Tectono-magmatic and thermal evolution of the SE China margin-NW Palawan breakup

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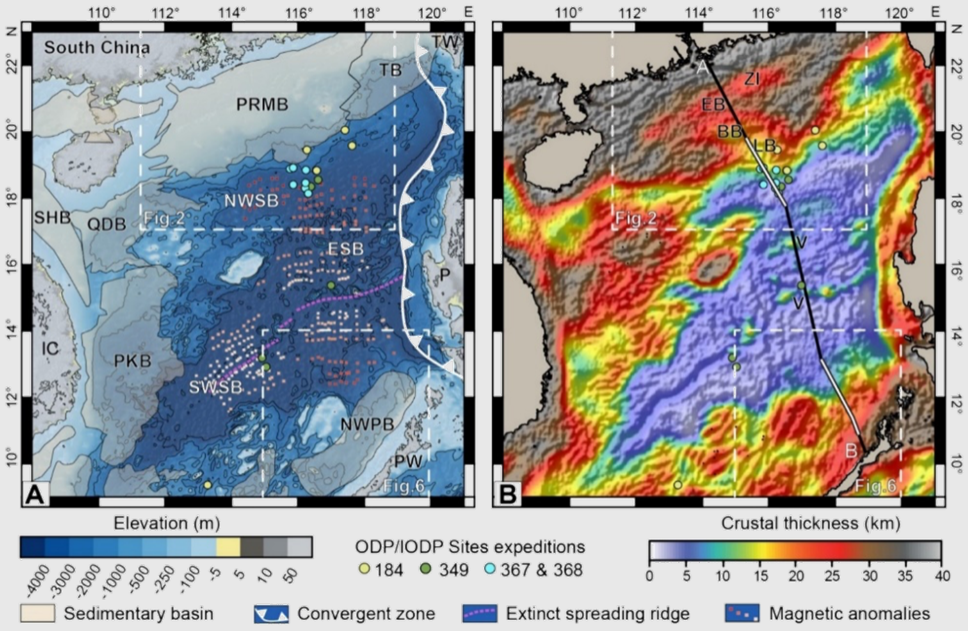
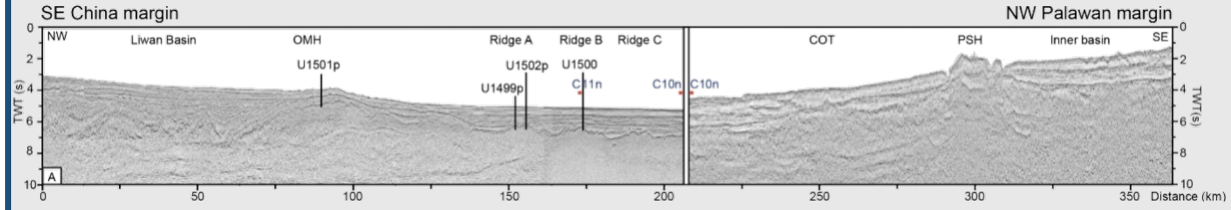
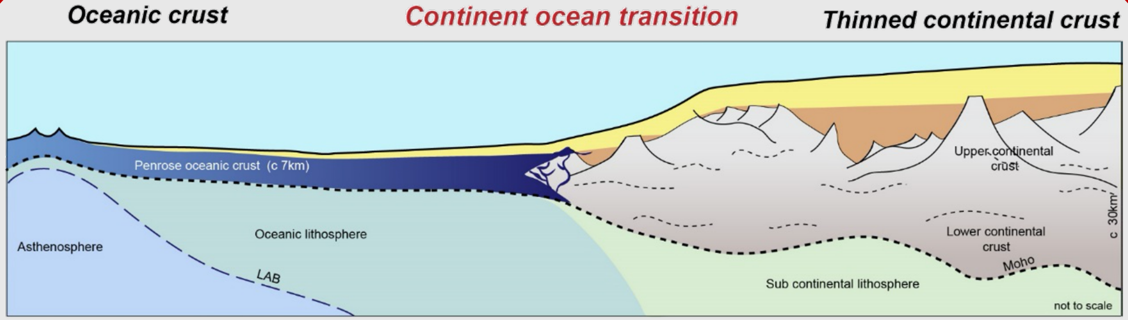
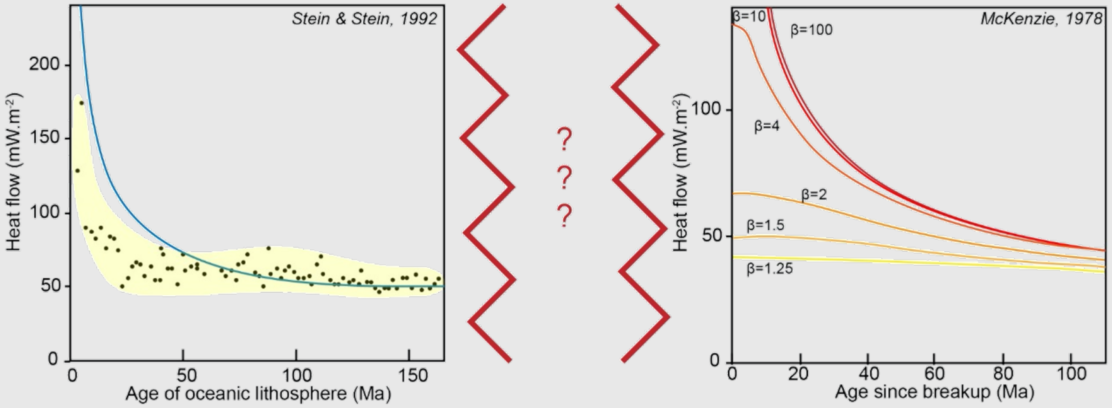
Questions:





What are the mechanisms of continental breakup in the South China Sea?



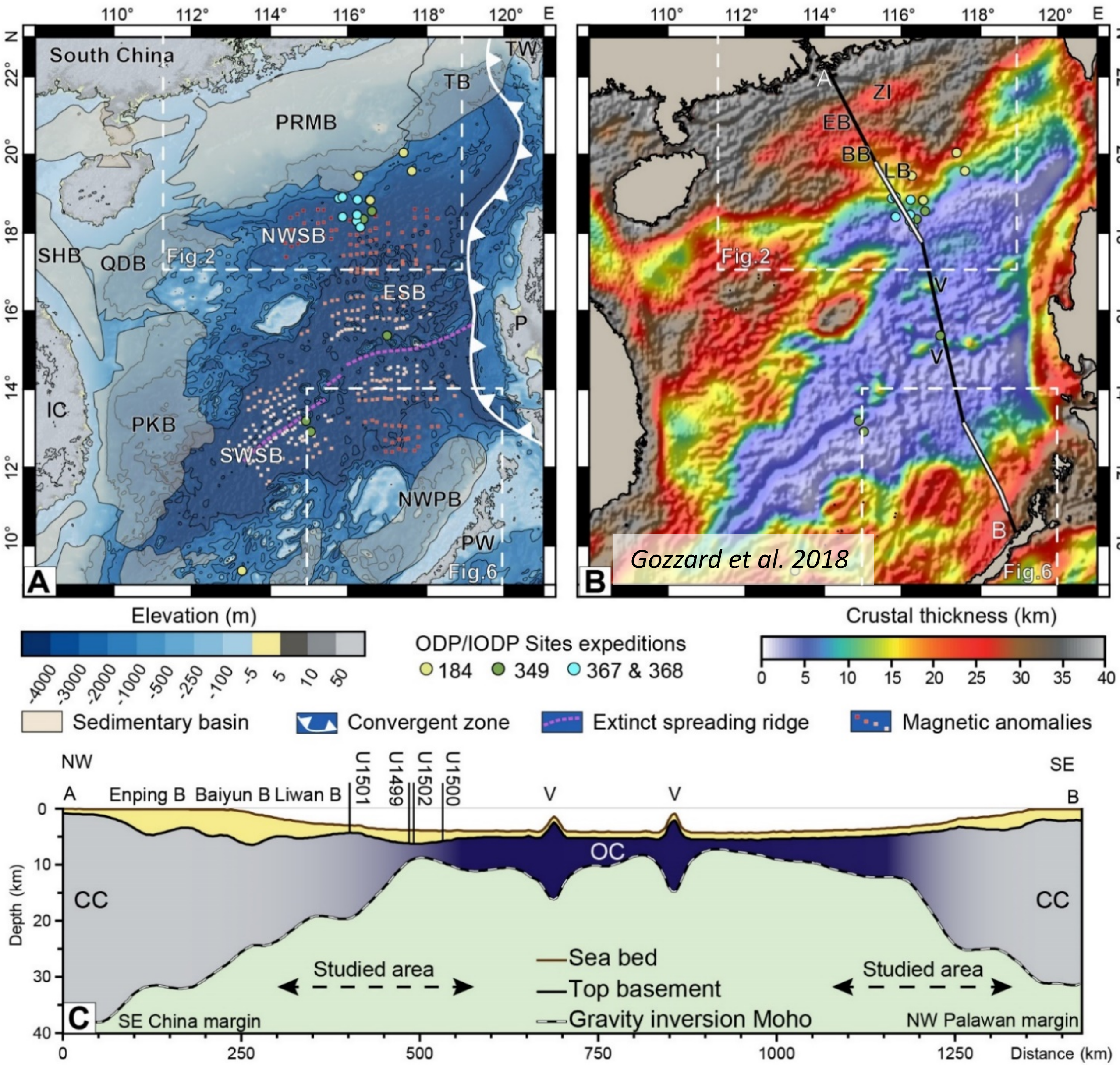


Heat flow vs Age of the oceanic lithosphere

Heat flow vs Rifting age and lithospheric thinning

What is the thermal evolution of the South China Sea continent ocean transition?

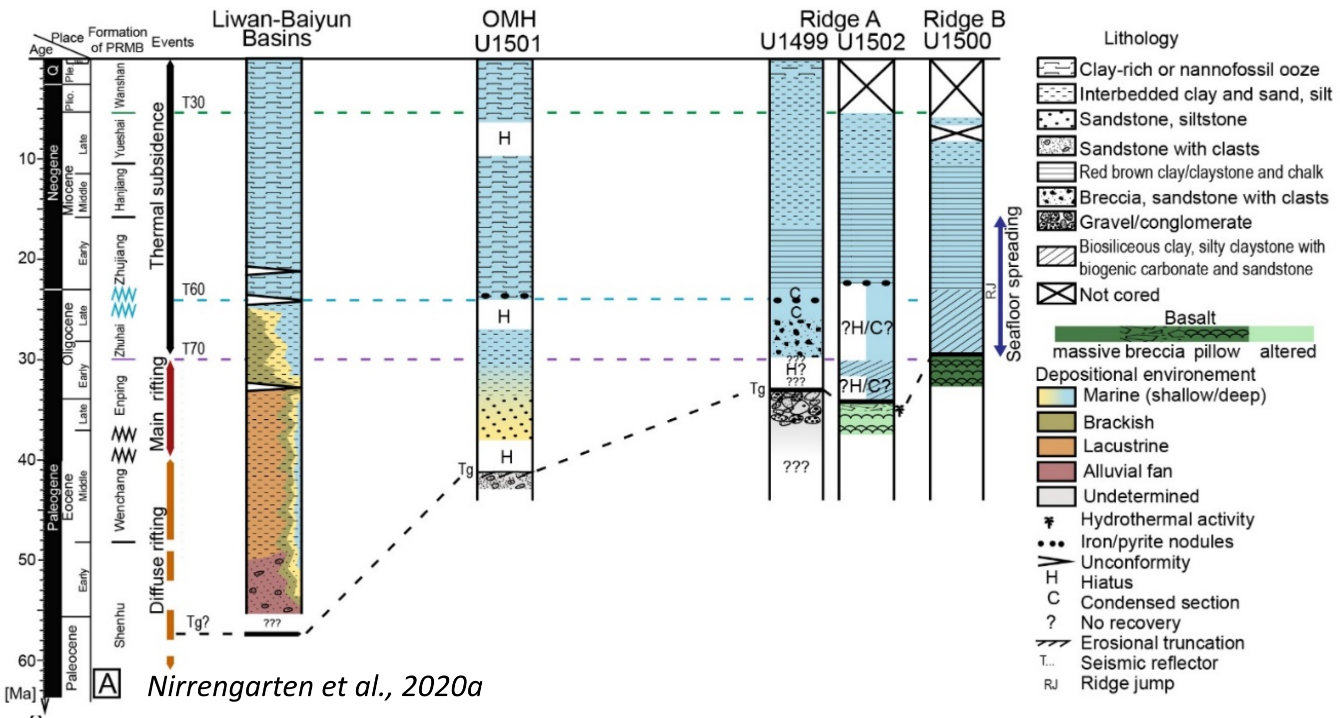
The South China Sea geological context



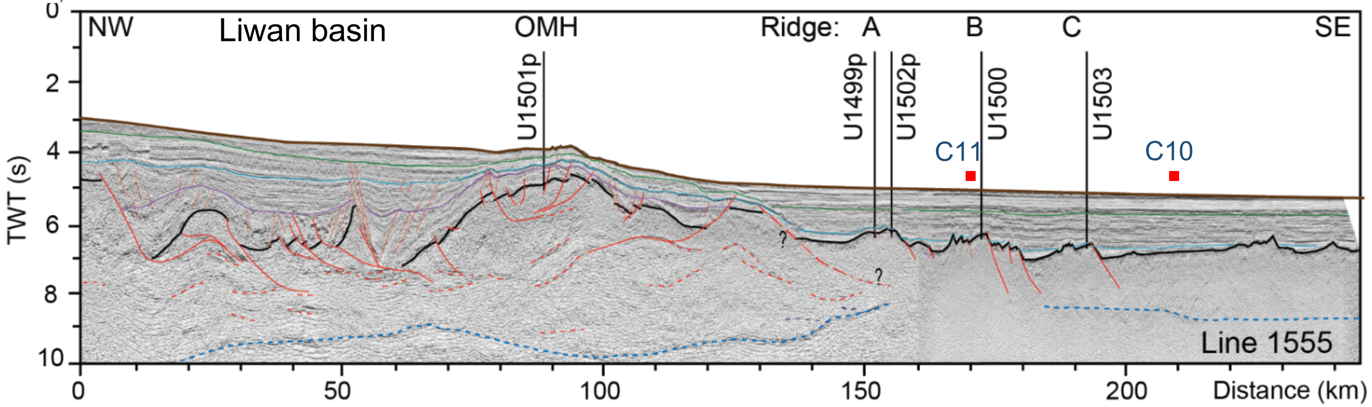
Nirrengarten et al., 2020a

- SCS is a Tertiary marginal basin
- Onset of rifting during the Paleogene (likely during the Eocene)
- SCS comprises three oceanic subbasins with ridge jumps
- Wide northern margin characterized by the huge Pearl River Mouth Basin (PRMB)
- SCS started to subduct below the Philippines at ~15 Ma.

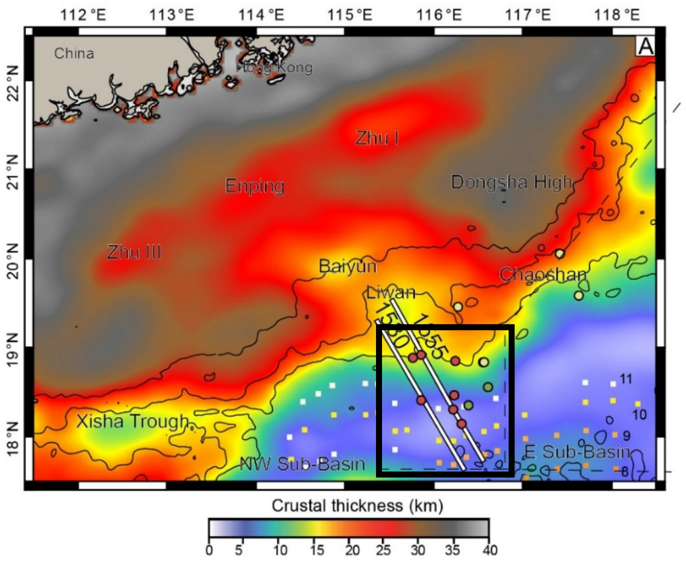
SE China margin: IODP 3676,368 & 368X summary

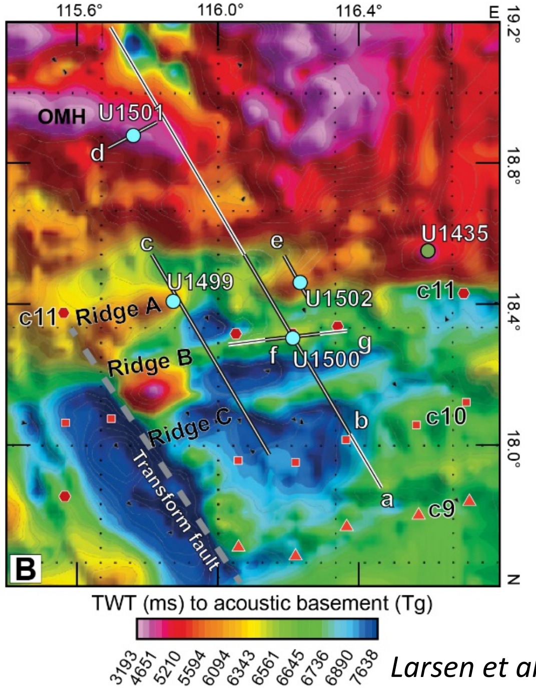


Nirrengarten et al., 2020a



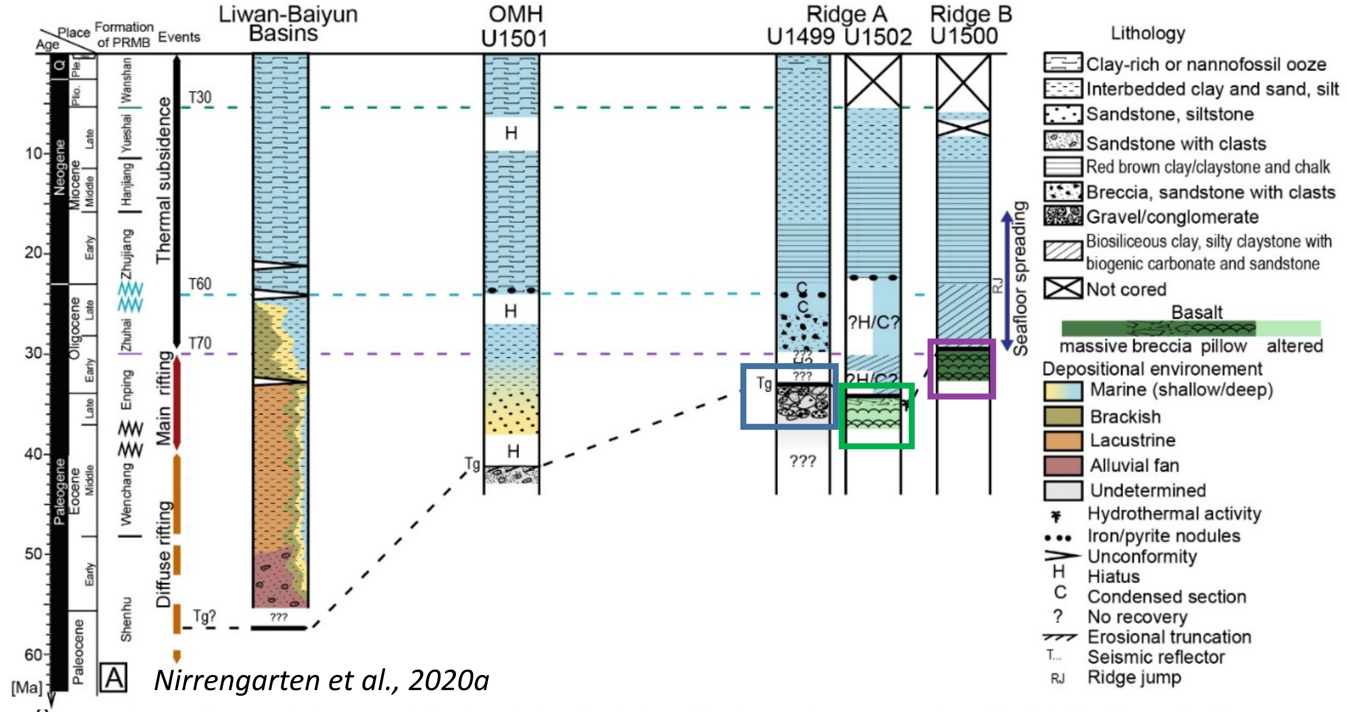
Sites locations



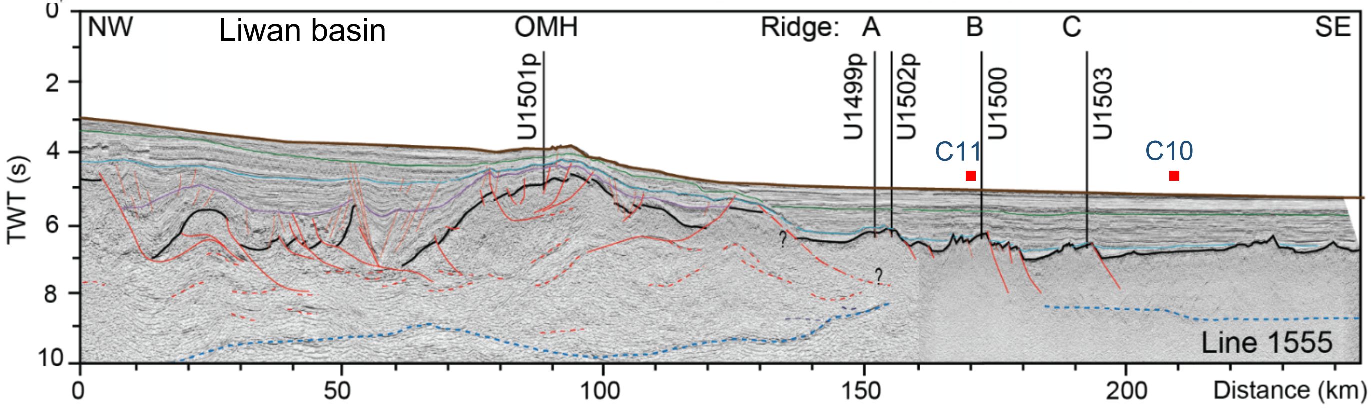


Larsen et al. 2018

SE China margin: IODP 3676,368 & 368X summary



Nirrengarten et al., 2020a



OMH

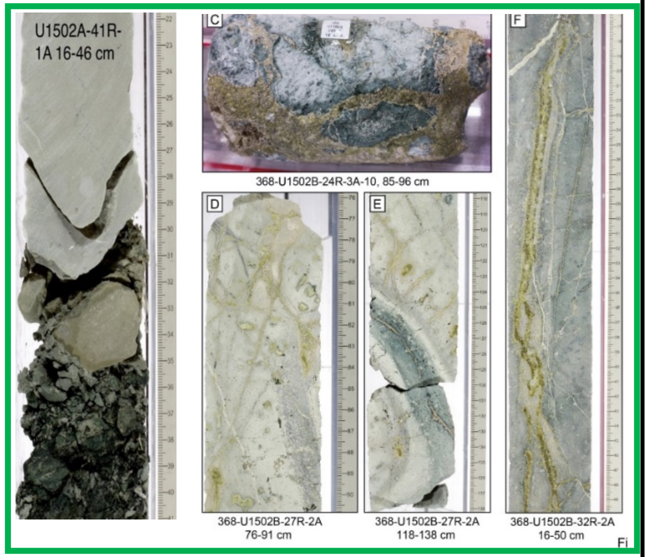
U1501: T60 unconformity 28-24 Ma---Rifting onset in the distal margin ~40 Ma

Ridge A

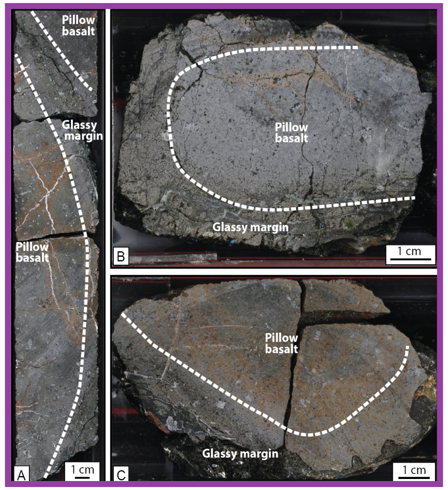
U1499: Undated conglomerates

Sun et al., 2018; Larsen et al., 2018

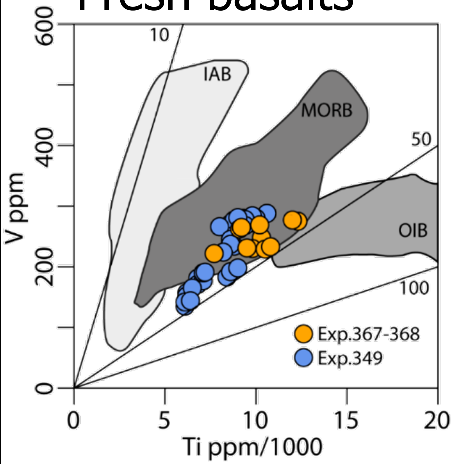
U1502: Altered basalts



Ridges B & C

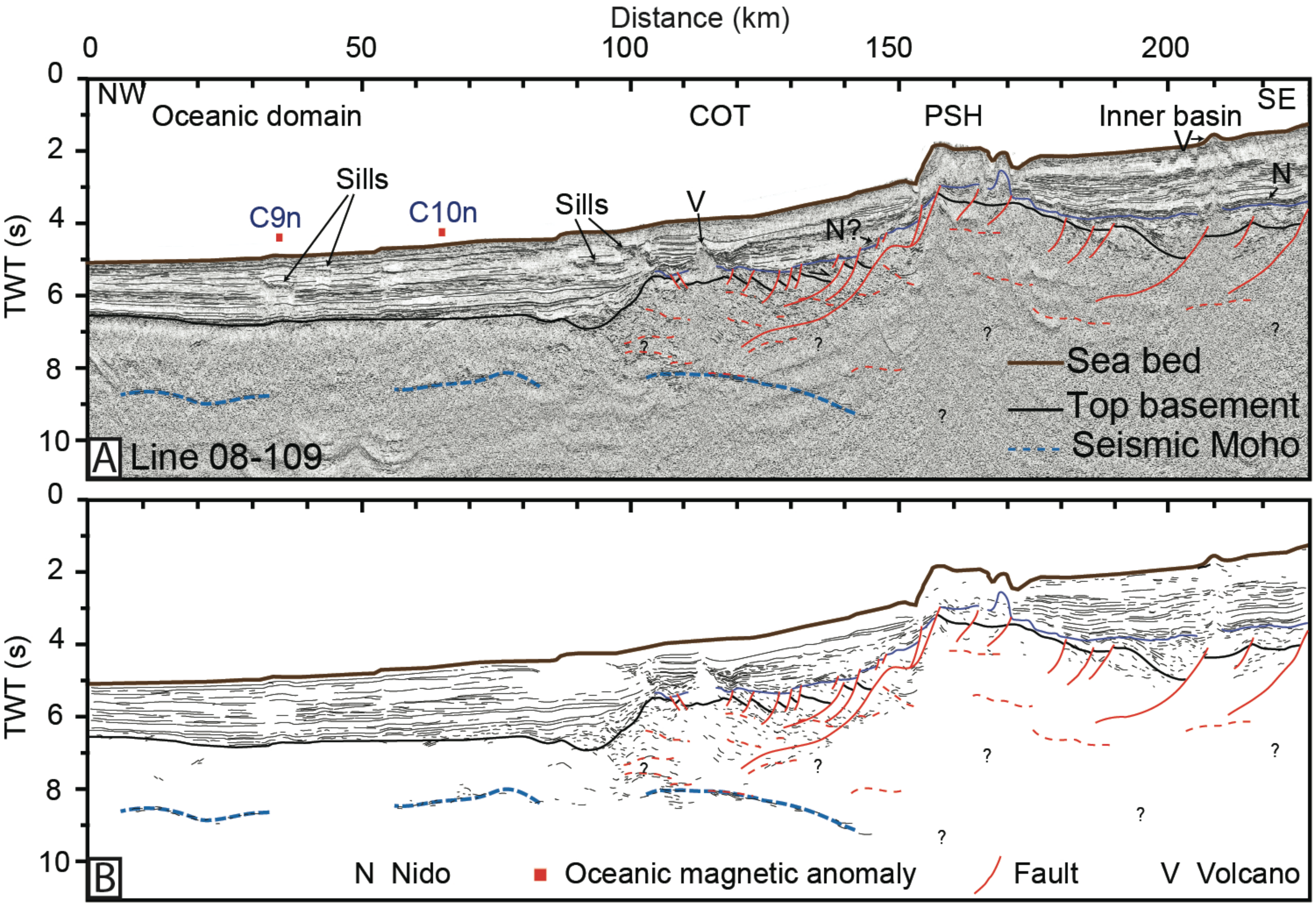


U1500-U1503: Fresh basalts

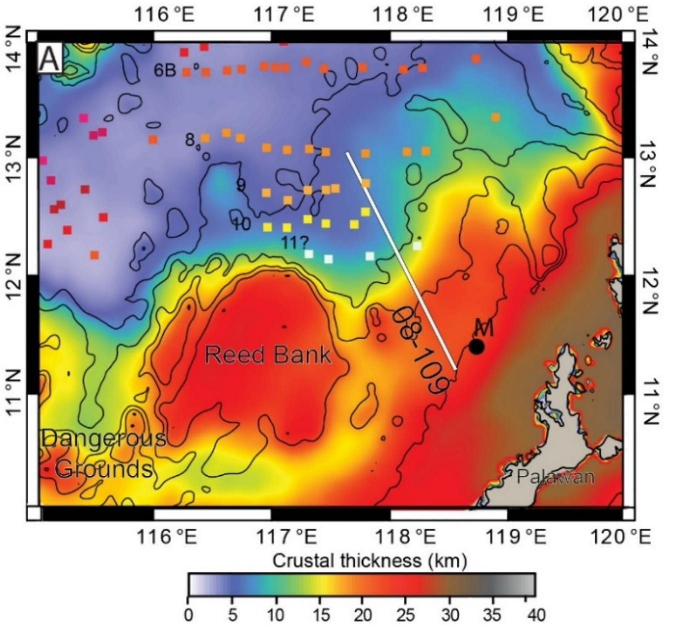


~30 Ma

NW Palawan margin: Seismic interpretation

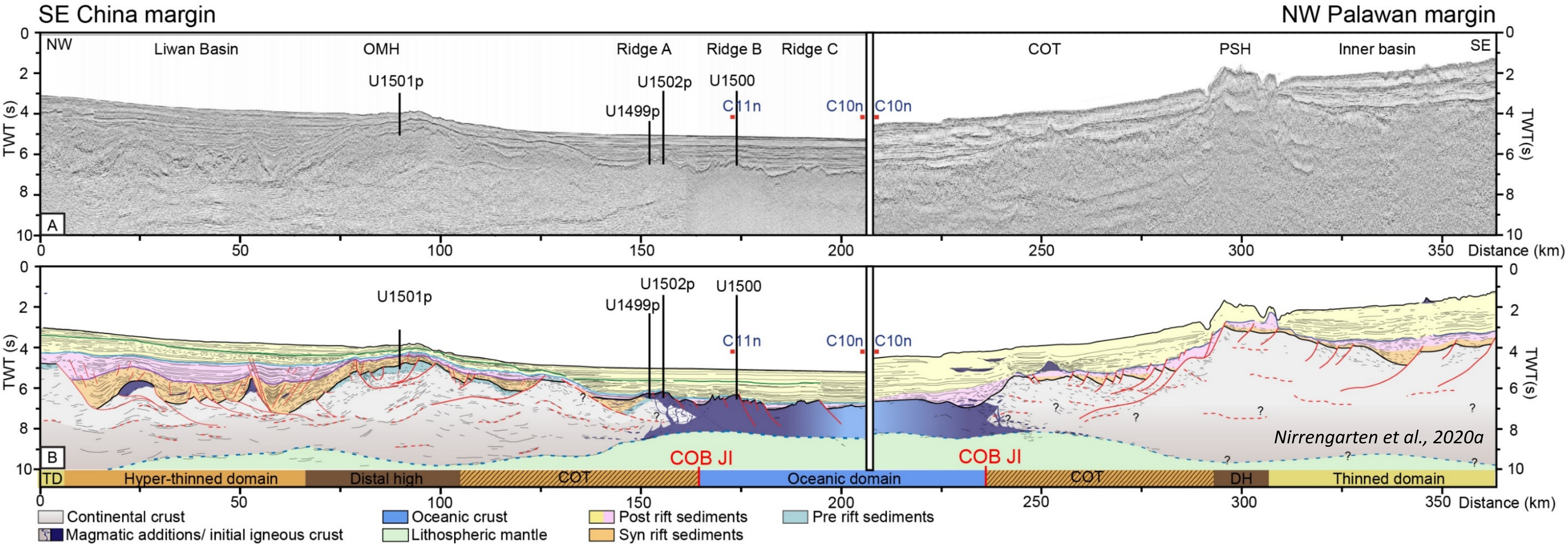


Nirrengarten et al. 2020a



Magnetic oceanic C11n is not defined on the magnetic profile of the Palawan margin (Briais et al., 1993)

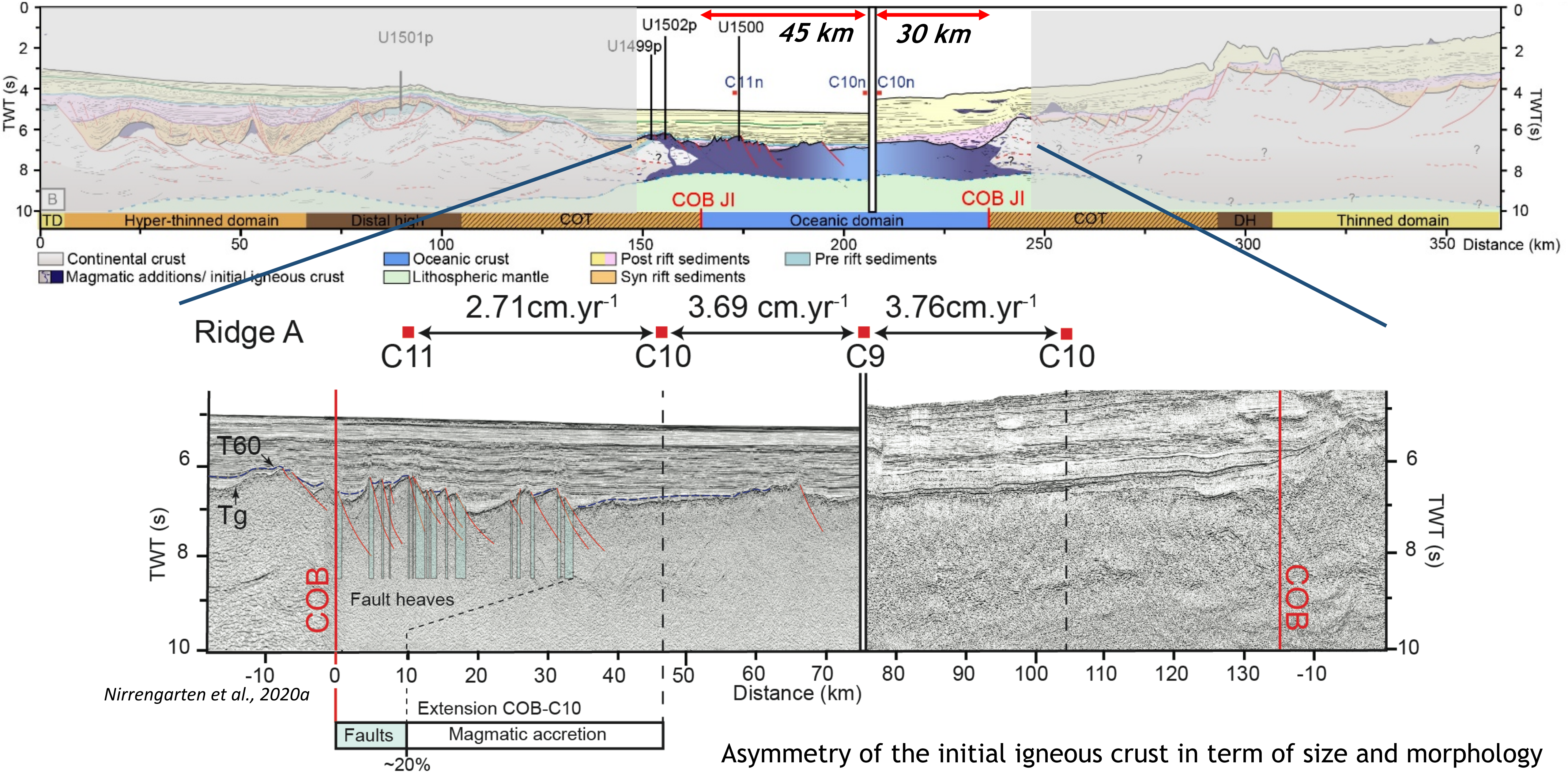
SE China-NW Palawan conjugate margins



Observation on the deformation style of the SCS margin

- Heterogeneous continental deformation with several decoupling levels implying ductile materials
- The deformation pattern is related to a high thermal regime inherited from Cretaceous convergence
- The COT is narrow and asymmetric showing tectonic deformation synchronous to volcanic activity

SE China-NW Palawan conjugate margins

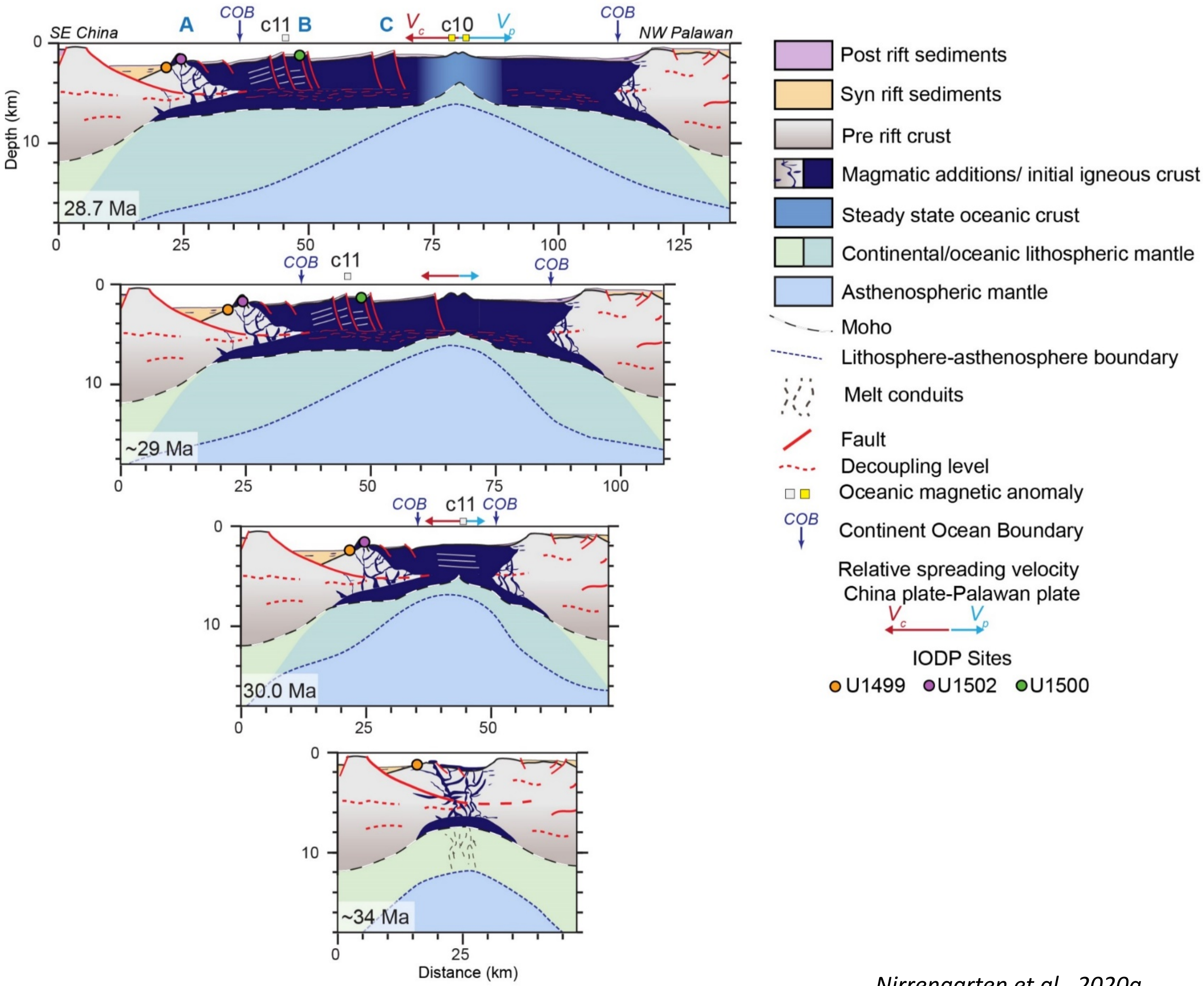


Nirrengarten et al., 2020a

Asymmetry of the initial igneous crust in term of size and morphology

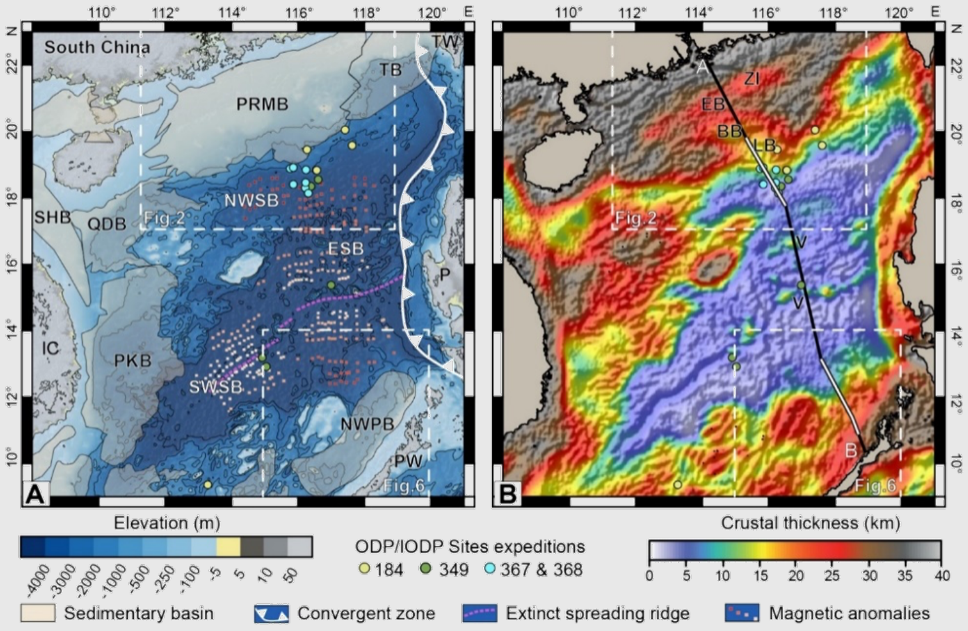
Breakup model of the SE China-NW Palawan conjugate margins

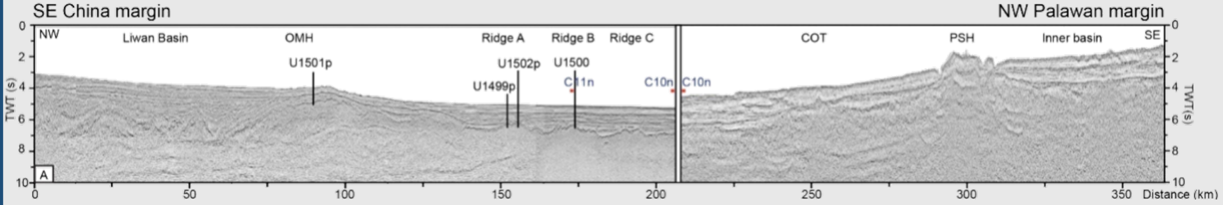
- Stabilisation of the oceanic ridge and steady state seafloor spreading
- Asymmetric initial spreading related to tectonic extension on the SE China side picturing the incipient initiation of an oceanic lithosphere
- Crustal separation and formation of fully igneous crust
- The continental crust is highly thinned associated with MOR type-magmatism

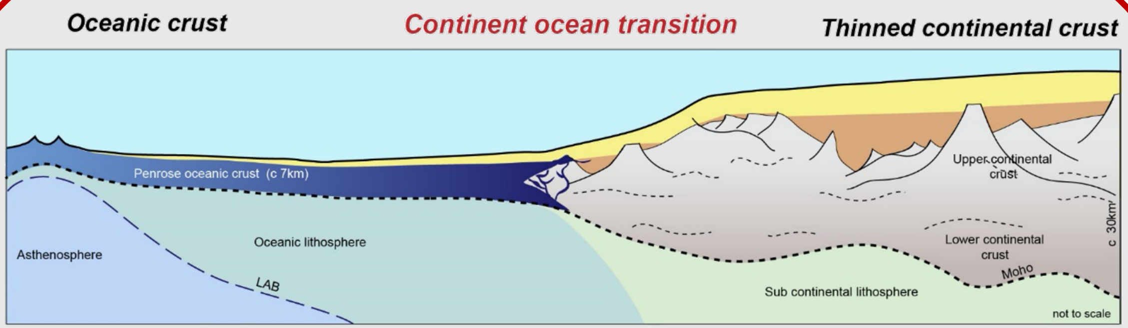


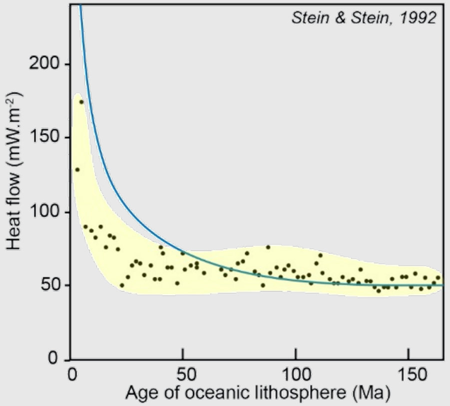
Nirrengarten et al., 2020a

Questions:



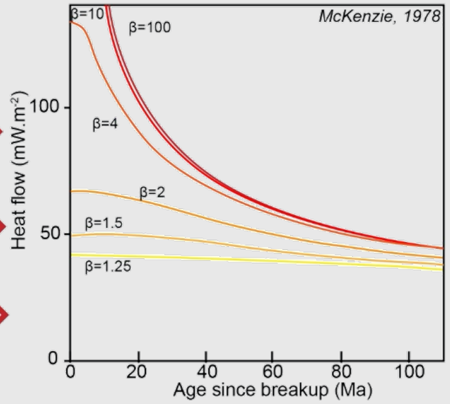






Heat flow vs Age of the oceanic lithosphere

? ? ?



Heat flow vs Rifting age and lithospheric thinning

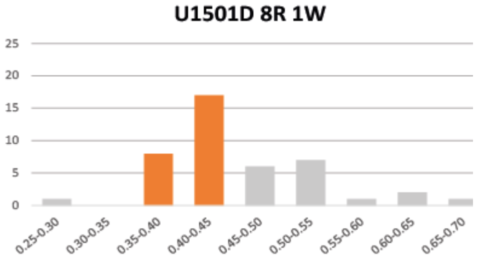
What are the mechanisms of continental breakup in South China Sea?

What is the thermal evolution of the South China Sea continent ocean transition?

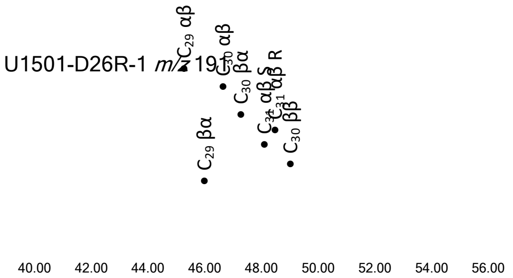
Thermal maturity at Ridge A

- Determination of the thermal maturity of organic mater contains in pre-, syn- and post-rift sediments at COT
- 3 technics are used to cover a range of temperature from ~40 °C to >200 °C

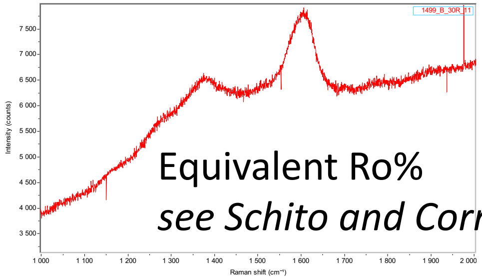
1) Vitrinite reflectance



2) Biomarkers

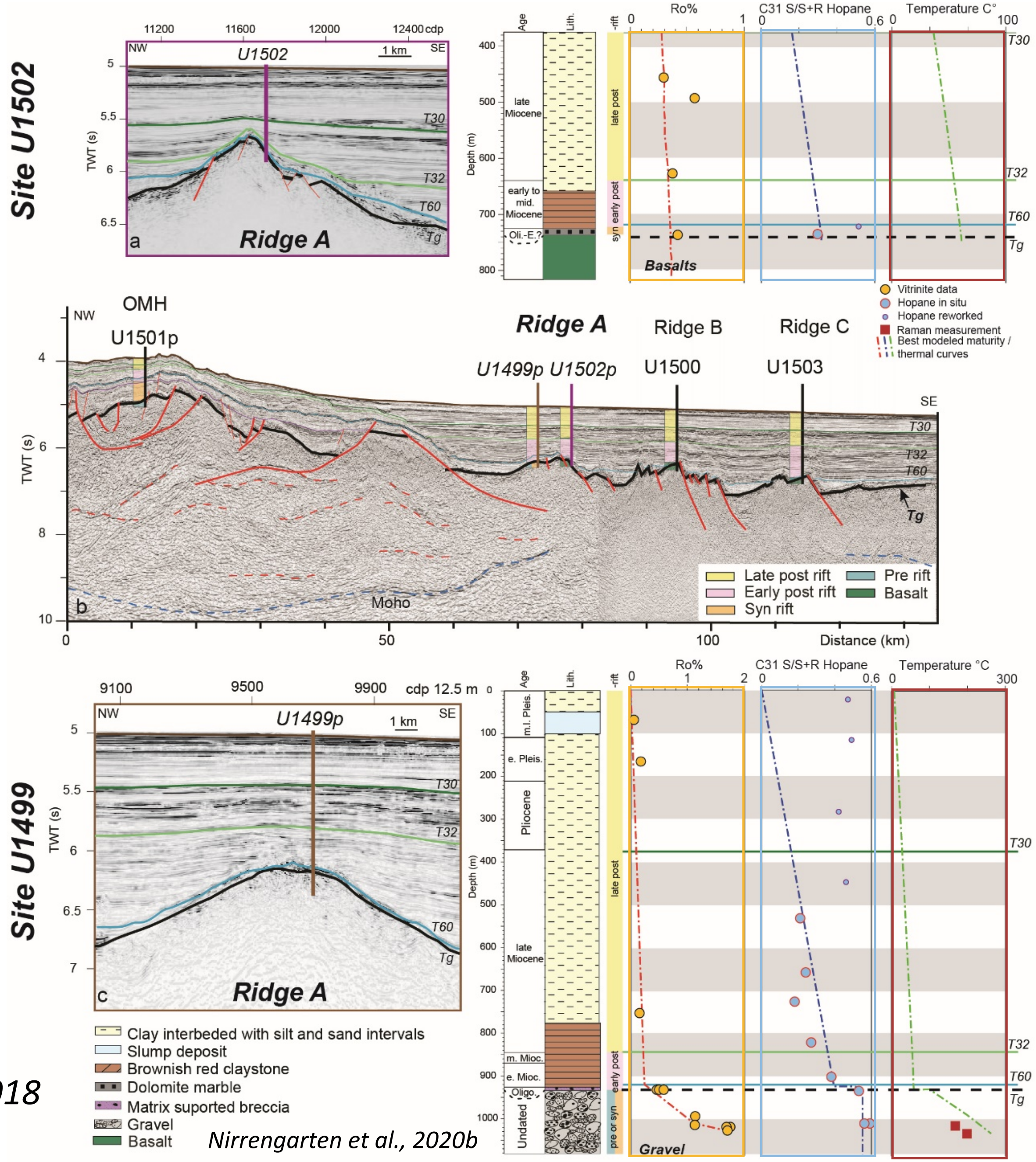


3) Raman spectroscopy



Equivalent Ro%

see Schito and Corrado 2018



Nirrengarten et al., 2020b

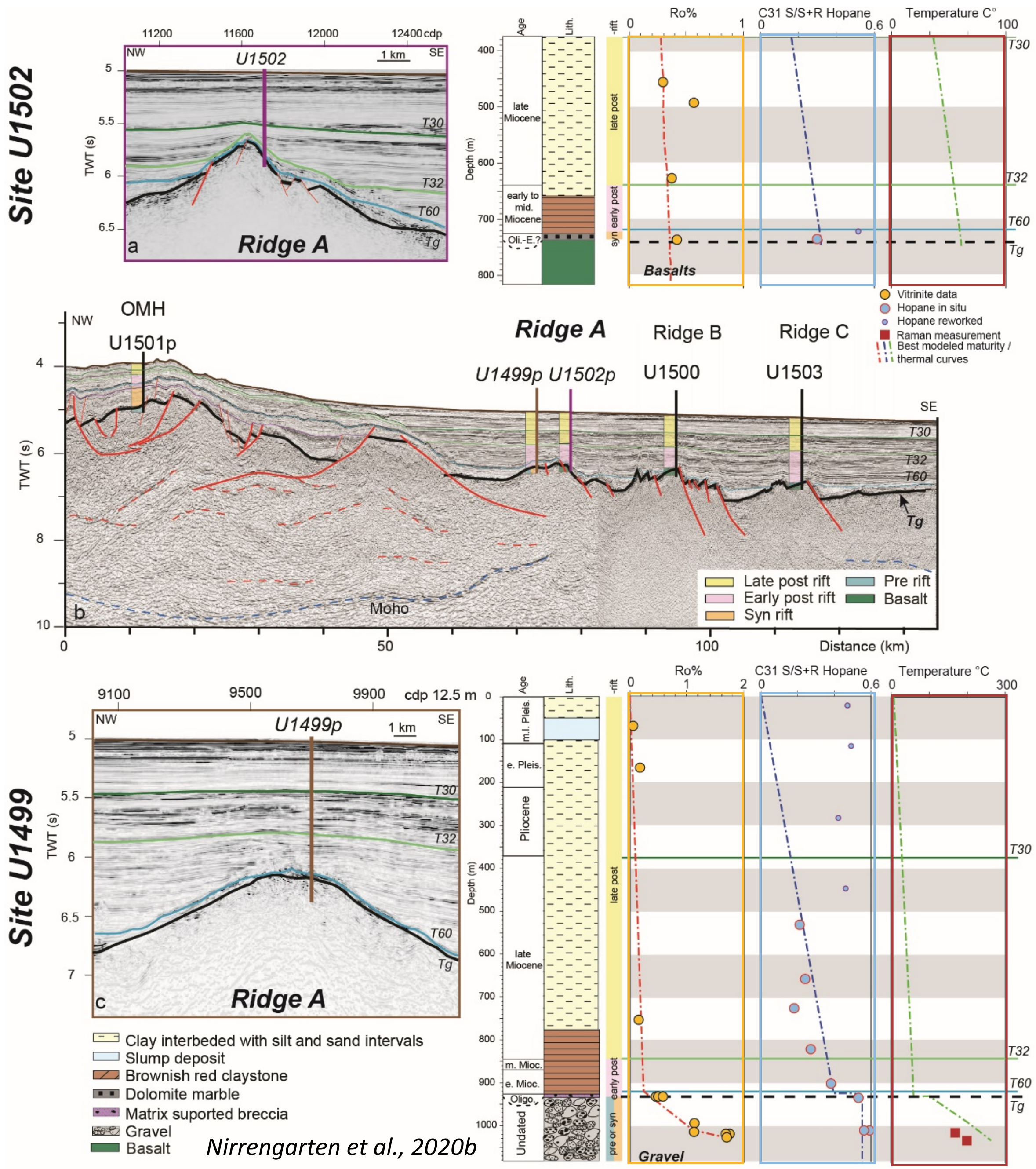
Analysis of thermal maturity data at Ridge A

Site 1502

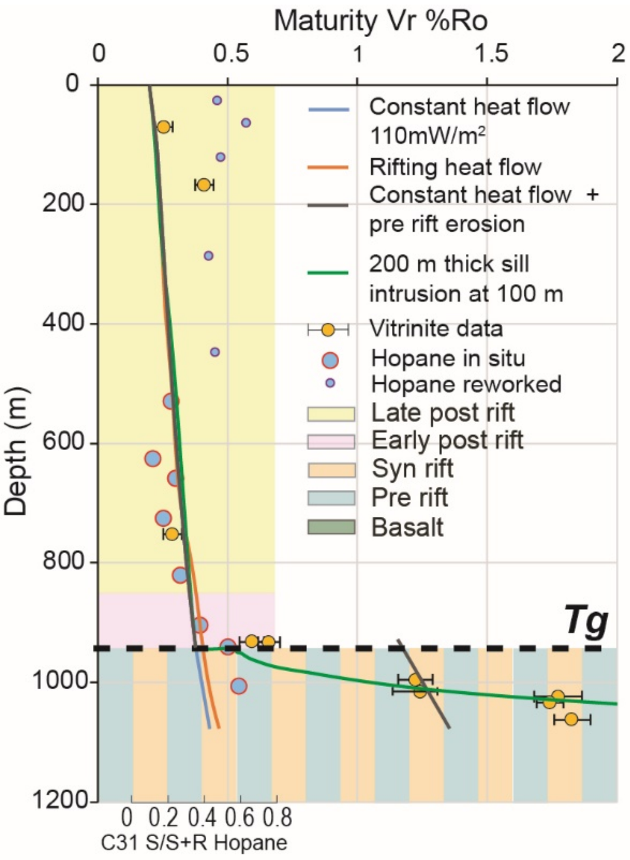
- One syn-rift and multiple post rift data where acquired
- Our data show a low thermal maturity based vitrinite and biomarker data
- The thermal maturity slightly increases with depth

Site 1499

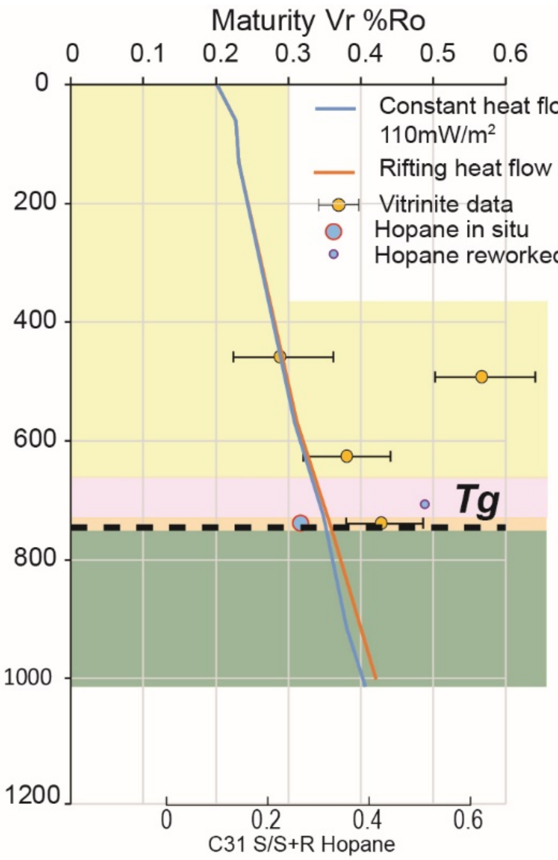
- Data on the post-rift sediments and in the gravel unit bellow Tg (pre- or syn-rift sediments)
- Low thermal maturity increasing with depth in the post-rift unit
- ***Strong thermal gradient in the gravel unit*** well marked in the vitrinite data. Biomarker detection limit is exceeded.
- Paleo-temperature in the gravel Unit over 200 °C determined with Raman spectroscopy



Modelling thermal maturity data at Ridge A



Site U1499



Site U1502

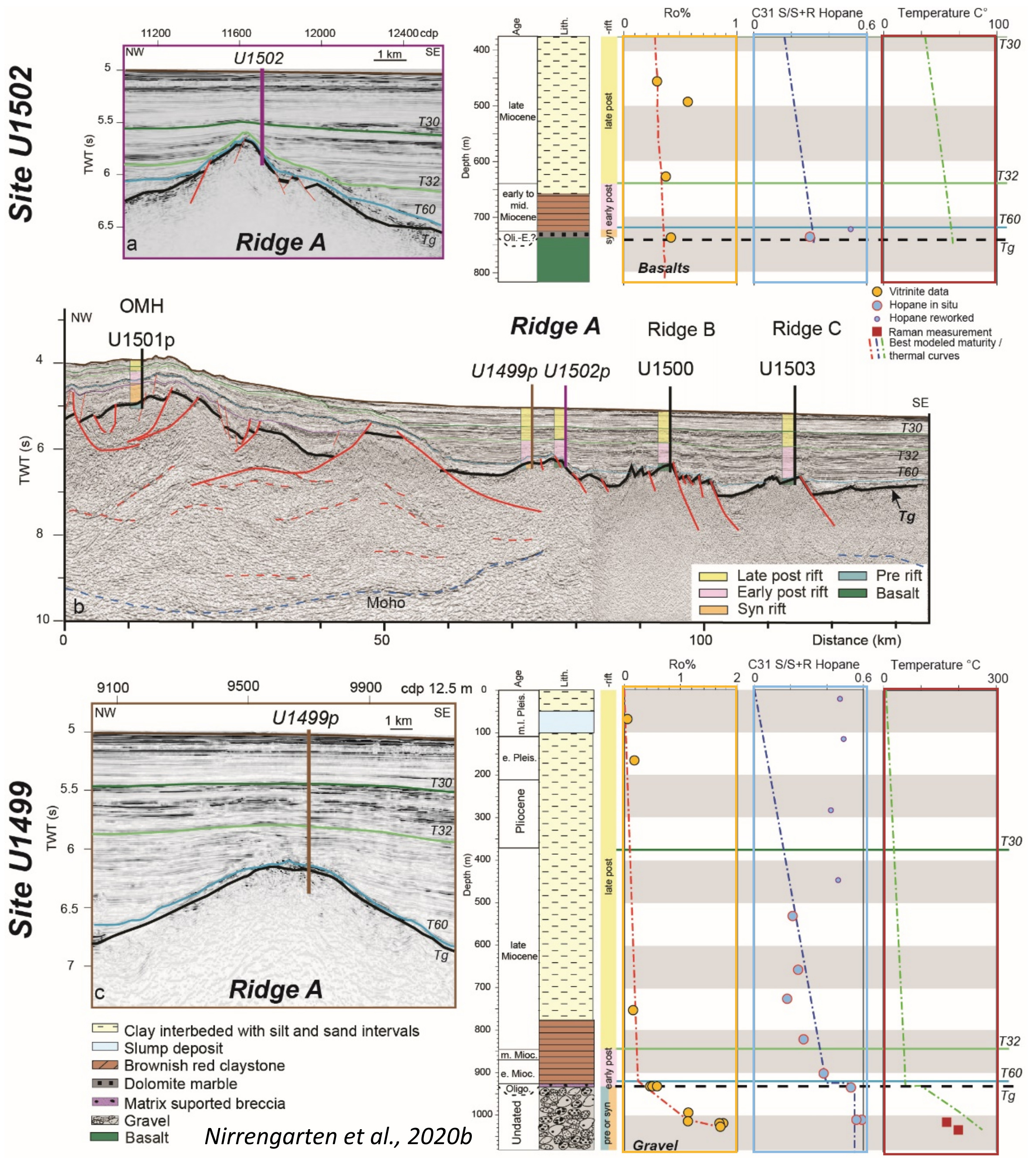
M1: Constant heat-flow

M2: Rifting heat-flow evolution

M3: Introduction of a pre-rift erosion

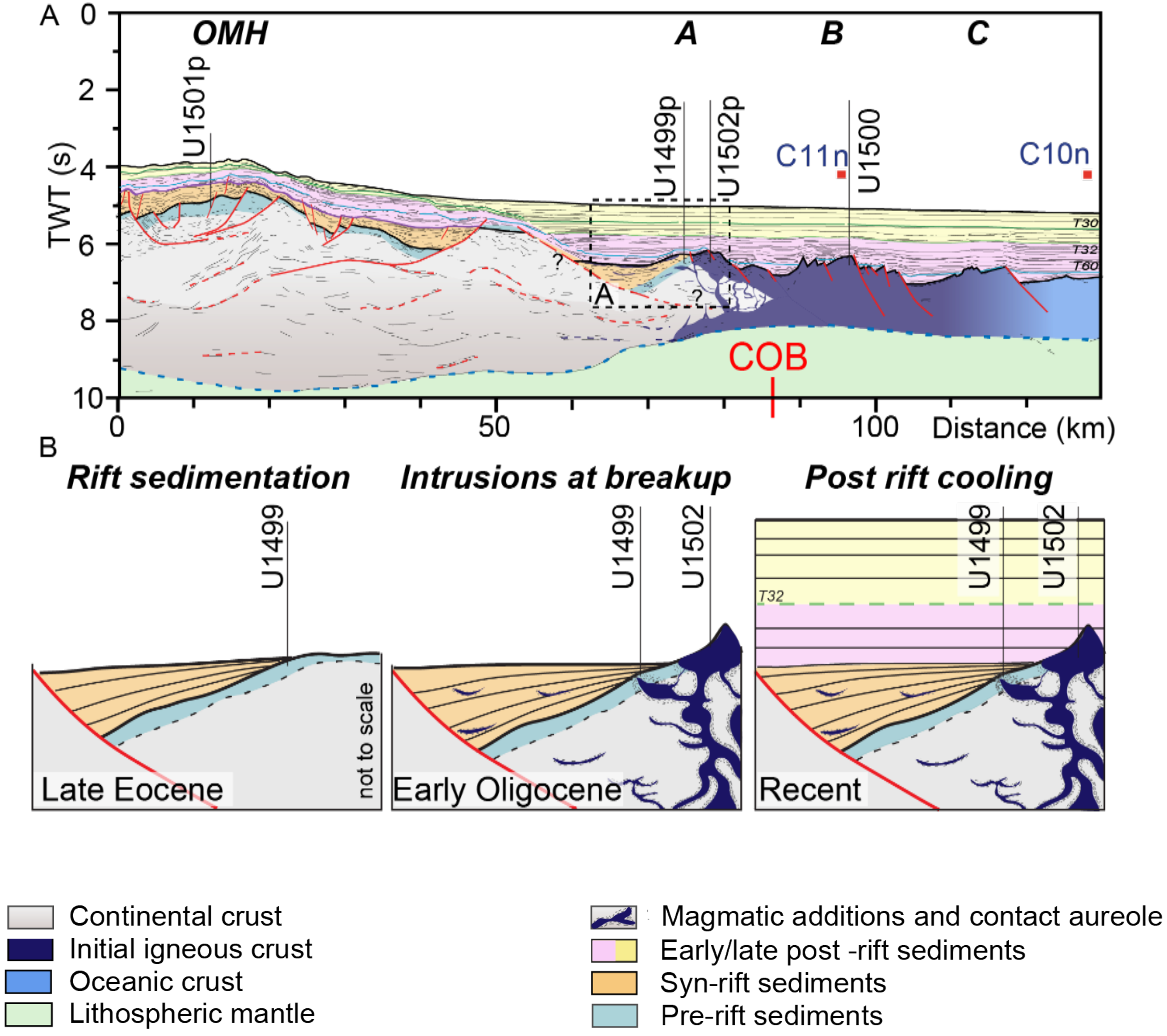
M4: Effect of an intrusion

- To fit the high thermal gradient below the acoustic basement we introduce a magmatic intrusion close to the bottom of the well
- The rifting type heatflow evolution is overprinted by local magmatic intrusion
- The regional thermal pick is not recorded in that case study because the early post-rift burial is low



Thermal and tectonic evolution of Ridge A

Tectonic evolution of Ridge A



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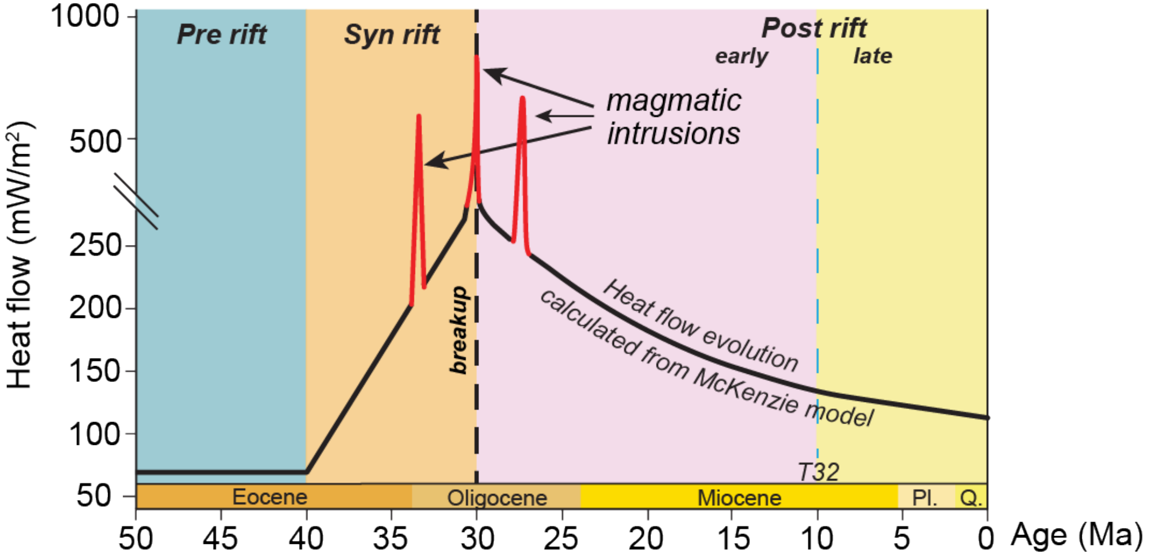
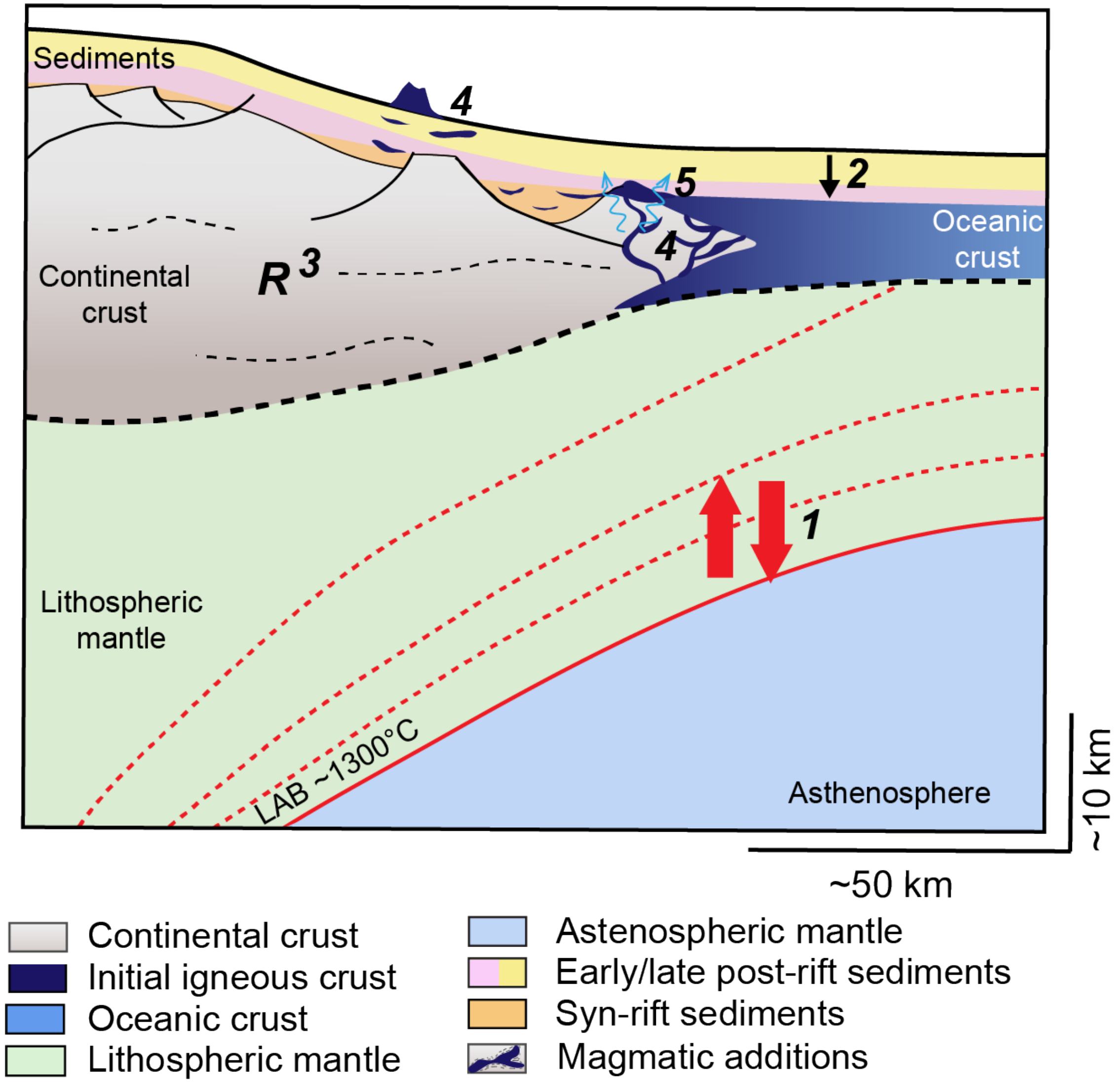
Thermal evolution of Ridge A



A background regional thermal regime plus local pulse linked to magmatic intrusions

Lessons from the SE China margin thermal evolution



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Parameters controlling the thermal evolution

Regional

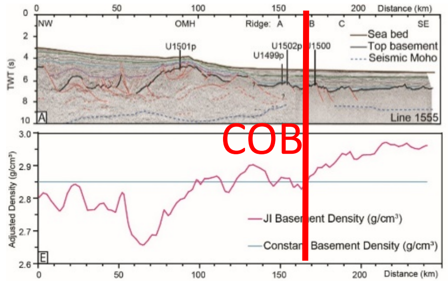
- *1 Mode of thinning*
- *2 Burial*
- *3 Radiogenic heat production*

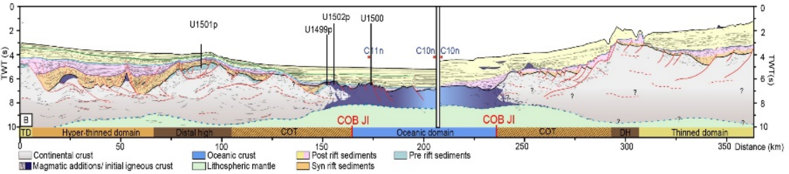
Local

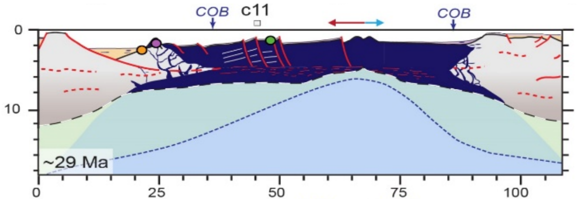
- *4 Syn- and post-rift magmatism*
- *5 Hydrothermal processes*

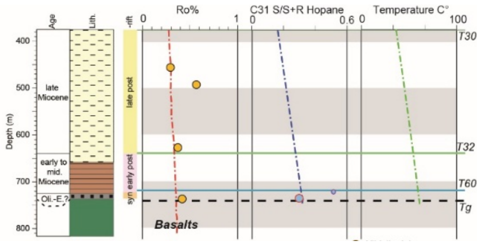
We show that the SCS continent ocean transition is regionally controlled by the position of the isotherms but the numerous magmatic additions and hydrothermal fluid circulations affect heterogeneously the thermal maturity.

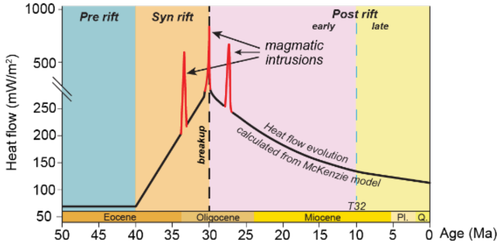
Conclusions











- Definition of clear COB based on geophysical and borehole data, confirmed by 3D gravity anomaly inversion and joint inversion not shown in this presentation
- Description of the rift to drift transition on conjugate sections of the SCS
- Highlight the interaction between tectonic extension and increase of magmatic addition until the stabilization of the spreading ridge
- Determination of the thermal maturity of post, syn and pre rift sequences of a COT
- Highlight the heterogenous thermal evolution of distal domain due to magmatic additions

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