<u>Responses to reviewer 1 and 2 comments on the paper titled</u>: Multi-scale analysis and Modeling of aeromagnetic data over the Bétaré-Oya area in the Eastern Cameroon, for structural evidences investigations.

Dear Chief Editor,

In general, all the reviewers remarks, and recommendations have been taken into consideration. The authors make changes and suggestions in yellow in the MS text, but in blue below responses are given to all the remarks. The authors are indebted to them for their valuable remarks.

<u>Reviewer1:</u> Bruno Gavazzi

I- Some references are missing in the reference list

L 43 – Oruç et al is not in the reference list

L 241 – 249 Zeng (1989) is not in the reference list.

We added the references in the list.

1. L 552 – 554 (Oruç et al., 2011)
2. L 645 – 646 (Zeng, 1989)

II- The methodology is not well described

1. L 47 - 49 Verduczco et al 2004 did not develop tilt derivative but discuss its use, please read the suggested reading provided at the end of the paper to correct your statements. Also, the tilt is used as an edge detector for vertical contacts, not for all shapes.

L 47 - 49 We have changed accordingly with the recommendation.

5. L 142 a)- what does it mean a sensitivity of 0,5 nT? Is it only the sensor?

L 142 b)- What about the FOM? L142 c)- What is the overall precision (differences at the crossing points?): It is the recording sensitivity of the magnetometer used and considered as the noise level. The figure of merit (FOM) in the present data has been considered as being the same as the noise level and their combination accepted as the overall precision.

L 142 d)- Also, I could not find the reference, is it an internal report? If so could it be published on an open archive in order to be available? : It's an internal report which is available in the format of CD rom at the " centre of geological & mining information (CIGM)" in the Ministry of mines but not online, and the corresponding author has a copy of this CD rom.

9. L 150 – 153 Blakely describes the upward continuation, not how to remove the regional effect, also the upward continuation was proposed by Henderson and Zietz (1949) https://library.seg.org/doi/10.1190/1.1437560. Please be more precise:

L 152 – 153 Done.

12. L 198 – how does reduction to equator gives position? Why don't you use reduction to the pole (there are many techniques to deal with proximity to equator, please see Nabighian 2005), how can you assume only induced magnetization? (you cannot reduce to the pole/equator with remanent magnetization): At low magnetic latitudes (between -15 ° and 15 °) as is the case here, the N-S magnetic field directions are amplified by the reduction at the pole and there is a great risk to have an exaggerated noise by amplifying pre-existing one. In this case the map reduced to the pole is unreadable and unstable. To overcome this problem, it is preferable to apply the reduction to the equator. In theory, the reduction to the equator transforms an anomaly caused by a magnetized body having a non-zero inclination, into another anomaly that would be associated with the same body if the inclination of the magnetization were zero. From a spatial representation point of view, the anomaly changes

from any shape to a characteristic symmetrical shape, with a latitudinal central lobe framed on the north and south by two lobes of opposite sign to the first. For a given anomaly, the shape of the anomaly reduced to the equator obtained therefore makes it possible to judge posteriori the parameters of inclination and declination of the magnetization. If the shape obtained is the most symmetrical as possible, this means that these starting parameters are close to actual parameters of the magnetization. Moreover, if these starting parameters are close to those from the current magnetic field, we can then hypothesize an induced behavior of the magnetic body, or conversely, its essentially remanent character. The disadvantage of pole reduction (Baranov, 1957; Baranov and Naudy 1964) is that it requires knowledge of the direction of the source magnetization vector which is often a difficult parameter to know. This is why it is commonly assumed that the magnetization of the source is purely induced, consequently it has a direction identical to the direction of the magnetic field assumed to be known, for example the global geomagnetic models (eg IGRF International Geomagnetic Reference Field) (Feumoe et al., 2012).

13. L 203 – 221 "positive" or "negative" anomaly has no sense, a magnetic anomaly has always a positive and a negative part. Also what do you mean by bipolar? Is it dipole? You should reformulate
this section to make it more scientifically correct.
L 215 – 216 The reformulation is done

III- Some assumptions are not explained enough

1. L 36 – 39 You should provide an explanation on why you want to achieve that in your particular case. It reads as if removal of large wavelength is always done on aeromagnetic dataset, but it depends on the application. Moreover, Ndougsa et al 2007 is about gravity and not magnetic data:
L 37 – 38 There was a confusion on the reference. The good one is Ndougsa et al., 2013. We revised the text and have followed the recommendation.

2. L 39 – 40 Here it also reads as if in the general case shallow bodies are associated to iron deposits. It obviously depends on the context; I think you should make an argument for your special case and context:
L 39 – 41 We revised the text and have restricted this part to our magnetic case.

4. L 50– 53 I think you should say why you do not use the method from Salem et al 2008 which seem well suited to what you want to do, is it because of the use of second order derivatives and your signal/noise ratio?: We have used Salem approach for the location of vertical contacts and source depth. In addition, because the identified source has a non-uniform volume from the roof to the bottom, we examine how this volume varies with depth by using upward continuation of magnetic anomaly.

6. L 144 is there any special reason for a grid step of 850 m? (it is common to use half the profile spacing or the profile spacing): There is no special reason, it was an error of transcription by the co-author who was in charge of the edition of the manuscript, we use effectively 750 m, thanks for that.

7. L144 – 145 Is it relevant to precise that the digitization was well done? :We did not see on the MS where this sentence "the digitization was well done" is mentioned.

8. L146 why do you use IGRF 1984 and not the latest available? (also, you should cite the associated publication): It is a mistake. We used IGRF -70 which is the nearest (Reeves, 2005)

10. L 163 – 164 this works for vertical contacts; how do you deal with non-vertical edges? Or what is your argument for an assumption of only vertical contacts?: It is certain that a great part of the work is devoted to the identification of vertical contacts, but we used also Euler deconvolution to do the inventory on non-vertical edges. The focus was to delineate the structural infrastructure of the near surface of this area under study, which has many small-scale mechanized gold exploitations. These vertical contacts at the near surface could be preferred zones of gold bearing.

11. L 166 – 169 I do not understand how coupling upward continuation and tilt do what you say, the advantage of tilt is that it is not dependent of depth of sources. Could you explain better?: Salem et al.,(2007) proposed the use of tilt angle for the localization of vertical contacts. Knowing that the upward continuation operator can attenuate short wavelengths and allow to visualize long wavelengths (Henderson and Zietz, 1949), We can therefore use it for a better visualization of the behavior of contacts with depth. Thus, we have:
- Generated the TMI maps reduced to the equator and then apply upward continuation for 1 and 2 km;
- Generated the vertical contacts of these different three maps using Salem et al. (2007; 2008);
- superimposed finally the different contact maps obtained to evaluate the continuity of the sources.
By applying those principles, it is generally observed from the obtained maps that:
i- They are not identical, which could mean that the contacts situated at the near surface could be masked by those located at the subsurface or in depth;
ii- There are some vertical contacts that narrowed with depth. This could be interpreted as a sign of crustal thinning of the source of the anomaly with depth;
iii- In some places, a lateral displacement of the contact is identified. It could suggest here, a dip of the source in the concerned direction.

14. L 241 – 249 Why don't you use the IGRF as regional field?
I had never seen this method, could you provide references and/or an explanation on why you choose this technique?: We subtracted the IGRF from the TMI, to obtain the crustal field. Considering that, we want to conduct a near surface investigation for a possible mineral prospecting because our study area is the object of semi-mechanized artisanal gold mining, we generated an optimal regional using the approaches of Zeng et al. (1989), Marcel Jean et al. (2016). The approach consists in generating the maxima of the extended maps at different altitudes, then extracting a database of these points that we can then compile in the Excell software. The valid altitude for the regional map to be retained will be the one from which the curve tends towards zero.

15. L 322-326 It works only for vertical contacts: Please see clarifications given in the response for L 163-164.

16. L 524 -525 "data available upon request" is not an open science statement. Could you upload the data on an open archive (such as zenodo) or are they confidential?: The data belongs to the Project of Capacity Building for the Mining Sector (PRECASEM) of Cameroon and this project is under the Minister of Mines, Industry and Technological Development.

IV- Technical corrections

17. You use sometimes modelling (British english), and sometimes modeling (US). Please choose one: Choice is done by using US.

18. L 44 “In the last few year” and then you cite literature from 1985. Would be more accurate to reformulate that. Fig 1B I cannot see well the faults as indicated in the legend. Also, what are “tectonic lines”: L 44 all the recommendations are done. tectonic lines are red lines on the map
19. L 149 I would remove “theory” as you do not discuss the theory behind it: L 149 Done.

17. L 150 the first sentence is not understandable: L 150 – 151 Reformulations done

Reviewer2: Anonymous

1. As the only observed magnetic dataset used in this study, the original locations and intensities of the aeromagnetic data should be shown: The original data set belongs to the Ministry of Mines, Industry & Technological Development. We got the TMI maps for our use, with a condition of not sharing with a third party. We digitized them and then, got all the results that are in the present manuscript submitted for publication. We are sorry not to be able to give:

2. What are the new findings in this manuscript compared to previous studies? Is it that in this work the sub-surface tectonic structures were for the first time related to the magnetic data?: The subsurface tectonic structures are for the first time related to the magnetic data, but we can mention the fact that, some other geophysical methods are used in investigating neighbouring areas respectively in the southern part (Pepogo et al., 2018, using audiomagnetotellurics soundings, Tadjou et al., 2009 by modelling and interpreting gravity data) and the southern East part (Owono-Amougou et al., 2019). All these previous studies are cited in the sub-section 2.3. Our results are corelated to those from other geophysical studies realized in surrounding sites by using the methods cited above. Here they are:
i)-Several major families of faults were mapped. Their orientations are ENE-WSW, E-W, NW-SE, N-S with a NE-SW prevalence. The latter are predominantly sub-vertical with NW and SW dips and appear to be prospective for the future mining investigation.
ii)-The evidence of compression, folding and shearing axis, was concluded from superposition of null contours of the tilt-derivative and Euler deconvolution. The evidence of the local tectonics principally due to several deformation episodes (D1, D2 and D4) associated with NE-SW, E-W, and NW-SE events, respectively.
iii)- Depths of interpreted faults ranges from 1000 to 3400 m.
iv)- Several linear structures correlating with known mylonitic veins were identified. These are associated with the Lom faults and represent the contacts between the Lom series and the granito-gneissic rocks; we concluded the intense folding caused by senestral and dextral NE-SW and NW-SE stumps.
v)- We propose a structural model of the top of the crust (schists, gneisses, granites) that delineates principal intrusions (porphyroid granite, garnet gneiss, syenites, micaschists, Graphite and Garnet gneiss) responsible for the observed anomalies. The 2.75D modeling revealed; many faults with a depth greater than 1200 m and confirmed the observations from RTE-TMI, Tilt derivative and Euler deconvolution.
vi)- We developed lithologic profile of Betare Oya basin.

3. How to evaluate the error and role of the 2.75D modelling to obtain new regional results in this study?:
The error on our 2.75 D model is evaluated by minimizing the difference between the measured value and the theoretical curve automatically generated by the GM-SYS operator. The smaller this difference, the acceptable are the values obtained. The role of 2.75 D modeling is to bring out an imagery of the different geological layers in the subsoil, responsible of the magnetic responses obtained at the surface

We humbly hope that the clarifications and the corrections made after receiving the reviewers remarks & recommendations are satisfactory.

Your kind reaction is awaited.

Sincerely yours