Reviewer #2 (M. Schmitz)

1.

Line 69: The authors state that "…applying Bayesian age modeling (Haslett and Parnell, 2008) based on these high-precision data sets allows us to detect sedimentary gaps and variations in sedimentation rate…"; certainly the age models establish the latter variations in sedimentation rate, however by definition the Bchron algorithm assumes constant sedimentation, thus its use cannot detect hiatuses and unconformities.

We agree and the respective part was changed accordingly to: "Moreover, applying Bayesian age modeling (Haslett and Parnell, 2008) based on these high-precision data sets allows us to model variations in sediment accumulation rate, and to directly compare other proxy data across different PTB sections, inclusive of the Meishan GSSP."

2.

Line 162: The authors should provide a more detailed description of the lithostratigraphy and sedimentology of the Penglaitan section, particularly describing and interpreting the depositional characteristics and environments of the volcanogenic sandstones, which make up a significant amount of rock accumulation. Are these interpreted as turbiditic event beds? Gradual accumulations of sandy facies? This matters when it comes to the age modeling.

Following part was added in the sample description of Penglaitan: "At Penglaitan, the lowermost and uppermost part of the Dalong Fm. were deposited in relatively deep water settings. All associated volcanogenic sandstones were deposited by geologically instantaneous turbidites, mainly reflecting the basal part (Bouma A-B sequence) of such gravity flow deposits. Gradual accumulations and sediment mixing are restricted to sands bars occurring in the middle part of the section, in association with coal seams during an intervening regressive episode. Hence, the volcanogenic sandstones from the top of the Dalong Fm. in Penglaitan may not suffer from substantial sediment reworking and mixing and do not represent substantial cumulative amounts of time relative to the interlayered shales and thin bedded limestones."

3.

Line 192: The description of the Bchron model might be better stated as "The model is based on the assumption of random variability sedimentation rate, yielding a family of dispersed piecewise monotonic sediment accumulation models between each dated stratigraphic horizon."

Following this suggestion, the sentence was changed to: "The model is based on the assumption of random variability of sediment accumulation rate, yielding a family of dispersed piecewise monotonic sediment accumulation models between each dated stratigraphic horizon."

4.

Line 208: The Bchron algorithm doesn't necessary require the thickness of the investigated ash beds, in fact as noted subsequently it might be a mistake to use those thicknesses as input (see note to Line xxx).

We agree and the relevant part has been changed to: "It provides a non-parametric chronological model according to the Compound Poisson-Gamma model defined by Haslett and Parnell (2008), requiring the weighted mean $^{206}Pb/^{238}U$ age and the stratigraphic position of the investigated ash beds as input parameters. Since the Bchron model was initially coded for radiocarbon dating with a commonly unknown duration of accumulation for a radiocarbon-dated bed, the model also allows to define the input thickness of such a horizon. However, the thickness of a geologically instantaneous event bed like a volcanic ash should be set to zero and the lithostratigraphy should be rescaled in order to remove the thickness of the volcanic horizons and to produce a more accurate age-depth model.

5.

Line 213: I would suggested that the authors provide their R scripts for their model runs as an Appendix.

This has been added in the Appendix C as follows:

Appendix C: Bchron R scripts

The age-depth models of Dongpan and Penglaitan have been run under the free and open-source software RStudio Desktop version 1.0.44 using the free Bchron R package version 4.1.1 (Haslett and Parnell, 2008; Parnell et al., 2008). Detailed documentation of available program commands is provided in the embedded description file of the Bchron package.

Dongpan model

Input parameter:	"id"	age [ka]	1s [ka]	position [cm]	thickness [cm]	"calCurves"
	"DGP-18"	252560	260	52	2	"normal"
	"DGP-21"	251953	19	93	2	"normal"
	"DGP-17"	251956	17	368	8	"normal"
	"DGP-16"	251978	20	426	4	"normal"
	"DGP-13"	252101	19	743	6	"normal"
	"DGP-12"	252121	18	833	5	"normal"
	"DGP-11"	251924	48	894	5	"normal"
	"DGP-10"	252170	28	1075	2	"normal"

Script:

```
data (Dongpan)
DGPOut=Bchronology(ages=Dongpan$ages,ageSds=Dongpan$ageSds,
calCurves=Dongpan$calCurves,positions=Dongpan$position,positionThicknesses=Dongpan$t
hickness,
ids=Dongpan$id,predictPositions=seq(0,1075,by=1),iterations=10000,extractDate=251700)
plot(DGPOut,main="Dongpan",xlab='Age (Ma)',ylab='Depth (cm)',las=1)
predictAges=predict(DGPOut, newPositions=c(100,415),newPositionThicknesses=c(0,0))
```

```
summary(DGPOut)
summary(DGPOut, type='convergence')
summary(DGPOut, type='outliers')
```

Dongpan model (rescaled)

Input parameter:

"id"	age [ka]	1s [ka]	position [cm]	thickness [cm]	"calCurves"
"DGP-18"	252560	260	50	0	"normal"
"DGP-21"	251953	19	89	0	"normal"
"DGP-17"	251956	17	356	0	"normal"
"DGP-16"	251978	20	410	0	"normal"
"DGP-13"	252101	19	682	0	"normal"
"DGP-12"	252121	18	767	0	"normal"
"DGP-11"	251924	48	819	0	"normal"
"DGP-10"	252170	28	988	0	"normal"

Script:

```
data (Dongpan)
DGPOut=Bchronology(ages=Dongpan$ages,ageSds=Dongpan$ageSds,
calCurves=Dongpan$calCurves,positions=Dongpan$position,positionThicknesses=Dongpan$t
hickness,
ids=Dongpan$id,predictPositions=seq(0,988,by=1),iterations=10000,extractDate=251700)
plot(DGPOut,main="Dongpan",xlab='Age (Ma)',ylab='Depth (cm)',las=1)
predictAges=predict(DGPOut, newPositions=c(96,399),newPositionThicknesses=c(0,0))
summary(DGPOut)
summary(DGPOut, type='convergence')
summary(DGPOut, type='outliers')
```

Penglaitan model

Input parameter:

"id"	age [ka]	1s [ka]	position [cm]	thickness [cm]	"calCurves"
"PEN-22"	251907	17	53	1	"normal"
"PEN-28"	252062	22	131	1	"normal"
"PEN-70"	252125	35	161	1	"normal"
"PEN-6"	252137	41	209	1	"normal"

Script:

```
data (Penglaitan)
PENOut=Bchronology(ages=Penglaitan$ages,ageSds=Penglaitan$ageSds,
calCurves=Penglaitan$calCurves,positions=Penglaitan$position,
positionThicknesses=Penglaitan$thickness,ids=Penglaitan$id,
predictPositions=seq(0,212,by=1),iterations=10000,extractDate=251700)
plot(PENOut,main="Penglaitan",xlab='Age (Ma)',ylab='Depth (cm)',las=1)
predictAges=predict(PENOut, newPositions=c(100),newPositionThicknesses=c(0))
summary(PENOut)
summary(PENOut, type='convergence')
summary(PENOut, type='outliers')
```

Penglaitan model (rescaled)

Input parameter:

"id"	age [ka]	1s [ka]	position [cm]	thickness [cm]	"calCurves"
"PEN-22"	251907	17	52	0	"normal"
"PEN-28"	252062	22	99	0	"normal"
"PEN-70"	252125	35	108	0	"normal"
"PEN-6"	252137	41	130	0	"normal"

Script:

```
data (Penglaitan)
PENOut=Bchronology(ages=Penglaitan$ages,ageSds=Penglaitan$ageSds,
calCurves=Penglaitan$calCurves,positions=Penglaitan$position,
positionThicknesses=Penglaitan$thickness,ids=Penglaitan$id,
predictPositions=seq(0,131,by=1),iterations=10000,extractDate=251700)
plot(PENOut,main="Penglaitan",xlab='Age (Ma)',ylab='Depth (cm)',las=1)
predictAges=predict(PENOut, newPositions=c(99),newPositionThicknesses=c(0))
summary(PENOut)
summary(PENOut, type='convergence')
summary(PENOut, type='outliers')
```

Haslett, J., and Parnell, A.: A simple monotone process with application to radiocarbon-dated depth chronologies. J. Roy. Stat. Soc. C-App., 57, 399–418, doi:10.1111/j.1467-9876.2008.00623.x, 2008.

Parnell, A.C., Haslett, J., Allen, J.R.M., Buck, C.E., and Huntley, B.: A flexible approach to assessing synchroneity of past events using Bayesian reconstructions of sedimentation history. Quat. Sci. Rev., 27, 1872–1885, doi:10.1016/j.quascirev.2008.07.009, 2008.

6.

Line 319 and Figure 3: There is a wide swing to lower ages in the Bchron age model for the Penglaitan section between PEN-70 and PEN-28, however it is not clear what is causing that excursion, unless perhaps it is because of the large input thickness for PEN-28. This highlights the question of how to handle the thickness of geologically instantaneous event beds like volcanic ashes. Using a thickness in the Bchron algorithm introduces a random uniformly distributed uncertainty in stratigraphic position for that dated horizon. Is this appropriate? In the case of a radiocarbon sample integrating a sampling thickness with an unknown duration of accumulation that might be appropriate, however a volcanic ash bed is deposited geologically instantaneously, e.g. there is no uncertainty in the duration of accumulation. One might argue instead that you should rescale your lithostratigraphy to remove the thickness of the volcanic horizons. In this way you might create a more accurate model of the deposition rates of the background sedimentation and rock accumulation between the dated volcanic events. I would suggest that the authors experiment with alternative age model construction; this might particularly impact the Penglaitan section given the thickness of the "volcanogenic sandstone" beds.

We agree that by removing the thickness of a geologically instantaneously deposited bed such as a volcanic ash and by rescaling the lithostratigraphy you might create more accurate deposition rate models for sedimentary successions. However, this approach has only minor effects in the Bchron age-depth model of Dongpan where the changes in the calculated age of the PTB and the radiolarian decline are negligible (see Fig. 1); this is mainly due to the overall very small thickness (max. 8 cm) of the volcanic horizons in Dongpan. The Bchron model of Penglaitan is much stronger affected by such a rescaling (see Fig. 2) though it is not clear if each volcanogenic sandstone represents only one "instantaneous" turbidity current event or might reflect a series of several turbidite deposits over a certain time. However, in Penglaitan, the relative substantial thickness of instantaneously deposited turbiditic volcanogenic sandstone at the top of the section may indeed induce some distortions in the Bchron model. Facies analysis did not reveal any signs of an omission surface at the formational boundary, but the strong contrast in sedimentation rates between the "instantaneous" deposition of the last Permian bed and the much slower accumulation of next overlying black shales likely generates a distortion of the Bchron model at the formational boundary. Hence, the Bchron model derived from Dongpan is certainly more reliable that that derived from Penglaitan.

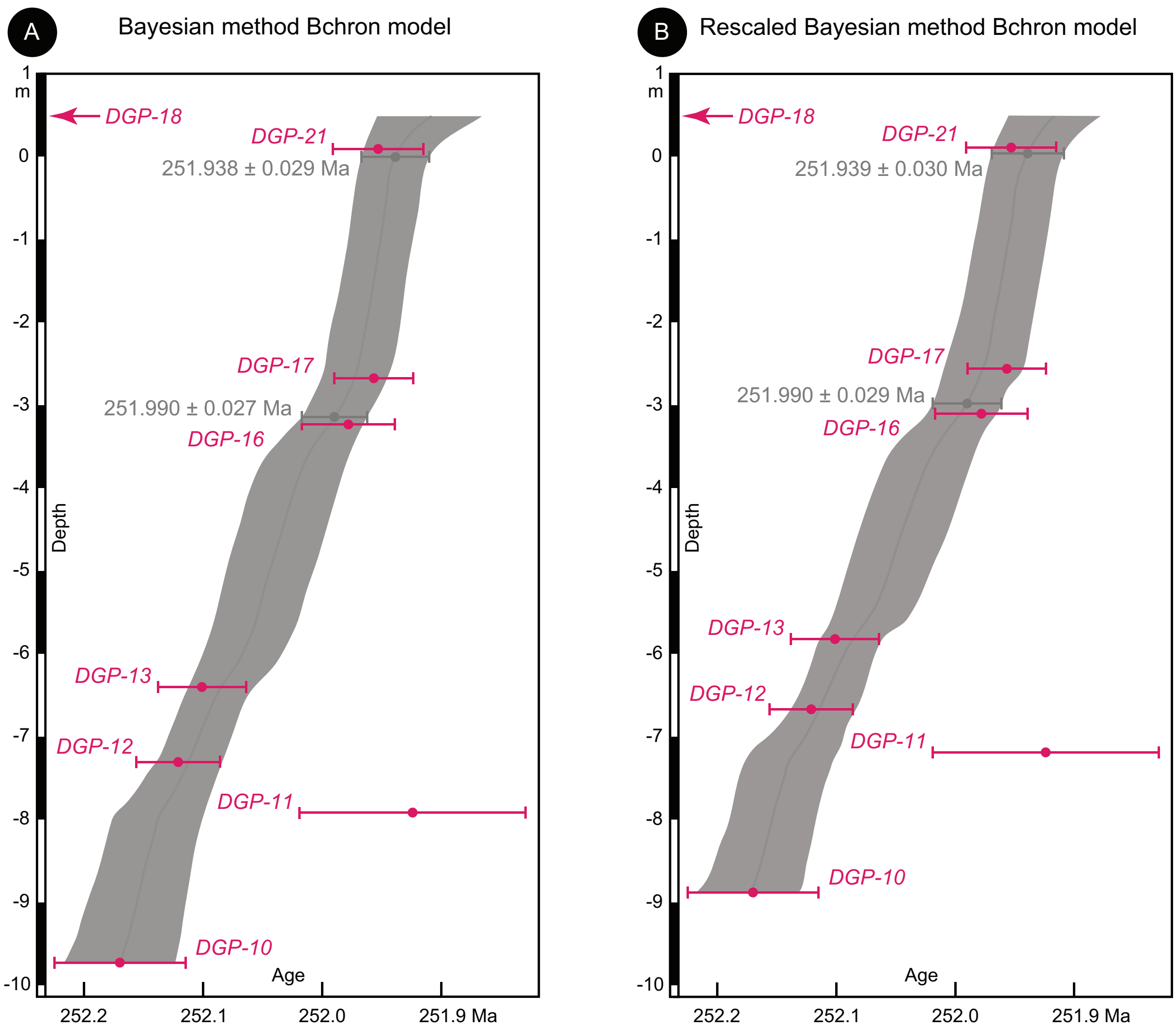

Figure 1. Comparison of the two different Bchron models for Dongpan using A) the real stratigraphic thickness of each volcanic ash and B) the rescaled lithostratigraphy to remove the thickness of the volcanic horizons. Each age-depth model is presented with its median (middle grey line) and its associated 95% confidence interval (grey area). Radioisotopic dates, used in the age-depth models, together with their uncertainty (red horizontal bars) are presented as $^{206}Pb/^{238}U$ weighted mean dates of the volcanic ash beds in their stratigraphic positions. U-Pb data of DGP-21 is taken from Baresel et al. (2016). Predicted dates (grey horizontal bars) for the onset of the radiolarian decline (RD)

and the Permian-Triassic Boundary (PTB) in Dongpan are calculated with their associated uncertainty using the different age-depth models.

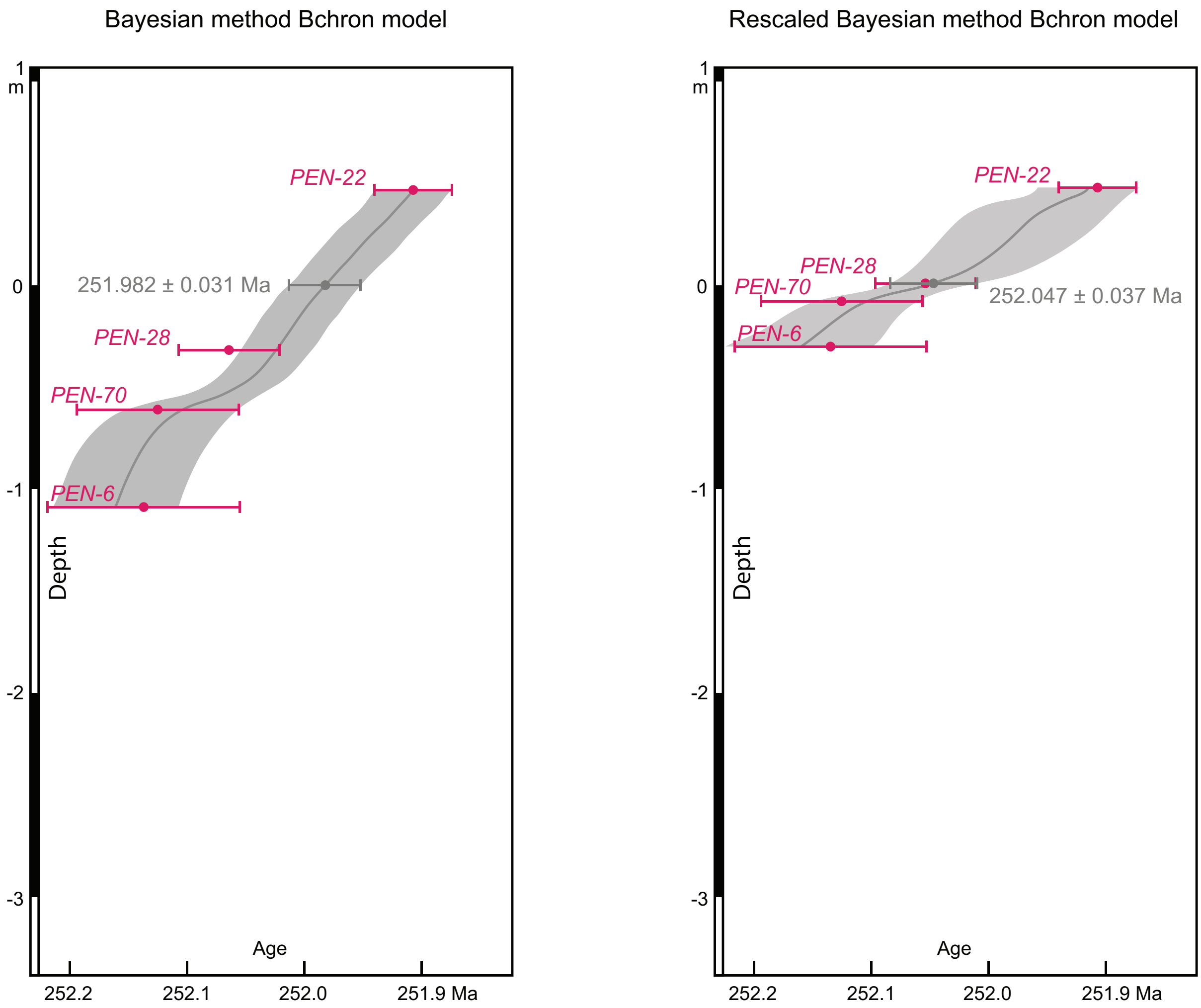

Figure 2. Comparison of the two different Bchron models for Penglaitan using A) the real stratigraphic thickness of each volcanic ash and volcanogenic sandstone and B) the rescaled lithostratigraphy to remove the thickness of the volcanic horizons. Each age-depth model is presented with its median (middle grey line) and its associated 95% confidence interval (grey area). Radioisotopic dates, used in the age-depth models, together with their uncertainty (red horizontal bars) are presented as $^{206}Pb/^{238}U$ weighted mean dates of the volcanic ash beds and volcanogenic sandstones in their stratigraphic positions. U-Pb data of PEN-28 and PEN-22 are taken from Baresel et al. (2016). Predicted date (grey horizontal bar) for the onset of the Permian-Triassic Boundary (PTB) in Penglaitan is calculated with its associated uncertainty using the different age-depth models.

7.

Line 340: The recalculation of age and uncertainty for Meishan Bed 25 sanidine (data for sample C-2 of Renne et al., 1995) using the method of Kuiper et al. (2008) should yield a result of 251.6 ± 0.6 Ma.

This was corrected to: "In order to properly compare the two systems, all older $^{40}Ar/^{39}Ar$ data have to be corrected for the revised age of the standard Fish Canyon sanidine of 28.201 ± 0.046 Ma (Kuiper et al., 2008) and the decay constant uncertainty has to be added to U-Pb and Ar-Ar ages which would drastically expand the $^{40}Ar/^{39}Ar$ age error and recalculate the $^{40}Ar/^{39}Ar$ age of Renne et al. (1995) to 251.6 ± 0.6 Ma."

8.

Lines 399-403 and Figure 3: The authors state, "When projected onto the age-depth models of Dongpan and Penglaitan, this UAZ1 is artificially expanded and even crosses the PTB in Penglaitan (Fig. 6). In Penglaitan, the last Permian UAZ2 projects correctly above UAZ1 without overlap but is completely within the Triassic. The cause of these contradictions stems from the irreconcilable conjunction of i) extreme condensation in Meishan, ii) high evolutionary rates of conodonts, and iii) the ca. 30 ka precision of the last generation of U-Pb dates." These conclusions appear to stem from equating the PTB at Penglaitan to the formational boundary, however this is an assumption that isn't necessarily accurate. In fact from a sedimentological perspective as well as the character of the age model for Penglaitan is seems likely that there is an unconformity at the top of the Permian strata, e.g. at the top of the volcanogenic sandstones. I would encourage the authors to re-examine their age model construction for Penglaitan considering the possibility of a hiatus across the PT transition; although beyond the scope of this manuscript it raises an important question for future work-how would you add possible unconformities at bed contacts into a Bayesian framework for age model construction?

We agree that there is a wide swing to lower age in the Bchron model for the Penglaitan section across the PTB (between the volcanogenic sandstone PEN-28 and the volcanic ash PEN-22) which makes the assumption of a sedimentary hiatus in Penglaitan at the top of PEN-28 quite likely. However, the field observations neither support nor disprove this hypothesis. An independent line of evidence in supporting the hiatus hypothesis might be reflected by the cogenetic nature of PEN-28 (Penglaitan section), WUZ-4 (Wuzhuan section) and TIE-6 (Tienbao section). These three volcanic beds are contemporaneous and cogenetic, rendering it a robust tie horizon (referred to as Horizon 1 in Baresel et al., 2016) in the Nanpanjiang Basin at the end of the Permian. The fact that the shallow marine sections in Wuzhuan and Tienbao are affected by an unconformity separating the last Permian rocks (WUZ-4 and TIE-6 represent the last Permian beds in these sections) from the first Triassic ones, might further hint to a similar unconformity in the deeper marine section in Penglaitan at the top of PEN-28, but how much strata is missing remains unclear. The effect of a potential hiatus in the age-depth modeling of Penglaitan might be better incorporated by combining the Bayesian and the linear interpolation, using the former one for the interval between PEN-6 and PEN-28 and the latter one for the PTB interval between PEN-28 and PEN-22 including the potential unconformity (Fig. 3). Since the unconformity in the shallow marine sections (Wuzhuan, Tienbao) of the Nanpanjiang Basin mainly comprises missing Permian strata (Baresel et al., 2017), we would expect that by using the combined modeling the age of the PTB in Penglaitan becomes even younger than the Bchron model age of 251.982 ± 0.031 Ma (and shifts closer to the PTB ages of Dongpan and Meishan), but in fact the combined interpolation approach gives an older age of 251.997 ± 0.032 Ma for the PTB. In that sense the younger Bchron model age for the PTB in Penglaitan provides a more realistic assumption than the combined one, but is probably still not the correct one.

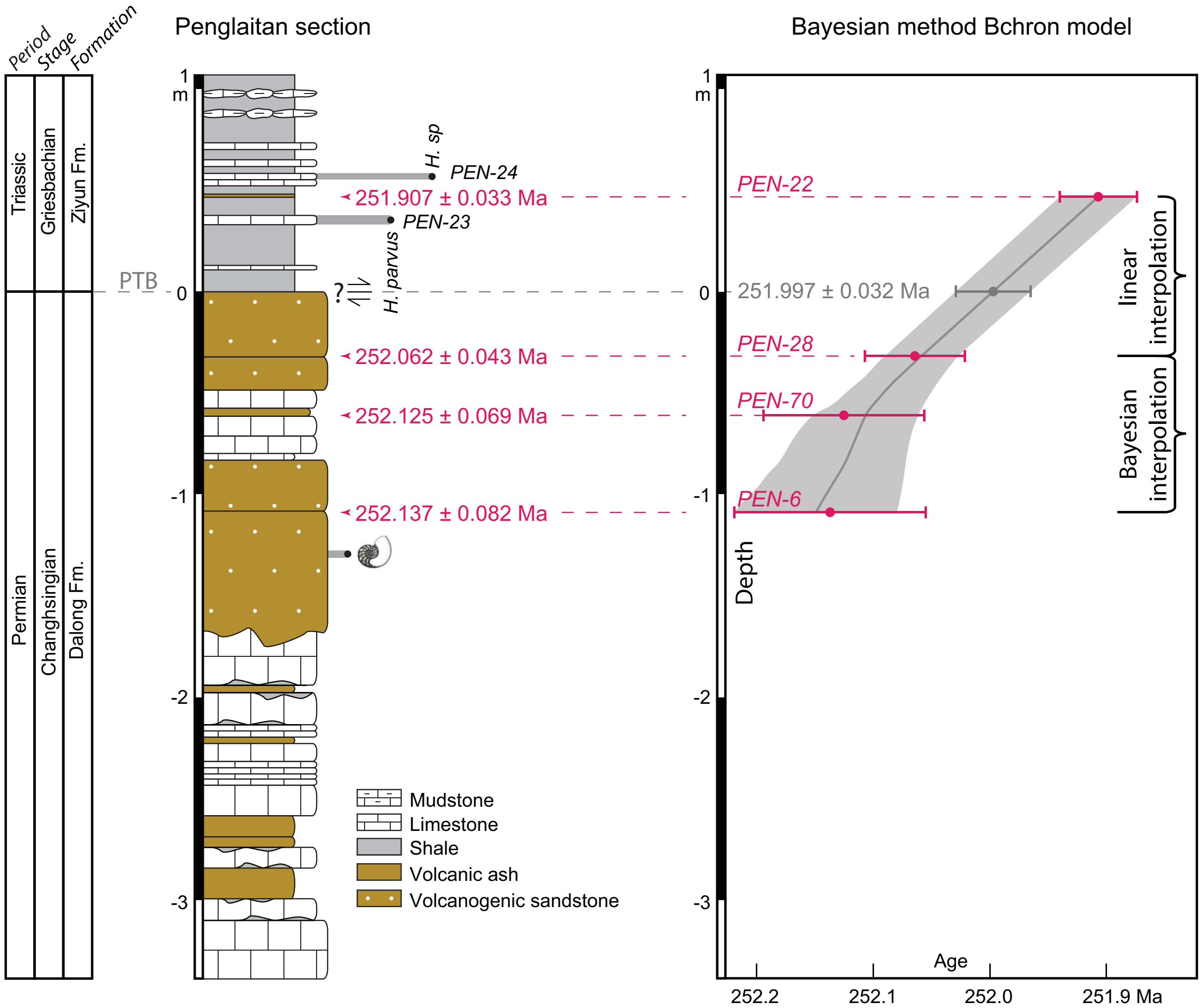

Figure 3. Stratigraphy and geochronology for the Penglaitan section from late Changhsingian to Griesbachian showing weighted mean $^{206}Pb/^{238}U$ dates of the volcanic ash beds and volcanogenic sandstones. U-Pb data of PEN-28 and PEN-22 are taken from Baresel et al. (2016a). Investigated conodont samples (PEN-23 and PEN-24) and first occurrence of Triassic conodonts are shown in their stratigraphic positions. A poorly preserved Permian nautiloid is indicated in its stratigraphic position ~1.3 m below the Permian-Triassic Boundary (PTB). The Bayesian Bchron and the linear interpolation age-depth model are presented with their median (middle grey line) and their associated 95% confidence interval (grey area). Radioisotopic dates together with their uncertainty (red horizontal bars) are presented as $^{206}Pb/^{238}U$ weighted mean dates of the dated volcanic ash beds in their stratigraphic positions. The predicted date for the PTB is calculated with its associated uncertainty using a combination of the Bayesian Bchron age-depth model and linear interpolation.

Baresel, B., D'Abzac, F.X., Bucher, H., and Schaltegger, U.: High-precision time-space correlation through coupled apatite and zircon tephrochronology: an example from the Permian-Triassic boundary in South China. Geology, 45, 83-86, doi:10.1130/g38181.1, 2016.

Baresel, B., Bucher, H., Bagherpour, B., Brosse, M., Guodun, K., and Schaltegger, U.: Timing of global regression and microbial bloom linked with the Permian-Triassic boundary mass extinction: implications for driving mechanisms. Scientific Reports, accepted, 2017.

9.

Lines 447-449: The comparison of zonal construction using unitary associations versus first occurrences is not discussed here, thus this conclusion isn't substantiated by the contents of this manuscript.

This part was deleted.