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Interactive comment on "Dawn and Dusk of Late Cretaceous Basin Inversion in Central Europe" *by* Thomas Voigt et al.

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General comments

The manuscript of "Dawn and dask of Late Cretaceous basin inversion in Central Europe" promises a briliant, highly interesting and useful review paper, which also brings new solutions following from the reviewed material. These new solutions concern, among others, finding that a rather synchronous beginning of basin inversion in central Europe occurred ∼5 million years earlier than generally thought so far and showing the complexity of the problem of how long the inversion lasted, when it finished and how one can look for the right answer to it. After a highly informative exposition of the questions related to the Late Cretaceous tectonic deformation over a vast area of cen-

tral to west-central Europe, the methods used to uravel the questions of its timing are presented and shortly discussed. These include stratigraphical analysis of reflection seismic sections, thermochronological data (AFT and AHe), thermal maturity of sediments, sediment composition and facies distribution. Subsequently, attempts at timing the deformation in a number of inverted basins are made, from the Lower Saxony basin in the NW, to basins adjacent to the Lausitz-Karkonosze high in the SE, using the results obtained with the above methods, and specific features of each of these basins are shown. In the discussion the results from the reviewed basins are correlated and compared and the conclusions are drawn, concerning the roughly synchronous but slow commencement of the inversion already in Cenomanian, a gradual deceleration of the compression and uplift in Campanian to Mastrichtian times and the difficulties in precise timing the very end of inversion, which might have happened diachronously in various basins. A humorous complaint of mine is, however, that the paper, while discussing the conditions and circumstances of the Late Cretaceous inversion in central Europe, leaves unanswered my favourite question if there were any real mountain chains at that time throughout the area. The authors, though not openly, seem, however, to believe that the erosion was in general effective enough as to keep up with the uplift, so not much hope remains as to the existence of a Late Cretaceous mountainous landscape over the so called Paleozoic platform of central Europe.

Another remark concerns an apparent missing in the paper of a recent concept of "deep" burial of the NE Bohemian Massif, which is now believed to have affected most part of the Sudetes during the Late Cretaceous. The concept is based on new low-temperature thermochronological results. This issue was first mentioned by Danišik et al. (2010, 2012) and later claimed by Sobczyk et al. (2015, 2020). Also Botor et al. (2019) found similar data for the Intra-Sudetic Basin rocks. In the paper by Sobczyk et al. (2020) there is a discussion about possible time frames for the Cretaceous basin evolution in the Sudetes, which was based not only on data from basement rock samples but, importantly, on those from sedimentary rocks. It would, perhaps, be of some use to look at these results in the context of scenarios you propose in this paper (the

links to the above mentioned papers are given in the end of this review).

In spite of the above possible minor shortages, the manuscript fully deserves being published in Solid Earth, though it also deserves a number of minor improvements to be introduced or some minor issues rethought, all of which are listed below as specific comments and technical corrections.

In particular, referring to the SE checklist for reviewers, I should state that: (1) The paper addresses scientifically important questions of wide, international interest, lying within the scope of SE. (2) It presents an original review of and a thorough discussion of the existing data and applicability of a range of methods to solve a scientifically significant problem of dating the Late Cretaceous basin inversion that occurred over a vast area of Central Europe and whose results are still of much importance in the regional geology. The reviewed results add important new elements to the knowledge on the studied object. (3) The presented approach, assumptions made, methods selected and results discussed are appropriate to achieve the goals set up by the authors. (4) The presented interpretation and conclusions are justified by the data employed and the presented ways of reasoning seem to be correct. (5) The paper gives proper credit to the related work by earlier authors (though some minor completion is suggested in specific comments) and its original contribution lies in correlation of relatively large amount of the existing data of various character, their critical discussion and, on this basis, arriving at novel conclusions. (6) The title is perfectly fitting the paper's content. (7) The abstract is sufficiently summarizing the paper's content, though, in my opinion it might contain slightly more information on the paper's conclusions. (8) The overall presentation is well structured, clear and linguistically well written. (9) There is no need to significantly change any part of the manuscript; hints how to improve some minor issues in the text or figures are given in the specific comments. (10) The amount and quality of referenced work seems appropriate.

Specific comments:

Line 42: the "Lausitz-Krkonosze High" is – as concerns its location - only a part of the Late Cenozoic uplifted "Sudetic block", north of which there is "Fore-Sudetic block" – in the present-day Polish geological nomenclature. Both have Palaeozoic and older basement below the Cenozoic, but the Sudetic block is uplifted and the Fore-Sudetic one - downthrown. These two units are identified in Fig. 5 as the Lausitz-Krkonosze High and Northsudetic High, respectively. Changing the nomenclature from the "Lausitz-Krkonosze High" and "Northsudetic High" into the "Lusatian-Sudetic high" and "Fore-Sudetic high" seems to be worth considering.

Line 141:- Consulting the paper of Sobczyk et al. (2020) is suggested for AFT data from sedimentary rocks, which complete those coming from the basement and are discussed there in this context.

Lines 365-368: It is disputable whether the geographical names applied to creating names of geological structures/units should be in original national languages used (today?) on their location or in their English (or anglicised version). A good example is provided by the "Lausitz Thrust". It occurs in Germany and Czechia and in the latter country is named "Lužicke nasunuti". The English (← Latin) name for Lausitz (=Czech and Polish "Lužice") is "Lusatia", so maybe the "Lusatian thrust" (already functioning in English-language papers by Polish and Czech authors) might be a better choice? Such a solution may apply to some other names in the paper. (By the way, I see now, in line 593 the "Lusatian block", which means that this solution is, actually, already applied in the paper in some cases. So, maybe, "only one way of applying names" would be beneficial for the consistency of the editorial aspect of the paper? Moreover in the paper's text, here and there one can see a tendency, which I personally prefer, to start the common-name parts of geological names with lowercase letters, which is, btw, not observed in Fig. 5 (Graben, Basin, High, Deformation Front) and which should be correlated with the spelling elsewhere in the text.

Line 370: I would suggest taking a look also at the Intra Sudetic Basin and the Nysa Graben (not labelled on the map in your Fig. 5, but defining an irregular NNW-SSE

directed lense within the basement, to the E of the Bohemian-Saxonian-Cretaceous basin and below the Northsudetic high label) as this structure contains quite an interesting Cretaceous stuff (see Botor et al., 2019, and Sobczyk et al., 2020).

Lines 465-466: This is debatable as the age of the peneplains is actually, still unknown - more likely this is just one of the possible scenarios – see Danišik et al. (2010) and discussion therein.

Line 645: Having a look on a discussion about the influence of a thrust regime on remodelling the Nysa Kłodzka Graben (Sobczyk et al. 2020) may be useful.

Line 657: Again, the paper by Sobczyk et al. (2020) can be of interest in this context, as it contains a relatively detailed discussion on the inversion onset in the Sudetes, based on data coming from both the basement and sedimentary cover rocks.

Fig 1: On the Mesozoic-Cenozoic tectonic map of Central Europe "the main thrusts/reverse faults" of presumed mainly Late Cretaceous age that are marked with heavy barbed lines along the Tornquist-Teissyere zone and the Polish trough are – to my knowledge – not known from the available seismic data as major, long distance reverse faults in the Permo-Mesozoic fill of the Polish part of the Central European basin (Polish basin). On the other hand, the similarly marked major "thrusts", along the NE margin of the Bohemian Massif (the Sudetes' Boundary Fault and the Middle Odra Fault) and of the Bruno-Vistulian Block are all – according to the available data – very steep fractures of original strike-slip origin. Due to their near verticality, it is difficult to term them "thrusts" or even "reverse faults", with the notable exception of the Lusatian (Lausitz) thrust to the north of the Bohemian-Saxonian Cretaceous Basin, which is, indeed, well exposed and clearly verified as a major thrust (or rather reverse fault – due to its high-angle attitude). The above remarks are, nevertheless, of minor general importance and can be disregarded.

Fig. 4. The significance of steep hachure lines on the N margin of the Harz Mts eroded area remains enigmatic and needs explanation.

Fig. 5. In my opinion the "Lausitz-Krkonosze High" might be preferably (here and in the paper's text) replaced by "only English"- "Lusatian – Sudetic high" (or still "Lusatia – Sudetes high"). At the same time, the "Northsudetic high" –would be better replaced by "Fore-Sudetic high" (as the term "Fore-Sudetic block" – in contrast to the, now uplifted, "Sudetic block" - is widely applied to this area in the tectonic literature).

Since such important Cenozoic tectonic elements as the Alpine deformation front are included in the map, I suggest considering usage of a broken line to mark the position of the Sudetic Boundary (Marginal) fault, which definitely existed in Late Cretaceous times, as a remnant Late Variscan strike-slip fault. Its possible importance would lie in supplying a reader of Fig 5 with a reference structure very well known from the present-day geology, according to which he/she will be able to better confront the map of Fig. 5 with "normal" geological maps of the area.

In terms of the lithologies included in the legend, the Opole basin should be filled with marl and not chalk and the Cretaceous of the Intra-Sudetic basin (not labelled as such on the map, but defining an irregular NNW-SSE directed lense inside the basement rocks, to the E of the Bohemian-Saxonian-Cretaceous basin and below the Northsudetic high label) should combine marl and sand.

The river Oder (Polish or Czech – Odra) should have its course significantly extended upstream, well beyond the frame of Fig. 6, since it is altogether strangely abandoned on the map still west of Wroclaw. It is also some of Oder's main tributaries (such as the Lausitzer Neisse and Glatzer Neisse) that should be added to the map (maybe also accompanied by the present-day state frontiers) to make it easier to the reader to find where "he/she is" geographically on the map.

Figs 10 and 11 have no explanation in their legends for the lithological(?) division covered with crosses.

Fig.12: Possibly it would be useful to show separately thermochronological signals reported from the basement and those coming from sedimentary rocks, especially for

the Cretaceous Bohemian Basin, for which such data are reported in the literature. Another suggestion is a recommendation to check thermal modelling results (instead of using only 'raw' ages) as this might inspire more detailed basin history reconstructions.

Technical corrections:

Line 27: North See should be transfomed into North Sea.

Line 85: "where" should be replaced by "were".

Line 88: Shouldn't "Wernigeröde" be replaced by "Wernigerode"?

Line 386: The citation of "T. Voigt, 2009" should probably read "T. Voigt et al., 2009", since the latter item has the closest shape to "T. Voight, 2009" on the reference list.

Line 427: Shouldn't the "northwestern edge of the Lausitz-Krkonosze high" be rather the "southwestern....." one?

Line 607: a reference to Kaeßner et al. 1999 is not reflected on the list of references. Fig. 2: The contours of the present-day European coastline should preferentially be better visible.

References cited

Danišik et al. 2010 https://doi.org/10.1016/j.geomorph.2009.11.010

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Sobczyk et al. 2015 https://doi.org/10.1016/J.TECTO.2015.02.021

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