Burschil:

General comment

This paper contain some interesting studies, but the material seem to be rushed through before the interpretations and methodologies had reached a mature level. It contains a number of separate studies that individually have interesting ideas, but they are not linked very well together. Also, the conclusions are not supported sufficiently by the data.

Hence, I suggest a much clearer focus of the paper and extensive elaboration of the key elements before publication – Major revision.

The title indicates that a "hydrological characterization" is the aim, but as far as I read it, the contents point towards the two following separate issues:

1. Establishing of various petrophysical relationships, resistivity/lithology, velocity/lithology and resistivity/hydr. conductivity
2. The construction of a 3D geological model based on AEM data, seismic data and borehole data

None of the above aims at a "hydrological characterization" as far as I see it. If these two items are *actively* joined the paper would be significantly strengthened, but if not I suggest to focus the paper on one of the two (or both in two separate papers…).

3D Geological model:

Figure 3 shows a diagram of the 3D geological modeling flow, but I really miss some detailed information on how the geological modeling is done, more than a reference to what program was used:

- How are the closed bodies (e.g. Fig.2) modeled in a stratified environment?
- How are the resistivity data used? When setting up the empirical relationships the authors claim that they can improve the hydrological modeling, but yet they say nothing about how these results were actually used.
- How are the seismic data used?
- How are the empirical relationsships used?
- The presense of a glaciotectonic complex with thrust faulting is claimed but none of the data presented examples support this idea directly. Yet in the conclusions these findings are stated as "unique", even though in the text they are correctly stated as "indications". Personally, I think the interpretation is correct, but the wording needs to reflect the data support.

To understand the 3D modeling a detailed (profile) example is absolutely crucial. The current figure 3 is nothing more than a flow-diagram with very little information. Figures 9-11 individually hold some of the information needed, but they do not refer to the same profile and it is impossible to see how the different data types are combined to end up with a geological model.

In the example the use of the entire set of data should be presented ending up with a presentation of the layers in the final stratified model, so that the reader can follow what information was actually used from the various datasets and how big are the inconsistencies.

Emperical petrophysical relationships:

This part of the paper actually contains interesting studies and the paper would have been significantly stronger if the findings had been used actively. Either these findings are included actively in the geological modeling or the paper need to be separated in two parts for clarity.

Specific comments

1. Section 1: *"In this paper we describe how the understanding of the local geological and hydrogeological situation is significantly improved by the geophysical surveys"*. It is not clear to me after reading the paper how the model was actually improved, even though I am sure it is the case!
2. Section 3.1: the penetration depth of the SkyTEm system is stated as 30-300 meter. What do you mean – does it vary between 30 and 300 (if yes, what controls it), or do you mean that the information can retried typically in that interval (if yes – does that mean that you cannot use the information from the top 30 meter of the models? To my knowledge SkyTEM collects useable data also for the top 10 meters)?
3. Section 3.5: Lacking a description of the lower element of figure 3 (3D views?)
4. Section 3.5: "*In a next step the SkyTEM and seismic data are added to the model"* Fine, but I really miss information on how these models are added to the building of the geological model.
5. Section 3.5: It is not clear to me whether the layers are globally present and continuous throughout the area, which seem quite contradicting to the conceptual model of Figure 2 having both incised valleys and thrust structures that are impossible to model in a layer model. The authors claim in the discussion section that the structures are "very complex and cannot be included in detail in a groundwater model". I disagree. The groundwater model should be able to handle the complexity level described by SkyTEM and seismics, but the problem might be that the geological modeling tool cannot handle the required complexity, or the time required (man-power) to build the model is not available.
6. Section 4.1: Rubin and Hubbard, 2005 seems to be superfluous as the two other references are specific sub-references to the Rubin and Hubbard book
7. Section 4.1.1: It is claimed that these relationships are made to improve the interpretation of the SkyTEM survey, but I did not find any information on how these findings were actually used.
8. Section 4.1.1: "*Overlapping resistivity values for sandy and clayey material are in the range of 50– 100ohmm. This can lead to interpretation problems".* Well, did it cause problems, and how did you handle it?
9. Section 4.1.1: "*If the drilling is not in the immediate vicinity of a SkyTEM flightline, projected datapoints were used*" It is unclear what this means. One nearest sounding (possibly of low quality?) or some average of a group of soundings within some radius? Also, it is unclear how this comparison is made – or at least it was unclear to me. Some sampling of the logs must take place and will also define the number of data points in the probability functions ("multiplicity") of figure 5. A few pages ahead a sampling of 1 m is mentioned, but it is unclear whether this refers backwards as well (and should of course then be mentioned there…)
10. What is "Y3" referring to in the text following figure 5?

11. Section 4.1.1: "*If low resistivity layers are embedded in the fine layered ground electrical anisotropy leads to reduced resistivity value for current flow parallel to the layering, while for current flow perpendicular to the layering an increased resistivity is measured.*" I do not believe that this is the explanation. To my knowledge (correct me if I am wrong) electrical downhole tools measure the horizontal resistivity as well (the so-called paradox of anisotropy), which means that they should reveal equal values (rho_Horiz). Another explanation is therefore required if these data should be used.
12. Section 4.1.1: I would like a quality assessment of the FEL compared to the 64" log as it seems that one is miscalibrated.
13. Section 4.1.2: It is not clear to me how the comparison between hydr. conductivity and resistivity is made. The figure presents 9 different K-values, but it is not clear to me what 9 different lithologies these values refer to.
14. Section 4.1.2: The actual setup making the comparison is not clear to me: *"The so obtained resistivity values were mean averaged for each petrographic unit (Table 2 and Fig. 7). Only resistivity data averaged over at least 50 samples (vertical spacing of samples is 1 m) were used for this comparison. For the clayey material not all variations are included as is seen in Fig. 4 (left panel) where variations in the till are shown in the gamma ray and resistivity logs."* Please write more clearly what you actually did.
15. Section 4.2: *"To integrate these sand bodies as aquifers in the model, their spatial extension was derived from the resistivity data.* How was this done? Searching for resistivities above some threshold or fully manual estimation?
16. Figure 11: The left panel of fig. 11 is quite poor in terms of getting any information across and it contains much information not described in the text. (Colors, panels, black thin line, etc.)
17. *Section 5: ""Concerning the resistivity, a clear discrimination between sand and till (Fig. 5) is possible using borehole data (long normal 6400, FEL). Using SkyTEM data, some overlapping of resistivities for sand and clay occur. A possible reason is that the SkyTEM results had 5 to be projected to the borehole locations (interpolation between flightlines) resulting in reduced resistivity resolution."*
    I do not agree that a clear discrimination is seen with the logs as huge overlaps is actually present. When doing volume averages over thin layers the SkyTEM will of course get many "misinterpretations" due to the limited capability of seeing thin layers. This is much more important than the interpolation. Also, I think it is very important to mention the ever-present limitations and inaccuracies of the borehole data, which is not mentioned at all!
18. Section 6: *"The extent of the freshwater occurrence is determined as well as the freshwater-saltwater boundary and the extent of glaciotectonic structures"* This might be true, but I see no evidence of that in the paper itself.
19. Section 6: *"The structural interpretation is improved by rock identification.* Not clear to me what you mean here.