

**To Topical Editor:** Juan Gómez-Barreiro

Dear editor,

Thanks for your message. It is rather unusual to receive a third revision from an editor, but we have tried to follow your last remarks. See below some explanations, because we have not properly understood some of your queries.

*A) It is not clear how the authors choose the studied areas in the Iberian Massif. A short description on these criteria could be very useful for the interested reader.*

The criteria for the selection of the targeted study areas was (and still is) explained at the end of the Introduction section. “Until now the Toledanian and Sardinic magmatic events had been studied on different areas and interpreted separately, without taking into account their similarities and differences. In this work, the geochemical affinities of the Furongian–Early Ordovician (Toledanian) and Early–Late Ordovician (Sardic) felsic magmatic activities recorded in the Central Iberian and Galicia-Trás-os-Montes Zones, Pyrenees, Occitan Domain and Sardinia are compared. The re-appraisal is based on 17 new samples from the Pyrenees, Montagne Noire and Sardinia, completing the absence of analysis in these areas and wide-ranging a dataset of 93 previously published geochemical analyses throughout the study region in south-western Europe”.

• Besides, according to up-to-date references (e.g. Martínez Catalán et al 2019; [https://doi.org/10.1007/978-3-030-10519-8\\_4](https://doi.org/10.1007/978-3-030-10519-8_4)), the Cantabrian, Westasturian-Leonese and Central Iberian zones were part of the Gondwana margin at that time span (broadly autochthon), while in the Galicia -Trás-os-Montes zone (Allochthon), only those units below the Ophiolites are clearly of that affinity (Basal and Parautochthon units). This connects with the non-usual division of the Iberian Massif in the Figure 1 which is not explained in the text. Please better use para-autochthon from the greek Παρά.

We agree in considering the CZ, WALZ and CIZ as part of the Gondwana margin. However, these units cannot be considered as a Variscan “autochthon” as they are overthrusting them toward the (present-day) NE. So the question is: do we use the term “autochthon s.l.”, the term “(par-)autochthon” (as suggested in the previous version) or simply “autochthon” (as many colleagues suggest though all of us consider this term as a very broad approximation)? A parautochthon is always “by comparison with” another unit, so this term fits well for the CZ, WALZ and CIZ units. We know that the “official terminology” used by Variscan-ologists is to call this “Autochthon” but we politely disagree.

We do not understand which is the “non-usual division” of the Iberian Massif used in Fig. 1 (probably you refer to Fig. 1A). The previous works on which this figure is based occur in the figure caption. We have modified the outline of the GTMZ in Figs. 1A and. 1B; maybe this was what you suggested in your query.

• Some suggestions about other parts of the Figure 1 (e.g. 82-Saldanha and 90-Urra are not in the map!) are included as comments in the PDF attached to this report.

The tiny outcrops of 82-Saldanha and 99 (now 90)-Urra are indicated in the figure.

*B). Regarding the geological setting it is important to note that:*

*B. 1) In the Central Iberian Zone an Upper Ordovician unconformity has been identified in two zones: the Truchas syncline and to the east of the Morais Allochthonous Complex. Data could be raised from Martínez Catalan et al. (1992) and Sarmiento et al. (1999) for the earlier, and from Dias da Silva et al. (2011), Dias da Silva et al. (2014) and Dias da Silva et al. (2016) for the latter. This data may well be included in the paper for their relevance, either for stating the existence of this unconformity, or for refuting it based on later/own data.*

We disagree. It is obvious we have different perceptions of the same data.

(i) In the Truchas Syncline, Martínez Catalán et al. (1992) suggested the presence of some “syn-sedimentary normal faults, though they had probably some strike-slip component, and

gave rise to a half-graben in which a syn-rift sequence was deposited”, based on distinct modifications in the thickness of the involved formations.

In contrast, Sarmiento et al. (1999) clearly indicated that a conodont-based biostratigraphic analysis contradicts a part of the synsedimentary tectonic model proposed by Martínez Catalán et al. (1992). The former authors described a Hirnantian glaciogenic unconformity capping a conformable succession formed by the Luarca and Casaio formations. In fact, the authors stated that “there are two opposed interpretations for the Upper Ordovician sedimentary context in the area, one based on the Hirnantian glaciogenic activity” (Sarmiento et al., 1999) and the other on extensional tectonic processes (Martínez Catalán et al., 1992). The latter was explained as a result of rift-related extensional pulses leading to the record of horst-and-graben palaeotopographies sealed by overlying strata (re-dated by Sarmiento et al. as Hirnantian and glaciogenic in character).

In any case, to avoid everlasting discussions, this “apparent” unconformity (or unconformities if they are several ones) could be related either to (i) glaciogenic activity (the chronostratigraphic conodont-based control of the Rozadais Formation precludes the interpretation of its base as tectonically induced; and (ii) extensional pulses leading to the onset of (half-)grabens. Even accepting the second interpretation, these events are overabundant in the Cambrian rifting and Ordovician passive-margin framework of SW Europe. These discontinuities are not marked in the figure 2 because they are abundant, such as those marking the lower-middle Cambrian transition in the CZ, the Iberian Chains and the Montagne Noire. We have not included them and we should not make an exception for the Truchas syncline. An unconformity is not necessarily equivalent to a tectono-thermal event; on the contrary, many of them can be interpreted as a result of sea-level changes, and these are not issued in our paper.

(ii) In the Morais Allochthonous Complex, an interpretative figure occurs in Dias da Silva (2013), interpreting this unconformity as a result of an extensional pulse related to a low-angle discordance and the distal disappearance of the Moncorvo black shales. Again, this is a syn-sedimentary unconformity associated with extensional conditions, associated with basic volcanics (basic not felsic, so no considered in our work) and similar to many other local extensional breakdowns that are not considered in our work. Therefore, we should not include them. Please, do not tell us that you consider this event as representative of the Sardic Phase simply because it is written in some papers. No arguments support this proposal.

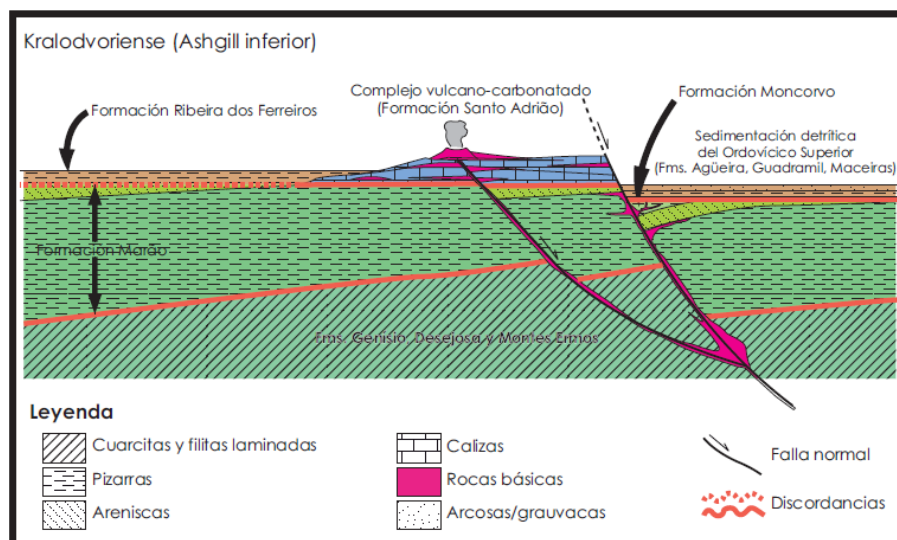


Figura 3.31 - Esquema interpretativo de la disposición de las unidades vulcano-carbonatadas de la Formación Santo Adrião. A semejanza del esquema propuesto para la Caliza de la Aquiana y la Formación Agüeira al Norte del Sinforme de Truchas (Martínez Catalán *et al.*, 1990), la sedimentación detrítica se desarrolla en lugares marginales a las plataformas carbonatadas, donde las condiciones no son ideales para la formación de estructuras biohémicas. La erosión previa al depósito del complejo vulcano-carbonatado produjo la discordancia angular con las formaciones de Marão y Vale de Bojas y la total desaparición del Ordovícico medio por debajo de la Formación Santo Adrião.

Let's read before what Da Silva et al. (2016) have written. They consider this discontinuity as the Sardinian unconformity because: "The regressive character of the basal Upper Ordovician sedimentary record in both domains points to the formation of horsts and half-grabens of local extent combined with the deposition of limestone beds in the shallower areas, deposited over the Sardinian Unconformity" (Fig. 3). It reads in Fig. 12 caption: "Tilting and gentle folding of the Lower-Middle Ordovician strata, due to the rotation of individual half-grabens and horsts, create the Sardinian Unconformity in Iberia". So, it is clear that Da Silva and co-authors are proposing a Sardinian Phase marking the base of the Upper Ordovician in the GTMZ and the CIZ simply based on the record of extensional breakdowns affecting the basement and developing normal faults. This is not at all the Sardinian Phase, but a localized extensional pulse with no cortical uplift + erosion of the uplifted areas under subaerial exposure + intrusion of calc-alkaline granites (now preserved as orthogneisses) + record of gaps of about 25-30 m.y. + record of alluvial-fluvial deposits overlapping the unconformity.

Although we would have preferred avoiding entering in this discussion, your remark has encouraged us to add a new paragraph discussing Días da Silva et al.'s surprising idea:

"The Sardinian Phase has been somewhat proposed marking a stratigraphic discontinuity close to the Middle-Upper Ordovician boundary interval in some areas of the Central Iberian (e.g., Buçaco and the Truchas Syncline; Martínez Catalán et al., 1992) and the Morais Allochthonous Complex of the Galicia-Trás-os-Montes Zones (Días da Silva et al., 2011, 2014, 2016; Días da Silva, 2013). In the Truchas Syncline, the significance of the discontinuity (or discontinuities) was questioned by a biostratigraphic study of conodonts and the re-interpretation of some of these scouring surfaces as the result of Hirnantian glaciogenic incisions (Sarmiento et al., 1999). The pre-Hirnantian discontinuities have been interpreted as linked to the development of "horsts and half-grabens of local extent", as a result of which "tilting and gentle folding of the Lower-Middle Ordovician strata, due to the rotation of individual half-grabens and horsts, create the Sardinian unconformity in Iberia" (Da Silva et al., 2016: pp. 1131 and 1143). However, the presence of synsedimentary listric faults associated with local outpouring of a basic volcanism, related to extensional pulses in the Ordovician passive-margin platform fringing Northwest Gondwana, cannot be associated with the Sardinian Phase. As summarized in this work, the Sardinian Phase is characterized by generalized cortical uplift, denudation of exposed uplifted areas under subaerial exposure, stratigraphic gaps of about 25–30 m.y., broad intrusion of felsic granitic plutons (now orthogneisses after Variscan deformation and metamorphism) with calc-alkaline affinity, and record of alluvial-to-fluvial deposits overlapping the unconformity. These are the features that characterize the Ordovician Sardinian Phase, not the record of Ordovician volcanism and of local listric faults. In contrast, the Sardinian aftermath is represented by abundant basic volcanic activity, mainly of tholeiitic affinity, and lining rifted branches highlighting the onset of listric-fault networks; this event could be compared with some processes recorded in the Central Iberian and the Galician-Trás-os-Montes Zones, but not with the Sardinian Phase. Therefore, the presence of the Sardinian Phase in Iberia was already ruled out by the information published during the last two decades, and should not be maintained except if the above-reported tectonothermal events are really found in Iberia. The presence of an Ordovician volcanism associated with local listric faults is not an argument to support the record of the Sardinian Phase".

*B.2) In the oriental areas included in the paper, a short comment is made on the presence of basic volcanic bodies at the considered ages, which are not included in the research. In order to have a more consistent geological setting between the several domains, the Truchas (Truchas syncline) and Santo Adrião (east Morais) basic volcanics (MAGNA map, Dias da Silva et al., 2011; Días da Silva et al., 2016) could also be included as a minor comment*

This has considered in the above paragraph (see previous remark).

*B.3) As figure 2 is an important asset of the paper, especially for readers with scant knowledge of some areas geology, several improvements would be inserted. In the CIZ the Cambrian sequence reflects only the southern part; lacking the Terreneuvian and Series 2 sequence of the northern part (Díez Balda, 1986). In the Upper Ordovician, the unconformity may well be reflected. A minor mistake exists in La Aquiana limestone's spelling. In Truchas area, the Upper Ordovician is mainly terrigenous and divided in Casaio, Rozadais and Losadilla formations,*

being the limestone (La Aquiana) a minor and discontinuous unit; for this reason the now reflected sequence is misleading. In the GTMZ only the Upper Parautochthon must be included, as the Lower Parautochthon is a sequence of Variscan synorogenic origin displaying ages from Uppermost Devonian to Carboniferous (Oliveira et al., 2019). In the UP the sequence does not reflect the proposed for Dias da Silva et al. (2016), as it doesn't include the voluminous Middle-Upper Ordovician acid and basic volcanism of the Morais Complex (Peso). The labels and legend must be revised as some mistakes have been found (including lost references which will help to fit data and sketch, especially on the older known ages for the Ollo de Sapo).

The Ediacaran-Cambrian lithostratigraphic chart of what you call "northern part of CIZ" is in need of re-evaluation. Díez Balda (1986) proposed a lithological subdivision and Valladares et al. (2000, 2006) proposed a subdivision into labelled facies associations (Ediacaran units I to IV, and Cambrian Units V to XII underlying the Tamames Sandstones). In our opinion, adding such a nomenclature would complicate the readability of the figure and we prefer avoiding it because we have not used these units in the paper. The remaining proposals have been updated. Thanks.

Regarding the suggestions marked in the pdf file:

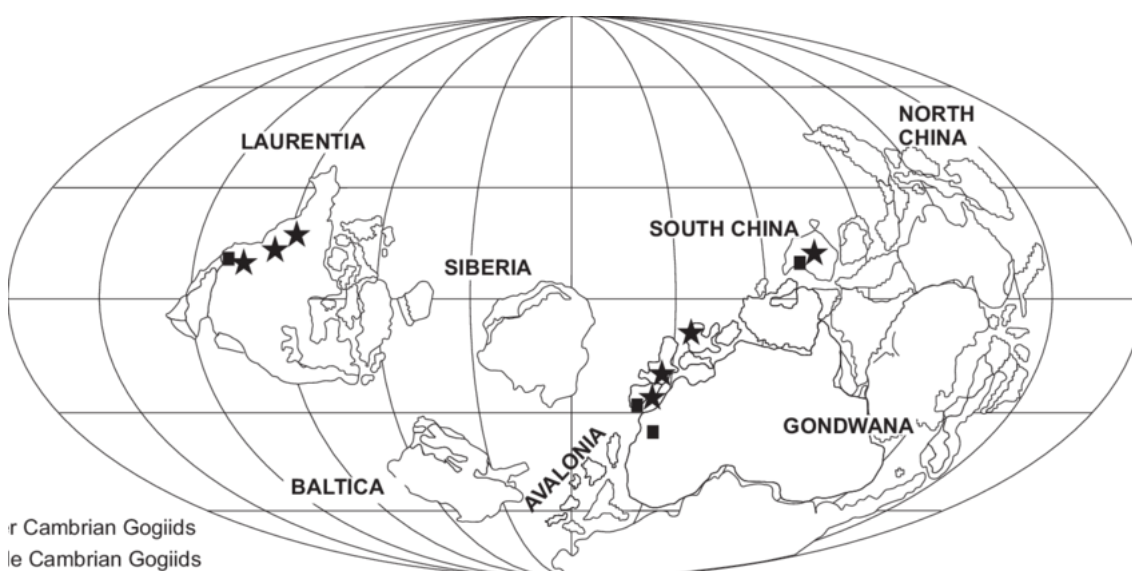
Lines 74: As no new data supporting the relationship between magmatism and the Sardinian unconformity are offered, it will be better to state both events are coeval.

The age of the Sardinian volcanism ranges from Early to Late Ordovician, and the gaps associated with the Sardinian unconformity (uplift + erosion + marine transgression and deposition) are about 16-20 m.y. In short, the gap is 16-20 m.y., whereas the magmatic activity took place during a time span of about 25-30 m.y. (from 475 to 445 Ma). Broadly speaking, both ranges can be considered as "contemporaneous".

Line 77: A comment on the presence or absence of folding and schistosity related to the Sardinian Phase must be added.

It is done.

Line 126. "A SW-NE palaeogeographic transect" is in today coordinates. We disagree, today we would follow a W-E trend, and all the palaeogeographic reconstructions of West Gondwana, during Cambrian times, show a SW-NE margin of Gondwana, e.g.:



Line 278. We have deleted "Furongian strata" as it misled the real information. Thanks.

Figures: they are updated following your remarks, except the Ediacaran-Cambrian lithostratigraphic subdivision in Salamanca, which is in need of re-evaluation.

Thanks again for your editing revision.