A vast Caledonian fan and an Ediacaran arc: The contrasting provenance of Devonian clastics of Brunia (Bohemian Massif)

By Collett et al.
Reviewer: Armin Zeh

General

This study presents the first systematic study of detrital zircons (U–Pb and Lu–Hf) from Devonian strata overlying Brunia's Neoproterozoic basement. Most exciting, the data reveal two distinct provenances for these sediments: (1) a local source (Brunia – perhaps Avalonia basement) and a remote distal source (Baltica-Caledonides), similar to sedimentary rocks exposed in the MGCZ, Rhenish Massif and UK. The comprehensive data compilations and comparisons are very much appreciated. The content of the paper is of clear interest for a wide international readership, working on the reconstruction of the Variscan puzzle. As such, it definitely deserves to be published. The manuscript is well written and illustrated and I recommend only minor revisions. See my detailed comments below.

General points to be considered:

1. For my opinion, the last section of the discussion could be completely deleted, as it contributes nothing to the story, which is definitely not about closure of the Rheic ocean. Also discussing the "strange" data of Linnemann et al., 2025 (not even properly published) is not needed here.
2. The authors also should note that the MGCR is a composite terrane, which hosts (meta)sedimentary rocks belonging to (i) the Rhenohercynian/Avalonia Domain and the (ii) Saxothurian Domain (see my detailed comments below), and in the southernmost part even juvenile arc terrane (Beck et al., 2026, IJES). This is all mixed a bit together here. (see my detailed comments below).

Kind regards

Armin Zeh

Additional comments while going through the text, figures and tables

Line 23: the Rhenish Massif and MGCR (Spessart and Rögis = Mid-German Crystalline Rise) ….please add.

Line 94: "These data reveal a localized contribution from a distal source, likely derived from the Caledonides of Scandinavia, and a dominant contribution from local sources, representing erosion of the late Neoproterozoic arc. The former clearly links Brunia to Laurussia in the Early Devonian, while the latter provides insight into Brunia's late Neoproterozoic affinities." This is interpretation and should be removed here.

Line 123: isotopically evolved that (than)

Line 125: in outcrop(s) in the Silesian nappes i

Line 255: located within significant zircon domains …. (take out significant)… yielded concordant U–
line 259: Pb isotopic ages .. (take out isotopic)
Line 260: The U–Pb isotopic data was acquired a….Better : …Uranium-Pb zircon dating was carried out at..
Line 262: The Lu–Hf isotopic data w… Better…The Lu-Hf isotope analyses were ….
Line 269: analytical standards …. Better use: …. reference material
270: ages(n = 2,184) add space

272 ff. …. Concordant data are defined as those with a concordia distance of <5%. Concordant data ……changover (of that). … this is not clear to me.
What means <5% (95-105% concordance?), also what is a "iterative single grain concordia ages" (at least give a reference here, and explain in method.

- Normally all ages <1000 Ma are (206/238 ages) and >1000 Ma (207/206 ages), is this convention followed here?

293: and 2740 Ma (Fig. 6). – here it would be nice to point to Figure 6a, b etc., as Fig. 6 is quite complex!
Line 294 (Fig.6a-e)

Line 300: a)(relatively consistent) minor Neoarchean population (~2600)

Line 307: Only 20 out of 678 co….

4.2 Zircons (better zircon grains, be consistent throughout the text)

Line 326: plot on either side of the…. Better … show sub- and superchondritic eHft values (by the way CHUR is not shown in Fig. 7.)

Line 330: range of (from) −8.9 to +9.6….with the oldest and youngest zircons showing the most negative εHf(t) values (not true)

Line 339: with Hf-in-zircon isotopic compositions clustered at positive εHf(t)values (strange formulation, better …..with most Hf isotope data showing highly superchondritic εHft values between +4 to +11.

line 341 Moravian and Silesian nappes…(please add a reference here)

line 380 a (Fig. 9a)→ just point to (Fig. 9) where all data are shown

- ➔ Mention 9a, 9b, 9c where appropriate, e.g. line 382: "generally lack this slightly negative component (Fig. 9a).

5.1.2 Wider paleogeographic significance (remove wider from the titel!)

Line 394 "With the Type-1 zircon spectra predominantly reflecting erosion of local sources within the Slavkov Domain" I wouldn't be so absolute here, its an interpretation.

Line 397: Previous studies (e.g., Košler et al., 2014; Soejono et al., 2022) have suggested (remove have)

Line 404: proterozoic age maxima and significant (>20%) contributions of Paleoproterozoic zircons. (please add references here, and present an example; best showing such differences in a Figure). … Where

Line 404: Linnemann et al., 2014, 2018) and… Here please also mention the data from the Ediacarian Murgtal unit in the southern Black Forest (Modanubian Zone) of Zeh et al. (2024).

Zeh, A., Zimmermann, M., Albert, R., Drüppel, K., Gerdes, A. (2024). Zircon U-Pb-Hf isotope systematics of southern Black Forest gneiss units (Germany) – implications for the Pre-Variscan evolution of Central Europe. *Gondwana Research.,* 128*, 351-367.* doi.org/10.1016/j.gr.2023.11.008

Line 405: a wider range of εHf(t) values is observed → an extremely wide range … (from +10 down to -40) is observed

Line 408: also to Moldanubian (also at line 410)

Line 424: of our detrital zircon data with (take out of)

Line 428: … from Brunia. (please add a reference here!)

426 ff. Maybe worth to mentioning here that there barely combined U-Pb-Hf istope data from Eastern Avalonia, that can be used for comparison.
Note, the data of Willner et al., 2013 from E- and W-Avalonia shows a much greater diversity in U-Pb ages and Hf istope data than reflected in Fig. 9h.

Willner, A.P., Barr, S.M., Gerdes, G., Massonne, H.J., White, C.E., 2013. Origin and evolution of Avalonia: evidence from U–Pb and Lu–Hf isotopes in zircon from the Mira terrane, Canada, and the Stavelot-Venn Massif, Belgium. J. Geol. Soc. London 170, 769–784. https://doi.org/10.1144/jgs2012-152

Line 430: the Rhenohercynian zone (and the adjacent MGCR → Ruhla and Spessart Crystalline Complexes)

Line 432: Yes/No, there are Hf isotope data from the Rögis quartzite in the Ruhla Crystalline Complex (MGCR) = Rhenohercynian/Baltica derived spectra (see Zeh & Gerdes, 2010).

Zeh, A., Gerdes, A., 2010. Baltica- and Gondwana-derived sediments in the Mid-German Crystalline Rise (Central Europe): implications for the closure of the Rheic ocean. Gondwana Res. 17, 254-263. doi:10.1016/j.gr.2009.08.004

Line 476: Timmerman et al.' (please present complete reference with year.., also in line 479.

Line 491: Additionally, the significant ~1600 Ma maximum in the Type-2 Devonian strata (Cluster-3, Fig. 10d)….Sorry, both spetrca in (c) and (d) show minima at 1600 Ma (I mean 1670 is not 1600 Ma). So please change 1600 at least into 1670 or 1700 Ma!

Line 517ff: " German Crystalline Rise to Saxo-Thuringia is uncertain but it is generally considered to represent the northern extension of Saxo-Thuringia (e.g. Linnemann et al., 2025)" → This is complete nonsense. Since Zeh & Gerdes 2020 it is clear that the MGCR represents a composite terrane with parts belonging to the Rhenohercynian Realm /Avalonia (i.e., parts of the Ruhla Crystalline Complex and Spessart (see Kirchner & Albert, 2021) with the typical Baltica zircon age spectra (in presumable Silurian-Devonian rocks), while others are part of Saxothuringia (Brotterode KuK). In the southern part it additional consists of a juvenile arc terrane (see Beck et al 2026, IJES)

Line 522: “tead, their zircon age distributions more closely resemble those of Teplá-Barrandia”→ better say show a typical Saxothuringian age spectra, similar to that from Tepla Barrandia.

Line 530: Silurian strata from the Oslo Rift (Kristofferson et al., 2014; Sláma, 2016). T
Here the Hf data from Zeh & Gerdes 2010 (Rögis quartzite) should be shown as well for comparison, as these reveal the same patterns (perhaps plot these also in Fig. 12, upper right).

Line 586
5.2.4 Implications for continuation of the Rheic Ocean in the Devonian

For my opinion, the entire paragraph could be deleted, as its content has nothing to do with the content of the paper, dealing with provenence of of Devonian clastics of Brunia (Bohemian Massif). It’s a discussion about data, which in some parts are not even well documented and available to the readership (Linnemann et al., 2025) and hard to follow, even for insider.
Also, all discussion about the Rheic suture are far beyond the scope of the paper and would require a more comprehensive compilation.

6. Conclucions

Too long. Should focus on the major findings without discussing certain points again.

Figures

Fig. 1a (legend, for sake of clarity, all info about granitoids should be removed (also in the MGCR there are many granitoids of upper Silurian to lower Devonian age (430-390 Ma).
What is the blue-grey striped field standing for (not in legend)?

Fig. 1b (legend should be sorted from oldest to youngest from bottom to top (not vice versa)

Fig. 2: Would be nice to have tha absolute ages here for stratigraphic boundaries

Table 1. I guess the header but also lining of the table was a bit disturbed during copy-past. This should be corrected in the final version.

Figure 4: ….. the caption perhaps should be rather: Cathodoluminescence images of representative zircons from each sample, with positions of laser spots for U-Pb and Lu-Hf isotope analyses…. All presented zircon ages have concordance level of 95-105%, and quoted uncertainties are 2 sigma.
If you show the Hf spot, why not also showing ehft(t) results.

Fig. 6. X-Axis should be shown complete at least for the lowermost diagrams, and start at the 0 intercept of the Y-axis. Age (ma) should be shown beneath the x-axis. Please show a, b, c, d etc., and perhaps show type 1 and type 2 in diagrams.

Fig. 7. The dotted line (CHUR) should be explained.

Fig. 9. Compiled zircon age- ehft(t) data of……rocks from ….Massif. It would be good to present the data sources directly in the Figure caption!

To me its not clear what the “age peaks” are good for, this comparison should be done elsewhere and is confusing here (perhaps show in Fig. 8). Also the diagrams doe not explain the isolines nor where these are coming from, and on how many data these are based on (percentage is relative, better would be absolute numbers).

Fig. 10 MDS (please say Multi-dimensional scaling)
……(b–d) Representative histograms and KDE , this is not correct as in Fig. 10a only data >800 Ma were used!

Fig. 11. Devonian strata in the Bohemian Massif…. Its not just the Bohemian Massif there are also data from the Saxothuringian Domain, the MGCR and the Rhenoherycynian Zone (this should be mentioned here. Perhpaps better say in Central European Variscides.

- ➔ In caption: ….K18….Koglin et al. (2018);
- ➔ In the MGCR tsyn-collisional magmatism occurred during the late-Silurian/ Early Devonian (425-395 Ma)! and Visean 340-330 Ma

Fig. 12. Its not clear where the Hf data of Fennoscandia are coming from (Krystoffersen & Andersen?). Also the Age-Hf diagram is neither a-b-c, etc, and nowhere really mentioned in the Figure caption.

Fig. 13: …. is the exposed Slavkov Terrane basement (not explicit shown in the Figure, please add). Stiped domains are not explained in legend.
Comment: Such a figure can be presented, but it don’t considers the dynamic of the Variscan Belt formation. For example, its shows a scenario that the sediments were delivered from source to sink during the Early Devonian, which is hard to believe. Also, where is Avalonia in this Figure?
The greatest problem I have is, that the Figure suggest a kind of stable shelf but instedt the souther margin of Avalonia was controlled by a magmatic arc (at least in the German part of the MGCR), with a kind of back arc basin behind, which existed from the Silurian until the Late Devonian (=Rhenohercynian Basin). For Details see Zeh & Gerdes 2010). Formation of the back arc basin was accompanied by destruction of the southern Avalania margin.

Fig. 14. This goes far beyond the scope of the paper. If Collet wants to write a paper about distinct provenance in Europe fine. To my opinion, this Figure should be removed. It just summarizes and repeats data collected in Colett 2025, which mostly have nothing to do with Brunia!

ESM
In the Lu-Hf Table for the unknowns, no results of 176Yb/177Hf and of stable isotope ratios (e.g., 178/177) are presented (Why not? Please add.)

Lu-Hf standard statistics: Comment: Uncertainties of reference material measurements should ever be presented as 2sigma of the mean (=STABW*2), and not as weighted averages!!!!!

U-Pb standard statistics: Unclear what mean the presented values are? Concordia ages?, weighted mean 206/238 ages?, please specify. What is the number of analyses involved?