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Gawler Craton: potential for unconformity-related uranium - spectral insights

John Keeling

Geological Survey of South Australia

15 April 2015, SAREIC

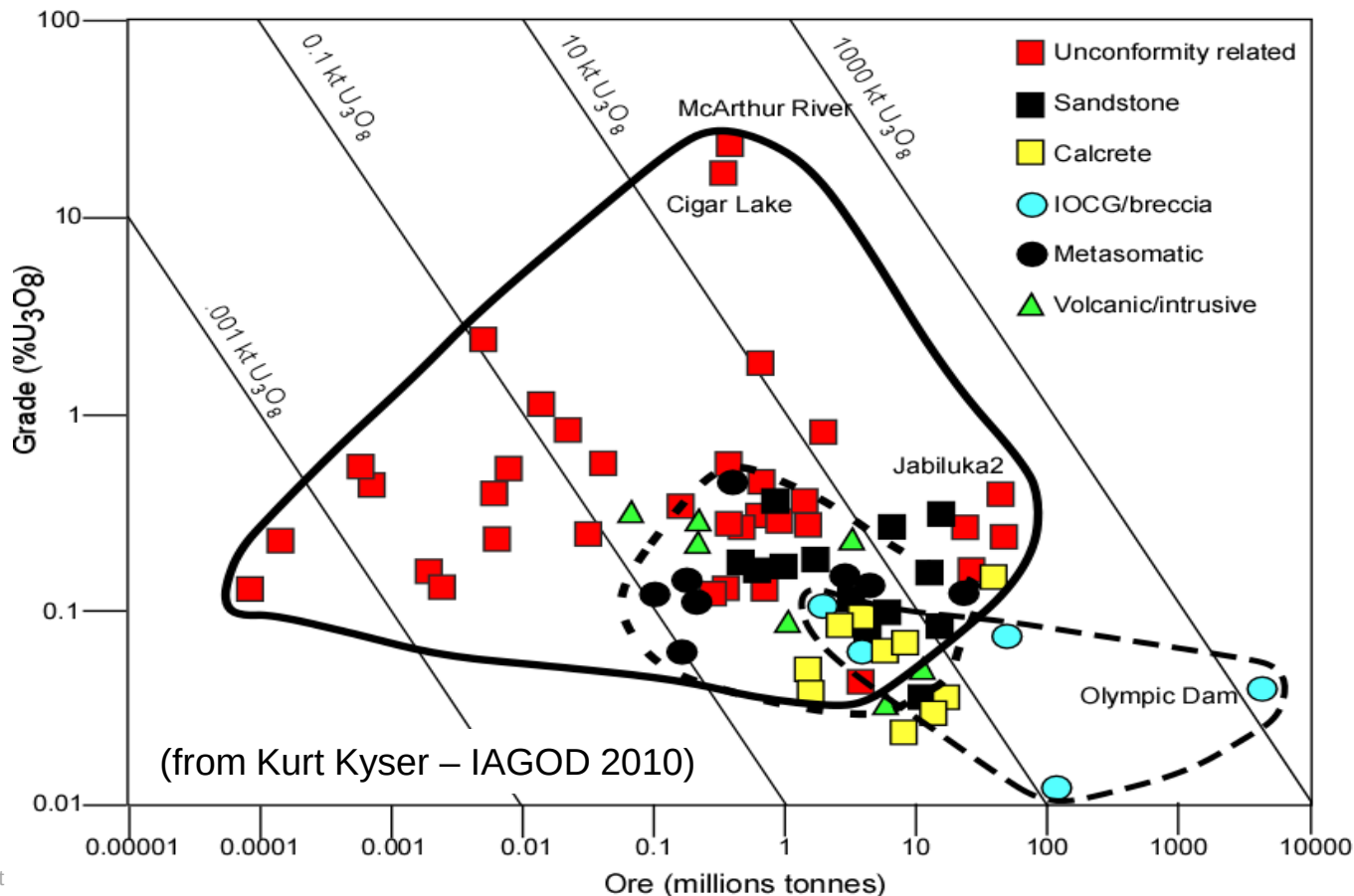
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Which are the giant uranium deposits?

Unconformity-related uranium accounts for ~20% of world uranium production

Include the highest-grade deposits



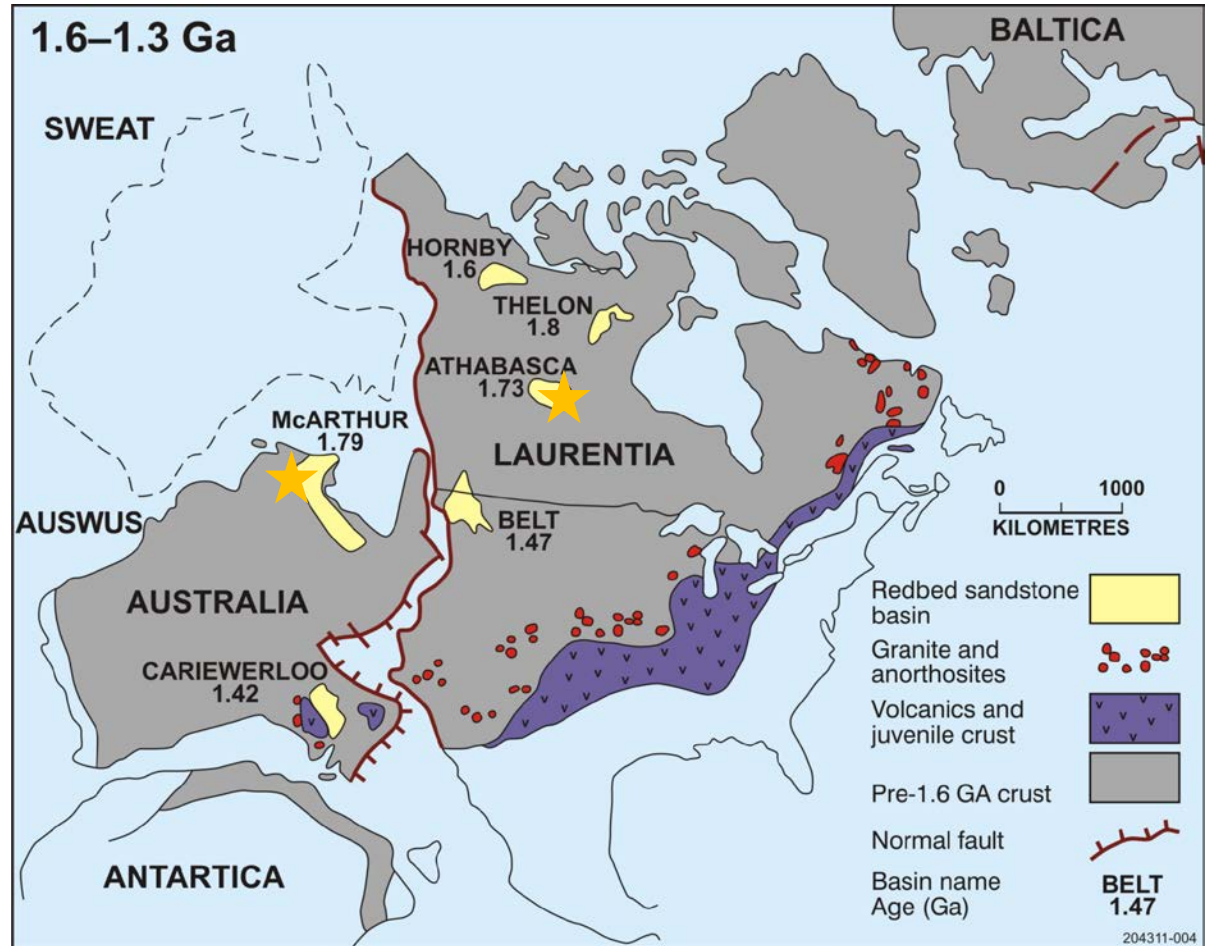
Proterozoic intracontinental basins

1.6 – 1.3 billion years

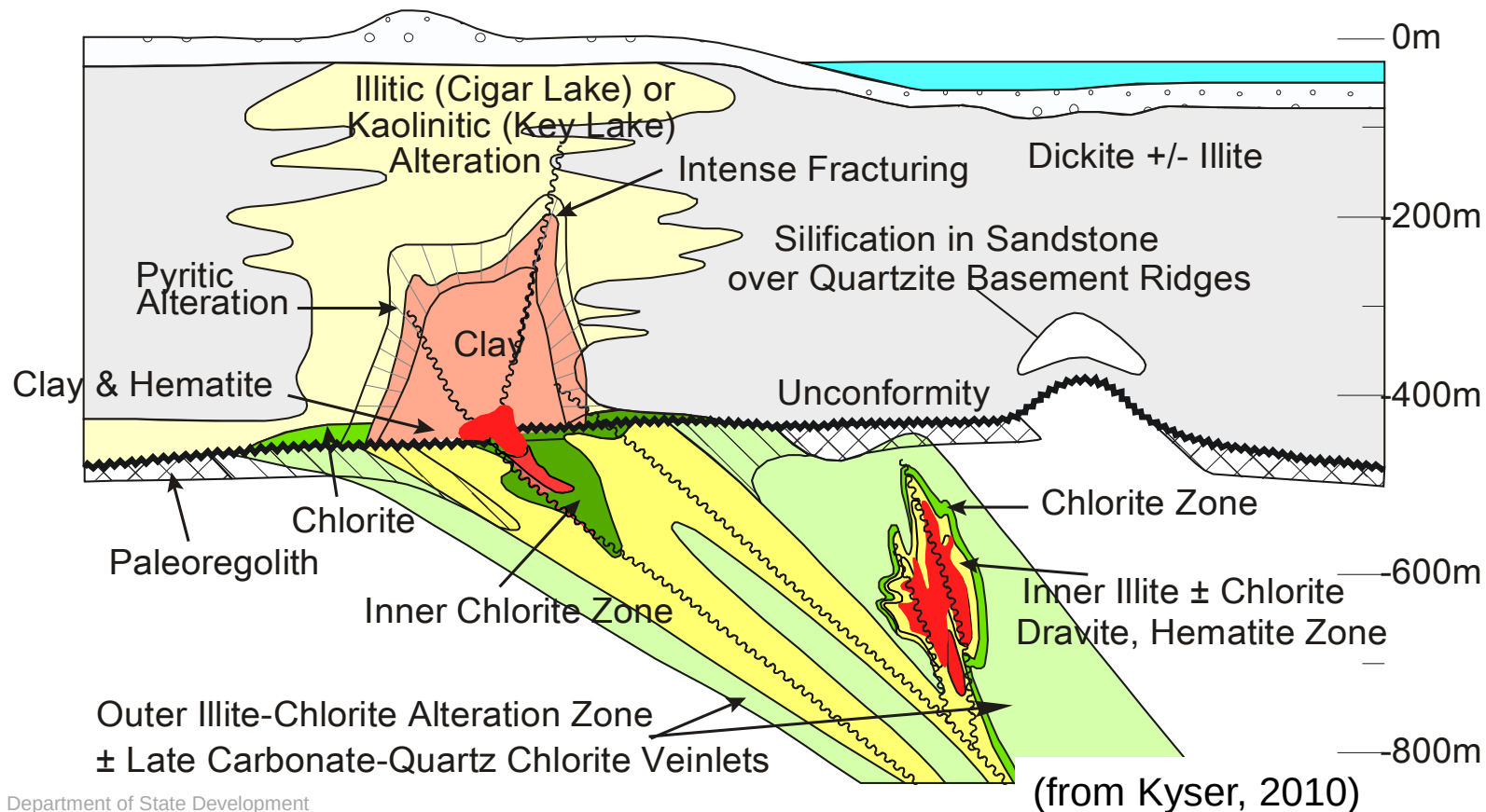
(after Karlstrom et al. 2001)



Unconformity-related
uranium deposits

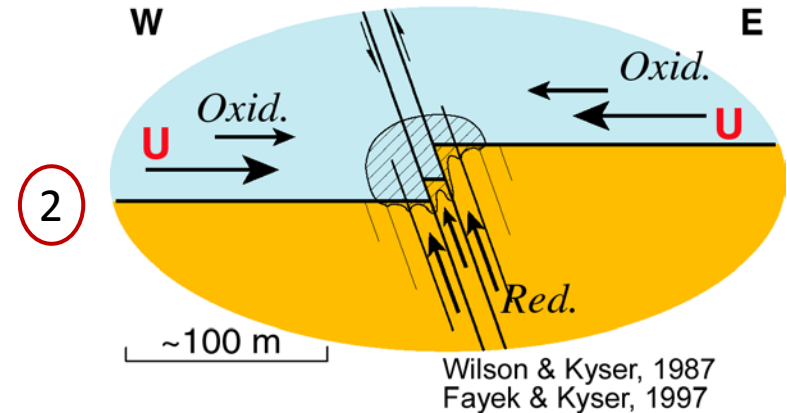
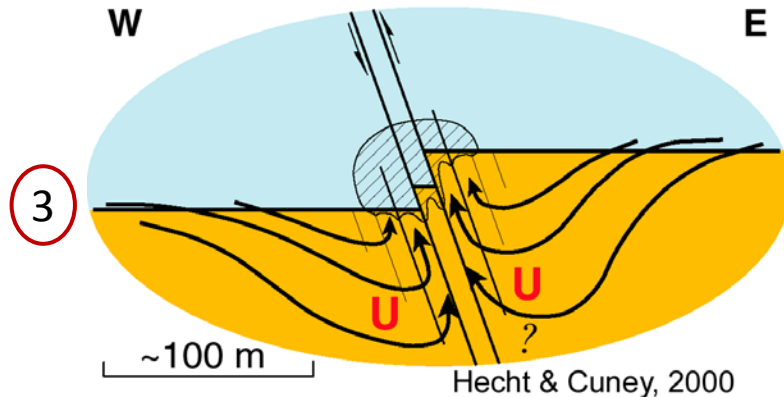
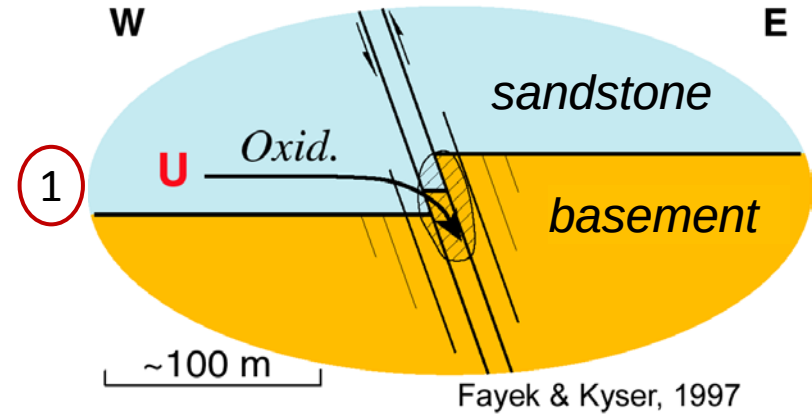


Unconformity-related uranium - Athabasca Basin model



Fluid models for uranium deposition

1. Fluids originate within the sandstone, then penetrate the basement where they react with reductants and U is deposited.
2. Basin fluids mix with basement-derived fluids at the unconformity and U deposited.
3. Fluids originate from the sandstone, then penetrate the basement where the U is leached before deposition in the fault.



Cariewerloo Basin

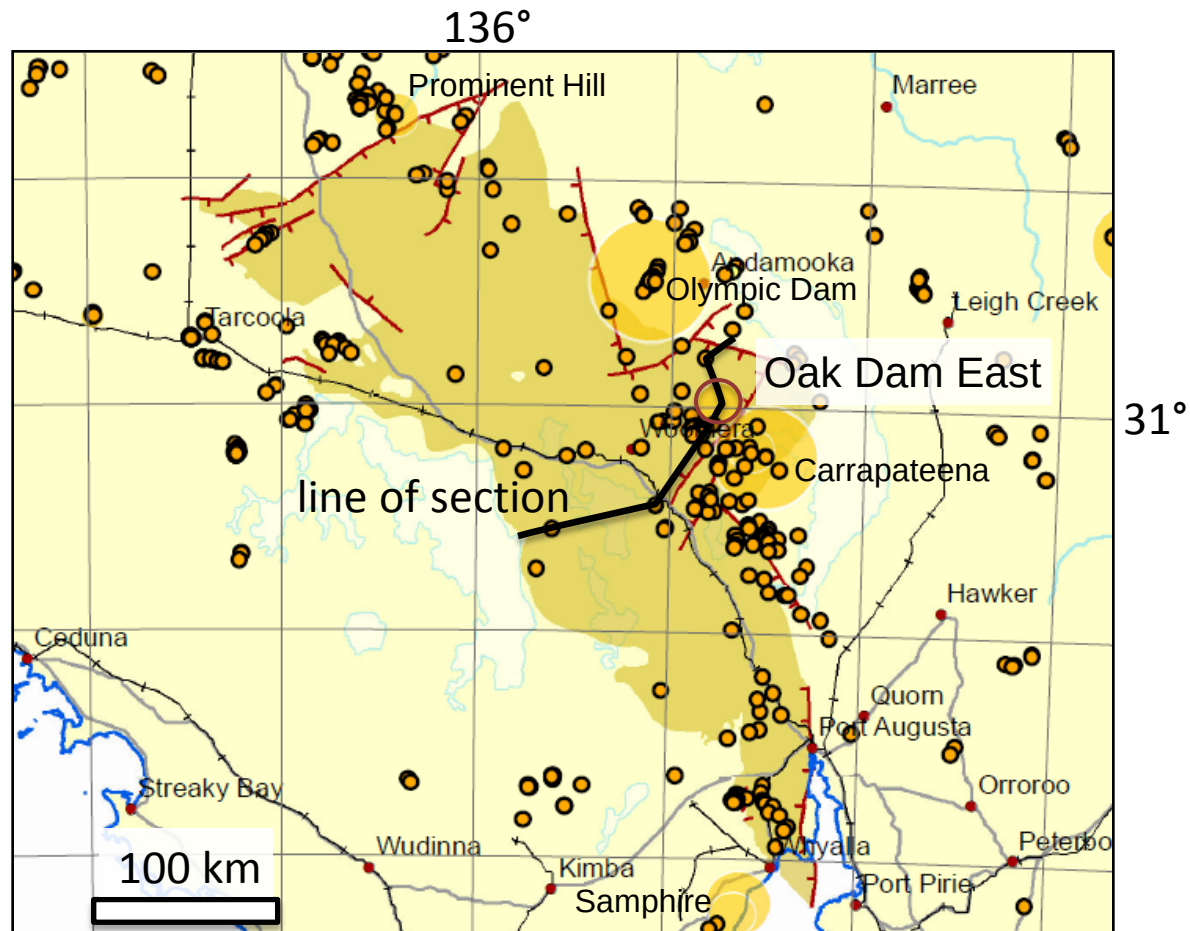
Approx. 430km NW-SE
up to 170km wide

At least 1500m thick

Age poorly constrained

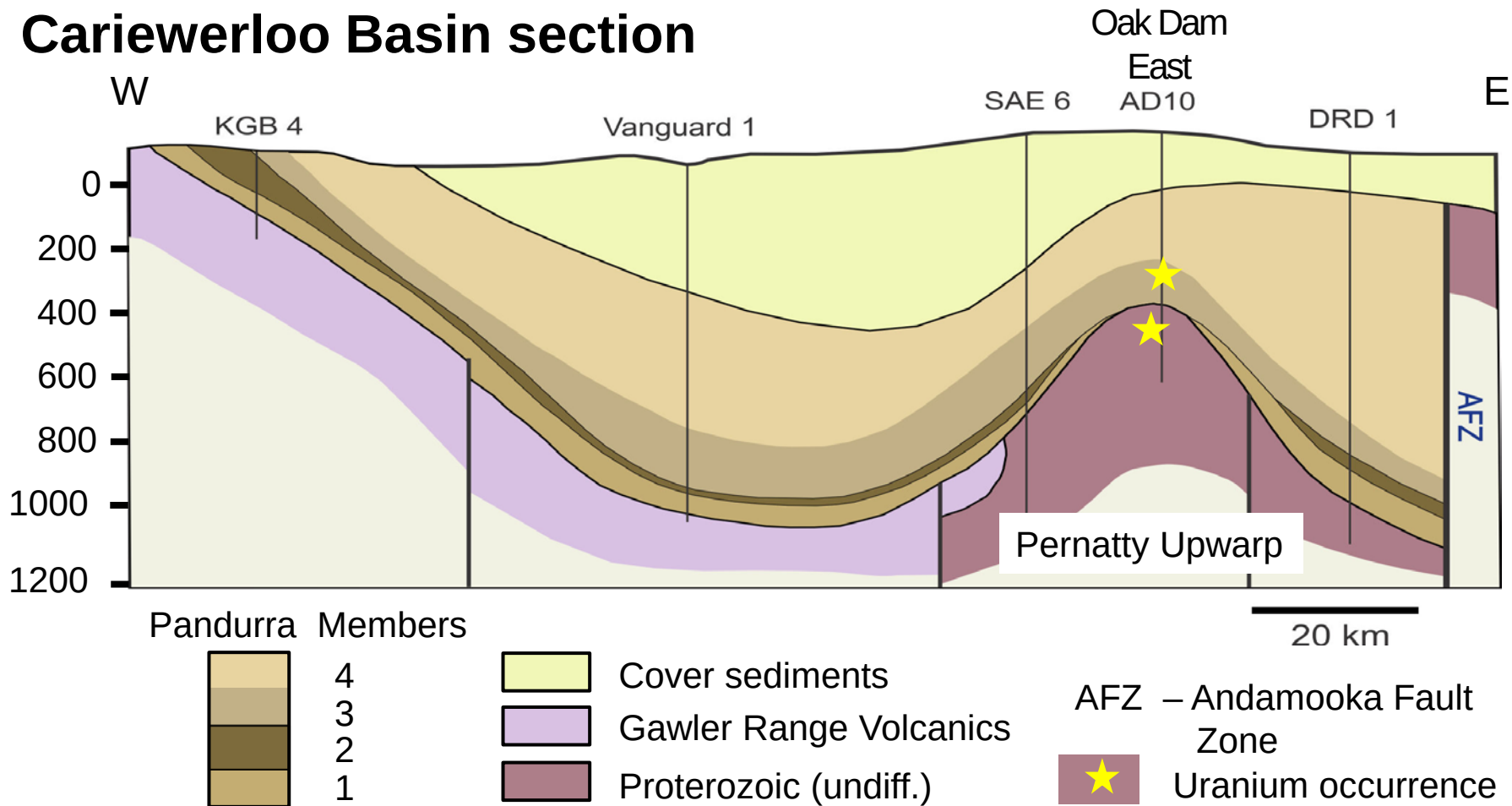
<1575 Ma Gawler
Range Volcanics

1450 - 1420 Ma
Rb/Sr whole rock
and $^{40}\text{Ar}/^{39}\text{Ar}$ illite/mica
alteration

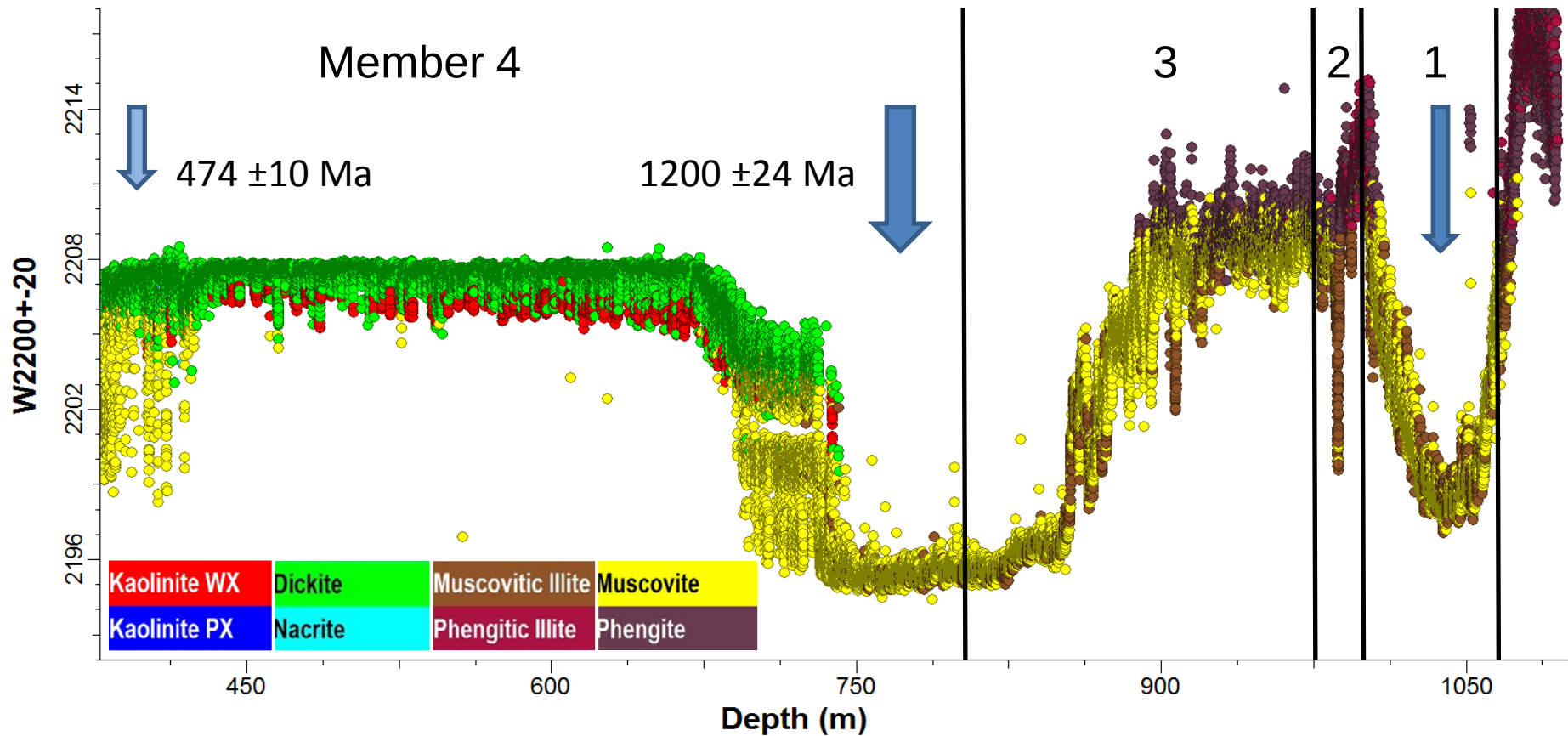


Cariewerloo Basin showing “HyLogged” holes and basement uranium

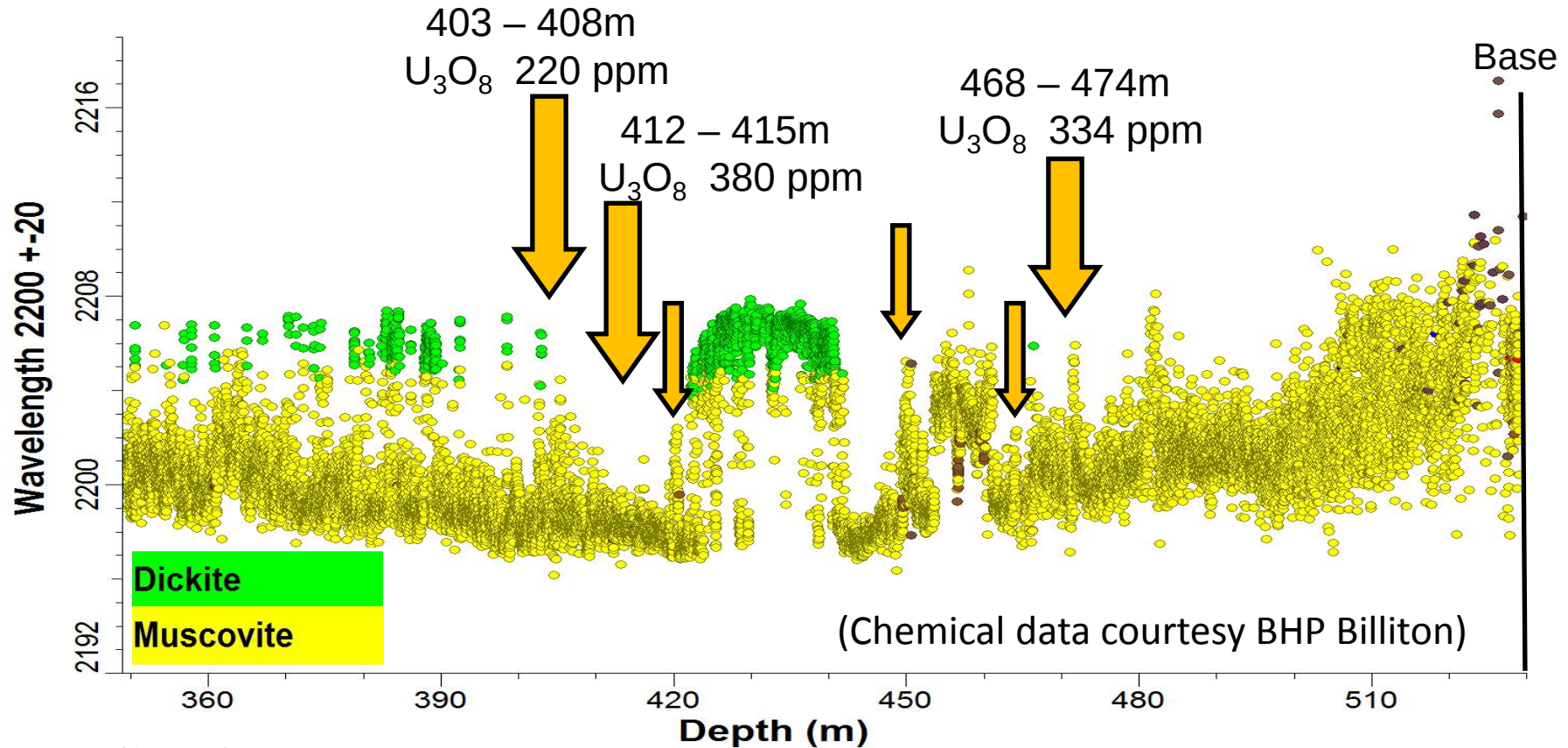
Cariewerloo Basin section



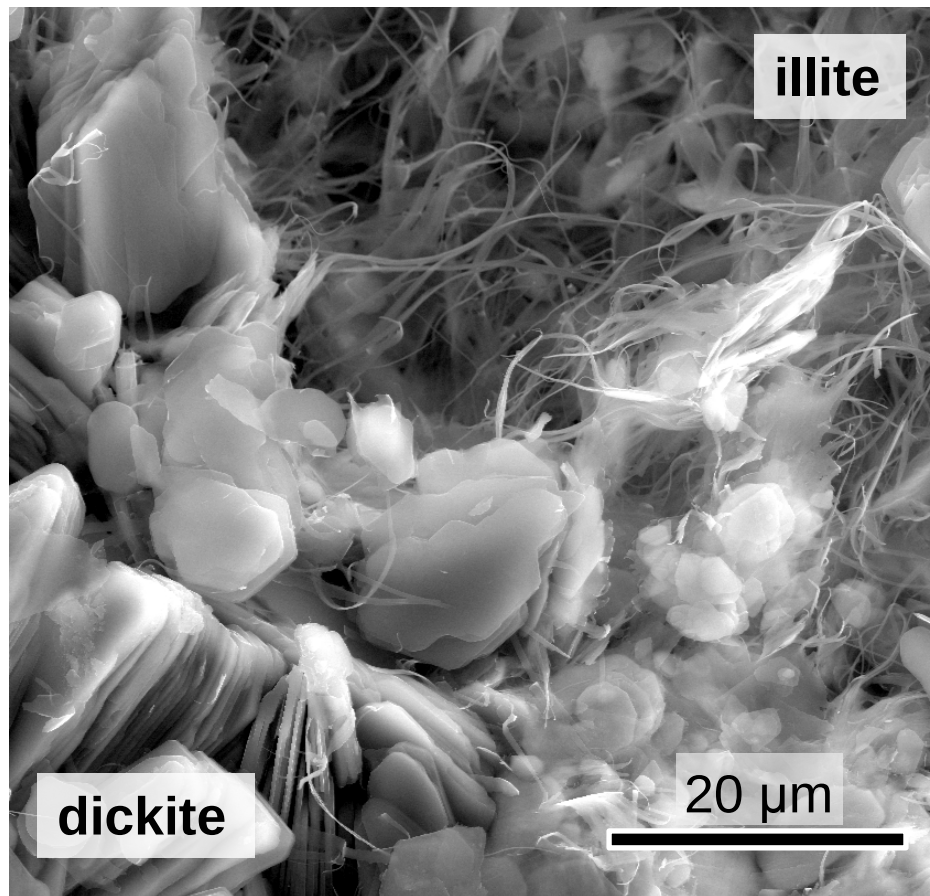
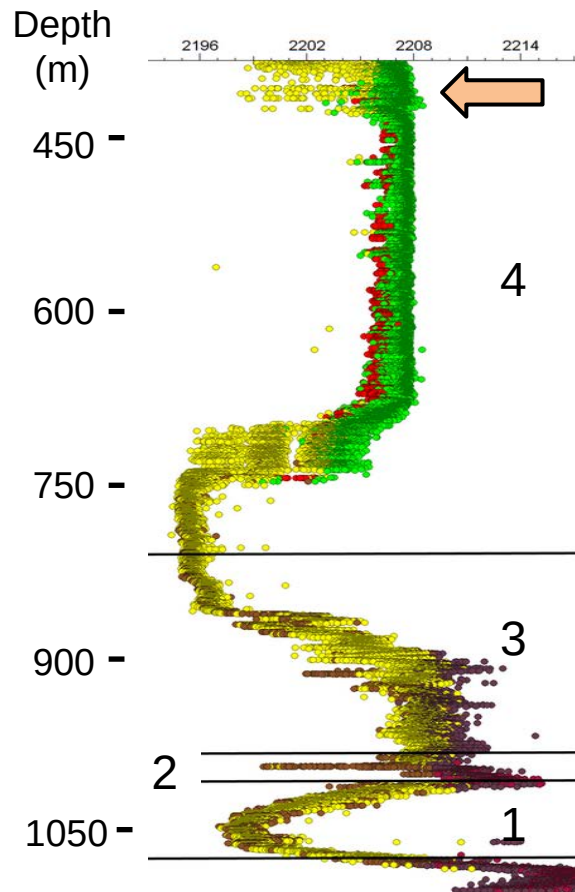
Vanguard 01: Wavelength vs depth (Al-OH absorption at ~2200 nm)



AD10: Oak Dam East – Pandurra Fm

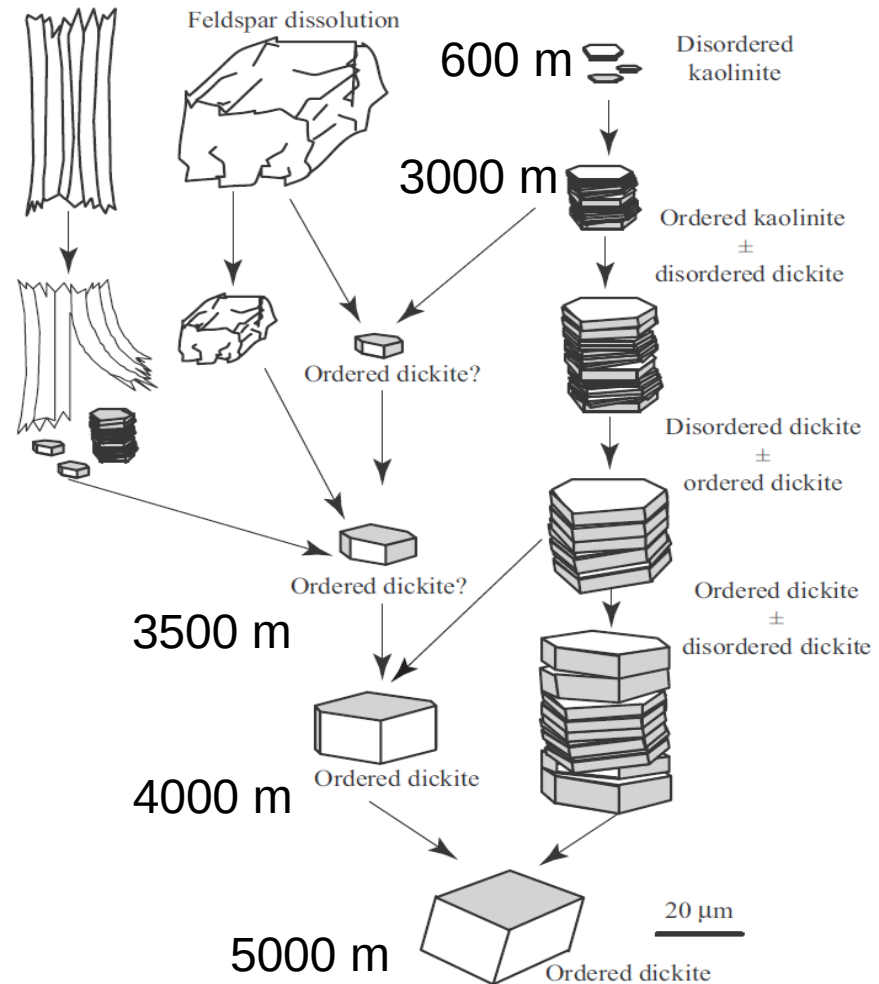


Vanguard 01: 403m 'hairy illite' alteration of dickite

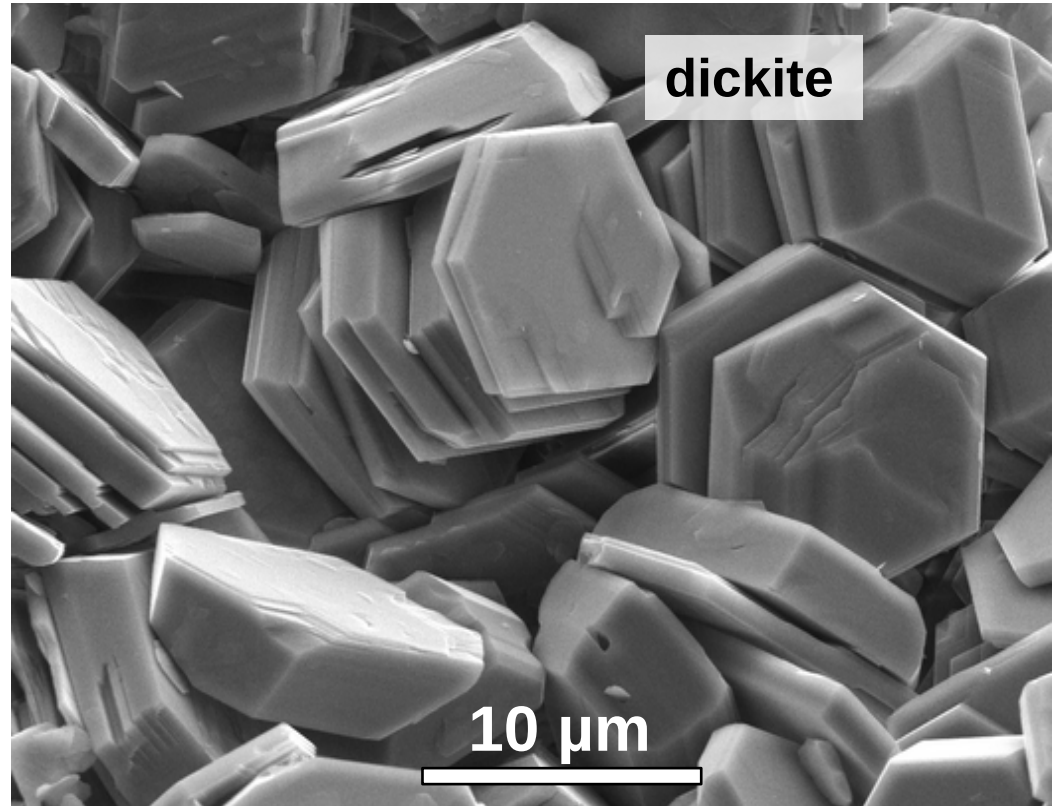
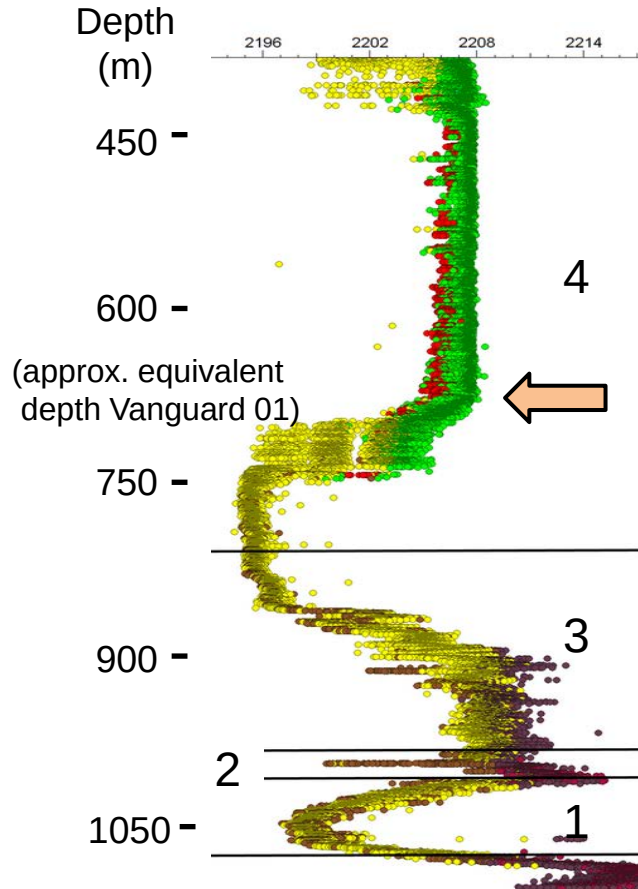


Sandstone diagenesis: Burial depth and dickite crystal thicknesss

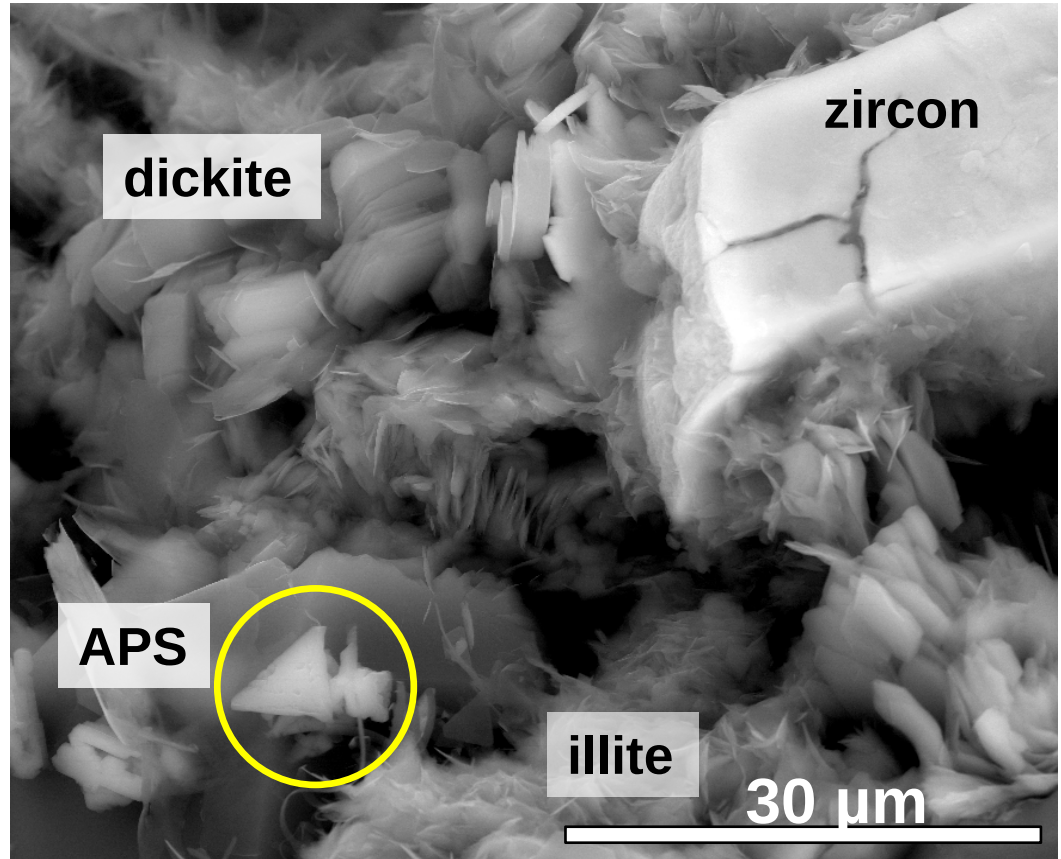
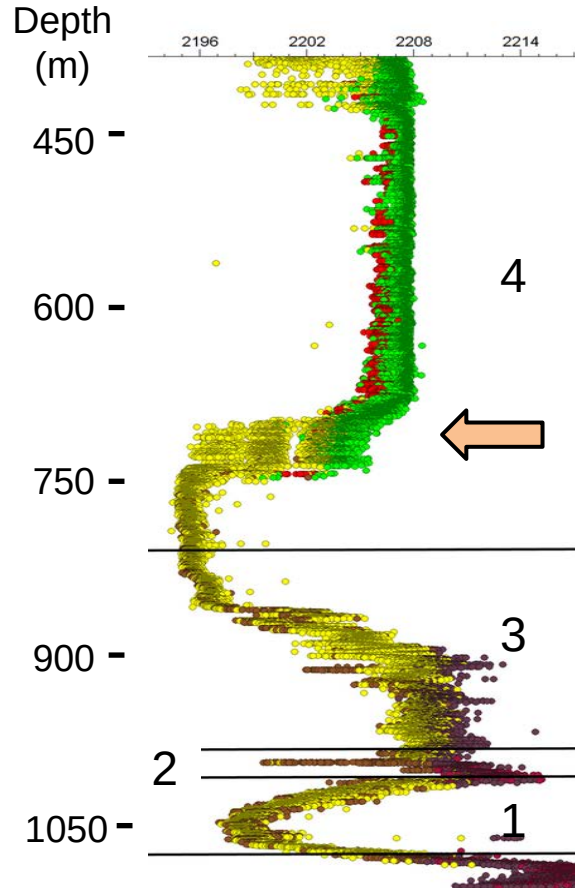
- Kaolinite / dickite crystallisation in sandstones is related to depth of burial (and temperature gradient?)
 - Dickite to Illite transformation requires influx of K^+ ions and possibly warmer fluids ($>150^{\circ}\text{C}$)
- (from Lanson et al. 2002)



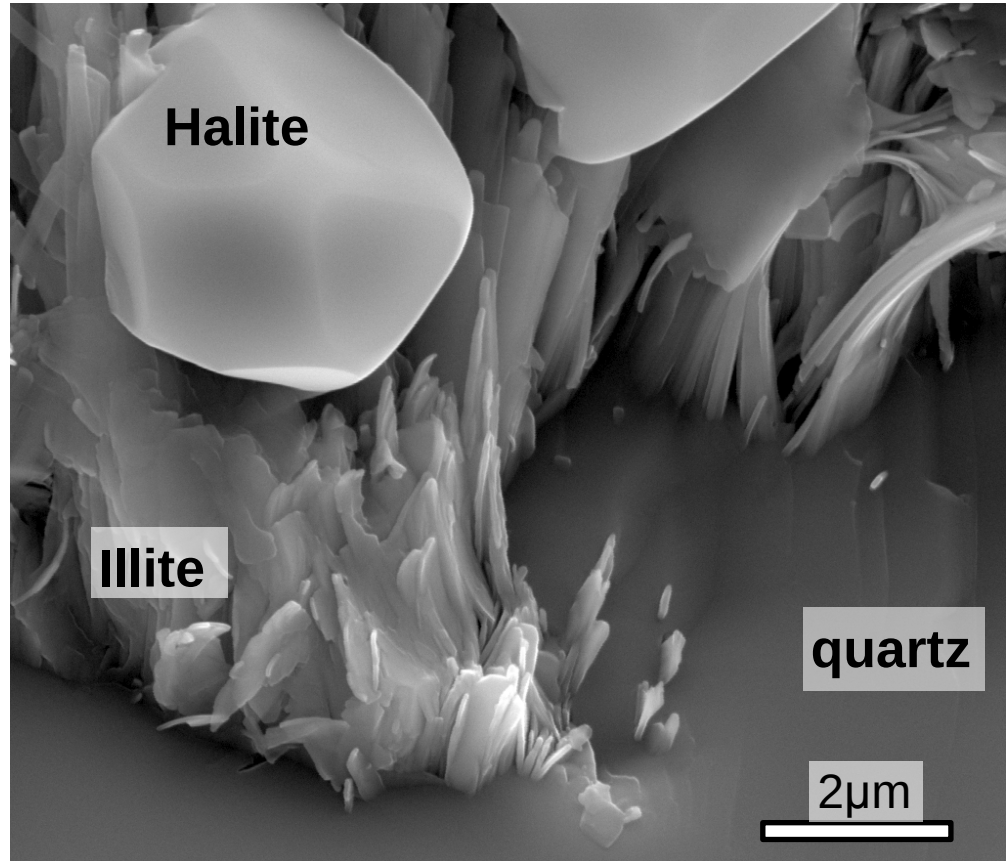
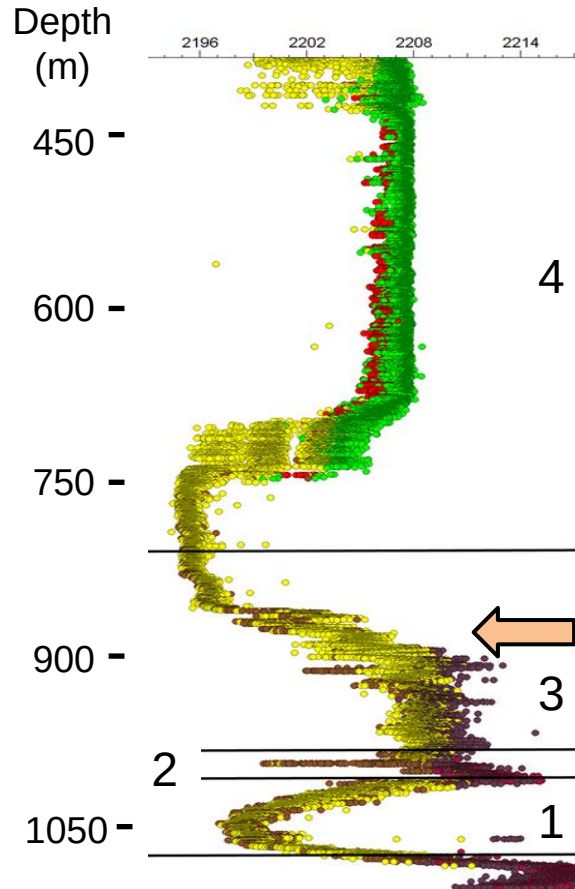
Hole LY2: 629 m - blocky dickite (3000 – 4000 m burial depth?)



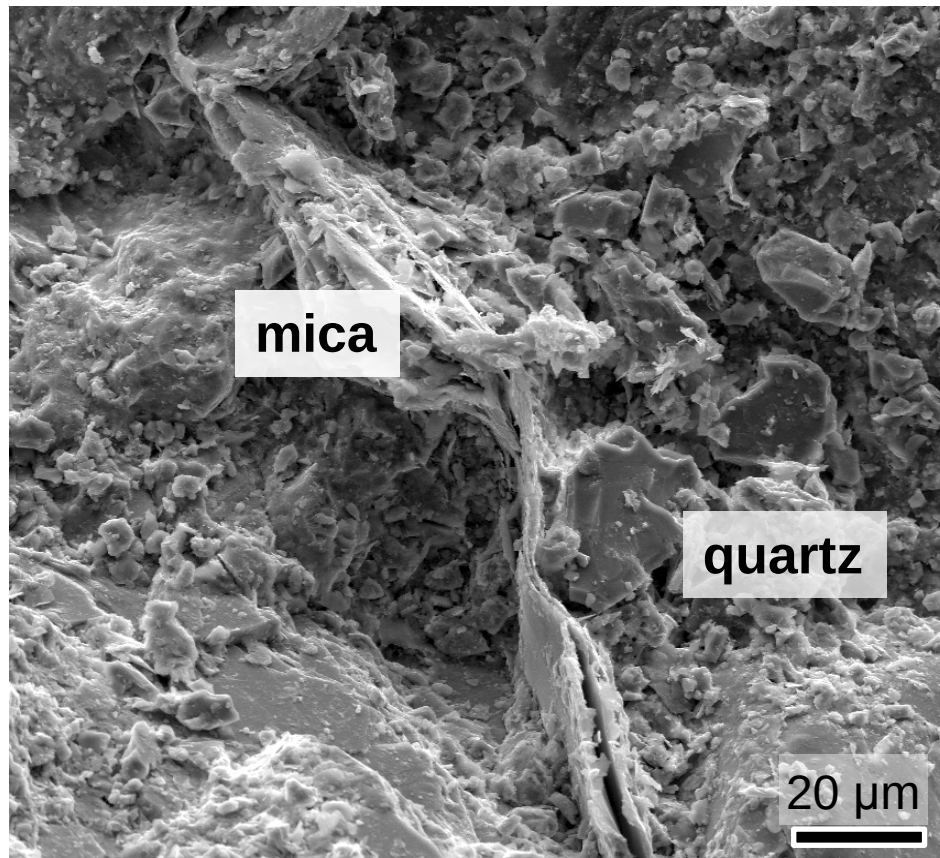
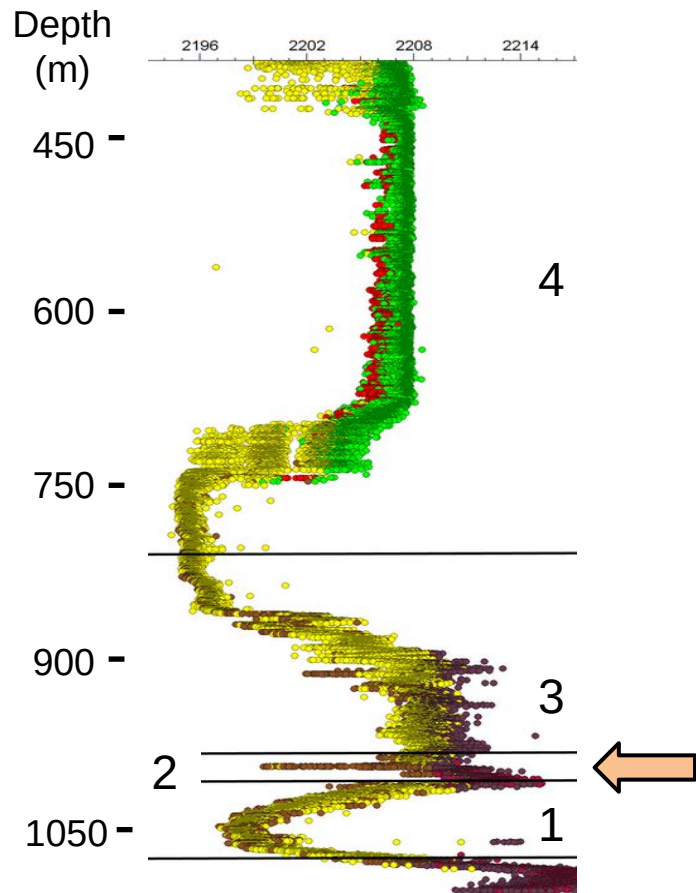
Vanguard 01: Pandurra - Member 4 (714m)



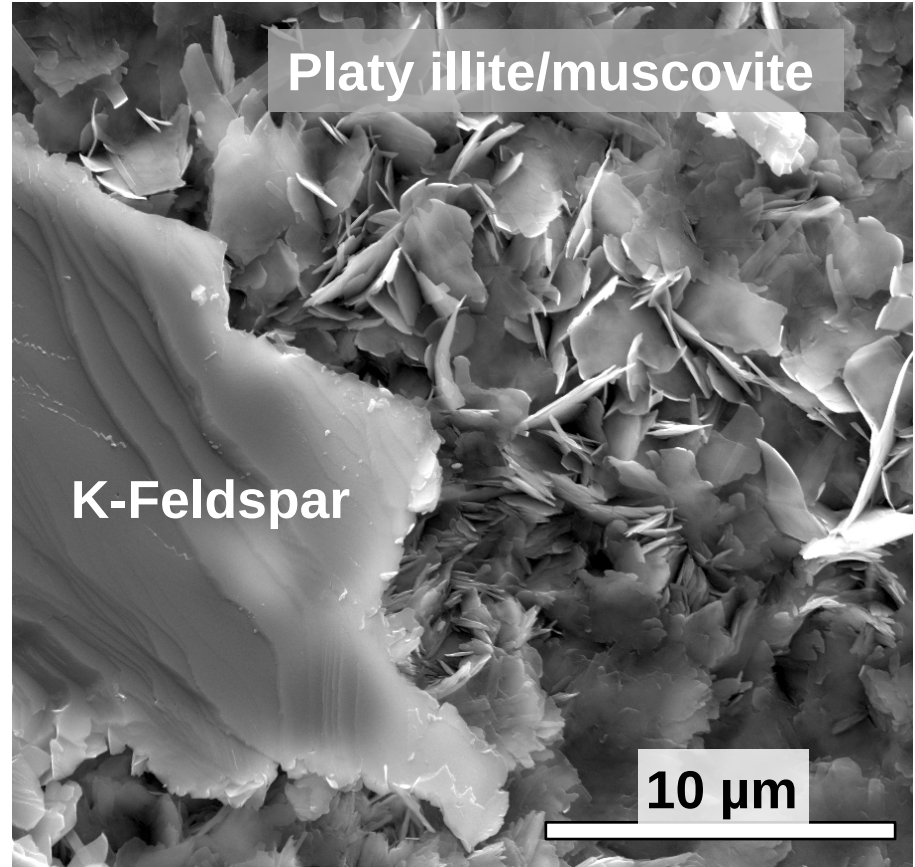
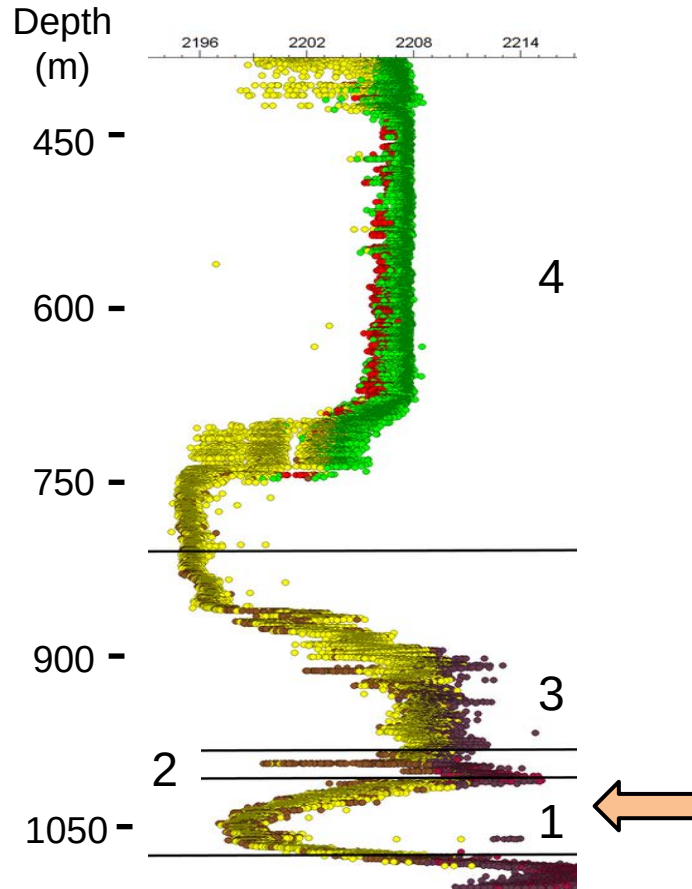
Vanguard 01: Pandurra - Member 3 (892 m)



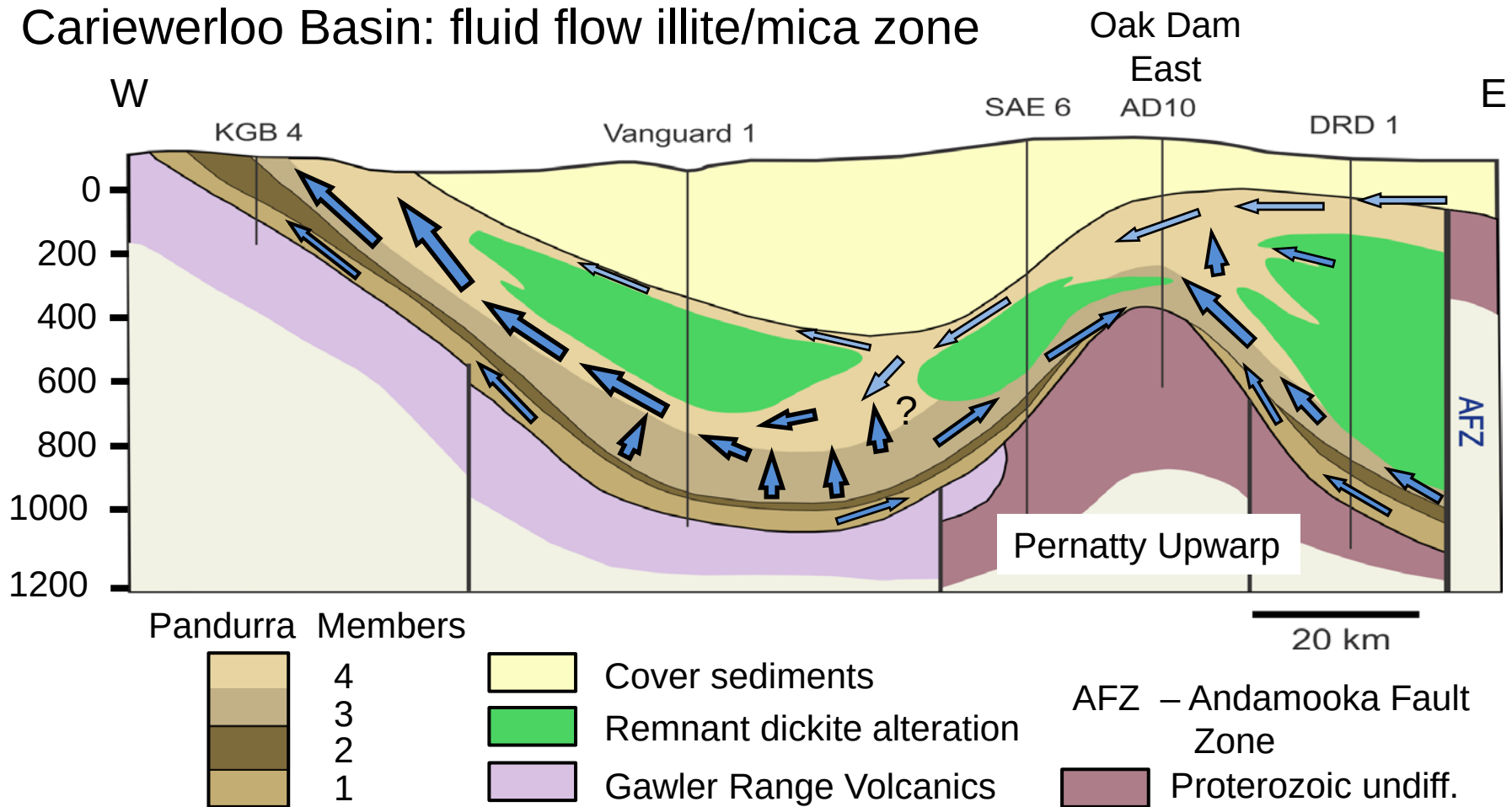
Vanguard 01: Pandurra - Member 2 (989m)



Vanguard 01: Pandurra - Member 1 (1031 m)



Cariewerloo Basin: fluid flow illite/mica zone

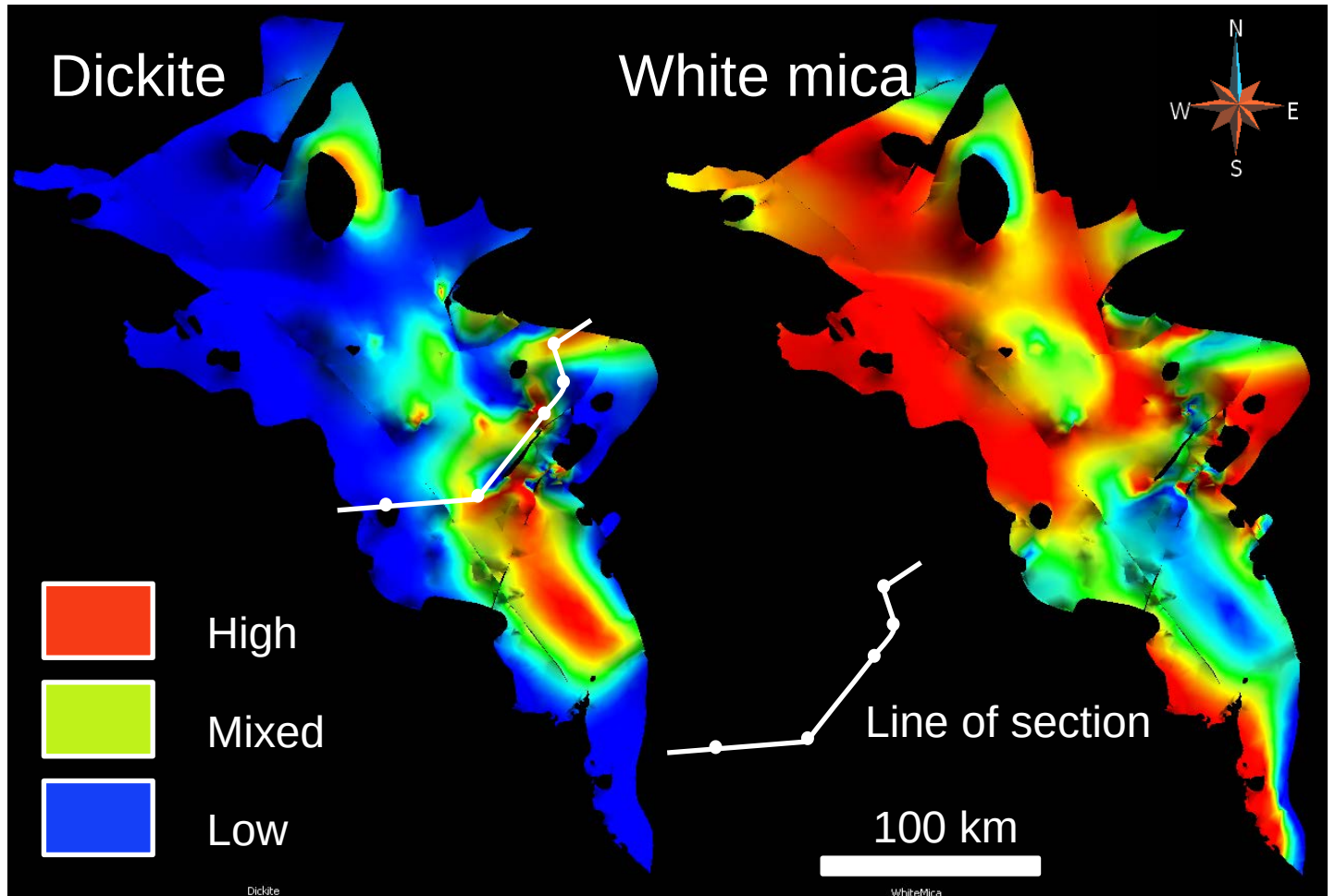


Pandurra Formation

Base of Member 4

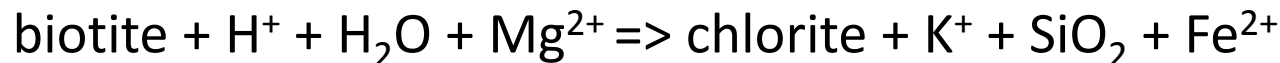
Diagenetic alteration: –

Dickite vs
White mica



Source of reductant: Fe^{2+} from silicates

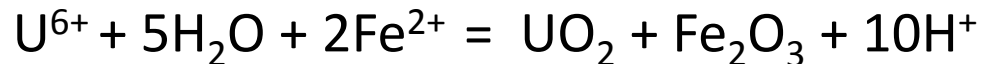
Fe^{2+} from chloritisation of biotite or illitisation of hornblende in basement rocks is a potential reductant (Alexandre, et al., 2005) :



or



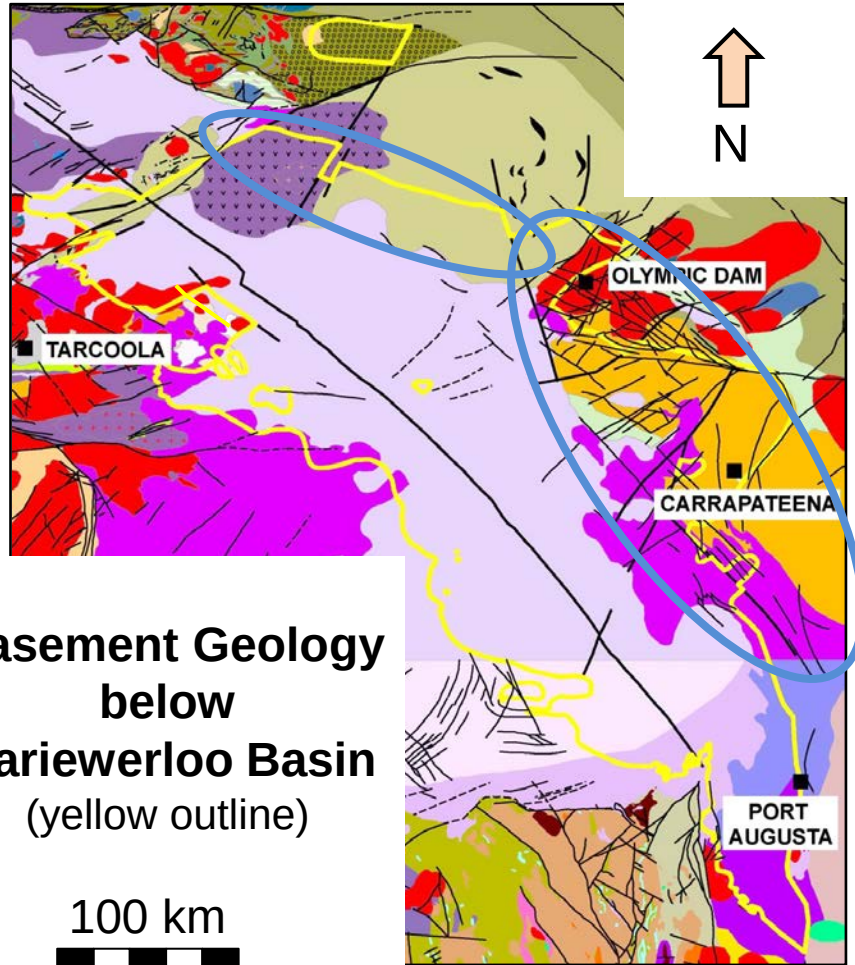
and then



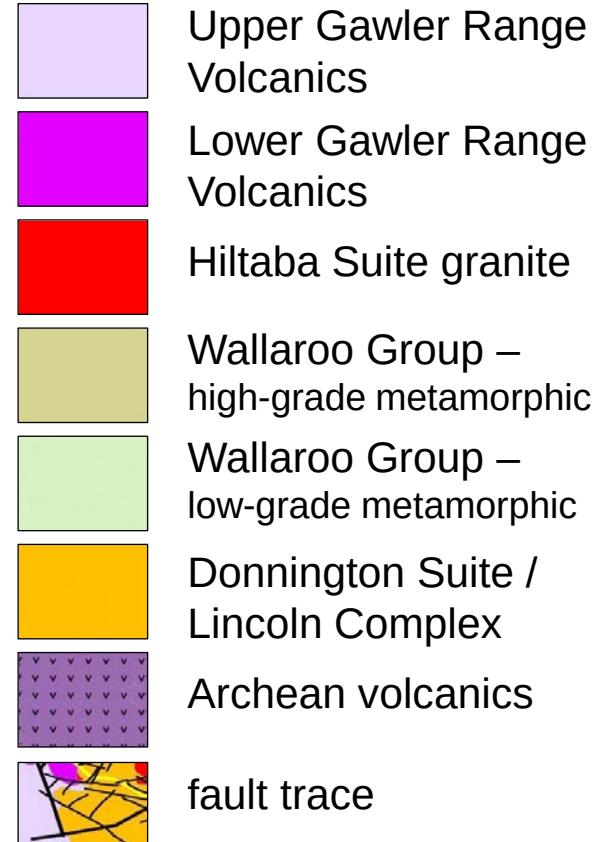
(after Yeo and Potter, 2010)

**Basement Geology
below
Cariewerloo Basin
(yellow outline)**

100 km



Legend



Summary

- Evidence for circulation of oxidising fluids capable of leaching uranium from monazite and zircon within Pandurra sandstone.
- Fluid circulation in basal sandstone (Member 1) was restricted by authigenic mica and overlying aquitard (Member 2).
- Active fluid circulation occurred in Members 3 and 4, at ~1200 Ma, but interaction with crystalline basement was limited to basin margins, active fault zones, and region of the “Pernatty Upwarp”.
- Basement rocks at “Pernatty Upwarp” and along the eastern basin margin were a potential source of reductant (Fe^{2+}).
- Spectral data facilitate mapping of diagenetic mineral alteration that can assist in interpreting fluid circulation and thereby help to focus future exploration for unconformity-related uranium.

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