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The Cryosphere Discussions

Interactive comment on "Application of ground penetrating radar (GPR) in Alpine ice caves" *by* H. Hausmann and M. Behm

Anonymous Referee #2

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This paper describes the collection of ground penetrating radar (GPR) profiles over ice deposited in caves beneath the Austrian Alps. The study of these deposits is of importance as the cave ice sequences might contain valuable climate information. The application of GPR to imaging the cave ice is a novel and appropriate approach and should provide ice volume data, information on the basal interface and internal ice structure. Unfortunately, in its current form, this paper lacks a clear aim and findings and firm scientific conclusions that add to our knowledge of cave ice deposits. My initial general points are:

The data is important, well collected and is generally well displayed. Integration of photographs with the radar profiles, rather than a separation of the image sets would make it easier to follow the labels and commentary. There is also only limited need to

display unmigrated profiles as they add little to the descriptions.

The title of the article does not indicate any real results – applying a tool, i.e. GPR is insufficient – there needs to be a scientific outcome for a paper in the Cryosphere.

I am unsure what the aims of the paper really are. In places there seems to be a suggestion that the paper will characterise the internal structure of the ice. There are also comments regarding the subsurface reflection signature, which is described and discussed. More critically, there is a comment in the abstract and in the last paragraph of Section 1 about characterising ice thickness and extent, i.e. ice volume, though this is not done.

A number of terms are used somewhat interchangeably for the ice in the cave:- 'ice fillings', 'ice caves' and 'cave ice'. The term 'ice cave' is confusing in this context. These are caves with ice in them. I would prefer to see a distinction between the cave and the 'cave ice' within it and this later term used throughout to describe the deposit.

The structure of the paper could be improved. Section 2 on ice caves is a general introduction that should come at the beginning of the paper.

Towards the end of section 2 there is acknowledgement that detailed field descriptions and ice thickness results have already been presented in another paper, suggesting that internal structure is key to this paper. If so, state this from the beginning and integrate results into the abstract. The statement in the abstract with regards to internal structure is that 'internal structure.. is characterised by banded structures which are inclined or parallel to the subsurface topography'. This is not particularly helpful as it seems to cover most eventualities, so lacks relevance.

The methods section is a general background to GPR rather than a description of the measurements and data processing that come in the next section.

The measurements section has obvious error or omissions e.g. the band pass filter given would not work for the 200 MHz data, so must be the filter used for the higher

frequency antennae. Clear filter parameters should be given for the data sets displayed in the paper. The Fresnel zone is mentioned, but not calculated for the different frequency of antennae or the ice depth. Errors are also found in the interpretation of the GPR. Following seismic descriptions, a multiple would have a dip twice that of the first reflector. I doubt there are any true multiples here – possibly ghosts or ringing but not multiples. The phrase 'high reflective diffraction hyperbolae' is very confusing. They are high amplitude reflections. Are they hyperbolae? This phrase has a strict meaning, i.e. they are generated at a point. Are they diffractions? The GPR descriptions need care and attention throughout.

The descriptions of the 4 caves are a mix of field site descriptions as well as results and interpretation from the GPR surveys. I suspect a significant amount of this description is found in other papers. These field site descriptions should be shortened and all results moved to the results section.

The results section is very short. Systematically describe all your reflections to explain your data.

There then needs to be a clear interpretation section. Some of the interpretation, indeed some of the results are found in the conclusions, where new data is presented for the first time. Comparing GPR reflections with sediment bands should be done systematically in the results section.

Conclusions need to address the aims of the paper, once the aims of the GPR survey are clearly stated.

I will happily send a list of corrections to the written English in the paper to assist with the Editorial process, but do not feel now is the appropriate time to do this as I believe the paper first needs restructuring to address the issue I raise above and there are a significant number of minor corrections to make.

I agree with the posting by the first reviewer – 'great data, more discussion needed'

Interactive comment on The Cryosphere Discuss., 4, 1365, 2010.