The Lusitanian Basin (Portugal) – lithostratigraphic and geodynamic correlation with other Portuguese and Moroccan basins

LUSITANIA RESEARCH GROUP

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INTRODUCTION

The Iberian and Northern Morocco regions are located in the eastern façade of the **Central-North Atlantic** (Fig. 1), therefore sharing signs of the main regional geodynamic controls. These regions were affected by the break-up of Pangea, at the Early Mesozoic, originating several marginal basins which are exposed today along the **Atlantic margins of Iberia** and in the **Atlas mountain chain (Morocco).**

The stratigraphic successions preserved in those basins record major basinal events and present strong signatures influenced by the **Tethys Ocean, to the East**, and later on by the opening of the **Atlantic ocean, to the West**.

The purpose of the present work is to compare the basins in the western and southern borders of the Iberian plate. This approach has been taken in order to assess the signals of the **major geodynamic events** and to improve regional **paleogeographic reconstructions**.

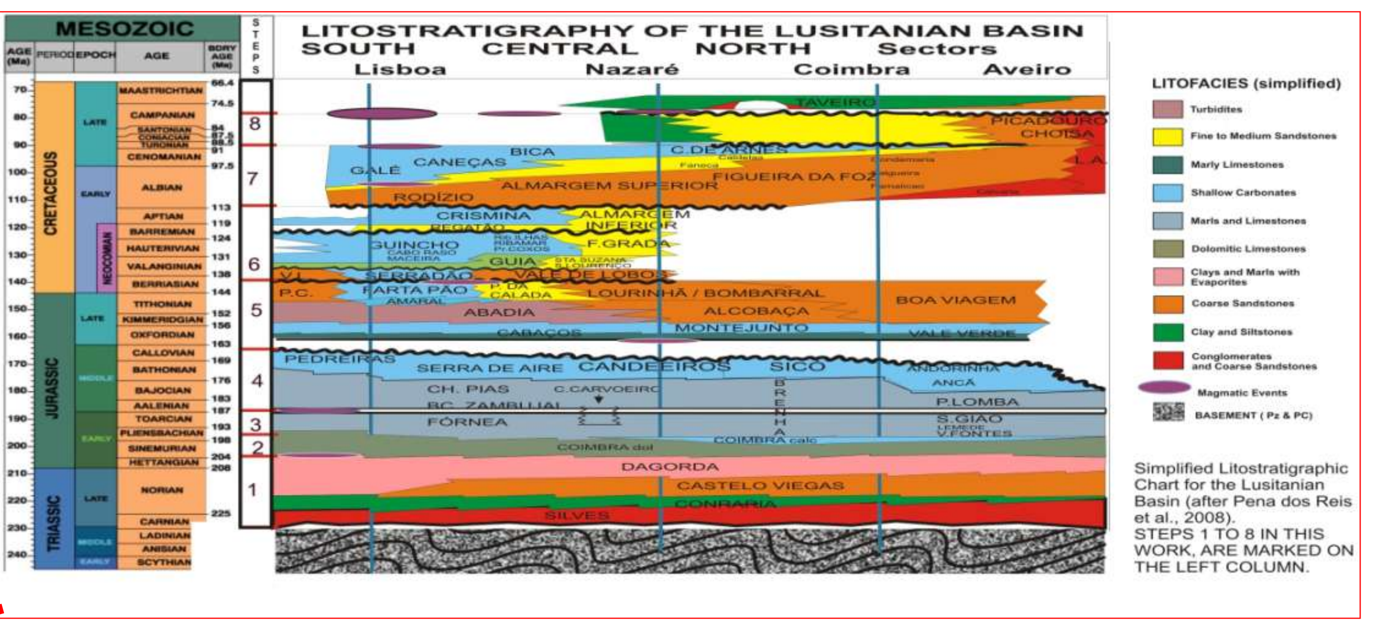
Fig. 1 – Location of the Lusitanian Basin and other basins refered in this work, at the eastern facade of the North and Central Atlantic.
1, 2 & 3 – Lusitanian Basin: North, Central and Southern Sectors;
4 – Santiago do Cacém Basin;
5 – Algarve Basin;
6 – Northern Morocco Atlas Basins.

CORRELATION AND GEODYNAMIC STEPS

The areas considered in this work are thought to have been bounded at Early Mesozoic times by different continental blocks (**Iberia, NW Africa, Grand Banks and North America**, as proposed in **Figure 3)**, being influenced by three major oceanic domains - Central Atlantic to the S, Western Tethys to the E and North Atlantic to the West (Manspeizer, 1988; Ziegler, 1988; Cavazza et al., 2004).

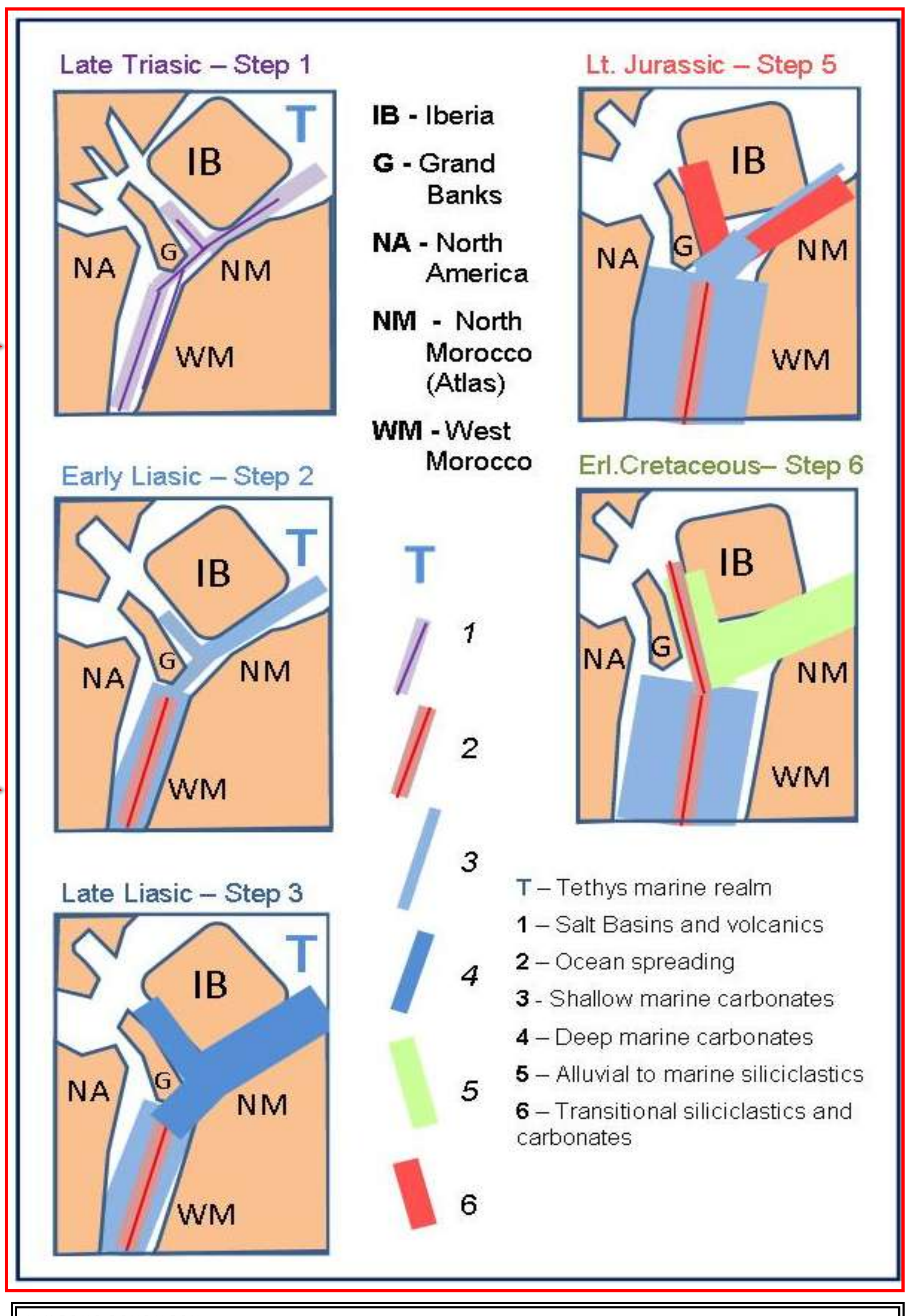
Tthe comparison of different basins (**Lusitanian (Fig. 2A), S.Cacem, Algarve and High Atlas**), through the description of its infills, has been put together in **Figure 2B**. A set of **8 major geodynamic steps** are established, spanning from the late Triassic until the latest Cretaceous.

The paleogeographic and geodynamic framework for some of these steps are presented in **Figure 4**, as an attempt to integrate the different basins into a regional framework.



STAGES	MOROCCO (Atlas)	ALGARVE	S.CACEM	S LUSITANIAN	CENTRAL LUSITANIAN	NORTH LUSITANIAN	Steps
Con.-Maast.	Continental					Continental	8
Turonian		EROSION	EROSION	EROSION	EROSION	Carb.Platf	
Cenom.	Carb.Platf	Carb.Platf			Carb.Platf	Carb.Platf	7
Albian						Fl.Deltaic	
Aptian	Fl-Deltaic to W	Deltaic-Carb.Platf.		Deltaic -	Deltaic-Carb.Platf.		
Hauteriv.			EROSION	Carb.Platf.		EROSION	
Valang.							6
Berriasian							
Tithonian	CONTINENTAL to NE		Fluvial	Fluvial	Fluvial		
Kimmer.		Carb.Platf			Fluvio-Deltaic	Fluvial	
Oxfordian	"COUCHES		Al.Fan	Al.Fan	Turbidites		5
Calovian	ROUGES"						
Bathonian		CR to SE (Deep)	CR-Shallow	CR-Shallow	CR-Shallow	CR-Shallow	
Bajocian	CONTINENTAL to NE						
Aalenian					CR (Tb)	CR (Tb)	4
Toarcian	Carb.Platf		Shallow Mar.	Shallow Mar.			
Pliensb.		CR to SE (Deep)			CR to NW (Deep)	CR to NW (Deep)	3
Sinemur.	CR to NE (Deep)	Shallow Mar.	Shallow Mar.	Shallow Mar.	Shallow Mar.	Shallow Mar.	2
Hetang.	Evapor. & VOLCANICS	Evapor.&Volc	Evap. & Volc	Evap.&Volc	Evaporites	Evaporites	
U.TRIASIC	Continental	Continental	Continental	Continental	Continental	Continental	1
Palaeozoic	VARISCAN PALAEOZOIC BASEMENT						

Fig. 2B– Correlation between the synthetic columns of the sedimentary filling of the studied basins (with emphasis on their paleoenvironmental significance); geodynamic steps numbered from 1 to 8 (see text for further explanations). Unconformities are represented as gray horizontal lines, and by white horizontal bars whenever they include a significant depositional hiatus. CR – Carbonate Ramp; Tb – Turbidites.
Data from Azerêdo et al., 2003; Rey et al., 2006; Pique et al. 2007; Souhel et al., 2007; Pena dos Reis et al., 2008.



MAIN GEODYNAMIC STEPS

STEP 1 - The earlier rifting episode has a Central Atlantic rifting signature, related with the Sinemurian break-up in the western Moroccan margin (Fig. 3). Step 1 began during Late Triassic times and led to the definition of a system of sub-meridian grabens and half-grabens filled up by siliciclastic red beds, capped by a broad evaporitic event in every basin, marking the transition to the post-rift interval from the Hetangian on. The volcanics associated to the top of the evaporitic deposits may be correlated to the CAMP event, gradually decreasing to the north, as they get farther away from the rifting sector, underlining a Central Atlantic signature, which faded out prior to the transgression of Step 2..

STEP 2 – The southern intra-continental rifting changed to oceanic spreading in the western Morocco sector. There is a general marine invasion, starting with the installation of lagoonal sabkha systems and grading later into shallow platform geometries in most places. Dolomitic deposition seems to be dominant in most of the basins, related with shallow seas with meteoric influences.

STEP 3 – A major regional unconformity underlines the beginning of the Step 3. This is characterized by a general and rapid deepening in every basin, except in two small sectors (Arrábida and Santiago do Cacém Basin), possibly due to some structural control inhibiting stronger subsidence between the Algarve and the Lusitanian basins. Large carbonate-marly ramps developed by then, and most of the domains present high TOC in bituminous shaly marls, being considered as very interesting source rocks. These changes are interpreted as the result of a major sin-rift event in the Tethys realm.

STEP 4 – The rift event described in Step 3 changed to Post-Rift in the Atlas Basin (Early Toarcian), some million years earlier than in the other portuguese basins (Early Aalenian), suggesting a northward propagation of the rifting influence. These changes are recorded in basinwide unconformities, whose expression is a long hiatus in the Atlas Basin (Fig. 2) gradually vanishing towards north. In the northern Lusitanian Basin it corresponds just to a short depositinal hiatus (c. 1 Ma), only detectable due to detailed biostratigraphic control. The infill changes show an overall tendency to prograding carbonate platforms, as the accommodation space decreased.

STEP 5 – Step 4 ends with a broad uplift event, leading to a shallowing pattern and later karstification of the carbonate platforms. These changes are recorded by a major unconformity with variable hiatus duration, by late Calovian to early Oxfordian times. The ocean spreading in the Central Atlantic sector must have produced an eastwards migration of the African plate, promoting the lining up of the Lusitanian rifting with the Central Atlantic spreading. As a result, an intense rifting occurred, followed by a thick progradation by clastic sediments, recording both terrestrial and deep marine systems. This atlantic influence is also suggested by the southwestwards orientation of the drainage patterns and the deeper systems to the SW, in the Lusitanian Basin sedimentary record. At this time, a terrestrial sedimentation was going on in the Atlas Basin, still connected with the tethysean domain.
According to different paleogeographic reconstructions, during most of the times between earliest Jurassic until latest Jurassic, the west Iberian basins were separated from the central Atlantic by the Grand Banks continental block. This explains the reason why during the first rifting episode and subsequent sag interval, the marine influence was dominated by the Tethys, coming in both via a northern Iberia boreal corridor and southern mesogean Tethys domain.

STEP 6 – Following this major still intra-continental rifting event, the drifting phase related with the North Atlantic rifting and spreading off-shore the Lusitanian Basin began to set up at the end of Berriasian (Earliy Cretaceous). Different authors suggest a three-step northward propagation of the North Atlantic ocean spreading initiation. This is recorded in different sectors by three major surfaces, overlain by clastics, interpreted as break-up unconformities. Data point out to rifting beginning by a south branch of 300 km, followed by a central branch with 200 km and a finally a north branch of 300 km, separated by transforming faults. The complete process is supposed to have duration of c.30 MA. As a result of this process, the Tethys influence was definitely interrupted, leading to an Atlantic drainage in every sector, including the High Atlas Basin.

STEP 7 – Step 7 is marked by a global eustatic rise of sea level (Cenomanian-Turonian transgression) defining a transgressive pattern with shallow open platform carbonates, recorded in all the basins of the considered area. There is already a clear Atlantic context which is spreading everywhere in the region.

STEP 8 - In the northern border of Iberia, changes related with local geodynamic accommodation between moving plates, will lead to a north–south compression from the late Cretaceous on, initiating the Tertiary inversion of different basins and sectors, with erosion areas, uplift and installation of mostly terrestrial depositional systems.

CONCLUSIONS

The analysis of the basins infills, used here together with the comparison of their interpreted controls, allow to propose some main conclusions.

1. **There is a set of major unconformities which separate depositional packages and can be followed across several basins in the region.**
2. **These surfaces display some minor variable timings and durations, suggesting differences in space related with the controlling factors.**
3. **It is possible to model, as shown, the combination of both Atlantic and Tethys influences as far as geodynamic changings are concerned.**
4. **The Tethys influence is dominant during the early Mesozoic times, whether the Atlantic signature is prominent in late Jurassic and later on.**
5. **The paleogeographic influence of the Grand Banks continental block is likely to have been very relevant separating the Iberian basins from the Central Atlantic influences during the Early Jurassic times.**

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