Geochronology Discuss.,
https://doi.org/10.5194/gchron-2020-26-AC2, 2020

Interactive comment on "Novel method for determining ^{234}U-^{238}U ages of Devils Hole 2 cave calcite" *by* Xianglei Li et al.

Xianglei Li et al.

li000477@umn.edu

Received and published: 4 November 2020

General comments: Based on sound analytical methods the authors present an impressive data set and an innovative approach which definitely deserves publication in this journal. However, prior acceptance, I would suggest that the authors clarify some of their statistical methods and the estimation of their uncertainties. One major point is that most paleo climate time series are impacted by autocorrelation (e.g. Macias-Fauria et al. (2012);Hu et al. (2017), and others). Serial correlation is known to reduce the degrees of freedom of the time series and has to be taken into account, by, e.g. adjusting the p-value or estimating appropriate confidence intervals (Olafsdottir and Mudelsee, 2014; Zwiers and von Storch, 1995;Mudelsee, 2003). I strongly recommend that the authors discuss this issue, such as to which extent their data is affected

by autocorrelation, and how this influences their results. I would further recommend to show some evidence that the derived correlation and the regression model are not dependent on single values (such as the few data points with the lowest δ234U in Fig. 1) and/or the choice of the calibration interval.

We greatly appreciate the valuable comments from the reviewers of our work. We have revised our manuscript, according to the reviewers' comments, questions, and suggestions. We believe that the manuscript has been further improved. Using the program provided in Olgfsdottir and Mudelsee (2014) with a bootstrap resample technique, we recalculate the correlation coefficients (r) between d234Ui and d18O/d13C, with the 95% confidence intervals (see the supplementary file attached), which offers more information about linear relationship between variables. The r values here are the same with that we obtained in the OriginPro software, and further confirmed that our calculation in the MS are about right but less detail description and interpretation. From the Table 1 in the supplementary file, the decreasing r between d234Ui and d18O, but with the 95% confidence intervals overlying each other to a large extent, will modify the regression model slightly, the difference between models is small with respect to the relatively large uncertainty of residual. Besides, using the Matlab-based program in Macias-Fauria et al (2012), we reconstructed the MLR models in term of the three groups split in the MS. Basically, the models are equal to the ones in the MS (see the Table 2 in the supplementary file). The R2 generated in the Matlab-based program over the period of 4-309 ka is 0.624 with p=0.025, which means the model is acceptable. Please find more information in the supplementary file attached.

Minor comments: L108ff: It is unclear which statistical method and/or settings of OriginPro have been used and how the analytical uncertainties are propagated to the predicted δ234U values. OriginPro does not automatically include the uncertainties of both the y and x values in correlation and regression analyses. However, it also allows to calculate confidence as well as prediction intervals. So please clarify.

We apologize for the lack of information and we here clarify the information like this: In the OriginPro, we choose the pairwise Pearson's correlation type to calculate the correlation coefficients with 95% confident level. For the regression analyses, user can find the "Fitting" option under the "Analysis" menu, and over there, "linear fit" and "multiple linear regression (MLR)" fitting method could be chosen for simple and multiple linear regression models, respectively, and "polynomial fit" for the simple quadratic and cubic regression. To obtain the multiple polynomial regression analysis, we firstly calculated series of square/cubic values of independent variables and then apply the MLR fitting method to establish the corresponding model. The analysis results report variety of parameters to help users to understand the model, including fit parameters (the value, standard error, t value and p value), and fit statistics (like coefficient of determination (COD), i.e. R2, Adjusted R2, Residual sum of squares (RSS)), analysis of variance (ANOVA), covariance and correlation matrix and residual analysis (histogram, residual lag plot and such as). For the single regression fitting method, this software also can calculate confidence and prediction bands. To ignore the analytical uncertainty of d234Ui in the regression model, we choose the part of dataset with smaller uncertainty to build the model, the model validation was discussed above and the response to the review #1. Please find the specific information in our response over there.

L132-134: In my opinion, the manuscript would be of even more value for the broader scientific community, if the main points of the proxy interpretation from the Devils Hole calcite deposits would be summarized in 1-2 more sentences. In my opinion, the description of the mechanistic understanding of the underlying processes is too short, and the authors focus mainly on the statistics. I understand that this is not the scope of the manuscript, but to support the statistical model, a proper mechanistic understanding of the underlying processes is essential. In the current version, however, one is referred to the numerous previous DH publications, which are probably not familiar to potential readers. L136-138: See previous comment. A bit more explanation of the processes would be very helpful.

We appreciate this suggestion and will extend the proxy interpretation in this para-

graph as follow. DH/DH2 δ18O is a reflection of meteoric precipitation at the principle recharge zones of the Ash Meadows Basin. Modern precipitation δ18O varies seasonally by >10‰ in southern Nevada. Winter precipitation (-12 to -14‰ VSMOW) is sourced from the Pacific and provides the dominate fraction of aquifer recharge ($\sim$90%), while summer precipitation (0 to -3‰ VSMOW) is sourced from monsoonal systems from the Gulfs of Mexico and California. We interpret past variations in DH/DH2 δ18O to be the result of (i) changes in temperatures and variations in the pathlength of moisture transport through Rayleigh fractionation processes, (ii) changes in δ18O values at moisture source regions, and (iii) changes in the relative contributions of summer versus winter precipitation (see Mosley et al., 2016 for details). Past DH/DH2 δ13C variations have been argued to reflect the extent and density of vegetation in the recharge zones of Ash Meadows Basin, such that δ13C minima correspond to periods of maximum vegetation.

L145/Figure 1: Please visualize the applied linear regression model and its uncertainties

Please find the revised figure attached (Fig. 1)

L148: Compare previous comments, please state if the r and p values are corrected for autocorrelation

Here, we did not correct the r and p values for autocorrelation, and we will replace this table with Table 1 in the supplementary file.

L156-157: Again, does the adjustment of R2 already take autocorrelation into account? L168: What is the critical value of the F-test when adjusting the DF for an autocorrelated time series?

In the MS, we did not take into the autocorrelation. To estimate the effective DF from the autocorrelated time series, we use the equation veff=N * (Dt/(2*Te)) to do the rough calculation, where N is the total number of data, Dt is the average time interval between data and Te is the persistent time. Here, we use the data over the past 309 ka. Using the program in Olgfsdottir and Mudelsee (2014) with the 230Th ages directly, we can easily obtain the persistent times for d13C, d18O, d234Ui and residual, which are 26, 15, 48 and 14ka, respectively. the ïĄĎt is about 4.7ka, and thus the effective DFs of d13C, d18O, d234Ui and residual are 6, 10, 3.2 and 11, respectively. In this case, the adjusted R2 will be 0.89, And the corrected F value is 9.2 which is still higher than the critical value of the F-test, 3.98. We will do this correction in detail in the revised MS.

L175-176: Which part of the data is treated in this part? The whole 590ka interval? Please clarify which values are used here for the validation of the regression model.

We apologize for the confusion in the part. All the residual analysis are based on the model in the MS established over the 4-309 ka interval, not the whole 590 ka interval. We will clarify this in the following revised MS.

L178-179: According to Table 4, the standard errors of the model coefficients are in the order of 15-20%, so how does the estimate of the residual uncertainty stated here compare to the uncertainty of the regression model itself? Does the width of the histogram change when taking into account the uncertainty of the regression model?

All the standard errors of the model coefficients are calculated based on the residual standard deviation, so the estimate of the residual uncertainty is basically the same with this standard errors here.

L194-195: The variability of the residuals may originate in the method used for calibration. When calibrating using linear regression, the variance of the proxy time series is always less than that of the calibration data set, since the resulting amplitude reductions are dependent on the correlation between the proxy and the calibration data set (Esper et al., 2005).

This statement indeed helps us better understand the meaning of the coefficient of determination, i.e. R2, and its relationship with the variance of residual.

L296: Reference not in alphabetical order.

We apologise for the issue and have it corrected in the MS.

Supplementary material: L20: Derived

We apologise for the typo and have it corrected.

Please also note the supplement to this comment:
https://gchron.copernicus.org/preprints/gchron-2020-26/gchron-2020-26-AC2-supplement.pdf

Interactive comment on Geochronology Discuss., https://doi.org/10.5194/gchron-2020-26, 2020.

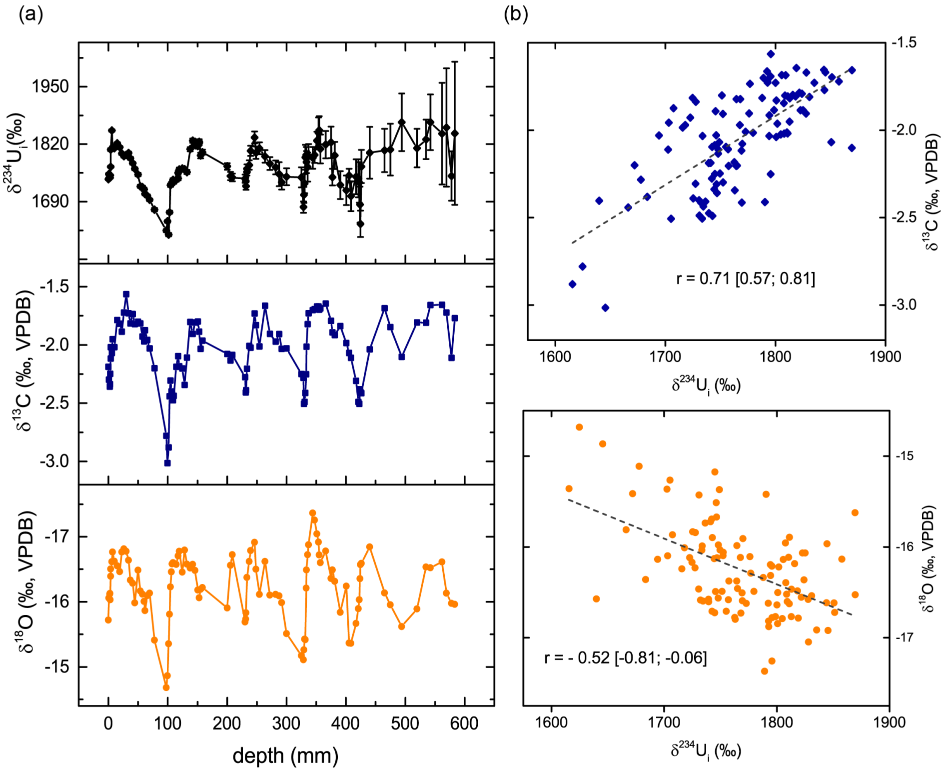

Fig. 1. Plots of the d234Ui, d13C and d18O curves versus the depth over the past 590 ka BP (a) and the scatter plots between d13C and d234Ui, and d18O and d234Ui with the linear regression lines.