Geochronology Discuss.,
https://doi.org/10.5194/gchron-2020-2-RC1, 2020

Interactive comment on “Extended range luminescence dating of quartz and alkali-feldspar from aeolian sediments in the eastern Mediterranean” *by* Galina Faershtein et al.

Anonymous Referee #1

Received and published: 7 February 2020

General comments

The authors have presented a comparison study using thermally-transferred optically stimulated luminescence (TT-OSL), violet stimulated luminescence (VSL) and post-infrared infrared stimulated luminescence (pIRIR) ages to extend the dating for the Kerem Shalom sequence from south-western Israel. This manuscript builds on their prior investigation into saturation of the natural OSL and TT-OSL signals at the site (published in Faershtein et al. 2019. Quat Geochron, 49, 146-152). The TT-OSL, VSL and pIRIR250 signals all saturate at the same depth (∼6 m), which is more likely due to the depositional environment rather than an agreement between the different luminescence signals. This allows the authors to measure ages beyond the range of the quartz blue OSL signal (which saturates at ∼2 m depth), although all ages below ∼6m are considered minimum ages. The new minimum age for the base of the Kerem Shalom section is ∼715 ka, implying deposition via aeolian activity since the early Pleistocene.

The study is effectively motivated, and the experimental design, results, and conclusions are generally sound. This manuscript is a well-written addition to the comparative testing and application of new luminescence chronometers being developed in order to extend the age range of luminescence dating. It is suited for publication in Geochronology if the following issues are addressed.

Specific comments

In the first paragraph of the introduction, several dating methods are presented i.e. magnetostratigraphy, cosmogenics, U-Th, U-Pb and Ar-Ar dating but the only method with any supporting references is cosmogenic dating. Please add references for the other 4 methods.

In section 2: methods you mention etching the non-magnetic fraction in HF acid for 40 min. Then the alkali-feldspar is extracted from the non-magnetic fraction by heavy liquid density separation and etched with HF for 10 min. Does this mean that your feldspar samples have been etched twice? Or is the first etch for 40 min for the quartz samples and the second etch of 10 min for the feldspar samples? Either way, please clarify this.

Since you have included the wavelength of the violet laser diode, please also include the values for the blue LEDs and IR diodes. If you know the power delivered to the sample position (in mW cm-2) for the individual Riso readers that should be reported as well.

Do you think that you have grown your VSL-MAAD DRC to high enough doses to

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accurately calculate the D0 value? If we are to expect comparable saturation doses for the VSL signal irrespective of location (lines 250-252), your reported D0,2 value of 369 Gy is comparatively low. The MAAD DRC presented by Ankjaergaard 2019 continued growing beyond 8000 Gy, although it diverged from the natural DRC at ~2000 Gy. When their natural DRC was fit with a double saturating exponential (DSE) function it had D0,1 ~75 Gy and D0,2 ~1300 Gy. So is it possible that the reason your data fit equally well with a SEPL or DSE fit is because you haven't extended the DRC to higher doses… Your DRC data in Fig 2 for the modern sand sample looks as though it is growing beyond 1000 Gy, although it is difficult to judge without the fitted DRC (and also because of the large uncertainties on the VSL data but there is nothing you can do about the low VSL signal intensity).

In section 3.5 you describe the TT-OSL ages as having one reversal (at 8m) and the uncorrected pIRIR ages as having two reversals (at 5 and 11 m). But looking at Tables 3 and 5 and Fig 8, there are two reversals in the TT-OSL ages (at 8m and 15m, although technically the ages at 12m and 15m are within uncertainty of each other) and only one reversal in the pIRIR ages (at 5m). Please clarify.

The final paragraph of section 3.5 becomes ambiguous because you are speaking about TT-OSL, uncorrected pIRIR, and two different versions of corrected pIRIR ages. Suggest changing line 319 slightly to remove any chance of ambiguity… "As the TT-OSL and pIRIR methods are limited by different factors (thermal and athermal signal loss respectively), there is no reason …"

In section 3.6 please refer back to Fig. 2 (in line 328)… it's been a long time since you discussed the VSL DRC data in section 2.

In section 3.7 (lines 357-366) you discuss the effect of bioturbation as a reason for the relatively young age of sample KR-10 at the top of unit 5, which is a well-reasoned explanation. However, you then state that this phenomenon is visible also in sample KR-15 in unit 2… I think here you are over-interpreting KR-15's apparent age differ-

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ence with the underlying KR-2 and suggest that you remove the last sentence in this paragraph. The relationship between ages does look similar on Fig 10 if you consider the plotted age/mid-point. But the TT-OSL and pIRIR signals are clearly saturated as shown by the Ln/Tn plot (Fig 6) and the Ln/Tn values for each signal are almost identical for these two samples. The TT-OSL De values overlap within uncertainty, so their age difference stems from variation in the quartz dose rates. In contrast, the feldspar dose rates are almost identical so the age difference is due to the different pIRIR De values. But when you compare the TT-OSL, uncorrected and corrected pIRIR ages for these two samples (Fig 8) they all overlap within uncertainty.

Following on from the previous comment, I'm not convinced about how the final chronology is presented in Fig. 10. It is not a simple task to combine multiple luminescence chronometers and your choice to use the oldest TT-OSL or pIRIR age is a good approach. But then for sample KR-14 you essentially disregard this approach and cite the principle of super position as a reason to "fix" that age between the two bracketing ages. The logic behind this argument is not necessarily incorrect but I think it glosses over the complexity of dealing with ages after signal saturation. How can you be sure that KR-13 isn't the age inversion? It has the largest variation between the different methods and although there is an hiatus between unit 3 and 4, there is another hiatus between unit 4 and 5 that is not visible in terms of the ages. If you use the uncorrected pIRIR age for KR-14 it still overlaps with the bracketing ages (KR-13 and KR-3) and it also puts into context the offset between samples KR-15 and KR-2. Ultimately, this makes the point that even when multiple luminescence signals are in saturation, the ages do not necessarily agree and can still be messy... which makes your Ln/Tn plots presented in Fig 6 even more impressive because they show really clearly what the ages cannot.

Fig. 2: please plot the DRC for the modern sample, preferably the single saturating exponential plus linear fit, as that is the fit ultimately used in the age comparison in Fig 11.

Fig 4. Why are there so few points reported on the bleaching experiment for the VSL signal (n=3)? The bleaching signal is much better defined for the TT-OSL and pIRIR experiments (n=7). Additional measurements should be made to better define the VSL signal bleaching curve.

Fig 10. Suggest adding a short explanation to the text about which ages are used in this figure. For example, "ages above 6m are based on uncorrected pIRIR250, while ages below 6m are the oldest TT-OSL or corrected pIRIR250"

Fig 11. Please use different symbols/colours for the samples above and below the 6m saturation cut-off to make the comparison easier to see.

Technical corrections

Line 24: change semi-colon (after reversals) to full stop

Line 32: change to "...(quartz or alkali-feldspar)..."

Line 55: remove "the" before luminescence methods

Line 59: the reference Haler et al. 2017 does not appear in the reference list, I assume this is a typo and is meant to be Harel et al. 2017

Line 69: change unites to units

Line 82: change experiment to experiments

Line 86: suggest changing this to "...from the KR section by drilling 30cm deep holes horizontally into the sediment".

Line 156: change Recycling to recycling

Line 164: change reduces to reduced

Line 190: change to "Previous studies reported lower residual signals..."

Line 198: remove hyphen from pIR-IR as it is not consistent with the rest of the manuscript

Line 199: changed droped to dropped

Line 233: change sample's to sample

Line 238: remove "Similarly" and begin sentence "The natural TT-OSL . . ."

Line 280: remove "the" so sentence reads "The natural growth signal is limited by anomalous fading"

Line 285: Change Huntly to Huntley

Line 309: change aged to ages

Line 334: remove farther

Line 367: The depositional ages reported for the units do not match with those reported in Fig 10. Please clarify.

Line 395: remove repeated "to" text should read ". . .later penetration of the silt into the sandy soil"

Line 470: change oncentrations to concentrations

Table 4: change samples to sample, text should read "For sample details see Table S2"

Fig. 4a legend: change bachground to background

Fig 5 caption: change experiments to experimental

Fig 6. caption: change modifies to modified

Fig 7. caption: change modifies to modified

Table S3 caption: change exponentials to exponential

Table S3: please order samples by depth (rather than sample ID) in keeping with the

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rest of the manuscript

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