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Tectonics

Tectonic relationships of Southwest Iberia with the allochthons of Northwest Iberia and the Moroccan Variscides

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Abstract

The Iberian Massif poses a problem of relationships between its northwestern and southern parts. Suture terranes (ophiolites and high-pressure rocks) crop out in NW Iberia but only as allochthonous units, unconnected from their root zone. Sutures cropping out in SW Iberia are discussed in order to relate them to the unknown root of the NW Iberia allochthons. On the other hand, the Moroccan Variscides are very briefly presented with a view to propose their correlation with the Iberian zones. Particularly important is the transition from the Variscides to the Paleoproterozoic basement in Morocco, which is a key argument for palaeogeographic reconstructions. ***To cite this article: J.F. Simancas et al., C. R. Geoscience 341 (2009).***

Résumé

Relations tectoniques du Sud-Ouest de l'Ibérie avec les allochtones du Nord-Ouest ibérique et le Maroc varisque. Le massif ibérique pose un problème de corrélation entre ses parties nord-occidentale et méridionale. Les affleurements de la suture (ophiolites et roches de haute pression) se localisent au nord-ouest seulement, sous forme d'unités allochtones sans lien avec la racine de la suture. D'une part, les sutures affleurant au sud-ouest de l'Ibérie sont discutées, dans l'optique de les relier avec les racines non connues de la partie allochtone du Nord-Ouest ibérique. D'autre part, la Chaîne varisque marocaine est brièvement présentée pour proposer des corrélations avec les zones varisques de l'Ibérie. Au Maroc, la transition du socle Paléoprotérozoïque à la Chaîne varisque est discutée comme étant un argument clé pour les reconstructions paléogéographiques. ***Pour citer cet article : J.F. Simancas et al., C. R. Geoscience 341 (2009).***

Keywords: Sutures; Correlations; Iberia; Morocco; Variscan orogen

Mots clés : Sutures ; Corrélations ; Ibérie ; Maroc ; Orogenèse varisque

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1. Introduction

The study of old, dismembered and reworked orogens must face the problem of putting together their dispersed fragments in order to reconstruct the precollisional palaeogeography. This is not an easy task, since the geometry of orogens changes across and along strike. This article aims to address two issues of this problem in the Variscan orogen, namely, correlations within the Iberian Massif and connections of Southwest Iberia with the African Variscides (Fig. 1). In our attempt, SW Iberia is the hinge to connect both to the North (NW Iberia) and to the South (NW Africa). Accordingly, we start with an extended up-to-date summary of the geologic features of SW Iberia, before undertaking the problem of correlations.

2. Southwest Iberia

The SW Iberian Variscides include the South Portuguese Zone (SPZ), the Ossa-Morena Zone (OMZ) and the southern part of the Central Iberian Zone (CIZ), containing two major tectonic contacts that coincide with the northern and southern boundaries of the OMZ (Fig. 2). The OMZ itself is a continental block whose Palaeozoic stratigraphy records an evolution characterized by:

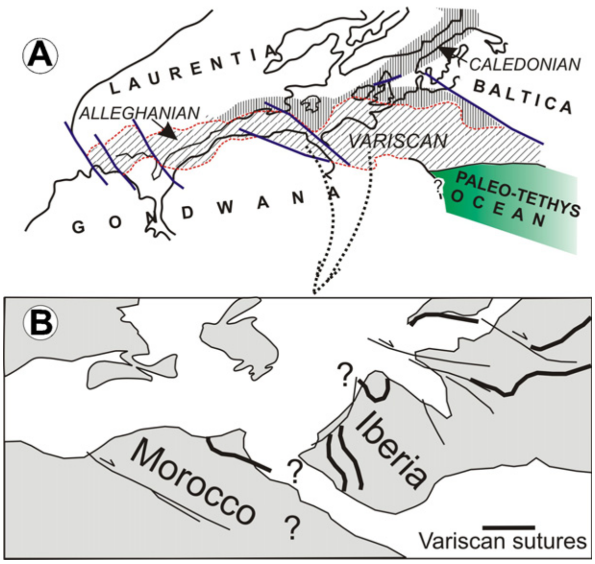

Fig. 1. Sketches showing the location of Iberia and Morocco in the Variscan–Alleghanian orogenic belt. Question marks in the lower sketch point out the issue of correlations addressed in this article.

Fig. 1. Schéma montrant la position de l'Ibérie et du Maroc dans la ceinture orogénique varisque et alléghanienne. Les points d'interrogation en bas du schéma montrent les thèmes de corrélations discutés dans cet article.

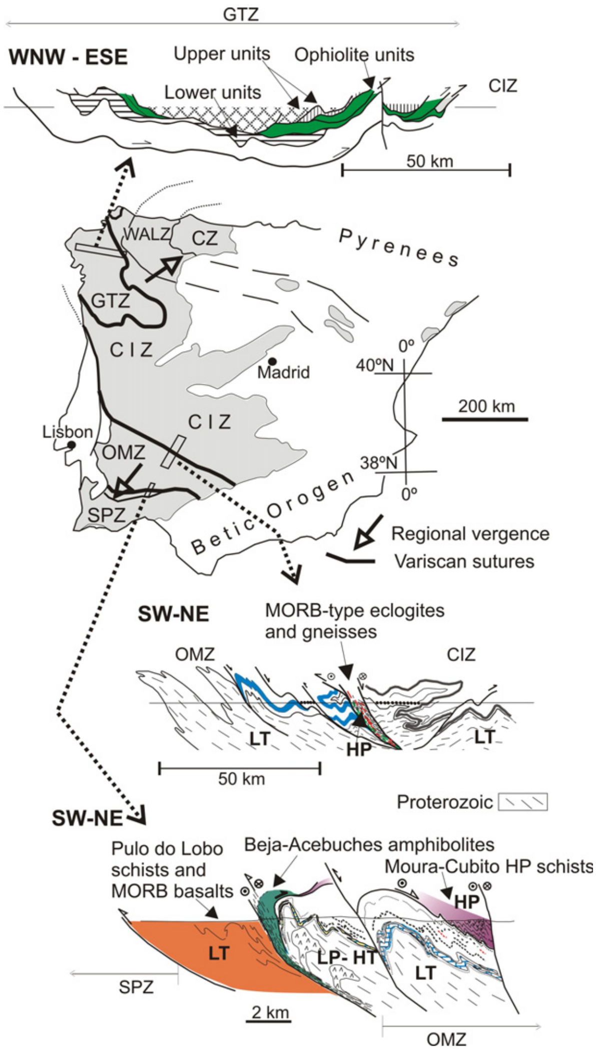

Fig. 2. Zones and sutures of the Iberian Massif. The three geological cross-sections show the suture units and the geometry of the sutures. The NW Iberia allochthons cross-section is simplified after Arenas et al. [3]. CZ: Cantabrian zone; WAL: Western Asturian–Leonese zone; CIZ: Central Iberia zone; GTZ: Galicia–Tras os Montes zone; OMZ: Ossa-Morena zone; SPZ: South Portuguese zone; HP: high-pressure metamorphism; LP–HT: low-pressure/high-temperature metamorphism; LT: low-temperature metamorphism.

Fig. 2. Zones et sutures du Massif ibérique. Les trois coupes géologiques montrent les unités de suture et la géométrie des sutures. La coupe des unités allochtones du Nord-Ouest de l'Ibérie est simplifiée d'après Arenas et al. [3]. CZ : Zone Cantabrique ; WAL : Zone occidentale de l'Asturie et Léon ; CIZ : Zone centrale ibérique ; GTZ : Zone de Galicia–Tras os Montes ; OMZ : Zone de l'Ossa-Morena ; SPZ : Zone Sud-Portugaise ; HP : métamorphisme haute pression ; LP–HT : métamorphisme basse pression/haute température ; LT : métamorphisme basse température.

- an Early Cambrian platform dominated by carbonates;
- rifting from the Early–Middle Cambrian to the Early Ordovician, with input of clastic sediments and magmatic rocks;
- Silurian pelagic black shales and radiolarian cherts;
- early orogenic clastic sediments in Early Devonian times;
- a Middle-Late Devonian hiatus related to a Devonian deformation phase;
- a synorogenic transtensional and magmatic event during the Early Carboniferous;
- a Carboniferous collisional deformation.

The boundaries of the OMZ are interpreted as sutures corresponding to oceanic domains developed in connection with the Early Palaeozoic rifting event recorded inside the OMZ [60].

Despite some controversy [1,6,51,61], we consider the OMZ northern boundary as a suspect suture based on the following arguments:

- it is the root of recumbent folds and thrusts of opposed vergence (Fig. 2), as suggested by surface structural geology [59] and imaged in the IBERSEIS seismic reflection profile [61];
- it coincides with a major ductile shear zone dipping to the north, with an average thickness of around 5 km and continuous outcrop along 250 km. Shearing has a main left-lateral component, as suggested by the presence of pervasive stretching lineation of low plunge and sinistral shear criteria. However, the metamorphic contrast with rocks bounding the shear zone also implies a remarkable dip–slip component [6];
- inside the shear zone there are, from top to bottom, medium- to low-grade aluminous schists, medium-grade calc-alkaline and alkaline orthogneisses, high-grade gneisses and retroeclogitic amphibolites. Up to now, all dated gneisses in the shear zone have yielded Early Palaeozoic protolith ages [5,41,42], while amphibolites have yielded Early Palaeozoic and Neoproterozoic ages [41]. The Early Palaeozoic amphibolites display MORB-type geochemistry [24]. Summing up, we view the OMZ/CIZ boundary as a suspect suture due to its structural relevance and the presence of eclogites and oceanic-type metabasites. However, it might not represent a wide oceanic domain, in view of Palaeozoic faunal similarities between the OMZ and the CIZ [53].

The southern boundary of the OMZ is usually considered as a suture because of the presence of three particular units (Fig. 2). These are the Beja-Acebuches amphibolites (BAA), the Pulo do Lobo schists and the Moura-Cubito schists and are discussed below:

- the BAA unit crops out as a nearly continuous strip of metabasic rocks along the OMZ/SPZ boundary, with oceanic-type geochemistry (MORB-type and back-arc type). It is commonly interpreted as a Variscan ophiolite of the Rheic Ocean realm [11,21,37,50]. However, these rocks have recently yielded an Early Carboniferous protolith age [7], i.e. they are younger than any Variscan ophiolite already described. Actually, the Rheic Ocean seems to have been consumed by subduction before the Early Carboniferous and this is a major difficulty in interpreting the BAA rocks as a Rheic-related ophiolite. Instead, the BAA unit might be formed during an extensional widespread magmatic event recorded all along SW Iberia at Early Carboniferous times, to which we will refer later. The BAA unit is affected by a high- to medium-grade shearing which, according to the nearly identical ages of metamorphism ($^{40}Ar/^{39}Ar$ on hornblendes [14]) and protoliths (SHRIMP U–Pb on zircons [7]), would have developed shortly after the formation of the mafic protoliths. The kinematics of this Early Carboniferous metamorphic shear zone corresponds to a left-lateral, top-to-the-southwest oblique thrusting, in agreement with similar age shearing in the northern border of the OMZ and with Late Carboniferous strike–slip faulting in the whole SW Iberia. Altogether, these data show that oblique (left-lateral) convergence in SW Iberia prevailed all along the Carboniferous period;
- the Pulo do Lobo unit (Fig. 2) is made up of highly-deformed low-grade schists and quartzites crowded with folded quartz veins, with the particular feature of including some MORB metabasalts associated to mélange-type metasediments [17,37]. This unit has been interpreted as a subduction-related accretionary prism. It must be pre-Late Devonian, since Upper Devonian slates and metasandstones unconformably overlie it [40,58];
- the third suture-type unit is a rather complex thrust sheet cropping out in the southernmost part of the OMZ (Fig. 2). Basically, it is made up of the Moura-Cubito schists, which show intercalations of other conspicuous lithologies, such as oceanic-type metabasites, nonoceanic (alkaline) eclogitic metabasites, marbles and gneisses. This ensemble has been interpreted as an allochthonous accretionary complex derived from a continental margin, which would incorporate obducted pieces of oceanic crust [2,22].

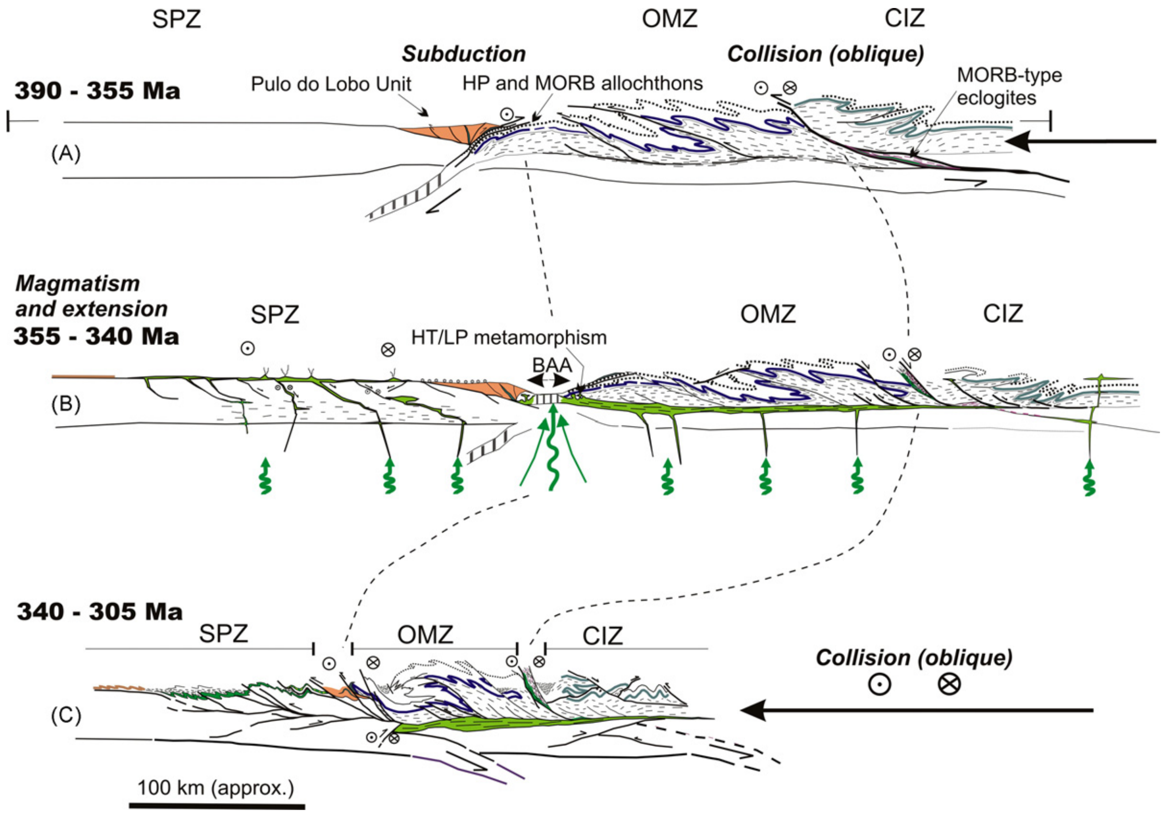

Fig. 3. Geological cartoon displaying our model for the evolution of SW Iberia. BAA: Beja-Acebuches oceanic-type Amphibolites. See text for more explanations.

Fig. 3. Esquisses géologiques montrant l'évolution du Sud-Ouest ibérique dans notre modèle. BAA : Amphibolites de type-océanique de Beja-Acebuches. Voir texte pour les explications.

The most probable root for this ensemble is the OMZ/SPZ boundary.

Fig. 3 summarizes our evolutionary model for SW Iberia. The first stage depicted (Fig. 3A) shows that the entire OMZ and the southern border of the CIZ record a main deformation of recumbent folds and thrusts in Devonian time. Thus, Middle–Late Devonian deposits are lacking and Lower Carboniferous ones lie unconformably on Cambrian or even Neoproterozoic rocks [59]. Devonian deformation is due to oblique convergence at the OMZ/CIZ boundary, after closure of an intervening domain which, based on the presence of eclogitic MORB-type 480–490 Ma-old metabasites [24,41], can be suspected to attest an Early Palaeozoic oceanic crust.

The OMZ/SPZ boundary has a different history, with continental collision delayed until Carboniferous times. Previous Early–Middle Devonian subduction built the Pulo do Lobo accretionary prism and obducted the accretionary complex onto the southern OMZ (Fig. 3A). The ocean between the OMZ and the SPZ would have been consumed just before the Early Carboniferous, drawing on the following arguments:

- the Upper Devonian deposits over the Pulo do Lobo seem to be continuous with deposits in the SPZ [40,56];
- the Lower Carboniferous pollen contents of both OMZ and SPZ sediments are similar [45].

Accordingly, the Early Carboniferous BAA unit can neither represent a remnant of the Rheic Ocean nor a late Rheic-related back-arc basin. Instead, these metabasites might be related to one of the most impressive features of SW Iberia: a voluminous Early Carboniferous magmatism (Fig. 3B).

Early Carboniferous volcanism (and some plutonism) is an extensive feature of the SPZ, where it is related to giant sulphide deposits [55]. Volcanism is also an important element of the Lower Carboniferous basins in the OMZ and the southernmost CIZ. Moreover, in the deep seismic reflection profile IBERSEIS all the OMZ middle crust appears as a variably thick (up to 2 s twt) high-amplitude complex reflective band, which has been interpreted as a lithologic package of mafic rocks (sills) interspersed with metamorphic rocks (Fig. 3B) [10,61]. Detailed wide-angle velocity modelling reveals abnormal high velocities for the OMZ middle crust, in agreement with the above interpretation [44]. Similar seismic features, i.e. high velocity layers and discrete thick packages of outstanding reflectivity have also been found in the upper crust of the SPZ, being also interpreted as mafic bodies intruding metasediments [44,57]. Furthermore, SW Iberia is characterized by a general positive Bouguer anomaly, in contrast with the negative anomaly of the remaining Variscan Iberia [28]. Thus, altogether, gravity outcrop and seismic data indicate dense (mafic) rocks in SW Iberia. In this context, the conspicuous BAA unit at the OMZ/SPZ boundary is likely to be another manifestation of this Early Carboniferous extensional/magmatic event, rather than an unbelievably young Rheic-related ophiolite (Fig. 3B). Late Visean time marked the end of this extensional/magmatic stage, the remaining Carboniferous period being a time of renewed continental collision in SW Iberia (Fig. 3C).

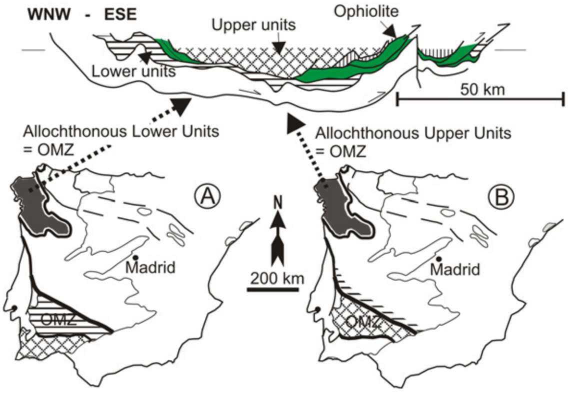

Fig. 4. Two alternative correlations of the SW Iberia zones with the NW Iberia allochthons. See text for discussion.

Fig. 4. Deux corrélations possibles entre les noyaux du Sud-Ouest ibérique et les allochtones du Nord-Ouest ibérique. Voir le texte pour la discussion.

3. Rooting the NW Iberia allochthons in continuity with SW Iberia

In NW Iberia, an allochthonous package (The Galicia/Trás-os-Montes zone) crops out over the autochthonous rocks of the CIZ (Fig. 2). This complex pile of allochthonous rocks includes ophiolite units sandwiched in between continental terranes [3,34,52]. Due to the curvature of the Variscan belt, the SW Iberia sutures are thought to have continuity with the roots of the allochthonous ophiolite units of NW Iberia (Figs. 1 and 2), though the correlation is far from being obvious. In order to tackle this issue, we assume that the two ophiolite ages found in the NW Iberia units (≈ 490 and 390 Ma [4,16,46]) represent different parts of the same oceanic realm, because no continental rocks separate the ophiolite units, i.e. the ophiolitic units represent a single suture. Furthermore, the orogenic structure between the roots of the NW Iberia allochthons and SW Iberia is assumed to be not so complex as to prevent a true reconstruction from the present-day outcrops. Provided these assumptions are correct, only two possibilities emerge (Fig. 4A and B):

- the root of the NW Iberia ophiolite is continuous with the OMZ/SPZ boundary;
- the root of the NW Iberia ophiolite has continuity in the OMZ/CIZ boundary.

Lithologic comparisons between the presumed equivalent terranes do not provide with solid arguments in favour of one of these two options, though zircon populations might give useful constraints in the near future. In this respect, the OMZ seems characterized by zircon ages jumping from the Paleoproterozoic (≈ 2000 Ma) to the Neoproterozoic (700–600 Ma), with a Mesoproterozoic gap [20]. The SPZ lacks studies on zircon populations but, assuming it to be a portion of Avalonia, it is expected to contain Mesoproterozoic zircons [23,32,39]. Thus, future studies on SPZ zircons are needed and comparisons established with zircon populations of the NW Iberia units, with a view to discriminate whether the units thrust onto the NW Iberia ophiolites, correspond to SPZ-type crust or to OMZ-type crust. Preliminary data [19] indicate that the Upper units of the NW Iberia tectonic pile have zircons recording Paleoproterozoic but not Mesoproterozoic ages. Thus, drawing on the fact that the NW Iberia ophiolites lie over units generally attributed to the CIZ, the easiest solution is to directly correlate the NW Iberia suture with the OMZ/CIZ boundary (Fig. 4B [60]).

4. A very brief account of the Moroccan Variscides

The Moroccan Variscides can be subdivided into the eastern Meseta, the western Meseta and the coastal Block. The front of the Variscan belt is observed in the Anti-Atlas region, as a progressive transition to

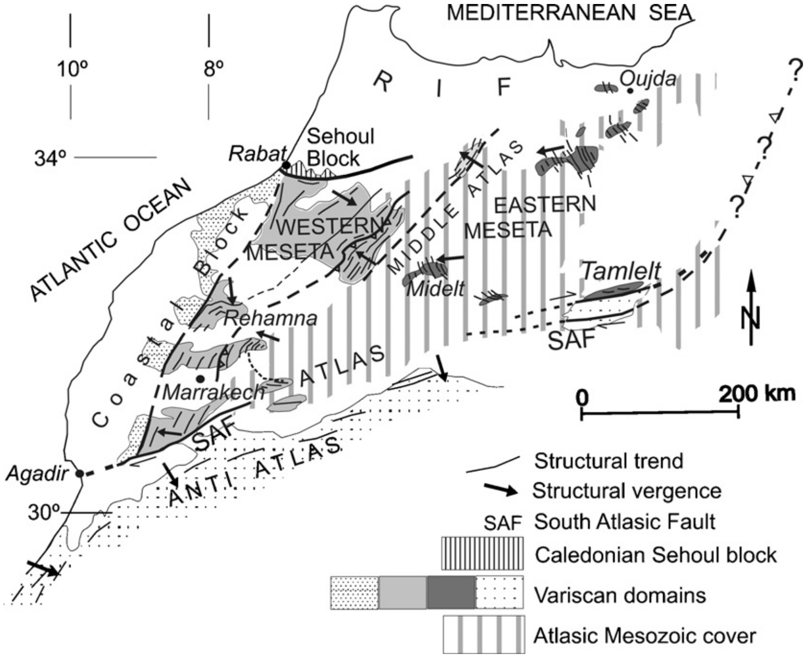

Fig. 5. Simplified geological map of the Moroccan Variscides (based mainly on Hoepffner et al. and Houari and Hoepffner [26,27]). The meaning of the South Atlasic Fault and the hypothesis of its connection to the east with a subduction boundary (indicated with question marks) is particularly discussed in the text.

Fig. 5. Carte géologique simplifiée de la Chaîne varisque du Maroc (d'après Hoepffner et al. et Houari et Hoepffner [26,27]). La signification de l'accident sud-atlasique et l'hypothèse de sa connexion vers l'est avec une frontière de subduction (marquée par des points d'interrogation) est particulièrement discutée dans le texte.

nondeformed Palaeozoic series overlying a Precambrian basement (Fig. 5).

Two main stages of Early and Late Carboniferous ages can be distinguished in the evolution of the Moroccan Variscides [25,26,48]. The Early Carboniferous was a time of development of subsiding areas (basins) and compressed highs. In the basins volcano-sedimentary series were deposited, while in the highs north–south to NE–SW trending folds were formed (Fig. 6A). To explain this scenario, a tectonic regime of transpression has been suggested [8], which fits well in the context of indentation of the Newfoundland Grand Banks (Fig. 6B). The Late Carboniferous tectonic scenario was different, featuring a generalized compression responsible for folds trending ENE–WSW, which suggest a clockwise rotation of the compression during the Carboniferous (Fig. 6C and D).

The volcano-sedimentary character of the series deposited in the Lower Carboniferous basins has been taken by some authors as an argument to correlate the Moroccan Variscides with the SPZ of Iberia. However, the Lower Carboniferous magmatism may be a foreign element superimposed to the normal orogenic evolution, in a similar way to the one envisaged for the abundant contemporaneous magmatism in SW Iberia. Actually, in the neighbouring Maritimes Basin of eastern Canada, important volumes of Latest Devonian to Lower Carboniferous continental tholeiites and felsic rocks crop out [15], and geophysical data suggest the existence of more underplated mafic rocks [33]. Thus, magmatism characterizes a wide geographic region at Early Carboniferous times, straddling very different geological domains (Fig. 6B). Expanding previous proposals regarding SW Iberia and Canadian Maritimes magmatism as related to a mantle plume [15,38,61,63], we suggest that the magmatic productivity found in Morocco at this time resulted from a favourable regional tectonic regime of local transpression coupled to a large-scale mantle anomaly.

5. Correlation of the Moroccan Variscides with the Iberian Massif

The previous discussion led us to suggest that the similarity of the Lower Carboniferous series found in Morocco and SW Iberia can be explained by the influence of a large-scale phenomenon (mantle plume) foreign to the orogenic architecture. Consequently, we

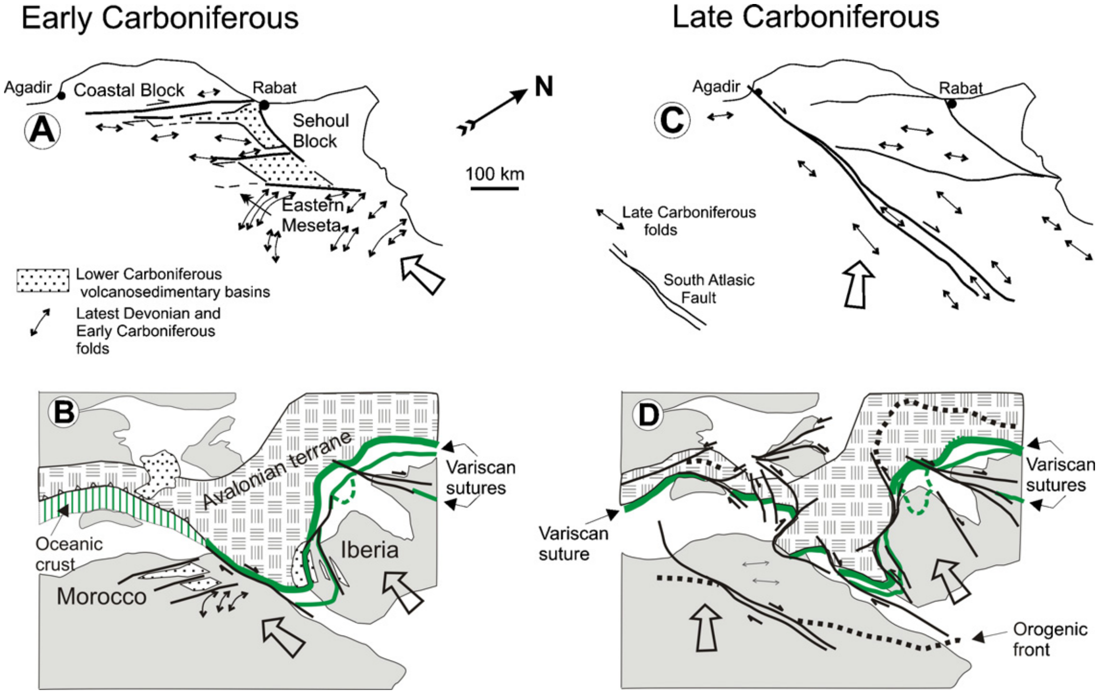

Fig. 6. Two main stages, Early and Late Carboniferous, in the evolution of the Moroccan Variscides. Early Carboniferous: sketch of the trend of the structures (A) and tectonic scenario for that regional structural pattern (B). Note the coeval development of basins and compressed highs in Early Carboniferous times (after Bouabdelli and Piqué [8]), while abundant magmatism was produced at this time in a wide area extending at least from the northern Appalachians (Maritimes Basin) to SW Iberia and Central Morocco. Late Carboniferous: sketch of the trend of the structures (C) and tectonic scenario for that regional structural pattern (D). See text for further explanations.

Fig. 6. Deux stades principaux dans l'évolution de la Chaîne varisque du Maroc. Carbonifère inférieur : schéma des directions des structures (A) et scénario tectonique correspondant (B). Notez que, lors du Carbonifère inférieur, il y avait un développement plus ou moins simultané de bassins et de rides en compression (d'après Bouabdelli et Piqué [8]) et qu'un abondant magmatisme a été produit pendant ces temps dans une vaste région s'étendant au moins des Appalaches Nord au sud-ouest de l'Ibérie et au Maroc central. Carbonifère supérieur : schéma des directions des structures (C) et scénario tectonique correspondant (D). Voir le texte pour plus d'explications.

discard this resemblance as an appropriate element for correlation of orogenic domains, thus emphasizing the need of considering other arguments.

The Gondwanan affinity of the Moroccan Variscides (i.e. Late Ordovician periglacial platform, Early–Middle Devonian benthic faunas and facies similar to those of Bohemia) and the apparent continuity of Ordovician and Devonian deposits from the Mesetas to the orogenic front of the Anti-Atlas [47] suggest that the Moroccan Variscides were part of the Gondwana margin. In this same view, the resemblance between central Iberia and the western Meseta of Morocco in terms of the typology of Carboniferous granitoids has been highlighted [18]. However, this interpretation is in apparent contradiction with the calc-alkaline signature of the Lower Carboniferous volcanism in the eastern Meseta [31,54], for which a subduction factory has been proposed [54]. The latter authors propose, following a previous suggestion by Boulin et al. [9], the existence of a major Carboniferous subduction zone (nowadays covered by younger sediments) dipping to the west, in the easternmost part of the Moroccan Variscides (Fig. 5). Since the orogenic front can be observed in the Anti-Atlas, the proposed major suture must necessarily continue somewhere between the Mesetas and the Anti-Atlas. The only candidate for that role is the South-Atlasic fault (Fig. 5), which has been considered by some researchers as a main Variscan fault [35,48].

The relevance of the South-Atlasic Variscan fault (SAF) is a little confusing due to both Mesozoic covering and Alpine structural reworking (Atlas Mountains building). The SAF crops out in two sectors located at Tamlelt and northeast of Agadir (Fig. 5). At Tamlelt, the SAF has been described as a 40 km-wide, heterogeneous, transpressional, ductile-to-brittle, dextral shear zone [27]. Simple calculations made by these authors suggest a mean shear strain of $\gamma \approx 1$. Despite great difficulties to quantitatively assess such a heterogeneous shear zone, the above estimation points to a lateral displacement of around 40 km, perhaps greater if there is additional slip along purely brittle faults. The outcrop of the SAF northeast of Agadir consists in a 200 km-long lineament studied in some detail by Proust et al. [49] who estimated a dextral displacement of 50 km. Actually, geological mapping indicates that the fault does not separate different Palaeozoic domains, with very similar Cambrian and Neoproterozoic rocks cropping out at both sides of the fault. Summing up, the appearance of the SAF is far from what would be a Variscan transform fault related to a major subduction zone, as the one invoked by Roddaz et al. [54]. Though we do not share the interpretation of Ouanaimi et Petit [43], who minimize the SAF dividing it into two independent segments separated by a central unfaulted block, we believe inconsistent not only the transform (suture) interpretation but also interpretations giving to the SAF the category of a major Palaeozoic continental fault accommodating the whole shortening of the Moroccan Variscides. In this respect, the dextral displacement of the SAF [27,49] does not seem compatible with the Early Carboniferous fold trending (Fig. 6A and B). Therefore, the dextral SAF could only have accommodated the Late Carboniferous deformation (Fig. 6C and D). To conclude, the hypothesis of a hidden major Variscan suture to the east of the eastern Meseta [9,54] can neither be sustained on the basis of the nature of the SAF fault, nor considering the lack of HP and MORB-featured rocks anywhere in the Moroccan Variscides [25,26,47,62].

6. An elementary pre-Variscan palaeogeography

The very voluminous background of research on the Caledonian, Appalachian and Variscan orogenic belts has proved that the Palaeozoic evolution of the northern border of the Gondwana supercontinent was rather complex. It involved the Early Palaeozoic breaking away of a number of terranes who experienced variable wanderings (some of them remaining close to Gondwana) before their docking in the Palaeozoic orogens [12,13,29,30,36,64,65]. Moreover, the breaking without wandering of the continental platforms around Gondwana, gave way to a variety of palaeogeographies at the regional scale. In this general scenario, the Moroccan Variscides insert in the fractured margin of Gondwana, recording a preorogenic evolution of platform with regional rift corridors. In other words, no sutures related to Palaeozoic oceanic domains developed anywhere in

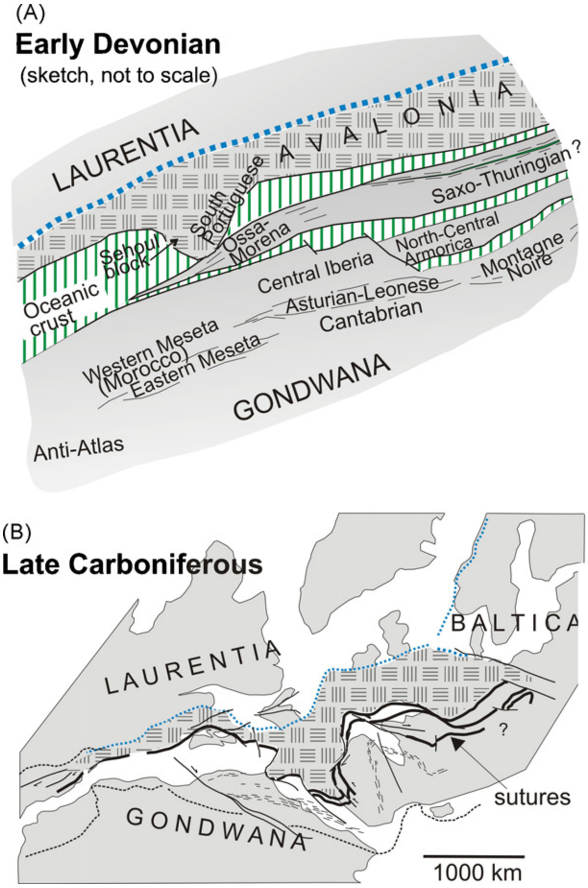

Fig. 7. A. Palaeogeographic sketch of Early Devonian times, showing a possible arrangement of Variscan continental domains and intervening oceans. B. Sketch of the Variscan–Alleghanian orogen after complete collision at the end of Carboniferous times.

Fig. 7. A. Schéma paléogéographique du Dévonien inférieur montrant la position possible de nombreux domaines continentaux et océaniques varisques. B. Schéma de la géométrie varisque–alléghanienne après la collision complète à la fin du Carbonifère.

the outcropping Variscides of Morocco. The western Meseta of Morocco easily correlates with central Iberia, from the stratigraphic point of view as well as from the common presence of metaluminous S-type granites. The eastern Moroccan Meseta has its orogenic counterpart in northern/northeastern Iberia, both of them near the southern Variscan front. Instead, the zones of SW Iberia and the sutures in-between (Fig. 2) seem to have no equivalent in Morocco. Accordingly, our elementary palaeogeographic picture is presented on Fig. 7, which also includes tentative correlations towards central Europe discussed in earlier papers [60,62]. As a final point, we note that some recent palaeogeographic maps show a Devonian–Early Carboniferous Palaeothetys ocean separating central and northern Iberia from

Gondwana [12,64]. However, such a picture is inconsistent if the correlations presented above between the Moroccan Mesetas and Iberia are correct, since no suture exists between the Meseta domain and the Anti-Atlas foreland.

7. Conclusions

Along-strike changes are inherent to orogenic architecture, thus complicating palaeotectonic reconstruction of ancient mountain belts, such as the Variscides, which are affected by terrane-dispersion and discontinuous outcrop. Our discussion of the orogenic reconstruction in the southern Variscides can be summarized in the following conclusions.

The Variscan outcrops of SW Iberia must be interpreted in terms of the interplay between a Palaeozoic orogenic evolution, recorded in two orogenic sutures at the boundaries of the OMZ, and an overimposed mantle-plume type Early Carboniferous magmatism straddling suture boundaries. The same Early Carboniferous magmatic event has been recognized elsewhere in the Canadian Maritimes and Morocco.

In NW Iberia, a Variscan suture has been recognized in ophiolitic allochthonous units thrust onto the central Iberian authocthon. Provided that the allochthonous ophiolitic units correspond to a single suture, it can be correlated reasonably with the northern boundary of the OMZ in SW Iberia.

The Moroccan Variscides do not show any orogenic suture, thus suggesting the absence of closed Palaeozoic oceanic domains. Therefore, the orogenic correspondence of the Moroccan Variscides with SW Iberia can no longer be sustained. Instead, the Variscan Mesetas of Morocco correlate well, based on stratigraphic affinities and granitoid similarities, with central and NE Iberian outcrops.

The Moroccan Variscides are the only Variscan segment showing the transition from the Variscan belt to the Paleoproterozoic basement. This fact together with the proposed correlations between Morocco and Iberia are important constraints for Devonian–Early Carboniferous palaeogeographic reconstructions of the southern Variscides.

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