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Interactive comment on "Last Interglacial (*sensu lato*, ∼130 to 75 ka) sea level history from cave deposits: a global standardized database" *by* Oana A. Dumitru et al.

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Last Interglacial (sensu lato, ∼130 to 75 ka) sea level history from cave deposits: a global standardized database

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General comments:

Dumitru et al. have compiled relevant data from the submerged speleothem archive that can be used to provide valuable relative sea level data for the last interglacial period (130 – 75 ka). They focus on a specific, but loosely defined time window - the

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last interglacial period- that will see plenty of attention because of the multitude of allied studies for this 'analogue' for future sea level change.

This component of the WALIS database will prove to be extremely useful. Speleothems provide robust constraints on sea level elevation, and phreatic overgrowths on speleothem provide precise sea level index points. The community needs such a framework; one that demands comprehensive documentation (and is sadly incomplete and inconsistent for some datasets – I am guilty myself for some of the gaps, and I have learned a great deal by revisiting the older data tables). Having said that, the database (and data) needs attention. The accompanying text also needs corrections and clarifications (see below).

I would like to see some indication of the management and governance of this facet/query of the database (i.e. speleothems). Some of this is inherited from WALIS general principles and guidelines, but it would benefit from repetition in brief, within the text. Is this a 'living dataset', and hence first version, or might it be described as an illustration of what might be call a thematic subset of data from the global standardised database WALIS?

On data coverage: Comprehensive, as far as I am aware, for MIS stage 5 in the strictest sense, but it would be worth reflecting on samples that have ages within the time window in title, but outside marine isotope stage 5 and could usefully be included because they help constrain the timing of the last interglacial (see data, for example, from the Bahamas incl. Gascoyne et al, 1984; Richards et al 1994; Smart et al, 1998 – see references).

A key concern (for authors and database managers, editors) that relates to this database (and SISALv2, Comas-Bru et al ., 2020) is the consistency of reporting measured U and Th ratios and terminology with respect to 'corrected ages'. Corrected ages as described in the database attributes are strictly 'initial Th-corrected ages' (using a correction based on a priori estimate of initial Th). 'Corrected ages'

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are distinguished from ‘recalculated ages’, which are based on new information (improved decay constants and or further insight into initial Th). There is also the possibility of 3-d U-Th isochron ages that might require an alternative column (and not require ‘correction’ for detrital Th). Please address these differences in the text and consider alternative attributes. It would be worth commenting on the extent to which ages _could_ be recalculated for speleothems, perhaps by referral to the supplementary information at https://essd.copernicus.org/articles/12/2579/2020/essd-12-2579-2020-supplement.pdf.

Also important – and not covered: Speleothems provide periods of continuous growth and additional chronological information beyond the U-Th ages alone. To accurately constrain sea levels, one needs to know the growth rate, sample mid-point etc to define start and cessation of growth. This is a challenge to accommodate in the database, but ought to be considered or at least discussed in relation to the age-model work in SISALv2 etc.

**Please reinforce statements seen elsewhere in speleothem review articles related to the safety risks of sample collection in such settings and also encourage the adherence to principles of conservation and preservation of these caves. Returning to samples sites should be discouraged if sufficient material and appropriate documentation has been archived by the original authors. **

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Details:

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Abstract. Line13 on. Cave deposits include much more than the POS and SVS presented here, one can get beach deposits and corals within caves that provide sea level information. Declare focus on secondary carbonate precipitates, or speleothems. Best to be more specific.. many cave deposits are not suitable for U-series dating. There

are examples of cave sediments having been dated by OSL. Cave deposits can provide archives of valuable information, alternative to 'powerful archives'.

Line 16. POS on pre-existing vadose supports.. but what of walls? Title and elsewhere – explain the terms sensu stricto, lato (strictest sense, broadest sense) – not commonly used. And perhaps refer to alternative texts that define the last interglacial (marine isotope stage 5 or 5a-e or 5.1-5.5 etc)

Line 24. Focussed on MIS 5e, but also data that have the potential to constrain sea level fluctuations during the longer duration MIS 5. Not just 5a and 5c, because speleothems assist with constraining low stands also (e.g. 5b and 5d).

Line 26 use U, Th isotopes used to generate U-Th ages

Line 28. Why 'more importantly'? And (i) and (ii) need rewording.. One would expect abstract to address the 'living database' aspects.. unless you think this is a given because of the journal demands.

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Section 1.

Line 38.. Expand on the 'samples and samples sites ..are better preserved'. I presume you mean that the context has been preserved and hence interpretation easier.

Line 38 'sea level evolution' – choose alternative.. and do you mean relative sea level

Line 40 'Yet to date . . .. are being debated' reword.

Line 46. There are many potential references, examples so use e.g Thompson et al., 2011.. etc. and consider Chutchavaran and Dutton (ESSD, this volume)

Line 50 use 'providing' rather than 'suggesting' maximum elevations

Line 55 include S+M 1972.. and maybe Dill, R.F., 1977, The blue holes, geologically significant submerged sinkholes and caves off British Honduras and Andros, Bahama

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Islands: 3rd International Coral Reef Symposium, Proceedings, v. 2, p. 237–242. It was recognised 50 years ago that such deposits would be useful see Benjamin (1970) in National Geographic

Line 82. Age of carbonate material below hiatus is a _maximum_ age for timing of submergence (assuming no post-depositional alteration of exposed surfaces)

Line 83. Avoid the 'dipstick' analogy.. dipsticks indicate level, not binary status.

Line 84.. choose alternative to roughly.. constraints are robust and accurate (elevation), but there may be lag between the constraint and changing water levels.

Line 87 on. Use the term minimum estimate. I would challenge that initiation of growth can be rapid after emerence, but difficult to predict. The likelihood/duration of lagged response has yet to be established. Rough estimate is overstating things. Another advantage, not mentioned in the work is that further growth over the earliest calcite, post emergence, is 'protected' by subsequent growth. This is not the case for ages prior to hiatuses, which are susceptible to diagenetic alteration.

Line 94.. they do not document the "moment".. they can constrain the maximum and minimum age of sea level change at this depth.

Line 95. Time will tell.. speleothems have the potential to document the rise and fall of sea levels in stage 5. Maye the that ideal sites have not been identified yet.

Line 96. Choose alternative to 'difficult'. The data are unambiguous and easy to interpret, once it is established that they are constraints and NOT sea level index points.

Fig. 1. A useful figure, but needs refinement. e.g. constraints on sea level in (b).. label vadose calcite and hiatus/biogenic overgrowths. (c).. grey background, poor reproduction and use of T1 to T3 will have reader question why the internal morphology with changing MSL is not illustrated. POS should start earlier than T1 and at lower elevations than illustrated.

Line 116.. shorten to ‘Cave deposits have received little or no attention in prior compilations’.

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Section 2

Line 146 ‘varying’ quality.. avoid. I’d accept ‘variable’.. but you have not discussed criteria thus far. And on this ote, it would be worth illustrating the range in RSL data quality (1 to 5, compiler defined) For this section, MIS stage 5 boundaries might be determined by material that falls outside MIS 5 (e.g. Bahamas data in Li et al 1989; Richards et al, 1994; Lundberg and Ford 1994).

Table 1. Sites For ‘not mentioned’ (Moseley et al, 2013) – numerous caves in Quintana Roo, or similar. Additional information on Bahamas samples/sites. Richards et al., 1994. AN samples are from Stargate, Andros; GB samples Sagittarius Cave, Grand Bahama.

Line 160. Barometric altimeter (or diver depth gauge) adjusted for density profile, where possible with information about the vertical density profile associated with freshwater, brackish and saline zones. This is declared in database but referred to in discussed in text.

Line 177. Sample ID – samples may have been referred to in a number of papers. Declare best endeavour to find the first occurrence for sample ID might be useful phrase here.

Line 180. Reported ID - this might be sample ID or lab code. Database may need expanding to reflect this. For many geochronology laboratories, the analysis has separate codes to that provided by the group responsible for sub-sampling (e.g. Moseley et al 2013) .

Line 192. Please allow for possibility of using broken speleothems where possible, to preserve the aesthetic quality of caves. For many cases, the original location of a

broken sample can be established.

Line 194. Mineralogy does not affect the reliability.. it may dictate the susceptibility to alteration, but equally important is the geochemical setting. Low magnesium calcite is a relatively stable form of calcium carbonate in fresh and/or saline water, but mixing zone corrosion can cause serious dissolution. Encourage use of petrographic investigation. Also, marine borings, encrustations etc can dramatically alter the isotopic signal

Line 204 Dutton et al (2017) "is very applicable. . . for speleothems aswell". It was written to apply to all U-Th geochronology. Please reword.

Line 209 use 'alpha spectrometry', or 'alpha counting'. 'Alpha detector' is use in database, which is usually reserved for more basic instruments.

Line 211 use measured isotopic 'ratios and concentrations', not 'characteristics'.

Line 212. Use 'analyses of well-characterised internationally-recognised standards or certified reference materials are used to demonstrate the reliability of results'.

Line 213 'reduced' age uncertainties – not 'lowered'

Line 214 delete 'progressively'

Line 217 insert 'reported alpha spectrometry . . .or TIMS _results_'

Line 220 insert used: initial ratios and the decay constants used

Line 221 delete the effect of detrital thorium concentration. NB it is not only detrital Th one needs to consider, but also what some would call hydrogenous Th. Use of a threshold value value of 300 (Helstrom, 2006) for 230Th/232Th is arbitrary and depends on the ratio used for initial Th.

Line 230 on. This text needs to be improved. I think it is fair to accept that if ages are not presented as BP (or AD1950) or yr b2k, you can assume that dates are calculated with respect to date of analysis.

Line 232 declare ± 100 years (2 sigma) for age uncertainties for material of last interglacial age and add typical U concentration and declare insignificant 230Th initial

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Line 236. correlated to the _same_ (insert?)

Line 250 replace ‘clear’ with ‘unambiguous’

Line 255 delete ‘absolute’, also declare early in text that all age uncertainties are quoted at 2 sigma.

Figure 3. You declare all ages are corrected for detrital Th. Begs the question – in original paper?, using updated decay constants? Please add more information.

Line 281. Calcite growth above and below (or before and after) a growth hiatus (not bottom and top).

Line 283. Again, avoid use of ‘roughly’

Line 288 from not form; deciphering the timing of stillstands – if that is what you mean

Line 290.. be consistent you use mapsl elsewhere and m here. Is there a difference?

Para L300 on. Andros – in addition to the data for Gascoyne et al (1979), there are data in Gascoyne (1984), Richards et al (1994), Smart et al (1998) - see references above. Mostly alpha-spectrometric or TIMS U-Th ages.

Figure 4 does not include dates from Andros (Gascoyne, 1984; Richards et al 1994) or Grand Bahama (Richards et al, 1994; Smart et al, 1998). Not necessary, but there is a suggestion that data relating to MIS 5 in broadest sense is included. Also.. plotting U-Th ages alone only goes so far. The duration of continuous growth is required (see earlier comment). This figure does not illustrate this. It is not necessary, but the point needs to be made that these are ages only and _not_ growth periods. Awkward

placement of legend, it distracts from the data.

Line 365. The Bahama archipelago (includes the Bahamas and Turks and Caicos).

It is worth noting the work conducted by the Miami group to assess the subsidence of the Bahamas, in part because of loading through periodic carbonate production on the platform. e.g. McNeil, D.F.; Ginsburg, R.N.; Chang, S.-B.R., and Kirshvink, J.L., 1988. Magnetostratigraphic dating of shallow water carbonates from San Salvador, Bahamas. Geology , 16(1), 8–12.

In addition.. it would be worth acknowledging the additional constraints on sea levels that are provided by the flank-margin caves that host such speleothem deposits in some places. Perhaps at the same time as notches are mentioned (e.g. papers by Mylroie et al., 2020; Carew and Mylroie, 1990; Mylroie and Carew, 1995).

From journal guidelines: Ma and Myr (also Ga, ka; Gyr, kyr): "Ma" stands for "mega-annum" and literally means millions of years ago, thus referring to a specific time/date in the past as measured from now. In contrast, "Myr" stands for millions of years and is used in reference to duration (CSE, p. 398; North American commission on stratigraphic nomenclature).

The data compilation/spreadsheet (speleothems - last interglacial from WALIS):

It would be useful to refer to the site https://walis-help.readthedocs.io/en/latest/ (or acceptable zenodo URL) earlier in body of text. A lot of critical relevant material can be found here.

File name needs to be more specific with date, perhaps? Or is this the standard file name for a query download? I note that other database compilations have name of first author compiler and version/ date.

Tuccimei et al. URL link is broken

For data on vertical movements – what qualifies here? Needs guidance.

Please comment on the “Quality of age information”, or signpost where this information can be found for speleothems in particular.

A component that needs to be considered is the definition of continuous growth. The age of growth initiation and cessation is dependent on sample position and growth rate. This caveat needs to be included in the paper. Would the database be expanded to include such information?

Reported age – please define (is this uncorrected for initial 230Th, for example). And what does corrected reported age mean? There is information at the WALIS website, but this should be included in the text for this paper.

Please reflect on the reporting of symmetrical U-Th age uncertainties for last interglacial ages. delta234U (declare that these are per mil values).

There is an assumption that [U] = [238U].. e.g Dorale et al (2010) quote [U] ppm, but spreadsheet is [238U]*. Please comment. *Only 0.73% difference, but outside uncertainty of typical measurement.

In database.. please distinguish between activity ratios and abundance ratios. Generally OK, but see heading for 230Th/232Th.. this is activity ratio.

Report latitude and longitude to full precision declared in paper ie. 87.00 rather than 87 to avoid confusion (see Moseley et al, 2013).

Explain the difference between coordinates and reported co-ordinates (latter not complete, see Cova del Dimoni, Mallorca).

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Additional references referred to in text above

Mylroie, J.E. and Carew, J.L. (1990) The flank margin model for dissolution cave de-

velopment in carbonate platforms. Earth Surface Processes and Landforms, 15(5), 413–424.

Carew, J.L. and Mylroie, J.E. (1995). Quaternary tectonic stability of the Bahamian Archipelago: Evidence from fossil coral reefs and flank margin caves. Quaternary Science Reviews, 14(2), 144–153.

Mylroie, J, Lace, M., Albury, N and Mylroie, J. (2020) Flank Margin Caves and the Position of Mid- to Late Pleistocene Sea Level in the Bahamas. Journal of Coastal Research, 36(2), 249-260.

Gascoyne M. (1984) Uranium-series ages of speleothems from Bahamian blue holes and their significance. Cave Science, 11(1) 45-49.

Smart PL, Richards DA, Edwards RL. (1998) Uranium-series ages of speleothems from South Andros, Bahamas: Implications for Quaternary sea-level history and palaeoclimate. Cave and Karst Science 25(2), 67-74.

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