

Tectonic Settings around a Thermogenic Gas Discovery offshore Morocco (Gharb Basin)

Carlos Giraldo¹

Search and Discovery Article #30680 (2024)**

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Abstract

The hydrocarbon exploration campaigns in the Gharb basin, southern east part of the Gulf of Cádiz, have demonstrated the existence of active petroleum systems. This talk summarizes the tectonic setting around a thermogenic gas discovery (Anchois -1X) made in the last decade, and recently confirmed with an appraisal well in 2022.

The Gharb Basin contains stratigraphic sequences, beginning during the syn-rift period (Late Triassic - Lower Jurassic) accompanied by deposition of evaporitic rocks. Following this, a passive margin developed through the Mesozoic to Quaternary. The northern edge is bounded by the alpine belt, associated with the collision between the Eurasian and African plates. This geodynamic scenario includes an attenuated continental crust that has been stretched during the breakup of Pangea.

The two exploration wells are located along the Moroccan slope, immediately to the south of the Larache mud volcano field. Miocene deepwater sands are the primary reservoir targets for exploration wells. The structural deformations around this gas accumulation appear to lie above an allochthonous salt layer (salt canopy) possibly emplaced during the early Miocene. The remobilization of evaporites from the Pliocene to the recent could be responsible for the extensional deformations, as well as the anticlines, and associated mini basins located above the salt canopy.

Several organic-rich intervals, ranging from the Jurassic to the Cretaceous, are considered potential source rocks for the gas trapped in the Miocene sands. Further studies are needed to establish the timing of generation and migration through Mesozoic and Tertiary sediments. Also, a detailed study of the tectonic evolution of the basin is required to minimize the uncertainty related to the age of the prospective structures. This will allow a better estimation of geological risks of the prospects that would be drilled in the future.

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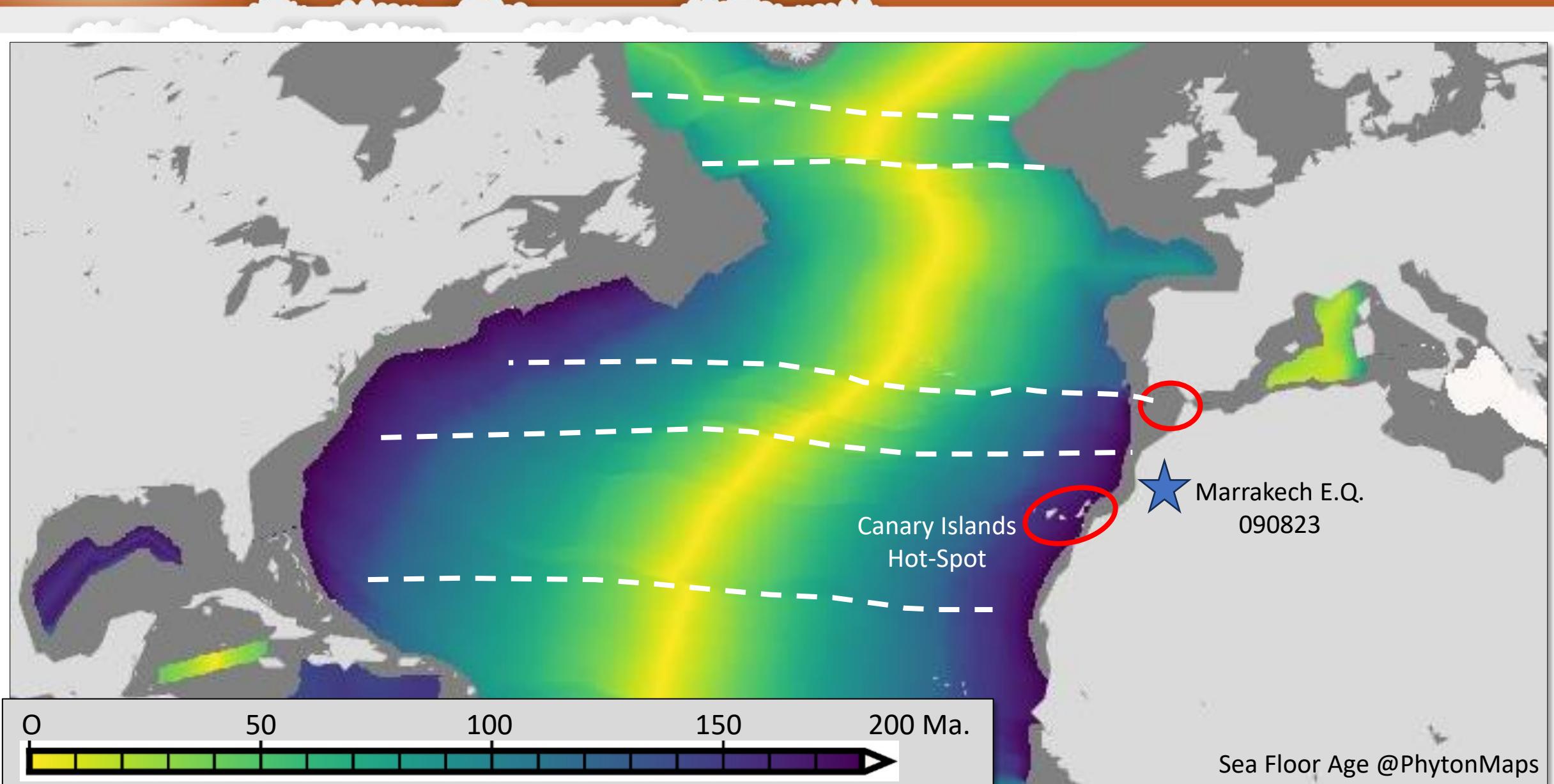
TECTONIC SETTINGS AROUND A THERMOGENIC GAS DISCOVERY OFFSHORE MOROCCO

*Carlos Giraldo
U3 Explore*

AGENDA

1. Introduction
2. Regional setting
3. Seismic sections
4. Discussion

Ocean-floor Age



190 Ma. Reconstruction (Lw. Jurassic)

American plate lithosphere

★ Thermogenic Gas Discovery

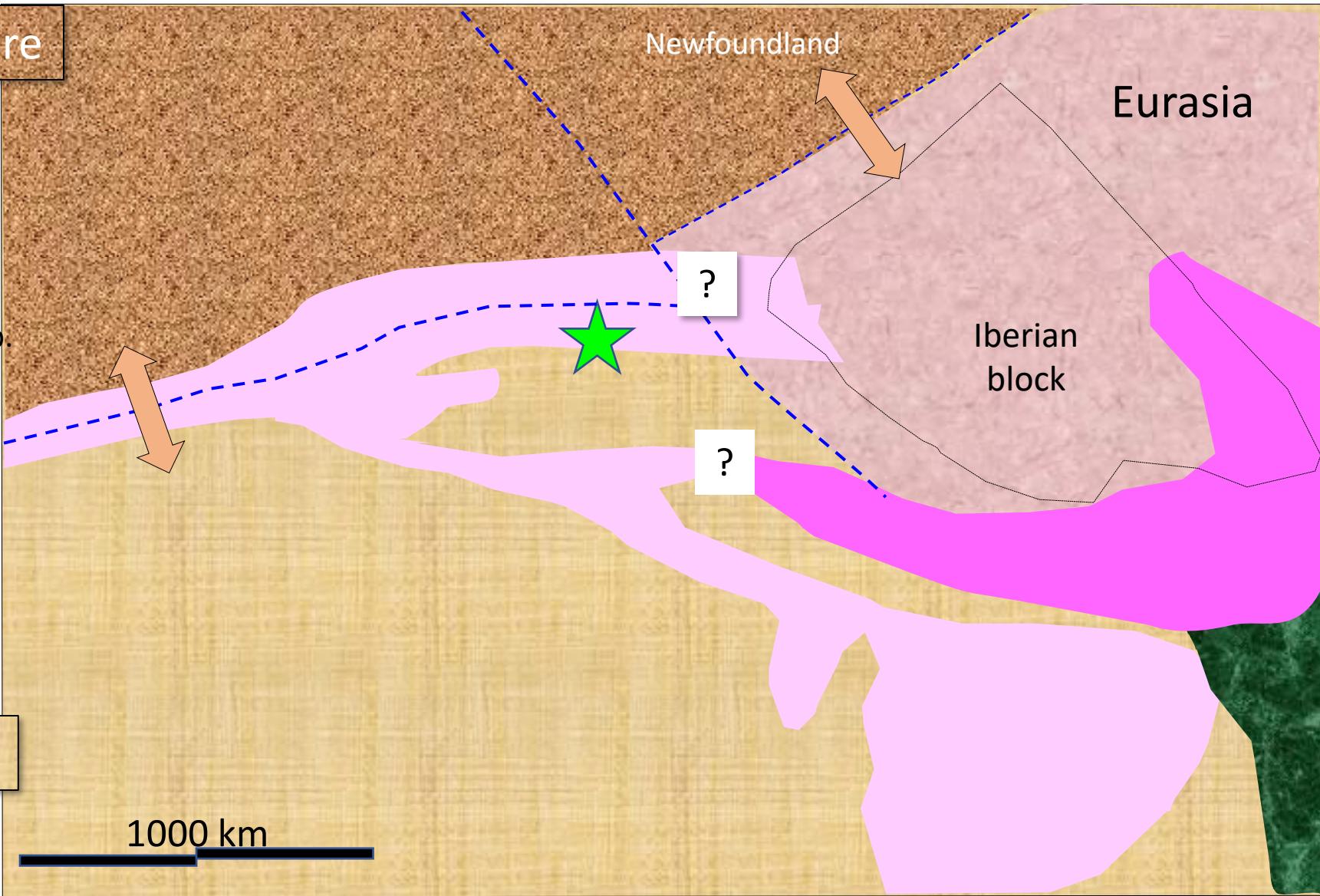
Aprox. distribution L. Tr - Lw. Jr. Evap.

Keuper salt

Tethys oceanic crust

African lithosphere

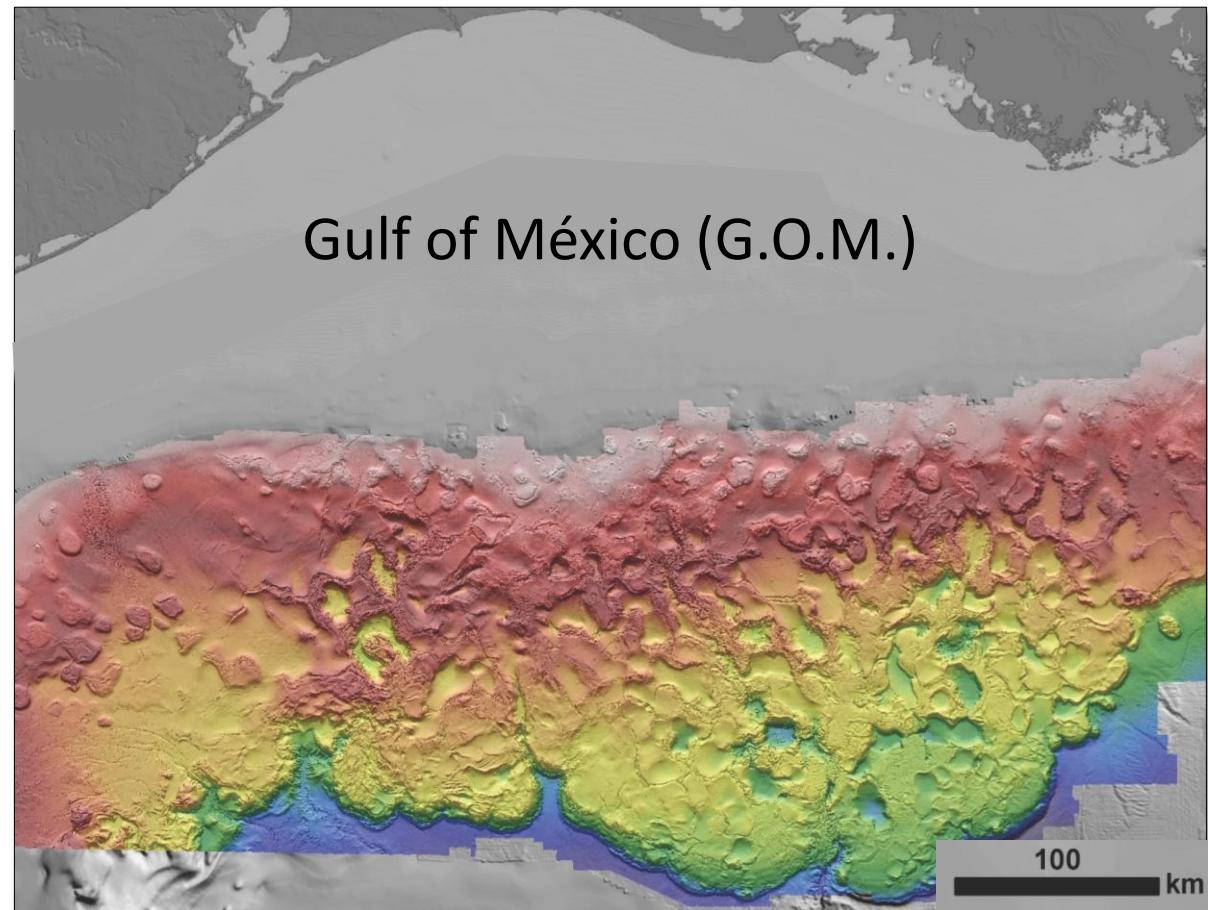
Mod. after Soto et al. (2017)



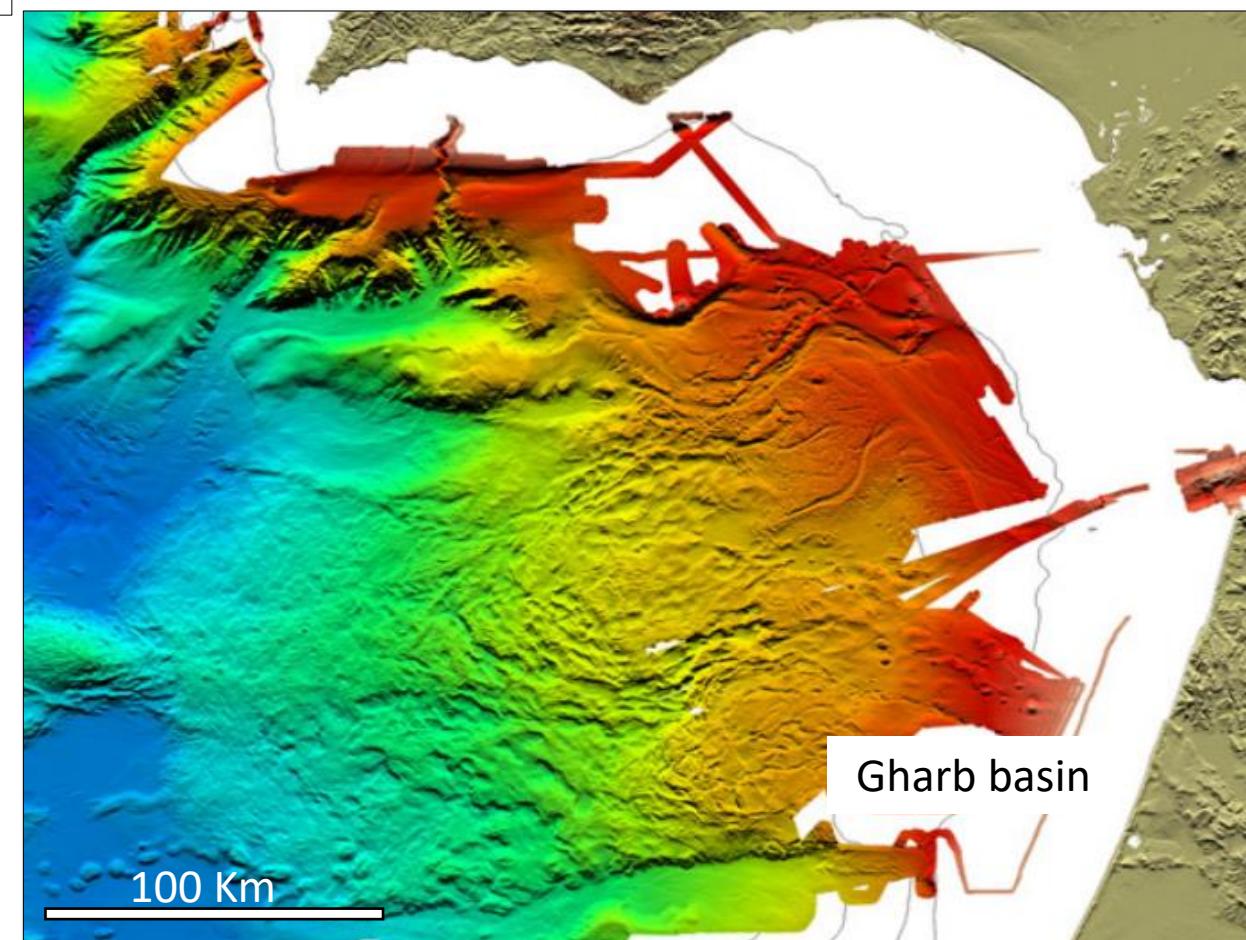
Salt-driven geomorphology

<https://www.boem.gov/oil-gas-energy/mapping-and-data/map-gallery/northern-gom-deepwater-bathymetry-grid-3d-seismic>

Gulf of México (G.O.M.)

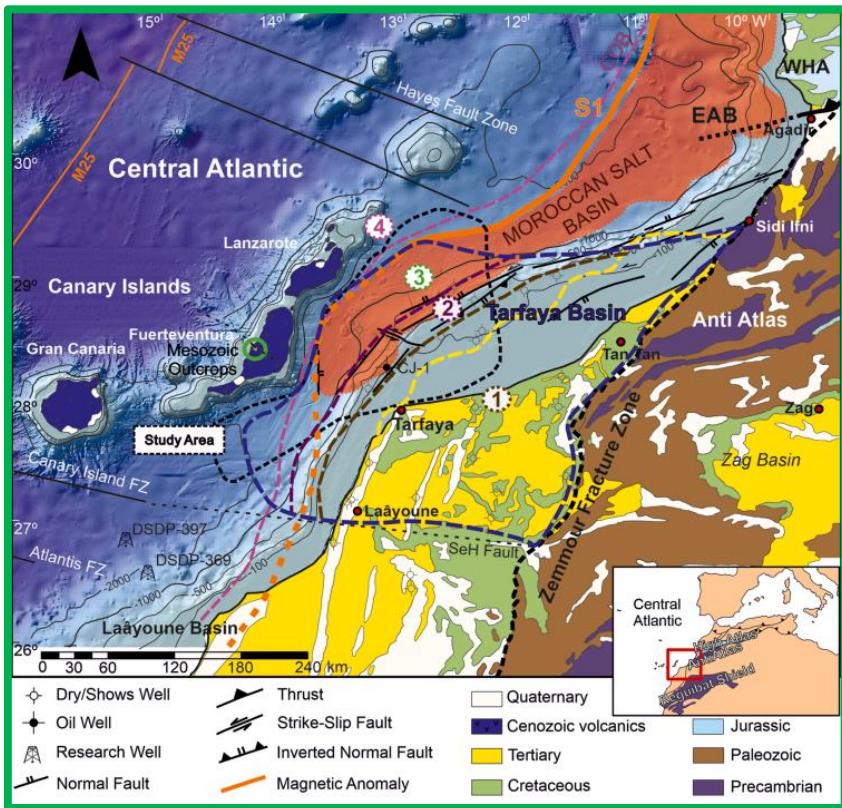


Gulf of Cádiz (G.O.C.)

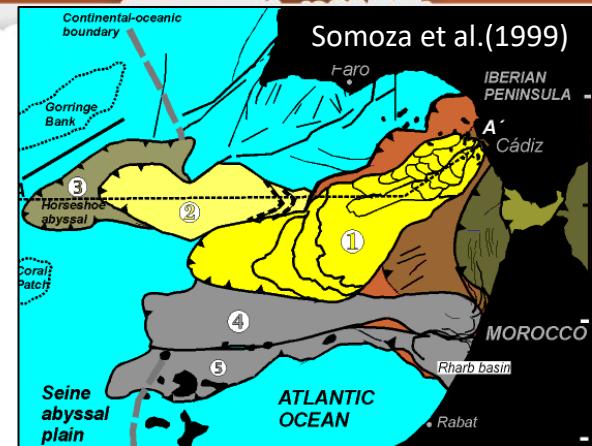


Zitellini et al. (2009)

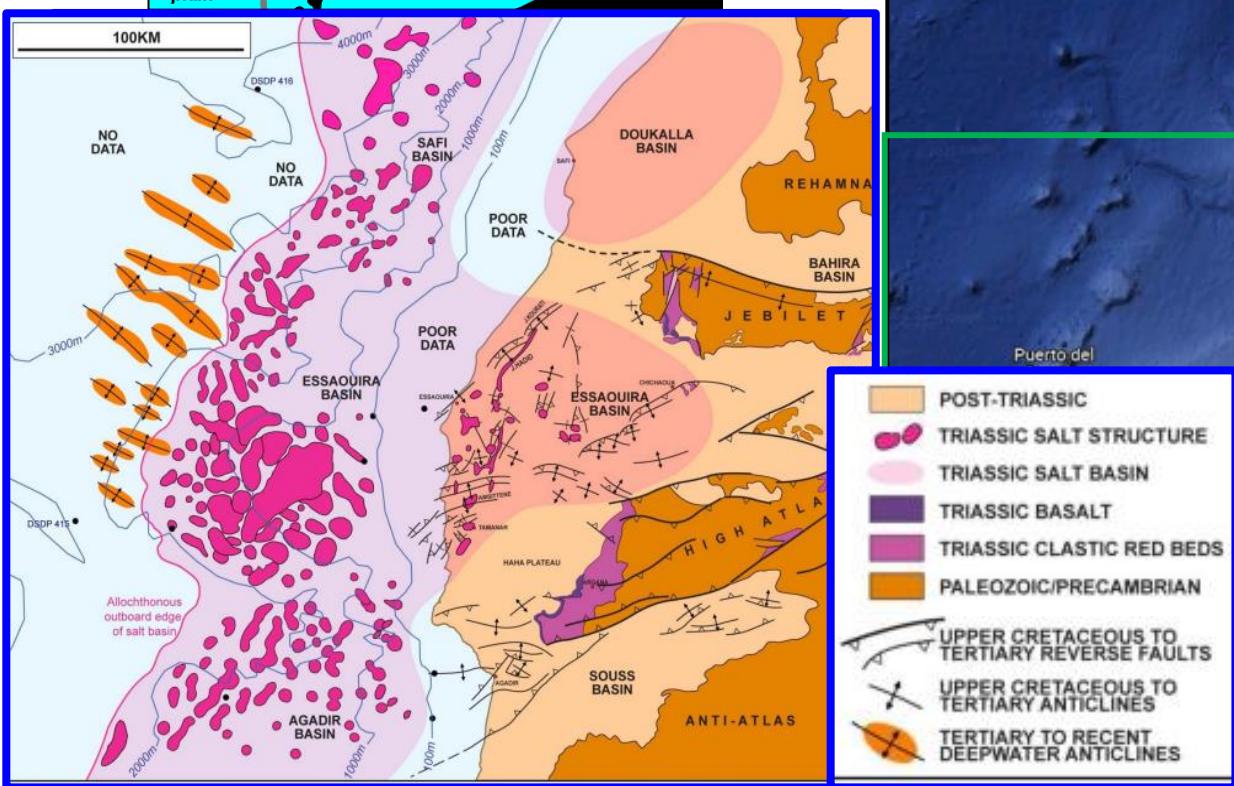
Salt Tectonics Bibliography



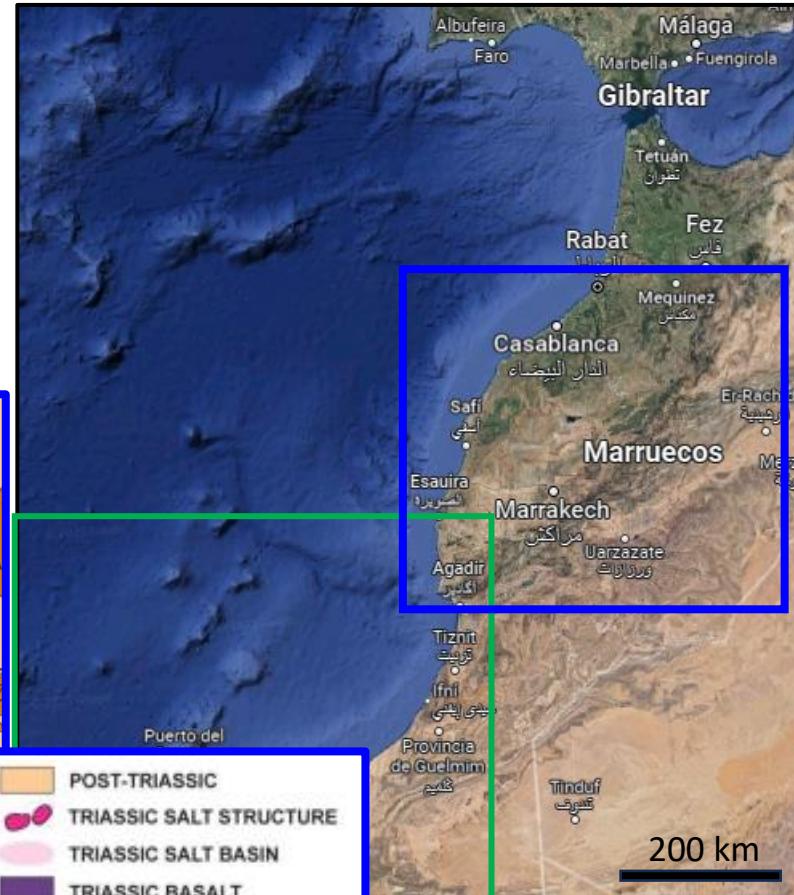
Uranga et al. (2022)



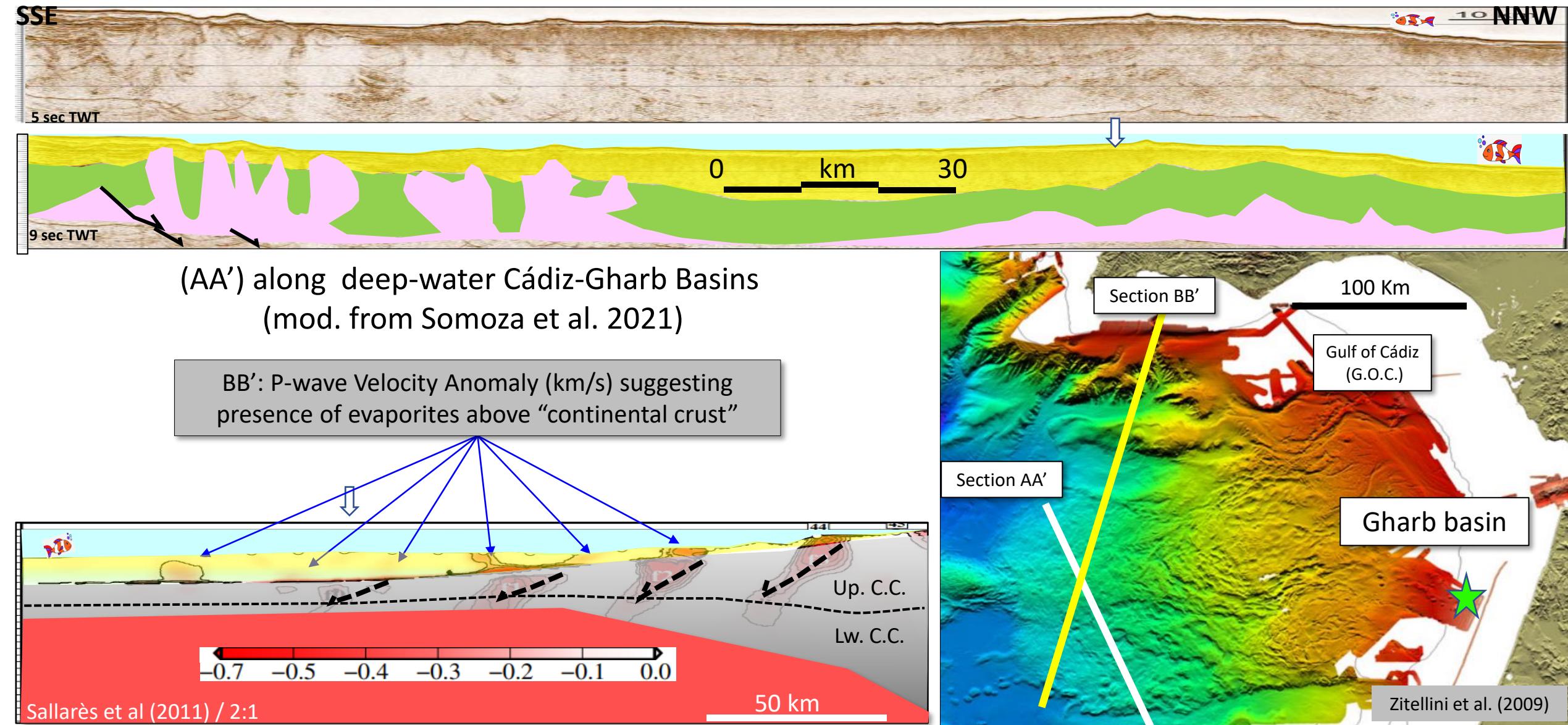
Somoza et al.(1999)



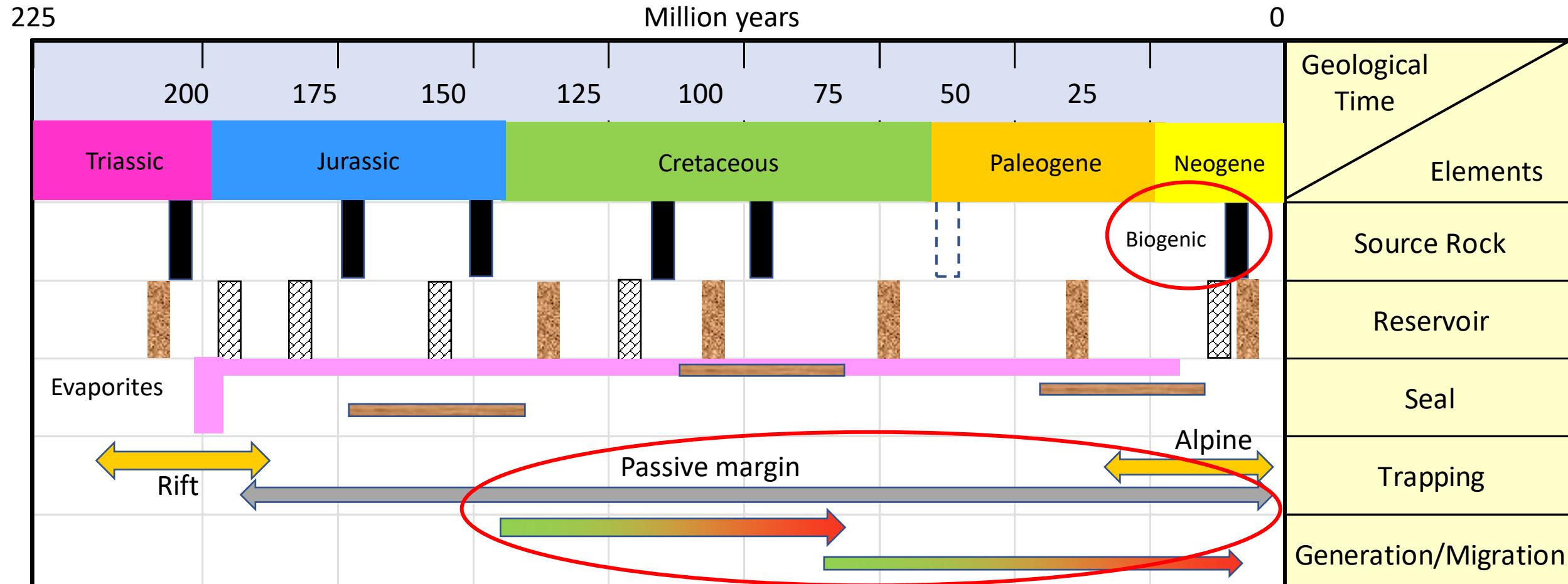
Tari and Hadour (2011)



Jurassic evaporites

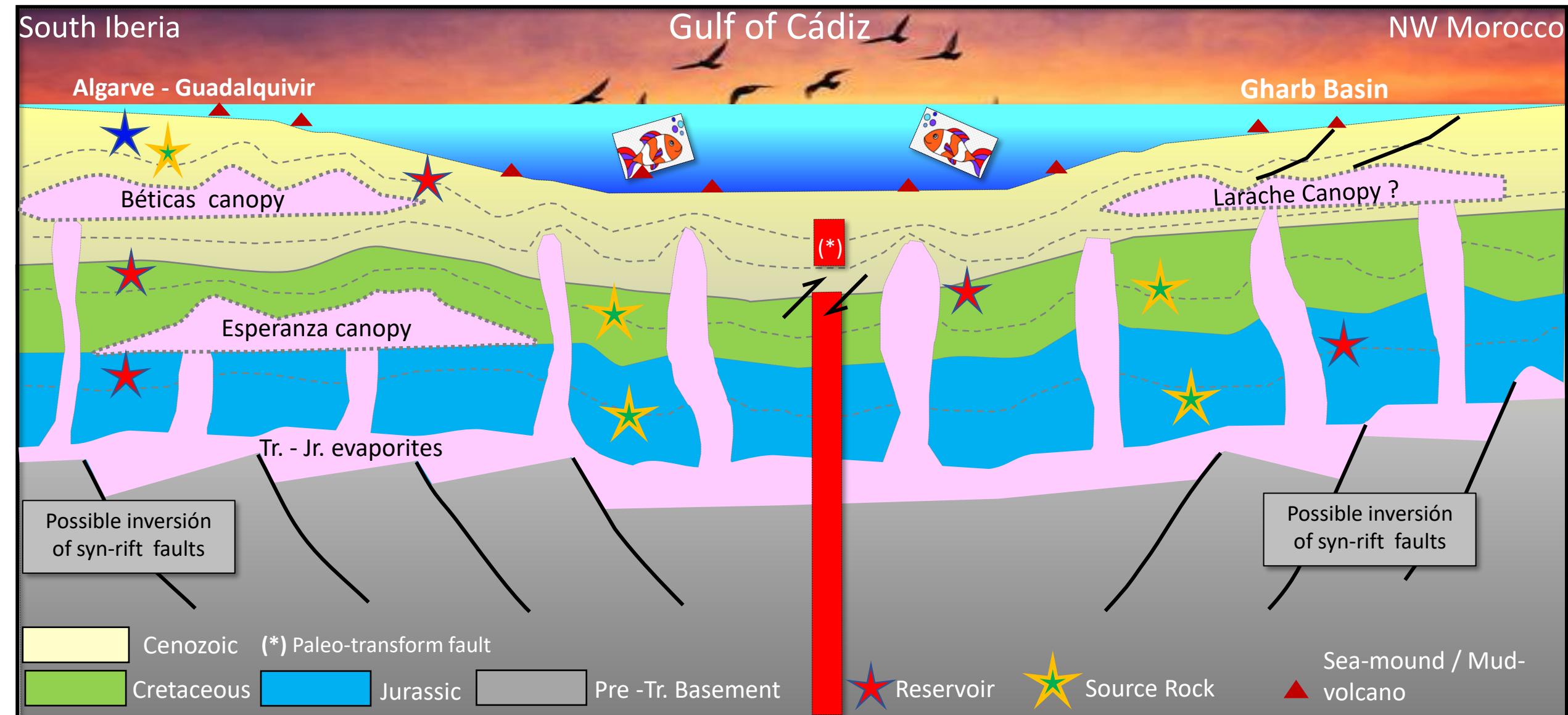


Petroleum System Elements Chart



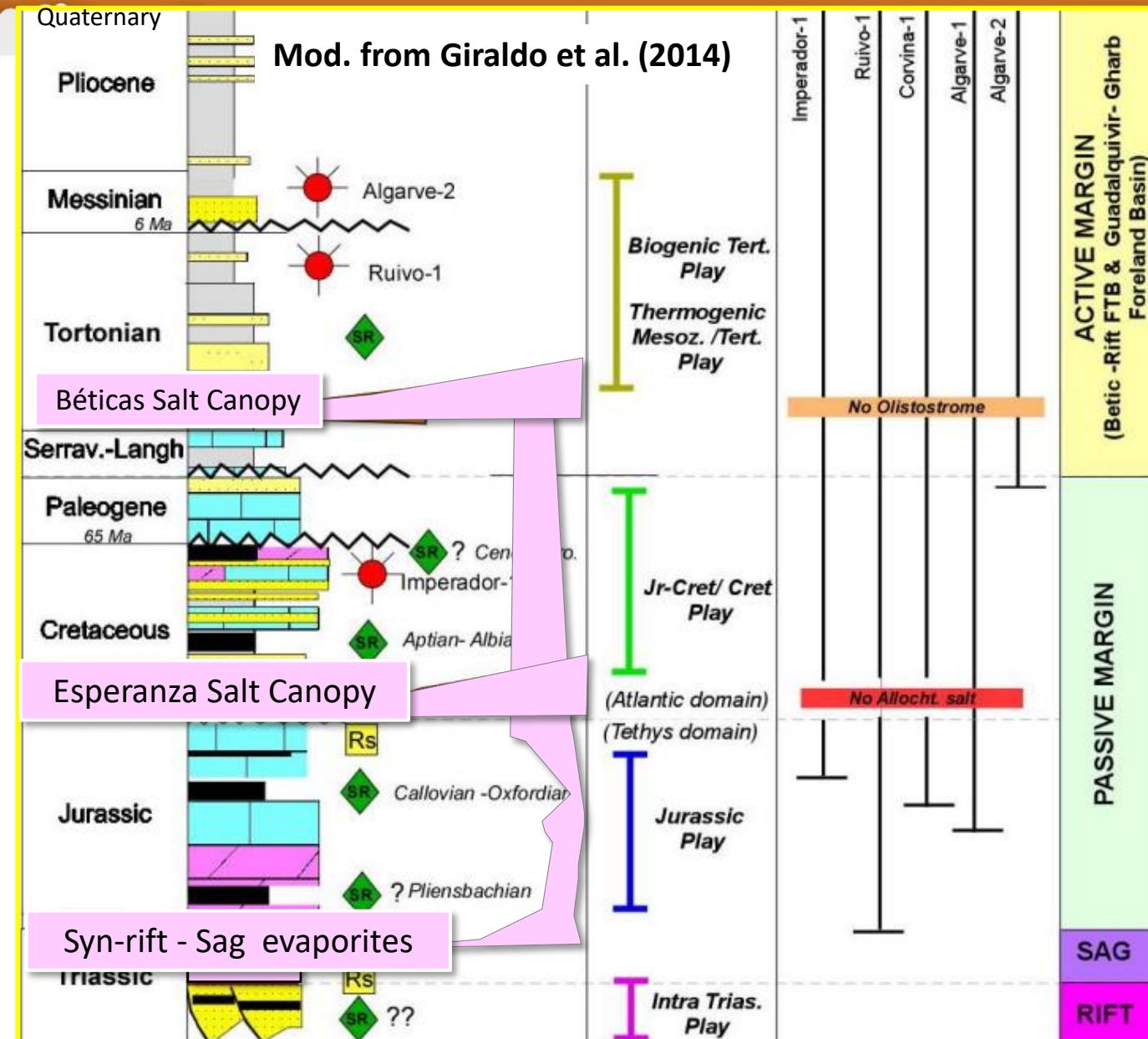
Giraldo et al.(2014)

Play cross - section



Petroleum Systems Elements

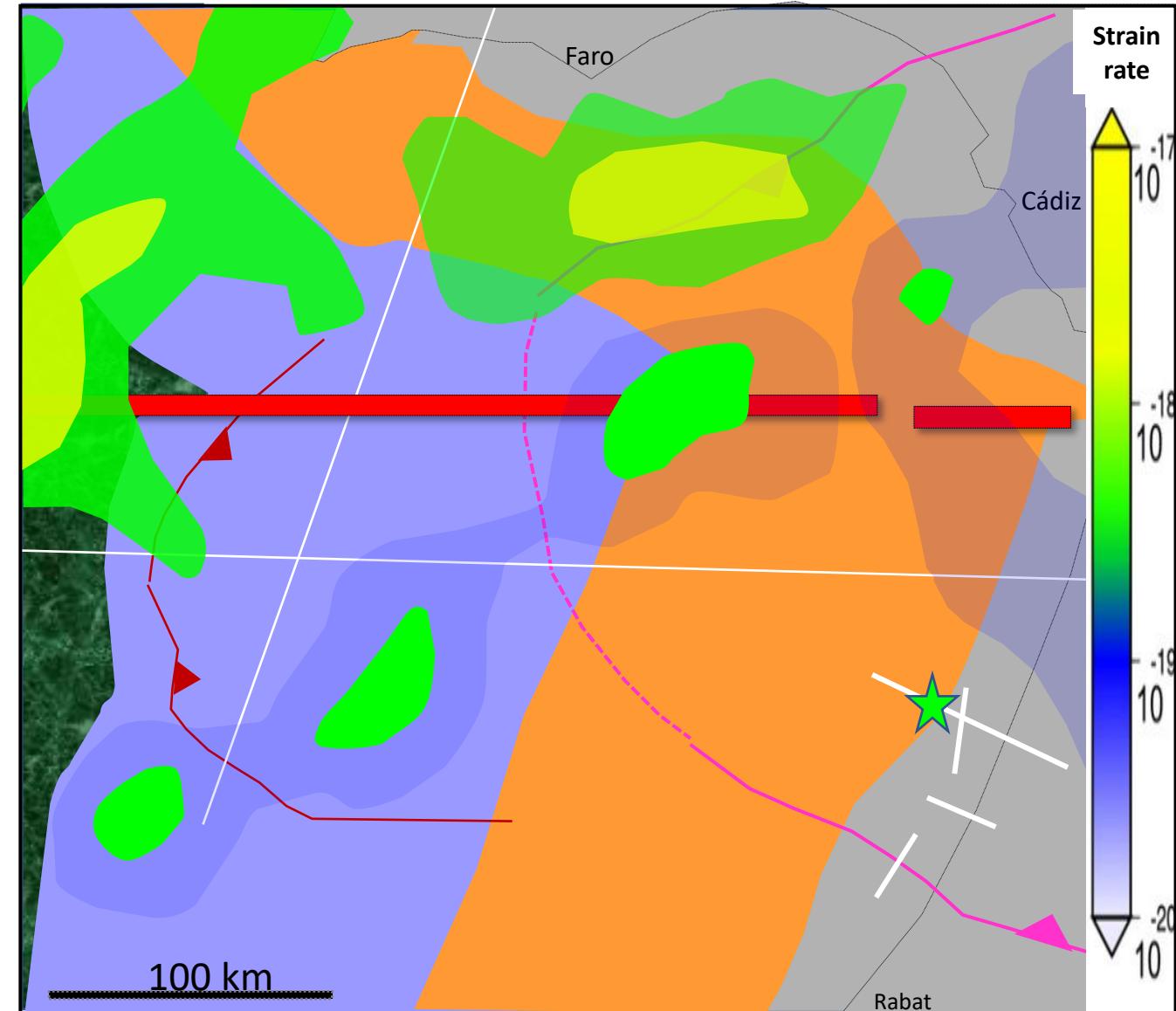
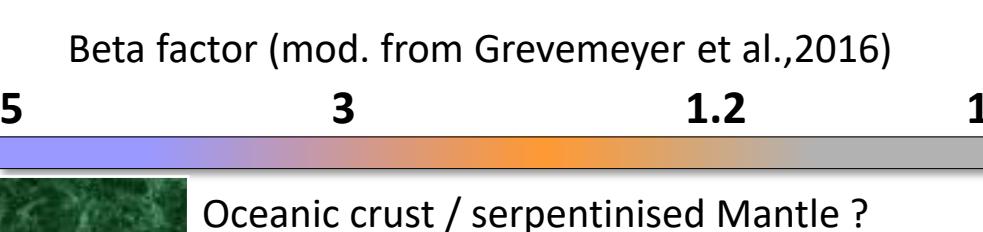
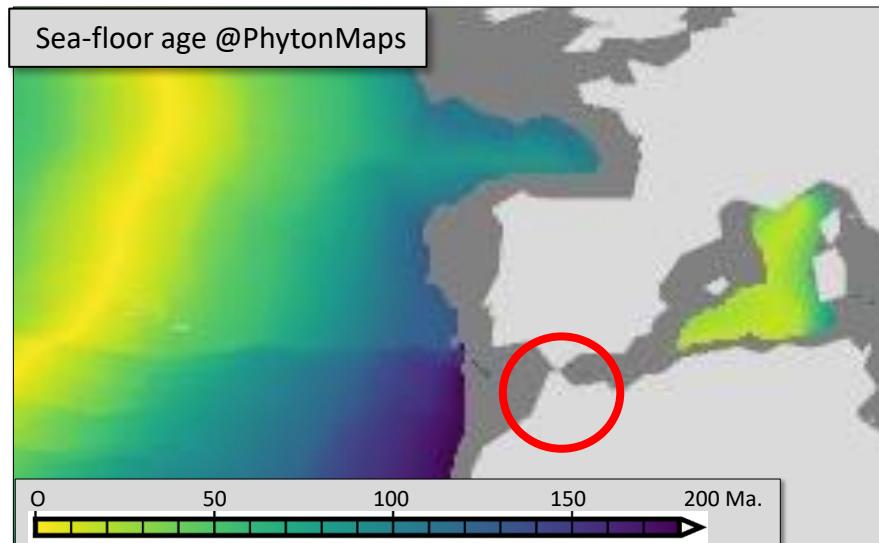
June 2023 (Gas blow-out
while drilling a
water-well / 4 months)



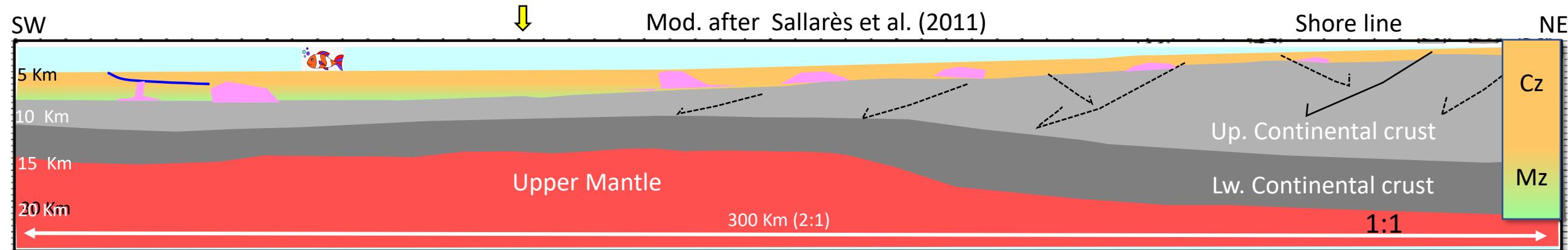
Strain rate deformation & Hyperextension

Strain rate deformation after seismicity
(Zitellini et al., 2009)

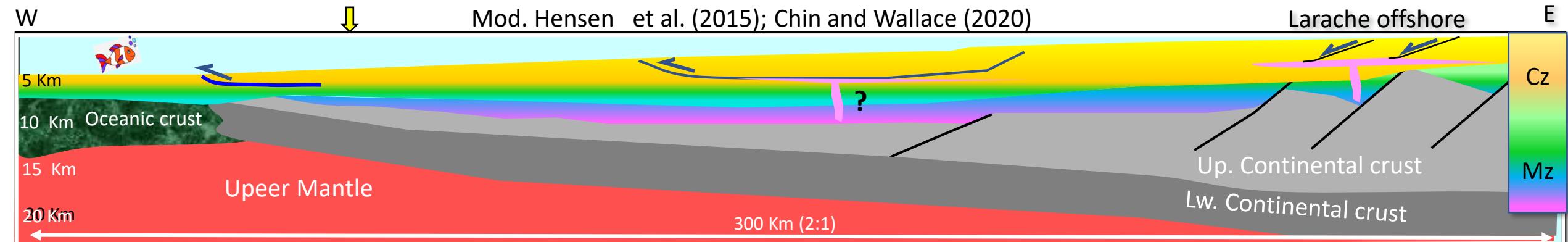
Analogy: Seismicity induced by Evaporites-Sediments
interaction / G.O.M.
(Gangopadhyay and Sen, 2008)



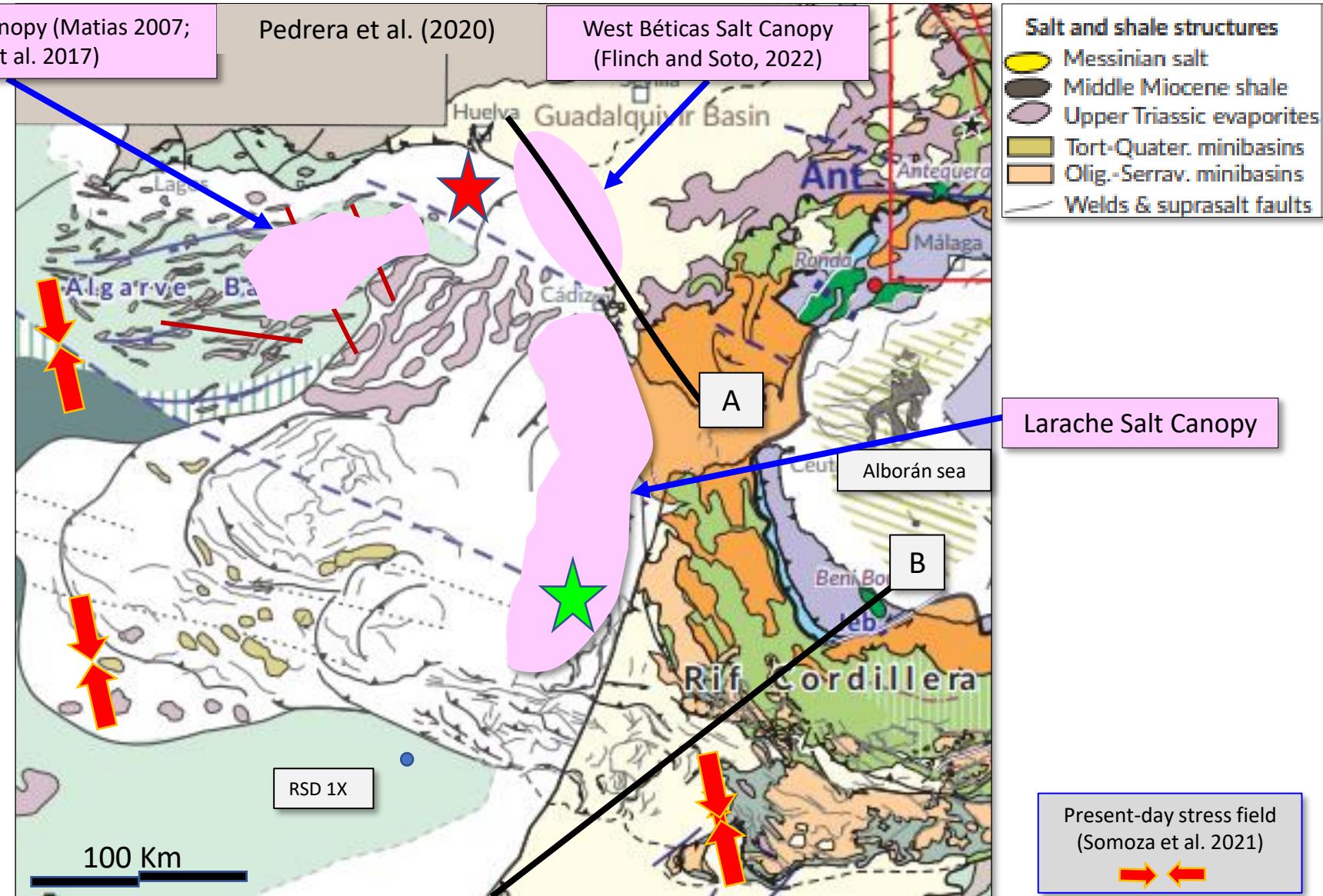
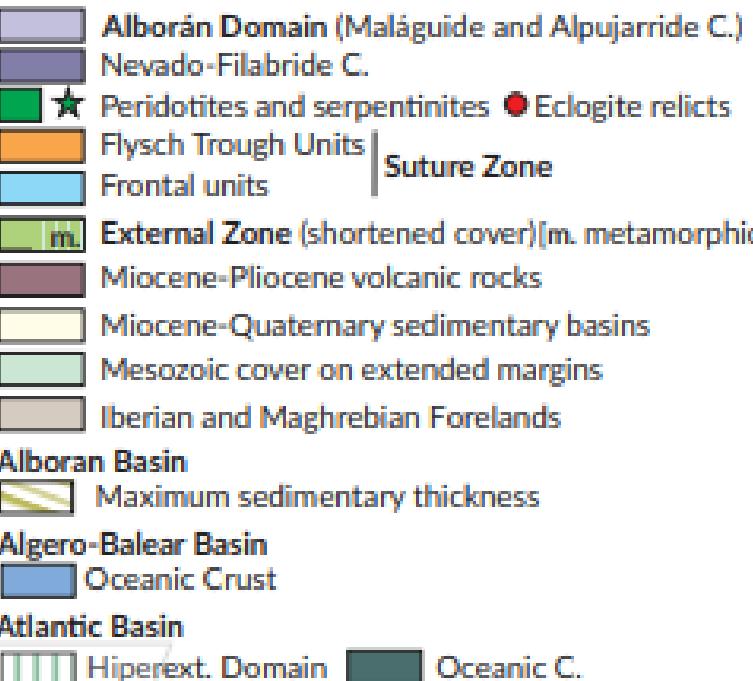
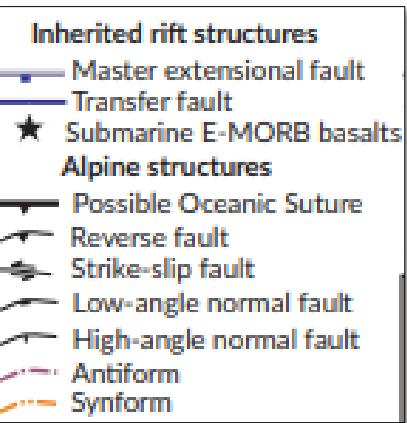
Regional cross-sections



Late Triassic – Lower Jurassic evaporites: Above an attenuated continental crust 😊



Regional setting

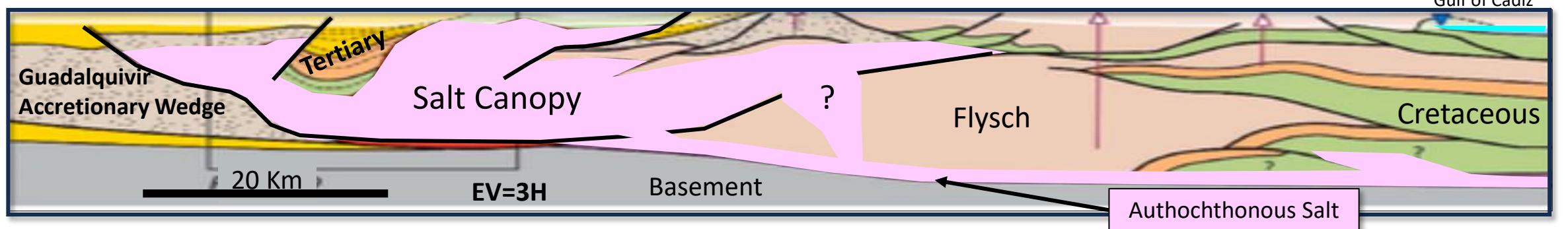


Regional x-sections (Spain and Morocco)

NW

Section A across West Béticas (mod. after Flinch and Soto, 2022)

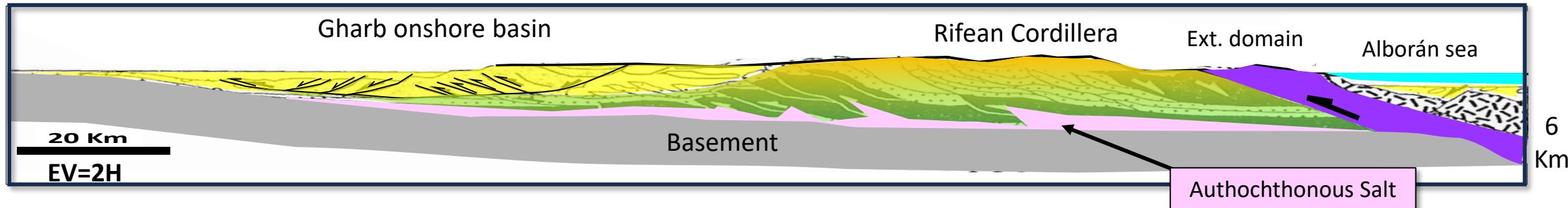
SE



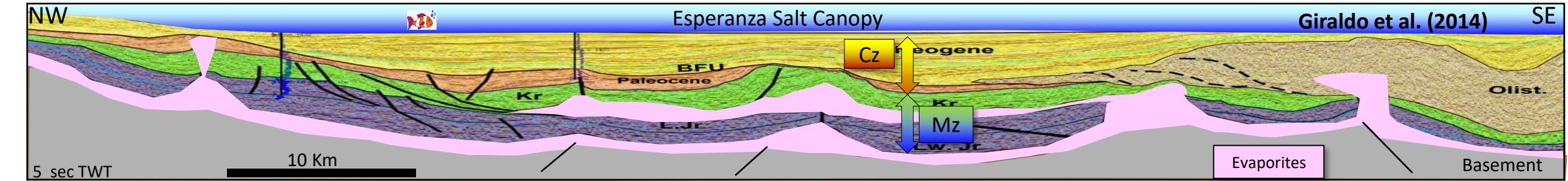
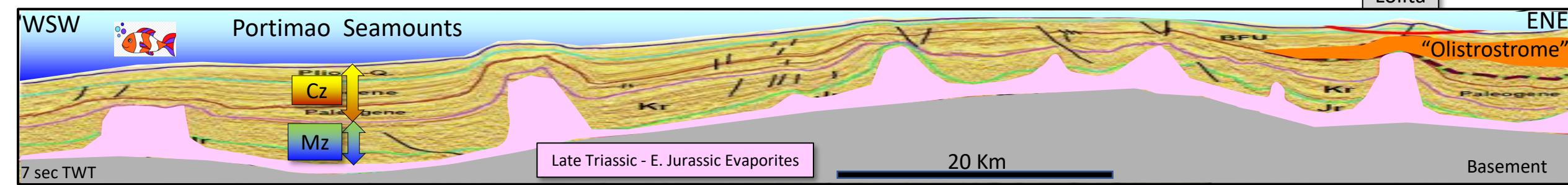
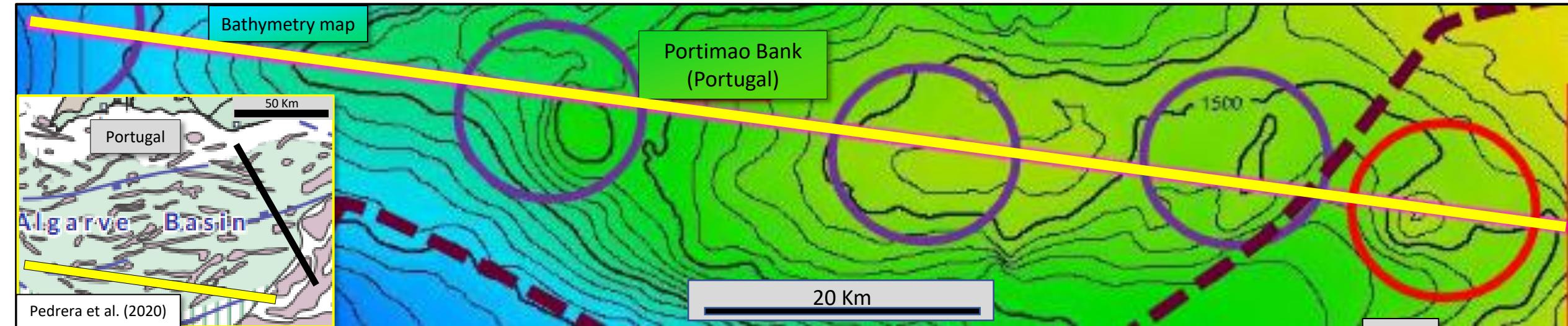
SW

Section B across Rifean cordillera (mod. after Flinch, 1996)

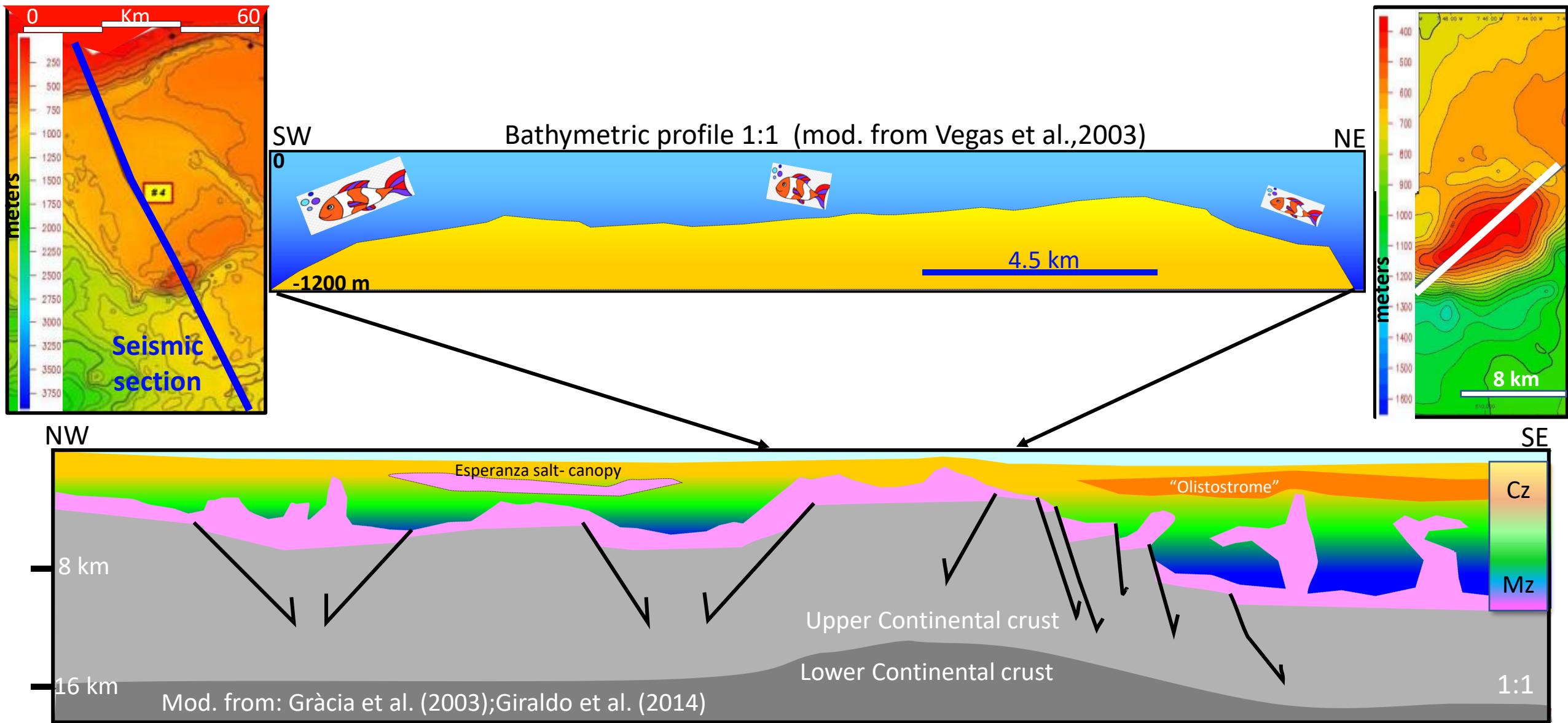
NE



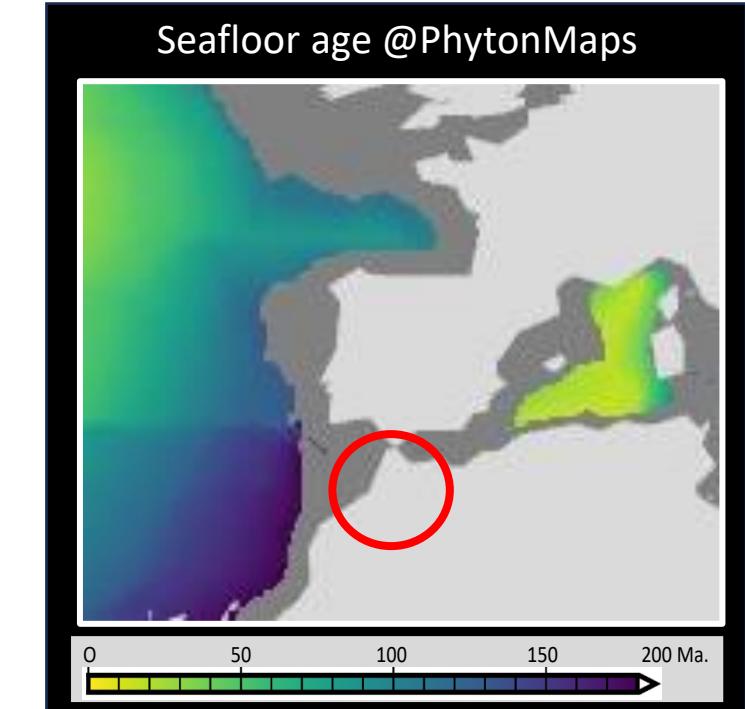
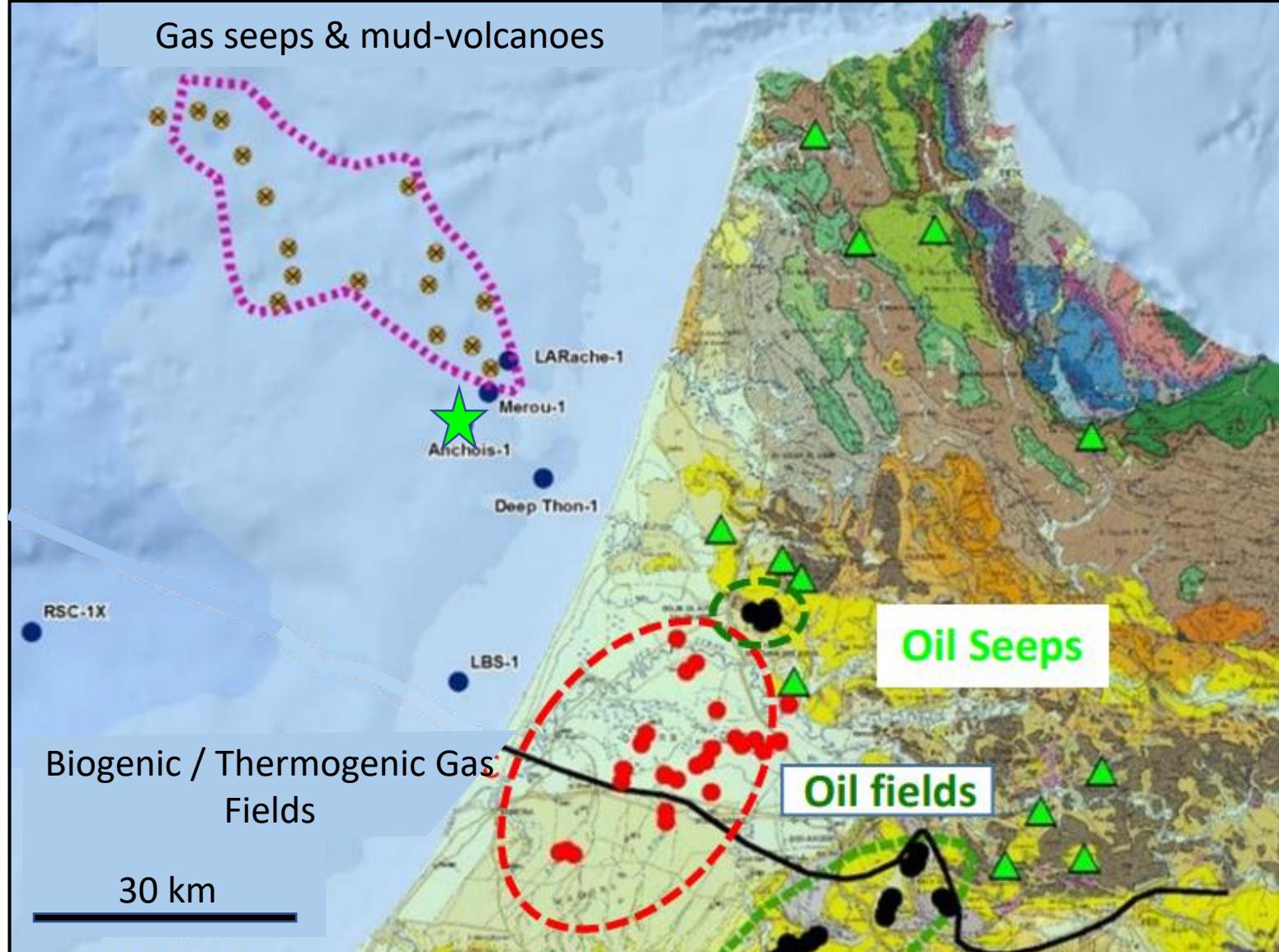
X-sections along Algarve (S. Portugal)



Guadalquivir Bank

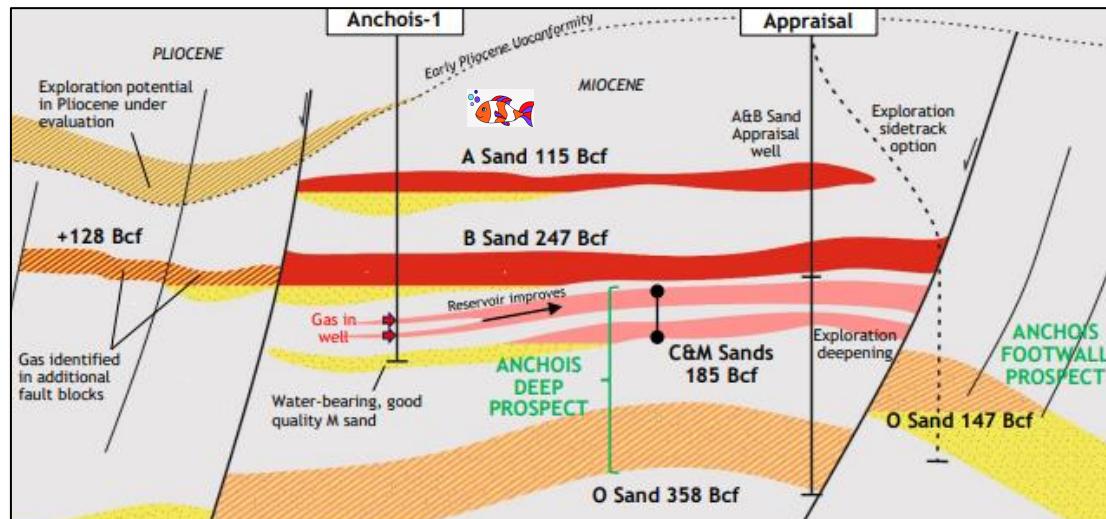


Thermogenic Gas discovery



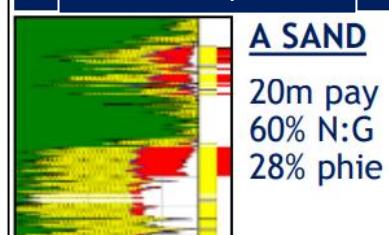
OHNYM (2016)

Deep-water Miocene Reservoirs

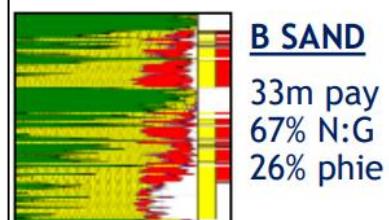


https://www.chariotenergygroup.com/wp-content/uploads/2021/09/Proactive-Presentation_14.1.21_Chariot-Oil-Gas-Limited.pdf

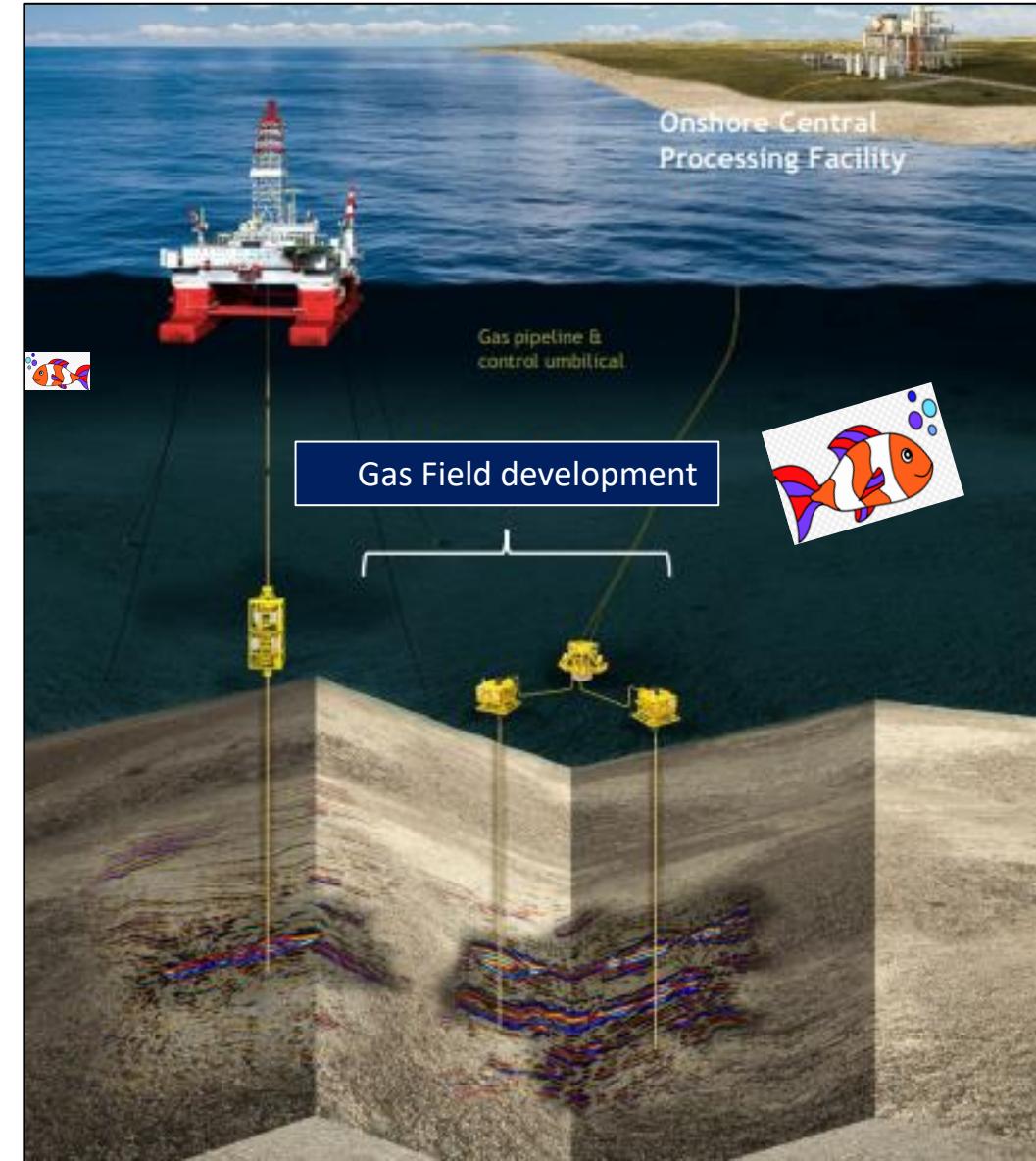
Discovery Well



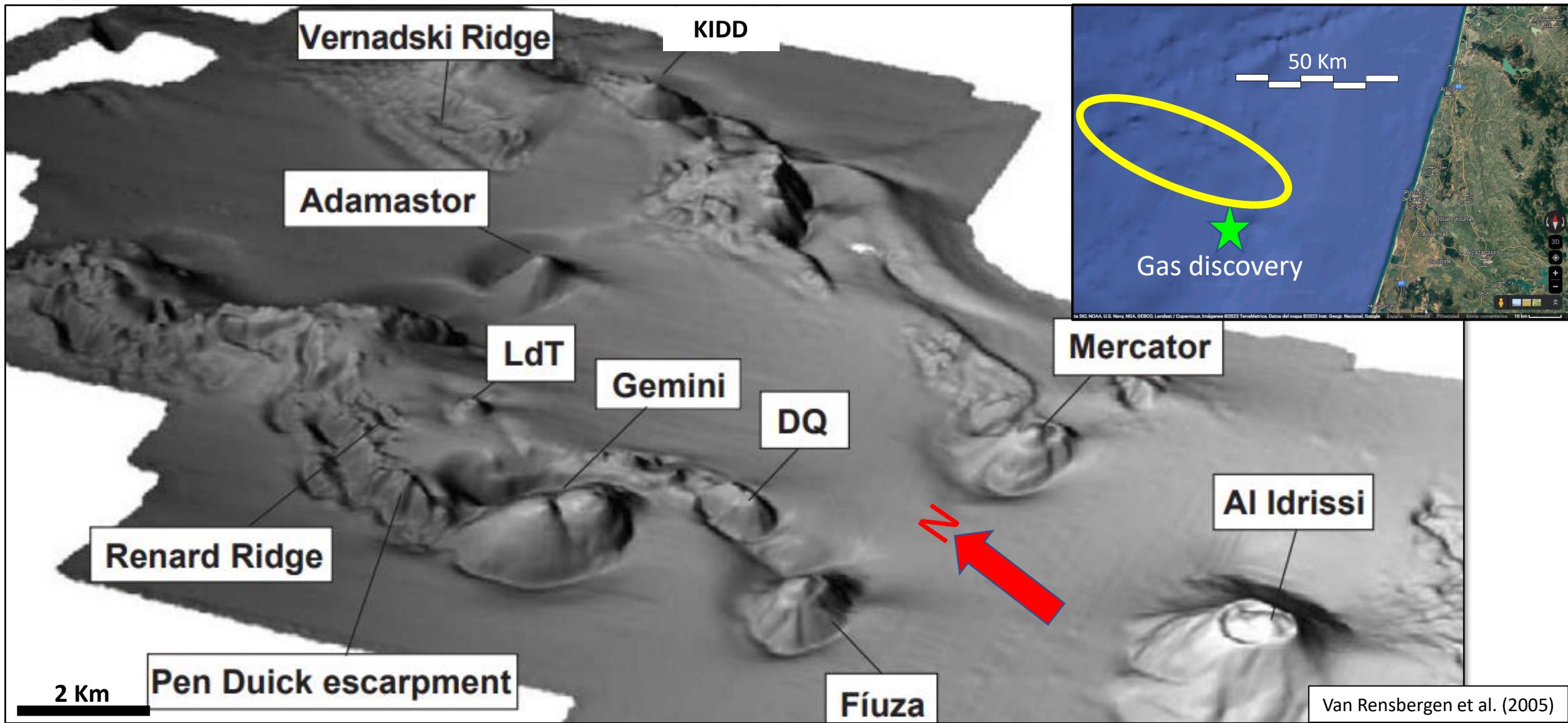
- Excellent reservoir confirmed by log data and cores
- Dry gas with no CO₂ or H₂S



Gas across several reservoirs with approx. 150 m net pay.



El Arraiche Mud-volcano field



Halokinesis & Mud-volcanism

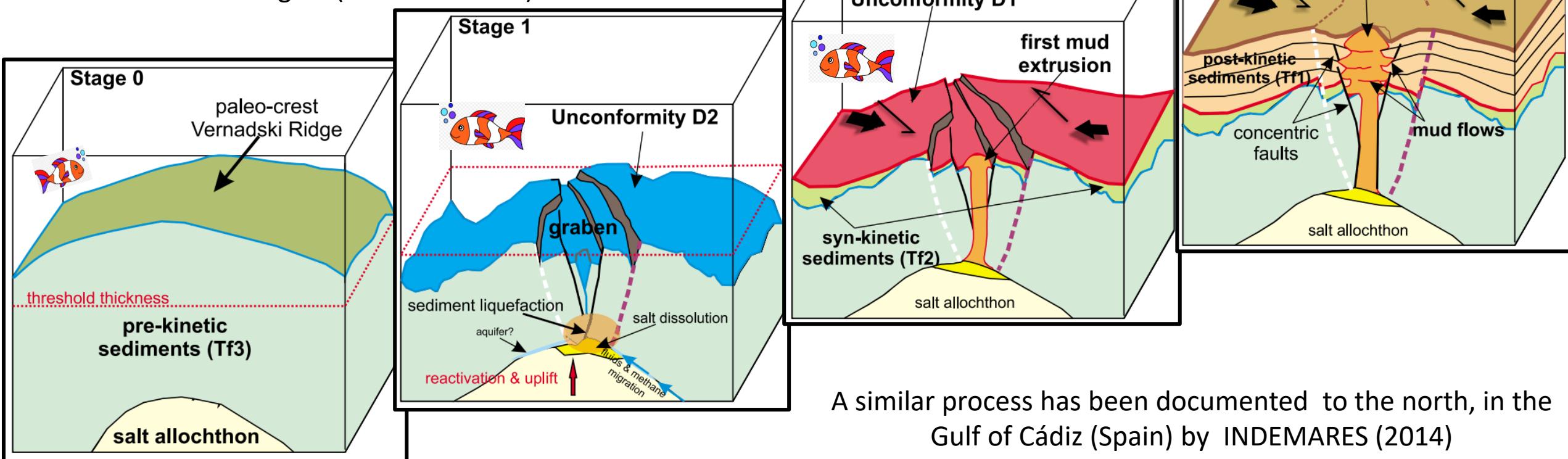
Mercator Mud-volcano (Pérez - García et al., 2011)

Stage 0 (initial conditions),

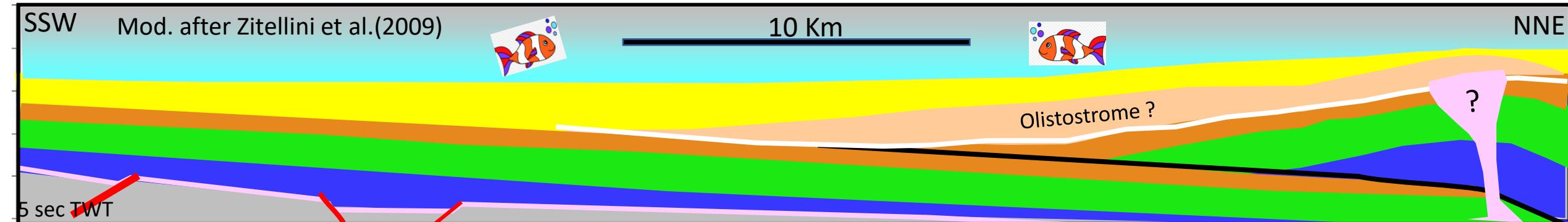
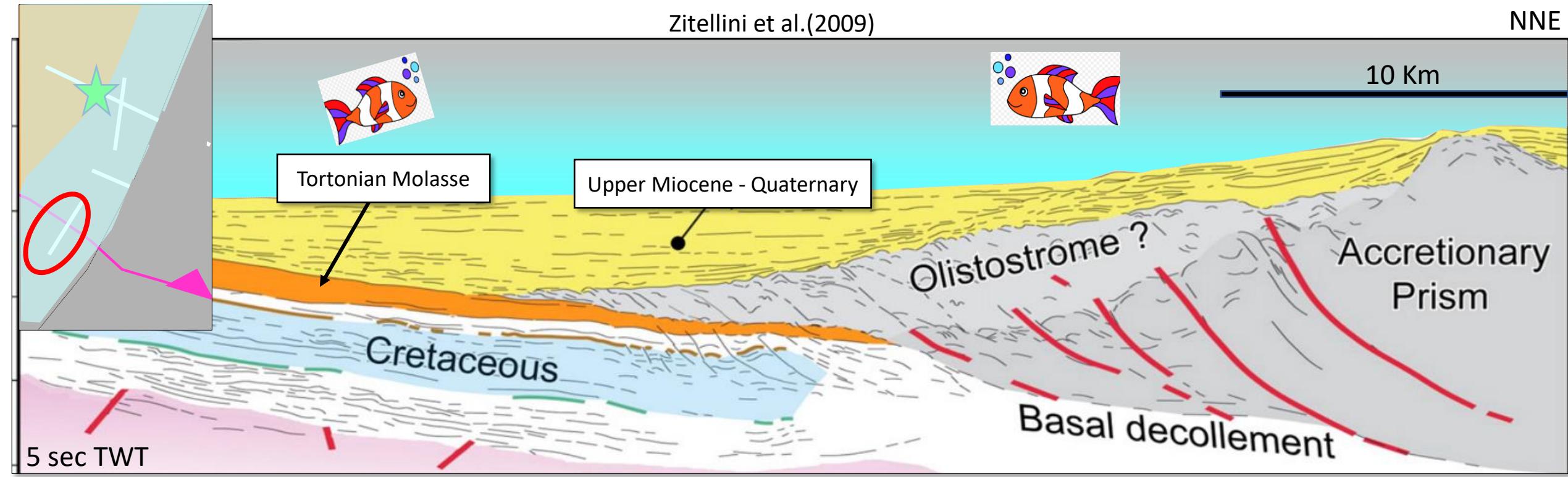
Stage 1 (reactivation of halokinesis),

Stage 2 (synkinematic mud formation), and

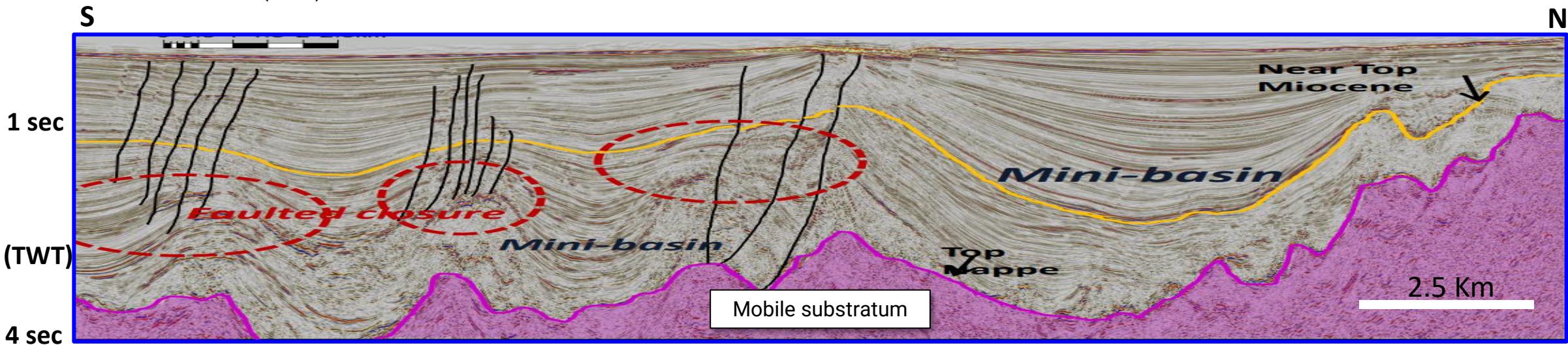
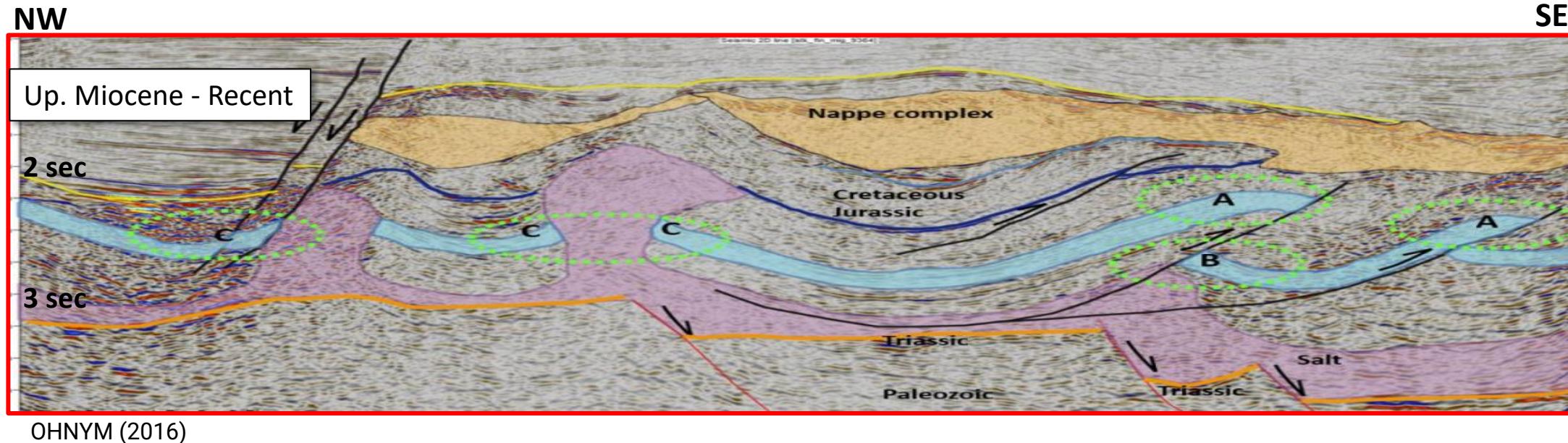
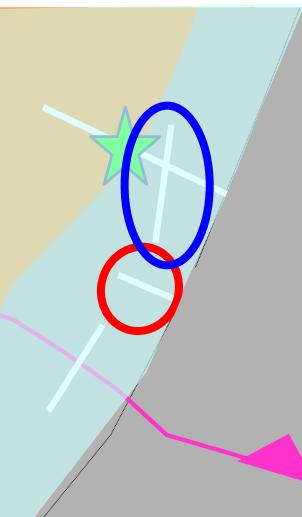
Stage 3 (mud volcanism).



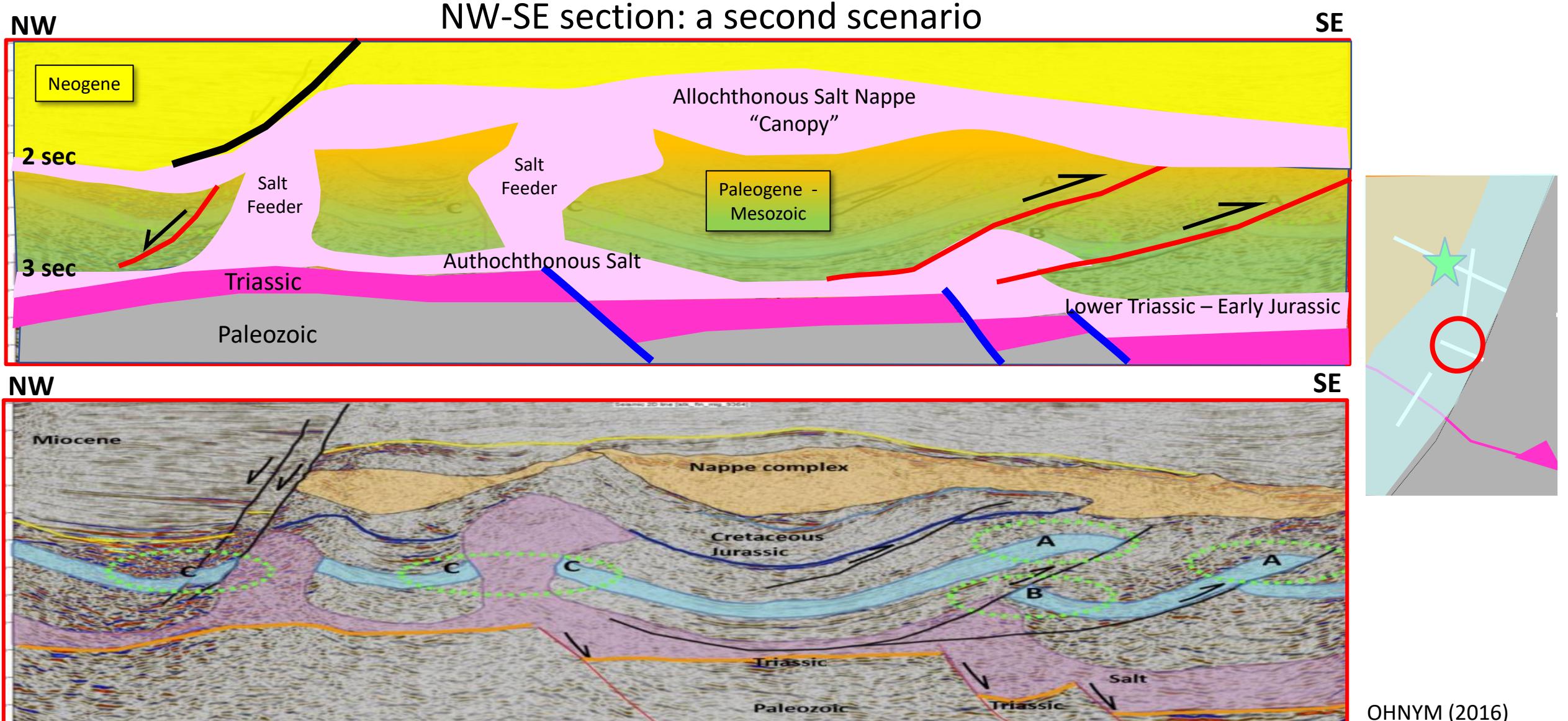
NNE-SSW cross-section



Sections to W & SW of discovery well



Halokinesis along Gharb Basin

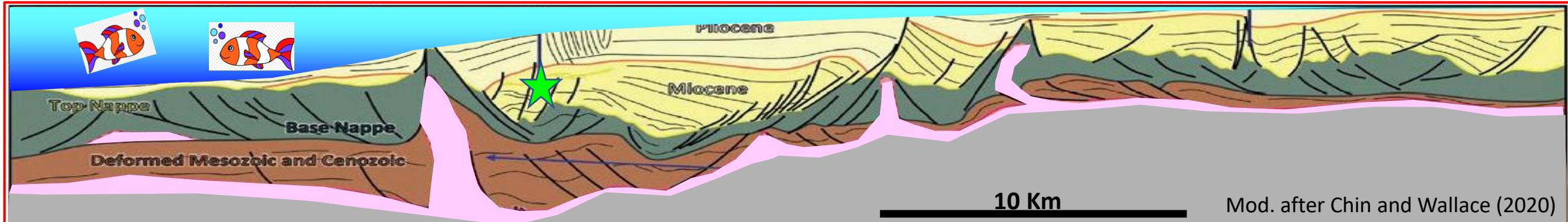


Halokinesis along Gharb Basin

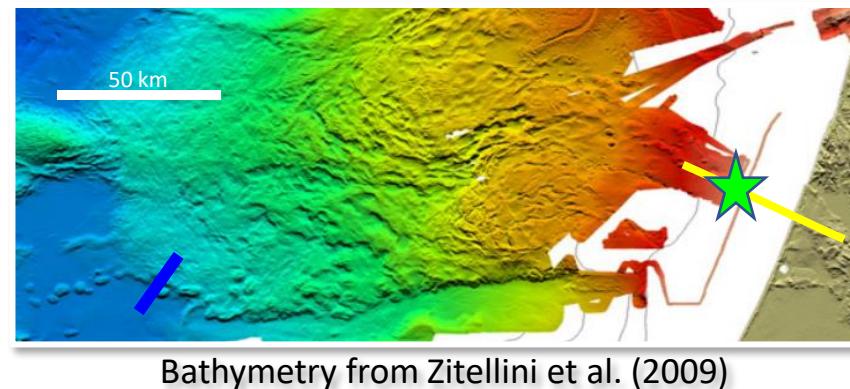
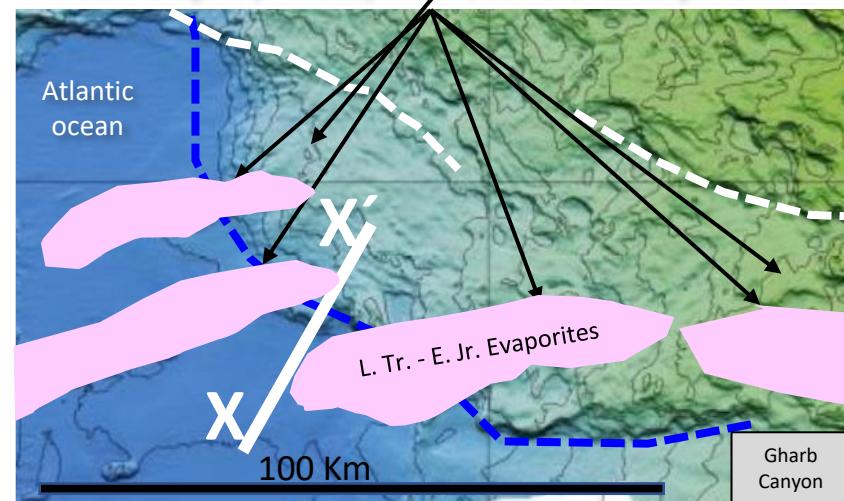
NW

Shallow water

SE

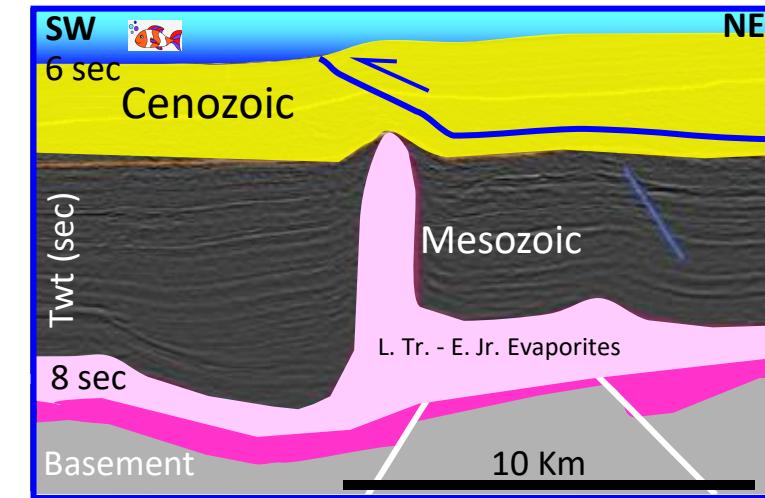


Salt-diapirs / knolls, mini-basins & escarpments



Deep water

Giraldo and Hermoza (2013)



3D seismic line across Well discovery

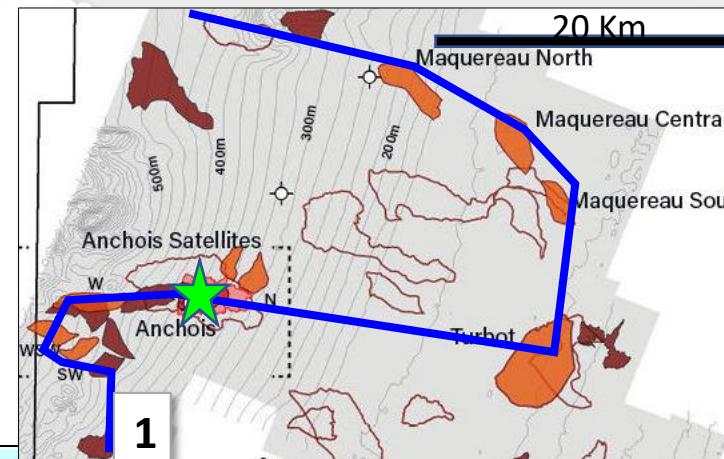


Nuria Antich



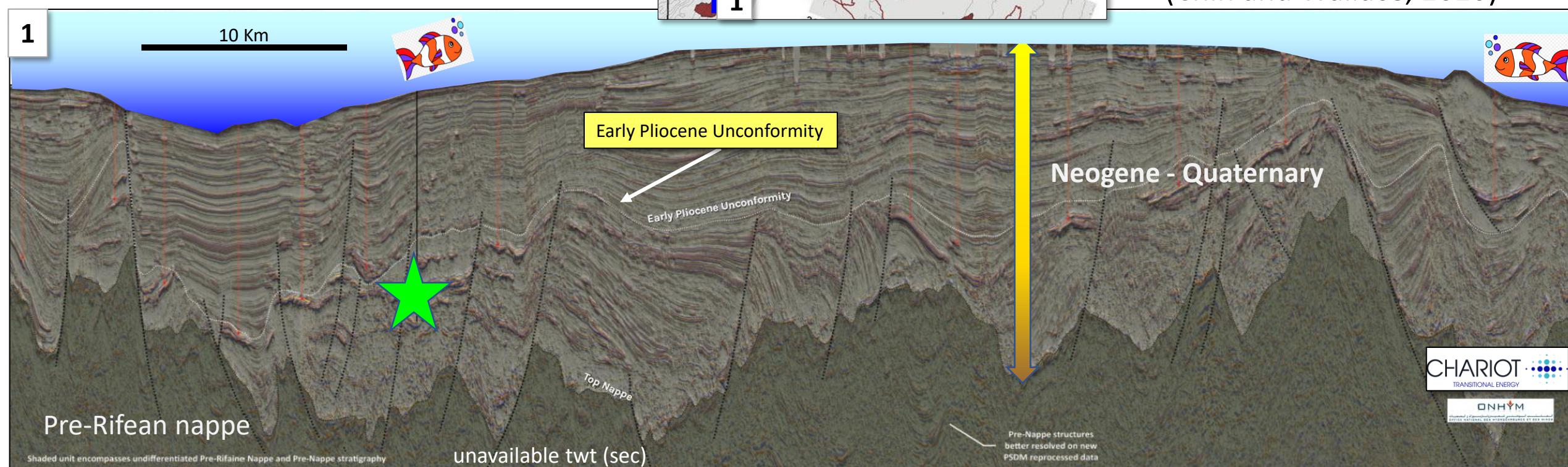
Bruce Blake

Nuria and Bruce , were part of REPSOL DISCOVERY TEAM (2008)



<https://www.chariotenergygroup.com/operations/transitional-gas/>

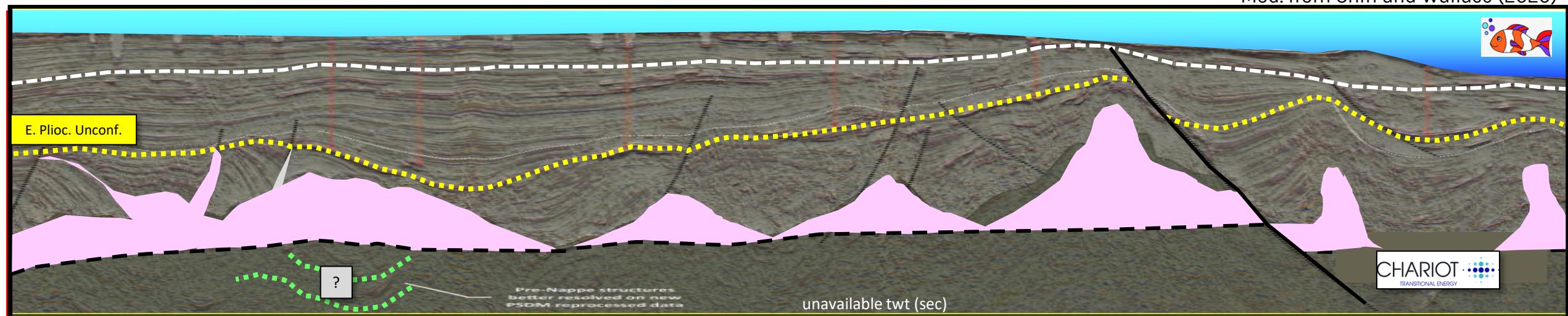
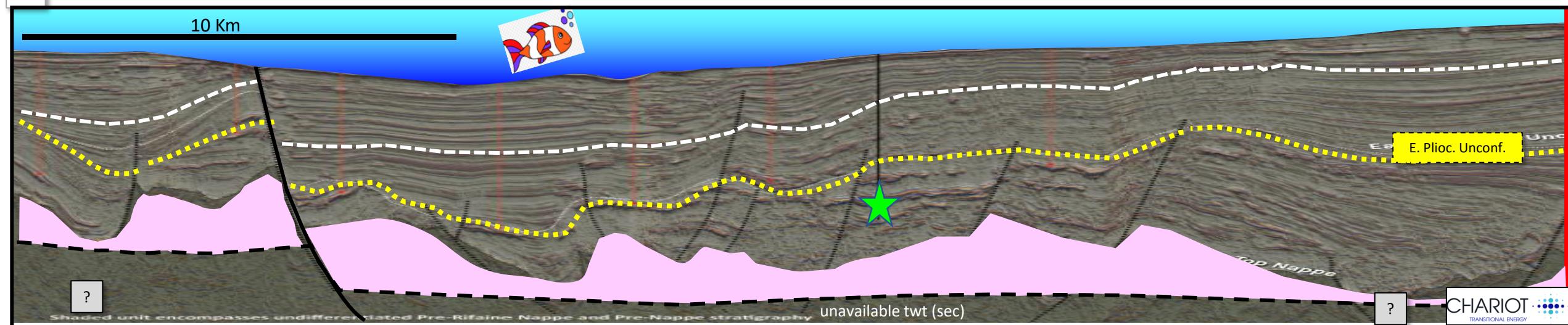
3D seismic line / next slide
(Chin and Wallace, 2020)



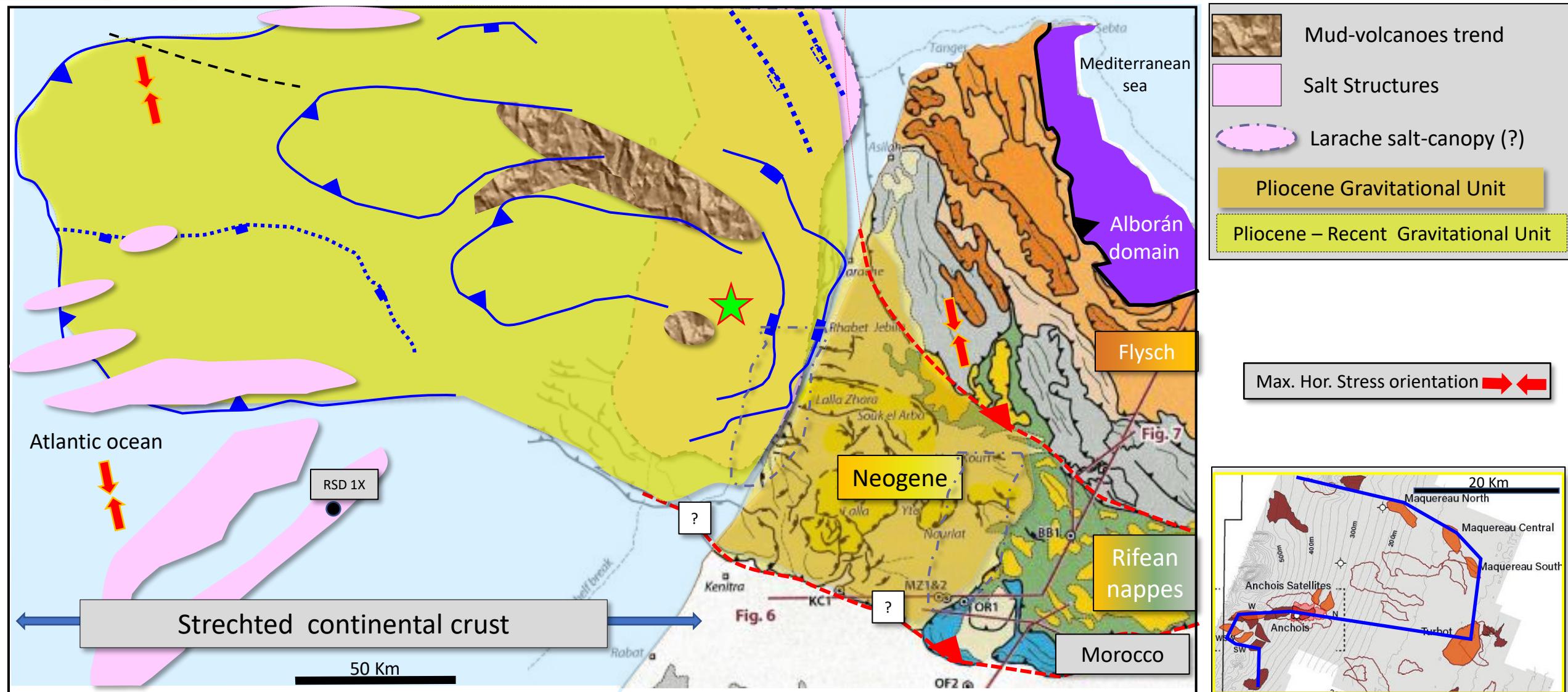
An alternative scenario

1

Mod. from Chin and Wallace (2020)



Tectonic summary (*)



(*) Flinch (1993);Medialdea et al. (2009);Gutscher et al. (2012);Giraldo et al. (2014);Tari and Jabour (2014);Pedrera et al. (2020);Somoza et al. (2021)

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