Hydrol. Earth Syst. Sci. Discuss., 9, C1880–C1883, 2012
www.hydrol-earth-syst-sci-discuss.net/9/C1880/2012/

Hydrology and Earth System Sciences Discussions

Interactive comment on "Ground-penetrating radar insight into a coastal aquifer: the freshwater lens of Borkum Island" *by* J. Igel et al.

I. Møller (Referee)

ilm@geus.dk

Received and published: 30 May 2012

General comments:

The manuscript shows how GPR can be used for shallow groundwater investigation in a coastal environment with sandy sediments. The manuscript document a thorough determination of the radar velocity in the ground before these are used in the determination of depth of the water table mapped by GPR profiles. In general the manuscript is well argued, though the documentation through the figures is to some extent weak.

Specific comments:

1) The greatest weakness of the manuscript is figs. 4-6. They are too small, the scale

is too small and the vertical exaggeration is too large to be able to actually see what is argued in the text about the reflection interpreted as the ground water table. Clear figures are needed, where one can see that the reflections display the characteristics of the groundwater table, e.g. crossing dipping reflections caused by sedimentary structures. From my experience with GPR surveys in similar environments on Danish Wadden see barrier islands, we are not able to identify a reflections caused by the groundwater table. The figs. 4-6 serves as the documentation that you are able to detect the groundwater table – then you have to produce figures that actually are showing it. I know it is hard to produce good quality figures with GPR sections. One way is to turn the figure into landscape and/or split the profile in more sections like in Nielsen et al 2009 in your References list. This will enlarge the figures. Less vertical exaggeration also make more structures visible. Additional figures with a shorter part of the GPR profiles where the water table reflection is visible are also needed. I will also address this problem to the editors: You need to make space in the journal for the size of figures needed to display the GPR sections properly.

2) A figure showing the survey area including positions of the data collected is required as the first figure and related to the text on page 3692 line 24 to page 3693 line 2. This figure should also include a map showing the location of the survey area on a regional scale – not all readers know where Borkum is located. All names of localities mentioned in the text should be on these maps.

3) On page 3693 line 12-13 a significant almost local reference is missing: Lindhorst et al 2008. Sedimentary Geology 206, 1-16.

4) There is a disagreement between the text on page 3696 line 18-22 and fig. 1. The resulting velocity model of the CMP in fig. 1 shows that velocity decreases down to 0.08 m/ns. In the text is stated that the velocity is 0.065 m/ns and that the velocities below the water table is at 0.065 m/ns within a variation of 10 %. This inconsistence between text and figure must be cleared out. Furthermore the velocity analysis does not include all jumps in rms velocity. Including a peak in the semblance analysis around

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115 ns will decrease the velocity of the lower layer.

5) On page 3698 line 22 is referred to fig. 10. Normally one should number the figures in the order they are referred to. The solution here is the survey area figure requested for in 2).

6) On page 3699 line 17: "The non-linear depth axis is calculated using ...". Does that mean you are not taking the topography of the water table into account in your display. It is possible to create a 2D velocity field and carry out a migration and depth conversion of the GPR profiles so that you get a depth axis that is valid for the entire section.

7) On page 3699 line 22-23 is stated that "A migration of the data was not necessary as the reflections were not steep". A migration not only moves dipping reflection to the right position but do also make diffraction hyperbolas collapse. It looks like some parts of the data are disturbed by diffraction hyperbolas and a migration would be appropriate.

8) On page 3702 line 23-25: "... an area above 5 m depth with predominantly cross bedding structures that are typical for aeolian sedimentation. Below, layering is horizontal and the material is interpreted as marine deposit". This is a rough sedimentary interpretation, marine sedimentation in e.g. the coastal zone and beach ridges also produce dipping structures and cross bedding structures, e.g. Nielsen et al 2009.

9) On page 3703 line 17-20: the statement should be possible to see in the figures, ad 1).

10) In "5 Conclusions and outlook" is added new information (paragraph on page 3706 line 16 to page 3707 line 2 and sentences on page 3707 lines 8-10). These subjects should be discussed before the "Conclusions and outlook" and the outlook of this can then be stated in "Conclusions and outlook".

11) On page 3706 line 16-18. The statement "An interesting feature can be seen

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in Figs. 5 and 6: in the centre part of the profile, a weak blurry reflection can be recognised ...” is not possible to see in the figures in their present quality.

Technical corrections

Page 3692 line 3: the abbreviation GPR is used without being spelt out the first time.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 9, 3691, 2012.