Reviewer Recommendation and Comments for Manuscript egusphere-2025-405

Brief communication: Use of lightweight and low-cost steel net electrodes for electrical resistivity tomography (ERT) surveys performed on coarse-blocky surface environments

Summary

The manuscript presents a study on a newly developed electrode design, i.e., stainless steel-net electrodes, which the authors propose for electrical resistivity tomography (ERT) measurements in coarse blocky environments. The electrodes facilitate and accelerate ERT surveys and are cheaper and lighter compared to conventional stainless-steel spike electrodes. The authors demonstrate that contact resistances and reciprocal errors are lower when using stainless-steel net electrodes compared to conventional stainless-steel spike electrodes. Correlations of apparent resistivity values between the two electrode types are high for an exemplary landslide deposit and an Italian rock glacier (with an R^2 between 0.91 and 0.99) and slightly lower for a Swiss rock glacier (R^2=0.8). The inversion results are similar for both electrode types and successfully reconstruct the known internal structure of the landforms. The results are clearly presented and highlight the relevance of lightweight, easily deployable equipment in harsh alpine terrain with limited accessibility.

However, upon closer examination, the manuscript offers limited novelty and primarily reiterates concepts and methodologies previously presented, particularly in the study by Bast et al. (2024). One of the main concerns lies in the similarity between the figures of the two articles. The representations and analysis of the data are almost identical, with no substantial additions, enhancements or new interpretations. For instance, the authors could have included additional pseudosections to visualize the spatial consistency in the apparent resistivity readings as well as the position of the removed quadrupoles for the different electrode types. In my opinion, the results related to the application of stainless-steel net and textile electrodes could have been presented together in one publication, as the study sites are identical and the data analysis and structure is very similar.

To strengthen the manuscript, I recommend that the authors explore the usability of such stainless-steel net electrodes for induced polarization measurements, as suggested in the Discussion section. Such an investigation would offer a clear advancement over previous research. Another benefit highlighted by the authors consists in the increased durability of stainless-steel net electrodes compared to textile electrodes, which tend to oxidize more rapidly. Showing time lapse ERT data of e.g., hourly measurements could further underline advantages of the stainless-steel net electrodes and enhance the relevance of the article. Clearly, this would require considerable additional effort. Nonetheless, without any further developments compared to Bast et al. (2024) the study lacks substantial new data or insights that would justify its publication as an independent contribution to the field. Additionally, I would include a comparative analysis between net and textile electrodes to clearly demonstrate the advantages of the new design over both textile and traditional spike electrodes. I also suggest revising the Discussion section; vague terms such as “good contact resistances” should be replaced and the discussion points need to be better supported with relevant literature.

Taking these concerns along with a number of specific comments and technical corrections listed below into account, I recommend accepting this manuscript after major revisions.

Specific comments and technical corrections

Line 10: I would also include talus slopes, debris-covered bedrock, moraines, debris-covered glaciers in the description, which also consist of blocky to coarse blocky surfaces.

Line 12: we have successfully tested alternative electrodes that are more robust, lighter (and cheaper than the recently proposed conductive textile electrodes

Abstract in general: How do you prove that these suggested electrodes are better than others, because the reciprocal error is lower for these electrodes? You also need to address your main findings and results within the abstract, not only in the conclusion.

Lines 16-19: different types of study environments: in which environments is ERT a widely applied method and why? "as data acquisition is usually relatively rapid and not particularly complicated" is not the first reason why ERT is used in all these environments. I would rather start with a sentence as "ERT is a non-destructive geophysical method that provides continuous and detailed 2D imaging of variations in the electrical properties of the subsurface.", shortly describe the method and list a few applications.

Line 22: I would cite here more fundamental studies concerning galvanic coupling between electrodes and ground.

Lines 22-24: I suggest going into more detail concerning data quality, high contact resistances, what is "high" and what is the influence of high contact resistances on ERT data?

Line 29: What are excellent mechanical properties? High mechanical strength and durability?

Lines 30-32: I would change it to: Accordingly, for several decades, electrodes in ERT surveys have commonly been produced as (or made out of) round stainless-steel spikes …

Line 36: change "is guaranteed" to "was guaranteed", and "were added"

Line 39: I would change "finally easily removed" to "easily removed after the measurements"

Lines 39-40: I would go into more detail here, what are the main aspects and conclusions of this study, are these textile electrodes reliable compared to traditional electrodes?

Line 55 and line 61: I would delete "a chaotic electrode arrangement/mixture of"

Line 66: Why did you use these dimensions? Did you test different dimensions of the square and the size of the sponges and analysed contact resistances/ injected current? You do not show the connectors to the cables. How do you connect the steel net electrodes to the cables? Do you have problems with oxidation of the connectors?

Line 73: … with different skips as described in Pavoni et al. (2023), …

Line 74: … and included reciprocal (interchanged current and potential dipoles) measurements… I would somewhere include a short description of normal and reciprocal measurements. How did you compute the reciprocal error? Why did you take the reciprocal error as an estimate to evaluate data uncertainty? Explain in more detail.

Line 77: The two different electrode types were placed at the same location between blocks and boulders.

Line 89: How did you define the data error within the inversion? I suggest describing it here.

Line 94: 100 kΩ is still not "optimal", I would delete/change this word.

Lines 99-102: I would somewhere (in the Appendix, in a table) add additional information on the three sites. What is the active layer depth or thaw layer depth of the measurement day for the two rock glaciers? You write that the ERT results reconstruct the known structure of the landslide deposit (Weidinger et al., 2014) and confirm the presence of a frozen layer at the rock glacier (Bast et al., 2024), I would then summarize these validation data for a better comparison to the results.

Line 111: Change “excellent” to “high”

Line 112: “In the first case R^2 = 0.91, while for the inverted resistivities R^2 = 0.93.” This sentence has no verb, please summarize with previous sentence.

Line 116: …. more than half of the electrodes yield contact resistances > 200 kΩ.

Line 118: inversion process

Line 119: delete “measured”

Results section in general: I suggest adding additional pseudosections to visualize the spatial consistency in the apparent resistivity readings as well as the position of the removed quadrupoles for the different electrode types. Additionally, it would be interesting to show injected current for the different electrode types.

Line 126: I suggest revising this sentence and providing a more detailed discussion on the effect of high contact resistances on ERT data quality, supported by references.

Line 128: What is good? I would use low or high

Line 137-139: You have the reciprocal error as an estimate of data error to evaluate data quality/uncertainty. Why don’t you refer to this here?

Line 137: “better” → “lower”

Line 138: “greater” → “higher”

Line 139: “best” → “lowest”

Lines 142-143: delete “although excellent”

Line 145: poorer → lower

Lines 146-148: I suggest revising these lines to provide a clearer comparison of your findings with existing studies. Please clarify which high-resistivity structure you are referring to.

Lines 149-151: How can it be demonstrated that the stainless-steel net electrodes yield results equivalent to those of conductive textile electrodes, given that no direct comparison is provided within your study? Please explain in more detail.

Line 156: induction polarisation measurements → induced polarization measurements!

Figures: The font size in some parts of the figures is too small and should be increased to ensure readability.

I would use abbreviations for apparent resistivity, electrical resistivity, contact resistance.