Triassic Rupture and Liasic Marine Invasion in the Lusitanian Basin (Portugal) – A Shift from Tectonic To Thermal Subsidence*

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Abstract

The Lusitanian Basin is a peri-Atlantic basin, related to the opening of the Northern Atlantic. The first rifting phase is related to the beginning of crustal stretching and Pangaea break, initiated on Upper Triassic (Carnian) along late-Variscan basement fractures, oriented mainly NNE-SSW. Several listric fault movements defined multiple grabens and semi-grabens filled up by alluvial clastics, laterally digitating with clayey and evaporitic deposits. The first Triassic sequence is composed of coarse deposits of fans and ephemeral rivers, grading to silts and clays deposited at shallow lacustrine and evaporitic environments, defining a retrograding succession. The second sequence is composed of coarse to fine sands, deposited by braided rivers in a broad alluvial plain, grading upwards to pelitic and thin dolomitic facies, which present an overall onlap geometry. Thickness variations of these two sequences suggest lateral shifting of depocentric areas and geometries of basement onlaping by the Triassic deposits.

A third sequence is initiated by a thin flux of siliciclastics, rapidly passing to clays with evaporitic layers and dolomitic limestones with a Hetangian poor fauna. In some depocentric sectors of this basin, with shallow lagoons and peri-tidal sabkhas, hundreds of meters thick evaporitic deposits with gypsum, halite and clays were accumulated. These deposits have been covered by tens of meters of dolomitic limestones with marly intercalations and a rich marine fauna of Sinemurian age, associated to the beginning of the post-rift subsidence. A low-energy carbonate ramp has been installed thereafter, rapidly opening to a deep margin influence in the Pliensbaquian, because of significant thermal subsidence throughout the Lower Jurassic. All this evolution has taken place at the Lusitanian Basin in around 30 Ma, showing a good example of rapid shifting from tectonic to thermal subsidence in a peri-Atlantic basin.

Selected References

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TRIASSIC RUPTURE AND LIASIC MARINE INVASION IN THE LUSITANIAN BASIN (PORTUGAL) – A SHIFT FROM TECTONIC TO THERMAL SUBSIDENCE

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Sumary

1. THE REGIONAL FRAMEWORK

The Lusitanian Basin (Portugal) in the Iberian-Maghrebin area

2. THE UPPER TRIASSIC - LOWER JURASSIC EVOLUTION

- Depositional sequences
- Palaeogeographic reconstructions
- Geodynamic interpretations

3. CONCLUSIONS

From the intra-continental rifting to the Tethysean invasion

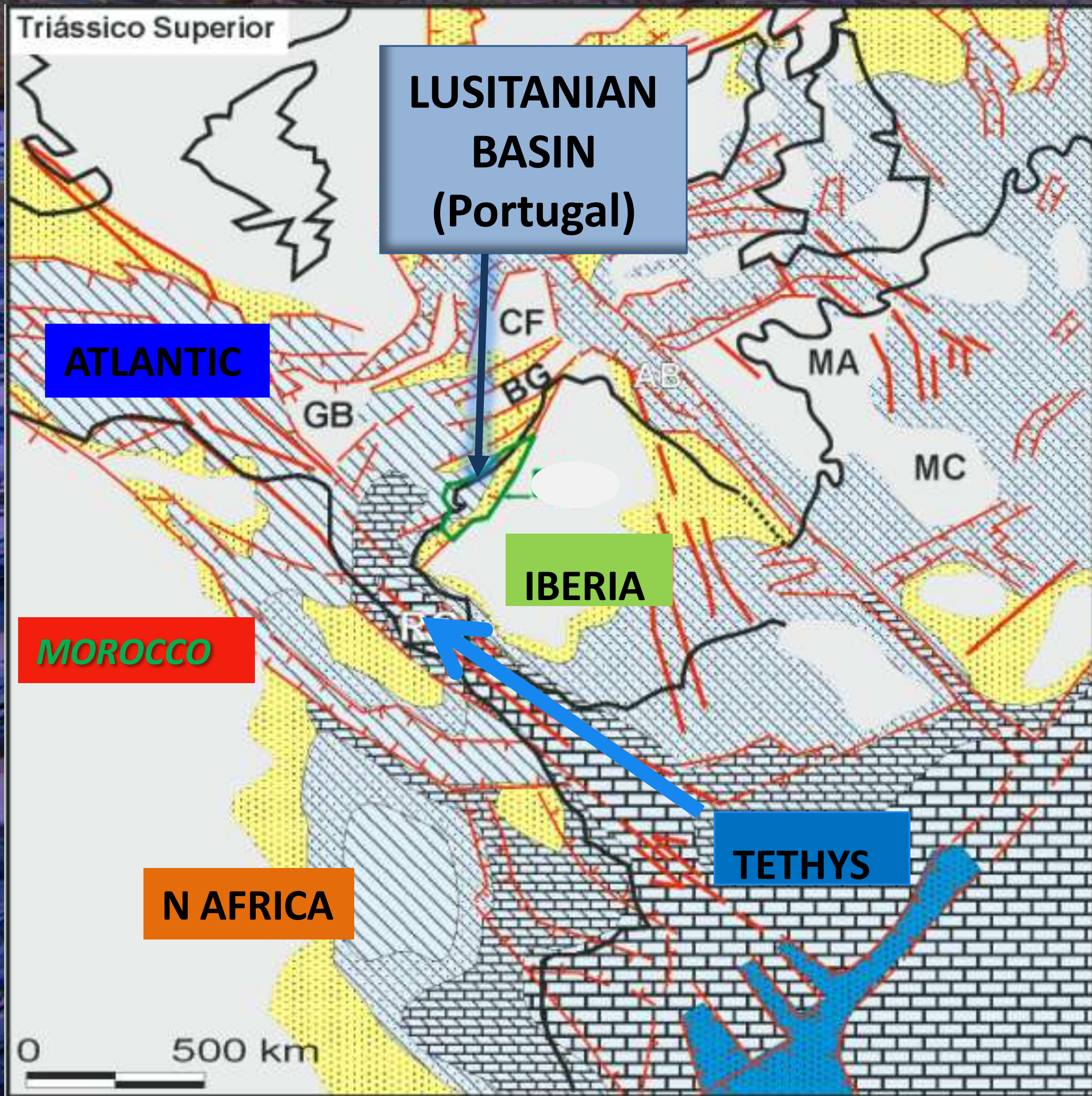
The Lusitanian Basin is a peri-Atlantic basin, related to the opening of the N Atlantic.

But it is also a peri-Tethysean basin related with its western tip.

245 MA - CARNIAN

195 MA - SINEMURIAN

GEODYNAMIC FRAMEWORK OF IBERIA IN UPPER TRIASSIC



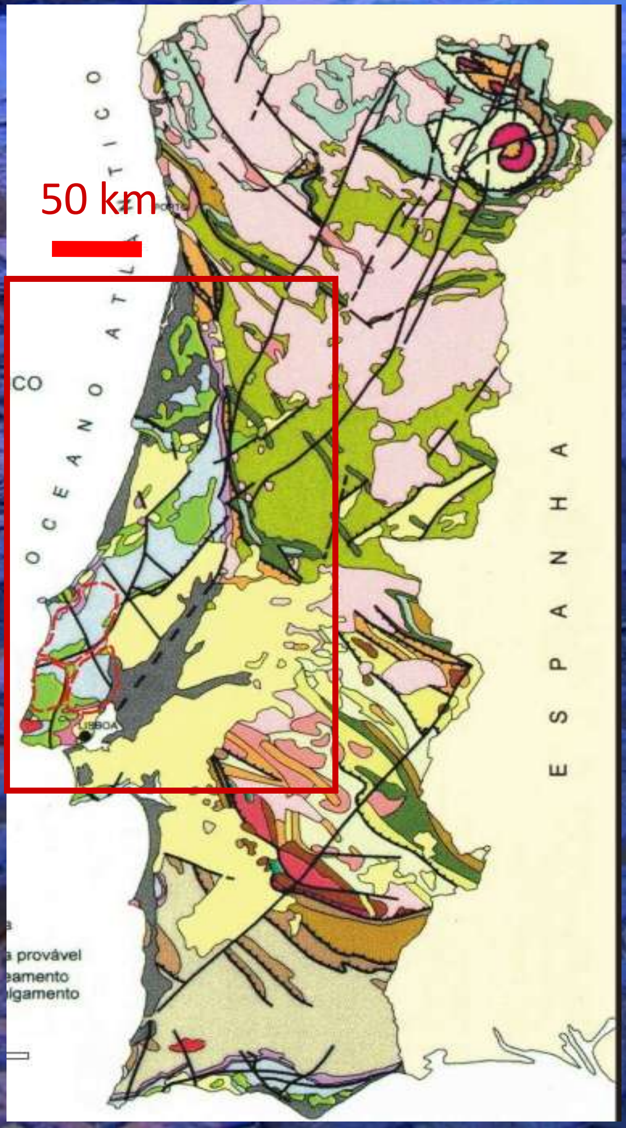
Modif. Ziegler, 1988

The initial rifting, initiated in Iberia on Upper Triassic (Carnian) is related to the beginning of crustal stretching and Pangaea break, along late-Variscan basement fractures, oriented mainly NE-SW.

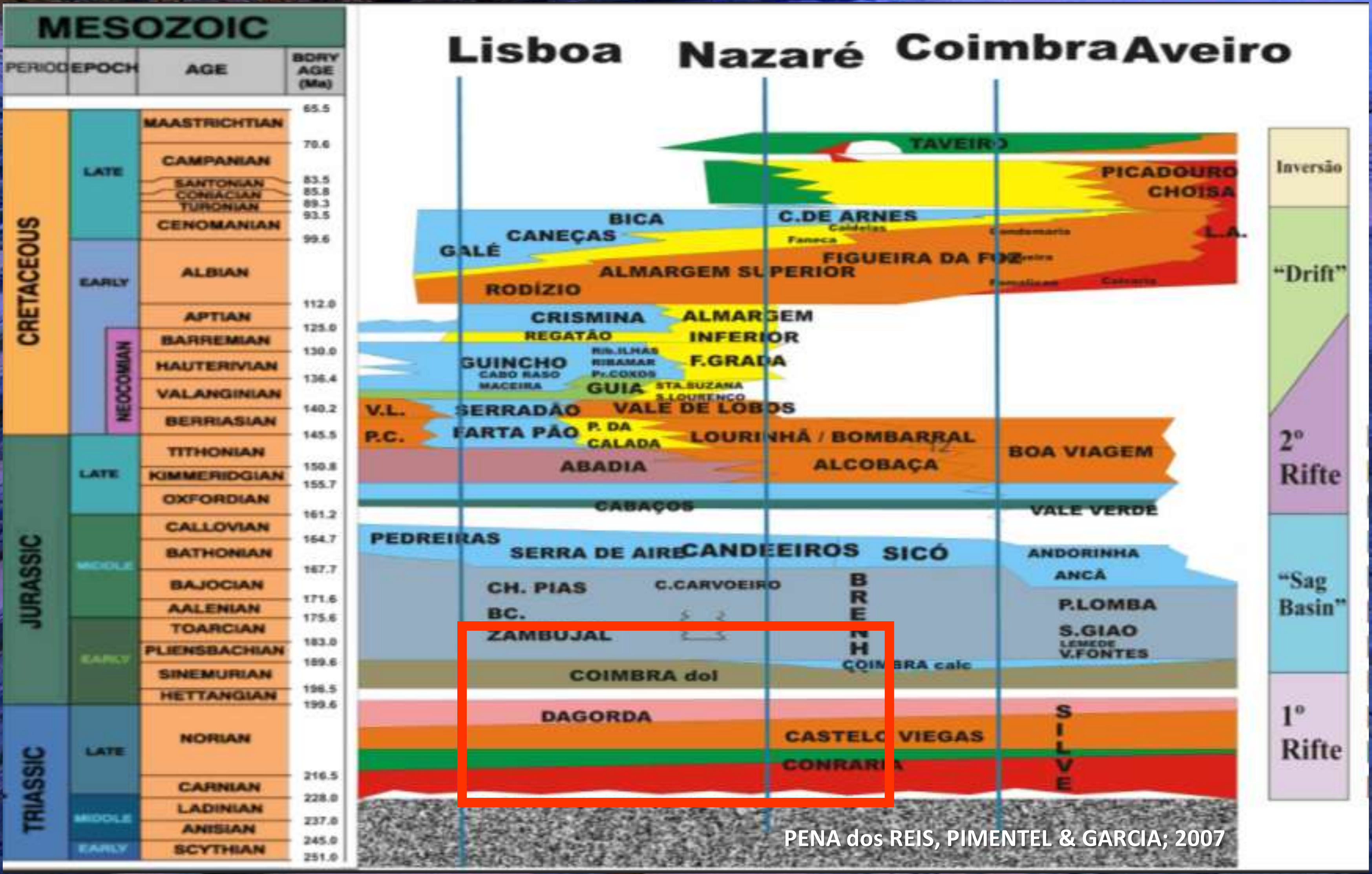
UPPER TRIASSIC OUTCROPS ARE RESCTRICTED TO THE EASTERN BORDER OF THE BASIN

HETANGIAN SALT DEPOSITS OUTCROP IN DIAPIRIC AREAS

LOWER JURASSIC OUTCROPS ALSO OCCUR IN SOME PLACES IN THE WESTERN ON-SHORE.



LITOSTRATIGRAPHIC UNITS OF THE LUSITANIAN BASIN



UPPER TRIASSIC – LOWER JURASSIC SEQUENCES IN THE LUSITANIAN BASIN

AGE	Ma	SEQ. (Formations)		Thickness (average)	Phase
PLIENSBACHIAN	190	S-5 (V. FONTES)		50 m	
SINEMURIAN	196	S-4 (COIMBRA)		100 m	SAG
HETANGIAN	200	S-3 (PEREIROS)	DAGORDA	70 m	Transition
		S-3 (DAGORDA)	DAGORDA	???	
RHETIAN NORIAN		S2 (CONRARIA)	DAGORDA	200 m	
CARNIAN	228	S-1 (C.VIEGAS)		200 m	RIFT

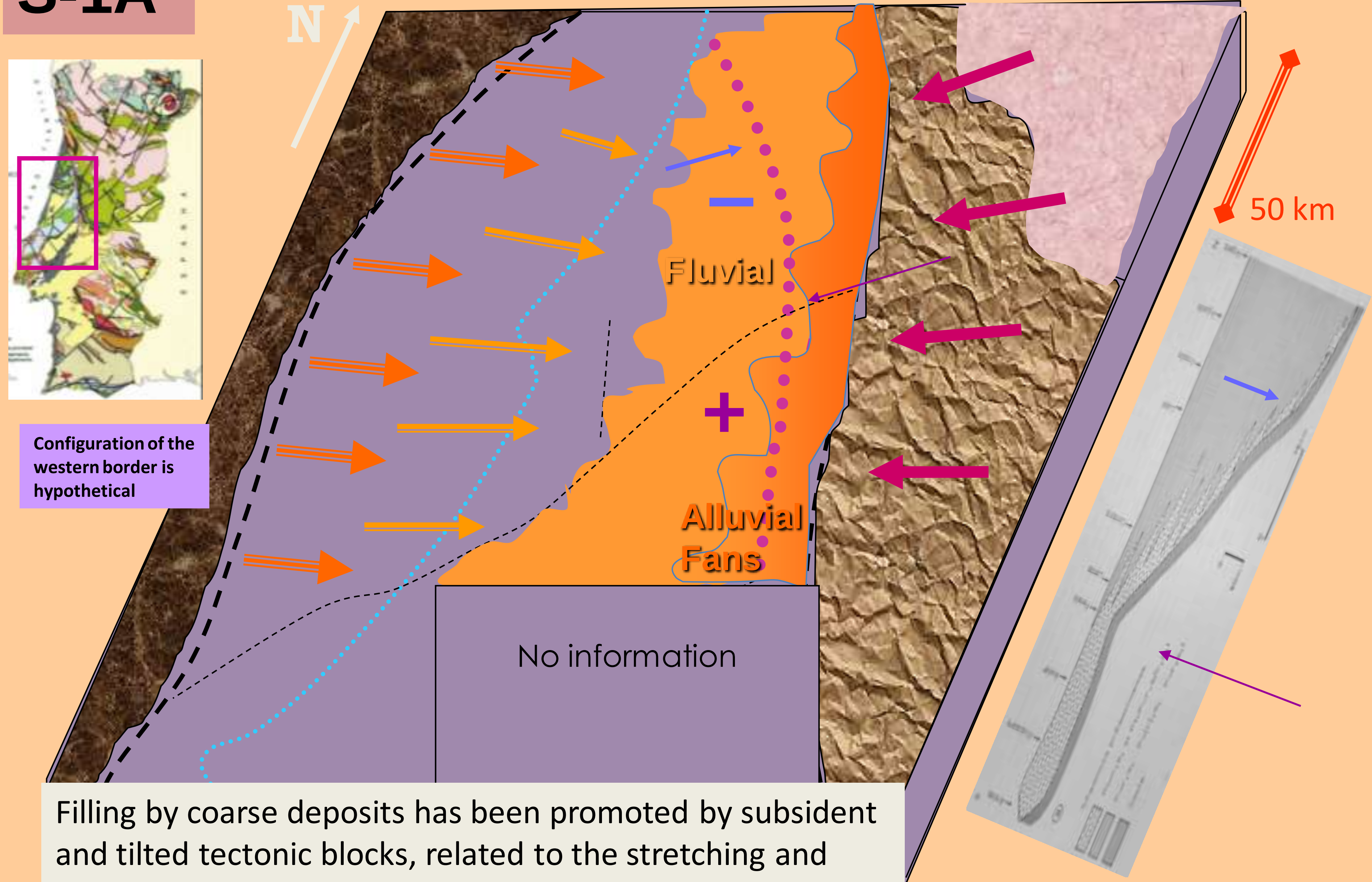
S-1 (C.VIEGAS Fm)

Coarse deposits of fans and ephemeral rivers, grading into silts and clays deposited at shallow lacustrine and evaporitic environments.

This succession, c. 200 m thick, is retrograding, underlining the increasing accomodation space.

S-1A

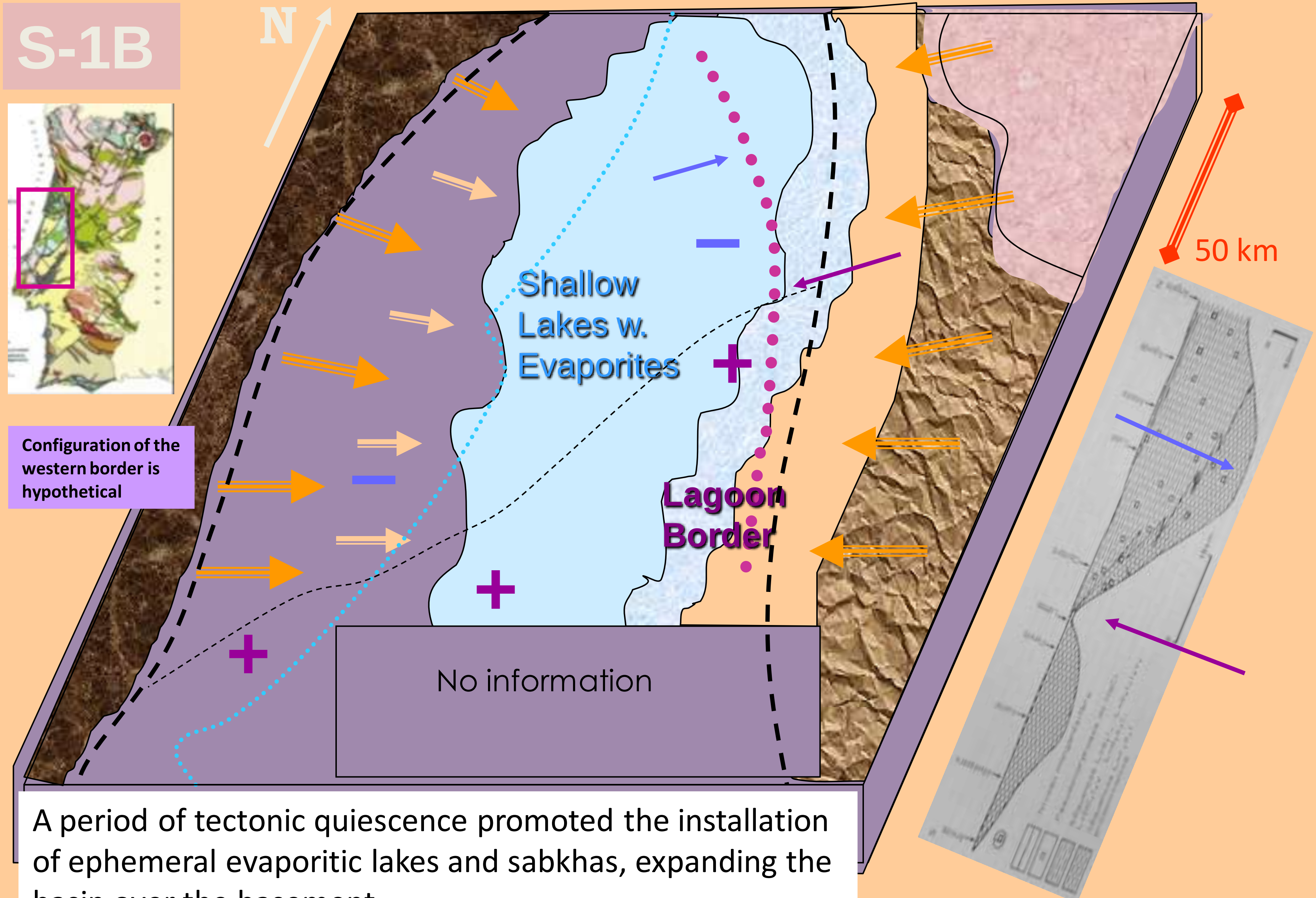
PENA dos REIS, PIMENTEL & GARCIA; 2007



Filling by coarse deposits has been promoted by subsident and tilted tectonic blocks, related to the stretching and flexure of the basement towards the W.

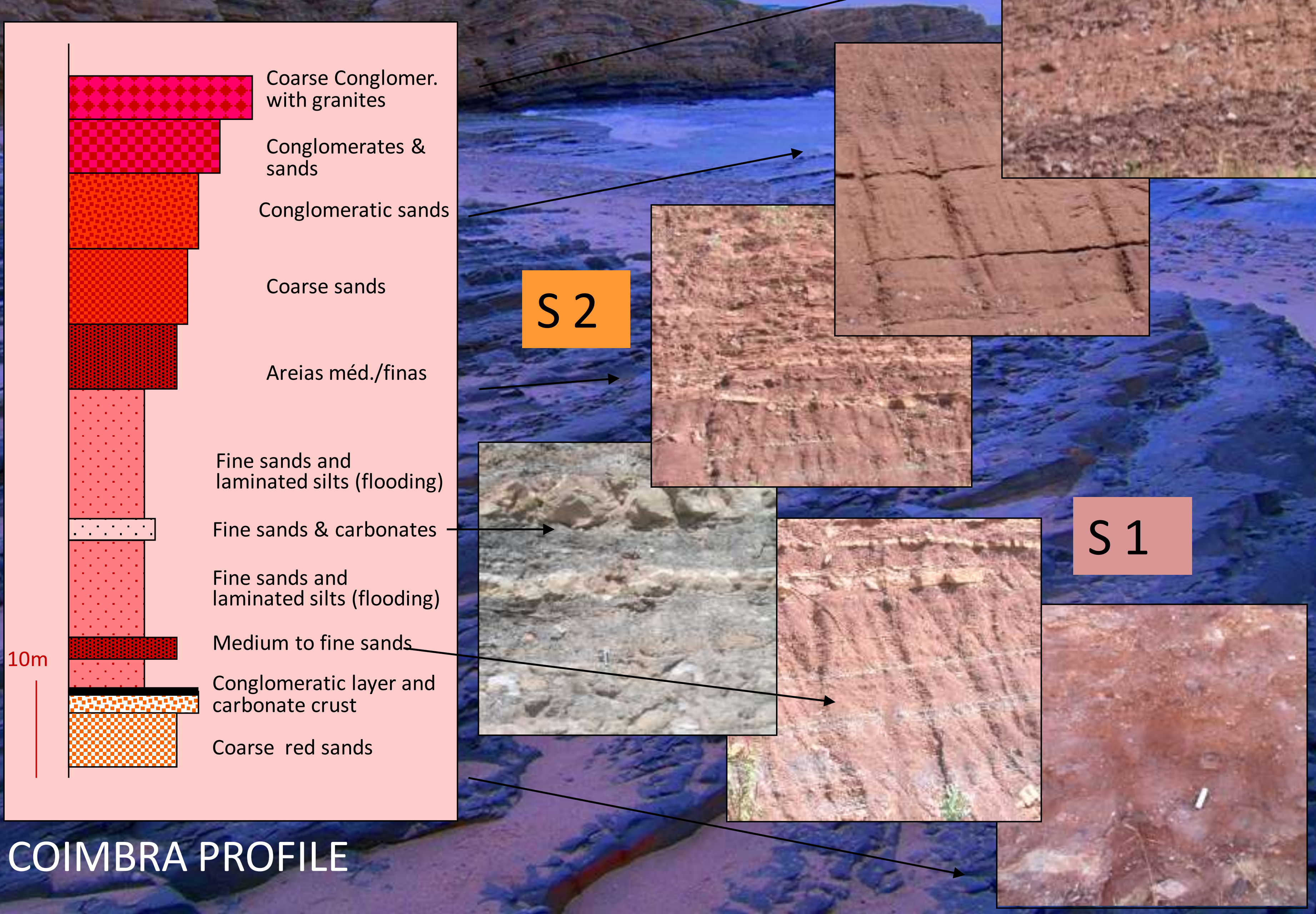
S-1B

PENA dos REIS, PIMENTEL & GARCIA; 2007



A period of tectonic quiescence promoted the installation of ephemeral evaporitic lakes and sabkhas, expanding the basin over the basement.

Terrigeneous facies of the Upper Triassic deposits



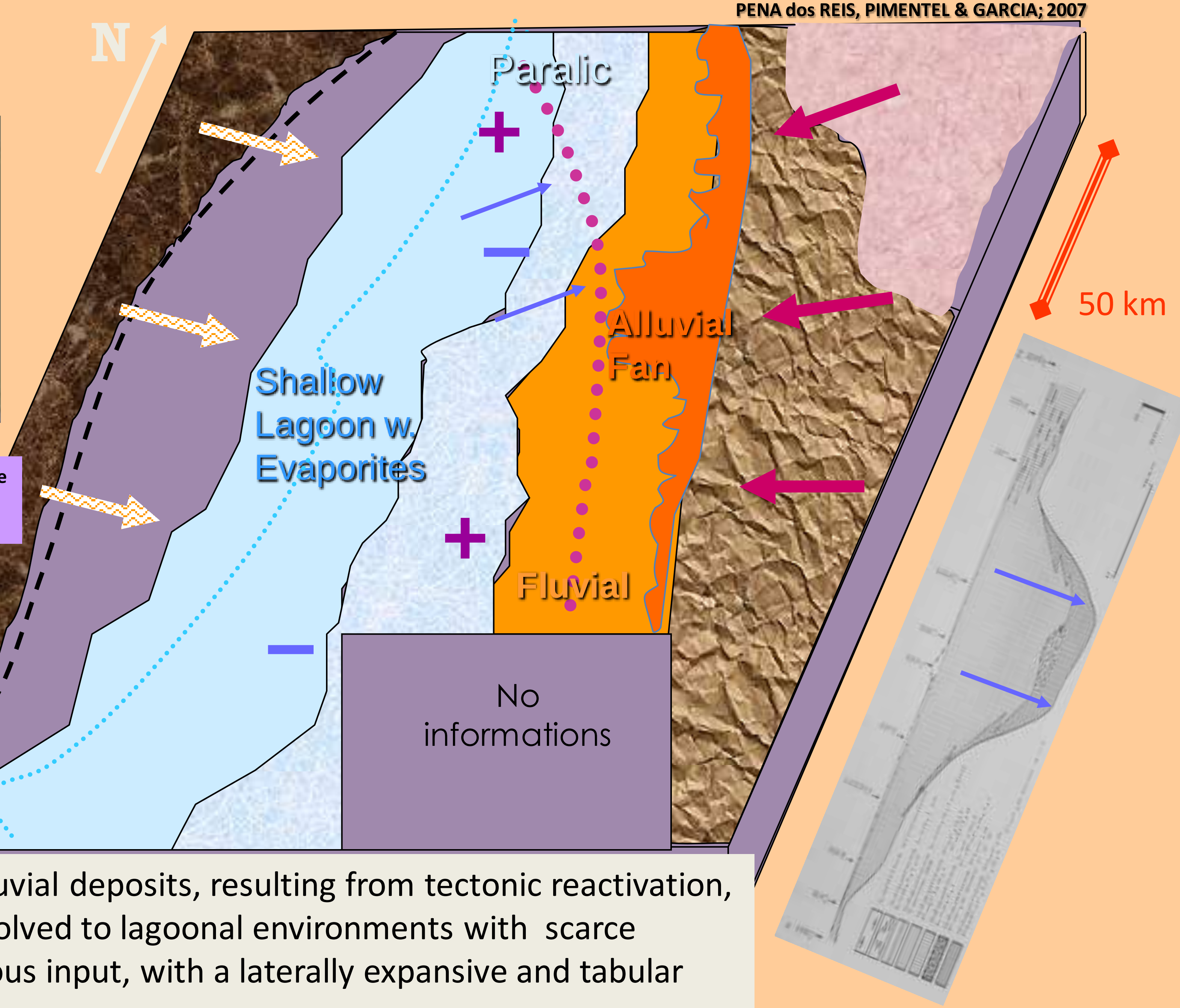
COIMBRA PROFILE

S-2 (CONRARIA Fm)

- Coarse to fine sands, deposited by braided rivers in a broad alluvial plain, rapidly grading upwards to pelitic and thin dolomitic facies.
- This succession, c.200 m thick, presents an overall *onlap* geometry.

S-2

PENA dos REIS, PIMENTEL & GARCIA; 2007



Configuration of the western border is hypothetical

Coarse alluvial deposits, resulting from tectonic reactivation, rapidly evolved to lagoonal environments with scarce terrigeneous input, with a laterally expansive and tabular geometry.

S-3 (DAGORDA & PEREIROS Fms)

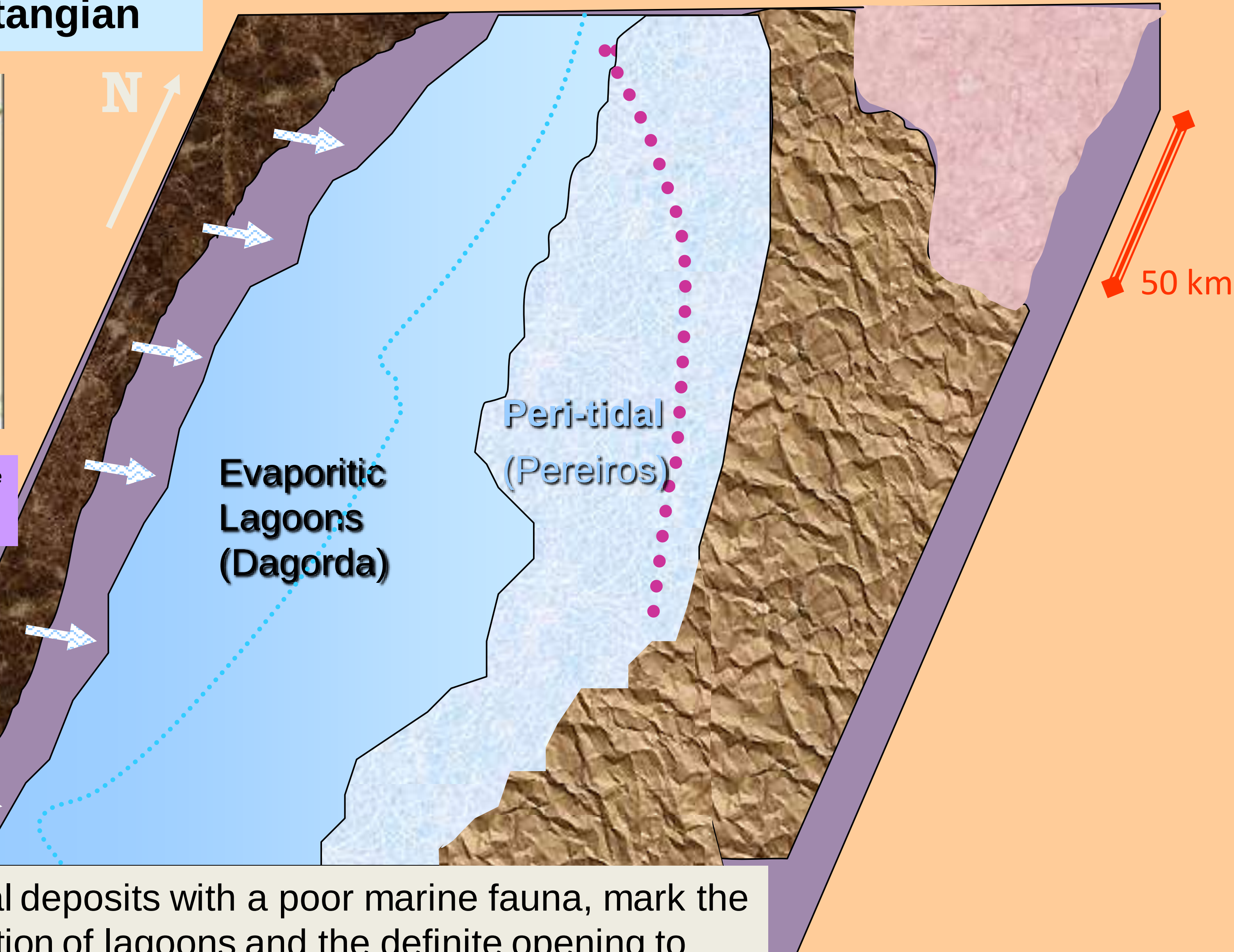
A thin flux of siliciclastics, rapidly passes into clays and dolomitic limestones with with evaporitic layers and an Hetangian poor fauna - **Pereiros Fm**.

In some depocentric sectors of this basin, with shallow lagoons and peri-tidal sabkhas, hundreds of meters of thick evaporitic deposits with gypsum, halite and clays were accumulated - **Dagorda Fm**.

S-3 Hetangian

PENA dos REIS, PIMENTEL & GARCIA; 2007

Configuration of the westŜrn border is hypothetical

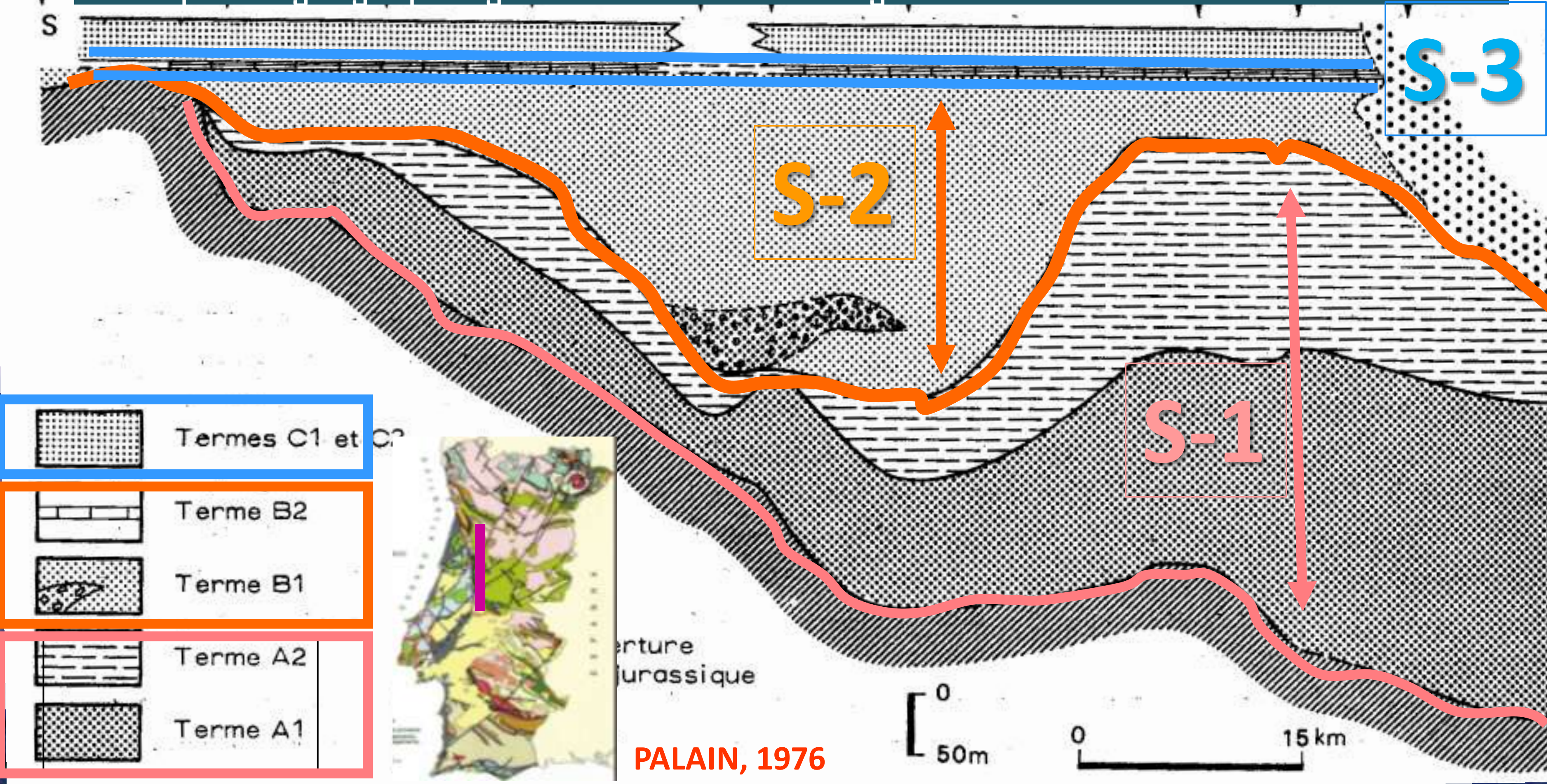


Peritidal deposits with a poor marine fauna, mark the installation of lagoons and the definite opening to restricted marine influences.

S-1 and S-2 (Upper Triassic) show strong thickness variations, particularly along a N-S direction, sub-perpendicular to the palaeogeographic gradient, suggesting:

- importance of independent blocks, with lateral shifting of depocentric areas;
- triassic geometries of basin expansion and basement onlaping.

S-3 (Hetangian) marks a transition to a different tectonic framework, with regular palaeogeographic gradient and without significant thickness variations.



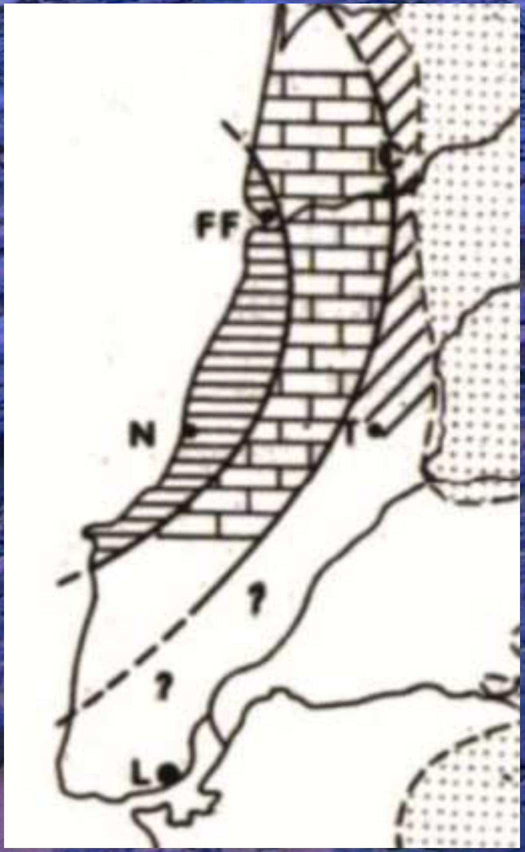
S-4 (COIMBRA Fm)

These continental and transitional deposits have been covered by tens of meters of dolomitic limestones with marly intercalations and a rich molusk marine fauna of **Sinemurian** age,

Towards the top, sedimentation becomes predominantly carbonated and occurrences of Amonoids mark the first signs of open marine influences and the installation of a Carbonate Ramp .

The facies distribution corresponds to the the installation of a low-energy homoclinal ramp, tilted to the West.

This regular palaeogeography is associated to the beginning of the post-rift thermal subsidence and the Sag Phase.



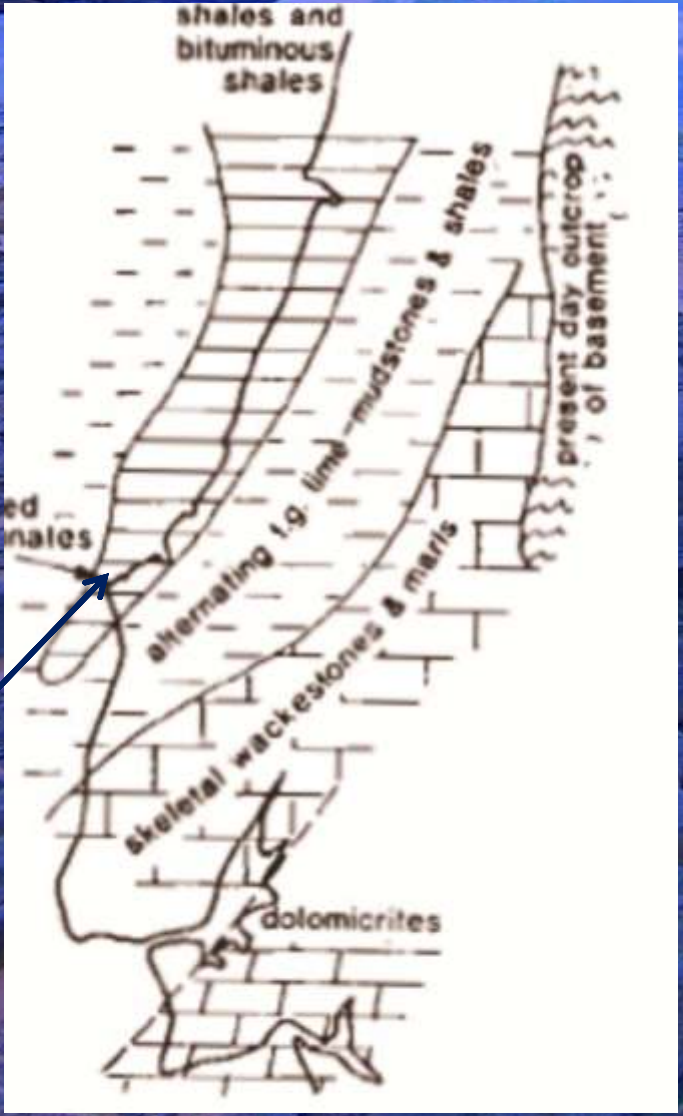
S-5 (VALE das FONTES Fm)

These deposits correspond to thick marly-limestone rhythmic sucessions, containing some black shales.

The abundance of **Pliensbachian** amonoids and belemnoids and the high organic content of some layers, indicate deepening and anoxic events in this highly stable basin.

Pliensbaquian black shales (S.Pedro de Muel)

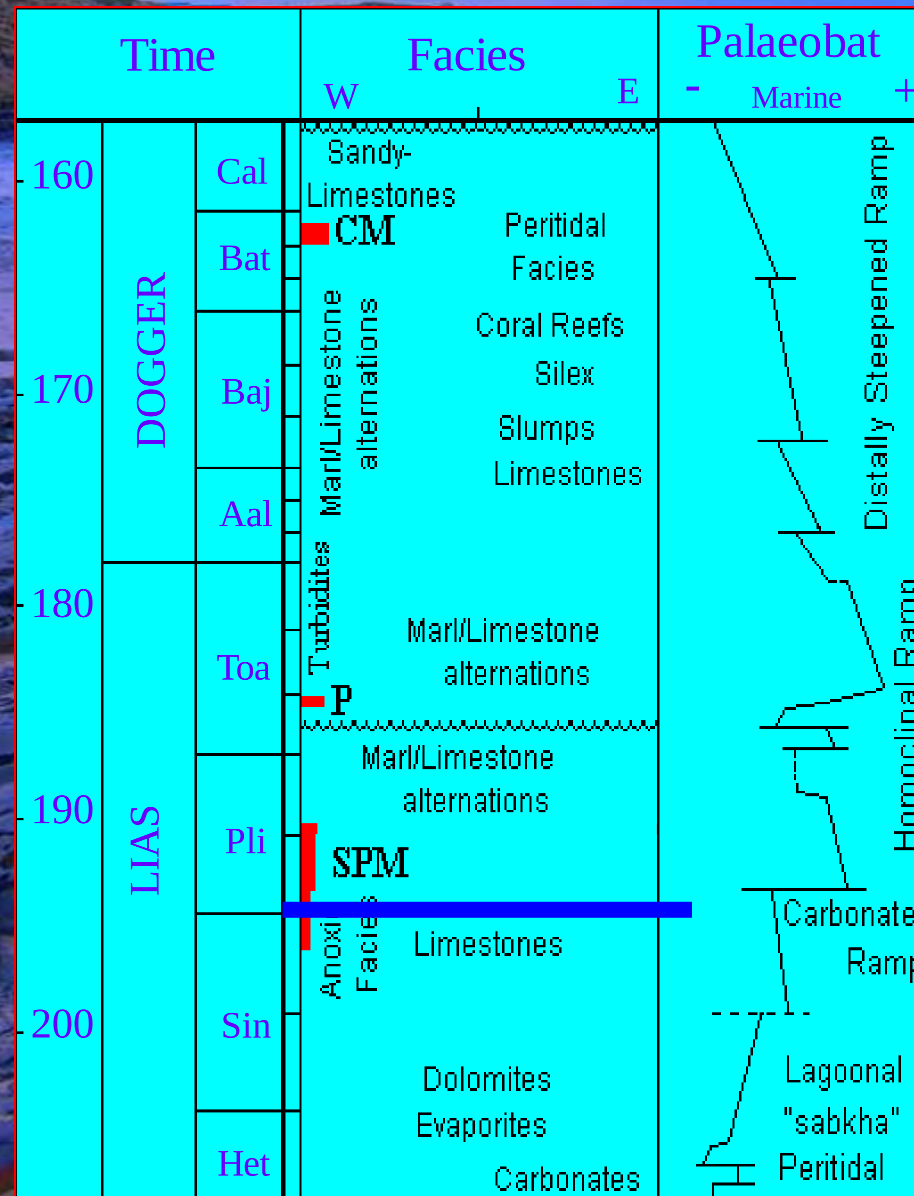
The Pliensbachian is marked by the accentuation of the Homoclinal Ramp with regular deepening gradient towards West from shallow to deep marine environments.



THIS PHOTO: Pliensbachian black shales and marls
at the Central Lusitanian Basin

This event of basin deepening is underlined by an unconformity transgressive surface over Sinemurian dolomitic and carbonate shallow facies.

Sinemurian-Pliensbaquian evolution is the result of increasing thermal subsidence, which would continue throughout the Toarcian, with accentuated opening to marine influences,



L.V.DUARTE, 2002

CONCLUSIONS

1. Upper Triassic evolution of the Lusitanian Basin resulted from initial intra-continental rifting, with fracturation and structuration into independent sub-basins.
2. Thickness variations of Upper Triassic sequences (S-1 and S-2) show depocenter migration, associated to the initial block-structuration.
3. Salt accumulation during the Rift-Sag transition (S-3) has been developped initially in shallow continental evaporitic sabkhas, and latter in shallow marine evaporitic environments (peritidal lagoons).
4. Hetangian evolution shows a different pattern, with tabular geometries, expansion of the depositional basin and overlapping over the basement.
5. The Sinemurian marine invasion and carbonate ramp installation (S-4) is marked by a transgressive surface rapidly migrating from W towards E.
6. Pliensbachian deposits (S-5) correspond to deep marine environments, with "high TOC content" marls and black shales.
7. All this evolution took place in around 30 Ma, showing a good example of rapid shifting from tectonic to thermal subsidence in a peri-Tethysean basin.

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Thank you !

Pliensbachian black shales at Peniche