

## ***Interactive comment on “Discharge of groundwater flow to the Potter Cove on King George Island, Antarctic Peninsula” by Ulrike Falk and Adrián Silva-Busso***

### **Anonymous Referee #1**

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#### General Comments

The paper analyzed is very interesting, aims to establish a conceptual hydrogeological model for then glacier ablation and groundwater discharge in the northern antarctic peninsula region. The studio is focused on the Potter Cove on King George Island. Most of the work dealing with this issue is addressed from a very large scale, however, this work is done from the scale of a small watershed. The work simultaneously applies numerous hydrogeological tools including: in situ observations, remote sensing, geologic and geomorphologic approach, aerial images, GPS data, Vertical electrical soundings etc.

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The objectives are well-thought out and clear. The conclusions are also clear, useful, and well-exposed. From a methodological point of view it is a correct job. It is very interesting how the problem has been addressed, using various complementary techniques.

In my opinion the main weaknesses are: a) it is an overly local work, b) as the authors say it is only representative of a very short period of time, approximately month and a half, c) is a very speculative work, the experimental part and direct measures are scarce. d) A lot of information about the analytical techniques used is lacking and analytical data for most of the variables used are not provided. (e) the bibliography review is poor.

However, I believe that it is a quality work, publishable and that it can be easily improved to achieve the quality required for its publication.

#### Specific Comments

[Page 3, Study área] The geological description of the study area is very interesting, although there is a lot of superfluous information from the point of view of the objectives and methodology of the paper, for example the ages of the geological strata.

[Page 4 – Line 8] The text says: “The permafrost found here is comparatively warm (mean annual ground temperatures are greater than -2.0”. If compared to permafrost elsewhere, it should be illustrated with some numerical data or some bibliographic reference.

[Page 4 – Line 13] This line is set as an example. The paper frequently cites works by Ermolin and Silva Busso (the text contains 18 self-references) to support the statements described by other authors much earlier. A thorough review of the scientific literature written in English on glaciology should be done.

[Page 5 – Line 5] The aims of the paper are described in the "Data and methods" section. I believe that a better place to present the objectives of the paper is in a

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specific paragraph or at the end of the introduction.

[Page 5 – Line 19] The VES technique has been used to determine the vertical structure of the aquifer. How has it been shown that the interpretation given to the values of resistivity corresponds to reality? The mechanical perforation used to perform these interpretations should be displayed. If no mechanical drilling have been performed, the way in which the correlation has been made should be indicated in more detail.

[Page 5 – Line 32] How deep are those perforations? What materials have been found in these perforations? Additional information on such perforations should be provided.

[Page 6 – Line 17] The following sentence is not understood: "The groundwater hydraulic gradient was calculated on the basis of the different hydrogeologic units obtained from the piezometric map." Have the hydrogeological units been obtained from the piezometric map? This should be better explained.

[Page 6 – Line 18, 19] Page 6 reads: "The meteorological, permafrost and glaciological data sets were used for ...." Where can the reader find those Data Sets?. Those Data Sets must be available for study.

[Page 6 – Line 22,23] The statement: "These assumptions are valid during 1 to 1.5 months in the austral summer (presumably January and February) " should be better explained, and if possible, it would be very interesting to know if global warming will cause that period to be extended.

[Page 7 Results, Geological deposits] I do not think this section corresponds to the results section. I'd be better off in the introduction or in section 3. It does not seem like a result, it seems an explanation based on previous work and in the bibliography.

[Page 8 – Line 2, 3] Where has that porosity value been obtained? How has this porosity value been obtained?. How many samples have been analyzed?

[Page 8 – Lines 16, 17] This statement: "These resistive layers can be interpreted as old till deposits of more ancient hummocky moraines or previous fluvio-glacial events"

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and similar ones should be justified by some kind of supplementary data. For example, line 20 says "it contains marine deposits" Is there any evidence or is it just a guess?

[Page 8 – Line 33] "..... the determination of in-situ permeability of each group with aquifer ....." The permeability determination has been made on the outcropping material. Can it be said that in depth it will have the same permeability?, the outcropping material will be altered and will be more permeable than the same material in depth. This should be explained better.

[Page 9 – Lines 17] "The results are presented in Table 3" it's already said on line 4

[Page 9 – Lines 17, 18] " . . . . and the obtained values are within the typical ranges for such types of lithologies . . ." Where are these types of lithologies said to show this range of values? This must be better justified and quoted in the literature where it can be consulted.

[Page 9 – Lines 33, 34] How has the topographic gradient subglacial been estimated? Why has it been estimated and not measured?

[Page 10 – Lines 1, 4] "On the other hand, there has been a high similarity between piezometric and topographic gradients in the Potter Basin and adjacent Matías Basin on the Potter Peninsula (Silva-Busso, 2009). Based on the above argumentation, topographical gradients instead of the hydraulic gradients are used here as input." This seems like a circular argument. To know that there is a strong correlation between topographic gradient and piezometric gradient you have to know both. If both are known it is no longer necessary to rely on correlation. Can data simply be extrapolated from one basin to another? This should be explained better.

[Page 10 – Lines 29, 30] "The application of the method after Khurstalev (2005) requires a percentage of positive degree days per month higher than that value." If this is the case then the proposed method is not applicable. This statement should be better explained.

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[Page 10 – Lines 30,31] “ . . . . taken from Silva Busso and Yermolin (2014).” This publication does not list how these values have been measured. It should be better justified from where these values have been obtained and whether they are estimated or measured.

[Page 11 – Lines 12, 13] Are the results presented in this paper only applicable to the month of February?. There should be detailed weather information from the Potter Bay area. If possible, the dependence between flow and temperature should be better explained. How will global warming affect the system? Can it be quantified how global warming will affect flows?

[Page 11 – Line 14] the next sentence should be better explained: “Little can be inferred about the hydraulic type.”

[Equation 8] Where have the sand, silt and clay values been obtained? How many samples have been analyzed?. Analytical data should be available.

[Page 11 – Line 20] How has porosity been measured? With what uncertainty has porosity been measured? . Analytical data should be available.

[Page 13 – Line 30, 31] If lithologies are inconsistent, how is it justified to use the same empirical relationships proposed by Bourbié?

[Page 13 – Line 2, 3] The "sensitivity analysis" section should answer the following questions: What is the reason for doing a sensitivity analysis? What its usefulness? What have the sensitivity analysis results been used for? What does the sensitivity analysis have to do with the hydrogeological scheme proposed in Figure 7? Why is the hydrogeological scheme included in the sensitivity analysis section (page 14, line 1)?

[Section 5 Discussion and Conclusions] The values of transmissivity, water velocity, water discharge, should be given as a range not as an exact value. Conclusions on changing seawater quality and its potential impact should be better argued and supported by bibliographic data. Is 0.43 m<sup>3</sup> s<sup>-1</sup> really significant as freshwater discharge

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into the sea? Is more fresh water spilled to the sea now than before warming? What are those biological changes? Is there any evidence of biological changes?

[Table 1] Based on which data the correlations have been made. Are there mechanical drillings to validate them?. How have they been validated?

[Table 2] Permeability data is provided with three decimal places, this is very optimistic. The range in which this value is moved should be provided. It is necessary to adjust the number of decimal places to the precision and error of the technique used.

[Table 3] How many tests have this data been obtained with? What is the uncertainty of the tests? For example, has thickness been accurately measured in millimeters?

[Figure 1] VESs are not installed.

[Figure 6] Is there enough continuity in the suprapermafrost aquifer to be able to draw the isolines as they have been drawn? This point should be better explained.

Technical Corrections [Page 3 – Line 15] piezometric sonde – water level meter (contact gauge?)

[Page 5 Line 2] Potter

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