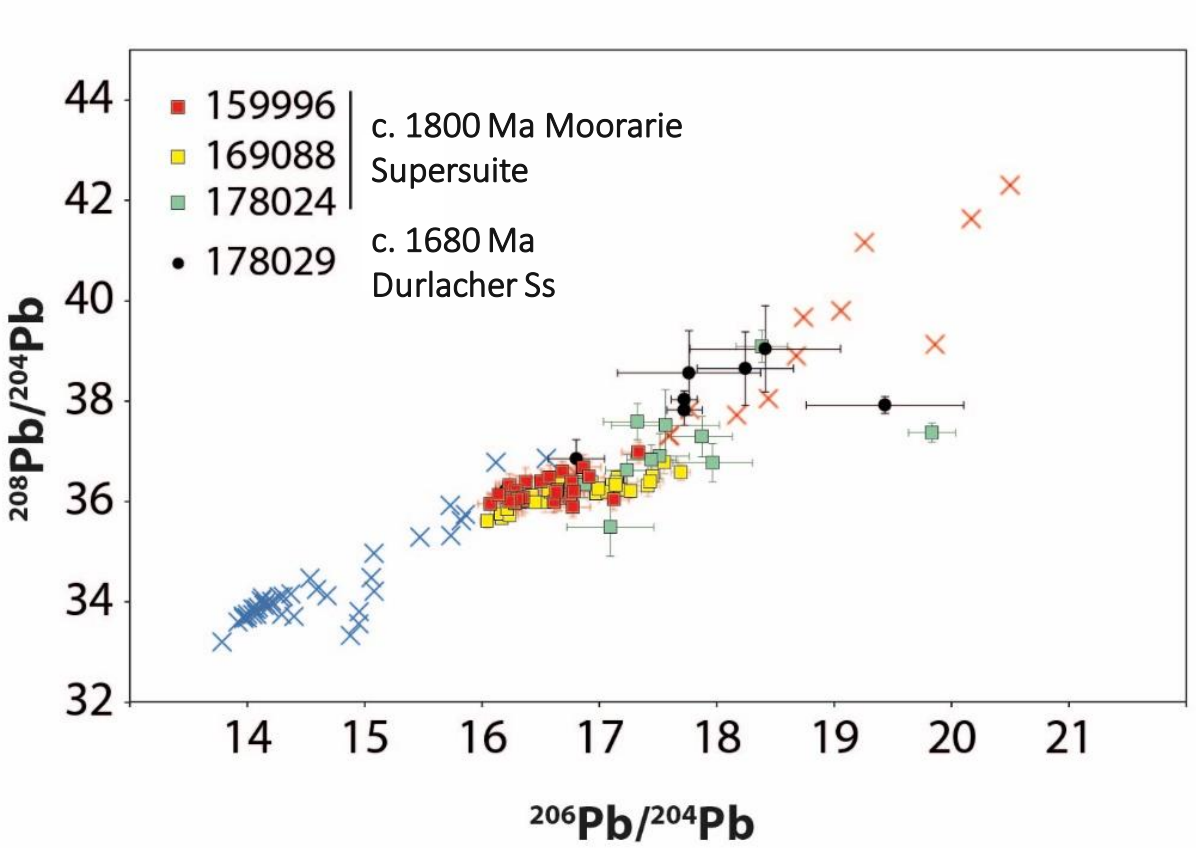
Pb isotope results of detrital K-feldspars





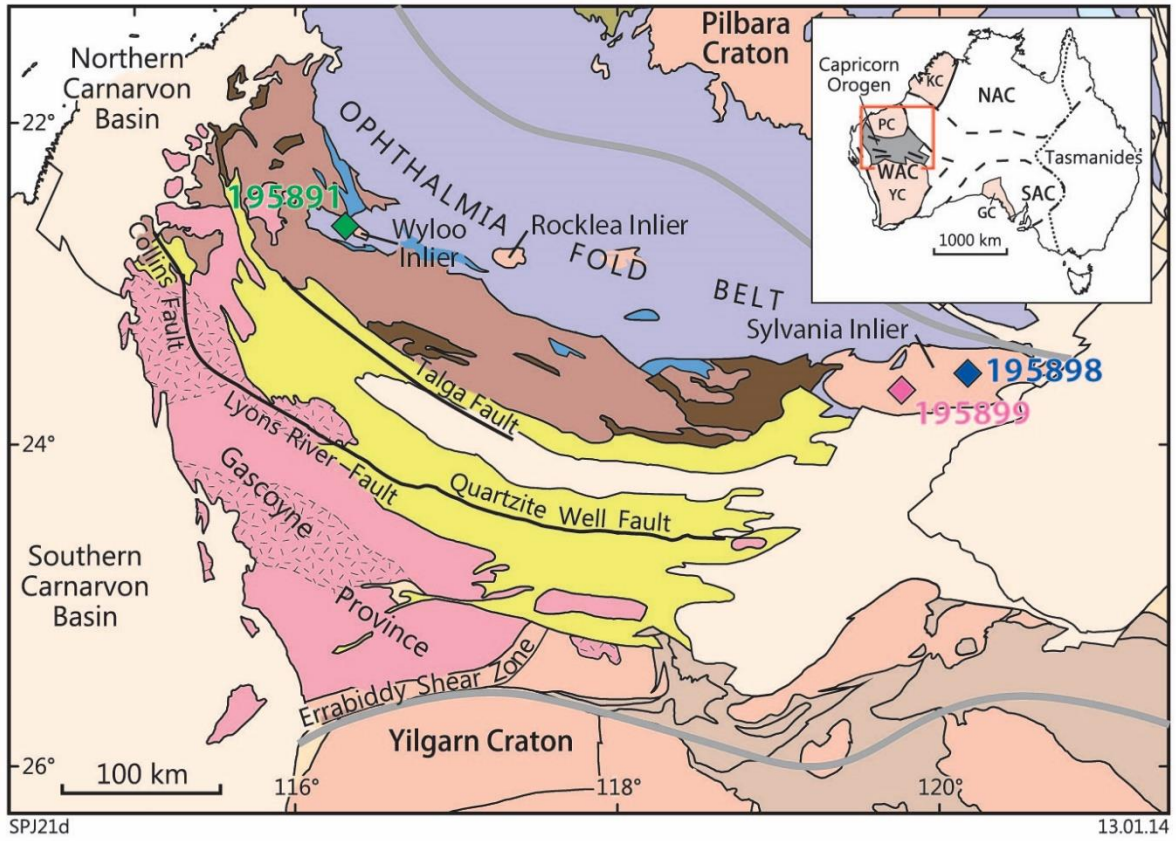
Comparison with magmatic K-feldspar





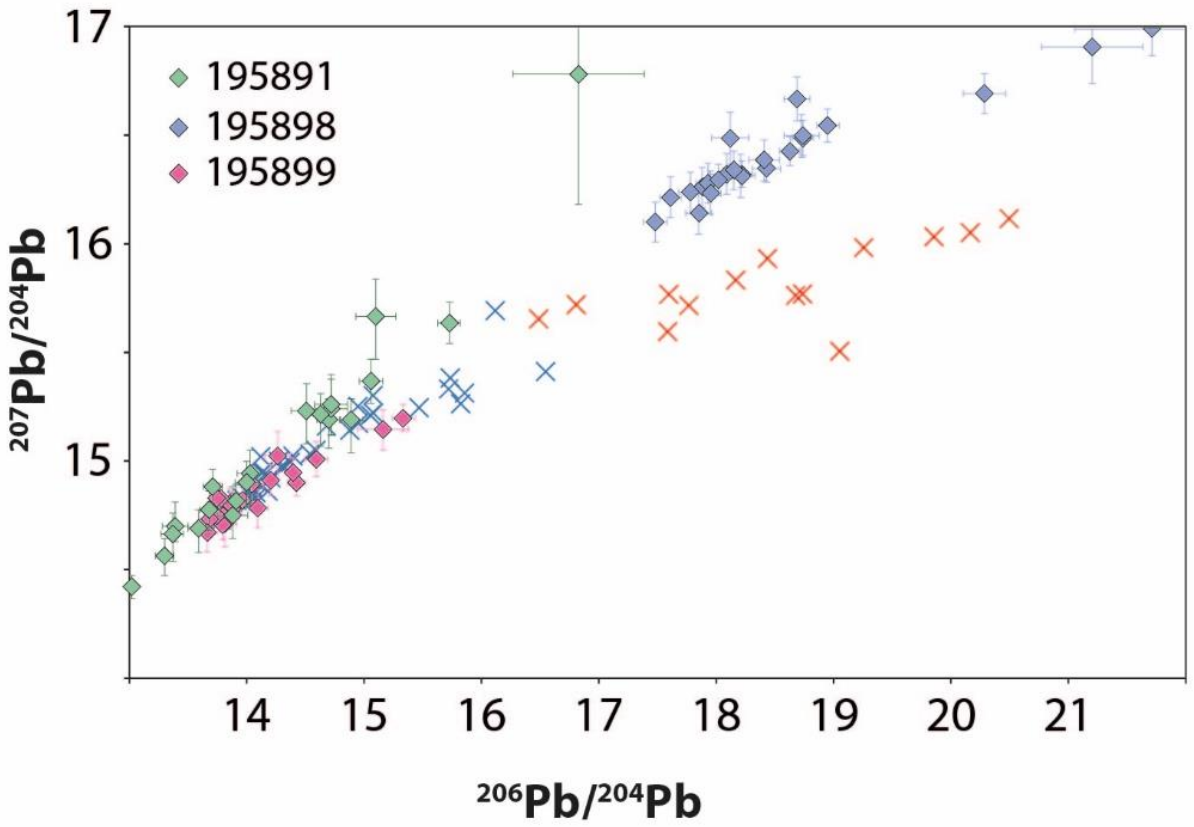
Can we trace the first cycle sedimentary source?

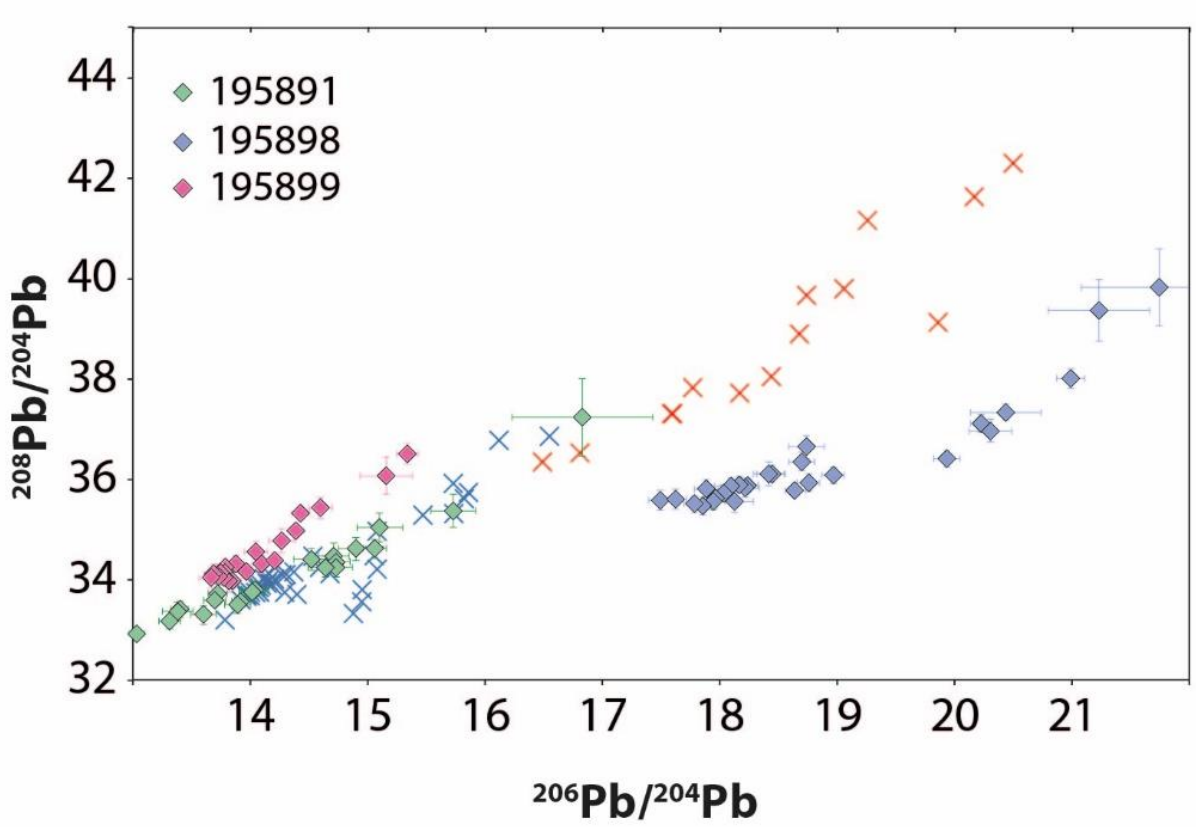
So: *'the detrital zircon cargo of the Edmund Group was NOT sourced directly from the Gascoyne Province – MULTI cycle zircon detritus'*



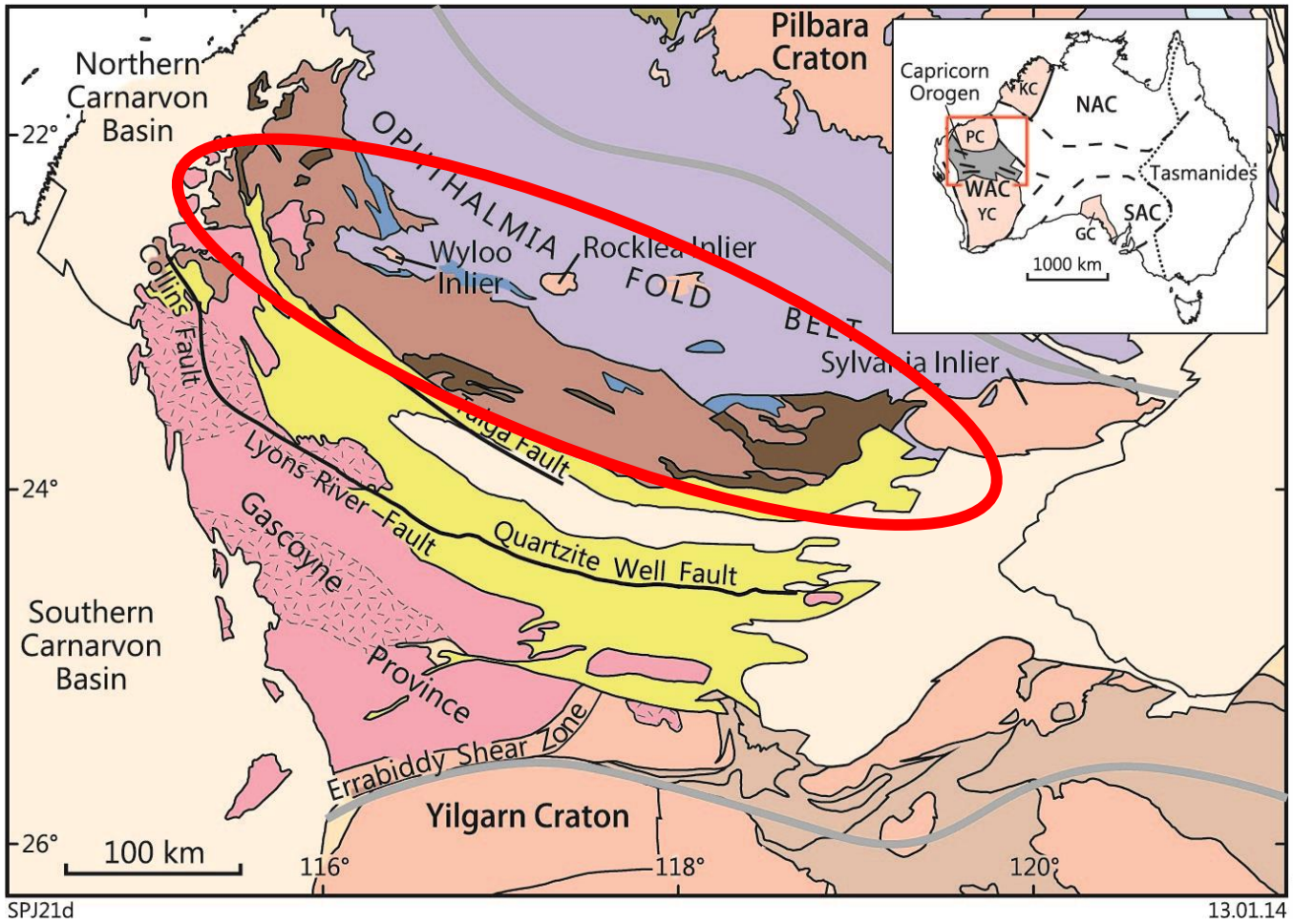
- Results indicate that the Gascoyne Province granitic rocks are NOT the source of detrital K-feldspar and zircon
- Paleoflow indicators suggest northerly source
- Measure and compare the Pb isotope ratios of detrital K-feldspar with magmatic K-feldspar from granitic sources to the north of the Edmund Group
  - two samples from the Sylvania Inlier
  - one sample from the Wyloo Inlier

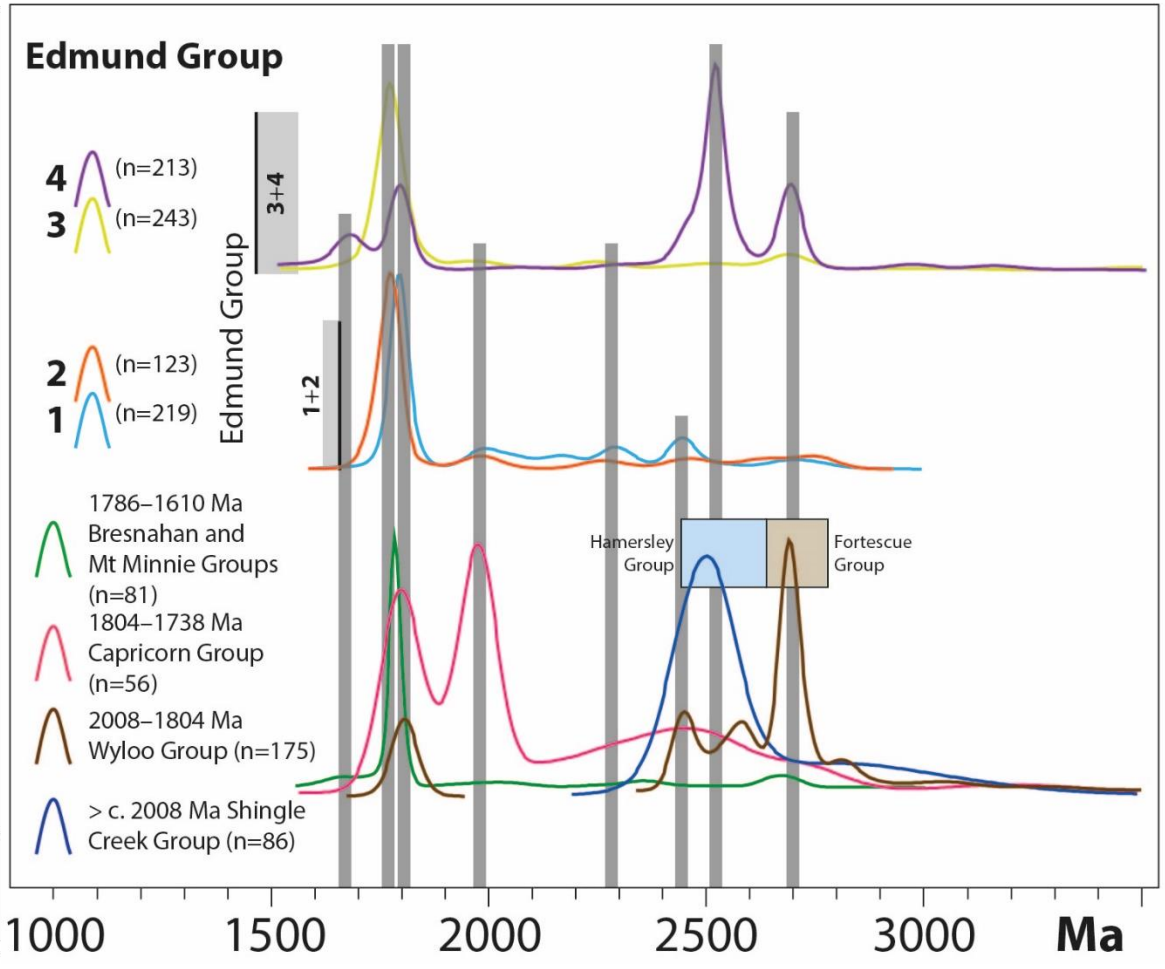
Comparison with magmatic K-feldspar





True provenance of the Edmund Group





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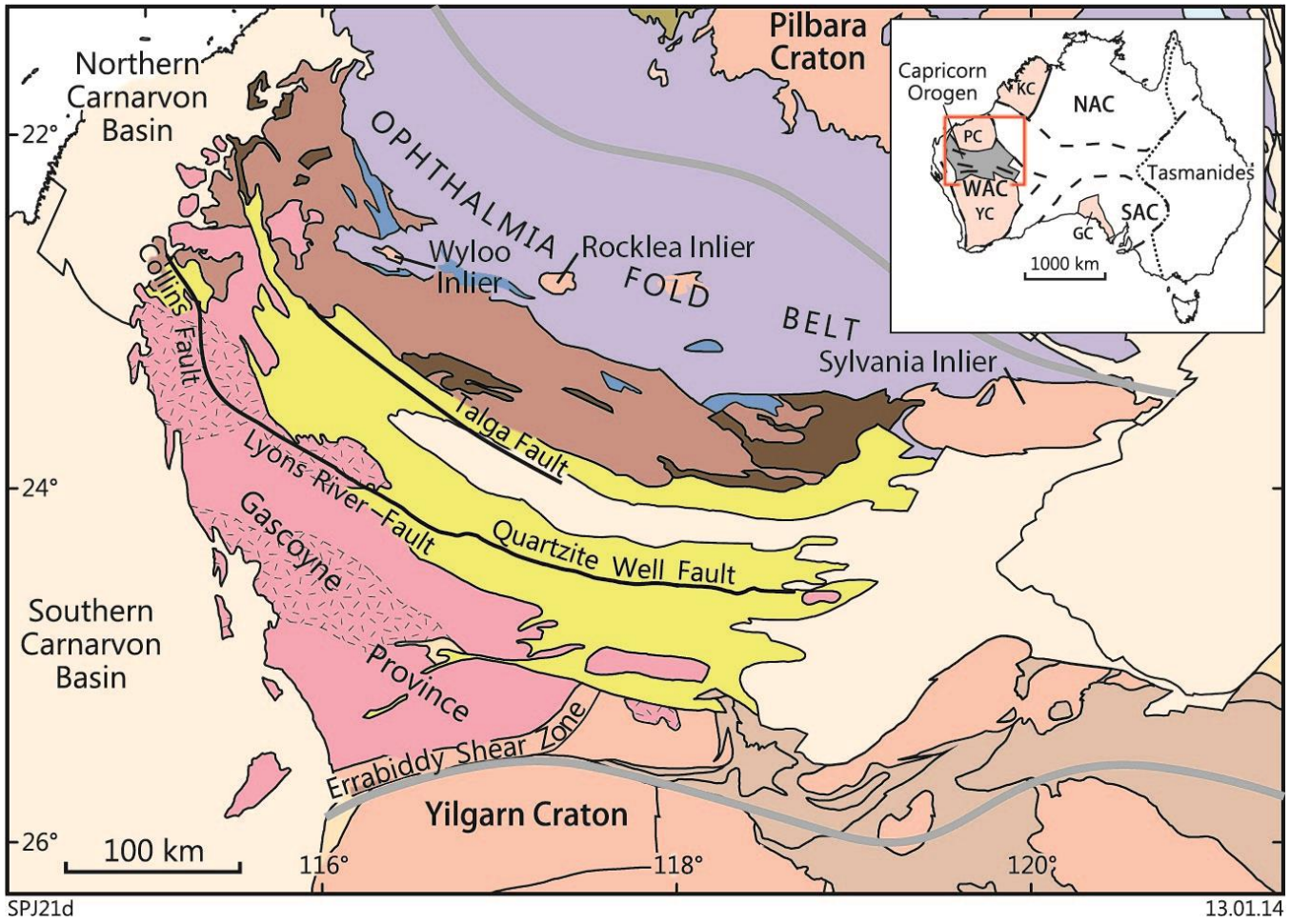
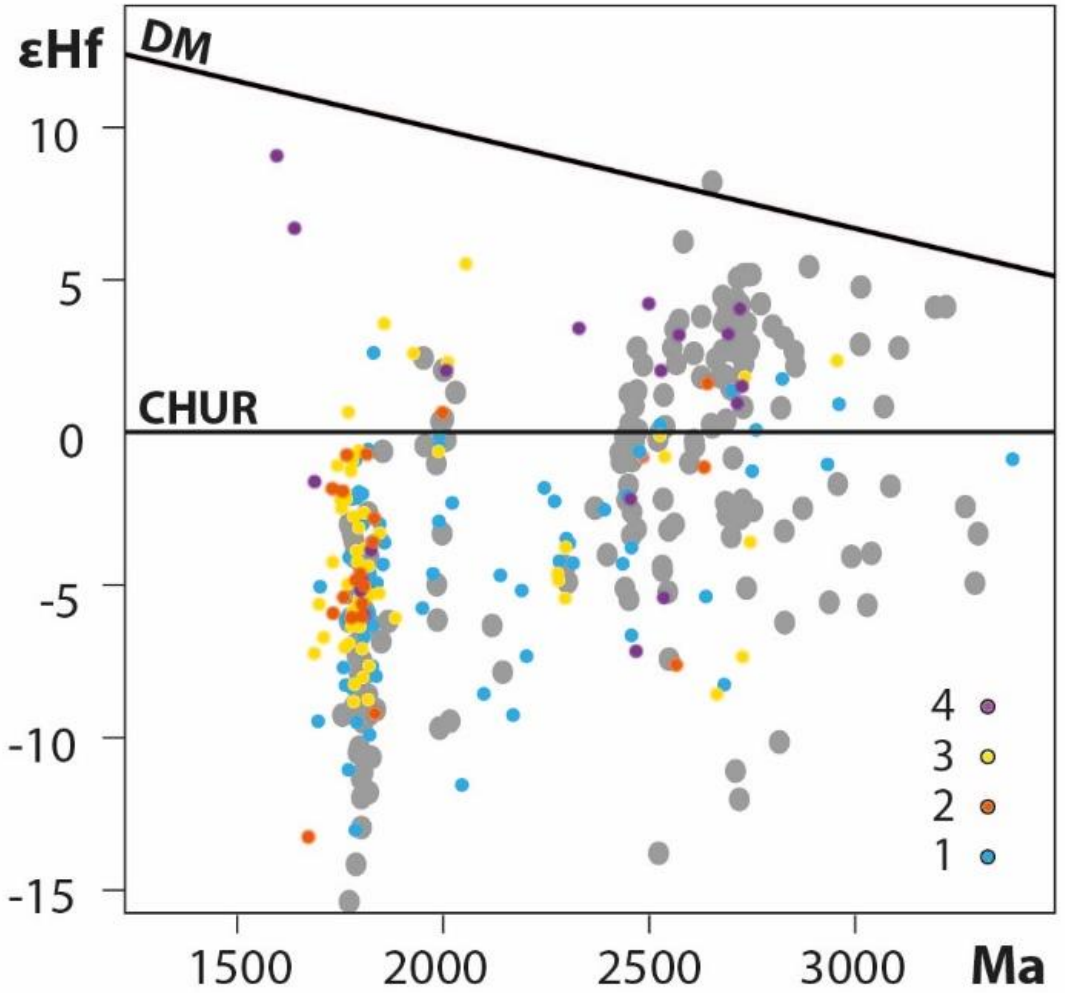
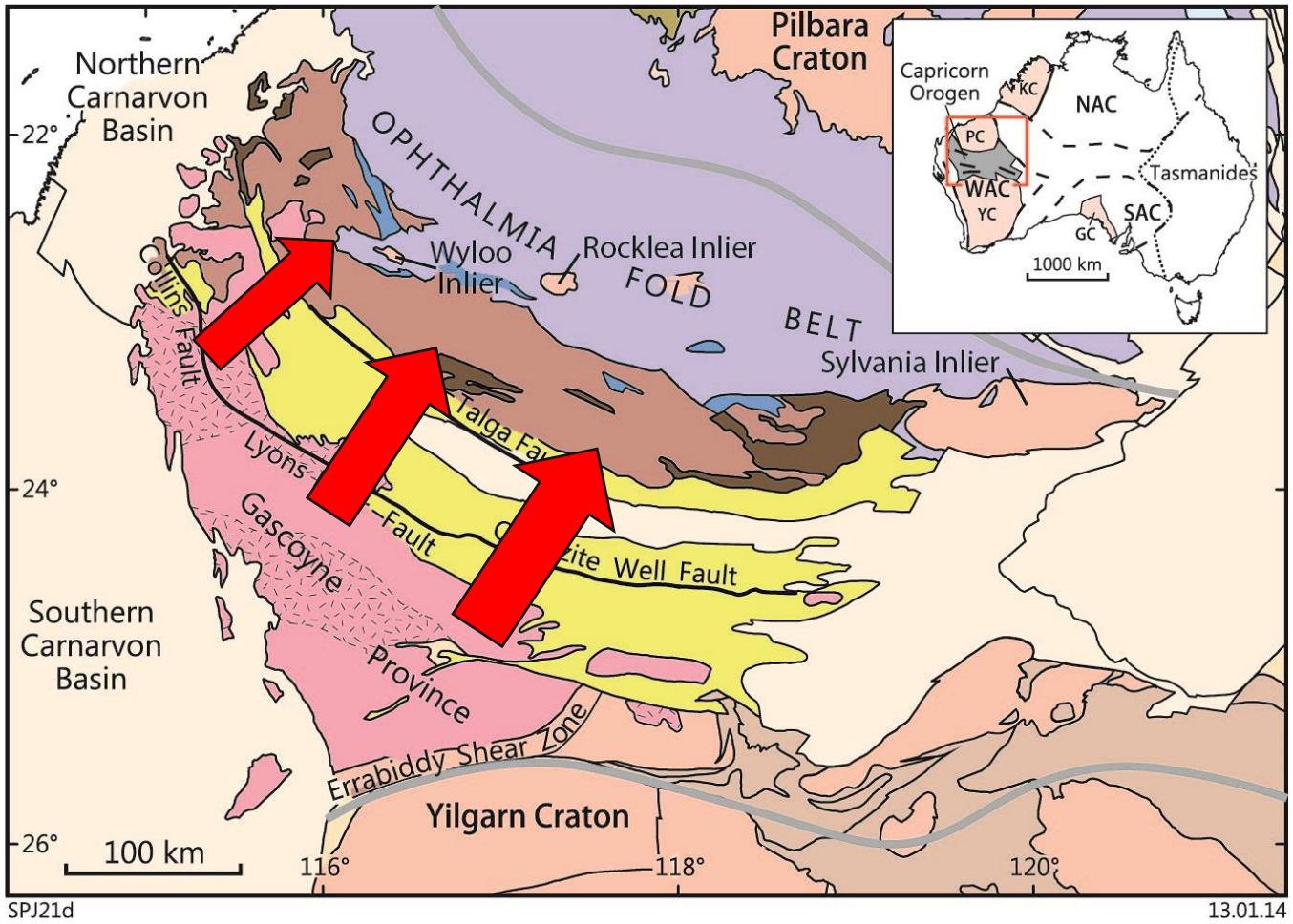




New tectono-sedimentary history



- Sediment from the Gascoyne Province was moved northward during the 1820–1770 Ma Capricorn Orogeny
  - uplift and erosion in the south
- Sediment was moved back southward into the Edmund Basin during the 1680–1620 Ma Mangaroon Orogeny
  - uplift and erosion in the north!
- Mineral prospectivity perspective the northern Capricorn is MOST prospective during the Mangaroon Orogeny
  - history of gold mineralization

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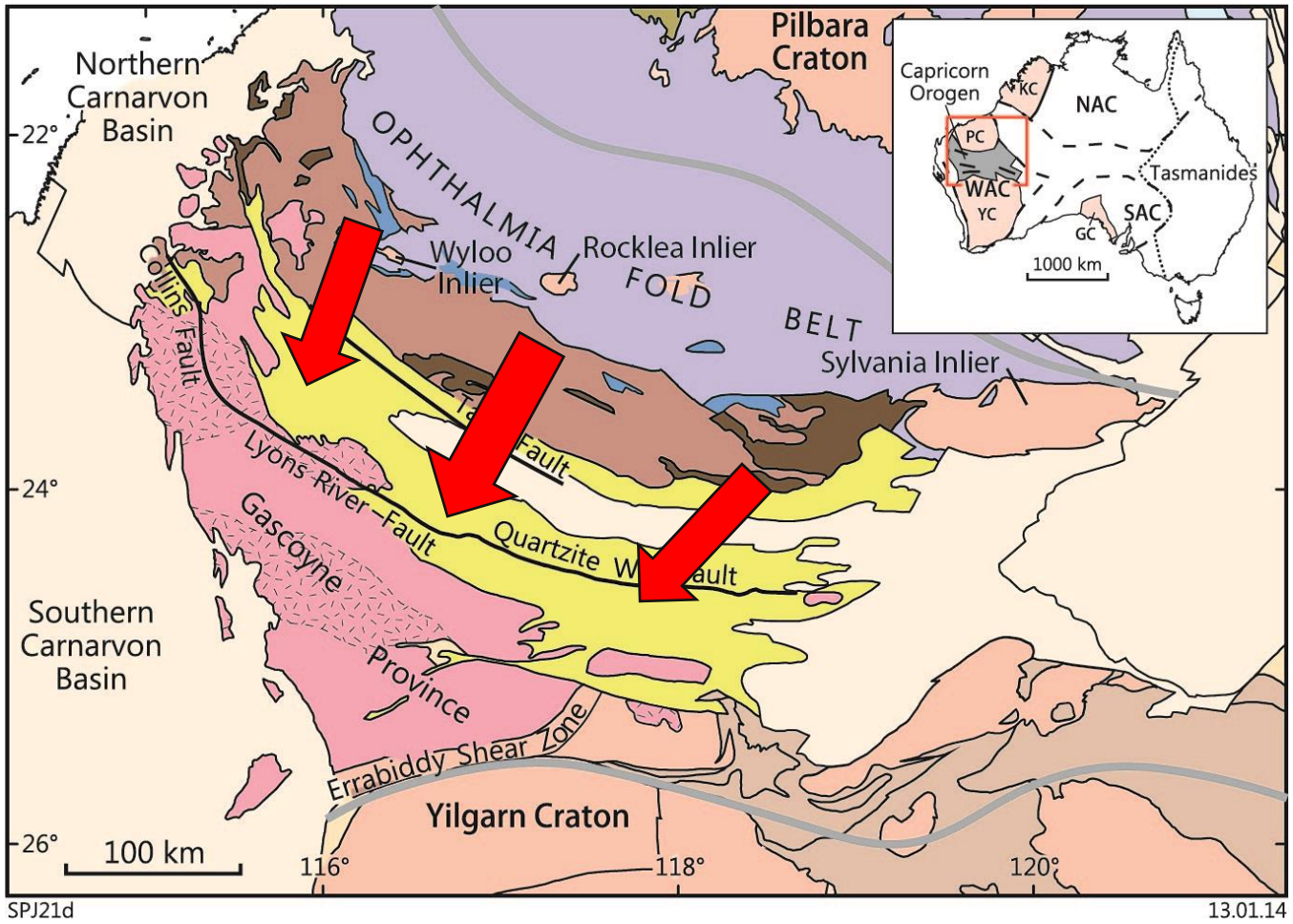

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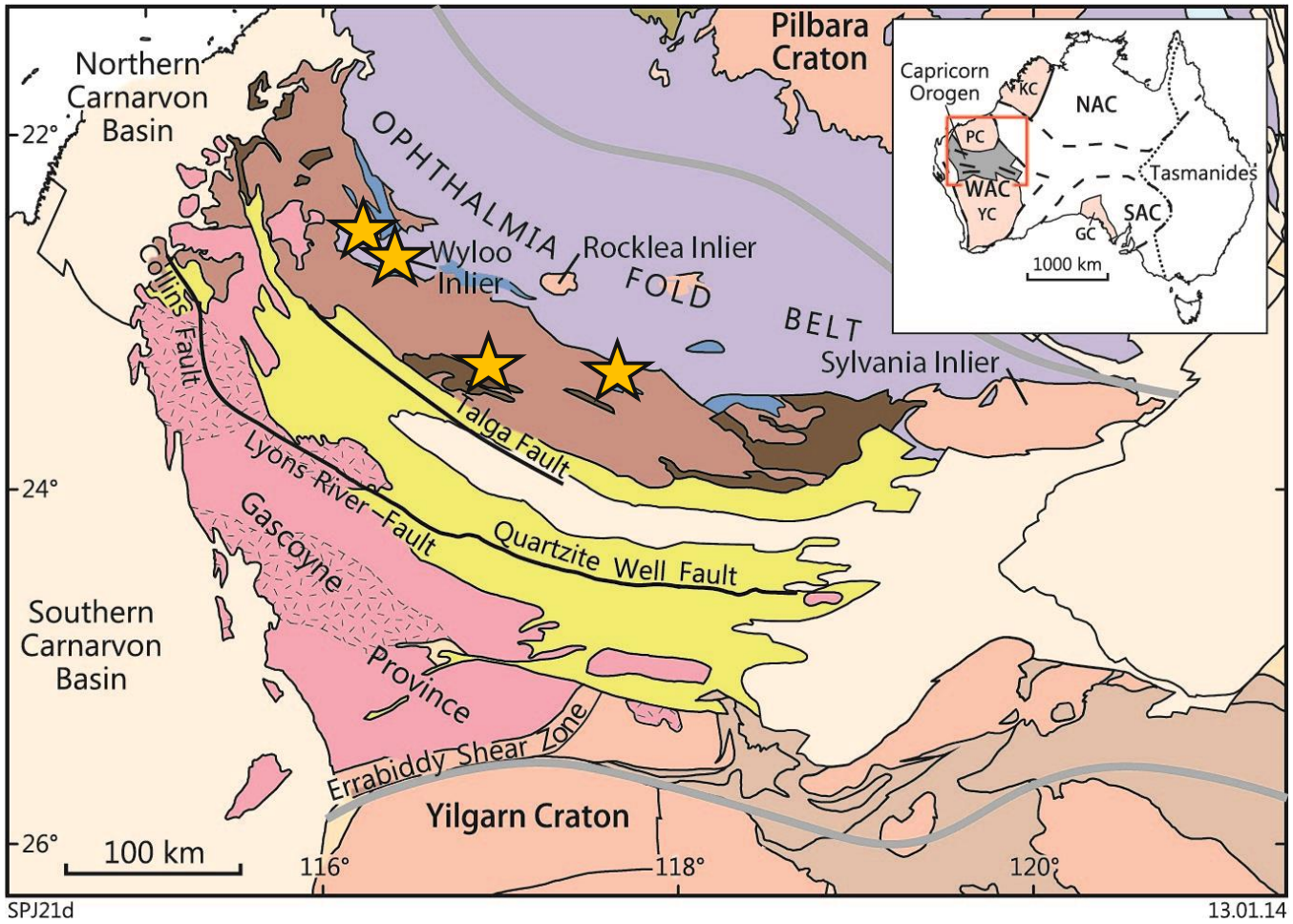

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Implications for sediment provenance

- Sediment source-to-sink pathways can be considerably more complex than thought
  - zircon's physical and chemical robustness can be a major hindrance to understanding this complexity
- Without additional information, such a paleoflow indicators, it is not possible to determine the cyclicity of detrital zircon
  - grain shape and rounding?
  - deformed or low grade metasedimentary rocks (Precambrian basins) that lack such macrostructures
- Pb isotope studies of detrital K-feldspar may help to identify the primary sedimentary source
  - comparison with whole rock Pb isotopes not possible due to the Pb-ingrowth due to U- and Th-bearing phases
  - need a lot of Pb isotope data on magmatic K-feldspar from basement rocks
  - isotope compositional space is limited – significant overlap of major basement sources


Questions?