Tectonic evolution of the East Vietnam-Southwest Borneo margins breakup

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ENS | PSL

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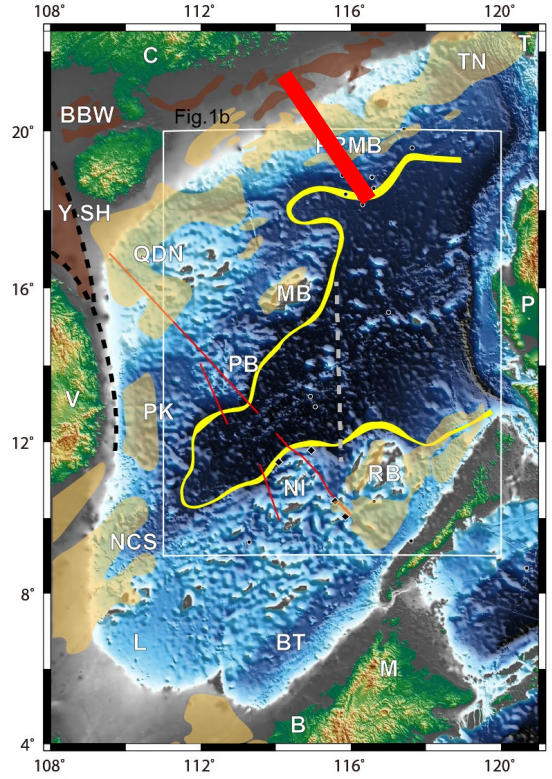
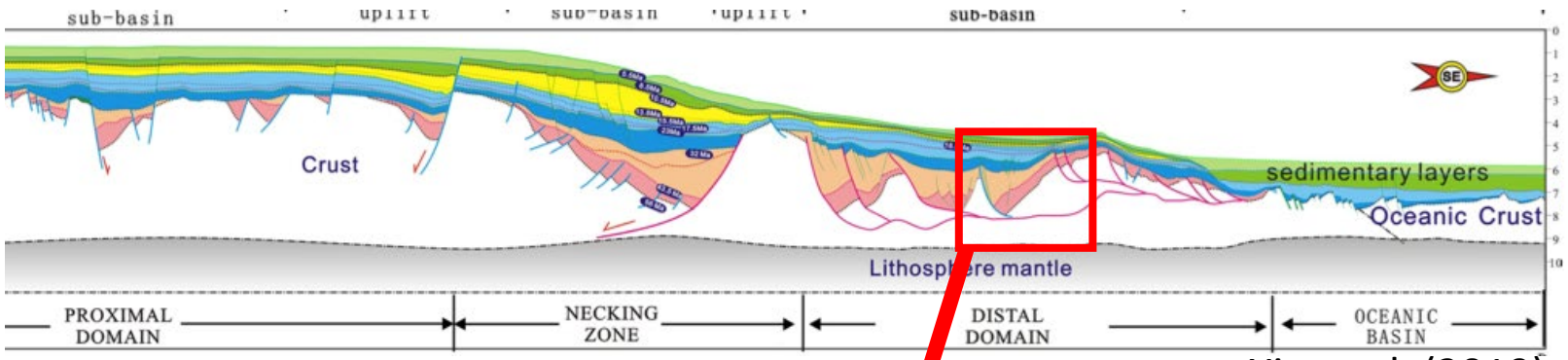
广州海洋地质调查局

Introduction: The northern section (SE China margin) in the South China Sea

- Crust thinned along detachment faults (Geoffroy et al., previous presentation).
- Syn-rift II associated with detachment fault.
- We hereafter focus on a key line further south

Bathymetry map





Xie et al. (2019)

NW

SE

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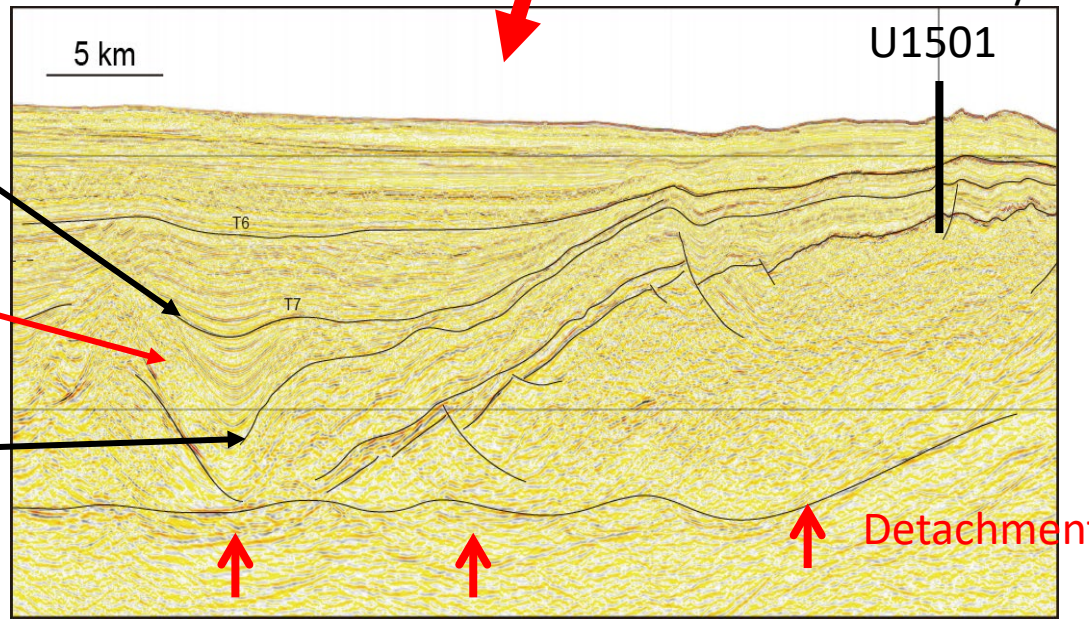


Breakup U.: 32 Ma

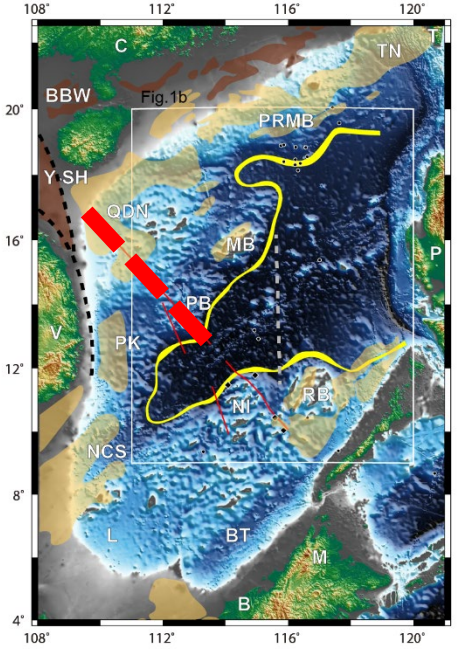
Upper Syn-rift: Syn-rift II

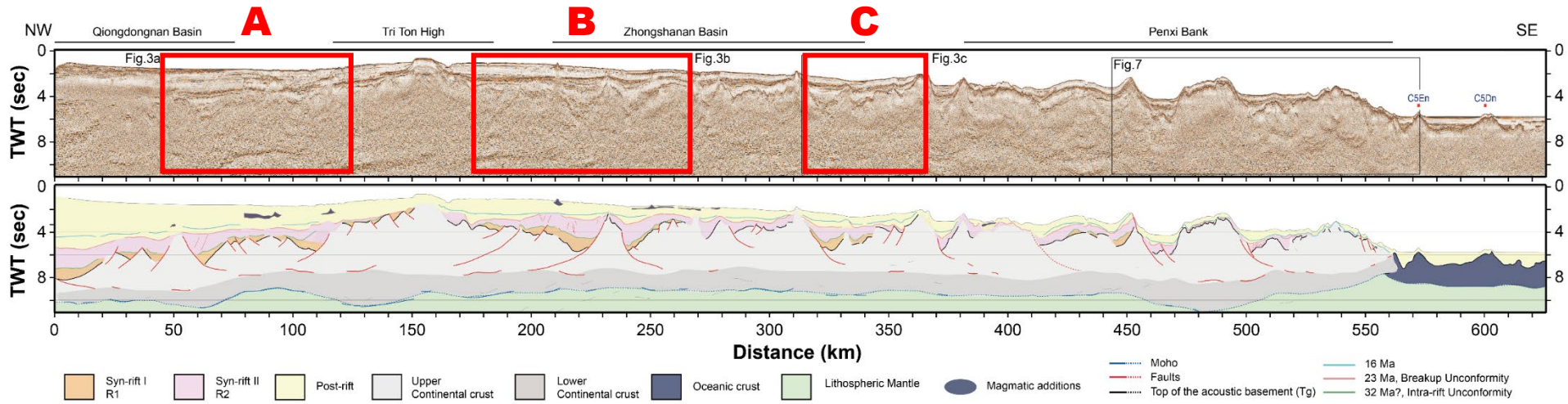
Intra-Rift U.: 36Ma
(Xie et al., 2019)

Modified from Nirrengarten et al. (2020)

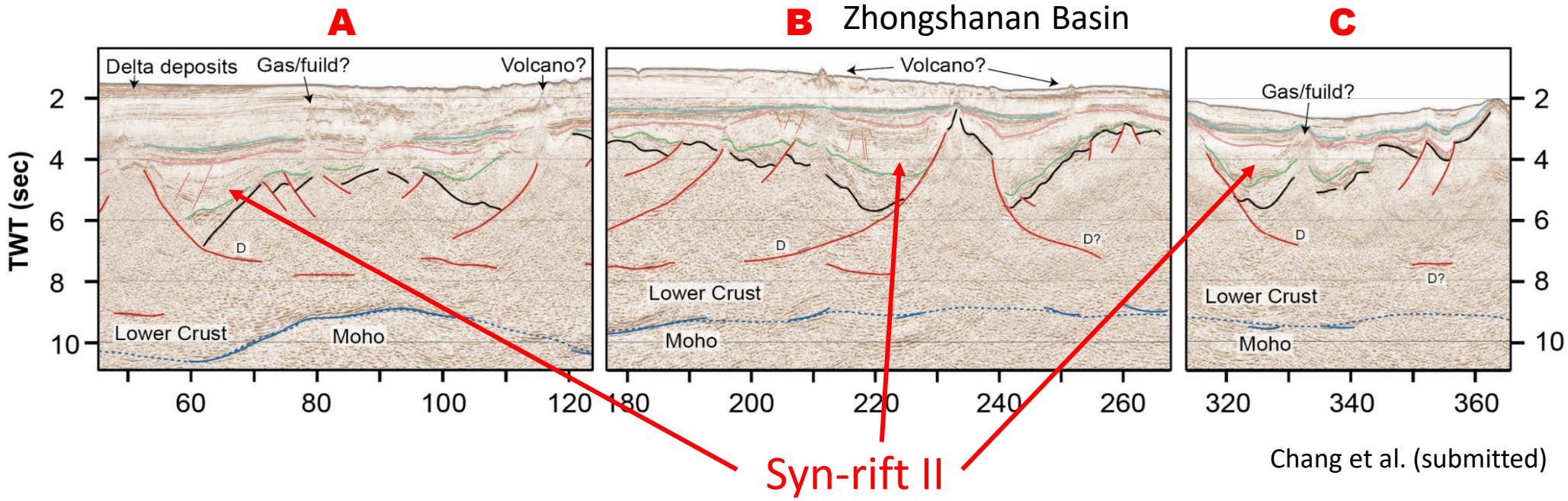
Introduction: The western section (E Vietnam margin) in the South China Sea

- The continental crust is very stretched
- The crust is also thinned along detachment faults
- Syn-rift II is associated with detachment fault.





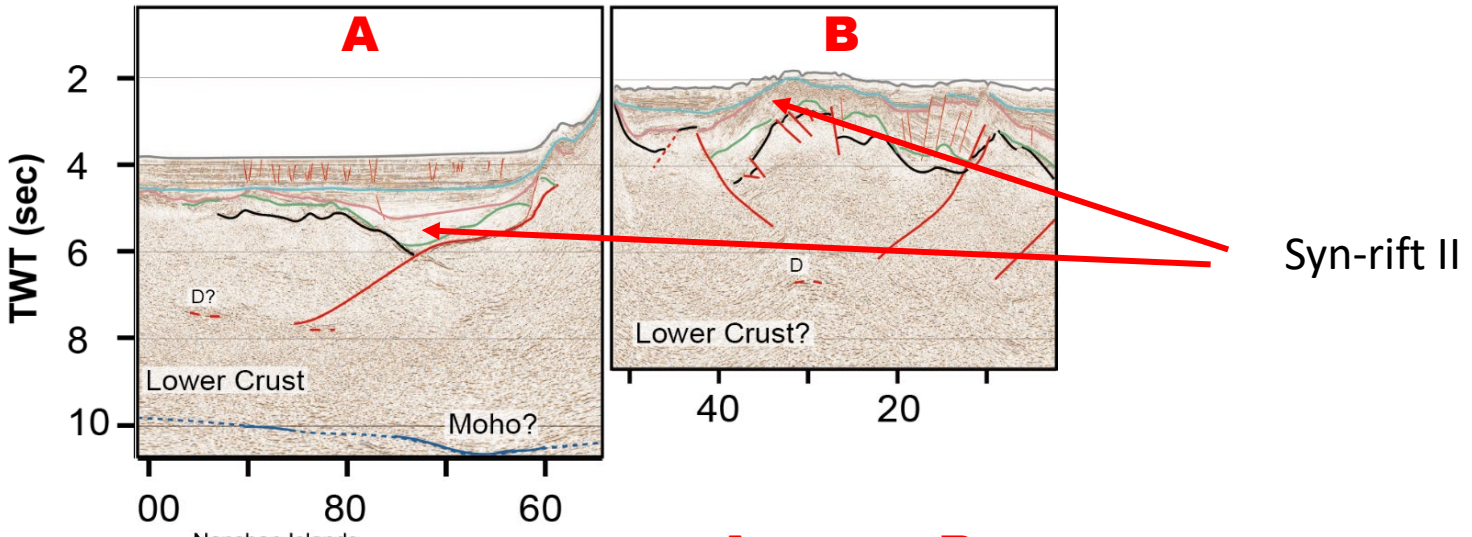
Chang et al. (submitted)

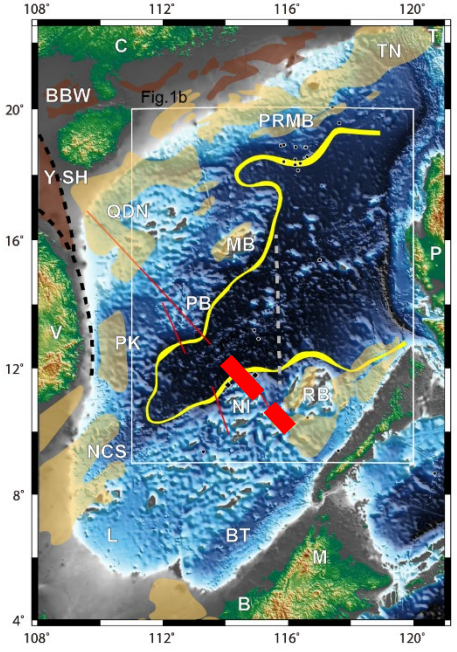


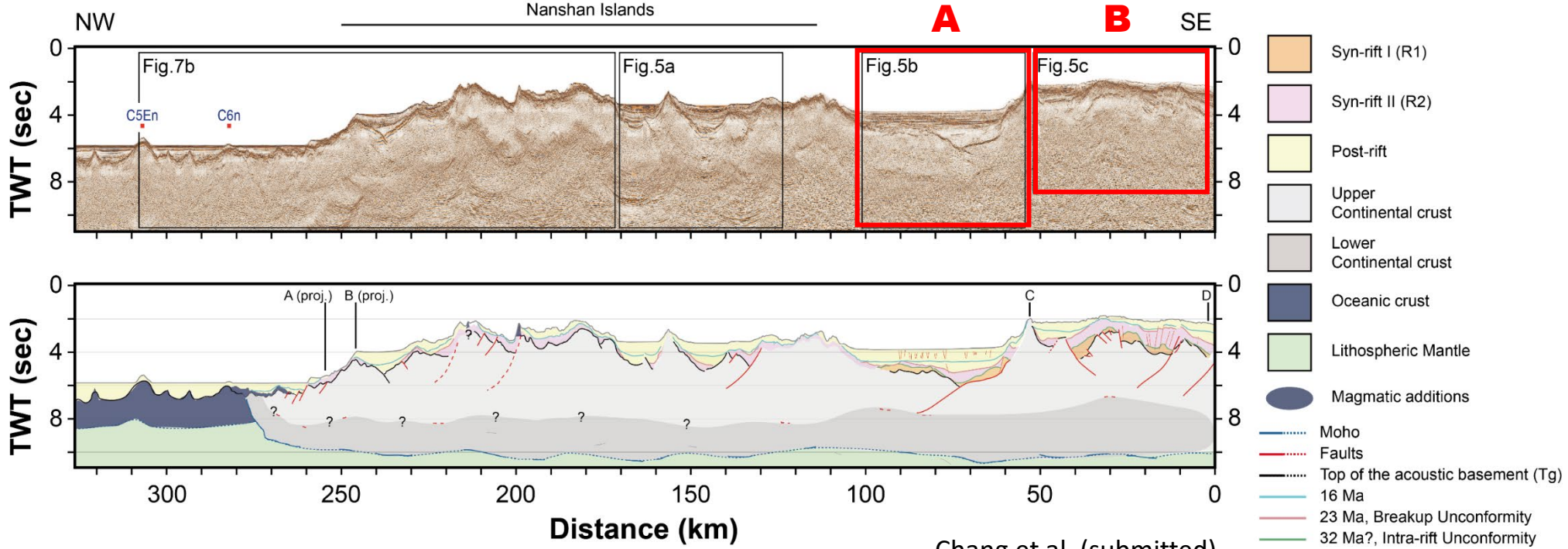
Chang et al. (submitted)

Introduction: The southwest section (NW Borneo margin) in the South China Sea

- Crust thinning along the detachment fault (although the margin was modified by later shortening)



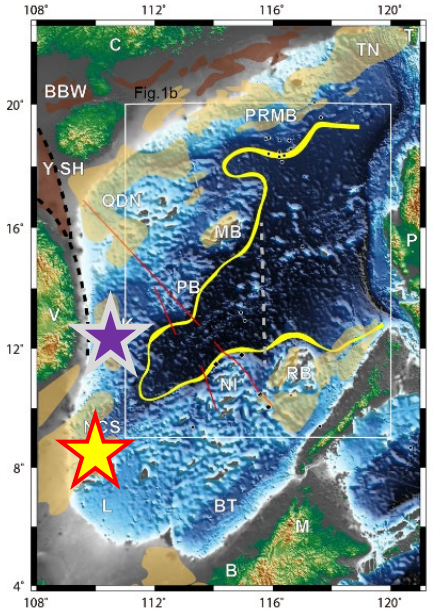




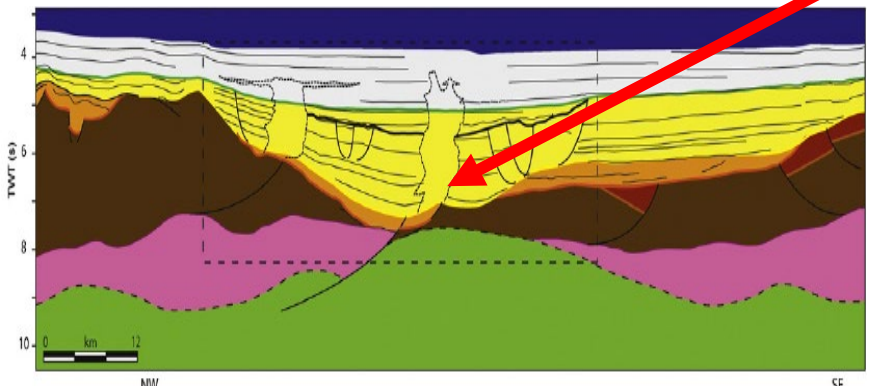
Chang et al. (submitted)

Introduction: Crust thinning at the tip of propagator but also elsewhere

- Timing of breakup is gradually younger (23 to 16 Ma)
- Thickly sedimented trough in the axial zone (Nam Cum Son, NCS)
- And also in more proximal basins (Zhongshanan Basin; Phu Khank, PK)
- Three stages for extension



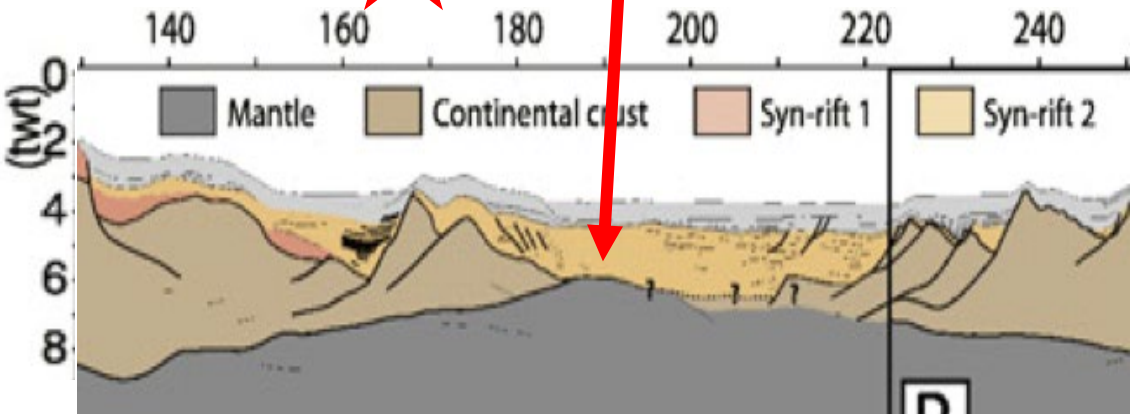
PK Basin



Savva et al. (2013)

Syn-rift II (Early Miocene)

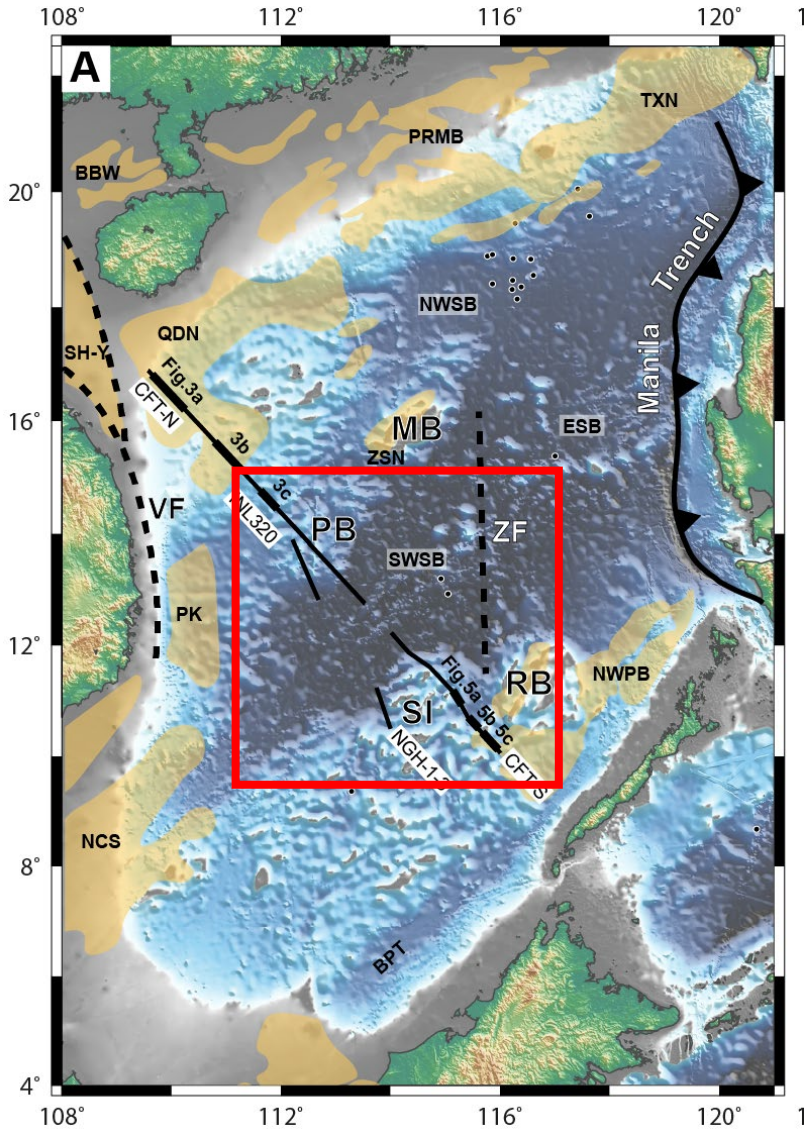
NCS Basin



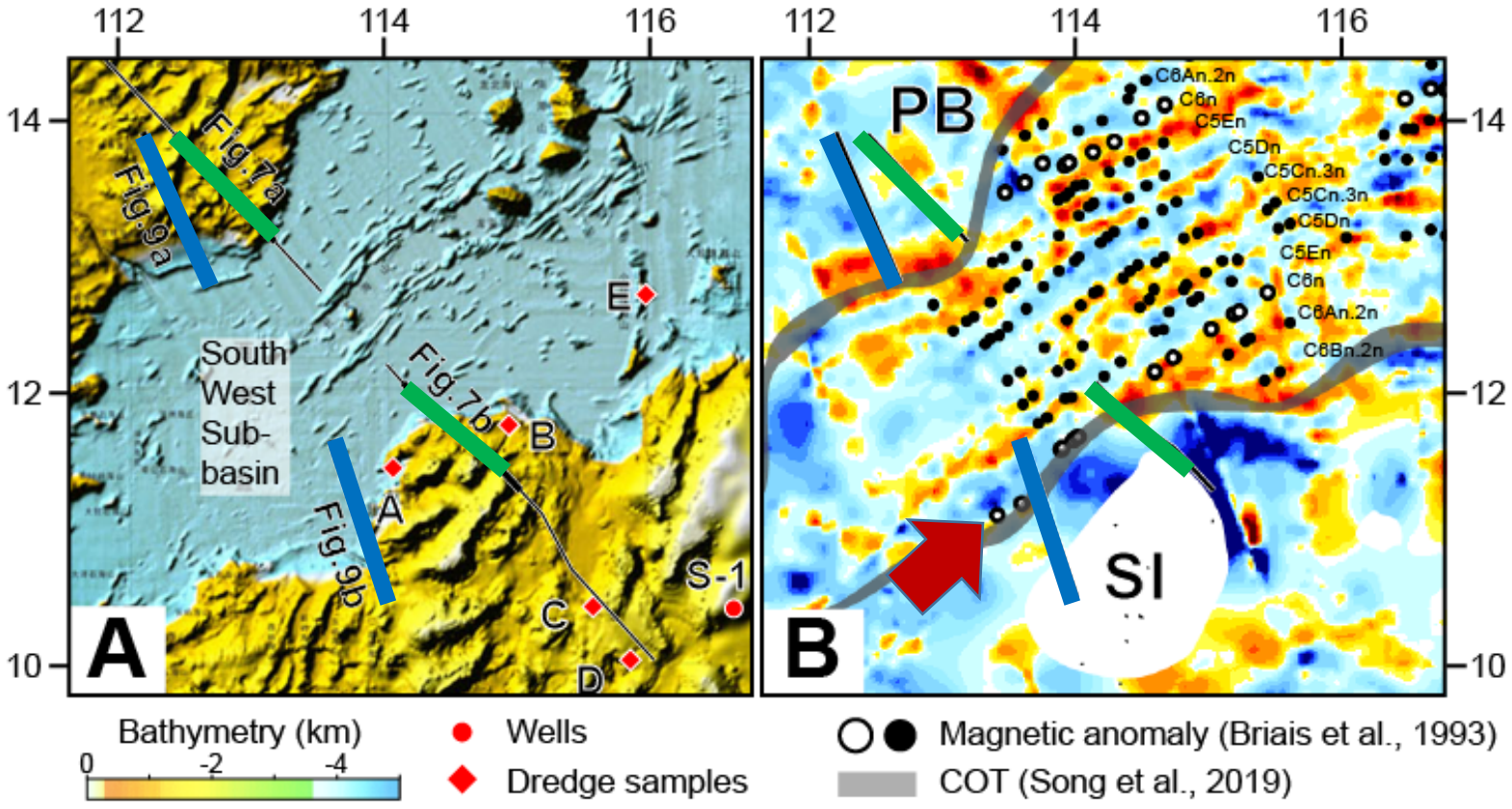
Clerc et al. (2018)

3 steps of structural evolution

Structure of the distal margin and COT



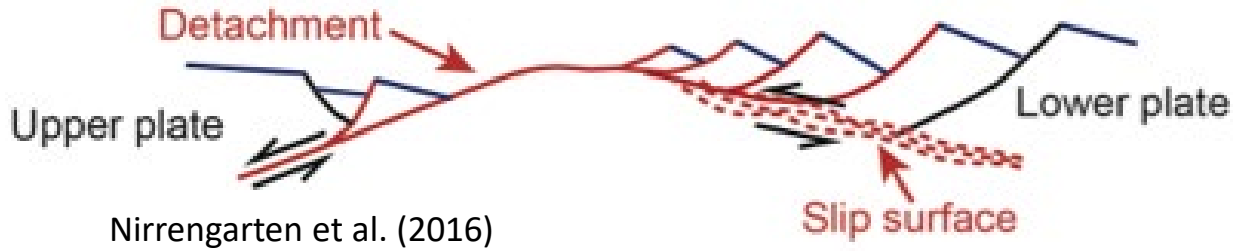
- Steep (green) and stretched (blue) segments
- The earliest magmatic anomaly (C6n, red thick arrow) is clear in the southern margin only



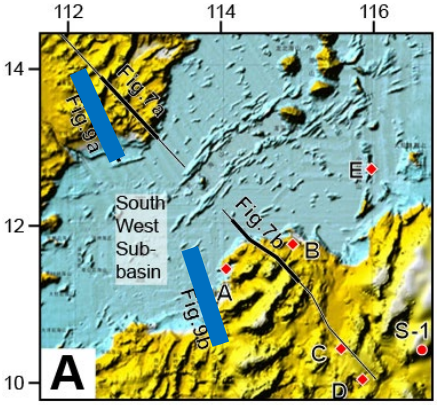
Chang et al. (submitted)

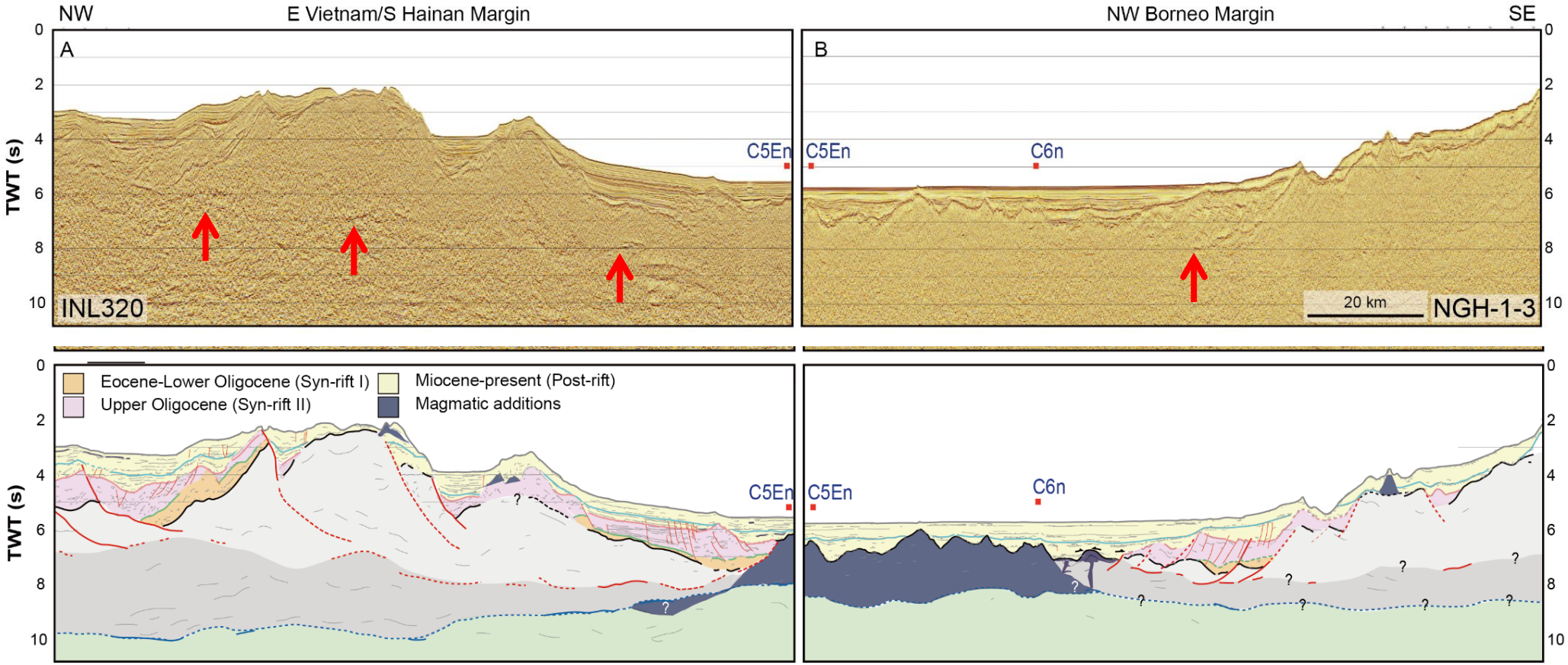
Juxtaposed conjugate E Vietnam-NW Borneo margins

- Detachment fault (red arrows)
- Syn-rift II (pink) pushed aside syn-rift I (orange)



Nirrengarten et al. (2016)

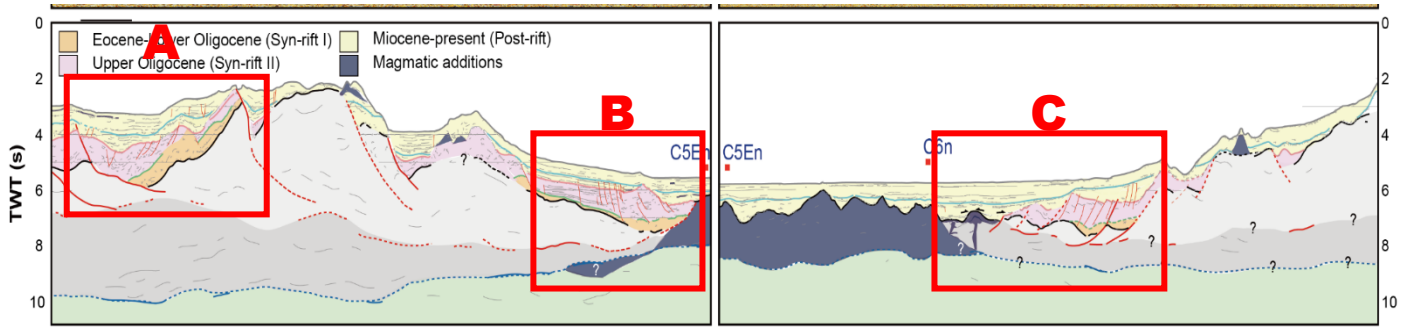




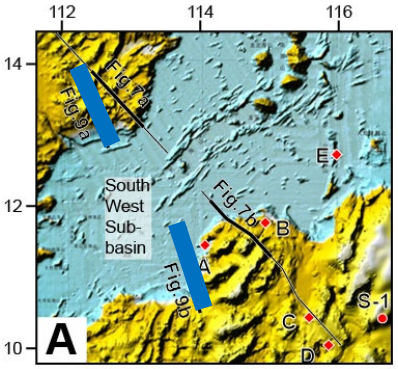
Chang et al. (submitted)

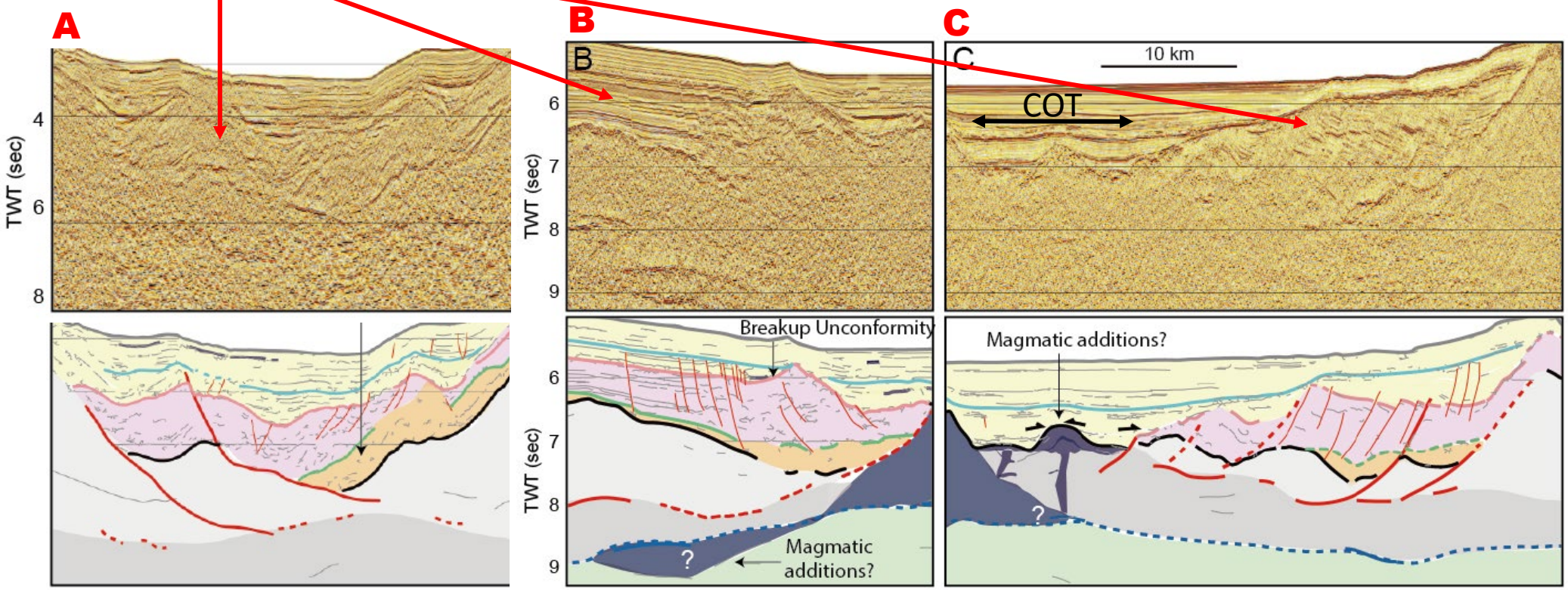
Characteristics of the syn-rift II at the COT

- Very thick syn-rift II collapse in the axial zone (B and C)



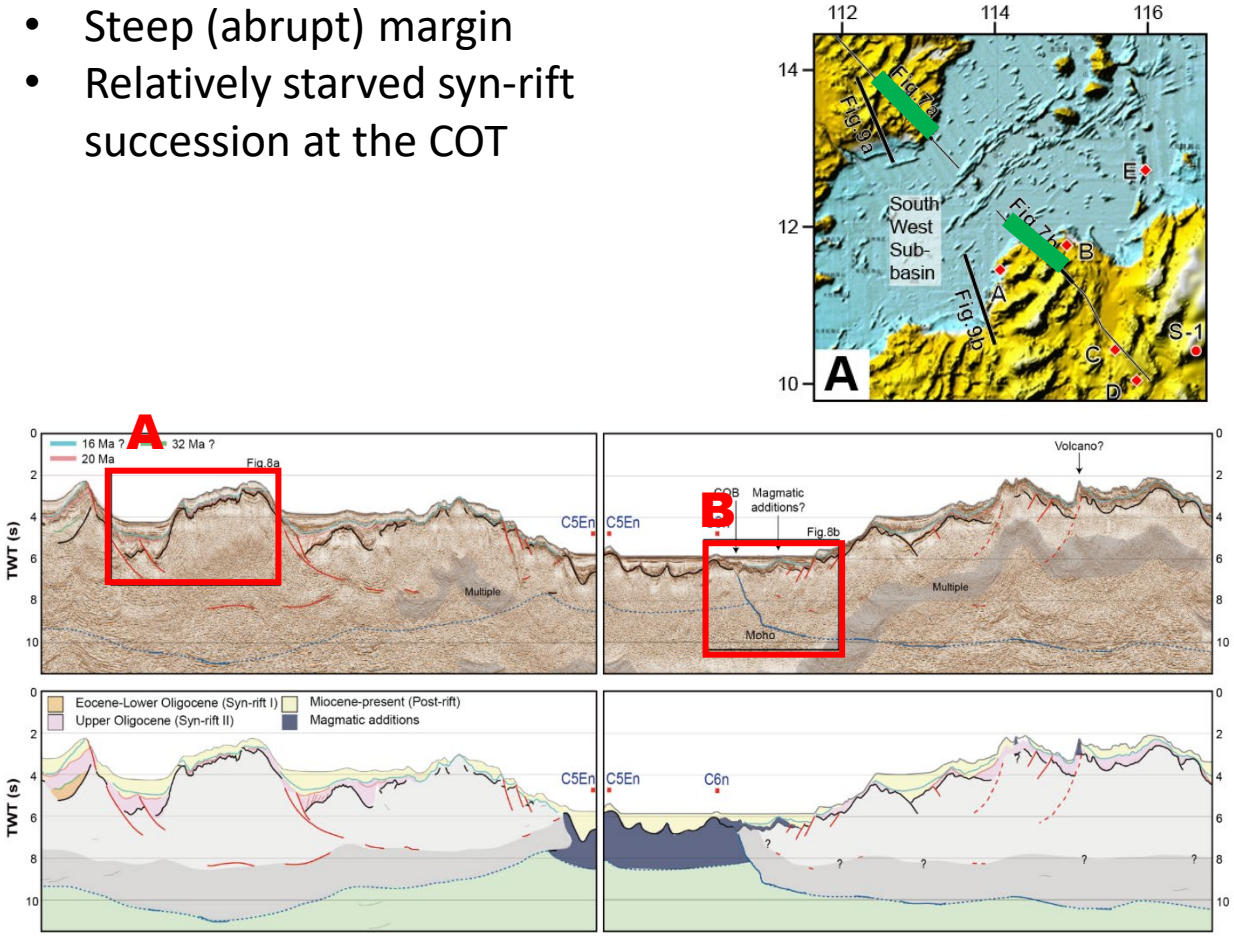
Syn-rift II

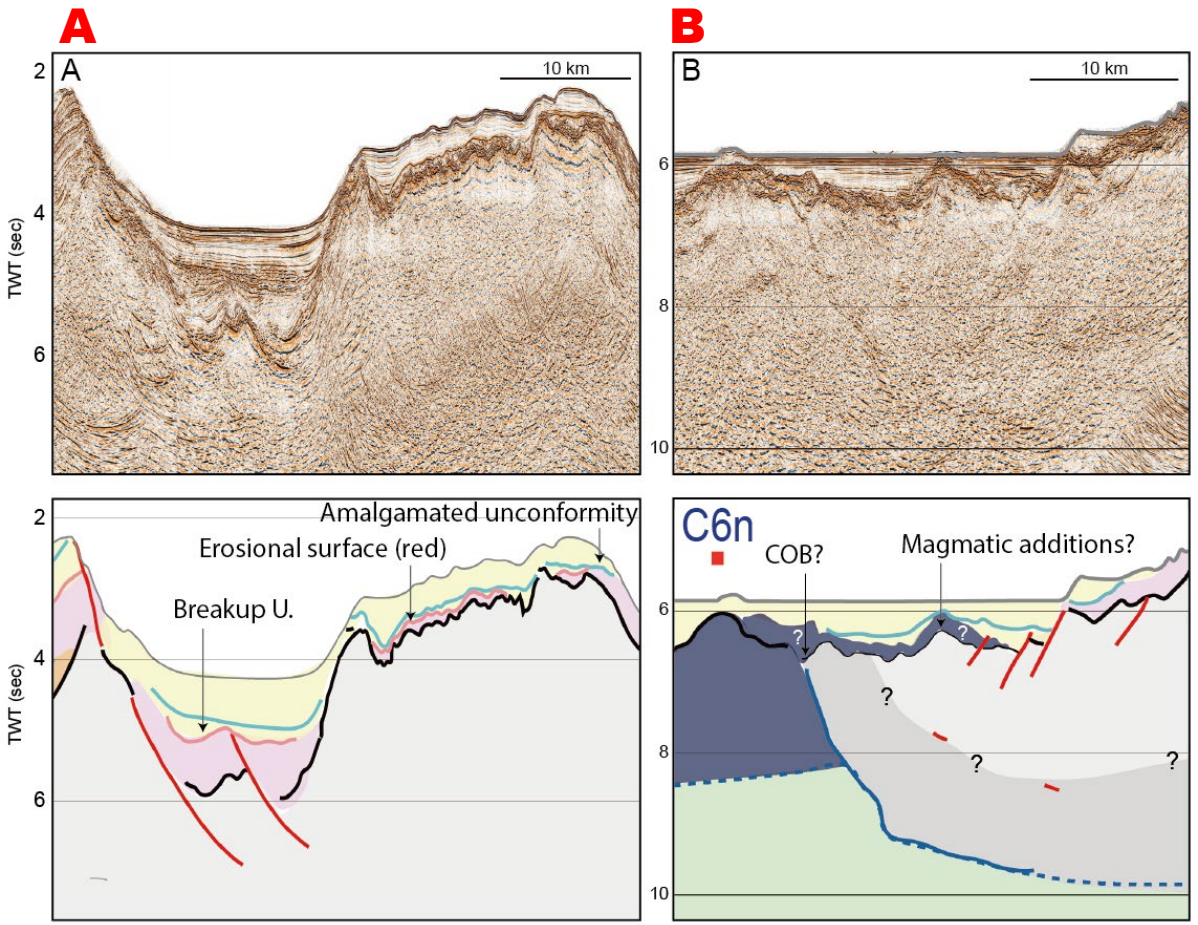




Conjugated margin across the N-S segment

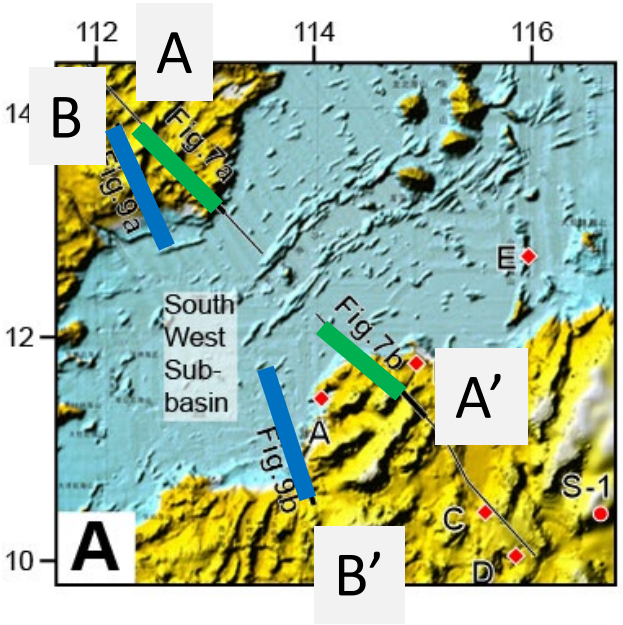
- Steep (abrupt) margin
- Relatively starved syn-rift succession at the COT



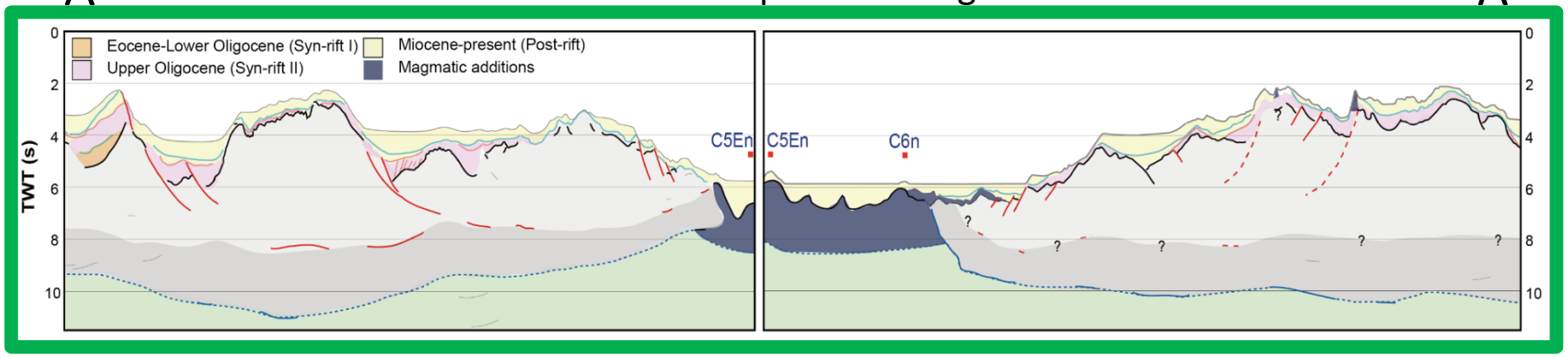


Chang et al. (submitted)

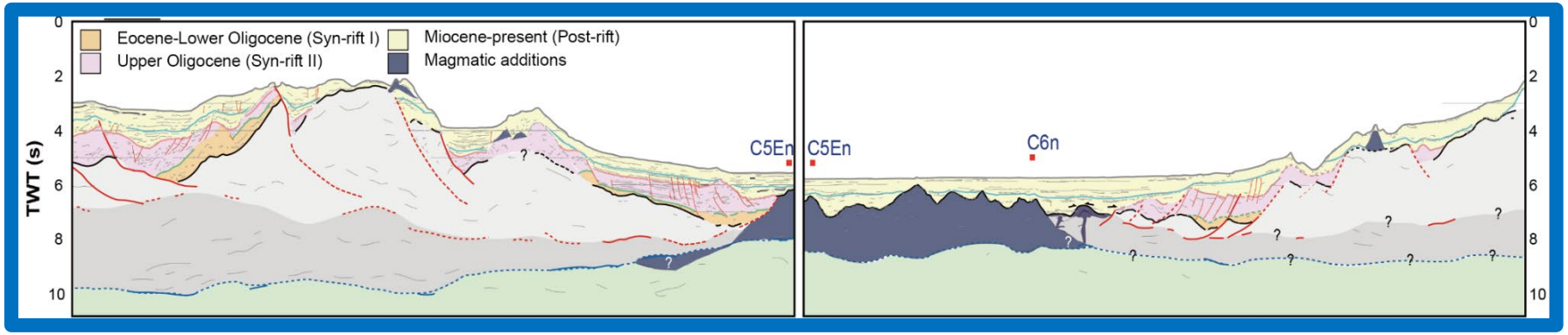
Compared N-S and E-W segments



- N-S Steep starved segment

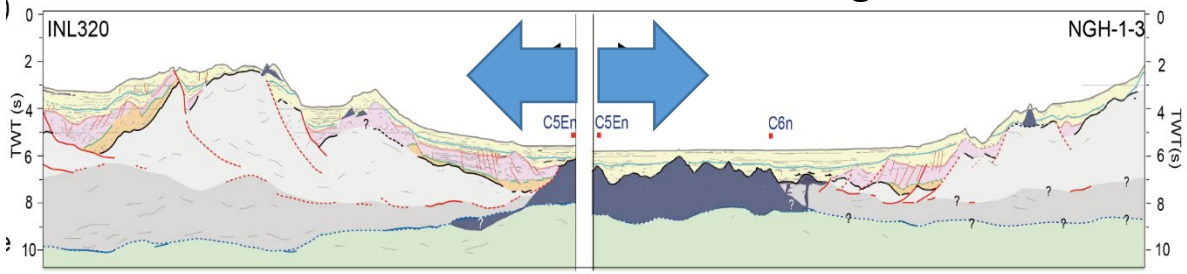


- E-W gently dipping and thickly sedimented segment

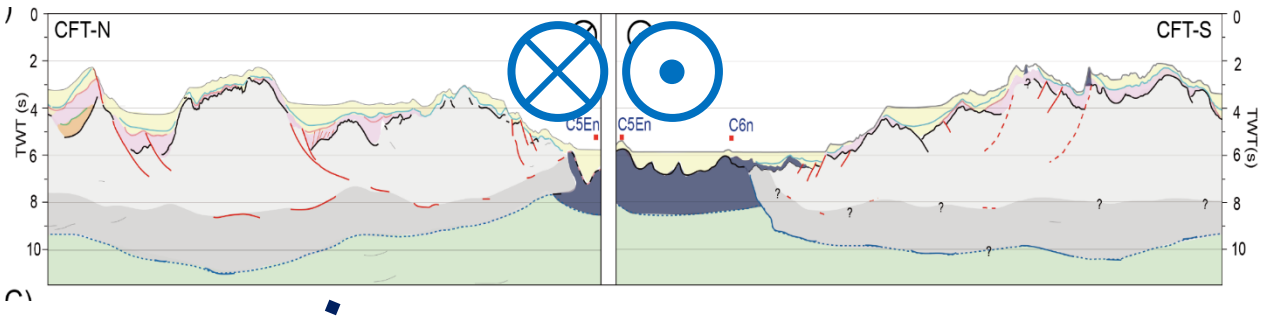


Implications on the breakup process

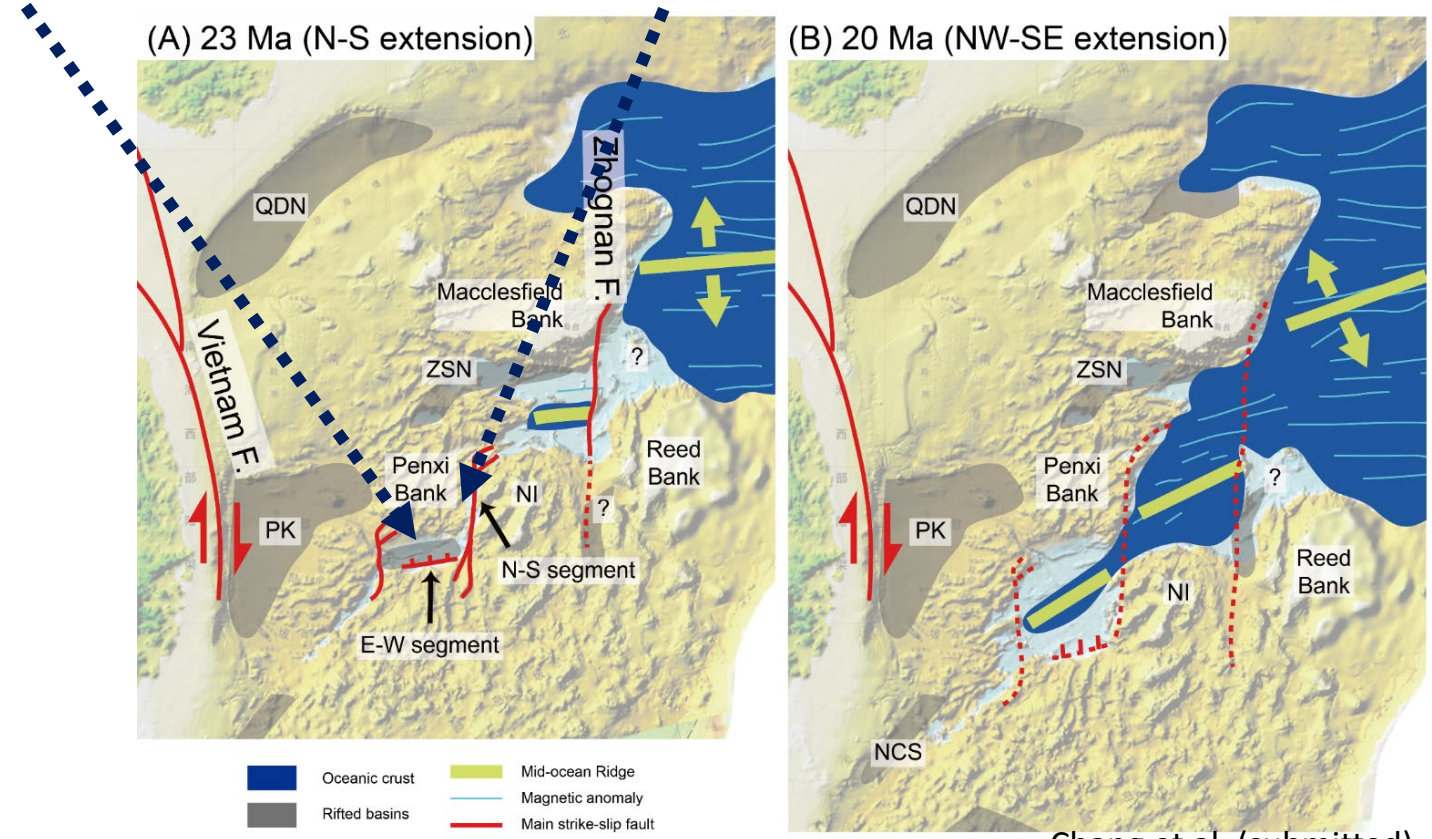
More finite extension on E-W segment



Strike-slip component on N-S segment



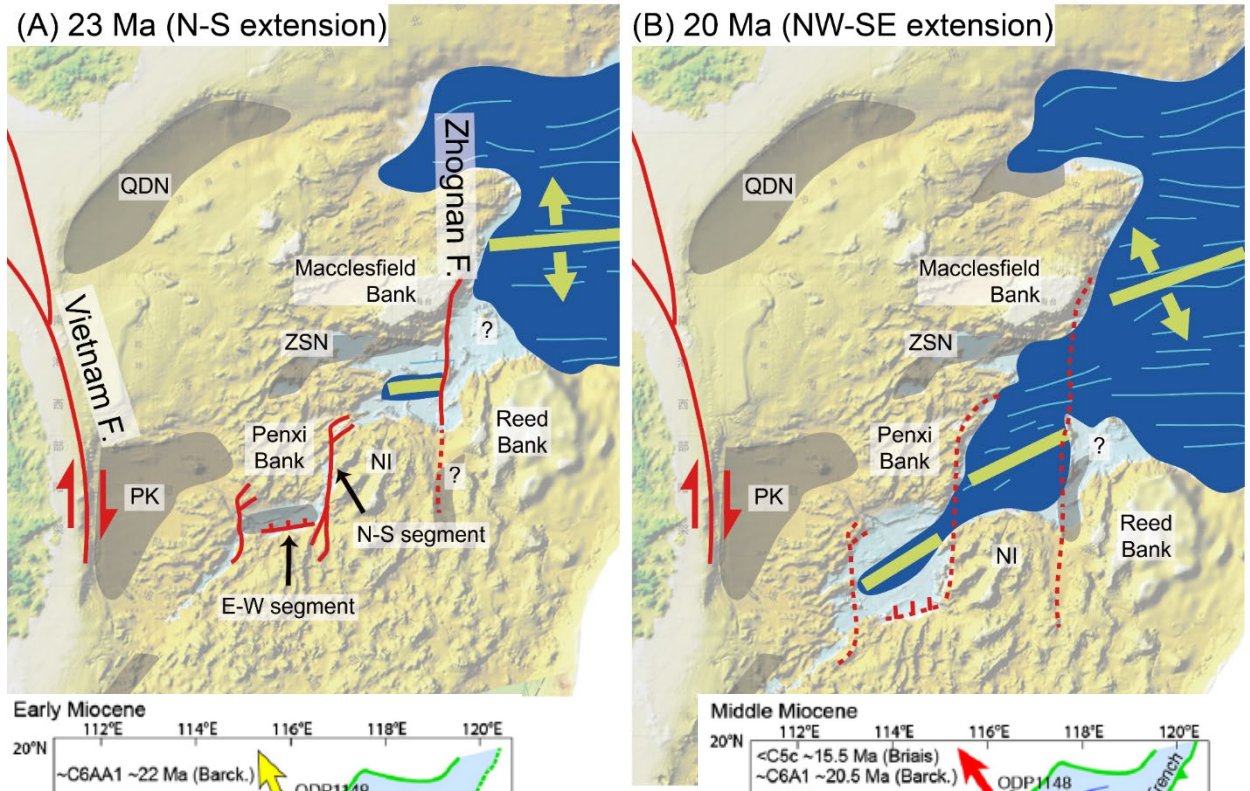
- A series of en echelon pull-apart basins at 23 Ma
- These coalesced around 20 Ma

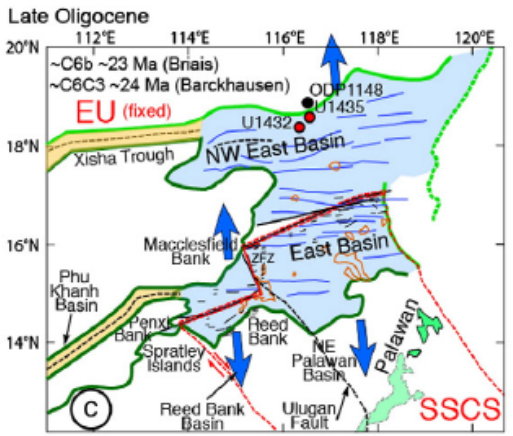


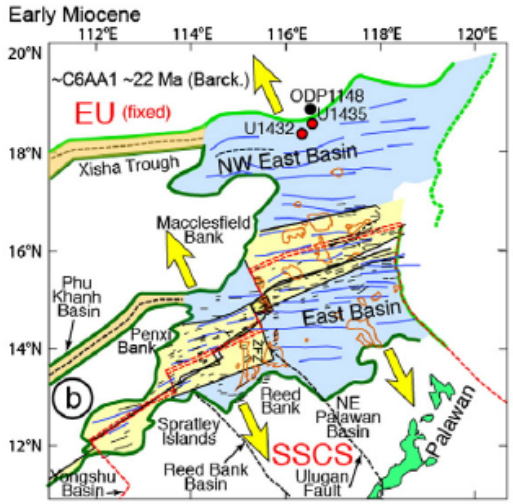
Chang et al. (submitted)

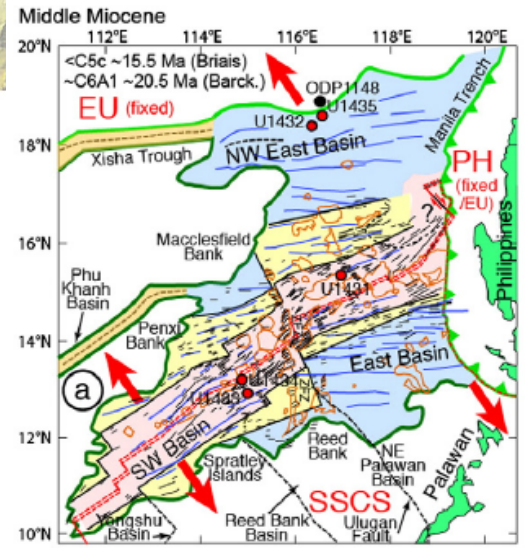
Changing rifting and spreading directions

- From en echelon pull-apart basins to coalesced
- Comparison of transition stage of Sibuet et al. (2016) around 23 Ma





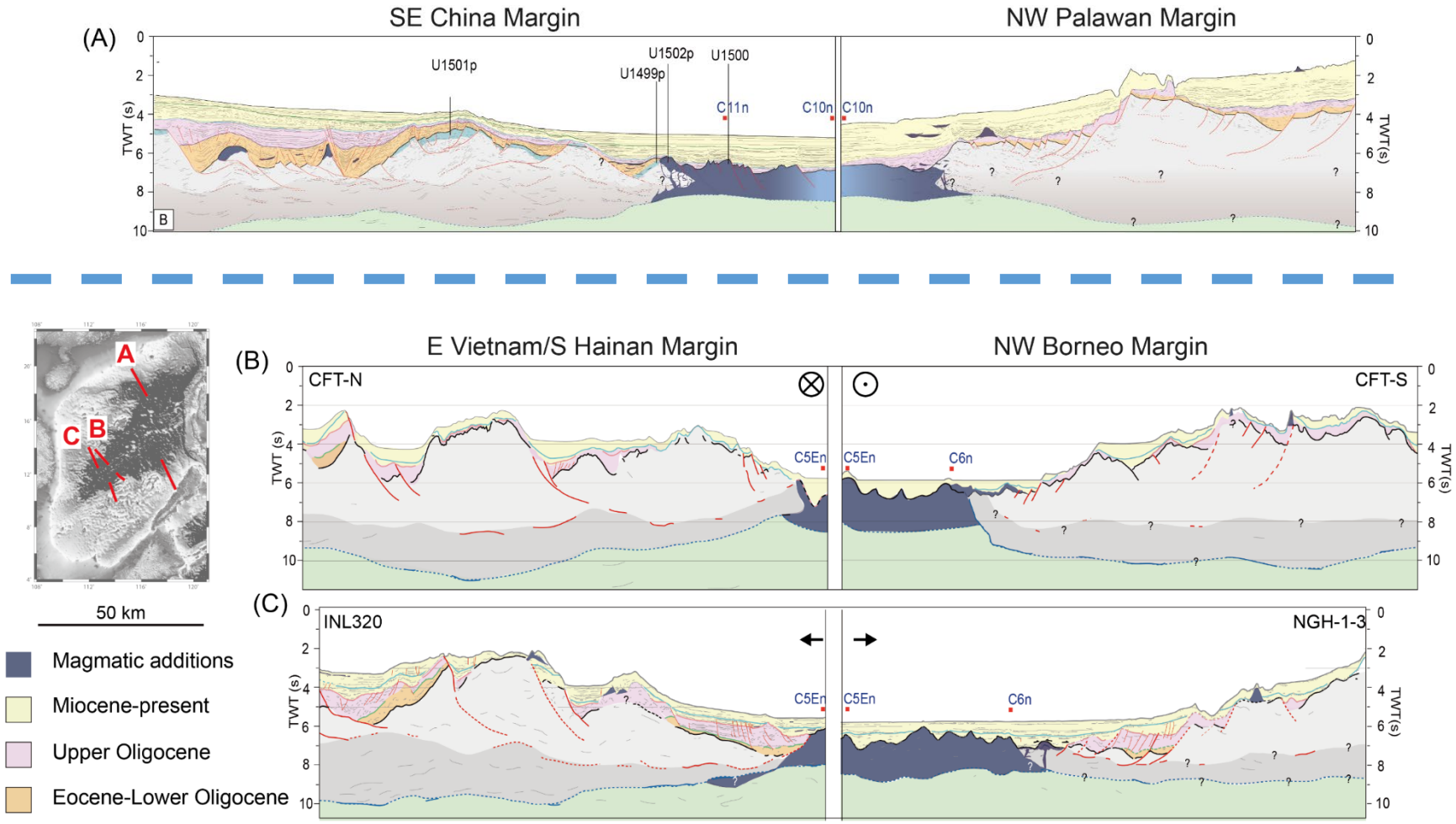




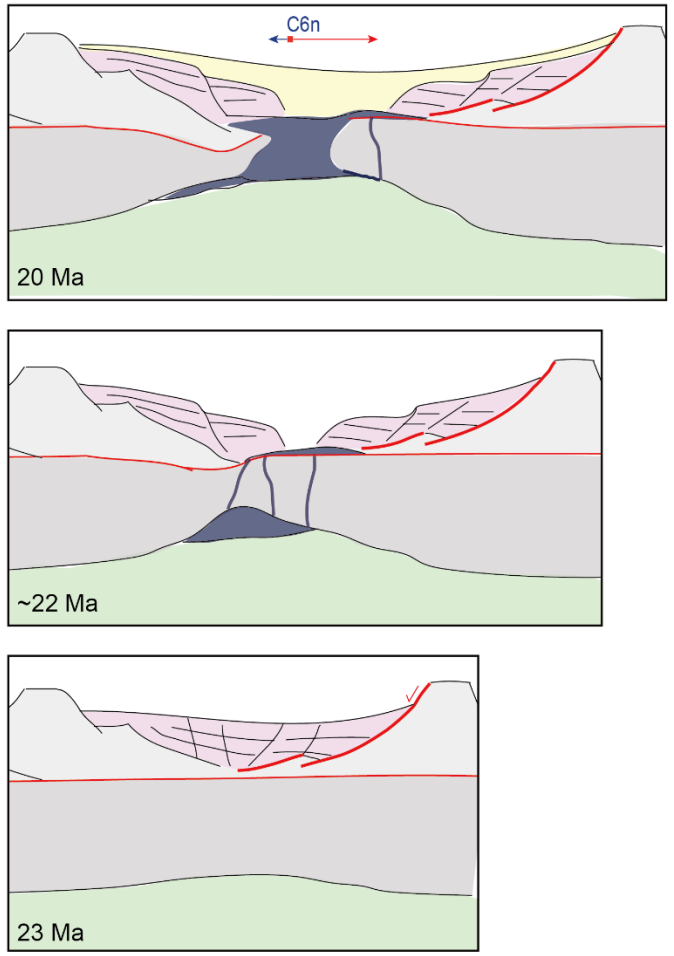
Sibuet et al. (2016) Tectonophysics

Difference between East sub-basin and southwest sub-basin

- Asymmetrical breakup in the beginning (?)
- Existence of wrenching components in the SW SCS



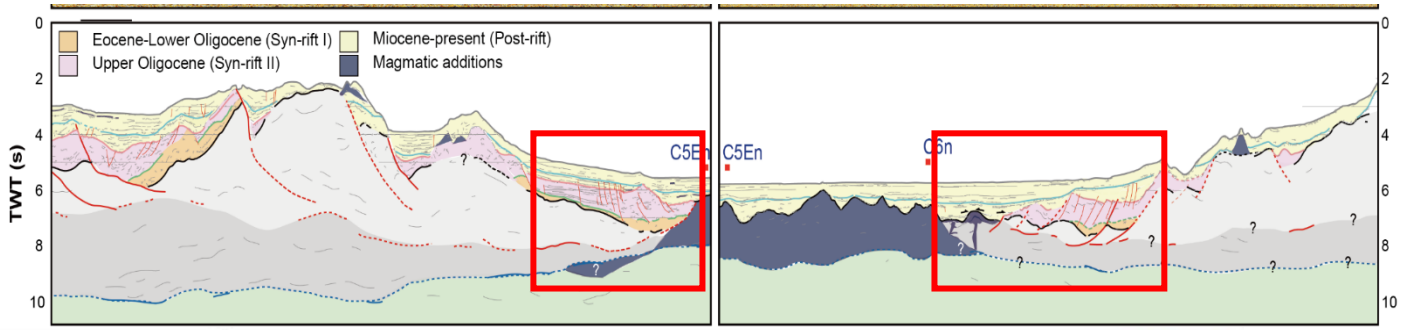
Evolution of breakup

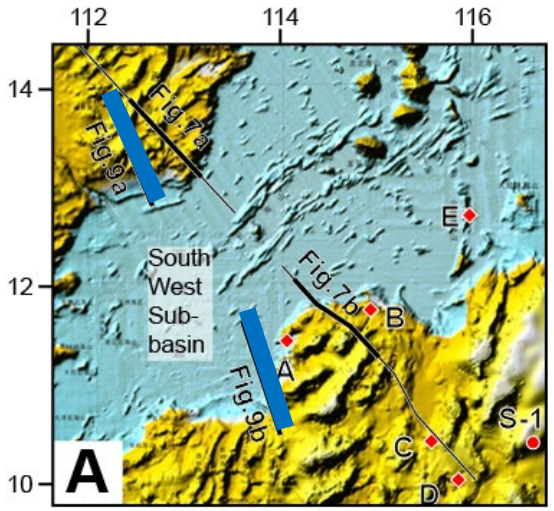


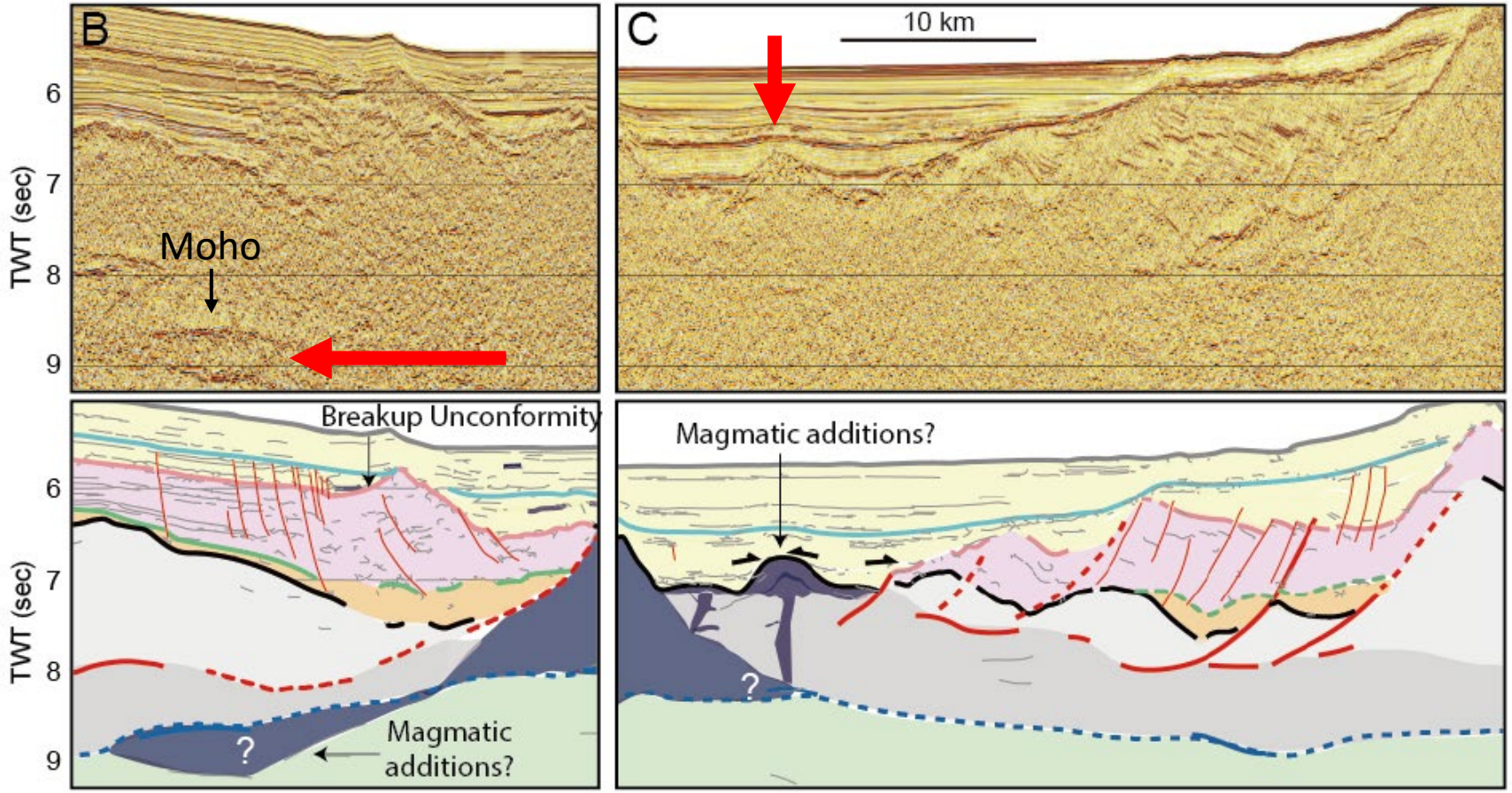
(Not to scale)

Associated magmatism

- Magmatism (red arrows) underneath the Moho(?) and overlying the top of basement(?)







Rifting-breakup through space and time

- Similar chain of process: R1-R2-breakup
- Time discrepancy

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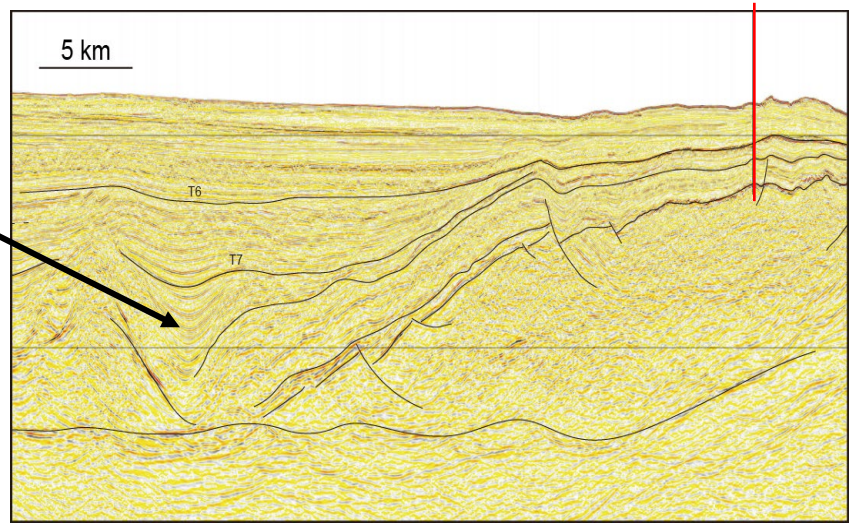
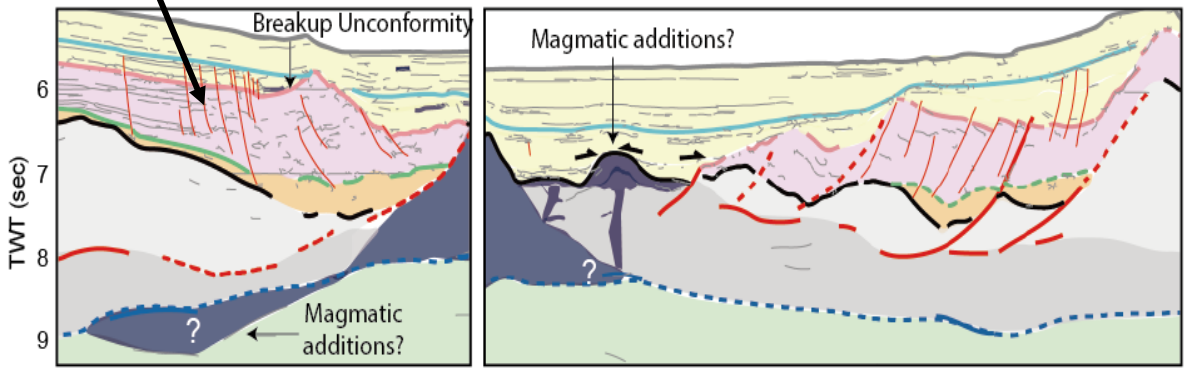
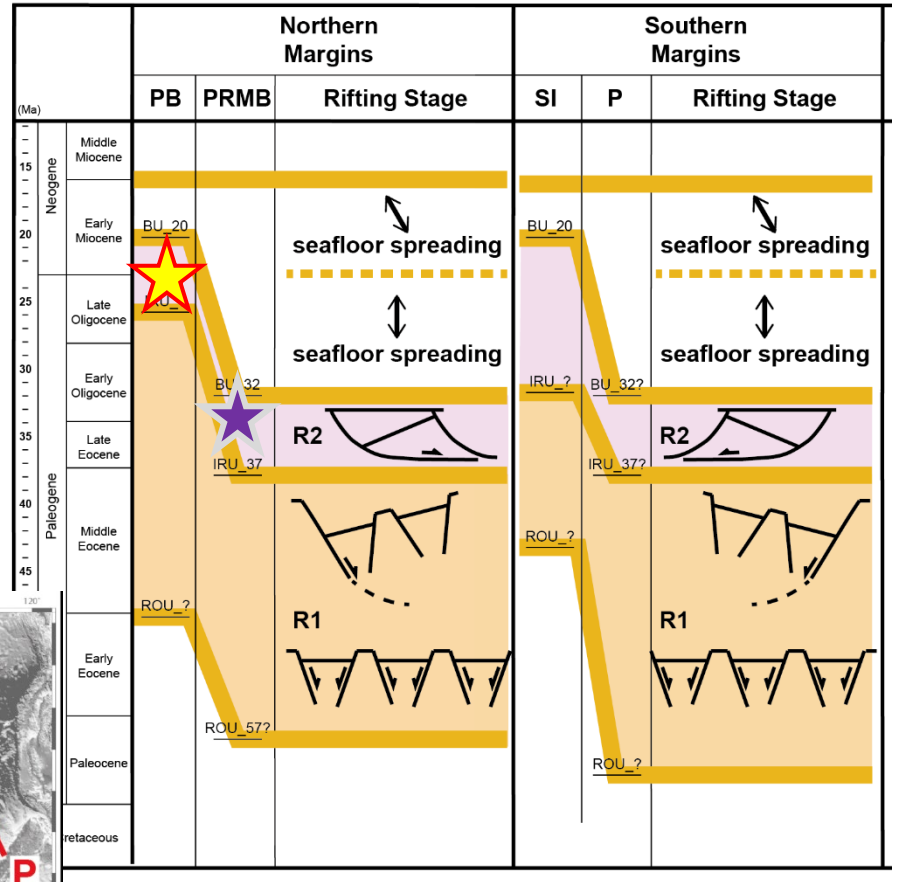
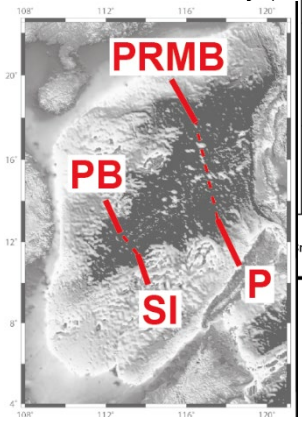
Syn-rift II
(Late Eocene –
Early Oligocene)



Syn-rift II
(Late Oligocene – Early Miocene)

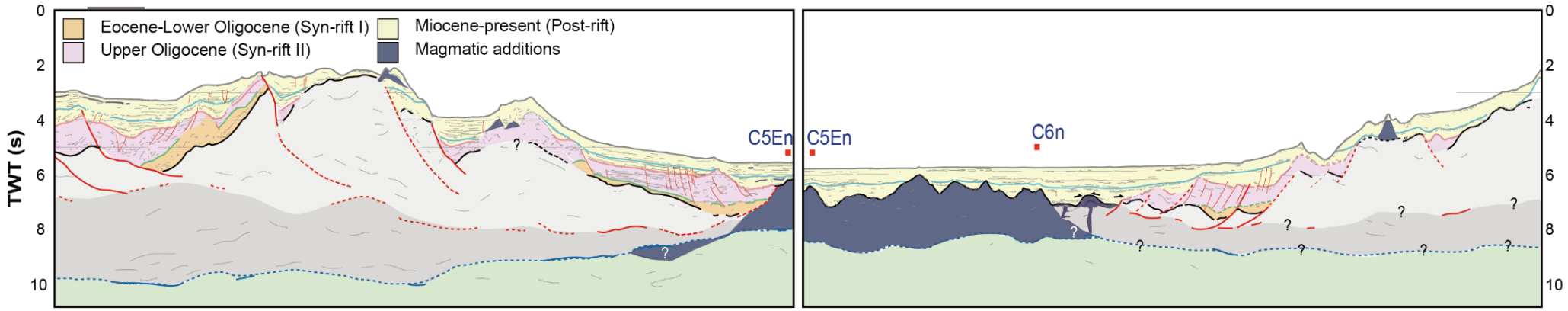






Conclusion

- Extensive syn-rift II which associated with the development of detachment faults
- Highly sedimented axial zone pushing aside early rift sediments (syn-rift I)
- E-W and N-S segments suggesting wrenching component
- En echelon pull-apart basins at 23 Ma coalescing afterwards
- Magmatic addition appear in the seismic profiles
- All corresponding to transitional spreading direction



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