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Interactive comment on "Comparative geochemical study on Furongian (Toledanian) and Ordovician (Sardic) felsic magmatic events in south-western Europe" *by* J. Javier Álvaro et al.

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REVIEWER – JOACHEM MEZGER

Many thanks for such a detailed revision. All the words and phrases highlighted in the Similarity Report have been re-written following your advice, except one question: "upper Cambrian" is a former statement of Furongian (we indicate now both terms).

The main problem is that a lot of data is being presented and discussed without providing a sufficient overview, leaving the reader a bit lost. A more concise presentation of the published data, and a discussion how their new analytical data adds to the un-

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derstanding of the geodynamic setting would improve the paper. In the discussion of the geodynamic setting of the Ordovician magmatic events it is not always clear what is a recapitulation of other authors and their own contribution. Better structuring should make this more clear.

The overview is clearly established in the figures 1 (tectonostratigraphic setting of samples), 2 (litho- and chronostratigraphic emplacement of samples) and Table 2 (summary of the geochemical features shown by the distinguished magmatic groups in which all the dataset has been subdivided). In the Introduction, it is now highlighted that "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." When the paper documents the geochemical subdivision of the study samples (new and previously published), we have differentiated new and already known data. However, in the geochemical discussion, we have characterized and discussed the geochemical dataset with its subdividing groups. As stated above, the new data allow completing the precious incomplete dataset from Montagne Noire and Sardinia.

Specific comments: The title is too general and unimaginative, suggesting that the paper only presents data. The key finding of this study should be reflected in the title.

We follow referee's advice and added a second subtitle explaining the geodynamic significance of the paper: "underplating of hot mafic magmas linked to the opening of the Rheic Ocean".

If I am correct, the Toledanian phase lasted into the early Ordovician. If so then the title is misleading as it reads ". . .Furongian (Toledanian) and Ordovician (Sardic) felsic magmatic events. . ."

Yes, we have adapted the title updating the "Furongian–earliest Ordovician (Toledanian)" character.

The introduction could be improved by stating the problem and the objective of the study, the latter of which is listed in the final paragraph. Also, it would be helpful to give an approximate time frame of the Toledanian and Sardic phases.

The problem was (and is) stated in the last paragraph: “Until now the Toledanian and Sardic 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 main purpose is written in the last sentence: “This comparison may contribute to a better understanding of the meaning and origin of this felsic magmatism, and thus, to discuss the geodynamic scenario of this Gondwana margin during Cambrian–Ordovician times”. The time frame of the Toledanian and Sardic Phases is repeated several times in the Introduction: “Furongian–Early Ordovician (Toledanian) and Early–Late Ordovician (Sardic)”. Later the referee suggests adding a new figure with a chronological distribution of the Toledanian and Sardic magmatic activities: this is now included in the new figure 3 (Relative probability plots of the age of the CambrianâĂŠOrdovician magmatism).

Some statements in the first paragraph (“but they are related to neither metamorphism nor penetrative deformation”, line 57) should be accompanied with key references.

Done.

The author’s own new analytical data should also be mentioned in the introduction with a justification on why it was deemed necessary. As it is, there is no mention of it and the reader has the impression that this is purely a review paper.

We repeat the response to the first query: “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."

Geologic Setting: A lot of geochronological data is presented with detailed listing of the age uncertainties, e.g. 478.1 +/- 1.2 Ma. Since it is not their own data, this can be represented as ca. 478 Ma. And instead of listing every single age of an orthogneiss complex, the ages of a zone can be summarized, e.g. 471-450 Ma for the migmatitic orthogneisses of the Montagne Noire (lines 289-291).

We follow this advice and have maintained the age uncertainties only in the figure captions.

When the authors discuss the Pyrenees, they refer to the Eastern Pyrenees. While most of the data is from the Eastern Pyrenees, the Aston and Hospitalet domes, discussed by Denèle et al. and Mezger & Gerdes, are located in the Central Pyrenees. So, I would refer to chapter 2.2 as "Central and Eastern Pyrenees".

It is true. We have updated the text to the description and interpretation of samples from the Central and Eastern Pyrenees.

In line 279 they refer to "augen gneisses" (the actual spelling is "augengneiss) as metamorphic high-grade gneisses. I don't think that is correct. The term augengneiss refers C2 SED Interactive comment Printer-friendly version Discussion paper to the microstructure, large augen (commonly, but not restricted to K-feldspar) in a finer grained matrix, mainly in metagranites. There is no direct metamorphic association, although most metagranitic augengneisses are probably amphibolite facies.

We explain now this point by explaining the equivalence between "augen gneiss" and "augengneiss" (lines 286-287).

At last, a map showing the trend of Ordovician ages throughout western Europe would nicely summarize this chapter and provide some needed overview.

As explained above, this has been done in the new figure 3.

Geochemical data: Since the authors also present new data, a paragraph on the analytical methodology should be included, as well as where the analyses were made. This is completely missing.

A new section entitled “Material and methods” is added explaining the analytical methodology and the labs where the geochemical analyses were made.

Similar to the Geologic Setting chapter, a lot of detailed geochemical data is presented, making for a repetitive reading. Most of the major elements data can be represented in an extra figure, and individual magmatic suites referred to as “potassium-rich dacite to rhyolite” (line 417) without listing the range of major elements.

We have deleted the descriptive repetitions made in this section and summarized them in the new Table 2.

The discussion of epsilon Nd data is a bit spotty. First, it is unclear in the text what epsilon Nd values are discussed (line 422). Obviously, they are not the present day values but those at the time of emplacement.

We refer to isotopic ÆŘNd(t) values: the suffix “(t)” is added throughout the paper.

Second, line 429 refers to erroneous TDM values, without elaborating what they are. Third, in the same sentence, a 147Sm/144Nd ratio of greater than 0.13 is considered high. That is an average value even for felsic rocks, mafic and ultramafic rocks can have ratios of 0.3. There needs to be some clarification.

Yes, this point was not discussed in detail. We have explained (see lines 644-654) that: “display anomalous TDM values and 147Sm/144Nd ratios > 0.17 (Table 2; Fig. 14), a character relatively common in some felsic rocks (DePaolo, 1988; Martínez et al., 2011). According to Stern et al. (2012), these values should not be considered, but a possible explanation for these high ratios may be related to the M-type tetrad effect (e.g., Irber, 1999; Monecke et al., 2007; Ibrahim et al., 2015), which affects REE fractionation in highly evolved felsic rocks due to the interaction with hydrothermal fluids.

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This process can be reflected as an enrichment of Sm related to Nd. Other authors, however, explain this enrichment as a result of both magmatic evolution (e.g., McLennan, 1994; Pan, 1997) and weathering processes after exhumation (e.g., Masuda and Akagi, 1989; Takahasi et al., 2002)".

Interpretation of epsilon Nd values: The second last paragraph (lines 730-733) states that very little variation in epsilon Nd values is a sign of magmas derived from young crustal rocks. An epsilon Nd value per se does not indicate the age of a rock, but rather how much the protolith melt was evolved. Negative epsilon Nd values of -3.5 to -4.0 indicate moderately evolved protoliths, not an Archean continental margin, but also not a juvenile volcanic arc. Likewise, referring to depleted mantle model ages of 1.8 to 1.4 Ga do not reflect a short crustal residence time. To summarize, the discussion and interpretation of Nd data requires some revision.

This point has been revised and developed in the new version based on the M-type tetrad effect (e.g., Irber, 1999; Monecke et al., 2007; Ibrahim et al., 2015).

Discussion: The geographic trend of younger ages of Ordovician magmatism is not discussed. Is there a link between the Toledanian and Sardic phases or are these strictly bounded to regions, CIZ and Pyrenees and north thereof, respectively?

Hope this point has been solved by including the new figure 3.

Technical corrections: Here I mainly refer to the figures and tables. Typos and minor grammatical errors are flagged in the annotated PDF that is attached to this review. Fig. 1: The sample numbers are very hard to read. Even when considering that figures can be viewed enlarged online. The majority of the sample localities in 1B are not discussed in the paper. So why listing them all in the figure captions? For easier location of the individual regions, add the region name to 1B through E. Figs. 2, 8 and 13: the labels are much too small. Fig. 5: Place symbols as inset in the figure instead of referring to the legend of a previous figure. Fig. 9: What do the double-sided arrows signify? Table 1: Add a vertical line separating the different regions to enhance orientation. Information on the lab that did the analyses should be included in a footnote or the table caption. The sample location (lat/long) should be moved to the column header. Latitudinal and longitudinal data are listed up to the fourth decimal of a second! Just as a reminder, one second latitude represents approximately 30 m. It is more than sufficient to report full seconds. Table 2: It consists only of already published data. This is not evident from the table caption. The table shows several rows without any data. Is there a purpose? Sr isotope data are listed in the table, but they are not discussed in the text. Why? If not necessary, that data should he deleted.

Following the journal's rules, all the tipos and labels are greater than "Arial 7 pt". Only the localities reported in the text are now referred to in figure 1. In some cases, the figures are so complex that we have explained the symbols outside the figures; otherwise, the result was unreadable. The double-arrows of figure 9 (now 10) were used in Syme's (1998) original definition; now, they are explained in the figure caption. Table is now better arranged and their latitude/longitude data are documented with a single decimal. Table 2 is completely updated summarizing the geochemical data reported in the text (Sr isotopic data are, of course, deleted).

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