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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Halon-1301 — further evidence of its performance as an age tracer in New Zealand groundwater" *by* Monique Beyer et al.

Monique Beyer et al.

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Dear Daren, We greatly appreciate your valuable feedback on our manuscript. Below, we detail our responses to your comments. We intend to closely follow all of your suggestions.

Comments from D. Gooddy (Referee) dcg@bgs.ac.uk Received and published: 30 March 2017 This manuscript presents and extensive data set for H1301, building on that previously published by the lead author in HESS 19, 2775-2789, 2015 and WRR, 50, WR015818, 2014. Main Comments: Despite the impressive data set I was slightly disappointed at the level of greater understanding that was gained from this. In partic-

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ular, the unavailability of other tracers at some sites which would have hopefully given greater lucidity as to the retardation/removal processes taking place. I think this is a significant weakness in the paper although not one that the authors can rectify.

–> Thanks for pointing this out. We agree with your comment and intend to tone down our message re further insight into the causes of reduced Halon-1301 concentrations in abstract and introduction.

I do think however that more thought needs to go into the discussion as this is key to the main knowledge advancement that the paper could potentially provide.

–> Thanks, we agree with your comment and intend to include a more detailed discussion around degassing following your suggestions below.

Where low concentrations of H1301 are found, have the authors considered degassing of N2 (as a result of denitrification) or CH4 as possible mechanisms for removal. Without any NO3 data this is hard for the reviewer to assess. I would therefore refer the authors to Visser et al 2007 (WRR 43, 10 W10434) and Visser et al. 2009 (JoH 369, 4-4, 427-439) where the issue of tracer degassing is discussed in extensive detail.

–> Thanks for pointing this out. Unfortunately we do not have NO3 data for over half of the sites to further assess degassing as possible cause of reduced Halon-1301 concentrations. Further, we note that degassing would affect all gaseous tracers (including Halon-1301) – with the most impact to the least soluble tracer, making it even harder to properly assess degassing as possible cause. However, we note that we assess the oxygen content of the sample (i.e. whether the sample is oxic or anoxic), which should give a good indication of whether deN could have taken place – and most of the samples that indicated reduced Halon-1301 concentrations were indeed anoxic.

–> Following your suggestions, we intend to discuss degassing as possible cause of reduced Halon-1301 concentrations (see also comment re Ne/Ar and determination of excess N in as response to your next comment). –> Further, to highlight that we

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had previously considered a more comprehensive range of possible causes of Halon-1301 'removal' (in our HESS 19, 2775-2789, 2015 paper), we intend to include a more detailed summary of these in our manuscript.

Related to this, I am interested that the authors are using N2/Ar ratios to correct for excess air, rather than the more normally accepted Ne. Could they comment on the possible issues relating to this, especially if denitrification is taking place.

–> While Ne/Ar is more robust, N2/Ar is much simpler to measure and still provides a useful excess air and recharge temperature correction in most cases. Significant denitrification (excess N) can be identified by anomalously high recharge temperatures. In such cases, excess N is corrected for by applying the mean annual air temperature. That method also allows for estimation of excess N. We think further assessment of degassing into excess N as possible cause of Halon-1301 'removal' would add significantly to the discussion on reduced Halon-1301 concentrations. We therefore intend to address it using the estimated excess N and available NO3 and CH4 data.

As a general observation there are far too many figures and figures within figures – As these are not really discussed in any detail, the true significance is not clear.

–> Thanks for your comment. We intend to assess the significance of each figure and remove them if we feel is needed.

Minor Comments: P1 Line 13. Could not rather than "couldn't" P1 Line 29. More description on the (speculation?) causes of H1301 reduction is needed here. In the Introduction section you are only really referring to recent groundwater age indicators and you need to be explicit about that. As a general over view of the state of the art I would refer the authors to Aqulina et al 2014 (Applied Geochemistry 50, 115-117) and Darling et al 2012 (Applied Geochemistry 27, 9, 1688-1697). P2 line 13 would add Darling and Gooddy 2007 (Science of the Total Environment 387, 353-362) P2 Line 15 after ambiguous age interpretations add Suckow 2014 (Applied Geochemistry 50, 222-230) P3 Line 12 replace 'They' with Bartyzel et al (2016) P4 Line 8 add reference to

Oster 1996 P6 Question. Is the input function for S Hemisphere and N hemisphere the same for H1301? Some reference to the differences would be helpful for other/future practitioners. P8 Line 19. Delete ‘in fact’ P9 Line 18. Give reference for the ‘issues’ eluded to. P11 Line 10. Need to justify assertion that T is one of the ‘most reliable’. What do you mean by reliable? P11 Line 14. The input of SF6 is exponential and not ‘near linear’. P13 line 15. Add in text relating to degassing potential.

–> Thanks for the above comments. We intend to follow your suggestions and make changes as per above comments.

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