Techniques in Subsurface Mapping using Spectral Decomposition and Well Log Character: Case Study of Cenozoic Fluvial & Marginal Marine Reservoirs of Llanos Foothills, Colombia

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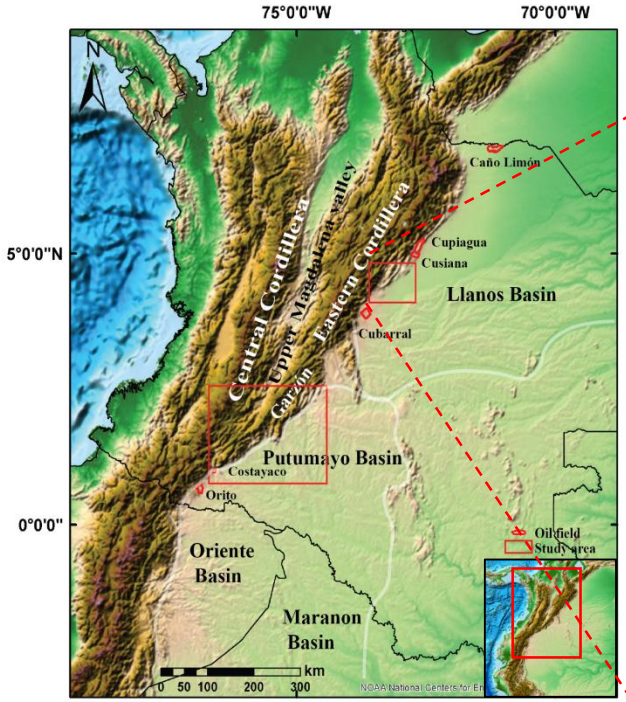
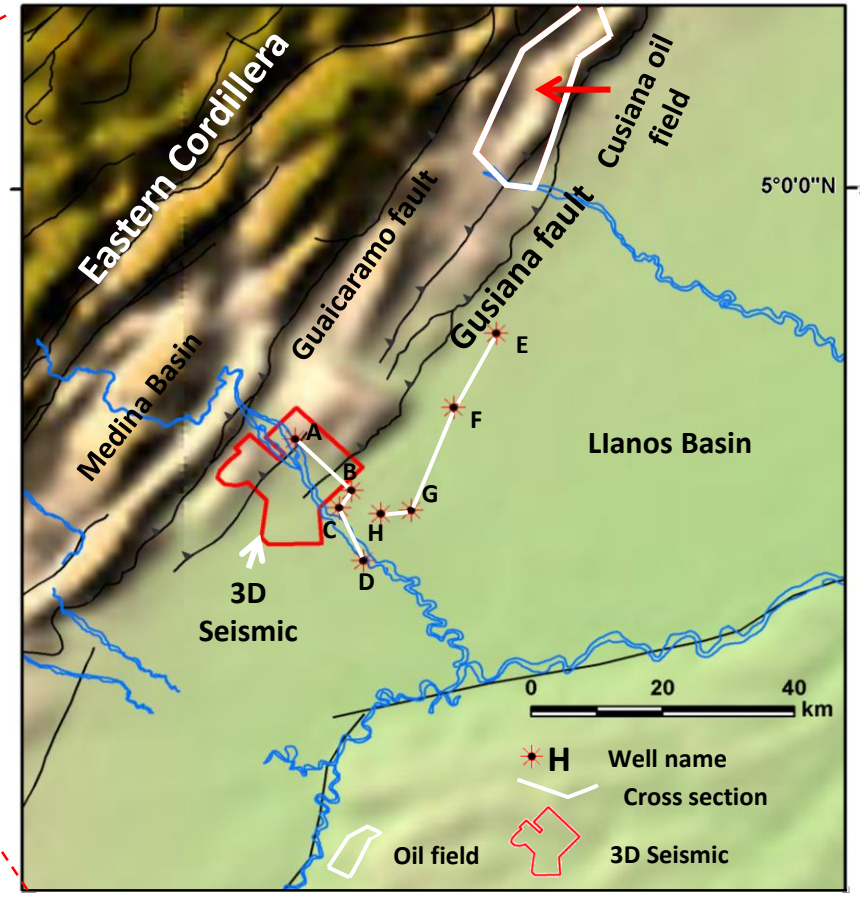
Techniques in Subsurface Mapping using Spectral Decomposition and Well Log Character



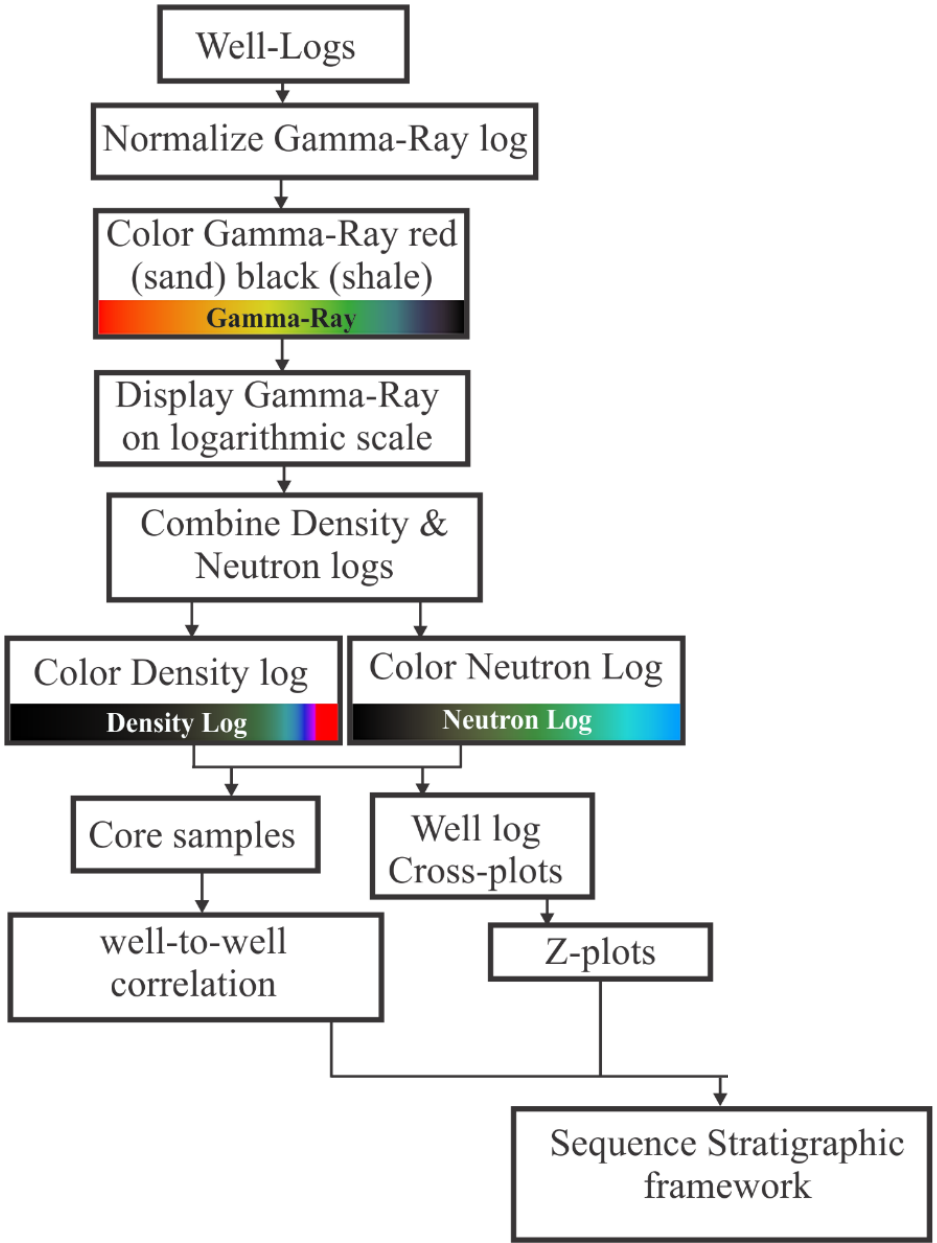


Objective of this study - use spectral decomposition method for subsurface mapping through frequency anomalies in a geologically and seismically challenging area - Llanos Foothills, Eastern Cordillera, Colombia

PRESENTATION OUTLINE

- New techniques of well-to-well correlation
- Spectral Decomposition
- Integration of Well logs and Spectral Decom as subsurface mapping techniques
- Spectral Decom. expression of Tectonic Deformation
- Conclusions

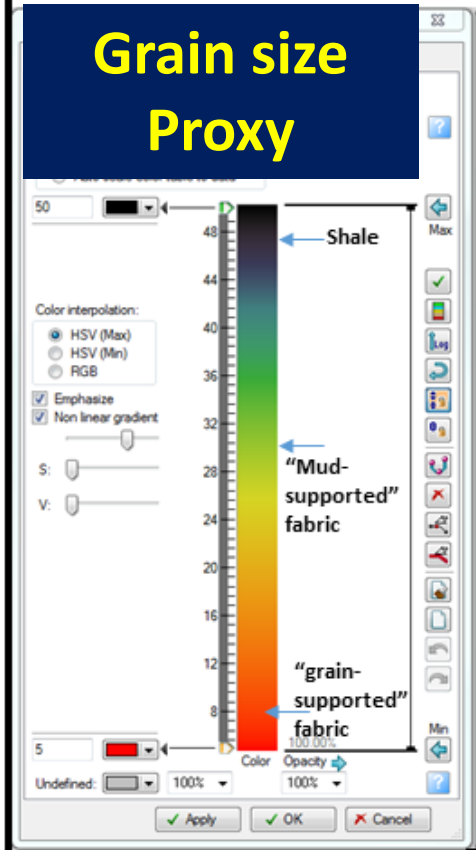
PROPOSED WORKFLOW



❑ CHOOSING A COLOR SCALE

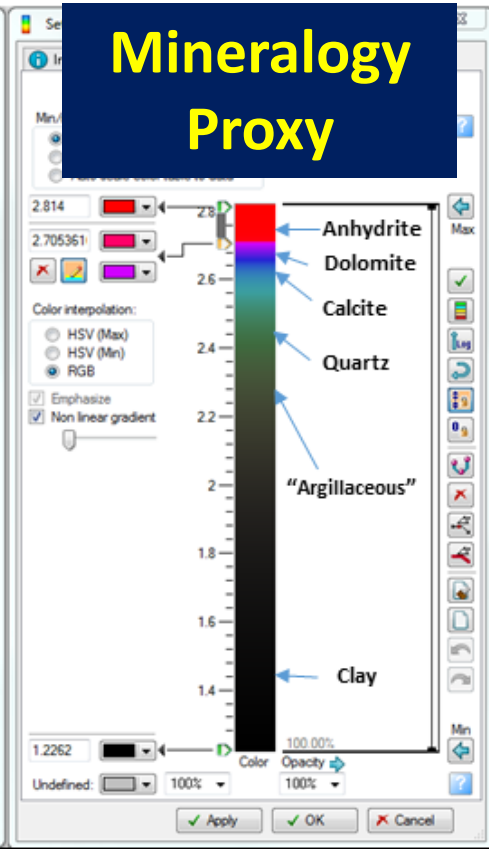
Well Logs Color Scale

Grain size Proxy



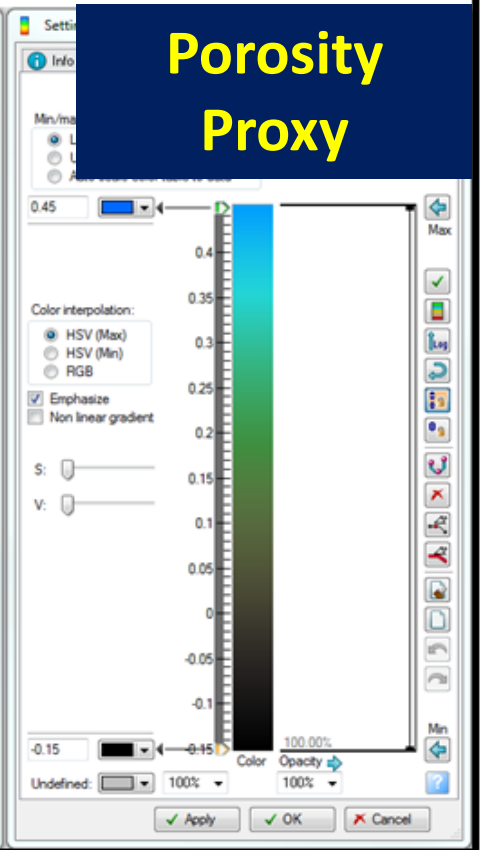
Scale for GR: logarithmic, 1-500
(GR logs normalized)

Mineralogy Proxy



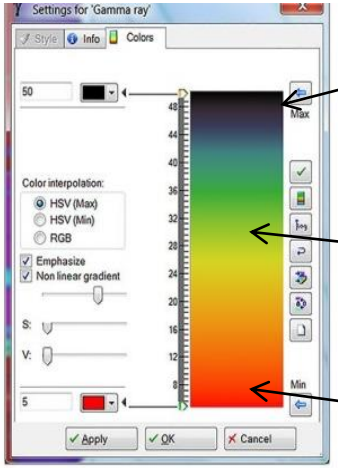
Scale for RHOB: normal, 1.95 - 2.95
Shaded red above 2.8

Porosity Proxy



Scale for NPHI: reverse, -0.15 - 0.45

❑ Normalized GR & Display on Log Scale

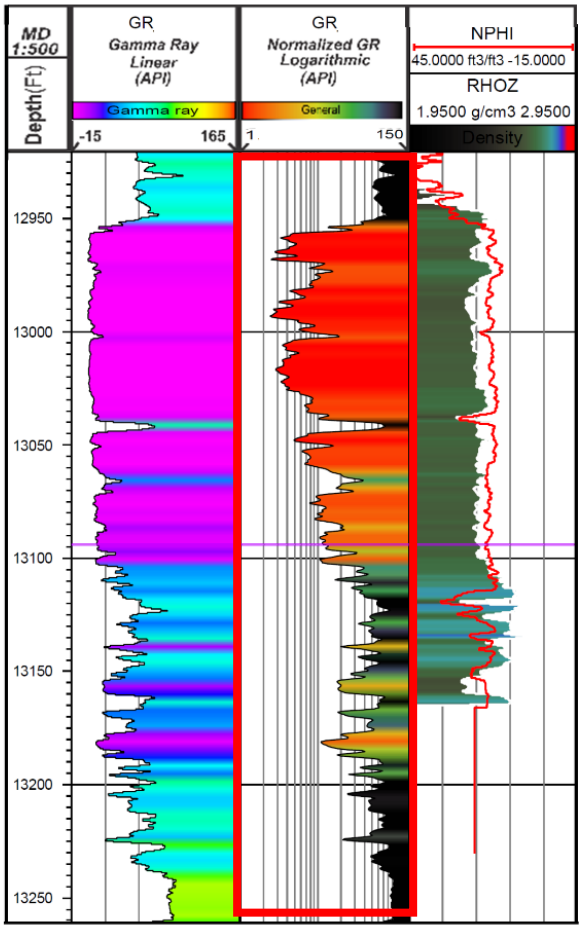


Shale

"Mud-supported"
Fabrics

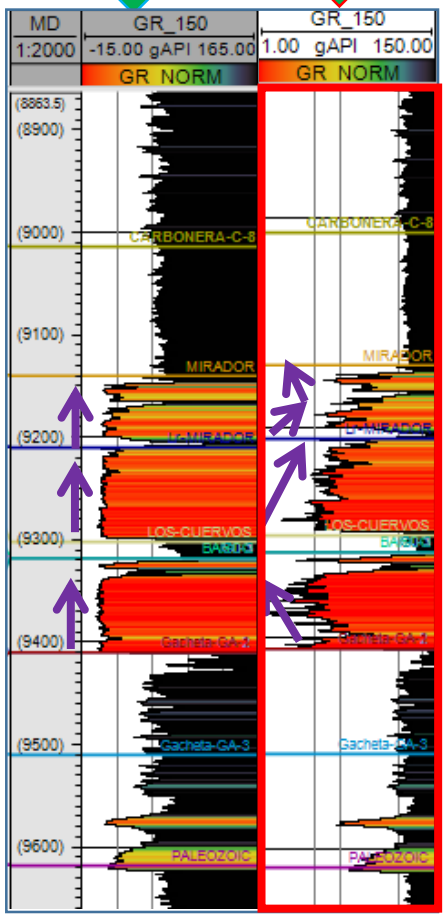
Sand
"grain supported"

Normalized GR (Log Scale)

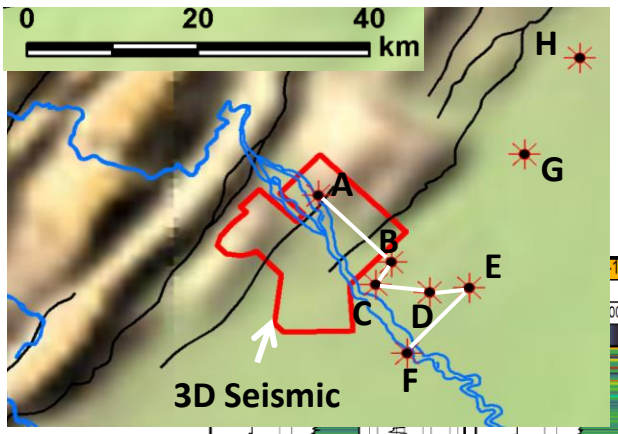


Normalized GR

Norm. GR (Log Scale)



Establishing sequence stratigraphy framework



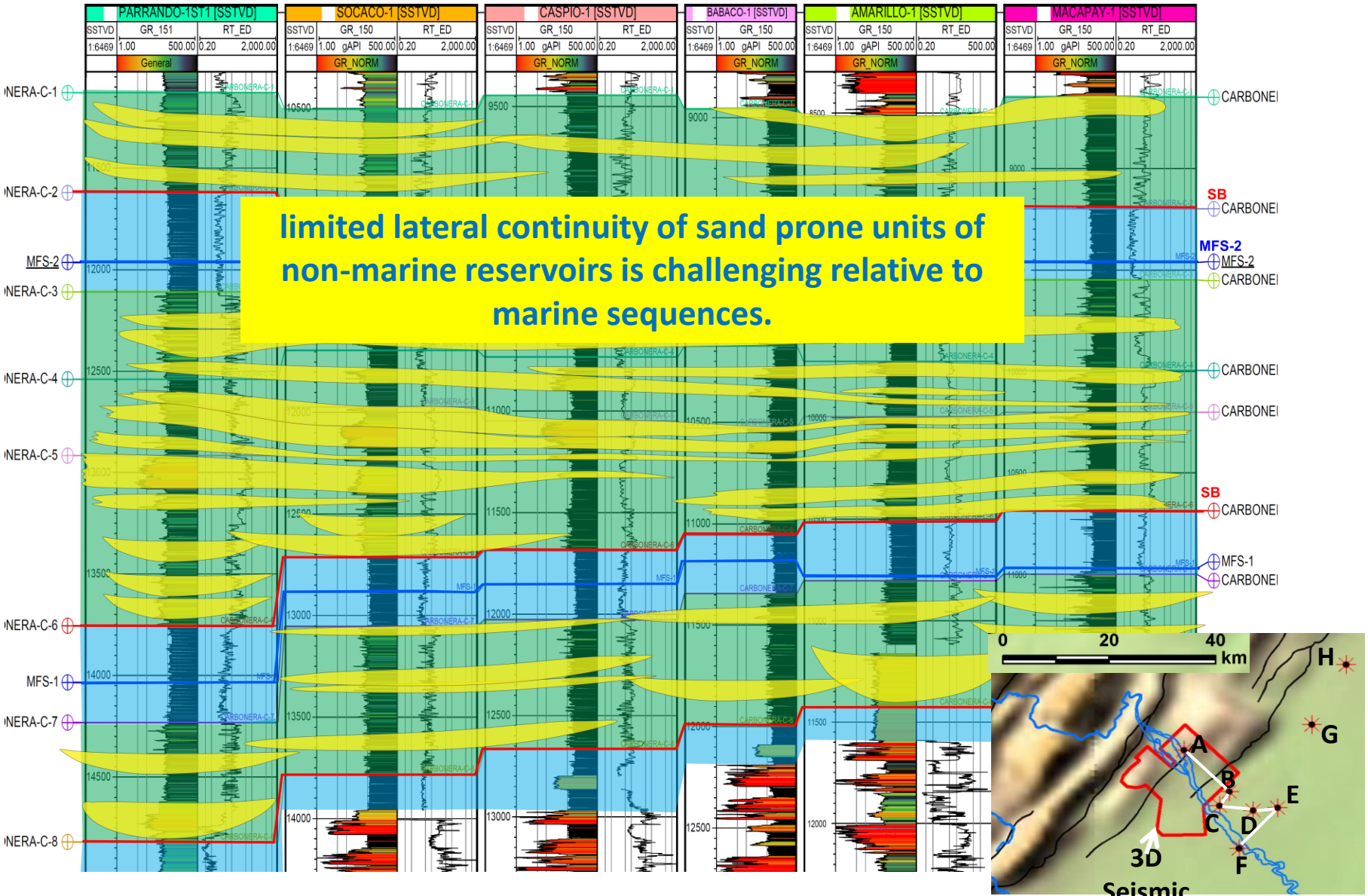
F (SE)

CASPIO-1 [SSTVD]
BABACO-1 [SSTVD]
AMARILLO-1 [SSTVD]
MACAPAY-1 [SSTVD]
SSTVD
GR_150
RT_ED
GR_NORM
CARBONERA-C-2
MFS-2
CARBONERA-C-3
CARBONERA-C-4
CARBONERA-C-5
CARBONERA-C-6
MFS-1
CARBONERA-C-7
CARBONERA-C-8

Connecting the potential reservoirs based on well logs

A (NW)

F (SE)



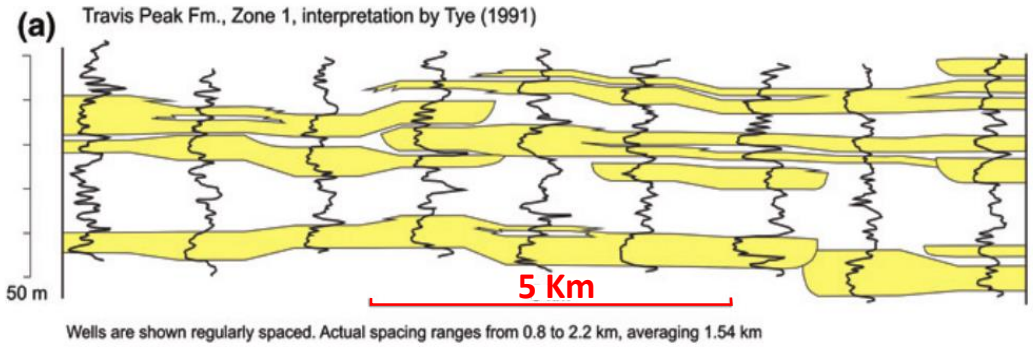
The Problem

- Well logs and cores can identify fluvial, estuarine and/or deep-water fans.
- It is impossible to predict channel orientation and correlate channels from well logs alone or from 3D seismic.
- My next slide shows 3 different interpretations by three experts interpreting the same geological section displaying fluvial sediments on well logs

Why this research is important?

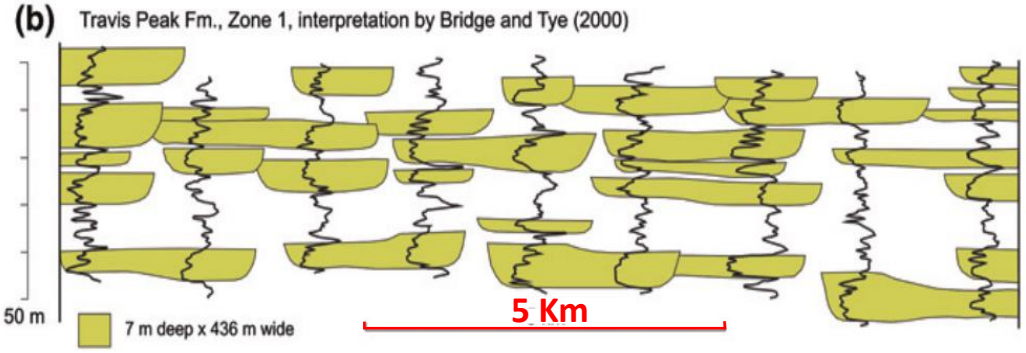
Three interpretations of the braided-fluvial deposits of the Travis Peak Formation TX.

Tye (1991)

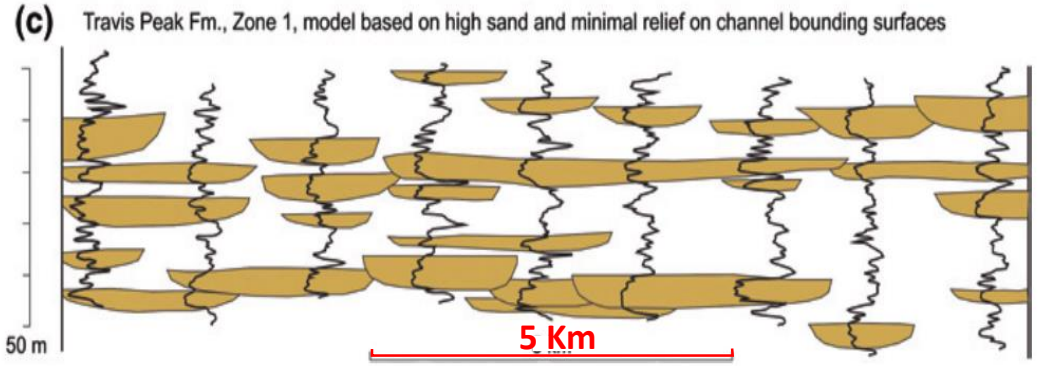


Sandstone connectivity Is the major rule in oil exploration and production

Bridge and Tye (2000)



Miall 2006 & 2014



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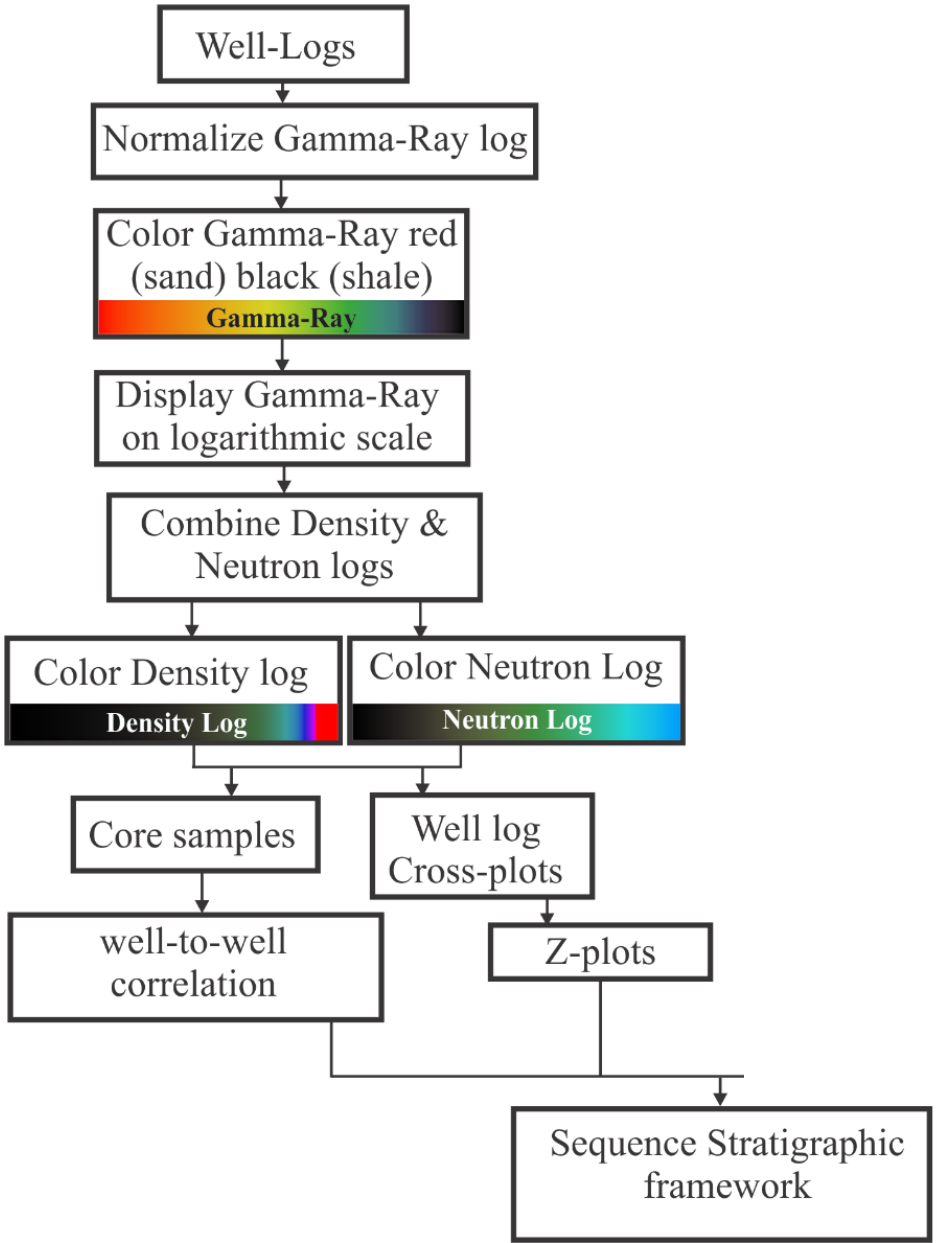
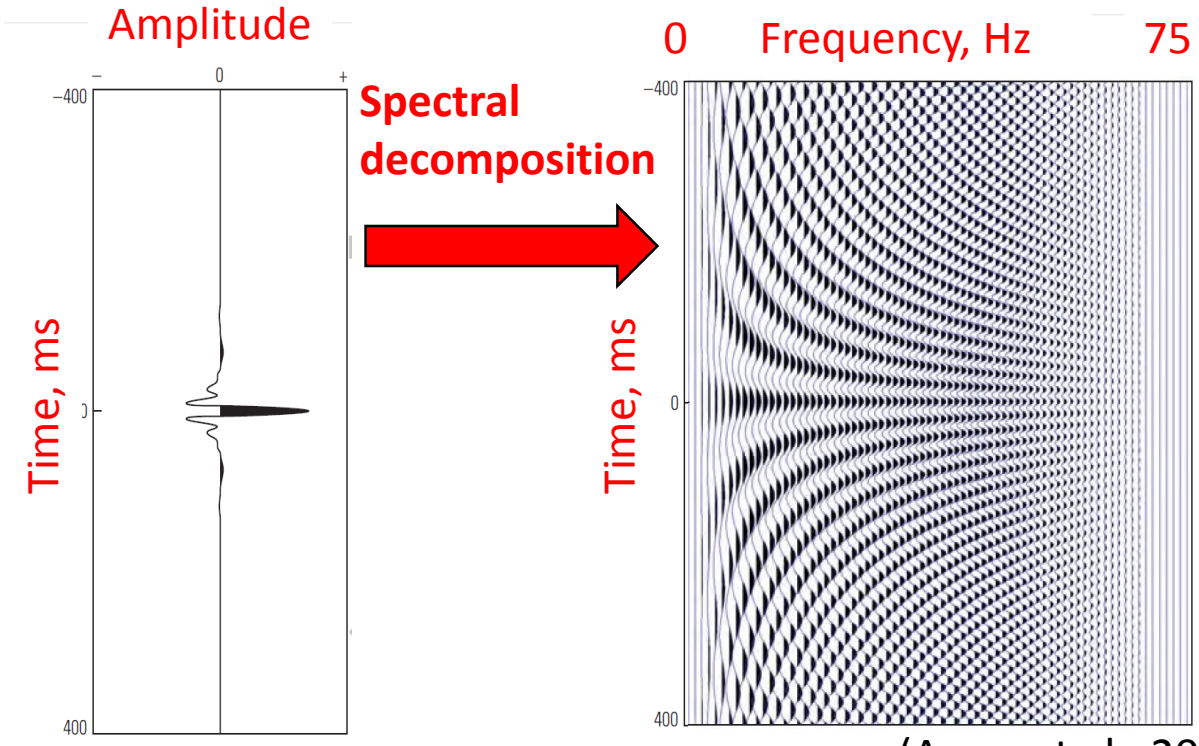


❑ What is Spectral Decomposition?

- A way of viewing the data contained in discrete sections of the 3D seismic data frequency spectrum



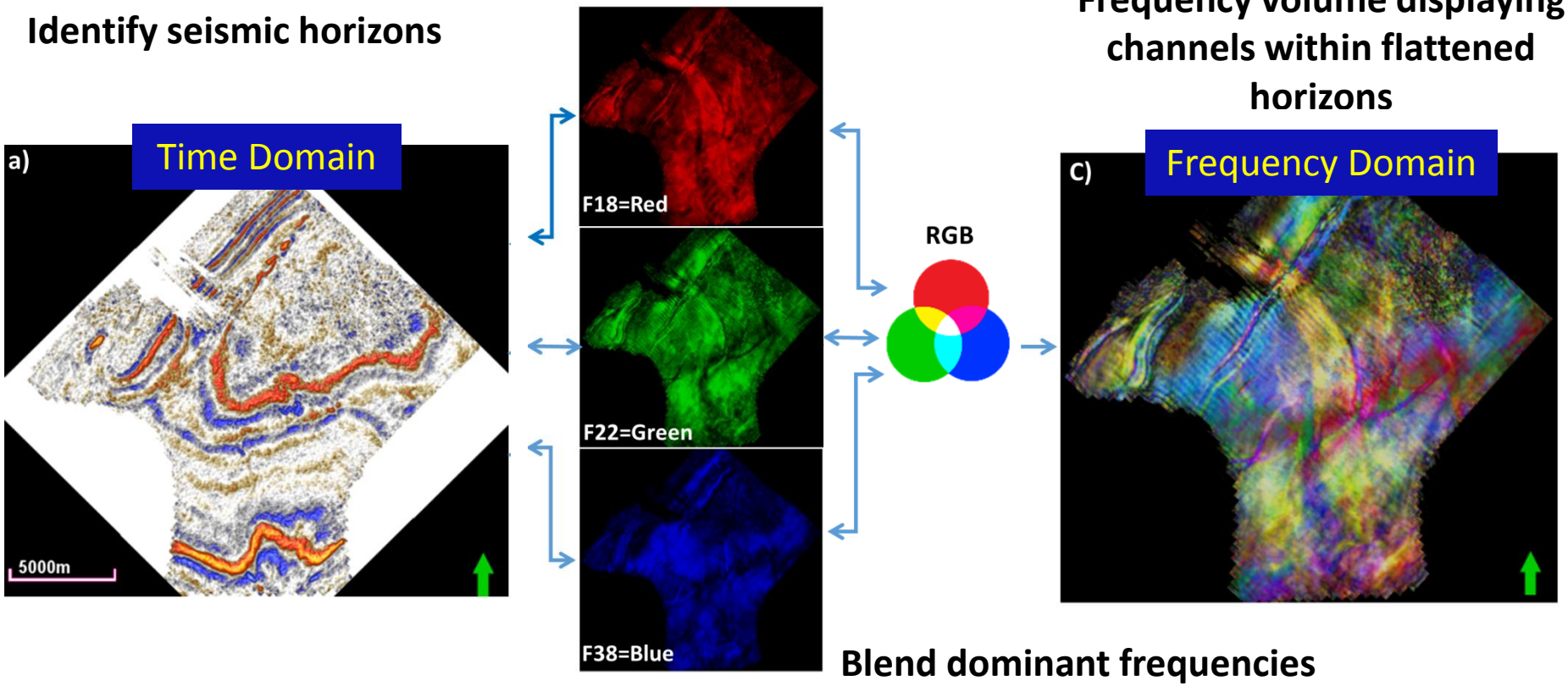
(Aarre et al., 2012)

Workflow of Spectral Decomposition

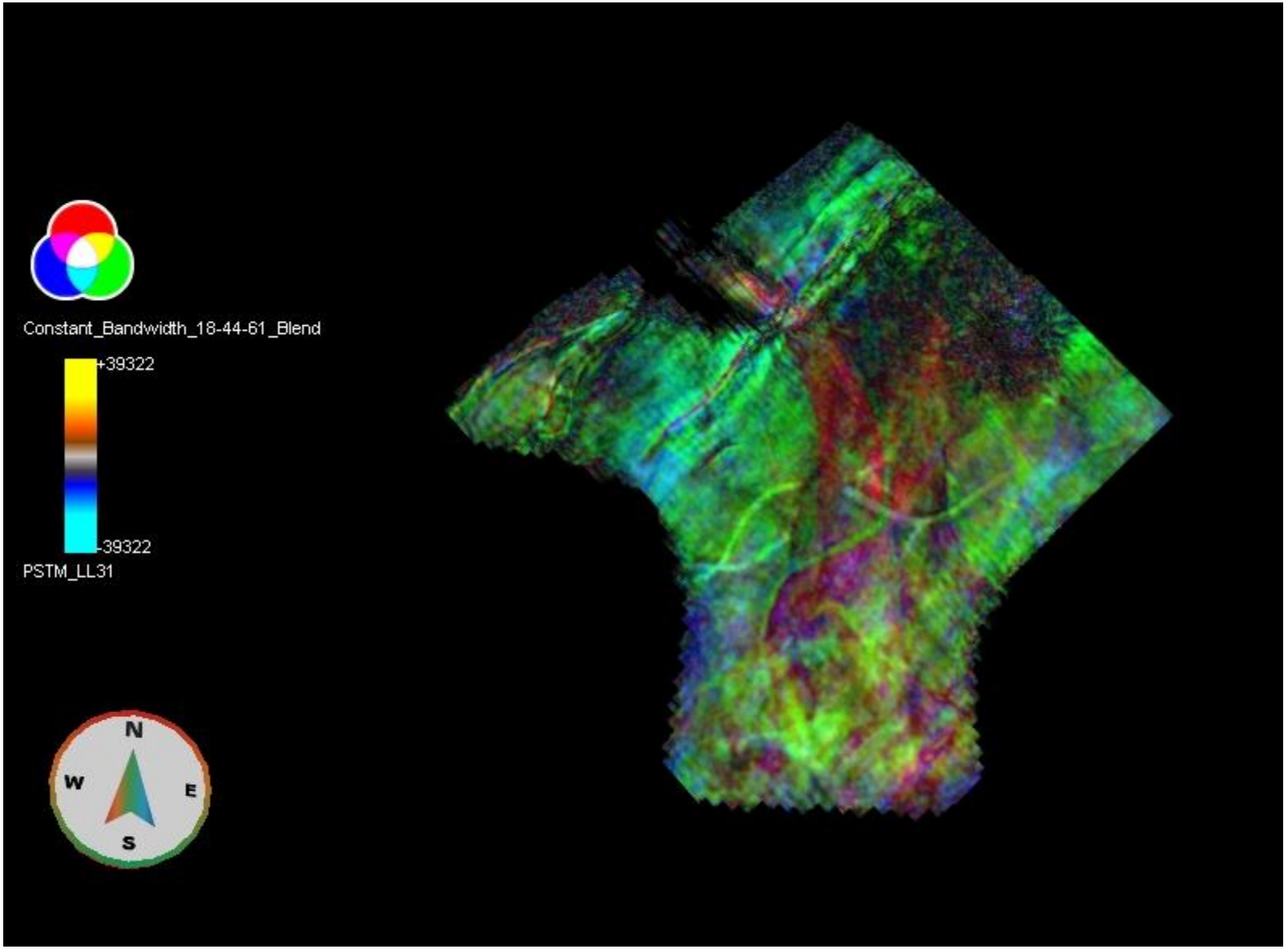
Extract (3) dominant frequencies, break into 3 discrete frequency volumes and flatten at the horizon of interest

Identify seismic horizons

Frequency volume displaying channels within flattened horizons

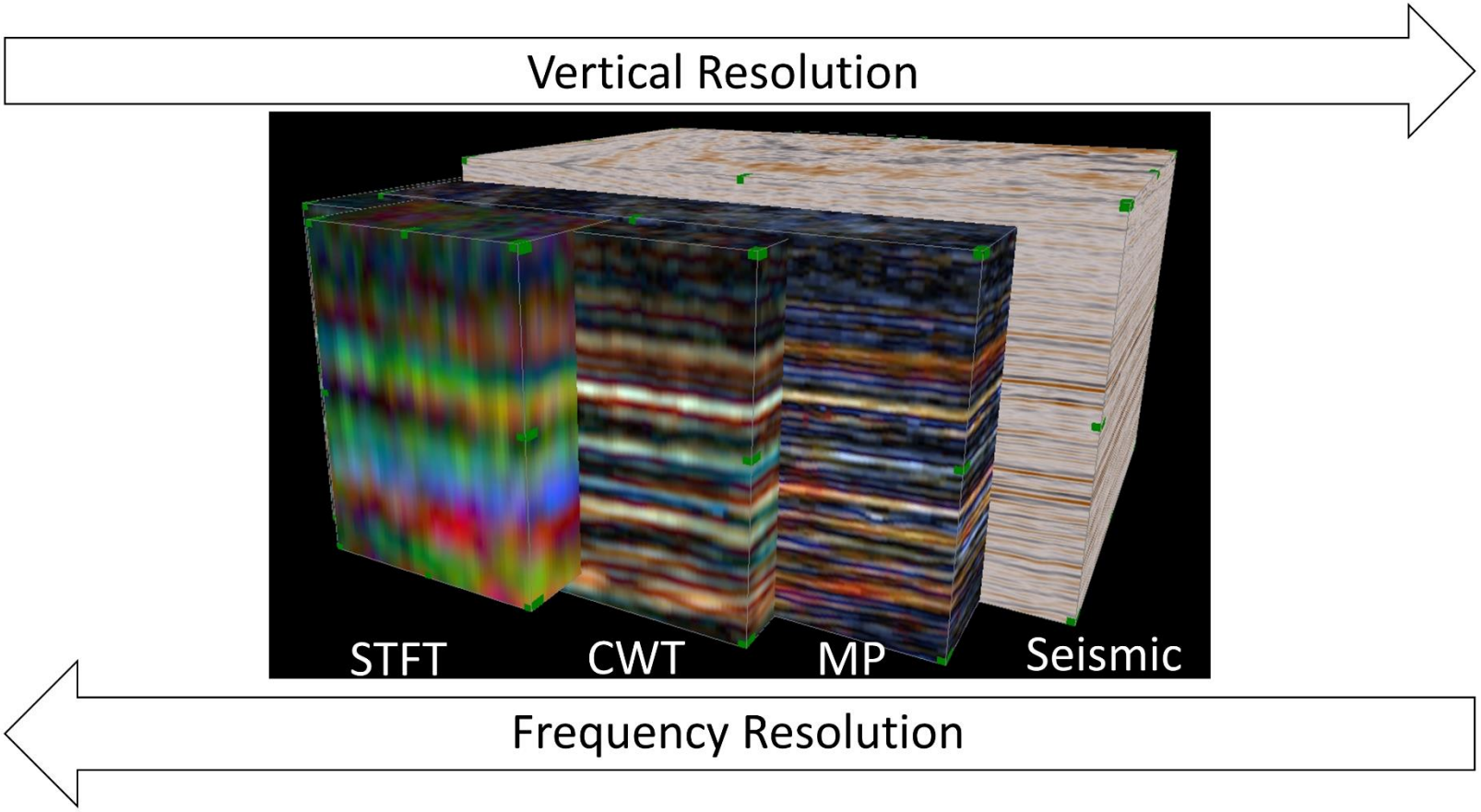


Blend dominant frequencies volumes by RGB mixer

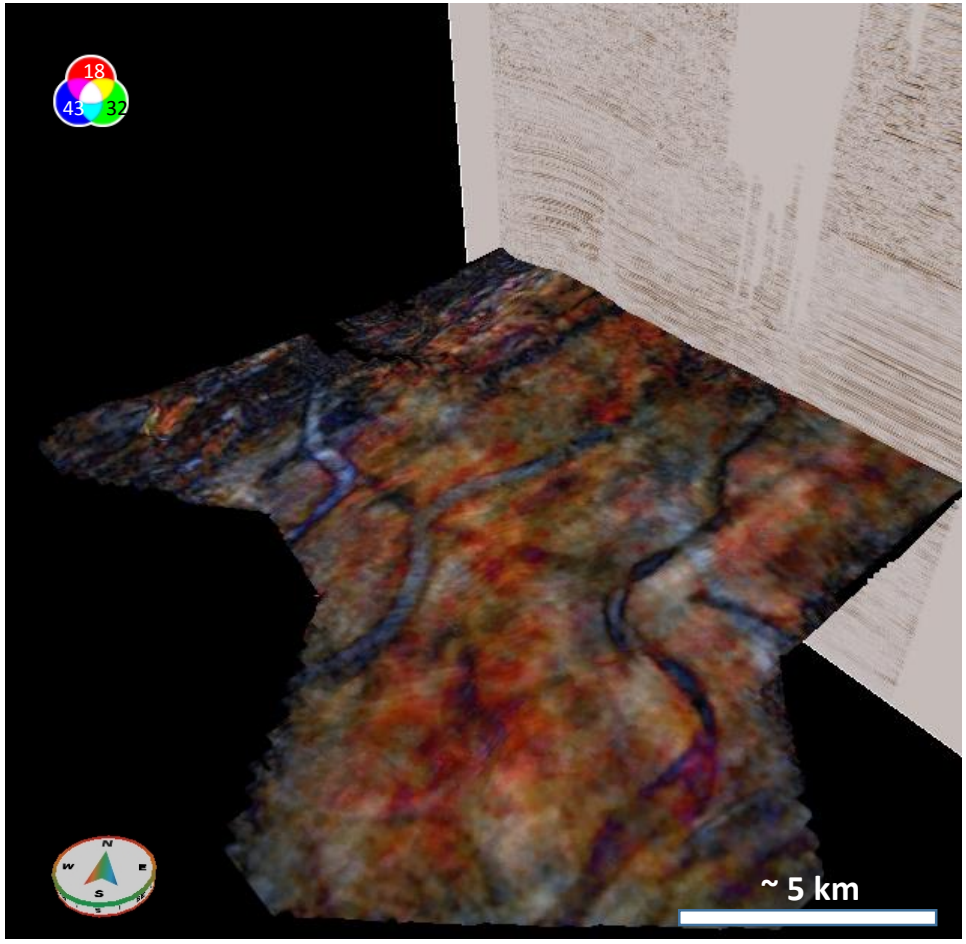

Constant_Bandwidth_18-44-61_Blend
+39322
-39322
PSTM_LL31
N
W
E
S

Types of Spectral Decomposition

1-STFT= Short Time FT **2-CWT= Continuous wavelet** **3-MP= Matching pursuit**



Spectral Decomposition results similar to modern fluvial analog from Peru



Ucayali River Peru

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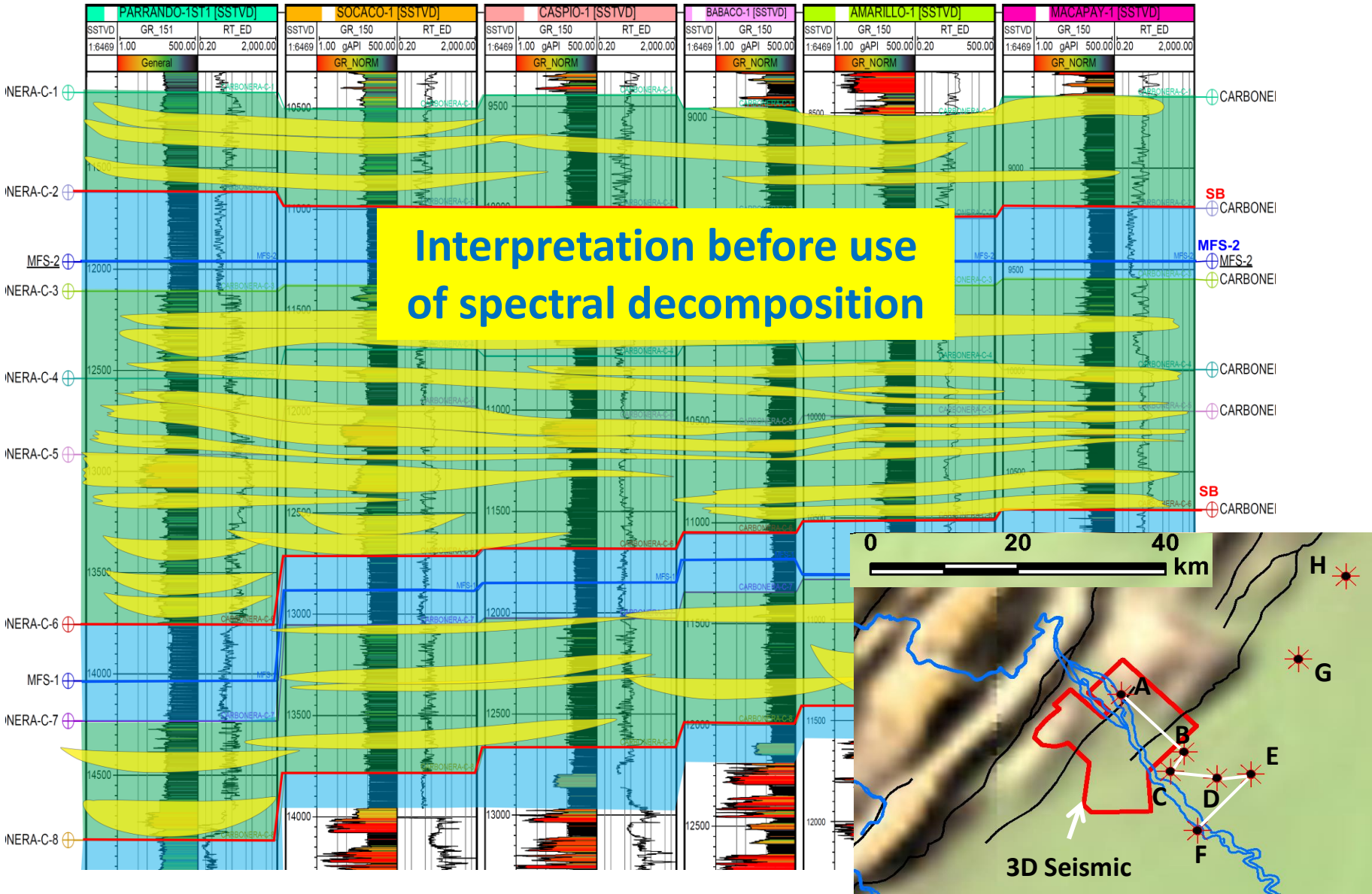
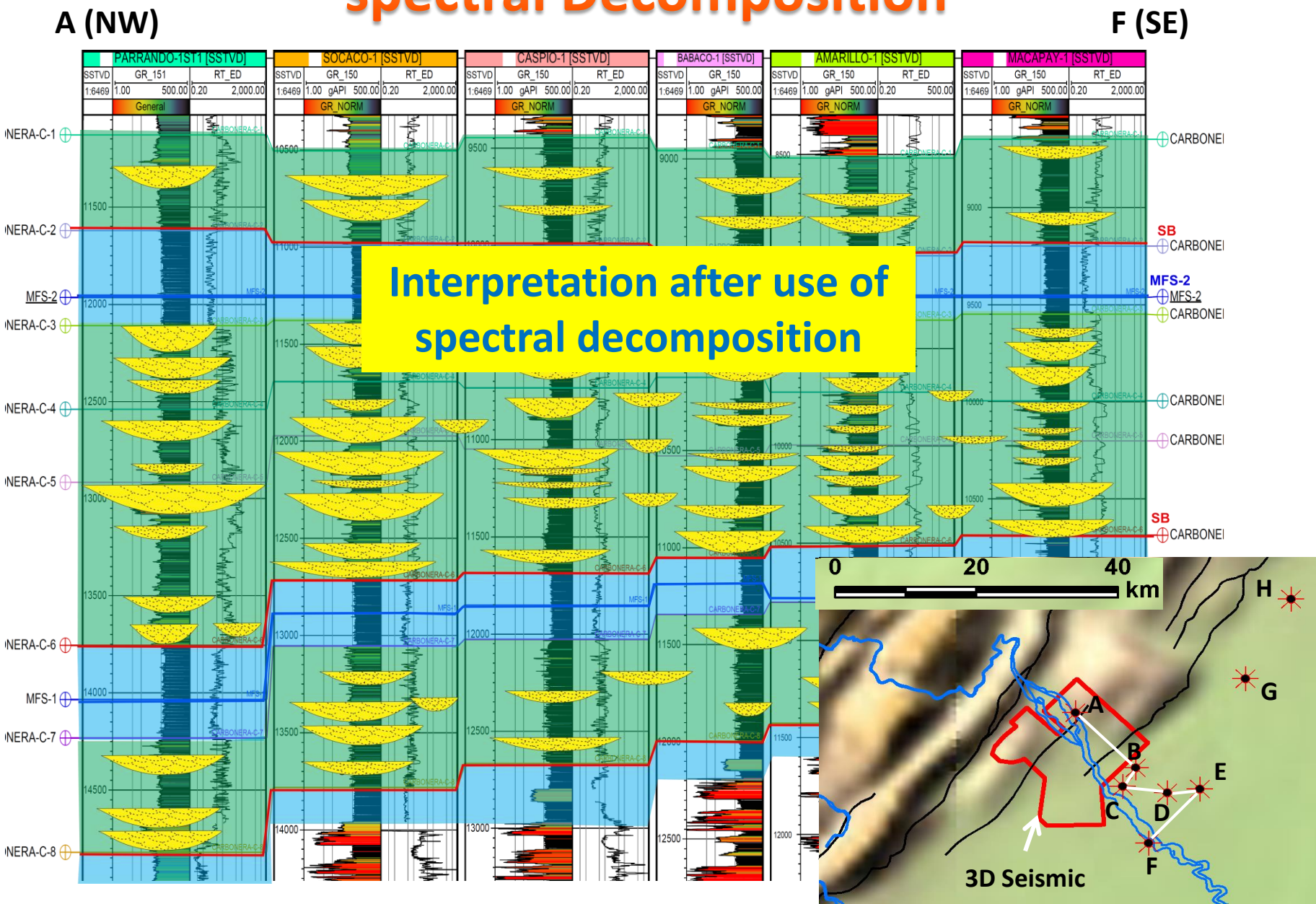


Connecting potential reservoirs based on spectral Decomposition



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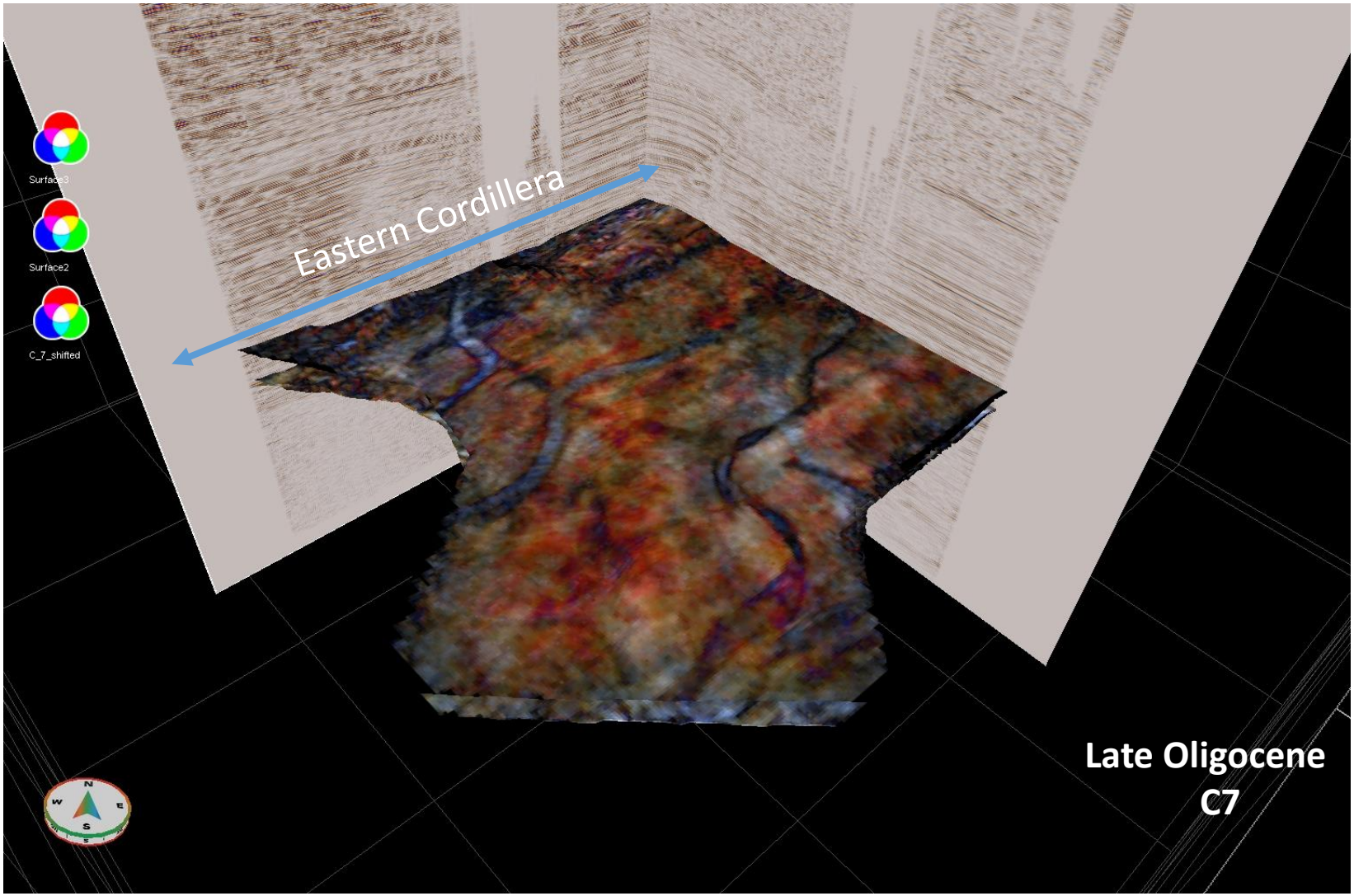
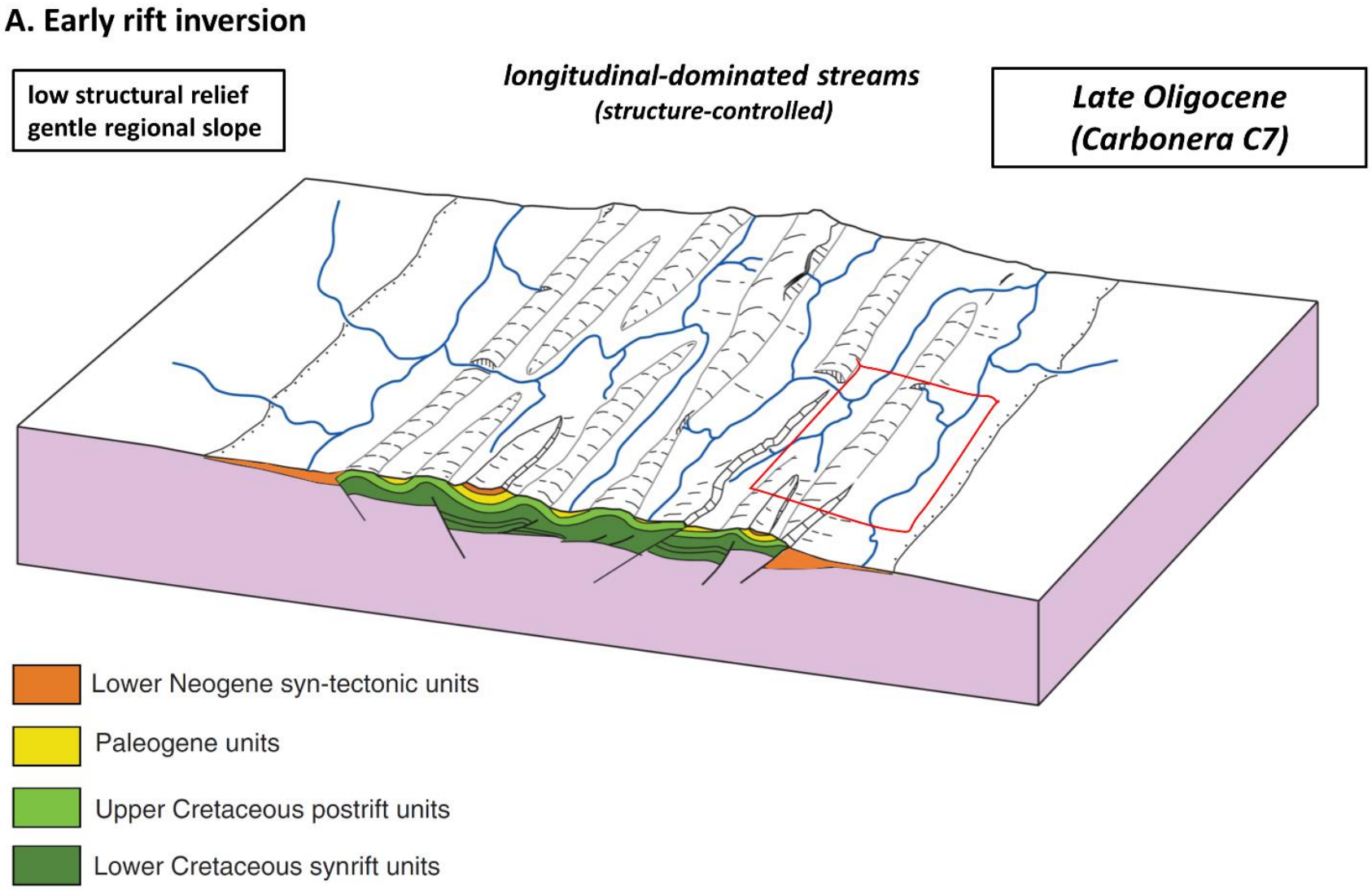
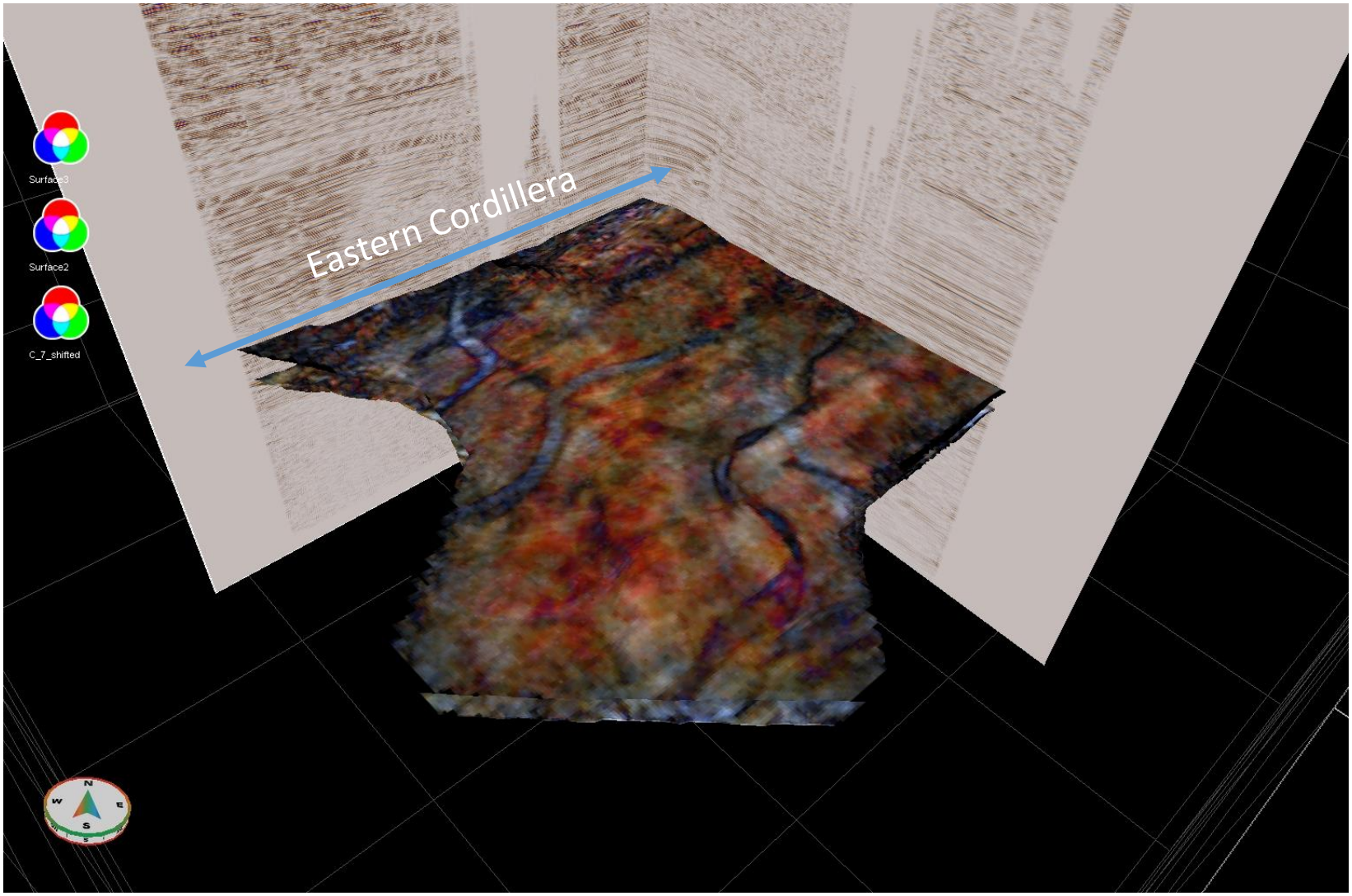
Spectral Decomposition Expression of Tectonic Deformation



Conceptual model of fluvial drainage versus tectonic structure and regional slope



Spectral Decomposition Expression of Tectonic Deformation



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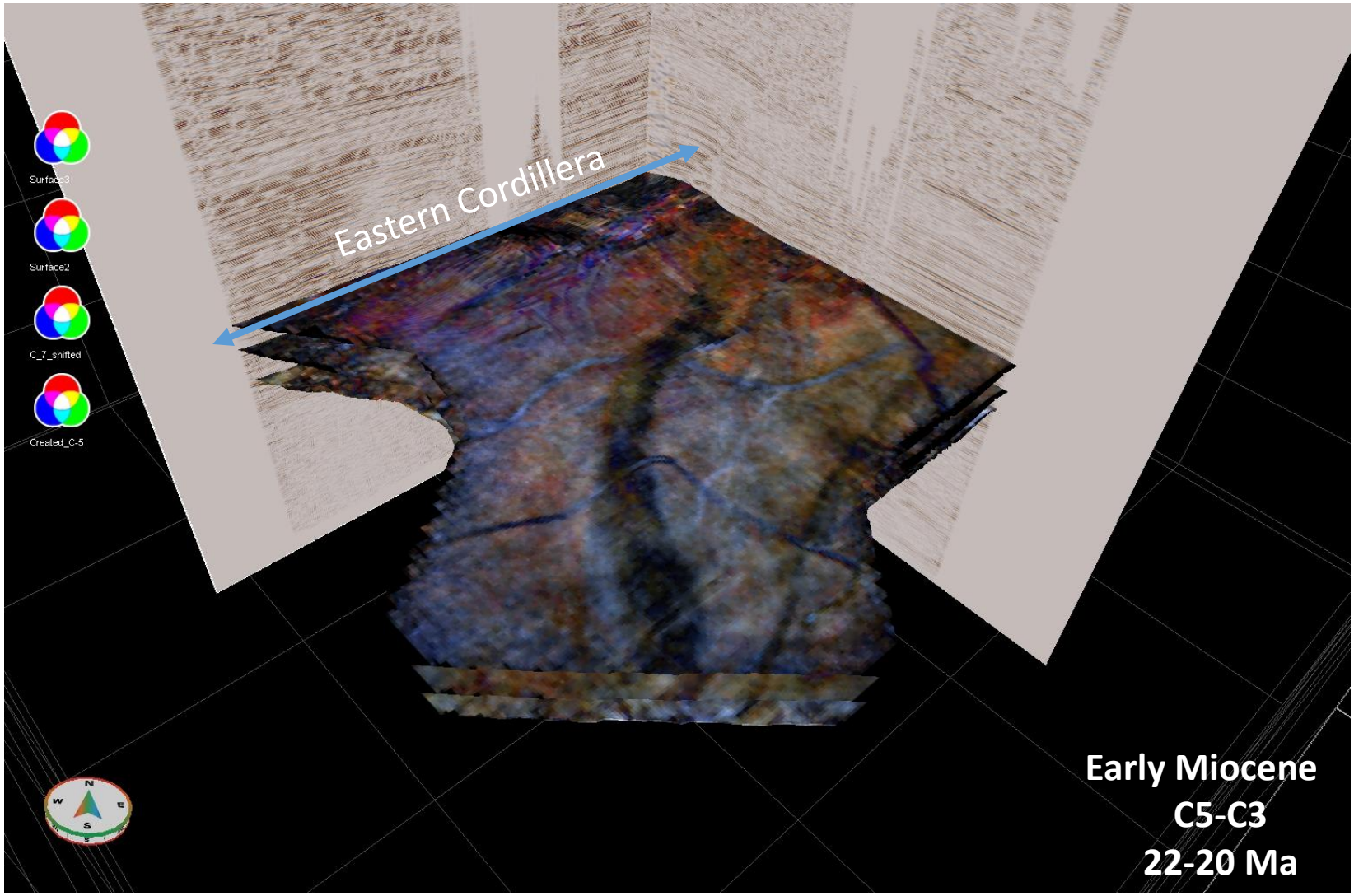

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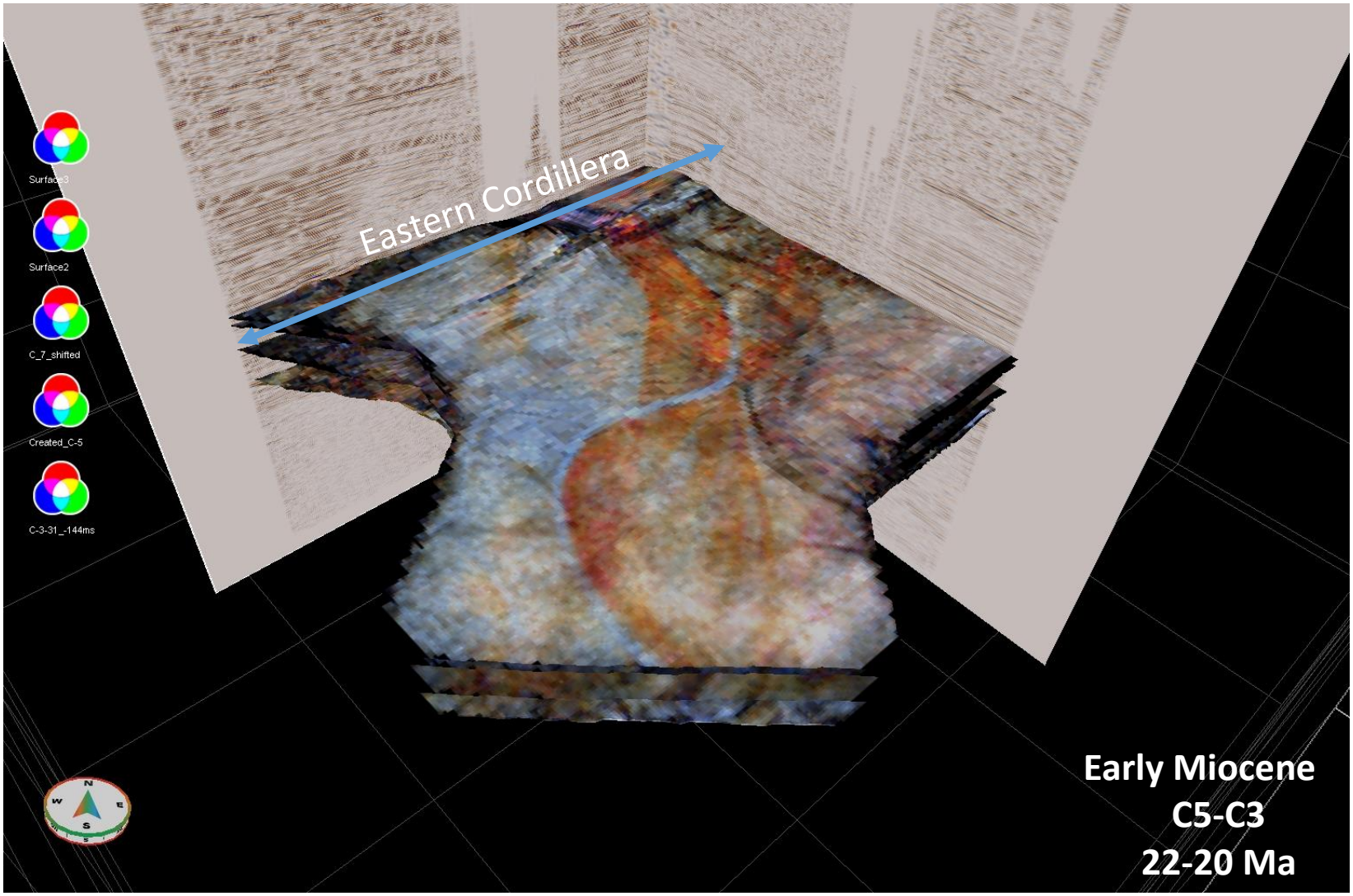

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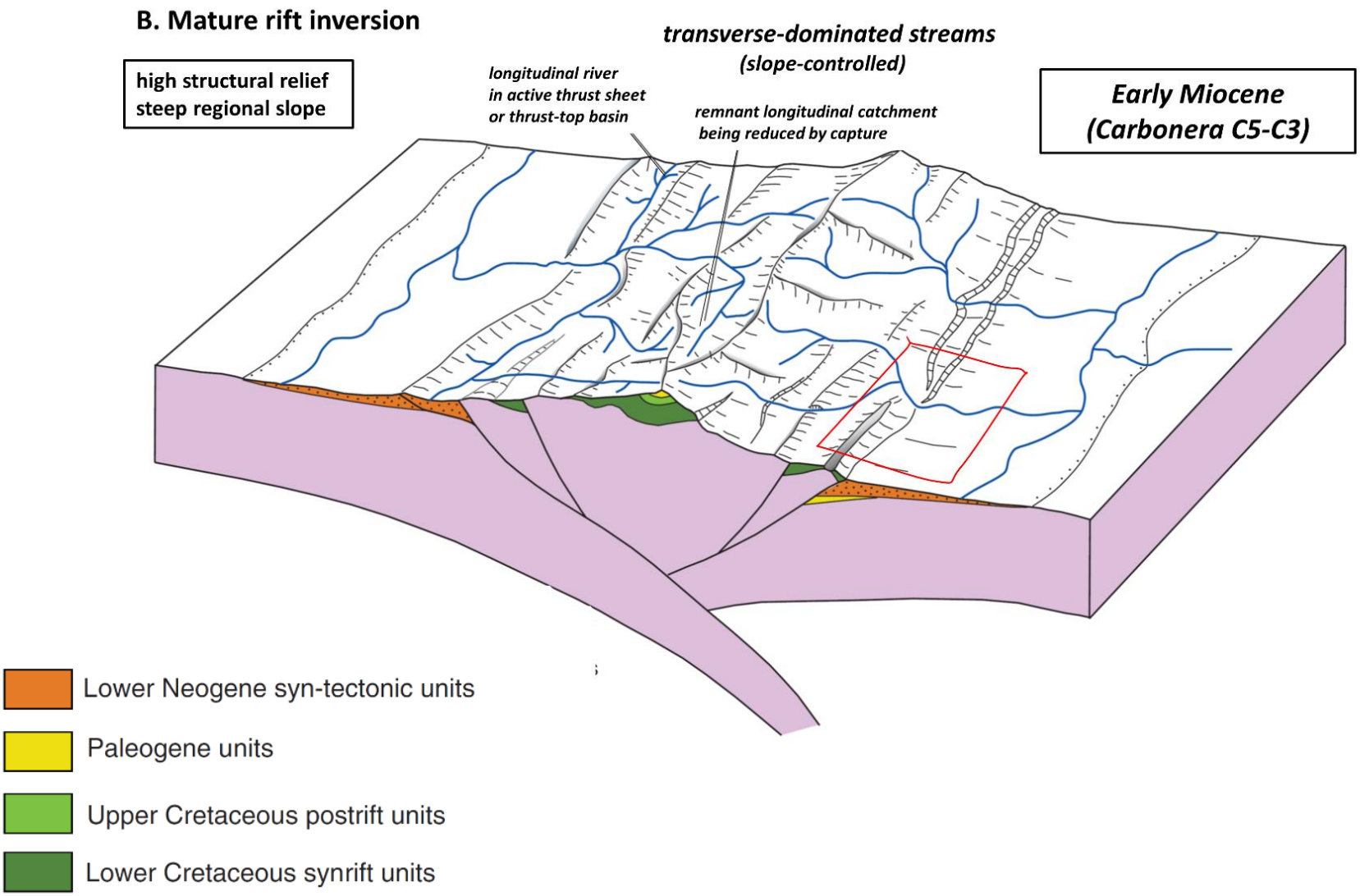
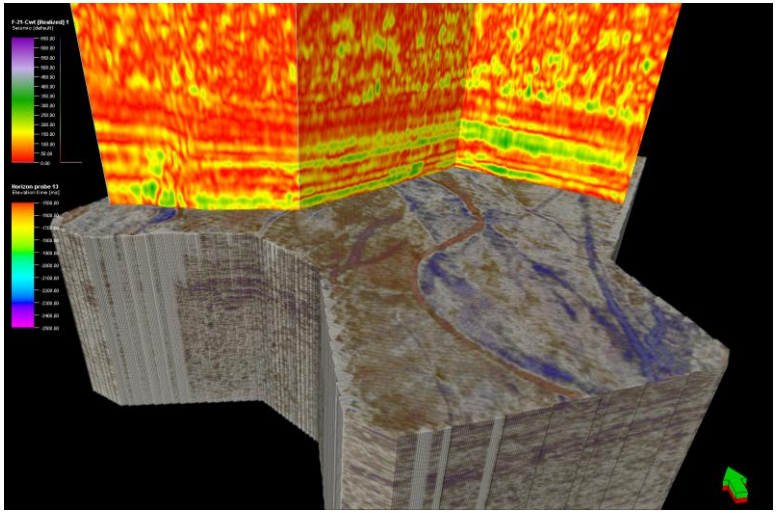
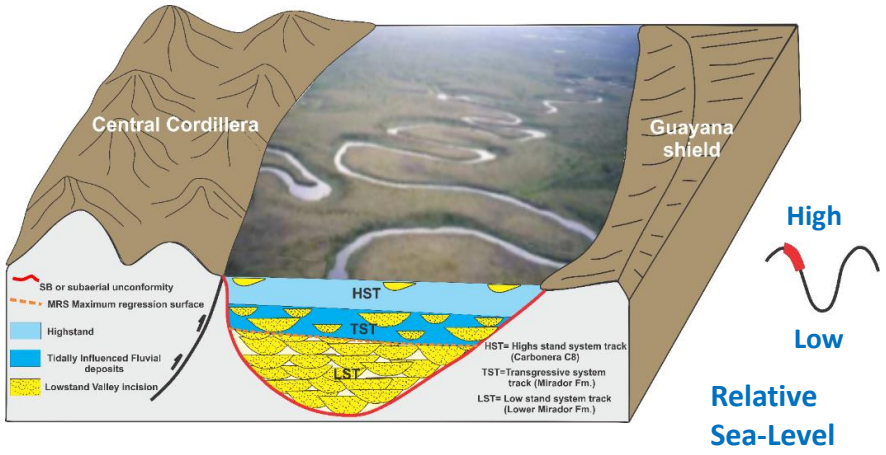


CONCLUSION

- By using spectral decomposition we can detect subtle stratigraphic features undetectable in the time domain seismic data and correlate the sand bodies from well to well.



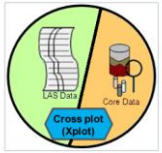
- The integration of spectral decomposition and well character are powerful subsurface mapping techniques that make it possible, at last, to resolve the subsurface configuration of the Llanos Foothills of Colombia.



ACKNOWLEDGEMENTS

Ministry of High
Education - Libya

the structural geology experts



Thank You