

Interactive comment on “Identifying, characterizing and predicting spatial patterns of lacustrine groundwater discharge” by Christina Tecklenburg and Theresa Blume

Anonymous Referee #2

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General comments This manuscript describes intensive field studies of LGD processes. An impressive amount of field data is presented, and an attempt is made to better comprehend spatial patterns of LGD on different spatial scales based on this large set of data. The major novelty of this contribution is the amount of data collected (as eluded to by the authors), but in my view overall few new insights into LGD processes are presented in the ms in its present form. In general, the ms is well-written, although it would benefit from a more concise and clearer structuring considering the large amount of data presented. I have a number of general comments that I believe should be addressed: 1) In parts, the ms reads like a data report, describing one experiment after another, with insufficient linkage between sections. It might help to

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re-structure and use the same subsection titles in methods and results. Similarly, the figures, in particular the presented maps, are very busy. Consider breaking up the figures into smaller sub-figures rather than overlying too many things on one graph. I encourage the authors to carefully consider which level of information and especially which data are really required to support the main findings and eliminate those that aren't. For example, data or analyses that have not yielded conclusive results could be removed, but mentioned in one sentence that this was tried, moved to an appendix etc. 2) I suggest to remove the radon part from the study. Data is very sparse, and does not contribute significantly to the final interpretation. It is argued that low Radon concentrations in the lake's center are a result of low LGD, but they could equally well be a result of (a) not taking into account greater depth (ie inventories were not calculated) (b) wind-driven radon loss to the atmosphere. In short, there is not sufficient information to adequately interpret the radon data. 3) It appears that the fibre-optics part of this study has previously been published (Blume et al 2013), or that the data presented here does not add new insights to those found previously. Please explain in detail what is new and / or consider reducing the part on FO-DTS in this ms. 4) It is in times difficult to follow the heavy reliance on statistical treatment. For example, what is the point of the autocorrelation analysis of LGD values (e.g. page 5)? Is there a physical process associated with LGD that requires an understanding of autocorrelation of LGD along a shoreline (there is no use made of this analysis in the discussion unless I overlooked it?). 5) A linear mixed effects model should be applied instead of independent linear relationships with explanatory far field predictors. 6) Data distribution is very irregular, in particular the largest coverage is in the northern section of the lake where you already know that the highest LGD is found from a previous paper. In addition, the lake is connected to a larger lake to the south (of which you make no mention). Could this affect LGD patterns, in particular with respect to far field predictors? 7) LGD flux was estimated / calculated / modelled using different methods, and it is somewhat difficult to reconcile the results obtained by different methods in quantitative terms. How do the flux estimates compare, and are they consistent with each

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other? 8) It was found that LGD correlated with grain size but not with slug test results (hydraulic conductivity). This is surprising (in particular in a large data set), and would require more detailed discussion. Were the slug tests done correctly, correct equations applied (there are a few for different experimental configurations), is there a possibility that there is a problem with the slug test results?

In the end I am a little lost what key message to take away from the ms. I believe this is likely due to 'too much data, too much analyses'. In this light, I suggest to include a detailed account of the value of each of the applied methods (incl a comparison and appraisal of the different tools to estimate flux on different scales), and to provide a 'recipe' how to design a 'good' study on LGD variability in the future. In summary, whilst some aspects of the study provide new general insights into LGD variability, overall this ms appears to be primarily of regional interest and as such I wonder if it would not be better placed in a journal with a more regional focus e.g. Journal of Hydrology – Regional Studies.

Specific comments Abstract – include relevant quantitative data on results (order of LGD fluxes etc). Also, include size of lake in abstract and study site description. Page 2 line 15-20 and relevant sections after: previous study results are not contradictory – they just highlight the fact that the effect of sediment structure on discharge is highly site-specific. Are your findings of a more general nature and as such applicable to other sites ? Page 3 methods: include site coordinates and a larger overview map. Page 5 line 23: show example data with and without SGD in a graph. Page 6: line 2: why compare 2 datasets with RMS / statistics? Why not just subtract one from another and analyse the difference if you have data from the same locations? Use statistical methods only where they are required. Page 5 line 14: provide temperature values of calibration points. Page 6 line 29: include month (August). Page 10 line 21: VTP could not be taken in areas with high stone content – however, these are areas with potentially high bulk hydraulic conductivity and could present a preferential flow path. Please acknowledge that you might have missed important entry points or

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explain why they are not considered important. Page 10 line 27 and onwards: the interquartile range is irrelevant as far as I can see. Further on in the section, you statistically analyse the LGD variation along lag distances. What is the point of this analysis, are the results interpreted in the discussion, and what is the physical meaning behind them? Again, use simpler metrics and less statistics where possible. Page 12 line 11 – am I mistaken or does this indicate higher LGD rates further offshore than measured with other methods? If so, this would not fit with your overall appraisal. Along those lines, please provide a table that summarises the LDG rate measurements with different tools including error bars and discuss advantages and disadvantages of different methods.

Page 13 line 5 – provide a grain size map, remove most of the text in this paragraph describing the grain size distribution and include only one or two sentences with the main information on grain size distribution that is required to understand the context. Page 13 line 15: include the data in table 3 in figure 4. The grain size model is nice, although I wonder a little about applicability given the large residual errors? In my view the most interesting message of this paper is shown in Figure 8: a variation of LGD of up to a factor 3 can be due to grain size alone. Page 13 line 32 and onwards – remove ordinary kriging from the ms (and remove this paragraph which is then obsolete) and use only the method that works best. If you can, justify the use of regression kriging. Similarly, remove the discussion section page 15 lines 5-9 – it is a circular argument to say that regression kriging is the more appropriate method because results fit better. Page 14 line 11 and onwards: applying individual linear regressions between far field predictors and LGD rates assumes the simplistic view that parameters can be isolated. Instead, use a linear mixed model to comprehensively analyse the combined effect of topographic far field predictors on LGD. Page 15 line 16-20 : can flow reversals be a result of measurement errors? Page 16 line 11: give % variations. Page 16 line 21: it is unfortunate that this important data is missing. This would have considerably strengthened the ms. Conclusions – only include FO-DTS results that provide new insights compared to those already published by your group. Fig 9 – would be better

presented in a plot modelled vs measured. Figures – include bathymetry contour labels in maps.

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