The Cryosphere Discussions

The Cryosphere Discuss., referee comment RC1
https://doi.org/10.5194/tc-2021-226-RC1, 2021

Comment on tc-2021-226

Anonymous Referee #1

Referee comment on "Review Article: Permafrost Trapped Natural Gas in Svalbard, Norway" by Thomas Birchall et al., The Cryosphere Discuss., https://doi.org/10.5194/tc-2021-226-RC1, 2021

General comments

Permafrost with the presence of ground ice is thought to be a good seal for natural gas. This review paper, for the first time, provided a synthesis dataset of the occurrence of sub-permafrost gas accumulations for Svalbard with 41 boreholes and other related measurements. The authors state (L65--67) that their aim is to provide a systematic review of the occurrence of sub-permafrost gas accumulation and to characterize the permafrost thickness and sealing properties.

I found the overall presentation is not well structured and clear, and hence is difficult to review. This, in my option, is because the paper mostly focuses on the data description, and did not clearly show how they help to fill the knowledge gap. Based on the author guideline of TC, a review article should *"summarize the status of knowledge"*. The paper in its current format is more like a datasets report rather than a scientific paper. This could be reflected by the Results section. It gives very detailed information on permafrost thickness, gas presence/absence, but lacks in-depth analyses.

Authors used a large number of observations from various sources: hydrocarbon exploration, coal boreholes, and scientific boreholes. If I understand correctly, these wells and boreholes were instrumented in different periods, by different technicians as well as scientists, and for different purposes. In this case, the data is expected to have different degree of confidence. In section data and methods, authors should clearly clarify such degree of confidence, and the data quality control.

Last but not least, I would suggest authors double-check the definition of permafrost (please see Van Everdin-gen, R. O., 1998), the current definition in L50 is not true (please also see my specific comment).

For these reasons, I would not recommend that the paper be published in TC in its current form. I would actually recommend authors significantly shorten the paper and focus on how the valuable data contribute towards knowledge of natural gas in/below permafrost. Another option would be thinking about publishing it in a data journal.

Specific comments:

- P2, L41: Why relatively young permafrost is important here?
- P2, L50: ... remains at or below 0°C for at least two consecutive...
- P2, L52: *Physically speaking, ice-saturated permafrost possesses extremely good sealing*, because of ? Also, this knowledge is similar to your conclusion 4: permafrost in valleys with more ice is a better seal. Then, why do you still need conclusion 4 if it has been widely known?
- P3, L72--73: 100--500 m is quite thick...
- P7, L196: I agree identifying the permafrost thickness is challenging. On the other hand, permafrost is a hidden phenomenon, and identifying its presence is also NOT simple (even at a site scale) and may even be ambiguous without direct evidence (e.g., soil temperature and samples). Please see Cremonese et. al (2011).

References

Cremonese, E., Gruber, S., Phillips, M., Pogliotti, P., Boeckli, L., Noetzli, J., Suter, C., Bodin, X., Crepaz, A.,Kellerer-Pirklbauer, A., Lang, K., Letey, S., Mair, V., Morra di Cella, U., Ravanel, L., Scapozza, C., Seppi, R.,and Zischg, A.: Brief Communication: "An inventory of permafrost evidence for the European Alps", TheCryosphere, 5, 651–657, https://doi.org/10.5194/tc- 5-651-2011, 2011.

Van Everdingen, R. O. Multi-language glossary of permafrost and re-260lated ground-ice terms. doi:https://nsidc.org/cryosphere/glossary-terms/261frozen-ground-or-permafrost, 1998