THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

What are the impacts on groundwater from CSG development in the Surat Basin?

A fast tour through some of the science

Jim Underschultz

Acknowledgements: Sam Guiton, Greg Keir, Sue Vink, Sven Arnold, Nena Bulovic, Alexandra Wolhuter, Neil McIntyre, Peter Pasini and Micaela Grigorescu.

Disclaimer & Disclosure

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http://www.ccsg.uq.edu.au

What are the main challenges to improving our understanding of groundwater impacts from CSG development?

Sorry not enough time for this

1) The Water Balance

- How effective is recharge and where?
- How much recharge stays in the GAB?
- How much water is being used and from where?

2) Heterogeneity of the Rocks

- Where is the
- Is it co

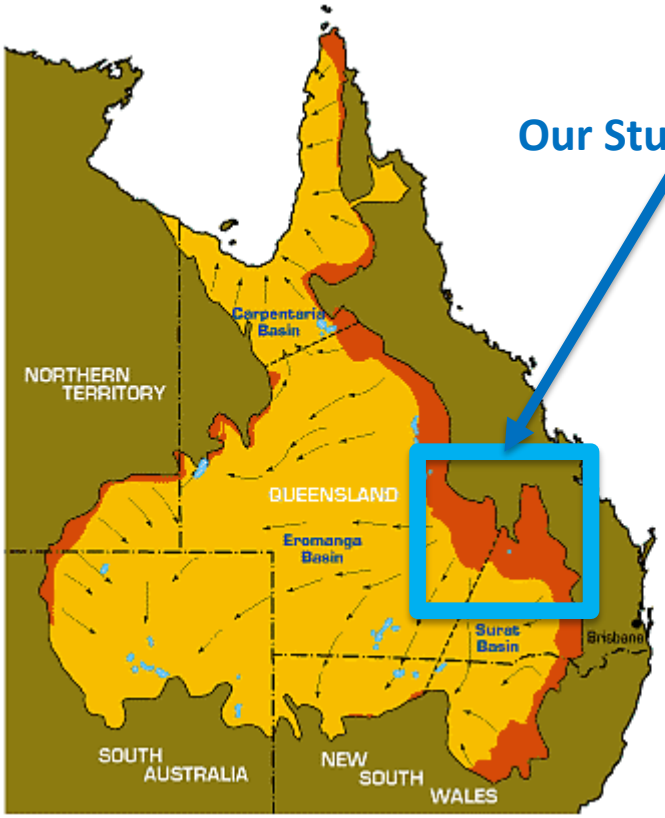
But First lets get the right Tools and Data

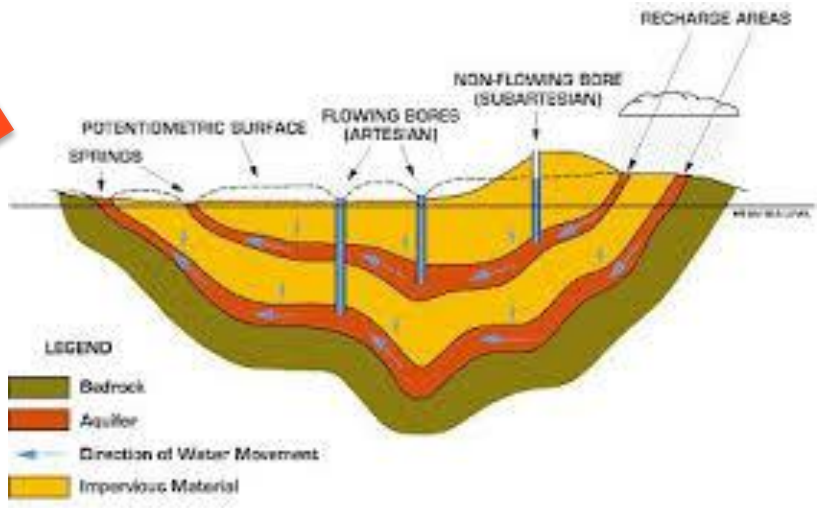
- is the water?
- Where are the hydrocarbons?
- How does gas production change this?

Water Atlas demo

2) What about Surat Basin heterogeneity?

Great Artesian Basin (a simple view)

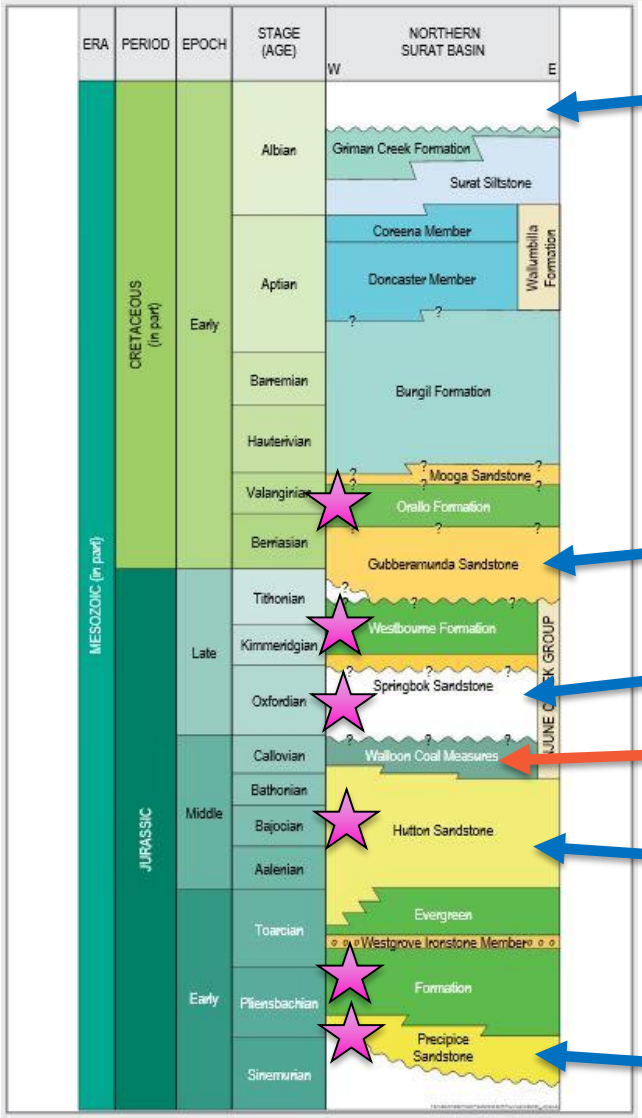




After Habermehl 1980 and friends

http://www.travelling-australia.info/Infsheets/Greatartesianbasin.html

With a complex Surat basin geology



Alluvial Aquifers (cotton irrigation)

Minor coal

Gubberamunda Aquifer (irrigation & town)

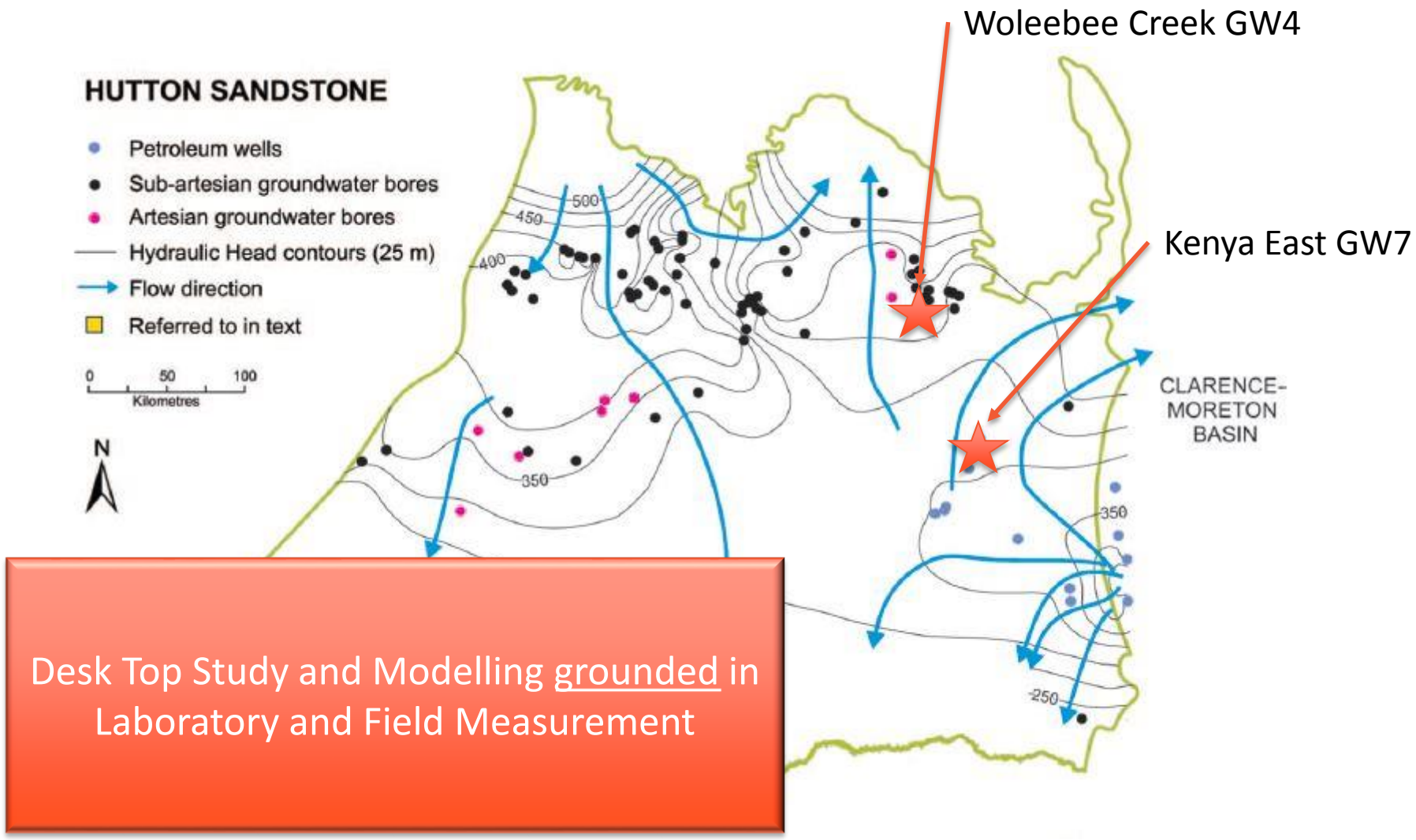
Springbok Aquifer (stock and domestic)

Commercial coal seam methane (Walloons)

Hutton Aquifer (stock and domestic)

Precipice Aquifer

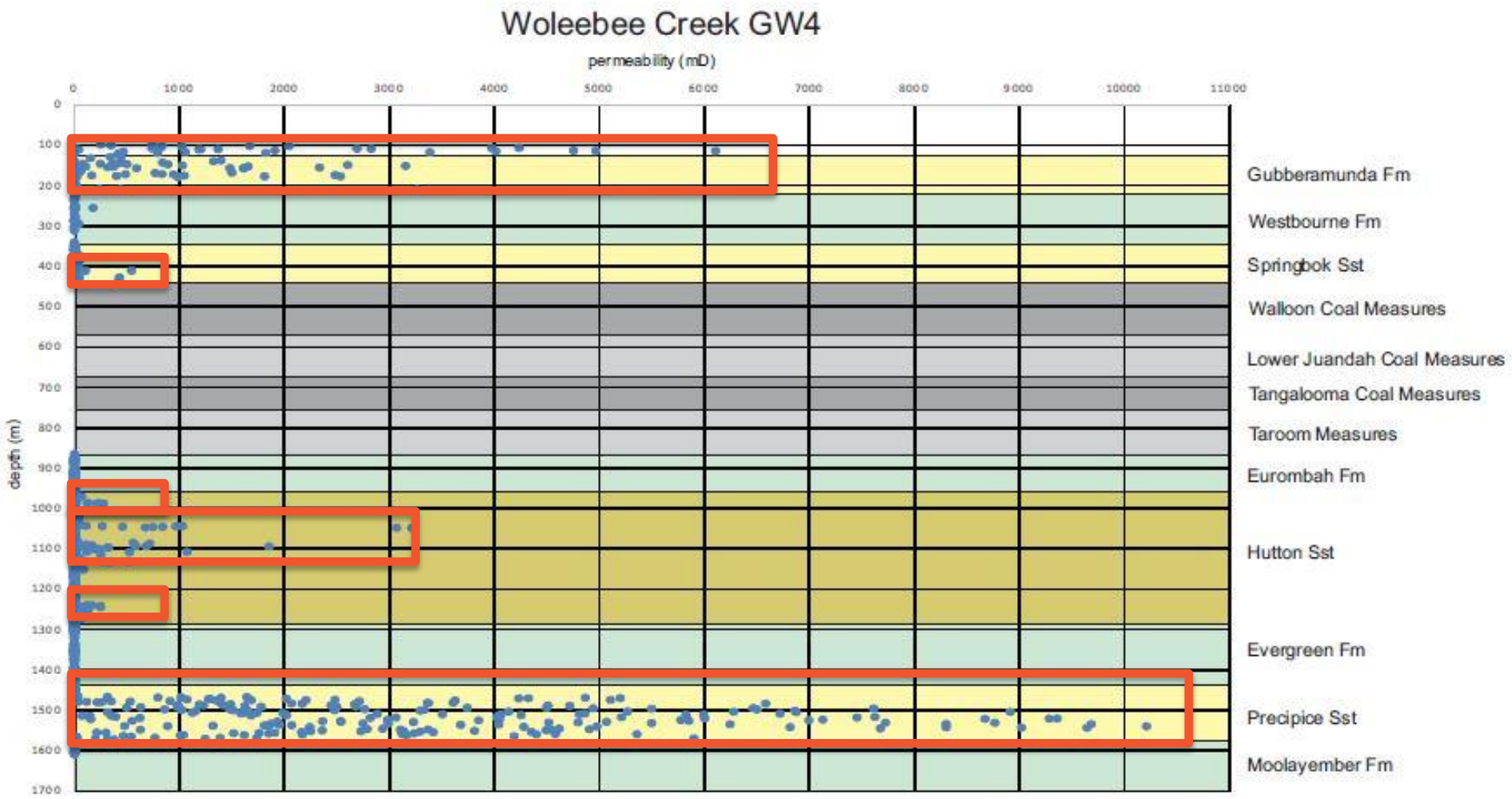
Hodgkinson, Hortle and friends say: “wait a minute……..”



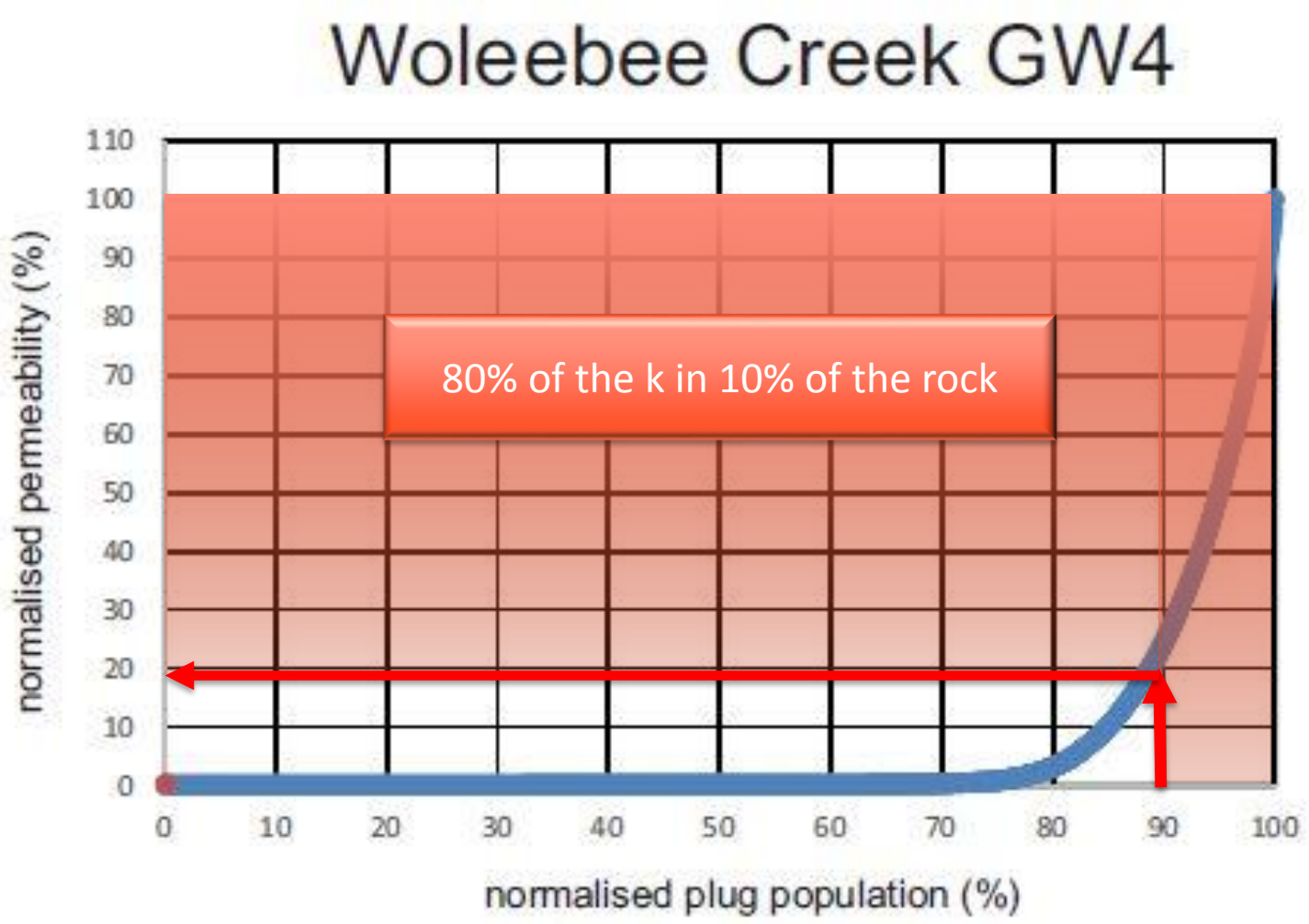
Desk Top Study and Modelling grounded in Laboratory and Field Measurement

Hodgkinson & Grigorescu (2012) AJES

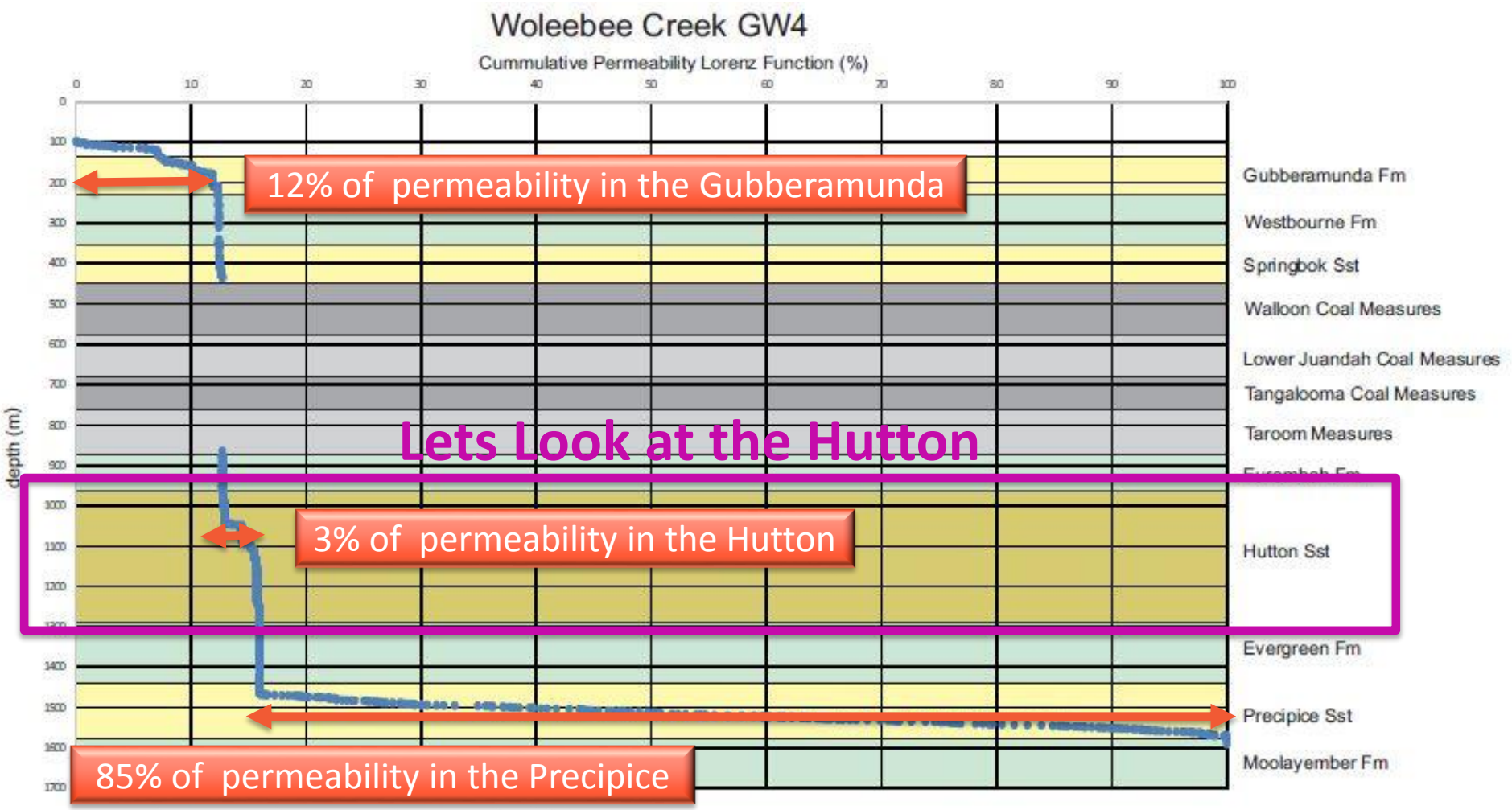
Vertical Permeability Distribution on a Normal-Scale



Permeability Distribution on a Lorenz Function Plot



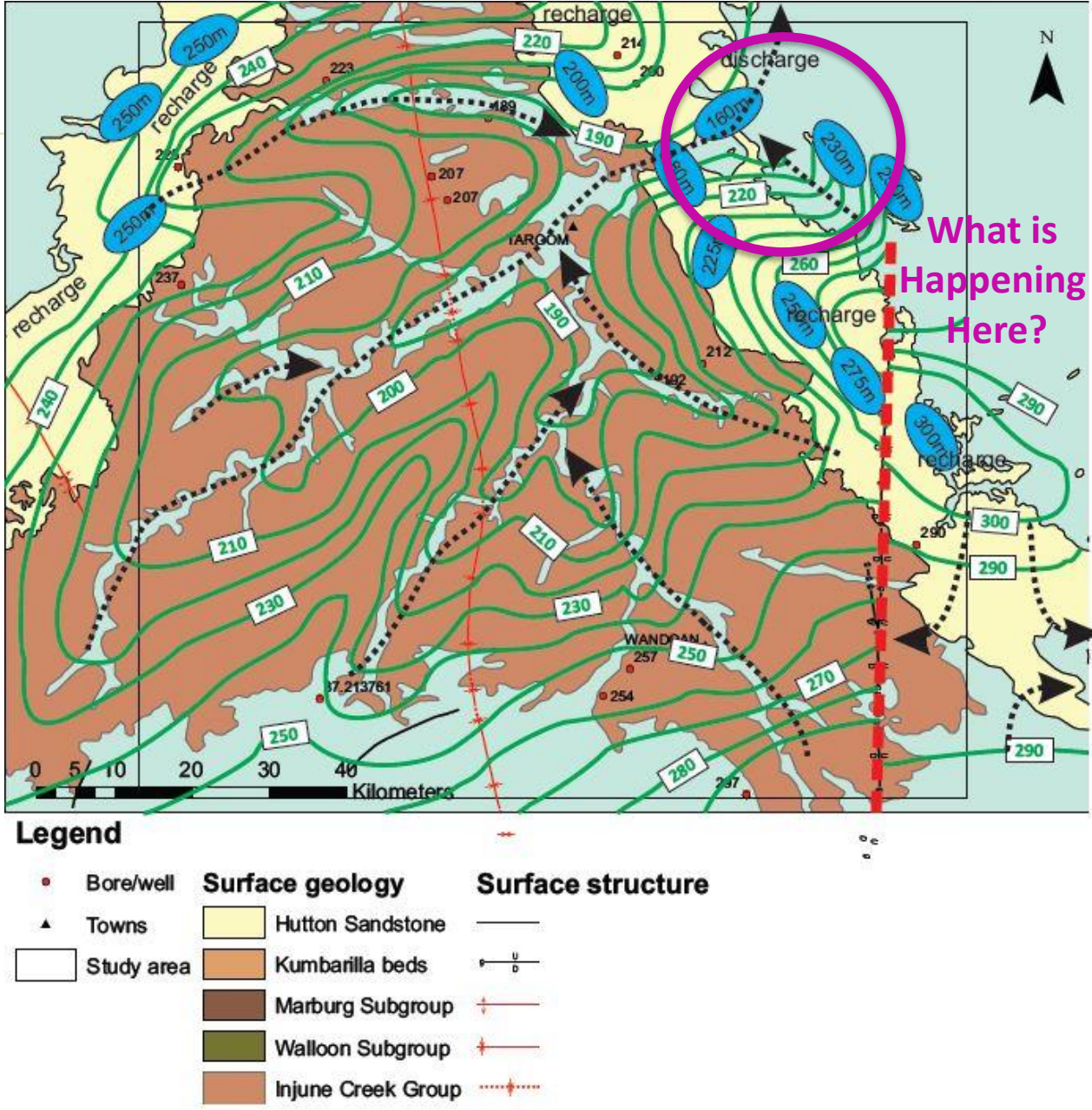
Vertical Permeability Distribution on a Cumulative-Scale



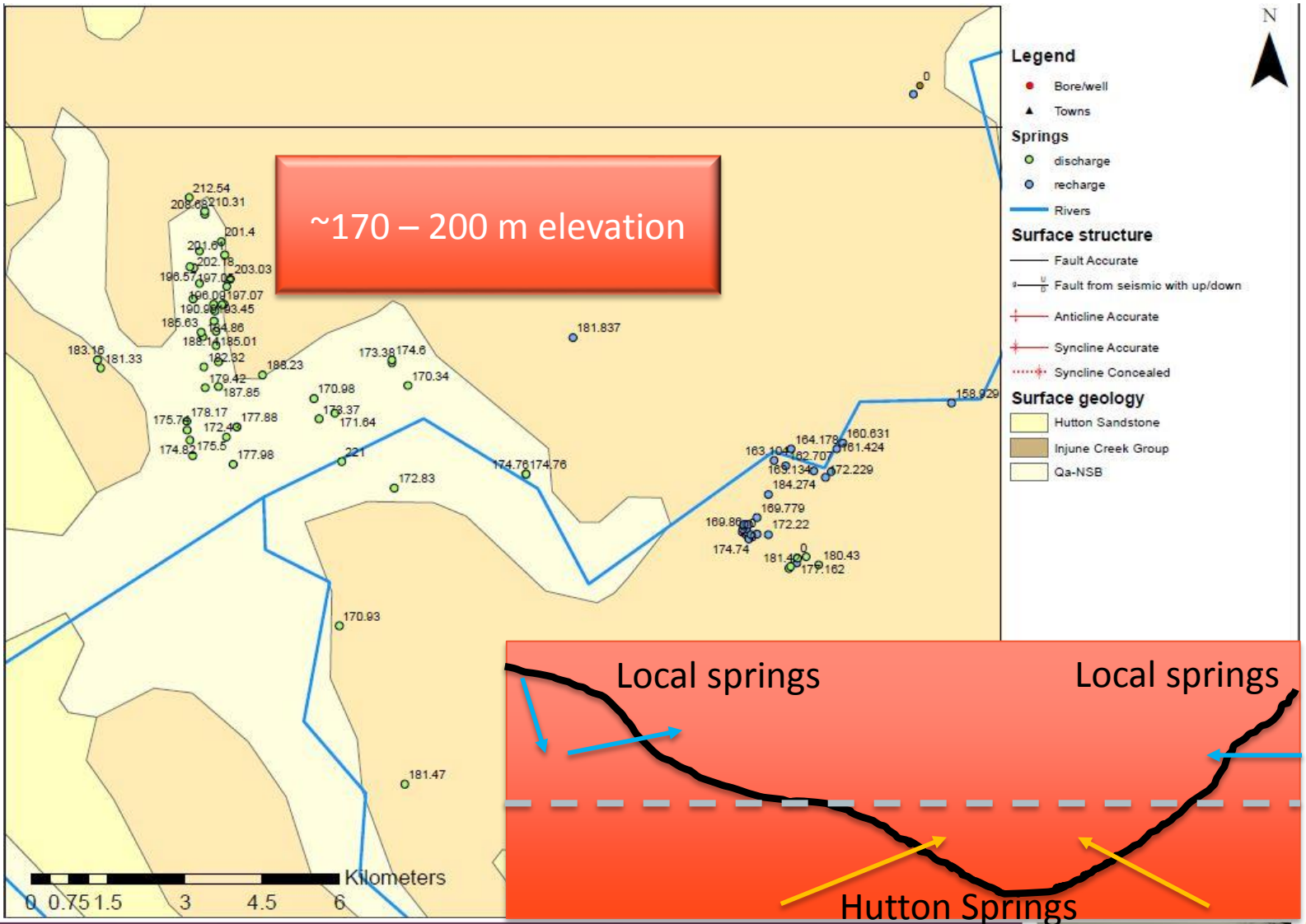
Hutton FW Head

- A stronge influence of the topography

- Heterogeneity
- 80% of flux through 10% of the rock volume?
- Regions connected linearly through lows of hydraulic head
- Discharge to subcrop



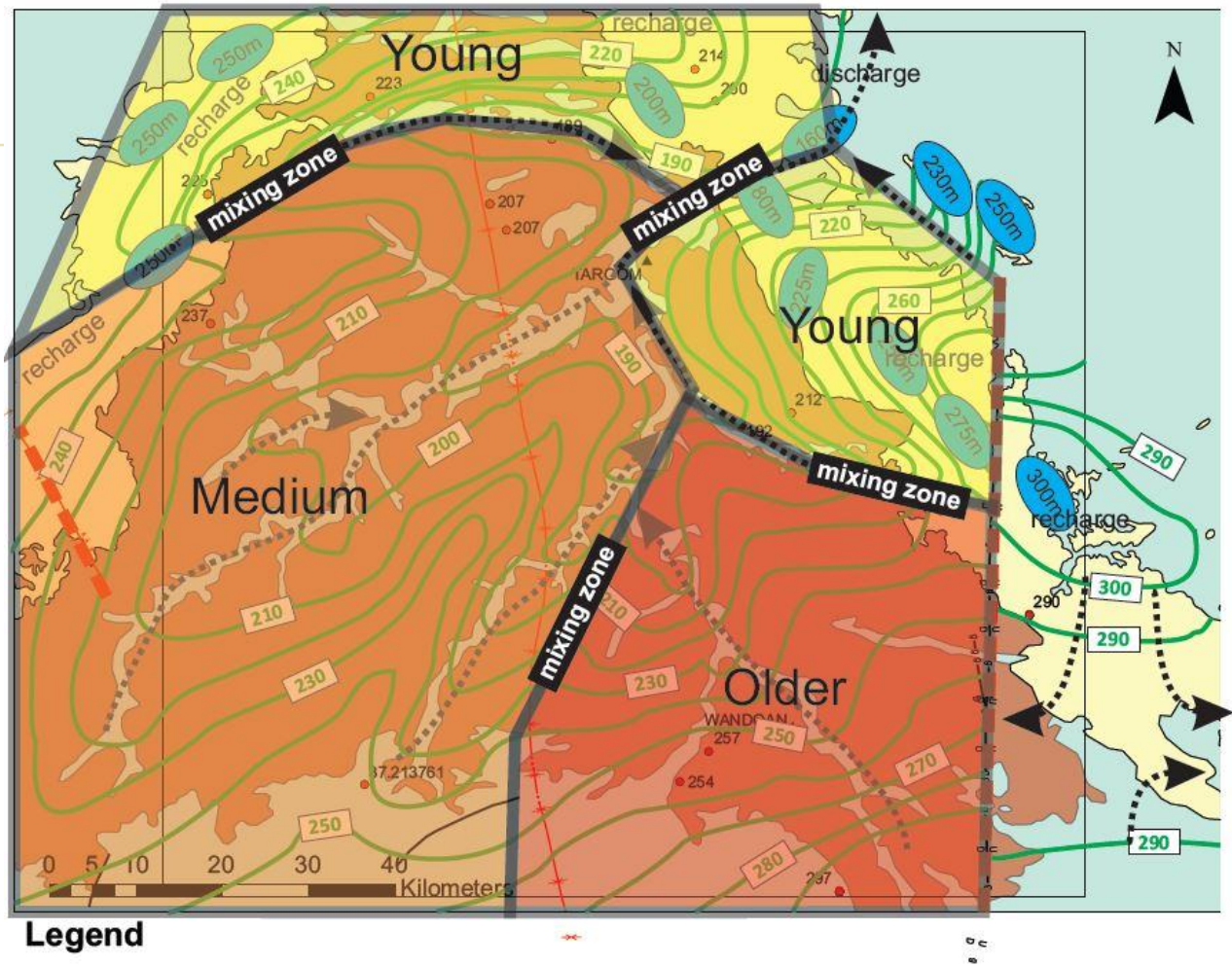
Springs data: pins the discharge area



Hutton FW Head

- Regions of various GW systems

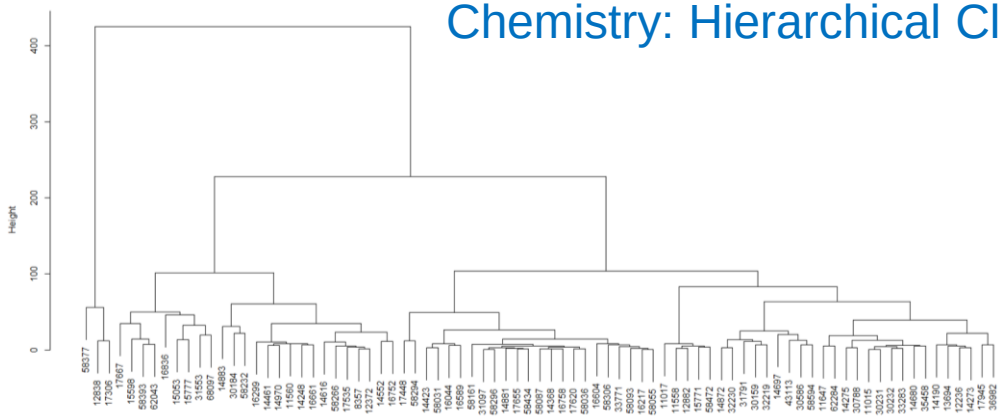
- Yellow: recharge captured by high flux to local discharge
- Orange: separated from recharge but draining toward high flux local discharge
- Red: sheltered from recharge but draining toward high flux local discharge
- Boundaries are mixing zones

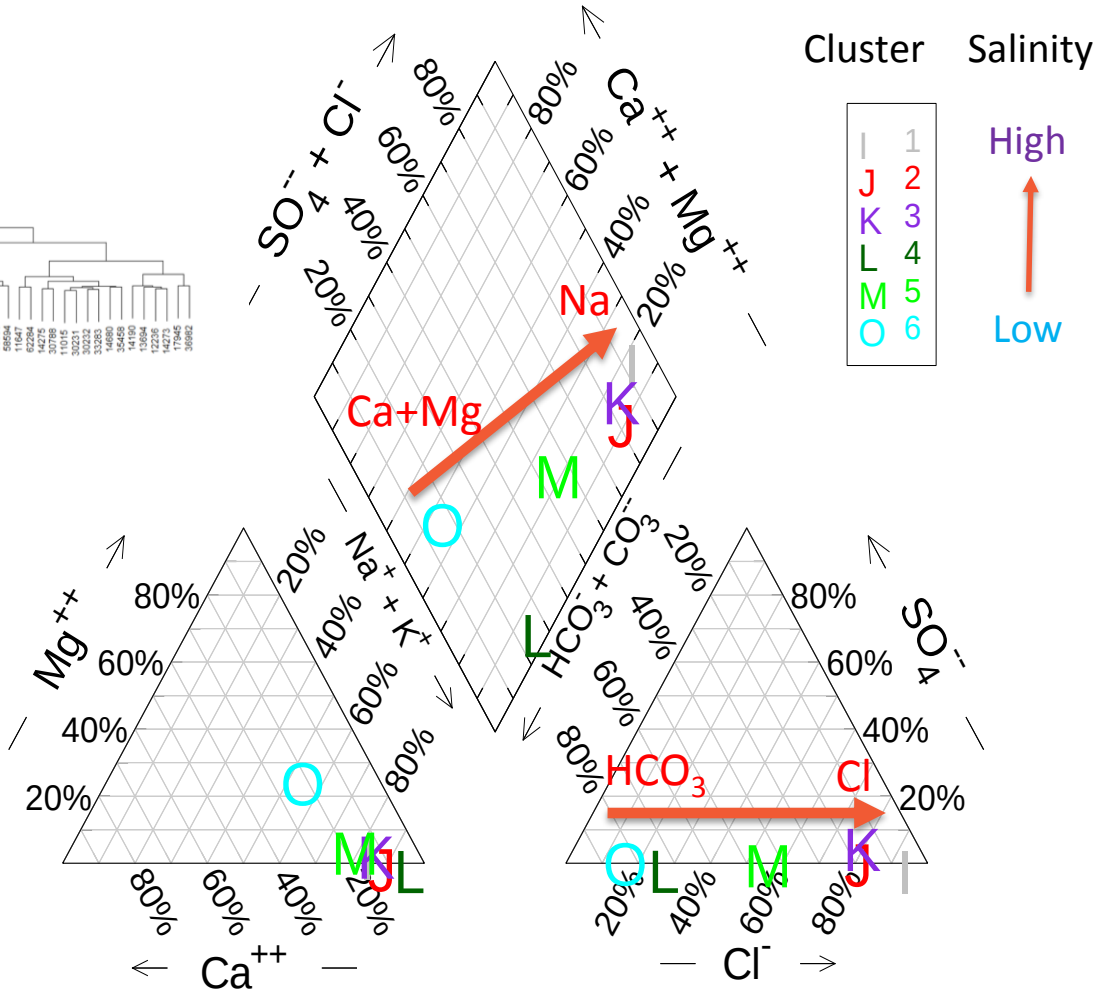


Virtually none of the recharge is heading to the regional GAB

3) The Nature of the Fluids

Chemistry: Hierarchical Cluster Analysis on 6 clusters

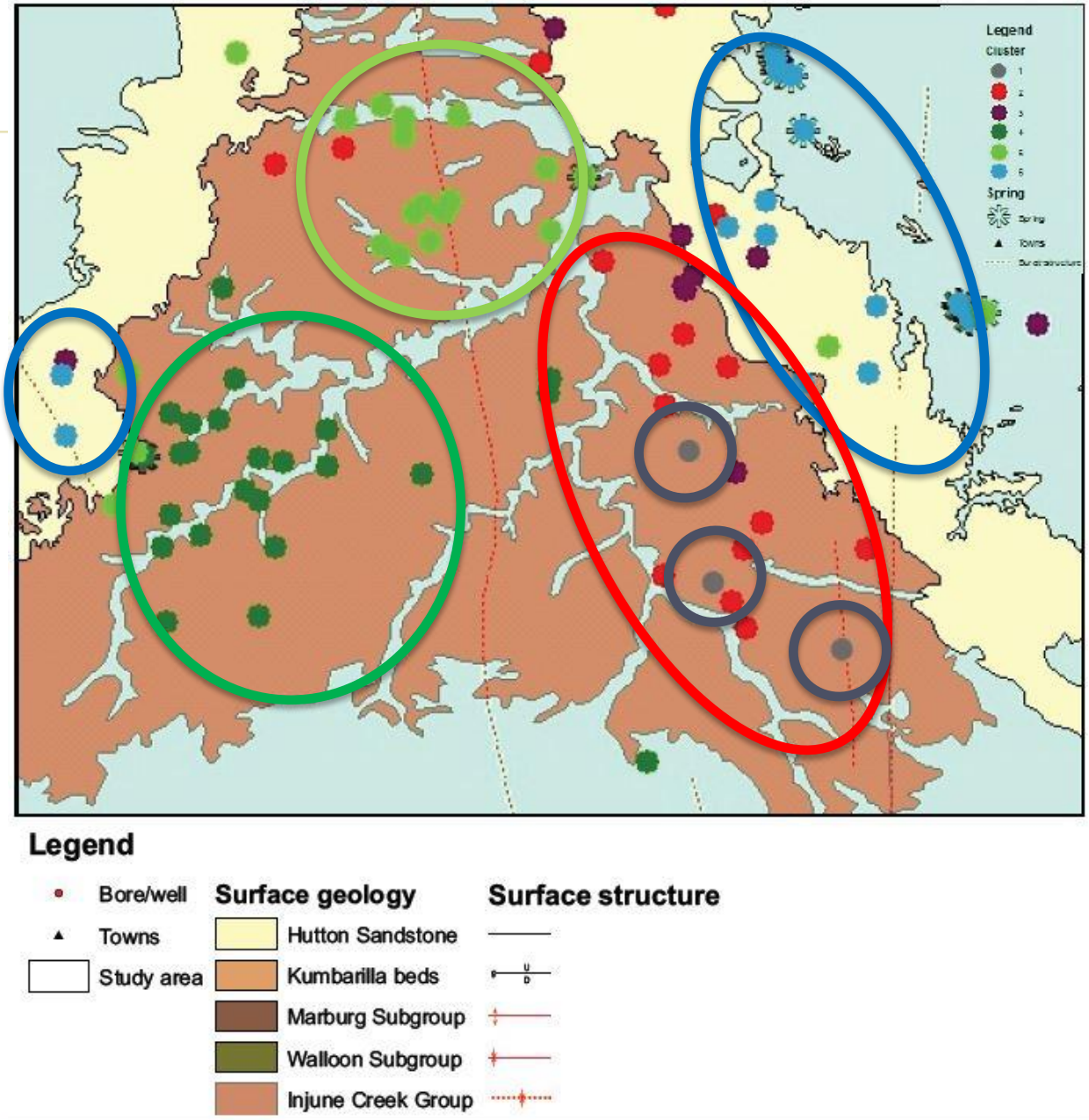




- Recharge = Fresh, HCO_3 > Cl & high Mg, Ca
- Trending to higher EC NaCl dominant

Water Chemistry

- Cluster 6: Fresh & higher HCO_3 , Ca, & Mg
- Cluster 5:
- Cluster 4:
- Cluster 3 & 2:
- Cluster 1: More saline & NaCl dominated has signature of coal?



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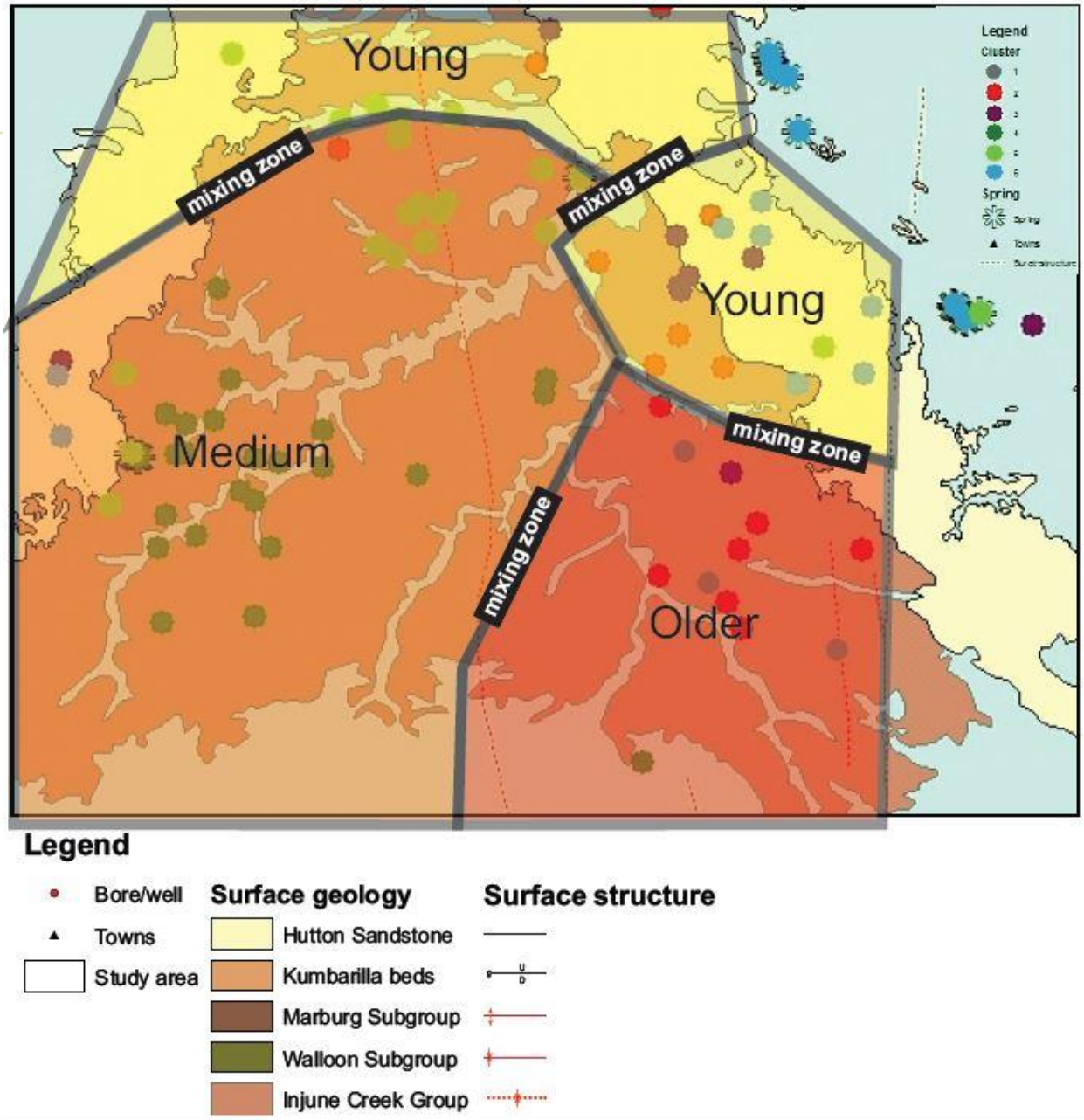
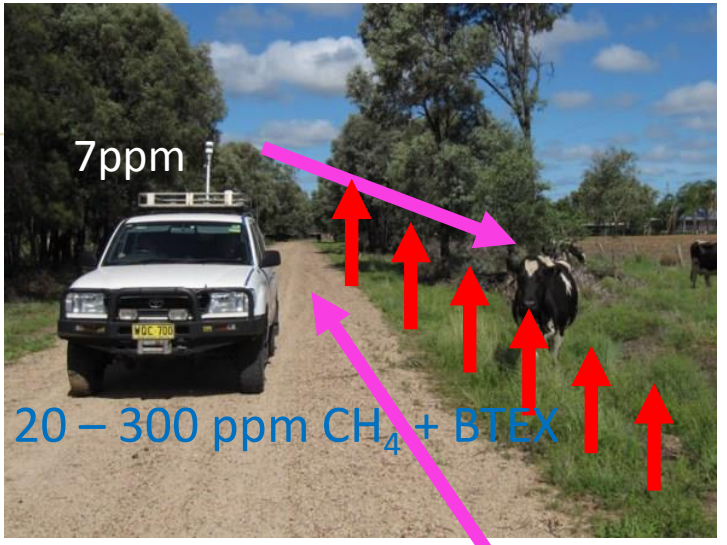


3) What about Gas?

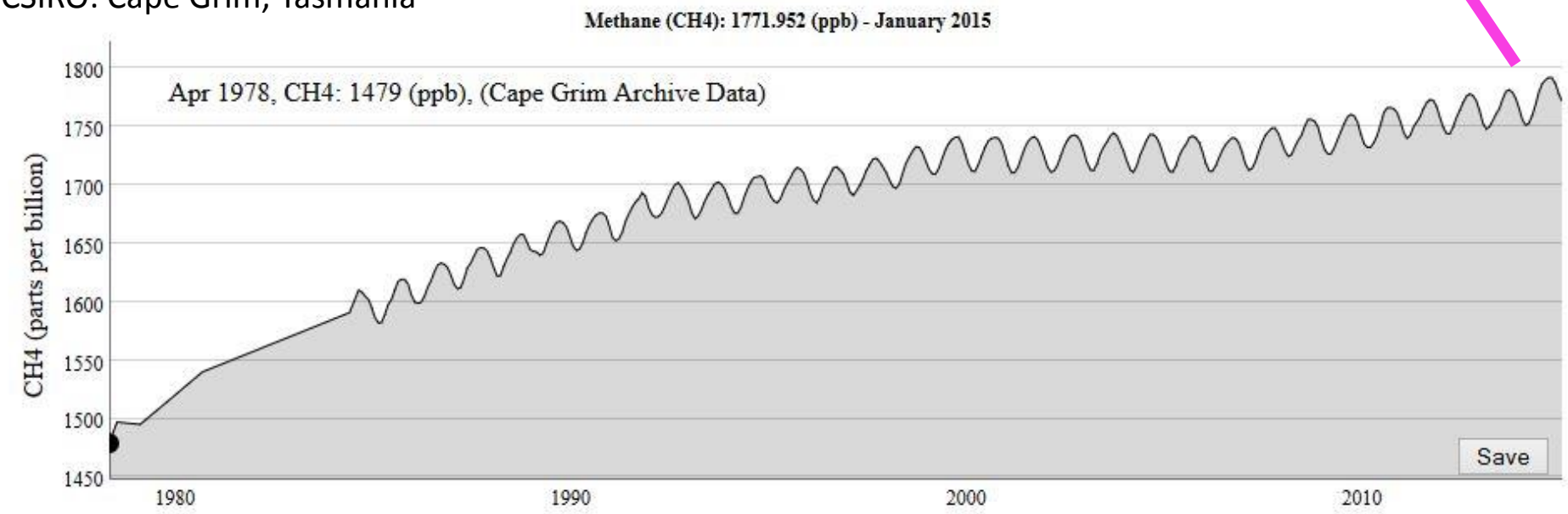
Fugitive CH_4 is complicated:

- Natural levels of methane in atmosphere and sub-surface
- Surface emissions from infrastructure
- Surface emissions diverse sources
- Changes in sub-surface environments
- How do we measure and where?
- It all changes over time



http://csironewsblog.com/2014/08/01/coal-seam-gas-emissions-lower-than-us-first-australian-study/

CSIRO: Cape Grim, Tasmania



3) Sub-surface Gas?

Understanding methane occurrence in the groundwater of coal basins:

Can we use historical O&G and Water Monitoring data to help define a baseline?

Can we define a quantitative approach to estimating the distribution of Flux to Surface?

What does this say about aquitard performance?

http://www.miningaustralia.com.au/news/no-conclusion-yet-for-condamine-river-csg-seepage

Soil Gas

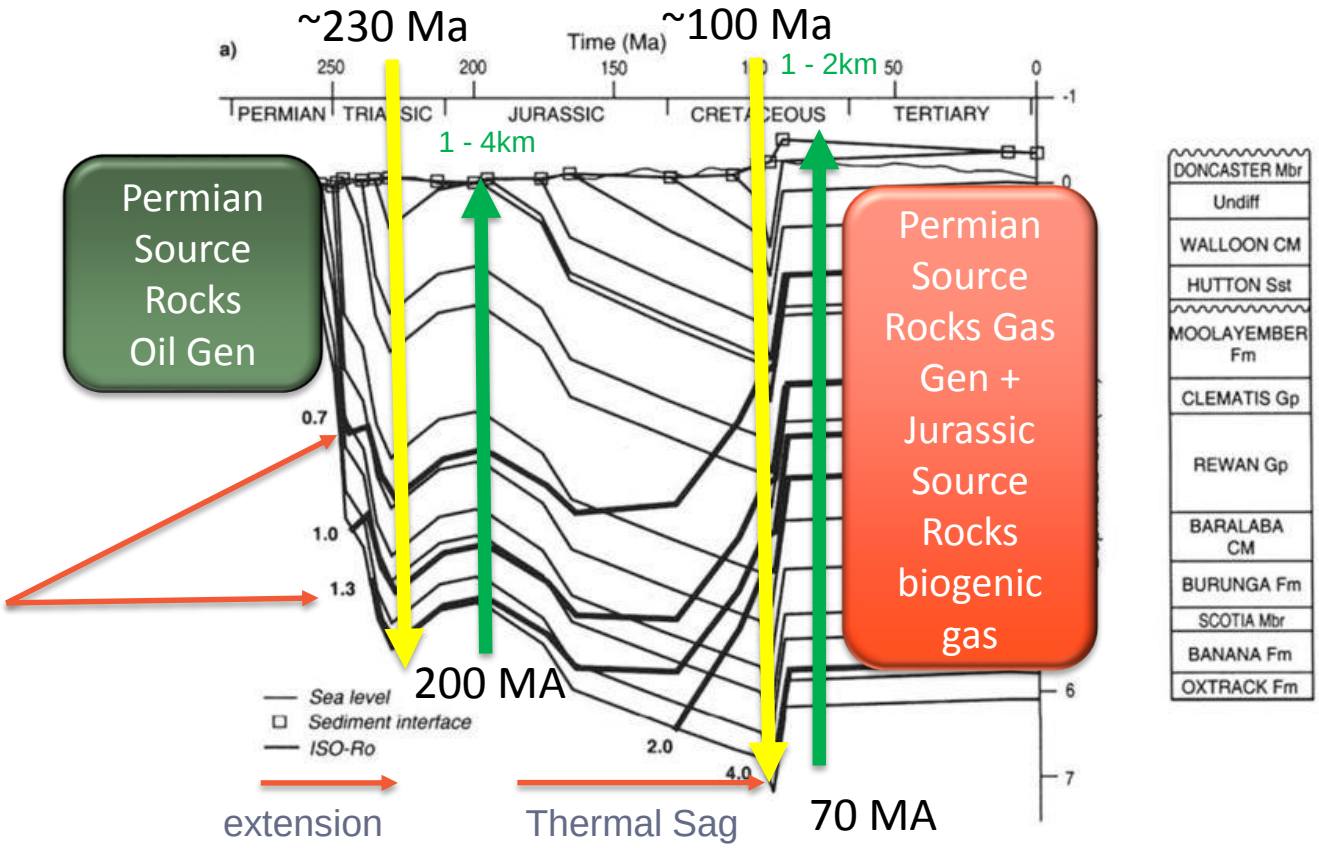
Year	Location	No. of Samples	Methane Range [ppm]
1983	Giligulgul (Wandoan)	258	2.5 - 48
1987	Chinchilla	58	1.2 - 25.5
1988	St George	314	1.9 - 89.1
	Bungil (South of Roma)	322	0.1 - 48.7
1989	Kalima (near Roma)	158	1.7 - 14.8
	Chinchilla	150	1.7 - 22.1
1991	Glenmorgan	534	8.09 - 42.45

Gas Fields Commission, Queensland

How we explored the research question…

Create a Hydrocarbon Habitat:

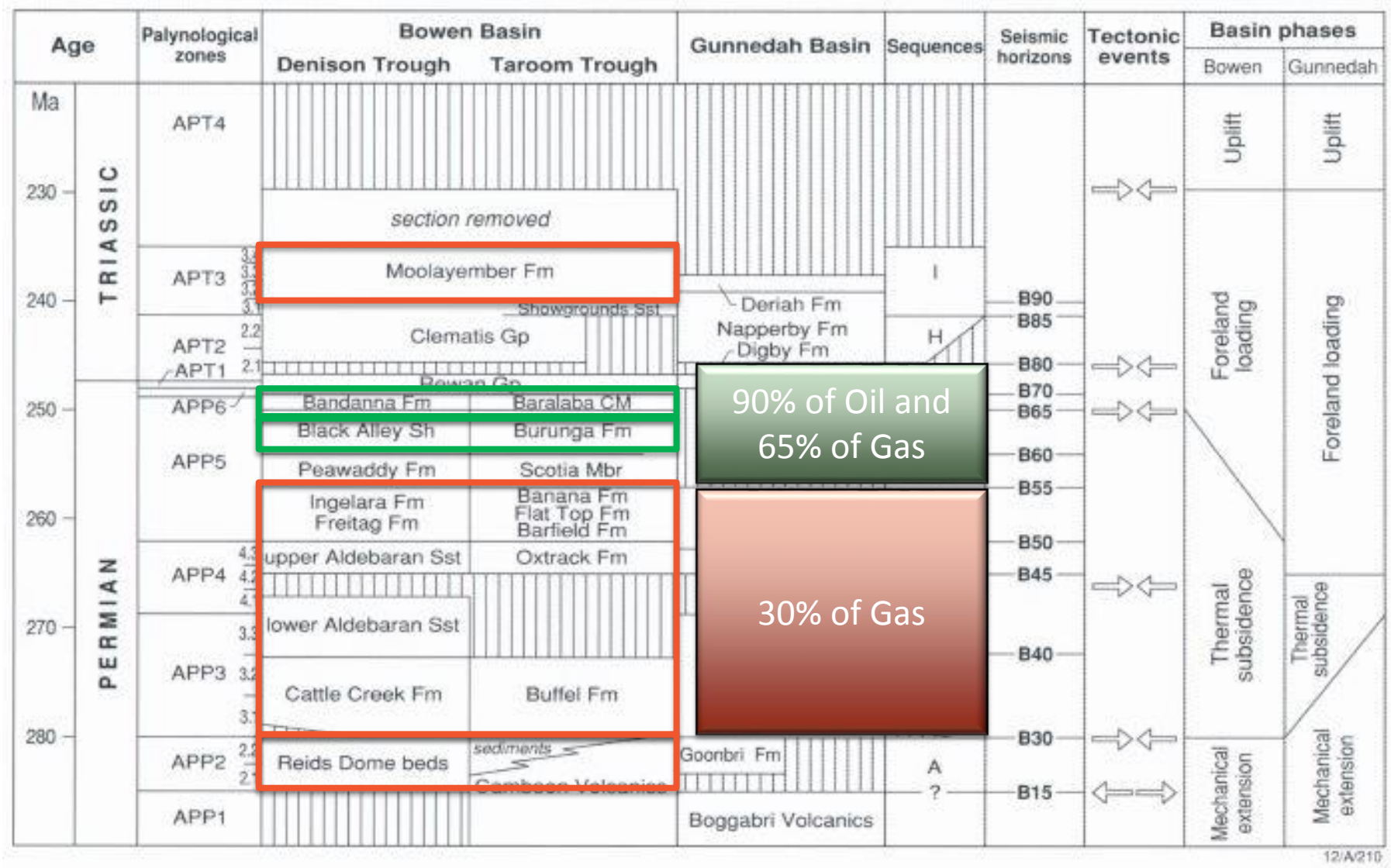
- Burial History
- Source Rock
- H/C Generation
- H/C Pools
- H/C migration fingerprints



Oil and gas window

Chris Boreham 1999

Bowen and Surat Hydrocarbon Generation (Boreham and others)



Where did all the hydrocarbon Go?

Calculated H/C generation (50% uncertainty)

- >3,400 billion barrels of Oil
- >2,700 billion barrels Oil equiv Gas (Shaw et al. 2000)

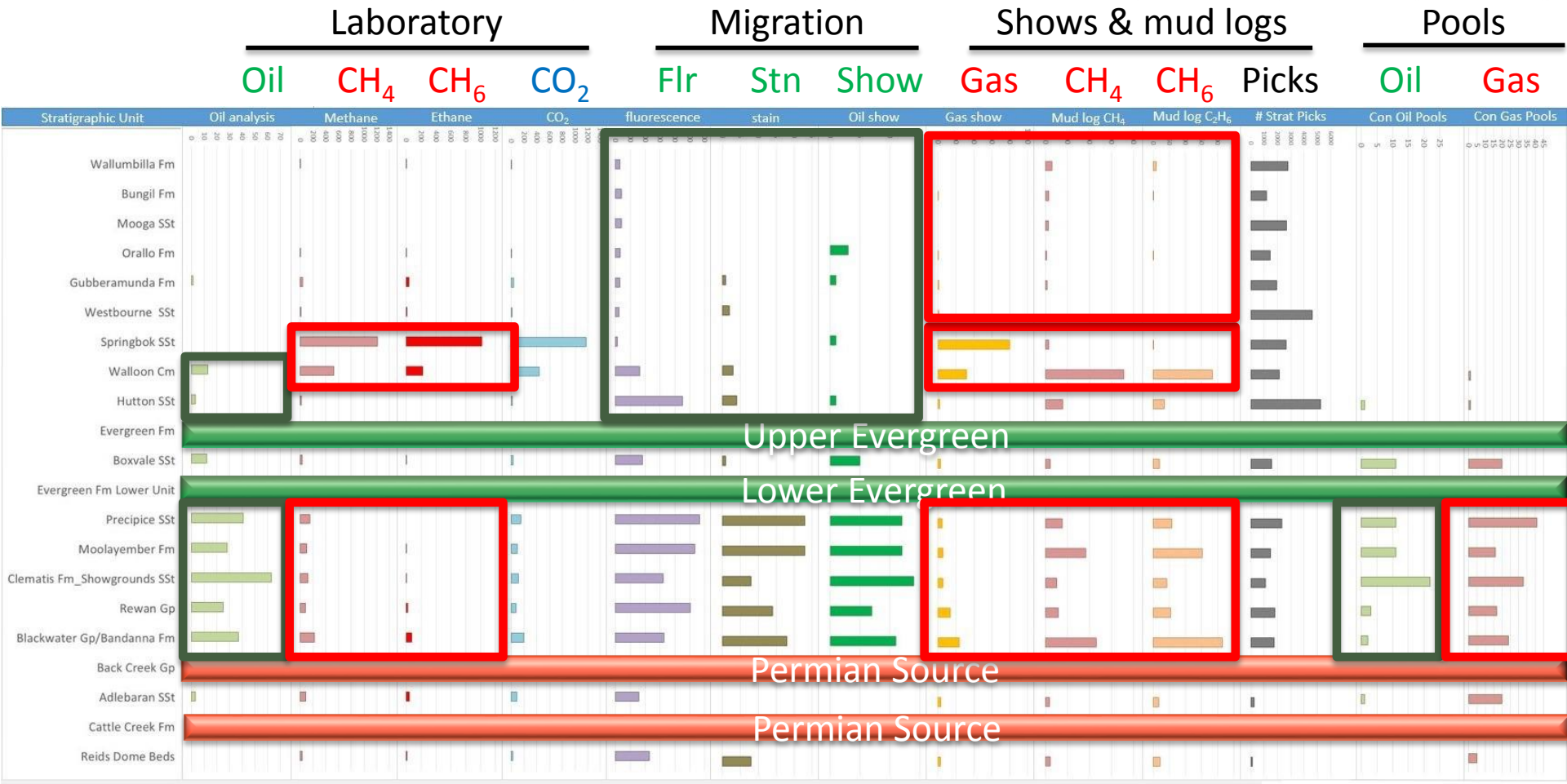
Discovered Con & CSG

- >57 million barrels oil
- >5.6 billion barrels equiv Gas
- BREE (2014)

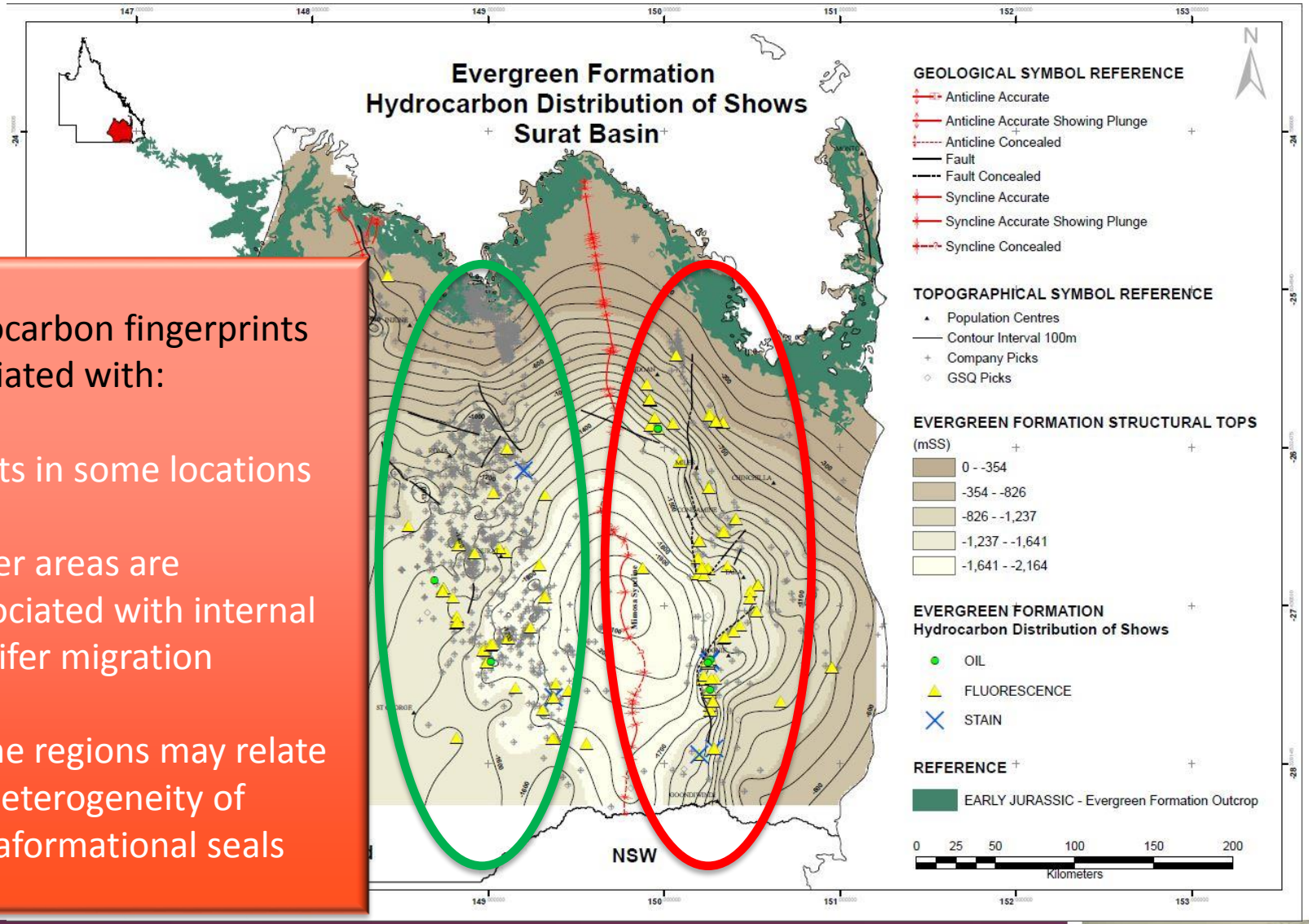
Still in source rock? Leaked out? Still to be found?

What we found: Summary of Hydrocarbon Indicators

Pools below the Evergreen (plus Walloons Gas) and Migration between Evergreen and Surface



What we found: Fingerprints of oil migration



Hydrocarbon fingerprints associated with:

- faults in some locations
- other areas are associated with internal aquifer migration
- some regions may relate to heterogeneity of intraformational seals

Conclusions:

1) The Water Balance (not shown)

- Recharge to GAB is uneven
- Water use uncertainty is dropping
- Better input for regional groundwater models

2) Heterogeneity of the Rocks

- 80% of the flux through 10% of the rock
- Loads of minor coal

3) The Nature of the Fluids

- Water chemistry matches heterogeneity of the rocks
- Hydrocarbons naturally migrate to surface
- We have the foundation of a baseline

THANK YOU

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