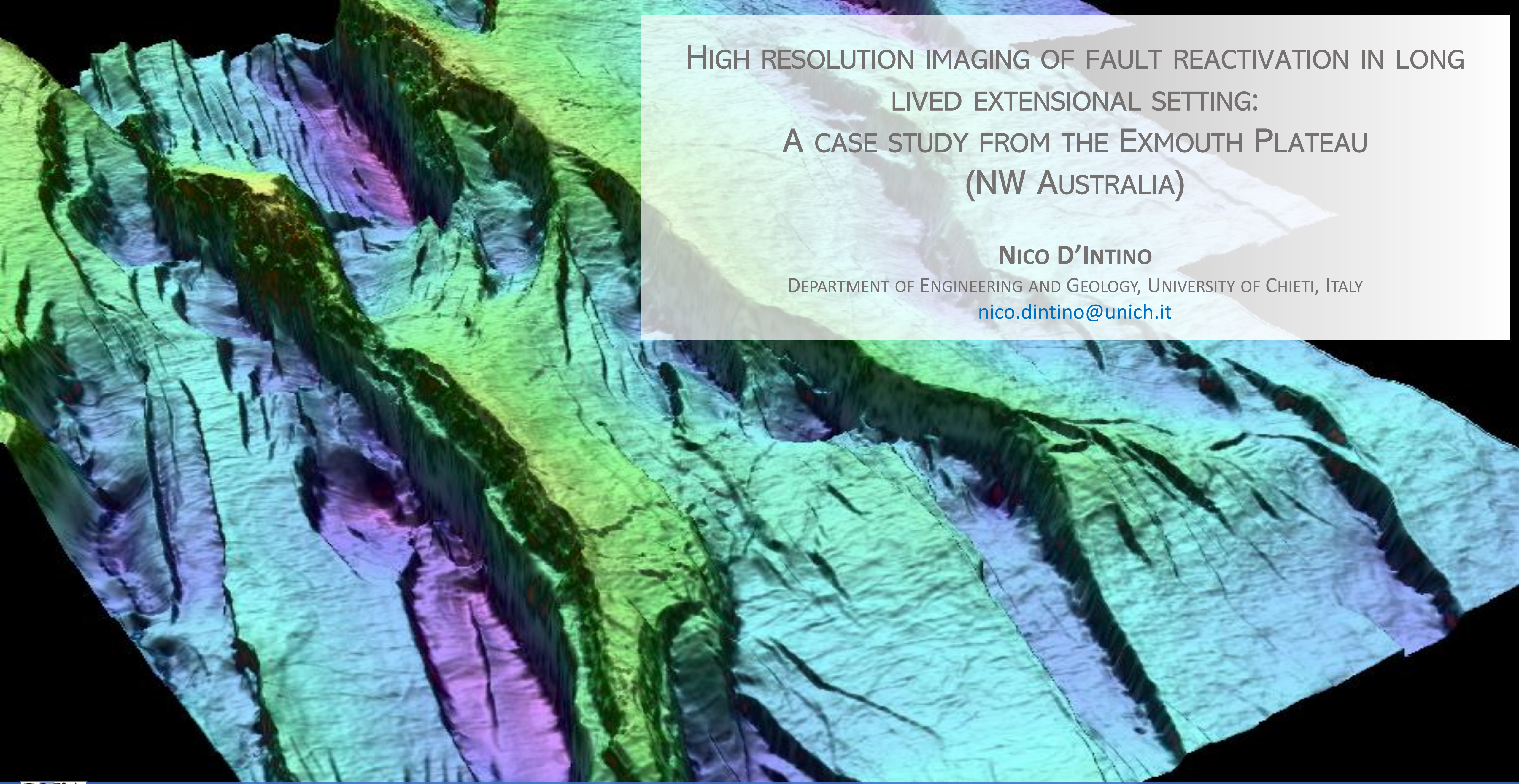

# High resolution imaging of fault reactivation in long lived extensional setting: A case study from the Exmouth Plateau (NW Australia)

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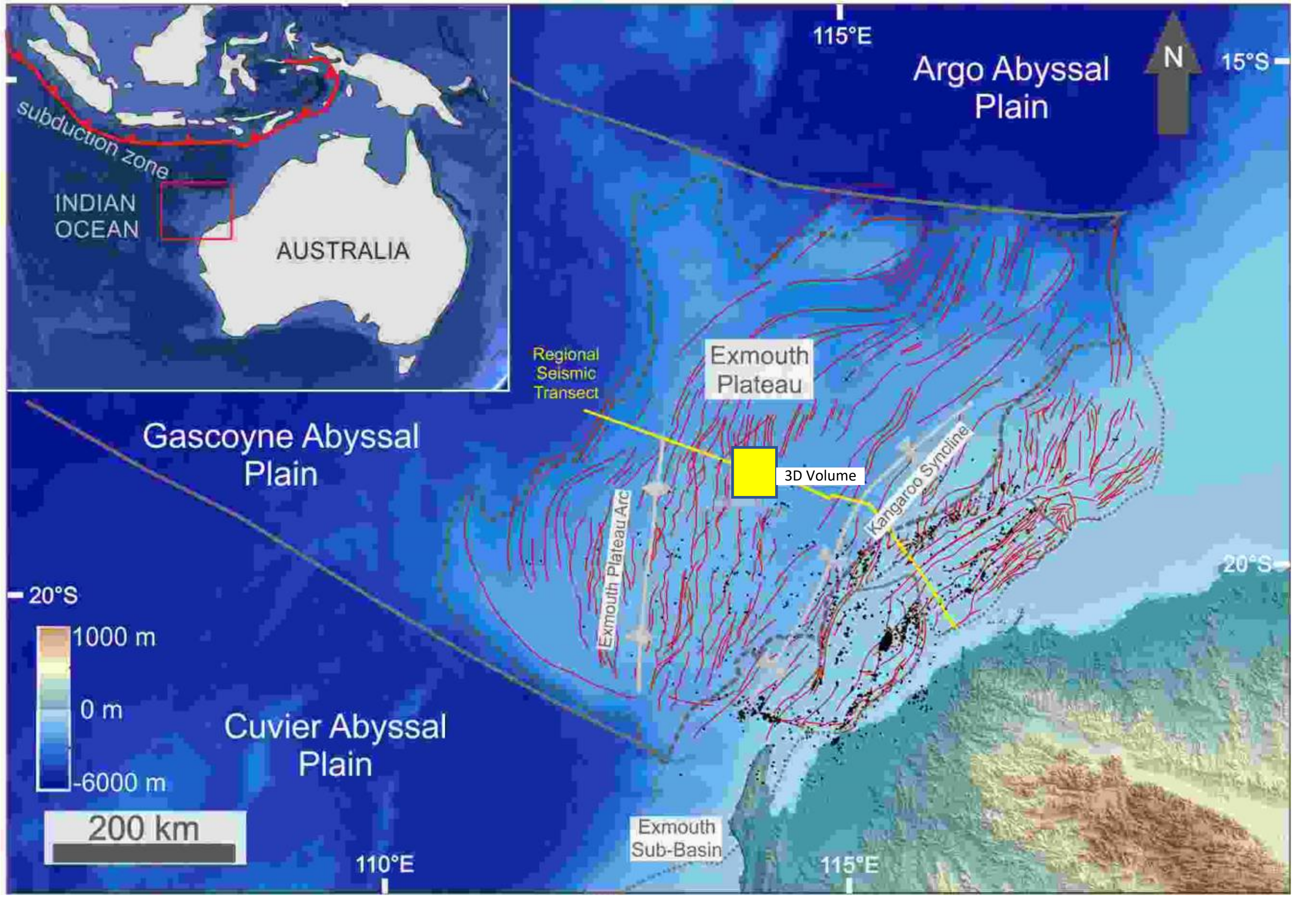
# STUDY AREA






- Continental shelf of NW Australia;
- Exmouth Plateau stands at an average water depth of c.a. 1400 m from the surrounding systems of abyssal plains floored by oceanic crust;
- Exmouth Plateau is a portion of the shelf that experimented polyphase extension;
  - Permo Carboniferous Rift;
  - Late Triassic-Jurassic Rift;
  - Early Cretaceous Rift and subsidence;
- Passive margin during the Cenozoic;
- Is about 1000 km south from the active Sunda Arc convergent margin, where the Australian continent is subducted under the Sunda plate;
- N-S ,SSW-NNE , trending normal faults;

# SEISMO-STRATIGRAPHY

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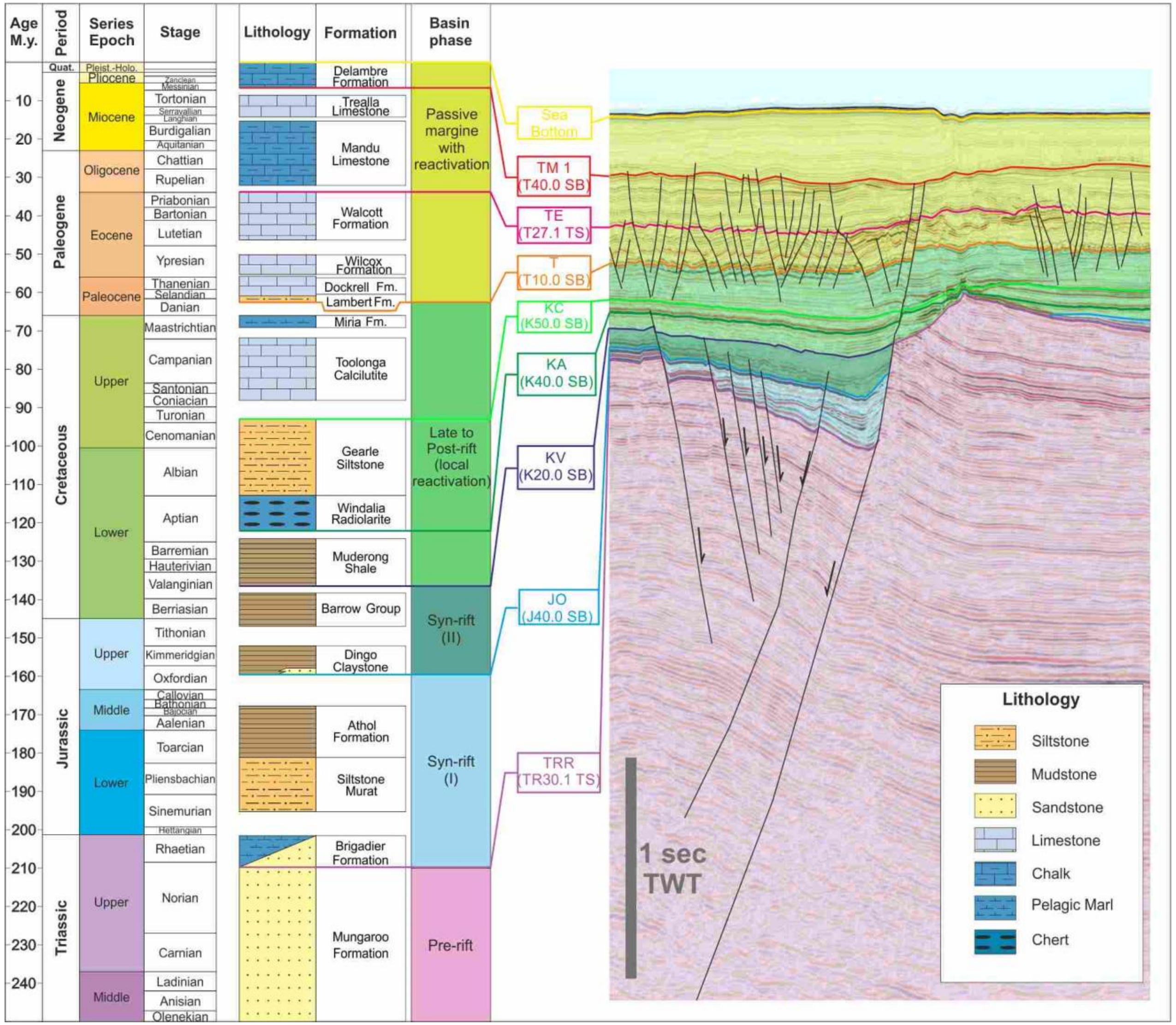


## Litho-mechanical stratigraphy

- Pre-rift sequence: sandstones-conglomerates (competent interval);
- Syn-rift sequence: shale and siltstone ("soft" interval);
- Post-rift and passive margin sequence: limestones, marls with shales (competent interval)

## Structures

- Major west-dipping normal faults;
- Antithetic east-dipping normal faults;
- Newly-formed faults in the sedimentary cover and reactivation of the main Mesozoic faults;
- Polygonal faults in the shaly-clayey intervals

## Key-horizons

- 9 calibrated key-horizons interpreted regionally;

# SEISMIC INTERPRETATION

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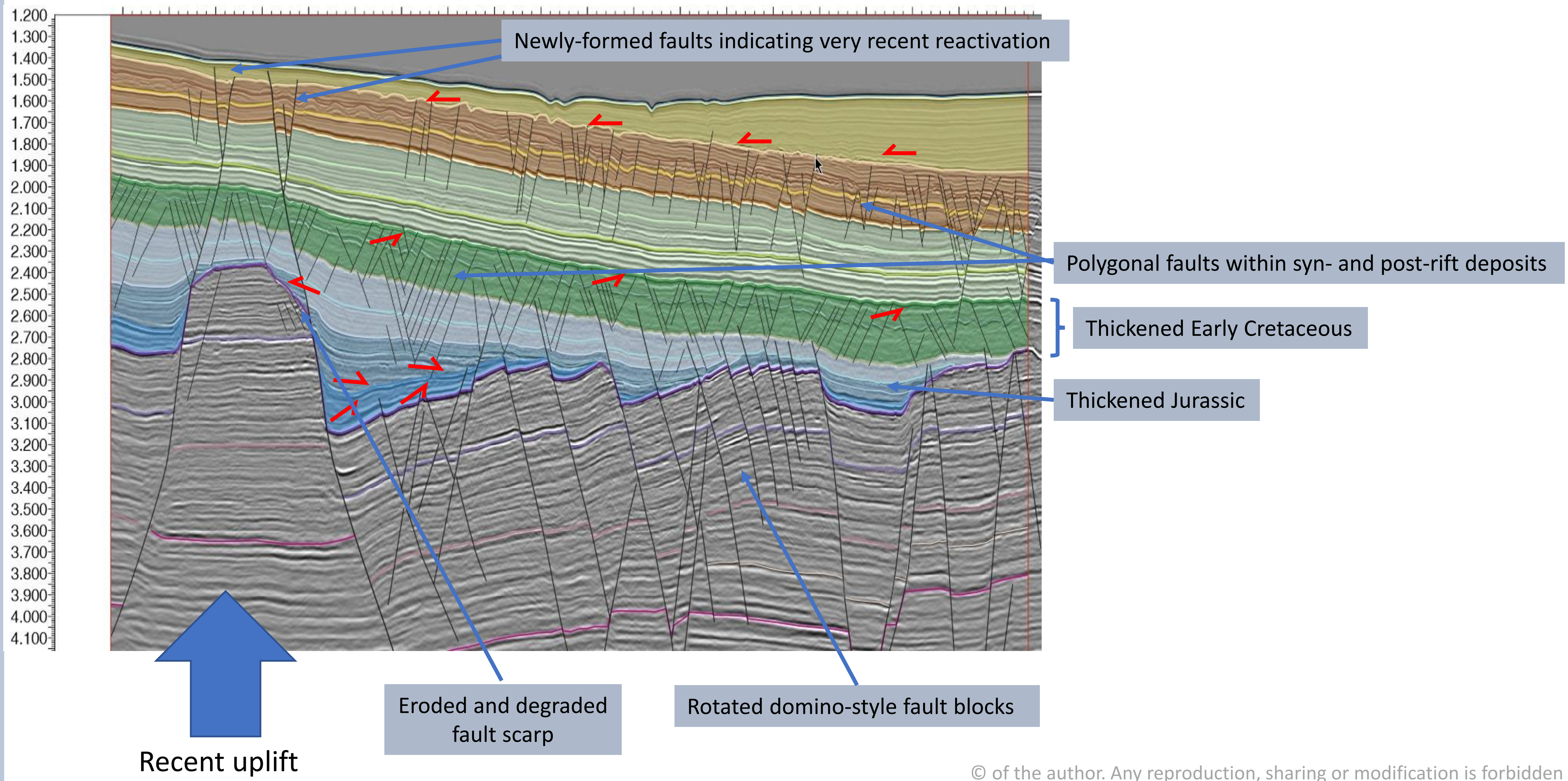

# STRUCTURAL SETTING

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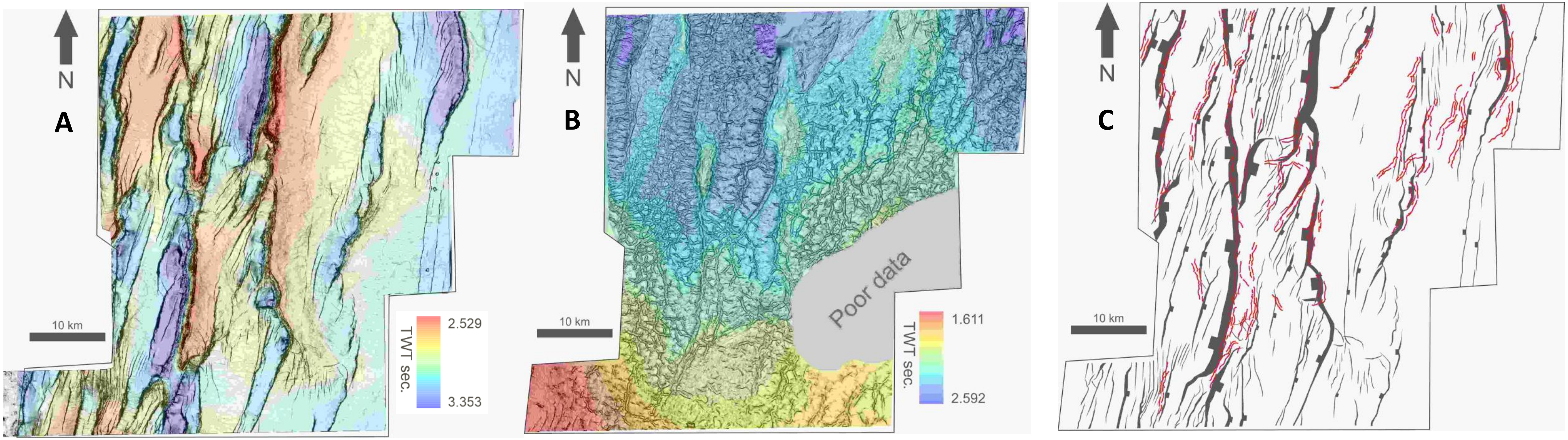


A. Top Mungaroo horizon (Top Carnian). Complex fault network in the deeper "brittle" layer with two principal fault sets: (i) the main west-dipping and (ii) antithetic east-dipping normal faults. N-S and NNE-SSW trends were measured (0°-5° and 15°-20°). En-echelon or hard-linked segments from (10 to 50 km long), characterized by incipient or breached relay ramps.

B. Base Tertiary horizon. Structures within the competent shallower layer. Two sets of faults : (i) faults forming elongate grabens with the same attitude of the older syn-rift structures affecting the underlying competent layer; (ii) polygonal faults, with random orientations;

C. Structures at the top Mungaroo (black) and the base Tertiary (red) horizons. The good overlap between the Mesozoic faults and the newly-formed Cenozoic faults suggests the recent reactivation of the deeper structures.

# FAULT ANALYSIS I

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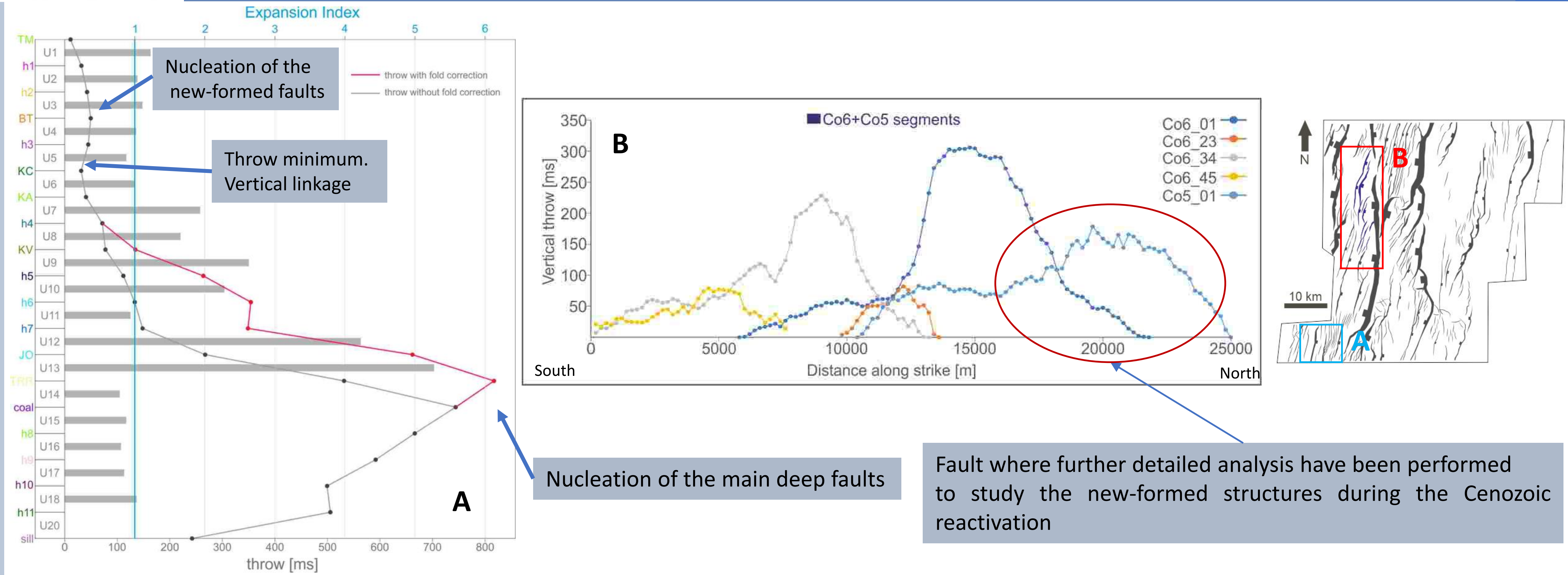


A. Combined TX and EI plot showing the main rift events in Late Triassic-Middle Jurassic and Early Cretaceous (EI>1). The reactivation of Mesozoic faults occurred between the Eocene and Miocene and the nucleation of newly-formed faults in the sedimentary cover occurred; these faults are vertical-linked with the major Mesozoic structures.

B. Along strike throw projections for an east-dipping array of faults where the newly-formed faults of the cover have been studied. Three main segments are distinguishable: the main-one, with the maximum throw and a symmetrical shape, and the two lateral minor-one with an asymmetrical shape. This segmented configuration suggests that the fault array behaved as an unique entity, with a coherent growth and a progressive linkage along the extensional phases.

# FAULT ANALYSIS II

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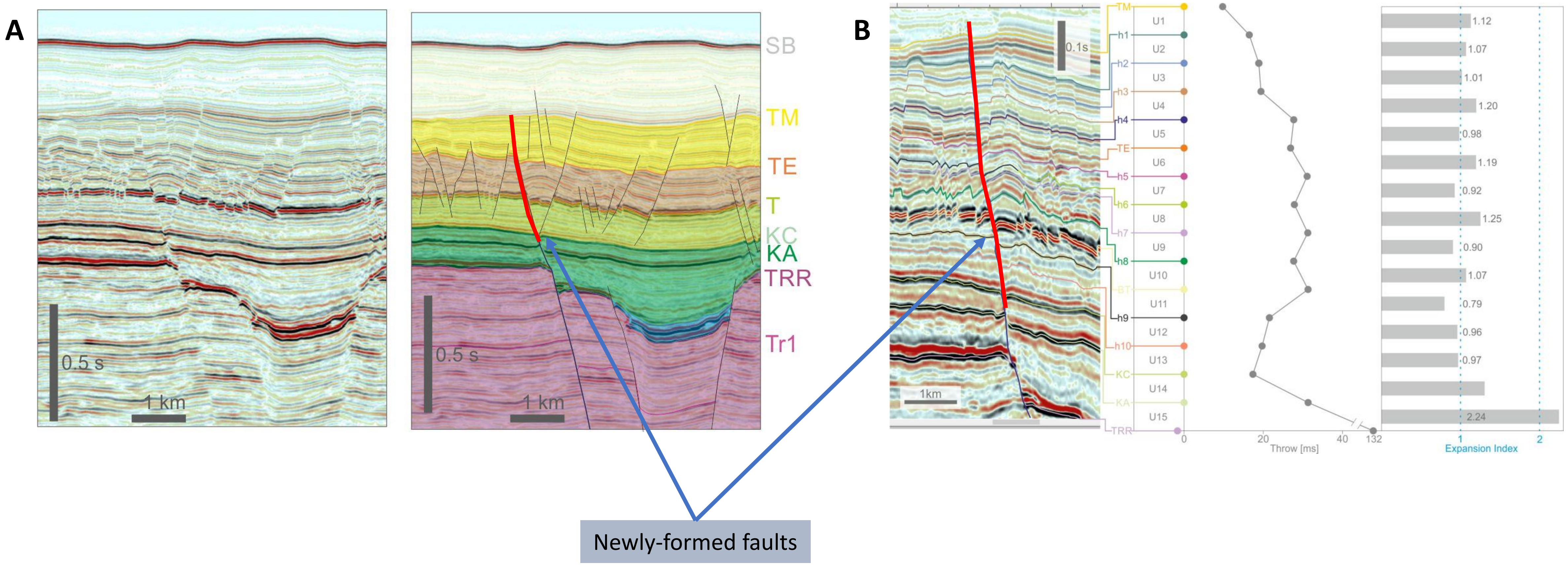


A. Part of a seismic profile showing the Tertiary reactivation of a Mesozoic normal fault.
B. Detailed throws and expansion index graphs of a reactivated fault. During the Paleocene-Miocene interval the EI is generally >1.

# FAULT ANALYSIS III

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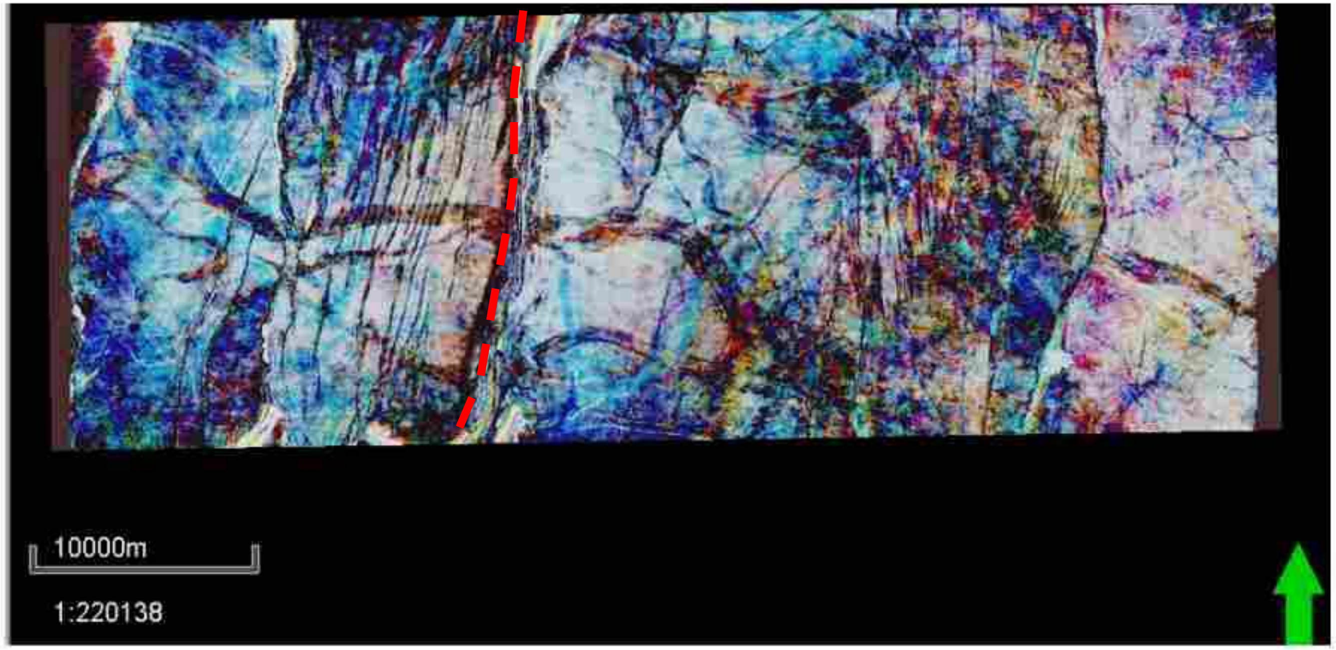


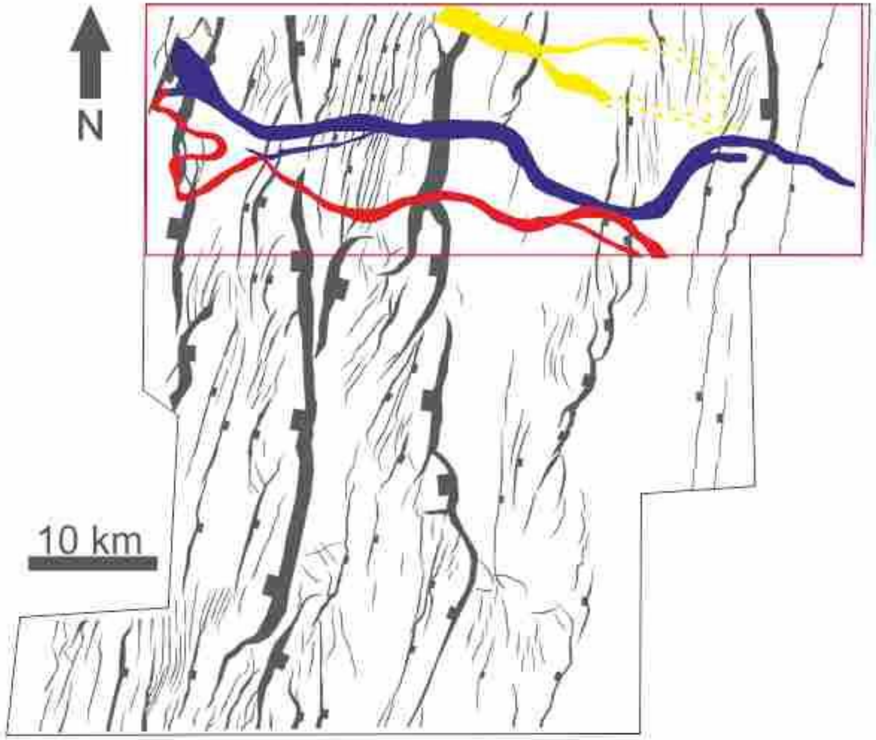


Spectral Decomposition attribute assembled by blending 3 filtered and flattened sub-volumes (15-25 Hz, 25-35 Hz and 35-45 Hz). The attribute extraction allowed us to enlighten the sedimentary channels within the Triassic pre-rift Mungaroo formation, and to analyze the horizontal offset of the channel-banks in correspondence of the cross-cutting planes of the faults. No significant horizontal offset has been documented (absence of relevant strike-slip kinematics) suggesting prevailing dip-slip kinematics for the normal faults.

# EARLY-LATE REACTIVATION

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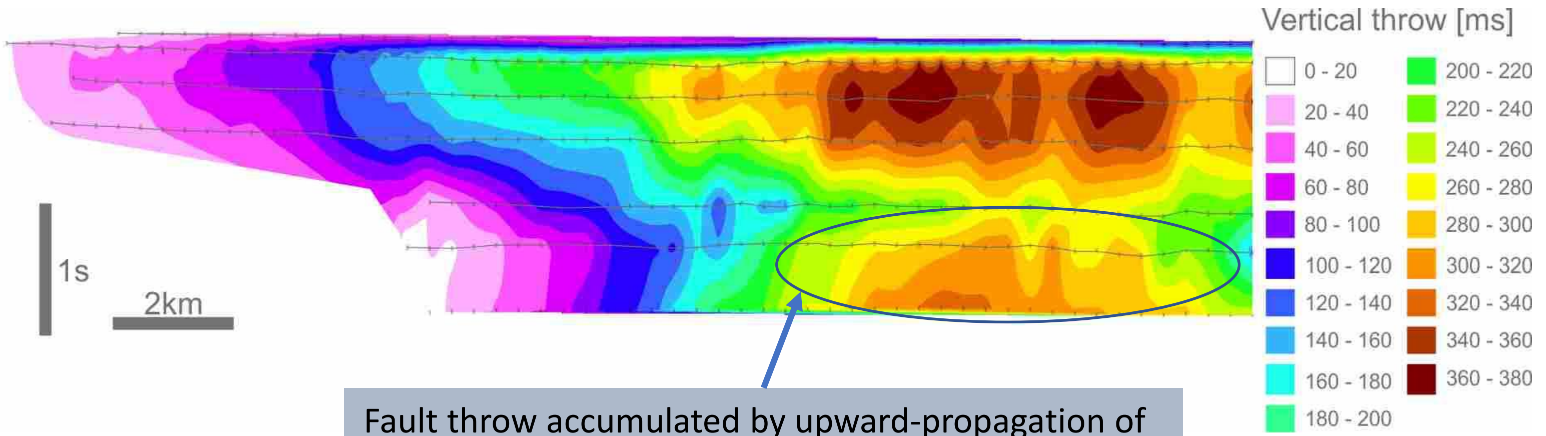
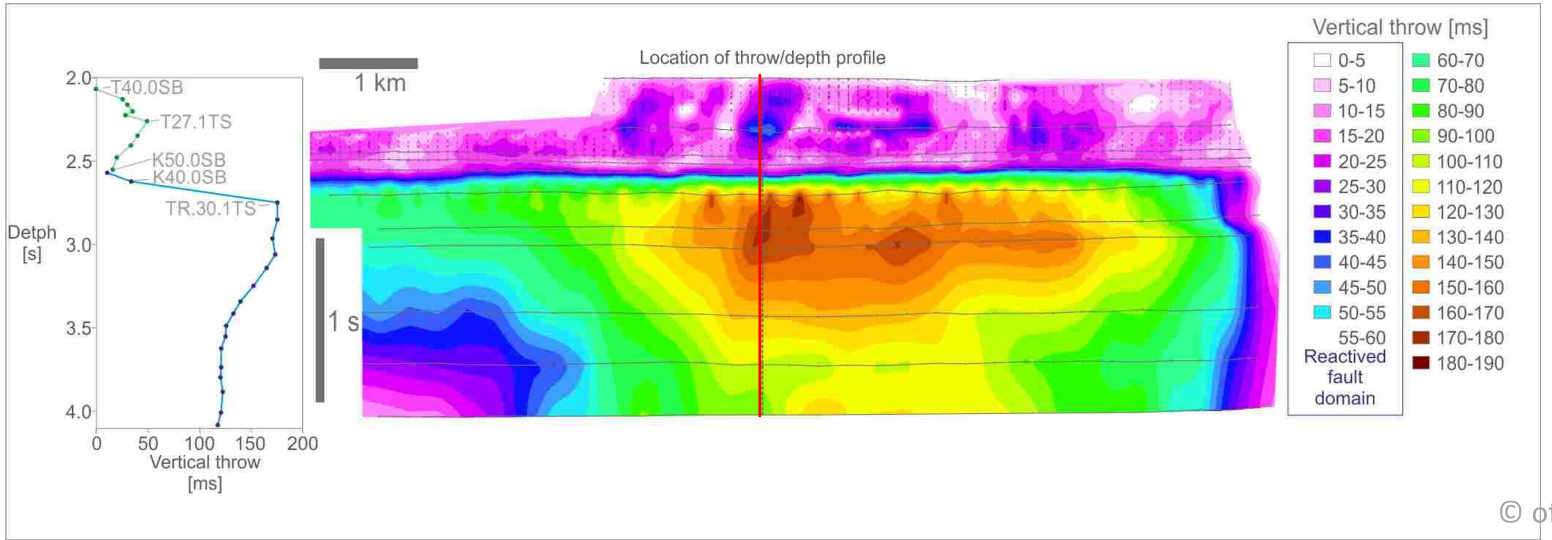
## A Ancient reactivation along pre-existing Paleozoic fabric?




Fault throw accumulated by upward-propagation of Paleozoic-structures?

## B Recent reactivation along pre-existing Mesozoic fabric




A. Throw contour plot of a Mesozoic west-dipping fault. Being the resolution of the seismic data depth-dependent, the deeper structures are sampled with a wider grid spacing, as in this case. The throw patterns observed are elliptical; in particular, the lower elliptical shape is bounded upwards by a throw minimum, suggesting that a deeper fault nucleated and propagated upward. The upper area of maximum throw, which stands over the deeper throw maximum, has an elliptical shape too, and formed by interaction and linkage of smaller elliptical shapes (segment coherent linkage??). The vertical juxtaposition of the two elliptical patterns suggests the possible reactivation during the Mesozoic of an inherited (Paleozoic?) structure.

B. Throw contour plot of a Mesozoic east-dipping fault. The shallower structures (between 2.0 and 2.5s of depth in TWT) are sampled with a denser grid spacing, compared to case A. Even in this case, the vertical juxtaposition of the elliptical throw patterns suggests the reactivation of the Mesozoic normal fault during Tertiary times.

# CONCLUSIONS



1)Long-lived rifting (Rethian-Early Cretaceous) with local reactivation during the late Early Createaceous-Late Createaceous;

2) reactivation of the Mesozoic normal faults during the Cenozoic;

3) possible reactivation during the Mesozoic of inherited (Paleozoic?) structures;

4) the litho-mechanical stratigraphy controls the style of fault reactivation as suggested by high resolution throw contour plots

Comments and discussions are very welcome!

# ACKNOLEDGMENTS

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