Palaeogeographic Mapping and Depositional Trends of the Patchawarra Formation, Cooper Basin*

Sam J. Kobelt[1], Brenton Schoemaker[2] and Peter McCabe[1]

Search and Discovery Article #51244 (2016)**
Posted April 25, 2016

*Adapted from oral presentation given at AAPG International Conference & Exhibition, Melbourne, Australia, September 13-15, 2015

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Abstract

The Patchawarra Formation was deposited in a coal-dominated fluvio-lacustrine environment. These environments have complex geometries, and facies distribution is difficult to predict spatially. This study defined palaeogeographic reconstructions using log-signature responses from equivalent chronostratigraphic intervals, modern fluvial analogues, and regional TWT isochrons. This resulted in the definition of spatial distribution of fluvio-lacustrine facies throughout the Tenapperra region, Cooper Basin, South Australia. The 379 wells in the study area were correlated into 21 chronostratigraphic intervals based on wireline log responses. Six electrofacies were identified from the gamma-ray and sonic-velocity log motifs. These were combined with modern fluvial analogues to yield four facies assemblages. Multiple modern analogues were considered suitable for the Patchawarra Formation in the Tenaperra Region. The Ob River, Siberia, is considered more suitable for depositional facies, whereas the McKenzie River, North West Territories, demonstrates the influence of a compressional stress regime on fluvial avulsion patterns and styles. In order to map channel-belt width within a chronostratigraphic interval, empirical relationships from previous studies were applied. By estimating bankfull depth from well data (thicknesses), an estimate of channel-belt width is obtained. 532 bankfull measurements were taken, giving maximum bankfull depth of 8.2m, minimum of 1.4 m, and mean value of 5.1m. Channelbelt-width ranges were then estimated by applying bankfull population statistics to applicable linear regression curves. Channel-belt width calculations give a range of variability from 76m to 3625m, with an average channel-belt width range from 1639–1908m. For the interpreted Patchawarra Formation intervals, there are eight populations with similar channel-belt ranges. High-solution palaeogeographic reconstruction of the Patchawarra Formation within the Tenapperra Region allows for better prediction of facies distribution. There are two distinguishable periods of fluvial

deposition in the upper and lower Patchawarra Formation. Ultimately, the palaeogeographic maps aid assessment of field prospects by defining depositional channel fairways which control reservoir distribution. These techniques could be applied to other fluvial-dominated petroleum systems.

Selected References

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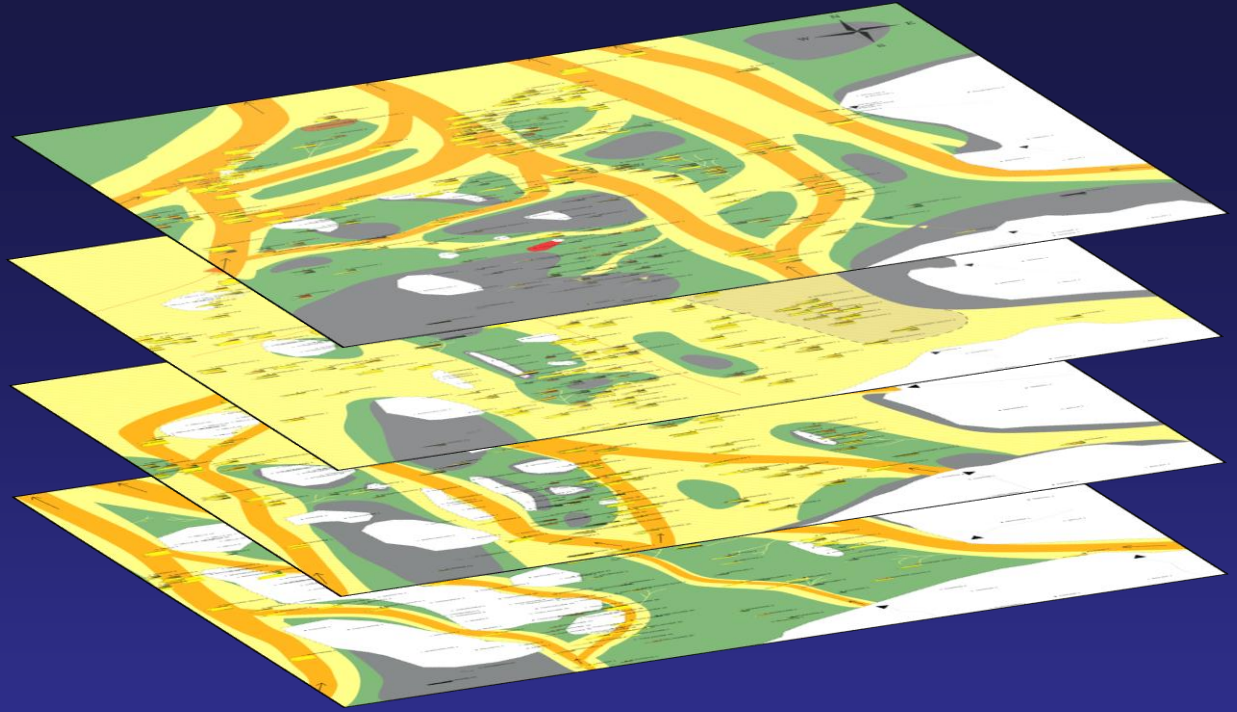

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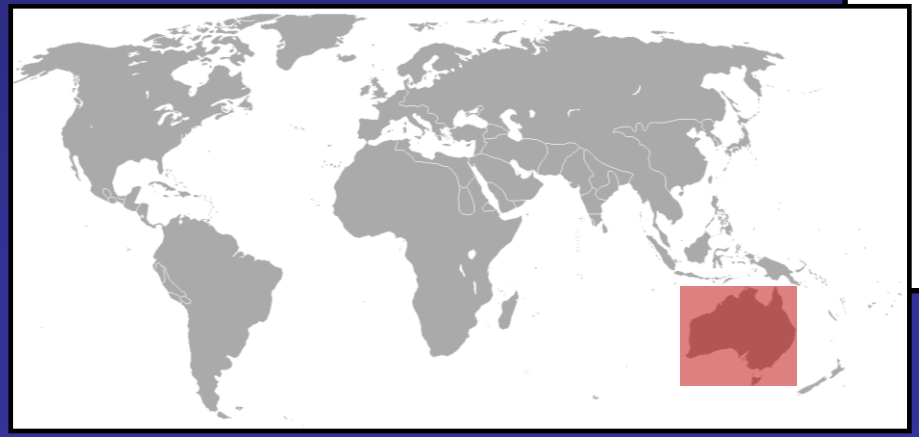
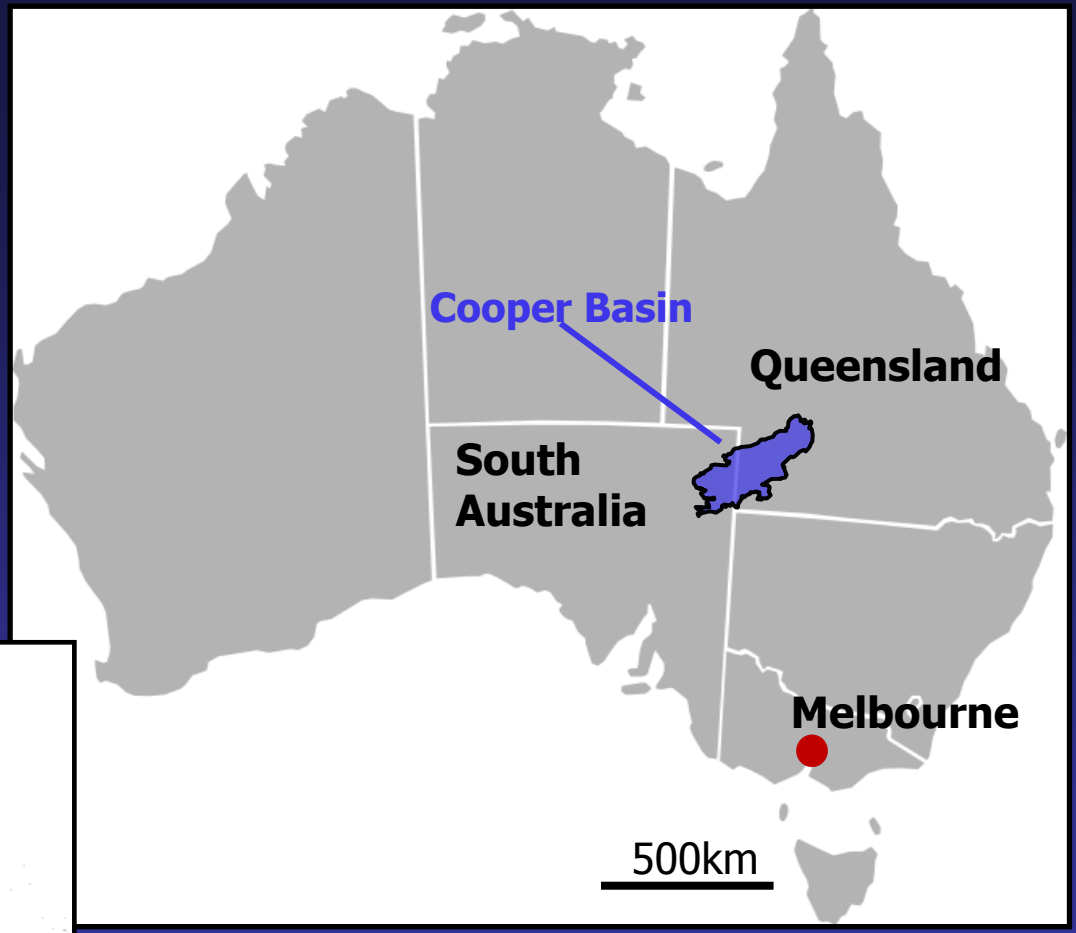
1: Australian School of Petroleum, University of Adelaide, SA 5005
2. Santos Ltd., 60 Flinders Street, Adelaide, SA 5000

- Permo-Triassic Age
- Intracratonic basin
- Located in central eastern Australia
- Covers approximately 130,000km^2

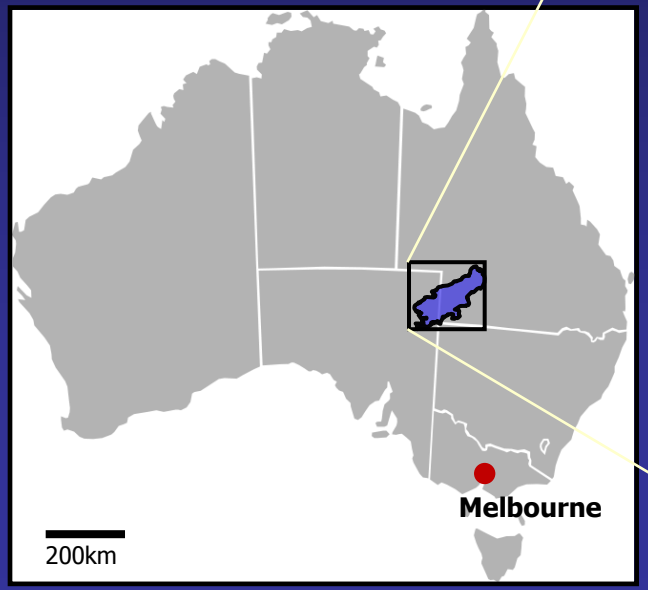


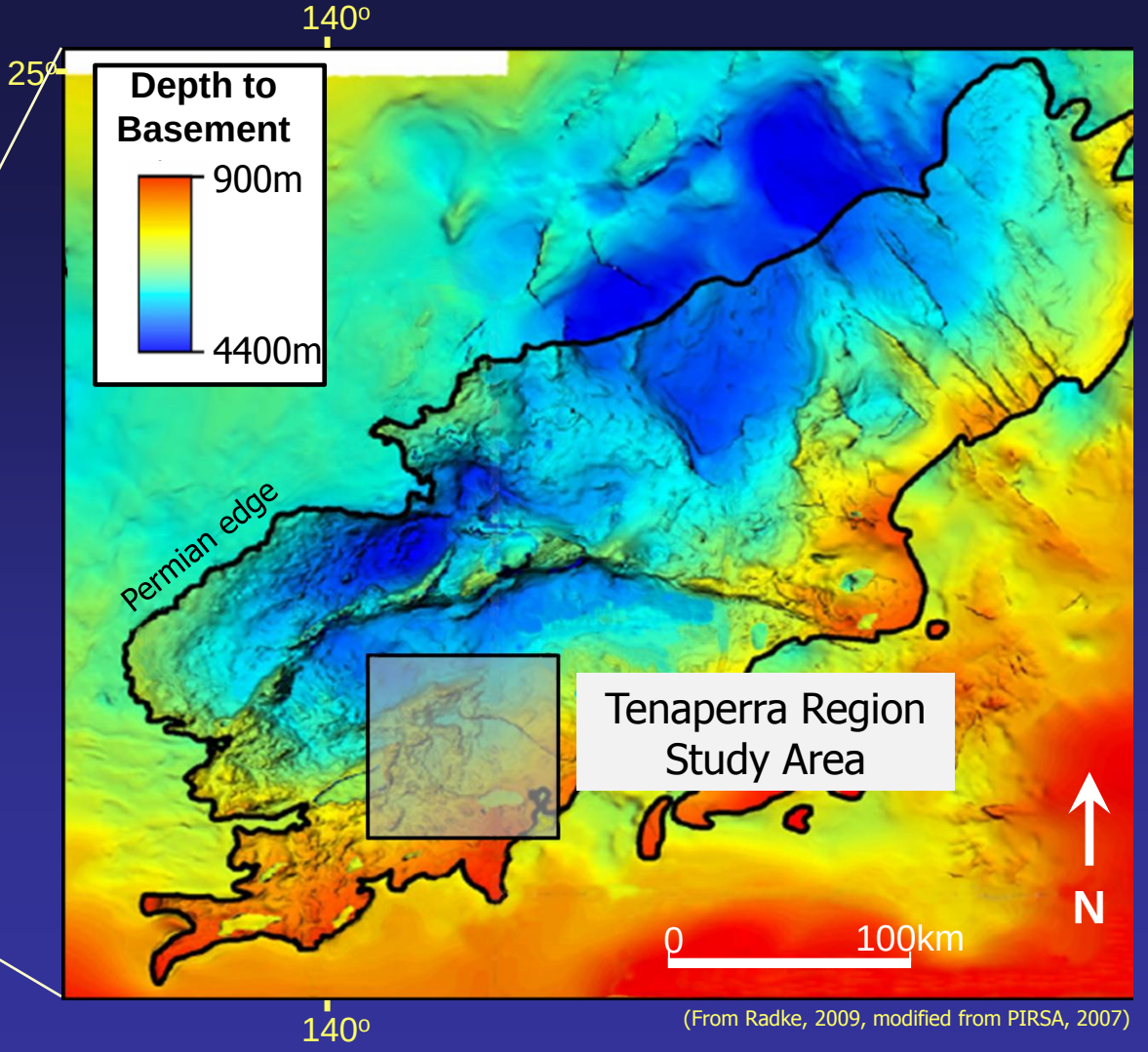


Cooper Basin

Study Area

- 397 Patchawarra Wells
- Study Area of 6400km^2
- High Well Density of =0.062 wells/km^2

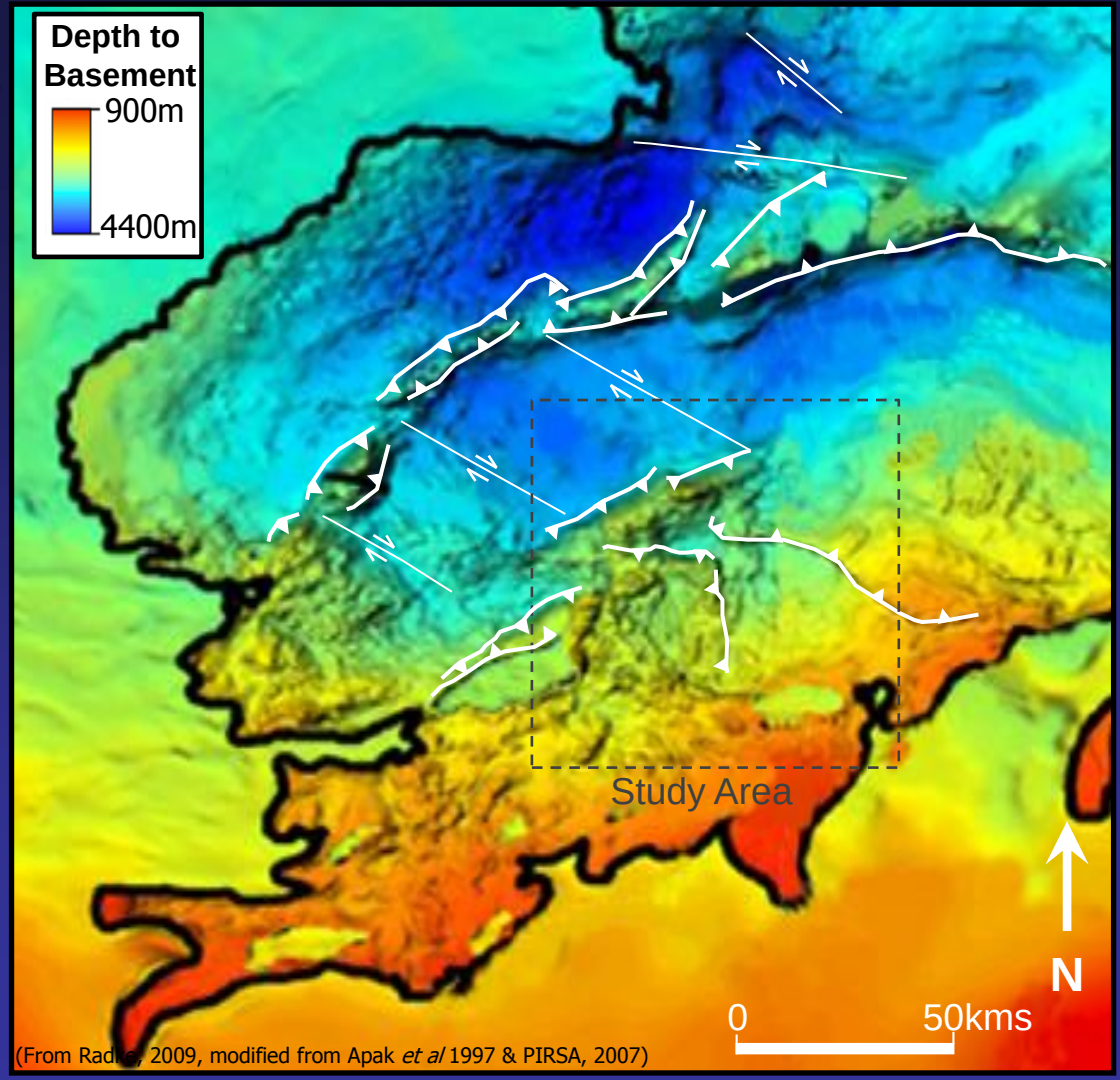




(From Radke, 2009, modified from PIRSA, 2007)

Structural Framework

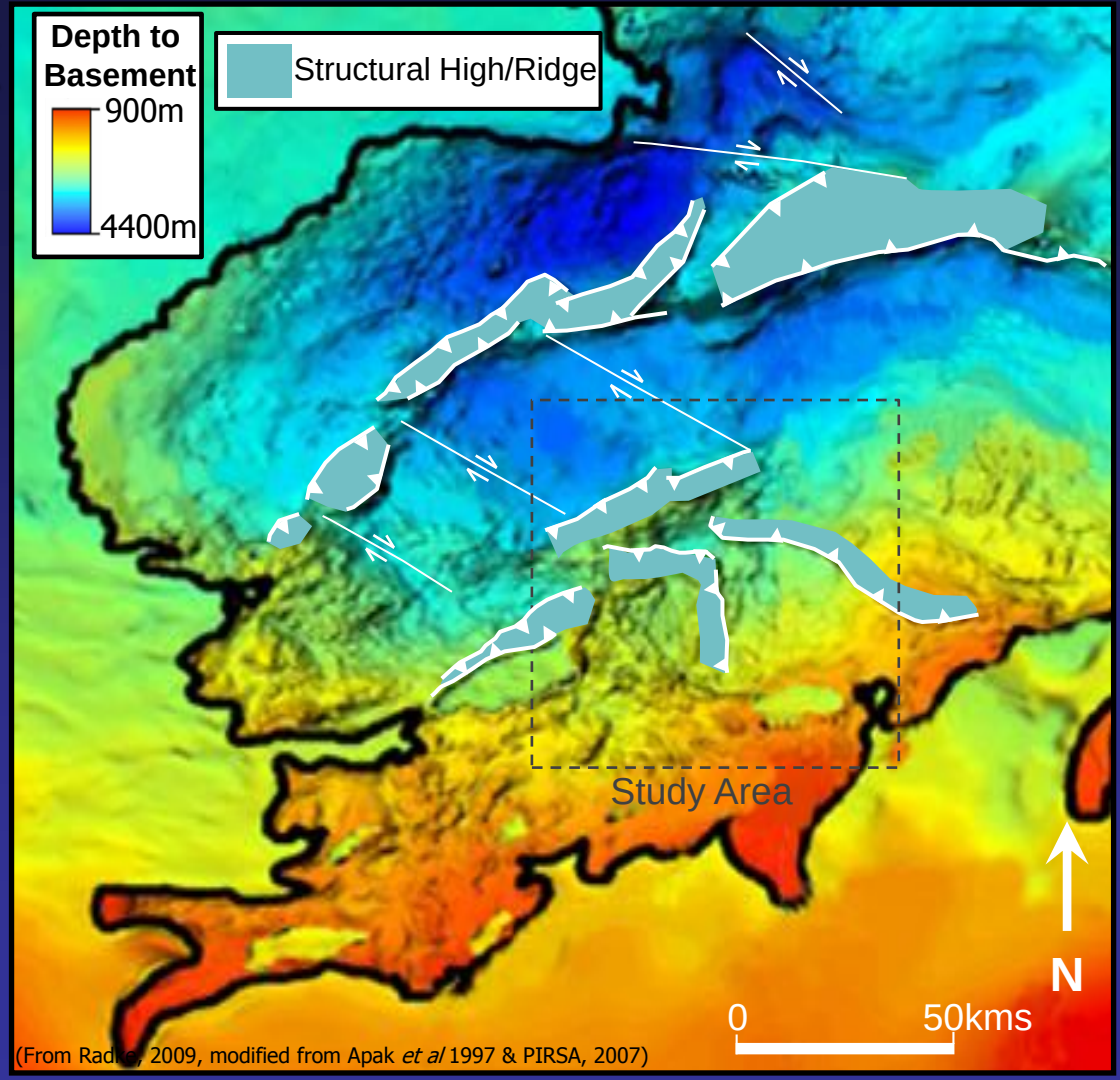
- **Strongly governed by pre-existing NE and NW compressional basement structures.**



(From Radic, 2009, modified from Apak *et al* 1997 & PIRSA, 2007)

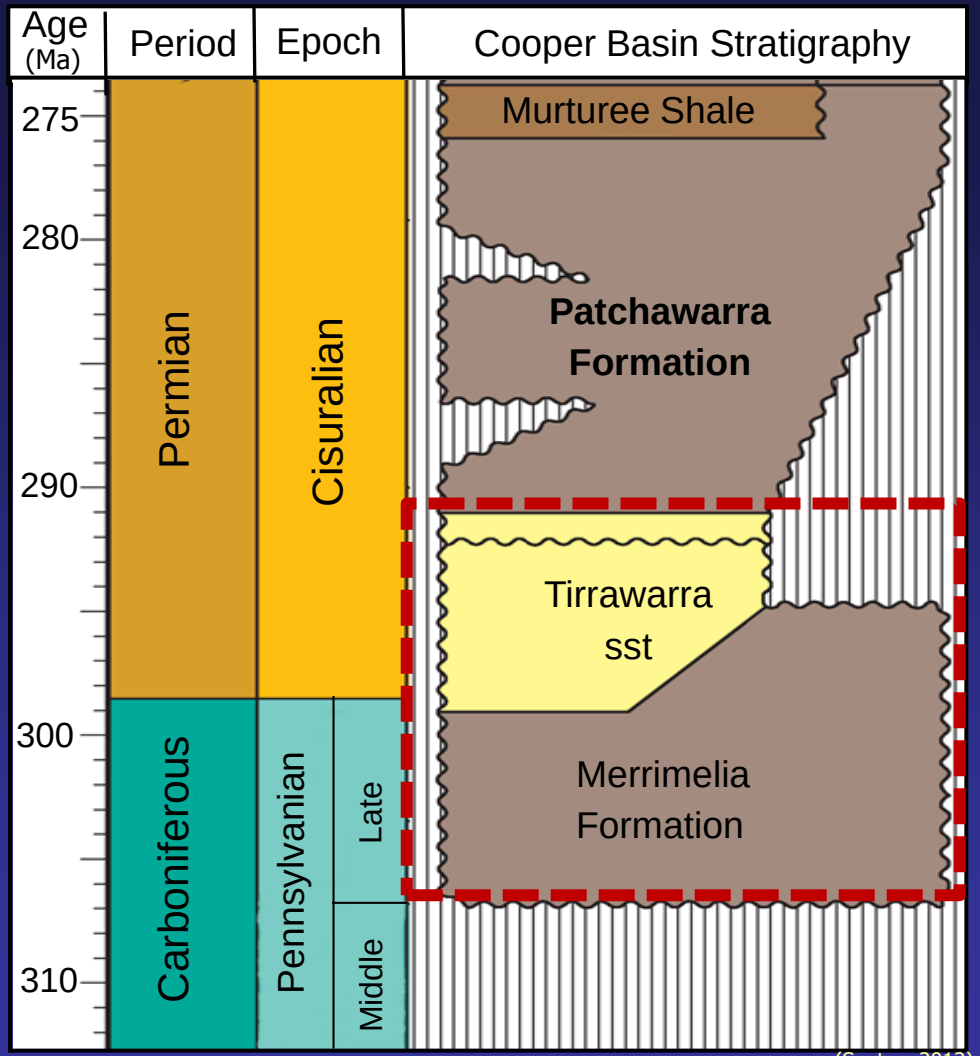
Structural Framework

- **Strongly governed by pre-existing NE and NW compressional basement structures.**
- **Intermittent compressional events continually rejuvenated these structures**
- **Gentle down warping between compressional events allowed for widespread deposition across the basin.**



Stratigraphy of the Patchawarra Formation

- **Mid-Carboniferous compression marks end glaciation.**
- **Glacial retreat exposes palaeotopography.**
- **Merrimelia Fm and Tirrawarra sandstone are glacial outwash deposits.**



(Santos, 2012)

Stratigraphy of the Patchawarra Formation

- **Patchawarra Formation:**
  - **Coal dominated fluvio-lacustrine environments.**
  - **High latitude, cool climate.**
- **Mid-Patchawarra unconformities mark periods of uplift.**

- **Mid-Carboniferous compression marks end glaciation.**
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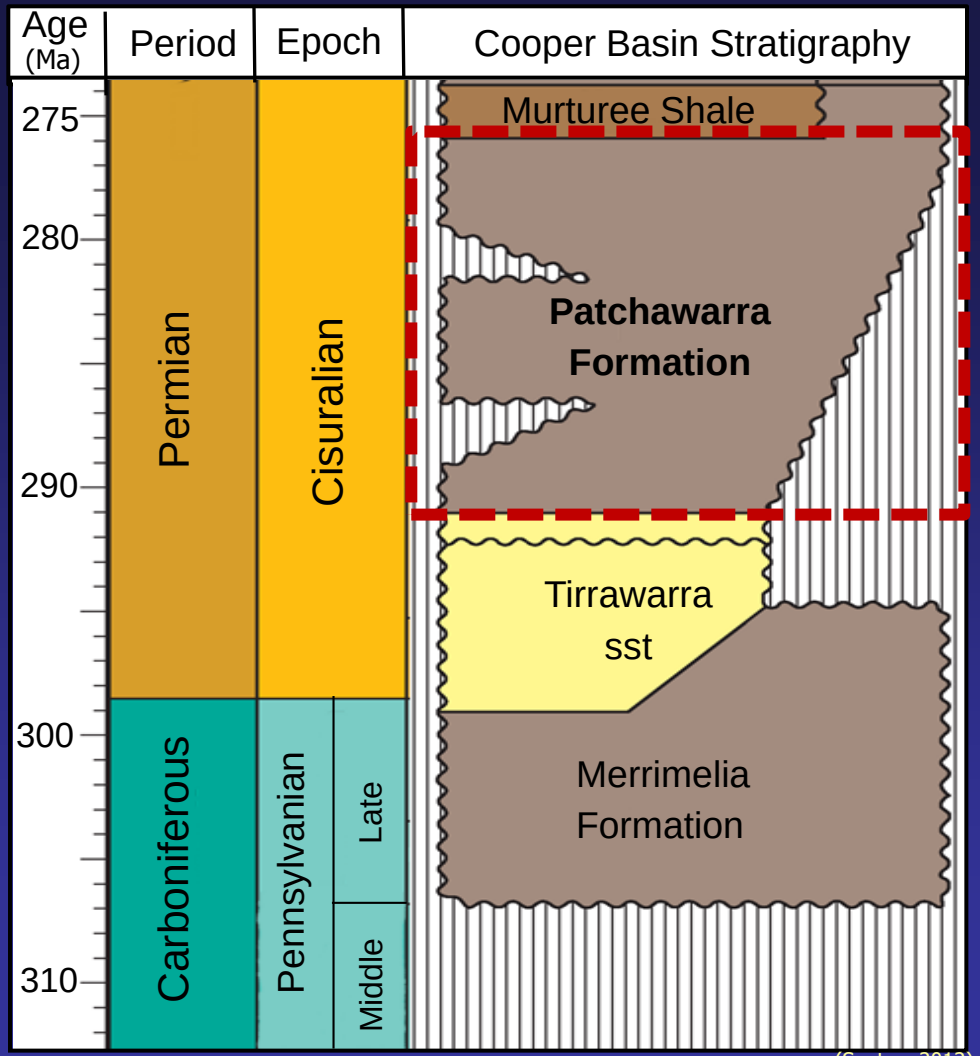


(Santos, 2012)

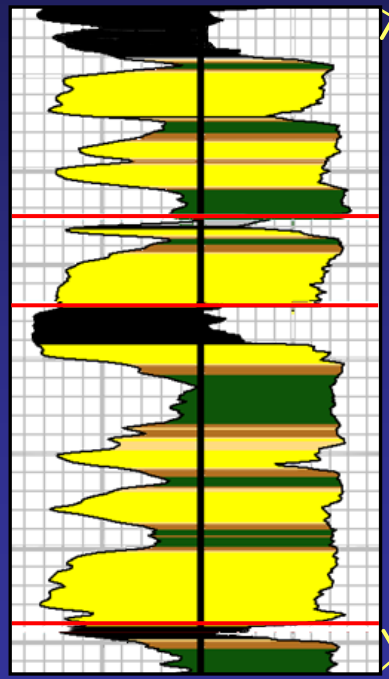
Stratigraphy of the Patchawarra Formation

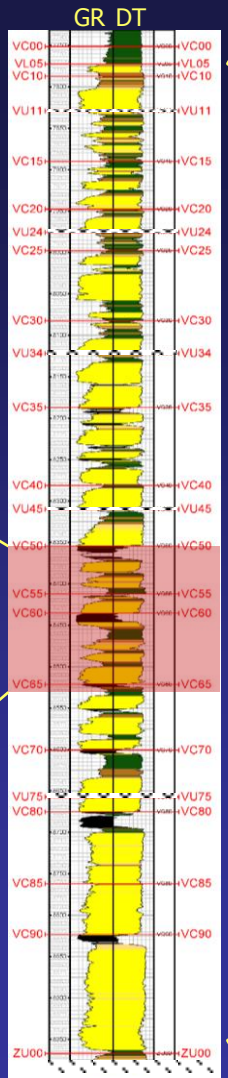
Thick, Regular Coals

Crevasse Splay Sandstones

Floodplain & Lacustrine shales

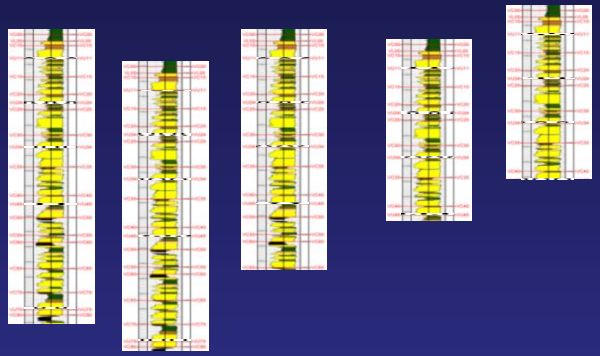
Channel Sandstones





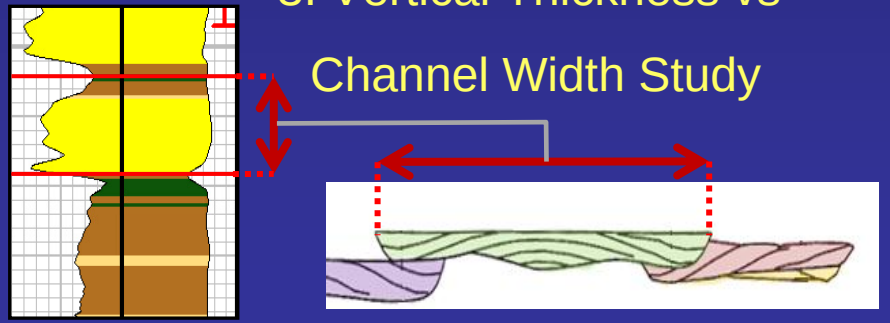
Methods

1. Regional Well Correlation & Log Signature Maps

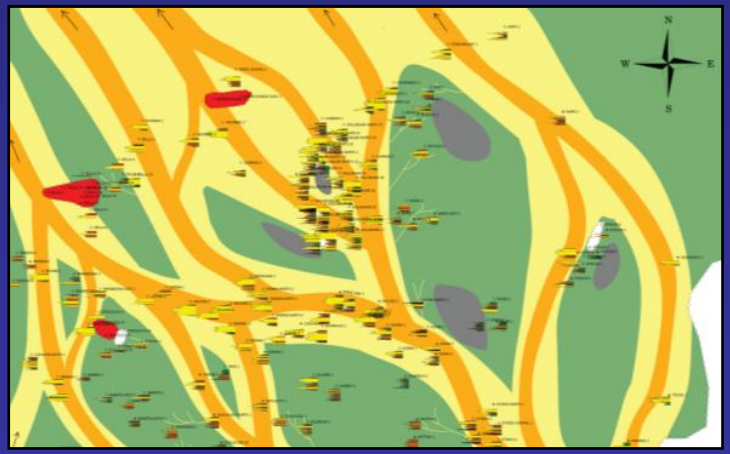


2. Analogue Study

3. Vertical Thickness vs Channel Width Study



4. Palaeogeographical Mapping



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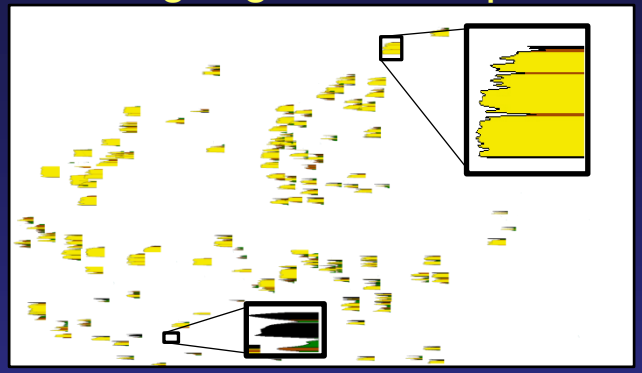

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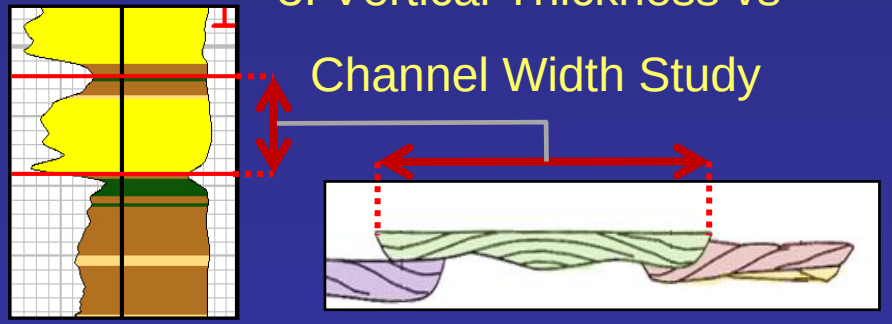

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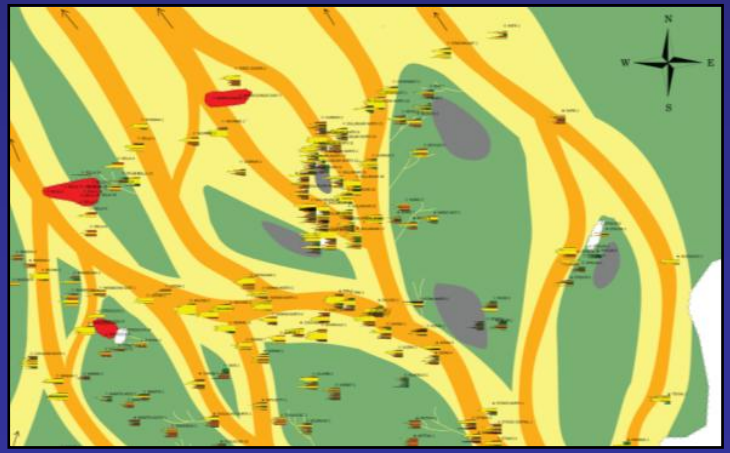
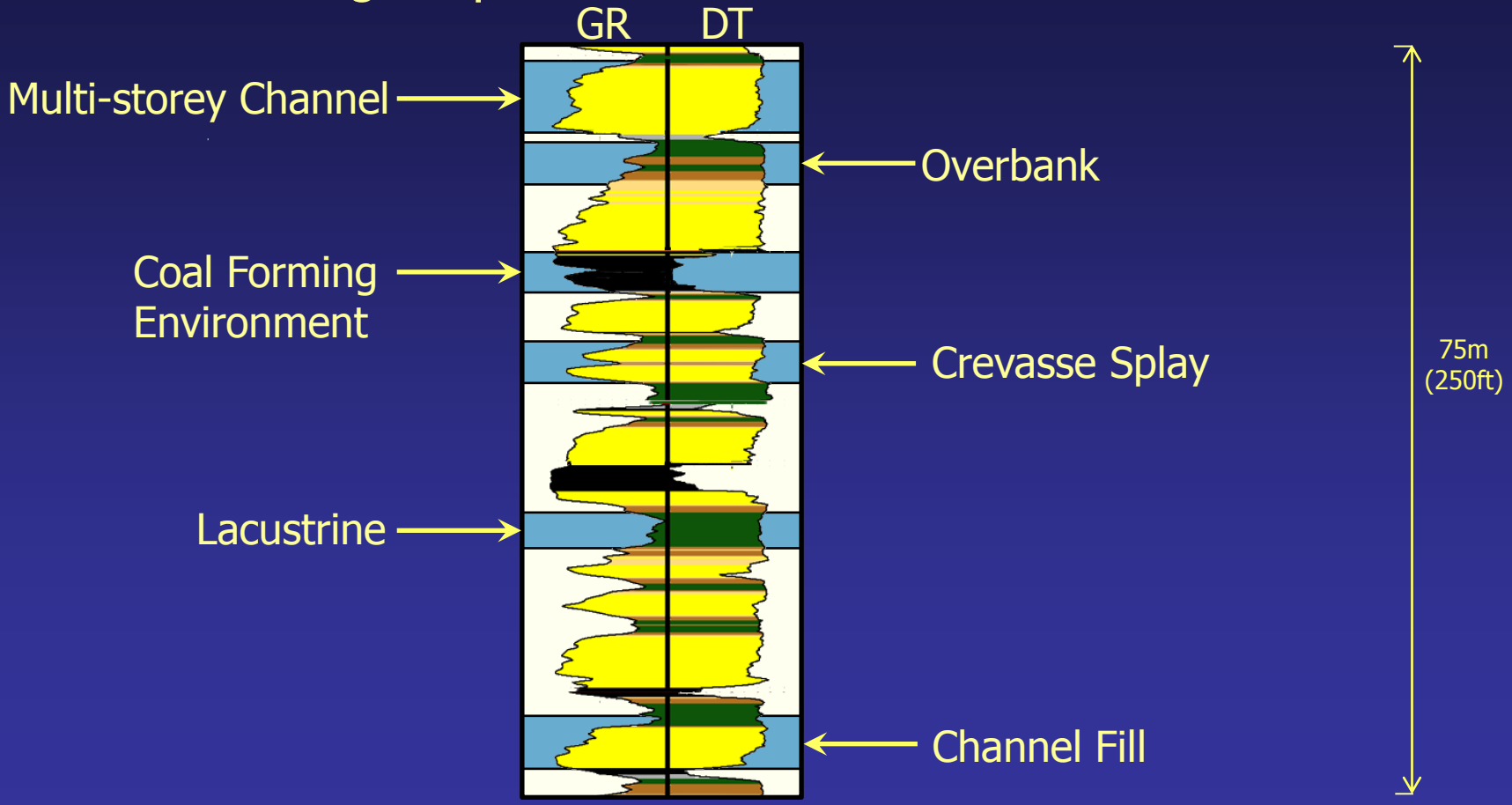


6 electrofacies were identified based on log motif and x-plot of GR and DT log responses.



Analogue Study: Ob River, Siberia

- **Commonly applied modern day analogue to the Patchawarra Fm**
- **Watershed is 10x larger than entire Cooper Basin.**

(Modified from Musser, 2008)

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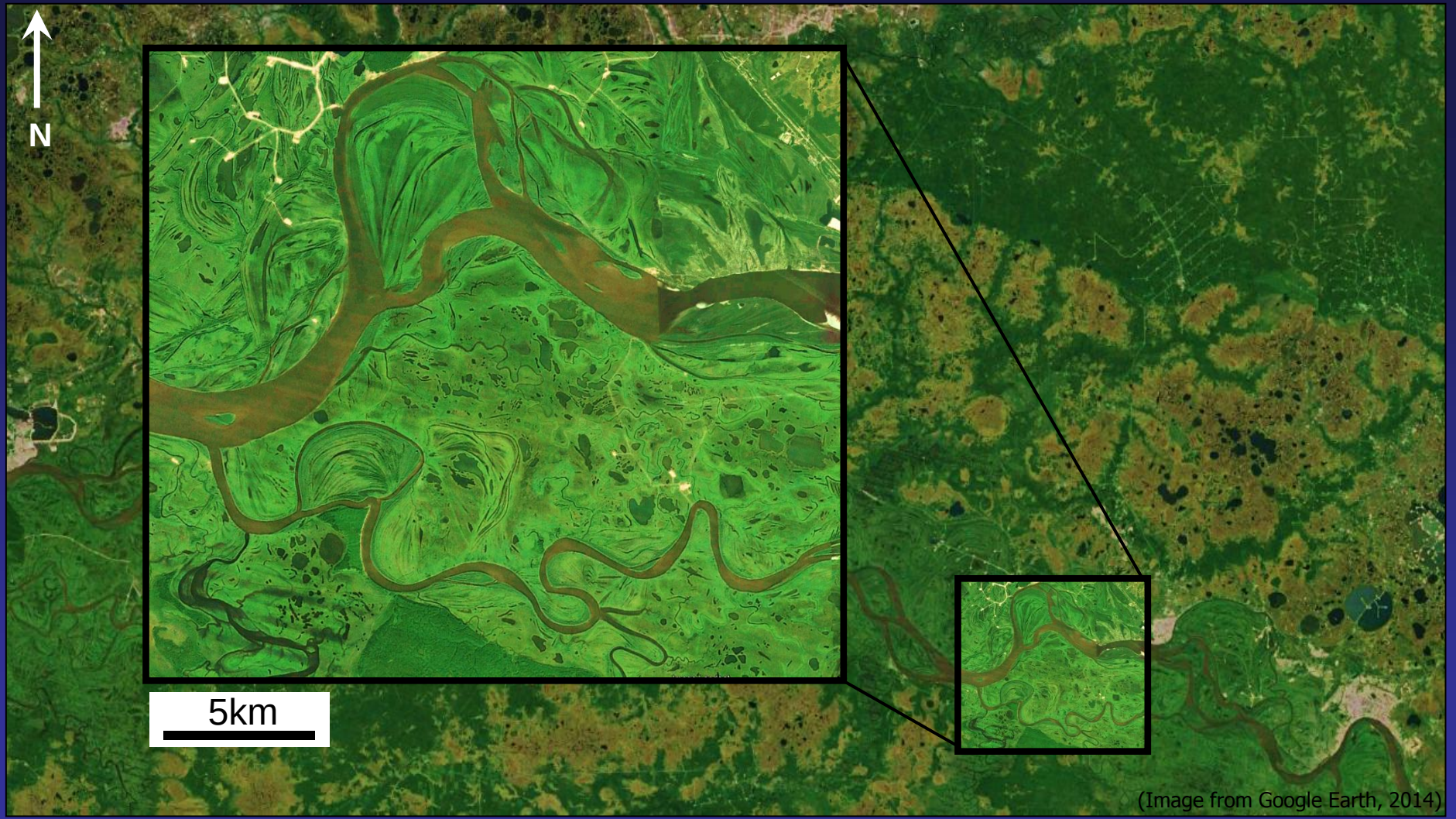
20km
(Image from Google Earth, 2014)


N
5km
(Image from Google Earth, 2014)


N
Floodplain & Lacustrine Uplands
Channel Belt
Minor Channel & Crevasse Splay
Peat Mire
20km
(Image from Google Earth, 2014)


N
Floodplain & Lacustrine Uplands
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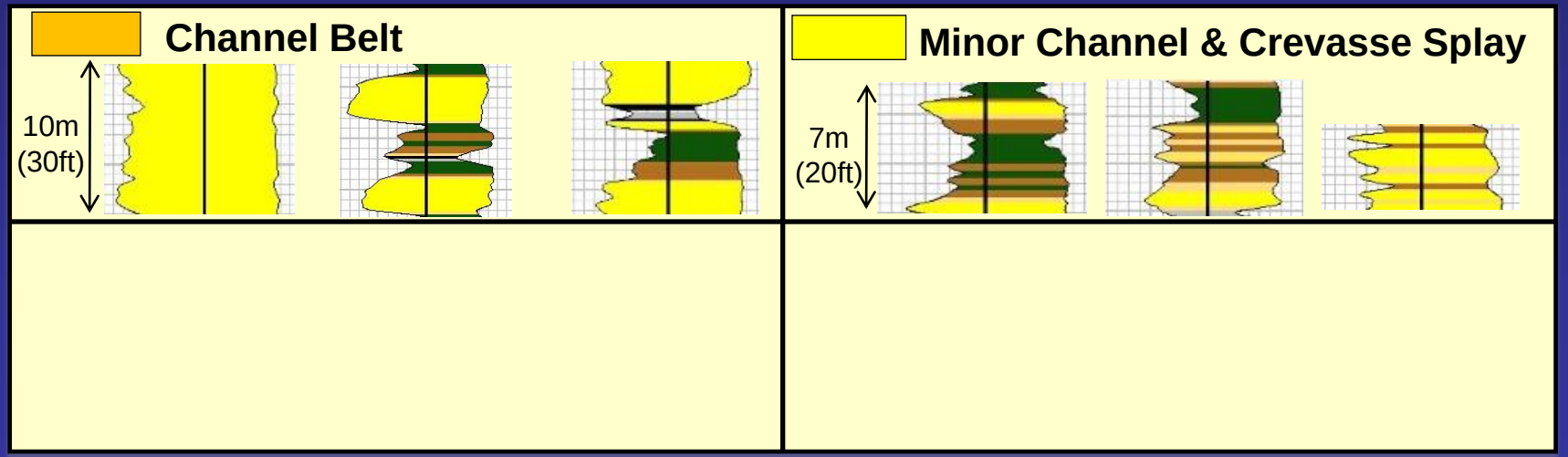
Electrofacies Assemblages

- Electrofacies were then associated to depositional environments identified in the analogue study to form 4 electrofacies assemblages.



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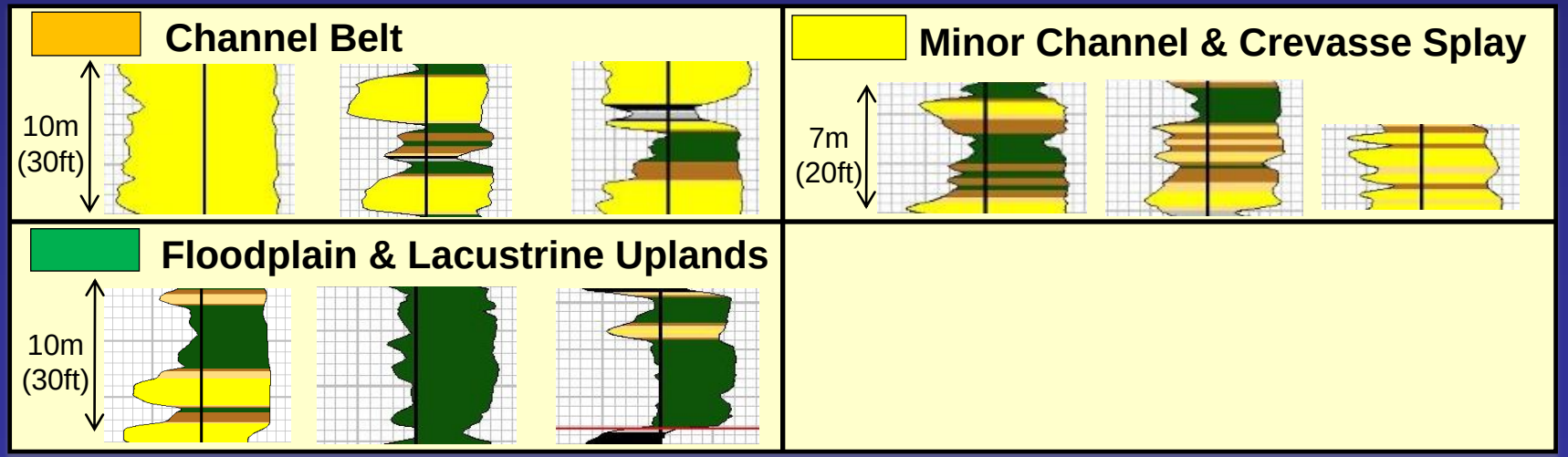

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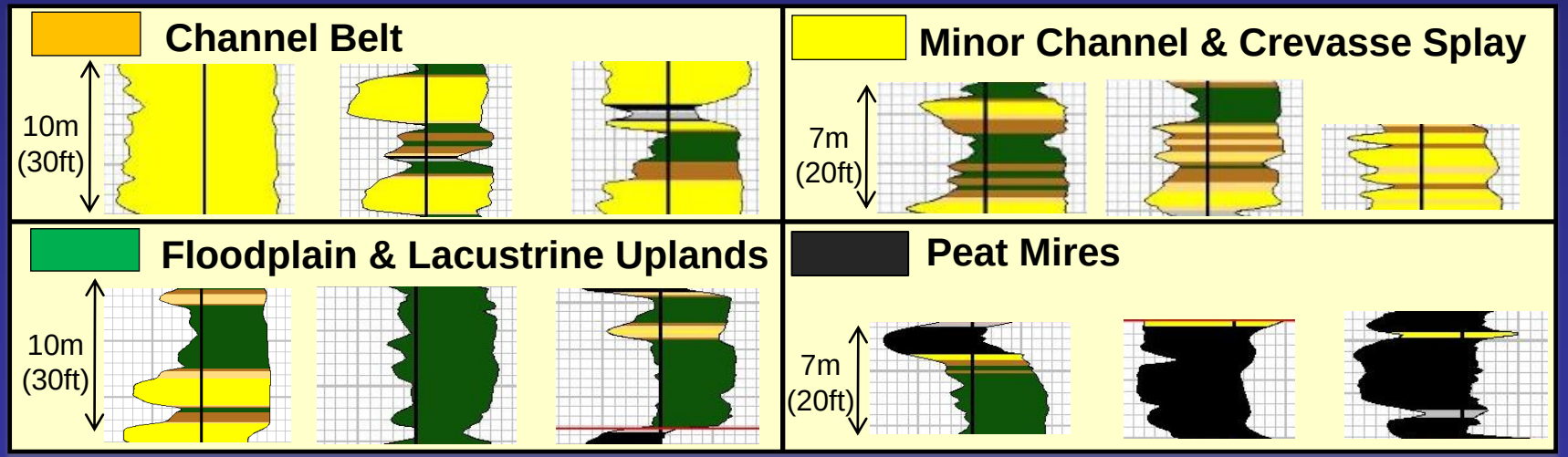
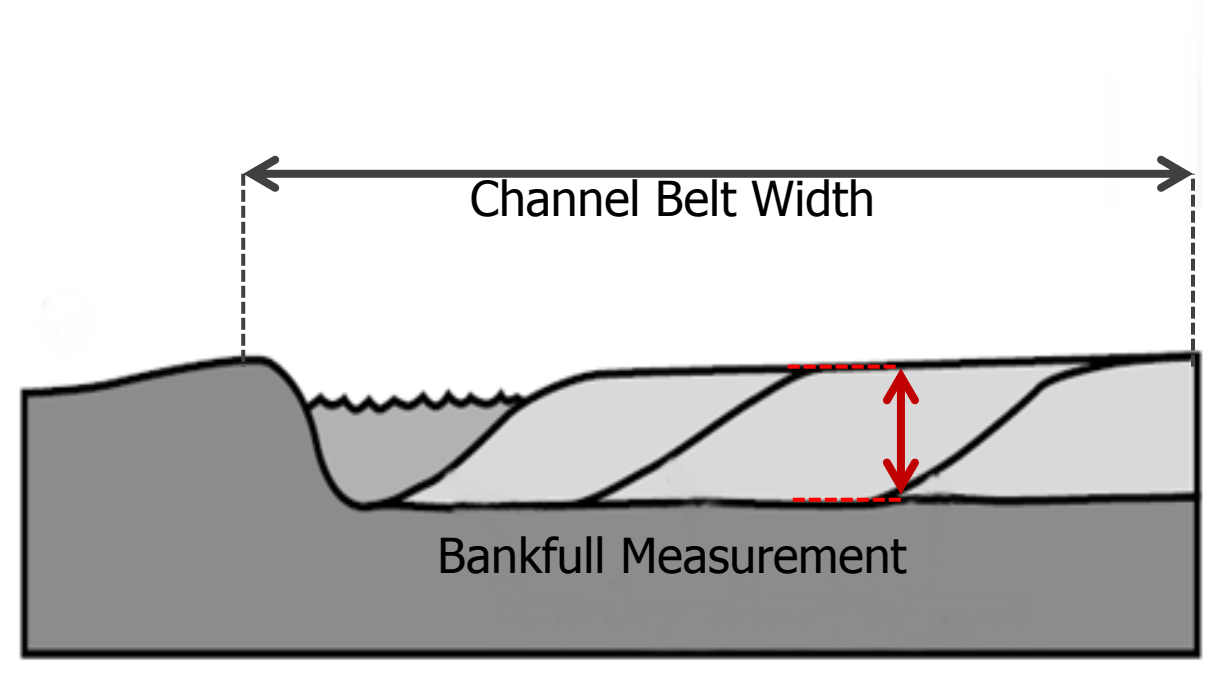


Channel Belt Width Estimation

- Relationship between bankfull thickness and channel belt width



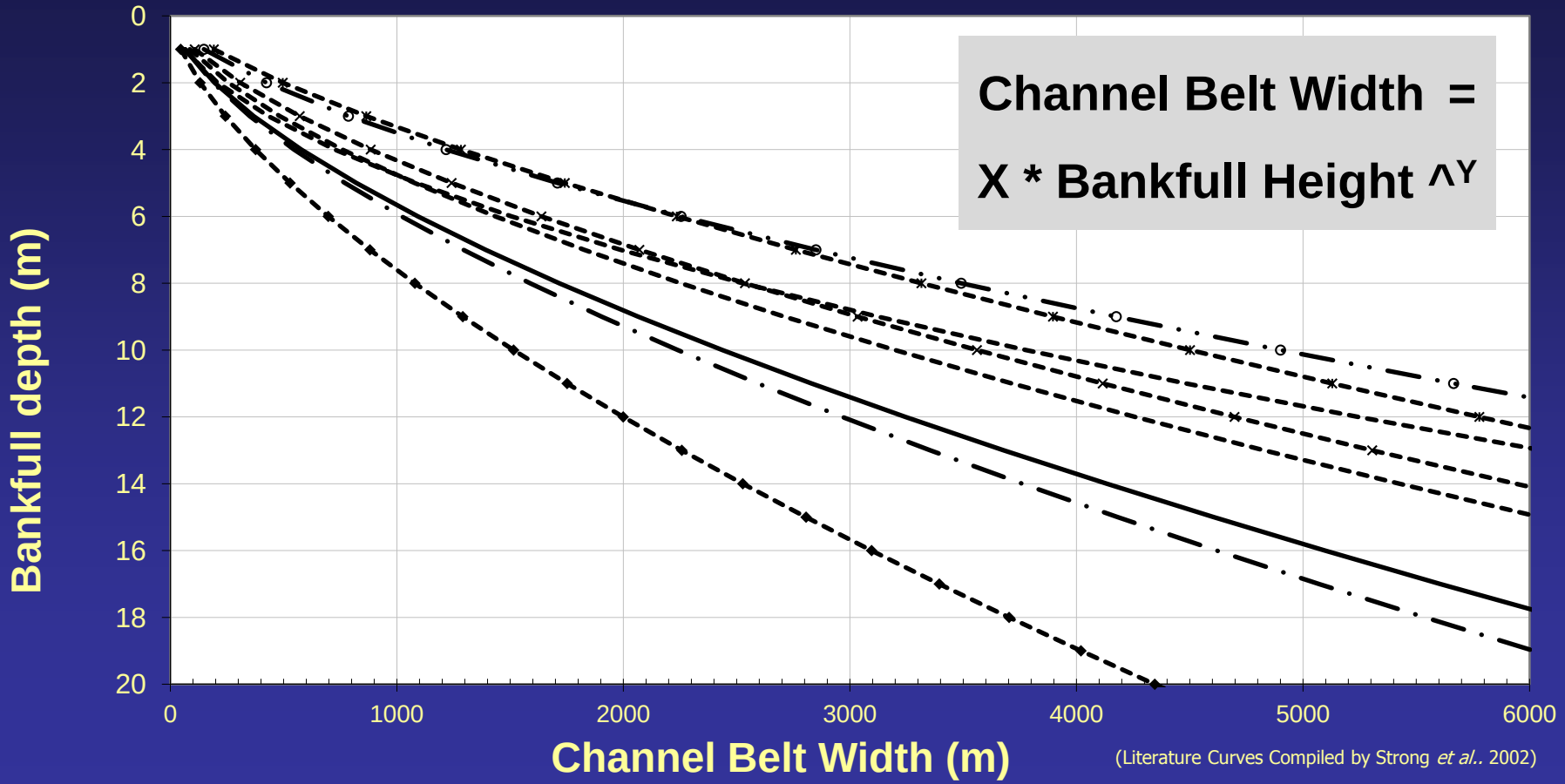
(Slatt, 2006)

Channel Belt Width =

X * Bankfull Height ^Y

Channel Belt Width Estimation

Sandbody Thickness:Width



(Literature Curves Compiled by Strong *et al.*. 2002)

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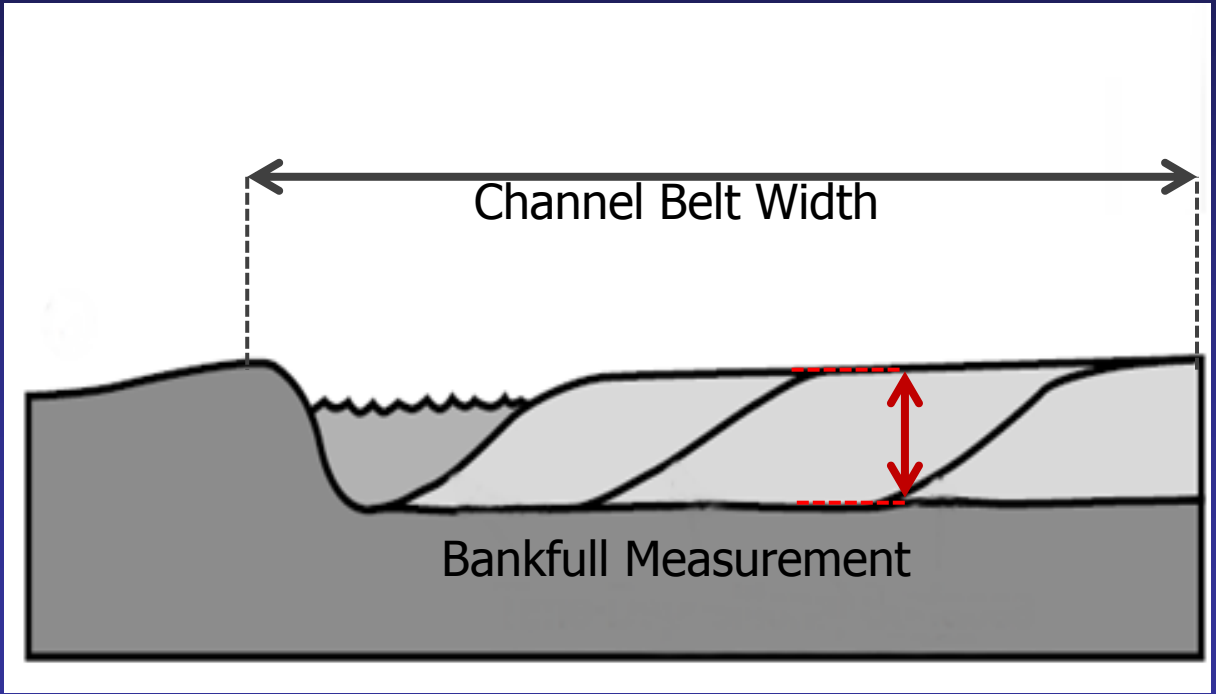

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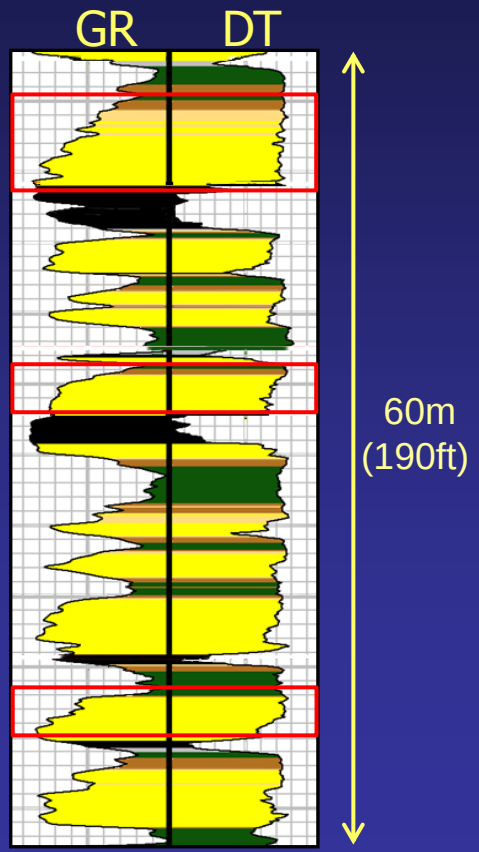
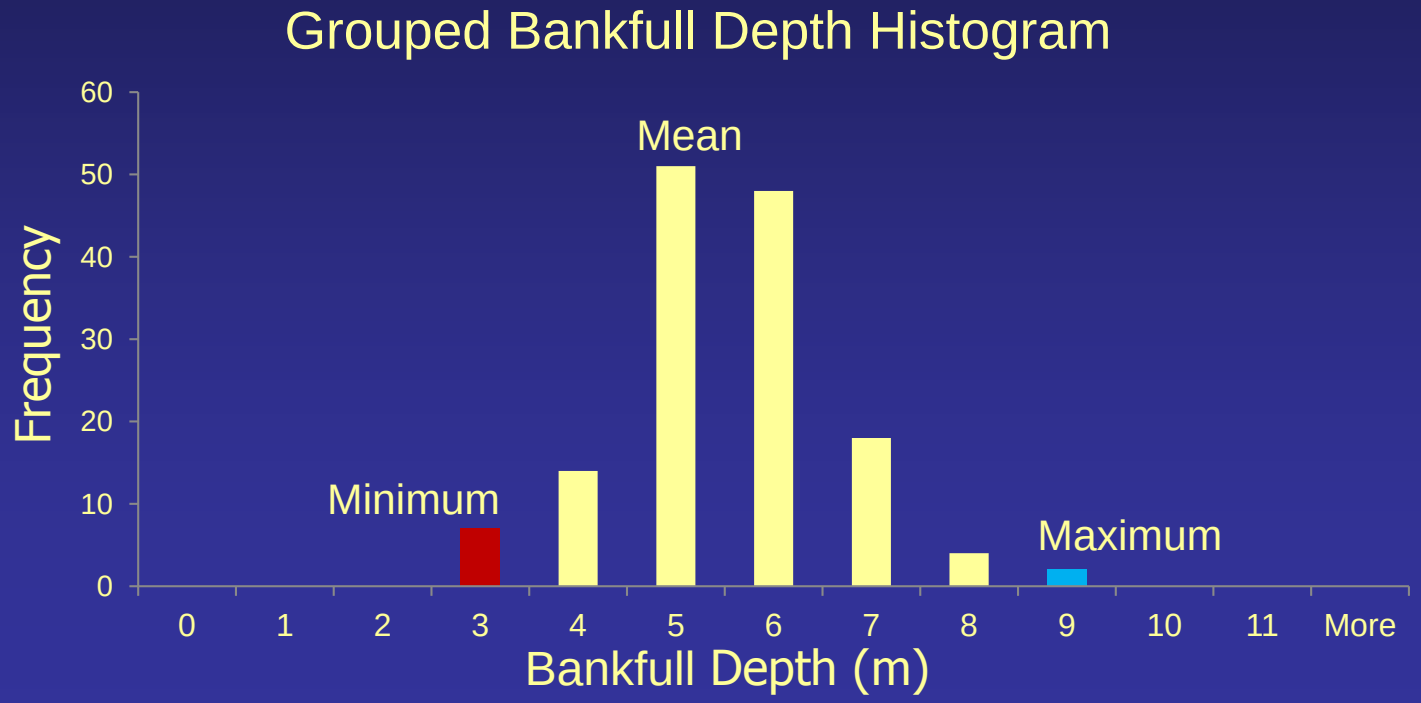


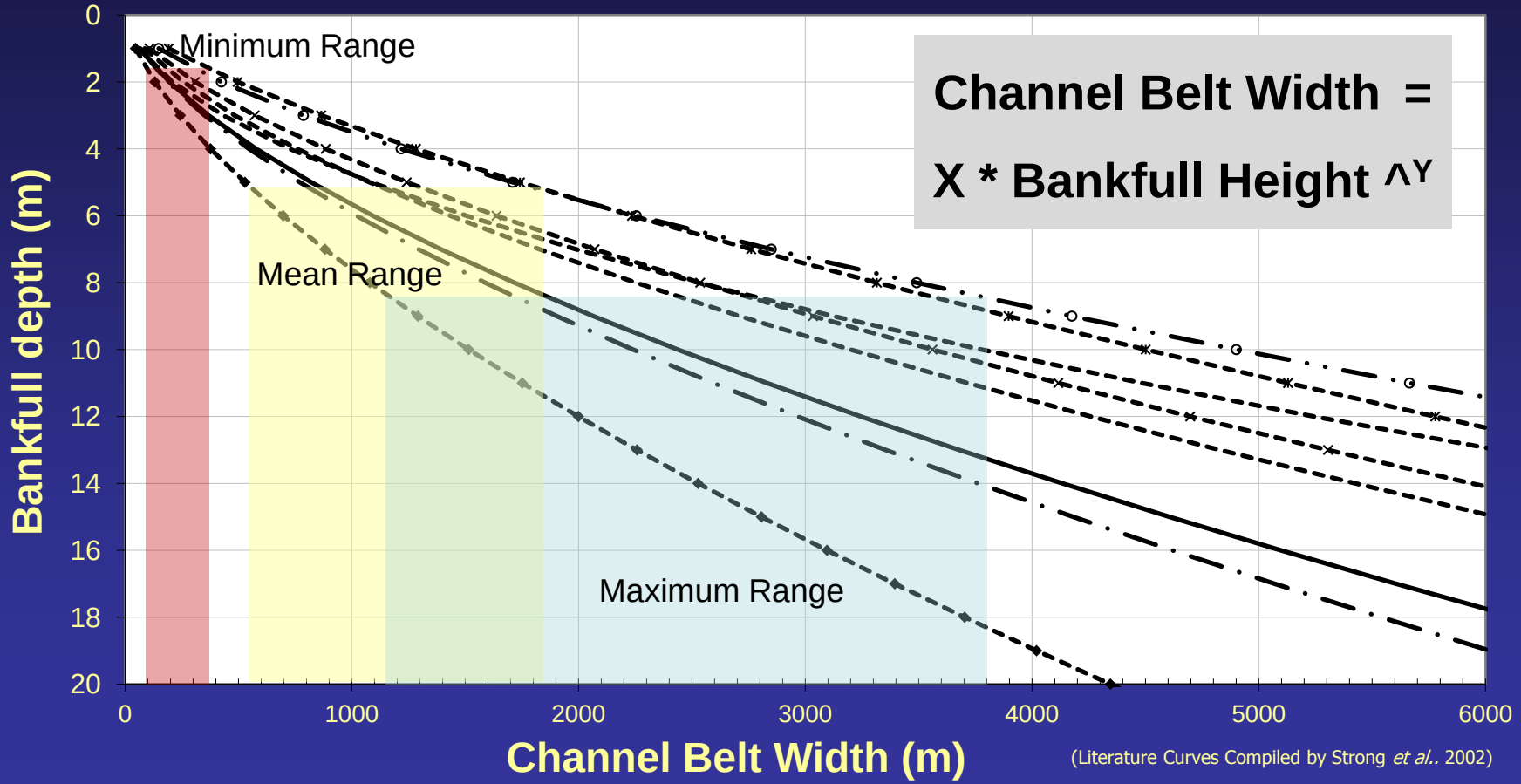
Channel Belt Width Estimation

- Bankfull statistical values can then be applied to literature regression curves to give channel belt width estimate ranges.



Channel Belt Width Estimation

Sandbody Thickness:Width



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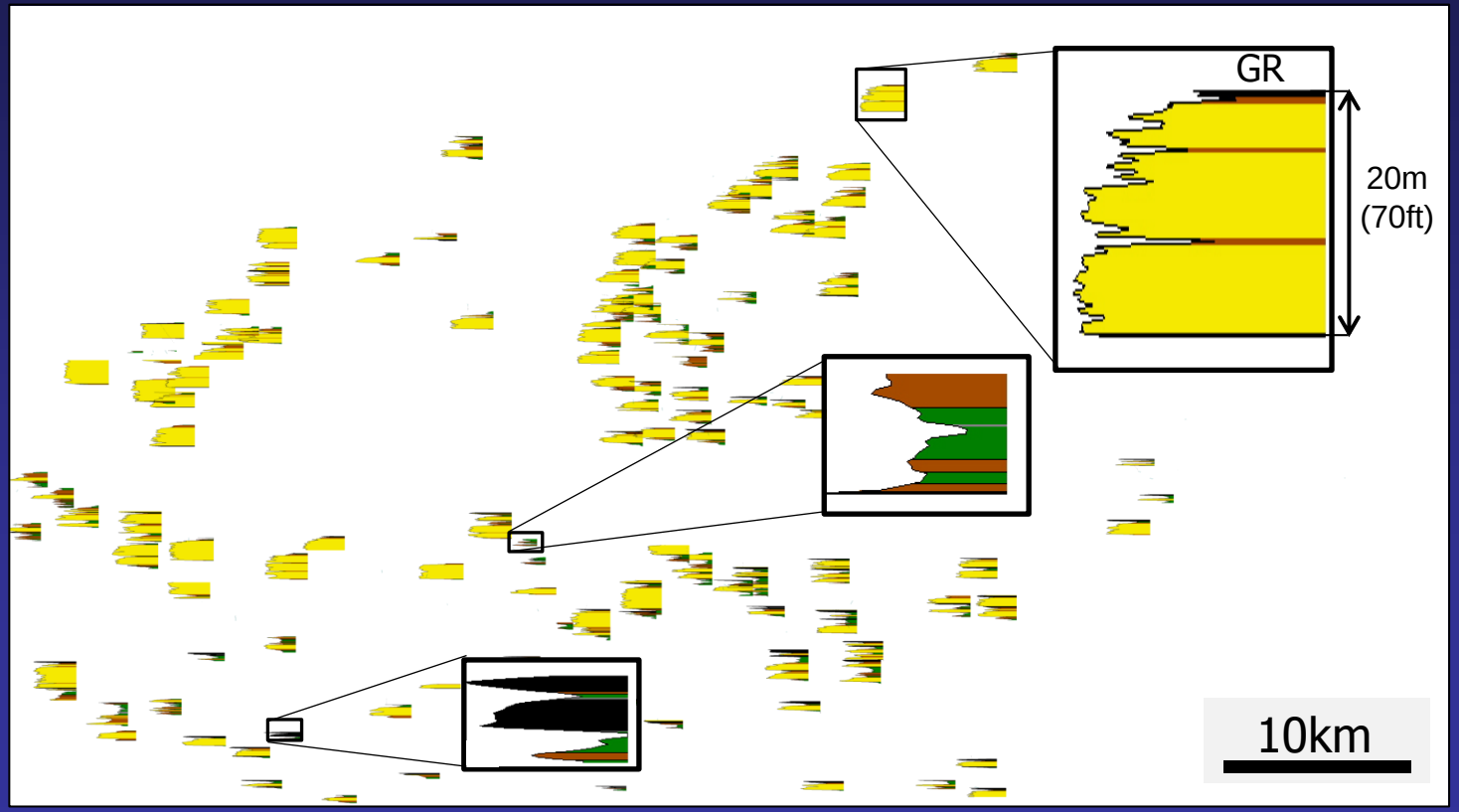
Palaeogeographic Reconstructions

- 17 palaeogeographic reconstructions were carried out by applying electrofacies assemblages to log signature maps.



VC25-VC30 PALAEOGEOGRAPHIC MAP

Legend

- **Floodplain & Lacustrine Uplands**
- **Channel Belt**
- **Minor Channel and Crevasse Splay Complex**
- **Peat Mire**

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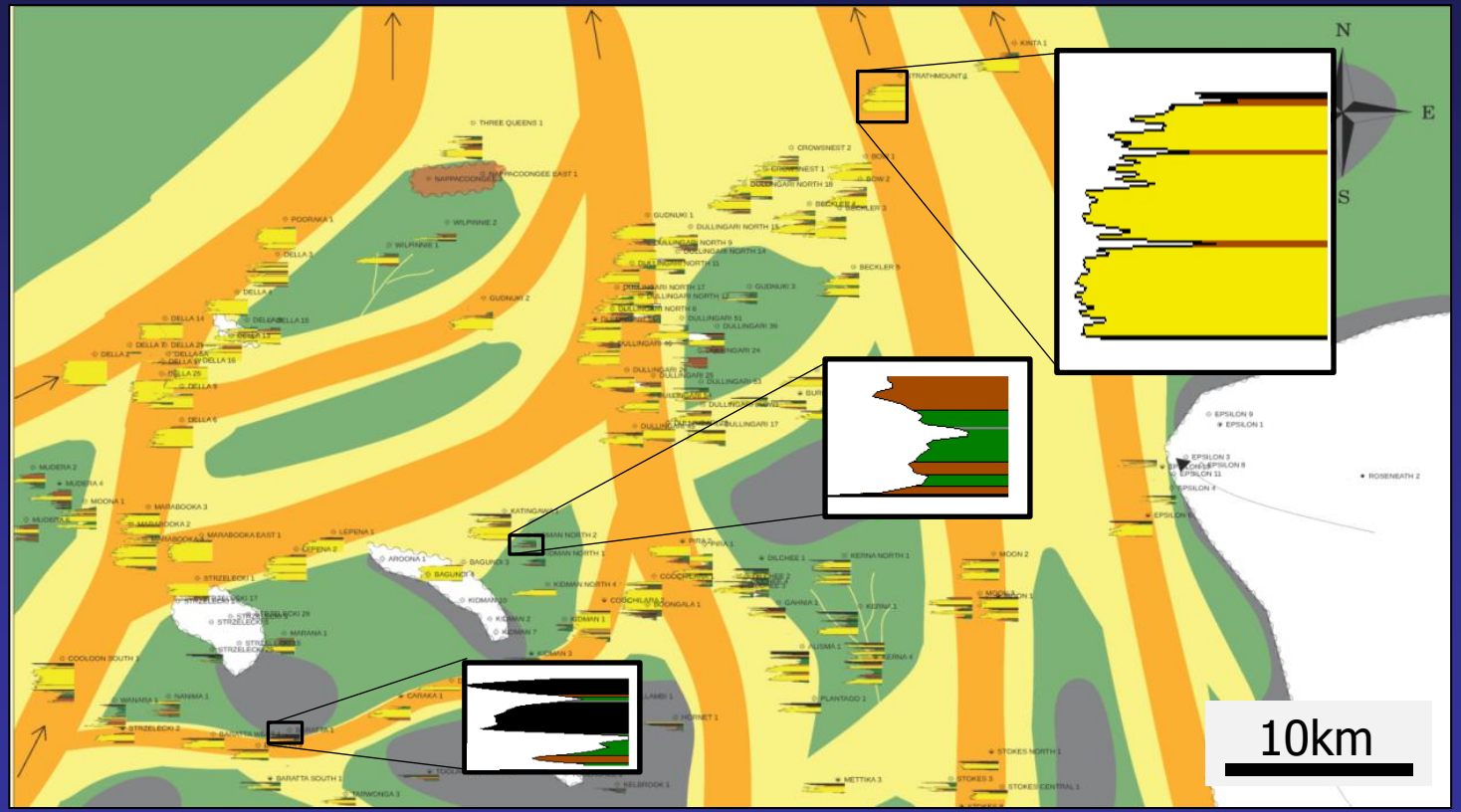

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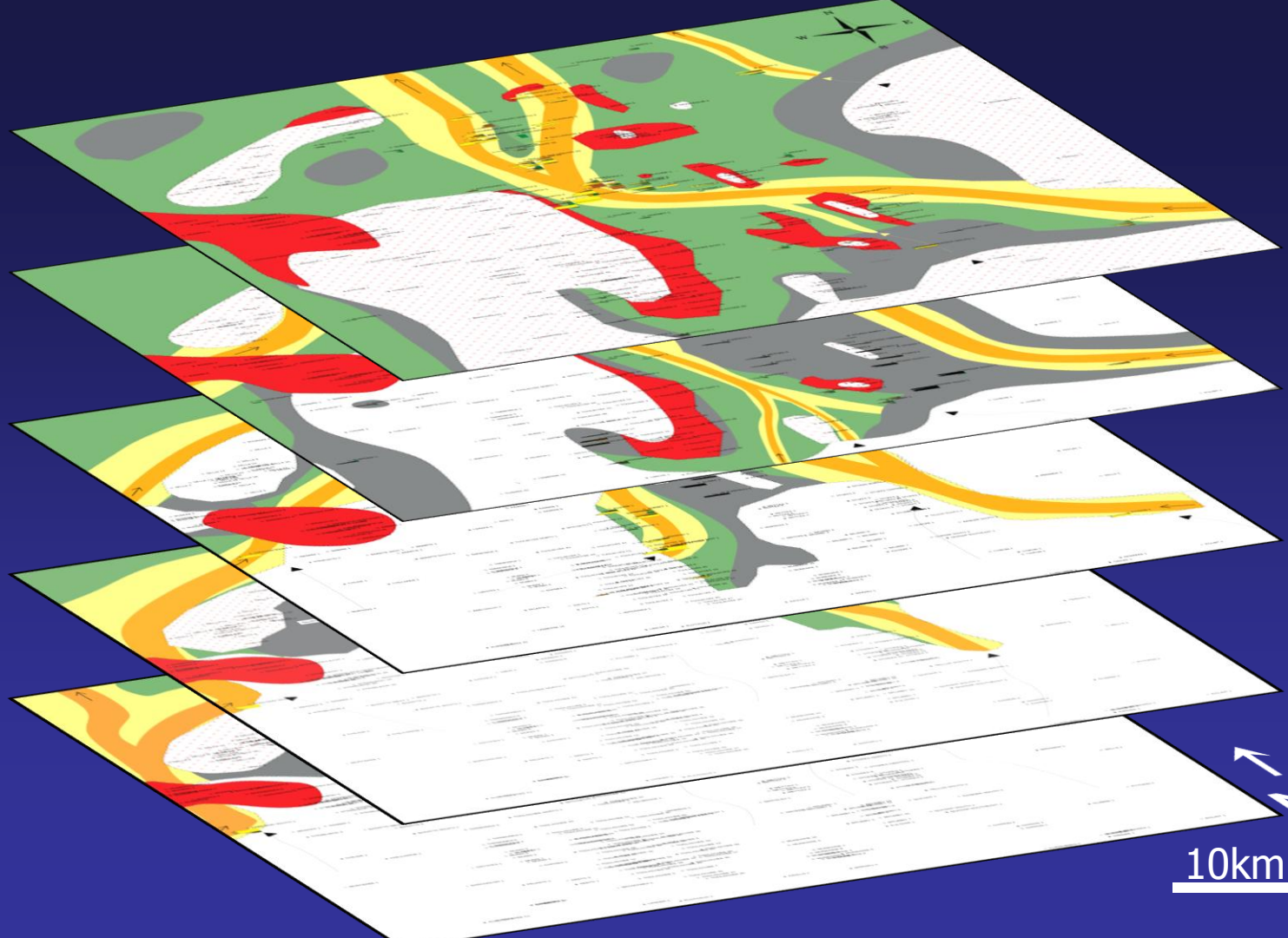


Floodplain & Lacustrine Uplands

Channel Belt

Minor Channel and Crevasse Splay Complex

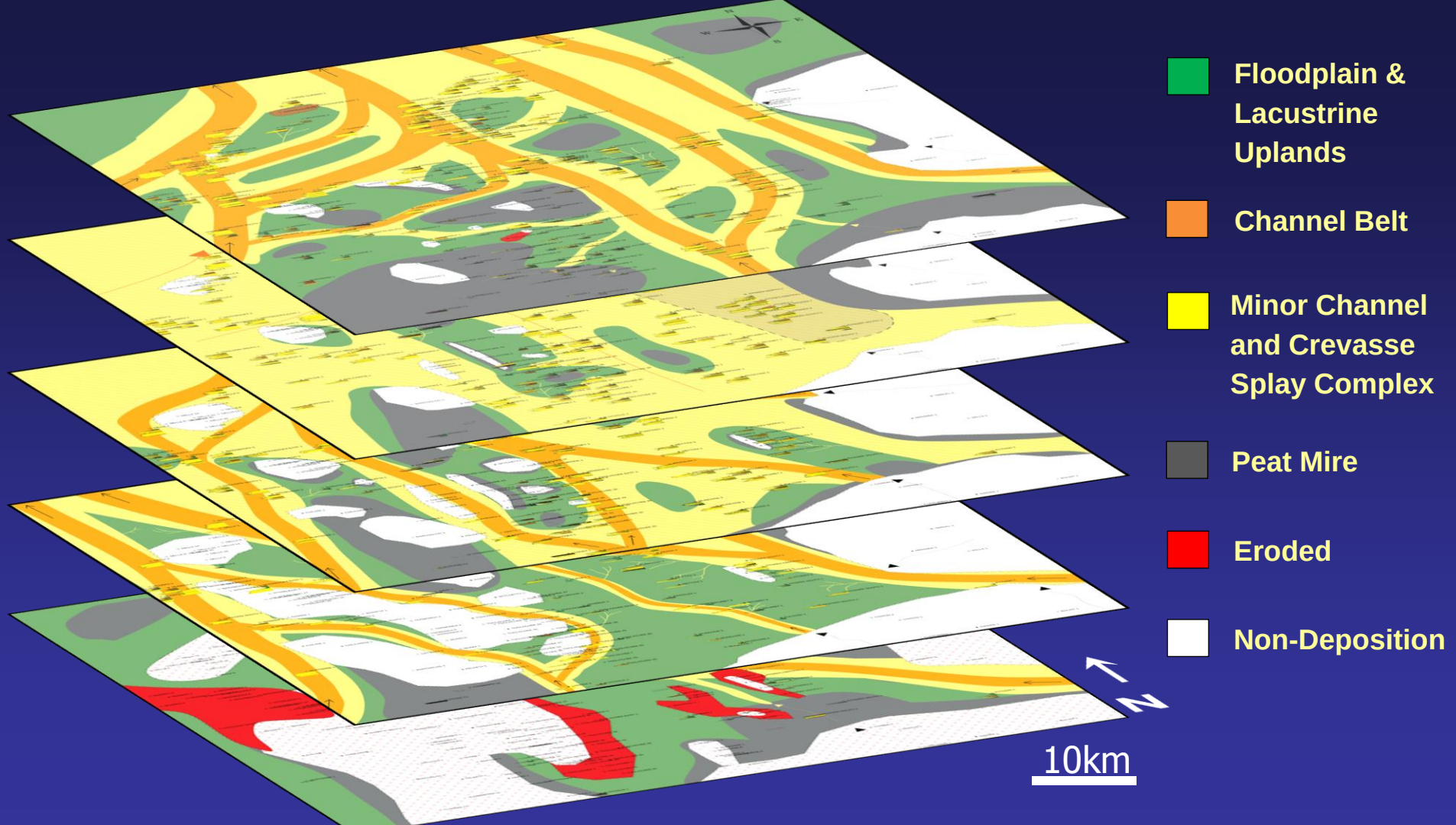
Peat Mire

Eroded

Non-Deposition

N

10km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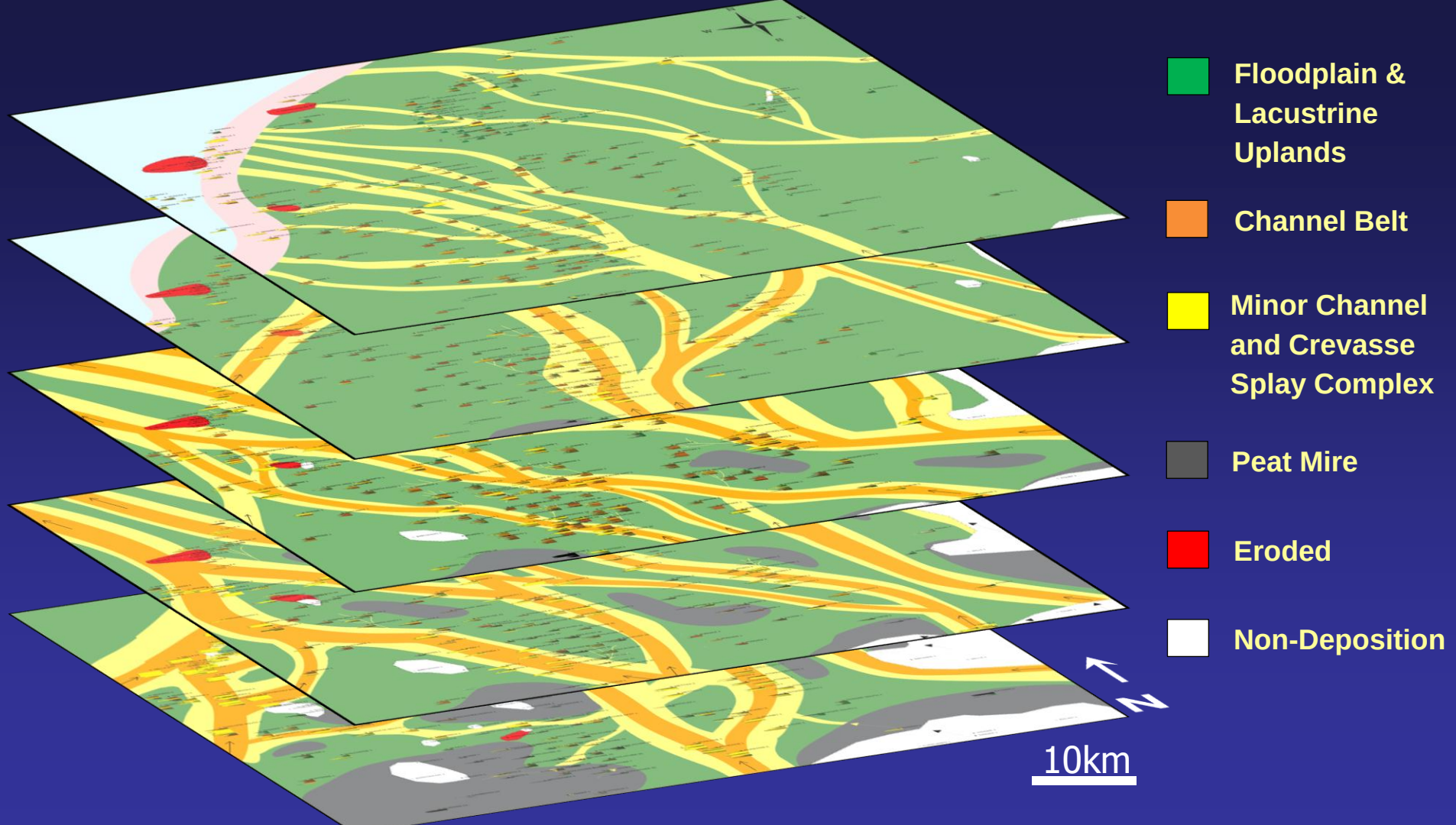
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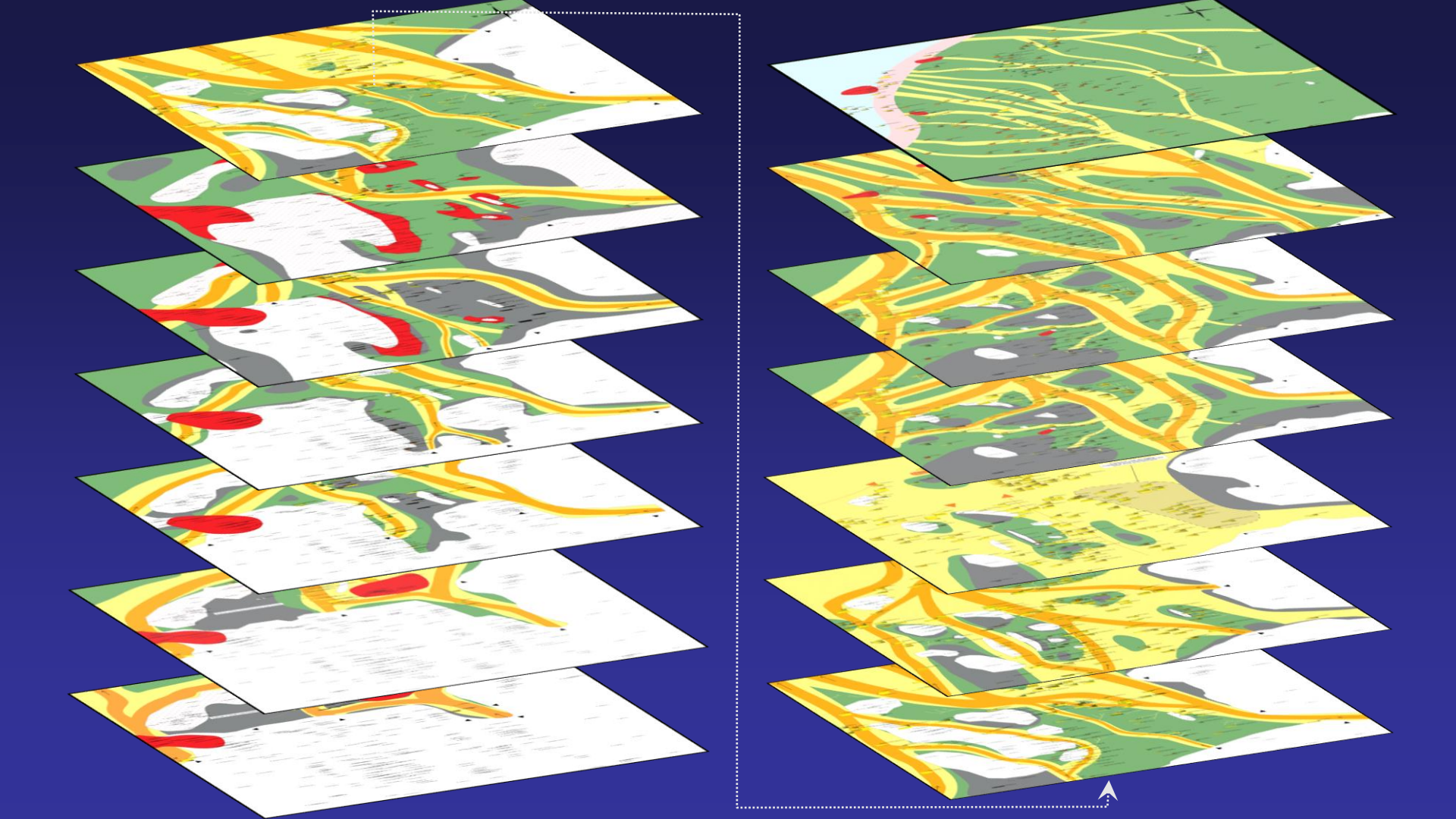

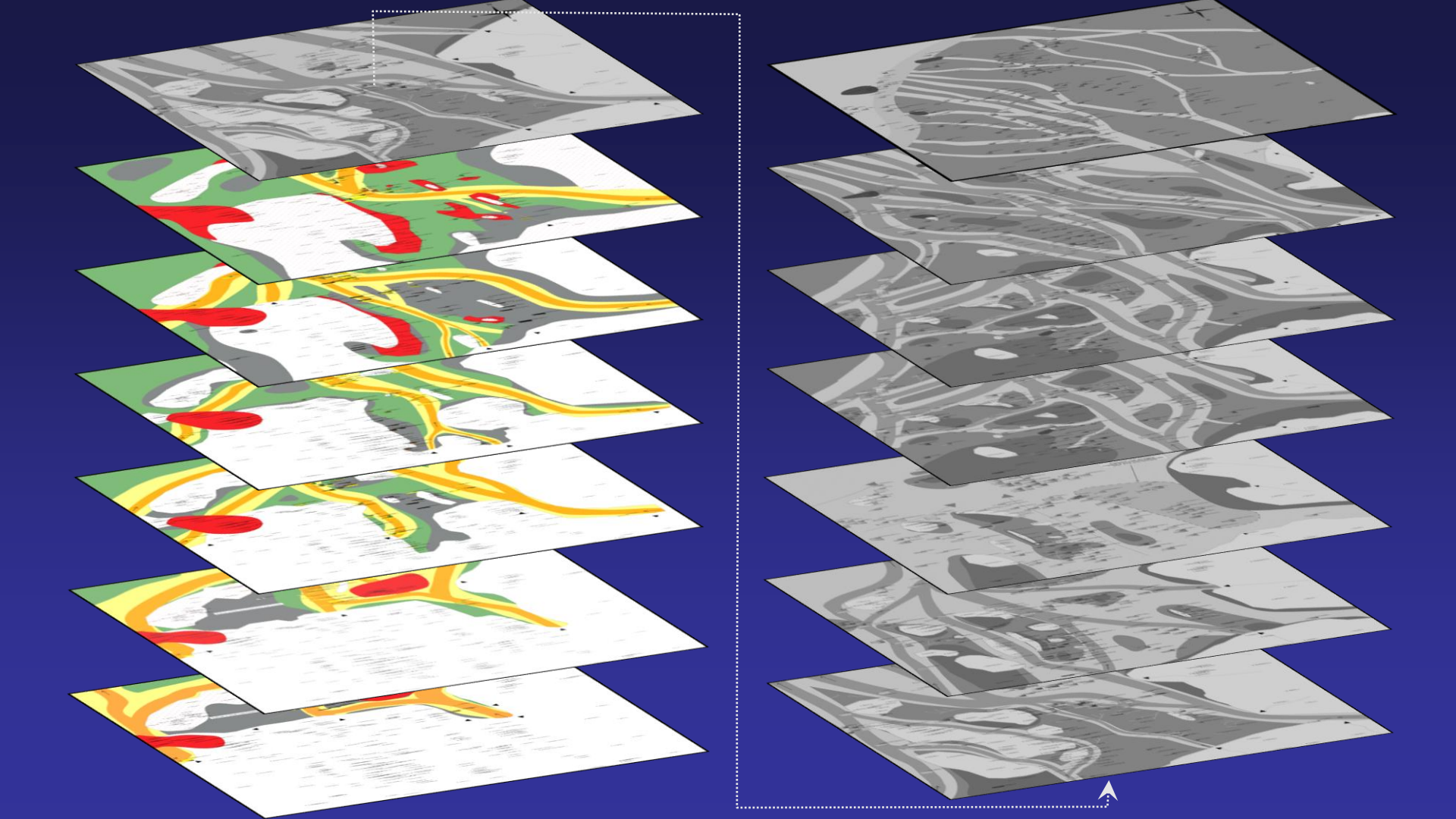

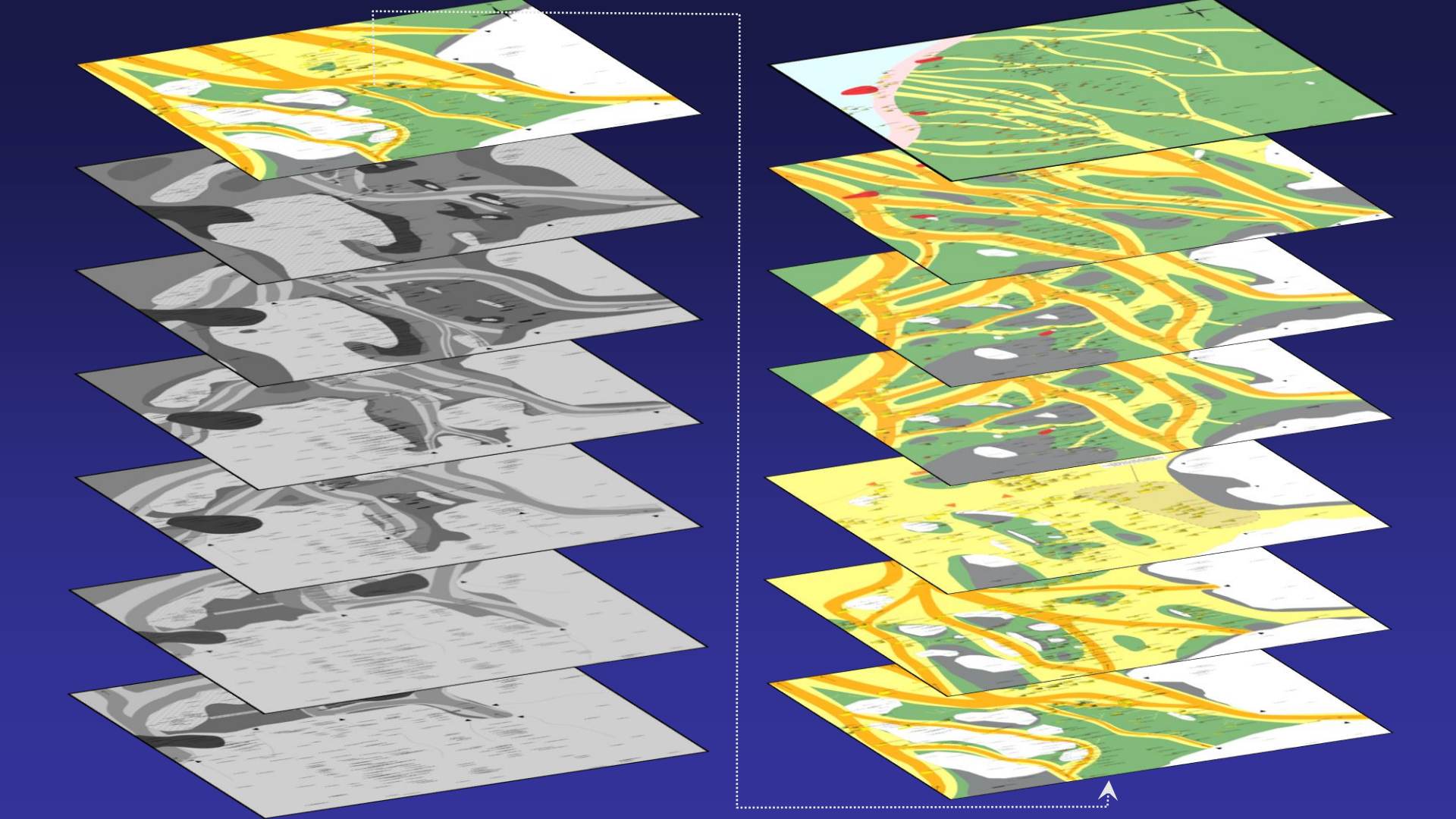

Analogue Study

- High latitude, cool climate??
- Pre-existing compressional structures??
- Strong structural control on facies distribution in the lower Patchawarra Fm??

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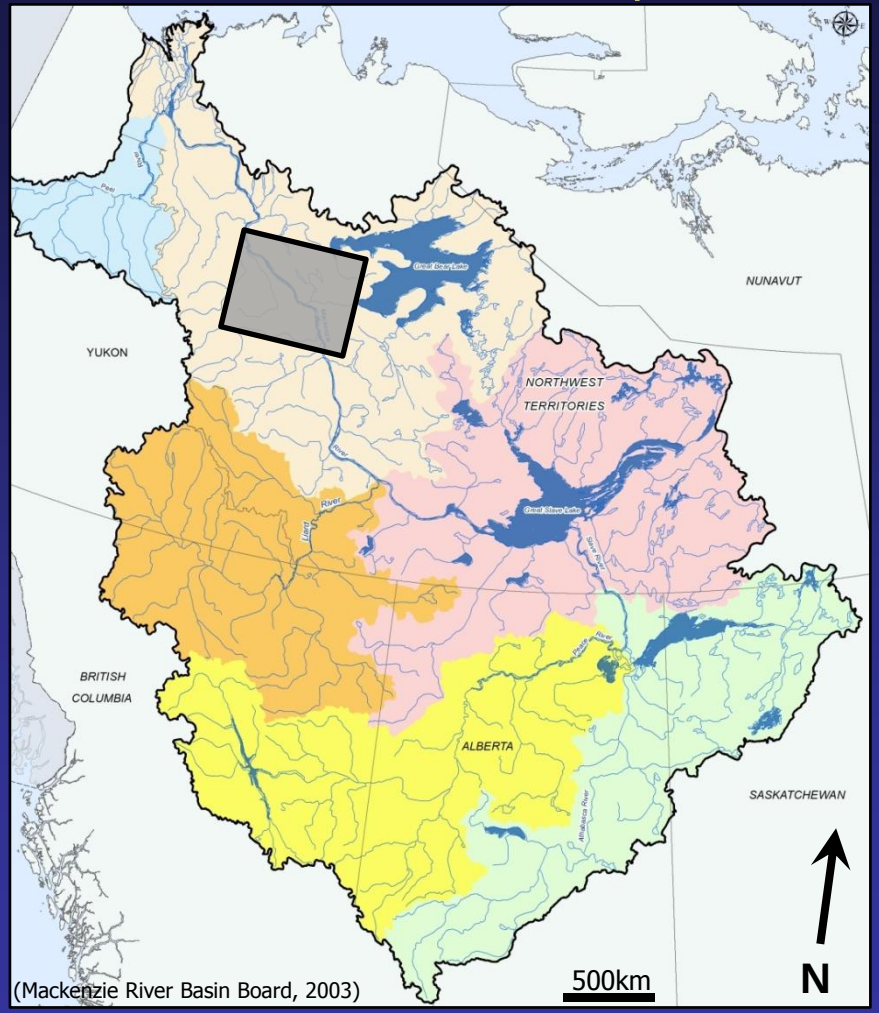
Mackenzie River Watershed, Canada




N
20km
(Image from Google Earth, 2014)


N
20km
1.
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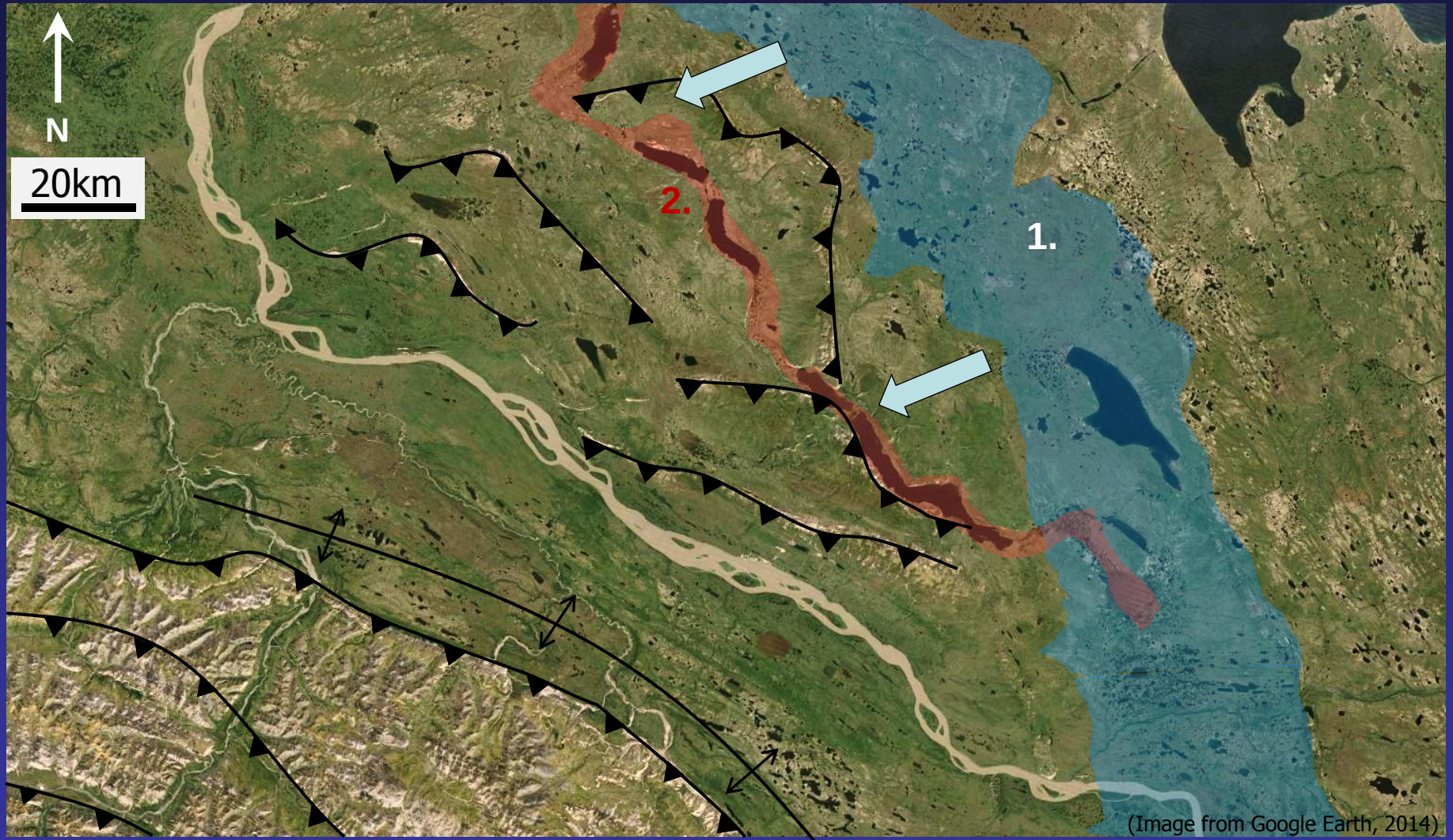
N
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2.
1.
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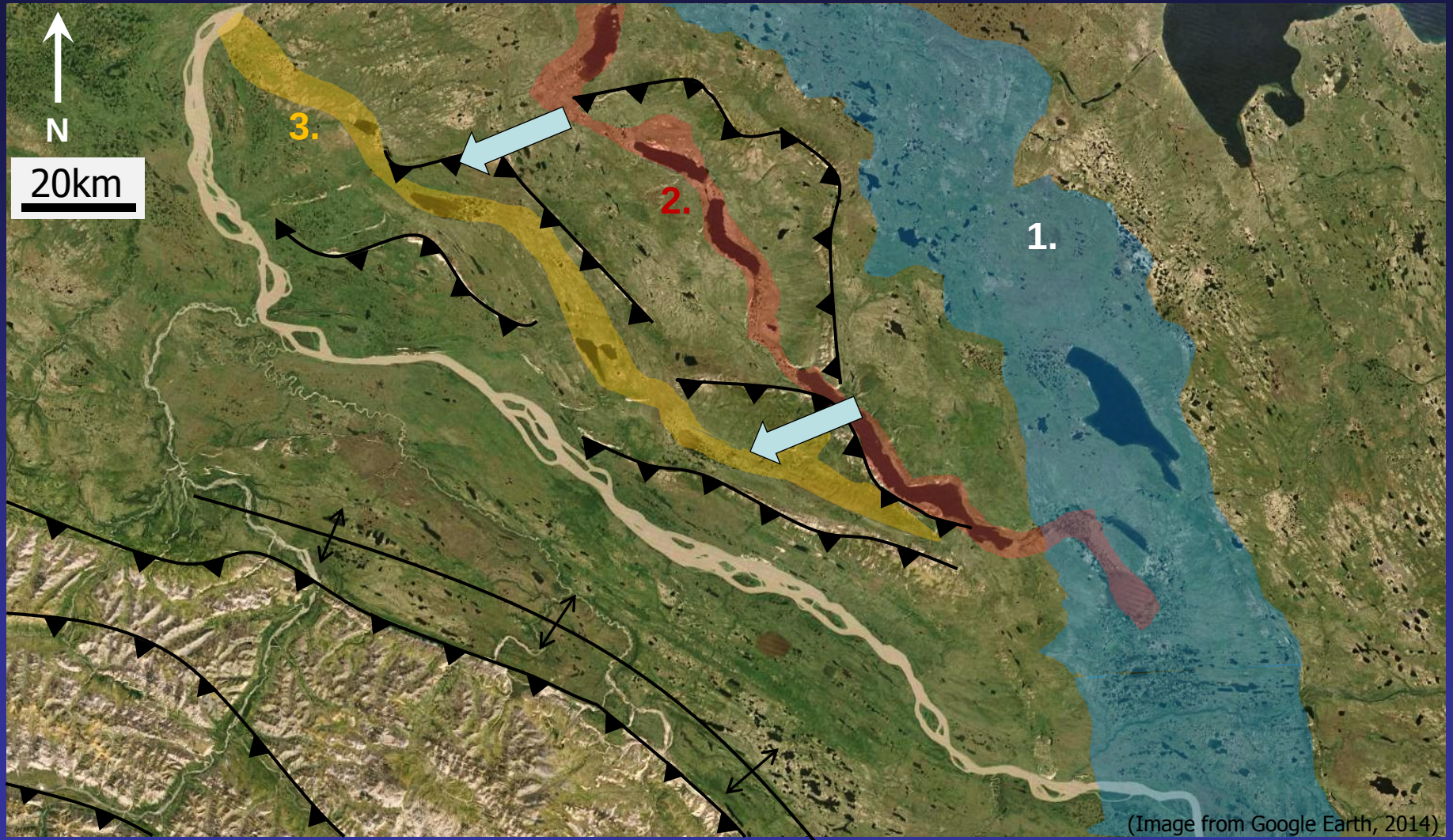
N
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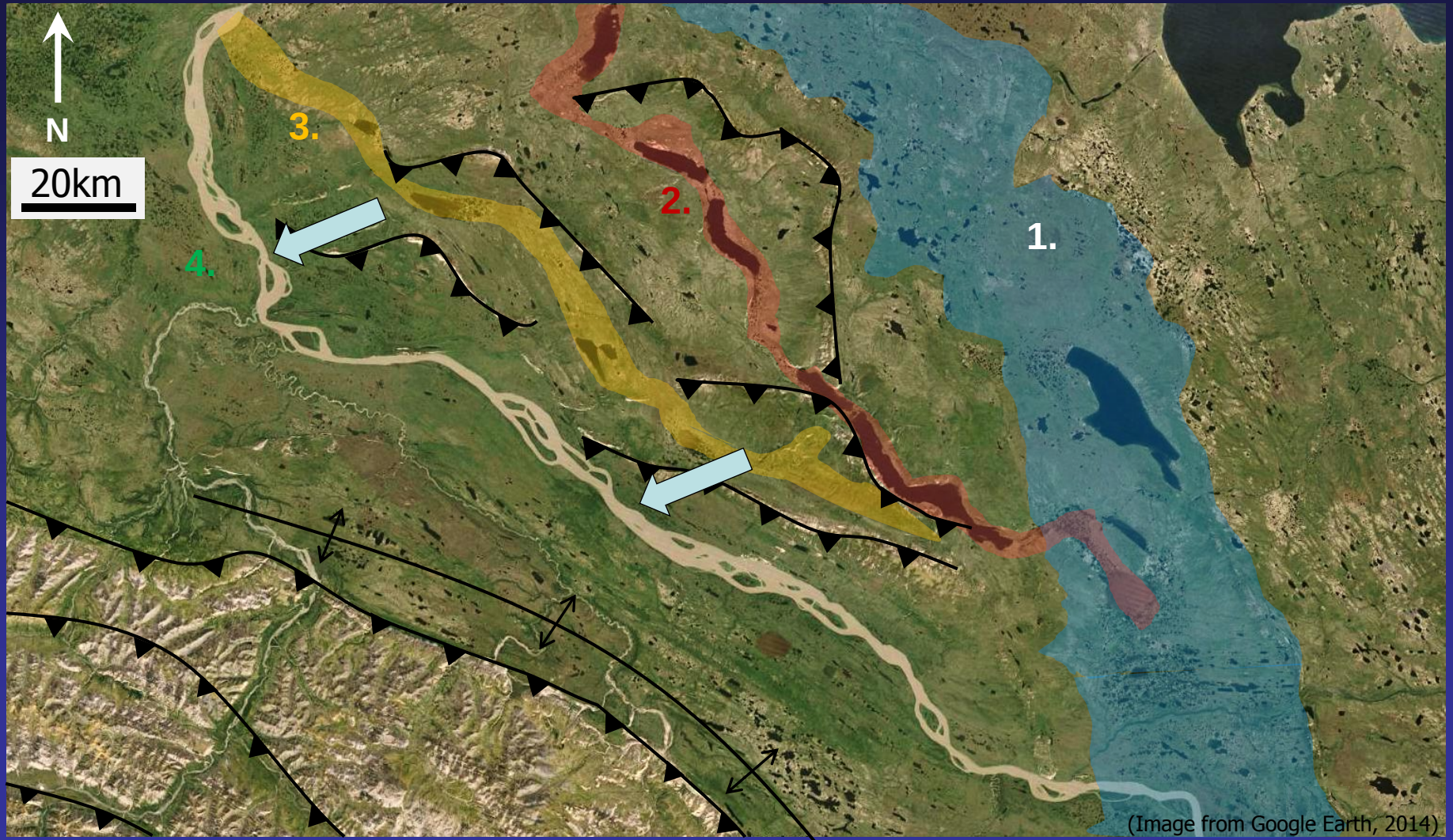
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2.
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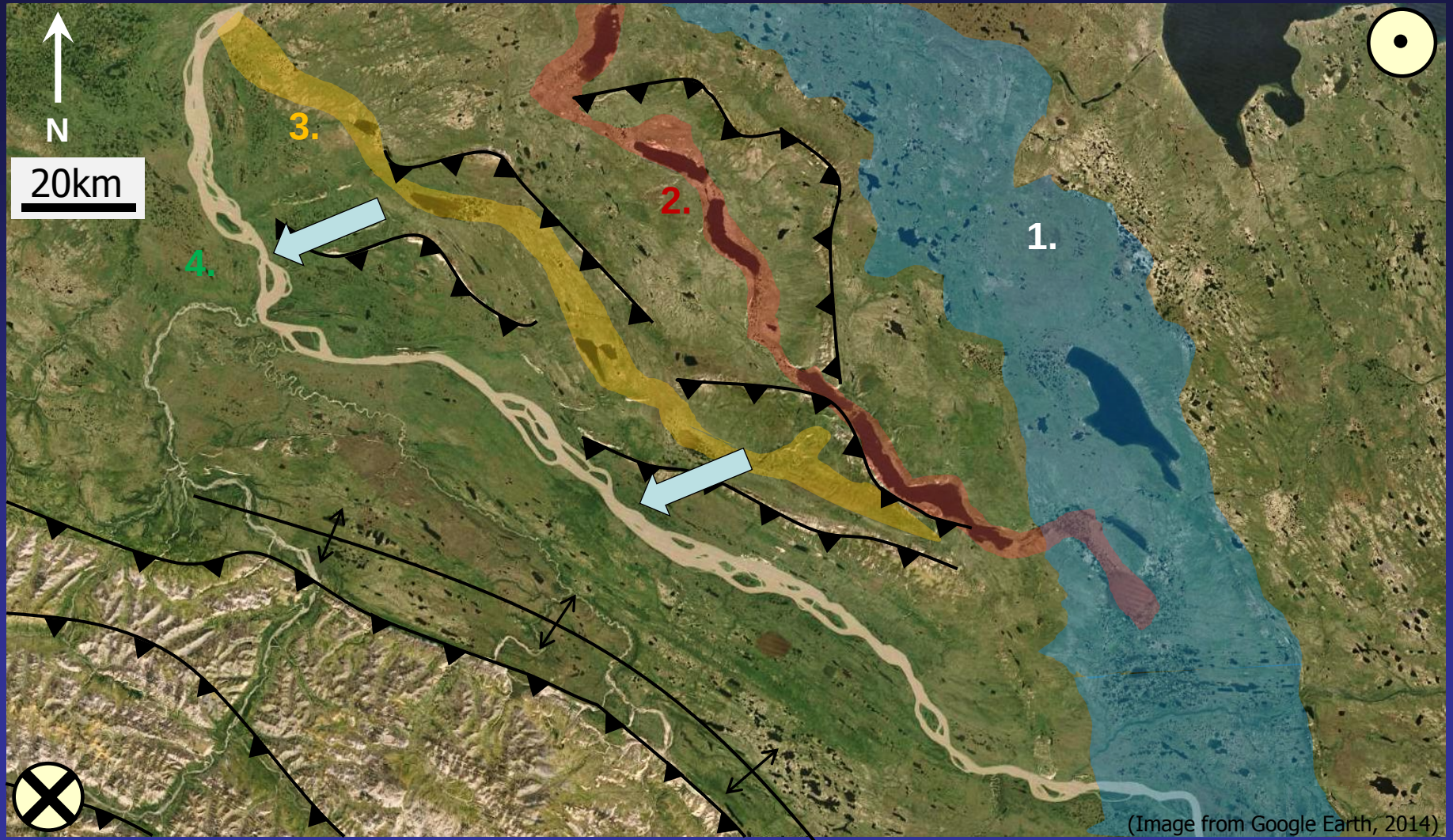
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3.
2.
1.
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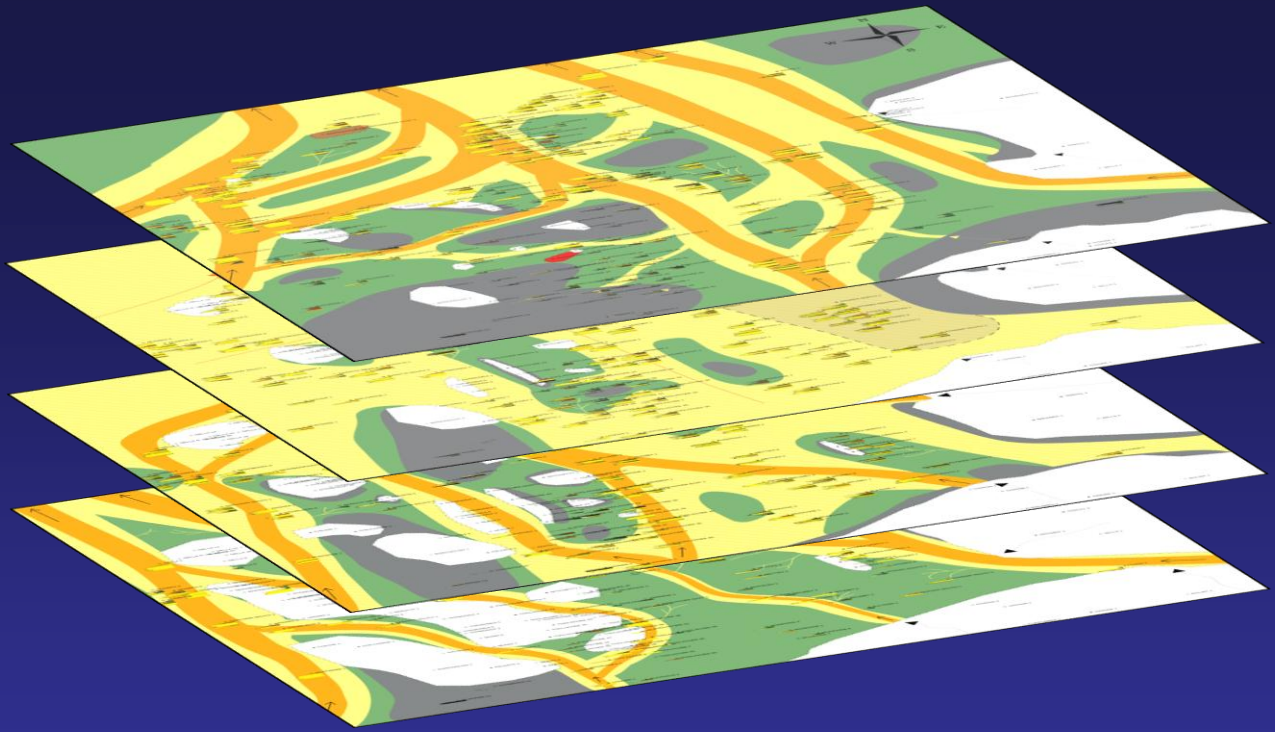
Outcomes

- High resolution palaeographic maps were constructed using wireline log data and analogue studies.
- Palaeogeographical reconstruction allowed detailed insight of spatial distribution of facies through time.
- This technique can be applied to a study area with sufficient well density, provided suitable analogues and facies schemes are applied.



Thank You

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