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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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Dawn and Dusk of Late Cretaceous Basin Inversion in Central Europe T. Voigt, J. Kley, S. Voigt Comments to the review of Pawel Aleksandrowski Thank you for the careful and comprehensive review. We added some comments and changed also the names as you proposed. Thanks for the hints to additional literature from Poland. As we started to write the paper two years ago, we missed some new interesting data.

We want to answer some of you questions: 1. ....leaves unanswered my favourite question if there were any real mountain chains at that time throughout the area.

The answer is given by the grain size of the marginal sediments. At the Lusatian thrust

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in Saxony, you can find clasts within the Turonian up to 10 cm (quartz, ironstones), maximum 15 cm (reworked sandstones). At the Harz margin, in the Santonian: 6-8 cm (Buntsandstein), in the Campanian 2-10 cm (Lower Carboniferous and Devonian slates). Other conglomerates more or less negligible. The rivers of the Harz and the Karkonosze transport granitic clasts up to 0.5 m into the foreland. The morphology of the Cretaceous mountains was hilly. Uplift rates were too small and erosion rates too high to create steep rivers and high cliffs at the coast.

2. ....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

Yes, we did not mention it, because these uplifts occurred after the Late Cretaceous inversion. At the same time as Danišik and Sobczyk published their results, we made some still unpublished investigations of the thermal maturity of some coals and drift wood pieces in northern Bohemia and in Saxony. We have the same results: 3-4 km of burial! As the basement rocks do not show a complete reset (Käßner et al. 2020), the maximum Cretaceous burial depth is also 3-4 km in the BCB. This considerable post-depositional uplift occurred in the period between the Cretaceous and the Oligocene. The driving force was probably different, considering timing and orientation of uplifts (escape tectonics of the Alps as driving force for the origin of the Carpathians?). We added this amazing facts to the paper.

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.

You are right the nomenclature is not easy. It starts with the Krkonoše – Riesengebirge – Karkonosze and does not end with Lausitz – ŁuÅijyce – Lužice. Lusatian-Sudetic High is the much better and more comprehensive term, because the Lausitzer Gebirge, Góry Kaczawskie, Jizerske hory, Góry Sowie and some other structures were involved in the uplift too. We used the term Lusatian-Sudetic High throughout the paper as you proposed.

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.

We added a short section, although we think that the enormous post-Cretaceous inversion reset does not fell into the Subhercynian phase, but has to be considered as a different event. Instead, the heating shows that the eastern Sudetes were initially part of the marginal trough. Nevertheles, it is simply not in agreement with adjacent areas of the basin, to deposit more than 4 km in the short period of 5 Ma between Late Cenomanian and Turonian (The section is still preserved in the Innersudetic syncline near Adršpach/Broumov and Gór Stołowych with limited thickness in line with other parts of the Bohemian-Saxonian Cretaceous Basin). A later (Maastrichtian to Paleogene) regional uplift is assumed from our side.

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. The names were changed as proposed.

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).?? The names of the structures were added. A problem is still the Opole Basin, because we. used a nice polish overview map (without Cenozoic cover) from 1972. I recently saw the very detailed map of Irek Walaczsyk that the structure is much more complicated. It would be possible to change it, but it would cost much time.

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. Section was changed

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.

Yes, We know this work, but did not consider it as the main uplift occurred after inversion. But we added a short section. This seems a really interesting work to find out, what caused this enormous young uplift (emplacement of the Carpathian nappes from the southwest?)

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.

This was considered in the text. It is really a very interesting result, because I (T. Voigt) assumed the thick cover already in the nineties (diagenesis of sandstones and claystones, formation of dickite as a marker of high temperatures in the porespace and high mature coals in the Cenomanian in Saxony, but was not able to fix it. Recently we had a masters thesis on the thermal maturity of the Cretaceous rocks – the results were the same as in the Intrasudetic basin. We wrote an additional section.

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.

The faults were taken from Ziegler (1990). They should exist because they mark the boundary of the Jurassic grabens and the marginal troughs. To realize the uplift, faults should be at least in the basement. Most of the faults are poorly known, if they are exposed or drilled (several times in Germany), they mostly show angles between 30 to 60° (maximum). Concerning the Lausitz fault: Thrust is the right expression. The observed angles at the good outcrops in Saxony are between 15° and 27° (quarry in Weinböhla, gas pipeline south of Dresden, outcrops near Hohnstein, exploration close to Hermsdorf, mapping in the Zittau mountains). Also in the Czech part, the angle is

much shallower than displayed in the maps (recent small-scale seismic investigations, Czech-German RESIBIL EU-project). Even the Harz-Nordrand-Fault has an angle between 30-40° (Franzke et al 2004).

Fig 4: The significance of steep hachure lines on the N margin of the Harz Mts eroded area remains enigmatic and needs explanation. The hachured line is explained in the text.

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).

The terminology has been changed in text and Fig. 5.

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. We added some faults and hope that we meet your wishes.

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.

We modified the lithology in the Intrasudetic Basin and labelled it.

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.

Sorry, the southern course of the Odra river was hidden behind the geology – repaired! The borders were not added as additional rivers, because this map is only made to show the general picture of Cretaceous basins and the relationship to the uplifts.

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

Fixed, the basement was added in the legend.

Fig. 12: Possibly it would be useful to show separately thermochronological signals reported from the basement and those coming from sedimentary rocks, especially for C6 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.

All AFT-data were derived from the basement, no data from sedimentary rocks are presented (except of Permo-Carboniferous sediments, because all strata below base Zechstein is considered as basement here). Fission Track ages of the sediments show only the ages of the basement cooling so far, with the exception in Poland and possibly the BCB. The Paleogene intrabasinal uplifts of the BCB are not considered, because their uplift inverted the inversion-related basin and is another story. The mentioned mistakes in spelling in Lines 27, 85, and 88 were corrected.

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. Voigt, 2009" on the reference list.

The citation T. Voigt, 2009 is correct, it is also replaced in the reference list.

Line 427: Shouldn't the "northwestern edge of the Lausitz-Krkonosze high" be rather the "southwestern....." one? Northwestern is correct; to make it clearer, the assumed margin was added.

Line 607: a reference to Kaeßner et al. 1999 is not reflected on the list of references.

It is Käßner et al. 2020, and is corrected

Fig. 2: The contours of the present-day European coastline should preferentially be better visible.

It was corrected.

We addedd the figures which were corrected.

Please also note the supplement to this comment:
https://se.copernicus.org/preprints/se-2020-188/se-2020-188-AC1-supplement.pdf

Interactive comment on Solid Earth Discuss., https://doi.org/10.5194/se-2020-188, 2020.

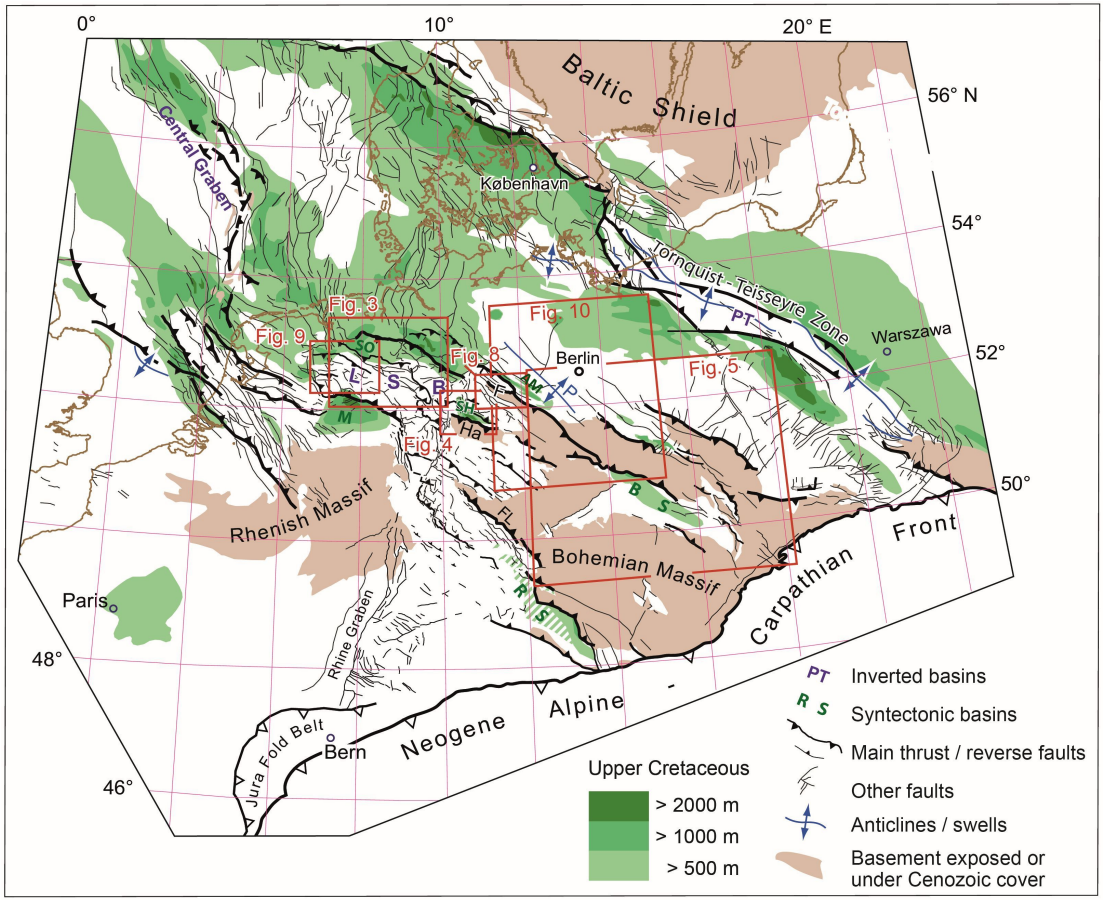

Fig. 1.

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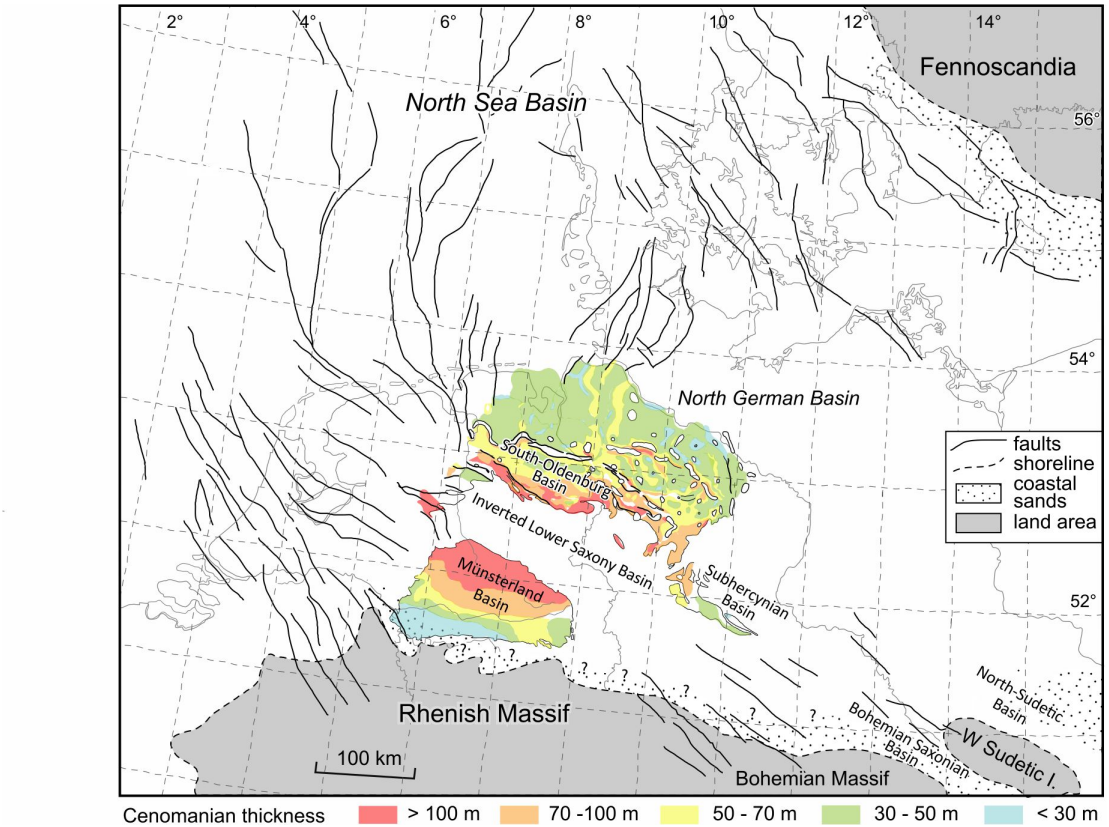

Fig. 2.

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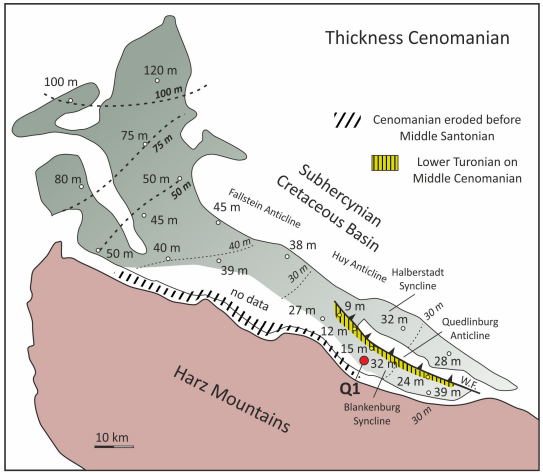

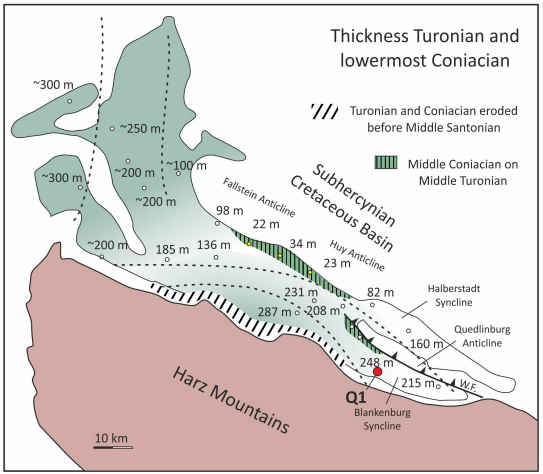

Fig. 3.

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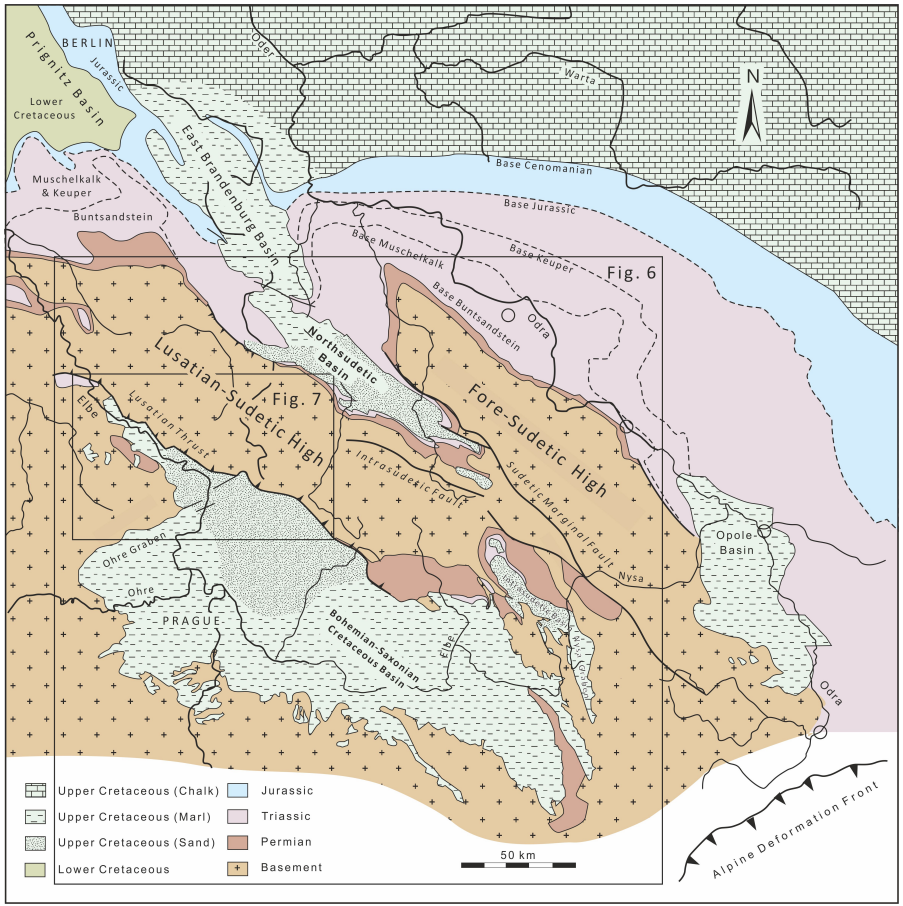

Fig. 4.

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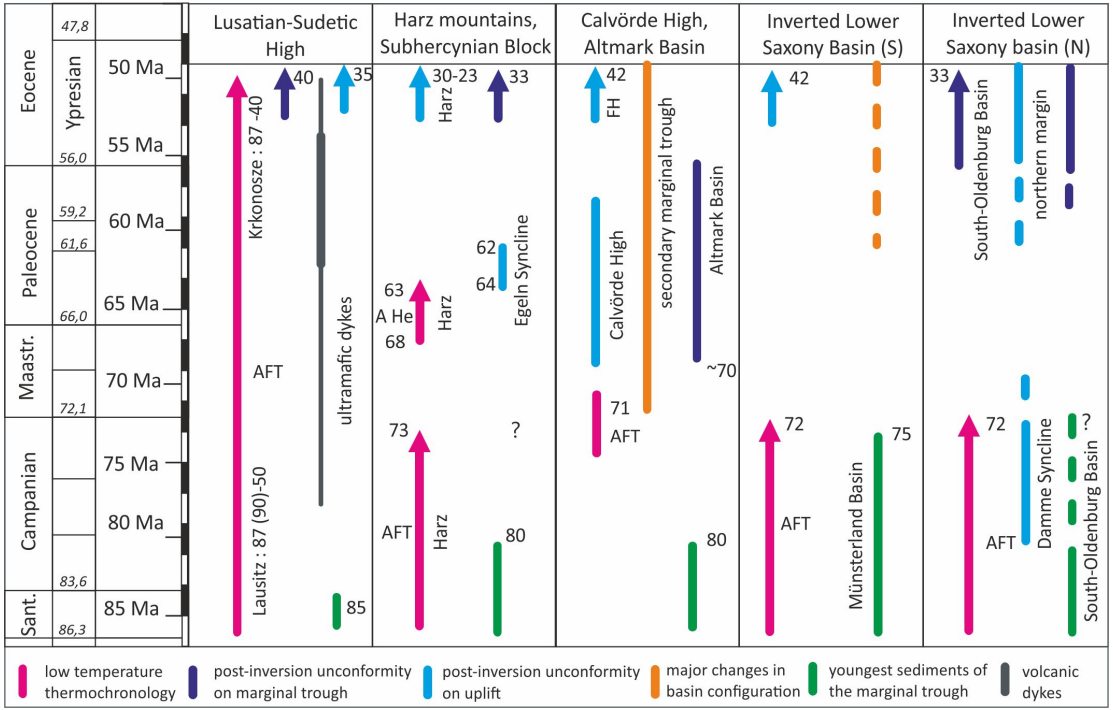

Fig. 5.

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