# SE-2021-42 - Topical Editor decision

Dear Editorial team,

We highly appreciate the opportunity to rule out any concerns raised by the reviewers and topical editor considering the manuscript. Please find below the letter of the topical editor with our responses.

**Comments to the author**:
The authors of the "Establishing an integrated workflow identifying and linking surface and subsurface lineaments for mineral exploration under cover: Example from the Gawler Craton, South Australia", try to present a methodology to detect potential ore bodies associated with faults systems by using different data sets, such as Lidar maps and airborne data. Although the work presented here seems to be of interest to the readers of the Solid Earth special issue: Stater of the art for mineral exploration, the manuscript still have some issues that need to be fixed. Considering all the issues presented here, we have concluded to reject this manuscript, as the authors seem to not solve the issues and answer the questions that the reviewers and the editor have presented, after considerable time and effort used for this manuscript.

R1, R4 and the handling editor requested a chart workflow to better follow the reading, as this is a methodological paper, and the manuscript title is "Establishing an integrated workflow ...". The mentioned chart is still missing. The only chart workflow is presented in Figure 1c, in a very simplistic way, and is only mentioned in the introduction (The underlying workflow is shown schematically in Figure 1). There is no more mention of the chart and is not associated with the methodology sections, which is where it will fit better. There is also no description of the chart, nor the procedure to follow. The chart, by itself, is kind of meaningless and useless. As pointed out by R4, SE is a journal where the main readers are geologists, therefore, sections 4 and 5 should be taken care of in a way that could be understandable by all kinds of readers. The manuscript still presents a very complex section 5, where it does not clearly explain why they chose each method or how they combine the maps to obtain the lineament data sets. As mentioned in the previous revisions, this is a methodological paper, where the key parts of this paper are sections 3-6, and they are, in some way, difficult to follow.

1.) The workflow chart, with a basic explanation of how to follow the procedure, would have been helpful here, but it is still missing.

We thank the editor for the opportunity to address this issue in more detail. We believe that the simplistic workflow diagram in Figure 1c should still be in the introduction, but we now extended the caption text to give a more detailed description of the procedures. In addition, we added a detailed workflow diagram to the appendix (Figure 1A) and a caption describing the applied workflow. We sincerely hope that this is deemed sufficient for being able to follow the workflow.

2.) If the detection algorithm (worms) was only used for gravity and magnetic data, what was the LINE (Lineament Extraction) model in the PCI Geomatics platform was applied on? On all the data sets? Please, clarify this.

In Table 1 we listed which extraction method was applied to which dataset. The automatic lineament extraction with the PCI Geomatica LINE module was performed on all datasets. We further added the following sentence to the caption of Figure 1:

"*Note that the multi-scale edge detection ('worming') is only applied to the magnetic and gravity data, manual segmentation was only performed on the DEM, and automatic lineament mapping with the PCI Geomatica LINE module was applied to all datasets.*"

> 3.) R3 asked what Targeting maps stand for. The author mentioned that they have added: "Towards that end, we further explore the use of targeting maps (i.e. a map generated to highlight areas with specific features) based on surface and subsurface lineaments. Targeting maps derived from lineament analysis are often based on the density of lineaments per unit area." But those lines cannot be found in the text. This issue was pointed out by R3 in several questions formulated by R2 during revision 1. The comment letter presented the answers, but those were not able to be found in the text. The same goes for the following questions of R3 and R4.

We apologise for not including this in the uploaded version of the manuscript. In lines 59-69 we now included the paragraph mentioned in our previous response:

*"Towards that end, we further explore the use of targeting maps (i.e., a map generated to highlight areas with specific features) based on surface and subsurface lineaments. Targeting maps derived from lineament analysis are often based on the density of lineaments per unit area. Density maps combining subsurface lineaments (potential field data) and surface lineaments (digital elevation model and satellite imagery) were proposed as an exploration tool for groundwater (Epuh et al., 2020) and for mineral exploration (Mohammadpour et al., 2020). Lineament intersections were also used previously for the analysis of groundwater (Ilugbo and Adebiyi, 2017) and locations of intersecting structural elements were suggested to represent favourable target areas for mineral exploration (Sheikhrahimi et al., 2019; Gonzalez-Alvarez et al., 2019; Krapf and Gonzalez-Alvarez, 2018; Gonzalez-Alvarez et al., 2020). In hydrocarbon exploration, cross-strike discontinuities were suggested as an exploration tool for natural gas (Wheeler, 1980). In the context of this contribution, we define targeting maps as maps which highlight areas that comprise the structural features preferable for mineral exploration."*

Note that we now added a final sentence to this paragraph defining what we consider a targeting map in the given context. We hope that this clarifies the term "targeting map" in the context of our contribution and will allow the reader to follow more easily.

> 4.) L.318 Gradients decrease with upward continuation. I still don't know why using those upward continuation values. Working with vertical derivatives will easily give you lineaments.
> Figure 8. why at 2070 m? Have you tried other altitudes? Have you calculated the approximate depth your are seeing with this upward continuation?
> Why a different upward continuation? You need to discuss the values you choose
> RPT might be misleading when there is magnetic remanence … Are you sure there is none? At least you should discuss it.
>
> Line 325: Again, magnetic data probably has remanence and then, RTP might be giving you wrong positions. The Earth magnetic field has had different orientations....and of course, intensities. And gravity data has little resolution.
> Some of the questions were well resolved, but in the text, it was a simple line in the figure caption of Figure 8 referring to the upward continuation heights. The other questions still remain unanswered.
> Line 321: And even so, are results realiable? What do you get if you use different values of

upward continuation? Or no upward continuation? Gravity data has less resolution too has not been answered.

In our opinion, the two concerns both referring to the potential field data are related, and we therefore collate our answer to the concerns mentioned above into a single response addressing both issues independently: the potential presence magnetic remanence and the choice of upward continuation.

**Upward continuation**

Please see our previous responses:

I.) "Upward continuation is described in the second paragraph of section 3.4 and is an integral part of the automatic gradient extraction algorithm (see Hornby et. al. (1999)). The resolution of the gravity and magnetic data do differ and is related to both differences in data density and the decay of each field away from subsurface sources. The worms shown here are a single example set from a range of upward continuation heights (see Foss et al. (2019)) that were identified as having similar detail when considering the above differences."

II.) Added to the discussion: "We note that the magnetic and gravity datasets are of different resolution and in particular the resolution of the gravity dataset is non-uniform. As the upward continuation acts similar to a low-pass filter the difference in resolution becomes negligible."

As pointed out, we added the reasoning behind the choice of upward continuation values to the caption of Figure 8. We now understand that adding just the single sentence to the caption of Figure 8 is not sufficient, and we therefore extended the first paragraph of the methodology section (3.4) on the multi-scale edge detection:

*"A multi-scale edge detection technique has been applied to the potential field data which produces edge features called "multiscale edges" (or colloquially "worms"). This technique (Holden et al., 2000; Hornby et al., 1999) relies on a wavelet transform based on the Green's function of vertical gravity or reduced-to-pole (RTP) total magnetic intensity. A low-resolution multi-scale edge mapping of the whole Gawler Craton was performed by Heath et al. (2009). Foss et al. (2019) applied a higher resolution mapping using the more recent GCAS Region 9A magnetic field data and updated gravity coverage. A fundamental part of this automatic edge detection technique is the upward continuation that acts similar to a filter suppressing shallow sources (see Hornby et al. (1999) and Foss et al. (2019)). In this contribution, we selected different heights of upward continuation for the gravity and magnetic data respectively in order to derive edge maps that comprise similar detail of the subsurface. The reasoning behind our choice is on one hand that gravity and magnetic field decay at different rates away from the source and on the other hand the datasets we utilised have different resolutions. In order to derive lineament maps that comprise a comparable level of detail from the gravity and magnetic data we choose an upward continuation of 930 m for the gravity data and an upward continuation of 2070 m for the magnetic data. Note that these only represent a single example of the geophysical lineament ensembles computed presented in Foss et al. (2019). In the framework of this study, where the potential field data was utilised to derive signal from the deeper subsurface, the two chosen datasets represent a good example for this automated lineament mapping technique."*

In addition, we added a sentence to the discussion to highlight the potential uncertainty resulting from the utilisation of different upward continuations:

*"We note that using different values will alter the results and represents a source of uncertainty. However, for the purpose of this study the two upward continuation values were chosen to allow a more reliable comparison between the different datasets."*

**Magnetic remanence**

As mentioned in our last response, we note that this is an important comment and as pointed out by the referees a potential source of spatial uncertainty. We therefore added in the last iteration the following section to the discussion:

*"We note that the presence of magnetic remanence may alter the field anomaly, rendering the reduction-to-pole data less useful, however for our purposes of extracting lineaments from multiple datasets, the uncertainty in the degree of magnetic remanence is of less concern than the uncertainty associated with the different automated and manual techniques in extracting lineaments."*

As the worming works on RTP magnetic data, we had to use these datasets even though the exact location of the extracted lineaments (edges) might be altered due to existing remanence. We believe that by adding the sentence above will highlight the potential uncertainty associated with the location of edges in the RTP data.

> 5.) R4 l.266 Please give an example, what you are merging, or directly refer to table 1. I had to read the sentence several times, an example would facilitate the understanding. This was not resolved properly. The authors have provided references in Table 1, something that was not requested by R4. No examples are provided, neither.

We now extended the caption of Figure 1 by:

*"The first step for obtaining these maps is to merged lineaments into a single dataset if the lineaments are extracted with the same method. This is performed for surface and subsurface lineaments respectively, i.e., lineaments extracted from the DEM and the radiometric with the PCI Geomatica line module are merged into a single dataset representing the collated lineaments attributed to changes in surface topology and chemical composition. A summary of the merged data utilised is shown in Table 1."*

We also now explain the merging in the first paragraph of section 5:

*"Lineament datasets that are obtained with the same method and correspond to signals either both from the surface or both from the subsurface are merged (see Tables 1 and 2). The resulting dataset comprises the collated lineaments associated with topographical or chemical changes in the surface. We performed the same for the potential field data (gravity and magnetics) to obtain a collection of all geophysical lineaments detected by the respective extraction method."*

The manuscript presents a change in format along the manuscript. Presenting a combination of indented and not indented paragraphs along the manuscript. This has provoked that some of the sentences are out of the margins or even out of the page (see l.75)!! The manuscript presents some other issues related to format, that do not follow the journal guidelines. Does are: Table captions always go on top of the table. The figures and the tables are cited as Table 1 and Figure 1, NOT as table 1 or figure 1. If it is needed to refer to more than one figure, then: Figures 1, 2 and 3,

and NOT Figures 1, 2&3. This issue has been pointed out by the handling editor, myself, during revisions 1 and 2, and we see that those issues still exist.

We are using the Copernicus Latex package and did not alter the default setting for indentation. In line 75 the URL was spanning across the document margin and we now fixed this issue. We further checked that we refer to figures and tables in a uniform manner and moved the table caption to the top of the tables.

> 6.) R1, R2 (rev1) and R4 mentioned that the text needed proofreading before submitting it. We have the impression that this has not been done, as the format of the manuscript would be consistent along the manuscript (see above comment) and the figures will not be in-between paragraphs, something also mentioned during rev1 and 2 by myself. The text presents several orthographic mistakes and typos (see adjacent document for further details).

We revised the orthography and spelling throughout. As we are using the Copernicus Latex package, we are restricted in terms of the figure placement. Please note that we worked though the pdf containing the editor's comments and implemented the suggested changes including changes to the figures.

We addressed all the reviewer's and editor's comments to the best of our knowledge and believe and hope that the editor acknowledges our efforts in streamlining and improving the manuscript. We sincerely hope that all the changes we implemented during this iteration will now be deems sufficient and the editor can agree to recommend the manuscript for publication.

Kind regards,

Ulrich Kelka